University of British Columbia
Botanical Garden & Centre for Plant Research: Reimagined

Brandon Green, Jason Tam, Jeremy Jin, Kai Marder, Kevin Preston, Sam Eichenberger

University of British Columbia

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Prepared by Civil 445 Group #5: Kevin Preston

Jason Tam

Jeremy Jin

Sam Eichenberger

Brandon Green

Kai Marder

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Executive Summary

As requested by the University of British Columbia Botanical Garden and Centre for Plant Research (henceforth "the Garden"), a redevelopment plan has been prepared to improve sustainability and functionality, attract year-round visitors, and generate profit for the Garden.

Currently, the Garden operates under an unsustainable stormwater management system, which is contributing to UBC's water use problem. The root of this issue lies in the fact that the majority of the Garden's water features are supplied by potable water sourced from the regional (Metro Vancouver) water supply. Furthermore, the Garden is suffering financially from a lack of year-round visitor profit. As mentioned by the Associate Director of the Garden, Douglas Justice, the existing attractions are failing to capture the interest of a younger demographic, which has translated to a lack of funding for the garden. Accessibility issues, such as parking, will also need to be addressed if the Garden is expected to accommodate increased numbers of visitors. The redevelopment plan proposed in this report will address these problems, through incremental change, and transform the Garden into a successful year-round attraction.

Table A: Implementation order of proposed improvements

Order	Description
1	Stormwater and Irrigation
2	Improved Paths and Plaques
3	Narrowing of SW Marine Drive
4	Multipurpose Building
5	Café
6	Covered BBQ Patio
7	Lookout Tower
8	Pedestrian Bridge

Incorporating incremental change into the redevelopment plan allows for gradual progress. Implementing the proposed development projects in an order that would provide the most value to least value to the Garden will make the redevelopment feasible and sustainable.

Improvement of stormwater management is the project of priority. As mentioned previously, current stormwater management practices at the Garden are unsustainable due to its use of potable water. The proposed solution to this problem is to utilize the cattail marsh located at the eastern garden to capture and clean rain water. In order to accommodate this, the cattail marsh will need to be expanded. By addressing this issue, the Garden will also conform to UBC's values of sustainability and save water-use related costs. In addition, geotextile mesh can be installed under the Garden's pathways to convey excess rainwater to the water storage. Even though this will not increase client's profit, it will save long term costs for the University.

Improving the signage and plaques around garden displays will help promote learning within the Garden. Customers will gain an appreciation for the educational value of the plants, embodying the values of the Garden. A boardwalk at the cattail pond at the Eastern Garden will

also allow exploration into a wetland setting for students who use the pond as an educational tool. Biological samples can be collected from the pond without damage to the marsh's banks.

Narrowing SW Marine Drive will slow down traffic while providing additional parking for customers. Decreasing speeds along this highway will increase pedestrian, motorist and cyclist safety. It is being proposed that two lanes be changed to parking, which would have the benefit of accommodating 130 additional parking spaces. In order to make the Garden more accessible for customers, the frequency of the C20 Bus could be increased. These are expected to be low-medium cost solutions which can increase the accessibility of the Garden, and hence customer visits.

Following the completion of these projects, new attractions should be developed which will entice customers to visit the Garden. The main attraction being proposed would be a 2-storey multipurpose building which will mainly function as a recreational center and restaurant. This is expected to be a major anchor for a broader demographic due to general public interests for health and fitness programs. This building is intended to be built outside the main entrance so that an entrance fee is not necessary. In order to reflect the Garden's values of sustainability, all of the buildings will be built to at least LEED Gold standards.

In order to attract customers to the North Garden, a barbeque patio and café should be built. These will provide food services and a nice place for customers to relax. A covered outdoor patio located next to the Garden Pavilion would serve as an anchor for Garden visitors during the summer. The patio will showcase locally-grown produce and provide a space for social gatherings and events. Culinary sessions will also attract customers interested in developing their skills. The café at the same location will also provide a unique setting for customers.

A lookout tower, approximately 30 m high and located at the Southeast corner of the Garden would provide an anchor for the public to visit this area. By offering panoramic views of the Garden, Pacific Ocean, campus and mountains, this tower can provide customers with a rare attraction in Vancouver. This tower can also be used as a landmark for the Garden and it is capable of capturing the attention of the public passing by the area.

The final component of this redevelopment plan would be the construction of a pedestrian bridge over Southwest Marine Drive. This bridge will improve circulation of the Garden, thereby improving the overall flow of the nature walk. The bridge will be covered in plant life, creating a "living bridge". These features of the bridge will improve both the functionality and appeal of the Garden.

By implementing the upgrades mentioned in this summary, the Garden will successfully be more sustainable, generate more profit, and attract year-round customers.

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1 Introduction

1.1 Purpose and Scope

The purpose of this report is to discuss a variety of concepts for the improvement of the University of British Columbia Botanical Garden & Centre for Plant Research. Possible methods of effectively implementing the developments are also discussed. The concepts are built around three major focus areas: Increasing visitation to the Garden, improving the functionality of the Garden, and improving access to the Garden.

This ideas presented in this report are developed to a conceptual design stage only. The concepts were analyzed for feasibility, functionality and costs/benefits; however, no detailed design work was performed. The intent of this report is to list a large number of potential developments, allowing the client to choose their preferred concepts.

1.2 Description of Existing Garden

The University of British Columbia established the Botanical Garden in 1916 as a tool for research into horticulture and plant life. Building upon this initial principle, the garden has gone through many transformations since inception on its way to becoming an internationally renowned botanical garden.

The Garden currently consists of two main areas of plant life, the David C. Lam Asian Garden and the North Gardens. Each of these areas contains flora from a variety of natural habitats, with the entire garden currently maintaining a collection of approximately 8,000 different species of plants. Certain species in the collection are exclusive to the UBC garden.

The Garden also has several existing non-plant features. The North Gardens contain a small amphitheatre which is adjacent to a large open lawn. These facilities are often rented out for weddings and other events. There is also a building called the Garden Pavilion located in the North Gardens. It serves as an indoor area for events and also as a rest area for garden visitors. A maintenance yard for garden workers is also located in a fenced-off enclosure at the northwest edge of the North Gardens.

The visitor's entrance to the garden is located at the west edge of the Asian Garden and is accompanied by a small gift shop, a lookout area, and offices for garden administration. A parking lot with a capacity of 77 vehicles is also located at the west edge of the Asian Garden. Visitor attractions within the garden include an elevated

canopy walkway (run by a third party – Greenheart Conservation Company Ltd.), and a 'moon gate' rest area at the mouth of the tunnel to the North Gardens.

1.3 Design Team Bios and Qualifications

Kevin Preston, GradTech

Specialty: Project and Construction Management

Kevin is a fourth year civil engineering student at UBC. Previously, he has earned an Advanced Diploma in Civil Engineering Bridge from Camosun College, a Certificate in Advanced Project Management from Langara College, and a Diploma of Technology in Civil Engineering from British Columbia Institute of Technology. He has worked several engineering jobs in his career, most notably as a Civil Design Technologist in ISL Engineering and Land Service's Transportation Group. The majority of Kevin's experience is in the transportation and construction sectors, with a total experience of approximately 2.5 years.

Jason Tam

Specialty: Geotechnical

Jason is a fourth year civil engineering student at UBC. He has 20 months' worth of Engineering Co-op Experience. While working as an Engineering Assistant at Klohn Crippen Berger Ltd. Jason was exposed to a variety of geotechnical and water resources engineering work, such as slope stability and flood frequency analysis for mining projects. In addition, he has carried out geotechnical lab and field tests on construction sites. Jason has also worked as a Civil Engineering Student at Allnorth Consultants and as a Materials Technician at AMEC.

Brandon Green

Specialty: Transportation

Brandon is a fourth year civil engineering student at UBC. He has worked as an engineering assistant with the City of Vancouver and as a material testing technician in both the lab and field for Metro Testing Ltd. Brandon's experience is mostly in the fields of construction and design practices for roadways in urban environments.

Jeremy Jin

Specialty: Structural

Jeremy is a fourth year civil engineering student at UBC. He has worked as an engineering assistant in a steel structure project in Shanghai at Jinge Construction Ltd. He has also enrolled in a part of the real estate development planning of a residential project. Jeremy's experience is mostly in the fields of steel structures.

Sam Eichenberger, GradTech

Specialty: Hydrotechnical

Sam is a fourth year civil engineering student at UBC. Previously, he has earned an Advanced Diploma in Civil Engineering Bridge from Camosun College and a Diploma of Technology in Civil Engineering from Camosun College. He has worked as an Engineering Assistant for the Municipality of Oak Bay as well as the City of Victoria. The majority of Sam's experience is in the municipal sectors, with a total of 2 years of fieldwork.

Kai Marder

Specialty: Structural

Kai is a fourth year civil engineering student at UBC. He has also completed the UBC Engineering cooperative education program. Kai has experience with structures and construction both in an on-site project management role, and as a design consultant. Previous engineering jobs held include working as an assistant project manager at CN Rail, and as a student design engineer at both Somerset Engineering and Buckland & Taylor Ltd.

2 Problem Statement

2.1 Project Vision

The vision guiding this project is to develop the UBC Botanical Garden into a larger attraction for a broader demographic, while also improving the functionality and sustainability of the Garden.

2.2 Overview of Issues to Address

The Garden is currently facing financial issues, mainly due to the lack of visitor revenue. The existing attractions in the Garden are tailored more towards an older audience. In order to generate more profit, newer attractions will need to be targeted more towards the younger demographic while maintaining the patronage of current visitors.

In order to accommodate the desired inflow of additional visitors, infrastructural and accessibility upgrades will need to be implemented. Additionally, the Garden is also facing storm water management problems. Currently, all water features and facilities use potable water supplied by the regional water supply system. This issue needs to be amended in order to reduce UBC's environmental and economic impact and to conform to the University's values of sustainability.

The full list of potential issues and ideas as provided by the Garden is as follows:

- Attraction of visitors all year around
- Improvement of public access
- Improvement of stormwater management on campus using the physical attributes of the Garden
- Improvement of touring the visitors of the garden
- Integration of the nursery of the Gardens
- Inclusion of tender plants that need protection in the winters
- Integration of surface water to enhance the Garden
- Enhancement of teaching and research capacity across the sciences
- Improvement of visitor experience
- Adding other attractions (e.g. zip lines, rides, etc…)
- Adding tents or greenhouses
- Displaying bird habitats
- Ponds with native fish
- Cultivated plants used as food

3 Proposed Improvements

3.1 Overall Site Plan

The UBC Botanical Garden and Centre for Plant Research is located on UBC at 16th Avenue and SW Marine Drive. SW Marine Drive passes through it, while a tunnel passes under SW Marine Drive connecting the two main areas of the Garden.

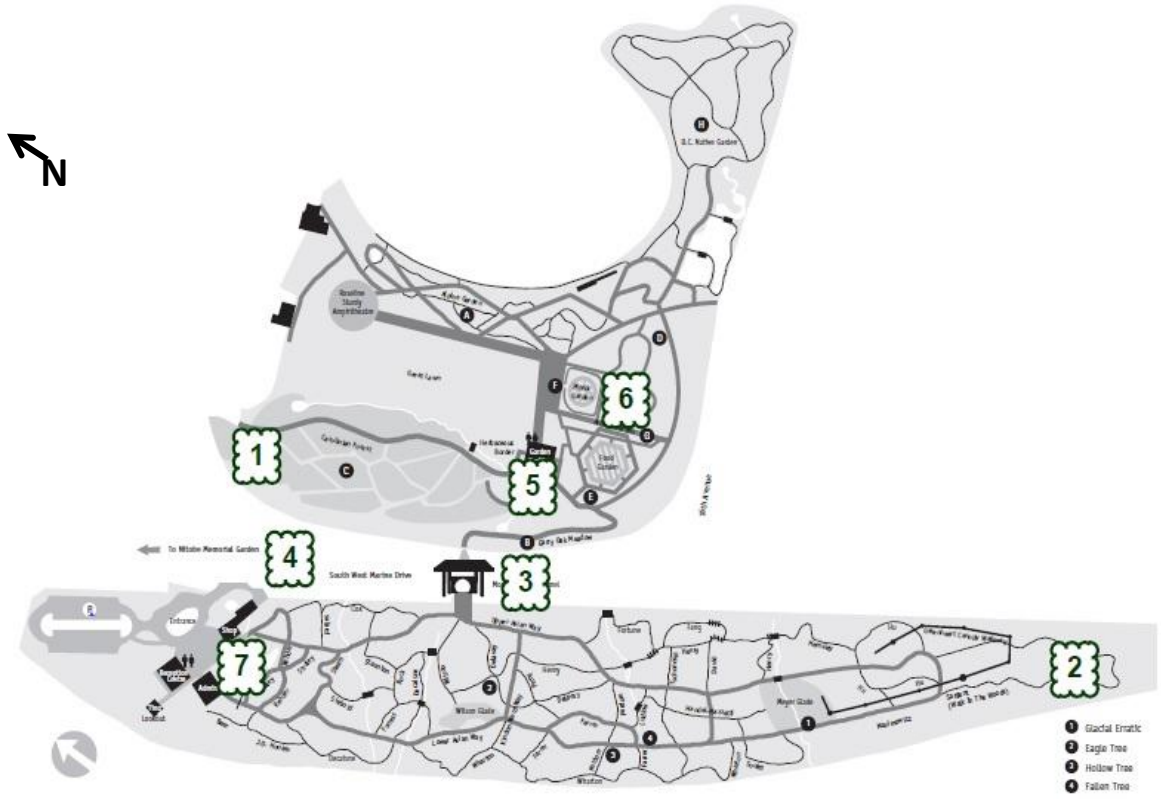

Figure 1: Site Plan of Proposed Improvements

The proposed improvements shown on the above map are as follows:

1. Multipurpose Building
2. Lookout Tower
3. Tunnel & Moon Gate Improvements
4. “Living” Pedestrian Bridge
5. Local Foods Café
6. BBQ Patio Area
7. Entrance Area Improvements

Other proposed improvements without a set location are:

- Signage, Path and Visitor Interaction Improvements
- Landscaping Improvements
- Transportation and Access Improvements
- Stormwater Management Plan

3.2 Multipurpose Building

In order to increase visitors to the Garden, it is being proposed that a multipurpose building that provides recreational and food services to the garden be incorporated into the Garden. It will be located on the west edge of the North Gardens and would provide a number of year-round attractions for garden visitors. Specifically this multipurpose building will serve as a combined social area, horticulture learning center and recreational center by providing a modern teaching space, a yoga studio, and a full restaurant. In order to reflect the Garden's values, the building will be constructed to the highest sustainability standards.

Figure 2: Rendering of Multipurpose Building

The multipurpose building will be a two storey building with three front entrances. The first floor is 10 feet high and has a concrete exterior, while the second floor is a wood structure with an outdoor patio and flagstone flooring. Large glass windows are incorporated into the design to maximize natural lighting and garden viewing opportunities. The restaurant and educational theatre/learning centre are located in the first floor while the yoga studio/fitness center is in the second floor.

3.2.1 Multipurpose Building - Restaurant

A full-size restaurant is provided in the multipurpose building for the general public, and for visitors of the Garden. Local and organic food grown in the Garden and the UBC Farm will be showcased in the menu. Considering the absence of other fine dining restaurants in the vicinity of UBC, a restaurant at the Garden will capture the interest of the local community and draw more people towards the otherwise sparsely populated area where the Garden is located. Visitors of the restaurant would also have excellent views of the Garden flora, which would increase public awareness about what the Garden has to offer.

3.2.2 Multipurpose Building - Yoga Studio

One of the key challenges the Garden is facing is the inability to attract customers from younger demographics. Considering the interest for health and fitness from today's student body, a yoga studio would entice more people to visit the Garden as a recreational center. This would be an attractive alternative to the UBC Recreation Center, located at the Bus Loop, for the residents living nearer the Garden in student housing complexes such as Marine Drive Housing. The yoga studio would also serve as a non-seasonal attraction, bringing visitors to the area year-round. By placing the multipurpose building outside the entrance of the Garden, visitors are free to use the facility without having to pay an entrance fee. The yoga studio will also provide a range of recreational programs, promote healthy living in the community, and generate profit from health and fitness program fees.

Figure 3: Possible Vine Yoga Studio Logo

The Vine Yoga Studio logo shown above is a play on words. The "vine" reflects the idea of the Gardens, but it also refers to Vinyasa yoga. The connection to the Garden could be further enhanced by including flora such as climbing vines on the walls of the studio.

Geographically, having a fitness facility at the Gardens may not be the most appealing option for students living at the west end of campus and trying to minimize their distance traveled, especially when the fitness facilities on the other side of campus tend to be closer. Because of this, the services offered at the Gardens would have to

provide a better experience than the current options in order to attract a sufficient number of customers.

The appeal of having a yoga studio at the Gardens is that the programs feature the added value of being a part of the overall Garden experience. Memberships can be bundled to include discounts at the café and shop. Fitness sessions can be held outside in the summer as well, which allows the room to be used for the bigger events such as weddings.

Part of the architecture of the multipurpose room or yoga studio is to have vines on the walls inside the room. It could have a greenhouse roof and trellis walls to provide growing space for the vines. This unique setting will also be attractive for weddings, receptions, galas, and other events.

3.2.3 Educational Room with "World's Wackiest Plants" Exhibit

A theatre that provides public education sessions, botany introduction lectures, and informative exhibits showcasing the unique flora of the botanical garden (e.g. a "World's Wackiest Plants" showcase) will attract a wider demographic who hope to learn more about the plants of the Garden. These educational programs can enhance the public knowledge of plants and biodiversity and encourage people's passion about plant research.

For example, plants in the physic garden have an inherent appeal because of their past use as medicines. As another example, many of the old trees on campus were planted by the first director of the garden, which is an interesting fact of heritage and provides links to the original botanical garden planted by him at the Riverside Mental Health Institution.

Education not only fulfills the mission of the Garden, but provides a selling feature. Education is something that the visitors crave, especially students, who are open-minded to learning about new things. The more that can be learned, the more appealing the Garden will be to new visitors and repeat visitors.

3.3 Lookout Tower

A lookout tower is being proposed in the Garden. It will allow a closer look at the canopy of the rainforest, a bird's-eye view of the ocean beyond the beach, and a spectacular view of the Garden and the rest of UBC.

Several options for placement were considered. It could be located at:

1. The southeast corner of the intersection of the entrance to the Garden, as the best place to view the entire garden
2. The south tip of the Garden as an anchor to draw visitors in that direction, and a great place to view the rainforest canopy
3. The North end of the Garden where the view of the ocean is the best

The current location being proposed is at southern tip of the Garden, which currently has no major attractions to encourage visitors to make the long walk to the farthest point from the visitor's centre. The lookout tower will draw visitors, and also offer a good view of the ocean, a close-up view of the canopy, and a decent view of the Gardens and western part of the campus.

The tower will have an observation deck that is 30 meters above the ground, rising above the canopy of the trees in the Garden. Because it's highly visible, it will attract the attention of visitors passing near the Garden, such as motorists along SW Marine Drive. The tower can be included as a stop during guided tours and also be accessible to any visitors who are roaming freely about the Garden. The tower will be built to the highest sustainability standards and utilize wood as the major building material to help maintain the peaceful, undeveloped setting deep in the Garden.

3.4 Tunnel Improvements

The tunnel crossing SW Marine Drive could be made to look more attractive by adding architectural finishings and more lighting. When it was conceived, it was intended to feature with skylights in the median to provide daylight, and possibly some texturing of the walls. Currently, the tunnel is a long, bolted, corrugated steel pipe with an asphalt floor and fluorescent lighting at points along the ceiling of the tunnel.

We propose several options for improvement:

- Install skylights at the midpoint of the tunnel to improve lighting and interest.
- Provide architectural finishing on the inside of the corrugated steel walls.
- Add additional electric lighting.

Figure 4: Existing Tunnel; the Moon Gate

With regards to the skylight option, electric lighting will still be required for when the tunnel needs to be used at night. Extra maintenance will be needed, particularly cleaning algae from the glass and cleaning spider webs from the cavity. This option requires careful excavation in the median, reinforced concrete or corrugated steel side walls, and glazing. It could be an expensive undertaking, providing scarce value compared to how much it costs. Another concern is vandalism: Broken glass is expensive to replace, especially in skylights.

Architectural finishing can provide the same value of appeal to the tunnel as the skylight option, but at a much lower cost. Possible options include wood paneling, stucco, or shotcrete. By smoothing out the corrugations with acoustical material, the tunnel will be improved both aesthetically and acoustically. Smoothing it out can provide a surface that can be painted with a mural.

Additional electric lighting can be added to the tunnel to provide a more interesting experience. Combined with the architectural finishing on the corrugated steel walls, the additional lighting would allow the improved appearance of the finishing to be fully appreciated. There are several options for lighting:

- Provide better lighting on the ceiling, shining down. Currently, the lighting is dim and sparse – the minimum lighting required to see at night. The lighting could be brighter and spaced more closely.
- Lighting could be provided on the ground, in the form of thin, glazed trenches with thick, tempered glass coverings. This type of lighting can be travelled on without breaking.
- Lighting outside the tunnel could make the ends of the tunnel feel safer.

3.5 "Living" Pedestrian Bridge

A pedestrian bridge crossing SW Marine Drive just east of Stadium Road could be constructed to enable circulation of visitors in the Garden, provide a replacement for the crosswalk across SW Marine for visitors not in the Garden, and provide an opportunity for a Garden attraction by creating a 'living' bridge. The bridge would be constructed using only one set of supports, but the ends would be split apart to separate the Garden visitors from the regular pedestrians. A barrier would be utilized in the main span of the bridge to ensure regular pedestrians could not enter the Garden.

Figure 5: Example "Living" Pedestrian Bridge

The pedestrian bridge would be designed to withstand the gravity loads due to a layer of topsoil and the plant life the Garden administration would grow on the bridge. The plant life could be used on both sides of the barrier with the added benefit of giving regular pedestrians a sample of what lies inside the Garden and thereby possibly attracting additional visitors. Constructing the bridge of aesthetically pleasing timber members would also catch the eye of pedestrians and help promote the Garden. However, this may not be feasible as timber is not the most cost-effective building material.

Advantages to the pedestrian bridge include:

- Improving the garden tour experience by providing an alternate crossing of SW Marine
- Improving safety for non-garden pedestrians wishing to cross SW Marine
- Providing space to grow attractive plant life in a highly visible location

The main disadvantage to the pedestrian bridge is that it is a large scale project that would have high initial costs. However, it should be noted that the bridge can function to display plant life and signage in a highly visible location, and therefore will be an ongoing source of advertisement for the Garden

Adding signage on the pedestrian bridge would provide raised awareness of the Garden and can be implemented very cost-effectively by adding a simple sign placed on or near the pedestrian bridge or a banner going across the bridge on both sides, serving as a welcome sign for the Garden.

3.6 Café

Providing food and drink to visitors to increase the length of their stay and the enjoyment they get from their time in the Garden is an important development for the Garden directors. The café would also bring in some revenue for the Garden and increase the quality of their experiences, making the visitors more likely to come back. A key feature of the café would be that it uses foods grown locally and organically, both in the Garden and the UBC Farm. The café can also serve as an anchor to draw visitors to the North Gardens.

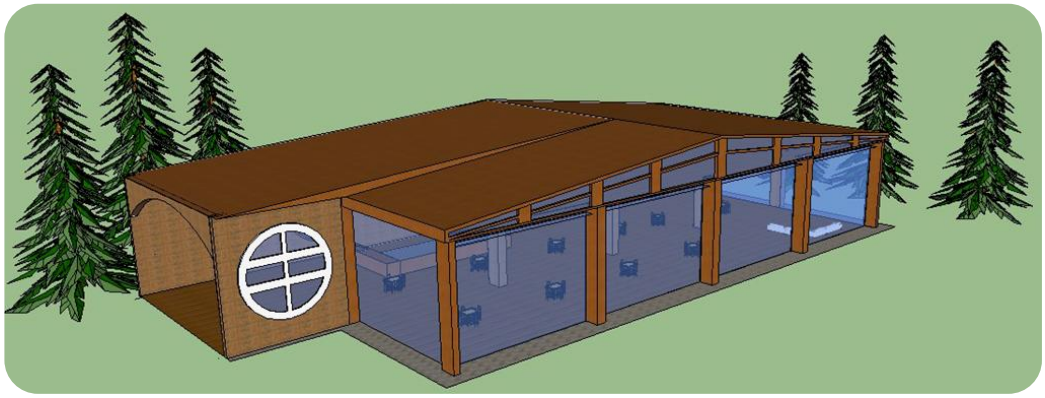

Figure 6: Rendering of "Local Foods" Cafe

Ideally, the café would look out on the Garden, and would be nestled in behind the existing Garden Pavilion facilities. This would prevent the café from being overly conspicuous while still allowing patrons to enjoy views of the Garden. Similarly to the

other proposed structures, the café would be built to the highest standards of sustainability and use wood as a primary building material.

3.7 Covered BBQ Patio

A covered barbeque patio will be constructed in the open lawn area in the North Gardens. It would serve as an anchor for Garden visitors during the summer season by providing a sheltered cooking area with all the equipment needed for family picnics and cooking events. The patio would also showcase locally grown produce and provide cooking demonstrations on how to prepare fresh garden-grown foods.

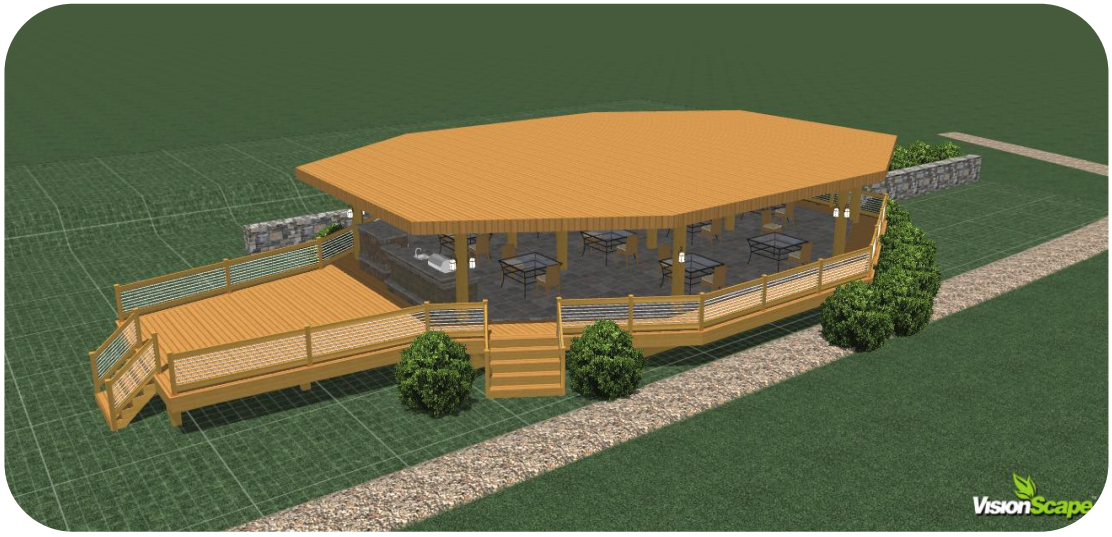

Figure 7: Rendering of the Covered BBQ Patio

This simple barbeque patio design has several advantages. It is relatively cheap and easy to construct and implement. It can be used for multiple purposes such as events, cooking lessons, and as a cozy place for social gatherings in most weather conditions.

3.8 Entrance Area Improvements

There currently exists a gift shop, seed store and small visitor centre at the entrance to the Garden. These facilities can be improved upon and expanded to appeal not only to gardeners, but to the new demographic that the Gardens is trying to attract. The shops could sell UBC Botanical Garden branded sweaters, clothing, etc... They could also sell fitness gear for the users of the new proposed yoga studio and seeds for the locally grown foods sold in the new proposed café and multipurpose building. This would promote home gardening for garden visitors and help increase the branding value of the UBC Botanical Garden.

3.9 Signage, Path and Visitor Interaction Improvements

Installing new signage and plaques that tell stories about how the plants came to be included in the garden, or interesting features and facts about the plants, can be implemented as a low-cost improvement that makes the Garden visit more interactive. There are currently some plaques existing in the garden, of several types, however they are inconspicuous and contain minimal information. New styles of signage and plaques that could be installed include:

1. QR Coded plaques. By using a QR Code scanner on a smart phone, the user can discover information about the plants in that area
2. Children-oriented informational plaques. These would have a simplistic, educational layout and engender interest in the plants for children
3. A "featured plant of the week" plaque that goes into greater detail about the plants history and origins
4. Map signage showing where the visitor is in the garden and how to get to the various garden attractions.

The existing paths in the Asian Garden are primarily made of mulch except for two main concrete paths. After rainy weather, the mulch paths can become wet and muddy and cause visitors to stick to the paved surfaces only, restricting their overall Garden experience. If the mulch paths were removed and replaced with hexagonal drainage tiles with gravel infill, the visitors would be more likely to explore the entire Garden in any weather.

The visitor experience can also be improved by creating scavenger hunts in which the visitors look for and discover information on various exotic plants within the garden. Upon entrance of the Garden, each visitor would be provided with a card showing pictures of the plants they are searching for. The scavenger hunts can be developed based on themes, such as autumn, flowers, trees, swamp life, etc... The scavenger hunts could also be seasonal, allowing for the attraction to change throughout the year.

3.10 Landscaping

3.10.1 Removal of Noise Attenuation Earth Berm

The noise attenuation earth berm installed at the NE corner of the intersection at Stadium and Marine is a noise impact mitigation structure, installed in adherence to Ministry of Transportation and Highways of BC (MOTH) policies. This policy is intended to prevent excessive noise impacts at residences and educational facilities. The berm was installed in anticipation of the traffic along SW Marine Drive exceeding MOT

limits. The traffic along SW Marine Drive, however, is usually calm and noise impact is believed to be kept well within limits.

Figure 8: Existing Noise Attenuation Berm

In order to improve the overall aesthetic appearance of the Garden, it is being proposed that the earth berm be replaced with a grass hedge. With a tolerable level of noise being generated along SW Marine Drive during busy hours, a noise attenuation earth berm would be considered a redundant structure. Its removal would not only improve the overall aesthetic of the NE Corner, it would also create more open space to accommodate additional features (e.g. washrooms).

Installation of hedges would involve excavation of the existing berm and re-grading of the ground. A hedge surrounding the NE corner of the intersection could serve as a miniature sound barrier, which would be sufficient for the traffic conditions. A decorative hedge will also create a more attractive visual effect for customers to enjoy.

The removal of the berm could indirectly generate more profit for the Garden. The extra space created as a result could be utilized for storage, or for additional attractions (e.g. plant displays). The extra space and the aesthetic appeal of a hedge could generate more customers. The presence of a hedge may also indicate to the public the existence of a garden attraction.

Figure 9: Decorative Hedge

The installation of a hedge would not be a prioritized issue because it is related to landscaping, which will not have immediate impacts on profit. Maintenance costs of a hedge would mainly come from the requirement to trim it on a scheduled basis.

3.10.2 Removal of Invasive Species

Roadways provide a major pathway for invasive species to spread. Highway vegetation, such as weeds and brush were observed to be growing along the edge of SW Marine. If not tended to, these invasive species of plants could spread further into the garden, eventually taking over the native vegetation.

In order to amend this issue, roadside vegetation management should be practiced. Maintenance of the roadside will preserve the surface while improving infiltration rates of the soil. Removal of the roadside vegetation will also improve the aesthetic appeal of the area.

3.11 Transportation and Access

The UBC Botanical Garden has identified several key issues related to transportation and access for its visitors. Currently, the majority of Garden visitors arrive by car. As a result, large events at the Garden require more parking than the current parking lot capacity. Alternatives to parking in the Garden's lot are quite restricted. A second concern is that the high speeds along SW Marine Drive are a major hazard for the pedestrian crossing at SW Marine Drive in front of the Garden.

3.11.1 Narrowing of SW Marine Drive

SW Marine Drive is currently designated by the Ministry of Transportation and Infrastructure as a highway. Traffic speeds along the stretch in front of the Gardens are extremely high. This redevelopment plan proposes that SW Marine Drive be narrowed from four lanes down to two by converting the curb lanes into regulated parking lanes. By implementing such a change, it is expected that motorist speeds would decrease, thus improving safety for motorists, cyclists, and pedestrians. This reconfiguration has been depicted in the figure below.

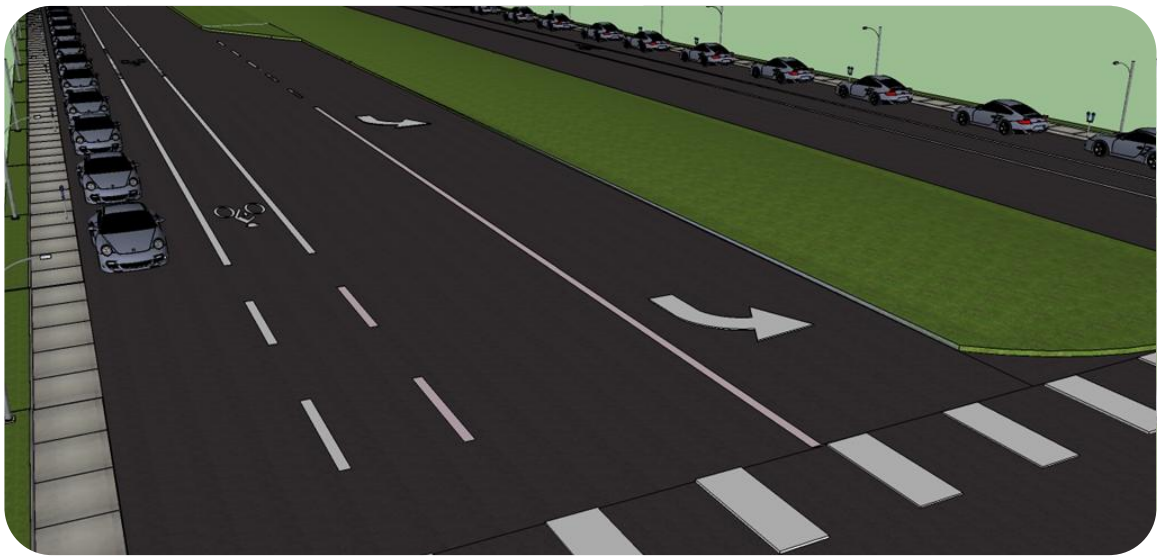

Figure 10: Rendering of a Narrowed SW Marine Drive

By converting two lanes to regulated parking, the parking capacity for the Garden would increase by approximately 130 spaces. This would drastically increase the Garden's parking capacity for its larger events. These parking spaces could be regulated either through signed parking restrictions, or parking meters. If these spaces were to be metered, negotiations regarding revenue would be required between UBC and the Ministry of Transportation and Infrastructure.

This travel lane removal, in conjunction with a reduction of the speed limit and regular enforcement, could result in significant speed reductions and increased safety for all road users. Specifically, pedestrians and cyclists would experience improved safety when travelling on, and crossing SW Marine Drive.

Additional measures that should be considered in order to improve access and safety for vulnerable road users include, but are not limited to:

- Advanced warning crosswalk lights
- Raised pedestrian crossing at Stadium Road
- Grade-separated sidewalks
- Designated cycling lanes
- Corner bulges to decrease crossing distance and improve pedestrian visibility

The proposed narrowing of SW Marine Drive would be a low-moderate cost solution to the shortage of nearby parking at the Garden. As well, the removal of travel lanes will address some of the safety concerns for vulnerable road users travelling on, or across this SW Marine Drive.

3.11.2 Changing Parking Restrictions on Old SW Marine Drive

By changing parking regulations on Old Marine Drive, or allowing for temporary event specific regulations, the Garden would be able to increase their supply of nearby parking for events drastically. Old Marine Drive has wide gravel shoulders on either side of the two-way road for the majority of its length. Its current use is mainly for beach-goers and students looking for free parking. Changes of this nature would be dependent on Ministry of Transportation and Infrastructure approval.

A similar approach would involve restricting traffic to one direction and using one lane and the wide shoulder for parallel parking. This option would improve traffic circulation through the area and significantly increase capacity for parking. This approach would involve more consideration, and likely be more difficult to implement.

Using Old Marine Drive for overflow parking is a cost effective way to increase nearby parking during large events. It requires almost no investment; the only cost is temporary signage and a permit.

In order to increase the Gardens' parking capacity, the existing parking lot could be replaced with a multi-storey parkade. UBC Parking requires that the parkade structure have the same, or smaller, footprint as the current parking lot. Due to the high cost of constructing a parkade, other more cost-effective solutions are being recommended; that is to say, the narrowing of SW Marine Drive and addition of curb parking, and the use temporary event parking on Old Marine Drive are the preferred options for implementation by the Garden.

3.11.3 Covered Bicycle Parking

The addition of covered bicycle parking is a simple approach to reducing motor vehicle parking demand, while increasing visitor capacity and encouraging sustainable transportation to the Garden. Covered bicycle parking can come in many different styles, designs, and materials, and is a cost effective solution to drastically improving accessibility for visitors using active modes of transportation.

Besides providing a weather-protected area for bicycles, there is also opportunity to improve Garden aesthetics by providing a visually attractive structure. This bicycle parking structure could potentially be used for advertisement, depending on where it is located. It is also a relatively low cost item.

3.11.4 Increase Bus Traffic to the Area

Currently, there are only a few options for taking public transit to the Garden. The first is to take the C20 from the bus stop on Student Union Boulevard. This stop is convenient for those already on campus, or those arriving at UBC's main bus loop. The bus stop nearest the Garden entrance is directly across SW Marine Drive on Stadium Road, providing a short walk to the garden. The C20 bus runs every 20 minutes during the Garden's operating hours. The second option, for those travelling west on SW Marine Drive, is to take the 43, 49, or 480 bus routes. The nearest bus stop to the garden for this option is located at the intersection of 16th Avenue and SW Marine Drive. Taking one of these buses requires a 500m walk to the garden from the bus stop.

By increasing the frequency of the C20, there is an opportunity to improve transit access to the Garden from the UBC Bus Loop. It should be noted that most people visiting the Garden from campus tend to walk directly to the Garden due to the infrequency of the C20. The pick-up locations may also be a contributing factor.

Potential rerouting of the 43, 49, and 480 such that it continues along SW Marine Drive to Stadium Road, rather than turning onto 16th Avenue, would shorten the walking distance for those travelling to the Garden along these routes. Data collection and analysis should be conducted regarding transit use by Garden visitors in order to determine the feasibility and necessity of these options.

3.11.5 Beautification of SW Marine Drive

Beautification of the grass median in front of the Garden is a great way to improve the aesthetics of the area, while increasing the presence of the Garden for people passing by. Hardy, flowering plant species can be planted along the length of the boulevard, in

conjunction with the rain garden proposed in the stormwater management section of this redevelopment plan.

3.12 Stormwater Management

Currently, the UBC Botanical Garden uses potable water in all of its facilities, including all water features in the garden and irrigation of all its plants. Approximately 4 billion litres of clean drinking water are delivered to UBC annually, with about 15% of this being dedicated to irrigation across the entire property. The potable water is supplied by the regional water supply system and wastewater is sent through the municipal infrastructure to a primary treatment plant before being released into the Strait of Georgia. UBC as a whole seeks to reduce its impact through minimizing potable water use, increasing water re-use and minimizing wastewater conveyance off-site. Upgrading the Garden's facilities to completely isolate the property from Vancouver's potable water system would be a great way to reduce the Garden's environmental impact and economic impact on the university's budget. In order to accomplish this goal, existing stormwater collected on campus will need to be stored and filtered within the Garden and used throughout for irrigation. Water features should also use the stormwater. On site wastewater treatment is also an attainable goal that should be investigated to further isolate the Garden from existing infrastructure and increase sustainability of the garden.

Vancouver's annual rainfall is approximately 1226 millimeters per year. With a campus of approximately 4.02 km^2, this amounts to nearly 5 billion litres of rainfall on campus every year. Not all of this rainfall can be captured and harvested for use in the Garden, but the potential is huge. Already the 16th Avenue storm catchment utility flows through the Garden but at the moment the conveyance system is largely underground in pipes until it daylights at the west end of the Garden's pedestrian tunnel. After this stormwater is discharged from the pipe system, it flows in a small stream through the west portion of the Garden to the cliffs where it then falls to the beach below. Not only is this water not being used for any irrigation purposes but it is also causing detrimental erosion to the streambed in the garden and to the cliffs above the beach.

Considering UBC's values of sustainability, stormwater management is a key issue of concern for UBC Botanical Garden. Collecting rainwater instead of allowing runoff through the Garden will mitigate flooding risks and erosion issues. CIRS has helped define how effective application of water collection and reuse strategies can be extremely successful on campus. The applications there have taken the water treatment some steps further than will be necessary in the Garden, including chlorination to ensure the water is acceptable for human consumption. Within the

Garden, the majority of the water will be used in surface water features and irrigation throughout the Garden.

Stormwater from the rest of campus will require treatment before it can be used for irrigation purposes. Sediments and surface contaminants such as gasoline and oil from road surfaces are commonly found in the stormwater. Necessary oil-water separators will initially remove oil and oil by-products from the stormwater, which would be extremely harmful to the plant life in the Garden if used for irrigation. Grit and sedimentation will also need to be removed from the water before it can be pumped through a pressure system and used for irrigation, as the sediment would ruin pumps and sprinkler heads throughout the system. Storing this water in a tank for the summer months will not only reduce water consumption by the Garden but it will also greatly lower the erosive power of the stream on the cliffs west of the Garden. Implementation of swales and rain gardens throughout the westernmost section of the Garden could also be used to reduce erosion and flooding events by keeping rainwater near where it falls and not allowing it to gain energy by flowing distances downhill.

3.12.1 Expansion of the Existing Cattail Marsh

Increasing the size of the cattail marsh located next to the events field in the eastern portion of the Garden will allow for treatment of stormwater collected in the 16th avenue catchment area. This natural method of contaminant scrubbing will provide adequate treatment to allow the otherwise unused water to be used for irrigation purposes throughout the Garden. As stated previously, this large volume of water currently comes into daylight just west of the moon gate and leaves the Garden over the cliffs causing detrimental erosion.

In addition to an expansion of the cattail marsh, introduction of a boardwalk through the cattails would allow for sampling stations for ecological and horticultural classes. These stations would save the edges of the cattail marsh from students destroying the weak banks and causing harm to the wetland area by walking through it. The boardwalk will also allow for Garden patrons to enjoy a closer look into the replicated wetland and further the educational experience for the average customer.

3.12.2 Rain Garden in SW Marine Drive

In order to collect stormwater runoff from the surface of SW Marine Drive, we are proposing an integrated stormwater retention facility. This facility could come in the form of a rain garden located in the center boulevard of SW Marine Drive. This garden will retain water during storms thereby preventing flooding and erosive events downstream in the western side of the Garden. This space will also improve aesthetics

of the motorway while improving visibility of the area for motorists. Plants native to watercourses and the west coast climate will be well suited for this area of display.

3.12.3 Storage Tank for Containment of Existing Streams

Research on a pair of streams near the Garden has shown that its annual flows sum to a total of 9.5 million litres, which accounts for nearly 70% of the garden's water consumption during the dry season. The Garden's cumulative potable water use has been found to be approximately 14 000 m^3 each year, with far less of this use accounted for in the wet season. Sizing of this tank will require further calculation to detail water use cycles along with stream flow cycles to determine the most effective tank size. To reduce the necessary size of the tank a more in depth irrigation scheduling system could be introduced that takes into account real time weather information from UBC. This system could calculate evapotranspiration along with recent rainfalls to determine how much irrigation is actually necessary rather than using a standard time based irrigation schedule. Design and sizing of the tank depends heavily on this calculated dry season irrigation demand. Figure 11 on the following page displays tank costs per cubic meter versus tank sizing; it is apparent that the larger the tank, the more cost-effective it is, so this will need to be taken into account when designing an appropriate tank for the Garden's needs. The costs for 1000, 2000 and 5000 m^3 tanks are summarized in the table below.

Table 1: Stormwater Storage Tank Costs

Size	1000 m^3	2000 m^3	5000 m^3
Cost	$600,000	$800,000	$1,000,000

The table above gives three points on Figure 11 (next page).

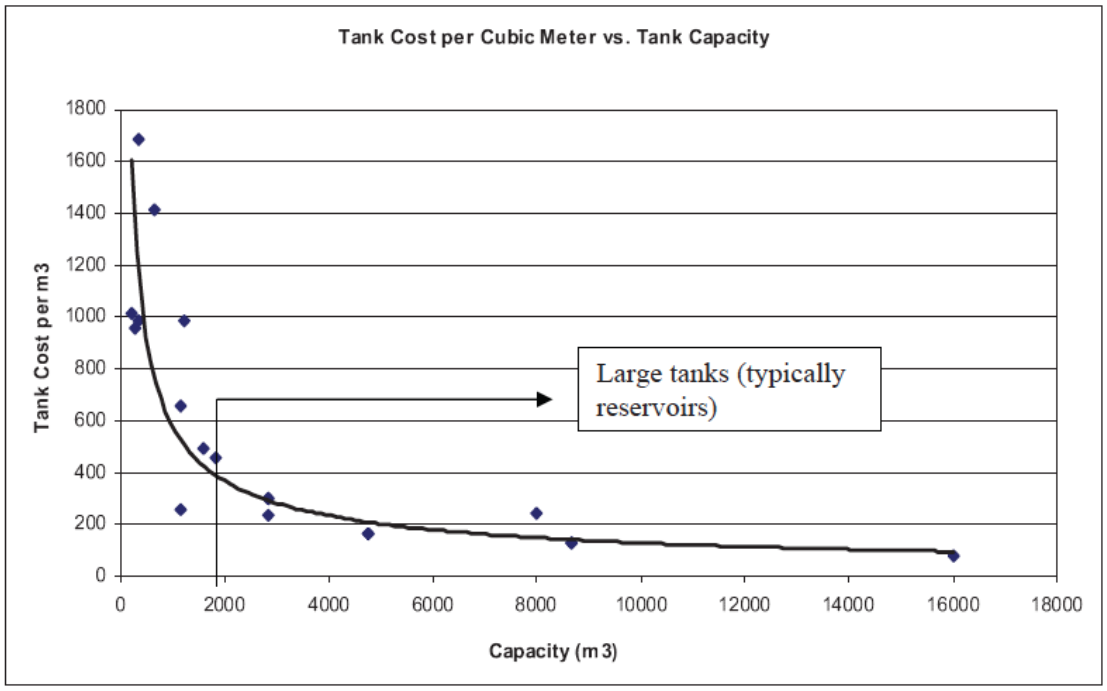

Figure 11: Stormwater Storage Tank Costs

3.12.4 Geotextile

A proposed method for obtaining uncontaminated stormwater is to use a system of honeycomb celled polypropylene panels as a stabilizing base for gravel pathways throughout the Garden. These permeable pathways can be used in conjunction with perforated pipe underlays to collect rainwater that lands on any of the paths within the Garden. There are five existing pathway surface types within the Garden and the implementation of this pathway substructure will not only provide uncontaminated stormwater for irrigation use but it will also create a more uniform look to the walkways through the Garden. This geotextile provides a durable, erosion-resistant surface that can withstand pedestrian use as well as vehicle use without developing rutting, migrating or sinking. This product has an approximate cost of $20 per square meter for materials and is simple to install. Installing perforated pipe below this permeable gravel surface would allow for the collection of uncontaminated stormwater to a low point in the Garden, where a pumping system that connects to the Garden's existing irrigation system would provide an excellent source of water that does not place any load on municipal treatment or pumping facilities.

3.12.5 Sewage Treatment

A facility similar to the Centre for Integrated Research on Sustainability (CIRS) could be introduced to the Garden in conjunction with stormwater reclamation processes to completely remove all of the Garden's facilities from the Metro Vancouver water

distribution system. This solar aquatic system is an ecologically engineered system that treats human biological waste to produce clean drinkable water. The existing system within the CIRS building is not the ideal size for a solar aquatic system of this type; it is approximately 10% the size of optimal. The Garden is an excellent candidate for a larger system that could serve as a campus wide system. This larger approach would have the added benefit of creating a resource of reclaimed water and nutrients, which would be perfect for landscape irrigation within the Garden, putting nutrients from the water back into the Garden environment and enriching its soils and plants.

4 Implementation

4.1 Implementation Plan Overview

The Garden development plan will be implemented by the principles of incremental change; namely, that small changes should happen often, and the changes should be done in the order of most value to least value, or best value-cost ratio to least value-cost ratio.

The first changes to be implemented will be the stormwater improvements. Stormwater improvements are important to UBC as a whole, and the infrastructure efficiencies will save costs over time. There is money earmarked for these improvements that can be used right away.

Next, or at the same time as the stormwater improvements, the improvements to signs, trails, and plaques should be improved. These are relatively inexpensive changes; from a financial perspective, but provide valuable benefits to the Garden visitor experience.

The next changes to implement are the changes to SW Marine Drive. The highway speeds are dangerous and inappropriate for the region. Narrowing and slowing SW Marine Drive will improve safety for everyone using the corridor, and it will also provide the parking that the Garden already needs. This change comes second because it may take time to negotiate with the BC Ministry of Transportation and Infrastructure for the land. It is possible that UBC would pay for these changes, rather than the Gardens.

After the narrowing of SW Marine Drive occurs, the parking supply will be increased and new buildings and attractions can be built. The first to be built should be the multipurpose building because it contains the restaurant and yoga studio, which have significant revenue potential, and because the multipurpose building facilitates larger events. The Garden café and covered BBQ patio would also be feasible at this stage as they are both revenue-earners with moderate total costs.

After these amenities are built, the Garden should consider whether additional attractions and features are required. If so, then it should look at building the lookout tower. While this feature does not create revenue, it would likely draw additional visitors to the garden.

Lastly, the pedestrian bridge should be considered. If high speed traffic is no longer a concern and the Garden has sufficient advertising, then it might be prudent to spend the money on something else.

Increasing the frequency of the C20 bus is not up to UBC or the Gardens. Likely, TransLink would increase the frequency after noticing an increase in demand for the route as a result of the increase in popularity and utility of the Gardens.

4.2 Cash Flow Diagrams

A series of cash flow diagrams has been prepared to represent the possible futures of the Garden as constrained by finances. In all of these models, a project budget of $1,000,000 per year was assumed. Several very rough cost estimates were also assumed, based on an order of magnitude costing, which is appropriate for this level of design. In each cash flow diagram, the order of the projects is the same, based on the implementation plan. The projects, their order, and their individual probable project budgets are summarized in the table below:

Table 2: Conceptual Cost Estimate

Order	Description	Low Cost	Probable	High Cost
1	Stormwater and Irrigation	$ 800,000.00	$ 1,000,000.00	$ 1,200,000.00
2	Improved Paths and Plaques	$ 8,000.00	$ 10,000.00	$ 12,000.00
3	Narrowing of SW Marine Drive	$ 136,000.00	$ 170,000.00	$ 204,000.00
4	Multipurpose Building	$ 8,000,000.00	$ 10,000,000.00	$ 12,000,000.00
5	Café	$ 240,000.00	$ 300,000.00	$ 360,000.00
6	Covered BBQ Patio	$ 160,000.00	$ 200,000.00	$ 240,000.00
7	Lookout Tower	$ 1,600,000.00	$ 2,000,000.00	$ 2,400,000.00
8	Pedestrian Bridge	$ 4,000,000.00	$ 5,000,000.00	$ 6,000,000.00
	TOTALS	**$ 14,944,000.00**	**$ 18,680,000.00**	**$ 22,416,000.00**

Because the projects happen in the same order for each of the following cash flow diagrams, the cost line will look the same in each one, except when there is a five year saving period for one of the projects. The list of assumptions is as follows:

1. The project budget is an annual allowance of $1,000,000, which can be saved up.
a. Exception: For one of the cash flow diagrams, a $2,000,000 budget was used.
2. Interest on debt, interest on savings, escalation, and the time value of money in general are ignored for simplicity, and to reflect that this is an order-of-magnitude level of cost estimate.
3. The costs in the table above are “order-of-magnitude” level. They are accurate only to the order of magnitude. The actual required project might cost many times more or less, depending on the specific needs of the client.

4. The Garden pays for the entirety of the project budget. We know that this will not be the case; that UBC will contribute to the projects as much as they can, and that other sources of funding may be available. For example, for the $10,000,000 multipurpose building, the Garden might only pay for $2,000,000 of it, while the rest is paid for by UBC Properties Trust, but it still shows up as $10,000,000 on the project budget.
5. The assets that make money do not provide money for the project budget.

The list above shows the most basic assumptions, which apply to the diagram below:

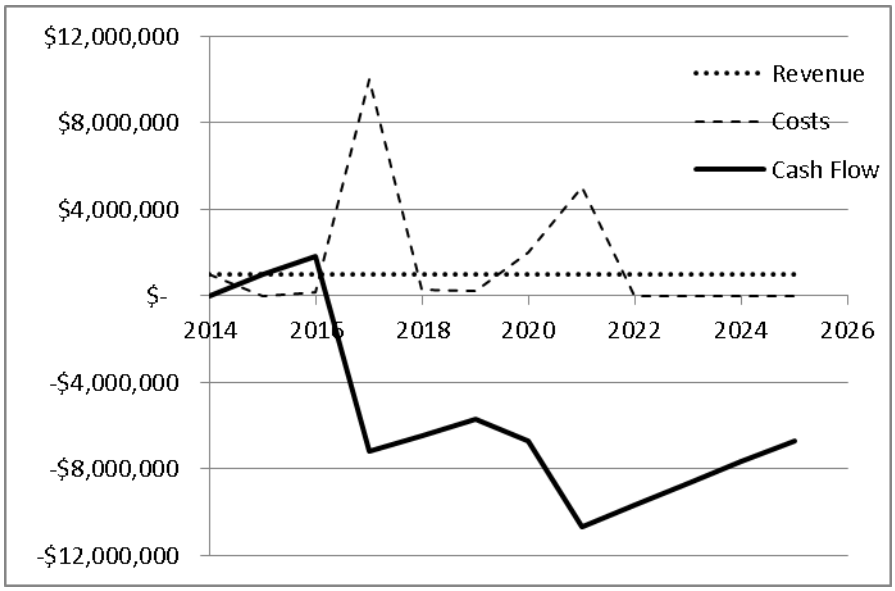

Figure 12: Cash flow diagram

The figure above shows the most basic case. Notice that even after the year 2025 the projects are not paid off. This cash flow is unfeasible, because it requires a deficit of at least $5 Million for at least ten years. The next three cash flow diagrams show various solutions o this cash flow problem.

The next diagram shows the cash flow with a $2,000,000 project budget. Doubling the budget solves the cash flow problem, but because it's the easiest and least feasible solution, other solutions are shown.

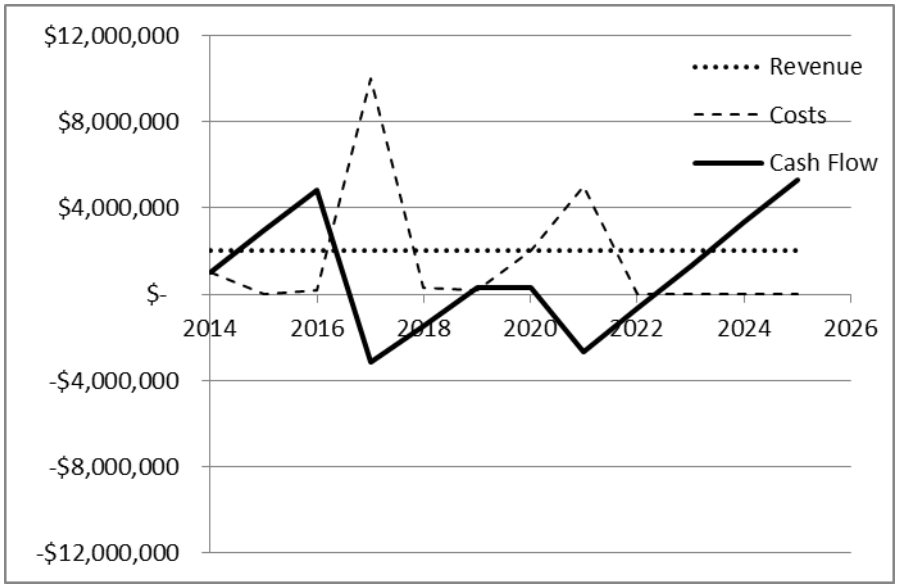

Figure 13: Cash flow diagram with the project budget doubled to $2,000,000

The next figure shows the cash flow at the $1,000,000 budget, but with a slight modification: that the multipurpose building project is delayed for five years. The delay allows the Gardens to save up a down payment of $5,000,000, but it also delays the problem of being in large amounts of debt at the end of the implementation plan.

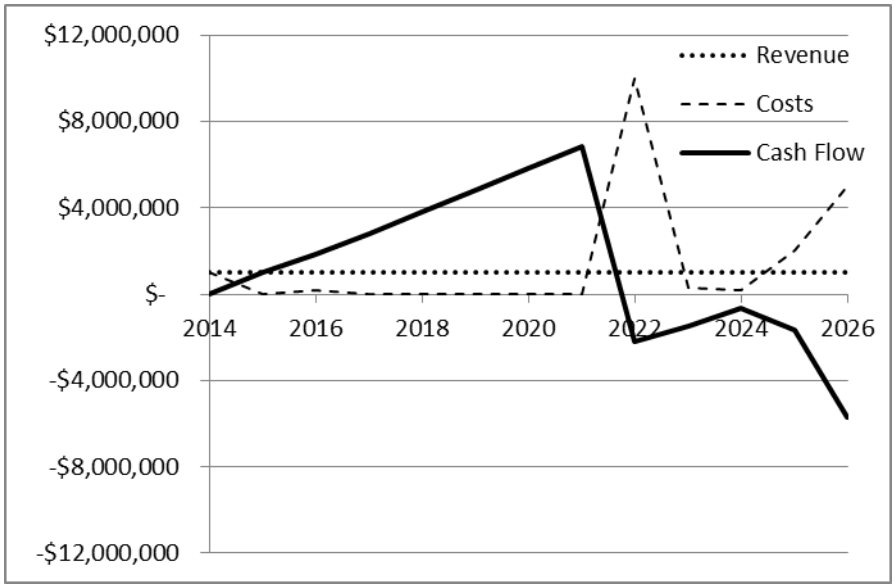

Figure 14: Cash flow diagram showing a five year delay of the multipurpose building

In the cash flow diagram above, the maximum debt is at close to $6,000,000, which only occurs if the program implements the pedestrian bridge. If the bridge is not

constructed then the maximum debt will be at nearly $2,000,000, which is a more acceptable value.

The exploration of various solutions leads to the recommended cash flow solution. In this solution, two new solutions are introduced, and one is repeated. The recommended cash flow solution uses the following three solutions:

1. Reduce the budget of the multipurpose building from $10 Million to $7 Million.
2. Remove the $5 Million pedestrian bridge from the implementation plan.
3. Institute a three year delay on the multipurpose building.

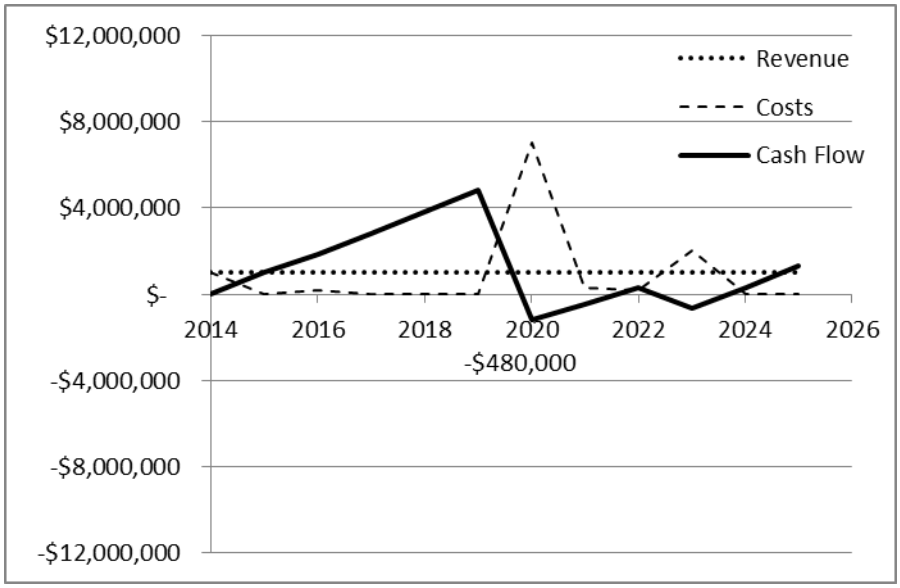

Figure 15: Cash flow diagram with a saving period, a reduction in cost for the multipurpose building, and elimination of the pedestrian bridge

It can be seen from looking at the four cash flow diagrams that the last one creates the minimum debt for the Garden. The maximum debt, shown on the diagram in the year 2020, is $480,000. The cash flow diagram is positive in 2024.

It's important to recognize that the numbers given here are very approximate. The actual costs will depend on the designs of the projects; the project budget will change year to year and is constrained by available funding; and the true financing scheme will account for the time value of money and involve mortgages and fundraising, rather than an allowance.

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