UBC Botanical Gardens Revitalization Project

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University of British Columbia

CIVL 445

November 28, 2013

CIVL 445 CAPSTONE PROJECT

UBC Botanical Gardens

Revitalization Project

CONCEPTUAL DESIGN PROPOSAL

NOVEMBER 28, 2013

PREPARED BY:

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PREPARED FOR:

UBC BOTANICAL GARDEN
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EXECUTIVE SUMMARY

Group 16 has been requested by UBC Botanical Garden to submit a concept design proposal in response to the needs identified by the Client and its stakeholders. The project proposal outlines six (6) Key Improvement Areas (IA) that have been identified for further development to address the issues from a variety of civil engineering disciplines. The following sections provide a brief illustration of the design components and considerations, justifications for design, preliminary cost analyses, and anticipated benefits delivered. Benefits have been categorized in terms of economic benefits, environmental benefits, and social/public appeal.

Our recommendations comprise of two (2) structures, two (2) transportation components, one (1) geotechnical component and one (1) drainage component.

The North Gardens Restaurant is a retrofit of the existing Education building and will feature a fully-functioning restaurant and bar open to the public and to guests participating in special events at the Garden. The Visitor Centre & Museum is a new structure which will replace the existing welcome centre and will be a multi-purpose space for admissions, shop, tours, and educational programs. Parking expansions, pathway improvements, and expansion of the water retention system have been proposed to improve overall functionality and accessibility of the garden facilities. The entrance archway and the fountain features provide aesthetic anchor points for an enhanced visitor experience.

The budget of all proposed Garden improvements is ***$1,482,300*** and includes the cost of materials, labor costs, and 35% contingency costs. Engineering design, construction mobilization, and environmental assessment costs are not included.

Table 1: Estimated Costs per Improvement Area

Improvement Area	Discipline	% Cost	Anticipated Cost	
North Gardens Restaurant	Structural	23%	$	250,000
Visitor Centre & Museum	Structural	65%	$	710,000
Entrance Improvements	Transportation/ Architectural	5%	$	54,000
Parking Expansion	Transportation	3%	$	36,000
Pathways Improvements	Geotechnical	3%	$	31,000
Water Retention System & Fountain	Drainage/ Architectural	2%	$	17,000
Subtotal			$	1,098,000
Contingency (35%)			$	384,300
Total Estimated Cost			**$**	**1,482,300**

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1 Introduction

1.1 Site Description

The UBC Botanical Gardens (UBCBG) was originally established in 1916 as a centre for education and research in botany and in 1966 moved to its present location near Thunderbird stadium. Further improvements were completed in 1990 and include the administration building, reception and shop, washrooms, lookout, and parking lot. The UBCBG is a vital part of the UBC community providing comprehensive and internationally recognized botany collections drawing researchers and the public alike to the local attraction.

All development is confined to the area bordered by SW Marine Drive and Stadium Road to the North and Old Marine Drive to the South as shown in Figure 1 below.

Figure 1: Extent of Proposed Development

1.2 Project Scope

Group 16 has been selected to submit a conceptual engineering design proposal towards the UBC Botanical Gardens Revitalization Project (Project) in response to the needs identified by the client and its stakeholders. The Project proposal is structured around key Improvement Areas (IAs) which address the issues from the perspective of the following disciplines: structural, hydrogeological, and transportation as shown in Table 2 below.

Table 2: Proposed Improvement Areas by Discipline

Improvement Area	Discipline
North Gardens Restaurant	Structural
Visitor Centre & Museum	Structural
Entrance Archway	Transportation/Architectural
Parking Expansion	Transportation
Pathways Improvements	Geotechnical
Water Retention System & Fountain	Drainage/Architectural

The scope of this proposal includes the conceptual designs for each IA including a description of key features, justifications, cost analysis and anticipated benefits delivered to the client. No detailed design has been carried out and therefore all cost analyses figures are preliminary and subject to change.

1.3 Vision Statement

The vision of the Project is to engage the scientific and public community through versatile and sustainable infrastructure, engaging informational outlets, and integrated accessibility and venue appeal.

1.4 Stakeholder Analysis

Stakeholders considered for this project include the UBC Botanical Garden managers and staff, paying visitors of the garden, botany researchers and interns, tour group and children's educational group members, UBC students, and donors to the garden. Additional stakeholders include governing jurisdictions such as the University of British Columbia, City of Vancouver, Greater Vancouver Regional District (GRVD) Parks, Ministry of Transportation (MOT), and various Environmental Agencies.

2 North Garden Restaurant

2.1 Approach

The restaurant and patio in the North Gardens was conceptualized to address the key issues identified to be most critical by the Client, namely, economic profitability, improved visitor appeal, and sustainability. Throughout the concept design phase, stakeholder needs and values were identified and expanded through site visits, plenary sessions, and direct consultation with Associate Director Douglas Justice. Several preliminary designs were envisioned and drafted using Google Sketch-up and considered for overall feasibility and potential benefits. Various options were considered with regard to location, extent of construction, and building functionality. The full restaurant and bar option, functional year round, and operated by the Garden, was selected as it provided the greatest value-to-cost ratio with justifications further described under Section 2.2. A preliminary budget was then generated to provide a better understanding of the extent of renovations required with consideration to major structural improvements including new and rehabilitated timber beams, roofing, stairways, doors and windows, and stonework.

2.2 Design Description & Justification

The proposed North Gardens restaurant concept is in keeping with the character of the Botanical Garden through its use of sustainable construction materials, integration with garden features and activities, and the versatility as a multi-functional living space located at the Garden focal point.

The existing structure shown in Figure 2 currently functions as an educational space for group tours and children's programs as needed. During the off-season, this multi-purpose space is rented out to third parties to be used for special events, generating income towards the Botanical Garden. The structure is a one-story wood frame construction building supported by concrete columns and faced with glass and wood paneling. The structure is slightly elevated off the main pathway and accessible via several staircases and ramps. The structure overlooks the Great Lawn to the North, the Food Garden to the southeast and is adjacent to SW Marine Drive to the southwest. The underground basement is utilized as storage space for various garden equipment and tools and is reachable through a separate, vehicle accessible entryway.

Figure 2: Existing Educational Centre

In selecting the best conceptual design for development, a number of options were considered including restaurant functionality, location, and construction method.

The following options for functionality were considered:

- Function A: Restaurant with bar and patio, Year round operation, Garden owned
- Function B: Restaurant with bar and patio, Seasonal Operation, Garden owned
- Function C: Café, Year round Operation, Garden owned
- Function D: Café, Seasonal Operation, Garden owned
- Function E: Franchise Restaurant, Independently owned

Functions A to D offer increased flexibility as the Garden owns and operates the establishment and has full control over the sourcing of food, revenue gains, and further expansion. Function E transfers the majority of day to day planning to the independent franchise, and will not require additional employees to be hired.

The following options for construction were considered:

- Method A: New construction following a full demolition of existing Educational Centre
- Method B: Retrofit existing Educational Centre with no expansion
- Method C: Retrofit and expansion of existing Educational Centre (Selected)
- Method D: Keep existing Educational Centre as is with restaurant built elsewhere

Function A and Method C were ultimately chosen as the best fit for the situation. The proposed structure will replace the function of the existing structure with a restaurant with outdoor patio and balcony seating and a licensed bar. Educational functions will be permanently reallocated to the Visitor Centre and Museum (See Section 3) located near the Garden entrance gates. Following assessment, it was determined that the restaurant will be able to provide services more relevant and beneficial to visitors in this area compared to the existing educational room. The restaurant will be located at a key focal point within the Garden grounds, offering an opportune resting location for all visitors from which the different regions of the Garden are visible and accessible. From here, visitors may proceed to the Alpine gardens, the Amphitheater, the Great Lawn, the Food garden, the Canopy Walkway, and other landmark locations. The

tunnel is directly adjacent to the restaurant and provides access to the south gardens and the Garden entrance.

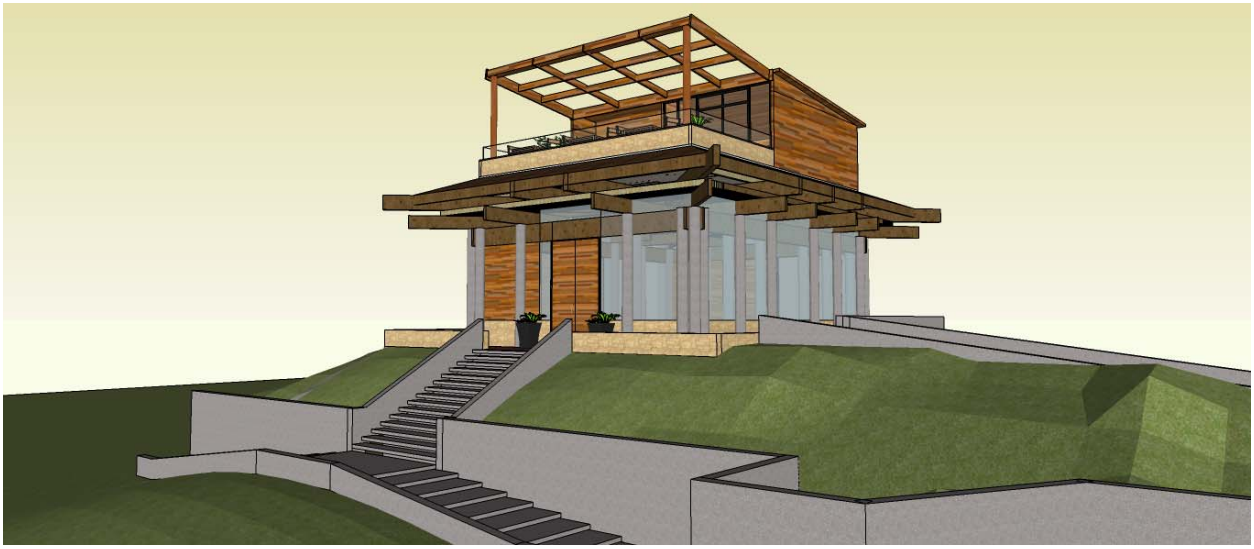

Figure 3: Proposed North Gardens Restaurant

2.2.1 Structural Framing

The proposed structure will incorporate the existing foundation and first floor of the educational centre. A visual inspection of the structure indicated that the components were in good structural condition with no observed rot or splitting in the timber members or significant cracking in the concrete members. Therefore, renovation has been selected as the most cost-effective and sustainable improvement route. Additional timber members will be installed to reinforce the roof of the first floor. The existing roof will be removed and replaced with the flooring for the second story of the building. The second floor will be constructed mainly using traditional timber framing methods for economy and ease of construction.

Where possible, similar structural members will be used to match the existing structure to enhance aesthetic uniformity. Hardwood flooring was chosen for all indoor portions of the restaurant, which will minimize maintenance and upkeep costs on a day-to-day basis as well as improve overall aesthetic appeal.

2.2.2 Building Materials

Timber was selected as the primary building material as it integrates aesthetics and strength, while providing excellent acoustic, thermal and environmental benefits. Timber is recognized universally for its ability to appeal to all senses, with its rich, warm hues and the tactile and visual appeal of grain patterning. The use of timber is widespread in theaters and auditoriums, and increasingly in more general use public buildings, as it provides an enhanced audial experience by reducing reverberation as opposed to concrete or steel. It is also a naturally insulating building material, and helps to minimize temperature fluctuations and reduce the need for artificial heating and cooling. This would result in significant cost and energy savings and will be a

major factor in determining the LEED certification for the building at the detailed design phase. (Wood Solutions, 2013)

2.2.3 Roofing

The roof will be constructed using sustainable roofing standards with regard to health and safety, reduced maintenance requirements, improved durability and ecological benefit. Roofing materials will be non-toxic and will be designed with gutters such that rainwater runoff can be effectively channeled and collected at the base of the structure. This collection point will tie into the rainwater retention system further discussed in Section 7. Roofing systems offering at least a 30 year life span will be used to reduce the likelihood of maintenance or replacement in the short term. (City of Vancouver, 2010)

The use of oriented strand board as roofing sheathing will be investigated further as it more effectively makes use of smaller sized trees and excess wood products and promotes more sustainable use of forest resources than its plywood equivalent. Wood will be required to be certified by the FSC as sustainable harvest. Underlayment and flashing will be provided as needed. (City of Vancouver, 2010)

Vancouver receives nearly 124cm of rain annually, which could be collected and utilized for landscaping in the surrounding gardens. Thus, roofing materials will be evaluated based on its suitability for rainwater collection and for durability. Asphalt shingles are most economical but will need to be selected to ensure that zinc, copper, and other toxins such as moss inhibitors have not been added. Aluminum shingles are another option which is more expensive but is more efficient in heat regulation, less toxins, and higher capacity for recycled content usage. (City of Vancouver, 2010)

2.2.4 Plumbing and HVAC

All kitchen functions will take place downstairs and a bar will be located upstairs. It is anticipated that a majority of the existing HVAC and plumbing set-up will be left in situ, with minor expansions to accommodate increased capacity.

2.2.5 Aesthetic and Serviceability Requirements

Other aesthetic and serviceability improvements may include resurfacing of the brick patio and walkway surrounding all four sides of the structure and replacement of rotting timber edging around the walkway. Some drainage chains were observed not to be functioning as intended and are marked for repairs after renovation is complete. Repainting of existing timber cladding, beams and columns will be undertaken as deemed necessary by the Client.

2.3 Cost Analysis

2.3.1 Economic justification

The cost justification for the restaurant can be broken down into the following 3 categories: Reuse of existing structure, material selection and energy efficiency.

2.3.1.1 Reuse of existing structure

The deciding factor to reuse the existing structure for the new proposed North Garden Restaurant was purely cost driven. As the entire bottom floor structure will stay intact, and the upper ceiling is made of materials that are easy to retrofit, it is more cost beneficial to build on the existing structure than to demolish the entire building. The location of the existing structure also provides costs savings in that it is located in close proximity to the pre-existing vegetable garden. This would allow employees of the restaurant to pick the vegetables daily to be used. In turn, this would reduce food and labor costs as they are utilizing food grown in the garden at close proximity to the restaurant. This would allow the restaurant to generate its own profits, and in a sense, pay for itself.

2.3.1.2 Energy efficiency

By installing a new mechanical system, the capital costs for this project will increase. However, the operation and maintenance costs will decrease over time until the building will actually provide energy cost savings. An efficient mechanical system will also provide for extra LEED credits. Moreover, by using efficient lighting fixtures and maximizing the sunlight entering the building, the operation cost for the electrical bill will decrease.

2.3.1.3 Material selection

Materials used in the construction of the upper floor are to be recycled or reused from previous buildings. This reduces the amount of new material required and lowers the building carbon footprint. Wood was selected as the primary construction material as it is less expensive, more sustainable, and more aesthetically pleasing. Overall, timber construction would have a greater benefit-to-cost ratio than steel or concrete alternatives.

2.3.2 Cost breakdown

The estimated cost of construction of the North Gardens Restaurant is summarized in Table 3 below. The total estimated cost without contingency is ***$249,730***. More detailed cost breakdowns can be found in Appendix A. Detailed unit costs for labor, materials and equipment were referenced from "Free Construction Cost Data" (b2-consultants LLC, 2013). The cost of plumbing, HVAC and electrical systems as shown below was estimated providing allowance for the design build nature of the construction process.

Table 3: Cost Estimate Summary: North Garden Restaurant

Expense Category	Estimated Cost	
General Requirements	$	22,290
Structural and Construction Costs	$	66,765
Architectural, Furnishing, Equipment & Specialties	$	19,554
Plumbing, HVAC & Electrical	$	141,121
Total Estimated Cost	$	249,730

2.4 Benefits Delivered

2.4.1 Environmental benefits – Sustainability ideals

The UBC Botanical Gardens and UBC pride themselves on striving for the highest environmental standards. By reusing the existing structure, environmental savings can range from 5-50% in comparison to new buildings with the same energy performance level, as determined using Life Cycle Assessments on new versus repurposed buildings. (The Greenest Building, 2011) Moreover, it has been proven consistently that by reusing buildings with an average level of energy performance, there are immediate climate change impact reductions possible (The Greenest Building, 2013)

The newly renovated UBC restaurant also aims for LEED Gold Standards in the category of New Construction. This will be done by installing new efficient mechanical systems, providing stormwater capture mechanisms, using grey-water and non-potable water, and using sustainable building materials. By implementing these techniques the building will be able to achieve credits in the Energy and Atmosphere, Water Efficiency, and Materials and Resources categories as outlined by the CaGBC. Moreover, by using an existing building and modifying it, the building will gain credits under the sustainable sites category in LEED.

During the conceptual design phase, Group 16 took into account passive architecture design for the overall layout of the building. This would allow the building to have gain optimum heating and cooling without using mechanical systems. To achieve this, a glass sliding door was built into the top floor with a wood overhang on top. This would allow the glass door to capture heat in when there is a lower winter sun, and shade the interior where there is a high summer sun.

Overall, all aspects of the building were considered to meet the highest sustainability standards, from the structure design itself, to choosing energy efficient interior fixtures.

2.4.2 Social benefits – Public appeal

There are many societal benefits to having a restaurant in the North Garden. Firstly, as the restaurant is located beside the vegetable garden, it was proposed the chefs would use the locally grown produce in their meal creations. This would attract visitors to visit the garden as it could become well renowned for its fresh food. Furthermore, during busy seasons, there could be live presentations and food sampling of the items grown in the garden. It would allow guests to get a feel for the range of what the garden performs and attract a younger crowd.

Moreover, the restaurant is marketed to be a small café-type venue. Members of the public visiting the garden would greatly utilize the restaurant especially during the winter season as it can act as a shelter from the cold. Hot beverages would be served as individuals could enjoy them while walking around the park, which is an added comfort.

As the restaurant is located in the North Garden, it would act as an anchor point for individuals to visit. It ensures people will want to visit, enter, and experience the North Garden.

The restaurant would also be beneficial to attract elementary schools to visit the botanical gardens. It would be attractive for potential teachers as lunches would be able to be provided

for school children, from which the garden could profit. Furthermore the restaurant showcases the vegetable garden, which is a good tool for small children to learn about agriculture.

3 Visitor's Centre & Museum

3.1 Approach

The concept for the new visitor's centre is heavily based on the consultation given by Patrick Lewis and Douglas Justice, Director and Associate Director of the UBC Botanical Garden, respectively.

From Director Lewis's presentation on the Garden, the key takeaways pertinent to the design of the visitor's centre were that the Botanical Garden is the oldest continuously operated university botanical garden and the only internationally significant botanical garden on a Canadian campus; and that the Garden reaches a limited demographic and needs to become more accessible to incorporate more public involvement.

Associate Director Justice focused on areas of improvements such as better public access and a new anchor to draw visitors that has multi-purpose functionality. The main concept pushed was 'incremental change'. The restrictions he mentioned were that any changes could not negatively impact visitor experience nor jeopardize the scientific collection.

With these considerations in mind, our group evaluated the current visitor centre and found there was major room for improvement in terms of functionality, public appeal, and could be developed as a viable anchor in the Garden.

3.2 Design Description & Justification

The proposed visitor center has been redeveloped by incorporating principal themes such as sustainability, education, and interaction into the design of the structure, complying with LEED requirements.

In the sketch below, the proposed visitor center has a much larger footprint (approx. 13 m x 27 m) than the original structure (13 m x 13 m), with many features to connect the community with the research regarding advancements in botany and horticulture. It is mainly a concrete and timber structure, as they are durable and complement each other well visually. Large glass window panels allow visitors to be immersed in the Garden environment, in addition to creating an open atmosphere within the building.

Figure 4: Visitor Centre & Museum: Exterior of structure

The increase in floor space facilitates the allocation for sections of the building to provide various functions, enabling visitors to be informed of any events and features in the Garden. The glass panels allow natural light to illuminate sections of the structure, as well as creating an open feeling inside for visitors and staff. Natural and engineered timber materials are included in various components of the building due to its clean and modern appearance, as well as providing structural support.

3.2.1 Ground floor

Walking into the entrance of the new building, visitors will be greeted by Garden staff in a circular information and admissions booth. Behind the booth and in the center of the floor, sits a large tree, growing through to the second floor of the building. Strategically placed lighting sources on the tree will provide atmospheric illumination throughout the year for both floors.

A walkway from the entrance and past the information booth will guide visitors through the center floor to the exit and into the Botanical Gardens. Upcoming events and featured research activities will be shown on large displays adjacent to glass walls looking out into a green space and driveway. Merchandise such as clothing, garden tools, and literature will be showcased in its own area, with doors leading to an enclosed space where visitors can browse through seasonal plants and flowers available for sale.

A key feature of the ground floor is the learning theatre, where Garden staff can hold presentations to small groups on any number of topics about the collections being held in the Gardens before entering the Garden area. The theatre will also be available for use by Horticulture students and faculty, and potentially private groups as well.

Figure 5: Visitor Centre & Museum: Ground floor interior

3.2.2 Second floor

On the second floor of the proposed center, visitors enter a museum-space dominated by wood and glass features. The museum immerses visitors into the rich history and background of the Botanical Garden and its role within the campus, in addition to showcasing projects conducted by past and present researchers. The museum encircles a large opening in the middle, where users can see down into the first floor and its amenities. Information boards are scattered throughout the space, in addition to small benches for users to rest.

A defining feature of the second floor is that the space can also be used as a multi-purpose facility, as the partitions defining the path through the museum can be removed and stored elsewhere in the building, creating a large open space with a certain ambiance for various functions and other events.

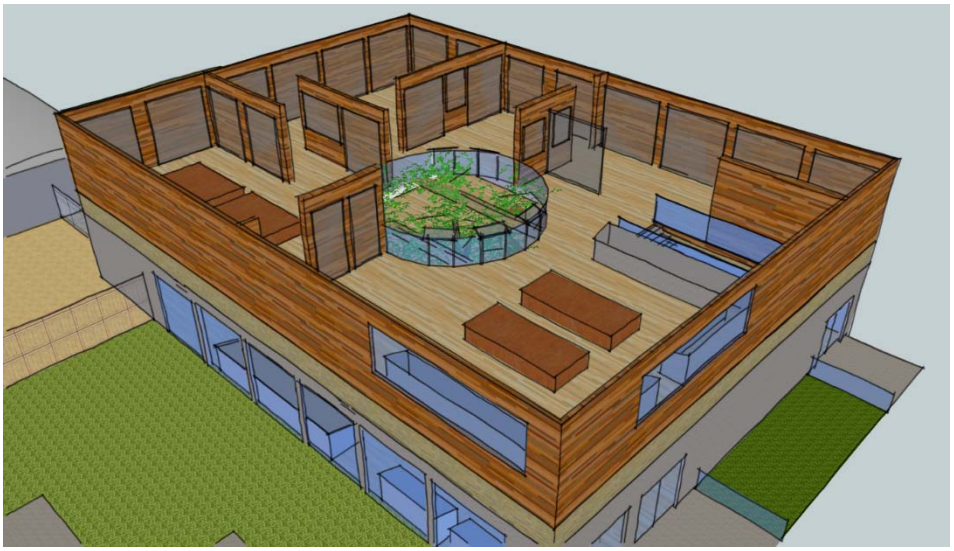

Figure 6: Visitor Centre & Museum: Second floor interior

3.2.3 Green roof

Topping off the structure is an extensive green roof using thick grass to provide a lush and sustainable method for the garden to capture stormwater and insulate the building throughout the year. Rainwater can be used within the garden to irrigate vegetation in the vicinity of the building, or can be stored for later use. The roof will be accessible to visitors by stairwell from the second floor museum, and a small walkway will lead to a cozy veranda, where a wide expanse of the surroundings can be seen from the vantage point.

The choice of an extensive green roof as opposed to an intensive green roof is due to the limited amount of space and minimal maintenance requirements. The extensive roof can be idealized and modeled during the design process and accounted for in the structural system.

3.3 Cost Analysis

Cost estimating was completed using the RSMeans Square Foot Method, which is the preferred method for conceptual stage values when little to no technical details are available. The method is derived from more than 11,200 projects which are updated yearly with new projects replacing outdated ones. The projects are located throughout the U.S. and have great variation in costs based on individual labor and material costs, as well as owner's requirements. As such, this is a rough albeit conservative estimate of the cost for the new visitors centre.

The building type selected was a country club, because the typical size is listed as 6,500 square feet, with a range between 4,500 to 15,000 gross square feet. The estimated size of the new visitors centre is 4,210 square feet, putting it closer to this range than to other building types. While another type of building might have been closer in range, such as a low-rise office building, the country club was chosen because it had a higher median cost per square foot and so gives a more conservative estimate at this early stage of preliminary design.

The median cost per square foot was then adjusted for size, location, year and contingency. The total estimated cost, without contingency is ***$710,000***.

3.4 Benefits Delivered

The proposed visitor centre addresses key areas of improvement emphasized by the Director and Associate Director of the Botanical Gardens. These areas are public access and visitorship, multi-purpose functionality and sustainable initiatives.

Public access and visitor immersion is improved by the interactive learning theatre and amenities such as the information and admissions centre, and gift shop. A major new attraction capable of drawing visitors in the off-season as well throughout the year is the new museum, showcasing the history of the Botanical Garden and its current scientific collection. Located on the second floor in a multi-functional room that can be modified for hosting private functions, the museum has the potential to be a lasting and dynamic aspect of the Gardens that is inviting to a wider demographic.

The green roof, in addition to improving the aesthetics of the building, is an economical and environmentally friendly feature that reduces surface runoff, moderates building temperatures, dampens external noises, and contributes to LEED certification.

4 Entrance Improvements

4.1 Approach

The entrance is critical in creating a first impression for visitors of the garden. Its primary purpose is to establish a sense of arrival, and express the image of the garden. One of the key issues identified in the *Botanical Garden and Centre for Horticulture Master Plan*, and also enforced by the garden's Associate Director Doug Justice, was the lack of visibility at the existing entrance to the main botanical garden (Figure 7).

Figure 7: Existing entrance area

We evaluated the existing entrance way based on aerial photos, background information presented in the CIVL 445 plenary sessions, and both a guided and self-lead site visit of the garden. The following issues and opportunities were examined to identify key focus areas for the integrated conceptual design:

- Improve visibility along Southwest Marine Drive
- Enhance sense of arrival
- Existing security and gate operation
- Improve wayfinding, signage, and lighting amenities

With the emphasis on feasibility and sustainability, our proposed entrance improvements aim at addressing the issues and opportunities identified to promote the botanical garden entrance as a defining landmark on the UBC campus.

4.2 Design Description & Justification

A clear entrance provides a focal point for the garden and also assists visitors in orienting themselves. Wayfinding is the methodology of positioning indicators to guide users to key destinations. In addition, lighting, colour, materials, and pathways play a huge part as architectural indicators.

Complying with the limitations within the garden's existing right-of-way, no modifications to Southwest Marine Drive was examined. Should there be a change in scope and extension of the study area, additional improvements along Southwest Marine Drive can be integrated with the proposed concept.

4.2.1 Wooden Archway

The garden entrance will be highlighted through architectural detailing by a grand wooden archway. An elegant and eye-catching feature, the archway will establish a distinctive sense of arrival for the entrance to the botanical garden. The proposed location, as shown in Figure 8, is situated south of the existing roundabout.

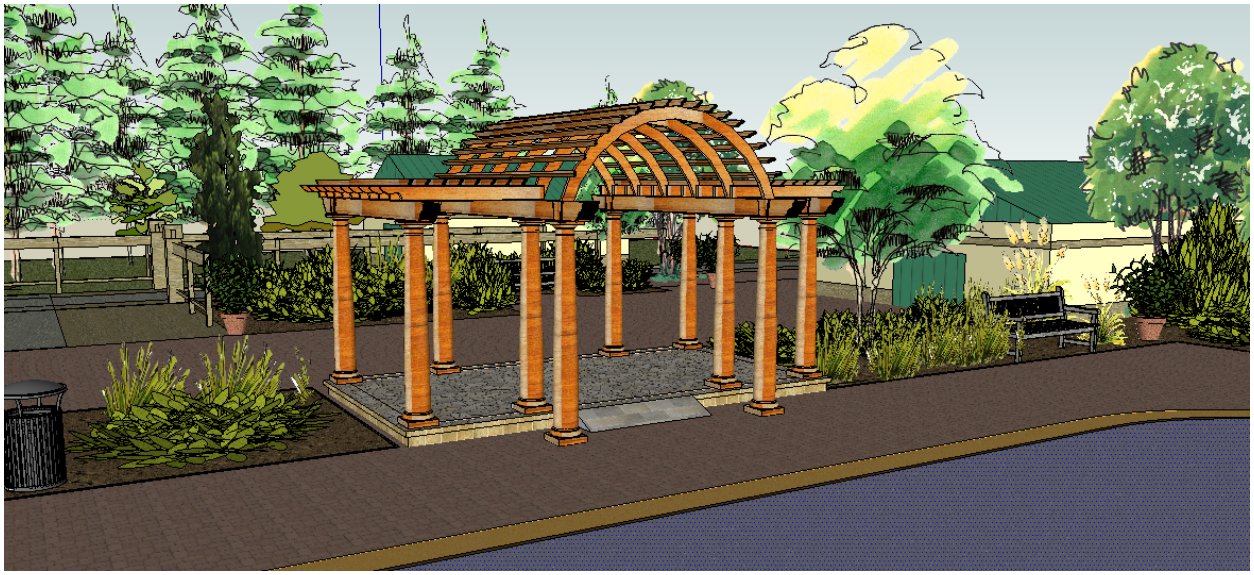

Figure 8: Proposed Wooden Archway

This position was selected over the option of spanning over the existing gate location, east of the roundabout. Although this alternate location would be directly more noticeable along Southwest Marine Drive, it would have to accommodate vehicular traffic, as opposed to only pedestrians at proposed location. The adjustment for larger vehicles, such as tour buses, would require a greater vertical clearance, and subsequently increase the cost of the archway considerably.

Focusing on the theme of sustainability, the primary material selected for the archway design is wood. Not only is wood a renewable resource, but its material properties lend to a durable, versatile, and cost effective design. The base platform beneath the archway will comprise of flagstone, with advantages in durability and climate resistance. Furthermore, the patterns on the flagstone base are more aesthetically pleasing than artificial or synthetic pavers, allowing a

unique contrast to the wooden archway columns. The platform is flush with the existing sidewalk, enabling wheelchair accessibility.

4.2.2 Mechanized Garden Gates

The main gates to the botanical garden currently require manual operation. An electric gate opener can be installed to transform the existing bi-parting gates to an automated system. Electro-mechanical equipment for entrance swing gates are recommended, as they are designed for a lower duty cycle that is not busy throughout the day. The gates will be controlled by a hand-held transmitter in the vehicle, which delivers a radio signal to a receiver box mounted adjacent to the gates.

This modification can also be applied to the service yard gates, which also requires manual operation currently. These gates are recommended to be powered by an electro-hydraulic system instead, given the higher traffic for the service yard access. The automated system will not only improve efficiency and mobility through the entrance and service yard access points, but it can also provide benefits in security.

4.2.3 Improved Signage and Wayfinding Amenities

An essential component in enhancing the visitor experience upon arrival is through improved signage and wayfinding. The proposed design involves development of the existing roundabout area, complete with featured flowers, and a new granite sign for the UBC Botanical Garden and Research Centre (Figure 9).

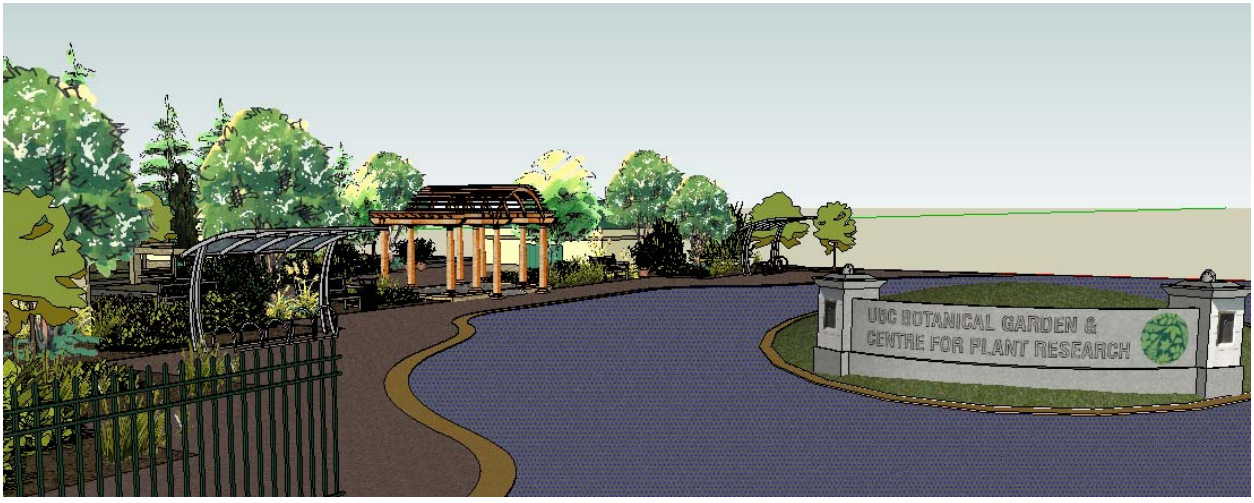

Figure 9: Looking west into conceptual garden entrance

Located past the proposed archway, a dynamic feature board will provide an overview map of the botanical garden, as well as upcoming events and showcases. Improved lighting will be installed along the paths leading to the existing shop, admission centre, and the proposed redesigned visitor's centre.

This ensemble of improvements will clearly indicate the garden's purpose and image, as well as enhance the overall attractiveness of the area.

4.3 Cost Analysis

4.3.1 Economic Justification

The package of entrance improvements work in conjunction to improve the visitor experience and garden operation. However, should the initial budget be insufficient to accommodate all of the proposed amenities, incremental implementation is an option. Improved visibility through the proposed entrance improvements will attract new and returning visitors over time.

4.3.2 Cost Breakdown

The total cost of all entrance improvements is ***$54,000***. Table 4 below summarizes the estimated cost for the various entrance improvement components. A more detailed cost breakdown is listed under Appendix A.

Table 4: Cost Estimate Summary: Entrance Improvements

Item	Cost	
Wooden Archway	$	30,000
Mechanized Garden Gates	$	4,000
Improved Signage and Wayfinding	$	20,000
Total Estimated Cost	$	54,000

4.4 Benefits Delivered

The proposed entrance improvements address key issues in visibility and identity. The world class plant collections and education opportunities in store the garden grounds required a wider outreach. Through timeless features like the proposed wooden archway, and dynamic signage, the proposed improvements will not only enhance the arrival experience, but also attract newcomers to the enticing venue. Thus, transforming the UBC Botanical Garden from a “hidden gem” to an irresistible destination.

5 Parking Expansion

5.1 Approach

Parking capacity has been a prevalent issue for the UBC Botanical Garden. As identified by the garden’s Associate Director Doug Justice, the limited on-site parking has been detrimental to the garden’s ability to attract external events.

Focusing on increasing parking capacity for all modes of transportation, our proposed parking expansion design encompasses both vehicular and bicycle traffic. Based on a self-lead site visit, a photo inventory, aerial photos of the area, and industry traffic engineering guidelines, a

conceptual design for the parking expansion was developed. Further research was carried out to examine an innovative and efficient bicycle shelter designs to upgrade the existing bicycle racks.

Equipped with an increase in parking capacity, the botanical garden will be able accommodate peak parking demands, and appropriately attract and host larger events.

5.2 Design Description & Justification

5.2.1 Vehicle Parking Expansion

Using the guidelines found in Chapter 11, "Parking: Studies, Characteristics, Facilities, and Programs" of Traffic Engineering Third Edition (Roess, 2004), design criteria were determined for the redesigned parking lot. The proposed concept involves the removal of and paving over the existing median island, transforming the parking lot into a three aisle, one-way configuration as shown in Figure 10.

Figure 10: Conceptual Layout of Reconfigured Parking Lot

A combination of dedicated small and large car space will be configured as angled parking at 75 or 45 degrees. The reduction in wall to wall parking module width allows for six rows of parking as compared to the four rows in the existing configuration. The lot redesign includes 75 small car spaces and 35 large car spaces.

Working with the limitations within the existing parking land-use, no widening into the adjacent green space, expansion above or underground was analyzed. Should there be a change in scope and extension of the study area, more radical parking design options can be studied.

5.2.2 Bicycle Parking Upgrades

The proposed innovative bicycle shelter sets to replace the conventional metal bike racks found at the garden entrance. The shelters will be located directly adjacent to the garden entrance on the south side of the existing roundabout. This gives cyclists a proximity advantage and provides

separation from the considerable traffic circulating around the roundabout. The storage capacity of the proposed design ranges up to ten bicycles, though further optimization can be examined in the functional design stage.

The weather resistant shelters are comprised of polycarbonate panels supported by a steel frame. Spaced along the roof of the shelter are solar panels, which will store and provide electricity to power the proposed lighting additions, described under the entrance improvements. The integrated design of the proposed shelters features an extension bench to supplement the available resting area at the entrance.

5.3 Cost Analysis

5.3.1 Economic Justification

The constructability of the redesigned parking lot lends to it being a cost-effective bridging solution for increasing vehicular parking capacity. The removal of the existing median and line repainting does not generate impacts to adjacent botanical garden grounds, allowing for flexibility in future expansion, should the right-of-way for parking land-use increase.

Bicycle shelters vary greatly in size, shape, and capacity. The proposed concept, with its integrated design, lands on the higher end for this kind of amenity. Should the client find that the innovative and sustainability aspects of the proposed shelters not warranted, more economically feasible alternatives can be explored.

5.3.2 Cost breakdown

The total estimated cost of all parking improvements is ***$36,000***. Table 5 below summarizes the estimated cost for the various parking improvement components. A more detailed cost breakdown complying with CSI Masterformat is listed under Appendix A.

Table 5: Cost Estimate Summary: Parking Improvements

Item	Cost	
Parking Lot Expansion	$	28,000
Bicycle Shelter Upgrade	$	8,000
Total Estimated Cost	$	36,000

5.4 Benefits Delivered

The proposed parking lot reconfiguration will increase the vehicular parking capacity by 30%. This will minimizing visitor inconvenience during periods of peak parking demand, and improve perceived occupancy for the parking lot. For special events, economic and environmental savings can be achieved through the reduction of off-site shuttling services. The increase in capacity will also improve the garden's attractiveness in hosting events by external parties, such as antique car showcases or weddings.

Showcasing an innovative design, highlighted by sustainable solar panels and bench integration, the proposed bike shelters not only delivers a weather resistant storage area for cyclists, but it also enhances the attractiveness of the garden as a cycling destination. This encourages active modes of transportation as a means of reaching the botanical garden, further promoting the university and garden's sustainability image.

6 Pathway Improvements

6.1 Approach

In an effort to further improve the garden's public appeal, it is proposed that a simple upgrade of exiting pathways be undertaken. This improvement is intended to create a more direct, and guided route through the garden, thus inducing a greater sense of "flow" to the garden. As such, the proposed improvement is to be implemented along Asian Way, the most travelled path through the South Garden. Not only will this improvement add a more natural sense of travelling through the garden, but will allow for easier wheelchair access, add to the aesthetics of the garden and will also aid in the drainage of runoff throughout the South Gardens.

Overall, in coming up with this improvement, the main goal was to achieve a simple improvement that would give the garden a greater sense of organized layout, whilst keeping with its very organic character, that is so unique to the garden.

6.2 Design Description & Justification

The design of the pathways involved simply the choosing of appropriate materials to achieve the desired results. It was determined that compacted pea gravel was the best option in reaching these goals. Pea gravel is an inexpensive and easily placed material that compacts well due to its uniformity and requires very little maintenance throughout its lifetime. It is also a proven, well draining material that aids in erosion mitigation and helps protect sensitive underlying materials, such as soil. Figure 11 below shows a rendering of what the addition of pea gravel along the pathways would look like.

Figure 11: Proposed pea gravel placement

6.3 Cost Analysis

6.3.1 Cost Analysis

The cost analysis of the pathway improvements has been based off a combination of supplier data in the local Vancouver area, for the price of pea gravel, and from the web sources, for the price of labor and placement (Home Depot & All Cost Data, 2013).

6.3.2 Economic Justification

Installation of pea gravel along the proposed route of Asian Way was found to be inexpensive and easily implemented. Thus justification was easily reached due to the far reaching benefits that this simple installation would provide.

6.3.3 Cost Breakdown

The total cost has taken into account labor and equipment that would be required for placement. The overall cost of the pathway improvement was found to be just over $30,000, with inclusion of labor and placement. A detailed cost breakdown can be found in Appendix A.

6.4 Benefits Delivered

The benefits of the proposed pathway improvement takes into account all key goals of the revitalization project; specifically environmental, social and economic benefits.

6.4.1 Environmental

The addition of pea gravel to the pathways will allow for greater drainage along slanted pathways, for the passage of rainwater runoff from the path into adjacent streams and flower beds. Added drainage also allows for greater potential for runoff collection into nearby drainage

streams, located throughout the garden, which can then be reused as part of the garden's irrigation system.

6.4.2 Economic

Pathway improvements will increase admission to the garden through the added public appeal brought on by them, as well as the broadened inclusion of those requiring wheelchair accessible routes. Furthermore, the addition of pea gravel will aid in mitigating erosion of the pathways. This means a reduction in maintenance costs of the pathways, both in the short and long term. Pea gravel is also proven to aid drainage and protect underlying materials. This means added runoff collection potential, thus working towards the garden's goal of requiring less potable water, consequently, reducing water costs.

6.4.3 Social

The pathway improvements are aimed at creating a more "visitor friendly" experience through the creation of a more fluid and defined route throughout the South Gardens. Along with the added aesthetic and practical implications of the compact gravel, the chosen material will allow access for wheelchairs, thus broadening the demographics that are accommodated by the garden. As afore mentioned, the main goal of this improvement was to implement a simple solution that would give the gardens a greater sense of organization, in competition with other botanical gardens, without compromising the organic feeling so unique to UBC Botanical Garden.

The simple addition of new material to the most travelled route in the South Gardens, Asian Way, is thought to address all these issue. By creating a more attractive location for visitor's to come and to not only enjoy the added pathway improvements, but be guided to all other attractions within the garden, the goal of social benefit has been achieved.

7 Water Retention System & Fountain

7.1 Approach

The ambition of the final proposal item is to create a retention pond, using the existing pond in the north east corner of the garden, with the ultimate goal of reducing the amount of total potable water utilized by the garden for irrigation needs, thus addressing one of UBC Botanical Garden's longest running aspirations. The pond will be lined with a geo filter fabric to assist in better retention of rainwater and runoff. A simple piping system will be connected to the base of the pond that will allow for gravity flow from the pond to adjacent areas of the garden with high watering demands, thus reducing current potable water use needs.

Some of the many advantages of water retention structures and water reuse include:

- Excellent source of water for landscape irrigation, with no chemicals such as fluoride and chlorine, and no dissolved salts and minerals from the soil
- Relatively simple to install and operate
- Promotes both water and energy conservation

- No filtration system required for landscape irrigation and watering plants/vegetables

In addition the retention pond installation, it is proposed that a fountain structure be installed within the pond in order to address the goal of public appeal.

7.2 Design Description & Justification

7.2.1 Retention Pond

A retention pond typically consists of a permanent pool along with a volume of water that is detained within it before being released. The pool's water depth can either be regulated by the natural present groundwater table or in the case of the proposed design, at a certain depth through the use of an impermeable membrane placed between the ground and the detained water. This option allows for greater retention volumes and better control of the system overall. Decisions to take into account in the design of a system of this sort include: how large to make the reuse volume, the rate of reuse, and the percentage of water to retain. A schematic of a typical retention pond used for irrigation purposes is shown in Figure 12 below.

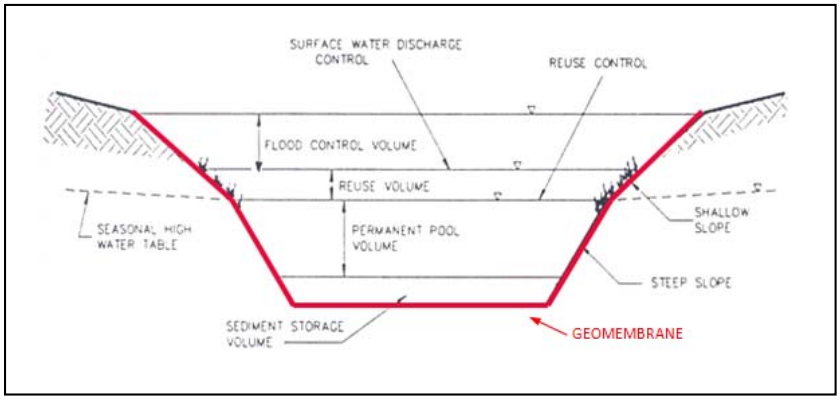

Figure 12: Typical retention pond structure (Stormwater Reuse, 2013)

The reuse volume of this system will be that of the existing pond in which the membrane is being placed. The estimated volume of this pond is approximately 77m^3.

In the case of this system, in order to maximize the amount of retained water available to the garden for watering needs, all excess water reserved by the pond will be made available for use. The rate of reuse, or the rate at which water is drawn from the pond, will be dependent on the season and amount of available rainfall, as well as evaporation rates and runoff conditions in the area.

The material of choice for the retention pond lining is geo-membrane fabric. This material is made from thin continuous polymeric sheets. Geo-membrane fabric offers high tensile strength as well as significant tear, impact, and puncture resistance. Additionally, it offers quality water retention while providing the added benefit of low costs associated with purchase, installation and minimal long term maintenance. Geo-membrane's long life expectancy also provides reduced impacts to the environment through more infrequent replacement.

7.2.2 Irrigation System

As stated by Dr. Sietan Chieng, creating new systems is often a more efficient and economical of an option versus connecting and improving current systems. The connection of the retained water flow to current water systems would involve treatment to reach similar standards. In order to avoid this, the new system will have its own piping system, linking the retention pond to adjacent water demanding areas. Specifically, the proposed design will involve a system that has outlets (for hoses, irrigation lines and sprinklers) in the current vegetable garden, the Great Lawn, and any other areas where attachment hoses are able to reach.

The breadth of the irrigation lines spanning from the retention pond was designed with cost, efficiency, and sustainability in mind. By analyzing the current layout of water lines within the north east corner of the garden, as shown in Figure 13 below, it was determined that the most cost efficient option was to lay the pipes down in a manner that would provide water to the most water demanding regions in close proximity to the pond, without overlapping with current water lines. By making the lines relatively short, but directed to regions of high demand, installation and material costs can be kept at a minimum while still satisfying a considerable amount of water demands. This choice of design will also reduce the amount of earth removal for pipe placement that will be required.

Figure 13: Current underground water services

PVC was chosen for the irrigation lines as it is a well-known and widely used material with many desirable characteristics. PVC pipes offer high chemical resistance, inherent toughness, heat resistance, and are electrically non-conductive/non-corrosive. Their material properties allow for easily placed, secure connections between other pipes, thus reducing leakage as well the potential for injury in construction applications. Additionally, they are proven to maintain quality in water (eHow, 2013).

Most notably however, is PVC's attributes of sustainability and environmental friendliness. PVC is produced from salt resin, an abundantly available resource. This type of piping also can last decades, reducing long term costs of recycling and the effects that replacement of piping would have on the environment. PVC pipes are also lightweight and can therefore be transported in greater quantities and fewer loads, thus reducing the fuel used in transportation of materials.

The proposed layout of the irrigation line spanning from the retention pond can be seen in Figure 14 below. Detailed as well is a proposed layout of micro irrigation lines to the adjacent areas of the outlet points. Drip lines used for micro irrigation are easily moveable and therefore the layout below is only a suggestion and is intended to depict the potential capabilities of the proposed system.

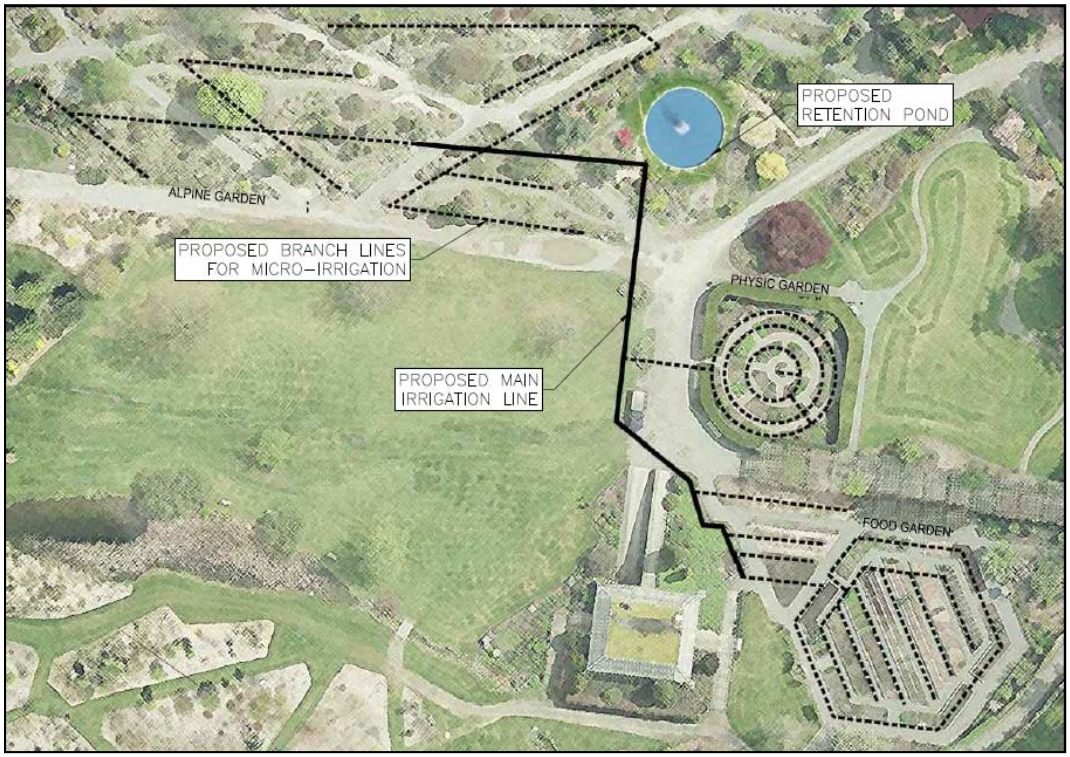

Figure 14: Proposed irrigation system

7.2.3 Fountain

Design of the fountain involved simply the choice of desired design. A fountain was then selected from a local provider, on the basis of all desired requirements being met, those being a low cost, low maintenance option with aesthetically pleasing results. The fountain system operates on a simple "on/off" basis, operated by garden personnel. Timing systems can also be incorporated into the system for automatic shut down and start up, if desired.

7.3 Cost Analysis

The cost analysis of the water retention improvements has been based off a combination of supplier data in the local Vancouver area (for the price of irrigation lines and pumps) and from

the web sources (for the price of labor, installation and geo-membrane fabric) (Home Depot & All Cost Data, 2013). The cost of the fountain structure was found through Pond Experts, a local supplier of various water related installations (Pond Experts, 2013).

7.3.1 Economic Justification

Economic justification has been analyzed separately for the retention system and for the added fountain structure.

In analyzing the costs and comparable benefits of the retention system, it was found that for the relatively inexpensive material and installation costs, huge benefits could be seen to the Garden. This was further justified by the Garden's (and UBC's) continual goal of working towards more efficient and environmentally sustainable systems. As had been presented to the group by many of the guest lecturers, a reduction in potable water use at the Garden has been a huge focus for many years and has been a driving force of many upgrade investigations that have gone under way. For these reasons, the benefits of the proposed system greatly outweigh the costs, resulting in the choice to go ahead with the proposal of this system.

The added design feature of the simple fountain structure within the existing pond was decided on based on the feeling of a need for more of a draw to that area of the garden. The cost of the fountain is nearly negligible when compared to the price of all other additions, while still providing a great amount of benefit to the overall aesthetics and draw to the area of the garden where the pond is located.

7.3.2 Cost Breakdown

Costs for the retention structure proposal have been broken down into two parts, firstly between the components of the retention mechanism and secondly, the fountain structure. The components of the retention structure have been further broken down into the material costs, ie. geo-membrane lining required, PVC piping for waterline system, pumps, and hypothetical irrigation lines that may need to be purchased in addition to those already owned by the Garden. These costs also include the cost of labor. The cost of geo-membrane has been assumed to be near equivalent to that of its common counterpart, geotextile fabric. The total cost of the retention system is ***$13,000***. The cost of each of these items is listed below in Table 6. A more detailed cost breakdown can be found in Appendix A.

Table 6: Cost Estimate Summary: Retention Pond

ITEM		TOTAL COST
Geotextile Fabric, 55 Mils Thick Non-Woven Polypropylene	$	94
Piping, water dist, PVC, schedule 40, 6"	$	10,635
Cocks & drains, 3/4" size, boiler drain, pipe thread to hose, bronze	$	81
Pump	$	1,850
Drip Irrigation Line	$	270
Total Estimated Cost	$	13,000

The cost of the fountain structure to be placed within the newly upgraded pond is approximately $1800, depending on the exact features preferred by the Garden. Installation can be performed by garden personnel and have therefore not been included in these costs.

7.4 Benefits Delivered

The benefits of the proposed retention system, along with the added fountain structure, takes into account all key goals of the revitalization project; specifically environmental, social and economic benefits.

7.4.1 Environmental

The main motivation behind the proposal of the retention pond has been the environmental benefits that it presents. This system allows for the sustainable reuse of water that is sufficient in quality for all plant watering needs. This in turn leads to the reduced use of potable water, while still meeting the high demands of the garden's vast watering needs. Overall, this addition to the North Garden increases efficiency throughout the garden in regards to water use. Furthermore, due to this system's incorporation into the existing structure of the garden, that is, using an already existing pond, extensive installation and disturbance is mitigated. A reduction in construction requirements reduces potential emissions emitted by equipment and consequently, the effects that these emissions have on the local environment.

As described in Section 7.2, material selection also took into account environmental effects. The choice of PVC piping for the water transport system was selected based on its low-impact characteristics, both in the long and short term. PVC is made from largely available resources, can last many decades, and has low transport costs and associated fuel impacts due to its lightweight properties. Geo-membrane is also a highly durable, long lasting material and exhibits minimal effects in comparison to its counterparts.

7.4.2 Economic

The economic benefits of the retention and fountain upgrades include both operational cost savings and increased profits due to higher visitor demand.

The retention structure will provide direct cost savings on water through the reduction of potable water use throughout the Botanical Garden. This is achieved through the piping system leading from the retention pond to adjacent areas of the garden, where it can be attached to irrigation lines or hoses and used as a source of water for tending to plants. This arrangement is a low cost method that will provide added water availability for maintaining plants throughout the seasons of the garden. This system is simple, inexpensive, yet has an immense impact on the efficiency of the garden, both in costs and operations.

Currently, the garden uses approximately 11,152 m^3 (or 11 million litres) of potable water for irrigation purposes throughout a given year. This is an incredibly large amount, and has been the consequence of much debate in the past years of how to tackle the costs associated with these numbers.

Considering the surface area dimensions of the proposed retention pond to be approximately 100 m^2 and average rainfall in Vancouver to be between 1200 to 1300 mm of precipitation per

year (Environment Canada, 2013), the detention pond will retain between 120,000 litres to 150,000 litres of water per year. This would aid in over 2% of the Garden's annual watering needs. Although seemingly little, this solution provides the beginning steps of long term overall reduction of potable water use at the Botanical Garden. As a long running facility, cost savings associated with this can account for up to $600 over the course of only 5 years, assuming a cost of approximately $0.80/1000L (BCMJ, 2009).

The public appeal brought on by the beautification of the pond currently present in the north east garden is ultimately intended to drive up revenues brought on by visitor numbers. This is a long term ambition that will work in conjunction with other improvements to the garden to create a more immersive and rich experience. The fountain install is, as a whole, an easy and inexpensive implementation with far reaching benefits to both the Garden and the public.

7.4.3 Social

The placement of a fountain within the retention pond structure is aimed at increasing public appeal and therefore creating social benefit to both the Garden and visitor's. This addition will provide an anchor point to the north east corner of the garden, drawing more visitors to the area and the garden altogether. It will create a more peaceful sanctuary to an already beautiful corner of the garden, greatly enhancing the overall visitor experience, by providing an area for quiet relaxation.

The addition of signs to the area with information regarding the recent upgrade of the pond to a retention system will allow the garden to showcase their core sustainability values – thus shedding positive light on both the Garden's and UBC's continual goal of up-keeping strong sustainable values, above and beyond the criteria.

8 Design Synthesis & Implementation

8.1 Synthesis

With great emphasis on public access and appeal, the proposed improvement areas have been designed with the motivation of allowing incremental change, so that the Garden can continue to function and self-improve at a sustainable rate to better engage the public and scientific community. In keeping with this goal, the proposed wayfinding and signage improvements shall feature the redesigned Visitors Centre and North Garden restaurant as key anchor points of the Garden. The parking lot expansion and upgraded bicycle shelter allows for better access throughout the Garden and can accommodate an increase in parking demand, as well as alleviate the need for shuttle service during large events. The pathway improvements integrate seamlessly with the overall additions that aid in public appeal. Leading from the newly upgraded entrance way and Visitors Centre, the pathways will guide guests through the Gardens in a naturally circular way, thus leading them to the North Gardens, where they will be greeted by the newly added restaurant. The multi-purpose functionality of the Visitors Centre allows for gradual implementation of the full facility while the Garden pursues other concurrent

improvements. The addition of the North Gardens restaurant, in conjunction with the new Visitors Centre, provides a draw for visitors throughout the year, including in the off-season.

Every key improvement area strives for the sustainability goals of the UBC Living Laboratory standards, in addition to LEED requirements. This is best exemplified by the water retention structure which will drastically reduce the need for the use of potable water in tending the Garden. The Visitors Centre has an extensive green roof with stormwater catchment capabilities, meeting the same LEED Gold standards as certain areas of the North Garden Restaurant. The upgraded bicycle shelters and entranceway bring the Garden's commitments to sustainability to the forefront of the public eye.

8.2 Implementation

8.2.1 North Garden Restaurant

The renovation of the structure is anticipated to be constructed in a single phase, requiring approximately nine (9) months to complete which will comprise of partial demolition of the existing structure, structural and mechanical retrofitting, erection of new timber framing, cladding, and post-furnishing. Materials presented in the conceptual design have been selected for local availability and ease of fabrication and transport. The anticipated construction timeline of the restaurant will not significantly hinder daily critical operations of the Gardens, though it is recommended that the facility be closed to the public during renovations. To ensure minimal conflict with the existing Garden programming and facility usage, a design bid build contract should be implemented to minimize site time and unnecessary delays.

8.2.2 Entranceway & Visitors Centre

The construction phase for the redesigned Visitors Centre and wooden archway entrance should be scheduled together to avoid access impact during two separate construction periods, and to provide a seamless integration. Lighting and signage can be implemented independently from the wooden archway; however it is recommended that these improvements all fall under the same contract, as there can be anticipated savings for the smaller areas of work. As for the electronic gate system, the implementation requires the least coordination, and can be carried out independently.

8.2.3 Parking Expansion

The parking expansion is recommended to occur during the winter season when visitor numbers are lowest, to accommodate a short closure for removal of median, repaving, and line painting. The new bicycle shelters involve off-site prefabrication and on-site installation, and therefore have minimal impact, and can be installed independently of other improvement constructions.

8.2.4 Pathways

Implementation of this new system into the current operations of the garden will be smooth, with little adjustment. No significant maintenance of the new pathways will be required and will allow for increased visitor inclusion (i.e. wheelchairs). It can be implemented early on as part of the incremental improvement efforts for public appeal.

8.2.5 Water Retention Structure

The system should be sized to meet the water demand in the dry season to support daily water consumption of the Garden. The rainfall capturing area must be large enough to maintain adequate flow and contain all captured water. All these considerations were taken into account in Section 2.2 Design and Justification.

Installation of the system will begin with pumping water out of the current pond for the installation of the geomembrane material. Concurrently, work can begin on the excavation along the proposed piping route. As stated in the design specifics, the required size of piping based on approximated volumes of retained water, water requirements, and consequent flows, will be 6". Due to the minimal size, excavation will not be intrusive to Garden's operations. In the final stage, a simple floating fountain is proposed for the centre of the pond for aesthetic appeal.

In order to minimize impacts of implementation of the new system, it is suggested that the system be installed during the down season of the garden, such as late fall or winter.

Apart from initial installation, the system will streamline current proceedings and create a more sustainable and efficient watering system within the Garden. Maintenance of the fountain is minimal. Operation of the fountain will require only the switching on and off of the fountain as desired. Timing systems can also be incorporated for automatic shut down and start up.

9 Final Recommendations

The options explored within this report have been identified and selected as the most optimal solutions for the criterion specified by the Client. The key design concept behind these improvements is incremental change, that is, small augmentations to the facilities within the Garden over a period of time that eventually culminates into a fiscally responsible and sustainable end product. The various improvement areas range in a number of characteristics such as scale, cost, and visual appeal. Using these methods to determine the features that would be included in the proposal incorporates both the vision of the Garden, and the creativity of the team.

After thorough investigation and preliminary analysis, the options put forth by the team within the report is thereby recommended for UBCBG to consider and explore in their endeavour to improve the Botanical Garden as a whole, as well as their place within the UBC community and campus. These options are recognized as having the greatest potential to increase the amount of visitor traffic throughout the year. They have been designed to foster an active learning environment that engages the campus community through the use of versatile and sustainable infrastructure, captivating exhibits and information outlets, integrated through enhanced accessibility and venue appeal.

10 References

b2-consultants LLC. "All Cost's Free Construction Cost Data." Free Construction Cost Data. b2-Consultants LLC, n.d. Web. 06 Nov 2013. <http://www.allcostdata.info/browse.html>.

"Bottled Vs. Tap Water." BC Medical Journal (2009): Web. Nov. 2013. <http://www.bcmj.org/council- health-promotion/bottled-vs-tap-water>.

City of Vancouver. City of Vancouver. Vancouver Green Capital. *Roofing: green home renovation, healthy homes for a healthy environment*. 2010. Web. <http://vancouver.ca/files/cov/green-roofing-guide.pdf>.

Durante Kreuk Ltd; Catherine Berris Associates Inc. (2001). Botanical Garden and Centre for Horticulture Master Plan. Vancouver.

"Floating Fountain Feature." Pond Experts. Web. Nov. 2013. <http://www.pondexperts.ca/products-koi- pond/#!/~/product/category=624309&id=2854428>.

"Pea Gravel." Home Depot. Web. Nov. 2013. <http://www.homedepot.ca/product/pea-gravel- 3-8-30kg/984853>.

Roess, R. P., & McShane, W. R. (2004). Chapter 11 Parking Studies, Charcteristics, Facilities, and Programs. In Traffic Engineering (pp. 277 - 283). Pearson Education.

"Vancouver Annual Rainfall." Environment Canada (2013): Web. Nov. 2013. <http://weather.gc.ca/index_e.html>.

Wanielista, Marty. "Stormwater Reuse." University of Central Florida (2013): 1-5. Print.

"What Are the Benefits of PVC Pipe?" EHow. Web. Nov. 2013. <http://www.ehow.com/about_5095877_benefits-pvc-pipe.html>.

Wood Solutions. "Recycled Timber, Wood in Eco Friendly & Energy Efficient Homes - Why Wood."*Wood Solutions*. N.p., n.d. Web. 12 Nov 2013. <http://www.woodsolutions.com.au/Why-Wood/Aesthetic-appeal>.

Appendix A – Cost Estimates

PRELIMINARY CONSTRUCTION BUDGET
UBC BOTANICAL GARDENS - NORTH GARDENS RESTAURANT

DIVISION 1	GENERAL REQUIREMENTS				
011000	*GENERAL REQUIREMENTS*				
ITEM	*AMOUNT*	*UNIT*	*UNIT COST*	*TOTAL COST*	*COMMENTS*
General Requirements	1	ea	$ 18,540 00	$ 18,540 00	Prices Estimated As Per Construction Cost Data Website
General Cleaning & Site Cleanliness	1	ea	$ 3,500 00	$ 3,500 00	Prices Estimated As Per Construction Cost Data Website
Project Insurance	1	ea	$ 250 00	$ 250 00	Prices Estimated As Per Construction Cost Data Website
TOTAL GENERAL REQUIREMENTS BUDGET				$ 22,290 00	
DIVISION 2	EXISTING CONDITIONS				
ITEM	*AMOUNT*	*UNIT*	*UNIT COST*	*TOTAL COST*	*COMMENTS*
024000	*SELECTIVE DEMOLTION*				
Demolish Existing Roof System	12 7	sm	$ 90 85	$ 12,414 83	
Demolish Existing Floor Finishes	12 7	sm	$ 0 82	$ 112 05	
Demolish Existing Interior Partitions (8 Walls)	57 6	m	$ 7 83	$ 4,852 85	As Per Design Drawings
TOTAL DEMOLITION BUDGET				$ 17,379 73	
DIVISION 3	CONCRETE				
ITEM	*AMOUNT*	*UNIT*	*UNIT COST*	*TOTAL COST*	*COMMENTS*
030000	*CONCRETE CAST IN PLACE*				
Upper Floor Slab	12 7	m cu	$ 10 79	$ 4,838 64	Assume Thickness of175mm, Cementuous Desk, Lightweight
Upper Floor Half Wall (Concrete) Running Around Exterior	1	m cu	$ 5 52	$ 194 91	Account for 15 % waste concrete
Upper Floor Columns	3	m cu	$ 5 52	$ 584 73	Price Based On Three Columns Depending On Design
Account For Concrete Repair On Initial Structure	N A	-	-	$ 2,000 00	Allow for $ Worth of Repairs (Estimate)
TOTAL CONCRETE BUDGET				$ 7,618 28	
DIVISION 4	MASONRY				
ITEM	*AMOUNT*	*UNIT*	*UNIT COST*	*TOTAL COST*	*COMMENTS*
040000	*MASONRY FINISHES*				
NOT IN SCOPE OF PROJECT					
DIVISON 6	WOOD, PLASTICS, AND COMPOSITES				
ITEM	*AMOUNT*	*UNIT*	*UNIT COST*	*TOTAL COST*	*COMMENTS*
061500	*WOOD DECKING*				
Exterior Wood Wall (Upper Floor Deck)	44 5	sm	$ 1 18	$ 560 28	Walls assumed to be 100 mm
Interior Partition Wood Wall (Upper Floor Deck)	7	sm	$ 1 18	$ 88 13	Walls assumed to be 100 mm
Upper Floor Roof (Panel 1)	42	sm	$ 1 38	$ 618 43	Roof Panel Thickness assumed to be 100 mm
Upper Floor Roof (panel 2)	25	sm	$ 1 38	$ 368 12	Uses Cost For Strl Plywood on Roof 5/8" Thick
Addition Structural Wood Beams (10m Long Plam)	3	ea	$ 21 79	$ 6,974 98	Cost Based On 3'x14'Gluelam Wood Beams
Addition Structural Wood Beams (8m Long Plam)	3	ea	$ 21 79	$ 5,579 98	
062000	*CASEWORK/MILLWORK*				
Upper Floor Bar Countertop	3 5	sm	$ 131 62	$ 460 67	Thickness assumed to be 400mm, Price Based On 2 Cab, 2 Drawer
Upper Floor Half Wall	2 5	sm	$ 131 63	$ 329 08	Walls assumed to be 100 mm
Upper Floor Bar Countertop	2 5	sm	$ 154 52	$ 386 30	Corian Countertop
First Floor Custom Front Lobby Hostessing Podium	1	ea	$ 701 68	$ 701 68	Assume Vanity Base, 2 Door Pricing
Kitchen Cabinets and Pantry Construction	10	sm	$ 56 20	$ 5,996 54	Assume top and bottom countertops
064300	*WOOD STAIRCASE*				
Exterior Wood Staircase	1	ea	$ 40 71	$ 407 10	As Per Design Drawings - Assume 10 ft staircase
TOTAL WOOD BUDGET				$ 22,471 29	
DIVISON 7	THERMAL AND MOISTURE PRODUCTION				
070000	*MASONRY FINISHES*				
NOT IN SCOPE OF PROJECT					
DIVISON 8	OPENINGS				
ITEM	*AMOUNT*	*UNIT*	*UNIT COST*	*TOTAL COST*	*COMMENTS*
081000	*DOORS & FRAMES*				
Exterior Wooden EntranceDouble Doors Painted Finish (First Floor)	2	ea	$ 281 21	$ 562 42	Patio Side and Entrance Side, 3'-4"x6'-8"/7'-0"
Rodeo Style Door (Kitchen Entrance)	1	ea	$ 988 33	$ 988 33	2'-4"x7'-0"x1-3/4"
Hollow Metal Frames As Per Design	2	ea	$ 161 94	$ 323 88	Assume Steel Frame Costing
085000	*WINDOWS*				
NOT IN SCOPE OF PROJECT					*All Exterior Windows To Remain In Current Condition.*
087000	*HARDWARE*				
Schlage D Pulls	2	ea	$ 65 22	$ 130 44	Push-pull, pull plate, 050" thick, 4" x 16"
088000	*GLAZING*				
Upper Floor Sliding Doors (1)	1	ea	$ 50 59	$ 539 80	Glass sliding, 6' W, premium, 5/8" tempered insul glass, al
Upper Floor Glazing Panels (2 short)	1	sm	$ 75 34	$ 803 88	As Per Design Drawings
Upper Floor Glazing Panels (1 long)	1	sm	$ 75 34	$ 803 88	As Per Design Drawings
TOTAL OPENINGS BUDGET				$ 4,152 62	
DIVISION 9	FINISHES				
ITEM	*AMOUNT*	*UNIT*	*UNIT COST*	*TOTAL COST*	*COMMENTS*
092000	*PLASTER & GYPSUM BOARD*				
Insulated Interior Partition Walls	14 58	sm	$ 13 29	$ 2,067 51	Walls separate Kitchen from dining area
093000	*TILING*				
Porcelain Washroom Floor & Wall Tiles	10	sm	$ 12 93	$ 1,379 63	
Ceramic Kitchen Tiles	7 24	sm	$ 10 82	$ 835 85	Ceramic tile, face mounted, 1" x 1", cem bed, cush edge
095000	*ACOUSTICAL CEILING*				
New T-Bar Ceiling Tile	12 7	sm	$ 10 90	$ 138 43	Clg tile, stpld/spnsn, fiberglass, 12" x 12" x 5/8" thick
New T-Bar Ceiling Grid	17 7	sm	incl	incl	
All Drywall Patch & Repair	1	ea	$ 2,000 00	$ 2,000 00	Allow for $2000 of existing patch & repair
096000	*FLOORING*				
First Floor - Hardware Flooring	12 5	ea	$ 25 85	$ 3,447 74	Wood, resil wd gym flush, 2 ply sub fl & steel spring system, 25/32"thk

Upper Floor - All Weather Terrain Flooring	12 5	ea	$ 25 85	$ 3,447 74	
097000 WALL FINISHES					
Repaint First Floor Walls & Columns	64	sm	$ 1 21	$ 826 28	
Patch & Repair All Damaged Paint	1	ea	$ 1,000 00	$ 1,000 00	Allow for $3000 for patch & repair
TOTAL FINISHES BUDGET				$ 15,143 19	
DIVISION 10 SPECIALTIES					
ITEM	*AMOUNT*	*UNIT*	*UNIT COST*	*TOTAL COST*	*COMMENTS*
101400 SIGNAGE					
Custom Signage For Restaurant	1	ea	-	$ 5,000 00	*To Be Located Near Food Garden Beside Restaurant, Given Allowance as Price May Vary*
102200 TOILET PARTITIONS					
New Toilet Partitions For First Floor Washrooms	2	ea	$ 1,569 87	$ 3,139 74	New Partitions In Washroom
102800 TOILET, BATH AND LAUNDRY ACCESSORIES					
Toilet Paper Dispenser	4	ea	$ 63 20	$ 252 80	
Soap and Grab Bar	2	ea	$ 104 20	$ 208 40	
Garbage Cans	2	ea	$ 35 00	$ 70 00	Price from Home Depot
Xcelerator Hand Dryers	2	ea	$ 736 89	$ 1,473 78	*More sustainable option than paper towel dispensers*
Mirrors	2	ea	$ 107 11	$ 214 22	
104400 FIRE PROTECTION SPECIALTIES					
Fire Extinguishers	2	ea	$ 225 39	$ 450 78	*Assuming one per floor, 10 lbs.*
TOTAL SPECIALTIES BUDGET				$ 10,809 72	
DIVISION 11 EQUIPMENT					
ITEM	*AMOUNT*	*UNIT*	*UNIT COST*	*TOTAL COST*	*COMMENTS*
114000 FOOD SERVICE EQUIPMENT					
Industrial Refrigerator - Lower Floor Kitchen	1	ea	$ 3,794 16	$ 3,794 16	Price Includes Compact Kitchen Set (Fridge, Stovetop etc)
Industrial Stovetop/Oven - Lower Floor Kitchen	1	ea	incl	incl	
Industrial Deep Fryer (Lower Floor Kitchen)	1	ea	incl	incl	
Allow For Miscellaneous Kitchen Equipment	1	ea	incl	incl	
TOTAL EQUIPMENT BUDGET				$ 3,794 16	
DIVISION 12 FURNISHINGS					
ITEM	*AMOUNT*	*UNIT*	*UNIT COST*	*TOTAL COST*	*COMMENTS*
122000 WINDOW COVERINGS					
Blinds (Window Coverings For Lower Floor)	16	ea	$ 11 56	$ 1,156 00	Assume 100 Square Feet of Blinds
125000 FURNITURE					
Dining Booths (Lower Floor)	6	ea	-	-	Price to be determined by clients preference of furniture
Upper Floor Table (2 seater)	3	ea	-	-	Price to be determined by clients preference of furniture
Upper Floor Table (4 seater)	3	ea	-	-	Price to be determined by clients preference of furniture
Upper Floor Table (6 seater)	1	ea	-	-	Price to be determined by clients preference of furniture
Wooden Patio Chairs	24	ea	-	-	Price to be determined by clients preference of furniture
Wooden Bar Stools	6	ea	-	-	Price to be determined by clients preference of furniture
TOTAL FURNISHINGS BUDGET				$ 1,156 00	
DIVISION 21 FIRE SUPPRESSION SYSTEMS					
ITEM	*AMOUNT*	*UNIT*	*UNIT COST*	*TOTAL COST*	*COMMENTS*
211000 WATER BASED FIRE SUPPRESSION SYSTEMS					
Install Fire Suppression System To Bring Building Up To Code (Lower Floor)	1	ea	$ 237 17	$ 3,794 72	Assume 10 Sprinkler Heads (To be Safe)
TOTAL SPRINKLER BUDGET				$ 3,794 72	
DIVISION 22 PLUMBING					
ITEM	*AMOUNT*	*UNIT*	*UNIT COST*	*TOTAL COST*	*COMMENTS*
221000 PLUMBING PIPES & PUMPS					
Plumbing for Air Conditioning/Heating System	1	ea	$ 20,000 00	$ 20,000 00	Design-Build Plumbing - Allowance Given (Approximate)
Plumbing for Upper Floor Bar	1	ea	$ 15,000 00	$ 15,000 00	Design-Build Plumbing - Allowance Given (Approximate)
Plumbing for Lower Floor Kitchen	1	ea	$ 15,000 00	$ 15,000 00	Design-Build Plumbing - Allowance Given (Approximate)
223000 PLUMBING FIXTURES					
Ice Dispenser	1	ea	$ 287 29	$ 287 29	
Upper Floor Bar Sink	1	ea	$ 416 96	$ 416 96	
Upper Floor Kitchen Sink	1	ea	$ 416 96	$ 416 96	
TOTAL PLUMBING BUDGET				$ 51,121 21	
DIVISION 23 HVAC - HEATING, AIR CONDITIONING & VENTILATION					
ITEM	*AMOUNT*	*UNIT*	*UNIT COST*	*TOTAL COST*	*COMMENTS*
232000 HVAC PIPING & PUMPS					
Upgrade HVAC system to Current Building Code	1	ea	$ 30,000 00	$ 50,000 00	Deign-Build HVAC - New System
TOTAL HVAC BUDGET				$ 50,000 00	
DIVISION 26 ELECTRICAL					
ITEM	*AMOUNT*	*UNIT*	*UNIT COST*	*TOTAL COST*	*COMMENTS*
265000 LIGHTING FIXTURES					
Design-Build As Required	1	ea	$ 30,000 00	$ 40,000 00	Design-Build Electrical System - Allowance Given (Approx)
TOTAL ELECTRICAL BUDGET				$ 40,000 00	
TOTAL BUDGET				$ 249,730 93	

Note: Contingency, engineering, environmental and geotechnical impacts of the proposed concept are not included within this estimate.

PRELIMINARY CONSTRUCTION BUDGET
UBC BOTANICAL GARDENS - VISITOR'S CENTRE & MUSEUM

VISITOR'S CENTRE & MUSEUM

	QTY	UNIT	UNIT COST	TOTAL COST
Base Cost (2010, US Average)	4210	sq.ft	$ 132.00	$ 555,720.00
Cost (2010, size adjusted)				
Proposed building area	4210	sq.ft		
Typical size	6500	sq.ft		
Area Conversion Scale	0.65			
Cost Modifier	1.06		$ 139.92	$ 589,063.20
Cost (2010-Vancouver)				
Location index Vancouver	106.6			
Location index US	100			
Cost Modifier	1.066		$ 149.15	$ 627,941.37
Cost (2013-Vancouver)				
ENR Index 2013, Jan	5226			
ENR Index 2010, Year	4888			
Cost Modifier	1.07		$ 159.47	$ 671,362.85
Cost (mid-2015)				
assume inflation = 2.5%	2.5%			
cost = C(1+i)^n				$ 705,350.59
TOTAL ESTIMATED COST				**$ 710,000.00**

Note: Contingency, engineering, environmental and geotechnical impacts of the proposed concept are not included within this estimate

PRELIMINARY CONSTRUCTION BUDGET
UBC BOTANICAL GARDENS - ENTRANCE AND PARKING IMPROVEMENTS

ENTRANCE IMPROVEMENTS

DIVISION 1	ENTRANCE ARCHWAY				
ITEM		***AMOUNT***	***UNIT***	***UNIT COST***	***TOTAL COST***
	Beams and Lattice: 4"x4", 1' High, Cedar Wood Post	100	l.m	$ 125.43	$ 12,543.00
	Columns: 4"x4", 1' High, Cedar Wood Post	104	l.m	$ 125.43	$ 13,044.72
	Base: Flagstone, 3/4" Thick Irregular, gravel Base, Sand Bedding	23.76	s.m	$ 182.88	$ 4,345.23
SUBTOTAL					$ 30,000.00
DIVISION 2	**MECHANIZED GARDEN GATES**				
ITEM		***AMOUNT***	***UNIT***	***UNIT COST***	***TOTAL COST***
	Main Entrance (bi-parting)	1	ea	$ 1,631.00	$ 1,631.00
	Service Yard (bi-parting)	1	ea	$ 1,631.00	$ 1,631.00
SUBTOTAL					$ 3,300.00
DIVISION 2	**SIGNAGE AND WAYFINDING AMENITIES**				
ITEM		***AMOUNT***	***UNIT***	***UNIT COST***	***TOTAL COST***
	Granite Entrance Sign	1	L.S	$ 5,000.00	$ 5,000.00
	Landscaping Allowance	1	L.S	$ 8,000.00	$ 8,000.00
	Wayfinding Signage Allowance (Dynamic Feature Board, Small Signs, and Sign Posts)	1	L.S	$ 4,000.00	$ 4,000.00
	Lighting	20	ea	$ 150.00	$ 3,000.00
SUBTOTAL					$ 20,000.00
TOTAL ENTRANCE IMPROVEMENTS BUDGET					**$ 54,000.00**

PARKING EXPANSION

DIVISION 1	PARKING LOT EXPANSION				
ITEM		***AMOUNT***	***UNIT***	***UNIT COST***	***TOTAL COST***
	Excavation	271.78	cu. m	$ 20.00	$ 5,435.52
	Saw Cut Asphalt	151.98	l. m	$ 10.00	$ 1,519.82
	Import Borrow Material/Gravel	271.78	cu. m	$ 60.00	$ 16,306.56
	Drainage	1	-	$ 3,000.00	$ 3,000.00
	Pavement Markings	420	l. m	$ 3.00	$ 1,260.00
SUBTOTAL					$ 28,000.00
DIVISION 2	**BICYCLE SHELTER UPGRADE**				
ITEM		***AMOUNT***	***UNIT***	***UNIT COST***	***TOTAL COST***
	Cycle Shelter with Canopy Panels	2	ea	$ 4,000.00	$ 8,000.00
SUBTOTAL					$ 8,000.00
TOTAL PARKING EXPANSION BUDGET					**$ 36,000.00**

Note: Contingency, engineering, environmental and geotechnical impacts of the proposed concept are not included within this estimate.

PRELIMINARY CONSTRUCTION BUDGET
UBC BOTANICAL GARDENS - PATHWAY AND RETENTION SYSTEM

PATHWAY DEVELOPMENT

DIVISON 1	PATHWAYS (ASIAN WAY)			
ITEM	*AMOUNT*	*UNIT*	*UNIT COST*	*TOTAL COST*
Pea Gravel	1800	s.m	$ 16.67	$ 30,000.00
Placement	116.21	c.m	$ 3.67	$ 426.49
TOTAL PATHWAY DEVELOPMENT BUDGET				**$ 31,000.00**

WATER RETENTION SYSTEM & FOUNTAIN

DIVISON 1	RETENTION POND / PIPING			
ITEM	*AMOUNT*	*UNIT*	*UNIT COST*	*TOTAL COST*
Geotextile Fabric, 55 Mils Thick Non-Woven Polypropylene	50	s.m	$ 1.87	$ 93.50
Piping, water dist, PVC, schedule 40, 6"	150	l.m	$ 70.90	$ 10,635.00
Cocks & drains, 3/4" size, boiler drain, pipe thread to hose, bronze	4	ea	$ 20.23	$ 80.92
Pump	1	ea	$ 1,850.00	$ 1,850.00
Drip Irrigation Line	1000	l.m	$ 0.27	$ 270.00
Floating Fountain Feature	1	ea	$ 1,799.99	$ 1,799.99
SUBTOTAL				$ 14,800.00
DIVISION 2	**FOUNTAIN**			
ITEM	*AMOUNT*	*UNIT*	*UNIT COST*	*TOTAL COST*
Floating Fountain Feature	1	ea	$ 1,799.99	$ 1,799.99
SUBTOTAL				$ 1,800.00
TOTAL RETENTION SYSTEM & FOUNTAIN BUDGET				**$ 17,000.00**

Note: Contingency, engineering, environmental and geotechnical impacts of the proposed concept are not included within this estimate.