ER 390

The Remediation of Rock Bay, Victoria B.C.

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This report has been constructed from personal experience of working during the remediation of the Rock Bay in the Summer of 2015. The information has been presented based on my understanding of the project and does not necessarily account for all the processes or variables throughout the project. Information about the project tasks that were completed in my absence were pieced together based on my understanding of the process. The final parts of the report on the final remediation plans are simply a model based on my research and do not necessarily reflect the actual outcome of the bay. This report is not to be distributed and is for class project report only. If there are any errors or errors in my methodology please notify.

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ABSTRACT

Rock Bay, Victoria has historically been at the center of industry and development in the downtown Victoria harbor. However throughout the industrial development there has been pollution of hydrocarbons into the bay causing deleterious effects on the residing biota. To date many remediation projects have dealt with hydrocarbon contamination and developed a variety of methods which were employed in the Rock Bay remediation. However what sets Rock Bay apart from the other projects is the scale of the project and the environment in which the remediation is taking place. Over the span of the last decade the Rock Bay project has been slowly removing the contamination of the bay which was deposited over the past century of industry in the area. In hopes of one day restoring the bay into a productive shallow marine habitat the final measures are currently being initiated to bring life back to the bay. This paper will go into the development of the project along with methods used and potential ecological options for the long term success of the bay.

INTRODUCTION

The Rock Bay site is located in the downtown core of Victoria B.C., two kilometers north of the British Columbia Parliament Buildings. The bay has historically been the site of industrial activity and is currently surrounded by industrial buildings. However from 1862 to 1952 the property was home to a coal gasification and coking plant. Waste and debris from these industries were allowed to contaminate the properties surrounding the bay during the plants operation. The contaminated material then migrated into the bay, where it mixed with the marine sediments at the bottom of the basin. The contaminated material then became incorporated into the marine sediment strata and negatively affected the biota of the bay. The objective of the remediation of the bay is to first remove all the contaminated materials, sediments and soils. This will then be followed by backfilling the bay to the dimensions by which it was found at the start of the project. Once these tasks are completed the bay will be filled and once again allowed to be a habitat for marine life. This project has progressed in a series of stages over the past decade and is currently in its final stages of completion. The deleterious material has been removed from the bay and backfilling has commenced as the remediation is almost complete.

Figure 1: Map of Victoria B.C. showing the location of Rock Bay.

Study Area

Historically Rock Bay has had a very socially, economically and industrial diverse community history around its shores. In the 1900s the community of Rock Bay included people of all industries and various industrial processing plants. Many prominent citizens of Victoria took residence around the bay including a former Premier, a Supreme Court judge and Captain William Grants (History 351). During their time of residence, the Northern and Southern shores of Rock Bay were connected via a pedestrian bridge which was erected in 1887 (The Rock Bay Bridge). Although since destroyed its legacy lives on in the famous art work of Emily Carr who sketched the bridge from across the shore. In the early 1900's the industries of Rock Bay included Machine Depots, Shipyards, Lumber mills, Tanneries, Asphalt Plants, Coal Gasification plant, Propane Tank farm, Concrete plants, and storage facility for polychlorinated-biphenyls (PCB) containing capacitors (Industry In Rock Bay 1820's to Present). As seen below the profile of the Rock Bay has not changed majorly over the past century except for the edge of the south eastern shore. Since the 1900's the bay has been slightly in-filled in certain regions and will be re-contoured during the restoration of the bay.

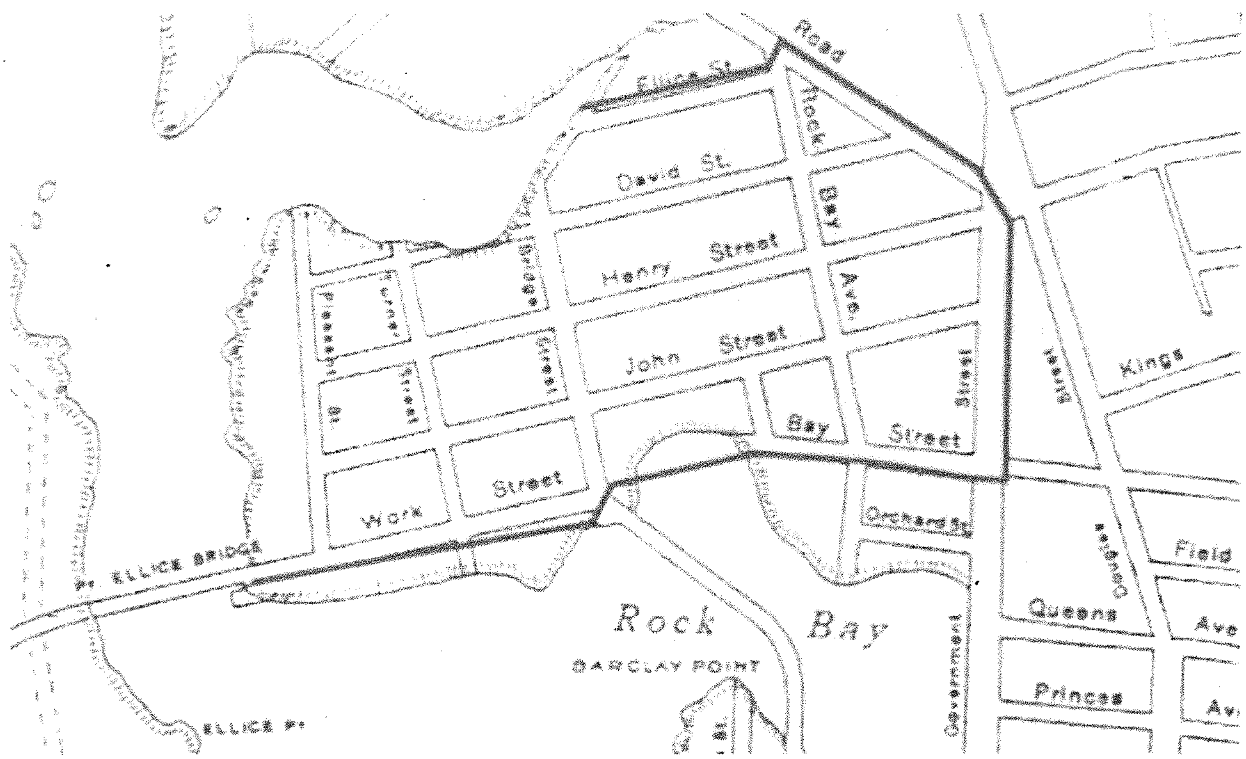

Figure 2: Victoria in the dawn of a new century, 1901 (Sourced From: **viu.ca**)

As shown in figure 3, the Rock Bay remediation has occurred in multiple stages throughout the past decade to slowly account for the century's worth of contamination. Stage one of the remediation was completed by BC Hydro on the lands they historically used as a PCB storage facility. Throughout the time that they utilized the grounds there was continuous underground leakage and contamination of PCB's into the soils and sediments. Their remediation consisted of removing the contaminated material and backfilling the cavity with sand as a bulk modulus. Stage two of the remediation was completed via the partnership of B.C. Hydro and Transport Canada in which they continued to remove PCB and hydrocarbon contamination. This second stage focused on the southwestern shore of the Rock Bay and resulted in a combined total of 200,000 tons of contaminated material being removed (Hazmat Management)(Rock Bay Remediation Project Review - Stage 2 and 3). Currently the final stage of the Rock Bay remediation is being completed which involves removing material from the bottom and sides of the bay. Stage three of the remediation has required by far the greatest amount of work to restore and has removed over 90,000 tons of contaminated sediments from the bay (Coal Gasification Plant - Stopping the Spread). The various stages of the bays remediation can be seen in the map below.

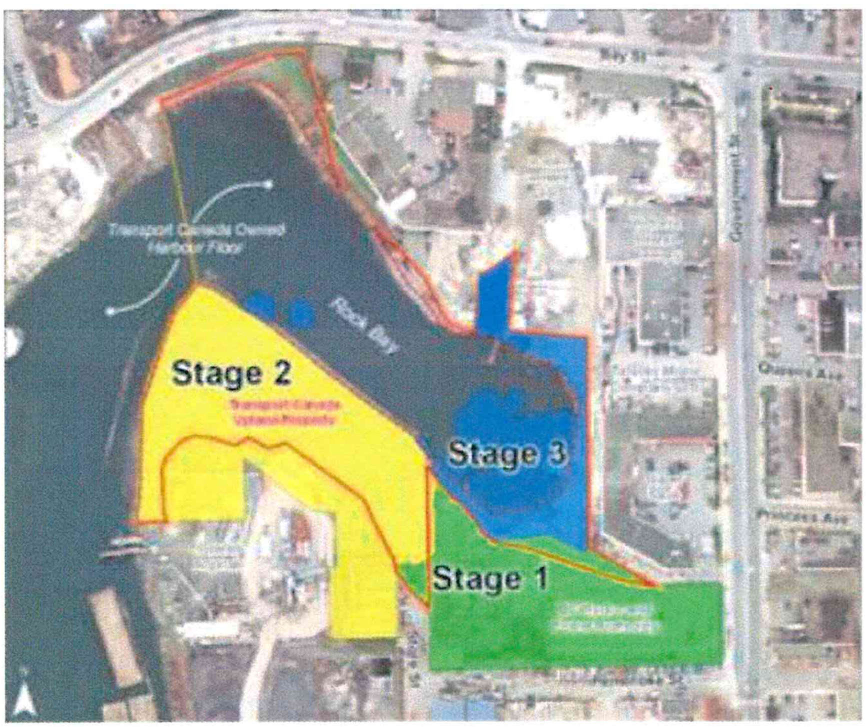

Figure 3: Location and Stage of remediation areas (Sourced from: **Design/Build – Rock Bay Restoration Project Stage 3)**

METHODS

The first task in the remediation of Rock Bay was to identify the locations of the contaminants, this was accomplished using an extensive drilling program in and around the bay. After the boreholes were created, sediment core were extracted and logged and tested for contaminants. From this data, the zones of contamination along with the nature of the contaminant concentration were spatially determined. The cores were then geo-located and logged into a database. By knowing the location and direction along with the characteristics of the cores, a 3D model was created of the bay identifying the areas of contamination. Having a 3D model outlying the location and grade of the contaminant was critical to ensure the proper methods were utilized when excavation began. The 3D model could then be rasterized into 2D layers for field use. Each one of these layer sections would then be printed as "layer maps" in one meter increments, to allow for the crew to gain a discontinuous picture of the contaminate field. These "layer maps" where then downloaded into a Trimble SPS GPS system in order to survey the contamination zones, before work started. The Trimble system was an excellent tool to have on site and consisted of a differential GPS and a base station to give good GPS precision. By knowing both the position and depth of the contaminants, along with having the layer map on the unit, the zones of contamination could quickly be identified.

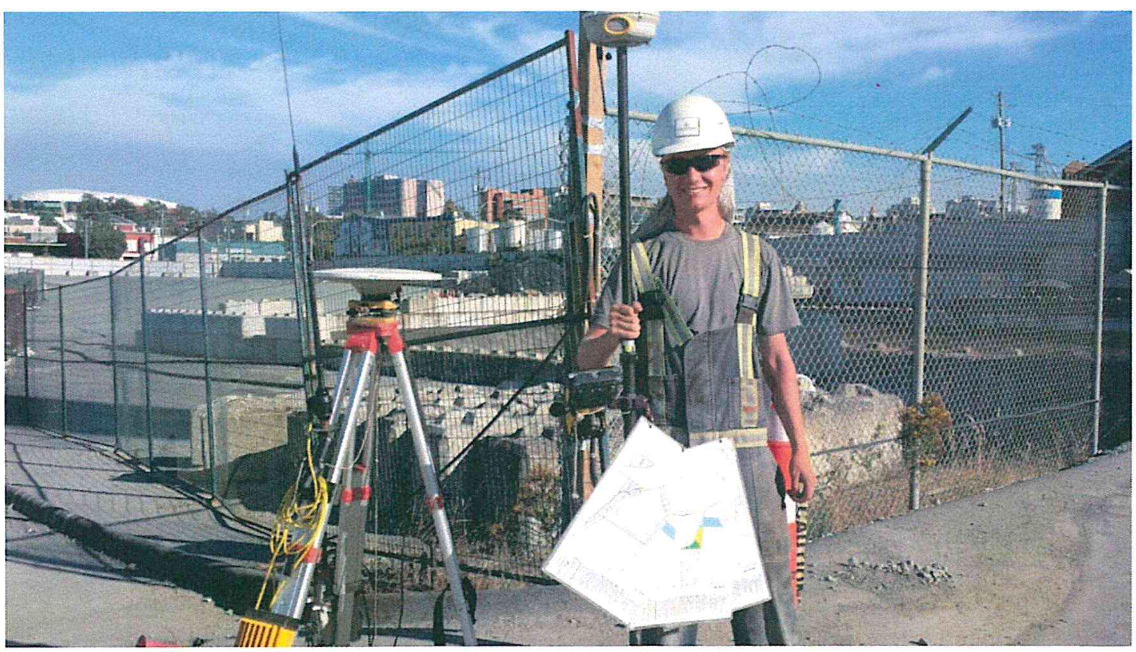

Figure 4: Trimble SPS GPS system and layer maps

Once the zones of contamination were identified, the onsite work preparations could begin. First the work site had to be prepared by installing utilities and paving the site with asphalt, erecting fencing and various other preparations. Once the sites infrastructure was established the preparation of the bay could begin. One of the first tasks was to install a sheet pile barrier around the bay to provide slope stability once the excavating occurred. To do so 60ft x 4ft sheet piles were driven into the perimeter of the bay to provide a continuous interlocking barrier. Normally when excavation is completed the walls of the cavity must be graded back to a 1:1 grade to ensure the walls of the cavity do not collapse. However the sheet piles allowed for a vertical face to be carved, which allowed for far less non contaminated sediment to be handled. In addition the sheet piles mitigated the travel of sediment and water back into the bay once the excavation began. The sheet pile barrier would eventually be further reinforced in certain sections for added support and safety. This was done by welding a series of "H" pile supports to the sheet pile wall to give it continuous horizontal strength. These reinforcements were especially prevalent in the corner regions of the bay.

After the construction of the sheet pile barrier around the perimeter of the bay, the erection of the coffer dam at the mouth of the bay commenced. The coffer dam's dimensions were approximately 15x30x100m in order to cover the mouth of the bay to drain the bay where the remediation was taking place. Similar to the barrier erected around the bay, sheet piles were used to create boxes as a skeleton. The dam was created by erecting a series of these sheet pile boxes, after a sheet pile box was erected, it would then be backfilled with 3" rock. The 3" fill was used to increase the density of the boxes and give the dam increased strength and rigidity. Once the first box was complete the work on the second in the series could then start, and this progressed until the dam covered across the mouth of the bay. Eventually after the water in the bay was drained the dam would then be reinforced for added strength and support. The extra support was installed on the "dry" side of the coffer dam and consisted of a series of steel "H-beams" welded to the sheet pile wall in the corner regions.

Figure 5: Coffer Dam Construction (sourced from: www.qmenv.com)

Once the coffer dam and sheet pile barrier was installed, work began on the pumping water out of the bay. At this point the water level on the inside of the bay was equal to that of the water level on the opposite side of the dam. To pump water from the bay to the harbor, two six inch pumps were utilized, each pump being capable of pumping large amounts of water. The pumps had a mesh screen around the intake and a silt screen around the outfall side. These screens were installed to minimize the amount sediment entering the pump, preventing damage to the pump and preventing sediment entering the harbor. The pumps however were set at less than their maximum rate to allow for a gentler draw down of water to allow the bay to adjust and compensate for the loss of density. The draining of the bay took a considerable amount of time to reach the lower contours of the bay. Then once the level of the bay was significantly low the 6" pumps were replaced by 3" pumps to pump out the remaining water in the newly exposed basin.

Before excavation could begin in the drained bay, a water treatment facility had to be constructed so that any groundwater remaining as excavation commenced could pumped off and processed thru the water treatment system to remove any contaminates. A unique feature of the Rock Bay site is that the majority of the city of Victoria's storm water ran into the Bay via two outfall drains. In order to prevent the bay from filling up with the storm water, the outfalls had to be temporally repositioned to allow for them drain further out into the Victoria harbor.

Once all the preparatory work on the property was completed, the excavation of contaminants could commence. From surveying work already completed, the zones of contamination where known along with the general nature of the material. The exact order by which the sites contaminants were excavated is hard to describe because there were multiple excavators operating at any given time and other factors such as dealing with water treatment, consulting and weather conditions came into play. In addition, the reasons for selecting the order for contaminant remediation was affected by managing work schedules with the onsite subcontractors who dealt with various components of monitoring and trade work. The excavation operations were conducted in the summer months in order to avoid water generated by coastal precipitation, which assisted with slope stabilization when excavating.

The general excavation procedure of a given cell included excavating at the base of a sheet pile barrier to the desired or temporary depth. The excavator would then dig perpendicular to the surface of the sheet pile wall away from its surface. The walls of this temporary excavation would be then graded back on a one to one ratio for safety reasons. The trench could vary in length and depth however the trench width was limited due to safety considerations (due to concern of placing additional stress on the sheet pile barrier). When the material was removed on one side of the barrier, the stress from material on the filled side of the barrier would be applied. In some areas the grades had to be taken down multiple times, by working on the neighboring cells in the same time frame. One excavator would begin to dig in a certain grid until it reached the maximum depth its arm could reach. The machine would then go to the adjacent grid and continue to dig. Then a long reach excavator which had twice the reach but half the bucket capacity would dig until the cell was at its desired contaminate free depth. Once this cell was vacant another excavator could then start to infill the vacant cavity to bring stabilization to the slope, while the other excavators continued down the line.

These excavators would work in coordination with a laborer equipped with a Trimble SPS GPS unit to determine the depth and position of the excavation. The Trimble unit had the zones of contamination loaded onto its interface so that the team could coordinate where and how deep to dig. In addition the consultants observing the process used surveying equipment to verify the depth of excavation with further accuracy. From knowing where exactly the team was excavating the operator could notify the truck drivers which class of material contamination was being excavated. The materials removed by the excavators where then loaded into trucks and hauled to the surface stockpiling area. The material would then be dumped into piles according to the level and nature of contamination based on the classifications determined by the consultants and GPS data. Each surface pile was separated from the other to prevent cross contamination of materials. To further prevent cross contamination, the trucks would be washed out whenever the grade of contaminate would change. In addition, whenever a truck would change from hauling contaminate to hauling backfill, they would be thoroughly washed out.

Once the desired excavation depth was reached, consultants would then take samples and photos of the work done. Each sample taken would then be geo-referenced with the surveying equipment on site. They would then verify that all of the contaminated material was removed from each of the excavations. In the event that there was potentially contaminated material remaining on the sheet pile barrier, a "lucky laborer" (often yours truly) would then have to scrape away until the sheet pile was deemed clean. This was to ensure that the clean backfill placed into the excavation site was not contaminated with the residual material.

Once the "all clean" was given by the consultant, the operations would then switch to backfilling for the rest of the day. The objective was basically to backfill to the level by which the excavated material stood at the start of the day. This procedure would often start sometime after lunchtime to allow the incoming trucks of backfill to build up enough of a stock for the day. The same truck that hauled contaminate earlier in the day would now start to haul backfill, (after the truck was cleaned). The truck would be loaded at the surface and haul the backfill down to where it was needed in the excavation.

Along the southern wall of the Rock Bay site, the previously excavated area (Phase one of the remediation completed years earlier) was backfilled with sand. Consideration was given to filling on either side of the wall, if one side had three inch backfill and the other was sand, there would be the potential of the sand to migrate through the large three inch pore space. If the migration of the sand material was allowed it could have serious effects on the stability of the previously excavated area and surrounding site. To prevent the migration of sand, a grading series of increasing porosity was utilized to minimize the porosity change between substrates. The grading started with bentonite sand, then was layered outward into birds eye gravel then finally the three inch was placed. By grading in this manner of gradually increasing the pore space of the substrate there would be very little migration of the sand material. However the ground water would still be allowed to naturally flow into the bay and the hydrology could continue from the surrounding land into the bay and prevent oversaturation of the substrate.

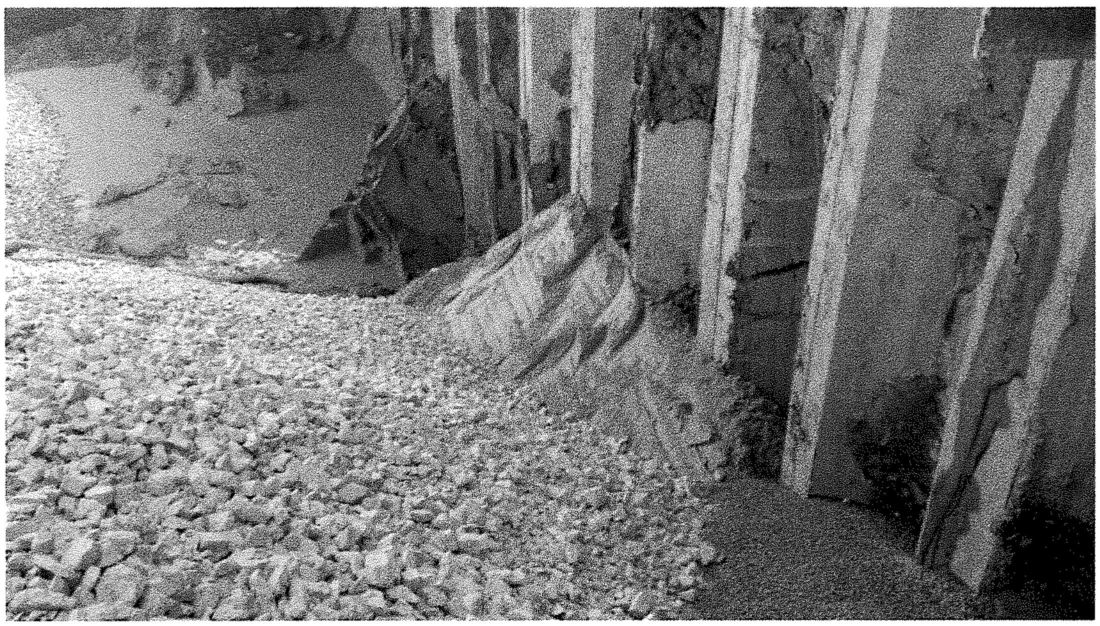

Figure 6: Grading sequence of the interface

The backfilling operations continued to proceed in this manner until approximately mid-September 2015. The estimated requirement for backfill was approximately 80,000 tons of the three inch grade and varying amounts of the other materials, such as bentonite sand and bird's eye gravel. The three inch backfill was used as a bulk modulus, however overtop of it will be placed large boulders and a variety of riprap. The large cobbles and boulder will act as anchors of the substrate and reduce tidal erosion. This layer will then be partially covered by clays and sands to allow for biota to eventually have a substrate for holdfasts. Once these layers were in place preparation of the flooding of the bay eventually occurred.

WATER TREATMENT

During the excavation of the bay water would naturally accumulate at the bottom of the excavated bay. In addition water would also naturally drain from the piles of excavated material. Both of these waters that where sourced from or came in contact with the potentially contaminated material would have to undergo treatment and testing before they could be moved offsite.

To begin the process, the waters at the bottom of the bay enter into one of the many water collection sumps onsite. These sumps would be located in areas of local depressions as to allow for the maximum amount of water capture. Each sump would then have a three inch pump at its base which would then move the water from the basin to the onsite water treatment facility. The pumps would have float switches attached to them as to allow for the pumps to be automatically turned on when there was water present in the sump. The multiple sump lines would then feed into a main line which would then take the waters to the surface. To prevent the water from travelling back down the line one way check-valves would be placed in the hose line to prevent backflow.

Figure 7: A Sump with a 3" Pump inserted

Once the waters reached the water treatment facility they are first collected into a 5000 liter sediment tank. The tank allows for large sediment particles to fall out of solution via gravity settling. The water from the sediment settling tank will then flow into another settling tanks to further allow sediment to settle out of solution. Since the tanks have a finite volume they must be often cleaned out with a vacuumed truck. The water then travels into a pH box, which measures and adjusts the pH of the water. The pH at this point of the system must be adjust to a pH of 9-9.5 by automatically adding a "lime" solution into the water. The water would then travel into an Oil-Water Separator system to eliminate any oil in the water. The separator works by utilizing the density difference between water and oil, it traps the oil at the surface and allows the water to flow underneath. As a result the unit can separate oil from water without the addition of chemical compounds. The water from the oil water separator unit then travels into another settling tank which chemically treats the water in order to remove any potential cyanide from the water.

From the sediment settling tank the water travels into a Sediment pond which can hold approximately 1.5M liters. The pond contains large screens jutting out from either side of the pond perpendicular to the direction of flow. This slows the flow of the current in the pond in order to maximize the amount of sediment to fall out of solution. However at this point in the process the sediment is mainly reduced to silt and fine clays. To prevent the pond water from leaking a double layer geo-membrane has been installed above and below of an ash fault base. It should be noted that the particulate matter can contain metals and contaminates so the ultimate goal is to reduce the suspended material.

Figure 8: Settling pond and water treatment system in background

Once the water has dwelled in the sediment settling pond for some time, the amount of sediment is significantly reduced and the water is ready to be transferred to the water treatment system. The first stage consists of six sand filter units which are networked in series in order to reduce fine sediment. Next the water travels into two bag filter units which are also connected in series. Each bag unit contains six bags, the water flows in a set path though the unit which causes the water to go through each bag in series. The bag filter unit gives the user a wide selection of sizes of filtration to optimize filtration. Such sizes include but are not limited to 1um, 5um, 10um, 20um, 50um, 100um in addition to bags optimized for oil and hydrocarbon filtration. Next the waters travel to the carbon filter units, which further remove fine particles from the water. The carbon filter units are filled with coarse "activated carbon" which have high surface area in which they entrap contaminates. On site there were eight carbon units which were networked in series which allowed for optimal fine contaminate removal. Once the water had gone through the system it was then tested to determine if the water treatment system was operating correctly. Then based on results from the independent tests the waters could be released from the site.

Results

Once the remediation of Rock Bay was completed and the bay filled, the result was simply a clean slate. All three of the stages of the remediation now sit idle until such time that testing on the remediated grounds confirm that the area is completely cleared of all contamination. This processes will last many years and include testing from many of the onsite boreholes.

In all, the remediation consisted of processing an enormous amount of material. The Quantum Murray website lists that the remediation of the three stages account for:

- Treatment and disposal of approximately 7,000,000 liters of hydrocarbon and metal impacted groundwater
- Excavation and restoration of approximately 40,000 tons of special waste
- Excavation and restoration of 60,000 tons of non-special waste soil and materials
- Transportation and disposal of approximately 70,000 tons of soil with various types and levels of contaminants.
- Remediation of 90,000 tons of contaminated sediments;

Since all of these contaminates were taken out of the site, new bulk modulus had to be placed back into the bay. An estimate puts the total of the 3" backfill at an amount of 80,000 tones along with varying amounts of birds-eye gravel and bentonite sand for stage 3. As a result the bay now appears to be pristine, simply waiting to be inhabited by a shallow marine community.

Discussion

The Rock Bay project is designed to restore the bay to its original dimensions and to allow the bay to become a productive ecosystem free from contamination. In this discussion I will outline possible solutions that could be or may have been used or adapted. I cannot verify the techniques used in the project, since I was not present at their time of implementation or planning.

Hopefully, one day the Rock Bay will become a productive costal marine ecosystem whereby the marine plants and animals may take refuge. During the final stages of backfilling and grading of the bay, a variety of large boulders and rip rap material was used to line the surface. The purpose of the large boulders is to reduce tidal reworking and to provide fish and plant species a place to take refuge.

A unique feature of the bay is that a large portion of Downtown Victoria's storm water will be drained into the bay sub aqueously. This fresh water input will mix instantly with the ocean water upon insertion into the bay. Any concerns of pollution from storm water are mitigated by testing regulated by the City of Victoria. One possible concern is the input of low levels of pesticides, herbicides and potential hydrocarbons. However if these substances were imputed into the bay they would be quickly diluted and mixed with the tidal waters to insignificant concentrations. It has been experimentally found that some types of eelgrass are actually able to absorb certain pollutants and in doing so clean the substrata (Huesemann et al., 2009).

Once the bay is filled with the harbor sea water, via the removal of the coffer dam, the ecological remediation of the bay can commence. The bay is relatively shallow with a depth of approximately 6m, which allows an abundance of sunlight to reach the benthic communities. Around the bay there are no major buildings, so the light will not be impeded by overhead structures. The city's storm water supply is imputing directly into the bay and will act as an input rich in detritus material. This material could be a potential food source for many benthic marine organisms provides a soil input for marine plants including eelgrass. The combination of a potential food source and a large input of light makes this bay an ideal setting for an eel grass ecosystem.

The eel grass ecosystem consists of a large array of organisms dominated by the flowering eel grass plant (*Zostera marina*). The eel grass in the ecosystem produces a large amount of primary production and so is vital to the Rock Bay food web and successful restoration. The lowest trophic level of the eel grass food web consists of a variety of invertebrate isopods, amphipods, worms, and crabs (Farlin et al., 2010). Higher tropic levels include sea stars, clams, snails, sea urchins and larvae. These organisms would have an abundance of habitat by utilizing the variety marine topography consisting of rip rap and large boulders for refuge. The species that may benefit the most are the juvenile salmon, herring and a variety of other fish species (BC Seafood Alliance, 2005). This ecosystem is critical for juvenile fish species since it provides an area of refuge and a food source that allows them to mature (Plummer et al., 2013). At the highest levels of the ecosystem are the diving and dabbling ducks in addition to geese and seagulls and the occasional sea otter.

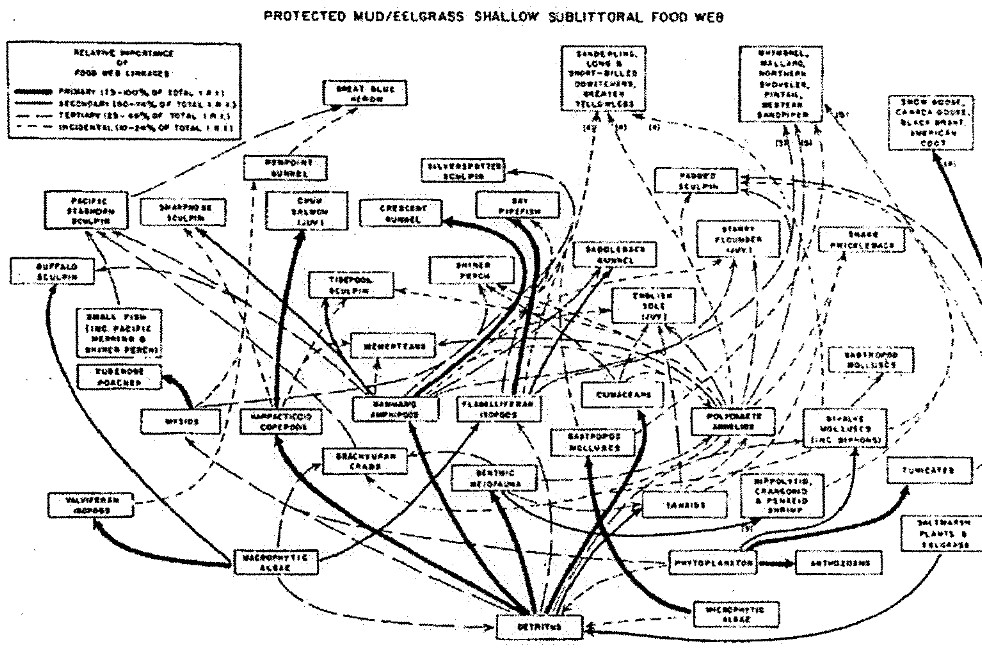

Figure 20. Composite food web characteristic of protected mud/eelgrass, shallow sublittoral habitats in northern Puget Sound and the Strait of Juan de Fuca (after Simenstad et al. 1979).

Figure 9: Eel Grass foodweb (sourced: Simenstad et al. 1979)

The eelgrass itself is an incredibly beneficial member of the community to both the organisms and the long term stability of the project. Eelgrass is a flowering plant, which when the climax community is established, creates a thick and dense field (Northwest and Eelgrass, 2008). The eelgrass body acts like a filter, collecting settling detritus from the waters that flow around it in the water column. The retained detritus is then held within the community and will either act as a food source for the organisms or is broken down to become a soil source for future plant growth (Bach et al., 1986). The rhizomes of the plant help to then secure the soils by acting as a holdfast and trapping the soil that has been accumulated for the long term growth of the community. Once the eelgrass community is in its climax community stage, the density of the grass will be significant and its coverage will be dominant through the bay. The shear density of the eel grass may then act to reduce wave and tidal action against the shoreline and minimize the tidal effects felt by the eelgrass inhabitants. This reduction in wave action for the shore would be the long term desired effect for the project for in insures the long term stability of the bay. Since the eelgrass acts to lessen the depositional energy in the bay, it will act to slowly allow for the deposition of fine sediments which further promotes the growth of the community (Fallis, 1983)(Jones and Jaffe, 2013).

The eel grass however is extremely sensitive to changes in the amount of sunlight it receives and any "shading stress" may lead to loss of sea grasses (Landry et al., 2008). Which is why it is critical that eel grass communities be considered when developing in this bay, to ensure no blockage of sunlight from reaching the grasses. In addition, measures should be put in place to reduce sediment input into the waters to further maximize the sunlight in the water column (Orth et al., 2006). These measures could include minimizing surface runoff from neighboring industrial facilities and reducing boat traffic in the bay. Other controlling factors on the health of the eel grass include temperature, salinity, substrata composition, nutrient abundance, water level and motion (Thom et al., 2012)(Touchette, 2007), however these variables do not experience major anthropogenic effects in this region.

To achieve the development of an eelgrass population in the bay, there are two possible methods that could be employed. Either allow the community to take place via natural succession from the surrounding communities, or introduce populations by transplanting the species into the bay. The first method of natural succession would be the most natural method and would insure that there would be no anthropogenic introduction of invasive species into the bay. This method would also be cost effective for it would only require monitoring and not the employment of civil resources. However the significant downside of this natural method is that it would take a significant amount of time for the desired climax community to be reached. The second option would be to introduce the eelgrass into the bay by transplanting eelgrass from the surrounding communities (Orth et al., 1999). This option would allow the rapid introduction of eel grass plants into the bay in addition to preserving the local gene pool. By transplanting in this manner the eelgrass within the bay would be able to be fertilized by eelgrass from outside the bay. This would insure a long term genetic base for the future development of the community. In addition by transplanting the eelgrass it will enable other organisms to naturally seek refuge in the bay from the surrounding communities and by doing so forming a meta-population.

A locally based project of a similar nature in the rehabilitation of eel grass is that of Guemes Channel in Anacortes, Washington. The eel grass community in that area was threatened by local construction projects, shading stresses and debris in the water. The eel grass plants there had to be transplanted into a new region before construction could begin. After removal of debris in the area and methods to mitigate the effects of shading stress, the plants were successfully transplanted (Gayaldo et al., 2001). To secure the long term longevity of the community, measures were implemented to reduce sediment load in the water and minimize damage from boat anchors. With ongoing monitoring, the Guemes channel restoration project is seen as being a successful restoration of an eel grass community. Similar projects involving the transplanting of eel grass to restore and establish communities include Drayton Harbor Eagle Harbor and Clinton, Washington (Busch et al., 2010) (Gayaldo et al., 2001)(Thom et al., 2012). From the respective monitoring programs it was found that the density of the eelgrass communities would fluctuate over a ten year period due to natural stress on the community (Vavrinec et al. 2009). Because of the long term fluctuations in natural stresses on the eel grass beds, monitoring in these areas continues to this day.

Long term monitoring of the Rock Bay project will continue until the work done to restore the bay has been proven to be effective in removing the contaminated material. This will be done with a variety of testing methods and could potentially involve eelgrass cut testing. By having the eelgrass in the bay, the plants could be used to detect if there is any contamination making its way into the ecosystem. The long term monitoring of the bay will also be supported by the local First Nation's people. The elders of the bands have a great deal of accumulated knowledge on the development and interactions of the eelgrass and other shallow marine ecosystems. From the utilization of ancestral knowledge of the elders a qualitative picture of the ecological progress of the bay can be made.

Conclusion

The remediation of Rock Bay was no small feat, for it took thousands of man hours over the span of a decade along with millions of dollars to complete. All this effort had to be invested into simply one bay because our ancestors did not appreciate that their actions would one day negatively affect our community. Historically industry allowed hundreds of thousands of tonnes of material to be contaminated which a generation later, we only recently were able to remediate. Fortunately we have learned from our ancestors' mistakes and have put into effect strict handling and storage procedures towards industry which will bring security to the future environment. Future development around the bay area is unclear and for the time being ownership is being placed in the hands of the local First Nation's band. From the exterior of the site there is a perimeter fence around the Stage One area with artwork by the First Nations peoples to show their support for the remediation of the bay.

The photo below of Rock Bay was taken on my last day on site, a couple months before the bay was flooded. I took this photo because I believe it symbolizes all the work that had be invested into the remediation of the bay. Just imagine for a moment that each piece of equipment was assigned a man, who worked often six days a week, 10-14 hours a day over sometime over the span of a decade. Behind these men is an army of consultants, support staff and the community which supports them simply to undo the mistakes and oversight of the past. I am very proud to see the bays completion and am thankful to be a part of the restoration community in Victoria.

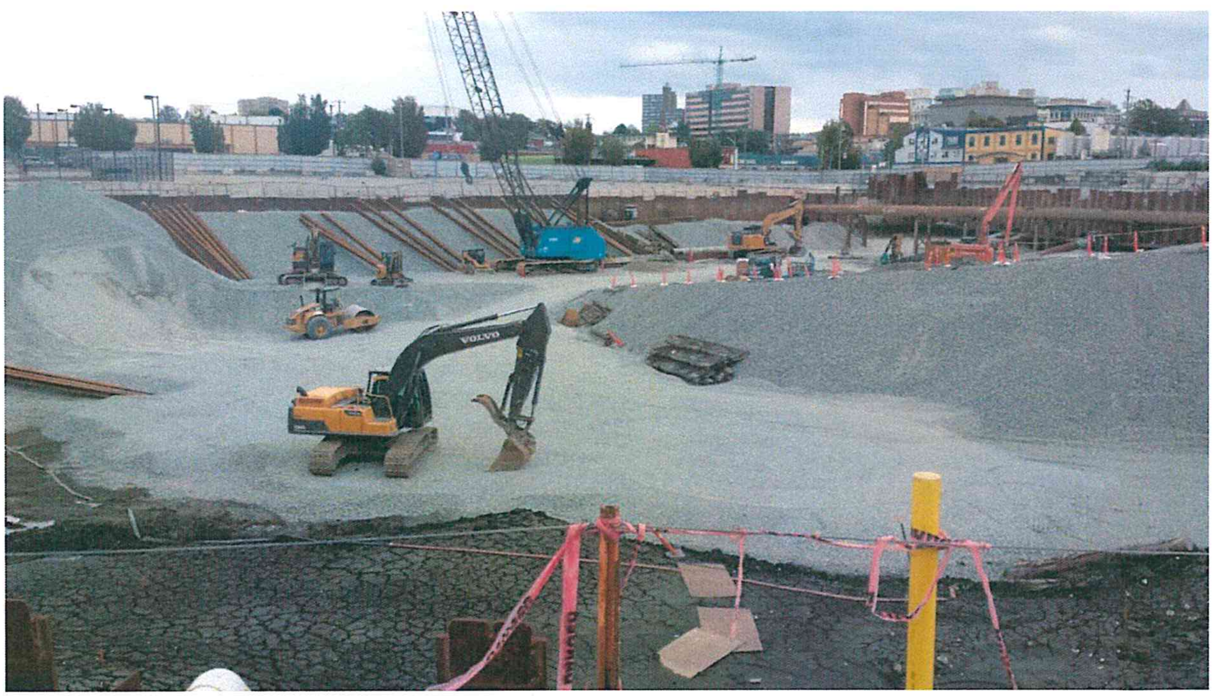

Figure 10: Rock Bay site September 2015 (Source: Kurtis Sanderson)

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