Fraser River Fisheries Habitat Restoration Using an Alternate Approach

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Introduction

Since 1905, the rate of bank erosion has been recorded for the Lower Fraser River of British Columbia, Canada. As one of the major river systems on the west coast of North America, the Fraser River bank erosion has created significant issues with flooding, infrastructure design and fisheries habitat.

Figure 1: Map of Mission, British Columbia Canada and Project site

The Fraser River at Mission is internationally recognized as a sensitive fisheries habitat for White Sturgeon (*Acipenser tranmortanus*), and Pacific Salmon (*Oncorhynchus*) species, including Chinook (Oncorhynchus tshawytscha), Chum (Oncorhynchus keta), Coho (Oncorhynchus kisutch), Pink (Oncorhynchus gorbuscha), and Sockeye (Oncorhynchus nerka).

The fisheries habitat restoration study for the Mission, BC site was undertaken on behalf of Fraser Pacific Enterprises Inc to study the potential effects of using alternative restoration methodology to reclaim the eroded foreshore and to enhance the fisheries habitat adjacent to this industrial site.

The alternate restoration study requirements included the establishment of spawning habitat for the Eulachon (*Thaleichthys pacificus)* (Figure 2) as it is an endangered species (SARA) and the spawning habitat in the lower Fraser River and enhancement of existing fisheries habitat for both salmon and White sturgeon.

Figure 2: Adult Eulachon

Photo provided by: http://upload.wikimedia.org/wikipedia/commons/9/9c/Eulachon.jpg

The additional requirements for the study included the re-establishment of the riparian area (30 m) in the foreshore area that will be reclaimed through the establishment of spur dikes and wildlife/fisheries habitat.

Methodology

A. Hydraulic Engineering Assessment – LaCas Consultants Inc.

The objective of the hydraulic modeling study was to determine if the standard engineering principles based on the US Corps of Engineers, Bank Protection Techniques Using Spur Dikes (HL-83-1) would provide an acceptable design for the river spur dikes being proposed as an alternate method to backfilling and armoring the foreshore as a reclamation program. The US Corps of Engineers hydraulic (HEC RAS v.4.1.0) numerical water surface profile model was conducted using the October, 2013 Fraser River cross sectional information generated from the Bathymetric Survey study (October, 2013).

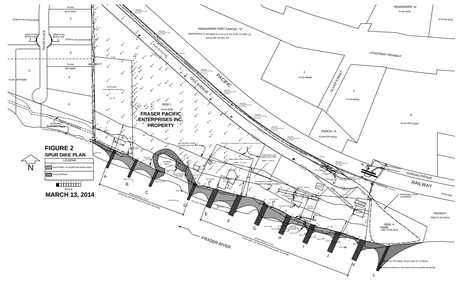

Figure 3: River Spur Dike Design- Using US Corps of Engineers Model

B. Geotechnical Assessment – LandTec Consulting Ltd.

The geotechnical assessment was undertaken in June 2014 to determine the effects of raising the industrial site to 9.2 m to accommodate an adequate freeboard above the design 1 in 200 year flooding event of the Fraser River as recently determined by the BC MFLNRO as result of climate change modeling for sea level rise and increased flooding from storm events and freshet and to assess seismic hazards for the project.

The methodology employed for this component of the overall foreshore restoration study included:

Solid stem auger holes to a depth of 30m;
Cone penetration test holes, each advanced to a depth of 30m
A seismic cone penetration test hole advanced to a depth of 40m
Two Nilcon vane tests

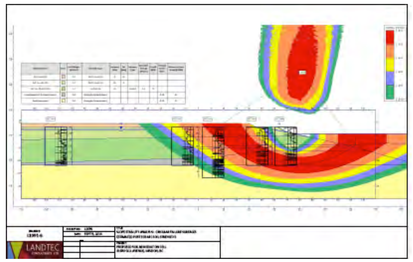

Figure 4: Slope Stability Analysis-Circular Failure Subsurfaces Estimated Post Seismic Soil Strengths

C. Bathymetric Survey – October, 2013

As the bathymetric information for the Fraser River at the Mission, BC site was limited or dated, a comprehensive bathymetric survey was undertaken to provide data for both the hydraulic modeling and the geotechnical analysis of the upland soils and river flow patterns.

As indicated in Figure 5, the survey confirmed the hydraulic modeling undertaken using the 1-D and later the 2-D modeling programs.

Figure 5- Bathymetric survey map

D. Fisheries Assessment – Fraser River at Mission, BC

As the lower Fraser River provides significant fisheries habitat for White Sturgeon, salmon, and many other freshwater and saltwater species, it is important to ensure that the riverbank restoration project is conducted in an environmentally sustainable manner. Therefore, a comprehensive review of Fisheries and Oceans Canada (DFO) data was required and interviews with the many local conservation groups to determine the ranking of fisheries habitat.

The establishment of Eulachon habitat as a component of the restoration program was deemed appropriate, as they are a significant food source of the White Sturgeon. A literature review of the Fraser River Eulachon habitat was undertaken using DFO (2000) sampling studies as the basis for the determination of the potential for the establishment of habitat at the Mission restoration site.

E. Biological Assessment – Riparian Area

A survey of the vegetation within the 30 m DFO fisheries setback was undertaken using a 10m by 10m grid method to assess type and quantity of existing vegetation, stability in regards to foreshore erosion and the presence of invasive species (i.e. Scotch Broom, Reed Canary Grass, Japanese Knotweed).

F. Stormwater Management Assessment

Two study requirements were identified for the stormwater management:

1. Current stormwater treatment required an interim treatment system that could then be adapted to the final design criteria;
2. Permanent stormwater management system would be a passive (naturally flowing system) and engineered wetlands would provide the treatment system for the treatment of sediments suspended in the stormwater.

The hydraulic modeling for the stormwater experimental design criteria was conducted using the US Corps of Engineers; HEC HMS v 4.0 numerical watershed model based on precipitation data and land drainage attributes.

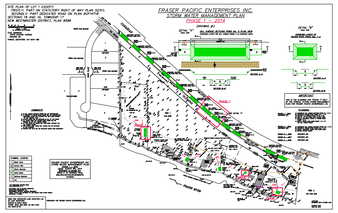

Figure 6: Stormwater Management design –Phase 1

OBJECTIVES

The experimental objectives for the fisheries restoration/enhancement project were to:

- Develop the foreshore restoration program using environmentally sustainable methods that support the "Working River" concept of the Fraser River at Mission, BC and incorporate the "Experience the Fraser" concept;
- Incorporate the potential effects of climate change (I.e. sea level rise, increased salinity, increased freshet flooding);
- Incorporate the habitat sensitivity into the restoration design whereby additional ecosystem habitats are created (i.e. fisheries, upland –bird, amphibians, wildlife), and;

RESULTS

Hydraulic River Flow Modeling Program

Initial review of the 1D hydraulic modeling results indicated that the LaCas spur dike design would not adversely affect the river flow patterns in the North Channel of the Fraser River as a result of the installation of the individual spur dikes.

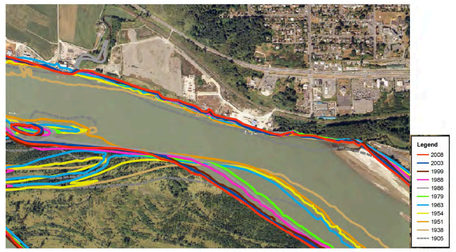

Figure 7: Historic Modeling of Fraser River Sediment Deposition/Erosion at Mission, BC

However, the initial hydraulic modeling was not supported by the geotechnical assessment of the soil stability of the upland site or the effects of raising the overall site elevation from an average of 7.0 m GSC to the floodplain standard of 9.2m GSC (District of Mission, 2013).

Further analysis identified through the Northwest Hydraulic Consultants (NHC) 2D modeling that the effects of the spur dikes would change the Fraser River flow patterns and may potentially affect both upstream and downstream erosion rates.

Geotechnical Assessment

The geotechnical assessment for the restoration site indicated that the spur dike design as presented by LaCas Consultants would fail the seismic standards for earthquakes of less than 7.0 magnitude based on the soil composition and proposed engineering construction. The spur dike design will have to be altered based on the NHC and LandTec criteria for river flow, climate change and seismic conditions.

Biological Assessment – Fisheries

As the Lower Fraser River at Mission, BC is a majority migratory pathway and habitat for salmonids species, sturgeon and other freshwater/saltwater species, consideration had to be undertaken to ensure that the proposed spur dike design does not adversely affect the existing habitat or ability for the migrating species to pass freely upstream to their historic spawning grounds.

If the spur dikes change the flow patterns of the North Arm of the Fraser River at Mission, BC in a manner that allow for increased/decreased sediment deposition, it is likely to have an effect on the fisheries habitat, current and potential. These effects may include the reduction of nutrients for the sturgeon population that resides in this area of the Fraser River, ability of the migrating salmon species to migrate either inbound or outbound from their spawning areas.

The vegetation assessment identified that the site has many invasive species, including Japanese Knotweed, and Scotch Broom, which will have to be treated and disposed of following the BCMOE Invasive Species requirements.

Stormwater Management

The site stormwater will be managed through a two-step approach (temporary containment/mechanical system and permanent gravity fed system) that will ultimately collect all rainfall from the entire site and direct it to engineered wetlands that will provide sediment and biological treatment.

As the slope of the site is currently towards the Fraser River, a temporary collection system will be engineered to collect all the stormwater from the site and direct it into three settling ponds before being discharged into a natural wetland area.

As the site elevation is raised to the floodplain standard (9.2 m GSC), the slope of the site will be directed north to the temporary settling ponds, which will be upgraded and the wetlands will be enhanced to allow for biological treatment of the stormwater prior to it being discharged into a creek on the western boundary of the property.

SUMMARY

The Fraser River bank restoration program that is being undertaken by Fraser Pacific Enterprises has required exploring alternate scientific approaches to the standard engineering method of stabilization with rip rap. As the primary goal is to undertake this program in an environmentally sustainable manner, examination of the biological implications to the ecosystems had to be carefully examined and the engineering concepts developed to support the project goals of creating and enhancing the fisheries and upland habitats.

Acknowledgements:

The primary recognition for acceptance of the restoration program using alternative methods must be given to the managing owners (family) of the property and the many professionals who contributed to the Project:

- Bev Toews, President, Fraser Pacific Enterprises Ltd
- Mike Giesbrecht, President, Sumas Trucking Ltd
- Jason Thiessen, Operations Manager, Fraser Pacific Enterprises Ltd.
- Ian Collings, Teranis Consultants
- Erin Clements, Corporation of Delta
- Rob Clements, City of Vancouver
- Jim Taylor, Stave Lake Salmonid Enhancement Society
- Fraser Valley Watershed Coalition
- Mike Younie, District of Mission
- Gina MacKay, District of Mission
- Stacey Crawford, District of Mission
- Chris Lee, AquaTerra Environmental Consultants

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