Dartmouth Fish Passage between Sullivan's Pond and the Halifax Harbour

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Scope of Work

Create a fish passage that accommodates all current fish species to be capable of swimming between Sullivan's Pond and the Halifax Harbour, as well as being capable of transporting flood flows during extreme weather.

Initial Conditions

Figure 1. Current Nine-Foot Corrugated Steel Pipe

- 9 foot corrugated steel pipe
- No fish passage due to lack of resting areas
- Cannot transport/support 100 year flood flow
- No daylighting present
- No viewing area for public

Project Location

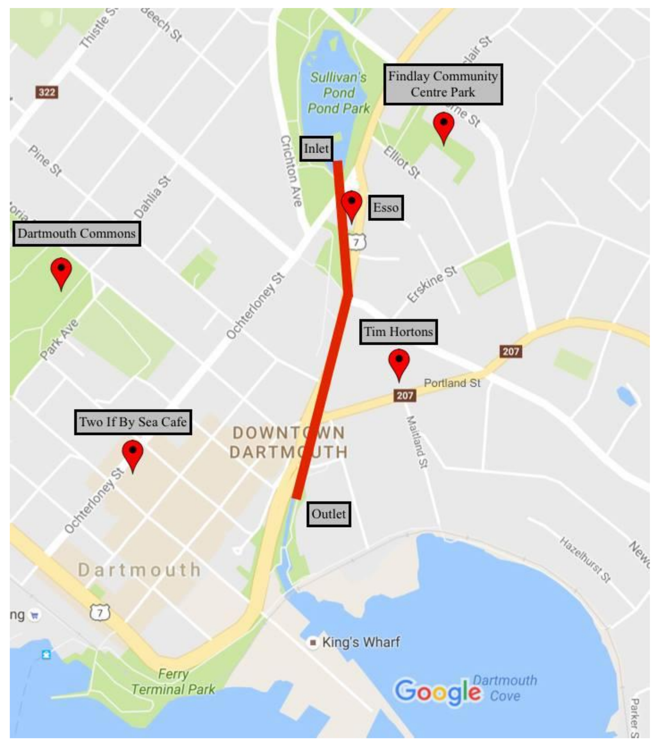

Figure 2. Map of Project Location (Google Maps, 2017)

- Project is fully located in Dartmouth, NS
- Input begins at Sullivan's Pond;
- carries under Ochterloney Street;
- passes through Starr Park and between households;
- underground downtown Dartmouth;
- output into Halifax Harbour by King's Wharf

Design Process

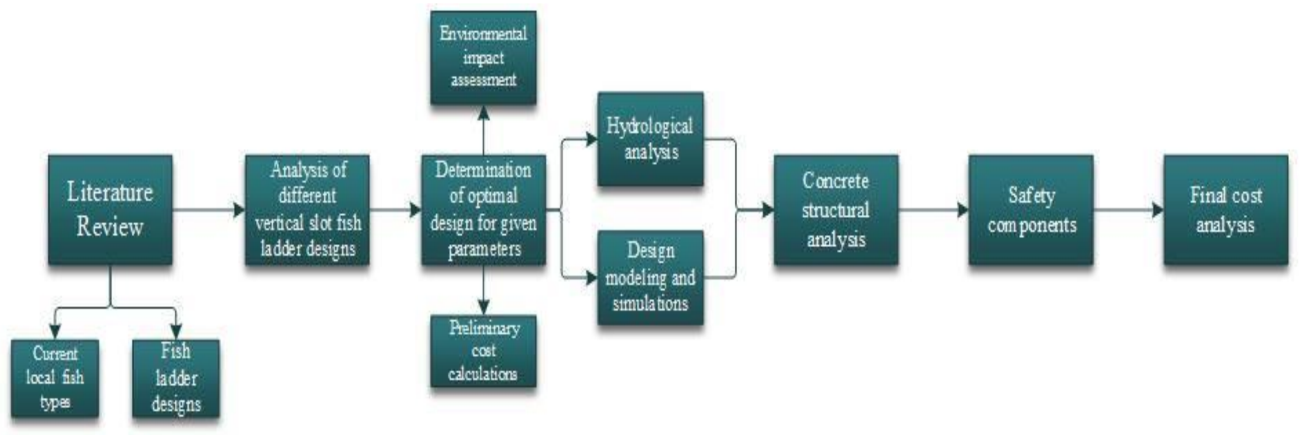

Figure 3. Process Flow Chart of the Design Process

Details of Final Design

Fish Analysis

- American Eel (*Anguilla rostrata*)
- Atlantic Salmon (*Salmo salar*)
- Sea Run Brook Trout (*Salvelinus fontinalis*)
- Alewife (*Alosa pseudoharengus*)

Design fish: The weakest fish in the area is the fish to which a design must be created. Alewife is the design fish because swimming ability is a key component for successful fish migration. Fish navigate through a variety of flows and water velocities.

Figure 4. An Alewife(Squiers, 2004)

Table 1. Alewife Swimming Characteristics

Burst velocity	1.32 m/s for 10 s
Prolonged swimming velocity	0.63 m/s for 30 min
Sustained swimming velocity	0.22 m/s
Migration velocity against current (preferred)	0.40 m/s
Hold position	Below 0.30 m/s
Resting position	Below 0.15 m/s

Computer Simulations

- Outlet velocity of the water flow is higher than the inlet velocity of the water flow by 0.1 m/s each time water passes through one pooling area
- Pressure exerted on the baffle wall increases by 1.3 Pa for each fish pooling area
- Velocity would be at its highest point in the center of the incoming slot
- Final pooling area outlet conditions: velocity= 1.53 m/s, pressure= 182.69 pa

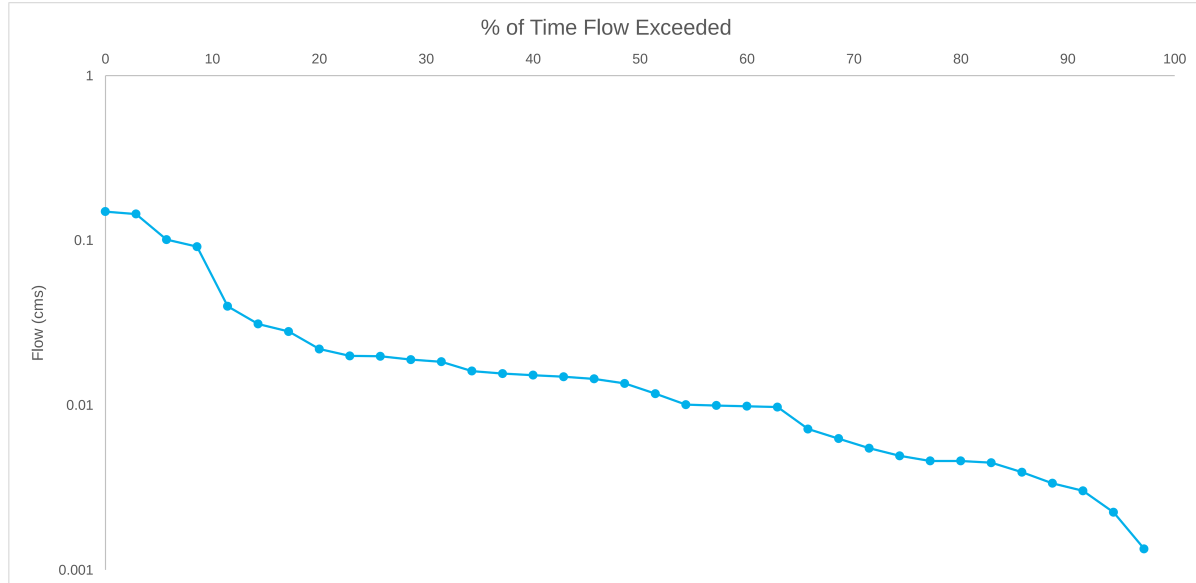

Figure 5. Flow Duration Curve for Sullivan's Pond

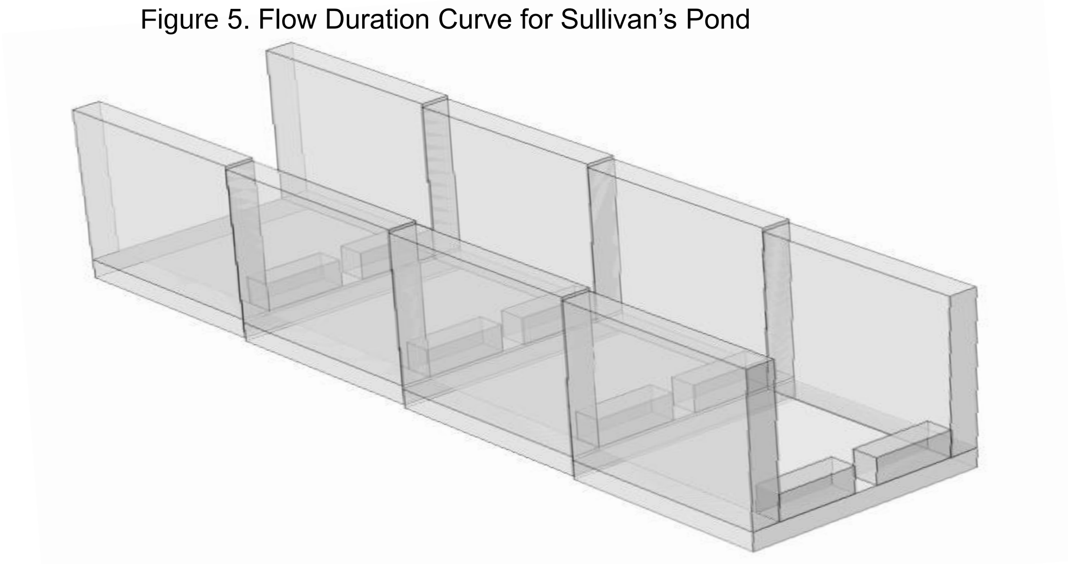

Figure 6. Schematic of Final Design Idea

Hydrologic Analysis

- The structure must conduct fish passage for the range of Q_{10}-Q_{90} flows and also handle the Q_{max} flood flow during a storm event
- Conducted by using the historical hydrometric data from the Water Office of Canada to predict the low flow (Q_{90}) and high flow (Q_{10}) that will be going through the structure
- Flow from Little Sackville River was sorted and prorated to our drainage areas of Sullivan's Pond, Lake Banook, and Lake Micmac
- By plotting the percent of time versus the logarithmic flow, a Q_{90} of 0.00626 m^3/s and a Q_{10} of 0.0564 m3/s were obtained
- Using the rational method equation and a climate change adjusted intensity-duration-frequency curve, the Q_{max} of a 100-year storm was determined to be 29.12 m^3/s

Structural Analysis

- A key component to the structural integrity of the fish passage is its ability to withstand the lateral earth pressures that are created by the soil it is installed within
- Required information: calculate the coefficient of lateral earth pressure at rest, effective friction angle of soil, overconsolidation ratio of soil, length of wall, unit weight of soil, and height of soil to determine the resultant horizontal force between wall and soil under the at-rest condition per unit length of wall (Coduto, Yeung, & Kitch, 2014)

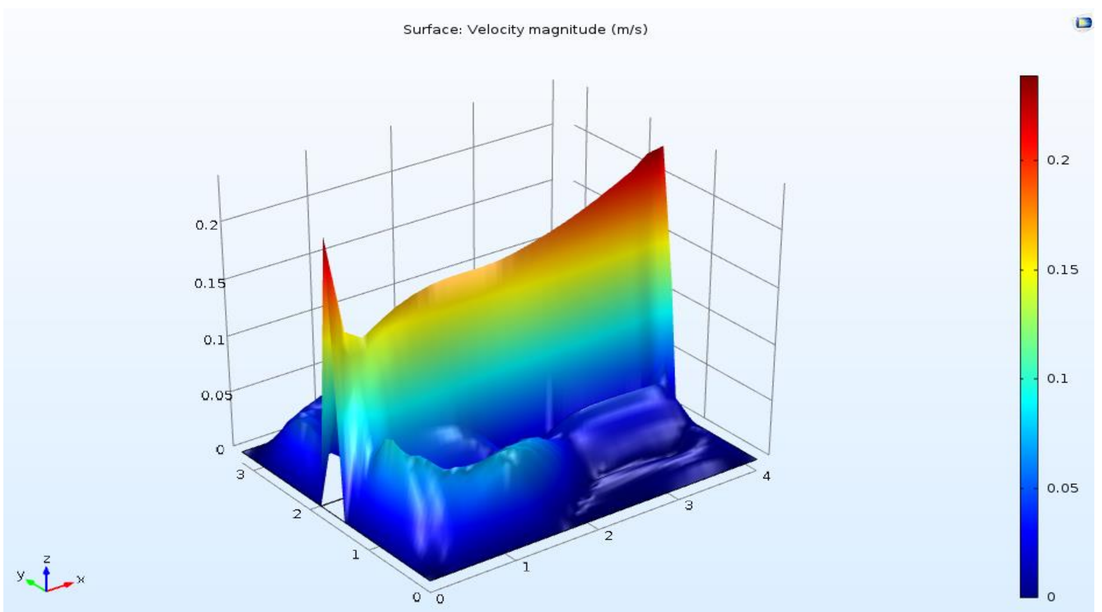

Figure 7. Velocity Profile of Water travelling through the First Pooling Area

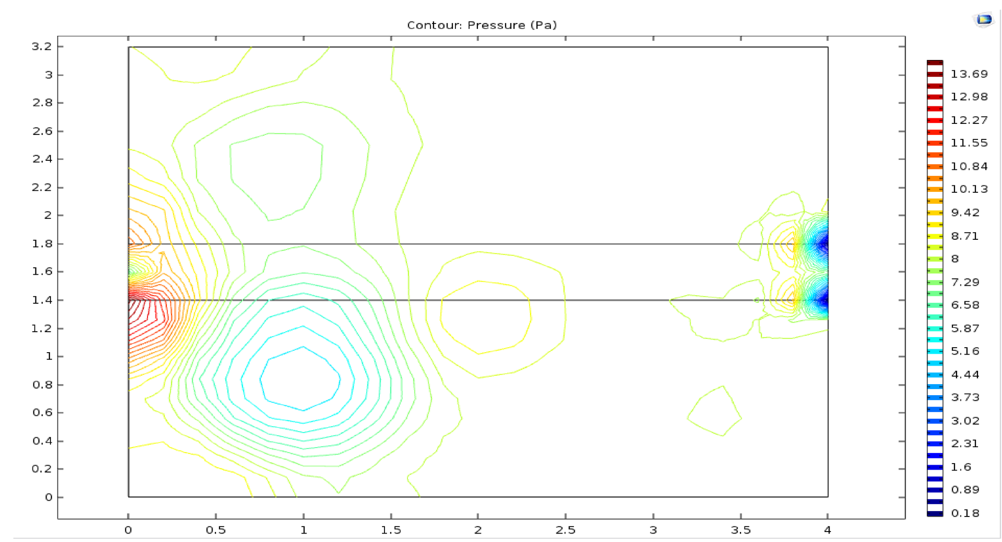

Figure 8. Pressure Profile created by Water travelling through First Pooling Area

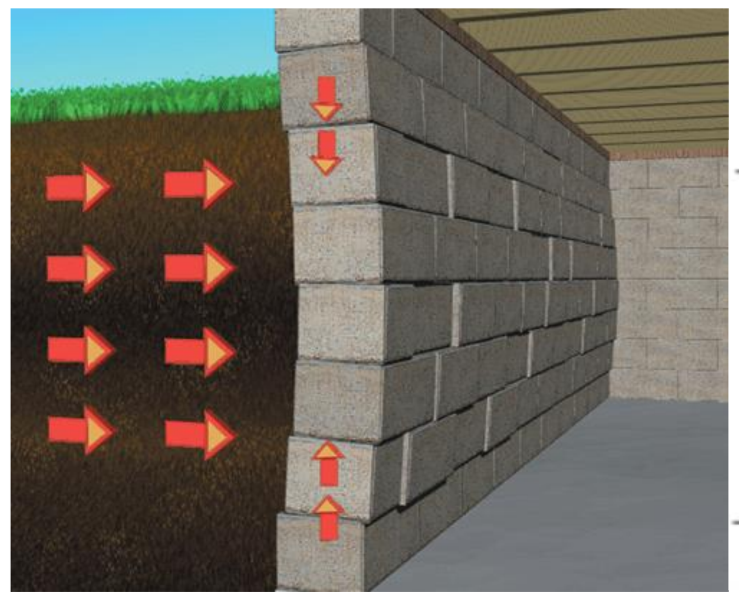

Figure 9. Image Demonstrating Lateral Earth Pressures and Dead Load (Thompson, 2006)

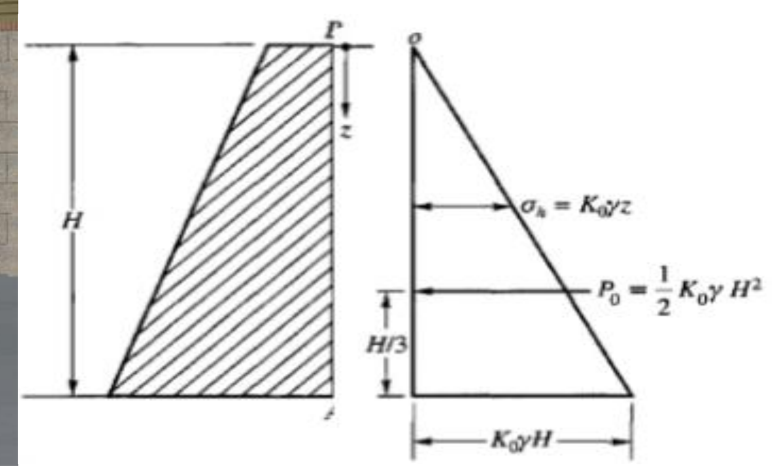

Figure 10. Diagram of Lateral Earth Pressure Equations (Parmar, 2012)

Conclusion and Recommendations

- As the flood flow cannot be supported, the existing structure must be replaced. Alterations must include fish passage by standards set by Department of Fisheries and Oceans
- Vertical slot design is recommended to allow fish to pass at all levels within the ladder (weaker fish swim at the bottom, stronger fish can swim at the top and jump) and to minimize maintenance requirements
- Sizing of the fish ladder should consist of 131 pools of 4m x 3.2m, with baffles that are 1.4m x 0.7m, and a slot opening of 0.4m to accommodate flood flows determined through a hydrologic analysis. Safety railings must be implemented in daylighted areas to ensure safety for the public. Concrete structural analysis and modeling simulations support these findings

References

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