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SIX GROUP

Client: Mary's Harbour, NL

Department of Civil Engineering

SAINT MARY'S RIVER HYDROELECTRIC PLANT

Introduction

Design of a Hydroelectric Facility to generate clean power to supplement current diesel power plant

The minimum requirements are:

- Installed Capacity: 600kW
- Energy Storage: 2400 kWh

Components needed include:

- Weir at head pond discharge
- Penstock
- Necessary gates to enable dewatering/maintenance
- Fish Passage for upstream Salmon migration
- Selection of Turbine type/capacity/setting

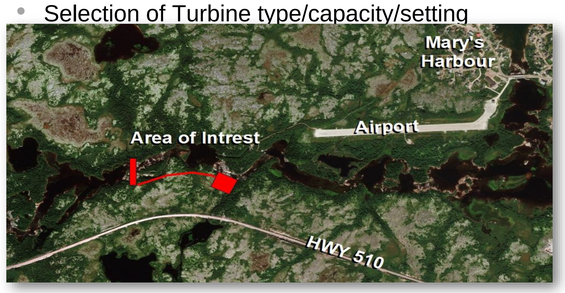


Figure 1 Area of Interest

Design Process

Background Data Collection
- Flow Data
- Historical Site information

Hydrologic Study
- Flow Duration Curve
- Class D Estimate

Intake and Penstock
- Hydraulic Power
- Class C Estimate

Detailed Design
- Turbine Selection
- Weir Sizing
- Class B Estimate

Design Details

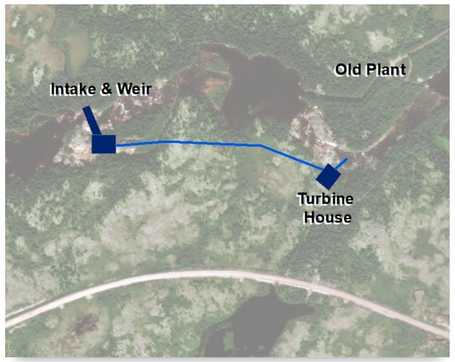


Figure 3 Proposed Penstock to Turbine layout

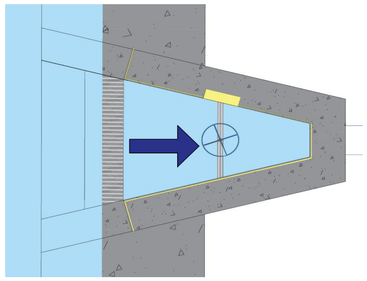


Figure 4 Intake Plan View

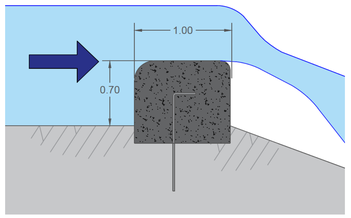


Figure 7 Weir Detail

Details of Penstock Design:

- 500m long, 1.8m diameter HDPE.
- Larger pipe diameter lead to smaller friction and minor loss.

Intake Details:

- 10m x 15m intake at 3% slope to 1.8m pipe
- Trash racks with fish screen
- Emergency sluice gate
- 0.7m (high) x 1.0m (deep) weir

Details of Fish Pass:

- Pool-type fish pass attached to weir
- Accommodates Salmon and Brook Trout

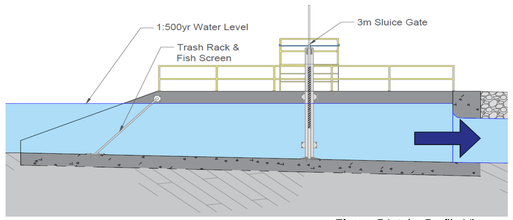


Figure 5 Intake Profile View

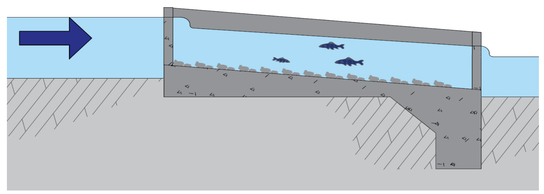


Figure 8 Fish Passage Profile

Turbine Selection and Design

Details of Turbine:

- Specific speed between 400-500 for Kaplan turbine to achieve efficiency of 90%
- High rotation speed leads to small turbine size
- Max draft height of 1.9m based on Newfoundland & Labrador atmosphere pressure

Kaplan Turbine	
Output power (kW)	950
Specific speed goal (metric)	400~500
Diameter of turbine(m)	1.2
Rotation speed (rpm)	360
Specific speed (metric)	421
Efficiency factor ϕ	1.7
Max draft height (m)	1.9

Hydraulic parameter	
Length (m)	500
Design discharge (m^3/s)	7.5
Diameter of pipeline (m)	1.8
HDPE pipe roughness (m)	1.50E-06
Reservoir Head (m)	15
Design minor loss factor	4
Viscosity (m^2/s)	1.31E-06

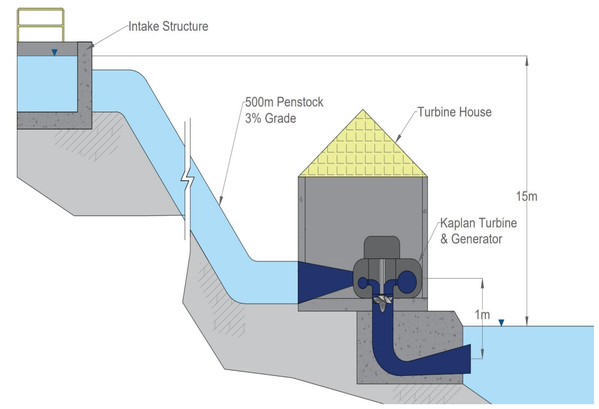


Figure 10 Sample Turbine Layout

Hydrologic Analysis

Watershed Delineation

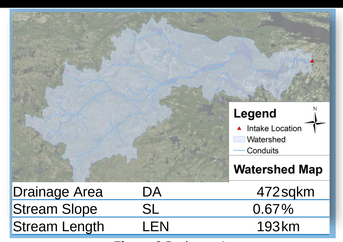
- Drainage area delineated to the proposed Intake structure using ArcGIS

HATCH Model Information

- Using orthographic imagery to determine watershed variables

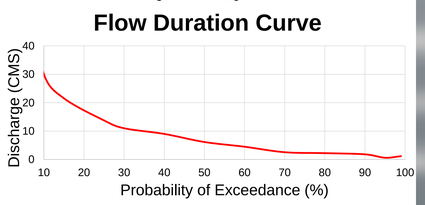
Flow Duration Curve

- Flow duration curve generated with HATCH empirical data as well as physical watershed scaling with adjacent rivers
- Best fit used to determine river design flow of 7.5 cubic meters per second



Drainage Area	DA	472sqkm
Stream Slope	SL	0.67%
Stream Length	LEN	193km

Figure 2 Drainage Area



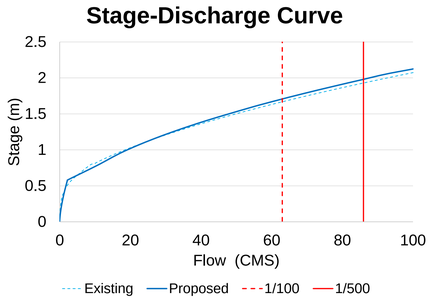
Hydraulic Analysis

Existing Stage Discharge Curve

- Existing channel leads to steep grade, thus critical flow will be experienced
- Relationship between flow and stage was determined

Proposed Stage Discharge Curve

- Proposed weir and intake will have the highest negative effects when turbine demand is zero



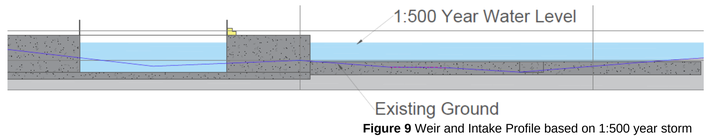


Figure 9 Weir and Intake Profile based on 1:500 year storm

Conclusion and Recommendations

- 7.5 CMS design flow, 13m net design head
- 500m 1.8m diameter HDPE penstock to turbine
- 2.5m high intake structure to withstand 1:500 year flow
- Sluice gate for emergency shutdown & trash racks with fish screen to prevent turbine damage
- 0.7m Weir at head pond with fish passage for salmon migration
- Turbine installed capacity of 950kW
- Class B estimate: $13,300,000.00

References:

- Dam Safety Guidelines, 2007. (2013). Edmonton, Alberta: Canadian Dam Association

Acknowledgements:

- Dr. Ian Hill – Industry Advisor
- Dr. Mysore Satish – Academic Advisor
- Andrew Treble – Canadian Hydro