Quidi Vidi Lake
Hydro Power Demonstration Project

The 17th Annual
Newfoundland Electrical and Computer Engineering Conference

Thursday, Nov. 8, 2007

Presented by
Eugene G. Manning, B. Eng
Candidate for Master of Engineering - Civil
Working with
Stephen E. Bruneau, PhD, P.Eng
Professor, Civil Engineering

IEEE Newfoundland and Labrador Section

Concept Description

A series of working and well displayed renewable energy generation sources on an urban walking trail

Comprised of a micro hydro generator a wind turbine and a solar array, metered and interpreted

This presentation describes the preliminary work on the micro hydro component of the installation

Primary attention paid to civil works, business and education plan

Purpose of Proposed Project

Raise public awareness of power generation options and consequences in light of heightened sensitivity to climate change

Display the potency of various renewable generation sources and describe the environmental impacts, new and offsetting

Demonstrate the potential for viable small scale initiatives in urban settings and in piggybacking on new or old infrastructure

Demonstrate synergistic approach to habitat renewal and improvement as part of a power generation project

Concept Background

Proponent has had commercial Non-Utility-Generation (NUG) interests over the previous decade, with niche interests in using existing infrastructure for low impact micro hydro generation.

Insurmountable Roadblocks: hydro power “moratorium”, lack of experience and will on behalf of utilities and regulators, no clear policy or initiatives to encourage green power in this Province.

There remains a need for public awareness and education so that informed choices can be made going forward.

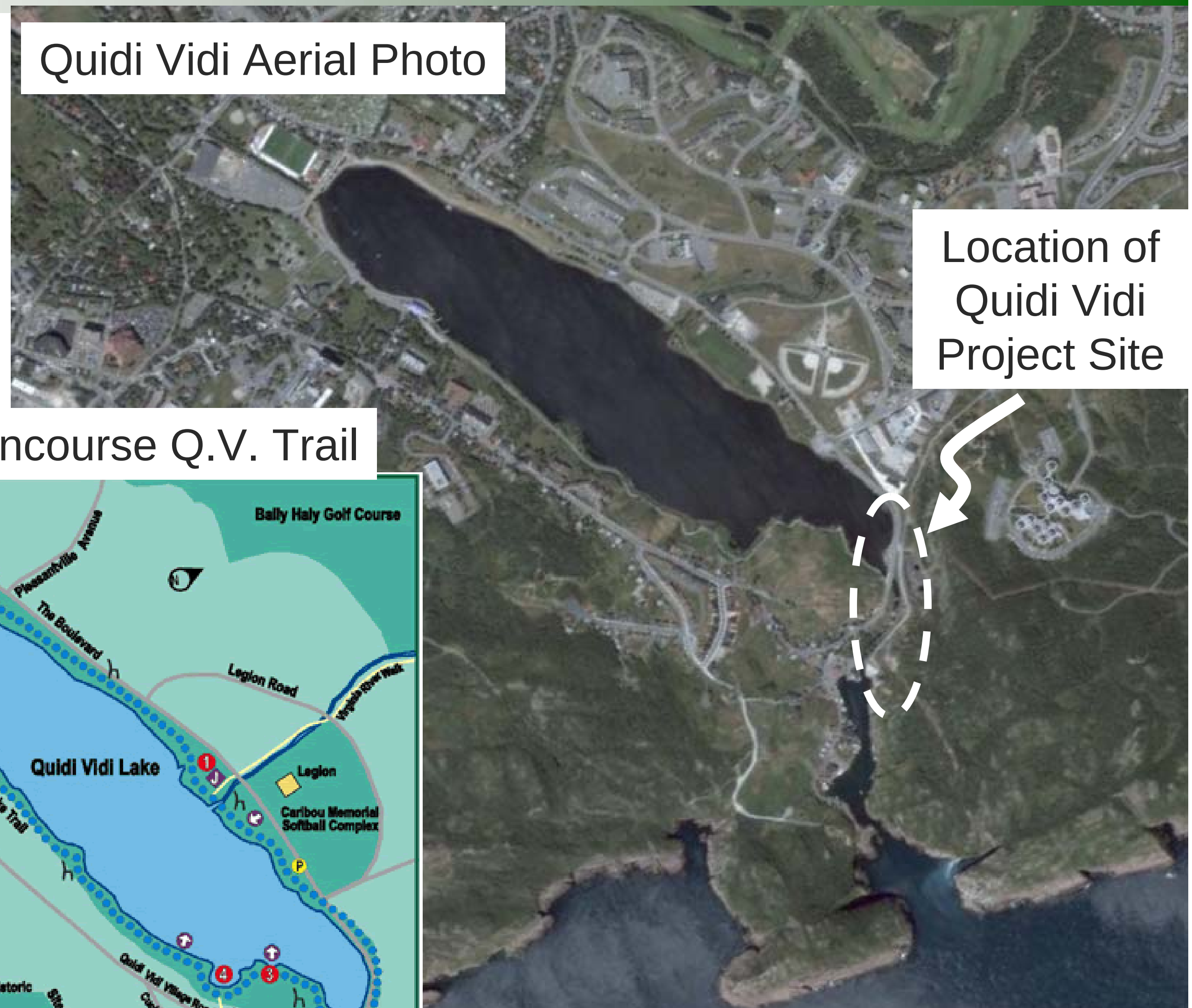
In 2005 a water control structure failure at Quidi Vidi, prompted the idea for this demonstration project.

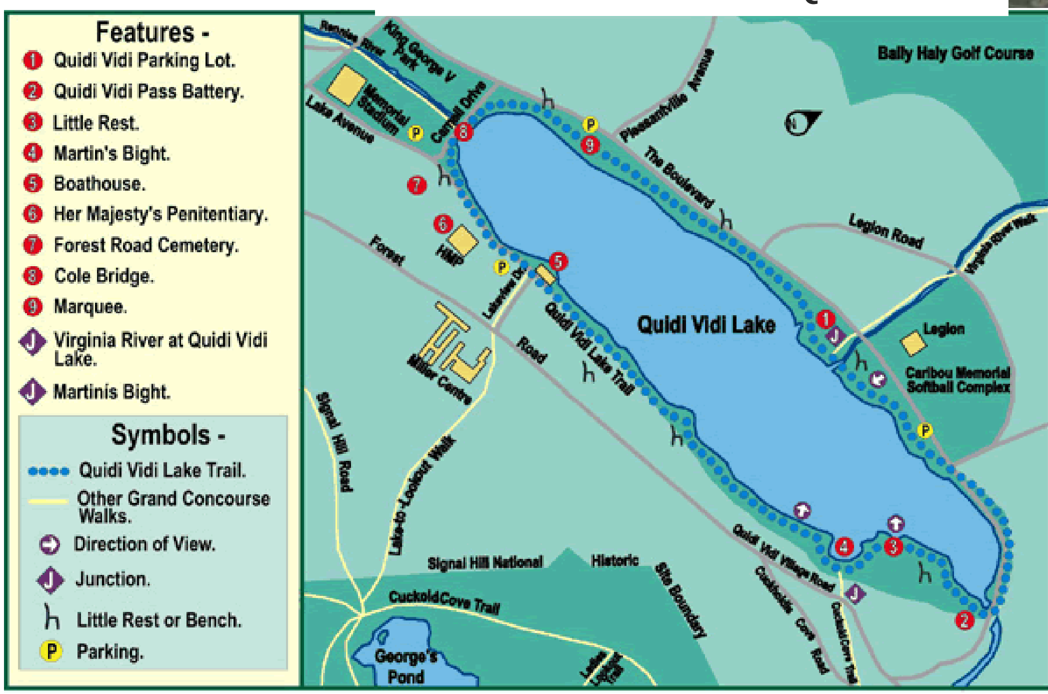
Site

Location of Quidi Vidi Site

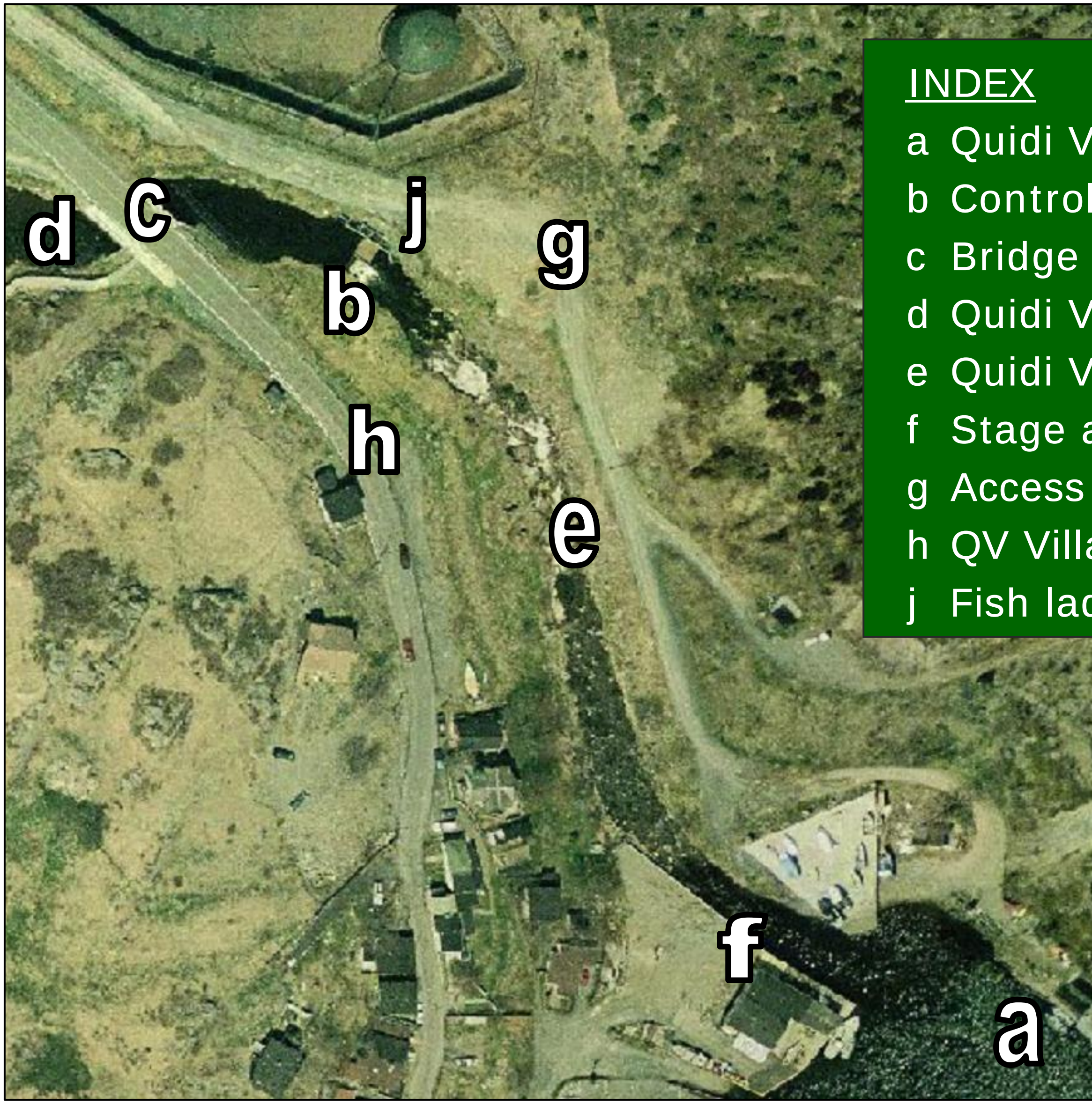
Approximate watershed is 32 sq kms (crosses over with City water supply, storm and sewage systems)

Site


Quidi Vidi Aerial Photo
Location of Quidi Vidi Project Site


Grand Concourse Q.V. Trail
Features -
1 Quidi Vidi Parking Lot.
2 Quidi Vidi Pass Battery.
3 Little Rest.
4 Martin's Bight.
5 Boathouse.
6 Her Majesty's Penitentiary.
7 Forest Road Cemetery.
8 Cole Bridge.
9 Marquee.
J Virginia River at Quidi Vidi Lake.
J Martinís Bight.
Symbols -
Quidi Vidi Lake Trail.
Other Grand Concourse Walks.
Direction of View.
Junction.
Little Rest or Bench.
P Parking.
Bally Haly Golf Course
Quidi Vidi Lake
Legion Road
Legion
Caribou Memorial Softball Complex
The Boulevard
Pleasantville Avenue
Lake Avenue
Memorial Stadium
Forest Road
HMP
Signal Hill Road
Lake-to-Lookout Walk
Signal Hill National Historic Site Boundary
Cuckold Cove Trail
George's Pond
Quidi Vidi Village Road
Cuckolds Cove Road

Site Index



INDEX

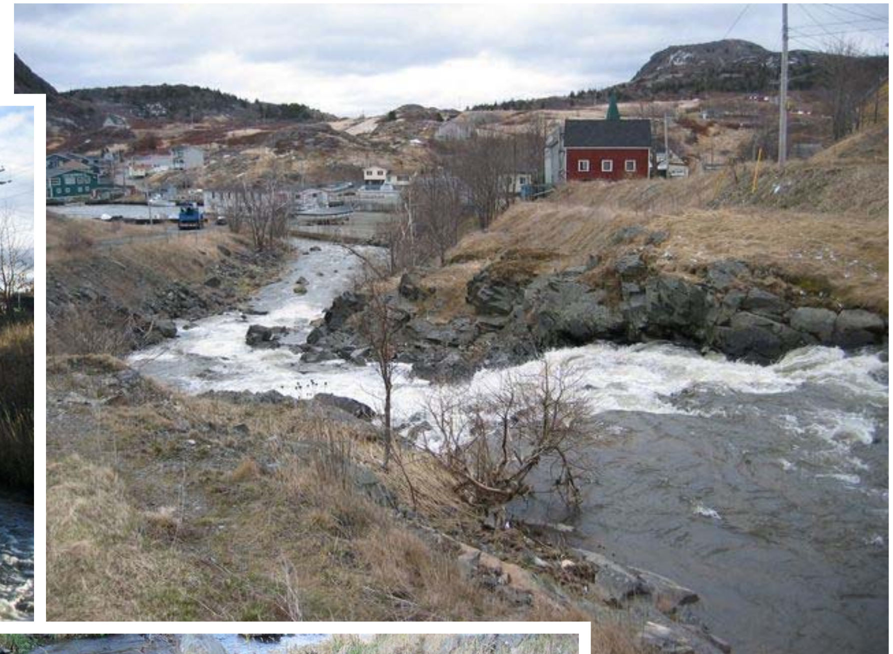
- a Quidi Vidi Gut
- b Control structure
- c Bridge
- d Quidi Vidi Lake
- e Quidi Vidi River
- f Stage area
- g Access road
- h QV Village road
- j Fish ladder

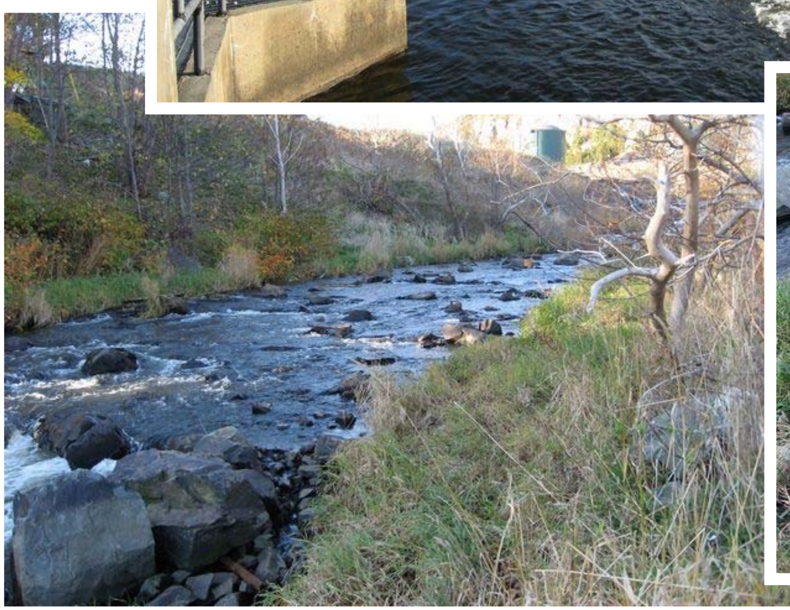
Site Photos

Control Structure

Site Photos

River

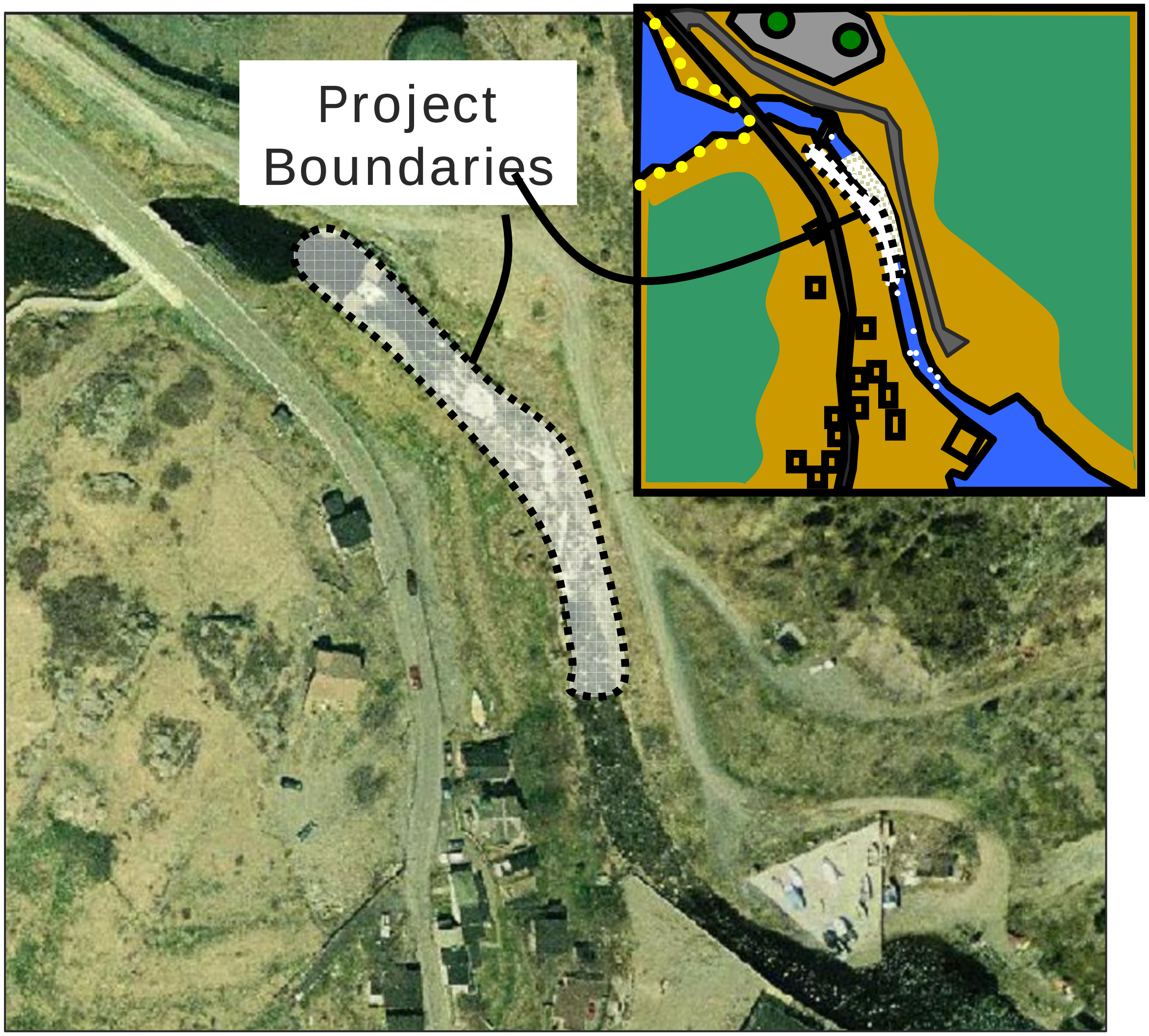




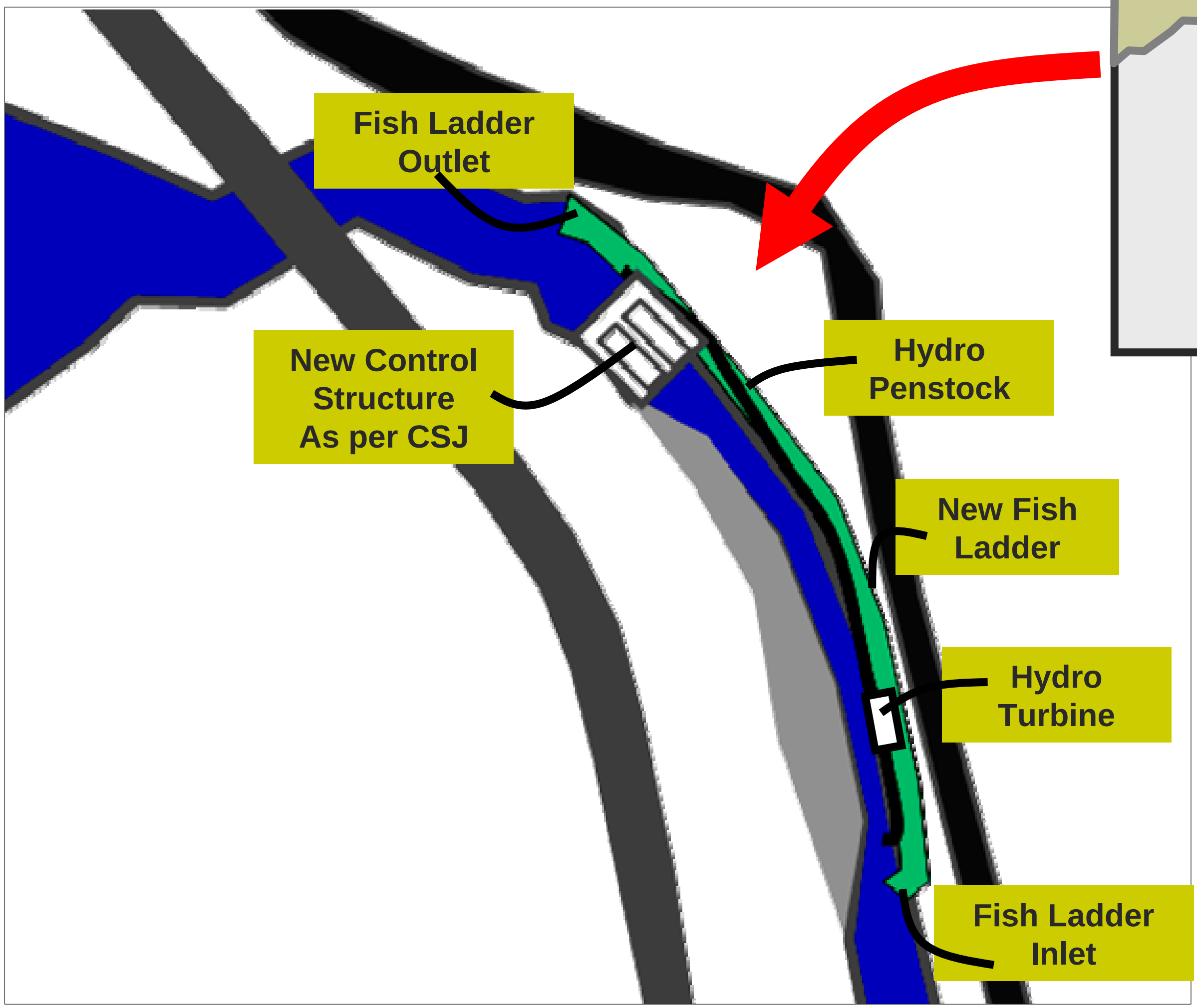
Site Photos

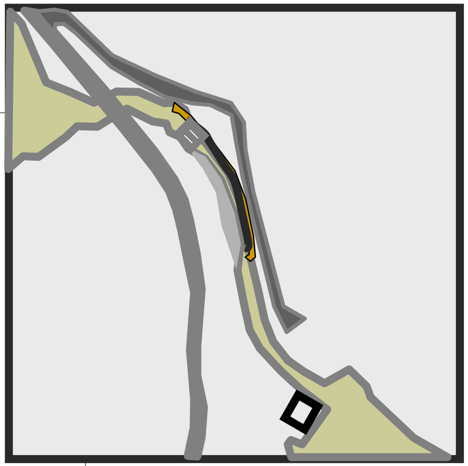
Lake/Flood

Project Boundaries



Infrastructure Overview





Approximated Hydrology –

Watershed Output and Lake Storage

Figure from Natural Resources

Mean Runoff = 1.4 cms

Estimated Quidi Vidi Watershed Output

	Est Area	Est Rate	Est. Runoff	Est. Runoff	
	sqmi (2.59)	cfs/sqmi	cfs	cms (28.32)	
Mean	12.36	4	49.42	1.40	
Min		58%		0.81	July
Max		146%		2.04	April

Numbers from Acres, 1989

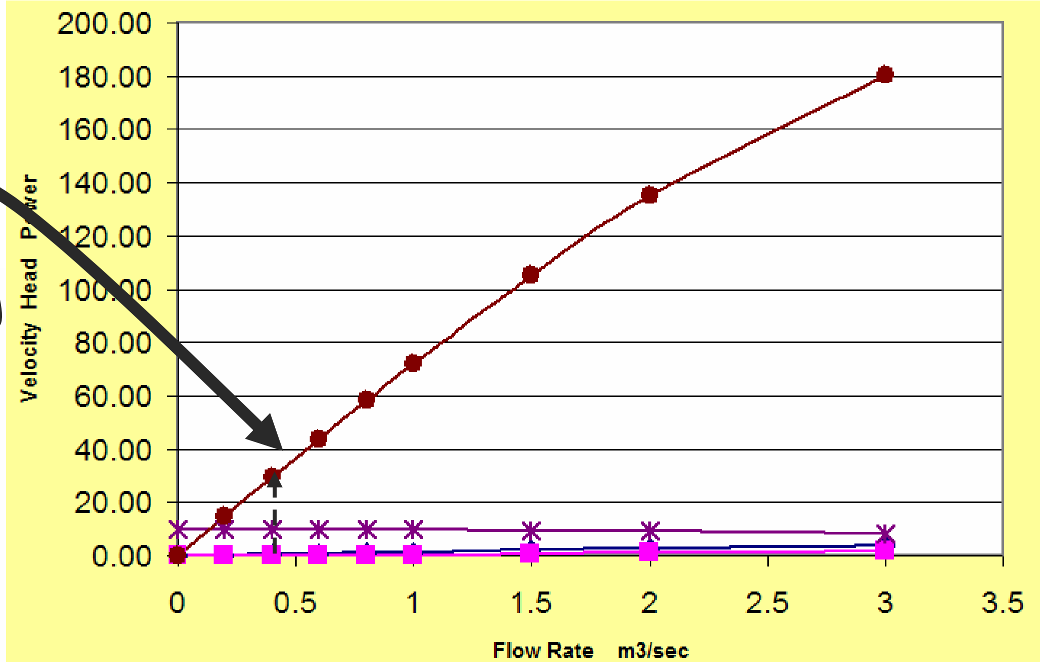
Q.V. Lake Storage

Approx Area	QV Pond Elevation	Top of Invert	Drawdown Max	Volume Approx	Storage @1.0cms	Storage
sqkm	m	m	m	m^3	sec	days
1	12	12	1	998001	998001	12

*

Sample Output Calculations

0.4 cms = Half of the Minimum flow
Power output is 30 KW



Development of Quidi Vidi Site

Quidi Vidi Site

Data

assumed		Penstock	
Length	L	30	
Gross Head	h	10	
Pipe Diameter	D	1	
Pipe Area	A	0.7854	
Hazen William	C	120	
Fitting Loss Coefficient	K	2	
turbine/generator efficiency	e	0.75	
calculated			
Flow Velocity	V	= Q/A	
Head Loss in Pipe	hL1	= Lx(Vel/0.355*C*Dia^0.63)^1.852	
Head Loss in Fittings	hL2	= Vel^2/(2*g)*K	NOTES m above msl
Net Head	hnet	= h-(hL1+hL2)	Elev of Intake poi 12
Power	P	= hnet*Q*e*g	Elev of outfall 2

Sample Economics

ECONO DATA

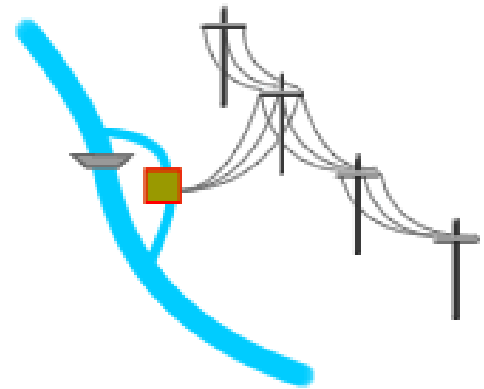
Plant Capacity KW	50
Plant Capex CAD	$ 150,000
Plant Opex at 10% Revenue	$ 15,000
Energy Price / kWH	**$ 0.090**
Plant Capacity Factor	0.95
Hours per year (capfac*hrs/yr)	8322
Revenue CAD	$ 37,449.00
Interest rate NPV factor	7%

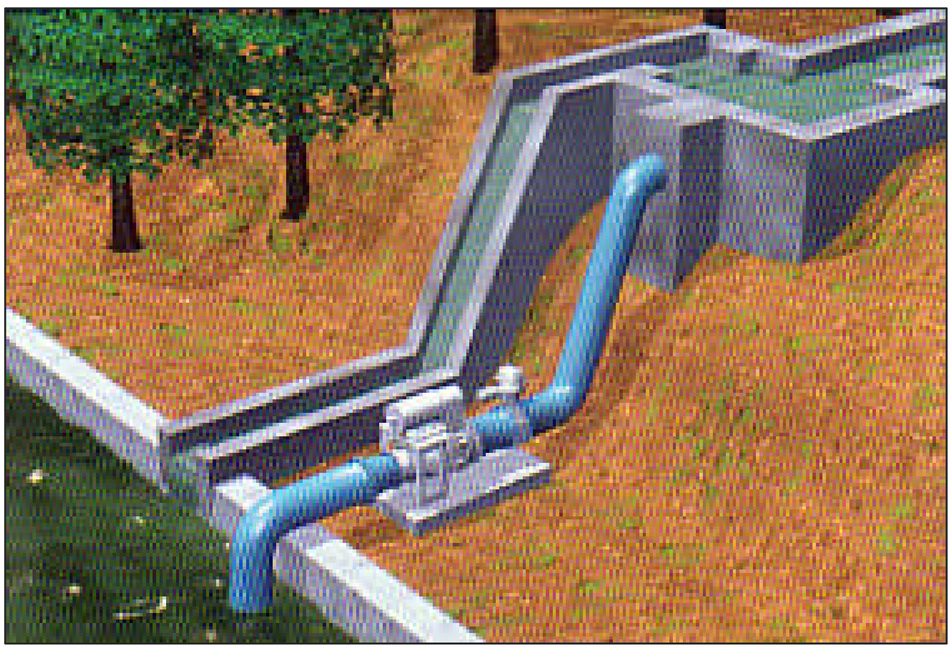
Half of Annual Mean Flow = 0.7 cms
Power output at 0.7 cms = 50 KW

Year	CAPEX	OPEX	Revenue	Balance	Cumulative Balance	
2008	$ 150,000	$ 15,000	$ 37,449	$ (127,551)	$ (127,551)	
2009	$ -	$ 15,000	$ 37,449	$ 22,449	$ (105,102)	
2010	$ -	$ 15,000	$ 37,449	$ 22,449	$ (82,653)	
2011	$ -	$ 15,000	$ 37,449	$ 22,449	$ (60,204)	
2012	$ -	$ 15,000	$ 37,449	$ 22,449	$ (37,755)	
2013	$ -	$ 15,000	$ 37,449	$ 22,449	$ (15,306)	
2014	$ -	$ 15,000	$ 37,449	$ 22,449	$ 7,143	
2015	$ -	$ 15,000	$ 37,449	$ 22,449	$ 29,592	
2016	$ -	$ 15,000	$ 37,449	$ 22,449	$ 52,041	
2017	$ -	$ 15,000	$ 37,449	$ 22,449	$ 74,490	
2018	$ -	$ 15,000	$ 37,449	$ 22,449	$ 96,939	
2019	$ -	$ 15,000	$ 37,449	$ 22,449	$ 119,388	
2020	$ -	$ 15,000	$ 37,449	$ 22,449	$ 141,837	
2021	$ -	$ 15,000	$ 37,449	$ 22,449	$ 164,286	
2022	$ -	$ 15,000	$ 37,449	$ 22,449	$ 186,735	
2023	$ -	$ 15,000	$ 37,449	$ 22,449	$ 209,184	
2024	$ -	$ 15,000	$ 37,449	$ 22,449	$ 231,633	
2025	$ -	$ 15,000	$ 37,449	$ 22,449	$ 254,082	
	150000	*270000*	*674082*	*254082*	16%	irr
					$234,998.53	npv

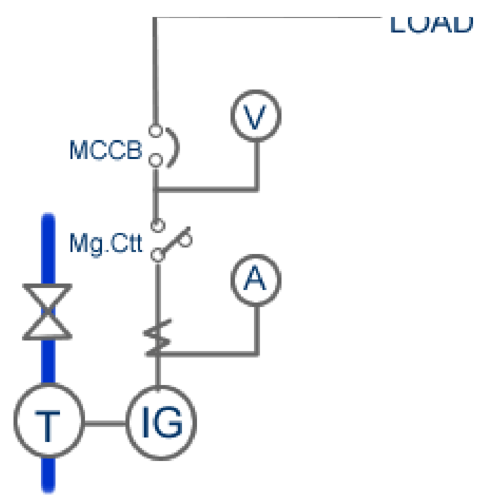
Basic Grid Intertie, Conceptual View

Based on Toshiba E-Kids* Units





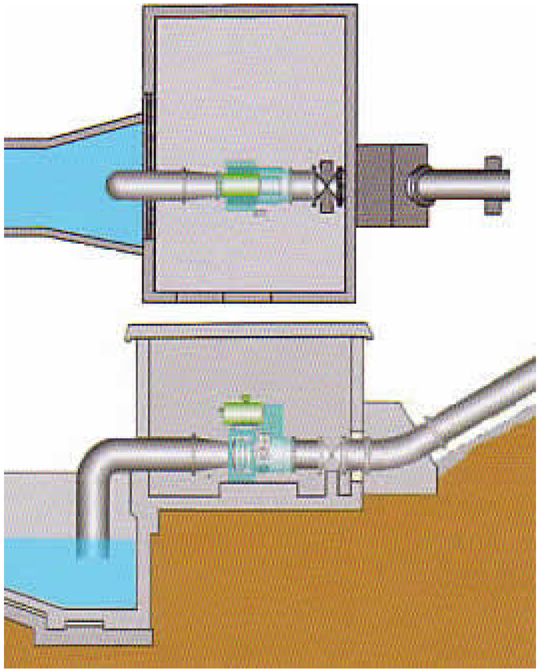
T = Turbine
IG = Induction Generator
Mg.Ctt = Magnetic Contactor
MCCB = Molded Circuit Breaker

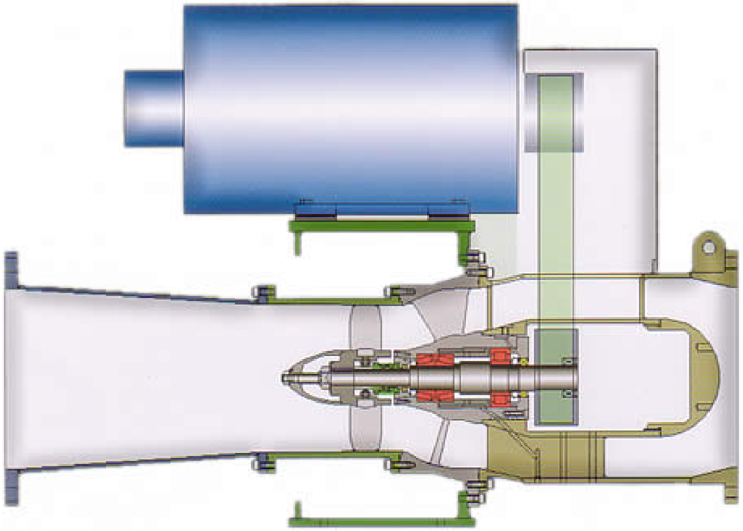


Power House, Generation Unit

Based on Toshiba E-Kids* Units

GENERIC POWER HOUSE SKETCH

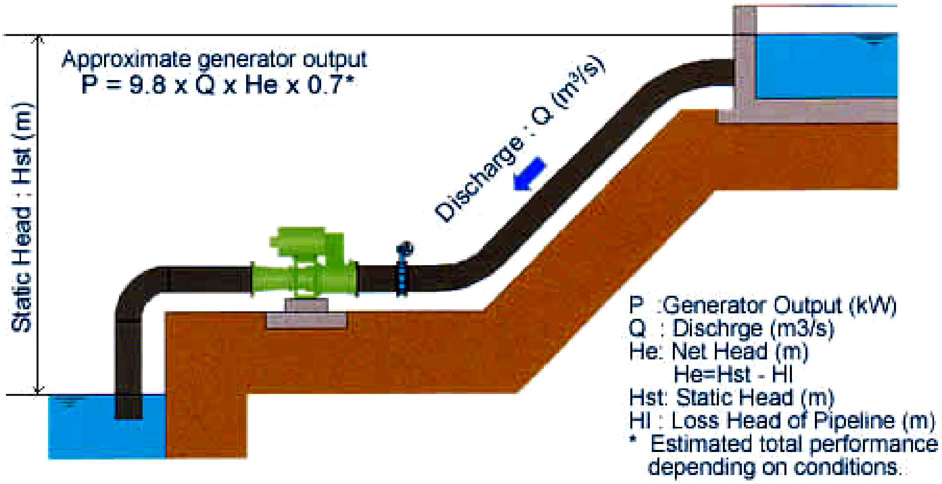




TURBINE AND GENERATOR SECTION

Sample Equipment Specifications

Based on Toshiba E-Kids* Units



INDUCTION GENERATOR

Frame Type : Drip Proof
Rotor Type : Squirrel Cage Type
Number of Pole : 4 or 6 Poles
Synchronous Speed:
1000 or 1500 min^{-1} (50 Hz)
1200 or 1800 min^{-1} (60 Hz)
Type of Rating : Continuous
Rated Voltage :200 V (75 kW or below)
400 V (90 kW or above)
Number of Phases :Three Phases
Frequency : 50 Hz or 60 Hz

SYNCHRONOUS GENERATOR

Frame Type : Drip Proof
Rotor Type : Revolving Field Type
Number of Pole : 6 Poles
Synchronous Speed :
1000 min^{-1} (50 Hz)
1200 min^{-1} (60 Hz)
Type of Rating : Continuous
Rated Voltage : 200 V
Number of Phases: Three Phases
Frequency : 50 Hz or 60 Hz
Excitation System: Brush-less Type

PROTECTION

Short Circuit Turbine
Over Current
Grounding
Over Speed
Power Transmission Fault Generator

MAINTENANCE

Bearings Every 5 years
Mechanical Seal Every 5 years
Belt for Power Transmission Every year
Lubrication Oil Every year
Bearings Every 3 years

GENERATOR OUTPUT ESTIMATION

Environmental Impact – *Displaced CO_2*

Natural Resources Canada | Ressources naturelles Canada

Canada

RETScreen® International

Clean Energy Project Analysis Software

Small Hydro Project Model

Approximate Tons of CO2 per MWhr	Average Annual QV Output MW	Hours per year hr	Annual Energy Output MWhr	Tons of CO2 Displaced tons
0.975	0.05	8760	438	**427**

Note also:

			tons
21	tonnes CO_2 =	1 tonne CH_4	**20**
310	tonnes CO_2 =	1 tonne N_2O therefore	**1**

Hydro Power Demonstration Project

Stephen Bruneau, PhD, P.Eng