Cowichan Lake Weir
Lake Pumping and Coldwater Release Options

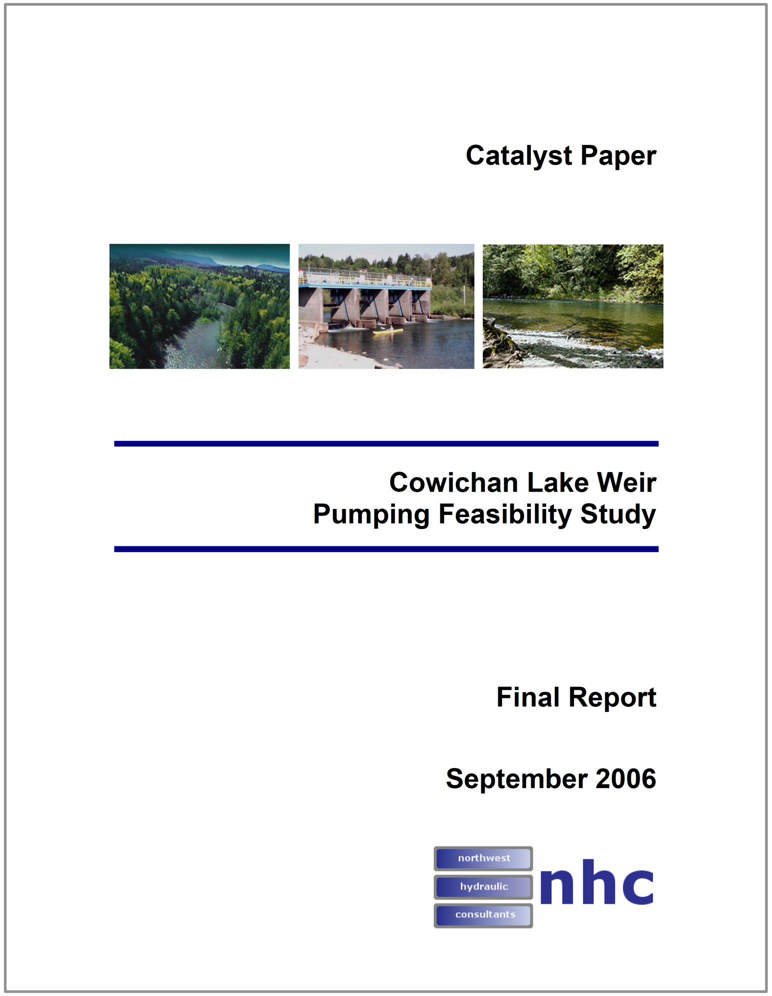
Barry Chilibeck PEng

nhc

Background

In 2006, NHC completed a conceptual or feasibility-level study examining the potential for a lake pumping station located at the current weir.

A link to a digital PDF copy will be provided to the Board for distribution.


Catalyst Paper

Cowichan Lake Weir
Pumping Feasibility Study

Final Report

September 2006

northwest hydraulic consultants nhc

Feasibility Design Options

2 options were examined in the feasibility study:

Option A – Lake pumping with a cold water supply pipeline

Option B – Lake pumping with a surface water supply

Both options were constructed on the left bank of the existing weir.

Design Criteria

The study used the conditions:

- Minimum lake elevation 161.26 m
- Weir crest elevation 162.37 m
- Minimum flow 7 m^3/s

Designed to operate infrequently – every 3 to 5 years continuously for up to 100 days.

Design Criteria

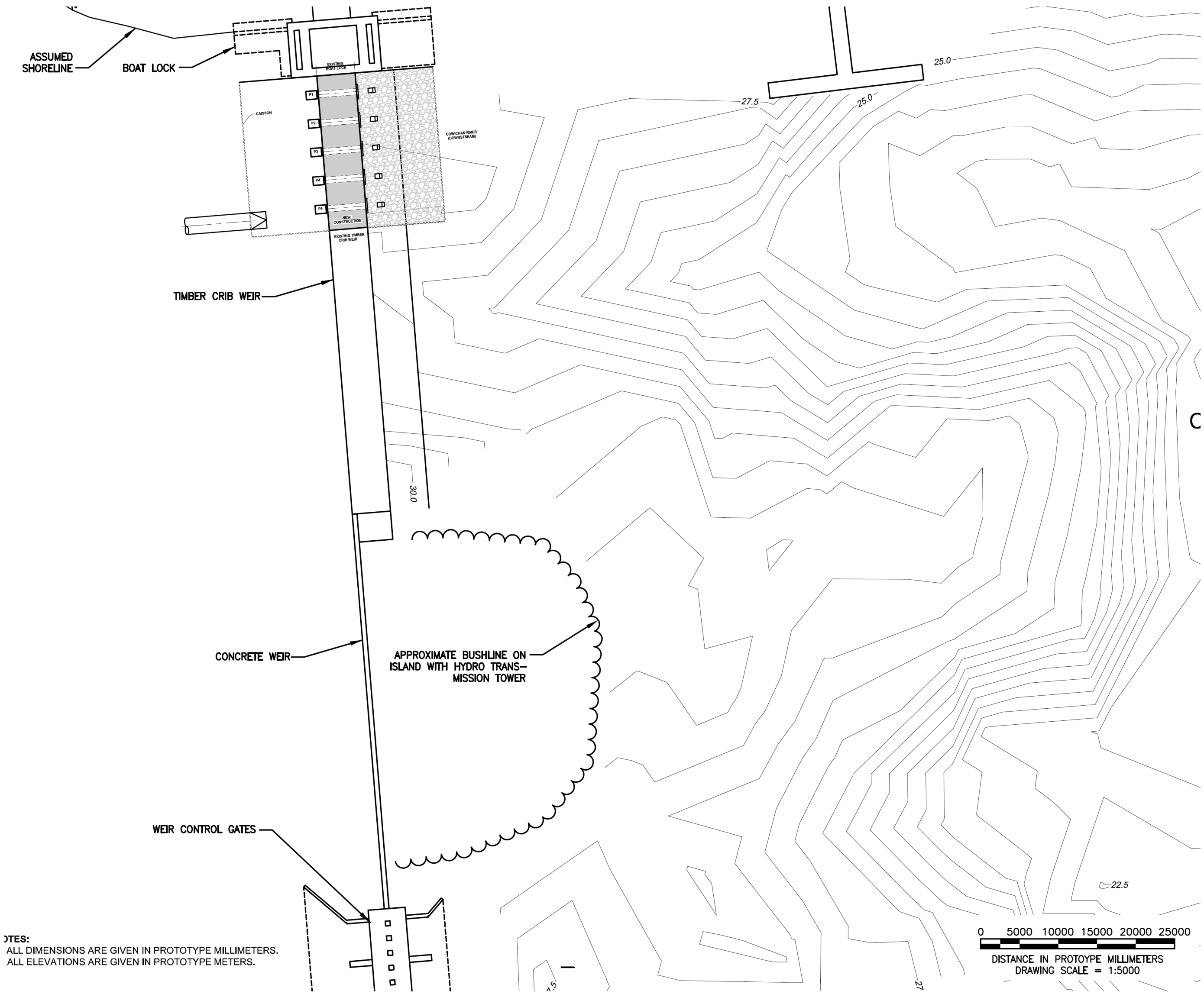
- Minimize civil works and off site impacts
- Minimize potential for fish entrainment impacts
- Safety for boaters and recreational use
- Flexible delivery of flows using up to 5 mixer-type pumps
- Incorporation of a 2.1 m dia. deepwater supply pipeline and surface water intakes
- Erosion protection installed downstream

Data Available at the time…

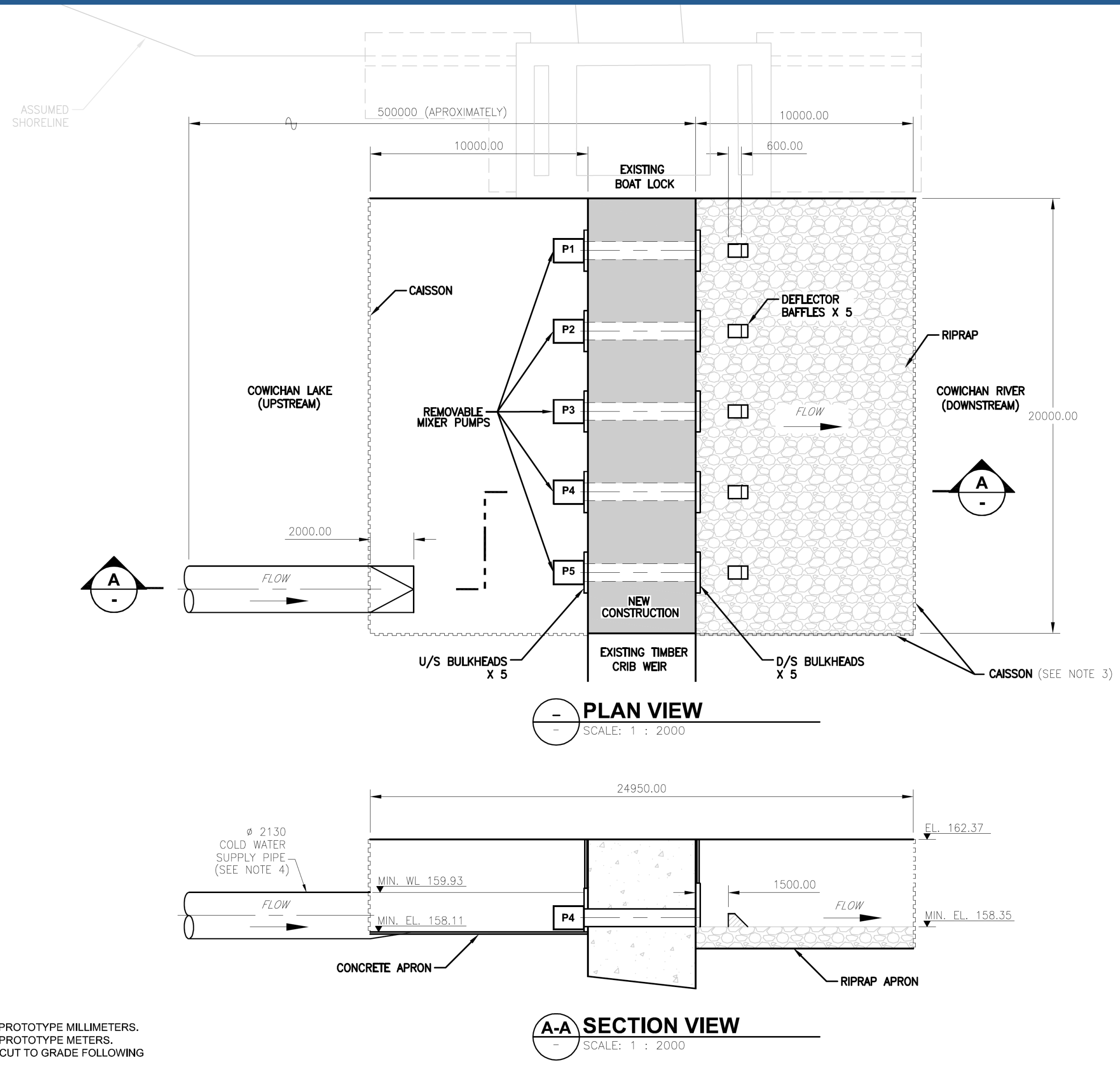
- Flow and water level data
- Climate data
- Limited bathymetric data
- Limited limnological data
- Limited design data….

Hmmmm?

Feasibility Study Project Location

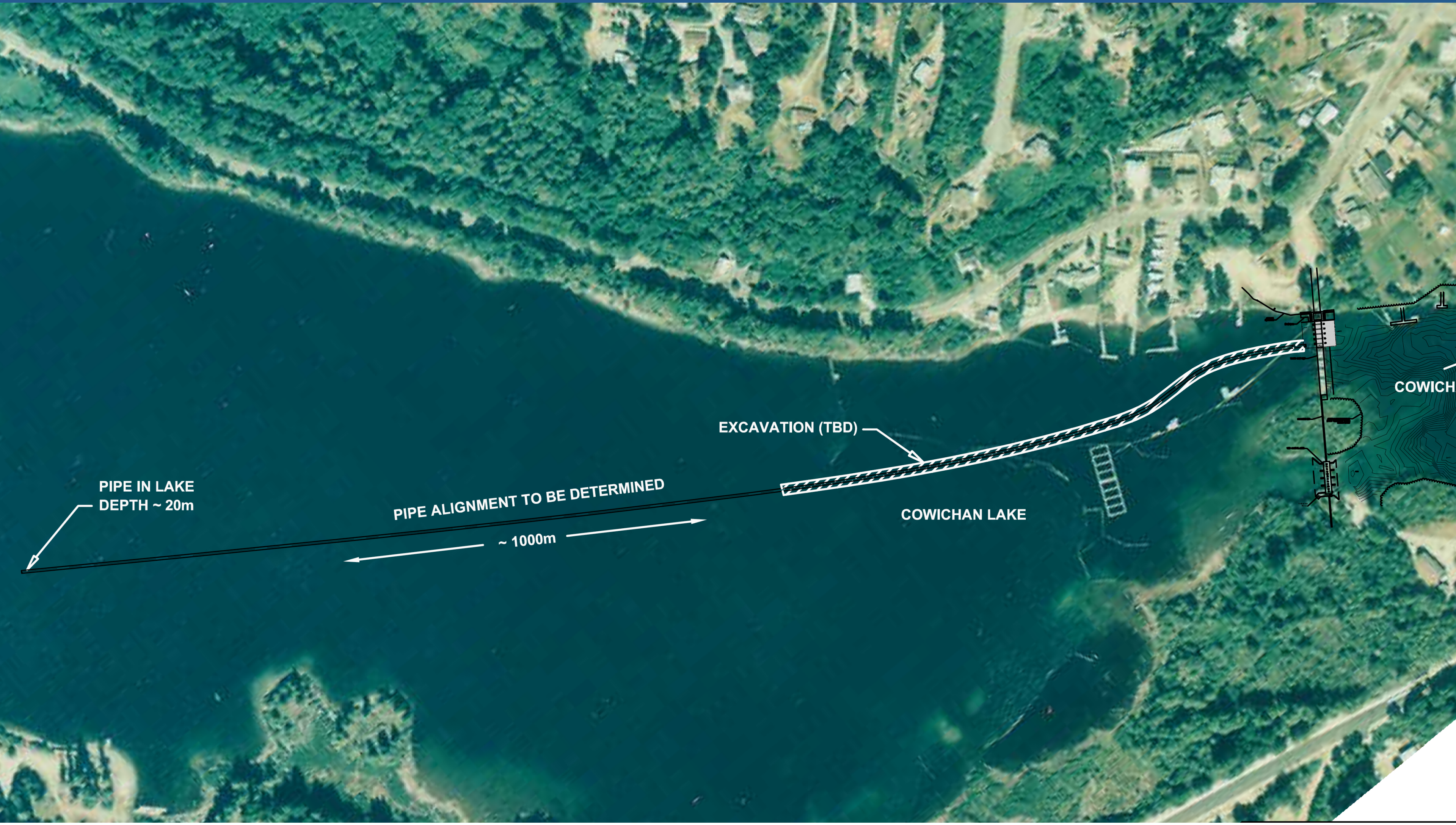


Option A – Deepwater Pipeline and Pump

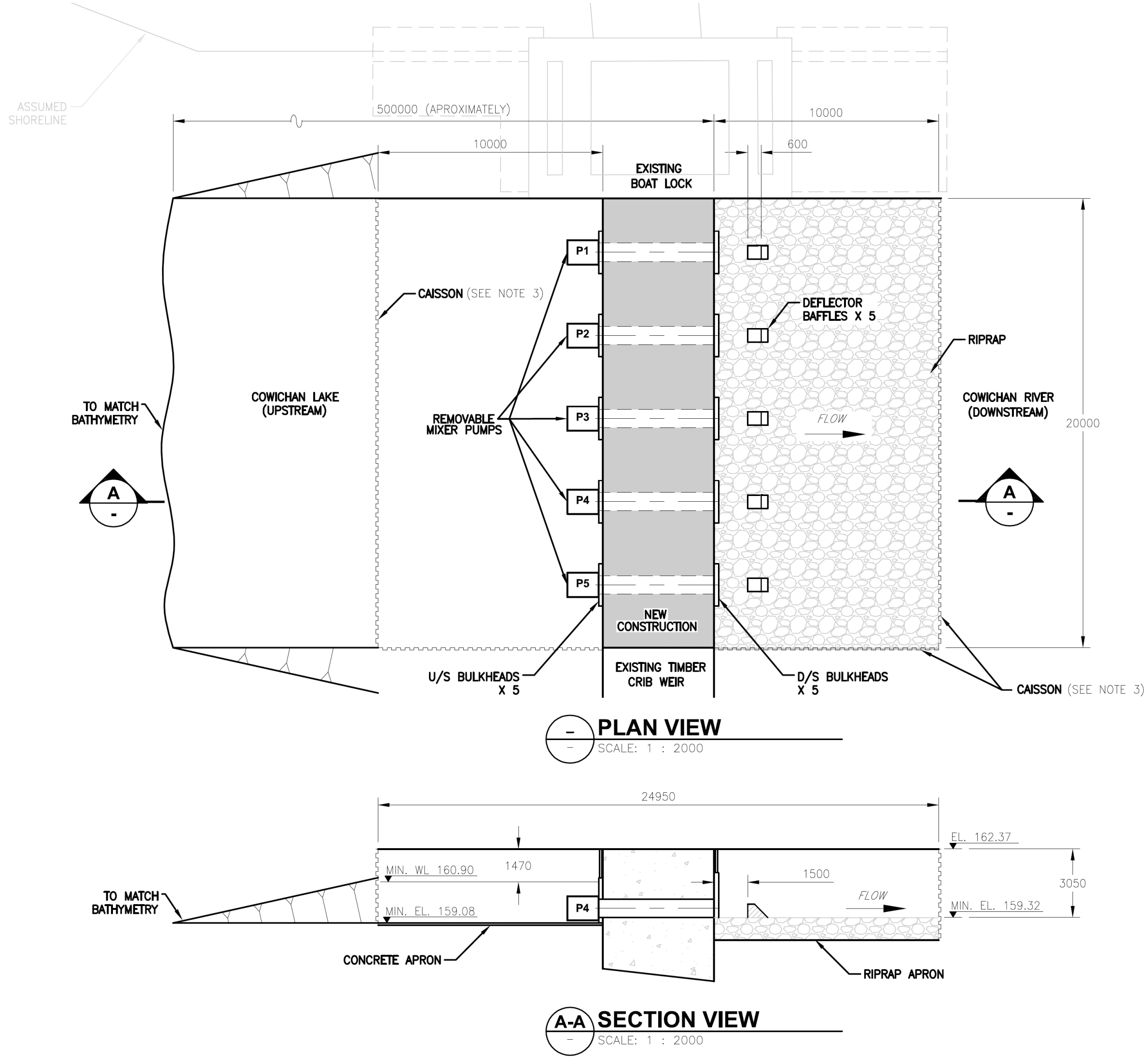


NOTES:
1. ALL DIMENSIONS ARE GIVEN IN PROTOTYPE MILLIMETERS.
2. ALL ELEVATIONS ARE GIVEN IN PROTOTYPE METERS.
3. DOWNSTREAM CIASSON TO BE CUT TO GRADE FOLLOWING CONSTRUCTION.
4. SUPPLY PIPE LOCATION TO BE DETERMINED.

Option A – Deepwater Pipeline and Pump



Option B – Surface Water Pump



NOTES:
1. ALL DIMENSIONS ARE GIVEN IN PROTOTYPE MILLIMETERS.
2. ALL ELEVATIONS ARE GIVEN IN PROTOTYPE METERS.
3. DOWNSTREAM CAISSON TO BE CUT TO GRADE FOLLOWING CONSTRUCTION.

Option A Costs

	Item	Unit	Rate	Quantity	Cost
1	Installation of sheet pile caisson	m^2	$270	500	$135,000
2	Demolition of existing weir	LS			$50,000
3	Excavation of caisson	m^3	$50	500	$25,000
4	Metalwork	kg	$5	40,000	$200,000
5	Sluice Gates	ea.	$20,000	5	$100,000
6	HDPE pipeline	m	$1,250	1,000	$1,250,000
7	Structural concrete	m^3	$1,200	904	$1,084,800
8	Riprap	m^3	$100	100	$10,000
9	Mixer Pumps and Support	ea.	$51,000	5	$255,000
Subtotal					$3,109,800
Detail Design and Engineering (7%)					$217,686
Construction Supervision and Environmental Mitigation (5%)					$203,180
Project Contingency (15%)					$466,470
Total Project Estimate					$3,949,446

Option B Costs

	Item	Unit	Rate	Quantity	Cost
1	Installation of sheet pile caisson	m^2	$270	500	$135,000
2	Demolition of existing weir	LS			$50,000
3	Excavation of caisson	m^3	$50	500	$25,000
4	Metalwork	kg	$5	40,000	$200,000
5	Sluice Gates	ea.	$20,000	5	$100,000
6	Structural concrete	m^3	$1,200	904	$1,084,800
7	Riprap	m^3	$100	100	$10,000
8	Mixer Pumps and Support	ea.	$51,000	5	$255,000
Subtotal					$1,859,800
Detail Design and Engineering (7%)					$130,186
Construction Supervision and Environmental Mitigation (5%)					$92,990
Project Contingency (15%)					$278,970
Total Project Estimate					$2,361,946

Operational Costs

- Use of up to 5 – 37 kW 600 V Flygt mixer pumps
- $500 per day at current BCH rates
- $7,000 per month for back-up diesel generators
- $50,000 per year for operations and maintenance (mobilization – removal – repairs – storage)

Data Gaps Identified

- Temperature monitoring and assessment of the lake outlet and upper Cowichan River
- Additional bathymetric surveys upstream and downstream of the weir
- Limnological monitoring and depth-integrated sampling in Cowichan Lake
- Assess potential fish entrainment and mitigation
- Assess geotechnical conditions and preliminary design requirements

Preliminary Design Questions

- Is 20 m depth enough for 10°C water?
- Value engineering and design to avoid a large costly sump?
- New low head pumping technology?
- Cost-benefit of pipeline length relative to depth and ambient hypolimnetic temperature?
- What downstream aquatic benefits can be realized from a cold water supply on Cowichan Lake?

Limnology

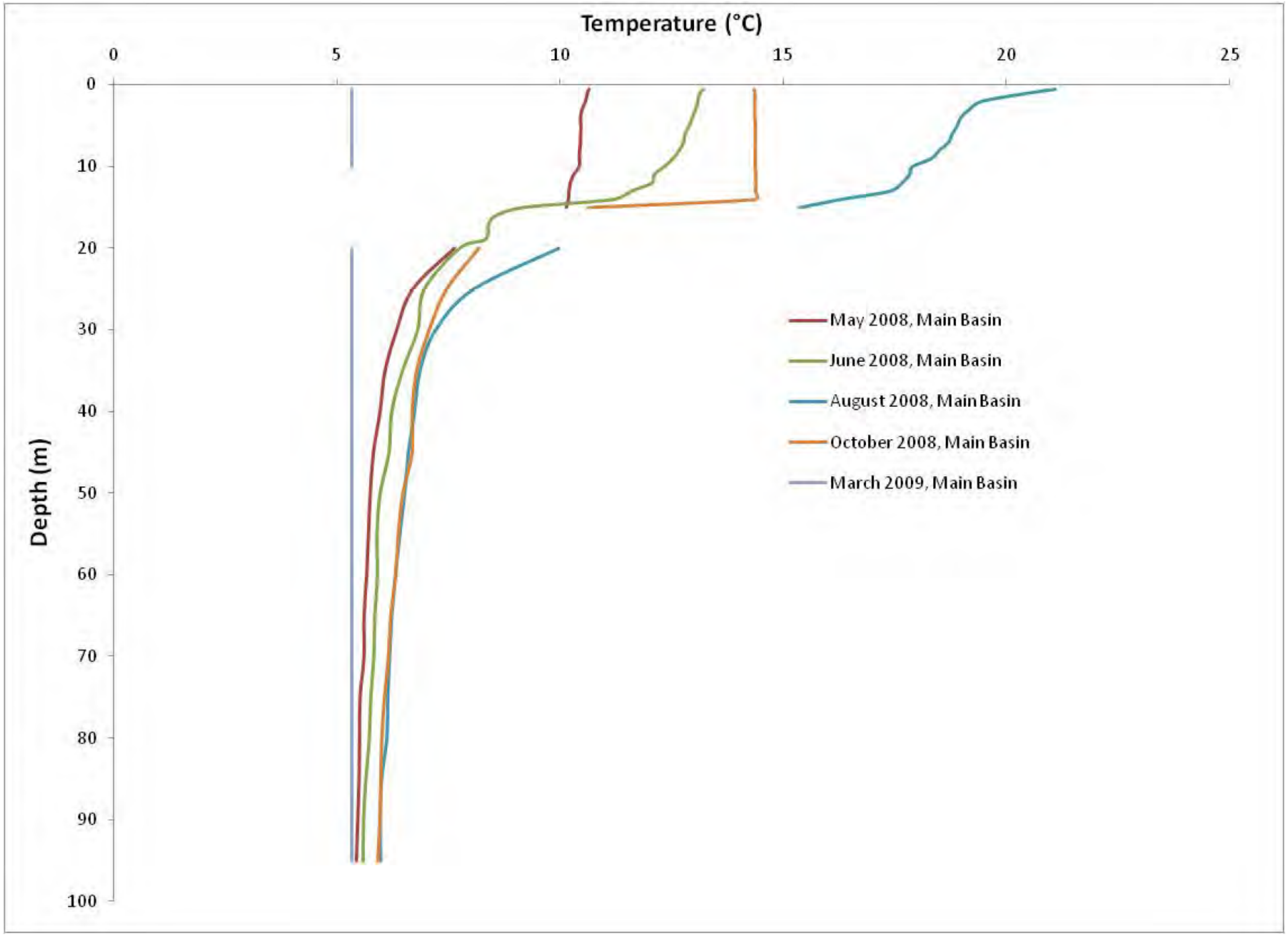


Figure 7. Seasonal water temperatures measured at 1m to 5 m metre intervals in Cowichan Lake in the main basin (Site E217509).

Mixer Pump Design Curves

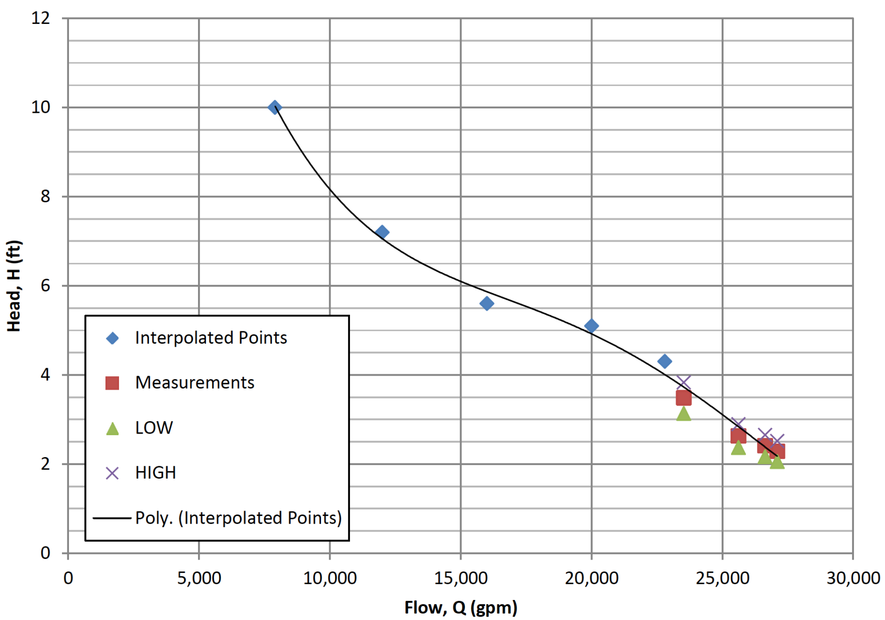


Figure 3-1: Total Dynamic Head Rating Curve for Flygt Model 4680 with a 17 Degree Impeller

Downstream Aquatic Benefits - Example

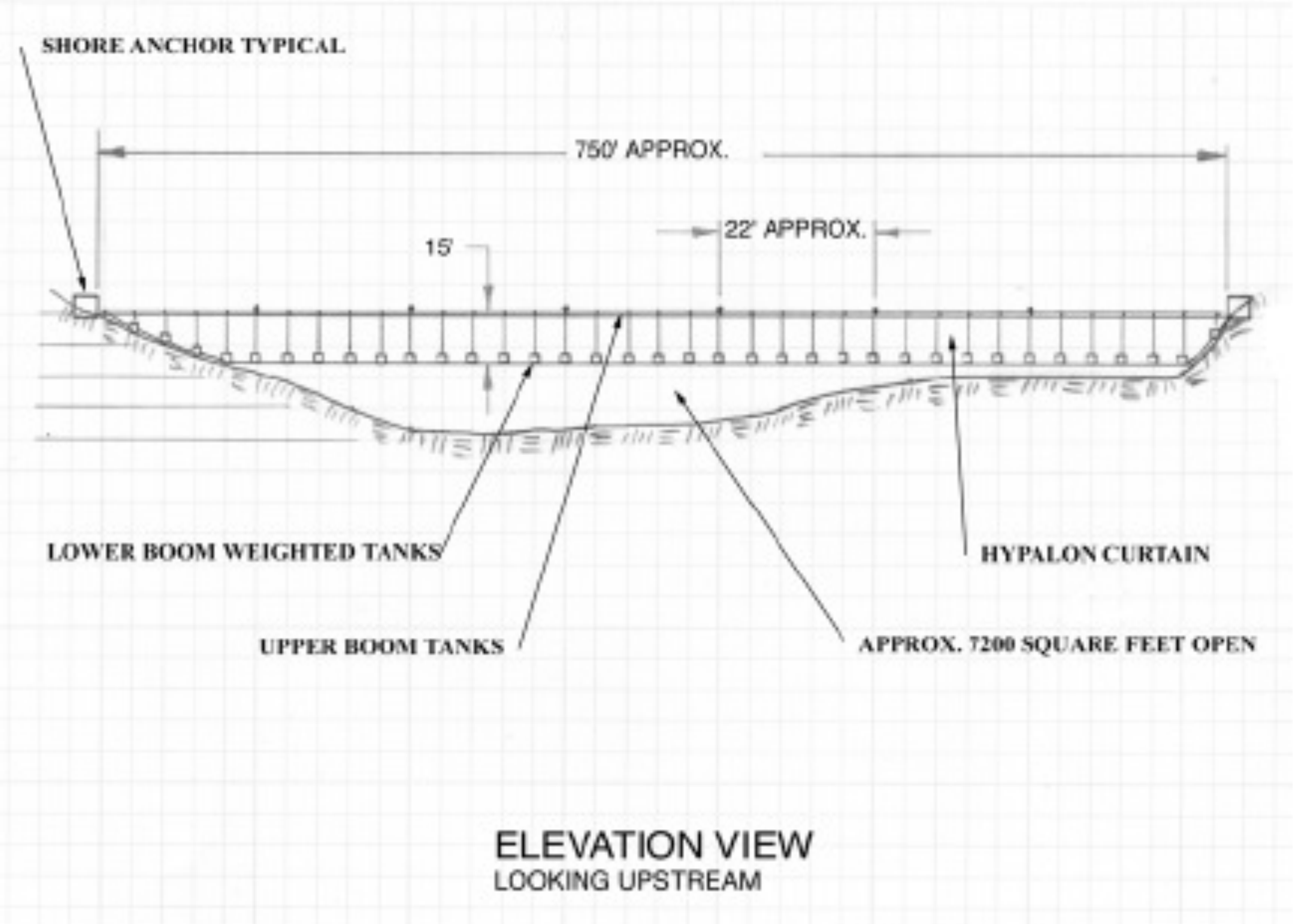
- Effects of potential climate change adaptation infrastructure on Sproat and Great Central Lake
- Effects of high water temperatures on Sockeye salmon migration delay and mortality
- Conducted temperature modelling and conceptual design of CCA Infrastructure to cool lower Somass, Sproat and Stamp Rivers

Conceptual Options

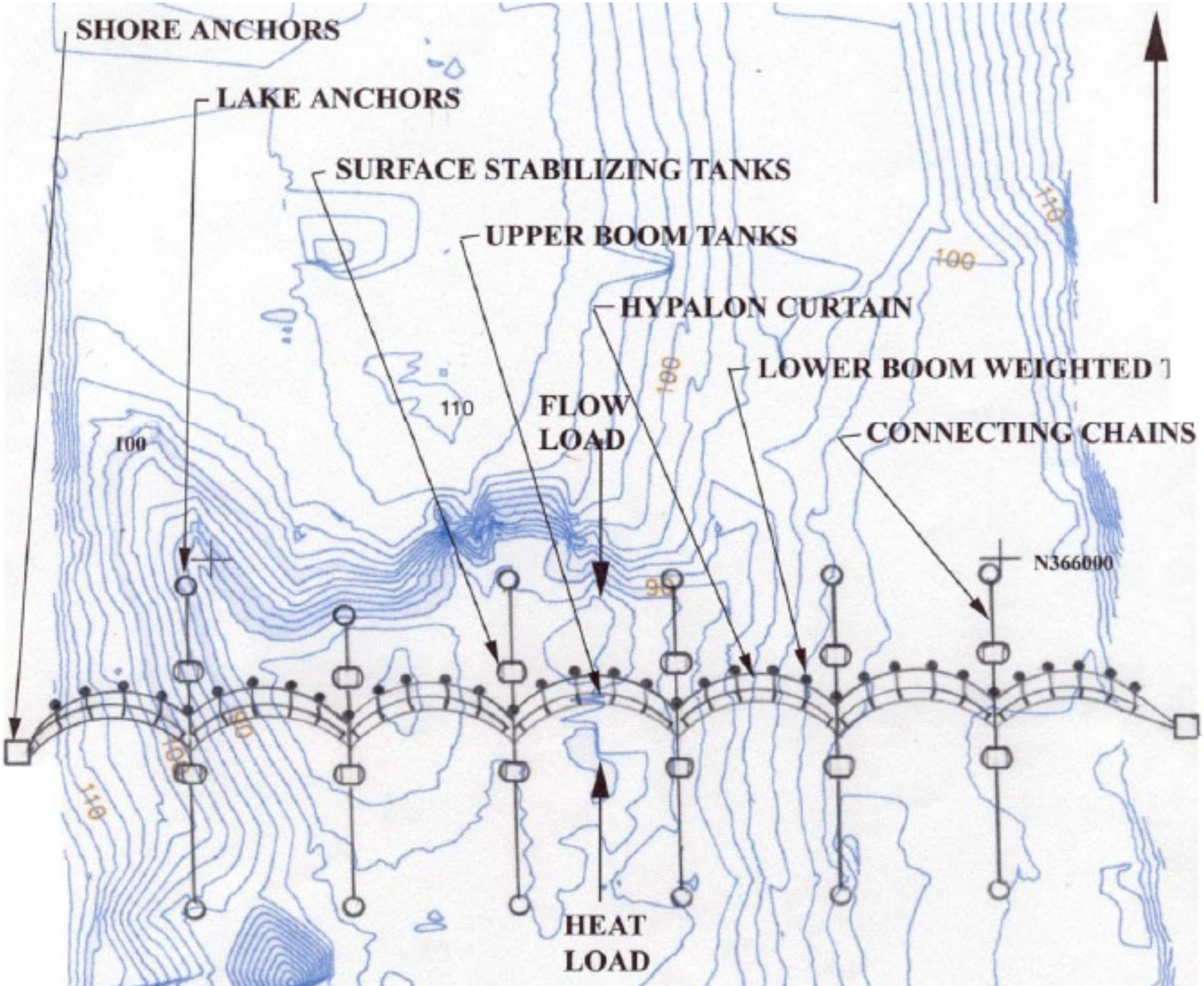
Need to supply between 2 to 10 m^3/s of water from depth out of Stamp and Sproat Lakes:

1. “Push” cold water out of lake with dam
2. Pump cold water from lake bottom
3. Epilimnetic Curtain system
4. Hypolimnetic Air-Lift Pump
5. Low head pump system – mixer or screw pump

Thermal Curtain Option



Thermal Curtain Option



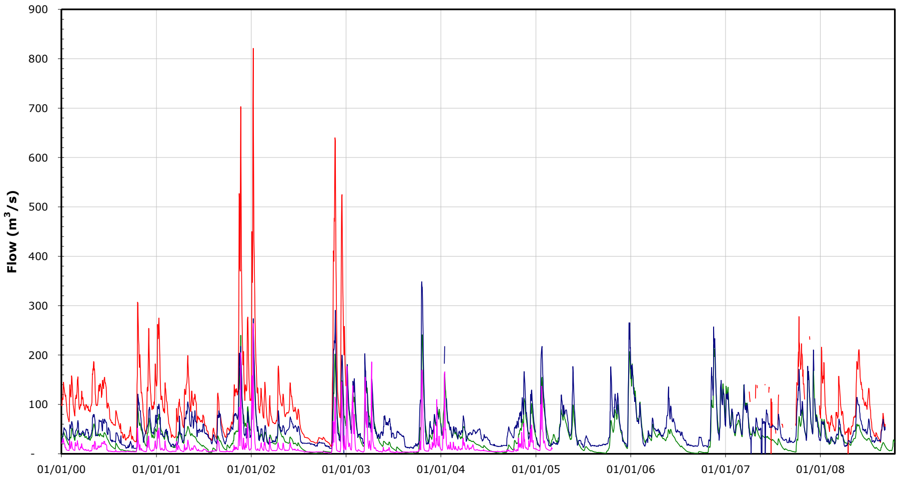
Gravity Pipeline Option

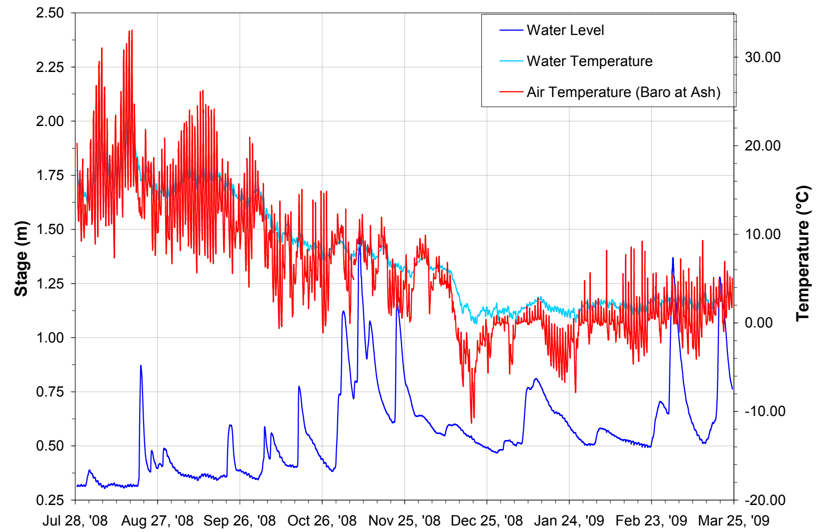
- Utilize existing dams and weirs to provide "energy" to drive water through deep water pipelines
- Require significant capital investment
- No change to water levels during summer
- Known technology and materials
- Need enough energy – water elevation or head – to overcome energy losses and velocity head

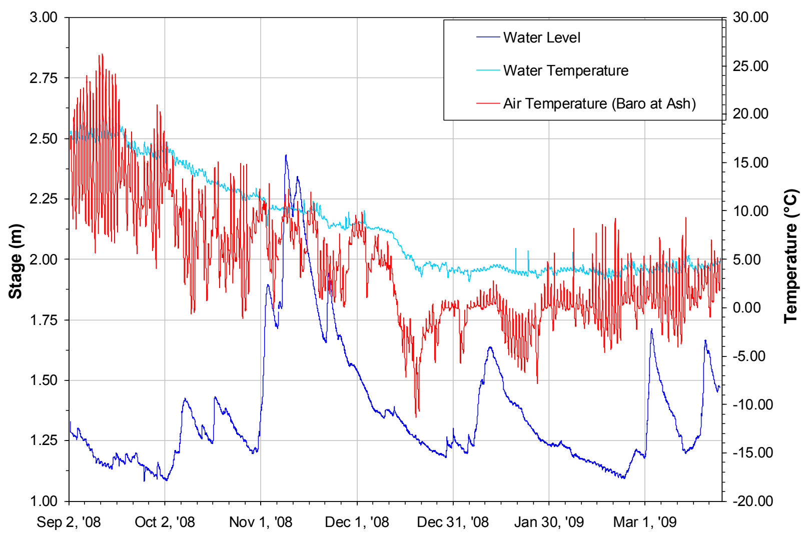
Temperature Modelling

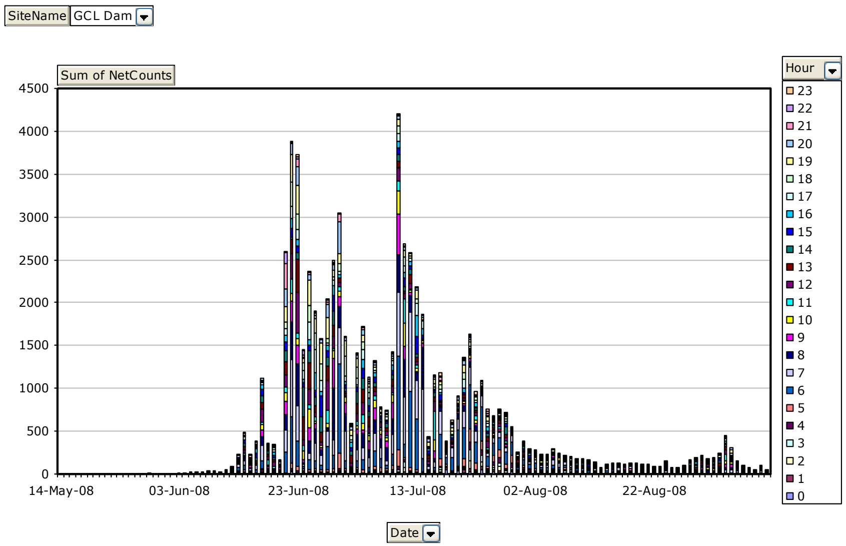
- Using 2 years of data, a hydraulic temperature model of the system was constructed for the entire system
- The model uses flow and meteorological data to estimate river temperatures at downstream locations on an hourly time step
- Preliminary Sockeye migration data indicted a high correlation to time-of-day and water temperature changes

Data – lots of it!





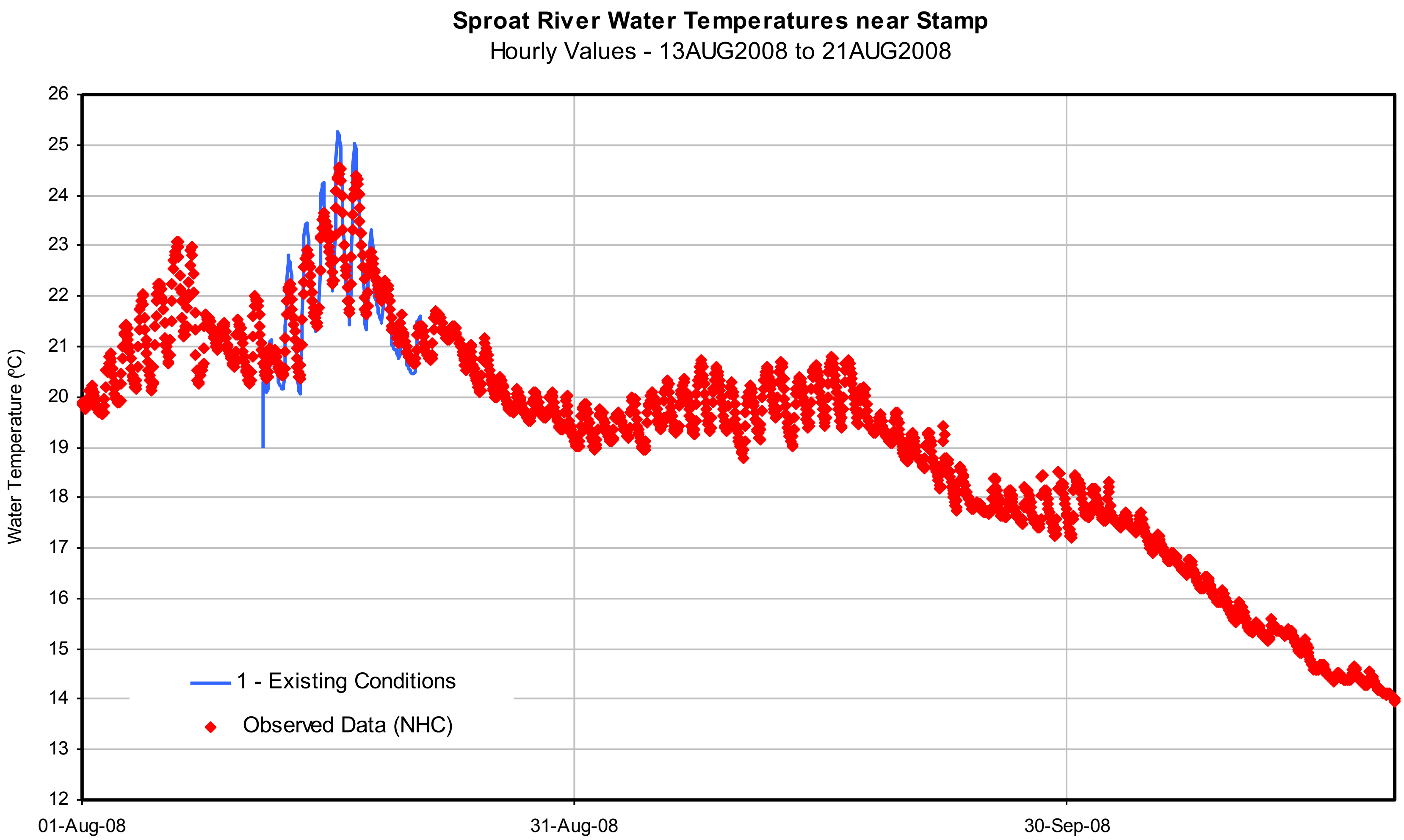




Data Results – Temperatures

- Data indicates that air temperatures dictate daily and seasonal water temperatures
- Water temperatures vary greatly over a 24 h period
- Shallow water outlets and stratified lake conditions lead to increased temperatures

Temperature Modelling

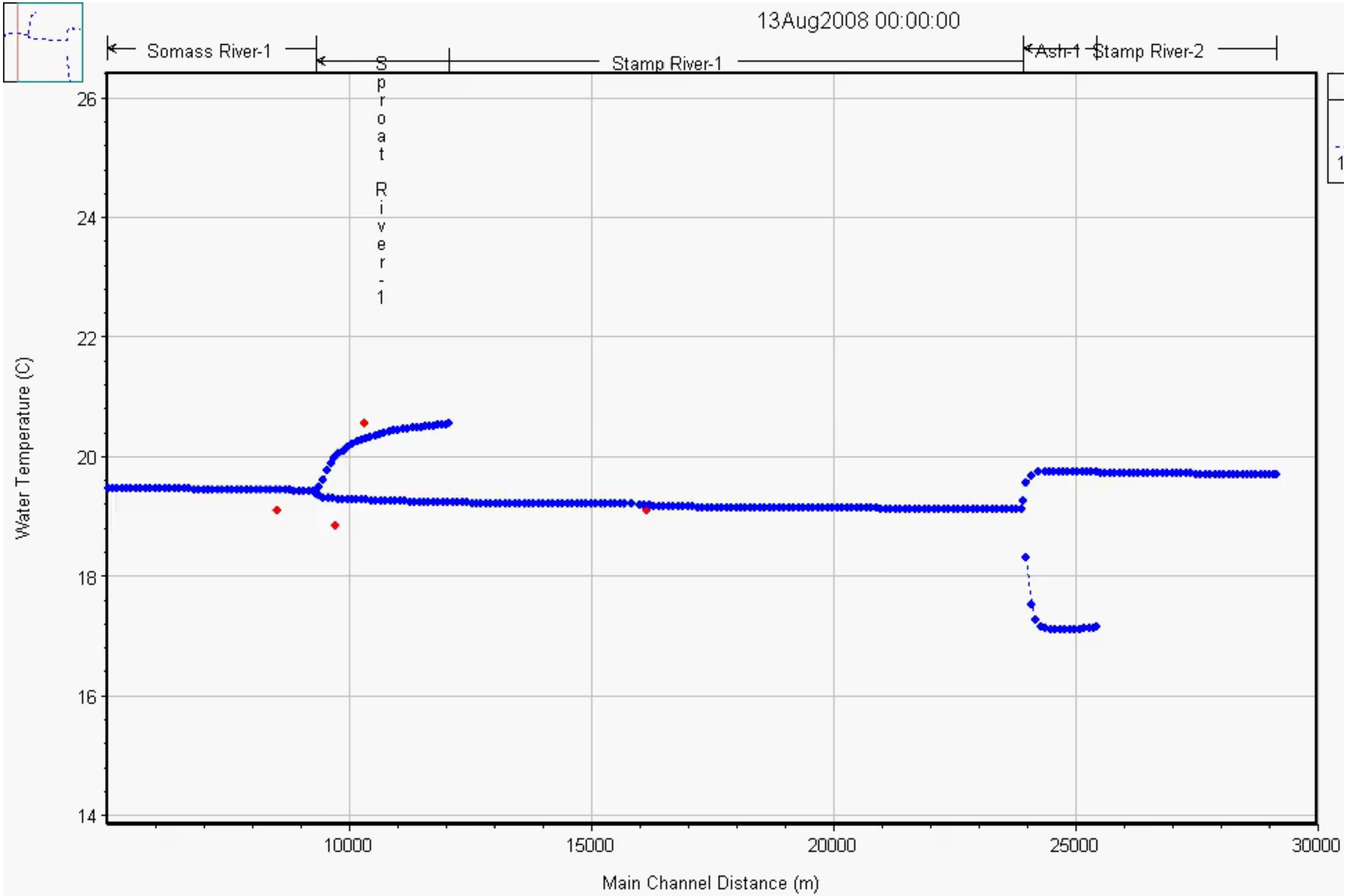


River Temperature Mitigation

A total of 4 test conditions were examined against the base case model:

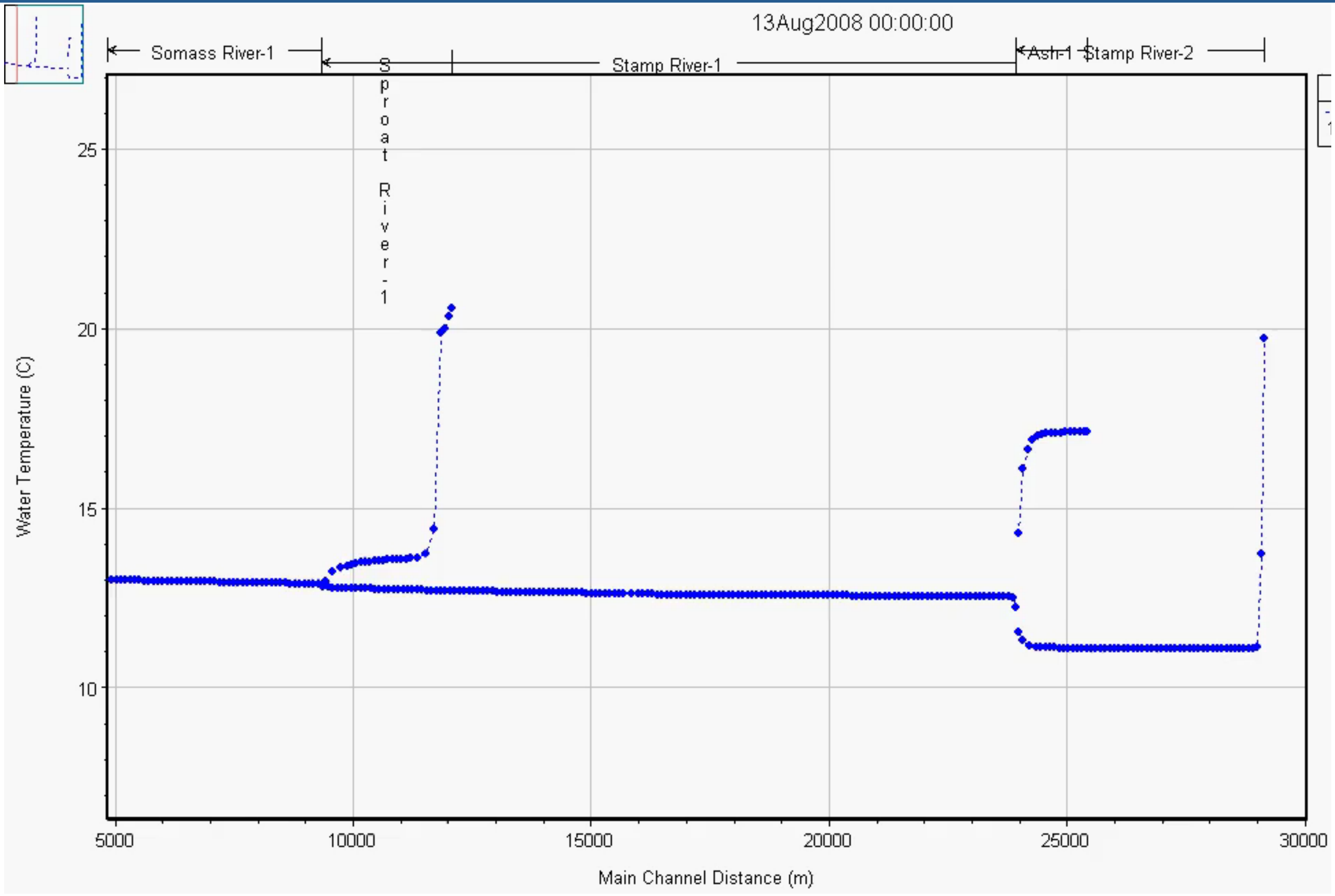
1. Coldwater release from Sproat Outlet
2. 5 m^3/s coldwater releases from GCL Dam
3. 10 m^3/s coldwater releases from GCL Dam
4. Flow control and coldwater release from both Sproat and GCL (coldwater only)

Status Quo

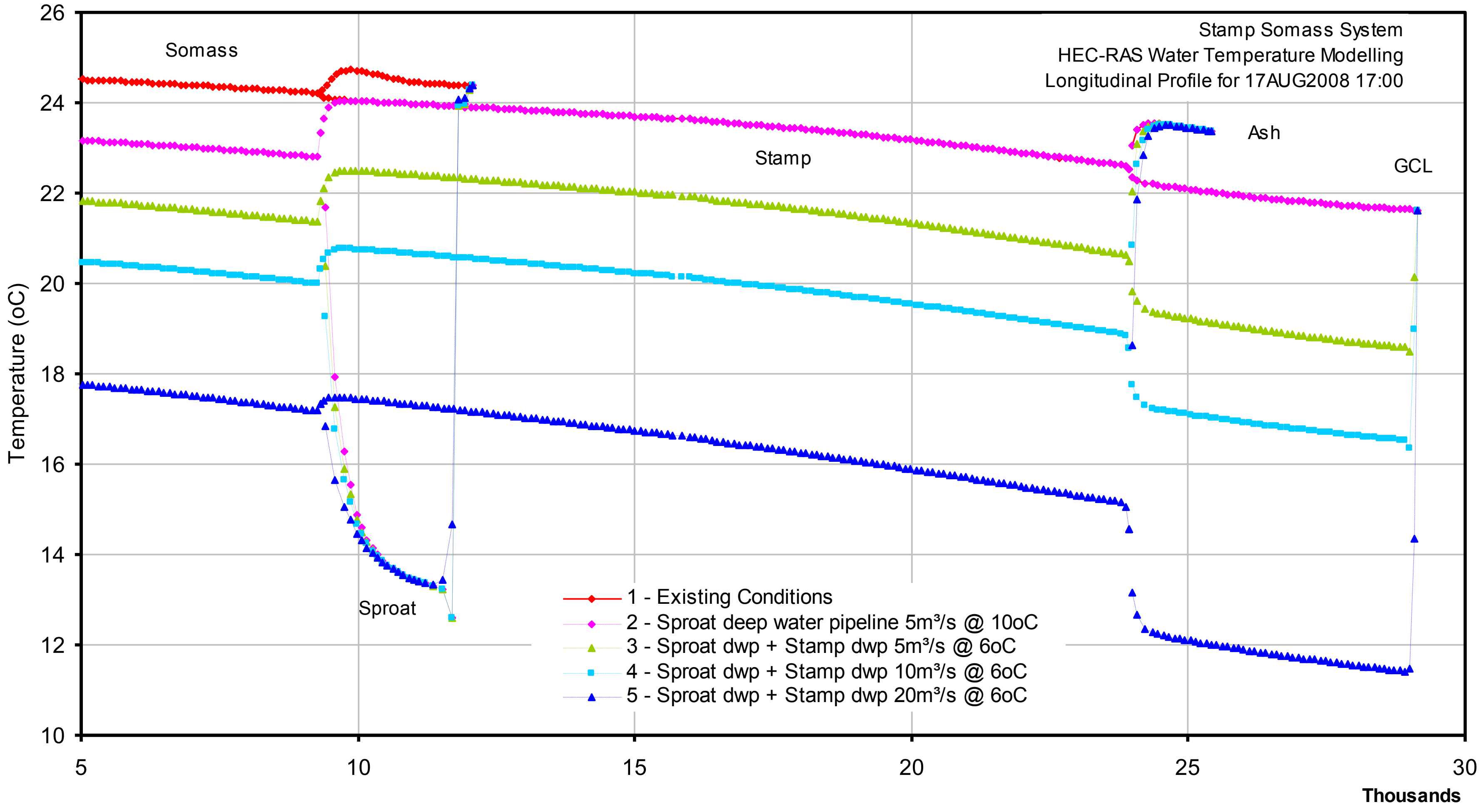


13Aug2008 00:00:00
Somass River-1
Sproat River-1
Stamp River-1
Ash-1
Stamp River-2
Water Temperature (C)
26
24
22
20
18
16
14
10000
15000
20000
25000
30000
Main Channel Distance (m)

Full Implementation of CCAI

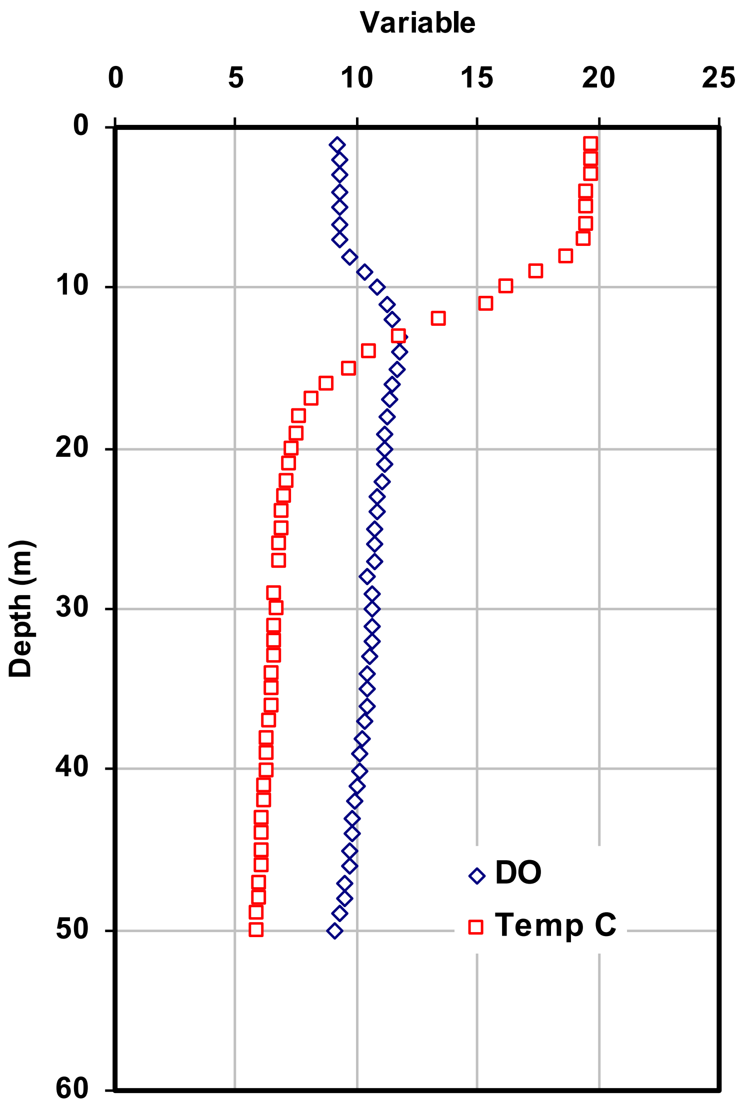


Scenario Results – Hottest Day



Coldwater in Sproat Lake and GCL

- Cold isothermal water lies below the thermocline in GCL and Sproat Lakes
- Stratification occurs May through late October every year



Proposed CWRF Infrastructure

Great Central Lake CWRF:

- 2 - 1000 m long 1.6 m dia. HPDE pipelines
- 30 m depth to 6°C lake water
- Use existing dam to provide 4 m head to drive 11 m^3/s
- Use existing fishway for returning adult salmon at weir
- Class D costs: $5.0M - $5.5M

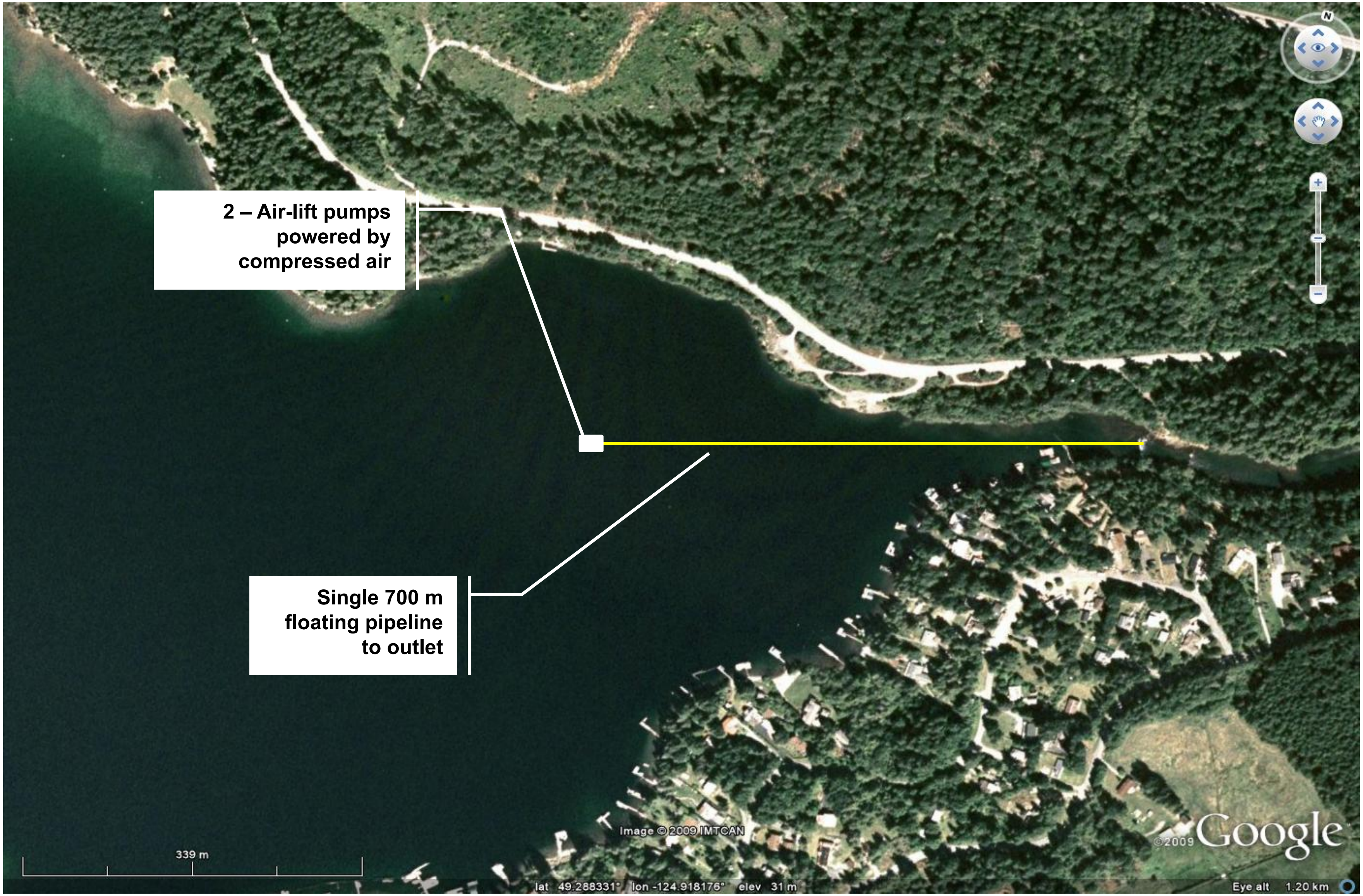
GCL Outlet Weir and Pipeline

Proposed Pilot CWRF Infrastructure

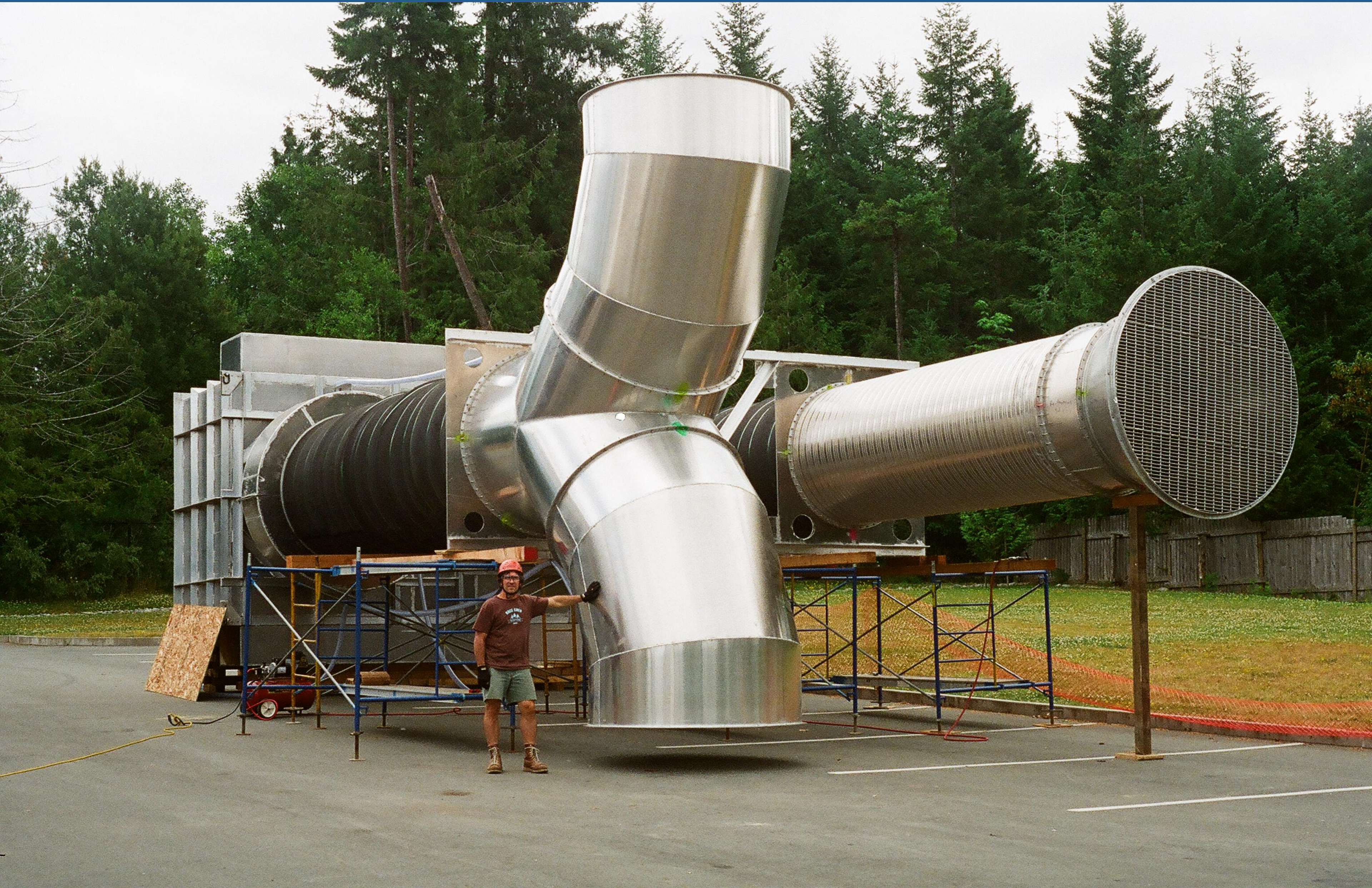
Sproat Lake CWRF:

- 5 m^3/s Hypolimnetic air lift pump
- 25 m depth to 6°C lake water
- 700 m floating pipeline
- No change in existing lake levels
- No modifications to lake outlet
- Class D costs: $0.8M – $1.2M

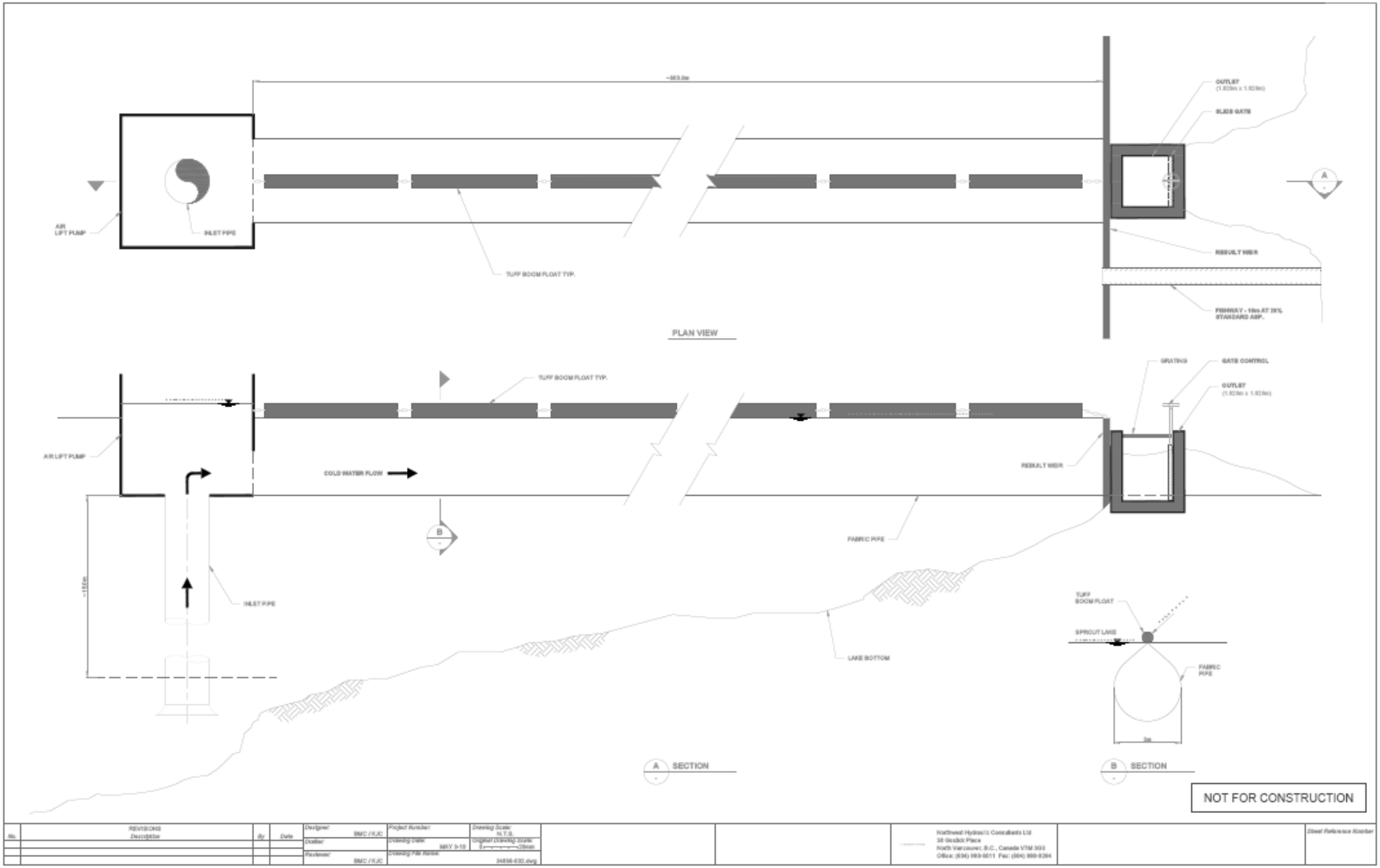
Sproat Lake Air Lift Pipeline



Air Lift Pump Technology



Sproat Lake CWRF – Conceptual Costs



Summary

- A coldwater release facility (CWRF) is conceptually viable at both Sproat Lake and GCL
- Existing infrastructure and access are positive aspects
- Detailed engineering and analysis of options would be required to prove concept to detailed levels

Questions?

Thanks for the opportunity to speak with you this morning. If you have any questions later, please feel free to contact me:

Barry Chilibeck
Northwest Hydraulic Consultants
(604) 980-6011
bchilibeck@nhcweb.com