

**Owikeno Salmon Enhancement Hatchery Site Review**

prepared for:

**Rivers and Smith Salmon Ecosystems Planning Society**

**DRAFT**

prepared by:  
D.G.V. Engineering Services Ltd.  
November 19, 2007

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# Owikeno Salmon Enhancement Hatchery Site Review

## 1. OVERVIEW

The salmon populations in the Rivers and Smith Inlets have declined dramatically in recent history. In an effort to address this decline, it has been proposed that a hatchery be considered in the vicinity of the Village of Owikeno, of the Wuikinuxv First Nation.

D.G.V. Engineering Services Ltd. and Don Sinclair, RPBio., were retained to examine four potential hatchery sites. The sites were visited in September 2007, and this report summarizes the investigation.

## 2. INTRODUCTION

The study area is located on the central coast at the head of Rivers Inlet. The four potential hatchery sites identified by the Rivers and Smith Inlets Salmon Ecosystem Planning Society in cooperation with Fisheries and Oceans Canada are located near the village of Owikeno, as illustrated in Location Map 9085-RV-01.

The objective of the study was to evaluate the sites and compare their relative merits with the intent of developing a facility capable of producing 500,000 Chinook pre-smolts and 100,000 pre-smolts of others species.

## 3. DISCUSSION

Area Climate and Hydrology:

Rivers Inlet and specifically, the study area around Owikeno Village, is exposed directly to weather systems from the Pacific. The area is exposed to the moisture-laden westerly winds blowing off the warmer Pacific Ocean. The warm air masses are forced up by the mountain ranges resulting in considerable precipitation falling on them during the winter months of September to March. Summers are relatively dry. The coastal mountains rise precipitously, with the Lillooet Ice Cap dominating the topography to the east. The steep terrain cut by the fiords tends to funnel weather systems, with the resulting intense winds and precipitation characteristic of the area.

### Area Geology:

The study area is located in the Coast Belt of BC's bedrock geology. It is made up largely of granites and various metamorphosed sedimentary and volcanic rocks, formed between 50 and 200 million years ago. Sulphides, suggesting mineralization are present in the contact zones between various rock sequences. Local major granite formations observed at the site are consistent with the general description. Local "shows" of mineralization have been reported, including copper. Hot springs in the area, including a reported warm spring near the village water reservoir suggest conditions that support mineralization. The presence of metal in local groundwater supplies is therefore a real possibility.

The area is in the coastal mountains of the North Coast of British Columbia, an area dominated by steep terrain incised by deep glacial valleys forming the long fiords of the coast that trend east-west towards the high icefields of the Lillooet Ice Cap. The Monarch Icefield and the Silverthorne Glacier form the headwaters of the watershed that supplies Owikeno Lake.

### Hydro-electric Development:

Apparently several studies have been commissioned to provide the Village with electricity from a hydro power site. Meadowse Creek has been examined but the Nicknaqueet River appears to be more promising. Apparently, work is currently underway to evaluate the potential of Nicknaqueet River and flow monitoring for the next two years is contemplated. Some flow data has been previously collected. While the author attempted to obtain information related to this work without success.

### Proposed hatchery sites:

#### The Village Site:

The village location is attractive because of the convenience and the existing infrastructure in the form of the village electrical supply, administrative facilities and water supply. There is good evidence to suggest that adequate flow capacity could be developed from drilled wells near the existing well field that serves the village. If a site was developed near the existing diesel generation station, it might be possible to use the waste heat from the generation to improve the water temperature in a facility, however it is understood that development of a hydropower source is anticipated in the future and therefore this advantage is likely short term only.

Unfortunately, the water sample taken directly at the manifold building confirms a previous water sample that indicated an unacceptably high copper concentration combined with relatively soft water (23 mg/l), make this water supply suspect. It is

unlikely that incubation using this water directly will be consistently successful although if a recirculation system is used for incubation and water hardness is increased with chemical additions, it may be possible to provide a hatchery at the village. If this site is to be considered, a pilot facility is strongly recommended before committing to major investments.

#### Medowse Creek:

Medowse Creek is located on the south side of Owikeno Lake, and is accessed by boat leaving from a beach approximately 4 km from the village centre, and crossing approximately 400 m to the creek outwash fan. Access could be limited at times by weather since the crossing is open to wind and waves coming off the high icefields of the Pacific Ranges of the Coast Mountains with a fetch of some 37 km over the length of Owikeno Lake. A sockeye hatchery was developed and operated by Fisheries and Oceans at the site between 1911 and 1937, although little evidence of the site remains.

A water quality sample of the site was taken, and is included in Appendix A. The water is very soft at 3 mg/l, the pH is low and the water was very cold for September, at approximately 8 °C. The creek has formed a large alluvial fan deposit at the valley wall above which the creek is very steep and bedrock confined. The creek transports significant quantities of rock and woody debris during peak flow events, material that has formed the large fan. There is no significant water storage in the upland area, and therefore the flow regime is flashy. The lower section of the creek on the fan area is utilized by wild fish.

Development of the site would require establishing docks on both sides of Owikeno Lake, development of a power supply in the form of either diesel or hydro electric (with diesel back up) and construction of a water intake. The intake for a hatchery would require a very robust structure to handle the debris, bedload and frequent peak flows. Any intake would be at risk from damage and plugging.

The site is not recommended because of the water quality issues, difficult access, and the challenge of developing a secure water supply.

#### Nicknaqueet River:

The Nicknaqueet River is located across the outlet of the Wannock River. The river has developed an extensive alluvial fan on which a logging camp was situated. Access to the site is by boat, approximately 2 Km. due south of the dock at Rivers Inlet which is about 2 Km from the Owikeno Village center.

The potential site for a hatchery would be located approximately 700 m from the dock location at the head of the fan deposit recognizing that wild fish utilize the reach of the river on the fan and the location is also probably favourable for a hydro

powerhouse. The river transports significant bedload and woody debris augmented by upstream damage associated with past timber harvesting. The peak flows in the river are large and installation of a robust and reliable intake will be a challenge. If a hatchery were coupled with the hydro power development, water from the powerhouse could be used only if care is taken to ensure that the total gas pressure (TGP) has reached equilibrium. Incubation and fry stages in hatchery rearing are especially vulnerable to high TGP.

The river has a fairly large watershed that includes some high altitude lakes and icefields that ensure a steady flow and a slightly better temperature regime than at Medowse Creek. The river has been studied<sup>1</sup> for hydro-electric potential as the power supply for the village, and if the development of the hatchery were coordinated with the power development, the cost of infrastructure could be reduced. In addition, waste heat from generator cooling could be utilized if a water-cooling system is used instead of the air cooling generally associated with smaller installations. In addition, since the demand for energy at the hatchery corresponds with higher flows, it may justify the installation of a larger turbine and generator than that justified to reliably meet domestic Village demands.

The water quality of the river is similar to Medowse Creek with very low hardness and low pH. The water supply is likely more reliable and there likely exists a slight edge with respect to more favourable temperatures.

This site has better potential than Medowse Creek but is challenged by soft water, and access. If the project was coupled with a hydro electric project, some costs savings would be possible, however no timeline is available for a power project. It is not a highly recommended project site.

#### Old Chinook Site:

A pilot hatchery was operated at a site near the Village air strip from 1989 through to about 2000. The site successfully reared fry on groundwater produced at the site from the glacial colluvium (sandy gravel material) underlying the site. Water quality data provided by DFO from hatchery records suggest the water hardness is in the range of 54 to 82 mg/l and the pH is in the range of 8. All other parameters except aluminum and phosphate are in acceptable ranges for fish culture. The water supply is proven by the success of the Pilot Hatchery. No data regarding water temperature from the old site was available, but it is expected that the water will be, on average, warmer than either of the surface supply sites. Water could be supplied from the two existing wells at the site, although the existing pumps will require examination and rehabilitation.

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<sup>1</sup> pers. communication - Mr. P. Sjolman who is involved in the hydrological monitoring expected to take at least two years

The site is approximately 4 km by road from the village center, making access convenient and about 3.7 km from the village electrical system, and therefore the facility could be fairly easily connected to the village electrical system. This would allow the facility to use energy from the village, reducing the level of on-site diesel back-up required, as well as taking advantage of hydro-power if and when that is developed. If a hatchery is developed at the Village or at this site, the potential for sizing the hydro plant to provide more energy when winter river flows are higher should be examined to augment energy available for fish rearing.

The old Chinook site was located approximately 1 m above the maximum observed lake level and if a site were developed in the general area, it is recommended that the base elevation be increased to at least 2 m above the maximum lake level either by relocation or mounding the site. Some of the old facilities of the Pilot Hatchery including some buildings and equipment will need to be removed.

Access to the site both by road from the Village and proximity to the lake for moving fry is good. The water supply has been proven to be suitable for fish rearing by the Pilot Hatchery project. There is adequate, easily developed land area in the area.

The Old Chinook site appears to be the most suitable for development at this time.

#### Fish Rearing:

The facility concept is based on incubation and rearing to 3 g on site, and moving the fry to lake net pens for grow-out and release. In order to improve smolt size at release, it is suggested that heating be applied at incubation when the flows are reduced. Heating costs could be further controlled by the use of recirculation units utilizing "bead filters" to control ammonia. Recirculation will reduce water demand from the well, effectively capturing the energy in the facility. Recirculation is relatively simple at the incubation stage when feed and waste products in the water are not a major issue. Recirculation is not recommended at the rearing stage since solids handling greatly increases systems complexity.

Target production is 500 000 Chinook and 100 000 Coho requires:

#### Incubation

double heath stacks, each stack supplied with 15 lpm water  
yields 260 lpm required for incubation under flow through conditions, or less than 30 lpm using recirculation technology.

Without heat, assuming:

Groundwater supply temperature of 8°C  
900 to 1000 ATU required to emergence or ponding  
Egg take 3<sup>rd</sup> week of October – yields ponding about the end of February.

With heat, the addition of 4°C using heat and recirculation (25 to 30 KW power required). Yields ponding about mid January.

Rearing to 3 g., 1770 Kg. Chinook fry and 356 Kg. Coho at maximum loading:

Assuming a loading density of 12 Kg/m<sup>3</sup>

Assuming 1 lpm/Kg biomass

- yields 2126 lpm required for rearing before moving to the lake

- yields 180 m<sup>3</sup> of tankage required, or 9 - 5 m Ø circular rearing tanks (for example)

#### **4. CONCLUSION**

A successful hatchery utilizing recirculation technology during incubation can be built at Owikeno. The preferred site, at this time appears to be the old Chinook Pilot Hatchery location that has good access and a proven water supply. If a facility at in the Village is contemplated, it is recommended that the water supply be pilot tested since the water quality testing suggests that there may be challenges.

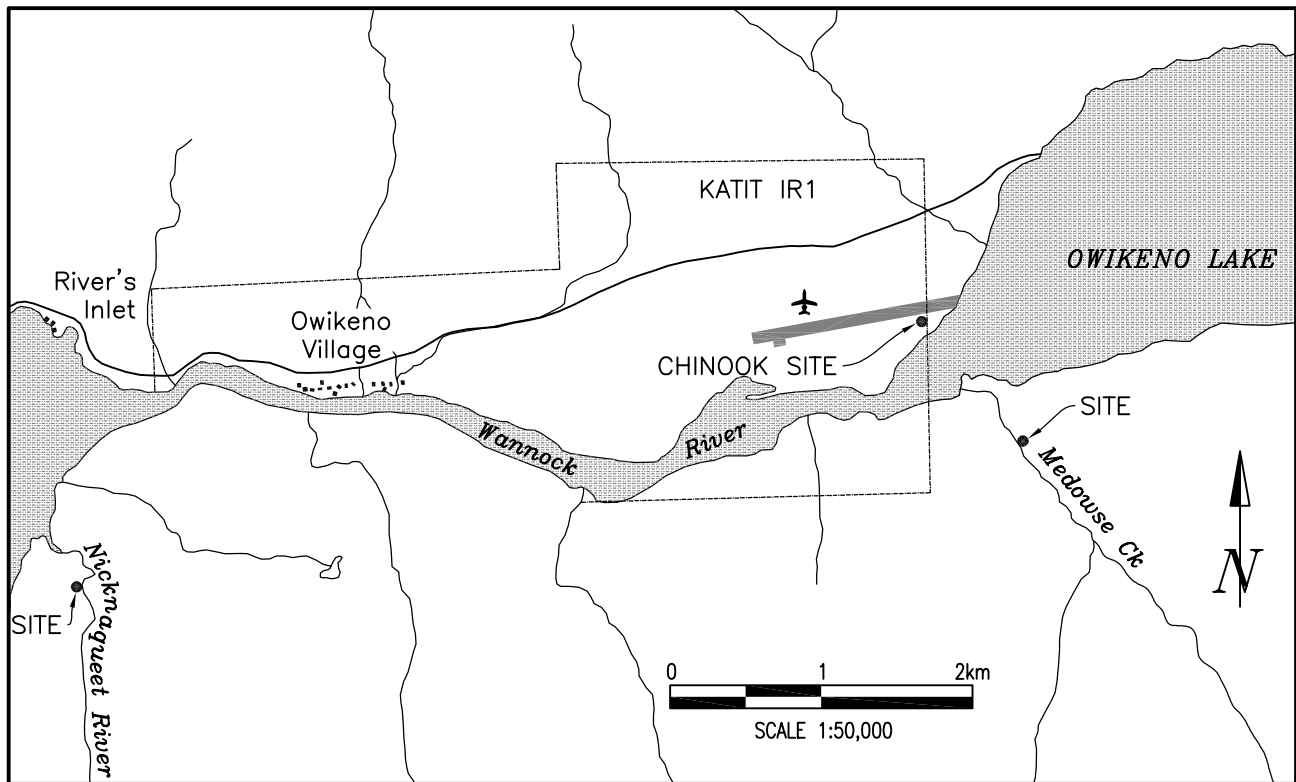
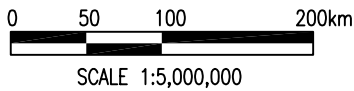
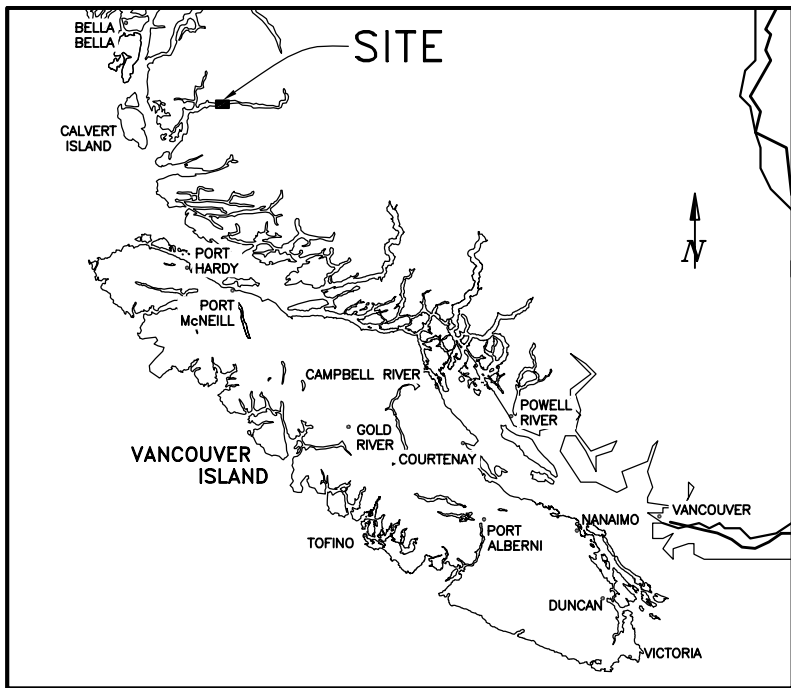
#### **5. DISCLAIMER**

This report was prepared by D.G.V. Engineering Services Limited for the account of Rivers and Smith Salmon Ecosystems Planning Society. The material in it reflects the best judgement of D.G.V. Engineering Services Ltd. and Mr. D. Vincent, P. Eng. in light of the information available at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. D.G.V. Engineering Services Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

#### **6. CERTIFICATION**

This report was respectfully submitted to Rivers and Smith Salmon Ecosystems Planning Society by D.G.V. Engineering Services Ltd.

David Vincent, P. Eng.



Client:	RIVERS AND SMITH ECOSYSTEMS PLANNING SOCIETY		D.G.V. ENGINEERING SERVICES LTD.® 2704 Cedar Heights Crescent, Nanaimo, BC		Revision No.: 0
	Project:	PROPOSED SALMON HATCHERY SITES		Designed by:	Sheet: 1
Title:		LOCATION MAP		Date: 26-NOV-07	Drawing No.:
			Drawn by: C.S.M.	Ref.:	9085-RV-01
		Checked by: D.G.V.	Scale: AS SHOWN	Sheet size: A	
			File No.: 010100AC	Subcode:	
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Appendices:

- A Water Quality Analysis
  - Nicknaqueet River
  - Meadowse Creek
  - Village Water Supply
  - Chinook Site
- B Biological Assessment
- C Site Comparison and Development Cost Assessment
- D Local Hydrology

## APPENDIX A

### Water Quality Analysis

- Nicknaqueet River
- Meadowse Creek
- Village Water Supply
- Chinook Site

A Summary of Water Sample Analysis for Various Water Supplies Near Wuikinuxv Village - Hatchery Feasibility Study 2007

Test	Results from Sept.19, 2007 Samples			Mar-96	1989 @ Pilot Hatchery		Oct-88			Units	Limits for	Comments
	Medowese	Nicknaqueet	Village Well	Village Well	Well 1	Well 2	Old Vil.Well	Old Hatch Well	Wan.River		Fish Culture	
Colour	6.0	16.0	<5							Colour units		
Conductivity	21.7	10.8	64.4	57.0						uS	<b>prefer&gt;150</b>	
Total Dissolved Solids	10.0	22.0	56.0							mg/L		
Hardness (CACO3)	<b>3.0</b>	<b>2.7</b>	23.0	26.0	54.1	82.3				mg/L	<b>&gt;15</b>	
pH	<b>6.65</b>	<b>6.7</b>	<b>7.0</b>	<b>6.8</b>	8.3	7.9					<b>7.2-8.5</b>	
Turbidity	<0.5	<0.5	<0.5							mg/L		
Alkalinity	<b>&lt;10</b>	<b>&lt;10</b>	26.0	26.0						mg/L	<b>@least 15-20</b>	
Chloride	<2.0	<2.0	<2.0	1.1	1.13	1.22				mg/L	<b>250</b>	
Floride	<1.0	<1.0	<1.0	<1.0	<0.2	<0.2				mg/L	<b>1.0</b>	
Sulfate	2.4	<2.0	<2.0	1.5	3.9	4.49				mg/L	<b>250</b>	
Nitrate	<0.1	<0.1	0.2	0.3	0.17	0.18				mg/L	<b>10</b>	
Nitrite	<0.1	<0.1	<0.1	<0.003	<0.005	<0.005				mg/L	<b>0.015</b>	if Chloride <2
Phosphate P				<0.005	<b>0.034</b>	<b>0.072</b>				mg/L	<b>0.025</b>	
T-Aluminum	0.038	0.074	<0.005	<0.01	<b>*0.611</b>	<b>*0.707</b>	0.06	0.09	<b>0.55</b>	mg/L	<b>0.1</b>	
T-Antimony	<0.0002	<0.0002	<0.0002		<0.0001	<0.0001	<0.05	<0.05	<0.05	mg/L		
T-Arsenic	<0.0002	<0.0002	<0.0002	<b>&lt;0.02</b>	0.0002	0.0002	<b>&lt;0.2</b>	<b>&lt;0.2</b>	<b>&lt;0.2</b>	mg/L	<b>0.001</b>	
T-Barium	0.003	0.003	0.006		0.0065	0.0090	0.0060	0.0080	0.0160	mg/L		
T-Boron	0.002	<0.002	0.002		0.014	0.012	<0.01	<0.01	<0.01	mg/L		
T-Cadmium	0.00002	0.00001	<0.00001	<b>&lt;0.0005</b>	<0.0002	<0.0002	<b>&lt;0.002</b>	<b>&lt;0.002</b>	<b>&lt;0.002</b>	mg/L	<b>0.0003</b>	@hardness of 10, .0004 if hardness 50
T-Calcium	1.2	1.1	7.0	6.9	17.1	26.7	7.2	11.3	4.2	mg/L		
T-Chromium	<0.0005	<0.0005	<0.0005	<0.001	0.0020	<0.0002	<0.002	<0.002	<0.002	mg/L	<b>0.04</b>	
T-Copper	<0.001	<0.001	<b>0.009</b>	<b>0.010</b>	0.0008	0.0009	<b>0.0980</b>	<b>&lt;0.005</b>	<b>&lt;0.005</b>	mg/L	<b>0.002</b>	@hardness of 10, .005 if hardness 25
T-Iron	<0.01	0.1	<0.01	0.03	<b>**1.21</b>	<b>**1.16</b>	<0.003	<b>1.86</b>	<b>0.261</b>	mg/L	<b>0.3</b>	
T-Lead	0.001	0.0002	0.0002	<b>&lt;0.005</b>	<0.002	<0.002	<b>&lt;0.02</b>	<b>&lt;0.02</b>	<b>&lt;0.02</b>	mg/L	<b>0.004</b>	
T-Magnesium	<0.1	<0.1	1.4	1.1	1.42	2.31	0.93	1.98	0.65	mg/L		
T-Manganese	<0.005	<0.005	<0.005	0.0012	0.0182	0.0398	0.005	<b>0.569</b>	0.006	mg/L	<b>0.1</b>	
T-Mercury	<0.0001	<0.0001	<0.0001		<0.00002	<0.00002	<0.05	<0.05	<0.05	mg/L		
Nickel				<0.002	0.0012	0.0020	<0.005	<0.005	<0.005	mg/L	<b>0.045</b>	
Phosphorus				<b>&lt;0.06</b>	<b>0.039</b>	<b>0.078</b>	<b>&lt;0.05</b>	<b>&lt;0.05</b>	<b>&lt;0.05</b>	mg/L	<b>0.025</b>	
T-Potassium	<0.4	<0.4	1.0	1.0	1.38	2.14	1.30	1.80	0.40	mg/L		
T-Selenium	<0.0002	<0.0002	<0.0002	<0.02	<0.0001	<0.0001	<0.05	<0.05	<0.05	mg/L	<b>0.05</b>	

A Summary of Water Sample Analysis for Various Water Supplies Near Wuikinuxv Village - Hatchery Feasibility Study 2007

Test	Results from Sept.19, 2007 Samples			Mar-96	1989 @ Pilot Hatchery		Oct-88			Units	Limits for	Comments
	Medowese	Nicknaqueet	Village Well	Village Well	Well 1	Well 2	Old Vil.Well	Old Hatch Well	Wan.River		Fish Culture	
T-Sodium	1.5	1.1	3.0	2.5	1.81	2.74	1.59	2.05	0.59	mg/L		
T-Uranium	<0.0005	<0.0005	<0.0005		<0.02	<0.02				mg/L		
T-Zinc	0.004	0.004	<b>0.033</b>	<b>0.091</b>	0.0013	0.0026	<b>0.030</b>	0.004	<0.002	mg/L	<b>0.015</b>	
NOTES FROM BRIAN ANDERSON RE: THE SEPTEMBER 2007 RESULTS												
The buffering capacity indicated for Medowese & Nicknaqueet (hardness, pH and alkalinity) is not thought to be adequate for fish culture.												
The town water supply would appear to be the best of a bad lot for fish culture purposes.												
The town well water is marginal from the perspective of conductivity-64.4 (>150 units desirable), hardness-23 (>20 mg/L desirable), and alkalinity-26 (>20 mg/L). These are all factors of buffering capacity and can be indicative of water chemistry stability.												
Nitrates-0.2 (<0.15 mg/L) are slightly above recommended values and zinc-0.033 (<0.015 @ hardness of 10; <0.035 @ hardness of 25) is marginal to high depending how the zinc complexes. Copper is high-0.009 (criteria indicate <.002@hard10, <.005@hard25) for fish culture purposes and would disqualify this source unless further work was carried out to determine actual toxicity.												
The town water supply (from the water test results) would be of questionable use for fish culture purposes. It would take a greater expertise than I have and more definitive sampling/testing to determine whether this water supply would be acceptable for fish culture purposes.												
I have used "Summary of Water Quality Criteria for Salmonid Hatcheries (Sigma environmental Consultants Ltd, 1983) as my criteria source.												
NOTES FROM DOUG LOFTHOUSE RE: THE NOVEMBER 1989 PILOT HATCHERY WELL RESULTS												
Hardness - in comparison to other water supplies we operate facilities on the two readings of 54.1 and 82.3 can be qualified as quite "hard", and hard waters are known to reduce the toxicity of several heavy metals.												
*Aluminum - the readings in the .6-.7 range appear quite high when compared to the criteria but the most likely source of these results must be considered. Total and dissolved levels of "non-toxic" forms of aluminum can often exceed the 0.1ppm criteria where a significant quantity of silt is present. This is confirmed by the analysis of the sample of mainstem Wannock water from early October '88 which showed aluminum levels of 0.55ppm. It is likely then, that these elevated readings from the initial sampling could be attributed to a "dirty sample" from non pump tested supply.												
**Iron - this parameter is a measure from before any pump testing occurred. Experience at another well at the old hatchery in the village showed that iron levels dropped after a short time of continuous pumping.												
SJM: This must have proved out as we did not have water quality problems at the New Pilot hatchery near the lake.												

**Summary of Water Sample Analysis for Medowese, Nicknaqueet & Wuikinuxv Village**

Test	Results from Sept. 19, 2007 Samples			Mar-96	Units	Limits for	Comments
	Medowese	Nicknaqueet	Village Well	Village Well		Fish Culture	
Colour	6.0	16.0	<5		Colour units		
Conductivity	21.7	10.8	64.4	57.0	uS	<b>prefer&gt;150</b>	
Total Dissolved Solids	10.0	22.0	56.0		mg/L		
Hardness (CACO3)	<b>3.0</b>	<b>2.7</b>	23.0	26.0	mg/L	<b>&gt;15</b>	
pH	6.65	6.7	7.0	6.8		<b>7.2-8.5</b>	
Turbidity	<0.5	<0.5	<0.5		mg/L		
Alkalinity	<b>&lt;10</b>	<b>&lt;10</b>	26.0	26.0	mg/L	<b>@least 15-20</b>	
Chloride	<2.0	<2.0	<2.0	1.1	mg/L	<b>250</b>	
Floride	<1.0	<1.0	<1.0	<1.0	mg/L	<b>1.0</b>	
Sulfate	2.4	<2.0	<2.0	1.5	mg/L	<b>250</b>	
Nitrate	<0.1	<0.1	0.2	0.3	mg/L	<b>10</b>	
Nitrite	<0.1	<0.1	<0.1	<0.003	mg/L	<b>0.015</b>	if Chloride <2
Phosphate P				<0.005	mg/L	<b>0.025</b>	
T-Aluminum	0.038	0.074	<0.005	<0.01	mg/L	<b>0.1</b>	
T-Antimony	<0.0002	<0.0002	<0.0002		mg/L		
T-Arsenic	<0.0002	<0.0002	<0.0002	<b>&lt;0.02</b>	mg/L	<b>0.001</b>	
T-Barium	0.003	0.003	0.006		mg/L		
T-Boron	0.002	<0.002	0.002		mg/L		
T-Cadmium	0.00002	0.00001	<0.00001	<b>&lt;0.0005</b>	mg/L	<b>0.0003</b>	@hardness of 10, .0004 if hardness 50
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T-Chromium	<0.0005	<0.0005	<0.0005	<0.001	mg/L	<b>0.04</b>	
T-Copper	<0.001	<0.001	<b>0.009</b>	<b>0.010</b>	mg/L	<b>0.002</b>	@hardness of 10, .005 if hardness 25
T-Iron	<0.01	0.1	<0.01	0.03	mg/L	<b>0.3</b>	
T-Lead	0.001	0.0002	0.0002	<b>&lt;0.005</b>	mg/L	<b>0.004</b>	
T-Magnesium	<0.1	<0.1	1.4	1.1	mg/L		
T-Manganese	<0.005	<0.005	<0.005	0.0012	mg/L	<b>0.1</b>	
T-Mercury	<0.0001	<0.0001	<0.0001		mg/L		
Nickel				<0.002	mg/L	<b>0.045</b>	
Phosphorus				<b>&lt;0.06</b>	mg/L	<b>0.025</b>	
T-Potassium	<0.4	<0.4	1.0	1.0	mg/L		
T-Selenium	<0.0002	<0.0002	<0.0002	<0.02	mg/L	<b>0.05</b>	
T-Sodium	1.5	1.1	3.0	2.5	mg/L		
T-Uranium	<0.0005	<0.0005	<0.0005		mg/L		
T-Zinc	0.004	0.004	<b>0.033</b>	<b>0.091</b>	mg/L	<b>0.015</b>	
<b>NOTES FROM BRIAN ANDERSON:</b>							
The buffering capacity indicated for Medowese & Nicknaqueet (hardness, pH and alkalinity) is not thought to be adequate.							
The town water supply would appear to be the best of a bad lot for fish culture purposes.							
The water is marginal from the perspective of conductivity-64.4 (>150 units desirable), hardness-23 (>20 mg/L desirable), and alkalinity-26 (>20 mg/L). These are all factors of buffering capacity and can be indicative of water chemistry stability.							
Nitrates-0.2 (<0.15 mg/L) are slightly above recommended values and zinc-0.033 (<0.015 @ hardness of 10; <0.035 @ hardness of 25) is marginal to high depending how the zinc complexes. Copper is high-0.009 (<.002@hard10, <0.005@hard25) for fish culture purposes and not recommended without further work to determine actual toxicity (See attached).							
The town water supply (from the water test results) would be of questionable use for fish culture purposes. It would take a greater expertise than I have and more definitive sampling/testing to determine whether this water supply would be acceptable for fish culture purposes.							
I have used "Summary of Water Quality Criteria for Salmonid Hatcheries (Sigma environmental Consultants Ltd, 1983) as my criteria source.							
The town water supply would appear to be the best of a bad lot for fish culture purposes.							

## **APPENDIX B**

### Biological Assessment

**HATCHERY BIO-DESIGN STANDARDS**

	<b>Chinook</b>	<b>Coho</b>		<b>Total Water Demand (LPM)</b>
<b>PRODUCTION TARGET:</b>	500,000	100,000	pre-smolts	
<b>BIO-STANDARDS:</b>				
fecundity	9000	2500	eggs	
Egg to fry survival	90%	90%		
Fry to smolt survival	85%	85%		
Two cell Atkins Tank (loading @ 100,000 to 150,000 eggs/cel)	100,000	100,000	green eggs/cel	
heath trays (eyed eggs@ 5000 to 8000 eggs/tray)	5,000	8,500	eyed eggs/cel	
<b>PRODUCTION:</b>				
Brood fish	69	50	females	
Green eggs	621,000	125,000	eggs	
Fry	589,950	118,750	fry	
Pre-smolts	501,458	100,938	pre-smolts	
<b>INCUBATION:</b>				
Atkins cels (2cels/box)	6	1	cels	
water supply (3 lines of 2 boxes each @ 30 lpm/line) lpm	90	30	lpm	120
heath trays	124	15	trays	
water supply eight tray stack @15lpm/stack)	233	28	lpm	260
<b>REARING:</b>				
<b>1. Rearing tanks</b>				
Biomass @ ponding 0.45gms	265	53	kgms	
Biomass @ 3gm fry	1,770	356	kgms	
max water demand @ 0.75 to 1kg fish/lpm	1,770	356	lpm	2,126
rearing space with loading density @12 kg fish/M3	147	30	M3	
<b>2. Net pen - rearing to release</b>	Marine	Lake	50x50 pens	
<b>MAXIMUM TOTAL WATER DEMAND</b>				<b>2507 lpm</b>
				662.2321082 USpgm

## **APPENDIX C**

### Site Comparison and Development Cost Assessment

## **APPENDIX D**

### Local Hydrology