PUBLIC INFORMATION REPORT

Englishman River Water Intake, Treatment Facilities and Supply Mains

Conceptual Planning, Budgeting and Scheduling – June 2011

Current Revision Date: June 24, 2011

arrowsmithwaterservice.ca

Purpose

As part of the Communication Strategy for the Arrowsmith Water Service (AWS), the intent of this public information report is to provide the reader with a general knowledge and understanding of the purpose of the AWS. This report will be particularly useful to readers who do not wish to review the detailed planning and engineering reports associated with the project. This report will be a living document that summarizes the history of the Arrowsmith Water Service (AWS), the current governance model, past studies, the purpose of bulk water and our current studies and activities that support future water supply. The report will be updated as new the AWS develops and used as a central repository of information.

Arrowsmith Water Service Mission Statement:

An environmentally sensitive use of water to improve fish habitat and domestic water supply.

Drinking water is the public's biggest natural resource and ensures our best security for the future. This is why we are currently in a planning process to ensure we have safe potable water supply for now and in the future.

Introduction – What is Planned?

The Arrowsmith Water Service (AWS) is planning to expand the joint venture drinking water supply system with:

- A new surface water intake and water treatment plant along the Englishman River
- Water main upgrades and the installation of new water supply lines.

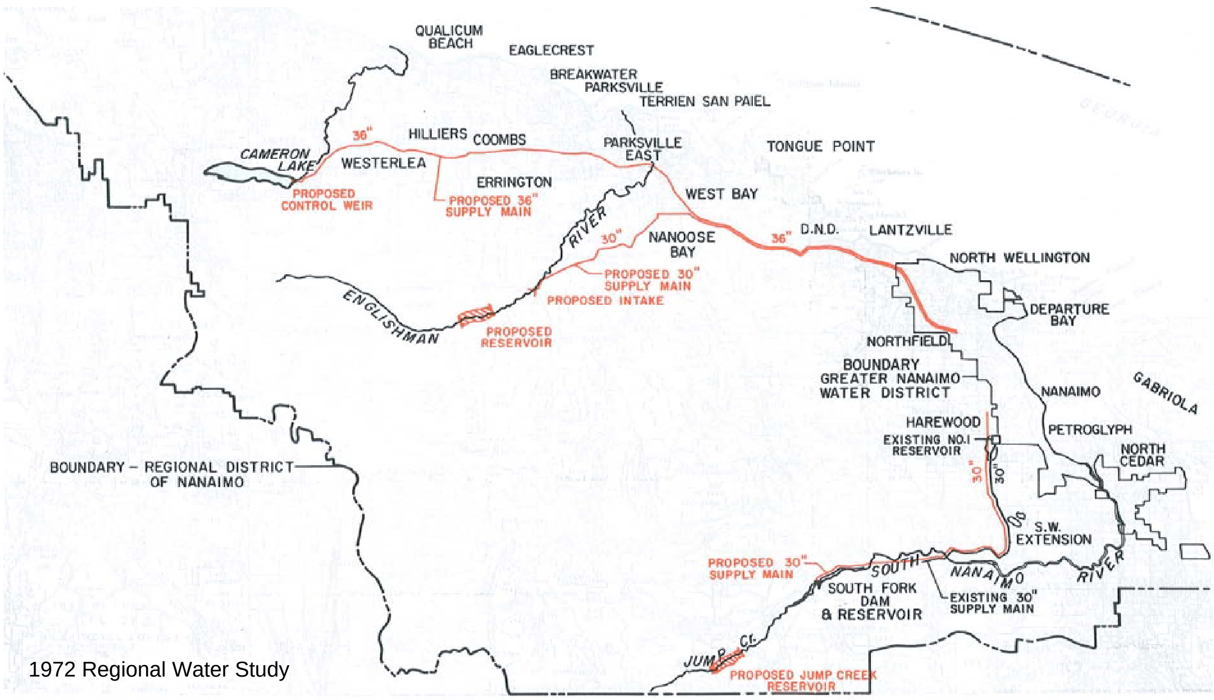
What is the Arrowsmith Water Service?

The AWS is a joint venture that was formed to secure a bulk water supply from the Englishman River for the City of Parksville (COP), the Regional District of Nanaimo (RDN) and the Town of Qualicum Beach (TQB). The AWS water supply is intended to supplement existing supply sources owned and operated by the individual jurisdictions. The AWS is governed by appointed members from the CoP and TQB councils and the RDN Board. Each jurisdiction has secured the following portion of the total allocated bulk water amount based on their respective investments in the venture:

- **City of Parksville 63.9%**
- **Regional District of Nanaimo 22.4% (i.e. Nanoose 14.4%, French Creek 8.0%)**
- **Town of Qualicum Beach 13.7%**

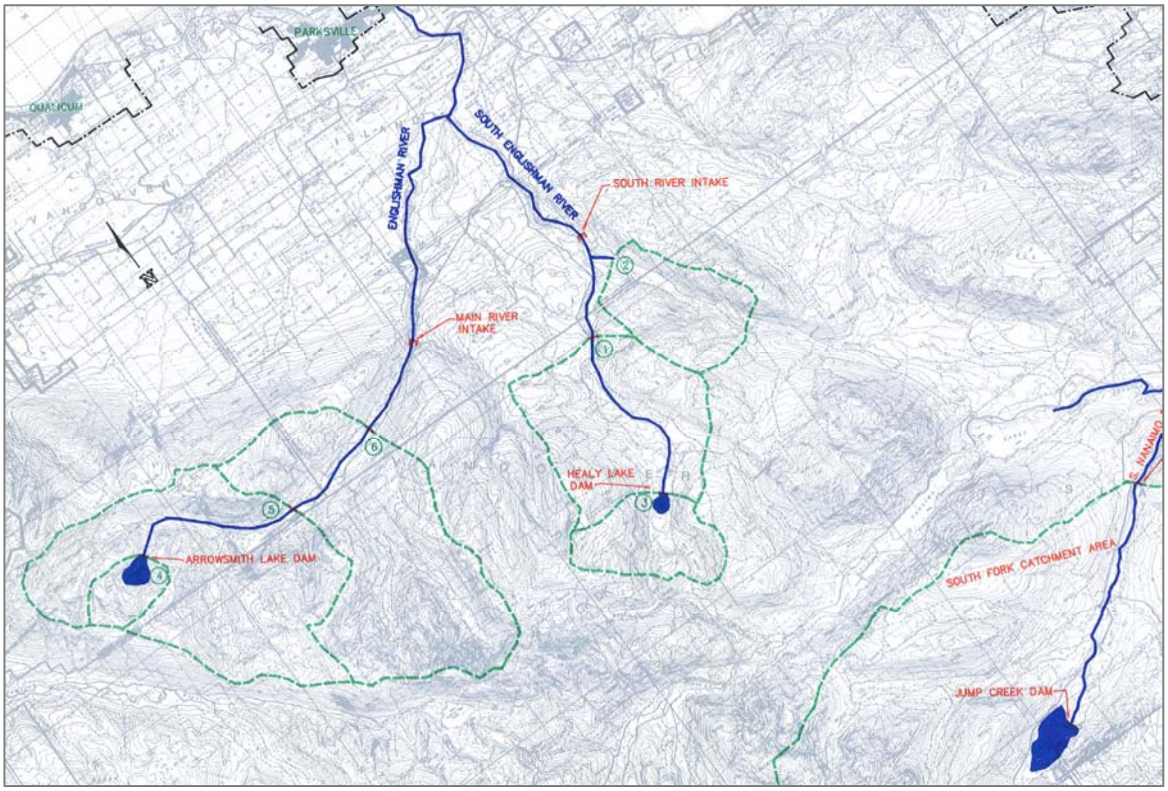
Background / History

The first Regional Water Study commenced in 1972 and incorporated all the Regional District of Nanaimo's water supply needs ranging from Bowser to Cedar. Three sources of future surface water supply were identified, Cameron Lake, Englishman River and Jump Creek.



1972 Regional Water Study

A comprehensive water supply study was completed in 1988. This was an integrated regional water study that focused on the Englishman River and Nanaimo River, South Fork - Jump Creek. At this time it was determined the Greater Nanaimo Water District (now the City of Nanaimo) would proceed on their own as it was determined to be more feasible to develop their own water supply system.



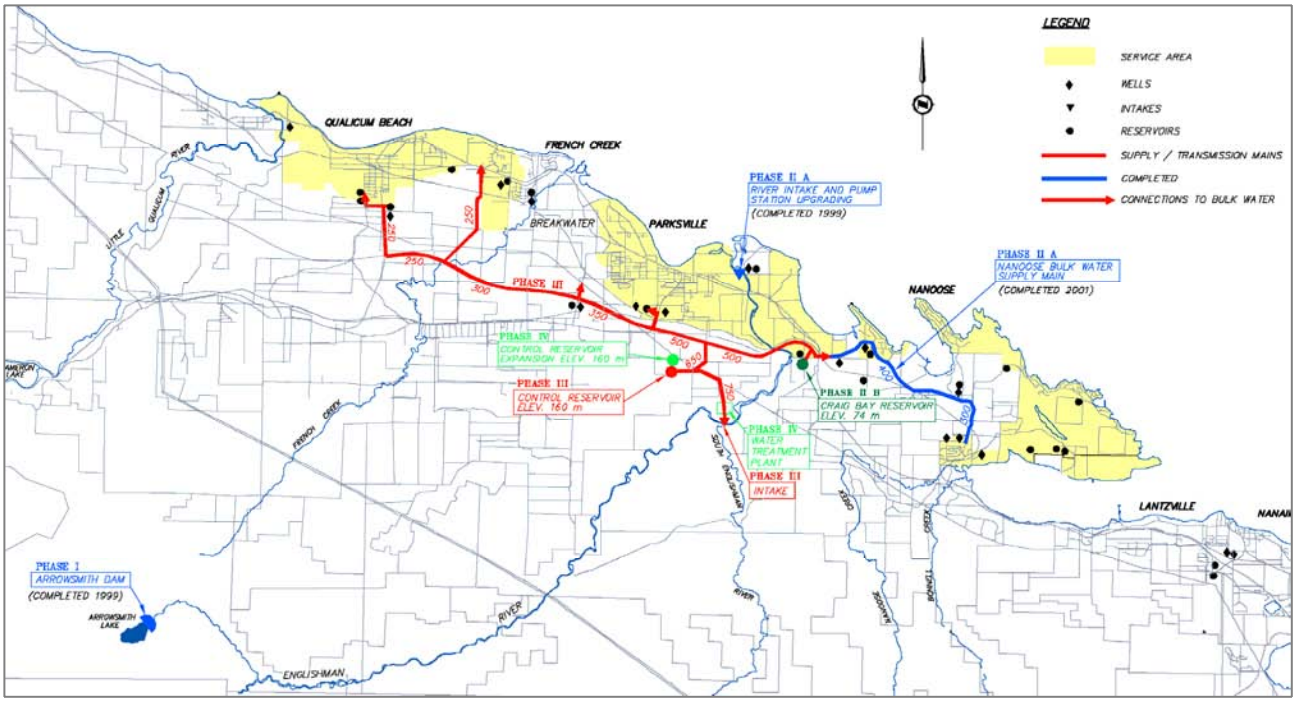
1988 Regional Water Study

- In 1990 a Referendum approved the borrowing of $ 450,000 for pre-design of a regional water supply system to serve the area from Lantzville to Qualicum Beach with a focus on Englishman River and Bonell Creek
- Pre-design was conducted between 1991 to 1993
- Concluded that it was more feasible to have two separate water systems (Qualicum Beach, Parksville and Nanoose (RDN) to be served by the Englishman River and Lantzville to be served by Bonell Creek)
- A referendum held in 1995 to approve design and construction of a bulk water supply system under the auspices of the Regional District of Nanaimo was defeated.
- Cameron Lake was ruled out by the Province and the focus was put on the Englishman River for additional fisheries benefit
- The Arrowsmith Water Service was formed in July 1996, as a joint venture between the Regional District of Nanaimo, the City of Parksville and the Town of Qualicum Beach.
- The original capital plan, presented as part of the 1995 pre-design of the bulk water supply system, went to referendum in 1996 and was approved for the design and construction of the Arrowsmith Dam by all partners of the AWS joint venture. The original plan concentrated on an intake at the confluence of the Englishman and South Englishman River with the remainder of the treatment facility located on Block 602.
- The City of Parksville limited its referendum to the borrowing for the dam only, whereas the Regional District of Nanaimo referendum provided authority for borrowing its projected share of the entire bulk water supply system over a 25 year period to supply bulk water to its systems in French Creek and

Nanoose. Qualicum Beach paid for its share of the dam from reserves and thus did not hold a referendum.

- The bulk water volume required for Breakwater bulk water residents (currently EPCOR – French Creek) was included in the RDN's allocation as it is part of the overall RDN bulk water service area.
- In 1996 a water licence application was submitted based on locating the proposed water intake at the confluence of the South Englishman River and the Englishman River (see Original 1996 Bulk Water Supply – below)

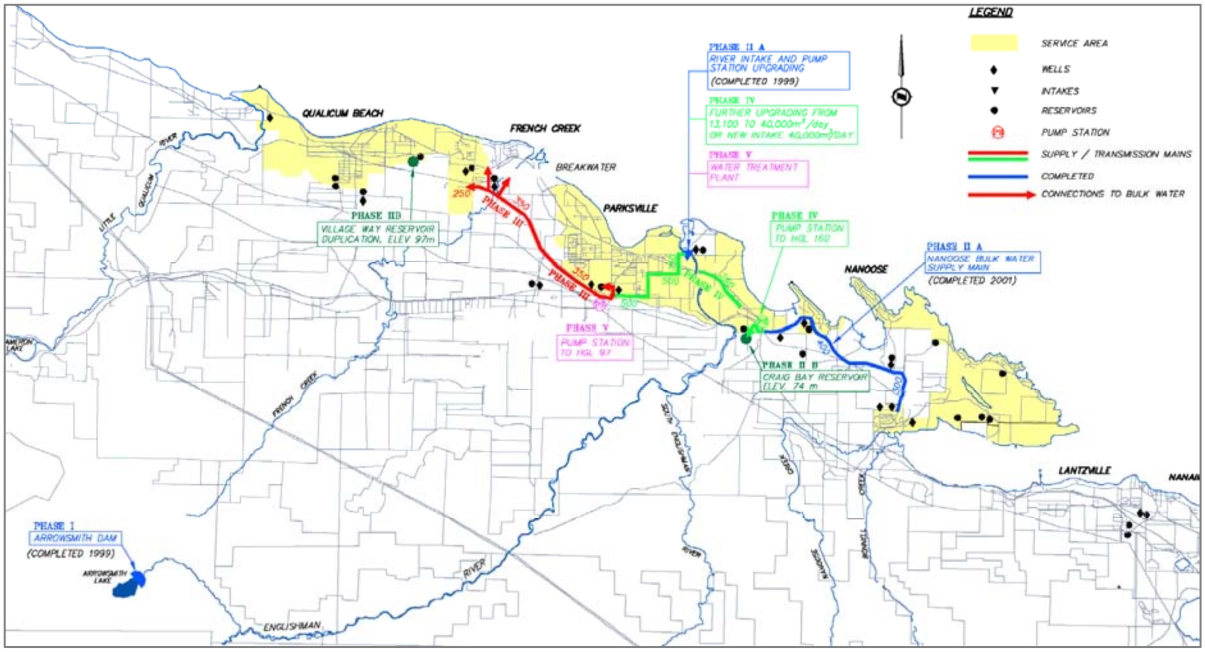
Original 1996 Bulk Water Supply Option (Downsized)



A Conditional Water License was issued in March 1997 authorizing the construction of the Arrowsmith Dam, a maximum withdrawal of 47,954 m3/day of water from the Englishman River for the proposed bulk water system and the storage of 9,000,000 m3 of water at Arrowsmith Lake. The Conditional Water Licence and corresponding Provisional Operating Rule were issued based on the premise of utilizing the existing City of Parksville water intake in the interim until such time the future proposed water intake location was determined and constructed.

This option would allow water to be extracted below the South Englishman River and the Englishman River confluence and be pumped to a control reservoir located in the vicinity of Little Mountain to an elevation of 160m. With this option, the AWS bulk water service area would receive water through a gravity based system controlled from the reservoir on Little Mountain.

2005 - Downstream Intake Bulk Water Supply Option



Between 2000 and 2005, further progression of the AWS capital plan commenced focusing on the future intake location. The capital plan took into account a triple bottom line approach of weighing environmental, financial, risk and social factors and therefore further determined that the best location would be downstream of the originally proposed intake.

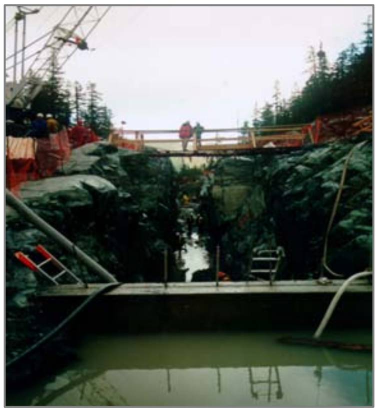
Although this option does not provide a gravity feed and control, it was determined that it represented the most attractive option as it presents substantial cost savings over the option of incorporating an upstream intake and also provides substantial fisheries benefits for the Englishman River due to extending the low flow enhancement further downstream from summer releases at the Arrowsmith Dam. This benefit will become more significant as climate change could adversely affect the low flow regime of the river as time progresses. This option received conditional support from the AWS Management Committee in July of 2005 and the report was finalized in March 2008.

In 2009, the AWS retained Associated Engineering through a quality based selection process to further develop the capital plan based on the downstream option. The primary objectives of the study were two-fold.

- The first was to determine the site and development concept for a new water intake, water treatment plant (WTP) on the Englishman River.
- The second and equally important objective was to determine how the surface water and groundwater resources can be best managed.

Arrowsmith Dam

The first phase of the AWS joint venture, the Arrowsmith Dam, was completed in 1999. The Dam is located at the headwaters of the Englishman River approximately 25 km upstream of the mouth and serves as a storage reservoir to allow augmentation of low summer flows. The Arrowsmith Dam has been a great benefit to fish enhancement on the Englishman River (i.e. colder water being released in the summer and supplementary water contributions provided when river flow rates are low).



Arrowsmith Dam Construction 1998 - 1999

Arrowsmith Lake Reservoir (April 2009) - looking north

Arrowsmith Dam (April 2009)

Arrowsmith Lake Reservoir in Operation

Arrowsmith Dam – Design Criteria

Arrowsmith Lake Reservoir

RESERVOIR STORAGE:

Water Level	= 828.5 m
Natural Water Level (Lake)	= 816 m
Low Water Level	= 802 m
Additional Storage	= 5 million m^3
Total Storage	= 9 million m^3

Approx. storage allocated for fisheries enhancement = 4.5 million $m^{3.}$ The Arrowsmith Reservoir was designed for a 1:15 year drought return.

FISHERIES FLOW TARGETS:

*Mean Average Discharge (MAD)	= 13.70 m^3/s
Critical Rearing Flow (1:79 Year occurrence)	= 0.70 m^3/s (5.1 % MAD)
DFO & MoE Target – Preferred Rearing Flow	= 1.13 m^3/s (8.2 % MAD) - Lower Reaches of E.R.

Design constraints of Dam – Fisheries Benefit (Sumer Flow Augmentation of Dam)

Extreme Low Flow (1:14 year occurrence)	= 1.24 m^3/s (9.05 % MAD)
Fair Rearing Flow	**= 1.36 m^3/s (10 % MAD)**
Good Spawning and Rearing Flow	= 2.05 m^3/s (15 % MAD)

The Province issued a provisional operating rule for the Arrowsmith Reservoir based on maintaining a flow of 1.6 m^3/s at the Highway 19A Bridge Englishman River gauging station (08HB002).

*Englishman River Water Allocation Plan – MoE, April 1993

What are the Current Water Supplies?

Full operation of the AWS system relies on a combination of bulk water from the Englishman River, and a collection of wells owned and operated by each individual jurisdiction.

Groundwater

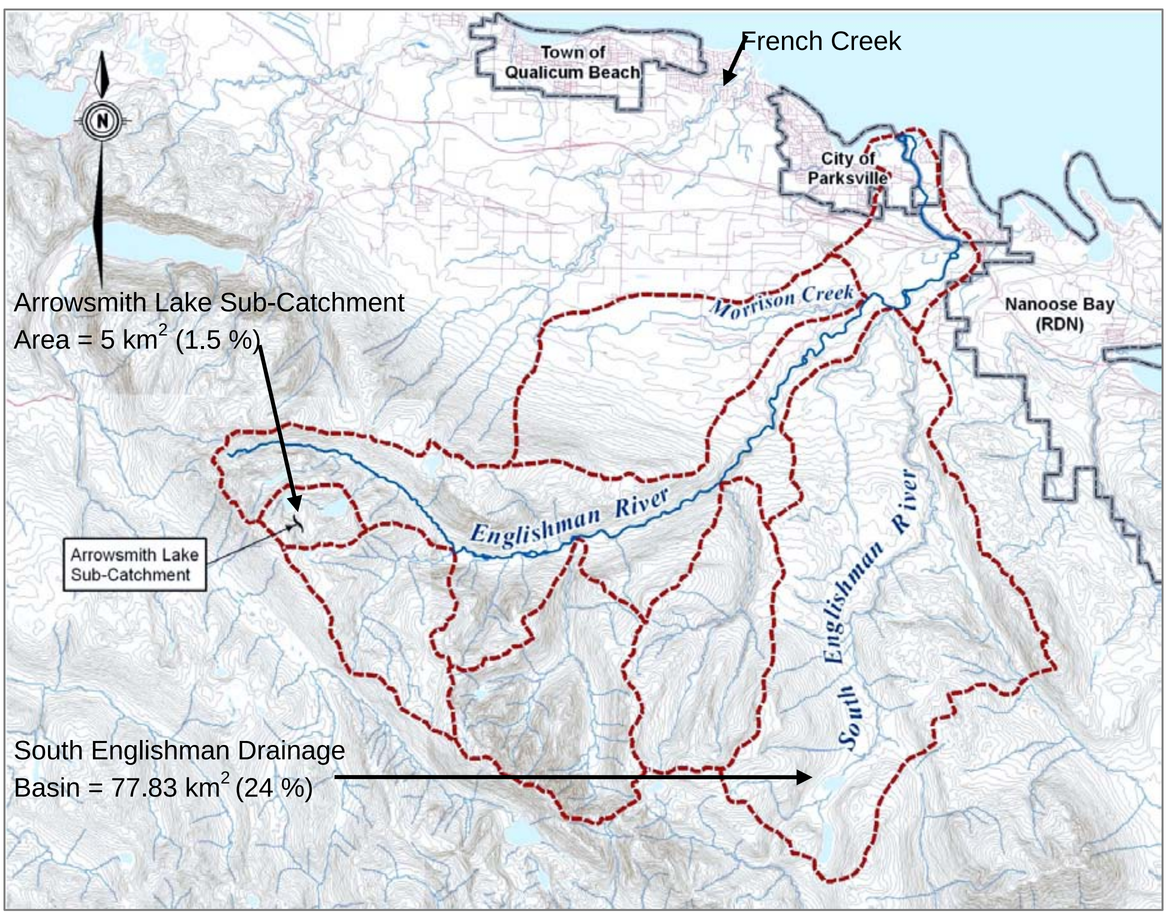
The region is generally blessed with an abundant and high quality groundwater resource. Historical analysis has identified and classified 13 aquifers in the AWS service area. Water is extracted from these aquifers by community, industry, and individual wells. Depending on each jurisdiction's operating permit and water system classification as determined by VIHA, the groundwater generally only requires disinfection for treatment prior to use in the municipal water systems.

Surface Water

The Englishman River is the AWS surface, or bulk, water supply. The Englishman River watershed extends from the alpine area of Mount Arrowsmith at El. 1820m to Georgia Strait, draining an area of about 324 km^2 (see below figure). The watershed supports all species of salmon, including steelhead, and has been designated a sensitive stream by the province under the Fish Protection Act. A significant amount of work has gone into and continues to go into river stewardship.

The Arrowsmith Lake watershed catchment area is only 5 km^2 or about 1.5% of the entire Englishman River catchment area.

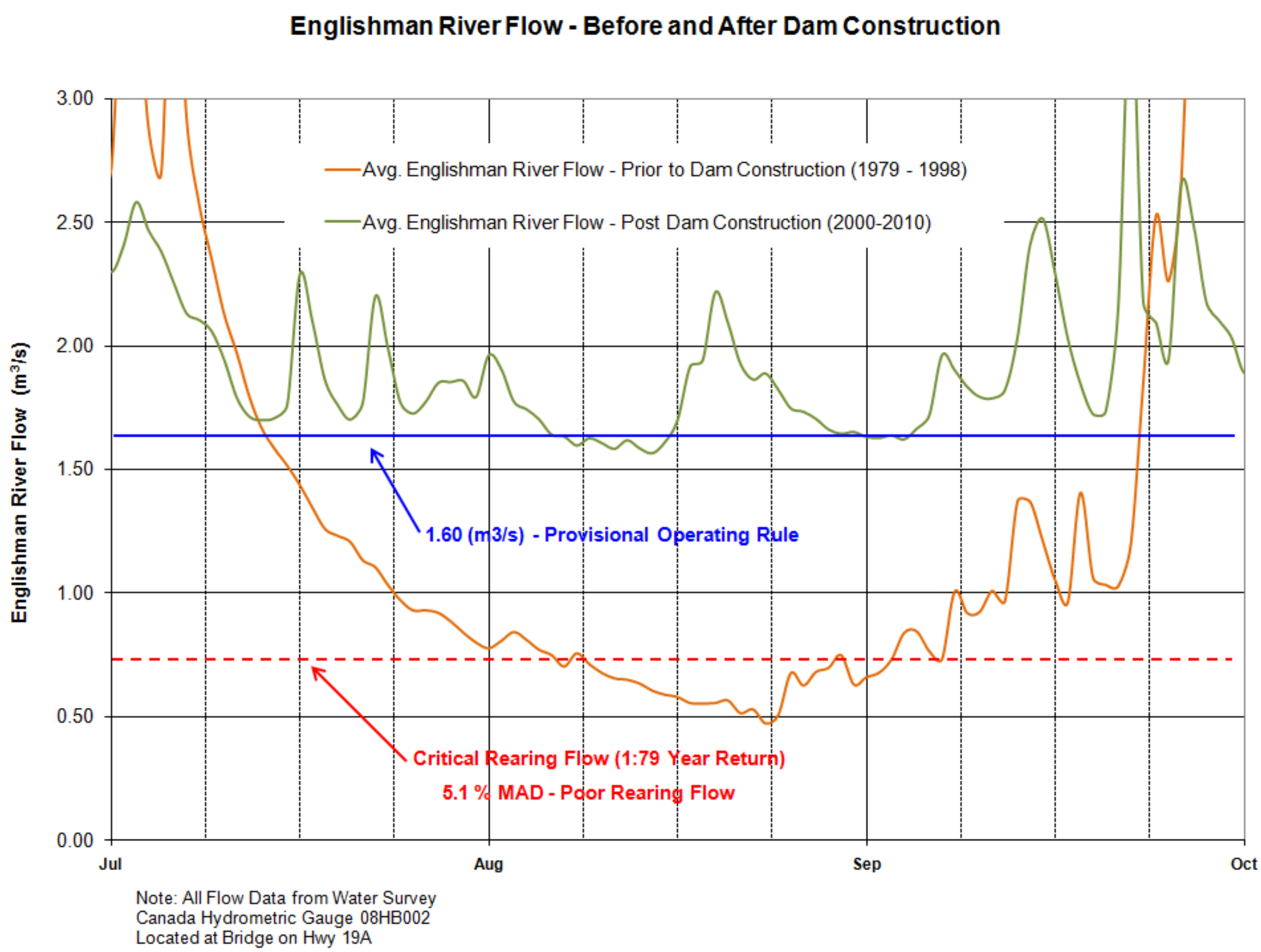
Arrowsmith Reservoir – Drainage Area



Total Englishman River Drainage Basin = 324 km^2

Arrowsmith Dam – Fisheries Benefits

The figure below shows an average of daily flows in the Englishman River, as measured above Highway 19A, before and after construction of the dam. Since construction of the dam, a significant increase in summer flows and minimum fish enhancement flow can now be maintained in the river, even during dry summer periods.



Of critical importance from both a fisheries and drinking water viewpoint is river hydrology. The watershed, in general, is at a low elevation and only the upper areas receive a significant snow pack. As a result, river flow tends to be strongly influenced by rainfall patterns, as demonstrated by how, prior to construction of the Arrowsmith Dam, river flows would drop to very low levels during the driest periods of the summer.

The Englishman River is primarily used by the AWS partners to supplement their groundwater supplies. For treatment, Englishman River water supply is currently chlorinated for protection against microbial contamination. A low chlorine residual is maintained throughout the distribution system to ensure that the quality of the water supply is maintained.

Arrowsmith Dam – Fisheries Benefits

6/20/2011

Monthly Average Discharge Volumes
Englishman River *1913 - 2010*

Year	June	July	August	September	October	
1913	9.25	5.43	1.01		7.94	
1914	7.24	2.42	0.63			
1915	3.04	1.24	0.78	0.68	17.50	
1916	17.30	9.11	3.04	1.15	2.18	
1917	11.70	4.60	1.24	1.42		
1970	6.38	1.43	0.65	0.88		
1971	13.30	7.11	2.06	2.04		
1979	2.85	2.40	0.65	6.06	12.90	
1980	5.94	3.39	0.84	1.21	1.61	
1981	4.95	1.75	0.65	2.84	21.50	
1982	12.00	3.50	1.03	0.71	22.80	
1983	6.59	5.16	1.04	0.97	2.96	
1984	7.33	2.84	0.72	1.21	17.20	
1985	4.64	1.29	0.50	0.85	10.30	
1986	4.88	1.79	0.53	0.42	1.29	
1987	5.94	1.55	0.58	0.34	0.29	
1988	8.32	3.07	0.87	0.70	1.84	
1989	4.32	1.93	0.87	0.40	5.79	
1990	6.65	1.32	0.38	1.02	21.60	
1991	2.15	0.89	7.10	3.10	0.64	
1992	1.31	1.04	0.42	0.84	6.87	
1993	6.17	1.34	0.50	0.25	1.13	
1994	4.06	1.14	0.48	0.46	3.36	
1995	4.09	1.62	0.91	0.35	7.49	
1996	3.41	1.16	0.33	0.50	8.29	
1997	9.48	5.37	1.98	5.62	28.40	
1998	4.00	1.63	0.39	0.34	2.34	
1999	18.01	10.5	4.38	2.11	4.87	**Arrowsmith Dam in Operation**
2000	8.51	2.59	2.29	1.58	8.58	
2001	3.51	1.52	2.51	1.72	3.27	
2002	6.83	2.14	1.72	1.58	1.11	
2003	3.6	1.34	1.23	1.57	31.7	
2004	2.85	2.06	1.83	2.89	8.9	
2005	3.55	1.85	1.74	1.76	10.3	
2006	6.49	2.34	1.61	1.18	1.03	
2007	3.41	3.91	1.77	1.79	11.21	
2008	7.97	2.42	2.04	2.07	4.59	
2009	3.06	1.27	1.26	1.50	5.39	
2010	8.98	2.50	1.66	3.63	9.13	

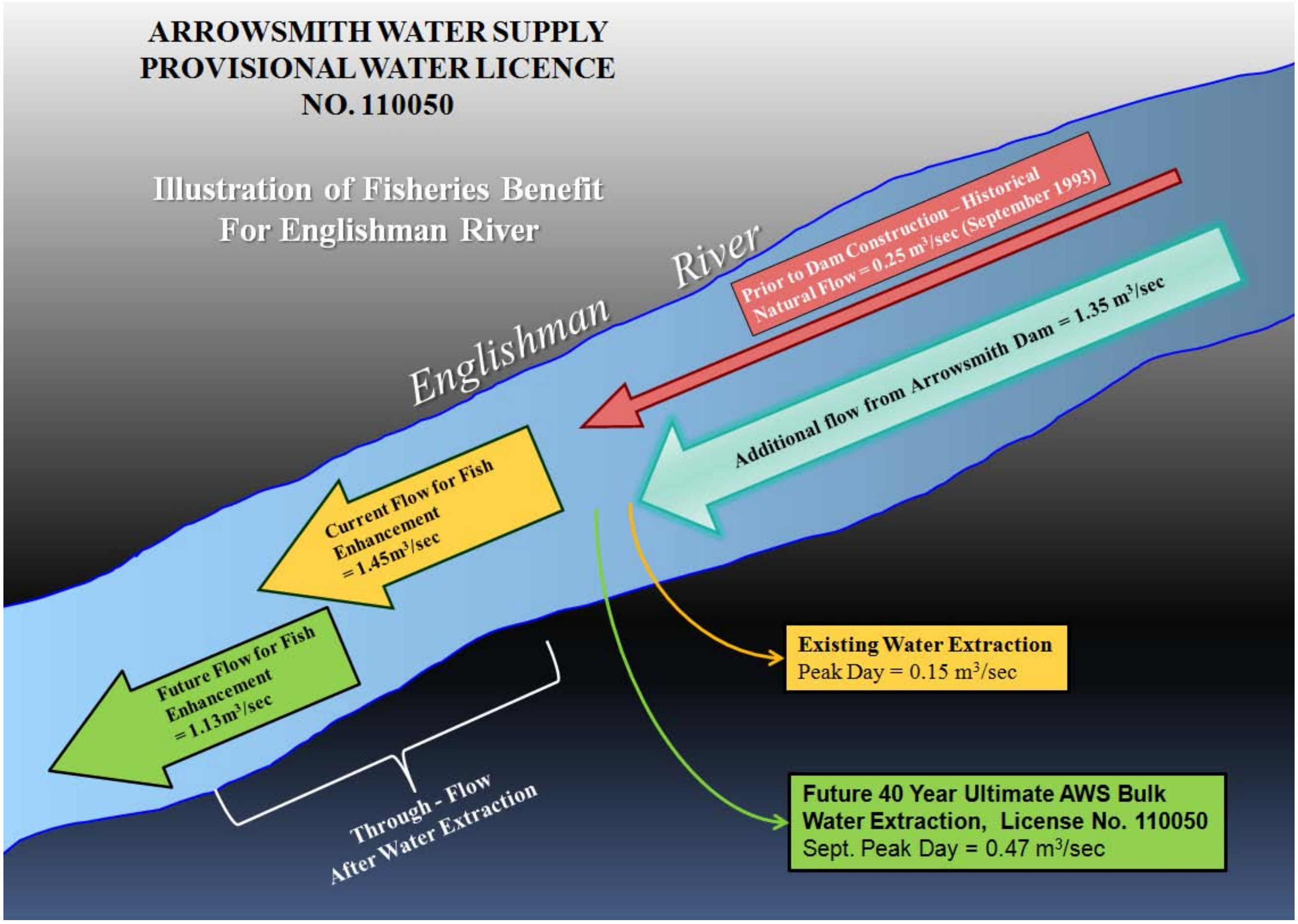
Values of below 1.0 cubic metres per second

Values greater than or equal to 1.6 cubic metres per second

Note:
This information was taken from the Water Survey of Canada Archived Hydrometric Data - Englishman River near Parksville site 08HB002 - Monthly Mean Discharge (m3/s)

AWS Englishman River Historical.xls

Arrowsmith Dam – Fisheries Benefits



The above is a scaled graphical illustration of flow in the Englishman River showing:

- In **red,** the flows in the Englishman River (0.25m^3/s) during critical summer months prior to the Arrowsmith Dam construction,
- In **blue**, additional flows from the Arrowsmith Dam reservoir (1.35m^3/s) for low flow summer base flow augmentation and future licensed potable water extraction (40 year horizon),
- In **yellow**, current water extraction,
- In **green**, flow available after the ultimate water extraction (1.13m^3/s) - 40 year horizon, for improved fish enhancement.

As part of the AWS exploring future water resources on a regional basis, it was determined by senior government that the best approach for the City of Parkville, Regional District of Nanaimo and the Town of Qualicum Beach to look toward the Englishman River for the main source of surface water supply rather than developing supplies on separate surface water sources. Given that all the water licences on the Englishman River were allocated at that time, the AWS would need to provide storage for bulk water extraction along with providing enhanced fisheries benefits. The current Water Licence No. 110050 in the name of the AWS joint venture reflects our current bulk water needs with the conditions of providing additional flows for fisheries benefits.

Arrowsmith Water Treatment Plant

The second phase of the AWS joint venture will be the construction of a new water intake, water treatment plant and water transmission system. The second phase is required to ensure that an adequate volume of bulk water can be provided, and that the water meets today's standards for good quality drinking water.

The three joint venture participants require bulk water at different times. Based on current information:

- The RDN will require additional water supplies by about 2015, for the Nanoose area.
- The CoP will require additional water supply by approximately 2015.
- The TQB will not require bulk water for at least 20 years.

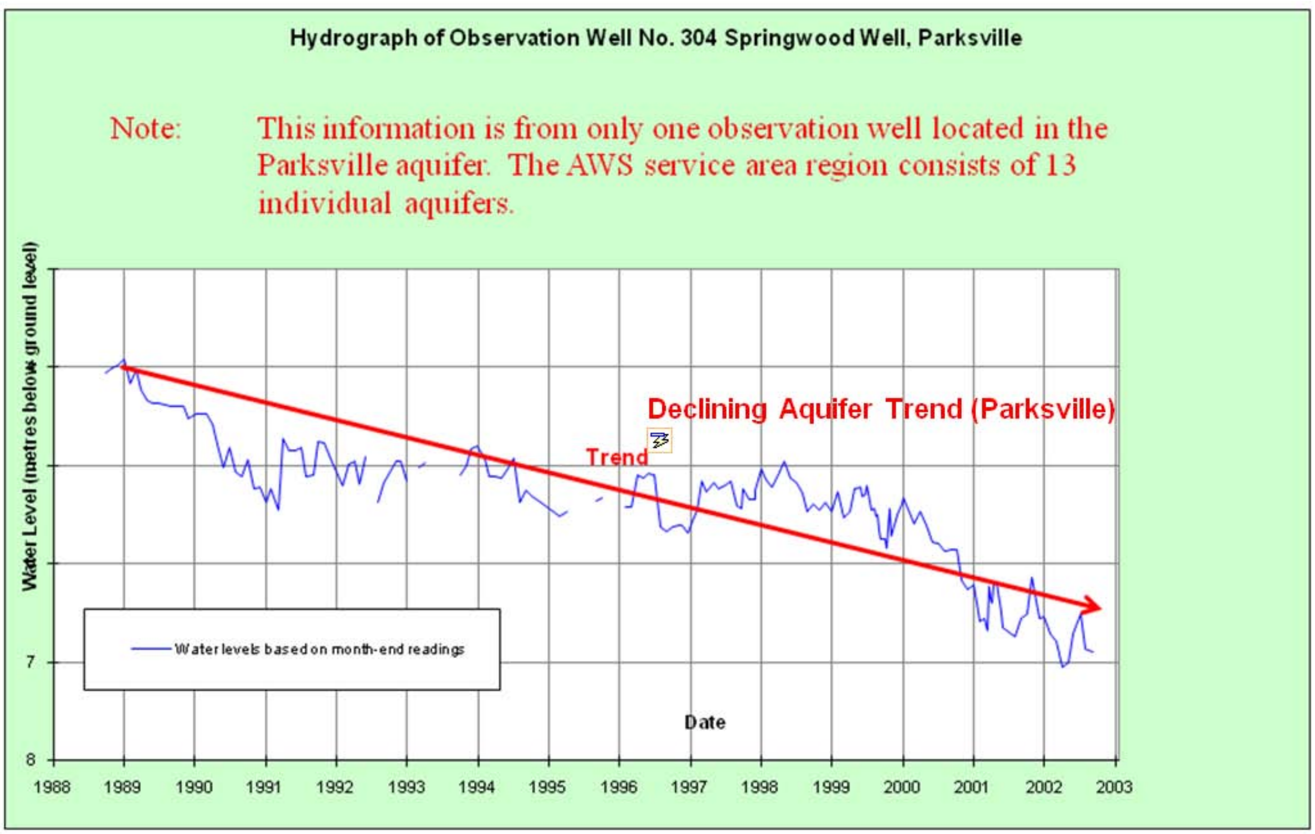
Why are Changes Needed to the Current Water Supply System?

There are many factors contributing to the need to expand the AWS water supply infrastructure:

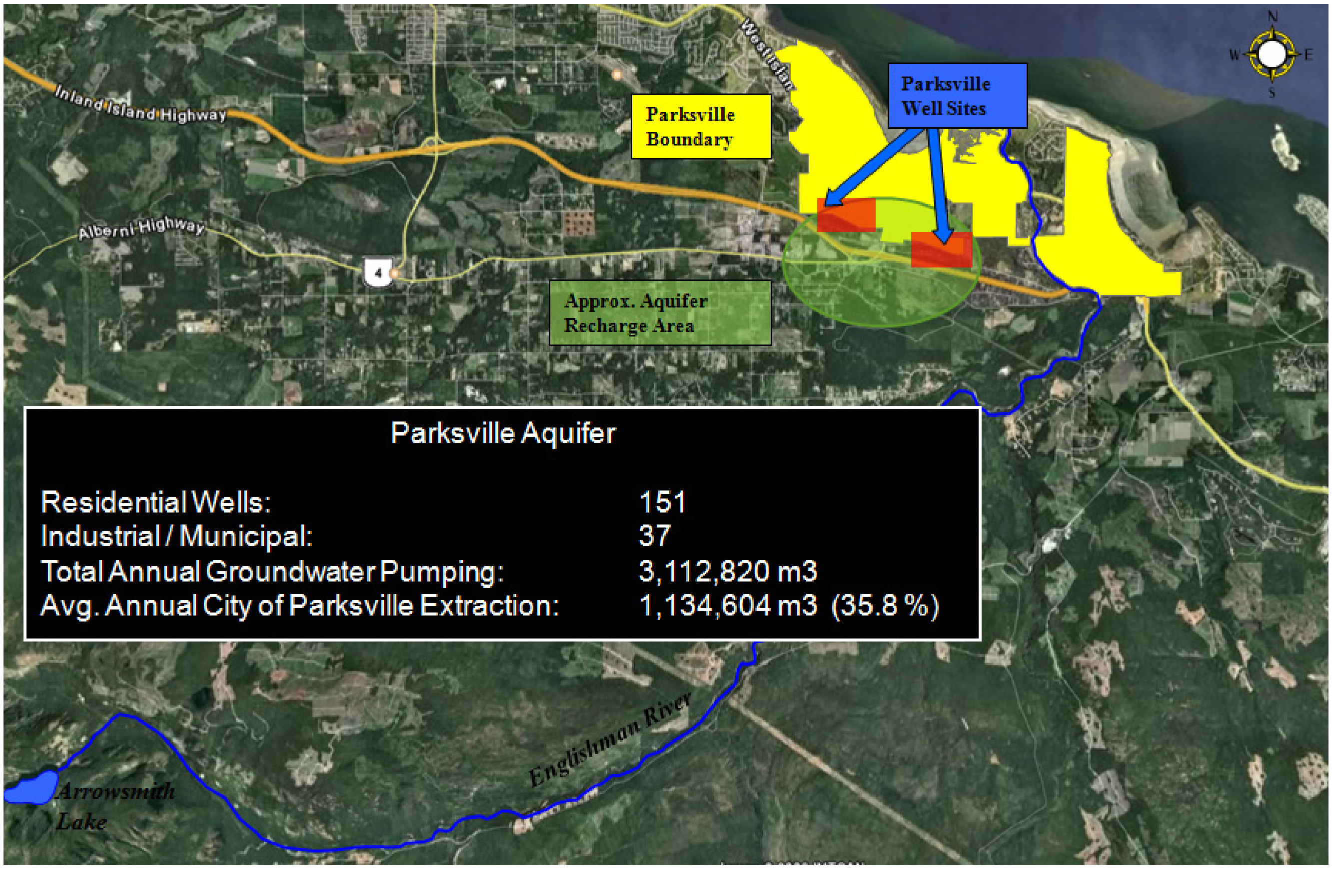
- Greater reliability and security,
- Higher drinking water quality standards, and
- Increasing water demands.

To Secure Supply Capacity

There is general concern of declining groundwater levels in the region's aquifers, due to increasing demands on the aquifers and on climatic changes. Specifically longer, drier summers, less precipitation and shorter periods of rain that, when combined, reduce the amount of recharge available to the aquifer. It is prudent to secure additional water sources in case groundwater levels continue to decline and well yields begin to suffer. Having multiple supply sources available also provides contingency should the use of one source be temporarily suspended. It also reduces stresses on a single source thereby supporting recovery and more sustainable supplies



Note: other aquifers within the region are not exhibiting this rate of decline.



Parksville Aquifer No. 216

- The majority of the Aquifer is outside the City Boundary.
- More water users and consumption than Municipal Water use.

Climate Change

- Indication of more extreme events (wetter) and drier summers – both drought and flood events
- Sea level rise – will it make the existing intake tidal?
- Salt water intrusion

To Ensure Water Quality

The Vancouver Island Health Authority (VIHA) works with public water providers to ensure that the objectives of the BC Drinking Water Protection Act are met. Water providers are encouraged to adhere to the Guidelines for Canadian Drinking Water Quality (GCDWQ), a set of water quality parameter objectives established and regularly updated by Health Canada. The GCDWQ are available on the Health Canada website (http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/index-eng.php). The objectives are set to protect human health, maintain the aesthetic appeal of drinking water, and to minimize vulnerability to contamination.

In response to changes to the turbidity guideline, in 2009 VIHA lowered the maximum turbidity level allowed for water from the Englishman River entering the distribution system from 5 NTU to 1 NTU. To satisfy this new limit, Englishman River water supply will need to undergo filtration as treatment. This has reduced the time that we can draw water from the Englishman River and therefore increases the need to extract from the wells.

Water Treatment Facility – City of Kamloops

Deficiencies in current Parksville water intake

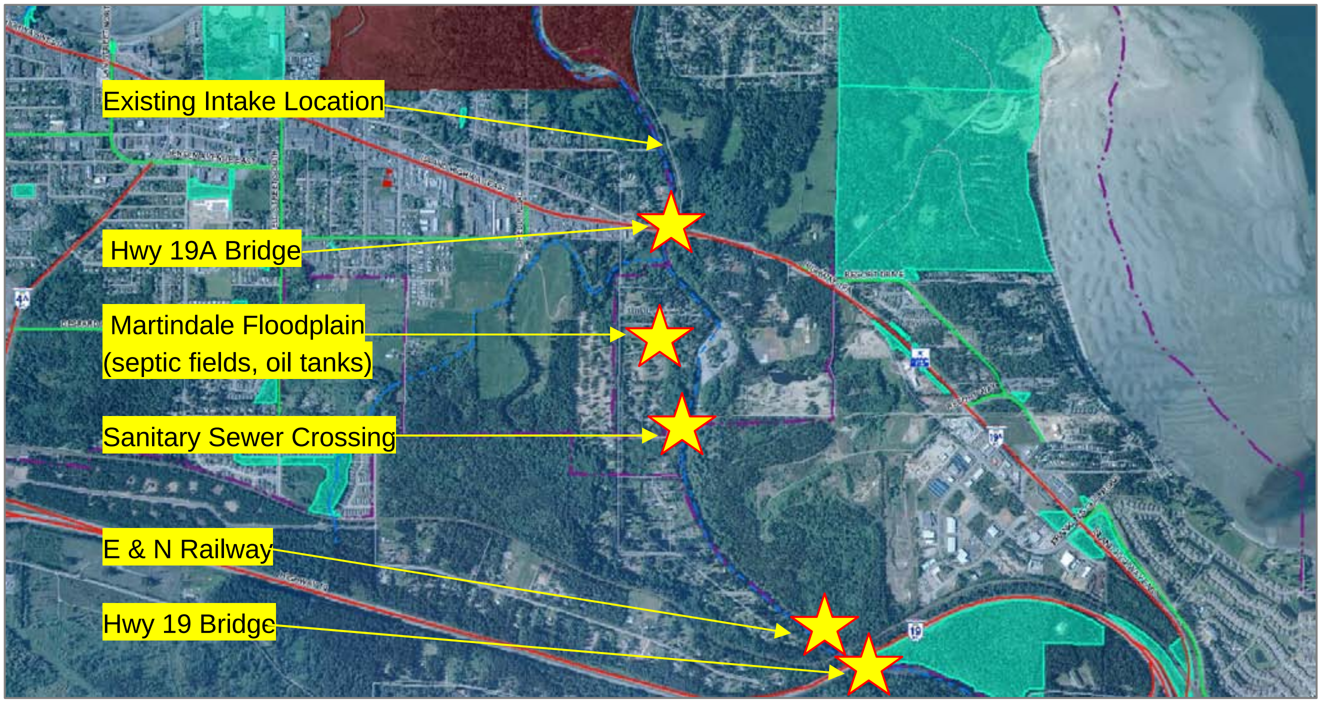
- Becoming increasing difficult to operate due to the age of the existing infrastructure and the current location being adjacent to a single family residential neighbourhood.
- Only two of the three infiltration gallery legs are operational
- The intake gallery is under the Englishman River gravel bed and current maintenance procedures implicate fish habitat
- In flood plain and therefore becomes inaccessible during annual flood events
- Type of intake does not lend itself for future expansion

Existing Intake Gallery – Englishman River

An effort is required to mitigate all known risks that are not in the immediate control of local government. Some of these risks have developed since the original intake was constructed.

Existing location (risk of contamination):

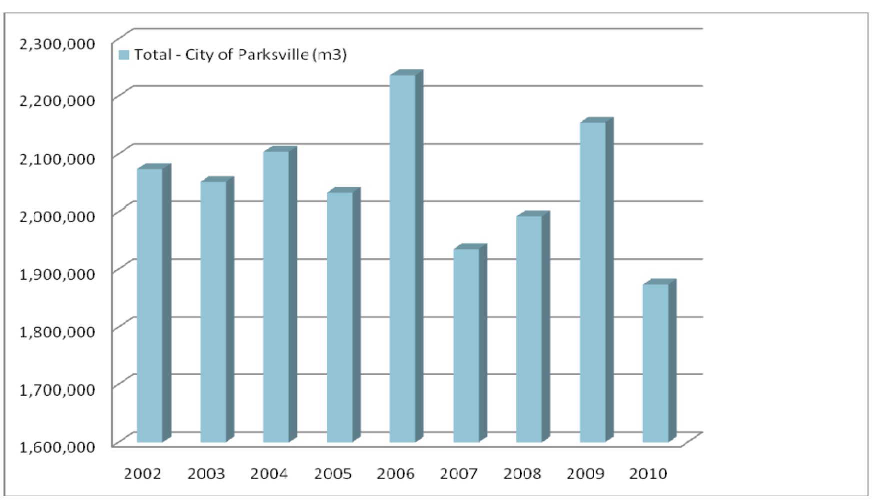
- Below two highways
- Below one railway
- Below flood plain area / sanitary sewer crossing



Known Risks to Existing Surface Water Intake

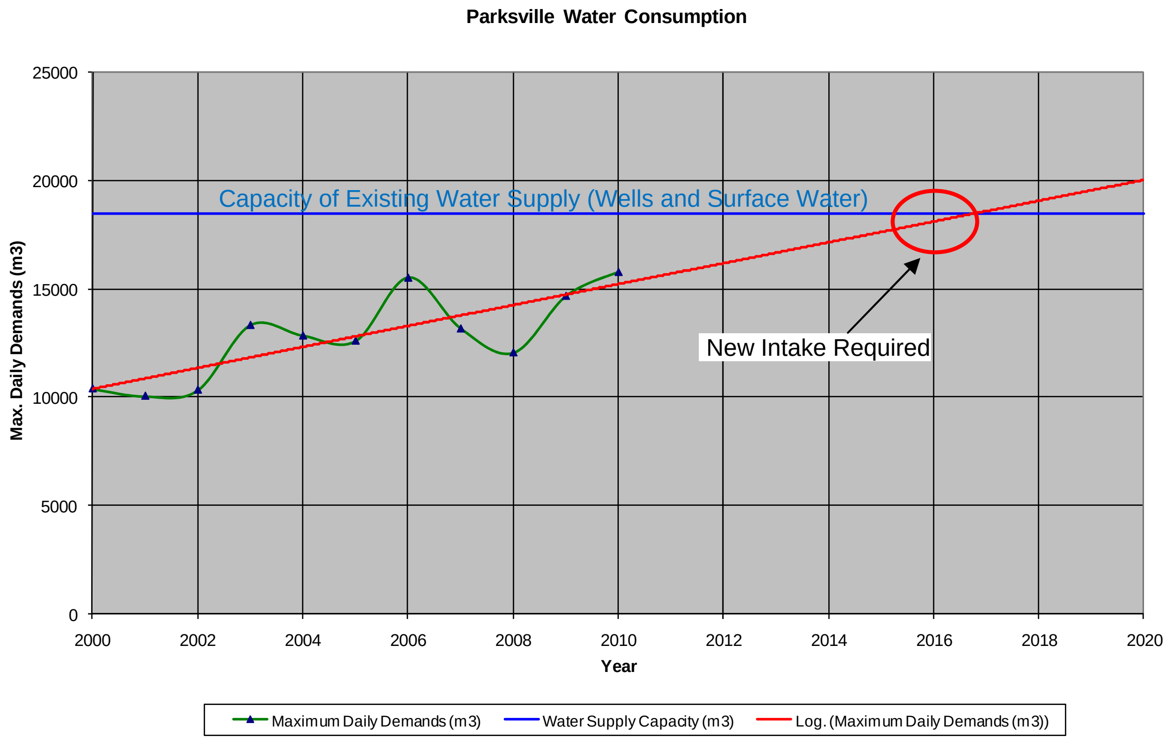
To Support Population Growth

Vancouver Island has experienced relatively high growth in recent decades and this is expected to continue. For example, on an annual basis water consumption for the City of Parksville has been reduced as a result of water conservation measures (as shown on the below graph).



Parksville - Annual Water Use (m3)

However, the below graph illustrates the maximum day peak demands are still continuing to increase. This is a result of visiting populations, special events and general high water use during hot summer days. The infrastructure (reservoirs, pumps, intakes, treatments facilities, etc.) all need to be sized to supply this peak day demand.



Parksville – Max. Peak Day Demands

How much water do we need?

Population Growth

The growth of residential population is typically used as the basis for prediction of future water supply needs. By using residential population, all water use by the community is equated to the number of residents. This includes industrial, commercial and institutional water use, as well as unaccounted for water use or loss.

Population growth projections over such a long period can be difficult, as growth in British Columbia has historically occurred in cycles of alternating high and low rates. A range of build-out populations were estimated for each jurisdiction based on the land use categories in the current Official Community Plans (OCP) and historical growth rates. The projected “high” and “low” 2050 service populations are shown below.

For the initial planning of water supply capacity, the “high” population growth rate was assumed. This is to ensure that water supply planning is conservative and capital budgets at this stage reflect the upper end of costs. It is easier to plan for the worst-case scenario and trim down than to determine later on that more water is needed than was originally determined.

Residential Population Growth

Service Area	Existing Population Year 2009	High Estimate Year 2050	Annual Percentage Growth Rate for High Estimate	Low Estimate Year 2050	Annual Percentage Growth Rate for Low Estimate
City of Parksville	11,500	25,000	1.9	19,000	1.2
Town of Qualicum Beach	8,910	16,000	1.4	11,000	0.6
RDN Nanoose	4,800	11,970	2.3	8,840	1.5
RDN French Creek Bulk Water Service	4,740	10,540	2.0	8,720	1.5
Total	**29,950**	**63,510**	**1.9**	**47,560**	**1.1**

Historical Water Use

The table below shows the current water use data on a per capita basis for the various water service areas. The average day demand (ADD) is the average amount of water used over a period of one year. The maximum day demand (MDD) is the maximum water use over a 24-hour period within a given year. The MDD typically occurs in the summer, when outdoor water use is at a seasonal high. The ADD is useful for planning the annual or multi-year yield from a water supply source, while the MDD is used to determine how large infrastructure such as pipes and pump stations need to be.

Current Per Capita Water Use

Water Service Area	Average Day Water Demand (L/d per capita)	Maximum Day Water Demand (L/d per capita)
City of Parksville	514	1094
Town of Qualicum Beach	572	1466
RDN Nanoose	479	1374
RDN French Creek	340	1203
Weighted Average	**498**	**1258**

Impact of Climate Change

Current water use is less than the MDD planning estimate that was developed in the 1990's (1375 L/s), which reflects the impact of water conservation initiatives implemented by the AWS jurisdictions. However, climate change modelling is predicting extended hotter and dryer periods through the summer months, which will likely increase both maximum day demand and annual water use. In addition, unaccounted for water system leakage is anticipated as the water infrastructure ages. Based on these factors, a range of per capita demands was assumed, ranging from 1100 to 1375 L/d per capita for MDD, and 480 to 550 L/d per capita for ADD.

Predicted Water Use

This table presents the future water demand projections based on the high growth residential population projections and the selected water use parameters.

Future Annual Water Use

Service Area	2050 Average Water Demand (ML/d)		2050 Maximum Day Water Demand (ML/d)	
	Low Demand	High Demand	Low Demand	High Demand
CoP	4.36	5.00	27.4	34.2
TQB	2.76	3.16	17.3	21.7
RDN Nanoose	2.10	2.41	13.2	16.5
RDN French Creek	1.87	2.15	11.8	14.6
Total	**11.10**	**12.72**	**69.6**	**87.0**

Note: ML/d = megalitre (1,000,000 litres) per day. The AWS area could require up to 87 ML/d of water by the year 2050.

Capacity of Existing Water Supplies

It is clear going forward that water supply will be a combination of groundwater and surface water from the Englishman River, but the amounts the two sources are required in each jurisdiction has a significant bearing on long term water supply planning. For example, if the AWS partners decide to withdraw more water on an annual basis from their aquifers or to develop more wells, less water is required from the Englishman River. Conversely, if one or more of the partners was to lose groundwater supply capacity through aquifer depletion or contamination, additional water from the Englishman River would be required. The decision as to the required capacity of the future Englishman River intake and water treatment plant is thus subject to some uncertainty.

Water conservation, water use reduction and reuse / recycling opportunities will have a positive effect on our future water requirements and phasing of the treatment facilities.

The table below shows the current well development by the water utilities.

Existing Groundwater Supply

Service Area	Number of Wells	Maximum Well Capacity (ML/d)	Annual Well Yield (ML/year)
City of Parksville	16	9.0	1,120
Town of Qualicum Beach	9	20.0	1,870
RDN Nanoose	11	4.8	700
RDN French Creek	20	5.2	680
Total	**56**	**39.0**	**4,370**

Surface Water Requirements

Water supply systems are typically sized to provide sufficient water, without relying on storage reservoirs, to meet maximum day demands. This table lists the amount of surface water that each water utility is projected to require by 2050.

Required Surface Water Capacity of Existing System

Service Area	A		B	A – B = C	
	2050 Maximum Day Demand (ML/d)		Maximum Well Yield (ML/d)	2050 Maximum Surface Water Supply Required (ML/d)	
	Low Demand	High Demand		Low Demand	High Demand
CoP	27.4	34.2	9.0	**18.4**	**25.2**
TQB	17.3	21.7	20.0	**-**	**1.7**
RDN Nanoose	13.2	16.5	4.8	**8.4**	**11.7**
RDN French Creek	11.8	14.6	5.2	**6.6**	**9.4**
Total	69.6	87.0	39.0	**30.6** [1]	**48.0**

Notes: [1] – Assumes excess yield from TQB wells can be used to support overall AWS demands. Otherwise low demand is 33.4 ML/d.

Planned Future Water Supply

For the AWS, the key to regional water management in the future is seasonal storage, that is, build up supply in the winter when water demands are low and water is abundant, for use in dry summers when demands are high. The ability to develop additional surface water storage is limited, due to space unavailability and due to modelled impacts of climate change indicating that filling more storage would not be possible under some scenarios. The opportunities are therefore in better management of the groundwater resource and enhancing groundwater storage.

The use of groundwater supplies is not without risks. While there is overall potential to enhance and increase groundwater use, the performance of individual wells can change over time. Declining GW levels and aquifer contamination may lead to less groundwater being available. Considering the water resources of the region as a whole and planning on a regional basis will ensure that the water supplies that the area has today will continue for future decades.

The plan is to continue to rely on groundwater wells and the Englishman River as water supply sources for the AWS. In addition, an innovative option called Aquifer Storage and Recovery (ASR) is being explored, which is described in greater detail in this report.

Groundwater

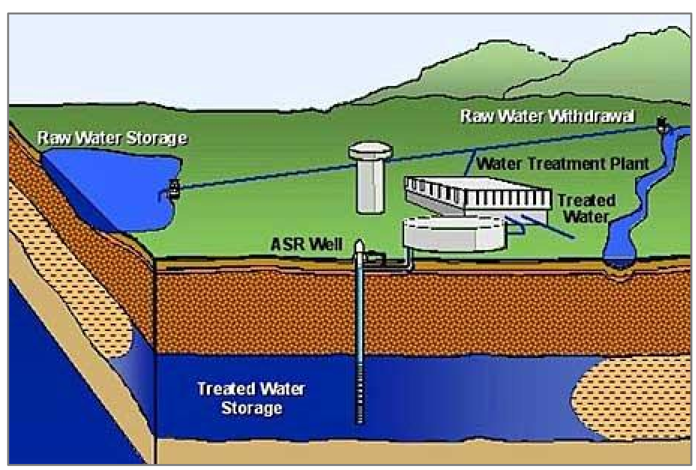
The existing groundwater sources are good, cost-effective source of drinking water for the AWS partners. As the existing wells draw water from what is considered a confined aquifer, the only treatment required to meet provincial objectives is disinfection for microbial protection. Each local government will continue to maintain their respective well systems.

Surface Water

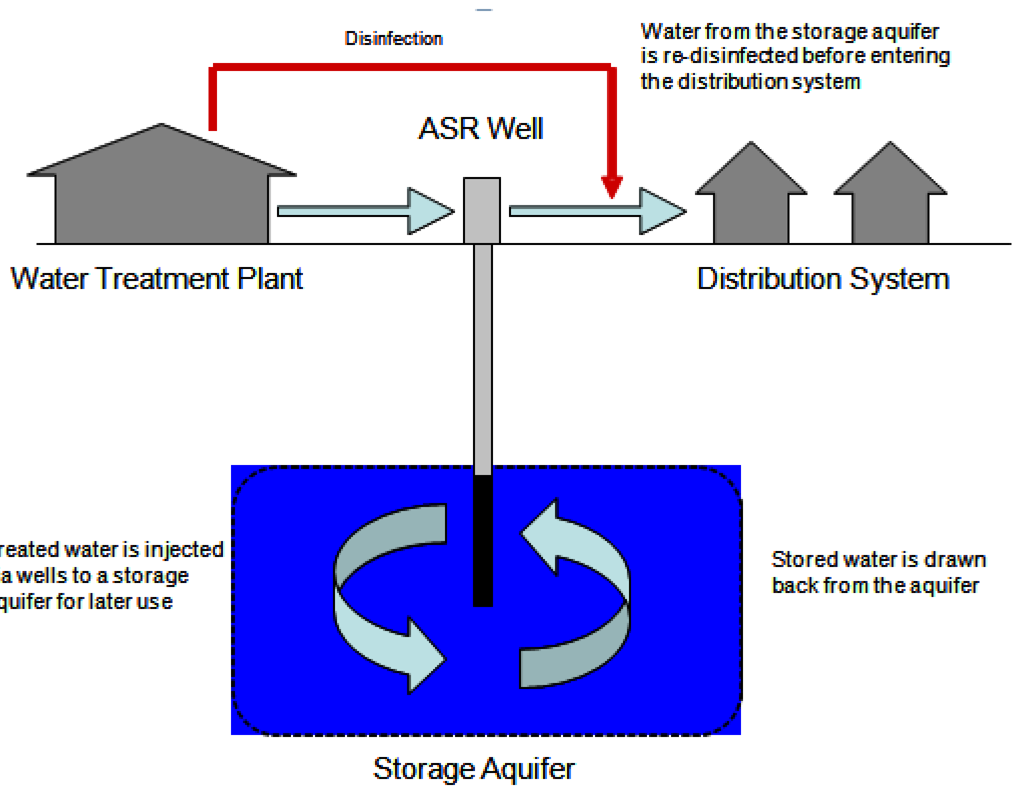
The Englishman River provides surface water of generally high quality. Plans are underway to develop a new intake and water treatment plant. The capacity and location of the surface water source may be limited by restrictions identified by DFO in order to protect aquatic life in the river.

Aquifer Storage and Recovery

ASR is defined as the storage of water in a suitable aquifer when water is available, and recovery of the same water later on when it is needed. A typical schematic of an ASR well, used to both inject and withdraw water, is shown in the below illustration. Although the concept is simple, ASR has only been implemented relatively recently by the water industry. There are approximately 100 ASR systems in production or in the planning stages in the United States and one operating in Canada (Kitchener – Waterloo).



Typical ASR Well Schematic



Incorporating ASR into the system would involve contributing water to the storage aquifer in the winter, when excess supply is available, and withdrawing this water in the summer when supply is most challenged to meet demands. ASR would create an additional supply for the AWS, which would provide more contingency should one supply source be taken off-line, and allow the AWS greater flexibility in managing the water resources. ASR can reduce the maximum amount of water that needs to be supplied by the treatment plant. This means that less water will need to be drawn from the Englishman River during the summer, when river water levels are at their yearly low.

Further investigation is required to determine if the concept of ASR is feasible and if suitable, a confined aquifer is available – could play a major role as third water source

Benefits:

- Gives us a "third water supply"
- Could potentially reduce the Englishman River water extraction up to 40% in the critical summer months
- Allows a balanced water supply
- Allows stored treated water from winter months to be used in the summer
- Can be substantially lower cost than above ground storage reservoirs

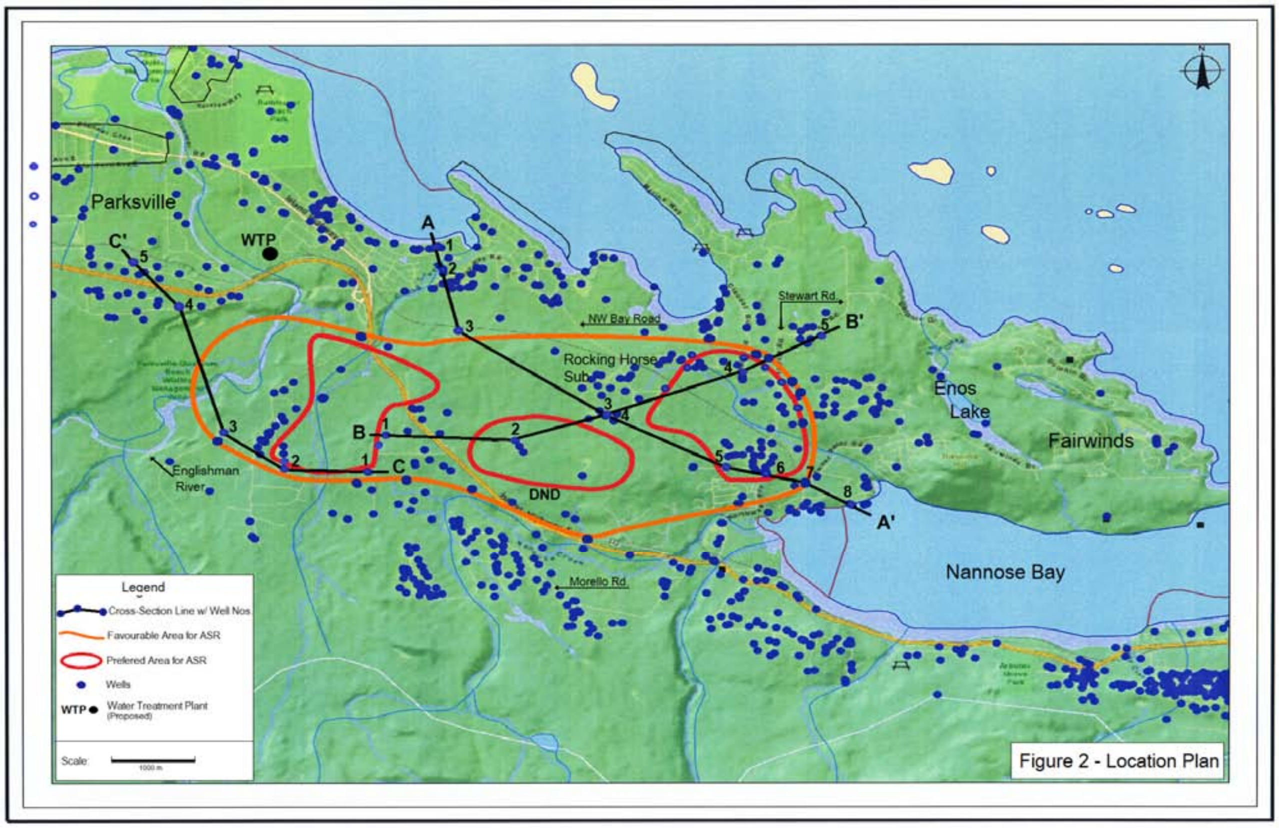
ASR requires an aquifer with specific characteristics such that the aquifer can protect and contain the stored water, but also allow easy extraction. Of the 13 aquifer systems in the region, five of them were identified as potentially suitable candidates.

Aquifer Number	Aquifer Location / Name	Confinement	Water Quality	Depth	Hydraulic Gradient	Depth to Water	Transmissivity	Storage	Multi-Layer	WTP * Large Pipes Distance	End of System Location	Development	Total Scores
664	Little Qualicum River	0	10	0	5	0	10	0	0	0	10	5	40
663	Upper Whiskey Creek	0	5	0	5	0	5	0	0	0	5	10	30
217	Qualicum	5	5	5	10	5	10	5	0	0	10	10	65
212	Parksville	10	10	5	5	5	0	0	0	5	0	5	45
216	Parksville	5	5	5	5	5	5	5	0	10	0	5	50
220	Errington	10	5	10	5	0	0	0	0	5	0	0	35
209	Errington	10	10	0	5	0	0	0	0	0	0	10	35
219	**Nanoose Creek**	**10**	**10**	**10**	**5**	**10**	**5**	**10**	**10**	**10**	**10**	**10**	**100**
221	Parksville	5	10	0	10	0	5	0	0	5	0	10	45
214	Madrona Point	5	5	5	10	0	0	0	0	10	5	10	50
218	Nanoose Hill	5	10	10	5	0	0	0	0	0	10	10	50
210	Nanoose Bay	5	10	10	5	0	0	0	0	0	10	0	40
213	Lantzville	5	0	10	0	5	0	5	0	0	10	10	45

* *WTP - Water Treatment Plant*

The most suitable locations appear to be between Parksville and Nanoose. The map below shows the potential areas.

Preferred Candidate Areas for ASR

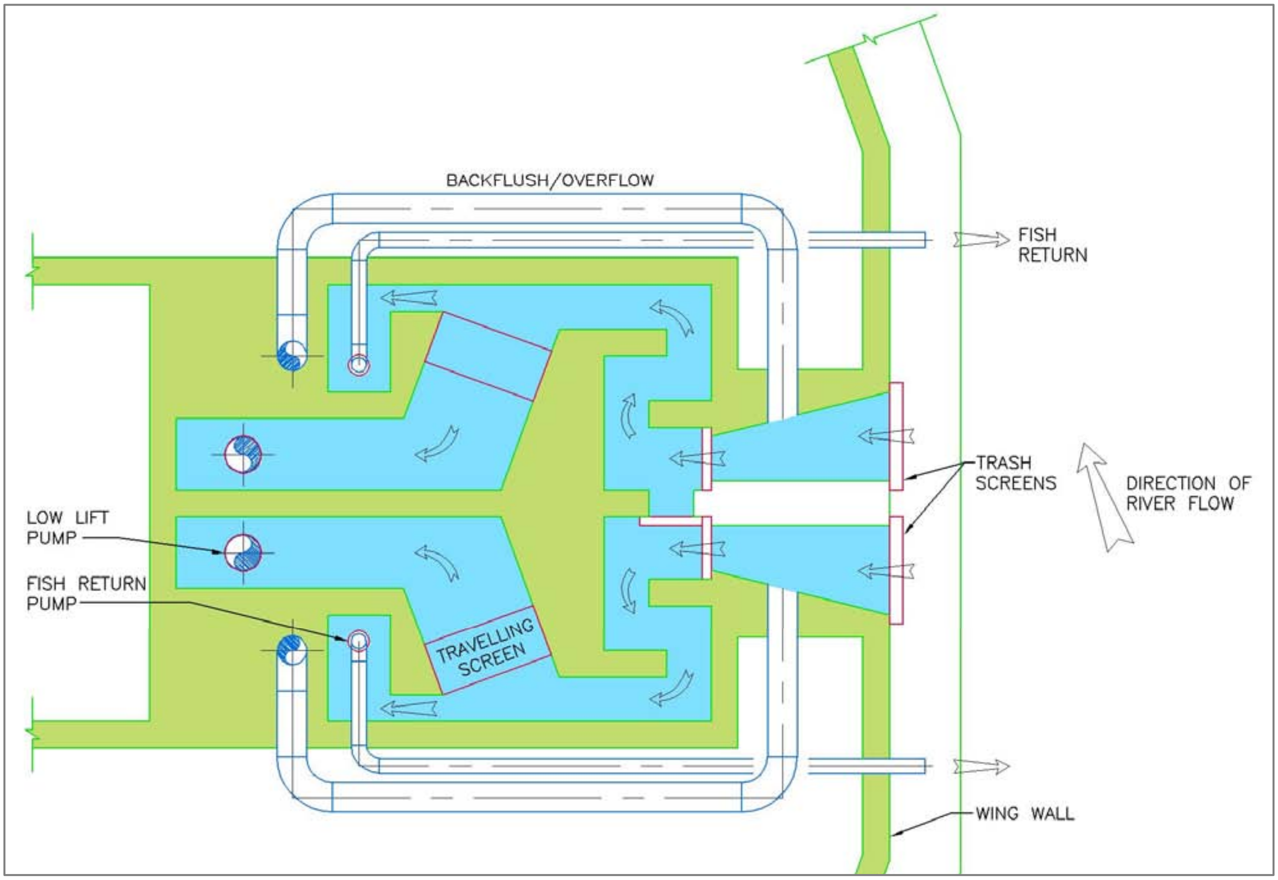


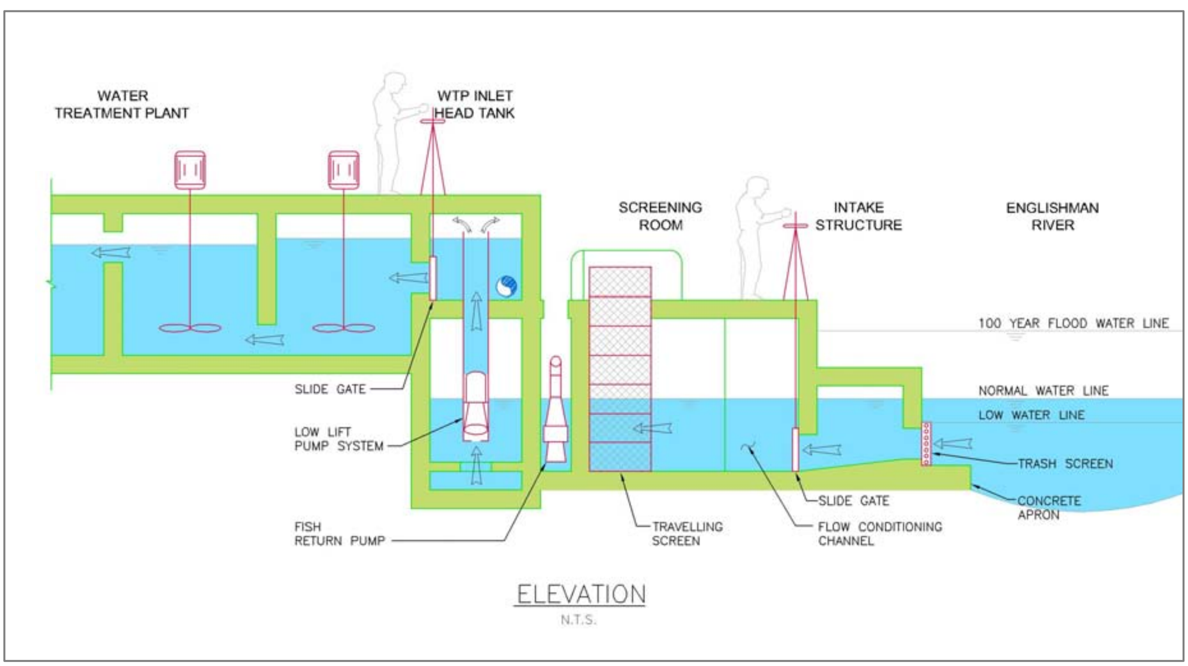
However, there are some general uncertainties when considering ASR. One risk is that the storage aquifer may not be sufficiently confined to fully retain the stored water. Some losses are expected as water slowly migrates through the ground, but if the losses are significant the amount of stored water that can be recovered might be unacceptably low. A second risk is that water injected into the aquifer may pick up material that is in the ground, such as iron and manganese. This may lead to the stored water requiring additional treatment when the water is pulled back out of the aquifer. To assess these risks for the AWS region, an extensive testing feasibility program is required to more accurately characterize the candidate sites and to simulate the ASR process. The testing program is planned to commence in late 2011.

Englishman River Intake

The most suitable intake design depends upon the nature of the river at a given site. Generally speaking, the majority of the river that is being considered for the intake is best served by a riverbank type intake. The concept of a riverbank intake is simple, water enters the intake structure and flows down concrete channels to a chamber called a wet well. From the wet well the water is pumped to the treatment plant. The concrete channels contain progressively finer screens that prevent debris and large materials from entering the intake, and block fish from entering the wet well. Bypass channels encourage fish that have entered the intake towards a fish wet well. Fish that reach this well enter a fish-friendly return pump that leads fish back out of the intake without causing injury to the fish. Following is an example illustration of a typical riverbank intake installation.

Typical Riverbank Intake





Continued use of the existing intake was considered, but rejected for the following reasons:

- Intake is located downstream of several locations where contamination/chemical spills could occur, including Highways 19 and 19A should a serious accident occur on either bridge and the rail corridor.
- The intake site is within the flood plain and therefore could be compromised during a catastrophic weather event.
- The existing intake would not be able to operate at the capacity required without frequent and onerous maintenance.
- The Englishman River is shallow along this area, and therefore the intake may not be able to withdraw as much water as required during a particularly dry summer.

Future Intake Location

Construction of the new intake and treatment plant presents an opportunity to move the infrastructure to an entirely new and more suitable site. Locating a new intake site on the Englishman River is a challenging exercise, as a balance must be met between environmental concerns, technical suitability, cost, and safety.

In the initial stages of the study, AWS met with provincial and federal regulators and local stakeholder groups to listen to their policy and suggestions on watershed management that pertained to siting a new intake. A two-stage approach for a comprehensive and defendable process for selecting the optimum intake location was developed. Initially, over 10 km of the Englishman River was reviewed to create a short-list of potential sites. This stretch of river was evaluated using five criteria categories:

- Land use compatibility
- Heritage/archaeology concerns
- Ecological impacts
- Geotechnical conditions
- Water system considerations

The evaluation determined that the lower reach of the Englishman River, from the Highway 19 Bridge, down to the upper end of the estuary, was the preferred location for the new intake and water treatment plant.

The short-list was narrowed down to three specific sites and subjected to a more detailed analysis. The sites were evaluated along the following categories:

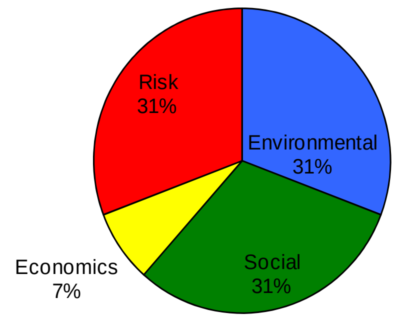
- *Environmental impact:* The impact of construction and operation of the intake and treatment plant on aquatic life, surrounding animals and vegetation, and possible presence of “endangered” or “at-risk” species on the site.
- *Social impact:* The impact of construction and operation of the intake and treatment plant on heritage sites, nearby residents and on the general aesthetic appeal of the surrounding area.
- *Economical implications:* Site-specific challenges or opportunities that have an impact on the capital and annual costs of building and operating the intake and treatment plant.
- *Risk:* Recognizing that some risks are inherent, or very difficult to mitigate should they occur, risk was evaluated as a separate category. Examples of risks taken into account include:
    - Vulnerability of sites to seismic activity
    - Fuel spills and other significant raw water contamination
    - Potential for site flooding

The evaluation used a Triple Bottom Line model, which is based on classic multi-criteria decision theory. A relative score was given to each site reflecting how well they performed for each criterion. These scores were then applied a weighting that represents their overall criticality with respect to the other factors considered. The below illustrates the relative weighting of the four criteria categories. Sensitivity analysis was conducted to confirm the apparent preference of one site to another if the weightings were shifted.

Weighting of Four Site Evaluation Criteria

It was determined that the cost of the new intake for all three short-listed potential sites were similar, therefore a weighting factor of 7% for economics was applied.

It was determined from this evaluation that the most suitable locations for an intake and water treatment plant are close to the Highway 19 Bridge with an alternate intake site developed near the 19A Bridge.



Future Englishman Water Treatment Plant

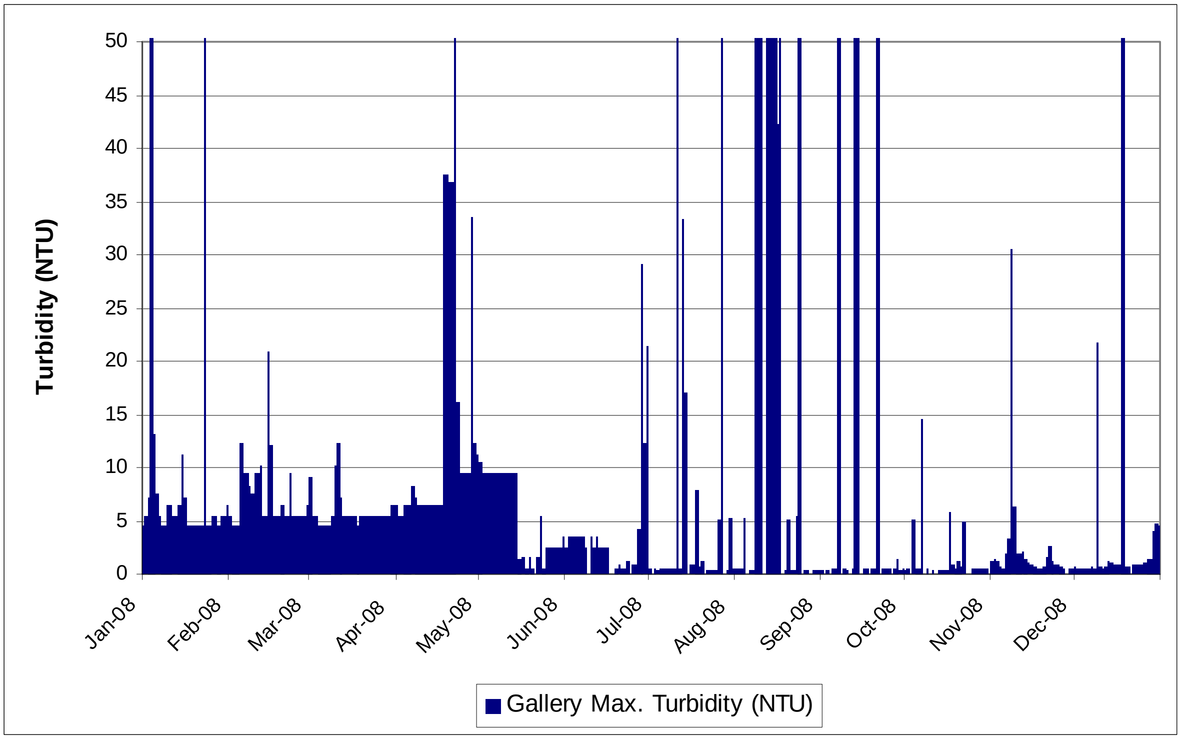
To comply with provincial water quality objectives, greater treatment of the Englishman River water is required. The primary treatment objectives for the plant are the following:

- Reduce turbidity.
- Reduce the risk of microbial contamination.

Turbidity

Turbidity has been identified as a concern because of its aesthetic impact on water; in particular, giving water a cloudy appearance. A more stringent turbidity limit was recently established in the GCDWQ, lowering the limit from 5 NTU to 1 NTU, after determining that turbidity can interfere with the disinfection process, leaving some systems vulnerable to microbial contamination. Turbidity is discussed in greater detail on Health Canada’s website here: http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/turbidity/index-eng.php. The existing Parksville intake and chlorination treatment plant is currently controlled to temporarily shut down when turbidity in the river exceeds 1 NTU, and goes back into operation when turbidity returns to below 1 NTU. The new regulation of keeping the turbidity below 1 NTU instead of 5 NTU from entering the water system means the treatment plant needs to shut down more frequently and for longer periods of time and the operational period has been reduced. As an example, the illustration below shows turbidity in the Englishman River measured near the Highway 19A in 2008. For that year, turbidity exceeded 5 NTU in only 8% of samples taken, but exceeded 1 NTU in 40% of the samples, meaning that the plant would have to be off-line five times as much under the revised turbidity objective.

Englishman River Turbidity, 2008



To ensure that the AWS region has enough water, a change in the treatment plant's operation strategy is required (i.e. we will need to extract water from the Englishman River year round). Given this, a filtration system will need to be implemented that would handle rapid turbidity spikes during winter storm events. Having a filtration also grants disinfection credits for some parameters that are more difficult to remove by chlorination, such as *Cryptosporidium parvum* and *Giardia lamblia.*

Disinfection

The GCDWQ recommends that all drinking water sources undergo disinfection to ensure a minimum level of protection from microbial contamination. Microbiological treatment requirements for surface water are more stringent than groundwater requirements due to the greater risk of contamination. For surface water, the treatment processes must achieve the following minimum objectives:

- 4-log (99.99%) removal or inactivation of viruses
- 3-log (99.9%) removal of *Cryptosporidium*
- 3-log (99.9%) removal of *Giardia*

It is also recommended that chlorine residual be maintained throughout the distribution system to ensure that the integrity of the treated water is maintained until it reaches the consumer.

Treatment

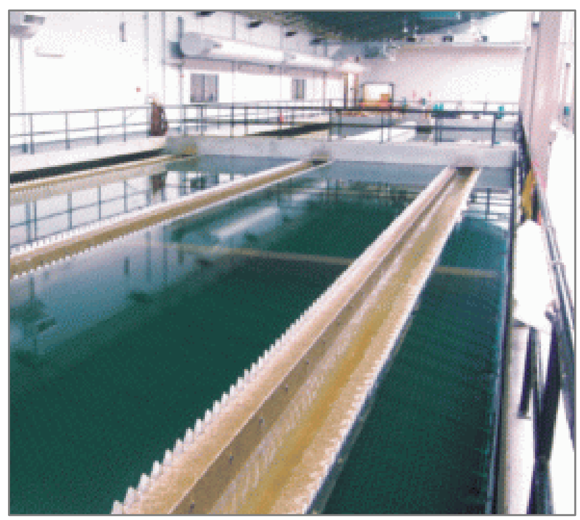
To reduce turbidity and to disinfect Englishman River water, treatment will consist of particulate removal processes, followed by chlorination. Ultraviolet Light (UV) reactors may be used to provide additional disinfection capabilities.

Particulate Removal
Particulate removal essentially means physically filtering out particulates from incoming water. The water may be subjected to pre-treatment to encourage suspended material in the water to floc together, creating larger size particles that are easier to remove. Several options for particulate removal have been identified for the Englishman River supply. The processes being considered by the AWS are the following:

Conventional Treatment: Conventional treatment involves coagulation, flocculation, and sedimentation followed by media filtration. This process is founded on the principle that particles tend to settle in water at an increasing rate corresponding to particle size and density. Coagulation is the addition of a chemical coagulant to the water to encourage suspended solids to floc together to form larger particles. Next, the flocculation process involves gently mixing the water at low energy to encourage further aggregation and larger floc. The water then undergoes sedimentation, where the floc settles out of the water. The rate at which the floc settles out is enhanced by increasing particle size. Floc collected at the bottom of the sedimentation basin is removed, while the clarified water at or near the surface passes on to the next treatment step.

Englishman River - During Storm Event

Example - Conventional Treatment Tank

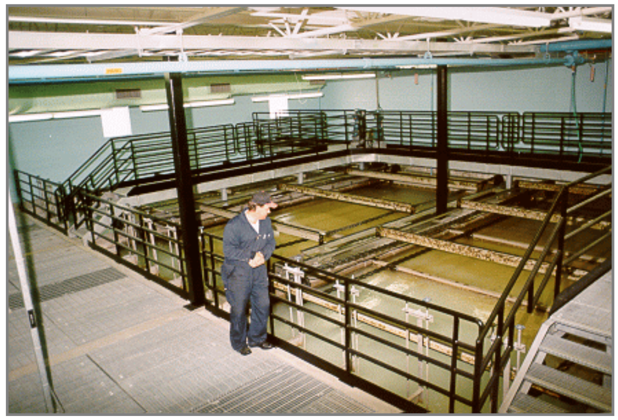


Filtration is usually used as a final particulate removal treatment step. Media filtration involves passing water though a granular media bed. Particles are removed from the water stream through contact with the media and other retained particles.

Example - Filter Columns

Dissolved Air Flotation: Dissolved air flotation (DAF) is an alternative to the sedimentation process in conventional treatment. Instead of encouraging the settling of floc, DAF introduces a cloud of very fine bubbles that attach to the floc to lower its effective density and rapidly floats the floc to the surface of the water. From there, the floc is skimmed from the surface. The DAF step is followed by a filtration step, similar to the conventional treatment process.

Example - DAF Units



Direct Filtration: In certain applications, the amount of particulates to remove from the water is low enough that the primary steps of removing larger particles from the water through settling or flotation is unnecessary. In these situations, the sedimentation or flotation steps can be omitted in favour of relying solely on filtration. This sequence is referred to as direct filtration. Direct filtration requires a smaller footprint and has a lower capital cost than conventional treatment but is only effective for lower raw water turbidity scenarios.

Membrane Filtration: Membranes are thin sheets or tubes of natural or synthetic material that are selectively permeable to substances in solution. Membrane treatment involves water passing through the pores of a membrane, with suspended and/or dissolved solids being physically strained out of the water stream. Membranes for drinking water typically come in a collection of fine filaments mounted into cartridges or racks.

Example - Membrane Racks

Actiflo® System: Actiflo® is the proprietary name for a ballasted flocculation and high-rate settling process. Ballasted flocculation refers to a process in which heavy carrier particles, called micro-sand, are injected into the process following coagulation. With the aid of an added polymer, the floc particles bind to the micro-sand and settle out at a faster rate. The Actiflo® process is typically followed by a filtration step, similar to that described under conventional treatment.

Disinfection

Chlorine would be used to provide primary disinfection and to provide chlorine residual that would protect the integrity of the treated water as it travels through the distribution system. Chlorine is very effective at destroying viruses, and when combined with filtration provides a robust “double barrier” to microbiological contaminants. The chlorination facilities will be designed to provide safety to the operators of the plant, and the people and environment around it. The facilities will include secondary containment and a dechlorination system to ensure any chlorine spills are first neutralized before being released harmlessly into the environment.

Example - On-Site Sodium Hypochlorite (Liquid Chlorine) Generator

UV reactors may be added if the existing filtration and chlorination system does not adequately remove some of the more complex biological parameters, called protozoa, such as *Cryptosprodium* and *Giardia*. UV does not leave a disinfectant residual for the distribution system, and is therefore is typically used in conjunction with chlorination.

Example UV Reactors

Residuals Treatment

Waste will inevitably be generated during plant operation. A relatively new development in residual management is the “zero-liquid discharge” approach, where no waste from the plant is returned to the raw water source. Waste from the treatment processes is dewatered and, where possible, the removed water is recycled or reused in the treatment plant. Where it is not possible, treatment and / or on-site disposal, such as artificial wetlands, may be used. The dewatered waste solids are disposed of at landfills. Sanitary wastewater is sent to a nearby wastewater treatment facility or dealt with through on-site management.

Timeline and Budgeting

The critical schedule driver is to meet the VIHA water quality directive to have the new intake and water treatment processes in place and operational by the end of 2016, it is therefore critical to have the intake constructed and at least a portion of the water treatment plant in operation by that time. The schedule for additional work will be based on the growing water demands of the region over time.

Phased Construction

Instead of implementing all the water system upgrades that are required by 2050 all at once, municipalities and other water suppliers typically phase construction of new infrastructure in multiple stages. Additional stages to the infrastructure are added over time as the community demands increase. The total cost of phased construction will be greater than if all required infrastructure was built as a single step. Phased construction does have some advantages:

- Some construction costs can be deferred for several years, possibly decades, allowing the AWS to more effectively finance the project.
- Later stages of construction can take advantage of advancements in treatment technology that will have developed since the previous stage of construction. A review of trends in water treatment technology indicates that treatment processes are continuously being improved to operate at a greater electrical efficiency and at a higher capacity, meaning that less space is required to treat the same amount of water.

Phased construction is not practical for all infrastructure. As is the case for the riverbank intake, some infrastructure is difficult to access or challenging to construct, and therefore should be installed all at once. The upgraded water system will therefore be a combination of fully upgraded infrastructure and infrastructure that is built in stages.

Schedule

As the AWS water supply upgrades continue to be designed, a feasibility study for the ASR concept will be explored. This study will involve the development of multiple test wells that would confirm aquifer characteristics, test the ability of the aquifer to receive treated surface water contributions and provide stored water withdrawals, and would identify impacts of ASR on water quality. The timeline is summarized below.

AWS Water Supply Upgrades Schedule

Objective	Year
Carry out first phase of ASR feasibility analysis	2011-2012
Complete ASR feasibility analysis	2012-2013
Construct new intake and Stage 1 of the water treatment plant	2014-2016
Construct Stage 2 of the water treatment plant	2035-2050

Budget

Conceptual-level cost estimates for the AWS water supply upgrades are provided in the below. The cost estimate will be refined as the design of the system progresses.

AWS Water System Upgrades Budget

Item	Cost ($ million)	
	Phase 1 to 2016	Phase 2 2035-2050
Direct Costs		
Intake	1.2	-
Raw Water Pipeline	0.4	-
Water Treatment Plant	13.5	3.9
Water Distribution Mains (incl. Pump Stations and Reservoirs)	5.0	5.9
Aquifer Storage and Recovery System	5.0	-
Subtotal	25.1	9.8
Contingencies - Design and Construction	5.3	2.4
Total Direct Costs	**30.4**	**12.2**
Indirect Costs		
Engineering	3.8	1.8
Administration	0.8	0.4
Miscellaneous	0.5	0.2
Total Indirect Cost	**5.1**	**2.4**
HST Allowance (3%)	1.0	0.4
Land Purchase	1.0	-
Total Capital Cost (2010 $)	**37.5**	**15.0**
	52.5	

The above costs are based on 2010 dollars and are considered preliminary estimates based on similar sized projects.

Site Selection

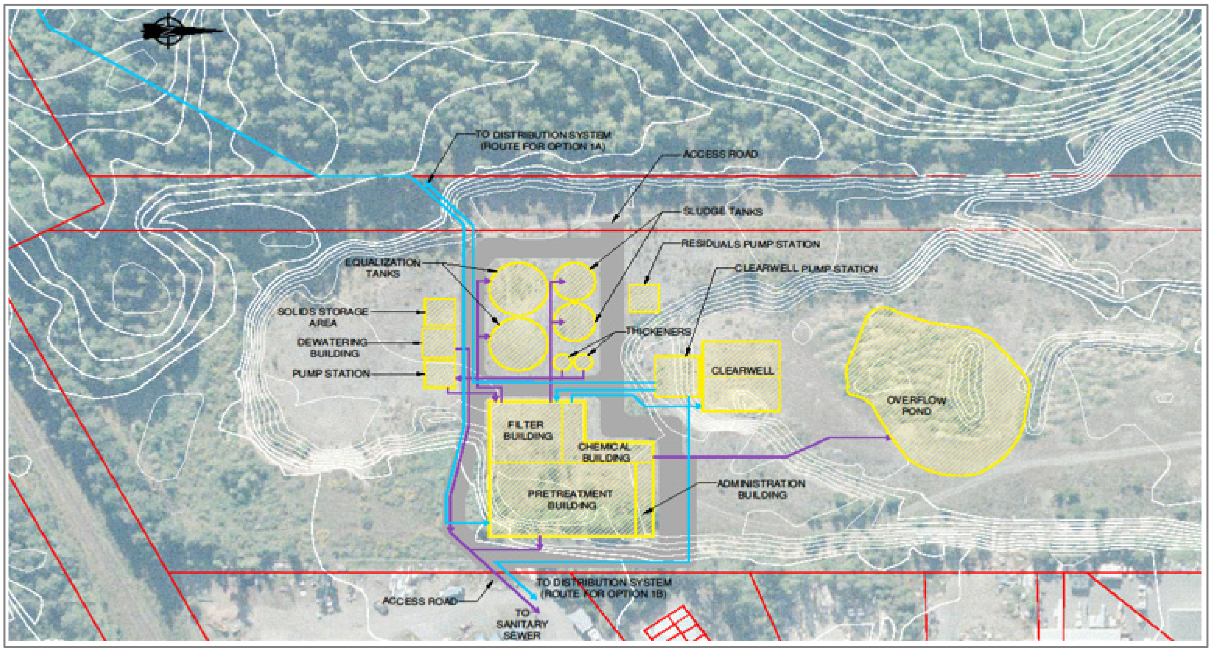
The intake and water treatment plant will be constructed at a site near the Highway 19 Bridge and railway crossing, on the east side of the Englishman River. The intake will be located at a bend along the river, slightly upstream of the highway crossing. The water treatment plant site (8.7 Hectares) is an abandoned gravel pit behind the City of Parksville Public Works yard. A 600 mm diameter raw watermain would connect the intake to the treatment plant.

The treatment plant site was heavily disturbed by human activity when used as a gravel pit, so construction of a plant and supporting infrastructure at this site will have a minimal impact on the natural habitat that remains in the area. It is planned that the portions of the site not required for the treatment plant will be rehabilitated into a park for public and recreational use. Access to the plant will be restricted to a main road through the Public Works yard. Conceptual site plans of the intake and water treatment plant are shown in the following illustrations.

Of the 10 km stretch of the river evaluated, this site was considered the preferred location for the intake and water treatment plant for a number of reasons, including the following:

- By locating the intake upstream of the two highway crossings, a rail crossing and a sewer force main crossing, the risk of the intake being exposed to contamination, such as by a fuel leak on the highway or a leak in the force main, is sharply reduced.
- The water treatment plant site is a heavily disturbed area, meaning that the amount of untouched habitat that would be affected during construction is small.
- The treatment plant is located in an isolated area beside a public works yard and will not adversely affect the aesthetics of the area.
- The intake is located a safe distance from areas of public recreational use of the river.
- The treatment plant's proximity to the Public Works yard will make it easier to maintain security and will allow operators to respond quickly should an emergency occur at the plant.

Future Schematic of the Intake and Treatment Facility



Project Costs – Overview:

- Capital cost of first stage is about $35 to 40 million
- Total capital cost over 40 years are estimated at $52 million
- Program should be attractive for senior government funding given the regional cooperation and ASR elements
- Partner cost sharing could be based on the expected quantity and required timing of future surface water supplies

Anticipated Work Plan

2011 - 2012

- Continue conceptual level planning / Implementation Plan
- Land negotiations
- Land acquisition
- Further develop communication strategy
- Refine governance model
- Public process – first open house
- Discussions with regulators, MoE,& DFO
- Permit application, E&N, MoT etc.
- Acquire right-of-ways
- Modify water license
- Explore senior government funding
- Develop a financial rate structure model
- Secure required properties and easements
- Carry out raw water characterization and bench scale treatment process testing
- Start process pilot testing
- Concept design and staging
- Carry out first phase of ASR feasibility analysis
- Grant application for ASR feasibility analysis and other grants as available
- Second open house

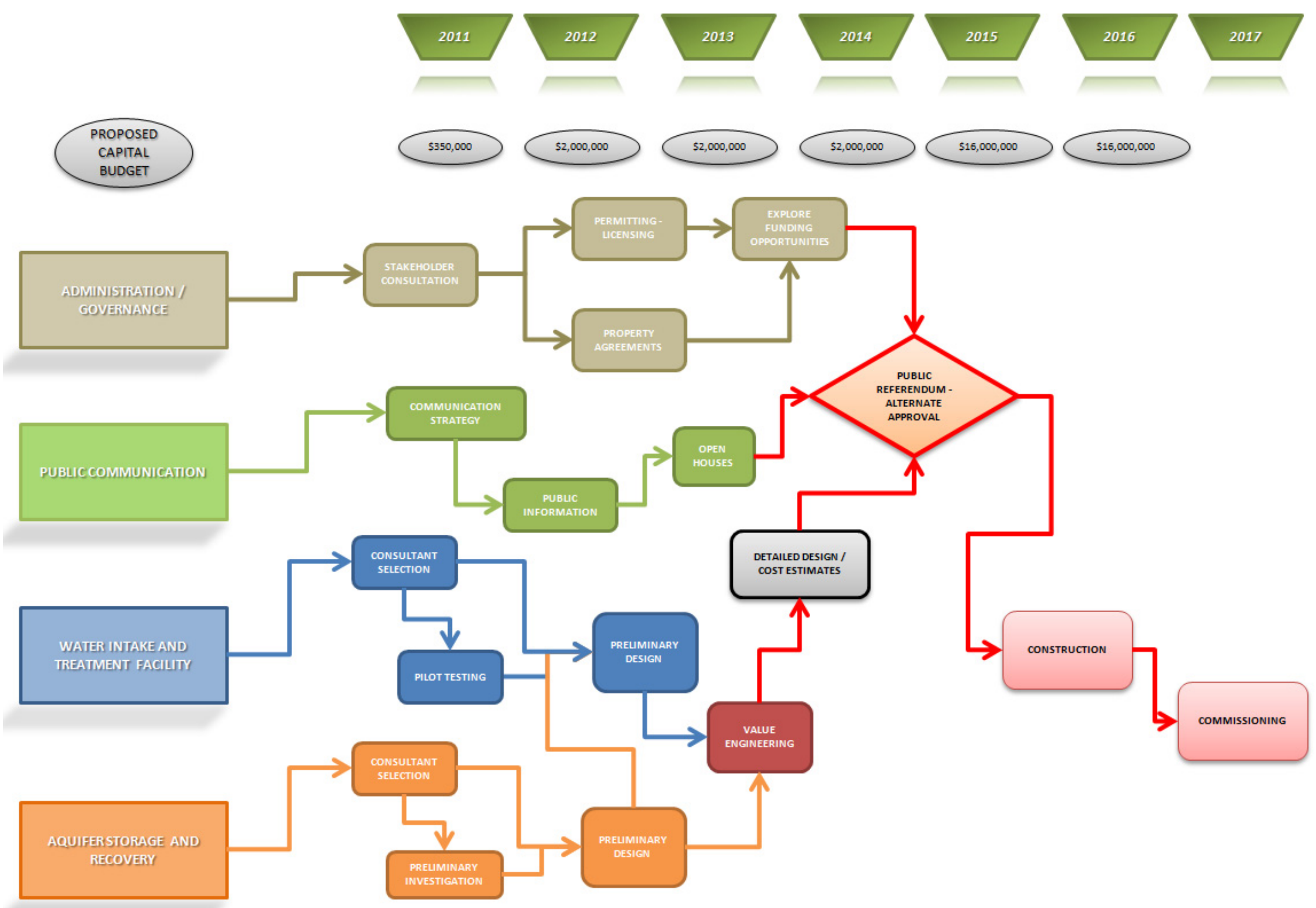
2013 and 2014

- Prepare terms of reference and expressions of interest
- Engage a design consultant
- Complete process selection
- Preliminary Design
- Complete ASR feasibility analysis
- Value Engineering
- Finalize approvals
- Treatment selection
- Process selection
- Product selection
- Permitting
- Secure senior government funding
- Detailed design of intake, WTP and water transmission mains
- Public Referendum – Alternate funding approval

2015 to 2017

- Tender construction contracts
- Construction
- Commissioning

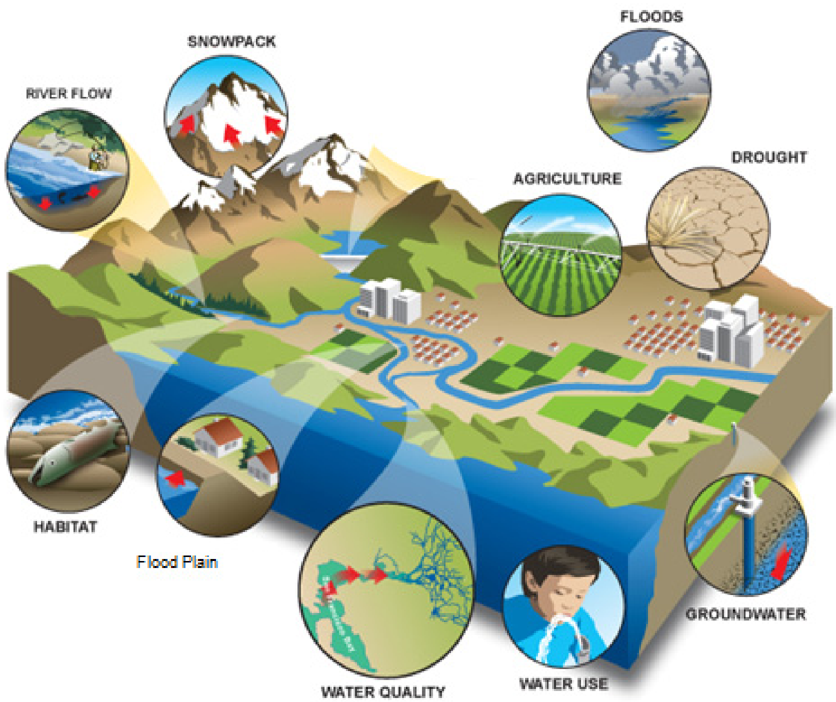
Implementation Plan



Why do we need Water Treatment and a New Intake ?

Bottom Line

- Further mitigate any potential risks to the potable water supply
- Develop a sustainable water supply for the future



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