Summary Report

South East Kelowna Irrigation District

Water Supply and Treatment Cost/Benefit Review

November 2007

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Appendix D - Golder Associates Hydrogeological Evaluation

1 Overview

This report provides a summary of the findings and recommendations relative to options for treated water to all domestic urban, commercial and rural residential connections in the South East Kelowna Irrigation District (SEKID). Considerable effort has already been directed towards evaluating water treatability issues and identifying various supply and distribution options. SEKID retained Associated Engineering through a proposal call process in 2007 to undertake this South East Kelowna Domestic Water Supply and Treatment Cost/Benefit Review Study.

This study involved undertaking sufficient investigation to review the feasibility and cost of a variety of options, taking into account the following issues:

- Conforming to the Interior Health Authority (IHA) Standards and Regulations.
- Reporting on the latest relevant drinking water treatment technologies.
- Examining a variety of system options available, and assessing their various advantages.
- Predicting both capital and operating costs to assess potential budget requirements.
- Examining the methods of addressing the impacts of agricultural demands on system capital and operating costs.

More detailed information is available from the following Technical Memoranda and Report which are appended hereto:

- Technical Memorandum No. 1 – Source Review and Water Treatability
- Technical Memorandum No. 2 – System Options Development
- Technical Memorandum No. 3 – Evaluation and Comparison of System Options
- Golder Associates – Report on Hydrogeological Evaluation Well Field Capacity, South East Kelowna Irrigation District, Kelowna, British Columbia

1.1 Objectives

The purpose of this study was to:

- To review the feasibility of various alternative supply sources and to develop water treatment solutions based on the sources being carried forward for system options development.

- To identify and develop water supply options to provide treated water to the South East Kelowna Irrigation District (SEKID) water system which complies with IHA requirements.

- To undertake a cost-benefit review and compare shortlist supply and treatment options from the alternatives and recommend an option which provides the best value to SEKID.

1.2 Background Information

In preparing this report, Associated Engineering reviewed the following reports available on SEKID's website:

a) South East Kelowna Irrigation District, Water Quality Improvement Study, updated May 2006, Mould Engineering.

b) South East Kelowna Irrigation District, Capital Works Program 2006-2016, Mould Engineering.

Some of the information contained in the above reports has been re-used in the preparation of this report.

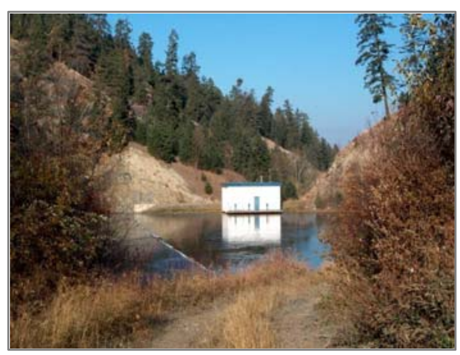
2 Existing System

SEKID, incorporated in 1920, is the second largest improvement district in British Columbia. It is located on Kelowna's east bench and is bordered on the north and east by Mission Creek. The District supplies water to 2400 Ha of serviced agricultural land, including approximately 2000 domestic, 420 agricultural, and 25 commercial and institutional connections. The District is primarily gravity fed with surface water collected through the McCulloch Reservoir/ Hydraulic Lake diversion system. Water is diverted to the users through a complex pipeline distribution system, with many different pressure zones. There have been efforts in recent years to separate the distribution system into potable domestic and raw water irrigation supplies, particularly in the more intensive residential areas.

The existing water supply system includes the following:

- **McCulloch Reservoir System** that produces, on average, 15,750 ML/yr of useable storage.

- **Hydraulic Creek Intake and Chlorination Facility** consisting of an impoundment on Hydraulic Creek from which water is drawn through a mechanical screening system at an elevation of 655 metres. The existing chlorination system consists of a gas system fed by liquid tonners.



- **Hydraulic Creek Supply Line** consisting of a 1050 mm diameter lined and coated steel pipeline to deliver water from the intake site to the distribution system.

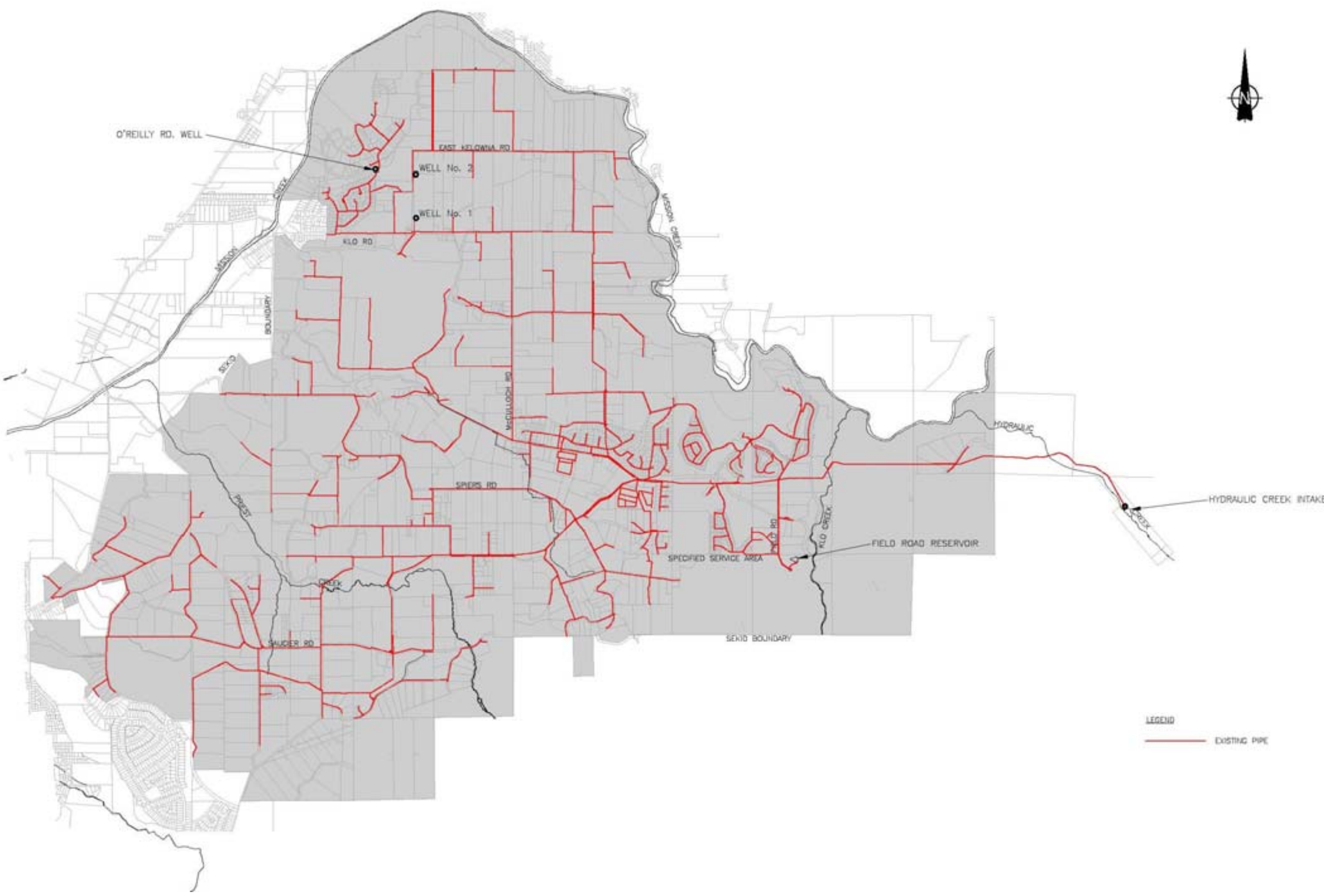
- **Gallagher's Canyon/McCulloch Road Distribution System** including the Field Road Reservoir and distribution network encompassing approximately 1200 connections.

- **SKL System** supplies rural residential and school properties bounded on the north approximately on Spiers Road and on the west by Swamp Road.

- **KLO System** supplies rural residential, golf course, commercial and school properties bounded to the north and east by Mission Creek.

- **O'Reilly Road System** including 172 connections supplied by groundwater supply since 1998. The O'Reilly Road well draws water from the Rutland Aquifer.

- **East Kelowna Road Wells** consisting of two wells which supplement the Hydraulic Creek supply through drought years as well as improving water quality to approximately 110 domestic connections in the pressure zone that they serve in the East Kelowna Road area.



The SEKID distribution system consists of approximately 2000 domestic service connections, 420 agricultural connections, and 25 commercial and institutional connections. All agricultural and commercial connections are metered. Approximately 660 of the domestic connections are metered.

3 Water Quality Objectives

The water quality objectives used for this study have been based on Interior Health Authority's 2006 water quality guidelines. The basic requirements under these guidelines are summarized as follows:

- 4 log virus removal
- 3 log Giardia and Cryptosporidium removal
- 2 stages of treatment
- 1 NTU turbidity maximum
- 0 coliforms

Additional information regarding these guidelines is included in Technical Memorandum No. 1. Contact was made with IHA during the course of this study to clarify their water treatment expectations. In order to meet the water quality objectives, the IHA confirmed that all treatment facilities on surface water supplies shall include filtration. IHA has, however, since issued a draft issue paper on Filtration Deferral, which defines certain criteria that may allow deferral of filtration installations to a later date to minimize initial cost impacts.

Because of significant colour and turbidity issues with the Hydraulic Creek Source supply, it is unlikely that IHA would grant a filtration deferral for any treatment scheme.

The IHA, as with most regulators in Canada, develop their requirements from industry recognized standards and guidelines. The principal reference in Canada is the Guidelines for Canadian Drinking Water Quality (GFCDWQ) which are developed and maintained by a Federal/Provincial Subcommittee operating under Health Canada. The GFCDWQ establish recommended standards for numerous chemical and physical parameters. These were considered when determining the water quality objectives. Two parameters of particular concern were the revised GFCDWQ turbidity limit of 0.3 NTU and the maximum trihalomethane (THM) limit of 100 ug/L. The revised turbidity limit was of concern as it goes beyond the current IHA requirement. For the surface water options, there is a cost to achieve this more stringent limit. However, there is a strong likelihood that the 0.3 NTU standard will be adopted. The concern over THMs is that the high organic carbon levels in the Hydraulic Creek water coupled with the long residence times in the piping system, particularly during low flow conditions, may lead to elevated THM levels. THMs are suspected carcinogens formed in reaction between certain types of organic carbon and the chlorine used to disinfect the water.

Another strong regulatory reference the IHA and other regulators draw from are the various rules established by the U.S. Environmental Protection Agency (EPA), Thus it is also prudent to determine if the SEKID water supply would meet those rules. The U.S. EPA set a limit of 80 ug/L for THMs and 60 ug/L for five of the haloacetic acids (commonly referred to as HAA5) which are also chlorination by-products. The GFCDWQ may also move in that direction. Thus, providing water quality that meets those standards is wise.

4 Study Methodology

SEKID established a Steering Committee responsible for overseeing the scope of the study. This Steering Committee consisted of the SEKID manager, the SEKID Board chairman, two Board members, and one outside participant. During the course of the study, three workshops were held as follows:

Project Initiation Meeting
Associated Engineering and SEKID personnel reviewed and discussed project issues, the work plan, design criteria, design options, and SEKID concerns at the opening meeting. SEKID provided the necessary background information and mapping to complete this preliminary assessment.

Options Development Workshop
Associated Engineering and the SEKID Steering Committee reviewed and discussed the various system options and treatment strategies with the representatives of IHA who were invited to attend this important workshop.

Options Evaluation Workshop
Associated Engineering presented their findings relative to the evaluation of the various system options and sought feedback from the Steering Committee regarding the evaluation.

5 Treatability Review

5.1 Water Source Analysis

Although Hydraulic Creek is the logical source of supply for this study, it is not necessarily the only one for domestic purposes. Another potential source of water is groundwater which is already being used to serve some customers. Other potential sources briefly examined included KLO Creek, Okanagan Lake, the City of Kelowna, and Mission Creek.

The source review concluded that Hydraulic Creek was the best and only practical surface source to serve the agricultural demand component. Well-field expansion was considered as a viable option for supplying the domestic demand component. The advantages of the existing supply sources over the other options are summarized as follows:

- The elevation of the Hydraulic Creek intake allows SEKID to deliver its high demand agricultural supply to its entire service envelope by gravity. This is a significant advantage in terms of energy costs and environmental sustainability when compared to options requiring pumping.

- The water quality in the existing well-field is significantly better than any of the other sources under consideration. This makes this source attractive as a domestic supply source due to the reduced capital investment that would be required to provide treatment infrastructure and the reduced ongoing operation and maintenance costs involved in treating and delivering it.

- All of SEKID's existing water supply and distribution infrastructure is already connected to the Hydraulic Creek source and portions of the infrastructure are connected to the well-field. Therefore, the necessary investment is minimized if these sources are used as SEKID's water supply.

For the above reasons water treatability assessment and development of water treatment concepts was based on utilizing/expanding SEKID's existing supply sources.

5.2 Water Treatment Requirements

Considerable work has already been undertaken in conducting bench scale testing of the existing water supply off Hydraulic Creek. We have used the bench scale testing results to develop our treatment concepts and costing for different size facilities.

Treatment processes considered in this study generally comprise of the following unit processes in various combinations:

a) *Chemical Coagulation and Mixing*: Application of a primary metal coagulant to improve organics removal and increase downstream process efficiency.

b) *Flocculation*: Application of mixing energy for an appropriate length of time to produce a Floc optimized for the subsequent treatment process.

c) *Clarification*: Utilization of gravity forces as flotation to remove flocculated solids and organic matter from the water to improve filter performances.

d) *Softening*: Utilization of a process for reducing the hardness of the groundwater supply.

e) *Filtration*: Utilization of either granular media or membrane technology to remove particles remaining in the water after clarification.

f) *Primary Disinfection*: Utilization of a disinfection process to inactivate micro- organisms including viruses, bacteria, and protozoa.

g) *Secondary Disinfection*: Utilization of a chlorine based chemical to ensure an adequate residual in the supply and distribution system.

h) *Residuals Management*: Utilization of a treatment process to assist in managing and disposing of residual products from the main treatment process.

Table 1 on the following pages provides a summary of the treatment options that were identified as candidates for this study.

Table 1
Summary of Water Treatment Options

Process	Description	Commentary
	Filtration Processes	
Direct Filtration	Involves chemical coagulation, flocculation, filtration and at least one level of disinfection.	During previous bench scale testing, this process was unable to meet the turbidity requirements. Additionally, reducing the colour during significant colour spikes may be a significant issue with this process unless other processes are integrated in with it.
Conventional Filtration	Adds clarification after flocculation in the Direct Filtration process. This assists in removing colloids, colour and organics through precipitation and settling, producing a more filterable water.	Typically, conventional filtration uses sedimentation, upflow clarification (with or without tube settlers) or lamella plate settlers. More recent clarification technologies such as dissolved air flotation (DAF), Actiflo® ballasted flocculation, etc. have proven to be successful clarification technologies in place of the above noted technologies utilizing hydraulic or mechanical processes to advance the process and utilize significantly smaller building footprints. We believe that clarification and filtration should be capable of meeting the IHA requirements and GCDWQ.
Membrane Filtration - Surface Water	Involves microfiltration (MF) or ultrafiltration (UF) membrane treatment process. Depending on the type of membrane, pre-treatment to remove foulants may be necessary to ensure membrane life. Pre-treatment to reduce colour and disinfection by-product pre-cursors is needed.	There are different levels of membrane filtration currently available. Some membrane technologies can remove colour and TOC but the costs and other pre-treatment requirements can make them less attractive. Microfiltration or ultrafiltration membranes with pre-treatment have proven to be cost effective for smaller plants and should be capable of meeting IHA requirements. This technology could be a cost effective treatment option for the domestic demand.

Process	Description	Commentary
Membrane Filtration - Groundwater	Involves utilizing a properly designed nanofiltration (NF) or reverse osmosis (RO) process to soften the groundwater. In this application, only a portion of the water would need to be filtered. This would then be blended with the non-filtered water to achieve the desired quality.	Chemical softening methods are also available, but appear to be less well-suited for this application. Water softening is not essential as it is an aesthetic parameter. NF and RO membranes use more energy than MF or UF membranes and the residuals are more difficult to manage.
Clarification Without Filtration	Involves the same process as Conventional Filtration except that the filters are omitted. 3-log disinfection of *Giardia* and *Cryptosporidium* would be included.	The clarification process can usually reduce turbidity to approximately 1 NTU. If there is a process upset, there is no other particle removal process to mitigate the upset. Robust disinfection (e.g., UV and chlorine) is essential. IHA do not recognize protozoan reduction credits for this process so a full 3-log disinfection is required. Clarification will help to reduce colour and disinfection by-product pre-cursors. IHA would require additional piloting to confirm this approach meets the current turbidity requirements. It is highly unlikely this method would consistently meet the potential 0.3 NTU turbidity limit. Filtration could be added at a later date should treatment requirements become more rigorous. Any of the clarification processes noted above could be considered depending on site space and topography although some are more likely better suited than others.
Additions to Clarification Process		
Polyelectrolytes (Polymers)	Used as a coagulant aid or a filter aid. May provide a charge or be neutral. Dry polymers must be placed into solution on-site. Some polymers are shipped in liquid form. Usually involves a simple liquid solution injection prior to clarification or filtration.	A large number of products exist. Finding a good product for a particular water can be challenging but when it works, the results can be excellent. Some waters require the polymer be changed as raw water characteristics change. Actiflo® ballasted flocculation and proprietary high-rate DAF processes require polymer.
Potassium Permanganate	Involves injection of potassium permanganate into water prior to clarification	Potassium permanganate is commonly used as an oxidant for removal of iron and manganese, colour, and taste and odour compounds. Often improves clarification performance. Required seasonally when colour levels spike. Easy to manage, moderately expensive.
Disinfection Processes		
Chlorination	Involves disinfection through the use of free chlorine to provide the 4 log virus inactivation/ removal requirement and to provide a residual in the distribution system to control microbial re-growth.	Chlorine Dioxide or Chloramine technologies could be considered as alternatives to the existing chlorination process to significantly reduce THM's. Both disinfectants have various other advantages and disadvantages that would need evaluation in this application. Both would need to be supplemented with other treatment processes to address turbidity for the drinking water component of the demand.

Process	Description	Commentary
Ultraviolet (UV)	Utilization of UV disinfection to provide the 3 log Giardia/ Cryptosporidium removal requirements.	UV would have to be accompanied by upstream processes such as clarification to remove organic carbon from the Hydraulic Creek water. UV disinfection will also provide the second level of treatment required by IHA unless appropriate particle removal processes are provided. Virus disinfection using chlorine also is required. Chlorine based disinfectant also required to provide a residual.
Residuals Management	Management of the liquid and solid wastes through treatment and/or disposal.	A very important factor when considering water treatment processes. The physical solids removal processes such as clarification and filtration produce residuals (up to 10% of the process capacity), which must be treated or handled and disposed of. This is particularly important where there is no sanitary sewer system available for disposal. NF and R.O. residuals can be very saline and more difficult to manage.
Alternative Processes		
Ozone	Injection of ozone to provide disinfection and possibly colour removal. Ozone is generated on-site from oxygen, and usually added downstream of clarification.	Ozone can address the colour and organics issues, however, alone would not address the turbidity requirements. Biologically active filters with chemical pre-treatment would also be required.
Ion Exchange	Utilization of an ion exchange medium to remove metal salts from the water. Similar in concept to domestic salt based water softeners.	Ion exchange processes may be a suitable treatment process for softening of the groundwater supply or reduction of TOC from the Hydraulic Creek supply. Large scale versions of domestic systems usually not practical at full plant scale. May add sodium to the water and create a brine residual that is difficult to manage. Other proprietary systems are available.
Lime Softening	Involves adding hydrated lime to a softening clarifier.	Softening processes would be appropriate treatment processes for reducing the hardness in the groundwater supply. Lime is relatively inexpensive but requires significant O&M effort. Residuals management is often an issue.
Point of Entry Devices	Involves treating raw or partially treated water at the service connection to the property or at the point of entry in the first building. Process varies by product and requirements. Granular Activated Carbon, UF membrane filtration and UV disinfection have been assumed for the SEKID system.	Access to and responsibility for the units would be a significant issue because IHA requires SEKID be responsible for operation and maintenance and water quality monitoring. Life of GAC for colour reduction would require field testing. Unit residuals have to be managed by disposal and this has been presumed to be to a septic field. SEKID's O&M responsibilities would necessitate right of way access on each property to the POE system. Chlorine is not added to the water as part of this process therefore treated water would probably not have a chlorine residual.

DAF – Dissolved Air Flotation

GAC – Granular Activated Carbon

GCDWQ – Guidelines for Canadian Drinking Water Quality

IHA - Interior Health Authority

MF – Microfiltration

NF - Nanofiltration

NTU – Nepthelometric Turbidity Units

O&M – Operations & Maintenance

RO – Reverse Osmosis

TOC – Total Organic Carbon

UF - Ultrafiltration

UV – Ultra-Violet

6 Supply Options Development

Options for water supply and treatment were identified by the study team, and then evaluated and compared. Each option included identification of raw water supply sources and capacities, raw water supply system upgrades, water treatment facilities location(s) and capacities, treated water pumping facilities locations and capacities, treated water pipeline(s) diameters and lengths, and any required off-sites such as power, etc.

6.1 Impacts of Flow Metering

SEKID has been very proactive in implementing strategies to reduce its agricultural water demands. A significant component in these strategies was the installation of flow meters on all agricultural services during the mid 1990's. By 2000, this program had resulted in an overall demand reduction of 10%. The second phase of the program, initiated in 2001, involved implementation of pricing strategies based on a water allotment system and inclined block rate. This program has resulted in further water demand reductions of as much as 30%. Clearly, the implementation of metering and consumption based pricing strategies for the irrigation system has been very successful.

Of the existing 2000 domestic connections, approximately 660 have been fitted with meters, leaving approximately 1340 unmetered domestic connections. Domestic tolls are charged on a flat rate basis. A key component of SEKID's strategy should involve implementation of full metering coupled with consumption-based pricing. Based on the experience of the irrigation system and of other municipalities, we believe that this will result in significant reductions in domestic water consumption. The estimated cost of metering all remaining unmetered domestic service connections is $1,100,000.

6.2 Water Demand Design Criteria

The Water Demand Criteria used in this study are as follows:

6.2.1 Domestic Demand Design Basis

The SEKID service area consisted of 1,973 domestic service connections as of the end of 2005. SEKID's current design criteria are stated as follows:

Connection Type	Peak Demand
Fee Simple Lots	0.12 Lps/connection
Bare Land Strata	0.06 Lps/connection
Multi-Family Units	0.06 Lps/unit
Domestic Demand	0.12 Lps/connection

The SEKID service envelope consists of basically two diverse domestic connection groups. One of these groups is made up of the residential service areas including the Gallaghers Canyon – McCulloch Road corridor area consisting of approximately 1200 connections, and the Hall Road area consisting of 173 connections. The other group is made up of the rural connections which consist primarily of agricultural land as well as some small country residential developments. For the residential service areas the domestic demand refers to both indoor and outdoor water use as these are both supplied off a common service connection. For the rural service areas the domestic demand refers to only the indoor water demand, due to the fact that outdoor demands can be provided via the irrigation system. Commercial and institutional customers make up a very small component of the domestic demands and therefore, for the purpose of this assessment, have not been analyzed separately.

Based on the foregoing, we recommend that a peak domestic demand of 0.10 Lps/connection provides a reasonably conservative basis for projecting the total domestic demand for the SEKID service area. Assuming that as of the end of 2007 there will be approximately 2053 domestic service connections, we have used the following as a design basis for the domestic demand:

Existing Domestic =	2053 conn. @ 0.10 Lps	= 206 Lps	(18.8 ML/d)
New Connections =	400 conn. @ 0.10 Lps	= 40 Lps	(3.5 ML/d)
Total Domestic Demand		**= 246 Lps**	**(21.3 ML/d)**

The above design criteria are considered to be conservative and thus suitable as a basis for comparing options. These criteria should be further reviewed and refined during the preliminary design stage of the project. When the project moves into predesign a more thorough breakdown of the connection types and the amount of commercial and institutional demands should be made.

Of the existing domestic connections, 172 are served via the O'Reilly Road well. Based on the above criteria, this would equate to 1.7 ML/d.

6.2.2 Agricultural Demand Design Basis

The agricultural demand was projected as follows:

Existing	2,349 ha	@ 0.623 Lps/ha	= 1463 Lps (126.4 ML/d)
Projected	100 ha	@ 0.623 Lps/ha	= 62 Lps (5.4 ML/d)
Total Agricultural Demand			**= 1525 Lps (131.8 ML/d)**

6.2.3 Total Combined Demand

Based on the above, the total projected combined demand used as a basis for comparing options is as follows:

Domestic	246 Lps (21.3 ML/d)
Agricultural	1525 Lps (131.9 ML/d)
Total	**1771 Lps (153.1 ML/d)**

A review of SEKID's SCADA HMI Hydraulic Creek intake flow data showed that from mid-October to mid-April demands remained consistently below 14.7 ML/d. During the shoulder seasons demands fluctuated significantly above this flow rate. Peaking during the summer peak demand period can vary significantly (as much as 90% of peak demand) depending on weather conditions.

6.2.4 Fire Protection

SEKID's current design criteria are stated as follows:

- Rural Residential 30 Lps
- Urban Residential 60 Lps

6.3 Servicing Options

6.3.1 Overview

Eight options were developed for comparison purposes. Each option was developed at a conceptual design level including capital and operating costs. The following is a summary of the options:

- Option 1 - Hydraulic Creek
- Option 2 - Hydraulic Creek Blended Concept
- Option 3 - Hydraulic Creek with Point of Entry Rural Treatment
- Option 4 - Hydraulic Creek Full Depth Separated System
- Option 5 - Hydraulic Creek Shallow Depth Separated System
- Option 6 - Groundwater Domestic Supply and Full Depth Separated System

- Option 7 - Groundwater Domestic Supply and Shallow Bury Separated System
- Option 8 - Dual Source Blended Domestic Supply and Full Depth Separated System

6.3.2 Separation of Domestic Distribution From Agricultural Irrigation System

Options 4 to 8 involve separation of the domestic and agricultural irrigation systems in the rural areas. The separation concept incorporated into these options involves installation of small diameter rural distribution mains sized to convey the indoor domestic demand component to all rural residences and institutional and commercial properties as described herein.

- **Domestic System Water Supply:** Water supply for the domestic water system would be treated potable water.

- **Domestic Distribution System**: The distribution laterals typically range from 50mm to 75mm in diameter and the feeder trunks being larger as required to convey the treated domestic water supply from the source treatment facilities to the laterals. The new rural domestic distribution system would be directly connected to the existing distribution systems serving the Gallagher's Canyon / McCulloch Road corridor and the Hall Road specified area.

- **Service Connections**: New domestic service connection pipes would be installed to the property line where they would be connected to an existing or new indoor service connection pipe (owner installed) terminating at a connection to the building plumbing system.

- **Irrigation Distribution System**: The existing distribution system would become an agricultural irrigation and fire protection distribution system and ultimately would provide all irrigation and yard water demands and fire demands to the rural areas. There would be no regulatory requirement to treat water distributed through the irrigation distribution system, although it may be desirable to continue to do so.

- **Fire Protection**: Fire demands in the rural areas would be provided from the irrigation distribution system. Fire demands to the Gallagher's Canyon / McCulloch Road corridor would be provided from the domestic distribution system utilizing treated water storage in the Field Road Reservoir.

6.3.3 Options Summary

Table 2 on the following page summarizes the options and issues involved with each. These options are described in further detail in Technical Memorandum No. 2.

Table 2
Summary of Water Supply and Treatment Options

Concept	Raw Water Supply		Water Treatment		Major Upgrades Required	Considerations
	Agricultural	Domestic	Agricultural	Domestic		
1. Hydraulic Creek Continued utilization of Hydraulic Creek to supply most demands Indoor Filtration Plant at Field Road to serve winter demands augmented by an Outdoor Filtration Plant at Field Road to serve summer demands	Hydraulic Creek East Kelowna Road Wells 1&2	Hydraulic Creek O'Reilly Road Well	Conventional Filtration	All - Hydraulic Creek - Conv. Filtration Hall Rd. - O'Reilly Rd. Well - Chlorination	151.3 ML/d Conventional Filt. Plant @ Field Rd 1.8 ML/d Chlorination Plant @ O'Reilly Rd 5 POE's Gregory Subdivision Field Rd 1050mm dia. Supply/Return Pipelines Field Rd Pump Station & Pipeline to high elev. areas	High water treatment plant capital cost High water treatment plant O&M cost High water treatment plant O&M staffing requirement Added complexities to current operation
2. Hydraulic Creek Blended Concept Continued utilization of Hydraulic Creek to supply most demands Filtration Plant at Hydraulic Cr to serve winter demands augmented by Clarification Without Filtration Plant at Hydraulic Creek to serve summer demands	Hydraulic Creek East Kelowna Road Wells 1&2	Hydraulic Creek O'Reilly Road Well	Clarification W/O Filtration	Urban - Hydraulic Creek - Conv. Filtration Hall Rd. - O'Reilly Rd. Well - Chlorination Rural - Hydraulic Creek - Clarif. w/o Filtr'n	14.7 ML/d Conventional Filtration Plant @ Hydr Cr 136.6 ML/d Clarification W/O Filt. Plant @ Hydr Cr 1.8 ML/d Chlorination Plant @ O'Reilly Rd Hydraulic Cr 1050mm dia. Supply/Return Pipelines	Rural users would receive lower quality water during summer Constructability of water treatment plant at the intake site
3. Hydraulic Creek with Point of Entry Rural Treatment Continued utilization of Hydraulic Creek to supply most demands Filtration Plant at Field Rd to serve Gallaghers/McCulloch demands POE devices to serve rural customers during summer months	Hydraulic Creek East Kelowna Road Wells 1&2	Hydraulic Creek O'Reilly Road Well	None	Urban - Conv. Filtration Hall Rd. - O'Reilly Rd. Well - Chlorination Rural - Point of Entry Treatment	14.7 ML/d Conventional Filtration Plant @ Field Rd 600 POE's Rural & 5 POE's Gregory Subdivision 1.8 ML/d Chlorination Plant @ O'Reilly Rd Field Rd Pump Station & Pipeline to high elev. areas Mahonia Dr 300mm dia. Watermain	Potential of human ingestion of non-potable irrigation water High POE O&M costs High POE O&M staffing requirement IHA may not approve
4. Hydraulic Creek Full Depth Separated System Continued utilization of Hydraulic Creek to supply most demands Filtration Plant at Field Rd to serve domestic demands Separate Domestic Distribution System to serve rural connections Domestic distribution system is full depth bury Fireflows to rural customers supplied from Irrigation System	Hydraulic Creek East Kelowna Road Wells 1&2	Hydraulic Creek O'Reilly Road Well	None	All - Hydraulic Creek - Conv. Filtration Hall Rd. - O'Reilly Rd. Well - Chlorination	19.5 ML/d Conventional Filtration Plant @ Field Rd 5 POE's Gregory Subdivision 1.8 ML/d Chlorination Plant @ O'Reilly Rd Field Rd. 450mm dia. Raw Water Supply Main Field Rd Pump Station & Pipeline to high elev. areas 86 km Domestic Distr. System - full depth	Potential of human ingestion of non-potable irrigation water High domestic distribution system capital cost Limited system expandability
5. Hydraulic Creek Shallow Depth Separated System Continued utilization of Hydraulic Creek to supply most demands Filtration Plant at Hydraulic Creek to serve domestic demands Separate Domestic Distribution System to serve rural connections Domestic Distribution System is shallow bury Domestic water distributed through Irrigation System during winter Fireflows to rural customers supplied from Irrigation System	Hydraulic Creek East Kelowna Road Wells 1&2	Hydraulic Creek O'Reilly Road Well	None	All - Hydraulic Creek - Conv. Filtration Hall Rd. - O'Reilly Rd. Well - Chlorination	19.5 ML/d Conventional Filtration Plant @ Hydr Cr 1.8 ML/d Chlorination Plant @ O'Reilly Rd McCulloch Rd 450mm dia. Treated Water Supply Main 86 km Domestic Distr. System - shallow bury	Potential of human ingestion of non-potable irrigation water Lower domestic distribution system capital cost than Option 4 Limited system expandability High O&M staffing required for semi-annual system changeover Potential cross-connection issues during system changeover IHA may not approve
6. Groundwater Domestic Supply and Full Depth Separated System Expand existing wellfield to serve all domestic demands Chlorination plant to treat groundwater Separate Domestic Distribution System to serve rural connections Domestic Distribution System is full depth bury Fireflows to rural customers supplied from Irrigation System	Hydraulic Creek	East Kelowna Road Wells 1&2 O'Reilly Road Well 2 new wells @ 5.3 ML/day	None	All - Chlorination	2 - 5.3 ML/d Wells - Dunster Rd 19.5 ML/d Chlorination Plant @ East Kelowna Rd 1.8 ML/d Chlorination Plant @ O'Reilly Rd Pooley Rd Booster Pump Station 4K McCulloch Rd Booster Pump Station 2K 85 km Domestic Distr. System - full depth Field Rd. Pump Station & Pipeline to high elev. areas	Potential of human ingestion of non-potable irrigation water High domestic distribution system capital cost Limited system expandability Higher pumping costs than Options 1, 2, 3, 4, 5, and 8
7. Groundwater Domestic Supply and Shallow Depth Separated System Expand existing wellfield to serve all domestic demands Chlorination plant to treat groundwater Separate Domestic Distribution System to serve rural connections Domestic Distribution System is shallow bury Domestic water distributed through Irrigation System during winter Fireflows to rural customers supplied from Irrigation System	Hydraulic Creek	East Kelowna Road Wells 1&2 O'Reilly Road Well 2 new wells @ 5.3 ML/day	None	All - Chlorination	2 - 5.3 ML/d Wells - Dunster Rd 19.5 ML/d Chlorination Plant @ East Kelowna Rd 1.8 ML/d Chlorination Plant @ O'Reilly Rd Pooley Road Booster Pump Station 4K McCulloch Rd Booster Pump Station 2K 85 km Domestic Distr. System - shallow bury Field Rd Pump Station & Pipeline to high elev. areas	Potential of human ingestion of non-potable irrigation water Lower domestic distribution system capital cost than Option 6 Limited system expandability High O&M staffing required for semi-annual system changeover Potential cross-connection issues during system changeover Higher pumping costs than Options 1, 2, 3, 4, 5, and 8 IHA may not approve
8. Dual Source Blended Domestic Supply and Full Depth Separated System Hydraulic Creek supplies half of domestic demands Expand existing wellfield to serve half of domestic demands Filtration Plant at Field Rd to treat Hydraulic Creek source water Chlorination plant to treat groundwater Separate Domestic Distribution System to serve rural connections Domestic Distribution System is full depth bury Fireflows to rural customers supplied from Irrigation System	Hydraulic Creek	Hydraulic Creek East Kelowna Road Wells 1&2 O'Reilly Road Well 1 new well @ 5.3 ML/day	None	All - Blended Hydraulic Creek treated by Conv. Filtration and Groundwater treated by Chlorination	1 - 5.3 ML/d Well - Dunster Rd 8.8 ML/d Chlorination Plant @ East Kelowna Rd 1.8 ML/d Chlorination Plant @ O'Reilly Rd 10.7 ML/d Conventional Filtration Plant @ Field Rd Pooley Rd Booster Pump Station 4K 92 km Domestic Distr. System - full depth Field Rd Pump Station & Pipeline to high elev. areas	2 sources of treated water Potential of human ingestion of non-potable irrigation water Added cost of water treatment compared to Options 6 & 7 High domestic distribution system capital cost Limited system expandability Improved operational flexibility Higher pumping costs than Options 1, 2, 3, 4, and 5

Nomenclature:
ML/day - Million Litres per day
POE - Point of Entry Water Treatment
O&M - Operations and Maintenance

7 Financial Assessment

A costing model was developed to review the impact each option would have on rate schedules for SEKID's ratepayers. The following assumptions and parameters were used:

- A 20 year financial life for the project;
- Capital cost estimates based on year 2007 dollars;
- Capital investment amortized over 20 years at an assumed interest rate of 5.0%;
- An annual inflation rate of 2%;
- Allowances included for operation and maintenance costs.

Table 3 summarizes the capital costs for each of the options. A breakdown of these costs is included in Technical Memorandum No. 2.

Table 3
System Options Capital Cost Summary

OPTION	DESCRIPTION	SUPPLY SYSTEM COSTS	REQUIRED WATER TREATMENT COSTS	TOTAL REQUIRED
1	Hydraulic Creek	$4,057,000	$50,725,000	**$54,782,000**
2	Hydraulic Creek Blended Concept	$156,000	$39,623,000	**$39,779,000**
3	Hydraulic Creek With Point of Entry Rural Treatment	$652,000	$15,438,000	**$16,090,000**
4	Hydraulic Creek Full Depth Separated System	$11,367,000	$11,980,000	**$23,347,000**
5	Hydraulic Creek Shallow Depth Separated System	$9,117,000	$11,980,000	**$21,097,000**
6	Groundwater Domestic Supply and Full Depth Separated System	$16,681,000	$883,000	**$17,564,000**
7	Groundwater Domestic Supply and Shallow Depth Separated System	$12,095,000	$883,000	**$12,978,000**
8	Dual Source Blended Domestic Supply and Full Depth Separated System	$14,680,000	$6,470,000	**$21,150,000**

Table 4 summarizes the life cycle costs for each of the options and breaks this down to an annual cost per connection. A more detailed breakdown of these costs is included in Technical Memorandum No. 2.

Table 4
System Options Life Cycle Costs Summary

OPTION	NAME	CAPITAL COST	TOTAL 20 YEAR DEBT SERVICING AND O&M COST (1) (2)	NO. OF CONNECTIONS IN 2007	TOTAL COST PER CONNECTION	TOTAL ANNUAL COST PER CONNECTION
1	Hydraulic Creek	$54,782,000	$117,146,724	2,053	**$57,061**	**$2,853**
2	Hydraulic Creek Blended Concept	$39,779,000	$86,241,572	2,053	**$42,008**	**$2,100**
3	Hydraulic Creek With Point of Entry Rural Treatment	$16,090,000	$34,617,712	2,053	**$16,862**	**$843**
4	Hydraulic Creek Full Depth Separated System	$23,347,000	$45,608,093	2,053	**$22,215**	**$1,111**
5	Hydraulic Creek Shallow Depth Separated System	$21,097,000	$43,406,424	2,053	**$21,143**	**$1,057**
6	Groundwater Domestic Supply & Full Depth Separated System	$17,564,000	$36,983,264	2,053	**$18,014**	**$901**
7	Groundwater Domestic Supply & Shallow Depth Separated System	$12,978,000	$30,789,688	2,053	**$14,997**	**$750**
8	Dual Source Blended Domestic Supply and Full Depth Separated System	$21,150,000	$42,786,857	2,053	**$20,841**	**$1,042**

Notes:
1) *Assumed Interest Rate – 5.0%*
2) *Assumed Inflation Rate – 2.0%*

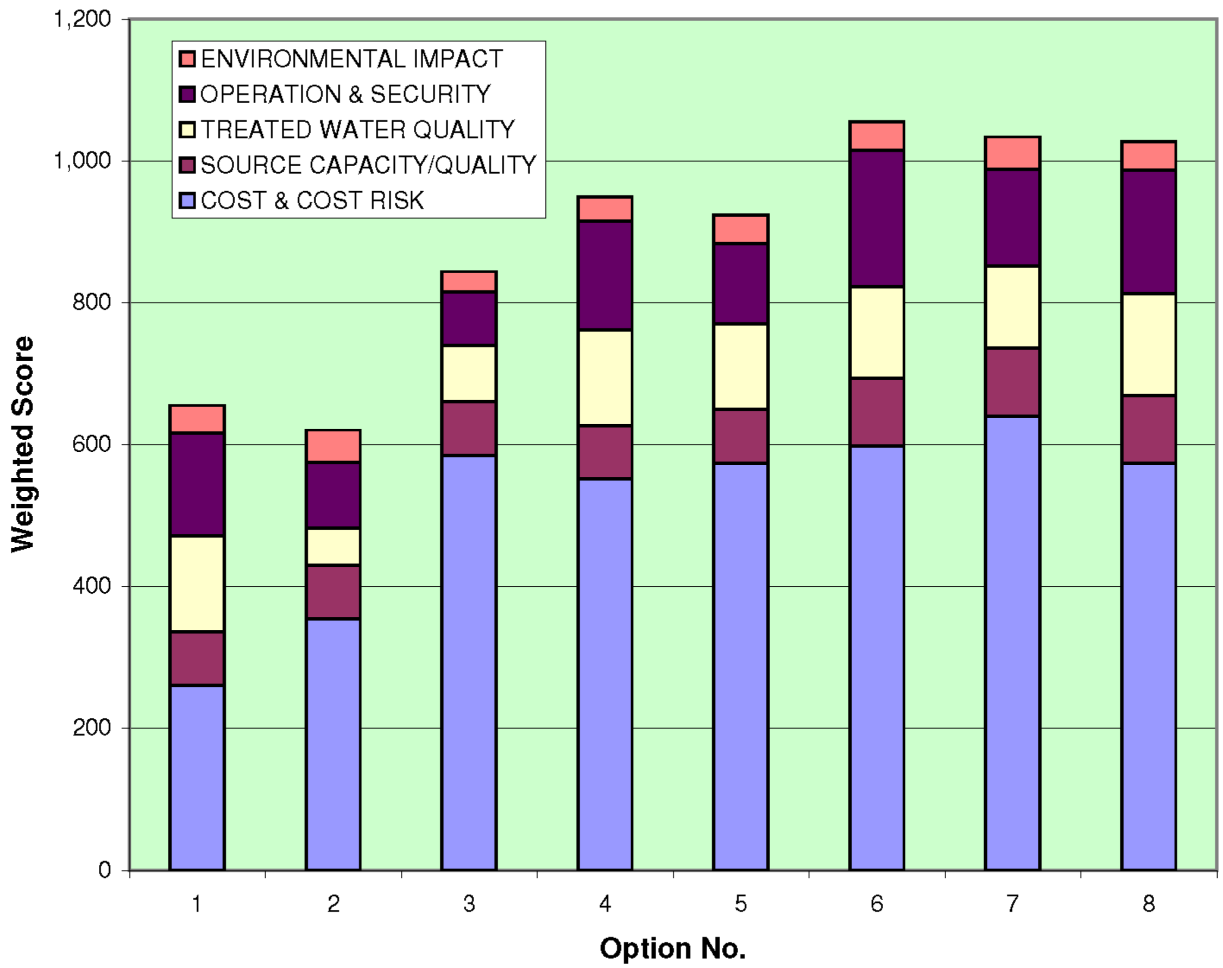
8 Options Evaluation

A decision matrix was developed for evaluating the supply and treatment options. The matrix was developed in consultation with SEKID. The major criteria included:

- Cost and Cost Risks
- Source Capacity and Water Quality
- Treated Water Quality
- Operation and Security
- Environmental Impact

The evaluation included development of a scoring system used as a tool for comparing the options. Figure 1 shows the consolidated results of the scoring comparison of the options.

Figure 1: Options Scoring



The evaluation approach, criteria importance, and results of the evaluation are presented in Technical Memorandum No. 3.

9 Conclusions

The following conclusions can be drawn from the study:

.1 SEKID's existing surface and groundwater supply sources provide the most practical and economical solutions for its future water supply requirements.

.2 The existing surface water supply will require water treatment incorporating pre-treatment (clarification), filtration and disinfection to meet IHA's water quality requirements if it is to be used as the source of supply for domestic consumption purposes.

.3 The existing groundwater supply would only require disinfection to meet IHA's water quality guidelines if it were expanded to be used as the source of supply for domestic consumption purposes. Available water quality data indicates that the groundwater source is considerably harder and has higher winter temperature than the surface water source. Optional softening or blending with treated surface water to reduce the hardness are treatment approaches that would address any aesthetic concerns over hardness. However, there are many communities in Canada with domestic water that is harder than the SEKID groundwater supply.

.4 The existing well-field can be expanded to supply SEKID's projected domestic water demands. Expansion of the well-field will necessitate undertaking an Environmental Impact Assessment.

.5 Domestic water consumption accounts for less than 15% of SEKID's total combined domestic and agricultural water demand. There is no regulatory requirement to treat the agricultural irrigation component of the water demand.

.6 Supply and treatment strategies involving treatment of the combined domestic and agricultural demands had the highest capital and life cycle costs of all of the options.

.7 The option of utilizing point of entry treatment for all rural connections was investigated, however, would result in significant regulatory, operational and maintenance challenges to SEKID and does not appear to be supported by IHA.

.8 Options involving utilizing groundwater to serve domestic demands utilizing a separate domestic distribution system have the lowest capital costs of all options which fully comply with the regulatory requirements.

.9 Two options involved utilizing shallow bury separate domestic distribution systems. These options could create significant operational challenges to SEKID as well as higher potential for service interruption. Further investigation would be required to determine the viability of shallow bury pipe installation.

10 Recommendations

We respectfully recommend the following:

.1 The South East Kelowna Irrigation District review this report with the community at large via a public consultation process to receive feedback on the options presented herein and impacts on water rates.

.2 SEKID consider implementing metering of all domestic service connections and couple this with consumption based billing to encourage reduced domestic water consumption throughout the system.

.3 Based on our assessment, we recommend proceeding on the basis of Option 6 – Groundwater Domestic Supply and Full Depth Separated System.

.4 Review with senior government agencies the potential for obtaining government funding for the proposed project.

.5 Proceed with preliminary design of SEKID's preferred option in order to develop more accurate cost estimates. As part of the preliminary design process, a more detailed review of the domestic water demands should be undertaken including refinement of the demands per connection and allowances for future development.

.6 Evaluate the viability and extent of installing the proposed separate domestic distribution system at shallower depths than SEKID's current standards. This evaluation should include a distribution heat loss analysis and service interruption risk analysis.

APPENDIX A - TECHNICAL MEMORANDUM NO. 1

APPENDIX B - TECHNICAL MEMORANDUM NO. 2

APPENDIX C - TECHNICAL MEMORANDUM NO. 3

APPENDIX D - GOLDER ASSOCIATES HYDROGEOLOGICAL EVALUATION