
# REGIONAL DISTRICT OF CENTRAL OKANAGAN

## KILLINEY BEACH AND WESTSHORE ESTATES WATER SYSTEMS STUDY: SUMMARY AND EVALUATION OF SUPPLY AND TREATMENT OPTIONS (REV.5)

URBAN SYSTEMS

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# EXECUTIVE SUMMARY

The Killiney Beach (Killiney) and Westshore Estates (Westshore) water systems are two small water systems owned and operated by the Regional District of Central Okanagan (RDCO). Both water systems are located on the northwest shore of Okanagan Lake and require upgrades to comply with the *Drinking Water Treatment Objectives (Microbiological) for Surface Water Supplies in British Columbia*.

Urban Systems was asked to review water system improvement recommendations provided by Larratt Aquatic (Larratt), AECOM, Associated Engineering (AE) and Agua Consulting (Agua) in the past, as well as an alternative option based in new information provided by Western Water Associates (Western Water). The options reviewed are:

**Option 1A**: Fintry/Shorts Creek Aquifer groundwater supply with a submarine transmission main submerged in Okanagan Lake.
**Option 1B**: Fintry/Shorts Creek Aquifer groundwater supply with an overland transmission main adjacent to Westside Road.
**Option 2A**: Independent intakes and WTP's (UV & chlorine disinfection and filtration) for Killiney and Westshore
**Option 2B**: Independent intakes and dual disinfection treatment facilities (UV and chlorine) for Killiney and Westshore in the near term; common intake, filtration WTP and submarine transmission main (submerged in Okanagan Lake) for both systems in the long term
**Option 3**: Common intake and WTP (UV & chlorine disinfection and filtration) at Killiney for both water systems and an interconnecting submarine transmission main submerged in Okanagan Lake.

Urban evaluated each option by looking at Technical, Financial and Environmental & Regulatory criteria. The results of the scoring for each option are presented below.

| Scoring | Option 1A – Groundwater supply w submarine transmission main | Option 1B – Groundwater supply w overland transmission main | Option 2A – Independent intakes and WTP's | Option 2B – Independent intakes and disinfection WTP's initially; common intake and filtration WTP in future | Option 3 – Common intake and WTP |
|---|---|---|---|---|---|
| Technical | ◕ (4) | ◕ (4.2) | ◐ (3.1) | ◐ (3.1) | ◐ (3.3) |
| Financial | ◕ (4.2) | ● (5) | ● (1.4) | ◔ (1.6) | ◐ (3.2) |
| Environmental & Regulatory | ● (1) | ◔ (2) | ◐ (3) | ◔ (2) | ◔ (2) |
| Average | ◕ (3.7) | ◕ (4.2) | ◐ (2.6) | ◐ (2.5) | ◐ (3.1) |
| Weighted Average | ◐ (3) | ◕ (3.7) | ◐ (2.5) | ◔ (2.2) | ◐ (2.8) |

● Most Desirable (5) | ◕ Moderate/Highly Desirable (4) | ◐ Moderately Desirable (3) | ◔ Low/Moderately Desirable (2) | ● Least Desirable (1)

The highest possible score for each category is five. Please refer to Table 3.4 for further scoring information.

Based on the scoring for each option, we consider Option 1B, with a common groundwater source and WTP at the Fintry/Shorts Creek Aquifer, the most favourable of the options.

There are critical aspects of Option 1B that should be verified before it can be considered a viable supply and treatment strategy.

1. An overland transmission main alignment must be determined. If MoTI will not permit a transmission main within their ROW on Westside Road, an alternate alignment will need to be secured. There may be land negotiations and Crown Tenure applications required with this option.
2. An Environmental Assessment Officer (EAO) should be engaged to determine if an Environmental Certificate or Exemption is appropriate for groundwater extraction volumes required for build-out MDD.
3. Complete additional water quality monitoring and characterization that considers higher extraction rates per Western Water's report. Septic systems in Lower Fintry may cause higher chloride, sodium and nitrate concentrations in the aquifer at increased pump rates.

If the results of any of the above reveal that Option 1B is not feasible, Option 1A and 3 should be given consideration.

This report is intended to provide the information required for the RDCO to select a preferred path forward for providing the Killiney and Westshore water systems with a water supply and treatment plan that meets the British Columbia Drinking Water Protection Regulation and the Guidelines for Canadian Drinking Water Quality.

# 1.0 INTRODUCTION

## 1.1 BACKGROUND

The Killiney Beach (Killiney) and Westshore Estates (Westshore) water systems are two small water systems owned and operated by the Regional District of Central Okanagan (RDCO). Both water systems are located on the northwest shore of Okanagan Lake and require upgrades to comply with the *Drinking Water Treatment Objectives (Microbiological) for Surface Water Supplies in British Columbia*.

Larratt Aquatic (Larratt), AECOM, Associated Engineering (AE) and Agua Consulting (Agua) have provided recommended improvements for the water systems in the past. Western Water Associates (Western Water) completed a groundwater capacity study during the writing of this report. The RDCO invited Urban Systems (Urban) to complete a study for the Killiney and Westshore water systems to review previous recommendations, identify knowledge gaps and provide alternative options.

Table 1.1 provides a summary of the existing infrastructure at each water system

**TABLE 1.1 – SUMMARY OF EXISTING INFRASTRUCTURE**

| Component | Killiney Beach | Westshore Estates |
|---|---|---|
| Source | Okanagan Lake | Okanagan Lake |
| Treatment provided | Chlorine disinfection | Chlorine disinfection |
| Intake size (mm), material[1] | 250, PVC | 450, CMP |
| Intake depth at average lake level (m)[2] | 9.26 | 6.06 |
| # of reservoirs[1] | 3 (Killarney, Udell, Winchester) | 2 (Mountain, Upper) |
| Total reservoir volume ($m^3$)[1] | 1,377 | 1,610 |
| # of pressure zones | 4 | 4 |
| # of pump stations | 4 | 2 |
| # of existing services[3] | 268[4] | 293 |
| # of services at buildout[3] | 427 | 526 |

*Notes:*

1. *taken from RDCO GIS*
2. *taken from Larratt 2012 report*
3. *provided by RDCO in 2022*
4. *# of existing services decreased from 295 to 268 due to the White Rock Lake wildfire.*

## 1.2 OBJECTIVE

The intent of this report is to summarize past recommendations made by others, provide alternative considerations, and evaluate the options to determine a preferred approach for achieving compliance with the Provincial drinking water objectives for the Killiney and Westshore water systems. The focus of this report is water supply and treatment. Distribution and fire protection were not reviewed.

## 1.3 ORGANIZATION OF DOCUMENT

The remainder of this report is divided into the sections shown below:

- 2.0 "Summary of Past Recommendations" provides an overview of the previous supply and treatment recommendations.
- 3.0 "Comparison of Past Recommendations" evaluates the past recommendations and identifies the most favourable approach.
- 4.0 "Alternative Options and Considerations" reviews what other water providers in the Okanagan Valley are doing to achieve drinking water objectives. Section 4.0 also considers Point of Entry / Point of Use (POE / POU) as an alternative water treatment strategy and touches on the possibility of tying into the Okanagan Indian Band (OKIB) distribution system with a shared water treatment plant (WTP).
- 5.0 "Recommendations" expands on the favourable option identified in section 3.0 and provides further considerations. We also provide the design criteria that will be used to further develop the recommended supply and treatment strategy.

# 2.0 SUMMARY OF PAST RECOMMENDATIONS

The RDCO provided thirteen relevant documents to review for this water study. They are listed below.

- Associated Engineering, *Killiney Beach Water System Review* (November 2010)
- Associated Engineering, *Westshore Estates Water System Review* (November 2010)
- Larratt Aquatic, *Source Assessment of the Regional District of Central Okanagan – Killiney Beach and Westshore Estates Water Systems* (September 5, 2012)
- AECOM, *Killiney Beach Water System Preliminary Design – Final* (April 2015)
- AECOM, *Source Water Investigations: Killiney Beach & Westshore Estates Water Systems – Final Report* (December 2015)
- Agua Consulting Inc., *Chlorine Contact Time Report – Killiney Beach Water System* (September 12, 2016)
- Agua Consulting Inc., *Disinfection Upgrade Report – Westshore Water Utility* (September 12, 2016)
- Associated Engineering, *Killiney Beach and Westshore Estates Water System Report Review* (September 18, 2017)

- Associated Engineering, *Technical Memorandum – Killiney Beach and Westshore Estates Water Systems Report Review* (August 30, 2018)
- Interior Health, *Killiney Beach Water Supply System* (February 1, 2019)
- Interior Health, *Westshore Estates Water Supply System* (February 15, 2019)
- Larratt Aquatic, *Near-Shore Water Quality and Periphyton Production in Okanagan Lake at Killiney Beach and Westshore Estates Area* (2021)
- Western Water Associates Ltd., *Feasibility Assessment of Sourcing Additional Groundwater Capacity from the Lower Fintry Community Water System Wells and Aquifer 358* (February 4, 2022)

The past reports reviewed the following source water supply options:

- Surface water supply:
    - Okanagan Lake: considered the most reliable source overall
    - Surface water source alternatives: Whiteman, Hope and Norris creeks
- Groundwater supply:
    - Fintry/Shorts Creek Aquifer (Aquifer 358): considered the most reliable groundwater source
    - Alternate groundwater sources: Sugarloaf Mountain and Whiteman Creek aquifers

The previous reports dismissed further consideration of the creek sources. We agree with not reviewing these creek water sources further because of their limited quantity and variable quality.

The Fintry/Shorts Creek Aquifer is the only groundwater source considered viable in the previous reports. We agree with the recommendations in AE's report that the Sugarloaf Mountain and Whiteman Creek aquifers should not be considered further due to their locations and yield uncertainty. We believe it is prudent to plan for long-term supply and treatment infrastructure upgrades around a more reliable water source, such as Okanagan Lake or the Fintry/Shorts Creek Aquifer.

There are five main options for the supply and treatment of drinking water for the Killiney and Westshore water systems. There are slight variations within each option (e.g., Option 3 has multiple options for siting the proposed WTP), but they fit into the following categories:

Option 1A: Fintry/Shorts Creek Aquifer groundwater supply with a submarine transmission main submerged in Okanagan Lake.
Option 1B: Fintry/Shorts Creek Aquifer groundwater supply with an overland transmission main adjacent to Westside Road.
Option 2A: Independent intakes and WTP's (UV & chlorine disinfection and filtration) for Killiney and Westshore
Option 2B: Independent intakes and dual disinfection treatment facilities (UV and chlorine) for Killiney and Westshore in the near term; common intake, filtration WTP

and submarine transmission main (submerged in Okanagan Lake) for both systems in the long term

Option 3: Common intake and WTP (UV & chlorine disinfection and filtration) at Killiney for both water systems and an interconnecting submarine transmission main submerged in Okanagan Lake.

Please refer to Figures 2.1 to 2.4 in Appendix A which show an overview of each option.

## 2.1 GENERAL RECOMMENDATIONS

Some of the past reports provided recommendations specific to certain aspects of the water systems, such as extending intakes, increasing chlorine contact time (CT), etc. Since these did not form complete water supply and treatment upgrade recommendations, they will be considered as general recommendations and are not evaluated against complete options.

### INTAKES

- Intakes should be at least 20 m deep to reduce the risk of algae blooms with 3 m of clearance above the lake bottom to prevent sediment accumulation.
- Intakes would have to be extended to a 40 m depth or treatment added at the intake mouth to prevent zebra & quagga mussel contamination.
- There is not a marked difference between the 20 m depth and 30 m depth turbidities, which strengthens the case for extending the intakes to 20 m initially with the plan to continue monitoring the intake location at 30 m depth
- Larratt provided defined intake protection zones for each water system intake. Because water currents travel faster in shallow water, the recommended intake protection zones are larger than if the intakes were in deeper water.
- An application for Crown tenure of the intake protection zone(s) would have to be made to the Ministry of Forests, Lands, Natural Resource Operations and Rural Development .

### CHLORINE CONTACT TIME

- Killiney Beach Water System:
    - There is sufficient chlorine contact time for 4-log removal of bacteria and viruses.
    - There is partially sufficient contact time for 3-log removal of *Giardia*; only upper two pressure zones have adequate contact time.
    - The Killiney system is non-compliant for inactivation of *Cryptosporidium*, which cannot be achieved through chlorination alone.
- Westshore Estates Water System:
    - There is sufficient contact time for 4-log inactivation of viruses and bacteria.
    - There is sufficient contact time for 3-log inactivation of *Giardia*.

- The Westshore system is non-compliant for inactivation of *Cryptosporidium*, which cannot be achieved through chlorination alone.

### DRINKING WATER PROTECTION ACT COMPLIANCE

- Both the Killiney and Westshore water systems are non-compliant with the *Drinking Water Protection Act* and do not meet the treatment objectives set out in Section 4 of the *Drinking Water Treatment Objectives (Microbiological) for Surface Water Supplies in British Columbia*.
- Additionally, Interior Health (IH) has requested:
  - Provide treatment for the Killiney Beach and Westshore Estates Water Systems that meets the Drinking Water Treatment Objectives for Surface Water Supplies in B.C.
  - Provide IH with an updated Water Treatment Improvements implementation schedule.
  - Provide a Source Protection Plan for the Killiney and Westshore water system intakes and detail source protection activities in the annual report.
  - Update the Water Quality Monitoring Plan for each water system.
- The data for the Upper Fintry/Shalal Road/Valley of the Sun water system shows that the water quality has remained stable over time and continues to meet all Guidelines for Canadian Drinking Water Quality. There has been one occurrence where lead concentrations exceeded allowable levels, but this was an isolated incident (Western Water, 2022).

## 2.2 OPTION 1A: FINTRY/SHORTS CREEK GROUNDWATER SUPPLY WELL (SUBMARINE TRANSMISSION MAIN)

Key elements:

- Develop groundwater well in the Fintry/Shorts Creek Aquifer.
- Chlorine disinfection at Fintry pump station site in the near term. Chlorine will be used to dose water for the Upper Fintry/Shalal Road/Valley of the Sun water system (as it does presently) as well as for the transmission main to Killiney and Westshore. Because the transmission main is approximately 12 km long, there is potential for bacterial growth. It is recommended to chlorinate the water distributed in the transmission main initially and dose it again at each downstream system as required to achieve target residuals.
- Provisions for UV disinfection in the future to further protect against possible contaminants. It is possible UV may not be required in the future if water quality and regulations remain consistent, but planning to add UV in the future is a conservative approach.

- Pump groundwater to Killiney and Westshore pump stations via a submerged transmission main within Okanagan Lake.
- New pump station required to pump from Killiney to Westshore.
- Filtration may not be required if groundwater quality meets "non-groundwater at risk of containing pathogens" (non-GARP) status.
- The aquifer is likely to provide quantity required for build-out MDD.
- The aquifer water quality is good at existing pumping rates. Pumping the wells at higher rates (i.e., MDD) may result in reduced water quality due to the presence of septic systems in the area.
- A new Source Protection Plan would be required.
- A notification under the *BC Reviewable Projects Regulation* is required for large groundwater users within 15% of the *Environmental Assessment Act* extraction threshold of 75 L/s (Fintry, Killiney and Westshore combined build-out MDD = 79.9 L/s). An Environmental Assessment Officer (EAO) will use the Notification to determine if an Environmental Certificate or Exemption is appropriate. A notification is required even if initial extraction volumes are below the threshold because the system would be designed to ultimately operate at MDD. More discussion with an EAO is warranted before pursuing this option.
- A new water licence would be required to extract the build-out MDD volumes from the Fintry/Shorts Creek Aquifer. Existing water licences should be reviewed to see if any can be rescinded, which would likely bode well for a new licence application. Rescinding some surface water licences, such as Norris Creek and Hope Creek, will likely improve habitat quality in those drainages. Careful consideration must be made before rescinding any existing licences.
- Further testing at the build-out MDD will need to be completed to address quality concerns at higher demand.
- This option has the third lowest capital cost of the five options (Net Present Value (NPV) = $16,052,113), and the second lowest 40-year lifecycle cost (NPV = $18,346,686). The costs presented do not consider adding a filtration building in the future if the water quality ever fails to meet non-GARP criteria. The works for this option cannot be phased.
- This option has the second lowest estimated asset renewal cost of the five options ($206,005).

## 2.3 OPTION 1B: FINTRY/SHORTS CREEK GROUNDWATER SUPPLY WELL (OVERLAND TRANSMISSION MAIN)

Option 1B shares most of the key elements in Option 1A. The only difference is that Option 1B will convey groundwater via an overland transmission main adjacent to Westside Road.

Other key elements:

- This option has the lowest capital cost of the five options (NPV = $12,613,597), and the lowest 40-year lifecycle cost (NPV = $14,908,170). The costs presented do not consider adding a filtration building in the future if the water quality ever fails to meet non-GARP criteria. The works for this option cannot be phased.
- This option has the lowest estimated asset renewal cost of the five options ($171,620).

## 2.4 OPTION 2A: INDEPENDENT INTAKES AND WTP'S FOR KILLINEY AND WESTSHORE

Key elements:

- Extend intakes for each system.
- Chlorine and UV disinfection at each lake pump station site.
- Obtain filtration exemption for each water system in the near term.
- Plan for ultra-filtration (UF) membrane filtration at each WTP in the future. Concentrate from the UF membranes (i.e., wastewater from filtration process) would be stored at the plant site and trucked to the Westside Regional Wastewater Plant. It is estimated that the UF system would achieve 95% recovery (5% waste).
- An update to the Source Protection Plan for each water system would be required.
- This option has the second highest capital cost (NPV = $18,765,234) and the second highest 40-year lifecycle cost (NPV = $24,953,551) of the five options. The initial capital cost can be reduced if filtration is deferred and the work can be phased (NPV = $11,225,625) The estimate for this option in the past reporting assumed the cost to extend the Killiney and Westshore intakes would be the same (NPV = $453,351). Larratt reported that the Killiney intake will have to be extended 300 m to reach a depth of 20 m. For Westshore to achieve a 20 m intake depth, it would need to be extended 400 m. The difference is even greater when extending the intakes to 30 m deep (500 m for Killiney, 800 m for Westshore). We have increased the estimate for the Westshore intake extension and updated the total cost of this option accordingly.
- This option has the highest estimated asset renewal cost of the five options ($481,984).

## 2.5 OPTION 2B: INDEPENDENT INTAKES AND DISINFECTION FOR KILLINEY AND WESTSHORE IN THE NEAR TERM; COMMON INTAKE AND FILTRATION WTP FOR BOTH SYSTEMS IN THE LONG TERM

Option 2B is like 2A but adds only one filtration WTP to be shared by both systems in the future. Option 2B extends intakes and provides chlorine and UV disinfection for both systems in the near term, then adds a shared filtration WTP at Killiney for both systems in the long term. A transmission main between Killiney and Westshore is required in this option when the conditions for obtaining filtration exemption are no longer achievable. Key elements:

- Extend intakes at both Killiney and Westshore.
- Provide chlorine and UV disinfection for each system, with filtration exemption delaying the need for a transmission main in Okanagan Lake.
    - UV can be added at the Mountain reservoir site for the Westshore water system.
    - Add UV and CT tank at the Killiney intake location. Or, alternatively, install these components at Killarney reservoir if a dedicated main is installed from the lake to the Killarney reservoir.
- Apply for filtration exemption once the works have been completed.
- Plan for UF membrane filtration in the future. Concentrate from the UF membranes (i.e., wastewater from filtration process) would be stored at the plant site and trucked to the Westside Regional Wastewater Plant. It is estimated that the UF system would achieve 95% recovery (5% waste).
- An update to the Source Protection Plan for each water system would be required.
- An estimated capital cost of this option is NPV = $20,747,239, which is the highest of the options. If filtration exemption is acceptable, this option has an initial cost of NPV = $11,225,625. The estimated 40-year lifecycle cost for Option 2B is the highest of all options (NPV = $25,647,316).
- This option has the second highest estimated asset renewal cost of the five options ($445,108).

## 2.6 OPTION 3: COMMON INTAKE AND WTP AT KILLINEY FOR BOTH WATER SYSTEMS

Key elements include:

- Extend the intake at the Killiney lake pump station site.
- Abandon the intake at Westshore.
- Connect Killiney and Westshore with a submerged transmission main in Okanagan Lake.

- New pump station required to pump treated water from Killiney to Westshore.
- Chlorine and UV disinfection provided at Killiney lake pump station site.
- CT tank sized to achieve required contact time.
- Filtration exemption in the near term.
- Plan for UF membrane filtration WTP in the future. Concentrate from the UF membranes (i.e., wastewater from filtration process) would be stored at the plant site and trucked to the Westside Regional Wastewater Plant. It is estimated that the UF system would achieve 95% recovery (5% waste).
- An update to the Source Protection Plan for each water system would be required.
- This option presents the second lowest capital cost of the five options considered (NPV = $15,231,216), and the third lowest 40-year life cycle cost (NPV = $19,646,593). The initial capital cost can be reduced further if filtration is deferred (NPV = $10,509,125).
- This option has the third highest estimated asset renewal cost of the five options ($319,976).

Variations of this option include:

- Locate WTP at Udell reservoir as opposed to locating it at the Killiney lake pump station site.
- Locate WTP at Killiney lake pump station and dedicated transmission main to Killarney site as opposed to having a CT tank at the lake station.

# 3.0 COMPARISON OF PAST RECOMMENDATIONS

We have considered the following criteria in our evaluation:

1. Source Quantity – near term: both the Fintry/Shorts Creek Aquifer and Okanagan Lake provide adequate water quantity for both water systems. Okanagan Lake source is marginally more reliable given its large volume when compared to a groundwater source.

2. Source Quality – near term: the Fintry/Shorts Creek Aquifer provides good water quality at existing system demands. Okanagan Lake quality is generally good but experiences seasonal turbidity issues. There is also the concern of algae blooms, zebra and quagga mussels getting into the lake, as well as cyanobacteria at deeper levels in Okanagan Lake.

3. Risk to Quantity – long term: the quantity of water available in Okanagan Lake long term is marginally more reliable than the Fintry/Shorts Creek Aquifer. The aquifer

level is hydraulically controlled by the lake which somewhat offsets the risk of the groundwater levels decreasing over time.

4. Risk to Quality – long term: there is some in-situ filtration provided for groundwater in the Fintry/Shorts Creek Aquifer. There is also, however, uncertainty of the groundwater quality at MDD pumping rates due to presence of septic fields. Okanagan Lake is more susceptible to quality issues, (e.g., algae blooms, turbidity events, invasive mussels) over time as it is a surface water source.

5. Source Redundancy: if the options that have a single, common, point of diversion for both water systems experience a significant failure event at the intake site (i.e., reservoir storage can't compensate for entire duration of failure), both water systems will be without water. Options that have two intake sites can at least be configured to provide water to one system if the other goes down due to a failure.

6. Transmission: evaluates the piping required to convey treated water to each water system, the risk of failure to the transmission main and considers water age.

   Option 1A requires approximately 12 km of transmission main in Okanagan Lake. Option 1B requires approximately 8 km of transmission main adjacent to Westside Road to connect the Fintry groundwater site, Killiney Beach and Westshore Estates. MoTI has expressed that any watermain installed on Westside Road must be outside of the road prism (i.e., outside of the road structure itself). MoTI is not providing any approvals in the area until they can monitor how it reacts during the first freshet in spring of 2022 after the White Rock Lake wildfire of 2021. Because of this, MoTI is unable to give an indication whether a watermain in the Westside Road right-of-way will be approved. Should a watermain be approved, MoTI must be assured that the slope stability and integrity of the road prism will not be impacted by the installation, operation and maintenance of the watermain.

   Option 2A, with separate intakes and WTP's, requires no new transmission infrastructure to convey water to each system. Option 2B does not initially require new distribution infrastructure but will ultimately require a 4 km transmission main in Okanagan Lake. Option 3 requires additional piping by way of an approximately 4 km Okanagan Lake transmission main.

   Water age and risk of quality degrading increases as the length of the transmission main and associated travel time increase. Data provided by the RDCO showed that the winter day demands (WDD) in the last two years for the Killiney and Westshore water systems were 1.6 L/s and 2.1 L/s, respectively. Considering a 350 mm diameter transmission main between Fintry and Killiney, and a 250 mm diameter

transmission main between Killiney and Westshore, the water age for each system is summarized below in Table 3.1:

**TABLE 3.1 – KILLINEY AND WESTSHORE WATER AGE**

| Parameter | Killiney Beach | Westshore Estates |
|---|---|---|
| WDD (L/s) | 1.6 | 2.1 |
| Transmission main diameter (mm) | 350 | 250 |
| Transmission main length (m) | 8,000 | 4,000 |
| Water Age (days) | 2.41 | 1.08 |

Water age typically becomes an issue at five days or more, so it is unlikely that water age will present a concern for either system. It is still recommended that both the Killiney and Westshore water systems allow for chlorine boosting if Options 1A or 1B are considered.

By nature of a submarine pipeline, the more of it that is exposed, the more susceptible it is to being damaged. Examples of this could include boat anchors snagging the watermain.

Transmission also takes the ease of potential future connections to other water systems into account. Any of the submarine pipeline options make potential connections to areas such as Ewings Landing challenging. If MoTI was to approve a watermain installation inside the Westside Road right-of-way, connections to future service areas would be simpler than to a submarine transmission main.

7. Water Treatment: considers the *Drinking Water Protection Act* and the likely number of treatment processes required to meet water treatment objectives for each water system based on existing conditions. A groundwater supply in Options 1A and 1B will likely require the least amount of water treatment when compared to Options 2A, 2B and 3. Option 2A, 2B and 3, all using Okanagan Lake as a water source, will require the same level of treatment.

8. Source Protection Plan: accounts for the level of effort required to complete Source Protection Plans (SPP) for each option. Larratt Aquatic completed a combined SPP for the existing Killiney and Westshore intakes in 2016. Larratt also completed a Source Water Assessment in 2012. Both documents complement each other and should be updated to account for significant watershed changes, namely the 2021 White Rock Lake wildfire, that have occurred since they were issued.

A new groundwater SPP would be required for the options that use the Fintry/Shorts Creek Aquifer as a water source. There is no such document that currently exists that can be used as a baseline.

9. Operation Considerations – System Complexity: groundwater treatment is likely the least complex if groundwater remains non-GARP. The system complexity to run treatment facilities for surface water sources will likely have to consider residuals management in the future. Operating a single, common facility is preferred to running two, separate facilities for each water system from an operations standpoint.

10. Lifecycle Costs: compares the capital (NPV) and 40-year lifecycle costs (NPV) of the options. Capital cost estimates consider the ability to phase the work to spread costs out over time. Table 3.2 provides a summary of the costs for each option. Note that the values were taken from one of AECOM's 2015 reports and have been adjusted based on the current infrastructure construction price index (August 2021 dollars) made available by Statistics Canada. Values from AECOM's 2015 report were applied to AE's recommended option in 2018 (Option 2B) to see how all four options compare. AE commented on AECOM's estimates but did not provide a separate estimate for their recommended approach.

    High level asset renewal cost estimates are also provided for each option. Components were grouped into "long life" (i.e., pipe, buildings) and "short life" (i.e., pumps, electrical components, disinfection equipment) categories and an average service life was applied to each category for those categories; 100-years for "long life" and 25-years for "short life". The asset group costs were divided by their average service life to arrive at the yearly asset renewal costs.

Table 3.2 summarizes the NPV costs for each option.

**TABLE 3.2 – NPV COST COMPARISON OF PAST RECOMMENDATIONS (FILTRATION COSTS BEGIN IN YEAR 20)[1]**

| | | Option 1A – Groundwater supply w submarine transmission main | Option 1B – Groundwater supply w overland transmission main | Option 2A – Independent intakes and WTP's | Option 2B – Independent intakes and disinfection WTP's initially; common intake and filtration WTP in future | Option 3 – Common intake and WTP |
|---|---|---|---|---|---|---|
| Capital Costs | | 2021 NPV | 2021 NPV | 2021 NPV | 2021 NPV | 2021 NPV |
| *Phase 1 Capital Costs (Filtration Exemption Achieved)* | 1. Fintry Pump Station | $2,016,974 | $2,016,974 | n/a | n/a | n/a |
| | 2. Killiney Pump Station | $453,351 | $453,351 | n/a | n/a | $272,260 |
| | 3. Killiney Disinfection WTP | n/a | n/a | $3,839,119 | $3,839,119 | $4,437,342 |
| | 4. Killiney Filtration WTP | n/a | n/a | n/a | n/a | n/a |
| | 5. Westshore Disinfection WTP | n/a | n/a | $4,328,687 | $4,328,687 | n/a |
| | 6. Westshore Filtration WTP | n/a | n/a | n/a | n/a | n/a |
| | 7. Killiney Intake | n/a | n/a | $453,351 | $453,351 | $453,351 |
| | 8. Westshore Intake | n/a | n/a | $604,468 | $604,468 | n/a |
| | 9. Fintry to Killiney Transmission Main (submarine) | $8,692,344 | n/a | n/a | n/a | n/a |
| | 10. Fintry to Westshore Transmission Main (overland)[3] | n/a | $9,600,000 | n/a | n/a | n/a |
| | 11. Killiney to Westshore Transmission Main (submarine) | $4,346,172 | n/a | n/a | n/a | $4,346,172 |
| | 12. Land Acquisition Costs[2] | $543,272 | $543,272 | $2,000,000 | $2,000,000 | $1,000,000 |
| ***Subtotal: Phase 1 Capital Costs*** | | ***$16,052,113*** | ***$12,613,597*** | ***$11,225,625*** | ***$11,225,625*** | ***$10,509,125*** |
| *Phase 2 Capital Costs (Filtration Required)* | 1. Fintry Pump Station | n/a | n/a | n/a | n/a | n/a |
| | 2. Killiney Pump Station | n/a | n/a | n/a | $453,351 | n/a |
| | 3. Killiney Disinfection WTP | n/a | n/a | n/a | n/a | n/a |
| | 4. Killiney Filtration WTP | n/a | n/a | $3,609,321 | $4,722,091 | $4,722,091 |
| | 5. Westshore Disinfection WTP | n/a | n/a | n/a | n/a | n/a |
| | 6. Westshore Filtration WTP | n/a | n/a | $3,930,288 | n/a | n/a |
| | 7. Killiney Intake | n/a | n/a | n/a | n/a | n/a |
| | 8. Westshore Intake | n/a | n/a | n/a | n/a | n/a |
| | 9. Fintry to Killiney Transmission Main (submarine) | n/a | n/a | n/a | n/a | n/a |
| | 10. Fintry to Westshore Transmission Main (overland)[3] | n/a | n/a | n/a | n/a | n/a |
| | 11. Killiney to Westshore Transmission Main | n/a | n/a | n/a | $4,346,172 | n/a |
| | 12. Land Acquisition Costs[2] | n/a | n/a | n/a | n/a | n/a |
| ***Subtotal: Phase 2 Capital Costs*** | | ***$0*** | ***$0*** | ***$7,539,609*** | ***$9,521,614*** | ***$4,722,091*** |
| ***Total Capital Costs*** | | ***$16,052,113*** | ***$12,613,597*** | ***$18,765,234*** | ***$20,747,239*** | ***$15,231,216*** |
| *Regulatory Costs* | 1. Groundwater Environmental Certificate/Exemption | $350,000 | $350,000 | n/a | n/a | n/a |
| | 2. Source Protection Plans required for groundwater and lake sources | $40,000 | $40,000 | $20,000 | $20,000 | $18,000 |
| ***Total Regulatory Costs*** | | ***$390,000*** | ***$390,000*** | ***$20,000*** | ***$20,000*** | ***$18,000*** |
| *Operating Costs* | 1. Base Costs (years 1 – 40) | $1,353,808 | $1,353,808 | $2,374,159 | $1,891,459 | $1,408,759 |
| | 2. Future Treatment (years 20 – 40)[4] | $191,082 | $191,082 | $3,794,158 | $2,988,618 | $2,988,618 |
| | 3. Well Refurbishment | $359,683 | $359,683 | n/a | n/a | n/a |
| ***Total Operating Costs*** | | ***$1,904,573*** | ***$1,904,573*** | ***$6,168,317*** | ***$4,880,077*** | ***$4,397,377*** |
| | | | | | | |
| ***Total 40-year Life Cycle Cost*** | | ***$18,346,686*** | ***$14,908,170*** | ***$24,953,551*** | ***$25,647,316*** | ***$19,646,593*** |
| ***Estimated Asset Renewal Cost ($/year)*** | | ***$206,005*** | ***$171,620*** | ***$481,984*** | ***$445,108*** | ***$319,976*** |

*Notes:*

1. *Majority of estimated values provided in AECOM 2015 report and adjusted to reflect August 2021 NPV*
2. *Land Acquisition Costs:*
    a. *Costs for options 1A & 1B provided in AECOM 2015 report*
    b. *Costs for options 2A, 2B & 3 provided by RDCO.*
3. *The following assumptions were made for the overland transmission main between Fintry and Westshore:*
    a. *$300/m for rock blasting and removal along entire alignment based on typical ground type in the area.*
    b. *$900/m for supply and install of pipe and bedding, considering project location*
    c. *Land acquisition costs not included but may be required depending on final alignment*
    d. *Power pole relocation costs not included but may be required depending on final alignment*
4. *UV added to Options 1A & 1B in year 20 | Filtration added to options 2A, 2B & 3 in year 20.*

Option 1A has the third lowest capital and second lowest 40-year lifecycle costs but cannot be phased.

Option 1B has the lowest capital and lowest 40-year lifecycle costs but cannot be phased.

Option 2A, with two WTPs and intake extensions, requires the most infrastructure and has the second highest initial and 40-year lifecycle costs but has the lowest initial cost as long as filtration exemption is approved by Interior Health.

Option 2B, where a common filtration WTP is added at the Killiney site in the future, would also make this option the lowest cost initially, but it has the highest ultimate capital cost when filtration is required. Option 2B also experiences a loss of initial capital investment of $605k when the Westshore intake is taken out of service in the future. The Westshore lake pump station, including disinfection equipment, will become a lost investment as well when the system is converted over to a common WTP.

Option 3 has the second lowest capital cost and third lowest 40-year lifecycle cost. By delaying construction of a filtration plant for as long as filtration exemption is acceptable, the initial capital investment of Option 3 is reduced further.

11. Operational Considerations – Staffing Level: long-term operations and maintenance (O&M) including filtration, disinfection and residuals management were considered. Options 1A and 1B, using a groundwater source, will likely require the least amount of effort.

    Option 2A, with two WTPs, will require the greatest amount of effort by Operators and have greater staffing requirements. This will become more pronounced when filtration is required. Option 2B will require the same level of effort as 2A in the near term, but less effort than 2A in the long term when a single filtration WTP is used.

    Option 3 will require a moderate level of effort to operate compared to Options 2A and 2B.

    If Options 1A and 1B end up requiring filtration based on water quality, then they will require a similar level of effort to operate as the single WTP in Option 3.

    Considerations must be made to have Operators on staff with the appropriate level of training to run the facility type of the preferred option based on the EOCP facility classification.

12. Environmental Considerations: Urban discussed the options with a Professional Biologist to gauge the environmental impact of construction for each option.

    In general, the options that require a submarine pipeline (1A, 2B and 3) will have the largest environmental impact. The longer the submarine pipeline, the larger the impact will be. This considers kokanee spawning zones that conflict with potential pipeline routing.

    Option 1A presents the second largest environmental impact because of the overland pipeline. Based on MoTI's feedback that any proposed watermain must be outside of the road prism, it is likely the proposed alignment will conflict with undisturbed areas which can be detrimental to habitat.

    Option 2A would have the lowest environmental impact despite having two facilities near the lakeshore because it does not require a transmission main.

    Environmental considerations do not account for operational differences between the options such as energy requirements for additional pumping, greenhouse gas emissions due to hauling filtration residuals off site, etc.

13. Regulatory Considerations considers the following Acts:
    - *Environmental Assessment Act* (Provincial)
    - *Water Sustainability Act* (Provincial)
    - *Land Act* (Provincial)
    - *Fisheries Act* (Federal)
    - *Navigable Waters Act* (Federal)

    This section also considers the level of effort and length of time necessary to receive certain approvals that relate to the above-mentioned Acts. Table 3.3 summarizes the regulatory considerations. Note that the Drinking Water Protection Act is not identified above but intent is to achieve compliance with each upgrade option that is identified.

Table 3.3 summarizes the regulatory considerations for each option:

**TABLE 3.3 – REGULATORY CONSIDERATIONS**

| Regulation | Option 1A – Groundwater supply w submarine transmission main | Option 1B – Groundwater supply w overland transmission main | Option 2A – Independent intakes and WTP's | Option 2B – Independent intakes and disinfection WTP's initially; common intake and filtration WTP in future | Option 3 – Common intake and WTP |
|---|---|---|---|---|---|
| BC Land Act: Crown Tenure | Crown Tenure required for submarine pipeline option. First Nations consultation is part of the Crown tenure application process and can be lengthy. | Crown Tenure may be required.[1] | Crown Tenure required for intake protection zones. First Nations consultation is part of the Crown tenure application process and can be lengthy. | Crown Tenure required for submarine pipeline and intake protection zones. First Nations consultation is part of the Crown tenure application process and can be lengthy. | Crown Tenure required for submarine pipeline and intake protection zones. First Nations consultation is part of the Crown tenure application process and can be lengthy. |
| BC Water Sustainability Act: Water Licencing | New water licence required to extract additional groundwater from the Fintry/Shorts Creek aquifer. | New water licence required to extract additional groundwater from the Fintry/Shorts Creek aquifer. | Existing water licences will need to be amended to add the proposed facility, treatment, etc. | Existing water licences will need to be amended to add the proposed facility, treatment, etc. | Existing water licences will need to be amended to add the proposed facility, treatment, etc. |
| BC Environmental Assessment Act: Environmental Certificate/Exemption | Environmental Certificate process can take several years and cost hundreds of thousands of dollars.<br><br>Applying for an exemption is an option but can still take 1 – 2 years and requires an early engagement plan.<br><br>First Nations consultation is part of both the Environmental Certificate process and the Exemption process. | Environmental Certificate process can take several years and cost hundreds of thousands of dollars.<br><br>Applying for an exemption is an option but can still take 1 – 2 years and requires an early engagement plan.<br><br>First Nations consultation is part of both the Environmental Certificate process and the Exemption process. | | | |
| BC Water Sustainability Act: Section 11 Applications | Section 11 applies to work in and about a stream, which will apply to the submarine pipeline. | Section 11 applies to work in and about a stream, which will apply to the overland pipeline option for stream crossings. | Section 11 applies to work in and about a stream, which will apply to the intakes and facility construction near the shoreline. | Section 11 applies to work in and about a stream, which will apply to the submarine pipeline, intakes, and facility construction near the shoreline. | Section 11 applies to work in and about a stream, which will apply to the submarine pipeline, intakes, and facility construction near the shoreline. |
| Federal Fisheries Act | This Act should be reviewed to determine what is applicable to this project.<br><br>Projects with the potential to adversely impact fish and/or fish habitat should be reviewed by Fisheries and Oceans Canada (DFO) through the Request for Review process. There are known "red" and "black" kokanee habitat areas near Fintry. | | This Act should be reviewed to determine what is applicable to this project.<br><br>Projects with the potential to adversely impact fish and/or fish habitat should be reviewed by Fisheries and Oceans Canada (DFO) through the Request for Review process. | This Act should be reviewed to determine what is applicable to this project.<br><br>Projects with the potential to adversely impact fish and/or fish habitat should be reviewed by Fisheries and Oceans Canada (DFO) through the Request for Review process. | This Act should be reviewed to determine what is applicable to this project.<br><br>Projects with the potential to adversely impact fish and/or fish habitat should be reviewed by Fisheries and Oceans Canada (DFO) through the Request for Review process. |
| Canadian Navigable Waters Act | This Act applies to work on navigable waters, which includes Okanagan Lake. | | This Act applies to work on navigable waters, which includes Okanagan Lake. | This Act applies to work on navigable waters, which includes Okanagan Lake. | This Act applies to work on navigable waters, which includes Okanagan Lake. |
| Transportation Acts & Regulations | N/A | Pipe within MoTI right-of-way must be approved by MoTI. Westside Road has several "very high potential hazard areas" with respect to geotechnical risk, per MoTI, and construction approvals will be challenging. | | | |

*Notes:*

1. *Depending on the proposed alignment and land ownership, the overland transmission main in Option 1B may also be subject to the following regulations:*
    a. *Species at Risk Act*
    b. *Migratory Birds Convention Act*
    c. *BC Land Act*
    d. *BC Wildlife Act*
    e. *BC Heritage Conservation Act*
2. *Local Government requirements (i.e., development permit requirements) were not considered*

Table 3.4 summarizes our comparison of each option:

**TABLE 3.4 – PREVIOUS OPTION COMPARISON REV.1**

| Component | Option 1A – Groundwater supply w submarine transmission main | Option 1B – Groundwater supply w overland transmission main | Option 2A – Independent intakes and WTP's | Option 2B – Independent intakes and disinfection WTP's initially; common intake and filtration WTP in future | Option 3 – Common intake and WTP |
|---|---|---|---|---|---|
| **TECHNICAL** | | | | | |
| Source Quantity – near term | Fintry/Shorts Creek Aquifer provides adequate quantity. ◕ (4) | Fintry/Shorts Creek Aquifer provides adequate quantity. ◕ (4) | Okanagan Lake provides adequate quantity. Larger volume relative to the Fintry/Shorts Creek Aquifer ● (5) | Okanagan Lake provides adequate quantity. Larger volume relative to the Fintry/Shorts Creek Aquifer ● (5) | Okanagan Lake provides adequate quantity. Larger volume relative to the Fintry/Shorts Creek Aquifer ● (5) |
| Source Quality – near term | Quality is good at existing demands. ● (5) | Quality is good at existing demands. ● (5) | Okanagan Lake quality is generally good. Algae blooms, zebra and quagga mussels possible at shallow depths; cyanobacteria at deeper depths. Surface water has seasonal turbidity issues, ◐ (3) | Okanagan Lake quality is generally good. Algae blooms, zebra and quagga mussels possible at shallow depths; cyanobacteria at deeper depths. Surface water has seasonal turbidity issues, ◐ (3) | Okanagan Lake quality is generally good. Algae blooms, zebra and quagga mussels possible at shallow depths; cyanobacteria at deeper depths. Surface water has seasonal turbidity issues, ◐ (3) |
| Risk to Quantity – long term | Aquifer is somewhat more susceptible than Okanagan Lake to quantity issues, but marginal as level is controlled by Okanagan Lake ● (5) | Aquifer is somewhat more susceptible than Okanagan Lake to quantity issues, but marginal as level is controlled by Okanagan Lake ● (5) | Okanagan Lake provides adequate quantity. Less concern with quantity long term than the Fintry/Shorts Creek Aquifer ● (5) | Okanagan Lake provides adequate quantity. Less concern with quantity long term than the Fintry/Shorts Creek Aquifer ● (5) | Okanagan Lake provides adequate quantity. Less concern with quantity long term than the Fintry/Shorts Creek Aquifer ● (5) |
| Risk to Quality – long term | Some in-situ filtration and barrier provided for groundwater. There is uncertainty of the quality at MDD pumping rates due to presence of septic fields. ◕ (4) | Some in-situ filtration and barrier provided for groundwater. There is uncertainty of the quality at MDD pumping rates due to presence of septic fields. ◕ (4) | Okanagan Lake is more susceptible to quality changes over time. ◔ (2) | Okanagan Lake is more susceptible to quality changes over time. ◔ (2) | Okanagan Lake is more susceptible to quality changes over time. ◔ (2) |
| Source Redundancy | Single point of diversion. ◐ (3) | Single point of diversion. ◐ (3) | Two points of diversion. ● (5) | Two points of diversion initially. Westshore intake can be configured to be brought online in emergency situations. ◕ (4) | Single point of diversion. ◐ (3) |
| Transmission | High – Approximately 12 km of transmission main in Okanagan Lake required. Concerns with increased water age and pipeline failure (e.g., from boat anchors) ● (1) | Medium – Approximately 8 km of transmission main adjacent to Westside Road required. Concerns with increased water age. Future connections easier with overland pipeline. ◐ (3) | Lowest – No new transmission mains required. Future service area connections difficult. ◕ (4) | Medium – Approximately 4 km of transmission main in Okanagan Lake required when filtration exemption is not acceptable. Future service area connections difficult. Some concern with pipeline failure (e.g., from boat anchors) ◐ (3) | Medium – Approximately 4 km of transmission main in Okanagan Lake required. Future service area connections difficult. Some concern with pipeline failure (e.g., from boat anchors) ◐ (3) |
| Water Treatment | Least amount of treatment possible, but dependent on non-GARP status and effects of nearby septic fields at increased pump rates. ● (5) | Least amount of treatment possible, but dependent on non-GARP status and effects of nearby septic fields at increased pump rates. ● (5) | Highest level of treatment required – UV and chlorine initially, filtration eventually. ● (1) | Highest level treatment required – UV and chlorine initially, filtration eventually. ◔ (2) | Highest level treatment required – UV and chlorine initially, filtration eventually. ◐ (3) |
| Source Protection Plan[1] | New SPP for groundwater source required. ◕ (4) | New SPP for groundwater source required. ◕ (4) | Updated to the existing combined SPP required. Significant effort required to implement and manage SPP. ◔ (2) | Updated to the existing combined SPP required. Significant effort required to implement and manage SPP. ◔ (2) | Updated to the existing SPP required for the Killiney intake only. Significant effort required to implement and manage SPP. ◐ (3) |
| Operational Considerations – System Complexity | Least complex as long as groundwater remains non-GARP. ● (5) | Least complex as long as groundwater remains non-GARP. ● (5) | Two facilities to Operate. Residuals management will be required when filtration is implemented. ● (1) | Two disinfection facilities to run initially. One facility to Operate ultimately. Residuals management will be required when filtration is implemented. ◔ (2) | One facility to Operate. Residuals management will be required when filtration is implemented. ◐ (3) |
| **Sum** | 36 | 38 | 28 | 28 | 30 |
| **Average** | ◕ (4) | ◕ (4.2) | ◐ (3.1) | ◐ (3.1) | ◐ (3.3) |

| | | | | | |
|---|---|---|---|---|---|
| **FINANCIAL[2]** | | | | | |
| Capital Costs – Grant Eligible | Medium lifecycle Cost:<br>Ph. 1 Capital: $16.052M<br>Ph. 2 Capital: $0<br>Total: $16.1M<br>◐ (3) | Low lifecycle Cost:<br>Ph. 1 Capital: $12.614M<br>Ph. 2 Capital: $0<br>Total: $12.6M<br>● (5) | High lifecycle Cost:<br>Ph. 1 Capital: $11.225M<br>Ph. 2 Capital: $7.540M<br>Total: $18.8M<br>◔ (2) | Highest lifecycle Cost:<br>Ph. 1 Capital: $11.225M<br>Ph. 2 Capital: $9.522M<br>Total: $20.7M<br>● (1) | Medium lifecycle Cost:<br>Ph. 1 Capital: $10.509M<br>Ph. 2 Capital: $4.772M<br>Total: $15.2M<br>◕ (4) |
| Regulatory and Operation Costs – non-Grant Eligible | Regulatory: $390K<br>O&M (1 – 40-yrs): $1.354M<br>O&M (20 – 40-yrs): +$191K<br>Well refurb.: $360K<br>Total: $2.3M<br>● (5) | Regulatory: $390K<br>O&M (1 – 40-yrs): $1.354M<br>O&M (20 – 40-yrs): +$191K<br>Well refurb.: $360K<br>Total: $2.3M<br>● (5) | Regulatory: $20K<br>O&M (1 – 40-yrs): $2.374M<br>O&M (20 – 40-yrs): $3.794M<br>Well refurb.: $0<br>Total: $6.2M<br>● (1) | Regulatory: $20K<br>O&M (1 – 40-yrs): $1.891M<br>O&M (20 – 40-yrs): $2.989M<br>Well refurb.: $0<br>Total: $4.9M<br>◔ (2) | Regulatory: $18K<br>O&M (1 – 40-yrs): $1.409M<br>O&M (20 – 40-yrs): $2.989M<br>Well refurb.: $0<br>Total: $4.4M<br>◐ (3) |
| Lifecycle Cost - Total | Total (40-yrs): $18.347M<br>◕ (4) | Total (40-yrs): $14.908M<br>● (5) | Total (40-yrs): $24.954M<br>◔ (2) | Total (40-yrs): $25.647M<br>● (1) | Total (40-yrs): $19.647M<br>◐ (3) |
| Asset Renewal Cost | $206K/yr – Second lowest annual cost<br>◕ (4) | $172K/yr – Lowest annual cost<br>● (5) | $482K/yr – Highest annual cost<br>● (1) | $445K/yr – Second highest annual cost<br>◔ (2) | $320K/yr – Third lowest annual cost.<br>◐ (3) |
| Operational Considerations – Staffing Levels | Lowest level of effort. Lower level of treatment required compared to surface water.<br>● (5) | Lowest level of effort. Lower level of treatment required compared to surface water.<br>● (5) | Highest level of effort. Two facilities to operate.<br>● (1) | Medium to high level of effort. Two facilities to operate initially; one facility to operate ultimately<br>◔ (2) | Medium level of effort. One facility to operate.<br>◐ (3) |
| **Sum** | 21 | 25 | 7 | 8 | 16 |
| **Average** | ◕ (4.2) | ● (5) | ● (1.4) | ◔ (1.6) | ◐ (3.2) |
| **ENVIRONMENTAL & REGULATORY** | | | | | |
| Environmental Considerations | High impact – Portion of 12 km transmission main is adjacent to "red" and "black" Kokanee habitat.<br>● (1) | Medium to high impact – 8 km of overland transmission main alignment can may be detrimental to habitat.<br>◔ (2) | Medium to high impact – two facilities in or near the riparian area and two lake intakes required.<br>◐ (3) | Medium to high impact – two facilities in or near the riparian area and two lake intakes required initially; 4 km submarine transmission main required eventually.<br>◔ (2) | Medium to high impact – one facility in or near the riparian area, one lake intake and 4 km transmission main required.<br>◔ (2) |
| Regulatory Considerations | Highest time and effort – Crown Tenure required for submarine pipeline option. New water licence required for additional groundwater extraction. Environmental Certificate or Exemption required for groundwater extraction. Section 11 applies.<br>● (1) | High time and effort – MoTI approval required. Areas along alignment are considered "very high potential hazard areas". Several other Acts may apply to this Option, depending on final alignment and land ownership. New water licence required for additional groundwater extraction. Environmental Certificate or Exemption required for groundwater extraction. Section 11 applies.<br>◔ (2) | Medium time and effort – Crown Tenure required for intakes. Section 11 applies. Water licence amendments are required.<br>◐ (3) | Medium to high time and effort – Crown tenure required for intakes and submarine pipeline. Section 11 applies. Water licence amendments are required.<br>◔ (2) | Medium to high time and effort – Crown tenure required for intakes and submarine pipeline. Section 11 applies. Water licence amendments are required.<br>◔ (2) |
| **Sum** | 2 | 4 | 6 | 4 | 4 |
| **Average** | ● (1) | ◔ (2) | ◐ (3) | ◔ (2) | ◔ (2) |
| **COMBINED** | | | | | |
| **Total Sum** | 59 | 67 | 41 | 40 | 50 |
| **Average** | ◕ (3.7) | ◕ (4.2) | ◐ (2.6) | ◐ (2.5) | ◐ (3.1) |
| **Weighted Average:**<br>Technical: 33.3%<br>Financial: 33.3%<br>Environmental and Regulatory: 33.3% | ◐ (3) | ◕ (3.7) | ◐ (2.5) | ◔ (2.2) | ◐ (2.8) |

● Most Desirable (5) | ◕ Moderate/Highly Desirable (4) | ◐ Moderately Desirable (3) | ◔ Low/Moderately Desirable (2) | ● Least Desirable (1)

*Notes:*

*General - Effects of climate change have been considered as much as possible with the information available.*

1. *Effort to implement and manage an SPP for surface water based on:*
   a. *RDCO feedback,*
   b. *challenges protecting large bodies of water compared to groundwater*
   c. *high risk contributors to source water quality (e.g., boat launch, beach access, wildfires, etc.)*
2. *Cost values reflect August 2021 NPV.*

# 4.0 ALTERNATIVE OPTIONS AND CONSIDERATIONS

## 4.1 OTHER OKANAGAN VALLEY WATER PROVIDERS

This section considers what other Okanagan Valley water purveyors are doing to provide water to their customers.

### VERNON

Greater Vernon Water operates two water treatment plants: Duteau Creek and Mission Hill. The Duteau Creek WTP uses a creek water source and has a three-step treatment process that includes clarification with Dissolved Air Floatation (DAF), UV and chlorine disinfection.

The Mission Hill WTP draws water from a 20 m deep intake in Kalamalka Lake and currently provides UV and chlorine disinfection. Greater Vernon Water has received federal funding to add filtration to the Mission Hill WTP.

### LAKE COUNTRY

The District of Lake Country uses four surface water sources: Okanagan, Kalamalka, Beaver and Oyama lakes. Each source is disinfected with chlorine. UV disinfection is provided for Okanagan Lake and Kalamalka Lake sources. Okanagan Lake and Kalamalka Lake provide the best raw water quality of the four sources. The District of Lake Country has constructed interconnects to supplement the Beaver Lake and Oyama Lake distribution systems when water quality in those systems is poor.

Lake Country's Water Master Plan includes an objective to add a water treatment plant in the future to provide a reliable, high quality water supply for each of their distribution systems.

There were discussions entertaining the possibility of connecting the Lake Country Okanagan Lake system with Killiney and Westshore, but this was ultimately ruled out due to limited residual capacity in Lake Country's system and challenges with installing a submarine transmission main across the lake.

### KELOWNA

Kelowna uses four different water providers to supply residents with water:

- City of Kelowna Water Utility (CITY)
- Glenmore Ellison Irrigation District (GEID)
- Rutland Waterworks (RWD)
- Black Mountain Irrigation District (BMID)

Two of the water providers, CITY and GEID, rely on Okanagan Lake as a primary water source and supply water to more than half of Kelowna's population. CITY draws water from four different lake intakes and disinfects using UV and chlorination. GEID primarily provides water from a 34 m deep lake intake and uses UV and chlorine disinfection as treatment.

The City of Kelowna has developed an Integrated Water Supply Plan which uses filtration exemption in its approach. Filtration will be added in the future after raw water quality has deteriorated or it is required by drinking water quality regulations.

### WEST KELOWNA

The City of West Kelowna operates four separate water systems. The water systems will be combined into two after the completion of the Rose Valley Water Treatment Plant, which is under construction.

The Powers Creek WTP uses a combined DAF clarification and filtration process, followed by UV and chlorine disinfection. The Rose Valley WTP will use a similar treatment process. Neither of the two systems uses Okanagan Lake as a water source.

### PEACHLAND

The District of Peachland's water source is Peachland Lake, which flows into Peachland Creek. Peachland has a new WTP which treats water using DAF clarification and dual media filtration, followed by UV and chlorine disinfection.

The District of Peachland considered using Okanagan Lake as a water source, but ultimately selected Peachland Creek based on two main factors:

1. Peachland is located on a long hill and pumping costs would be prohibitively expensive if their WTP site was at the lake.
2. Peachland Creek provides reliable source water in terms of both quality and quantity.

### SUMMERLAND

The District of Summerland uses Trout Creek as a water source. Treatment is provided using a micro-sand ballasted clarification process, filtration, and chlorine disinfection.

### PENTICTON

The City of Penticton uses water from two sources: Penticton Creek and Okanagan Lake. Penticton's WTP can treat a single or blended source. The treatment process uses DAF, filtration and chlorine disinfection.

## 4.2 POINT OF ENTRY / POINT OF USE (POE / POU)

A POE water treatment process treats all water entering a home, whereas a POU system treats water at a single location inside a home (i.e., a faucet). Although the water treatment

equipment is installed at each individual residence, the equipment is typically owned and maintained by the water purveyor and not the homeowner. Every single homeowner must agree to POE / POU treatment and sign a letter of consent for it to be approved of as a water treatment strategy in a water system.

POE / POU systems are approved for water systems that service 500 or fewer individuals and are typically considered by communities with fewer than 40 homes (Small Water Systems BC, 2021). In BC, communities with POE / POU typically have 15 or fewer connections. The British Columbia Water & Waste Association (BCWWA) recently completed a small water system project and found that the cost/benefit begins to drop after five installations.

Given that the ultimate build-out for Killiney and Westshore are 427 and 526 residential connections, respectively, we do not believe that POE / POU water treatment should be considered further.

### 4.3 CONNECTION TO OKANAGAN INDIAN BAND

The RDCO requested that Urban explore the possibility of a shared WTP and connection with Okanagan Indian Band (OKIB), who has a distribution system north of Westshore. OKIB has indicated that they are in the process of developing improvements to their own system and are not interested in joining a shared system at this time.

# 5.0 RECOMMENDATIONS

Overall, we consider Option 1B, with a common groundwater source and WTP at the Fintry/Shorts Creek Aquifer, the most favourable of the options. Here is a summary of why Option 1B was selected:

- Lifecycle Costs – Its estimated total capital cost is the lowest of the options. Option 1B also has the lowest 40-year lifecycle cost.
- Eliminates Waste – There are no lost investments in infrastructure with Option 1B. All work that would be completed in the initial phase is used in the ultimate scenario.
- Operations - From an operations standpoint, one site for all disinfection is preferred. As long as the groundwater remains non-GARP, filtration will likely not be required with current regulations.
- Grant Funding - Combining the water systems will likely be viewed positively by the Province of BC if grant funding is sought.
- Service Extension – the overland transmission main alignment may create opportunities for extending servicing to new areas

## 5.1 RECOMMENDED SUPPLY AND TREATMENT STRATEGY

There are critical aspects of Option 1B that should be verified before it can be considered a viable supply and treatment strategy.

1. An overland transmission main alignment must be determined. If MoTI will not permit a transmission main within their ROW on Westside Road, an alternate alignment will need to be secured. There may be land negotiations and Crown Tenure applications required with this option.
2. An Environmental Assessment Officer (EAO) should be engaged to determine if an Environmental Certificate or Exemption is appropriate.
3. Complete additional water quality monitoring and characterization that considers higher extraction rates per Western Water's report. Septic systems in Lower Fintry may cause higher chloride, sodium and nitrate concentrations in the aquifer at increased pump rates.

If the results of any of the above reveal that Option 1B is not feasible, Option 1A and 3 should be given consideration.

## 5.2 DESIGN CRITERIA

We will consider the following design criteria when expanding on the preferred option in Urban's subsequent report:

### 5.2.1 HYDRAULIC CRITERIA

#### DEMANDS

The water supply and treatment equipment will be sized to supply up to the maximum day demand (MDD). Fire flows and peak flows would be supplied by reservoirs.

The previous reports offered conflicting build-out connection numbers for the Killiney and Westshore Water Systems. The RDCO verified the correct values to use. The build-out also needs to include the Upper Fintry/Shahal Road/Valley of the Sun service area, which is presently supplied by the Fintry/Shorts Creek Aquifer:

- Upper Fintry/Shahal Road/Valley of the Sun: 325 connections
- Killiney: 427 connections
- Westshore: 526 connections

The RDCO Subdivision Servicing Bylaw domestic demand criteria for designing water distribution systems in residential areas is 2,100 L/cap/day for maximum day demands. The City of Kelowna uses 1,800 L/cap/day for the same criteria and 3.0 people per dwelling. Flow data for Killiney and Westshore provided by the RDCO from 2020 and 2021 compares more closely to the 1,800 L/cap/day while considering three people per household with the existing number of connections. Note that the flow data is from the last 12 months, while the connection totals were provided in June 2022:

| | Upper Fintry/Shahal Road/ Valley of the Sun | Killiney | Westshore |
|---|---|---|---|
| # of ex. connections | 159 | 295 | 293 |
| Calculated MDD (using 1,800 L/cap/day) | 9.9 L/s | 18.4 L/s | 18.3 L/s |
| Actual MDD (from 2021 data)[1] | 17.1 | 17.3 L/s | 15.21 L/s |

*Notes:*

1. *Actual 2021 MDD for the existing water system service area was significantly higher than typical (more than 3x higher than 2020) due to the prolonged drought and forest fires which impacted the west side of Okanagan Lake. (Western Water, 2022)*

Given that the actual MDD values for Killiney & Westshore from the current data (outside of 2021 where the water demand was significantly higher than usual due to the White Rock Lake fire) are lower than the calculated demand estimates, we believe that 1,800 L/cap/day is a reasonable, conservative value for estimating build-out water demands as noted below:

- Upper Fintry/Shahal Road/Valley of the Sun: 20.3 L/s
- Killiney: 26.7 L/s
- Westshore: 32.9 L/s
- **Combined: 79.9 L/s**

### 5.2.2 WATER TREATMENT CRITERIA

#### CHLORINE DISINFECTION

As mentioned previously in this report, the Killiney water system does not provide adequate CT time for 3-log removal of *Giardia* in the two lowest pressure zones. Agua used 7.5 °C as the minimum temperature to calculate the required CT time (Agua, 2016). Larratt reported that that the minimum measured water temperature at the proposed intake depths (20 m to 40 m deep) was 4 °C (Larratt, 2012). We will use 4 °C as the minimum water temperature when calculating the required CT time for each system.

The transmission main between Killiney and Westshore should provide ample CT time between the two water systems and may even require that chlorine is boosted at some point along the main. We will determine if chlorine boosting is likely in the subsequent "concept refinement" stage.

We will also need to determine if the chlorine contact time for the Upper Fintry/Shahal Road/Valley of the Sun area is adequate with the proposed changes (i.e., increased pump rates).

#### WATER QUALITY – SURFACE WATER

The Drinking Water Treatment Objectives for Surface Water Supplies in British Columbia provides the microbiological targets for treating surface water in BC (Province of British Columbia, 2012). They are:

- 4-log reduction or inactivation of viruses.
- 3-log reduction or inactivation of *Giardia* and *Cryptosporidium*.
- Two treatment processes for surface water.
- Less than or equal to (≤) one (1) nephelometric turbidity unit (NTU).
- No detectable E. Coli, fecal coliform and total coliform

Raw water quality must meet, and continue to meet, the following criteria for filtration exemption to be accepted:

- Minimum of two disinfections, providing 4-log reduction of viruses and 3-log reduction of *Cryptosporidium* and *Giardia*.
- The number of *E. coli* in raw water does not exceed 20/ 100 mL in at least 90% of the weekly samples in the past six months.
- Average daily turbidity levels measured at equal intervals (at least every four hours) immediately before the disinfectant is applied are around 1 NTU, but do not exceed 5 NTU for more than two days in a 12-month period.
- A watershed control program is maintained that minimizes the potential for fecal contamination in the source water (Health Canada, 2012b).

## WATER QUALITY – GROUNDWATER

The Drinking Water Treatment Objectives (Microbiological) for Ground Water Supplies in British Columbia provides guidance on what microbiological objectives need to be achieved for a groundwater source to be considered potable (Province of British Columbia, 2015). They are:

- Groundwater supplies determined to be 'at risk' of containing pathogens (GARP): Two disinfection methods equivalent to surface water sources required at a minimum.
- Groundwater supplies determined to be 'at risk' of containing viruses (GARP-viruses only): 4-log removal of viruses required.
- Groundwater supplies determined to be at 'low risk' of containing pathogens: disinfection not required for water source to be considered potable.

Given the stability of the existing water quality, it is likely that filtration deferral will continue to be acceptable for the Fintry groundwater source with increased demands. Turbidity is expected to remain consistently below 1 NTU (Western Water, 2022). Filtration exemption is also more likely to be approved if a well is properly constructed and protected to minimize the potential for fecal or other pathogenic-related contamination in the source water, and a Well Protection Plan (or equivalent satisfactory to the Drinking Water Officer) is in place (Province of British Columbia, 2015).

It should be noted that groundwater turbidity samples may be required not to exceed 3.0 NTU for filtration exemption to be acceptable, which is lower than the 5.0 NTU limit for surface water filtration exemption. Per the BC Drinking Water Treatment Objectives (Microbiological) for Ground Water Supplies in British Columbia:

> "For subsurface filtration, an increase in turbidity at the well may be indicative of a failure of the treatment barrier provided by subsurface filtration. In comparison, a system with a filtration exemption (as outlined in Ministry of Health's "Drinking Water Treatment Objectives (Microbiological) for Surface Water Supplies in British Columbia" does not rely on filtration to help reduce Giardia and Cryptosporidium, rather sufficient disinfection technologies are employed. This is why the allowable upper limit for turbidity in systems that have credit for subsurface filtration is lower (3.0 NTU) than the 5.0 NTU maximum permitted for a system that has a filtration exemption."

To confirm turbidity level requirements for filtration exemption, the credit for subsurface filtration will have to be determined in accordance with the Guidelines for Pathogen Log Reduction Credit Assignment (Province of British Columbia, 2022).

If a filtration exemption is approved by the Ministry of Health, it is likely to be accepted indefinitely so long as the RDCO is able to demonstrate acceptable water quality data to a Drinking Water Officer through regular reporting.

## 5.3 NEXT STEPS

Our next step is to move to the "concept refinement" stage for the preferred option. Provided RDCO is in agreement with the recommended option per Section 5.1, we suggest that the following items be reviewed as part of the concept refinement work:

| System Component | Items to be Reviewed |
|---|---|
| Groundwater Well | Engage an EAO to better understand the Environmental Certificate or Exemption process and requirements. |
| | Determine the extent of the required well upgrades to supply the build-out MDD. |
| | Optional – additional water quality monitoring & characterization considering high extraction rates per Western Water's report. |
| Treatment | Review available source water quality and identify if any parameters do not meet filtration exemption criteria |
| | Confirm requirements to achieve required chlorine contact time in the Killiney and |

| | |
|---|---|
| | Westshore water systems using a lower temperature than that used in past reports. |
| | Determine if there is adequate chlorine contact time for treated water conveyed to the Upper Fintry/Shahal Road/Valley of the Sun service area due to higher pump/flow rates. |
| | Determine if chlorine boosting is required for water conveyed to Killiney and Westshore. |
| | Update past conceptual site layout and verify that there is adequate space for proposed works |
| | Continue to communicate with MoTI to assess the feasibility of placing a watermain in the Westside Road ROW. Review alternate alignments if MoTI won't permit the watermain within their ROW. |
| High Lift Pump Station and Transmission Main | Review regulatory requirements for the watermain alignment. |
| | Confirm sizing for the proposed pump station |
| | Confirm the site location of the proposed treatment facility. |
| | Identify a preferred tie-in location for the transmission main to the Killiney and Westshore water systems |
| | Review past cost estimate in detail and update as required based on recent tender prices in the Interior. Prepare updated cost estimate for the works that incorporates findings from the above tasks |
| Costs | Prepare an updated cost estimate that incorporates findings from the above tasks. |

# 6.0 CLOSURE

We trust this report includes the information required for the RDCO to select a preferred path forward for providing the Killiney and Westshore water systems with a supply and treatment plan that meets the British Columbia Drinking Water Protection Regulation or

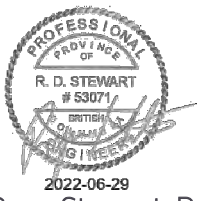
Groundwater Protection Regulation, and the Guidelines for Canadian Drinking Water Quality.

If you have any questions regarding the content of this report, please feel free to contact us.

Sincerely,

URBAN SYSTEMS LTD.


Jeremy Clowes, P.Eng.
Principal, Water and Wastewater Engineer




Ryan Stewart, P.Eng.
Project Engineer

PERMIT TO PRACTICE
URBAN SYSTEMS LTD.
Signature _____
Date 2022-06-29
PERMIT NUMBER: 1000527
Engineers and Geoscientists BC (EGBC)

/rs
*Enclosure*

U:\Projects_KEL\1179\0109\01\R-Reports-Studies-Documents\R1-Reports\1.1 Summary and Evaluation of Supply and Treatment\2022-06-15 - Summary and Evaluation of Supply and Treatment Options_tech memo_Rev5_final.docx

## CITED LITERATURE

BC Water Resources Atlas, (2021)

Health Canada

Province of British Columbia, Drinking water treatment objectives (microbiological) for ground water supplies in British Columbia (2015)

Province of British Columbia, Drinking water treatment objectives for surface water supplies in British Columbia (2012)

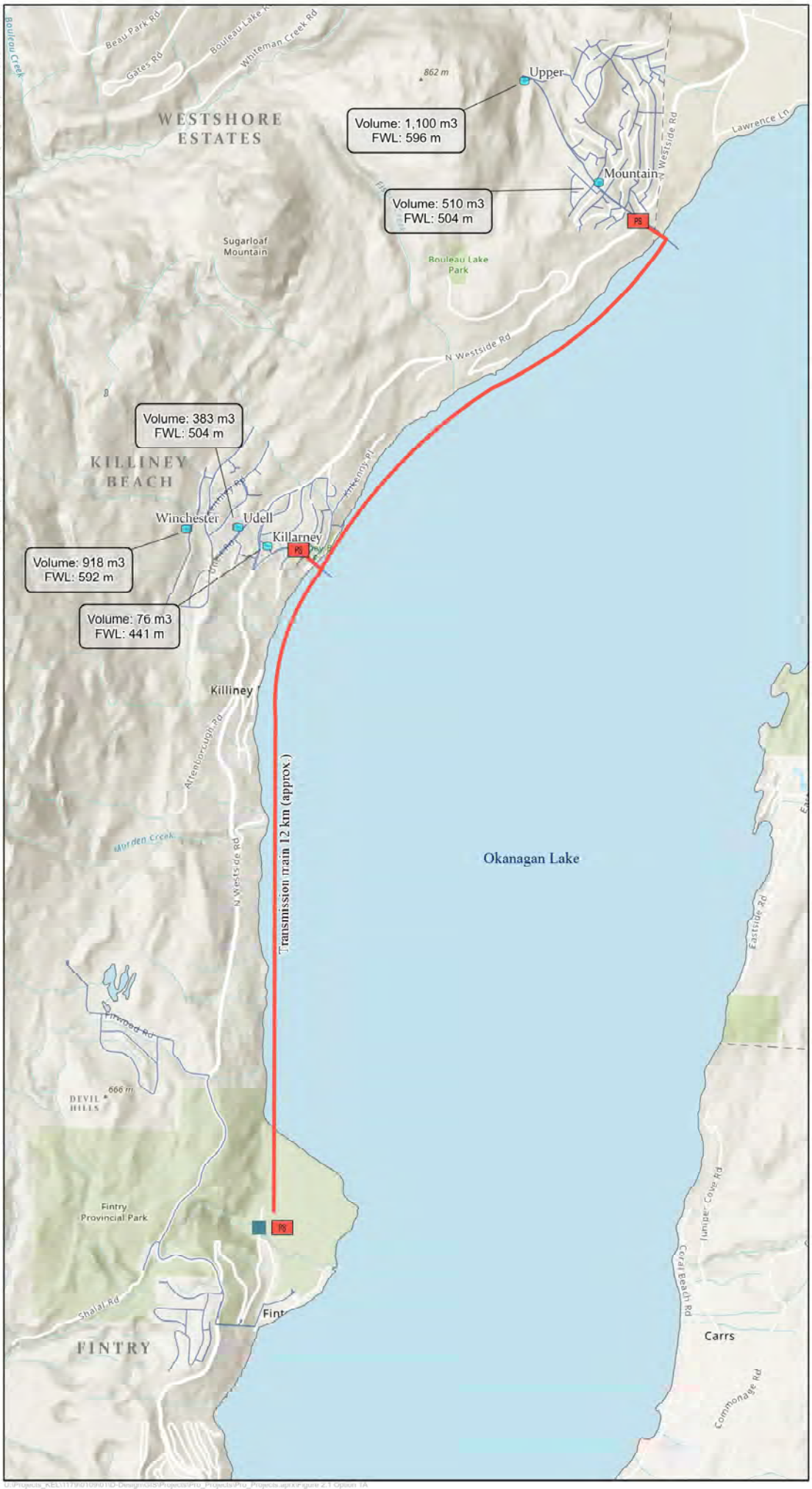
Province of British Columbia, Guidelines for Pathogen Log Reduction Credit Assignment (2022)

Small Water Systems BC (2021)

Statistics Canada. Infrastructure construction price index, annual (2021)

# APPENDIX A

FIGURES




Regional District of Central Okanagan

# Killiney and Westshore Water Systems Study

Option 1A: Fintry/Short Creek Aquifer Groundwater Supply Well & Submarine Transmission Main

FIGURE 2.1

**Legend**

- PS — Pump Station
- Disinfection WTP
- Reservoir
- Distribution Main
- Transmission Main

**Data Sources:**
- Fresh Water Atlas
- ESRI Basemap

**Coordinate System:**
Name: NAD 1983 UTM Zone 11N

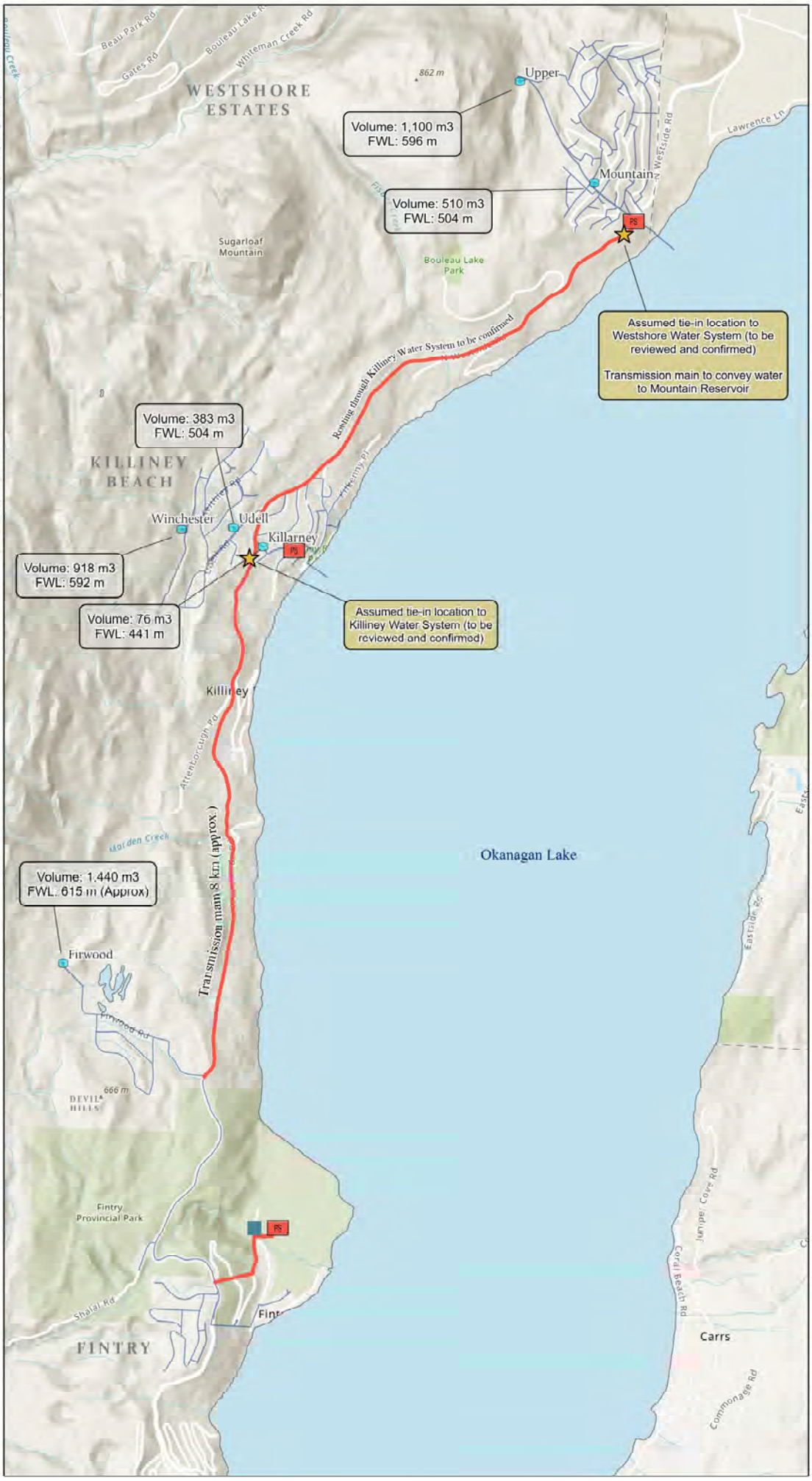
0 200 400 600
Meters

**Scale:** 1:30,000
(When plotted at 11"x17")



URBAN systems

| | |
|---|---|
| Project #: | 1179.0109.01 |
| Author: | RB |
| Checked: | RS |
| Status: | |
| Revision: | A |
| Date: | 2022 / 6 / 1 |




Regional District of Central Okanagan

# Killiney and Westshore Water Systems Study

Option 1B: Fintry/Short Creek Aquifer Groundwater Supply Well & Overland Transmission Main

FIGURE 2.2

Legend

- PS Pump Station
- Disinfection WTP
- Reservoir
- Distribution Main
- Transmission Main

Data Sources:
- Fresh Water Atlas
- ESRI Basemap

Coordinate System:
Name: NAD 1983 UTM Zone 11N

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Meters

Scale: 1:30,000
(When plotted at 11"x17")



URBAN systems

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| Project #: | 1179.0109.01 |
| Author: | RR |
| Checked: | RS |
| Status: | |
| Revision: | A |
| Date: | 2022 / 6 / 1 |


Regional District of Central Okanagan

# Killiney and Westshore Water Systems Study

## Option 2A: Independent intakes and WTP's for Killiney and Westshore

FIGURE 2.3

**Legend**

- Disinfection WTP
- Future Filtration WTP
- PS Pump Station
- Reservoir
- Extended Intake
- Distribution Main

**Data Sources:**
- Fresh Water Atlas
- ESRI Basemap

**Coordinate System:**
Name: NAD 1983 UTM Zone 11N

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Meters

**Scale:** 1:24,000
(When plotted at 11"x17")

The accuracy & completeness of information shown on this drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate & establish the precise location of all existing information whether shown or not.

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| Project #: | 1179.0109.01 |
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| Checked: | RS |
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| Revision: | A |
| Date: | 2022 / 6 / 1 |


Regional District of Central Okanagan

# Killiney and Westshore Water Systems Study

Option 2B: Independent intakes and disinfection WTP's for Killiney and Westshore in the near term; common intake and filtration WTP for both systems in the long term

**FIGURE 2.4**

Legend

- Disinfection WTP
- Future Filtration WTP
- PS Pump Station
- Reservoir
- Distribution Main
- Extended Intake
- Future Transmission Main

Data Sources:
- Fresh Water Atlas
- ESRI Basemap

Coordinate System:
Name: NAD 1983 UTM Zone 11N

0 200 400 600
Meters

Scale: 1:24,000
(When plotted at 11"x17")

The accuracy & completeness of information shown on this drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate & establish the precise location of all existing information whether shown or not.

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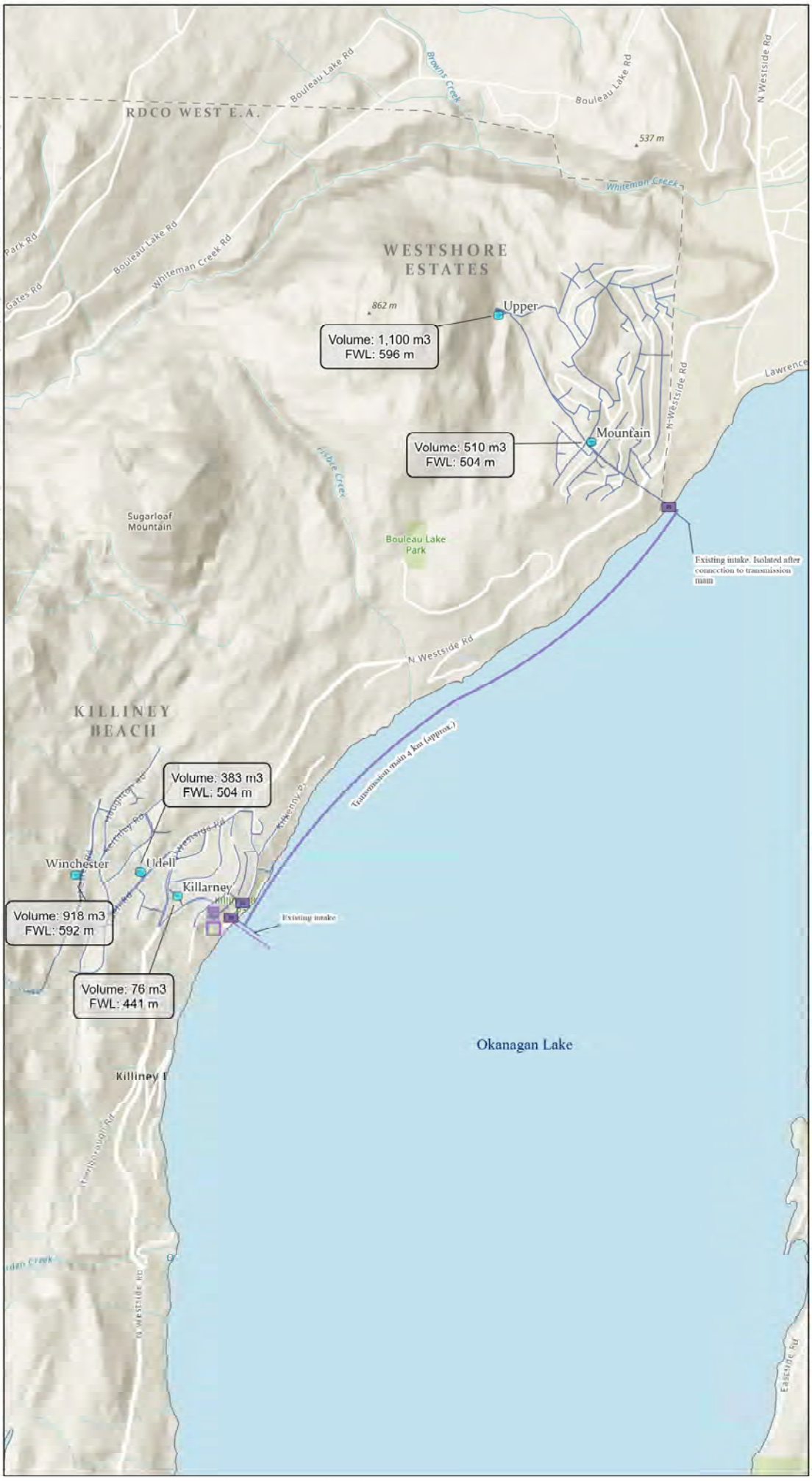
| Revision: | A |
| Date: | 2022 / 6 / 1 |




Regional District of Central Okanagan

# Regional District of Central Okanagan

## Killiney and Westshore Water Systems Study

Option 2A: Common intake and WTP at Killiney for both water systems

FIGURE 2.5

Legend

- Disinfection WTP
- Future Filtration WTP
- Pump Station
- Reservoir
- Distribution Main
- Transmission Main
- Extended Intake

Data Sources:
- Fresh Water Atlas
- ESRI Basemap

Coordinate System:
Name: NAD 1983 UTM Zone 11N

0 200 400 600
Meters

Scale: 1:24,013
(When plotted at 11"x17")



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| Project #: | 1179.0109.01 |
| Author: | RR |
| Checked: | RS |
| Status: | |
| Revision: | A |
| Date: | 2022 / 6 / 1 |

# APPENDIX B

REFERENCE INFORMATION

# APPENDIX C

## WESTERN WATER GROUNDWATER EXPANSION FEASIBILITY REPORT

February 28, 2021 WWAL Project 21-132-01VR

Regional District of Central Okanagan
1450 KLO Road
Kelowna, BC,
V1W 3Z4

Attn: Clarke Kruiswyk

**Re: Feasibility Assessment of Increasing Capacity of the Fintry RDCO Community Water System Wells and Aquifer 358**

Western Water Associates Ltd. (WWAL) is pleased to provide the following report for the above-noted project. The scope of work for the project was outlined in our proposal dated October 25, 2021.

## 1.0 PROJECT BACKGROUND

In 2010, the Regional District of Central Okanagan (RDCO) commissioned the drilling of two 200 mm diameter supply wells in Lower Fintry, on the alluvial fan created by Shorts Creek. The wells are 35 m and 45 m deep, and were completed in unconfined Aquifer No. 358 IIA. Testing found the wells to be highly productive, and in 2012 after the new pump house and water distribution system were built to serve Upper Fintry, Salal Rd and Valley of the Sun, the wells were commissioned. The Lower Fintry community (i.e. the neighbourhood where the wells are located) is not connected to the system and obtains water from Okanagan Lake.

### 1.1 Existing water system at Fintry

The water system design by TRUE Consulting called for an estimated average day demand (ADD) of 918 $m^3$/day and a peak day demand of 2,448 $m^3$/day, and we understand key components of the water system were designed and built to accommodate this capacity. WWAL hydrogeologists Ryan Rhodes and Douglas Geller oversaw the drilling and testing of those wells (Summit 2010), and in 2011 completed a Source Water Protection Plan on behalf of RDCO for the water supply wells (WWAL 2011). In order to develop the groundwater supply, RDCO purchased a vacant lot on Morden Road in Lower Fintry where the existing two-well system and pump house were subsequently built in 2011 and commissioned in early 2012. RDCO holds a Conditional Water Licence issued in 2017 that allows extraction of only 30,000 m3/year (far below the ADD of 918 $m^3$/day or 355,000 $m^3$/year), but allowing for a maximum daily well flow rate of 2,448 $m^3$/day that meets the system design criteria for MDD. The licence allows the water to be used in accordance with RDCO Water Services Bylaw 1254. Bylaw 1370 governs how the RDCO will provide water to properties within a water service area and how residents can use water.

### 1.2 System Expansion Options

It is our understanding that the RDCO is evaluating options to supply water to other areas of the Westside, specifically the Killiney Beach and Westshore Estates communities located north of Fintry. Two water supply options are being considered: a new deep intake on Okanagan Lake and groundwater from Aquifer 358. For the groundwater option, water could be provided by the existing community supply wells in Lower Fintry if spare

capacity exists and a water licence amendment is feasible, or from newly drilled wells (which would also require a licence or licence amendment). The RDCO also wished to understand whether additional groundwater extraction would affect existing well users, and to understand the effects of and sensitivity to climate change on groundwater supplies.

## 2.0 SCOPE OF SERVICES

WWAL completed the following for this project:

1. Developed an understanding of the additional water demand being sought, both average and maximum day demands. This included consideration of how many undeveloped lots existed within the current and contemplated expanded water system service area.
2. Reviewed available background information including the well completion report, driller's logs for wells in the area, historical water quality data, environmental studies of Shorts Creek, aquifer and geological mapping, hydrometric and climate data. Reviewed pertinent groundwater and surface water licenses.
3. Obtained and analyzed historical data from the existing Lower Fintry supply wells, including water consumption, water quality and water level data from the SCADA system. Assessed current well efficiency for comparison to original 2010 testing data.
4. Visited the Lower Fintry Well Site, assessed land use in the area and determined whether and where vacant land may be available for future well drilling if needed. Attempted to confirm other groundwater uses in Aquifer 358. Assessed potential impact of additional groundwater extraction from the aquifer on other wells using aquifer parameters derived from previous pumping tests and a distance-drawdown analysis.
5. Assessed the potential for climate change to affect groundwater availability. Using groundwater elevation data from the wells and Okanagan Lake, assessed the level of influence lake levels have on groundwater levels and developed a conceptual model of aquifer recharge to Aquifer 358. Assessed the relationship of Shorts Creek to the aquifer system.
6. Prepared this report with findings and recommendations.

## 3.0 HYDROGEOLOGICAL SETTING

In depth information regarding the hydrogeologic setting of the current water system supply wells is presented in the well completion report (Summit 2010) and the water system source water protection plan report (WWAL 2011). What follows is a brief summary of key information.

The current water system water supply wells are located on the alluvial fan created by Shorts Creek. The alluvial fan hosts an aquifer, mapped by the Province as Aquifer 358. The aquifer is unconfined and very productive. The principal form of aquifer recharge is from infiltrative losses from Shorts Creek. Losses from the creek near the apex of the fan just below the prominent set of waterfalls and along its channel to the lake creates a groundwater mounding effect. The direction of groundwater flow radiates from the apex of the fan; north of Shorts Creek

groundwater generally flows northwestward (WWAL 2018), while south of the creek groundwater flow is generally to the southeast. An additional and less significant component of aquifer recharge results from the direct infiltration of rainfall and snowmelt over the footprint of the aquifer.

Okanagan Lake exerts a strong influence on the water level in the aquifer, and during high and low water events, it may also influence creek water levels. As detailed in a later section of the report, water levels in the aquifer and lake rise and fall in unison with little or no lag time. Under pumping conditions, induced recharge from the lake could become a meaningful source of aquifer recharge.

The groundwater study completed by Golder and Summit (2009) for the Okanagan Basin Water Board Water Supply and Demand Project characterized the aquifer. For that study, the aquifer was identified as No. 259, and assigned a hydraulic gradient and hydraulic conductivity of 0.01 and 9.0 x $10^{-4}$ m/s, respectively. The estimated average groundwater discharge through the aquifer under ambient conditions was estimated at 7.62 x $10^{6}$ $m^3$/year. Averaged throughout the year, this equals a flow of approximately 242 L/s (3,800 US gpm).

Select construction details for the wells are provided in Table 3.1.

**Table 3.1: Summary of Fintry Production Well Construction Details**

| Well ID | Diameter (mm / inch) | Finished Depth (m / ft) | Static Water level (m / ft) | Well screen details | Screen transmitting capacity |
|---|---|---|---|---|---|
| Well 1 (WPID29316) | 200 / 8 | 34.5/113 | 4.1 / 13.5 | • Top of screen assembly at 28.2 m (92.5 ft)<br>• Screened interval 28.2 m to 34.5 m (92.5 ft to 113 ft)<br>• 0.080" (80 slot) and 0.060" (60 slot) screens | 420 US gpm (26.5 L/s) |
| Well2 (WPID17864) | 200 / 8 | 44.1 / 144.7 | 3.7 / 12.0 | • Top of screen assembly at 35.1 m(115ft)<br>• Screened interval 35.1 m to 45.1 m (115 ft to 148 ft)<br>• 0.100" (100 slot) and 0.080" (80 slot) screens used, separated by a blanked interval. | 640 US gpm (40.3 L/s) |

## 4.0 PROJECTED WATER DEMANDS FOR EXPANDED WATER SYSTEM

Projected water demands for the expanded system were estimated based on data provided by the RDCO and Urban Systems, as summarized in Table 4.1.

**Table 4.1: Projected Water System Demands**

| Area | Current # connections | Full Build out # connections | Actual MDD (2021) L/s | Full Build-out MDD L/s | Full Build-out ADD[1] L/s |
|---|---|---|---|---|---|
| Upper Fintry / Shahal RD / Valley of the Sun (Current Service Area) | 153 | 325 | 17.1[2] | 20.3 | 8.1 |
| Westshore Estates | 290 | 526 | 15.2 | 32.9 | 13.2 |
| Killiney Beach | 296 | 427 | 17.3 | 26.7 | 10.7 |
| | | | **Total** | **79.9** | **32.0** |

Notes:

1) Full build-out MDD assumed to be 2.5 times ADD.

2) 2021 MDD for the current service area was higher than expected. See next section.

## 4.1 Analysis of SCADA Data for Existing System

The RDCO provided 2019 through 2021 water system SCADA data which included pumping rates, pump run hours, water levels and total volumes pumped. The pumps currently installed in the wells each have a typical operating rate of ~26 L/s, which is less than the rated capacity of the wells (31.5 L/s) provided in the well completion report (Summit 2010).

Figure 4.1 shows water consumption for the existing service area for the past three years and illustrates the significant increase in water use in July and August of 2021. Actual 2021 MDD for the existing water system service area was significantly higher than typical (more than three times higher than 2020) due to the prolonged drought and forest fires which impacted the Westside of Okanagan Lake.

**Figure 4.1: Upper Fintry Water System Recent Water Consumption by Month**

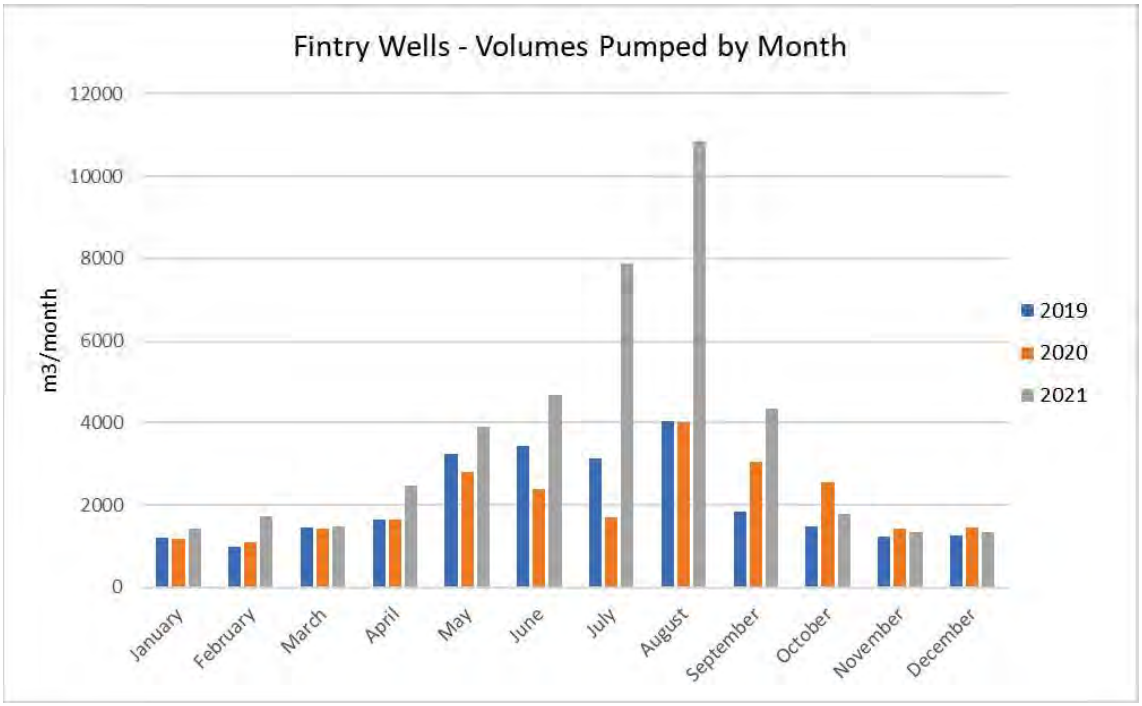


Figure 4.2 depicts monthly water consumption (expressed in $m^3$/month) in recent years along with source capacity for three scenarios:

1. Current source capacity with one well running at its current operating rate 24 hours per day.
2. Current source capacity with both wells running at current operating rates 24 hours per day.
3. Source capacity with both wells running 24 hours per day at their rated capacity of 31.5 L/s.

The data indicate that there is significant excess source capacity compared to current usage. Estimated ADD for the contemplated expanded service area could easily be met by the two wells with the existing pumps.

Figure 4.3 presents the same scenarios in units of $m^3$/day along with projected ADD and MDD. Again, this figure illustrates that ADD can easily be met by the two existing wells, but the two wells cannot meet projected MDD.

**Figure 4.2: Recent Water Consumption by Month Compared to Source Capacity**

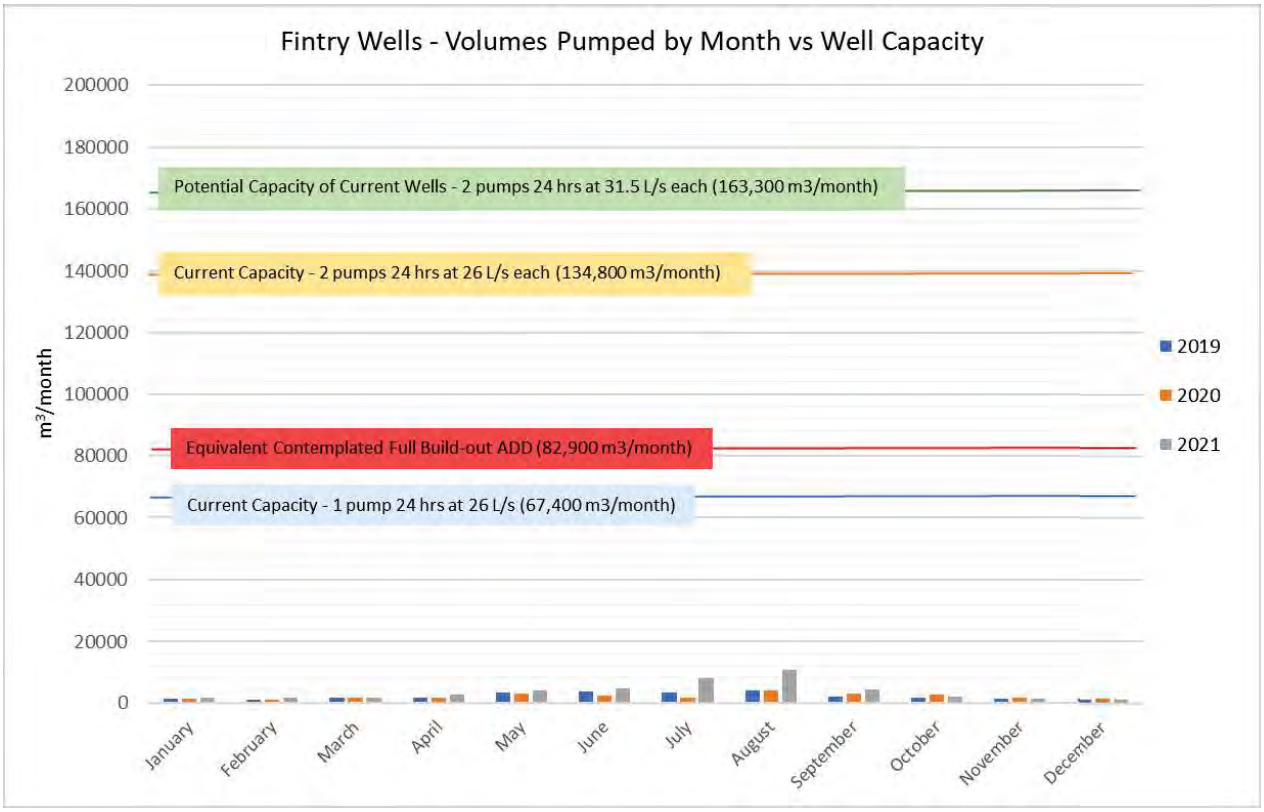
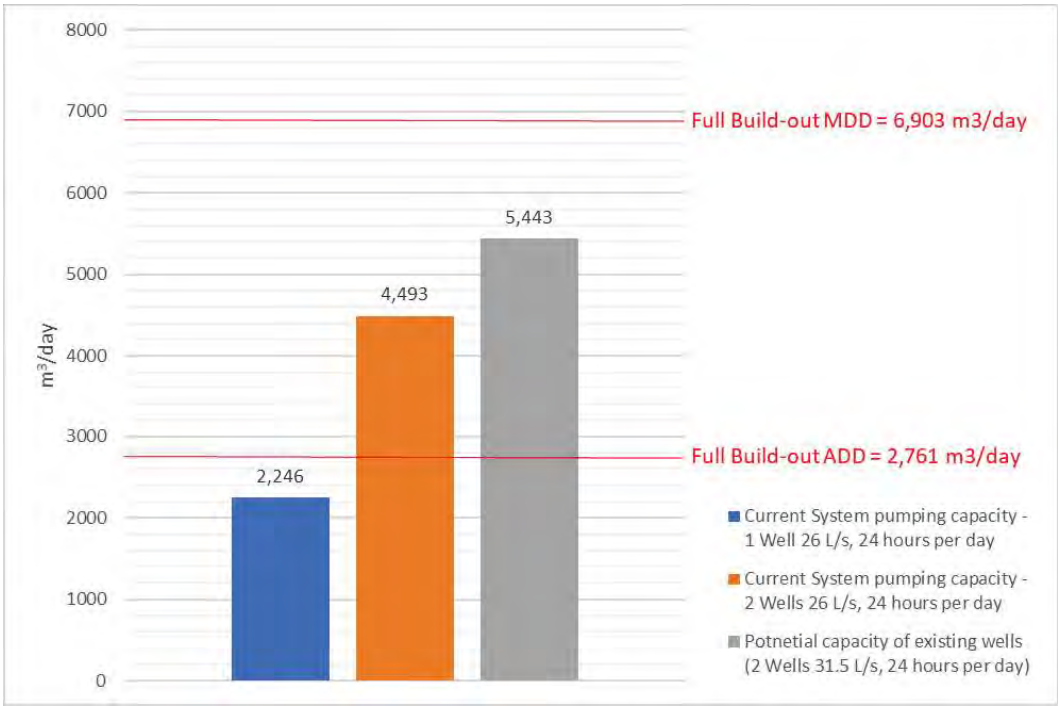


**Figure 4.3: Source Capacity ($m^3$/day) Compared to Projected Demands for Expanded Water System**




## 5.0 ASSESSMENT OF WELL SPECIFIC CAPACITY

Specific capacity (determined by dividing pumping rate by drawdown in a well) is an indicator of aquifer productivity and well efficiency. While the physical properties affecting an unconsolidated aquifer's productivity are typically stable over time, wells may become less efficient (require more drawdown to produce a given amount of water) over time due to chemical and mechanical changes on and around the well screen. These changes may include mechanical plugging by fine grained sediments around the well screen, geochemical reactions that result in chemical encrustation of the well screen or biological growth on and around the well screen. More than one of these factors can occur in a given well, and all contribute to a decrease in specific capacity. Periodic rehabilitation of wells can be required to maintain or restore specific capacity, and redevelopment can consist of both mechanical and chemical methods. The need for and frequency of rehabilitation varies, dependent on groundwater chemistry, well pumping rates and aquifer properties.

The Fintry wells have been in operation for over 10 years. As a check on well efficiency over time, specific capacity from the original testing was compared to specific capacity values derived from the SCADA data provided. In order to make a useful comparison, data from similar pumping rates, similar durations and similar water levels was compared, with results shown in Table 5.1. The data indicate that there has been a relatively minor decrease in specific capacity at both wells, on the order of 9% at Well #1 and 3-4% at Well #2.

Well #1 was completed first, at a shallower depth and was developed primarily with compressed air, while Well #2 was developed with the surge and bail method with a cable tool drilling rig. After initial testing of both wells in 2010, it was clear that Well #2 was much more efficient, and some additional development using the surge and

bail method was completed on Well #1 which was effective at increasing the specific capacity. It is possible that additional development at Well #1 could have been warranted.

In conclusion, both wells display relatively small declines in specific capacity over the last 10 years, and well re-development is not warranted at this time. A good rule of thumb is to schedule well rehabilitation works when specific capacity declines reach 15%. It appears Well #1 may reach this threshold first, perhaps in another five years time.

**Table 5.1 Summary of 2010 and 2021 Specific Capacity**

| Well | Original Specific Capacity ( April 2010) | April 2021 Specific Capacity |
|---|---|---|
| Well 1 | 8.9 L/s/m (pumping at 25.2 L/s) | 8.0 to 8.2 L/s/m (pumping at 26 L/s) |
| Well 2 | 11.4 L/s/m (pumping at 25.2 L/s) | 10.6 - 11.2 L/s/m (pumping at 26 L/s) |

## 6.0 ASSESSMENT OF THE POTENTIAL FOR WELL INTERFERENCE

There are few wells in Lower Fintry with which the Fintry wells could interfere. On the south side of the Shorts Creek, there are only three other wells reported, one of which is abandoned (Figure 1). WWAL attempted to contact both property owners while at Fintry in early January 2021 but no one was home at either property. It is not clear whether either of these wells are in use, as the lower Fintry community is serviced by a water utility sourcing water from Okanagan Lake.

North of Shorts Creek, four wells are reported, one of which is abandoned. There is a shallow domestic well just north of Shorts Creek near the lake that is likely the domestic supply well for a Manor in the Provincial Park. Fintry Provincial Park obtains water from dedicated potable and irrigation wells, both of which are located more than 1.1 km to the north. These wells, which operate only seasonally, are not at risk of well interference from the RDCO wells.

**Table 6.1 Summary of Reported Wells in Lower Fintry**

| Well Tag Number | Depth | Purpose | Driller Estimated Well Yield | Distance from Closest Fintry Water System Well |
|---|---|---|---|---|
| South of Shorts Creek | | | | |
| 82621 | | unknown | | 340 m |
| 57019 | 12.2 m | irrigation | 9.4 L/s | 205 m |
| 103882 | abandoned | | | |
| North of Shorts Creek | | | | |
| 57494 | 6 m | Manor within Fintry PP, domestic supply | 1.3 L/s | 435 m |
| 18228 | abandoned | | | |
| 70259 | 21.6 | Fintry PP Domestic Supply Well | 33.1 L/s | 1,130 m |
| 76776 | 23.2 | Fintry PP Irrigation Well | 6.3 L/s | 1,130 m |

Well interference was assessed during initial testing of the wells. After pumping Well #2 for 11 hours at 31.5 L.s, 0.23 m of interference was induced at Well #1 located 30 m away (Summit 2010). Pumping water levels had stabilized for several hours at this point. To assess the potential for water level interference at greater distances, we modelled the distance-drawdown relationship using Aqtesolv, a commercial hydrogeological analysis software, and data from the 2010 pumping tests. The analysis indicates that when pumping at 31.5 L/s (essentially the ADD of the contemplated water system), drawdown at a distance of 100 m from the pumping well is approximately 0.1 m. Drawdown declines to near zero at a distance of 220 m. Higher pumping rates, like those contemplated by the water system expansion, would result in larger drawdowns that reach farther, but not significantly so. Considering the small number of wells in the area (if present and actively used south of Shorts Creek), their distance from the supply wells and small modelled drawdown, its is our opinion well interference would not be an issue at the contemplated pumping rates. It is unlikely well interference effects would be measurable north of Shorts Creek.

## 7.0 WATER QUALITY

The RDCO provided WWAL with the results of comprehensive water quality sampling for recent years. That data, along with the data collected during original testing of the wells is summarized in Table 7.1. The data indicates water quality has remained stable over time and continues to meet all Guidelines for Canadian Drinking Water Quality. The only exception is one result for lead in 2013 which exceeded the MAC, but this is an isolated occurrence. Parameters associated with impacts from septic systems such as chloride, sodium and nitrate have been stable and all remain at very low concentrations.

## Table 7.1: Fintry Raw Groundwater Quality

| General Parameters | Date | 2010-03-25 | 2010-04-20 | 2013-03-04 | 2014-03-17 | 2016-03-02 | 2018-03-06 | 2020-03-25 | GCDWQ |
|---|---|---|---|---|---|---|---|---|---|
| | Sample ID | Well 1 | Well 2 | Morden | Booster Station | Booster Station | Booster Station | Booster Station | |
| | Units | | | | | | | | |
| pH | -- | 8 | 8.08 | 7.84 | 8.01 | 7.98 | 7.92 | 8.07 | 7.0 - 10.5 |
| Conductivity | us/cm | 285 | 282 | 295 | 297 | 290 | 277 | 272 | n/a |
| Turbidity (lab) | NTU | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.14 | varies |
| TDS | mg/L | 162 | 167 | 160 | 157 | 167 | 166 | 167 | AO ≤ 500 |
| Hardness, Total | mg/L | 143 | 146 | 143 | 140 | 149 | 144 | 143 | n/a |
| Alkalinity, Total | mg/L | 143 | 149 | 149 | 144 | 151 | 157 | 164 | n/a |
| **Select Ions** | | | | | | | | | |
| Fluoride | mg/L | 0.15 | 0.12 | 0.11 | 0.12 | 0.12 | 0.11 | <0.10 | MAC = 1.5 |
| Chloride | mg/L | 0.74 | 0.8 | 0.97 | 2.94 | 3.07 | 2.45 | 0.62 | AO ≤ 250 |
| Nitrate, N | mg/L | <0.01 | <0.01 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | MAC = 10 |
| Nitrite, N | mg/L | <0.01 | <0.01 | <0.011 | <0.010 | <0.010 | <0.010 | <0.011 | MAC = 1 |
| Sulfate | mg/L | 7.2 | 7.3 | 8.8 | 7.5 | 7.9 | 7.4 | 7.4 | AO ≤ 500 |
| **Selected Total Ions and Metals** | | | | | | | | | |
| Aluminum | mg/L | 0.008 | 0.014 | <0.05 | <0.05 | <0.05 | <0.0050 | <0.0050 | AO < 1.0 |
| Antimony | mg/L | <0.0001 | <0.0001 | <0.001 | <0.001 | <0.001 | <0.00020 | <0.00020 | MAC = 0.006 |
| Arsenic | mg/L | 0.0016 | <0.0005 | <0.005 | <0.005 | <0.005 | <0.00050 | <0.00050 | MAC = 0.01 |
| Barium | mg/L | 0.0125 | 0.0138 | 0.07 | <0.05 | <0.05 | 0.0103 | 0.0126 | MAC = 2 |
| Boron | mg/L | 0.008 | 0.006 | <0.04 | <0.04 | <0.04 | 0.0095 | 0.0105 | MAC = 5 |
| Cadmium | mg/L | <0.00001 | <0.00001 | <0.0001 | 0.0001 | <0.0001 | <0.000010 | <0.000010 | MAC = 0.005 |
| Calcium | mg/L | 44.4 | 42.9 | 43 | 42 | 45.4 | 43.6 | 42.8 | n/a |
| Chromium | mg/L | 0.0014 | 0.0015 | <0.005 | <0.005 | <0.005 | <0.00050 | <0.00050 | MAC = 0.05 |
| Copper | mg/L | 0.0012 | 0.001 | <0.002 | 0.025 | 0.036 | 0.0209 | 0.00152 | MAC = 2, AO ≤ 1 |
| Iron | mg/L | 0.05 | 0.07 | <0.1 | <0.10 | <0.1 | 0.03 | 0.038 | AO ≤ 0.3 |
| Lead | mg/L | 0.0001 | <0.0001 | 0.012 | <0.001 | 0.001 | <0.00020 | 0.00174 | MAC = 0.01 |
| Manganese | mg/L | 0.0016 | 0.0013 | 0.003 | <0.002 | <0.002 | 0.00065 | 0.00106 | MAC = 0.12, AO ≤ 0.02 |
| Selenium | mg/L | <0.0003 | <0.0003 | <0.005 | <0.005 | <0.005 | <0.00050 | <0.00050 | MAC = 0.05 |
| Sodium | mg/L | 5.37 | 6.81 | 6.3 | 8.1 | 9.2 | 7.47 | 5.65 | AO ≤ 200 |
| Uranium | mg/L | 0.003 | 0.00305 | 0.0024 | 0.0026 | 0.0029 | 0.00279 | 0.00295 | MAC = 0.02 |
| Zinc | mg/L | 0.007 | 0.019 | <0.04 | <0.04 | <0.04 | <0.0040 | <0.0040 | AO ≤ 5 |
| **Microbiological Parameters** | | | | | | | | | |
| Total Coliforms | CFU/100mL | <1 | <1 | -- | -- | -- | <1 | -- | MAC = non-detect |
| E.Coli | CFU/100mL | <1 | <1 | -- | -- | -- | <1 | -- | MAC = non-detect |

## 7.0 ASSESSMENT OF CLIMATE CHANGE IMPACTS ON GROUNDWATER AVAILABILITY

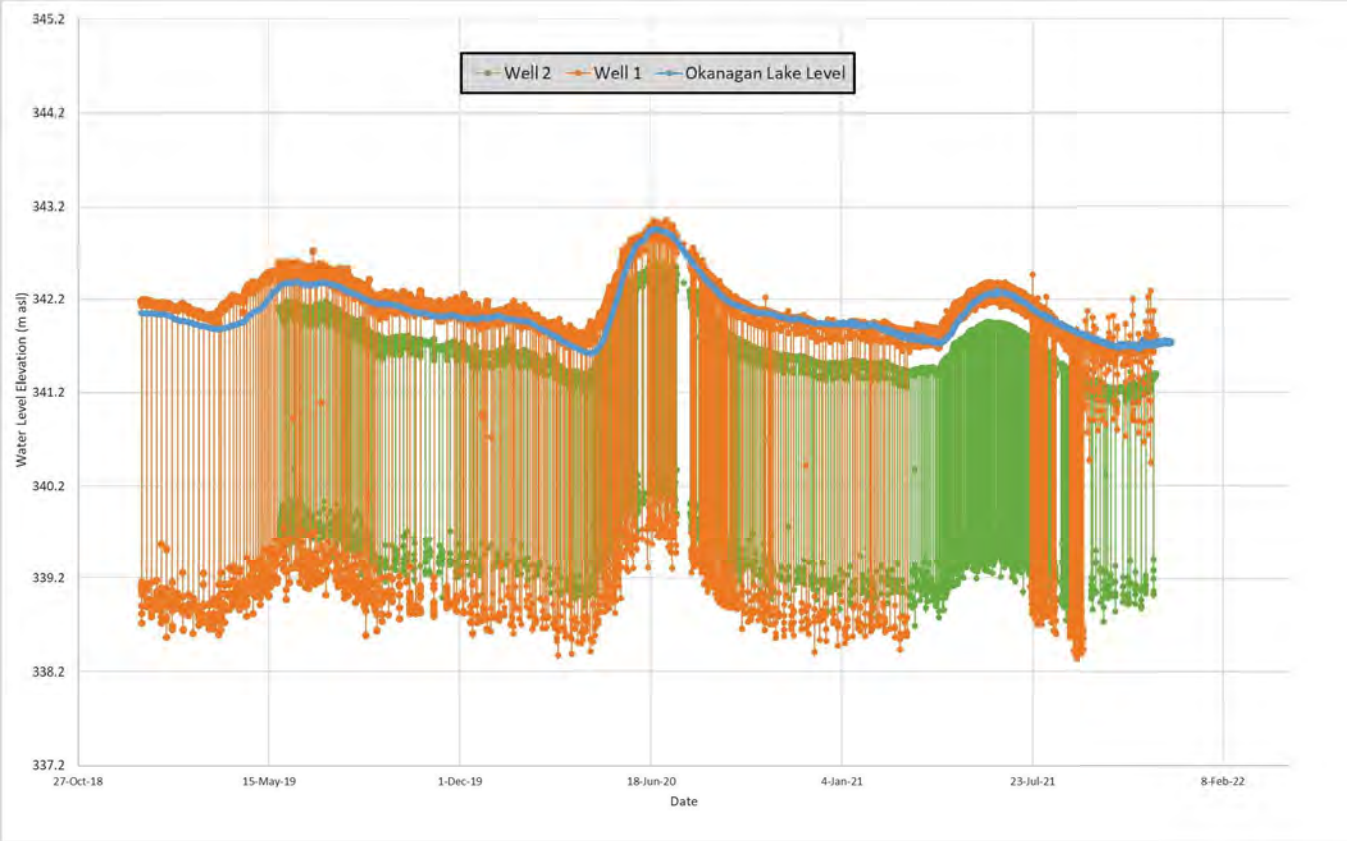
The Pacific Climate Impacts Consortium (PCIC) climate change summary for the Thompson-Okanagan Region (PCIC 2013) forecasts warming in all seasons, with the largest projected increase in the summer. The average prediction of multiple climate change models predicts that average summer temperatures will increase by 2.2°C over the 1961-1990 average summer temperature by 2050. Precipitation is expected to increase in the autumn through spring and decrease in the summer months. Coupled with rising temperatures, this could mean more precipitation falling as rain at low and mid-elevations and decreased mid-elevation snowpacks. At higher elevations, the projected increase in precipitation could result in increased snowpacks and a higher potential for spring flooding. The climate change summary acknowledges that the topography in the Thompson-Okanagan region is highly variable and that climate change effects may therefore vary significantly over short distances. Climate change projections for the Okanagan Regions were updated in a 2020 document commissioned by the Okanagan Basin Water Board and the three Regional Districts in the Okanagan Valley (Pinna Sustainability 2020). Climate projections were based on an ensemble of climate models developed by the PCIC and are largely the same as the 2013 document. The main expectations remain warmer temperatures year round particularly in the summer, with increased precipitation in the fall through spring (17% increase) and drier summers than in the past.

As mentioned previously, the main source of recharge to the Lower Fintry aquifer is losses from Shorts Creek. There is no current hydrometric station on Shorts Creek, but one was present from 1969 to 1982 located near the mouth of the creek. The hydrograph of the creek is typical of Okanagan streams, with a freshet dominated peak in runoff lasting approximately two months in the April to June range. A report on Shorts Creek prepared by the Ministry of Environment indicated that in some years no flow was observed at the mouth of the creek while flows were still present in the highlands to the west (Summit 2010). This is due to the permeable nature of the fan materials, when seepage losses are greater than streamflows reaching the fan. In the absence of visible streamflow across the fan, the aquifer is likely still being recharged by subsurface flows down the Shorts Creek drainage.

While Shorts Creek is the primary aquifer recharge source under ambient conditions, Okanagan Lake is inferred to be the primary control on aquifer water levels and the rate of groundwater flow through the system, and under high-rate and extended pumping conditions, the lake may become a significant or the dominant recharge source. As a check on the relationship between groundwater levels and lake levels, we determined groundwater elevations based on survey data contained on the Morden Road pump house as built and a spot water level measurement made on January 11, 2022. We then used this measurement to convert the SCADA water level data (which reads water level above the transducer) to geodetic, and compared the groundwater levels to Okanagan Lake water levels as recorded at Water Survey of Canada hydrometric station 08NM083 (Water Survey Canada 2022). The results of this comparison are shown on Figure 8.1 and indicate that lake levels and groundwater levels rise and fall in unison with little or no time lag. The lake elevation matched very well with the groundwater elevation calculated for Well #1. We caution that there may be some error in our conversion of groundwater levels to geodetic, as the conversion was based on a surveyed ground surface elevation next to each well head which may have changed slightly over time, and because the water level SCADA data was adjusted based on one spot measurements in January 2022. For example, the groundwater elevation at Well 2 should not be lower than the lake level as indicated on Figure 8.1. We expect that on a long-term average basis, groundwater levels at both

Wells #1 and #2 would typically trend slightly higher than the lake, resulting from a groundwater mounding effect caused by infiltration under Shorts Creek and owing to the fact that groundwater flow is toward the ultimate discharge point of Okanagan Lake. For relatively short periods during high lake level events, the groundwater gradient could flatten or locally be reversed with water moving from the lake into the aquifer.

**Figure 7.1: Comparison of Groundwater Levels in Aquifer 358 to Okanagan Lake Levels**




With the strong relationship between aquifer and lake levels confirmed, the level of Okanagan Lake is the primary factor affecting the availability of groundwater for the supply wells. Okanagan Lake levels are controlled in a fairly tight target range by the Province, with the dam in Penticton. Lake level targets were set in 1974, and reaffirmed in 1982 (OBWB 2019). The 1982 Okanagan Basin Implementation Board set the target lake levels that remain in place today. That document states that Okanagan Lake is managed within a range of 341.3 m asl to 342.5 m asl in all but anticipated extreme flood years and successive drought years. Under prolonged drought conditions, the lake may be drawn down by up to 0.9 m below the target low, to an elevation of 340.4 m asl (ENV 2000), a level not reached in the 2021 drought (Water Survey Canada 2022). The lake level exceeded 343.2 m asl in the 2017 flood event (Associated Environmental 2017).

Recent flood hazard assessment work in the Okanagan Valley that considers climate change has led the OBWB to call for a review of how Okanagan Lake is managed (OBWB 2021). Presumably, in order to account for increased freshet flows or rain on snow events, Okanagan Lake could be pre-emptively drawn down in the late winter to accommodate those inflows.

While the changing climate could eventually lead to a change in the way water levels in the lake are managed, it appears unlikely that regulation of the lake will be dramatically altered such that the available drawdown in the aquifer and by extension the productivity of the Fintry production wells will be impaired. A one metre decrease to the lake low level target would be significant and unlikely. Based on the performance parameters of the wells, a one metre decrease in lake levels will not affect the yield or total volumes available from the wells.

In completing our research on the control of lake levels, we briefly reviewed a document prepared by the OBWB outlining proposed drought stage trigger guidelines for Okanagan Mainstem Lakes and River (OBWB 2019). This document suggests using lake levels as the main factor in determining drought level and decision-making related implementation of drought management plans and water restrictions. This same framework could potentially be applied to the Fintry production wells given the strong control on groundwater water levels the lake exerts.

## 8.0 REGULATORY CONSIDERATIONS

In this section, we review the pertinent legislation and regulations that would govern the increase in capacity of the lower Fintry groundwater supply system, which are water licensing under the *Water Sustainability Act* and environmental assessment under the *Environmental Assessment Act*. Both of these pieces of legislation have regulations that result in timelines that can be lengthy, on the order of many months to years depending on the project. It will be important to engage the respective ministry staff responsible early in the project in order to plan properly for meeting these regulations while keeping to a timeline to build the project.

### 8.1 Water Licensing under the *Water Sustainability Act*

WWAL was provided with and reviewed the groundwater licence issued to the RDCO for the Upper Fintry water system, as well as the surface water licences associated with the existing Killiney Beach and Westshore Estates water systems. Select details of these licences are summarized in Table 8.1. All licences indicate water can be used year-round.

First, with regards to the water licence associated with the current Upper Fintry Water System, we note that the annual licensed volume was sufficient for 2019 and 2020 where consumption was in the 25,000 $m^3$/year range. In 2021, water usage increased significantly (43,208 $m^3$) due to the drought and fires that occurred on the Westside, both of which could be considered exceptional events. As already noted, the maximum daily withdrawal limit on the licence meets the original design criteria and would be adequate to meet current and full build-out MDD for the Upper Fintry system. The RDCO should apply for expanded licence capacity for the existing wells to match the current water system ADD. This application, if submitted, could trigger additional technical information requirements. One of the technical issues could potentially involve an assessment on whether increased groundwater withdrawal could have an impact on low flows of Shorts Creek, particularly near its mouth. The 2020 Environmental Flow Needs (EFN) assessment of Shorts Creek (ONA 2020) suggested that based on the existing situation, meeting EFNs on Shorts Creek is “problematic.” This suggests that the Ministry water officer reviewing a licence amendment application would need to consider EFNs in making a licence decision.

**Table 8.1: Summary of Water System Water Licences**

| | Licence Number | Licence Type | Licence Status | Annual Volume ($m^3$) | Daily Max ($m^3$) |
|---|---|---|---|---|---|
| **Upper Fintry Water System** | 500183 | Groundwater | Current | 30,000[1] | 2,448 |
| | | | | | |
| **Killiney Beach** | | | | | |
| Okanagan Lake | 60438 | Surface Water | Current | 364,221 | 2,998 |
| Norris Creek | 61569 | Surface Water | Current | 112,834 | 773 |
| Hope Creek | 61570 | Surface Water | Current | 76,993 | 526 |
| | | | | | |
| **Westshore** | | | | | |
| Okanagan Lake | 41569 | Surface Water | Current | 142,702 | 391 |
| Okanagan Lake | 43787 | Surface Water | Current | 299,508 | 819 |
| | | | | | |
| | | | **Total** | **1,026,258** | **7,955** |
| | | | | | |
| Contemplated Water System ADD | | | | 1,009,152 | 2,765 |
| Contemplated Water System MDD | | | | N/A | 6,903 |

Second, should the RDCO proceed with amalgamating the water systems, in theory (and on paper) there is enough licensed capacity on the whole to cover the projected ADD of the combined water system at full build out. There is also enough daily maximum capacity associated with the licence to cover the projected combined MDD. It would have to be confirmed with the MFLNRORD, but we believe it is feasible for an amalgamation of water licences to occur. The surface water licences associated with Killiney Beach and Westshore Estates are either on Okanagan Lake or tributaries to the lake, and the aquifer in which the Upper Fintry wells are completed is hydraulically connected to and ultimately discharges to Okanagan Lake. As such it reasonable to propose abandoning licences associated with surface water in exchange for an equivalent expansion to the Upper Fintry groundwater licence. The Province would likely look favourably on this exchange, as it would reduce potential low flow issues with Hope and Norris Creeks and potentially increase habitat values along those drainages.

## 8.2 Environmental Assessment under *Environmental Assessment Act*

Under the B.C. *Environmental Assessment Act*, a groundwater extraction project is reviewable if the design capacity of the system exceeds 75 L/s or for an existing system greater than 75 L/s if a 35% expansion in capacity is proposed. We note that the full build-out MDD of the combined water systems of 79.9 L/s exceeds the 75 L/s groundwater extraction threshold. In addition, there has been a recent amendment to this Act which requires large groundwater users within 15% of the threshold (64 L/s) to consult with the Environmental Assessment Office (EAO). The Environmental Assessment process can be lengthy and expensive. The fact that the system ADD would be much less than the threshold and that the proposed extraction would be a replacement and amalgamation of

[1] The Fintry groundwater supply system is designed for ADD of 918 $m^3$/day which is 335,000 $m^3$/year. It is not known why the licence was issued for less than the design ADD but adequate for the design MDD. This apparent discrepancy will need to be addressed.

several direct withdrawals from the lake would be supportive of a potential application to the EAO for an EA exemption. The exemption process itself is fairly involved and if successful, would result in a Ministerial Order with conditions (e.g. monitoring, limits on withdrawal, etc). More investigation and preliminary discussions with the EAO would be required to confirm whether an environmental assessment would be required for the contemplated project. It is our understanding that MFLNRORD prefers that the EAO requirements be met prior to making a water licence decision on an integrated application submitted under the B.C. *Environmental Assessment* and *Water Sustainability Acts*.

## 9.0 CONCLUSIONS

Based on our assessment we offer the following conclusions:

**C1** Our comparison of projected combined water system demands to existing source capacity indicates that the two existing wells, as they currently operate, can meet projected build-out ADD but not MDD. The existing wells could be equipped with higher capacity pumps such that they both operate at their rated capacity (31.5 L/s), which would increase combined output, but would still not be capable of meeting MDD. A question for the engineering team would be whether the difference between MDD and current source capacity can be met with storage.

**C2** In order to meet the project MDD, additional source capacity would be required. Our recommendation would be to complete a larger diameter well (10 or 12-inch) in the vicinity of Well #1, and that the well be completed at the depth of Well #2. A larger diameter well would likely be capable of producing 63 L/s or more and could operate along with Well #2 to meet the full build-out MDD. A larger diameter well could be completed on the same property as the current water infrastructure; acquiring additional land does not seem necessary. The addition of a third high capacity well would result in a very resilient water system in terms of source capacity.

The estimated costs to construct, test, and licence application under the well under the *Water Sustainability Act*, including hydrogeological oversight and reporting are summarized in the table below. These costs do not include equipping the well with a permanent pump and controls. A detailed environmental flow needs assessment is not included in the provided hydrogeology estimate. The costs associated with obtaining an environmental certificate for the groundwater withdrawal under the *Environmental Assessment Act*, or a formal exemption, are less certain (See Conclusion C6), but could be significant.

| | |
|---|---|
| Well Drilling and Development (12-inch diameter, 150 ft deep, 15 ft of well screen). | $65,000 |
| Pumping Test Program | $15,000 |
| Hydrogeology (tendering, oversight, reporting, permitting) | $25,000 |
| **Total** | **$105,000** |

**C3** The potential for well interference between wells supplying the contemplated water system and other wells in the area was assessed and is considered to be low. There are only two other wells reported south of Shorts Creek, both located over 200 m from the Morden Road well site. We were not able to confirm whether these wells are still in use. Distance drawdown projections were used to estimate well interference at the contemplated water system ADD and is found to be negligible at the potential well locations. Higher pumping rates (MDD demands) would result in slightly more drawdown, but would not impair the use of other wells south of Shorts Creek, if present. Drawdown interference with wells north of Shorts Creek would likely not be measurable.

**C4** Water quality from the original testing of the wells in 2010 was compared to more recent sampling completed by the RDCO. The data indicate stable water quality over time. Operating the wells at current pumping rates does not appear to have resulted in a change in water quality.

Pumping the wells at higher rates could result in a change in water quality. It is possible that at higher pumping rates, the influence of septic systems in Lower Fintry could result in higher chloride, sodium and nitrate concentrations in the water supply. Higher pumping rates may also result in more recharge to wells coming from Okanagan Lake. We do not anticipate major changes to water quality, but additional monitoring and characterization of water quality in light of higher extractions rates would be prudent and should be planned for. Turbidity is expected to remain consistently below 1 NTU.

**C5** We assessed the effects of climate change on the availability of groundwater in lower Fintry. Water levels in Aquifer 358 are strongly linked with and controlled by the Okanagan Lake level. As the Okanagan Lake level is regulated within a set range that would not result in the wells being unable to produce the desired volumes of groundwater, we find that Aquifer 358 would be resilient to climate change. We understand that there have been recent calls for changes to how lake levels are managed, but do not believe those changes would affect the above conclusion.

**C6** The current licence for the Fintry system appears to be inconsistent with system design in that it allows for a maximum flow rate of 2,448 $m^3$/day (450 US gpm) but only 30,000 $m^3$/year, which is about 15 US gpm. The annual volume has already been exceeded once (in 2021), which means the licence needs to be reviewed and amended, regardless of whether the contemplated expansion occurs.

Should the proposed water system expansion proceed, two applications/amendments need to be planned and proposed:

- Increase the annual volume to meet the new system requirements to build-out ADD of 1,009,150 $m^3$/year. In exchange, propose relinquishing existing surface water licences associated with the Killiney Beach and Westshore Estates water systems.
- Change the appurtenance from existing (Water Services Bylaw 1254) to proposed (Bylaw to be determined).

Factors supporting a licence amendment to increase the annual extraction volume from Aquifer 358 would include lack of well interference concerns, low susceptibility to drought, and the potential abandonment of surface water licences on Okanagan Lake and tributaries currently held for operation of

the Killiney Beach and Westshore Estates water systems. The technical issue that may require assessment would be whether or not increased extraction from Aquifer 358 would impact EFNs in lower Shorts Creek.

C7 We note that the proposed MDD of the combined system of 79.9 L/s exceeds the threshold for the completion of a groundwater Environmental Certificate under the *Reviewable Projects Regulation* under the BC *Environmental Assessment Act*. As the design capacity of the contemplated groundwater system exceeds 75 L/s, an environmental assessment or exemption certificate would likely be required. To further investigate whether an Environmental Certificate would be needed for the project, we would recommend preparing a conceptual project design brief and providing that to the EAO for comment. Then the next steps can be identified (pursue EA, EA exemption, or other alternative).

C8 Regulatory timelines for water licensing and EA processes are typically lengthy (years) and these timelines will need to be built into the overall project plan.

## CLOSURE

We trust this report provides the information you require at this tie. If you have any questions on the information provided, do not hesitate to contact the undersigned.

**Western Water Associates Ltd.**
**(EGBC Permit to Practice #1001419)**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**Senior Hydrogeologist**

**Reviewed By:**

**Douglas Geller, M.Sc., P.Geo, FGC**
**Principal Hydrogeologist**

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**Figure 1 - Wells and Aquifer Mapping at Lower Fintry**

| | | | |
|---|---|---|---|
| Date: January 2022 | Image Source: BC Water Resources Atlas | | WWAL Project: 21-132-01VR |
| Drawn by: RR | Checked by: RR | Client: RDCO | Client Project: |

western water ASSOCIATES LTD
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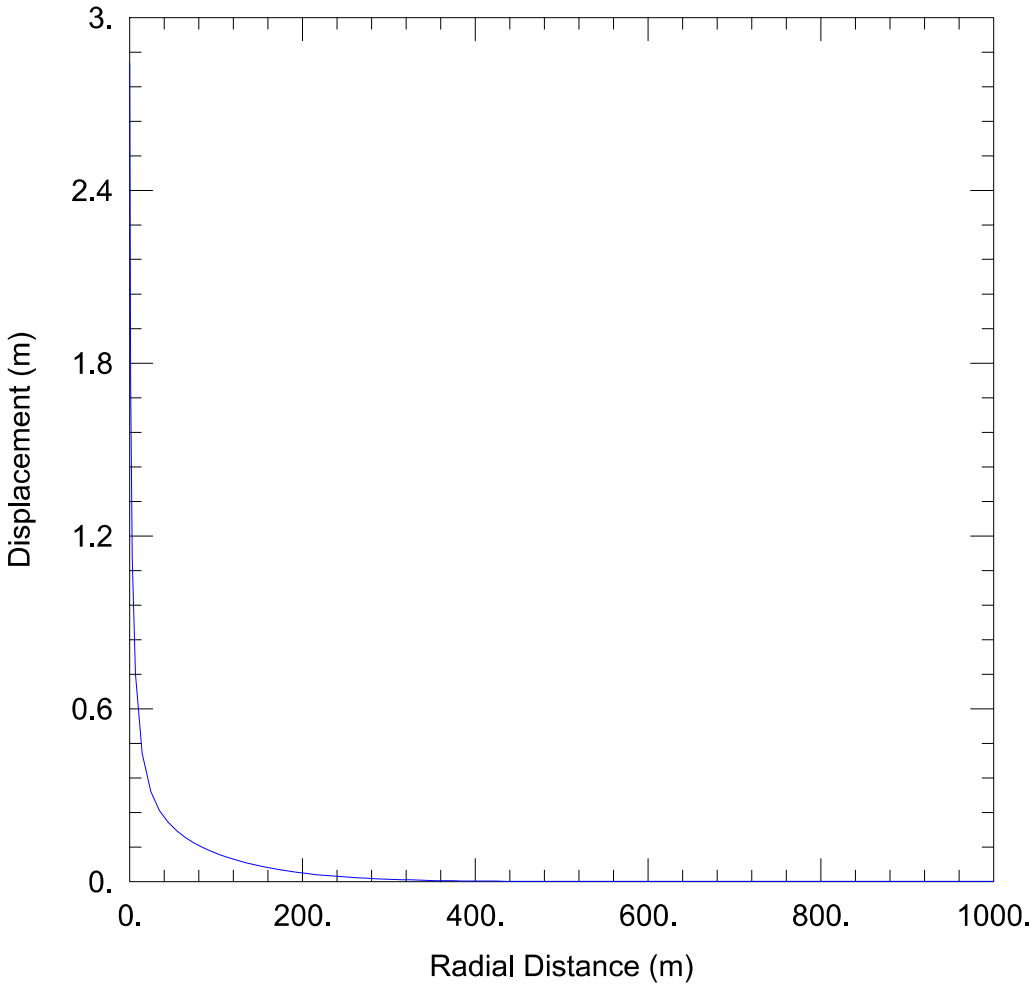


## WELL TEST ANALYSIS

Data Set: D:\...\fintry forward solution.aqt
Date: 01/31/22 Time: 20:18:51

## PROJECT INFORMATION

Company: WWAL
Client: RDCO
Project: 21-132-01VR
Location: Lower Fintry
Test Well: Fintry Well 2
Test Date: April 2010

## WELL DATA

Pumping Wells

| Well Name | X (m) | Y (m) |
|---|---|---|
| Fintry Well 2 | 0 | 0 |

Observation Wells

| Well Name | X (m) | Y (m) |
|---|---|---|
| ▫ Fintry Well 2 | 0 | 0 |

## SOLUTION

Aquifer Model: Unconfined
Solution Method: Theis

T = 3162.3 $m^2$/day
S = 0.1
Kz/Kr = 1.
b = 40. m