Greater Vernon Water (GVW)

Technical Memorandum No. 3
Source Storage and Supply

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Table of Contents

Appendices

Technical Memorandum No. 3: Source Storage and Supply

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1. Introduction

Greater Vernon Water (GVW) relies primarily on surface water sources for its raw water supply. The Regional District of North Okanagan (RDNO) holds 57,420 ML of consumptive use water licenses; with 33,051 ML of this quantity currently under license for storage. The GVW system may be at risk of water supply shortages in the future, particularly in the Duteau Creek watershed, where only 54 percent of annual consumption is stored in reservoirs.

In 2012, GVW demand requirement is estimated to be 27,100 ML. In 2052, this demand is expected to increase to 30,800 ML. Table 1-1 identifies the anticipated consumption based on parameters established in this Master Water Plan.

Table 1-1. Demand Forecast
(Source TM1- Domestic & Agricultural Water Demand Forecast)

	Annual Demand (ML)				Max. Day Demand Consumption (MLD)		
Year	Domestic	Agricultural (typ.)	Agricultural (allotment)	Total	Domestic	Agricultural	Total
2011	9,670	12,600	17,400	27,100	59.4	213	272
2016	9,880		17,400	27,300	60.1	213	273
2021	10,470		17,400	27,900	63.1	213	276
2026	11,060		17,400	28,500	66.0	213	279
2031	11,550		17,400	29,000	68.1	213	281
2041	12,450		17,400	29,900	73.4	213	286
2052	13,360		17,400	30,800	78.5	213	292

1.1 Objectives of Study

The objective of this study is to analyze future reservoir storage potential in the GVW system. Assessment of storage requirements are generally based on demand and anticipated need for additional supply. This assessment is further examined based on the potential changes due to climate fluctuations anticipated over the next 40 years. The work includes:

- An analysis of potential future reservoir storage in the GVW system.
- Prioritizing reservoir projects based on long term requirements determined from the Master Water Planning process.
- Developing order of magnitude cost estimates.

- A brief analysis of potential hydraulic issues that may significantly affect cost estimates and flag environmental concerns.
- Review and establish appropriate return periods for drought years (This is covered more in depth in the water source technical memorandum).
- Recommendations of further study or site information.
- An analysis of recommended future work based on current plan.
    - 5 year capital plan – Detailed cost requirement.
    - 10 year planning horizon – Identify most likely project and order of magnitude cost.
    - 40 year planning horizon – Identify projects with most likely greatest benefit.

The information in this reference document is then used in later planning technical memoranda of the Master Water Plan.

2. Storage Opportunities

2.1 Water Licensing

In Technical Memorandum No. 2 – Evaluation of Water Supply Sources, it was determined that RDNO holds 57,420 ML of water licenses within watersheds or sub-watersheds. Of this quantity, 37,068 ML is considered irrigation licenses, and the remaining are for waterworks. The largest quantity of water is out of Duteau Creek, where 35,243 ML is allocated to GVW. There is currently 33,051 ML of storage licenses allocated to the Duteau system; however, only 28,369 ML are allocated within the Aberdeen, Haddo, and Grizzly Reservoirs. The remaining Duteau storage licenses are contained in Goose Lake and a minor quantity in Kalamalka / Wood Lake.

Issues regarding potential transfer of some of these water licenses in the future are addressed in Section 3.0 of this Technical Memorandum.

2.2 Duteau Creek

For the purposes of the 2012 Master Water Plan, the total live storage in the upper Duteau watershed is estimated at 18,340 ML: 10,330 ML in Aberdeen Reservoir, 2,730 ML in Haddo Reservoir and 5,280 ML in Grizzly Reservoir. Some of the historic documents for these reservoirs refer to slightly different volumes due to the low and high water level elevations used in the volume calculations. This range does not affect the conclusions of the 2012 Master Water Plan, although it is recommended that this live storage figure be examined more precisely prior to implementing further assessments on storage requirements.

The outlet at Haddo supplies the controlled releases to Lower Duteau Creek, with subsequent GVW intake further downstream at Harvey Lake.

The mean annual runoff in the watersheds upstream of Haddo Dam is 33,618 ML/yr (Technical Memorandum No. 2 – Evaluation of Water Supply Sources). The 1 in 10 year mean annual low flow is 19,162 ML/yr. By increasing storage, GVW can potentially increase supply quantities.

In addition, an estimated mean annual runoff of 17,340 ML/yr is potentially available from the Lower Duteau Creek watershed, which currently is uncontrolled flow during the spring freshet downstream of Haddo Dam.

Studies have been conducted that identify possible projects to increase water available to GVW. These project areas are identified below and summarized in Figure B1 in Appendix B.

- Upstream of Haddo Dam, increasing storage on the existing reservoirs,
- On-stream storage on Lower Duteau Creek, upstream of the GVW Diversion.

2.2.1 Increasing Storage in Aberdeen Reservoir

The most feasible site for increasing storage in the Duteau watershed is by enlarging Aberdeen Reservoir. KWL (2012) examined the feasibility of raising Aberdeen dam (currently 10,330 ML live storage). Raising Aberdeen reservoir by 2 metres would store an additional storage of 5,316 ML.

- Increasing the height by 4 metres adds 11,670 ML for a total of 22,000 ML. Under the current watershed arrangement, the reservoir would not fill every year, and mostly in years greater than the average annual volumes. This 4 metre addition has some additional structural costs identified, which increases the complexity of the work.

Mould (2007) identified that raising Aberdeen Reservoir by more than two metres has other implications, particularly a potential problem with a backwater effect in the Heart Creek Diversion Canal (between Aberdeen and Grizzly Reservoirs). The impact on the diversion has not been analyzed in detail, but could increase dam construction costs, particularly on the outlet.

The capital costs (Tables A1 and A1a – Appendix A) are summarized as follows:

- Raising dam 2 metres = $3.39M for 5,316 ML ($640/ML)
- Raising dam 4 metres = $6.41M for 11,670 ML ($550/ML)

2.2.2 Flyfish Lake Diversion

KWL (2012) also investigated an option to divert water from unregulated portions of the lower Duteau Creek Watershed. The work would consist of constructing a 1.5 km channel routing water from the Flyfish Lake sub-catchment into Haddo Lake. As Haddo is already a small reservoir, there is little room for additional storage. There is no feasible way of diverting water to the larger Aberdeen reservoir. Other options included diversions to Grizzly Reservoir, however this was also deemed not feasible in the KWL (2012) report.

The capital cost of construction of the diversion from Flyfish Lake to Haddo Lake is estimated to be $3.3M. While the construction of this project is feasible, there continues to be no additional storage available to capture the additional water.

2.2.3 New Lower Duteau Creek Dam and Reservoir

Collecting runoff from the spring freshet from the Lower Duteau Creek watershed is another potential source of water for GVW. The average annual runoff from this area is 17,340 ML. By developing a reservoir on Lower Duteau Creek downstream of the Haddo Outlet, approximately 10,000 ML of this water could be regulated for additional consumptive use downstream. Minimum flows in Duteau Creek would need to be maintained for fish management.

One potential reservoir location is shown in Figure B1. The reservoir would be impounded with a 35 metre high earthen dam, and protected by a service spillway, emergency spillway and low level outlet. There may also be an opportunity to blend the dam and spillway components within the design of the dam by using

concrete or roller compacted concrete as a base. Regardless, there would be complications concerning fish passage and approvals.

This facility would also provide an ideal location for small hydro electricity generation for use at the water treatment plant. Additional costs to accommodate such a generation and transmission package would need to be incorporated into the hydraulic design of the outlet structure.

The cost estimate of $17.7M is significantly higher than the $5.5M cost estimate presented by Mould (2007) for a similar facility. The increased costs in this report are attributed to a larger spillway and construction of the high dam. There may be opportunity to blend these two facilities by constructing a roller compacted concrete dam, however fish passage would remain a concern.

2.2.4 Gold-Paradise Diversion Extension into Paradise Creek

Paradise Creek is a sub-watershed of the Harris Creek watershed. Currently, the Gold-Paradise Diversion (operated & maintained by GVW) intercepts water from both Paradise and McAuley (Gold) Creeks (via a 3 km interceptor channel, two head ponds, and a diversion structure on Paradise Creek), and is then diverted into Heart Creek and eventually into Aberdeen Reservoir. The RDNO currently holds a license for 9,864 ML (8,000 ac-ft) of diversion and consumption from this watershed. Based on a topographic review of the watershed adjacent to the current Gold-Paradise Diversion contributing area, an additional 10.4 km^2 of the Paradise Creek sub-watershed could also be considered for diversion. This diversion assumes that the network of existing forest service roads could be utilized to divert this additional water into the existing Gold-Paradise Diversion infrastructure.

The existing diversion on Paradise and McAuley Creeks require additional upgrades to the fisheries flow bypasses. There were requests by downstream stakeholders to close the bypass due to concerns of a recent landslide potentially caused by the flow releases. The extent of the work requirement is unknown at this stage, but an allowance for this work has been included in the cost estimate.

The additional annual water supply (standardized mean) for the proposed Paradise Creek sub-watershed and diversion is 7,609 ML (see Appendix C). Aberdeen Dam would need to be raised in order to store the additional water.

The capital cost estimate of $3.6M ($475/ML) is based on construction of a new road, berm, channelization and construction of new diversion structures.

2.2.5 Harvey Lake

Harvey Lake is the head pond created on Lower Duteau Creek for the main pipeline diversion into the GVW distribution system. The head pond and associated infrastructure were completed in the late 1960's with travelling intake screens, gas chlorination system, flow meter and telemetry. AECOM (2006) identified potential upgrades to the headgates as part of the Duteau WTP upgrades.

Prior to construction of the Duteau WTP, GVW commissioned Earthtech (2005) to examine options for updating the Harvey Lake intake. The intake pond requires dredging every five to ten years, as well as frequently cleaning silt and debris from the infrastructure. The study examined different forms of silt prevention and complete bypass. The study summarized that the most economical option was to do nothing. The infrastructure will, one day, require replacement.

2.3 Other Storage Potential

2.3.1 Goose Lake

Goose Lake (See Figure B2 in Appendix B) is an open reservoir with a live storage capacity of 2,360 ML within the GVW distribution system. The lake has a negligible watershed of its own, but has been an integral component of the GVW water system dating back over 100 years. It was originally supplied by water from Duteau Creek through the old Grey Canal and was supplemented by water from B.X. Creek and other small upland reservoirs intercepted by the Grey Canal. Today, it is supplied solely from Duteau Creek through the pipeline distribution system. Once the West Swan Lake pipeline separation project is completed in the summer of 2013, water stored at Goose Lake will be for agricultural purposes only.

Raising the Goose Lake Dam and increasing the capacity of the reservoir can improve operational flexibility of the irrigation supply system:

1. It provides an additional option for routing water from B.X. Creek, thereby relieving some of the supply requirement from Duteau Creek. As B.X. Creek has a licensed potential of 9,221 ML/yr, Goose Lake storage of 2,360 ML would still not be enough. The B.X. system would also require dedicated pipeline conveyance, similar to the Grey Line canal from the early development years.
2. Goose Lake can be a key connection point in the distribution for the City of Vernon reclaimed water system. If approved for agricultural use, water could be directly supplied to Goose Lake and distributed to agricultural users in the GVW.
3. Goose Lake could also be filled from a pump supply from Okanagan Lake.

The reservoir is situated on the boundary between Electoral Area “B” and land owned by the Okanagan Indian Band. Raising the reservoir level would impact Band lands, and possibly surrounding housing developments.

TM9 – System Separation Options provides an analysis of the need and size of Goose Lake in the overall long term plan. As part of this analysis, we have estimated the capital cost of raising the dam 2.5 metres is $1.40M ($700/ML), thereby providing an increase in capacity of 2,000 ML.

2.3.2 MacKay Reservoir

MacKay Reservoir is currently owned and operated by the City of Vernon as a storage facility for treated wastewater effluent. The reservoir is currently impounded by 3 dams, and has a total live storage capacity of 9,374 ML. The reservoir was expanded by 400 ML with the completion of dyke upgrades in 2010. The City currently spends $738k annually to pump effluent to MacKay. There may be some opportunity in the future to increase the size of the reservoir by raising the dams. This storage would be directly related to growth of the City of Vernon. The current Liquid Waste Management Plan does not include increased storage at MacKay Reservoir at this time. A reasonable estimate to expand this facility significantly would be approximately $4.0M. This would include the replacement of outlet facilities, raise the emergency spillways and negotiate purchasing of surrounding lands. It is uncertain at this time if use of reclaimed water would form part of the 2012 Master Water Plan, or another budget.

2.3.3 Swan Lake

Swan Lake is a very shallow Lake supplemented by water diverted from B.X. Creek. KWL identified that an intake could be installed on Swan Lake to supplement flows and storage at Goose Lake for agricultural purposes. There is a gate structure located at the south end of Swan Lake, however there are no

opportunities available to increase storage on this lake. The main natural water source for Swan Lake is Greenhow Creek, which extends into the hills to the north east. KWL (2012) identified a pump station scheme to pump more diverted water off B.X. Creek. This is examined later in this report.

2.3.4 Coldstream Creek

The RDNO has a license for 415 ML/yr on Coldstream Creek, and little potential for future additional storage. Section 3.0 in this Technical Memorandum discusses potential handling of these water licenses issue in greater detail.

2.3.5 Okanagan Lake

Okanagan Lake is the largest lake, reservoir and water supply in the region. The lake elevation of 345.0 m (approximate) makes pumping generally un-economic for agricultural purposes, however it is likely suitable for future domestic supply and water treatment. The City of Kelowna was recently successful in obtaining a filtration deferral from Interior Health. Obtaining this form of deferral is discussed in more detail in TM7 – Water Treatment.

As discussed in Section 3.0 of this Technical Memorandum, water licensing and future access to Okanagan Lake should continue to be a priority, even if as a long term reserve.

2.3.6 Kalamalka Lake

As described in Technical Memorandum No. 2 - Evaluation of Water Supply Sources, there are limited options available for new water licenses for storage or consumption off Kalamalka Lake. Section 3.0 in this Technical Memorandum discusses this issue in greater detail.

2.3.7 King Edward Lake

King Edward Lake is a reservoir that impounds runoff from the Deer Creek watershed. The reservoir has a licensed storage capacity of 1,357 ML/yr, and the watershed has an average annual runoff of 5856 ML/yr. Upgrades were completed in 2011 to provide a seasonal supplement to the irrigation supply. Its future potential is limited due to potential water quality issues and small size of the watershed (20.3 km^2).

2.4 B.X. Creek Diversion

The average annual runoff volume from B.X. Creek is 9,107 ML/yr, where the majority is available during the spring freshet. The recent water quality of the runoff limits direct use to agricultural use only. There are few, if any, feasible locations to establish a reservoir capable of supplying a reasonably sized water source for irrigation. The B.X. Creek source has not been used since 2000. The water currently flows to Swan Lake, then back into B.X. Creek and eventually flow into Vernon Creek and Okanagan Lake.

- Option 1. In terms of future water licensing, GVW could transfer all or portions of their current water licenses on B.X. Creek to storage on Okanagan Lake. This water could then be accessed in the future with an intake off Okanagan Lake for domestic use.

- Option 2. If captured within the creek itself, the water could be used for irrigation. A diversion and separate irrigation pipeline to capture freshet flows from B.X. Creek and supply Goose Lake in the spring. The works would include a diversion and control structure, pipeline and spillway.
    - KWL (2012) examined two options for diverting water into Goose Lake:
        - Grey Line: This involves constructing a creek diversion and 12 km pipeline (in the alignment of the old Grey Canal around the north end of Swan Lake and emptying into Goose Lake.
            - Cost Estimate: $15.0M (Table A6)
        - Swan Lake Pump Station: This option involves pumping raw water from Swan Lake into Goose Lake or directly into the separated agricultural distribution system.
            - Estimated cost: $8.7M (Table A7)
- Option 2a. Dixon Dam and other small reservoirs could be constructed within the watershed to store and release as much of the freshet water as possible for diversion downstream. Dixon Lake was a small 148 ML reservoir originally owned by the City of Vernon (Associated Engineering, 2001). It has since been decommissioned due to safety concerns. Capital construction costs for such small dams are typically in the range of $500k per dam.
- Option 3. Diversion of Greenhow Creek to Goose Lake: Greenhow Creek supplies Swan Lake from uplands to the north east. The watershed size is approximately 5 square kilometres. With a median elevation of 1000 m and using curves established in Technical Memorandum No. 2 - Evaluation of Water Supply Sources, the estimated mean annual runoff is 500 ML. The diversion would require approximately 6000 metres of 400 mm diameter pipe for distribution in the Swan Lake area or captured in Goose Lake. Even assuming 100% of this can be captured and licensed and a dependable water supply of 500 ML per year, the cost is very high. Cost estimate: $ 5.4M or $10,800/ML (Table A8).

2.5 Groundwater Projects

As noted in Technical Memorandum No. 2 - Evaluation of Water Supply Sources, groundwater is a potential source of water supply:

1. As a domestic water supply source under current regulations, groundwater is not subjected to the same water treatment and filtration requirements as with surface water sources, with the exception of wells that are classified as "*groundwater under the direct influence"* of surface water (GWUDI). GWUDI wells are treated as surface water within provincial regulations. It is possible for GWUDI wells to qualify for filtration deferral based on water quality, but a more rigorous source protection process may be required to limit activities within the aquifer. Health agencies generally require chlorination at a minimum for GWUDI wells, and dependant on the water quality and riverbank filtration assessment, may also require additional treatment for parasites such as UV treatment. There may be selective areas during individual system separation planning process that may prove that a high quality water well may be a more opportune alternative than the general treated main domestic supply.
2. As an agricultural water supply, groundwater in the greater Vernon region is generally of high quality. Again, existing and new wells may have some value in the distribution system separation process where the need for system separation and smaller volumes are required.
    a. The capital costs of well development are generally similar to that of costs to connect to a distribution system, but can vary depending on a variety of factors, such as distance to the distribution system, distance to power supply and costs of land acquisition. Operational costs will generally be higher for a groundwater supply than a gravity supply, along with increased costs for operations and maintenance (ie. hydro and pump maintenance).

Existing operational RDNO wells consist of the Antwerp deep and shallow wells and Ranch Wells 1 and 2. Antwerp shallow well and the Ranch well 2 are both shallow GWUDI wells and should only be considered for agricultural water supply.

The Antwerp deep well and Ranch well 1 can be used in the domestic system and are designated for use when the capacity of the existing Duteau and Kal Lake Supply systems cannot meet maximum day demand. The water from these wells is considered to be very hard, with elevated manganese levels that have caused problems in the past with staining laundry and plumbing fixtures.

As part of this Master Water Plan, there are no immediate plans to develop further wells in the system. As the agricultural system separation expands, there may be opportunities to develop wells if system separation and domestic demand improvement strategies are the optimal and most financially sound option.

The costs of developing a high volume well can vary significantly. Typical costs for constructing high capacity wells can range from $500k to over $1.0M, depending on depth, flow requirement, distance to distribution system, power supply and allowances for SCADA. A conservative estimate of $750k is prudent for budgeting purposes to construct a new well. Operations costs can range between 5 and 10 percent of capital cost per annum.

3. Potential Transfers of Water Licenses

Over a century ago, those who designed and built the Vernon water supply understood the importance of a secure and reliable water system. In those days, the domestic drinking supply came from creeks, wells, or by pumping from one of the nearby lakes. Irrigation supply required large volumes of water during a 6 month growing season, and needed to be supplied economically to all connections. By introducing pipelines, the irrigation systems could be pressurized and operated with little or no fuel costs. The surface sources, such as Duteau Creek, were often preferred because of the low operations costs, therefore surface diversions and storages were investigated in the hills surrounding the area. Sources within the Okanagan/Kalamalka basin were available from B.X. Creek, Coldstream Creek and other smaller supplies noted in this report. The Duteau Creek watershed, however was more favorable because of its gravity supply to most areas in GVW.

Duteau Creek is on the fringes of the Shuswap watershed, which routes eventually into the Fraser River Basin. Water from the Okanagan watershed is routed naturally through the Columbia River to the Pacific Ocean. Without the man-made diversions off Duteau Creek, the ability to farm the lands in the North Okanagan area may not be feasible due to the extended annual drought conditions experienced in the summer months. The licenses and supply system has been grandfathered into acceptance as part of the GVW water supply, and can remain in use as long as the purpose of the license remains for direct consumption.

Large scale water transfers between basins are now prohibited under the Water Protection Act. An excerpt of this act is given below:

WATER PROTECTION ACT
CHAPTER 484 [RSBC 1996]

Prohibition against large scale transfers between major watersheds

6. *(1) A person must not construct or operate a large scale project capable of transferring water from one major watershed to another major watershed.*

(2) A person must not modify a project capable of diverting or of extracting water if the modification results in, or if completed would result in, the project having the capability of transferring water at a peak instantaneous flow of 10 m^3 or more a second from one major watershed to another major watershed.

1995-34-6.

As in the previous Master Water Plans, the option remains to supply all GVW domestic demand with water from Kalamalka Lake. There is not, however, enough water license available to supply all future demand beyond this Master Water Plan. Questions remain whether it is possible to divert more water directly to Kalamalka Lake from Duteau Creek, Deer Creek or Coldstream Creek. GVW has contacted the Ministry of Environment, and noted the following:

1. **Potential transfer of Duteau Licenses to Kalamalka (Transfer between water basins):** These transfers are very difficult and are prohibited under the Water Protection Act. There is a remote possibility that a transfer might be feasible based on the fact that the water license was obtained prior to the Water Protection Act enactment. The transfer would require that there could be no environmental impact, including affecting Kalamalka Lake water colour and chemistry. Extensive study would also be required to demonstrate that there is a viable water balance after the transfer of water license for both Kalamalka Lake and Duteau Creek. Finally, objections by DFO, First Nations and other environmental interest groups would need to be addressed.

   It should be noted that there are already two “supplemental” water licenses in the system (Table 3-1) granted in 1960 which permitted diversions directly water from Duteau Creek to Kalamalka Lake. GVW does not currently “physically divert” water through any channel or canal system.

Table 3-1
Water Licenses from Duteau Creek Source Diverted to Kalamalka Lake

License No.	Quantity (ML/y)	Applicable Comments	Result
C025665	493	• License for diversion and use from Duteau Creek into Kalamalka Lake. • Supplemental to Conditional License C25666 off Kalamalka Lake. • Issued April, 1960	Water can be extracted from Kalamalka Lake Intake for the City of Vernon at rate 5.9 ML/d year round.
C025909	166	• License for diversion and use from Duteau Creek into Kalamalka Lake. • License is “in part” supplementary to Conditional License C025731 • Issued April, 1960	Water can be extracted by GVW at a maximum 0.45 ML/d (0.1M gal/day) all year round.

2. **Potential transfers of B.X. Creek, Coldstream Creek and other small licenses (Internal water basin transfers):** These are certainly feasible. License amendments would be required, including processes required to minimize environmental impact and demonstrate the water balance afterwards is viable. Significant capital investment would be required to divert B.X. water to Kalamalka Lake, as well as additional operational costs to pump it back up. This water can also transferred or diverted to Okanagan Lake. Similarly, the transfer of water from the reclaimed water system under the City of Vernon Liquid Waste Management Plan may also be considered a credit towards obtaining a transfer approval.

   Regardless of scenario, costs of pumping will always need to be considered when considering permanent transfer of water to other low elevation storage sites.

GVW has also noted that there is already indirect transfer of Duteau Creek sourced water through the distribution system. Duteau sourced water enters the Kalamalka and Okanagan Lake watersheds indirectly via irrigation, seepage, groundwater, sewer or septic systems to the lower elevations. A large percentage of this water is disinfected prior to entering the distribution system. The Von Keyserlingk and King Edward areas are the main exceptions.

4. Discussion

The total licensed storage in the Duteau Creek and Kalamalka Lake systems is 41,893 ML/yr (Table 4-1). The actual live storage available in these two supplies is 27,182, as the reservoir capacity in the Duteau watershed is lower than the allowable under the license (currently 18,340 ML). Therefore in successive dry years and higher than normal demands, GVW is prone to water shortages. Water conservation programs have had some effect on reducing consumption, however long term sustainability requires maintaining a guaranteed supply into the future. It should be noted that at this point in time, there is no expectation that agricultural demands will increase or decrease in the long term. Nearly all growth in demand will occur in the potable water sector.

Table 4-1
Summary of Storage Licenses and Actual Storage on Duteau Creek and Kalamalka Lake

Watershed	Storage License Volumes (ML)	Live Storage (ML)
Duteau Creek	33,051	18,340
Kalamalka Lake	8,842	8,842
Totals	41,893	27,182

Note: The Kalamalka Lake licenses include storage and diversion.

Within the Duteau watershed, it has been generally noted through discussions with previous operators and irrigation district managers that there few opportunities within GVW for new storage. This statement is further noted by Okanagan Basin Study (1974). There is some opportunity to increase useable supply within the Duteau watershed:

- Expand the diversion works of the Gold-Paradise watershed further east to capture more water. This portion of watershed could provide anywhere from 3000 to 7000 ML of additional annual supply (depending on area), with the added bonus of a delayed freshet in May and June due to the snow capture and freezing at the higher elevations. Water from this area would be conveyed to Aberdeen Lake. This option will likely have significant regulatory hurdles involving additional water licensing, as the inter-basin transfer issue identified in Section 3.0 comes into play, and may render this option as unfeasible.
- KWL (2012) showed that raising Aberdeen reservoir by 2 metres would store an additional 5,316 ML of water.
    - Increasing the height by 4 metres adds 11,670 ML for a total live storage of 22,000 ML. According to GVW operations, the current reservoir does not always fill to capacity. This 4 metre addition has some additional structural costs identified, which increases the complexity of the work. In our view, the viability of the project appears to improve if more water is sourced through the extension of the Gold-Paradise diversion watershed. Raising the dam above 4 metres will increase the capacity of the reservoir to levels beyond the current licensed storage capacity in the watershed (KWL, 2012).

  - GVW has also noted in discussions that options were presented to raise this reservoir by 5.5 metres. While no studies are available to confirm this, the benefits of an even larger reservoir than mentioned previously would be for flood control on Lower Duteau Creek, and minimizing damage to downstream stakeholders in Lumby and to provide increased base flow in Bessette Creek for fisheries purposes. Controlling flood flows could also benefit and lower the spillway costs of a future dam on Lower Duteau Creek.
- The Lower Duteau storage projects, such as the Flyfish diversions or one of the Duteau Dam concepts are attempts to capture the freshet; the majority of the 19,000 ML of uncontrolled runoff from the Lower Duteau Creek Watershed.

By implementing all of the above projects (see Table 4-2), we estimate that up to 24,000 ML/yr of additional annual demand in the GVW could be supplied from the Duteau watershed.

Table 4-2
Remaining Storage Projects Available in the Duteau Watershed

Project	Annual Supply Available (ML/yr)
Gold-Paradise diversion	3,000
Aberdeen Dam Upgrades	10,000
Lower Duteau Dam	8,000
Flyfish Diversion	3,000
Total Potential Supply Increase	24,000

To assist with distribution and storage balancing within the GVW distribution system, an attractive internal storage project is to expand Goose Lake, although land ownership issues involving the additional reservoir land would need to be negotiated with the Okanagan Indian Band. This would provide additional storage of irrigation water for lands west of Swan Lake and the Bella Vista area. It would also allow for future supply to irrigated areas east of Swan Lake, if system separation does occur in the future. Filling of this reservoir would continue from the Duteau water supply, and provide some assistance in supplying peak demand during the summer months. As noted in the analysis, other options include:

- Construct the “Grey Line” and diversion from B.X. Creek. This would reduce water supplied off the Duteau System. This option only works if Goose Lake is expanded, and systems are separated.
- Blend or integrate the COV Reclaimed Water System into the agricultural supply. Goose Lake is a potential internal storage location for direct supply from the water treatment plant or indirectly from MacKay Reservoir. The filling of Goose Lake with reclaimed water would occur during the winter months from MacKay Reservoir when the irrigation systems are idle.

The projects noted in this analysis, along with possible localized groundwater supply opportunities, offer enough supply to meet the anticipated demands to 2052 in Table 1-1, and the region’s water supply requirements well beyond the scope of this Master Water Plan. Once these projects are completed, and all of the existing licenses supplies would be utilized. The long term domestic water supply option for GVW would then likely be from Okanagan Lake. In TM2 – Evaluation of Water Supply Sources, it is recommended that GVW apply for a license reserve for all domestic supply off Okanagan Lake to maintain options for future development and growth.

4.1 Implementation Options

Several projects and strategies have been discussed in this report to either increase storage or develop new sources. TM 9 – System Separation options will examine some of the different factors that affect where source and storage development will be required and part of the long term plan into the future.

Table 4-3 presented a summary of potential storage projects potentially available to GVW to augment storage and water supply. There will always be many factors which affect how and when these projects can be implemented. These factors, both internal and external, include increase of demand, chronic drought shortages, water availability, licensing, water infrastructure condition, fisheries and environmental constraints, water quality, land ownership, cost of development, etc. The list is extensive.

Table 4-3
Summary of Potential Storage or Diversion Projects Available

Year	Project	Potential Storage Increase (ML)	Predicted Annual Supply Increase (ML)	Cost	Cost $/ML of supply	Potential for Construction
2022	Aberdeen Dam Upgrades (4m)	11,670	10,000	$6.41 M	$641	Good
2027	Goose Lake Expansion	2,000	0	$1.4M	N/A	Fair – Band land Issues
2037	Gold-Paradise Extension	0	3,000-7,600	$3.6 M	$1,200 – $475	Poor – inter-basin Transfer issues
2042	Incorporation of MacKay Reservoir	4,000	3,000	$4.0 M	$1,333	Fair
>2052	Lower Duteau Creek Dam	10,000	8,000	$17.7 M	$2,200	Fair
>2052	Flyfish Diversion	0	3,000	$3.3 M	$1,100	Poor
	B.X. Creek Supplies					
>2052	Grey Line	0	3,000	$15.0M	$5,000	Poor
>2052	Swan Lake Pump PS	0	3,000	$8.7M	$2,900	Poor
>2052	Greenhow Diversion	0	500	$5.4M	$10,800	Nil
> 2052	Okanagan Lake	50,000	50,000	N/A	N/A	Good

Notes:

1. Most annual supply quantities are unsubstantiated estimates based on conversion of storage and diversions to actual annual demand. It is estimated that not all reservoir storage increases result in an equivalent increase in annual demand capacity due to growth.
2. Timing of expansion of MacKay Reservoir would depend on a variety of factors. We e assume that the CoV Reclaimed Water system would be integrated into the agricultural water supply of GVW.
3. Only one of the B.X. Creek projects can be constructed (Grey Line or Swan Lake PS).
4. Potential for Construction is based on likelihood of construction given the cost of construction and difficulty in obtaining approvals. It is used in this analysis only to establish an implementation schedule.

It should also be noted that each of the GVW sources, including Okanagan Lake, Kalamalka-Wood Lake, Coldstream Creek and Duteau Creek have Water Quality Protection Plan, Environmental Plan and Source Protection Plans already in place or being enacted. There are also demands for additional minimum flows and minimum lake levels for various fisheries. The Water Act has the regulatory structure in place to license groundwater extraction, but the regulations are not being used. The Ministry of Environment has indicated that groundwater licenses will be required in the near future. The Ministry and DFO have noted in recent correspondence that additional minimum instream flows for Vernon Creek and other Duteau tributaries (ie. Bessette Creek) are required. Many of the factors noted above will affect some of the license transfer or diversion strategies discussed during this planning process. The transfers discussed included:

- Transfer of B.X. Creek licenses
- Transfer of Duteau or other licenses (ie. Deer Creek) to Kalamalka Lake or Okanagan Lake.
- Transfer and disposal of CoV reclaimed water to Kalamalka or Okanagan Lake then obtaining a consumptive use license.

5. Conclusions

Opportunities exist to add new storage or diversions into the GVW water system. The new projects either increase storage or increase water supply, and can be staged to meet the increasing demands of GVW. We conclude the following:

- Potential projects have been identified within both the Duteau and B.X. Creek systems to accommodate 24,000 ML/y of new domestic demand without accessing the Okanagan Lake as a source.
- Raising Aberdeen Dam by 4 metres results in 11,670 ML of increased storage capacity within the Duteau Creek Watershed.
    - Additional watershed acquisition, such as extending the Gold-Paradise Diversion, can guarantee that the new Aberdeen Reservoir will remain full, and lower the potential of risks due to drought.
- It is anticipated that Goose Lake will play a larger role in storage and distribution of raw water for the agricultural supply. We have included a project cost estimate to increase the storage at Goose Lake by 2,000 ML.
    - If the City of Vernon Reclaimed Water system is approved as an agricultural water supply source, then Goose Lake will likely become an important balancing reservoir with a MacKay Reservoir supply. For this to occur, an environmental assessment and public input process will be required.
- As demand increases, other, more expensive projects are available to increase supply out of Duteau Creek. These include a dam downstream of Haddo Lake on Lower Duteau Creek, diversion options of B.X. Creek, or a diversion off of Flyfish Lake to Haddo Lake (only if the Lower Duteau Creek option is not feasible).
- The decision to use Okanagan Lake may still be viable, but only as a potable water source.
- The expectations are that agricultural water use will not increase over the next 40 years, therefore all new water supply decisions should be based on urban/domestic demands. Cost allocation to agricultural users could be considered if supplies improve reliability during drought years. Otherwise cost allocation to domestic as new sources would free up domestic capacity from existing supplies.

6. Recommendations

- We recommend that GVW initiate discussions with the Ministry of Environment to examine water license transfers from existing unused licenses to other storage sources.
- We recommend that, regardless of the outcome of the long term plan for the water system, GVW should make an application for a water license reserve from Okanagan Lake for 50,000 ML/year to assure access to a long term potable source.
- We recommend that GVW further analyze and update the elevation-storage curves for Haddo and Aberdeen reservoirs to confirm actual live storage, prior to any assessment of additional upland storage needs.

7. References

City of Vernon. 2005. Liquid Waste Management Plan.

Clarke Geoscience Ltd. 2011. Drought Management Plan (Update Revised October 2011). Greater Vernon Water Utility.

EarthTech. 2005. Harvey Lake By-Pass Feasibility Study – Final Report, Greater Vernon Water Utility.

Kerr Wood Leidal. 2012. Duteau Creek Water Source Project Alternatives. Final Report. Greater Vernon Water Utility.

Kerr Wood Leidal. 2012. West Swan Lake System Separation, Greater Vernon Water Utility.

Mould Engineering, 2007. Water Source Review – Duteau Creek and Kalamalka-Wood Lake Systems. Greater Vernon Services – Water.

Appendix A. Conceptual Cost Estimates

Table A1. Conceptual Cost Estimate
Greater Vernon Water
2012 Water Master Plan
Aberdeen Dam (4 Metre Raise)

Component	Quantity	Units	Unit Cost	Extension
GENERAL CONTRACT REQUIREMENTS				
Bonds, Performance and Insurance (4%)	1	LS	$154,000	154,000
CIVIL				
Dam				
Stripping and Excavation	20,000	m^3	$5	100,000
Land Clearing	50	ha	$5,000	250,000
Earthworks	65,000	m^3	$30	1,950,000
Riprap and Channel Protection	6,000	m^3	$80	480,000
Spillway Expansion				
Concrete Structure	350	m^3	$1,500	525,000
Low Level Outlet Expansion				
Inlet and Gate	1	LS	$150,000	150,000
Concrete Retaining Wall	190	m^3	$1,500	285,000
Concrete Pipe - 750 diameter	30	m	$2,000	60,000
Outlet Channel	1	LS	$50,000	50,000
Road Works				
Revise road structure/Recreation	1	LS	$250,000	250,000
ELECTRICAL				
Upgrade Instrumentation/Automation	1	LS	$100,000	100,000
Sub-Total				*4,354,000*
Permitting and Approvals[3]			2%	90,000
Engineering			15%	660,000
Contingencies			30%	1,310,000
Total				*$ 6,414,000*

Notes

1. Concept developed from KWL (2012) - Duteau Creek Water Source Project Alternatives. Quantities adjusted by AE.
2. All prices are supply and installation, no taxes
3. Assume permitting and approvals include stakeholder involvement, Environmental Assessments, DFO and Nav Canada Authorizations.

Table A1a. Conceptual Cost Estimate
Greater Vernon Water
2012 Water Master Plan
Aberdeen Dam (2 Metre Raise)

Component	Quantity	Units	Unit Cost	Extension
GENERAL CONTRACT REQUIREMENTS				
Bonds, Performance and Insurance (4%)	1	LS	$81,000	81,000
CIVIL				
Dam				
Stripping and Excavation	15,000	m^3	$5	75,000
Land Clearing	25	ha	$5,000	125,000
Earthworks	30,000	m^3	$30	900,000
Riprap and Channel Protection	4,000	m^3	$80	320,000
Spillway Expansion				
Concrete Structure	150	m^3	$1,500	225,000
Low Level Outlet Expansion				
Inlet and Gate	1	LS	$150,000	150,000
Concrete Retaining Wall	90	m^3	$1,500	135,000
Concrete Pipe - 750 diameter	20	m	$2,000	40,000
Outlet Channel	1	LS	$50,000	50,000
Road Works				
Revise road structure/Recreation	1	LS	$100,000	100,000
ELECTRICAL				
Upgrade Instrumentation/Automation	1	LS	$100,000	100,000
Sub-Total				*2,301,000*
Permitting and Approvals[3]			2%	50,000
Engineering			15%	350,000
Contingencies			30%	690,000
Total				*$ 3,391,000*

Notes

1. Concept developed from KWL (2012) - Duteau Creek Water Source Project Alternatives. Quantities adjusted by AE.
2. All prices are supply and installation, no taxes
3. Assume permitting and approvals include stakeholder involvement, Environmental Assessments, DFO and Nav Canada Authorizations.

Table A2. Conceptual Cost Estimate
Greater Vernon Water
2012 Water Master Plan
Goose Lake Expansion

Component	Quantity	Units	Unit Cost	Extension
GENERAL REQUIREMENTS				
Bonds, Performance and Insurance (4%)	1	LS	27,000	27,000
CIVIL				
Diversion				
Land Clearing	3	ha	10,000	30,000
North Dam - Earthworks (2.5:1 side Slope) [2]	8,000	m^3	50	400,000
South Dam - Earthworks (2.5:1 side Slope) [2]	3,000	m^3	50	150,000
Low Level Outlet				
New Inlet and Gate[1]	1	LS	100,000	100,000
Concrete Pipe - 600 diameter	40	m	1,000	40,000
Outlet and Channel	1	LS	50,000	50,000
Road Works				
Revise road structure	1	LS	50,000	50,000
ELECTRICAL				
Instrumentation/Automation	1	LS	100,000	100,000
Sub-Total				*947,000*
Permitting and Approvals[3]			2%	20,000
Engineering			15%	150,000
Contingencies			30%	280,000
Total				*$ 1,397,000*

Notes

1. All prices are supply and installation, no taxes
2. Assume dam is earthen dam 2 metres high, including filter and riprap.
3. Assume permitting and approvals include stakeholder involvement, Environmental Assessments, DFO and Nav Canada Authorizations.

Table A3. Conceptual Cost Estimate
Greater Vernon Water
2012 Water Master Plan
Gold Paradise Diversion Extension

Component	Quantity	Units	Unit Cost	Extension
GENERAL REQUIREMENTS				
Bonds, Performance and Insurance (4%)	1	LS	94,000	94,000
CIVIL				
Dam				
Land Clearing	90	ha	5,000	450,000
Road/Dam Earthworks (2.5:1 side Slope) [1]	3,000	m	500	1,500,000
Channeling	3,000	m	100	300,000
Diversion Structure				
New Inlet and Gate	1	LS	100,000	100,000
Sub-Total				*2,444,000*
Permitting and Approvals[2]			2%	50,000
Engineering			15%	370,000
Contingencies			30%	730,000
Total				*$ 3,594,000*

Notes

1. All prices are supply and installation, no taxes
2. Assume permitting and approvals include stakeholder involvement, Environmental Assessments, DFO and Nav Canada Authorizations.

Table A4. Conceptual Cost Estimate
Greater Vernon Water
2012 Water Master Plan
Flyfish Diversion to Haddo

Component	Quantity	Units	Unit Cost	Extension
GENERAL REQUIREMENTS				
Bonds, Performance and Insurance (4%)	1	LS	$86,000	86,000
CIVIL				
Diversion				
Land Clearing	30	ha	$5,000	150,000
Miscellaneous Civil and Drainage	1	LS	$100,000	100,000
Channeling	65,000	m^3	$20	1,300,000
Rock Excavation	1	LS	$500,000	500,000
Diversion Structure				
New Inlet and Gate	1	LS	$100,000	100,000
Sub-Total				*2,236,000*
Permitting and Approvals[3]			2%	50,000
Engineering			15%	340,000
Contingencies			30%	670,000
Total				*$ 3,296,000*

Notes

1. Concept developed from KWL (2012) - Duteau Creek Water Source Project Alternatives.
2. All prices are supply and installation, no taxes
3. Assume permitting and approvals include stakeholder involvement, Environmental Assessments, DFO and Nav Canada Authorizations.

Table A5. Conceptual Cost Estimate
Greater Vernon Water
2012 Water Master Plan
Lower Duteau Creek Dam

Component	Quantity	Units	Unit Cost	Extension
GENERAL CONTRACT REQUIREMENTS				
Bonds, Performance and Insurance (4%)	1	LS	458,000	458,000
CIVIL				
Dam				
Land Clearing	20	ha	5,000	100,000
Earthworks (2.5:1 side Slope) [2]	120,000	m^3	50	6,000,000
Spillway				
Concrete Structure [3]	2,800	m^3	1,200	3,360,000
Rock Excavation	1	LS	500,000	500,000
Low Level Outlet				
Inlet and Gate	1	LS	250,000	250,000
Concrete Structure	1	LS	500,000	500,000
Concrete Pipe - 750 diameter	120	m	2,000	240,000
Outlet and Channel	1	LS	250,000	250,000
Road Works				
Revise road structure	1	LS	100,000	100,000
ELECTRICAL				
Instrumentation/Automation	1	LS	250,000	250,000
Sub-Total				*12,008,000*
Permitting and Approvals[4]			2%	250,000
Engineering			15%	1,810,000
Contingencies			30%	3,600,000
Total				*$ 17,668,000*

Notes

1. All prices are supply and installation, no taxes
2. Assume dam is earthen dam, 35 metres high. Earthworks assume supply, handling and compaction.
3. Assume spillway is concrete, rectangular configuration with 300 mm thick walls, 10 m wide.
4. Assume permitting and approvals include stakeholder involvement, Environmental Assessments, DFO and Nav Canada Authorizations.

Table A6. Conceptual Cost Estimate
Greater Vernon Water
2012 Water Master Plan
Gravity Supply from BX Creek (Gray Line)

Component	Quantity	Units	Unit Cost	Extension
GENERAL CONTRACT REQUIREMENTS				
Bonds, Performance and Insurance (4%)	1	LS	$393,000	393,000
CIVIL				
WATERMAIN				
Supply & Install 600 mm ductile iron	12,300	m	$570	7,011,000
Supply 600 mm gate valve	2	ea	$30,000	60,000
Install air release chamber	1	ea	$15,000	15,000
Pressure test and disinfect new main	1	LS	$55,000	55,000
Level/valve control station	2	ea	$175,000	350,000
Case bore for highway crossing	50	lin.m.	$2,500	125,000
DIVERSION STRUCTURE				
Land Clearing	2	ha	$5,000	10,000
Screened Intake	1	LS	$500,000	500,000
ROADWORK				
Salvage existing road structure	1	LS	$1,500,000	1,500,000
Access Road to Intake	1	LS	$100,000	100,000
ELECTRICAL				
Instrumentation/Automation	1	LS	$100,000	100,000
Sub-Total				*10,219,000*
Permitting and Approvals[3]			2%	210,000
Engineering			15%	1,540,000
Contingencies			30%	3,070,000
Total				*$ 15,039,000*

Notes

1. Quantities and concept developed from KWL (2012) - Greater Vernon Water West Swan Lake System Separation KWL File No. 773.088
2. All prices are supply and installation, no taxes
3. Assume permitting and approvals include stakeholder involvement, Environmental Assessments, DFO and Nav Canada Authorizations.

Table A7. Conceptual Cost Estimate
Greater Vernon Water
2012 Water Master Plan
Pumpstation on Swan Lake

Component	Quantity	Units	Unit Cost	Extension
GENERAL CONTRACT REQUIREMENTS				
Bonds, Performance and Insurance (4%)	1	LS	$228,000	228,000
CIVIL				
WATERMAIN				
Supply & Install 600 mm HDPE watermain	200	m	$300	60,000
Supply & Install 600 mm Ductile Iron watermain	500	m	$570	285,000
Supply 600 mm butterfly valves	3	ea	$15,000	45,000
Miscellaneous Mechanical	1	ea	$20,000	20,000
Directional Drilling	200	m	$900	180,000
PUMPSTATION				
Pump Station Construction	1	LS	$5,000,000	5,000,000
Decommission existing station	1	LS	$50,000	50,000
ROADWORK				
Salvage existing road structure	1	LS	$30,000	30,000
Access Road to Intake	1	LS	$30,000	30,000
Sub-Total				*5,928,000*
Permitting and Approvals[3]			2%	120,000
Engineering			15%	890,000
Contingencies			30%	1,780,000
Total				*$ 8,718,000*

Notes

1. Quantities and concept developed from KWL (2012) - Greater Vernon Water West Swan Lake System Separation
2. All prices are supply and installation, no taxes
3. Assume permitting and approvals include stakeholder involvement, Environmental Assessments, DFO and Nav Canada Authorizations.

Table A8. Conceptual Cost Estimate
Greater Vernon Water
2012 Water Master Plan
Greenhow Diversion

Component	Quantity	Units	Unit Cost	Extension
GENERAL CONTRACT REQUIREMENTS				
Bonds, Performance and Insurance (4%)	1	LS	$142,000	142,000
CIVIL				
WATERMAIN				
Supply & Install 400 mm ductile iron	6,000	m	$375	2,250,000
Supply 400 mm gate valve	2	ea	$25,000	50,000
Install air release chamber	1	ea	$15,000	15,000
Pressure test and disinfect new main	1	LS	$25,000	25,000
Level/valve control station	1	ea	$200,000	200,000
Case bore for highway crossing	50	lin.m.	$2,500	125,000
DIVERSION STRUCTURE				
Land Clearing	4	ha	$5,000	20,000
Screened Intake	1	LS	$300,000	300,000
ROADWORK				
Salvage existing road structure	1	LS	$300,000	300,000
Access Road to Intake	1	LS	$200,000	200,000
ELECTRICAL				
Instrumentation/Automation	1	LS	$60,000	60,000
Sub-Total				*3,687,000*
Permitting and Approvals[3]			2%	80,000
Engineering			15%	560,000
Contingencies			30%	1,110,000
Total				*$ 5,437,000*

Notes

1. Quantities and concept developed from RDNO Staff communications
2. All prices are supply and installation, no taxes
3. Assume permitting and approvals include stakeholder involvement, Environmental Assessments, DFO and Nav Canada Authorizations.

Appendix B. Figures

Legend

Sub-Catchment

Headgates

Lower Duteau Dam (Option A)

Lower Duteau Dam (Option B)

Raise Aberdeen Dam (4 m)

Flyfish Diversion

Existing diversion

Gold - Paradise (new) diversion extension

Existing diversion

Cosens Cr.
Crastey Cr.
Duteau Cr.
Nicklen Cr.
Bessette Cr.
Grazer Lake
Mosquito Lake
Vidler Cr.
High Lake
King Edward Lake
Kaiser Bill Lake
Bear Lake
Edwin Lakes
Sinclair Lake
McAuley Cr.
Lily Pad Lake
Harris Cr.
Min Lake
Streak Lake
Hidden Lake
Nicklen Lake
Goat Mountain Lake
Wilma Lake
Vernon Cr.
Curtis Lake
Jerry Lakes
Park Lakes
Doreen Lake
Roly Lake
Aberdeen Lake
Dee Lake
Loon Lake
Alex Lake
Rankin Lake
Island Lake
Flyfish Lakes
Aileen Lake
Home Cr.
Haddo Lake
Specs Lakes
Heart Cr.
Lost Lake
Deer Lake
Ruth Lake
Brunette Lake
Paradise Cr.
Crib Cr.
Gal Cr.
Harris Lake
West Harris Cr.
Nahm Lake
Crooked Lake
Rod Lake
Grizzly Lake
Wollaston Lake
Swalwell Lake
Thelma Lake
Moore Lake
Ideal Lake

N W E

0 0.5 1 2 3 4 Kilometers

DRN BY:	BdJ				
DES BY:	RM				
CHK BY:					
APP BY:					
REV	DESCRIPTION		DRN	CHK	DATE (M/D/Y)
	2012 WMP				

AECOM
SUITE 201, 3275 LAKESHORE ROAD,
KELOWNA, B.C. V1W 3S9
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WWW.AECOM.COM

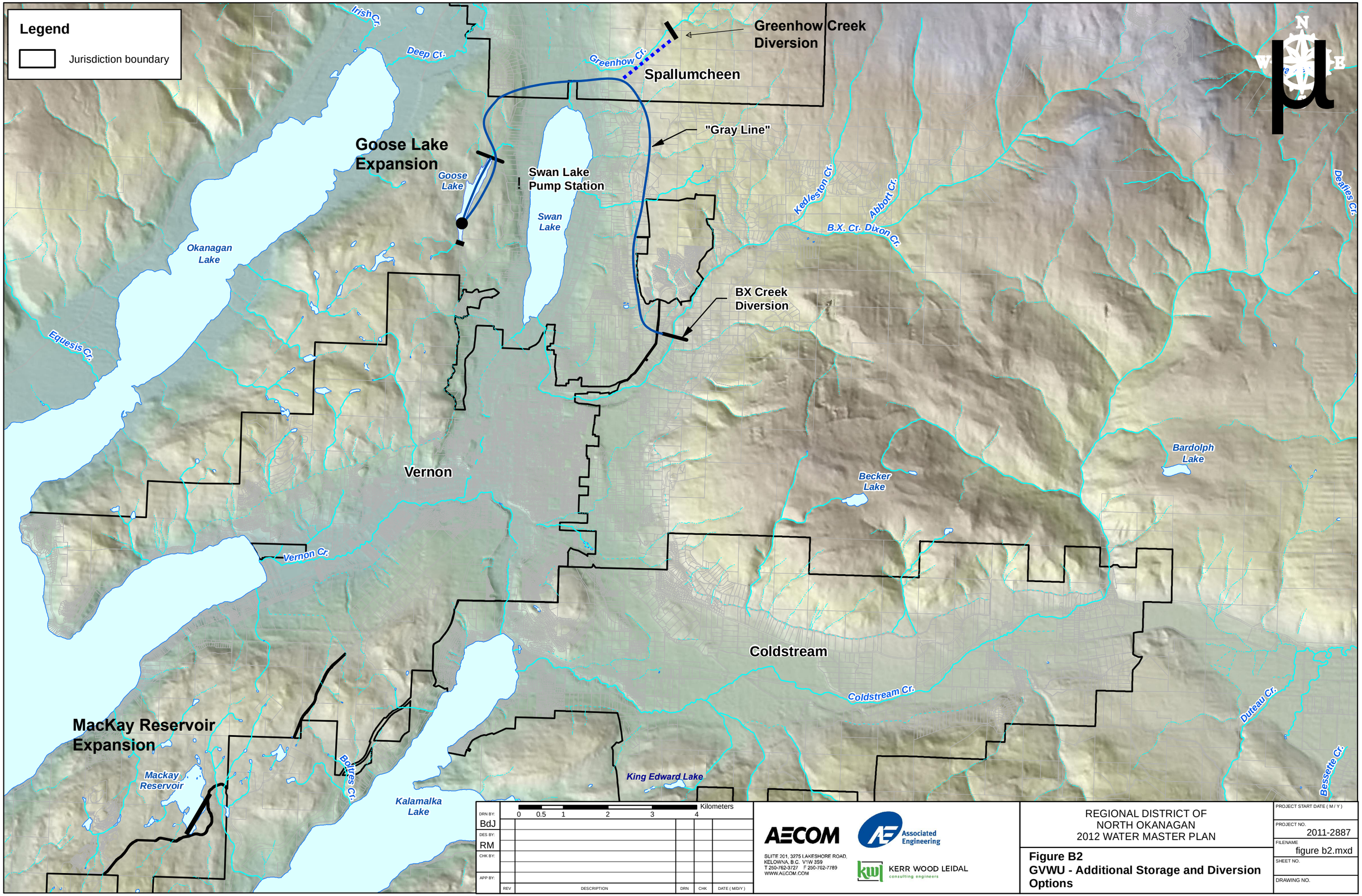
Associated Engineering

KERR WOOD LEIDAL consulting engineers

REGIONAL DISTRICT OF
NORTH OKANAGAN
2012 WATER MASTER PLAN

Figure B1
Additional Storage and Diversion Options

PROJECT START DATE (M / Y)	
PROJECT NO.	2011-2887
FILENAME	figure b1.mxd
SHEET NO.	
DRAWING NO.	



DRN BY:	DES BY:	CHK BY:	APP BY:	REV	DESCRIPTION	DRN	CHK	DATE (M/D/Y)
BdJ	RM							

AECOM
SUITE 201, 3275 LAKESHORE ROAD,
KELOWNA, B.C. V1W 3S9
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Associated Engineering

KERR WOOD LEIDAL consulting engineers

REGIONAL DISTRICT OF
NORTH OKANAGAN
2012 WATER MASTER PLAN

Figure B2
GVWU - Additional Storage and Diversion Options

PROJECT START DATE (M / Y)	
PROJECT NO.	2011-2887
FILENAME	figure b2.mxd
SHEET NO.	
DRAWING NO.	

Appendix C. Duteau Creek Watershed – Potential Water Source

Duteau Creek Watershed – Potential Water Sources

Potential new water sources were identified to provide additional water supply for GVW (Figure B1 – Appendix B). The two new sources include a portion of the headwaters of Paradise Creek and a portion of the headwaters of Nicklen Creek above Nicklen Lake. Both of these water source areas would require diversion infrastructure to be implemented; however, based on a preliminary topographic review and location of existing infrastructure (e.g. forest service roads) both of these water source areas could be considered for further feasibility investigations. Only the Paradise Creek extension option is presented here.

Option 1 – Paradise Creek

Paradise Creek is a sub-watershed of the Harris Creek watershed. Currently, the Gold-Paradise Diversion operated by GVW intercepts water from both Paradise and McAuley Creeks (via a 3 km interceptor channel, two headponds, and a diversion structure on Paradise Creek), which is then diverted into Heart Creek (in the Aberdeen Creek watershed). Based on a topographic review of the watershed adjacent to the current Gold-Paradise Diversion contributing area, an additional 10.4 km^2 of the Paradise Creek sub-watershed could be considered for diversion. This diversion assumes that the network of existing forest service roads could be utilized to divert this additional water into the existing Gold-Paradise Diversion infrastructure.

Based on the above assumption, the water supply estimate for this Paradise Creek option was estimated as follows:

- The Paradise Creek sub-watershed is located in the Okanagan Highlands Hydrologic Zone #23; subzone “c” (Obedkoff 2003);
- Drainage area (10.4 km^2) and median elevation (1809 m) were calculated using available GIS coverage and digital elevation information (Land Resources Data Warehouse 2011);
- This analysis used the annual runoff vs. median elevation relations developed during Phase 2 of the OWSDP (Summit 2009). The Okanagan Basin’s Hydrologic Group 8 runoff relationship was assumed representative of the Paradise Creek sub-watershed, which is similar to the runoff relationship developed by Obedkoff (1998) for the Okanagan Highlands Hydrologic Zone #23. The OWSDP runoff relationship is naturalized to a 1996-2006 period, while the Obedkoff (1998) is naturalized to a 1961-1990 period. In order to ensure consistency of periods of records between runoff relationships, any differences in periods of record were eliminated by standardizing all records using the Water Survey of Canada (WSC) station “Kettle River near Ferry” (WSC Station No. 08NN013), which has records extending from 1929-2010. This station was selected because it contains the longest continuous record of natural streamflow in proximity to the Okanagan Basin and is expected to be generally representative of the hydrologic regime of the Okanagan Basin; and
- The standardized mean annual water supply for the Paradise Creek sub-watershed is 7,609 ML. For this study, we are assuming that 3000 ML/year of this runoff is available for consumption.