REPORT

7 March 2016

MOE GROUNDWATER SCIENCE STUDY

Lower Nicola Valley Groundwater Budget

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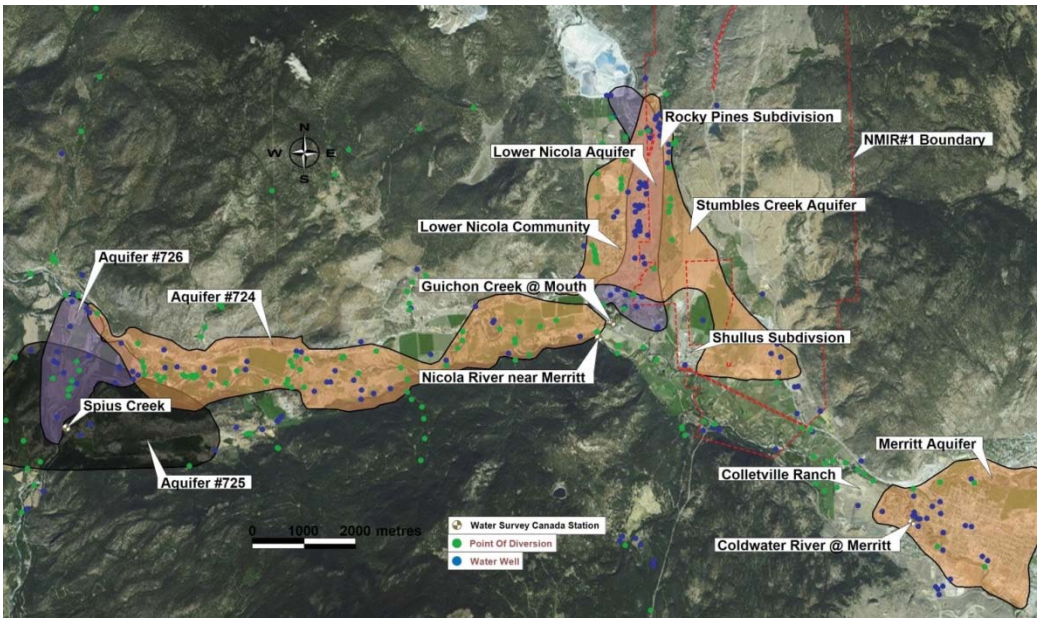

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) is pleased to provide this groundwater budget for the Nicola Valley between Merritt and Spius Creek. The work program followed Golder's proposals to the Fraser Basin Council dated June 4, 2015 and September 23, 2015.

2.0 OBJECTIVE

The project's objective was to develop a groundwater budget for the area encompassing the unconfined aquifers in the Lower Nicola Valley between the confluence of the Coldwater and Nicola Rivers in Merritt to the east and the confluence of Spius Creek and the Nicola River to the west (the "study area").

The unconfined aquifers have been mapped and classified by the BC Ministry of Environment (MOE) and have been described as connected whereby changes in flow or water level in an aquifer will result in changes in flow or water level in the connected surface water or vice versa. Presentations given by MOE March 1, 2016 support the aquifers being connected as they are alluvial with rivers cutting through, and simultaneously depositing the alluvial material. The purpose of developing a water budget is to better understand the aquifer system to assist provincial regulators in allocating or managing groundwater extraction in the study area. The province wishes to allocate groundwater licences in a manner that reduces the potential for long-term groundwater level declines in the aquifers and protects base flow in the Nicola River. It is stressed, however, that this document is a first step in reaching that goal and further work may be required to allow the use of the water budget tool for water allocation.

3.0 SCOPE OF WORK

The general scope of work was to develop a conceptual hydrogeological model and groundwater budget for the study area. The model and budget would provide an estimate of inflow (recharge) and outflow (discharge) from the aquifer system. The conceptual model and groundwater budget were to be developed using existing available information that included but was not limited to: MOE databases, hydrometric data, climate data, land use and population information, surface water licences, irrigation requirements, previous groundwater and watershed studies.

The water budget was to be developed as a spreadsheet mass water balance. The mass balance was to be for the entire study area and not broken into individual stream reaches. Where possible, identification of probable gaining or losing sections of the Nicola River was made based on river geomorphology, available data and literature review.

The scope of work did not include gathering any new data for the project; however, Golder and MOE collected groundwater and surface water samples for analyses of stable oxygen and hydrogen isotopes. The isotope analyses were completed to help understand mixing of waters from deep confined aquifers, shallower/unconfined aquifers and the Nicola River and where possible to identify elevation of recharge. The additional work was completed within the allocated project budget.

The project deliverables were:

- A summary report presenting the conceptual model and describing the water budget;
- The water budget; and,
- Identification of information gaps and suggestions for additional data acquisition.

4.0 DESCRIPTION OF THE STUDY AREA

The study area was established by the MOE and the Ministry of Forests, Lands and Natural Resource Operations (FLNR) and encompassed the Nicola River Valley from the confluence of the Nicola and Coldwater Rivers at the City of Merritt (Merritt), to the confluence of the Nicola River and Spius Creek. The study area also encompasses the lower reach of Guichon Creek by extending to the north end of the Lower Nicola community and Rocky Pines subdivision. The study area is illustrated on Figure 1 and encompasses approximately 3,000 hectares (ha). Figure 1 extends from Nicola Lake in the east to the Water Survey of Canada (WSC) station on the Nicola River near Spences Bridge to the west, as data from this geographic area was used to prepare the groundwater budget and was relevant to evaluating flows into and out of the study area.

Figure 1: Area Plan

Figure 2 provides a more detailed map of the study area that includes licensed surface water points of diversion (PODs), water wells in the MOE WELLS database and MOE mapped aquifers. The relationships between these aquifers are discussed in more detail in Section 4.4. Moving westward from Merritt, the study area includes the Collettville Ranch, the Nicola-Mameet Indian Reserve #1 (NMIR), the community of Lower Nicola and a collection of ranches and rural agricultural areas. Based on water license information and aerial photography from Google Earth, Golder estimated that approximately 600 ha of land were irrigated by direct surface water extraction from the Nicola River in the study area. The Collettville Ranch obtains its water from the Nicola River downstream of the Nicola-Coldwater confluence; however, its water licence is for the Coldwater River.

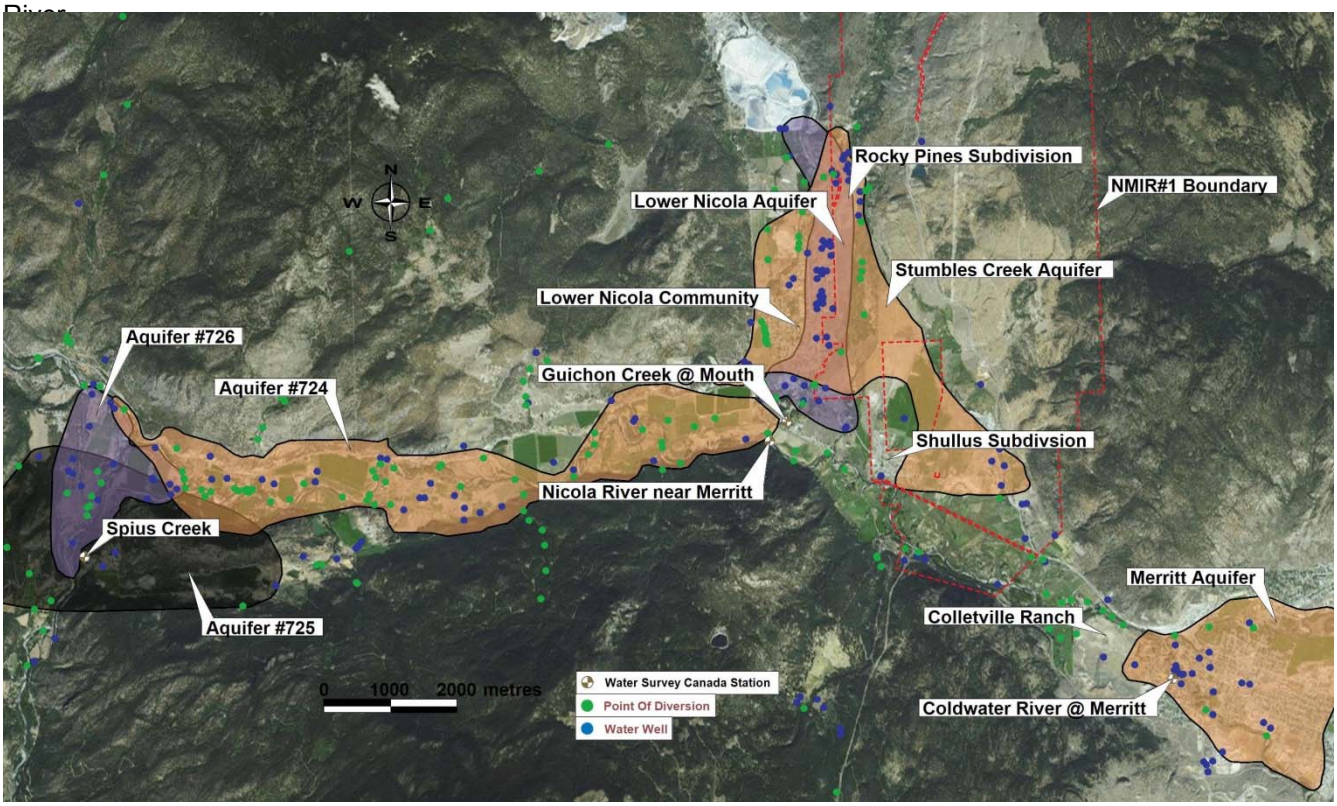

Figure 2: Site Plan

4.1 Surficial and Bedrock Geology

The surficial geology of the study area has been mapped by the Geological Survey of Canada (Fulton 1975) and consists of:

- In the NMIR and Lower Nicola community, Quaternary fan deposits consisting of poorly sorted gravel, sand, silt and clay overlying thick glaciolacustrine sediments, overlying glacial and interglacial deposits. Fulton (1975) states that these geological formations represent two periods of distinct glaciation and at least two periods of non-glacial (interglacial) sediment deposition; and,
- Along the main Nicola River valley axis, modern alluvium consisting of sand, gravel and silt, with some smaller Quaternary fan deposits from valley side drainage features.

The uplands at the west and southwest ends of the study area predominantly comprise Lower Cretaceous volcanic rocks of the Spences Bridge Group. The uplands to the east of the study area comprise volcanic (and minor sedimentary) rocks of the Upper Triassic Nicola Group (Cockfield 1961). Plutonic intrusions of Early Jurassic are present south and further north of the study area. The north end of the study area is composed of Cenozoic to Eocene andesitic volcanic rocks of the Princeton Group.

4.2 Hydrometric Data

The locations of the hydrometric stations (shown as Water Survey of Canada - WSC) used to develop the groundwater budget are illustrated on Figure 1. The hydrometric data were used to estimate river gain or loss due to groundwater exchange. Hydrometric stations above and below the study area were utilized as there were no long term stations corresponding to the upstream and downstream study area boundaries. The stations and the periods of record (data verified by WSC) used to assess mean monthly flows are listed below. All of the WSC stations are currently active except for “Nicola River near Merritt”.

- Nicola River at Outlet Nicola Lake (WSC 08LG065) 1983 to 2013;
- Coldwater River at Merritt (WSC 08LG010) 1962 to 2103;
- Nicola River near Merritt (WSC 08LG007) 1958 to 2007;
- Guichon Creek at Mouth (WSC 08LG067) 1985 to 2010;
- Spius Creek near Canford (WSC 08LG008) 1971 to 2011; and,
- Nicola River near Spences Bridge (WSC 08LG006) 1958 to 2011.

Ungauged stream flows between WSC stations were also estimated and included in the water budget to estimate river gain or loss due to tributary inflow. These ungauged streams are illustrated on Figure 1 with the majority of streams situated between WSC stations “Nicola River near Merritt” and “Nicola River near Spences Bridge”. The methodology to estimate ungauged stream flow and the estimated mean monthly flows for the ungauged streams is provided in Appendix A.

4.3 Climate

The closest Environment Canada climate station to the study area is the “Merritt STP” station located in Merritt at an elevation of 609 m amsl. Environment Canada 1981 to 2010 climate normals indicate that the mean annual temperature in Merritt is 4.2ºC, and daily average temperature ranges from -3.7ºC in December to 18.8ºC in July. The total annual precipitation is 321 mm, of which 50% falls between October and March. The wettest month is December and the driest month is April. Snowfall accounts for 20% of the annual precipitation.

4.4 Aquifer Mapping

MOE has mapped two unconfined aquifers and one confined aquifer in the study area. Aquifer mapping is based on available water well records and geological mapping and interpretation. Mapped aquifers adjacent to the study area are the Merritt Aquifer (unconfined aquifer #74) at the upstream/east study boundary and confined bedrock (#725) and overburden aquifers (#726) at Spius Creek near the downstream study boundary. Merritt has completed a water supply well in a confined aquifer beneath its city for water supply but the aquifer has not yet been mapped by MOE. Mapped aquifer boundaries are illustrated on Figure 2.

Figure 3 shows the locations of two hydrogeological cross-sections prepared through the study area. The cross-sections were developed from available water well records from the WELLS database and elevation data available from Google Earth. Lithology reported on the water well records was interpreted to comprise the geological units of alluvium, alluvial fan (Quaternary) deposits, glaciolacustrine deposits, glaciofluvial deposits or bedrock. Figure 4 provides a cross-section A-A’ looking eastward through the western portion of the study area and Figure 5 provides a cross-section B-B’ looking north through the NMIR and Lower Nicola community. Cross-sections A-A’ and B-B’ have vertical exaggerations of 2 times and 5 times respectively. The lateral (east-west) extent of the Lower Nicola Aquifer (B-B’ cross-section) is based on MOE aquifer mapping. In both cross-sections, the total thicknesses of the unconsolidated valley bottom deposits are unknown; similarly, the exact locations of the contacts between overburden deposits are unknown in some areas. Uncertainties in geological contacts in the cross-sections are illustrated by question marks. Cross-section B-B’ shows the glaciolacustrine confining layer being continuous across the valley however, it is unknown if the confining layer is continuous across the entire aquifer.

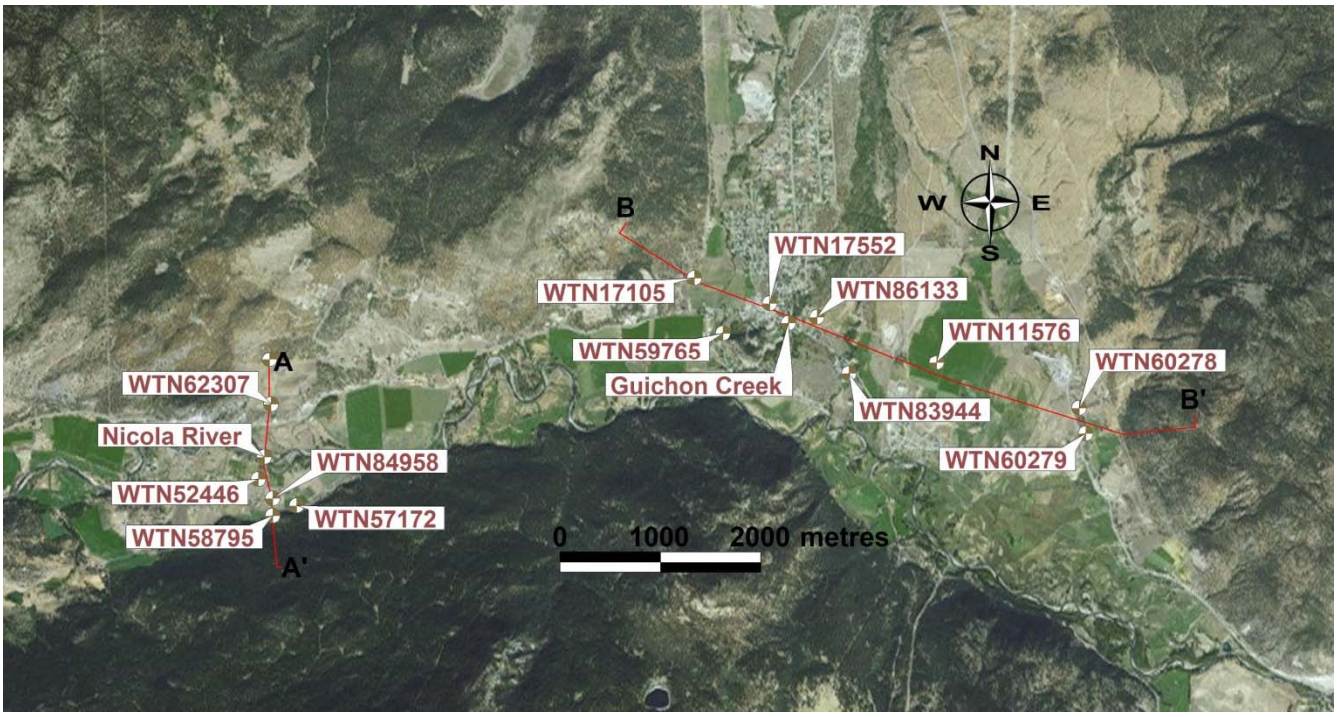

Figure 3: Hydrogeological cross-section locations

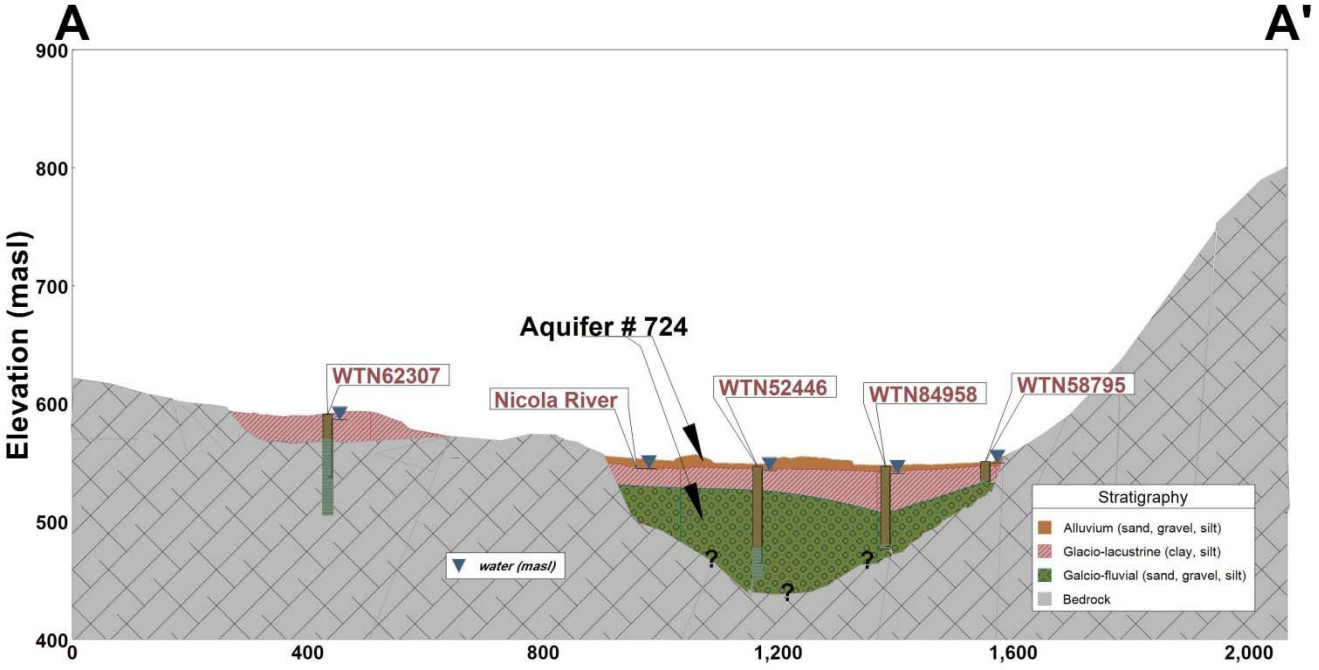

Figure 4: Hydrogeological cross-section A-A' looking east

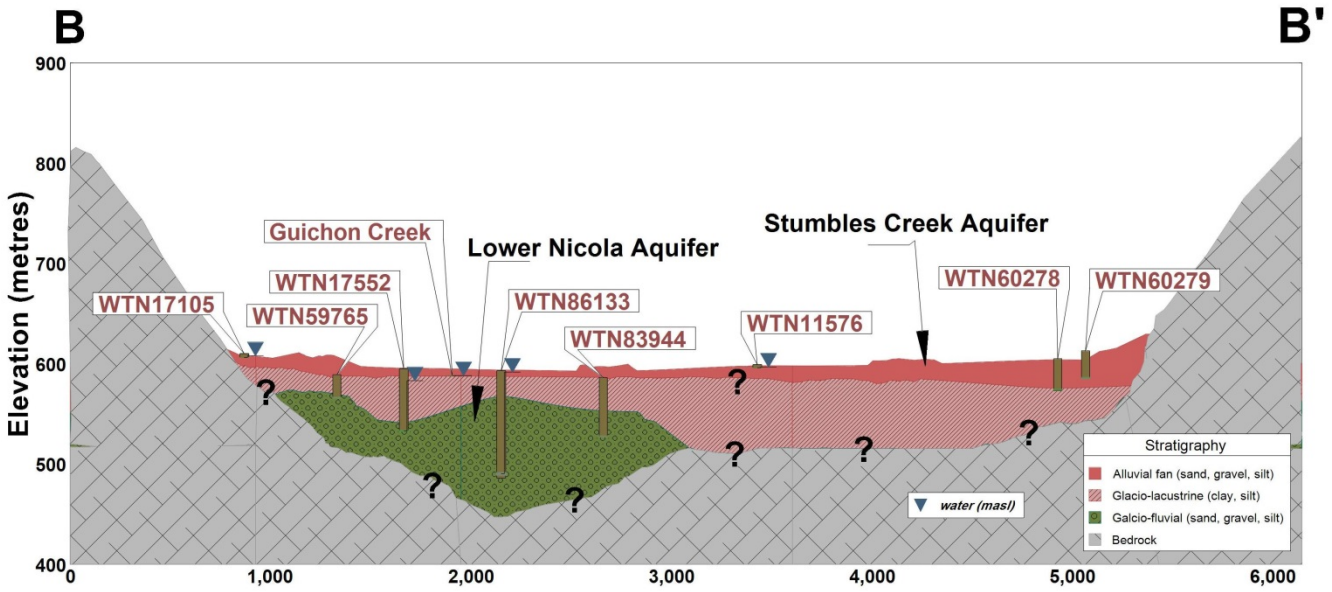

Figure 5: Hydrogeological cross-section B-B' looking north

Aquifers mapped by MOE are summarized in Table 1. The aquifer classification used by MOE is presented in Berardinucci and Ronneseth (2002). In general terms, aquifers are rated based on a development sub-class from I to III which are respectively heavy to light use and for their vulnerability sub-class from A to C which are respectively from high to low vulnerability. Unconfined aquifers such as the Stumbles Creek Aquifer have an A rating and confined aquifers such as the Lower Nicola Aquifer have a C rating. In very general terms, an IA aquifer would be of the greatest concern (heavily used and highly vulnerable) and an IIIC aquifer (lightly used and of low vulnerability) of the least concern. The ranking component for each aquifer is also described in Berardinucci and Ronneseth (2002).

Table 1: MOE Mapped Aquifers in Study Area

	76	77	724	725	726
Aquifer name	Stumbles Ck	Lower Nicola	None	None	None
Year mapped	1994	1994	2004	2004	2004
Aquifer Classification	IIIA	IIC	IIIA	IIIB	IIIC
Rank	10	8	10	8	8
Geological formation	Fan Deposits	Pre-Glacial Deposits	Gravel, Cobble Terrace	Bedrock	Buried Floodplain
Materials	Sand, Gravel	Sand, Gravel	Sand, Gravel	Volcanic	Sand, Gravel
Confined/unconfined	Unconfined	Confined	30% Confined	Confined	Confined
Use	Domestic	Domestic, Water System	Domestic	Domestic	Domestic & Irrigation
Demand	Low	Moderate	Low	Low	Low
Productivity	Not Given	Not Given	Moderate	Low	Moderate
Average yield (L/sec)	0.8	1.3	3.3	0.3	2.7
Vulnerability	High	Low	High	Moderate	Low
Source of recharge	Precipitation	Precipitation	Precipitation & River Loss	Precipitation	Adjacent Formations
Size (km^2)	7	3	11	11	3.5

4.5 Groundwater Use

Locations of water wells identified on the BC Water Resources Atlas (WRA) are plotted on Figure 2. The WRA indicates that two 203 mm (8 inch) diameter irrigation wells have been completed in Aquifer #724 with reported yields of 3.4 L/sec and 7.6 L/sec. An irrigation well is identified at the Collettville Ranch but its location is outside of the aquifer boundaries that have been mapped to date. Golder is aware of two flowing irrigation wells completed in the north end of the Lower Nicola Aquifer; the WRA contains information for one of the wells. Well data available from the WRA indicates that the majority of wells in the study area are used for domestic supply.

The Lower Nicola Indian Band operates two water systems on the Nicola-Mameet Indian Reserve. One of these water systems services the Shullus subdivision from water wells completed in the east side of the Stumbles Creek Aquifer and the second water system services the Rocky Pines subdivision from water wells completed in the north end of the Stumbles Creek Aquifer.

The Lower Nicola community is serviced by the Lower Nicola Waterworks District (LNWD). The LNWD utilizes three water wells completed in the Lower Nicola Aquifer that range from 57 m to 110 m in depth. One of the three wells (Well 3-99) is completed in the central portion of the Lower Nicola Aquifer with a reported shut in pressure of 38 psi at the time of construction (Golder 2005). The two remaining wells are not identified in the WRA but Golder is aware that the wells are completed in the southern portion of the Lower Nicola Aquifer. All three of the Lower Nicola community wells are flowing artesian wells.

The Lower Nicola Trailer Park is located on the south side of Highway 8 adjacent to the Shullus subdivision and obtains its water supply from two flowing wells completed in the Lower Nicola Aquifer. The wells are 54 m and 59 m deep.

5.0 ISOTOPE SAMPLING

5.1 Background

The stable isotopes of water mark it with a signature. The isotopes of oxygen and hydrogen referred to as Oxygen-18 (^{18}O) and Deuterium (^{2}H) respectively are compared with their respective "light" isotopes ^{16}O and ^{1}H using the ratio of heavy to light isotope against the Vienna Standard Mean Ocean Water (VSMOW). The ratios are presented as "del" (δ) values compared with the standard in values of per mil ‰ (1/1000). The del values are calculated for $\delta^{18}O$ as shown below:

$$\delta^{18}O \qquad {}^{o}/_{oo} = \left(\frac{(^{18}O/^{16}O)_{sample} - (^{18}O/^{16}O)_{smow}}{(^{18}O/^{16}O)_{smow}} \right) x1000$$

Where:

$(^{18}O/^{16}O)_{sample}$ is the heavy to light isotope ratio for the oxygen in the sample

$(^{18}O/^{16}O)_{smow}$ is the heavy to light isotope ratio for the oxygen in an internationally distributed standard

Similarly, the value of δD is calculated by replacing the ratio $^{18}O/^{16}O$ with the ratio $^{2}H/\,^{1}H$.

The two ratios of interest are $\delta^{18}O$(‰vsmow) and $\delta\,^{2}H$(‰vsmow). The term stable denotes the opposite of radioactive (i.e. the isotopes do not decay, do not emit any particles, and do not represent a health risk).

Meteoric water at differing elevations and differing latitudes is fingerprinted with a distinct stable isotope signature generally attributable to the physical processes that the water has undergone causing fractionation of the heavy and light isotopes. Primarily, these processes are evaporation, condensation and freezing where each cycle of evaporation and condensation (and freezing) tends to concentrate the heavy isotope in the condensed material.

Isotopic fractionation occurring during formation of precipitation at different temperatures results in differing values of $\delta^{18}O$ and $\delta\ D$ in precipitation from different latitudes. These differing values have been found to plot on a straight line referred to as the Global Meteoric Water Line (GMWL) which has the general form (Craig 1961):

$$\delta D = (8)\ \delta^{1\,8}O + 10$$

Although the slope of 8 is nearly constant globally, both the slope and the intercept can vary considerably, reflecting local meteorological, topographic and seasonal conditions and resulting in local meteoric water lines (LMWL). The ratios of the stable isotopes of water can be used as natural tracers of that water. Stable isotopes are considered to be conservative tracers as they are essentially unreactive in the subsurface and any changes in their values can be assumed to have resulted either from mixing of differing proportions of water with differing signatures or the recharge of water at differing elevations (with the signature increasingly depleted with higher elevation - Clark and Fritz 1997). Additionally, once water of a certain isotopic signature has entered the subsurface its signature can in many instances be used to identify the point of recharge relative to the point where the sample was collected. In regional flow systems, for instance, this may provide information or corroboration of physical hydrogeological interpretations related to the elevation of recharge.

5.2 Samples Collected

In late October 2015, Golder and MOE collected a series of surface water and groundwater samples within the study area to fingerprint water types and examine potential mixing of groundwater from shallow unconfined aquifers with groundwater from deeper confined aquifers and mixing of groundwater and surface water at known groundwater upwelling zones in the Nicola River. At the upwelling zones, mini-piezometers were driven approximately 0.7 m to 0.8 m below the river base. Groundwater samples were collected from the hyporheic zone using a peristaltic pump and Teflon tubing inserted in the temporary piezometer. A river sample was also collected at the upwelling location The Laboratory Analysis Reports are provided in Appendix B. The isotope sampling locations are illustrated on Figure 6 and comprised:

- The Nicola River 100 m upstream and 300 m downstream of its confluence with the Coldwater River;
- The Coldwater River at Voght Park in Merritt;
- A Merritt municipal supply well at Voght Park – Merritt Aquifer #74;
- Groundwater upwelling and the Nicola River at the Shullus subdivision;
- Guichon Creek at WSC station 08LG067;
- A domestic well drilled into the south end of the Stumbles Creek Aquifer #76;
- A flowing irrigation well drilled into the north end of the Lower Nicola Aquifer #77;
- The hyporheic zone and the Nicola River at the “Sunshine Road upwelling”;
- The hyporheic zone and the Nicola River at the “Pozzibon upwelling”;
- Herter Spring alongside Highway 8 between Lower Nicola and Spius Creek;
- Two shallow domestic water wells dug into Aquifer #724 alluvial sediments; and,
- The Nicola River 100 m upstream of its confluence with Spius Creek.

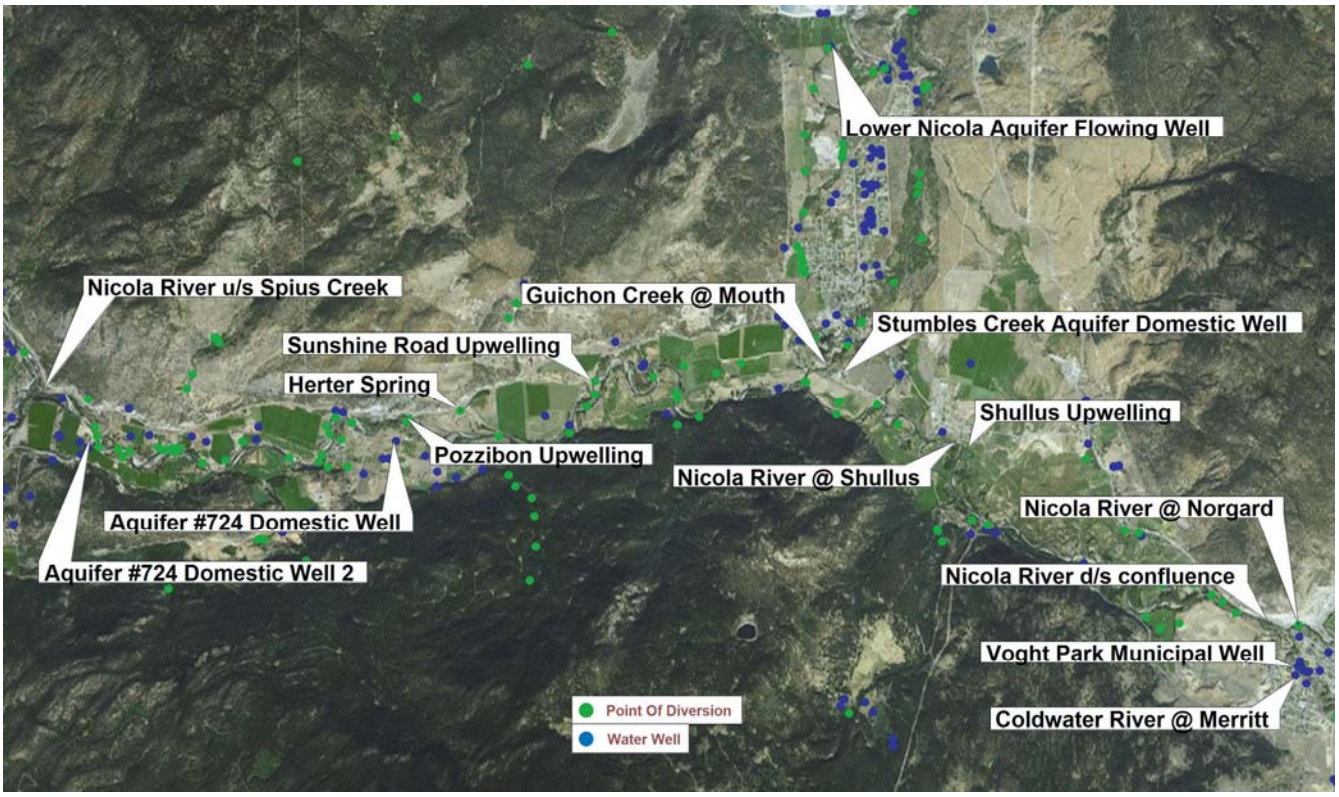

Figure 6: Isotope Sampling Locations

The water samples were analyzed for the stable isotopes of deuterium and oxygen-18. The results of the analyses are plotted on Figure 7. The GMWL and the Okanagan Meteoric Water Line (OMWL, Wassenaar et.al. 2011) are also shown on Figure 7.

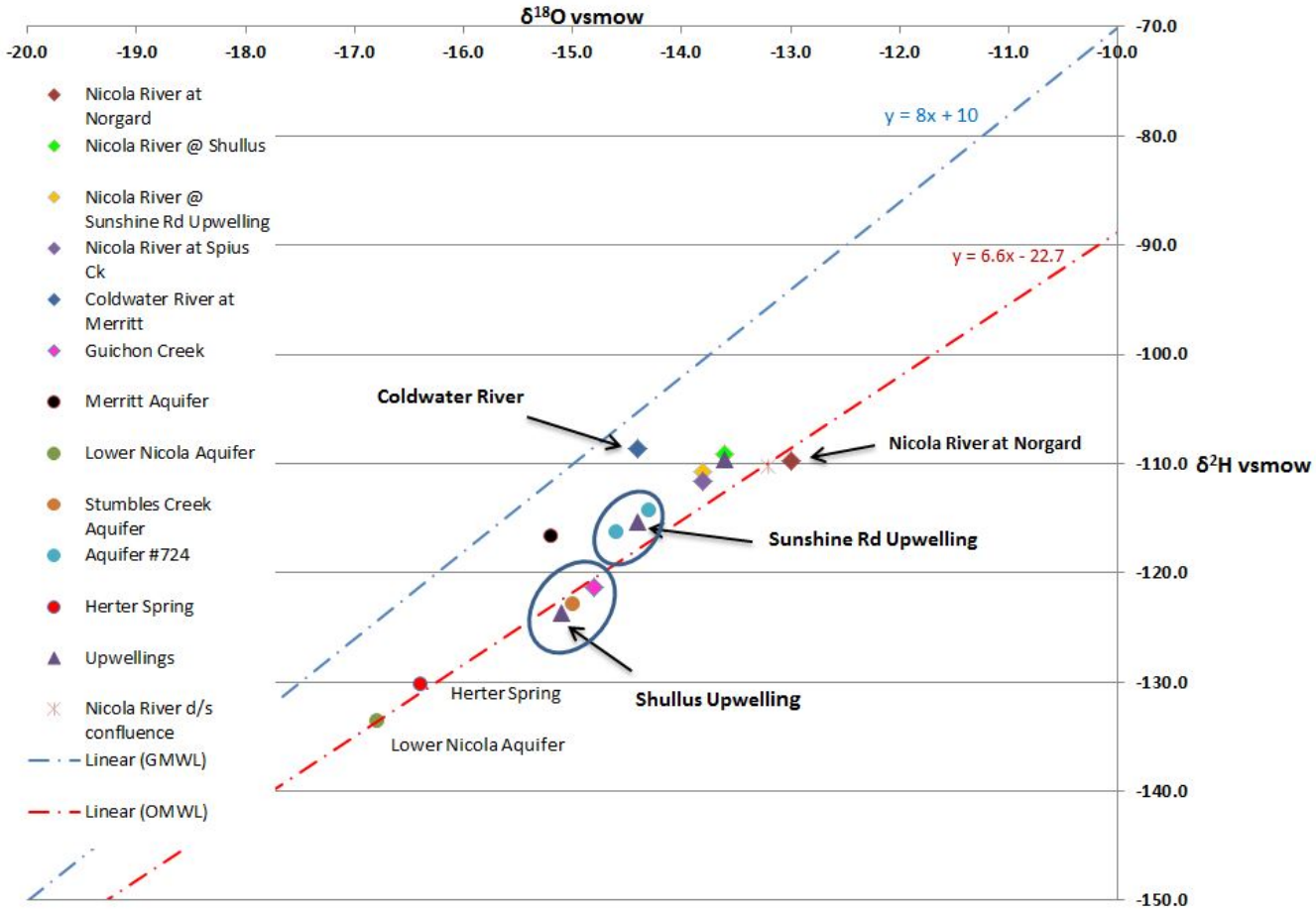

Figure 7: Deuterium and Oxygen- 18

The surface water samples (Nicola and Coldwater Rivers) are closest to the graph origin and are the most enriched in the heavy isotopes of δD and $\delta^{18}O$. The most isotopically depleted (or unaltered) samples are from the Lower Nicola Aquifer and the Herter Spring and are assessed to represent groundwater that was probably recharged at significantly higher elevations than the sample locations.

Figure 7 also illustrates that:

- The OMWL falls to the right of the GMWL which reflects evaporative processes occurring in the dry interior climate. The Coldwater River sample lies much closer to the GMWL which may reflect recharge from its headwaters located in the more humid coastal mountains;
- The Nicola and Coldwater Rivers have different isotope signatures with the Nicola River samples collected downstream of Merritt illustrating the blending of the two surface waters. At the time of sampling the Nicola and Coldwater Rivers evenly contributed to flow downstream of their confluence based on WSC records;
- The Nicola River and Coldwater River isotope samples fall to the right of the GMWL due to evaporative processes. The Nicola River is more enriched in isotopes than the Coldwater River likely due to evaporation occurring in Nicola Lake;

- Guichon Creek has a distinct isotope signature. Guichon Creek, the Stumbles Creek Aquifer and the Shullus upwelling show evidence of mixing. The groundwater upwelling(s) at Shullus are assessed to be sourced from the Stumbles Creek Aquifer;
- The Nicola River at Sunshine Road and at Spius Creek, show mixing of groundwater inflow and Guichon Creek inflow;
- The Sunshine Road upwelling (hyporheic zone) sample was characteristic of the two Aquifer #724 groundwater samples. The two groundwater samples were collected from shallow dug wells completed within the alluvium. The upwelling sample was characteristic of a gaining river reach; and
- The two groundwater samples from Aquifer #724 show mixing of groundwater and river water within the alluvium.

6.0 CONCEPTUAL HYDROGEOLOGICAL MODEL

Based on the information reviewed in this project, a conceptual groundwater flow model, which provides the basis for the groundwater budget, has been developed for the study area. The valley bottom unconsolidated aquifers consist of Quaternary fan deposits that form the unconfined Stumbles Creek Aquifer (#76) and modern alluvium that form Aquifer #724 and the Merritt Aquifer (#74). Thick glaciolacustrine sediments separate the Quaternary deposits from interglacial deposits that form confined aquifers at Lower Nicola and Merritt. Sediments at depth within Aquifer #724 may also be glaciofluvial in origin.

The total thickness of the valley bottom sediments in the study area is unknown but has been proven to be up to 165 m thick at Merritt. Based on available well records, the Quaternary fan deposits (Stumbles Creek Aquifer) are up to 42 m thick. Maximum reported well depths in the modern alluvium were 46 m at the Merritt Aquifer and 33 m in Aquifer #724 located in the western portion of the study area.

An 82 m deep flowing well was completed in the north end of the Lower Nicola Aquifer. In 2007, the City of Merritt constructed a 140 m deep municipal supply well that intercepted three separate confined aquifers below the unconfined Merritt Aquifer. A nested observation well completed in the confined aquifers encountered flowing conditions representing an upward groundwater gradient into the overlying Merritt Aquifer.

In general terms, the groundwater flow system in the valley bottom is recharged by:

- Precipitation infiltrating in the uplands surrounding the study area that recharges the valley bottom sediments through contact along the bedrock valley sides. All of this recharge is assessed to report to the main valleys as demonstrated by Jameison and Freeze (1982) and many later workers for mountain regions. Based on topographic and watershed divides, Golder estimated that the upland contribution area was 145 km^2. Golder also estimated that 10% or 40 mm/year of upland precipitation resulted in recharge to the valley bottom aquifer system. Aquifers positioned at increasing depth will have been recharged at increasing elevations as indicated by increasingly depleted isotopes of oxygen and hydrogen with increasing well depths such as the Lower Nicola Aquifer isotope sample (Figure 7), which was the most depleted sample collected;

- Upward groundwater flow from deep confined aquifers recharging the overlying Quaternary aquifers (Stumbles Creek Aquifer and Aquifer #724). Areas of connection between aquifers are not well understood; however, the phenomenon is evidenced by Herter Spring and the review of isotope results from shallow and deep aquifer samples;
- Groundwater flow into the study area from adjacent aquifers such as the Merritt Aquifer and the unmapped confined aquifer at Merritt;
- Groundwater flow through valley side fan deposits. The Stumbles Creek Aquifer is assessed to provide recharge to Aquifer #724 as well as directly recharging the Nicola River through groundwater discharge zones;
- Minor amounts of direct precipitation and irrigation return. Golder has estimated that 5% of direct precipitation and 5% of applied irrigation recharges the valley aquifers based on the coarse granular lithology reported on well logs; and
- Minor amount of river loss (flow of river water into the aquifer); however, analysis of hydrometric data indicates that the Nicola River is primarily a gaining river through the study area (water flow is from the aquifers to the river).

Flow out of aquifer systems contributes to:

- Recharge to the Nicola River;
- Groundwater flow out of valley bottom unconsolidated sediments at the downstream end of the study area; and
- Evapotranspiration.

Conceptual drawings illustrating the primary sources of recharge (blue arrows) to and discharge (red arrows) from the study area in plan view and cross section are provided as Figures 8 and 9 respectively.

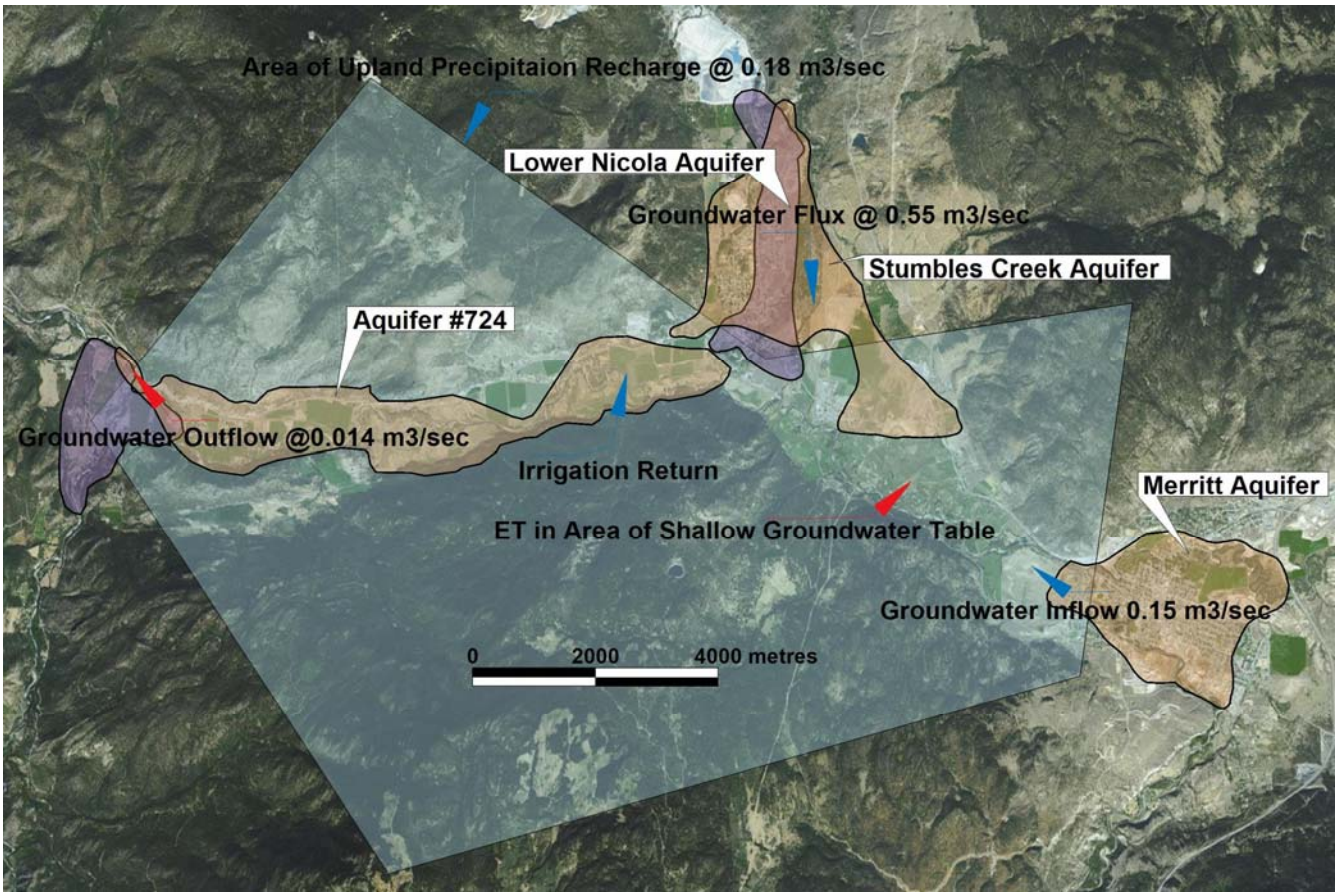

Figure 8: Conceptual illustration of recharge (blue arrows) to and discharge (red arrows) from study area

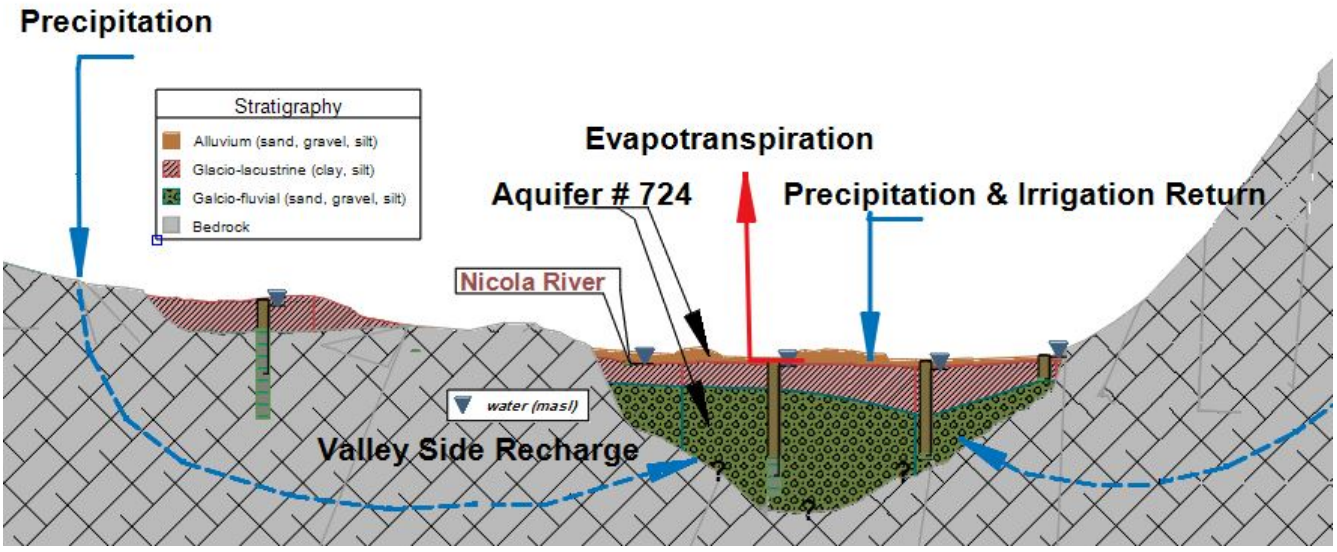

Figure 9: Conceptual cross-section illustration of recharge (blue arrows) to and discharge (red arrows) from study area

Golder is unaware of any aquifer pumping tests to evaluate the hydraulic conductivity of Aquifer #724. Testing of municipal wells drilled into the Merritt Aquifer indicated that the hydraulic conductivity of the sand and gravel alluvial aquifer was 0.001 m/sec to 0.002 m/sec (MOE 2009). For use in the groundwater budget, Golder has assigned a hydraulic conductivity of 0.001 m/sec to the alluvium and alluvial fan deposits (Aquifers #724 and Stumbles Creek Aquifer respectively). Hydraulic conductivity values available for the Lower Nicola Aquifer range from 2×10^{-5} m/sec to 6×10^{-4} m/sec (Golder 2005).

The direction of groundwater flow in the study area is inferred to be aligned with the axes of the valleys. Flow in the Stumbles Creek Aquifer is southward towards the Nicola River valley and groundwater flow in the Nicola River valley is westerly parallel to the valley axis. Horizontal groundwater gradients through Aquifer #724 were inferred to be the same as the gradient of the Nicola River. The river and aquifer gradients were assessed from MOE floodplain mapping to be 0.0046 m/m. The horizontal groundwater gradient through the Stumbles Creek aquifer was inferred to be similar to the topographic gradient which was estimated from Google Earth to be 0.02 m/m. The upward groundwater gradient from the Lower Nicola Aquifer into the overlying Stumbles Creek aquifer was estimated at 0.6 m/m based on the shut-in pressure at LNWD Well 3-99 at the time of drilling and its depth of completion, and the average depth to water in the Stumbles Creek aquifer. Anecdotal information from the LNWD indicates that the shut in pressure of 3-99 has decreased substantially since the well was constructed in 1999 and the vertical gradient, at least in the vicinity of the well, is now much less than originally encountered.

7.0 WATER BUDGET METHODOLOGY AND EQUATIONS

A groundwater budget or model is commonly calibrated to known annual groundwater elevation changes i.e. a groundwater hydrograph(s), within the model area. If groundwater hydrographs are not available, a model may be calibrated to changes in stream flow where the changes are due to stream loss to the aquifer or groundwater flow from the aquifer into the stream. As no groundwater hydrographs were available for the study area, hydrometric data were used to estimate stream (Nicola River) loss and gain to calibrate the groundwater budget.

The water budget equations consist of river flow equations to estimate change in river flow due to groundwater exchange and aquifer equations consisting of recharge into, and flow out of, the study area. The equations are:

River flow equations

1) $F_{d/s} = F_{u/s} + Tribs – Irrigation + GW_{gain} - SW_{loss}$
2) $GW\_SW_{flux} = GW_{gain} - SW_{loss}$
3) $GW\_SW_{flux} = F_{d/s} - F_{u/s} - Tribs + Irrigation$

Where:

$F_{d/s}$ = flow at downstream point of study reach

$F_{u/s}$ = flow at upstream point of study reach

Tribs = tributary flows into study reach

Irrigation = surface water withdrawals from study reach

GW_{gain} = groundwater flow from connected aquifers into the river (river gaining)

SW_{loss} = surface water flow from river into connected aquifers (river losing)

GW_SW_{flux} = net groundwater/surface water exchange over study reach: river gain(+ve value) or river loss (–ve value)

Aquifer equation:

4) ΔS = recharge – discharge – GW_SW_{flux}

Where:

ΔS = change in water stored in aquifer

recharge = groundwater inflow from adjacent formations + anthropogenic recharge (rapid infiltration basins, irrigation return) + precipitation recharge

discharge = evapotranspiration + groundwater pumping + groundwater outflow to adjacent formations

GW_SW_{flux} = groundwater/surface water exchange (+ve flux = aquifer losing/river gaining).

8.0 WATER BUDGET SPREADSHEET

The water budget was developed in excel spreadsheet format utilizing the river flow and aquifer equations. The excel file is included with this report and a spreadsheet printout is provided in Appendix C. WSC hydrometric data for mean monthly flows, estimated mean monthly flows for ungauged tributaries and surface water licensing information were used to estimate Nicola River gain or loss due to groundwater exchange (GW_SW_{flux}). Monthly recharge to, and discharge from, the valley sediments/aquifers were calculated from available hydrogeological information and estimated conditions where data were unavailable. Monthly changes in aquifer storage were calculated from recharge, discharge and GW_SW_{flux} calculations, i.e., Equation 4.

The change in storage results in a change in water level in the aquifer that was used to generate a theoretical groundwater hydrograph for the valley bottom aquifers. Change in storage is not instantaneous and the hydrograph allows for a one month delay in the overall water level rise or fall, i.e. January's surplus or deficit results in a water level rise or fall that would be not be fully realized until February. The groundwater budget is based on long term data and assumes a general equilibrium exists where the quantity of groundwater entering the system is equal to the quantity of groundwater leaving the system; furthermore, the net change in the groundwater hydrograph over a one year period is assumed to be zero. However, this assumption would have to revisited if known overdrafts (excessive water use) are occurring reflected in year over year declines in river or aquifer levels. The theoretical groundwater hydrograph for the study area and a normalized hydrograph for the Merritt Aquifer Observation Well #296, just upstream of the study area, are provided on Figure 10. The Merritt data represent the average month end water level from 1989 to 2010 (Janciki 2011).

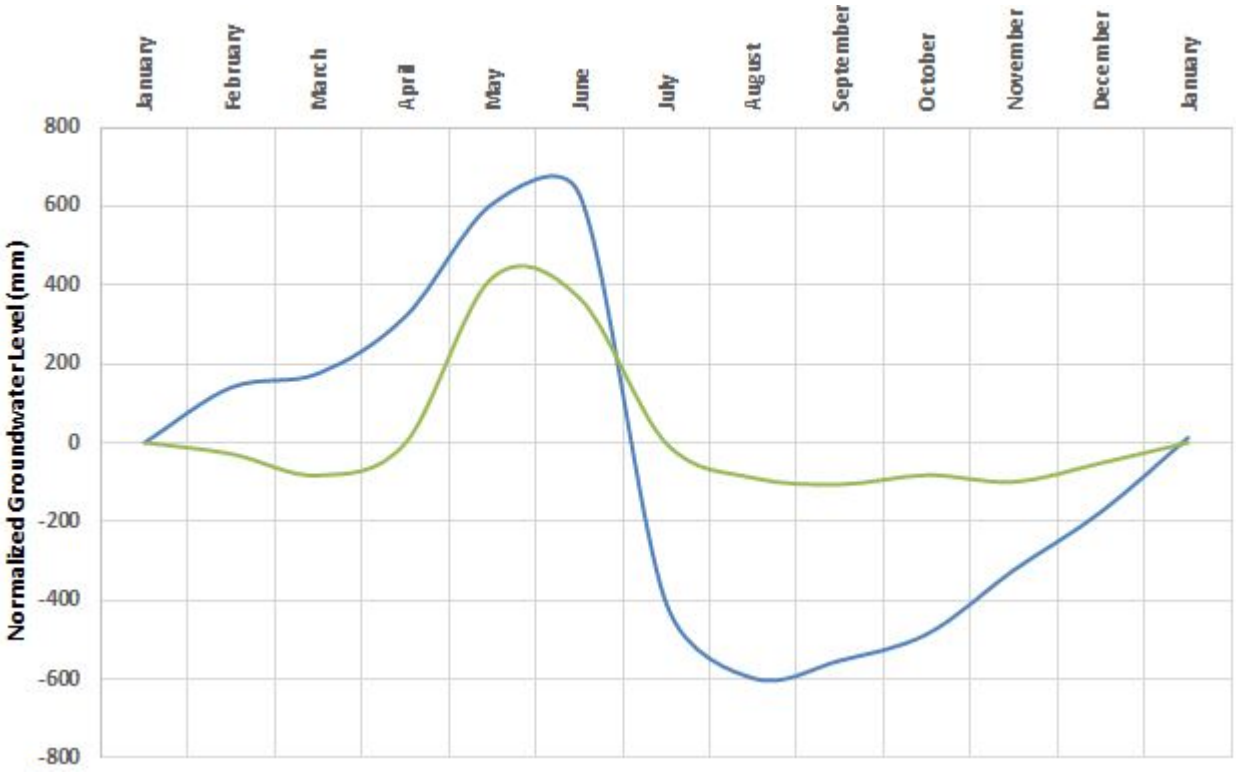

Figure 10: Theoretical Groundwater Hydrograph (blue) and Merritt Observation Well #296 (green)

Both hydrographs show a similar groundwater table rise and fall during and following river freshet in May and June. The long term average groundwater level in the Merritt aquifer is very consistent outside of freshet whereas the theoretical hydrograph for the study area shows much more of a decline in the aquifer level through summer and a steady recovery in the fall period. The hydrogeology of the study area and the Merritt Aquifer and the hydrograph for Observation Well #296 differ in that:

- The Coldwater River through Merritt is a losing reach throughout the year and the river loss is the largest source of recharge to the Merritt aquifer (Bennett and Caverly 2009); and,
- The Nicola River in the study area is, except for April, a consistently gaining river and the primary source of recharge to the aquifers is groundwater inflow from adjacent formations and precipitation recharge.

Input and output parameters in the water budget spreadsheet and the sources or methods of estimation or calculation are described in Tables 2, 3 and 4.

Table 2: River Budget Parameter Table

#	Parameter	Source of values/ method of estimation
Nicola Lake Outlet to Confluence with Coldwater River		
1	Nicola River at outlet Nicola Lake	Water Survey Canada (WSC) station 08LG065: 1983 to 2013
2	Clapperton Creek	Water Management Consultants 2008 Table 6.3a current conditions
3	Irrigation withdrawals Nicola Lake to Merritt	Nicola Water Demand Study, Summit 2007: average applied irrigation (mm/month) x estimated irrigated area (Google Earth)
4	Estimated net natural river loss/gain Nicola Lake to Merritt	(Study uncertainty) Estimated at 0% of flow at Nicola Lake. (note this may be a parameter worthy of further and future evaluation)
5	Coldwater River at Merritt	WSC station 08LG010: 1962 to 2013
6	Nicola River downstream confluence with Coldwater River	Equals parameters 1 + 2 + 5 - (3 + 4)
Nicola River From Coldwater River to Guichon Creek		
7	Nicola River near Merritt	WSC station 08LG007: 1958 to 2007
8	Tributaries	Flow estimated as equal to licenced volume of a very small tributary on south side of valley
9	Irrigation withdrawals Merritt to upstream Guichon Creek	Nicola Water Demand Study, Summit 2007: average applied irrigation (mm/month) x estimated irrigated area (Google Earth.)
10	GW_SW_{flux} Merritt to u/s Guichon Creek	Flow equation 3 with parameters 6 ($F_{u/s}$), 7 ($F_{d/s}$), 8 (Tribs) and 9 - -(Irrigation)
Nicola River from Guichon Creek to Near Spences Bridge		
11	Nicola River near Spences Bridge	WSC station 08LG006: 1958 to 2011
12	Guichon Creek at mouth	WSC station 08LG067: 1985 to 2010
13	Stumbles Creek	From Golder regional hydrological assessment (Appendix A)
14	Spius Creek near Canford	WSC station 08LG008: 1971 to 2011
15	Combined tributaries d/s Spius Creek	From Golder regional hydrological assessment (Appendix A)
16	Irrigation withdrawals Guichon Creek to u/s Spius Creek	Nicola Water Demand Study, Summit 2007: average applied irrigation (mm/month) x estimated irrigated area (Google Earth)
17	Industrial withdrawals	Nicola WUMP study - 125,664 m^3/year; assume spread evenly throughout year
18	GW_SW_{flux} Guichon Creek to near Spences Bridge	Flow equation 3 with parameters 7 ($F_{u/s}$), 11 ($F_{d/s}$), 12 to 15(Tribs), 16 and 17 -(Irrigation)
19	% of GW_SW_{flux} (parameter 18) occurring between Guichon Creek and Spius Creek	Study reach represents about 38% of total reach from Merritt to WSC near Spences Bridge. Assume flux evenly distributed over entire reach (a study uncertainty)
20	GW_SW_{flux} Guichon Creek to Spius Creek	38% of Parameter 18 (GW_SW_{flux} Guichon Creek to near Spences Bridge)

Table 3: Groundwater Budget Parameter Table

	Parameter	Method of Estimation
Recharge		
21	Groundwater inflow from Merritt Aquifer	Groundwater flowing from Merritt Aquifer enters valley sediments at upstream end of study boundary. Darcy Flux estimate Q=KiA: K=0.002 m/sec, i = 0.007 m/m (Bennett and Caverly 2009), width = 700 m, saturated thickness = 15 m
22	Groundwater inflow from Merritt RIBs	See Variable 43
23	Groundwater inflow from Lower Nicola unconfined Aquifer No 76	Darcy flux. Cross section width estimated at 2,250 m from aquifer mapping, aquifer depth based on MOE aquifer mapping: mean well depth 12.8 m, average depth to water 4.3 m. (saturated thickness = 8.5 m) Gradient based on ground surface elevations from Google Earth. K value - see parameter 40
24	Groundwater inflow from confined aquifers: Lower Nicola Aquifer & unmapped Merritt	Study uncertainty. Infer connection to Nicola Valley in downstream portion of study area based on isotope analyses.
25	Valley side recharge	Two methods of estimation: Method 1) assume groundwater flux to river in February due to groundwater recharge from bedrock. Total flux to Nicola R in reach from Guichon to WSC Spences Bridge est. = 0.75 m^3/sec. Stream reach = 38 km: average flux = 0.0197 m^3/sec/km. Study reach bounded by bedrock approximately 12.5 km x 0.0197 m^3/sec/km = 0.25 m^3/sec. Method 2) estimated upland area where precipitation infiltration would become valley bottom groundwater recharge through bedrock at 145 km^2. Estimate annual precipitation at 400 mm/year – Highland Valley Coper climate normal. Estimate 10% of annual precipitation as groundwater recharge = 40 mm/yr. 145 km^2 @ 44 mm/yr = 0.18 m^3/sec. Water Management Consultants (2008) estimated that annual precipitation infiltration in areas near the study area, ranged from 24 mm/year in Upper Guichon Creek to 132 mm/year in Upper Spius Creek.
Recharge		
26	Direct precipitation recharge	Calculated as percentage of Mean Monthly Precipitation
27	Irrigation return to unconfined aquifers	Calculated as percentage of applied irrigation (Parameters 9 & 15)
Discharge		
28	Evapotranspiration	Assume that no ET occurs November to March when ground frozen ET occurs where groundwater table <2m below grade. ET = theoretical requirement for forage crop at 575 mm/year Annual ET, 5% occurs May, 10% June, 20% July, 25% August, 25% September, 15% October (Bennett 2012)

	Parameter	Method of Estimation
Discharge		
29	Groundwater pumping from connected aquifers	Assume domestic use only, no known high capacity irrigation wells in unconfined aquifers. Lower Nicola community water system supplied by deep/confined aquifer
30	Groundwater outflow at Spius Creek	Darcy flux: K assume at 0.001m/sec, *i* from floodplain mapping elevations = 45m/9.75 km = 0.0046 m/m, cross section width = 200 m, saturated thickness estimated at 15 m

Table 4: Variables Table

	Variable	Method of Estimation
31	Monthly Mean total precipitation (mm)	Canadian climate normals for Merritt STP: 1981 to 2010
32	Historical monthly average moisture deficit (mm)	From Farmwest.com not used in calculations
33	Percentage of precipitation recharging valley bottom	Professional judgement 5%
34	Study Area Valley Floor (ha)	Estimated from Google Earth
35	Valley floor area subject to groundwater evapotranspiration (ha)	Pasture/forage area in valley bottom from Merritt/ Collettville Ranch to Guichon Creek south Hwy 8 that does not appear actively irrigated in Google Earth
36	Irrigated area sourced from Nicola River: Nicola Lake to Merritt (ha)	Estimated from Google Earth & MOE water licencing. Chutter Ranch licence on Nicola River & Nicola Ranch licence on Clapperton Creek
37	Irrigated area sourced from Nicola River: Merritt to Guichon Creek (ha)	Estimated from Google Earth & MOE water licencing
38	Irrigated area sourced from Nicola River: Guichon Creek to Spius Creek (ha)	Estimated from Google Earth & MOE water licencing
39	Irrigated area sourced from Nicola River: Spius Creek to WSC station near Spences Bridge (ha)	Estimated from Google Earth & MOE water licencing
40	Average applied irrigation (mm per month)	From Nicola Water Demand Study, Summit 2007
41	Irrigation return - percentage of applied irrigation recharging aquifer	Estimated at 5% (Bennett 2012)
42	Estimated hydraulic conductivity of unconfined aquifers (m/s)	From Bennett and Caverly (2009): Merritt aquifer values 1 x 10^{-3} m/sec to 2 x 10^{-3} m/sec
43	Specific yield of aquifers	Variable - estimated at 0.35 based on published values
44	Merritt RIB discharge	Assume equal to average daily winter water use of 0.06m^3/sec – *The Complete Circle* – http://www.merritt.ca/city-services/public-works/community-water-system

9.0 RESULTS

A discussion of the results of the Groundwater Budget Spreadsheet is provided in this section. Figure 11 plots mean monthly flows for the period of record in the Nicola River (WSC 08LG007: 1958 to 2007) near the Guichon Creek confluence midway along the study area. Predicted groundwater-surface water flux (GW_SW_{flux}) for the entire study reach (Merritt to Spius Creek), calculated using the spreadsheet developed, is also plotted on Figure 11. The data illustrate that the Nicola River is a net gaining river (positive GW_SW_{flux}) across the study area for every month except for April (negative GW_SW_{flux}). Groundwater recharge to the river is estimated to represent up to 18% of the river flow. The months of February and September are the periods when groundwater recharge to the river provides the highest percentage of river flow at 16% and 18% of mid reach flows respectively. The data and interpretation using the water budget spreadsheet also suggest that during the fall period roughly 70% of the study area groundwater recharge to the Nicola River occurs between Merritt and the Guichon Creek confluence and in late winter and early spring, groundwater flux into the river is evenly divided between the reaches upstream and downstream of the Guichon Creek confluence.

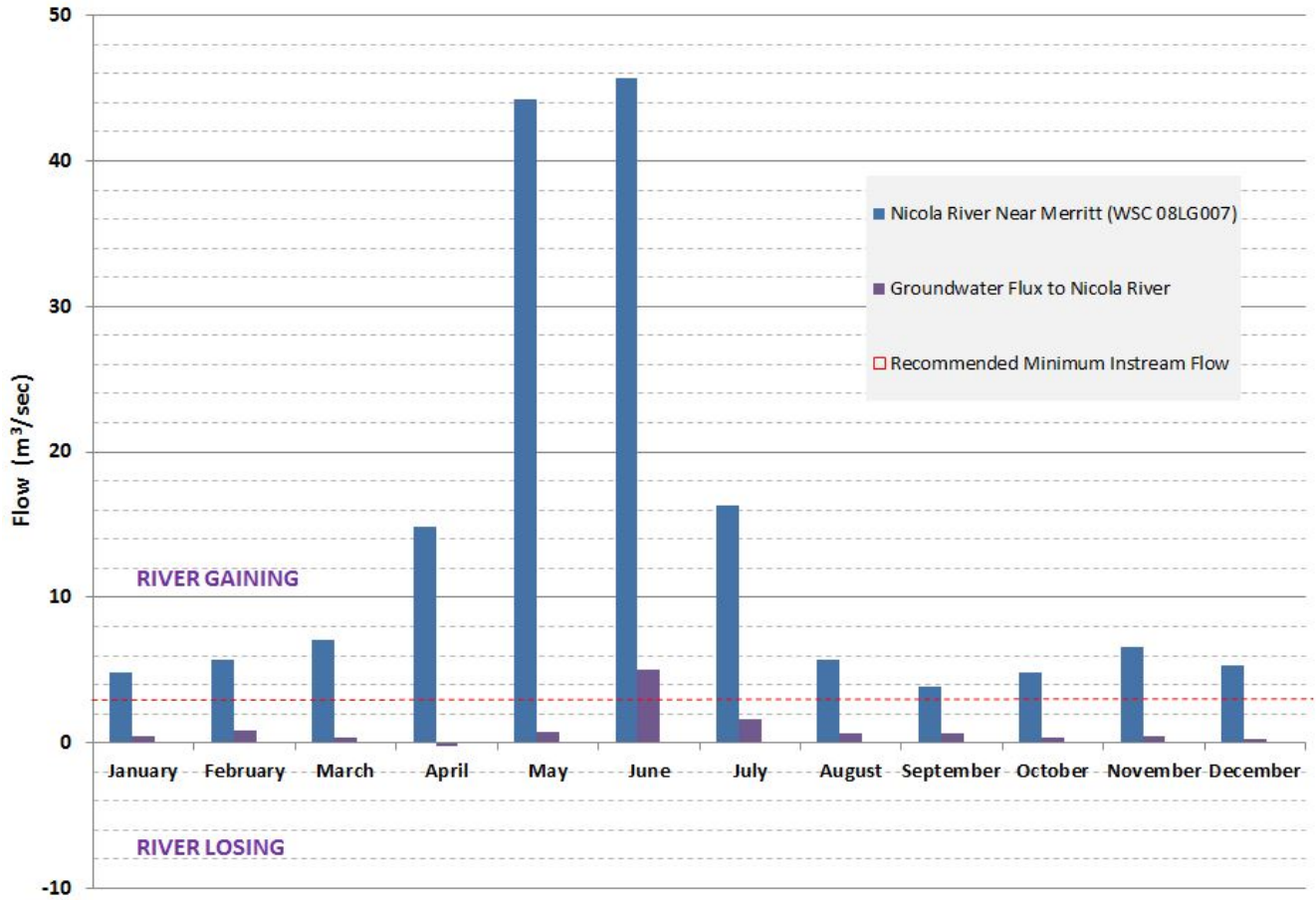

Figure 11: Nicola River Hydrograph and Groundwater Flux.

The largest source of recharge to the Nicola River is estimated to be the Stumbles Creek Aquifer. Based on long term averaged data, the sources of recharge as monthly averages to the Nicola River valley unconsolidated deposits that ultimately provides baseflow to the Nicola River in order of significance are estimated at:

- Stumbles Creek Aquifer at 0.55 m^3/sec;
- Nicola River loss during the month of April at 0.24 m^3/sec;
- Upland precipitation infiltration as valley bottom recharge through bedrock at 0.18 m^3/sec;
- Groundwater inflow from the Merritt aquifer at 0.15 m^3/sec;
- Groundwater inflow from the Lower Nicola and Merritt confined aquifers at 0.10 m^3/sec;
- Inflow from the Merritt rapid infiltration basins at 0.06 m^3/sec;
- Infiltration of valley bottom precipitation at 0.009 to 0.02 m^3/sec; and
- Irrigation return at up to 0.019 m^3/sec.

It is also assessed that for most of the year the Nicola River (along its reach) has various gaining and losing sections. Where these sections are located varies with the relationship of the water table to the river level which is related to the season. It is assessed that only during April is the Nicola River entirely losing along its reach.

Primary discharges from the Nicola Valley unconsolidated deposits were estimated as:

- Groundwater recharge to the Nicola River ranging from 0.27 m^3/sec in December to 5.08 m^3/sec in June;
- Evapotranspiration at up to 0.19 m^3/sec;
- Groundwater pumping at 0.01 m^3/sec to 0.02 m^3/sec; and
- Groundwater outflow at the downstream study boundary at 0.014 m^3/sec.

10.0 INFORMATION GAPS AND ADDITIONAL STUDIES

Golder recommends that that the following additional studies and work be continued or initiated to address existing data gaps and improve the calibration and accuracy of the groundwater budget developed for the Lower Nicola Valley:

- Activate the MOE hydrometric station on the Nicola River at Norgard which is just upstream of the confluence with the Coldwater River. Using this station and WSC Coldwater River at Merritt station would provide a more accurate assessment of flow in the Nicola River at the upstream end of the study area and a more precise measurement of river gain or loss through the study area;
- Continue to operate the MOE hydrometric station (“UREP”) on the Nicola River at the downstream end of study area (just upstream of confluence with Spius Creek);

- Establish an observation well in the Stumbles Creek Aquifer to help calibrate the water budget. The work completed to date suggests that this aquifer is the largest source of groundwater recharge to the river. Previous work by Golder at the Nicola-Mameet Indian Reserve suggests that the LNIB may have test wells or unused wells that could be used as observation wells;
- Complete a pumping test on one or more wells on the Stumbles Creek Aquifer or gather existing data from the LNIB water systems wells if available;
- Establish a multi-level observation well in Aquifer #724 in the western end of the study area to monitor groundwater fluctuations/hydrograph in the aquifer, assess the connectivity between shallow and deeper aquifers and help calibrate the water budget;
- Instrument a valley side, or in valley, bedrock monitoring well to allow evaluation of valley bottom recharge through bedrock hillsides;
- Complete additional oxygen and hydrogen isotope sampling at locations including: the confined aquifer at Merritt, a LNIB Shullus water system well(s), the deeper/semi-confined portion of Aquifer #724, bedrock wells and Guichon Creek upstream of Lower Nicola;
- Refine estimates of upland precipitation providing valley bottom recharge by developing a simple precipitation and hydrologic model of the study area; and
- Implement the spreadsheet model as a stochastic model to allow better evaluation of sensitivity to various input parameters.

11.0 LIMITATIONS

This report was prepared for the exclusive use of Fraser Basin Council, BC Ministry of Environment and BC Ministry of Forests, Lands and Natural Resources Operations. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Golder Associates Ltd. (Golder) accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

The report is based on data and information collected during investigations conducted by Golder and is based solely on the condition of the Site at the time of the investigations as described in this report, supplemented by historical data provided to Golder as described in this report. Golder has relied in good faith on information provided by third parties. We accept no responsibility for any deficiency, misstatements, or inaccuracies contained in this report as a result of omissions, misinterpretations, or fraudulent or negligent acts of others.

Golder makes no warranty, expressed or implied, and assumes no liability with respect to the use of the information contained in this report at the subject Site, or any other site, for other than its intended purpose. If new information is discovered during future work, including excavations, borings or other studies, Golder should be requested to re-evaluate the conclusions of this report and provide amendments as required prior to any reliance upon the information presented herein.

The services performed as described in this report were conducted in a manner consistent with that level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions, subject to the time limits and financial and physical constraints applicable to the services.

12.0 CLOSURE

We trust this report is sufficient for your current needs. If you have any questions or concerns, please do not hesitate to contact the undersigned.

GOLDER ASSOCIATES LTD.

Kevin Bennett, P.Eng.
Senior Groundwater Engineer

Nick Sargent, M.Sc., P.Geo.
Principal, Senior Hydrogeologist

KB/NS/kv/rja

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APPENDIX A

Regional Hydrologic Assessment

Regional Hydrologic Assessment

The Nicola River crosses through a variety of different landscapes. The study reach spans over 50 km in distance through the valley bottom eventually discharging into the Thompson River. Tributary streams to the Nicola River are located in mountainous terrain and forest/range land. Their watershed characteristics vary in attributes such as contributing watershed area, aspect, and elevation.

Golder performed a regional assessment focused on the Nicola River and its contributing tributaries between available gauges near Nicola Lake and Clapperton. To estimate mean monthly flows for the main tributaries to the Nicola River, a regional hydrology approach was used to analyze the various watersheds based on the above characteristics. This study focussed on 3rd order or larger tributary systems. Smaller tributary streams are not included in this assessment.

Coulson and Obedkoff (1998) delineated British Columbia into different Hydrologic Zones that exhibit similar hydrologic characteristics. Based on their work, this study reach of the Nicola River is located in the *Northern Thompson Plateau* and the *Eastern South Coast Mountains* Hydrologic Zones. The majority of runoff in the Nicola River basin (approximately 80%) results from spring snowmelt. The remaining runoff is primarily generated by spring and fall rainstorms (Obedkoff, 1987).

Golder mapped the Nicola River and associated tributaries, and overlaid the *Northern Thompson Plateau* and *Eastern South Coast Mountains* Hydrologic Zone boundaries. Water Survey of Canada (WSC) hydrometric stations (active and discontinued) within a 55 km radius of the Nicola River were assessed. A radius of 55 km was used as the area remained largely within the two hydrologic zone boundaries.

A total of 84 stations were initially identified. These were screened and hydrometric stations were removed if they were located outside of the two hydrologic zone boundaries, had less than 10 years of data available, or had too large/small watershed area. A regional analysis was then conducted based on the remaining WSC hydrometric stations. The purpose was to identify gauged watersheds that could be used as an analogue for the ungauged tributary systems. Table 1 shows a summary of the delineated watersheds contributing to the Nicola River as well as the hydrometric stations associated with each watershed used in the analysis.

Catchment Names, Areas, and associated Hydrometric Stations used in the Regional Analysis

Watershed Name of Tributary to Nicola River	Watershed Area (km^2)	WSC Hydrometric Stations Used in Analysis		
		Station ID	Name	Operation Status
Shackelly Creek	24.2	08LG066	Chataway Creek Near the Mouth	Discontinued
Skeikut Creek	25.8	08LG066	Chataway Creek Near the Mouth	Discontinued
Gordon Creek	29.7	08LG066	Chataway Creek Near the Mouth	Discontinued
Stumbles Creek	52.1	08LG019	Stumbles Creek	Discontinued
Shakan Creek	55.0	08LG019	Stumbles Creek	Discontinued
Hamilton Creek	57.8	08LG019	Stumbles Creek	Discontinued
Nuaitch Creek	83.6	08LG056	Guichon Creek	Discontinued
Skuhun Creek	108.5	08LG009	Witches Brook Near Merritt	Discontinued
Clapperton Creek	166.6	08LG068	Spius Creek below Silver Creek	Discontinued
Spius Creek	292.2	08LG008	Spius Creek Near Canford	Active
Guichon Creek	320.8	08LG067	Guichon Creek at the Mouth	Active
Coldwater River	473.4	08LG010	Coldwater River at Merritt	Active

The purpose of the regional analysis was to determine mean monthly flows of streams that contribute to the Nicola River. Based on available hydrometric data, as well as contributing drainage area, a summary of the results of estimated mean monthly flow for each drainage area is provided in Table 2.

APPENDIX B

Laboratory Analysis Reports

GOLDER ASSOCIATES LTD.
ATTN: Kevin Bennett
929 McGill Rd
Kamloops BC V2C 6E9

Date Received: 27-OCT-15
Report Date: 17-NOV-15 11:55 (MT)
Version: FINAL

Client Phone: 250-828-6116

Certificate of Analysis

Lab Work Order #: L1694193

Project P.O. #: NOT SUBMITTED
Job Reference: 1533225
C of C Numbers: 14-432701
Legal Site Desc:

Amber Springer, B.Sc
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID					
Grouping **Analyte**					

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location

Chain of Custody Numbers:

14-432701

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: GOLDER ASSOCIATES LTD.
929 McGill Rd
Kamloops BC V2C 6E9
Contact: Kevin Bennett

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Operator Name: Sandra Timsic
Client Name: ALS Environmental
ALS Work Order L1694193
Date Received: November 2, 2015
Date Analyzed: November 3, 2015

Contact:
Amber Springer
amber.springer@alsglobal.com
ALS Environmental
8081 Logheed Hwy, Suite 100
Burnaby, BC, V5A 1W9
ph 1-604-253-4188

Data

ALS ID		Date collected	$\delta^{18}O$ (‰ VSMOW)	Std deviation within run	δD (‰ VSMOW)	Std deviation within run
L1694193-1	Nicola River D/S Shulus	27/10/15	-13.6	0.12	-109.1	0.41
L1694193-2	Nicola River at Pozzibon	27/10/15	-13.8	0.04	-110.7	0.85
L1694193-3	Shulus Upwelling	27/10/15	-15.1	0.01	-123.7	0.59
L1694193-4	Pozzibon Upwelling	27/10/15	-13.6	0.03	-109.6	0.62
L1694193-5	Sunshine Rd Upwelling	27/10/15	-14.4	0.03	-115.3	0.39
L1694193-6	DFO Flowing Well	27/10/15	-16.8	0.00	-133.5	0.39

Standards

Standard ID	$\delta^{18}O$ (‰ VSMOW)	Std deviation within run	δD (‰ VSMOW)	Std deviation within run
Low13	-15.0	0.04	-118.9	0.21
Low13	-15.0	0.01	-118.9	0.19
High13	-7.3	0.06	-68.8	0.12
High13	-7.5	0.02	-68.8	0.94
Average Low13	**-15.0**	**0.03**	**-118.9**	**0.37**
Average High13	**-7.4**	**0.04**	**-68.8**	**0.53**

Standard Accepted Values

Standard ID	$\delta^{18}O$ (‰ VSMOW)	δD (‰ VSMOW)
High13	-7.5	-68.7
Low13	-15.0	-118.8

Methodology

Samples are analyzed using a Thermo Finnigan TC/EA coupled to a Conflo III and a Delta Plus XL mass spectrometer. 0.5 microliters of water is injected into a glassy carbon furnace and pyrolyzed at 1400°C to form hydrogen and carbon monoxide gases. These gases are carried in a helium stream to a GC column held at 100°C to separate the gases before being diluted in the Conflo III and passed to the mass spectrometer for analysis. Isotope ratios are reported in per mil notation relative to the VSMOW-VSLAP scale. Four in-house standards are directly calibrated against the international standards VSMOW and VSLAP, which are by definition: VSMOW: δD = 0‰ VSMOW, $\delta^{18}O$ = 0‰ VSMOW; and VSLAP: δD = -428‰ VSMOW, $\delta^{18}O$ = -55.5‰ VSMOW. GISP, an intermediate international standard, gave the following results during calibration of the in-house standards: δD = -191.0 ± 0.6‰ VSMOW (n = 5) and $\delta^{18}O$ = -25.03 ± 0.07‰ VSMOW (n=5). Compare to the accepted values of δD = -189.5 ± 0.7‰ VSMOW and $\delta^{18}O$ = -24.8 ± 0.1‰ VSMOW. Two of the in-house standards are used to set up a two-point calibration line. A third in-house standard is used to correct for drift. A fourth in-house standard is used to monitor accuracy of data. Every sample was analyzed five consequtive times to increase accuracy of data; the average of the last three or four injections was taken to represent the final isotope value reported with a standard deviation (i.e. std. deviation within run). Accuracies of δD and $\delta^{18}O$ are 2‰ and 0.2‰, respectively (n = 10, one sigma), though saline waters have a higher standard deviation due to the buildup of salts in the system and increasing memory effects as a result.

BC MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE
ATTN: Laurie Lyons
1259 Dalhousie Drive
Kamloops BC V2C 5Z5

Date Received: 29-OCT-15
Report Date: 06-NOV-15 12:54 (MT)
Version: FINAL

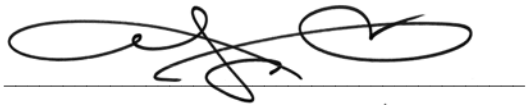
Client Phone: 250-371-6200

Certificate of Analysis

Lab Work Order #: L1695652

Project P.O. #: 50221830
Job Reference: 1837 NICOLLS RD
C of C Numbers:
Legal Site Desc:

Other Information: Client: GK
EMS ID: NONE
Project: N/A



ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1695652-1				
	Description					
	Sampled Date	28-OCT-15				
	Sampled Time	10:40				
	Client ID	REG				
Grouping	**Analyte**					
WATER						
Field Tests	EC, Client Supplied (uS/cm)	303.5				
	pH, Client Supplied (pH)	6.57				
	Temperature, Client Supplied (C)	10.2				
Physical Tests	Conductivity (uS/cm)	287				
	Hardness (as CaCO3) (mg/L)	123				
	pH (pH)	7.49				
	Total Dissolved Solids (mg/L)	185				
	Turbidity (NTU)	0.13				
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	130				
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Phenolphthalein (as CaCO3) (mg/L)	<2.0				
	Alkalinity, Total (as CaCO3) (mg/L)	130				
	Ammonia, Total (as N) (mg/L)	<0.0050				
	Chloride (Cl) (mg/L)	7.96				
	Fluoride (F) (mg/L)	0.084				
	Nitrate and Nitrite (as N) (mg/L)	0.259				
	Nitrate (as N) (mg/L)	0.259				
	Nitrite (as N) (mg/L)	<0.0010				
	Dissolved Organic Nitrogen (mg/L)	<0.063				
	Dissolved Kjeldahl Nitrogen (mg/L)	0.057				
	Total Dissolved Nitrogen (mg/L)	0.316				
	Phosphorus (P)-Total Dissolved (mg/L)	<0.0020				
	Sulfate (SO4) (mg/L)	15.5				
Dissolved Metals	Dissolved Metals Filtration Location	FIELD				
	Aluminum (Al)-Dissolved (mg/L)	0.0050				
	Antimony (Sb)-Dissolved (mg/L)	<0.00010				
	Arsenic (As)-Dissolved (mg/L)	0.00013				
	Barium (Ba)-Dissolved (mg/L)	0.0416				
	Beryllium (Be)-Dissolved (mg/L)	<0.00010				
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050				
	Boron (B)-Dissolved (mg/L)	<0.010				
	Cadmium (Cd)-Dissolved (mg/L)	0.0000204				
	Calcium (Ca)-Dissolved (mg/L)	35.1				
	Chromium (Cr)-Dissolved (mg/L)	0.00015				
	Cobalt (Co)-Dissolved (mg/L)	<0.00010				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1695652-1				
	Description					
	Sampled Date	28-OCT-15				
	Sampled Time	10:40				
	Client ID	REG				
Grouping	**Analyte**					
WATER						
Dissolved Metals	Copper (Cu)-Dissolved (mg/L)	0.0294				
	Iron (Fe)-Dissolved (mg/L)	0.0168				
	Lead (Pb)-Dissolved (mg/L)	0.000826				
	Magnesium (Mg)-Dissolved (mg/L)	8.55				
	Manganese (Mn)-Dissolved (mg/L)	0.00235				
	Molybdenum (Mo)-Dissolved (mg/L)	0.00151				
	Nickel (Ni)-Dissolved (mg/L)	0.00094				
	Phosphorus (P)-Dissolved (mg/L)	<0.010				
	Potassium (K)-Dissolved (mg/L)	1.93				
	Selenium (Se)-Dissolved (mg/L)	0.000113				
	Silicon (Si)-Dissolved (mg/L)	5.66				
	Silver (Ag)-Dissolved (mg/L)	<0.000010				
	Sodium (Na)-Dissolved (mg/L)	9.17				
	Strontium (Sr)-Dissolved (mg/L)	0.177				
	Sulfur (S)-Dissolved (mg/L)	5.16				
	Thallium (Tl)-Dissolved (mg/L)	<0.000010				
	Tin (Sn)-Dissolved (mg/L)	0.0125				
	Titanium (Ti)-Dissolved (mg/L)	<0.00030				
	Uranium (U)-Dissolved (mg/L)	0.000650				
	Vanadium (V)-Dissolved (mg/L)	0.00061				
	Zinc (Zn)-Dissolved (mg/L)	0.0835				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Alkalinity, Total (as CaCO3)	B	L1695652-1
Duplicate	Antimony (Sb)-Dissolved	DLA	L1695652-1
Duplicate	Bismuth (Bi)-Dissolved	DLA	L1695652-1
Duplicate	Boron (B)-Dissolved	DLA	L1695652-1
Duplicate	Titanium (Ti)-Dissolved	DLA	L1695652-1
Duplicate	Fluoride (F)	DLDS	L1695652-1
Duplicate	Nitrite (as N)	DLDS	L1695652-1
Duplicate	Nitrite (as N)	DLDS	L1695652-1
Duplicate	Nitrite (as N)	DLDS	L1695652-1
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1695652-1
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1695652-1
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1695652-1
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1695652-1
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1695652-1
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1695652-1
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1695652-1
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1695652-1
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1695652-1
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1695652-1
Matrix Spike	Potassium (K)-Dissolved	MS-B	L1695652-1
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1695652-1
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1695652-1
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1695652-1
Matrix Spike	Aluminum (Al)-Dissolved	MS-B	L1695652-1
Matrix Spike	Potassium (K)-Dissolved	MS-B	L1695652-1
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1695652-1
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1695652-1
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1695652-1
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1695652-1
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1695652-1
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1695652-1
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1695652-1
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1695652-1
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1695652-1
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1695652-1
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1695652-1
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1695652-1
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1695652-1
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1695652-1
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1695652-1

Qualifiers for Individual Parameters Listed:

Qualifier	Description
B	Method Blank exceeds ALS DQO. All associated sample results are at least 5 times greater than blank levels and are considered reliable.
DLA	Detection Limit adjusted for required dilution
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-PP-VA	Water	Phenolphthalein alkalinity by titration	APHA 2320 "Alkalinity"

Reference Information

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity".

ALK-PP-VA Water Phenolphthalein alkalinity by titration APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity".

ALK-TITR-VA Water Alkalinity Species by Titration APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-N+N-CALC-VA Water Nitrite & Nitrate in Water (Calculation) EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

CL-IC-N-VA Water Chloride in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

DKN-CALC-VA Water DKN in Water (Calculation) EN12260 (EU STD METHOD)/EPA 300.0

Dissolved Kjeldahl Nitrogen is a calculated parameter. Dissolved Kjeldahl Nitrogen (calc) = Total Dissolved Nitrogen - [Nitrite (as N) + Nitrate (as N)].

EC-PCT-VA Water Conductivity (Automated) APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

F-IC-N-VA Water Fluoride in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

FE-D-L-CCMS-VA Water Diss. Iron (Low) in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

N-D-ORG-CALC(TN)-VA Water Dissolved Organic Nitrogen(Calc from DN) EN12260/J. ENVIRON. MONIT, 2005/EPA 300

Dissolved Organic Nitrogen is a calculated parameter. Dissolved Organic Nitrogen = Total Dissolved Nitrogen - {Ammonia + (Nitrate+Nitrite)}.

N-TD-COL-VA Water Total Dissolved Nitrogen by Colour APHA Method 4500-P (J) / NEMI 5735

Following filtration through a 0.45 micron filter, the sample is analysed using procedures adapted from APHA Method 4500-P (J) "Persulphate Method for Simultaneous Determination of Total Nitrogen and Total Phosphorus" and National Environmental Methods Index - Nemi method 5735.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-U-IC-N-VA Water Nitrate in Water by IC (Ultra Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

P-D-L-CCMS-VA Water Diss. Phos. (Low) in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Reference Information

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

P-TD-COL-VA	Water	Total Dissolved P in Water by Colour	APHA 4500-P Phosphorous

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Dissolved Phosphorus is determined colourimetrically after persulphate digestion of a sample that has been lab or field filtered through a 0.45 micron membrane filter.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 "Turbidity"

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 Turbidity

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

Additional Information:

Average Cooler Temperature (Deg Celsius): 4

Project: N/A

Sampling Agency Code: 30

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: BC MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE
1259 Dalhousie Drive
Kamloops BC V2C 5Z5
Contact: Laurie Lyons

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-PP-VA	**Water**							
Batch R3303747								
WG2205383-33 DUP		**L1695652-1**						
Alkalinity, Phenolphthalein (as CaCO3)		<2.0	<2.0	RPD-NA	mg/L	N/A	20	02-NOV-15
WG2205383-1 MB								
Alkalinity, Phenolphthalein (as CaCO3)			<2.0		mg/L		2	02-NOV-15
WG2205383-6 MB								
Alkalinity, Phenolphthalein (as CaCO3)			<2.0		mg/L		2	02-NOV-15
WG2205383-7 MB								
Alkalinity, Phenolphthalein (as CaCO3)			<2.0		mg/L		2	02-NOV-15
ALK-TITR-VA	**Water**							
Batch R3302611								
WG2205385-10 CRM		**VA-ALK-TITR-CONTROL**						
Alkalinity, Total (as CaCO3)			103.4		%		85-115	02-NOV-15
WG2205385-11 CRM		**VA-ALK-TITR-CONTROL**						
Alkalinity, Total (as CaCO3)			107.6		%		85-115	02-NOV-15
WG2205385-12 CRM		**VA-ALK-TITR-CONTROL**						
Alkalinity, Total (as CaCO3)			108.0		%		85-115	02-NOV-15
WG2205385-14 CRM		**VA-ALK-TITR-CONTROL**						
Alkalinity, Total (as CaCO3)			107.6		%		85-115	02-NOV-15
WG2205385-15 CRM		**VA-ALK-TITR-CONTROL**						
Alkalinity, Total (as CaCO3)			109.8		%		85-115	02-NOV-15
WG2205385-9 CRM		**VA-ALK-TITR-CONTROL**						
Alkalinity, Total (as CaCO3)			105.4		%		85-115	02-NOV-15
WG2205385-1 MB								
Alkalinity, Total (as CaCO3)			1.0		mg/L		1	02-NOV-15
WG2205385-3 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	02-NOV-15
WG2205385-4 MB								
Alkalinity, Total (as CaCO3)			1.1	B	mg/L		1	02-NOV-15
WG2205385-5 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	02-NOV-15
WG2205385-6 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	02-NOV-15
WG2205385-7 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	02-NOV-15
CL-IC-N-VA	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CL-IC-N-VA	**Water**							
Batch R3300770								
WG2204012-18 LCS								
Chloride (Cl)			102.5		%		90-110	29-OCT-15
WG2204012-2 LCS								
Chloride (Cl)			102.7		%		90-110	29-OCT-15
WG2204012-1 MB								
Chloride (Cl)			<0.50		mg/L		0.5	29-OCT-15
WG2204012-10 MB								
Chloride (Cl)			<0.50		mg/L		0.5	29-OCT-15
WG2204012-13 MB								
Chloride (Cl)			<0.50		mg/L		0.5	29-OCT-15
WG2204012-16 MB								
Chloride (Cl)			<0.50		mg/L		0.5	29-OCT-15
WG2204012-4 MB								
Chloride (Cl)			<0.50		mg/L		0.5	29-OCT-15
WG2204012-7 MB								
Chloride (Cl)			<0.50		mg/L		0.5	29-OCT-15
EC-PCT-VA	**Water**							
Batch R3302548								
WG2204806-17 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			105.0		%		90-110	02-NOV-15
WG2204806-18 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			104.9		%		90-110	02-NOV-15
WG2204806-19 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			104.0		%		90-110	02-NOV-15
WG2204806-20 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			105.8		%		90-110	02-NOV-15
WG2204806-21 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			104.7		%		90-110	02-NOV-15
WG2204806-22 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			105.6		%		90-110	02-NOV-15
WG2204806-1 MB								
Conductivity			<2.0		uS/cm		2	02-NOV-15
WG2204806-2 MB								
Conductivity			<2.0		uS/cm		2	02-NOV-15
WG2204806-3 MB								
Conductivity			<2.0		uS/cm		2	02-NOV-15
WG2204806-4 MB								
Conductivity			<2.0		uS/cm		2	02-NOV-15
WG2204806-5 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
EC-PCT-VA	**Water**							
Batch R3302548								
WG2204806-5 MB								
Conductivity			<2.0		uS/cm		2	02-NOV-15
WG2204806-6 MB								
Conductivity			<2.0		uS/cm		2	02-NOV-15
F-IC-N-VA	**Water**							
Batch R3300770								
WG2204012-18 LCS								
Fluoride (F)			101.5		%		90-110	29-OCT-15
WG2204012-2 LCS								
Fluoride (F)			101.9		%		90-110	29-OCT-15
WG2204012-1 MB								
Fluoride (F)			<0.020		mg/L		0.02	29-OCT-15
WG2204012-10 MB								
Fluoride (F)			<0.020		mg/L		0.02	29-OCT-15
WG2204012-13 MB								
Fluoride (F)			<0.020		mg/L		0.02	29-OCT-15
WG2204012-16 MB								
Fluoride (F)			<0.020		mg/L		0.02	29-OCT-15
WG2204012-4 MB								
Fluoride (F)			<0.020		mg/L		0.02	29-OCT-15
WG2204012-7 MB								
Fluoride (F)			<0.020		mg/L		0.02	29-OCT-15
FE-D-L-CCMS-VA	**Water**							
Batch R3300304								
WG2204205-2 LCS								
Iron (Fe)-Dissolved			102.3		%		80-120	30-OCT-15
WG2204205-1 MB		**NP**						
Iron (Fe)-Dissolved			<0.0050		mg/L		0.005	30-OCT-15
MET-D-CCMS-VA	**Water**							
Batch R3300304								
WG2204205-2 LCS								
Aluminum (Al)-Dissolved			102.3		%		80-120	30-OCT-15
Antimony (Sb)-Dissolved			98.7		%		80-120	30-OCT-15
Arsenic (As)-Dissolved			98.3		%		80-120	30-OCT-15
Barium (Ba)-Dissolved			100.0		%		80-120	30-OCT-15
Beryllium (Be)-Dissolved			101.3		%		80-120	30-OCT-15
Bismuth (Bi)-Dissolved			99.4		%		80-120	30-OCT-15

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA	**Water**							
Batch R3300304								
WG2204205-2 LCS								
Boron (B)-Dissolved			102.1		%		80-120	30-OCT-15
Cadmium (Cd)-Dissolved			99.4		%		80-120	30-OCT-15
Calcium (Ca)-Dissolved			101.2		%		80-120	30-OCT-15
Chromium (Cr)-Dissolved			99.2		%		80-120	30-OCT-15
Cobalt (Co)-Dissolved			100.5		%		80-120	30-OCT-15
Copper (Cu)-Dissolved			97.6		%		80-120	30-OCT-15
Lead (Pb)-Dissolved			100.1		%		80-120	30-OCT-15
Magnesium (Mg)-Dissolved			102.3		%		80-120	30-OCT-15
Manganese (Mn)-Dissolved			100.8		%		80-120	30-OCT-15
Molybdenum (Mo)-Dissolved			104.5		%		80-120	30-OCT-15
Nickel (Ni)-Dissolved			100.2		%		80-120	30-OCT-15
Potassium (K)-Dissolved			106.7		%		80-120	30-OCT-15
Selenium (Se)-Dissolved			98.0		%		80-120	30-OCT-15
Silicon (Si)-Dissolved			120.0		%		80-120	30-OCT-15
Silver (Ag)-Dissolved			97.3		%		80-120	30-OCT-15
Sodium (Na)-Dissolved			103.5		%		80-120	30-OCT-15
Strontium (Sr)-Dissolved			99.98		%		80-120	30-OCT-15
Sulfur (S)-Dissolved			107.4		%		80-120	30-OCT-15
Thallium (Tl)-Dissolved			98.4		%		80-120	30-OCT-15
Tin (Sn)-Dissolved			100.2		%		80-120	30-OCT-15
Titanium (Ti)-Dissolved			97.4		%		80-120	30-OCT-15
Uranium (U)-Dissolved			97.9		%		80-120	30-OCT-15
Vanadium (V)-Dissolved			102.4		%		80-120	30-OCT-15
Zinc (Zn)-Dissolved			90.5		%		80-120	30-OCT-15
WG2204205-1 MB		**NP**						
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	30-OCT-15
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	30-OCT-15
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	30-OCT-15
Barium (Ba)-Dissolved			<0.000050		mg/L		0.00005	30-OCT-15
Beryllium (Be)-Dissolved			<0.00010		mg/L		0.0001	30-OCT-15
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	30-OCT-15
Boron (B)-Dissolved			<0.010		mg/L		0.01	30-OCT-15
Cadmium (Cd)-Dissolved			<0.000005(		mg/L		0.000005	30-OCT-15
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	30-OCT-15

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA	**Water**							
Batch R3300304								
WG2204205-1 MB		**NP**						
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	30-OCT-15
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	30-OCT-15
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	30-OCT-15
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	30-OCT-15
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	30-OCT-15
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	30-OCT-15
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	30-OCT-15
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	30-OCT-15
Potassium (K)-Dissolved			<0.050		mg/L		0.05	30-OCT-15
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	30-OCT-15
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	30-OCT-15
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	30-OCT-15
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	30-OCT-15
Strontium (Sr)-Dissolved			<0.00020		mg/L		0.0002	30-OCT-15
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	30-OCT-15
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	30-OCT-15
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	30-OCT-15
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	30-OCT-15
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	30-OCT-15
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	30-OCT-15
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	30-OCT-15
N-TD-COL-VA	**Water**							
Batch R3304405								
WG2206226-3 DUP		**L1695652-1**						
Total Dissolved Nitrogen		0.316	0.316		mg/L	0.1	20	03-NOV-15
WG2206226-2 LCS								
Total Dissolved Nitrogen			99.8		%		75-125	03-NOV-15
WG2206226-6 LCS								
Total Dissolved Nitrogen			99.7		%		75-125	03-NOV-15
WG2206226-8 LCS								
Total Dissolved Nitrogen			102.0		%		75-125	03-NOV-15
WG2206226-1 MB								
Total Dissolved Nitrogen			<0.030		mg/L		0.03	03-NOV-15
WG2206226-5 MB								
Total Dissolved Nitrogen			<0.030		mg/L		0.03	03-NOV-15

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
N-TD-COL-VA	**Water**							
Batch R3304405								
WG2206226-7 MB								
Total Dissolved Nitrogen			<0.030		mg/L		0.03	03-NOV-15
WG2206226-4 MS		**L1695652-1**						
Total Dissolved Nitrogen			100.3		%		70-130	03-NOV-15
NH3-F-VA	**Water**							
Batch R3305411								
WG2207017-10 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			94.7		%		85-115	04-NOV-15
WG2207017-18 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			86.2		%		85-115	04-NOV-15
WG2207017-2 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			101.2		%		85-115	04-NOV-15
WG2207017-4 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			93.9		%		85-115	04-NOV-15
WG2207017-6 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			94.1		%		85-115	04-NOV-15
WG2207017-8 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			93.7		%		85-115	04-NOV-15
WG2207017-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	04-NOV-15
WG2207017-17 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	04-NOV-15
WG2207017-3 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	04-NOV-15
WG2207017-5 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	04-NOV-15
WG2207017-7 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	04-NOV-15
WG2207017-9 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	04-NOV-15
NO2-L-IC-N-VA	**Water**							
Batch R3300770								
WG2204012-18 LCS								
Nitrite (as N)			101.4		%		90-110	29-OCT-15
WG2204012-2 LCS								
Nitrite (as N)			101.1		%		90-110	29-OCT-15
WG2204012-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	29-OCT-15

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO2-L-IC-N-VA	**Water**							
Batch R3300770								
WG2204012-10 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	29-OCT-15
WG2204012-13 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	29-OCT-15
WG2204012-16 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	29-OCT-15
WG2204012-4 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	29-OCT-15
WG2204012-7 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	29-OCT-15
NO3-U-IC-N-VA	**Water**							
Batch R3300770								
WG2204012-18 LCS								
Nitrate (as N)			102.2		%		70-130	29-OCT-15
WG2204012-2 LCS								
Nitrate (as N)			102.2		%		70-130	29-OCT-15
WG2204012-1 MB								
Nitrate (as N)			<0.0030		mg/L		0.003	29-OCT-15
WG2204012-10 MB								
Nitrate (as N)			<0.0030		mg/L		0.003	29-OCT-15
WG2204012-13 MB								
Nitrate (as N)			<0.0030		mg/L		0.003	29-OCT-15
WG2204012-16 MB								
Nitrate (as N)			<0.0030		mg/L		0.003	29-OCT-15
WG2204012-4 MB								
Nitrate (as N)			<0.0030		mg/L		0.003	29-OCT-15
WG2204012-7 MB								
Nitrate (as N)			<0.0030		mg/L		0.003	29-OCT-15
P-D-L-CCMS-VA	**Water**							
Batch R3300304								
WG2204205-2 LCS								
Phosphorus (P)-Dissolved			104.9		%		80-120	30-OCT-15
WG2204205-1 MB		**NP**						
Phosphorus (P)-Dissolved			<0.010		mg/L		0.01	30-OCT-15
P-TD-COL-VA	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
P-TD-COL-VA	**Water**							
Batch R3300142								
WG2204253-6 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total	Dissolved		100.6		%		80-120	30-OCT-15
WG2204253-5 MB								
Phosphorus (P)-Total	Dissolved		<0.0020		mg/L		0.002	30-OCT-15
WG2204253-8 MS		**L1695652-1**						
Phosphorus (P)-Total	Dissolved		101.2		%		70-130	30-OCT-15
PH-PCT-VA	**Water**							
Batch R3302548								
WG2204806-25 CRM		**VA-PH7-BUF**						
pH			7.01		pH		6.9-7.1	02-NOV-15
WG2204806-26 CRM		**VA-PH7-BUF**						
pH			7.01		pH		6.9-7.1	02-NOV-15
WG2204806-27 CRM		**VA-PH7-BUF**						
pH			7.02		pH		6.9-7.1	02-NOV-15
WG2204806-28 CRM		**VA-PH7-BUF**						
pH			7.02		pH		6.9-7.1	02-NOV-15
WG2204806-29 CRM		**VA-PH7-BUF**						
pH			7.02		pH		6.9-7.1	02-NOV-15
WG2204806-30 CRM		**VA-PH7-BUF**						
pH			7.02		pH		6.9-7.1	02-NOV-15
SO4-IC-N-VA	**Water**							
Batch R3300770								
WG2204012-18 LCS								
Sulfate (SO4)			103.0		%		90-110	29-OCT-15
WG2204012-2 LCS								
Sulfate (SO4)			103.1		%		90-110	29-OCT-15
WG2204012-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	29-OCT-15
WG2204012-10 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	29-OCT-15
WG2204012-13 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	29-OCT-15
WG2204012-16 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	29-OCT-15
WG2204012-4 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	29-OCT-15
WG2204012-7 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	29-OCT-15

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TDS-VA	**Water**							
Batch R3301468								
WG2205263-2 LCS								
Total Dissolved Solids			105.4		%		85-115	31-OCT-15
WG2205263-5 LCS								
Total Dissolved Solids			103.0		%		85-115	31-OCT-15
WG2205263-1 MB								
Total Dissolved Solids			<10		mg/L		10	31-OCT-15
WG2205263-4 MB								
Total Dissolved Solids			<10		mg/L		10	31-OCT-15
TURBIDITY-VA	**Water**							
Batch R3300337								
WG2204803-2 CRM		**VA-FORM-40**						
Turbidity			101.5		%		85-115	30-OCT-15
WG2204803-5 CRM		**VA-FORM-40**						
Turbidity			102.0		%		85-115	30-OCT-15
WG2204803-8 CRM		**VA-FORM-40**						
Turbidity			102.0		%		85-115	30-OCT-15
WG2204803-1 MB								
Turbidity			<0.10		NTU		0.1	30-OCT-15
WG2204803-4 MB								
Turbidity			<0.10		NTU		0.1	30-OCT-15
WG2204803-7 MB								
Turbidity			<0.10		NTU		0.1	30-OCT-15

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
B	Method Blank exceeds ALS DQO. All associated sample results are at least 5 times greater than blank levels and are considered reliable.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH by Meter (Automated)							
	1	28-OCT-15 10:40	02-NOV-15 09:28	0.25	119	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1695652 were received on 29-OCT-15 09:00.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

WATER & GENERAL CHEMISTRY REQUISITION

Province Of British Columbia

Ministry of Environment

ALS Global

Req # 50221830

L1695652-COFC

Urgent?	**Csr No.**	**Office** 30	**Client** GK
Study		**Project** N/A	
Lab	ALS Global		
Ministry Contact	LALYONS Laurie Lyons		
Sampler	Laurie Lyons		
Signature	LA Lyons		
EMS Id	NONE	**Well Plate #**	
Location	1837 NICOLLS RD		

Sampling Agency	
Code 30	**Name** Southern Region, Kamloops
Address	1259 Dalhousie Drive
City	Kamloops
Postal Code	V2C5Z5 **Phone** (250)371-6200
Number of Containers	4

Instructions To Lab Return cooler. FIELD FILTERED & PRESERVED

State FIN Descriptor GW Collection Method GRAB

No.	Class	Collection Start YYYY-MM-DD HH:MI	Collection End YYYY-MM-DD HH:MI	Depth Upper	Depth Lower	Tide	Comment
1	REG	2015-10-28	10:40				
2							
3							
4							
5							
6							

GENERAL (1 L PLASTIC)	Med'm		Pres'n	
	Acidity pH 8.3			
	Alkalinity: Phenolphthalein			
	Alkalinity: Total: pH 4.5			
	Biochemical Oxygen Demand (BOD)			
	Bromide			
	Carb. Biochem. Oxygen Demand (CBOD)			
	Chloride			
	Colour: True			
	Fluoride			
	Nitrogen: Nitrate			
	Nitrogen: Nitrate and Nitrite			
	Nitrogen: Nitrite			
	pH			
	Phosphorus: Diss. ortho-phosphate			
	Residue: Filterable (TDS)			
	Residue: Nonfilterable (TSS) -Subsample			
	Residue: Nonfilterable, Fixed			
	Residue: Total			
	Silica, Reactive			
	Specific Conductance			
	Sulphate			
	Turbidity			

GENERAL (250 mL AMBER GLASS	Med'm		Pres'n	
	Carbon: TOC (H2SO4)			
	Chem. Oxygen Demand (COD) (H2SO4)			
	Nitrogen: Ammonia (H2SO4)			
	Nitrogen: Total (H2SO4)			
	Nitrogen: Total Kjeldahl (Calc) (H2SO4)			
	Nitrogen: Total Organic (H2SO4)			
	Phosphorus: Total (H2SO4)			

GENERAL (125 mL AMBER GLAS	Med'm		Pres'n	
	Carbon: DOC (FF, H2SO4)			
	Nitrogen: Total Dissolved (FF,H2SO4)			
	Nitrogen:Diss Kjeldahl(Calc)(FF,H2SO4)			
	Phosphorus: Total Dissolved (FF,H2SO4)			

METALS: TOTAL		Med'm	Pres'n	Med'm	Pres'n
High	Low				
		Metal Pkg. (ICPMS) - HIGH (250 mL Plastic) - HNO3			
		Metal Pkg. (ICPMS) - LOW (250 mL Plastic) - HNO3			
		Mercury - 40mL Glass, HCl			
		Hardness (250 mL Plastic) - HNO3			

METALS: DISSOLVED		Med'm	Pres'n	Med'm	Pres'n
High	Low				
		Metal Pkg (ICPMS) - HIGH (250 mL Plastic)-Field Filter, HNO3			
		Metal Pkg. (ICPMS) - LOW (250 mL Plastic)-Field Filter, HNO3			
		Mercury - 40mL Glass, Field Filter, HCl			
		Hardness (250 mL Plastic) - Field Filter, HNO3			

SPECIFIC	Test	Med'm	Pres'n	Med'm	Pres'n
X	1 Obs Well Package				
	2 Cyanide: SAD				
	3 Cyanide: WAD				
	4 Sulphide: Total				
	5 Residue: Nonfilterable (TSS) - Whole Bottle				
	6 Carbon: TIC (H2SO4)				
	7 Carbon: DIC (FF, H2SO4)				
	8 Chlorophyll "a"				
	9 Phaeophytin				

ORGANICS		Med'm	Pres'n
	1 BTEX		
	2 VOC Full List		
	3 Volatile Hydrocarbons (VH)		
	4 Trihalomethanes (THM)		
	5 VPH		
	6 EPH		
	7 PAH		
	8 LEPH/HEPH (Calc)		
	9 Oil and Grease		
	10 Mineral Oil & Grease		
	11 Organochlorine Pesticides (OCP)		
	12 Organophosphorus Pesticides (OPP)		
	13 Polychlorinated Biphenyls (PCB)		
	14 Chlorophenols (Tri, Tetra & Penta)		
	15 Phenolics, Chlorinated		
	16 Phenolics, Non-Chlorinated		
	17 Phenols: Colorimetric		
	18 Acid Extractable Herbicides		
	19 Resin Acids		
	20 Fatty Acids		

OTHER	Med'm	Pres'n	Test

FIELD TEST DETAILS	No.	Parameter	Method	Results	Units
				6.57	pH
				10.2	C
				303.5	uS/cm

Short Holding Time

Rush Processing

Report ID: EMSR0900

Date: 2015-10-22 17:11

lady OCT 29 2015 9Am 4°C

BC MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE
ATTN: Laurie Lyons
1259 Dalhousie Drive
Kamloops BC V2C 5Z5

Date Received: 30-OCT-15
Report Date: 06-NOV-15 12:19 (MT)
Version: FINAL

Client Phone: 250-371-6200

Certificate of Analysis

Lab Work Order #: L1696217

Project P.O. #: 50221967
Job Reference: GUICHON CR AT MOUTH
C of C Numbers:
Legal Site Desc:

Other Information: Client: GK
EMS ID: 0600003
Project: N/A
Comments: Results will be sent in Excel format.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID					
Grouping **Analyte**					

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location

Chain of Custody Numbers:

Additional Information:

Average Cooler Temperature (Deg Celsius): 2.5

Project: N/A

Sampling Agency Code: 30

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: BC MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE
1259 Dalhousie Drive
Kamloops BC V2C 5Z5
Contact: Laurie Lyons

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

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WATER & GENERAL CHEMISTRY REQUISITION

ALS Global

Province Of British Columbia

Ministry of Environment

Req # 50221967

Urgent?	**Csr No.**	**Office** 30	**Client** GK
Study		**Project** N/A	
Lab	ALS Global		
Ministry Contact	LALYONS Laurie Lyons		
Sampler	Laurie Lyons		
Signature	L A Lyons		
EMS Id	0600003	**Well Plate #**	
Location	GUICHON CR AT MOUTH		

Sampling Agency	
Code 30	**Name** Southern Region, Kamloops
Address	1259 Dalhousie Drive
City	Kamloops
Postal Code	V2C5Z5 **Phone** (250)371-6200
Number of Containers	1

Instructions To Lab Return cooler.

State FW Descriptor SE Collection Method GRB

No.	Class	Collection Start YYYY-MM-DD HH:MI	Collection End YYYY-MM-DD HH:MI	Depth Upper	Depth Lower	Tide	Comment
1	REG	2015-10-28 14:30					
2							
3							
4							
5							
6							

GENERAL (1 L PLASTIC)	Med'm		Pres'n	
	Acidity pH 8.3			
	Alkalinity: Phenolphthalein			
	Alkalinity: Total: pH 4.5			
	Biochemical Oxygen Demand (BOD)			
	Bromide			
	Carb. Biochem. Oxygen Demand (CBOD)			
	Chloride			
	Colour: True			
	Fluoride			
	Nitrogen: Nitrate			
	Nitrogen: Nitrate and Nitrite			
	Nitrogen: Nitrite			
	pH			
	Phosphorus: Diss. ortho-phosphate			
	Residue: Filterable (TDS)			
	Residue: Nonfilterable (TSS) -Subsample			
	Residue: Nonfilterable, Fixed			
	Residue: Total			
	Silica, Reactive			
	Specific Conductance			
	Sulphate			
	Turbidity			

GENERAL (250 mL AMBER GLASS	Med'm		Pres'n	
	Carbon: TOC (H2SO4)			
	Chem. Oxygen Demand (COD) (H2SO4)			
	Nitrogen: Ammonia (H2SO4)			
	Nitrogen: Total (H2SO4)			
	Nitrogen: Total Kjeldahl (Calc) (H2SO4)			
	Nitrogen: Total Organic (H2SO4)			
	Phosphorus: Total (H2SO4)			

GENERAL (125 mL AMBER GLAS	Med'm		Pres'n	
	Carbon: DOC (FF, H2SO4)			
	Nitrogen: Total Dissolved (FF,H2SO4)			
	Nitrogen:Diss Kjeldahl(Calc)(FF,H2SO4)			
	Phosphorus: Total Dissolved (FF,H2SO4)			

METALS: TOTAL			Med'm	Pres'n	Med'm	Pres'n
High	Low					
		Metal Pkg. (ICPMS) - HIGH (250 mL Plastic) - HNO3				
		Metal Pkg. (ICPMS) - LOW (250 mL Plastic) - HNO3				
		Mercury - 40mL Glass, HCl				
		Hardness (250 mL Plastic) - HNO3				

METALS: DISSOLVED			Med'm	Pres'n	Med'm	Pres'n
High	Low					
		Metal Pkg (ICPMS) - HIGH (250 mL Plastic)-Field Filter, HNO3				
		Metal Pkg. (ICPMS) - LOW (250 mL Plastic)-Field Filter, HNO3				
		Mercury - 40mL Glass, Field Filter, HCl				
		Hardness (250 mL Plastic) - Field Filter, HNO3				

SPECIFIC	Test	Med'm	Pres'n	Med'm	Pres'n
	1 Obs Well Package				
	2 Cyanide: SAD				
	3 Cyanide: WAD				
	4 Sulphide: Total				
	5 Residue: Nonfilterable (TSS) - Whole Bottle				
	6 Carbon: TIC (H2SO4)				
	7 Carbon: DIC (FF, H2SO4)				
	8 Chlorophyll "a"				
	9 Phaeophytin				

ORGANICS		Med'm	Pres'n
	1 BTEX		
	2 VOC Full List		
	3 Volatile Hydrocarbons (VH)		
	4 Trihalomethanes (THM)		
	5 VPH		
	6 EPH		
	7 PAH		
	8 LEPH/HEPH (Calc)		
	9 Oil and Grease		
	10 Mineral Oil & Grease		
	11 Organochlorine Pesticides (OCP)		
	12 Organophosphorus Pesticides (OPP)		
	13 Polychlorinated Biphenyls (PCB)		
	14 Chlorophenols (Tri, Tetra & Penta)		
	15 Phenolics, Chlorinated		
	16 Phenolics, Non-Chlorinated		
	17 Phenols: Colorimetric		
	18 Acid Extractable Herbicides		
	19 Resin Acids		
	20 Fatty Acids		

OTHER	Med'm	Pres'n	Test
			Deuterium - O18 isotope

FIELD TEST DETAILS	No.	Parameter	Method	Results	Units

L1696217-COFC

Report ID: EMSR0900

Date: 2015-10-27 19:11

lady OCT 30 2015 9Am 3·C / 2·C

BC MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE
ATTN: Laurie Lyons
1259 Dalhousie Drive
Kamloops BC V2C 5Z5

Date Received: 30-OCT-15
Report Date: 06-NOV-15 12:21 (MT)
Version: FINAL

Client Phone: 250-371-6200

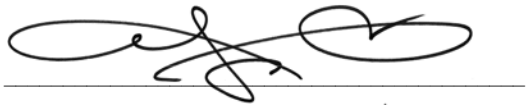
Certificate of Analysis

Lab Work Order #: L1696230

Project P.O. #: 50221987
Job Reference: 1837 NICOLLS RD
C of C Numbers:
Legal Site Desc:

Other Information: Client: GK
Project: N/A

Comments: Results will be sent in Excel format.



ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID					
Grouping **Analyte**					

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location

Chain of Custody Numbers:

Additional Information:

Average Cooler Temperature (Deg Celsius): 2.5

Project: N/A

Sampling Agency Code: 30

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

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Quality Control Report

Client: BC MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE
1259 Dalhousie Drive
Kamloops BC V2C 5Z5
Contact: Laurie Lyons

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

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WATER & GENERAL CHEMISTRY REQUISITION

ALS Global

Province Of British Columbia

Ministry of Environment

Req # 50221987

Urgent?	**Csr No.**	**Office** 30	**Client** GK
Study		**Project** N/A	
Lab	ALS Global		
Ministry Contact	LALYONS Laurie Lyons		
Sampler	Laurie Lyons		
Signature	L.R Lyons		
EMS Id	NENG	**Well Plate #**	
Location	1827 NICOLLS RD		

Sampling Agency

Code 30	**Name** Southern Region, Kamloops
Address	1259 Dalhousie Drive
City	Kamloops
Postal Code	V2C5Z5 **Phone** (250)371-6200

Number of Containers 1

Instructions To Lab Return cooler.

State FW Descriptor GE Collection Method GRB

No.	Class	Collection Start YYYY-MM-DD HH:MI	Collection End YYYY-MM-DD HH:MI	Depth Upper	Depth Lower	Tide	Comment
1	REG	2015-10-27	10:30				
2							
3							
4							
5							
6							

GENERAL (1 L PLASTIC)	Med'm		Pres'n	
	Acidity pH 8.3			
	Alkalinity: Phenolphthalein			
	Alkalinity: Total: pH 4.5			
	Biochemical Oxygen Demand (BOD)			
	Bromide			
	Carb. Biochem. Oxygen Demand (CBOD)			
	Chloride			
	Colour: True			
	Fluoride			
	Nitrogen: Nitrate			
	Nitrogen: Nitrate and Nitrite			
	Nitrogen: Nitrite			
	pH			
	Phosphorus: Diss. ortho-phosphate			
	Residue: Filterable (TDS)			
	Residue: Nonfilterable (TSS) -Subsample			
	Residue: Nonfilterable, Fixed			
	Residue: Total			
	Silica, Reactive			
	Specific Conductance			
	Sulphate			
	Turbidity			

GENERAL (250 mL AMBER GLASS	Med'm		Pres'n	
	Carbon: TOC (H2SO4)			
	Chem. Oxygen Demand (COD) (H2SO4)			
	Nitrogen: Ammonia (H2SO4)			
	Nitrogen: Total (H2SO4)			
	Nitrogen: Total Kjeldahl (Calc) (H2SO4)			
	Nitrogen: Total Organic (H2SO4)			
	Phosphorus: Total (H2SO4)			

GENERAL (125 mL AMBER GLAS	Med'm		Pres'n	
	Carbon: DOC (FF, H2SO4)			
	Nitrogen: Total Dissolved (FF,H2SO4)			
	Nitrogen:Diss Kjeldahl(Calc)(FF,H2SO4)			
	Phosphorus: Total Dissolved (FF,H2SO4)			

METALS: TOTAL			Med'm	Pres'n	Med'm	Pres'n
High	Low					
		Metal Pkg. (ICPMS) - HIGH (250 mL Plastic) - HNO3				
		Metal Pkg. (ICPMS) - LOW (250 mL Plastic) - HNO3				
		Mercury - 40mL Glass, HCl				
		Hardness (250 mL Plastic) - HNO3				

METALS: DISSOLVED			Med'm	Pres'n	Med'm	Pres'n
High	Low					
		Metal Pkg (ICPMS) - HIGH (250 mL Plastic)-Field Filter, HNO3				
		Metal Pkg. (ICPMS) - LOW (250 mL Plastic)-Field Filter, HNO3				
		Mercury - 40mL Glass, Field Filter, HCl				
		Hardness (250 mL Plastic) - Field Filter, HNO3				

SPECIFIC	Test	Med'm	Pres'n	Med'm	Pres'n
	1 Obs Well Package				
	2 Cyanide: SAD				
	3 Cyanide: WAD				
	4 Sulphide: Total				
	5 Residue: Nonfilterable (TSS) - Whole Bottle				
	6 Carbon: TIC (H2SO4)				
	7 Carbon: DIC (FF, H2SO4)				
	8 Chlorophyll "a"				
	9 Phaeophytin				

ORGANICS		Med'm	Pres'n
	1 BTEX		
	2 VOC Full List		
	3 Volatile Hydrocarbons (VH)		
	4 Trihalomethanes (THM)		
	5 VPH		
	6 EPH		
	7 PAH		
	8 LEPH/HEPH (Calc)		
	9 Oil and Grease		
	10 Mineral Oil & Grease		
	11 Organochlorine Pesticides (OCP)		
	12 Organophosphorus Pesticides (OPP)		
	13 Polychlorinated Biphenyls (PCB)		
	14 Chlorophenols (Tri, Tetra & Penta)		
	15 Phenolics, Chlorinated		
	16 Phenolics, Non-Chlorinated		
	17 Phenols: Colorimetric		
	18 Acid Extractable Herbicides		
	19 Resin Acids		
	20 Fatty Acids		

OTHER	Med'm	Pres'n	Test
			Deuterium - O18 isotope

FIELD TEST DETAILS	No.	Parameter	Method	Results	Units

L1696230-COFC

Report ID: EMSR0900

Date: 2015-10-27 19:22

lady OCT : Oct 30 2015 9am 3·c/2·c

BC MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE
ATTN: Laurie Lyons
1259 Dalhousie Drive
Kamloops BC V2C 5Z5

Date Received: 30-OCT-15
Report Date: 06-NOV-15 12:22 (MT)
Version: FINAL

Client Phone: 250-371-6200

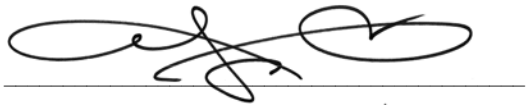
Certificate of Analysis

Lab Work Order #: L1696233

Project P.O. #: 50221988
Job Reference: UREP SITE
C of C Numbers:
Legal Site Desc:

Other Information: Client: GK
Project: N/A

Comments: Results will be sent in Excel format.



ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID					
Grouping **Analyte**					

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

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Laboratory Definition Code	Laboratory Location

Chain of Custody Numbers:

Additional Information:

Average Cooler Temperature (Deg Celsius): 2.5

Project: N/A

Sampling Agency Code: 30

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

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Quality Control Report

Client: BC MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE
1259 Dalhousie Drive
Kamloops BC V2C 5Z5
Contact: Laurie Lyons

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

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WATER & GENERAL CHEMISTRY REQUISITION

ALS Global

Province Of British Columbia

Ministry of Environment

Req # 50221988

Urgent?	**Csr No.**	**Office** 30	**Client** GK
Study		**Project** N/A	
Lab	ALS Global		
Ministry Contact	LALYONS Laurie Lyons		
Sampler	Laurie Lyons		
Signature			
EMS Id	NONE	**Well Plate #**	
Location	UREP SITE		

Sampling Agency

Code 30 **Name** Southern Region, Kamloops

Address 1259 Dalhousie Drive

City Kamloops

Postal Code V2C5Z5 **Phone** (250)371-6200

Number of Containers 1

Instructions To Lab Return cooler.

State FW Descriptor GE Collection Method GRB

No.	Class	Collection Start YYYY-MM-DD HH:MI	Collection End YYYY-MM-DD HH:MI	Depth Upper	Depth Lower	Tide	Comment
1	REG	2015-10-28	11:30				
2							
3							
4							
5							
6							

GENERAL (1 L PLASTIC)	Med'm		Pres'n	
	Acidity pH 8.3			
	Alkalinity: Phenolphthalein			
	Alkalinity: Total: pH 4.5			
	Biochemical Oxygen Demand (BOD)			
	Bromide			
	Carb. Biochem. Oxygen Demand (CBOD)			
	Chloride			
	Colour: True			
	Fluoride			
	Nitrogen: Nitrate			
	Nitrogen: Nitrate and Nitrite			
	Nitrogen: Nitrite			
	pH			
	Phosphorus: Diss. ortho-phosphate			
	Residue: Filterable (TDS)			
	Residue: Nonfilterable (TSS) -Subsample			
	Residue: Nonfilterable, Fixed			
	Residue: Total			
	Silica, Reactive			
	Specific Conductance			
	Sulphate			
	Turbidity			

GENERAL (250 mL AMBER GLASS	Med'm		Pres'n	
	Carbon: TOC (H2SO4)			
	Chem. Oxygen Demand (COD) (H2SO4)			
	Nitrogen: Ammonia (H2SO4)			
	Nitrogen: Total (H2SO4)			
	Nitrogen: Total Kjeldahl (Calc) (H2SO4)			
	Nitrogen: Total Organic (H2SO4)			
	Phosphorus: Total (H2SO4)			

GENERAL (125 mL AMBER GLAS	Med'm		Pres'n	
	Carbon: DOC (FF, H2SO4)			
	Nitrogen: Total Dissolved (FF,H2SO4)			
	Nitrogen:Diss Kjeldahl(Calc)(FF,H2SO4)			
	Phosphorus: Total Dissolved (FF,H2SO4)			

METALS: TOTAL		Med'm	Pres'n	Med'm	Pres'n
High	Low				
		Metal Pkg. (ICPMS) - HIGH (250 mL Plastic) - HNO3			
		Metal Pkg. (ICPMS) - LOW (250 mL Plastic) - HNO3			
		Mercury - 40mL Glass, HCl			
		Hardness (250 mL Plastic) - HNO3			

METALS: DISSOLVED		Med'm	Pres'n	Med'm	Pres'n
High	Low				
		Metal Pkg (ICPMS) - HIGH (250 mL Plastic)-Field Filter, HNO3			
		Metal Pkg. (ICPMS) - LOW (250 mL Plastic)-Field Filter, HNO3			
		Mercury - 40mL Glass, Field Filter, HCl			
		Hardness (250 mL Plastic) - Field Filter, HNO3			

SPECIFIC	Test	Med'm	Pres'n	Med'm	Pres'n
	1 Obs Well Package				
	2 Cyanide: SAD				
	3 Cyanide: WAD				
	4 Sulphide: Total				
	5 Residue: Nonfilterable (TSS) - Whole Bottle				
	6 Carbon: TIC (H2SO4)				
	7 Carbon: DIC (FF, H2SO4)				
	8 Chlorophyll "a"				
	9 Phaeophytin				

ORGANICS		Med'm	Pres'n
	1 BTEX		
	2 VOC Full List		
	3 Volatile Hydrocarbons (VH)		
	4 Trihalomethanes (THM)		
	5 VPH		
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	15 Phenolics, Chlorinated		
	16 Phenolics, Non-Chlorinated		
	17 Phenols: Colorimetric		
	18 Acid Extractable Herbicides		
	19 Resin Acids		
	20 Fatty Acids		

OTHER	Med'm	Pres'n	Test
			Deuterium - O18 isotope

FIELD TEST DETAILS	No.	Parameter	Method	Results	Units

L1696233-COFC

Report ID: EMSR0900

Date: 2015-10-27 19:23

lady OCT 30 2015 9AM 3.C/2.C

BC MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE
ATTN: Laurie Lyons
1259 Dalhousie Drive
Kamloops BC V2C 5Z5

Date Received: 30-OCT-15
Report Date: 06-NOV-15 12:23 (MT)
Version: FINAL

Client Phone: 250-371-6200

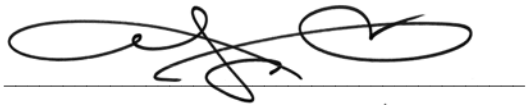
Certificate of Analysis

Lab Work Order #: L1696252

Project P.O. #: 50221989
Job Reference: 3040 SUNSHINE VALLEY RD
C of C Numbers:
Legal Site Desc:

Other Information: Client: GK
Project: N/A

Comments: Results will be sent in Excel format.



ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID					
Grouping **Analyte**					

Reference Information

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ALS Test Code	Matrix	Test Description	Method Reference**

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Chain of Custody Numbers:

Additional Information:

Average Cooler Temperature (Deg Celsius): 2.5

Project: N/A

Sampling Agency Code: 30

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mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
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Quality Control Report

Client: BC MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE
1259 Dalhousie Drive
Kamloops BC V2C 5Z5
Contact: Laurie Lyons

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
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RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
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MS	Matrix Spike
MSD	Matrix Spike Duplicate
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MB	Method Blank
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CVS	Calibration Verification Standard
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WATER & GENERAL CHEMISTRY REQUISITION

ALS Global

Province Of British Columbia

Ministry of Environment

Req # 50221989

Urgent?	**Csr No.**	**Office** 30	**Client** GK
Study		**Project** N/A	
Lab	ALS Global		
Ministry Contact	LALYONS Laurie Lyons		
Sampler	Laurie Lyons		
Signature	X Laurie S		
EMS Id	NONE	**Well Plate #**	
Location	3040 SUNSHINE VALLEY RD		

Sampling Agency

Code 30 **Name** Southern Region, Kamloops

Address 1259 Dalhousie Drive

City Kamloops

Postal Code V2C5Z5 **Phone** (250)371-6200

Number of Containers 1

Instructions To Lab Return cooler.

State FW Descriptor GE Collection Method GRB

No.	Class	Collection Start YYYY-MM-DD HH:MI	Collection End YYYY-MM-DD HH:MI	Depth Upper	Depth Lower	Tide	Comment
1	REG	2015-10-28	11:45				
2							
3							
4							
5							
6							

GENERAL (1 L PLASTIC)	Med'm		Pres'n	
	Acidity pH 8.3			
	Alkalinity: Phenolphthalein			
	Alkalinity: Total: pH 4.5			
	Biochemical Oxygen Demand (BOD)			
	Bromide			
	Carb. Biochem. Oxygen Demand (CBOD)			
	Chloride			
	Colour: True			
	Fluoride			
	Nitrogen: Nitrate			
	Nitrogen: Nitrate and Nitrite			
	Nitrogen: Nitrite			
	pH			
	Phosphorus: Diss. ortho-phosphate			
	Residue: Filterable (TDS)			
	Residue: Nonfilterable (TSS) -Subsample			
	Residue: Nonfilterable, Fixed			
	Residue: Total			
	Silica, Reactive			
	Specific Conductance			
	Sulphate			
	Turbidity			

GENERAL (250 mL AMBER GLASS	Med'm		Pres'n	
	Carbon: TOC (H2SO4)			
	Chem. Oxygen Demand (COD) (H2SO4)			
	Nitrogen: Ammonia (H2SO4)			
	Nitrogen: Total (H2SO4)			
	Nitrogen: Total Kjeldahl (Calc) (H2SO4)			
	Nitrogen: Total Organic (H2SO4)			
	Phosphorus: Total (H2SO4)			

GENERAL (125 mL AMBER GLAS	Med'm		Pres'n	
	Carbon: DOC (FF, H2SO4)			
	Nitrogen: Total Dissolved (FF,H2SO4)			
	Nitrogen:Diss Kjeldahl(Calc)(FF,H2SO4)			
	Phosphorus: Total Dissolved (FF,H2SO4)			

METALS: TOTAL			Med'm	Pres'n	Med'm	Pres'n
High	Low					
		Metal Pkg. (ICPMS) - HIGH (250 mL Plastic) - HNO3				
		Metal Pkg. (ICPMS) - LOW (250 mL Plastic) - HNO3				
		Mercury - 40mL Glass, HCl				
		Hardness (250 mL Plastic) - HNO3				

METALS: DISSOLVED			Med'm	Pres'n	Med'm	Pres'n
High	Low					
		Metal Pkg (ICPMS) - HIGH (250 mL Plastic)-Field Filter, HNO3				
		Metal Pkg. (ICPMS) - LOW (250 mL Plastic)-Field Filter, HNO3				
		Mercury - 40mL Glass, Field Filter, HCl				
		Hardness (250 mL Plastic) - Field Filter, HNO3				

SPECIFIC	Test	Med'm	Pres'n	Med'm	Pres'n
	1 Obs Well Package				
	2 Cyanide: SAD				
	3 Cyanide: WAD				
	4 Sulphide: Total				
	5 Residue: Nonfilterable (TSS) - Whole Bottle				
	6 Carbon: TIC (H2SO4)				
	7 Carbon: DIC (FF, H2SO4)				
	8 Chlorophyll "a"				
	9 Phaeophytin				

ORGANICS		Med'm	Pres'n
	1 BTEX		
	2 VOC Full List		
	3 Volatile Hydrocarbons (VH)		
	4 Trihalomethanes (THM)		
	5 VPH		
	6 EPH		
	7 PAH		
	8 LEPH/HEPH (Calc)		
	9 Oil and Grease		
	10 Mineral Oil & Grease		
	11 Organochlorine Pesticides (OCP)		
	12 Organophosphorus Pesticides (OPP)		
	13 Polychlorinated Biphenyls (PCB)		
	14 Chlorophenols (Tri, Tetra & Penta)		
	15 Phenolics, Chlorinated		
	16 Phenolics, Non-Chlorinated		
	17 Phenols: Colorimetric		
	18 Acid Extractable Herbicides		
	19 Resin Acids		
	20 Fatty Acids		

OTHER	Med'm	Pres'n	Test
			Deuterium - O18 isotope

FIELD TEST DETAILS	No.	Parameter	Method	Results	Units

L1696252-COFC

Report ID: EMSR0900

Date: 2015-10-27 19:26

lady OCT 30 2015 9AM 3°C/2°C

BC MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE
ATTN: Laurie Lyons
1259 Dalhousie Drive
Kamloops BC V2C 5Z5

Date Received: 30-OCT-15
Report Date: 06-NOV-15 12:28 (MT)
Version: FINAL

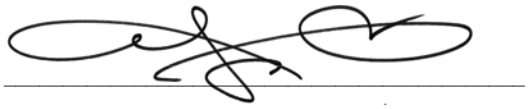
Client Phone: 250-371-6200

Certificate of Analysis

Lab Work Order #: L1696256

Project P.O. #: 50221827
Job Reference: COLDWATER RIVER U/S COLLETT BRIDGE
C of C Numbers:
Legal Site Desc:

Other Information: Client: GK
EMS ID: E279294
Project: N/A
Comments: Results will be sent in Excel format.



ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID					
Grouping **Analyte**					

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location

Chain of Custody Numbers:

Additional Information:

Average Cooler Temperature (Deg Celsius): 2.5

Project: N/A

Sampling Agency Code: 30

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: BC MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE
1259 Dalhousie Drive
Kamloops BC V2C 5Z5
Contact: Laurie Lyons

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

WATER & GENERAL CHEMISTRY REQUISITION

ALS Global

Province Of British Columbia

Ministry of Environment

Req # 50221827

Urgent?	**Csr No.**	**Office** 30	**Client** GK
Study		**Project** N/A	
Lab	ALS Global		
Ministry Contact	LALYONS Laurie Lyons		
Sampler	Laurie Lyons		
Signature	L A Lyons		
EMS Id	E279294	**Well Plate #**	
Location	COLDWATER RIVER U/S COLLETT BRIDGE		

Sampling Agency

Code 30	**Name** Southern Region, Kamloops
Address	1259 Dalhousie Drive
City	Kamloops
Postal Code	V2C5Z5 **Phone** (250)371-6200

Number of Containers 1

Instructions To Lab Return Cooler.

State FW Descriptor GE Collection Method GRB

No.	Class	Collection Start YYYY-MM-DD HH:MI	Collection End YYYY-MM-DD HH:MI	Depth Upper	Depth Lower	Tide	Comment
1	REG	2015-10-28 13:30					
2							
3							
4							
5							
6							

GENERAL (1 L PLASTIC)	Med'm		Pres'n	
	Acidity pH 8.3			
	Alkalinity: Phenolphthalein			
	Alkalinity: Total: pH 4.5			
	Biochemical Oxygen Demand (BOD)			
	Bromide			
	Carb. Biochem. Oxygen Demand (CBOD)			
	Chloride			
	Colour: True			
	Fluoride			
	Nitrogen: Nitrate			
	Nitrogen: Nitrate and Nitrite			
	Nitrogen: Nitrite			
	pH			
	Phosphorus: Diss. ortho-phosphate			
	Residue: Filterable (TDS)			
	Residue: Nonfilterable (TSS) -Subsample			
	Residue: Nonfilterable, Fixed			
	Residue: Total			
	Silica, Reactive			
	Specific Conductance			
	Sulphate			
	Turbidity			

GENERAL (250 mL AMBER GLASS	Med'm		Pres'n	
	Carbon: TOC (H2SO4)			
	Chem. Oxygen Demand (COD) (H2SO4)			
	Nitrogen: Ammonia (H2SO4)			
	Nitrogen: Total (H2SO4)			
	Nitrogen: Total Kjeldahl (Calc) (H2SO4)			
	Nitrogen: Total Organic (H2SO4)			
	Phosphorus: Total (H2SO4)			

GENERAL (125 mL AMBER GLAS	Med'm		Pres'n	
	Carbon: DOC (FF, H2SO4)			
	Nitrogen: Total Dissolved (FF,H2SO4)			
	Nitrogen:Diss Kjeldahl(Calc)(FF,H2SO4)			
	Phosphorus: Total Dissolved (FF,H2SO4)			

METALS: TOTAL		Med'm	Pres'n	Med'm	Pres'n
High	Low				
		Metal Pkg. (ICPMS) - HIGH (250 mL Plastic) - HNO3			
		Metal Pkg. (ICPMS) - LOW (250 mL Plastic) - HNO3			
		Mercury - 40mL Glass, HCl			
		Hardness (250 mL Plastic) - HNO3			

METALS: DISSOLVED		Med'm	Pres'n	Med'm	Pres'n
High	Low				
		Metal Pkg (ICPMS) - HIGH (250 mL Plastic)-Field Filter, HNO3			
		Metal Pkg. (ICPMS) - LOW (250 mL Plastic)-Field Filter, HNO3			
		Mercury - 40mL Glass, Field Filter, HCl			
		Hardness (250 mL Plastic) - Field Filter, HNO3			

SPECIFIC Test	Med'm	Pres'n	Med'm	Pres'n
1 Obs Well Package				
2 Cyanide: SAD				
3 Cyanide: WAD				
4 Sulphide: Total				
5 Residue: Nonfilterable (TSS) - Whole Bottle				
6 Carbon: TIC (H2SO4)				
7 Carbon: DIC (FF, H2SO4)				
8 Chlorophyll "a"				
9 Phaeophytin				

ORGANICS	Med'm	Pres'n
1 BTEX		
2 VOC Full List		
3 Volatile Hydrocarbons (VH)		
4 Trihalomethanes (THM)		
5 VPH		
6 EPH		
7 PAH		
8 LEPH/HEPH (Calc)		
9 Oil and Grease		
10 Mineral Oil & Grease		
11 Organochlorine Pesticides (OCP)		
12 Organophosphorus Pesticides (OPP)		
13 Polychlorinated Biphenyls (PCB)		
14 Chlorophenols (Tri, Tetra & Penta)		
15 Phenolics, Chlorinated		
16 Phenolics, Non-Chlorinated		
17 Phenols: Colorimetric		
18 Acid Extractable Herbicides		
19 Resin Acids		
20 Fatty Acids		

OTHER	Med'm	Pres'n	Test
			Deuterium O18
			Deuterium - O18 Isotope

FIELD TEST DETAILS	No.	Parameter	Method	Results	Units

L1696256-COFC

Report ID: EMSR0900

Date: 2015-10-22 16:39

lady OCT 30 2015 9AM 3.0/2.0

BC MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE
ATTN: Laurie Lyons
1259 Dalhousie Drive
Kamloops BC V2C 5Z5

Date Received: 30-OCT-15
Report Date: 06-NOV-15 12:30 (MT)
Version: FINAL

Client Phone: 250-371-6200

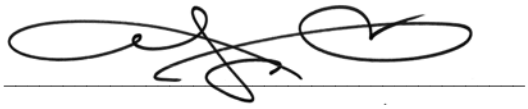
Certificate of Analysis

Lab Work Order #: L1696257

Project P.O. #: 50221828
Job Reference: NORGARD
C of C Numbers:
Legal Site Desc:

Other Information: Client: GK
Project: N/A

Comments: Results will be sent in Excel format.



ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID					
Grouping **Analyte**					

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

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Laboratory Definition Code	Laboratory Location

Chain of Custody Numbers:

Additional Information:

Average Cooler Temperature (Deg Celsius): 2.5

Project: N/A

Sampling Agency Code: 30

GLOSSARY OF REPORT TERMS

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mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
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Quality Control Report

Client: BC MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE
1259 Dalhousie Drive
Kamloops BC V2C 5Z5
Contact: Laurie Lyons

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

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WATER & GENERAL CHEMISTRY REQUISITION

ALS Global

Province Of British Columbia

Ministry of Environment

Req # 50221828

Urgent?	**Csr No.**	**Office** 30	**Client** GK
Study		**Project** N/A	
Lab	ALS Global		
Ministry Contact	LALYONS Laurie Lyons		
Sampler	Laurie Lyons		
Signature	L H Lyons		
EMS Id	NONE	**Well Plate #**	
Location	NORCARD		

Sampling Agency

Code 30 **Name** Southern Region, Kamloops

Address 1259 Dalhousie Drive

City Kamloops

Postal Code V2C5Z5 **Phone** (250)371-6200

Number of Containers 1

Instructions To Lab Return Cooler.

State FW Descriptor GE Collection Method GRB

No.	Class	Collection Start YYYY-MM-DD HH:MI	Collection End YYYY-MM-DD HH:MI	Depth Upper	Depth Lower	Tide	Comment
1	REG	2015-10-28 13:50					
2							
3							
4							
5							
6							

GENERAL (1 L PLASTIC)	Med'm	Pres'n
Acidity pH 8.3		
Alkalinity: Phenolphthalein		
Alkalinity: Total: pH 4.5		
Biochemical Oxygen Demand (BOD)		
Bromide		
Carb. Biochem. Oxygen Demand (CBOD)		
Chloride		
Colour: True		
Fluoride		
Nitrogen: Nitrate		
Nitrogen: Nitrate and Nitrite		
Nitrogen: Nitrite		
pH		
Phosphorus: Diss. ortho-phosphate		
Residue: Filterable (TDS)		
Residue: Nonfilterable (TSS) -Subsample		
Residue: Nonfilterable, Fixed		
Residue: Total		
Silica, Reactive		
Specific Conductance		
Sulphate		
Turbidity		

GENERAL (250 mL AMBER GLASS	Med'm	Pres'n
Carbon: TOC (H2SO4)		
Chem. Oxygen Demand (COD) (H2SO4)		
Nitrogen: Ammonia (H2SO4)		
Nitrogen: Total (H2SO4)		
Nitrogen: Total Kjeldahl (Calc) (H2SO4)		
Nitrogen: Total Organic (H2SO4)		
Phosphorus: Total (H2SO4)		

GENERAL (125 mL AMBER GLAS	Med'm	Pres'n
Carbon: DOC (FF, H2SO4)		
Nitrogen: Total Dissolved (FF,H2SO4)		
Nitrogen:Diss Kjeldahl(Calc)(FF,H2SO4)		
Phosphorus: Total Dissolved (FF,H2SO4)		

METALS: TOTAL		Med'm	Pres'n	Med'm	Pres'n
High	Low				
		Metal Pkg. (ICPMS) - HIGH (250 mL Plastic) - HNO3			
		Metal Pkg. (ICPMS) - LOW (250 mL Plastic) - HNO3			
		Mercury - 40mL Glass, HCl			
		Hardness (250 mL Plastic) - HNO3			

METALS: DISSOLVED		Med'm	Pres'n	Med'm	Pres'n
High	Low				
		Metal Pkg (ICPMS) - HIGH (250 mL Plastic)-Field Filter, HNO3			
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		Hardness (250 mL Plastic) - Field Filter, HNO3			

SPECIFIC Test	Med'm	Pres'n	Med'm	Pres'n
1 Obs Well Package				
2 Cyanide: SAD				
3 Cyanide: WAD				
4 Sulphide: Total				
5 Residue: Nonfilterable (TSS) - Whole Bottle				
6 Carbon: TIC (H2SO4)				
7 Carbon: DIC (FF, H2SO4)				
8 Chlorophyll "a"				
9 Phaeophytin				

ORGANICS	Med'm	Pres'n
1 BTEX		
2 VOC Full List		
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6 EPH		
7 PAH		
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15 Phenolics, Chlorinated		
16 Phenolics, Non-Chlorinated		
17 Phenols: Colorimetric		
18 Acid Extractable Herbicides		
19 Resin Acids		
20 Fatty Acids		

OTHER Med'm	Pres'n	Test
		ISOTOPE
		DEUTERIUM - O18
		Deuterium - O18 Isotope

FIELD TEST DETAILS	No.	Parameter	Method	Results	Units

L1696257-COFC

Report ID: EMSR0900

Date: 2015-10-22 16:42

lady OCT 30 2015 9AM 3.C/2.C

BC MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE
ATTN: Laurie Lyons
1259 Dalhousie Drive
Kamloops BC V2C 5Z5

Date Received: 30-OCT-15
Report Date: 06-NOV-15 12:31 (MT)
Version: FINAL

Client Phone: 250-371-6200

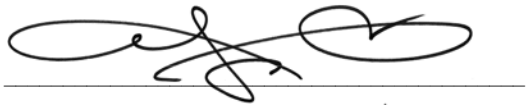
Certificate of Analysis

Lab Work Order #: L1696258

Project P.O. #: 50221829
Job Reference: HESTER SPRING
C of C Numbers:
Legal Site Desc:

Other Information: Client: GK
Project: N/A

Comments: Results will be sent in Excel format.



ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID					
Grouping **Analyte**					

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

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Laboratory Definition Code	Laboratory Location

Chain of Custody Numbers:

Additional Information:

Average Cooler Temperature (Deg Celsius): 2.5

Project: N/A

Sampling Agency Code: 30

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Quality Control Report

Client: BC MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE
1259 Dalhousie Drive
Kamloops BC V2C 5Z5
Contact: Laurie Lyons

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
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LCS	Laboratory Control Sample
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MS	Matrix Spike
MSD	Matrix Spike Duplicate
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IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
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LCSD	Laboratory Control Sample Duplicate

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WATER & GENERAL CHEMISTRY REQUISITION

ALS Global

Province Of British Columbia

Ministry of Environment

Req # 50221829

Urgent?	Csr No.	Office 30	Client GK
Study		Project N/A	
Lab	ALS Global		
Ministry Contact	LALYONS Laurie Lyons		
Sampler	Laurie Lyons		
Signature	LA Lyons		
EMS Id	NENG	Well Plate #	
Location	HESTER SPRING		

Sampling Agency

Code 30	Name Southern Region, Kamloops
Address	1259 Dalhousie Drive
City	Kamloops
Postal Code	V2C5Z5 Phone (250)371-6200

Number of Containers 7

Instructions To Lab: Return Cooler.

State FW | Descriptor GE | Collection Method GRB

No.	Class	Collection Start YYYY-MM-DD HH:MI	Collection End YYYY-MM-DD HH:MI	Depth Upper	Depth Lower	Tide	Comment
1	REG	2015-10-28 12:00					
2							
3							
4							
5							
6							

GENERAL (1 L PLASTIC)	Med'm	Pres'n
Acidity pH 8.3		
Alkalinity: Phenolphthalein		
Alkalinity: Total: pH 4.5		
Biochemical Oxygen Demand (BOD)		
Bromide		
Carb. Biochem. Oxygen Demand (CBOD)		
Chloride		
Colour: True		
Fluoride		
Nitrogen: Nitrate		
Nitrogen: Nitrate and Nitrite		
Nitrogen: Nitrite		
pH		
Phosphorus: Diss. ortho-phosphate		
Residue: Filterable (TDS)		
Residue: Nonfilterable (TSS) -Subsample		
Residue: Nonfilterable, Fixed		
Residue: Total		
Silica, Reactive		
Specific Conductance		
Sulphate		
Turbidity		

GENERAL (250 mL AMBER GLASS	Med'm	Pres'n
Carbon: TOC (H2SO4)		
Chem. Oxygen Demand (COD) (H2SO4)		
Nitrogen: Ammonia (H2SO4)		
Nitrogen: Total (H2SO4)		
Nitrogen: Total Kjeldahl (Calc) (H2SO4)		
Nitrogen: Total Organic (H2SO4)		
Phosphorus: Total (H2SO4)		

GENERAL (125 mL AMBER GLAS	Med'm	Pres'n
Carbon: DOC (FF, H2SO4)		
Nitrogen: Total Dissolved (FF,H2SO4)		
Nitrogen:Diss Kjeldahl(Calc)(FF,H2SO4)		
Phosphorus: Total Dissolved (FF,H2SO4)		

METALS: TOTAL		Med'm	Pres'n	Med'm	Pres'n
High	Low				
		Metal Pkg. (ICPMS) - HIGH (250 mL Plastic) - HNO3			
		Metal Pkg. (ICPMS) - LOW (250 mL Plastic) - HNO3			
		Mercury - 40mL Glass, HCl			
		Hardness (250 mL Plastic) - HNO3			

METALS: DISSOLVED		Med'm	Pres'n	Med'm	Pres'n
High	Low				
		Metal Pkg (ICPMS) - HIGH (250 mL Plastic)-Field Filter, HNO3			
		Metal Pkg. (ICPMS) - LOW (250 mL Plastic)-Field Filter, HNO3			
		Mercury - 40mL Glass, Field Filter, HCl			
		Hardness (250 mL Plastic) - Field Filter, HNO3			

SPECIFIC Test	Med'm	Pres'n	Med'm	Pres'n
1 Obs Well Package				
2 Cyanide: SAD				
3 Cyanide: WAD				
4 Sulphide: Total				
5 Residue: Nonfilterable (TSS) - Whole Bottle				
6 Carbon: TIC (H2SO4)				
7 Carbon: DIC (FF, H2SO4)				
8 Chlorophyll "a"				
9 Phaeophytin				

ORGANICS	Med'm	Pres'n
1 BTEX		
2 VOC Full List		
3 Volatile Hydrocarbons (VH)		
4 Trihalomethanes (THM)		
5 VPH		
6 EPH		
7 PAH		
8 LEPH/HEPH (Calc)		
9 Oil and Grease		
10 Mineral Oil & Grease		
11 Organochlorine Pesticides (OCP)		
12 Organophosphorus Pesticides (OPP)		
13 Polychlorinated Biphenyls (PCB)		
14 Chlorophenols (Tri, Tetra & Penta)		
15 Phenolics, Chlorinated		
16 Phenolics, Non-Chlorinated		
17 Phenols: Colorimetric		
18 Acid Extractable Herbicides		
19 Resin Acids		
20 Fatty Acids		

OTHER	Med'm	Pres'n	Test
/			ISOTOPE
			DEUTERIUM - O18
			Deuterium - O18 isotope

FIELD TEST DETAILS	No.	Parameter	Method	Results	Units

L1696258-COFC

Report ID: EMSR0900

Date: 2015-10-22 16:44

lady OCT 30 2015 9AM 3°C/2°C

BC MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE
ATTN: Laurie Lyons
1259 Dalhousie Drive
Kamloops BC V2C 5Z5

Date Received: 30-OCT-15
Report Date: 06-NOV-15 12:40 (MT)
Version: FINAL

Client Phone: 250-371-6200

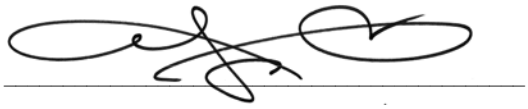
Certificate of Analysis

Lab Work Order #: L1696259

Project P.O. #: 50221831
Job Reference: 2205 COYLERD
C of C Numbers:
Legal Site Desc:

Other Information: Client: GK
Project: N/A

Comments: Results will be sent in Excel format.



ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID					
Grouping **Analyte**					

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location

Chain of Custody Numbers:

Additional Information:

Average Cooler Temperature (Deg Celsius): 2.5

Project: N/A

Sampling Agency Code: 30

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: BC MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE
1259 Dalhousie Drive
Kamloops BC V2C 5Z5
Contact: Laurie Lyons

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

WATER & GENERAL CHEMISTRY REQUISITION

ALS Global

Province Of British Columbia

Ministry of Environment

Req # 50221831

Urgent?	**Csr No.**	**Office** 30	**Client** GK
Study		**Project** N/A	
Lab	ALS Global		
Ministry Contact	LALYONS Laurie Lyons		
Sampler	Laurie Lyons		
Signature			
EMS Id		**Well Plate #**	
Location	2205 COYLE RD		

Sampling Agency	
Code 30	**Name** Southern Region, Kamloops
Address	1259 Dalhousie Drive
City	Kamloops
Postal Code	V2C5Z5 **Phone** (250)371-6200
Number of Containers	1

Instructions To Lab Return Cooler.

State FW Descriptor GE Collection Method GRB

No.	Class	Collection Start YYYY-MM-DD HH:MI	Collection End YYYY-MM-DD HH:MI	Depth Upper	Depth Lower	Tide	Comment
1	RGS	2015-10-28 14:40					
2							
3							
4							
5							
6							

GENERAL (1 L PLASTIC)	Med'm	Pres'n
Acidity pH 8.3		
Alkalinity: Phenolphthalein		
Alkalinity: Total: pH 4.5		
Biochemical Oxygen Demand (BOD)		
Bromide		
Carb. Biochem. Oxygen Demand (CBOD)		
Chloride		
Colour: True		
Fluoride		
Nitrogen: Nitrate		
Nitrogen: Nitrate and Nitrite		
Nitrogen: Nitrite		
pH		
Phosphorus: Diss. ortho-phosphate		
Residue: Filterable (TDS)		
Residue: Nonfilterable (TSS) -Subsample		
Residue: Nonfilterable, Fixed		
Residue: Total		
Silica, Reactive		
Specific Conductance		
Sulphate		
Turbidity		

GENERAL (250 mL AMBER GLASS	Med'm	Pres'n
Carbon: TOC (H2SO4)		
Chem. Oxygen Demand (COD) (H2SO4)		
Nitrogen: Ammonia (H2SO4)		
Nitrogen: Total (H2SO4)		
Nitrogen: Total Kjeldahl (Calc) (H2SO4)		
Nitrogen: Total Organic (H2SO4)		
Phosphorus: Total (H2SO4)		

GENERAL (125 mL AMBER GLAS	Med'm	Pres'n
Carbon: DOC (FF, H2SO4)		
Nitrogen: Total Dissolved (FF,H2SO4)		
Nitrogen:Diss Kjeldahl(Calc)(FF,H2SO4)		
Phosphorus: Total Dissolved (FF,H2SO4)		

METALS: TOTAL		Med'm	Pres'n	Med'm	Pres'n
High	Low				
		Metal Pkg. (ICPMS) - HIGH (250 mL Plastic) - HNO3			
		Metal Pkg. (ICPMS) - LOW (250 mL Plastic) - HNO3			
		Mercury - 40mL Glass, HCl			
		Hardness (250 mL Plastic) - HNO3			

METALS: DISSOLVED		Med'm	Pres'n	Med'm	Pres'n
High	Low				
		Metal Pkg (ICPMS) - HIGH (250 mL Plastic)-Field Filter, HNO3			
		Metal Pkg. (ICPMS) - LOW (250 mL Plastic)-Field Filter, HNO3			
		Mercury - 40mL Glass, Field Filter, HCl			
		Hardness (250 mL Plastic) - Field Filter, HNO3			

SPECIFIC Test	Med'm	Pres'n	Med'm	Pres'n
1 Obs Well Package				
2 Cyanide: SAD				
3 Cyanide: WAD				
4 Sulphide: Total				
5 Residue: Nonfilterable (TSS) - Whole Bottle				
6 Carbon: TIC (H2SO4)				
7 Carbon: DIC (FF, H2SO4)				
8 Chlorophyll "a"				
9 Phaeophytin				

ORGANICS	Med'm	Pres'n
1 BTEX		
2 VOC Full List		
3 Volatile Hydrocarbons (VH)		
4 Trihalomethanes (THM)		
5 VPH		
6 EPH		
7 PAH		
8 LEPH/HEPH (Calc)		
9 Oil and Grease		
10 Mineral Oil & Grease		
11 Organochlorine Pesticides (OCP)		
12 Organophosphorus Pesticides (OPP)		
13 Polychlorinated Biphenyls (PCB)		
14 Chlorophenols (Tri, Tetra & Penta)		
15 Phenolics, Chlorinated		
16 Phenolics, Non-Chlorinated		
17 Phenols: Colorimetric		
18 Acid Extractable Herbicides		
19 Resin Acids		
20 Fatty Acids		

OTHER	Med'm	Pres'n	Test
			ISOTOPE
			DEUTERIUM-018
			Deuterium - O18 isotope

FIELD TEST DETAILS	No.	Parameter	Method	Results	Units

L1696259-COFC

Report ID: EMSR0900

Date: 2015-10-22 16:48

lady OCT 30 2015 9AM 3°C/2°C

BC MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE
ATTN: Laurie Lyons
1259 Dalhousie Drive
Kamloops BC V2C 5Z5

Date Received: 30-OCT-15
Report Date: 06-NOV-15 12:41 (MT)
Version: FINAL

Client Phone: 250-371-6200

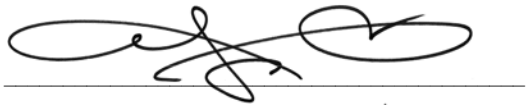
Certificate of Analysis

Lab Work Order #: L1696260

Project P.O. #: 50221832
Job Reference: NICOLA R D/S CONFLUENCE
C of C Numbers:
Legal Site Desc:

Other Information: Client: GK
Project: N/A

Comments: Results will be sent in Excel format.



ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID					
Grouping **Analyte**					

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location

Chain of Custody Numbers:

Additional Information:

Average Cooler Temperature (Deg Celsius): 2.5

Project: N/A

Sampling Agency Code: 30

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
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Quality Control Report

Client: BC MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE
1259 Dalhousie Drive
Kamloops BC V2C 5Z5
Contact: Laurie Lyons

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

WATER & GENERAL CHEMISTRY REQUISITION

ALS Global

Province Of British Columbia

Ministry of Environment

Req # 50221832

Urgent?	Csr No.	Office 30	Client GK
Study		Project N/A	
Lab	ALS Global		
Ministry Contact	LALYONS Laurie Lyons		
Sampler	Laurie Lyons		
Signature	L A Lyons		
EMS Id	NONE	Well Plate #	
Location	NICOLA R D/S CONFLUENCE		

Sampling Agency

Code 30	Name Southern Region, Kamloops
Address	1259 Dalhousie Drive
City	Kamloops
Postal Code	V2C5Z5 Phone (250)371-6200

Number of Containers 1

Instructions To Lab: Return Cooler.

State FW | Descriptor GE | Collection Method GRB

No.	Class	Collection Start YYYY-MM-DD HH:MI	Collection End YYYY-MM-DD HH:MI	Depth Upper	Depth Lower	Tide	Comment
1	REG	2015-10-28 15:05					
2							
3							
4							
5							
6							

GENERAL (1 L PLASTIC)	Med'm	Pres'n
Acidity pH 8.3		
Alkalinity: Phenolphthalein		
Alkalinity: Total: pH 4.5		
Biochemical Oxygen Demand (BOD)		
Bromide		
Carb. Biochem. Oxygen Demand (CBOD)		
Chloride		
Colour: True		
Fluoride		
Nitrogen: Nitrate		
Nitrogen: Nitrate and Nitrite		
Nitrogen: Nitrite		
pH		
Phosphorus: Diss. ortho-phosphate		
Residue: Filterable (TDS)		
Residue: Nonfilterable (TSS) -Subsample		
Residue: Nonfilterable, Fixed		
Residue: Total		
Silica, Reactive		
Specific Conductance		
Sulphate		
Turbidity		

GENERAL (250 mL AMBER GLASS	Med'm	Pres'n
Carbon: TOC (H2SO4)		
Chem. Oxygen Demand (COD) (H2SO4)		
Nitrogen: Ammonia (H2SO4)		
Nitrogen: Total (H2SO4)		
Nitrogen: Total Kjeldahl (Calc) (H2SO4)		
Nitrogen: Total Organic (H2SO4)		
Phosphorus: Total (H2SO4)		

GENERAL (125 mL AMBER GLAS	Med'm	Pres'n
Carbon: DOC (FF, H2SO4)		
Nitrogen: Total Dissolved (FF,H2SO4)		
Nitrogen:Diss Kjeldahl(Calc)(FF,H2SO4)		
Phosphorus: Total Dissolved (FF,H2SO4)		

METALS: TOTAL			Med'm	Pres'n	Med'm	Pres'n
High	Low					
	■	Metal Pkg. (ICPMS) - HIGH (250 mL Plastic) - HNO3				
■		Metal Pkg. (ICPMS) - LOW (250 mL Plastic) - HNO3				
		Mercury - 40mL Glass, HCl				
		Hardness (250 mL Plastic) - HNO3				

METALS: DISSOLVED			Med'm	Pres'n	Med'm	Pres'n
High	Low					
	■	Metal Pkg (ICPMS) - HIGH (250 mL Plastic)-Field Filter, HNO3				
■		Metal Pkg. (ICPMS) - LOW (250 mL Plastic)-Field Filter, HNO3				
		Mercury - 40mL Glass, Field Filter, HCl				
		Hardness (250 mL Plastic) - Field Filter, HNO3				

SPECIFIC Test	Med'm	Pres'n	Med'm	Pres'n
1 Obs Well Package				
2 Cyanide: SAD				
3 Cyanide: WAD				
4 Sulphide: Total				
5 Residue: Nonfilterable (TSS) - Whole Bottle				
6 Carbon: TIC (H2SO4)				
7 Carbon: DIC (FF, H2SO4)				
8 Chlorophyll "a"				
9 Phaeophytin				

ORGANICS	Med'm	Pres'n
1 BTEX		
2 VOC Full List		
3 Volatile Hydrocarbons (VH)		
4 Trihalomethanes (THM)		
5 VPH		
6 EPH		
7 PAH		
8 LEPH/HEPH (Calc)		
9 Oil and Grease		
10 Mineral Oil & Grease		
11 Organochlorine Pesticides (OCP)		
12 Organophosphorus Pesticides (OPP)		
13 Polychlorinated Biphenyls (PCB)		
14 Chlorophenols (Tri, Tetra & Penta)		
15 Phenolics, Chlorinated		
16 Phenolics, Non-Chlorinated		
17 Phenols: Colorimetric		
18 Acid Extractable Herbicides		
19 Resin Acids		
20 Fatty Acids		

OTHER	Med'm	Pres'n	Test
			ISOTOPE
			Deuterium - O18
			Deuterium - O18 isotope

FIELD TEST DETAILS	No.	Parameter	Method	Results	Units

L1696260-COFC

Report ID: EMSR0900

Date: 2015-10-22 16:48

lady OCT 30 2015 9AM 3.C/2.C

BC MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE
ATTN: Laurie Lyons
1259 Dalhousie Drive
Kamloops BC V2C 5Z5

Date Received: 30-OCT-15
Report Date: 06-NOV-15 12:43 (MT)
Version: FINAL

Client Phone: 250-371-6200

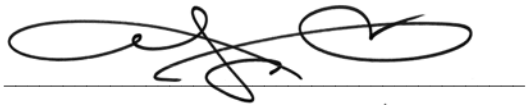
Certificate of Analysis

Lab Work Order #: L1696261

Project P.O. #: 50221833
Job Reference: 12729 VOGHT PARK WELL
C of C Numbers:
Legal Site Desc:

Other Information: Client: GK
Project: N/A

Comments: Results will be sent in Excel format.



ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID					
Grouping **Analyte**					

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

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Laboratory Definition Code	Laboratory Location

Chain of Custody Numbers:

Additional Information:

Average Cooler Temperature (Deg Celsius): 2.5

Project: N/A

Sampling Agency Code: 30

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: BC MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE
1259 Dalhousie Drive
Kamloops BC V2C 5Z5
Contact: Laurie Lyons

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

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WATER & GENERAL CHEMISTRY REQUISITION

ALS Global

Province Of British Columbia

Ministry of Environment

Req # 50221833

Urgent?	**Csr No.**	**Office** 30	**Client** GK
Study		**Project** N/A	
Lab	ALS Global		
Ministry Contact	LALYONS Laurie Lyons		
Sampler	Laurie Lyons		
Signature			
EMS Id		**Well Plate #**	
Location	12729 VOGHT PARK WELL		

Sampling Agency

Code 30	**Name** Southern Region, Kamloops
Address	1259 Dalhousie Drive
City	Kamloops
Postal Code	V2C5Z5 **Phone** (250)371-6200

Number of Containers 1

Instructions To Lab Return Cooler.

State: FW Descriptor: GE Collection Method: GRB

No.	Class	Collection Start YYYY-MM-DD HH:MI	Collection End YYYY-MM-DD HH:MI	Depth Upper	Depth Lower	Tide	Comment
1	REG	2015-10-28	13:30				
2							
3							
4							
5							
6							

GENERAL (1 L PLASTIC)	Med'm		Pres'n	
	Acidity pH 8.3			
	Alkalinity: Phenolphthalein			
	Alkalinity: Total: pH 4.5			
	Biochemical Oxygen Demand (BOD)			
	Bromide			
	Carb. Biochem. Oxygen Demand (CBOD)			
	Chloride			
	Colour: True			
	Fluoride			
	Nitrogen: Nitrate			
	Nitrogen: Nitrate and Nitrite			
	Nitrogen: Nitrite			
	pH			
	Phosphorus: Diss. ortho-phosphate			
	Residue: Filterable (TDS)			
	Residue: Nonfilterable (TSS) -Subsample			
	Residue: Nonfilterable, Fixed			
	Residue: Total			
	Silica, Reactive			
	Specific Conductance			
	Sulphate			
	Turbidity			

GENERAL (250 mL AMBER GLASS	Med'm		Pres'n	
	Carbon: TOC (H2SO4)			
	Chem. Oxygen Demand (COD) (H2SO4)			
	Nitrogen: Ammonia (H2SO4)			
	Nitrogen: Total (H2SO4)			
	Nitrogen: Total Kjeldahl (Calc) (H2SO4)			
	Nitrogen: Total Organic (H2SO4)			
	Phosphorus: Total (H2SO4)			

GENERAL (125 mL AMBER GLAS	Med'm		Pres'n	
	Carbon: DOC (FF, H2SO4)			
	Nitrogen: Total Dissolved (FF,H2SO4)			
	Nitrogen:Diss Kjeldahl(Calc)(FF,H2SO4)			
	Phosphorus: Total Dissolved (FF,H2SO4)			

METALS: TOTAL			Med'm	Pres'n	Med'm	Pres'n
High	Low					
	■	Metal Pkg. (ICPMS) - HIGH (250 mL Plastic) - HNO3				
■		Metal Pkg. (ICPMS) - LOW (250 mL Plastic) - HNO3				
		Mercury - 40mL Glass, HCl				
		Hardness (250 mL Plastic) - HNO3				

METALS: DISSOLVED			Med'm	Pres'n	Med'm	Pres'n
High	Low					
	■	Metal Pkg (ICPMS) - HIGH (250 mL Plastic)-Field Filter, HNO3				
■		Metal Pkg. (ICPMS) - LOW (250 mL Plastic)-Field Filter, HNO3				
		Mercury - 40mL Glass, Field Filter, HCl				
		Hardness (250 mL Plastic) - Field Filter, HNO3				

SPECIFIC Test	Med'm	Pres'n	Med'm	Pres'n
1 Obs Well Package				
2 Cyanide: SAD				
3 Cyanide: WAD				
4 Sulphide: Total				
5 Residue: Nonfilterable (TSS) - Whole Bottle				
6 Carbon: TIC (H2SO4)				
7 Carbon: DIC (FF, H2SO4)				
8 Chlorophyll "a"				
9 Phaeophytin				

ORGANICS	Med'm	Pres'n
1 BTEX		
2 VOC Full List		
3 Volatile Hydrocarbons (VH)		
4 Trihalomethanes (THM)		
5 VPH		
6 EPH		
7 PAH		
8 LEPH/HEPH (Calc)		
9 Oil and Grease		
10 Mineral Oil & Grease		
11 Organochlorine Pesticides (OCP)		
12 Organophosphorus Pesticides (OPP)		
13 Polychlorinated Biphenyls (PCB)		
14 Chlorophenols (Tri, Tetra & Penta)		
15 Phenolics, Chlorinated		
16 Phenolics, Non-Chlorinated		
17 Phenols: Colorimetric		
18 Acid Extractable Herbicides		
19 Resin Acids		
20 Fatty Acids		

OTHER Med'm	Pres'n	Test
		Deuterium O18

FIELD TEST DETAILS	No.	Parameter	Method	Results	Units

L1696261-COFC

Report ID: EMSR0900

Date: 2015-10-22 16:54

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APPENDIX C

Water Budget Spreadsheet

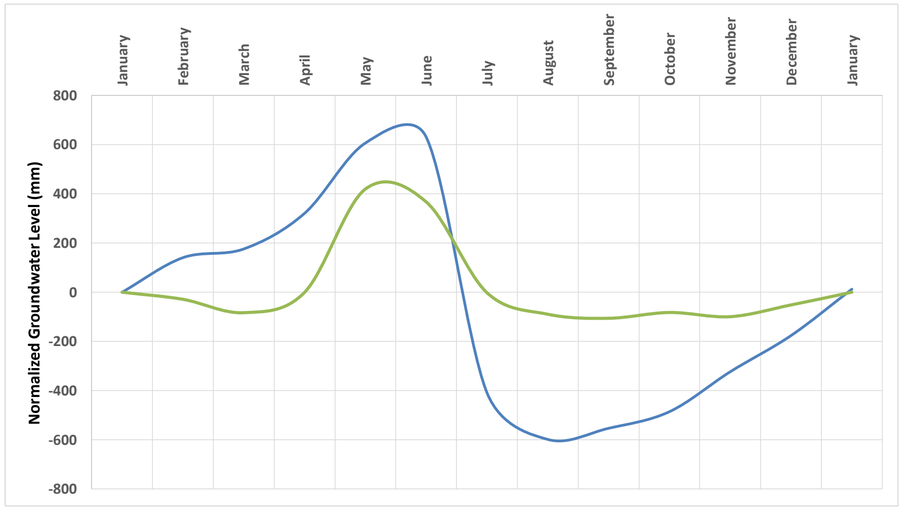
Period of Record
MOE
Nicola River - Merritt to Spius Creek

Parameter #	RIVER BUDGET		Period of Record Monthly Means (m3/sec) January	February	March	April	May	June	July	August	September	October	November	December
	Nicola Lake to Confluence with Coldwater													
1	Nicola River at Outlet Nicola Lake (WSC 08LG065: 1983 to 2013 continuous)	(m3/sec)	1.51	1.7	2.22	3.94	15.9	16.9	6.88	3.83	2.3	1.89	1.84	1.61
2	Clapperton Creek	(m3/sec)	0.049	0.04	0.034	0.033	0.282	0.348	0.242	0.137	0.109	0.089	0.071	0.058
3	Irrigation withdrawals	(m3/sec)	0.0000	0.0000	0.0000	-0.0096	-0.2257	-0.2720	-0.3221	-0.2720	-0.1929	0.0000	0.0000	0.0000
4	Estimate natural river loss to aquifers in reach (0% of flow at dam)	(m3/sec)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Nicola River u/s confluence	(m3/sec)	1.56	1.74	2.25	3.96	15.96	16.98	6.80	3.70	2.22	1.98	1.91	1.67
5	Coldwater River at Merritt (WSC 08LG010: 1962 to 2103 continuous)	(m3/sec)	3.05	3.33	4.61	10.8	29.3	26.5	8.65	1.67	1.22	2.61	4.31	3.43
6	**at confluence = sum of flows**	(m3/sec)	4.61	5.07	6.86	14.76	45.26	43.48	15.45	5.37	3.44	4.59	6.22	5.10
	Study Reach: Nicola R from Confluence to U/S Guichon Ck													
7	F_{ds} = Nicola River d/s Merritt (WSC 08LG007: 1958 to 2007 continuous)	(m3/sec)	4.84	5.67	7.04	14.90	44.20	45.70	16.30	5.75	3.84	4.84	6.63	5.31
	F_{us} = Nicola River below Coldwater Confluence		4.61	5.07	6.86	14.76	45.26	43.48	15.45	5.37	3.44	4.59	6.22	5.10
	F_{ds} - F_{us} = Reach Difference (+ve = reach gain, -ve = reach loss)	(m3/sec)	0.23	0.60	0.18	0.14	-1.06	2.22	0.85	0.38	0.40	0.25	0.41	0.21
	% change in Study Reach		5%	12%	3%	1%	-2%	5%	6%	7%	12%	5%	7%	4%
8	Total Tributaries (Tribs)	(m3/sec)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
9	Estimated Irrigation withdrawals (Irrigation)	(m3/sec)	0.0000	0.0000	0.0000	0.0058	0.1354	0.1632	0.1933	0.1632	0.1157	0.0000	0.0000	0.0000
		(US gpm)	0	0	0	92	2,149	2,590	3,068	2,590	1,837	0	0	0
10	Groundwater Flux (GW_SW_{flux}) = F_{ds} - F_{us} - Tribs + Irrigation (+ve flux = river gaining, -ve flux= river losing)	(m3/sec)	0.21	0.58	0.16	0.12	-0.94	2.37	1.02	0.53	0.50	0.23	0.39	0.19
		(US gpm)	3,349	9,524	2,794	2,169	-16,767	35,301	13,494	6,111	6,411	3,984	6,492	3,365
	Groundwater Flux as percentage of average flow in reach		4%	11%	2%	1%	2%	5%	6%	10%	14%	5%	6%	4%
	Study Reach Nicola R from U/S Guichon Ck to Near Spences Bridge													
11	F_{ds} = Nicola River near Spences Bridge (WSC 08LG006: 1958 to 2011)		9.23	10.5	13.4	30.1	90.7	85.7	28.3	8.96	6.26	8.34	12.7	9.98
	F_{us} = Nicola River d/s Merritt (WSC 08LG007: 1958 to 2007)	(m3/sec)	4.84	5.67	7.04	14.9	44.2	45.7	16.3	5.75	3.84	4.84	6.63	5.31
	F_{ds} - F_{us} = Reach Difference (+ve = reach gain, -ve = reach loss)	(m3/sec)	4.39	4.83	6.36	15.20	46.50	40.00	12.00	3.21	2.42	3.50	6.07	4.67
12	Guichon Creek at Mouth (WSC 08LG067:1985 to 2010)	(m3/sec)	0.2	0.266	0.313	0.681	2.49	2.12	0.98	0.478	0.335	0.291	0.247	0.217
13	Stumbles Creek	(m3/sec)	0.045	0.042	0.044	0.047	0.106	0.044	0.033	0.028	0.040	0.038	0.041	0.044
14	Spius Ck near Canford (WSC 08LG008: 1971 to 2011)	(m3/sec)	3.4	3.65	5.29	14.8	37.7	30.2	9.36	2.35	1.63	2.78	5.54	4.1
15	Combined tributaries d/s Spius Ck (Nuaitch, Shakelly, Gordon, Shackan, Skuhun, Skeikut)	(m3/sec)	0.115	0.118	0.158	0.584	2.109	1.086	0.400	0.163	0.134	0.128	0.119	0.110
	Total Tributaries (Tribs)	(m3/sec)	3.761	4.076	5.804	16.112	42.405	33.451	10.772	3.019	2.139	3.237	5.947	4.471
16	Estimated Irrigation withdrawals	(m3/sec)	0.0000	0.0000	0.0000	0.0077	0.1806	0.2176	0.2577	0.2176	0.1543	0.0000	0.0000	0.0000
		(US gpm)	0	0	0	122	2,866	3,454	4,091	3,454	2,450	0	0	0
17	Estimated industrial withdrawals - Craigmont Mine	(m3/sec)	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
		(US gpm)	63	63	63	63	63	63	63	63	63	63	63	63
	Total Withdrawals (Irrigation)	(m3/sec)	0.0040	0.0040	0.0040	0.0117	0.1846	0.2216	0.2617	0.2216	0.1583	0.0040	0.0040	0.0040
18	Groundwater Flux (GW_SWflux) = F_{ds} - F_{us} - Tribs + Irrigaion (+ve flux = river gaining, -ve flux= river losing)	(m3/sec)	0.63	0.76	0.56	-0.90	4.28	6.77	1.49	0.41	0.44	0.27	0.13	0.20
		(US gpm)	10,052	12,027	8,887	-14,298	67,930	107,471	23,642	6,550	6,973	4,240	2,013	3,219
	Groundwater Flux as percentage of average flow in reach		10%	10%	6%	4%	6%	11%	8%	7%	10%	5%	1%	3%
	Summary of GW flux by reach													
	Total gw flux from Guichon to Spences		0.633	0.758	0.560	-0.901	4.280	6.771	1.489	0.413	0.439	0.267	0.127	0.203
19	% of total flux occurring between Guichon Ck and Spius Ck	40%												
20	Net estimated gw flux from Guichon to Spius		0.253	0.303	0.224	-0.360	1.712	2.708	0.596	0.165	0.176	0.107	0.051	0.081
	Total gw flux from Merritt to u/s Guichon		0.21	0.58	0.16	0.12	-0.94	2.37	1.02	0.53	0.50	0.23	0.39	0.19
	Total GW Flux (GW_SWflux) Merritt to Spius	(m3/sec)	0.464	0.883	0.380	-0.238	0.771	5.075	1.619	0.693	0.675	0.338	0.440	0.273
		(m3/month)	1,203,467	2,288,977	984,851	-616,563	1,998,296	13,155,576	4,196,971	1,796,904	1,750,540	875,718	1,139,791	707,913
	Groundwater Flux as percentage of mid reach flow - WSC Nicola River near Merritt			16%	5%	-2%	2%	11%	10%	12%	18%	7%	7%	5%
	Percentage of toal flux occuring Merritt to Guichon		45%	66%	41%	-51%	-122%	47%	63%	76%	74%	68%	88%	70%

Period of Record
MOE
Nicola River - Merritt to Spius Creek

Parameter #	RIVER BUDGET		Period of Record Monthly Means (m3/sec) January	February	March	April	May	June	July	August	September	October	November	December
	GROUNDWATER BUDGET													
	Estimated inflows to and outflows from unconfined aquifers/alluvium along Nicola River													
	Recharge													
21	GW inflow from Merritt aquifer: Aq No 74	(m3/sec)	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
22	GW inflow from Merritt RIBs	(m3/sec)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
23	GW inflow from Stumbles Creek unconfined aquifer (# 76)	(m3/sec)	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
24	GW Inflow from Lower Nicola confined aquifer (#77) & Merritt confined aquifer	(m3/sec)	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
25	Valley side recharge from bedrock	(m3/sec)	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
26	Direct precipitation infiltration to valley unconfined aquifers - percentage of precipitation	(m3/sec)	0.018	0.011	0.009	0.009	0.017	0.021	0.017	0.012	0.014	0.016	0.020	0.021
27	Irrigation return to unconfined aquifers	(m3/sec)	0.000	0.000	0.000	0.001	0.014	0.016	0.019	0.016	0.012	0.000	0.000	0.000
	Recharge Subtotal	(m3/sec)	1.0567	1.0502	1.0484	1.0483	1.0700	1.0765	1.0752	1.0672	1.0648	1.0550	1.0595	1.0598
	Discharge													
28	Evapotranspiration	(m3/sec)	0.0000	0.0000	0.0585	0.1056	0.1656	0.1770	0.1899	0.1570	0.0828	0.0357	0.0000	0.0000
29	Groundwater Pumping from "connected" aquifers	(m3/sec)	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01
		(US gpm)	159	159	159	159	317	317	317	317	317	159	159	159
30	GW outflow at Spius Creek	(m3/sec)	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
	Discharge Subtotal	(m3/sec)	0.024	0.024	0.082	0.129	0.199	0.211	0.224	0.191	0.117	0.059	0.024	0.024
	Groundwater Flux (GW_SWflux) to river (+ve flux = river gaining/aquifer losing)	(m3/sec)	0.464	0.883	0.380	-0.238	0.771	5.075	1.619	0.693	0.675	0.338	0.440	0.273
	Change in Aquifer Storage = Recharge - Discharge - Groundwater Flux to River	(m3/sec)	0.569	0.143	0.586	1.157	0.100	-4.210	-0.768	0.183	0.273	0.658	0.596	0.763
		(m3/month)	1,473,681	371,522	1,519,148	2,998,311	258,233	-10,911,697	-1,989,842	474,774	707,238	1,704,580	1,544,707	1,977,486
	Net monthly water level change in valley aquifers (mm)		140	35	145	286	25	-1039	-190	45	67	162	147	188
	Hydrograph - 1 month delay		0	140	176	320	606	631	-409	-598	-553	-486	-323	-176
	VARIABLES													
31	Monthly Mean total precipitation (mm)		30.5	19.4	16.2	15.1	30.1	36.6	29.1	20.6	24.6	27.6	35.4	36
32	Historical monthly average moisture deficit: Farmest.com (mm)		0	0	41	74	116	124	133	110	58	25	0	0
33	Percentage of precipitation recharging aquifers	5%												
34	Study Area Valley Floor (ha)	3000												
35	Valley floor area subject to groundwater evapotranspiration (ha)	370												
36	Irrigated Area from Nicola River: Nicola Lk to Merritt (ha)	500												
37	Irrigated Area from Nicola River: Merritt to Guichon Ck (ha)	300												
38	Irrigated Area from Nicola River: Guichon Ck to Spius Ck(ha)	300												
39	Irrigated Area from Nicola River: Spius Ck to WSC station near Spences Bridge (ha)	100												
40	Average applied irrigation (mm per month)		0	0	0	5	117	141	167	141	100	0	0	0
41	irrigation return - percentage of applied irrigation recharging aquifer	5%												
42	Estimated Hydraulic Conductivity of unconfined aquifers (m/s)	0.001												
43	Specific yield of unconfined aquifers	0.35												
44	Merritt RIB discharge estimated at 300 gpm (0.06 m3/sec)	0.06												
45	Groundwater use increase factor	1												

Estimated total annual applied irrigation sourced from Nicola River	**Spreadsheet**	**Licenced Amount**	**Nicola Demand Study estimate**
Irrigated Area Nicola Lk to Merritt (m3/yr.)	3,355,000	3,094,266	N/A
Irrigated Area Merritt to Guichon Ck (m3/yr.)	2,013,000	747,800	6,794,000 - Entire Guichon Watershed
Irrigated Area Guichon Ck to Spius Ck (m3/yr.)	2,684,000	2,394,096	7,882,000 Guichon to Spences Bridge



MONTH END GWL IN M BELOW GRADE FROM MOE OBS WELL REPORT

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
1989			4.174	4.142	3.833	3.863	4.185	3.934	4.093	4.01	3.944	3.979	
1990			4.254	4.084	3.704	3.279	3.785		4.064	3.956		3.941	
1991	3.683	3.661			3.148	3.043	3.601	3.744	3.952	4.136			3.683
1992	4.134	4.104	4.04			3.972	4.14	4.168	4.1	4.107			4.134
1993		4.198	4.26	4.336	3.835	3.932	3.79	3.904	4.154	4.148	4.112	4.119	
1994	4.164	4.203	4.229	3.879	3.864	4.018	4.509	4.355	4.394	4.324	4.371	4.341	4.164
1995	4.144	4.165	4.239		3.787	3.644	4.024	4.119	4.191	4.129	3.859	3.992	4.144
1996	3.944	3.891	3.905	3.69	3.269	3.388	3.836		4.052	4.107	3.929	3.773	3.944
1997	3.626	3.567	3.733	3.538	2.856	2.981		3.758	3.959	3.997	4.152	4.208	3.626
1998	3.853	3.913	3.926	3.83	3.506	3.584	4.052	4.254	4.231	4.294	4.426	4.202	3.853
1999	4.21	4.304	4.284	4.069	3.443	3.348	3.713	4.055	4.298			4.374	4.21
2000	4.319	4.275	4.379	4.284	3.817	3.754	4.099	4.169	4.154	4.109	4.184	4.284	4.319
2001	4.464	4.475	4.424	4.424	4.244	4.194	3.634		4.444	4.464	4.534	4.474	4.464
2002	4.374	4.474	4.334	4.344	3.644	3.564	4.084	4.309	4.324		4.324	4.324	4.374
2003	4.354	4.404	4.194							4.312	4.426	4.375	4.354
2004	4.31	4.299		4.345	4.236	4.36	4.707	4.5	4.355	4.319	4.427	4.418	4.31
2005	4.195	4.261	4.305	4.273	4.175	4.317	4.689	4.681	4.509	4.38	4.497	4.413	4.195
2006	4.533	4.587	4.626	4.425	3.907	4.059	4.627	4.578	4.417	4.516	4.194	3.886	4.533
2007	3.786	3.958	4.098	3.973	3.954	3.883	4.296	4.341	4.439	4.38	4.255	4.191	3.786
2008	4.242	4.361	4.502	4.447	4.116	4.073	4.492	4.699	4.641	4.491	4.587	4.632	4.242
2009	4.598	4.521	4.551	4.503		4.695	4.861	4.773	4.667	4.538	4.289	4.209	4.598
2010	4.219	4.274	4.526	4.414	3.852	3.824	4.236						4.219
Average	4.166	4.195	4.249	4.167	3.747	3.799	4.168	4.255	4.272	4.248	4.265	4.218	4.166
Diff	0.000	-28.855	-83.255	-0.772	419.053	367.085	-2.105	-89.458	-106.005	-82.368	-99.399	-51.737	0.000

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