Report

Regional District of Kootenay Boundary

KETTLE RIVER WATERSHED MANAGEMENT PLAN: PHASE 1 TECHNICAL ASSESSMENT

November 2012
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November 16, 2012
File: 2011-8049.000

Mark Andison
Director, Planning and Development
Regional District of Kootenay Boundary
202 - 843 Rossland Ave,
Trail, BC V1R 4S8

Re: KETTLE RIVER WATERSHED MANAGEMENT PLAN: PART 1 TECHNICAL ASSESSMENT

Dear Mr. Andison:

Summit Environmental Consultants Inc. is pleased to provide the final report for the Kettle River Technical Assessment, which is Part 1 of the Kettle River Watershed Management Plan.

The report includes a summary of existing information on surface water hydrology, water licensing, climate, groundwater, water quality, fish and fish habitat, and riparian habitat. In addition, it provides estimates of current actual water use compared to the licensed volumes, as well as data on groundwater use by the major water utilities in the Kettle River watershed and estimates of the natural flow at seven points of interest in the watershed. Estimates of late summer flows during periods of drought (10-year and 50-year low flows) have also been calculated and compared to the threshold values below which fish habitat becomes significantly constrained.

In general, there is enough water resources information for the Regional District of Kootenay Boundary to move forward with the watershed planning process, although there are a number of information gaps that should be addressed in 2012 to support the plan. The report includes recommendations for addressing those gaps, as well as for on-going monitoring to support water management decision making.

Please contact me if you have any questions.

Yours truly,

Signature on original

Hugh Hamilton, Ph.D., P.Ag.
Senior Environmental Scientist
Executive Summary

The Kettle River is one of British Columbia's Heritage Rivers. An international river, it crosses the Canada-US border three times before flowing south through Washington State. Approximately 75% of the watershed area of 11,000 square kilometres is within Canada. The hydrologic regime of the Kettle River is typical of interior watersheds, dominated by snowmelt in the spring. Flows are significantly reduced by mid-summer when demand from water users is high. Watershed residents have expressed concerns about water supply for communities and flow for fish, which are exacerbated by uncertainty about the implications of climate change. Other local water concerns include water quality (both surface and groundwater) and the health of riparian ecosystems.

To address these concerns and uncertainty over water resources, the Regional District of Kootenay Boundary (RDKB) is developing a Watershed Management Plan for the Kettle River basin. Phase 1 of the plan is a Technical Assessment intended to summarize existing information in a single “State of the Kettle River Watershed” document. Phase 1 will lead into Phase 2, which will set planning goals, actions, and policy that can be implemented to maintain the health of the watershed in the long term. This document is the report of the Phase 1 Technical Assessment. It has been prepared for the project Technical Advisory Committee (TAC) and Stakeholder Advisory Committee (SAC), and was completed primarily using existing data and reports.

Surface Water and Water Licences

The Kettle River watershed hydrologic regime exhibits very large differences between high flows in the spring and early summer and low flows from mid-summer through winter. Climate change projections for the RDKB indicate warmer annual average temperatures, less rainfall in summer, and a decrease in snowfall as more of the winter/spring precipitation falls as rain. As a result, stream flows from late fall to early spring are expected to be slightly greater, while flows in late spring, summer and early fall are expected to be smaller, thus adding to the current constraints on fish and water users in late summer. Spring runoff will likely occur sooner on average and annual total water yield will likely increase.

There are 994 current licences (at 826 points-of-diversion) for surface water in the Canadian portion of the watershed (with 1,100+ more in the U.S.), with irrigation as the largest licensed volume followed by domestic use. Off-stream licenses account for 57,765 ML/yr, storage is 7,351 ML/yr, and conservation is 1,352 ML/yr. There are relatively few dams in the watershed and none are major structures. Cascade Power holds a license for power generation on the Kettle River near Cascade that has not been developed. In anticipation, a Water Reserve has been created for the Kettle River that gives precedence to other water uses over this power license.

The water licences tell us the volume of water that licence holders could use. For this study estimates of actual use have been developed by obtaining the records from the community water utilities in the watershed and from the Ministry of Agriculture’s recent irrigation demand model. The major finding from the analysis of the use records is that even though the major water suppliers have surface water licenses, they mostly use groundwater and many of the largest licenses have not been used for many years.

The data records from water suppliers were used to estimate the natural flows at selected points (known as POIs) where flow data are available. The results indicate that on an annual basis the average flow is only slightly less than the natural (pre-development) flows. However, average August flows at the study POIs range from 74% to 96% of the naturalized flows. Near the final crossing of the Kettle River into the U.S., the average August flow is estimated to be 83% of the naturalized flow. This is a conservative (i.e. low) estimate, made by assuming the groundwater withdrawals near Grand Forks are in reality drawing water
out of the river. In an average year the net flow in August is likely in the range of 85%-90% of natural flow at this location.

In addition to information about water supply under average conditions, water use planning requires information on stream flows during periods of low flow. The lowest flows in the Kettle River and its tributaries usually occur in August and September. The magnitudes of those low flows vary from year to year, and planning decisions must consider flows during periods of drought and understand the probability that an extreme low-flow will occur. Estimates of the 1-in-10 year and 1-in-50 year return period monthly low flows have been calculated for each POI, and the minimum 7-day net low flows (7Q10 and 7Q50) were estimated where there are adequate data. In the critical July to September period when water demand is highest, the monthly 10-year net low flows are about one-third of the average and the 50-year net low flows are about 20% of the average monthly flow (see Fisheries and Aquatic section below for summary of fish flow needs).

Previous studies and research on the Grand Forks aquifer suggest that some sections the Kettle and larger tributaries are "losing streams", where a portion of the flow infiltrates to ground. However, beyond Grand Forks this process is not well understood and this is a key information gap that should be addressed, beginning with areas of existing or projected high groundwater demand.

Floodplain mapping is in place for the major inhabited areas along the Kettle River, showing the 20-year and 200-year flood elevations. The existing floodplain mapping is based on data from before 1996, and there would be value in updating it to include data collected since then for developed areas and to consider the effects of climate change.

**Groundwater**

Relative to other watersheds in southern B.C., groundwater makes up a significant proportion of agricultural and domestic water use in the Kettle River watershed. The provincial government has mapped a total of 15 aquifers in the watershed, all located along or in proximity to the valley bottoms where agricultural activities and communities are concentrated. Most of the mapped aquifers are sand and gravel deposits ranked as having moderate-high productivity and moderate-high vulnerability to contamination from surface activities. The demand on these aquifers is either low or moderate, with the exception of the Grand Forks aquifer where demand is high. Given this high demand, the Grand Forks aquifer has been studied in detail, and there is a very good base of information for the aquifer. Less is known about aquifers in other parts of the watershed.

There are more than 1,400 wells in the B.C. water well database in the Kettle River watershed. Registration of drilled wells is not mandatory, so the actual number is likely higher, although it isn’t known how many are not in use or have been closed. About half of all known wells are in Sub-Basin 6, which includes the Grand Forks aquifer. Of the well records with reported yields, more than 85% have yields of 100 USgpm or less.

The aquifers in the Kettle River watershed are re-charged by a number of processes, the most significant being infiltration from streams and rivers where they flow across sand and gravel alluvial deposits. For the Grand Forks aquifer, it has been estimated that 11-20% of flow in the Kettle River is transferred to groundwater during freshet. Some of that water moves back to the river as baseflow from mid-autumn through the winter. There is some indication that this pattern is repeated at Beaverdell, Westbridge, and Midway, but it has not been studied at the same level of detail as at Grand Forks. The aquifers are hydraulically connected to the Kettle River, evidenced by the parallel rise and fall of river and groundwater levels, and trends in groundwater level generally mirror trends in river level. At Grand Forks and Beaverdell groundwater level data have been collected since 1977 and 1989 respectively. Water levels have varied
over this period, but no statistically significant trend is apparent at Grand Forks. At Beaverdell there is a very slight decreasing trend.

Although the Grand Forks aquifer is re-charged by the Kettle River during freshet, there is evidence that groundwater pumping in the latter part of the summer begins to induce additional re-charge from the river and reduce flows compared to natural (pre-development) conditions. This makes little difference annual water yield (total flow in a year), but in late summer the average flow is less than the estimated natural flow. Note, however, that the water suppliers in the area do not use their surface water licences, and the reduction in flow as a result of groundwater use is less than if they did pump from the river.

Similar to much of B.C., there is relatively little information on groundwater quality in the public domain, again with Grand Forks being an exception. Nitrate has been the contaminant of greatest interest. Concentrations of nitrate-N have exceeded the 10 mg/L drinking water guideline, especially in the southeast part of the aquifer.

**Water Quality**

Surface water quality in the Kettle River is sampled every two weeks at two stations that are run by the Canada-B.C. water quality monitoring program; downstream of Midway and downstream of Grand Forks. A recent (2009) summary report concluded that water quality at both sites was very similar and “generally good”. The parameters that regularly exceed water quality guidelines at these sites are water temperature (for both aquatic life and drinking water), fluoride (aquatic life), and some metals (aquatic life). With metals, the concentrations of the metals that exceed guidelines were strongly correlated with turbidity and thus likely bound to suspended sediments and organic matter. As such, these metals are not available for uptake by biota. Statistically significant increasing trends were found at one or both sites for turbidity, total hardness, total phosphorus, total molybdenum, dissolved chloride, dissolved fluoride, and fecal coliforms. Statistically significant decreasing trends were found at one or both sites for total colour, specific conductivity, and several metals.

There are relatively few point (i.e. end-of-pipe) discharges in the Kettle River watershed. Treated effluent from the Greenwood wastewater treatment plant is discharged to ground adjacent to Boundary Creek. Statistical analysis of “upstream-downstream” data found no significant difference between the upstream and downstream sites, indicating that the wastewater is not having a detectable effect on the creek for the measured parameters. All of the parameters assessed met the applicable water quality guidelines for aquatic life protection. The wastewater facility at Midway discharges treated effluent to the Kettle River. In the most-recent Canada-B.C. water quality assessment report, several variables that may be indicative of wastewater inputs were found to have increased slightly at this site over 1990-2007, including fecal coliforms, total phosphorus, and dissolved chloride. The City of Grand Forks WWTP discharges reclaimed water to the Kettle River. Total phosphorus increased very slightly over 1990-2007, but none of the other parameters that could be linked to municipal wastewater showed evidence of a trend.

Water quality in Christina Lake is regularly monitored because of the lake’s value for both aquatic life and recreation, and site-specific Water Quality Objectives (WQO) have been set. The most recent WQO attainment report (2006 data) found that the WQO were met 97% of the time, with minor excursions for dissolved oxygen and Secchi depth. In addition to water quality sampling by government and dischargers, several community groups have been monitoring water quality. The Boundary Environmental Alliance has measured several metals, including uranium, in the tissue of freshwater mussels. The Christina Lake Stewardship Society carries out Secchi depth and water quality sampling in Christina Lake.
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Although our understanding of water quality in the basin is well served by regular monitoring at the Canada-B.C. sites, Christina Lake, and near the WWTPs; most of the data are concentrated in the southern third of the watershed. Less is known about water quality in tributaries.

**Fisheries and Aquatic Habitat**

The Kettle River supports several fish species, with most of the management effort focussed on rainbow trout and whitefish, with a more recent additional focus on speckled dace due to its endangered status under the *Species at Risk Act*. Of the 39 fish species present in the watershed, two are provincially red-listed (speckled dace and Umatilla dace) and five are provincially blue-listed (westslope cutthroat trout, cutthroat trout, bull trout, chiselmouth and shorthead sculpin). Westslope cutthroat trout, Columbia sculpin, and shorthead sculpin are listed as being of “Special Concern” under the federal *Species at Risk Act*, while speckled dace are listed as “Endangered”.

There is a century-long history of fish stocking in the watershed, reflecting the local importance of the sport fishery and possibly a long-standing recognition of low sport fish abundance. Rainbow trout in particular have been stocked in the watershed many times and over many years, primarily with stocks from elsewhere in B.C. This may have affected the robustness of the native stocks, but this hypothesis has not been tested. The Kettle River and its tributaries are currently managed for conservation of wild stocks and for recreational fishing, and stocking is limited to lakes.

The population of adult rainbow trout is estimated to be below carrying capacity. In recent decades a progressive deterioration of the Kettle River sport fish fishery has been identified, indicated by decreasing abundance and size of rainbow trout present. These declines have been attributed in previous reports to interactions between natural and anthropogenic factors; chiefly seasonal low flow, high water temperatures, decreased habitat availability, and over-fishing. No single factor appears to be driving the decline in fish numbers and size; rather it is their combined effect on adult recruitment and survival.

Recent studies (2010-2011) sponsored by the Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) have confirmed that there are substantial reductions in rainbow trout parr rearing habitat under low flow conditions and suggest that these flow conditions in the lower portions of the watershed are significantly exacerbated by water withdrawal. However, the work conducted for this report indicates that current water usage may not as influential as other studies have suggested because of water suppliers’ use of groundwater instead of surface water. Nevertheless, under below-average conditions, late summer flows fall below the 10% of Mean Annual Discharge (10% MAD) threshold where fish habitat availability and quality both decline significantly. The 10-year net low flows in September range between 3.6% MAD and 5.7% MAD, and the September 50-year net low flows range from 1.0% MAD to 3.0% MAD.

The MFLNRO studies have also documented variations in water temperature and shown that air temperature exerts the greatest influence on water temperature in late summer. The FLNRO studies aim to identify thresholds for regulation and closure of the fishery, determine minimum stream flow requirements and targets for protection of fish stocks; and specify management strategies to protect fish and fish habitat during critical low flow periods. Work is scheduled to be completed in 2013.

Speckled dace are abundant in the Kettle River watershed, but there are no assessments of population trends. This species is less affected by water temperature than are the salmonids in the watershed and prefer shallow, slow water over deeper fast water, and so may be less affected by current and predicted low flows than are rainbow trout.
Executive Summary

Information Availability and Gaps
Despite the relatively low human population of the Kettle River watershed, there is a solid information base that can support water resource management decisions. This is because of its status as an international river and the history of irrigated agriculture in the watershed. The numbers of streamflow monitoring and long-term water quality monitoring stations are above average for B.C., but those stations are concentrated in the southern part of the basin near the border. At present, there are only two Environment Canada climate stations, both in the valley bottom. The recent development of a climate model by federal researchers enables a better understanding of climate variation in the watershed, but better coverage in the mid- to high elevations would be of benefit to confirm the model estimates. Building on the climate model, the Ministry of Agriculture’s Irrigation Demand Model (IDM) and the water use records obtained for this study have improved the understanding of actual water use compared to a few years ago (Note that only the initial IDM estimates were available when this report was prepared). Future model runs will generate results for a broader range of conditions.

There is good groundwater data for the Grand Forks aquifer, leading to a reasonable understanding of surface water-groundwater interaction in this area. Less is known about these processes in other areas. The information base for fisheries is also reasonably good, augmented over the past three years by a focussed MFLNR study on low flows and water temperatures, and by monitoring of the effectiveness of LWD structures. Nevertheless, some information gaps remain. Although it is generally understood that riparian function has been affected by land use practices, only selected areas have been studied, limiting the ability to set priorities for management or restoration. A CWS study of riparian wildlife function is in progress.

To summarize, there is sufficient information for RDKB to begin moving forward with Part 2 of the Watershed Management Plan, although there are a number of important data gaps that should be addressed. Recommendations for additional technical studies fall into two categories: 1) those that should take place in the near future to support the management plan process, and 2) longer-term monitoring to support future water resource decision making.

Recommendations to Support the Watershed Management Plan
Technical studies that should be completed or started in 2012 to support the Watershed Management Plan are:

Groundwater-Surface Water Interaction
- An office-based assessment of surface water-groundwater interaction for valley-bottom areas outside of the Grand Forks aquifer, combined with updates of the existing and projected demand for groundwater from valley aquifers. This assessment will determine whether field studies or new Observation Wells are needed to better understand groundwater resource availability if the population grows, new economic activity is introduced, and/or the climate changes.
- Develop estimates of return flows from irrigation.

Irrigation Demand
- Complete additional studies with the Ministry of Agriculture Irrigation Demand Model to determine demand in average years and under one or more climate change scenarios (to date the model has only been run for 2003). Complete field audits and farmer/rancher interviews to assess how well the model matches with actual irrigation rates.

Water Quality
- A reconnaissance-level water and sediment quality sampling program (4 samples per year for 2 years) should be completed in tributary streams that are currently the focus of mineral exploration.
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Fisheries
- Conduct creel surveys in 2012 to update current angler use and fishing effects for both summer and winter fisheries; and
- Carry out a radio-telemetry study of adult and sub-adult rainbow trout to identify critical habitats that support summer rearing, spawning, and overwintering; and to confirm the fate of adult fish through the summer period, including whether they depart the river or die in response to ambient conditions.

Riparian Habitat and Function
- Summarize the results of the on-going riparian habitat assessment being completed by CWS and integrate that information with the high-level inventory of riparian cover completed for this study. The results should then be reviewed with stakeholders who are familiar with riparian condition in the watershed to set priorities for additional assessment, as needed.

In addition to these recommended technical studies, RDKB should work with the TAC and SAC to develop of a number of population and economic growth scenarios for the Kettle River watershed. Once scenarios are in place it will be possible to estimate water demand and compare the demand to what is known about water supply.

Recommendations for Longer-term Assessment and Monitoring
- At least one new automated climate monitoring station should be installed at mid- to high elevation to augment the two existing low-elevations stations. The number and preferred location(s) of new stations should be determined in consultation with Environment Canada.
- A Farmwest climate station in rural Grand Forks should be installed as it would be of value to support irrigation planning and water conservation.
- Re-establish streamflow monitoring on Boundary Creek. Automated water quality monitoring systems should be installed at the same site to obtain continuous turbidity, temperature, and conductivity data to assess how often water quality meets guidelines.
- Conduct water quality monitoring at the former Canada-BC station at Gilpin, on the Kettle River downstream of Grand Forks to assess potential changes from historical data (1980-1994) and to compare to data from the Carson site upstream of Grand Forks.
- Depending on the findings of the groundwater-surface water data analyses recommended above, re-establish the decommissioned groundwater Observation Well at Midway or establish a new well at another suitable location between Midway and Westbridge.
- Install an additional groundwater Observation Well in the Grand Forks aquifer, as recommended by Wei et al. (2010).
- Continue with the fisheries studies that have been sponsored by MFLNRO over 2010-2011 to address the questions originally identified by Oliver (2001).