**Water Quality**

***RESOURCE QUALITY SECTION***
***WATER MANAGEMENT BRANCH***
***MINISTRY OF ENVIRONMENT***

# OVERVIEW REPORT

Prepared pursuant to Section 2(e) of the
Environment Management Act, 1981

Original signed by Ben Marr
Deputy Minister
Ministry of Environment
April 21, 1986.

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## Canadian Cataloguing in Publication Data

Nijman, R. A.
Skeena-Nass area, Bulkley River basin water quality assessment and objectives

[Vol. 2] constitutes technical appendix.
ISBN 0-7726-1745-7

1. Water quality - British Columbia - Bulkley River Watershed.
I. BC Environment. Water Management Division.
II. Title

TD227.B7N542 1993 363.73'942'0971182 C93-092118-6

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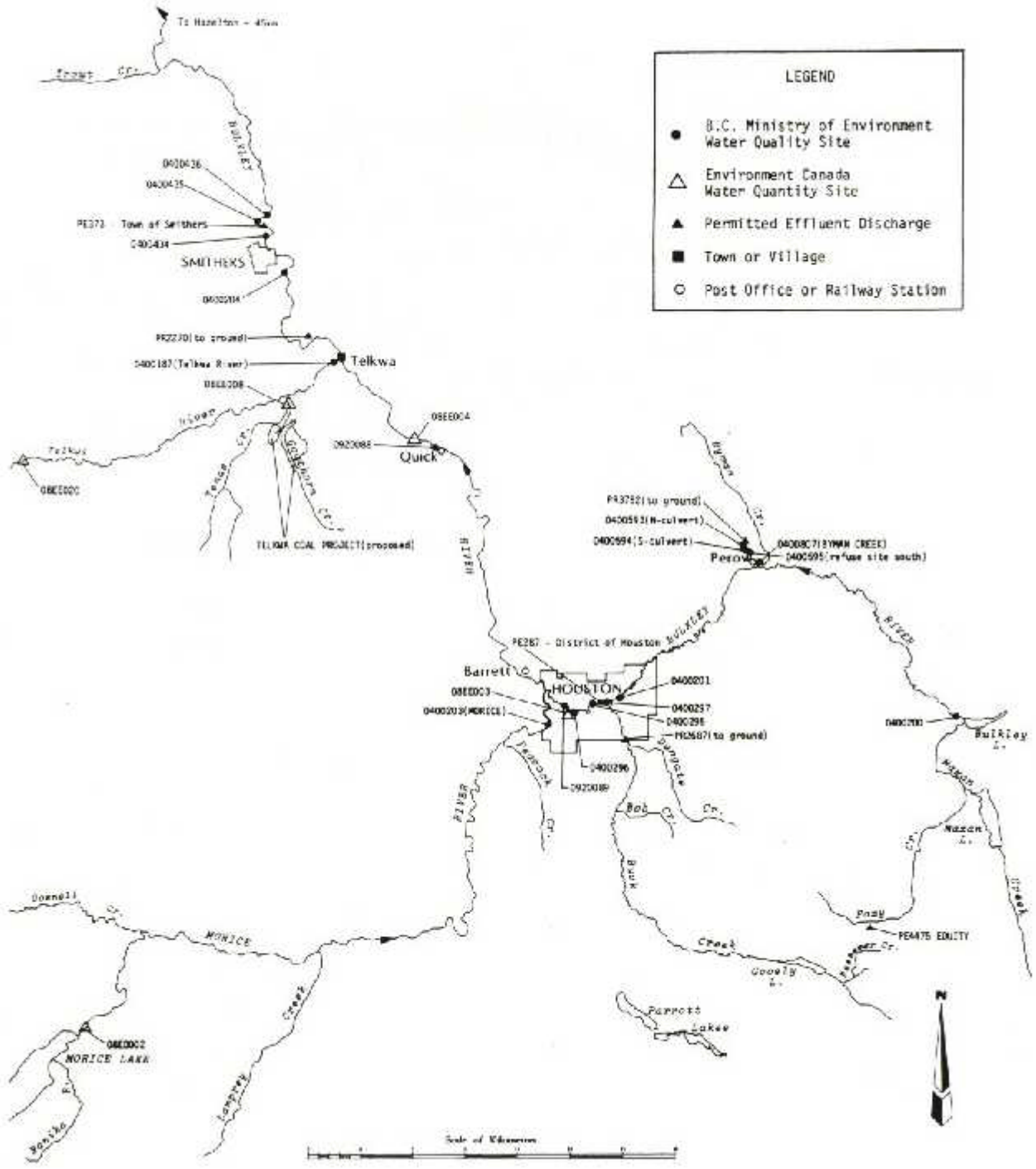
**Figure 1. Permitted Waste Discharges and Monitoring Sites in the Bulkley River Basin**

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## PREFACE

**Purpose of Water Quality Objectives**

Water quality objectives are prepared for specific bodies of fresh, estuarine and coastal marine surface waters of British Columbia as part of the Ministry of Environment, Lands and Parks' mandate to manage water quality. Objectives are prepared only for those waterbodies and water quality characteristics that may be affected by human activity now or in the near future.

**How Objectives Are Determined**

Water quality objectives are based the BC approved and working criteria as well as national water quality guidelines. Water quality criteria and guidelines are safe limits of the physical, chemical, or biological characteristics of water, biota (plant and animal life) or sediment which protect water use. Objectives are established in British Columbia for waterbodies on a site-specific basis. They are derived from the criteria by considering local water quality, water uses, water movement, waste discharges, and socio-economic factors.

Water quality objectives are set to protect the most sensitive designated water use at a specific location. A designated water use is one that is protected in a given location and is one of the following:

- raw drinking water, public water supply, and food processing
- aquatic life and wildlife
- agriculture (livestock watering and irrigation)
- recreation and aesthetics
- industrial water supplies.

Each objective for a location may be based on the protection of a different water use, depending on the uses that are most sensitive to the physical, chemical or biological characteristics affecting that waterbody.

**How Objectives Are Used**

Water quality objectives routinely provide policy direction for resource managers for the protection of water uses in specific waterbodies. Objectives guide the evaluation of water quality, the issuing of permits, licences and orders, and the management of fisheries and the province's land base. They also provide a reference against which the state of water quality in a particular waterbody can be checked, and help to determine whether basin-wide water quality studies should be initiated.

Water quality objectives are also a standard for assessing the Ministry's performance in protecting water uses. While water quality objectives have no legal standing and are not directly enforced, these objectives become legally enforceable when included as a requirement of a permit, licence, order, or regulation, such as the Forest Practices Code Act, Water Act regulations or Waste Management Act regulations.

**Objectives and Monitoring**

Water quality objectives are established to protect all uses which may take place in a waterbody. Monitoring (sometimes called sampling) is undertaken to determine if all the designated water uses are being protected. The monitoring usually takes place at a critical time when a water quality specialist has determined that the water quality objectives may not be met. It is assumed that if all designated water uses are protected at the critical time, then they also will be protected at other times when the threat is less.

The monitoring usually takes place during a five week period, which allows the specialists to measure the worst, as well as the average condition in the water.

For some waterbodies, the monitoring period and frequency may vary, depending upon the nature of the problem, severity of threats to designated water uses, and the way the objectives are expressed (*i.e.*, mean value, maximum value).

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# INTRODUCTION

Water quality objectives are prepared for specific surface waters of the province, as part of the Ministry of Environment's mandate to manage water quality. They are prepared for waterbodies and water quality characteristics which may be affected by man's activities, now or in the foreseeable future. A water quality assessment and water quality objectives were prepared for the Bulkley River basin because the area would be affected by the Kemano-Completion Project. A similar report for the Nechako River basin, which would also be affected by the project, is being prepared. Both river systems are important salmon migration routes and salmon rearing areas.

This report includes: (i) an assessment of present water quality using available information (up to April, 1984) on waste discharges, water quality, streamflow and water uses; (ii) a prediction of future water quality, considering future waste discharges and the effects of the Kemano-Completion Project on flows in the Morice and Bulkley Rivers; (iii) recommended water uses that should be protected, and recommended provisional water quality objectives, where applicable, to protect those uses; (iv) recommended monitoring to check whether those objectives are being met and to develop future objectives. A detailed technical appendix was prepared and forms the basis for the conclusions presented in this report.

The Kemano-Completion Project has been indefinitely postponed by Alcan, which is not proceeding with its application under the governmnet review process at this time. However, the provincial government is completing its review of Alcan's proposal.

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# HYDROLOGY

The Bulkley River is a major tributary to the Skeena River. The Bulkley River flows west from Bulkley Lake past Perow and is joined near Houston by the Morice River, its major tributary. The Bulkley then flows north past Quick, Telkwa and Smithers, before entering the Skeena River near Hazelton (see Figure 1.)

One-in-ten-year 7-day average low-flow estimates fot the Bulkley River are 0.1 $m^3/s$ near Houston, 13.7 $m^3/s$ at Quick and 15 $m^3/s$ at Smithers. The maximum daily discharge for the Bulkley River at Quick is 957 $m^3/s$. The Morice River supplies over 90% of the Bulkley River water. The proposed Kemano-Completion Project will generally reduce flows in the Morice River but is predicted to increase winter low flows slightly in the Morice and Bulkley Rivers. These are Alcans projections, but it is not yet certain whether Alcan can or will provide extra water during dry years. Alcan may be optimistic in their reservoir inflow projections, having used data collected only since 1950 (a period which was wetter than previous years). The effect on flow projections of using the longer period of record available (1930-1983) is not yet known.

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# WATER USES

Licences for drinking water are located in the headwaters near Bulkley Lake and that reach of the Bulkley River between Telkwa and Smithers. Teniers Enterprises (industrial licence CL-55785) has a commercial water hauling operation with water used for a variety of purposes including domestic supply. Teniers takes water from locations on the Bulkley River in addition to their licenced points (near Houston and Telkwa). Unlicenced water haulers also withdraw water from the Bulkley River. The Bulkley River is the drinking water source for the village of Telkwa, and indirectly for the Town of Smithers and the District of Houston through water wells. Agricultural capability on the Bulkley River floodplain is the highest within the Skeena-Nass area. Agricultural uses include hay and vegetable production as well as raising beef and dairy cattle. There are ten irrigation licences between the Morice River and Smithers. An undetermined number of irrigation and domestic licences on the Bulkley River are also used for livestock watering. There is no licenced use of the Bulkley River between Smithers and Hazelton, although there is likely some unlicenced use for domestic purposes on Indian Reserves.

There is year-round fisheries use in the Bulkley River. It is used as a migration route by steelhead and all salmon species except chum. There is adult holding throughout the winter. Although some spawning is known to occur in the Bulkley River by pink and chinook, it is more important as a juvenile rearing area. Steelhead spawning occurs in the Bulkley River and its tributaries, but most production of juvenile steelhead fry is attributed to the Morice River with rearing and overwintering primarily in the Bulkley River

below Houston. The Bulkley River also suopports resident cutthroat trout, Dolly Varden and rainbow trout. There is a native food fishery for the Moricetown Indian Band downstream from Smithers.

Recreational use of the Bulkley River is high upstream from Smithers and includes sport fishing, boating and swimming. Commercial enterprises dependent on recreation uses include guiding (for fishermen) and hotels catering to fishermen. Two areas for recreation are located between Smithers and Hazelton, including Trout Creek Emporium (campground and tackle shop), and a tourist operation of the Moricetown Indian Band which centers on the sport and native food-fishing attraction.

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# WASTE DISCHARGES

Permitted waste discharges which could affect water quality include the Equity Silver Mine (PE 4475) in the headwaters, the sewage-treatment plants at Houston (PE 287) and Smithers (PE 373) and the refuse sites at Perow (PR 3782), Houston (PR 2687) and Telkwa (PR 2270).

Waste Management Permit PE 4475 is for discharges from a copper-silver mine (Equity) about 32 km southeast of Houston. These discharges flow from Foxy Creek into Maxan Creek, which flows into Bulkley Lake. and from Bessemer Creek into Buck Creek, which flows into the Bulkley River before its confluence with the Morice River. A dry concentrate of copper and silver is produced in an acid-leach process. There are concerns about acid generation from the waste rock, spills and uncontrolled discharges from tailing impoundments, and heavy metals (*e.g.*, arsenic, selenium, copper, lead and zinc) associated with the mine waste water. A detailed assessment of the receiving water around the Equity Mine will be made in a separate report when data now being collected are available. This assessment will be important in indicating the likelihood of maintaining the existing water uses in Buck and Maxan Creeks in the future. There has been no direct indication so far of deterioration in the fisheries of Buck and Maxan Creeks and their tributaries, and hence of the Bulkley River.

Permit PE 287 allows the District of Houstan to discharge an average of 1550 $m^3$/d of chlorinated treated effluent to the Bulkley River just downstream from its confluence with Buck Creek. Effluent flow is not to exceed 10% of the Bulkley River flow at any time. It is predicted that the storage lagoon used to control effluent flow would be required infrequently, or not at all, if maximum effluent flows and minimum river flows do not coincide. The chlorinated effluent could theoretically cause total residual chlorine levels in the Bulkley River to exceed criteria for fresh water aquatic life, except during freshet. Dechlorination therefore may be necessary to protect the fishery. Un-ionized ammonia and nitrite-nitrogen could also theoretically exceed water quality criteria for freshwater aquatic life during low river flows. The relatively sparse data collected downstream from the discharge indicated that the ammonia and nitrite criteria were not exceeded. Fecal coliform levels were on several occasions very high for a chlorinated effluent (maximum of 92000 MPN/100 mL), and could have caused primary-contact recreation criteria to be exceeded in the river (200-400 MPN/100 mL) during the summer recreation period. Future data will show whether the new chlorination chamber installed in 1984 (to replace the original unit built in 1970) will reduce fecal coliforms. As future waste loads from the Houston sewage treatment plant increase, the effect on water quality should remain the same as at present. This prediction assumes that the existing storage lagoon will be expanded as effluent flow increases to maintain the minimum 10:1 dilution in the Bulkley River.

Permit PE 373 allows the Town of Smithers to discharge an average of 4200 $m^3$/d and a maximum of 10800 $m^3$/d of unchlorinated treated sewage to the Bulkley River, about 90 km upstream from its confluence with the Skeena River. The new aerated-lagoon sewage treatment plant began operation in September of 1983. The few available data suggest that the new treatment facility is lightly loaded and that good performance is to be expected. The impact of $BOD_5$, suspended solids, nitrogen and phosphorus on water quality should not be significant because of the high dilution (at least 120:1). Fecal coliform levels following complete mixing with the Bulkley River, should be within criteria for primary-contact recreation (200-400 MPN/100 mL). The future concentrations in the Bulkley River (post Kemano-Completion) of characteristics specified by permit ($BOD_5$ and suspended solids() are predicted to be within water quality criteria. No problems are expected, primarily because the future dilution of the effluent at low flow will still be high.

The few data available for the refuse sites at Perow (PR 3782) and Houston (PR 2687) suggest no effect on the Bulkley River. There are no data to assess the effect of the refuse site at Telkwa (PR 2270) on Bulkley River water quality.

The proposed Telkwa Coal Project in the Goathorn Creek drainage of the Telkwa River is currently in Stage II of the Mine Development Review Process. The Telkwa River is a western tributary to the Bulkley River. Construction is currently planned for the late 1980's or early 1990's. The potential effects of the Telkwa Coal Project on downstream water quality are expected to be minimal for the Telkwa and Bulkley Rivers. Potential water quality problems from surface coal mining include: 1) suspended solids, turbidity and sedimentation due to land disturbances; 2) nitrate, nitrite, ammonia and algal growth due to use of explosives (blasting is predicted to be minimal so this impact may be minor); 3) acid mine drainage and 4) abnormal ground water quality. Although these

effects are expected to be minor, a complete assessment including water quality objectives will be the subject of a separate report, when the required data are available

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# WATER QUALITY

In general, water in the Bulkley and Morice Rivers was shown to be soft, low in alkalinity and nutrients and with turbidity and colour exceeding drinking water standards during freshet. Several metals equalled or exceeded aquatic life criteria, usually during freshet (April to July) when the majority of metal would be bound to suspended solids. These metals included aluminum, cobalt, cadmium, chromium, copper, iron, manganese, nickel, lead and zinc. This situation, although natural, suggests that the capacity of the Bulkley and Morice Rivers to accept further inputs of metals from future developmenrts may be limited during freshet.

The proposed Kemano-Completion Project involves, in part, damming the Nanika River at the outlet of Kidprice Lake. The Nanika River feeds Morice Lake, the source of the Morice River, which provides most of the water to the Bulkley River downstream from Houston. The consequent reduction in Bulkley River flows will not significantly change water quality in the Bulkley River. Most of the water stored behind the Nanika dam would be subtracted from peak Nanika River flow in late spring and early summer. Remaining flows and subsequent dilution of downstream effluents at that time of year will still be high. The main impact of effluents on water quality is usually expected at low river flows when the resulting dilution is lowest. The minimum monthly post-Kemano-Completion flow data from Alcan predict that the quantity of water released at the Nanika dam will be slightly higher than normal during the period of low flow (February to April). This would result in slightly higher minimum-dilutions of effluents than under unregulated flow conditions. For example, the predicted dilution of the treated sewage from the plant at Smithers, using the predicted minimum mean monthly post-Kemano-Completion flow in the Bulkley River (13.9 $m^3$/s), is between 111:1 and 286:1 (depending on the volume of treated sewage discharged). The natural minimum monthly mean low flow is 12.1 $m^3$/s, which results in a lesser dilution of between 97:1 and 249:1, under the same effluent discharge conditions.

Reduced peak flows (late spring to early summer) in the Morice River are not expected to affect water quality in the Bulkley River downstream, with the exception of elevating the concentration of metals, some of which already exceed water quality criteria naturally during freshet. These metals include aluminum, cobalt, cadmium, chromium, copper, iron, manganese, nickel, lead and zinc. The high concentration of these metals in the Morice and Bulkley Rivers is attributed to the loading of suspended solids from inflowing tributaries below Morice Lake. Reduced flows from Morice Lake with Kemano-Completion will reduce the dilution of these and other metals in the Morice and Bulkley Rivers, both increasing their concentrations and the frequency with which they exceed water quality criteria.

Elevated mercury levels are expected in the Morice and Bulkley Rivers with the formation of the new Nanika-Kidprice Reservoir in the headwaters due to leaching of newly flooded soils. Mercury levels in reservoir fish are expected to increase within two or three years. This may necessitate the prohibition of fishing until levels in sportfish are within acceptable limits for human consumption. The effect of these post-impoundment mercury levels on water quality and fish in the downstream Morice and Bulkley Rivers is not known; nor is the downstream effect of the predicted temporary increase in reservoir phosphorus and phytoplankton. Dilution of reservoir discharge-water in the Morice and Bulkley Rivers will reduce the impact of both mercury and phosphorus.

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# PROVISIONAL WATER QUALITY OBJECTIVES

The proposed designated water uses for the Bulkley and Morice Rivers include aquatic life (fisheries) and wildlife, irrigation, livestock watering, industrial use and primary-contact recreation throughout the rivers, from the headwaters at Bulkley Lake to the junction with the Skeena River at Hazelton.

Irrigation is proposed as a designated use throughout the Bulkley and Morice Rivers to protect future options. Although there are no irrigation licences above the confluence with the Morice River to Bulkley Lake, there is increasing demand for irrigation water to increase hay production. Neither are there irrigation licences downstream from Smithers, as licenced use of inflowing creeks is more practical than pumping water uphill from the Bulkley River.

Drinking water is a proposed designated use for the reaches of the Bulkley and Morice Rivers including: (1) from the confluence with Buck Creek upstream to Bulkley Lake; and (2) from the outlet of Morice Lake, past the junction with the Upper Bulkley River, downstream to Smithers. Excluded are two reaches of the Bulkley River, which are: (1) downstream from Buck Creek and the Houston sewage discharge to the mouth of the Morice River: although there are no domestic (drinking) water licences on this reach, industrial licence CL55785 permits hauling of water to domestic-use cusotmers; (2) downstream from the Smithers sewage discharge to the Skeena River. There is probably some unlicenced drinking water use in this area by the Indians on the reserves at Moricetown.

Provisional water quality objectives proposed for the Morice and Bulkley Rivers are summarized in Table 1. The objectives are based on approved Ministry criteria as well as preliminary working criteria foer water quality and on available data on ambient water quality, waste discharges, water uses and river flows. The objectives will renmain provisional until receiving water monitoring programs provide adequate data, and the Ministry has established approved water quality criteria for all the characteristics of concern.

The objectives can be considered as policy guidelines for resource managers to protect water uses in the specified water bodies. For example, they can be used to draw up waste management permits and plans, regulate water use or plan fisheries management. They can also provide a reference against which the state of water quality in a particular water body can be checked.

Water quality objectives have no legal standing and their direct enforcement would not be practical. This would be due to the difficulty of accurately measuring contaminants in receiving water and attributing the contamination exceeding the objective to particular sources for legal purposes, and thus of proving violations and their causes. Hence, although water quality objectives should be used when determining effluent permit limits, they should not be incorporated as part of the conditions in a waste management permit.

Unless indicated otherwise, the objectives summarized in Table 1 apply to any discrete sample taken at any point in the designated reaches of the Bulkley or Morice Rivers, except within initial dilution zones of effluents. These initial dilution zones extend up to 100 m downstream from the effluent-discharge points, but are not to exceed more than 25% of the width of the river.

Depending on the circumstances, water quality objectives may already be met in a water body, or may describe water quality conditions which can be met in the future. To limit the scope of the work, objectives are only being prepared for waterbodies and for water quality characteristics which may be affected by man's activity, now and in the foreseeable future.

No water quality objective is proposed for mercury because elevated levels will be due to an uncontrolled discharge (natural leaching from soils) if Kemano-Completion proceeds. It is recommended that the guidelines reported by Environment Canada be used as alert levels for possible water use restrictions in the Morice and Bulkley Rivers. These levels for total mercury are maxima of: 0.5 micrograms/gram wet weight in fish tissue and 0.0001 mg/L in water to protect consumers of fish; 0.001 mg/L for drinking water and recreation; and 0.003 mg/L to protect livestock and wildlife.

Site-specific water quality objectives may be developed for surface waters adjacent to the planned Telkwa Coal Mine, based on results of the baseline monitoring program submitted with the Stage II report. Objectives would be included late in Stage II or in Stage III of the Mine Development Review Process when more information about the project is available, including the impact assessment and evaluation of water use. A separate report, to be written when data are available, will also present water quality objectives for streams affected by the Equity Mine in the headwaters.

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# MONITORING RECOMMENDATIONS

The recommended effluent and water quality monitoring for the Bulkley River is outlined in Table 2. Recommendations are made from a technical perspective and the extent of the monitoring will be determined by the overall priorities and monitoring resources available. This monitoring is recommended primarily to support the provisional objectives and to determine whether objectives are being attained at monitored sites in the Bulkley River. The recommended monitoring program will also provide data to set future objectives for metals.

Coordinated sampling of waste discharges and the receiving environment is currently carried out by Waste Management Branch. It is recommended that any sampling agencies continue this practice so that cause and effect relationships can be established.

The monthly sampling frequency for suspended solids, turbidity and metals is recommended to investigate their relationship and to provide a data base for setting future water quality objectives for metals. Elevated levels of some metals with respect to water quality criteria have been noted in the data.

Should Alcan again proceed with Kemano-Completion, a detailed evaluation of mercury in the Morice-Bulkley system should be considered as there are no background data. This study should include an evaluation of mercury levels in water and fish, as well as the potential for mobilization of mercury from the soils to be flooded in the Nanika-Kidprice Reservoir. These data would contribute to the evaluation of post-Kemano-Completion mercury levels.

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# TABLES

**Table 1** Provisional Water Quality Objectives for the Bulkley and Morice Rivers

| Water Bodies | Morice River | Bulkley River | | | |
|---|---|---|---|---|---|
| | | Bulkley Lake to Houston | Houston to Morice River | Morice River to Smithers | Smithers to Skeena River |
| Designated Water Uses | drinking water, aquatic life, wildlife, recreation, livestock, irrigation, industrial use | drinking water, aquatic life, wildlife, recreation, livestock, irrigation, industrial use | aquatic life, wildlife, recreation, livestock, irrigation, industrial use | drinking water, aquatic life, wildlife, recreation, livestock, irrigation, industrial use | aquatic life, wildlife, recreation, livestock, irrigation, industrial use |
| fecal coliforms | less than or equal to 10 MPN/100 mL; 90th percentile | less than or equal to 10 MPN/100 mL; 90th percentile | less than or equal to 200 MPN/100 mL; geometric mean<br>less than or equal to 400 MPN/100 mL, 90th percentile | less than or equal to 10 MPN/100 mL; 90th percentile | less than or equal to 200 MPN/100 mL; geometric mean<br>less than or equal to 400 MPN/100 mL, 90th percentile |
| turbidity | 5 NTU maximum increase when u/s is less than or equal to 50 NTU<br>10% maximum increase when u/s exceeds 50 NTU | | | | |
| suspended solids | 10 mg/L maximum increase when u/s is less than or equal to 100 mg/L<br>10% maximum increase when u/s exceeds 100 mg/L | | | | |
| total chlorine residual | 0.002 mg/L maximum | | | | |
| periphyton | less than 50 mg/m$^2$ chlorophyll-*a* | | | | |

| | |
|---|---|
| standing crop | |
| nitrite-N | less than or equal to 0.007 mg/L average<br>0.030 mg/L maximum |
| nitrite-N, dissolved oxygen | less than or equal to 0.020 mg/L average<br>0.060 mg/L maximum |
| dissolved oxygen | 7.8 mg/L minimum |

***Note: The objectives apply to discrete samples from all parts of the water body except from initial dilution zones of effluents. These excluded dilution zones are defined as extending up to 100 m downstream from the discharge point and no more than 25 percent across the width of the stream, from the surface to the bottom. The routine sampling as recommended in Table 2. may need to be increased to check objectives, depending on circumstances.***
***1. The fecal coliform geometric mean and 90th percentile are calculated from at least 1 sample per week for 5 weeks in a period no longer than 30 days. The drinking water objective (10/100 mL) applies year-round and the recreation objective (200-400/100 mL) applies during the recreation season.***
***2. The increase (in NTU, mg/L or %) for turbidity and suspended solids, is over levels measured at a site u/s from a discharge or series of discharges and as close to them as possible, and applies to d/s levels.***
***3. Since the total chlorine residual objective is less than the minimum detectable concentration, it will be necessary to estimate the receiving water concentration using effluent loading and streamflow. The objective applies only if sewage effluent is chlorinated.***
***4. The periphyton standing crop is collected from natural substrates. The average of at least 10 samples collected at random from the stream bed on one day should be below the maximum.***
***5. The nitrite-N is an average calculated from at least 1 sample per week for 5 weeks in a period no longer than 30 days.***

**Table 2a** Recommended Effluent and Water Quality Monitoring for the Bulkley River

| Characteristics | Sites | | | | |
|---|---|---|---|---|---|
| | Houston STP | | | d/s 0400296 | Morice River 0400203 |
| | u/s 0400297 | PE 287 | d/s 0400295 | | |
| fecal coliforms | 5(30) | 5(30) | 5(30) | ..... | ..... |
| periphyton standing crop | LF(1) | ..... | LF(1) | ..... | ..... |
| suspended solids | LF(2) | LF(2) | LF(2) | M | M |
| turbidity | LF(2) | LF(2) | LF(2) | M | M |
| dissolved oxygen | LF(2) | LF(2) | LF(2) | ..... | ..... |
| total dissolved ammonia-N | LF(2) | LF(2) | LF(2) | ..... | ..... |

| | | | | | |
|---|---|---|---|---|---|
| nitrite-N | LF(2) | LF(2) | LF(2) | ..... | ..... |
| nitrate/nitrite-N | LF(2) | LF(2) | LF(2) | ..... | ..... |
| Kjeldahl total-N | LF(2) | LF(2) | LF(2) | ..... | ..... |
| total calculated-N | LF(2) | LF(2) | LF(2) | ..... | ..... |
| ortho dissolved-P | LF(2) | LF(2) | LF(2) | ..... | ..... |
| total dissolved-P | LF(2) | LF(2) | LF(2) | ..... | ..... |
| total-P | LF(2) | LF(2) | LF(2) | ..... | ..... |
| temperature | LF(2) | LF(2) | LF(2) | ..... | ..... |
| pH | LF(2) | LF(2) | LF(2) | ..... | ..... |
| hardness | LF(2) | ..... | LF(2) | ..... | ..... |
| specific conductivity | LF(2) | ..... | LF(2) | ..... | ..... |
| metals (total and dissolved): Al, Co, Cd, Cr, Cu, Fe, Mn, Ni, Pb, Zn | ..... | ..... | ..... | M | M |

**Table 2b** Recommended Effluent and Water Quality Monitoring for the Bulkley River

| Characteristics | Sites | | | | |
|---|---|---|---|---|---|
| | Smithers STP | | | Quick 0920088 | Telkwa River 0400187 |
| | u/s 0400434 | PE 373 | d/s 0400435 | | |
| fecal coliforms | 5(30) | 5(30) | 5(30) | ..... | ..... |
| periphyton standing crop | LF(1) | ..... | LF(1) | ..... | ..... |
| suspended solids | LF(2) | LF(2) | LF(2) | M | M |
| turbidity | LF(2) | LF(2) | LF(2) | M | M |
| dissolved oxygen | LF(2) | LF(2) | LF(2) | ..... | ..... |
| total dissolved ammonia-N | LF(2) | LF(2) | LF(2) | ..... | ..... |
| nitrite-N | LF(2) | LF(2) | LF(2) | ..... | ..... |

| | | | | | |
|---|---|---|---|---|---|
| nitrate/nitrite-N | LF(2) | LF(2) | LF(2) | ..... | ..... |
| Kjeldahl total-N | LF(2) | LF(2) | LF(2) | ..... | ..... |
| total calculated-N | LF(2) | LF(2) | LF(2) | ..... | ..... |
| ortho dissolved-P | LF(2) | LF(2) | LF(2) | ..... | ..... |
| total dissolved-P | LF(2) | LF(2) | LF(2) | ..... | ..... |
| total-P | LF(2) | LF(2) | LF(2) | ..... | ..... |
| temperature | LF(2) | LF(2) | LF(2) | ..... | ..... |
| pH | LF(2) | LF(2) | LF(2) | ..... | ..... |
| hardness | LF(2) | ..... | LF(2) | ..... | ..... |
| specific conductivity | LF(2) | ..... | LF(2) | ..... | ..... |
| metals (total and dissolved): Al, Co, Cd, Cr, Cu, Fe, Mn, Ni, Pb, Zn | ..... | ..... | ..... | M | M |

***Note: The routine sampling as recommended may need to be increased or decreased to check objectives, depending on circumstances.***
***The fecal coliforms are calculated from at least 1 sample per week for 5 weeks in a period no longer than 30 days during late summer (August to September) when water is used for both recreation and drinking.***
***u/s - upstream from***
***d/s - downstream from***
***M - monthly***
***LF(1) - at low flow once per year***
***LF(2) - at low flow, twice per year***