Water Quality

Ambient Water Quality Objectives For The Bullmoose Creek Sub-Basin Peace River Area

Overview Report

Water Management Branch
Environment And Resource Division
Ministry Of Environment, Lands And Parks

Prepared Pursuant To Section 2(E) Of The
Environment Management Act, 1981

Original Signed By Ben Marr
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FIGURES

Figure 1. Map of Bullmoose Creek Showing TECK Bullmoose Coal, Inc. Minesite and Water Quality Sites

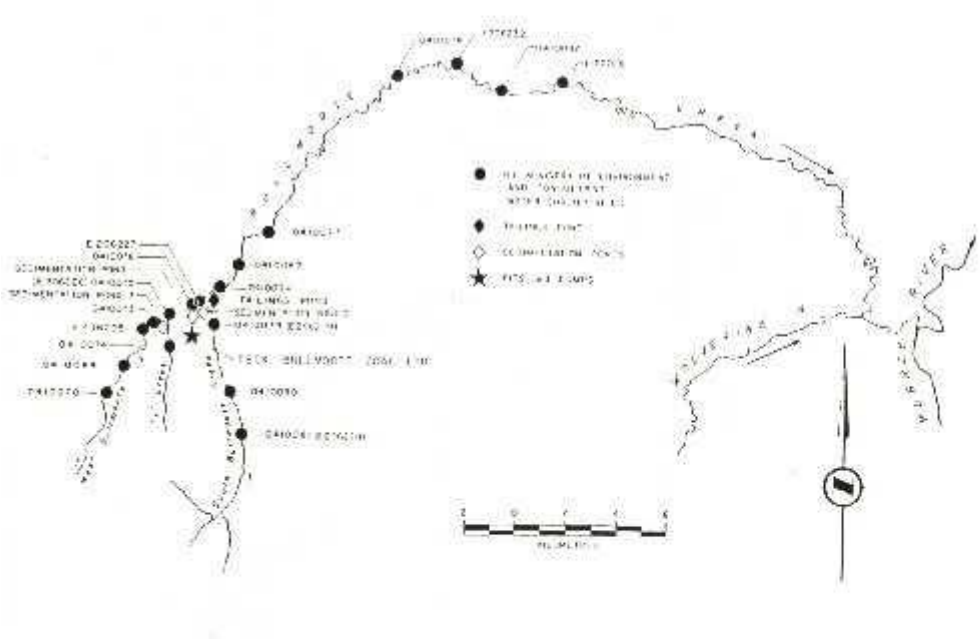

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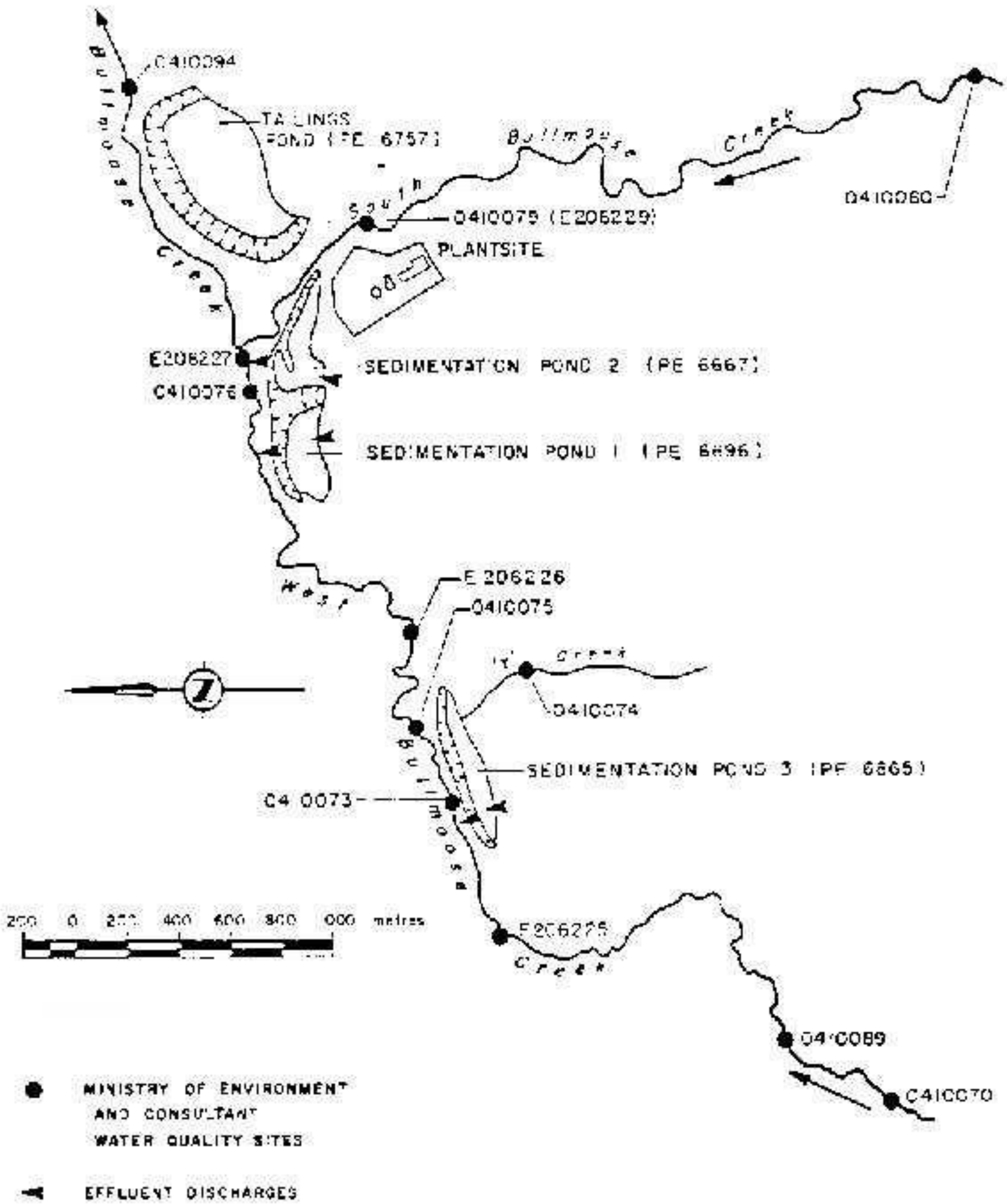
Figure 2. Detailed Map of the Bullmoose Coal, Inc. Minesite



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).

INTRODUCTION

This assessment presents the major findings and recommendations of the report on Bullmoose Creek, a tributary of the Murray River. It is one of seven priority sub-basins in the Peace River area for which water quality assessments are being conducted. A detailed technical appendix was prepared and forms the basis for the conclusions presented in this summary.

This report is the product of data assessments undertaken during 1984 and 1985. In general, the study was designed to examine the status of existing and future water quality with particular reference to the waste discharges from the Teck Bullmoose Coal Ltd. open-pit mine. Included in this report are provisional water quality objectives to protect designated water uses and recommendations for monitoring. The goal of this assessment is to guide water and waste management in the Bullmoose Creek portion of the Murray River Sub-basin.

HYDROLOGY

Bullmoose Creek is a tributary of the Wolverine River, which in turn flows into the Murray River (Figure 1). The Murray River flows north into the Pine River at a point 40 km downstream from the Village of Chetwynd. Over its entire 50 km length, Bullmoose Creek lies within the coal-bearing Rocky Mountain Foothills physiographic region. West Bullmoose Creek and South Bullmoose Creek join to form Bullmoose Creek at the site of the Teck Bullmoose Creek Coal Ltd. open-pit mine (Figure 2).

South Bullmoose Creek is the name given to that portion of the main Bullmoose Creek upstream from the confluence with West Bullmoose Creek. These stream names were used in the Teck Bullmoose Coal Inc. (1982) Stage II Report to differentiate the southern branch of the mainstem upstream from the mine site.

The hydrologic regime of Bullmoose Creek is similar to other drainages on the east slopes of the Rocky Mountains. It is characterized by a spring snowmelt flood peak during ice break-up (early May to June), followed by declining summer flows. Precipitation during the fall again increases the streamflow, and during the winter the creek experiences extreme low flows. The mean low flows (7-day average) expected in South Bullmoose Creek and West Bullmoose Creek (respectively) are 24 L/s and 22 L/s during the winter, and 170 L/s and 160 L/s during the late summer.

WATER USE

There are no existing water withdrawals from Bullmoose Creek either upstream or downstream from the minesite, and no proposals for future withdrawals which would be affected by minesite discharge. Water contact recreation (canoeing, fishing, swimming) is deemed an important potential water use. Fish habitat in the immediate vicinity of the minesite is most critical for Dolly Varden char spawning, rearing, and overwintering.

WASTE WATER DISCHARGES

Prior to the development of the Teck Bullmoose Coal Ltd. minesite, most of the Bullmoose Creek watershed was in a natural state apart from some logging activity and petroleum exploration. The water management plan for the coal mine involves a series of ditches which channel sediment-laden runoff into three sedimentation ponds (Figure 2). The only permitted discharge to Bullmoose Creek is decant from these ponds for up to a four-month period during spring discharge. For the remainder of the year, the sedimentation ponds exfiltrate to West Bullmoose Creek. The minesite tailings pond does not discharge to the creek directly, but rather exfiltrates to recharge the valley aquifer, and from there may enter Bullmoose Creek several kilometers downstream from the mine.

No effluent discharge data and no post-development water quality data were available at the time this assessment was conducted. Conclusions in this report were derived from worst-case waste loadings and receiving water concentrations projected from permitted and expected effluent quality at various streamflows.

The Teck Bullmoose Coal Ltd. open-pit mine had a production capability of approximately 2.3 million tonnes/year over a lifetime of 26 years. The coal is processed (crushed, washed, dried, and sorted) in the minesite preparation plant and then trucked to the coal loadout terminal near the mouth of Bullmoose Creek. There are no townsites in the Bullmoose Valley at present and none are anticipated in the foreseeable future. Washroom domestic sewage from the minesite is treated and then pumped to the tailings pond for ultimate disposal by exfiltration.

The tailings pond collects fine refuse and water from the coal washing plant, treated sewage effluent from the two package treatment plants, and surface runoff. Although contaminant loadings to Bullmoose Creek cannot be calculated, significant attenuation of the contaminants in the seepage is expected as it is diluted by and travels with the ground water before emergence in Bullmoose Creek downstream from the mine. Phosphates from the sewage are expected to absorb to the soil and coal particles and be retained in the pond, while the more mobile nitrate could eventually reach Bullmoose Creek. Most ammonia and nitrite from the sewage is predicted to be nitrified to nitrates.

Acid generation is not expected to be a problem. Waste rock was not proven to be a net acid producer. Although one of the five coal seams was found to be a weak acid producer, surface runoff from the pits is not expected to be acidified because of the low sulfide content of the coal and because of the high buffering capacity of the surrounding geologic materials.

WATER QUALITY ASSESSMENT

The three sedimentation ponds collect maintenance shop effluent, pit water, and surface runoff from the plant site, waste dumps, and mine area. While this effluent can reach Bullmoose Creek in two ways, as seepage or as spring overflow discharge, in neither situation will natural streamflow provide 20:1 dilution. Water quality variables such as pH, alkalinity, hardness, colour, dissolved oxygen, and temperature are not expected to be altered significantly by sedimentation pond discharge or mine-site development. Suspended solids loadings are also not expected to impair water quality. In contract, high nitrogen loadings from explosives residues and low streamflow dilution are predicted to result in levels of un-ionized ammonia-nitrogen which would be toxic to aquatic life during severe winter low flow periods. Additionally, receiving water nitrite-nitrogen concentrations could increase 100-200 times; however, phosphorus levels in Bullmoose Creek are naturally low and the minesite is expected to contribute insufficient phosphorus loads to allow the excess nitrate input to form nuisance algal growth beyond that occurring naturally. The potential effects of metals loading to Bullmoose Creek are unknown, but based on experience at other BC coal mines, metal contamination in pit drainage waters should not be a problem, provided there is no acid generation.

The prediction of toxic levels of un-ionized amonia-N requires verification through future monitoring. The actual levels may be less than the theoretical concentrations since there may be significant ammonia-nitrogen absorption at the cation exchange sites in the soil particles as the waste-waters exfiltrate from the sedimentation ponds. Also, good explosives management in the pits may cause nitrogen losses to be lower than predicted. There are presently no proven or cost-effective methods for the removal of nitrogen from large volumes of wastewater resulting from explosives use. It may be possible to increase the rate of nitrification through increased pond-retention times or the installation of mechanical aeration.

WATER QUALITY OBJECTIVES

The designated water uses of Bullmoose Creek to be protected are aquatic life, wildlife, recreation and drinking water. Provisional water quality objectives are proposed to protect these uses, (Table 1 and **Table 2**). The objectives apply to discrete samples taken in Bullmoose Creek (including South and West Bullmoose Creeks) outside the initial dilution zones of the permitted sedimentation pond discharges on a year-round basis. The objectives are based on working criteria for water quality, on available data for ambient water quality, water uses and river flows, and on projected worst-case waste loadings. According to the worse-case projections, the objectives would be met for turbidity, suspended solids, pH, dissolved oxygen, substrate sedimentation, fecal coliforms, and periphyton standing crop. However, the projections suggest that there may be problems with meeting the objectives for ammonia-N, nitrite-N, and nitrate-N.

The objectives will remain provisional until receiving water monitoring programs provide adequate data, and the Ministry has established approved water quality criteria for the characteristics of concern.

Water quality objectives have no legal standing and would not be directly enforced. The objectives can be considered as policy guidelines for resource managers to protect water uses in the specified water bodies. They will guide the evaluation of water quality, the issuing of permits, licences, and orders, and the management of the fisheries and of the Province's land base. They will also provide a reference against which the state of water quality in a particular water body can be checked, and serve to make decisions on whether to initiate basin-wide water quality studies.

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.

WATER QUALITY MONITORING

The present effluent sampling program required of the permittee is deemed complete and well designed. No additions to the list of variables or increase in the sampling frequency are necessary at this time. Recommendations for receiving water monitoring in the Bullmoose Creek watershed are summarized in Table 3. This program is based on technical considerations, and the extent to which the monitoring is conducted will depend on the over-all priorities and monitoring resources available for the region and the province.

TABLES

Table 1. Provisional Water Quality Objectives for Bullmoose Creek, South Bullmoose Creek and West Bullmoose Creek (at points both upstream and downstream from the TECK minesite)

Water Quality Characteristics	Objectives for drinking water, aquatic life, recreation and wildlife
fecal coliforms	less than or equal to 10 MPN/100 mL, 90th percentile
turbidity	5 NTU maximum increase when the upstream value is less than or equal to 50 NTU a 10% maximum increase when the upstream value exceeds 50 NTU
suspended solids	10 mg/L maximum increase when the upstream value is less than or equal to 100 mg/L a 10% maximum increase when the upstream value exceeds 100 mg/L
substrate sedimentation	no significant (95% confidence level) increase (by weight) in particulate matter less than 3 mm in diameter
periphyton standing crop	50 mg/m^2 chlorophyll a maximum
total ammonia-N	Table 2
nitrite-N	less than or equal to 0.020 mg/L average 0.060 mg/L maximum
nitrite-N + nitrate-N	10 mg/L maximum
dissolved oxygen	7.75 mg/L minimum
pH	6.5 minimum

1. 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 50 percent across the width of the stream, from the surface to the bottom.
2. The fecal coliform 90th percentile is calculated from at least 5 weekly samples taken in a period of 30 days.
3. The increase (in NTU, mg/L or mg/m^3) for turbidity, suspended solids and substrate sedimentation, is over levels measured at a site upstream from a discharge or series of discharges and as close to them as possible, and applies to downstream levels.
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 5 weekly samples taken in a period of 30 days.

Table 3. Recommended Routine Water Quality Monitoring for Bullmoose Creek

Sites	Frequency and Timing	Characteristics to be Measured
West Bulmoose Creek E206225 u/s from the minesite E206226 d/s from sediment pond 3 E206227 d/s from sediment ponds 1 and 2 ... South Bullmoose Creek E206223 u/s from minesite E206229 d/s from the plant site ... Bullmoose Creek E206232 20 km d/s from the minesite 0410094 1 km d/s from the confluence	weekly between April 1 and June 23, monthly the rest of the year	total alkalinity, phenol, phosphorus and mercury dissolved oxygen and phosphorus total and dissolved aluminum, arsenic, barium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, vanadium, zinc and silver flow; hardness; ammonia, nitrate and nitrite nitrogen; oil and grease; pH; suspended solids; COD; temperature; fecal coliforms; turbidity.

1. Receiving water sampling should be carried out at the same time as effluent sampling required by the Waste Management Branch.
2. Sampling may need to be increased to check the actual water quality relative to the objectives, depending on circumstances. Sampling may be decreased if monitoring provides sufficient water quality information or if objectives are being met on a consistent basis.

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