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Environmental Protection
Agency

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Environmental Assessment

Red Dog Mine Project NPDES Permit Renewal
Alaska

Teck Cominco Alaska, Inc.

NPDES Permit No. AK-003865-3

Revised January 2006

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1.0 PURPOSE AND NEED FOR THE PROPOSED ACTION

1.1 Background

The Red Dog lead and zinc mine is located in northwest Alaska, approximately 80 miles north of Kotzebue and about 50 miles inland from the Chukchi Sea (Figure 1). The mine site is located on Red Dog Creek in the DeLong Mountains. In the early 1980s, Teck Cominco Incorporated submitted several applications for federal authorizations for the project. One of the applications was for a National Pollutant Discharge Elimination System (NPDES) permit to discharge wastewater to Middle Fork Red Dog Creek. The surface water discharge was a new source in accordance with 40 CFR 122.2. As a result, 40 CFR Part 6, the Agency's implementing regulations for the National Environmental Policy Act, required EPA to prepare an Environmental Impact Statement (EIS) on the potential environmental impacts of the proposed operation. EPA issued that EIS in 1984 (USEPA/DOI 1984).

The original NPDES permit issued to the mine (AK-003865-2) expired in 1990. In its application for a permit renewal, Teck Cominco requested an increase in the volume of effluent that it was permitted to discharge. The requested change was outside the range of alternatives considered in the original EIS and therefore raised issues not addressed in the original EIS. As a result, EPA prepared an Environmental Assessment (EA) that evaluated potential impacts of the increase in effluent discharge volume and selected alternatives (USEPA 1993). EPA subsequently made a Finding of No Significant Impact (FONSI) and reissued the permit on August 28, 1998.

The 1998 NPDES permit included metals limits that were significantly more stringent than the metals limits in the original NPDES permit. The permit also included limits for total dissolved solids (TDS) based on the State's narrative water quality criterion for aquatic life use, which limited the concentration of TDS to "one-third above background." Based on measured in-stream background concentrations, the limits were set at 176 mg/L (monthly average) and 196 mg/L (daily maximum).

Teck Cominco uses lime precipitation and sodium sulfide precipitation in its wastewater treatment process to lower the concentration of toxic metals in the wastewater. This treatment process changes the composition of TDS in the mine's effluent from a heavy metal–sulfate based TDS to a calcium-sulfate based TDS. Currently, there is no proven technology to remove TDS from wastewater at the flow volumes discharged by the facility.

The mine's wastewater essentially consists of precipitation runoff from exposed ore in the mine pit and waste rock piles. It is collected in a tailings impoundment, where it is exposed to mine tailings. The tailings impoundment water is also used in ore processing and then returned to the tailings

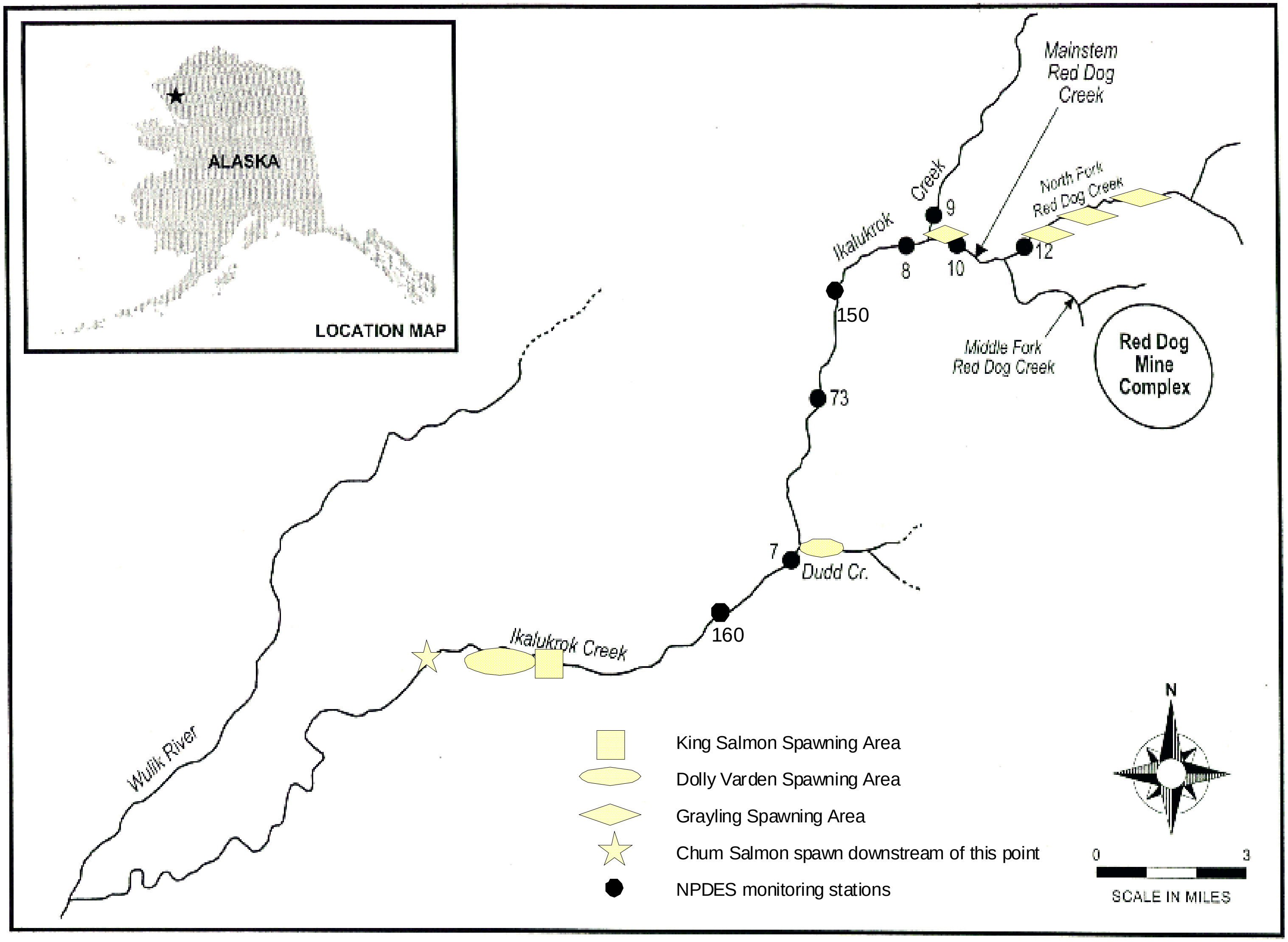


Figure 1 - Red Dog Mine

impoundment. The mine must discharge water from the tailings impoundment in order to make room for new precipitation runoff that must be captured and treated before discharge. The tailings impoundment is near its water holding capacity. Because the water in the tailings impoundment is highly toxic to aquatic life and human health, it is critical to maintain the water in the tailings impoundment at a level to ensure the impoundment's structural integrity. To do this, the mine must discharge all of the mine drainage (i.e., rainfall and snowmelt that comes into contact with exposed ore) that is collected in the tailings impoundment each year and a portion of the process water that enters the impoundment with the tailings. Teck Cominco is planning a new lift for the tailings impoundment to increase the impoundment capacity.

In 1999, the Alaska Department of Environmental Conservation (ADEC) revised its state-wide water quality regulations (18 AAC 70) to delete the "one-third above background" narrative criterion for TDS. The criterion was replaced with "not-to-exceed" limits that depend on the designated beneficial use classification. The aquatic life use classification can allow a TDS criterion value of 1,000 mg/L. However, as stated in the 1999 revisions:

> If a permit applicant proposes to raise the TDS levels in the receiving water to result in a concentration in the waterbody between 500 mg/l and 1,000 mg/l for all sources or above 110 mg/l for the potassium ion, the department will require a permit applicant to provide information that the department identifies as necessary to determine if the proposed TDS level will cause or can reasonably be expected to cause an adverse effect on aquatic life; based on its analysis, the department will limit the TDS level in the waterbody as necessary to prevent an adverse effect, and will set permit effluent limits accordingly; the burden of proof to demonstrate no adverse effect is on the permit applicant; implementation of the "no adverse effect" criterion is not subject to 18 AAC 70.235.

Table 1, below, summarizes the use classifications for each stream segment, and the most stringent TDS criterion applicable to each stream segment.

Figure 2
Mixing Zone Locations

Table 1. Use Classifications and TDS Criteria for Area Streams

Stream Reach	***Use Classifications***	***TDS Criterion for the Most stringent Use Classification***
Upper Middle Fork Red Dog Creek (Headwaters to terminus of the Red Dog mine water management system)	**Industrial water supply**	No amounts above natural conditions that can cause corrosion, scaling or process problems.
Lower Middle Fork Red Dog Creek (Terminus of the Red Dog mine water management system to confluence with North Fork Red Dog Creek)	**Industrial water supply** Contact recreation (wading only) Secondary recreation (except fishing)	No amounts above natural conditions that can cause corrosion, scaling or process problems.
Mainstem Red Dog Creek (Confluence of North Fork Red Dog Creek to confluence of Ikalukrok Creek)	**Aquatic life** Industrial water supply Contact recreation (wading only) Secondary recreation	May not exceed 1,000 mg/L; may not be present in a concentration that causes an adverse effect to aquatic life.
Ikalukrok Creek	**Aquatic life** Industrial water supply Contact recreation (wading only) Secondary recreation	May not exceed 1,000 mg/L; may not be present in a concentration that causes an adverse effect to aquatic life.

NOTE: The TDS criterion listed is associated with the use classification that is in bold letters.

In January 2001, Teck Cominco submitted a request to ADEC to establish a site-specific water quality criterion for TDS in the Mainstem Red Dog Creek. Teck Cominco requested an in-stream TDS criterion of 500 mg/L during Arctic grayling spawning and a TDS criterion of 1,500 mg/L (maximum) which would apply after resident Arctic grayling finish spawning (this occurs when there is free-flowing water after ice breakup, usually in late May or early June, when the water temperature is approximately 4^{o}C).

Teck Cominco also requested that ADEC approve a permit limit for TDS that allows 1,000 mg/L (maximum) in Ikalukrok Creek from its confluence with Mainstem Red Dog Creek to its confluence with the Wulik River. This limit would apply at all times except during the spawning period for Dolly Varden, king, and chum salmon (species that spawn in Ikalukrok Creek, see Figure 1). During spawning periods, in spawning areas, the permit limit would be based on the TDS criterion of 500 mg/L (maximum). Spawning in Ikalukrok Creek occurs approximately 9.5 miles downstream of Dudd Creek (see Figure 1) from July 25th through the end of the discharge season (i.e., the facility ceases its discharge for the year when the creeks start to freeze up, the exact time will vary from year to year).

Teck Cominco also requested that ADEC modify its Clean Water Act Section 401 certification of the Red Dog Mine NPDES permit to include the above TDS criteria and to authorize two mixing zones: one in Mainstem Red Dog Creek and the other in Ikalukrok Creek. A mixing zone is a limited area in a waterbody downstream of the discharge, where the effluent is diluted by the receiving water. Within the mixing zone the TDS criterion can be exceeded locally due to incomplete mixing of effluent and the receiving water. Outside of the mixing zone the criterion must be met. The proposed mixing zone in Mainstem Red Dog Creek would begin at the confluence with North Fork Red Dog Creek and continue downstream for 1,930 feet. The proposed mixing zone in Ikalukrok Creek would start at the confluence with Mainstem Red Dog Creek and continue downstream for 3,420 feet (Figure 2). ADEC authorized the mixing zones in 2003.

The effluent flow volume from the mining facility outfall (Outfall 001) would be adjusted as necessary to avoid exceeding the applicable criterion outside of the mixing zone. Teck Cominco (Teck Cominco Alaska, Inc. 2000b) developed a TDS/conductivity model that can be used to adjust the outfall flow volume to meet the in-stream limit. Teck Cominco requested that ADEC modify its certification to incorporate the 500 mg/L TDS site-specific criterion for Mainstem Red Dog Creek, the 1,000 mg/L criterion for Ikalukrok Creek (except during spawning periods), and the mixing zones in Mainstem Red Dog Creek and Ikalukrok Creek.

Teck Cominco requested that EPA modify the mine's NPDES permit to reflect the changes outlined above. On July 17, 2003, EPA issued a modified NPDES permit. On the same day, EPA issued a Clean Water Act Section 308 Information Request to Teck Cominco that required tests to be performed to determine the effects of TDS on the spawning success of Arctic grayling and Dolly Varden (discussed in Section 4.2.1 of this EA). The modified permit was appealed, which stayed the grayling spawning TDS limit. On June 15, 2004, the limit was remanded back to EPA by the Environmental Appeals Board (EAB). On August 28, 2003, the NPDES permit (as modified, except for the one stayed condition) expired and was administratively extended pending its renewal.

1.2 Purpose and Need for Proposed Action

NPDES permits are written for a term of five years. After five years the permit conditions are reviewed and a renewed permit is issued based on data collected over the previous permit life and any applicable regulatory changes or changes to water quality standards. Since the Red Dog Mine discharge is a new source in accordance with 40 CFR 122.2, any change to the renewed permit that has the potential to cause environmental impacts must be assessed through the NEPA process. Only new conditions in the renewed permit with the potential to result in environmental impacts are assessed in this document. Most provisions in the Red Dog Mine's draft permit renewal have already been assessed in previous NEPA documents (USEPA/DOI 1984; USEPA 1993; USEPA 2003) and are not considered here.

Teck Cominco submitted an application for renewal of its mine-site NPDES permit on February 25, 2003, more than 180 days prior to expiration of the existing permit. EPA reviewed the application and determined that it was complete. The purpose and need for this action is to reissue the expired NPDES permit to include revised conditions based on recent data and to respond to the EAB remand order.

1.3 Scope of this Environmental Assessment

EPA has prepared this Environmental Assessment to support the proposed reissuance of the Red Dog Mine NPDES permit. Consequently, the analyses in this EA are restricted to matters directly related to proposed changes in the NPDES permit and the reasonable alternatives. This EA evaluates only the proposed permit conditions that are less stringent than the current permit. Changes that make the permit more stringent do not need to be assessed since they will not adversely affect the environmental resources in comparison to the current conditions. The affected environment described herein is limited to water resources, aquatic life, and human health. EPA dos not expect other environmental resources, such as soils, vegetation, wildlife, air quality, land use, and socioeconomics to be affected in any way by the proposed action. Descriptions of these resources can be found in previous environmental assessments associated with the Red Dog Mine, to which the reader is referred (USEPA/DOI 1984; USEPA 1993; USEPA 2003). EPA prepared this EA in compliance with NEPA regulations of the Council on Environmental Quality (40 CFR Parts 1500-1508) and EPA's NEPA implementing regulations (40 CFR Part 6).

2.0 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVE

This chapter describes the proposed action and an alternative to the proposed action.

2.1 Proposed Action and Alternative

2.1.1 Alternative 1 - Proposed Action: Renew the NPDES Permit with Changes

The proposed action is to renew Teck Cominco's NPDES permit for the Red Dog Mine with changes consistent with State of Alaska Water Quality Standards. The proposed permit renewal contains the following requirements and/or changes that are less stringent than the current permit:

1. If EPA approves the SSC of 1,500 mg/L for TDS for the Arctic grayling spawning period in Mainstem Red Dog Creek, the permittee would be required to maintain in-stream TDS concentration at or below 1,500 mg/L at the edge of the mixing zone, including during spawning periods (varied from as few as 6 days to as long as 11 days). If EPA does not approve the SSC, ADEC may allow for an adjustment up to 1,000 mg/L TDS during

spawning periods. If the adjustment is not approved, then EPA will require 500 mg/L TDS limit at the edge of the mixing zone during spawning.

2. Remove the 3,900 mg/L end-of-pipe TDS limit for Outfall 001.

3. ADEC has proposed a mixing zone for cyanide. EPA determined that there is no reasonable potential for the effluent to cause or contribute to an exceedance of the standard outside the mixing zone, therefore, no limit is necessary. Weekly monitoring for cyanide remains unchanged. The proposed reissued permit requires the use of the Weak Acid Dissociable (WAD) cyanide analytical method.

4. ADEC has not re-certified the site-specific criterion used for zinc in the current permit, which contained a zinc limit based on the natural condition site specific-criteria provided in ADEC's 1998 CWA Section 401 certification of the permit of 210 µg/L. Therefore, the state-wide criteria of 269 µg/L would be utilized to calculate the permit effluent limit.

2.1.2 Alternative 2: Renew the NPDES Permit with No Changes

Under the alternative, EPA would not change any provisions in the 1998 NPDES permit. Instead, EPA would:

1. Retain the 1998 effluent limits for TDS of 170 mg/L (monthly average) and 196 mg/L (daily maximum) during grayling spawning in Mainstem Red Dog Creek.

2. Retain an effluent limit of 3,900 mg/L TDS at end-of-pipe.

3. Retain effluent limits for cyanide of 9 mg/L daily max and 4 mg/L monthly average. Compliance with the cyanide limits would be determined by the total cyanide analytical method.

3.0 THE AFFECTED ENVIRONMENT

As noted in Section 1.3, the scope of this EA includes only potential impacts from the proposed reissuance of the existing NPDES permit, and the alternative. These actions would affect only water resources, aquatic life, and human health. Therefore, the discussion of the affected environment in this EA is limited to these resources. USEPA/DOI 1984, and USEPA 1993 contain discussions of the potential impacts of the Red Dog Mine on other resources, such as soils, vegetation, air quality, land use and socioeconomics, which this proposed action does not affect. Figures 1 and 2 show the locations of monitoring stations where stream flow and water quality data have been collected.

3.1 Water Resources

3.1.1 Hydrology and Stream Flow

Hydrology information is detailed in USEPA/DOI 1984. Seasonal stream flows vary significantly in the Arctic environment of the mine site, with virtually all flow occurring in the five-month period from spring thaw in May to winter freeze in October. Stormwater runoff can vary significantly depending on topography, degree of soil saturation, and depth to the frozen layer. Small tributary streams typically freeze to the bottom in the winter months, whereas larger rivers can continue to flow beneath an ice covering.

Red Dog Creek. Red Dog Creek, which drains the western foothills of the DeLong Mountains, including the Red Dog Mine site, flows into Ikalukrok Creek, a major tributary of the Wulik River (Figure 1). The stream has two major tributaries (Middle Fork and North Fork) that combine to form Mainstem Red Dog Creek. A third tributary, the South Fork, was impounded to form the tailings impoundment and no longer flows to its natural confluence with the Middle Fork. The Red Dog Mine facilities, including the Red Dog Mine pit and Red Dog Creek diversion, are contained within the drainage areas of Middle and South Fork Red Dog Creek.

North Fork Red Dog Creek drains approximately 41 km^2. The stream is typically from 7 to 15 meters wide and from 0.1 to 2 meters deep (ADNR-OHMP, 2005). It is characterized by abundant streamside vegetation, riffles and pools that flow over substrate of gravel and boulders. Middle Fork Red Dog Creek drains approximately 12 km^2. This segment is a meandering channel that is 3 to 10 meters wide and 0.03 to 0.45 meters deep. Mainstem Red Dog Creek drains approximately 64 km^2 (ADF&G, 1999). Mainstem Red Dog Creek flows across a substrate mostly of gravel, cobbles, and small boulders. This creek meanders and has widths ranging from 3.5 to 18 meters wide and depth between 0.06 to 2.5 meters.

Figure 3 shows the mean daily flow in Mainstem Red Dog Creek, as measured at Station 10 from May – October 2004. The creek is generally frozen during winter months. The creek flow peaks at slightly over 200 cfs during ice breakup in May.

Table 2 shows the minimum, maximum, and median flows for the outfall, station 10, station 150, station 160 (located in Ikalukrok Creek below Dudd Creek), and station 2 (in the Wulik River below the confluence of Ikalukrok Creek). The flows represent data collected from 2003 through 2005. The flow at Station 10 ranges from 1 to 766 cubic foot per second (cfs) with a mean value of 74 cfs (late summer storms can cause fluctuating high flows ranging up to 766 cfs). Approximately 16 percent of the mean flow is from the mine outfall discharge.

Table 2. Flow Rates in cfs
May – October, 2003-2005

	Outfall Discharge	Station 10 (Mainstem Red Dog Creek)	Station 150 (Ikalukrok Creek below Mainstem Red Dog Creek)	Station 160 (Ikalukrok Creek below Dudd Creek)	Station 2 (Wulik River below Ikalukrok Creek)
Minimum	0.0	1	4	11	65
Maximum	31	766	2402	4057	21600
Mean	12	74	284	467	2235
Count	436	448	448	437	448

Ikalukrok Creek. Ikalukrok Creek flows into the Wulik River which, in turn, flows to the Chukchi Sea. Near the headwaters of Ikalukrok Creek, the stream flows through areas of natural mineralization (ADF&G, 1999) and is impacted by natural seepage of minerals from Cub Creek (ADNR-OHMP, 2005a) located in upper Ikalukrok Creek approximately 1 mile upstream of the confluence with East Fork Ikalukrok Creek.

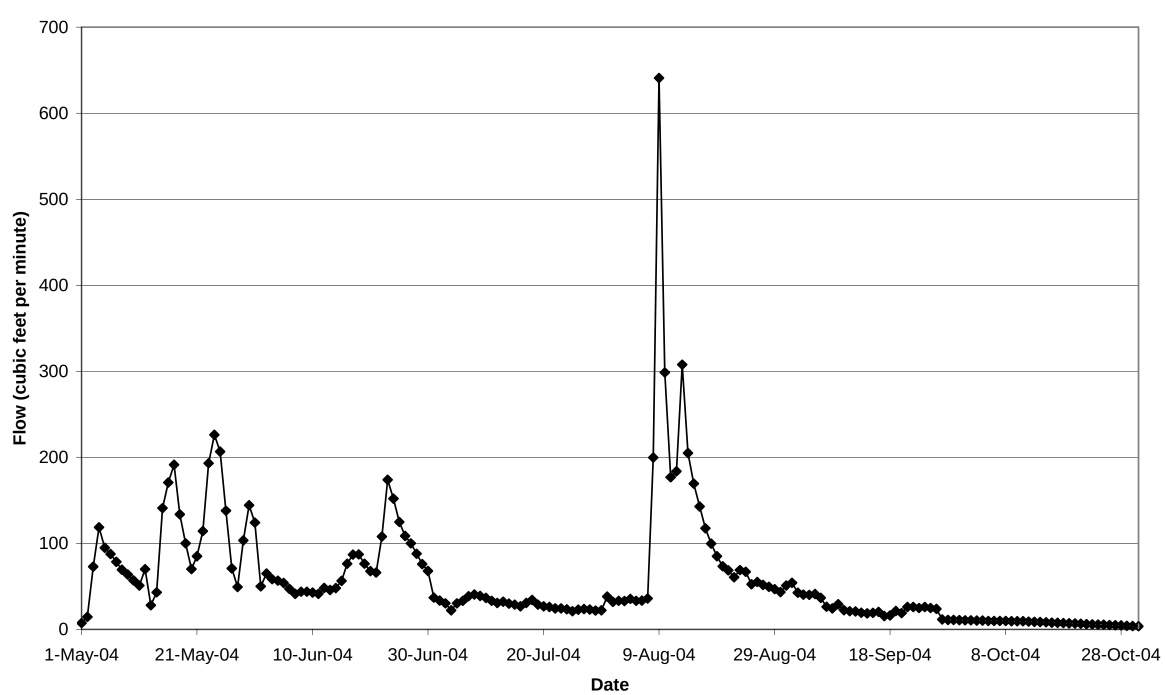
Ikalukrok Creek above the confluence with Mainstem Red Dog Creek drains approximately 150 km^2. This segment, which has not been disturbed by human activity, has a substrate of cobbles, gravel, and rocks. At Station 9, in Ikalukrok Creek above the confluence of Mainstem Red Dog Creek the rocks in the stream bed are frequently stained orange from naturally occurring iron precipitate (ADF&G, 1999). In this reach, Ikalukrok Creek is typically 2 to 7 meters wide (up to 20 meters during high flow), with depths of 0.15 to 1.2 meters. Below the confluence with Mainstem Red Dog Creek, Ikalukrok Creek is a comparatively fast-flowing stream with a substrate of small cobbles and gravel. ADF&G (1999) reported a dense growth of filamentous algae and iron precipitate on the stream bottom at Station 8 (located in Ikalukrok Creek just below the confluence of Mainstem Red Dog Creek, see figure 1). Gravel bars are exposed during low flow. Ikalukrok Creek below the Dudd Creek confluence ranges in wetted-width from 3.5 to 40 meters and in depth from 0.3 to 1.2 meters. The substrate in this location consists of small to medium sized gravel (ADF&G, 1999).

Average seasonal flow at Station 150, in Ikalukrok Creek below the Mainstem confluence, is highly variable. Essentially all stream flow occurs from May through October. Due to the presence of shallow permafrost and saturated soils, rapid snowmelt or rainfall results in rapid changes in stream discharge. Surface discharge volume peaks in late May during ice breakup and during summer storms. Peak flow volume may exceed 2,000 cfs during these periods. Flow decreases with the onset of winter (September/October) and by mid-winter the creek is substantially frozen, although intermittent aufeis fields may form from ice pressure. Based on data from years 2003-2005, the flow at Station 150 ranged from 4 cfs to 2,400 cfs with a mean value of 284 cfs (Table 2). Approximately 4 percent of the mean flow is attributable to the mine outfall discharge.

In Ikalukrok Creek downstream of Dudd Creek at Station 160 (see location on Figure 1), flows generally range between 11 and 4,000 cfs, with a mean flow of 467 cfs. Approximately 3 percent of the median flow is attributable to the mine outfall.

Flow in the Wulik River, as measured for the years 2003-2005 at Station 2 (lower Wulik River below the confluence of Ikalukrok Creek) ranged from 65 cfs to 21,600 cfs with a mean flow of 2,235 cfs. Less than 1% of the mean flow is attributable to the mine outfall.

Figure 3. Mean Daily Flow in Mainstem Red Dog Creek (Station 10), May - October 2004



3.1.2 Surface Water Quality

Elevated metal sulfates in the mine water, which ultimately result in increased levels of TDS downstream of the mine discharge point, originate from oxidation of the naturally occurring metal sulfide mineralization abundant in the district. Metal sulfide oxidation is a naturally occurring process, which explains the high levels of metals in Red Dog Creek prior to mining activity (EVS, 1983). Mining greatly accelerates the oxidation process, however, another significant source of metal sulfides in the mine water is the diversion of the naturally impacted waters historically flowing into Red Dog Creek into the Red Dog Mine wastewater treatment facility.

Teck Cominco treats Red Dog Mine wastewater to reduce metals and other constituents to concentrations required in the NPDES permit. This treatment results in increased TDS concentrations in the effluent that is discharged to the receiving waters. Lime, containing calcium, and sodium sulfide are the primary additives used to remove metals from the wastewater. Based on available analytical data, the effluent TDS concentration in 2005 was between 2,510 mg/L and 4,175 mg/L, with a median concentration of 3,817 mg/L. The approximate percent composition of ions in the effluent TDS was:

Potassium	1.0 %
Bicarbonate/Carbonate/Hydroxide	0.7%
Chloride	0.6 %
Sodium	2 %
Magnesium	1.7 %
Calcium	24.7 %
Sulfate	69.3 %

All of these ions are typically found in natural waters, and with the exception of calcium and sulfate, in roughly the same concentration as the mine effluent. Sulfate and calcium are the predominant ions in this TDS mixture. Table 3 summarizes analytical TDS data for Red Dog and Ikalukrok Creeks since the effective date of the modified permit (August 22, 2003 – 2005).

Table 3. Summary of TDS Concentrations in Red Dog Creek and Ikalukrok Creek Since Effective Date of Permit Modification (August 22, 2003 – 2005)

TDS	North Fork Red Dog Creek (unaffected by effluent)	Mainstem Red Dog Creek		Ikalukrok Creek, below Mainstem Red Dog Creek	Ikalukrok Creek, below Dudd Creek
	Station 12	Station 10	Station 151[a]	Station 150[b]	Station 160
Minimum	50	166	154	70	78
Maximum	400	1370	1410	630	450
Mean	270	772	826	337	289
Count	24	51	96	98	49

See Figures 1 and 2 for station locations.

[a] Edge of Mixing Zone 1.

[b] Edge of Mixing Zone 2.

Red Dog Creek. In general, higher concentrations of TDS in Red Dog Creek occur when mine effluent flow volumes are high compared to the stream flow. Because of the mine effluent, the concentrations of TDS are substantially higher in Mainstem Red Dog Creek than upstream in North Fork Red Dog Creek.

The data in Table 3 show that TDS concentrations in Mainstem Red Dog Creek vary substantially under the present discharge conditions. However, there have been no TDS measurements over 1,500 mg/L since the effective date of the modified permit.

Decreases of metal loads at the source insure reduced loads and concentrations at all points downstream. ADNR-OHMP (2005) has documented the reduced concentrations from pre-mining levels. Figures 4, 5, and 6 compare median pre-mining concentrations of cadmium, lead and zinc to post-mining concentrations in the Mainstem Red Dog Creek.

Figure 4. Mainstem Red Dog Creek Median Cadmium Concentrations
Pre-Mining and 1999-2004

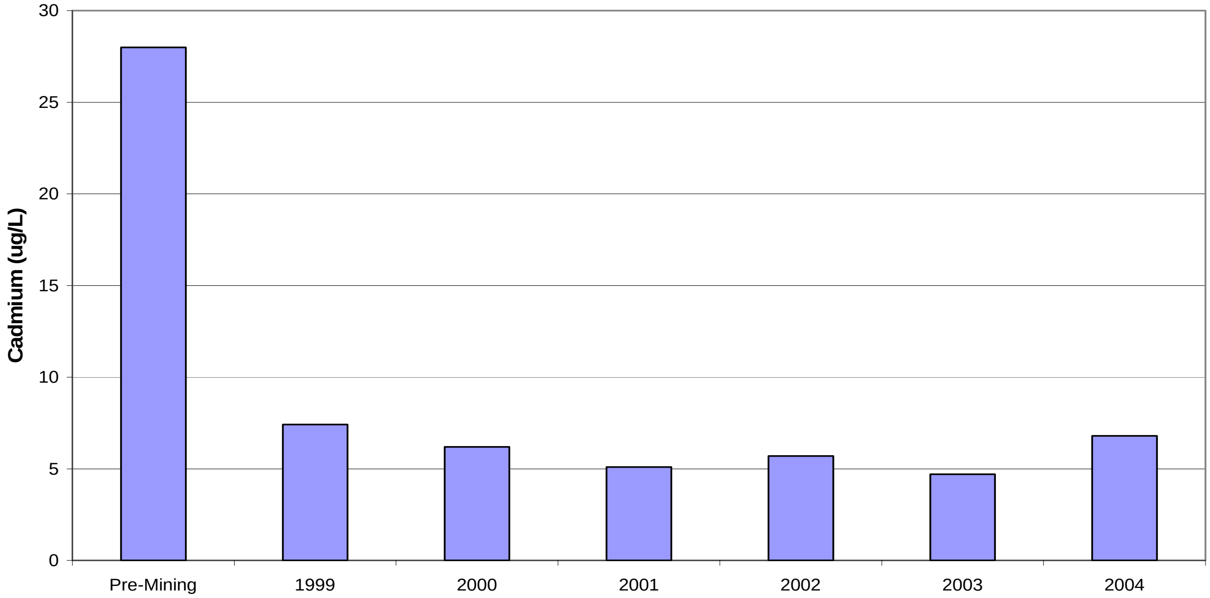


Figure 5. Mainstem Red Dog Creek Median Lead Concentrations
Pre-Mining and 1999-2004

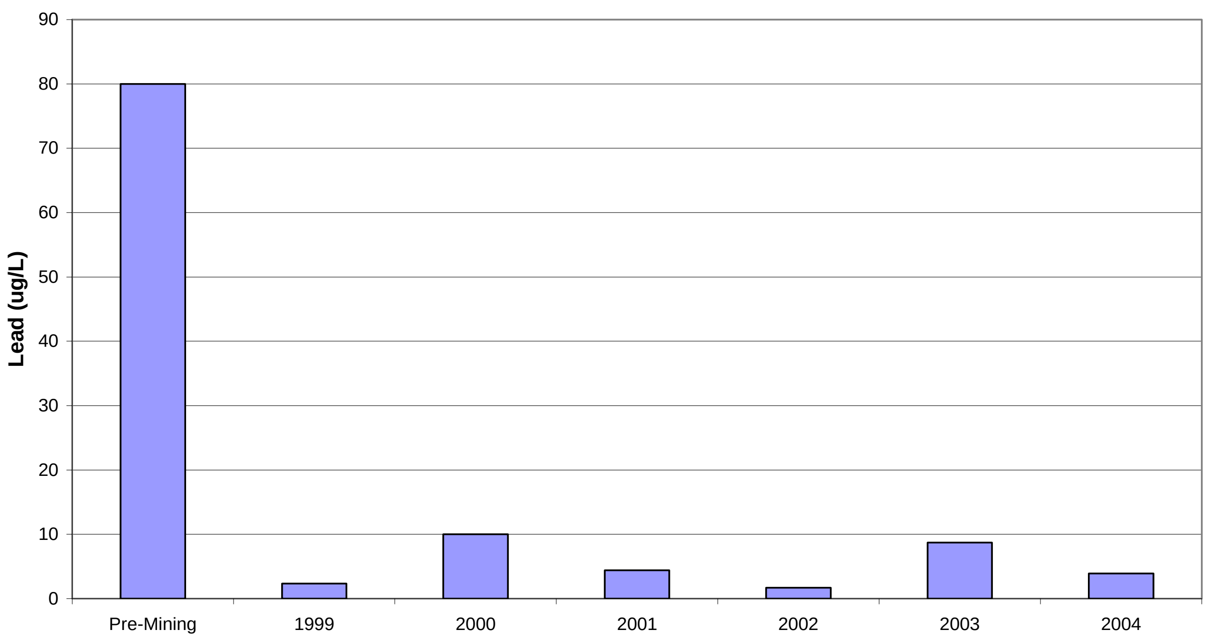
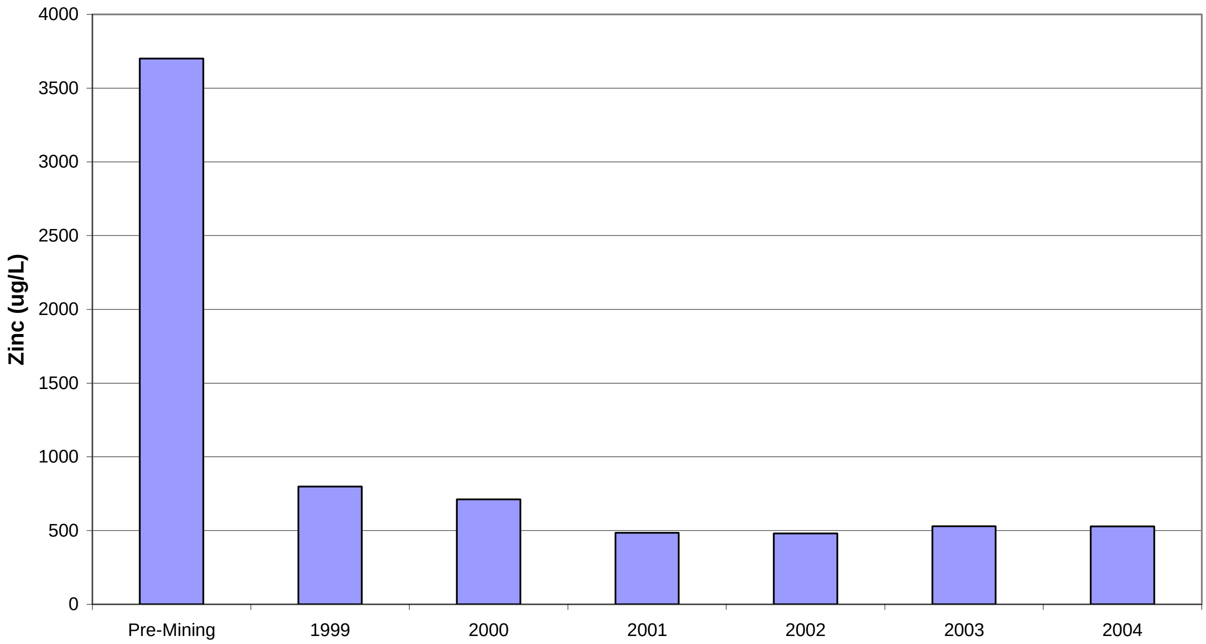


Figure 6. Mainstem Red Dog Creek Median Zinc Concentrations
Pre-Mining and 1999-2004



Ikalukrok Creek. As can be seen from Table 3, in general, the mean concentrations of TDS at Stations 150 and 160 are less than half the concentration in the Mainstem Red Dog Creek. None of the measurements at Station 150 exceeded the TDS criterion of 1,000 mg/L TDS, and none of the measurements at station 160 exceeded the TDS criterion of 500 mg/L that is applicable during salmonid spawning periods.

3.2 Aquatic Resources

Aquatic resources and fisheries have been described in several ADF&G and ADNR publications (ADF&G 1990; 1992; 1993; 1994; 1996a,b; 1998; 1999; 2000; 2001a; 2002a; ADNR-OHMP 2004; 2005). In addition, aquatic resources were described in earlier baseline reports (EVS and Ott Water Engineers 1983; EPA/DOI 1984; Dames and Moore 1981, 1983).

3.2.1 Fish

<u>Arctic grayling (*Thymallus arcticus*)</u>
When break-up occurs (usually in May), adult Arctic grayling migrate upstream in Ikalukrok Creek to Mainstem Red Dog Creek and into North Fork Red Dog Creek to spawn. Since mine

development, grayling spawning has been known to occur in Mainstem Red Dog Creek when water temperatures remain colder in North Fork Red Dog Creek for an extended period of time relative to the Mainstem. Spawning activity begins when water temperatures reach approximately 4^{o}C, for a period that varies from as few as 6 days to as long as 11 days. Fry hatch in late June and rear in Mainstem Red Dog Creek and North Fork Red Dog Creek until fall. Grayling feed on benthic invertebrates and terrestrial insects. In late August or September, young-of-the-year and adults migrate downstream to overwintering areas in Ikalukrok Creek or the Wulik River. ADF&G and ADNR (2005) have observed significant numbers of grayling young-of-the-year in Mainstem Red Dog Creek in 1995, 1996, 1997, 1999, 2003 and 2004 (ADNR-OHMP, 2005a), suggesting that Arctic grayling spawn in lower Mainstem Red Dog Creek (ADF&G 2002b). Use of Mainstem Red Dog Creek by Arctic grayling adults and young-of-the-year in the past few years appears to be increasing (ADF&G 1998). Increased use is likely related to overall improvements in water quality, increased primary production and increased numbers and diversity of benthic invertebrates (Weber Scannell, 2005).

Dolly Varden (*Salvelinus malma*)

Approximately 90 percent of overwintering Dolly Varden in the Wulik River drainage occur in the Wulik River downstream of the mouth of Ikalukrok Creek (ADF&G 1998). Dolly Varden spawn in the fall and juveniles emerge in the spring. Spawning has been documented in Ikalukrok Creek below Station 160 and near the confluence of Ikalukrok Creek and Dudd Creek and in Dudd Creek. Juvenile distribution is broader than that of adult spawners. Juveniles have been collected in Mainstem and North Fork Red Dog Creek and in Ikalukrok Creek.

Chum salmon (*Oncorhynchus keta*)

Chum salmon are found in Ikalukrok Creek. They spawn in the lower 9.5 mile reach of Ikalukrok Creek below Dudd Creek from late July through August (ADF&G 2002a). The population in this reach increased after the early 1990s, presumably due to the construction of a diversion ditch at the Teck Cominco mine site. The 2001 surveys conducted by ADF&G counted 2,250 adult chum salmon - the highest number since mining began (ADF&G 2002b). ADNR reports that the large number of chum salmon in recent years, particularly 2001 and 2002, are good indications that the population has recovered from the low numbers reported in the early 1990s (ADNR-OHMP, 2005a).

Chinook and Sockeye Salmon

Both chinook and sockeye salmon are rare in the system. Prior to construction of Red Dog Mine, Chinook salmon used Ikalukrok and Dudd Creeks for spawning (Dames and Moore 1983). In 2001, two Chinook salmon were observed on a redd in lower Ikalukrok Creek. No juvenile Chinook salmon have been caught in sampling nets between 1990 and 2003. Townsend and Conley (2004) observed 56 adult Chinook salmon in a side channel slough in lower Ikalukrok Creek in August 2004. Water temperature measurements (Ott and Townsend, 2005) indicate that the slough containing the Chinook salmon is dominated by groundwater with little influence from Ikalukrok Creek water or the Red Dog Mine effluent. In 2004, juvenile Chinook salmon were observed near Dudd Creek and in Anxiety Ridge Creek. In 2005, minnow traps were fished in lower Ikalukrok for the first time since 1990. Six juvenile Chinook salmon were captured in these minnow traps (Ott and Townsend, 2005). The Alaska Department of Environmental Conservation reports that the Chinook salmon in Ikalukrok Creek do not represent a significant breeding population (ADEC, 2003).

In field surveys conducted in 1997, eight sockeye salmon were observed in lower Ikalukrok Creek (ADF&G 2002b). The only presence of sockeye salmon in Mainstem Red Dog Creek was the observation of a single male carcass in 2003 (Scannell, 2003). Sockeye salmon use and abundance in the Ikalukrok Creek drainage is probably limited.

Slimy sculpin (*Cottus cognatus*)

Slimy sculpin have been observed in the North Fork and were caught for the first time in the Mainstem of Red Dog Creek in 1995. Slimy sculpin also occur in Ikalukrok Creek.

Table 4 summarizes fish presence by life history stage in the major stream segments. Fish have not been observed in the Middle Fork Red Dog Creek at any time, including the pre-mining period. The winter distribution of all fish species appears to be limited to Ikalukrok Creek downstream of the confluence with Dudd Creek and in the Wulik River. There are no threatened or endangered species or critical habitats in or near the waters that may be affected by the proposed changes in the renewed NPDES permit.

Table 4. Fish Use in the Project Area

Creek Segment	**Spawning**	**Rearing**	**Juvenile Outmigration**
North Fork Red Dog Creek	AG	AG, DV, SS	AG, DV, SS
Middle Fork Red Dog Creek	--	--	--
Mainstem Red Dog Creek	AG	AG, DV, SS	AG, DV, SS
Ikalukrok Creek upstream of Red Dog Creek [a]	AG [c]	AG, DV, SS	AG
Ikalukrok Creek between Red Dog Creek and Dudd Creek	AG	AG, DV	AG, DV, SS

Table 4. Fish Use in the Project Area			
Creek Segment	**Spawning**	**Rearing**	**Juvenile Outmigration**
Ikalukrok Creek downstream of Dudd Creek [b]	DV, Chum Chin, SK [c]	DV, Chin	DV
AG = Arctic grayling, DV = Dolly Varden, SS = Slimy Sculpin, Chum = Chum Salmon Chin= chinook salmon, SK= sockeye salmon a = Incomplete surveys b = Arctic grayling and slimy sculpin survey data not available c = Species present but spawning activity not confirmed			

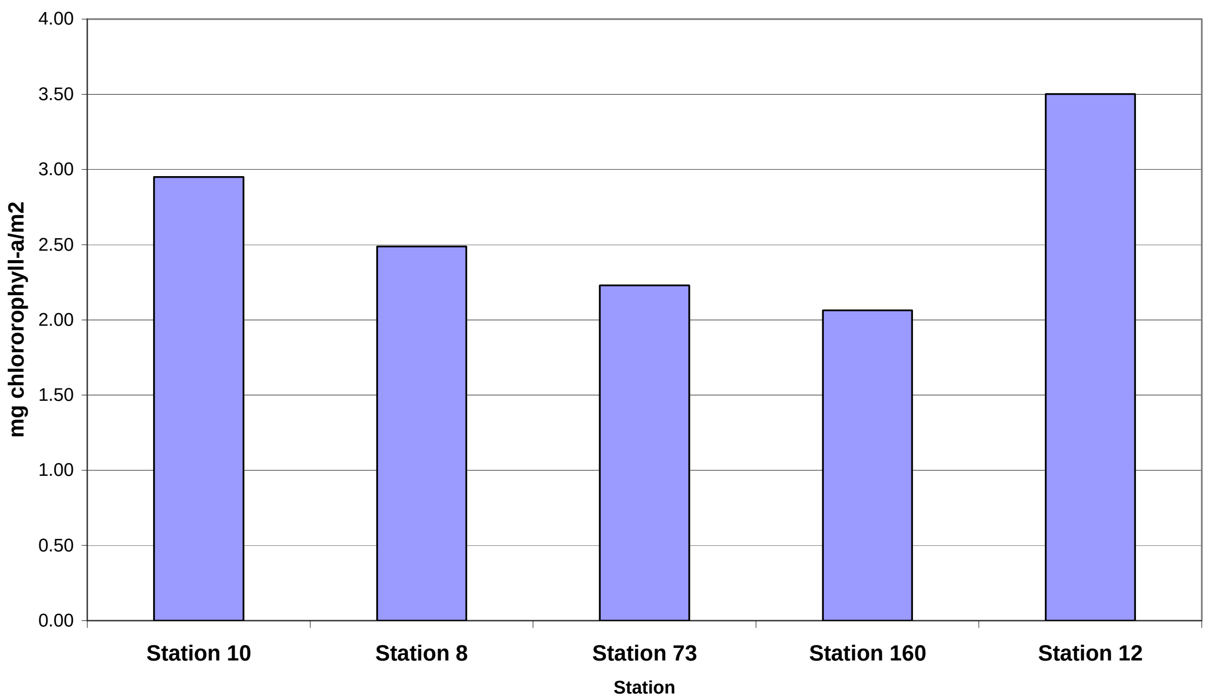
3.2.2 Aquatic Invertebrate Communities

The benthic community found in Mainstem Red Dog Creek is highly variable and can be comprised of up to 20 different taxa. In 2003 and 2004, the majority of the taxa collected were composed of pollution-sensitive taxa such as Ephemeroptera, Plecoptera, and Trichoptera (EPT), typical of high-latitude streams (ADNR-OHMP, 2005a). Similar to Mainstem Red Dog Creek, the benthic community in North Fork Red Dog Creek includes up to 25 different taxonomic groups, including EPT. Station 8 (located in Ikalukrok Creek just below the confluence of Mainstem Red Dog Creek) benthos community is highly variable peaking in abundance and density in 2003. Taxonomic richness is somewhat less variable and is most often dominated by chironomids (ADNR-OHMP, 2005a). Seasonal differences, different sampling methods, and timing of emergence account for differences in the number of taxa collected. The dominant taxa at all Ikalukrok Creek sampling locations downstream of Red Dog Creek (Station 160, and upstream of Dudd Creek) were somewhat similar to Station 8 (ADNR-OHMP, 2005a).

3.2.3 Periphyton

ADF&G and ADNR have been monitoring the presence of periphyton by measuring concentrations of chlorophyll-a on the surface of rocks collected from streams. Biomass (as reflected by chlorophyll-a concentrations) are comparable in the Mainstem and North Fork Red Dog Creek and vary slightly in Ikalukrok Creek downstream of Red Dog Creek. Since 2000, an increasing trend in algae biomass has been identified by ADNR-OHMP (2005) at Stations 10 and 8. Figure 7 compares the median chlorophyll-a concentrations between several stations over a several-year period.

Figure 7. Average Values of Periphyton in Red Dog and Ikalukrok Creeks, 1999 - 2004



4.0 ENVIRONMENTAL CONSEQUENCES

4.1 Water Resources

4.1.1 Hydrology and Stream Flow

The current 1998 permit contains an annual discharge limit of 2.418 bgy (billion gallons per year) for Outfall 001 (instead of the daily and monthly volume limits contained in the prior permit). This limit is retained in the proposed permit. Although the permit renewal does not specify how much flow volume can be discharged at a particular time, it is likely that the effluent flow volumes discharged during Grayling spawning increase due to the higher TDS limit. The higher flows themselves would not adversely impact the overall hydrology of the Mainstem Red Dog and Ikalukrok Creeks. However, the permit renewal will affect the timing of when various flow volumes are released because of in-stream TDS concentration limits. Generally, flow discharges from the mine will be high when natural in-stream flow volumes are high and low when natural in-stream flow volumes are low.

4.1.2 Water Quality

Water treatment at the Red Dog Mine consists of precipitating (altering the form of an ion from a dissolved state to a solid state), heavy metals as sulfides or hydroxides, and then removing the precipitated metals through gravity clarification and sand filtration. Metals are precipitated using sodium sulfide and lime to adjust pH. The treatment system was designed and is operated to reduce the concentrations of heavy metals to below the permit limits. However, the treatment plant does not treat non-metal compounds such as ammonia, cyanide and TDS directly. Concentrations of these compounds can be reduced through indirect means such as volatilization, co-precipitation and precipitation at saturation concentrations.

Alternative 1 - Proposed Action: Renew the NPDES Permit with Changes

The proposed action is to renew Teck Cominco's NPDES permit for the Red Dog Mine with changes consistent with State of Alaska Water Quality Standards. The proposed permit renewal contains the following requirements and/or changes:

1. If EPA approves the SSC of 1,500 mg/L TDS for the Arctic grayling spawning period, the permittee would be required to maintain in-stream TDS concentration at or below 1,500 mg/L at the edge of the mixing zone in Mainstem Red Dog Creek, including during spawning periods (varied from as few as 6 days to as long as 11 days). If EPA does not approve the SSC, ADEC may allow for an adjustment up to 1,000 mg/L TDS during spawning periods. If the adjustment is not approved, then EPA will require 500 mg/L TDS limit at the edge of the mixing zone during spawning.

2. Remove the 3,900 mg/L end-of-pipe TDS limit for Outfall 001.

3. ADEC has proposed a mixing zone for cyanide. EPA determined that there is no reasonable potential for the effluent to cause or contribute to an exceedance of the standard outside the mixing zone, therefore, no limit is necessary. Weekly monitoring for cyanide remains unchanged. Compliance with the cyanide limit would be tested through the use of the Weak Acid Dissociable (WAD) cyanide analytical method.

4. ADEC has not re-certified the site-specific criterion used for zinc in the current permit, which contained a zinc limit based on the natural condition site specific-criteria provided in ADEC's 1998 CWA Section 401 certification of the permit of 210 µg/L. Therefore, the state-wide criteria of 269 µg/L would be utilized to calculate the permit effluent limit.

The State of Alaska has revised the SSC for TDS in the Mainstem Red Dog Creek to change the TDS limit for Arctic grayling spawning periods in Red Dog Creek from 500 mg/L, the current state standard, to 1500 mg/L, which is the same as the current TDS limit for non-spawning time periods. If EPA approves the SSC, it will be included in the permit. This will result in higher TDS concentration during Grayling spawning. TDS concentrations would have to meet the 1,500 mg/L at the edge and everywhere outside the mixing zone.

The renewed permit would eliminate the end-of-pipe effluent TDS limit of 3,900 mg/L. In the previous permit, the end-of-pipe limit of 3,900 mg/L was included for TDS. The primary reason for including this limit was to make assumptions to determine the flow that the facility could discharge and still remain in compliance with its in-stream limits. The limit of 3,900 mg/L was not a water quality-based effluent limitation, but the best professional judgment at the time the permit was modified. During this reissuance, EPA is removing this end-of-pipe limit from the permit based on new information showing that the control of flow is more of a determining factor in limiting the downstream concentration of TDS than is the TDS concentration in the effluent. EPA is replacing the 3,900 mg/L in the equations with 110% of the highest measured effluent value. A review of the equations shows that this will be more conservative than relying on an absolute value of 3,900 mg/L because the equations will assume higher effluent concentrations and therefore will not underestimate the downstream impact of the effluent (See USEPA 2003 EA). The flow volume would be reduced if effluent concentrations increase, so as to attain the same receiving water TDS concentration.

In 2003, the State of Alaska modified its aquatic life water quality standard for cyanide such that determination of compliance with the free cyanide criteria is now accomplished through the use of the Weak Acid Dissociable (WAD) cyanide analytical method. Additionally, the draft State certification to the proposed permit renewal grants a mixing zone for cyanide in the Mainstem Red Dog Creek. EPA has determined that there is no reasonable potential to exceed the standard and no limit is necessary at the edge of the mixing zone. Weekly monitoring remains the same.

From August 1998 through September 2005, 97 WAD cyanide analyses were conducted on samples collected at Station 10. All 97 samples were reported at levels below the minimum level of quantification (ML) for the WAD cyanide analytical method and 74 of the samples were reported as less than the method detection limit (MDL) for the WAD cyanide analytical method. Identical results have been documented in Ikalukrok Creek and the Wulik River. A combined 217 samples have been collected and analyzed by the WAD cyanide method at Stations 150, 160 and 2 since August 1998. Results from all samples were reported at levels below the minimum level of quantification (ML) and 189 of the samples were reported as less than the method detection limit (MDL).

ADEC has determined that the use of the state-wide criteria of 269 µg/L for zinc would not violate their antidegradation policy. Also, EPA believes that the adoption by ADEC of the EPA Water Quality Criteria for Water for zinc is protective of existing uses downstream of the outfall.

Alternative 2: Renew the NPDES Permit with No Changes

Under the alternative, during Arctic grayling spawning, the maximum TDS concentrations would be at the point of discharge; the monthly average TDS concentrations could not exceed 170 mg/L and the daily average could not exceed 196 mg/L. Treatment and removal of about 95 percent of TDS in the mine effluent would be necessary to meet this limit, or the mine simply would not discharge during this period. Since there is no known treatment of TDS, and as explained in Section 1.1, because the water in the tailings impoundment is toxic to aquatic life and human health, it is critical to maintain the water in the tailings impoundment at a level that will ensure the structural integrity of the tailings impoundment.

Retaining the end-of-pipe TDS limit of 3,900 mg/L in the renewed permit has no effect to water quality as downstream TDS concentrations are controlled by the volume of effluent discharged rather than the concentration of TDS in the effluent. (See USEPA 2003 EA)

Cyanide would be regulated at end-of-pipe with no mixing zone and compliance with the free cyanide criteria would be through the total cyanide method.

4.2 Aquatic Resources

4.2.1 Fish

Alternative 1 - Proposed Action: Renew the NPDES Permit with Changes

The change in the proposed renewed permit with the greatest potential for impacts to fish is allowing 1,500 mg/L TDS in the Mainstem Red Dog Creek during Arctic grayling spawning. The current in-stream TDS criterion of 1,500 mg/L applies to Mainstem Red Dog Creek throughout the year except during periods of Arctic grayling spawning (the only fish to spawn in Red Dog Creek). Data available previously supported the conclusion that 1,500 mg/L was protective for all fish life history stages except for the fertilization stage. The limit of 500mg/L was applied during the spawning period as the literature and research at the time showed the fertilization stage is the most sensitive to TDS exposure, and preliminary work by Stekoll et al. (2003a, 2003b) showed a Lowest Observable Effects Concentration (LOEC) is variable among salmonid species embryos (750 mg/L for chum and steelhead and 250 mg/L for king, pink, and coho salmon). The EAB remanded this limit and it is currently stayed. Because these data were preliminary, EPA issued a 308 Information Request to

Teck Cominco that required further testing to determine the effects of TDS on the spawning success of Arctic grayling. Effects of TDS on Dolly Varden were also conducted, as this species is present in the area with spawning habitat in Dudd and Ikalukrok creeks. The purpose of this work was to obtain information adequate to establish the TDS effects limit concentrations that would be protective of Arctic grayling spawning in Mainstem Red Dog Creek.

The fertilization success tests were designed and conducted by Ecotox Inc., a contractor for Teck Cominco. EPA had substantial input into the development of the testing protocols along with ADEC, the Alaska Department of Natural Resources, Office of Habitat Management and Permitting, and the Alaska Department of Fish and Game. In the development of the study design, an effort was made to follow methods used in prior TDS fertilization tests (Stekoll et al. 2003a) in order to have a basis of comparison with this previous work on salmonid fertilization. The methodologies used in the study are described in Brix et al. (2004) and were submitted prior to the testing in 2004.

EPA also provided recommendations on the statistical treatment of the data in order to determine the TDS concentration that would cause an effect to fertilization success of Arctic grayling. The Species Mean Value (SMV) calculated from the geometric mean of the EC_{20} (the concentration causing a 20% effect) values of individual fertilization tests was selected as the statistical endpoint. Only tests that met the control performance criteria of at least 70% fertilization were included. The use of this statistical endpoint and its calculation were considered appropriate and consistent with current EPA practices for setting water quality criteria (Stephan et al. 1985, USEPA 1999, USEPA 2001).

During the 2004 testing, the researchers modified some of the study methodologies as necessitated by the test conditions (Brix and Grosell 2005). The following substantial modifications were noted: (1) very small amounts of milt obtained from male Arctic grayling necessitated a modification to the technique of mixing the eggs, effluent, and sperm resulting in no pre-exposure of eggs to the effluent; and (2) difficulty in capturing numbers of fish necessitated conducting the test with fewer fish than was detailed in the study design (Brix et al. 2004). In the 2005 testing, the modification to the mixing procedure was retained but the number of fish used in the testing was consistent with the original study design. Because of the likely quick closure of the micropyle (Hoysak and Liley 2001, Liley et al. 2002) and the limited amount of milt available, the altered method used during these experiments to efficiently mixing eggs, milt, and test solution seemed to be a reasonable deviation from the study methods proposed.

Table 5 contains Arctic grayling results reported by Brix and Grosell (2005) from the testing conducted in 2004 (tests AG1-AG4) and 2005 (tests AG8-AG11).

Table 5. Toxicity Testing Results with Arctic Grayling (mg l^{-1} TDS) (Source: Brix and Grosell, 2005).

Test	NOEC[1]	LOEC[2]	Chronic Value	EC_{20}[3]	EC_{50}[4]
AG1	921	>921	>921	>921	>921
AG2	1381	>1381	>1381	>1381	>1381
AG3	254	503	357	748	>1381
AG4	132	254	183	202	>1381
AG8	2782	>2782	>2782	>2782	>2782
AG9	2782	>2782	>2782	>2782	>2782
AG10	2782	>2782	>2782	>2782	>2782
AG11	2782	>2782	>2782	>2782	>2782

[1]NOEC=no observable effects concentration, [2]LOEC=lowest observable effects concentration, [3]EC_{20}=effects concentration 20%, [4]EC_{50}=median effects concentration.

The eight toxicity tests conducted for Arctic grayling fertilization success during 2004-2005 yielded EC_{20} values ranging from 202 mg/L to >2782 mg/L. Pooling the eight EC_{20} values from the two years of Arctic grayling testing, four EC_{20} values from 2004 (202, 748, >921, >1381) and four EC_{20} values from 2005 (all >2782), yields a geometric mean value of 1,357 mg/L. All but three of the individual Arctic grayling toxicity test results exceed this mean value, with all four of the 2005 tests far exceeding this mean value (>2782 mg/L). In the 2004 results, one very low value of 202 mg/L was recorded. Because there was no basis for concluding that the 202 mg/L result was due to errors occurring during the field collection, laboratory processing and handling, or toxicity testing procedures, this value was not excluded from the calculation. Also, none of the data points can be considered statistical outliers (based on Dixon's test calculations).

The researchers noted issues that could have influenced the inconsistent results seen in the first year of study (Brix and Grosell 2005). These include sperm holding times that may have been excessive and using gametes collected from the very end of the spawning period. However, tests were not conducted to substantiate that these factors actually affected the Arctic grayling results. The researchers believe that the experimental procedures followed in 2005 eliminated these concerns and the 2005 results were more consistent (>2782 mg/L for all tests), supporting this hypothesis.

The results of this study are acceptable as a basis for a water quality criteria because: (1) the laboratory methods and quality assurance measures were reasonable and adequate; (2) the quantity of data was sufficient; (3) the methods used to analyze the data and to derive the endpoint were acceptable; and (4) the test species and test water were specific to the Red Dog mine. EPA's review of the final report on the effects of TDS to Arctic grayling fertilization success (Brix and Grosell, 2005) determined that 1,500 mg/L will be protective of Arctic grayling during all life history phases including the fertilization to egg hardening phase.

Based on the tests conducted in 2004-2005 summarized above, the calculated SMV of 1,357 mg/L will be protective of the Arctic grayling fertilization and the 500 mg/L criterion is not appropriate. The 1,357 mg/L value is very close to the 1,500 mg/L that applies to the rest of the year, and EPA believes that 1,500 mg/L is appropriate to use as the year-round water quality criterion in Red Dog Creek, for several reasons. Using a weight of evidence approach, half of the toxicity test results with Arctic grayling support 1,500 mg/L, and the very consistent results of the second year of data, using improved lab methods, are all in excess of the 1,500mg/L. Also Dolly Varden toxicity test results discussed below support 1,500 mg/L as protective.

Brix and Grosell (2005) also tested the effects of TDS on Dolly Varden fertilization success in fall 2004 (Table 6). They determined that Dolly Varden are not sensitive to TDS concentrations below 1,500 mg/L during fertilization. Study results for Dolly Varden for seven tests had EC_{20}values that ranged from >1704 to >1817mg/L. Additionally, results from Stekoll et al. (2003) indicated that the chronic value (geometric mean of the NOEC and LOEC) for chum salmon fertilization is over 600 mg/L TDS. Although the proposed reissued permit just limits TDS to 1,500 mg/L in Mainsteam Red Dog Creek, data shows that TDS levels in spawning areas in Ikalukrok Creek are consistently below the 500 mg/L TDS limit in during the spawning periods. The limit of 1,500 mg/L in Mainstem Red Dog Creek is also protective of Dolly Varden in Ikalukrok Creek.

Table 6. Toxicity Testing Results with Dolly Varden (mg l^{-1} TDS) (Source: Brix and Grosell, 2005).

Test	NOEC[1]	LOEC[2]	Chronic Value	EC_{20}[3]	EC_{50}[4]
DV1	1817	>1817	>1817	>1817	>1817
DV2	1789	>1789	>1789	>1789	>1789
DV3	1704	>1704	>1704	>1704	>1704
DV4	N/A[\a]	N/A	N/A	N/A	N/A
DV5	1762[\b]	>1762	>1762	>1762	>1762
DV6	1777	>1777	>1777	>1777	>1777
DV7	1796	>1796	>1796	>1796	>1796
DV8	1808[\2]	>1808	>1808	>1808	>1808

[1]NOEC=no observable effects concentration, [2]LOEC=lowest observable effects concentration, [3]EC_{20}=effects concentration 20%, [4]EC_{50}=median effects concentration.

[\a] Invalid test due to low control fertilization

[\b]Inverse dose response relationship observed in this test

EPA does not anticipate that the proposed elimination of the cyanide limits in the draft renewed permit will have impacts on fish. There is no reasonable potential for the effluent to exceed the aquatic life criteria where aquatic life use designation applies. Further, as described in Section 4.1.2, there is no reasonable potential for the criteria for free cyanide to be exceeded downstream of Station 151. The permit limit changes are based on new data demonstrating that the mine wastewater does not contain enough cyanide to cause exceedances of the cyanide criterion outside the mixing zone.

No spawning occurs in any of the proposed mixing zones (ADF&G, 2002b). Potential for impacts within the proposed mixing zones were assessed in the USEPA EA (2003).

Alternative 2: Renew the NPDES Permit with No Changes

This alternative would require additional technology controls or water management controls to lower TDS in the effluent discharge so that TDS levels during Arctic grayling spawning in Mainstem Red Dog Creek remain no greater than one-third above background TDS. This limit is based on a water quality standard for TDS which is no longer contained in Alaska's water quality standards. Further, given the limited duration of the Arctic grayling spawning period (6-11 days), it would likely be preferable to Teck Cominco not to discharge during the period of reduced limits rather than face the consequences of potential violations. This may not be a desirable option since the water in the tailings impoundment is highly toxic to aquatic life and human health, it is critical to maintain the water in the tailings impoundment at a level that will ensure the structural integrity of the tailings impoundment.

However, the spawning period occurs soon after breakup (at approximately 4^oC), which is also during the high flow season. It would be important for the mine to release the effluent during this period when large volumes of water could be discharged.

4.2.2 Aquatic Invertebrate Communities

Alternative 1 - Proposed Action: Renew the NPDES Permit with Changes

It is not anticipated that any of the proposed changes in the draft renewed permit will have impacts on the aquatic invertebrate community in the receiving water bodies.

Alternative 2: Renew the NPDES Permit with No Changes

Since there are no potential impacts from the proposed alternative, there is no reason to believe that the alternative offers any benefit.

4.2.3 Periphyton

Alternative 1 - Proposed Action: Renew the NPDES Permit with Changes

It is not anticipated that any of the proposed changes in the draft renewed permit will have impacts on the periphyton community in the receiving water bodies.

Alternative 2: Renew the NPDES Permit with No Changes

Since there are no potential impacts from the proposed alternative, there is no reason to believe that the alternative offers any benefit.

4.2.4 Other Potential Impacts

Red Dog Creek and Ikalukrok Creek are not used nor protected under Alaska's Water Quality Standards for drinking water purposes, although it is possible that a transient visitor may occasionally drink the water. Ikalukrok Creek flows into the Wulik River which is used as drinking water by the village of Kivalina. Residents of Kivalina have reported that the taste of their drinking water has changed since the Red Dog Mine started operations. EPA has reviewed water quality data from Station 1 (located in the Wulik River approximately 2.5 miles upstream of Kivalina). While the data show there are metals in the water at concentrations that could affect the taste of drinking water, such as iron and manganese, there are no data suggesting that these metals are coming from the Red Dog mine site. Rather, based on data collected from Station 9 (Ikalukrok Creek above the confluence of Mainstem Red Dog Creek) they appear to be coming from Ikalukrok Creek above Mainstem Red Dog Creek, out of the influence of the mine's wastewater discharge. Another possible source contributing to the change in taste of the drinking water is the sulfate or possibly the calcium from the Red Dog mine TDS. However, to date, it has not been possible to isolate the source of the taste change. Cadmium and sulfate concentrations at Station 1 are far below any levels that could have human health effects.

The National Primary Drinking Water Standards protect public health by limiting the level of contaminants in drinking water. EPA has not developed primary drinking water standards for TDS because TDS in drinking water is not a hazard to human health. EPA does recommend acceptable levels of TDS in drinking water in its National Secondary Drinking Water Regulations. These regulations provide non-mandatory recommendations for contaminants that can cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as changes in taste, odor, or color). EPA recommends TDS not exceed 500 mg/L in water used for drinking. The 2003 EA provides a discussion on the assessment of the TDS limits relative to drinking water uses. The proposed change would not cause TDS to exceed 500 mg/L in the Wulik.

4.3 Relationship Between Local Short-Term Uses of the Environment and the Maintenance and Enhancement of Long-Term Productivity

Environmental impacts from the proposed action and the alternative could apply for the duration of activities associated with the operating life of the mine (approximately 20 years depending on economic conditions). Once the mine ceases production and depending on the mine closure plan, pre-mining conditions could return, resulting in increased metal levels and decreased TDS. Likewise, metals available for uptake by the biota and the distribution of fishes may return to the pre-mining situation. For example, the use of Mainstem Red Dog Creek by Arctic grayling and slimy sculpin may be reduced. However, it is recognized that the aquatic system could be very different post-mining.

Based on nearly a decade of environmental monitoring in the two creeks, the short-term increase in TDS as a result of the mine's discharge does not appear to have adversely impacted the aquatic system. Furthermore, the mine has provided a source of jobs to the area which is an economic benefit.

4.4 Irreversible and Irretrievable Commitments of Resources which would be Involved with the Proposed Action

The Council on Environmental Quality regulations for implementing the National Environmental Policy Act specify that the environmental analysis must address "any irreversible and irretrievable commitment of resources which would be involved in the proposed action should it be implemented." Irreversible effects primarily result from permanent use of a non-renewable resource (e.g., minerals, energy). Irretrievable resource commitments involve the loss in value of an affected resource that cannot be restored as a result of the action (e.g., disturbance of a cultural site) or consumption of renewable resources that are not permanently lost.

The mining of the ore at Red Dog Mine represents an irreversible commitment of resources. The proposed action, which involves the change of some provisions and the inclusion of two mixing zones in the renewed NPDES permit, is also narrower in scope. The proposed action does not result in the use of any non-renewable resources, and therefore does have irreversible effects.

The water quality has changed since the mine went into operation. Primarily, TDS concentrations have increased and metals concentrations have decreased since the mid-1990s. Fish surveys indicate that the present level of TDS is not having a negative impact on fish populations. Aquatic invertebrates are also not expected to be adversely affected by the effluent. Based on the definition above, there is no loss in value of the aquatic life and the water quality to support the aquatic community. Therefore, the action does not have irreversible effects on the aquatic community.

There may be an irretrievable effect on drinking water in the Wulik River because the villagers in Kivalina report that the water from the Wulik River tastes different when compared to pre-mining conditions. This represents a loss in value of a renewable resource which may possibly be due to the increased TDS concentrations. Although the water tastes different, based on the analysis in section

4.2.4, the proposed allowable increase in TDS concentrations in the Wulik River will not cause adverse effects to human health.

4.5 Secondary and Cumulative Impacts

Secondary impacts are those that are caused by an action and are later in time or farther removed in distance, but are still reasonably foreseeable. Cumulative impacts are effects that may be incrementally minor, but when considered in combination with other similar impacts may accumulate to more substantial proportions. No secondary impacts to the environment are expected as a result of the changes contained in the draft renewed permit. There are no foreseeable future discharges of metals, ammonia, cyanide, TDS, or high or low pH dischargers into the Red Dog Creek and/or Ikalukrok Creek watersheds that would cumulatively impact the streams.

5.0 MITIGATION MEASURES

Teck Cominco is investigating alternatives to the use of cyanide in the milling process. Cyanide is a pyrite depressant in the lead flotation circuit. To date, several alternatives have been evaluated with only marginal results. However, there are several other candidates planned for testing.

Teck Cominco is undertaking several activities to reduce the concentration of TDS in the effluent, as outlined below.

Water Management and Selective Water Treatment

TDS in the effluent is composed primarily of calcium and sulfate. The calcium originated from lime used in the water treatment plant, which treats the tailings pond water by replacing dissolved metal ions with calcium ions. Tailings pond water which contains high levels of zinc, lead and cadmium is mixed with lime (CaOH) in the water treatment plant which results in metal hydroxides that are then removed from the solution. The TDS and sulfate concentration of the tailings pond water is approximately the same as the TDS and sulfate concentration of the effluent water. However, the metals that were in the tailings pond water have been removed in the treatment process and replaced with calcium.

A TDS load balance model established that the majority of TDS in the tailing pond comes from the mine sump (i.e., the area where mine drainage from the mine site is collected) and drainage from the mine waste dump. Bench scale testing in 2001, 2003 and 2004 showed that by treating high TDS flows from the mine sump and main waste dump directly in a water treatment plant, a significant TDS load could be kept from entering the tailings pond water. In 2005, a treatment plant, Water Treatment Plant 3 (WTP 3) was constructed to specifically treat these flows. While operation of WTP 3 was limited in 2005, it is anticipated that the plant will be operational for the entire 2006 season. This would result in a reduction of TDS. However, the amount and rate of reduction is difficult to predict due to the large volume of water in the tailings impoundment.

TDS Source Control

A method to reduce the rate of metal sulfide oxidation, which would result in the reduction of the rate of TDS production, is being evaluated. Teck Cominco participated in an EPA funded research project which tested the application of a proprietary compound on waste rock to attempt to eliminate the biologically catalyzed portion of the oxidation reaction. Tests conducted on-site with Red Dog waste rock resulted in the production of 50% less sulfate in the test plots versus the control plots. Teck Cominco has solicited a proposal from the laboratory conducting the tests to continue research on their product at the mine site.

Teck Cominco has engaged in an evaluation of water/rock management to control the rate of oxidation in the waste rock that results in the elevated TDS levels in the impoundment. While nothing has been implemented to date, plans are progressing to segregate waste rock by its ability to produce TDS and isolate waste rock with the highest potential from contact with oxygen and water.

Water Management

Teck Cominco is continuing its effort to reduce the amount of clean water going into the tailings impoundment. In 2003, Teck Cominco constructed a clean water diversion on the west side drainage into the tailings impoundment. It is believed that the structure diverted approximately 60 millions gallons of clean water away from the impoundment. While this action does not reduce TDS loads, it does reduce the amount of water that needs to be annually discharged.

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