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Water Management Plan
For the Chuitna Coal Project

Prepared for:

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January 14, 2010

TABLE OF CONTENTS

1.0 INTRODUCTION

This report presents an engineering plan for the control and management of surface water runoff, sediment, and pumped groundwater at the Chuitna Coal Project. This plan is integrated with the mining plan and allows for planning and implementation of water management structures. The plan provides a water balance for mine operations that is sufficient for planning, sizing, and constructing sedimentation ponds, diversions, and other water control structures. The plan and mine project water balance, in part, is based on the baseline surface water and groundwater characterization (Riverside Technology, Inc. [RTI] 2009, 2007), as well as other project studies.

1.1 Project Background

The Chuit River basin is located in south-central Alaska on the west side of Cook Inlet approximately 40 miles west of Anchorage. The village of Tyonek lies to the south of the basin and the community of Beluga is located to the north. The basin occurs within the Cook Inlet-Susitna Lowlands physiographic sub-province, a broad lowland that generally lies below an elevation of 1,000 feet bounded by the Alaska Range to the west, and the Talkeetna Mountains to the east (RTI 2007). The region is mantled by metal-rich deposits of glacial origin overlying Tertiary-aged sedimentary rocks. The topography of the plateau is characterized by relatively gentle but irregular topography with discontinuous hills and numerous depressions typical of highly glaciated terrains.

The proposed Chuitna Coal Project is based on a nominal 1 billion metric ton low sulfur sub-bituminous coal reserve located within a 20,571-acre lease tract. The proposed area to be mined in the lease tract is approximately 5,000 acres and will yield a projected 300 million metric tons of coal. Coal will be mined using surface mining techniques which will include dragline and truck and shovel operations. The proposed mine plan calls for a 25-year mine life, depending on market conditions.

The Chuit River (Chuitna) is the river basin within which the proposed mine site is located. Three Chuitna tributaries, designated as 2002 (Lone Creek), 2003, and 2004, are potentially affected by the mining operation. The Chuit River watershed and the three main sub-watersheds are depicted in Figure 1-1 along with the proposed project boundary. Characterization of surface water hydrology and water quality is presented in RTI (2009).

The geology of the site consists of semi-consolidated coal-bearing sedimentary rocks of the Tyonek Formation overlain by younger unconsolidated sediments. These sediments include the broadly prevalent Glacial Drift which covers nearly the entire project site and a large majority of the basin and Alluvium that occurs along stream reaches. The stratigraphy can be broken into four main hydrogeologic units. From top to bottom, these are the Glacial Drift and Alluvium, Mineable Coal Sequence, Sub Red 1 Sand, and a Lower Coal Sequence (Arcadis, 2007). The groundwater flow system can be divided into an upper system, consisting of the Glacial Drift and Alluvium, and a middle system, consisting of the Mineable Coal Sequence, and a lower system consisting of the Sub Red 1 Sand. The upper flow system is unconfined, is recharged by precipitation and snow melt and discharges to surface streams as base flow. The middle and lower flow system is generally separated from the upper flow system and does not significantly affect base flows of area streams. A clay layer that is up to 30 feet thick occurs above the Sub Red 1 Sand unit which serves as an aquitard. For this reason, the Sub Red 1 Sand unit is confined, providing further hydrologic separation from the upper hydrogeologic units. It also exhibits a potentiometric surface that can reach into the Mineable Coal Sequence.

1.2 Overview of Mining

Based on the configuration of the coal resources within the project area, surface mining techniques will be used to extract the coal resources from multiple pits within the project area. The process involves:

- Clearing vegetation from the current mining area;
- Removing and storing topsoil for use during revegetation;
- Excavating interburden and overburden and storing the material in a stockpile or backfilling into pits that have been previously mined;
- Excavating the coal resource;
- Backfill and recontouring the mined pit with interburden and overburden in preparation for revegetation; and
- Covering with topsoil and reclaiming vegetation.

During excavation, the surface elevation will be lowered in the mined area compared to the surrounding area. Direct precipitation and snowmelt on the mining pits, overburden spoil piles, topsoil stockpiles, and other disturbed areas will require management to prevent the runoff and transport of sediments off site and into area streams. In addition, mining will require groundwater to be pumped from the Glacial Drift hydrogeologic unit to dewater the immediate area being mined. Water will also need to be pumped from the Sub Red 1 aquifer to reduce (depressurize) the potentiometric head and prevent significant upwelling of water into the mine pit. The dewatering wells will be installed and operated prior to initiation of mining, and the wells in the Glacial Drift will be replaced as needed as they are overtaken by advancing mine pits. A three-dimensional groundwater model was prepared to predict the geographic extent and magnitude of groundwater drawdown that will be caused by mining (Arcadis, 2007). The model also predicts potential stream base flow depletions in adjacent reaches of streams 2002, 2003, and 2004 drainages, resulting from the groundwater drawdown.

1.3 Summary of Water Management Control Plan

The control and management of surface water runoff, sediment, and pumped groundwater are regulated by several provisions of the Clean Water Act (CWA), including Sections 304(e), 307(b), 308(a), 402(a), and 501(a), the Alaska Water Quality Standards promulgated under 18 AAC 70 of the Alaska Administrative Code, and the Alaska Surface Coal Mining Control & Reclamation Act (ASMCRA) under 11 AAC 90. The purpose of this report is to provide a plan for managing and discharging surface and groundwater generated as a result of mining in compliance with regulations under the CWA and ASCMRA, and to prevent or minimize effects to off site water resources and the hydrologic balance of the area.

This report provides projected site water management plans and maps for the first 8 years of mining, year 15, year 22, and year 26 (after final reclamation) in Appendix A. It replaces all previous drafts of conceptual plans for water control for the Chuitna Project. The plans and maps depict areas of surface disturbance, stream channel diversion, surface water interception and conveyance channels, sumps, sediment control ponds, groundwater pumping areas in both the Glacial Drift and Sub Red 1 Sand hydrogeologic units, and proposed National Pollutant Discharge Elimination System (NPDES) discharge outfall locations. The hydrologic control structures are presented in plan view only and do not include detailed profile, cross sectional, geotechnical, textural and hydrologic information that will be required by ADNR for review and approval before construction, or to meet requirements of ASMCRA. Detailed designs for all structures will be prepared and presented for regulatory review and approval before commencing construction.

The specific objectives of this plan are:

- Provide PacRim Coal a road map for managing waters on the site. This road map (plan) is integrated with the mining plan and will allow for planning and implementation of water management structures. The plan provides a water balance that is sufficient for planning, sizing, and constructing sedimentation ponds, diversions, and other water control structures.
- Provide initial information to support the development of the operational water control portion of the ASMCRA application. An updated application section will be submitted that outlines information required in an ASMCRA application, including engineering specifications for ditches, sediment ponds, and effects analyses.
- Along with other environmental information documents, provide information regarding mine water balance and planned mine infrastructure to support effects analyses being conducted under the National Environmental Protection Act (NEPA).

PacRim Coal received a request from EPA in a letter dated May 15, 2009 to provide additional data regarding site hydrology, discharges to surface water, stream flow-duration frequencies, projected characteristic stream flows and projected water quality. This request was made to provide additional data for evaluation of impacts and preparation of the Draft Environmental Impact Statement. While this report and management plan address some of the information and data requested by EPA, as specified by the objectives above, PacRim will develop a subsequent comment response document to specifically address and itemize the requested additional baseline data and effects analysis.

2.0 WATER BALANCE

Prior to developing the water management plan, a detailed monthly water balance was developed, incorporating site hydrology, projected groundwater pumping rates, and the projected mining plan. The water balance was then used to develop a site water management plan, including stormwater and sediment control structures, clean water diversions, and proposed NPDES discharge locations on an annual basis. Planning was conducted for the first 8 years of mining, as well as projected facilities for years 15, 22, and 26, covering the life of the project. Stream flow estimates were made at critical locations, based on the water balance and water management plan. A review and reissuance of both ASMCRA and NPDES permits usually occurs on a five year cycle. It is anticipated that the projected mine site water balance and the water management control plan will be reviewed and modified, if necessary, in conjunction with future project reviews and permit applications under ASMCRA and NPDES.

2.1 Water Balance Equation

Development of the water management plan first required a site-specific precipitation estimate. Available precipitation data was limited, so a water balance approach was taken to estimate precipitation based on the total water yield from 2003 Creek. The water yield in a stream is the sum of the inflows, minus the losses, and can be expressed as follows:

Water Yield = Total Stream flow
= Base flow (supported by groundwater) + Surface Runoff
= Precipitation (including snowmelt) – Evaporation – Deep Groundwater Recharge

The various components of the water balance equation are generally determined from site-specific data, estimated from empirical equations, or determined by subtraction from the known components. The latter approach was followed for the Chuitna Coal Mine water balance. Long-term stream flow (measured on-site) and evaporation data (from the Matanuska station, with modifications discussed below) were available, and groundwater recharge and base flow were estimated using a calibrated groundwater model (Arcadis 2007, 2009). Precipitation was then determined by subtraction. Use of the modeled base flow allowed tracking of groundwater discharge/stream base flow and surface runoff separately in the water management computations. This was an important distinction when considering surface water diversions. An alternative computation using the total stream flow yield, without using the groundwater model data to separate base flow and surface runoff, was also conducted as a check on the sensitivity of the precipitation estimates. The result produced very similar annual precipitation estimates (within 5%). The specific calculation of each of the individual components of the water balance is discussed in more detail in the sections below.

2.2 Stream Gage Data

As was previously discussed in Section 2.1 above, no long-term precipitation record was available for the project site that was sufficiently reliable for evaluation of site hydrology and development of the water balance. However, continuous stream flow records were available for several stations throughout the watershed, including stations in the 2002, 2003, and 2004 drainages (Riverside Technology Inc., 2009). Given the relative accuracy of the available precipitation, stream flow, and evaporation data, it was determined that the water balance should be based on the stream flow record, with allowances for evapotranspiration and percolation to deep groundwater used to develop an "effective" precipitation depth for each month during wet, dry, and average years.

Some of the stream flow data was only collected over short, non-overlapping periods of record; however, gage C180, located near the outlet of the 2003 drainage and below the proposed area of mining, provided data for 24 calendar years, during the period 1982 through 2008. Gages C140 and C141, located in the upper reaches of 2003 and downstream of the majority of proposed mining disturbance, provided limited periods of overlap with C180, from which no consistent flow ratio relationship could be determined for individual months. It was therefore determined to use the record from C180, transposed to upstream locations by the use of drainage area ratios, for computation of the monthly water balance. To ensure that monthly average flows were not biased by months with partial data, especially during transition months between high and low seasonal runoff, the C180 data was censored to include only months with complete records. In all, 9 partial months were removed, and 40 months lacked a record, yielding a 239-month (19.9-year) dataset.

Watershed yield calculations support the approach of using C180 gage data to develop the water balance. RTI (2009) examined watershed yield for gages within the Chuitna basin, computing yields for all gages for the entire period of record, and paired gages with overlapping records. They determined that yield was strongly affected by the watershed's average elevation. Table 2-1 presents updated watershed yield calculations, comparing multiple gages across the available overlapping periods of record. Similar to Riverside's results, yield tends to increase with both drainage area and average elevation, both among and within watersheds. 2003 Creek yields less water per unit drainage area than 2004 or 2002 Creeks, as those creeks have headwaters that occur at higher elevations with higher annual precipitation. Areas within the 2002 and 2004 basins, but adjacent to the mined area of the 2003 basin, however, can be expected to produce similar yields as 2003, due to similar topography, soils, and elevation. The long term record at gage C180 in the 2003 basin shows a yield of 2.66 cubic feet per second/square mile (cfs/mi^2).

2.3 Evaporation Data

Long-term (1948-2008) pan evaporation data, available from the Matanuska weather station, was considered the best option for translating measured stream flow to effective precipitation for use in the water balance. Monthly average pan evaporation was computed from the daily dataset, and adjusted using a standard pan coefficient of 0.70. This coefficient is used to adjust measured evaporation from a Class A pan to evaporation rates that would be expected from a larger lake or reservoir. To achieve more realistic summertime runoff rates in the water balance, July's evapotranspiration was partially reassigned to occur in May (50%) and June (10%). This was necessary because stream flow data were used to derive the precipitation estimation. Some of the water that would normally be intercepted by vegetation and infiltrated into soil during spring runoff in May and June would be evaporated and transpired in the drier month of July. For disturbed areas, some water that would normally transpire in July would thus occur as runoff in

May and June. The percentages used are engineering estimates. Table 2-2 summarizes the evaporation data and calculations.

2.4 Groundwater Recharge and Base flow Components

The base flow and groundwater recharge components of the water balance were determined from a calibrated groundwater model of the site (Arcadis 2007, 2009), which computed recharge rates, stream base flow, and groundwater flow in the three major hydrogeologic units: the Glacial Drift, Mineable Coal Sequence, and Sub Red 1 Sands. The calibrated model indicated that 27% of average precipitation recharges the Glacial Drift unit, of which 97.2% becomes stream base flow. The remaining 2.8% recharges the units below the Glacial Drift and does not contribute to stream flow. The resulting base flow at gage C180 of 11.9 cfs, or 11.05 inches per year, was subtracted from the total measured stream flow to determine the surface runoff component for the water balance. The groundwater model predicted base flow (i.e., at any given stream location) on an average annual basis. Development of the water management plan required base flow predictions on a monthly basis and it was recognized that base flow would be higher in some months and lower in other months, especially winter. To improve accuracy of the site water balance, monthly base flow was calculated as the lesser of either the observed average monthly stream flow or the monthly average base flow predicted by the groundwater model (i.e. annual base flow divided by 12). Differences in the annual flow volumes were then applied to other months (30% each to April and June, 40% to May) to maintain an annual average base flow of 11.05 inches per year. Deep groundwater recharge (a loss from the surface system) was computed as base flow multiplied by 0.028. Surface runoff was computed as total stream flow minus base flow.

2.5 Precipitation Estimate and Runoff Coefficients

Precipitation estimates and runoff coefficients were computed for “wet”, “dry”, and “average” years, based on the C180 stream flow data and Matanuska evaporation data. The design “wet” year was developed in order to ensure that there will be sufficient water storage capacity for the mine site to handle an above-average year-round precipitation conditions (highest during the spring runoff period) without intruding on the storm water and settling capacity of ponds that will be based on control of the 10-year, 24-hour storm event. The “dry” year was developed to provide an estimate of the worst-case stream flow depletions due to dewatering of the Glacial Drift unit, and to evaluate the potential effectiveness of stream flow augmentation using pumped groundwater.

The “wet” year scenario was developed to provide reasonable assurance in handling long-duration high spring runoff flows during above-average years, while relying on the 10-year storm capacity of the ponds for shorter, more intense flood-producing rainfalls such as occur in the fall. The “wet” year scenario can also help identify periods of higher flows caused by the combined effects of higher post-mining surface runoff, groundwater discharge, and interbasin transfers. The scenario was therefore developed using monthly stream flows of 15% of one standard deviation above the station C180 mean for the critical spring runoff months of April, May, and June, and 10% of a standard deviation above the mean for the remaining months. These percentages were based on best professional judgment using experience in evaluating water balances and sizing structures at other sites. These increases lead to an annual runoff of 20.3% of one standard deviation above the mean. For the design "dry" year, each month was assigned a total runoff rate 20% of one standard deviation below the mean for that month. This yielded an annual rate of 45.7% of one standard deviation below the mean annual value.

Monthly precipitation was computed by using by rearranging the water balance equation. Precipitation was computed by adding total stream flow to evapotranspiration and deep groundwater recharge. The precipitation estimate computed for this water management plan is an "effective" value, in that winter snowfall appears in the water balance in the spring, when it melts, rather than when it falls. The "average" year precipitation estimate by this method was 44.4 inches, similar to the 44 inches used in previous studies at the mine site. The "wet" year estimate was 47.3 inches, or 109% of an average year, and the "dry" year estimate was 39.6 inches, 84% of an average year.

Runoff coefficients for undisturbed land (based on the pre-mining condition) were computed by dividing the surface runoff depth by the precipitation depth for each month. Resulting runoff coefficients varied by month (Table 2-3), ranging from 0.00 to 0.84, and averaging 0.47 for the "wet" year. Both monthly maxima and annual average coefficients were lower for the "average" (0.82/0.44) and "dry" (0.76/0.37) years. The annual minimum occurred during months with zero surface runoff (i.e., base flow only), including February and July for a "wet" year, and additional months in "dry" and "average" years. Tables 2-3 through 2-5 summarize the calculations for wet, dry, and average years, respectively.

To differentiate the runoff response of disturbed land for predictive modeling estimates (including truck-shovel stripped areas, open pit/dragline areas, and stockpiles), it was assumed that 80% of evaporation losses were eliminated, and the runoff coefficients recomputed. Grubbed areas were not assigned this value because vegetative cover and surface roughness remains high. The resulting computed runoff coefficients ranged up to 0.85 for the "wet" year, averaging 0.70. Tables 2-3 through 2-5 summarize the calculations for wet, dry, and average years, respectively. The precipitation estimates and runoff coefficients for disturbed and undisturbed land were applied to the mine site and surrounding area, along with groundwater pumping and mine inflow estimates, to obtain an estimate of site water management and stream flow augmentation needs, discussed in Section 5.0, below.

2.6 Groundwater Pumping

As noted in Section 1.3, groundwater will be pumped from both the Glacial Drift and Sub Red 1 Sand hydrogeologic units. Pumped groundwater will be discharged to streams for flow augmentation, and therefore must be accounted for in the water management plan developed from the water balance. Arcadis (2007, 2009) developed groundwater pumping, drawdown, residual pit inflow, and stream flow depletion estimates based on the pit limits and dewatering/depressurization requirements of the mine plan. Residual pit inflow is residual groundwater flux (seepage) that will flow from the mineable coal sequence hydrostratigraphic unit into the pits. The 2009 groundwater pumping and residual inflow estimates are presented in Table 2-6 on an annual basis. Projected groundwater pumping rates for the groundwater model were estimated on an annual basis, while residual pit inflows varied monthly. The reported values are the annual averages for the latter case. Stream flow depletions are discussed in Section 5.0

3.0 WATER CONTROL STRUCTURES

PacRim Coal will use a variety of water control structures to manage runoff, control erosion and sediment generation, and to meet NPDES effluent limits prior to discharge off site. Additionally, a variety of structures will be used to divert unimpacted runoff and stream flows around the mine site. These structures will be used to minimize the amount of water that comes in contact with mining disturbance.

In addition to major control structures, PacRim Coal will use Alternate Sediment Control Measures (ASCMs) to control runoff from temporary construction sites, topsoil stockpiles, principal haul roads, the main access road, and other small areas as appropriate. ASCMs minimize erosion and reduce sediment transfer using best management practices. They are practical in cases where construction of conventional conveyance and containment structures for water runoff would impact additional lands that would otherwise not be physically disturbed by mining.

3.1 Description of Major Structures

3.1.1 Sediment Control Ponds

Sediment control ponds will be used to manage discharges from all mining areas and facilities, including mine pits, grubbed areas, stripped areas, overburden piles, top soil storage areas, recently reclaimed areas, and ancillary facilities that result from rainfall and snowmelt runoff. Sediment control ponds will also be used to manage residual groundwater that will seep into the mine pits through the pit slopes. This source will primarily be seepage through the pit walls from the Mineable coal sequence. Since the Glacial Drift and the Sub Red 1 Sand will be dewatered and depressurized ahead of the mine pit, only small seepage volumes are expected from these units. Runoff and seepage (i.e. residual groundwater) within the mine pit will be directed (report) to sumps where it will then be pumped to sediment control ponds. In the winter, snow within the pit may be managed by stockpiling within the pit in areas or other storage areas where melting and runoff will be directed to mine sumps or sediment ponds.

All sediment control ponds will be designed and constructed to meet ASMCRA requirements specified by 11 ACC 90.336, plus additional features needed to meet NPDES requirements under the CWA. These structures will be designed to detain and impound precipitation and snowmelt runoff, and apply flocculants and coagulants to reduce sediment and metals associated with the sediments to meet NPDES permit limits. Control ponds will be designed and constructed to detain, at a minimum, the 10-year, 24-hour precipitation event for the watershed above the structure, plus the volume of the continuously managed runoff and residual groundwater as predicted from the water balance under the “wet year” scenario. Peak discharges above the 10-year 24-hour storm volume will be discharged through a controlled principal outflow structure, such as a standpipe, perforated standpipe, or similar type outfall. The ponds would also be constructed to safely pass the peak discharge from the 25-year, 6-hour storm event over or through an emergency spillway. In addition to these volumes, ponds will be sized to store, at a minimum, one year of sediment accumulation. Accumulated sediment in the ponds will be periodically removed from the ponds and deposited in the mine backfill as necessary.

In order to meet NPDES effluent limits, the sedimentation ponds will be designed using the optimum test results for settling and removal of sediments and metals associated with the sediments, as determined from bench scale treatment studies (Riverside Technologies and Poudre Valley Environmental Services, 2008). Each pond will have three cells. The first cell will be designed as a pretreatment/detention cell where a majority of settleable solids in the runoff will drop out of suspension. Water will then decant from the first cell to the second cell through a designed outfall structure or spillway. Coagulants and flocculants such as those identified by the study will then be added in the second cell or its entrance spillway to enhance settling of remaining suspended sediments and colloids. Optimal types of coagulants and flocculants that maximized treatment effectiveness and that were also shown to be safe for aquatic resources were identified during the study (RTI and PVES, 2008). Water from the second cell will decant to a third cell for increased detention time and to provide final polishing prior to discharge. Each cell will be sized to provide at least the minimum amount of detention (throughput) time as determined from the bench scale study (generally not more than 48 hours).

During normal operation (base flow and storms up to and including the 10-year event), water from a final cell will be pumped or drain by gravity to an NPDES surface water outfall at rates established by the monthly water balance. A regular sampling program for this effluent will be established by the NPDES and ASMCRA permits. During storms exceeding the 10-year, 24-hour precipitation event, peak flows will discharge via both the primary outfall and potentially the emergency spillway, depending on the magnitude of the event. NPDES discharge points will be to area streams, in reaches that are undisturbed by mining. For some ponds, such as MI(SP)-Y00-03 (Figure A-3), uncontrolled discharges exceeding the 10-year event would discharge to the mine pit rather than to an off site drainage. These ponds are depicted on the plan maps.

3.1.2 Temporary Stream Channel Diversions

Temporary stream channel diversion structures are constructed channels that divert stream flow from the natural channel around the topsoil stripping or vegetal grubbing areas of the mine to avoid commingling of undisturbed area runoff with areas that have been disturbed or affected by mining. They also serve to protect the mine work area from flooding. Portions of the 2003 drainage will be diverted around the proposed mine area by a temporary diversion structure. Channels will be sized according to the structure's expected lifetime and risk of failure and in accordance with ASMCRA under 11 ACC 90.327. At a minimum, diversion structures will be designed to convey the peak flow rates from the 2-year, 6-hour storm event occurring on the upstream watershed for ephemeral streams, and for the 10-year, 6-hour event for perennial or intermittent streams. Side slopes of diversion channels will be shaped to have a 2 to 1, horizontal to vertical ratio or flatter. The sides and bottoms of the channels may utilize natural gravels, rock riprap or be seeded to provide channel stability. The design peak flow velocity of temporary diversions will typically be less than five feet per second, but may be greater in some diversion reaches. Rock riprap will be used, as necessary, to stabilize steeper diversion reaches or at outlets where diversions rejoin the receiving streams.

In some cases, the general topography and necessary diversion route may not easily allow the stream channel diversion to naturally convey gravity flow to the undisturbed receiving channel.

In these cases, appropriately sized impoundments will be constructed to detain the stream flow and a pump lift station will be used to transfer the flow to a continuance of the diversion channel or to the undisturbed receiving channel. The size of the detention structure will be determined by the pump capacity, expected base flow, and allowance for average peak flows. Using pump stations will prevent unnecessarily deep cuts along hillsides or along other topographic features in order to construct a continuous diversion.

There are no permanent stream diversions proposed for the mine. The current mine plan provides for reclamation of all areas and restoration of the 2003 stream channel where it was removed and diverted by mining.

3.1.3 Temporary Interception or Run-on Diversion Channels

These structures will function to intercept and collect overland runoff, flow through litter and potentially some shallow groundwater from unaffected lands outside of mining and convey that water to natural channels, stream channel diversions, or to flood control structures (described below). This type of channel is distinguished from stream diversions in that collector channels do not divert stream flows but intercept and redirect ephemeral and overland runoff. Interception channels will be designed according to ASMCRA standards specified by 11 ACC 90.325 for temporary diversions and conveyance of flow.

Collector/interceptor channels will also be employed to collect water from affected, unreclaimed lands and from reclaimed lands for conveying disturbed area runoff to sediment control ponds, to active mine pits and to backfill sumps. In consultation with the ADNR and on a site-by-site basis, some segments of interceptor channels not diverting stream flows may be retained in the permanent landscape if it is shown that regrading of the channels will provide effective erosion control during reclamation and re-establishment of vegetation.

3.1.4 Flood Control Structures and Ponds

These structures will consist of on-channel or off-channel impoundments that capture runoff from lands undisturbed by mining. Flood control impoundments are constructed to prevent flooding of mine pits and facility areas, and as such, are sized according to the expected longevity of the mine feature they are to protect. Some flood control structures at Chuitna Coal Mine will be relatively small, having minimal water storage and being located at the beginning of stream channel diversions. As opposed to impounding stream flows, these types of flood control structures will be constructed as blocking dikes that force or direct stream flows into a diversion channel. In cases where water in flood control structures cannot be diverted into diversion ditches via gravity flow, the water may be pumped to a diversion channel conveying non-disturbed runoff. As mining progresses, some flood control structures could eventually receive water from disturbed lands. In these cases these structures will be converted or modified to sediment control ponds, as described in Section 3.1.1, or discharge waters would be routed to existing sediment control ponds.

3.1.5 Pit Sumps

Mine pits will have water collection sumps on the pit floors. Operating pits may have multiple sumps, depending on the configuration and drainage of the pit floor. Sumps will collect surface water runoff and snowmelt within the pit, as well as residual groundwater that will seep into the mine pits through the pit walls. This source will primarily be seepage through the highwall from the Minable coal sequence. It is anticipated that dewatering will remove a majority of the Glacial Drift inflows, and that depressurization will significantly reduce the head in the Sub Red 1 Sand units. However, some minor seepage volumes from residual groundwater in these formations could also be expected to enter the pits. Runoff and seepage (i.e. residual groundwater) within the mine pit will be directed (report) to the sumps where it will then be pumped to sediment control ponds. Though conceptual sump locations are depicted on the water control maps, these structures will be opportunistically located and operated as needed, with the water pumped out of the sumps to sediment control ponds. Some settling of sediments can be expected to occur in the sumps prior to pumping to sediment control ponds. Final sediment removal from this water will occur in the sediment control ponds, as described in Section 3.1.1.

3.1.6 Backfill Sumps

As mining progresses, multiple mine pits will be established that migrate in opposite directions with backfilling and reclamation occurring behind the advancing pit. As reclamation progresses, backfill sumps will be used to intercept and collect surface water runoff from the reclaimed area and prevent it from reentering the mine pits or other areas of active mine operations. These sumps will be designed to allow collected water to infiltrate into the regraded or reclaimed substrate. This will enhance the recharge of groundwater into these areas that had been previously dewatered for mining.

3.2 Alternate Sediment Control Measures

Sediment control is an integral part of mining and reclamation operations at coal mines in the United States in general, and Alaska in particular. Erosion and sediment controls known as Best Management Practices (BMP) and Alternative Sediment Control Measures (ASCM) are employed to reduce the amount of soil particles entrained and transported from a land area and deposited either down slope or in a stream or other water body. BMPs and ASCMs are employed to minimize and control erosion and transport of sediments near the source or site of the entrainment.

Alternate Sediment Control Measures (ASCM) are minor structures or measures used to establish sediment control while minimizing additional disturbance within or adjacent to a disturbed area, or to enhance reclamation as it matures. ASCMs and other BMPs will be employed as needed to minimize the development of erosion and transport of sediment from relatively small disturbed areas. In general, ASCMs will be employed to reduce raindrop impact, slow overland flow, reduce interrill and rill erosion, physically collect or filter out sediment, or minimize sediment entrainment. In some cases, a combination of several types of ASCMs will be used at specific locations to control erosion and sedimentation.

Not all ASCM sites or structures are depicted on the water management and control maps and drawings. Rather, PacRim Coal will evaluate ASCM sites and establish appropriate ASCMs on a site-specific, on-the-ground basis. Prior to installation and use of major ASCMs, ADNR will be provided plans as required for review, comment and approval. Plans may include topographic base maps showing the drainage basin serviced by proposed ASCMs, size and dimensions if appropriate, a summary of hydrologic analyses and design storm characteristics used to size the structure, and results of sediment modeling if appropriate. Where necessary, topsoil in the vicinity of an installed ASCM will either be salvaged or protected in-situ by minimizing the extent of disturbance during construction and operation.

ASCMs that could potentially be employed during mining and reclamation operations are described below. Graphical depictions of ASCMs and other BMPs are illustrated on Figure 3-1.

3.2.1 Sediment Trap or Depression

Sediment Traps are designed to contain or detain most of the surface runoff from a storm event occurring over a small watershed normally less than 3 acres. Site topography typically determines the type of structure selected. In most cases these are excavated depressions along a drainage path with an armored overflow point (rock weir) to direct overflow. Sediment traps are usually constructed with a maximum capacity of less than 0.5 acre-feet. The trap may include an anchored sediment filter (silt) fence or a loose rock check dam immediately below the outfall to further minimize sediment transport.

3.2.2 Ring Ditches

Ring ditches will generally be used around topsoil or overburden stockpiles. They consist of berms of topsoil or overburden placed around a disturbed area by a blade, scraper, or other type of machinery. In some instances, the ditch will be consistent around the entire area. In other areas, where the berm is adjacent to native soil or where topography permits, a small loose rock check dam may be installed at a low point in the berm to control overflow. When used, sediment filter fence will be reinforced and anchored into native soil. The sediment filter fence or loose rock check dam will extend into the berm on each end to prevent flow circumvention.

3.2.3 Natural Depressions

Natural depressions will be used, where possible, to control sediment and to minimize disturbance. Natural depressions in areas where topsoil has been removed may be used to provide sediment control for disturbed areas. Natural depressions from small areas where topsoil has not been removed may be used to provide sediment control for runoff from disturbed areas that have been re-topsoiled and seeded.

3.2.4 Contour Furrows

Contour furrows may be used along regraded and reseeded hillsides to reduce overland flow velocities and runoff from causing excessive rilling and gully formation, and to trap sediment transport. Furrows are usually temporary and will be used to control erosion help establish vegetation on reclaimed hillsides.

3.2.5 Edge Filtration Barriers

Edge filtration barriers, such as loose rock check dams, sediment fence or staked straw bales, will be used, as needed to filter out suspended sediment as water passes along depressions, storm water ditches, or through more significant the water control structures.

3.2.6 Sediment Filter Fence

Sediment filter fence (SFF), or silt fence, will be employed where necessary to control sediment transport along gently sloping to relatively flat terrain. SFF will also be used in swales or parallel to the contour downgrade from disturbed areas. When water can skirt the structure and erode the SFF's anchoring material, straw bales or rock may also be installed at intervals up-gradient of the structure to route flow to the structure.

3.2.7 Loose Rock Check Dams

Loose rock check dams (LRCDs) will be employed where it is necessary to allow suspended sediment to settle out, restrict flow velocities to prevent erosion, or provide grade control. LRCDs effectively control sediment movement from drainages with moderate to high relief. Installation will usually be in well-defined, incised channels or constructed ditches where the LRCDs will decrease channel flow velocities and thereby enhance sediment settling while reducing erosion potential. LRCDs will be constructed of stable rock of diameters ranging from 3 to 10 inches, or as appropriate.

An additional benefit of LRCDs is that, under certain circumstances during reclamation, they may be left in place to promote stable channel development in the watershed. Since the function of the LRCD is to trap sediment, the small basin upstream from the structure may eventually fill with sediment. Unlike the more degradable ASCM structures such as straw bales and sediment filter fence, the LRCDs will remain intact, especially along the critical downstream slope, thus preventing washout and sediment sluicing downstream. The revegetation of sediment captured by a LRCD will often promote stable integration of a channel thalweg profile with the profile upstream and downstream of the check dam.

3.2.8 Gabions

Gabions or gabion dams may be employed if necessary to control any identified high erosive areas where other ASCMs are not being effective at controlling erosion near the source. Gabions are extremely durable and effective structures with long life expectancies and are best suited for highly erosive areas where long-term sediment control is required.

3.2.9 Mulch

Mulch cover will be employed as necessary on reclamation or seeded sites to provide short-term stability from splash erosion and sediment entrainment. Mulch assists establishment of vegetation which further stabilizes the area.

3.2.10 Excelsior and Jute Matting

Excelsior and/or jute matting may be used on steep slopes or areas of concentrated flow such as swales and ditches. This matting is made from organic materials that will be staked on topsoiled surfaces to assist vegetation establishment in reclaimed or seeded areas.

3.2.11 Native Gravel

Gravel, which is common to the area, may be used in limited quantities on steeper slopes where lighter material such as mulch could wash away. Gravel cover helps to establish vegetation, which stabilizes the soil, reduces direct raindrop impact, and slows runoff velocity.

3.2.12 Vegetation

Establishing vegetation in a reclaimed area will be the preferred method of sediment control. Vegetation reduces raindrop impact, reduces runoff velocity, and reduces wind erosion. In recently reseeded areas, structural ASCMs will be used where necessary until desirable vegetation cover is established. ASCMs will be removed from reclaimed areas in accordance with ASMCRA and inspection by ADNR.

3.2.13 Slope Protection Ditches

These ditches typically exhibit shallow, triangular cross sections and are placed just up-gradient from and parallel to the upper-most edge of a cut slope associated with roads or other facilities. Slope protection ditches serve to minimize the amount of runoff that flows onto cut slopes from outside the area of cut, as these slopes tend to be relatively steep and prone to erosion. Slope protection ditches will be constructed the same time the slope is being cut and will remain as a permanent slope feature. Energy dissipators will typically be used at the downstream end of slope protection ditches.

4.0 Water Management Plan

The site-wide water management plan was developed to mimic natural stream flows in the unimpacted areas of the basin. The plan replicates natural stream base flows, while keeping high flows within the range of natural variability. The water management plan was developed from the monthly water balance discussed in Section 2.0, the mine plan, long-term stream flow monitoring data, and groundwater information provided by Arcadis (2007) and Arcadis (2009). The water management plan consists of allowable stream flow targets, estimates of stream flow changes under mining conditions, and calculation of the resulting stream flow augmentation and storage volume requirements. Planning was conducted for the first 8 years of mining, as well as years 15, 22, and 26. As previously discussed, it is assumed that the water balance and the water management plan will be reviewed at least every five years corresponding with ASMCRA and NPDES permit renewal cycles.

4.1 Stream Flow Targets

As demonstrated in the baseline monitoring report (RTI 2009), natural stream flow is highly variable, both daily, seasonally and year-to-year, in the Chuitna tributaries potentially affected by mining. Average monthly stream flows are lowest in February, during which time streams are fed solely from groundwater discharge. The highest sustained flows occur in May due to spring snowmelt, followed by a recession to summer low flows in July. Less-sustained high flows occur in the fall, in response to heavy rainfall. The fall rains produce the highest instantaneous peak discharges annually, but May consistently produces the highest monthly runoff volume. Owing to the high variability of natural flows, and the limited data time series at other locations, monthly upper and lower flow targets for water management planning were determined from the measured extremes of the long-term record at gage C180. Stream flow statistics and flow targets for the 2003 drainage at C180 are shown in Table 4-1. Targets at other locations were developed by multiplying the C180 targets by the drainage area ratio at the location on a monthly basis. For example, at a given station, upper and lower stream flow targets for March are based on the actual observed low and high flows for March at station C180, and then adjusted according to drainage area. Flow targets were compared to predicted flows after mining, to determine the need for stream flow augmentation or additional carryover storage.

4.2 Predictive Stream Flow Estimating Methodology

Monthly stream flow was estimated through the end of year 8 of mining, along with mining years 15, 22, and 26, based on the water balance described in Section 2.0. These data were compared with stream flow targets, predicted base flow depletions, and groundwater discharge rates. Stream flow estimates assume the following:

- Undisturbed terrain, grubbed areas, and reclaimed areas (4 years or longer after seeding) were assigned the runoff coefficients for undisturbed areas. Truck/shovel operations, open pits, facilities, overburden or topsoil stockpiles, and newly reclaimed areas (up to 3 years after seeding) were assigned the disturbed-area values from Section 2. These coefficients may be further refined during detailed design runs.

- Computed surface water yields include rainfall and snowmelt-generated runoff. Groundwater yields are computed using the groundwater model (Arcadis 2009), and added to surface water yields to determine stream flow.
- Residual groundwater inflows to the pit were computed separately for each mining operation (Truck Shovel 1-3, Truck Shovel 2, Dragline, and Haul Road) in the groundwater model, and assigned to the appropriate sedimentation pond outfall according to the projected destination of pumped pit water.
- Pumped groundwater discharges were assumed to be transferable between outfall locations using valves. The conceptual groundwater discharge pipelines and outfall location shown in the plans (Appendix A) reflect this.
- Pumped groundwater was assigned first to 2002 and 2004 creeks, in an amount equal to or greater than the base flow depletions predicted by the groundwater model. Remaining available pumped groundwater was discharged to 2003 Creek.

Summary output for each stream flow estimation point (important gaging stations) can be found in Appendix B. These data are discussed in the following section. Computational details can be found in Appendix C. Appendix C data are only included on the CD included with this report because they consist of several hundred pages. Appendix C contains four tables. Table C-1 summarizes the monthly surface runoff calculations for all locations in 2003 Creek, and all outfall locations. Each line of the table represents a particular drainage subarea with a uniform land cover. Table C-2 presents the corresponding NRCS TR-55 calculations for the sedimentation ponds, arranged according to the same sub-drainage areas as C-1. Tables C-3 and C-4 present the individual area computations for 2002 and 2004 Creeks, respectively. Because only small amounts of the 2002 and 2004 drainages were affected by mining, runoff values were computed for only the affected areas (diverted or changed land cover). Basin-wide impacts were then computed by subtraction. Hence, the first few columns of Table C-3 and C-4 document the inter-basin transfers and land cover changes between 2002, 2003, and 2004 creeks. Subsequent columns compute the monthly flows in the same fashion as Table C-1. Total stream flow (reported in the Appendix B summaries) is computed by addition or subtraction from baseline (pre-mining) values computed for the entire 2002, 2003 or 2004 watershed at the beginning of the table.

4.3 Estimated Stream Flow and Depletions

Stream flow depletions caused by groundwater pumping are mitigated by returning pumped groundwater to the stream system. Surface outflows from the sediment ponds only provide a modest amount of augmentation at most outfall locations during the critical low flow months (February and July), except when counterbalanced by out-of-basin transfers. Table 4-2 provides a summary of annual flow depletions with groundwater pumping totals. For clarity, only the largest absolute depletion for a given stream is reported; upstream locations have smaller absolute depletions of flow but larger relative values. Total groundwater withdrawals exceed base flow depletions in 2002, 2003, and 2004 drainages for all mining years evaluated except year 15, 22, and 26. The Sub Red 1 Sand unit is not hydrologically connected to the surface water system in the vicinity of mining, so pumping of the Sub Red 1 Sand results in a net increase in water yield above what is depleted by Glacial Drift pumping. Locations of groundwater discharge pipelines in upstream and midstream locations allow mitigation of impacts and are shown on the mine plan maps (Appendix A). The volume of water pumped from the Sub Red 1 Sand unit and Glacial Drift unit vary year by year according to the mine plan. In years 15 through 25, additional Sub Red 1 Sand pumping will be used to augment stream flows, if required. In years 26 and beyond, surface ponds will be pumped to augment stream flow.

The tables in Appendix B present the predicted monthly stream flow for stations C196, C195, C198, and C220 in 2002 Creek, stations C141, C140, and C180 in 2003 Creek, and stations C080 and C110 in 2004 Creek, under the wet, dry, and average scenarios. Predicted stream flow is shown versus the monthly stream flow targets along with all components of the water balance, including predicted depletions and augmented discharges. In general, the estimated changes in water yield due to mining did not result in significant deviations from target flows in the 2002, 2003, or 2004 drainages. Increases in water yield under the wet scenario were within the natural range of flows for a given period, while dry weather flow depletions were chiefly due to groundwater withdrawals, rather than changes in land cover associated with mining disturbances. As can be seen from these tables, depletions in stream flow caused by groundwater pumping were successfully mitigated by discharge of pumped groundwater. There are no predicted depletions below targeted minimum stream flows.

With the exception of station C140 on 2003 Creek, increased surface runoff due to mining did not increase monthly flow rates above the upper stream flow target at any station in any of the potentially affected drainages. This was consistent for all scenarios ("wet", "average" and "dry"). At station C140 in 2003 Creek, increased base flow exceeded the February high flow target by approximately 0.3 to 1.0 cfs in years 2 through 4 and 6 through 8 of mining. This is due to a return flow of as much as 2.5 cfs from the diversion west of the mining operation in combination with the discharges of pumped groundwater. It should be noted, however, that that the February high flow target is quite low (7.9 cfs) in comparison to the January (24.5 cfs) and March (20.1 cfs) high flow targets. The low February flow target is partially an artifact of using the C180 gage record to develop the flow targets and partly because prevailing frozen conditions during this month produce flows with very little variability. The January and March records contain higher flows, presumably because there are brief thawing periods in those months in some years. The slight exceedance of the February high flow target at station C140 is still substantially lower than either the January or March high flow targets. A further contributor to the apparent February exceedance is that the average annual base flow estimate from the groundwater model was used to calculate the monthly flow (i.e., the average annual base flow divided by 12). As previously discussed, the groundwater predicts base flow on an annual basis which causes base flow predictions during winter months to be higher than would actually occur in the stream.

During "dry" scenarios, the critical period for base flow depletion, no stream base flows fell below the target range at any of the stations in any basin. Expectedly, results for "wet" and "average" scenarios also show no depletions below the target range.

4.4 Storage Volume Requirements

Sediment control ponds will be required for runoff from areas that are disturbed by mining. Runoff to be controlled in surface ponds includes rainfall runoff, snowmelt, and residual groundwater inflow to the pits. The required storage volume depends on the flow rate entering the pond, and the required detention time. An estimate of the required pond storage volume was made, using the water balance model described above, under the following assumptions:

- The continuously-managed runoff volume was computed as the maximum flow rate reporting to the structure, estimated from the "wet" year water balance, multiplied by the treatment detention time. The May flow rate from the "wet" year was consistently the largest, and used in all calculations. Short-term May high flows, larger than those based on the "wet" monthly average, will be handled using the available 10-year pond capacity.
- Based on bench-scale flocculent testing, 48 hours provides a useful upper bound on required detention time.
- The storm runoff volume was the 10-year, 24-hour runoff volume for the contributing area, computed using the NRCS Curve Numbers from Table 5-3 (after NRCS 1987), and 3.8 inches of rainfall. Runoff volume was computed separately for each land cover category, a conservative practice, rather than computing a weighted-average Curve Number first. Reclaimed areas were assigned Curve Numbers reflecting progressively improving hydrologic condition, starting in the year seeding occurred, and increasing in successive years through 7 years after seeding, when reclaimed areas were treated similarly to natural areas.
- The primary source of inflow to the main mine stormwater pond early in the mine life is runoff from open pits and disturbed areas draining to pits. Pits have substantial runoff storage capacity available in pit sumps, spoil void space, and below the lowest working bench. Following a large storm event, this volume would be pumped dry over a period of days. Assuming that it would take 48 hours to pump the pit sumps dry following a 10-year event, the 10-year, 24-hour volume was halved for computing target pond volumes in years 0 through 8. Due to increasing proportions of gravity flow from partially reclaimed areas reporting to ponds in later mining years, the 10-year volume was only reduced by 40% in year 15, and 25% in year 22. In year 26, when all pit areas are reclaimed and all drainage is via gravity flow, the full value was used.
- Residual groundwater inflow from the drift, coal sequence, and sub-Red 1 sand was included in the volume estimate for sedimentation ponds receiving pit water. Residual groundwater inflow occurring in the winter months (December through April) was assumed to accumulate as ice within the pit, and melt in May. The residual inflow volume in the table thus reflects the accumulated residual inflows from December through May, reporting to the pond during May.

Summary results are found in Table 4-4, while detailed calculations are in Appendix C, included on the accompanying CD. In general, the 10-year, 24-hour volume is nearly quadruple that of the spring-time continuous inflow detention volume during early years of mining. Later, when large tracts of reclaimed area report to the main pond outfall location, spring volumes achieve more parity with 10-year volumes, but are still substantially smaller. This is due to the fact that NRCS TR-55 calculations predict larger differences in runoff volumes between differing land cover types than those predicted by the water balance. This is an expected result given that TR-55 is designed for the prediction of large storms rather than continuous water yield.

Also of note are the predicted runoff volumes for the main mine outfall locations in later mining years. Because these outfall calculations include large tracts of reclaimed area upstream, it will be possible and perhaps desirable to disperse treatment ponds within the reclamation areas, to avoid constructing a single, large pond. These could also add to post-mine fish habitat and could be a source to accelerate post-mine aquifer resaturation.

5.0 NPDES OUTFALLS

After approval of a final water management plan, PacRim Coal, LP will resubmit an application for discharges under the NPDES program. The water management plan has been developed to meet standards for hydrologic and sediment controls specified under ASMCRA, as well as meet applicable technology effluent guidelines for coal operations as promulgated by EPA in 40 CFR 434. It is also designed to meet possible Water Quality Based Effluent Limits (WQBEL) for constituents that have reasonable potential.[1] Based on the water management plan, there will be two types of NPDES discharge outfalls, discharges from sediment control ponds and discharges of pumped groundwater to surface water.

5.1 Discharges from Sediment Control Ponds

As described in Section 3.1.1, sediment control ponds will be used to manage discharges from rainfall and snowmelt runoff from all mining areas and facilities, and water collected in sumps within the mine pits. Surface water quality data at the proposed mine site suggests that the majority of baseline samples with observed elevated metal concentrations also have high suspended sediment concentrations. Tables 5-1 and 5-2 show typical surface water quality from area streams (Riverside Technologies, 2009). These data show how total iron, copper, and zinc are higher when Total Suspended Solids (TSS) concentrations are elevated.

As previously described, the sediment control ponds will be designed using the test results for settling of suspended solids and reduction of metals associated with sediments, as determined from bench scale studies (Riverside Technologies and PVES, 2008). After initial settling, coagulants and flocculants similar to those used by the study will be added in the second cell of each pond to further enhance settling of remaining suspended sediments and colloids. During normal operation (base flow and storms up to and including the 10-year event), water from a final cell will be pumped or drain by gravity to the NPDES surface water outfall at rates established by the monthly water balance. During storms exceeding the 10-year, 24-hour precipitation event, peak flows will discharge via both the primary outfall and potentially the emergency spillway, depending on the magnitude of the event. The emergency spillway will be designed to pass peak discharges up to and including that of the 25-year, 6-hour event. NPDES discharge outfall locations will be to area streams, in reaches that are undisturbed by mining. For some ponds, uncontrolled discharges exceeding the 10-year event will drain to the mine pit rather than to an area stream.

5.2 Discharges of Pumped Groundwater

As described in Section 1.2, mining will require groundwater to be pumped from the Glacial Drift hydrogeologic unit to dewater the immediate area being mined; and water will also need to be pumped from the Sub Red 1 Sand aquifer to reduce the potentiometric head and prevent upwelling of water into the mine pit. Glacial Drift dewatering wells will be installed and

[1] It is assumed that a Reasonable Potential Analysis will be conducted based on methods outlined by EPA (1991).

operated before initiation of mining (Appendix A, Figure A-1. Year 0), and will be replaced, as needed, as they are overtaken by advancing mine pits.

Based on site data, groundwater from the Sub Red 1 Sand exhibits good water quality. Data suggests that the quality of this water, in most all cases, is better than that of the surface water. Table 5-3 shows water quality data typical of the Sub Red 1 Sand (RTI, 2009).

Table 5-4 shows water quality data typical of the Glacial Drift (RTI, 2009). Similar to surface water, water quality data from the Glacial Drift unit shows that samples with high metal concentrations, particularly for iron, copper and zinc also had high to very high suspended sediment concentrations. As shown in Table 4-4, some samples from the Glacial Drift show very high concentrations of TSS while others do not. These data show a very strong correlation between high concentrations of TSS and high levels of total iron, total copper, total lead and total zinc. While this water is naturally high in dissolved iron and manganese, samples with low concentrations of TSS show very similar water quality characteristics as surface water. These data confirm the strong connection between the water in the Glacial Drift and base flows in surface water drainages. Formation water in the Glacial Drift should not be naturally high in TSS, and the data suggests that samples high in TSS are a function of well construction techniques.

During operation, dewatering wells established in both the Glacial Drift and Sub Red 1 Sand will be completed with appropriate filter packs around the screened intervals and properly sealed, if appropriate, with grout or bentonite. For this reason, this plan was developed assuming that the water quality pumped from the Glacial Drift will have similar characteristics to those samples shown in Table 5-4 with low TSS concentrations. Even when TSS concentrations are low or not detected, data from both surface water in the area and the Glacial Drift may not meet promulgated statewide water quality criteria for total iron and total manganese. To address this issue, PacRim Coal is currently conducting a testing and analysis program using EPA protocols to prepare an application to the State of Alaska for setting site specific water quality criteria. It is likely that PacRim Coal will pursue the development of site specific criteria for aluminum, iron, manganese, copper and/or zinc that are specific to the natural conditions at this site, but also protective of stream uses. These criteria, if accepted, will be more appropriate for the waters that naturally occur at the site than the statewide criteria.

This water management plan assumes that pumped groundwater will be of suitable quality for permitted direct discharges to surface water streams. Previous project planning assumed that groundwater will be discharged to infiltration basins located in the Glacial Drift or the Alluvium in areas near surface streams. This concept is not being considered for this management plan for various reasons. Pumped groundwater will be directly conveyed via pipe to surface water outfalls. Outfalls will be engineered structures that convey water to the stream or through diffusers located directly on the bottom of the streams. These structures will be designed so discharges can occur year-round including under ice in the winter. Pipes will be insulated and will primarily be installed above ground. Outfalls will be constructed with appropriate armoring to prevent or minimize impacts to stream morphology, bank erosion, or alteration of the substrate. Outfall locations will be located in stream reaches, primarily in 2003 Creek below mining, and in several locations in the 2002 and 2004 drainages, that have been shown by the groundwater model (Arcadis, 2007, 2009) to be susceptible to reduced base flows from drawdown in the Glacial Drift.

5.3 NPDES Outfall Discharges

Groundwater and surface water discharges were computed for all proposed NPDES outfall locations. Outfall locations for each year are shown on the Water Management Control Maps (Appendix A). Table 5-5 presents the predicted discharge rates to NPDES groundwater discharge outfalls for each year of mining under the "average" conditions scenario. Table 5-6 presents predicted discharge rates to NPDES outfalls from sedimentation ponds for each month and year under the "average" conditions scenario. Detailed computations can be found in Appendix C, included on CD.

5.4 Discharge Quality and Temperature

The surface water quality in the Chuit River Basin naturally exceeds the applicable State water quality criteria for aquatic life for several metals (RTI, 2009). As discussed in Section 5.2, PacRim Coal is currently conducting a testing and analysis program using EPA protocols to prepare an application to the State of Alaska for setting site specific water quality criteria that are more appropriate for site conditions. It is likely, that PacRim Coal will pursue the development of site specific criteria for aluminum, iron, manganese, copper and zinc that are specific to the natural conditions at this site, but protective of its uses. These criteria, if accepted, will be more appropriate for the waters that naturally occur within the Chuit River Basin than the statewide criteria.

This water management plan assumes that discharges from sediment control ponds and from pumped groundwater will be of suitable quality for permitted direct discharges to surface water streams, including temperature criteria. Under 18 ACC 70.020, the applicable Alaska water temperature criteria for waters designated for the growth, propagation of fish, shellfish, other aquatic life, and wildlife are:

Habitat	May Not Exceed
Migration routes	15 °C
Spawning areas	13 °C
Rearing areas	15 °C
Egg & fry incubation	13 °C

Temperature data for groundwater in the Glacial Drift and Sub Red 1 Sand hydrogeologic units are provided in Tables 5-6 and 5-7 (RTI, 2007). Groundwater temperatures in the two units is very similar, ranging from approximately 4 to 8 °C for both formations. The average monitored temperature is 5.8 °C for the Glacial Drift and 6.0 °C for the Sub Red 1 Sand with no exceedences during any time of the year. Based on these data, discharges of groundwater would meet the applicable Alaska water temperature criteria during all times of the year. Surface water control ponds will be continuously monitored for temperature during the months when they are discharging.

6.0 REFERENCES

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Riverside Technolgy, Inc. and Poudre Valley Environmetal Services. 2008. Jar test results for the Chuitna Coal Mine Project. August 2008.

TABLES

Table 2-1. Watershed Yield at Selected Gages

Basin	Gage I.D.	Drainage Area (mi^2)	Recent Data (8/16/06 through 9/30/08*) Record Length (yrs)	Recent Data (8/16/06 through 9/30/08*) Average Yield (cfs/mi^2)	Historical Data (10/1/85 through 10/31/95) Record Length (yrs)	Historical Data (10/1/85 through 10/31/95) Average Yield (cfs/mi^2)	Historical Data (7/26/82 through 2/25/84) Record Length (yrs)	Historical Data (7/26/82 through 2/25/84) Average Yield (cfs/mi^2)
20	C120	88.3	1.2*	2.68	10.1	3.31		
	C230	131.7	1.2*	2.40	10.1	3.30		
2002	C195	5.8			10.1	3.26		
	C196	5.2	2.1	2.49				
	C198	7.8			10.1	3.40		
	C220	21.4	1.3*	2.46				
2003	C128	3.8			10.1	2.66		
	C129	3.7	2.1	1.76				
	C140	6.4					1.5	2.02
	C141	5.2	2.1	1.70				
	C180	14.3	2.1	1.40	10.1	2.66	1.6	1.59
2004	C110	14.8	1.9*	2.00				

**Data for C120 and C230 start 7/27/07; C220 & C110 have data gaps.*

Table 2-2. Evaporation Summary

Month	Pan Evap. (in)	Adjusted Evap. (in)	Applied Evap. (in)
Jan	0	0	0.00
Feb	0	0	0.00
Mar	0	0	0.00
Apr	0	0	0.00
May	4.81	3.37	4.86
Jun	4.74	3.32	3.62
Jul	4.27	2.99	1.20
Aug	3.29	2.31	2.31
Sep	2.14	1.50	1.50
Oct	0	0	0.00
Nov	0	0	0.00
Dec	0	0	0.00
Total	19.25	13.48	13.48

Table 2-3. Runoff Calculation and Precipitation Estimate – Wet Conditions

Month	Flow at C180		Applied Evap. (in)	Base-flow (in)	Recharge to Lower GW (in)	Surface Runoff (in)	Estimated Precip. (in)	Runoff Coefficient		Runoff Depth (in)	
	(cfs)	(inches)						Natural	Disturbed	Natural	Disturbed
Jan	12.9	1.01	0.00	0.94	0.03	0.07	1.04	0.07	0.07	0.07	0.07
Feb	8.6	0.61	0.00	0.61	0.02	0.00	0.63	0.00	0.00	0.00	0.00
Mar	12.4	0.97	0.00	0.94	0.03	0.03	1.00	0.03	0.03	0.03	0.03
Apr	44.3	3.37	0.00	0.99	0.03	2.38	3.40	0.70	0.70	2.38	2.38
May	108.7	8.55	4.86	1.05	0.03	7.49	13.44	0.56	0.85	7.49	11.38
Jun	35.5	2.70	3.62	0.99	0.03	1.70	6.34	0.27	0.72	1.70	4.60
Jul	11.3	0.89	1.20	0.89	0.03	0.00	2.11	0.00	0.45	0.00	0.96
Aug	22.0	1.73	2.31	0.94	0.03	0.79	4.06	0.19	0.65	0.79	2.64
Sep	61.3	4.66	1.50	0.91	0.03	3.76	6.19	0.61	0.80	3.76	4.95
Oct	75.6	5.94	0.00	0.94	0.03	5.01	5.97	0.84	0.84	5.01	5.01
Nov	24.0	1.83	0.00	0.91	0.03	0.92	1.85	0.50	0.50	0.92	0.92
Dec	15.6	1.23	0.00	0.94	0.03	0.29	1.25	0.23	0.23	0.29	0.29
Total	432.3	33.49	13.48	11.05	0.32	22.44	**47.28**	0.47	0.70	22.44	33.22

Table 2-4. Runoff Calculation and Precipitation Estimate – Dry Conditions

Month	Flow at C180		Applied Evap. (in)	Base-flow (in)	Recharge to Lower GW (in)	Surface Runoff (in)	Estimated Precip. (in)	Runoff Coefficient		Runoff Depth (in)	
	(cfs)	(inches)						Natural	Disturbed	Natural	Disturbed
Jan	9.6	0.75	0.00	0.75	0.02	0.00	0.78	0.00	0.00	0.00	0.00
Feb	7.5	0.53	0.00	0.53	0.02	0.00	0.55	0.00	0.00	0.00	0.00
Mar	9.4	0.74	0.00	0.74	0.02	0.00	0.76	0.00	0.00	0.00	0.00
Apr	33.9	2.58	0.00	1.19	0.03	1.40	2.62	0.53	0.53	1.40	1.40
May	91.4	7.19	4.86	1.31	0.04	5.88	12.08	0.49	0.81	5.88	9.77
Jun	22.2	1.69	3.62	1.19	0.03	0.50	5.34	0.09	0.64	0.50	3.39
Jul	9.1	0.71	1.20	0.71	0.02	0.00	1.93	0.00	0.50	0.00	0.96
Aug	17.5	1.38	2.31	0.94	0.03	0.44	3.71	0.12	0.62	0.44	2.28
Sep	47.3	3.60	1.50	0.91	0.03	2.69	5.12	0.53	0.76	2.69	3.89
Oct	51.4	4.04	0.00	0.94	0.03	3.10	4.06	0.76	0.76	3.10	3.10
Nov	20.3	1.55	0.00	0.91	0.03	0.64	1.57	0.41	0.41	0.64	0.64
Dec	13.0	1.02	0.00	0.94	0.03	0.08	1.05	0.08	0.08	0.08	0.08
Total	332.6	25.77	13.48	11.05	0.32	14.72	**39.57**	0.37	0.64	14.72	25.50

Table 2-5. Runoff Calculation and Precipitation Estimate – Average Conditions

Month	Flow at C180		Applied Evap. (in)	Base-flow (in)	Recharge to Lower GW (in)	Surface Runoff (in)	Estimated Precip. (in)	Runoff Coefficient		Runoff Depth (in)	
	(cfs)	(inches)						Natural	Disturbed	Natural	Disturbed
Jan	11.8	0.93	0.00	0.93	0.03	0.00	0.95	0.00	0.00	0.00	0.00
Feb	8.2	0.59	0.00	0.59	0.02	0.00	0.60	0.00	0.00	0.00	0.00
Mar	11.4	0.89	0.00	0.89	0.03	0.00	0.92	0.00	0.00	0.00	0.00
Apr	39.9	3.03	0.00	1.04	0.03	2.00	3.06	0.65	0.65	2.00	2.00
May	101.3	7.96	4.86	1.11	0.03	6.85	12.86	0.53	0.84	6.85	10.74
Jun	29.8	2.26	3.62	1.04	0.03	1.23	5.91	0.21	0.70	1.23	4.12
Jul	10.6	0.83	1.20	0.83	0.02	0.00	2.05	0.00	0.47	0.00	0.96
Aug	20.5	1.61	2.31	0.94	0.03	0.67	3.95	0.17	0.64	0.67	2.52
Sep	56.6	4.31	1.50	0.91	0.03	3.40	5.83	0.58	0.79	3.40	4.60
Oct	67.5	5.31	0.00	0.94	0.03	4.37	5.34	0.82	0.82	4.37	4.37
Nov	22.8	1.73	0.00	0.91	0.03	0.83	1.76	0.47	0.47	0.83	0.83
Dec	14.7	1.16	0.00	0.94	0.03	0.22	1.19	0.19	0.19	0.22	0.22
Total	395.2	30.61	13.48	11.05	0.32	19.56	**44.41**	0.44	0.68	19.56	30.35

Table 2-6. Groundwater Discharge Summary (values in cfs)

Year	Residual (Passive) Inflows to Mine Pits				Average Groundwater Dewatering Pumping Rates		
	Mineable Coal	Sub Red 1 Sand	Glacial Drift	Total Residual Inflows	Glacial Drift	Sub Red 1 Sand	Total Pumping
0	0.00	0.00	0.00	0.00	0.78	0.51	1.28
1	0.07	0.03	0.50	0.60	0.43	1.53	1.95
2	0.11	0.00	0.30	0.42	0.34	2.87	3.21
3	0.43	0.00	1.51	1.94	1.62	2.24	3.86
4	0.55	0.00	1.32	1.87	2.21	1.82	4.04
5	0.49	0.00	0.83	1.32	1.78	1.64	3.42
6	0.55	0.10	1.07	1.72	3.97	1.47	5.45
7	0.79	0.18	1.26	2.23	2.59	3.43	6.03
8	0.54	0.12	1.40	2.06	3.45	3.24	6.70
9	0.84	0.17	1.91	2.92	2.11	3.03	5.13
10	0.76	0.66	2.03	3.46	0.86	2.25	3.11
11	0.84	0.36	1.69	2.90	3.24	2.00	5.24
12	0.91	0.45	1.55	2.92	1.53	2.93	4.46
13	0.82	0.19	1.61	2.62	2.48	3.23	5.71
14	0.85	0.36	1.53	2.73	2.09	3.05	5.14
15	1.01	0.39	2.03	3.43	1.30	2.85	4.15
16	0.98	0.46	2.19	3.63	2.02	2.71	4.73
17	0.84	0.47	1.67	2.98	2.39	2.66	5.05
18	1.10	0.49	1.63	3.22	2.35	1.71	4.06
19	1.05	0.70	1.73	3.48	0.94	1.79	2.74
20	0.97	0.73	1.33	3.03	0.56	3.12	3.68
21	0.82	1.23	2.32	4.37	1.80	2.76	4.56
22	0.86	0.79	1.88	3.52	2.69	2.67	5.36
23	0.85	0.42	1.55	2.82	2.89	3.00	5.88
24	0.78	0.56	1.31	2.65	1.95	2.77	4.72
25	0.51	0.17	0.38	1.06	0.65	2.30	2.95

Table 4-1. Stream flow Targets at C180, monthly mean discharge (cfs)

Month	Mean	Standard Deviation	Minimum Recorded	Maximum Recorded	Target / Allowable Minimum	Target / Allowable Maximum
Jan	11.8	10.9	3.0	53.7	3.0	53.7
Feb	8.2	3.7	2.8	17.3	2.8	17.3
Mar	11.4	10.0	2.3	44.1	2.3	44.1
Apr	39.9	29.6	7.2	119.4	7.2	119.4
May	101.3	49.4	34.0	223.8	34.0	223.8
Jun	29.8	38.0	8.0	182.4	8.0	182.4
Jul	10.6	7.4	4.6	34.4	4.6	34.4
Aug	20.5	14.9	3.3	58.7	3.3	58.7
Sep	56.6	46.8	10.5	204.9	10.5	204.9
Oct	67.5	80.9	10.3	389.3	10.3	389.3
Nov	22.8	12.3	5.1	49.1	5.1	49.1
Dec	14.7	8.6	4.0	36.8	4.0	36.8

Table 4-2. Base flow Depletion and Augmentation Summary

Year of Mining	Base flow Depletions versus Pre-Mine Conditions (cfs)				Available Ground-water Pumping* (cfs)
	C220-2002	C180-2003	C110-2004	Total	
0	0.00	0.00	0.00	0.00	1.28
1	0.13	0.38	0.00	0.55	1.95
2	0.37	0.68	0.00	1.13	3.21
3	0.56	1.25	0.00	1.95	3.86
4	0.77	1.64	0.00	2.59	4.04
5	0.89	2.41	0.00	3.55	3.42*
6	0.96	2.53	0.00	3.76	5.45
7	1.04	3.09	0.00	4.45	6.03
8	1.09	3.44	0.00	4.89	6.70
15	1.43	3.12	0.19	5.10	4.15*
22	1.75	2.76	1.00	5.85	5.36*
26	1.59	2.68	0.76	5.36	0.00*

*Available groundwater pumping is the pumping quantity required for dewatering and depressurization to facilitate mining. Additional withdrawals are possible from the Sub Red 1 Sand unit to compensate for shortfalls between available groundwater and base flow depletions.

Table 4-3. Curve Number Summary for Pond Volume Calculations

Description	TR-55 Land Cover	Hydrologic Condition	Hydrologic Soil Group	Curve Number
Grubbed	Bare soil	n/a	B	86
Open Pit	Bare soil	n/a	B	86
Reclaim_01-03*	Brush	Poor	C	77
Reclaim_04-06*	Brush	Fair	C	70
Reclaim_07-10*	Brush	Good	C	65
Reclaim_11+*	Brush	Good	C	65
TS Stripped	Bare soil	n/a	B	86
Undisturbed	Brush	Good	C	65

*Numbers denote age since seeding of reclaimed areas.

Table 4-4. Sedimentation Pond Volume Summary – Wet Conditions

Year of Mining	Pond ID	10-yr, 24-hr Runoff Volume (ac-ft)	Spring Runoff Volume+ (ac-ft)	Residual Inflow Volume+ (ac-ft)	Maximum Pond Volume (ac-ft)	Target Pond Volume (ac-ft)
Year 0	SP-Y00-03*	87.7	26.4		114.1	70.2
	SP-Y00-04	11.4	4.1		15.5	9.8
	SP-Y00-05	18.4	5.7		24.1	14.9
	SP-Y00-07	8.8	3.2		12.0	7.6
Year 1	SP-Y00-03*	87.7	26.7	15.7	130.1	86.2
	SP-Y00-04	11.4	4.1		15.5	9.8
	SP-Y00-05	18.4	5.7		24.1	14.9
	SP-Y00-07	8.8	3.2		12.0	7.6
Year 2	SP-Y00-03*	130.3	38.1	10. 9	179.3	114.2
	SP-Y00-04	11.4	4.1		15.5	9.8
	SP-Y00-05	18.4	5.7		24.1	14.9
	MI(SP)-Y00-03	9.3	2.6		11.8	7.2
	SP-Y00-07	8.8	3.2		12.0	7.6
Year 3	SP-Y00-03*	152.7	46.6	50.7	250.0	173.7
	SP-Y00-04	11.4	4.1		15.5	9.8
	SP-Y00-05	18.4	5.7		24.1	14.9
	MI(SP)-Y00-01	14.2	3.6		17.8	10.7
	MI(SP)-Y00-02	10.4	3.5		13.9	8.7
	MI(SP)-Y00-03	18.7	5.5		24.2	14.8
	SP-Y00-07	8.8	3.2		12.0	7.6
Year 4	SP-Y00-03*	237.1	73.9	50.2	361.2	242.6
	SP-Y00-04	11.4	4.1		15.5	9.8
	SP-Y00-05	18.4	5.7		24.1	14.9
	MI(SP)-Y03-01	3.5	1.0		4.6	2.8

Year of Mining	Pond ID	10-yr, 24-hr Runoff Volume (ac-ft)	Spring Runoff Volume+ (ac-ft)	Residual Inflow Volume+ (ac-ft)	Maximum Pond Volume (ac-ft)	Target Pond Volume (ac-ft)
	MI(SP)-Y03-02	4.3	1.4		5.6	3.5
	MI(SP)-Y03-03	7.6	2.4		10.0	6.2
	SP-Y00-07	8.8	3.2		12.0	7.6
	SP-Y04-01	32.2	12.8		45.0	28.9
Year 5	SP-Y00-03*	277.1	87.4	37.1	401.6	263.1
	SP-Y00-04	11.4	4.1		15.5	9.8
	SP-Y00-05	18.4	5.7		24.1	14.9
	SP-Y05-01	10.2	2.9		13.1	8.0
	SP-Y00-07	8.8	3.2		12.0	7.6
	SP-Y04-01	32.2	12.8		45.0	28.9
Year 6	SP-Y06-01*	318.5	106.2	47.0	471.7	312.5
	SP-Y00-04	11.4	4.1		15.5	9.8
	SP-Y00-05	18.4	5.7		24.1	14.9
	MI(SP)-Y05-01	4.6	1.4		6.1	3.7
	MI(SP)-Y04-02	2.6	0.8		3.4	2.1
	MI(SP)-Y04-01	8.9	2.4		11.3	6.8
	SP-Y00-07	8.8	3.2		12.0	7.6
	SP-Y04-01	32.1	12.8		44.9	28.8
Year 7	SP-Y06-01*	368.3	124.8	65.3	558.4	374.3
	SP-Y00-04	11.4	4.1		15.5	9.8
	SP-Y00-05	18.4	5.7		24.1	14.9
	SP-Y00-07	7.9	2.7		10.6	6.7
	SP-Y04-01	32.1	12.8		44.8	28.8
Year 8	SP-Y06-01*	386.7	134.5	59.6	580.8	387.4
	SP-Y00-04	11.4	4.1		15.5	9.8
	SP-Y00-05	18.4	5.7		24.1	14.9
	SP-Y08-01	3.5	0.8		4.3	2.6
	MI(SP)-07-02	3.4	1.2		4.7	2.9
	SP-Y00-07	7.9	2.7		10.6	6.7
	SP-Y04-01	32.1	12.8		44.8	28.8
Year 15	SP-Y06-01*	565.6	230.0	37.8	833.4	607.2
	SP-Y00-04	11.4	4.1		15.5	10.9
	SP-Y00-05	18.4	5.7		24.1	16.7
	SP-Y00-01	21.4	8.8		30.2	21.6
	SP-Y15-03	60.0	18.9	16.5	95.4	71.4
	SP-Y15-02	18.9	5.9		24.8	17.2
	SP-Y15-01	55.3	17.3	11.8	84.4	62.3
	SP-Y00-07	7.3	2.3		9.6	6.7
	SP-Y04-01	95.7	33.9	13.8	143.4	105.1

Year of Mining	Pond ID	10-yr, 24-hr Runoff Volume (ac-ft)	Spring Runoff Volume+ (ac-ft)	Residual Inflow Volume+ (ac-ft)	Maximum Pond Volume (ac-ft)	Target Pond Volume (ac-ft)
Year 22	SP-Y16-01	3.0	1.3		4.3	3.5
	SP-Y06-01*	278.9	127.4	34.5	440.8	371.0
	SP-Y00-04	11.4	4.1		15.5	12.7
	SP-Y00-05	18.4	5.7		24.1	19.5
	SP-Y00-01	67.9	23.9		91.8	74.8
	SP-Y20-02	22.0	8.9		30.9	25.4
	SP-Y22-02	58.0	18.0	18.6	94.7	80.2
	SP-Y21-02	47.6	15.2	23.0	85.7	73.8
	SP-Y20-01	28.9	22.1		51.0	43.8
	SP-Y21-01	10.8	7.4		18.2	15.5
	SP-Y00-07	7.5	2.4		9.9	8.0
	SP-Y04-01	66.2	23.7	6.0	95.9	79.4
Year 26	SP-Y16-01	2.5	1.3		3.8	3.8
	SP-Y06-01*	637.9	300.3		938.1	938.1
	SP-Y00-04	11.3	3.6		14.9	14.9
	SP-Y00-05	18.4	5.7		24.1	24.1
	SP-Y00-01	0.9	0.4		1.4	1.4
	SP-Y20-02	13.7	6.2		19.9	19.9
	SP-Y21-02	0.7	0.3		1.0	1.0
	SP-Y20-01	35.6	15.3		50.9	50.9
	SP-Y23-01	18.1	8.0		26.1	26.1
	SP-Y21-01	12.4	5.7		18.1	18.1
	SP-Y00-07	7.5	2.4		9.9	9.9
	SP-Y04-01	27.6	12.6		40.2	40.2

* = Main mine outfall; total includes runoff from reclaimed areas surrounded by pit.
\+ = Treatment volume required for 48-hour detention time.

Table 5-1. Recent Water Quality Data for Specific Metals at Station 141 on 2003 Creek

Date	TSS mg/L	Hardness (mg/L as CaCO3)	Al - Total µg/L	Cu - Total µg/L	Cu - Diss µg/L	Fe - Total µg/L	Fe - Diss µg/L	Pb - Total µg/L	Pb - Diss µg/L	Mn - Total µg/L	Mn - Diss µg/L	Zn - Total µg/L	Zn - Diss µg/L
8/21/2006	10	20	180	1	< 1	1,420	860	< 0.3	< 0.3	90	100	6	6
2/22/2007	< 5	40	50	< 1	< 1	3,170	1,520	< 0.3	< 0.3	270	210	< 5	< 5
5/23/2007	23	20	530	< 1	< 1	3,590	1,670	< 0.3	< 0.3	170	100	8	< 5
7/24/2007	< 5	30	50	< 1	< 1	3,350	1,740	< 0.3	< 0.3	230	210	< 5	< 5
10/4/2007	< 5	10	100	< 1	< 1	1,280	870	< 0.3	< 0.3	70	-10	< 5	< 5
2/9/2008	< 5	30	60	< 1	< 1	2,910	1,450	2.2	< 0.3	220	220	< 5	< 5
5/11/2008	11	< 10	130	< 1	< 1	480	250	< 0.3	< 0.3	80	70	< 5	< 5
8/3/2008	< 5	20	60	< 1	< 1	3,090	970	< 0.3	< 0.3	350	340	< 5	< 5
9/24/2008	8	< 10	140	1	< 1	930	610	< 0.3	< 0.3	40	-10	< 5	< 5

Diss = dissolved

Table 5-2. Recent Water Quality Data for Specific Metals at Station 196 on 2004 Creek

Date	TSS mg/L	Hardness (mg/L as $CaCO_3$)	Al - Total µg/L	Cu - Total µg/L	Cu - Diss µg/L	Fe - Total µg/L	Fe - Diss µg/L	Pb - Total µg/L	Pb - Diss µg/L	Mn - Total µg/L	Mn - Diss µg/L	Zn - Total µg/L	Zn - Diss µg/L
8/23/2006	< 5	10	240	< 1	< 1	1,080	530	< 0.3	< 0.3	40	30	10	8
2/22/2007	< 5	30	30	< 1	< 1	1,050	500	< 0.3	< 0.3	100	80	< 5	< 5
5/23/2007	58	10	1200	3	< 1	2,270	690	< 0.3	< 0.3	100	50	10	< 5
7/24/2007	< 5	30	80	< 1	< 1	1,450	830	< 0.3	< 0.3	140	130	< 5	< 5
10/4/2007	< 5	10	110	< 1	< 1	680	450	< 0.3	< 0.3	50	< 10	< 5	< 5
2/9/2008	< 5	20	30	< 1	< 1	720	450	< 0.3	< 0.3	50	50	< 5	< 5
5/11/2008	< 5	< 10	130	< 1	< 1	380	210	< 0.3	< 0.3	20	20	< 5	< 5
8/3/2008	< 5	20	40	< 1	< 1	880	460	< 0.3	< 0.3	60	50	< 5	< 5
9/24/2008	< 5	< 10	130	< 1	< 1	490	490	< 0.3	< 0.3	40	-10	< 5	< 5

Diss = dissolved

Table 5-3. Recent Groundwater Quality for the Sub Red 1 Sand Formation

Date	TSS	Hardness	Al - Total	Cu - Total	Cu - Diss	Fe - Total	Fe - Diss	Pb - Total	Pb - Diss	Mn - Total	Mn - Diss	Zn - Total	Zn - Diss
	mg/L	(mg/L as CaCO3)	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
7/12/2006	< 5	10	< 20	< 1	< 1	70	70	< 0.3	< 0.3	< 10	10	< 5	6
9/26/2006	< 5	10	< 20	< 1	< 1	70	70	0.5	< 0.3	< 10	< 10	10	8
3/4/2007	< 5	< 10	< 20	< 1	< 1	70	60	< 0.3	< 0.3	< 10	< 10	< 5	< 5
6/6/2007	< 5	< 10	< 20	< 1	< 1	100	70	< 0.3	< 0.3	< 10	< 10	< 5	< 5
8/1/2007	< 5	10	< 20	< 1	< 1	80	70	< 0.3	< 0.3	< 10	< 10	< 5	< 5
11/3/2007	< 5	< 10	< 20	< 1	< 1	70	70	< 0.3	< 0.3	< 10	< 10	< 5	< 5
1/27/2008	< 5	< 10	< 20	2	< 1	1,270	70	5.7	< 0.3	10	10	< 5	< 5
5/28/2008	< 5	< 10	< 20	< 1	< 1	70	60	< 0.3	< 0.3	< 10	< 10	< 5	< 5
7/27/2008	< 5	< 10	< 20	< 1	< 1	70	60	0.4	< 0.3	< 10	< 10	< 5	< 5

Diss = dissolved

Table 5-4. Recent Groundwater Quality Data for the Glacial Drift Formation

Date	TSS	Hardness	Al - Total	Cu - Total	Cu - Diss	Fe - Total	Fe - Diss	Pb - Total	Pb - Diss	Mn - Total	Mn - Diss	Zn - Total	Zn - Diss
	mg/L	(mg/L as CaCO3)	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
8/21/2006	304	60	1,130	3	< 1	59,200	3,620	6.3	< 0.3	1,570	650	127	37
2/22/2007	136	50	1,410	4	< 1	50,100	310	6.8	< 0.3	1,900	230	184	44
5/23/2007	36	50	250	10	4	9,560	4,160	1.3	< 0.3	630	520	15	< 5
7/24/2007	5	50	30	< 1	< 1	5,310	4,500	< 0.3	< 0.3	490	440	5	< 5
10/4/2007	< 5	50	< 20	1	< 1	4,620	4,030	0.4	< 0.3	470	440	< 5	< 5
2/9/2008	< 5	50	< 20	< 1	< 1	4,510	4,130	< 0.3	< 0.3	450	440	< 5	< 5
5/11/2008	< 5	50	< 20	1	< 1	3,790	3,660	< 0.3	< 0.3	460	450	< 5	< 5
8/3/2008	< 5	50	< 20	< 1	< 1	7,080	3,760	< 0.3	< 0.3	550	420	< 5	< 5
9/24/2008	26	50	290	2	< 1	4,430	3,540	< 0.3	< 0.3	440	420	< 5	< 5

Diss = dissolved

Table 5-5. NPDES Groundwater Outfall Discharge Summary (values in cfs)

Year of Mining	2002 Creek				2003 Creek				2004 Creek	
	GWD-2002-01	GWD-2002-02	GWD-2002-03	GWD-2002-04	GWD-2003-01	GWD-2003-02	GWD-2003-03	GWD-2003-04	GWD-2004-01	GWD-2004-02
0	1.10	--	--	--	0.18	--	--	--	--	--
1	1.43	--	--	--	0.52	--	--	--	--	--
2	1.67	--	--	--	1.31	0.23	--	--	--	--
3	1.86	--	--	--	1.58	0.42	--	--	--	--
4	2.07	--	--	--	1.42	0.55	--	--	--	--
5	1.09	--	--	--	1.53	0.80	--	--	--	--
6	2.26	--	--	--	--	--	1.59	1.59	--	--
7	2.34	--	--	--	--	--	1.84	1.84	--	--
8	2.39	--	--	--	--	--	2.15	2.15	--	--
15	0.80	0.63	--	--	--	--	1.26	1.26	0.19	--
22	--	0.51	0.74	0.51	--	--	2.61	--	0.21	0.79
26	--	--	--	--	--	--	--	--	--	--

Note: Discharges are assumed to be constant throughout a given mining year.

Table 5-5. NPDES Surface Water Outfall Discharge Estimate Summary – Average Conditions

Year of Mining	NPDES Outfall I.D.	NPDES Surface Water Outfall Discharges (cfs), by Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	SP-Y00-03	0.00	0.00	0.00	1.51	6.19	1.83	0.29	1.05	2.95	3.20	0.62	0.16
	SP-Y00-04	0.00	0.00	0.00	0.22	0.96	0.32	0.06	0.18	0.45	0.46	0.09	0.02
	SP-Y00-05	0.00	0.00	0.00	0.26	1.36	0.54	0.12	0.32	0.60	0.55	0.11	0.03
1	SP-Y00-03	0.09	0.07	0.09	1.60	9.79	2.56	0.98	1.76	3.62	3.85	1.31	0.25
	SP-Y00-04	0.00	0.00	0.00	0.22	0.96	0.32	0.06	0.18	0.45	0.46	0.09	0.02
	SP-Y00-05	0.00	0.00	0.00	0.26	1.36	0.54	0.12	0.32	0.60	0.55	0.11	0.03
2	SP-Y00-03	0.21	0.15	0.20	2.23	11.47	3.53	1.13	2.30	4.71	4.85	1.45	0.42
	SP-Y00-04	0.00	0.00	0.00	0.22	0.96	0.32	0.06	0.18	0.45	0.46	0.09	0.02
	SP-Y00-05	0.00	0.00	0.00	0.26	1.36	0.54	0.12	0.32	0.60	0.55	0.11	0.03
	MI(SP)-Y00-03	0.00	0.00	0.00	0.18	0.59	0.11	0.00	0.06	0.30	0.38	0.07	0.02
3	SP-Y00-03	0.23	0.16	0.22	2.52	22.45	6.13	2.95	4.47	7.06	6.95	3.10	0.47
	SP-Y00-04	0.00	0.00	0.00	0.22	0.96	0.32	0.06	0.18	0.45	0.46	0.09	0.02
	SP-Y00-05	0.00	0.00	0.00	0.26	1.36	0.54	0.12	0.32	0.60	0.55	0.11	0.03
	MI(SP)-Y00-01	0.00	0.00	0.00	0.25	0.84	0.16	0.00	0.09	0.43	0.53	0.10	0.03
	MI(SP)-Y00-02	0.00	0.00	0.00	0.22	0.80	0.19	0.02	0.11	0.40	0.46	0.09	0.02
	MI(SP)-Y00-03	0.00	0.00	0.00	0.33	1.29	0.35	0.05	0.20	0.62	0.70	0.14	0.04
4	SP-Y00-03	0.31	0.22	0.30	4.00	28.48	8.33	3.38	5.76	9.99	9.91	3.69	0.70
	SP-Y00-04	0.00	0.00	0.00	0.22	0.96	0.32	0.06	0.18	0.45	0.46	0.09	0.02
	SP-Y00-05	0.00	0.00	0.00	0.26	1.36	0.54	0.12	0.32	0.60	0.55	0.11	0.03
	MI(SP)-Y03-01	0.00	0.00	0.00	0.07	0.24	0.04	0.00	0.02	0.12	0.15	0.03	0.01
	MI(SP)-Y03-02	0.00	0.00	0.00	0.09	0.31	0.06	0.00	0.03	0.16	0.20	0.04	0.01
	MI(SP)-Y03-03	0.00	0.00	0.00	0.16	0.54	0.11	0.00	0.06	0.28	0.34	0.07	0.02
	SP-Y04-01	0.00	0.00	0.00	0.75	3.00	0.86	0.13	0.49	1.44	1.58	0.31	0.08
5	SP-Y00-03	0.38	0.27	0.37	4.63	28.51	9.25	3.24	6.11	10.87	10.58	3.44	0.84
	SP-Y00-04	0.00	0.00	0.00	0.22	0.96	0.32	0.06	0.18	0.45	0.46	0.09	0.02
	SP-Y00-05	0.00	0.00	0.00	0.26	1.36	0.54	0.12	0.32	0.60	0.55	0.11	0.03

Year of Mining	NPDES Outfall I.D.	NPDES Surface Water Outfall Discharges (cfs), by Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	SP-Y05-01	0.00	0.00	0.00	0.19	0.66	0.14	0.01	0.07	0.33	0.40	0.08	0.02
	SP-Y04-01	0.00	0.00	0.00	0.75	3.00	0.86	0.13	0.49	1.44	1.58	0.31	0.08
6	SP-Y06-01	0.47	0.33	0.45	5.61	35.34	11.38	4.06	7.56	13.32	12.95	4.30	1.02
	SP-Y00-04	0.00	0.00	0.00	0.22	0.96	0.32	0.06	0.18	0.45	0.46	0.09	0.02
	SP-Y00-05	0.00	0.00	0.00	0.26	1.36	0.54	0.12	0.32	0.60	0.55	0.11	0.03
	MI(SP)-Y05-01	0.00	0.00	0.00	0.10	0.33	0.06	0.00	0.03	0.17	0.21	0.04	0.01
	MI(SP)-Y04-02	0.00	0.00	0.00	0.06	0.19	0.04	0.00	0.02	0.10	0.12	0.02	0.01
	MI(SP)-Y04-01	0.00	0.00	0.00	0.16	0.56	0.11	0.00	0.06	0.28	0.35	0.07	0.02
	SP-Y04-01	0.00	0.00	0.00	0.74	2.99	0.85	0.13	0.49	1.43	1.58	0.31	0.08
7	SP-Y06-01	0.55	0.39	0.53	6.59	42.75	13.61	4.99	9.10	15.86	15.41	5.25	1.20
	SP-Y00-04	0.00	0.00	0.00	0.22	0.96	0.32	0.06	0.18	0.45	0.46	0.09	0.02
	SP-Y00-05	0.00	0.00	0.00	0.26	1.36	0.54	0.12	0.32	0.60	0.55	0.11	0.03
	SP-Y04-01	0.00	0.00	0.00	0.74	2.98	0.85	0.13	0.49	1.43	1.57	0.31	0.08
8	SP-Y06-01	0.66	0.46	0.63	7.15	44.08	14.40	5.10	9.54	16.78	16.27	5.37	1.35
	SP-Y00-04	0.00	0.00	0.00	0.22	0.96	0.32	0.06	0.18	0.45	0.46	0.09	0.02
	SP-Y00-05	0.00	0.00	0.00	0.26	1.36	0.54	0.12	0.32	0.60	0.55	0.11	0.03
	SP-Y08-01	0.00	0.00	0.00	0.06	0.19	0.04	0.00	0.02	0.10	0.12	0.02	0.01
	MI(SP)-07-02	0.00	0.00	0.00	0.08	0.28	0.05	0.00	0.03	0.14	0.18	0.03	0.01
	SP-Y04-01	0.00	0.00	0.00	0.74	2.98	0.85	0.13	0.49	1.43	1.57	0.31	0.08
15	SP-Y06-01	0.66	0.46	0.64	8.77	44.69	13.29	4.13	8.60	18.40	19.25	5.60	1.52
	SP-Y00-04	0.00	0.00	0.00	0.22	0.96	0.32	0.06	0.18	0.45	0.46	0.09	0.02
	SP-Y00-05	0.00	0.00	0.00	0.26	1.36	0.54	0.12	0.32	0.60	0.55	0.11	0.03
	SP-Y00-01	0.00	0.00	0.00	0.41	2.09	0.82	0.18	0.48	0.93	0.86	0.17	0.04
	SP-Y15-03	0.21	0.15	0.21	1.07	8.68	2.63	1.28	1.92	2.82	2.67	1.27	0.30
	SP-Y15-02	0.00	0.00	0.00	0.35	1.38	0.39	0.06	0.22	0.66	0.74	0.14	0.04
	SP-Y15-01	0.15	0.11	0.15	0.95	7.12	2.21	0.98	1.57	2.42	2.31	0.99	0.24
	SP-Y04-01	0.18	0.13	0.17	1.97	11.49	3.38	1.23	2.28	4.39	4.50	1.50	0.37
22	SP-Y16-01	0.00	0.00	0.00	0.09	0.31	0.06	0.00	0.03	0.16	0.19	0.04	0.01

Year of Mining	NPDES Outfall I.D.	NPDES Surface Water Outfall Discharges (cfs), by Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	SP-Y06-01	0.11	0.08	0.11	8.26	38.30	8.49	2.18	5.41	16.23	18.83	4.96	0.98
	SP-Y00-04	0.00	0.00	0.00	0.22	0.96	0.32	0.06	0.18	0.45	0.46	0.09	0.02
	SP-Y00-05	0.00	0.00	0.00	0.26	1.36	0.54	0.12	0.32	0.60	0.55	0.11	0.03
	SP-Y00-01	0.00	0.00	0.00	1.26	5.64	1.88	0.35	1.09	2.61	2.68	0.52	0.13
	SP-Y20-02	0.00	0.00	0.00	0.45	2.10	0.73	0.15	0.43	0.96	0.96	0.19	0.05
	SP-Y22-02	0.11	0.08	0.10	0.97	8.99	2.49	1.23	1.83	2.78	2.69	1.26	0.20
	SP-Y21-02	0.13	0.09	0.13	0.81	9.42	2.52	1.42	1.94	2.65	2.52	1.39	0.20
	SP-Y20-01	0.00	0.00	0.00	1.06	5.24	1.97	0.42	1.16	2.35	2.25	0.44	0.11
	SP-Y21-01	0.00	0.00	0.00	0.40	1.74	0.57	0.10	0.33	0.81	0.84	0.16	0.04
	SP-Y04-01	0.15	0.11	0.15	1.35	7.13	2.33	0.77	1.52	2.90	2.90	0.90	0.28
26	SP-Y16-01	0.00	0.00	0.00	0.09	0.30	0.06	0.00	0.03	0.16	0.19	0.04	0.01
	SP-Y06-01	0.00	0.00	0.00	10.16	37.50	9.12	0.92	5.10	18.50	21.53	4.20	1.08
	SP-Y00-04	0.00	0.00	0.00	0.17	0.86	0.33	0.07	0.19	0.39	0.37	0.07	0.02
	SP-Y00-05	0.00	0.00	0.00	0.26	1.36	0.54	0.12	0.32	0.60	0.55	0.11	0.03
	SP-Y00-01	0.00	0.00	0.00	0.03	0.10	0.03	0.00	0.02	0.05	0.06	0.01	0.00
	SP-Y20-02	0.00	0.00	0.00	0.43	1.42	0.26	0.00	0.14	0.73	0.91	0.18	0.05
	SP-Y21-02	0.00	0.00	0.00	0.02	0.07	0.02	0.00	0.01	0.04	0.04	0.01	0.00
	SP-Y20-01	0.00	0.00	0.00	1.06	3.52	0.65	0.00	0.35	1.81	2.25	0.44	0.11
	SP-Y23-01	0.00	0.00	0.00	0.37	1.90	0.75	0.17	0.45	0.84	0.77	0.15	0.04
	SP-Y21-01	0.00	0.00	0.00	0.40	1.32	0.24	0.00	0.13	0.68	0.84	0.16	0.04
	SP-Y04-01	0.00	0.00	0.00	0.72	2.95	0.87	0.14	0.50	1.40	1.53	0.30	0.08

Table 5-6. Groundwater Temperature for the Glacial Drift Unit.

Well ID	Unit	Date	Temp °C
07A2	Glacial Drift	4/26/1982	4.4
07A2	Glacial Drift	7/23/1982	6.7
22H2-G	Glacial Drift	7/15/2006	4.2
23T	Glacial Drift	7/12/2006	7.1
23T	Glacial Drift	9/26/2006	5.6
26C1	Glacial Drift	7/16/1982	6.1
27G	Glacial Drift	7/19/1982	7.8
27G	Glacial Drift	6/23/1983	5.5
28S	Glacial Drift	7/13/2006	8.5
28S	Glacial Drift	9/26/2006	5.5
35U	Glacial Drift	7/12/2006	6.2
G19B	Glacial Drift	9/29/2006	3.7
G20A	Glacial Drift	9/29/2006	3.9
		Average	5.8
		Min	3.7
		Max	8.5

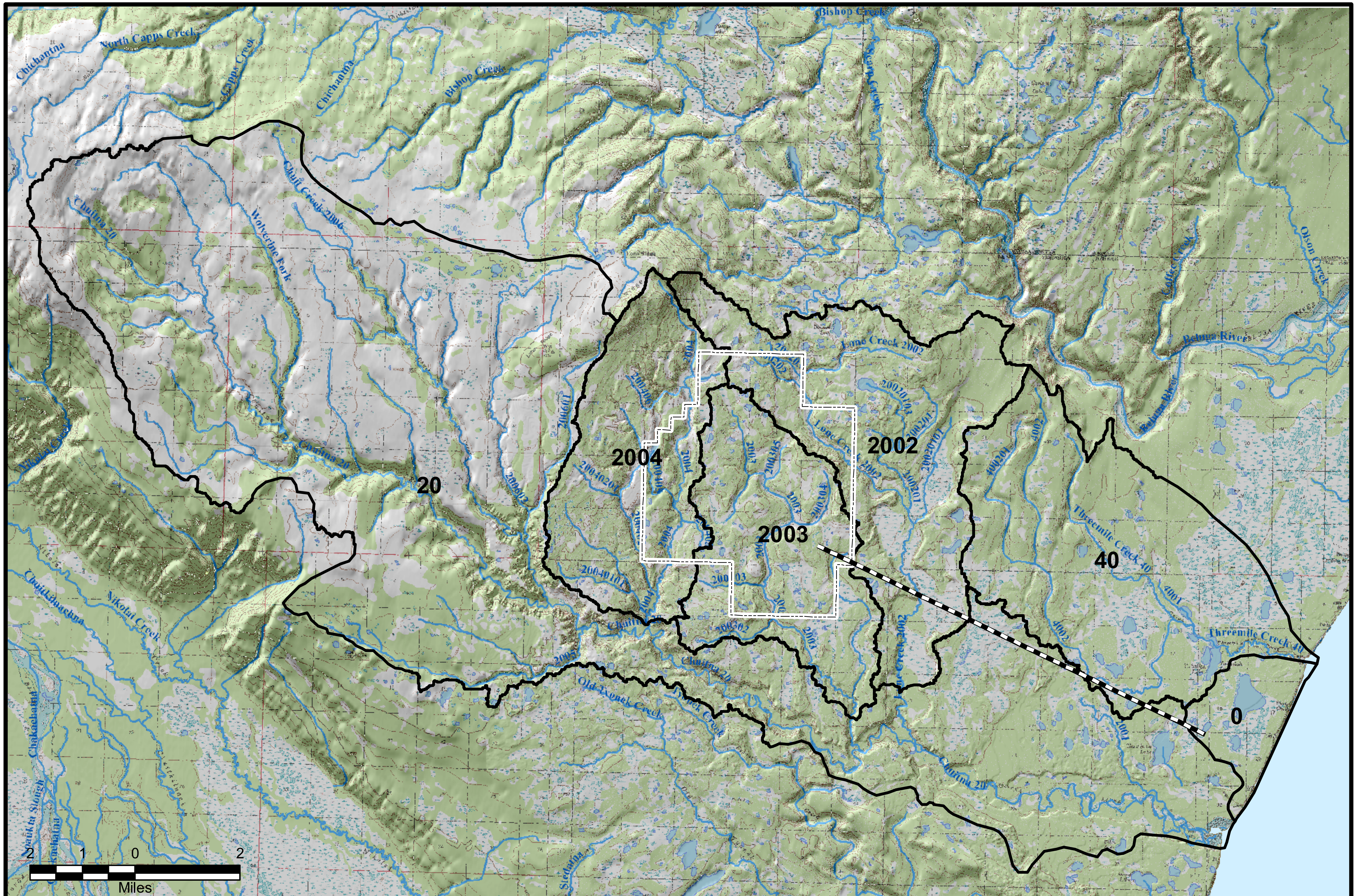
Adapted from RTI (2007)

Table 5-7. Groundwater Temperature for the Sub Red 1 Sand Unit.

Well ID	Unit	Date	Temp °C
24D2	Sub Red 1 Sand	4/20/1982	4.4
24D2	Sub Red 1 Sand	7/25/1982	6.7
24D2	Sub Red 1 Sand	6/22/1983	6.0
24D2	Sub Red 1 Sand	10/23/1983	6.0
27G1U	Sub Red 1 Sand	7/13/2006	4.9
35G1	Sub Red 1 Sand	4/22/1982	5.6
35G1	Sub Red 1 Sand	7/17/1982	6.1
35G1	Sub Red 1 Sand	7/12/2006	8.0
35G1	Sub Red 1 Sand	9/26/2006	6.7
		Average	6.0
		Min	4.4
		Max	8.0

Adapted from RTI (2007)

FIGURES



Legend

Conveyor

Permit Boundary

Subbasins

Notes:

Datum/Coordinate system:
NAD 83 Alaska State Plane
Zone 4 foot

Hillshade derived from:
MSL_Chuitna400-ACAD2000.dwg
and USGS NED DEM

Topography from USGS 1:63360 DRG

N

1 in. = 2 miles

No	Revision	Date	By	CHKD

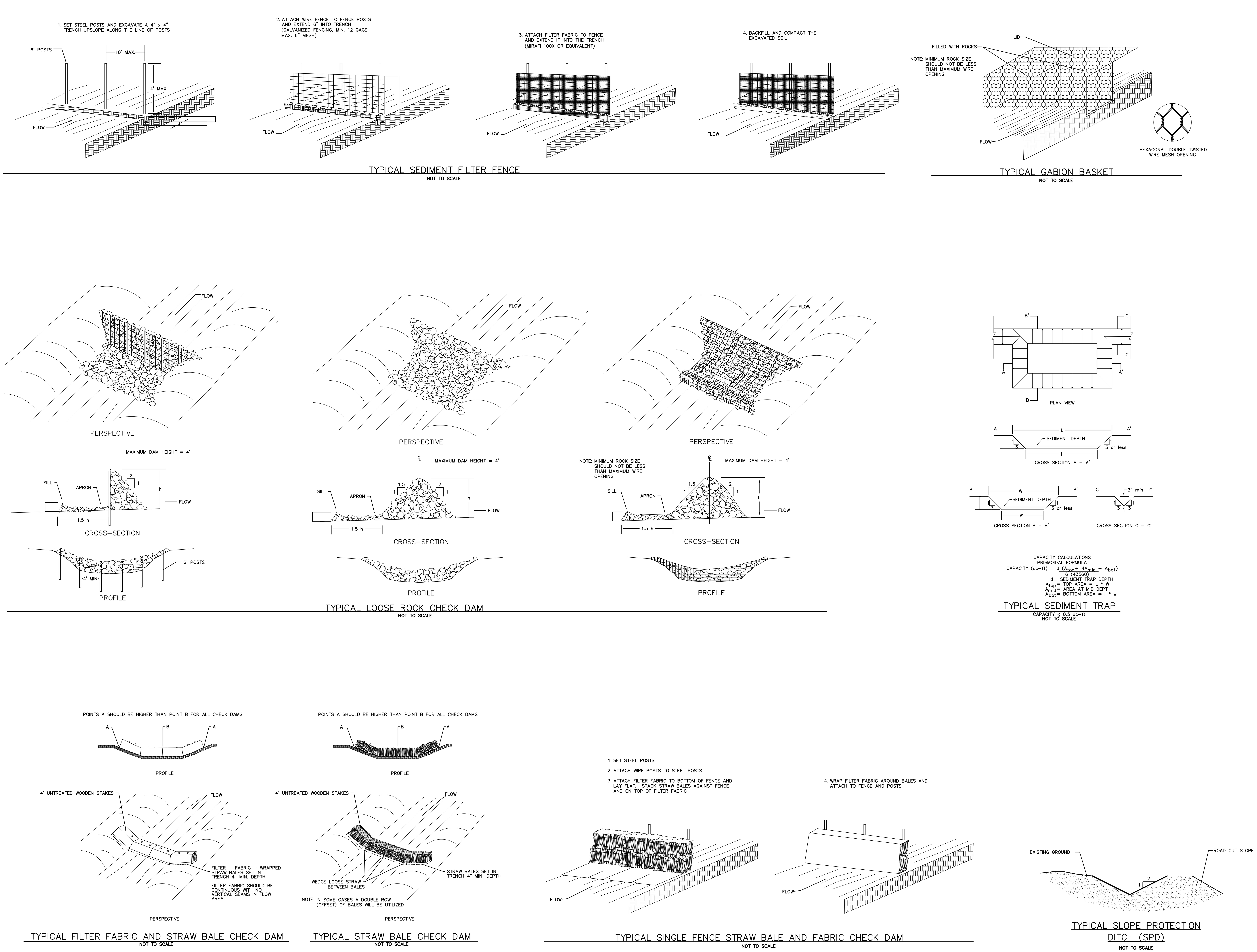
Chuitna Coal Project
Chuitna Coal Mine

Title: Chuit River and Project Area Watersheds

Scale	Date	Design	Projection
1:126,720	7/10/2009	KH	NAD83 AK SP Z4 ft

Pacific Rim Coal, LP
1007 W 3rd Ave, Suite 304
Anchorage, AK 99501 USA
Phone: (907) 276-6868

Fig. 1-1



Notes

1. Final wire gage specifications for fencing shall be determined on a site-specific basis depending upon estimated design peak flow rates.

2. Maintenance of alternative sediment control measures (ASCM) will be performed at a frequency appropriate for the type of structure utilized. Structures will be inspected following significant runoff events. Repairs to ASCM's will be initiated promptly following any inspection where problems are noted.

PRELIMINARY
NOT FOR
CONSTRUCTION

PROFESSIONAL ENGINEERS CERTIFICATION

No.	REVISION	DATE	BY	CHKD

Chuitna Coal Project
Chuitna Coal Mine

Title: *Alternative Sediment Control Structure Details*

Scale:	Date:	Design By:	Drawn By:	Approved By:
As Shown	07/09	EKB	DSF	——

PacRim Coal, LP
711 H Street, Suite 350
Anchorage, AK 99501 USA
Phone: (907) 276-6868

Fig. 3-1

APPENDIX A
WATER MANAGEMENT PLAN MAPS

APPENDIX B
STREAM FLOW SUMMARY TABLES

APPENDIX C
WATER MANAGEMENT CALCULATION DETAILS (ON CD)