0005

STATE OF UTAH
NATURAL RESOURCES
Oil, Gas & Mining

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355 W. North Temple • 3 Triad Center • Suite 350 • Salt Lake City, UT 84180-1203 • 801-538-5340

May 21, 1986

Mr. Douglas C. Pearce, Mine Engineer
Kaiser Coal Corporation
P.O. Box D
Sunnyside, Utah 84539

Dear Mr. Pearce:

Re: Wellington Preparation Plant, Request to Modify Water Monitoring Program, ACT/007/012, Carbon, County, Utah.

The Division has received and reviewed your request to modify the water monitoring program at the Wellington Preparation Plant (dated April 9, 1986). The Division is prepared to give partial approval for this request at this time. Approval is granted for the following:

1. Frequency of monitoring for SW-1 through SW-8 exclusive of SW-3 is modified to biannual (twice per year) with one sample to be taken at each the high flow and low flow periods.

2. The qualtiy parameter list for the above points will conform to the parameter list given for operational monitoring in the Division's Water Quality Monitoring Guidelines (enclosed for your reference).

Monitoring for the groundwater sites (GW-1 through GW-14) must continue on the currently approved (quarterly) schedule until the baseline data aquisition requirements are met. The parameter list for those points must conform to the baseline parameter list given in the Division's Water Quality Monitoring Guidelines.

A copy of the technical memo outlining the rationale for our decision is attached for your information. For operational monitoring points that will not be discharging during the cessation of operations, the applicant should simply note on the quarterly report that the current status of the point was no discharge.

The Division requests that the information noted in the recommendation section of the enclosed memo concerning SW-3 and BCW be clarified.

FILE COPY

In order for Kaiser Coal to come into compliance with the recently adopted Water Quality Monitoring Guidelines, the following parameters must be added to the monitoring schedule: (1) oil and grease for applicable sites, (2) settable solids, (3) field temperature, (4) dissolved oxygen (except for groundwater sites), (5) and a cation-anion balance for each sample analysis. Flow measurements must also be taken for each sample.

When Kaiser Coal Corporation has completed the baseline data aquisition requirements for sites GW-1 through GW-14, the Division will be receptive to a modification to additionally reduce the monitoring requirements for those sites during the temporary cessation period.

Thank you for your time to keep the Division posted of the activities at the Wellington Preparation Plant. If you have any questions on this review, please contact myself or Rick Summers of my technical staff.

Sincerely,

L. P. Braxton

L. P. Braxton
Administrator
Mineral Resource Development
and Reclamation Program

RPS:crh
cc: D. Lof
S. Linner
D. Cline
6000R-27.

May 21, 1986

TO: Technical File

FROM: Rick P. Summers, Hydrologist RPS

RE: Kaiser Coal Corporation, Wellington Preparation Plant, ACT/007/012, Carbon County, Utah.

Summary:

Kaiser Coal Corporation submitted a request (dated April 9, 1985) to reduce the frequency of water monitoring at the Wellington Prep. Plant due to a temporay cessation of operations. A review of the data submitted to the Division indicated that this proposal is only partially approvable at this time. The data is summarized in the body of this memo. Essentially, a complete water monitoring program for the surface water sites (SW-1, SW-2, SW-4, SW-5, SW-7, and SW-8) was initiated in November of 1983. According to the Division's water quality guidelines, a two year period of baseline data must be collected (guidelines attached). The applicant has submitted two years of data which was collected quarterly for surface water points. Therefore, the Division is prepared to grant approval for a modified monitoring program to be implemented during the period of temporary cessation of operations for the surface water points SW-1 through SW-8 exclusive of SW-3.

Groundwater monitoring was intitiated in November of 1984 and to date, the only samples collected for 1984 include that single sample. Samples were collected quarterly for 1985 and the analysis results have been submitted to our office. The applicant has not met the baseline data aquisition requirements (two years) for groundwater sampling sites GW-1 through GW-14.

Additionally, while this review was conducted, it was noted that the required parameters that need to be sampled are deficient. These are outlined below.

Recommendations:

Respond to the applicant with a partial approval letter for the modification. The applicant must complete the baseline data aquisition requirements for the groundwater sites before any modifications to the monitoring program for those sites can be considered. Therefore, the applicant may reduce the monitoring requirements for points SW-1 through SW-8 exclusive of SW-3 to the following:

1. Sampling must be biannual (twice per year) with one sample each at high and low flow periods.

2. The sampling parameters must conform to the operation parameters of the Division Water Quality Guidelines (enclosed for applicant's reference).

Sampling for the groundwater sites GW-1 through GW-14 must continue on the current frequency (quarterly) until the baseline data requirements are met. The applicant must use the required parameter list for baseline data outlined in the Division's Water Quality Monitoring Guidelines.

No data for sampling point SW-3 has been submitted to date. The applicant should justify why no data has been collected at this site (i.e. Division approved modification to the monitoring plan). Additionally, the data set appears to be incomplete for sampling site BC-W. The applicant should clarify this situation.

The applicant must also be requested to implement the Division water quality monitoring guidelines. In addition to the current parameter list the applicant must add the following: (1) oil and grease for applicable sites, (2) settable solids, (3) field temperature, (4) dissolved oxygen (except for groundwater sites), (5) and a cation-anion balance for each sample analysis. Flow measurements must also be taken for each sample. To date, the applicant has taken 52 flows for the submitted 112 samples taken since January 1983.

cc: S. Linner
D. Lof
D. Cline
6000R-25,26,28 & 29

Body: Data on file w/the Division indicate the following:

sw (surface water points)

Date (collected)	Points sampled:	Comments:
1-14-83	A, B, D	No flows
4-25-83	A, B, D	No flows
8-17-83	A, B, D	No flows
11-14-83	A, B, D	No flows
1-13-84	1, 2, 4, 5, 6, 7, 8	No flows
3-14-84	1, 2, 4, 5, 6, 7, 8	
5-11-84	1, 2, 4, 5, 6, 7, 8	
7-27-84	1, 2, 4, 5, 6, 7, 8	
9-21-84	1, 2, 4, 5, 6, 7, 8	for #1, 2, 4 only flows attached for sw-1, 2, 4, only.
11-27-84	1, 2, 4, 5, 6, 7, 8	
1-29-85	1, 2, 4, 5, 6, 7, 8	
3-18-85	BCW, 1, 2, 4, 5, 6, 7, 8	
5-28-85	BCW, 1, 2, 4, 5, 6, 7, 8	
7-31-85	BCW, 1, 2, 4, 5, 6, 7, 8	
9-26-85	BCW, 1, 2, 4, 5, 6, 7, 8	
11-22-85	BCW, 1, 2, 4, 5, 6, 7, 8	

2-14-86	1, 2, 4, 5, 6, 7, 8	Flow attached for #1, 2, 3*, 4 *no quality data.

Ground Water Wells:

11-29-84	#1-14	Note:
2-18-85	#1-14	SW-5 - no flows
5-28-85	#1-14	SW-6 - no flows
8-30-85	#1-14	SW-7 - no flows
11-22-85	#1-14	SW-8 - no flows

Summary of Dates on file

Surface Water:	Comment
1983: January, April, August, November	1st 3 only 3 pts.
1984: January, March, May, July, Sept. Nov.	
1985: January, March, May, July, Sept., Nov.	

Groundwater:

1984: November

1985: Feb., May, August, Nov.

1986: No samples submitted

(Revised January 1986)

STATE OF UTAH
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF OIL, GAS AND MINING
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GUIDELINES FOR ESTABLISHMENT OF SURFACE AND GROUND WATER MONITORING PROGRAMS FOR COAL MINING AND RECLAMATION OPERATIONS

This guideline document provides suggestions to coal operators for compliance with Sections UMC 783.13, 783.15-.17, 817.41-.42, 817.52-.54, of the rules and regulations pursuant to the Coal Mining and Reclamation Operations Act of 1979, Chapter 10, Title 40, UCA.

The purpose of these guidelines is to provide direction in acquiring a data base to be used by the operator for determining the probable hydrologic consequences of proposed and existing mining and reclamation operations (UMC 784.14[c]). This information will allow the Division of Oil, Gas and Mining to assess the probable cumulative impacts of anticipated or existing mining operations on the hydrologic balance in the general area (UMC 786.19[c]). The determination and assessment will apply to the mine plan and adjacent area with respect to the hydrologic regime and include the quantity and quality of the water in the surface and ground water systems. Moreover, the assessment will help insure that a proper mining and reclamation plan is developed and adopted to minimize hydrologic impacts both on- and offsite. The Act and regulations require that hydrologic monitoring take place before, during and after mining and reclamation operations. The operator is responsible for minimizing the impact and/or disturbance to the prevailing hydrologic balance.

This document is intended to delineate and reference acceptable methodologies and procedures that may be used to collect, analyze and interpret hydrologic data as set forth in the requirements of the regulations. These methods are not considered mandatory but do represent the Division's best approximation of required information to address the regulations for most situations. These methods may be modified with the Division's approval to reflect the characteristics of a particular situation.

It is highly recommended that prior to initiating data acquisition (including exploration drilling) or monitoring programs, operators contact the Division to arrange a conference to develop a suitable approach for characterizing water resources and thereby cost effectively and expeditiously achieve regulatory compliance.

The Utah State Division of Oil, Gas and Mining reserves the right to alter these guidelines as field experience, research and practical demonstrations delineate a better understanding of hydrologic processes in Utah's coal mining regions.

I. Surface Water Hydrology

A. Identification of surface water systems.

1. Determine watershed basin characteristics (with map of a scale 1:24,000 or larger).

a. Delineate drainage basin boundaries and include watershed names.

b. Describe physical characteristics (topographic relief, slope, drainage patterns).

B. Baseline data to establish surface water conditions.

1. Compile existing flow and quality data on streams and reservoirs from state and federal agencies, private agencies, past and on-going mining operations, regulatory agencies, etc.

2. Inventory all streams, lakes, reservoirs and impoundments within permit area and adjacent and downstream areas which could potentially be affected by mining.

a. Stream information to be inventoried:

(1) location of primary channel and tributaries;

(2) historical and present seasonal variability of flows and water quality;

(3) categorization of stream (i.e., perennial, intermittent or ephemeral) based on above information;

(4) water usage, water rights and permission for sampling.

b. Lake, reservoir and impoundment information to be inventoried:

(1) location and relationship to local drainage;

(2) composition of material of impounding dam; length of crest and height of dam from upstream toe to top of crest;

(3) historical and present seasonal variability of water levels and water quality;

(4) water usage, water rights and permission for sampling.

3. Determine on-site erosion rates and sediment yields. Refer to B.5.c for acceptable methodology.

4. Selection of baseline monitoring sites:

B.4. (continued)

a. Sites shall include a combination of lake, reservoir, impoundment and stream locations.

b. The number of monitoring sites is dependent upon the:

(1) complexity of the surface water system;

(2) size of mine plan area.

c. In general for streams, samples should be taken upstream and downstream from affected areas.

All sites for measurement of stream flow need not be sampled for quality, but all quality samples should be accompanied by a flow measurement.

All quality samples should be accompanied by the current maximum water level measurement of reservoir or lake.

5. Data acquisition.

a. Stream flow measurement and analyses.

(1) Flow measurements can be made using a current meter, flume (portable or permanent), weir, stage recorder, or other applicable method as approved by the Division, giving a reliable flow estimate. Refer to Water Measurement Manual, U. S. Bureau of Reclamation 1974 for other accepted methods of flow determination.

(2) Water samples should be collected in accordance with: Methods for Collection and Analysis of Water Samples for Dissolved Minerals and Gases, National Handbook of Recommended Methods for Water Data Acquisition, 1977, and Methods for Chemical Analysis of Water and Wastes, EPA, March 1979.

(3) Ephemeral streams should be sampled by use of a crest gage (or similar device) and single stage sediment sampler.

(4) Stream sampling and analysis.

(A) Frequency and duration, refer to Table 2.

(B) Field measurements, refer to Table 1.

(C) Laboratory analyses, refer to Table 1.

B.5. (continued)

b. Lake, reservoir, impoundment measurement and analyses.

(1) Maximum lake level data should be collected by taking readings from a stadia staff installed in the lake itself.

(2) Water samples should be collected by use of a Kemmerer depth sampler, a similar weight- activated device or other device approved by the Division.

(3) Lake/reservoir sampling and analysis.

(A) Frequency and duration, refer to Table 2.

(B) Field measurements, refer to Table 1.

(C) Laboratory analyses, refer to Table 1. Other parameters determined to be specific to operational processes may be analyzed.

c. Soil loss and sediment yield analyses.

Onsite soil losses and sediment yields can be predicted using the Universal Soil Loss Equation (USLE), Modified Universal Soil Loss Equation (MUSLE), Pacific Southwest Interagency Committee (PSIAC), a sediment test plot or other applicable professionally practiced method(s) and models.

6. Predict or describe the consequences of mining and reclamation on the existing flow regime, including peak flows, low flows, water yield, chemical water quality, erosion and sediment and aquatic biota.

a. Submit a minimum of one year baseline data in the Permit Application Package (PAP) in accordance with Table 2.

b. Interpret baseline data to provide information in the PAP about the probable hydrologic consequences from mining of the quantity and quality of surface water.

C. Operational monitoring.

1. Construction monitoring.

a. Submit a monitoring plan which will demonstrate that on a weekly basis, total suspended solids and total settleable solids will not be excessive during construction activities.

b. Other water quality parameters may require analysis by the Division on a site-specific basis.

C. (continued)

2. Streams.

a. Select, with Division approval, representative stream sites for operational monitoring.

b. Monitor selected sites as described in Table 2.

c. Parameter selection and analysis frequency as described in Table 1 and Table 2, respectively.

3. Lakes, reservoirs and impoundments.

a. Select with Division approval representative lake locations for operational monitoring.

b. Continue measuring and sampling selected sites as described in Table 2.

c. Parameter selection and analysis frequency as described in Table 1 and Table 2, respectively.

4. Submit monitoring results quarterly, with an annual summary. The annual summary must analyze variance in flow characteristics and water quality and should include tables, graphs, hydrographs, etc.

D. Postmining monitoring--begins one year after cessation of earthmoving and site activity.

1. Identify representative stream and lake sites for measuring and sampling.

2. Continue monitoring representative sites as described in Table 2.

3. Parameter selection and analysis frequency as described in Table 1 and Table 2, respectively.

4. Submit monitoring data annually. Summarize and assess mining impacts and system recovery at the termination of the bonding period.

II. Ground Water Hydrology

A. Geology of the ground water system.

Describe the general geology for the mine plan and adjacent area down to and including the first aquifer below the lowest coal seam to be mined. Pertinent information may be derived from published literature. The description shall include:

1. Stratigraphic column(s) characteristic of the property.

A.1. (continued)

2. Cross-section(s) showing extent, thickness and continuity of all aquifers and confining layers.

3. Stratigraphy and geologic structure that may control or potentially affect aquifers.

   a. Depositional and/or erosional facies relationships.

   b. Intrusions.

   c. Faults, folds and joints.

   d. Regional and, if variable, local strike and dip.

4. Potential hydrologic boundaries (i.e., faults, incised drainages and other structural features) and:

   a. Recharge and discharge areas.

   b. Significant perched aquifers.

   c. Local and regional aquifer systems.

B. Baseline data to establish ground water conditions.

1. Inventory all ground water wells, springs and seeps, mine inflows and water usage and water rights within and adjacent to the permit area. Identify seasonal variability in water levels and/or flow and quality.

   a. Well information to be inventoried:

      (1) Location, total depth, diameter and owner(s) of well(s).

      (2) Well yield, water quality and local usage.

      (3) Casing depth, type of casing, perforated interval(s) and monitoring zone(s).

      (4) Elevation at well and static water level.

      (5) Past well problems, historic water level and water quality fluctuation records, and permission to utilize the well for monitoring purposes, if needed.

      (6) Formation name(s) and/or rock type(s) and lithologic properties of aquifer(s).

      (7) Geophysical and driller logs.

   b. Spring and seep information to be inventoried:

B.1. (continued)

(1) Location, elevation, geologic occurrence and formation or rock type governing discharge.

(2) Present and historic flow and water quality.

(3) Local usage and permission for spring sampling.

c. Sustained mine inflow (e.g., wall weeps, roof bolt drips) and discharge information to be inventoried:

(1) Location and geologic occurrence.

(2) Present and historic inflow, discharge and water quality.

2. Selection of baseline monitoring sites.

a. Sites shall include, but not be limited to, a combination of:

(1) Existing water wells (as determined from inventory in B.1. above);

(2) Surface and subsurface boreholes drilled explicitly for ground water monitoring;

(3) Properly developed, cased and completed exploration boreholes;

(4) A representative number of springs as approved by the Division; and

(5) Mine inflows and/or discharges at representative sites within the mine.

b. Location, distribution and number of monitoring sites shall delineate gradients and directions of ground water flow. The number and density of monitoring points must reflect site-specific conditions.

(1) Monitoring sites should be located up- and down-gradient in the mine plan and adjacent area.

(2) For water quality monitoring, emphasis should be placed on sites down-gradient from the mine plan area. This does not eliminate the need for up-gradient quality monitoring.

(3) The number of monitoring sites is dependent upon the:

(A) Complexity and continuity of aquifer systems above and below the coal to be mined.

B.2. (continued)

(B) Size of the mine plan area.

(C) Results of findings from observation wells drilled for quality and water level monitoring, unless:

i. Sufficiently detailed site-specific ground water information is available.

ii. Appropriate wells exist within and adjacent to the mine plan area that can be used for ground water monitoring.

3. Data acquisition.

a. Well testing and analyses.

The following pumping tests and water level data should be used to determine transmissivity, hydraulic conductivity, specific capacity, storage coefficients and other aquifer properties such as homogeniety, isotropy, hydrologic boundaries, leakage, etc.

If sufficient site-specific data exist for the permit and adjacent area, then the need for further borehole testing may be waived by the Division.

(1) Multiple well pumping tests.

Constant discharge pump tests with observation wells and/or piezometers to monitor effective drawdown and recovery rates are recommended.

(2) Single hole tests.

Single hole tests should not be utilized if precise control over the variables and measurements cannot be maintained in the field.

(A) Pump test;

(B) Slug test;

(C) Bailer test;

(D) Open-hole test;

(E) Packer test;

(F) or, any other appropriate single hole pumping tests.

(3) Well sampling and analyses.

B.3. (continued)

(A) Frequency and duration, refer to Table 4.

(B) Field measurements, refer to Table 3.

(C) Laboratory analyses, refer to Table 3.

b. Spring sampling and analyses.

(1) Frequency and duration, refer to Table 4.

(2) Field measurements, refer to Table 3.

(3) Laboratory analyses, refer to Table 3.

c. Mine inflow and/or discharge sampling and analyses.

(1) Frequency and duration, refer to Table 4.

(2) Field measurements, refer to Table 3.

(3) Laboratory analyses, refer to Table 3. Other parameters determined to be specific to operational processes may be analyzed.

4. Characterize ground water occurrence, quality and movement for the permit and adjacent area.

a. Submit a minimum of one year baseline data in the Permit Application Package (PAP) in accordance with Table 4.

b. Interpret baseline data to provide information in the PAP about the probable hydrologic consequences of mining on ground water occurrence, quality and movement.

C. Operational monitoring.

1. Springs and wells.

a. Select, with Division approval, representative springs and wells for operational monitoring.

b. Continue measuring and sampling selected springs and wells as described in Table 4.

b. Parameter selection and analysis frequency as described in Table 3 and Table 4, respectively.

2. Mine inflow and discharge monitoring.

C.2. (continued)

a. Quarterly inflow inventory in the working portion of mine; identify inflow location and geologic occurrence.

b. Select, with Division approval, representative sustained mine inflows for monitoring.

c. Frequency of inflow sampling and measurement as described in Table 4.

d. Laboratory and field inflow analyses as described in Table 3.

e. Collect quarterly discharge volume data.

3. Submit monitoring data and summarize quantity, quality and sources of water encountered in the annual hydrologic report. Include an analysis of the mine workings water balance by accounting for mine inflows, discharge, outflows, evaporation losses and sump storage.

D. Postmining monitoring.

1. Identify representative wells and springs for measuring and sampling.

2. Continue monitoring representative wells and springs as described in Table 4.

3. Parameter selection and analysis frequency as described in Table 3 and Table 4, respectively.

4. Submit monitoring data annually. Summarize and assess mining impacts and system recovery at the termination of the bonding period.

TABLE 1

SURFACE WATER BASELINE, OPERATIONAL AND
POSTMINING WATER QUALITY PARAMETER LIST

Field Measurements:

*	-	Water Levels or Flow
*	-	pH
*	-	Specific Conductivity (umhos/cm)
*	-	Temperature (C^o)
*	-	Dissolved Oxygen (ppm) (perennial streams only)

Laboratory Measurements: (mg/l) (Major, minor ions and trace elements are to be analyzed in total and dissolved forms.)

#	*	-	Total Settleable Solids
#	*	-	Total Suspended Solids
	*	-	Total Dissolved Solids
	*	-	Total Hardness (as $CaCO_3$)
	*		Acidity ($CaCO_3$)
		-	Aluminum (Al)
		-	Arsenic (As)
		-	Barium (Ba)
		-	Boron (B)
	*	-	Carbonate (CO_3^{-2})
	*	-	Bicarbonate (HCO_3^-)
		-	Cadmium (Cd)
	*	-	Calcium (Ca)
	*	-	Chloride (Cl^-)
		-	Chromium (Cr)
		-	Copper (Cu)
		-	Fluoride (F^-)
	*	-	Iron (Fe)
		-	Lead (Pb)
	*	-	Magnesium (Mg)
	*	-	Total Manganese (Mn)
		-	Mercury (Hg)
		-	Molybdenum (Mo)
		-	Nickel (Ni)
		-	Nitrogen: Ammonia (NH_3)
		-	Nitrite (NO_2)
		-	Nitrate (NO_3^-)
	*	-	Potassium (K)
		-	Phosphate (PO_4^{-3})
		-	Selenium (Se)
	*	-	Sodium (Na)
	*	-	Sulfate (SO_4^{-2})
		-	Sulfide (S^-)
		-	Zinc (Zn)
	*	-	Oil and Grease
	*	-	Cation-Anion Balance

Sampling Period:

-Baseline

*Operational, Postmining

#Construction

TABLE 2 SURFACE WATER SAMPLING

	Baseline	Operational	Postmining
Type of Sampling Site	Surface Water Bodies	Surface Water Bodies	Surface Water Bodies
Field Measurements (see Table 1)	Performed during water level/flow measurements.	Performed during water level/flow measurements.	Performed during water level/flow measurements.
Sample Frequency	Quarterly for lakes, reservoirs and impoundments (water level and quality); monthly flow measurements and quarterly water quality measurements (one sample at low flow and high flow each) for perennial streams. Monthly flow and water quality measurements during period of flow for intermittent streams. Sampling for ephemeral streams determined at pre-design conference.	Quarterly for lakes, reservoirs and impoundments (water level and quality); monthly flow measurements and quarterly water quality measurements (one sample at low flow and high flow each) for perennial streams. Monthly flow and water quality measurements during period of flow for intermittent streams. Sampling for ephemeral streams determined at pre-design conference.	Two per annum for perennial streams (high & low flow); two per annum during snowmelt and rainfall for intermittent streams.
Sampling Duration	Two years (one complete year of data before submission of PAP.	Every year until two years after surface reclamation activities have ceased.	Every year until termination of bonding.
Type of Data Collected and Reported	Flow and/or water levels and water quality.	Flow and/or water levels and water quality.	Flow and/or water levels and water quality per operational parameters.
Comments	All field measurements should be performed concurrently with water level/flow measurements.	All field measurements should be performed concurrently with water level/flow measurements.	All field measurements should be performed concurrently with water level/flow measurements

TABLE 2 (continued)

	Baseline	Operational	Postmining
Comments		For every fifth year preceding repermitting, one sample at low flow and high flow each should be taken for baseline water quality parameters. The construction monitoring program will be conducted on a site-specific basis in addition to the operational monitoring.	

TABLE 3

GROUND WATER BASELINE, OPERATIONAL AND
POSTMINING WATER QUALITY PARAMETER LIST

Field Measurements:

* - Water Levels or Flow
* - pH
* - Specific Conductivity (umhos/cm)
* - Temperature (C^{o})

Laboratory Measurements: (mg/l) (Major, minor ions and trace elements are to be analyzed in dissolved form only.)

* - Total Dissolved Solids
* - Total Hardness (as $CaCO_3$)
- Aluminum (Al)
- Arsenic (As)
- Barium (Ba)
- Boron (B)
* - Carbonate (CO_3^{-2})
* - Bicarbonate (HCO_3^{-})
- Cadmium (Cd)
* - Calcium (Ca)
* - Chloride (CL^{-})
- Chromium (Cr)
- Copper (Cu)
- Fluoride (F^{-})
* - Iron (Fe)
- Lead (Pb)
* - Magnesium (Mg)
* - Manganese (Mn)
- Mercury (Hg)
- Molybdenum (Mo)
- Nickel (Ni)
- Nitrogen: Ammonia (NH_3)
- Nitrite (NO_2)
- Nitrate (NO_3^{-})
* - Potassium (K)
- Phosphate (PO_4^{-3})
- Selenium (Se)
* - Sodium (Na)
* - Sulfate (SO_4^{-2})
- Sulfide (S^{-})
- Zinc (Zn)

Sampling Period:

-Baseline
*Operational, Postmining

TABLE 4 GROUND WATER SAMPLING

	Baseline Monitoring	Operational Monitoring	Postmining Monitoring
Type of Sampling Site	Springs, In-Mine Flows, Boreholes, Observation Wells	Springs, In-Mine Flows, Boreholes, Observation Well	Springs, Observation Wells
Field Measurements (see Table 3)	Yes	Yes	Yes
Sampling Frequency Each Site	At least four samples per annum, at fixed monthly intervals.	Quarterly samples for in-mine flows. For other sites, four samples per annum at fixed monthly intervals.	One sample per annum (spring sampling at low flow).
Sampling Duration	Two years (one complete year of data before submission of PAP).	Every year until two years after surface reclamation activities have ceased.	Every year until termination of bonding.
Type of Data Collected and Reported	Water levels and/or flow and water quality.	Water levels and/or flow. For springs, one water quality sample at low flow.	Water levels and/or flow and water quality per operational parameters.
Comments	First year of baseline monitoring and the year preceding repermitting; spring and seep inventory taken both during the Fall and Spring.	During the year preceding repermitting. For springs, one water quality sample at low flow per baseline parameters. For other sites, one sample per baseline parameter.	