SAMPLING AND ANALYSIS PLAN

Section 8.0

Surface Water

APRIL 2009

Prepared for Roca Honda Resources, LLC
4001 Office Court, Suite 102, Santa Fe, NM 87507

Contents

Figures

Tables

8.0 Surface Water

8.1 Introduction and Background

The Roca Honda permit area is drained by ephemeral arroyos that in turn drain to San Mateo Creek, to the Rio San Jose, which joins the Rio Puerco southwest of the city of Belen. The Rio Puerco joins the Rio Grande near the community of Bernardo, south of the city of Belen. (Figure 8-1). San Mateo Creek, the Rio San Jose, and the Rio Puerco are all ephemeral arroyos that flow only in response to high rainfall or snow melt events. The permit area lies in the Upper San Mateo Creek Watershed (Figure 8-2).

San Mateo Creek begins in San Mateo Canyon on the north flank of Mount Taylor. In its upper reaches above the community of San Mateo, the creek is perennial, but its flow disappears into the stream bed below the community of San Mateo. During peak runoff from snow melt in the late spring or during heavy rain storms, which typically occur during the summer/early fall, flow in San Mateo Creek can extend downgradient until it discharges to the Rio San Jose north of the community of Milan. Neither San Mateo Creek nor the Rio San Jose contains Outstanding National Resource Water as defined in NMAC 20.6.4. San Mateo Creek will be the receiving drainage for mine discharge water.

Dewatering of the proposed mine will result in discharge of an estimated average of 8.9 cfs (4,000 gpm) of ground water. This estimate is based on experience of Gulf Mineral Resources Company (RGRC 1994), which discharged ground water at a rate of 5.6 to 11.1 cfs (2,500 to 5,000 gpm) from the Mount Taylor mine when it was in operation. Discharge from the Roca Honda mine may create surface flow that could reach the Rio San Jose about 4 miles north of the community of Milan.

Mine water will be discharged into a dry arroyo in the SE¼ SW¼ Section 16 T13N R8W; this drainage heads in the NE¼ Section 16. Discharge water would flow southwestward across the NW¼ Section 21 and southward along the border between Sections 20 and 21 before entering San Mateo Creek approximately 1.5 miles from the discharge point. The drainage and the portions of San Mateo Creek that will be affected directly by discharged water are ephemeral.

An NPDES permit and NMED ground water discharge permit will be required for RHR to discharge mine water. The assessment of requirements to prepare these permits will include reviewing the existing data, conducting a survey of the water quality of the receiving drainage, and developing a monitoring plan to measure the quality of water once discharge begins.

Existing data relevant to surface water issues are discussed in Section 8.1.1 below. The baseline data needed to develop the discharge plan for water produced during dewatering , the baseline information needed to determine if mining activities affect sediments in the basin , and the baseline data necessary to determine the effects of dewatering on springs in the vicinity of the Roca Honda permit area will be collected. Existing data for each of these issues is described below in the respective subsequent sections. Data needs identified in the baseline data and the information are summarized in Section 8.3.

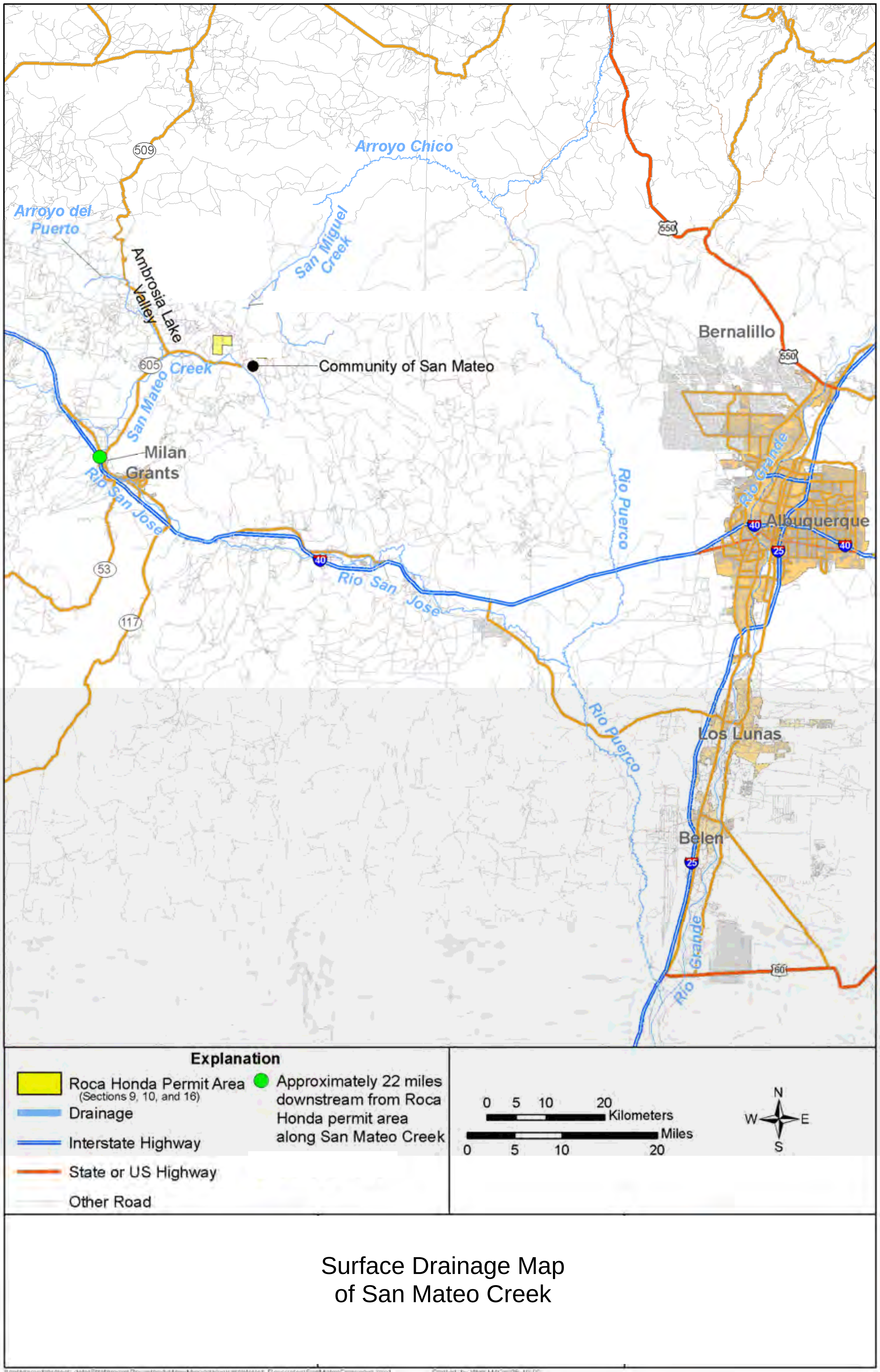

Figure 8-1. Drainage Map of San Mateo Creek

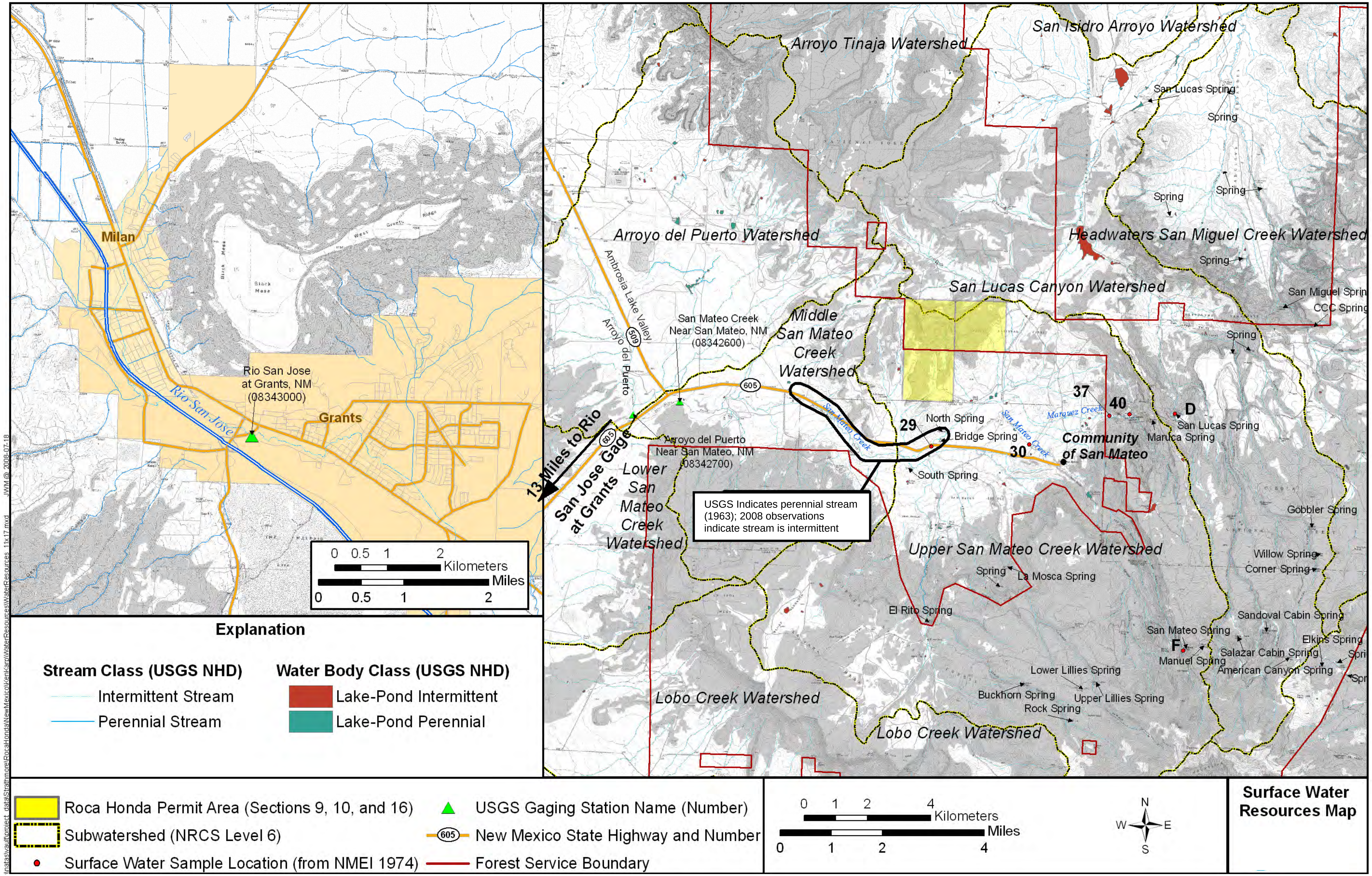

Figure 8-2. Surface Water Resources Map

8.1.1 Existing Baseline Surface Water Information

Two USGS stream flow gaging stations that operated in the late 1970s and early 1980s provide flow data for San Mateo Creek and Arroyo del Puerto (which drains Ambrosia Lake Valley). The gaging stations, designated as San Mateo Creek near San Mateo, NM (Station 08342600) and Arroyo del Puerto near San Mateo, NM (Station 08342700), are approximately 1 mile apart (Figure 8–2). A third gaging station is located on Rio San Jose at Grants, NM (Station 08343000).

The San Mateo gaging station was located about 10 miles downgradient from the community of San Mateo. It recorded daily flow of the creek from a watershed drainage area of 75.6 square miles from May 1977 to October 1982. Daily streamflow data for the 5-year operational period are shown on Figure 8-3. Monthly average flow of San Mateo Creek is shown on Figure 8-4. Elevated base flow of the creek—from 2 to 12 cfs (900 to 5,400 gpm) prior to March 1978—was the result of mine dewatering discharge during active mining of the Johnny M mine and excavation of the shafts for development of the Mount Taylor mine. Sporadic high flows of the creek after that period generally reflect high rainfall episodes during the summer/early fall and spring snowmelt runoff periods.

The Arroyo del Puerto gaging station is about 0.1 mile north of the confluence with San Mateo Creek. The station operated from September 1979 to October 1982, and the daily streamflow data for this 3-year operational period are shown on Figure 8-3. Elevated flows of this drainage are less frequent than those for San Mateo Creek and mainly reflect high rainfall episodes during the summer/early fall period.

The Rio San Jose gaging station was located just downgradient from the confluence with San Mateo Creek at Grants. This station was operational from October 1912 through September 2004. Daily streamflow data are plotted for the 6-year period from 1977 through 1982 to coincide with data from the two stations above (Figure 8-3). Elevated flow in this drainage generally reflects high rainfall episodes during the summer/early fall period. Mine-water discharge from the Johnny M and Mount Taylor mines into San Mateo Creek from May 1977 to February 1978 had no apparent effect on flows in the Rio San Jose. It should also be noted that high peak flows of 30 to 40+ cfs at the San Mateo gaging station during the summers of 1977 and 1978 had little or no expression at the Rio San Jose Station, suggesting that there is little chance that an 8.9-cfs (4,000-gpm) discharge will have effects this far downgradient (approximately 20 miles).

A previous investigation of the stream flow in San Mateo Creek was conducted in 1974 by the New Mexico Environmental Institute (NMEI) as part of the environmental baseline study of the Mount Taylor area associated with the permitting of the proposed Mount Taylor uranium mine by Gulf Mineral Resources Company (NMEI 1974). Flow measurements were made for tributaries to San Mateo Canyon to determine base flow in San Mateo Creek. Mean annual runoff of the creek was calculated. NMEI estimated that the mean annual runoff of San Mateo Canyon is 1,800 ac-ft/yr, and that of this volume, about 0.5 cfs, or 360 ac-ft/yr, was contributed by spring and ground water discharge (NMEI 1974). Three observed rainfall events varied from 0.22 to 0.90 inch.

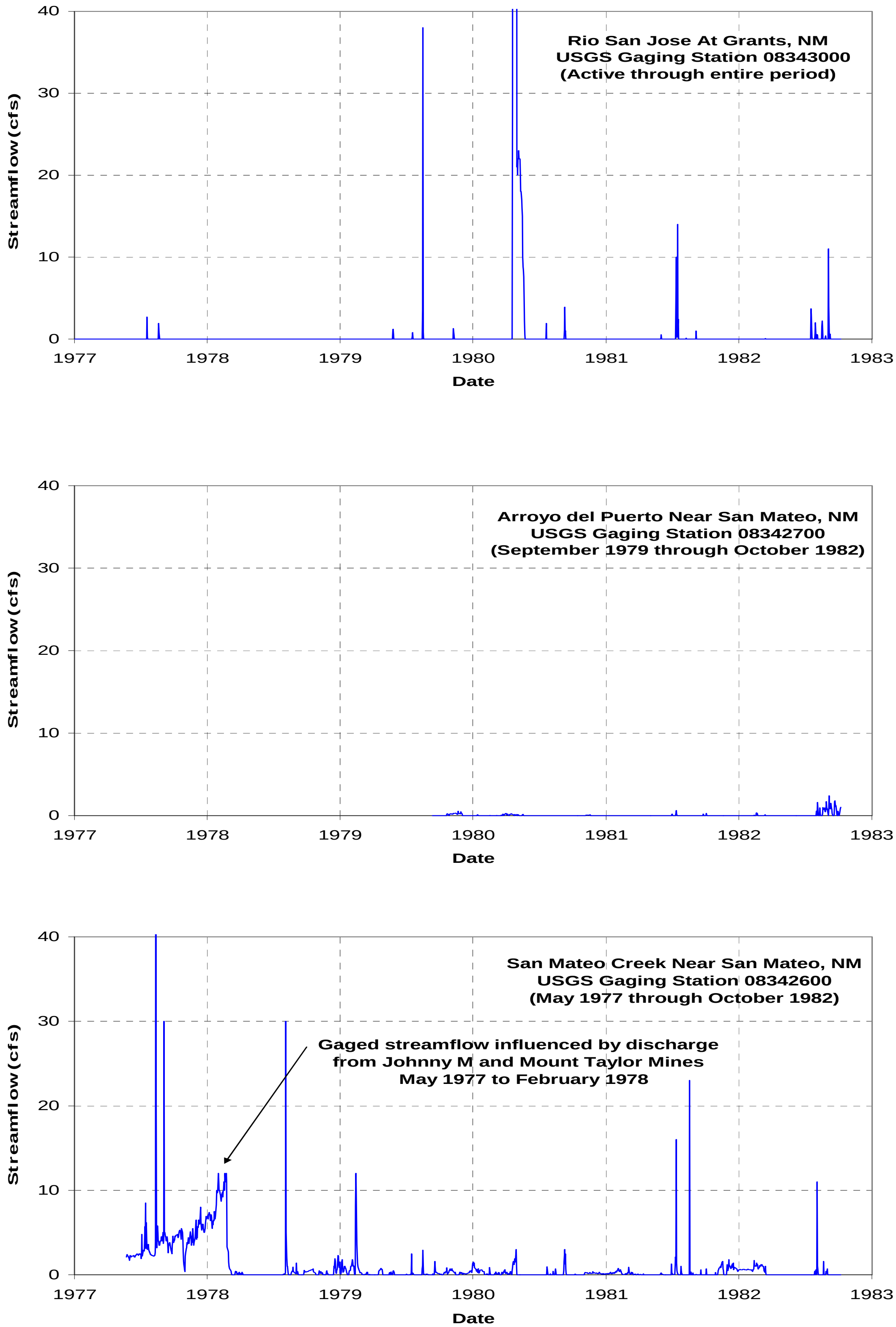

Figure 8-3. Daily Streamflow for San Mateo Creek, Arroyo del Puerto, and Rio San Jose

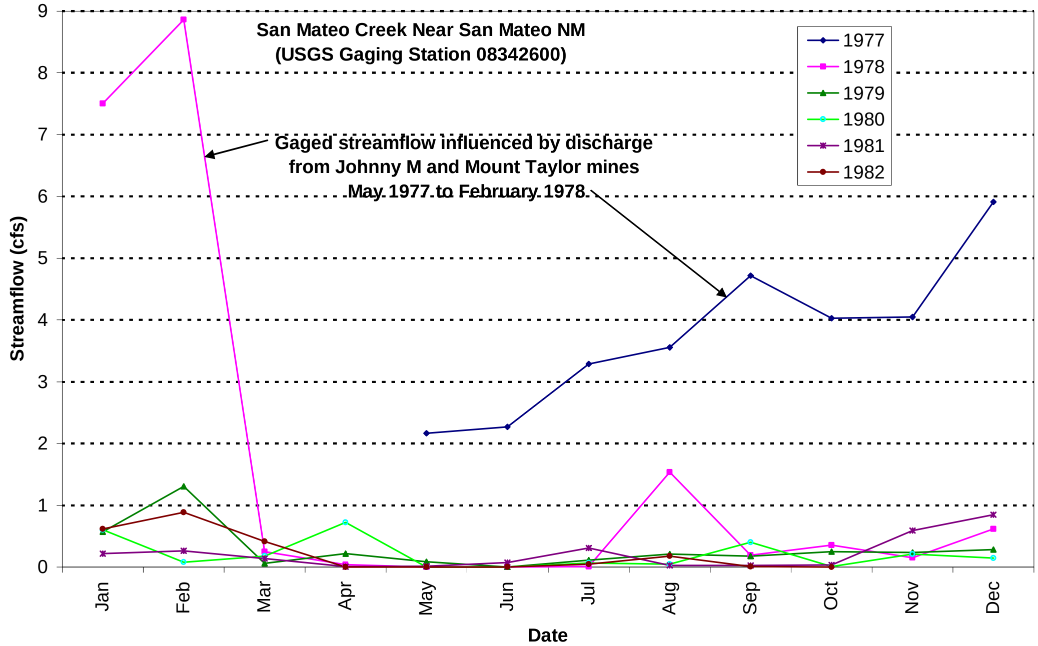

Figure 8-4. Monthly Average Flow of San Mateo Creek

The data needs for surface water flow are the rate at which flow is lost to the creek and the length of stream bed that could be affected by the discharge under normal (and storm) flow conditions. Historical aerial photographs will be reviewed in conjunction with gaging data to evaluate flow loss to the stream bed.

The 1974 baseline study collected data on surface water chemistry in the vicinity of the Roca Honda permit area. Surface water samples were collected from springs and perennial portions of San Mateo Creek and from ephemeral water sources during rain or spring runoff events. The study distinguished between upper elevation (higher than 7,950 ft) and lower elevation locations. The upper elevations generally contain snowpack for most of the winter and contributed snowmelt to the stream in late April and early May, but all springs were observed to be dry by mid to late June except American Canyon Spring. Lower elevations receive runoff in mid to late March. Watersheds in and around the Roca Honda permit area with springs and gaging stations are shown on Figure 8-2.

The historical study did not target all of the chemical constituents of interest for licensing purposes, but does provide general information on water quality. Surface water collected from higher elevations tended to be lower in total dissolved solids (TDS), but more acidic and higher in sulfate than water from lower elevations. Water from high elevation springs was of the calcium-sulfate bicarbonate type, and water from low elevation areas was of the calcium-bicarbonate type. Samples from some locations, for example, near the community of San Mateo, exhibited high levels of sodium. High levels of suspended solids were associated with high flow rates (NMEI 1974).

Data for some surface water constituents are available for San Mateo Creek and the Marquez Canyon drainage in the upper San Mateo Creek watershed, where the Roca Honda permit area is located (Table 8-1). The table shows concentration data for two locations along San Mateo Creek south of and closest to the permit area (locations 29 and 30 on Figure 8-2). Water flowed only periodically at these locations due to removal of water for irrigation. Also shown are data for two locations (37 and 40 on Figure 8-2) in Marquez Canyon, which is drained by an ephemeral stream that flows as a result of snowmelt or heavy rainfalls during the summer/early fall period. It is estimated that the drainage in Marquez Canyon had an annual discharge of 7.5 ac-ft/yr (NMEI 1974).

Table 8-1. Range of Constituents from San Mateo Creek and Marquez Canyon Sample (See Figure 8-2 for sample locations)

Constituent	San Mateo Creek at State Highway 605 Bridge (Loc. 29)	San Mateo Creek at Marquez Ranch (Loc. 30)	Marquez Canyon (Loc. 37, 2 Samples)	Junction with Maruca Canyon (Loc. 40)
pH	8.62–8.97	8.16–8.45	9.17–9.18	8.46–8.69
Specific conductance (µmhos)	650–1,090	187–241	522–526	405–1180
Calcium (mg/L)	24.53–93.76	22.98–88.01	5.98	61.01–102.5
Magnesium (mg/L)	16.12–30.40	4.32–6.21	1.46–2.13	11.38–33.75
Potassium (mg/L)	3.85–204	3.93–5.65	3.63–4.42	9.40–28.93
Sodium (mg/L)	148–281	11.83–19.89	127.1–129.5	67.48–249.0
Chloride (mg/L)	16.7–41.4	2.4–7.0	3.4–3.8	13.3–130
Sulfate (mg/L)	42–250	6–23	2	37–352
Phosphate (mg/L)	0.02–0.38	0.28–0.53	0.07–0.18	0.20–0.39
Nitrate (mg/L)	0.33–1.71	0.20–1.64	0.32–0.33	0.76–1.26
Bicarbonate (mg/L)	369.2–550.8	78.8–134.8	244.2–249.0	288.2–387.2
Alkalinity ($CaCO_3$) (mg/L)	336.8–469.7	64.6–112.5	244.2–246	256.0–350.3
Total solids (mg/L)	535–2020	180–620	640–896	850–7450

Abbreviations: mg/L = milligrams per liter µmhos = micromhos
Data from NMEI 1974.

8.1.2 Receiving Surface Water

The primary requirements for characterizing receiving drainages affected by discharges are identified in NMAC 20.6.4, which establishes water quality standards for surface waters and includes an anti-degradation policy. The discharge from the Roca Honda mine will enter an ephemeral drainage in the SE¼ SW¼ Section 16 and will flow southward to San Mateo Creek as shown in Figure 8-5. Flow in the receiving part of San Mateo Creek is intermittent based on field observations, although the USGS mapped the stream as perennial in 1963. The potential for discharge to reach areas of intermittent or perennial flow constitutes a data need for the proposed discharge.

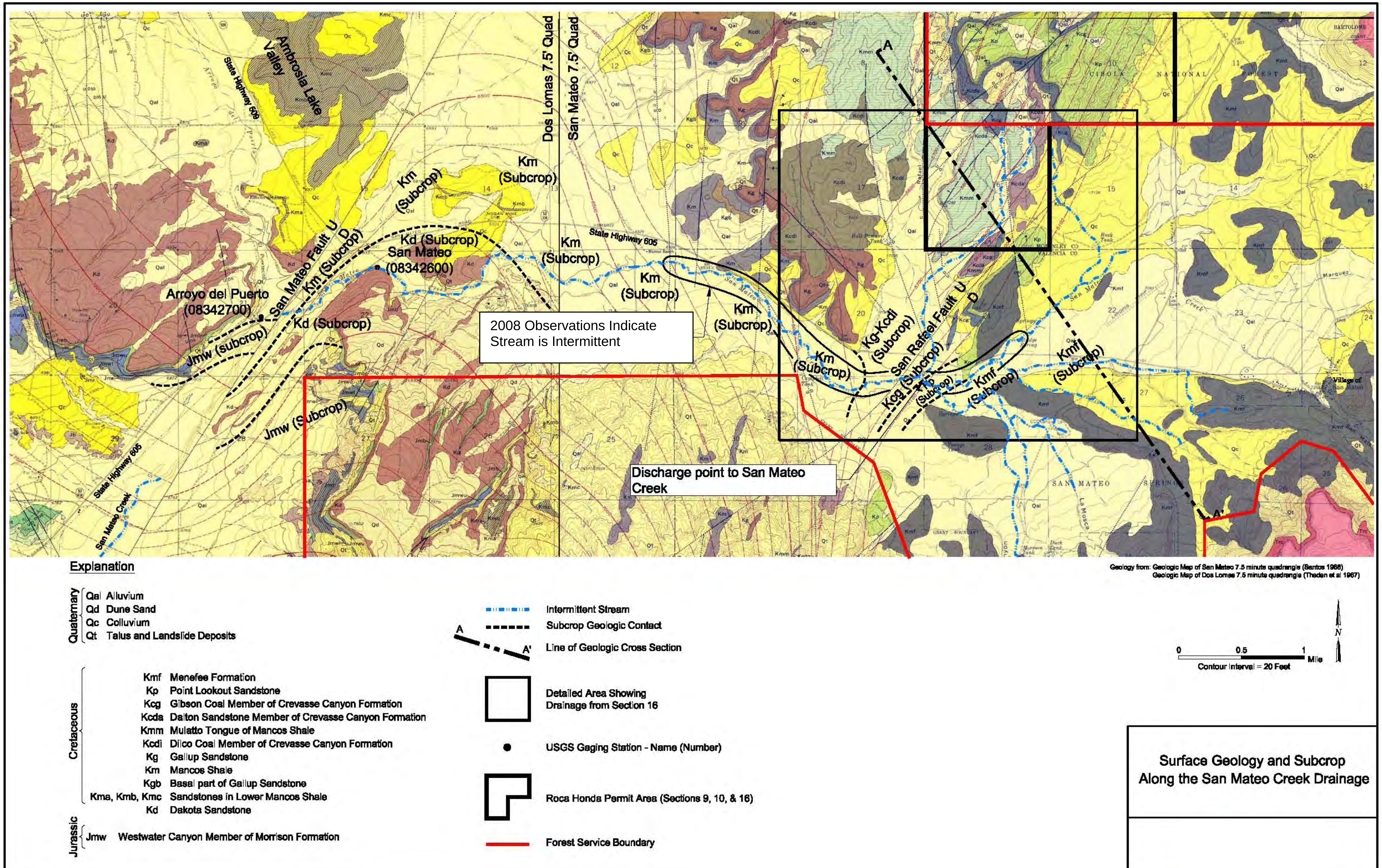

Figure 8-5. Surface and Subcrop Geology along the San Mateo Creek Drainage

8.1.2.1 General Monitoring Requirements for Drainages

The general requirements for surveying the quality of the receiving drainage, including ephemeral, intermittent, and perennial water bodies, are established in NMAC 20.6.4.13 and include limits on the following:

- Suspended or settleable solids,
- Floating solids,
- Oil and grease,
- Color,
- Odor and taste of water,
- Concentrations of plant nutrients,
- Toxic pollutants,
- Radioactivity,
- Pathogens,
- Temperature,
- Turbidity,
- TDS, and
- Dissolved gases (nitrogen, oxygen and ammonia).

8.1.2.2 Pollutants Requirements for Ephemeral Drainage

Ephemeral waters have designated uses of livestock watering, wildlife habitat, limited aquatic life, and secondary (human) contact. The standard for secondary (human) contact is a monthly geometric mean *Escherichia coli* (*E. coli*) bacterial concentration of 548 colony forming units (cfu)/100 mL and single sample of 2,507 cfu/100 mL. The acute requirements for aquatic habitats also include limits for ammonia and oxygen. The ammonia requirements are dependent on pH and temperature of the receiving drainage, and the dissolved oxygen requirements are dependent on elevation and temperature. Tables of both sets of values are included in NMAC 20.6.4.900 J, K, L, and M, and are not listed here.

8.1.2.3 Other Requirements for Intermittent and Perennial Surface Waters

The more stringent numerical criteria for intermittent and perennial receiving drainages is that they must meet all standards for aquatic life, including chronic limits. The chronic limits are lower than the acute limits for 22 compounds, and the standards include one additional compound (polychlorinated biphenyls). The chronic criteria for aquatic habitats also include requirements for ammonia. The limits for ammonia are dependent on pH and temperature. There are no additional targeted analytes for intermittent or perennial waters, although the detection limits required are more stringent.

8.1.2.4 Other Requirements for Potential Recharge Areas

The pathway of the discharged water from the proposed Roca Honda mine related to the underlying (subcropping) bedrock units is shown in the detailed map in Figure 8–6. Normal faults affect the geologic units along the drainage pathway to the south through Section 16 and the NW¼ Section 21.

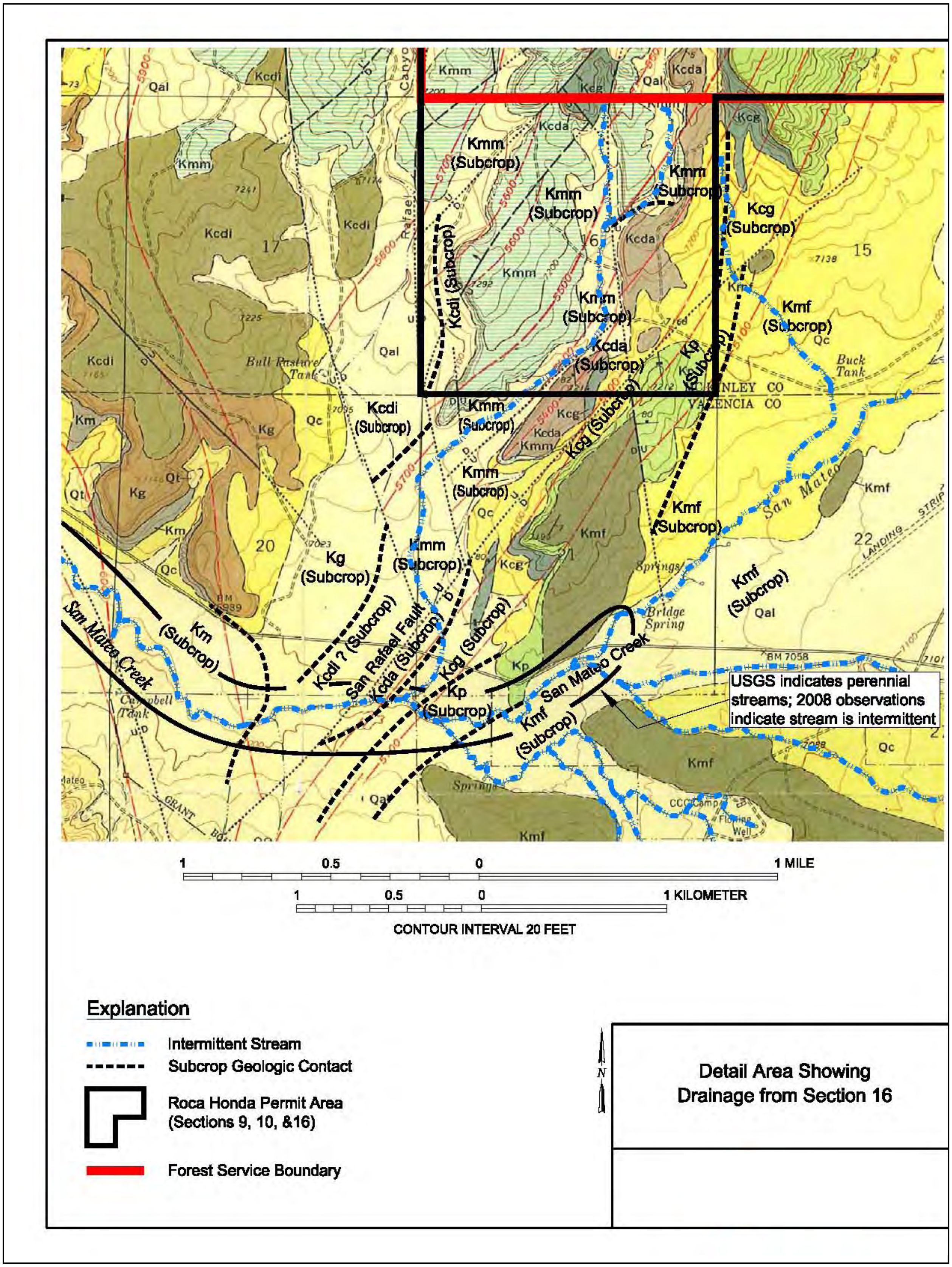

Figure 8-6. Detailed Geologic and Subcrop Map Showing Drainage from Section 16

As the drainage continues southward into the SW¼ Section 21 and crosses the San Rafael fault, subcropping geologic units are the Dalton Sandstone Member and the Gibson Coal Member of the Crevasse Canyon Formation. West of the confluence of the drainage with San Mateo Creek, the creek passes back over the Gibson Coal and Dalton Sandstone Members, crosses the San Rafael fault, and passes over the increasingly older units of the Dilco Coal Member of the Crevasse Canyon Formation, Gallup Sandstone, and Mancos Shale.

The San Mateo Creek drainage, westward from where the mine discharge water will enter, is shown in Figure 8–6. After passing over subcrop of Mancos Shale for approximately 4 miles, the course of the creek crosses the subcrop of Dakota Sandstone on the nose of a north-trending anticline. For a short distance, the creek bed crosses subcrop of the Mancos Shale before crossing the San Mateo normal fault. West of the fault, the creek passes over subcrop of the Morrison Formation to its confluence with Arroyo del Puerto. All of these units may contain water, although the Gibson Coal Member and the Mancos Shale are typically aquitards rather than aquifers, except where sandstone units occur in the Mancos Shale.

The effects of discharge water on the quality and flow characteristics of water in the shallow alluvium is a data need and will be discussed in more detail in Section 9.0, "Ground Water". The discharge water initially will be of high quality and is expected to dilute existing background water constituents present in alluvial water flushing existing poor background quality water from the alluvium. The extent of communication between the alluvium and underlying formations that contain potable ground water is not clear and will be investigated as part of the effort to fill ground water data needs. The NMAC 20.6.4 standards for domestic water supplies may apply to surface water that recharges ground water used for human consumption.

8.1.3 Sediments in the Drainage from Section 16 and San Mateo Creek Basin

The current concentrations of constituents in sediments downgradient of the proposed discharge are not known and constitute a data need. Water flowing over sediments may pick up constituents from the sediments. The concentrations of water soluble constituents in the drainage from Section 16 and San Mateo Creek are not known and represent a data need. The data necessary to address these data needs are discussed in more detail in Section 8.3.

Increased flow in the Section 16 drainage and San Mateo Creek also may increase the movement of sediments downgradient. Such movement depends on the grain size of the sediments, any existing and potential armoring of the stream bed, the quantity of water flowing under normal and flood conditions, and the slope of the stream bed. The slope of the stream bed is known from USGS topographic maps, but more detailed information will help quantify movement potential in the San Mateo Creek bed. Grain size of the sediments, presence and extent of armoring, potential to form additional armor, and water flow under normal and storm conditions are all data needs. The data that will be collected to address these data needs are described in more detail in Section 8.3.

8.1.4 Existing Baseline Springs Information

Bridge Spring, North Spring, and South Spring are within 2 miles of the Roca Honda permit area. All are to the south in and near San Mateo Creek (Figure 8–2 and Table 8–2).

Table 8-2. Springs within 2 Miles of the Roca Honda Permit Area.

Spring Designation	Northing*	Easting*	Watershed
Bridge Spring	3913747	255976	Upper San Mateo Creek
North Spring	3914036	255981	Upper San Mateo Creek
South Spring	3912891	254949	Upper San Mateo Creek

*NAD83 datum and UTM Zone 13 projection

These springs are upgradient and outside of the drainage arroyo where the proposed mine water would discharge in Section 16, which is underlain mainly by the Mulatto Tongue of the Mancos Shale. Therefore, it is unlikely that the discharge of mine water or dewatering operations would have any surface impact on these springs. Cross section A-A' shown on Figure 8-7 demonstrates that Bridge Spring and other nearby springs are underlain by southeast-dipping bedrock of the lower part of the Menefee Formation. The location of cross section A-A' is shown in Figure 8-5.

Confirming the presence and seasonal persistence of springs along San Mateo Creek and their flow rate and water chemistry are data needs. Information on the location and flow rates of springs around the Lee Ranch is available from a detailed inventory of water rights commissioned by the ranch in the early 1980s. RHR is currently assembling a database with these data. Once completed, the database will supplement information on springs from the USGS NHD (Figure 8–2) and serve as the base for determining location and flow rates of springs. No information is available on the quality of water produced from these springs.

Table 8–3 is a summary of the range of water quality data collected from springs farther from the Roca Honda permit area: San Lucas Spring and San Mateo Spring (Figure 8–2). Generally, San Mateo Spring had lower concentrations of most constituents than San Lucas Spring.

Table 8-3. Range of Constituents from Spring Samples

Constituent	San Lucas Spring (Loc. D) (mg/L)	San Mateo Spring (Loc. F) (mg/L)
pH	7.85–8.20	6.89–7.21
Specific conductance (mmhos)	159–228	83.9–116
Calcium	20.68–32.34	211.66–13.04
Magnesium	5.28–9.45	2.04–2.86
Potassium	2.61–4.84	1.28–1.61
Sodium	8.90–21.02	3.15–3.72
Chloride	3.6–12.0	2.9–4.2
Sulfate	1–5	9–13
Phosphate	0.11–0.21	0.09–0.90
Nitrate	0.18–0.58	0.28–0.56
Bicarbonate	102.0–128.0	20.0–34.2
Alkalinity ($CaCO_3$)	83.6–105.1	16.4–28.0
Total solids	115–180	60–108

Abbreviations: mg/L = milligrams per liter mmhos = millimhos Data from NMEI 1974

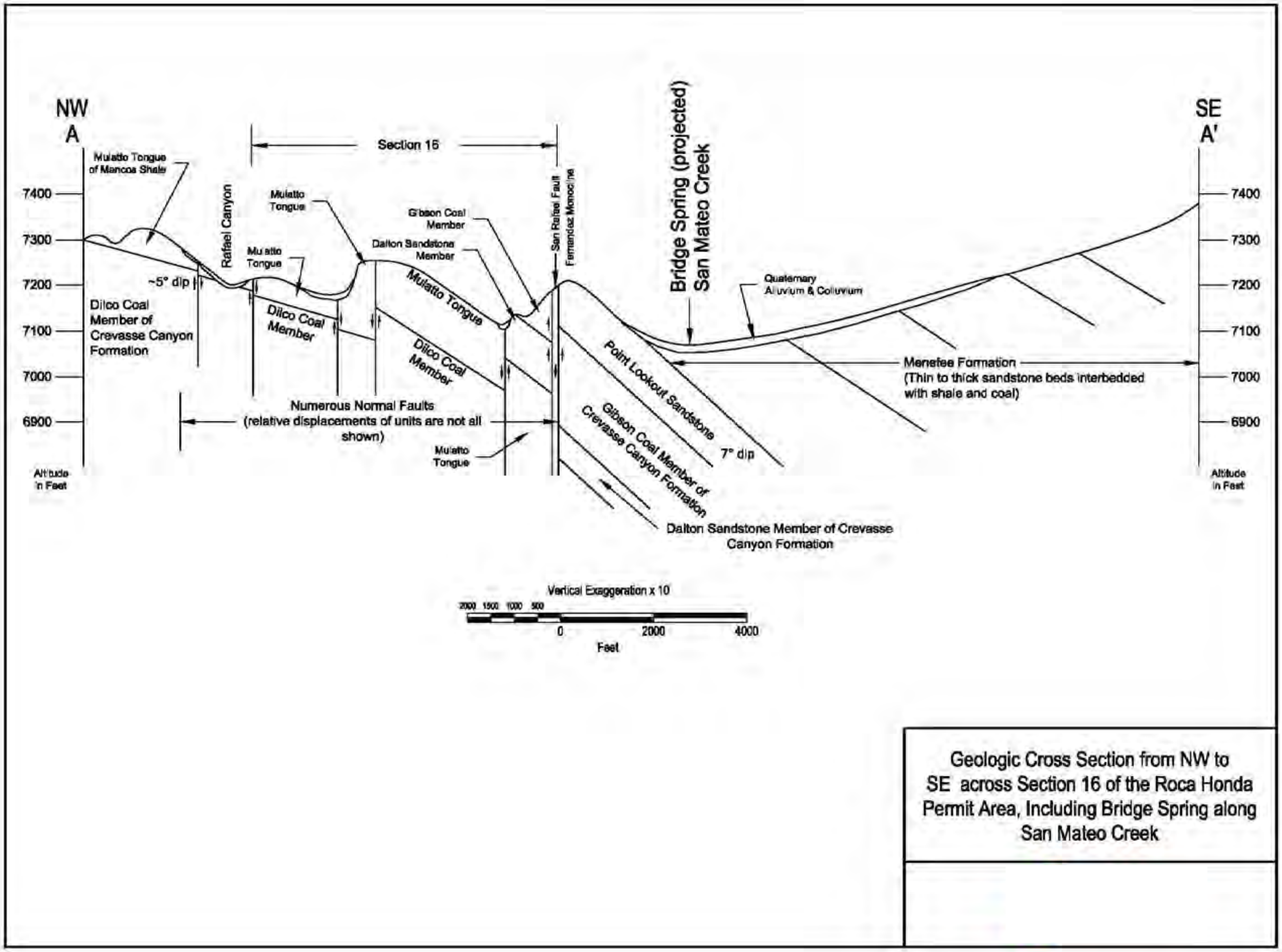

Figure 8-7. Geologic Cross-Section across Section 16 and the San Mateo Creek

8.2 Sampling Objectives

The objective of surface water sampling is to fill data needs identified for baseline surface water conditions as shown in Table 8-4. The information collected in this effort will supplement existing information and provide the baseline information necessary to assess potential and actual affects of mining on surface water.

8.3 List of Data to be Collected

This section provides detailed information to direct the collection of data needed for baseline data related to surface water. The data needs identified for surface water are presented in Table 8-4.

Table 8-4. Data Needs Identified for Surface Water

Data Need	Plan to Address Data Need
Historical extent of flow in San Mateo Creek.	Review historical aerial photographs.
Nature of flow in San Mateo Creek.	Ground surveys will determine the nature of flow in the drainage from Section 16 that will be receiving discharge water. The presence or absence of water in the alluvium at the base of the stream bed will be determined . Work to be performed will be described in detail in the ground water section of the SAP.
Potential for the discharge to affect reaches with intermittent or perennial flow.	Aerial photographs and ground surveys will be used to determine the location of the nearest downgradient intermittent or perennial water.
Baseline water quality for receiving drainage.	Samples of surface water will be collected upgradient and downgradient of planned discharge and analyzed. Targeted information will include major cations, major anions, other water quality parameters, targeted constituent for ephemeral, intermittent, and perennial receiving drainages course. Constituents not detected in the initial round of analyses may not be targeted in subsequent sampling events. Four quarterly sampling events are anticipated.
Baseline information on the chemistry of sediments.	Samples will be analyzed for the same suites of constituents targeted in water samples.
Concentration of water soluble constituents in sediments.	Samples collected for baseline information on the chemistry of sediments will be analyzed to determine the concentrations of soluble constituents. Analyses will be limited to constituents positively detected in the analysis of the total concentrations of constituents in sediments.
Grain size of sediments.	Samples will also be analyzed for grain size to help determine potential erosion and for correlation to chemical data.
Presence and extent of armoring in the drainage from Section 16 and San Mateo Creek bed.	Field surveys will be conducted to document the extent of armoring present or that may form. The field survey will note the presence and approximate abundance of large clasts too large to collect for analysis.
Detailed topography of drainage channels.	Stream bed profiles will be collected at appropriate intervals across the channel of the drainage from Section 16 to quantify stream cross sections under various flow conditions.
Flow conditions in San Mateo Creek.	Gaging stations will be placed in San Mateo Creek to determine the frequency and volume of flow and the rate of loss of flow to the creek bed. Information collected will include both depth of water and flow. A rating curve will be prepared for each site.
Completeness and accuracy of combined USGS and Lee Ranch information on the location of springs and their water quality.	The combined information on the location of springs from the USGS and Lee Ranch will be cross checked. The locations of springs near the Roca Honda permit area will be verified in the field. Selected springs will be sampled for flow and water quality.

8.4 Methods of Collection

Table 8-5 lists the types and amounts of data to be gathered, the objectives and purpose of the proposed samples, the number of locations that would be sampled and the map where the locations are plotted, the frequency of sampling, and the parameters to be analyzed. Final selection of sampling sites is contingent upon obtaining access agreements. The rows of the table are discussed sequentially in the following sections along with details of sample collection

8.5 Parameters to be Analyzed

Table 8-6 list the parameters to be analyzed.

8.5.1 Nature of Flow in the Drainages

8.5.1.1 Data Collection

The nature of historical flow in San Mateo Creek is important because it will help in the calculation of the rate water is lost to the drainage bed, and it will help evaluate the potential for discharge water to affect the drainage. The nature and extent of flow will be determined using available historical aerial photographs. The analysis will determine the presence or absence of water in each reach extending from the proposed discharge point to the maximum expected extent of flow (22 miles from the point of discharge). The information will be supplemented by depth/flow information obtained using automatic data loggers. Data loggers will be placed at the proposed stream gage and surface water sampling locations shown in Figure 8–8.

8.5.1.2 Intermittent or Perennial Water and Structures

Recent aerial photographs will be used to determine the location of the nearest intermittent and perennial water bodies and structures that could be impacted by the proposed discharge. Once the aerial photographic analysis is completed, a ground survey will be conducted to confirm the location of perennial water bodies and the location and use of structures.

As noted in the ground water section of this SAP (Section 9.0), monitor wells will be installed to determine the thickness and extent of the alluvium at the Roca Honda permit area and at a location in San Mateo Creek below the proposed point of Roca Honda Mine water discharge. The presence or absence of water in the alluvium at the base of the stream bed will be used to determine if the unnamed arroyo and San Mateo Creek are ephemeral or intermittent.

8.5.1.3 Baseline Water Quality

Surface water samples will be collected to characterize water quality of receiving drainages. Characterization will include perennial, intermittent, and ephemeral reaches of the drainage; all reaches will be characterized initially for the complete list of targeted analytes shown in Table 8–6. Sampling will be accomplished using autosampling equipment collocated with pressure transducers, flow meters, and autologgers. Sampling of flow events will extend across one or more years to determine seasonal variability. An exact schedule cannot be established because sampling events will coincide with flow within the reaches. Flow is not expected at all of the locations because most of the effected reaches are ephemeral or intermittent. Targeted analytes include analytes of interest in ground water as discussed in Section 9.

Table 8-5. Proposed Data Gathering Activities

Type of Data Gathering	Purpose	Locations	Frequency	Parameters to be Analyzed
1. Ground survey (Section 8.5.1.1)	Determine nature of historical flow.	Aerial photographs and ground survey.	Once.	Observations.
2. Ground survey (Section 8.5.1.2)	Determine location of intermittent or perennial water, and locations of any houses and structures potentially affected.	Aerial photographs coupled with a ground survey confirmation.	Once.	Observations.
3. Surface water sampling (Section 8.5.1.3)	Characterize receiving drainage.	Seven sample locations extending over the 10 miles of drainage downgradient of the proposed discharge.	When flow event occurs, if possible.	Major cations; major anions; other water quality parameters; targeted constituents for ephemeral, intermittent, and perennial receiving drainages.
4. Samples of sediments (Section 8.5.1.4)	Characterize the sediment constituents in the drainage bed.	Thirty one sample locations (plus seven quality control samples) extending approximately 22 miles from the discharge.	Once.	Major cations; major anions; radionuclides; other water quality parameters; targeted constituents for ephemeral, intermittent, and perennial receiving drainages.
6. Samples of sediments (Section 8.5.1.6)	Grain size of sediments.	Thirty one samples.	Once.	Grain size distributions.
7. Field survey (Section 8.5.1.7)	Armoring of the stream bed.	Walkover surveys will be conducted along the beds of the arroyo and drainages to a distance of 22 miles from the discharge point.	Once.	Field descriptions of the distribution of medium to large gravel clasts. Photographic documentation of armoring.
8. Topographic information (Section 8.5.1.8)	Baseline topographic information for arroyo and drainage.	Profiles across stream bed at 500-ft intervals for the first 5 miles and 1,000-ft intervals thereafter. GPS surveys linked to GIS.	Once.	Stream bed profiles at intervals across the channel of the arroyo and drainages.
9. Stream gages on the arroyo and San Mateo Creek (Section 8.5.1.9)	Determine volume, rate and timing of water flow of water loss to the channel.	In the arroyo, on the creek bed upgradient of the planned discharge, and downgradient of the planned discharge.	Information will be collected for 1 or more years.	Gages and flow meters will be automated to capture storm events.
10. Local interviews to gather historic springs data and characterize (Section 8.5.1.10)	Determine the completeness of the database. Sample where possible.	Springs in vicinity to dewatered units.	Quarterly for one year where possible.	Interviews and field surveys will be documented. Sample analyses per item 3 above.

Table 8-6. Analytes and Methods to be Used

Analyte	Method for Determination in Water (EPA* or SMEWW**)	Method for Determination in Sediment
Suspendable or settleable solids	SMEWW Method 2540F	NA
Floating solids	SMEWW Method 2530B	NA
Oil and grease	SW846 Method 1664A	SW846 Method 9071B
pH	EPA Method 150.1	SW846 Method 9045D
Color	SMEWW Method 2120B	NA
Odor	SMEWW Method 2150B	NA
Hardness	A2340B	NA
Concentrations of plant nutrients	See specific methods below	See specific methods below
E. coli	EPA Method 1103.1	NA
Toxic pollutants	See specific methods below	See specific methods below
Radioactivity	See specific methods below	See specific methods below
Pathogens	See specific methods below	NA
Temperature	Field Measurement; SMEWW Method 2550B	NA
Turbidity	Field Measurement using EPA Method 180.1	NA
Total dissolved solids	Field Measurement using SMEWW Method 2540B	NA
Dissolved gases (nitrogen, oxygen, and ammonia)	Field Measurement	SMEWW Method 2710B
Alkalinity	EPA Method 310.1	NA
Aluminum	Dissolved. Field filtered and analyzed by EPA Method 200.7	Total. SW846 Method 6010B
Antimony	Dissolved. Field filtered and analyzed by EPA Method 200.8	Total. SW846 Method 6010B
Arsenic	Dissolved. Field filtered and analyzed by EPA Method 200.8	Total. SW846 Method 6020
Barium	Dissolved. Field filtered and analyzed by EPA Method 200.7	Total. SW846 Method 6010B
Beryllium	Dissolved. Field filtered and analyzed by EPA Method 200.7	Total. SW846 Method 6010B
Boron	Dissolved. Field filtered and analyzed by EPA Method 200.7	Total. SW846 Method 6010B
Cadmium	Dissolved. Field filtered and analyzed by EPA Method 200.8	Total. SW846 Method 6020
Calcium	Dissolved. Field filtered and analyzed by EPA Method 200.7	Total. SW846 Method 6010B
Chlorine residual	SMEWW 4500-Cl G	NA
Chromium	Dissolved. Field filtered and analyzed by EPA Method 200.7	Total. SW846 Method 6010B
Cobalt	Dissolved. Field filtered and analyzed by EPA Method 200.7	Total. SW846 Method 6010B
Copper	Dissolved. Field filtered and analyzed by EPA Method 200.7	Total. SW846 Method 6010B
Cyanide (weak acid dissociable)	Unfiltered sample. SMEWW Method 4500 CN^- I (macro distillation, colorimetric finish).	NA
Cyanide, dissolved	Field filtered. SMEWW Method 4500 CN-C	NA
Iron	Dissolved. Field filtered and analyzed by EPA Method 200.7	Total. SW846 Method 6010B
Lead	Dissolved. Field filtered and analyzed by EPA Method 200.7	Total. SW846 Method 6020
Manganese	Dissolved. Field filtered and analyzed by EPA Method 200.7	Total. SW846 Method 6020
Magnesium	Dissolved. Field filtered and analyzed by EPA Method 200.7	Total. SW846 Method 6010B
Mercury	Total. Not filtered and analyzed by EPA Method 245.1	Total. SW846 Method 7471B
Mercury	Dissolved. Field filtered and analyzed by EPA Method 245.1	NA
Molybdenum	Dissolved. Filed filtered and analyzed by EPA 200.7	Total. SW846 Method 6020
Nickel	Dissolved. Field filtered and analyzed by EPA Method 200.7	SW846 Method 6010B
Nitrite	SMEWW Method 353.1	NA
Nitrate	SMEWW Method 353.2	NA
TKN	SMEWW Method 4500-Norg B	SM 4500-N org

Table 8-6. Analytes and Methods to be Used (Continued)

Analyte	Method for Determination in Water (EPA* or SMEWW**)	Method for Determination in Sediment
Phosphate	SMEWW Method 365.1	NA
Potassium	Dissolved. Field filtered and analyzed by EPA Method 200.7	Total. SW846 Method 6010B
Selenium	Dissolved. Field filtered and analyzed by EPA Method 200.8	Total. SW846 Method 6020
Selenium, total recoverable	Not filtered and analyzed by EPA Method 200.8	NA
Silver	Dissolved. Filtered and analyzed by EPA Method 200.7	Total. SW846 Method 6010B
Sodium	Dissolved. Filtered and analyzed by EPA Method 200.7	Total. SW846 Method 6010B
Thallium	Dissolved. Filtered and analyzed by EPA Method 200.8	Total. SW846 Method 6020
Thorium (Isotopic)	Dissolved. Filtered and analyzed by EPA Method 907.0	Total. SW846 Method 6020
Uranium	Dissolved. Filtered and analyzed by EPA Method 200.8	Total. SW846 Method 6020
Vanadium	Dissolved. Filtered and analyzed by EPA Method 200.8	Total. SW846 Method 6020
Zinc	Dissolved. Filtered and analyzed by EPA Method 200.7	Total. SW846 Method 6010B
Adjusted gross alpha	EPA Method 900.1	EPA Method 900.1 modified
Gross alpha/beta	EPA Method 900.0	EPA Method 900.0 modified
Radium 226 + Radium 228	EPA Method 903.0 and 904.0	EPA Methods 903.0 modified and 904.0 modified
Radon-222	SMEWW Method 7500-Rn B	NA
Strontium 90	EPA 905.0	EPA Method 905.0 modified
Aldrin	EPA Method 608	SW846 Method 8081B
Tritium	EPA Method 906.0	EPA Method 906.0
alpha-BHC	EPA Method 608	SW846 Method 8081B
beta-BHC	EPA Method 608	SW846 Method 8081B
Gamma-BHC (Lindane)	EPA Method 608	SW846 Method 8081B
Chlordane	EPA Method 608	SW846 Method 8081B
4,4'-DDT and derivatives	EPA Method 608	SW846 Method 8081B
Dieldrin	EPA Method 608	SW846 Method 8081B
Alpha-Endosulfan	EPA Method 608	SW846 Method 8081B
Penta-chlorophenol	EPA Method 625	SW846 Method 8270
Toxaphene	EPA Method 608	SW846 Method 8081B
Asbestos	EPA Method 100.1	NA
Acenaphthene	EPA Method 625	SW846 Method 8270
Acrolein	EPA Method 624	SW846 Method 8260B
Acrylonitrile	EPA Method 624	SW846 Method 8260B
Anthracene	EPA Method 625	SW846 Method 8270
Benzene	EPA Method 624	SW846 Method 8260B
Benzidine	EPA Method 625	SW846 Method 8270
Benzo(a)anthracene	EPA Method 625	SW846 Method 8270
Benzo(a)pyrene	EPA Method 625	SW846 Method 8270
Benzo(b)fluoranthene	EPA Method 625	SW846 Method 8270
Benzo(k)fluoranthene	EPA Method 625	SW846 Method 8270
Bis(2-chloroethyl) ether	EPA Method 625	SW846 Method 8270
Bis(2-chloroisopropyl) ether	EPA Method 625	SW846 Method 8270
Bis(2-ethylhexyl) phthalate	EPA Method 625	SW846 Method 8270
Bromoform	EPA Method 624	SW846 Method 8260B
Butylbenzyl phthalate	EPA Method 625	SW846 Method 8270
Carbon tetrachloride	EPA Method 624	SW846 Method 8260B

Table 8-6. Analytes and Methods to be Used (Continued)

Analyte	Method for Determination in Water (EPA* or SMEWW**)	Method for Determination in Sediment
Chlorobenzene	EPA Method 624	SW846 Method 8260B
Chlorodibromomethane	EPA Method 624	SW846 Method 8260B
Chloroform	EPA Method 624	SW846 Method 8260B
2-Chloronaphthalene	EPA Method 625	SW846 Method 8270
2-Chlorophenol	EPA Method 625	SW846 Method 8270
Chrysene	EPA Method 625	SW846 Method 8270
Dibenz(a,h)anthracene	EPA Method 625	SW846 Method 8270
Dibutyl phthalate	EPA Method 625	SW846 Method 8270
1,2-Dichlorobenzene	EPA Method 624	SW846 Method 8270
1,3-Dichlorobenzene	EPA Method 624	SW846 Method 8270
1,4-Dichlorobenzene	EPA Method 624	SW846 Method 8270
3,3'-Dichlorobenzidine	EPA Method 625	SW846 Method 8270
Dichlorobromomethane	EPA Method 624	SW846 Method 8260B
1,2-Dichloroethane	EPA Method 624	SW846 Method 8260B
1,1-Dichloroethylene	EPA Method 624	SW846 Method 8260B
2,4-Dichlorophenol	EPA Method 625	SW846 Method 8270
1,2-Dichloropropane	EPA Method 624	SW846 Method 8260B
1,3-Dichloropropene	EPA Method 624	SW846 Method 8260B
Diethyl phthalate	EPA Method 625	SW846 Method 8270
Dimethyl phthalate	EPA Method 625	SW846 Method 8270
2,4-Dimethylphenol	EPA Method 625	SW846 Method 8270
2,4-Dinitrophenol	EPA Method 625	SW846 Method 8270
2,4-Dinitrotoluene	EPA Method 625	SW846 Method 8270
2,3,7,8-TCDD dioxin	EPA Method 1613B	SW846 Method 8290
1,2-Diphenylhydrazine	EPA Method 625	SW846 Method 8270
Ethylbenzene	EPA Method 624	SW846 Method 8260B
Fluorene	EPA Method 625	SW846 Method 8270
Fluoranthene	EPA Method 625	SW846 Method 8270
Hexachlorobenzene	EPA Method 625	SW846 Method 8270
Hexachlorobutadiene	EPA Method 625	SW846 Method 8270
Hexachlorocyclopentadiene	EPA Method 625	SW846 Method 8270
Hexachloroethane	EPA Method 625	SW846 Method 8270
Ideno(1,2,3-cd)pyrene	EPA Method 625	SW846 Method 8270
Isophorone	EPA Method 625	SW846 Method 8270
Methyl bromide	EPA Method 624	SW846 Method 8260B
2-Methyl-4,6-dinitrophenol	EPA Method 625	NA
Methylene chloride	EPA Method 624	SW846 Method 8260B
Nitrobenzene	EPA Method 625	SW846 Method 8270
N-Nitrosodimethylamine	EPA Method 625	SW846 Method 8270
N-Nitrosodi-n-propylamine	EPA Method 625	SW846 Method 8270
N-Nitrosodiphenylamine	EPA Method 625	SW846 Method 8270
PCBs	EPA Method 608	SW846 Method 8082A
Penta-chlorophenol	EPA Method 625	SW846 Method 8270
Phenol	EPA Method 625	SW846 Method 8270
Pyrene	EPA Method 625	SW846 Method 8270

Table 8-6. Analytes and Methods to be Used (Continued)

Analyte	Method for Determination in Water (EPA* or SMEWW**)	Method for Determination in Sediment
1,1,2,2-Tetrachloroethane	EPA Method 624	SW846 Method 8260B
Tetrachloroethylene	EPA Method 624	SW846 Method 8260B
Toluene	EPA Method 624	SW846 Method 8260B
1,2-Trans-dichloroethylene	EPA Method 624	SW846 Method 8260B
1,2,4-Trichlorobenzene	EPA Method 625	SW846 Method 8270
1,1,2-Trichloroethane	EPA Method 624	SW846 Method 8260B
Trichloroethylene	EPA Method 624	SW846 Method 8260B
2,4,6-Trichlorophenol	EPA Method 625	SW846 Method 8270
Vinyl chloride	EPA Method 624	SW846 Method 8260B
Grain size	NA	ASTM Standard E 112

*EPA U.S. Environmental Protection Agency
**SMEWW Standard Methods for the Examination of Water and Wastewater
NA Not applicable

The number of samples needed to define variance between sites and between seasons will vary from constituent to constituent, from site to site, and from season to season. The size of these variances cannot be estimated until data is collected. Data for each constituent will be analyzed as it is collected to estimate total variance, variance between sample sites, and seasonal variance. Variance results for all constituents will be tested for statistical significance as they become available, and the degree of confidence in the analysis for each constituent will be determined.

Seven proposed sampling locations are shown in Figure 8-8. These locations and the number of samples may be adjusted once the perennial or intermittent reaches are found. Samples will be analyzed for the parameters shown in Table 8-6.

Samples to be collected for each sampling event will include a field duplicate sample as a part of the QA/QC program. Sample size and preservation and holding time requirements for each group of analytes are specified in Table 8-7. Analyte suites with no positive detections above levels of concern in the initial round of analyses will not be targeted in subsequent sampling events

8.5.1.4 Sediment Constituents

Thirty one samples (plus seven quality control samples) will be collected to characterize the 22 miles downgradient from the discharge—the upper limit on the distance mine discharge water is anticipated to flow. Samples will be relatively closely spaced near the point of discharge and will be spaced at greater intervals farther away from the discharge. The approximate sampling locations are shown in Figure 8-9. Samples will be analyzed for the parameters shown in Table 8-6.

8.5.1.5 Soluble Constituents in Sediments

Thirty one samples will be co-collected with the sediment samples described in Section 8.5.1.4. The samples will be analyzed following EPA SW846 Method 1312, "Synthetic Precipitation Leaching Procedure," to determine the concentrations of water soluble constituents in the sediments.

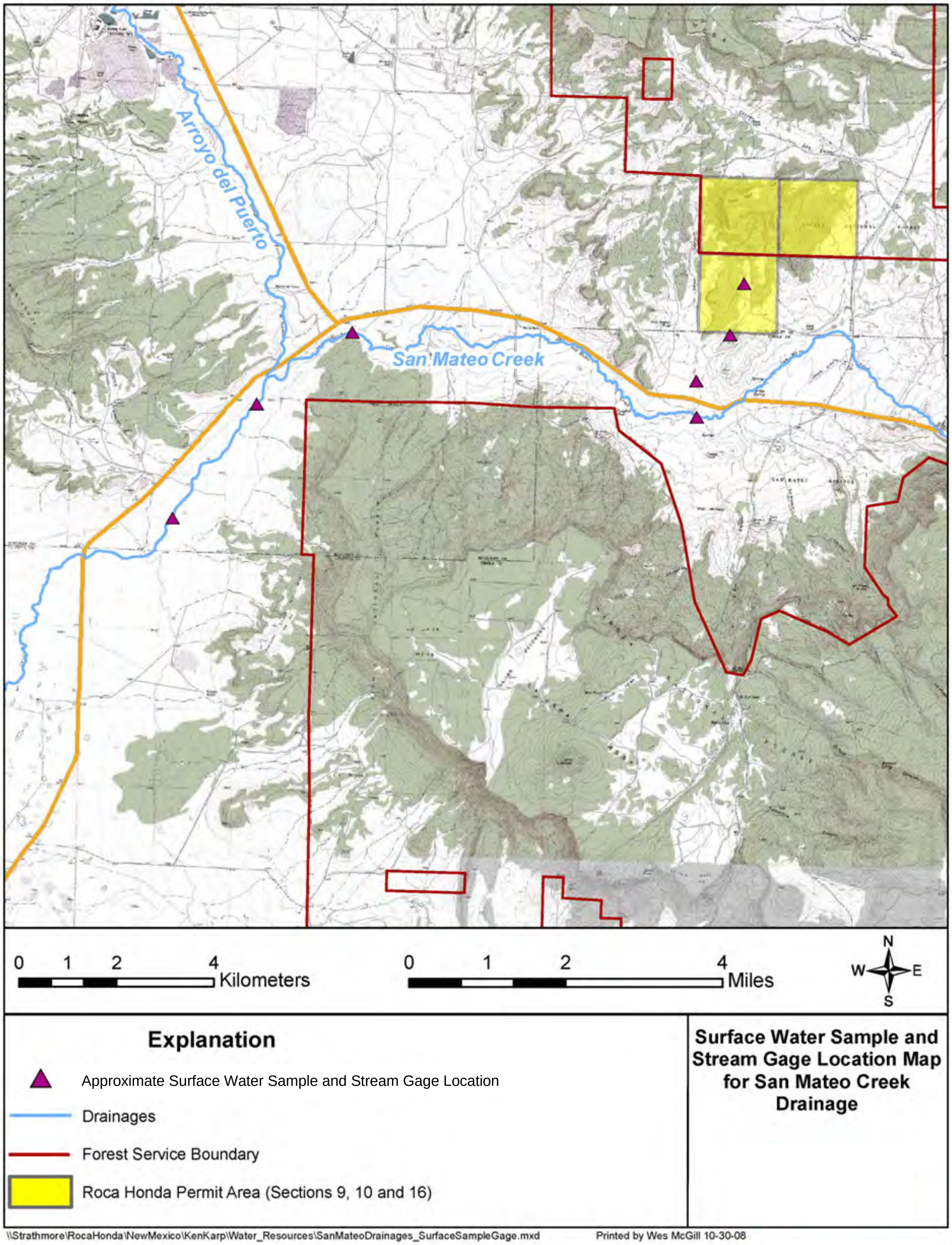

Figure 8-8. Approximate Stream Gauge and Surface Water Sampling Locations

Table 8-7. Analytical Method, Container, Preservation, and Holding Time Requirements

Analytical Method	Analyte	Containers P=Plastic G=Glass	Preservation	Holding Times
Water Samples				
EPA Method 1103.1	E. coli	P	None	24 hours
SMEWW Method 2540F	Suspendable or Settleable Solids (water)	P or G	Cool, 4 °C	7 days
SMEWW Method 2530B	Floating solids (water)	P	None	7 days
SW846 Method 1664A	Oil and Grease (water)	G	H_2SO_4 to pH<2 cool, 4 °C	20 days
SMEWW Method 2120B	Color	P or G	Cool, 4 °C	NA
SMEWW Method 2150B	Odor and Taste	G	None	48 hours
EPA Method 200.7	Metal ions by ICP (filtered water)	P or G	Filter (0.45 micron), then add HNO_3 to pH<2	6 months
EPA Method 200.7	Metal ions by ICP (unfiltered water)	P or G	HNO_3 to pH<2	6 months
SMEWW 4500-Cl G	Residual chlorine (water)	P or G	None	Analyze immediately
SMEWW Method 4500 CN^- I (macro distillation, colorimetric finish).	Cyanide (weak acid dissociable) (water)	P or G	N_2O_4 to pH>12 cool, 4 °C	14 days
SMEWW Method 4500 CN-C	Cyanide dissolved (water)	P or G	N_2O_4 to pH>12 cool, 4 °C	14 days
SMEWW Method 353.1	Nitrite (water)	P or G	Cool, 4 °C	48 hours
SMEWW Method 353.2	Nitrate (water)	P or G	Cool, 4 °C	48 hours
SMEWW Method 4500-Norg B	TKN (water)	P	H_2SO_4 to pH<2, cool, 4 °C	28 days
SMEWW Method 365.1	Phosphate (water)	P or G	H_2SO_4 to pH<2, cool, 4 °C	28 days
EPA Method 200.8	Uranium (water)	P or G	HNO_3 to pH<2	6 months
SMEWW 7110C	Adjusted gross alpha (water)	P or G	HNO_3 to pH<2	6 months
SMEWW Methods 903.0 and 904.0	Radium 226 + Radium 228 (water)	P or G	HNO_3 to pH<2	6 months
SMEWW Method 7500-Rn B	Radon-222 (water)	G	Cool, 4 °C	4 days
EPA Method 608	Organochlorine Pesticides (water)	G	None	7 days
EPA Method 100.1	Asbestos (water)	P	None	48 hours
SMEWW Method 625	Semivolatile Organics (water)	G	$Na_2S_2O_3$	7 days extraction, 40 days analysis
SMEWW Method 624	Volatile Organic Compounds (water)	VOA vials	HCL<2	14 days
EPA Method 1613B	2,3,7,8-TCDD Dioxin (water)	G	None	21 days
Sediment Samples				
SW846 Method 9071B	Oil and Grease (sediments)	G	None	28 days
SW846 Method 6010B	Metal ions by ICP (soil)	100-g soil jar	NA	NA
SW346 Method 6020	Uranium (soil)	100 g	NA	NA

Table 8-7. Analytical Method, Container, Preservation, and Holding Time Requirements (Continued)

Analytical Method	Analyte	Containers P=Plastic G=Glass	Preservation	Holding Times
EPA Method 900.0 modified	Adjusted gross alpha (soil)	100 g	NA	NA
EPA Method 903.0 modified and 904.0 modified	Radium 226 + Radium 228 (soil)	100 g	NA	NA
SW846 Method 8081B	Organochlorine Pesticides (soil)	G	None	14 days
SW846 Method 8270	Semivolatile Organics (soil)	G	None	14 days
SW846 Method 8260B	Volatile Organic Compounds (soil)	G	None	14 days
SW846 Method 8270	2,3,7,8-TCDD Dioxin (soil)	G	None	21 days

SMEWW Standard Methods for the Examination of Water and Wastewater

8.5.1.6 Sediment Grain Size

Thirty one samples will be collected to determine grain size information. Samples will be collected once from the same locations used to sample for sediment chemistry described in Section 8.5.1.4 and to determine the concentration of soluble constituents described in Section 8.5.1.5. The abundance of large gravel clasts will be described in the field to estimate the abundance of this size class. This size class will be excluded from samples submitted to the laboratory for estimates.

8.5.1.7 Stream Bed Armoring

Armoring present in the drainage will be evaluated through a field survey. Walkover surveys will be conducted along the beds of the drainage. The surveys will document the presence and extent of bedrock, natural and man-made armoring, and the potential for the formation of armoring during erosion. The survey will provide field descriptions of the distribution of medium to large gravel clasts. Photographic documentation will be obtained to demonstrate the presence and type of armoring, the presence of large clasts that could form armor, or the lack of such features.

8.5.1.8 Topography of Drainage Channels

Topographic information will be collected using standard engineering techniques (high accuracy GPS surveys linked to GIS). These data will be collected to establish baseline conditions and to evaluate potential impacts from expected flow at several distances downgradient from the proposed discharge. Drainage profiles will be collected at appropriate intervals. If possible, profiles will be collected at 500-ft intervals for the first 5 miles of channel downgradient of the proposed discharge. For the next 17 miles of channel, profiles will be collected at 1,000-ft intervals. Permanent monuments will be emplaced for each transect. These monuments will allow the transects to be resurveyed to document changes in the channel.

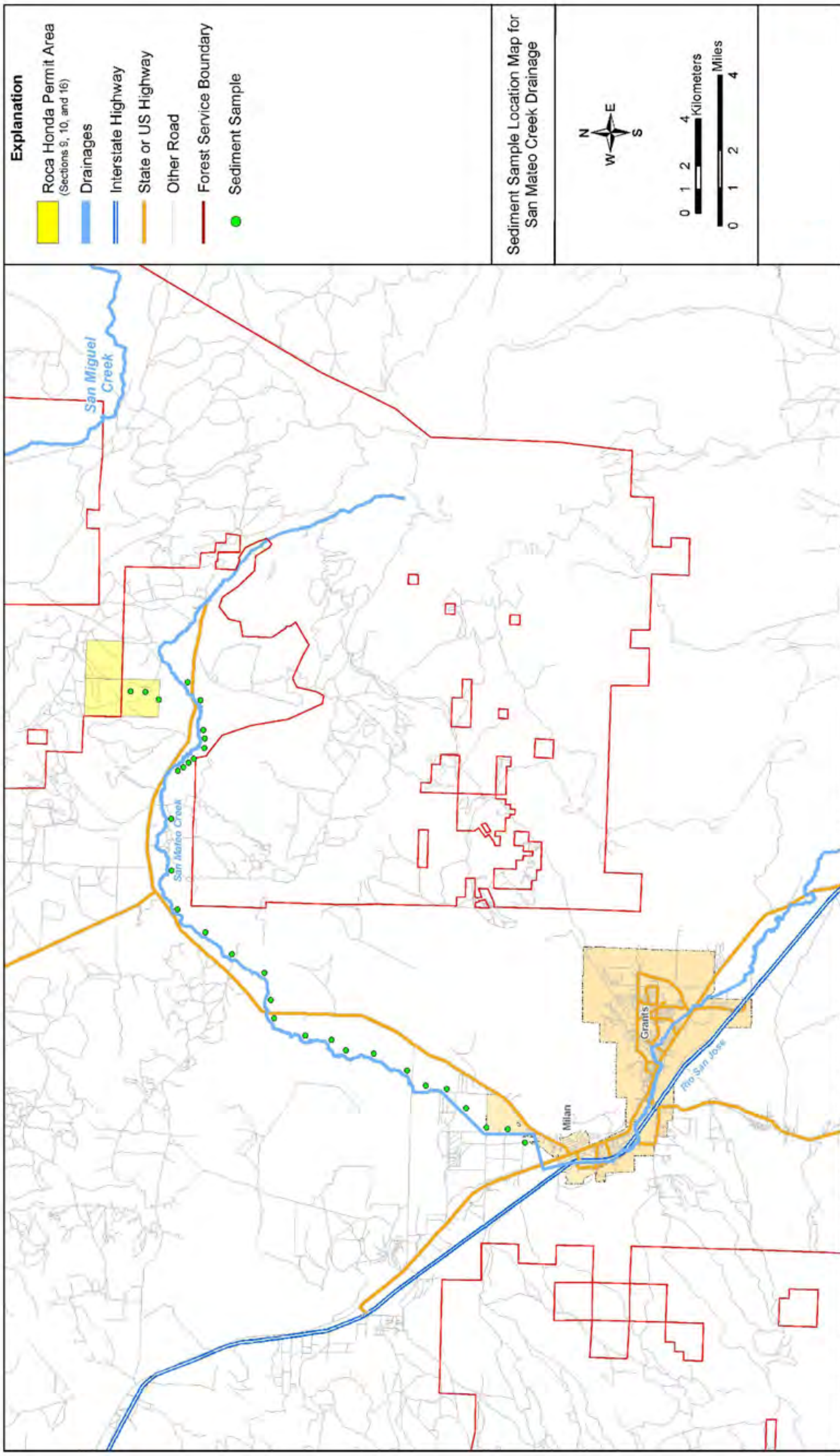

Figure 8-9. Sediment Sampling Locations

8.5.1.9 Flow Conditions in San Mateo Creek

Stream gages and automatic flow meters will be co-located with the water sample locations on San Mateo Creek to determine the volume and timing of water flow and the rate of water loss to the channel (Figure 8–8). The gages will be either electronic or analog and allow measurements of flow events.

A rating table will be prepared showing the relationship between stage (gauged height) and discharge (flow in CFS) for each location where stream measurements are collected. Stream flow measurements using a current meter will be needed to prepare these tables. The reaches of interest flow occasionally and current measurements will be recorded automatically during flow events. Flow may not be encountered at all of the monitoring locations during the first year of monitoring, and records may not include rare high flow events.

It may be necessary to revise the ratings curves if the river channel changes to any large degree. The surveyed profiles of channel cross sections will be used to assess the magnitude of changes, and ratings curves will be modified as necessary in response to major changes in the channel.

Ratings curves commonly have break points associated with bank tops. The surveyed stream profiles will be used to determine breakpoints for each location.

8.5.1.10 Springs Database

Springs in the vicinity of the permit area provide water for livestock and other uses. RHR is developing a database of springs around the permit area. The completeness of the database will be determined by interviewing those familiar with the area. This process will be documented with interview notes on standard forms. Samples for baseline water quality will be collected and flow will be estimated for springs within 2 miles of the boundary of the site. This information may vary seasonally. Four sampling events will be performed if possible to allow the estimation of seasonal variation. Water quality will be established for the complete list of constituents in Table 8–6.

8.6 Maps Providing Sampling Locations

Locations for stream gage and surface water samples, and sediment samples are indicated on Figures 8-8 and 8-9, respectively.

8.7 Sampling Frequency

See Table 8-5 for sampling frequency.

8.8 Laboratory and Field Quality Assurance Plan

The surface water data collection will be conducted in conformance with the Strathmore QA/QC program and field procedures for sampling and the recording of observations in a log book. Field notes will be retained in the project files as a record of the data collected.

The new aerial photograph discussed in Section 3.0, Topography, will be used to direct a ground survey to confirm the location of perennial water bodies and the location and use of structures that could potentially be impacted by mine water discharge. Photographs and detailed field notes will be important for future design efforts to enhance channels and/or protect channels and water bodies.

Sampling of flowing streams will be accomplished using auto-sampling equipment co-located with pressure transducers, flow meters, and auto-loggers. Calibration procedures will be implemented for the applicable equipment. The locations of the stream gages and samplers will be GPS surveyed. Intermittent water bodies and springs will be sampled manually and on a seasonal basis. Sampling activities will follow Strathmore SOPs. The samples for chemical analysis will be properly preserved and sent to an EPA certified analytical laboratory. Sample packages will randomly include quality control samples to include duplicates and equipment blanks.

8.9 Brief Discussion Supporting Proposal

The results of the sample collection strategy outlined in this section will supplement existing surface water quality and quantity data, and sediment quality from past activities in the San Mateo drainage basin. The characterization will establish baseline surface water and sediment conditions across the Roca Honda permit area in advance of mining in order to assess potential and actual affects of mining on surface water. The data will also aid in design of features to protect drainages during the mine water discharge.

8.10 References

ASTM (American Society for Testing and Materials) Standard E 112. *Standard Test Methods for Determining Average Grain Size,* American Society for Testing and Materials.

NMAC (New Mexico Administrative Code) 20.6.4. *New Mexico Administrative Code* Title 20, “Environmental Protection,” Chapter 6 “Water Quality,” Part 4 “Standards for Interstate and Intrastate Surface Waters,” Water Quality Control Commission.

NMAC (New Mexico Administrative Code) 20.6.2. Title 20, “Environmental Protection,” Chapter 6 “Water Quality,” Part 2 “Ground and Surface Water Protection,” New Mexico Administrative Code, Water Quality Control Commission.

——— 20.6.4. Title 20, “Environmental Protection,” Chapter 6 “Water Quality,” Part 4 “Standards for Interstate and Intrastate Surface Waters,” New Mexico Administrative Code, Water Quality Control Commission.

NMEI (New Mexico Environmental Institute), 1974. *An Environmental Baseline Study of the Mount Taylor Project Area of New Mexico*, prepared by Whitson, M.A., and Study Team for Gulf Mineral Resources Company, March.

NMHED (New Mexico Health and Environmental Department), 1980. *Water Quality Data for Discharge from Uranium Mines and Mills in New Mexico*, Environmental Improvement Division, Water Pollution Control Bureau, July.

RGRC (Rio Grande Resources Corporation), 1994. *Environmental Site Assessment, Mt. Taylor Uranium Mine Operation*, June.

Santos, E.S. 1966. *Geologic Map of the San Mateo Quadrangle, McKinley and Valencia Counties, New Mexico*, U.S. Geological Survey Map GQ-517, scale 1:24,000.

Thaden, R.E., E.S. Santos, and E.J. Ostling, 1967. *Geologic Map of the Dos Lomas Quadrangle, Valencia and McKinley Counties, New Mexico*, U.S. Geological Survey Map GQ-680, scale 1:24,000.