SURFACE WATER MONITORING PLAN

ENVIRONMENTAL RESTORATION PROGRAM

ROCKY FLATS PLANT

JANUARY, 1990

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1.0 INTRODUCTION

The surface water monitoring plan developed for the Rocky Flats Plant (RFP) Environmental Restoration (ER) Program documents the overall program goals, specific monitoring objectives, and a consistent, scientifically defensible protocol for reaching these goals and objectives and for the implementation and operation of a surface water monitoring program for the RFP. The plan describes the program from initial network design through field sampling procedures and equipment, laboratory and analytical requirements, data validation, data management, statistical data analysis, and information reporting requirements. The protocol is consistent with the following RFP ER Program documents that have been developed for other programs:

- Standard Procedures for the Design of Environmental Monitoring Systems (Rockwell, 1988a).
- Background Hydrogeochemical Characterization and Monitoring Plan (Rockwell, 1989a).
- Standard Operating Procedures (SOP) (Rockwell, 1989b).
- Quality Assurance/Quality Control (QA/QC) Plan (Rockwell, 1989c).
- Health and Safety Plan (HSP) (Rockwell, 1989d).
- Technical Data Management Plan (TDMP) (Rockwell, 1989e).

1.1 Program Goals

The overall goals of the surface water monitoring program for the RFP ER Program are as follows:

1) Characterize the surface water and sediment quality of the Rocky Flats Plant.

2) Assess the significance and impacts of contaminant releases to and transport via the surface water pathway.

The information obtained from reaching these goals will be incorporated into the Remedial Investigation (RI) and Feasibility Study (FS) process and will provide ER Program management the ability to make sound decisions based on quantitative and scientifically defensible data and monitoring protocols.

1.2 Monitoring Objectives

The specific objectives of the surface water monitoring program that have been developed to reach the program goals are as follows:

1) Characterize background (baseline) water and sediment quality.

2) Determine average or seasonal conditions.

3) Assess trends or changing conditions.

4) Detect extreme values or excursions beyond a limit.

5) Assess relationships between water quality and flow.

These objectives apply to numerous monitoring stations within the RFP site, as well as to a wide variety of water and sediment quality parameters at each station.

This plan addresses Phase 1 of the RFP ER Program surface water monitoring program. Phase 1 will be in place for approximately one year after implementation of the program. Some aspects of this plan may change upon the conclusion of Phase 1 and after a review of the monitoring data collected and analyzed during this phase and of the overall effectiveness of the surface water monitoring program.

2.0 SITE DESCRIPTION

2.1 RFP Description

The Rocky Flats Plant is located approximately 16 miles northwest of downtown Denver, in Jefferson County, Colorado (Figure 2.1). The RFP encompasses about 6,550 acres of federally owned land and is a government-owned and contractor-operated (GOCO) facility that has been operational since 1951. The plant is a U.S. Department of Energy (DOE) facility which manufactures metal components for nuclear weapons from plutonium, uranium, beryllium, and stainless steel. Other production activities include chemical recovery and purification of recyclable transuranic radionuclides, metal fabrication and assembly, and related quality control functions. The plant also conducts research and develpoment in metallurgy, machining, non-destuctive testing, coatings, remote engineering, chemistry and physics. Parts manufactured at the plant are shipped off-site for final assembly. Primary plant structures and all production buildings are located within a 400-acre secure plant complex area. A 6150-acre buffer zone surrounds the perimeter of the main plant complex.

Solid and liquid nonhazardous, hazardous, radioactive, and mixed radioactive wastes are generated in the RFP manufacturing process and operations. Current waste handling and disposal practices include on-site treatment and both on-site and off-site recycling of hazardous and mixed radioactive wastes, on-site storage, or shipment off-site for disposal of hazardous and solid radioactive materials at another DOE facility. However, disposal of hazardous, mixed, and solid radioactive wastes has occurred on the RFP site in the past. Nonhazardous wastes, such as office trash, are disposed of in an on-site landfill.

Preliminary assessments performed by the ER Program identified some of the past on-site storage and disposal locations as potential sources of environmental contamination. A comprehensive list of all known and suspected hazardous, radioactive, and mixed waste sources at the RFP has been compiled. This list includes descriptions and all known release information for all identified RCRA-regulated units and CERCLA Solid Waste Management Units (SWMU's). Each of the regulated and waste management units at the RFP have been categorized for further environmental investigation and remediation into Operable Units (OU's) based on potential threats to human health and the environment. Waste management units that received hazardous waste after November 19, 1980 require RCRA closure plans. Those land disposal units which received hazardous wastes after July 26, 1982 (regulated units) are also subject to RCRA interim status groundwater monitoring requirements prior to closure, and post-closure care requirements subsequent to closure. The RFP regulated units are described in detail in the RCRA, Post-Closure Care Permit Application (Rockwell, 1988b).

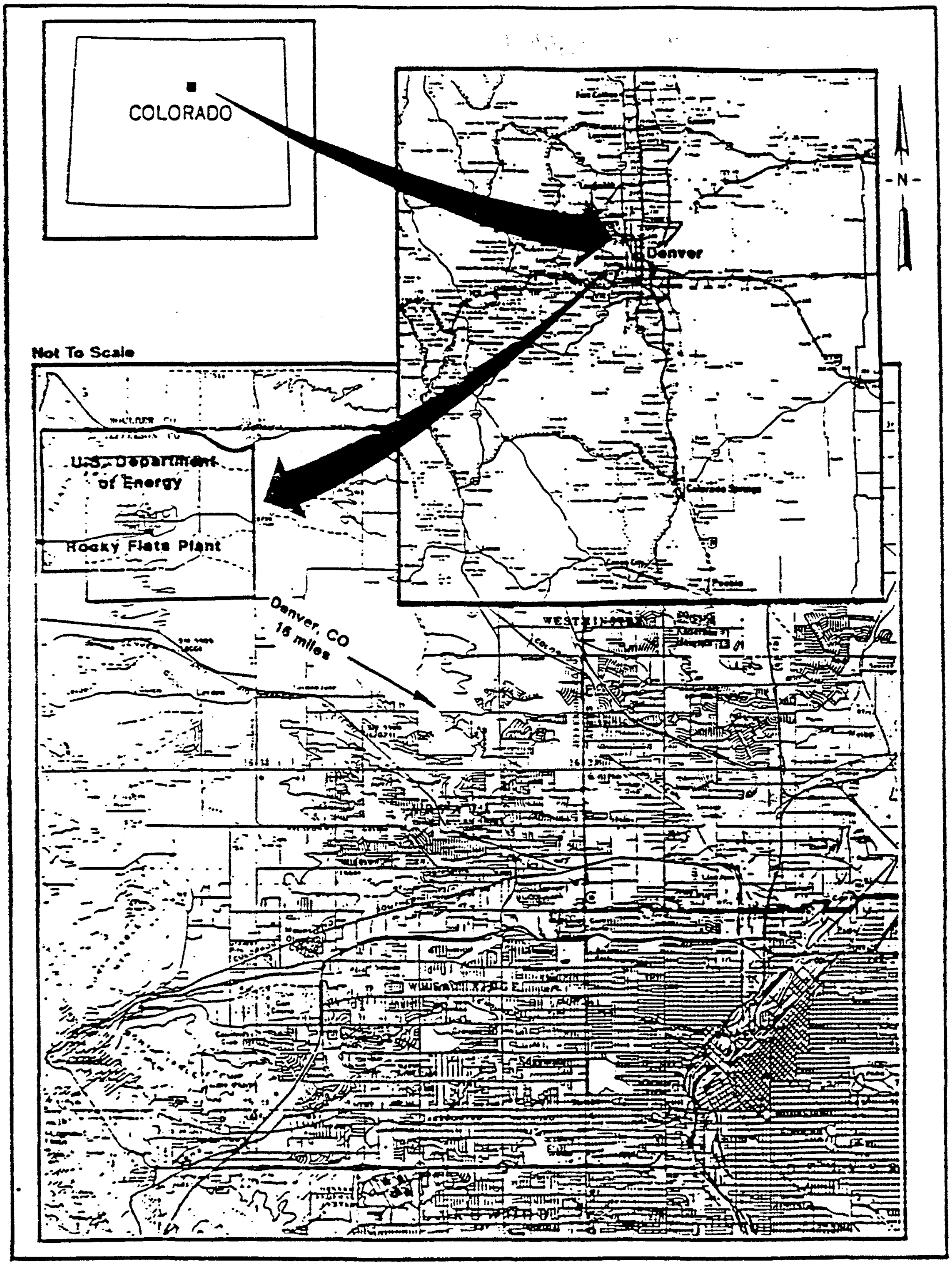


Figure 2-1: LOCATION OF ROCKY FLATS PLANT

Under a Compliance Agreement between DOE, the U.S. Environmental Protection Agency (EPA), and the State of Colorado Department of Health (CDH), the ER Program has responsibility for complying with CERCLA/SARA, RCRA 3004u, and RCRA closure requirements. As an integral component of compliance with these regulations, as well as of the comprehensive goals of the ER Program in general, environmental monitoring is necessary for site characterization and for performing effective remedial investigations and feasibility studies to assess potential contamination problems and to evaluate alternative remedial actions where problems do exist. Surface water monitoring is an important part of this overall environmental monitoring effort.

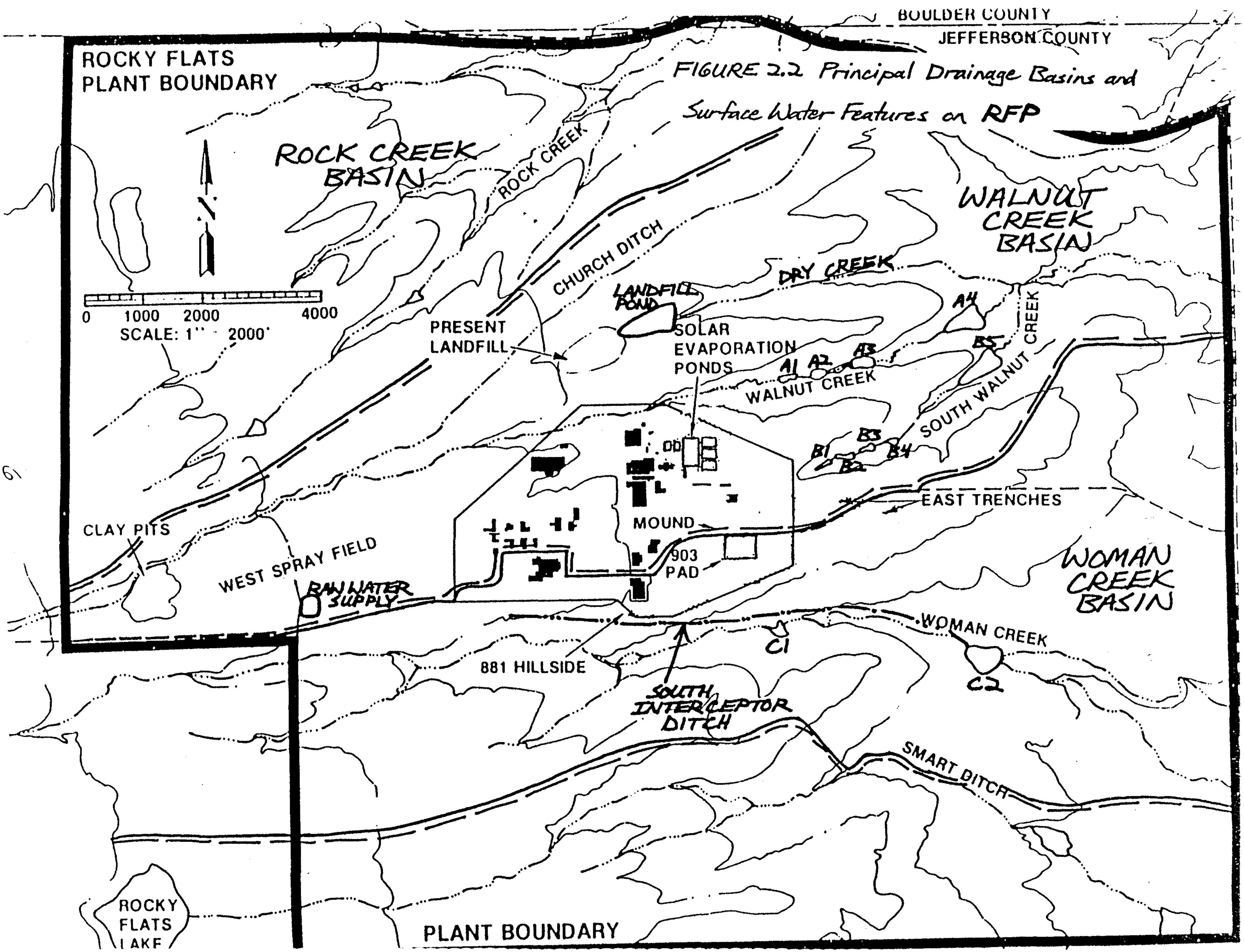
2.2 Surface Water Hydrology

2.2.1 Natural Drainages

Figure 2.2 presents a generalized map of the principal drainage basins and surface water features on the RFP site. Three drainage basins and natural ephemeral streams traverse the RFP and surface water flow across the site is generally from west to east. A topographic divide bisects the site that trends east-west and lies slightly south of Central Avenue (the approximate center line of the site). TheRock Creek drainage basin traverses and drains the northwestern portion of the plant site and is located in the buffer zone entirely separate from the operational plant complex. This drainage is, therefore, generally unimpacted by plant operations and potential contaminant releases to surface water. Rock Creek flows to the northeast to its off-site confluence with Coal Creek. Preliminary surface water modeling of the Rock Creek basin using the Colorado Urban Hydrograph Procedure (CUHP) (Urban Drainage and Flood Control District, 1985) indicates that the 2-year, 2-hour storm would result in a flood peak of approximately 55 cubic feet per second (cfs) at the outlet of the basin. To date, the largest flow observed at the outlet (SW004) from monthly monitoring was less than one cfs.

The Woman Creek drainage basin traverses and drains the southern portion of the site. Although this basin primarily is located in the buffer zone, it does extend into the extreme southern boundary of the plant complex. An interceptor ditch (South Interceptor Ditch) is located between and parallel to Woman Creek and the southern boundary of the plant complex. The relatively small quantity of surface runoff that flows from the southern boundary of the plant complex toward Woman Creek is intercepted by this ditch. This intercepted flow eventually rejoins Woman Creek downstream of a retention pond. Surface runoff downstream of the South Interceptor Ditch is tributary to Woman Creek, which flows to the east eventually off-site to Standley Lake, a water supply for the City of Westminster and for portions of the cities of Northglenn and Thornton. Woman Creek also delivers some water off-site to Mower Reservoir. Preliminary modeling of the Woman Creek basin using CUHP shows that the 2-year, 2-hour storm would result in a flood peak of approximately 35 cfs at the basin outlet. Another modeling effort using the Soil

FIGURE 2.2 Principal Drainage Basins and Surface Water Features on RFP



Conservation Service TR-20 hydrologic model indicates that the 25-year, 2-hour storm results in a flood peak of about 595 cfs at the outlet (RFP, 1987). To date, the largest flow observed at the outlet (SW001) from monthly monitoring was eight cfs during the month of May.

The Walnut Creek drainage basin traverses the western, northern and northeastern portion of the RFP site, and receives runoff from the majority of the plant complex. Three ephemeral streams are actually tributary to Walnut Creek; Dry Creek, North Walnut Creek, and South Walnut Creek (which receives most of the runoff from the plant complex). These three forks of Walnut Creek join in the buffer zone (about 0.7 miles west of the eastern perimeter of the RFP) and flow east off-site to Great Western Reservoir, a water supply for a portion of the City of Broomfield approximately one mile east of this confluence. Preliminary modeling of this basin using CUHP indicates the 2-year, 2-hour storm would result in a flood peak of approximately 50 cfs at the outlet of the basin. Modeling using TR-20 indicates that the 25-year, 2-hour storm results in a flood peak of about 1660 cfs at the outlet. To date, the largest flow observed at the outlet (SW003) from monthly monitoring was two cfs during the month of September.

2.2.2 Ditches and Diversions

In addition to natural flows and the South Interceptor Ditch, there are seven ditches or diversion canals in the general vicinity of the RFP. The Church, Mckay, Kinnear and Reservoir Co. Ditches (diversions of Coal Creek) cross the site. Church Ditch delivers water to Upper Church Lake and Great Western Reservoir. Mckay Ditch also supplies water to Great Western Reservoir. Kinnear Ditch and Reservoir Co. Ditch divert water from Coal Creek and deliver it to Woman Creek and eventually to Standley Lake. Last Chance Ditch flows south of the RFP and supplies water to Rocky Flats Lake and Twin Lakes. Smart Ditch diverts water from Rocky Flats Lake and transports it off-site to the east. The South Boulder Diversion Canal is located just west of the western boundary of the RFP, diverts water from South Boulder Creek, and delivers water to Ralston Reservoir, a water supply for the City of Denver.

2.2.3 Retention Ponds and RFP Discharges

A series of dams, retention ponds, diversion structures and ditches has been constructed at the RFP to control the release of plant discharges and surface (stormwater) runoff that may not consistently meet water quality standards developed by EPA and CDH. The ponds located downstream of the plant complex on North Walnut Creek are designated A-1 through A-4. Ponds on South Walnut Creek are designated B-1 through B-5. These A- and B-series ponds receive runoff from the plant complex. Pond B-3 also receives treated effluent from the Sanitary Treatment Plant (STP). Pond C-1 is located on Woman Creek and receives natural flows, while Pond C-2 is located just south of Woman Creek (the creek is diverted to the north around the pond) and receives diverted flow from the South Interceptor Ditch as well as some natural flows from its immediate drainage basin. Another retention pond (Landfill pond) is located at the upper end of Dry Creek just downstream from the present landfill. Following water quality monitoring, water from the Landfill pond and Pond B-3 is occasionally spray irrigated. Any discharges from the downstream ponds on Walnut or Woman Creeks (A-4, B-5, or C-2) to downstream surface water are regularly monitored according to the requirements of the RFP National Pollutant Discharge Elimination System (NPDES) permit under the Clean Water Act (CWA).

This NPDES monitoring and compliance is the responsibility of the RFP Clean Water Act Division. The NPDES permit currently requires monitoring of specific parameters at seven discharge points. Discharges at the these points are normally in compliance with the NPDES permit. In addition to the specific NPDES monitoring requirements, all discharges to Walnut and Woman Creeks are monitored for plutonium, americium, uranium, and tritium concentrations. The seven permitted discharge points are as follows:

Discharge Point	Location
001	Pond B-3
002	Pond A-3
003	Reverse Osmosis Pilot Plant (not operational)
004	Reverse Osmosis Plant (not operational)
005	Pond A-4
006	Pond B-5
007	Pond C-2

3.0 MONITORING PROTOCOL

3.1 Data Quality Objectives

Data Quality Objectives (DQO's) are qualitative and quantitative statements of the quality of data needed to support specific decisions or actions. One measure of the success of the surface water monitoring program is the extent to which the DQO's are achieved. Establishing useful and attainable DQO's depends on identifying the data users, data uses, types of data needed, sampling and analysis options, and parameters related to precision, accuracy, representativeness, comparability, and completeness of the data.

The data users consist of decision-makers and program management staff and technical personnel. The decision-makers include the DOE Albuquerque Operations Office's Environment, Safety, and Health Division Director and ER Program Manager, as well as the DOE Rocky Flats Area Office's Manager and Environmental, Safety and Health Branch Chief. The program management staff are the prime contractor personnel responsible for the ER Program. The program management technical personnel are the contractor technical specialists (ER Program and other contractors) responsible for supervising, coordinating, and performing the ER Program activities. Additional data users may be identified in the future based upon an evaluation of the effectiveness of the surface water monitoring program and the resulting information and reports.

The monitoring data uses include the determination of overall surface water quality and compliance with relevent regulations, the determination of the nature and extent of contamination as part of the RI process, the evaluation of the potential risks of identified contaminants to human health and the environment, and the evaluation of remedial alternatives as part of the FS process.

The data types include the following five classes of surface water measurement data:

- Hydrology (flow)
- Organic Chemistry
- Metal Chemistry
- Major Ion, Indicator Parameter, and Field Parameter Chemistry
- Radiochemistry

The data collected must conform to the following criteria:

- Data must be of known and documented quality.
- Data must be obtained in accordance with rigorous, documented, QA/QC criteria.
- Data obtained from analyses are characterized by low detection limits and method-specific detection limits. Where available, CLP methods and protocols are used. Methods and associated detection limits are selected such that data may be compared with federal and state Applicable or Relevant and Appropriate Requirements (ARAR's) and/or RFP background concentrations.
- Data are reviewed and validated according to validation procedures prescribed by EPA and DOE. Review and validation activities are documented. Data are not used until they have been reviewed and their validity determined. Data validity has three classifications: 1) Valid; 2) Acceptable for Use with Qualification(s); and 3) Rejected (Unacceptable).

Precision and accuracy are generally dependent on the analysis methods used and the results of duplicate, blank, and spike analyses. Generally, only data which meet the validation criteria of (1) valid, or (2) acceptable, will achieve the necessary level of precision and accuracy required to reach the monitoring objectives. However, some data from data sets validated as rejected (unacceptable) may be used in rare instances such as storm samples collected under unique occurrences. Such data must be flagged as rejected whenever they are cited.

3.2 Water and Sediment Quality Parameters

Parameters to be monitored in the surface water monitoring program include volatile and semivolatile organic compounds, pesticides/PCB's, metals, radionuclides, major ions and indicator parameters, and field parameters. Parameters will be somewhat different for water and sediment analyses since dissolved compounds cannot be analyzed for separately in sediment. Analyses of volatile and semivolatile organics and pesticides/PCB's will be performed for the compounds on the EPA Contract Laboratory Program (CLP) Target Compound List (TCL) to the CLP required quantitation limit (Table 3.1). These limits are the current practical minimum detection limits.

Table 3.1

CLP Target Compound List (TCL) of Volatile Organics

	Volatiles	CAS Number	Quantitation Limits Water ug/L	Low Soil/Sediment ug/Kg
1.	Chloromethane	74-87-3	10	10
2.	Bromomethane	74-83-9	10	10
3.	Vinyl Chloride	75-01-4	10	10
4.	Chloroethane	75-00-3	10	10
5.	Methylene Chloride	75-09-2	5	5
6.	Acetone	67-64-1	10	10
7.	Carbon Disulfide	75-15-0	5	5
8.	1,1-Dichloroethene	75-35-4	5	5
9.	1,1-Dichloroethane	75-34-3	5	5
10.	1,2-Dichloroethene (Total)	540-59-0	5	5
11.	Chloroform	67-66-3	5	5
12.	1,2-Dichloroethane	107-06-2	5	5
13.	2-Butanone	78-93-3	10	10
14.	1,1,1-Trichloroethane	71-55-6	5	5
15.	Carbon Tetrachloride	56-23-5	5	5
16.	Vinyl Acetate	108-05-4	10	10
17.	Bromodichloromethane	75-27-4	5	5
18.	1,2-Dichloropropane	78-87-5	5	5
19.	cis-1,3-Dichloropropene	10061-01-5	5	5
20.	Trichloroethene	79-01-6	5	5
21.	Dibromochloromethane	124-48-1	5	5
22.	1,1,2-Trichloroethane	79-00-5	5	5
23.	Benzene	71-43-2	5	5
24.	trans-1,3-Dichloropropene	10061-02-6	5	5
25.	Bromoform	75-25-2	5	5
26.	4-Methyl-2-pentanone	108-10-1	10	10
27.	2-Hexanone	591-78-6	10	10
28.	Tetrachloroethene	127-18-4	5	5
29.	Toluene	108-88-3	5	5
30.	1,1,2,2-Tetrachloroethane	79-34-5	5	5
31.	Chlorobenzene	108-90-7	5	5
32.	Ethyl Benzene	100-41-4	5	5
33.	Styrene	100-42-5	5	5
34.	Xylenes (Total)	1330-20-7	5	5

Table 3.1 (cont'd) CLP Target Compound List (TCL) of Semi-Volatile Organics

	Semivolatiles	CAS Number	Quantitation Limits Water ug/L	Low Soil/Sediment ug/Kg
35.	Phenol	108-95-2	10	330
36.	bis(2-Chloroethyl)ether	111-44-4	10	330
37.	2-Chlorophenol	95-57-8	10	330
38.	1,3-Dichlorobenzene	541-73-1	10	330
39.	1,4-Dichlorobenzene	106-46-7	10	330
40.	Benzyl alcohol	100-51-6	10	330
41.	1,2-Dichlorobenzene	95-50-1	10	330
42.	2-Methylphenol	95-48-7	10	330
43.	bis(2-Chloroisopropyl)ether	108-60-1	10	330
44.	4-Methylphenol	106-44-5	10	330
45.	N-Nitroso-di-n-dipropylamine	621-64-7	10	330
46.	Hexachloroethane	67-72-1	10	330
47.	Nitrobenzene	98-95-3	10	330
48.	Isophorone	78-59-1	10	330
49.	2-Nitrophenol	88-75-5	10	330
50.	2,4-Dimethylphenol	105-67-9	10	330
51.	Benzoic acid	65-85-0	50	1600
52.	bis(2-Chloroethoxy)methane	111-91-1	10	330
53.	2,4-Dichlorophenol	120-83-2	10	330
54.	1,2,4-Trichlorobenzene	120-82-1	10	330
55.	Naphthalene	91-20-3	10	330
56.	4-Chloroaniline	106-47-3	10	330
57.	Hexachlorobutadiene	87-68-3	10	330
58.	4-Chloro-3-methylphenol (para-chloro-meta-cresol)	59-50-7	10	330
59.	2-Methylnaphthalene	91-57-6	10	330
60.	Hexachlorocyclopentadiene	77-47-4	10	330
61.	2,4,6-Trichlorophenol	88-06-2	10	330
62.	2,4,5-Trichlorophenol	95-95-4	50	1600
63.	2-Chloronaphthalene	91-58-7	10	330
64.	2-Nitroaniline	88-74-4	50	1600
65.	Dimethylphthalate	131-11-3	10	330
66.	Acenaphthylene	208-96-8	10	330
67.	2,6-Dinitrotoluene	606-20-2	10	330
68.	3-Nitroaniline	99-09-2	50	1600
69.	Acenaphthene	83-32-9	10	330

Table 3.1 (cont'd)

	Semivolatiles	CAS Number	Quantitation Limits Water ug/L	Low Soil/Sediment ug/Kg
70.	2,4-Dinitrophenol	51-28-5	50	1600
71.	4-Nitrophenol	100-02-7	50	1600
72.	Dibenzofuran	132-64-9	10	330
73.	2,4-Dinitrotoluene	121-14-2	10	330
74.	Diethylphthalate	84-66-2	10	330
75.	4-Chlorophenyl-phenyl ether	7005-72-3	10	330
76.	Fluorene	86-73-7	10	330
77.	4-Nitroaniline	100-01-6	50	1600
78.	4,6-Dinitro-2-methylphenol	534-52-1	50	1600
79.	N-nitrosodiphenylamine	86-30-6	10	330
80.	4-Bromophenyl-phenylether	101-55-3	10	330
81.	Hexachlorobenzene	118-74-1	10	330
82.	Pentachlorophenol	87-86-5	50	1600
83.	Phenanthrene	85-01-8	10	330
84.	Anthracene	120-12-7	10	330
85.	Di-n-butylphthalate	84-74-2	10	330
86.	Fluoranthene	206-44-0	10	330
87.	Pyrene	129-00-0	10	330
88.	Butylbenzylphthalate	85-68-7	10	330
89.	3,3'-Dichlorobenzidine	91-94-1	20	660
90.	Benzo(a)anthracene	56-55-3	10	330
91.	Chrysene	218-01-9	10	330
92.	bis(2-Ethylhexyl)phthalate	117-81-7	10	330
93.	Di-n-octylphthalate	117-84-0	10	330
94.	Benzo(b)fluoranthene	205-99-2	10	330
95.	Benzo(k)fluoranthene	207-08-9	10	330
96.	Benzo(a)pyrene	50-32-8	10	330
97.	Indeno(1,2,3-cd)pyrene	193-39-5	10	330
98.	Dibenz(a,h)anthracene	53-70-3	10	330
99.	Benzo(g,h,i)perylene	191-24-2	10	330

Table 3.1 (cont'd) CLP Target Compound List (TCL) for Pesticides/PCBs

Pesticides/PCBs	CAS Number	Quantitation Limits** Water ug/L	Quantitation Limits** Low Soil/Sediment[c] ug/Kg
100. alpha-BHC	319-84-6	0.05	8.0
101. beta-BHC	319-85-7	0.05	8.0
102. delta-BHC	319-86-8	0.05	8.0
103. gamma-BHC (Lindane)	58-89-9	0.05	8.0
104. Heptachlor	76-44-8	0.05	8.0
105. Aldrin	309-00-2	0.05	8.0
106. Heptachlor epoxide	1024-57-3	0.05	8.0
107. Endosulfan I	959-98-8	0.05	8.0
108. Dieldrin	60-57-1	0.10	16.0
109. 4,4'-DDE	72-55-9	0.10	16.0
110. Endrin	72-20-8	0.10	16.0
111. Endosulfan II	33213-65-9	0.10	16.0
112. 4,4'-DDD	72-54-8	0.10	16.0
113. Endosulfan sulfate	1031-07-8	0.10	16.0
114. 4,4'-DDT	50-29-3	0.10	16.0
115. Methoxychlor	72-43-5	0.5	80.0
116. Endrin ketone	53494-70-5	0.10	16.0
117. alpha-Chlordane	5103-71-9	0.5	80.0
118. gamma-Chlordane	5103-74-2	0.5	80.0
119. Toxaphene	8001-35-2	1.0	160.0
120. Aroclor-1016	12674-11-2	0.5	80.0
121. Aroclor-1221	11104-28-2	0.5	80.0
122. Aroclor-1232	11141-16-5	0.5	80.0
123. Aroclor-1242	53469-21-9	0.5	80.0
124. Aroclor-1248	12672-29-6	0.5	80.0
125. Aroclor-1254	11097-69-1	1.0	160.0
126. Aroclor-1260	11096-82-5	1.0	160.0

Note: Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

**Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher.

[c]Medium Soil/Sediment Contract Required Quantitation Limits (CRQL) for Pesticide/PCB TCL compounds are 15 times the individual Low Soil/Sediment CRQL.

Metals analyses will be performed for the compounds on the CLP inorganic Target Analyte List (TAL). In addition, analyses will be performed for the following metals:

- Cesium
- Chromium (hexavalent)
- Lithium
- Molybdenum
- Strontium
- Tin

These metals have been added to the TAL because they are used in plant operations (chromium) or existing surface or ground water data indicate possibly anomalous concentrations (lithium, strontium and tin). Table 3.2 presents all of the metals for which analyses will be performed as well as their corresponding required detection limits.

Analyses for major ions and indicator parameters will also be performed. Major cations for which analyses will be performed and their corresponding detection limits are presented in Table 3.2 with the metals. Major anions are presented in Table 3.3 along with their corresponding detection limits. For water samples, Table 3.3 also lists the indicator parameters for which analyses will be performed as well as parameters to be measured in the field.

Radionuclides for which analyses will be performed are presented in Table 3.4. Also presented in this table are the corresponding minimum detectable activities for each parameter.

Sediment (bed material) samples will be collected from stream channels at numerous locations within the RFP site. Chemical analyses of the sediment samples will be performed for the aforementioned parameters with the exception of some of the indicator parameters and the dissolved components of all of the parameters. A grain size distribution analysis of bed material samples will also be performed to determine the relative fractions of cobbles, sands, and clays and silts in each sample. Suspended sediment and adsorbed constituent concentrations in major stream channels on the RFP will be investigated and characterized in a separate investigation.

It should be noted that not all of the parameters discussed above will be sampled or analyzed for at every sampling location at the same frequency. In addition, data analysis and an evaluation of the effectiveness of the surface water monitoring program after Phase 1 (one year) may indicate that the parameters for which analyses will be performed, the frequency of sampling and/or analysis, or the sampling locations for these parameters may require modification.

Table 3.2 CLP Target Analyte List (TAL) for Metals

Element	Nominal Detection Limit Water (ug/L)	Nominal Detection Limit Soil (mg/kg)
Aluminum	200	40
Antimony	60	12
Arsenic	10	2
Barium	200	40
Beryllium	5	1.0
Cadmium	5	1.0
Calcium	5000	2000
Chromium	10	2.0
Cobalt	50	10
Copper	25	5.0
Cyanide	10	10
Iron	100	20
Lead	5	1.0
Magnesium	5000	2000
Manganese	15	3.0
Mercury	0.2	0.2
Nickel	40	8.0
Potassium	5000	2000
Selenium	5	1.0
Silver	10	2.0
Sodium	5000	2000
Thallium	10	2.0
Vanadium	50	10.0
Zinc	20	4.0

Table 3.2 (cont'd) Additional Metals

Analyte	Required Detection Limits Water (mg/L)	Soil (mg/kg)
Cesium	1000	200
Chromium (VI)	10	1
Lithium	100	20
Molybdenum	200	40
Strontium	200	40
Tin	200	40

Table 3.3 Major Anions, Indicator Parameters, and Field Parameters

PARAMETER	DETECTION LIMITS	
	Water (ug/l)	Sediment (ug/g)
Major Anions		
Bicarbonate as CaCO3	10	N/A
Carbonate as CaCO3	10	N/A
Chloride	5	60
Fluoride	0.05	?
Nitrate+Nitrite as N	5	60
Phosphate (Orthophosphate)	0.01	?
Sulfate	5	60
Sulfide	N/A	4
Indicator Parameters		
Total Dissolved Solids (TDS)	5	N/A
Total Suspended Solids (TSS)	10	N/A
pH	0.1 pH units	0.1 pH units
Silica (possibly)	0.45	N/A
Oil and Grease	5	N/A
Field Parameters		
pH	0.1 pH units	0.1 pH units
Temperature	N/A	N/A
Specific Conductivity	1	N/A
Dissolved Oxygen	0.1	N/A

Table 3.4 Radiochemistry Parameters

Parameter	Required Detection Limit (MDA) Water (pCi/L)	Soil (pCi/g)	
Gross Alpha	2	4	(dry)
Gross Beta	4	10	(dry)
Tritium	400	400	(pCi/ml)
$Pu^{239,240}$	0.01	0.03	(dry)
$U^{233,234}$	0.6	0.3	(dry)
U^{235}	0.6	0.3	(dry)
U^{238}	0.6	0.3	(dry)
$Americium^{241}$	0.01	0.02	(dry)
$Strontium^{89+90}$	1	. 1	(dry)
$Cesium^{137}$	1	0.1	(dry)
$Radium^{226}$	0.5	0.5	(dry)
$Radium^{228}$	1	0.5	(dry)

Radium analysis performed only if gross alpha is greater than 5 pCi/l. First, radium 226 is analyzed. If radium 226 is greater than 3 pCi/l, then radium 228 is analyzed.

3.3 Water Flow

In addition to the water and sediment quality parameters discussed above, surface water flowrate or stage (rating curves exist for flumes for computation of flowrate) will also be monitored every time a water or sediment sample is collected at the periodic stations. Flowrate and/or stage will also be monitored continuously using automated equipment at several permanent stream gaging and and sampling stations.

3.3 Sampling Locations

3.3.1 Permanent Stations

Figure 3.1 presents the monitoring network and locations of all sampling stations incorporated into the surface water monitoring program. All surface water monitoring stations are also listed in Table 3.5. The monitoring network consists of two parts or two types of monitoring stations. One portion of the monitoring network consists of four locations where automated equipment at permanent stream gaging and sampling stations will be utilized in conjunction with a field crew for flow and water quality monitoring on a continuous basis as long as enough flow exists in the channel. One of these stations (Walnut Creek Station, SW003 at Indiana Street and the eastern downstream plant boundary on Walnut Creek) is already operational (although it will be upgraded) and has been monitoring flow and water quality on a continuous basis as part of the RFP NPDES monitoring program for several years. The other three stations will be installed at Indiana Street and the eastern downstream plant boundary on Woman Creek (Woman Creek Station, SW001), State Highway 128 and the northern downstream plant boundary on Rock Creek (Rock Creek Station, SW004), and just upstream of the western plant boundary on Woman Creek (Upper Woman Creek Station, SW107). This permanent monitoring station network has two primary functions. One function is to monitor flow and water quality on a continuous basis during storm and snowmelt runoff events and pond discharges to downstream surface water and as long as enough flow exists in the channel. The other major function is to monitor the flow and quality of water entering and exiting the site boundaries in order to characterize background surface hydrogeochemistry and provide information on the significance and impacts of potential contaminant releases from plant operations to downstream surface water.

The Woman Creek and Walnut Creek stations will monitor the flow and quality of water exiting the RFP site at two points on its eastern downstream boundary. These stations are designed to provide information on the significance and impacts of potential contaminant releases from plant operations to downstream surface water.

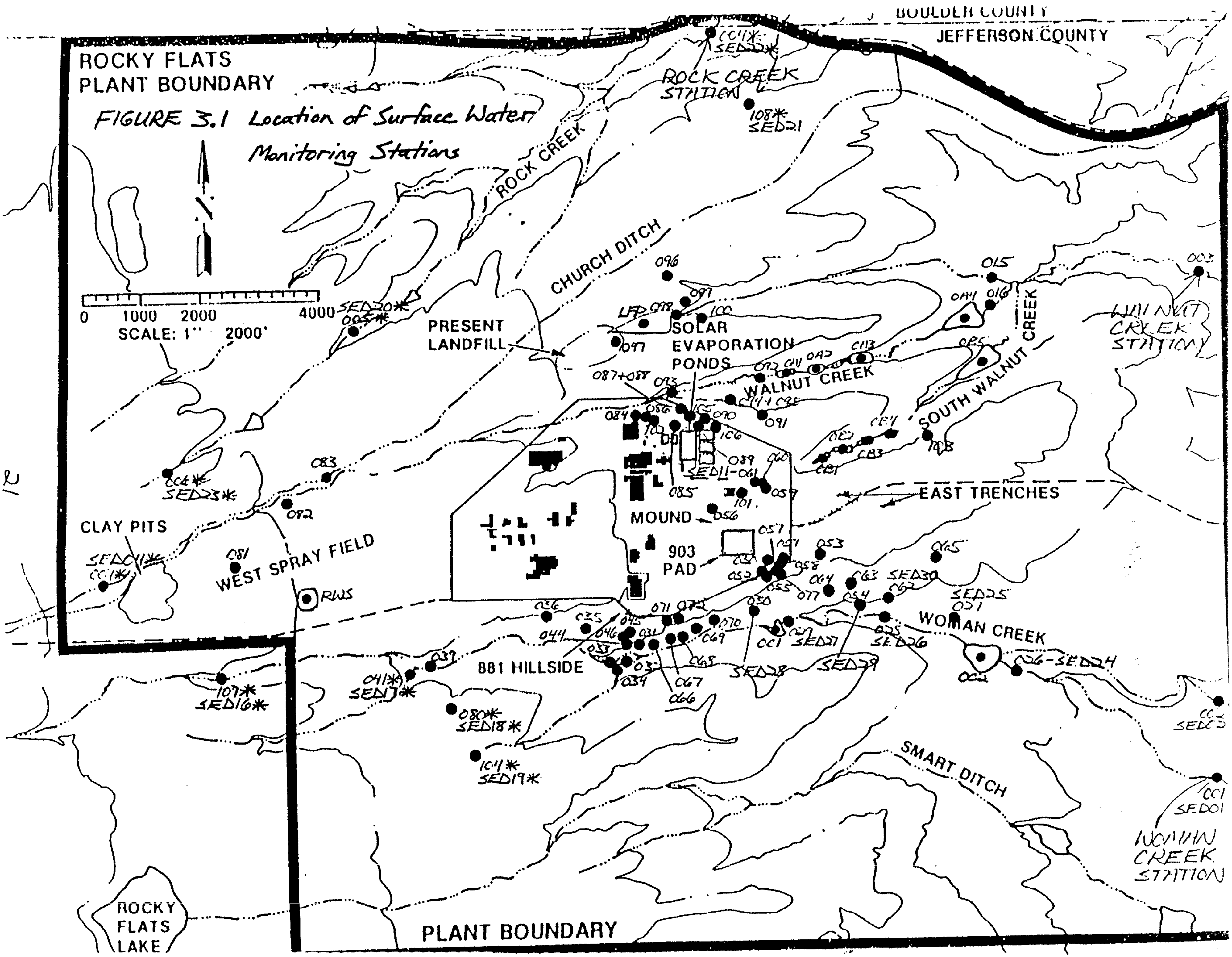


FIGURE 3.1 Location of Surface Water Monitoring Stations

Table 3.5 Surface Water Monitoring Stations

STATION ID		STATION ID	
Water	Sediment	Water	Sediment
SW001+	SED01+	SW071	
SW002+	SED02+	SW072	
SW003		SW077	
SW004*+	SED22*+	SW080*	SED18*
SW005*	SED20*	SW081	
SW006*	SED23*	SW082	
SW007*	SED04*	SW083	
SW015		SW084	
SW016		SW085	
SW026	SED24	SW086	
SW027	SED25	SW087	
SW028	SED26	SW088	
SW029	SED27	SW089	
SW030	SED28	SW090	
SW031		SW091	
SW032		SW092	
SW033		SW093	
SW034		SW094	
SW035		SW095	
SW036		SW096	
SW039		SW097	
SW041*	SED17*	SW098	
SW044		SW099	
SW045		SW100	
SW046		SW101	
SW050		SW102	
SW051		SW103	
SW052		SW104*	SED19*
SW053		SW105	
SW054	SED29	SW106	
SW055		SW107*+	SED16*+
SW056		SW108*	SED21*
SW057		SWPA1	
SW058		SWPA2	
SW059		SWPA3	
SW060		SWPA4	
SW061	SED11	SWPB1	
SW062	SED30	SWPB2	
SW063		SWPB3	
SW064	SED31	SWPB4	
SW065		SWPB5	
SW066		SWPC1	
SW067		SWPC2	
SW068		SWRWS	
SW069		SWLFP	
SW070			

* Background Station
+ Permanent Station

The Rock Creek Station will serve as a "control" or background station since it is generally unimpacted by plant activities and no RFP manufacturing operations have occurred in the drainage. No disposal operations have occurred except for very infrequent destruction of glass vessels containing various inorganic, non-radioactive gases at the site of the Rock Creek Ranch. Rock Creek is considered a reliable source of background data because it has similar characteristics to Walnut and Woman Creeks. Specifically, Rock Creek drains similar terrain and flows over similar geologic material. The Upper Woman Creek Station will also serve as a background station since it will monitor the flow and quality of water entering the site at its western upstream boundary. Although geologic materials which are somewhat different than those characteristic of the locations of the other three permanent monitoring stations may influence the water quality at the Upper Woman Creek Station, this upstream location is unimpacted by plant operations and may be useful for comparison purposes. It will also provide information on the concentrations and loadings of constituents entering the RFP site at its western upstream boundary.

Volatiles, semi-volatiles, and pesticides/PCB's will not be continuously monitored at the two background permanent monitoring stations. These types of compounds will, however, be monitored at these two locations and other background stations on a periodic basis as described in Section 3.3.2.

3.3.2 Periodic Stations

The other portion of the monitoring network consists of 90 stations where flow and/or water quality will be monitored on a periodic basis using a field crew and portable sampling equipment and flumes. These stations are also shown in Figure 3.1 and listed in Table 3.5. The locations of four of these periodic stations will correspond to the locations of the four permanent stream gaging and sampling stations. SW001 is the Lower Woman Creek Station, SW003 is the Walnut Creek Station, SW004 is the Rock Creek Station, and SW107 is the Upper Woman Creek Station. 78 of these periodic stations are currently being monitored on a monthly basis as part of the ER Program preliminary surface water monitoring program. In addition, 19 of these stations correspond to sediment stations that are currently being monitored semi-annually (twice per year) for sediment (bed material) quality. One more sediment monitoring station (at Walnut Creek Station, SW003) will be added to the network to provide a total of 20 stations used for periodic bed material monitoring (Figure 3.1 and Table 3.5). The primary function of the 90 periodic monitoring stations is to provide information to evaluate the significance and impacts of potential contaminant releases to surface water from suspected source areas on the RFP site.

Although most of the periodic stations are located downgradient of potential contaminant source areas, nine of the stations are located in areas of the site that are generally unimpacted by plant operations (Table 3.5). These stations will serve as background stations and will provide water and sediment quality data to characterize background conditions and for comparison purposes to help determine if an actual release has occurred in other areas of the site. One station (SW107) is located in the upstream region of the Woman Creek drainage basin at the Woman Creek Station. Three stations (SW041, SW080, and SW104) are located within tributaries entering Woman Creek from the southwest. Station SW007 is located in a tributary of Walnut Creek. Stations SW004, SW005, SW006, and SW108 are located in the Rock Creek drainage basin. These background stations correspond to the following background sediment monitoring stations, respectively: SED16, SED17, SED18, SED19, SED04, SED22, SED20, SED23, and SED21. These unimpacted stations were selected to collect a variety of surface water and sediment samples which are representative of background conditions.

Currently, volatile and semi-volatile organics, and pesticides/PCB's are not monitored at the background stations since it is believed that these compounds are not present at the unimpacted locations. However, because it is possible that some of these compounds (such as pesticides) could be used or have been usedin the past in upstream offsite areas, all of these compounds will be monitored at all background locations on a periodic basis in the future.

Data analysis and an evaluation of the effectiveness of the surface water monitoring program after Phase 1 (one year) may indicate that new monitoring locations should be incorporated into the program or that existing stations are inadequate or unnecesary. Consequently, the sampling locations specified in this plan may be modified in the future if deemed appropriate by ER Program management and technical staff.

3.4 Sampling Frequency

3.4.1 Permanent Stations

The four permanent gaging and sampling stations will monitor flow and water quality on a continuous basis during storm, pond discharge, and snowmelt events and as long as enough flow exists in the channels. This will be accomplished using automated streamflow measurement and water quality sampling equipment, as discussed in Section 3.5. The Walnut Creek Station (SW003) currently monitors flow and water quality on a continuous basis. The automated composite sampler at this location is runoff event-actuated and collects about a 250-milliliter (ml) sample in a 22-second period every 40 minutes when enough flow exists in the channel. The new automated samplers will also be runoff event-actuated. The new samplers at the two downstream locations (Walnut Creek and Woman Creek stations) will collect 4-gallon samples at specific time intervals, while the samplers at the two background stations (Rock Creek and Upper Woman Creek stations) will collect 250-ml samples at specific time intervals. The time intervals will be set via a telemetry system to attempt to effectively characterize the water quality over the expected time period of the hydrograph resulting from a storm, pond discharge, or snowmelt event. Generally, the shorter the expected duration of the event or time period of the hydrograph, the shorter the time interval between samples will be set. During baseflow conditions, i.e. when an event is not occurring or expected, the time interval between samples will generally be set longest. During the summer season, when short, intense thunderstorms are common and may be expected, the sampling frequency will be set higher to attempt to fully characterize the water quality over the expected length of the hydrograph. Consequently, the exact sampling frequency will vary depending on the season, the expected event, and the expected timing and characteristics of each hydrograph.

3.4.2 Periodic Stations

The existing 78 periodic stations that are currently monitored using portable equipment (Section 3.5) will continue to be sampled on a monthly basis during Phase 1 of the monitoring program. The additional 12 periodic stations located in the retention ponds and the raw water supply will be monitored on a quarterly basis. However, pesticides/PCB's and semi-volatiles are currently only sampled and analyzed for on a semi-annual basis (twice per year) at all existing non-background stations. This frequency will be increased to quarterly. In addition, volatile and semi-volatile organics and pesticides/PCB's are currently not monitored at the nine background stations since it is believed that these compounds should not be found in these areas of the site. However, because it is possible that some of these compounds (such as pesticides) could be used or have been used in the past in upstream areas (for example, in agricultural applications), they will be monitored at all of the background stations on a quarterly basis during Phase 1 (one year) of the monitoring program. If any of these contaminants are found at any of the background stations, they will continue to be monitored at an appropriate frequency. If none of these contaminants are found at any of the background stations, monitoring for these parameters may be terminated after Phase 1 if deemed appropriate.

Currently, the 19 sediment stations are sampled on a semi-annual basis and volatile and semi-volatile organics and pesticides/PCB's are not monitored at the nine background sediment stations. However, all 20 sediment stations will be monitored for all parameters on a quarterly basis during Phase 1 of the monitoring program. This frequency may be modified after Phase 1 and after analysis of the analytical data if deemed appropriate.

Any sampling frequencies may be modified in the future (after Phase 1) for some or all of these stations or parameters if deemed appropriate after analyses of the data are performed and the effectiveness of the surface water monitoring program is evaluated. For example, if pesticides/PCB's or semi-volatiles are detected in any quarterly samples for any particular station, the monitoring frequency for the detected compound or class of compounds may be increased to monthly at this or all stations if appropriate.

3.5 Field Sampling Protocol and Equipment

3.5.1 Permanent Stations

Flow monitoring and water sampling at the four permanent gaging and sampling stations will be accomplished using automated equipment in conjunction with a field crew. Streamflow will be monitored on a continuous basis as long as enough water exists in the channel using double-throated Parshall flumes coupled with Drexelbrook Engineering Company Radio-Frequency (RF) level measurement and recording instrumentation (or equal). Such a flume is currently in use at the Walnut Creek Station (SW003) to more accurately measure both low and high flows. The flume has two steel Parshall flumes in parallel: the first is six-inches wide at the throat and 42-inches deep to accurately measure low flows, and the second is 36-inches wide and 36-inches deep to accurately monitor higher flows. Each flume has a Drexelbrook RF level measurement sensor coupled with a flow totalizer housed in an insulated and heated storage building. Engineering drawings and specifications for the gaging station at SW003 are available. An automated composite sampler is also currently used at this station. The totalizer and sampler do not meet the requirements of this monitoring protocol. Consequently, the Walnut Creek Station will be upgraded with a new Drexelbrook continuous totalizer and flowrate indicator and recorder (or equal) for each of the flumes, a new ISCO automated sampler (or equal) for composite and/or sequential sampling, and telemetry equipment for remote readout and control of flow measurement and sampling equipment at a centralized location.

The three new gaging stations will also use double-throated flumes. The Rock Creek Station (SW004) will consists of one 36-inch Parshall flume (capacity of 50 cfs). The Woman Creek Station (SW001) will have one 24-inch Parshall flume (capacity of 30 cfs) and one six-inch flume. The Upper Woman Creek Station (SW107)will have one 18-inch Parshall flume (capacity of 25 cfs) and one six-inch flume. Each flume will have one Drexelbrook RF level measurement sensor coupled with a totalizer and flowrate indicator/recorder. The two totalizers and flowrate indicators/recorders at each station will be housed in an insulated and heated storage building to ensure continuous flow monitoring during freezing weather. Telemetry equipment will also be installed at each of the stations for remote readout and control at a centralized location. Electricity will be provided to each of the new storage buildings from the nearest existing power lines.

Water samples for continuous water quality monitoring will be collected with a refrigerated ISCO sampler (or equal). The sampler is electrically operated, can be activated by the presence of water in the flume (runoff-event actuated), and can be programmed to collect a water sample of a specified volume at regular (or specified) time intervals or at regular intervals of total flow through the flume. For this application, the sampler will be runoff event-actuated, and will collect sequential samples at specific time intervals as discussed in Section 3.4.1. The sample will be pumped using the peristaltic pump provided in the ISCO sampler from a mixing box immediately downstream of the flume. The Walnut Creek Station already includes such a mixing box. The sampler at this station is runoff event-actuated and collects approximately 250 ml of sample for 22 seconds every 40 minutes. All new samplers will be installed in an insulated and heated storage building to allow sample collection during freezing weather.

The dedicated field crew will consist of five people; two full-time at each downstream station (Walnut and Woman Creek stations) and one person full-time to transport, refrigerate, package, and ship samples. The crew will be resonsible for transferring samples from the bulk containers in the ISCO samplers to the appropriate sample containers at the correct volumes (depending on compound types) for subsequent laboratory analysis according to the RFP ER Program SOP's and QA/QC Plan. They will also be responsible for removing the old bulk sample containers from the samplers and installing new bulk sample containers in the samplers for the next sequential sample. They will maintain all equipment at the station on an ongoing basis to be sure that it is operating correctly and efficiently. The person responsible for transporting samples will bring all samples to a centralized location for refrigeration, packaging, and shipping according to the procedures detailed in the SOP's and QA/QC Plan. This person will also be responsible for maintaining the two background stations (Rock Creek and Upper Woman Creek stations) and for transporting, refrigerating, and shipping the samples collected at these stations. The field crew will also collect one grab sample at each of the downstream stations during each sampling event directly from the stream channel (mixing box) for volatile organics analysis. Samples for volatile organics analysis will not be collected on a continuous basis from the two backround stations. However, volatiles will be monitored on a periodic basis at these two locations.

3.5.2 Periodic Stations

Field sampling protocol have been developed for the RFP ER Program to ensure the collection of data of known quality for the periodic monitoring portion of the surface water monitoring program. Sampling protocol and equipment used for periodic sampling of the 90 surface water stations will be consistent with that described in the SOP's (Rockwell, 1989b) for the RFP. SOP number 2.9 documents the general protocol that will be followed for surface water sampling, while SOP number 2.10 presents the protocol to be followed for streamflow measurement. Bed material (sediment) sampling protocol and equipment used for quarterly sampling of the 20 sediment stations will follow SOP number 5.2 for soil sampling with a spade and scoop. An SOP has also recently been developed for retention pond sampling. In addition, the specific protocol in the following SOP's will be followed to ensure careful sample documentaion, preservation, and packaging and shipping, field measurements, volatile organics sampling, and equipment and personnel decontamination:

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.3	Sample Control and Documentation
1.4	Sample Containers and Preservation
1.5	Guide to the Handling, Packaging, and Shipping
1.6	General Equipment Decontamination
1.7	Sampling for Removable Alpha Contamination
1.8	Personnel Decontamination - Level D Protection
1.9	Personnel Decontamination - Level C Protection
1.10	Personnel Decontamination - Level B Protection
2.2	Field Measurements on Ground and Surface Water
2.8	Sampling for Volatile Organics
	SOP for Retention Pond Sampling

Health and safety requirements for field personnel will be consistent with those described in the Health and Safety Plan (Rockwell, 1989d) for the RFP ER Program. Field operations QA/QC procedures will be adhered to as documented in the individual SOP's and the QA/QC Plan (Rockwell, 1989c) for the RFP ER Program.

3.6 Laboratory Analysis

The parameters for which analyses will be performed are discussed in Section 3.1 of this plan. The specific analytical methods for all water and sediment quality parameters included in the surface water monitoring program are documented in the RFP ER Program QA/QC Plan (Rockwell, 1989c). This document also presents analytical detection limits, sample container and volume requirements, preservation techniques and sample holding times.

3.7 Data Validation

Analytical data from the laboratory will be reviewed and validated by the ER Program QA/QC staff. The data and laboratory performance will be carefully evaluated to determine whether they achieve the DQO's discussed in Section 3.1 of this plan. EPA data validation guidelines will be used for validating data for organic and inorganic (metals) compounds. Data validation methods and documentation requirements have been developed by the ER Program QA/QC staff for radionuclides and major ions. These procedures will be followed since the EPA has not established any protocol for these compounds. Details of these data validation procedures are documented in the QA/QC Plan (Rockwell, 1989c) for the RFP ER Program. The results of data review and validation procedures will be documented in data validation reports, as discussed in the QA/QC Plan.

3.8 Data Management

Once data are validated, they will be incorporated into a centralized surface water monitoring program data base. The computerized data base will be the core of the data management system, and will provide an organized, systematic and consistent framework within which all technical data pertaining to this program can be stored, accessed, manipulated, and tracked. The specific objectives of the data management system are to provide a structured, accurate, and verifiable method to accomplish the following:

- Track all samples from field collection, through laboratory analysis, to final disposition.
- Record all field data generated during sample collection.
- Record all results of laboratory analyses performed on samples and overall laboratory performance.
- Allow all recorded data to be accessed and manipulated for data analysis and/or report preparation.

- Comply with the Technical Data Management Plan (Rockwell, 1989e) for the RFP ER Program.

Currently, all surface water analytical data from the laboratory are loaded electronically into "analytical" files based on types or classes of compounds. All surface water quality data measured in the field are loaded manually into a separate "driver" file. All surface water flow data measured in the field are loaded into a third file. The current surface water data base actually consists of one file for surface water flow measurements and 15 separate chemical files based on two types of media (water and sediment) and nine types or classes of parameters (volatile organics, semi-volatile organics, pesticides/PCB's, dissolved metals, total metals, inorganics and indicator parameters, dissolved radionuclides, total radionuclides, and field parameters). The general structure of the current surface water data base is presented in Figure 3.2.

The Environmental Monitoring and Assessment Division (EMAD) of the ER Program will be instituting a new relational environmental data base system to handle all geologic, geochemical, hydrologic and hydrogeologic information in the near future. This system will be driven by the ORACLE commercial data base software package, which will be customized to the specific needs of ER Program users. All past, present and future surface water data will be incorporated into this data base. The system will initially reside on a dedicated IBM PC but will have data access to the unclassified VAX mainframe system at the RFP. The system will be maintained and updated on a continuous basis and will allow for upload/download of data for other internal applications required by ER Program users.

Within the overall environmental data base system, all surface water data will be stored in a separate file or "sub" data base. Within the surface water data base, stations and sample dates will be stored as records and each parameter (and additional information) will be stored as a column or field. The data for each parameter within each file will be sorted first by station identification and then by sample date to develop a time series for every parameter for each station. This will be the generalized format of the surface water data base that will allow easy visual examination and screening of all of the data. It will also allow quantitative time series analysis for any parameter at any station when imported into a statistical software package.

3.9 Statistical Analysis

3.9.1 Selection of Parameters and Stations to be Analyzed

Because of the very large total number of parameters and stations that will be incorporated into the surface water monitoring program and data base, a detailed statistical analysis of all parameters at all stations is not currently possible. At

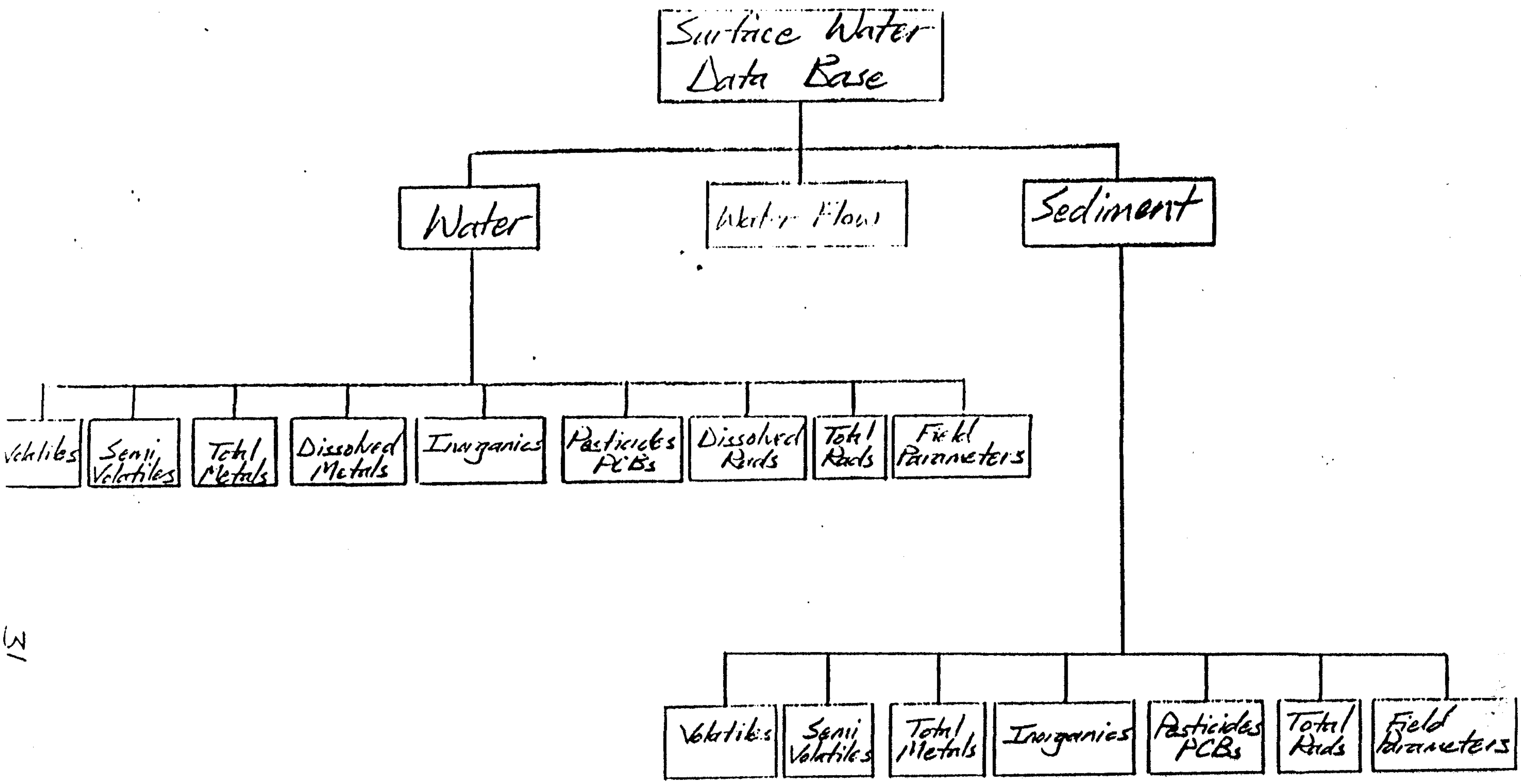


Figure 3.2 Structure of Surface Water Data Base

some time in the future such analyses may be feasible when time and manpower resources permit. Until such a time, however, specific parameters and stations for which statistical analyses will be performed will have to be selected according to some criteria. Although some subjectivity and judgement will be used in selecting or prioritizing the parameters and stations to be analyzed, as objective a procedure as possible should be used in the selection process.

Parameters and stations for which statistical analyses will be performed will be selected by visually screening the observations in the data base (sorted by station ID and sample date) for each parameter for every station. It is assumed that some sort of limit (standard or guideline which may be defined by ARAR's, or background concentration or confidence limits) will be established for every parameter. Naturally-occurring parameters (such as TDS, pH, or metals) will have a corresponding limit defined by a background concentration or confidence limits. These parameters may also have a limit defined by a standard or guideline established by regulatory agencies above which concentrations are considered undesirable. A statistical analysis will be performed for any of these naturally-occurring parameters at a given station where any one observation exceeds the lower of any of these two limits (as determined by visual screening). If a naturally-occurring parameter has no pre-defined regulatory limit, then the background concentration or confidence limits will be used to define an exceedence.

For parameters which are not naturally-occurring, such as volatile or semi-volatile organics, a background concentration cannot be defined and consequently some type of regulatory limit or ARAR must be defined and used to determine exceedences. A statistical analysis will be performed for any of these parameters at a given station where any one observation exceeds this limit.

Additional parameters for which no observations exceed a limit at a particular station may be selected for statistical analysis in order to achieve the stated monitoring objectives or program goals and if time and manpower resources permit. Examples of such parameters may include common indicator parameters or major ions that are required to characterize background conditions. In addition, simple summary statistics such as an average, standard deviation, and range of observations will be determined for all parameters.

3.9.2 Characterization of Statistical Attributes of Data

In initial efforts to design a monitoring system it is usually necessary to statistically analyze existing data and determine those characteristics of the population that will influence the selection of data analysis procedures (Ward and McBride, 1986). As part of the system design, the statistical procedures to be used to analyze the data must be selected. Those procedures whose assumptions best fit the population characteristics should be identified as the most appropriate data analysis procedures for that particular population. Therefore, statistical design usually consists of statistically characterizing the population to be measured and confirming that the statistical approach and specific methods selected to obtain the desired information do not have their underlying assumptions violated by the population characteristics.

Because the statistical characterization of existing surface water data for the RFP has not been performed to date, the statistical procedures whose assumptions best fit the population characteristics and that are most appropriate for the analysis of the data obtained in the surface water monitoring program are currently not known. One of the implicit objectives of the surface water monitoring program, however, is to statistically characterize the populations of the water and sediment quality parameters selected. The most appropriate statistical procedures for data analysis may be then chosen. Therefore, a two-phased statistical approach will be used for surface water data analysis to correspond to the phases of the overall surface water monitoring program. Phase 1 will include an initial characterization of the statistical attributes of the data for selected parameters and will utilize nonparametric statistical methods for routine analysis of this data. Nonparametric tests do not require a knowledge or assumption of the probability distribution of the parameter population. These methods are generally robust and maintain most of the power of parametric tests for a particular distribution function without requiring the prior analysis of existing data or the knowledge or assumption of a distribution.

Phase 1 of the surface water monitoring program and statistical analysis will last one year. The results of the statistical characterization of data during Phase 1 and an evaluation of the effectiveness of the surface water monitoring program after this time period will assist in selecting the most appropriate methods to be used for data analysis during the second phase. Phase 2, therefore, may utilize parametric statistical methods for routine data analysis if a particular distribution is known and if deemed appropriate. It may also include a refined characterization of the attributes of the data as more data are collected during the second year and subsequent years of the surface water monitoring program.

The statistical characterization of surface water data will include time series plots for the selected parameters. These graphs are developed by plotting concentration and flow observations (dependent variables) versus time (independent variable). General ideas of seasonality, trends and flow dependence can be obtained through a visual examination of these plots (Ward and Loftis, 1986). Characteristics of the data which can derived from graphical displays include detection of extreme values or excursions, trends or abrupt changes, seasonality, known and unknown interventions, correlation between observations (dependence), nonstationarity, cycles, and the need for data transformation.

Statistical characterization will also include testing for normality, equality (homogeneity) of variance, independence, seasonality, trend and change. Detailed procedures for utilizing these methods and interpreting their results for data characterization may be found in Standard Procedures for the Design of Environmental Monitoring Systems (Rockwell, 1988b).

3.9.3 Characterization of Background Water and Sediment Quality

Representative background analytical data are necessary for interpreting surface water analytical results. Background data assist in the assessment of surface water degradation by determining naturally-occurring spatial and temporal variability of constituents. Background data can then be statistically compared with data from downstream sites to determine the likelihood that a particular constituent concentration represents a release from the RFP site. Background data can also be used to assess whether upstream constituent concentrations at a site represent a release from potential off-site sources.

A background geochemical characterization program is ongoing at the RFP that has the following goals:

- Establish a baseline monitoring program to characterize background soils, surface water, and groundwater chemistry.
- Use information from the baseline program to identify changes in site water chemistry due to plant operations.
- Provide data to enable statistical comparisons to be made that can identify central tendencies and water quality variability over time at both upgradient and downgradient locations.
- Evaluate whether releases at particular sources have occurred by comparing background water quality, downgradient water quality, and ARAR's.

The details of the background characterization program and methods are presented in the Background Hydrogeochemical Characterization and Monitoring Plan (Rockwell, 1989a) for the RFP ER Program.

3.9.4 Assessment of Water Quality and Flow Relationships

The relationships between water quality and flow will be assessed at various monitoring locations. This evaluation will be performed for the parameters selected according to the criteria discussed above for the data collected from the permanent gaging and sampling stations. If adequate flow data exist from the periodic stations, an evaluation will also performed for the selected parameters at these locations. Concentration (dependent variable) will be plotted against flow (independent variable) to visually assess correlations. If the plot indicates a correlation, a least-squares regression will be performed to quantify the dependence of concentration on flow. In addition, flow dependence may be removed from the water quality observations according to the methods in Gilbert (1987) to more accurately analyze the variability of the chemical data without the influence of changes in flow. Mass flux of constituents will be calculated for the specified parameters at the continuous monitoring stations to determine total loadings.

Eventually, a separate investigation will be implemented to evaluate the mass flux of constituents from individual potential source areas contributing to the flows at particular periodic stations if the downgradient permanent stations indicate upstream contaminant sources.

3.9.5 Determination of Average or Seasonal Conditions

"Average" or "seasonal" conditions represent the central tendancy of a parameter for a specific time interval and area or point in space. The mean is an estimate of the central tendency of the population of a parameter and may be calculated as the arithmetic average of a given set of observations of that parameter. The median is the middle value of a given set of the ranked data for a parameter and may represent a better estimate of the central tendency of that parameter than the mean if an unusually high or low value(s) is present that may bias the mean. Both of these values should be calculated for a given year of data and may be computed for any period longer than this if appropriate. A "moving average" may be computed for all the observations over time of a parameter as new data are collected in the monitoring program to continuously update and improve an overall estimate of the mean or median. The mean or median should be computed for every parameter monitored at every station. The range or maximum and minimum values should also be reported for every parameter at every station for a given monitoring period (except when only one observation exists).

Seasonality may be defined as the deterministic or predictable periodic variation of a parameter over time due to the annual cycle. The occurrence, magnitude and regularity of periodic behavior can often be inferred from an inspection of the time series plot. Specific quantitative nonparametric methods that may be used to confirm seasonal behavior are documented in Standard Procedures for the Design of Environmental Monitoring Systems (Rockwell, 1988a). If a parameter exhibits seasonality it is desirable to compute seasonal means or medians in addition to an annual value. The year should be divided into four seasons or periods and a mean or median may be computed for each of these based on all of the observations within each period. As data are collected in additional years, the seasonal means or medians may be recalculated incorporating the newer observations to develop multi-year seasonal values.

Whether the central tendency of a parameter is estimated on a seasonal, annual, or longer basis, the variance or the standard deviation of the set of observations should also be computed to characterize the dispersion or variability about the mean value. Approximate two-sided confidence limits for the mean should also be computed using the methods described in Gilbert (1987) to provide an interval in which the true mean is expected to lie with specified confidence. A 90 percent level of confidence is usually acceptable. Approximate two-sided confidence limits for the median from any distribution can also be easily computed as described in Gilbert (1987) to provide an interval in which the true median is expected to lie with specified confidence. The computation of a confidence interval provides an estimate of the uncertainty associated with any calculated mean or median or any estimation of an average or seasonal condition.

3.9.6 Assessment of Trends or Changing Conditions

A visual inspection of time series plots of concentration and flow versus time for a given set of observations may indicate that a trend exists where values are either gradually increasing or decreasing over time. Alternatively, the plots may indicate an abrupt change (increase or decrease) over a very short time interval. In either case, a trend or change may indicate a constituent release from plant operations, and statistical tests must be used to test or confirm this hypothesis. Several nonparametric tests which may be used for the assessment of trend and change are described in detail in Standard Procedures for the Design of Environmental Monitoring Systems (Rockwell, 1988a)

3.9.7 Detection of Extreme Values or Excursions Beyond a Limit

Extreme values or excursions beyond some pre-defined limit or "standard" may indicate a constituent release from plant operations to surface water. A simple visual screening of a series of observations or an examination of time series plots of a parameter may indicate an extreme value relative to the majority of observations or an excursion if a limit is known. A perceived extreme value or excursion may, however, actually be an outlier resulting from sampling, laboratory, or some other error associated with the monitoring methodology. Consequently, extreme care must be taken in the evaluation of outliers and in the detection of extreme values or excursions.

Statistical tests for outliers must be used to quantitatively detect extreme values or excursions, but most of these tests require an approximately normal or lognormal population distribution. Control charts can be developed for a parameter to monitor the inherent statistical variation of the data, to flag anamolous results and to identify outliers. This technique, however, also requires a normal or lognormal distribution. Therefore, a visual determination of extreme values relative to the majority of observations or excursions beyond a limit (ARAR or background concentration or confidence limits) will be used for the Phase 1 analyses. If the statistical characterization of data attributes indicates that the population of a particular parameter exhibits an approximately normal or lognormal distribution, then the parametric statistical methods discussed in Rockwell (1988a) should be used for the detection of extreme values or excursions beyond a limit for the Phase 2 analyses.

3.10 Information Reporting

The effective reporting of information obtained from the statistical analysis of surface water data and achieving the monitoring objectives is the critical path to reaching the overall program goals and making sound environmental management decisions. Much of the data and/or information collected from the program will be incorporated into the RI/FS process for the RFP as well as for individual contaminant source areas within the site. Monthly reports that document all field measurements and sampling procedures, laboratory analytical results and performance, data validation, and results of all statistical analyses (including the detection of extreme values or excursions) for each month of monitoring will be prepared for internal RFP ER Program review. Quarterly reports will also be prepared for internal review that will provide the same information (seasonal conditions should also be reported) for each quarter of monitoring. Any deviations from or modifications to the monitoring plan should be reported along with the specific reasons for such deviations or modifications.

An annual surface water monitoring program report will be issued to the RFP ER Program staff that will provide all of the aforementioned information for each year of monitoring as well as a summary of significant findings, a statistical characterization of surface water data, an estimate of background water and sediment quality, average or seasonal conditions, trends or changing conditions, and all extreme values or excursions beyond some pre-defined limit. Deviations from the monitoring plan should be reported along with the specific reasons for such deviations. Problems with the operation or management of the surface water monitoring program, as well as changes or proposed modifications to the program, should be discussed along with the rationale for each. A discussion or summary of whether the stated monitoring objectives and program goals have been achieved should also be included.

4.0 COSTS

4.1 Capital Costs

Table 4.1 presents the estimated capital costs for the implementation of Phase 1 of the surface water monitoring program. All costs are to the nearest 100 dollars.

4.2 Operational Costs

Table 4.2 presents the estimated operational costs for the implementation of Phase 1 of the surface water monitoring program. All costs are to the nearest 100 dollars.

Table 4.1 Capital Costs for Surface Water Monitoring Program

ITEM	MANUFACTURER	UNIT COST	QUANTITY	TOTAL COST
EQUIPMENT:				
24" Parshall Flume	Freeflow	$3,300	2	$6,600
36" Parshall Flume	Freeflow	4,000	1	4,000
Flow Measurement Inst. Model 303-341-XXX	Drexelbrook	3,200	8	25,600
Automatic Sampler Model 2700R	ISCO	3,000	4	12,000
SUBTOTAL:				$48,200
DESIGN: (15%)				$7,000
CONSTRUCTION MANAGEMENT:				6,000
CONSTRUCTION AND INSTALLATION:				30,000
INSPECTION: (3%)				1,500
SUBTOTAL:				$92,700
CONTINGENCY: (25%)				$23,200
TOTAL				$115,900

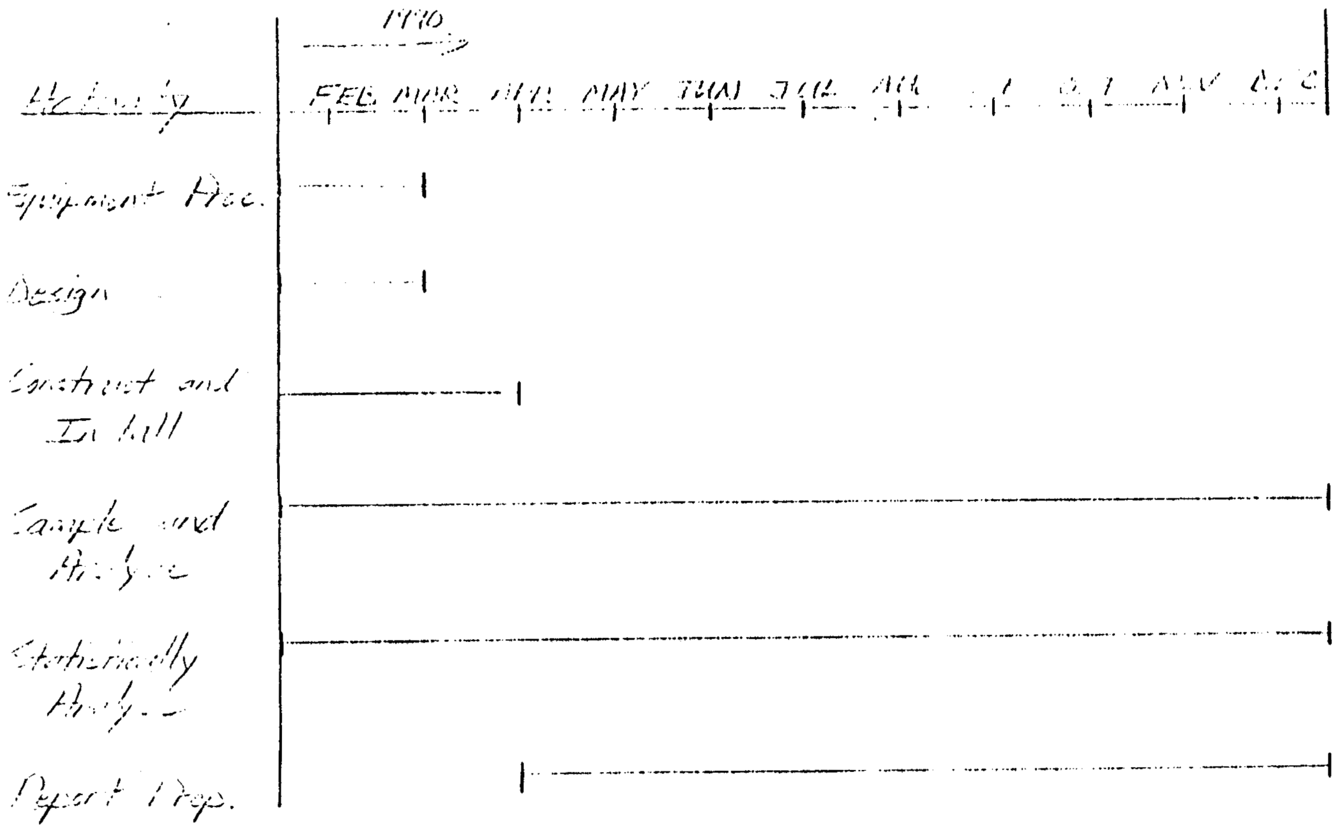
Table 4.2 Annual Operational Costs for Surface Water Monitoring Program (does not include operational costs for permanent monitoring stations)

ITEM	UNIT COST	QUANTITY	TOTAL COST
FIELD PERSONNEL:	(hour)	(annual)	
Water	$50	3,160	$118,500
Sediment	50	210	10,500
SUBTOTAL			$129,000
EQUIPMENT:	(month)	(annual)	
Vehicle Rental	$800	12	$9,600
Gas	80	12	1,000
Sampling Equipment	1,400	12	16,800
Shipping Supplies	1,000	12	12,000
Protective Equipment	2,600	12	31,200
SUBTOTAL			$70,600
SHIPPING:	(month)	(annual)	
	$4,200	12	$50,400
SUBTOTAL			$50,400
ANALYTICAL:	(sample)	(annual)	
Water (downgradient)			
Monthly	$2,600	840	$2,184,000
Quarterly	900	280	252,000
Water (background)			
Monthly	2,300	108	248,400
Quarterly	1,200	36	43,200
Sediment (all)			
Quarterly	3,000	84	252,000
SUBTOTAL			$2,979,600
ADMINISTRATIVE: (10%)			$323,000
CONTINGENCY: (25%)			$807,400
TOTAL			$4,360,000

5.0 SCHEDULE

Figure 5.1 presents a preliminary schedule for the implementation of Phase 1 of the surface water monitoring program for the RFP ER Program. This schedule includes a time frame for permanent monitoring station design, equipment procurement, construction and installation, sample collection, laboratory analysis, data analysis, report preparation, and program evaluation. Because the program will be ongoing and may be modified to some extent in the future based on an analysis of the data collected during the first year of operation and an evaluation of the effectiveness of the program, the schedule only presents the activities included in Phase 1 of the program. A schedule for Phase 2 will be prepared upon completion of Phase 1.

Figure 5.1 Schedule ... Water
Monitoring ...



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