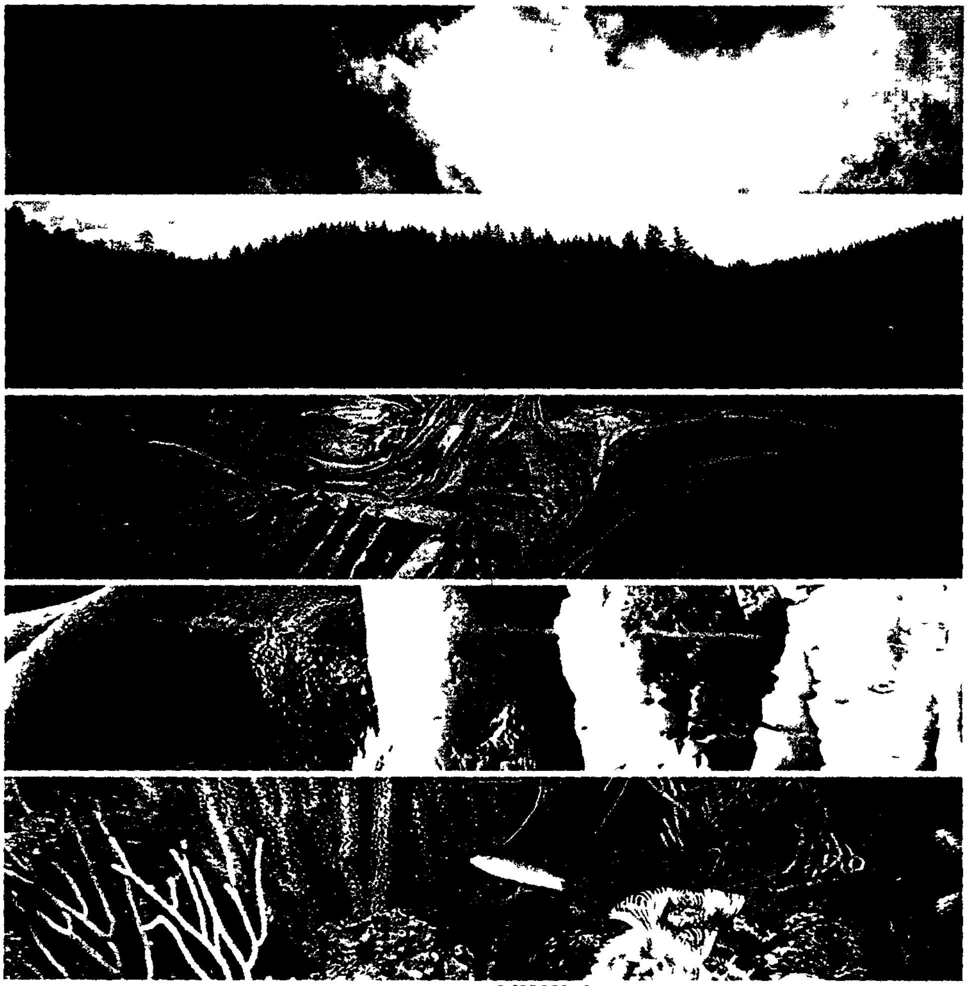

ENVIRONMENTAL EVALUATION WORK PLAN
WEST SPRAY FIELD - OPERABLE UNIT NO. 3
ROCKY FLATS TASK ORDER BA#73499GS
Revision 1.0

Prepared for.
EG&G Rocky Flats

August 23,

DAMES & MOORE

ADMIN RECORD

A-OU11-000118

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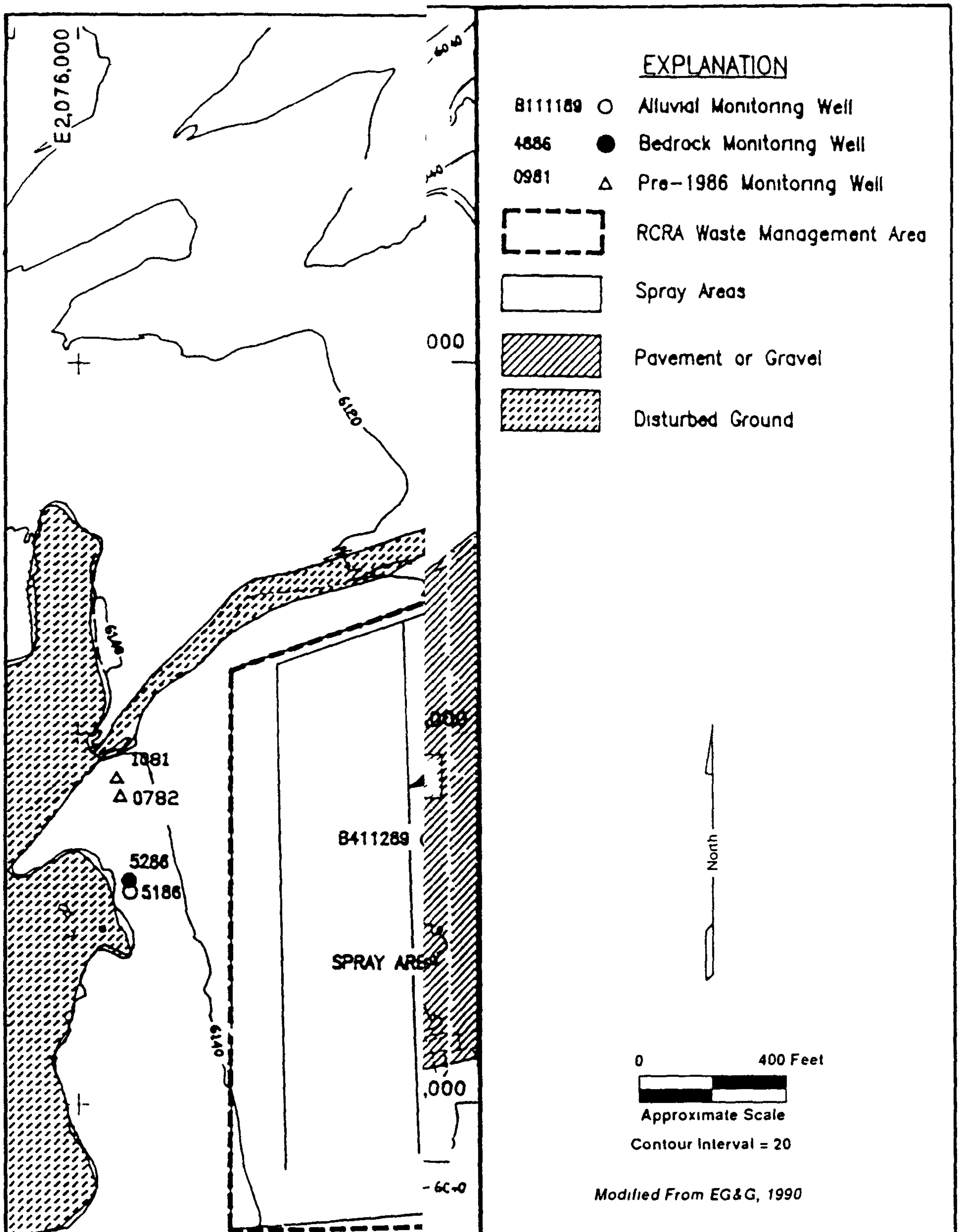
1.0 INTRODUCTION

1.1 Discussion

This work plan defines the scope of activities for the Environmental Evaluation of the West Spray Field at the Rocky Flats Plant. The Rocky Flats Plant is a federally owned nuclear weapons research, development, and production complex situated on 6,550 acres of federal property 16 miles northwest of downtown Denver, Colorado. The plant is managed and operated by EG&G Rocky Flats, Inc., (EG&G), a contractor to the U.S. Department of Energy (DOE). The West Spray Field area (Figure 1-1) is one Solid Waste Management Unit (SWMU) of Operable Unit No.3 (OU3) at the Rocky Flats Plant

The West Spray Field was in operating from April 1982 to October 1985. During operation, excess liquids from the Solar Evaporation Ponds 207-B North and 207-B Center, were pumped periodically to the West Spray Field for spray application. Pond 207-B North received water from an interceptor system installed to collect ground water seepage from the hillside north of the solar ponds Pond 207-B Center received treated sanitary effluent

Under the Draft Interagency Agreement (IAG), Attachment 2, dated December 1989, between the Colorado Department of Health (CDH), the U.S Environmental Protection Agency (EPA), and the Department of Energy (DOE), an Environmental Evaluation Work Plan and supporting documentation shall be submitted to the EPA and the CDH as a chapter of the West Spray Field Baseline Risk Assessment for OU3. The Draft IAG states that CDH will be the lead agency



U S DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden, Colorado

West Spray Field Location Map

FIGURE 1-1

DAMES & MOORE

The Draft IAG describes the general response activities under the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), for sites containing hazardous substances at the Rocky Flats Plant These sites are currently grouped into 10 operable units.

On-going characterization activities at the Rocky Flats Plant includes the Phase I RCRA Facility Investigation/Remedial Investigation (RFI/RI) of the West Spray Fields The principal technical objective of the implementation of the Phase I RFI/RI is to characterize contaminant sources and soil contamination resulting from past application of waste waters on the West Spray Fields. Information (e g., waste characterization) gathered from the Phase I RFI/RI and subsequent investigative phases (Phase II) will support the West Spray Field environmental evaluation

Information provided in the West Spray Fields Draft Phase I RFI/RI Work Plan (Phase I Work Plan), dated April 1990, is referenced throughout this draft environmental evaluation work plan in order to avoid redundancies.

There are several interim status RCRA units, including the West Spray Field, for which the DOE has previously submitted Closure Plans. These closure units have been combined for the purpose of the IAG into Operable Unit 3.

1.2 Environmental Evaluation Objectives

The objective of the environmental evaluation process is to identify contaminants that present a threat to the environment The environmental evaluation also provides information to support remediation alternatives during the baseline risk assessment and the development of potential Interim Measure/Interim Remedial Actions (IM/IRA)

The objectives of this work plan are.

- To gather data to characterize the nature and extent of contamination, and to identify the environmental media (pathways) that are contaminated,

- To gather data to support detailed descriptions of the environmental factors that must be understood to design appropriate IM/IRA; and

- To gather data to support a baseline risk assessment.

2.0 ENVIRONMENTAL SETTING

The Rocky Flats Plant is a government-owned and contractor-operated facility It is administered by the DOE Albuquerque Operations Office and, as previously mentioned, is managed and operated by EG&G

The facility produces metal components for nuclear weapons. Components are fabricated at the facility 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. Research and development in metallurgy, machining, nondestructive testing, coatings, remote engineering, chemistry and physics are also performed at the facility Parts made at the plant are shipped elsewhere for final assembly (Rockwell International, 1988b, Vol. I, p. 4).

The Rocky Flats Plant is located in northern Jefferson County, Colorado approximately 16 miles northwest of Denver and 9 to 12 miles from the neighboring communities of Boulder, Broomfield, Golden, and Arvada. It is bounded on the north by State Highway 128, on the west by a parcel of land east of State Highway 93, on the south by a parcel of land north of State Highway 72, and on the east by Jefferson County Highway 17 Access to the plant is from an east access road exiting from Jefferson County Highway 17, and a west access road exiting from State Highway 93

The facility is situated at an elevation of approximately 6,000 feet above mean sea level (msl). It is on the eastern edge of a geological bench known locally as Rocky Flats The bench is approximately 5 miles wide and flanks the eastern edge of the foothills of the Rocky Mountains. The Plant consists of approximately 6,500 acres of federally-owned land in Sections 1 through 4, and Sections 9 through 15 of T2S, R70W, 6th Principal Meridian. Major buildings are located within the Plant security area of approximately 400 acres. The security area is surrounded by a buffer zone of approximately 6,105 acres

2.1 Physical Environment

2.1 1 Physiography

The Rocky Flats Plant is located on the western margin of the Colorado Piedmont section of the Great Plains Physiographic Province (Rockwell International, 1988b, Vol. II, p. 3-3) The Colorado Piedmont ranges in elevation from 4000 feet msl on the east to 7000 feet msl on the west The Piedmont merges to the east with the High Plains section of the Great Plains Province and is terminated abruptly on the west by the Front Range section of the Southern Rocky Mountain Province.

The Colorado Piedmont is an area of dissected topography and denudation where Tertiary strata underlying the High Plains have been almost completely removed. In a regional context, the Piedmont represents an old erosional surface along the eastern margin of the Rocky Mountains It is underlain by gently dipping sedimentary rocks (Paleozoic to Cenozoic in age), which are abruptly upturned at the Front Range to form hogback ridges parallel to the mountain front The Piedmont surface is broadly rolling and slopes gently to the east with a topographic relief of only several hundred feet This relief is due to resistant bedrock units that locally rise above the surrounding landscape and to the presence of incised stream valleys. Major stream valleys which transect the Piedmont from west to east have their origin in the Front Range Small local valleys have developed as tributaries to these major streams within the Piedmont. In the area of the Plant, a series of Quaternary pediments have been eroded across this gently rolling surface (Rockwell International, 1988b, Vol. II, p 3-5)

The eastern margin of the Front Range, a few miles west of the Plant, is characterized by a narrow zone of hogback ridges and flatirons formed by steeply east-dipping Mesozoic strata (such as the Dakota Sandstone and the Fountain Formation). The Front Range reaches elevations of 12,000 to 14,000 feet msl 15 miles farther west

Several pediments have been eroded across both hard and soft bedrock in the area of the Plant during the Quaternary (Rockwell International, 1988b, Vol. II, p 3-5). The Rocky Flats pediment is the most extensive of these, forming a broad flat surface south of Coal Creek From oldest to youngest, the three pre-Wisconsin deposits are the Rocky Flats Alluvium, the Verdos Alluvium and the Slocum Alluvium (Rockwell International, 1988b, Vol. II, p. 3-6) A series of Wisconsin and post-Wisconsin terrace deposits are present at lower elevations along streams that have incised the older pediments (east of the Plant).

The Rocky Flats Plant is located on a relatively flat surface of Rocky Flats Alluvium The pediment surface and overlying alluvium (generally 10 to 50 feet thick, although the alluvium is as much as 100 feet thick west of the Plant) have been eroded by Walnut Creek on the north and Woman Creek on the south so that terraces along these streams range in height from 50 to 150 feet. The grade of the gently eastward-sloping, dissected Rocky Flats Alluvium surface varies from less than one percent at the Plant to approximately two percent just east of the Plant

The natural ground surface in the West Spray Field is nearly level to gently sloping down to the east and east-northeast. The slopes of the irrigated areas and surface runoff areas range between approximately only percent and three percent. There are a number of minor drainages in the West Spray Field which trend to the east Relief within the drainages is on the order of one to two feet.

The topography of the West Spray Field was altered during use of the field in response to NPDES Permit violations A series of small ditches and berms were constructed just east of Area 1 to prevent surface runoff of water. These ditches and berms were designed to pond the water on the West Spray Field until infiltration could occur.

2.1 2 Surface Water Hydrology

Surface water existing at the Plant can be divided into three main categories. natural drainages, ditches and diversions, and retention ponds and plant discharges.

A topographic high that bisects the Plant approximately along its center line trends eastwest. This topographic high controls the drainage of the three ephemeral streams that are located within the Plant boundaries Rock Creek is located in the northwest corner of the buffer zone and flows to the northeast to its off-site confluence with Coal Creek. North and South Walnut Creeks and an unnamed tributary drain the remainder of the Plant. These streams also flow eastward and drain into Great Western Reservoir

A series of dams, retention ponds, diversion structures, and ditches have been constructed at the Plant to control surface water and limit the potential for release of poor quality water. The largest of the Plant's control ditches is the Central Avenue Ditch which runs eastward along Central Avenue and discharges to South Walnut Creek. The other major ditch is the South Interceptor Ditch which prevents runoff from the south side of the plant from entering Woman Creek. The retention ponds are located in the drainages of Walnut and Woman Creeks. Their purpose is to receive stream flow and surface water and to receive treated effluent from the sanitary sewage treatment plant. All discharges from the downstream pond in each series are in accordance with the Plant's NPDES permit

The Church and McKay ditches cross the northern portion of the plant and run through the West Spray Field In addition to these, there are four more ditches in the general vicinity of the Plant The South Boulder Diversion Canal runs along the western up-gradient edge of the Plant

2 1 3 Geology

Information for this section was gathered from numerous sources The primary sources used include· The 1988 Rockwell Post-Closure Care Permit and Closure Plan, Logs from 1986 monitor wells installed at the West Spray Field, The EG&G Annual RCRA Ground-Water Monitoring Report for Regulated Units at Rocky Flats Plant, and EG&G on-going studies

2.1 3.1 Geologic and Stratigraphic History

The Rocky Flats Plant is located on the northwestern flank of the Denver Basin and is underlain by about 12,000 feet of Paleozoic and Mesozoic sedimentary rocks (Rockwell International, 1988b, Vol. II, p 3-7). The Denver Basin is an asymmetric syncline that formed during the Late Cretaceous Laramide Orogeny The western limb of the basin dips steeply to the east, and the eastern limb dips gently to the west.

The geologic history of northeastern Colorado involves several episodes of mountain-building and oceanic transgression and regression, resulting in the deposition of thousands of feet of sedimentary rock on top of the Precambrian basement. Detailed descriptions of the units present onsite are provided in subsection 2.1.3.2 and 2.1 3 3 of this work plan.

2.1.3.2 Plant Bedrock Geology

Bedrock units mapped at the Plant consist of the Laramie and Arapahoe Formations (Rockwell International, 1986a) Because of the thickness (750 to 800 feet) and low permeability of the Upper Laramie Formation, it is considered to be the base of the hydrologic system which could be affected by Plant operations (Hurr, 1976) Therefore, this discussion is limited to the Laramie and the Arapahoe Formations as these are the only bedrock formations which immediately underlie the West Spray Field The Laramie and Arapahoe Formations are described in the remainder of this section.

The cretaceous basal Arapahoe and Laramie Formation underlie surficial materials at the West Spray Field. Steeply dipping beds of the Fox Hill

Sandstone and Laramie Formation are found west of the West Spray Field. These relatively steep dips are found near the axis of the monoclinal fold flanking the front range uplift. During field mapping of the West Spray Field area in 1986, strike and dips were collected from Laramie Formation outcrops west of the Plant in the clay pits The measured dip angles ranged between 3\42 and 45 degrees with a dip direction of approximately N80°E. The dip angle of the Laramie Formation quickly flattens out with depth to approximately 2 degrees (EG&G on-going studies)

The Laramie Formation is a fluvial sequence of sandstones, siltstones, claystones, and coals, which is subdivided into two major lithologic units: a lower sandstone unit and an upper claystone unit The lower sandstone unit is exposed in clay pits west of the Plant, and the upper claystone unit was observed in outcrop and in cores of several 1986 monitor wells west of the Plant. Logs and associated data for these wells are presented in Appendix G of the Phase I Work Plan.

The Laramie Formation in the West Spray Field area consists of claystone with occasional zones of interbedded siltstones and sandstones. Contacts between various lithologies are both gradational and sharp

The Arapahoe Formation which underlies the eastern margin of the West Spray Field consists of fluvial claystones with interbedded channel sandstones and siltstones (EG&G on-going studies, 1990). Contacts between these lithologies are both sharp and gradational The claystones are olive gray (5 Y 3/2) to dark gray (N 3/0), poorly indurated, and silty, and obtain up to 15 percent organic material Weathering has penetrated from 10 to 40 feet into bedrock. The weathered claystone is light olive gray, blocky, slightly fractured, and has iron staining as mottles and along bedding planes and fractures (Rockwell, 1986a)

Sandstones in the Arapahoe Formation are light gray (N 6/0) to yellowish gray (5 YR 8/1), very fine to medium grained, with varying amounts of siltstone and claystone. The sand grains are subangular to subrounded and are predominantly quartzose, with 10 percent lithic fragments. The sandstones are poorly to moderately cemented and exhibit ripple marks, load casts, and planar, angular, and trough crossbedding. Arapahoe Formation siltstones exhibit the same coloration, constituents, bedding characteristics, and sedimentary structures as the sandstones, however, they consist predominantly of silt-sized particles (Rockwell International, 1986a)

Weathered bedrock was encountered directly beneath surficial materials in all the monitoring wells during previous investigations Weathering penetrates from approximately 31 feet (Well 46-86) to 61 feet (Well 52-86) into the claystone bedrock. The weathered claystones generally range from light olive gray (5 Y 5/2) to medium light gray (N 6/0) and medium gray (N 5/0) with moderate oxide staining of dark yellowish orange (10 YR 6/6). Stains may occur as banding or mottling. Occasional zones of sandstone or siltstone interbeds up to 0 5 feet thick were encountered.

Unweathered claystone was encountered in well 48-86 from 121.5 feet to 126 9 feet and again at 131 5 feet to 141 5 feet below ground surface. The claystone is medium dark gray (N 4/0) with at race of silt and has very fine-grained sand beds approximately 0 5 feet thick from 136.5 feet to 141.4 feet. A calcite filled fracture in the claystone occurred in the zone from 126.5 to

126.9 feet. Between the two zones of claystone a 4 6 foot thick sandstone was encountered (Rockwell, 1988)

Drilling in the vicinity of the West Spray Field also encountered shallow siltstones. Bedrock well 46-86 is completed in Laramie Formation siltstone and range from 1 0 feet to 43.0 feet in thickness.

Weathered siltstone is typically medium light gray (N6/0) to light olive gray (SY 5/2) with stains and mottles of dark yellowish orange (10 YR 6/6) (Rockwell, 1988) Thickness of the siltstone range from approximately one to eight feet with sandy siltstone or clayey siltstone interbeds one to three inches thick. Iron nodules are occasional and fractures abundant from 99 to 104 feet near Area 2 and from 133 to 136 feet just west of Area 1 (Rockwell, 1988).

Unweathered siltstone is typically medium light gray (N 6/0) to medium dark gray (N 4/0) and has approximately 0.25 foot thick beds of sandstones or claystone Coal occurs occasionally and carbonaceous fragments are abundant (Rockwell, 1988)

Bedrock wells 48-86 and 52-86 are completed in the basal Arapahoe and Laramie Formation Sandstones, respectively Weathered sandstone was encountered in well 52-86, varying from light gray (N 7/0) to yellowish gray (5 Y 7/2) with dark yellowish orange (10 YR 6/6) staining or mottling The sandstone is generally composed of very fine grained to medium grained quartz sand with silica cementation. Siltstone interbeds 0 30 to 0 80 feet thick, crossbedding, and cut and fill structures, were encountered from 118.0 to 123.0 in well 52-86 Bedding planes dipping 60-70° and 35-40° off horizontal were also encountered from 111 to 118 0 feet and 118 0 to 123 0 feet in well 52-86, respectively.

Unweathered sandstone was encountered in 46-48 and 48-86, ranging in thickness from 0 7 to 11 0 feet. These sandstones are generally moderately to poorly sorted, very fine-grained to medium-grained calcite cemented. The sandstone may be silty or clayey with occasional thin laminae of fine silt and clay The sandstone color typically ranged from medium light gray (N 6/0) to medium dark gray (N 4/0). The thin sandstone bed in well 46-86 at 126 9 to 127 6 feet was additionally described as dark greenish gray (5 GY 4/1) in color.

Unweathered sandstone in well 48-86 occurred at 151.30 to 153 feet and again at 197 0 to 208.3 feet. Recent data indicate that the structural dip underlying the West Spray Field flattens out to approximately 9 degrees (EG&G on-going studies, 1990).

2.1.3 3 Plant Surficial Geology

There are six distinct units of Quaternary unconsolidated surficial materials in the vicinity of the Plant: Rocky Flats Alluvium, Verdos Alluvium, Slocum Alluvium, terrace alluviums, valley fill alluvium, and colluvium The West Spray Field is primarily on the Rocky Flats Alluvium. Thus, a description of the Rocky Flats Alluvium only is provided in this text (see Rockwell International, 1988b for details on the other alluviums)

The Rocky Flats Alluvium unconformable overlies the Laramie and Arapahoe formations in the vicinity of the Plant. The deposit is a series of laterally coalescing alluvial fans deposited by streams (Hurr, 1976) The fans were deposited on an erosional surface cut into the bedrock units, including channelization around the hogbacks of the lower Laramie Formation.

The soil in the West Spray Field is included in the Flatirons Soil Series. The Flatirons Soil is a deep, well drained, strongly developed soil composed of stony to gravelly and silty material, as described by the Soil Conservation Service in the 1983 Golden Area Soil Survey (United States Department of Agriculture, 1983). The soil occurs on high terraces and pediments The soil was formed in the Rocky Flats Alluvium, a calcareous, gravelly, cobbly and silty material. Permeability of the soil is moderate and runoff erosion is not considered a hazard (Rockwell, 1988)

Based on test pit logs, the A soil horizons at the West Spray Field range from 1.1 feet (WSF-03, WSF-06, WSF-08, WSF-09) to 1 35 feet (WSF-04) in thickness (Rockwell, 1988) Plate 2-3 of the Phase I Work Plan presents a fence diagram illustrating the soil zones within the test pits at the West Spray Field. This surface and upper part of the B horizon is described as dusky brown (5 YR 2/2) gravelly, cobbly, sandy soil that is moist to wet. The zone is typically poorly to moderately sorted with subrounded and subangular fine-graded to coarse-graded (Grain Size Scale - American Geological Institute, 1982) gravels with occasional small cobbles. The contact with the B horizon is wavy and sharp.

The B horizon extends from 1 1 feet (WSF-03, WSF-06, WSF-08, WSF-09) to 3 5 feet in depth below ground surface (WSF-01, WSF-06, WSF-07). This subsoil is a moderate brown (5 YR 4/4) clayey sand to clayey gravel with small zones of intense red and brown staining indicative of weathering Sand is generally moderately sorted, subangular to subrounded, medium-grained to coarse-grained with occasional fine grained pockets. Gravels are described as subrounded, fin-graded to very coarse-grained pebbles and small to large cobbles with occasional small boulders The gravels and sands are indicative of a short transport distance Clay occurs in the matrix but mostly in pockets associated with the gravel. The zone is generally moist to saturated. Some organic soil stringers from the A horizon were noted in WSF-02, WSF-03, WSF-04, WSF-05, and WSF-06. The contact into the C horizon is irregular and gradational and occurs from 3.0 feet to 3.5 feet in depth.

The C horizons extend from 2 5 feet (WSF-03) to 5 2 feet (WSF-01) in depth This zone consists of clayey to silty sands and gravel or gravelly sands. Colors range from light brown (5 YR 5/6) to moderate yellowish brown (10 YR 5/4) with zones of red, brown, orange or yellow staining The sand is typically medium-grained, subangular to subrounded, moderately sorted, with some fine-grained and coarse-grained sands Gravels are subrounded, moderately to poorly sorted, fine-grained pebbles to large cobbles with occasional small boulders. Clay zones of olive gray are commonly associated with the gravel and cobbles. The zone is generally moist with occasional saturated zones Caliche stringers were encountered at 4.4 feet in WSF-06

2.1 4 Ground Water Hydrology

There are two hydraulically connected ground water systems at the Plant. These systems occur in the surficial material (Rocky Flats Alluvium, colluvium, and valley fill material) and the underlying bedrock formations (Laramie-Fox Hills Formations and the Arapahoe Formation). The upper most system is discussed below

2.1.4.1 Ground Water System in Surficial Materials

The upper most ground water system in the Rocky Flats Alluvium and other surficial materials occurs under unconfined conditions. The system is recharged by infiltration of incident precipitation and surface water. The shallow ground water flow generally follows topography to the east and toward the drainages. Discharge occurs at springs and seeps at the alluvium/bedrock contact and major drainages. As a result of water table fluctuations in response to seasonal wet and dry periods, unsaturated zones occur within the system during certain portions of the year.

In the West Spray Field area, ground water flows east-northeast following the regional topography of the Rocky Flats Alluvium In the vicinity of the drainage basin of Woman Creek, ground water flows southeast into this drainage system.

Depth to the upper-most ground water as identified in previous studies, varies considerably Recent ground water data shows depths that range between 40-50 feet. This general pattern of ground water flow is evidence by the water-table maps constructed for four quarters in 1989 (EG&G, 1989).

Horizontal hydraulic conductivity values calculated for the Rocky Flats Alluvium at the West Spray Field area range from 2.1 x 10^{-5} centimeters per second (cm/s) to 5.3 x 10^{-4} cm/s based on drawdown-recovery and slug tests performed on 1986 wells (U S DOE, 1988) and slug tests performed in 1989 (EG&G, 1989). Drawdown-recovery tests were analyzed using the Residual Drawdown Plot (Driscoll, 1986) and the method of Bouwer (1978), and slug tests were analyzed by the method of Bouwer and Rice (1976) These values correspond to horizontal groundwater flow velocities of 3.5 to 87 8 feet per year (ft/yr), respectively (EG&G, 1989). Portions of the Rocky Flats Alluvium are probably saturated throughout the year, and conservative (nonattenuated) species in Rocky Flats Alluvium ground water could travel annual distances on the order calculated. However, conservative species in valley fill ground water cannot travel the predicted distances because these materials are dry during portions of the year

2.1.5 Biota

2.1.5 1 Vegetation

The Rocky Flats Plant is located at an elevation of approximately 6,000 feet, just below the elevation at which plains grasslands grade abruptly into lower montane (foothills) forests (Marr, 1964) The present vegetation of Rocky Flats and adjacent grassy uplands is dominated by mixed prairie showing the influence of previous grazing Most of the broad divides and hillsides are dominated by a mixture of native grasses, forbs (wildflowers), and subshrubs. Weedy forbs and cheatgrass are locally prominent in disturbed or heavily grazed sites; introduced pasture grasses are present on sites where an attempt has been made to improve degraded range. Yucca and cacti are conspicuous in areas of heavy grazing and on sites with shallow, rocky soils. Individuals or small clumps of ponderosa pine occur on some rock outcrops Isolated undisturbed sites support remnant stands of midgrass or tallgrass prairie, including big bluestem, little bluestem, and side-oats grama

The valley floors and seeps on adjacent slopes support various wetland types, ranging from sedges, rushes, or cattails to stands of mature cottonwoods and willows The drainages also contain scattered clumps of wild plum, chokecherry, hawthorn, snowberry, golden currant and leadplant. Sideslopes of the deeper ravines contain skunkbrush and ninebark, two shrub species more characteristic of the lower foothills.

2.1 5.2 Wildlife

As in most of the Front Range Urban Corridor, the wildlife of Rocky Flats has been greatly influenced by the increase in human use and disturbance over the past 100 years Most notable have been reductions in the number and diversity of ungulates (hoofed animals) and predators However, the relative isolation and habitat diversity of Rocky Flats have resulted in a fairly rich animal community.

During a mark-recapture program, Winsor et al (1975) caught eight species of small mammals: the deer mouse, harvest mouse, meadow vole, thirteen-lined ground squirrel, northern pocket gopher, hispid pocket mouse, silky pocket mouse, and house mouse White-tailed jackrabbits and cottontails are also present onsite The most abundant large mammal is the mule deer, of which an estimated 100-125 appear to be permanent residents of the site (DOE, 1980). Carnivores present include coyotes, red foxes, raccoons, badgers, long-tailed weasels, and striped skunks.

Common grassland birds at Rocky Flats include western meadowlarks, horned larks, vesper sparrows, lark sparrows, grasshopper sparrows, and western kingbirds. Wetlands support song sparrows, common yellowthroats, and red-winged blackbirds Black-billed magpies, northern orioles, yellow warblers, warbling vireos, American robins, indigo buntings, and lesser and American goldfinches--among other species--nest in cottonwood/willow stands. Wooded draws attract foothills species, including MacGillivray's warblers, yellow-breasted chats, black-headed grosbeaks, green-tailed and rufous-sided towhees, and luzuli buntings Common birds of prey in the area include American kestrels, northern harriers, red-tailed hawks, Swainson's hawks, and great horned owls

The most abundant reptiles are the bullsnake, racer, western terrestrial gartersnake, and prairie rattlesnake

2.1.5.3 Aquatic Resources

Four streams flow within the Rocky Flats boundary· Rock Creek, North Walnut Creek, South Walnut Creek, and Woman Creek. All of these streams are ephemeral to intermittent, with peak flows during spring and early summer The two forks of Walnut Creek also contain a series of small impoundments formed by earthen dams

The surface waters support a variety of aquatic macroinvertebrates, including snails, crayfish, as well as larvae or adults of several orders of Insecta (DOE, 1980) Some of the ponds are inhabited by fathead minnows, green sunfish, and largemouth bass. The ponds also attract water birds such as mallards, gadwall, green-winged and blue-winged teal, spotted sandpipers, and great blue herons. Killdeer are common near pond margins, and muskrats are reported to occur in some areas (DOE, 1980) In addition, the ponds and creeks provide feeding habitat and water sources for various terrestrial species and breeding habitat for amphibians Leopard frogs, Woodhouse's toads, and northern chorus frogs have all been observed on Rocky Flats

3.0 BACKGROUND

3.1 HISTORY AND DESCRIPTION OF WEST SPRAY FIELD

The West Spray Field was operated from Apnl 1982 to October 1985. During operation, excess liquids from the Solar Evaporation Ponds 207-B North and 207-B Center were pumped periodically to the West Spray Field for spray applicaton. Pond 207-B North receıved water from an interceptor system installed to collect ground water seepage from the hillside north of the solar ponds. Pond 207-B Center received treated sanitary effluent

The following subsections describe the history, as well as the configurations and uses of the spray fields

3.2 Spray Application Procedures

3 2 1 Inıtial Spray Application

Based on interviews wıth Plant personnel (Rockwell, 1988), direct application of the liquids occurred in portıons of the spray field designated Areas 1, 2 and 3 (see Figure 2-1, Appendıx A of the Phase I Work Plan. This conclusion is supported for Areas 1 and 2 by examination of 1986 aerial photographs. However, the location of Area 3 ıs not confirmed by the aerial photographs due to limited use and various locations of application, but is known from operating personnel (Rockwell, 1988) The photographs ındicate some surface run-off occurred beyond the limits of Areas 1, 2, and 3 but was wıthin the approximate location of the spray fields' exterıor boundary Limited quantities of windblown spray may have also contributed to the vegetation pattern observed on the aerial photographs (Rockwell, 1988)

Spray application was initially performed by two moving spray irrigation lines mounted on metal wheels with stationary impulse heads. In Area 1, the portable lines were initially replaced by the two western-most fixed lines, and in 1985 by a third fixed irrigation line These lines were fitted with stationary impulse heads. A spray impulse cannon was placed in various locations of Area 3 after use of the portable irrigation systems stopped (Shirk, 1986).

The total combined area of direct application is about 14 1 acres or about one-seventh of the total West Spray Field area. Area 1 is approximately 1,553,000 square feet or about 35.6 acres in surface area. The three fixed irrigation lines had a spray width of 80 feet and average length of 1,524 feet. This resulted in a spray area of approximately 8 4 acres for the three lines. Area 1 is the general area of application for the original portable irrigation lines

Area 2 is approximately 1,360 feet by 80 feet in size with a surface area of 109,000 square feet or about 2.5 acres. This area corresponds to the estimated application area of the single anchored portable irrigation line

Area 3 is an oval shape made up of small circular application areas all with a radius of approximately 100 feet, the estimated maximum radius of the impulse cannon. The source area is approximately 140,000 square feet or about 3 2 acres.

3.2.2 Operations

The West Spray Field, which operated from 1982 to 1985, was used when excess liquids accumulated in Ponds 207-B North or 207-B Center When the storage capacity of one of the ponds was reached, the liquids were pumped to the spray field for land application (Shirk, 1986). All process wastes were removed in the B-series solar ponds 207-B North, Center, and South in the late 1970s, as detailed in the Solar Pond Closure Plan of July 1, 1988. Since that time, the B-series solar ponds have not held process waste. The 207-B North and Center ponds had liquid inputs on a relatively constant basis due to the constant generation of treated sanitary wastewater which was placed in 207-B Center, and also due to relatively constant generation of ground water collected north of the solar ponds which was placed in Pond 207-B North The ground water in this area was, and is, collected because of elevated nitrates present and the need to prevent off-site migration of the water. These wastes were considered nonradioactive and nonhazardous and, therefore, amenable to land application

Liquids from Pond 207-B North were primarily applied in Area 1 Generally, spraying from Pond 207-B North occurred in intervals of six to ten hours daily for periods of two to four days The contaminated ground water collected in Pond 207-B North is characterized typically by high nitrate concentrations, trace levels of volatile organic compounds (VOCs), and elevated gross alpha, gross beta, and uranium

Liquids from Pond 207-B Center were applied to all three application areas. Application periods for these liquids were similar to those for the 207-B North pond water (Shirk, 2986). The water present in Pond 207-B Center consisted of treated sanitary effluent from the Rocky Flats Plant sanitary wastewater treatment plant.

The total monthly volumes of liquids applied to the West Spray Field from Ponds 207-B North and Center are shown on Tables 2-1 and 2-2 of the Phase I Work Plan, respectively. Total application rates for the spray field were between 250 and 450 gallons per minute. For the spray irrigation lines, these total rates convert to maximum surface application rates of between about 20 and 40 gallons per minute per acre. These application rates are based on an average application area of 2.7 acres along each of four irrigation lines and 0 7 acres for the impulse canon The spray impulse cannon had a discharge of 125 gallons per minute for a surface application rate of about 179 gallons per minute per acre. The spray impulse cannon was moved over a total area of 3.2 acres.

Based on the total volumes applied between April 1982 and October 1985 and the estimated areas of application of 8.4, 2.5 and 3 2 acres for Areas 1, 2 and 3, a total average was estimated The estimated total application is about 40 inches from Pond 207-B North applied in Area 1 The estimated total application is about 150 inches for Pond 207-B Center liquids, applied in Areas 1, 2 and 3 Since liquid from both ponds were applied in Area 1, the maximum total application could have been as much as 190 inches per unit area for all four years of operation.

3.2.3 Auxiliary Equipment

The auxiliary equipment required to transfer the liquid from Ponds 207-B North and Center to the West Spray Field consisted of a pump at the solar ponds, a delivery pipeline, the irrigation lines and an impulse cannon The spray field was operated by one person at a time with no more than four or five applications over a period of spraying (Shirk, 1986) The former approximate locations of the irrigation lines are shown on Figure 2-1 of the Phase I Work Plan.

The pump was a portable, engine driven centrifugal pump installed on the separator dike between Ponds 207-B North and Center The pump and propane-fueled drive engine were mounted on a trailer. The pump was a flexible hose which could be connected to either valve stub from Ponds 207-B North or Center. The pump discharge was a rigid pipe connected to the delivery line. The pump has since been removed for other use.

The delivery pipeline was initially a six-inch diameter PVC pipe. The PVC pipe extended from the pump discharge at Pond 207-B North beneath the patrol road, perimeter security zone, and access road, and was approximately 900 feet in length The pipeline was laid on the ground surface, except at the North Walnut Creek crossing where it was supported on about three-foot high stanchions. The pipeline extended approximately 6,000 feet to the West Spray Field The pipeline was drained after operation by a drain valve at the low point of the line just above the interceptor trench pump house (ITPH) Liquids were drained into the pump house through a flexible hose

The delivery pipeline was connected to the irrigation header pipe with a six-inch diameter flexible hose The header pipe was a six-inch diameter aluminum pipe similar to the delivery pipe, except at every other connection a four-inch diameter valved riser was installed. At the end of the header pipe was a plug and vacuum relief valve.

Initially, four-inch diameter portable spray irrigation lines approximately 1,300 feet in length were connected by flexible hose to the valve risers. The lines were attached to a ground anchor rod to prevent movement. The irrigation lines were equipped with fixed head impulse sprinklers for uniform application of the wastes. Subsequent to installation, the portable lines were damaged by wind and abandoned at the site with the exception of the single line presently located in Area 2. Subsequently, three fixed irrigation lines with lengths of between 1,350 and 1,570 feet were installed in Area 1 These lines consisted of fixed head impulse sprinklers for uniform application A 125 gallons per minute spray impulse cannon with a flexible hose connection was placed in Area 3.

3.3 Waste Characterization

Liquids applied in the West Spray Field were derived from the Solar Evaporation Pond 207-B North and 207-B Center. Approximately 66,000,000 gallons of waste-water were applied at the West Spray Field during its operation. Of this quantity, approximately 9,000,000 gallons were taken from 207-B North, and 57,000,000 gallons were taken from 207-B Center (Rockwell, 1988).

The contents in Pond 207-B North during operation of the West Spray Field generally consisted of ground water collected in the trench and French drain system located in the hillside north of the Solar Evaporation Ponds (Rockwell, 1988) The interceptor system collected ground water and has historically controlled seepage from the solar ponds from entering North Walnut Creek The liquid is piped to Pond 207-B North from the low point of the interceptor system, i e , the ITPH. The liquid contained in Pond 207-B Center generally consists of effluent from the Rocky Flats sanitary sewage treatment plant. However, some seepage contents from Pond 207-B North collected in the interceptor trench system have also been placed in Pond 207-B Center.

3 3.1 Nitrates, Gross Alpha, Gross Beta

Sampling to characterize the waste composition of the liquids from 207-B North, 207-B Center, the ITPH and the sewage treatment plant has taken place periodically from 1984 to 1988. During the period of 1984 to 1985, several indicator parameters were monitored on a weekly basis in the solar ponds (U S. Department of Energy, 1985). These weekly analyses were conducted prior to the spray application of the liquids to the West Spray Field and included the following parameters· pH, nitrate (as nitrogen), gross alpha and gross beta The samples exhibited elevated levels of nitrates, gross alpha, and gross beta.

3.3 2 Metals

Two sets of metal analyses of Pond 207-B North and Center liquids were performed in October 1984 and April 1985 The data from the 1984 and 1985 sampling efforts suggest that the applied liquids contained low concentrations of metals. The liquids from Pond 207-B North and the ITPH were also sampled in 1986, 1987 and 1988. In the 1986 sampling, a few metals were identified above the detection limit but selenium was the only primary drinking water metal detected above the EPA Contract Laboratory Program (CLP) contract-required detection limit (CRDL) Gross beta and uranium were also detected in Pond 207-B North samples and in the ITPH liquid samples.

3 3 3 Volatile Organics

Various volatile organic compounds were detected in the liquid samples from the 207-B Ponds and the ITPH Methylene chloride was detected in all three samples collected from Pond 207-B and ranged from 19 to 35 ug/l. It was also detected in two of the samples analyzed from the ITPH (10 and 15 ug/l). However, because methylene chloride was also present in the sampling blank at a concentration of 71 ug/l for the 207-B samples and at 99 ug/l for the ITPH sampling blank, these detections appear to be the result of laboratory contamination Chloroform, carbon tetrachloride, and trichloroethylene were also identified in the liquid samples collected from the ITPH Chloroform was present in two samples at 3 and 6 ug/l; carbon tetrachloride was found in three samples at 7, 6, and 7 ug/l; and trichloroethylene was detected in three samples at 7, 8, and 8 ug/l

Two sediment samples were collected from the ITPH during the 1986 investigation Methylene chloride was the only volatile organic compound detected in the ITPH sediments (27 and 44 ug/kg). It was also reported in the sampling blank at 24 ug/kg and is therefore considered to be a laboratory artifact Pesticides or PCBs were not found in the ITPH liquid and sediment samples. Semi-volatiles were not found in the ITPH and 207-B North liquids. Nitrates and radionuclides were not analyzed for in the 1986 investigations.

The 1988-89 sampling data from ITPH liquids are in the process of being validated and will be evaluated when they become available.

3.4 Summary of Previous Investigations

3 4.1 History of Known Releases

As previously mentioned, the West Spray Field was operated from April 1982 to October 1985. The total application of liquid from Pond 207-B North and 207-B Central to the West Spray Field during its period of operation was calculated to be 9,013,000 and 57,363,000 gallons, respectively.

3.4 2 Soil Testing Performed to Date

Preliminary soil testing to evaluate whether the soils in the West Spray Field are contaminated has been conducted. Soil samples were collected during 1986 and 1988 to characterize the soil chemistry in the West Spray Field.

The 1986 sampling of the West Spray Field was undertaken in an attempt to identify the extent, if any, of contamination. The sampling locations were chosen within a 400 foot diameter grid using a random number generating table At each location, a surface scrape was collected using a disposable plastic scoop In addition, two samples were collected from each location from 0-6 inches and 6-12 inches below ground surface using a split tube sampler driven with a sledge hammer to the desired depth Each sample interval from all of the sampling locations were then composited resulting in three composite samples from the three depths The 1986 sampling plot was not in an area of direct spray application but may have been affected by windspray contamination. At the time of sampling, it was believed this area received application from the spray impulse cannon in the West Spray Field. Additional information subsequent to sampling and testing indicated the sample area was only affected by surface runoff, and perhaps windblown spray from application in Area 1. Table 2-4 of the Phase I Work Plan lists the 1986 soil sampling parameters for the West Spray Field and Buffer Zone Table 2-5, 2-6, and 2-7 of the Phase I Work Plan present the analytical results for metals, radionuclides, and volatile organics, respectively

In 1988, the sampling program consisted of excavating 12 test pits (WSF-01 to WSF-23) with a backhoe and collecting three soil samples for chemical analyses from each location at varying depths Table 2-8 of the Phase I Work Plan lists the 1988 soil sampling parameters for the West Spray Field Test Pits.

The soil sampling conducted to date in the West Spray Field provides a general idea of the types and levels of contamination which may be present in the West Spray Field soils. These general findings, including a discussion of laboratory contamination, are specifically addressed in the Phase I Work Plan and are summarized below·

Metals: Soil samples from the West Spray Field test pits were analyzed for lead and mercury. These metals were chosen because previous analyses had shown them to be present in the spray application liquids. The soil samples collected in the West Spray Field during the 1986 sampling were analyzed for the metals listed in Table 2-5 of the Phase I Work Plan Mercury was not reported above background in any sample analyzed from the 1986 sampling effort However, mercury was present in six samples collected from the test pits above the background detection value of 0.1 mg/kg in 1988 (see Table 2-7, Phase I Work Plan). The values ranged from 0.20 to 0.46 mg/kg. In addition, eight samples exhibited concentrations above the background detection limit value of 0 1 mg/kg but were estimated values since they were below the laboratory detection limit. These detection limit values range from 0.12 to 0.18 mg/kg. Lead was not reported above the maximum background concentration of 48 mg/kg in any sample from the test pits Occurrences of lead above the maximum background standard were in two samples collected from the West Spray Field in the surface scrape samples. Composite sample #1D3 contained a concentration of lead at 61 mg/kg and composite sample #2D3 contained 63 mg/kg Although mercury consistently appeared in the 1988 soil samples above the background detection limit standard (0.1), there does not seem to be a pattern relating the mercury concentrations to a particular depth or area since mercury was reported in all but two of the test pits and the depths from which the samples were collected ranged from 0 9 feet to 4 6 feet This random pattern of mercury concentrations in soil samples appears to be indicative of natural background variations (Rockwell, 1988).

Review of the additional metals data from the 1986 soil sampling effort indicates slightly elevated concentrations of aluminum, chromium, and zinc (see Table 2-5, Phase I Work Plan). Aluminum occurred in one sample (3F3) at a concentration of 10,600 mg/kg in the composite sample collected at 6-12 inches below ground surface Chromium (14 mg/kg) was also reported slightly above the maximum background value (13 mg/kg) in sample 3F3. Finally, zinc was found in two surface scrape composite samples (1D3) and (2D3) at 50 and 52 mg/kg All of these values are slightly higher than their respective background concentrations

Radionuclides: Historical data for radionuclide concentrations greater than estimated environmental background is presented in Table 2-14 of the Phase I Work Plan. As reported, radionuclide concentrations with error terms larger than their respective measured values were not considered statistically different from the environmental background value, also shown in Table 2-14 of the Phase I Work Plan. Also, if the measured value for a radionuclide fell within the background measured range, it was not considered to be above background levels regardless of the error term. This was the basis for stating that a radionuclide concentration was within background ranges Similarly, if the measured value minus the error term of a sample was greater than the measured value plus the error term for the upper limit of the background range, it was considered to be statistically different from background (Rockwell International, 1988b, Vol II, p 4-27)

As reported, uranium, plutonium, and americium concentrations in soil and core samples from the West Spray Field's borehole sample, generally met the above criteria for being below background concentrations (Rockwell International, 1988b, Vol. II, p 4-27). Background data were not reported for strontium 90 and cesium 137 Table 2-14 of the Phase I Work Plan shows only results in which radionuclide concentrations were above environmental background levels. Minimum detectable concentrations (MDCs) for individual radionuclides were not reported. Two soil samples had positive results for uranium-223+234, and five soil and three core samples had uranium-238 concentrations reported above estimated background levels.

Nitrate: Nitrate was not analyzed in the 1986 soil samples. However, soil samples collected from the test pits in 1988 were analyzed for nitrate (as nitrogen) A total of five samples exhibited concentrations greater than twice the detection limit (20 mg/kg) as presented in Table 2-11 of the Phase I Work Plan. These samples were WSF0704 (140 mg/kg), WSF0702 (150 mg/kg), WSF 1002 (110 mg/kg), WSF1105 (80 mg/kg), and WSF1205 (420 mg/kg). Once again, there appears to be no distinct pattern correlating concentrations of nitrate with depth. The samples containing the higher concentrations were collected from various depths within the pits.

Organics: Several Hazardous Substance List (HSL) organics were found in soil samples at concentrations above detection limits. Although these results could be indicative of contamination, they could also result from laboratory contamination. Generally, indication of possible laboratory contamination is provided by comparison with laboratory blanks but no analyses for laboratory blanks were included with the volatile organics analytical results for the 1986 soil samples and 1988 test pit soil samples Therefore, it is not possible to evaluate for certain whether the detected concentrations of acetone, methylene chloride, trichlorethene, chloroform, carbon disulfide, toluene, 1,1,1-trichloromethane, and 1,1,2-trichlorethane are laboratory contaminants. However, inspection of the data in Tables 2-7 and 2-12 of the Phase I Work Plan indicate volatile organics are generally near or below detection limits.

3.4.2.1 Background Soil Chemistry Study

Background metals and radionuclide concentrations in soils were based on reports from sampling done in 1986 and 1989

The 1986 sampling and analysis was conducted in the west buffer zone, an area assumed to be unaffected by spray application activities (Rockwell, 1988) The top one foot of soil (Rocky Flats Alluvium) west of the West Spray Field was sampled. Eighteen locations were pooled into three composite samples (consisting of six cores randomly selected) The same methodology that was used to select the sampling locations for the previously mentioned 1986 background study was used for this sampling activity (Rockwell, 1988). Table

2-3 of the Phase I Work Plan presents a summary of the background soils data. This sampling is not considered a complete characterization of background alluvial and bedrock materials, however, it serves as a basis for assessing potential contamination.

The 1989 sampling was performed as part of the Rocky Flats background geochemical characterization study. According to this study (Rockwell, 1989) samples were collected from nine borings in the Rocky Flats Alluvium and nine from the colluvium. Bedrock samples were also collected from the colluvium boreholes in order to characterize the weathered sandstone and claystones Samples from the alluvium materials were collected from the Plant's southwestern and northern buffer zones, samples for the colluvium/bedrock were collected from the northern and southern buffer zones.

Split-spoon samples were collected to total depth in each borehole. A three foot composite sample was collected at the surface of each borehole. Rocky Flats alluvium samples had six-foot composites collected three feet below ground to the alluvium/bedrock contact (unless a lithologically distinct layer greater than two feet was encountered) Seventy samples were collected from the alluvium.

Sample collection in the colluvium was the same except the drilling extended twelve feet into bedrock in order to obtain bedrock samples. A total of 28 colluvial material samples were collected; twenty bedrock samples were obtained.

Tables from the 1989 study are included as Appendix F to the Phase I Work Plan. A separate off-site investigation is being conducted to verify the background concentration range of plutonium in surficial soils (Rockwell 1989).

Examination of the soil analyses indicates that the concentrations of nitrate, mercury, and plutonium are above estimated background concentrations in the West Spray Field soils. Except for probable laboratory contamination of the samples, volatile organic compounds (VOC) were not detected in the 1988 test pit soil samples

3 4 3 Previous Investigations Summary

Data from the above-mentioned sampling and background studies are summarized in Table 2-13 of the Phase I Work Plan Although further testing is necessary in order to fully characterize the extent of contamination in West Spray Field soils, data to date indicate that lead, nitrate, zinc and various radionuclide levels are elevated above background.

3.4 4 Proposed Additional Studies

As previously mentioned, a Phase I RFI/RI work plan for the West Spray Fields has been prepared in accordance with the draft Interagency Agreement stipulated between DOE, U S EPA, and CDH. The purpose of the Phase I RFI/RI is to review previous data and further characterize contaminant sources and contaminated soils associated with this waste management unit.

The Phase I RFI/RI will focus on the West Spray Fields as the most probable source of contaminants and, concurrently, will concentrate on the areal extent of contaminated soils in the vadose zone Subsequent phases (Phase II) will focus on groundwater, air, biota, and appropriate corrective/remedial studies, proposed plans, designs, and actions The primary technical objective of the Phase I RFI/RI is to characterize the contaminated sources and soil contamination resulting from application of waste waters on the West Spray Field.

Following Phase I RFI/RI activities, a Preliminary Site Characterization (PSC) report will be prepared that will provide recommendations for a Phase II RFI/RI The results of these investigations and the environmental evaluation will be used as a decision tool to support the baseline risk assessment and direct IM/IRA, if deemed appropriate All responses to corrective action investigations, remedial design, and construction will be implemented in accordance with the IAG and all appropriate guidance manuals

4.0 RISK BASED APPROACH

4.1 Discussion

The purpose of the National Contingency Plan (NCP) establishes the mechanism by which the protection of the public health and environment, as mandated by CERCLA (1980), and subsequently amended by SARA in 1986, can be implemented. The goal of the environmental evaluation at the West Spray Field is to determine if contaminants have caused or are causing any adverse environmental impacts

The environmental evaluation is designed to support the baseline risk assessment in determining the appropriateness of the no-action alternative at the West Spray Field site. To determine the appropriateness of the no-action alternative at the West Spray Field site, a qualitative and/or quantitative environmental evaluation consistent with the current guidelines will be conducted as an integral part of the baseline risk assessment. The degree of resolution that the environmental evaluation will provide and the associated degree of uncertainty in the assessment's conclusions will be directly related to the quality of data resulting from the West Spray Field ecological investigation and the Phase II RFI/RI activities Much is known in general terms about the West Spray Field such as the history, geology, and how the became contaminated, specific information is uncertain, or altogether unknown. What is known about the site is based on data that may not have been validated and is of uncertain quality. Also, some data may not have been validated to current EPA standards for acceptable quality and reliability Thus, the data to be collected during the Phase I and II RFI/RI activities and the ecological investigation are to fill in gaps of missing data or to supplement data of uncertain quality and ultimately support the baseline risk assessment. Sections 4.2 through 4.5 describe the environmental evaluation process. Section 4.6 outlines the selection of assessment and measurement endpoints Section 4.7 identifies the data collection requirements, and Section 4 8 establishes the uncertainties associated with risk assessments

4.2 Contaminants of Concern

Selection of contaminants of concern was based on those contaminants with concentrations above background and on the frequency of detection. The contaminants were evaluated based on the mobility of the compounds detected in soil surface, and the persistence and potential transformation of the compounds detected in the above-mentioned media This selection ranking process is modeled on the approach described in SPHEM (EPA, 1986)

The use of indicator chemicals provides an efficient and effective method of assessing potential risks associated with site-related contaminants such as those which have been identified at the West Spray Field Evaluation of the contaminants of concern for the effects of potential exposures will also provide adequate evaluation of potential risks posed by all other, potentially less hazardous chemicals

The following discussion summarizes the contaminants of concern for the West Spray Fields and references applicable summary tables of the Phase I Work Plan.

4 2.1 Soils and Groundwater Contamination

The West Spray Field soil is a potential pathway for groundwater contamination due to the past waste disposal practices employed. The liquid waste applied to the West Spray Field from ponds 207-B North and Center was sprayed directly onto the existing soils The soil sampling conducted to date in the West Spray Field provides a general idea of the types and levels of contamination which may be present in the West Spray Field soils Soil analyses to date indicate that nitrate, lead, zinc and radionuclides are above estimated background concentrations in the West Spray Field soils Due to possible laboratory contamination in the 1988 test pit samples, it can not be concluded whether volatile organic compounds (VOCs) are a potential contaminant of concern in West Spray Field soil samples Consequently, the information collected to date is not definitive enough to reach final conclusions Therefore, additional soil sampling and analysis is required to determine which constituents should be the best indicators of soil (or groundwater) contamination that may have resulted from application of solar pond liquids at the West Spray Field

4.2 2 Surface Water and Sediments Contamination

Surface water provides a pathway for transporting potential contaminants off the West Spray Field area. Woman Creek and Walnut Creek may receive compounds leached from contaminated surface soils. A series of dams, retention ponds, diversion structures, and ditches have been constructed at the Plant to control surface water and limit the potential for release of poor quality water. The ponds are located in the drainages of Walnut and Woman Creeks These creeks and associated surface water control structures eventually lead to reservoirs where the potential contaminants could be concentrated in related sediments

The surface water system represents a potential route of exposure from ingestion/absorption and direct contact exposure routes. If present, dissolved and suspended heavy metals, radionuclides, organics, and other contaminants may be released to and transported by the surface water system. Sediment from both Woman and Walnut Creeks may currently act as an accumulation point for site contaminants These sediments may also be resuspended and diverted downstream during high flows.

Additional sampling of the surface water and sediments is required to determine which constituents should be the best indicators of soil (or ground water) contamination that may have resulted from application of solar pond liquids at the West Spray Field. To address these concerns, sediment and surface water samples will be collected at locations within the West Spray Field unit boundary.

Based on concentrations above background and frequency of detection of the contaminants of concern identified in the West Spray Field Phase I Work Plan, the following contaminants have been identified

Metals	Inorganics	Radionuclides
• Lead (Pb)	• Nitrate (NO_3)	• Gross Alpha (for screening purposes only)
• Zinc (Zn)		• Gross beta (for screening purposes only)
		(1) Uranium - 233, 234, 235 & 238
		(1) Americium-241
		(1) Plutonium 238, 239 & 240
		(1) Strontium-90
		(1) Cesium-137
		(1) Tritium

(1) Additional radionuclide parameters based on elevated gross alpha and gross beta screening results

4.3 Exposure Assessments

The objective of this task will be to estimate the extent of potential exposures of nonhuman receptors to site-related contaminants. This objective will be attained through the following steps

- Identification and characterization of potentially exposed populations (i.e., receptor assessment),

- Characterization of critical exposure pathways and estimation of end-point concentrations in soils and surface water which could affect target species of insects and small mammals; and

- Determination of the bioavailability and toxicity of contaminants to flora and fauna.

The individual exposure assessment subtasks are described below

4 3.1 Potential Migration Pathways Characterization

Migration of site-related contaminants may result from shallow groundwater movement and/or surface runoff Site-related contaminants may be contained in the surface soils and may be subject to transport by wind or water erosion. Compounds that are contained deep in the soil matrix may leach into groundwater depending on such factors as the permeability and composition of the surrounding geological strata

Potential migration of site-related contaminants through water and soil can only be quantitatively assessed with the additional data available from the field investigation phase of the Phase I Work Plan. Chemical concentration data will be used when applicable to estimate the contaminant mass that is available for transport from a specific source to the exposure points for a given receptor population. Simple deterministic models will be used when applicable to evaluate the site-related contaminants that may leach to groundwater or surface water The results of this subtask will also provide inputs for the critical exposure pathway analyses of the human health evaluation The following discussion summarizes the ecological exposure pathways.

4.3.1.1 Soil

Soil exposure pathways are potentially important for plants and wildlife at the West Spray Field. Terrestrial animals at the site may be directly and indirectly exposed to contaminants in the soil Direct dermal contact with contaminated soil and incidental ingestion of soil could frequently occur among burrowing animals or among dustbathing animals. In general, information for quantifying and evaluating the toxicity of dermal exposures to wildlife species is limited. Incidental ingestion of soil is also a possible exposure route for animals such as small mammals which may ingest soil while grooming Herbivorous animals such as rabbits may ingest soil while feeding on plants, and seed-eating bird species may ingest soil while foraging for seeds on the ground Indirect exposure to soil contaminants may occur via ingestion of soil invertebrates (e.g , earthworms) or grasses and other plants which may bioaccumulate contaminants As with other exposure pathways, the importance of this pathway varies from species to species because of behavioral differences For example, populations of animals such as field mice, which are ground-dwelling animals and fastidious groomers, may be more greatly affected by contaminated soil than other species which contact soil less often.

Other exposures to soil contaminants, particularly to aquatic organisms, may result during rainfalls when surface runoff can transport soil particles to nearby surface waters Exposure to soil contaminants via this pathway is dependent upon such factors as the intensity of the storm (i.e , amount of rainfall), adsorption characteristics of both the surface soils and the contaminants, the extent and type of vegetation covering the soil, and the degree of slope to the body of surface water Slopes at the site are in some cases great enough to be of concern; however, the potential for runoff at the site is limited by the low rainfall in the area. The fate and transport characteristics of the selected chemicals of concern will be addressed in the human health evaluation of the baseline risk assessment.

Plants may be directly exposed to contaminants in soil via uptake through the roots. Contaminants may accumulate in different plant tissues depending on the species Because contaminant uptake is known to vary between plant species and tissue, evaluating the potential impacts to plants is often difficult.

4 3 1 2 Shallow Ground Water

Most potential ecological receptors are not likely to be directly exposed to chemicals present in shallow ground water. Plants could absorb chemicals from shallow ground water in the root zone and subsequently be used as a food source for wildlife. However, it should be recognized that there is potential for chemicals in ground water to enter surface water. Thus, a variety of the chemicals of concern has been detected on site in this medium at above background levels, direct exposures to shallow ground water are not expected to be of major concern. Exposure may, however, occur to the extent that chemicals in shallow ground water are transported into other more readily accessible media such as surface water.

4.3.1 3 Surface Water and Sediment

Surface water and sediment exposure pathways are potentially the most important pathways in this environmental evaluation. Most terrestrial wildlife species are dependent to some extent on surface water as a source of drinking water. Aquatic organisms (e.g., fish, snails) may be directly exposed to contaminants in surface water and sediments.

Many contaminants are known to bioconcentrate in aquatic organisms. Because some terrestrial wildlife rely on aquatic organisms as a food source, these species may function as a source of contaminants to animals higher in the food chain Omnivorous mammals such as raccoons or birds such as ducks and herons may be exposed via this pathway Agricultural crops irrigated with surface water may also bioaccumulate contaminants via absorption and uptake of surface water through the roots and translocation to various edible portions of the plant resulting in exposure of animals consuming the plants

Exposure to contaminants present in sediments is another possible exposure pathway for ecological receptors In addition to benthic (bottom dwelling) aquatic organisms, which may be continuously exposed to contaminants in the sediment, wading birds such as herons or other animals may also be exposed to contaminants from direct contact with sediment while foraging for food

4.3.2 Receptor Assessment

Data from the ecological investigation, along with other available data, will be used to define potential zones of impact for the site at the West Spray Field These zones of impact will be used to identify and describe potential receptor populations.

Identification of the potential environmental receptors requires knowledge of the potentially endangered flora or fauna Both flora and fauna will be considered as potential environmental receptors, since any evidence of potential environmental stress will be most evident on or immediately adjacent to the West Spray Field. In addition, the potential for wild animals to provide a pathway for the site-related contaminants will be evaluated. The following discussion summarizes the potential environmental receptors as identified in the Phase I Work Plan.

4.3.2.1 Vegetation

As stated earlier, the Rocky Flats Plant is located at an elevation of approximately 6,000 feet, which is just below the elevation at which plains grasslands grade abruptly into lower montane (foothills) forests (Marr, 1964). The present vegetation of Rocky Flats and adjacent grassy uplands is dominated by mixed prairie flora showing the influence of previous grazing. Most of the broad divides and hillsides support a mixture of resistant, less palatable native grasses, forbs (wildflowers), and subshrubs. Weedy forbs are locally prominent in disturbed or heavily grazed sites, introduced pasture grasses are present on sites where an attempt has been made to improve degraded range. Yucca and cacti are conspicuous in areas of heavy grazing and on sites with shallow, rocky soils. Individuals or small clumps of ponderosa pine occur on some rock outcrops. Isolated, undisturbed sites support remnant stands of midgrass or tallgrass prairie, including big bluestem, and side-oats grama.

The valley floors support various wetland types, ranging from sedges, rushes, or cattails to mature stands of cottonwoods and willows. The drainages also contain scattered clumps of wild plum, chokecherry, hawthorn, snowberry, and golden currant Sideslopes of the deeper ravines contain skunkbrush and ninebark, two shrub species more characteristic of the lower foothills.

4 3 2.2 Wildlife

As in most of the Front Range Urban Corridor, the wildlife of Rocky Flats has been greatly influenced by the increase in human use and disturbance over the past 100 years. Most notable have been reductions in the number and diversity of ungulates (hoofed animals) and predators. However, the relative isolation and habitat diversity of Rocky Flats have resulted in a fairly rich animal community

During a mark-and-recapture program, Winsor et al. (1975) caught eight species of small mammals the deer mouse, harvest mouse, meadow vole, thirteen-lined ground squirrel, northern pocket gopher, hispid pocket mouse, silky pocket mouse, and house mouse. White-tailed jackrabbits and cottontails are also present onsite The most abundant large mammal is the mule deer, of which an estimated 100-125 appear to be permanent residents of the site (DOE, 1980) Carnivores present include coyotes, red foxes, raccoons, badgers, long-tailed weasels, and striped skunks.

Common grassland birds at Rocky Flats include western meadowlarks, horned larks, vesper sparrows, lark sparrows, grasshopper sparrows, and western kingbirds. Wetlands support song sparrows, common yellowthroats, and red-winged blackbirds. Black-billed magpies, northern orioles, yellow warblers, warbling vireos, American robins, indigo buntings, and American and lesser goldfinches--among other species--nest in cottonwood/willow stands. Wooded draws attract foothills species, including MacGillivray's warblers, yellow-breasted chats, black-headed grosbeaks, green-tailed and rufous-sided towhees, and luzuli buntings. Common birds of prey in the area include American kestrels, northern harriers, red-tailed hawks, Swainson's hawks, and great horned owls.

The most abundant reptiles are the bullsnake, racer, western terrestrial gartersnake, and prairie rattlesnake

4.3.2.3 Aquatic Resources

Four streams flow within the Rocky Flats boundary: Rock Creek, North Walnut Creek, South Walnut Creek, and Woman Creek All of these streams are ephemeral to intermittent, with peak flows during spring and early summer. The two forks of Walnut Creek also contain a series of small impoundments formed by earthen dams.

The surface waters support a variety of aquatic macroinvertebrates, including snails, crayfish, and insects (DOE, 1980). Some of the ponds are inhabited by fathead minnows, green sunfish, and largemouth bass The ponds also attract water birds such as mallards, gadwall, green- and blue-winged teal, spotted sandpiper, and great blue herons. Killdeer are common near pond margins. In addition, the ponds and creeks provide feeding habitat and water sources for various terrestrial species and breeding habitat for amphibians. Leopard frogs, Woodhouse's toads, and northern chorus frogs have all be observed on Rocky Flats. Muskrats are reported to occur in some areas (DOE, 1980)

4.4 Toxicity Assessment

As part of the environmental evaluation, a toxicity assessment will be performed to determine the nature and extent of any environmental hazards associated with potential exposure to the site-related contaminants of concern. It is a two-step process consisting of.

- Toxicological evaluation
- Dose-response assessment.

The first step in the toxicity assessment, the toxicological evaluation, will be a qualitative evaluation of the scientific data to determine the nature and severity of the toxic properties associated with the contaminants of concern.

Once the contaminant's potential adverse effects have been characterized, the next step is a quantitative estimation of the amount of exposure to a contaminant that may result in an adverse effect. This defines the relationship between the dose of a contaminant and the incidence of the adverse effect.

4.5 Risk Characterization

Health risk estimation quantitatively defines the general magnitude of health risks posed by a defined set of circumstances. The precision of such estimates is limited by the size and quality of the database. Often, these limitations can be overcome by defining a range of extremes. However, the overriding uncertainties associated with estimating risks that may result from contaminant exposure include.

- The extrapolation of toxic effects observed at the high doses necessary to conduct animal studies to effects that might occur at the much lower, environmentally relevant doses, and

- The extrapolation from toxic effects in animals to toxic effects in humans (i e., responses of animals may be different from responses of humans).

The approach to be taken in this part of the environmental evaluation will use health-protective assumptions that likely overestimate any potential risks. This biased approach for managing uncertainties has a magnifying effect on the outcome of the risk assessment process. Because each step builds on the previous one, the overall result of biased assumptions is to overestimate risks rather than underestimate them. This approach compensates for risk assessment uncertainties and provides a safety margin The protocol of the risk characterization will take into account specific site conditions while maintaining the protective bias described above. The risk characterization will quantify the level of potential hazards identified by the exposure assessment.

The estimated exposure levels will be compared with applicable chemical-specific or site-specific requirements (ARARs), where available, as defined by EPA (EPA, 1987) In the absence of applicable requirements, relevant and appropriate requirements will be identified

Available chemical-specific standards, criteria and guidance for the protection of plants and animals exist for the contaminants of concern at the West Spray Field area For example, Ambient Water Quality Criteria (AWQC) for the protection of freshwater aquatic life have been established under the U S Clean Water Act for a number of chemicals AWQCs are the maximum recommended concentrations in water for acute and chronic exposures. The AWQCs for the selected metals of concern in surface water are summarized in Table 4-1

These criteria are developed to be protective of 95 percent of all aquatic species, and therefore protect fish, aquatic invertebrates, and plants These criteria may be compared with average and maximum surface water concentrations to determine the likelihood of adverse effects to aquatic life. Criteria have not been developed specifically for the protection of terrestrial wildlife. The primary literature or documents summarizing this literature are usually the source of most of the relevant toxicity data for these receptors.

For purposes of evaluation, toxicity values are obtained from studies reporting no observed effect levels (NOELs), lowest observed effect levels (LOELs), or median lethal doses (LD_{50}s) for terrestrial and avian species, and are presented in this section The NOEL represents the highest chemical dose not associated with an adverse effect in an animal, whereas the LOEL represents the lowest dose reported to cause an effort The LD_{50} represents the dose which was lethal to 50 percent of an experimental population.

This evaluation is essentially a qualitative and/or quantitative evaluation and is most useful as an indication of the relative toxicities of the selected chemicals of concern Therefore, relative toxicity ranking schemes will be used in this assessment.

The following classification scheme (based on Zucker 1985) is used to categorize the relative acute toxicity (based on LC_{50} values[3] or EC_{50} values[4]) of the contaminants to aquatic organisms

LC_{50} (or EC_{50}) mg/1 water	Toxicity Category
<0.1	Very highly toxic
0.1 - 1	Highly toxic
>1 - $\leq$ 10	Moderately toxic
>10 - $\leq$ 100	Slightly toxic
>100	Practically non-toxic

LC_{50} - Median Lethal Concentration It is the concentration in water of specific chemical that results in death to 50 percent of the tested organisms.

EC_{50} - Median Effective Concentration. It is the concentration in water of a specific chemical that results in a specific effect (such as immobilization) in 50 percent of the tested organisms. This is often used with macrocrustaceans such as Cladocerans (e.g , Daphnia) and copepods for which it is difficult to determine death.

The relative toxicity of the chemicals of concern based on oral acute studies with laboratory mammals is described using the scheme by Maxwell (1982, as cited in Walstad and Dost 1984) where:

LC_{50} (mg/kg-body weight)	Toxicity Category
$\leq$50	Severely toxic
>50 - 500	Moderately toxic
500 - 5,000	Slightly toxic
>5,000	Very slightly toxic

The relative hazards of the contaminants at the West Spray Field are summarized below for aquatic organisms, mammals, and vegetation

TABLE 4-1

FRESHWATER AMBIENT WATER QUALITY CRITERIA (AWQCS)
FOR SELECTED METALS OF CONCERN
AT THE WEST SPRAY FIELD SITE

METALS	AMBIENT WATER QUALITY CRITERIA (ug/l)	
	Acute	Chronic
Lead	82	32
Zinc	320	47

Source. EPA 1986

4 5.1 Aquatic Organisms

Lead is quite toxic to aquatic life, and has acute and chronic ambient water quality criteria of less than 100 ug/1.

4.5 2 Mammals

Based on acute toxicity values, lead is considered severely toxic to mammals. The LD_{50}s is less than 50 mg/kg body weight for this contaminant.

4.5.3 Vegetation

Adequate information on plant toxicity is not available for most of the chemicals of concern in soils. For contaminants for which ARARs are not available, EPA has provided guidance on the use and application of other chemical-specific advisory levels, such as carcinogenic potency factors or reference doses (RfDs) (EPA, 1987) While not actually ARARs, these data may be used to determine risk-based action levels in a site-specific approach In choosing criteria appropriate for the estimation of potential site-related risks, both carcinogenic and noncarcinogenic risks will be considered

The level of potential risk posed by each indicator chemical to ecological receptors identified in the exposure assessment will be characterized for all pathways of exposure relevant to the specific receptor population identified Predicted exposure levels for any indicator chemical that is a Class A or B carcinogen (by the Carcinogen Assessment Group ranking system) will be compared to either unit cancer risks or carcinogenic potency factors, where available This will aid in evaluating the need for more site-specific exposure criteria. Variability in exposure frequency and duration will be considered. Uncertainties that may affect the risk estimates will be presented qualitatively.

Short-term and long-term exposures for noncarcinogens will be determined for the receptor populations as appropriate and related to the potential toxic effects. Comparisons of any current exposure levels to EPA-derived RfDs or acceptable daily intakes or other relevant criteria will be made when possible. If relevant EPA-derived RfDs or acceptable daily intakes do not exist for certain indicator chemicals, suitable values will be derived. Justification will be provided for any derived values Exposure to multiple contaminants will also be evaluated for their potential relevance to the sites Uncertainties that may affect the estimates of risk from noncarcinogens will be presented in a qualitative framework.

4.6. Assessment and Measurement Endpoints

4.6 1 Environmental Media Analysis

4 6.1 1 Soil and Groundwater

Assessment endpoints for monitoring soil and groundwater include the concentrations and locations of contaminants within North Walnut Creek, South Walnut Creek, and Woman Creek drainages This information will be used to indicate whether the West Spray Field is the source of any contamination, and (if so) how far from that source the contaminants have migrated. Measurement endpoints will be the concentrations of individual compounds in soil and groundwater, and the locations from which the samples were obtained.

4 6.1 2 Sediment and Surface Water

Hazardous substances and/or alteration of physicochemical parameters (e g , pH) in surface waters may impact terrestrial biota around seeps and aquatic organisms in streams and ponds. Many contaminants may also become bound to material in stream and pond sediments. Sediment can be a reservoir for contamination of surface water and may selectively affect organisms that live exclusively within or on the sediment. Terrestrial plants and animals, including humans, that utilize surface water resources are also at risk when these supplies are contaminated. The assessment endpoints of the sediment and surface water sampling program will be estimates and measurements of contaminant concentrations to which aquatic organisms and other biota using these resources are exposed. Measurement endpoints will include the concentrations of individual compounds and the locations from which samples were obtained

4 6.2 Biotic Communities Analysis

4.6.2 1 General Considerations

An ultimate effect of environmental contamination is the adverse impact on biota (plants and animals) and human health. Changes in population and biotic community indices can indicate impacts due to environmental contamination. The assessment endpoints employed in this study will include integrated measures of biotic community structure such as species richness, abundance, and diversity. When possible, the similarity to potentially impacted sites will be compared with those of presumably unimpacted sites in the immediate vicinity Measurement endpoints used to derive population or community indices will be the occurrence and abundance of plant and animal species and their spatial distribution within a given habitat. Measurement endpoints will vary according to the group of organisms being sampled and the habitat in which they live. For example, sampling techniques differ for plants and animals, as well as for aquatic and terrestrial organisms. The presence or absence of indicator organisms, usually abundant only under relatively uncontaminated conditions, will also be noted.

The actual uptake of contaminants by plants and animals is indicative of the bioavailability of environmental contaminants. Contamination of foodstuff plants and animals also represent an exposure pathway for humans Measurement endpoints will include the concentrations of xenobiotic compounds (those not found naturally), and potentially hazardous natural materials such as metals and radionuclides, in plant and animal tissues

4.6 4 Histopathology

Once contaminant effects have been substantiated through bioaccumulation and toxicity testing, histopathological examinations can be performed to confirm these effects The actual organ or tissue to be examined is primarily dependent on the contaminant and its affinity for particular organ(s) or tissue. In this particular case, histopathological examinations of deer mouse kidneys are recommended to provide a qualitative and confirmatory substantiation of the results obtained during the bioaccumulation and toxicity testing.

4 6.5 Toxicity Test Results

Toxicity tests provide an indication as to the bioavailability of toxic contaminants on a particular site Usually the tests will present the results of contaminants' effects on survival, growth, and/or reproduction of aquatic and terrestrial organics. The toxicity tests also provide an indication of the net effect of chemical contaminants that are not so easily quantifiable (analytical detection limits) or are contained in complex matrices

Toxicity testing is usually classified as acute (short-term) or chronic (long-term). Short-term tests provide a quick determination of the effects a particular contaminant may have on an organism; however, short-term testing is less sensitive than the chronic testing Chronic testing is used to measure the effects of less severe longer duration contamination. Laboratory bioassay testing of Ceriodaphnia (water flea) for aquatic contamination, and ants for soil contamination is recommended.

4.7 Data Collection Requirements

The purpose of the approach outlined above is to support both an immediate and long-term evaluation of the viability of the no-action alternative based on the results of a baseline risk assessment. To satisfy the data needs of this approach, the results of the ecological investigation should provide the information outlined below·

- Identify the bioavailability and toxicological impacts of the contaminants of concern for flora and fauna

- Support the identification and characterization of the extent and transport of site-related contaminants.

The statement of work described in Section 5 0 has been designed to meet the requirements described in this section. Satisfying the above data collection requirements is an important adjunct to successfully executing a risk-based approach to the Environmental Evaluation

4.8 Uncertainties Discussion

All risk assessments involve the use of assumptions, judgement, and imperfect data to varying degrees. This results in uncertainty in the final estimates of risk Uncertainty in a risk assessment may arise for many reasons including

- Environmental chemistry sampling and analysis,
- Misidentification or failure to be all-inclusive in hazard identification,
- Choice of models and input parameters in exposure assessment and fate and transport modeling;
- Choice of models or evaluation of toxicological data in dose response quantification,

- Assumptions concerning exposure scenarios and population distributions; and

- Assumption regarding future site and land use conditions.

The assessment should be understood as providing upper estimates on the risks to exposed populations. The risk assessment should not, as a result of the uncertainties described above, be construed as presenting an estimate of the true risks to environmental populations Whenever possible, however, the uncertainties will be resolved by making conservative assumptions about risk and exposure parameters.

5.0 WORK PLAN RATIONALE

5.1 Introduction

This section cites specific activities, methods, and procedures that will govern the ecological investigation of the West Spray Field. Proposed activities are projected based on applicable data gathered in previous West Spray Field investigations. The overall environmental evaluation will assist in the determination of what actions must be taken, if any, to reduce receptor exposure to any contamination to an acceptable level An Interim Measures/Interim Remedial Action (IM/IRA) for the West Spray Field site will be completed and designed, if deemed necessary, based on the findings of the baseline risk assessment

A baseline risk assessment will ultimately be conducted under a separate statement of work to evaluate the no-action alternative based on current conditions at the West Spray Field site. Information from the environmental evaluation regarding the potential for contaminant releases, routes of exposure, ecological end-points, and the assessment of potential risks developed for the no-action alternative will support the baseline risk assessment for determining the need for IM/IRA and for establishing a time frame to develop any required long-term alternatives.

The work effort to implement the environmental evaluation requires.

- Evaluating the previous data and findings,
- Establishing methods and procedures for the ecological investigation

- Specifying site specific actions that will yield the data needed to complete the environmental evaluation; and
- Evaluating the data gathered relative to the IM/IRA.

5.2 Work Plan Approach

The activities completed under this workplan will be conducted in four phases:

Phase 1 - Field reconnaissance trip designed to familiarize key personnel with site-specific conditions;

Phase 2 - Field mobilization period to coordinate materials and logistics for the ecological investigation,

Phase 3 - Field surveys designed to characterize biological conditions, and

Phase 4 - Data evaluation/interpretation and report preparation.

Phase 1, the initial work effort under this program, will include a site reconnaissance, reference areas selection, and the collection and evaluation of existing data.

The site reconnaissance will emphasize the selection of specific sampling stations and the location of "reference areas." Reference areas will be selected during Phase I to be representative of the upland and lowland communities Reference areas will be chosen on the basis of topography, substrate, moisture, and apparent land use history, as well as dominant vegetation. Even if subsequent phases do not begin until 1991, Phase 1 should proceed during late summer or early fall 1990, if possible Stream flow and vegetation conditions are more reliable indicators of appropriate locations during this season than during the spring. For example, it will be important to sample persistent segments of the various streams. These will be apparent in summer/fall, but not in spring during peak runoff. Similarly, summer/fall is the preferred season for selecting reference areas because vegetation has achieved its full height and diversity In spring, it is more difficult to recognize subtle differences in community structure and composition that would influence the selection of reference areas.

Review of existing data will focus upon ensuring that sampling locations, protocols, and analyte suites are consistent and that unnecessary duplication with EG&G on-going studies is avoided. The sampling programs for soils, groundwater, sediments, and surface water are likely to be refined following this effort. To the extent possible, data collected as part of EG&G's on-going studies of these environmental media will be used to replace or supplement environmental evaluation program-specific sampling.

Phase 2, focuses on the field mobilization activities to coordinate materials and logistics for field investigations at the Rocky Flats Plant

Phase 3, focuses on the ecological investigation activities to characterize the biological and chemical contaminant conditions at the West Spray Field. The ecological investigation tasks are discussed in Section 5 6.

Phase 4, focuses on data evaluation/interpretation and report preparation. Section 5.7 describes how the data will be analyzed to determine whether differences are statistically significant Section 7 2 presents the proposed environmental evaluation report outline.

5.3 Sampling and Analysis Plan (SAP)

Upon the completion of Phase I field reconnaissance activities, a sampling and analysis plan (SAP) will be prepared for soils, sediments, surface water, alluvial groundwater, and biota The SAP will consist of two parts· (1) a quality assurance project plan (QAPjP) that will describe the policy, organization and quality control protocols necessary to achieve the data quality objectives (DQO) of the ecological investigation, and (2) the field sampling plan (FSP) will provide guidance for all fieldwork by defining ,in detail, the sampling and data-gathering methods to be used during the ecological investigation. The format of the proposed SAP is presented in Table 5-1.

As discussed in Section 4.1, information collected from previous West Spray Field investigations indicate data gaps and data of uncertain quality Data of known quality collected from Phase I and II RFI/RI activities will be compiled and analyzed prior to the ecological investigation in order to develop DQO's and define a conceptual model of the West Spray Field that describes suspected sources, contamination pathways, and potential receptors In addition to the SAP, a site-specific health and safety plan (HSP) will be prepared concurrently with the SAP to identify potential problems early, prior to field activities, and will be consistent with the following requirements

- EPA Order 1440.1 - Respiratory Protection
- EPA Order 1440.3 - Health and Safety Requirements for Employees Engaged in Field Activities

- EPA Occupational Health and Safety Manual
- EPA Interim Standard Operating Guide (September 1982)
- Other appropriate EPA guidance
- Applicable standards of the Occupational Safety and Health Administration
- Site conditions
- 29 CFR 1910.20
- Applicable DOE Orders

5.4 Ecological Investigation Tasks

The nine ecological investigation Phase 3 tasks summarized below will be performed to fulfill the following general uses·

- Baseline Risk Assessment -- Support the development of current risk posed by contaminants to the environment as a function of toxicity and migration potential

- Health and Safety -- Support the determination of risk to remedial personnel if remediation (i.e , IM/IRA) activities are employed.

- Response Actions (i e , IM/IRA) -- Support the evaluation of actions to protect the environment, and to comply with applicable or relevant and appropriate requirements (ARARs)

The Phase 3 tasks are outlined and discussed below:

Task 1 - Soil and Alluvial Groundwater Sampling

Task 2 - Sediment and Surface Water Sampling

Task 3 - Vegetation Survey

Task 4 - Terrestrial Invertebrate Survey

Task 5 - Aquatic Survey

Task 6 - Small Mammal Survey

Task 7 - Bioaccumulation Survey

Task 8 - Toxicity Tests

Task 9 - Critical Habitats and Endangered Species

5.4 1 Task 1 - Soil and Alluvial Groundwater Sampling

It is the intent of this task to (a) determine the vertical and lateral extent of contaminants originating at the West Spray Field area, and (b) assess the extent to which the contaminants pose a present or potential risk to the environment. Soil and groundwater sampling will be designed to indicate whether site area contaminants are being transported through the vadose or saturated zones toward North Walnut Creek or Woman Creek, where they could potentially come in contact with surface water or biota Exact numbers and locations for soil and alluvial groundwater sampling will be determined upon the completion of Phase 1 The analytical methods for soil and groundwater samples at the West Spray Field are presented in Table 5-2 and 5-3, respectively.

5.4.1 1 Soil Sampling

Soil sampling locations will be in a grid pattern (N-S, E-W) overlain upon the study area. Grid nodes (sampling points) will be selected using a systematic approach to ensure adequate coverage of three distinct strata: (1) within the three spray areas, (2) outside the spray areas but within the site area, and (3) between the site area and adjacent drainages or ditches Each stratum will include sixteen sampling locations.

Soil sampling at each location will consist of vertical composites across the following depth increments 0-3 inches, 3-6 inches, 6-18 inches, 18-30 inches, and 30-60 inches. Each sample shall consist of at least 1 kilogram. Samples will be placed in double plastic bags and sent to the laboratory for chemical analysis. Labeling and maintenance of samples and laboratory procedures will be specified in the project-specific SAP Analytical parameters and methods of the contaminants of concern are shown in Table 5-2. The site-specific modeling parameters include basic physicochemical characteristics (e.g , particle size distribution, total organic carbon, cation exchange capacity, acidity, alkalinity, and pH

5 4.1.2 Alluvial Groundwater Sampling

Existing alluvial groundwater monitoring wells are generally sufficient to address the potential transport of West Spray Field area contaminants into nearby surface waters. These include wells within and adjacent to the West Spray Field site, in reaches of North Walnut and Woman Creek immediately downgradient of the West Spray Field, and between the site and McKay Ditch.

5.4 2 Task 2 - Sediments and Surface Water Sampling

Sediments and surface water could potentially have received West Spray Field area contaminants either via sheet runoff or via migration through shallow groundwater These two media are important as indicators of the nature and extent of contamination, as well as potential exposure pathways to biota. The exact sample locations for sediment and surface water sampling will be finalized upon completion of the Phase I field reconnaissance. The analytical methods for sediment and surface water samples at the West Spray Field are presented in Table 5-2 and 5-3, respectively

5.4.2.1 Sediment Sampling

Existing sediments sampling sites SED-09 on North Walnut Creek and SED-07, 17, and 14 will be sampled as part of this program, unless additional data are available for 1990. Additional sediment stations will be located as follows

Adjacent to surface water monitoring stations SW-08 and 83 (and a new station between these two) on North Walnut Creek,

At surface water sites SW-10 and 11 on McKay Ditch,

On South Walnut Creek west of McKay Ditch, and

On the McKay Ditch cutoff from North Walnut Creek, between SW-83 and SW-10.

Sampling of the additional stations will follow the same protocol as is used during EG&G's on-going studies program

5.4 2.2 Surface Water Sampling

Existing surface water monitoring stations near the West Spray Field site, in reaches of North Walnut Creek, Woman Creek, and McKay Ditch are generally sufficient and will be sampled only if data are not available for 1990. In addition, surface water will be sampled at the new sediment stations previously described for which analogous surface water stations do not currently exist (i e., on North Walnut Creek between SW-08 and 83, and on McKay Ditch). Sampling protocols at any new stations should be the same as employed during EG&G's on-going studies program

5.4.3 Task 3 - Vegetation Survey

Terrestrial plants can serve as indicators of contamination by changes in community composition (structure and individual plant growth) This can be evaluated by collecting data at increasing distances away from potential source areas or comparing potentially affected areas with unaffected "reference" sites. Vegetation also represents a potential exposure pathway to wildlife of contaminants absorbed into the plant tissue or accumulated on the surface of above-ground parts. The analytical methods for the vegetation survey at the West Spray Field are presented in Table 5-4 Accordingly, the vegetation survey will consist of two distinct subtasks· community evaluation and tissue sampling.

5.4 3.1 Community Evaluation

Quantitative sampling of species composition, abundance, and production will be conducted in the two predominant vegetation community types -- mixed prairie upland and mixed wet meadow/riparian -- near the site area. Sampling of the mixed prairie will include areas variously dominated by native perennial grasses and forbs, weedy annual or biennial forbs, and shrubs Sampling of the wet meadow/riparian type will include areas variously dominated by mesophytic grasses, sedges, rushes, forbs, and shrubs, as well as cottonwoods and peachleaf willows Hydrophytic species occur as scattered stands within the stream channels These species will be surveyed as part of the aquatic program

Quantitative sampling of vegetation in upland grasslands will include estimates of cover, frequency, production, and woody plant density along 16 - 50-meter transects located randomly in each of three sampling strata. The three strata for this sampling scheme will consist of (1) the three spray areas, (2) outside the spray areas but within the site area, and (3) between the site and adjacent drainages or ditches Sampling locations will be selected using pairs of random numbers as Cartesian (x,y) coordinates on a grid overlain upon an aerial photograph of the site Locations in lowland wet meadow communities will be selected using a "random-systematic" approach because of their linear configuration. Unsuitable sites (e g , roads or structures) will be discarded and another location selected.

Data collection along the 50-meter transects, and data presentation in the environmental evaluation report, will be as follows:

> Frequency -- Contractor will report frequency, by species, for each sampling area and community type. Frequency is defined as the percentage of point-intercept transects along which a species was "hit" In addition, notations will be made as to species present in the stand but not encountered within the quadrants or intercepted by the points These data will be summarized by species for each sampling area and community type.

Woody Plant Density -- Data on the density of trees and shrubs will be collected by counting the number of individuals, by species, within 100-m^2 belt transects (i.e., 50 m by 2 m) centered along the cover transects. Density will be reported as the number per 100 m^2 and hectare for each transect, and summarized for each sampling area and type.

Production -- Standing biomass of upland communities will be estimated by clipping the current year's growth of graminoids and forbs within 1 m^2 plots located at each end of the cover transects. The clipped material will be sorted by species (minor species will be lumped by lifeform), oven-dried at 104° C for 24 hours, and weighed to the nearest 0.1 gram. Production will be reported as grams per square meter and pounds per acre, by major species and lifeform. A list of minor species not reported separately will be prepared for each plot

The narrative text will describe the results of (a) the quantitative sampling, including discussions of dominant, subdominant, and associated species, (b) successional status, including the proportion of increaser versus decreaser, native versus introduced, annual versus perennial, and forb versus graminoid species; (c) species diversity, including reference to both richness and equability, (d) provenance, including reference to species associated with prairie, mesa, or foothill environments, (e) apparent ecological relationships, including substrate, slope, aspect, snow accumulation, and subirrigation; and (f) human influence, such as livestock grazing and physical disturbance

5.4.3 2 Tissue Sampling

Additional plant tissue will be collected for tissue analysis at each sampling location described above. Samples will consist of at least twenty individuals of the dominant grass and forb species at each location, with six replicate samples for each of the two species

Enough tissue material will be collected at each site to comprise six 200-gram (fresh weight) samples for each species. The samples will be placed in double plastic bags, sealed, and kept below 40° F (4°C). Each sample will be marked with indelible ink as to sampling site, species, and date of collection. Laboratory analysis procedures will be specified in the project-specific SAP.

Each sample will be divided into two subsamples. One subsample will be washed with distilled water to remove airborne material deposited on the surface of the plant. Sonication may be used in addition to distilled water if it is determined to be appropriate. The other subsample will be left unwashed. The two subsamples from each location will be subjected to identical analyses.

5.4 4 Task 4 - Terrestrial Invertebrate Survey

Invertebrates can be important indicators of contamination because of their short life cycles, sensitivity to or bioaccumulation of certain metals or organic compounds, and relatively small home ranges (except for some flying insects). Invertebrates also are important components of the terrestrial food web, representing a major prey for many reptiles, songbirds, and small mammals, as well as American kestrels and some carnivores. For the West Spray Field site, invertebrates may be less useful because of limited habitat near the site area and the probable low levels of contaminants away from the site Nonetheless, collection of population and body-burden data will be conducted to ensure that the environmental evaluation is comprehensive and that no major indicators or exposure pathways are overlooked. The analytical methods for the terrestrial invertebrate survey at the West Spray Field are presented in Table 5-4

5.4.4.1 Population Studies

Sweep-netting and pitfall traps will be used for evaluating populations of terrestrial invertebrates Sweep-netting will provide information on the diversity and abundance of above-ground invertebrates (especially insects). Major groups expected include orthopterans (grasshoppers), lepidopterans (butterflies), hymenopterans (bees), hemipterans (true bugs), dipterans (flies), and coleopterans (beetles), as well as spiders Sampling will be conducted along the vegetation quantitative transects (Task 3) and comparisons should be limited to similar habitats in the reference area. Samples will be preserved in jars for later identification and enumeration.

5.4.4 2 Tissue Sampling

Samples for laboratory analysis will be collected in the same manner and locations as the population studies. Sampling will use a nonsystematic approach until sufficient quantities of the most important taxon have been collected for laboratory analysis Importance will be determined based on abundance and biomass. Each analytical sample will be a homogenate of whole bodies of the dominant species It is anticipated that some stations will provide only enough biomass for heavy metals plus gross alpha and gross beta Some stations may not provide sufficient biomass for any tissue analysis. All samples will be maintained on ice until transferred to the laboratory.

5.4.5 Task 5 - Aquatic Survey

Aquatic environments of Woman Creek and North and South Walnut creeks represent potential indicators and exposure pathways of West Spray Field contaminants. This is because aquatic ecosystems are sensitive to physicochemical changes and receive relatively intensive use by a variety of terrestrial as well as aquatic organisms. As with terrestrial biota, the aquatic ecology survey will include both a community evaluation and tissue sampling. The analytical methods for the aquatic survey at the West Spray Field are presented in Table 5-4.

5.4.5 1 Community Evaluation

Sampling stations will be located upstream and downstream of the area of potential impact and on an offsite reference stream. Sampling stations along creeks and in ponds will be identified during the preliminary site reconnaissance in late summer/early fall 1990. It is expected that aquatic sampling sites will coincide with sediment sampling sites described above (Task 2) Site selection should consider the ephemeral nature of the streams. Sections that are dry during late summer may be sampled, but comparisons should be limited to similar habitats in the reference stream. The reference stream will be matched to the subject streams according to stream order (size) and maturity, gradient, flow, substrate, and adjacent vegetation

Sampling of aquatic biota for a community evaluation should begin in late April-early May so that pre-emergent insect larvae are included. A second sampling should be conducted in September to include species emerging later in the fall. Because of limited flows, sampling will generally be "semiquantitative." That is, quantitative techniques will be employed, but the results will mostly be used for relative comparisons among sites Such techniques are outlined in EPA publications on rapid bioassessment techniques.

At each site, periphyton, benthic macroinvertebrates, and nektonic (free-swimming) macroinvertebrates will be collected to determine species composition and abundance, richness, trophic structure, biomass, and the presence or absence of key indicator taxa. Standard survey techniques will be employed Benthic macroinvertebrates in streams will be collected using a Surber sampler (200-mesh), if the substrate is composed of sediments, collection will be to a standardized depth of 10 cm (4 inches) A fine-mesh dipnet will be used to collect grab samples of free-swimming forms. A minimum of three replicates will be taken at each stream station and five at each pond. Samples will be "fixed" in the field using cold 4% formalin and returned to the laboratory for identification to the lowest practicable level and identification. Data will be reported for each station and summarized by habitat type (i e , riffle, run, or pool)

Concurrent with the aquatic ecology survey, water quality will be evaluated for basic physicochemical parameters as presented in Table 5-3. Water quality data from the surface water program will also be used to assist in evaluating the aquatic community.

5.4.5.2 Tissue Sampling

When the community sampling is completed at each site, aquatic organisms will be collected for tissue analysis of contaminants. Tissue sampling of benthic invertebrates and minnows will be done using whole animals. If abundance permits, five samples containing enough biomass of the dominant taxon for analysis will be taken from each station. However, low abundance and biomass of invertebrates may make it necessary to composite benthic and nektonic forms across taxa or feeding guilds In addition, it is anticipated that many stations will provide only enough biomass for analysis of heavy metals plus gross alpha and gross beta. Some stations may not provide sufficient biomass for any tissue analysis. All samples will be maintained on ice until transferred to the laboratory

5.4.6 Task 6 - Small Mammal Survey

Small mammals are an important component of the environmental evaluation because they live in intimate contact with the soil, consume a variety of plant and/or invertebrate tissue, have small home ranges, and are the principal prey for a variety of snakes, raptors, and carnivores. As with invertebrates, small mammal surveys will include both population studies and tissue sampling The analytical parameters for the small mammal survey at the West Spray Field are presented in Table 5-4.

5 4.6 1 Population Studies

Small mammals will be surveyed by live-trapping in upland and lowland habitat types in the West Spray Field study area. This will include four trapping locations in each of four strata: (1) inside the spray areas, (2) outside the spray areas but inside the site area, (3) in upland grasslands between the site area and adjacent drainages, and (4) in lowland wet meadows along the creeks. In upland habitats, traps will be arranged in rectangular grids 100 meters long; grid width (up to five columns) will depend upon the configuration of the specific area being surveyed Individual trap stations will be spaced 10 meters apart (rows and columns), two traps will be placed at each station. Single traplines 100 meters long with 10 meters between stations and two traps per station will be used in linear wet meadows habitats. When possible, small mammal sites will be co-located with terrestrial invertebrate and vegetation sites to facilitate data comparisons and interpretations. Each trapline or grid will be run for six consecutive nights Traps will be baited with a mixture of peanut butter and rolled oats. Traps will be checked before mid-morning to avoid undue mortality, and polyester "cotton balls" or wool will be placed in the traps for thermal protection at night

Data will be recorded as to species, sex, age (adult versus juvenile), weight, and apparent health (e g , parasites, tumors, pelage). The report should describe the habitat quality (structure, diversity, species dominance, etc.) along each trapline and the abundance of each small mammal species As with the vegetation survey, the results should allow for comparisons of potentially affected sites with analogous reference sites Small mammal reference areas will coincide with vegetation reference areas. Trapping in the reference areas will use the same techniques as in potentially effected areas, as described above.

5.4 6.2 Tissue Sampling

The numerically dominant species along each trapline will be used for tissue analyses, after the population studies are completed. It is anticipated that these will be deer mice in upland areas and meadow voles in lowlands. Samples for tissue analysis will be collected by livetrap and sacrificed immediately prior to preservation on ice. Sampling will continue until a minimum of five individuals of the selected species have been collected at each sampling site.

Each mouse will be placed in a plastic bag, which will be sealed and kept on ice until the kidneys can be surgically removed in a "clean room " in the laboratory in accordance with procedures specified in the project-specific SAP.

One kidney from each mouse will be placed in an individual vial containing a 10% buffered neutral formalin solution for preservation. Each vial will be double-labeled (one label on the inside and one on the outside of each vial) as to species, sampling location, date collected, tissue, and replicate number. Each kidney will be analyzed for inclusion bodies and other cellular abnormalities The five kidneys from mice collected at each site will then be composited, weighed, and frozen. The remaining carcasses will also be composited for each site, weighed, and frozen. Concentration of metals, radionuclides, and organics of concern will be determined for each composite kidney and carcass sample in accordance with procedures described in project-specific SAP. Wholebody concentrations will be calculated from the weights and concentrations for kidneys and carcasses.

5 4.7 Task 7 - Bioaccumulation Study

5 4.7.1 Vegetation and Soil Sampling

At each soil sampling site described in Section 5 4.1.1 above, plant tissue will be collected to allow investigation of the relationship between plant-available concentrations in the soil and concentrations within or on the plant surface Collection and handling of samples will follow the protocol described in the project-specific SAP. The analytical parameters for the bioaccumulation study at the West Spray Field are presented in Table 5-4

5 4.7.2 Terrestrial Invertebrates and Small Mammals

Samples of invertebrates and small mammals will be collected following the protocols described in Sections 5 6.4 2 and 5 6.6 2, above If the concentration of chemical contaminants is significant in terrestrial animals, histopathology studies of deer mice (Peromyscus manicalatus) will be conducted. Histopathological studies will be performed by a qualified pathologist familiar with the standard methods developed by Meyers and Hindrick (1986) referenced in "Ecological Assessment of Hazardous Waste Sites," EPA, March 1989 (EPA 600/3-89/013)

5 4.7.3 Aquatic Animals

Samples of aquatic animals will be collected following the protocols described in Sections 5 4.5 1 and 5.4 5 2. If the concentration of chemical contaminants is significant in terrestrial aquatic animals, histopathology studies of fathead minnows (Pimephales promelas) will be conducted. As mentioned in Section 5.4 7 2, histopathological studies will be performed by a qualified pathologist familiar with the standard methods developed by Meyers and Hindrick (1986) referenced in "Ecological Assessment of Hazardous Waste Sites," EPA, March 1989 (EPA 600/3-89/013)

Tissue analysis for contaminants of interest for these organisms, in conjunction with data from soils and plants, and terrestrial animals, will provide an integrated approach to the movement and preferential accumulation of contaminants, if any.

5.4.8 Task 8 - Toxicity Testing

Four types of bioassays for specific ecological niches in soil, sediments, and surface waters near the West Spray Field have been chosen to indicate whether contaminants are having a significant effect on the environment These tests will determine the toxicity of surface water to Ceriodaphnia, soil to Pogonomyrex, surface water to Pimephates, and sediments to amphipods and/or midges. Each of the tested species represents a different ecological niche present in the area surrounding the West Spray Field. The analytical parameters for toxicity testing at the West Spray Field are presented in Table 5-4

5.4 8.1 Ceriodaphnia Bioassays

Water (10 liters) for Ceriodaphnia bioassays will be collected by combining water from at least three points in the streams' cross section of each sampling station so that the composite sample is representative of average conditions across the entire stream width The water will be collected, labeled, stored, and transported to the laboratory in accordance with the protocols of EPA 600/4-85/014. The standard contractor chain of custody form will be employed. Unless scheduled water quality sampling is to be conducted on the same day that the biological samples are taken, a separate water sample will be taken in accordance with the surface water sampling procedures as specified in the project-specific SAP Ceriodaphnia bioassays will be run on water shipped to an EPA approved laboratory in accordance with Protocols of EPA 600/4-85/014.

5.4 8.2 Pogonomyrex (Harvester Ant) Bioassays

These ants are common in all arid and semi-arid habitats of the United States. They construct conspicuous nests and represent an organism that lives in intimate contact with the soil at the Rocky Flats Plant Ongoing work near waste sites at the Idaho National Engineering Laboratory indicates that body burdens of these ants can be used to evaluate the spatial distribution of contaminants in soils, the potential for carrying buried wastes to the surface, and leachates in ground water (Paul Blom, pers. comm.) In addition, harvester ants exposed in petri dishes containing soil amended with toxicants (Gano et al. 1985) and irradiated with cesium-137 gamma radiation (Gano 1981) were sensitive to certain chemicals and consistently ranked these chemicals in order of greatest toxicity to ants. Thus, ant body burdens for contaminants of interest and laboratory-based toxicity testing are test methods that are recommended for incorporation into the ecological evaluation at Rocky Flats Plant.

Composite samples soil (10 kilograms) for Pogonomyrex bioassays will be collected from each of three sites to be determined during initial site reconnaissance phase for each of the following areas

1) contaminated soil near the West Spray Fields;
2) contaminated soil downstream from the West Spray Fields; and
3) uncontaminated soil (control) from a presumably unimpacted site

The soil will be collected, labeled, stored, and transported to the laboratory in accordance with EPA protocols. The standard contractor chain of custody forms will be employed An aliquot of each composite soil sample will be taken in accordance with the project soil sampling procedures as defined in the project-specific SAP, and sent to the laboratory for measurement of contaminants of interest as determined from previous studies.

A series of phased Pogonomyrex bioassays will be run on soil in a laboratory utilizing small ant farms Depending on the results of initial bioassays, the soil may need to be diluted with uncontaminated soil to determine ant LD_{50}s. Ant body burdens for contaminants of interest will be determined as appropriate Bioassays of simulated soil with contaminants discovered at the Rocky Flats Plant added may be required to adequately define the toxicological process In-situ bioassays may also be conducted as appropriate

5.4 8.3 Sediment Toxicity Tests

ASTM is in the process of developing a "Standard Guide for Conducting Sediment Toxicity Tests with Freshwater Invertebrates" (C G. Ingersoll personal communication). These methods are referenced in "Ecological Assessment of Hazardous Waste Sites," March 1989 (EPA 600/3-89/013) as sufficiently standardized and in "sufficient widespread use to be considered ready for general use." Therefore it is proposed to conduct toxicity tests from sediments impacted by the West Spray Field using ASTM methods

Composite sediment samples (10 kilograms) will be collected from each of three sites, to be determined during the initial site reconnaissance phase:

1) Pond A-1;

2) Walnut Creek downstream from the Solar Evaporation Ponds (if feasible), and

3) Uncontaminated sediment (control) from a presumably unimpacted site.

An aliquot of each composite sediment will be saved and sent to the laboratory for analysis in accordance with the site-specific SAP

Sediment bioassays for the amphipod Hyallella azteca, a species common in the aquatic habitats at the Rocky Flats Plant and/or the midge Chirononomus riparius will be performed in a laboratory setting as per ASTM methods. Data from these bioassays will be used to assess the effects of contaminants in sediments on survival, growth, and emergence of amphipods and midges.

5.4.9 Task 9 - Critical Habitats and Endangered Species

Although ecological judgement is necessary to define some priorities, State and Federal laws and regulations designate certain types of environments such as wetlands, as requiring special consideration or protection. Critical habitats for species listed as threatened or endangered also may require protection. The importance of habitats vary from area to area, depending on such factors as:

- The species native to the area and their significance;
- The availability and quality of substitute habitats;
- The land use and management patterns in the area, and
- The value (economic, recreational, aesthetic, etc.) placed on such habitats by local residents and others.

During the implementation of Tasks 1 through 8, information will be collected regarding species present, population indexes, environmental and biological tissue contamination with xenobiotic agents, and sensitive/affected habitats. This information will be evaluated in this task, Task 9, relative to critical habitats and endangered species. If cause and effect relationships between contaminants from the West Spray Field and adverse impact on critical habitats and endangered species can be established, they will be identified in this task.

5.5 Statistical Analyses

Data collected during the ecological evaluation will be analyzed to determine whether differences are statistically significant. The statistical tests that will be used, will depend upon the comparisons being made. These will be as follows·

- Sampling designs will be based on the statistical procedures anticipated for use in data analysis. Wherever possible balanced designs and random (or systematic-random) sampling should be employed to maximize statistical power Data tests should be routinely tested for homogeneity of variance and appropriate tests used if this criterion is not met. If the assumptions of data distribution (e.g , normality) and homogeneity of variance are not met, distribution-free statistical tests may be substituted for parametric tests Independent t-tests or analysis of variance (ANOVA) will be used when the assumptions of these procedures are met.

- Comparisons between two analogous data sets, such as mean vegetation cover in the site area versus cover in the reference area, will use an independent t-test.

- Comparisons among three or more analogous data sets, such as macroinvertebrate in all of the stream segments sampled, will use an analysis variance.

- Comparisons among variable within a pooled data set, such as correlations between small mammal densities and various habitat parameters, will use a multiple regression analysis.

For t-tests and analyses of variance, difference will be defined as follows: $p < 0.01$ (99%)--highly significant, $p < 0.05$ (95%)--significant, $p < 0.10$ (90%)--approaching significance, $p > 0.10$--nonsignificant. When indicated by

ANOVA, the Tukey test on or Shiffe tests should be used to detect differences between means. Statistical tables will show means, ranges or standard deviations, p-values, and sample sizes. For multiple regression analyses, statistical tables will show r^2 (the correlation coefficient) and a notation as to whether the correlations are strong, moderate, or weak, and positive or inverse

5.6 Work Plan Elements (in-preparation)

The standard operating procedures (SOPs) for project specific activities are currently being developed by EG&G under a separate task The SOPs, upon completion and approval, will be incorporated into the project-specific SAP. The proposed analytical methods/protocol for soils, sediments, surface water, groundwater and biota are presented in Tables 5-2, 5-3, and 5-4 The required detection limits of the contaminants of concern are shown in Table 5-5

TABLE 5-1

FORMAT FOR SAP (FSP and QAPP)

FSP

1. Site Background
2 Sampling Objectives
3. Sample Location and Frequency
4 Sample Designation
5. Sampling Equipment and Procedures
6. Sample Handling and Analysis

QAPP

Title Page
Table of Contents
1. Project Description
2. Project Organization and Responsibilities
3. QA Objectives for Measurement
4. Sampling Procedures
5. Sample Custody
6. Calibration Procedures
7. Analytical Procedures
8 Data Reduction, Validation, and Reporting
9 Internal Quality Control
10. Performance and Systems Audits
11. Preventative Maintenance
12. Data Assessment Procedures
13. Corrective Actions
14 Quality Assurance Reports

TABLE 5-2
ANALYTICAL METHODS FOR SOILS AND SEDIMENTS SAMPLES

PARAMETER/ELEMENT	METHOD/PROTOCOL
• Metals	
- Lead	EPA 6010/7000 Series
- Zinc	EPA 6010/7000 Series
• Inorganics	
- Nitrate	EPA 353 2
• Radioactivity	
- Gross Alpha (for screening purposes only)	
- Gross Beta (for screening purposes only)	
(1)Uranium-^{233,234,235,238}	
(1)Americium-^{241}	
(1)Plutonium-^{239,240}	EML HASL 300
(1)Strontium-^{90}	
(1)Cesium-^{137}	
(1)Tritium	
• Physiochemical	
- Soil Description	ASTM D-1452, D-2487, D-2488
- Cation Exchange Capacity	(Black, 1985)
- Total Organic Carbon	ASTM D-2216-71
- Acidity	EPA 601/602
- Alkalinity	EPA 310.1
- Soil pH	Method 9045
- Particle Size Distribution	ASTM-D-422

(1) Additional radionuclide parameters based on elevated gross alpha and gross beta screening results

TABLE 5-3
ANALYTICAL METHODS FOR SURFACE WATER AND GROUNDWATER

PARAMETER	METHOD/PROTOCOL
• <u>Metals</u>	
- Lead	EPA 6010/7000 Series
- Zinc	EPA 6010/7000 Series
• <u>Inorganics</u>	
- Nitrate	EPA 353.2
• <u>Radioactivity</u>	
- Gross Alpha (for screening purposes only)	
- Gross Beta (for screening purposes only)	
(1)Uranium-^{233,234,235,238}	
(1)Americium-^{241}	
(1)Plutonium-^{239,240}	EML HASL 300
(1)Strontium-^{90}	
(1)Cesium-^{137}	
(1)Tritium	
• <u>Physiochemical</u>	
	EPA 160 1
- Total dissolved solids	Field pH meter
- pH	Field conductivity meter
- Conductivity	Field thermometer
- Temperature	Field dissolved O_2meter
- Dissolved Oxygen Content	EPA 314B
- Hardness	EPA 601/602
- Acidity	EPA 9060
- Total Organic Carbon	EPA 310 1
- Alkalinity	EPA 625
- Base/neutrals and acid extractable compounds	

(1) Additional radionuclide parameters based on elevated gross alpha and gross beta screening results

TABLE 5-4
ANALYTICAL METHODS FOR BIOTA SAMPLES

PARAMETER	METHOD/PROTOCOL
• Metals	
- Lead - Zinc	ASTM (Laboratory Specific)
• Inorganics	
- Nitrate	ASTM (Laboratory Specific)
• Radioactivity	
- Gross Alpha (for screening purposes only) - Gross Beta (for screening purposes only) (1)Uranium-233,234,235,238 (1)Americium-241 (1)Plutonium-239,240 (1)Strontium-90 (1)Cesium-137 (1)Tritium	Laboratory Specific

(1) Additional radionuclide parameters based on elevated gross alpha and gross beta screening results

TABLE 5-5
REQUIRED DETECTION LIMITS FOR THE CONTAMINANTS

Metals	Nominal Detection Limit Water (ug/L)	Nominal Detection Limit Soil/Biota (mg/kg)
Lead	5	1.0
Zinc	20	4.0

Inorganic	Required Detection Limits (mg/L)
Nitrate	5

Radionuclides	Required Detection Limit (MDA) Water (pCi/L)	Required Detection Limit (MDA) Soil/Biota (pCi/g)	
Gross Alpha (for screening purposes only)	2	4	(dry)
Gross Beta (for screening purposes only)	4	10	(dry)
Tritium	400	400	(pCi/ml)
Plutonium$^{239, 240}$	0.01	0.03	(dry)
Uranium$^{233,234,235, 238}$	0 6	0 3	(dry)
Americium^{241}	0 01	0 02	(dry)
Storntium^{-90}	1	1	(dry)
Cesium^{-137}	1	0.1	(dry)

6.0 WORK ORDER ORGANIZATION AND RESPONSIBILITIES

The following paragraphs describe the project organization, responsibilities of key personnel (Figure 6-1), and personnel training that will be included in the West Spray Field site Environmental Evaluation:

6.1 Organization

The project team for the investigation consists of the following key personnel.

- Project Manager
- Work Order Manager
- Project Quality Assurance Officer
- Project Corporate Safety Officer
- Field Operations Manager
- Environmental Risk Assessment Scientist
- Chemist
- Biologist
- Health Physicist
- Geologist/Hydrogeologist
- Field Sampling Personnel

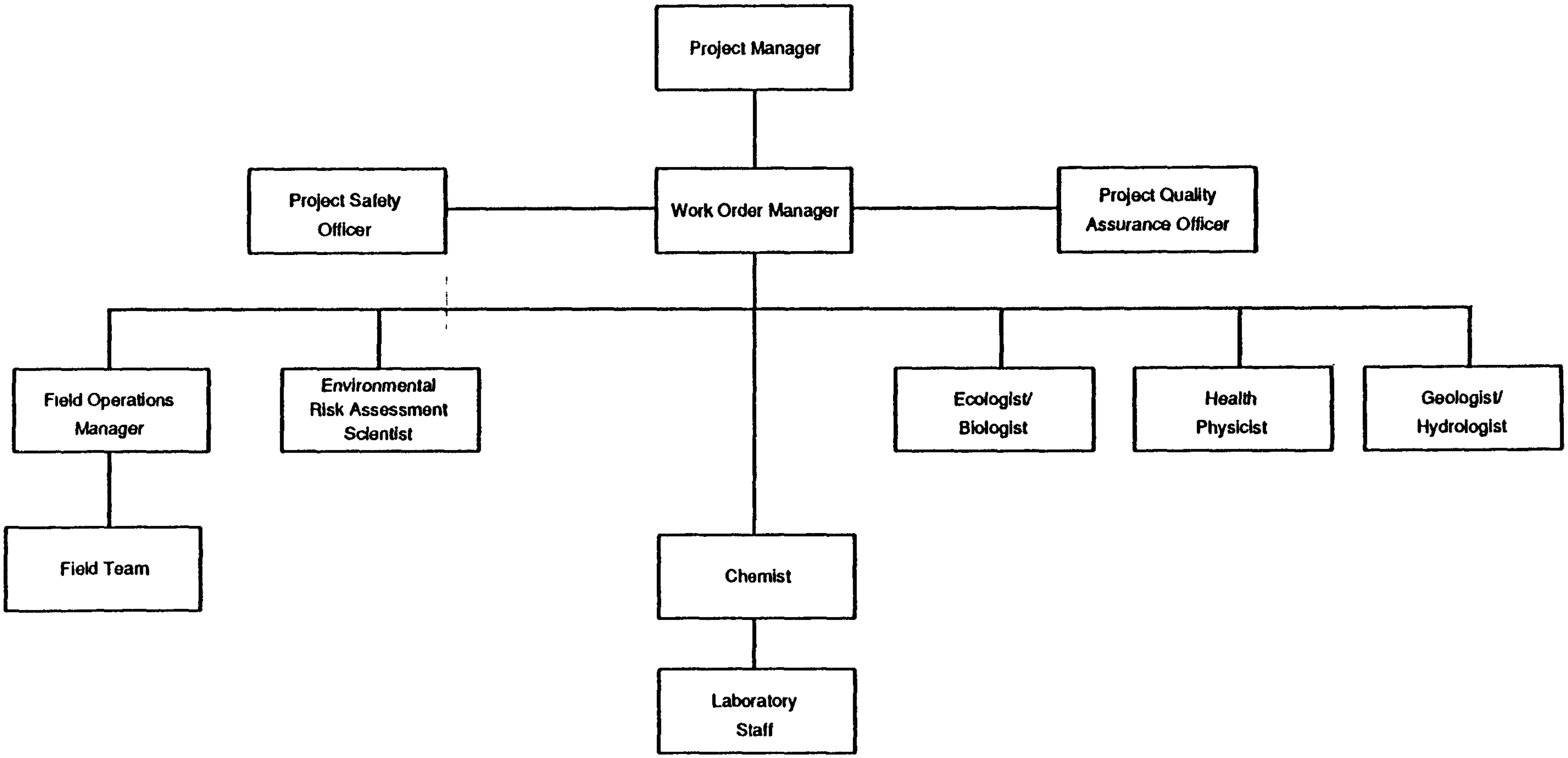
6.2 Responsibilities

Specific responsibilities of key project personnel are summarized below.

07/04/90 EE ORG2 DWG

Figure 6-1

Work Order Organization Chart for West Spray Fields Environmental Evaluation



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Project Manager: The Project Manager will monitor the project budget and schedule and ensure the availability of necessary personnel, equipment,subcontractors, and services. The Project Manager is responsible for determining the scope of effort, reviewing and evaluating findings, developing conclusions and recommendations, and reviewing reports, procedures, and controlling documents in support of Environmental Evaluation activities.

Work Order Manager: The Task Manager is responsible for directing and coordinating day-to-day performance of the technical tasks associated with Environmental Evaluation activities, including supervising preparation of workplans, implementing applicable procedures, reviewing project controlling documents, and ensuring an effective communication matrix is in place between management, quality assurance, and technical staff.

Project Quality Assurance Officer: The Quality Assurance Officer (QAO) is responsible for ensuring that all QA objectives for the project are met in accordance with applicable Quality Assurance Project Plans The QAO is also responsible for performing unannounced field surveillance of sampling and field data collection activities to ensure internal compliance with approved SOPs, for periodically reviewing analytical and field data, for compiling corrective action measures, and submitting QA progress reports

Corporate Safety Officer: The Corporate Safety Officer is responsible for supervising the preparation of, and approving, a Health and Safety Plan tailored to the specific needs of the investigation. In consultation with the Project Manager, the Corporate Safety Officer will ensure that an adequate level of personal protection from anticipated potential hazards for all field personnel is achieved.

Field Operations Manager: The Field Operations Manager is responsible for directing the work of field team members in the collection, preparation, handling, labeling, transporting, packaging, and shipping of environmental samples, and the collection of environmental measurements in accordance with the Project Quality Assurance Plans and applicable SOPs.

Environmental Risk Assessment Scientist: The Risk Assessment Scientist is responsible for oversight of the technical quality of the work and ensuring that deliverable products are developed in accordance with data quality objectives and are fit for use in risk assessments pertaining to human health and the environment.

Chemist: The Chemist has overall responsibility for laboratory technical quality, cost control, laboratory personnel management, and adherence to schedules. The Chemist is responsible for QA/QC requirements within the laboratory pertaining to sample analysis, reporting, and development of and transmission of raw data by the laboratory for environmental measurements The Chemist will serve as the primary contact for coordinating field sampling and laboratory analysis, and is responsible for ensuring that all laboratory work is performed in accordance with approved SOPs.

Ecologist/Biologist: The lead Ecologist/Biologist is responsible for supervising project ecologists/biologists and integrating technical requirements into project workplans, for interpreting results of environmental measurements and analyses, for preparing technical memoranda and reports on assigned project tasks, and for keeping the Task Manager informed of technical requirements as they relate to the project in his/her area of expertise.

Health Physicist: The Health Physicist is responsible for integrating technical requirements into project workplans, for interpreting results of environmental measurements and analyses, for preparing technical memoranda and reports on assigned project tasks, and for keeping the Task Manager informed of technical requirements as they relate to the project in his/her area of expertise

Geologist/Hydrologist: The Geologist/Hydrologist is responsible for integrating technical requirements into project workplans, for interpreting results of environmental measurements and analyses, for preparing technical memoranda and reports on assigned project tasks, and for keeping the Task Manager informed of technical requirements as they relate to the project in his/her area of expertise

6.3 Training

All personnel scheduled for field work at the West Spray Field site shall be trained in accordance with Occupational Safety and Health Administration (OSHA) Interim Final Standard 51 FR 45654, issued December 12, 1986, and shall be experienced in hazardous waste site work, use of personal protective equipment, and emergency response procedures

All personnel assigned to field work at the West Spray Field site will receive copies of the work plan, SAP, and HSP in a timely manner to allow for a sufficient review period A staff field orientation and briefing will be held prior to the initiation of site sampling to acquaint personnel with the site, assign field responsibilities, and provide training in the operation of any unusual field equipment

7.0 REPORTING

7.1 Progress Report

Monthly progress reports will be submitted to the EG&G Environmental Evaluation Manager detailing the progress of the work to date, highlighting any problems encountered, and noting any changes in scope

7.2 Environmental Evaluation Report

An initial draft Environmental Evaluation Report (EER) will be submitted upon completion of data analysis from the ecological investigation

The suggested West Spray Field EER format is presented below

Executive Summary
1.0 Introduction
1 1 Scope and Objectives of the Environmental Evaluation
1.2 Site Background
    1 2.1 Site Description
    1 2.2 Site History
    1.2.3 Previous Investigations
1 3 Report Organization
2 0 Study Area Investigation
2.1 Phase I RFI/RI
2.2 Phase II RFI/RI
3.0 Selection of Chemicals of Concern
3.1 Shallow Groundwater
3.2 Soil
3 3 Surface Water
3.4 Sediment
4.0 Exposure Assessment
5.0 Toxicity Assessment
5 1 Assessment and Measurement Endpoints
    5 1 1 Environmental Media Analysis

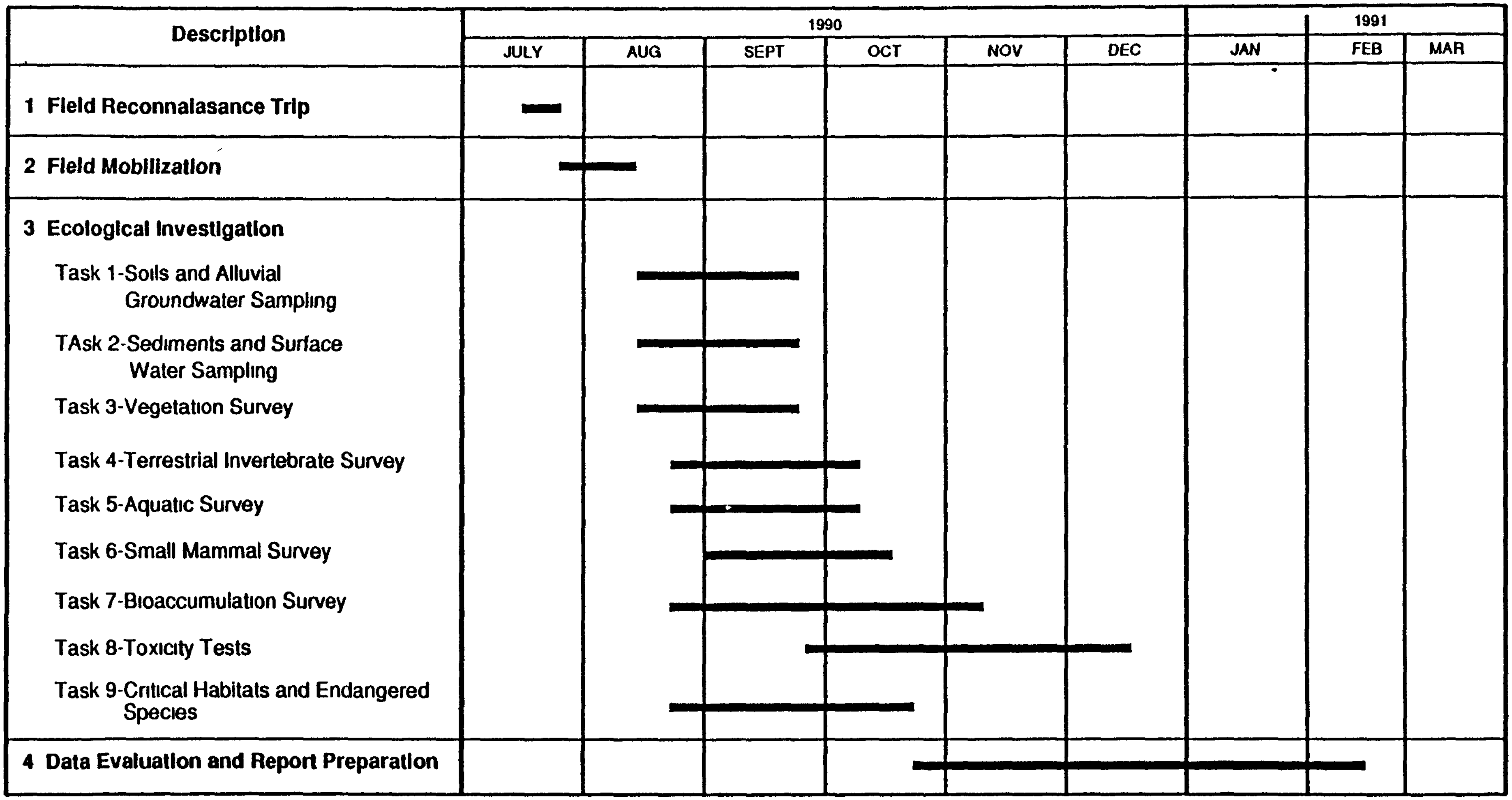
After the transmittal of the internal draft EER, there will be a review meeting with EG&G Environmental Restoration personnel and their consultants. A draft EER will then be issued addressing comments of EG&G and their consultants. Another review meeting will be held with DOE personnel. Upon incorporation of DOE comments a draft EER will then be submitted to EPA and CDH for review and comment. Comments on the draft EER will be addressed in a final EER which will be issued

8.0 SCHEDULING

Scheduling for completion of the Environmental Evaluation in shown in Figure 8-1

07/04/90 TIME SEP DWG

FIGURE 8-1
Schedule of the West Spray Fields Environmental Evaluation



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