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TECHNICAL MEMORANDUM

OPERABLE UNIT 9
PHASE I RFI/RI WORK PLAN

SECTION 9
ENVIRONMENTAL EVALUATION
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9.0 ENVIRONMENTAL EVALUATION

9.1 APPROACH

Where sufficient ecological attributes exist on an Operable Unit (OU) to justify the effort, an environmental evaluation (EE) at Rocky Flats Plant (RFP) consists of sampling and evaluation of various terrestrial and aquatic ecosystem components. Terrestrial ecosystem field sampling may be conducted for large and small mammals, birds, reptiles, amphibians, arthropods, and vegetation. Aquatic ecosystem field sampling may be conducted for periphyton, benthic macroinvertebrates, plankton, and fishes. Surface and subsurface soil characterization and surface water characterization data are obtained from remedial investigations conducted at the OU and, in some cases, from studies specified in the EE work plan for the OU.

An ecosystems approach is used to integrate the data resulting from the analysis of field and laboratory data. This approach is comprehensive in that it initially integrates all ecosystem components, then progressively focuses on aspects of the system such as populations, structure, productivity, or diversity that are potentially affected by contamination. The result is an evaluation of the nature and extent of contamination in biota, its relationship to abiotic sources, and the type and extent of adverse effects at the ecosystem, population, and community levels of biological organization.

Operable Unit 9 (OU9) is an industrial site that has been developed such that only fragmented biotic populations in non-functional ecosystems current exist in the area. Those habitat units or ecosystems that do occur are greatly reduced in size, as are their associated biotic components. Therefore, the objective of this technical memorandum is to define an OU9 EE Work Plan (EEWP) reduced in focus and scope so that its requirements are proportional to the depauperate system under consideration. As such, this modified EEWP will vary greatly from a typical EE done in an area with viable habitat or ecosystems. Because OU9 has no ecological attributes at risk within its own boundaries, ecological risk in this context is viewed as the probability for biological vector (target taxa and/or their predators) transport of potentially toxic quantities of bioaccumulating contaminants outward from OU9, either to another OU or elsewhere.

This modified EEWP replaces Section 9, Environmental Evaluation, of the Phase I RFI/RF Work Plan, becomes the work plan referenced in Section 4.2.5 of the OU9 SOW, and will consist of three components:

1) A survey for migratory bird foraging, breeding, and nesting habitat. This study will yield a Final Habitat Survey Report.

2) A survey for the presence of threatened and endangered species or their critical habitat to assure compliance with the Endangered Species Act (ESA)[50 CFR Part 402]. Only if there is habitat

suitable for these species within the industrial area will this survey yield a Final Biological Survey Report. This report will be consistent with RFP administrative and operations procedures (NEPA.12 and FO.21) for the protection of threatened, endangered and special concern species.

3) An ecotoxicological investigation to determine, in the absence of significant ecological values at OU9, the potential for biotic dispersal of contaminants from OU9 into adjacent watersheds, drainages, or operable units.

Components (1) and (2) will be accomplished during Phase I and will include the entire industrial area; component (3) will be restricted to the OU9 study area and will be delayed until Phase II when additional data on contaminants of concern (COCs) and their spatial distribution will be available. To limit needless duplication of effort, information resulting from Components (1) and (2) will be included intact in other industrial area operable unit RFI/RI documents. Because of variations in the types and concentrations of COCs throughout the industrial area, information resulting from Component (3) may be too OU-specific for general inclusion in other industrial area operable unit RFI/RI documents.

9.2 SITE DESCRIPTION

Operable Unit 9 encompasses IHSS 121, the Original Process Waste Lines (OPWL). The OPWL is a network of tanks and underground pipelines constructed to transport and temporarily store process wastes from point of origin to on-site treatment points. As currently defined, the system consists of approximately 35,000 linear feet of pipelines and 39 separate tank locations that house a total of 65 tanks.

Components of the OPWL exist in RFP areas 100, 400, 500, 600, 700, 800, and 900, the RFP Solar Evaporation Ponds, and between the Solar Ponds area and holding pond B-2 in the Walnut Creek drainage. The system was placed into operation in 1952 and additions were made to it through 1975. The OPWL system was replaced over the 1975-1983 period by an inspectable process waste system. Some tanks and pipelines from the original system were incorporated into the new process waste system or into the RFP exhaust plenum fire deluge system (DOE, 1988).

The OPWL is known to have transported or stored various aqueous process wastes containing low-level radioactive materials, nitrates, caustics, and acids. Small quantities of other liquids were also handled in the system, including pickling liquor from foundry operations, medical decontamination fluids, miscellaneous laboratory wastes, and laundry effluent. Certain process waste streams also contained metals, Volatile Organic Compounds (VOCs), oils and greases, and cleaning compounds. The composition of individual process waste streams handled by the OPWL varied widely, and some OPWL components were not exposed to all potential process waste compounds.

Considerable overlap with other operable units is expected and coordination with them for the exact extent of the OU9 study area boundaries (the "study area") will be necessary. Tentative study area boundaries follow the system of pipelines and tanks but exclude the drainages of Walnut (OU6) and Woman (OU5) Creeks (including the eastern stretch of pipeline to Pond B-2), the Solar Evaporation Ponds (OU4), and the 881 Hillside (OU1). The 700 Area (OU8), the 400 and 800 Area (OU12), and the 100 Area (OU13) are within the preliminary OU9 study area but the extent of their study boundaries are not known at this time and may be excluded when known. Note, however, that the habitat and biological surveys conducted for OU9 will cover the entire industrial area and the results made available to the investigations at the other OUs.

The entire OU9 study area has been disturbed by buildings, parking lots, roads, drainage control, grading and the placement of the pipelines and tanks themselves. Much of the pipeline area is covered by buildings and concrete (20,000 linear feet). Much of the remaining pipeline surface (15,000 linear feet) is bare ground, some is under landscape (lawns), and some areas have subsequently revegetated (mostly with weedy species) by natural invasion. Animals have become reestablished, but are generally vagrant or sporadic users of the area.

9.3 RESOURCE & HABITAT DESCRIPTION

Terrestrial and aquatic species in the RFP area have been described by several researchers[1].

1// Quick, H.F., 1964. "Survey of Mammals", in Natural History of the Boulder Area, H.G. Rodeck, ed., University of Colorado Leaflet No. 13.

Weber, W.A., Kunkel, G. and L. Schultz, 1974. "A Botanical Inventory of the Rocky Flats AEC Site, Final Report," Boulder, Colorado: University of Colorado, COO-2371-2.

Winsor, T.F., 1975. "Plutonium in the Terrestrial Environs of Rocky Flats," in Radioecology of Natural Systems in Colorado, 13th Technical Progress Report, Fort Collins, Colorado: Colorado State University, Department of Radiology and Radiation Biology.

Clark, S.V., 1977. "The Vegetation of Rocky Flats, Colorado," Masters Thesis, USERDA Contract No. E(11-1-2371), University of Colorado, Boulder.

Clark, S.V., Webber, P.J., Komarkova, V., and W.A. Weber, 1980. "Map of Mixed Prairie Grassland Vegetation, Rocky Flats, Colorado," Occasional Paper No. 35, Boulder, Colorado: Institute of Arctic and Alpine Research, University of Colorado.

Colorado Division of Wildlife, 1981. "Colorado Reptile and Amphibian Distribution Latilong Study," Second Edition, Denver, Colorado: Nongame Section.

Colorado Division of Wildlife, 1982. "Colorado Mammal Distribution Latilong

Many of these reports are summarized in the sitewide Final EIS. In addition, terrestrial and aquatic radioecology studies conducted by Colorado State University and DOE, along with annual monitoring programs at RFP, have provided information on the occurrence and relative distribution of plants and animals in the area[2]. More recent data on species distribution and abundance was obtained from the Baseline Vegetation/Wildlife Study (due for completion in April 1992) and EEs underway at OU1, OU2, and OU5 (scheduled for completion in FY92-93).

Initial site visits were conducted in the industrial area between June and September 1991 to note present site conditions, nature and extent of terrestrial and aquatic ecosystems, plant and animal species, and habitats. The study area for the EE was preliminarily defined to help scope the investigations and field sampling plan as well as to physically locate the OU9 study area in relationship to North and South Walnut Creek (OU6), Woman Creek (OU5), 881 Hillside (OU1), Solar Evaporation Ponds (OU4), and Pond B-2 (part of OU6). Other OUs within the control area have been designated but no known study areas have been delineated.

The initial site visit determined the extent of the ecosystems and habitats present on the site, and the relationship of the study area for OU9 to other OUs. The ecosystems and habitats at the OU9 study area are within the industrial portion of the plant with buildings, roads and other infrastructure to support the operations. The area has been highly altered by construction and operation of the waste lines and other surrounding buildings and facilities. There are no natural ecosystems present, although OU9 has some vegetation established by planted trees and landscaping around buildings and natural seeding (mostly weed species) and some wide ranging and hardy animals.

Study," Second Edition, Denver, Colorado: Nongame Section.

Colorado Division of Wildlife, 1982. "Colorado Bird Distribution Latilong Study," Second Edition, Denver, Colorado: Nongame Section.

2/ Johnson, J.E., Svalberg, S., and D. Paine, 1974. "Study of Plutonium in Aquatic Systems of the Rocky Flats Environs, Final Technical Report," Fort Collins, Colorado: Colorado State University, Department of Animal Sciences and Radiation and Radiation Biology.

Little, C.A., 1976. "Plutonium in a Grassland Ecosystem," Ph.D. Thesis, Colorado State University, Fort Collins, Colorado, USERDA Contract No. E(11-1-1156).

Hiatt, G.S., 1977. "Plutonium Dispersal by Mule Deer at Rocky Flats Colorado," Masters Thesis, Colorado State University, Fort Collins, Colorado, USERDA Contract No. E(11-1-1156).

Paine, D., 1980. "Plutonium in Rocky Flats Freshwater Systems," in Transuranic Elements in the Environment, W.C. Hansen, ed., U.S. Department of Energy, DOE/TIC-22800.

No systematic assessment of vegetation cover or animal species was conducted during the initial site visit. Observations were made on the vegetation present and notes on the presence or signs of animals. The following comments are based on observations taken during the initial site visit and general information from other reports. Habitats in the study area were identified in accord with SOP 5.11, Identification of Habitat Types. Habitats at OU9 and the study area are greatly influenced by the industrial site and its use and are all disturbed types. Industrial buildings and facilities (type #520) occupy the majority of the study area surface. The main habitat type outside of the industrial portion on OU9 is disturbance/barren land habitat (type #420) with a few areas of cheatgrass/weedy forbs habitat (type #410). There were no other habitat types observed during the initial site visit, with the exception of small areas of short marsh (type #020) around seeps north of the 700 buildings.

9.3.1 Terrestrial Habitat

Industrial area terrestrial ecosystems are highly modified by the industrial complex within the study area. There are only a few small areas within OU9 in the first stages of revegetation by plants and invasion by small animals. Weedy vegetation has established on open ground at places on and around the waste lines and tanks, but control and management of the area for weeds has limited plant growth. Very few arthropods and other invertebrates were observed on plants, although birds and small mammals occasionally visit the site. Ubiquitous small mammals such as deer and house mice are expected, and cottontail rabbits were observed within the area.

The weedy species found at most sites in the industrial area included: kochia (*Kochia scoparia*), yellow sweet clover (*Melilotus officinalis*), white sweet clover, (*Melilotus albus*), knot weed (*Polygonum sp.*), daisy fleabane (*Erigeron strigosus*), scorpionweed (*Phacelia heterophylla*), Russian knapweed (*Centaurea repens*), goatsbeard (*Tragopogon dubius*), woody plantain (*Plantago sp.*), Canada thistle (*Cirsium arvense*), musk thistle (*Carduus nutans*), peppergrass (*Lepidium sp.*), birdweed (*Convolvulus arvensis*), ragweed (*Ambrosia sp.*), sunflower (*Helianthus sp.*), mullein (*Verbascum thapsus*), verbena (*Verbena bracteata*), toadflax (*Linaria dammatica*), ragwort (*Senecio sp.*), dock (*Rumex sp.*), common St. John's-wort (*Hypericum performatum*), salsify (*Tragopogon dubris*), quackgrass (*Agropyron repens*), filaree (*Erodium cicutarium*), yucca (*Yucca glauca*), buffalograss (*Buchloe dactyloides*), and prickly lettuce (*Lactuca serriola*). These species often formed an ecotone between asphalt areas and better developed habitats.

Meadow sideslopes were found to contain smooth brome (*Bromus inermis*), Japanese brome (*Bromus japonicus*), redtop (*Agrostis stolonifera*), crested wheatgrass (*Agropyron cristatum*), gumweed (*Grindelia squarrosa*), Velvety Guara (*Guara parviflora*), and cottonwoods (*Populus sargentii*). Drainage bottoms contained common cattail (*Typha latifolia*) and narrow-leaved cattail (*Typha augustifolia*). A moist area near IHSS 176 contained sand bluestem (*Andropogon hallii*), sand dropseed (*Sporobolus cryptandrus*), redtop, eriogonum (*Eriogonum sp.*), red threeawn (*Aristida longiseta*), crested wheatgrass, mullein, ragwort, yellow and white

sweet clover, ragweed, thistle, and sunflower.

A dry upland area in the vicinity of IHSS 213 contained bluegrass (*Poa sp.*), needle-and-thread (*Stipa comata*), smooth brome (*Bromus inermis*), Junegrass (*Koeleria pyramidata*), foxtail (*Setaria viridis*), western wheatgrass (*Agropyron smithii*), as well as some of the more weedy species such as toadflax, mullein, allysum (*Allysum sp.*), plantago, sunflower, goatsbeard, dandelion (*Taraxacum officinale*), daisy fleabane, and geranium (*Geranium caespitosum*). A spruce tree (*Picea pungens*) had been planted near the north end of the site. Within the PPA is a dry weedy upland area surrounded by extensive grassland areas with the following species present: rush (*Juncus sp.*), foxtail, Russian knapweed (*Centaurea repens*), peppergrass, geranium, Canada bluegrass (*Poa compressa*) and *Gaillardia sp.* Plantings adjacent to several of the buildings included horticultural varieties of juniper (*Juniperus virginiana*) and spruce trees.

9.3.2 Aquatic Habitat

Extensive aquatic ecosystems are lacking within the industrial area due to its location at the head of a drainage. There are no streams or natural bodies of water that are not in overlap with those in other OUs. To the north and east are the drainages of North and South Walnut Creek; Woman Creek and the 881 Hillside are located to the south. Both these drainages have terrestrial and/or aquatic ecosystems that could be impacted by contaminants migrating from OU9. Two small marshy seeps with cattails were observed just north of the 771 and 774 buildings.

9.3.3 Biota

Plant and animal species observed and known to be present on the OU9 study area are small in numbers and diversity compared to the buffer zone. Restricted numbers of individuals and reduced diversity are a result of the large amount of surface and space occupied by the industrial facilities, bare areas, and intense management for weeds and insects. Plant species are weedy forbs and hardy grasses with no shrubs or trees, other than planted landscape trees. Animal species are those adapted to disturbed or industrially developed areas or are wide ranging and highly mobile. The higher trophic levels of consumers and predators are few, and those present are in small numbers and are occasional visitors not restricted to the ecosystems at OU9.

Flying over the industrial area, and occasionally perched on structures within it, were a number of bird species: barn swallow (*Hirundo rustica*), house finch (*Carpodacus mexicanus*), vesper swallow (Pooecetes gramineus), western meadowlark (*Strunella neglecta*), American robin (*Turdus migratorius*), western kingbird (*Tyrannus verticalis*), Say's phoebe (*Sayornis saya*), house sparrow (*Passer domesticus*), common grackle (*Quiscalus quiscula*), starling (*Sturnus vulgaris*), raven (*Corvus corax*), killdeer (*Charadrius vociferus*), common nighthawk (*Chordeiles minor*).

Bees, damselflies, dragonflies, and grasshoppers were observed in the area, as were a gartersnake (*Thamnophis sirtalis*) and desert cottontails (*Sylviladus audubonii*).

9.3.4 Wetlands

Wetlands have been identified north of OU9 on the slopes below the 700 series buildings. These occur mostly as isolated seeps that support hydrophytic vegetation species, including broad-leaf cattail (*Typha latifolia*), baltic rush (*Juncus balticus*), and various bulrushes (*Scripus spp.*). These may be evaluated by releve plots for collection of phytosociological data on density and species composition.

9.3.5 Species of Concern and Habitats

In general, use of the OU9 study area or the industrial area by species of concern is lessened due to lack of suitable habitat and/or prey. Endangered animal species potentially present in or near Rocky Flats include the black-footed ferret (*Mustela nigripes*), two subspecies of peregrine falcon (*Falco peregrinus tundris* and *F. p. tanatum*) and bald eagle (*Haliaeetus leucocephalus*).

Black-footed ferrets are not known to occur in the vicinity of Rocky Flats, although there are historical reports of their presence in the Denver area. Their critical habitat is primarily associated with colonies of their major food item, prairie dogs. There are no colonies within the OU9 study area, although two small black-tailed prairie dog colonies are located about 1500 meters northeast and 2000 meters east of OU9 and aggregate to about 10 and 5 hectares, respectively. Each contained fewer than 40 individuals. Ferrets may be associated with prairie dog colonies above a certain size; however, given the small size of these colonies, it is extremely unlikely that *M. nigripes* is present.

Bald eagles occur occasionally in the RFP area, primarily as irregular visitors during the winter or migration seasons. This eagle is primarily a winter resident around lakes and rivers, and the closest known nesting pair is located at Barr Lake, 40 km east of RFP. Although RFP lacks habitat suitable bald eagle nesting habitat, this species has been observed flying over the northeast quadrant of the buffer zone and one pair has been observed feeding regularly at Great Western Reservoir, approximately 0.9 km east of RFP. None have been observed to roost or hunt on RFP and none have been observed in proximity to OU9.

Peregrine falcons may occur as migrants. Two individuals of this species were observed at RFP in early fall: one flying from west to east near the west gate, the other perched on a powerline near Pond B-5 attempting to capture a killdeer inbound to Pond B-5. The Peregrine Falcon Recovery Plan discourages land-use practices and development which may adversely alter the character of the hunting habitat or prey base within a 10-mile radius of a nesting cliff. As there are two such cliffs within five and seven miles of RFP, the entire plant site is within the area of protection of potential foraging habitat. However, no nesting activities have been observed at RFP and no nesting or foraging activities have been observed on or in proximity to OU9. In 1991, a pair was reported as nesting approximately 10 km to the northwest of RFP. It

is possible that the hunting territory of the nesting peregrines will include Rocky Flats, although suitable habitat and prey are lacking at OU9.

Other federal candidate animal species that are potentially present at RFP include the white-faced ibis (*Plegadis chichi*), mountain plover (*Charadrius montanus*), long-billed curlew (*Numenius americanus*), Preble's meadow jumping mouse (*Zapus hudsonius preblei*), ferruginous hawk (*Buteo regalis*), Swainson's hawk (*Buteo swainsonii*), and swift fox (*Vulpes velox*).

To date, the Preble's mouse, ferruginous hawk, and Swainson's hawk have been documented at RFP. One *Z. h. preblei* was confirmed as having been captured and released in a rehabilitation habitat type transect (in OU1 at MR02A) about 200 meters south of the industrial area during the spring 1991 sampling season. Ferruginous hawks were observed adjacent to the industrial area in winter, spring, and early summer 1990-91. A juvenile male was resident in the vicinity for a six week period in early late spring and early summer 1991; nesting was not documented. This individual was observed hunting primarily in the riparian zone of Woman Creek and along the 881 Hillside, directly south of the industrial area. Most observations of this species have been in association with prairie dog colonies southeast of RFP. A pair of Swainson's hawks attempted to nest in early June 1991 in a cottonwood about 2000 meters southeast of the industrial area. The nest was abandoned for unknown reasons in early July 1991. During this period, members of the pair were not observed hunting in the vicinity of RFP, although other observations of this species have been documented infrequently but widely on the RFP site.

Only one endangered plant species, the Diluvium (or Ute) Lady's Tresses (*Spiranthes diluvialis*) is potentially present in or near Rocky Flats. Appropriate habitat for *Spiranthes diluvialis* includes wet soils in the company of a variety of mesic native and introduced grasses and forbs. Populations of the plant have been found along Clear Creek in Jefferson County to the south and near South Boulder Creek in Boulder County to the north of RFP. There are a small marshy areas around seeps adjacent to the study area that may be suitable habitat for this species. A search of these areas will have to be conducted during the flowering period (late July to late August) of this species in order to verify its presence or absence.

Other federal candidate or state species of concern plants that are potentially present at RFP include the Colorado butterfly plant (*Gaura neomexicana var. coloradensis*), forktip threeawn (*Aristida basiramea*), and Toothcup (*Rotala ramosior*). The forktip threeawn was reported along Woman Creek in 1973 and, in 1991, just south of the west access road entering Rocky Flats, growing on gravel scars bordering an old roadway, 500 meters west of the industrial area This gravel habitat can apparently support the species when other plants are absent and adequate moisture can accumulate. Given these habitat preferences, it is possible that this species will be found in the industrial area, although none have been observed there. Appropriate habitat for the Colorado butterfly plant includes the transition zone between wetland bottoms and the drier uplands associated with wet meadow habitat. The toothcup was reported in a temporary pool approximately 6 km east of Boulder. Given a lack of suitable habitat for these species in the industrial area, there is little probability that they will occur in

or near OU9.

9.4 HABITAT & BIOTA SURVEYS (RFI/RI PHASE I)

The data gathered during the initial site assessment will be expanded through the conduct of more detailed, qualitative surveys at the OU9 study area. These surveys will provide the following information:

- a more comprehensive view of the types and areal extent of habitat at OU9 and vicinity;
- a determination as to the presence or absence of migratory and raptor bird species, including waterfowl and passerine species;
- a determination as to the presence or absence of foraging, breeding, or nesting habitat for migratory and raptor bird species, including waterfowl and passerine species;
- a determination as to the presence or absence of species of special concern for which habitat exists;
- a determination as to the presence or absence of foraging, breeding, or nesting habitat for species of special concern;
- data on the species, numbers, and movement patterns of small mammals living in or near the OU9 study area, including an assessment of the presence or absence of the Preble's mouse within the industrial area;
- data on the histopathology of selected tissues from small mammals and unfledged birds living in or near the OU9 study area.

Methodologies used for ecological surveys at RFP are specified in the EG&G Environmental Management Department Standard Operating Procedures (SOP) Volume 5.0, Ecology. These SOPs have been approved for use on CERCLA/RCRA investigations by EPA, CDH, USFWS, and the Colorado Division of Wildlife (CDOW). Each Ecology SOP specifies a Master's Degree and two years of field experience as the minimum qualifications required of personnel conducting the surveys.

9.4.1 SOC Species Compliance List

A list of all of the species of concern, both federal and state, that may be present at Rocky Flats is provided in Table 1. Species which have been documented at RFP are marked with a "Y" in the "RFP" column. Species that have some probability of being present at OU9 study area due to either a sighting or the presence of suitable habitat are marked with a "Δ" in the "SITE" column; the surveys will focus on these species. Species not marked in this table have been screened from consideration at this time due to a lack of suitable habitat; some may be brought back into consideration if surveys reveal the presence of suitable habitat.

9.4.2 Literature Review

A comprehensive literature review was performed as part of the Rocky Flats baseline biological inventory program. This literature review involved surveying available pertinent documents and data to provide a synoptic background description of the wildlife and vegetation resources on the Rocky Flats site. Information extracted during this process was summarized in the form of an annotated bibliography which will be used to support interpretation of survey results.

A recent report, Threatened and Endangered Species Evaluation Report, Rocky Flats Plant Site (April 4, 1991), provides a broad picture of potential SOC species at RFP and contains a literature review for those species, which include migratory bird species. Literature searches have been performed for all of the additional species, including migratory bird species, on the SOC Species Compliance List (Table 1) and this information is included as Attachment 2 in Identification and Reporting of Threatened and Endangered and Special Concern Species, EMD Administrative Procedures Manual (3-21000-ADM), Procedure NEPA.12 (15 October 1991).

9.4.3 Expert Consultations

EG&G has discussed the potential occurrence of *Spiranthes diluvialis*, *Aristida basiramea*, *Zapus hudsonius preblei*, *Gaura neomexicana*, and other SOC species with Dr. Fred Harrington (Ebasco Environmental), who currently serves as Field Supervisor for the sitewide biological baseline studies and for the OU1 EE. In addition, EG&G has obtained the services of Dr. David Buckner (ESCO Associates) to conduct surveys specifically for *Spiranthes diluvialis* and/or its habitat. Dr. Buckner is a locally recognized expert in the life history and habitat preferences of this particular species and has done similar work for the Army Corps of Engineers and the U.S. Fish and Wildlife Service. EG&G may also call upon the services of Dr. Jim Fitzgerald, a mammalogist at the University of Northern Colorado, who can provide guidance with regards to the life history, habitat preferences, and trapping requirements of *Zapus hudsonius preblei*.

9.4.4 Ecological Field Investigations

All surveys will take place between the beginning of April and the end of September 1992 (the "study period"), to coincide with the height of the summer season when there will be the greatest probability of encountering plant and animal species using habitats on or near OU9. Surveys for *Spiranthes diluvialis* will occur between the last week of July and the end of August to coincide with the peak flowering period for this species. These investigations will cover the entire industrial area, as well as OU9, and the results obtained will be applied to the preparation of RFI/FI Pahse reports for other industrial area OUs.

9.4.4.1 habitat presence verification

Habitat types at OU9 and in the immediate vicinity were cursorily described during initial site assessments in June and September 1991, at which time four habitat types were enumerated. A

more recent Rocky Flats Vegetation Map (November 8, 1991, final draft) details a total of seven habitat types within the industrial area. A comparison of these results, along with a rough estimate of the areal extent of each habitat type, is provided in Table 2. During this study period, a more accurate assessment of the types and areal extent of habitat at OU9 and within the industrial area will be undertaken. Habitats in the study area will be identified in accord with SOP 5.11, Identification of Habitat Types. Survey results will be used to validate or correct the Rocky Flats Vegetation Map, as well as determine the extent of other survey efforts, such that:

- bird surveys (Section 9.4.4.2) will not be performed if it is not possible to verify the existence of suitable migratory bird or raptor foraging habitat within the industrial area;
- vegetation surveys (Section 9.4.4.3) will not be performed if it is not possible to verify the existence of either: (a) suitable migratory bird or raptor breeding or nesting habitat or (b) suitable species of concern habitat, or (c) specifically, suitable *Spiranthes diluvialis* habitat within the industrial area.

9.4.4.2 birds

Qualitative methods will be employed during this Phase I survey to determine bird species present, their number, their general behavior, and habitat where observed. Opportunistic observations of bird nests and raptor nests will also be recorded. Birds species in the study area will be surveyed in accord with SOP 5.7, Sampling of Birds. If initial qualitative surveys suggest that avian utilization of the industrial area is greater than might be expected, quantitative sampling methods may also be employed.

9.4.4.3 vegetation

The objectives of the vegetation survey are to assess the extent, quality, and structure of habitat available to migratory bird species. In addition, this survey program may provide data for: (a) description of site vegetation characteristics, (b) determination of impacts to plant communities, (c) identification of potential exposure pathways from contaminant releases to higher trophic-level receptors, and (d) selection of target taxa for contaminant analysis during Phase II, and (e) identification of any protected plant species or habitats. Qualitative methods will be employed during this Phase I survey to determine plant species present by community type, as well as data on abiotic features. Terrestrial and aquatic vegetation in the study area will be surveyed in accord with SOP 5.10, Sampling of Vegetation. If initial qualitative surveys suggest that terrestrial or aquatic vegetation communities in the industrial area are more complex than might be expected, quantitative sampling methods may also be employed.

Qualitative sampling will involve compiling a comprehensive species list for each community type (as identified in Section 9.4.4.1) by traversing all appropriate portions of the study area at least twice throughout the growing season, and describing abiotic features such as substrate,

topography, and soil moisture that could influence composition and structure. The relevé-method (also known as the sample-stand or species-list method) will be used since the area is too limited for cover transects (Section 6.3.1, SOP 5.10).

9.4.4.3.1 *S. diluvialis*

Directed surveys for this species will be conducted at all points near OU9 or within the industrial area where potential habitat for this species exists. These surveys will be conducted by a locally recognized expert in the life history and habitat preferences of this particular species.

9.4.4.4 mammal population characterization

During Phase I, general field surveys will be conducted to collect data on terrestrial wildlife in the OU9 study area and the industrial area. The objectives of this general work are to: (a) describe existing wildlife habitats in the area, (b) develop food web models, including contributions from vegetation, (c) identify potential contaminant pathways through trophic levels, (d) identify target taxa for collection and tissue analysis during Phase II, and (e) provide a general description of the community.

Small mammal (primarily cricetine or microtine rodents), and possibly larger mammal (cottontail rabbits), populations will be surveyed throughout the study area for their presence or absence. Small mammals in the study area will be live-trapped in accord with SOP 5.6, Sampling of Small Mammals; larger mammals in accord with SOP 5.5, Sampling of Large Mammals. Mark-recapture or other population assessment methods will be employed to gain an understanding of their population characteristics and movement patterns. This information will be used during Phase II to guide ecotoxicological sampling efforts.

9.4.4.4.1 *Z. h. preblei*

Directed surveys for this species will be conducted at all points within the industrial area where either potential habitat for this species exists or where it is possible that this species is foraging. A locally recognized expert will provide guidance with regards to the life history, habitat preferences, and trapping requirements of this species. It is anticipated that destructive trapping techniques ("Museum Specials") be required to provide a reasonable probability of capture for this species. Any destructive trapping for this species will occur only after all live trapping for the determination of popluation characteristics has been completed.

9.4.4.5 preliminary ecotoxicological investigations

The use of "Museum Special" traps during the *Z. h. preblei* survey will undoubtedly result in the inadvertent collection of specimens of other small mammal species. Any such fortuitous specimens will be either: (a) utilized to initiate histopathological investigations of selected organs and tissues in order to develop baseline pathology data or (b) appropriately preserved

for use in ecotoxicological investigations following definitization of the target analyte list (c.f., Section 9.5.1.3).

9.4.5 Reports

The products of the Phase I survey effort will be three discrete reports: (1) a Final Habitat Survey Report which will assure compliance with the MBTA and FWCA, (2) if there is habitat suitable for threatened and endangered species within the industrial area, a Final Biological Survey Report which will assure compliance with the informal consultation requirements of the ESA, and (3) a brief technical memorandum describing the outcome of the small mammal investigations.

9.4.5.1 final habitat survey report

This report will discuss the findings of the field survey work relative to the presence or absence of migratory bird or raptor species and/or the habitat required for their foraging, breeding or nesting activities. Should such species or habitat be present at OU9 or within the industrial area, an analysis of potential impacts resulting from site characterization activities will be presented. Where appropriate, the discussion will cover effects on water-related activities, wildlife benefits and losses, or possible conservation measures; concluding with a determination by DOE,RFO as to the impact of site characterization activities. Should a substantive report emerge from this Phase I effort, the information contained therein will be available for preparation of future reports analyzing potential impacts resulting from proposed site remediation activities.

9.4.5.2 final biological survey report

This report will discuss the findings of the field survey work relative to the presence or absence of compliance-listed species (Table 1) and/or the habitat required for their foraging, breeding or nesting activities. Should such species or habitat be present at OU9 or within the industrial area, an analysis of potential direct, indirect or cumulative impacts resulting from site characterization activities will be presented; concluding with a determination by DOE,RFO as to the impact of site characterization activities on compliance-listed species. The presence of a federal threatened or endangered species at OU9 or within the industrial area will also trigger the mandatory consultation process with the U.S. Fish and Wildlife Service as stipulated by 3-21000-ADM-NEPA.12, Identification and Reporting of Threatened and Endangered and Special Concern Species. Should a substantive report emerge from this Phase I effort, the information contained therein will be available for preparation of future reports analyzing potential impacts resulting from proposed site remediation activities.

9.4.5.3 small mammal population technical memo

This is intended as a brief technical memorandum describing results obtained from the small mammal live-trapping and mark-recapture survey. Information contained in this

memorandum will provide a basis for the design and/or modification of proposed Phase II ecotoxicological investigations.

9.5 ECOTOXICOLOGICAL INVESTIGATION (RFI/RI PHASE II)

It is anticipated that an ecotoxicological investigation will not be conducted until Phase II of the OU9 RFI/RI process. A narrative overview of the proposed work effort is being presented at this time to solicit constructive comments on the work scope and to permit anticipation of funding requirements.

The work scope of this ecotoxicological investigation will be significantly less than one performed in a more ecologically robust OU. A guiding assumption for OU9 is that few, if any, contaminant susceptible ecological features exist within the study area. OU9 will be treated as a potential source for contaminants, rather than as a point of impact for contaminants. Therefore, investigations proposed for OU9 will focus on determining the potential for biotic uptake and transport of contaminants from the study area into adjacent watersheds, drainages, or operable units.

9.5.1 Objectives

Investigative tasks will consist of: (a) developing a site-specific Conceptual Exposure Model to identify potential exposure pathways for on-site biota, (b) developing a site-specific Conceptual Biota Transport Model to identify potential biotic off-site transport pathways, (c) selection of biologically active COCs (target analytes), (d) selection of representative target taxa, (e) direct measurement for target analytes within target taxa, and (f) histopathological investigations of selected organs and tissues in order to develop baseline pathology data.

9.5.1.1 conceptual exposure model

A biota-specific model (Figure 1) will be used to qualitatively identify the actual or potential pathways by which various biological receptors at or near OU9 might be exposed to site related chemicals or radionuclides. It will help to focus the search for potentially impacted habitats or taxa within the study area. The model identifies the following five mandatory elements for a valid exposure pathway: (a) chemical/radionuclide source, (b) mechanism of release to the environment, (c) environmental transport medium (e.g., soil, water, air) for the released chemical/radionuclide, (d) point of potential biological contact (exposure point) with the contaminated medium, and (e) biological uptake mechanism and absorption (dose) at the point of exposure.

The airborne pathway has not been determined to be a significant source of suspended radionuclide contamination from surficial soils or surface waters on OU9. It is also unlikely that this pathway is of much importance in the transport of non-radioactive contaminants.

Surficial soil samples will be of prime importance for determining source contaminants for on-

site biota. This uppermost layer is a major source of nutrients and contaminant uptake for on-site vegetation. It is also a potential source for contaminants ingested by soil dwelling animals and invertebrates, and their predators. Soil samples from all depths are related to surface water and ground water regimes. Fluids moving through soils can leach contaminants, transport them through available flow paths, and deposit them in downgradient environments. Contamination in soil and ground water at a depth of greater than 6 meters (20 feet; maximum depth of burrowing animals and plant root penetration) will not be considered as affecting biota. Contamination at these depths may be considered if other RFI/RI studies suggest that they may reach the surface.

Surface water from OU9 flows toward North Walnut, South Walnut, and Woman Creeks. Surface water drainage and runoff is collected from buildings and roads by water collection and diversion structures (drains and ditches) that run into a series of three detention ponds along these creeks. Once impounded in these ponds, the water is treated and released. Surface water and sediment samples are collected on a regular basis as part of ongoing site-wide investigations.

Ground water generally flows to the east of OU9 in two connected ground water systems. In the surficial materials, ground water flow diverges in two directions: northeast toward North Walnut Creek and east-southeast toward South Walnut Creek. In weathered bedrock, the ground water also flows to the northeast and southeast. These flows are influenced by topography, facilities construction and grading, seasonal recharge, and the top of the bedrock. Inorganic constituents and radionuclides have been measured in the vicinity of the Solar Ponds and the 881 Hillside. The ground water has been found to contain VOCs, elevated total dissolved solids and nitrates, and some radionuclides. OU9 is one potential source for contaminants in the ground water. There is a potential for contaminants in ground water to reach vegetation in wetlands around seeps and impact the biota in this habitat.

Sediments in OU9 subject to disturbance by aquatic biota are limited to nonexistent. Therefore, with regards biota, sediments were not considered to be a viable exposure pathway and were excluded from the conceptual exposure model. This exclusion may be reversed should a preliminary report of PCB (Aroclor 1254) contamination near the PPA prove accurate or should PCB contamination be found elsewhere in the industrial area.[3]

9.5.1.2 conceptual biota transport model

The goal of a Biota Transport Model (BTM) is the prediction of contaminant loads dispersing outward in biotic vectors from an industrial OU. It will provide data on the biotic dispersal of contaminants to complement data on contaminant transport in abiotic media. BTM development must rely on a combination of information sources to establish values for the

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3/ EG&G Rocky Flats, Inc., 1991. "Assessment of Known, Suspect, or Potential Environmental Releases of Polychlorinated Biphenyls (PCBs), Preliminary Assessment/Site Description."

parameters involved. Such sources include published life history data on target taxa and associated predators, empirical data from traplines and sweeps deployed on the OU9 boundaries, immigration trapline data from adjacent OUs, and professional judgement. The following discussion outlines one form that a BTM might assume and is intended as a point of departure for further work on the development and uses of such a model.

Mark-recapture methods can be used to statistically estimate the total population (T_t, where [t] is the target taxa identifier) of a given target taxa [t] within OU9. Directly measured target analyte body burdens for a statistically representative subset of the target taxa population will allow derivation of an estimate for the contaminated share (S_{ct}) of T_t. These two data points will be used to calculate the number of target taxa with target analyte body burdens greater than background, so that:

$$C_t = (T_t)*(S_{ct}) = \text{number of contaminated target taxa [t]}$$

This calculation could be performed for a matrix of target taxa and target analytes but it would be more expedient, and perhaps just as meaningful, to treat body burden as a composite of all target analytes. C_t will then be an estimate of given target taxa with above background levels of any target analyte or combination of analytes.

A contaminated target taxa (C_t) is assumed to have one of three mutually exclusive fates: (1) retention (R_t) within OU9 and the industrial area, (2) movement (M_{ti}, where i = the OU number) to another OU either through migration or predation, or (3) movement (E_t) elsewhere than another OU; where $C_t = R_t + \sum(M_{ti}) + E_t$.

The number of taxa (M_{ti}) dispersing from OU9 to any other given OU might be estimated from the portion of their border in common with OU9, while the number of taxa (E_t) dispersing elsewhere from OU9 might be estimated from the portion of OU9 border not in common with any other OU, therefore:

$$M_{ti} = (C_t)*(B_i)$$

$$E_t = (C_t)*(B_e)$$

where B_i represents the portion of common border between OU9 and any other OUi, B_e represents the portion of common border between OU9 and elsewhere, and $\sum B_i + B_e = 1.0$.

Mark-recapture or tagging studies could be used to statistically estimate the total numbers of a given taxa ($\sum M_{ti} + E_t$) leaving OU9; values could then be proportionally assigned to M_{ti} and E_t with the remainder allocated to R_t.

As shown in Figure 2, target taxa dispersing from OU9 (either as M_{ti} or E_t) are assumed to

follow one of three mutually exclusive pathways: (1) death off-site, (2) absorption into an already extant off-site population, or (3) predation by a predator resident off-site. The share of M_{ti} or E_t entering each pathway is represented by S_d, S_a, and S_p respectively and the numbers of taxa [t] following each pathway are given by (with E_t substituted for M_{ti} as required):

$M_{tdi} = (M_{ti})*(S_d)$	number of migrants to OUi dying at OUi
$M_{tai} = (M_{ti})*(S_a)$	number of migrants to OUi entering extant populations at OUi
$M_{tpi} = (M_{ti})*(S_p)$	number of migrants to OUi consumed by predators at OUi

where $S_d + S_a + S_p = 1$.

Values for S_d, S_a, and S_p might be derived from a synthesis of published life history data, field observations, and professional judgement. Values for S_d and S_a are expected to be less than S_p (≤ 0.5). As a result, M_{tdi} and M_{tai} are not expected to be particularly large and may not be significant to the model. If empirically demonstrated, a large value for M_{tai} would allow the OUi EE to differentiate between target taxa contaminated on-site versus those contaminated elsewhere; a finding which could, in term, affect remediation strategies at OUi.

Several different predator taxa may consume target taxa available for predation (M_{tpi}) at each OUi. P_{tj} (where [j] is the predator taxa identifier) represents the proportional contribution of target taxa t to the diet of predator [j], with the number of target taxa consumed by predator [j] (N_{tj}) given by $(M_{tpi})*(P_{tj})$. Values for P_{tj} might be derived from a synthesis of published life history data, field observations, and professional judgement.

This biota source model is essentially a mass balance model displaying the property that, within limits imposed by any statistical methods employed, numbers of a given taxa distributed to each pathway within an OU should equate to total numbers of that taxa entering the OU so that:

$$M_{ti} - \{\Sigma N_{tj} + M_{tai} + M_{tdi}\} \approx 0$$

and for all dispersal pathways from OU9:

$$C_t - \{\Sigma M_{ti} + E_t + R_t\} \approx 0$$

This is a simple mass balance budget model wherein "leaks" (unidentified dispersal pathways or sinks) are identified when variances between the above values do not approach 0 (again given the limits imposed by any statistical methods employed).

Thus far, all calculations have involved movement and fate of numbers of contaminated target

taxa without reference to contaminant concentrations in such taxa. Estimation of contaminant quantities dispersing from OU9 requires a method for calculating these quantities at the end of each pathway. One rough approach would use directly measured target analyte body burdens from a statistically representative subset of the target taxa population, along with an assumption that contaminant loads are equally distributed, to derive average contaminant load (L_t) in each member of a population (C_t) of contaminated target taxa [t]. Combining contaminant load values and pathway numbers yields an estimate for loads present in taxa [t] at the end of each pathway, (with E_t substituted for M_{ti} as required) so that:

$Q_{dti} = (M_{tdi})*((L_t)*(K_c))$ Q in dead taxa [t] at OUi

$Q_{ati} = (M_{tai})*(L_t)$ Q in assimilated taxa [t] at OUi

$Q_{pti} = (\Sigma N_{tj})*(L_t)$ Q in predated taxa [t] at OUi

K_c is an estimate for the bioavailable fraction of contaminant released by decomposition. Empirical values for K_c could be ascertained but such an effort might not be justified in the absence of high contaminant levels.

This BTM, or some more sophisticated variation of the concept it embodies, could be used to estimate biotic transport of contaminants from an OU, as an adjunct to abiotic transport data. Development and validation of any BTM will be unnecessary if two specific conditions cannot be met at OU9: (1) bioaccumulating target analytes are found in target taxa at above background levels and (2) life history and/or ecological data demonstrate that these taxa can or do move beyond OU9 boundaries.

9.5.1.3 COCs (target analytes)

A preliminary list of COCs was prepared (Table 3) based on information on contaminants presented in Section 2.0 and on Sunday's report (Appendix C, Document C-2), both in the main Operable Unit 9 RFI/RI Work Plan. The list is preliminary because of the unavailability of quantitative data on COCs when this work plan was prepared.

A complete list of COCs will be prepared following Phase I based on criteria in three general categories: (1) documentation of COC occurrence in environmental media, (2) ecotoxicity of the material, and (3) spatial extent of contamination at the site. Given the depauperate nature of the biota communities present in the industrial area, the disparate nature of the taxa present, and the limited character of the food webs present, target analyte selection criteria have been limited to the following (which vary slightly from criteria employed at more ecologically robust OUs):

1) Occurrence: the known or suspected occurrence of a chemical in environmental media will be ascertained from: existing data

regarding abiotic media (soil, water, air), biota, waste stream identification and disposal practices, process analyses to identify potentially hazardous substances used in large quantities, or historical accounts of use or accidental release.

2) Ecotoxicity: a chemical will be considered for inclusion on the list of target analytes if, at levels detected within the OU, it is known to exhibit: bioaccumulation; or significant BCFs (>0.03 for terrestrial species; >300 for aquatic species); or adherence to skin or fur; or accumulation in lung tissue.

3) Extent of Contamination: a chemical will be considered for inclusion on the list of target analytes if it: is widely distributed; or occurs in ecologically sensitive areas such as wetlands or seeps which may serve as a drinking water source for wildlife; or occurs in localized areas of high concentration ("hot spots").

9.5.1.4 target taxa

Given the depauperate nature of the biota communities present in the industrial area, the disparate nature of the taxa present, and the limited character of the food webs present, target taxa selection criteria have been limited to the following (which vary slightly from criteria employed at more ecologically robust OUs):

- have a reasonable home range within or near the industrial area and,
- be present in sufficient numbers (or sizes) to allow collection of sufficient biomass for tissue analysis and,
- not be a threatened, endangered, or special concern species (c.f., Table 1) and,
- display morphological anomolies or,
- have a reasonable probability (based on published information, results from RFI/RI Phase I surveys, or results from EE work at other OUs) of having a target analyte or analytes present in its tissues or,
- have a reasonable probability (based on published information, results from RFI/RI Phase I surveys, or results from EE work at other OUs) of displaying an aberrant histopathology due to contaminant exposure.

All habitats extant in the industrial area are disturbed, small, and limited in the number of taxa and trophic levels present. The most likely terrestrial food chains are: (a) weedy vegetation => small mammals or small birds, (b) weedy vegetation => insects => small mammals or small birds, (c) weedy vegetation => small mammals or small birds => predator,

or (d) weedy vegetation => insects => small mammals or small birds => predator. Aquatic habitats are also extremely limited and are likely to contribute only insect taxa with aquatic life stages to a food web. Winged adult forms of these insects will enter terrestrial food chains as indicated in (b) and (d) above.

Taking into consideration the above selection criteria and food web structure within the industrial area, target taxa for use in ecotoxicological investigations will be limited to small mammals (mice and voles), large mammals (cottontail rabbits) and small birds (eggs or unfledged nestlings). In RFI/RI Phase II, all taxa will be sampled by destructive techniques in order to supply tissue samples for contaminant concentration mesurements and histopathological preparations.

Small mammals are primarily species of rodents in the following families: Cricetidae [New World rats and mice], Muridae [Old World rats and mice], Heteromyidae [pocket mice and kangaroo rats], and Zapodidae [jumping mice]. In a broader sense, the term is also applied to Soricidae [shrews], Geomyidae [gophers], and Sciuridae [smaller ground squirrels]. Small mammals are an important component of ecological investigations and contaminant pathways analyses, because they: (a) are generally abundant and easily captured, (b) occupy small home ranges and thus reflect habitat quality or contamination of a specific area, (c) live in intimate contact with the soil and thus are maximally exposed to surficial contaminants, (d) include species with a wide range of diets, including leafy tissue, seeds, and invertebrates, and (e) are a primary prey component for a variety of predators, including weasels, foxes, coyotes, owls, hawks, kestrels, and snakes.

Large mammals, for the purposes of this study, are defined as all mammals other than bats that are not subject to sampling under the small mammal live trapping program. The taxa of interest here are Lagomorphs [rabbits and hares], particularly cottontail rabbits which have been observed in the study area.

Perching birds (Passeriformes) are the major taxonomic group of birds occurring within the industrial area at RFP. Bird abundance and richness are good indicators of habitat quality, including factors such as the availability of food, cover, and nesting sites. Avian communities may be impacted by exposure to environmental contaminants, either directly through contact with hazardous materials or indirectly via contaminant transport in the food web. Perching birds (including "songbirds") are the most appropriate group for ecotoxicological investigations due to their greater numbers, wider distributions, and smaller home ranges than larger species. They also exhibit more intimate contact with the industrial area environment and greater home range fidelity than do migrant species.

Although final selection of target taxa will be deferred until completion of the Phase I habitat and biota surveys (c.f., Section 9.4), a preliminary list (Table 4) of target taxa have been selected based on the criteria of being important to the structure and function of the food webs present on the industrial area.

Deer, coyotes, fox (other large mammals possibly present in the study area), raptors, and migratory birds will have only occasional contact with the study area due to their high mobility and therefore sampling of these taxa is unlikely. Amphibians are also unlikely to be sampled largely due to a lack of habitat suitable for these taxa. Habitat exists for certain reptiles, but these taxa may not be present in sufficient numbers to allow or justify destructive sampling.

9.5.2 Field Sampling

Objectives of the Phase II field sampling program are to: (a) collect tissue samples for measurement of target analyte concentrations in terrestrial organisms, (b) collect site specific data on biota and important abiotic parameters, (c) collect tissue samples to support histopathological investigations, (d) provide data for verification and validation of the conceptual models. As indicated in Section 9.5.1.4 ("Target Taxa"), terrestrial sampling will be limited to small mammals (mice and voles), large mammals (cottontail rabbits) and birds.

9.5.2.1 mammals

Small mammals will be collected using the live trapping techniques described in SOP 5.6. Trap grids or lines (size and shape to be field determined) will be set for four consecutive nights in the spring (April-May) and early fall (September-October), providing the population will support this intensity. A trapping strategy and technique will have to be developed for the collection of cottontail rabbits.

To collect individuals for tissue analysis, each individual of the designated target taxon will be randomly assigned to a particular analytical suite. Collection will continue until all of the required sample quantity is obtained. If composite samples are required, each individual will be randomly assigned to a sample, and collection will continue until six samples of the appropriate quantity are obtained. If multiple trap-nights are required to obtain adequate sample quantity, individuals will be frozen as soon as possible, but no later than four hours after collection. Only adult males and non-lactating females will be collected for tissue analysis.

Animals collected for tissue analysis will be sacrificed by placing them in a sealed container with Metafane-saturated cotton, by induced hypothermia, or by cervical separation. The dead animal will be placed in a glass sample container in a cooler with Blue® or dry ice for no more than four hours. After four hours, samples must be immediately shipped to the analytical laboratory or placed in a freezer overnight or until shipped. Labeling, handling, and shipping of small or large mammals for laboratory analysis should be generally consistent with SOP 1.13. Samples collected for tissue analysis must follow the sample preparation and packaging specified by the laboratory protocols for the target analytes.

QA/QC will follow procedures defined in SOP 5.0. Any variance from the SOP will be described and an explanation provided. QA/QC for tissue sample collection should be accomplished by

collection of co-located duplicates according to the QAPjP. Samples collected for tissue analysis will follow the preparation and packaging procedures specified in laboratory protocols for the target analytes and should be generally consistent with SOP 1.13. Special attention will be given to minimizing chance of harm to animals not intended for tissue analysis and to avoid injury to workers from animal bites or scratches.

9.5.2.2 birds

Eggs and un-fledged nestlings will be collected from established nests using manual or net tchniques in the spring (April-May), providing the breeding population will support this intensity.

To collect individuals for tissue analysis, each individual of the designated target taxon will be randomly assigned to a particular analytical suite. Collection will continue until all of the required sample quantity is obtained. If composite samples are required, each individual will be randomly assigned to a sample, and collection will continue until six samples of the appropriate quantity are obtained. If multiple nest visits are required to obtain adequate sample quantity, individuals will be frozen as soon as possible, but no later than four hours after collection. Only eggs and un-fledged nestlings will be collected for tissue analysis.

Un-fledged nestlings collected for tissue analysis will be sacrificed by placing them in a sealed container with Metafane-saturated cotton, by induced hypothermia, or by cervical separation. The dead animal or egg will be placed in a glass sample container in a cooler with Blue® or dry ice for no more than four hours. After four hours, the samples must be immediately shipped to the analytical laboratory or placed in a freezer overnight or until shipped. Labeling, handling, and shipping of birds for laboratory analysis should be generally consistent with SOP 1.13. Samples collected for tissue analysis must follow the sample preparation and packaging specified by the laboratory protocols for the target analytes.

Un-fledged nestlings collected for histopathological examination will be sacrificed by placing them in a sealed container with Metafane-saturated cotton, by induced hypothermia, or by cervical separation. The dead animal or egg will then undergo initial processing the field, in accord with procedures provided by the histopathology laboratory, to timely gross preservation of tissues. Preserved samples will be shipped to the histopathology laboratory within 24 hours of collection.

QA/QC will follow procedures defined in SOP 5.0. Any variance from the SOP will be described and an explanation provided. QA/QC for tissue sample collection should be accomplished by collection of co-located duplicates according to the QAPjP. Samples collected for tissue analysis will follow the preparation and packaging procedures specified in laboratory protocols for the target analytes and should be generally consistent with SOP 1.13. Special attention will be given to minimizing chance of harm to animals not intended for tissue analysis and to avoid injury to workers from animal bites or scratches.

9.5.3 Laboratory Analysis

Tissues samples collected for target analyte analysis will be processed in accord with EG&G SOPs and/or recognized laboratory practices appropriate to the type of tissue and target analyte involved. Analysis of tissue contaminant concentrations will provide direct proof that target taxa carry a body burden of target analytes, as well as a measure of the relationship between environmental concentrations and target taxa contaminant loads.

Histopathological tissue samples will be processed for light microscopic examination in accord with EG&G SOPs and/or recognized laboratory practices appropriate to the type of tissue or organ involved. Consideration should be given to staining techniques that are differentially sensitive to various target analytes or are discriminant for a particular suspected pathologic feature.

9.5.4 Ecological Risk Assessment

Because the industrial area is known to have no ecological attributes at risk within its own boundaries, ecological risk in this context is viewed as the probability for biological vector (target taxa and/or their predators) transport of potentially toxic quantities of bioaccumulating contaminants outward from an industrial area OU, either to another OU or elsewhere. Therefore, unlike more typical ecological risk assessments, an assessment for OU9 will address the following chain of logic:

(a) are target analytes accumulating or concentrating in target taxa at levels that may pose a threat either to that target taxa or their prey species?

<u>if yes, then</u>

(b) are the contaminated target taxa capable of migration beyond the study or industrial area boundaries?

<u>or</u>

(c) are contaminated target taxa (if any) prey for highly mobile species that move beyond the study or industrial area boundaries?

<u>else</u>

(d) there is presumed to be no risk of contamination of off-site biota by target taxa inhabiting the industrial area.

If conditions (a) and [(b) or (c)] are fulfilled, the conceptual biota transport model will be populated with measured target analyte concentration values. Quantitative estimates of off-site transport masses may be calculated by converting the conceptual model into a logic diagram and assigning probabilities to the steps in the model. These quantitative estimates will be made available to EEs being conducted at adjacent OUs to serve as input source terms for contaminants reaching these other OUs via the biota.

9.5.4.1 remediation criteria

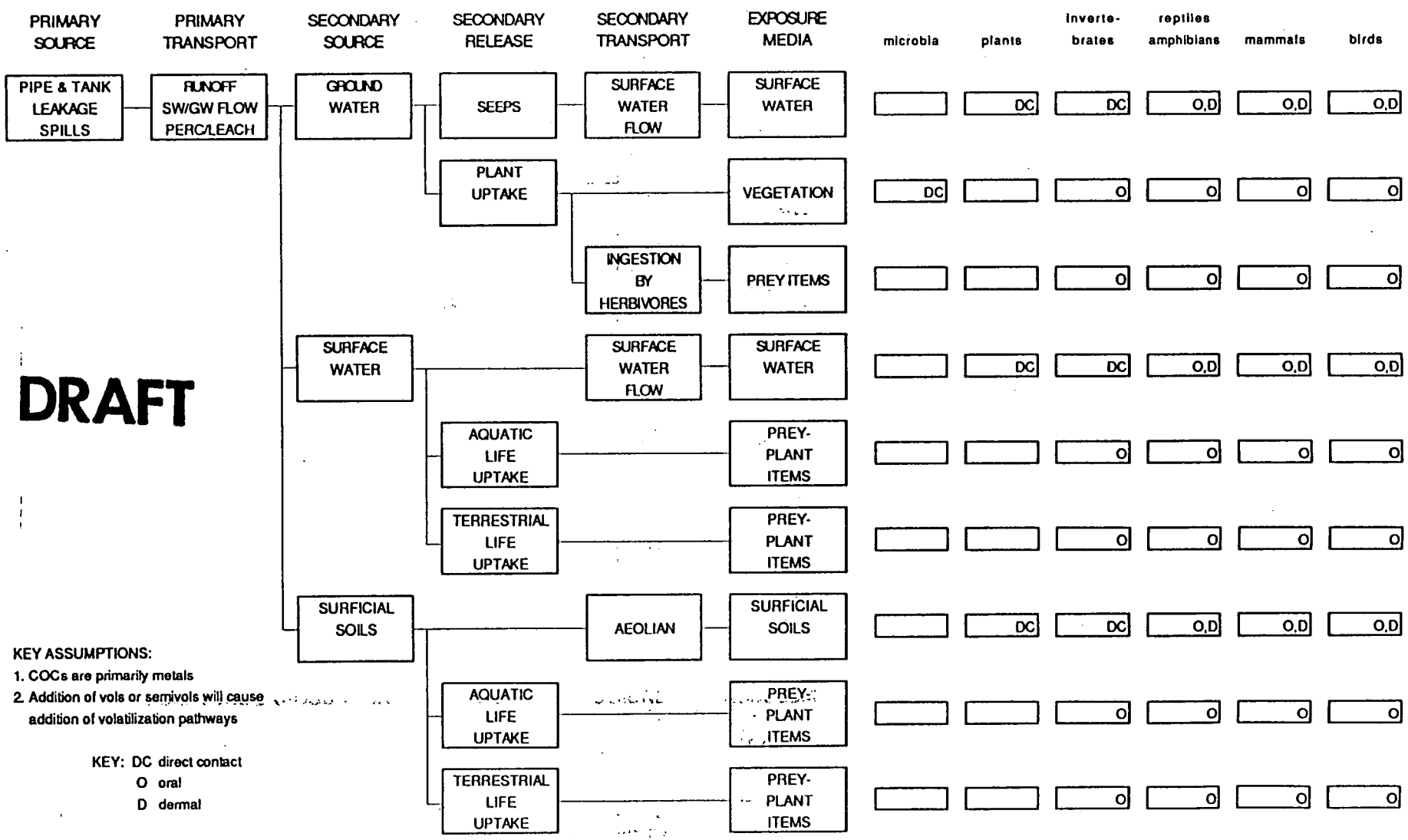
Remediation criteria will be developed for contaminants for which a significant probability of transport is detected or for which a significant risk exists. Criteria will address remediation of the contaminant source so that remaining environmental concentrations and forms do not pose a threat to target taxa or other ecological receptors. "Acceptable" environmental concentrations will be estimated using exposure assessments to calculate contaminant concentrations in abiotic media below which ecotoxicological effects are not expected to occur. The acceptable (no effects) criteria levels will be used in conjunction with ARARs to evaluate potential adverse effects on biota as appropriate for the EE portion of the Phase II RFI/RI. This approach will be integrated with the baseline human health risk assessment process and will assist in development of potential remediation criteria.

9.5.4.2 operable unit coordination

Work at OU9 will be coordinated with the human health risk assessment for OU9, adjacent off-site OUs, and the site characterization studies for contaminants in abiotic environmental media. Potential sample sites for biota and contaminants will be coordinated with the field sampling plan for soil, water, and sediments at OU9, and the field sampling plan will be tied into those for the 881 Hillside (OU1), Solar Ponds (OU4), OU2, and Walnut and Woman Creeks (OU5 and OU6 respectively) to avoid duplication. The COCs selected for the OU9 EE will suggest similar surveys, measurements, and sample collections on adjacent OUs. Information developed on other OUs will be compared with information developed on OU9.

There is an, as yet, not fully understood potential for groundwater, surface water, sediments, and surficial soils to be transported from the OU9 and the industrial area to the Woman Creek (OU5) or Walnut Creek (OU6) drainages. Should this occur, there may be potential impacts to biota outside of OU9. This potential for transport by groundwater, surface water, sediments, and surficial soils will be fully evaluated during the Phase II RFI/RI process.

FIGURE 1 - CONCEPTUAL EXPOSURE MODEL FOR OU 9 ECOLOGICAL RISK ASSESSMENT



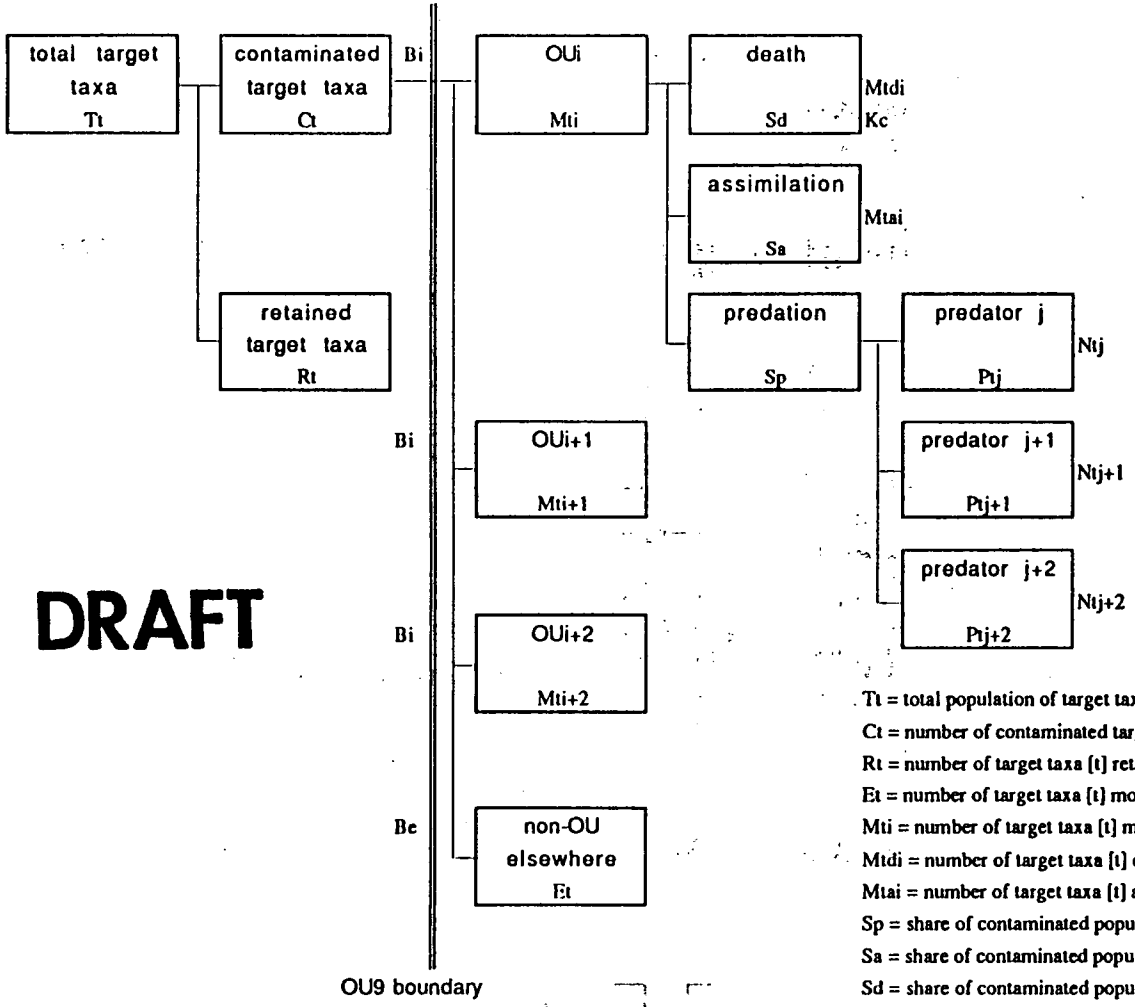
DRAFT

KEY ASSUMPTIONS:

1. COCs are primarily metals
2. Addition of vols or semivols will cause addition of volatilization pathways

KEY: DC direct contact
O oral
D dermal

FIGURE 2 - CONCEPTUAL BIOTA TRANSPORT MODEL FOR OU9 ECOLOGICAL RISK ASSESSMENT



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Tt = total population of target taxa [t]
Ct = number of contaminated target taxa [t]
Rt = number of target taxa [t] retained on OU9
Et = number of target taxa [t] moving eleswhere than OUi
Mti = number of target taxa [t] moving to OUi
Mtdi = number of target taxa [t] dying at OUi
Mtai = number of target taxa [t] assimilated at OUi
Sp = share of contaminated population subject to predation
Sa = share of contaminated population subject to assimilation
Sd = share of contaminated population subject to death
Ptj = portion of predator [j] diet formed by members of target taxa [t]
Ntj = number of predator [j] diet formed by members of target taxa [t]
Kc = portion of bioavailable contaminant released by decomposition
Bi = portion of OU9 boundary in common with OUi
Be = portion of OU9 boundary in common with elsewhere

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TABLE 1	SOC SPECIES COMPLIANCE LIST & HABITAT PREFERENCE						10-Mar-92
GROUP	COMMON NAME	SCIENTIFIC NAME	STATUS	RFP	SITE	HABITAT	TIME
PLANTS	Forktip Threeawn	*Aristida basiramea*	cs	Y	Δ	xeric uplands with sandy soils and open barrens	year-round blooms ?
	Colorado Butterfly Plant	*Gaura neomexicana var. coloradensis*	C2,cs			transition between wetland bottoms and drier uplands above wet meadows	year-round blooms Jul-Sep
	Toothcup	*Rotala ramosior*	cs			obligate wetland species	year-round blooms?
	Diluvium Lady's Tresses	*Spiranthes diluvialis*	E,cs		Δ	moist swales dominated by grasses, wetlands dominated by sedges, rushes, and cattails	year-round blooms late Jul - Aug
AMPHIBIANS & REPTILES	Northern Leopard Frog	*Rana pipens spp.*	C2,cu	Y?		breeds in marshes and intermittant ponds, forages in riparian and mountain cadows	year-round breeds Mar-Jun
	Texas Horned Lizard	*Phrynosoma cornutum*	C2,ng			arid and semiarid open country, xeric uplands	year-round forage in sm
FISH	Plains Topminnow	*Fundulus sciadicus*	C2			streams, lakes	year-round spawn sp & esm
	Common Shiner	*Notropis cornutus*	cs			streams, lakes	year-round spawn sp & esm
BIRDS	Peregrine Falcon	*Falco peregrinus*	E,e	Y	Δ	nest in cliffs, forage in upland and wetland areas	year-round sp & fl
	Bald Eagle	*Haliaeetus leucocephalus*	E,e	Y		perch trees near body of water, riparian areas, or wetlands	year-round sp & fl
	White-faced Ibis	*Plegadis chichi*	C2,ng			near streams, meadows, ponds, and agricultural fields	migrant sp, esm, fl
	Ferruginous Hawk	*Buteo regalis*	C2,ng,cs	Y	Δ	breeds in shortgrass prairie, croplands, mtn meadows, parks	year-round
	Whooping Crane	*Grus americana*	E,e			forages in marshes, cropland (grain fields), and sagebrush	migrant sp & fl
	Harlequin Duck	*Histrionicus histrionicus*	C2			open water	migrant sp & fl
	Western Snowy Plover	*Charadrius alexandrius nivosus*	C2,ng,cs			prefers lakes & reservoirs	migrant sp & fl
	Mountain Plover	*Charadrius montanus*	C2,ng,cs			xeric upland, shortgrass prairie	breeds esp-fl
	Piping Plover	*Charadrius melodus*	T,t			forages on open water or wet open ground	migrant sp & fl
	Long-billed Curlew	*Numenius americanus*	C3,ng,cs			grassland, lakes, reservoirs or marshes.	migrant sp & fl
	Least Tern	*Sterna antillarum*	E,e			forages on open water or wet open ground	migrant sp & fl
	Black Tern	*Chlidonias niger*	C2,ng			breeds in marshes, uses marshes and open water for migration	breeds esp-sm migrates sp & fl
	Swainson's Hawk	*Buteo swansonii*	C3C,ng	Y	Δ	nests in trees/shrubs, forages in grassland, ag land, riparian areas, and greasewood	year-round breeds lwn-sp
	Yellow-billed Cuckoo	*Coccyzus americanus*	C3B,cu,ng			riparian lowland, transition areas	breeds sp migrates sp & fl
MAMMALS	Swift Fox	*Vulpes velox*	C2,cu			shortgrass prairie, arid areas with loose soils	year-round breeds wn
	Black-footed Ferret	*Mustela nigripes*	E,e			prairie dog colonies	year-round
	Preibles Meadow Jumping Mouse	*Zapus hudsonius preblei*	C2,cs	Y	Δ	moist fields, brush, brushy field, marsh, thick veg woods	breeds lsp-esm forage sp & sm
	Fringed Myotis	*Myotis thysanodes*	C2,ng			old buildings	breeds sp forage sm

STATUS:
(E) endangered species (federal)
(T) threatened species (federal)
(P) proposed to list (federal)
(e) endangered species (state)
(C1) Federal Category 1 (propose to list)
(C2) Federal Category 2 (appropriate to list but no data)
(C3) Federal Category 3 (formerly proposed)
(t) threatened species (state)
(ng) Colorado State nongame species
(cs) Colorado State species of concern
(cu) Colorado State undetermined species

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TABLE 2 - IDENTIFIED INDUSTRIAL AREA HABITAT TYPES			
HABITAT TYPE	HAB CODE	ESTIMATED AREAL EXTENT	
		Sep-91	Nov-91
short marsh	020	1%	
tall marsh	030		1%
pond/impoundment	040		6%
tree plantings	130		1%
mesic mixed grassland	322		1%
xeric mixed grassland	323		1%
reclaimed grassland	324		20%
cheatgrass/weedy forbs	410	4%	
disturbed/barren land	420	10%	
buildings/structures	520	85%	70%
		100%	100%

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TABLE 3 - POTENTIAL TARGET ANALYTES	
primary expected constituents	uranium-238 uranium-235 plutonium chromium(VI) PCBs
secondary expected constituents	chromium beryllium iodine tritium

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TABLE 4 - POTENTIAL TARGET TAXA		
CATEGORY	TAXON	
	COMMON NAME	SCIENTIFIC NAME
small mammals		
	deer mouse	*Peromyscus maniculatus*
	house mouse	*Mus musculus*
	meadow vole	*Microtus pennsylvanicus*
large mammals		
	desert cottontail	*Sylvilagus audubonii*
birds (eggs & un-fledged nestlings)		
	house finch	*Caprodacus mexicanus*
	house sparrow	*Passer domesticus*
	American robin	*Turdus migratorius*