GUIDANCE FOR ECOLOGICAL RISK ASSESSMENT AT HAZARDOUS WASTE SITES AND PERMITTED FACILITIES

PART B: SCOPING ASSESSMENT

State of California
California Environmental Protection Agency

Department of Toxic Substances Control
Human and Ecological Risk Division

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PREFACE

The Department of Toxic Substances Control (DTSC), within the California Environmental Protection Agency has the responsibility of managing the State's hazardous waste program to protect public health and the environment. The Human and Ecological Risk Division provides scientific assistance in the areas of toxicology, risk and environmental assessment, training, and guidance to the regional offices within DTSC. Part of this assistance and guidance is the preparation of scientific guidelines, and recommended procedures for use by regional staff, local governmental agencies, or responsible parties and their contractors in hazardous waste site mitigation. This document is one of a series of DTSC guidelines for the investigation, monitoring, and remediation of hazardous waste sites and facilities. It presents a general framework for conducting ecological risk assessments. More detailed guidance relating to specific aspects of ecological risk assessment will be developed as information becomes available.

The procedures and suggested approaches set forth here are intended solely as guidance to DTSC and other government employees and contractors. This guidance does not constitute rule making by DTSC and should not be interpreted as an enforceable standard.

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We thank the U.S. Navy for graciously agreeing to allow use of the conceptual site model diagram (Figure 2) from a site currently under investigation and Ms. Sabrina Russo in the San Francisco office of PRC Environmental Management, Inc. who originally developed the evaluation criteria matrix for representative species (Example Table 4).

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1.0 Introduction

The initial scoping assessment of potential ecological risk related to a hazardous substance release site is meant to determine the potential ecological receptors, the potential contaminants of concern and the potentially complete exposure pathways. Completion of a scoping assessment relies on the professional judgment of the investigator to qualitatively evaluate the potential threat to non-human receptors posed by potential contaminants and site-specific activities.

It cannot be assumed that the human health screening evaluation provides an estimate of the threat to biota. Ecological receptors are frequently more sensitive to adverse contaminant-induced effects than humans. In addition, many terrestrial organisms, may be exposed to higher concentrations of contaminants than humans. Burrowing animals, such as rodents or burrowing owls, would typically be exposed to higher concentrations of soil gases than humans.

The term ‘biota’ generally refers to non-domesticated terrestrial and aquatic plants and animals, but may include domesticated species, such as livestock. The scoping assessment uses a habitat approach as the basis for identifying the potentially complete exposure pathways between the areas of contamination and specific species or habitats which occupy, or potentially could occupy, the site. A list of the potentially exposed receptors and potentially complete exposure pathways in a scoping assessment report is useful in deciding whether additional assessment is required or whether the site poses minimal threat to ecological receptors.

The basis for the scoping assessment guidance is the Department of Toxic Substances Preliminary Endangerment Assessment (PEA) Manual (DTSC, 1994). Assessments completed prior to the release of this Scoping Assessment Guidance, using the approach outlined in the PEA Manual are viewed as equivalent to a Scoping Assessment report.

2.0 Identification of Potential Contaminants of Concern

It is important to recognize that the identification of contaminants of potential concern to ecological receptors may necessitate a separate identification process from any human health screening evaluation, since a chemical not generally considered a threat to human health may be a potential chemical of concern for biota. . For example, the chronic ambient water quality criteria (AWQC) for copper is 6.5 ug/l while the maximum contaminant level goal (MCLG) for drinking water is 1300 ug/l. The chronic AWQC for zinc is 1.1 ug/l while the secondary maximum contaminant level (SMCL) for drinking water is 5000 ug/l (U. S. EPA IRIS2, 1995). In contrast to aquatic organisms, individual exposure pathways for terrestrial organisms can be more easily evaluated. It is, therefore, difficult to offer similar media-specific comparisons for terrestrial organisms because toxicity can differ significantly depending on the route of exposure. However, for

example, organophosphate pesticides such as diazinon (Eisler, 1986), carbamate pesticides such as carbofuran (Eisler, 1985), organochlorine pesticides such as mirex (Eisler, 1985), herbicides such as atrazine (Eisler, 1989), and polychlorinated biphenyls (PCBs) (Eisler, 1986) may be of concern for terrestrial organisms at lower concentrations than for humans. We recommend that complete justification be provided in the text for inclusion or exclusion of potential contaminants of concern. Physical parameters such as water solubility, volatility and persistence should be specified in addition to the toxicity of potential degradation products and the potential for bioaccumluation.

The list of potential contaminants of concern may be developed based either on site-specific history of use or laboratory testing of environmental media. The history of site-specific use is more typically the source of potential contaminants of concern in the scoping assessment phase of work. Where laboratory analytical results are available, the method detection limits should be compared to ecological effect concentrations or Applicable or Relevant and Appropriate Criteria (ARARs) to determine whether the laboratory detection limits were sufficiently low to allow selection of contaminants of ecological concern. For example, detection limits in water should be compared against Federal AWQC or California Water Quality Objectives (WQO) to ensure appropriate analytical methods were used. We recommend that a table, similar to Example Table 1, be prepared listing the potential contaminants of concern, whether historical use or laboratory results were the basis for inclusion, the contaminated or potentially-contaminated environmental media and the potentially affected habitat. In listing potential contaminants of concern which are included based on chemical analysis, we recommend that the number of samples analyzed, the method detection limit, the minimum concentration, the maximum concentration, the mean concentration and the standard deviation for each contaminated medium be included in a tabular form to facilitate independent review.

2.1 Inorganic Background

The identification of chemicals of ecological concern is the point at which a potentially responsible party (PRP) may choose to demonstrate that inorganic contaminants are present at ‘background’ concentrations and that the facility or site therefore poses no greater risk than the surrounding unimpacted area. If organic chemicals of ecological concern are present or concentrations of inorganic elements are present above ‘background’ concentrations the Scoping Assessment proceeds to identify the potentially affected habitats or communities. If no organic chemicals of ecological concern are present or concentrations of inorganic elements are at or below ‘background’ concentrations the facility or site exits from the ecological risk assessment process upon preparation and acceptance of a minimal Scoping Assessment report detailing these findings and conclusions. The work plan for any study of inorganic ‘background’ concentrations should be submitted for HERD review, through the DTSC Project Manager, prior to initiation of the inorganic ‘background’ study.

3.0 Biological Characterization

A biological characterization of the site, conducted by a qualified field biologist, is usually necessary to identify the biota actually or potentially occurring at the site. Site surveys should be scheduled to occur at various times throughout the day in order to maximize the potential for identification of potential ecological receptors. In order to facilitate the process, we recommend that advance notice of the date and time of the site survey be given to concerned regulatory agencies and natural resource trustees.

The biological characterization of the site should ultimately result in d evelopment of a conceptual site model which can direct investigation of potential ecological threat toward species and habitats most likely to demonstrate site-related effects. We recommend that the biological characterization be presented in the Scoping Report in a manner similar to Example Table 2.

3.1 Identification of Habitats

In lieu of an extensive site-specific biological survey conducted over an extended period of time to physically identify species occupying each distinct habitat, the species expected to occupy each habitat can be identified using available electronic data bases or publications prior to an actual site visit. For such an analysis, a qualified field biologist would first identify each distinct habitat occupying the site and the surrounding area within 1 mile (include identification of locations where contaminants may be transported). The site survey should allow identification and determination of the relative extent of site-specific habitats. Off-site habitats, and the associated receptors that may be affected by site-related contamination, are also important and warrant evaluation. Marine or estuarine habitats should be evaluated in terms of both the water and sediment components. Terrestrial habitats such as forest, oak woodland, grasslands, Jepson prairie, vernal pools, riparian, lacustrine, palustrine, desert, sand dune, coastal chaparral, agricultural or maintained landscape such as golf courses warrant evaluation and characterization. Transition zone habitats such as freshwater wetlands, saltwater wetlands, brackish water wetlands, marine intertidal and mudflats of rivers, lakes or streams should be evaluated and characterized. Biological characterization of the site should also identify the species and types of communities potentially occurring due to their occurrence at nearby areas (i.e., within 1 mile). Identification of the location of all wildlife areas, preserves, reserves, sanctuaries, parks, natural areas, conservation areas, or other protected areas within 1 mile of the site is beneficial to the evaluation of ecological risk.

3.2 Identification of Potential Receptors

Particular emphasis should be placed on identification of "special species" and their habitats which occur on or within a one-mile radius of the site. Special species include:

1. California species of special concern;
2. State and federally listed rare, threatened or endangered species;
3. Species which are proposed or recommended for state or federal listing.

The California Department of Fish and Game's (DFG) Natural Heritage Division should be contacted for the current special animal and special plant lists. The DFG's Natural Diversity Data Base (NDDB) can be a starting point for location information on special species which have been found near the site, although the NDDB is not an all-inclusive listing. For more information on special plant and animal lists, and the NDDB, contact:

Information Services Coordinator
Information Services
Natural Heritage Division
California Dept. of Fish and Game
1416 9th St., 12th floor
Sacramento, CA 95814
(916)324-3812 or (916)327-5960

In addition to the rare, threatened or endangered species, the initial list of potential receptors includes those species which can be expected to occupy the habitats identified for the site based on the available literature. Examples of useful literature sources include (Airola, 1988; Mayer and Laudenslayer, 1988; Zeiner,et al., 1991). These references are available for purchase from Wildlife Habitat Relationship Coordinator, California Department of Fish and Game, (916) 657-3933. These references also provide summary information on food items, life history, and habitat requirements for many species found in California.

We recommend that a field biologist visit the site to note the species, or signs of species activity, at the site. This 'site walk' should be conducted at various times of the day to maximize the identification of potential receptors. In the Scoping Assessment report, the species noted to be present, or signs of activity, can be presented for comparison with the list of potential species based on the habitat evaluation in a manner similar to Example Table 2.

4.0 Identification of Potentially Complete Exposure Pathways

Pathway assessment is conducted once potential species and habitats are identified. Pathway assessment identifies the potential for contact between biota and chemicals of concern in any medium and by any route. Media to be considered include soil, air, water, and biota. Of particular importance is consideration and evaluation of physical and chemical characteristics which influence environmental fate and transport. Persistent chemicals should receive special consideration. We recommend that potential off-site transport of contaminants, such as surface water transport in drainage channels, be evaluated.

Pathways may be direct, such as inhalation of air, or indirect, such as movement through the food web. Direct exposure routes to be considered include inhalation, ingestion, and dermal contact. Indirect exposure via consumption of food items also warrant evaluation, especially for those chemicals of concern with physical parameters which indicate a potential for persistence, bioaccumulation and toxicity. Generally, exposure via food web transfers should be evaluated for persistent, toxic compounds which have a log octanol-water partition coefficient (log K_{ow}) greater than 2.0. Persistent, extremely bioaccumulative compounds which have a log octanol-water partition coefficient (log K_{ow}) greater than 5.0 may require a greater degree of assessment be applied to bioaccumulation than to the pathways of direct exposure. In general, potential exposure pathways should be included when (EPA, 1989):

- There was or is a potential release to the environment, based on site-history or preliminary characterization data.
- Transport of the contaminant to a point of exposure is possible based on preliminary site characterization data or fate and transport modeling.
- A point of contact exists for the contaminant and potential receptors.
- An exposure route, such as inhalation or ingestion, exists at the point of contact.

We recommend that pathways shall be considered complete unless there is scientific justification to demonstrate the chemical will not enter the medium or the receptor will not contact the medium, either directly or indirectly, now or in the future.

For completeness and to facilitate independent review, we recommend that a qualitative description of the magnitude, duration and frequency of exposure to the various biological receptors, representing multiple trophic levels, for each contaminant or area of contamination be included in the Scoping Assessment report. A tabular summary of the exposure pathway analysis for each habitat type should be provided, identifying the most significant exposure pathways given the potential contaminants of concern and the potential ecological receptors similar to the Example Table 3. The exposure pathway table should be used to develop the conceptual site model.

In the event that there are no contaminants of concern for ecological systems or the potential exposure pathways are incomplete, the identification of habitats and potential receptors may be used to evaluate any potential impact associated with remediation efforts based on the human health risk assessment. An estimate of potential damage to ecological systems may be a critical factor in selecting an appropriate remedial alternative.

5.0 Contents of Scoping Report

It is recommended that a site-wide habitat map be included as part of the scoping assessment. For comparison, we recommend that all major habitats be displayed on a map at least equivalent to a USGS quadrangle map (1:25000) or of greater resolution if necessary. Separate indication of the coverage of tree canopy, shrubs or dominant herbaceous plants may be appropriate. A site-wide map of similar dimension which indicates historical land-use patterns, particularly those land-uses which may have resulted in release of hazardous substances is also recommended. In addition, it may also prove beneficial to include an additional map showing current land-use if it differs from historical land-use. Location of former landfills, waste piles, material stockpiles, burn pits, surface impoundments, firing ranges, strafing or bombing ranges, hazardous waste storage areas, reutilization areas, storm drains, storm water outfalls and surface drainages are especially important. Both the habitat coverage and the land-use may be displayed on the same map if the degree of detail is not confusing. Additional smaller scale maps of portions of the site may be warranted, as appropriate, to adequately portray habitat-specific information. Industrial sites where future land-use is industrial or commercial may not require smaller habitat-specific maps.

A qualitative statement should be provided which summarizes the findings of the screening-level assessment. If the conclusion is that the site, and areas actually or potentially impacted by the site, are not utilized by biota and do not contain wildlife habitats, or that there are no actually or potentially complete exposure pathways, this conclusion must be clearly stated and justified. If potentially toxic chemicals have contaminated, or may reasonably be expected to contaminate media which may contact wildlife or wildlife habitats, either on-site, or off-site, directly or indirectly, the potential for exposure is considered to exist and further investigation and assessment may be warranted.

We recommend the Scoping Assessment report contain, at a minimum, the following materials or their functional equivalents:

5.1 Figures

a. A site-wide or facility-wide habitat map showing all major habitat types to at least a USGS quadrangle map scale (1:25000). A ‘qualitative’ habitat map which outlines the general boundaries and extent of all major habitat types, with notation of features such as canopies, shrubs, dominant herbs will fulfill this requirement. A formal plant community field survey is generally not warranted for the Scoping Assessment report.

b. A site-wide or facility-wide land-use history map showing current and historical land use, such as landfills, waste piles, firing ranges, strafing areas, burn pits, explosives areas, hazardous waste storage areas, pesticide storage and wash areas, scrap

(reutilization) yards, motor pools, gasoline stations, fuel farms, existing or former surface drainage channels, storm drains and storm water outfalls.

c. An overlay or combination of the facility-wide habitat map and the facility-wide land-use map if significant to the findings of the Scoping Assessment study.

d. A subsite-specific habitat map if significant to the findings of the Scoping Assessment study. Alter the scale of the subsite-specific habitat map to suit each subsite, each habitat, and diversity of ecological receptors or habitats. For industrial sites where future land use is industrial, commercial or residential, subsite -scale maps may not be necessary.

5.2 Tables

a. Summary table of potential contaminants of concern with descriptive statistics including minimum detected concentration, maximum detected concentration, mean, standard deviation and 95th upper confidence limit (95th UCL) on the mean. Use one half the detection limit for non-detects when calculating the mean, standard deviation and 95th UCL. The detail will vary with facility and site and how much is known at the time of the Scoping Assessment.

Example Table 1. Potential chemicals of concern.

Chemical	Medium	Site History	Analysis	Number of Detects and Samples	Limit of Detection	Minimum	Maximum	Mean	Standard deviation	95th UCL
2,4,5-T	Soil	X								
Beryllium	Soil	X	X	0/5	100 ug/kg	ND	ND	ND		
DDT	Soil	X	X	3/5	100 ug/kg	1 mg/kg	66 mg/kg	15 mg/kg	28.7	36.1 mg/kg
Mercury	Sediment		X	4/5	10 ug/kg	200 ug/kg	900 ug/kg	472 ug/kg	370.4	744.6 ug/kg
Beryllium	Water		X	3/5	0.5 ug/l	1 ug/l	100 ug/l	20.9 ug/l	44.2	53.4 ug/l

b. Current and historical land use information. This table may accompany and more fully explain the land use history map in 5.1(b) or 5.1(c).

c. Summary table of potential receptors including the following additional information using known species lists as a base: species name; season(s) in which it is expected to be found on the facility; presence noted during the site walk (visual sighting (photograph), tracks (photograph), nest (photograph), call, scat, etc.); nocturnal or diurnal in habit, and Federal or California special species status.

Example Table 2. Site habitat summary and potential ecological receptors.

Habitat Type	Hectares (% Site)	Expected species	Observed species	Relative occurrence	Rare, Threatened or Endangered
Chaparral	(<<1 %)			Uncommon	No
Oak woodland	10 (50 %)	Scrub jay	am x pm x	Common	No
Oak woodland	10 (50%)	Deer mouse	am x pm	Common	No
Stream	1 (5 %)	Rainbow trout	am x pm x	Common	No
Oak/willow riparian	9 (45 %)	Least bell's vireo	am x pm	Rare	Yes

e. Summary table of potentially complete exposure pathways. This table normally would include all habitats or ecological guilds including those, such as piscivorous birds or waterfowl, which may have significant exposure via consumption of aquatic food items.

Example Table 3. Assessment of potentially complete exposure pathways listing all pathways evaluated, those potentially complete and those apparently incomplete.

Habitat Type	Potential Receptor Group	Potential Contaminants	Contaminated Media	Direct Exposure Pathway	Food Web Exposure	Complete Exposure Pathway
Oak woodland	Burrowing Mammals	DDT	Soil	Soil Ingestion		Yes
Oak woodland	Burrowing mammals	DDT	Soil	Ingestion of prey	Soil invertebrates and plant seeds to mouse	Yes
Oak woodland	Burrowing Mammals	DDT	Soil	Particulate Inhalation		Yes
Oak woodland	Burrowing Mammals	DDT	Soil	Dermal Absorption		Yes
Oak woodland	Burrowing Mammals	Chloroform	Groundwater	Inhalation of soil gases		Yes
Oak woodland	Burrowing Mammals	Chloroform	Groundwater	Ingestion of water		No
Stream	Fish (secondary consumers)	DDT	Sediment	Ingestion of prey	Stream invertebrates to fish	Yes
Stream	Benthic Invertebrates	DDT	Sediment	Sediment ingestion		Yes

5.3 Data

a. Copies of data logs used during site walk to generate tables of observed species.
b. Copies of photographs used to document presence of ecological receptors.

6.0 Contents of Phase I Work Plan Outline

a. A figure depicting the potentially complete exposure pathways for ecological receptors, similar to Figure 1 should be included. The relative importance of environmental transfer processes is indicated by the thickness of the arrows and with potentially complete or incomplete exposures for decomposers, primary producers and subsequent consumers indicated by shading the appropriate exposure routes.
b. Preliminary conceptual site model. In addition to the information contained in Example Table 3, the conceptual site model may be presented in a diagram similar to Figure 2. This diagram of the conceptual site model is presented as an example only. The original differentiated the significant routes of exposure and assessment endpoints through the use of color which was too expensive to reproduce in this document
c. Preliminary list of potential receptors to be evaluated in detail. The list of proposed assessment endpoints, potential representative species and the evaluation criteria should be presented in a table similar to Example Table 4.
d. Preliminary list of potential pathways for each receptor to be evaluated.
e. Field validation of preliminary facility -specific habitats maps.
f. Proposed hypotheses for any statistical testing.
g. Proposed data quality objectives and measurement endpoints.

Example Table 4. Biological, toxicological and societal criteria for selection of representative species.

		Ecological Factors						Toxicological Factors			Societal Factors		
	Observed at Site	High Trophic Level Predator	Important Prey Species	Important to Structure or Function of Ecosystem (i.e. key species)	High Potential for Exposure based on Feeding or Life History	High Potential for Exposure Based on Amount and Type of Site Use	Susceptible to Bioaccumulation or Biomagnification of COCs	Toxicological Literature Available	Likely to Exhibit Toxic Effects	Directly Measure Toxic Endpoint	Species of Special Conservation Concern	Economically Important	High Social or Recreational Value
Assessment Endpoints (numbered)													
1.) Protection of Threatened and Endangered Species													
Northern harrier (Circus cyaneus) reproductive success	x	x			x		x	x	x	x	x		x
2.) Protection of benthic invertebrate community													
Amphipod (Hyallela azteca) population survival	x		x		x	x		x	x	x			
Mayfly (Hexagenia sp.) population survival	x		x		x	x		x	x	x			
3.) Protection of carnivourous fish populations													
Rainbow trout (Onchorynchus mykiss) reproductive success	x	x		x	x	x	x	x	x	x		x	x
4.) Protection of terrestrial mammal populations													
Deer mouse (Peromyscus maniculatus) population success	x		x			x		x	x	x			
Red fox (Vulpes vulpes) reproductive success	x	x			x		x	x	x	x			
5.) Protection of plant community	x			x		x							

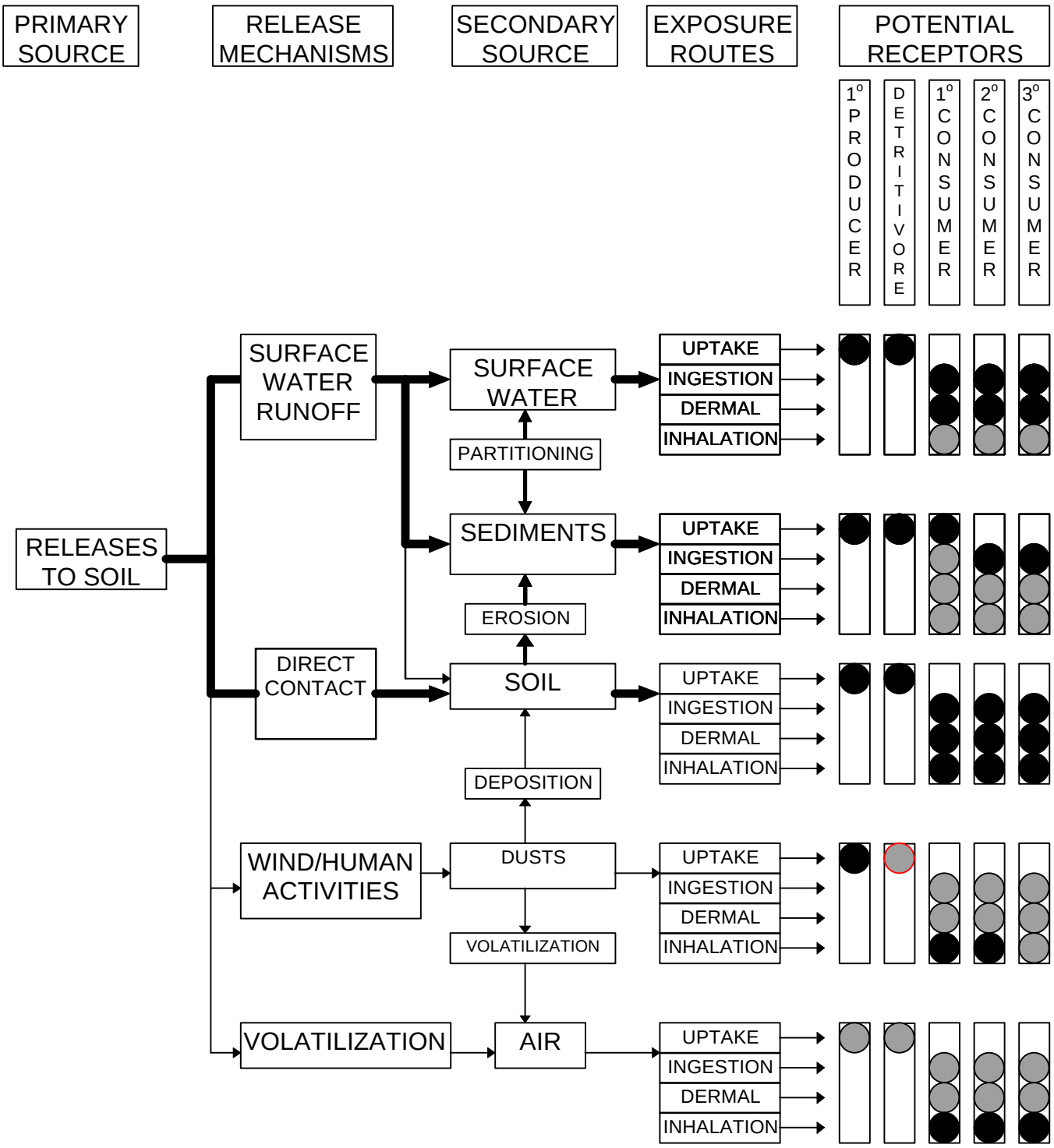

FIGURE 1. EXPOSURE PATHWAY ANALYSIS
● = POTENTIALLY COMPLETE EXPOSURE PATHWAY
● = POSSIBLY COMPLETE EXPOSURE PATHWAYS (INSUFFICIENT DATA)
CLEAR = INCOMPLETE EXPOSURE PATHWAY

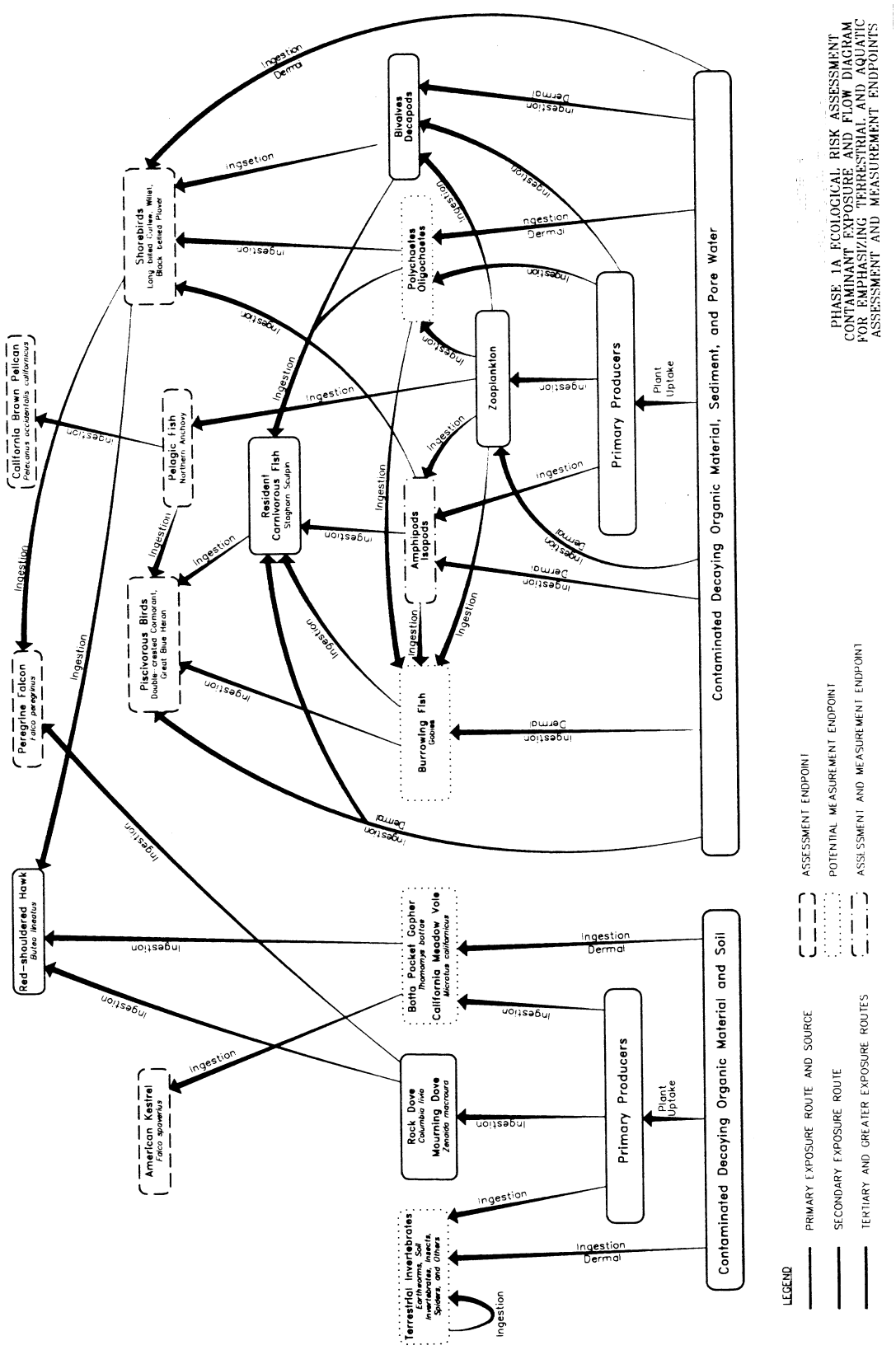

FIGURE 2. CONCEPTUAL SITE MODEL DIAGRAM.

References

Airola, Daniel A. 1988. Guide to the California Wildlife Habitat Relationships System. California Department of Fish and Game. Sacramento, March, 1988. 74 pp.

California Department of Toxic Substances Control. 1994. Preliminary Endangerment Assessment Manual. Sacramento, January, 1994.

Eisler, Ronald. 1985. Mirex Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. U.S. Fish and Wildlife Service , Contaminant Hazard Reviews Report No. 1, Biological Report 85(1.1). March 1985.

Eisler, Ronald. 1985. Carbofuran Hazards to Fish, Wildlife, and Invertebrates: A Synoptic
Review. U.S. Fish and Wildlife Service , Contaminant Hazard Reviews Report No. 3, Biological Report 85(1.3). August 1985.

Eisler, Ronald. 1986. Polychlorinated Biphenyl Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. U.S. Fish and Wildlife Service, Contaminant Hazard Reviews Report No. 7, Biological Report 85(1.7). April 1986.

Eisler, Ronald. 1986. Diazinon Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. U.S. Fish and Wildlife Service, Contaminant Hazard Reviews Report No. 9, Biological Report 85(1.9). August 1986.

Eisler, Ronald. 1989. Atrazine Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. U.S. Fish and Wildlife Service, Contaminant Hazard Reviews Report No. 18, Biological Report 85(1.18). May 1989.

Mayer, Kenneth E. and William F. Laudenslayer, Jr. (Eds.). 1988. A guide to wildlife habitats of California. California Department of Forestry and Fire Protection. Sacramento, 166 pp.

U.S. Environmental Protection Agency. 1989. Risk Assessment Guidance for Superfund. Human Health Evaluation Manual. Volume I. Part A.

U. S. Environmental Protection Agency. 1995. Integrated Risk Information System for Microcomputers (IRIS2), October, 1995 update.

Zeiner, David C., William F. Laudenslayer, Jr. and Kenneth E. Mayer (Eds.) 1988. California's Wildlife, Volume I, Amphibians and Reptiles. California Department of Fish and Game. Sacramento, May 2, 1988. 272 pp.

Zeiner, David C., William F. Laudenslayer, Jr., Kenneth E. Mayer and Marshall White (Eds.) 1990. California's Wildlife, Volume II, Birds. California Department of Fish and Game. Sacramento, November, 1990. 732 pp.

Zeiner, David C., William F. Laudenslayer, Jr., Kenneth E. Mayer and Marshall White (Eds.) 1990. California's Wildlife, Volume III, Mammals. California Department of Fish and Game. Sacramento, April, 1990. 407 pp.