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COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY

NAVY CLEAN II

FINAL RI/FS
RISK ASSESSMENT WORK PLAN
CTO-0037
LONG BEACH NAVAL SHIPYARD
LONG BEACH, CALIFORNIA

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ACRONYMS/ABBREVIATIONS

bsl	Below Sea Level
Cal/EPA	California Environmental Protection Agency
CIA	Controlled Industrial Area
COPC	Chemicals of Potential Concern
CPF	Cancer Potency Factor
CSF	Cancer Slope Factor
CTO	Contract Task Order
DON	Department of Navy
HEAST	Health Effects Summary Tables
IRIS	Integrated Risk Information System
LBNSY	Long Beach Naval Shipyard
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PRG	Preliminary Remediation Goal
RfD	Reference Dose
RfC	Reference Concentration
ROD	Record of Decision
TICs	Tentatively Identified Chemicals
URF	Unit Risk Factor
USEPA	U.S. Environmental Protection Agency

EXECUTIVE SUMMARY

This Risk Assessment Work Plan describes the potential risk to human health that may be associated with chemicals released to the environment through the Navy's use of Sites 8, 9, 10, 11, 12 and 13 (shipyard sites) of the Long Beach Naval Shipyard (LBNSY). The assessment will focus on potential exposure pathways related to chemicals detected in samples of surface soils, subsurface soils and groundwater during the site investigation.

This risk assessment will consist of four steps: (1) hazard identification, (2) toxicity assessment, (3) exposure assessment, and (4) risk characterization.

Hazard identification, the process of selecting the chemicals to be evaluated in a risk assessment, is being performed as a part of the RI/FS Sampling and Analysis Plan for LBNSY. Some of the steps in that process are: identifying chemicals that might have been released at a site; identifying areas of release; implementing the sampling and analysis plan to determine if the chemicals of potential concern are present; critical evaluation of the chemical analytical data to identify analytical artifacts; and identifying naturally-occurring chemicals with concentrations above normally expected values (i.e., background).

Once the hazards have been identified and the chemicals to be evaluated are selected, the toxicity of each chemical is assessed. For most chemicals, the toxicity assessment involves assembling toxicity criteria developed by USEPA and Cal/EPA for use in risk assessments. These criteria are used to characterize risk numerically and reflect the toxic potencies of the chemicals. The exposure assessment will be performed in parallel with the toxicity assessment, since neither is dependent on the other for completion.

The exposure assessment will consist of (1) selecting reasonable hypothetical exposure scenarios, (2) identifying exposure pathways and routes associated with each scenario, (3) calculating the exposure level or dose associated with each exposure route, and (4) characterizing the individuals at risk. For each scenario assessed, risk will be based on exposure of a hypothetical person under what the U.S. USEPA calls reasonably maximum exposure conditions. Upper-bound estimates of chemical concentrations, exposure times, and intake rates will be used to estimate risk. This deliberate attempt to overestimate risk is made in the interest of public protection. Once the exposure and toxicity assessments are completed, the risk characterization will proceed.

EXECUTIVE SUMMARY (continued)

Risk characterization is the process by which risk is quantified. Noncancer risk and cancer risk will be quantified separately. The toxicity assessment and exposure assessment will be summarized and integrated into estimations of health risks. Cancer risk is expressed as a probability that a person receiving an estimated dose will develop cancer during his/her lifetime. In this risk assessment, two sets of cancer risk estimates will be developed. The first set of estimates will be obtained using USEPA criteria exclusively. The second set will be obtained using available Cal/EPA criteria and USEPA criteria when Cal/EPA criteria are not available. The uncertainties inherent in conducting a risk assessment of chemicals released to the environment will be addressed as part of the risk characterization.

The overall objectives of this multimedia baseline human health risk assessment are to determine the magnitude and probability of harm to public health posed by the release of hazardous substances. This information will be used to determine if remediation of the sites are required.

CTO-0037

RISK ASSESSMENT WORK PLAN

1.0 INTRODUCTION

This Risk Assessment Work Plan describes the potential risk to human health that may be associated with chemicals released to the environment through the Navy's use of Sites 8, 9, 10, 11, 12 and 13 (shipyard sites) of the Long Beach Naval Shipyard (LBNSY). The work will be performed under Contract Task Order (CTO)-0037.

The assessment will focus on potential exposure pathways related to chemicals detected in samples of surface soils, subsurface soils and groundwater during the site investigation. The risks associated with each of the seven shipyard sites will be evaluated separately. The potential ecological risks associated with chemicals that might enter the groundwater from soil, or enter the surface water from groundwater or surface runoff, are not addressed in this risk assessment; these will be addressed, to the extent possible, under CTO-0026. The potential human health risks associated with the ingestion of fish caught by hypothetical current or future recreational anglers in site surface waters are not addressed in this risk assessment as they will be addressed under CTO-0016.

The overall objectives of a multimedia baseline human health risk assessment are to determine the magnitude and probability of actual or potential harm to public health and safety posed by the release of hazardous substances.

The following guidance documents form the basis of the risk assessment approach described in the work plan:

- U.S. EPA Office of Solid Waste and Emergency Response, Directive 9285.701A. *Risk Assessment Guidance for Superfund (RAGS), Volume I - Human Health Evaluation Manual (Part A).* December 1989.
- U.S. EPA, Office of Health and Environmental Assessment, EPA/600/8-89/043. *Exposure Factors Handbook.* July 1989.
- U.S. EPA, Office of Solid Waste and Emergency Response, Directive 9285.7-01B. *Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors.* March 1991.
- U.S. EPA, Office of Research and Development, EPA 600/8-91/011B. *Interim Guidance for Dermal Exposure Assessment.* January 1992.

- U.S. EPA, Office of Emergency and Remedial Response. *Final Guidance for Data Useability in Risk Assessment (Part A).* April 1992.
- California EPA, Department of Toxic Substances Control, Office of the Science Advisor. *Supplemental Guidance for Human Health Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities.* July 1992 (reprinted September, 1993).

2.0 OVERVIEW OF THE RISK ASSESSMENT PROCESS

The general elements of the assessment of risk to human health from chemicals released to the environment consist of the following: (1) hazard identification, (2) toxicity assessment, (3) exposure assessment, and (4) risk characterization. The general steps for evaluating each of these elements are described briefly below. Project-specific procedures associated with each of these elements are described in Section 3.0.

2.1 HAZARD IDENTIFICATION

Hazard identification is a process for selecting the chemicals to be evaluated in a risk assessment. Some of the steps in the process are: identifying chemicals that might have been released at a site, identifying areas of release, developing and implementing a sampling and analysis plan to determine if the chemicals of potential concern are present, critical evaluation of the chemical analytical data to identify analytical artifacts, and identifying naturally-occurring chemicals with concentrations above normally expected values (i.e., background). If an unmanageably large list of chemical candidates results, a subset of chemicals may be selected on the basis of a combination of high toxicity and concentration.

2.2 TOXICITY ASSESSMENT

Once the chemicals to be evaluated are selected, the toxicity of each chemical is assessed. For most of the chemicals, the toxicity assessment involves assembling toxicity criteria developed by regulatory agencies for use in risk assessments. These criteria are used to characterize risk numerically and reflect the toxic potencies of the chemicals. The criterion for assessing noncancer risk is called a reference dose (RfD) or reference concentration

(RfC). The criterion for assessing cancer risk is called a cancer slope factor (CSF), cancer potency factor (CPF) or unit risk factor (URF). When a chemical with no toxicity criterion is encountered, a criterion may be developed using one of several approaches. Alternately, the risk posed by the chemical may be qualitatively assessed.

2.3 EXPOSURE ASSESSMENT

The exposure assessment can be performed in parallel with the toxicity assessment, since neither is dependent on the other for completion. The exposure assessment involves (1) selecting reasonable hypothetical exposure scenarios, (2) identifying exposure pathways and routes associated with each scenario, (3) calculating the exposure level or dose associated with each exposure route, and (4) characterizing the individuals or populations at risk. Exposure scenarios used in a risk assessment depend on existing and future land use, both of the site and surrounding areas. Residential use is considered to be the highest risk scenario. When appropriate, an industrial or occupational scenario is used alone or in combination with the residential scenario.

With each scenario, risk is based on exposure of a hypothetical person under what the U.S. Environmental Protection Agency (USEPA) calls reasonably maximum exposure conditions. Upper-bound estimates of chemical concentrations, exposure times, and intake rates are used to estimate risk. This deliberate attempt to overestimate risk is made in the interest of public protection. When the assessment indicates that risk is acceptable, one can be reasonably assured that it is. When the assessment indicates that risk is not acceptable, the question remains as to whether risk might be lower if better estimates of exposure conditions were used. In such cases, refined risk assessments may be performed. Such assessments often require collecting additional data, including information on the behavior of the individuals or population at risk.

2.4 RISK CHARACTERIZATION

The final step in assessing risk consists of quantifying the risk associated with each chemical and exposure pathway for each exposure scenario, and assessing the accuracy of the risk estimates. Here, noncancer risk and

cancer risk are evaluated separately. Noncancer risk is expressed as the ratio of the estimated dose and the reference dose (the ratio is called a hazard quotient). Cancer risk is expressed as the probability that an individual will develop cancer as the result of exposure to the carcinogens evaluated. Population burden (the number of people in the population at risk expected to develop cancer) may also be calculated if the hypothetical individual(s) at risk represents a real population and the number of people in the population is known.

The accuracy of the risk estimates can be appraised qualitatively or quantitatively by conducting an uncertainty analysis. The analysis estimates the degree to which each of the major factors affecting risk overestimates or underestimates risk. The analysis is usually qualitative.

3.0 PROJECT-SPECIFIC PROCEDURES

3.1 HAZARD IDENTIFICATION

Chemicals evaluated in a risk assessment comprise the chemicals of potential concern (COPC). The USEPA defines COPCs as chemicals that are potentially site-related and whose data are of suitable quality to quantify risk (EPA 1989). COPCs will be identified according to guidelines contained in the USEPA risk assessment guidance manual (EPA, 1989) for identification of COPCs. The candidate list for COPCs will consist of chemicals that are found at concentrations above their detection limits in samples of soil and groundwater obtained from the site. The list will comprise chemicals whose concentrations are reported by the analytical chemistry laboratory without qualifiers or with a "J" qualification (numerical value is estimated quantity). Tentatively identified chemicals (TICs) will also be included.

Chemicals on this list will be removed from further consideration if they are reported by the analytical chemistry laboratory as being field or laboratory artifacts and their concentrations in the soil samples are less than 10 times the concentration in the blank sample(s). Other chemicals found in soil or groundwater and blank samples will be removed from the candidate list if their concentrations in the soil or groundwater sample are less than five times the concentrations in the blanks. TICs that are found only once will be removed from the list. Naturally-occurring chemicals (e.g., metals and essential nutrients) will be removed from further consideration when their

measured concentrations are within the range considered normal for the area around the site (i.e., background range). If more than the detection limits are reported for any chemical, the detection limit that is higher than the highest reported measured concentration will be removed from further consideration.

From the preliminary site investigation, the potentially contaminated sites identified can be divided into two general source types: spills/surface releases and landfills. The preliminary site investigation also provides a generalized picture of the main chemicals of concern. Basically, there are two broad categories: heavy metals (including organotins from sandblast operations) and volatile organic compounds (e.g., solvents and petroleum-related contaminants). Polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) may present some site-specific concerns as well.

3.2 TOXICITY ASSESSMENT

The toxicity assessment will consist of (1) gathering toxicological information on each chemical and summarizing the information in the risk assessment report, and (2) assembling RfDs and CPFs for the COPCs.

The purpose of the toxicological summaries is to provide the nontoxicologist an overview of the health effects that the COPCs are capable of producing. The summaries will contain acute toxicity estimates, describe the symptoms of acute and chronic toxicity, and identify organ and systemic effects (carcinogenic and noncarcinogenic) when such information is available. Some of the chemicals, such as the PAHs, will be treated as classes. The summaries will also describe the basis of the CPFs and RfDs of the COPCs.

RfDs are estimates of doses that will not cause adverse noncarcinogenic chronic health effects and are chemical-specific. CPFs are estimates of the cancer risk associated with unit doses of chemical carcinogens. The USEPA has developed RfDs and CPFs for a large number of chemical substances. The USEPA RfDs and CPFs are first published in the USEPA's Health Effects Summary Tables (HEAST), which are issued annually and contain provisional numbers only. RfDs and CPFs that have been approved by the agency after extensive review and evaluation are entered into the Integrated Risk Information System (IRIS) database, which is updated periodically.

The California Environmental Protection Agency (Cal/EPA) has developed two sets of CPFs. One set comprises 78 chemicals with CPFs that have been used to establish promulgated health standards, such as maximum contaminant levels for drinking water and air quality standards. The other set, which comprises "expedited" CPFs for about 140 chemicals, was developed primarily to implement the Safe Drinking Water and Toxics Enforcement Act (Proposition 65). Cal/EPA has not developed RfDs for any chemical. Cal/EPA CPFs for some chemicals differ from those developed by the USEPA.

Both USEPA and Cal/EPA CPFs will be used in the assessment of LBNSY site COPCs, along with the RfDs developed by the USEPA. Although the Department of the Navy (DON) has agreed to use Cal/EPA's CPFs, it clearly and expressly reserves the right to reject their use at a later date if the CPFs are not adequately supported. The DON has not endorsed the use of Cal/EPA CPFs or risk estimates based on Cal/EPA CPFs in either the RI/FS, Proposed Plan, or Record of Decision (ROD), and reserves the right to decline their use if it is determined that they are not appropriate.

RfDs and CPFs developed by the USEPA will be obtained from the IRIS database first, then from the latest issue of HEAST when not available from the IRIS database. When neither source contains a RfD or CPF for a chemical, the chemical will be assigned the RfD or CPF of a structurally-related chemical.

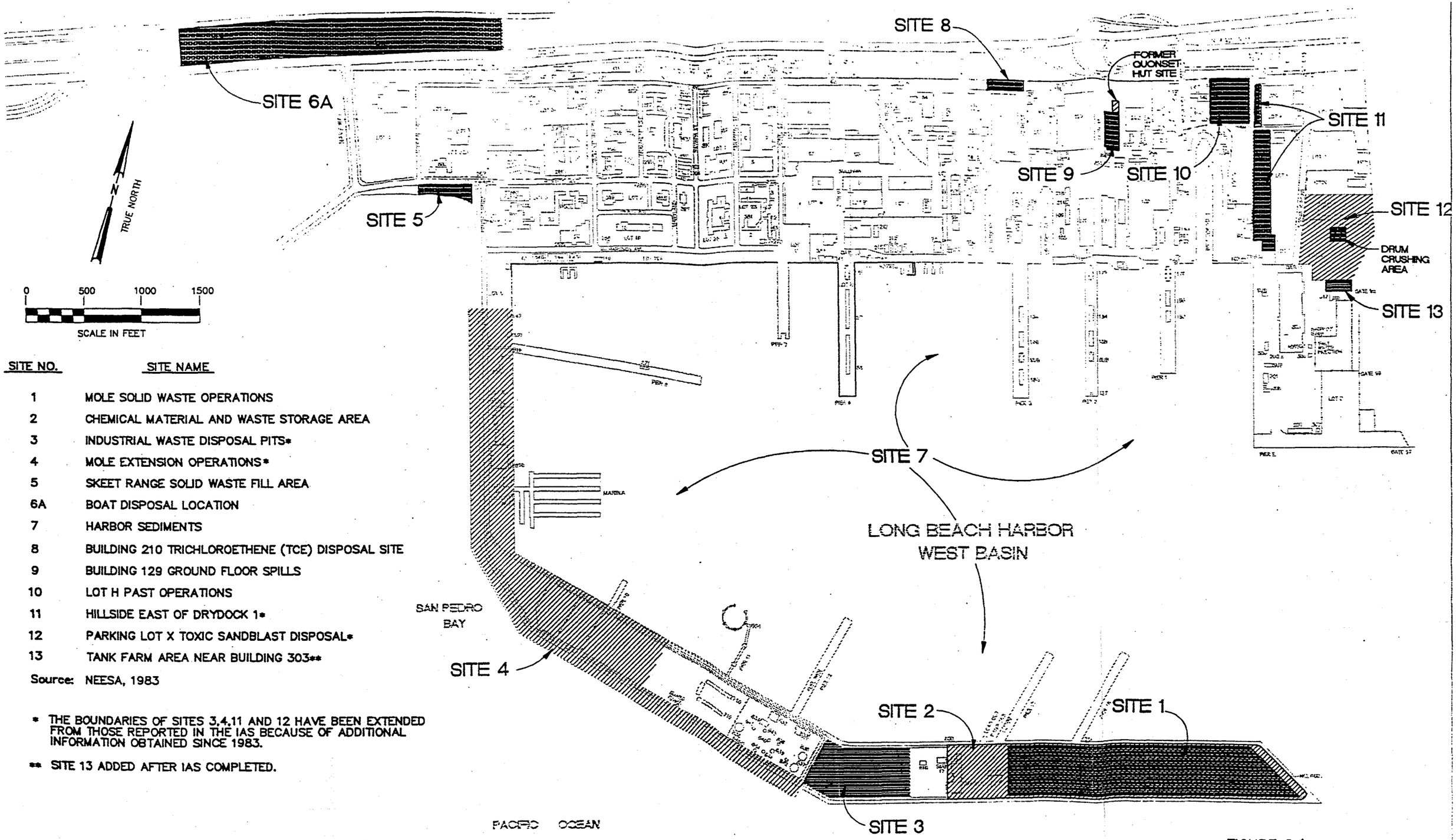
Cal/EPA CPFs used in the assessment will come from the July 1992 set of CPFs used to develop promulgated standards. If necessary, the April 1992 set of expedited CPFs will be used. If these sets are updated before the risk assessment is performed, the updated values will be used.

3.3 EXPOSURE ASSESSMENT

3.3.1 Site Descriptions and Current Use

The locations of LBNSY Sites 8 through 13 are identified on Figure 3-1.

Site 8 is located along the southern fenceline of Lot S, north of Building 210. The site dimensions are approximately 85 feet by 300 feet. The area is flat and consists of an unpaved parking lot presently used by base personnel.



SITE NO.	SITE NAME
1	MOLE SOLID WASTE OPERATIONS
2	CHEMICAL MATERIAL AND WASTE STORAGE AREA
3	INDUSTRIAL WASTE DISPOSAL PITS*
4	MOLE EXTENSION OPERATIONS*
5	SKEET RANGE SOLID WASTE FILL AREA
6A	BOAT DISPOSAL LOCATION
7	HARBOR SEDIMENTS
8	BUILDING 210 TRICHLOROETHENE (TCE) DISPOSAL SITE
9	BUILDING 129 GROUND FLOOR SPILLS
10	LOT H PAST OPERATIONS
11	HILLSIDE EAST OF DRYDOCK 1*
12	PARKING LOT X TOXIC SANDBLAST DISPOSAL*
13	TANK FARM AREA NEAR BUILDING 303**

Source: NEESA, 1983

* THE BOUNDARIES OF SITES 3,4,11 AND 12 HAVE BEEN EXTENDED FROM THOSE REPORTED IN THE IAS BECAUSE OF ADDITIONAL INFORMATION OBTAINED SINCE 1983.

** SITE 13 ADDED AFTER IAS COMPLETED.

FIGURE 3-1
POTENTIALLY CONTAMINATED HAZARDOUS WASTE SITES
NAVAL SHIPYARD LONG BEACH
RI/FS WORK PLAN

The primary activity in the area is industrial. Access to Site 8 is limited by the security provided for the Controlled Industrial Area (CIA) section of the LBNSY.

Site 9 includes the ground surface beneath Building 129, located in the north-central portion of the LBNSY, and the area north of Building 129, referred to as the "Former Quonset Hut" site. Site 9 is located in the controlled industrial access section of the LBNSY. A marine machine shop currently operates within Building 129, and the area directly adjacent to Building 129 is flat and paved with asphalt. Two hazardous waste staging areas are situated north of Building 129. Access to Site 9 is limited by the security provided for the CIA section of the LBNSY.

Site 10 is located in Parking Lot H in the northeastern portion of LBNSY. Building 142 (personnel/employment) is adjacent to Site 10. Subsidence on Terminal Island has lowered the elevation in the area to approximately 10 feet below sea level (bsl). The site is flat and is currently paved with asphalt. Access to Site 10 is limited by the security provided for the LBNSY.

Site 11 is located on a hillside in the eastern portion of LBNSY. The site covers approximately 188,000 square feet and is bordered by Parking Lots A, E, and F to the east and Parking Lots G and H to the west; an asphalt roadway bisects the site between Parking Lots A and F. A removal action has been performed on Site II. Vegetation covers the northern extent of the site. The southern portion of the site has been encapsulated in gunite. The primary activities in the area are industrial. The southern edge of the site is approximately 150 feet from the West Basin of Long Beach Harbor. Access to Site 11 is limited by the security provided for the LBNSY.

Site 12 is located in Parking Lot X, east of Skipjack Road on the eastern part of the LBNSY. Site 12 is flat and covered mostly with gravel or asphalt. Access to Site 12 is limited by the security for the LBNSY.

Site 13 is located on the eastern boundary of the LBNSY, northeast of Building 303 and south of parking lot H. The site is a hazardous waste storage area (tank farm) that is used for storing portable waste-storage tanks. The tank farm is approximately 220 feet by 98 feet and is enclosed by a chain-link fence. A strip of unpaved area outside the eastern fenceline, where some soil stains have been observed, is also included in Site 13. Access to the site is limited by the security provided for the LBNSY.

3.3.2 Exposure Scenarios

All of the LBNSY sites covered in this risk assessment are currently in heavy industrial use. By far the most probable future use is continued heavy industry, therefore residential exposure is not considered plausible and is not evaluated.

Based on a current understanding of the nature and extent of contamination at the shipyard sites, the following potential exposure pathways have been identified under current or future site conditions:

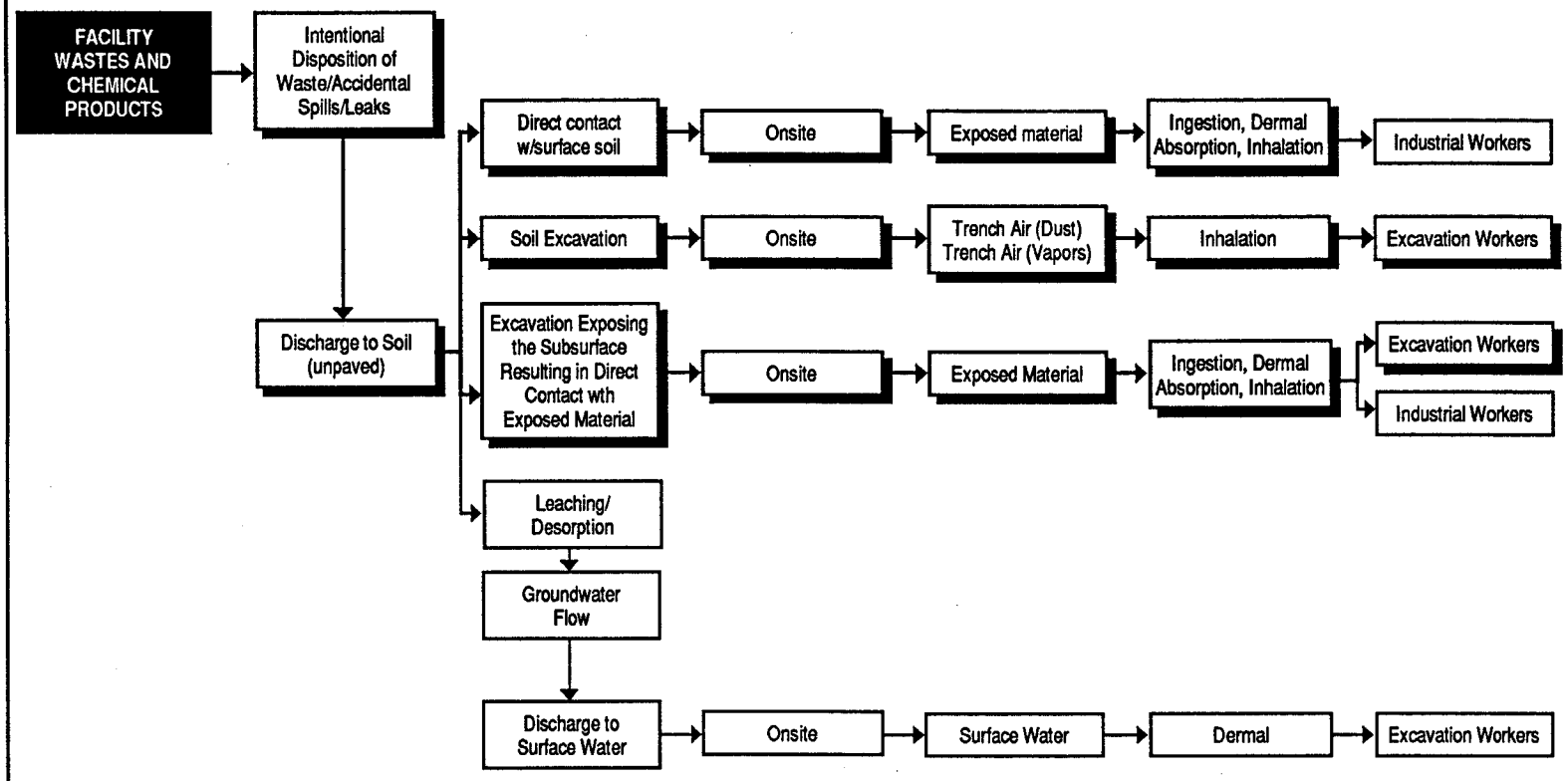
- Exposure of hypothetical current or future on-site Navy or civilian industrial workers to chemicals in surface soils through inadvertent ingestion, dermal contact, or inhalation as dusts (at sites with surface soil COPCs). For risk assessment purposes an "industrial worker" includes both office and non-office personnel who work at the site on a regular basis.

- Exposure of hypothetical current or future Navy or civilian maintenance, construction or utility workers to chemicals in surface and subsurface soils through inadvertent ingestion, dermal contact, or inhalation as dusts or vapors (at sites with subsurface soil COPCs). For risk assessment purposes, these workers will be termed "excavation workers". Excavation workers will include those workers with potential exposure in an excavation trench, whether for periodic maintenance or construction activity.

- Exposure of hypothetical current or future on-site Navy or civilian maintenance, construction or utility workers (excavation workers) to chemicals in groundwater through inadvertent dermal contact (at sites with groundwater COPCs).

3.3.3 Potential Exposure Pathways and Routes

Figures 3-2 through 3-7 present the conceptual models of the pathways by which COPCs at their presumed sources in the shipyard sites could reach human receptors and the exposure routes associated with each pathway. The term pathway identifies the environmental medium(s) (water, soil, air) and transfer mechanisms by which a chemical travels from its source to the



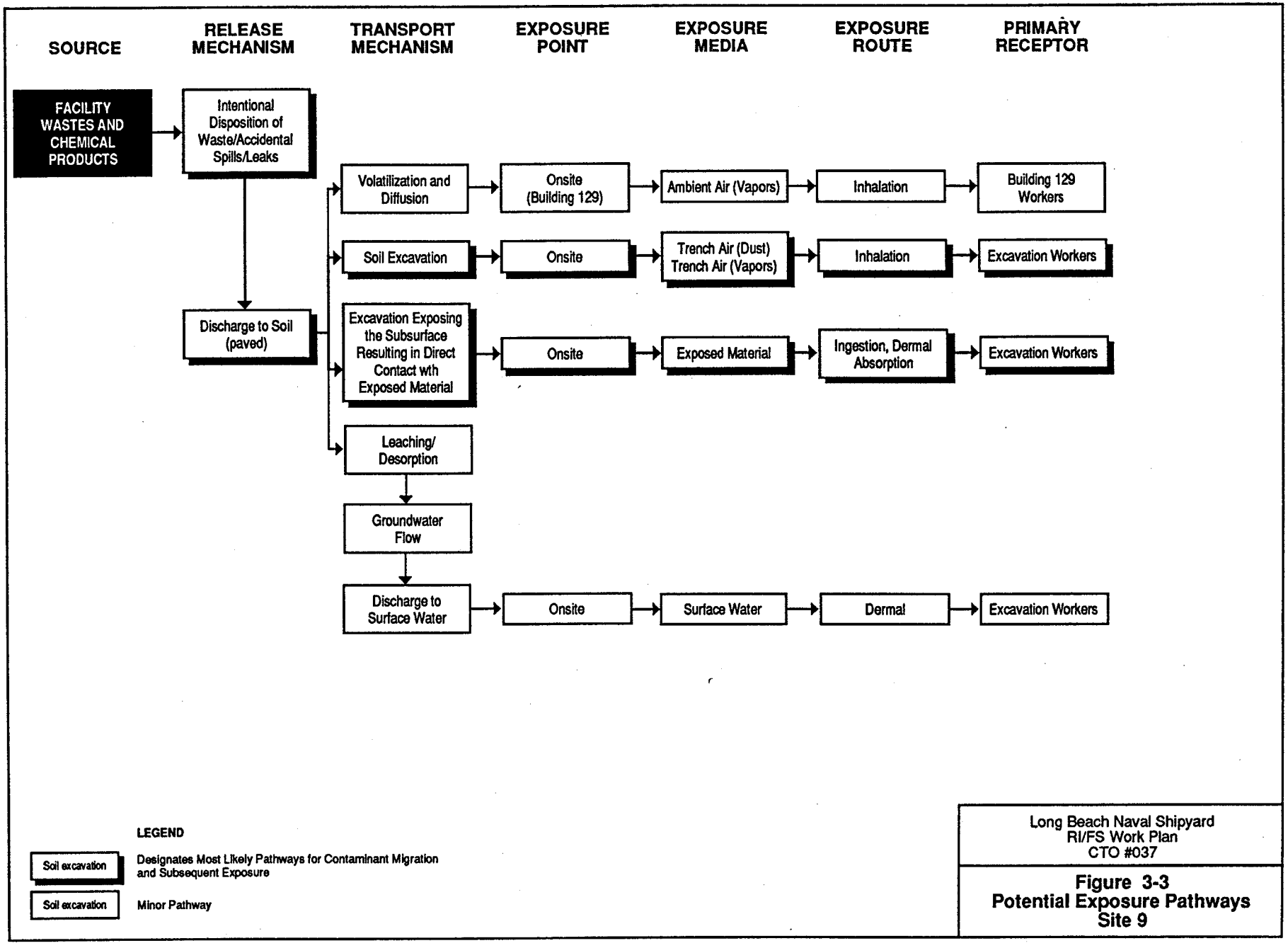
LEGEND

Soil excavation — Designates Most Likely Pathways for Contaminant Migration and Subsequent Exposure

Soil excavation — Minor Pathway

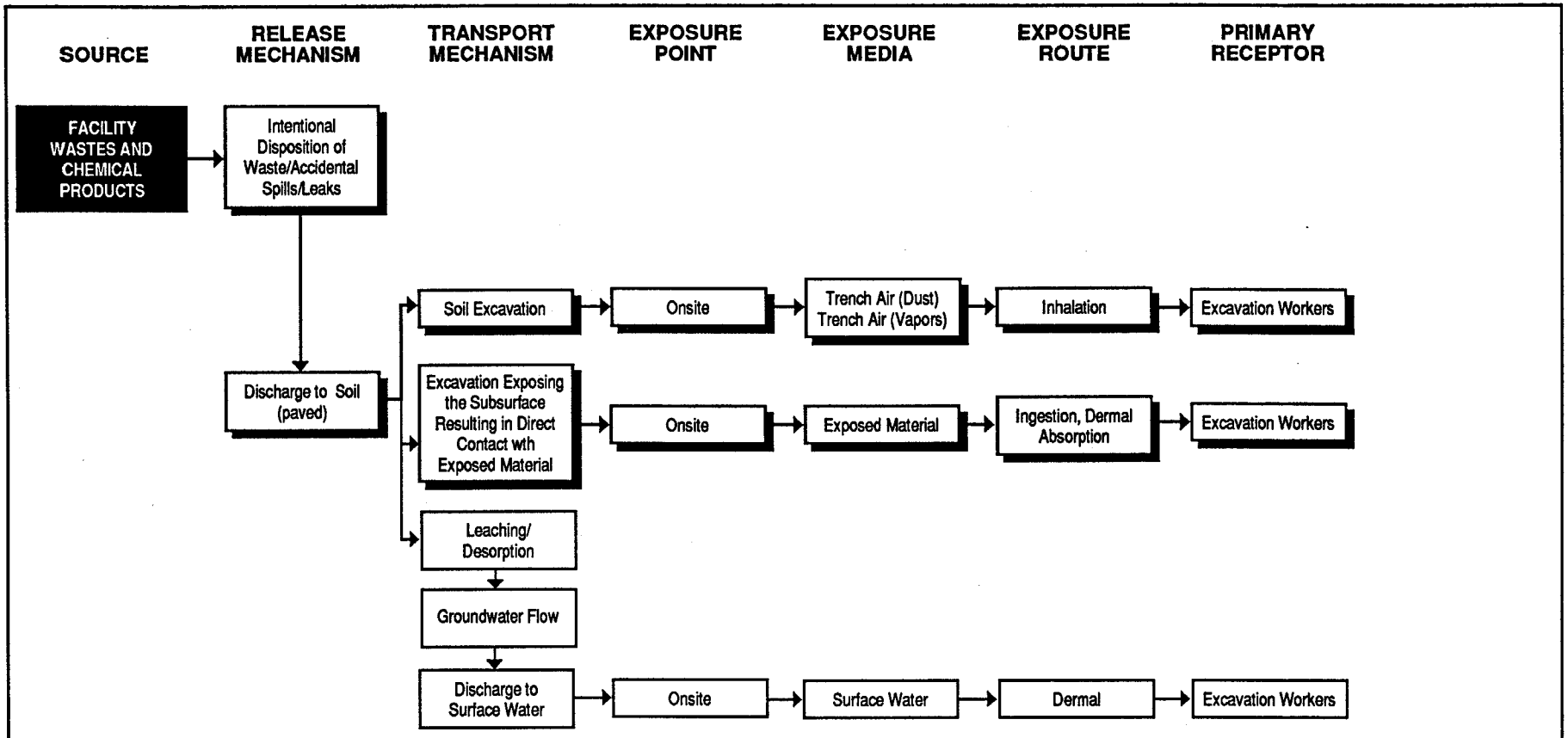
Long Beach Naval Shipyard
RI/FS Work Plan
CTO #037

Figure 3-2
Potential Exposure Pathways
Site 8



Long Beach Naval Shipyard
RI/FS Work Plan
CTO #037

Figure 3-3
Potential Exposure Pathways
Site 9



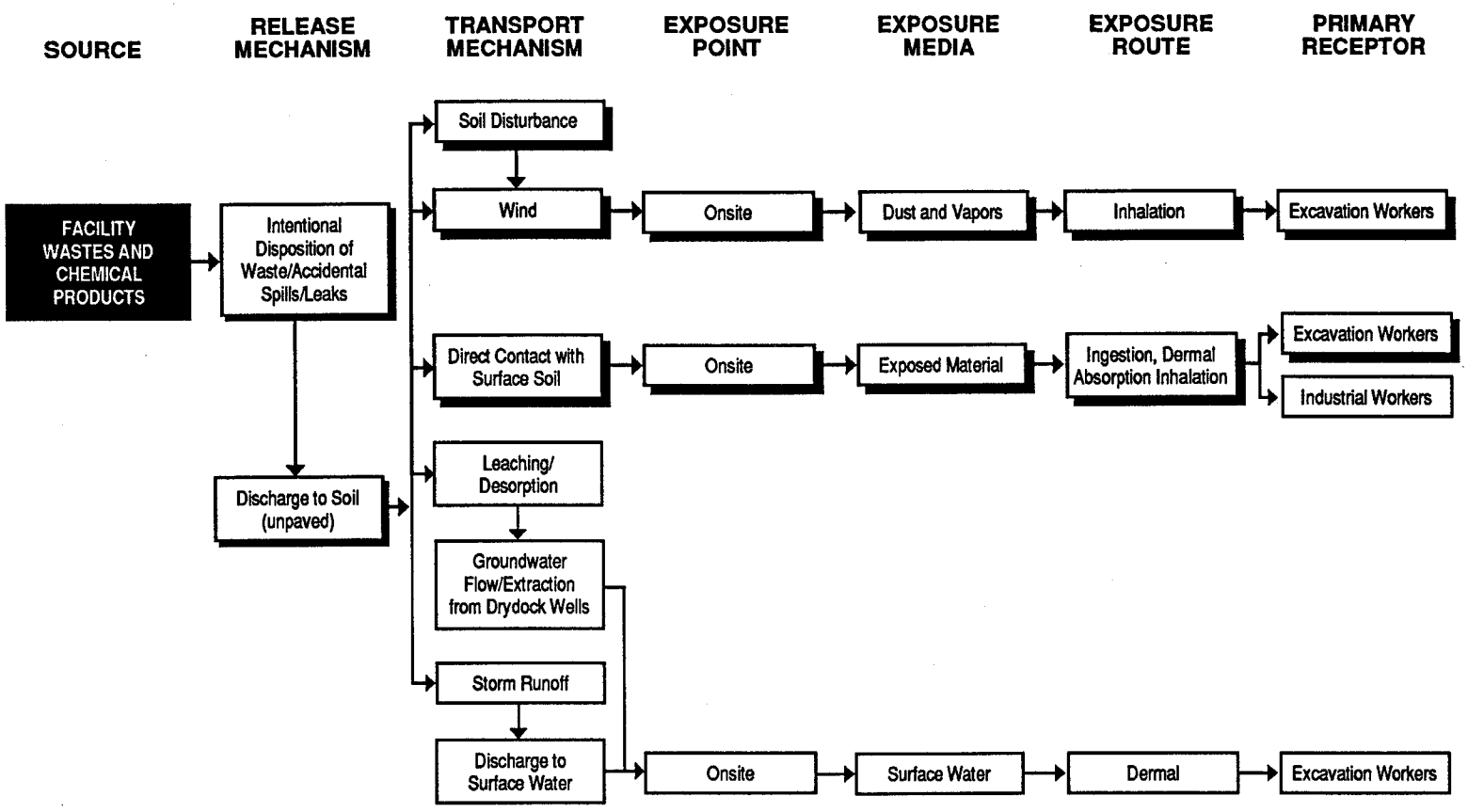
LEGEND

Soil excavation — Designates Most Likely Pathways for Contaminant Migration and Subsequent Exposure

Soil excavation — Minor Pathway

Long Beach Naval Shipyard
RI/FS Work Plan
CTO #037

Figure 3-4
Potential Exposure Pathways
Site 10



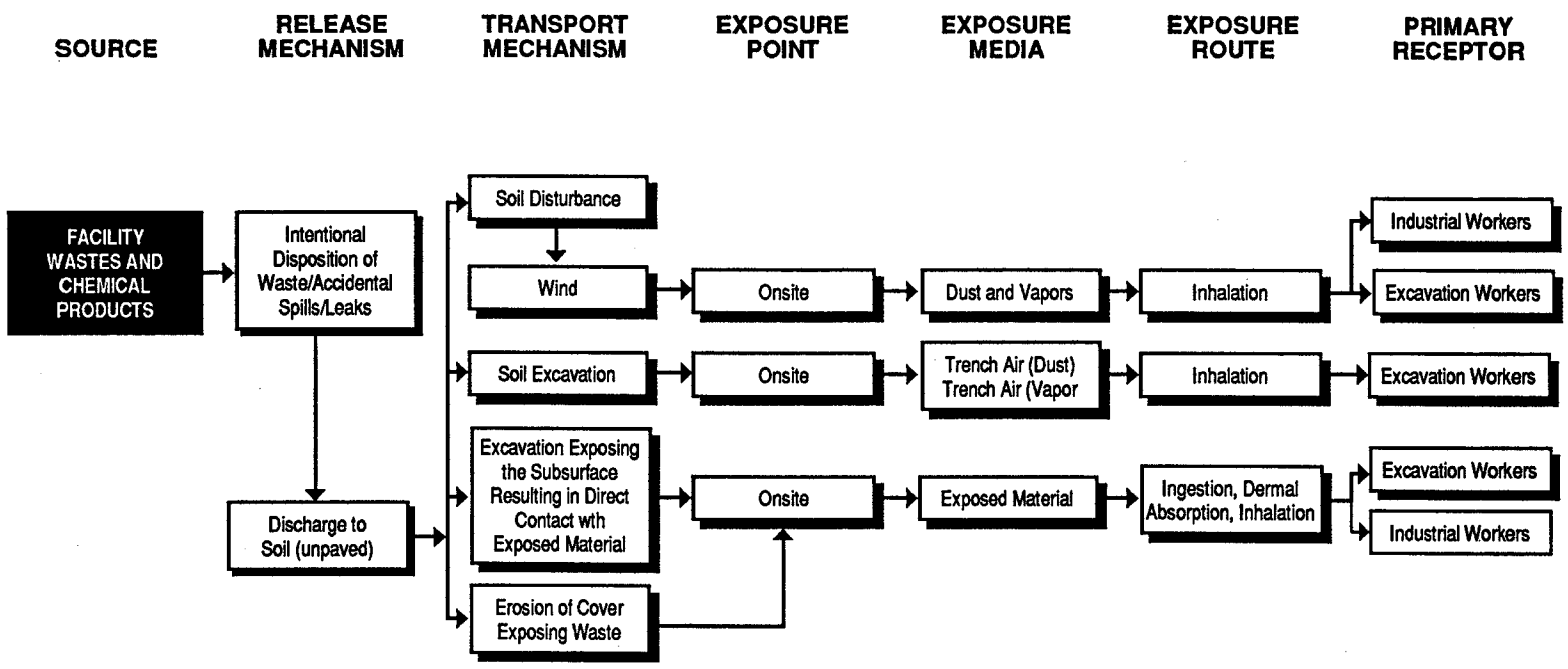
LEGEND

Soil excavation — Designates Most Likely Pathways for Contaminant Migration and Subsequent Exposure

Soil excavation — Minor Pathway

Long Beach Naval Shipyard
RI/FS Work Plan
CTO #037

Figure 3-5
Potential Exposure Pathways
Site 11 *(Sheet 1 of 2)*



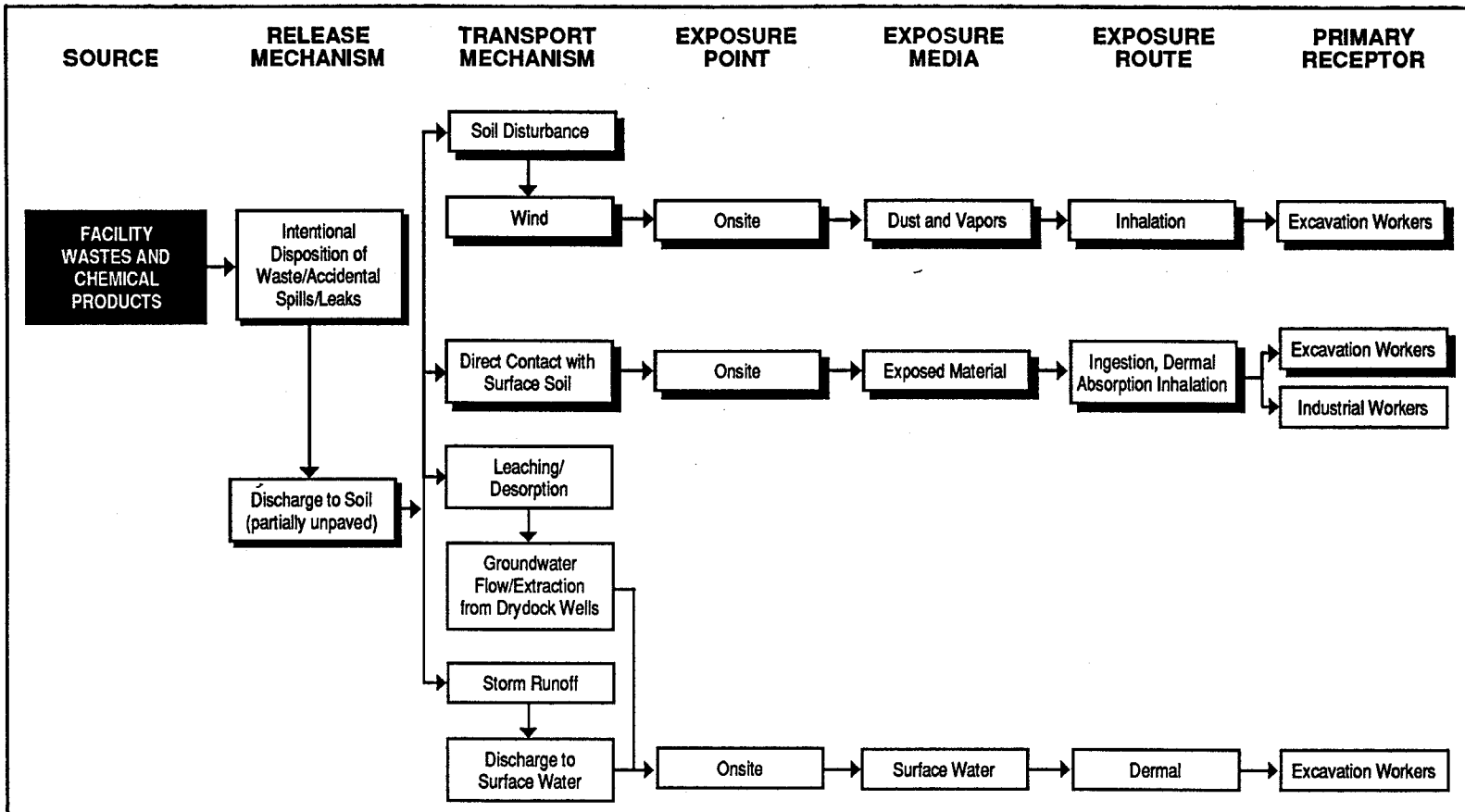
LEGEND

Soil excavation — Designates Most Likely Pathways for Contaminant Migration and Subsequent Exposure

Soil excavation — Minor Pathway

Long Beach Naval Shipyard
RI/FS Work Plan
CTO #037

Figure 3-5
Potential Exposure Pathways
Site 11 *(Sheet 2 of 2)*



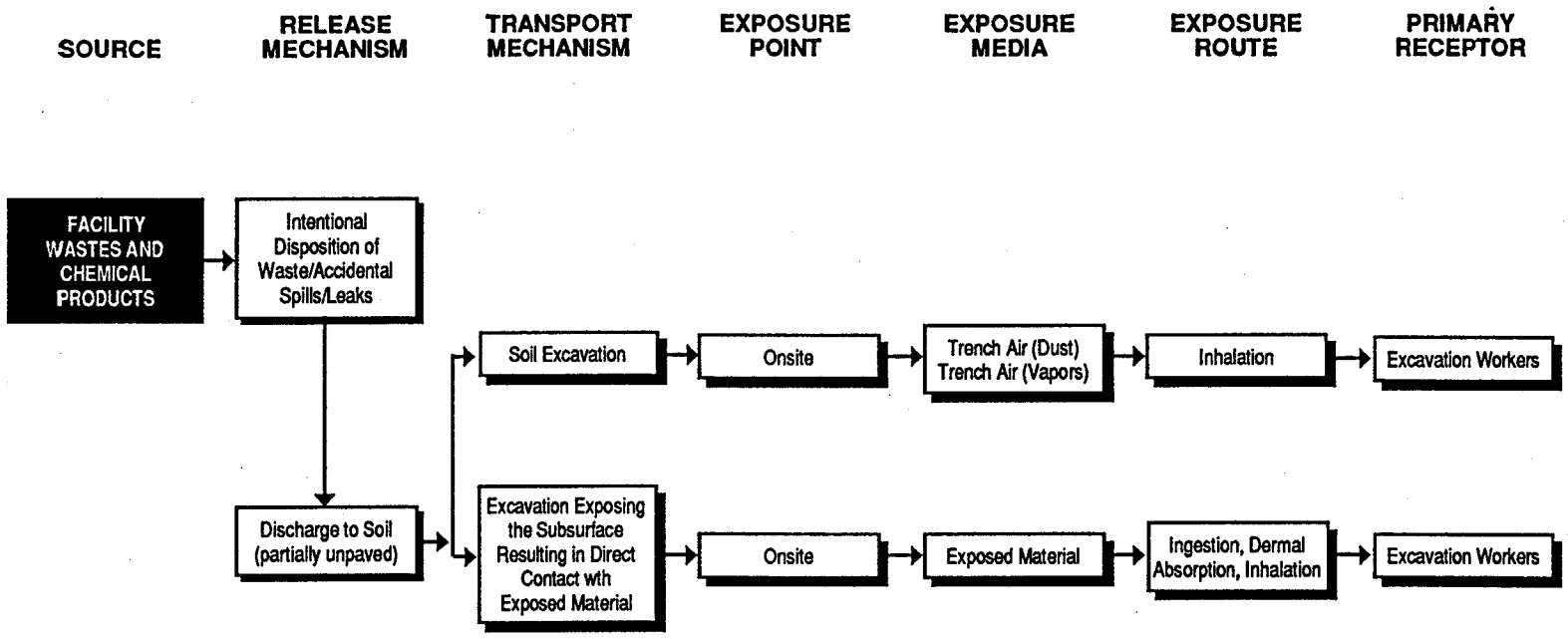
LEGEND

Soil excavation — Designates Most Likely Pathways for Contaminant Migration and Subsequent Exposure

Soil excavation — Minor Pathway

Long Beach Naval Shipyard
RI/FS Work Plan
CTO #037

Figure 3-6
Potential Exposure Pathways
Site 12 *(Sheet 1 of 2)*



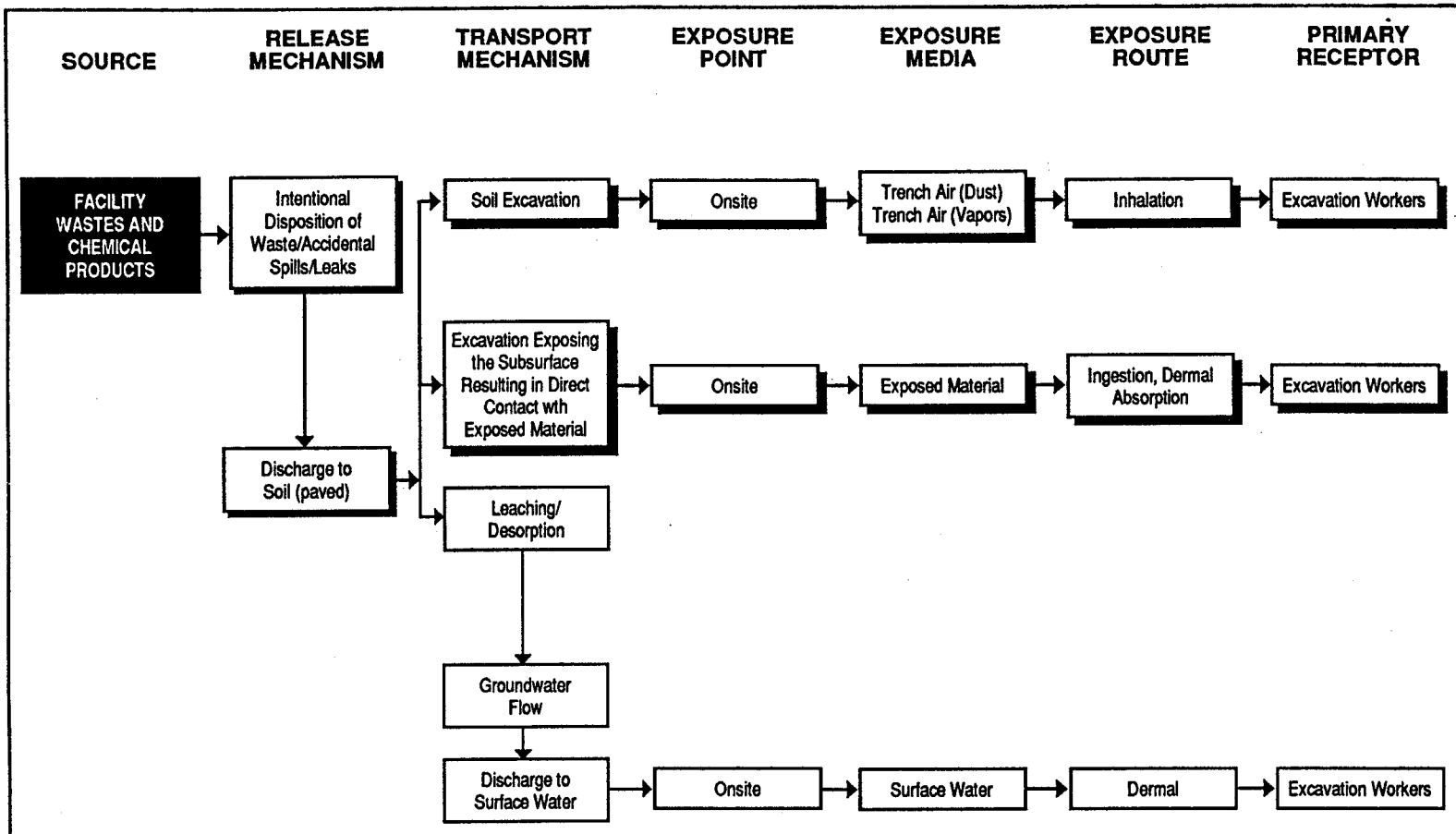
LEGEND

Soil excavation — Designates Most Likely Pathways for Contaminant Migration and Subsequent Exposure

Soil excavation — Minor Pathway

Long Beach Naval Shipyard
RI/FS Work Plan
CTO #037

Figure 3-6
Potential Exposure Pathways
Site 12 *(Sheet 2 of 2)*



LEGEND

Soil excavation — Designates Most Likely Pathways for Contaminant Migration and Subsequent Exposure

Soil excavation — Minor Pathway

Long Beach Naval Shipyard
RI/FS Work Plan
CTO #037

Figure 3-7
Potential Exposure Pathways
Site 13

receptor, and the term route identifies the mechanism by which the chemical enters the body (ingestion, inhalation, dermal contact). The conceptual models reflect only those pathways which will be evaluated under CTO-0037.

The conceptual models vary among sites, depending on the presumed source of COPCs. For example, Sites 9 and 10 are completely paved, and therefore no complete pathway exists between surface soil and on-site industrial workers. Site 8 is unpaved while site II is encapsulated and revegetated. Therefore, the surface soil to on-site industrial worker pathway for these sites is presumed to be complete and will be assessed. Sites 12 and 13 are largely paved, and the need for assessment of exposure of the on-site industrial worker to surface soils from these two sites will be determined by the results of additional surface soil sampling.

For all sites, the risk assessment will be limited to on-site exposures. Although it is possible that some off-site exposure may occur, it will be less than any on-site exposure. The reasonable maximum exposure scenarios for on-site exposure pathways are being examined and will be used for decision making purposes.

The results of the chemical analyses of groundwater, surface soil, and subsurface soil samples taken during the preliminary site investigation indicate that elevated levels of a range of chemical substances are present at the various sites. Organic compounds found in the soil and subsurface soil samples are classified by the USEPA as either volatile or semivolatile compounds. Semivolatile compounds have moderately low vapor pressures and are thus unlikely to be released at appreciable rates from the soil to the atmosphere. Metals found at elevated concentrations in the soil are most likely present in the form of salts and/or oxides, which are also not volatile. Therefore, exposure to semivolatile chemicals and metals in the soil would occur primarily through direct contact of the soil with human skin (dermal contact), inadvertent ingestion of the soil, and inhalation of airborne soil (dust) of respirable size. Exposure to semivolatiles in groundwater would occur primarily through inadvertent contact with human skin.

Volatile compounds (those which have moderate to high vapor pressures) may be released at appreciable rates from the soil or groundwater to the atmosphere. Exposure to volatile compounds in the soil or groundwater, therefore, would occur primarily through inhalation of vapors.

Exposure of occupant workers to vapors from volatile COPCs in the subsurface soils below Building 129 (Site 9) may need to be assessed. The need for evaluating this scenario will be determined based on the level of COPCs found in the subsurface soils and groundwater surrounding Building 129, whether the vapor pressure of the COPCs is sufficiently high to make them volatile, and the thickness and integrity of the concrete floor of the building. If it is determined that a complete exposure pathway exists and this exposure scenario is therefore plausible, a risk assessment methodology will have to be developed, particularly a procedure for estimating the concentration of COPCs in the building.

Associated minor pathways may also exist, but they will be covered through the fish ingestion and related assessments in CTOs 0016 and 0026, and therefore will not be addressed in this risk assessment.

3.3.4 Exposure Point Concentrations

An exposure point concentration is the concentration of a chemical in an environmental medium, such as air, water, soil, or food, at the point of contact with a biological receptor (in this case, the hypothetical worker). The USEPA risk assessment guidance manual (USEPA, 1989) recommends that the upper 95 percent confidence limit on the mean be used either as an exposure point concentration or to calculate an exposure point concentration when estimating reasonable maximum exposure and upper-bound risk. For each potentially complete pathway, the reasonable maximum exposure level will be quantified for each COPC. As part of this evaluation, exposure point concentrations will be derived and the frequency, duration, and magnitude of possible exposures will be estimated. Exposure point concentrations will be measured directly using field data or estimated using modeling techniques. No average case exposure estimates will be used as the maximum exposure concentrations will represent a more conservative scenario.

The exposure print concentration will be the upper 95 percent confidence limit of the mean, and in its computation, concentrations reported as being below detection limits will be assigned values equal to one-half the detection limit. Exposure, in terms of intake, will be calculated using the exposure point concentrations and standard values for estimating human intakes of environmental media. Estimates of chemical intake will be calculated in accordance with standard equations contained in Chapter 6 of the USEPA

Risk Assessment Guidance for Superfund (USEPA, 1989).

For the industrial worker/soil scenario, only surface soil concentrations will be used in the calculation of exposure point concentrations. For the excavation worker/soil scenario, an average of the surface and subsurface soil concentrations will be used to calculate exposure point concentrations.

3.3.4.1 Calculation of Atmospheric Concentration of Solid Chemicals

Inhaled chemical concentrations will be calculated using the following equation:

$$C_a = C_s \times CF \times ML$$

where:

C_a	=	chemical concentration in air (mg/m^3)
C_s	=	upper 95 % confidence limit chemical concentration in soil (mg/kg)
CF	=	conversion factor (0.001 kg/g)
ML	=	mass loading factor (g/m^3)

For the industrial worker, the mass loading factor will be 3.9×10^{-5} g/m^3, which is the arithmetic mean concentration of PM_{10} recorded for North Long Beach in 1992 (Cal/EPA, 1992b). The North Long Beach PM_{10} monitoring station is the closest such station to the Long Beach Naval Shipyard. PM_{10} particles are those with an aerodynamic diameter of up to 10 microns and are classified as respirable. For the excavation worker, the ML parameter will be assigned a value of up to 10 mg/m^3, which is the OSHA standard for nuisance dust. The exact value will be determined after discussion with the regulatory agencies. The above equation overestimates the chemical concentration in air because it assumes that all of the suspended particulates in the air above the site come from the site where, in fact, many of the particulates suspended in air may be blown in from adjacent areas.

3.3.4.2 Calculation of Atmospheric Concentration of Volatile Compounds

Calculation of the atmospheric concentrations of volatile compounds from soils and groundwater will be in accordance with the procedures outlined in

the memorandum from Stanford J. Smucker to the PRG Table Mailing List for the Region IX Preliminary Remediation Goals (PRGs), for the first half of 1994.

3.3.5 Calculation of Dose

Dose is the amount of chemical to which a biological receptor is exposed per unit body weight and time. Dose may be expressed as rate of application (applied dose) or as a rate of absorption (absorbed dose). Equations recommended in the USEPA risk assessment guidance manual calculate applied dose when exposure is by ingestion and inhalation and absorbed dose when exposure is by dermal contact.

3.3.5.1 Incidental Ingestion of Soil

$$D_s = (CS \times IR \times CF \times FI \times EF \times ED) / (BW \times AT)$$

where:

D_s = dose resulting from ingestion of soil (mg/kg/day)
CS = chemical concentration in soil (mg/kg)
IR_s = soil intake rate by ingestion (mg/day)
CF = conversion factor (10^{-6} kg/mg)
FI = fraction ingested from soil (unitless)
EF = exposure frequency (days/year)
ED = exposure duration (years)
BW = body weight (kg)
AT = averaging time (days)
ED x 365 days for noncancer assessment, or
70 yrs x 365 days for cancer assessment

3.3.5.2 Dermal Contact With Soil

$$D_{ab} = (CS \times CF \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT)$$

where:

D_{ab} = absorbed dose from dermal contact with soil (mg/kg/day)
CS = chemical concentration in soil (mg/kg)
CF = conversion factor (10^{-6} kg/mg)
SA = skin surface area available for contact (cm^2/day)
AF = soil-to-skin adherence factor (mg/cm^2)
ABS = absorption factor (unitless)
EF = exposure frequency (days/year)
ED = exposure duration (years)
BW = body weight (kg)
AT = averaging time (days)
ED x 365 days for noncancer assessment, or
70 yrs x 365 days for cancer assessment

3.3.5.3 Inhalation of Dust

$$D_{inh} = (C_a \times IR \times CF \times ET \times EF \times ED) / (BW \times AT)$$

where:

D_{inh} = dose resulting from inhalation of dust (mg/kg-day)
C_a = chemical concentration in air (mg/m^3)
IR_a = air intake rate by inhalation(m^3/day)
CF = conversion factor (0.042 day/h)
ET = exposure time (h/day)
EF = exposure frequency (days/year)
ED = exposure duration (years)
BW = body weight (kg)
AT = averaging time (days)
ED x 365 days for noncancer assessment, or
70 yrs x 365 days for cancer assessment

3.3.5.4 Dermal Contact With Groundwater

$$D_{ab} = (CW \times CF \times SA \times PC \times ET \times EF \times ED) / (BW \times AT)$$

where:

D_{ab} = absorbed dose from dermal contact with groundwater mg/kg/day)
CW = chemical concentration in groundwater or surface water (mg/L)
CF = volumetric conversion factor for water (1 L / 100 cm^2)
SA = skin surface area available for contact (cm^2)
PC = dermal permeability constant
ET = exposure time (h/day)
EF = exposure frequency (days/year)
ED = exposure duration (years)
BW = body weight (kg)
AT = averaging time (days)
ED x 365 days for noncancer assessment, or
70 yrs x 365 days for cancer assessment

With the exception of body weights and skin surface area, the values assigned to the equation parameters will be upper-bound values recommended by USEPA (1988) in:

- U.S. EPA, Office of Health and Environmental Assessment, EPA/600/8-89/043. *Exposure Factors Handbook.* July 1989.
- U.S. EPA, Office of Solid Waste and Emergency Response, Directive 9285.7-01B. *Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors.* March 1991.

The exposure time and frequency for the excavation worker will be based on DON estimates.

3.4 RISK CHARACTERIZATION

Risk characterization is a process by which the risk is quantified. The process uses the reference doses and cancer potency factors assembled during the toxicity assessment and the doses calculated in the exposure assessment. Noncancer risk and cancer risk are quantified separately. The toxicity assessment and exposure assessment will be summarized and integrated into estimations of health risks.

Quantified health risks will be presented as the:

- Cancer risk and noncancer hazard quotient for each chemical for each exposure pathway
- Sum of the cancer risks associated with each exposure pathway
- Sum of the hazard quotients (hazard index) for each exposure pathway
- Total cancer risk to the exposed individual for each exposure scenario calculated by summing the cancer risks associated with exposure pathways
- Total noncancer hazard to the exposed individual for each exposure scenario calculated by summing the relevant hazard indexes for potentially simultaneous exposure pathways.

3.4.1 Quantification of Cancer Risk

Cancer is believed to be the end result of a multistage process in which a large number of biological and environmental factors interact, simultaneously or in sequence, to disrupt normal cell growth and division. The first stage, called initiation, involves the creation of errors in genetic coding. Because the effects of initiation are thought to occur at the molecular level, current regulatory policy assumes that there is no finite dose below which the initiation effect cannot occur. Current regulatory policy assumes that at any dose there is some finite probability associated with the occurrence of the initiation event.

CPF is an estimate of the cancer risk associated with a dose of one milligram per kilogram of body weight per day (risk per mg/kg-day). A mathematical model describing the relationship between dose and the cancer development process is used to calculate the CPF. Several models have been developed, each based on a different hypothesis regarding cancer development. The linearized multistage model is preferred by USEPA and Cal/EPA when it is applicable. The CPFs of most of the chemicals in the IRIS database and on the Cal/EPA 1992 list of cancer potency factors were obtained with the linearized multistage model. The CPF produced by the model is the upper 95 percent confidence limit of the potency.

Cancer risk is expressed as a probability and is calculated by multiplying the estimated dose of a given carcinogen by the CPF developed for the carcinogen. The resulting number represents the probability that a person receiving the estimated dose will develop cancer during his/her lifetime. Because cancer risk is a probability estimate, the cancer risk presented by different carcinogens can be added to obtain an estimate of overall risk. Cancer burden is the number of people in a population that will develop cancer and is calculated by multiplying the cancer risk to the individual by the number of people in the population at risk.

In this risk assessment, two sets of cancer risk estimates will be developed. The first set of estimates will be obtained using USEPA CPFs exclusively. The second set will be obtained using available Cal/EPA CPFs and USEPA CPFs when Cal/EPA CPFs are not available.

Although the DON agrees at this time to display Cal/EPA CPFs, it clearly and expressly reserves the right to reject their use at a later date if it determines they are not adequately supported. DON has not endorsed the utilization of Cal/EPA CPFs in the RI/FS, Proposed Plan, or ROD and reserves the right to decline their use if it is determined that they are not appropriate.

3.4.2 Quantification of Noncancer Risk

In risk assessments, noncancer effects are those that result primarily from chemically-induced impairment of biochemical and/or physiological function and manifest themselves in some kind of illness. It has been well demonstrated that noncancer effects do not occur below a certain dose called the threshold dose. This dose is chemical-specific and therefore differs from chemical to chemical. The presence of a threshold dose means that there is a dose below which chemicals are not toxic. The reference dose is a representation of the nontoxic dose. For some chemicals, it may be the threshold dose or very close to it. For others, it may be below the threshold dose. Regardless of its position in the range of nontoxic doses, the reference dose is regarded in risk assessment as a dose above which toxic effects may occur. Therefore, the occurrence of toxic effects (i.e., noncancer effects) is measured by calculating the ratio of the estimated dose and the reference dose. This ratio is called a hazard quotient.

A hazard quotient of less than 1.0 indicates that the estimated dose is less than the reference dose and toxic effects should not occur. A hazard quotient of 1.0 reflects a borderline situation where effects may or may not occur depending on the proximity of the reference dose to the threshold dose. A hazard quotient larger than 1.0 indicates that the estimated dose exceeds the reference dose and that toxic effects are likely. This likelihood increases as the ratio increases above 1.0.

A conservative estimate of the hazard associated with exposure to all chemicals by a specific pathway, such as the inhalation pathway, is obtained by summing the hazard quotients of the chemicals associated with the pathway. The sum of hazard quotients is call a hazard index. A conservative estimate of the hazard associated with an exposure scenario exposure is obtained by summing the hazard indices of the pathways associated with the exposure scenario.

3.4.3 Evaluation of Lead

At present there is no reference dose for lead. The current approach recommended by EPA for assessing the risk presented by lead is to predict the level of lead in the blood using a pharmacokinetic model developed by EPA and determining if the predicted level exceeds the current "safe" level of 10 micrograms per deciliter (μg/dl).

Cal/EPA has developed a lead risk assessment spreadsheet that uses the EPA model to calculate the lead concentration in the blood of children and adults. If lead is a COPC, this spreadsheet will be used in the assessment of the hazard presented by lead in soil and subsurface soil at the shipyard sites to the hypothetical on-site industrial workers, and excavation workers.

3.4.4 Characterization of Higher Risk Locations

Use of the upper 95 percent confidence limits on the mean to estimate the risk presented by COPCs found in the soil at a site assumes that the chemicals and their concentrations are normally distributed in the soil and that the concentrations of the chemicals are uniform throughout the site. This approach does not account for the potential risk associated with measured chemical concentrations above the upper 95 percent confidence

limits. Depending on the number of samples in which a chemical is found and the variation in the measured concentrations, the highest measured concentration could be substantially higher than the upper 95 percent confidence limit.

Chemicals whose highest measured concentrations exceed a cancer risk of 1×10^{-6} or a hazard quotient of 1.0, and the points within each site where this condition exists, will be identified by a three-step procedure.

Step 1 will entail calculating for the concentration corresponding to a hazard quotient of 1.0 for each chemical and the concentration corresponding to a cancer risk of 1×10^{-6} for each carcinogen. This step will be accomplished by using the equation:

$$C_2 = C_1 \times R_2 / R_1$$

where:

C_1	=	chemical concentration used to calculate multipathway cancer risk or hazard
R_1	=	multipathway risk or hazard index associated with C_1
C_2	=	concentration corresponding to a cancer risk of 1×10^{-6} or a hazard index of 1.0
R_2	=	target risk of 1×10^{-6} or target hazard of 1.0

Step 2 entails calculating the risk or hazard associated with the highest measured concentration of each chemical. This will be accomplished by dividing the highest measured concentration of each chemical by C_2 and, with carcinogens, multiplying the dividend by 1×10^{-6}.

Step 3 will consist of identifying the sampling locations where the highest measured chemical concentrations correspond to a cancer risk exceeding 1×10^{-6} or a hazard index greater than 1.0.

3.4.5 Analysis of Uncertainties

There are many uncertainties inherent in conducting a risk assessment of chemicals released to the environment. These uncertainties can have a large impact on the characterization of risk. In risk assessments performed on Superfund sites, the intent is to overestimate risk to protect public health. By overestimating risk, a comfortable level of confidence is obtained when the results of the risk assessment indicate (or more correctly, a decision is made by risk managers) that risk is not significant. When the results of an assessment indicate that risk is significant, there is the possibility that the true risk is much lower. In such a case, a refined risk assessment may be indicated.

For this risk assessment, a quantitative analysis of uncertainty will be performed. It will consist of identifying the factors that tend to overestimate or underestimate risk.

APPENDIX A

RESPONSE TO COMMENTS
DRAFT PLAN

RESPONSE TO COMMENTS
LONG BEACH NAVAL SHIPYARD RI/FS
DRAFT RISK ASSESSMENT WORK PLAN

July 15, 1994

Comments by: California Department of Toxic Substances Control (DTSC)
Response by: Susan R. Livenick, Bechtel

Number	Comment	Response
	General Comments	
1	*Regarding the Draft Risk Assessment Plan is acceptable but any changes or amendments to the risk assessment plan for the Long Beach Naval Station should be incorporated into assessment of all terrestrial sites for Long Beach Naval Shipyard. The workshop had resulted in no further comment on the RAWP.*	*This comment was discussed with DTSC Risk Assessor John Christopher on June 9, 1994. Mr. Christopher stated that the comment directly addressed any changes relevant to CTO 37 which might arise that same afternoon in a workshop on the Long Beach Naval Station terrestrial site risk assessment issues.* *At the conclusion of that workshop, John Christopher stated that none of the issues raised pertained to CTO 37, and that no revisions to the Risk Assessment Work Plan were required.*