RESPONSES TO DEPARTMENT OF TOXIC SUBSTANCES CONTROL (DTSC) COMMENTS, JANUARY 24, 1995

1. All "no further action" recommendations will be removed from the revised (draft final) remedial investigation (RI) work plan. Screening risk assessments and preliminary endangerment assessments (PEAs) will be completed for the installation restoration program (IRP) sites following completion of the RI field activities. The screening risk assessment and PEA results will be presented in a separate document.

2. The Navy has begun review of California Environmental Quality Act (CEQA) requirements and will consider these requirements during the remedial action selection phase.

3. The Navy has begun review of applicable portions of California Code of Regulations Title 22 remedial action plan (RAP) requirements. Record of decision (ROD) terminology will be replaced with RAP/ROD terminology as requested.

Risk Assessment General Comments

1. Screening of the sites for no further action decisions and PEAs for the IRP sites will be presented in a separate document. References to the screening analysis will be removed from the draft final RI work plan.

2. Section 5.0 in the RI work plan presents a general human health risk assessment approach which will be tailored to each site as necessary. The exposure pathways which are presented in the document are comprehensive and include soil ingestion; dermal contact with soil; inhalation of vapors and particulates; dermal contact with groundwater; groundwater ingestion; and ingestion of homegrown fruits and vegetables. The Navy believes that these exposure pathways will fully characterize risks to future residents and workers at NALF Crows Landing.

   All site investigation (SI) sampling data were included as an appendix to the draft RI work plan and will be included in the draft final work plan. Additionally, the screening risk assessment document will evaluate the SI data.

In addition, Tables 5-2 through 5-5 will be revised as follows. Separate evaluation of children for inhalation of particulates and vapors, dermal contact with soil, dermal contact with groundwater, ingestion of groundwater and ingestion of homegrown produce will not be quantified. For these exposures, the lower intake rates and body surface area of children are balanced by their lower body weight. Therefore, additional information and accuracy are not obtained by evaluating children and adult exposures separately. For these pathways, adult exposure parameters and an exposure duration of 30 years will be used. Children and adults will be evaluated separately for the soil ingestion pathway because the soil ingestion rate for children is twice as high as that for adults. Additionally, Tables 5-2 and 5-3 will be corrected to show site-specific exposure frequency for current agricultural workers. Assuming a year-round exposure frequency of 250 days per year (d/y) is not reasonable due to the nature of current agricultural work at the base. Under current conditions, agricultural workers are exposed to the site only for part of the year, with the most intensive exposure during the harvesting season. However, future agricultural worker exposure frequency will be assumed to be 250 days per year.

Additionally, the work plan will be revised to reflect that soil contamination resulting from irrigation of crops or landscaping with contaminated groundwater will be modeled and evaluated.

3. Conceptual site models and screening risk assessments for the six IRP sites will be presented in a separate document. The screening risk assessment will follow guidance presented in "Preliminary Endangerment Assessment Guidance Manual" (California Department of Toxic Substances Control ([DTSC] 1993) and "Recommended Outline for Using U.S. Environmental Protection Agency Region IX Preliminary Remediation Goals in Screening Risk Assessments at Military Facilities" (DTSC 1994). The draft final RI work plan will be revised as necessary; risk analysis information in Section 3.0 will be removed from the work plan.

Risk Assessment Specific Comments

1. A screening risk assessment, including data and screening of chemicals of potential concern (COPCs) against preliminary remediation goals (PRGs) will be presented in a separate document. The screening risk assessment will also include a conceptual site model for each IRP site and conform to DTSC guidance (DTSC 1993; DTSC 1994). Hazards to potential

ecological receptors will be assessed separately from human receptors. Potential future threats to groundwater will be evaluated and discussed in the screening risk assessment document.

2. The tables will be removed from the draft final RI work plan. A complete presentation of site data, background data, and background comparisons will be presented in the screening risk assessment document. Tables will be reformatted for clarity.

3. The citation will be corrected.

4. The Navy agrees that metals detected at concentrations within the range of background should not be included in the risk assessment. However, the frequency of detection and essential nutrient criteria will also be used in selecting COPCs. U.S. Environmental Protection Agency (EPA) guidance (1989) recommends the use of a 5 percent frequency of detection to remove from consideration those chemicals which are sampling artifacts. It states:

> Chemicals that are infrequently detected may be artifacts in the data due to sampling, analytical, or other problems, and therefore may not be related to site operations or disposal practices. Consider the chemical as a candidate for elimination from the quantitative risk assessment if: (1) it is detected infrequently in one or perhaps two environmental media, (2) it is not detected in any other sampled media or at high concentrations, and (3) there is no reason to believe that the chemical may be present.

Eliminating infrequently detected chemicals from the COPC list prevents the reader from being distracted "from the dominant risks presented by the site" (EPA 1989). Spreadsheet limitations are not considered when selecting COPCs for the site.

Essential nutrients will also be eliminated as COPCs at the site if the estimated intakes do not exceed recommended daily allowances or safe and adequate daily intakes. Essential nutrients will be limited to calcium, iron, magnesium, potassium, and sodium.

5. The Navy will collect background data to assess pesticide and metals concentrations in area surface soils. Site data will be statistically compared to background pesticide and metals concentrations to determine if site concentrations are significantly greater than background.

Homegrown fruit and vegetable ingestion will be assessed for any site which may be developed for residential use. This pathway is considered complete only for residential receptors.

6. The tables will be revised to more clearly present exposure parameters. It is the Navy's intention to calculate soil ingestion intakes using exposure durations of 6 years and 24 years; ingestion rates of 200 milligrams per day (mg/d) and 100 mg/d; and body weights of 15 kilograms (kg) and 70 kg for children and adults, respectively. All other residential exposure pathways will be assessed using adult exposure parameters and a 30-year exposure duration. For all pathways except soil ingestion, the lower intake rates for children are balanced by a lower body weight. Additional information and accuracy are not gained by assessing child and adult intakes separately. Tables 5-2 and 5-5 will be revised.

7. Risks will be calculated and presented using both EPA and DTSC toxicity values. DTSC toxicity values must be used to comply with DTSC guidance. However, for consistency with other naval bases throughout the U.S., it is also necessary to calculate risks using EPA toxicity values.

8. Screening ecological risk assessments will be completed at each IRP site. Section 6.0 in the draft RI work plan, which describes the ecological risk assessment procedures, was completed using the guidance suggested by DTSC.

RESPONSES TO CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD (RWQCB), CENTRAL VALLEY REGION, COMMENTS, JANUARY 23, 1995

GENERAL COMMENTS

1. Background soil concentrations for inorganic constituents were evaluated in 18 background soil samples collected in June 1994 (PRC 1995a). These background soil samples were analyzed for both total and deionized water waste extraction test (DI-WET) concentrations according to RWQCB guidance (RWQCB 1992). Additional background surface soil samples will be collected during the RI to enhance the background database. Background groundwater samples have been collected and analyzed from three background monitoring wells on a quarterly basis since June 1994. Analysis of background groundwater samples will continue through the fourth quarterly groundwater monitoring event scheduled for March 1995.

   Water quality assessments will be completed according to RWQCB guidance (RWQCB 1989, 1992) at applicable IRP sites. The Navy proposes using soil screening levels to evaluate existing SI data to determine if water quality assessments are needed at each IRP site. Soil screening levels are needed to determine if low concentrations of petroleum hydrocarbons identified in many SI soil samples warrant further investigation. Specifically, soil screening levels are needed to evaluate total recoverable petroleum hydrocarbon (TRPH), extractable total petroleum hydrocarbon (TPH-E), toluene, and xylene concentrations.

   The Navy proposes using 100 milligrams per kilogram (mg/kg) as a soil screening level for TRPH and TPH-E. This concentration is consistent with RWQCB underground storage tank (UST) guidance for evaluating TRPH or TPH-E concentrations usually requiring no further investigation (RWQCB 1990). For toluene and xylenes, the Navy proposes using EPA soil screening levels for potential migration to groundwater assuming a dilution and attenuation factor of 10 (EPA 1994). A quick reference fact sheet prepared by EPA describing the soil screening level process is attached to these comment responses. The proposed soil screening levels are summarized below.

Soil Constituent	Proposed Soil Screening Level
TRPH	100 mg/kg[1]
TPH-E	100 mg/kg[1]
Toluene	5.0 mg/kg[2]
Xylenes	74 mg/kg[2]

1 RWQCB 1990
2 EPA 1994 (assuming a dilution and attenuation factor of 10)

The approach to completing water quality assessments at each applicable site is described in the site-specific comment responses. These descriptions will be added to the draft final RI work plan.

2. The possible need for additional field activities following completion of the proposed RI activities is recognized and will be acknowledged in the draft final RI work plan. However, it is the intention of this RI work plan to be as comprehensive as possible to minimize the need for subsequent field work.

3. The identification and evaluation of areas of potential contamination are ongoing processes at NALF Crows Landing. The draft RI work plan described all currently recognized IRP sites except Site 10, the rubble disposal area, and Site 14, the fire fighting training area. Site 10 was previously removed from consideration for future investigation based on preliminary assessment results (EPA 1990) and Site 14 was remediated (Battelle 1992). Descriptions of Sites 10 and 14 will be added to the draft final RI work plan to make the document comprehensive for all currently recognized IRP sites. However, potential areas of contamination described in the baseline environmental report (Tetra Tech 1994) or identified in the future will be addressed separately from this RI work plan.

4. Evaluating background sample data, including determining appropriate statistical methods to compare background with site-specific sample data, is continuing and will continue as additional sample data are collected. The ranges of background and site-specific constituent

concentrations will be added to statistical comparison tables in the draft final RI work plan and to any comparison tables in future documents.

5. The draft final RI work plan will include a proposal to collect six surface soil samples from background locations in cultivated fields to evaluate background pesticide concentrations and to enhance the background metals concentration database. These additional background samples will be analyzed for both total and DI-WET concentrations. Table 1, attached to these comment responses, summarizes the additional background sampling activities.

6. This comment was previously addressed in the responses to comments on the draft first quarterly groundwater monitoring report and the draft site investigation report (PRC 1995b). The comment response is repeated below. In general, it appears that sample analytical data are currently reported for NALF Crows Landing projects in a format compatible with the review comment requests.

All analytical methods have limits of measurement. The most frequently used limits of measurement are the detection and quantitation limits. The detection limit is the lowest concentration that can be reliably differentiated from zero, but cannot be quantified with acceptable precision. Detection limits are method, matrix, and laboratory specific. The quantitation limit is the lowest concentration that can be detected and quantified with a specific degree of precision. The quantitation limit is the detection limit corrected for sample dilution and other sample-specific adjustments, such as percent moisture. The quantitation limit is always greater than the detection limit, usually by a factor of about three. The contract required quantitation limit (CRQL) and the contract required detection limit (CRDL) are the quantitation limits for organic and inorganic analytes, respectively, that the laboratories are required to report.

Detections above the CRQL or CRDL are reported without qualification. Detections below the CRQL or CRDL but above the detection limit are reported as estimated and given a "J" qualifier. Concentrations below the detection limit (nondetect) are given a "U" qualifier and are reported with the CRQL or CRDL. For example, if an analysis has a detection limit of 3 and a quantitation limit (CRQL or CRDL) of 10, a concentration of 12 would be reported as 12, a concentration of 7 would be reported as 7J, and a concentration less than 3 would be

reported as 10U. The term "trace" is subjective and not quantifiable; however, the term may be applied to a "J" qualified result.

Laboratory analyses for the Comprehensive Long-term Environmental Action Navy (CLEAN) contract are completed under a basic ordering agreement (BOA) established with several different laboratories. By contract, the BOA laboratories are required to report analytical data as described above. In response to this comment, definitions of all data qualifiers used in reporting laboratory analytical results will be added to future NALF Crows Landing reports.

7. The irrigation and domestic use wells on base may be affected by contamination from either IRP or UST sites. Consequently, these wells should be evaluated under the base-wide groundwater monitoring program. An evaluation of the on-base irrigation and domestic use wells will be included in the groundwater monitoring annual report and procedures for any additional evaluation of these wells will be included in the long-term monitoring plan. Both the annual report and long-term monitoring plan will be completed following the fourth quarterly monitoring event in March 1995. Draft versions of both documents will be submitted by approximately June 1, 1995. Maps showing the locations of all on-base irrigation and domestic use wells will be included in both documents.

8. Additional detail will be added as appropriate to site maps in the draft final RI work plan. However, maps for Sites 11, 12, 13, and 16 were redrafted for the RI work plan using recent monitoring well survey data, actual building measurements, and detailed aerial photograph enlargements. In general, the site maps presented in the RI work plan are far more accurate than previous maps presented in the original SI report (PRC 1992). In addition, the scale of each map was adjusted to standard sizes (for example, 1 inch equals 100 feet) to simplify measurements with an engineering scale.

SITE-SPECIFIC COMMENTS

Site 11

1. Historical descriptions of Site 11 indicated that four disposal pits were used over a period from the late 1960s to 1982 (Naval Energy and Environmental Support Activity [NEESA]

1984). Three of the pits were used to dispose of general refuse and the fourth pit was used to dispose of approximately 300 pounds of scrap metal collected from two nearby practice bombing ranges. Refuse was burned in all four disposal pits.

Historical descriptions (NEESA 1984) and information from base personnel were used to identify probable disposal pit locations. Geophysical surveys using a magnetometer and ground-penetrating radar (GPR) were then completed during the SI at Site 11 to search for the disposal pit locations (PRC 1992). Historical aerial photographs were also reviewed to help locate the disposal pits. These efforts to locate the disposal pits met with mixed success. Soil borings were placed in the probable disposal pit locations described by base personnel and in geophysical anomalies delineated during the SI. Two soil borings drilled through approximately 6 feet of suspected fill material that contained no refuse. Two other soil borings drilled through approximately 20 feet of suspected fill material that contained minor amounts of construction debris. The historical aerial photographs showed no evidence of any disposal pits. In general, the exact locations and sizes of the disposal pits remain uncertain.

As described in the draft RI work plan, cone penetrometer tests (CPTs) and HydroPunch groundwater sampling will be completed to evaluate the extent of groundwater contamination, determine if areas of more concentrated contamination exist, and to select locations for new monitoring wells. To address RWQCB's concerns, the draft final RI work plan will include at least two soil borings located in areas of highest groundwater contaminant concentrations identified through HydroPunch groundwater sampling. Soil samples from these borings (located in the most prospective contaminant source areas) will be collected from depths of 0, 5, 10, 15, 20, 30, and 40 feet below ground surface (bgs) or from zones of obvious contamination. One soil sample from each boring will also be collected from immediately above the water table surface. These soil samples will be analyzed for total constituent concentrations. DI-WET concentrations will be obtained for samples from 0, 5, 10, 15, and 20 feet bgs or from zones of obvious contamination. If HydroPunch groundwater sampling is not successful at identifying probable groundwater contaminant source areas, one of the planned source area soil borings will be located adjacent to SI boring 12-SB-03 where TRPH concentrations as high as 120 mg/kg were previously identified. Soil gas sampling is not proposed because no volatile compounds have been identified in previous groundwater samples from the site. Table 1 summarizes all RI sampling proposed at Site 11.

2. The probable disposal pit locations will be added to Figures 3-1 and 4-1 in the draft final RI work plan. However, as explained in the response to Site 11 comment 1, the exact locations and sizes of the disposal pits remain uncertain. Reference to Figure 4-1 has not been added to Section 4.1.2.2.1 because the soil boring locations discussed in this section will be located based on HydroPunch groundwater sampling results and cannot be estimated at this time.

Site 12

1. Contaminant investigation activities for USTs 117 and Cluster 1 have been described in the UST Site Investigation field sampling plan (FSP) submitted January 30, 1995 (PRC 1995c). This FSP describes procedures to evaluate the nature and extent of soil and groundwater contamination associated with these USTs and will include HydroPunch groundwater sampling and monitoring well installation in the Site 12 area as appropriate. The draft final RI work plan will be revised to include additional soil sampling to evaluate potential groundwater contamination sources at Site 12 (see response to Site 12 comment 2), but evaluation of the nature and extent of groundwater contamination in the area will continue to be pursued under the UST program.

   A soil vapor extraction (SVE) pilot-scale study is planned for the UST 117 area to evaluate SVE as an alternative to remediate contaminated soils remaining in the unsaturated zone beneath the tank excavation (PRC 1995c). Specifically, the SVE pilot-scale study will evaluate soil permeability to air and the radius of influence to expect from a vapor extraction well. The approximate extent of contaminated soils in the unsaturated zone beneath the tank excavation is known from previous investigations and there are no plans at this time to extend the SVE pilot-scale test into the Site 12 area.

   The Navy believes that groundwater contamination detected beneath Site 12 is similar to that detected beneath the UST 117 and Cluster 1 areas. Contamination at UST 117 is from gasoline and contamination at UST Cluster 1 is from JP-5. Groundwater contamination at UST 117 includes purgeable TPH (TPH-P), TPH-E, benzene, toluene, ethylbenzene, and xylenes while groundwater contamination at UST Cluster 1 includes primarily TPH-E, ethylbenzene, and xylenes. Groundwater contamination detected beneath Site 12 includes TPH-E, lesser concentrations of TPH-P, and low concentrations of benzene, toluene, and xylenes. The groundwater contamination at Site 12 most resembles that observed at the

fringes of the UST 117 plume, but may include some mixing of contamination from UST Cluster 1. Field investigation activities planned for the UST sites are designed to evaluate whether the contaminant plumes merge or remain discrete. Methylene chloride was not detected in the groundwater sample collected from Site 12. In general, however, methylene chloride is considered a common laboratory contaminant and detections at low concentrations are usually regarded as such.

2. The draft final RI work plan will be revised to include soil sampling to evaluate TPH-E and pesticide contamination identified during the SI at the northern end of the vehicle parts washrack pad. A soil boring will be completed adjacent to SI sampling location 12-HB-06 to evaluate the vertical extent of this contamination and to complete a water quality assessment. The lateral extent of this contamination is already constrained by SI sampling locations approximately 13 feet north (12-HB-07), 14 feet south (12-SB-03), and 23 feet west (12-HB-01) where contaminants were either not detected or were detected below the screening levels proposed in response to general comment 1. Soil samples will be collected from depths of 0, 5, 10, 20, 30, and 40 feet bgs or from zones of obvious contamination. One soil sample will also be collected from immediately above the water table surface. Soil samples will be analyzed for total constituent concentrations. DI-WET concentrations will be obtained for samples from 0, 5, and 10 feet bgs or from zones of obvious contamination. Table 1 summarizes the RI sampling proposed at the northern end of the vehicle parts wash rack pad.

   The draft final RI work plan will also be revised to include additional soil sampling at the Site 12 pesticide mixing area. One hand-auger boring will be completed adjacent to SI sampling location 12-HB-05. Two soil samples will be collected from depths of approximately 0 and 3 feet bgs. The soil samples will be analyzed for total and DI-WET pesticide concentrations. Table 1 summarizes the RI sampling proposed at the pesticide mixing area.

   No RI sampling is proposed at the waste bowser area. Petroleum hydrocarbons, the contaminants expected at this area, were not detected above the soil screening levels proposed in response to general comment 1 in the SI soil samples.

3. Additional detail will be added to the draft final RI work plan describing activities in the auto maintenance shop. In general, the auto maintenance shop was used for routine maintenance, such as oil changes and tune ups on automobiles and other equipment. Waste oils were

collected in buckets or cans that were emptied into the waste bowser. The contents of the waste bowser were periodically transferred to Site 14, the fire training area, and burned during fire training exercises. No oil/water separator or drain lines existed and the only sewer line in the area was connected to the toilet and sink in the building bathroom.

Site 13

1. Slanted hand-auger borings were completed at Site 13 specifically to sample native soils that were adjacent to the original concrete pad. This sampling scheme was designed to collect potentially contaminated soil near the edge of the original concrete pad. The sampling procedures were reviewed by representatives of both DTSC (James Pinasco) and RWQCB (Michael Mosbacher) prior to beginning the SI. The Navy believes the SI sampling activities were sufficient to evaluate possible polychlorinated biphenyl (PCB) contamination at Site 13. The results indicate that either transformer oil never was spilled off the edge of the original concrete pad or that all contaminated soil was removed when the pad was enlarged. No additional sampling activities are proposed to evaluate potential PCB contamination at Site 13.

The draft final RI work plan will be revised to include soil sampling to evaluate pesticide (toxaphene) contamination identified at Site 13. One hand-auger boring will be completed adjacent to SI sampling location 13-HB-01 to collect soil samples for water quality assessment purposes. Two soil samples will be collected from approximate depths of 0 and 3 feet bgs. The soil samples will be analyzed for both total and DI-WET pesticide concentrations.

In general, the Navy believes the toxaphene contamination identified at Site 13 resulted from overspraying of cropland adjacent to the concrete pad and not from any Navy disposal activities. Toxaphene was a common organochlorine insecticide used on a variety of California crops beginning in the mid 1940s (Eisler and Jacknow 1985). Most uses of toxaphene were banned by EPA in 1982 due to the environmental persistence of the compound and its toxicity to aquatic fauna. However, the use of existing stockpiles was allowed through 1986.

No RI sampling is proposed to evaluate inorganic constituents at Site 13. The site was originally sampled to evaluate potential PCB contamination. Organochlorine pesticide contamination was detected as a result of the analytical method used to evaluate potential PCB

contamination (EPA Method 8080 for PCBs and pesticides). The Navy sees no rationale or justification for evaluating inorganic constituents in soils at this site.

Site 16

1. Pesticides were not detected in either soil or groundwater samples collected during the SI at Site 16 and all petroleum hydrocarbon soil concentrations detected were below the soil screening levels proposed in the response to general comment 1. In general, the Navy's use of pesticides at NALF Crows Landing included primarily common herbicides of organic formulation and some insecticides and rodenticides. Samples collected during the SI were analyzed for the most environmentally persistent organochlorine pesticides. However, heavy-metal containing pesticides, primarily arsenic formulations, could have been used at NALF Crows Landing. Consequently, the draft final RI work plan will be revised to include one hand-auger boring adjacent to SI sampling location 16-SB-01. Two soil samples will be collected from depths of approximately 0 and 3 feet bgs. The soil samples will be analyzed for total and DI-WET metals concentrations. Table 1 summarizes the RI sampling proposed at Site 16.

   Monitoring well 16-MW-01 was located approximately 12 feet north of the faucet reportedly used to rinse the pesticide spray tanks. Presumably, rinsate from the spray tanks would have been spread in the gravel area north of the faucet. The Navy considers well 16-MW-01 to be neither upgradient nor downgradient of the site, but rather in the middle of the site and therefore appropriately located to detect any possible pesticide contamination resulting from Site 16 activities.

Site 17

1. The draft final work plan will be revised to specify that at least two soil borings will be completed in the most prospective groundwater contamination source areas. The potential groundwater contamination source areas will be determined in the field based on observations from the excavation of the floor drain sump and HydroPunch groundwater sampling results. Soil samples from these borings will be collected from depths of 0, 5, 10, 20, 30, and 40 feet bgs or from zones of obvious contamination. One soil sample from each boring will also be collected from immediately above the water table surface. These soil samples will be

analyzed for total constituent concentrations. DI-WET concentrations will be obtained for samples from 5, 10, and 20 feet bgs or from zones of obvious contamination. A vertical profile of volatile organic compound (VOC) concentrations in soil gas will also be completed at the potential source area soil borings. Table 1 summarizes all RI sampling proposed at Site 17.

2. The locations of the floor drain sump and the demolished laundry facility will be added to Figure 4-2 in the draft final RI work plan. Currently, no piping is known to be associated with either the floor drain sump or the demolished laundry facility.

3. All soil gas sampling results were added to the draft final SI addendum report submitted January 6, 1995 (PRC 1995a). All soil gas sampling results will be added to the draft final RI work plan.

Site 18

1. As described in the response to general comment 5, additional background surface soil samples will be collected as part of the RI activities. In addition, the draft final RI work plan will be revised to include and additional hand-auger boring adjacent to SI sampling location 18-HB-2, the location of the highest total lead concentrations detected in the SI soil samples. Two soil samples will be collected from depths of approximately 0 and 3 feet bgs. The soil samples will be analyzed for total and DI-WET metal concentrations. Table 1 summarizes the RI sampling proposed at Site 18.

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TABLE 1

IRP RI Sample Collection Summary

Location and Number of Samples	Sample Analyses	Objective of Sampling
SITE 11		
HydroPunch Groundwater Samples A minimum of 16 samples will be collected from immediately beneath the water table surface.	Immunoassay field analysis for TPH with 10% laboratory confirmation analysis for TPH-E.	To obtain a preliminary estimate of the TPH-E groundwater contaminant plume size, shape, and most concentrated areas. To determine optimal locations for soil borings to evaluate possible groundwater contaminant source areas and permanent groundwater monitoring wells.
A minimum of two samples will be collected from approximately 30 feet below the top of water table surface.	Immunoassay field analysis for TPH with 10% laboratory confirmation analysis for TPH-E	To evaluate the vertical extent of groundwater contamination.
Soil Boring Samples A minimum of two borings will be completed in potential contaminant source areas as determined from HydroPunch groundwater sample analyses. Samples will be collected from depths of approximately 0, 5, 10, 15, 20, 30, and 40 feet bgs and immediately above the water table surface or from zones of obvious contamination.	VOCs SVOCs[1] Metals[1] Pesticides/PCBs[1] TPH-E Total organic carbon (TOC), grainsize, moisture content, and Atterberg limits analyses in approximately three samples.	To evaluate possible soil contamination in areas where groundwater contamination is most concentrated and to complete RWQCB water quality assessment requirements. TOC and geotechnical analyses will be used to evaluate soil characteristics for contaminant transport modeling and remedial design purposes.

TABLE 1 (Continued)

IRP RI Sample Collection Summary

Location and Number of Samples	Sample Analyses	Objective of Sampling
A minimum of three borings will be completed to install groundwater monitoring wells at the maximum extent of contaminant plume as determined from HydroPunch groundwater sample analyses. Soil samples will be collected only from obvious zones of contamination and immediately above the water table surface.	VOCs SVOCs Metals Pesticides/PCBs TPH-E	To evaluate possible soil contamination in the capillary fringe zone at the maximum extent of the groundwater contaminant plume.
Groundwater Samples A minimum of two wells will be located in the most contaminated portion of the plume and three wells will be located at the maximum extent of the plume. All locations will be based on HydroPunch groundwater sample analyses.	VOCs SVOCs Total and dissolved metals Pesticides/PCBs TPH-E	To evaluate groundwater contaminant characteristics where contamination is most concentrated and to monitor the lateral extent of the plume.
SITE 12		
Soil Boring Soil Samples One boring will be completed at north end of the vehicle parts washrack pad. Samples will be collected from depths of approximately 0, 5, 10, 20, 30, and 40 feet bgs and immediately above the water table surface or from zones of obvious contamination.	VOCs SVOCs[2] Metals[2] Pesticides/PCBs[2] TPH-E	To evaluate the vertical extent of soil contamination detected at northern end of the vehicle parts washrack and to complete RWQCB water quality assessment requirements.
One hand-auger boring will be completed adjacent to SI sampling location 12-HB-05. Samples will be collected from depths of approximately 0 and 3 feet bgs.	Pesticides/PCBs - total constituent and DI-WET concentrations	To complete RWQCB water quality assessment requirements.

TABLE 1 (Continued)

IRP RI Sample Collection Summary

Location and Number of Samples	Sample Analyses	Objective of Sampling
SITE 13		
Soil Boring Soil Samples One hand-auger boring will be completed adjacent to SI sampling location 13-HB-01. Samples will be collected from depths of approximately 0 and 3 feet bgs.	Pesticides/PCBs - total constituent and DI-WET concentrations	To complete RWQCB water quality assessment requirements.
SITE 16		
Soil Boring Soil Samples One hand-auger boring will be completed adjacent to SI sampling location 16-SB-01. Samples will be collected from depths of 0 and 3 feet bgs.	Metals - total constituent and DI-WET concentrations.	To complete RWQCB water quality assessment requirements.
SITE 17		
HydroPunch Groundwater Samples A minimum of nine samples will be completed from immediately beneath the water table surface.	VOCs	To obtain a preliminary estimate of the carbon tetrachloride groundwater contaminant plume size, shape, and most concentrated areas. To determine optimal locations for soil borings and soil gas testing locations to evaluate possible groundwater contaminant source areas, and for permanent groundwater monitoring wells.
A minimum of two samples will be completed from approximately 30 feet below top of water table surface.	VOCs	To evaluate the vertical extent of groundwater contamination.

TABLE 1 (Continued)

IRP RI Sample Collection Summary

Location and Number of Samples	Sample Analyses	Objective of Sampling
Soil Samples (from floor drain sump excavation) A minimum of three samples will be completed from beneath the base of the floor drain sump or along any associated piping.	VOCs TPH-E	To determine whether contaminants leaked from the floor drain sump structure.
Soil Boring Soil Samples A minimum of two borings will be completed in potential contaminant source areas as determined from floor drain sump excavation observations and HydroPunch groundwater sample analyses. Samples will be collected from depths of approximately 0, 5, 10, 20, 30, and 40 feet bgs and immediately above the water table surface or from zones of obvious contamination.	VOCs SVOCs[2] Metals[2] TPH-E	To evaluate soil contamination in probable groundwater contamination source areas and to complete RWQCB water quality assessment requirements.
	TOC, grainsize, moisture content, and Atterberg limits analyses in approximately three samples.	TOC and geotechnical analyses will be completed to evaluate soil characteristics for contaminant transport modeling and remedial design purposes.
A minimum of three soil borings will be completed to install groundwater monitoring wells at the maximum extent of the contaminant plume as determined from HydroPunch groundwater sample analyses. Soil samples will be collected only from obvious zones of soil contamination and immediately above the water table surface.	VOCs SVOCs Metals TPH-E	To evaluate possible soil contamination in the capillary fringe zone at the maximum extent of the groundwater contaminant plume.

TABLE 1 (Continued)

IRP RI Sample Collection Summary

Location and Number of Samples	Sample Analyses	Objective of Sampling
Soil Gas Samples To evaluate a vertical profile of soil gas characteristics at locations paired with the soil borings completed in potential contaminant source areas.	VOCs	To evaluate soil contamination in probable groundwater contamination source areas.
Groundwater Samples A minimum of two wells will be located in the most contaminated portion of the plume and three wells located at the maximum extent of the plume. All locations will be based on HydroPunch groundwater sample analyses.	VOCs SVOCs Metals TPH-E	To evaluate groundwater contaminant characteristics where contamination is most concentrated and to monitor the lateral extent of the plume.
SITE 18		
Soil Boring Soil Samples One hand auger boring will be completed adjacent to SI sampling location 18-HB-2. Samples will be collected from depths of approximately 0 and 3 feet bgs.	Metals - total constituent and DI-WET concentrations	To complete RWQCB water quality assessment requirements.
BACKGROUND		
Surface Soil Samples A minimum of six surface soil samples will be collected from cultivated fields.	Metals and pesticides/PCBs-total constituent and DI-WET concentrations	To determine typical background pesticide concentrations and to enhance the background metal concentrations database.

Notes:

1 Total constituent and DI-WET concentration analyses in samples from 5, 10, 15, and 20 feet bgs or from zones of obvious contamination.

2 Total constituent and DI-WET concentration analyses in samples from 0, 5, and 10 feet bgs or from zones of obvious contamination.

STATE OF CALIFORNIA—CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY PETE WILSON, *Governor*

DEPARTMENT OF TOXIC SUBSTANCES CONTROL
REGION 1
10151 CROYDON WAY, SUITE 3
SACRAMENTO, CA 95827-2106
(916) 255-3705

January 24, 1995

Mr. Hubert H. S. Chan
Remedial Project Manager
Western Division
Naval Facilities Engineering Command
BRAC Environmental Program, Code T4A
900 Commodore Drive
San Bruno, California 94066-2402

DRAFT REMEDIAL INVESTIGATION WORK PLAN-CROWS LANDING NAVAL AUXILIARY LANDING FIELD

Dear Mr. Chan:

This transmittal constitutes the comments of the Department of Toxic Substances Control and the Regional Water Quality Control Board, Central Valley Region on the subject report delivered November 21, 1994. Please find enclosures from the respective agencies.

If there are any questions or comments regarding this matter, please contact me at (916) 255-3705.

Sincerely,

Kent Strong

Kent Strong
Project Manager
Office of Military Facilities

Enclosures

cc: Ms. Karen Bessette
Regional Water Quality Control Board
Central Valley Region
3443 Routier Road
Sacramento, California 95827-3098

Mr. Neil J. Bingert
PRC Installation Coordinator
PRC Environmental Management, Incorporated
1099 18th Street, Suite 1960
Denver, Colorado 80202

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ENCLOSURE

DEPARTMENT OF TOXIC SUBSTANCES CONTROL
COMMENTS ON
DRAFT REMEDIAL INVESTIGATION WORK PLAN
NAVAL AUXILIARY LANDING FIELD, CROWS LANDING

The Department of Toxic Substances Control (Department) received the Draft Remedial Investigation (RI) Work Plan November 21, 1994. The Department has reviewed the report and has the following comments:

(1) No Further Action (NFA) - NFA is proposed at Sites 12, 13, 16, and 18. Additional information is necessary before we can concur with the proposed NFA at these sites.

Recommendation: Screening risk assessments must be presented. Please review the enclosed Department memorandum for additional guidance on implementation of this assessment.

(2) Application of portions of the California Environmental Quality Act (CEQA) at Crows Landing NALF will be necessary during the remedial action selection phase. The Navy must begin consideration of these requirements.

Recommendation: Start review of the initial study requirements for a CEQA negative declaration.

(3) The Remedial Action Plan (RAP) is the California equivalent for the Federal Superfund Record of Decision (ROD). Since Crows Landing NALF is a Non-National Priorities List Site, the Navy must comply with California RAP requirements. For the most part, California RAP requirements are functionally equivalent to Federal ROD requirements.

Recommendation: Review applicable portions of Title 22 of the California Code of Regulations to ensure compliance with RAP requirements. In the future, the Navy should use the term RAP/ROD as a replacement for ROD. By using RAP/ROD terminology, the Navy will be following the California regulatory process better. This will provide an advantage in the permitting process.

Mr. Robert Fourt
Stanislaus County Department of Environmental Resources
1716 Morgan Road
Modesto, California 95351

Ms. Sandra Olliges
Environmental Program Manager
National Aeronautics and Space Administration
Ames Research Center
Moffett Field, California 94035-1000

KS:sm
KS22W.015

STATE OF CALIFORNIA - ENVIRONMENTAL PROTECTION AGENCY PETE WILSON, Governor
DEPARTMENT OF TOXIC SUBSTANCES CONTROL
301 Capitol Mall, 2nd Floor
Sacramento, CA 95814
Mail: P. O. Box 806
Sacramento, CA 95812-0806
Voice: (916) 327-2491
Fax: (916) 327-2509

MEMORANDUM

TO: Kent Strong
Office of Military Facilities
Region 1, Sacramento

FROM: John P. Christopher, Ph.D., D.A.B.T.
Staff Toxicologist
Office of Scientific Affairs (OSA)
Human and Ecological Risk Section (HERS)

DATE: 13 January 1995

SUBJECT: NALF Crows Landing: Remedial Investigation Work Plan
Outcome: 02 PCA: 14740 Site: 100245-45

Background

Naval Auxiliary Landing Field Crows Landing is an closed military facility located in Stanislaus County. Several portions of the base have turned over to the National Aeronautics and Space Administration (NASA). Environmental restoration for this base is being managed by Engineering Field Activity West, Naval Facilities Engineering Command (WESTDIV). A Preliminary Assessment and Site Inspection (PA/SI) has been completed. The current document summarizes that activity and presents a work plan for those areas of the base which require a Remedial Investigation (RI).

Document Reviewed

We reviewed "Naval Auxiliary Landing Field, Crows Landing, California, Draft Remedial Investigation Work Plan". The document is dated 18 November 1994. It was prepared by PRC Environmental Management, Inc., contractors to WESTDIV. HERS received a request to review and comment upon this document on 8 December 1994.

Scope of Review

The document was reviewed for scientific content. Minor grammatical or typographical errors that do not affect the interpretation have not been noted. However, these should be corrected in the final version of the document. We assume that sampling of environmental media, analytical chemistry data, and quality assurance procedures have

been examined by regional personnel. If inadequacies in this regard for the purposes of risk assessment were encountered, they have been noted. Any future changes or additions to the document should be clearly identified.

General Comments

1. We find that the PA/SI report (Section 3) for the six sites identified in the Installation Restoration Program (IRP) is not acceptable, because screening risk assessments are described in text but not presented. We are can neither agree nor disagree with the conclusions regarding which IRP sites require further investigation at the level of an RI, which conclusions are said to be based on the low probability of adverse health effects.

2. The portion of the RI work plan which refers to risk assessment (Section 5) is not incorrect, but the absence of an analysis of the PA/SI data makes it impossible for us to accept statements regarding which media are contaminated and which exposure pathways are complete.

3. We recommend for each IRP site that conceptual models be constructed and screening risk assessments be performed. This will involve adding new text, figures, and tables to Section 3 of the present document. Section 5 may then be altered as necessary to reflect this analysis.

Specific Comments

1. **Screening Risk Assessment, Sections 3.1-3.6, pp. 3-1 ff.:** Screening risk assessments are absent. We find repeated references to "preliminary risk calculations" and many statements to the effect that concentrations of chemicals detected do "not represent a potential health hazard". In fact, several IRP sites are recommended for no further action based on a lack of any potential for adverse health effects. We cannot accept these assertions, because no data or analyses are presented to support them. Upon presentation of screening assessments with their documentation, we might very well find that we agree with the Navy's recommendations for no further investigation or remedial investigation.

   A screening risk assessment should present a conceptual site model for each IRP site and tabular comparisons of the highest concentrations of chemicals detected to conservatively derived values represented acceptable risks or hazards for both human and non-human (ecological) receptors. In addition, the screening assessment should take into account any potential future threat to groundwater.

We recommend that such screening risk assessments be performed according to the methods described in the Department's *Preliminary Endangerment Assessment Guidance Manual* (DTSC, 1994). If the Navy chooses to make comparisons of site-related concentrations of chemicals to preliminary remediation goals (PRGs) published by USEPA Region IX, then we recommend using the attached memorandum as guidance for this purpose.

2. **Comparison to Background, Tables 3-1, 3-3, 3-4, and 3-6:** These tables were not legible in the copy we reviewed. The very small print had become blurred, probably by photocopying. We recommend constructing these tables in "portrait" orientation, even if this causes the tables to run to multiple pages. Furthermore, we require that the range of detected values be shown in these table for each metal, both for the site and for background. This will aid in the identification of possible "hot spots" which could be missed by a statistical comparison of mean values.

3. **Guidance Documents, p. 5-1:** Please correct the reference to the Department's 1992 publication *Supplemental Guidance for Multimedia Human Health Risk Assessments for Hazardous Waste Sites and Permitted Facilities*

4. **Chemicals of Potential Concern (COPC), Sec. 5.1, p. 5-4:** Although methods for shortening the list of COPC is given in USEPA guidance for risk assessment, the Department recommends as a general rule that all detected chemicals be included in the risk assessment, except for metals within the range of background. Spreadsheet software makes this a relatively simple task, except for the most complicated sites. We expect this is not a complicated site. Regarding elimination of metals as essential nutrients, please confine this to the five mentioned in USEPA guidance: Na, K, Ca, Mg, and Fe. Regarding the background data for metals, please present a summary which shows the ranges of sample quantitation limits and detected values.

5. **Pesticides for Agricultural Use, Sec. 5.1.3. p. 5-4:** We understand that many areas of the base have been under cultivation for decades, including areas close to identified IRP sites. Because this is a closed base, future land use is out of the Navy's control. If the Navy has any potential future liability, this RI presents an opportunity to characterize it. It might behoove the Navy to characterize risks of exposure to legally applied pesticides in a residential setting, in case such a land use is contemplated at some future time. Such an assessment should include potential risks and hazards attendant upon exposure to chlorinated insecticides taken up from soils into home-grown produce. We note that Table 5-6 refers to exposure parameters for fruits and vegetables, but we cannot discern from the text which IRP sites these values will be used for.

6. **Default Exposure Parameters, Tables 5-1 through 5-6:** The Department recommends that a residential exposure to carcinogens be composed of 6 yr exposure to a 15 kg child and 24 yr exposure to a 70 kg adult. Exposures to threshold agents should be characterized for children, with an averaging time of 6 yr; this will be adequately protective for adults. In Table 5-3, we find it surprising that the values for exposed skin surface are equal for adults and children. The Department recommends using 2,000 cm^2 for skin area in children exposed to residential soils.

7. **Toxicity Criteria, Sec. 5.3, p. 5-10:** For chemicals which have cancer potency factors published by both USEPA and Cal/EPA, please use the higher of the available values for estimating risks.

8. **Ecological Assessment, Sec. 6, pp. 6-1 ff.:** Screening ecological risk assessments should be completed for <u>all</u> the IRP sites, not just for Sites 11 and 17. The attached memorandum provides guidance for conducting such screening assessments. We enclose the following two draft documents recently released for public comment and ask that the Navy consider using them as additional guidance for the Crows Landing facility:

   Draft Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities, Part A: Overview (August 1994) and

   Draft Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities, Part B: Scoping Assessment (September 1994).

   Please contact HERS regarding selection of toxicity criteria prior to estimating risks and hazards for indicator species. We have found that this can be a contentious area and consensus on appropriate criteria should be achieved prior to submission of a completed assessment.

Conclusions and Recommendations

We find the work plan unacceptable. We recommend that screening risk assessments are be presented for each IRP site. Elements of the RI work plan related to risk assessment are generally acceptable. The document can be made acceptable overall upon adequate responses to the comments above.

Reviewer: Michael J. Wade, Ph.D., D.A.B.T. MJW
Senior Toxicologist, HERS

cc: Dr. C. Salocks

STATE OF CALIFORNIA - Environmental Protection Agency PETE WILSON, *Governor*

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION
3443 Routier Road, Suite A
Sacramento, CA 95827-3098
PHONE: (916) 255-3000
FAX: (916) 255-3015

23 January 1995

Mr. Kent Strong
Department of Toxic Substances Control
10151 Croyden Way, Suite 3
Sacramento, CA 95827

DRAFT REMEDIAL INVESTIGATION WORK PLAN, NAVAL AUXILIARY LANDING FIELD (NALF) CROWS LANDING, STANISLAUS COUNTY

We have reviewed the Draft Remedial Investigation Work Plan (RI Work Plan) submitted on 21 November 1994. We have deferred formal review and comment on both the Baseline Risk Assessment and the Ecological Assessment, Sections 5.0 and 6.0 of the RI Work Plan, to your department. Our main concern with the RI Work Plan is regarding the need to conduct water quality assessments to evaluate potential site-specific threats to ground water quality. As discussed in our comments on the Site Investigation Draft Final Field Work Plan Addendum, letter dated 13 April 1994, soluble concentrations of soil contaminants which threaten ground water quality need to be determined during the Remedial Investigation at NALF Crows Landing. The need for water quality assessments and our other general and site-specific comments are discussed in detail below.

General Comments

1. Water Quality Assessment. In our 13 April 1994 comment letter, we emphasized the need to establish background concentrations for use in conducting water quality assessments. The Remedial Investigation at NALF Crows Landing must include a water quality assessment at each site to evaluate impacts, and potential impacts, of vadose zone contaminants on ground water. Contaminant concentrations found above background levels in soil pose a threat to water quality. A demonstration must be made, to the satisfaction of the Regional Board, that any potential leaching from contaminants allowed to remain in the vadose zone does not pose a threat to ground water quality. Potentially contaminated soil samples must be compared to background soil sample results to evaluate if a potential threat to water quality exists. Data obtained from performing the Waste Extraction Test, using de-ionized water (DI-WET), on additional soil samples must be used to evaluate site-specific threats to water quality. These evaluations may be conducted using the Designated Level Methodology. The RI Work Plan must be modified to acknowledge that a water quality assessment will be conducted, including a proposed approach, to evaluate impacts and potential impacts to water quality posed by constituents remaining in soil at each site. Enclosed is a copy of our Draft Water Quality Assessment document, 5 November 1992 (Enclosure 1), which describes how these assessments should be conducted. The need for further action at each site must be based on the results of the water quality assessments.

2. Potential Phased RI. The RI Work Plan proposes field sampling activities to address the remaining data gaps. However, implementing this RI Work Plan may represent only part of an iterative process to complete the Remedial Investigation. Additional field activities may be necessary to

define the horizontal and vertical extent of contamination at each area at NALF Crows Landing. The RI Work Plan should be modified to acknowledge that an additional phase of investigation activities may be necessary.

3. Potential Areas of Contamination. All potential areas of contamination at NALF Crows Landing must be assessed. Previous investigations have focused on past areas of disposal identified through record searches. However, it is unclear whether all areas of past and ongoing operations have now been reviewed to determine if additional, currently unidentified, areas that warrant investigation exist at NALF Crows Landing. In particular, areas of potential contamination are identified in the Baseline Environmental Report (BER), dated June 1994, provided by copy during the Project Manager's Meeting held on 14 December 1994. As agreed on 14 December 1994, the Navy must address the need for additional investigation activities at the areas identified in the BER for which a Preliminary Assessment (PA) has not been conducted. It would be very useful to develop a summary table, to be included in the RI Work Plan, which lists all potential sites, suspected contaminants, no further action determinations, and other pertinent information, in order to track each site from the PA phase through the CERCLA process. This table could be updated, as appropriate, and included in future comprehensive deliverable documents for NALF Crows Landing.

4. Table of Background Concentrations. In some cases, comparisons made between an average concentration of all samples collected at a site and an average background concentration, as presented in Tables 3-1, 3-3, 3-4, and 3-6, may underestimate the potential threat posed by constituents present in concentrations above background. A table that illustrates the ranges of total background concentrations for each inorganic constituent in soils should be included in the RI Work Plan so that potentially contaminated total inorganic concentrations may be readily compared to the background data for soil samples. Similarly, a table that illustrates the ranges of background concentrations for inorganic constituents in ground water should be included.

5. Background for Pesticides. As discussed in our comments on the Draft Site Investigation (SI) Report, letter dated 18 November 1994, pesticides detected in soils sampled as part of previous SI activities may result from regional agricultural use unrelated to waste handling or disposal at NALF Crows Landing. However, a larger data base for background with respect to pesticides in soil is necessary. As we have also previously indicated, it may be necessary to analyze additional soil samples from sites, where background levels are exceeded, for soluble pesticides concentrations to determine if soils at these sites pose a threat to water quality (also see site-specific comments below).

6. Reporting Analytical Results. As indicated in our comments on the Draft First Quarterly Groundwater Monitoring Report and the Draft Site Investigation Report, letter dated 18 November 1994, all future reports for NALF Crows Landing which present analytical laboratory results must differentiate between "non-detect" and "trace" results. The analytical detection limits must be identified. All analytical detections must be reported, when quantifiable or not. All data must be reported as either: 1. numerical concentrations, for results.at or above the quantitation limit; 2. "trace" along with detection and quantitation limits, or numerical concentrations with appropriate qualifers, for results which fall between those limits; or 3. "less than [detection limit]", for results which are below the analytical detection limit.

7. Well Abandonment. The Work Plan indicates that there are approximately 42 irrigation or domestic

wells located within 1 mile of NALF Crows Landing, and at least 10 of these wells are on base property. Wells which are screened in both the upper and lower water-bearing zones must be evaluated as potential conduits of ground water contamination between these zones, and may need to be abandoned. The irrigation and domestic wells must be identified on a base well map which illustrates the facility layout and monitoring well locations.

8. Site Diagrams. The site diagrams presented in figures 3-1 through 3-6 of the RI Work Plan lack sufficient detail. These figures should be modified to illustrate the site-specific features which are shown in the site diagrams presented in the Final Site Investigation Report (PRC, 1992).

Site-specific Comments

Site 11

1. Additional Soil Sampling. The soil samples collected at this site may underestimate the nature of contamination associated with past disposal activities at the site and any potential threat to ground water quality. It is unclear whether all past disposal pits, including the reported burn pit, were located, or if samples were collected in areas of highest potential contamination. Additional soil samples must be collected, including samples at depth and just above the ground water table, in order to identify potential source areas for petroleum hydrocarbon ground water contamination, to better characterize other potential soil contamination in the areas of past disposal, and to determine if these potential wastes pose a threat to water quality. The approach to selecting soils samples to be collected for chemical analysis, as described in Section 4.1.2.2.1 (p. 4-6) of the RI Work Plan is not acceptable. It is acceptable to target samples from contaminated intervals, based on highest PID readings and/or visual or olfactory indications of the presence of contamination, for laboratory analysis. However, soil boring samples must be collected to determine the lateral and vertical extent of vadose zone contamination at this site. Soil and soil gas samples must be collected every 5 feet, and at locations of discoloration or lithologic changes, throughout the entire length of each soil boring with the lower most sample collection from just above the ground water table. These samples must be submitted to the laboratory for chemical analyses. Methods of analyses and analytes must be in accordance with those set forth for soil samples collected during the previous site investigation (PRC SI Report, JULY 1992). In cases where total concentrations of a contaminated soil sample exceed total background concentrations, comparisons between soluble concentrations must also be made, as part of a site-specific water quality assessment. In these cases, the samples with the highest total concentrations of inorganic, Polychlorinated Biphenyl (PCB), and pesticide constituents of concern must be analyzed using the DI-WET to determine soluble concentrations which may pose a threat to ground water quality.

2. Waste Disposal Boundaries. Previous magnetometer surveys at Site 11 identified anomalous areas and "probable burial pit" locations illustrated in figure 8 of the Final Site Investigation Report (PRC, 1992). This information is used to estimate the locations of the boundaries of the waste disposal pits at this site. These estimated boundaries must be illustrated on both Figures 3-1 and 4-1 of the RI Work Plan. In addition, a reference to Figure 4-1 should be provided in Section 4.1.2.2.1 which discusses proposed sampling locations at Site 11.

Site 12

The Work Plan (p.3-7) states that no further actions are recommended at Site 12 under the IRP at this time. We do not concur with this recommendation.

1. Additional Ground Water Sampling. The Work Plan (p.3-7) states that "it is anticipated that the ground water contamination at Site 12 will be shown to be associated with the UST Sites", specifically Sites 117 or Cluster 1 (CL-1). However, the Navy has not yet proposed ground water investigation activities in the Site 12 area as part of planned UST investigation activities. The soil vapor study proposed to be conducted as part of the UST Site 117 investigation activities should be expanded to the Site 12 area. The nature of volatile organic contaminants (VOCs) previously detected in 12-MW-01 appears to be somewhat different from those detected at UST Site 117 or Cl-1. Methylene chloride has not been detected at the UST sites, but is shown to be present at Site 12. Also, it is not clear that VOC concentrations at Site 12 are consistent with VOC concentrations at the UST sites. An investigation of the nature and extent of the ground water contamination detected at Site 12 must be conducted. Data obtained from new monitoring wells, or ground water sampling using hydropunch methods, at Site 12 may be used to supplement the continued ground water investigations and development of corrective actions at Sites 117 and Cl-1.

2. Additional Soil Sampling. Additional soil samples must be collected to determine the lateral and vertical extent of total petroleum hydrocarbon contamination in soils at the northern end of the vehicles parts and washrack area. In addition, a water quality assessment must be conducted at each of the three past disposal areas at Site 12 to evaluate the threat to ground water quality posed by the pesticide and inorganic constituents detected in these areas. Additional soil samples must be collected at depth, and just above the ground water table, in these areas to characterize the nature and extent of the vadose zone contamination. The samples with the highest total concentrations of inorganic, or pesticide constituents of concern (i.e totals soil concentration exceeds totals background concentration) must be analyzed using the DI-WET, to determine soluble concentrations which may pose a threat to ground water quality.

3. Automotive Maintenance Shop Activities. The RI Work Plan should discuss past activities conducted in the Automotive Maintenance Shop area. In particular, the RI Work Plan must discuss the disposition of waste oils and clarify if an oil/water seperator was used. The RI Work Plan must also identify the location of sewer lines/drains on the site map (Figure 3-2).

Site 13

The RI Work Plan (p.3-9) indicates that no further actions are recommended at Site 13. We do not concur with this recommendation. Existing data is not sufficient for determining whether a limited or no further action decision is appropriate for this site.

1. Additional Soil Sampling. The soil samples collected during the site investigation at this site may underestimate the nature of contamination associated with the reported spill and any potential threat to ground water quality. The soil samples were collected at approximate depths of 1.5 to 2.0 feet on a slant adjacent to the enlarged concrete pad. However, as indicated in the RI Work Plan, an unspecified quantity of the adjacent surface soils were excavated when the pad was enlarged. Therefore, the site investigation soil samples may not represent potentially contaminated native soils. Additional soil samples must be collected to investigate the native soils beneath the spill area. In addition, soil samples must be collected to further investigate the nature and extent of pesticides detected at low levels at this site. In particular, toxaphene, detected in one site soil sample at an

estimated concentration of 1889 micrograms per kilogram, was not detected in the background soil sample collected from the nearby cultivated field. Methods of analyses and analytes must be in accordance with those set forth for soil samples collected during the site investigation (PRC SI report, JULY 1992). Analyses for Inorganic constituents must also be conducted. As part of the water quality assessment, the samples with the highest total concentrations of inorganic, PCB, or pesticide constituents of concern (i.e totals soil concentration exceeds totals background concentration) must be analyzed using the DI-WET, to determine soluble concentrations which may pose a threat to ground water quality.

Site 16

The RI Work Plan (p.3-10) indicates that no further actions are recommended at Site 16. We do not concur with this recommendation. Existing data is not sufficient for determining whether a limited or no further action decision is appropriate for this site.

1. Analyses for Metals in Soils and Ground water. Soils and ground water at Site 16 were not investigated for the presence of metals which may be expected. The soil and ground water samples collected during this site investigation may underestimate the potential contamination associated with discharges from this site and any potential threat to ground water quality. Additional soil samples must be collected at this site to further characterize the nature and extent of the vadose zone petroleum contaminants and to determine the presence or absence of metals constituents which may pose a threat to water quality. Furthermore, based on the evidence of petroleum vadose zone contamination, and documented ground water flow reversals, which indicate that the monitoring well (16-MW-01, currently dry) may not be located downgradient of Site 16, additional ground water samples must be collected. These ground water samples may be collected using the hydropunch methods proposed in the RI Work Plan. All additional samples must be analyzed for all Title 22 metals. Methods of analyses and analytes must otherwise be in accordance with those set forth for soil and ground water samples collected during the site investigation (PRC SI report, JULY 1992). As part of the water quality assessment, the samples with the highest total concentrations of inorganic or pesticide constituents of concern (i.e totals soil concentration exceeds totals background concentration) must be analyzed using the DI-WET, to determine soluble concentrations which may pose a threat to ground water quality.

Site 17

1. Additional Soil Sampling. The RI Work Plan (p.3-12, p.4-4) indicates soil sampling and analyses to evaluate the floor drain sump as a source of ground water contamination will be completed at Site 17. This will be done in conjunction with the removal of the floor drain sump structure, which will be completed separate from the Remedial Investigation. However, the approach to selecting soils samples to be collected for chemical analysis, as described in Section 4.1.2.2.1 (p. 4-6) of the RI Work Plan is not acceptable. It is acceptable to target samples from contaminated intervals, based on highest PID readings and/or visual or olfactory indications of the presence of contamination, for laboratory analysis. However, soil boring samples must be collected to determine the lateral and vertical extent of vadose zone contamination at this site. Soil and soil gas samples must be collected every 5 feet, and at locations of discoloration or lithologic changes, throughout the entire length of each soil boring with the lower most sample collection from just above the ground water table. These samples must be submitted to the laboratory for chemical analyses. In addition, a water

quality assessment must be conducted at Site 17 to evaluate the threat to ground water quality posed by the inorganic constituents detected in this area. The samples with the highest total metals concentrations of concern (i.e totals soil concentration exceeds totals background concentration) must be analyzed using the DI-WET, to determine soluble metals concentrations which may pose a threat to ground water quality.

2. Site Features. The RI Work Plan (p.4-3) discusses that proposed CPT and hydropunch sampling locations are oriented to surround the floor drain sumps, existing monitoring well location, and to extend to a demolished laundry facility location. The locations of the floor drain sumps, associated piping, and the demolished laundry facility must be shown in figure 4-2 of the RI Work Plan.

3. Soil Gas Survey Results. As discussed in our 18 November 1994 comment letter, the Draft SI Report indicates that all analytical results from the Site 17 sampling efforts are included in Appendix C (page 20.). However, the analytical results from the soil gas samples do not appear to be included in this SI Report. Although both the Draft SI Report and the RI Work Plan state that no compounds were detected in the Site 17 soil gas samples, the analytical results from these samples must be incorporated into the SI Report and the RI Work Plan.

Site 18

The Work Plan (p.3-16) states that no further actions are recommended at Site 18 under the IRP at this time. We do not concur with this recommendation.

1. Additional Soil Samples. The SI Report states that "Because nearly all metals are elevated in the Site 18 soil samples relative to background, including metals unrelated to firing range activities, it appears that statistical differences are due to variable lateral and vertical soil conditions and not contamination resulting from firing range activities." However, as discussed in general comment #4, comparisons made between an average concentration of all samples collected at a site and an average background concentration may underestimate the potential threat posed by constituents present in concentrations above background. An average concentration of all background samples is not appropriate for comparisons to evaluate potential metals contamination at Site 18. Background total metal concentrations in surface soils should be evaluated and compared to Site 18 soil samples data. Additional soil samples must be collected at Site 18, including samples within and directly beneath the highest potentially contaminated zones to determine if the metals previously detected above background concentrations pose a threat to water quality. The samples with the highest total metals concentrations, and the samples collected from directly beneath the potential highest metals contaminated zones, must be analyzed using the DI-WET to determine soluble concentrations which may pose a threat to ground water quality.

If you have any questions, please contact me at (916) 255-3065.

Karen A. Bessette
KAB:kb

Enclosure

United States Environmental Protection Agency

Office of Solid Waste and Emergency Response

9355.4-14FS
EPA/540/R-94/101
PB95-963529
December 1994

EPA

Soil Screening Guidance

FEB 14 1995

U.S. EPA Region 8 Library
Denver, Colorado

Office of Emergency and Remedial Response
Hazardous Site Control Division

Quick Reference Fact Sheet

NOTICE: This document is draft for review only and should not be used until the guidance is finalized following public comment and peer review.

BACKGROUND

On June 19, 1991, the U.S. Environmental Protection Agency's (EPA's) Administrator charged the Office of Solid Waste and Emergency Response (OSWER) with conducting a 30-day study to outline options for accelerating the rate of cleanups at National Priorities List (NPL) sites. One of the specific proposals of the study was for OSWER to "examine the means to develop standards or guidelines for contaminated soils."

On June 23, 1993, EPA announced the development of "Soil Trigger Levels" as one of the Administrative Improvements to the Superfund program. On September 30, 1993, a draft fact sheet was released that presented generic Soil Screening Levels (SSLs) for 30 chemicals. The fact sheet presented standardized equations to model exposures to soil contaminants via ingestion, inhalation, and migration to ground water. The fact sheet provided generic defaults for each parameter in the equations and a sampling methodology to measure soil contaminant levels. The SSL initiative underwent widespread review both within and outside the Agency. Suggestions were made on how to improve the methodology and increase the usefulness of screening levels by finding simple ways to modify them using site-specific data.

Based on that review, EPA modified the SSLs into a Soil Screening framework that emphasizes the application of standardized equations for the site-specific evaluation of soil contaminants. This framework provides an overall approach for developing SSLs for specific contaminants and exposure pathways at a site under a residential land use scenario. Areas with soil contaminant concentrations below SSLs generally would not warrant further study or action under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

The Soil Screening framework's point of departure is a simple methodology for calculating site-specific SSLs using easily obtained site data with standardized equations. An option for conducting a more detailed site-specific analysis is also included in the framework. In addition, default parameters are used in the standardized equations to produce a table of generic Soil Screening Levels for 107 chemicals that update those presented in the September 30, 1993, draft SSL fact sheet. These generic SSLs are included in the framework as a default option for use when site-specific values are not available.

PURPOSE OF SOIL SCREENING FRAMEWORK

The Soil Screening framework represents the first of several tools EPA plans to develop to standardize the evaluation and cleanup of contaminated soils. SSLs streamline the remedial investigation/feasibility study (RI/FS) process by accelerating and increasing consistency in decisions concerning soil contamination. As a future companion to the Soil Screening framework, EPA also intends to develop a methodology to identify levels of contamination that clearly warrant a response action or, possibly, concentrations for which treatment would be required. The screening levels at the low end and the higher concentration values that warrant response can be used to identify the bounds of a risk management continuum (Figure 1). Generally, within this continuum lies a range of possible cleanup levels that will continue to be determined on a site-specific basis.

EPA anticipates the use of the Soil Screening framework as a tool to facilitate prompt identification of the contaminants and exposure areas of concern during both remedial actions and some removal actions under CERCLA. SSLs do not trigger

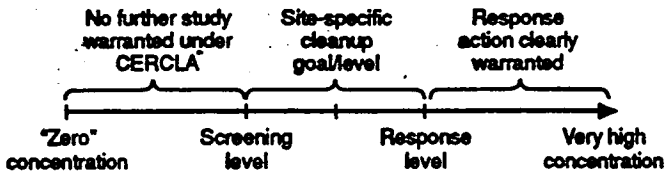


Figure 1. Risk management spectrum for contaminated soil.

the need for response actions or define "unacceptable" levels of contaminants in soil. SSLs may serve as Preliminary Remediation Goals (PRGs) under certain conditions (see section on Use of SSLs as Preliminary Remediation Goals/Cleanup Levels). In the future, EPA will consider expanding the guidance to address the Resource Conservation and Recovery Act (RCRA) Corrective Action program.

The SSLs are, as noted above, intended for use as a tool; their use is not mandatory at sites being addressed under CERCLA. The framework leaves a broad range of discretion to the site manager, both on whether the SSL approach is appropriate for a site and, if it is used, on the appropriate method. This guidance anticipates three optional approaches—simple site-specific, detailed site-specific, and generic. In the first two, some or all default values would be replaced as appropriate with site-specific data. Furthermore, the models themselves are not codified as rules and can be modified if appropriate, although some explanation should be provided if such modification is made.

SOIL SCREENING FRAMEWORK

A Soil Screening Level is a chemical concentration in soil that represents a level of contamination below which there is no concern under CERCLA, provided conditions associated with the SSLs are met. Generally, if contaminant concentrations in soil fall below the SSL, and there are no significant ecological receptors of concern, then no further study or action is warranted for residential use of that area. (Some States have developed screening numbers that are more stringent than the generic SSLs presented in this fact sheet; therefore further study may be warranted under State programs.) Concentrations in soil above either the generic or site-specific screening level would not automatically designate a site as "dirty" or trigger a response action. However, exceeding a screening level suggests that a further evaluation of the potential risks that may be posed by site contaminants is appropriate to determine the need for a response action.

The Soil Screening framework presents three approaches for establishing screening levels. The option emphasized in this Fact Sheet is a simple method that incorporates readily obtainable, site-specific data into standardized equations to derive site-specific screening levels for selected contaminants. When questions still exist at a site regarding whether or not contaminant levels are of concern, as a second approach, more tailored screening levels can be derived for most contaminants by incorporating additional site data into more complex fate and transport models. The third approach is to apply the generic SSLs presented in Appendix A. Although the default parameters used to derive the generic SSLs are not necessarily "worst case," they are conservative.

The progression from generic to simple site-specific and detailed (full-scale) site-specific SSLs usually will involve an increase in investigation costs and a decrease in conservatism (Figure 2). Generally, the decision of which method to use

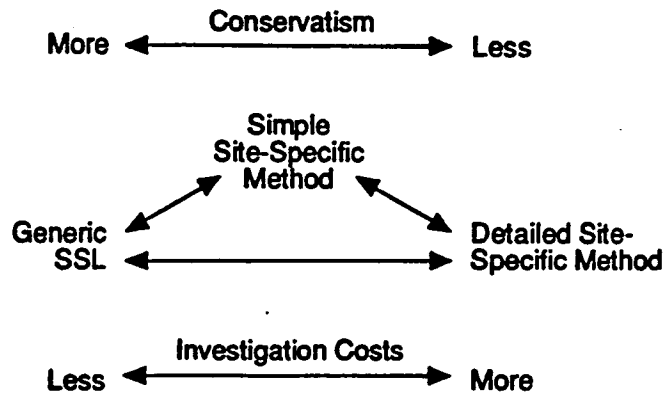


Figure 2. Components of the Soil Screening framework.

involves balancing the increased investigation costs with the potential savings associated with higher (but protective) SSLs. Therefore, the framework promotes the option of using site-specific data to derive screening levels. More guidance regarding which option to use is presented later in this fact sheet.

Site-Specific SSLs: Simple Method

The simple method for developing site-specific SSLs requires the collection of a small number of easily obtained site parameters (e.g., fraction organic carbon, percent soil moisture, and dry bulk density) for use in the standardized equations so that the calculated screening levels can be appropriately conservative for the site but not as conservative as the generic values. Once derived, the user then compares measured site or area contaminant concentrations to the site-specific screening levels. If concentrations do not exceed the SSLs for each pathway of concern, it would generally be appropriate to exclude the area from further investigation. If the levels are exceeded, the site manager may decide that a more comprehensive evaluation is needed to determine the risk posed via a particular exposure pathway (see Technical Background section).

Site-Specific SSLs: Detailed Approach

A more detailed method for developing site-specific SSLs is a full-scale model evaluation requiring the collection of additional site data. Full-scale modeling allows the application of complex transport and fate models and allows for consideration of a finite contaminant source. Applying these models will further define the risk associated with exposure via the inhalation or migration to ground water pathway. The model application may show that there is no concern over exposure from the pathway, thereby eliminating it from further concern. This potential outcome provides the incentive for incurring the cost and time to conduct a comprehensive site evaluation.

Generic SSLs

Generic SSLs can be used in place of site-specific screening levels. The decision to use generic SSLs will likely be driven by time and cost. The site manager must weigh the cost of conducting a more site-specific investigation with the potential for deriving a higher SSL that provides for an appropriate level of protection. The Technical Background section of this guidance presents a more detailed discussion of the level of effort required to conduct further study of site conditions and risks. Appendix A provides generic SSLs for 107 chemicals.

SCOPE OF SOIL SCREENING FRAMEWORK

The Soil Screening framework has been developed for 107 chemicals using assumptions for residential land use activities for three pathways of exposure (see Figure 3):

- Ingestion of soil
- Inhalation of volatiles and fugitive dusts
- Ingestion of contaminated ground water caused by migration of chemicals through soil to an underlying potable aquifer.

Reviews of risk assessments at hazardous waste sites indicate that these pathways are the most common routes of human exposure to contaminants in the residential setting. These are the pathways for which generally accepted methods, models, and assumptions have been developed that lend themselves to a standardized approach. Data on dermal exposures have also been considered, and the generic SSL for pentachlorophenol has been modified accordingly. **The scope of the SSL framework is limited to human exposure via the pathways listed above; therefore, sites with other significant exposure pathways, nonresidential land uses, possible ecological concerns, or unusual site conditions should consider their associated risks on a site-specific basis apart from the SSL framework.** Key attributes of the Soil Screening framework are given in Highlight 1.

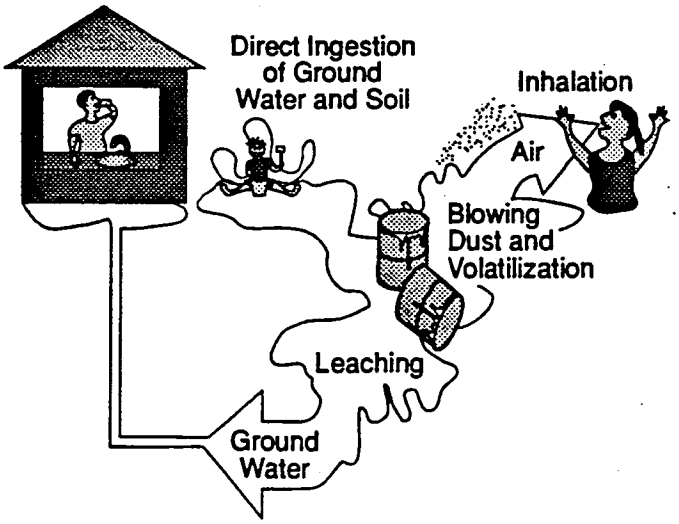


Figure 3. Exposure pathways addressed by the Soil Screening framework.

Highlight 1: Key Attributes of the SSL Framework

- Standardized equations are presented to address three individual human exposure pathways.
- Parameters are identified for which site-specific information is needed to develop site-specific SSLs.
- Default values are provided and used to calculate generic SSLs that are consistent with Superfund's concept of "Reasonable Maximum Exposure" (RME).
- SSLs are generally based on a 10^{-6} risk for carcinogens, or a hazard quotient of 1 for noncarcinogens. SSLs for migration to ground water are based on nonzero maximum contaminant level goals (MCLGs), or, when not available, maximum contaminant levels (MCLs). Where neither of these are available, the aforementioned risk-based targets are used.

Soil Ingestion Pathway

For the direct soil ingestion pathway, only generic SSLs were developed. Simple and full-scale site-specific methods were not developed because cost and complexity make developing site-specific data for this pathway, such as soil ingestion rates or chemical-specific bioavailability, generally impracticable. However, EPA is evaluating the data available to support adjustment of the exposure frequency term based on regional climatic conditions.

Inhalation Pathway

For **inhalation of volatiles and fugitive dust**, both generic values and a method for incorporating site-specific data into the standardized equations have been developed. To estimate the site-specific potential for volatilization of contaminants, soil conditions such as fraction organic carbon, soil moisture content, and dry bulk density must be evaluated. To estimate the site-specific potential for generation of fugitive dusts, other parameters must be evaluated, such as mean annual windspeed, threshold friction velocity, and the mode soil aggregate size to further tailor the SSLs to the site. For both the inhalation of volatiles and fugitive dust pathways, a site-specific determination of the area of contamination and meteorologic inputs can be incorporated into dispersion calculations.

Migration to Ground Water

The simple site-specific method for addressing potential contaminant migration to ground water uses the same soil parameters required to address volatilization, along with easily obtainable hydrogeologic parameters. The simple site-specific method for this exposure pathway also requires a determination of the area of contamination.

Other Pathways

Additional exposure pathways to contaminants in soil—dermal absorption, plant uptake, and migration of volatiles into basements—may contribute significantly to the risk to human health in a residential setting. The Superfund program has evaluated the data and methods available to address these potential exposures and has incorporated as much information as possible into the SSL framework.

Based on limited empirical data, the ingestion SSL for pentachlorophenol has been adjusted to account for potential dermal exposure. Additionally, empirical data indicate that plant uptake may be important for some chemicals (i.e., As, Cd, Hg, Ni, Se, Zn). The fact that these chemicals' potential for plant uptake and dermal absorption has been noted in Appendix A should not be misinterpreted to mean that other chemicals are not of potential concern for dermal exposure or plant uptake. As additional information becomes available, other chemicals may be addressed as well.

At this time, Superfund does not believe that the potential for migration of contaminants into basements can be reasonably incorporated into the SSL framework. The parameters required for the models (e.g., the number and size of cracks in basement walls) do not lend themselves to standardization or to evaluation of potential future exposure, and the models have not been adequately validated. The Technical Background Document (U.S. EPA, 1994e) provides a detailed analysis of available modeling of this pathway.

Other Land Uses

Longer-term efforts will be required to develop standardized tools to address exposures relevant to other land uses such as industrial land use. The results of these efforts may be included in future revisions of this guidance.

Ecological Receptors

As part of the baseline risk assessment, an ecological assessment should be conducted at every Superfund site. The SSL framework does not attempt to define significant ecological receptors or quantify ecological risks. However, a comparable list of screening level benchmarks, called Ecotox Thresholds, is being developed by Office of Emergency and Remedial Response (OERR) for application during the ecological risk assessment addressed in OSWER Directive No. 9285.7-17 (U.S. EPA, 1994d). These values are defined as media-specific chemical concentrations above which there is sufficient concern regarding adverse effects to ecological receptors to warrant further site investigation. OERR is developing guidance on designing and conducting ecological risk assessments that will describe the use of such screening values in the Superfund Remedial Investigation process.

HOW TO USE THE SOIL SCREENING FRAMEWORK

The decision to use the Soil Screening framework at a site will be driven by the potential benefits of eliminating areas, exposure pathways, or contaminants from further investigation. By identifying areas where concentrations of contaminated soil are below levels of concern under CERCLA, the framework provides a means to focus resources on exposure areas, contaminants, and exposure pathways of concern.

Highlight 2 outlines the process of applying the Soil Screening framework at a site. To enable early comparison with site background concentrations and to provide information necessary for determining an adequate sample size, site-specific SSLs should be developed as early in the process as possible. They can be adjusted during the process to accommodate additional site information and the resulting changes to the conceptual site model.

Developing a Conceptual Site Model

The primary condition for use of SSLs is that exposure pathways of concern and conditions at the site match those taken into account by the Soil Screening framework. Thus, at all sites it will be necessary to develop a conceptual site model to identify likely contaminant source areas, exposure pathways, and potential receptors. This information can be used to

Highlight 2: Using the Soil Screening Framework

- Develop site conceptual model and compare with SSL conceptual model to determine applicability of framework.
- Determine if background contaminant concentrations are above generic SSLs.
- Select approach (simple or detailed site-specific, generic) and develop SSLs.
- Measure average soil contaminant concentrations in exposure areas (EAs) of concern.
- Compare average soil concentrations with SSLs and eliminate site or area of site where EA mean concentration is less than SSL.
- Consider further study or use of SSLs as PRGs for sites or site areas with contaminant concentrations greater than SSLs.

determine the applicability of the framework at the site and the need for additional information.

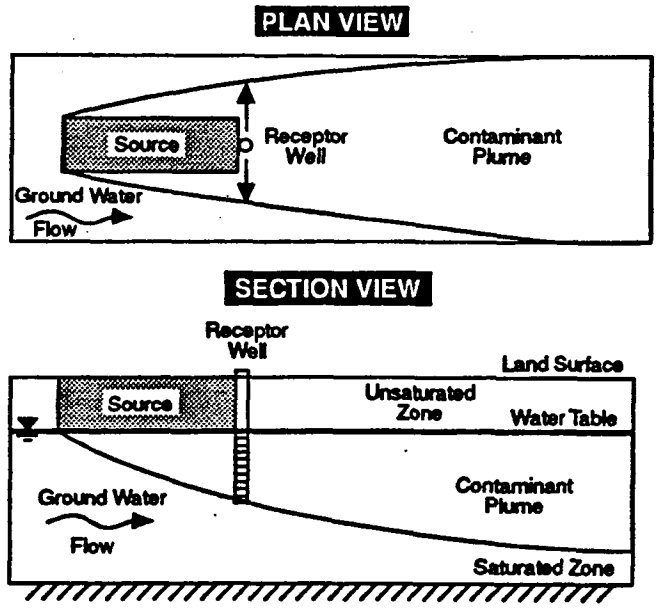
A conceptual site model is developed from available site sampling data, historical records, aerial photographs, and hydrogeologic information. The model establishes a hypothesis about possible contaminant sources, contaminant fate and transport, exposure pathways, and potential receptors. The DQO Guidance for Superfund (U.S. EPA, 1993a) provides an excellent discussion on the development of a conceptual site model. The rationale for including the contaminant migration to ground water exposure pathway should be consistent with EPA ground water policy (U.S. EPA, 1988, 1990b, 1992a, 1992b, 1993b).

The conceptual model upon which the generic SSLs are based is a 30-acre property that has been divided up for residential use. Thus, the generic SSLs have been developed to be protective for source areas up to 30 acres. The contamination is assumed to be evenly distributed across the area of concern and extends from the ground surface to the top of the aquifer. The soil type is assumed to be loam that has 50 percent vegetative cover. Loam is soil with approximately equal proportions of sand and silt. Exposure to contaminants can occur via ingestion of soils, inhalation of volatiles and fugitive dusts, or migration to ground water.

For the migration to ground water pathway, the point of compliance is assumed to be at the edge of the site, which is assumed to be homogeneously contaminated. No attenuation is considered in the unsaturated zone; however, dilution is assumed within the aquifer to the point of compliance. For the generic conceptual site model, the source is assumed to extend across the entire site. See Figures 3 and 4 for a graphic representation of aspects of the conceptual model applicable to the Soil Screening framework.

Partitioning of contaminant mass between media is not addressed in the SSL framework because the fate and transport models used to derive the generic SSLs are based on the assumption of an infinite source. Although the assumption is highly conservative, a finite source model cannot be applied unless there are accurate data regarding source size and volume. Obviously, in the case of the generic SSLs, such data are not available. It is also unlikely that such data will be available from the limited subsurface sampling that is done to apply the simple site-specific method. Thus, it is most likely that a finite source model would be applied as part of a detailed site-specific investigation. EPA will continue to seek consensus on the appropriate methods to incorporate contaminant partitioning and a finite source into the simple site-specific method. The results of these efforts may be included in future updates to this guidance.

The Technical Background Document (U.S. EPA, 1994e) presents information on equations and models that can accommodate finite sources and predict the subsequent impact on either ambient air or ground water. However, when using



Default assumptions:

- Infinite source
- Source extends to water table
- Well at downgradient edge of source
- 30-acre source size

Figure 4. Migration to ground water pathway—SSL conceptual model.

a finite source model, the site manager should recognize the uncertainties inherent in site-specific estimates of subsurface contaminant distributions and use conservative estimates of source size and concentrations to allow for such uncertainties.

The following questions should always be considered in the development of the conceptual site model before applying the Soil Screening framework:

- Is the site **adjacent to surface waterbodies** where the potential for contamination of surface water by overland flow or release of contaminated ground water should be considered?
- Are there potential terrestrial or aquatic **ecological concerns**?
- Is there potential for **land use other than residential**?
- Are there **other likely human exposure pathways** that were not considered in development of the SSLs (e.g., local fish consumption; raising of beef, dairy, or other livestock)?
- Are there **unusual site conditions** (e.g., area of contamination greater than 30 acres, unusually high fugitive dust levels due to soil being tilled for agricultural use, or heavy traffic on unpaved roads)?

If the conceptual site model indicates that residential assumptions are appropriate for your site and no pathways of concern other than those covered by the Soil Screening framework are present, then the framework may be applied directly to the site. If the conceptual site model indicates that the site is more complex than the scenario outlined in this guidance, the framework above will not be sufficient. Additional pathways, receptors, or chemicals must be evaluated on a site-specific basis.

Considering Background Contamination

A necessary step in determing the usefulness of the SSL framework is the consideration of background contaminant concentrations, since the framework will have little utility where background concentrations exceed the SSLs.

EPA may be concerned with two types of background at sites: naturally occurring and anthropogenic. Natural background is usually limited to metals whereas anthropogenic (i.e., human-made) background includes both organic and inorganic contaminants.

Generally, EPA does not clean up below natural background; however, where anthropogenic background levels exceed SSLs and EPA has determined that a response action is necessary and feasible, EPA's goal will be to develop a comprehensive response to the widespread contamination. This will often require coordination with different authorities that have jurisdiction over other sources of contamination in the area (such as a regional air board or RCRA program). This will help avoid response actions that create "clean islands" amid widespread contamination. The background information and understanding of the site developed as part of the conceptual model can help determine background concentration.

When considering background, one should also consider the bioavailability and mobility of compounds. Some compounds may form complexes that are immobile and unlikely to cause significant risk. This situation is more likely to occur with naturally occurring compounds. Therefore, background concentrations of compounds exceeding the SSLs do not necessarily pose a threat. Alternately, activities at a site can adversely affect the natural soil geochemistry, resulting in the mobilization of compounds. Consequently, background contamination should be considered carefully. Regardless, where background concentrations are higher than the SSLs, the SSLs generally will not be the best tool for site decisionmaking.

Sampling Exposure Area

After the conceptual site model has been developed, and the applicability of the Soil Screening framework is determined, the next step is to collect a representative sample set for each exposure area. An exposure area is defined as that geographic area in which an individual may be exposed to contamination over time. Because SSLs are developed for a residential scenario, EPA assumes the exposure area is a 0.5-acre residential lot.

In those situations where little or no sampling has been done, it will be beneficial to collect the site data required for the simple site-specific methodology in tandem with the collection of samples to identify contaminant concentrations. The site manager should work to limit the total number of trips to the site by maximizing the usefulness of the samples collected. (See section on Measuring Contaminant Concentrations in Soil for additional guidance.)

Comparing Exposure Area Concentration to SSLs

The fourth step is to compare onsite soil contaminant concentrations with site-specific SSLs or the generic SSLs listed in Appendix A. At this point, it is reasonable to review the conceptual site model with the actual site data in hand to reconfirm the accuracy of the conceptual site model and the applicability of the Soil Screening framework. Once this is confirmed, site contaminant levels may be compared with the SSLs.

In Appendix A, the first column to the right of the chemical name presents levels based on direct ingestion of soil. The second column presents the levels based on inhalation of volatiles or soil particulates. The third column presents SSL values for the migration to ground water pathway multiplied by a dilution and attenuation factor (DAF) of 10 to account for natural processes that reduce contaminant concentrations in the subsurface. The fourth column contains the SSL multiplied by a DAF of 1, which may be appropriate to use in instances where there are high water tables, karst topography, fractured bedrock, or source size greater than 30 acres. The lowest SSL of the three pathways (ingestion, inhalation, and ground water with DAF of 10) is highlighted in bold for each contaminant.

Generally, the comparison of SSLs to site contaminant levels will result in one of three outcomes:

1. Site-measured values indicate that an area falls below all of the SSLs. Soils from these areas of the site generally can be eliminated from further evaluation under CERCLA.

2. Site-measured data indicate that one or more SSLs have clearly been exceeded. In this case, the SSLs have helped to identify site areas, contaminants, and exposure pathways of potential concern on which to focus further analysis or data-gathering efforts.

3. A site-measured value exceeds one pathway-specific value but not others. In this case, it is reasonable to focus additional site-specific data collection efforts only on data that will help determine whether there is truly a risk posed via that pathway or by a limited set of chemicals at the site. When an exceedance is marginally significant, a closer look at site-specific conditions and exposures may result in the area being eliminated from further study.

Use of SSLs as Preliminary Remediation Goals/Cleanup Levels

SSLs are not nationwide cleanup levels or standards. Where the basis for response action exists and all exposure pathways of concern are addressed by the SSLs, the SSLs may serve as PRGs as defined in HHEM, Part B (U.S. EPA, 1991d). A PRG is a strictly risk-based value that serves as the point of departure for the establishment of site-specific cleanup levels. PRGs are modified to become final cleanup levels based on a consideration of the nine-criteria analysis described in the National Contingency Plan (NCP; Section 300.430 (3)(2)(i)(A)), including cost, long-term effectiveness, and implementability. See *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions* (U.S. EPA, 1991e) for guidance on how to modify PRGs to generate cleanup levels.

The SSLs should only be used as site-specific cleanup levels when a nine-criteria evaluation using the SSLs as PRGs for soils indicates that a selected remedy achieving the SSLs is protective, ARAR-compliant, and appropriately balances the other criteria, including cost. An example is a small site or exposure area where the cost of additional study would exceed the cost of remediating to the generic SSLs.

Addressing Exposure to Multiple Chemicals

The SSLs generally correspond to a 10^{-6} risk level for carcinogens and a hazard quotient (HQ) of 1 for noncarcinogens. This "target" hazard quotient is used to calculate a soil concentration below which it is unlikely for even sensitive populations to experience adverse health effects. The potential for additive effects has not been "built in" to the SSLs through apportionment. For carcinogens, EPA believes that setting a 10^{-6} risk level for individual chemicals and pathways generally will lead to cumulative risks within the 10^{-4} to 10^{-6} risk range for the combinations of chemicals typically found at Superfund sites.

For noncarcinogens, there is no widely accepted risk range. Thus, for developing national screening levels, options are either (1) to set the risk level for individual contaminants at the RfD or RfC (i.e., a hazard quotient of 1), or (2) to set chemical-specific concentrations by apportioning risk based on some arbitrarily chosen fraction of the acceptable risk level (e.g., one-fifth or one-tenth the RfD or RfC). The Agency believes, and EPA's Science Advisory Board agrees (U.S. EPA, 1993d), that noncancer risks should be added only for those chemicals with the same toxic endpoint or mechanism of action.

Highlight 3 lists the chemicals from Appendix A that have SSLs based on noncarcinogenic toxicity and affect the same target organ. If more than one chemical detected at a site affects the same target organ (i.e., has the same critical effect as defined by the RfD methodology), site-specific SSLs for each chemical in the group should be divided by the number of chemicals present. The concentration of contaminants at the site should then be compared to the SSLs that have been modified to account for this potential additivity.

Highlight 3: SSL Chemicals with Noncarcinogenic Toxic Effects on Specific Target Organs

Kidney
- Acetone
- 1,1-Dichloroethane
- Dimethyl phthalate
- 2,6-Dinitrotoluene
- Di-*n*-octyl phthalate
- Nitrobenzene
- 2,4,5-Trichlorophenol
- Vinyl acetate

Liver
- Acetone
- Chlorobenzene
- Di-*n*-octyl phthalate
- Nitrobenzene
- 2,4,5-Trichlorophenol

Central Nervous System
- Butanol
- 2,4-Dichlorophenol
- 2,4-Dinitrotoluene
- 2,6-Dinitrotoluene
- 2-Methylphenol

Circulatory System
- Antimony
- Barium
- *p*-Chloroaniline
- *cis*-1,2-Dichloroethylene
- Nitrobenzene
- Zinc

Reproductive System
- Carbon disulfide
- 2-Chlorophenol
- 1,2,4-Trichlorobenzene

Gross Pathology
- Diethyl phthalate
- 2-Methylphenol
- Naphthalene
- Nickel
- Vinyl acetate

Because the combination of contaminants will vary from site to site, apportioning risk to account for potential additive effects could not be considered in the development of generic SSLs. Furthermore, for certain noncarcinogenic organics (e.g., ethylbenzene, toluene), the generic SSLs are not based on toxicity but are determined instead by a "ceiling limit" concentration (C_{sat}) at which these chemicals may occur as nonaqueous phase liquids (NAPLs) in soil (see Technical Background section). For these reasons, the potential for additive effects and the need to apportion risk must be a site-specific determination.

TECHNICAL BACKGROUND

The models and assumptions supporting the Soil Screening framework were developed to be consistent with Superfund's concept of "reasonable maximum exposure" (RME) in the residential setting. The *Risk Assessment Guidance for Superfund, Volume 1* (U.S. EPA, 1989b) and the *Standard Default Exposure Factors* guidance (U.S. EPA, 1991b) outlined the Superfund program's approach to calculating an RME. Since that time, the Agency (U.S. EPA, 1991a) has coined a new term that the Superfund program believes corresponds to the definition of RME: "high-end individual exposure."

The Superfund program's method to estimate the RME for chronic exposures on a site-specific basis is to combine an average exposure point concentration with reasonably

conservative values for intake and duration in the exposure calculations. The default intake and duration assumptions are presented in the *Standard Default Exposure Factors* guidance (U.S. EPA, 1991b). The duration assumptions were chosen to represent individuals living in a small town or other nontransient community. (Exposure to members of a more transient community is assumed to be shorter and thus associated with lower risk.) Exposure point concentrations are either measured at the site (e.g., ground water concentrations at a receptor well) or estimated using exposure models with site-specific model inputs. An average concentration term is used in most assessments where the focus is on estimating long-term, chronic exposures. Where the potential for acute toxicity is of concern, exposure estimates based on maximum concentrations may be more appropriate.

The resulting site-specific estimate of RME is then compared with chemical-specific toxicity criteria such as RfDs or RfCs. EPA recommends using criteria from the Integrated Risk Information System (IRIS) (U.S. EPA, 1994c) and Health Effects Assessment Summary Tables (HEAST) (U.S. EPA, 1993c), although values from other sources may be used in appropriate cases.

The Soil Screening framework differs from a site-specific estimate of risk in that the exposure equations and models are run in reverse to backcalculate to an "acceptable level" of contaminant in soil. Toxicity criteria are used to define the acceptable level: a level corresponding to a 10^{-6} risk for carcinogens and a hazard quotient of 1 for noncarcinogens. The concept of backcalculating to an acceptable level in soil was presented in RAGS Part B (U.S. EPA, 1991d), and the Soil Screening framework serves to update Part B for addressing residential soils. Site-specific SSLs are consistent with the Superfund approach to estimating RME on a site-specific basis. Standard default factors are used for the intake and duration assumptions, site-specific inputs are used in the exposure models, and chemical-specific concentrations averaged over the exposure area are used for comparison to the SSLs.

Consistent with the site-specific SSLs, the generic SSLs use the same intake and duration assumptions and are compared to area average concentrations. However, the generic SSLs are based on a hypothetical site model. In developing the parameters for the hypothetical site, the Superfund program considered the conservatism inherent in the exposure models (e.g., assumption of an infinite source) and then combined high-end and central tendency parameters for size, location, and soil characteristics. The resulting generic SSLs should be protective for most site conditions across the Nation.

OERR performed a sensitivity analysis to determine which parameters most influenced the output of the volatilization and fugitive dust models used to calculate SSLs for the inhalation pathway. For fugitive dusts, the particulate emission factor (PEF) was most sensitive to threshold friction velocity, which was set at a "high-end" value. For calculation of the volatilization factor (VF), soil moisture content was set at a conservative value because it drives the air-filled soil porosity that in turn provides the pathway for chemicals to volatilize from soils. Climatic conditions have a significant impact on dispersion of both volatile and particulate emissions and were set at high-end values to be protective for conditions at most sites. Different high-end meteorological data sets were selected to calculate 90th percentile dispersion coefficients for the VF and for the PEF.

For the migration of contaminants from soils to ground water, only average soil conditions are used to calculate generic SSLs because of the conservatism inherent in the partition equation. The generic DAF for this pathway was developed using a weight of evidence approach to be protective under most hydrogeologic conditions across the country as described in the following section on the migration to ground water.

Characteristics of the generic, hypothetical site used to develop generic SSLs were described previously in the section discussing the conceptual site model. The Technical Background Document (U.S. EPA, 1994e) accompanying this guidance describes the pathway-specific equations, assumptions, and methodology that form the basis for both the simple site-specific approach and the generic SSLs. The Technical Background Document also describes development of the specific default input values used to calculate generic SSLs for the inhalation and migration to ground water pathways.

The generic SSLs are based on default assumptions. EPA recognizes that site-specific conditions may differ significantly from these default assumptions. The Soil Screening framework emphasizes the substitution of some of the generic fate and transport assumptions with site-specific data to derive site-specific SSLs. However, one purpose of the SSLs is to define a level in soil below which no further study or action would be required. Therefore, alternative levels that are set using site-specific data should generally be calculated assuming the RME/"high-end" individual exposure.

The following sections present the standardized equations and default assumptions that form the basis for the simple site-specific methodology and the generic SSLs. The soil ingestion discussion is limited to default assumptions because only generic SSLs have been developed for this pathway.

Direct Ingestion

Agency toxicity criteria for noncarcinogens establish a level of daily exposure that is not expected to cause deleterious effects over a lifetime (i.e., 70 years). Depending on the contaminant, however, exceeding the RfD (i.e., the "acceptable" daily level) for a short period of time may be cause for concern. For example, if there is reason to believe that exposure to soil may be higher at a particular stage of an individual's lifetime, one would need to protect for that shorter period of high exposure. Because a number of studies have shown that inadvertent

ingestion of soil is common among children age 6 and younger (Calabrese et al., 1989; Davis et al., 1990; Van Wijnen et al., 1990), the SSLs in the default option are set at concentrations that are protective of this increased exposure during childhood by ensuring that the chronic reference dose (or RfD) is not exceeded during this shorter (6-year) time period (Equation 1). If there is reason to believe that exposures at a site may be significant over a short period of time (e.g., extensive soil excavation work in a dry region), depending on the contaminant, the site manager should consider the potential for acute health effects as well.

Equation 1: Screening Level Equation for Ingestion of Noncarcinogenic Contaminants in Residential Soil

$$\text{Screening Level (mg/kg)} = \frac{THQ \times BW \times AT \times 365\ d/yr}{1/RfD_o \times 10^{-6}\ kg/mg \times EF \times ED \times IR}$$

Parameter/Definition (units)	Default
THQ/target hazard quotient (unitless)	1
BW/body weight (kg)	15
AT/averaging time (yr)	6[a]
RfD_o /oral reference dose (mg/kg-d)	chemical-specific
EF/exposure frequency (d/yr)	350
ED/exposure duration (yr)	6
IR/soil ingestion rate (mg/d)	200

[a] For noncarcinogens, averaging time is equal to exposure duration.

In some cases, children may ingest large amounts of soil (i.e., 3 to 5 grams) in a single event. This behavior, known as pica, may result in relatively high short-term exposures to contaminants in soils. Such exposures may be of concern for contaminants that primarily exhibit acute health effects. Review of clinical reports on contaminants addressed in this guidance suggests that acute effects of cyanide and phenol may be of concern in children exhibiting pica behavior. If soils containing cyanide and phenol are of concern and pica behavior is expected at a site, the protectiveness of the ingestion SSLs for these chemicals should be reconsidered.

For carcinogens, both the magnitude and duration of exposure are important. Duration is critical because the toxicity criteria are based on "lifetime average daily dose." Therefore, the total dose received, whether it be over 5 years or 50 years, is averaged over a lifetime of 70 years. To be protective of exposures to carcinogens in the residential setting, OERR focuses on exposures to individuals who may live in the same residence for a "high-end" period of time (i.e., 30 years). As mentioned previously, exposure to soil is higher during childhood and decreases with age. Thus, Equation 2 uses a time-weighted average soil ingestion rate for children and adults. The derivation of this time-weighted average is presented in U.S. EPA (1991d).

Equation 2: Screening Level Equation for Ingestion of Carcinogenic Contaminants in Residential Soil

$$\text{Screening Level (mg/kg)} = \frac{TR \times AT \times 365\ d/yr}{SF_o \times 10^{-6}\ kg/mg \times EF \times IF_{soil/adj}}$$

Parameter/Definition (units)	Default
TR/target cancer risk (unitless)	10^{-6}
AT/averaging time (yr)	70
SF_o /oral slope factor $(mg/kg\text{-}d)^{-1}$	chemical-specific
EF/exposure frequency (d/yr)	350
$IF_{soil/adj}$ /age-adjusted soil ingestion factor (mg-yr/kg-d)	114

Inhalation of Volatiles and Fugitive Dusts

Agency toxicity data indicate that risks from exposure to some chemicals via inhalation far outweigh the risks via ingestion. **The models and assumptions used to calculate SSLs for inhalation of volatiles and fugitive dusts are updates of the equations presented in U.S. EPA's HHEM Part B guidance (U.S. EPA, 1991d). The volatilization factor (VF), soil saturation limit (C_{sat}), particulate emission factor (PEF), and dispersion model have all been revised.**

Another change from the Part B methodology is the separation of the ingestion and inhalation pathways. Toxicity criteria for oral exposures are presented as administered doses in units of milligrams per kilograms per day (mg/kg-d); whereas, the inhalation criteria are presented as concentrations in air ($\mu g/m^3$ or mg/m^3) that require conversion to an estimate of internal dose to be comparable to the oral route. EPA's Office of Research and Development (ORD) now believes that the conversion from concentration in air to internal dose is not always appropriate and suggests evaluating these exposure routes separately.

As explained in HHEM Part B, the basic principle of the volatilization model is applicable only if the soil concentration is at or below soil saturation (C_{sat}). Above this level the model cannot predict an accurate VF. C_{sat} is the concentration at which soil air, pore water, and sorption sites are saturated and above which free-phase contaminants may be present. For compounds that are liquid at ambient soil temperatures, C_{sat} indicates a concentration above which NAPLs may be suspected in site soils and further investigation may be necessary. Thus, for liquid compounds for which the SSL exceeds C_{sat}, the SSL is set at C_{sat}. For compounds that are solid at soil temperatures for which the SSL exceeds C_{sat}, volatile emissions can be assumed to be of no concern and the SSL is calculated considering particulate emissions only (i.e., the 1/VF term in Equation 3 or 4 is set to zero).

Equation 3: Screening Level Equation for Inhalation of Carcinogenic Contaminants in Residential Soil

$$\text{Screening Level (mg/kg)} = \frac{TR \times AT \times 365\ d/yr}{URF \times 1000\ \mu g/mg \times EF \times ED \times \left[\frac{1}{VF} + \frac{1}{PEF}\right]}$$

Parameter/Definition (units)	Default
TR/target cancer risk (unitless)	10^{-6}
AT/averaging time (yr)	70
URF/inhalation unit risk factor $(\mu g/m^3)^{-1}$	chemical-specific
EF/exposure frequency (d/yr)	350
ED/exposure duration (yr)	30
VF/soil-to-air volatilization factor (m^3/kg)	chemical-specific
PEF/particulate emission factor (m^3/kg)	6.79×10^8

Equation 4: Screening Level Equation for Inhalation of Noncarcinogenic Contaminants in Residential Soil

$$\text{Screening Level (mg/kg)} = \frac{THQ \times AT \times 365\ d/yr}{EF \times ED \times \left[\frac{1}{RfC} \times \left(\frac{1}{VF} + \frac{1}{PEF}\right)\right]}$$

Parameter/Definition (units)	Default
THQ/target hazard quotient (unitless)	1
AT/averaging time (yr)	30
EF/exposure frequency (d/yr)	350
ED/exposure duration (yr)	30
RfC/inhalation reference concentration (mg/m^3)	chemical-specific
VF/soil-to-air volatilization factor (m^3/kg)	chemical-specific
PEF/particulate emission factor (m^3/kg)	6.79×10^8

Equations 3 through 7 form the basis for deriving both simple site-specific and generic SSLs for the inhalation pathway. The following parameters in the standardized equations can be replaced with specific site data to develop a more site-specific SSL:

- **VF and C_{sat}**
  - — Average soil moisture content
  - — Average fraction organic carbon content
  - — Dry soil bulk density

Equation 5: Derivation of the Volatilization Factor

$$VF\ (m^3/kg) = Q/C \times \frac{(3.14 \times \alpha \times T)^{1/2}}{(2 \times D_{ei} \times \theta_a \times K_{as})} \times 10^{-4} m^2/cm^2$$

where

$$\alpha = \frac{D_{ei} \times \theta_a}{\theta_a + (\rho_s)\ (1 - \theta_a)/K_{as}}$$

Parameter/Definition (units)	Default
VF/volatilization factor (m^3/kg)	--
Q/C/inverse of the mean conc. at the center of a 30-acre-square source $(g/m^2\text{-}s$ per $kg/m^3)$	35.10
T/exposure interval (s)	9.5×10^8 s
D_{ei}/effective diffusivity (cm^2/s)	$D_i(\theta_a^{3.33}/n^2)$
θ_a/air-filled soil porosity (L_{air}/L_{soil})	0.28 or $n\text{-}w\rho_b$
D_i/diffusivity in air (cm^2/s)	chemical-specific
n/total soil porosity (L_{pore}/L_{soil})	0.43 (loam)
w/average soil moisture content $(g_{water}/g_{soil}$ or $cm^3_{water}/g_{soil})$	0.1 (10%)
ρ_b/dry soil bulk density (g/cm^3)	1.5 or $(1 - n)\ \rho_s$
ρ_s/soil particle density (g/cm^3)	2.65
K_{as}/soil-air partition coefficient (g-soil/cm^3-air)	$(H/K_d) \times 41$ (41 is a conversion factor)
H/Henry's law constant $(atm\text{-}m^3/mol)$	chemical-specific
K_d/soil-water partition coefficient (cm^3/g)	$K_{oc} \times f_{oc}$
K_{oc}/organic carbon partition coefficient (cm^3/g)	chemical-specific
f_{oc}/organic carbon content of soil (g/g)	0.006 (0.6%)

Equation 6: Derivation of the Soil Saturation Limit

$$C_{sat} = \frac{S}{\rho_b}\ (K_d\ \rho_b + \theta_w + H'\theta_a)$$

Parameter/Definition (units)	Default
C_{sat}/soil saturation concentration (mg/kg)	--
S/solubility in water (mg/L-water)	chemical-specific
ρ_b/dry soil bulk density (kg/L)	1.5 or $(1 - n)\ \rho_s$
n/total soil porosity (L_{pore}/L_{soil})	0.43 (loam)
ρ_s/soil particle density (kg/L)	2.65
K_d/soil-water partition coefficient (L/kg)	$K_{oc} \times f_{oc}$ (organics)
K_{oc}/soil organic carbon/water partition coefficient (L/kg)	chemical-specific
f_{oc}/fraction organic carbon of soil (g/g)	0.006 (0.6%)
θ_w/water-filled soil porosity (L_{water}/L_{soil})	$w\rho_b$ or 0.15
θ_a/air-filled soil porosity (L_{air}/L_{soil})	$n - w\rho_b$ or 0.28
w/average soil moisture content $(kg_{water}/kg_{soil}$ or $L_{water}/kg_{soil})$	0.1 (10%)
H'/Henry's law constant (unitless)	$H \times 41$, where 41 is a conversion factor
H/Henry's law constant $(atm\text{-}m^3/mol)$	chemical-specific

Equation 7: Derivation of the Particulate Emission Factor

$$PEF(m^3/kg) = Q/C \times \frac{3600\,s/h}{0.036 \times (1-V) \times (U_m/U_t)^3 \times F(x)}$$

Parameter/Definition (units)	Default
PEF/particulate emission factor (m^3/kg)	6.79×10^8
Q/C/inverse of the mean conc. at the center of a 30-acre-square source (g/m^2-s per kg/m^3)	46.84
V/fraction of vegetative cover (unitless)	0.5 (50%)
U_m/mean annual windspeed (m/s)	4.69
U_t/equivalent threshold value of windspeed at 7 m (m/s)	11.32
F(x)/function dependent on U_m/U_t derived using Cowherd (1985) (unitless)	0.194

- **PEF**
  - — Mean annual windspeed
  - — Threshold friction velocity (as determined by):
    - mode of the surface soil aggregate size
    - roughness height
    - correction for nonerodible particles
    - f(x)
  - — Equivalent threshold windspeed at a 7-m anemometer height.

Site location (to some extent) and site size (i.e., "area of contamination") can be factored into the simple site-specific methodology for the inhalation pathways. The dispersion factor (Q/C) for both volatiles and fugitive dusts was calculated using a 90th percentile meteorological data set selected from 29 data sets across the United States (see Technical Background Document [U.S. EPA, 1994e]). Los Angeles was selected as the 90th percentile data set for volatiles and Minneapolis was selected as the 90th percentile data set for fugitive dusts. Replacing the default city and site size of 30 acres will affect the Q/C values in both the VF and PEF equations (Equations 5 and 7). The Technical Background Document supporting this guidance (U.S. EPA, 1994e) provides a table of Q/C values for 29 cities across the country over a range of contaminant source areas for use in the simple site-specific method.

The particulate emission factor derived by using the default values in Equation 7 results in an ambient air concentration of approximately 1.5 $\mu g/m^3$. This represents an annual average emission rate that is based on wind erosion and is not appropriate for evaluating the potential for more acute exposures.

Migration to Ground Water

The methodology for addressing migration of contaminants from soil to ground water reflects the complex nature of contaminant fate and transport in the subsurface. In this methodology, a concentration in soil is backcalculated from an acceptable ground water concentration. The generic SSLs presented in Appendix A for this pathway represent a conservative estimation of the concentration of a contaminant in soil that would not result in exceedances of the acceptable concentration of a contaminant in ground water. Flexibility to consider site-specific conditions is addressed in the simple and detailed site-specific methodologies.

The first step in applying the SSL framework is a comparison of the SSL conceptual model presented earlier in this document with the conceptual model developed for the site. This forms the basis for determining the appropriateness of conducting a more detailed investigation and the applicability of the SSL guidance for the migration to ground water pathway. Some of the assumptions used to develop the SSL conceptual model have implications for the ground water pathway. Highlight 4 lists assumptions implicit in the conceptual model that should be understood before applying the SSL ground water framework.

Both the simple site-specific and generic methods are based on the commonly used equilibrium soil/water partition equation (Equation 8) that describes the ability of contaminants to sorb

Equation 8: Soil Screening Level Partitioning Equation for Migration to Ground Water

$$\text{Screening Level in Soil (mg/kg)} = C_w\left[K_d + \frac{(\theta_w + \theta_a H')}{\rho_b}\right]$$

Parameter/Definition (units)	Default
C_w/target soil leachate concentration (mg/L)	nonzero MCLG, MCL, or HBL × 10 DAF
K_d/soil-water partition coefficient (L/kg)	chemical-specific, $K_{oc} \times f_{oc}$ (organics)
K_{oc}/soil organic carbon/water partition coefficient (L/kg)	chemical-specific
f_{oc}/fraction organic carbon in soil (g/g)	0.002 (0.2%)
θ_w/water-filled soil porosity (L_{water}/L_{soil})	0.3 or $w\rho_b$
w/average soil moisture content (kg_{water}/kg_{soil} or L_{water}/kg_{soil})	0.2 (20%)
ρ_b/dry soil bulk density (kg/L)	1.5 or $(1 - n)\,\rho_s$
n/soil porosity (L_{pore}/L_{soil})	0.43 (loam)
ρ_s/soil particle density (kg/L)	2.65
θ_a/air-filled soil porosity (L_{air}/L_{soil})	0.13 or $(n - \theta_w)$
H'/Henry's law constant (unitless)	H × 41
H/Henry's law constant (atm-m^3/mol)	chemical-specific (assume to be zero for inorganic contaminants except mercury)

Highlight 4: Simplifying Assumptions of the Default Conceptual Model for Ground Water

1. The source of contamination is defined as an evenly contaminated 30-acre site. Source size has significant implications for the development of the dilution/attenuation factor. Large sources generally tend to result in low DAFs, while smaller sources generally justify higher DAFs. Where actual source size differs significantly from the default 30-acre assumption, the user should consider a site-specific evaluation to develop a more site-specific DAF.

2. The soil contamination extends from the surface to the top of the aquifer. This is a reasonable assumption for sites where the water table is fairly shallow (e.g., 5 to 10 feet below surface). However, in areas where the water table is very deep, this assumption may not be valid and should be considered in the decision to apply a detailed site-specific evaluation.

3. No attenuation is considered in the unsaturated zone. This assumption also has implications for the DAF. As discussed above, a detailed site-specific evaluation should be considered at sites that have a very thick uncontaminated unsaturated zone because a higher DAF may be justified.

4. The point of compliance is at the edge of the site, which is assumed to be uniformly contaminated. This conservative assumption also has implications for the calculation of the DAF. The user should consider whether this assumption is valid for the site in question and whether further evaluation would be appropriate.

5. The simple site-specific or generic DAF assumes that an unconfined, unconsolidated aquifer with homogeneous and isotropic hydrologic properties underlies the site. A DAF greater than 1 may not be appropriate for soils underlain by karst or fractured rock aquifers.

6. NAPLs are not present. If NAPLs are present in soils, the SSLs do not apply (i.e., further investigation is necessary).

to organic carbon in soil (Dragun, 1988). An adjustment to relate sorbed concentration in soil to the analytically measured total soil concentration has been added to the equation.

The partition equation contains parameters for chemical-specific (Henry's law constant; K_d or K_{oc}) and subsurface characteristic variables (dry bulk density, porosity, air-filled and water-filled pore space). In the default method, national default values for the parameters in the partition equation were used to calculate the generic SSLs in Appendix A. Nonzero ground water maximum contaminant level goals (MCLGs) were used as the acceptable ground water limits for each contaminant in the partitioning equation. If nonzero MCLGs were not available, maximum contaminant levels (MCLs) were used. If MCLs were not available, concentrations associated with a target cancer risk of 10^{-6} and/or a noncancer HQ of 1 were derived using Agency toxicity criteria. The acceptable ground water limit is multiplied by the DAF of 10 to obtain a target soil leachate concentration for calculating generic SSLs.

In the simple site-specific method, site-measured data would replace the default values for the subsurface characteristic and soil variables (i.e., fraction organic carbon, dry bulk density, average soil moisture content). These variables would then be used to calculate a more site-specific screening value. Even this screening number is fairly conservative because of the underlying assumptions regarding the absence of attenuation and placement of the well adjacent to the source.

As described above, the C_{sat} ceiling limit defines (for organic chemicals that are liquid at soil temperatures) a concentration above which chemicals may occur as NAPLs in soil. For liquid chemicals present at concentrations greater than C_{sat}, NAPL presence may be suspected and the Soil Screening framework would not be applicable (i.e., further investigation is necessary). See U.S. EPA (1992b) for guidance on determining the likelihood of NAPL occurrence in the subsurface and on conducting the additional investigations necessary if NAPL occurrence is suspected at a site.

Partitioning of inorganic constituents in the subsurface is more complex than for organics. A variety of soil conditions affect the derivation of the partitioning coefficient for inorganics, while organic carbon is the parameter that most affects organic partitioning. For this reason, the EPA MINTEQ2 equilibrium geochemical speciation model was used to calculate K_d values for the metals, which were then used in Equation 8. K_d values for metals are most significantly affected by pH; therefore, metal K_d values were calculated over a range of subsurface pH conditions (4.9 to 8.0). K_d values corresponding to this pH range are presented in the revised Technical Background Document (U.S. EPA, 1994e) for use in the simple site-specific method. Based on the pH at the site, the appropriate K_d should be selected and used in the calculation. Also note that all metals except mercury are essentially nonvolatile and their Henry's law constant (H') in Equation 8 should be set at zero.

Generic SSLs for inorganics corresponding to a pH of 6.8 are presented in Appendix A for the default method. Table 1 lists inorganic SSLs corresponding to pH values of 4.9 and 8.0 and a DAF of 10. If pH conditions at a site are not known, the generic SSL corresponding to a pH of 6.8 should be used in the default method. Table 1 also includes SSLs for ionizing organics, whose partitioning behavior is also pH dependent. Readers are referred to the Technical Background Document (U.S. EPA, 1994e) for a more detailed discussion of the derivation of K_d values for inorganics and K_{oc} values for ionizing and nonionizing organics.

The framework also includes the option of using a leach test instead of the partitioning equation. In some instances a leach

Table 1. pH-Specific SSLs for Metals and Ionizing Organics (mg/kg) (DAF = 10)

Chemical	pH 4.9	pH 8
Arsenic	13	16
Barium	16	340
Beryllium	0.1	19,000
Cadmium	0.06	230
Chromium (+6)	31	14
Mercury	0.006	4
Nickel	1	140
Selenium	9	1
Thallium	0.2	0.5
Zinc	180	1.6E+6
Benzoic acid	300	280
2,4-Dichlorophenol	0.5	0.3
Pentachlorophenol	0.2	0.01
2,4,5-Trichlorophenol	200	26
2,4,6-Trichlorophenol	0.07	0.01

test may be more useful than the partitioning method, depending on the constituents of concern and the possible presence of RCRA wastes. This guidance suggests using the EPA Synthetic Precipitation Leaching Procedure (SPLP, EPA SW-846 Method 1312, see the Technical Background Document [U.S. EPA, 1994e]). The SPLP was developed to model an acid rain leaching environment and is generally appropriate for a contaminated soil scenario. Like most leach tests, the SPLP may not be appropriate for all situations (e.g., soils contaminated with oily constituents may not yield suitable results). Therefore, discretion is advised when applying the SPLP.

The Agency is aware that there are many leach tests available for application at hazardous waste sites, some of which may be appropriate in specific situations (e.g., the Toxicity Characteristic Leaching Procedure, known as the TCLP, models leaching in a municipal landfill environment). It is beyond the scope of this document to discuss in detail other leaching procedures and the appropriateness of their use. *Stabilization/Solidification of CERCLA and RCRA Wastes* (U.S. EPA, 1989c) and the SAB's review of leaching tests (U.S. EPA, 1991c) contain information on the application of various leach tests to various waste disposal scenarios. The user is encouraged to consult these doucments for further information.

DETERMINING THE DILUTION/ ATTENUATION FACTOR

As contaminants move through soil and ground water, they are subjected to a number of physical, chemical, and biological processes that generally reduce the eventual contaminant concentration level at receptor points. The reduction in concentration can be expressed succinctly by the DAF, defined as the ratio of the soil leachate concentration to the receptor point concentration. The lowest possible value of DAF is 1, corresponding to the situation where there is no dilution or attenuation of a contaminant; i.e., the concentration at the receptor point is the same as that in the soil leachate. High DAF values, on the other hand, correspond to a high degree of dilution and attenuation of the contaminant from the leachate to the receptor point.

The soil/water partition equation relates concentrations of contaminants adsorbed to soil organic carbon to soil leachate concentrations in the unsaturated zone. Contaminant migration through the unsaturated zone to the water table generally reduces the soil leachate concentration by attenuation processes such as adsorption and degradation. Ground water transport in the saturated zone further reduces concentrations through adsorption, degradation, and dilution. Generally, to account for this reduction in concentration, acceptable ground water limits are multiplied by a DAF to obtain a target soil leachate concentration for the partition equation.

A default DAF of 10 is applied to calculate the generic SSLs. A weight of evidence method was used to determine this default DAF. In the weight-of-evidence approach, OERR evaluated a number of methods for calculating DAFs. Included in this approach was an evaluation of DAFs calculated by the EPACMTP model, using a range of assumptions including those associated with the conceptual site model for the generic SSLs. The comparison also included DAFs calculated from a more simplified mixing-zone equation, as well as acceptable DAFs used in existing State programs. The comparison indicated that, for the default scenario, a DAF of 10 is conservatively protective of the majority of site conditions, including the site scenario developed for the generic SSLs. The Technical Background Document (U.S. EPA, 1994e) supporting this guidance contains additional detail on the development of the generic DAF.

The simple site-specific method relies on a fairly simple mixing zone equation (Equation 9) to calculate a site-specific dilution factor to be used instead of the default DAF. In this method, site-measured values for hydraulic gradient, hydraulic

Equation 9: Derivation of Dilution Factor

$$\text{dilution factor} = 1 + \frac{Kid}{IL}$$

Parameter/Definition (units)

dilution factor (unitless)
K/aquifer hydraulic conductivity (m/yr)
i/hydraulic gradient (m/m)
d/mixing zone depth (m)
I/infiltration rate (m/yr)
L/source length parallel to ground water flow (m)

conductivity, and estimates of infiltration, contaminant source length, and mixing-zone depth are used to calculate the dilution factor. The mixing-zone depth is estimated from an equation relating it to aquifer thickness, infiltration rate, ground water velocity, and source length parallel to flow (Equation 10).

Equation 10: Estimation of Mixing Zone Depth
$d = (0.0112\ L^2)^{0.5} + d_a\ \{1 - \exp[(-LI)/(Kid_a)]\}$
Parameter/Definition (units) d/mixing zone depth (m) L/source length parallel to ground water flow (m) I/infiltration rate (m/yr) K/aquifer hydraulic conductivity (m/yr) d_a/aquifer thickness (m)

Detailed Site-Specific Method

In this investigation, site-specific data are collected and used in a fate and transport model to determine whether a threat to ground water exists and, if so, to further determine site-specific cleanup goals as would typically be done for the remedial investigation/feasibility study (RI/FS). Consequently it represents the highest level of site-specificity in evaluating the migration to ground water pathway. A DAF is not used in this method because the model would account for fate and transport mechanisms in the subsurface. The advantage of this approach is that it accounts for site hydrogeologic, climatologic, and contaminant source characteristics and may result in fully protective but less stringent remediation goals. However, the additional cost of collecting the data required to apply the model should be factored into the decision to conduct a detailed site-specific investigation.

Choosing a model for site-specific application is integral to an accurate evaluation of potential concern. However, the data used in the application and interpretion of the results are equally important. In an effort to provide useful information for a model application, EPA's ORD Laboratories in Ada, Oklahoma, and Athens, Georgia, conducted an evaluation of nine unsaturated zone fate and transport models. The information in this report is summarized in the Technical Background Document (U.S. EPA, 1994e) supporting this guidance. These nine models are only a subset of the potentially appropriate models available to the public and are not meant to be construed as having received EPA approval. EPA also has developed guidance for the selection and application of ground water transport and fate models and for interpretation of model applications. The user is referred to *Ground Water Modeling Compendium* (U.S. EPA, 1994b) and *Framework for Assessing Ground Water Model Applications* (U.S. EPA, 1994a) for further information.

MEASURING CONTAMINANT CONCENTRATIONS IN SOIL

In order to compare site soil concentrations with the SSLs, it is important to develop a sampling strategy that will result in an accurate representation of site contamination. This Soil Screening Guidance recommends that site managers use the Data Quality Objectives (DQO) process (Figure 5) to develop a sampling strategy that will satisfy Superfund program objectives. The site manager can use the DQO process to conveniently organize and document many site-specific features and assumptions underlying the sampling plan. In the last step of the DQO process, "Optimize the Design for Obtaining Data," the site manager can choose between two alternative approaches to measuring surface soil contaminant concentrations. The first is a site-specific strategy that uses site-specific estimates of contaminant variability to determine how many samples are needed to support the screening decision. The second is a fairly prescriptive approach that can be used in lieu of the site-specific strategy. Recommendations for subsurface sampling that can be modified to accommodate site-specific conditions are also included in the guidance.

Exposure to site contaminants over a long (chronic) period of time is best represented by an arithmetic average concentration for an exposure area (U.S. EPA, 1992d). Therefore, measurement of site concentrations for comparison to the SSLs should

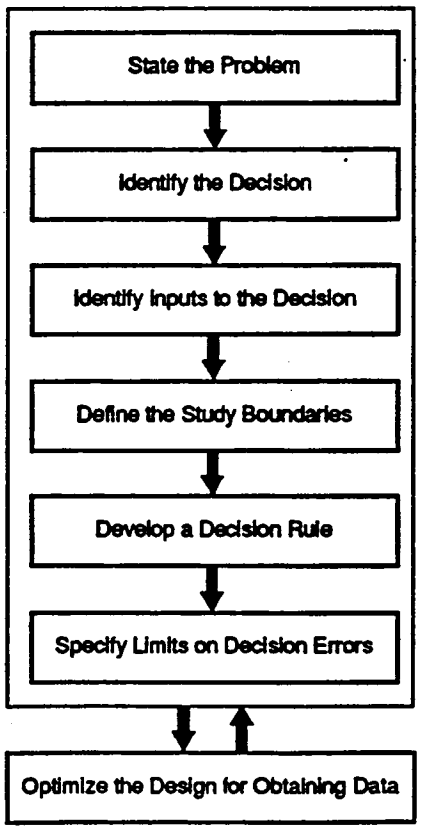


Figure 5. The Data Quality Objectives process.

be based on the arithmetic mean concentration as well. For the purposes of this guidance, the Agency has assumed that the size of a typical residential lot (0.5 acre) is an appropriate averaging area for residential land use. For large sites that could be divided into multiple residential lots, the site should be sectioned into appropriate 0.5-acre parcels.

For measurement of surface soil samples for the inhalation and ingestion pathways, samples should be collected over a depth of 6 inches because it is the top 6 inches of soil that is most likely to be ingested or inhaled as fugitive dusts. Additional sampling beyond 6 inches may be appropriate, depending on the contaminant's mobility. If soils at the site are of concern for the migration to ground water pathway as well as the ingestion and/or inhalation pathways, then surface soils should be sampled first since the results of the composite samples may indicate source areas to target for subsurface sampling.

As discussed previously, the initial steps for implementing the Soil Screening framework are to (1) develop the conceptual site model and determine the applicability of the framework; (2) determine if background concentrations exceed the (generic) SSLs; and (3) select the method (simple site-specific, detailed site-specific, or generic) to determine the SSLs. Once these steps have been completed, it will then be necessary to choose either a site-specific or a generic, prescriptive sampling strategy for surface soils.

Surface Soils—Site-Specific Strategy

The site-specific sampling strategy utilizes a sampling design approach that allows statistically valid conclusions to be drawn about contaminant concentrations at a site based on relatively limited sampling. EPA recommends that site managers use this strategy to determine the number of samples needed to compare average contaminant concentrations within each exposure area against the SSLs. The site-specific strategy provides procedures for ensuring that screening decisions can be made with acceptable levels of confidence despite variability in soil contaminant concentrations that can sometimes mask true conditions at the site. This approach provides flexibility to incorporate site-specific information about likely contamination patterns so that sampling can be concentrated in areas where uncertainty about the risk posed by soil contaminants is greatest.

The sampling design developed for the site should be based on the conceptual site model and should reflect conditions at the site. It is flexible in that the information used to develop the conceptual site model (historical records, aerial photographs, existing sampling data, etc.) can also be used to develop an appropriate sampling strategy. Such a strategy may include stratification of the site, if appropriate, into areas where soil contaminant concentrations are expected to clearly exceed the SSLs, areas where soil contaminant concentrations are expected to fall well below the SSLs, and areas of the site where there is greater uncertainty as to whether soil contaminant concentrations exceed the SSLs.

This classification of areas of the site can help in designing an efficient sampling plan, since the number of samples required to support good decision making depends on the contaminant variability likely to be encountered and how greatly contaminant concentrations differ from the SSLs. By grouping similar areas together, each area can be sampled in accordance with the level of uncertainty or variability associated with that area. For example, EPA expects that a relatively small number of samples will be needed to make the screening decision where average contaminant concentrations clearly exceed or are well below the SSLs. More intensive sampling is expected for those areas where relatively high contaminant variability or concentrations close to the SSLs make it more difficult to determine with confidence whether the average contaminant concentration exceeds the screening level.

Inherent in the statistically based site-specific sampling strategy is the specification of limits on decision errors, which is performed in the sixth step of the DQO process. Limits on decision errors are quantitative performance requirements for the quality and quantity of data that will support the screening decision. These performance requirements are specified in terms of the probability of making a decision error, which can occur in two ways:

- Type I: The data mislead the site manager into deciding that the exposure area concentration is below the SSLs when the true average contaminant concentration exceeds the screening level; or

- Type II: The data mislead the site manager into deciding that the exposure area concentration is above the SSL and further investigation is required when in fact the true average contaminant concentration is less than the SSL.

To ensure consistency in applying the framework, EPA has specified tolerable limits on decision errors at the program level. The Technical Background Document (U.S. EPA, 1994e) provides a full discussion of the Soil Screening framework's limits on decision errors and of the site-specific strategy in general. EPA encourages the project manager to seek the assistance of a statistician or the Regional quality assurance staff for the development of the sampling strategy. For more detailed guidance on the DQO process the user should refer to the Technical Background Document and *Data Quality Objectives for Superfund (Interim Final)* (U.S. EPA, 1993a).

Surface Soils—Prescriptive Approach

The guidance provides a second sampling methodology—a "prescriptive approach"—that can be used as an alternative to the site-specific approach. A sampling design effort is required for the site-specific strategy, whereas the prescriptive approach provides a simple, standard sampling approach that will be most useful for small sites that do not warrant an extensive design effort. It emphasizes composite sampling for

nonvolatile contaminants and specifies the number of samples to be collected for analysis of volatile contaminants. It differs from the site-specific approach in that the same sampling strategy must be applied to each 0.5-acre exposure area. Although it does not explicitly control decision errors, preliminary simulations suggest that it does not underestimate mean concentrations for commonly occurring patterns of soil contamination. Additional simulations comparing the performance of the prescriptive approach to the site-specific strategy will be a subject of peer review.

Studies by ORD indicate that at least 20 samples per exposure area are needed to closely estimate the true mean. To balance the need for statistical confidence in determining a meaningful arithmetic mean contaminant concentration with the costs of analyzing multiple samples for each exposure area, EPA recognizes the benefits of composite samples and advocates compositing, where appropriate. Compositing may mask contaminant levels that are slightly higher than the SSL, but areas of high contamination will still be detected. Compositing is a reasonable approach and an efficient use of resources since the Superfund program is interested in the average exposure over time. (See the Technical Background Document [U.S. EPA, 1994e] for a more detailed discussion of compositing and its limitations.)

Using the prescriptive approach, 20 discrete samples can be reduced to four composite samples. (The exposure area can be divided into quadrants and five random samples can be collected and composited within each quadrant.) The contaminant concentrations from the four composite samples should be compared directly with their respective SSLs. If any one of the composites equals or exceeds the SSL, then that portion of the exposure area should be studied further.

Compositing is not appropriate for volatile organic compounds (VOCs) since much of the contaminant will be lost during homogenization of the soil (U.S. EPA, 1989a, 1992c). For VOCs, 10 discrete samples can be taken per exposure area and any sample above the SSL would trigger the need for additional study in that exposure area. Additionally, it is not appropriate to average the contaminant levels in each exposure area and evaluate the mean concentration against the SSLs because 10 discrete samples may underestimate the true mean.

Subsurface Sampling

For the migration to ground water pathway, subsurface soils that have constituents that might contribute to ground water contamination are of primary concern. Therefore, it is the source areas that are of interest and not necessarily a 0.5-acre exposure area as specified for the ingestion and inhalation pathways. To determine whether contaminants in the subsurface soils (defined as below 6 inches for the purposes of implementing SSLs) potentially pose a risk to ground water, the guidance suggests sampling at least two boreholes using split spoon or Shelby tube samples in each source area. Samples should begin at 6 inches below ground surface and continue at 2-foot intervals until no contamination is encountered. If the average concentration in any borehole exceeds the SSL, then further site-specific study is warranted.

Subsurface sampling depths and intervals can be adjusted at a site to accommodate site-specific information on subsurface contaminant distributions and geological conditions. In addition, soil investigation for the migration to ground water pathway should not be conducted independent of ground water investigation. Ground water should be sampled to determine whether there is concern for existing ground water contamination, and the results should be considered in the holistic application of the Soil Screening framework.

Geostatistics

If the SSLs are to be compared with the data resulting from the initial sample collection efforts of the remedial investigation, the site manager may want to consider using geostatistics to estimate contaminant concentrations across the site. Geostatistics is probably most appropriate to use in the detailed site-specific approach. Geostatistics is a field of study in which statistical analyses of geologic or environmental data are conducted. It differs from single-sample classical statistics in that it assumes that variability and independence between samples is not random, but that there is some spatial continuity between samples. Geostatistics can be used to estimate contaminant concentrations at unsampled points and estimate average contaminant concentrations across the site.

Software packages have been developed to facilitate geostatistical analyses. One package is GEO-EAS, developed by EPA's Environmental Monitoring Systems Laboratory in Las Vegas, Nevada. Assistance and consultation with skilled geostatisticians is recommended prior to initiating any sampling plan to ensure that the sampling strategy will capture the critical data necessary for the geostatistical analyses.

WHERE TO GO FOR FURTHER INFORMATION

More detailed discussions of the technical background and assumptions supporting the development of the Soil Screening framework are presented in the *Technical Background Document for Soil Screening Guidance* (U.S. EPA, 1994e). For additional copies of this Fact Sheet and/or the Technical Background Document, call the National Technical Information Service (NTIS) at (703) 487-4650.

NOTICE: This guidance is based on policies in the Final Rule of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), which was published on March 8, 1990 (55 *Federal Register* 8666). The NCP should be considered the authoritative source.

The policies set out in this document are intended solely as guidance to the U.S. Environmental Protection Agency (EPA) personnel; they are not final EPA actions and do not constitute rulemaking. These policies are not intended, nor can they be relied upon, to create any rights enforceable by any party in litigation with the United States. EPA officials may decide to follow the guidance provided in this document, or to act at variance with the guidance, based on an analysis of specific site circumstances. EPA also reserves the right to change the guidance at any time without public notice.

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Appendix A. Generic Soil Screening Levels for Superfund[a]

NOTICE: These values were developed for use in application of the Soil Screening Guidance only. They were developed for specific exposure pathways constituting a residential scenario and should only be used in that context.

CAS No.	Chemical	Pathway-specific values for surface soils (mg/kg)		Migration to ground water pathway levels (mg/kg)	
		Ingestion	Inhalation	With 10 DAF	With 1 DAF
83-32-9	Acenaphthene	4,700 [b]	— [c]	200 [b]	20 [b]
67-64-1	Acetone	7,800 [b]	62,000 [d]	8 [b]	0.8 [b]
309-00-2	Aldrin	0.04 [e]	0.5 [e]	0.005 [e]	5E-4 [e,f]
120-12-7	Anthracene	23,000 [b]	— [c]	4,300 [b]	430 [b]
71-43-2	Benzene	22 [e]	0.5 [e]	0.02	0.002 [f]
56-55-3	Benzo(*a*)anthracene	0.9 [e]	— [c]	0.7	0.07 [f]
205-99-2	Benzo(*b*)fluoranthene	0.9 [e]	— [c]	4	0.4
207-08-9	Benzo(*k*)fluoranthene	9 [e]	— [c]	4	0.4
50-32-8	Benzo(*a*)pyrene	0.09 [e,f]	— [c]	4	0.4
111-44-4	Bis(2-chlorethyl)ether	0.6 [e]	0.3 [e,f]	3E-4 [e,f]	3E-5 [e,f]
117-81-7	Bis(2-ethylhexyl)phthalate	46 [e]	210 [d]	11	1
75-27-4	Bromodichloromethane	5 [e]	1,800 [d]	0.3	0.03
75-25-2	Bromoform	81 [e]	46 [e]	0.5	0.05
71-36-3	Butanol	7,800 [b]	9,700 [d]	8 [b]	0.8 [b]
85-68-7	Butyl benzyl phthalate	16,000 [b]	530 [d]	68	7
86-74-8	Carbazole	32 [e]	— [c]	0.2 [e,f]	0.02 [e,f]
75-15-0	Carbon disulfide	7,800 [b]	11 [b]	14 [b]	1 [b]
56-23-5	Carbon tetrachloride	5 [e]	0.2 [e]	0.03	0.003 [f]
57-74-9	Chlordane	0.5 [e]	10 [e]	2	0.2
108-90-7	Chlorobenzene	1,600 [b]	94 [b]	0.6	0.06
124-48-1	Chlorodibromomethane	8 [e]	1,900 [d]	0.2	0.02
67-66-3	Chloroform	110 [e]	0.2 [e]	0.3	0.03
218-01-9	Chrysene	88 [e]	— [c]	1	0.1 [f]
72-54-8	DDD	3 [e]	— [c]	0.7 [e]	0.07 [e]
72-55-9	DDE	2 [e]	— [c]	0.5 [e]	0.05 [e]
50-29-3	DDT	2 [e]	80 [e]	1 [e]	0.1 [e]
53-70-3	Dibenzo(*a,h*)anthracene	0.09 [e,f]	— [c]	11	1
84-74-2	Di-*n*-butyl phthalate	7,800 [b]	100 [d]	120 [b]	12 [b]
95-50-1	1,2-Dichlorobenzene (*o*)	7,000 [b]	300 [d]	6	0.6
106-46-7	1,4-Dichlorobenzene (*p*)	27 [e]	7,700 [b]	1	0.1 [f]
91-94-1	3,3-Dichlorobenzidine	1 [e]	— [c]	0.01 [e,f]	0.001 [e,f]
75-34-3	1,1-Dichloroethane	7,800 [b]	980 [b]	11 [b]	1 [b]
107-06-2	1,2-Dichloroethane	7 [e]	0.3 [e]	0.01 [f]	0.001 [f]
75-35-4	1,1-Dichloroethylene	1 [e]	0.04 [e]	0.03	0.003 [f]
156-59-2	*cis*-1,2-Dichloroethylene	780 [b]	1,500 [d]	0.2	0.02
156-60-5	*trans*-1,2-Dichloroethylene	1,600 [b]	3,600 [d]	0.3	0.03
78-87-5	1,2-Dichloropropane	9 [e]	11 [b]	0.02	0.002 [f]
542-75-6	1,3-Dichloropropene	4 [e]	0.1 [e]	0.001 [e,f]	1E-4 [e,f]
60-57-1	Dieldrin	0.04 [e]	2 [e]	0.001 [e,f]	1E-4 [e,f]
84-66-2	Diethyl phthalate	63,000 [b]	520 [d]	110 [b]	11 [b]
131-11-3	Dimethyl phthalate	7.8E+5 [b]	1,600 [d]	1,200 [b]	120 [b]
121-14-2	2,4-Dinitrotoluene	160 [b]	— [c]	0.2 [b,f]	0.02 [b,f]
606-20-2	2,6-Dinitrotoluene	78 [b]	— [c]	0.1 [b,f]	0.01 [b,f]

(continued)

Appendix A (continued)

CAS No.	Chemical	Pathway-specific values for surface soils (mg/kg)		Migration to ground water pathway levels (mg/kg)	
		Ingestion	Inhalation	With 10 DAF	With 1 DAF
117-84-0	Di-*n*-octyl phthalate	1,600 [b]	— [c]	— [g]	— [g]
115-29-7	Endosulfan	470 [b]	— [c]	4 [b]	0.4 [b]
72-20-8	Endrin	23 [b]	— [c]	0.4	0.04
100-41-4	Ethylbenzene	7,800 [b]	260 [d]	5	0.5
206-44-0	Fluoranthene	3,100 [b]	— [c]	980 [b]	98 [b]
86-73-7	Fluorene	3,100 [b]	— [c]	160 [b]	16 [b]
76-44-8	Heptachlor	0.1 [e]	0.3 [e]	0.06	0.006
1024-57-3	Heptachlor epoxide	0.07 [e]	1 [e]	0.03	0.003
118-74-1	Hexachlorobenzene	0.4 [e]	1 [e]	0.8	0.08 [f]
87-68-3	Hexachloro-1,3-butadiene	8 [e]	1 [e]	0.1 [f]	0.01 [f]
319-84-6	α-HCH (α-BHC)	0.1 [e]	0.9 [e]	4E-4 [e,f]	4E-5 [e,f]
319-85-7	β-HCH (β-BHC)	0.4 [e]	16 [e]	0.002 [e]	2E-4 [e,f]
58-89-9	γ-HCH (Lindane)	0.5 [e]	— [c]	0.006	6E-4 [f]
77-47-4	Hexachlorocyclopentadiene	550 [b]	2 [b]	10	1
67-72-1	Hexachloroethane	46 [e]	49 [e]	0.2 [e,f]	0.02 [e,f]
193-39-5	Indeno(1,2,3-*c,d*)pyrene	0.9 [e]	— [c]	35	3
78-59-1	Isophorone	670 [e]	3,400 [d]	0.2 [e,f]	0.02 [e,f]
72-43-5	Methoxychlor	390 [b]	— [c]	62	6
74-83-9	Methyl bromide	110 [b]	2 [b]	0.1 [b]	0.01 [b,f]
75-09-2	Methylene chloride	85 [e]	7 [e]	0.01 [f]	0.001 [f]
91-20-3	Naphthalene	3,100 [b]	— [c]	30 [b]	3 [b]
98-95-3	Nitrobenzene	39 [b]	110 [b]	0.09 [b,f]	0.009 [b,f]
1336-36-3	Polychlorinated biphenyls (PCBs)	1 [h]	— [c,h]	— [h]	— [h]
129-00-0	Pyrene	2,300 [b]	— [c]	1,400 [b]	140 [b]
100-42-5	Stryene	16,000 [b]	1,400 [d]	2	0.2
79-34-5	1,1,2,2-Tetrachloroethane	3 [e]	0.4 [e]	0.001 [e,f]	1E-4 [e,f]
127-18-4	Tetrachloroethylene	12 [e]	11 [e]	0.04	0.004 [f]
108-88-3	Toluene	16,000 [b]	520 [d]	5	0.5
8001-35-2	Toxaphene	0.6 [e]	5 [d]	0.04 [f]	0.004 [f]
120-82-1	1,2,4-Trichlorobenzene	780 [b]	240 [b]	2	0.2 [f]
71-55-6	1,1,1-Trichloroethane	— [c]	980 [d]	0.9	0.09
79-00-5	1,1,2-Trichloroethane	11 [e]	0.8 [e]	0.01 [f]	0.001 [f]
79-01-6	Trichloroethylene	58 [e]	3 [e]	0.02	0.002 [f]
108-05-4	Vinyl acetate	78,000 [b]	370 [b]	84 [b]	8 [b]
75-01-4	Vinyl chloride	0.3 [e]	0.002 [e,f]	0.01 [f]	0.001 [f]
1330-20-7	Xylenes (total)	1.6E+5 [b]	320 [d]	74	7
	Ionizable Organics				
65-85-0	Benzoic acid	3.1E+5 [b]	— [c]	280 [b,i]	28 [b,i]
106-47-8	*p*-Chloroaniline	310 [b]	— [c]	0.3 [b,f,i]	0.03 [b,f,i]
95-57-8	2-Chlorophenol	390 [b]	53,000 [d]	2 [b,i]	0.2 [b,f,i]
120-83-2	2,4-Dichlorophenol	240 [b]	— [c]	0.5 [b,i]	0.05 [b,f,i]
105-67-9	2,4-Dimethylphenol	1,600 [b]	— [c]	3 [b,i]	0.3 [b,f,i]
51-28-5	2,4-Dinitrophenol	160 [b]	— [c]	0.1 [b,f,i]	0.01 [b,f,i]
95-48-7	2-Methylphenol	3,900 [b]	— [c]	6 [b,i]	0.6 [b,i]

(continued)

Appendix A (continued)

CAS No.	Chemical	Pathway-specific values for surface soils (mg/kg)		Migration to ground water pathway levels (mg/kg)	
		Ingestion	Inhalation	With 10 DAF	With 1 DAF
86-30-6	*N*-Nitrosodiphenylamine	130 [e]	— [c]	0.2 [e,f,i]	0.02 [e,f,i]
621-64-7	*N*-Nitrosodi-*n*-propylamine	0.09 [e,f]	— [c]	2E-5 [e,f,i]	2E-6 [e,f,i]
87-86-5	Pentachlorophenol	3 [e,j]	— [c]	0.01 [f,i]	0.001 [f,i]
108-95-2	Phenol	47,000 [b]	— [c]	49 [b,i]	5 [b,i]
95-95-4	2,4,5-Trichlorophenol	7,800 [b]	— [c]	120 [b,i]	12 [b,i]
88-06-2	2,4,6-Trichlorophenol	58 [e]	210 [e]	0.06 [e,f,i]	0.006 [e,f,i]
	Inorganics				
7440-36-0	Antimony	31 [b]	— [c]	— [k]	— [k]
7440-38-2	Arsenic ⚘	0.4 [e]	380 [e]	15 [i]	1 [i]
7440-39-3	Barium	5,500 [b]	3.5E+5 [b]	32 [i]	3 [i]
7440-41-7	Beryllium	0.1 [e]	690 [e]	180 [i]	18 [i]
7440-43-9	Cadmium ⚘	39 [b]	920 [e]	6 [i]	0.6 [i]
7440-47-3	Chromium (6+)	390 [b]	140 [e]	19 [i]	2 [i]
7439-92-1	Lead	400 [l]	—	—	—
7439-97-6	Mercury ⚘	23 [b]	7 [b,i]	3 [i]	0.3 [i]
7440-02-0	Nickel ⚘	1,600 [b]	6,900 [e]	21 [i]	2 [i]
7782-49-2	Selenium ⚘	390 [b]	— [c]	3 [i]	0.3 [i]
7440-22-4	Silver	390 [b]	— [c]	— [k]	— [k]
7440-28-0	Thallium	— [c]	— [c]	0.4 [i]	0.04 [i]
7440-62-2	Vanadium	550 [b]	— [c]	— [k]	— [k]
7440-66-6	Zinc ⚘	23,000 [b]	— [c]	42,000 b,i	4,200 b,i
57-12-5	Cyanide	1,600 [b]	— [c]	— [k]	— [k]

DAF = Dilution and attenuation factor.

[a] Screening levels based on human health criteria only.
[b] Calculated values correspond to a noncancer hazard quotient of 1.
[c] No toxicity criteria available for that route of exposure.
[d] Soil saturation concentration (C_{sat}).
[e] Calculated values correspond to a cancer risk level of 1 in 1,000,000.
[f] Level is at or below Contract Laboratory Program required quantitation limit for Regular Analytical Services (RAS).
[g] Chemical-specific properties are such that this pathway is not of concern at any soil contaminant concentration.
[h] A preliminary remediation goal of 1 ppm has been set for PCBs based on *Guidance on Remedial Actions for Superfund Sites with PCB Contamination*, EPA/540G-90/007, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, DC, 1990, and on Agency-wide efforts to manage PCB contamination.
[i] SSL for pH of 6.8.
[j] Ingestion SSL adjusted by a factor of 0.5 to account for dermal exposure.
[k] Soil/water partition coefficients not available at this time.
[l] A preliminary remediation goal of 400 mg/kg has been set for lead based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities*, OSWER Directive #9355.4-12, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, DC, July 14, 1994.

⚘ Indicates potential for soil-plant-human exposure.

Levels developed for residential use only:

Residential

Industrial

Agricultural

PRC Environmental Management, Inc.
1099 18th St.
Suite 1960
Denver, CO 80202
303-295-1101
Fax 303-295-2818

PRC

March 7, 1995

Mr. Hubert Chan
Department of the Navy
Engineering Field Activity West
Naval Facilities Engineering Command
900 Commodore Drive, Building 208
San Bruno, California 94066-5006

Subject: Responses to Comments; Naval Auxiliary Landing Field Crows Landing; CLEAN Contract N62474-88-D-5086; Contract Task Order 0247

Dear Mr. Chan:

Attached to this letter are responses to review comments on the draft installation restoration program (IRP) remedial investigation (RI) work plan for Naval Auxiliary Landing Field (NALF) Crows Landing. The comments were submitted by the California Department of Toxic Substances Control (DTSC) and the California Regional Water Quality Control Board (RWQCB), Central Valley Region.

The comment responses are keyed to the specific review comments. For completeness, the original review comments are also attached.

Please call me at 303-295-1101 if you have any questions regarding the comment responses.

Sincerely,

Neil J. Bingert
PRC Installation Coordinator

cc: Kent Strong, California Department of Toxic Substances Control
Karen Bessette, California Regional Water Quality Control Board, Central Valley Region
Robert Fourt, Stanislaus County Department of Environmental Resources
Sandy Olliges, National Aeronautics and Space Administration
Don Chuck, Moffett Federal Airfield
NALF Crows Landing Administrative Record, 2 copies

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