

## 5.0 BASELINE RISK ASSESSMENT FOR SITE 3

The baseline risk assessment for Site 3, the former Beach Trainfire Range, is presented in this section. This BRA follows the methodology presented in Section 2.0, with any deviations from these methods identified in the sections that follow.

### 5.1 Background

This section briefly summarizes background information on site history and the physical setting, past and planned future potential land uses, and the human populations near Site 3.

#### 5.1.1 Physical Setting

Site 3 spans approximately 3.2 miles and occupies 780 acres along the western boundary of Fort Ord (Plate 1.1). The site is bordered to the south by Sand City, to the north by the city of Marina, to the west by Monterey Bay, and to the east by Highway 1. Most of the surface area of Site 3 is unpaved and vegetated, with dune sands present at the surface. The topography is controlled by a series of sand dunes that have been eroded on the west side by wind and waves, resulting in steep drops to the beach along Monterey Bay. Depth to groundwater ranges from approximately 20 (near the shoreline) to over 100 feet below ground surface (feet bgs). Small arms firing ranges, numbered 1 through 17, are scattered along the eastern half of the site. There are no firing ranges numbered 10 or 13. A former ammunition storage area is between ranges 3 and 4.

Stilwell Hall and two sewage treatment plants are the main on-site structures. Stilwell Hall is located in the central part of Site 3 and was formerly used as a recreational center. Stilwell Hall was 200 to 300 feet from the shoreline when it was built in the 1940s, but natural forces have eroded the shoreline cliffs so that Stilwell Hall is now adjacent to the shoreline. A seawall was constructed to protect the structure from the encroaching surf. The Ord Village Sewage Treatment Plant (STP) and Main Garrison STP lie

within the Site 3 boundaries but are not considered part of Site 3 in the RI; these STPs are being investigated separately as Sites 1 and 2, respectively. Site 2 has been grouped with Site 12. Site 1 is still under investigation as one of the site elimination actions sites. Sewage is no longer treated at either of these plants but is instead pumped from Site 1 and gravity fed from Site 2 to the Monterey Regional Treatment Plant in the city of Marina.

Seven storm drain outfalls, which collect stormwater from the Main Garrison area of Fort Ord (east of Site 3), discharge either to the dune area or to the intertidal zone of Site 3: three outfalls discharge to the dunes near Range 11, Range 8, and Site 1; and four outfalls discharge to Monterey Bay in the surfzone. The storm drain outfalls were investigated as part of the Basewide Storm Drain and Sanitary Sewer Investigation (see the Remedial Investigation, Volume II, Section 2.5).

#### 5.1.2 Land Use

Although not currently active, the site was used since the 1940s for small arms training. Activities at the Beach Trainfire Ranges consisted of firing hand-held weapons at targets located near the leeward (east-facing) dune faces. According to the California Department of Parks and Recreation, proposed future land use entails conversion to a limited-access state park that would include construction of hiking trails, hike-in/bike-in campgrounds, and boardwalks from proposed parking lots to the beaches (*Fax transmittal from Jay Verett, COE to Steve Farley, HLA May 2, 1994*). These boardwalks will be constructed to limit human impacts on the dunes.

#### 5.1.3 Nearby Populations

The nearest resident populations are within 1/2 mile of the site in the city of Marina, which borders Site 3 to the northeast. In addition, U.S. Army personnel are on Fort Ord east of Site 3, across Highway 1 (Plate 5.1). Although

future development plans for this area of Fort Ord are not final, residential areas could be constructed at locations directly across Highway 1 from this site.

## 5.2 Data Evaluation

A preliminary visual survey in two areas on Site 3 was conducted by HLA on October 13, 1992 (HLA 1993f): one between Ranges 11 and 17 and the other at Range 8. This initial survey identified and characterized the distribution of spent ammunition at Site 3. Most spent ammunition observed consisted of spent bullets and metal fragments (e.g., bullet casings). The concentration of spent ammunition appeared to be greatest in an area approximately 10- to 30-foot high along the sand dunes immediately behind the target ranges. In this area, approximately 10 percent or more of the dune surface was covered with spent ammunition. The concentration of spent ammunition decreased to approximately zero percent at 1 to 2 feet bgs.

Given the large size of Site 3, three representative areas of the site were selected for sampling and evaluation in the RI: Ranges 11 and 12 (Study Area 1) represent the older range areas not used since 1975. Ranges 5 through 8 (Study Area 2) represent the areas that have received the most recent heavy use. An area between Ranges 8 and 9 was selected as the Control Area because, reportedly, it was never used as a firing range. Each of these three areas are approximately 68 acres in area and extend from the east side of the ranges to the shoreline.

Based on the amount of spent ammunition detected on the surface at Study Areas 1 and 2, the following "soil cover" categories were defined by the proportion of spent ammunition covering surface areas: heavy ( $\geq 10$  percent ammunition cover); moderate (1 to 10 percent ammunition cover); and light ( $< 1$  percent ammunition cover). A graphical representation of these three distributions across Site 3 is in Volume II, Site 3, Plate 8. Table 5.1 presents total surface areas of Study Areas 1 and 2, grouped into these three categories. Sampling activities conducted by HLA as part of the RI at these three areas involved collection of surface and subsurface soil

samples and subsurface soil samples and bullet fragment, as described below.

- Surface and subsurface soil sample were collected from 23 locations at depths ranging from 0 to 6.25 feet bgs. These samples were collected from 10 locations each in Study Areas 1 and 2 and from three locations in the Control Area. Samples were analyzed for metals (i.e., copper, lead, iron, zinc, antimony, tin, total chromium, and hexavalent chromium), total organic carbon, pH, and cation exchange capacity as sodium (Na).
- Bullet fragments in surface soil were collected at 10 unrecorded locations on Site 3.
- Soil for leachate samples were collected from five locations at depths ranging from 0.13 to 6.25 feet bgs. The leachate samples were collected from two locations each in Study Areas 1 and 2, and one sample was collected from the Control Area. Each leachate sample was split into four equal fractions: two fractions were sieved with a No. 8 (2.36 mm) sieve, and two fractions were not sieved. With the exception of hexavalent chromium, the leachate samples were analyzed for the same list of metals as were the soil samples.

Hexavalent chromium was not detected at Site 3. A total of 58 soil samples were analyzed for hexavalent chromium; detection limits for these samples ranged from 0.10 to 5.00 mg/kg. Detected concentrations of total chromium are therefore assumed to represent trivalent chromium.

Detailed results of the soil analyses performed at Site 3 are presented in Volume II, Site 3, Section 4.2. Summaries of detected compounds in soil for Study Area 1, Study Area 2, and the Control Area are presented in Tables 5.2a through 5.2f. The data on these tables are separated into two depth groups for each area 0 to 2 feet bgs and greater than 2 feet bgs. Tables 5.2g through 5.2l provide summaries for each of the three bullet distribution areas (e.g.  $< 1$  percent, 1 to 10 percent, and  $\geq 10$  percent).

As shown on the tables, seven metals were detected in soil: antimony, chromium, copper, iron, lead, tin, and zinc. As discussed in the RI, the results of the leachate analyses suggest that metals have not migrated downward to groundwater aquifers beneath Site 3. A number of groundwater monitoring wells exist on and near Site 3; these wells were installed to evaluate the potential migration of chemicals from Sites 2 and 12. Therefore, Site 3 groundwater data are not considered appropriate to assess conditions related to past use of Site 3. In addition, because the leachate concentration of chemicals decreased with depth, and only two chemicals collected from the deepest samples (lead and iron) exceeded MCLs, no detected chemicals in sand at Site 3 are expected to be in the groundwater. As indicated in Section 5.1.1, depth to groundwater at the site ranges from approximately 20 (near the beaches) to over 100 feet bgs.

The data used for this BRA consist of soil samples collected from 20 test pit locations in Study Areas 1 and 2 at depths ranging from 0 to 2 feet bgs. Of all the data collected at Site 3, this subset represents a reasonable worst-case dataset. Given the likely future use of this site, it is assumed that humans would not likely be exposed to sand deeper than 2 feet bgs. Since measured concentrations of chemicals at Site 3 decrease with depth, any potential exposures to sand deeper than 2 feet bgs will pose a much lower risk than the exposures to surface soil estimated in this BRA.

Data collected at Site 3 were evaluated assuming two potential exposure scenarios. Soil data were analyzed to evaluate the possibility of a human receptor either walking randomly throughout Site 3 or walking exclusively within one of the three bullet distribution areas. Specific methods used to evaluate these are described below.

### 5.2.1 Weighted Surface Area Concentrations

Potential exposure by any potential human receptor at Site 3 is not expected to be limited to a single hotspot nor is it expected only in an area with little or no bullet cover. Rather, a hypothetical future receptor at the site would likely walk through areas of varying type. In

addition, because over 90 percent contains little or no bullet cover and, therefore, has lower concentrations of chemicals, potential exposure to chemicals at Site 3 will likely not be at the maximum concentrations detected in the areas of heavy bullet cover.

Methods used to estimate site-related chemical concentrations representative of all three bullet distribution areas is described in the following text.

The concentrations of chemicals detected at Site 3 were weighted surface area, that is, weighted in proportion to the surface areas of Study Areas 1 and 2 having different percentages of bullet cover as follows:

- Four percent of the surface area has heavy bullet cover ( $\geq 10$  percent)
- Five percent of the surface area has moderate bullet cover (1 to 10 percent)
- Ninety-one percent of the surface area has little or no bullet cover ( $< 1$  percent to none).

Weighting the chemical concentrations by transforming the data prior to statistical analysis takes into account variations in potential exposure that a receptor is likely to encounter at Site 3. Chemical concentrations for each sample were transformed using the following equation:

$$C_{i-wx} = \frac{C_{si} \times SA_x}{SA_t}$$

Where:

$C_{i-wx}$  = Weighted surface area concentration of chemical  $i$  in mg/kg in category  $x$ , where "x" is one of the three categories of surface bullet cover: light ( $< 1$  percent or none), moderate (1 to 10 percent), and heavy ( $\geq 10$  percent) (Table 5.1).

$C_{si}$  = Absolute detected chemical concentration for chemical  $i$  in soil or one-half the detection limit for NDs (mg/kg)

SA<sub>x</sub> = Surface area in both Study Areas 1 and 2 classified in category x, in square feet (ft<sup>2</sup>)

SA<sub>t</sub> = Total measured surface area (ft<sup>2</sup>) of Study Areas 1 and 2 combined

Three example surface area weighting transformation calculations for lead are provided below:

Station Number	Concentration (mg/kg)	Percent Bullet Cover	SA <sub>x</sub> (ft <sup>2</sup> )	SA <sub>t</sub> (ft <sup>2</sup> )	C <sub>i-wx</sub> (mg/kg)
AREA1K13	43.2	<1	5,307,696	5,846,112	39.2
AREA1E15	34.8	1 to 10	223,632	5,846,112	13.3
AREA1DO1	4270	≥ 10	314,784	5,846,112	23.0

where:

mg/kg = milligrams per kilogram  
 ft<sup>2</sup> = square feet

Arithmetic means and associated 95 percent upper confidence limits of the transformed values were calculated for each chemical at Site 3. The resultant weighted surface area concentrations (Table 5.3) were used to select COPCs (Section 5.3) and represent possible exposure point concentrations (Section 5.4.4).

**5.2.2 Chemical Concentrations by Bullet Distribution Areas**

In the unlikely event that a human receptor limits his/her exposure at Site 3 to a specific bullet distribution area, potential adverse health effects were estimated based on exclusive contact with chemicals detected in surface soil (0 to 2 feet bgs) at the <1 percent (Table 5.2g), 1 to 10 percent (Table 5.2i), or ≥10 percent areas (Table 5.2k).

**5.3 Selection of Chemicals of Potential Concern (COPCs)**

The seven metals detected in soil at Site 3 were evaluated using the COPC selection criteria described in Section 2.1.2.3. This selection process was conducted only for chemicals detected in surface soil on the basis of the predicted future land uses of the site, as described in Section 5.1.2. COPCs were selected for each of the different datasets described in Sections 5.2.1 and 5.2.2. The COPC selection

process is discussed below for the weighted surface area (Section 5.3.1) and the three bullet distribution areas (Section 5.3.2).

**5.3.1 Weighted Surface Area**

The first step of COPC selection was comparison to background concentrations. This eliminated no chemicals at Site 3.

The second step was elimination of chemicals considered to be essential human nutrients. Based on the essential nutrient evaluation presented in Appendix B, the estimated expected daily doses (EDDs) are 2.8 mg/day/ and 0.009 mg/day for zinc. These values are well below the Food and Drug Administration's (FDA's) recommended daily allowances (RDAs): 6 to 10 mg/day for iron and 5 to 10 mg/day for zinc (NRC, 1989). As a result of this analysis, both iron and zinc were eliminated as COPCs.

The third step is comparison of the maximum detected lead concentration to the health-based

screening level (HBSL). As a result of this analysis, lead was retained as a COPC. The maximum weighted surface area concentration of 1852 mg/kg for lead is well above the HBSL of 240 mg/kg.

In the fourth step, any detected chemicals still remaining were evaluated using a toxicity screen as described in Section 2.1.2. The details of this screening analysis are discussed in Appendix C and presented in Table C9. This step eliminated chromium and tin, whose screening HQs are less than the target screening HQ of 0.01. The remaining chemicals, antimony, copper, and lead, were retained as COPCs for this BRA. Table 5.4a summarizes the criteria used in the selection of COPCs for the weighted surface area.

### 5.3.2 Bullet Distribution Areas

In the <1 percent area, copper, lead, zinc were below background levels. In the 1 to 10 percent area, zinc was below background levels. In the ≥10 percent area, only chromium was below background levels. These three chemicals were therefore eliminated as COPCs from their respective areas.

In the evaluation of chemicals as essential nutrients, the EDDs for iron and zinc for each of the three datasets (where applicable) were:

- 6.24 mg/day for iron in the <1 percent area
- 4.34 mg/day for iron in the 1 to 10 percent area
- 6.08 mg/day for iron and 0.43 mg/day for zinc in the ≥10 percent area.

Because the EDDs for iron were below the RDA of 6 to 10 mg/day at all three areas, iron was eliminated as a COPC. The EDD for zinc at the ≥10 percent area was below the RDA of 5 to 10 mg/day and was therefore eliminated as a COPC at this area.

The maximum concentrations of lead in the 1 to 10 percent area (32600 mg/kg) and the ≥10 percent area (46300 mg/kg) exceeded the HBSL of 240 mg/kg, so lead was retained as a COPC. In the <1 percent area, the maximum

detected concentration of lead (43.2 mg/kg) was below the HBSL, so lead was eliminated as COPC.

Based on the toxicity screen, for the <1 percent area, the remaining detected chemical, chromium, was eliminated as a COPC. Chromium and tin were eliminated as COPCs from the 1 to 10 percent area and the ≥10 percent areas. Tables C10, C11, and C12 in Appendix C present the results of the toxicity screen for the <1 percent, 1 to 10 percent, and ≥10 percent areas, respectively. Table 5.4b summarizes the criteria used in COPC selection for these three bullet distribution areas. As a result of this selection process, no chemicals were identified as COPCs for the <1 percent area. Antimony, copper, and lead were selected as COPCs for both the 1 to 10 percent and the ≥10 percent areas.

None of the chemicals detected in Site 3 soil are considered Group A carcinogens by EPA or Cal/EPA. In addition, only lead has been identified by Cal/EPA under California Proposition 65 as a developmental and reproductive toxicant.

### 5.4 Exposure Assessment

The methods used to evaluate potential exposure scenarios for Site 3 are outlined in detail in Section 2.2. The following section discusses the nature and degree of potential exposure to the COPCs that may occur at Site 3.

#### 5.4.1 Chemical Source and Migration Analysis

Section 3.0 of the Introduction to the RI (Volume II) presents a general discussion of chemical fate and transport. Section 3.0 of the Introduction to the RI also includes a table of physical and chemical properties pertaining to environmental fate and transport of chemicals detected at the Fort Ord RI sites, and a discussion of potential chemical migration pathways. Section 6.0 of the Site 3 RI presents a site-specific discussion of chemical fate and transport, and identifies potential chemical migration pathways at Site 3. The potential migration pathways identified in Section 6.0 of

the Site 3 RI are discussed in the following sections.

The only potential source of exposure at Site 3 is the presence of chemicals in soil directly resulting from the spent ammunition. Release of chemicals from soil can potentially occur through volatilization of chemicals, wind or mechanical erosion, stormwater runoff, or downward migration of chemicals into groundwater. These types of releases may result in chemical vapor or dust (with sorbed chemicals) emissions into the air, chemical migration in stormwater runoff, or the movement of chemicals downward into groundwater with infiltrating rainwater. A discussion of these four potential release mechanisms follows.

#### **5.4.1.1 Chemical Vapors**

Metals were the only class of chemicals detected in Site 3 soil. In general, metals may be found in the environment either in their pure elemental form or as inorganic ionic salts. Both of these forms are considered nonvolatile because they do not volatilize from a solid to a gaseous phase. Therefore, volatilization of metals is not considered a viable migration pathway and was not quantitatively evaluated in this BRA.

#### **5.4.1.2 Fugitive Dust**

Wind or mechanical erosion can lead to the release from soil of chemicals bound to soil particulates (i.e., dust). The same physical and chemical properties that limit the migration of the COPCs from soil via volatilization result in the tendency of these chemicals to sorb to soil particles; these particles may then become entrained in the air as fugitive dust from wind erosion. However, based on the climatic conditions at Fort Ord, air does not appear to be a likely transport pathway for chemicals at the RI Sites (Section 3.0, Volume II). As a conservative measure, it was assumed that this potential migration pathway could possibly result in human exposures to COPCs via inhalation of dust, and was therefore quantitatively evaluated in this BRA.

#### **5.4.1.3 Stormwater Runoff**

Because the soil at the site consists of sand, it is likely that water from rainstorms will either be absorbed or vaporize by evapotranspiration. Therefore, no runoff is expected and stormwater runoff was not evaluated in this BRA.

#### **5.4.1.4 Leaching**

The potential for chemicals to leach from soil to groundwater depends on the physical and chemical characteristics of the chemicals, as well as on the chemical concentration, soil type, soil pH, and other site-specific conditions. In general, metals present in a low-pH (i.e., acidic) environment will tend to leach from soil. The pH values measured at Site 3 range from 5.8 to 8.0. Because the soil at Site 3 is not acidic, there is little potential for metals to leach.

Additional evaluation of the potential for the leaching of metals from the soil at Site 3 was conducted in the RI (Volume II, Site 3), which indicated that (with one exception) lead was below the Maximum Contaminant Level (MCL) of 0.05 mg/l in the deepest sample from each sample location within Study Areas 1 and 2. The exception was the leachate concentration for lead of 0.3 mg/l for a sample from Study Area 1 at a depth of 2.5 to 3.0 feet. Iron was the only other metal detected above the MCL in the leachate from the deepest collected sample. These results suggest that lead in the soil and spent ammunition are not readily leachable under current or anticipated future conditions. Therefore, leaching was not evaluated as a viable migration pathway for chemicals in soil in this BRA.

#### **5.4.2 Potential Receptors and Exposure Pathways**

As indicated in Section 2.2.3, human receptors selected for evaluation in this BRA were identified by proximity to the site, future plans for land use plans (i.e., conversion to a state park), and proposed activities that could possibly result in direct or indirect contact with site chemicals. This BRA evaluated a range of possible receptors as follows:

- Hypothetical onsite recreational users
  - Long-distance day and overnight visitor (i.e., living over 100 miles from Site 3)
  - Nearby resident day visitor/trespasser
  - Nearby resident overnight camper
- Hypothetical onsite workers
  - Construction or utility worker
  - Maintenance worker
  - Park ranger.

The potential future recreational users were assumed to be involved with very similar activities with similar probabilities of exposure to site-related chemicals. The onsite camper was not evaluated because the estimated total worst-case exposure to Site 3-related chemicals of 5040 hours per year (24 hours/day x 7 days/year x 30 years) was less than that of the nearby resident day visitor/trespasser of 5820 hours per year (2 hours/day x 97 days/year x 30 years). Because the hypothetical nearby resident would most likely experience the longest exposure of these hypothetical receptors, this reasonable worst-case receptor was selected for quantitative evaluation.

Although a construction or utility worker receptor may be present on the site, it was not evaluated in this BRA. It is expected that a construction worker would be exposed to higher concentrations of chemicals than a resident (via a higher ingestion rate, for example); however this is expected to occur over a much shorter time: 1 year for a construction worker versus 30 years for the resident. In addition, a statistical analysis indicated that residents would be exposed to higher concentrations of chemicals, i.e., 20637 mg/kg (surface soil, 0 to 2 feet bgs) versus 17240 mg/kg (soil at 0 to 10 feet bgs) for the worst case scenario.

The park ranger was also selected for quantitative evaluation because this receptor's assumed exposure is likely to be greater than that of a maintenance worker. Maintenance workers were

assumed to be present at Site 3 infrequently, perhaps to fix and repair park property as needed. And their visits to the site would be limited to pre-existing structures such as buildings or parking lots places where exposure to site-related chemicals would be highly unlikely. The job duties of a park ranger, on the other hand, would daily involve work on the site. They would also be more likely to contact site-related chemicals during their duties such as guiding tours and patrolling. Therefore, the park ranger was quantitatively evaluated.

These two receptors may be exposed to the COPCs at Site 3 via the pathways of ingestion of soil, dermal contact with soil, or inhalation of dust. Given the uncertainty associated with future land use plans at Site 3, it was assumed that movement by visitors on the dunes at Site 3 may be restricted solely to boardwalks. For this reason, the "average" nearby resident was assumed to be exposed to Site 3 chemicals via inhalation of dust only. In the event, however, that campsites are constructed on Site 3, the RME nearby resident was assumed to be exposed to Site 3 chemicals via dermal contact, ingestion of soil, and inhalation of dust.

Given the uncertainty associated with accessibility to various sections of Site 3, exposure to chemicals was assumed to occur through either (1) a random walk throughout the site or from (2) exclusive exposure to only one of the three bullet distribution areas.

### 5.4.3 Exposure Scenarios

This section presents a discussion of the site-specific conditions (i.e., exposure assumptions) used to quantitatively evaluate the exposures of the nearby resident and the park ranger at Site 3. Two types of exposure scenarios were evaluated in this BRA: an average exposure scenario; and a reasonable maximum exposure (RME) scenario. As indicated in Section 5.1.2, future land use plans include conversion of Site 3 to a limited-access state park involving construction of hiking trails, hike-in/bike-in campgrounds, and boardwalks spanning the distance between proposed parking lots and the beaches (Verett, 1994). Because boardwalk construction has been proposed to limit damage

to the dunes, direct contact with COPCs by visitors (i.e., nearby residents) was assumed to be limited. Therefore, only inhalation of dust was evaluated for the average exposure scenario. However, because campgrounds and hiking trails might also be constructed on Site 3, the RME scenario evaluated potential exposure to COPCs by ingestion and dermal contact as well as by inhalation of dust.

Section 2.2 presents the methodology used to estimate potential exposure doses. Chemical doses were estimated on the basis of a number of intake assumptions, also referred to as exposure factors, including exposure point concentrations (EPCs), exposure durations (EDs), exposure frequencies (EFs), exposure times (ETs), body weights (BWs), soil contact rates, and other parameters. Section 2.2.5 discusses the bases of many of the intake assumptions used to estimate potential exposure doses for receptors assumed to be exposed to COPCs at Site 3.

For the conversion of Site 3 to a state park, it was assumed that hypothetical children and adults from nearby residences as well as park rangers may be present at the site. For this BRA, consistent with EPA (1990b) data, it was assumed that a nearby resident would visit the site for 9 and 30 years for the average and RME scenarios, respectively. The resultant age group evaluated for nearby residents was 0 to 9 years of age for the average exposure scenario. For the RME scenario, the age groups evaluated were 0 to 6, 6 to 18, and 18 to 30 years of age. Based on EPA (1990b) data, a park ranger was assumed to work at the site for 10 (18 to 28) and 25 (18 to 43) years for the average and RME scenarios, respectively.

The nearby residents were assumed to visit the site for 57 and 97 days per year, during any given calendar year, for the average and RME scenarios, respectively. These values were estimated from data available on monthly visitor use of the Marina State Park in the city of Marina, California (*Telephone conversation between Lanell Nash, Monterey District Parks and Recreation, and Dan Lee, HLA, dated April 28, 1994; Table 5.5a*). These data reflect three different categories of use: light (January through May); medium (June, July, and August); and heavy (September,

through December). For the average exposure scenario, it was assumed that residents would visit Site 3 two, five, and eight times per month during light-, medium-, and heavy-use months, respectively. For the RME exposure scenario, it was assumed that residents would visit Site 3 five, eight, and twelve times per month during light, medium, and heavy-use months, respectively. For the park ranger, an EF of 250 days per year was assumed for both the average and RME scenarios (EPA, 1990b, 1991d).

For the average scenario, the nearby resident receptor was assumed to visit at the site for 2 hours per day for both the average and RME scenarios; these values were based on EPA (1990b) estimates of indoor and outdoor activity for children and adults. The park ranger was assumed to work at the site for 8 hours per day (ET), 250 days per year (EF) for both the average and RME scenarios (EPA, 1990b, 1991d).

The fraction of intake (FI) is used to evaluate exposure to soil via ingestion and dermal contact; this term accounts for the fact that only a portion of any given day is assumed to be spent at the park by a nearby resident (2 hours, or less than 10 percent of a 24 hour day) or a park ranger (8 hours, or 33 percent a 24 hour day). However, all receptors were conservatively assumed to contact and ingest 50 percent site-related soils for the average scenarios and 100 percent site-related soils for the RME scenario. Site-specific exposure assumptions used in the risk assessment for Site 3 are summarized in Table 5.5b.

#### 5.4.4 Exposure Point Concentrations (EPCs)

The EPCs used in the estimation of potential exposure dose were derived directly from the soil concentrations shown in Tables 5.2 and 5.3. As discussed in Section 5.4.2, this BRA evaluated incidental ingestion and dermal contact with soil and inhalation of dust for the nearby resident and for the park ranger. For ingestion and dermal contact, surface soil concentrations were used. The EPCs used to evaluate dust inhalation were estimated by multiplying the surface soil concentrations of each COPC by the site-specific  $PM_{10}$  value ( $11.5 \mu\text{g}/\text{m}^3$ ). The arithmetic mean

was used to estimate the average scenario. The lesser of either the upper 95th percentile upper confidence limit or the maximum weighted surface area COPC concentration in soil was used to estimate the RME scenario. The methods used to estimate EPCs are discussed in Section 2.2.7. EPCs for weighted surface area soil and air are presented in Table 5.6a. Tables 5.6b and 5.6c present soil and air EPCs for the 1 to 10 percent and the  $\geq 10$  percent areas, respectively.

#### **5.4.5 Estimation of Exposure (Dose)**

Intake assumptions presented in Tables 2.4, 2.5, and 5.5b were used with the EPCs (Section 5.4.4; Table 5.6) and chemical-specific absorption factors (Table 2.6) to estimate pathway-specific doses or daily intakes. Equations for daily intakes are presented in Section 2.2.4. These values represent estimates of the total amount of chemical (i.e., concentration) that a specific receptor may incur over the length of an assumed exposure duration. Potential adverse effects resulting from exposure to lead are not evaluated via this method; the unique toxicological properties of lead require exposure assessment and risk characterization techniques different from those used for all other chemicals (Section 2.2.9). The results of the lead evaluation for Site 3 are in Section 5.6.3.

#### **5.5 Toxicity Assessment**

Section 2.3 presents information on the purpose of the toxicity assessment and describes the basis for developing RfDs and SFs for noncarcinogenic and carcinogenic chemicals, respectively. SFs have not been developed by EPA or Cal/EPA for any of the COPCs at Site 3. Therefore, only noncarcinogenic endpoints are evaluated in this assessment. Section 2.3.3 discusses the unique toxicological properties of lead, which preclude development of either an RfD or a SF. Table 2.9 presents the RfDs for antimony and copper that were used to estimate noncancer effects.

#### **5.6 Risk Characterization**

Section 2.4 presents the methods used to quantify potential human health risks associated with the COPCs at Site 3. Sections 2.4.1 describes the methods used to estimate noncancer adverse health effects for all the COPCs except lead. Section 2.4.3 describes the methods used to evaluate the potential health risks associated with exposure to lead. The following sections present the results of risk characterization for Site 3.

##### **5.6.1 Possible Noncancer Health Effects**

###### **5.6.1.1 Weighted Surface Areas**

For the average exposure scenario, multipathway hazard indices (HIs) for nearby resident receptors are 0.000009 and 0.000007 for the 0 to 6 and 6 to 9 year old groups, respectively. For the RME scenario, the multipathway HIs for the nearby resident receptors are 0.7, 0.1, and 0.08 for the 0 to 6, 6 to 18, and the 18 to 30 year old groups, respectively. The estimated multipathway HIs for the Park ranger are 0.01 and 0.4 for the average and RME scenarios, respectively. None of these HIs exceeds the threshold level of concern for noncarcinogenic effects. The results of the risk characterization based on the weighted surface area chemical concentrations are presented in Tables E26 through E32 of Appendix E and summarized in Tables 5.7a (residents) and 5.7b (park ranger).

###### **5.6.1.2 Bullet Distribution Areas**

For the 1 to 10 percent area, the average exposure scenario multipathway HIs for the nearby resident receptors are 0.00003 for both the 0 to 6 and the 6 to 9 year old groups. For the RME scenario, the multipathway HIs for the nearby resident receptors are 2, 0.4, and 0.2 for the 0 to 6, 6 to 18, and the 18 to 30 year old groups, respectively (Table 5.7c). The multipathway HIs for the onsite park ranger are 0.03 and 1 for the average and RME scenarios, respectively (Table 5.7d).

For the  $\geq 10$  percent area, the average exposure scenario multipathway HIs for the nearby

resident receptors are 0.0004 for both the 0 to 6 and the 6 to 9 year old groups. For the RME scenario, the multipathway HIs for the nearby resident receptors are 26, 5, and 3 for the 0 to 6, 6 to 18, and the 18 to 30 year old groups, respectively (Table 5.7e). The multipathway HIs for the onsite park ranger are 0.6 and 16 for the average and RME scenarios, respectively (Table 5.7f).

At both the 1 to 10 percent and the  $\geq 10$  percent bullet distribution areas, the average exposure multipathway HIs for both the nearby resident and the park ranger are below the threshold level of concern for noncarcinogenic effects (1.0). However, RME multipathway HIs for both receptors exceed 1.0, suggesting that noncarcinogenic adverse health effects resulting from exposure to antimony and copper may occur in the unlikely event that these receptors are only exposed to medium and high bullet-density areas. The results of the risk characterization are presented Tables E33 through E39 (1 to 10 percent area) and E40 through E46 ( $\geq 10$  percent area) in Appendix E and summarized in Tables 5.7c (resident) and 5.7d (park ranger) for the 1 to 10 percent area and in Tables 5.7e (resident) and 5.7f (park ranger) for the  $\geq 10$  percent area.

### 5.6.2 Possible Cancer Risk

Because the COPCs at Site 3 are not evaluated as carcinogens by U.S. EPA and Cal/EPA, cancer risk estimates were not made for the COPCs at Site 3.

### 5.6.3 Lead Exposure

The results of the lead exposure modeling described in Section 2.3.3 are presented for the weighted surface areas (Section 5.6.3.1) and the bullet distribution areas (Section 5.6.3.2).

#### 5.6.3.1 Weighted Surface Area

Blood-lead levels estimated for children 0 to 6 years of age exposed to weighted surface area concentrations of lead are 2.76 and 7.15  $\mu\text{g}/\text{dl}$  for the average and the RME scenarios, respectively. The blood-lead levels for the 6 to 9 year old offsite child resident (average scenario) are 3.46

(95th percentile) and 3.90  $\mu\text{g}/\text{dl}$  (99th percentile). The blood-lead levels for the 6 to 18 year old child and the adult offsite resident (RME Scenario) are 4.40 (95th percentile) and 5.61  $\mu\text{g}/\text{dl}$  (99th percentile). The blood-lead levels estimated for the park ranger are 3.33 (95th percentile) and 4.25  $\mu\text{g}/\text{dl}$  (99th percentile) for the average scenario and 4.40 (95th percentile) and 5.61 (99th percentile) for the RME scenario. All blood levels estimated based on weighted surface area concentrations are below the EPA's (1990e) 10- $\mu\text{g}/\text{dl}$  threshold level of concern. The results of these analyses are presented in Tables F11 through F16 in Appendix F and are summarized in Table 5.8a for all receptors.

#### 5.6.3.2 Bullet Distribution Areas

This section estimated blood-lead levels for the 1 to 10 percent area and the  $\geq 10$  percent area.

##### 1 to 10 Percent Area

At the 1 to 10 percent area, the blood-lead levels estimated for children 0 to 6 years of age are 2.77 and 89.36  $\mu\text{g}/\text{dl}$  for the average and RME scenarios, respectively. The blood-lead levels for the 6 to 9 year old offsite child resident (average scenario) are 3.16 (95th percentile) and 4.03  $\mu\text{g}/\text{dl}$  (99th percentile). The blood-lead levels for the 6 to 18 year old child and the adult offsite resident (RME Scenario) are 27.05 (95th percentile) and 34.46  $\mu\text{g}/\text{dl}$  (99th percentile). The blood-lead levels estimated for the park ranger are 6.70 (95th percentile) and 8.53  $\mu\text{g}/\text{dl}$  (99th percentile) for the average scenario and 26.97 (95th percentile) and 34.36  $\mu\text{g}/\text{dl}$  (99th percentile) for the RME scenario.

Blood-lead levels exceed the EPA's (1990e) 10  $\mu\text{g}/\text{dl}$  threshold level of concern for the RME 0 to 6 and 6 to 18 year old child as well as the adult resident and the park ranger receptors. The results of these analyses are presented in Tables F17 through F22 in Appendix F and are summarized in Table 5.8b for receptors exposed to chemicals in the 1 to 10 percent area.

**Text Revisions  
Volume III, Site 3  
Page 67**

**In Volume III, Site 3, fourth paragraph, second column of page 67:**

- a) In the first sentence delete:** *"health-based cleanup level (level of concern)"* **and replace with:** *"health-based level of concern (HBLC)"*
- b) In the third sentence delete:** *"cleanup level of"* **and replace with** *"level of concern"*
- c) In the fourth sentence insert:** *"threshold"* **immediately after** *"EPA."*
- d) Insert new paragraph at end of second column**

*This (HBLC) is used in the feasibility study to focus remediation in area of highest potential human-health risk. However, it is important to note that cleanup in the high-density bullet areas at Site 3 will achieve a soil-lead level below the HBLC, and in most cases lead levels (following cleanup activities) should be at background. Please see Volume V for further details.*

### ≥10 Percent Area

At the ≥10 percent area, the blood-lead levels estimated for children 0 to 6 years old are 2.79 and 177.42  $\mu\text{g}/\text{dl}$  for the average and RME scenarios, respectively. The blood-lead levels for the 6 to 9 year old offsite child resident (average scenario) are 3.43 (95th percentile) and 4.37  $\mu\text{g}/\text{dl}$  (99th percentile). The blood-lead levels for the 6 to 18 year old child and the adult offsite resident (RME Scenario) are 48.14 (95th percentile) and 61.32  $\mu\text{g}/\text{dl}$  (99th percentile). The blood-lead level estimated for the park ranger are 16.09 (95th percentile) and 20.50  $\mu\text{g}/\text{dl}$  (99th percentile) for the average scenario and 48.14 (95th percentile) and 61.32  $\mu\text{g}/\text{dl}$  (99th percentile) for the RME scenario.

Blood-lead levels in all receptors (except the 0 to 6 and the 6 to 9 year old average resident receptors) exceed the EPA's (1990e) 10  $\mu\text{g}/\text{dl}$  threshold level of concern. The results of these analyses are presented in Tables F23 through F28 in Appendix F and are summarized in Table 5.8c for receptors exposed to chemicals in the ≥10 percent area.

### 5.7 Uncertainty Analysis

Section 8.0 summarizes the uncertainties common to BRAs conducted for all five RI sites. An uncertainty peculiar to Site 3 involves the method of weighting the chemical concentrations by distribution of spent ammunition at certain locations within Site 3, i.e., Study Areas 1 and 2. For this BRA, it was assumed that the distribution of COPCs within Study Areas 1 and 2 reflects conditions throughout Site 3. The degree to which this affects the results of the BRA is not clear. From visual inspections and an evaluation of past use at Site 3, it appears that the distribution of chemicals within Study Areas 1 and 2 represent sitewide conditions. Therefore, this assumption may not significantly add to the uncertainty of the BRA for Site 3.

### 5.8 Summary of the Baseline Risk Assessment for Site 3

The BRA for site 3 evaluated exposure of future nearby resident and onsite park ranger receptors to three COPCs (antimony, copper, and lead). It

was assumed that the receptors would be either (1) walking randomly throughout the site or (2) limiting their visits to only one of the three bullet distribution areas (i.e., <1 percent, 1 to 10 percent, or ≥10 percent).

For the "random" site walk exposure scenario, HIs estimated for both the nearby resident and the park ranger were all below 1 for antimony and copper. In addition, the results of the lead exposure modelling indicate that exposure to lead would result in estimated blood-lead levels below EPA's 10  $\mu\text{g}/\text{dl}$  threshold level of concern (EPA, 1990e). Therefore, potential adverse health effects resulting from exposure to COPCs are not expected for a random walk at Site 3. If, however, a receptor were to limit their visits solely to either the 1 to 10 percent or the ≥10 percent bullet distribution area, estimated HIs and blood-lead levels for some receptors exceed agency threshold levels of concern.

### 5.9 Health-Based Levels of Concern

Blood-level levels and HIs associated with some resident and onsite park ranger receptors exposed solely to the 1 to 10 percent or ≥10 percent bullet distribution areas exceed regulatory threshold levels of concern. Because lead is present in the highest concentrations among the three COPCs throughout Study Areas 1 and 2, it may represent the greatest concern for human health.

Therefore, a health-based cleanup level (level of concern) for lead in soil was estimated so that the EPA threshold level of blood-lead for children and adults would not be exceeded. The EPA (1990e) UBK and the Cal/EPA (1992) LEADSPREAD lead exposure models described in Section 2.3.3 were used to estimate the cleanup lead concentration level for children and for adults, respectively. Results of this modeling indicated an estimated cleanup level of 1,860 mg/kg for children and 4,192 mg/kg for adults. Long-term exposure to a lead concentration of 1,860 mg/kg (the level of concern for children) is not expected to result in any exceedance of the EPA level of concern of 10  $\mu\text{g}/\text{dl}$  blood-lead level for children or adults.