

Revised Technical Memorandum

Recreational Visitor Exposure Scenario for Federal Land

PG&E Topock Compressor Station Remediation Project, California

Introduction

The Department of the Interior (DOI), through the Bureau of Land Management (BLM), the U.S. Fish and Wildlife Service (USFWS), and the Bureau of Reclamation (BOR), manages land that has been impacted by releases of hazardous substances from the PG&E Topock Compressor Station (Topock site or Site)¹ and is the subject of response actions pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The land consists of the Havasu National Wildlife Refuge (HNWR) which is managed by USFWS and BLM-managed lands under the jurisdiction of BLM and/or BOR (collectively, “the federal land”). The federal land is managed pursuant to a number of land use objectives and is approved for specific uses, including recreation. DOI has advised PG&E and the Technical Working Group (TWG) that DOI will provide information to complete a recreational visitor risk assessment for federal land at the Site. This information includes a discussion of the different types of recreational activities that may occur and the frequencies that people may engage in these activities. The risk assessment will be integrated with the remedial investigation (RI) of the soils operable unit at the Site for decision making purposes. This technical memorandum discusses the Site background, possible recreational uses of federal land on and in the vicinity of the Site, and provides DOIs recommended exposure assumptions to support a quantitative risk assessment for recreational visitors to Topock.

Site Description

Releases at and from the Site have impacted land owned by the federal government, local tribal governments, California state and municipal governments, and private entities. **Figure 1** shows the land ownership in the vicinity of the Topock site. Much of the land is undeveloped or minimally developed, notwithstanding the presence of the PG&E Compressor Station, IM-3, the BNSF Railroad, Park Moabi, Pirate’s Cove Resort, and Interstate 40. Due to the openness of the federal land and limited restrictions to site access, recreational access is potentially present across much of the area. Recreational land use can encompass a variety of activities, including (but not limited to) hiking, camping, hunting, visiting historic Route 66, and riding off-highway vehicles (OHVs, also known as all-terrain vehicles [ATVs]). These uses are influenced by a variety of issues, including site access, vegetation, natural or man-made features of interest, weather, and an interested population. The Colorado River is adjacent to the Topock site and provides recreational opportunities; access to the river may be gained across federal land, although access is easier using designated boat ramps that are available nearby at Park Moabi or the Topock Marina.

¹ For the purposes of this document, the “Topock site” or Site is synonymous with the Area of Potential Effect (APE) as defined in the Programmatic Agreement.

Some federal land within and adjacent to the Topock site has been developed for routine recreational use. Park Moabi is leased by San Bernardino County and comprises BLM and State Land within the Site and provides seasonal residential use to the public and year-round residential use for a limited number of San Bernardino County staff. The Pirate's Cove is a concessionaire on BLM-leased land to the east of Park Moabi; it has boat docks, a restaurant, and condos to rent. The Topock Marina is a private facility in Arizona within the APE, which is adjacent to the HNWR. It provides boat docks and gasoline and soon will provide overnight rentals. The Colorado River floodplain attracts OHVs and other recreators since it has an open area of sandy beach. Parcels of federal land are near to the Colorado River and could be suitable for camping and access to the river.

The BLM Lake Havasu office, which manages land in the vicinity of the Topock site, has stated that it does not collect data regarding recreational visitation or use of BLM land (Cox, 2013). There are no sign-in logs or user fees collected at any access points on BLM land. The BLM's Needles Field Office manages the BOR lands near the Topock site and has designated many hiking trails near the site in the Bullhead Travel Management Plan (DOI/BLM 2009). These trails cross portions of the Site, although there is no organized trail network through the soil investigation area.

The Havasu National Wildlife Refuge (HNWR), managed by the USFWS, provides recreation opportunities for the public. The HNWR comprises 37,515 acres along the lower Colorado River in Arizona and California. The HNWR protects 30 river miles and encompasses 300 miles of shoreline from Needles, California, to Lake Havasu City, Arizona. The HNWR near the Topock site consists of two main areas: Topock Marsh and the wilderness area surrounding the Needles Mountains. Near the Site, the HNWR is underdeveloped in regards to general public access. Most of the HNWR is outside of the area impacted by the Topock Compressor Station.

The primary purpose of the National Wildlife Refuge System is to provide habitat for fish, wildlife, and plant resources. All activities that take place on the HNWR have to be appropriate and compatible with this main purpose. There are six main activities that have been determined to be compatible with the refuge's purpose: hunting, fishing, wildlife observation, photography, environmental education, and interpretation (61 FR 13647, 1996). Camping (land or water) is prohibited on HNWR per regulation (USFWS, 2013). There are no established hiking trails but most areas of the refuge are open to hiking. Near the Topock site, the most common recreational activities are hiking and boating/fishing. Street legal vehicles and OHVs are allowed on refuge roads, but off-roading is not allowed. Hunting is allowed on HNWR; hunting upland game would be the most likely form of hunting near the Topock site although it is rare. The HNWR has the authority to close off portions of the refuge for hunting and/or safety concerns. Closed areas are marked by regulatory signs and/or buoys (USFWS, 2013).

Recreation Exposure Information from Published Sources

As noted in the Site Description, there are a variety of recreational activities that may be conducted on federal land near the Topock site. These activities include hiking, camping, bird watching, hunting, and riding OHVs. Of primary concern for this evaluation is how often a

person comes to the Site and how they may be exposed to chemicals that could be present in the soil. Several relevant documents have been identified that describe the frequency that individuals have been observed, or were assumed, to be engaged in these activities at other sites in the area and across California.

In 2008 a human health risk assessment was prepared for the **Clear Creek Management Area (CCMA)**, a BLM property in Central California (USEPA, 2008a). The CCMA includes part of the New Idria Formation, a serpentinite rock body which contains a 31,000 acre outcrop of naturally occurring asbestos. The BLM has designated the New Idria portion of the CCMA as the Serpentine Area of Critical Environmental Concern (ACEC). The risk assessment evaluated a number of scenarios representative of typical recreational activities at the 75,000 acre property.

Although there are significant differences in some of the site attributes between CCMA and the Topock site (e.g., CCMA is primarily a naturally occurring asbestos site), some of the activities considered in the risk assessment at CCMA are similar to those proposed for recreational visitors at the Site. The primary concern at the CCMA was the inhalation of asbestos fibers in ambient air generated from soil-disturbing activities, particularly by motorized vehicles. The scenarios were designed to reflect the spectrum of activities an individual would participate in during a typical day, weekend, or work year visit to CCMA, e.g., driving in, riding motorcycles, camping, and driving out.

In summary, the scenarios at CCMA included:

- Weekend rider
- Day use rider
- Day use hiker
- Weekend hunter
- Combined rider/workday
- Patrol
- SUV/truck patrol

The risk assessment reported levels of airborne asbestos generated by activity based simulations of typical recreation activities at CCMA. Airborne dust levels, which are more relevant to the Topock site, were not reported (USEPA, 2008a).

The **State of California Natural Resources Agency** published a “*Survey on Public Opinions and Attitudes on Outdoor Recreation in California in 2009*” (CNRA, 2009). This report was developed in order to provide a comprehensive view of the outdoor recreation patterns and preferences of Californians, based on their opinions and attitudes about outdoor recreation and self-reported levels of physical activity in places where they recreate.

The primary goals of this survey were:

- to learn about the recreational activities Californians are engaged in and what they would like to do more;
- to learn about Californians' opinions and attitudes regarding recreation facilities, programs, services and policies;
- to learn about Californians' physical activity in parks;
- to assess changes in responses compared to prior surveys.

The California Natural Resources Agency report did not contain recreational activity data specific to the Topock area or to federal land in the area. It did, however, confirm that the recreational activities proposed for the Topock human health risk assessment are popular with Californians in many regions across the state. The "mean number of participation days" from survey respondents for off-highway vehicle use was reported to be 14.8 days in 2008; the mean number of days for other relevant activities, such as camping (at developed sites), picnicking, or RV/trailer camping, ranged from 7-9 days/year.

The **USDA Forest Service** compiled visitor use data in their "*National Visitor Use Monitoring Results, USDA Forest Service, National Summary Report*" (USDA, 2013). Although there is no Forest Service land at the Topock site, the data can give insight into land use patterns of recreational visitors to federal land. This report provides science-based estimates of the volume and characteristics of recreation visitation to the National Forest System, as well as the benefits recreation brings to the American public. Completed in 5-year cycles, the report helps the Forest Service to manage its recreation resources in such a way that best meets the needs of visitors while maintaining the quality of the natural resource base.

The most popular activity reported on Forest Service lands was hiking/walking, by 42% of respondents. Primitive camping (3%) and OHV use (3.6%) were activities also engaged in by Forest Service land visitors. Less than half of the OHV riders reported this was their primary activity, suggesting that they were using OHVs to access forest land for other activities (e.g., hunting, fishing, climbing).

Recreational Visitor Exposure Scenario for Federal Land at the Topock Site

The lands managed by the federal agencies in the vicinity of the Topock site are largely undeveloped, but opportunities for recreation are available across the Site area. The development of exposure assumptions for recreational visitors to federal land at Topock are discussed in this section of the Technical Memorandum.

Figure 2 presents a conceptual site model (CSM) diagram that links the contaminant source with exposure to potential recreational visitors on federal land. As a simplifying assumption, it is assumed that each of these recreational activities could take place at any location on federal land. In reality, specific locations may be preferred for certain activities while other locations may be less attractive or may limit recreation options (e.g., HNWR). The most probable recreational land use activity on federal land includes hiking, camping, hunting, and OHV riding.

Published default exposure factors are generally not available for recreational land use (except for some specific scenarios, such as fishing and fish ingestion rates). EPA's 2011 Exposure Factors Handbook Update does not present exposure factors for any recreational scenarios other than fishing (EPA, 2011a). Rather, informed professional judgment is necessary to select factors that best represent the types of recreational activities that may be conducted at the site of interest.

Exposure Parameters of Interest: Once a particular activity or scenario has been selected, it is necessary to develop estimates of the frequency a person may be engaged in this activity (exposure frequency, EF, in days/year) and the length of time spent doing this activity (exposure duration, ED, in years). The routes of exposure, including inhalation of dust, incidental ingestion of soil, and dermal contact with soil, are important factors in determining how much of a contaminant may enter the body during these activities.

Factors Impacting Exposure Potential: Recreational use of federal land at the site is expected to vary during the course of a year due to a variety of factors, including weather conditions (especially hot, cold, or rainy periods), seasonality of hunting, and the time of year. In general, recreational activities at the site are expected to be limited in frequency and duration during the hottest summer months. Hunting would only occur during those months that are legally permitted; the exposure potential could vary based on game species being hunted. The exposure frequency is expected to be limited to a few weeks for the species of interest (e.g., game birds).

The exposure frequency and duration parameters presented in **Table 1** are proposed for recreational visitors on federal land in the vicinity of the Topock site, based on site-specific considerations and information provided from nearby sites. The EF parameters were developed from information presented in CNRA's document "*Complete Findings: Survey on Public Opinions and Attitudes on Outdoor Recreation in California, 2009*", particularly Table 25 (Recreation Activity Participation of Respondents During the Past 12 Months). The use rates provided by CNRA are mean values; for risk assessment purposes, an upper bound measure of exposure (e.g., the 95% upper confidence limit on the mean) is generally preferred. To protect human health, it is assumed herein that a participant's entire annual recreational activity is conducted on federal land at Topock rather than spread out at various sites across the state. That is, the entire annual activity rate for day hiking on trails, 15.9 days/year, is spent at the Topock site. This approach is expected to provide a conservative upper bounds estimate of the potential exposure frequency and duration at the Site.

Particulate Emissions: A primary exposure concern associated with riding OHVs is the generation and subsequent inhalation of airborne particulate matter. With their large and heavily treaded tires, OHVs can release relatively large amounts of soil into the ambient air when they are ridden. For the recreational OHV rider population at Topock, it is necessary to identify an appropriate particulate emission factor (PEF, in m^3/kg) that provides an estimate of the airborne level of respirable dust resulting from riding OHVs. The PEF is the soil to air emission factor and provides a means for estimating the contaminant levels in air due to re-suspended soil particles (EPA, 2011b). A generic PEF has been developed by the USEPA for evaluation of windblown

fugitive dust from surface contamination sites (EPA 1991), but that scenario does not agitate the soil as aggressively as the tires of an OHV and is not specifically relevant to an OHV scenario.

Airborne particulate levels generated during OHV riding at the Topock site have not been measured. PEFs derived for other sites were reviewed to determine their relevance for use at the Topock Site. The development of several site-specific PEFs for OHV riding at other sites are discussed in this Memorandum, along with a recommendation for evaluating risks to OHV riders at the Topock site.

Review of Relevant PEF Studies

The USEPA derived site-specific PEFs for OHV riding at two mine sites in Colorado. The baseline human health risk assessments (BHHRAs) for the Standard Mine Site and the Nelson Tunnel/Commodore Waste Rock Pile used the results from activity based air sampling to calculate PEFs for OHV riding. These risk assessments conducted field measurements that directly measured airborne levels of particulates generated from riding an OHV. These activity based projects were the only project examples identified in the literature where dust generation from OHV riding was quantitatively measured.

Standard Mine Site: The USEPA derived a PEF for riding OHVs at the Standard Mine Site in Gunnison County, Co (USEPA, 2008b; 2009). This PEF was calculated from empirical data collected by measuring airborne dust generated during activity simulations using two OHVs at the Quincy Smelter site (California) in 2004. (A reference for the Quincy Smelter project was not provided in the Standard Mine risk assessment; only a personal communication from B. Brass, USEPA/ERT West was cited.)

As reported in the Standard Mine BHHRA, a dust collector was attached to the front rack of the second (trailing) OHV and measurements taken over a six hour period. The concentrations of dust varied considerably during the measurement period, from a minimum concentration of 18.7 ug/m³ to a maximum of 23,539 ug/m³. The investigators took this to be due primarily to variations in speed and the positions of the OHVs relative to each other. From the collected air data, EPA generated a PEF for OHV riding by “taking the mean concentration of dust in air generated during OHV use (3,400 ug/m³) and multiplying it by the fraction of total dust that is respirable to estimate the PM10 fraction” (35%; USEPA, 2009). A PEF of 1.18E-06 kg/m³ (equivalent to 8.47E+5 m³/kg) was calculated from this data.

Nelson Tunnel/Commodore Waste Rock Pile: The USEPA conducted site-specific activity based air sampling for the Nelson Tunnel/Commodore Waste Rock Pile BHHRA and RI in Creede, CO (USEPA, 2011b). The primary purpose of this study was to determine exposure point concentrations in air for lead, manganese and zinc. The appendix discussing the PEF derivation notes that three air samples were collected from the area traversed by the OHVs but does not describe where the air monitors were located or how long data was collected. Individual PEFs for each of the three metals were estimated from the site soil and air data. An “average PEF” of 6.08E-05 kg/m³ (1.65E+04 m³/kg) was calculated from the combined PEFs for the three metals.

A comprehensive description of the study design was not provided in the BHHRA for the Nelson Tunnel site. Although a limited amount of site-specific air data is presented for OHV riding, there is no substantiating information included (e.g., location of air monitors, actual dust levels). The lack of information for this project limits its usefulness, and it is not recommended as a surrogate for a PEF at the Topock Site.

Rand Historic Mining Complex: The BLM conducted an inhalation risk assessment for OHV riders as part of the RI at the Rand Historic Mining Complex in San Bernardino County, CA (DOI, 2011). In the Rand RI evaluation, airborne dust concentrations during OHV use were modeled by modifying an equation for calculating the PEF associated with construction traffic over an unpaved road (USEPA, 2002). This construction scenario is similar to OHV use, in that significant airborne soil and dust are generated by tires during repetitive driving activities. A combination of default values and activity-specific assumptions were integrated into the PEF estimation for the Rand RI. A PEF of $5.3\text{E}+03 \text{ m}^3/\text{kg}$ was developed for the inhalation risk assessment for OHV riders at Rand.

Recommended PEFs for Topock Recreational Visitors

All of the OHV scenarios reviewed for this Technical Memorandum generated significant amounts of airborne dust. While particulate masks are often worn by riders in dusty conditions, for the purposes of this evaluation it is assumed that OHV riders are maskless and may be fully exposed to the dust generated from their activities.

The Standard Mine Site BHHRA derived a PEF for OHV riding based on airborne dust measurements collected during activity based sampling. Because it is based on actual measurements collected during OHV riding, the Standard Mine Site PEF ($8.47\text{E}+05 \text{ m}^3/\text{kg}$) is considered to be the most accurate value for estimating airborne respirable dust levels from OHV riding at the Topock Site. It is recommended that this value be used as the PEF for estimating inhalation risks from OHV riding at the Topock Site. The recommended PEF for OHV riding is very similar to the default value recommended by DTSC (2011) for construction workers ($1.0\text{E}+06 \text{ m}^3/\text{kg}$).

For campers, hikers, and hunters, the default residential PEF value of $1.316\text{E}+09 \text{ m}^3/\text{kg}$ (DTSC, 2011) is recommended. This PEF represents the fugitive dust level a recreational visitor could be exposed to while present at the Site. The PEFs proposed for all recreational visitors to federal land are presented in Table1.

Table 1
Exposure Duration and Frequency for Recreational Visitors, Federal Land,
Topock Site

Camper:

- EF: 1 day/month, 8 months/year
 - (*slightly greater than rate for “camping in developed sites”, mean of 6.9 days/year, CNRA 2009*)
- ED: 30 years (6 as a child, 24 as an adult) (DTSC, 2011)
- PEF 1.316E+09 m³/kg (DTSC, 2011)

Hunter:

- EF: 8 days, 1 month/year
 - (*4 weekends; assumes 1 month game season*)
- ED: 30 years for adult
 - (*default residential exposure assumption, USEPA, 1991*)
- PEF 1.316E+09 m³/kg (DTSC, 2011)

Hiker:

- EF: 2 days/month, 8 months/year
 - (*corresponds to “day hiking on trails”, mean of 15.9 days/year, CNRA 2009*)
- ED: 30 years (6 as a child, 24 as an adult) (DTSC, 2011)
- PEF 1.316E+09 m³/kg (DTSC, 2011)

OHV Rider:

- EF: 2 days/month, 8 months/year
 - (*corresponds to “off-highway vehicle use”, mean of 14.8 days/year, CNRA,2009*)
 - 1.5 hours/day
 - (*corresponds to time spent riding solely on the potentially contaminated area, USEPA 2008b*)
- ED: 30 years (6 as a child, 24 as an adult) (DTSC, 2011)
- PEF: 8.47E+05 m³/kg (USEPA, 2008a; 2009)

Pathway-Specific Exposure Assumptions

Table 2 presents DOI's recommended assumptions for each exposure pathway of interest for the different recreational visitor populations. All populations are assumed to be exposed to site contaminants in soil by ingestion, dermal contact, and inhalation of particulates, but to varying degrees depending on their activities. When relevant, default exposure assumptions recommended by DTSC (2011) were used. Standard default exposure assumptions are not available for OHV riders, and a combination of site-specific information and professional judgment was used to select parameters for this population.

The default soil ingestion rate for construction workers is recommended to represent the higher rates of exposure expected from OHV activities than experienced by most recreational visitors. Similarly, the soil adherence factor for dermal exposure for construction workers is recommended for adult OHV riders. Both soil ingestion and dermal contact are considered episodic in nature, where an individual could receive the equivalent of a full day's exposure in less time during a limited number of exposure events (e.g., hand to mouth actions, dermal contact while sitting on the ground). Although OHV riders were assumed to ride on the Site for only a portion of a day, it was conservatively assumed they would incur a full day's exposure rate for the soil ingestion and dermal contact pathways.

The skin surface area values for dermal exposure assumes that the face, forearms, hands, lower legs, and feet are exposed skin. Separate default values have been provided for both children (up to age 6) and adults. As noted in Table 2, the skin surface area for adult hunters is likely overestimated, since they will probably wear shoes or boots.

Dermal absorption rates of inorganic chemicals have not been studied for recreational populations. Lacking population- or activity-specific information for skin surface area for soil contact and the soil adherence factor, default assumptions were made for this pathway. As shown in Table 2, DTSC-recommended default values for residents and construction workers were used in lieu of site-specific information for campers, hikers, hunters, or OHV riders. While this introduces some uncertainty into the analysis, it is not considered to be significant, as dermal exposure to metals is typically a low risk pathway.

The inhalation rates for all recreational populations potentially exposed to airborne particulates are also shown in Table 2. It was assumed that the populations of campers/hikers/hunters could be present at the Site all day and potentially exposed to airborne dust for the entire period. OHV riders are assumed to spend 1 ½ hours actively riding on the Site during each exposure period, although they may certainly ride for longer periods of time across a larger and non-impacted area.

It was also assumed that an individual could participate in these recreational activities for 30 years. For campers and hikers, it was assumed that 6 years of this activity would occur as a child aged 1-6 and 24 years as an adult (a standard assumption for exposure purposes) aged 7-30. Children riding OHVs were considered to be slightly older; EPA used the ages 6-12 in the

Standard Mine Site BHHRA (USEPA, 2008b; 2009). Exposure assumptions for a child ages 6-12 riding OHVs are included in Table 2. Children were not evaluated for the hunter scenario.

It is anticipated that these populations and pathways will be evaluated in the human health risk assessment for recreational visitors on federal land at the Topock site. In the event that any exposure parameters need clarification or updating, values recommended in the Topock HHRA workplan or EPA and DTSC guidance should be considered.

Table 2
**Pathway-Specific Exposure Assumptions for Recreational Visitors, Federal Land,
 Topock Site**

Parameter	Adult Value	Child Value	Reference
Body weight (kg)			
OHV Rider	70	33 (ages 6-12)	USEPA 2008b
Camper/Hiker	70	15 (ages 1-6)	DTSC 2011
Hunter	70	NA	DTSC 2011
Soil Ingestion (mg/day)			
OHV Rider	330 ^a	330 ^a (ages 6-12)	DTSC 2011
Camper/Hiker (resident default value)	100	200 (ages 1-6)	DTSC 2011
Hunter (resident default value)	100	NA	DTSC 2011
Dermal Contact			
Skin surface area (cm ²)			
OHV Rider	5,700	2,900 (ages 1-6)	DTSC 2011
Camper/Hiker	5,700	2,900 (ages 1-6)	DTSC 2011
Hunter	5,700 ^b	NA	DTSC 2011
Soil adherence factor (mg/cm ²)			
OHV Rider	0.8 ^c	0.8 ^c (ages 6-12)	DTSC 2011
Camper/Hiker	0.07	0.2 (ages 1-6)	DTSC 2011
Hunter	0.07	NA	DTSC 2011
Inhalation of Particulates (m³/hour)			
OHV Rider	2.4	1.55 (ages 6-12)	USEPA 2008b
Camper/Hiker/Hunter ^d (resident default value)	0.833 ^d	0.417 ^d (ages 1-6)	DTSC 2011
Averaging Time			
Carcinogens (days)	25,550 days	25,550 days	DTSC 2011
Noncarcinogens (days)	ED x 365	ED x 365	DTSC 2011

NA = Not applicable; not recommended for evaluation.

^athe soil ingestion rate for a construction worker was used for both children and adults because OHV riding generates a large amount of dust, which can result in higher ingestion rates than more typical recreational exposures.

^bthe skin surface area for adult hunters is likely overestimated, since they will probably wear shoes or boots.

^cthe soil adherence value for a construction worker was used for both adult and children OHV riders.

^dassumes 24 hours per day exposed to airborne particulates from the Site, equivalent to the residential default inhalation rate of 20 m³/day for adults and 10 m³/day for children.

References

Cox, Douglas N. 2013. Personal Communication with Jayson Barangian, BLM Lake Havasu Field Office. November 12.

61 FR 13647. 1996. Executive Order 12996. Management and General Public Use of the National Wildlife Refuge System.

DOI. 2009. US Department of the Interior, Bureau of Land Management, Bullhead Travel Management Plan. March. http://www.blm.gov/az/st/en/prog/travel_mgmt/lhfo/bullhead-tmp-docs.html

DOI. 2011. Final Remedial Investigation Report, Rand Historic Mining Complex. US Department of the Interior, Bureau of Land Management. June.

CNRA. 2009. Complete Findings, Survey on Public Opinion and Attitudes on Outdoor Recreation in California 2009. State of California Natural Resources Agency. http://www.parks.ca.gov/pages/795/files/2009%20spoa%20complete%20findings%209_28_09.pdf

DTSC. 2011. Human Health Risk Assessment (HHRA) Note Number 1. California EPA Department of Toxic Substances Control, Office of Human and Ecological Risk (HERO). May 20.

USDA. 2013. National Visitor Use Monitoring Results. National Summary Report. Last updated 20 May 2013. US Department of Agriculture, Forest Service. http://www.fs.fed.us/recreation/programs/nvum/2012%20National_Summary_Report_061413.pdf

USEPA. 1991. Risk Assessment Guidance for Superfund (RAGS), Supplemental Guidance, Standard Default Exposure Factors (US Environmental Protection Agency, OSWER Directive: 9285.6-03).

USEPA. 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24. December.

USEPA. 2008a. Clear Creek Management Areas Asbestos Exposure and Human Health Risk Assessment. Region 9. May. <http://www.epa.gov/region09/toxic/noa/clearcreek/pdf/CCMARiskDoc24Apr08-withoutAppxG.pdf>

USEPA. 2008b. Baseline Human Health Risk Assessment for the Standard Mine Site, Gunnison County, CO. Prepared by Syracuse Research Corporation for USEPA Region 8. March 19. http://www2.epa.gov/sites/production/files/documents/SM_HHRA.pdf

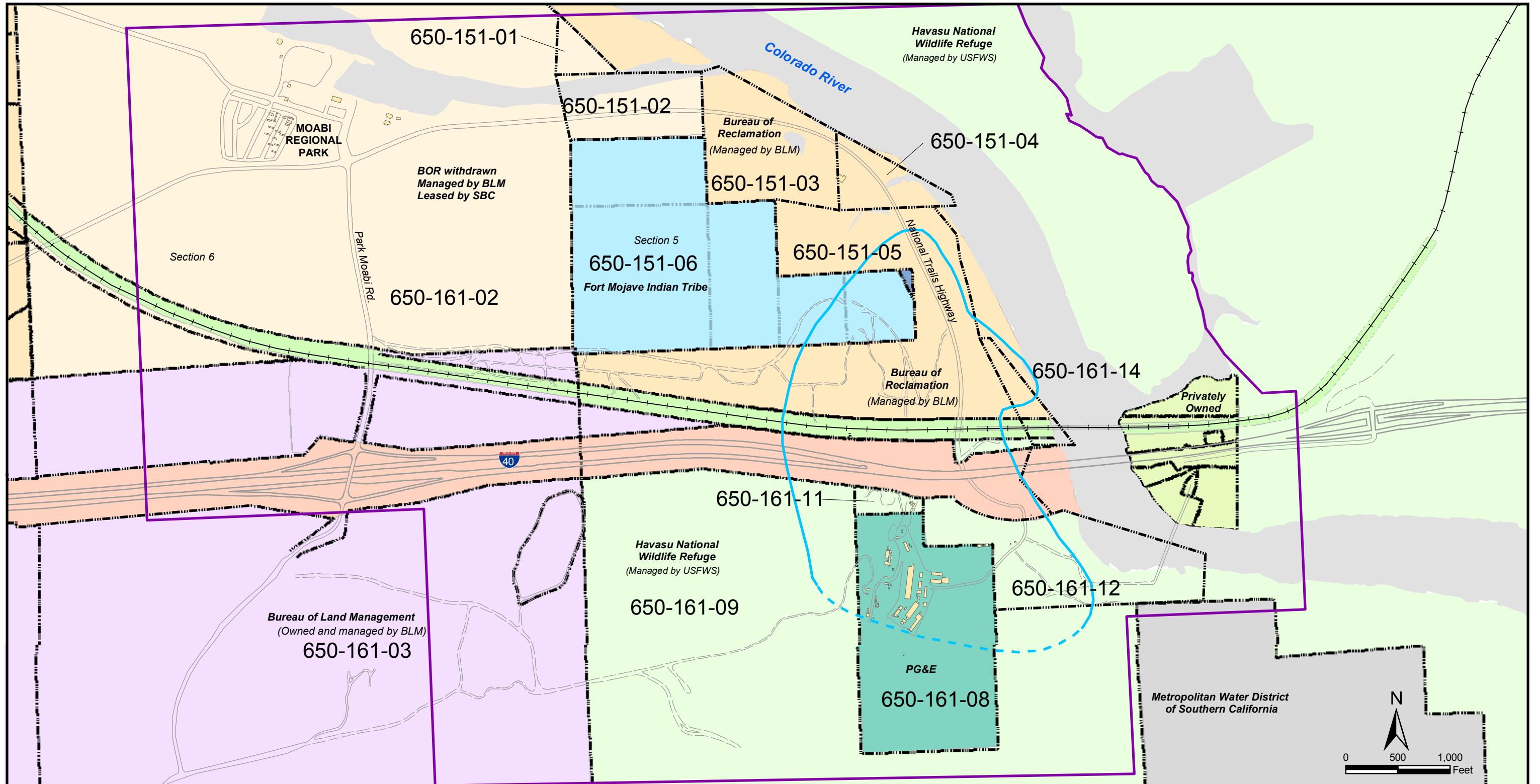
USEPA. 2009. Baseline Human Health Risk Assessment for the Standard Mine Site, Gunnison County, CO; Addendum. Prepared by SRC for USEPA Region 8. November 24. http://www2.epa.gov/sites/production/files/documents/SM_HHRA_Addendum.pdf

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USEPA. 2011a. Exposure Factors Handbook: 2011
Edition. <http://www.epa.gov/ncea/efh/pdfs/efh-complete.pdf>

USEPA. 2011b. Remedial Investigation, Nelson Tunnel/Commodore Waste Rock Pile, NPL Site, Creede CO. Prepared by HDR Engineering, Inc. and TechLaw, Inc. for USEPA Region 8. November. http://www2.epa.gov/sites/production/files/documents/NT_RI_Nov2011.pdf

USFWS. 2013. US Fish and Wildlife Service Regulations at Havasu NWR. <http://www.fws.gov/refuge/Havasu/FAQs.html>



Legend

- Area of Potential Effect (APE)
- Railroad
- Parcel Boundary
- Highway
- Paved Road
- Dirt or Gravel Road
- Building

Owner

- BNSF Railroad
- Bureau of Land Management (Owned and Managed by BLM)
- Bureau of Reclamation (Managed by BLM)
- Caltrans Leased From Underlying Federal Owner
- Fort Mojave Indian Tribe owner in fee, with PG&E easement and access for remediation

Havasu National Wildlife Refuge

Metropolitan Water District of Southern California

PG&E

Privately Owned

San Bernardino County Leased (Managed by BLM)

State of California

Approximate extent of hexavalent chromium [Cr(VI)] concentrations exceeding 32 micrograms per liter (µg/L) at any depth in groundwater based on October 2008 and July 2009 sampling events. Dashed where based on limited data. The outline of Cr(VI) depicted as greater than 32 µg/L near or under the Colorado River is 80 feet below the bottom elevation of the Colorado River.

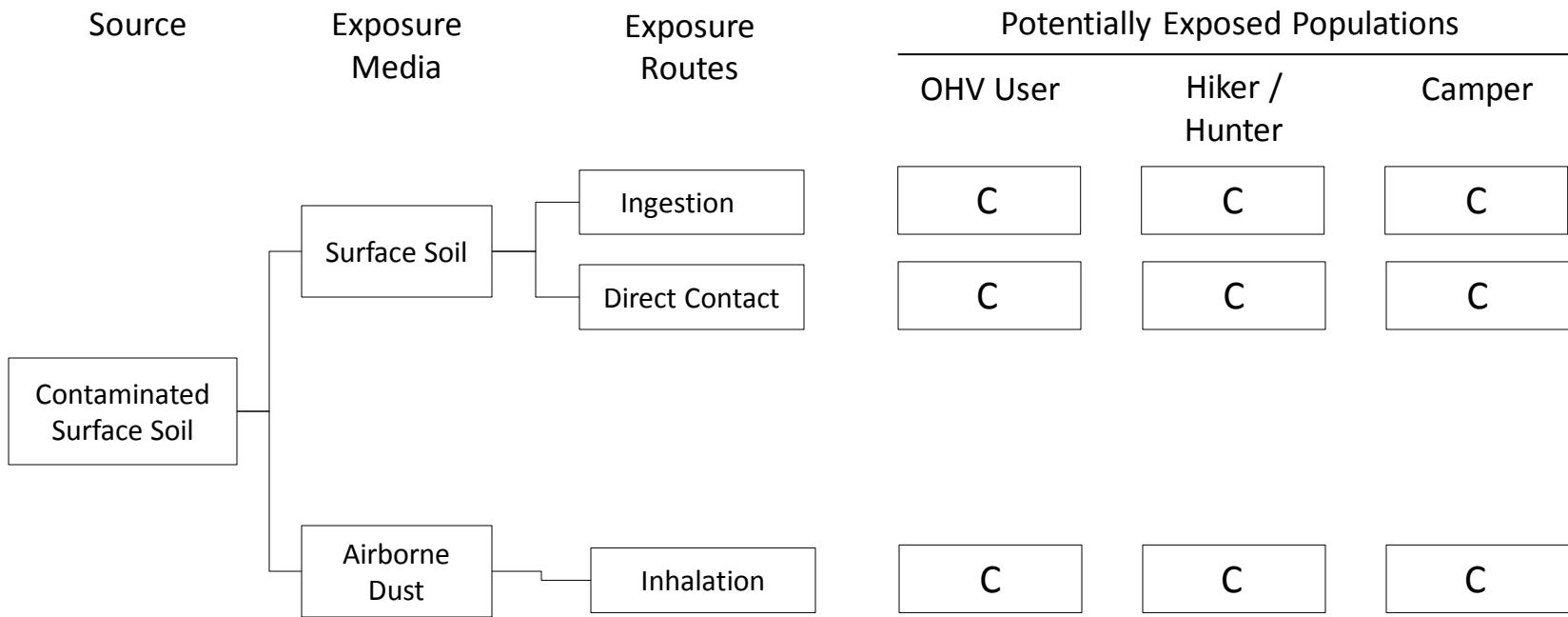
Note:
The boundary lines shown are approximate and for reference only.

- Sources:
1. San Bernardino County Assessor
 2. Parcel quest
 3. State Board of Equalization
 4. Pacific Gas and Electric Company
 5. Ecology and Environment and Plate maps provided by BLM.

FIGURE 1

Property Ownership and Management Map (modified from CH2M Hill)

**Figure 2. Draft Human Health Conceptual Site Model (CSM):
Recreational Visitors, DOI Federal Land, Topock Compressor Station**



C = Exposure Pathway Complete

N = Exposure Pathway Negligible

OHV = Off Highway Vehicle