# ATTACHMENT 16B

# HUMAN HEALTH RISK ASSESSMENT FOR OB/OD

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# HUMAN HEALTH RISK ASSESSMENT FOR OB/OD

A screening risk assessment has been conducted to evaluate impacts of open burning (OB) and open detonation (OD) operations at Tooele Army Depot (TEAD). Open burning operations also include the static firing (SF) of rocket motors using silos for demilitarization purposes. The human health screening assessment is discussed in Section 1 of this attachment and the ecological screening assessment in Section 2. These assessments have been conducted commensurate with the Tooele Army Depot Implementation Plan to Address the Utah OB/OD Permitting Guidance (Implementation Plan). (U.S. Army, June 1997.)

Major impacts for the screening risk assessments include sampling results from the OB/OD baseline sampling program (from Attachment 24 of the Permit) and dispersion modeling results (from Attachment 16A).

## 1.0 HUMAN HEALTH SCREENING RISK ASSESSMENT

The human health screening risk assessment has included the following components:

- Data evaluation
- Exposure assessment
- Toxicity assessment
- Risk characterization, and
- Uncertainty assessment

These components are discussed in Sections 1.1 - 1.5, respectively.

## 1.1 DATA EVALUATION

The primary purpose of the data evaluation task is to identify available and applicable TEAD information as input to the OB/OD risk assessment. Specifically, this has been based on results from the OB/OD baseline sampling program (i.e., input from Attachment 19) and dispersion modeling results (i.e., input from Attachment 16A).

### 1.1.1 OB/OD Baseline Sampling Program

data are used to define a source term input for a contaminant TEAD conducted a baseline environmental program for the OB/OD Unit. The specific objectives of the baseline sampling program were:

- Determining the degree to which demilitarization activities associated with the OB/OD Unit have impacted surface/subsurface soils and groundwater conditions within the Unit and nearby area, and

- Sampling surface soils from within specific zones (OB/OD, background, and boundary zones). Composite samples represent various exposure areas (source, operations, and impact) in order to characterize average contaminant levels within the OB/OD Unit. This migration model for assessing potential offsite impacts

The baseline sampling program involved:

- Composite surface soil sampling and analysis of OB and OD source exposure areas; OB and OD operations exposure areas; OB and OD impact exposure areas; a background area; and a boundary zone area. Eight composite samples, each consisting of six equal portions, were collected at discrete (pre-selected) locations within each exposure area.

- Grab sampling of subsurface soils from split-spoons positioned at 2, 5, 10, 20, 30, and 40 feet below ground surface (bgs) at eight OD source (pit) areas with the highest surface TNT screening levels.

- Composite sediment sampling and analysis from eight locations downstream from OB/OD operations in Box Elder Wash. Each composite sample consisted of sediment from six discrete locations based on a random sampling scheme using a sector radius equal to half the width of the streambed.

- Installation of one exploratory/monitoring well to determine groundwater quality and aquifer characteristics in the immediate vicinity of the OB/OD Unit. The direction and rate of groundwater flow were determined by using colloidal borescope techniques in the single monitoring well (MW-1).

The baseline sampling areas are illustrated in Fig. 1.1.1-1 (based on the results of historical OB/OD operations at TEAD). Table 1.1.1-1 lists the contaminants of potential concern (COPCs) for surface/subsurface soils and groundwater based on the screening assessment presented in Attachment 24 of the Permit. These COPCs have been evaluated in this Attachment (26) to determine the potential for offsite migration and associated impacts. Additional details regarding the baseline sampling program and approach for the selection of air pathway COPCs are presented in Attachment 24 - OB/OD Site Characterization of the Permit.

### 1.1.2 Air Pathway Screening Assessment

Attachment 16B presents an air pathway screening assessment which was conducted to identify COPCs for the air media considering potential future OB/OD operations at TEAD. The screening assessment was based on numerous conservative assumptions which overestimate potential OB/OD impacts but also serve to streamline the air pathway assessment process. Emission factors for OB/OD sources were based on Bang Box emission tests conducted by the U.S. Army (U.S. Army, January 1992; U.S. Air Force, January 1994; U.S. EPA, March 1998). The OBODM was used to identify maximum concentration values and associated locations (U.S. Army, July 1997). This dispersion model was developed by the U.S. Army specifically for OB/OD releases. Meteorological data used were based on 1992-1996 data for the National

**Fig. 1.1.1-1. Baseline sampling areas**

Weather Service station at Salt Lake City, UT, as well as limited available onsite data (November 1996 - November 1997). Background air quality levels were also evaluated.

Air pathway COPCs were identified in Attachment 25 of the Permit by comparison of model concentration values to Utah Toxic Screening Levels (TSLs) and U.S. EPA Region 9 Preliminary Remediation Goals (PRGs) (UDAQ, 1998; U.S. EPA, June 1998). A contaminant was considered to be a COPC if the Hazard Quotient (i.e., ratio of medium concentration to the screening criteria) exceeded 0.1. A listing of air pathway COPCs is presented in Table 1.1.2-1.

Air concentration estimates for receptor locations of interest from the air pathway screening assessment (as provided in Attachment 25 – OB/OD Air Modeling of the Permit) were used as inputs for the risk assessment. Similarly, annual deposition quantities (based on a deposition velocity of 0.001 m/sec) presented in Attachment 25 were also used as input data for this risk assessment. Additional details on the air pathway screening assessment is presented in Attachment 16A – Air Dispersion Modeling for OB/OD.

## 1.2 HUMAN HEALTH EXPSOSURE ASSESSMENT

The exposure assessment step of the human health risk assessment program involves the following components:

- Identify potential receptors
- Identify significant exposure pathways
- Model environmental transport
- Select appropriate exposure factors, and
- Calculate body intakes (doses).

These components are discussed in Sections 1.2-1 through 5, respectively.

### 1.2.1 Potential Receptors

Potential Reasonable Maximum Exposure (RME) receptors have been identified based on consideration of local land use, population distribution, and dispersion modeling results.

#### 1.2.1.1 Land Use

TEAD is located in Tooele County, Utah, immediately west of the city of Tooele. It is in the north-central part of the state, 35 miles southwest of Salt Lake City.

**Table 1.1.1-1. Summary of human health COPCs onsite at OB/OD Unit (based on baseline sampling results)**

| COPCs | Surface soil | Subsurface soil | Groundwater[b] |
|---|---|---|---|
| <u>Metals</u> | | | |
| (Aluminum)[a] | XX | | |
| (Arsenic)[a] | XX | XX | |
| Beryllium | | XX | |
| (Cadmium)[a] | X | X | |
| Chromium | XX | XX | |
| Copper | X | | |
| Lead | XX | | |
| <u>Energetics</u> | | | |
| 2,4,6-TNT | X | X | |
| RDX | XX | XX | |
| <u>Semivolatiles</u> | | | |
| Dibenz(a,h)anthracene | X | | |
| Hexachlorobenzene | XX | | |
| Pentachlorophenol | X | | |

X = Based on EPA Region 9 “residential” screening criteria
XX = Based on EPA Region 9 “residential” and “industrial” screening criteria

[a]( ) = considered only as a tentative COPC because of the high background levels and local mineral content and variability for these metals.

[b]Lead, zinc and bis (2-ethylhexyl) phthalate were tentative COPCs based on the first quarter sampling. But these results may not be reliable due to sampling problems. The second quarter sampling results do not justify the selection of any COPCs.

**Table 1.1.2-1. Summary of human health COPCs at offsite locations (based on air pathway assessment results)**

| COPCs | Maximum Concentration Location | Grantsville | Seabase Prawn Farm |
|---|---|---|---|
| Metals | | | |
| Arsenic | X | X | X |
| Cadmium | XXX | XXX | XXX |
| Chromium | XX | XX | XX |
| Energetics | | | |
| RDX | XXX | X | X |
| Semivolatiles | | | |
| Hexachlorobenzene | XX | | |
| Other | | | |
| Hydrogen chloride | X | | |

X = Based on EPA Region 9 screening criteria
XX = Based on Utah Toxic Screening Level
XXX = Based on both EPA Region 9 screening criteria and Utah Toxic Screening Level

TEAD is used mainly for military ordnance and material storage, maintenance, and demilitarization. The depot mission at TEAD requires large isolated tracts of land (minimal use areas) to store munitions. These tracts also require buffer areas around them to ensure adequate public safety and provide for weapons security. About 92 percent of TEAD is comprised of minimal use areas including firing ranges, ammunition demolition, and weapons storage igloos, among other uses (U.S. Army, August 1995).

The BRAC parcel of TEAD consists of two discrete properties (an Industrial Area and an Administration Area) on the east side of the installation. The location of TEAD is illustrated in Fig. 1.2.1.1-1. The

1,700-acre BRAC parcel includes the Industrial Area (areas designed to maintain, reconstruct, and store heavy military equipment) and the Administrative Area (an area of administrative offices and community service buildings). Some of the administrative and community service buildings in the BRAC parcel are being retained for depot use and/or will be acquired by the Utah National Guard (U.S. Army, August 1995).

Most of the land around TEAD is agricultural, used for livestock grazing and limited cultivation. Areas of low to moderate intensity development are located in the city of Tooele, east of TEAD. The community of Grantsville abuts TEAD on the northwest, although the closest urban

**Fig. 1.2.1.1-1.  TEAD location map**

development is about two miles away from the facility. The small community of Stockton is about two miles south of TEAD (U.S. Army, August 1995).

TEAD is bounded on the north by SR 112. Except for the Tooele County Landfill and a salvage company, land north of this road is grazed or farmed. The Union Pacific Railroad's main line (Salt Lake City to Los Angeles) cuts through the east side of the depot between the BRAC parcel Administrative Area and the rest of TEAD. The city of Tooele Commercial Park lies to the east along with some residential areas. The main entrance to TEAD is via SR 36, which skirts the southeast side of the depot. Land to the south and west of TEAD is used mainly for livestock grazing (U.S. Army, August 1995).

TEAD is adjoined by three land uses: low-density residential, industrial/manufacturing, and agricultural. Property west and south of TEAD is controlled by the U.S. Forest Service, the U.S. Bureau of Land Management (BLM), or Tooele County and is designated by Tooele County for multiple uses (MU-40), including agricultural, grazing, and mining. MU-40 zoning is intended to minimize public utility and service expenditures (which could result from urban sprawl) and to promote the preservation of local watersheds and wildlife habitats. Zoning designations on the northern boundary are either rural residential (RRI), allowing low-density family dwelling units and limited domestic livestock habitation, or agricultural (A-20) which promotes the preservation of favorable agricultural land and maintains greenbelts (U.S. Army, August 1995).

The city of Tooele abuts the BRAC parcel (east side of Industrial Area, north side of Administration Area). Tooele County abuts the east and south sides of the BRAC parcel Administrative Area. Property adjacent to the BRAC parcel is zoned for agricultural, residential, and manufacturing. City of Tooele parcels that abut the BRAC parcel to the east of TEAD are designated predominantly as high and medium density industrial/manufacturing (M-D and M-G), along with a rural residential subdivision zone located on the southeast side of the installation (U.S. Army, August 1995).

### 1.2.1.2 Population Distribution

The total 1990 population within 50 km of the TEAD OB/OD Unit is 68,193. The distribution of this population is summarized in Tables 1.2.1.2-1 through 3 (U.S. Census Bureau, 1992).

Approximately 70 percent of Tooele County residents live in the cities of Tooele and Grantsville, with 52 percent in the city of Tooele and 18 percent in Grantsville. The city of Tooele had a 1992 population of 14,416, up 3.8 percent from its 1990 population of 13,887. Grantsville had 4,747 residents in 1992, a 5.5 percent increase from its 1990 population of 4,500 (U.S. Army, August 1995).

Recent population growth and other socioeconomic data show that the Tooele Valley is shifting from an agricultural and mining economy to that of a bedroom community for the Salt Lake City metropolitan area. Population growth and projected increases for Tooele and adjacent counties is summarized in Table 1.2.1.2-4 (U.S. Army, August 1995).

Based on 1990 census data, the population distribution by race, ethnicity, and sex for Tooele County, Utah County, and Salt Lake County is presented in Table 1.2.1.2-5. The general racial/ethnic composition and sex distribution is not expected to have changed significantly between 1990 and the present. The ethnic and racial population characteristics of the three counties are similar. Over 90 percent of the ROI population is white, and people of Hispanic origin represent the largest minority: 11 percent of the population in Tooele County, three percent of Utah County, and six percent of Salt Lake County. A person of any race may be of Hispanic origin; therefore these classifications are not mutually exclusive.

In 1990, approximately 11 percent of the residents in the three county area were classified by the U.S. Census as living in poverty, ranging from 9.7 percent in Salt Lake County to 14.8 percent in Utah County. Tooele County's 11 percent was the same as the three-county average (U.S. Census Bureau, 1992). The Census Bureau bases poverty status of families and individuals on 48 threshold variables, including income, family size, number of family members under 18 and over 65 years of age, and amount spent on food. Although more recent data are unavailable on poverty by race, the distribution percentages are not expected to have significantly changed between 1990 and the present (U.S. Army, August 1995).

Poverty in Tooele County was not equally distributed among its racial and ethnic populations. Approximately 50 percent of the Asian/Pacific Islander population was living in poverty compared to 10 percent of the white population, 12 percent of the black population, and 8 percent of the American

**Table 1.2.1.2-1. Distribution of total population within 50 km of the TEAD OB/OD Unit**

| | Distance (km) | | | | | |
|---|---|---|---|---|---|---|
| Sector | 0-10 | 11-20 | 21-30 | 31-40 | 41-50 | Total |
| N | 356 | 2,327 | 0 | 0 | 0 | 2,683 |
| NNE | 644 | 1,173 | 0 | 0 | 0 | 1,817 |
| NE | 0 | 509 | 687 | 6,578 | 11,142 | 18,916 |
| ENE | 532 | 12,980 | 375 | 0 | 22,374 | 36,261 |
| E | 0 | 6,162 | 0 | 0 | 0 | 6,162 |
| ESE | 0 | 0 | 0 | 283 | 0 | 283 |
| SE | 0 | 0 | 0 | 0 | 0 | 0 |
| SSE | 0 | 0 | 0 | 0 | 0 | 0 |
| S | 0 | 0 | 0 | 174 | 0 | 174 |
| SSW | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | 0 | 0 | 0 | 1,777 | 0 | 1,777 |
| WSW | 0 | 0 | 0 | 0 | 0 | 0 |
| W | 0 | 0 | 0 | 0 | 0 | 0 |
| WNW | 0 | 0 | 0 | 0 | 0 | 0 |
| NW | 0 | 0 | 0 | 0 | 0 | 0 |
| NNW | 0 | 120 | 0 | 0 | 0 | 120 |
| Total | 1,532 | 23,271 | 1,062 | 8,812 | 33,516 | 68,193 |

**Table 1.2.1.2-2. Distribution of total population under 6 years within 50 km of the TEAD OB/OD Unit**

| Sector | Distance (km) 0-10 | 11-20 | 21-30 | 31-40 | 41-50 | Total |
|---|---|---|---|---|---|---|
| N | 0 | 37 | 230 | 0 | 0 | 267 |
| NNE | 0 | 117 | 223 | 0 | 0 | 340 |
| NE | 2,140 | 0 | 89 | 101 | 987 | 3,317 |
| ENE | 5,987 | 76 | 903 | 61 | 0 | 7,027 |
| E | 0 | 0 | 821 | 0 | 0 | 821 |
| ESE | 0 | 0 | 0 | 0 | 38 | 38 |
| SE | 0 | 0 | 0 | 0 | 0 | 0 |
| SSE | 0 | 0 | 0 | 0 | 0 | 0 |
| S | 0 | 0 | 0 | 0 | 14 | 14 |
| SSW | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | 0 | 0 | 0 | 0 | 320 | 320 |
| WSW | 0 | 0 | 0 | 0 | 0 | 0 |
| W | 0 | 0 | 0 | 0 | 0 | 0 |
| WNW | 0 | 0 | 0 | 0 | 0 | 0 |
| NW | 0 | 0 | 0 | 0 | 0 | 0 |
| NNW | 0 | 0 | 21 | 0 | 0 | 21 |
| Total | 8,127 | 230 | 2,287 | 162 | 1,359 | 12,165 |

**Table 1.2.1.2-3. Distribution of population over 62 years within 50 km of the TEAD OB/OD Unit**

| Sector | Distance (km) 0-10 | 11-20 | 21-30 | 31-40 | 41-50 | Total |
|---|---|---|---|---|---|---|
| N | 0 | 41 | 104 | 0 | 0 | 145 |
| NNE | 0 | 105 | 193 | 0 | 0 | 298 |
| NE | 987 | 0 | 130 | 109 | 201 | 1,427 |
| ENE | 2,107 | 205 | 1,276 | 25 | 0 | 3,613 |
| E | 0 | 0 | 917 | 0 | 0 | 917 |
| ESE | 0 | 0 | 0 | 0 | 61 | 61 |
| SE | 0 | 0 | 0 | 0 | 0 | 0 |
| SSE | 0 | 0 | 0 | 0 | 0 | 0 |
| S | 0 | 0 | 0 | 0 | 18 | 18 |
| SSW | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | 0 | 0 | 0 | 0 | 22 | 22 |
| WSW | 0 | 0 | 0 | 0 | 0 | 0 |
| W | 0 | 0 | 0 | 0 | 0 | 0 |
| WNW | 0 | 0 | 0 | 0 | 0 | 0 |
| NW | 0 | 0 | 0 | 0 | 0 | 0 |
| NNW | 0 | 0 | 13 | 0 | 0 | 13 |
| Total | 3,094 | 351 | 2,633 | 134 | 302 | 6,514 |

**Table 1.2.1.2-4. Population changes**

| County | Population Increases 1980-90 | Projected Increases 1990-2000 |
|---|---|---|
| Tooele | 2% | 37% |
| Salt Lake | 17% | 21% |
| Utah | 21% | 29% |
| Total | 18% | 23% |

Source: U.S. Census 1990; State of Utah 1993; Tooele County Economic Development Corporation 1994.

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**Table 1.2.1.2-5. Population by race/ethnicity and sex in 1990**

| | Tooele County | | Utah County | | Salt Lake County | | Total | |
|---|---|---|---|---|---|---|---|---|
| Race | Persons | % of Total | Persons | % of Total | Persons | % of Total | Persons | % of Total |
| White | 24,347 | 91.5% | 253,596 | 96.2% | 675,141 | 93.0% | 953,084 | 93.8% |
| Black | 228 | 0.9% | 374 | 0.1% | 5,663 | 0.8% | 6,265 | 0.6% |
| Asian/Pacific Islander | 205 | 0.8% | 3,958 | 1.5% | 20,035 | 2.8% | 24,198 | 2.4% |
| American Indian | 391 | 1.5% | 1,913 | 0.7% | 6,111 | 0.8% | 8,415 | 0.8% |
| Other | 1,430 | 5.4% | 3,749 | 1.4% | 19,006 | 2.6% | 24,185 | 2.4% |
| TOTAL | 26,601 | 100% | 263,590 | 100% | 725,956 | 100% | 1,016,147 | 100% |
| Hispanic (any race)[1] | 2,960 | 11.1% | 8,488 | 3.2% | 43,647 | 6.0% | 55,095 | 5.4% |
| Female Population | 13,155 | 49.4% | 133,309 | 50.6% | 365,895 | 50.4% | 512,359 | 50.4% |

Source: U.S. Census 1990.
[1]Hispanic origin is an ethnicity, not a race. Hispanics may be any race.

Indian population. In Salt Lake and Utah Counties, American Indians represent the highest percentage of residents living in poverty. Poverty status data by race and ethnicity is presented in Table 1.2.1.2-6 (U.S. Army, August 1995).

### 1.2.1.3 Reasonable Maximum Exposure Receptors

Reasonable maximum exposure scenarios have been evaluated for the human health risk assessment. Specifically the following RME receptor types have been evaluated based on current and extended future land use in the vicinity of TEAD:

- Adult resident
- Child resident
- Subsistence farmer
- Subsistence fisher

The residential scenario represents potential current and future population in the vicinity of TEAD. The subsistence farmer scenario is based on a potential receptor whose diet includes consumption of beef, milk, and vegetables from their own farm and/or ranch. The diet of the subsistence fisher is assumed to include a high amount of local fish. The exposure factor and consumption rate assumptions for these potential receptor types are included in Sect. 1.2.4.

Potential RME locations have been selected as follows (also refer to Fig. 1.2.1.3-1):

- Maximum air concentration location (approximately 200 m south of the OB/OD Unit and TEAD southern boundary).

- Grantsville (approximately 9-10 km north-northeast of the OB/OD Unit).

- Seabase prawn farm (approximately 20 km north of the OB/OD Unit).

These locations are consistent with those receptors evaluated in the air pathway screening assessment (i.e., Attachment 25- OB/OD Air Modeling of the Permit). Table 1.2.1.3-1 identifies the receptor type associated with each of the potential RME locations. Grantsville represents the population center with the highest potential for exposure to OB/OD emissions considering prevailing wind patterns. The Seabase prawn farm has been selected to evaluate the potential RME subsistence fisher.

Onsite worker exposures were not specifically evaluated. However, the adult resident receptor at the maximum concentration location also represents a conservative exposure scenario for the onsite worker. TEAD uses protective measures to reduce onsite worker exposure to fugitive dust (e.g., facemasks or enclosed cabs for heavy equipment operators during pit excavation/filling operations or during high wind erosion conditions).

### 1.2.2 Significant Exposure Pathways

A conceptual site model has been prepared to identify potential human health exposure pathways. The major components of the conceptual model are as follows:

- Source,
- Release mechanism,

**Table 1.2.1.2-6. Poverty status by race and ethnicity in 1990**

| | Tooele County | | Utah County | | Salt Lake County | | Total | |
|---|---|---|---|---|---|---|---|---|
| Race | Persons | % of Total | Persons | % of Total | Persons | % of Total | Persons | % of Total |
| White | 2,555 | 10% | 36,304 | 14% | 58,045 | 8.5% | 96,904 | 10% |
| Black | 28 | 12% | 170 | 45% | 1,542 | 27% | 1,740 | 28% |
| Asian/Pacific Islander | 104 | 50 | 507 | 13% | 2,263 | 11% | 2,874 | 12% |
| American Indian | 32 | %8 | 1,062 | 55% | 4,079 | 67% | 5,173 | 61% |
| Other | 286 | %20 | 1,075 | 28% | 4,824 | 25% | 6,185 | 25% |
| TOTAL | 3,005 | %11 | 39,118 | 14.8% | 70,753 | 9.7% | 112,876 | 11% |
| Hispanic | 516 | %17 | 2,049 | 24% | 9,268 | 21% | 11,833 | 21% |

Source: U.S. Census 1990.

**Fig. 1.2.1.3-1. Potential RME receptor locations.**

**Table 1.2.1.3-1. Reasonable maximum exposure potential receptors**

| | Receptor Locations | | |
|---|---|---|---|
| Receptor Type | Maximum Air Concentration | Grantsville | Seabase Prawn Farm |
| Adult resident | √ | √ | |
| Child resident | √ | √ | |
| Subsistence farmer | √ | √ | |
| Subsistence fisher | | | √ |

- Transport medium,
- Exposure mechanism,
- Exposure route, and
- Receptor.

The conceptual model for the OB/OD source at TEAD is illustrated in Fig. 1.2.2-1. The direct pathway is considered to be the OB/OD air emissions which occur during treatment operations.

Inhalation is the direct exposure mechanism associated with the air pathway for OB/OD air emissions. Deposition and associated ingestion, as well as dermal contact, are considered to be indirect exposure mechanisms.

Potential secondary OB/OD release mechanisms are associated with the transport of soil contaminants from the OB/OD Unit. Potential release mechanisms for this secondary source include leaching to groundwater, runoff to surface water (as well as sediment transport), and wind erosion. But the leaching and runoff pathways are considered to be incomplete for the TEAD OB/OD Unit as discussed in Sect. 1.2.3.

Leaching of soil contaminants to groundwater as well as transport to a receptor are not considered to be a viable pathway at TEAD. Monitoring well results (based on the second quarter results for the baseline sampling program) at the OB/OD Unit indicate that there are no groundwater COPCs. These results indicate that leaching to groundwater has not occurred after approximately 50 years of OB/OD operations at TEAD. In addition, the nearest water supply well to the OB/OD Unit is TEAD supply well No. 4 (completed at a total depth of 700 feet and used only by TEAD). This well is about 1.5 miles north of the OB/OD Unit. The nearest offsite water supply well is approximately 5 miles from the OB/OD Unit, north of the TEAD boundary. However, the groundwater flow direction is to the south-southwest (based on colloidal borescope measurements for the OB/OD Unit groundwater monitoring well). Therefore, there are no receptors for the OB/OD leaching to groundwater pathway.

Runoff from OB/OD Unit soils is also not considered to be associated with a complete pathway at TEAD. COPCs were not identified for surface soil/sediment samples from Box Elder Wash for the baseline sampling program at the OB/OD Unit. Box Elder Wash is an ephemeral stream channel. TEAD staff have indicated that Box Elder Wash has rarely had any water in it during

**Fig. 1.2.2-1. Conceptual human health exposure site model for the TEAD OB/OD Unit source.**

the last 10-15 years, based on personal observations. In addition, there is a dam on the Wash about 1.5 miles downstream of the OB/OD Unit. Downstream of the dam, it is more than 4 miles before Box Elder Wash leaves TEAD (at the north installation boundary). Therefore, there are no receptors for the runoff pathway.

Although the leaching and runoff pathway are considered incomplete, these release scenarios have been modeled (in addition to the direct air pathway and wind erosion) to further substantiate the premise of no-migration conditions. The environmental transport modeling approach is discussed in Sect. 1.2.3.

### 1.2.3 Environmental Transport

The Multimedia Environmental Pollutant Assessment System (MEPAS) has been used to evaluate the potential for offsite environmental transport of COPCs from the OB/OD Unit soils (DOE, 1995). These COPCs (as listed in Table 1.1.1-1) were based on results from the baseline sampling program and are attributed to past OB/OD operations at the Unit.

Although the leaching and runoff pathway are considered incomplete, these release scenarios have been modeled (in addition to the direct air pathway and wind erosion) to further substantiate the premise of no-migration conditions. The environmental transport modeling approach is discussed in Sect. 1.2.3.

### 1.2.3 Environmental Transport

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MEPAS was selected over others because of its flexibility and potential for modeling multiple transport pathways in sequence. The MEPAS methodology uses empirically, analytically, and semianalytically based mathematical algorithms to predict the potential for contaminant migration from a site to receptors of concern using pathway analysis. Four major pathways of contaminant migration are considered in the MEPAS model: groundwater, overland, surface water, and atmospheric (resuspension). These transport pathways can be linked to form a chain of environmental transport media specific to the site in question.

The MEPAS model accounted for the following factors for this TEAD evaluation:

- Specific site information and constituent characteristics (metals, energetic, and semivolatile organic compounds) associated with the transport pathways being modeled;
- The potential direction of contaminant movement;
- Pollutant mobility and persistence;
- Various routes of exposure;

- Contaminant toxicities; and

- Contaminant arrival times to receptors of concern.

Baseline sampling results were used to define a source term needed as input for MEPAS modeling as follows:

- Sampling results
  - Baseline increment including background contribution
  - OB/OD increment (i.e., subtracting out the background level)

- Future estimates
  - Future OB/OD increment (increase of 20 percent from baseline)
  - Future OB/OD increment (increase of 20 percent from baseline) plus background

The 20 percent increase for the future OB/OD increment is an estimate associated with an additional 10 years of OB/OD operations (i.e., a total operational period of 60 years = 50 years historical + 10 years future).

Specifically, the following transport scenarios were evaluated to determine the potential for offsite migration of soil COPCs from the OB/OD Unit:

- Infiltration to groundwater and the potential for subsequent exposures

- Overland runoff to Box Elder Wash and the potential for offsite exposures

- Resuspension of soils due to wind erosions and site activity soil disturbances with the potential for subsequent offsite exposures.

A discussion of the MEPAS modeling approval and results is presented in Appendix 1.2.3-A. MEPAS input/output files are included in Appendix 1.2.3-B.

A summary of Hazard Quotient (i.e., ratio of exposure concentrations to a health criterion) results based on MEPAS modeling of the OB/OD Unit COPCs is presented in Table 1.2.3-1. These results indicate environmental transport pathways related to soil contamination at the OB/OD Unit are considered insignificant for potential offsite receptors. The only COPC with a Hazard Quotient greater than 0.1 was TNT (with a value of 0.2). However, the transport time for infiltration to groundwater and transport to the TEAD boundary is more than 1,300 years. Therefore, there are no contaminants of concern (COCs) associated with transport of COPCs from the OB/OD Unit via resuspension, infiltration, or overland runoff. (However, OD ejecta has been accounted for in the air modeling results based on Sect. 1.1.2 or Attachment 24 of the permit). <u>Thus, for the remainder of this OB/OD Unit risk assessment the focus will be on future air emissions from the OB/OD Unit and associated potential offsite exposures (including indirect pathways subsequent to deposition)</u>.

### 1.2.4 Exposure Factors

Standard U.S. EPA guidance and Utah Hazardous Waste Management Rule R315-101 have been used for the selection of appropriate exposure factors (USEPA, 1990; USEPA, March 1991; USEPA, April 1994; USEPA, May 1992). These exposure factors are representative of the RME potential receptor. Summaries of exposure factors and receptor consumption assumption are documented in Tables 1.2.4-1 and 2, respectively.

### 1.2.5 Body Intakes

Exposure concentrations (based on site investigation and/or modeling data) provide input for the calculation of contaminant-specific intakes to the human body (i.e., doses). Following is the generic equation for the calculation of chemical intakes (USEPA, December 1989):

$$I = \frac{C \cdot CR \cdot EFD \cdot F}{BW \cdot AT} \qquad \text{Eq. 1.2.5-1}$$

where

I = Intake: the amount of chemical at the exchange boundary (mg/kg body weight-day)

<u>Chemical-related variable</u>

C = Chemical concentration: the representative concentration contacted over the exposure period (e.g., mg/liter water)

and the following are variables that describe the exposed population (see Tables 1.2.4-1 and -2 for values):

CR = Contact rate: the amount of contaminated medium contacted per unit time or event (e.g., liters/day)

EFD = Exposure frequency and duration: describes how long and how often exposure occurs, often calculated using two terms (EF and ED)

EF = Exposure frequency (days/year)

Table 1.2.3-1. Summary of TEAD boundary hazard quotient (HQ) values for human health COPCs (based on OB/OD Unit baseline sampling results and MEPAS environmental transport modeling)[a]

| COPCs | Wind erosion (air) | Overland runoff (surface water) | Infiltration (groundwater)[c] |
|---|---|---|---|
| Metals | | | |
| (Aluminum)[b] | <0.1[e] | <0.1[e] | <0.1[e] |
| (Arsenic)[b] | <0.1[e] | <0.1[e] | <0.1[e] |
| Beryllium | <0.1[e] | <0.1[e] | <0.1[e] |
| (Cadmium)[ba] | <0.1[e] | <0.1[e] | <0.1[e] |
| Chromium | <0.1[e] | <0.1[e] | <0.1[e] |
| Copper | <0.1[e] | <0.1[e] | <0.1[e] |
| Lead[c] | <0.1[e] | <0.1[e] | <0.1[e] |
| Energetics | | | |
| 2,4,6-TNT | <0.1[e] | <0.1[e] | 0.2[d] |
| RDX | <0.1[e] | <0.1[e] | <0.1[e] |
| Semivolatiles | | | |
| Dibenz(a,h)anthracene | <0.1[e] | <0.1[e] | <0.1[e] |
| Hexachlorobenzene | <0.1[e] | <0.1[e] | <0.1[e] |
| Pentachlorophenol | <0.1[e] | <0.1[e] | <0.1[e] |

[a]Based on EPA Region 9 screening criteria (U.S. EPA, June 1998).

[b](       ) = considered only as a tentative COPC because of the high background levels and local mineral content and variability for these metals.

[c]Lead, zinc and bis (2-ethylhexyl) phthalate were tentative groundwater COPCs based on the first quarter sampling. But these results may not be reliable due to sampling problems. The second quarter sampling results do not justify the selection of any COPCs.

[d]Transport time for TNT to infiltrate to groundwater estimated to be greater than 1,300 years based on MEPAS modeling.

[e]HQ results indicate that the HQ is <u>significantly</u> (generally by many orders of magnitude) less than 0.1 (see Appendix 1.2.3-A for details).

ED = Exposure duration (years)

BW = Body weight: the average body weight over the exposure period (kg)

F = Fraction of medium contaminated (dimensionless)

<u>Assessment-determined variable</u>

AT = Averaging time: period over which exposure is averaged (days)

Note that exposure frequency and duration (EFD) equal the averaging time (AT) in days for evaluating noncarcinogenic effects. For evaluating cancer risk the averaging time is assumed to be the equivalent of 70 years (in units of days), which represents a typical lifetime.

The intake parameters can also be expressed in units of mg/day by eliminating the body weight (BW) term. Also, for risk characterization calculations the intake parameter can be simplified by eliminating the exposure parameters (i.e., EF, ED, and AT) as follows:

$$I' = C \cdot CR \cdot F \qquad \text{Eq. 1.2.5-2}$$

where

I´ = Modified contact parameter (mg/day)

**Table 1.2.4-1. Summary of exposure factors**

| Land use | Exposure Pathway | Exposure frequency[a] (EF) | Exposure duration[b] (ED) | Body weight[b] (BW) |
|---|---|---|---|---|
| Residential | Ingestion of potable water | 350 days/year | 6 years (child)<br>70 years (adult)[c] | 15 kg (child)<br>70 kg (adult) |
| | Ingestion of soil and dust | 350 days/year | 6 years (child)<br>70 years (adult)[c] | 15 kg (child)<br>70 kg (adult) |
| | Inhalation of contaminants | 350 days/year | 6 years (child)<br>70 years (adult)[c] | 15 kg (child)<br>70 kg (adult) |
| Subsistence Farmer | Ingestion of potable water | 350 days/year | 40 years | 70 kg |
| | Ingestion of soil and dust | 350 days/year | 40 years (adult) | 70 kg (adult) |
| | Inhalation of contaminants | 350 days/year | 40 years (adult) | 70 kg (adult) |
| | Consumption of homegrown produce | 350 days/year | 40 years (adult) | 70 kg (adult) |
| Subsistence Fisher | Consumption of locally caught fish | 350 days/year | 30 years (adult) | 70 kg (adult) |

[a]Source: USEPA, March 1991 unless indicated otherwise.
[b]Source: USEPA, April 1994.
[c]Source: Utah Hazardous Waste Management Rule, R315-101.

**Table 1.2.4-2. Consumption rates and fraction contaminated used in exposure scenarios (USEPA, April 1994)**

| Contaminated food or media | Subsistence Farmer | | Subsistence Fisher | | Adult Resident | | Child Resident | |
|---|---|---|---|---|---|---|---|---|
| | Rate | Frac. | Rate | Frac. | Rate | Frac. | Rate | Frac. |
| Beef (g/day) | 100 | 0.44 | NA | NA | NA | NA | NA | NA |
| Milk (g/day) | 300 | 0.40 | NA | NA | NA | NA | NA | NA |
| Fish (g/day) | NA | NA | 140* | 1 | NA | NA | NA | NA |
| Above-ground vegetables (g DW/day) | 24 | 0.95 | 24 | 0.25 | 24 | 0.25 | 5* | 0.25 |
| Root vegetables (g DW/day) | 6.3 | 0.95 | 6.3 | 0.25 | 6.3 | 0.25 | 1.4* | 0.25 |
| Soil (mg/day) | 100 | 1 | 100 | 1 | 100 | 1 | 200 | 1 |
| Air ($m^3$/day) | 20 | 1 | 20 | 1 | 20 | 1 | 5* | 1 |
| Water (l/d) | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 1 |

Notes: DW = dry weight NA = not applicable * = provisional value for interim use only
All values from the Exposure Factors Handbook (U.S. EPA, 1990).
Units shown are for consumption rate; all fractions contaminated are dimensionless.

A screening of applicable exposure mechanisms for intake calculations is presented in Table 1.2.5-1. The calculated methodologies for I´ for various exposure mechanism are provided in Appendices 1.2.5-A through F. The methodologies for the estimates of soil concentrations from deposition quantities and evaluation of food-chain pathways have been based on USEPA guidance, (USEPA, April 1994). Exposure factors and consumption rate values listed in Sect. 1.2.4 have been used to evaluate intakes.

The methodology for using I (including EF, ED, AT, and BW parameters) as well as I´ values for risk characterization is discussed in Sect. 1.4. Intake calculation results are also presented in Sect. 1.4.

## 1.3 HUMAN HEALTH TOXICITY ASSESSMENT

A toxicity assessment has been conducted to characterize the potential human health effects for COPCs. This has involved the preparation of toxicological profiles for each COPC which includes information on pertinent toxicological parameters. This information is summarized in Table 1.3-1. Input for this table was based primarily on data from the USEPA Integrated Risk Information System (IRIS) as compiled and presented by USEPA Region 9 (USEPA, June 1998). IRIS toxicological profiles are available via the world wide web (www.epa.gov/ngispgm3/iris).

The most critical toxicological parameters for risk characterization are reference doses (RFDs) for toxicants and cancer slope factors (CSFs), and for carcinogens, both oral and inhalation.

Table 1.2.5-1

**Table 1.3-1. Toxicological profiles for COPCs**

| COPC | RfD oral (mg/kg-day) | RfD inhal. (mg/kg-day) | Target Organs | CSF oral $(mg/kg\text{-}day)^{-1}$ | CSF inhal $(mg/kg\text{-}day)^{-1}$ | Cancer Weight of Evidence |
|---|---|---|---|---|---|---|
| Arsenic | 3E-4[a] | NA [a] | Central nervous system, gastro intestinal, skin | 1.5EO[a] | 1.5E+1[b] | A[a] |
| Cadmium | 5E-4[a] | 5.7E-5[b] | Lungs | NA[a] | 6.3EO[b] | B1[a] |
| Chromium | 8.6E-1 [a] | NA[a] | Lungs, liver, spleen | NA[a] | 4.2E+1[b] | A[a] |
| Hexachlorobenzene | 8E-4 | 8E-4 | Skin, central nervous system, thyroid | 1.6EO | 1.6EO | B2 |
| Hydrogen chloride | NA[a] | 5.7E-3[b] | Respiratory system | NA[a] | NA[a] | NA[a] |
| RDX | 3E-3 [a] | 3E-3[b] | Central nervous system, liver[a] | 1.1E-1[a] | 1.1E-1[a] | C[a] |

NA = Not available/applicable
A = Human carcinogen
B1 = Probable human carcinogen
B2 = Probable human carcinogen
C = Possible human carcinogen

A summary of chemical, physical, and environmental data for each COPC is presented in Appendix 1.3-A. These data were obtained from the MEPAS chemical database.

## 1.4 HUMAN HEALTH RISK CHARACTERIZATION

Exposure data and toxicological criteria have been used to characterize potential risks to human health for RME receptors. Risk characterization involves the calculation of Hazard Index values to evaluate noncarcinogenic effects and cancer risk values for carcinogens. The electronic files for HI and cancer risk values (and associated intake data) are presented in Appendix 1.4-A.

### 1.4.1 Hazard Index Values

The Hazard Index (HI) methodology has been used to characterize noncarcinogenic effects. The HI is calculated by summing the Hazard Quotient (HQ) values for all exposure mechanisms and associated chemicals (in this case COPCs) as follows:

$$HI = \sum_i \sum_j HQ_{ij} \qquad \text{Eq. 1.4.1-1}$$

[a]Based on IRIS.
[b]Based on Region 9 Preliminary Remediation Goals. (U.S. EPA, June 1998.)

where

| | | |
|---|---|---|
| HI | = | Hazard Index (dimensionless) |
| $HQ_{ij}$ | = | Hazard Quotient for $i^{th}$ exposure mechanism and $j^{th}$ toxicant (dimensionless) |

The HQ is determined as follows (USEPA, June 1994):

$$HQ = \frac{I'}{RfD \cdot BW} \qquad \text{Eq. 1.4.1-2}$$

where

| | | |
|---|---|---|
| I´ | = | Intake (mg/day) |
| RFD | = | Reference dose for oral ingestion or inhalation (mg/kg-day) |
| BW | = | Body weight (kg) |

Pursuant to Utah Administrative Code, R315-101 impacts will be considered acceptable if the HI is less than 1.0. Otherwise, a risk management plan in the form of site-specific environmental performance standards should be presented to ensure compliance with the impact criteria.

Summaries of HQ (which include background) results and associated intake values are presented in Appendix 1.4.1-A through D. The results of the HI calculations (which include background) are listed in Table 1.4.1-1 for noncarcinogens. Since all HI values are less than 1.0, it can be concluded that there are no noncarcinogenic Contaminants of Concern (COCs) associated with the TEAD OB/OD Unit.

### 1.4.2 Cancer Risk Values

The total incremental cancer risk has been calculated as follows:

$$ICR_{Total} = \sum_i \sum_j ICR_{ij} \qquad \text{Eq. 1.4.2-1}$$

where

$ICR_{total}$ = Total incremental cancer risk (dimensionless)
$ICR_{ij}$ = Cancer risk for the $i^{th}$ exposure mechanism and $j^{th}$ toxicant.

**Table 1.4.1-1. HI summary for noncarcinogens.[a]**

| RME Receptor | Direct Pathway[b] | Indirect Pathway[c,d] | Total |
|---|---|---|---|
| Max. Air Concentration | | | |
| • Adult resident | 1.3 E-1 | 2.0 E-2 | 1.5 E-1 |
| • Child resident | 2.7 E-1 | 2.8 E-2 | 3.0 E-1 |
| • Subsistence farmer | 2.3 E-1 | 1.4 E-1 | 3.7 E-1 |
| Grantsville | | | |
| • Adult resident | 8.5 E-2 | 1.2 E-2 | 9.7 E-2 |
| • Child resident | 1.0 E-1 | 1.5 E-2 | 1.2 E-1 |
| • Subsistence farmer | 8.5 E-2 | 7.5 E-2 | 1.6 E-1 |
| Seabase Prawn Farm | | | |
| • Subsistence fisher | 4.2 E-2 | 1.4 E-2 | 5.6 E-2 |

[a]Includes background contributions (which are considered insignificant relative to OB/OD emissions).
[b]Hydrogen chloride emissions from OB and SF and cadmium emissions from OD ejecta are the primary COPCs for the direct pathway (inhalation) for noncarocinogens.
[c]Primary indirect pathway noncarcinogen COPCs are cadmium (associated with OD ejecta emissions) and RDX (associated with OD emissions).
[d]Primary indirect exposure pathway of potential concern is the ingestion of root vegetables.

The ICR is determined as follows (U.S. EPA, June 1994):

$$ICR = \frac{I' \cdot EF \cdot ED \cdot CSF}{BW \cdot AT} \quad \text{Eq. 1.4.2-2}$$

where

I′ = Intake (mg/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
CSF = Cancer slope factor $(mg/kg\text{-}day)^{-1}$
BW = Body weight (kg)
AT = Averaging time, period over which exposure is averaged (days)

Acceptable risk for carcinogen is generally considered to be in the $10^{-6}$ to $10^{-4}$ range. Pursuant to Utah Administrative Code, R315-101 impacts will be considered acceptable if the cancer risk is less than 1.0 E-6. Otherwise, a risk management plan in the form of site-specific environmental performance standards should be presented to ensure compliance with the impact criteria.

Summaries of cancer risk results and associated intake values are presented in Appendix 1.4.2-A through D. The cancer risk results (which include background conditions) are listed in Table 1.4.2-1. These results all range from 2.0 x $10^{-6}$ (i.e., child resident at Grantsville) to 6.6 x $10^{-5}$ (adult resident at the maximum concentration locations). Inhalation is the primary exposure pathway and the primary COPCs are cadmium and chromium associated with potential OD ejecta emissions. For the indirect pathway, RDX is the primary COPC associated with OD operations. The energetic RDX is the principal constituent for the explosive mixture C-4 which is frequently used as a donor charge for OD operations. The primary exposure pathway (hypothetical) for the indirect pathway is the ingestion of root vegetables. However, root vegetables are not a major crop in the TEAD area. Risk management measures to reduce the potential cancer risk are identified in Section 3.

## 1.5 UNCERTAINTY ANALYSIS FOR THE HUMAN HEALTH RISK ASSESSMENT

There is a large degree of uncertainty associated with the estimates of human health risks in any risk assessment. Consequently, the estimates calculated for OB/OD Units should not be construed as absolute estimates of risk but rather as conditional estimates based on a number of assumptions regarding exposure and toxicity. In general, the primary sources of uncertainty are associated with the following:

- Data evaluation,
- Toxicological data,
- Concentrations predicted using transport models,
- Exposure assessment assumption, and
- Risk characterization

A thorough understanding of the uncertainties associated with the risk estimates is critical to understanding the true nature of the estimated risks and to placing the estimated risks in proper perspective. Some of the more important sources of uncertainty associated with the estimates of risk are summarized below.

**Table 1.4.2-1. Cancer risk summary**

| RME Receptor | Direct Pathway[b] | Indirect Pathway[c,d] | Total |
|---|---|---|---|
| Max. Air Concentration | | | |
| • Adult resident | 6.2 E-5 | 4.0 E-6 | 6.6 E-5 |
| • Child resident | 6.2 E-6 | 4.7 E-7 | 6.7 E-6 |
| • Subsistence farmer | 3.5 E-5 | 9.3 E-6 | 5.1 E-5 |
| Grantsville | | | |
| • Adult resident | 1.7 E-5 | 2.2 E-6 | 1.9 E-5 |
| • Child resident | 1.7 E-6 | 2.5 E-7 | 2.0 E-6 |
| • Subsistence farmer | 1.0 E-5 | 5.0 E-6 | 1.5 E-5 |
| Seabase Prawn Farm | | | |
| • Subsistence fisher | 3.4 E-6 | 6.1 E-7 | 4.0 E-6 |

[a]Includes background contributions which are considered insignificant relative to OB/OD emissions.
[b]Primary direct pathway (inhalation) carcinogenic COPCs are cadmium and chromium associated with OD ejecta emissions.
[c]Primary indirect pathway carcinogenic COPC is RDX associated with OD emissions.
[d]Primary indirect exposure pathway of concern is the ingestion of root vegetables.

### 1.5.1 Data Evaluation Uncertainty

There is some uncertainty associated with the baseline sampling data which has been used to select COPCs and to provide contamination concentrations for soils and groundwater. These uncertainties are associated with sampling procedures, analytical procedures, and data quality.

The primary program objective of the OB/OD baseline site investigation has been to characterize average contamination levels in order to define a source term input for contamination migration modeling to assess potential offsite impacts. The sampling strategy for surface soils has been based on an adaptation of EPA soil screening guidance (U.S. EPA, April 1996) to TEAD. Commensurate with the goal of characterizing average contamination levels for migration modeling, composite surface soil samples were collected.

The number of composite surface soil samples (8) and specimens (6) per composite for each sampling/exposure zone were selected to be statistically significant based on the Soil Screening Guidance: User's Guide (U.S. EPA, April 1996) and Soil Screening Guidance: Technical Background Document (U.S. EPA, May 1996). This selection was based on a data quality objective for TEAD of a Type I error of 0.10 or less and a Type II error of 0.40. Therefore, based on the Soil Screening Guidance, the selection of eight composite samples (with six specimens per composite) corresponds with a Type I error of 0.06 and a Type II error of 0.40. A Type I error (as defined in the Soil Screening Guidance for the Max test) is the probability of incorrectly concluding that a screening health criterion has not been exceeded when the exposure area mean is actually twice the screening criterion. A Type II error is the probability of incorrectly concluding that a screening health criterion for a contaminant has been exceeded when actually the exposure area mean is only half of the screening level.

### 1.5.2 Toxicological Data and Models Uncertainty

In most risk assessments, one of the largest sources of uncertainty is health criteria values. The health criteria used for evaluating long-term exposures, such as reference doses or cancer slope factors, are based on concepts and assumptions that bias an evaluation in the direction of overestimation of health risk. The toxicological data that form the basis for all risk assessments contain uncertainty in the following areas:

- The extrapolation of nonthreshold (carcinogenic) effects from the high doses administered to laboratory animals to the low doses received under more common human exposure scenarios.
- The extrapolation of the results of laboratory animal studies to human or environmental receptors.
- The differences in uptake, metabolism, and organ distribution of chemicals, as well as species and strain differences in target site susceptibility.
- The interspecies variation in toxicological endpoints used in characterizing potential health effects resulting from exposure to a chemical.
- The variations in sensitivity among individuals of any particular species.

These uncertainties are compensated for by using 95 percent upper confidence limits (UCLs) or maximum likelihood estimates for cancer slope factors for carcinogens, and safety factors for reference doses for noncarcinogens. These adjustments are made to result in a rough but plausible estimate of the upper estimate of risk.

There is also a great deal of uncertainty in assessing the toxicity of a mixture of chemicals. Prediction of how these mixtures will interact at low concentrations in the environment must be based on an understanding of the mechanisms of such interactions. The interactions of the individual components of chemical mixtures may occur during absorption, distribution, metabolism, excretion, or activity at the receptor site. Individual compounds may interact chemically, yielding a new toxic component or causing a change in the biological availability of an existing component, or may interact by causing different effects at different receptor sites. Suitable data are not currently available to rigorously characterize the effects of chemical mixtures similar to those present at the site. Consequently, as recommended by EPA (USEPA, 1989), chemicals present at the site were assumed to act additively, and potential health risks were evaluated by summing excess lifetime cancer risks and calculating HIs for noncarcinogenic effects. This approach to assessing risk associated with mixtures of chemicals assumes that there are no synergistic or antagonistic interactions among the chemicals considered and that all chemicals have the same toxic end points and mechanisms of action. To the extent that these assumptions are incorrect, the actual risk could be under- or overestimated.

### 1.5.3 Exposure Assessment Uncertainty

There are several sources of uncertainty in the exposure assessment section of the risk assessment that should be recognized. These include the use of predicted concentrations through modeling, the selection of input parameters used to estimate doses, and other assumptions used in the exposure models.

The air pathway assessment and baseline risk assessment have been based on source scenarios that will overpredict potential impacts. The impacts associated with OD donor charges (which may typically represent about half of the total net explosives weight detonated) have been included in this risk assessment although the donor is RCRA exempt). Maximum OB/OD treatment amounts have been the basis for specifying these source scenarios. Averages for emission factors (based on BangBox tests for various munitions categories) have been used for inhalation exposures. However, the maximum of the average values for the OD ejector emissions rate is considered to be very conservative.

Environmental transport was predicted using screening models that are based on conservative assumptions. Thus, these models will overpredict potential OB/OD impacts. The air dispersion model used (i.e., OBODM) is considered to be a screening model. The OBODM results are significantly higher (e.g., order of magnitude) compared to the U.S. EPA INPUFF screening model that is frequently used for OB/OD assessments. Worst-case meteorological conditions have been identified and selected to evaluate atmospheric dispersion and transport short-term exposures. Long-term exposures were based on considering the maximum annual concentrations. In addition, the maximum concentration locations for OB/OD and SF were always conservatively assumed to occur at the same location. There is a great amount of uncertainty related to depositions velocities of contaminants from the air to the soil or to other receptor surfaces. For example, alternative deposition velocities of 0.001 m/sec. and 0.050 m/sec. were presented in Attachment 25 – OB/OD Air Modeling of the Permit. Furthermore, although deposition values were calculated and presented, predicted air concentrations did not account for depletion of the OB/OD cloud because of deposition. Similarly, the DOE model MEPAS used for evaluating surface and subsurface transport is a screening model based on conservative assumptions.

There are, however, uncertainties associated with the model regarding environmental transport. Uncertainty in the model output is due to the limitations in the mathematical and numerical codes used to represent the physical system. This includes uncertainty introduced by differences between the conceptual model and physical reality. Thus, the greatest uncertainty in the MEPAS lies in the equations that govern the model. Because the algorithms used by MEPAS to simulate environmental processes are standard transport and dispersion methods that are generally accepted, the uncertainty associated with these methods is well documented.

The parameter values used to describe the extent, frequency, and duration of exposure are associated with some uncertainty. Actual risks for certain individuals within an exposed population may vary from those predicted depending upon actual intake rates (e.g., ingestion rates), nutritional status, body weights, or other exposure factors. In general, the exposure assumptions were selected to produce a reasonable upper-bound estimate of exposure in accordance with EPA guidelines regarding evaluation of potential exposures at Superfund sites. Therefore, exposures and estimated potential risks for the vast majority of the population are likely to be overestimated.

The exposure parameters used for the soil ingestion pathway are associated with uncertainty. Current EPA guidance recommends default soil ingestion rates of 200 mg/day for child receptors, 100 mg/day for adult nonworkers (residents and trespassers), 50 mg/day for adult workers with noncontact exposure, and 480 mg/day for contact intensive workers. Some studies, such as Calabrese et al. (1990), have shown that the EPA default soil ingestion rate of 100 mg/day is likely to greatly overestimate adult exposures and risks.

Evaluation of the dermal exposure pathway is affected by uncertainties in exposure parameters specific to dermal contact. For example, there is uncertainty associated with the exposed skin surface areas used, since the choice of exposed body parts could slightly over- or underestimate risks. More significant uncertainties are associated with the selection and use of dermal absorption factors. Very limited information is available on dermal absorption of chemicals from contacted soil under realistic environmental conditions. In fact, there are no actual human epidemiological data to support the hypothesis that absorption of soil-bound chemicals under realistic exposure conditions is a complete route of exposure.

Uncertainty in risk characterization results primarily from assumptions made regarding additivity of effects from exposure to multiple compounds from various exposure routes. High uncertainty exists when summing cancer risks for several substances across different exposure pathways. This assumes that each substance has a similar effect and/or mode of action. Often compounds affect different organs, have different mechanisms of action, and differ in their fate in the body, so additivity may not be an appropriate assumption. However, the assumption of additivity is made to provide a conservative estimate of risk.

In addition, the risk characterization does not consider antagonistic or synergistic effects. Little or no information is available to determine the potential for antagonism or synergism for the COPCs. Therefore, this uncertainty cannot be discussed for its impact on the risk assessment, since it may either underestimate or overestimate potential human health risk.

## 3.0 RISK MANAGEMENT

Air dispersion modeling results (from Attachment 25 of the Permit) and risk assessment results (from this Attachment) have been used to identify risk management needs for OB/OD operations at TEAD. Table 3.0-1 lists the maximum allowable OB/OD Unit treatment quantities on an annual basis. These limits correspond to the source scenario treatment limits used as input to this risk assessment. In addition, OB/OD operations will be limited to the following meteorological conditions:

- Wind speeds of 3 mph (1.3 m/sec) to 20 mph (8.9 m/sec) with gusts of up to 30 mph (13.4 m/s).
- Unstable or neutral stability conditions.
- No significant precipitation.

Table 2.3.1-1

Table 2.7.1-1

Table 2.7.1-2

Table 2.8.1-1

Table 2.9-1

Additional risk management measures also may be warranted as discussed in Sections 3.1 - 3.3. Potential mitigation measures might include one or more of the following on an as-needed basis:

- More restrictive dispersion (i.e., wind speed and atmospheric stability) criteria for OB/OD operations.
- Wind direction (i.e., transport path) criteria for OD operations to limit the magnitude of offsite exposures.
- Constituent-specific waste treatment limits.
- More restrictive NEW treatment quantities.
- Use of a wetting agent on the OD soil cover prior to treatment to reduce OD ejecta emissions.

Risk management will be based on consideration of the following exposure categories:

- Ambient air quality
- Noncarcinogens
- Carcinogens

These risk management categories are discussed in Sections 3.1-3.3, respectively.

## 3.1 AMBIENT AIR QUALITY RISK MANAGEMENT

Dispersion modeling results indicate compliance with Utah and National Ambient Air Quality Standards (UAAQS, NAAQS) with the exception of PM-10 criteria. A summary of PM-10 modeling results is provided in Table 3.1-1. Open detonation ejecta is the primary source of PM-10 emissions from the OB/OD Unit.

The OD ejecta emission factors used for the air quality assessment are considered to be conservative and overestimate potential impacts. Available PM-10 data from the air monitoring station (part of the Utah monitoring network) in Grantsville do not indicate a PM-10 problem attributable to the TEAD OB/OD Unit as indicated in Table 3.1.2. However, TEAD will evaluate mitigating measures, as well as prepare and implement a risk management plan, if future PM-10 monitoring data indicate noncompliance attributed to the OB/OD Unit.

**Table 3.0-1. Summary of maximum allowable treatment quantities, scenarios, short tons NEW**

| Time period | *OB* | OD[a] | SF |
|---|---|---|---|
| 1 hr[b] | 5.0 | 7.125 | 4.5 |
| 3 hr | 10.0 | 14.25 | 9.0 |
| 8 hr | 10.0 | 14.25 | 9.0 |
| 24 hr | 10.0 | 14.25 | 9.0 |
| Quarterly | 400.0 | 570.0 | 360.0 |
| Annual | 1,200.0 | 1,710.0 | 1,080.0 |

[a]Includes donor charge quantities. A typical donor to waste NEW ratio is 1:1.
[b]TEAD only conducts one treatment event (i.e., only OB, OD, or SF, but not more than one) per hour. However, any treatment event may involve multiple pans (for OB), pits (for OD), or silos (for SF).

**Table 3.1-1. Summary of compliance with PM-10 ambient air quality standards (based on modeling future OB/OD operations)**

| | | **Maximum ambient concentration (($\mu g/m^3$)[a]** | | | **NAAQS/UAAQS ($\mu g/m^3$)** | |
|---|---|---|---|---|---|---|
| **Pollutant** | **Averaging time** | **Max. Conc. locations** | **Grantsville** | **Seabase Prawn Farm** | **Primary** | **Secondary** |
| **$PM_{10}$ (without background )** | **Annual**<br>**24 hr** | **68**<br>**4,790** | **36**<br>**719** | **17**<br>**287** | **50**<br>**150** | **50**<br>**150** |
| **$PM_{10}$ (with background )** | **Annual**<br>**24 hr** | **24**<br>**4,816** | **52**<br>**745** | **43**<br>**313** | **50**<br>**150** | **50**<br>**150** |

Sources: UDAQ, February 1998.
NA = Not available
— = Greater than ambient air quality standard.
[a] = OB + OD + OD ejecta + SF

**Table 3.1-2. Summary of PM 10 monitoring data, Grantsville, UT.**

| Year | Annual Mean | | 24-Hours | | |
|---|---|---|---|---|---|
| | Standard | Measured | Standard | Highest | Second Highest |
| 1994 | 50 $\mu g/m^3$ | 26 $\mu g/m^3$ | 150 $\mu g/m^3$ | 133 $\mu g/m^3$ | 98 $\mu g/m^3$ |
| 1993 | 50 $\mu g/m^3$ | 26 $\mu g/m^3$ | 150 $\mu g/m^3$ | 186 $\mu g/m^3$ [a] | 75 $\mu g/m^3$ |

[a]Attributed to exceptional events (e.g., road repair).

## 3.2 NONCARCINOGENS RISK MANAGEMENT

A summary of HI values applicable to noncarcinogen COPCs for short-term exposures (24 hours or less) is presented in Table 3.2-1 (based on data from Attachment 25 – OB/OD Air Modeling). Considering the target organs for each COPC the resulting organ-specific HI values are all less than 1.0. Therefore, it can be concluded that there are no short-term, noncarcinogenic COCs for the TEAD OB/OD Unit.

As discussed in Section 1.4.1 there are no noncarcinogenic chronic exposure COCs associated with the TEAD OB/OD Unit.

In summary, the proposed OB/OD treatment quantities and operational meteorological conditions will ensure protection of human health and the environment. Therefore, additional risk management measures are not warranted.

## 3.3 CARCINOGENS RISK MANAGEMENT

Cancer risks attributed to the TEAD OB/OD Unit are within the acceptability range of $10^{-6}$ to $10^{-4}$ as discussed in Section 1.4.2. The sources of OB/OD carcinogenic COPCs are identified in Table 3.3-1.

The OD ejecta potential source for arsenic, chromium and hexachlorobenzene are correlated with PM-10 OD ejecta emissions. As discussed Section 3.1 the potential for PM-10 may be overestimated based on available Grantsville monitoring data. However, PM-10 risk management measures (if necessary as discussed in Section 3.1) would also mitigate emissions of other OD ejecta constituents.

Cancer risk for OB/OD emission COPCs, (associated directly with the thermal treatment process) will be managed by limiting the treatment quantities of these waste constituents. These maximum treatment quantities are specified in Table 3.3-2 and are based on the values used as input for OB/OD air modeling (i.e., Attachment 16A) and for this risk assessment.

### Table 3.2-1. Summary of direct pathway (inhalation) COPCs (24-hrs or less)

| | COPC | | | | |
|---|---|---|---|---|---|
| Target Organ | Aluminum (HQ = 1.2 E-1) | Barium (HQ = 1.9 E-1) | Hexachlorobenzene (HQ = 4.1 E-1) | RDX (HQ = 4.0 E-1) | HI |
| Cardiovascular | | X | | | 1.9 E-1 |
| Central nervous system | | | X | X | 8.7 E-1 |
| Gastrointestinal | | X | | | 1.9 E-1 |
| Liver | | | | | 4.6 E-1 |
| Lungs, respiratory | X | | | | 1.2 E-1 |
| Skin | | | | | 4.1 E-1 |
| Thyroid | | | | | 4.1 E-1 |

### Table 3.3-1. Source of OB/OD carcinogenic COPCs

| COPC | OB Emissions | OD Emissions | OD Ejecta | SF Emissions |
|---|---|---|---|---|
| Arsenic | | | X | |
| Cadmium | | X | | |
| Chromium, | X | X | X | X |
| Hexachlorobenzene | | | X | |
| RDX | | X | | |

### Table 3.3-2. Carcinogenic COPC maximum treatment quantities

| COPC | Maximum Annual OB/OD Treatment Quantity (lbs) |
|---|---|
| Cadmium | 2,240[a] |
| Chromium | 360[a] |
| RDX | 3,420,000[b] |

[a]Based on a OB/OD treatment emission factor of 1.0 (lb/lb).
[b]Based on OD treatment quantity evaluated in the risk assessment.

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# APPENDICES