HARGIS + ASSOCIATES, INC.

FORMER BENZENE STORAGE TANK

CONCEPTUAL SITE MODEL

HENDERSON, NEVADA

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ACRONYMS AND ABBREVIATIONS

1,2-DCB	1,2-dichlorobenzene
1,4-DCB	1,4-dichlorobenzene
atm-m^3/mole	atmospheres-cubic meters per mole
bgs	below ground surface
bls	below land surface
BMI	Black Mountain Industrial Complex
CPA	Closed Ponds Area
CSM	Conceptual Site Model
ECA	Environmental Conditions Assessment
EPA	U.S. Environmental Protection Agency
ET	Earth Tech
FBT	Former Benzene Storage Tank
f_{oc}	fraction organic carbon
FPS	Former Plant Site
FTF	Former Tank Farm
H+A	Hargis + Associates, Inc.
HLA	Harding Lawson Associates, Inc.
K_H	Henry's Law Constant
K_{ow}	octanol-water coefficient
LOU	Letter of Understanding
md	millidarcies
mg/kg	milligrams per kilogram
mg/l	milligrams per liter
Montrose	Montrose Chemical Corporation of California
msl	mean sea level
NAPL	non-aqueous phase liquid
NDEP	Nevada Division of Environmental Protection
NFA	no further action
PRG	Preliminary Remediation Goal
Qal	Quaternary alluvium

ACRONYMS AND ABBREVIATIONS (continued)

RAS	Remedial Alternatives Study
SAPs	sampling and analysis plans
SGIWP	Supplemental Groundwater Investigation Workplan
SRCs	site-related chemicals
SSIWP	Supplemental Soil Investigation Workplan
UMCf	fine-grained Upper Muddy Creek Formation
USGS	U.S. Geological Survey
UST	underground storage tank
VOCs	volatile organic compounds
xMCf	transitional UMCf

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1.0 INTRODUCTION

On behalf of the Montrose Chemical Corporation of California (Montrose), Hargis + Associates, Inc. (H+A) is submitting this source area-specific Conceptual Site Model (CSM) for the Montrose Former Benzene Storage Tank (FBT) Area, located on what is known as "Parcel C" of the former Montrose leased properties within the Black Mountain Industrial Complex (BMI) in Henderson, Nevada (Figure 1). Previously, Remedial Alternative Study (RAS) workplans for the Montrose site assessment areas including the FBT Area, the Montrose Former Tank Farm (FTF), the Former Plant Site (FPS) and the Closed Ponds Area (CPA) were requested by the Nevada Division of Environmental Protection (NDEP) in a letter to Mr. Joe Kelly dated January 29, 2008 (NDEP, 2008a). The work plans were requested as deliverables under the existing Phase II Administrative Order on Consent (NDEP, 1996a and 1996b).

Subsequent to that letter, Draft RAS work plans for the FBT, FTF and FPS were submitted by Hargis & Associates to NDEP on April 11, 2008 and for the CPA by GeoSyntec also on April 11, 2008. NDEP provided comments to the April 11 FBT, FTF, and FPS submittals in a letter dated June 30, 2008. Correspondence for the CPA was handled separately. NDEP's June 30, 2008 letter did not require revision of the draft work plans, but rather requested that source area-specific CSMs and sampling and analysis plans (SAPs) be prepared for the source areas as the first step in the RAS process. Subsequent to discussions on the RAS process and a meeting on September 3, 2008, NDEP provided a RAS Process Document that specified the format and content for source area-specific CSMs and SAPs identified as Deliverable Number 3 of the Process Document (NDEP, 2008c).

The FBT site assessment area is located approximately 1,800 feet northwest of the Former Plant Site with the only nearby facilities currently being railroad tracks (Figure 2). Potential sources in the FBT area include the former railcar loading station and the former above-ground benzene storage tank. The former rail car loading station and the former benzene storage tank are designated as LOU items 3 and 21 in the August 15, 1994 NDEP Phase II Letter of Understanding, respectively (NDEP, 1994).

1.1 OBJECTIVE

The objective of this report is to develop a preliminary source area-specific CSM from existing information to support development of the RAS document and as partial fulfillment of Deliverable Number 3 of the RAS Process document (NDEP, 2008c). The source area-specific CSM will be used to:

- formulate remedial alternatives for each source area, and
- identify data gaps for preliminary screening of alternatives against the primary criteria of effectiveness, implementability, and cost.

A proposed path forward for the FBT area is discussed in Section 4.0 of this report. After NDEP has completed a review of this document and upon further discussion, if necessary, a letter workplan/SAP detailing the methods and procedures to be used during implementation of the path forward will be submitted to NDEP under separate cover.

2.0 SOURCE AREA-SPECIFIC CSM

2.1 SITE HISTORY

Montrose manufactured organic chemicals including chlorobenzene, polychlorinated benzenes, chloral, and 4,4'-dichlorobenzil at the facility from 1947 until 1983. Montrose ceased operations at the organic chemical plant in 1983 and subsequently demolished the plant in 1984 (Converse, 1993).

The former benzene storage tank was a 540,000-gallon steel above-ground storage tank used to store benzene for use in the manufacturing processes at the former Montrose site. The tank was situated on a concrete pad surrounded on three sides by berms and site records indicate it was only used for benzene storage. According to Montrose documents, the benzene storage tank was removed from service in 1981 and dismantled between 1984 and 1988. The concrete pad is still present and was found to be in good condition during a FBT area site inspection in October 1991 for the Phase I Environmental Conditions Assessment (ECA) Report (Converse, 1993). There is no documentation of any leaks or releases from the tank in the historical Montrose records.

The railcar loading station was located along the southeast side of the tank. The Phase I ECA Report indicates that a benzene release from a railcar loading incident in June 1966 may have occurred near the FBT area (Converse, 1993). However, the historical document describing this incident focused on the actions taken to prevent a reoccurrence and did document the volume released or the steps taken to clean up the spill. No further information is available regarding this incident.

2.2 PHYSICAL SETTING

The FBT area is located in Township 21 South (T21S), Range 62 East (R62E), approximately 12 miles southeast of Las Vegas within an unincorporated area of Clark County (Figures 1 and 2). The FBT area is approximately one acre in size.

The Las Vegas-Henderson area climate is arid (Malmberg, 1965). Daytime high temperatures in the summer are extreme and are often above 100 degree Fahrenheit (°F). Winters are considered mild. Average annual temperatures range from a high of approximately 80°F to a low of approximately 56°F (National Oceanic & Atmospheric Administration, 2007). Precipitation averages slightly less than 4.5 inches per year. In general, precipitation occurs during the winter months of December through March, and during the summer months of July through September. Winter storms are characterized as being sustained and of low intensity. Summer storms often occur as thunderstorms of high intensity and brief duration causing significant surface overland flow. Potential evapotranspiration is significantly greater than average precipitation, ranging from approximately 60 to 82 inches annually (Southern Nevada Water Authority, 1996).

The FBT area is located on alluvial fan deposits derived principally from the McCullough Range to the south. As such, natural land surface elevations in the area slope significantly from the south to the north. The land surface elevation in the vicinity of the FBT area is approximately 1,796 feet above mean sea level (msl) (U.S. Geological Survey [USGS], 1983). Land surface slopes at an average gradient of approximately 0.02. Land surfaces have been altered in the vicinity of the FBT area to accommodate historic operations and processes, provide secondary containment for the former benzene storage tank and stormwater control.

There are no naturally occurring, perennial surface water bodies located in the vicinity of the FBT area. Surface water is occasionally present as stormwater runoff during and after precipitation events. The majority of the FBT area is unpaved and sparsely vegetated. Ground surface features that reduce the infiltration of surface water and divert water to natural and anthropogenic drainage features include paved areas and the FBT cement footing that remains at the site. Surface water runoff in the immediate vicinity of the FBT is controlled the remnants of the berm that served as secondary containment for the former tank. Surface water in the remainder of the area is controlled by the current site drainage features.

2.2.1 Regional Geology and Hydrogeology

The FBT site assessment area is located in the Las Vegas Valley. The Las Vegas Valley is a northwest-southeast trending structural trough located within the Basin and Range physiographic province (Malmberg, 1965; Plume 1989). The Basin and Range province is characterized by uplifted fault-blocks forming the surrounding mountain ranges, alternating with down-dropped blocks forming sediment-filled valleys.

The mountain ranges bounding Las Vegas Valley in the study area include Frenchman Mountain to the northeast, which is comprised of Paleozoic and Mesozoic sedimentary rocks (limestone, dolomite, sandstone, and siltstone), and the McCullough Range to the south, which is comprised of Tertiary volcanic rocks (basaltic and andesitic lava flows, flow breccia, and ash-flow tuff). Further to the west and east, the Las Vegas Valley is bounded by the Spring Mountains and Sunrise Mountains, respectively. The Las Vegas Valley, which locally contains up to 13,000 feet of Tertiary and Quaternary basin-fill sediments and volcanic flows and deposits, is interpreted to have largely formed through right-lateral movement along the Las Vegas Shear zone (located approximately four miles north of the Site) (USGS, 2005).

The valley-fill sediments in Las Vegas Valley consist of Miocene to Pliocene Muddy Creek Formation and younger sediments (Plume, 1989). The valley fill is reported to be several thousand feet in thickness and comprise the primary water-bearing zones in Las Vegas Valley. In general, the primary source of potable water is within coarse-grained deposits which comprise the “deep aquifer” or “principal aquifer” generally from 300 to 2,000 feet below ground surface (bgs). However, in the central and eastern parts of Las Vegas Valley, clays and silts predominate in lieu of the transmissive coarse-grained deposits (Plume, 1989). Where present, the deep aquifer is overlain and confined by a regional aquitard which is several hundred feet thick. Groundwater which is often present within the upper portion of the regional aquitard or overlying alluvium (i.e, upper thirty feet of saturated sediments) comprises the “shallow aquifer”, and is not considered a source of potable water in Las Vegas Valley. In most areas of Las Vegas Valley, water quality of the shallow aquifer exceeds standards for potable water due to elevated concentrations of total dissolved solids which exceed 1,000 milligrams per liter (mg/l) (Plume, 1989; Las Vegas Valley Water District, 1991).

In general, the valley fill within the east and southeast parts of Las Vegas Valley (vicinity of the BST assessment area) is comprised of predominantly fine-grained deposits interbedded with thin intervals of coarse-grained and heterogeneous deposits that are not laterally continuous (Plume, 1989); the exception being where near surface coarse-grained deposits are present along the Valley margins. The aggregate thickness of these fine-grained deposits is reported to be at least 500 feet in the vicinity of the study area (Plume, 1989).

2.2.2 Vadose Zone/Soil

Lithologic data from borings and monitor wells completed in the vicinity of the FBT assessment area indicate that the vadose zone consists predominantly of the coarse-grained Quaternary alluvium (Qal) sediments from land surface to approximately 30 to 60 feet bgs. This zone is underlain by a sequence of fine-grained sediments, which corresponds to either a transition zone between the Qal deposits or the Muddy Creek Formation (UMCf).

Based on physical samples analyzed as part of pilot testing activities for the Montrose Former Plant Site SVE system located within approximately 1,800 feet of the BST area, significant differences in measured permeabilities exist between the coarse-grained and fine-grained sediments. Measured horizontal and vertical permeabilities for the coarse-grained, upper vadose zone materials are reported to be 862 and 432 millidarcies (md), respectively (Earth Tech [ET], 2005). Measured horizontal and vertical permeabilities for the underlying fine-grained materials are reported to be 30.6 and 5.89 md, respectively. These measurements illustrate the differences in permeability between the two vadose zone lithologies.

In the FBT area, the thickness of the vadose zone, based on water level measurements collected in alluvial aquifer monitor wells in the vicinity of the FBT area during the period 2006 through 2008, ranges from approximately 47 to 55 feet. Lithologic logs of soil borings constructed in the FBT area indicate that the soils of the vadose zone are comprised of well graded sand and silty sand of the Qal to approximately 46 feet and clayey silt of the transitional UMCf (xMCf) or UMCf to 50 feet.

2.3 EXTENT OF SOIL CONTAMINATION

This section summarizes the nature and extent of Site Related Compounds (SRCs) in soil in the FBT area. Based on the site history for the FBT assessment area, the results of previous investigations and agreement with NDEP, the soil samples collected in this assessment area were analyzed only for VOCs and the only compounds commonly detected were benzene and MCB (ET, 2005a) (Tables 1 through 4) based on validated data. The location of this site assessment area, remote from other plant processes and the exclusive use of Parcel C for benzene storage, precludes the possibility of contamination by other Montrose operations.

Data available from past investigations in the vicinity of this assessment area include soil investigation results from the mid 1990's Phase II ECI program as well as the 2005 and 2006 field investigations conducted under Supplemental Soil Investigation Workplan (SSIWP) (H+A, 2005).

The details of the Phase II ECI investigation for the FBT area are presented in the Draft Phase II Environmental Investigation Report (SECOR, 1997). A total of four shallow soil borings were drilled to a depth of six feet below land surface (bls) around the perimeter of the existing storage tank pad, borings FBT-1 and FBT-2, and at the Former Railcar Loading Station, borings RCL-1 and RCL-2. Soil samples were collected at six feet bls from each boring and analyzed for VOCs. The locations and associated data are depicted on Figure 3. No odors, soil discoloration, or elevated headspace concentrations were reported to be observed in the samples (SECOR, 1997). Benzene was detected in one sample obtained at a concentration of 0.0059 milligrams per kilogram (mg/kg) and chlorobenzene was detected at concentrations of 0.0061 and 0.011 mg/kg (Tables 1 through 4and Figure 4). No VOCs were detected at concentrations exceeding their respective EPA Preliminary Remediation Goal (PRG) reference concentrations.

As part of the Supplemental Soil Investigation program, one deep soil boring was constructed and soil samples were collected. This boring was to explore the possibility of soil contamination at depths deeper than explored during the Phase II ECI investigation. The results of this work

are summarized here and are presented in the Site-Wide CSM (H+A, 2007b). To address the possibility of undocumented leakage at the tank and/or spills at the railcar unloading facility, the soil boring was located as close as practicable to the existing concrete tank pad on the southeast side. This location formerly faced the railcar loading station and is presumably the location of the tank inlet piping and connections. Soil samples were collected at 10, 20, 30, 40, and 50 feet bls and were analyzed for volatile organic compounds (VOCs) using U.S. Environmental Protection Agency (EPA) Method 8260B.

Per the results of the soil analyses, benzene was detected in all soil samples at low concentrations not exceeding the EPA PRG of 1.41 mg/kg. Concentrations ranged from 0.0045 to 0.025 mg/kg as shown on Tables 1 through 4 and in Figure 4 Several other VOCs including 1,2,3-Trichlorobenzene, 1,2-Dichlorobenzene (1,2-DCB), 1,2-Dichloroethane, 1,3- and 1,4-dichlorobenzene (1,4-DCB), chlorobenzene and chloroform were also detected at low concentrations not exceeding their respective PRG (Tables 1 through 4).

Most of the compounds were detected in the deepest sample (50 feet bls) near the groundwater table indicating that these compounds may be related to groundwater contamination and are not related to a surface release at the FBT. The FBT area is directly downgradient of an underground storage tank (UST) release of benzene that reportedly occurred in 1976. The release was reported to be approximately 30,000 gallons (Converse, 1993). Extensive groundwater monitoring conducted during the investigation of that release indicated that free product was originally observed in several wells in the vicinity of the FBT. In addition, groundwater sampling conducted as part of the Supplemental Groundwater Investigation program and reported in the Site-Wide CSM indicate high concentrations of benzene exist in groundwater both upgradient and down gradient of the FBT assessment area (Figure 5).

In summary, the combination of the soils sampling and groundwater analytical data indicate that the FBT assessment area is not a source of VOCs. The soil samples collected in the FBT area, particularly those close to the capillary fringe of the groundwater table, likely reflect benzene concentrations from the UST release rather than from historic operations at the FBT assessment area.

2.4 ESTIMATED VOLUME OF CONTAMINATED SOIL

Based on the available information on the FBT area operations, the results of soil investigations and the documentation of groundwater impacts from other sources areas, it can be clearly concluded there are no soils in the FBT area that are contaminated with VOCs at concentrations that exceed the PRGs. Therefore, at a meeting with NDEP on September 3, 2007, Montrose expressed interest in seeking a No Further Action (NFA) decision on the FBT area during the RAS. However, NDEP felt that additional characterization of the deeper soils at the FBT area is necessary before proceeding with an NFA procedure since only one deep boring had been constructed in the area and that boring (FBT-3D) had been located between the former tank and the rail car loading area and not topographically downgradient of the area most likely to be contaminated if the former tank had leaked or a spill had occurred during railcar off-loading. This uncertainty has been identified as a data gap and is further addressed in Section 4.0.

3.0 CONTAMINANT FATE AND TRANSPORT

Although data collected to date at the FBT assessment area indicate that soils do not contain SRCs at concentrations greater than EPA PRGs, a brief summary of contaminant fate and transport is provided in this section for completeness and to be consistent with Deliverable Number 3 of the NDEPs RAS Process Document. Therefore, this section provides a summary of contaminant fate and transport mechanism for the vadose zone soils in the FBT area, including:

- Potential release mechanisms for each source;
- Environmental media (primary and secondary) that may have been impacted;
- Exposure points, and
- Potential receptors.

This information is a summary of the pertinent portions of the Fate and Transport sections of the Site-Wide CSM and focuses primarily on VOCs in soil, primarily deep soil (soil from 1 foot below ground surface to the water table) and secondarily on the potential for soil VOC contamination to impact air. Surface soils and groundwater are being dealt with as Site-Wide issues dealt with in detail in other RAS deliverables.

3.1 RELEASE MECHANISMS/TRANSPORT PATHWAYS

Potential release mechanisms at the FBT Area could include spills of benzene during deliveries or loading of benzene to/from the former benzene storage tank at the Rail Car Loading Station, accidental spills of benzene during delivery of benzene to the manufacturing process or leaks from the former benzene storage tank. As indicated previously, one spill was reported at the Rail Car Loading Station, but no information is available regarding the size of the spill. There are no records of spills or leaks from the former benzene storage tank and the tank was reported to be in good condition when decommissioned.

Potential contaminant transport pathways within the FBT area include air, soil, surface water and groundwater. Each pathway and potential transport mechanism is discussed in the

following sections except groundwater. While groundwater contamination is present at the BST assessment area, it is related to another source area and therefore the groundwater fate and transport will be addressed in the Site-Wide Groundwater RAS process to be submitted separately.

3.1.1 Air Pathway

Contaminant transport can occur through the air pathway via two mechanisms: 1) windborne particulates, and 2) volatilization of contaminants into ambient air. Windborne particulate transport can occur when contaminated surface soils are present and particulates are mobilized and carried by wind. This pathway and mechanism can also transport contaminants from subsurface soils if they are excavated or grading exposes them to the effects of wind. The second mechanism by which contaminants can be transported via the air pathway is the migration of volatile compounds through soil pore space.

Surface soil samples and shallow soil samples (less than approximately one foot bgs) have been collected from shallow soil borings at the FBT area. The samples have been analyzed for VOCs based on the facility location and date of sampling (H+A, 2005a; PES, 2007a and 2007b).

The second mechanism via the air pathway is the migration of volatile compounds through soil pore space. These vapors can migrate into the atmosphere or can be transported deeper into the ground and potentially impact groundwater, depending primarily on volatility of the compound, and also on molecular weight, the carbon content (fraction organic carbon [f_{oc}]) and physical properties of the soil matrix (porosity, grain size distribution, and moisture content) and temperature gradients.

The volatility of a chemical compound increases as its vapor pressure increases. Vapor pressures greater than 1 mm of mercury are considered highly volatile, vapor pressures in the range of 0.001 to 0.1 mm of mercury are considered semi-volatile and vapor pressures less than 0.001 mm of mercury are non-volatile under normal conditions. Due to the high summer temperatures at the Site, the volatile and semi-volatile compounds in the surface or near surface are susceptible to being volatized and released to the atmosphere. This process of near

surface volatilization is probably complete because the operations that may have resulted in the release of SRCs to the subsurface ceased over 20 years ago and concentrations of the SRCs in soil in the FBT area are very low (all less than 0.025 mg/kg (Tables 1 through 4)).

VOCs dissolved in soil moisture and groundwater can also volatilize and be released to the atmosphere via soil gas respiration. The potential for these compounds to volatilize from the vadose zone soil moisture and groundwater is defined by the Henry's Law Constant (K_H) for that compound. K_H provides a measure of the extent of chemical partitioning between air and water at equilibrium. The higher the K_H the more likely a chemical is to volatilize than to remain in water. A K_H exceeding 10^{-3} atmospheres-cubic meters per mole (atm-m^3/mole) indicates a compound that is readily volatilized from a dilute aqueous solution. Compounds that have a K_H of less than 10^{-7} atm-m^3/mol are considered to have a low volatility.

The potential volatility of the SRCs range from volatile to highly volatile based on their vapor pressure and K_H (H+A, 2007b). These data indicate that the SRCs benzene, chlorobenzene, 1,2-DCB and 1,4-DCB, 1,2,4-trichlorobenzene, and chloroform are volatile and that there is a potential for these compounds to be transported as vapor to the atmosphere.

Soil sampling indicate that volatilization and transport of contaminants in air from the shallow soil and/or groundwater, although possible, is not likely a significant transport pathway at the site as shallow soil sampling results do not indicate significant concentrations of VOCs in the shallow soil (H+A, 2007b). In addition, air monitoring has been performed at the former Montrose and Stauffer facilities. Breathing space air monitoring during drilling activities and groundwater sampling activities conducted at the site have not detected significant concentrations of volatile compounds (H+A, 2006, Appendix B).

3.1.2 Soil Pathway

Contaminants may be transported in soil by several mechanisms including vapor transport, dissolved-phase transport in soil moisture, and non-aqueous phase liquid (NAPL) migration to groundwater. A detailed discussion of these transport mechanisms and the factors that effect the transport and fate of VOCs (the primary SRCs in the FBT assessment area) in soil are presented in the Site Wide CSM section 5.2. The information is not reiterated in this document

because the concentrations of VOCs detected in the soils in the FBT Area are very low and it is unlikely that soil in the FBT Area is a potential source of the SRCs to groundwater.

In addition to vapor transport and migration via infiltration, contaminants can also be transported in soil via NAPL migration. A detailed discussion of NAPL transport is provided in the Site-Wide CSM (H+A, 2007b). However, the data collected to date in the FBT area indicate that concentrations of VOCs in soil are extremely low and no evidence of NAPL has been reported.

3.1.3 Surface Water and Sediment Pathway

Contaminants spilled during delivery from the Rail Car Loading Station or from potential undocumented spills and leaks at the former benzene storage tank could also have been transported via surface water runoff during precipitation events. Contaminants can be transported as dissolved phase in the surface water runoff or adsorbed onto the sediment load in the runoff. Soluble contaminants can be dissolved and transported across the land surface and/or infiltrate into the subsurface, contaminating the vadose zone and potentially migrating to the groundwater. Surface water can also concentrate and deposit-dissolved contaminants through evaporation when runoff pools in topographic low areas after precipitation events.

3.1.4 Transport of Site-Related Chemicals with Surface Water Runoff

SRCs were conveyed off of the former facilities historically in a series of unlined ditches (Weston, 1993). Soil sampling indicates that detectable concentrations of pesticides and benzene compounds were found in the vicinity of the ditches as a result of historical wastewater disposal and stormwater management. In December 1976, the BMI Complex became a “zero discharge” industrial effluent facility under National Pollutant Discharge Elimination System resulting in the discontinuance of the use of the ditch conveyances (Section 2.1.7). Stormwater originating upgradient of the Pioneer property is diverted around the former facilities and onsite stormwater is collected and conveyed to onsite ponds.

3.2 EXPOSURE PATHWAYS AND POTENTIAL RECEPTORS

Previous sections of this document have described the nature and extent of chemicals within the site area, along with potential transport mechanisms that could disperse chemicals to other media or locations. This section builds upon that analysis to provide a summary of the human and ecological receptors that could be exposed to the SRCs and the routes by which exposures could occur. The synthesis of this collective information is referred to as an exposure pathway.

EPA (1989) has defined the four elements that must exist for an exposure pathway to be considered complete:

- A source and mechanism of chemical release;
- A retention or transport media;
- A point of potential contact by receptors, and
- An exposure route at the contact point.

If any one of these elements is missing, then the exposure pathway is considered incomplete. For example, if human activity patterns and/or the location of potentially exposed individuals prevent contact with the impacted media, then no completed pathways can exist.

This section focuses on the potential contact points and related exposure routes that are relevant for the sources and transport mechanisms previously discussed. Site-specific soils in the FBT area contain SRCs and are considered here. Additionally, air, which can contain SRCs as a result of dust generation or volatilization, also is considered. Potentially complete exposure pathways associated with these media are discussed.

Surface water onsite is not considered a potential contact point or exposure route since no permanent surface water bodies exist onsite. Exposure to chemicals in downgradient groundwater has been described in the Site-Wide CSM and will be dealt with in the Site-Wide Groundwater RAS documents and is not discussed here.

In some cases, an exposure pathway may be complete but is not significant because: 1) the exposure may be less than that from another pathway involving the same medium at the same exposure point; 2) the magnitude of exposure has low toxicological significance, and/or 3) the probability of exposure is low and potential risks associated with the pathway are not high (EPA, 1989). Exposure pathways that are potentially complete but are considered insignificant will be discussed as "minor" routes to differentiate them from the "primary" exposures pathways identified for the Site.

The remainder of this section first describes the human receptor populations and their related exposure pathways, followed by a discussion of the ecological receptors and pathways.

3.2.1 Human Receptors and Exposure Pathways

The land use within the FBT area has historically been industrial/commercial. As such, worker populations were considered in the exposure pathway analysis. It was assumed that the current land use within the FBT area would remain the same in the future.

3.2.2 Worker Exposure Pathways

For the industrial/commercial workers at the FBT area and adjacent areas within the Site, a total of four exposure scenarios have been identified:

- Indoor workers who spend the majority of their work day indoors;
- Outdoor workers who spend the majority of their work day outside;
- Construction workers who are assumed to contact shallow and subsurface soils, and
- Maintenance workers at the groundwater treatment system could potentially contact pumped groundwater.

For indoor workers, the primary exposure media is indoor air. The inhalation exposure route could result from release of volatile SRCs from soils. Volatile chemicals released from soil could be transported through ambient air and infiltrate into indoor air. Volatile chemicals in

subsurface soils could migrate through the vadose zone and infiltrate indoor air through the building foundation. However, as indicated above, the concentrations of SRCs in soil in the FBT assessment area are very low and there are no buildings on or within several hundred feet of the FBT assessment area. Thus exposure via the indoor air route is not likely. Fugitive dusts generated from wind erosion or soils handling activities could also be transported via ambient air and ultimately infiltrate indoor air. Exposure pathways associated with outdoor soil contact also could occur, though it is expected that contact with outdoor soils would be minor because workers in this scenario are assumed to spend the majority of their workday indoors.

The outdoor worker scenario is designed to represent employees of commercial or industrial facilities within the study area who spend the majority of their workday outdoors. Consequently, pathways related to indoor air exposures are considered incomplete for outdoor workers. The primary exposure media for outdoor workers are soils and ambient air. Two potentially complete exposure pathways from direct contact with soils are incidental ingestion, and dermal contact. These direct contact pathways are assumed to be limited to surface soils. Outdoor workers could potentially be indirectly exposed to SRCs in soils via the inhalation route through fugitive dusts or volatile chemicals released into ambient air.

The construction worker scenario reflects temporary activities that could occur within the study area. The construction worker is assumed to be exposed to surface soils. In addition, it is assumed that the worker will be exposed to deep subsurface soils that may be exposed as part of excavation activities occurring at the Site. For this receptor, potentially completed pathways resulting from direct contact with soils are incidental ingestion and dermal contact. In addition, construction workers could potentially be exposed to SRCs in soil via the inhalation route through volatilization and from fugitive dusts released to ambient air through wind erosion or soils handling. Again, the data collected to date indicate that the concentrations of SRCs in the soils in the FBT assessment area are below the EPA PRGs and thus it is unlikely that construction workers would be exposed to SRCs in this area.

3.2.3 Residential Exposure Pathways

Non-occupational exposures in the study area can occur onsite as a result of trespassing or off-site in the adjacent residential areas. The trespasser scenario is assumed to involve adolescent and teenage children from the nearby residential areas. The potential exposures associated with trespassing onsite would be infrequent and for a shorter duration than the assumed residential exposures. Potential direct contact with soil by trespassers could result in exposures through the incidental ingestion and dermal contact pathways. Inhalation exposures to chemicals in soils could occur via releases from wind erosion and soils handling, and from volatilization.

All other residential scenarios are assumed to take place in the off-site portions of the CSM study area. Fugitive dusts and volatiles released from onsite soils and transported to off-site residential areas via ambient air could result in potentially completed inhalation exposure pathways. Impacted groundwater could also contribute to potential exposure for the residential scenario through the inhalation route.

Residents also could be exposed to chemicals in offsite soils that have been transported from the site, such as dust transport. Exposures could occur via incidental ingestion or dermal contact. Again, based on the data collected to date the soils in the FBT assessment area do not contain concentrations of SRCs greater than the EPA PRGs.

3.3 ECOLOGICAL RECEPTORS AND PATHWAYS

Ecological receptors and pathways are not considered relevant to the FBT assessment area. By agreement with NDEP, potential ecological receptors and exposure pathways can only occur in the downgradient area and through exposure to groundwater. Groundwater pathways have been described and discussed in the Site-Wide CSM (H+A, 2007b) and will be dealt with in the Site-Wide Groundwater RAS documents.

4.0 PATH FORWARD

In general, the progression of activities anticipated for the BST site assessment area is to first gather additional soil contaminant data, conduct a Data Useability evaluation of the total data set relevant to the BST area, then discuss with NDEP if either a risk assessment is necessary of it is more pragmatic for Montrose to simply seek an NFA for the two LOU items associated with this area. Montrose will submit a letter work plan/SAP to construct one boring and collect sub-surface soil samples in the FBT area located within the secondary containment berm at the point most likely for a spill to collect (i.e. the lowest point within the bermed area). The boring location will be selected based on a field survey using topographic data or using a hand level to locate the lowest elevation point north (down natural topographic gradient) of the former benzene tank within the berm.

The soil boring will be installed using the rotosonic method of drilling to obtain core for inspection and sampling. Soil samples will be collected at the same intervals as used in the previous investigation for deep boring (FBT-3D), approximately 10, 20, 30, 40, and 50 feet bls or immediately above the groundwater surface. Sampling protocols are described in the Field Sampling and Standard Operating Procedures (H+A, 2007a). The soil samples will be analyzed for VOCs by EPA Method 8260B.

Once the analytical reports are completed for samples collected from the boring, the analytical results will be validated. The validated data from the boring and the soil analytical data previously collected in the FBT area that has been evaluated deemed appropriate as part of the Data Usability study that will be conducted as Deliverable Number 2 of the RAS Process (NDEP, 2008c) The validated data set will be either be used support a risk assessment for the FBT area or Montrose may seek an NFA decision for the two LOUs in this site assessment area.

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