THE RIVERFRONT SITE
NEW HAVEN, FRANKLIN COUNTY, MISSOURI

CERCLIS ID: MOD981720246

Baseline Risk Assessment
Operable Unit 3 (OU3) – The Old City Dump

Prepared for the Superfund Division
U.S. Environmental Protection Agency, Region VII

Prepared by:

Missouri Department of Health and Senior Services
Section for Environmental Public Health
930 Wildwood Drive, P.O. Box 570
Jefferson City, Missouri 65102

January 2003

THE RIVERFRONT SITE
NEW HAVEN, FRANKLIN COUNTY, MISSOURI

Operable Unit 3 – The Old City Dump Baseline Risk Assessment

Table of Contents

List of Tables and Figures

Appendices

Baseline Risk Assessment
Operable Unit 3 – The Old City Dump
The Riverfront Site, New Haven, Franklin County, Missouri

1.0 INTRODUCTION

1.1 Overview

The U.S. Environmental Protection Agency (EPA) requested that the Missouri Department of Health and Senior Services (MDHSS) perform a risk assessment of the Riverfront Superfund Site, New Haven, Missouri. The Riverfront Site has been found to be contaminated with tetrachloroethene (PCE) and other volatile organic compounds (VOCs). As PCE was found to have affected the town's public water supply, the site was added to the National Priorities List in December 2000. In order to better manage response actions for the Riverfront Site, which encompasses multiple contaminant source locations across the New Haven area and is influenced by a diverse and dynamic hydrogeology, EPA has delineated a number of sub-areas or "Operable Units," that allow a focused analysis of localized contaminated media and exposure pathways. This MDHSS risk assessment addresses one of these sub-areas of the Riverfront Site – the Old City Dump Operable Unit (OU3). Presented in Figures 1 and 2 are maps developed by the U.S. Geological Survey (USGS) depicting the location of New Haven, Missouri, and the relative location of OU3 within the city limits.

This assessment is based on sampling results obtained during investigations conducted by the USGS, the principle investigator for the Expanded Site Investigation/Remedial Investigation (ESI/RI, 2001) and Remedial Investigation (RI, 2002) of the Riverfront Site. USGS's objective has been to characterize the extent and magnitude of contamination at each of the Riverfront operable units. MDHSS was provided with the laboratory sampling results collected from the Riverfront Site and in the vicinity of OU3. This assessment will evaluate risks that may result from human exposure to contaminated groundwater.

1.2 Riverfront Site

Missouri Department of Natural Resources (MDNR) investigations at this site began in 1986 when PCE was detected in the two New Haven public water supply wells at levels exceeding EPA's Maximum Contaminant Level (MCL) for PCE of 5 micrograms per liter (μg/L). One of the wells (W1) was removed from service within the next few years due to other water quality problems. The other well (W2), however, was removed from service in 1993 when PCE concentrations were detected at 140 μg/L. Installation of two additional public water supply wells has reduced the potential for human exposure to PCE in the New Haven area. However, subsequent investigations by EPA, USGS, and MDNR have identified multiple locations of solvent disposal in the area. These investigations also have established that contaminants have migrated through soils and groundwater beyond the initial source areas, creating additional potential for human exposure.

1.3 OU3 Site Background

During the period of the mid-1950s through the early 1970s, the old city dump operated under private ownership and was used as a community dump for domestic and industrial wastes. During its operation, hundreds of drums of industrial waste including industrial dyes and flammable solvents were reportedly placed in the dump. Reports also indicate that the liquid contents of the drums were burned in a pit on-site. The dump was closed in 1972 when the land was purchased by the City of New Haven. After its closure, the City of New Haven used the dump for disposal of demolition debris and yard waste.

1.4 OU3 Site Description

The old city dump (OU3) in New Haven, Missouri is located on approximately 1.5 acres at the upper end of a steep ravine in the southeast portion of town on the north side of State Highway 100 (see Figure 2). The entire upper end of the ravine is filled with waste. The surface area of the dump is approximately 350 by 200 feet, and refuse has been covered by demolition debris, yard waste, and fill. The dump is bordered to the south by the highway. A small industrial tract is located immediately east of the dump. The areas immediately north and west of the dump are covered by dense woods. Land use downgradient of the dump is predominately rural, and contains several homes with domestic wells.

1.5 Scope of the Risk Assessment

A Baseline Risk Assessment (BRA) evaluates human health risks from hypothetical exposures to sampled contaminated environmental media if no final remedial action were taken at the site. The BRA provides the basis for taking action and identifies contaminants and exposure pathways to be addressed by remedial action.

This risk assessment used sampling results obtained during site investigations and sampling events conducted by the USGS under the ESI/RI and RI between February 1999 and March 2002. This assessment examined risks that may result from human exposure to contaminated groundwater.

MDHSS evaluated potential health risks of OU3 contaminants under current and possible future land-use scenarios. MDHSS' site assessment evaluated the potential for current and future health impacts of OU3 contaminants on receptors inhabiting or employed in the vicinity of the Old City Dump area. Current human receptors that may be exposed to OU3 contaminants include residents potentially exposed to contaminated groundwater through the use of domestic wells located in the area. Future human receptors that may be chronically exposed to OU3 contaminants include residents or occupational workers potentially exposed to contaminated groundwater.

2.0 POTENTIAL CONTAMINANTS OF CONCERN (COCs)

2.1 Source Residuals

The potential contaminants at the Old City Dump include volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and inorganics. Potential sources of contamination at OU3 are disposal of industrial wastes.

2.2 Data Collection and Evaluation

This assessment used groundwater sampling results collected between July 1999 and March 2002 taken from seeps and monitoring and domestic wells in the vicinity of the Old City Dump Operable Unit. The various samples were tested for either one or a combination of the following: volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and inorganics. PCE and chloroform were the only target VOCs detected in the sampling. Chloroform was dropped from analysis due to the fact that its associated trip blank was contaminated with this constituent at reportable levels. No SVOCs were detected in the sampling; however, a number of inorganics were detected including metals and trace elements.

Target constituents with detectable concentrations were retained as COCs, with the exception of chloroform as noted above. Further, this report will not address whether variation in the inorganic samples taken from OU3 is related to natural background variation or has an anthropogenic origin.

It is important to note that one monitoring well sample contained large estimated concentrations of two Tentatively Identified Compounds (TICs). These compounds were tentatively identified as ethyl acetate with an estimated concentration of 3,600 µg/L and ethanol with and estimated concentration of 120,000 µg/L. As identification and quantitation of TICs are less accurate than those for target compounds, these were not retained as COCs.

A complete listing of the COCs is presented in Table 1. Sample results along with spreadsheets demonstrating the COC selection and determination of final concentrations are attached to this document as Appendix A.

2.2.1 Groundwater Exposure Point Concentration (EPC)

Groundwater samples were obtained from two seep locations, one monitoring well location, and two domestic well locations. Due to limited sampling, a 95% Upper Confidence Limit (UCL) was unable to be statistically calculated; therefore, to estimate potential groundwater intake, the maximum contaminated sample concentration for each COC was used as representative of the EPC.

Groundwater concentrations for COCs detected are presented in Tables 2 and 3.

3.0 EXPOSURE ASSESSMENT

3.1 Exposure Pathways

Exposure to contaminants is defined as the contact of a receptor with a contaminant. For exposure to occur, there must be a source of contaminant (for example, contaminated water or soil), a receptor (a person), and a mechanism or pathway for receptors to be exposed to contaminants (such as ingestion of, or dermal contact with, contaminated media, or inhalation of particulates or vapors from contaminated media). Contaminated media at OU1 includes groundwater.

Contaminants may be transported from a site to secondary media (surface and subsurface soils, ambient and indoor air, groundwater, surface water, and sediments) through several processes, including leaching of contaminants to groundwater from soil or surface water, recharge of surface water from contaminated groundwater, and migration or erosion of contaminated soil particles to air or surface water. Several potential exposure pathways may exist for each contaminated media. For OU1 these pathways include:

Groundwater

- current residential drinking water ingestion
- future residential drinking water ingestion, dermal contact from showering, and inhalation risk from volatiles while showering
- future drinking water ingestion during occupational activities

3.2 Exposure Scenarios

Current and Future Residential and Future Occupational Exposures to Groundwater

At present, drinking water is currently supplied to residents by the two uncontaminated municipal wells; however, a potential ingestion pathway exists for a current residential exposure scenario to contaminated groundwater via a contaminated domestic well located just west of OU3. The exposure concentrations for this scenario consist of the results of one sample taken from the domestic well on 02/07/00. The current resident's daily intake of contaminated groundwater consists solely of drinking water ingestion.

Because the potential exists for leaching of contaminants and future exposures, MDHSS also examined future residential and occupational exposure scenarios to evaluate risks from potential exposure to detected contaminant concentrations found in groundwater. The future resident's assumed daily intake of contaminated groundwater includes drinking water ingestion, and dermal contact and inhalation of volatilized contaminants while showering, and incorporate a time-weighted average (TWA) approach to modeling risks to an individual living near the site from birth through adulthood who may be exposed to groundwater. The future occupational worker's assumed daily intake of contaminated groundwater consists solely of drinking water ingestion.

The specific exposure assumptions used to calculate intake and risks for the residential and occupational scenarios are detailed in Table 4.

3.3 Calculation of Contaminant Intake

Intake rates for all contaminants were quantified using pathway-specific equations given in EPA's (1989) Risk Assessment Guidance for Superfund: Volume I (RAGS).

Chemical intake for the current and future residential scenarios were calculated using the modified equations listed below that take into account a child's exposure by utilizing time-weighted averages for both an adult and a child exposure (EPA 1989).

Drinking Water Ingestion of Groundwater
Intake (mg/kg-day) = [Cw*EF*((IRWa*EDa*BWa)+(IRWc*EDc / BWc))] / AT

Dermal Contact with Groundwater while Showering
Dermally Absorbed Dose (mg/kg-day) =
Cw*CFw*PC*ET*EF*[(SAa*EDa / BWa)+(SAc*EDc / BWc)] / AT

Inhalation of Vapors while Showering
Intake (mg/kg-day) = [Ca*IRA*ET*EF*((EDa / BWa)+(EDc / BWc))] / AT

Chemical intakes for the future occupational scenario were calculated using the equations listed below.

Drinking Water Ingestion of Groundwater
Intake (mg/kg-day) = (Cw*IRW*EF*ED) / (BW*AT)

The variable definitions and values for these equations are also presented in Table 4. Calculation worksheets are included as attachments to this document as Appendix B.

4.0 TOXICITY ASSESSMENT

4.1 Carcinogenic Effects
Slope Factors (SF) are the toxicity values used in assessing carcinogenic effects from exposure. SFs are defined as the plausible upper-bound estimate of the probability of carcinogenic effects per unit intake of a chemical expressed over a 70-year lifetime. EPA's Integrated Risk Information System (IRIS) contains many contaminant-specific Oral SFs and Inhalation Unit Risks (UR_i). SF_o and UR_i values which are unable to be found on IRIS, may be found in EPA's Health Effects Assessment Summary Tables (HEAST), (EPA, 1997b). If SF_o or UR_i values were not available in IRIS or HEAST, EPA's National Center for Environmental Assessment (NCEA) - Superfund Technical Support Center (STSC) risk assessment issue papers (EPA, 1993-2001) were reviewed to obtain provisional values.

In order to assess carcinogenic effects from dermal exposure, it is necessary to convert oral SFs to absorbed SFs by use of an oral absorption efficiency (OAE) variable. The formula to adjust oral toxicity values to absorbed toxicity values for use in dermal equations is:

SF_{oral} (mg/kg-d)$^{-1}$ ÷ OAE (unitless) = SF_{dermal} (mg/kg-d)$^{-1}$

To estimate the contribution of carcinogenic effects from inhalation of volatiles, it is necessary to convert the Inhalation Unit Risks (UR_i) to SFs. The formula to adjust these values to toxicity values for use in inhalation equations is:

UR_i (μg/m^3)$^{-1}$ * 70 (kg) * 1000 (μg/mg) /20 (m^3/d) = $SF_{inhalation}$ (mg/kg-d)$^{-1}$

COC-specific SF values along with the associated target organs, including the OAE and UR_i values utilized for conversion-purposes, to calculate the Carcinogenic Risks for groundwater are presented in Table 5.

Carcinogenic risk could not be calculated for all contaminants of concern due to lack of carcinogenic toxicity information. In particular, carcinogenic toxicity information was not available for any of the inorganics; therefore, carcinogenic risk is calculated only for PCE. This information is also presented in the aforementioned table.

4.2 Non-Carcinogenic Effects

References Doses (RfDs) are the toxicity values used in assessing non-carcinogenic effects from exposure. A chronic RfD is defined as an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime. EPA's Integrated Risk Information System (IRIS) contains many contaminant-specific Oral RfDs and Inhalation Reference Concentrations (RfC). RfD_o and RfC values which are unable to be found on IRIS, may be found in EPA's Health Effects Assessment Summary Tables (HEAST), (EPA, 1997b). If RfD_o or RfC values could not be found in IRIS or HEAST, EPA's National Center for Environmental Assessment (NCEA) - Superfund Technical Support Center (STSC) risk assessment issue papers (EPA, 1993-2001) were reviewed to obtain provisional values.

In order to assess non-carcinogenic effects from dermal exposure, it is necessary to convert oral RfDs to absorbed RfDs by use of an oral absorption efficiency (OAE) variable. The formula to adjust oral toxicity values to absorbed toxicity values for use in dermal equations is:

RfD_{oral} (mg/kg-d) * OAE (unitless) = RfD_{dermal} (mg/kg-d)

To estimate the contribution to non-carcinogenic effects from inhalation of volatiles, it is necessary to convert the Reference Concentrations (RfC) to RfDs. The formula to adjust these values to toxicity values for use in inhalation equations is:

RfC (mg/m^3) * 20 (m^3/d) / 70 (kg) = $RfD_{inhalation}$ (mg/kg-d)

COC-specific RfD values along with the associated effects of concern, including the OAE and RfC values utilized for conversion-purposes, to calculate the Hazard Index for groundwater are presented in Table 6.

Non-carcinogenic Hazard Quotients could not be calculated for all contaminants of concern due to lack of non-carcinogenic toxicity information. Those constituents for which information was unavailable for the specified pathways are also presented in the aforementioned table.

5.0 RISK CHARACTERIZATION

5.1 Carcinogenic Risks

Lifetime excess cancer risks (CR) were calculated for each contaminant in each pathway by multiplying the slope factor (SF) by the Chronic Daily Intake (CDI). Within a pathway, the chemical specific risks were summed to give the total pathway risk. The Total Excess Lifetime Cancer Risk was then determined by summing the total pathway risks. EPA generally considers a total excess lifetime cancer risk for a reasonable maximum exposure that exceeds 10^{-4} (1 in 10,000) to be unacceptable. Total excess lifetime cancer risks below 10^{-6} (1 in 1,000,000) are considered acceptable.

5.1.1 Current Resident Exposed to Groundwater Scenario -- Carcinogenic Risks

The total excess lifetime cancer risk for the current residential exposure to groundwater scenario was unable to be calculated due to lack of toxicity information for the inorganic constituents detected. This information is presented in Table 7.

5.1.2 Future Resident Exposed to Groundwater Scenario -- Carcinogenic Risk

The total excess lifetime cancer risk for the future residential groundwater scenario is 3.0×10^{-7} (3 in 10,000,000), and is presented in Table 8. Because carcinogenic toxicity information for this pathway was unavailable for the inorganic constituents, the risk presented is contributed solely from PCE.

5.1.3 Future Occupational Worker Exposed to Groundwater -- Carcinogenic Risk

The total excess lifetime cancer risk for the future occupational groundwater scenario is 5.8×10^{-8} (5.8 in 100,000,000), and is presented in Table 9.

5.2 Non-Carcinogenic Effects

Non-cancer hazard quotients (HQs) were calculated for each contaminant in each pathway by dividing the Chronic Daily Intake (CDI) by the RfD. The HQ represents the quantitative estimate of non-carcinogenic hazard from exposure through each individual pathway to each specific chemical. These contaminant-specific HQs are then summed within each exposure pathway to determine the pathway hazard index (HI). Each pathway within a media has the same COCs, at the same concentrations, as other pathways in that media, but may differ in the amount of contaminant a receptor may intake depending on the pathway. The Total Hazard Index was then calculated by summing the hazard indices from each pathway. According to RAGS, human health risks may exist when the Total Hazard Index exceeds unity (1.0).

5.2.1 Current Resident Exposed to Groundwater Scenario -- Hazard Index

The Total Hazard Index for the current residential scenario is 0.2, and is presented in Table 10. Because the total hazard index is less than 1.0, adverse non-carcinogenic health effects are not expected to occur for this scenario.

5.2.2 Future Resident Exposed to Groundwater Scenario -- Hazard Index

The Total Hazard Index for the future residential groundwater scenario is 9, and is presented in Table 11. Because the total hazard index is greater than 1.0, there is a potential for adverse non-carcinogenic health effects for future residents living near the site who may be exposed to contaminated groundwater from OU3. Exposure in this scenario occurs via drinking water ingestion, and dermal contact and inhalation of vapors while showering. Ingestion exposure to antimony and boron were the primary drivers resulting in a total pathway Hazard Index greater than 1.0. None of the contaminants contributed an individual contaminant Hazard Quotient greater than 1.0 in the dermal or inhalation pathways.

5.2.3 Future Occupational Worker Exposed to Groundwater -- Hazard Index

The Total Hazard Index for the future occupational groundwater scenario is 2.5, and is presented in Table 12. Because the total hazard index is greater than 1.0, there is a potential for adverse non-carcinogenic health effects for a future adult worker who may be exposed to contaminated groundwater from OU3. Exposure to antimony is the primary driver resulting in a total Hazard Index greater than 1.0.

6.0 UNCERTANTIES

As with any risk assessment, there are several areas of uncertainty specific to this risk assessment. The chemical concentrations in the samples may have been over- or underestimated. This would result in an over- or underestimation, respectively, of the risk posed by the site. Additionally, the recovery of contaminants during sample extraction can be less than 100%. This inability to extract all contaminants present at the site may result in an underestimation of the risks posed by the site.

Uncertainty about the accuracy of Tentatively Identified Compounds, precluded ethanol and ethyl acetate from being retained as COCs and carried through the risk assessment. This may also result in an underestimation of the risks posed by the site.

A risk assessment is also based on conservative estimates of exposure that may tend to under- or over-estimate the site risks. This estimation of risk posed by a site is a complex problem and involves assumptions to determine chemical intake and toxicity. Due to limited sampling, the daily chemical intake was estimated using the maximum sample concentration of each COC. This is done to ensure the protection of public health, but it may overestimate the true risk posed by the site. Additionally, the EPC for all inorganics with the exception of copper are based on sampling results from the seep locations. Using this data to calculate drinking water ingestion is conservative in nature, as it is unlikely that exposure from a seep would be anything more than an incidental ingestion source; however the seep water data was added to the well data to account for the potential for leaching and to demonstrate a worst-case exposure scenario. Furthermore, in the modeling of contaminant intake, chemical concentrations in groundwater were assumed to remain constant over time. This is a conservative estimate and is also likely to overestimate the true risk posed by the site.

Most of the toxicity values used to calculate risk are derived from toxicity testing carried out on animals. Interspecies, as well as intraspecies variation adds uncertainty to the toxicity values, thus the true risk posed by the site may be higher or lower than presented in this assessment.

Carcinogenic and non-carcinogenic risks could not be calculated for all contaminants of concern due to lack of toxicity information. In particular, carcinogenic toxicity information was not available for any of the inorganics; therefore, the carcinogenic risks presented solely corresponds to the risk from PCE. All inorganic COCs have been assigned a weight-of-evidence classification of D – not classifiable as to human carcinogenicity, or have not been assessed under the IRIS Program. This lack of toxicity information may underestimate the true risk posed at the site.

Sample analysis at the site included detections for total chromium, fluoride, and nitrite + nitrate. Toxicity information is not available for these specific compounds; therefore, toxicity assumptions were made. Assumptions were made that the toxicity data for chromium VI is representative for total chromium; the toxicity data for fluorine (soluble fluoride) is representative of risks from fluoride; and toxicity data for nitrate is representative of risks from nitrite + nitrate (NO23). These are conservative assumptions and may over- or underestimate the risks from the site.

7.0 SUMMARY

A summary of the final calculated cancer risks and hazard indices for each scenario are presented in Table 13.

This assessment found that unacceptable excess carcinogenic risks are not expected to occur for current residents potentially consuming contaminated groundwater from a domestic well in the OU3 area. In addition, unacceptable excess carcinogenic risks are not expected for future residents or occupational workers from exposure to contaminated groundwater. It is important to note, however, that this carcinogenic evaluation solely corresponds to the risk from PCE because of lack of carcinogenic toxicity information for the inorganics.

Additionally, adverse non-carcinogenic health effects are not expected to occur for current residents potentially consuming contaminated groundwater from a domestic well in the OU3 area.

The potential does exist, however, for adverse non-carcinogenic health effects for future residents and future occupational workers who ingest groundwater from contaminated aquifers underlying OU3. This evaluation is associated strictly with contribution of the metals, antimony and boron.

8.0 REFERENCES

EPA. 1989. *Risk Assessment Guidance for Superfund: Volume 1 - Human Health Evaluation Manual, Part A.* Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002.

EPA. 1991. *Risk Assessment Guidance for Superfund, Volume 1 - Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors*. Office of Emergency and Remedial Response, Washington, D.C. OSWER Directive 9285.6-03.

EPA. 1992. *Guidance for Data Useability in Risk Assessment, Part A*. Office of Emergency and Remedial Response, Washington, D.C. Publication 9285.7-09A.

EPA. 1992-2001. *National Center for Environmental Assessment (NCEA) – Superfund Technical Support Center Risk Assessment Issue Papers for: Lithium* (Nov. 1992); and *Tetrachloroethene* (June 1997 and Dec. 2001).

EPA. 1997. *Health Effects Assessment Summary Tables (HEAST).* Office of Research and Development, Office of Emergency and Remedial Response, Washington, D.C. EPA 540/R-97-036.

EPA. 2000a. *Standard Default Factors memorandum*. U.S. Environmental Protection Agency Region VII, Kansas City, KS. April 2000.

EPA. 2000b. *NPL Site Narrative at Listing: Riverfront, New Haven, Missouri*. EPA Webpage available at http://www.epa.gov/superfund/sites/npl/nar1607.htm

USGS. 2000. *Workplan for the Remedial Investigation of the New Haven Public Water Supply Site, New Haven, Missouri*. U.S. Geological Survey, Water Resources Division, Missouri District. November 2000.

USGS. 2001. *Expanded Site Investigation/Remedial Investigation Results for the Riverfront Site, New Haven, Missouri*. U.S. Geological Survey, Water Resources Division, Missouri District. January 2001.

EPA. 2001. *Risk Assessment Guidance for Superfund: Volume 1 – Human Health Evaluation Manual, Part E, Supplemental Guidance for Dermal Risk Assessment – Interim Review Draft for Public Comment, September 2001*. Office of Emergency and Remedial Response, Washington, D.C. EPA/540/R/99/005.

EPA. 2002a. *CERCLIS Hazardous Waste Sites: Riverfront Site Information*. EPA Webpage available at http://www.epa.gov/superfund/sites/cursites/c3mo/s0702089.htm

EPA. 2002b. *Integrated Risk Information System (IRIS)*. Office of Research and Development, National Center for Environmental Assessment. Available on-line at http://*www.epa.gov/iris/* September 2002.

USGS. 2002a. *The Riverfront Site, New Haven, Missouri: Samples Collected for Laboratory Analysis from February 19, 1999 to December 31, 2001*. U.S. Geological Survey. January 2002.

USGS. 2002b. *Riverfront Superfund Site*. USGS Webpage available at http://missouri.usgs.gov/epa/NH/default.asp

New Haven. 2002. *New Haven Area Chamber of Commerce*. Webpage available at http://www.newhavenmo.com/

TABLE 1.

Contaminants of Concern (COCs) at Operable Unit 3 - The Old City Dump
The Riverfront Site, New Haven, Franklin County, Missouri

Groundwater COCs
Antimony
Barium
Boron
Cadmium
Chromium
Copper
Lithium
Manganese
Molybdenum
Nickel
Strontium
Zinc
Chloride
Fluoride
Silica
Sulfate
Ammonia
Nitrite + Nitrate
Nitrite
Ortho Phosphorus
Total Phosphorus
Tetrachloroethene

TABLE 2.

Ground Water Concentrations for COCs
in Domestic Well Sampling at Operable Unit 3 - The Old City Dump
The Riverfront Site, New Haven, Franklin County, Missouri

	OUX-GW-JS-26
	000390008
	02/07/00 @1230
	GW
	Domestic Well
	OUX-JS-26
	William Litzsinger
	14.1C
	1
	mg/L
Inorganics	**Barium**	**0.049**
	Copper	**0.01**
	Strontium	**0.1**
	Zinc	**0.063**
	Fluoride	**0.2**
	Silica	**13.9**
	Sulfate	**5.6**
	Ammonia	**0.002**
	Nitrite + Nitrate	**1.291**
	Ortho Phosphorus	**0.005**

TABLE 3.

Ground Water Concentrations for COCs at Operable Unit 3 - The Old City Dump
The Riverfront Site, New Haven, Franklin County, Missouri

		Sample Mean mg/L	Sample Standard Deviation mg/L	Minimum Detected Value mg/L	Maximum Detected Value mg/L	**Exposure Point Concentration** mg/L
Inorganics	**Antimony**	0.04	0.06	0.00146	0.082	**0.082**
	Barium	0.09	0.04	0.049	0.124	**0.124**
	Boron	0.96	1.52	0.166	2.71	**2.71**
	Cadmium	0.002	0	0.002	0.002	**0.002**
	Chromium	0.002	0	0.002	0.002	**0.002**
	Copper	0.01	0.005	0.001	0.01	**0.01**
	Lithium	0.01	0.01	0.013	0.013	**0.013**
	Manganese	0.08	0.09	0.017	0.147	**0.147**
	Molybdenum	0.004	0	0.004	0.004	**0.004**
	Nickel	0.01	0.01	0.003	0.024	**0.024**
	Strontium	0.27	0.17	0.1	0.435	**0.435**
	Zinc	0.23	0.34	0.007	0.627	**0.627**
	Chloride	113.28	97.51	155	183	**183**
	Fluoride	0.2	0	0.2	0.2	**0.2**
	Silica	19.47	5.45	13.9	24.8	**24.8**
	Sulfate	97.63	137.75	5.6	256	**256**
	Ammonia	0.01	0.01	0.002	0.018	**0.018**
	Nitrite + Nitrate	7.09	5.02	1.291	9.99	**9.99**
	Nitrite	0.01	0.005	0.007	0.01	**0.01**
	Ortho Phosphorus	0.02	0.01	0.005	0.034	**0.034**
	Total Phosphorus	0.14	0.20	0.043	0.374	**0.374**
VOCs	**Tetrachloroethene**	0.0002	0.0003	0.00011	0.0008	**0.0008**

Table 4.

Exposure Variable Values Used To Calculate Intake and Risk Levels for Exposure to Contaminated GroundWater

	Variable	Unit	Value	References
Intake Variables	Cw = Chemical Concentration in Water	mg/L	chemical-specific	
	IRW = Water Ingestion Rate	L/day		
	Occupational		1	1
	IRWa - Residential Adult		2	1
	IRWc - Residential Child		1	1
	CFw = Conversion Factor for Water	L/cm^3	0.001	2
	SA = Skin Surface Area Available for Contact	cm^2		
	SAa - Residential Adult		18,000	3
	SAc - Residential Child		6,600	3
	PC = Permeability Constant	cm/hour	chemical-specific	
	Ca = Air Concentration	mg/m^3	chemical-specific (Cw*K)	
	K = Volatilization constant	L/m^3	0.5	1
	IRA = Inhalation Rate	m^3/hour	0.6	2
	ET = Exposure Time	hours/day	0.58	3
	EF = Exposure Frequency	days/year		
	Occupational		250	1
	Residential		350	1
	ED = Exposure Duration	years		
	Occupational		25	1
	EDa - Residential Adult		24	1
	EDc - Residential Child		6	1
	BW = Body Weight	kg		
	BWa - Adult		70	1
	BWc - Child		15	1
	ATc = Averaging Time - carcinogenic	days	25550	1
	ATn = Averaging Time - noncarcinogenic (ED*365)	days		1
	Occupational		9125	
	Residential		10950	
Risk Variables	SF = Slope Factor - carcinogenic	$(mg/kg-d)^{-1}$	chemical-specific	
	SF_o - Oral			
	SF_d - Dermal			
	SF_i - Inhalation			
	RfD = Reference Dose - noncarcinogenic	mg/kg-d	chemical-specific	
	RfD_o - Oral			
	RfD_d - Dermal			
	RfD_i - Inhalation			

1 EPA Region VII Standard Default Factors Memorandum (2000) or EPA RAGS Supplemental Guidance: Standard Default Exposure Factors (1991)

2 EPA RAGS, Part A (1989)

3 EPA RAGS, Part E: Supplemental Guidance for Dermal Risk Assessment (2001)

TABLE 5.

Carcinogenic Toxicity Values and Target Organs for COCs in Ground Water
Operable Unit 3 - The Old City Dump, The Riverfront Site, New Haven, Franklin County, Missouri

		Carcinogenic Weight of Evidence Classification	SFo (mg/kg-d)$^{-1}$	Reference	OAE unitless	Reference	SFd (mg/kg-d)$^{-1}$	URi (ug/m^3)$^{-1}$	Reference	SFi (mg/kg-d)$^{-1}$	Target Organs/Systems
GroundWater COCs	Antimony	Not Assessed									
	Barium	D									
	Boron	Not Assessed									
	Cadmium	Not Assessed (oral route)									
	Chromium (Chromium VI)	D (oral route)									
	Copper	D									
	Lithium	D									
	Manganese	D									
	Molybdenum	Not Assessed									
	Nickel	Not Assessed									
	Strontium	Not Assessed									
	Zinc	D									
	Chloride	Not Assessed									
	Fluoride (Fluorine)	Not Assessed									
	Silica	Not Assessed									
	Sulfate	Not Assessed									
	Ammonia	Not Assessed									
	Nitrite + Nitrate (Nitrate)	Not Assessed									
	Nitrite	Not Assessed									
	Ortho Phosphorus	Not Assessed									
	Total Phosphorus	Not Assessed									
	Tetrachloroethene	C-B2	2.07E-02	N	1	E	2.07E-02	3.06E-06	N	1.07E-02	Liver, kidney, and central nervous system

Carcinogenic Toxicity Values

Weight of Evidence Classifications

A - Human Carcinogen, based on sufficient evidence from epidemiological studies
B1 - Probable Human Carcinogen, based on sufficient evidence from animal studies and limited evidence from epidemiological studies
B2 - Probable Human Carcinogen, based on sufficient evidence of animal studies, but inadequate epidemiological data
C - Possible Human Carcinogen
D - Not Classifiable as to Human Carcinogenicity

Source References

I - Integrated Risk Information System (IRIS), September 2002
H - Health Effects Assessment Summary Tables (HEAST), 1997
N - National Center for Environmental Assessment Risk Assessment Issue Papers
E - Draft RAGS, Part E: Supplemental Guidance for Dermal Risk Assessment, 2001
Toxicity Informaiton Not Available
Toxicity Information Not Applicable

TABLE 6.

Non-Carcinogenic Toxicity Values and Effects of Concern for COCs in Ground Water
Operable Unit 3 - The Old City Dump, The Riverfront Site, New Haven, Franklin County, Missouri

		RfDo mg/kg-d	Reference	OAE unitless	Reference	RfDd mg/kg-d	RfC mg/m³	Reference	RfDi mg/kg-d	Effects of Concern
Ground Water COCs	Antimony	4.00E-04	I	0.15	E	6.00E-05				Longevity, blood glucose, and cholesterol
	Barium	7.00E-02	I	0.07	E	4.90E-03				Oral: Increased kidney weight; Inhalation: Fetotoxicity
	Boron	9.00E-02	I	1	E	9.00E-02				Oral: Testicular atrophy, spermatogenic arrest; Inhalation: Respiratory tract irritation
	Cadmium	5.00E-04	I	0.025	E	1.25E-05				Significant proteinuria
	Chromium (Chromium VI)	3.00E-03	I	0.025	E	7.50E-05				Oral: None reported; Inhalation: Pneumocyte toxicity
	Copper	3.70E-02	H	1	E	3.70E-02				Gastrointestinal system irritation
	Lithium	2.00E-02	N	1	E	2.00E-02				Impaired renal ability and polyuria
	Manganese	1.40E-01	I	0.04	E	5.60E-03				Oral: CNS effects; Inhalation: Impairment of neurobehavioral function
	Molybdenum	5.00E-03	I	1	E	5.00E-03				Increased uric acid levels
	Nickel	2.00E-02	I	0.04	E	8.00E-04				Decreased body and organ weights
	Strontium	6.00E-01	I	1	E	6.00E-01				Rachitic bone
	Zinc	3.00E-01	I	1	E	3.00E-01				Anemia, pancreas, and decrease levels of a blood enzyme and HDL cholesterol
	Chloride									
	Fluoride (Fluorine)	6.00E-02	I	1	E	6.00E-02				Dental fluorosis
	Silica									
	Sulfate									
	Ammonia									
	Nitrite + Nitrate (Nitrate)	1.60E+00	I	1	E	1.60E+00				Early clinical signs of methemoglobinemia in infants
	Nitrite	1.00E-01	I	1	E	1.00E-01				Methemoglobinemia
	Ortho Phosphorus									
	Total Phosphorus									
	Tetrachloroethene	1.00E-02	I	1	E	1.00E-02	6.00E-01	N	1.71E-01	Oral: Hepatotoxicity in mice, weight gain in rats; Inhalation: Renal tubular cell karyomegaly in chronically exposed male and female mice

Source References

I - Integrated Risk Information System (IRIS), September 2002
H - Health Effects Assessment Summary Tables (HEAST), 1997
N - National Center for Environmental Assessment Risk Assessment Issue Papers
E - Draft RAGS, Part E: Supplemental Guidance for Dermal Risk Assessment, 2001
Toxicity Informaiton Not Available
Toxicity Information Not Applicable

TABLE 7.

Carcinogenic Risks Calculated for Current Residential Exposure
to Contaminated Groundwater from Operable Unit 3 - The Old City Dump
The Riverfront Site, New Haven, Franklin County, Missouri

	CARCINOGENIC RISK Domestic Well Water Sampling Drinking Water Ingestion
Barium	
Copper	
Strontium	
Zinc	
Fluoride (Fluorine)	
Silica	
Sulfate	
Ammonia	
Nitrite + Nitrate (Nitrate)	
Ortho Phosphorus	
TOTAL CARCINOGENIC RISK FOR CURRENT RESIDENTIAL SCENARIO	**0.0E+00**

Not Available - lacks toxicity values

TABLE 8.

Carcinogenic Risks Calculated for Future Residential Exposure
to Contaminated Groundwater from Operable Unit 3 - The Old City Dump
The Riverfront Site, New Haven, Franklin County, Missouri

	CARCINOGENIC RISK		
	Drinking Water Ingestion	**Dermal Contact**	**Inhalation**
Antimony			
Barium			
Boron			
Cadmium			
Chromium (Chromium VI)			
Copper			
Lithium			
Manganese			
Molybdenum			
Nickel			
Strontium			
Zinc			
Chloride			
Fluoride (Fluorine)			
Silica			
Sulfate			
Ammonia			
Nitrite + Nitrate (Nitrate)			
Nitrite			
Ortho Phosphorus			
Total Phosphorus			
Tetrachloroethene	2.47E-07	3.83E-08	1.52E-08
Pathway Carcinogenic Risks	2.5E-07	3.8E-08	1.5E-08
TOTAL CARCINOGENIC RISK FOR FUTURE RESIDENTIAL SCENARIO	3.0E-07		

Not Available - lacks toxicity values
Not Applicable to Exposure Pathway

TABLE 9.

Carcinogenic Risks Calculated for Future Occupational Exposure
to Contaminated Groundwater from Operable Unit 3 - The Old City Dump
The Riverfront Site, New Haven, Franklin County, Missouri

	CARCINOGENIC RISK
	Drinking Water Ingestion
Antimony	
Barium	
Boron	
Cadmium	
Chromium (Chromium VI)	
Copper	
Lithium	
Manganese	
Molybdenum	
Nickel	
Strontium	
Zinc	
Chloride	
Fluoride (Fluorine)	
Silica	
Sulfate	
Ammonia	
Nitrite + Nitrate (Nitrate)	
Nitrite	
Ortho Phosphorus	
Total Phosphorus	
Tetrachloroethene	5.80E-08
TOTAL CARCINOGENIC RISK FOR FUTURE OCCUPATIONAL SCENARIO	5.8E-08

Not Available - lacks toxicity values

TABLE 10.

Non-Carcinogenic Risks Calculated for Current Residential Exposure
to Contaminated Groundwater from Operable Unit 3 - The Old City Dump
The Riverfront Site, New Haven, Franklin County, Missouri

	HAZARD INDEX
	Domestic Well Water Sampling
	Drinking Water Ingestion
Barium	0.02
Copper	0.01
Strontium	0.01
Zinc	0.01
Fluoride (Fluorine)	0.1
Silica	
Sulfate	
Ammonia	
Nitrite + Nitrate (Nitrate)	0.03
Ortho Phosphorus	
TOTAL HAZARD INDEX FOR CURRENT RESIDENTIAL SCENARIO	0.2

Not Available - lacks toxicity values

TABLE 11.

Non-Carcinogenic Risks Calculated for Future Residential Exposure
to Contaminated Groundwater from Operable Unit 3 - The Old City Dump
The Riverfront Site, New Haven, Franklin County, Missouri

	HAZARD INDEX		
	Drinking Water Ingestion	Dermal Contact	Inhalation
Antimony	7	0.2	
Barium	0.1	0.004	
Boron	1	0.005	
Cadmium	0.1	0.03	
Chromium (Chromium VI)	0.02	0.01	
Copper	0.01	0.00004	
Lithium	0.02	0.0001	
Manganese	0.04	0.004	
Molybdenum	0.03	0.0001	
Nickel	0.04	0.001	
Strontium	0.03	0.0001	
Zinc	0.1	0.0002	
Chloride			
Fluoride (Fluorine)	0.1	0.001	
Silica			
Sulfate			
Ammonia			
Nitrite + Nitrate (Nitrate)	0.2	0.001	
Nitrite	0.003	0.00002	
Ortho Phosphorus			
Total Phosphorus			
Tetrachloroethene	0.003	0.0004	0.00002
Pathway Non-Carcinogenic Risks	9	0.3	0.00002
TOTAL HAZARD INDEX FOR FUTURE RESIDENTIAL SCENARIO	9		

Not Available - lacks toxicity values
Not Applicable to Exposure Pathway

TABLE 12.

Non-Carcinogenic Risks Calculated for Future Occupational Exposure
to Contaminated Groundwater from Operable Unit 3 - The Old City Dump
The Riverfront Site, New Haven, Franklin County, Missouri

	HAZARD INDEX
	Well Water Sampling
	Drinking Water Ingestion
Antimony	2
Barium	0.02
Boron	0.3
Cadmium	0.04
Chromium (Chromium VI)	0.01
Copper	0.003
Lithium	0.01
Manganese	0.01
Molybdenum	0.01
Nickel	0.01
Strontium	0.01
Zinc	0.02
Chloride	
Fluoride (Fluorine)	0.03
Silica	
Sulfate	
Ammonia	
Nitrite + Nitrate (Nitrate)	0.1
Nitrite	0.001
Ortho Phosphorus	
Total Phosphorus	
Tetrachloroethene	0.001
TOTAL HAZARD INDEX FOR FUTURE OCCUPATIONAL SCENARIO	**2.5**

Not Available - lacks toxicity values

TABLE 13.

Summary of Calculated Risks for Operable Unit 3 - The Old City Dump
The Riverfront Site, New Haven, Franklin County, Missouri

Scenario	Media	Total Excess Cancer Risk	Total Hazard Index
Current Residential	GROUNDWATER	0.0E+00	0.2
Future Residential		3.0E-07	9
Future Occupational		5.8E-08	2.5

FIGURE 1.
Location of New Haven, Missouri

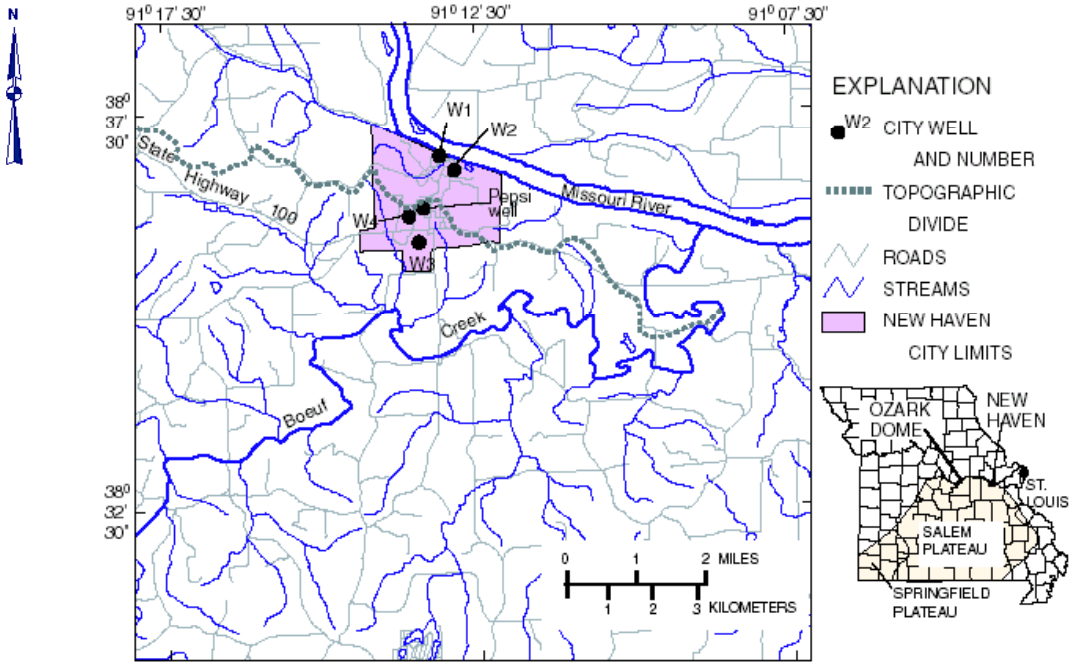

FIGURE 2.
Locations of the Riverfront Site Operable Units