



Superfund Record of Decision:

Chemical Sales
(New Location)
(Operable Unit 1), CO

EPA/ROD/R08-91/045
Chemical Sales (New Location) (Operable Unit 1), CO
First Remedial Action

Abstract (Continued)

into the ground water from the CS Property. The site has been divided into three operable units for remediation. This Record of Decision (ROD) addresses remediation of soil and ground water contamination south of Sand Creek, as OU1. Future RODs will address other site contamination including the ground water plume and associated contamination (OU2), and residential exposure to contaminated wells and domestic water from the municipal water supply (OU3). The primary contaminants of concern affecting the soil and ground water are VOCs including PCE and TCE.

The selected remedial action for this site includes treating contaminated onsite soil using vapor extraction; treating air emissions with catalytic oxidation; recirculating exhaust from the catalytic oxidation system into the contaminated soil; pumping and onsite treatment of ground water in the source area and plume area using air stripping, followed by reinjecting the treated water from the source area wells and reinfiltrating treated water from the plume area through onsite discharge; monitoring ground water, treated water, and air; providing public notice of potential health threat from contamination ground water; and implementing institutional controls including ground water use restrictions. The estimated cost for this remedial action is \$2,081,000. No O&M costs were provided for this remedial action.

PERFORMANCE STANDARDS OR GOALS: Chemical-specific soil cleanup goals are based on an acceptable concentration of leachate multiplied by the partitioning coefficient for the soil, and include PCE 0.150 mg/l and TCE 0.115 mg/l. Chemical-specific ground water cleanup goals are based on SDWA MCLs, and include PCE 0.005 mg/l and TCE 0.005 mg/l.

**RECORD OF DECISION
CHEMICAL SALES COMPANY SUPERFUND SITE
OPERABLE UNIT 1 - LEYDEN STREET LOCATION
JUNE 28, 1991
PART 1 - DECLARATION STATEMENT**

SITE NAME AND LOCATION

Chemical Sales Company Site
4661 Monaco Pkwy., Denver, Colorado
Operable Unit 1 - Leyden Street Location

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected Remedial Action (RA) for Operable Unit 1 - Leyden Street Location (OU1) of the Chemical Sales Company (CSC) Superfund site located in the counties of Denver and Adams, State of Colorado. The remedy was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA, as amended by the Superfund Amendments and Re-authorization Act of 1986) and the National Contingency Plan.

This decision document explains the basis for selecting the remedy for OU1 of this Site. The information that forms the basis of this RA decision is contained in the Administrative Record for this Site and is summarized in the attached decision summary.

The State of Colorado concurs with the selected remedy for OU1.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from OU1 of this Site, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF SELECTED REMEDY

The CSC Superfund site has been divided into three OUs. OU1 addresses the source area located in the vicinity of the CSC property and groundwater contamination south of Sand Creek. OU2 addresses the groundwater plume emanating from OU1 and other groundwater contamination located north of Sand Creek. OU3 addresses residential exposure to contaminated alluvial groundwater through use of domestic private wells and domestic water supplied by the SACWSD. The selected remedy presented in this ROD addresses soil and groundwater contamination within the boundaries of OU1. It describes remediation intended to reduce levels of contaminants in groundwater south of Sand Creek that

were released from the CSC facility. OU2 addresses downgradient residual groundwater contamination north of Sand Creek associated with the CSC OU1 site and another identified plume of groundwater contamination, referred to as the "PCE Plume." OU3 addresses residential exposure to contaminated groundwater through use of private alluvial wells.


The Remedial Action (RA) selected by the Environmental Protection Agency (EPA) for OU1 includes a system for extraction and treatment of contaminated soils and groundwater identified for this operable unit. Contaminated soils have been detected on and directly adjacent to the CSC property. A contaminated groundwater plume emanates from CSC OU1. The major components of the selected action include:


- * Monitoring of groundwater, discharged treated water and air;
- * Notification of potential health risks associated with use of contaminated groundwater upon request for an alluvial well permit within the OU1 area;
- * High volume (i.e., 1000 gallons per minute (gpm)) and pulsed pumping of groundwater exceeding groundwater remediation levels in the source area (area south of East 48th Avenue);
- * High volume (i.e., 1000 gpm) groundwater extraction within the CSC plume area (area north of East 48th Avenue and south of Sand Creek);
- * Treatment of contaminated groundwater with two air stripping towers for both source and plume areas; the source area air stripping tower would be located on CSC property; the plume area air stripper would be located near East 52nd Avenue;
- * Re-injection and re-infiltration of treated groundwater; aquifer re-injection by wells for treated water from the source area; re-infiltration through discharge into a trench or existing gravel pit for treated water from the plume area;
- * Soil vapor extraction of contaminated soils exceeding soil remediation levels;
- * Catalytic oxidation of air emissions from the soil vapor extraction system and source area air stripping unit; recirculation of exhaust from catalytic oxidation system into the contaminated soil.

DECLARATION OF STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost effective. This remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable.

Because this remedy may result in hazardous substances remaining on site above health based levels, and based on EPA policy (Structure and Components of 5-Year Reviews, May 29, 1991), a review of the remediation will be conducted within five years after commencement of the RA to ensure that the remedy continues to provide adequate protection of human health and the environment.


James J. Scherer
Regional Administrator
EPA Region VIII

 27, 1991
Date

RECORD OF DECISION
CHEMICAL SALES COMPANY SUPERFUND SITE
OPERABLE UNIT 1 - LEYDEN STREET LOCATION
PART 2 - DECISION SUMMARY

Decision Summary

TABLE OF CONTENTS

I.	SITE NAME, LOCATION AND DESCRIPTION	1
II.	SITE HISTORY AND ENFORCEMENT ACTIVITIES	7
III.	HIGHLIGHTS OF COMMUNITY INVOLVEMENT	12
IV.	SCOPE AND ROLE OF OPERABLE UNIT WITHIN SITE STRATEGY . .	13
V.	SITE CHARACTERISTICS	14
VI.	SUMMARY OF SITE RISKS	37
VII.	DESCRIPTION OF ALTERNATIVES	53
VIII.	SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES . . .	64
IX.	SELECTED REMEDY	70
X.	STATUTORY DETERMINATIONS	80
XI.	DOCUMENTATION OF SIGNIFICANT CHANGES	85

LIST OF FIGURES

FIGURE 1. Operable Units 1 and 2	2
FIGURE 2. Map of Groundwater Plumes	3
FIGURE 3. OU1 Site Layout	5
FIGURE 4. Elements of the Leyden Street Site	8
FIGURE 5. Configuration of Bedrock Surface	16
FIGURE 6. Saturated Thickness of Unconsolidated Deposits, September 1990	17
FIGURE 7. Water Table Configuration, September 1990	18
FIGURE 8. Regions of Contamination Above Field GC Soil Headspace Action Levels	21
FIGURE 9. Thickness of Soil Above Water Table Exceeding Field GC Headspace Action Levels	22
FIGURE 10. Areal Extent of Soil Contamination Exceeding Action Levels Based on Laboratory Results	23
FIGURE 11. Storage Tank Locations	27
FIGURE 12. Distribution of Tetrachloroethene (PCE) in Ground Water	35
FIGURE 13. Distribution of Trichloroethene (TCE) in Ground Water	36
FIGURE 14. Passive Pumping System, OU1	56
FIGURE 15. Active Pumping System, OU1	61

LIST OF TABLES

TABLE 1.	Summary of Underground and Aboveground Tank Data	25-26
TABLE 2.	Laboratory Ground Water Quality Summary Table for Target Volatile Organic Compounds	30-33
TABLE 3.	Summary of Cancer Risks by Pathway for Potential Receptors at the Chem Sales OU1 Site	44
TABLE 4.	Summary of Non-carcinogenic Risks (Hazard Indices) by Pathway for Potential Receptors at the Chem Sales OU1 Site	45
TABLE 5.	Groundwater Remediation Level	50

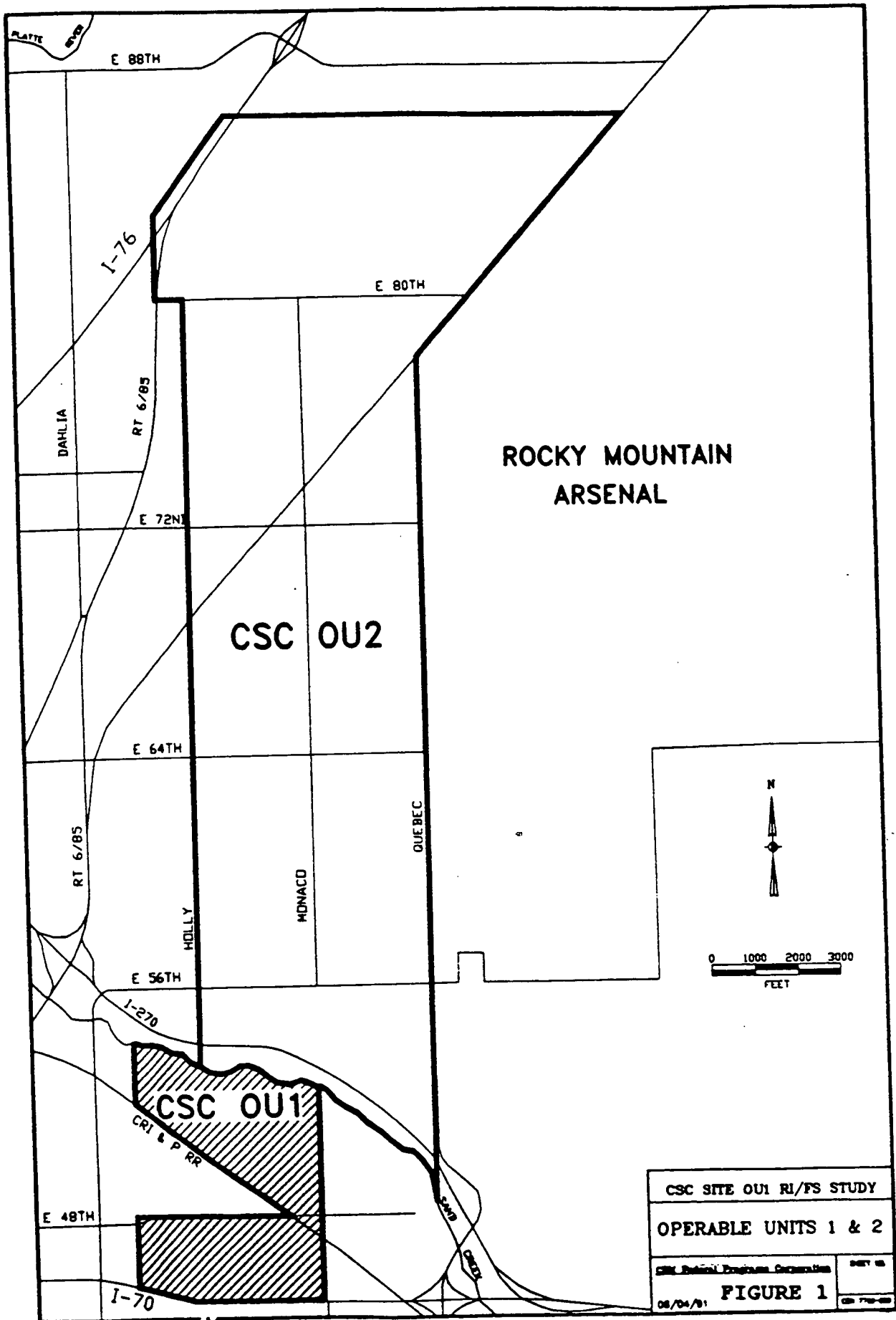
I. SITE NAME, LOCATION AND DESCRIPTION

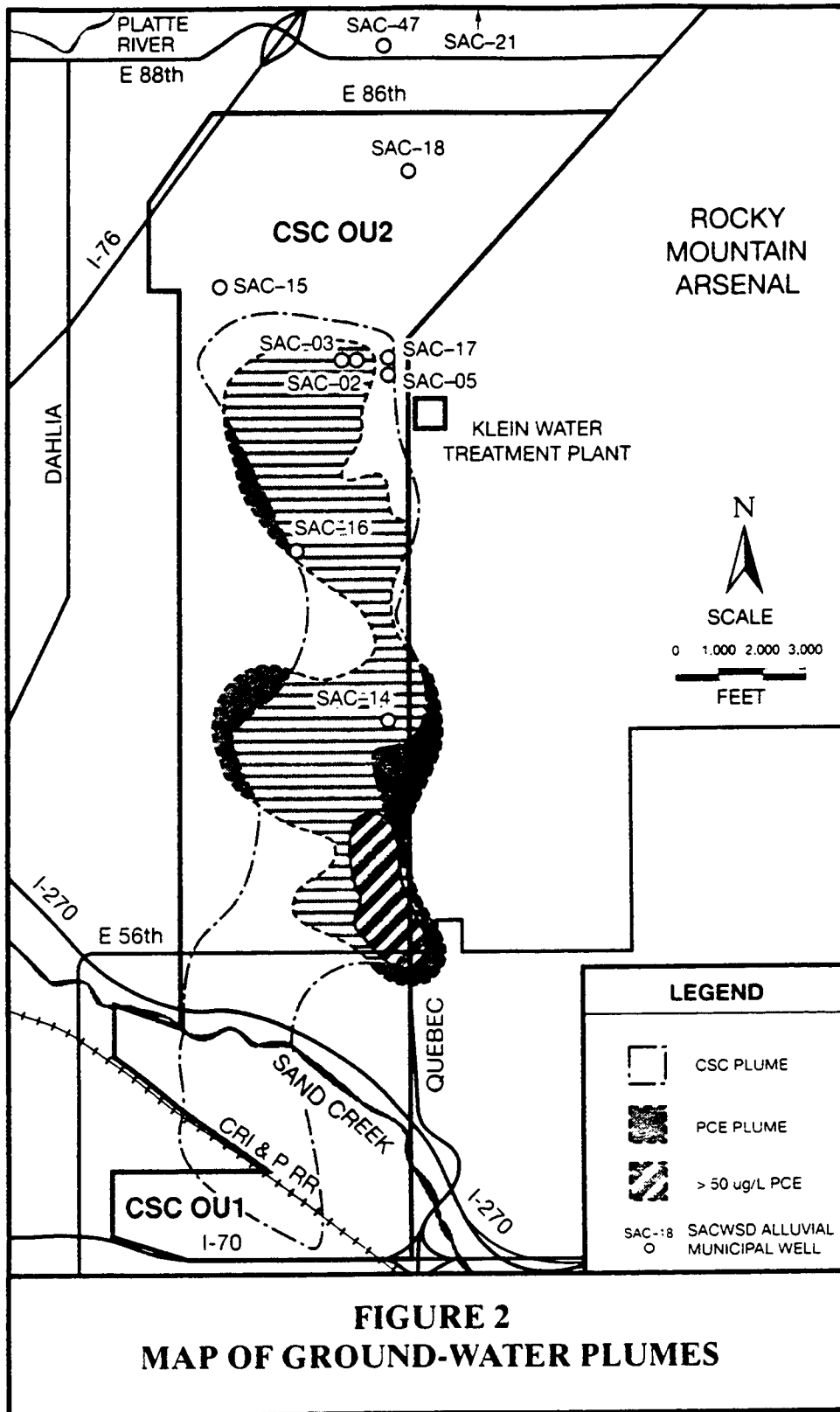
The Chemical Sales Company (CSC) Superfund site is located in Commerce City, Colorado and in the northern portion of Denver, Colorado, approximately five miles northeast of downtown Denver. The site is divided into three operable units.

OU1: This operable unit (OU) includes the CSC property and addresses soil and groundwater contamination south of Sand Creek. It is approximately bounded by Forest Street to the west; I-70 to the south; Monaco Parkway to the east; and Sand Creek to the north as shown in Figure 1. This OU is also referred to in this ROD as the Leyden Street Location and/or Leyden Street Site.

OU2: This OU addresses groundwater contamination generally downgradient of OU1. It is approximately bounded by Quebec Street to the east; Holly Street to the west; Sand Creek to the south; and East 86th Avenue to the north (see Figure 1). The boundaries for OU1 and OU2 are defined by the approximate extent of groundwater contamination (Figure 2). If contaminants within the groundwater continue to migrate, the boundaries of CSC OU1 and OU2 will correspondingly expand.

OU3: This OU covers the same area as OU2 but addresses residential exposure to contaminants through domestic use of alluvial groundwater.

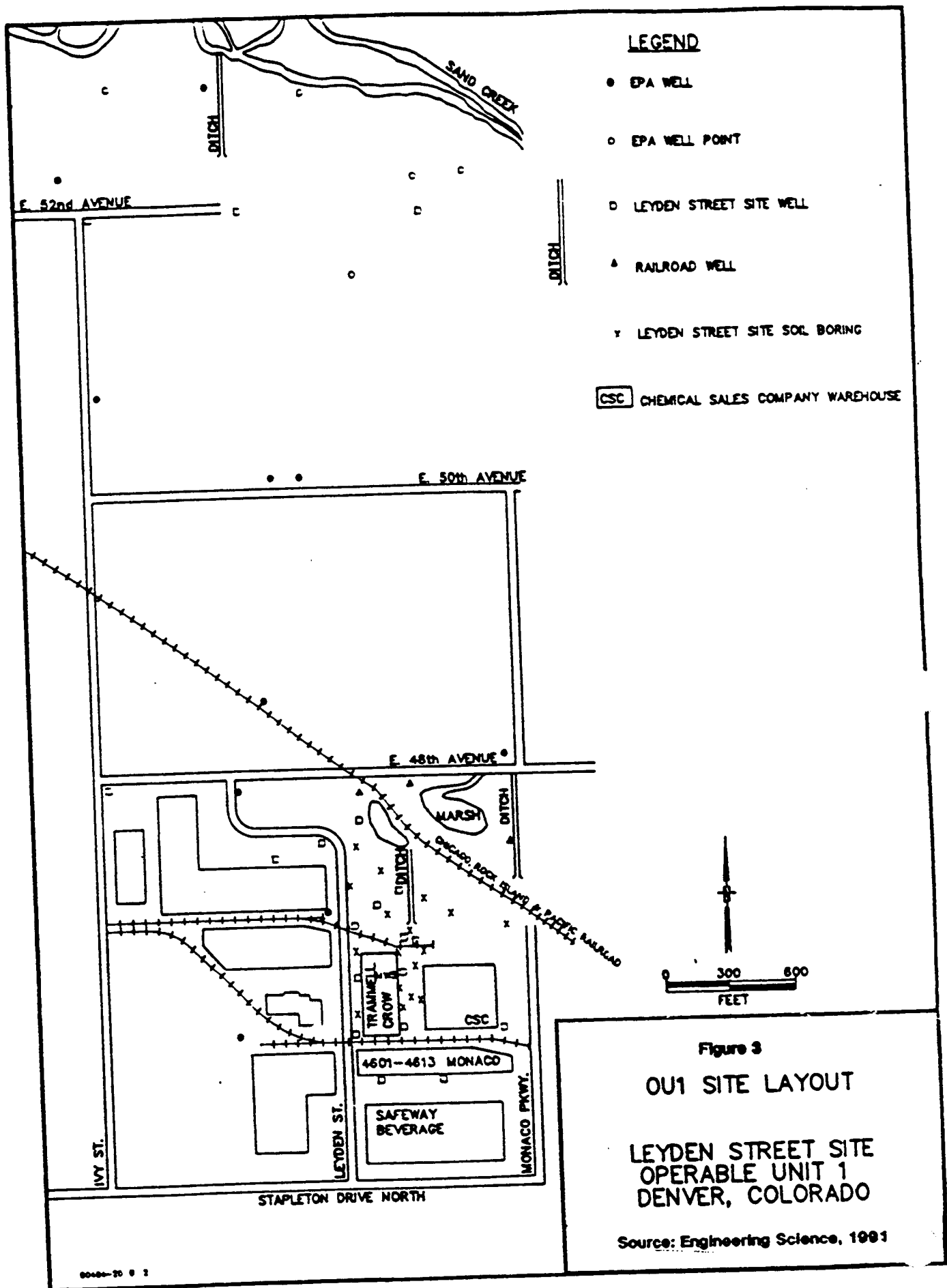




The subject of this Record of Decision (ROD) is CSC OU1. This OU includes the CSC property located at 4661 Monaco Parkway in Denver, Colorado. The topography within OU1 slopes northward toward Sand Creek. Elevations range from 5,200 feet near Sand Creek to 5,265 feet Above Mean Sea Level (AMSL) in the southeastern corner of OU1. Natural topographic features have been extensively modified by construction and earthwork. A relatively abrupt change in the natural topography occurs as a terrace in the vicinity of East 48th Avenue, where there is as much as a 50 foot change in elevation to the north. This slope roughly parallels East 48th Avenue from Leyden Street, and then parallels the Chicago, Rock Island & Pacific Railroad (Figure 3). The northern portion of OU1 lies within the Sand Creek floodplain. Sand Creek, which forms the northern boundary of OU1, is the primary discharge point for drainage ditches in OU1. Approximately three miles downstream (northwest of OU1), Sand Creek enters the South Platte River.

Two drainage ditches were identified in the southern portion of OU1. The drainage ditch near the CSC site (located on the northern portion of CSC property) drains the CSC property north of the CSC warehouse and tank farm. The other ditch originates at a culvert beneath the Chicago Rock Island & Pacific Railroad and terminates at a culvert at the intersection of Monaco Parkway and East 48th Avenue.

The property located adjacent to the western boundary of the CSC property is owned by the Interstate Distribution Center Associates (IDCA), LTD. The Trammell Crow Company acts as an agent for IDCA. The figures of this ROD text refer to the building constructed on the IDCA property as the "Trammell Crow" building. Prior to the preparation and construction of this building at 4650 Leyden St., a drainage swale existed which provided surface drainage from the CSC property. This drainage



swale extended from just south of the CSC tank farm across what is now the IDCA property.

Groundwater within CSC OU1 flows northward into CSC OU2. Groundwater in the CSC OU2 area is the principal source of domestic drinking water for the South Adams County Water and Sanitation District (SACWSD). SACWSD supplies water to approximately 30,000 customers. The majority of the SACWSD municipal water supply is derived from the alluvial aquifer. A total of six alluvial aquifer production wells are currently in use within OU2.

The land use within OU1 is largely industrial. Six residences are located in the northern portion of OU1. One residence is located on East 50th Avenue and the others are located on East 52nd Avenue. All of the residences within OU1 are connected to the SACWSD system.

Railroad spurs located to the north and south of the CSC warehouse service the CSC. Chemicals are transported in bulk to the CSC facility by train and are unloaded along these railroad spurs.

Most of the OU1 population consists of workers who commute from outside OU1 to jobs in the office and warehouse buildings. Other than the few residences in the northern portion of OU1, the predominant land use consists of commercial offices and warehouses, with a gravel mining operation along Sand Creek in the northernmost portion of OU1.

Past and present surface and subsurface storage units and other structures on the CSC OU 1 property include several underground and above ground chemical storage tanks and drums. The size of these tanks ranges from 5,000 to 15,000 gallons, and they contain a variety of organic chemicals and acids. Several underground

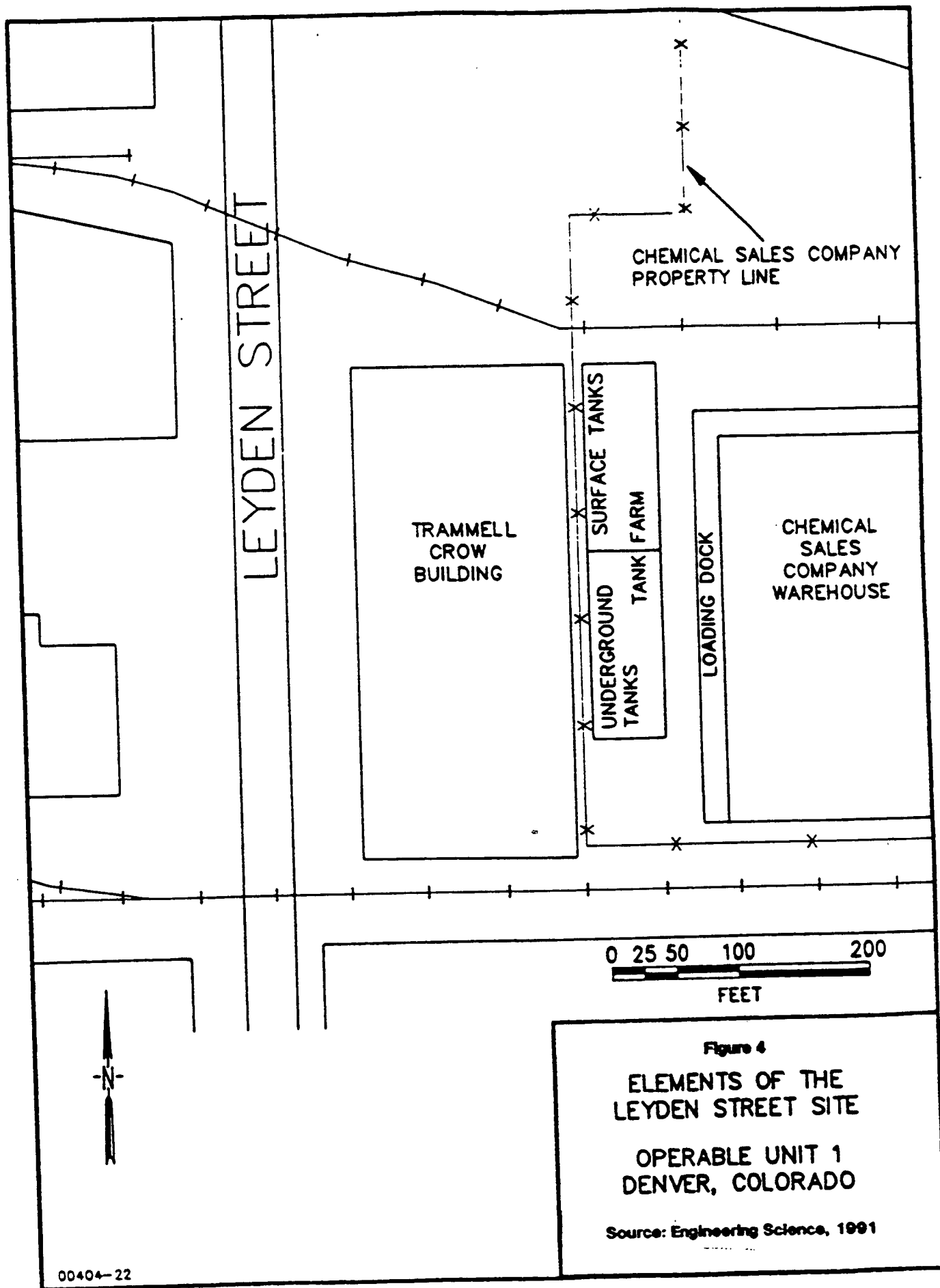
tanks have been removed from the CSC property. The CSC storage tanks are located along the western boundary of the CSC property (Figure 4).

II. SITE HISTORY AND ENFORCEMENT ACTIVITIES

Initial Investigations

In 1981, the Environmental Protection Agency (EPA) conducted a random national survey of drinking water systems. During this survey, several organic chemicals were detected in SACWSD alluvial municipal water supply wells. Additional sampling in 1982 and 1985 confirmed these results. As a result of these findings, EPA began a RI/FS for an area named the "Off-Post Rocky Mountain Arsenal (RMA) OU 1" (Off-Post RMA OU1). This area extended from Sand Creek to the south; East 80th Avenue to the north; the South Platte River to the west; and the western border of the RMA to the east. The RI/FS was completed in December 1986. The RI results consistently indicated widespread contamination by chlorinated volatile organic compounds in groundwater along the eastern portion of the study area. The selected alternative was a permanent water treatment system for SACWSD water. A Record of Decision was signed in June 1987 which implemented the construction of the Klein Treatment Plant, which began operating in October 1989. In addition, approximately 400 residents within the CSC OU2 site were connected to SACWSD.

The adjacent RMA was suspected as one of the sources of groundwater contaminants in the former Off-Post study area because of the history of waste disposal on that site. Further investigation by EPA indicated that additional source areas were potentially contributing to contamination detected within the study area.



In April 1986, the EPA Field Investigation Team (FIT) conducted a soil gas survey of a 65-acre area near East 48th Avenue. Elevated trichloroethene (TCE) values were discovered on the north side of the rail spur in the northern portion of the CSC property. In August 1986, EPA's FIT installed monitoring wells in the area where elevated soil gas TCE values were observed. These wells were sampled by the FIT in late August and early September 1986. A full description of these field investigation activities and a summary of the data obtained through these efforts are provided in the following reports:

- * South Adams Soil Gas Survey (E&E 1986a)
- * I-270 and Quebec Street (E&E 1986b)
- * E. 48th Ave. and Leyden Street (E&E 1986c)
- * E. 50th Ave. and Ivy Street (E&E 1986d)
- * E. 56th Ave. and Magnolia (E&E 1987).

The results of these studies indicated the release of hazardous substances into groundwater from the CSC property. As a result of this finding and subsequent scoring of the site based on the Hazard Ranking System (HRS), EPA proposed the CSC site for the National Priorities List (NPL) in June 1988. This listing was finalized in August 1990.

EPA issued the CSC a Special Notice Letter in August 1988, requesting that CSC conduct a RI/FS for the CSC site. CSC notified EPA that the company would not undertake the RI/FS for the entire CSC site. In June 1989, EPA subdivided the groundwater RI/FS activities into two separate OUs for the CSC site (OU1 and OU2) and requested that CSC conduct a RI/FS for OU1. In August 1989, CSC submitted a good faith offer to EPA to conduct the RI/FS for OU1. In September 1989, EPA and CSC entered into an Administrative Order (AO) on Consent (Docket No.

CERCLA-VIII-90-03) requiring CSC to conduct a RI/FS for CSC OU1.

As a result of site characterization activities conducted during the OU1 RI/FS, hazardous substances in the form of chlorinated volatile organic compounds were detected in soils within the IDCA property boundaries at 4650 Leyden Street (noted as "Trammell Crow" on figures). As a result of this finding, EPA issued general notice to IDCA in October 1990 notifying IDCA that it was considered a Potentially Responsible Party (PRP) for the CSC Superfund site.

Chemical Sales Company Operations

In 1962, a warehouse was constructed at 4661 Monaco Parkway. Between 1962 and 1976, the warehouse was occupied by Samsonite, and then by Gates Rubber Company. These companies reportedly used the facility solely as a product warehouse. CSC purchased and occupied the facility in October 1976. All existing surface and underground storage tanks, pipelines, and appurtenances were installed between October 1976 and February 1977.

There have been three reported chemical releases of hazardous substances into the soil and groundwater at the site from the CSC facility. The first occurred on August 21, 1985, when approximately 200 gallons of methylene chloride were released as a result of a spigot breaking off during chemical transfer (Colorado Department of Health, 1986a). The second release occurred on March 28, 1986, when contaminated rainwater in the transfer pipe gallery was discharged into a nearby drainage ditch (Colorado Department of Health 1986b). Sampling conducted by the Colorado Department of Health indicated that methylene chloride, chloroform, and 1,1,1-trichloroethane (1,1,1-TCA) were present in the discharge. The third release was a methanol spill which occurred on May 9, 1990, when approximately 3,700 gallons of

methanol were spilled on the ground surface in the area of the CSC tank farm (Foster, 1990).

Remedial Investigation/Feasibility Study

As stated previously, on September 29, 1989, an AO on Consent was issued to the CSC requiring the company to conduct a RI/FS to characterize the nature and extent of contamination and identify and evaluate alternatives to address the identified contamination. The remedial investigation included geophysical surveys, drilling and sampling 45 soil borings, installing and sampling 22 groundwater monitoring wells, and collecting six surface water samples.

The RI/FS report, completed in February 1991, indicates that hazardous substances are present in soils and groundwater in portions of OU1. The contaminated aquifer of concern is a shallow, unconsolidated aquifer which is not presently used as a drinking water source within OU1. This alluvial aquifer, however, supplies drinking water for approximately 30,000 people further downgradient in the CSC OU2 area. The source areas contributing to the observed groundwater contamination have been identified as contaminated soils within the properties owned by CSC (4661 Monaco Parkway) and IDCA (4650 Leyden St).

As part of the RI/FS, EPA prepared a Baseline Risk Assessment (RA) in October 1989 to estimate potential health and environmental risks which could result if no action were taken in CSC OU1. The RA indicated that exposure to groundwater and soil contaminants at the CSC OU1 site could result in significant unacceptable risks to public health. Details of the RA are summarized in Section VI of this ROD.

III. HIGHLIGHTS OF COMMUNITY INVOLVEMENT

Community interest in the groundwater contamination in South Adams County was very intense in 1985 and early 1986 when the problem first became public. The initial blame was placed on the Rocky Mountain Arsenal, which was adjacent to the contaminated public water supply area and already receiving significant media attention. Local citizens formed a very vocal group Citizens Against Contamination (CAC), which held a number of well attended public meetings (over 600 people attended the March 6, 1986 meeting). CAC kept the issue in the press and in the attention of local, State, and federal politicians. EPA and the Army responded to numerous public and media inquiries, issued press releases for new developments, and attended the public meetings. Community relations activities were coordinated among the EPA, the Army, and the south Adams County Water and Sanitation District (SACWSD). The State conducted a separate program.

Public interest subsided in mid-1986 after a temporary water treatment system funded by the Army and the EPA came into operation at SACWSD and was made available to the affected residences. In the fall of 1986, EPA named the Chemical Sales site as a source of groundwater contamination. EPA has since issued a number of fact sheets discussing the progress of the investigation and activities at the site. The Chemical Sales site was also included in joint community relations activities with several other south Adams County superfund sites.

The Proposed Plan for OU2 was issued to the public concurrently with proposed plans for OU1 and OU3 on February 25, 1991. The proposed plan and RI/FS reports were made available to the public in the Administrative Record maintained at the EPA Region VIII Superfund Records Center in Denver, Colorado. A notice of availability for these documents was published in the Denver Post

and Rocky Mountain News on February 28, 1991; in the Commerce City Beacon February 27, 1991; and in the Commerce City Express on March 5, 1991. The public comment period was open from February 28 to April 1, 1991. The public meeting was held March 14, 1991 at the Commerce City Recreation Center. A transcript of the public meeting is included in the Administrative Record. At this meeting, EPA representatives answered questions about the site and discussed the remedial alternatives under consideration. Responses to comments received during the public comment period on the proposed plan are presented in the Responsiveness Summary section of this ROD.

IV. SCOPE AND ROLE OF OPERABLE UNIT WITHIN SITE STRATEGY

The CSC Superfund site has been divided into three OUs. OU1 addresses the source area located in the vicinity of the CSC property and groundwater contamination south of Sand Creek. OU2 addresses the groundwater plume emanating from OU1 and other groundwater contamination located north of Sand Creek. OU3 addresses residential exposure to contaminated alluvial groundwater through use of domestic private wells and domestic water supplied by the SACWSD.

The remedy selected in this ROD is for OU1. This remedy addresses the contaminated soil on the CSC and IDCA property and contaminated groundwater south of Sand Creek emanating from these properties. The groundwater poses an unacceptable risk to human health and the environment due to ingestion, and inhalation during showering, of contaminants in groundwater above existing or proposed Maximum Contaminant Levels (MCLs) as established by the Safe Drinking Water Act or exceeding the 10^{-6} risk level. Due to high concentrations of PCE, and other solvents, there is a strong possibility that pools and pockets of liquid PCE or other solvents are present at the site. These contaminants in their liquid form are called dense non-aqueous phase liquids (DNAPLs).

If detected, they will present a source of groundwater contamination and thus a "principal threat" to public health and the environment.

Contaminated groundwater in CSC OU1 migrates northward into OU2. A reduction in the mass of contaminants within OU1 will result in a subsequent reduction in concentration of contaminants in groundwater within the OU2 area.

In addition, surficial soils pose an unacceptable risk through ingestion and inhalation of contaminants associated with contaminated soils.

V. SITE CHARACTERISTICS

Site Geology and Hydrology

The northern portion of OU1 (north of East 48th Avenue) lies within the Sand Creek flood plain, which is part of the South Platte River System. The topography, distribution of surficial deposits, and the materials encountered during drilling suggest that the southern portion of OU1 (south of 48th Avenue) is a terrace comprised of Slocum Alluvium beneath eolian sand, silt and clay. The terrace was most likely formed by renewed downcutting of the Sand Creek tributary of the South Platte River.

The alluvial aquifer below OU1 is generally composed of fine to coarse, poorly sorted sands and occasional gravels containing silt and clay. North of East 48th Avenue, the aquifer appears to be composed of coarser grained sand and gravel compared to the area south of East 48th Avenue.

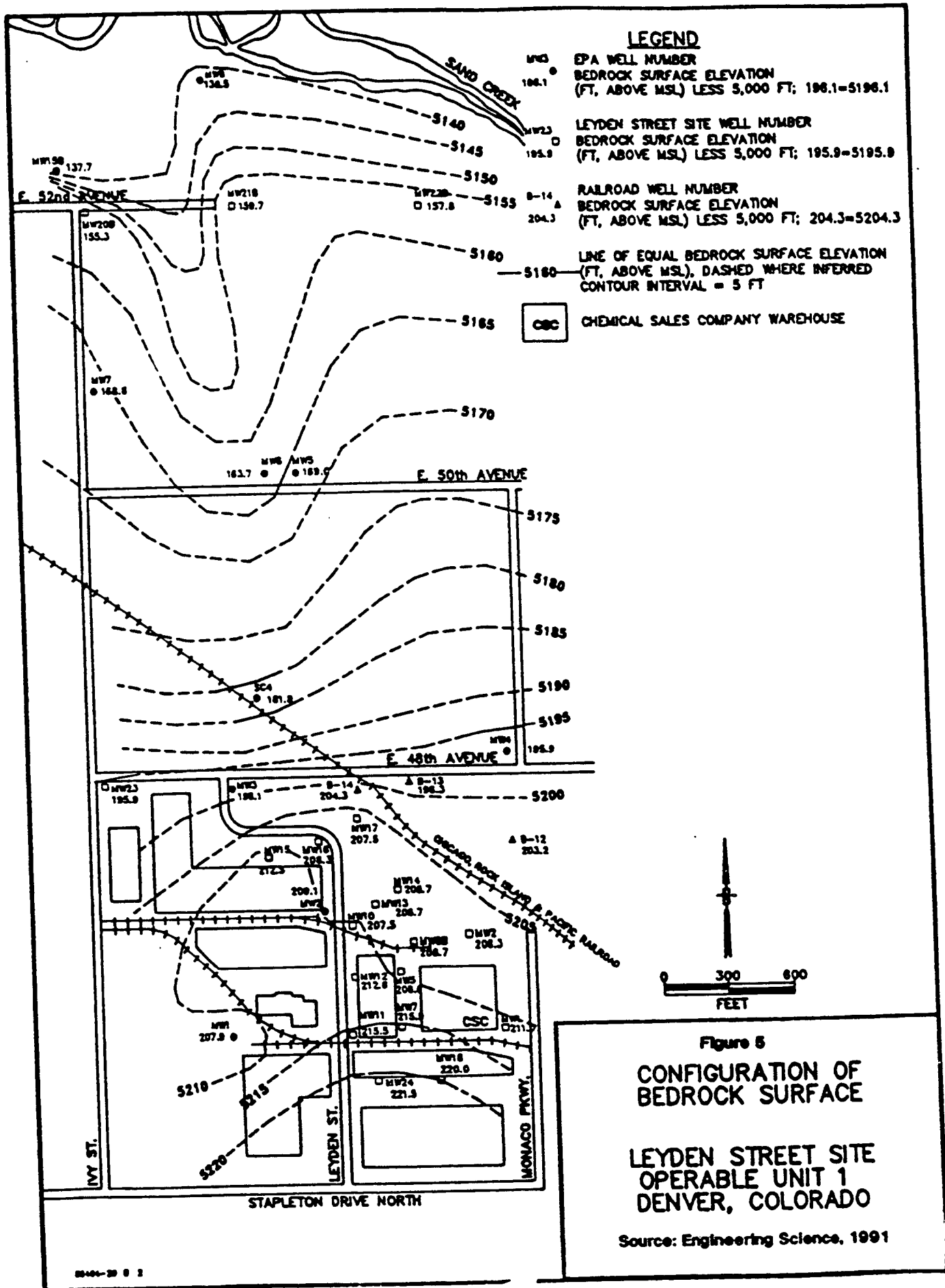
The alluvial aquifer is underlain by shale, siltstone, and sandstone of the Denver Formation. The bedrock surface of the

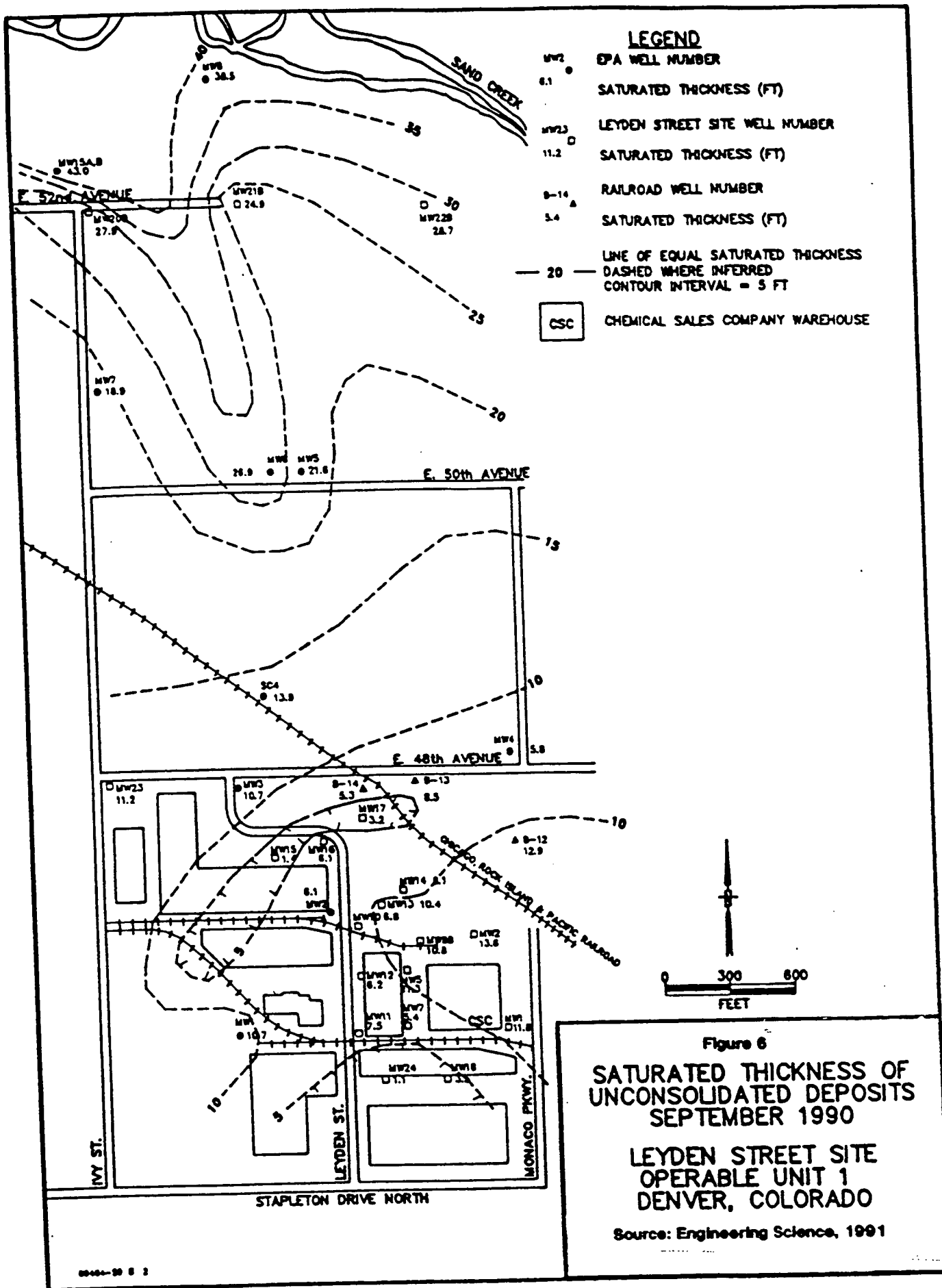
Denver Formation reflects the erosional development of the South Platte River Valley, and is characterized by isolated bedrock highs and paleochannels. In general, the bedrock surface exhibits a regional northward slope, with maximum elevations occurring in the southern portion of OU1 and minimum elevations in the northern portion of OU1 (Figure 5). As illustrated in Figure 5, a paleochannel may be present within OU1, trending north-northwestward toward Sand Creek.

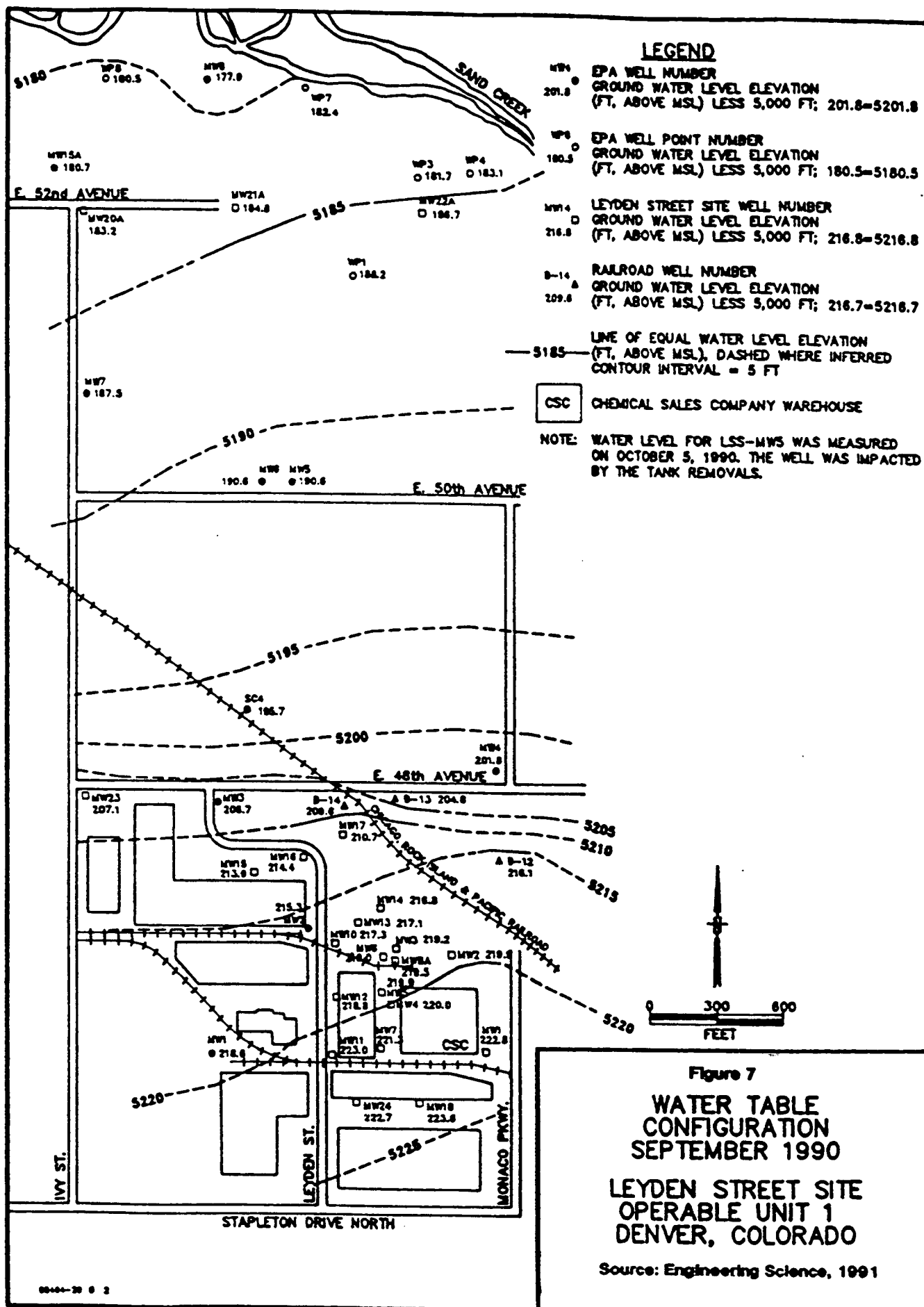
Depths to groundwater beneath OU1 generally decrease from south to north toward Sand Creek. The decreased depth to water toward the north corresponds to an increase in saturated thickness. Figure 6 illustrates the saturated thickness of the alluvial aquifer.

The water table shown in Figure 7 indicates that the alluvial groundwater flows in a northerly to northwesterly flow direction. Because of the increase in the presence of coarser-grained sand and gravel from south to north, the alluvial groundwater velocity increases three-fold north of East 48th Avenue. South of East 48th Avenue, the groundwater flow velocity is estimated to be approximately 1 ft/day. North of East 48th Avenue, the groundwater flow velocity is estimated to be approximately 10 ft/day.

Sand Creek does not act as a barrier to northward groundwater migration. This determination is based on the (1) detection of contaminants in groundwater north of Sand Creek, (2) lack of detection of contaminants in Sand Creek (based on data collected for the Sand Creek Industrial RI (1988)) and (3) the occurrence of unnatural perennial discharges associated with the Aurora Wastewater Treatment Plant located upstream. The artificial flows probably exceed Sand Creek's base flow during most of the year, and thus some portion of its flow infiltrates to the







underlying aquifer resulting in dilution of the contaminant plume.

Additional efforts to determine groundwater/surface water interactions in this portion of Sand Creek have included gauging and installation of piezometer nests, but the results of those studies were inconclusive.

Nature and Extent of Contamination

The RI for CSC OU1 included an investigation of the groundwater, soils, surface water and air media. Based on data collected during these investigations, the surface water medium was determined not to be of concern with regard to contaminant pathways at the Site.

The RI investigatory activities were divided into three separate phases (Phases I - III). During Phase I, a soil gas survey and geophysical survey were conducted to identify potentially contaminated areas requiring further characterization. Soil borings and monitoring wells were installed during Phase II to determine the areal extent of soil and groundwater contamination. Additional soil borings and monitoring wells were installed in Phase III. Ambient air data were also collected during this phase.

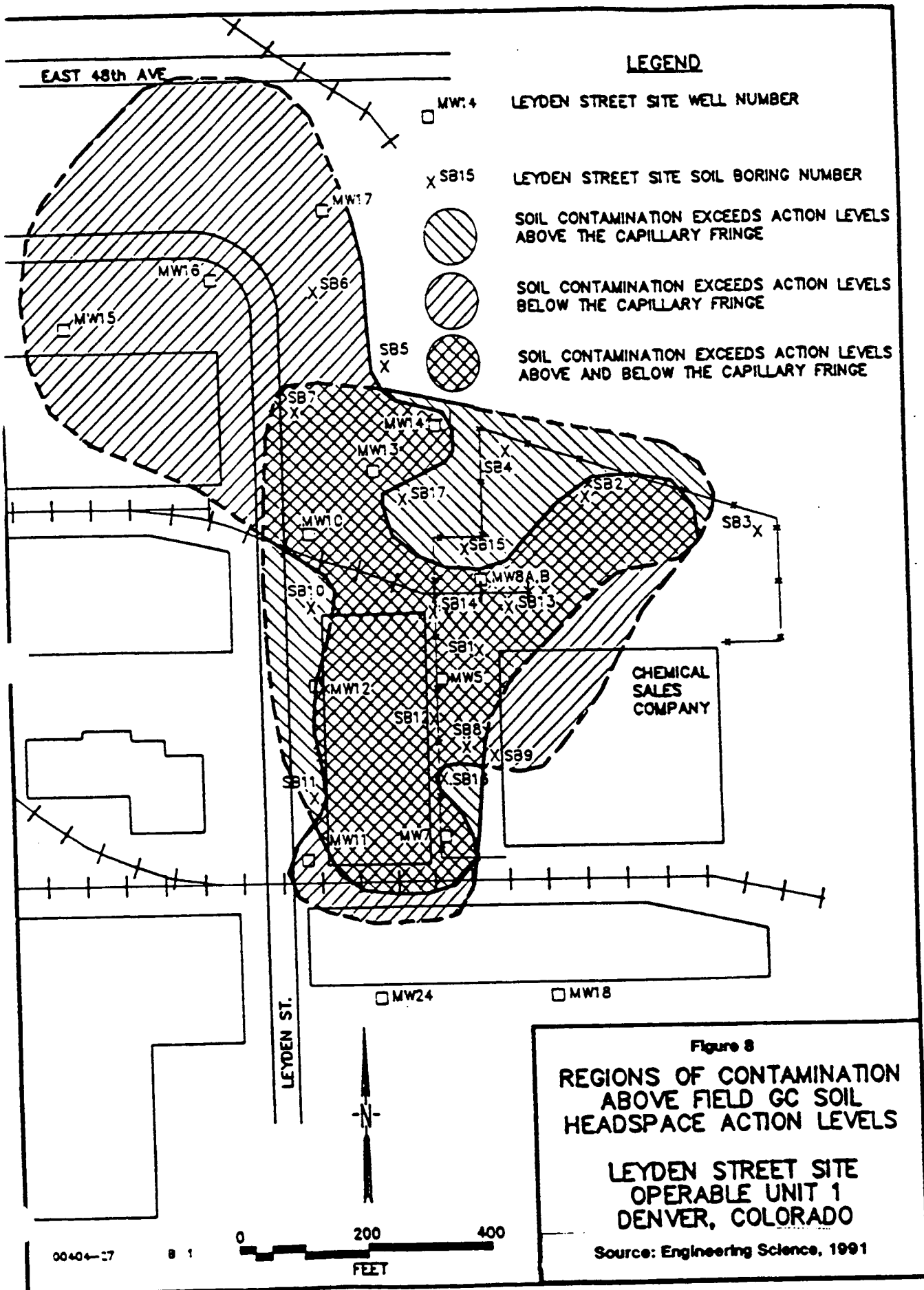
Soil Contamination. Forty-five (45) soil borings were installed during the RI to characterize the nature and extent of soil contamination. Soil headspace measurements were taken for soils at 5-foot depth intervals. Measurements were based on readings of soil headspace made with a field gas chromatograph (GC). Gas chromatograph readings of the soil headspace were initially conducted as a preliminary screen to determine the presence or absence of contaminants in the soil. During Phase II soil sampling, approximately 30 percent of soil samples displaying

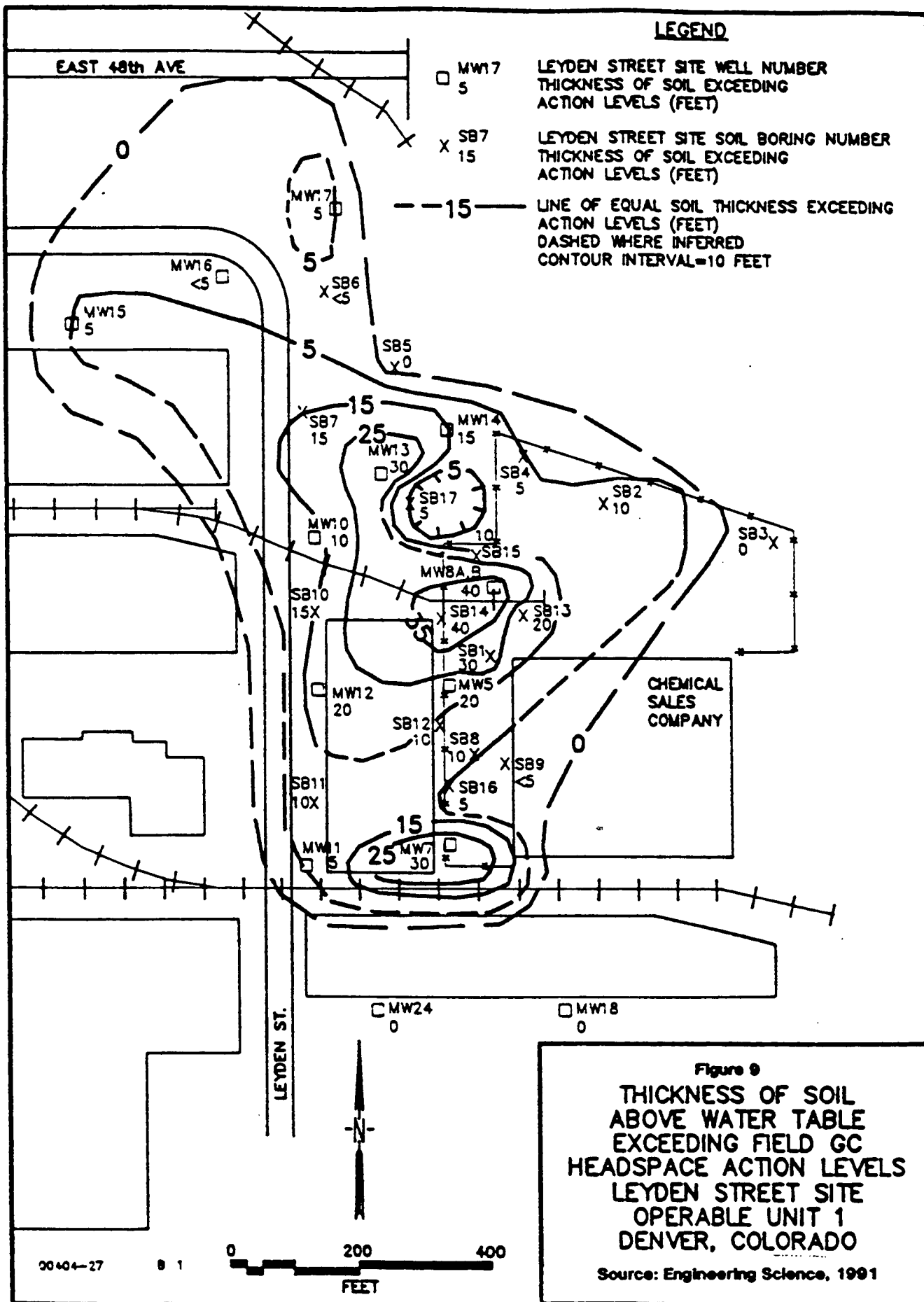
soil gas detections were submitted for laboratory analysis. Due to analytical discrepancies and difficulties associated with both soil field GC headspace analysis and laboratory analysis of soil, all samples registering soil headspace detections were submitted for laboratory analysis during the Phase III investigation.

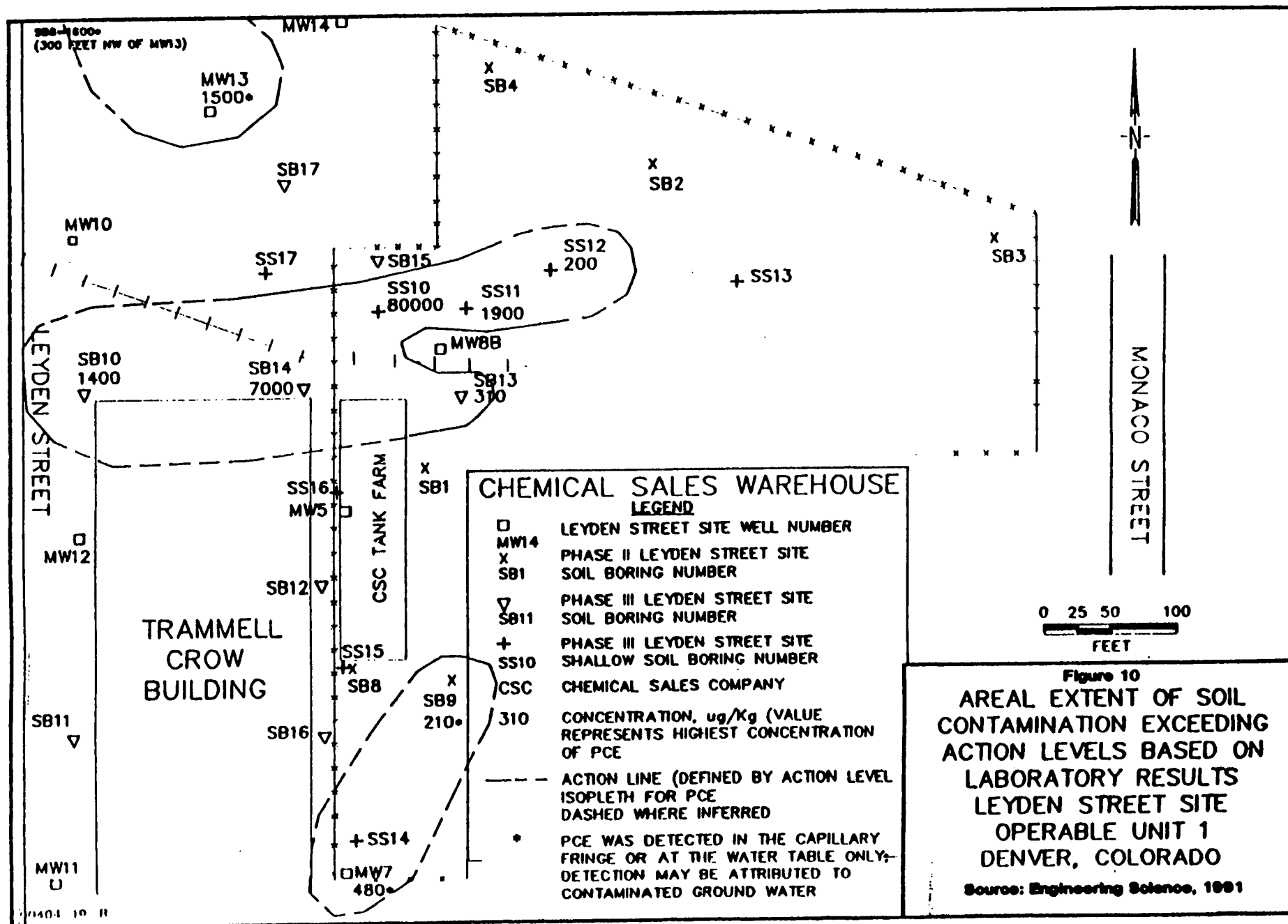
RI investigations indicated the presence of hazardous substances in the soil media in the vicinity and within the properties owned by CSC and IDCA. The areal extent of soil contamination based on soil headspace GC measurements is presented in Figure 8. The vertical extent of the soil contamination based on measurements is presented in Figure 9. Contamination is present in the soils and capillary fringe areas. (The capillary fringe is located between the water table and vadose zone). Soil contamination indicated by the laboratory analyses is presented in Figure 10. The contaminated areas outlined in these figures represent the soil zones contributing to groundwater contamination.

Discrepancies between soil and soil headspace data can be attributed to: (1) lack of adequate laboratory confirmation by laboratory analysis of soil samples during Phase II sampling; (2) loss of volatiles prior to laboratory analysis of soils during Phase II sampling; and (3) difficulties in comparing concentrations of contaminants detected in the soil vapor and of contaminants bonded to the soil (through a process referred to as adsorption); and (4) lack of precision and accuracy of soil headspace data.

EPA has determined that the extent of soil contamination requiring remediation should be based on the field GC head space data as depicted in Figure 8. Field GC head space data for CSC OU1 are more comprehensive than laboratory data collected for the site. In addition, the potential for loss of volatiles prior to laboratory analysis was minimized for the GC head space analyses since samples were analyzed immediately following sampling.







Contaminants were detected in the surficial soil, throughout the soil column, and in the capillary fringe area. This contamination is the principal source of alluvial groundwater contamination within OUI. Potential sources of the observed soil contamination include: (1) organic solvents stored at CSC tank farm; (2) surface drainage from the CSC property; (3) leaks and spills from rail cars during unloading operations; and, (4) releases during CSC operations. The following chemicals of concern (COCs) were detected in the soil:

Tetrachloroethylene (PCE),
Trichloroethylene (TCE),
1,1-Dichloroethylene (DCE),
cis-1,2-Dichloroethylene (cis-1,2-DCE),
1,1,1-Trichloroethane (TCA),
1,1 Dichloroethane (DCA), and
Methylene chloride.

A description of each of the four source areas is provided below.

CSC Tank Farm. The CSC tank farm is located within the western boundary of the CSC property. CSC has stored various acids and organic solvents in this area (See Figure 11 and Table 1). The tank contents reported in Table 1 were current as of the date of the final RI report (Engineering Science, 1991). High concentrations of the COCs have been detected in soil and groundwater immediately northwest of this area. High soil-gas detections of the compounds PCE, TCE, and 1,1,1-TCA were also observed in the southern portion of the CSC tank farm. PCE has been and is currently being stored aboveground in the northwestern portion of the CSC surface tank farm (presently stored in Tank T-17, Figure 11).

TABLE 1 (Continued)

SUMMARY OF UNDERGROUND AND ABOVEGROUND TANK DATA
LEYDEN STREET SITE
OPERABLE UNIT 1
DENVER, COLORADO

Tank ID	Date Installed	Size (gallons)	Dimensions (feet)	Tank Contents	Remarks
Aboveground Tanks					
S-1	1977	1,500	NA	Empty	
S-2	1977	1,500	NA	Empty	
S-3	1977	1,500	NA	Empty	
S-4	1977	1,500	NA	Empty	
S-8	1977	3,000	NA	Odorless Mineral Spirits	
S-9	1977	5,000	NA	Stoddard® Solvent	Petroleum Distillate
S-10	1977	4,000	NA	140 Solvent	Petroleum Distillate
T-13	1977	10,000	NA	Methylene Chloride	
T-14	1977	15,000	NA	Empty	
T-15	1977	15,000	NA	Chlorothene SM	1,1,1-Trichloroethane
T-16	1977	15,000	NA	Chemtrex	Petroleum Distillate
T-17	1977	20,000	NA	Dowper	Tetrachloroethylene
T-18	1977	15,000	NA	Hydrochloric Acid	Hazardous Substance
T-19	1977	13,000	NA	Hydrochloric Acid	Hazardous Substance
T-20	1977	5,000	NA	Sulfuric Acid	Hazardous Substance
T-21	1977	5,000	NA	Nitric Acid	Hazardous Substance
T-22	1977	4,000	NA	Stoddard® Solvent	

NA = information not available.

TABLE 1
SUMMARY OF UNDERGROUND AND ABOVEGROUND TANK DATA
LEYDEN STREET SITE
OPERABLE UNIT 1
DENVER, COLORADO

Tank ID	Date Installed	Size (gallons)	Dimensions (feet)	Tank Contents	Remarks
Underground Tanks					Underground Tanks T-1 through T-12 removed as of June 1990
T-1	1976	10,000	9 x 21	Empty	
T-2	1976	5,000	8 x 16	Butyl Cellosolve	2-butoxyethanol
T-3	1976	10,000	9 x 21	Xylene	Hazardous Substance
T-4	1976	10,000	9 x 21	Isopropyl Alcohol (95%)	Isopropanol
T-5	1976	15,000	11 x 21	Toluene	Hazardous Substance
T-6	1976	15,000	11 x 21	Methyl Ethyl Ketone	Hazardous Substance
T-7	1976	15,000	11 x 21	Xylene	Hazardous Substance
T-8	1976	15,000	11 x 21	Acetone	Hazardous Substance
T-9	1976	15,000	11 x 21	Methanol	
T-10	1976	15,000	11 x 21	Isopropyl Alcohol (99%)	Isopropanol
T-11	1976	15,000	11 x 21	Dow Frost	Propylene Glycol
T-12	1976	15,000	11 x 21	VM & P Naptha	
#13	NA #/	6,000	NA	Unleaded Gasoline	Dates of tank installation and dimensions for #13 and #14 are unknown; tanks were already installed when Chemical Sales Company purchased the property.
#14	NA	10,000	NA	Diesel Fuel	

Surface Drainage of the CSC Property. Prior to site preparation for the IDCA building (4661 Leyden St.), a drainage swale extended from just south of the CSC tank farm across what is now the IDCA property (Legal Memorandum on the Defenses to Liability of IDCA, 1991). This swale potentially provided a pathway for releases of hazardous substances on the CSC property. The railroad spur, north of the tank farm, may potentially have caused ponding of surface drainage from the CSC property. Soil contamination has been detected in close proximity to the swale and suspected ponding area.

Railroad Spur. Another potential primary source for the identified soil and groundwater contamination is the railroad spur immediately north of the tank farm. Chemicals are delivered to CSC via the rail spur, and have been stored in rail cars parked on the spur. Leaks and spills during unloading operations could have contributed to the contamination at that location. PCE, 1,1,1-TCA, and other chemicals are transferred directly from rail cars into the surface tanks via fill pipes and hoses. Soil and groundwater contamination has been detected in the vicinity of the railroad spur north of the CSC tank farm.

Releases During CSC Operations. Several documented releases of hazardous substances have been reported resulting from CSC operations. On August 21, 1985, approximately 200 gallons of methylene chloride were released. On March 28, 1986, contaminated rainwater in the transfer pipe gallery was discharged into a nearby drainage ditch. Additionally, on May 9, 1990, 3700 gallons of methanol were spilled on the ground surface in the area of the CSC tank farm. Several releases of acid fumes have also been reported. On February 13, 1990, the Denver Fire Department

responded to an acid release reported from CSC property. The fire department evacuated workers from nearby buildings, including 4650 Leyden, and treated several workers for the inhalation of acid fumes. Three additional releases of acid fumes have been reported and investigated by the Denver Fire Department. These releases occurred on the following dates: August 2, 1990; September 11, 1990; and February 16, 1991.

Groundwater Contamination. During the Remedial Investigation, 36 groundwater monitoring wells were sampled and analyzed for volatile organic compounds, semi-volatile organic compounds, total and dissolved metals, and anions. As a result of this effort, a groundwater contaminant plume was identified in the alluvial aquifer, emanating from the CSC and IDCA properties. The direction of contaminant migration is to the north-northwest. The following COCs have been identified for the groundwater medium:

- PCE,
- TCE,
- 1,1,1-TCA,
- 1,1-DCE,
- 1,1-DCA,
- cis-1,2-DCE,
- Vinyl chloride,
- Methylene chloride, and
- Carbon tetrachloride.

Groundwater data collected for the COCs during the RI are provided in Table 2. The data indicate the presence of high concentrations of volatile organic compounds (VOCs) in the groundwater beneath the CSC and IDCA properties and in an area approximately three hundred feet northwest of the CSC tank farm. PCE has been detected at concentrations as high as 30 parts per

TABLE 2
LABORATORY GROUND WATER QUALITY SUMMARY TABLE
FOR TARGET VOLATILE ORGANIC COMPOUNDS
LEYDEN STREET SITE
OPERABLE UNIT 1
DENVER, COLORADO

SAMPLE ID	Date Sampled	DF w/ b/	Vinyl Chloride µg/L b/	Methylene Chloride µg/L	1,1-Dichloro- ethene µg/L	1,2-Dichloro- ethene(Total) µg/L	trans-1,2- Dichloroethene µg/L	Carbon Tetrachloride µg/L
LSS WELLS SAMPLED DURING PHASES II AND III								
LSS-MW05-G01	02-23-90	100	0.51	15,000	500	500 U d/	500 UM d/	500 U
LSS-MW07-G01	01-29-90	10,100	100 U	50 U	40 J	320	0 M	50 U
LSS-MW08A-G01	02-12-90	1	10 U	1 J	14	5 U	5 UM	5 U
LSS-MW08B-G01	02-12-90	1	10 U	1 J	14	5 U	5 UM	5 U
LSS-MW10-G01	02-20-90	20	200 U	2 J g/	80 J	100 U	100 UM	100 U
LSS-MW11-G01	02-21-90	20	200 U	3 J g/	150	100 U	100 UM	100 U
LSS-MW12-G01	03-28-90	1,100	0.19 J	90 g/	990 D	340 E b/	0 M	5 U
LSS-MW13-G01	04-02-90	1,100,500	1.12	39,000	17,000 D	5 U	5 UM	5 U
LSS-MW14-G01	04-02-90	1,100	10 U	1 J g/	120	6	0 M	19
LSS-MW15-G01	04-13-90	1,100	10 U	0 g/	170	130	0 M	5 U
LSS-MW16-G01	04-04-90	1,100	10 U	0 g/	5,700 D	120 J	0 M	5 U
LSS-MW17-G01	04-03-90	10,50,500	100 U	6 g/	1,200	64	0 M	50 U
LSS-MW18-G01	03-30-90	1	0.20 U	4 J g/	5 U	5 U	5 UM	5 U
LSS-MW20A-G01	03-29-90	1	10 U	7 g/	22	31	0 M	5 U
LSS-MW20B-G01	03-30-90	1	10 U	11 g/	6	25	0 M	5 U
LSS-MW21A-G01	04-12-90	1,20	3.37	0 g/	9	22	0 M	5
LSS-MW21B-G01	04-03-90	1,10	10 U	0 g/	8	25	0 M	5 U
LSS-MW21B-G01(f.dup)/	04-03-90	1,10	10 U	0 g/	9	25	0 M	5 U
LSS-MW22A-G01	04-25-90	1	10 U	0 g/	5 U	5 U	5 UM	5 U
LSS-MW22B-G01	04-25-90	1	10 U	0 g/	3 J	6	0 M	5 U
LSS-MW23-G01	08-08-90	1	10 U	0 g/	10	5 U	5 U	5 U
LSS-MW23-G01(f.dup)	08-08-90	1	10 U	0 g/	5 U	5 U	5 U	5 U
LSS-MW24-G01	09-14-90	1	10 U	0 g/	5	5 US j/	5 U	5 U

TABLE 2 (Continued)
 LABORATORY GROUND WATER QUALITY SUMMARY TABLE
 FOR TARGET VOLATILE ORGANIC COMPOUNDS
 LEYDEN STREET SITE
 OPERABLE UNIT 1
 DENVER, COLORADO

SAMPLE ID	Date Sampled	DF u/ b/	Vinyl Chloride µg/L b/	Methylene Chloride µg/L	1,1-Dichloro- ethene µg/L	1,2-Dichloro- ethene(Total) µg/L	trans-1,2- Dichloroethene µg/L	Carbon Tetrachloride µg/L
WELLS SAMPLED IN SEPTEMBER 1990								
FIT-MW01-G01	09-07-90	1	10 U	5 U	5 U	5 US	5 U	5 U
FIT-MW02-G01	09-06-90	10,1000	100 U	5 g/	480	190 S	2 J	50 U
FIT-MW03-G02	09-07-90	1,10	10 U	5 U	51	23 S	5 U	61
FIT-MW15A-G01	09-04-90	1	10 U	5 U	5 U	5 S	5 U	5 U
FIT-MW15B-G01	09-05-90	1	10 U	5 U	22	44 S	5 U	5 U
SC04-G01	09-06-90	1,50	5 J	0 g/	64	260 DS	2 J	5 U
FIT-WP04-G01	09-05-90	1	5 J	0 g/	26	60 S	5 U	5 U
RR-B13-G01	09-12-90	1	10 U	5 U	1 J	5 US	5 U	2 J
RR-B14-G01	09-12-90	1,20	30	3 J g/	290 D	190 S	5 U	14
RR-B14-G01(f.dup)	09-12-90	1,10,100	35	4 J g/	310 D	150.0 S	5 U	29
WELLS SAMPLED IN NOVEMBER 1989								
LSS-MW01	11-08-89	1	1.8 U	2.0 U	1.3 U	NQ W/	1.0 U	1.2 U
LSS-MW06	11-07-89	50	1.8 U	11,436	593	NQ	1.0 U	1.2 U
FIT-MW03	11-03-89	1	1.8 U	2.0 U	49	NQ	1.0 U	1.2 U
FIT-MW04	11-03-89	1	1.8 U	2.0 U	1.3 U	NQ	1.0 U	1.2 U
FIT-MW05	11-03-89	1	1.8 U	2.0 U	42	NQ	1.0 U	1.2 U
FIT-MW07	11-07-89	1	1.8 U	2.0 U	1.3 U	NQ	1.0 U	1.2 U
FIT-MW08	11-02-89	1	1.8 U	2.0 U	19	NQ	1.0 U	1.2 U
FIT-WP-01	11-06-89	1	1.8 U	2.0 U	1.3 U	NQ	1.0 U	1.2 U

TABLE 2 Continued
LABORATORY GROUND WATER QUALITY SUMMARY TABLE
FOR TARGET VOLATILE ORGANIC COMPOUNDS
LEYDEN STREET SITE
OPERABLE UNIT 1
DENVER, COLORADO

SAMPLE ID	Date Sampled	DF #	cis-1,2-Di- chloroethene µg/L	1,1-Dichloro- ethane µg/L	1,2-Dichloro- ethane µg/L	1,1,1-Tri- chloroethane µg/L	Trichloro- ethene µg/L	Tetrachloro- ethene µg/L
LSS WELLS SAMPLED DURING PHASES II AND III								
LSS-MW05-G01	02-23-90	100	500 UM	290 J #	500 U	820	1,400	6,700
LSS-MW07-G01	01-29-90	10,100	320 M	50 U	50 U	160	910	4,900 D //
LSS-MW08A-G01	02-12-90	1	5 UM	5 U	5 U	140	18	34
LSS-MW08B-G01	02-12-90	1	5 UM	5 U	5 U	160	19	91
LSS-MW10-G01	02-20-90	20	100 UM	100 U	100 U	1,300	850	1,700
LSS-MW11-G01	02-21-90	20	100 UM	100 U	100 U	460	5,000	1,300
LSS-MW12-G01	03-28-90	1,100	340 EM	35	5 U	8,200 D	4,700 D	10,000 D
LSS-MW13-G01	04-02-90	1,100,500	5 UM	190	25	12,000 D	5,900 D	17,000 D
LSS-MW14-G01	04-02-90	1,100	6 M	5 U	5 U	1,300 D	370 E	2,100 D
LSS-MW15-G01	04-13-90	1,100	130 M	6	5 U	1,300 D	2,300 D	4,900 D
LSS-MW16-G01	04-04-90	1,100	120 JM	5 U	5 U	3,400 D	5,500 D	10,000 D
LSS-MW17-G01	04-03-90	10,50,500	64 M	50 U	50 U	7,200 D	9,500 D	30,000 D
LSS-MW18-G01	03-30-90	1	5 UM	5 U	5 U	5 U	5 U	3 J
LSS-MW20A-G01	03-29-90	1	31 M	12	5 U	5 U	37	55
LSS-MW20B-G01	03-30-90	1	25 M	13	5 U	14	34	44
LSS-MW21A-G01	04-12-90	1,20	22 M	5 U	5 U	18	440 D	50
LSS-MW21B-G01	04-03-90	1,10	25 M	5 U	5 U	8	740 D	12
LSS-MW21B-G01(f.dup)	04-03-90	1,10	25 M	4 J	5 U	7	620 D	16
LSS-MW22A-G01	04-25-90	1	5 UM	5 U	5 U	2 J	6	10
LSS-MW22B-G01	04-25-90	1	6 M	5 U	5 U	7	27	39
LSS-MW23-G01	08-08-90	1	5 U	5 U	5 U	25	4 J	4 J
LSS-MW23-G01(f.dup)	08-08-90	1	5 U	5 U	5 U	5 U	5 U	5 U
LSS-MW24-G01	09-14-90	1	5 U	5 U	5 U	9	87	15

TABLE 2^a (Continued)
 LABORATORY GROUND WATER QUALITY SUMMARY TABLE
 FOR TARGET VOLATILE ORGANIC COMPOUNDS
 LEYDEN STREET SITE
 OPERABLE UNIT 1
 DENVER, COLORADO

SAMPLE ID	Date Sampled	DF ^{d/}	cis-1,2-Di- chloroethene µg/L	1,1-Dichloro- ethene µg/L	1,2-Dichloro- ethene µg/L	1,1,1-Tri- chloroethene µg/L	Trichloro- ethene µg/L	Tetrachloro- ethene µg/L
WELLS SAMPLED IN SEPTEMBER 1990								
FIT-MW01-G01	09-07-90	1	5 U	5 U	5 U	5 U	1 J	13
FIT-MW02-G01	09-06-90	10,1000	190	11 J	50 U	7,200 D	2,000	5,500 D
FIT-MW03-G02	09-07-90	1,10	23	1 J	5 U	500 D	970 D	1,500 D
FIT-MW15A-G01	09-04-90	1	5	6	5 U	16	32	56
FIT-MW15B-G01	09-05-90	1	44	18	5 U	5 U	31	26
SC04-G01	09-06-90	1,50	260 D	8	5 U	520 D	320 D	1,100 D
FIT-WP04-G01	09-05-90	1	60	29	1 J	17	24	16
RR-B13-G01	09-12-90	1	5 U	5 U	5 U	11	6	13
RR-B14-G01	09-12-90	1,20	190	23	1 J	1,300 D	940 D	3,700 D
RR-B14-G01(f.dup)	09-12-90	1,10,100	150 D	27	5 U	2,300 D	1,000 D	3,300 D
WELLS SAMPLED IN NOVEMBER 1989								
LSS-MW01	11-08-89	1	NA U	0.7 U	0.3 U	0.3 U	1.2 U	19
LSS-MW06	11-07-89	50	NA	485	0.3 U	13,769	9,450	14,300
FIT-MW03	11-03-89	1	NA	4	0.3 U	295	1,172	626
FIT-MW04	11-08-89	1	NA	0.7 U	0.3 U	0.3 U	1.2 U	0.3 U
FIT-MW05	11-03-89	1	NA	9	0.3 U	116	60	42
FIT-MW07	11-07-89	1	NA	30	0.3 U	0.3 U	12	19
FIT-MW08	11-02-89	1	NA	9	0.3 U	28	168	38
FIT-WP-01	11-06-89	1	NA	0.7 U	0.3 U	100	69	47

^{a/} DF = dilution factors. Data was derived from multiple sample dilution results.

^{b/} µg/L = micrograms per liter.

^{c/} U = compound was analyzed for, but not detected.

^{d/} M = value was derived from mass spectrum inspection.

^{e/} J = compound is present at a concentration below the sample quantitation limit.

^{f/} D = Compound was identified at a secondary dilution factor.

^{g/} Methylene Chloride results have been corrected for associated method blank contamination.

^{h/} E = Concentration of the compound exceeded the calibration range of the instrument.

^{i/} (f.dup) = Field duplicate of preceding sample.

^{j/} S = Value was derived from the summation of values for cis-1,2 dichloroethene and trans-1,2 dichloroethene.

^{k/} NQ = not quantifiable.

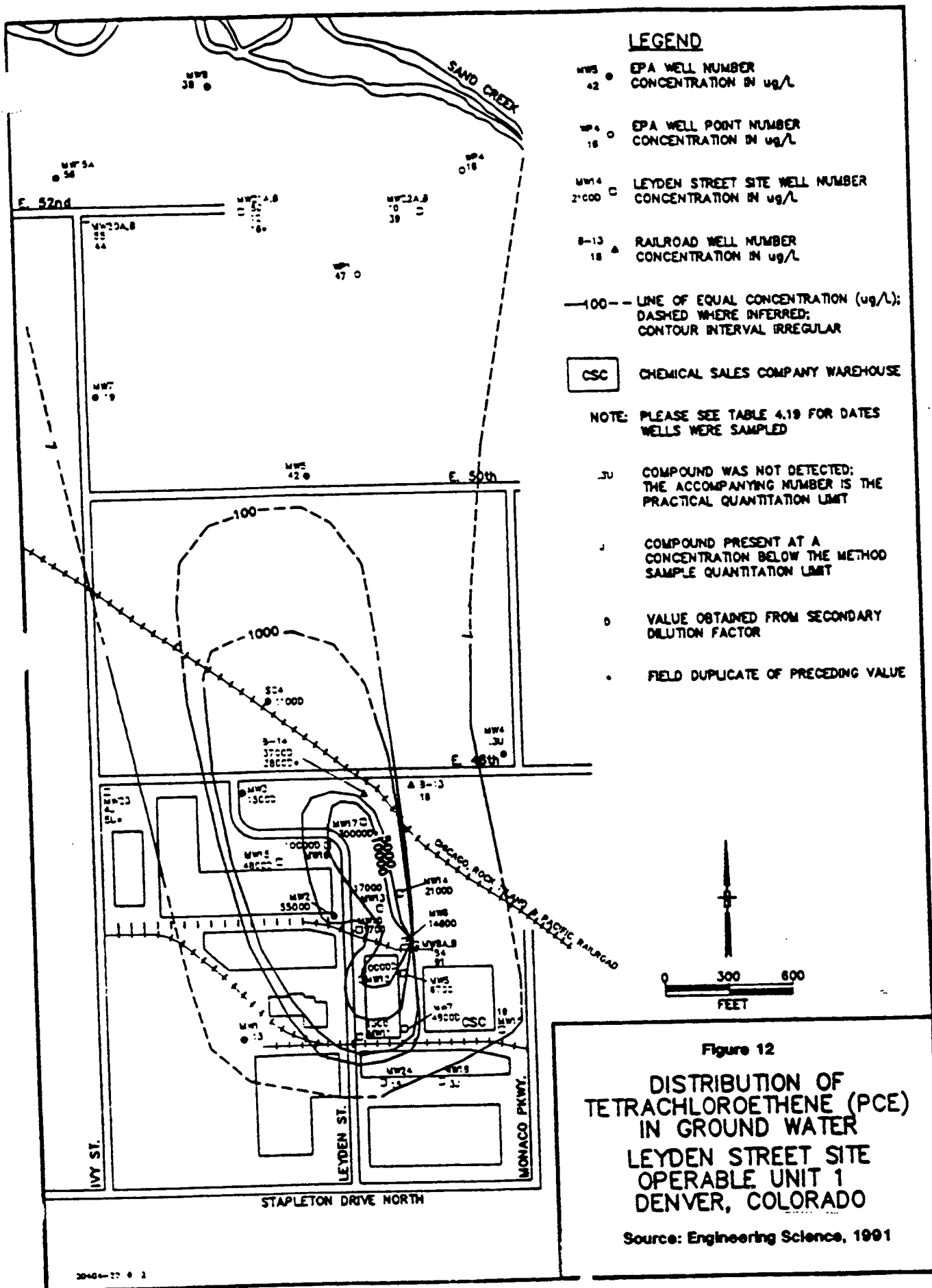
^{l/} NA = not analyzed.

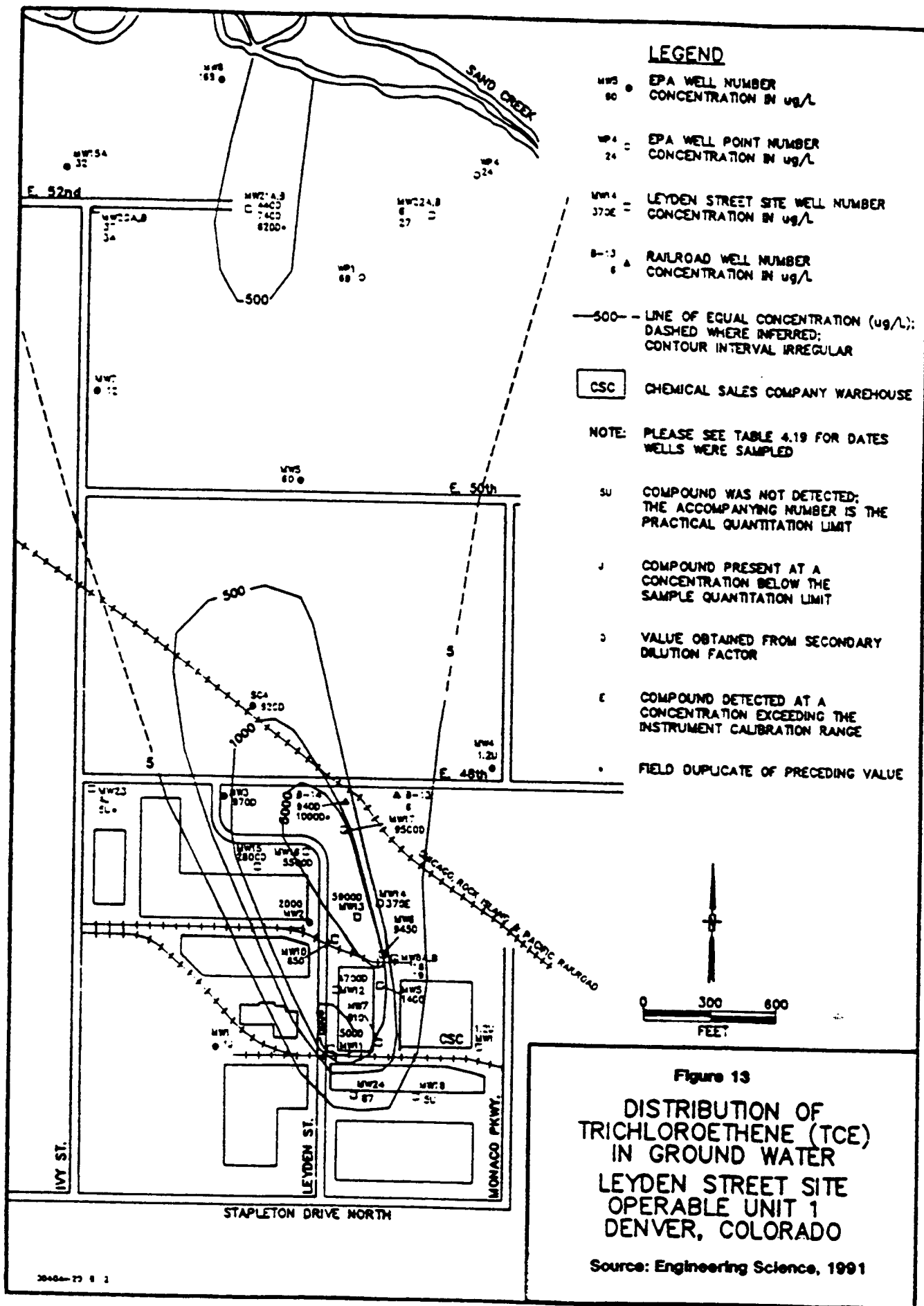
million (Well LSS-MW17). The highest TCE concentrations detected were 9.5 parts per million (Well LSS-MW17).

The concentrations of groundwater contaminants decrease significantly, and the width of the groundwater plume increases, toward the northern portion of OU1. Concentrations of contaminants in the groundwater decrease by an order of magnitude immediately north of Sand Creek. This is most likely a result of dilution due to groundwater recharge from the Creek. Figures 12 and 13 depict the areal extent of groundwater contamination due to PCE and TCE, respectively. The areal distribution of these two chemicals is representative of the distribution of all CSC OU1 groundwater COCs with respect to areal extent of contamination and physical and chemical behavior.

In the liquid phase, all of the COCs, with the exception of vinyl chloride, are heavier than water and tend to sink in an aquifer. Contaminants which are heavier than water are called dense non aqueous-phase liquids (DNAPLs). DNAPLs have greater mobility as a separate phase than lighter-than-water non aqueous-phase liquids (referred to as LNAPLs) due to their relatively low solubility, high density and low viscosity. Because of their low solubility, DNAPLs do not readily mix with water. If a small volume is spilled, it flows downward under gravity until reaching a residual saturation in the vadose zone. It can partition into the vapor phase, with dense vapors sinking to the capillary fringe. Infiltrating waters can dissolve residual constituents, including vapors, and carry them to the groundwater.

If a large volume of a DNAPL is spilled, the liquid may penetrate into the aquifer as a separate phase liquid and pool above an impermeable barrier. In the aquifer, the liquid will remain until dissolved by the groundwater. Groundwater contaminant concentrations in excess of 10 percent of the chemical's solubility limit may indicate the presence of a pure DNAPL source





in the aquifer. PCE has been detected at levels approaching 20 percent of its solubility limit in the suspected source areas of OU1, indicating a pure PCE residual may exist as a long-term source of contamination. However, the RI did not locate such a source.

Once dissolved, the COCs are transported in the direction of the groundwater flow, and travel at a rate somewhat lower than the rate of groundwater movement. All of the COCs are relatively mobile in groundwater. The estimated rate of groundwater migration is about one foot per day (south of East 48th Avenue) and about 10 feet per day (north of East 48th Avenue).

The COCs (except vinyl chloride) for OU1 can be degraded by aerobic and anaerobic bacteria. The compounds are degraded through dehalogenation. Anaerobic biodegradation of the COCs may generate vinyl chloride, which is more toxic than its precursors. Vinyl chloride was detected in groundwater from 8 monitoring wells. The highest vinyl chloride concentration was observed at 30 parts per billion. Three of the vinyl chloride detections were observed north of East 48th Avenue (Wells FIT-SC4, FIT-WP4, and LSS-MW21A). These detections are most likely the result of the biodegradation of COCs. Subsequent biodegradation of the vinyl chloride is not a significant process under normal environmental conditions.

VI. SUMMARY OF SITE RISKS

Actual or threatened releases of hazardous substances from this OU, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

CERCLA mandates that EPA select remedies that protect human health and the environment from current and potential exposures

to hazardous substances. Therefore, EPA has conducted a Baseline RA to evaluate the risk posed by the presence of contaminants at CSC OU1. The risk analysis resulting from EPA's Baseline RA was used for the CSC FS and for this ROD. This risk assessment was carried out to characterize the current and potential threats to human health and environment which exist at this OU in the absence of any remedial action.

For a risk to exist, three components must be present: (1) a source of contamination; (2) a pathway for contaminants to reach humans, plants or animals; and (3) a population that could potentially be exposed. If any of the three components is missing, no risk can exist.

The key component of any health risk assessment is the amount of chemical reaching the population. This is known as the dose. For any given dose, there are two general types of toxic responses: non-carcinogenic and carcinogenic (cancer-causing).

Non-carcinogenic risks are calculated by assuming that there is a dose below which no adverse health effects will occur. These calculations are usually based on results of animal studies and include a number of additional conservative assumptions to take into account what the estimated risk is to humans. For such chemicals, exposures less than this dose (referred to as the "reference dose" (RFD)) will result in no toxic effects. Potential concern for non-carcinogenic effects of a single contaminant in a single medium is expressed as the hazard quotient (HQ) or the ratio of the estimated intake derived from the contaminant concentration in a given media referred to as the chronic daily intake (CDI) to the reference dose (RFD). By adding the HQs for all contaminants within a medium or across all media to which a given population may be reasonably be exposed, the Hazard Index can be generated. The HI provides a useful reference point for gauging the potential significance of

multiple contaminant exposures within a single medium or across media.

For carcinogens, it appears that there is no safe dose. Instead, the risk of cancer becomes smaller and smaller as the dose decreases. Cancer potency factors (CPFs) are used for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. Excess lifetime cancer risks are determined by multiplying the intake level with the cancer potency factor. These risks are probabilities that are generally expressed in scientific notation (i.e., 1×10^{-6} or $1E^{-6}$). An excess lifetime cancer risk of 1×10^{-6} indicates that an individual has a one in one million chance of developing cancer as a result of site-related exposure to a carcinogen over a 70-year lifetime under the specific exposure conditions at the site. A risk in the range of 10^{-4} to 10^{-6} is considered to be acceptable. EPA generally uses 10^{-6} as a goal in evaluating cleanup alternatives. However, other factors, such as exposure, availability of chemical-specifics ARARs, technical limitations, background concentrations, and uncertainties may result in the setting of a different goal.

Contaminants and Toxicity Assessment

CSC RI results indicate contamination in the soil, groundwater, and air media. In order to characterize site risk at CSC OU1, the RA identified nine COCs for the groundwater and soil media at the CSC OU1. These chemicals were identified based on the concentrations at the site, frequency of detection, toxicity, physical/chemical properties that affect mobility, and prevalence/persistence in these media. A listing of these chemicals is presented in Section V. They were determined to represent the total potential health and environmental risks at the Site.

The COCs for OU1 are a diverse group of volatile chlorinated hydrocarbon solvents. Most of the chemicals are central nervous system depressants and either liver or kidney toxins at high doses. Six of the COCs are carcinogenic (PCE, TCE, Methylene Chloride, Carbon Tetrachloride, 1,1-DCA, and 1,2 DCE). The carcinogenic potency of a compound is represented by its cancer potency factor (CPF). The CPFs for OU1 COCs are presented in Appendix A. DCE and PCE are generally the carcinogens present at the highest concentrations in the groundwater, soil and soil gas. The potential for the COCs identified for OU1 to cause noncarcinogenic health effects varies widely. The RFDs for the COCs are presented in Tables 1-11, 1-12, 1-13 and 1-14 of Appendix A.

Land Use

Land use within OU1 was assessed based on a survey conducted by the Tri-County Health Department of Colorado. The land use within OU1 is largely industrial. The OU1 population is comprised mostly of workers who commute from outside OU1 to jobs in the office and warehouse buildings within the Site. Six residences are located in the northern portion of OU1. One residence is located on East 50th Avenue and the others are located on East 52nd Avenue. All of the residences within OU1 are connected to the SACWSD system. The alluvial groundwater within OU1, however, is considered to be a potential future drinking water source for OU1 residences. In addition, contaminated groundwater within the CSC OU1 area flows northward into the CSC OU2 area. Alluvial groundwater within the OU2 area is the principal source of water for domestic uses in Commerce City.

Based on an analysis of current and future land use, risk calculations have been performed for three different populations that could be exposed to contaminants present at the OU1 area:

industrial workers, current residents and hypothetical future on-site residents. Based on the current land use, industrial land use (i.e., occupational exposure) exists for the area south of East 48th Avenue. This area is currently zoned for industrial and commercial uses. Risks for a "current resident" were assessed based on residential land use north of East 48th Avenue. Residential land use exists in the area north of East 48th Avenue. In order to assess future residential exposure for a "hypothetical future resident" at the site, potential risk associated with residential land use in the area south of East 48th Avenue was evaluated. Because this area is currently zoned for industrial and commercial uses, it is unlikely that residential land use will exist in this area within the next few years. There is a possibility, however, that future residential development may occur within the current industrial area during the time period required to implement the remedial alternatives evaluated in this ROD.

There are no endangered species at the CSC OU1 area. Potential environmental receptors include aquatic habitat, wildlife and vegetation within the Sand Creek floodplain. The alluvial aquifer is a Class I aquifer as described in EPAs Groundwater Protection Strategy.

Exposure Assessment

The results of site investigations conducted under the CSC RI indicated the presence of contaminants in the soil, groundwater, and air media. Based on these results and the evaluation of land use at the site, the following potential exposure pathways were quantitatively evaluated:

1. Ingestion of groundwater contaminants in drinking water and inhalation of volatilized contaminants through showering (industrial, current and future residential

land uses). No site residents within OU1 are currently exposed to contaminated groundwater.

2. Dermal contact with COCs during showering (industrial, existing and future residential land uses).

In addition, the following existing exposure pathways were quantitatively evaluated:

1. Direct contact and incidental ingestion of contaminated soil (industrial and future residential land uses).
2. Inhalation of onsite ambient air (industrial). For future residents, a potential pathway exists regarding inhalation of vapors from soil and groundwater contaminants in basements. Due to the high degree of uncertainty associated with quantitatively assessing risk from this pathway through use of the Garbesi and Sextro model (1989), risks for this pathway are presented qualitatively. Basement VOC exposure is not evaluated for this reason since a validated basement exposure model was not available at the time the risk assessment was prepared. Such potential risks will be reevaluated during the 5 year review to ensure the remedies selected are protective.

Since only undetectable amounts of groundwater contaminants discharge into Sand Creek, it was determined that a complete pathway does not exist for the environmental receptors within OU1.

Concentrations of contaminants used to estimate current and potential risk were based on the 95 percentile confidence limit of the geometric mean of data collected for the groundwater, soil and air media. These concentrations are presented in Appendix A.

Exposure assumptions used to determine the average amount of chemical in contact with a particular individual are also presented in Appendix A. These estimates represent Reasonable Maximum Exposure scenarios.

The highest exposure potential is associated with current workers and future residents. This represents potential exposure based on current and future use of the area south of East 48th Avenue. This risk potential represents both existing and potential pathways. In the case of current workers, there is no indication that groundwater is used for any domestic or commercial purpose in the area. The future resident scenario would require conversion of the current industrial area (south of East 48th Avenue) to residential use.

Risk Characterization

The baseline risk assessment quantitatively estimated potential noncarcinogenic and carcinogenic risks posed by the COCs in various media at CSC OU1. As stated previously, noncarcinogenic risk is presented as the fraction of the daily dose of a given chemical which is estimated to result in no adverse health effects. Carcinogenic risk is presented as a probability value (i.e., the chance of developing cancer over a lifetime). These risk estimates are conservative and many overestimate the actual risk due to exposure. A summary of noncarcinogenic and carcinogenic risk at CSC OU1 is presented in Tables 3 and 4. A description of these risk is presented below.

Industrial Land Use, Noncarcinogenic Risk. High concentrations of contaminants in groundwater pose a large noncarcinogenic aggregate risk of 75 due to ingestion (HI of 62) and inhalation (HI of 13) of contaminants during drinking and showering with contaminated groundwater. Soil contamination does not pose a significant noncarcinogenic risk.

TABLE 3

**SUMMARY OF CANCER RISKS BY PATHWAY FOR
POTENTIAL RECEPTORS AT THE CHEM SALES OUI SITE**

Exposure Pathway	Current Workers	Current Residents	Future Residents	Future Children
<u>Groundwater Pathways</u>				
Ingestion of ground water	4×10^{-2}	3×10^{-4}	1×10^{-1}	NE
Inhalation of VOCs during showering	2×10^{-2}	4×10^{-4}	9×10^{-2}	NE
Direct contact with VOCs during showering	3×10^{-6}	1×10^{-7}	8×10^{-6}	NE
Total Risk for Groundwater Pathways	6×10^{-6}	7×10^{-4}	1×10^{-1}	NE
<u>Soil Pathways</u>				
Direct contact with surface soil (dermal absorption)	2×10^{-6}	NE	6×10^{-6}	1×10^{-4}
Incidental ingestion of surface soil	7×10^{-7}	NE	7×10^{-7}	9×10^{-5}
Total Risk for Soil Pathways	2×10^{-6}	NE	6×10^{-6}	1×10^{-4}
Inhalation of VOCs in outdoor ambient air	5×10^{-5}	NE	NE	4×10^{-5}
Total Risk for Air Pathways	5×10^{-5}	NE	NE	4×10^{-3}
TOTAL RISK	6×10^{-2}	7×10^{-4}	2×10^{-1}	3×10^{-4}

NE = Not Evaluated

TABLE 4

SUMMARY OF NONCARCINOGENIC RISKS (HAZARD INDICES) BY PATHWAY
FOR POTENTIAL RECEPTORS AT THE CHEM SALES OUI SITE

Exposure Pathway	Current Workers	Current Residents	Future Residents	Future Children
<u>Groundwater Pathways</u>				
Ingestion of ground water	62	0.3	84	NE
Inhalation of VOCs during showering	13	0.2	26	NE
Direct contact with VOCs during showering	0.006	0.00005	.01	NE
Total Risk for Groundwater Pathway	75	0.5	110	NE
<u>Soil Pathways</u>				
Direct contact with surface soil (dermal absorption)	0.0001	NE	0.3	3.9
Incidental ingestion of surface soil	0.003	NE	.003	0.02
Total Risk for Soil Pathway	0.003	NE	0.3	3.9
Inhalation of VOCs in outdoor ambient air	0.007	NE	NE	0.01
Total Risk for Air Pathway	0.007	NE	NE	0.01
TOTAL HAZARD INDEX	75	0.5	110	4.0

NE = Not Evaluated

Industrial Land Use, Carcinogenic Risk. High concentrations of contaminants in groundwater present a high potential cancer risk (5.4×10^{-2}) due primarily to ingestion and inhalation of contaminants during drinking and showering with contaminated groundwater. In addition, inhalation of COCs in outdoor ambient air and dermal absorption of contaminants through direct contact with soil contamination exceeds EPA's 10^{-6} acceptable risk point of departure. The risk posed through inhalation of ambient air is estimated at 5×10^{-5} . The risk posed through dermal contact of contaminated soils is 2×10^{-6} . The total cancer risk posed to this population (workers) is 6×10^{-2} . The chemicals contributing the largest potential risk are DCE and PCE.

Existing Residential Land Use, Noncarcinogenic Risk. Concentrations of contaminants in the groundwater decrease significantly north of East 48th Avenue. Due to this factor, a hazard index of less than 1.0 was determined for the groundwater pathway. Soil contamination has not been detected in the existing residential area.

Existing Residential Land Use, Carcinogenic Risk. Potential carcinogenic risk posed to current site residents is based solely on the groundwater media. Due to the decrease in concentration of groundwater contamination in the existing residential area (north of East 48th Avenue), potential carcinogenic risk posed through ingestion and inhalation of contaminants during drinking and showering with contaminated groundwater is much less than either the worker or future resident exposure scenarios. This risk is estimated at 7×10^{-4} . This potential risk, however, still exceeds EPA's acceptable risk range of 10^{-4} to 10^{-6} .

Future Residential Land Use, Noncarcinogenic Risk.

Potential noncarcinogenic risks posed to future site residents are associated with the groundwater and soil media. Noncarcinogenic risk at the Site are the highest for this population because this scenario assumes residential habitation in the most highly contaminated areas. CDI estimates are higher for residents than workers due to a higher frequency and duration of exposure. The estimated potential noncarcinogenic aggregate risk associated with the groundwater media is 110.

Future Residential Land Use, Carcinogenic Risk. Potential carcinogenic risks posed to future site residents are associated with contamination detected in the groundwater and soil media. Children were identified as the most sensitive group of this population. Potential carcinogenic risks associated with the groundwater media is 1×10^{-1} . Potential carcinogenic risk for children through exposure to contaminated surficial soils is 2×10^{-4} due to direct contact, incidental ingestion and inhalation. Inhalation of contaminants in basements constructed in areas of high concentration of soil and groundwater contaminants would most likely present unacceptable carcinogenic and noncarcinogenic risk.

Results

The results of the CSC OU1 RA indicate that contaminants detected within this OU pose an unacceptable potential risk to site workers and current and future site residents. Risks posed to these populations exceed the 10^{-4} risk level. These risks represent hypothetical exposure since groundwater is not currently used for domestic indoor uses and no basements exist within OU1.

Based on the results of the RA, two actual or existing pathways pose unacceptable risks to public health at CSC OU1. These pathways relate to soil contamination at the Site. Carcinogenic risk posed through inhalation of volatile COCs in the ambient air by site workers is estimated at 5×10^{-5} risk, and posed through dermal contact with surficial soils is estimated at 2×10^{-6} risk. These risks exceed EPA's 10^{-6} point of departure.

Groundwater Remediation Levels

Federal regulations require that maximum contaminant level goals (MCLGs) established under the Safe Drinking Water Act, and that are set at levels above zero, shall be attained by remedial actions for ground or surface waters that are current or potential sources of drinking water, where the MCLGs are relevant and appropriate under the circumstances of the release based on the factors in 40 CFR §300.400(g)(2). If an MCLG is determined not to be relevant and appropriate, the corresponding maximum contaminant level (MCL) shall be attained where relevant and appropriate to the circumstances of the release.

Where the MCLG for a contaminant has been set at a level of zero, the MCL promulgated for that contaminant under the Safe Drinking Water Act shall be attained by remedial actions for ground or surface waters that are current or potential sources of drinking water, where the MCL is relevant and appropriate under the circumstances of the release based on the factors in 40 CFR § 300.400(g)(2).

In cases involving multiple contaminants or pathways where attainment of chemical-specific ARARs will result in cumulative risk in excess of 10^{-4} , other criteria in paragraph (e)(2)(i)(A) of 40 CFR Part 300.400 cleanup level to be attained.

Maximum Contaminant Level Goals (MCLGs) exist for some of the CSC OU1 COCs. All of these MCLGs are set at zero and therefore are not considered in establishing groundwater remediation levels. MCLs for CSC OU1 are available for TCE, 1,1-DCE, Cis-1,2-DCE, vinyl chloride and carbon tetrachloride. The cumulative risk associated with exposure to groundwater contamination at the MCLs for these compounds is 1×10^{-4} based on the ingestion and inhalation of contaminants.

MCLs are drinking water standards for specific chemicals that are enforceable for public drinking water systems. These standards are "relevant and appropriate" requirements for establishing acceptable groundwater remediation levels of contaminants in groundwater. Proposed MCLs are "To Be Considered" (TBCs) for establishing acceptable groundwater remediation levels in the groundwater for those chemicals without a promulgated Federal or State standard. For those chemicals without a promulgated MCL, State standard, or proposed MCL, acceptable groundwater remediation levels have been derived based on a 10^{-6} cancer risk and practical quantitation levels. Practical quantitation levels represent the lowest concentration that a laboratory can "practically" detect. Residential use exposure assumptions were used in the development of these values. Attainment of these groundwater remediation levels will assure that risk associated with exposure to contaminated groundwater will fall within the acceptable risk range of 10^{-4} to 10^{-6} .

Acceptable groundwater remediation levels as determined by chemical-specific ARARs and TBCs for OU1 COCs are presented in Table 5.

Based on the evaluation conducted in the CSC OU1 Baseline RA, evaluation of chemical-specific ARARs and TBCs, and EPA policy,

TABLE 5
GROUNDWATER REMEDIATION LEVEL
Chemical Standard(mg/l) Comment

DCA	.005	10 ⁻⁶ Risk Level,
DCE	.007	MCL (40 CFR 141)
TCA	.200	MCL (40 CFR 141)
PCE	.005	MCL, (56 FR No. 20, 1/30/91)
TCE	.005	MCL (40 CFR 141)
1,2 DCE	.070	Colorado Basic Standard for Groundwater, Effective September 30, 1989
VC	.002	MCL (40 CFR 141)
Carbon Tetrachloride	.005	MCL (40 CFR 141)
Methylene Chloride	.010	10 ⁻⁶ Risk Level

the following remedial action objectives have been established for OU1 groundwater.

1. Prevent ingestion and inhalation of groundwater 1) with carcinogens in excess of remediation levels identified in Table 5 and, 2) which presents a total carcinogenic risk range greater than 1×10^{-6} - 1×10^{-4} .
2. Protect uncontaminated groundwater for current and future use by preventing migration of contaminants in excess of remediation levels.
3. Restore contaminated groundwater to 1) remediation levels specified Table 5, and 2) concentrations which present a total carcinogenic risk of 1×10^{-4} - 1×10^{-6} .

Soil Remediation Levels

Appropriate soil remediation levels were determined based upon leaching of soil contaminants into the underlying groundwater. Levels are based on restoring the groundwater to its most beneficial use which is drinking water" (see Table 5). Based on exposure calculations, performed during the RA, these levels are also protective for the incidental soil ingestion, inhalation and direct contact pathways.

Soil remediation levels are based on the groundwater remediation levels, aquifer dilution, the physical and chemical properties of the contaminant, and the ability of the soil to retard leaching of the contaminant due to adsorption. Soil remediation levels were calculated by multiplying the acceptable concentration of leachate from the soil by the partitioning coefficient (K_d) for the soil. The K_d represents the mobility of a particular

contaminant within the soil at the CSC property. They were developed based on site-specific batch and column adsorption studies conducted for CSC OU2.

The acceptable concentration of leachate represents the amount of contaminants in the soil that will be allowed to migrate into the groundwater. For CSC OU1, this value was derived by multiplying the groundwater remediation levels (i.e., MCLs) by a Dilution/Attenuation Factor. A Dilution/Attenuation Factor of 100 was used for these calculations. This factor assumes that leachate concentrations will be reduced by a factor of 100 due to aquifer dilution and soil attenuation in the soil above the aquifer. This value has been determined to be protective and appropriate based on evaluations and studies documented in the Toxicity Characteristic Rule, 40 CFR 261.

Soil Remediation Levels and Kd values for the COCs in the soil medium are as follows:

Compound	Groundwater Remediation Level	KD	x 100 =	Soil Remediation Level (ppm)
PCE	0.005	0.30		0.150
TCE	0.005	0.23		0.115
1,1,1-TCA	0.200	0.22		4.400
1,1-DCE	0.070	0.15		0.105
DCA	0.005	0.18		0.090
Vinyl Chloride	0.002	0.06		0.012
Methylene Chloride	0.010	0.14		0.140

Soil remediation levels are based on soil data collected during the RI/FS and on the assumption that the soil column is uniformly contaminated. These levels will only be revised if additional data are collected pertaining to the mobility of contaminants

(i.e., if column and batch flushing tests are conducted). These data may be collected during Remedial Design/Remedial Action (RD/RA). Any revised soil remediation levels derived from additional data must be protective of groundwater based on the groundwater remediation levels cited in Table 5.

VII. DESCRIPTION OF ALTERNATIVES

An FS was conducted to develop and evaluate remedial alternatives for OU1 at the Chemical Sales Superfund site. Remedial alternatives were assembled from applicable remedial technology process options and were initially evaluated for effectiveness, implementability, and cost. As a result of this screening, three alternatives were considered for detailed evaluation. These three alternatives (1, 3, and 5) were then evaluated and compared to the nine criteria required by the NCP. Alternative 1, the "no action" alternative, is required by the NCP to be retained for detailed evaluation. The no action alternative serves as a baseline point of comparison for other alternatives.

A batch flushing groundwater model was used to estimate the time required to clean up the contaminated groundwater (USEPA, 1988c). This model predicts the volume of water that would be required to be removed and treated to reduce existing concentration levels to groundwater remediation levels. Because the model cannot simulate actual conditions in the aquifer, a great deal of uncertainty is associated with estimates of aquifer restoration time frames.

As stated previously, the groundwater remediation levels are based on MCLs, proposed MCLs and 10^{-6} risk. Attainment of these levels will be protective of human health and the environment. EPA recently studied the effectiveness of groundwater extraction systems in achieving specified goals and found that it is often difficult to predict the ultimate concentration to which

contaminants in the groundwater may be reduced. The effectiveness of groundwater extraction may be further inhibited if DNAPLs are present. The study did find that groundwater extraction is an effective remediation measure to prohibit further migration of contaminants and can achieve significant mass removal of contaminants. Two of the remedial alternatives described in this section include groundwater extraction systems and assume that it is technically feasible to achieve the groundwater remediation levels cited in this ROD.

Except for the "no action" alternative, which includes groundwater monitoring only, each alternative includes the following two common elements:

Groundwater Monitoring. Existing and future groundwater monitoring wells would be sampled and analyzed periodically throughout OU1 to assess the effectiveness of ongoing remedial activities. Monitoring points are anticipated to be located upgradient of the plume (to detect contamination from other sources), within the plume (to track the plume movement during remediation), and downgradient from the OU (to detect plume migration and remediation effectiveness).

Notification of Potential Health Threat. Upon request for a well permit within the OU1 area, the applicant would be notified by the Colorado State Engineers Office of the potential health risk associated with the contaminated groundwater until groundwater is cleaned up to groundwater remediation levels.

Alternative 1. No action with groundwater monitoring.

Under this alternative, EPA would take no further action to control or remediate contamination detected within OU1. Groundwater monitoring would continue on an annual basis at approximately 12 monitoring wells. Measured contaminant

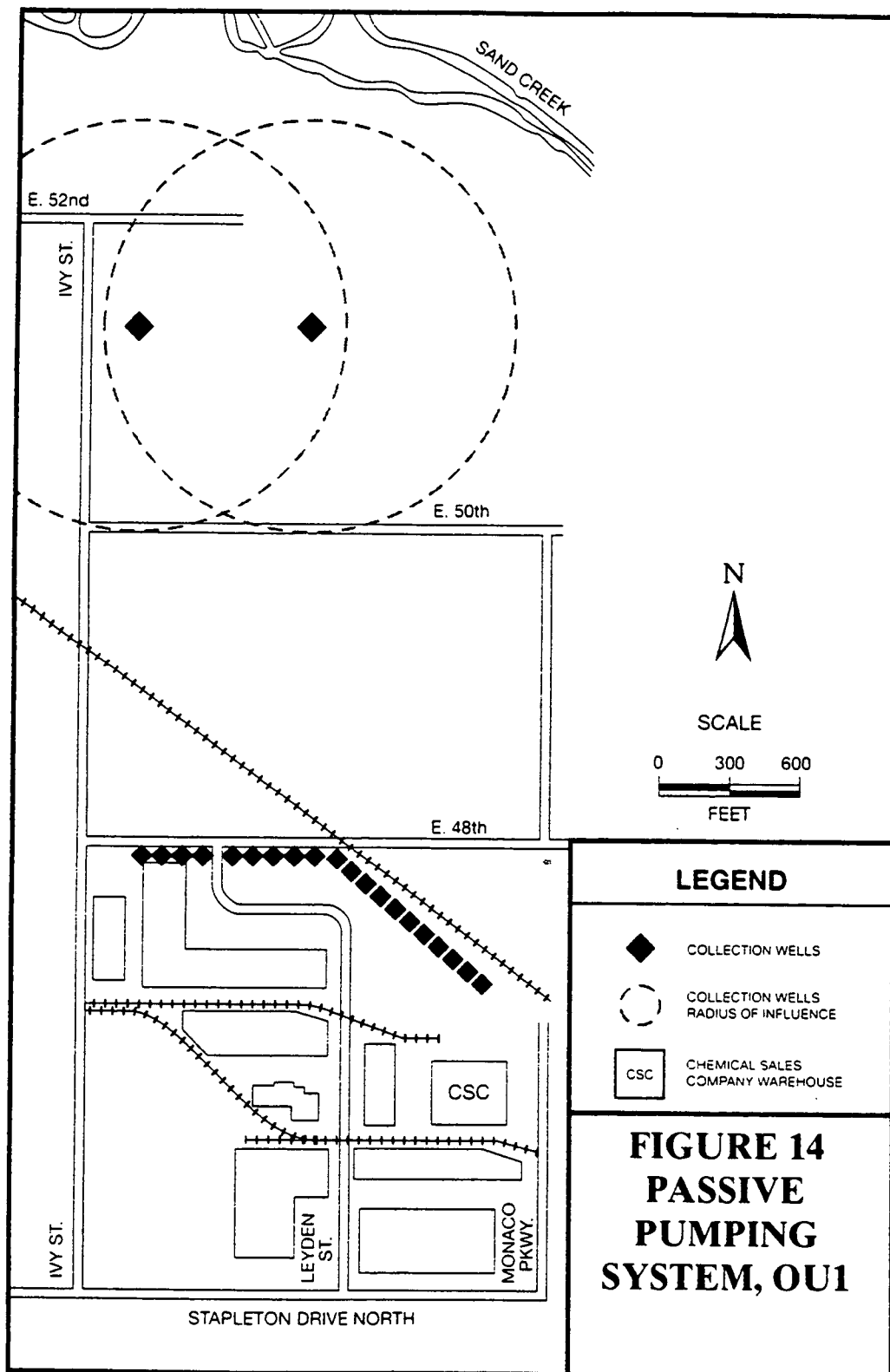
concentrations would be used to update the prediction of the groundwater contaminant migration patterns and impacts on downgradient water supply wells. Contaminated groundwater originating from OU1 would be treated by the SACWSD Klein Treatment facility for 30 years, the expected operating life of the facility. Residents within the area would continue to be provided with water from SACWSD. Because this alternative would result in contaminants remaining onsite, CERCLA requires that the site be reviewed every five years. If indicated by the review, remedial actions would be implemented at that time to remove or treat the wastes.

Results of groundwater modeling indicated that at a minimum, approximately 50 years would be required to remediate the contaminated groundwater to groundwater remediation levels based on Alternative 1. This estimate does not take into consideration the potential presence of DNAPLs or account for leaching of soil contaminants into groundwater.

The present worth cost for Alternative 1 would be \$301,000. Since the alternative requires "no action", there would be no capital cost. Annual operation and maintenance (O&M) costs are estimated to be \$19,600 for groundwater monitoring.

Alternative 3. Thermally Enhanced Soil Vapor Extraction, Low Volume Groundwater Interception in Source and Plume Areas, Air Stripping, Catalytic Oxidation in Source Area, Reinfiltration of Treated Water.

This remedial alternative would entail the installation of two lines of groundwater extraction wells or drain systems, one south of East 48th Avenue and another along East 52nd Avenue, (Figure 14). One or more aquifer tests would be required to obtain appropriate data for design of these systems. Estimates of the number of wells and specific locations of wells would be refined



Adapted from Engineering Science, 1991

during remedial design based on aquifer test data, additional groundwater monitoring data and other relevant site and design information.

The objective of the East 48th Avenue system would be to collect contaminated groundwater from the contaminant source area for treatment. Approximately 20 extraction wells located along an 1,800-foot-long pumping line south of East 48th Avenue would be used to contain and collect the more highly contaminated groundwater in the source area. This pumping line would produce approximately 100 gpm. The extracted groundwater would be transported to a central air stripping unit. VOC emissions from the air stripping unit would be treated through catalytic oxidation. This process would result in the destruction of approximately 97 to 99 percent of the VOCs emitted from the air stripping unit.

The objective of the East 52nd Avenue system would be to prevent northward migration and reduce the impact from this groundwater plume on the SACWSD water supply wells. Groundwater collection would be accomplished using two high-volume extraction wells. These wells would be located approximately 400 feet south of East 52nd Avenue to collect groundwater in the Sand Creek area and would pump approximately 420 gpm each. The combined flow of 840 gpm would be treated in a 6- to 8-foot diameter air stripping tower. The total VOC emissions from this tower are estimated to be less than six pounds per day. Air emissions resulting from air stripping operations at the East 52nd Avenue system would be sampled as necessary to assure compliance with State of Colorado Air Quality Standards and Regulations as promulgated under the Colorado Air Quality Control Act and EPA policy. The CSC site is located in an ozone non-attainment area.

Colorado Air Quality Regulations Nos. 1, 2, 3, 7, and 8 are applicable requirements for actions involving air stripping. The

specific citations of these regulations and their purpose are as follows: (a) 5 CCR 1001-5, Reg. 3, requires air pollution emission notices (APENs), air impact analyses for toxic pollutants, and the attainment and maintenance of State standards; (b) 5 CCR 1001-5 Sec. IVD, Reg. 3, regulates the attainment and maintenance of any National Ambient Air Quality Standards (NAAQS); (c) 5 CCR 1001-9, Reg. 7, regulates emissions of volatile compounds; (d) 5 CCR 1001-10, Reg. 8, regulates vinyl chloride and benzene emissions; (e) 5 CCR 1001-4, Reg. 2, requires that the design provide for odor-free operations; and (f) 5 CCR 1001-3, Reg. 1, requires that particulate emissions be minimized, opacity limitations be observed, and a particulate emission control plan be filed. Federal ARARs pertaining to air stripping include National Emission Standards for Hazardous Air Pollutants for regulating vinyl chloride emissions (40 CFR 61).

In addition, EPA has established a policy (OSWER Directive 9355.0-28, Control of Air Emission from Superfund Air Strippers at Superfund Groundwater sites) regarding the control of air emissions from air stripping units at Superfund sites located within ozone non-attainment areas. This policy recommends controls for air emissions exceeding 3 pounds per hour, 15 pounds per day and 10 tons per year. The estimated maximum VOC air emissions from the East 52nd Avenue system is less than six pounds per day (based on 840 gpm). It is anticipated that this emission rate will drop substantially throughout the implementation of this action. Estimated risk associated with this action is less than 1×10^{-6} .

Treated groundwater would be discharged to the aquifer through downgradient infiltration trenches for the East 48th Avenue system, and discharged into gravel-filled infiltration beds located near Sand Creek for the East 52nd Avenue system.

The treated groundwater would be sampled as necessary to substantively comply with Underground Injection Control (UIC) requirements (40 CFR 144, 146, and 147), EPA RCRA requirement Section 3020 and Colorado Regulations 5 CCR 1002-2, Sec. 6.1.0; 5 CCR 1002-3 sec. 10.1.0 and 6 CCR 1007-3 section 100.21(b). Under these requirements, reinjected groundwater must be treated to health-based levels (i.e., MCLs or proposed MCLs).

Contaminated soils contributing to groundwater contamination, would be treated through the installation and operation of a thermally enhanced soil vapor extraction system. Extracted vapors from both the soil vapor extraction system and air stripping unit would be treated through catalytic oxidation. The hot combustion gases from the catalytic oxidation unit would be recycled to the soil to enhance extraction of the soil contaminants.

On June 28 - July 2, 1990, soil vapor extraction pilot tests were conducted at CSC OU1. Pilot test results indicated that a vapor extraction rate of 100 cubic feet per minute (CFM) would remove contaminants within a 75 to 100-foot radius. Contaminant removal rates for these tests ranged from 7.0 to 9.6 pounds per hour. In addition, similar vacuum readings were observed at various pressure monitoring points screened at the same depth and same distance from the extraction wells, indicating that soils within the test area are relatively homogeneous. Based on the high VOC removal rates, large radius of influence and homogeneous nature of the soil, the results of these tests indicate that this type of technology is extremely effective in removing soil contaminants at the CSC site. It is anticipated that 10 soil vapor extraction wells, spaced 150 feet apart, with a total extraction of 1000 CFM (100 CFM per well) would be installed under this alternative. Based on this conceptual design, it is estimated that soil remediation levels would be attained within 150 days. Laboratory analysis of soil would be conducted upon

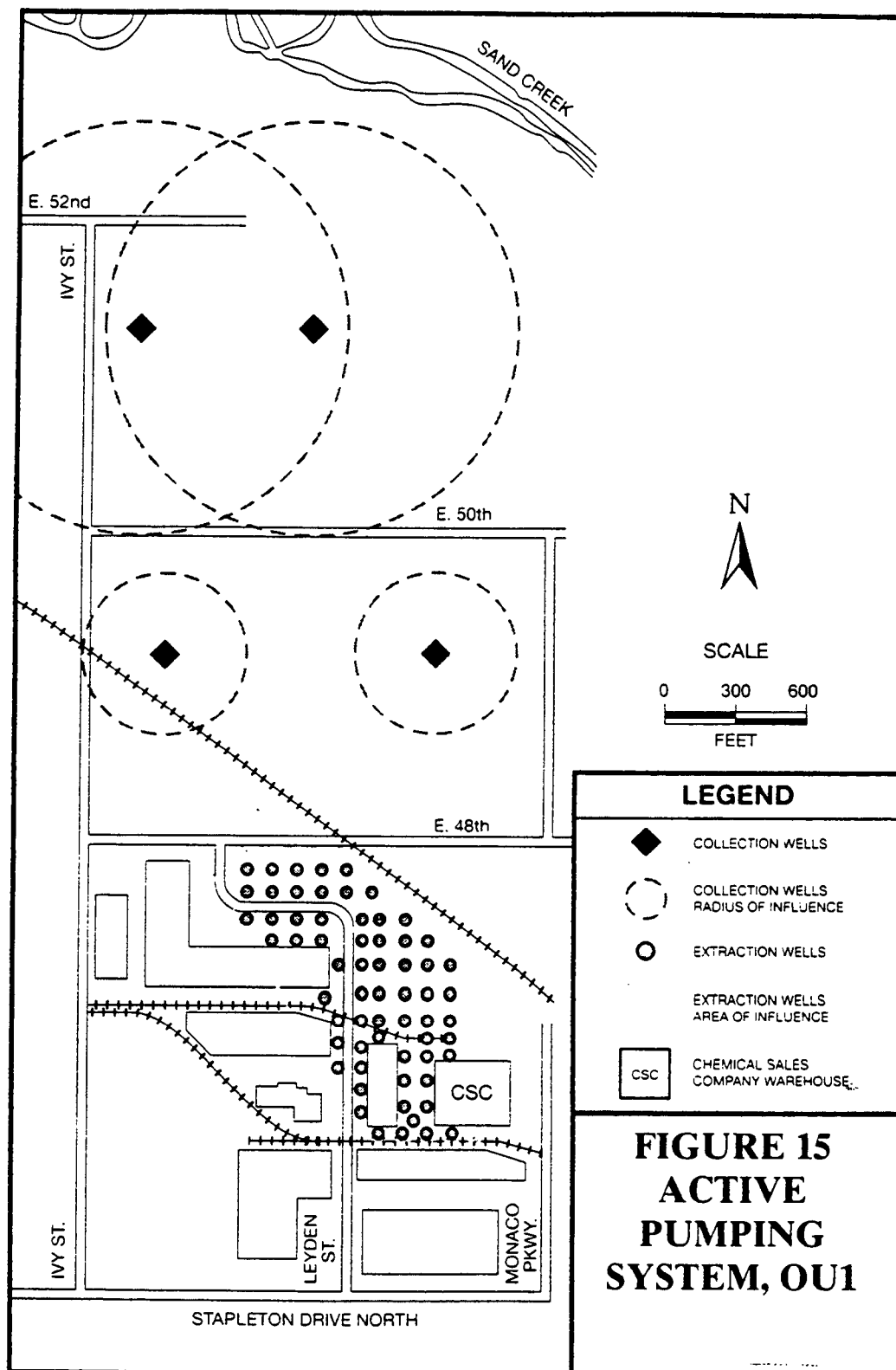
completion of the soil vapor extraction activities to verify compliance with soil remediation levels. A full summary of the soil vapor extraction pilot test is presented in Appendix J of the CSC OU1 RI/FS report.

It is estimated that approximately 7 years would be required to clean up the groundwater plume area (between East 48th Avenue and Sand Creek) and approximately 34 years would be required to attain groundwater remediation levels for the source area (south of East 48th Avenue). Capital costs for Alternative No. 3 would be approximately \$733,000, with an annual O & M cost of \$96,000 for years 1-7 and \$66,000 for years 8-34. The present worth cost would be approximately \$1,922,000.

Alternative 5. Thermally Enhanced Vapor Extraction, High Volume Groundwater Extraction in Source Area and Plume Area, Air Stripping, Catalytic Oxidation in Source Area, Aquifer Reinjection of Treated Water.

This alternative is similar to Alternative No. 3, except that a more aggressive groundwater extraction system would be implemented (Figure 15). Soil contamination would be treated through soil vapor extraction as described in Alternative No. 3. It is anticipated that 150 days would be required to attain soil remediation levels for CSC OU1.

Contaminated groundwater located near the source (south of East 48th Avenue) would be removed through a pulsed pumping operation with upgradient reinjection of treated groundwater to improve flushing efficiency and contaminant recovery. A grid of approximately 65 extraction wells is estimated for this alternative. Each well would be equipped with a submersible pump and recharge line so that any problem well could be used for either extraction or reinfiltration. The anticipated pumping and recycle rate for this alternative is approximately 250 gpm. To



Adapted from Engineering Science, 1991

minimize pumping volumes, operation of extraction wells and reinjection wells would be alternated. The groundwater extraction system would also lower the water table and expose the capillary fringe area and improve vapor extraction from this highly contaminated region.

If DNAPLs are present at the Site, this alternative would be able to effectively extract and treat these liquids due to a large volume of pumping and number of wells. If DNAPLs are detected, separate pumping of the DNAPLs and the contaminated groundwater would possibly be required. Additionally, if DNAPLs are detected, investigations may be required to delineate the pockets of DNAPLs. These activities include the installation of additional soil borings and monitoring wells.

Similarly to Alternative No. 3, air stripping would be used to treat contaminated groundwater in the source area. Groundwater would be required to be treated to groundwater remediation levels. Due to the high groundwater contaminant concentrations in the source area, emissions from the air stripping operation at the source area would be treated by catalytic oxidation. Exhaust from the catalytic oxidation system would be recirculated to the soil. Treated groundwater would be sampled as necessary to comply with Federal UIC requirements (40 CFR Parts 144, 146, and 147 and State of Colorado Regulations 5 CCR 1002-2, Sec. 6.1.0 and 5 CCR 1002-3, sec. 10.1.0). Concentrations of reinjected groundwater must be below health based levels as stipulated under these requirements.

Extraction of groundwater in the plume area (between East 48th Avenue and East 52nd Avenue) would also be similar to Alternative No. 3, with the exception of the addition of two extraction wells in the southern portion of the plume area. These two additional extraction wells would be located in the more heavily contaminated area between 48th Avenue and East 50th Avenue. The

extraction rate of these wells would be approximately 150 gpm. The extraction rate of the two extraction wells located between East 50th Avenue and East 52nd Avenue would be approximately 350 gpm compared to 420 gpm under Alternative No. 3. The estimated combined groundwater extraction rate for the plume area would be 1000 gpm. Use of the additional extraction wells would more rapidly remove contaminated groundwater in the plume area and would reduce plume area remediation time to approximately 6 years.

The additional water generated by these wells would be combined with water collected at the two high-volume wells at East 52nd Avenue and treated in a central 6- to 8-foot diameter air stripping tower. The total VOC emissions from this tower are estimated to be six pounds per day. The treated water would then be discharged into infiltration beds or trenches or an existing gravel pit located in the Sand Creek area. The treated groundwater would be sampled as necessary to comply with UIC requirements. Air emissions resulting from air stripping operations at the East 52nd Avenue system would be sampled as necessary to comply with the State of Colorado regulations promulgated under the Colorado Air Quality Control Act, Federal requirements, and EPA policy. The State and Federal ARARs pertaining to air stripping emissions for this alternative are identical to the ARARs cited for Alternative No. 3 (CCR 1001-5, Reg. 3; 5 CCR 1001-5 Sec. IVD, Reg. 3, 5 CCR 1001-9, Reg. 7, 5 CCR 1001-10, Reg. 8; 5 CCR 1001-4, Reg. 2; 5 CCR 1001-3, Reg. 1; and 40 CFR 261). A summary of these ARARs is provided in the Alternative No. 3 description and in Appendix B.

The treated plume area groundwater would be sampled as necessary to comply with Federal UIC requirements (40 CFR 144, 146, and 147), RCRA requirements (section 3020) and State of Colorado Regulations (5 CCR 1002-2, Sec. 6.1.0, 5 CCR 1002-3, sec. 10.1.0, and 6 CCR 1007-3 Sec. 100.21(b)). After treatment, water would

be discharged into reinfiltration trenches or into an existing gravel pit along Sand Creek.

It is estimated that approximately six years would be required to attain EPA groundwater remediation levels in the plume area and approximately 13 years would be required to attain EPA groundwater remediation levels in the source area.

Capital cost for Alternative No. 5 would be approximately \$989,000. Annual O & M cost are estimated at \$135,000 for years 1-6 and \$95,000 for years 7-13. The present worth cost would be approximately \$2,081,000.

VIII. SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

The remedial alternatives developed in the CSC OU1 FS were analyzed in detail using nine evaluation criteria. The resulting strengths and weaknesses of the alternatives were then weighed to identify alternatives providing the best balance among the nine criteria. These criteria are (1) overall protection of human health and the environment; (2) compliance with applicable or relevant and appropriate requirements (ARARs), (3) reduction of toxicity, mobility, or volume through treatment, (4) long term effectiveness and permanence; (5) short-term effectiveness; (6) implementability; (7) cost; (8) state acceptance; and (9) community acceptance. Each of these criteria is described below.

Criterion 1: Protection of Human Health and Environment

Overall protection of human health and the environment addresses whether a remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

The "no action" alternative (Alternative No. 1) is not protective of the environment because it would not eliminate or reduce risk through the treatment of contaminants in soil and groundwater. Due to the observed soil contamination, an unacceptable risk would exist under Alternative No. 1 through direct contact with contaminated soil (industrial exposure). Current risk associated with inhalation of volatile contaminants in ambient air (industrial exposure) is outside the acceptable risk range. In addition, with regard to potential pathways associated with groundwater use, this alternative is not protective of public health and the environment (aggregate risks of 6×10^{-2} current workers; 7×10^{-4} current residents; and 2×10^{-1} future residents) and does not reduce potential risks associated these pathways.

Alternative Nos. 3 and 5 are protective of public health and the environment. All the treatment technologies employed by these alternatives are protective of human health and the environment by eliminating or reducing risk through the treatment of contaminants in soils and groundwater. Alternative No. 5, however, would reduce risks associated with groundwater in less than one third of the time required by Alternative No. 3, thereby reducing the period of potential exposure by two thirds.

Criterion 2: Compliance with Applicable Relevant and Appropriate Requirements (ARARs).

Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal or State environmental or facility siting law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations

promulgated under Federal or State environmental siting law that while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.

Compliance with ARARs addresses whether a remedy will meet all federal and State environmental laws and/or provide basis for a waiver from any of these laws. These ARARs are divided into chemical specific, action specific, and location specific groups.

Alternative Nos. 3 and 5 would comply with all ARARs. Alternative No. 1 would not comply with chemical-specific ARARs for alluvial groundwater. The alluvial groundwater would not be cleaned up to Federal and State standards within a reasonable time frame (i.e., less than 50 years). Because the no action alternative does not satisfy the requirements of the threshold criteria (protection of public health and attainment of ARARs), it will not be discussed under the evaluation of the other seven criteria. An evaluation of ARARs for CSC OU1 is provided in Appendix B.

Criterion 3: Long-term Effectiveness and Permanence

Long-term effectiveness and permanence refers to the ability of a remedy to maintain reliable protection of human health and the environment over time. This criterion includes the consideration of residual risk and the adequacy and reliability of controls.

Alternative No. 5 would result in minimal residual risks. Under this alternative, soil and groundwater contaminants would be reduced to acceptable levels through treatment. It is anticipated that Alternative No. 3 would also result in minimal risk unless DNAPLs are present. If pockets of DNAPLs are

detected to be present, this alternative would not be effective at removing these liquids. These liquids would continue to act as a source of contamination to the alluvial groundwater. Due to the long period of time required to implement Alternative No. 3, this alternative would not be effective in controlling risk during the period of implementation.

Criterion 4: Reduction of Toxicity, Mobility, or Volume through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the preference for a remedy that uses treatment to reduce health hazards, contaminant migration, or the quantity of contaminants at the site. All the alternatives employ an irreversible treatment as a primary element to address the principal threat of contamination. Both Alternative Nos. 3 and 5 reduce toxicity, mobility, and volume of contaminants in soil and groundwater in the source area through catalytic oxidation. With regard to treatment of groundwater in the plume area, these alternatives indirectly reduce toxicity and volume through photodegradation of contaminants. Alternative No. 3 will not meet EPA's statutory preference for treatment of a principal threat of contamination to the maximum extent practicable, if DNAPLs are present.

Criterion 5: Short-term Effectiveness

Short-term effectiveness refers to the period of time needed to complete the remedy and any adverse impacts on human health and the environment that may be posed during construction and implementation of the remedy.

Due to a larger extraction volume, greater number of wells, and construction design, Alternative No. 5 would achieve groundwater remediation levels in one third the time required under

Alternative No. 3. These alternatives are not expected to pose any appreciable short-term risks to the community and workers during construction and implementation.

Alternatives Nos. 3 and 5 release emissions to the atmosphere, but at negligible levels and minimal risk (i.e., less than 1×10^{-6}). Additional controls for these two alternatives include monitoring to ensure compliance with State of Colorado air quality standards, and a Reasonable Available Control Technology analysis to ensure emissions are minimized.

Criterion 6: Implementability

Implementability refers to the technical and administrative feasibility of the remedy, including the availability of materials and services needed to implement the chosen solution. It also includes coordination of Federal, State and local governments to clean up the site.

Both Alternative Nos. 3 and 5 are technically and administratively feasible. Alternative No. 3 would be slightly more easy to implement than Alternative No. 5 because of the technical complexities associated with a pulsed pumping system. In Alternative No. 5, catalyst would be required to be replaced more frequently and access would be required to be obtained from a significant number of property owners. These concerns are considered to be minor and technically and administratively feasible.

Both alternatives require air and groundwater monitoring. Air monitoring activities would be coordinated with EPA and the State of Colorado.

Criterion 7: Cost

This criterion examines the estimated costs for each remedial alternative. For comparison, capital and annual O & M costs are used to calculate a present worth cost for each alternative. Alternative No. 3 has lower O & M and capital costs than Alternative No. 5. The present worth costs of Alternative No. 3 and Alternative No. 5 are relatively equivalent (\$1,922,000 and \$2,081,000 respectively); however, Alternative No. 5 would be completed in a much shorter time.

Criterion 8: State Acceptance

This criterion pertains to the State of Colorado's opposition, support, or comment regarding the remedial alternatives proposed for CSC OU1. The State of Colorado has been actively involved throughout the RI/FS and remedy selection process. The State of Colorado was provided the opportunity to comment on the RI/FS document and proposed plan, and took part in the public meeting held to inform the public on the proposed plan. Written comments from the State of Colorado received during the public comment period indicate that the State concurs with EPA's identification of Alternative 5 as the preferred remedy for CSC OU1. The State of Colorado indicated, however, that several State requirements were ignored in the FS and noted concerns regarding exposure calculation conducted to assess public health impacts resulting from air stripping. The State of Colorado's comments are further addressed in the attached Responsiveness Summary.

Criterion 9: Community Acceptance

Community acceptance includes determining which components of the alternatives interested persons in the community support, have reservations about, or oppose. EPA solicited input from the

community on the clean up methods proposed for CSC OU1. Although public comment indicated no opposition to the preferred alternative, many CSC site residents raised concerns at the public meeting over cumulative public health impacts resulting from air stripping operations either proposed or in operation at CSC OU1, CSC OU2, and the Rocky Mountain Arsenal.

IX. SELECTED REMEDY

EPA has selected Alternative No. 5 as the remedy for the CSC site OU No. 1. This remedy is comprised of the following components:

- * Monitoring groundwater, discharged treated water and air; monitoring will include determination of the presence or absence of DNAPLs;
- * Notification by the Colorado State Engineers Office of the potential health risks associated with use of contaminated groundwater upon request for an alluvial well permit within the OU1 area;
- * High volume (1000 gpm) and pulsed pumping of groundwater exceeding groundwater remediation levels (i.e., MCLs and proposed MCLs) in the source area (area south of East 48th Avenue);
- * High volume (1000 gpm) groundwater extraction within the CSC plume area (area north of East 48th Avenue and south of Sand Creek);
- * Treatment of contaminated groundwater with two air stripping towers for both source and plume areas; The source area air stripping tower would be located on the CSC property. The plume area air stripper would be located near East 52nd Avenue;

- * Reinjection and reinfiltration of treated groundwater. Aquifer reinjection by wells for treated water from the source area.
Reinfiltration through discharge into a trench or gravel pit for treated water from the plume area;
- * Soil vapor extraction of contaminated soils exceeding soil remediation levels;
- * Catalytic oxidation of air emissions from the soil vapor extraction system and source area air stripping unit. Recirculation of exhaust from the catalytic oxidation system into the contaminated soil.

The remedial design will specify the appropriate number and locations of wells and monitoring points, and system parameters such as flow rates for the source and plume area systems. The presence or absence of DNAPLs will be monitored during RA. How this monitoring will be conducted will be determined during RD. Some modifications or refinements may be made to the remedy during remedial design and construction. Such modifications or refinements, in general would reflect results of the engineering design process. Estimated cost for the selected remedy is \$2,081,000.

The selection of this remedy is based upon the comparative analysis of alternatives presented in Section VIII, and provides the best balance of tradeoffs with respect to the nine evaluation criteria. ARARs for the selected remedy are provided in Appendix B. Short term effectiveness was critical in selecting Alternative No. 5. This alternative will clean up the groundwater in approximately one third less time and at relatively the same cost as Alternative No. 3. The selected

remedy will also effectively remove and treat DNAPL's if detected during RD/RA.

Remediation Goals and Performance Standards for Ground Water and Soil

Remedial Action Objectives

Remedial Action Objectives for this site are presented in Section VI.

Ground Water

Area of Attainment. The area of attainment for the ground water remediation shall be the entire CSC OU1 plume exceeding ground water remediation levels for all COCs. This includes ground water exceeding remediation levels within CSC OU1, irrespective of CSC and IDCA property boundaries. The estimated area requiring remediation is shown on Figure 12. PCE is an indicator compound for the volatile organic plume. The plume area shown in Figure 12 currently includes all areas where other COCs exceed their respective remediation levels. This area may be revised based on water quality sampling during RD/RA.

Restoration Time Frame. The restoration time frame for this remedial action is estimated to be approximately six years in the source area (south of East 48th Avenue) and approximately 13 years in the plume area (between Sand Creek and East 48th Avenue).

Performance Standards. Specific performance standards, used to ensure attainment of the remedial action objectives for ground water are:

- 1) Reduce contaminant concentrations in ground water within the area of attainment to the remediation levels specified in Table 5 and to levels which present a total carcinogenic risk of 10^{-4} to 10^{-6} .
- 2) Ensure capture of the plume within the area of attainment. Verify that plume movement is being controlled by measuring hydraulic gradient within and outside of the plume, and demonstrating that the gradient is inward toward the pumping wells.
- 3) Meet all ARARs identified in this ROD for the remediation of ground water, including requirements for air emissions monitoring and UIC requirements for reinjection of ground water.
- 4) The remedial action shall be considered complete after the remediation levels have been maintained in all compliance monitoring wells for four years.

The extraction system shall continue to operate until remediation levels have been maintained in all compliance monitoring wells for four consecutive quarters of sampling.

After that time, ground water extraction may be terminated upon approval by EPA. The remediation levels must then be met for three additional years (with a sampling frequency to be determined during RD/RA, but expected to be quarterly), after which the remedial action may be considered complete. After the remedial action is complete, there may be additional monitoring required by EPA, at EPA's sole discretion. If any exceedence of the performance standards occurs in any of the compliance monitoring wells during this

three-year period, the extraction and treatment system shall be restarted and operated until performance standard are again attained in all compliance monitoring wells. This cycle shall continue until quarterly monitoring for one year demonstrates no exceedence of performance standards in the compliance monitoring wells.

The wells to be used for compliance monitoring for water quality and water levels will be approved by EPA during review of the 60% RD completion report, and will, at a minimum, include wells upgradient of the plume, within the plume, around the plume, and downgradient of the plume. Any statistical methods to average well concentrations shall be specified during RD/RA.

The third remedial action objective, stated above, is to restore ground water to its beneficial use as a drinking water aquifer. Based on information obtained during the Remedial Investigation and a careful analysis of all remedial alternatives, EPA and the State of Colorado believe that the selected remedy will achieve this objective. It may become apparent, however, during implementation or operation of the ground water extraction system and its modifications, that contaminant levels have ceased to decline or are remaining constant at levels higher than the remediation goal over some portion of the contaminated plume. In such a case, the system's performance standards and/or the remedy may be reevaluated. If new extraction or remediation technologies become available in the future which would significantly improve the remediation process (allow attainment of remediation levels which were not previously attainable, or

expedite the cleanup), the remedy will be reevaluated in light of the new information.

The selected remedy will include ground water extraction for an estimated period of six years in the source area and 13 years in the plume area, during which time the system's performance will be carefully monitored on a regular basis and adjusted as warranted by the performance data collected during operation. Modifications may include any or all of the following:

- a) at individual wells where cleanup goals have been attained, pumping may be discontinued;
- b) alternating pumping at wells to eliminate stagnation points;
- c) pulse pumping to allow aquifer equilibration and to allow adsorbed contaminants to partition into ground water; and
- d) installing additional extraction wells to facilitate or accelerate cleanup of the contaminant plume.

To ensure that remediation levels are maintained at those wells where pumping has ceased, those wells will be monitored every year following discontinuation of groundwater extraction, until the remedial action is completed.

- 5) Best efforts shall be used to remediate the plume in a timely manner. "Best efforts" shall include implementation of the remedy in compliance with the ROD, Consent Decree and SOW, to maximize performance of the remedial action to achieve the performance

standards as quickly as possible.

Performance and Compliance Sampling Program. A sampling program for monitoring the remedial action performance and for determining compliance with the performance standards shall be implemented during the remedial action. This program will be developed during remedial design and shall include, at a minimum, the following: locations of performance and compliance monitoring wells for water quality sampling, frequency of monitoring of performance and compliance wells, analytical parameters (focusing on COCs with possible use of indicator chemicals), sampling field methods, water level measurement frequency, analytical methods for chemical analysis (with possible use of non-CLP analysis), locations and methods for water level measurement, and statistical methods for evaluating data. The performance and compliance sampling program will be specified in the RA Workplan and may be modified during the RA.

The performance monitoring system will be designed to provide information that can be used to evaluate the effectiveness of the remedial action with respect to the following:

- horizontal and vertical extent of the plume and contaminant concentration gradients, including a mass balance calculation, if possible
- rate and direction of contaminant migration
- changes in contaminant concentrations or distribution over time
- effects of any modifications to the original remedial action.

Other items to be specified in the performance monitoring plan

include:

- monitoring of concentrations of influent and effluent to the air stripper and catalytic oxidation units (influent water concentration, and effluent water and air concentrations) so as to meet air emission standards
- concentrations of contaminants in ground water to be reinjected, so as to comply with UIC requirements for reinjected ground water.

Soils

Area of Attainment. The area of attainment for the soil remediation shall be the entire area within CSC OU1 with soil concentrations exceeding the remediation levels cited in Section VI, irrespective of CSC and IDCA property boundaries. The entire vertical soil column will be used to determine where remediation is required. The estimated area requiring remediation is shown in Figure 8. This area may be revised based on soil sampling during RD/RA.

Restoration Time Frame. The restoration time frame for this remedial action is estimated to be approximately 150 days.

Performance Standards. Specific performance standards, used to ensure attainment of the remedial action objectives for soil, are:

- 1) Reduce contaminant concentrations in soil within the area of attainment to the soil remediation levels specified in Section VI.
- 2) Meet all ARARs identified in this ROD for the

remediation of soil, including requirements for air emissions monitoring.

- 3) The remedial action shall be considered complete after the soil remediation levels have been attained in all compliance soil borings and surface soil samples. Attainment of the remedial action objectives for the incidental ingestion and direct contact pathways must be verified through chemical analysis of the upper six inches of soil. Attainment of the remedial action objectives for the pathway of migration of soil contaminants into ground water must be verified by sampling the soil concentrations areally (from a number of boreholes) and vertically (from a number of samples collected from a single borehole). The extraction system shall continue to operate until remediation levels have been reached in all compliance soil borings and surface soil samples (upper six inches of soil). Attainment of the soil remediation levels will be verified by chemical analysis of soil samples, not by soil headspace analysis. After the remedial action is complete, there may be additional monitoring required by EPA, at EPA's sole discretion.

The soil borings and surface soil samples to be used for compliance monitoring for soil will be specified during Remedial Design, and will, at a minimum, include borings and samples within and surrounding the area of attainment. The borings shall be drilled to the water table, at a minimum, as approved by EPA during RD. Any statistical methods to average soil concentration areally or vertically within a borehole shall be specified during RD/RA. The EPA guidance document entitled "Methods for Evaluating the Attainment of Cleanup Standards--Volume 1: Soils and Solid Media"

(EPA 230/02-89-042) will be consulted when establishing the Performance and Compliance Sampling Program, described in the following subsection.

It may become apparent during implementation or operation of the soil remediation system that contaminant levels have ceased to decline or are remaining constant at levels higher than the remediation level. In such a case, the system's performance standards and or the remedy may be reevaluated. If new extraction or remediation technologies become available in the future which would significantly improve the remediation process (allow attainment of remediation levels which were not previously attainable, or expedite the cleanup), the remedy will be reevaluated in light of the new information.

The soil remediation system's performance will be carefully monitored on a regular basis and adjusted as warranted by the performance data collected during operation.

- 4) The PRP shall use best efforts to remediate the soil in a timely manner. "Best efforts" shall include implementation of the remedy in compliance with the ROD, Consent Decree and SOW, to maximize performance of the remedial action to achieve the performance standards as quickly as possible.

Performance and Compliance Sampling Program. A sampling program for monitoring the remedial action performance and for determining compliance with the performance standards shall be implemented during the remedial action. This program will be developed during remedial design and shall include, at a minimum,

the following: locations of performance monitoring points within the soil vapor extraction system; locations of compliance monitoring boreholes to be drilled after remediation is believed to be complete, to confirm that remediation levels have been reached; frequency of monitoring of the performance of the SVE system, analytical parameters (focusing on COCs, with possible use of indicator chemicals), analytical methods for laboratory and field chemical analysis (with possible use of non-CLP analysis), field sampling methods, and statistical methods for evaluating data. The performance and compliance sampling program will be specified in the RA Workplan, and may be modified during the RA.

Other items to be specified in the performance monitoring plan include:

- monitoring of concentrations of influent and effluent air into and out of the catalytic oxidation unit.

X. STATUTORY DETERMINATIONS

EPA's primary responsibility at Superfund sites is to select Remedial Actions that are protective of human health and the environment. CERCLA also requires that the selected remedial action for a site comply with applicable or relevant and appropriate environmental standards established under Federal and State environmental laws, unless a waiver is granted. The selected remedy must also be cost-effective and utilize permanent treatment technologies or resource recovery technologies to the maximum extent practicable. The statute also contains a preference for remedies that include treatment as a principal element. The following sections discuss how the selected remedy for the CSC OU1 site meets these statutory requirements.

Protection of Human Health and Environment

In order to meet the remedial objectives outlined previously, the risk associated with exposure to the contaminated soil and groundwater must fall within the acceptable risk for carcinogens.

Attainment of soil and groundwater remediation levels described previously in Section VI will assure that site risk falls within this range. EPA expects that contaminants will be reduced to acceptable levels in 150 days for the soil, 6 years for groundwater in the plume area (between Sand Creek and East 48th Avenue) and 13 years for groundwater in the source area (south of East 48th Avenue). Of all the alternatives evaluated for CSC OU1, the selected alternative provides the best protection to human health in the least amount of time. No unacceptable short-term risks or cross-media impacts would result through implementation of this remedy.

Attainment of Applicable or Relevant and Appropriate Requirements of Environmental Laws

All ARARs would be met by the selected remedy.

Chemical-Specific ARARs. The selected remedy would achieve compliance with chemical-specific ARARs related to the alluvial groundwater within the CSC OU1 area. The relevant and appropriate requirements include Federal and State primary drinking water standards established by the Safe Drinking Water Act. Some contaminants of concern identified for CSC OU1 have MCLs. MCLs have been proposed for the majority of the remaining contaminants of concern identified for this ROD as TBCs. Concentration of COCs at the CSC OU1 site would be reduced below MCLs or proposed MCLs by implementation of Alternative 5.

Vinyl Chloride emissions from the air stripping treatment system will be monitored and if required, controls would be implemented

to ensure compliance with National Emission Standards for Hazardous Air Pollutants (40 CFR PART 61.60). At present it is not expected that constituents for which standards have been established for the Colorado Air Quality Control Act (CRS-25-7-101-2) will be emitted. In the unlikely event that these constituents are produced, the necessary controls would be implemented in order for the emissions to comply with the regulations. Predicted air emission concentrations for the plume area in the OU1 FS are within acceptable levels based on an assessment conducted in the FS. These estimates are based on generalized assumptions which cannot be verified until the final location of the air stripping unit is identified. Risks associated with air stripping operations for the plume area will be reevaluated based on the identification of a specific location for the air stripping unit during remedial design. Implementation of air emission controls and/or emission limitations may be required pending that assessment.

Action-Specific ARARs. The selected remedy would comply with action-specific ARARs for injection of treated water back into the groundwater as set forth in State of Colorado Regulations 5 CCR 1002-3 sec. 10.1.0, 5 CCR 1002-2, Sec. 6.1.0 and 6 CCR 1007-3 Sec. 100.21(b), Federal UIC Program 40 CFR 144-147 and RCRA Sec. 3020.

EPA policy (Applicability of Land Disposal Restrictions to RCRA and CERCLA Groundwater Treatment Injection Superfund Management Review: Recommendation No. 26 OSWER Directive No. 9234.1-06, December 27, 1989) is that UIC rules take precedence over LDRs for injection of hazardous waste into the groundwater. Therefore, for injection of the treated water, the LDRs are not relevant and appropriate. However, as noted previously, UIC regulations are applicable to this action.

As discussed above, land disposal restrictions are not applicable to the groundwater injection aspects of the selected remedy. Instead, RCRA section 3020 applies to reinjection of treated groundwater into Class IV injection wells during CERCLA response actions. Since the goal is to clean up groundwater to drinking water levels, health based drinking water standards (MCLs), rather than land disposal restrictions, are relevant and appropriate clean up standards.

Federal and State of Colorado requirements pertaining to air emissions will be met with regard to air stripping operations. These include Colorado Air Quality Regulations 1,2, 3 and 8 (for vinyl chloride). The specific actions regulated and the specific regulatory citations are presented in Appendix B.

Location Specific ARARs. The selected remedy would address and comply with all location-specific ARARs for preservation and protection of the Sand Creek River floodplain according to requirement of 40 CFR 6.3022 and protection of site wetlands within the CSC OU1 area.

Cost Effectiveness

EPA believes the selected remedy is cost-effective in mitigating the principal risk posed by contaminated groundwater within a reasonable period of time. Section 300.430(f)(ii)(D) of the NCP requires EPA to evaluate cost-effectiveness by comparing all the alternatives which meet the threshold criteria: Protection of human health and the environment and the attainment of ARARs, against three additional balancing criteria: long-term effectiveness and permanence; reduction of toxicity, mobility or volume through treatment; and short-term effectiveness. The selected remedy meets these criteria and provides for overall effectiveness in proportion to its costs. The selected remedy is approximately the same cost as Alternative No. 3, however, it

will achieve groundwater remediation levels in approximately one third the time required for Alternative No. 3.

Therefore, the selected remedy is cost-effective as defined in the NCP. The estimated cost for the selected remedy is approximately \$2,081,000.

Utilization of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable

EPA believes the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost-effective manner for CSC OU1. Of those alternatives that are protective of human health and the environment and comply with ARARs, EPA has determined that the selected remedy provides the best balance of trade-offs in terms of long-term effectiveness and permanence, reduction in toxicity, mobility or volume achieved through treatment; short-term effectiveness; implementability; and cost, and also considering the statutory preference for treatment as a principal element and considering State and community acceptance.

Of the two alternatives which meet the threshold criteria (Alternative Nos. 3 and 5), the selected remedy (Alternative No. 5) reduces toxicity, mobility and volume of the contaminants in the groundwater and soil equally as well as Alternative No. 3. Short term effectiveness was critical in choosing Alternative No. 5 due to the much shorter remediation time frame.

Preference for Treatment as a Principal Element

The selected remedy satisfies the statutory preference for treatment as a principal element. If pools and pockets of DNAPL are detected, they will be treated through extraction, air

stripping and catalytic oxidation. Treatment of DNAPLs may require that the DNAPL be diluted prior to treatment. Surficially contaminated soils do not pose a sufficient risk to be considered a "principal threat".

XI. DOCUMENTATION OF SIGNIFICANT CHANGES

No Significant Changes

The proposed plan for OU1 of the Chemical Sales Company site was released for public comment on February 28, 1991. The proposed plan identified Alternative 5 as the preferred alternative. EPA reviewed all written and verbal comments submitted during the public comment period. Upon review of these comments, it was determined that no significant changes to the remedy, as it was originally identified in the Proposed Plan, were necessary.

REFERENCES

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- Colorado Department of Health. 1986a. Colorado Department of Health Waste Management Division Hazardous Waste Inspection Report. Inspection of Chemical Sales Company Property Conducted on March 18, 1986.
- Colorado Department of Health. 1986b. Colorado Department of Health Waste Management Division Hazardous Waste Inspection Report. Inspection of Chemical Sales Company Property Conducted on April 1, 1986.
- Ecology and Environment (E and E). 1987. Analytical Results from E. 56th Ave. and Magnolia Street, Denver, CO; TDD F08-8701-01 submitted September 1, 1987.
- _____. 1986a. South Adams County Soil Gas Survey Interpretive Report, South Adams County, CO; TDD R8-8603-07, submitted June 24, 1986.
- _____. 1986b. Final Results Report for I-270 and Quebec Street, Commerce City; TDD R8-8609-05, resubmitted November 18, 1986.
- _____. 1986c. Analytical Results from E. 48th Ave. and Leyden Street, Denver, CO; TDD R8-8609-04. Submitted December 15, 1986.
- _____. 1986d. Analytical Results Report, E. 50th Ave. and Ivy Street, Commerce City, CO; TDD R8-8609-03 and TDD R8-8604-03, submitted December 17, 1986.
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- U.S. Environmental Protection Agency. 1988c. Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites. EPA/540/G-88/003.

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- _____. 1989. Control of Air Emissions from Superfund Air Strippers at Superfund Groundwater Sites (OSWER Directive 9355.0-28).

APPENDIX A
SUMMARY OF BASELINE RISK ASSESSMENT

**SUMMARY OF ASSUMPTIONS USED TO ESTIMATE CHRONIC DAILY INTAKE
OF CHEMICALS OF CONCERN AT THE CHEMICAL SALES COMPANY OUI SITE**

Exposure assumptions used in the CDI estimates for the exposure pathways evaluated in the Chemical Sales Company OUI site risk assessment are discussed in this appendix. Many of the exposure assumptions are based on values that are recommended by EPA in Risk Assessment Guidance for Superfund (RAGS) (EPA 1989a). Additional values were obtained from the Exposure Factors Handbook (EPA 1989b) or are age-specific and site-specific values that are considered appropriate for the Chemical Sales Company OUI site.

Several of the exposure assumptions such as exposure duration, body weight and averaging time are used in all of the exposure pathway calculations and are the same for all pathways. The average adult body weight is 70 kg and is recommended by EPA (1989a, 1989b). The average body weight for a child ages one through six is 16 kg and was obtained from the Exposure Factors Handbook (EPA 1989b). The exposure duration for workers and residents is 30 years and is based on the national upper-bound time (90th percentile) at one residence, and is also recommended by EPA (1989a). The averaging times for carcinogens and noncarcinogens are pathway-specific periods of exposure and are recommended by EPA (1989a). These exposure values have been revised downward (e.g. exposure duration for workers = 25 years, soil ingestion 50 mg) in the Supplemental Guidance "Standard Default Exposure Factors" (OSWER Directive 9285.6-3) dated March 25, 1991.

Since the exposure factors utilized in this risk assessment result in a more protective remedy than would be prescribed if the new exposure factors were used, EPA has decided to maintain the risk assessment as originally prepared. Exposure point concentrations are upper 95th confidence intervals of the

arithmetic mean for groundwater. Maximum detected concentrations in soil and air were used as exposure point concentrations due to lack of sufficient data to calculate an arithmetic mean. Tables 1-1 through 1-8 of Appendix A present the exposure point concentrations, cancer potency factors (CPF) and reference doses (RfD) for each chemical as well as the cancer risk and hazard index for each pathway and each chemical of concern.

The remaining exposure assumptions for individual pathways will be discussed below. Table 1-1 presents exposure assumptions for ingestion of groundwater. Frequency of exposure for residents is based on the likelihood of groundwater being ingested every day of the year. For workers, the exposure frequency of 245 days/year was based on exposure occurring 5 days a week and considers that a worker will have 2 weeks of vacation, 96 days of weekends and 10 days of holidays. The ingestion rate of 2 L/day is the 90th percentile water ingestion rate for adults (EPA 1989d) and is recommended by EPA (1989a).

Table 1-2 presents assumptions used to estimate exposure via inhalation of volatiles while showering. The frequency of exposure for residents assumes that a resident may take a shower every day while for a worker it is assumed that they may shower three times a week. The ventilation rate of 15 L/minute is recommended by Foster and Chrostowski (1987) and is used in their model to evaluate exposure to volatiles while showering. The exposure duration of 20 minutes assumes 15 minutes is spent showering and 5 minutes is for after showering activities as volatiles may still be present in the room after showering. A shower time of 15 minutes is recommended by EPA (1989a).

Table 1-3 presents exposure assumptions for dermal contact with groundwater via showering. As previously discussed above, it is assumed that a resident may shower every day of the year while a worker may shower only three times a week out of a possible 245

TABLE 1-1

EXPOSURE ASSUMPTIONS USED TO ESTIMATE CHRONIC DAILY INTAKE OF
CHEMICALS OF CONCERN VIA INGESTION OF GROUNDWATER

$$CDI = \text{Intake (mg/kg-day)} = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

Parameter	Exposure
Chemical concentration in water (CW)	mg/L(a)
Frequency of Exposure (EF)	
Residents (current and future)	365 d/yr (b)
Workers	245 d/yr (c)
Exposure Duration (ED)	30 yr (d)
Ingestion Rate (IR)	2 L/day (d)
Average Body Weight (BW)	70 kg (d)
Averaging Time (AT)	
Carcinogens	365 d/yr x 70 yr (d)
Noncarcinogens	365 d/yr x 30 yr (d)

(a) Concentration is the upper 95th confidence interval of the arithmetic mean.

(b) Based on exposure occurring 7 days a week.

(c) Based on exposure occurring 5 days a week and takes into account that a worker will have 2 weeks of vacation, 96 days of weekends and 10 days of holidays (365 - 2(7) - 10 - 96 = 245).

(d) USEPA (1989a)

TABLE 1-2

EXPOSURE ASSUMPTIONS USED TO ESTIMATE CHRONIC DAILY INTAKE OF CHEMICALS OF CONCERN VIA INHALATION OF VOLATILES WHILE SHOWERING

$$\text{CDI} = \text{Intake (mg/kg/day)} = \frac{\text{CV} \times \text{VR} \times \text{ET} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

Parameter	Exposure
Chemical Concentration in Vapor (CV)	mg/m ³ (d)
Frequency of Exposure (EF)	147 d/yr (b)
Workers	365 d/yr (a)
Residents (current and future)	
Exposure Duration (ED)	30 yr (c)
Ventilation Rate (VR)	15 L/min (d)
Exposure Time (ET)	20 min (c,d)
Average Body Weight (BW)	70 kg (c)
Averaging Time (AT):	
Noncarcinogens	365 d/yr x 30 yr (c)
Carcinogens	365 d/yr x 70 yr (c)

- (a) Based on exposure occurring 7 days a week.
 (b) Based on exposure occurring 3 times a week and takes into account that a worker will have 2 weeks of vacation, 96 days of weekends and 10 days of holidays (365 - 2(7) - 10 - 96 = 245; 3/5 x 245 = 147).
 (c) USEPA (1989a)
 (d) Based on shower model by Foster and Chrostowski (1987).

TABLE 1-3

EXPOSURE ASSUMPTIONS USED TO ESTIMATE
CHRONIC DAILY INTAKE OF CHEMICALS OF CONCERN VIA DERMAL
CONTACT WITH GROUNDWATER

$$\text{CDI - Absorbed Dose (mg/kg/day)} = \frac{\text{CW} \times \text{SA} \times \text{PC} \times \text{ET} \times \text{EF} \times \text{ED} \times \text{CF}}{\text{BW} \times \text{AT}}$$

Parameter	Exposure
Chemical Concentration in Water (CW)	mg/L (a)
Conversion Factor (CF)	10^{-6} kg/mg
Frequency of Exposure (EF) Residents (current and future) Workers	365 d/yr (b) 147 d/yr (c)
Exposure Duration (ED)	30 yr (d)
Skin Surface Area (SA)	$18,200 \text{ cm}^2$ (d,e)
Exposure Time (ET)	0.25 hr/day (d,f)
Average Body Weight (BW)	70 kg (d)
Permeability Constant (PC)	8×10^{-4} cm/hr (d,g)
Averaging Time (AT): Noncarcinogens Carcinogens	365 d/yr x 30 yr (d) 365 d/yr x 70 yr (d)

- (a) Concentration is the upper 95th confidence limit of arithmetic mean.
 (b) Based on exposure occurring seven days a week.
 (c) Based on exposure occurring 3 times a week and takes into account that a worker will have 2 weeks of vacation, 96 days of weekends and 10 days of holidays ($365 - 2(7) - 10 - 96 = 245$; $3/5 \times 245 = 147$).
 (d) USEPA (1989a)
 (e) USEPA (1989a). 50th percentile body surface area values for an adult are used (average of males and females).
 (f) USEPA (1989a). Assumes a shower/bath time of 15 minutes.
 (g) USEPA (1989a). Permeability constant for water is used as a default value.

days/year. The skin surface area of $18,200 \text{ cm}^2$ is the 50th percentile body surface area value for adult males and females. The 50th percentile value is recommended by EPA (1989a). Exposure time is 15 minutes and is also recommended by EPA (1989a). The permeability constant of $8 \times 10^{-4} \text{ cm/hr}$ is that for water and reflects the movement of the chemical across the skin to the stratum corneum and into the bloodstream. This value is recommended by EPA (1989a) in the absence of chemical specific data.

Table 1-4 presents the assumptions used to calculate exposure via inhalation of VOCs in ambient air. Workers are assumed to be exposed all working days of the year. The inhalation rate of $20 \text{ m}^3/\text{day}$ assumed for workers is the average inhalation rate for adults and is recommended by EPA (EPA 1989a, b). The inhalation rate assumed for children was $30 \text{ m}^3/\text{day}$ and was obtained from the Exposure Factors Handbook (EPA 1989d). This is the average inhalation rate for a child ages one through six at moderate activity.

Table 1-5 presents exposure assumptions used to estimate exposure via ingestion of surface soil. Climatological data from the National Weather Service (1990) indicate that the ground may be covered with snow or frozen for the months of December through March, therefore leaving the months of April through November available for exposure. Based on this information, exposure frequencies were calculated as follows. For workers, exposure was assumed to occur two times a week during the months of April and November and 3 times a week during May through October. This results in 98 days/yr of potential exposure for workers. Children are assumed to be exposed to surface soil all year round due to exposure to wind-entrained soil particles present in household dust. This frequency of exposure (365 days/yr) for children is recommended by EPA (1989a). Soil ingestion rates of 100 mg for adults and 200 mg for children are recommended by EPA and are based on Interim Final Guidance for Soil Ingestion Rates from the Office of Solid Waste and Emergency Response (EPA 1989a,

TABLE 1-4

EXPOSURE ASSUMPTIONS USED TO ESTIMATE CHRONIC DAILY INTAKE OF
CHEMICALS OF CONCERN VIA INHALATION OF VOCS IN AMBIENT AIR

$$CDI = \text{Intake (mg/kg-day)} = \frac{CA \times IR \times ET \times EF \times ED}{BW \times AT}$$

Parameter	Exposure
Chemical Concentration in Air (CA)	mg/m ³ (a)
Frequency of Exposure (EF)	245 d/yr (b)
Workers	365 d/yr (c)
Children (future)	
Exposure Duration (ED)	
Workers	30 yr (c)
Children	6 yr (c)
Inhalation Rate (IR)	
Workers	20 m ³ /day
Children	(c, d, e) 30 m ³ /day (c, d, e)
Average Body Weight (BW)	
Workers	70 kg (c, f)
Children	16 kg (c, f)
Averaging Time (AT):	
Noncarcinogens	365 d/yr x 30
Carcinogens	yr (c) 365 d/yr x 70 yr (c)

- (a) Concentration is the maximum detected value.
- (b) Based on exposure occurring 5 days a weeks and takes into account that a worker will have 2 weeks of vacation, 96 days of weekends and 10 days of holidays (365 - 2(7) - 10 = 96 - 245).
- (c) USEPA (1989a).
- (d) USEPA (1989c).
- (e) 20 m³/day is the average inhalation rate for an adult, 30 m³/day is the average inhalation rate for a child ages 1 through 6 at moderate activity.
- (f) 70 kg is the average adult body weight, 16 kg is the average body weight for a child ages 1 through 6.

TABLE 1-5

**EXPOSURE ASSUMPTIONS USED TO ESTIMATE CHRONIC DAILY INTAKE OF
CHEMICALS OF CONCERN VIA INGESTION OF SURFACE SOIL**

$$\text{CDI} = \text{Intake (mg/kg-day)} = \frac{\text{CS} \times \text{IR} \times \text{CF} \times \text{FI} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

Parameters	Exposure
Conversion Factor (CF)	10 ⁻⁶ kg/mg
Chemical Concentration in Soil (CS)	mg/kg (a)
Frequency of Exposure (EF)	
Workers	98 d/yr (b)
Children	365 d/yr (c)
Exposure Duration (ED)	
Workers	30 yr (c)
Children	6 yr (c)
Ingestion Rate (IR)	
Workers	100 mg/day (c,d,e)
Children	200 mg/day (c,d,e)
Average Body Weight (BW)	
Workers	70 kg (c,f)
Children	16 kg (c,f)
Averaging Time (AT):	
Noncarcinogens	365 d/yr x 30 yr (c)
Carcinogens	365 d/yr x 70 yr (c)
Fraction Ingested (FI)	1 (c)

- (a) Concentration is the maximum detected value.
- (b) Based on exposure occurring 3 times a week for the months of May through October and 2 times a week for the months of April and November. Climatological data indicates the ground may be covered or frozen for the month of December through March (National Weather Service, 1990).
- (c) USEPA (1989a).
- (d) USEPA (1989c). Interim Final Guidance for Soil Ingestion Rates. Office of Solid Waste and Emergency Response. (OSWER Directive 9850.4).
- (e) Current EPA suggests soil ingestion rates.
- (f) 70 kg is the average adult body weight, 16 kg is the average body weight for a child ages 1 through 6 (EPA, 1989b).

c). The fraction ingested accounts for the fraction of soil contacted that is presumed to be contaminated. Due to the extensive soil contamination at this site, all soil contacted was presumed to be contaminated resulting in a fraction ingested value of one.

Table 1-6 presents assumptions used to estimate exposure via dermal contact with surface soil. The frequency of exposure for workers and children are 98 and 365 days/year respectively and have been previously described for the soil ingestion pathway. The exposed skin surface area for workers considers exposure to forearms and hands and is 3,120 cm². The exposed skin surface area for children considers exposure to forearms, hands and legs and is 7,070 cm². Skin surface areas are 50th percentile body surface areas as recommended by EPA (1989a). A skin adherence factor for Kaolin clay was used due to lack of site-specific soil data. This value is a conservative estimate and is presented in RAGS (EPA 1989a, 1989d, 1988b). An absorption factor of one was used due to lack of chemical specific data and is a conservative estimate. In the absence of chemical specific data a conservative estimate is recommended by EPA (1989a). The soil matrix factor used is 0.15 and represents the percentage of chemical that is available for absorption due to soil binding and the small amount of chemical that is in actual contact with the skin. This value is based on a study by Poiger and Schlatter (1979). This value was recommended by EPA Region VIII (Weis, 1990).

Tables 1-7 through 1-14 present exposure point concentrations, chronic daily intakes, cancer potency factors or reference doses and carcinogenic or non-carcinogenic risks for all pathways and receptors considered.

TABLE 1-6

EXPOSURE ASSUMPTIONS USED TO ESTIMATE CHRONIC DAILY INTAKE OF
CHEMICALS OF CONCERN VIA DERMAL CONTACT WITH SURFACE SOIL

$$CDI = \text{Absorbed Dose (mg/kg-day)} = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED \times SM}{BW \times AT}$$

Parameter	Exposure
Chemical Concentration in Soil (CS)	mg/kg (a)
Conversion Factor (CF)	10^{-6} kg/mg
Frequency of Exposure (EF)	
Workers	98 d/yr (b)
Children	365 d/yr (c)
Exposure Duration (ED)	
Workers	30 yr (c)
Children	6 yr (c)
Skin Surface Area (SA)	
Workers	3,120 cm ² (d)
Children	7,070 cm ² (d)
Average Body Weight (BW)	
Workers	70 kg (c,e)
Children	16 kg (c,e)
Averaging Time (AT):	
Noncarcinogens	365 d/yr x 30 yr
Carcinogens	(c) 365 d/yr x 70 yr (c)
Soil Matrix Factor (SM)	0.15 (g)

Skin Adherence Factor (AF)

2.77 mg/cm²
(c,f)

Absorption Factor (ABS)

1 (c)

- (a) Concentration is the maximum detected value.
- (b) Based on exposure occurring 3 times a week for the months of May through October and 2 times a week for the months of April and November. Climatological data indicates the ground may be covered or frozen for the months of December through March (National Weather Service, 1990).
- (c) USEPA (1989a)
- (d) USEPA (1989a). 50th percentile body surface area values for adult forearms and hands were used for workers, and forearms, hands, and legs were used for children ages 1 through 6.
- (e) USEPA (1989a). 70 kg is the average adult body weight, 16 kg is the average body weight for a child ages 1 through 6.
- (f) USEPA (1989a). Adherence factor is for Kaolin clay.
- (g) Soil matrix factor is based on a study by Poiger and Schlatter (1979) and recommended by EPA (Weis, 1990).

TABLE 1-7

TOTAL CANCER RISKS FOR WORKERS AT THE CHEMICAL SALES COMPANY SITE OU1 AREA

Chemical	Conc. in Medium (e)	CDI (mg/kg/day)	Cancer Potency Factor	Upper Bound Excess Lifetime Cancer Risk	Total Pathway Risk	Cancer Potency Source	Weight of Evidence (g)
Exposure Pathway: Ingestion of ground water							
Methylene Chloride	1.3E+04	1.1E-01	7.5E-03	7.9E-04		ATSDR (d)	B2
1,1-Dichloroethene	5.7E+03	4.6E-02	6.0E-01	2.8E-02		HEA(a)	C
1,1-Dichloroethane	2.6E+02	2.2E-03	9.1E-02	2.0E-04		HEA	C
Chloroform	2.4E+02	2.0E-03	6.1E-03	1.2E-05		HEA(a)	B2
Carbon Tetrachloride	8.5E+01	7.0E-04	1.3E-01	9.1E-05		HEA(a)	B2
cis-1,3-Dichloropropene	1.4E+02	1.1E-03	1.8E-01	2.0E-04		HEA	B2
Trichloroethene	5.3E+03	4.3E-02	1.1E-02	4.8E-04		HEA	B2
Tetrachloroethene	1.4E+04	1.1E-01	5.1E-02	5.8E-03		HEA	B2
Vinyl Chloride	1.4E+00	1.1E-05	2.3E+00	2.6E-05	3.5E-02	HEA	A
Exposure Pathway: Inhalation of volatile organics while showering							
Methylene Chloride	4.5E-02	4.4E-03	1.4E-02	6.1E-05		ATSDR (d)	B2
Carbon Tetrachloride	2.0E-03	1.9E-04	1.3E-01	2.5E-05		HEA(a)	B2
Chloroform	6.0E-03	5.8E-04	8.1E-02	4.7E-05		HEA(a)	B2
cis-1,3-Dichloropropene	3.4E-03	3.3E-04	1.3E-01	4.3E-05		HEA	B2
1,1-Dichloroethene	1.6E-01	1.6E-02	1.2E+00	1.9E-02		HEA(a)	C
Trichloroethene	1.3E-01	1.3E-02	1.7E-02	2.2E-04		HEA	B2
Tetrachloroethene	3.2E-01	3.1E-02	3.3E-03	1.0E-04		HEA	B2
Vinyl Chloride	5.2E-05	5.0E-06	3.0E-01	1.5E-06	1.9E-02	HEA	
Exposure Pathway: Dermal exposure to organics while showering (b,c)							
Methylene Chloride	1.3E+04	4.8E-06	1.5E-02	7.2E-08		NA	NA
Carbon Tetrachloride	8.5E+01	3.2E-08	2.6E-01	8.3E-09		NA	NA
1,1-Dichloroethene	5.7E+03	2.1E-06	1.2E+00	2.5E-06		NA	NA
1,1-Dichloroethane	2.6E+02	9.9E-08	1.8E-01	1.8E-08		NA	NA
Chloroform	2.4E+02	8.9E-08	1.2E-02	1.1E-09		NA	NA
Trichloroethene	5.3E+03	2.0E-06	2.2E-02	4.4E-08		NA	NA
Tetrachloroethene	1.4E+04	5.2E-06	1.0E-01	5.2E-07		NA	NA
Vinyl Chloride	1.4E+00	5.2E-10	4.6E+00	2.4E-09	3.2E-06	NA	NA
Exposure Pathway: Dermal exposure to surface soil (b,c)							
Trichloroethene	9.5E-01	2.6E-07	2.2E-02	6.0E-09		NA	NA
Tetrachloroethene	8.0E+01	2.0E-05	1.0E-01	2.0E-06	2.0E-06	NA	NA
Exposure Pathway: Incidental ingestion of surface soil							
Trichloroethene	9.5E-01	1.6E-07	1.1E-02	1.7E-09		HEA	B
Tetrachloroethene	8.0E+01	1.3E-05	5.1E-02	6.7E-07	6.7E-07	HEA	B
Exposure Pathway: Inhalation of VOCs present in ambient air							
Methylene Chloride	1.4E-01	3.7E-03	1.4E-02	5.2E-05	5.2E-05	ATSDR (d)	F
TOTAL CANCER RISK TO WORKERS					5.5E-02		

TABLE 1-8

TOTAL CANCER RISKS FOR CURRENT RESIDENTS AT THE CHEMICAL SALES COMPANY SITE OU1 AREA

Chemical	Conc. in Medium (e)	CDI (mg/kg/day)	Cancer Potency Factor	Upper Bound Excess Lifetime Cancer Risk	Total Pathway Risk(f)	Cancer Potency Source	Weight of Evidence (g)
Exposure Pathway: Ingestion of ground water							
Methylene Chloride	1.3E+02	1.6E-03	7.5E-03	1.2E-05		ATSDR (d)	B2
1,1-Dichloroethene	1.4E+02	1.7E-04	6.0E-01	1.0E-04		HEA(a)	C
1,1-Dichloroethane	1.2E+02	1.5E-04	9.1E-02	1.3E-05		HEA	C
Trichloroethene	6.0E+02	7.4E-03	1.1E-02	8.1E-05		HEA	B2
Tetrachloroethene	5.0E+01	6.1E-04	5.1E-02	3.1E-05		HEA	B2
Vinyl Chloride	3.4E+00	4.1E-05	2.3E+00	9.5E-05	3.3E-04	HEA	A
Exposure Pathway: Inhalation of volatile organics while showering							
Methylene Chloride	3.6E-03	1.5E-03	1.4E-02	2.2E-05		ATSDR (d)	B2
1,1-Dichloroethene	4.0E-04	1.7E-04	1.2E+00	2.1E-04		HEA(a)	C
Trichloroethene	1.5E-02	6.5E-03	1.7E-02	1.1E-04		HEA	B2
Tetrachloroethene	1.1E-03	5.0E-04	3.3E-03	1.6E-06		HEA	B2
Vinyl Chloride	1.1E-02	4.8E-05	3.0E-01	1.4E-05	3.5E-04	HEA	A
Exposure Pathway: Dermal exposure to organics while showering (b,c).							
Methylene Chloride	1.3E+02	1.2E-07	1.5E-02	1.8E-09		NA	NA
1,1-Dichloroethene	1.4E+01	3.1E-08	1.2E+00	3.7E-08		NA	NA
1,1-Dichloroethane	1.2E+01	2.6E-08	1.8E-01	4.7E-09		NA	NA
Trichloroethene	6.0E+02	1.3E-06	2.2E-02	2.9E-08		NA	NA
Tetrachloroethene	5.0E+01	1.1E-07	1.0E-01	1.1E-08		NA	NA
Vinyl Chloride	3.4E+00	7.3E-09	4.6E+00	3.4E-08	1.2E-07	NA	NA
TOTAL CANCER RISK TO CURRENT RESIDENTS:					6.9E-04		

TABLE 1-9

TOTAL CANCER RISKS FOR FUTURE RESIDENTS AT THE CHEMICAL SALES COMPANY SITE OU1 AREA

Chemical	Conc. in Medium (e)	CDI (mg/kg/day)	Cancer Potency Factor	Upper Bound Excess Lifetime Cancer Risk	Total Pathway Risk(f)	Cancer Potency Source	Weg. Evidence (g)
Exposure Pathway: Ingestion of ground water							
Methylene Chloride	1.3E+04	1.6E-01	7.5E-03	1.2E-03		ATSDR (d)	B2
Chloroform	2.4E+02	6.8E-03	6.1E-03	4.1E-05		HEA(a)	B2
Carbon Tetrachloride	8.5E+01	2.4E-03	1.3E-01	3.2E-04		HEA(a)	B2
cis-1,3-Dichloropropene	1.4E+02	3.9E-03	1.8E-01	7.0E-04		HEA	B2
1,1-Dichloroethene	5.7E+03	1.6E-01	6.0E-01	9.7E-02		HEA(a)	C
1,1-Dichloroethane	2.6E+02	7.5E-03	9.1E-02	6.8E-04		HEA	C
Trichloroethene	5.3E+03	1.5E-01	1.1E-02	1.7E-03		HEA	B2
Tetrachloroethene	1.4E+04	3.9E-01	5.1E-02	2.0E-02		HEA	B2
Vinyl Chloride	1.4E+00	3.9E-05	2.3E+00	9.0E-05	1.2E-01	HEA	A
Exposure Pathway: Inhalation of volatile organics while showering (b)							
Methylene Chloride	4.5E-02	1.9E-02	1.4E-02	2.7E-04		ATSDR (d)	B2
Chloroform	6.0E-03	2.6E-03	8.0E-02	2.1E-04		HEA(a)	B2
Carbon Tetrachloride	2.0E-03	8.6E-04	1.3E-01	1.1E-04		HEA(a)	B2
cis-1,3-Dichloropropene	3.4E-03	1.5E-03	1.3E-01	1.9E-04		HEA	B2
1,1-Dichloroethene	1.6E-01	6.9E-02	1.2E+00	8.3E-02		HEA(a)	C
Trichloroethene	1.3E-01	5.7E-02	1.7E-02	9.7E-04		HEA	B2
Tetrachloroethene	3.2E-01	1.4E-01	3.3E-03	4.5E-04		HEA	B2
Vinyl Chloride	5.2E-05	2.2E-05	3.0E-01	6.6E-06	8.5E-02	HEA	A
Exposure Pathway: Dermal exposure to organics while showering (b,c)							
Methylene Chloride	1.3E+04	1.2E-05	1.5E-02	1.8E-07		NA	NA
Carbon Tetrachloride	8.5E+01	7.9E-08	2.6E-01	2.1E-08		NA	NA
Chloroform	2.4E+02	2.2E-07	1.2E-02	2.7E-09		NA	NA
1,1-Dichloroethene	5.7E+03	5.3E-06	1.2E+00	6.3E-06		NA	NA
1,1-Dichloroethane	2.6E+02	2.5E-07	1.8E-01	4.4E-08		NA	NA
Trichloroethene	5.3E+03	4.9E-06	2.2E-02	1.1E-07		NA	NA
Tetrachloroethene	1.4E+04	1.3E-05	1.0E-01	1.3E-06		NA	NA
Vinyl Chloride	1.4E+00	1.3E-09	4.6E+00	5.9E-09	8.0E-06	NA	NA
Exposure Pathway: Dermal exposure to surface soil (b,c)							
Trichloroethene	9.5E-01	4.7E-07	2.2E-02	1.0E-08		NA	
Tetrachloroethene	8.0E+01	6.0E-05	1.0E-01	6.1E-06	6.1E-06	NA	
Exposure Pathway: Incidental ingestion of surface soil							
Trichloroethene	9.5E-01	1.6E-07	1.1E-02	1.7E-09		HEA	
Tetrachloroethene	8.0E+01	1.3E-05	5.1E-02	6.7E-07	6.7E-07	HEA	
TOTAL CARCINOGENIC RISK TO FUTURE RESIDENTS:					2.1E-01		

TABLE 1-10

TOTAL CANCER RISKS FOR FUTURE CHILDREN AT THE CHEMICAL SALES COMPANY SITE OU1 AREA

Chemical	Conc. in Medium (e)	CDI (mg/kg/day)	Cancer Potency Factor	Upper Bound Excess Lifetime Cancer Risk	Total Pathway Risk(f)	Cancer Potency Source	Weight Evidence (g)
Exposure Pathway: Incidental ingestion of surface soil							
Tetrachloroethene	9.5E-01	8.6E-05	5.1E-02	4.4E-06		HEA	B2
Trichloroethene	8.0E+01	1.0E-06	1.1E-02	1.1E-08	8.7E-05	HEA	B2
Exposure Pathway: Dermal contact with surface soil (b,c)							
Trichloroethene	9.5E-01	9.9E-05	2.2E-02	3.3E-07		HEA	B2
Tetrachloroethene	8.0E+01	8.4E-03	1.0E-01	1.3E-04	1.3E-04	HEA	B2
Exposure Pathway: Inhalation of ambient air							
Methylene Chloride	1.4E-01	3.0E-03	1.4E-02	4.1E-05	4.1E-05	ATSDR (d)	B2
TOTAL CARCINOGENIC RISK TO FUTURE CHILDREN:					2.6E-04		

TABLE 1-11

TOTAL NONCARCINOGENIC RISKS FOR WORKERS AT THE CHEMICAL SALES COMPANY SITE OU1 AREA

Chemical	Conc. in Medium (c)	CDI (mg/kg/day)	Reference Dose (RfD)	Hazard Index (HI)	Total Pathway HI	RfD Source
Exposure Pathway: Ingestion of ground water.						
Acetone	3.6E+04	6.9E-01	1.0E-01	6.9E+00		HEA(a)
Chloroform	2.4E+02	4.6E-03	1.0E-02	4.6E-01		HEA(a)
Carbon Tetrachloride	8.5E+01	1.6E-03	7.0E-04	2.3E+00		HEA(a)
cis-1,3-Dichloropropene	1.4E+02	2.6E-03	3.0E-04	8.8E+00		HEA
1,1-Dichloroethene	5.7E+03	1.1E-01	9.0E-03	1.2E+01		HEA(b)
1,1-Dichloroethane	2.6E+02	5.0E-03	1.0E-01	5.0E-02		HEA(b)
1,2-Dichloroethene	2.0E+02	3.9E-03	2.0E-02	1.9E-01		HEA(a)
Ethylbenzene	9.1E+01	1.8E-03	1.0E-01	1.8E-02		HEA(a)
Methylene Chloride	1.3E+04	2.5E-01	6.0E-02	4.1E+00		ATSDR(d)
Tetrachloroethene	1.4E+04	2.6E-01	1.0E-02	2.6E+01		HEA(a)
1,1,1-Trichloroethane	5.9E+03	1.1E-01	9.0E-02	1.3E+00		HEA(a)
Toluene	1.2E+03	2.3E-02	3.0E-01	7.8E-02		HEA(a)
Xylenes (total)	3.5E+02	6.7E-03	2.0E+00	3.3E-03	6.2E+01	HEA(a)
Exposure Pathway: Inhalation of volatile organics while showering						
Acetone	2.2E-01	4.9E-02	1.0E-01	4.9E-01		HEA
1,1-Dichloroethane	7.3E-03	1.6E-01	1.0E-01	1.6E+00		HEA
1,1-Dichloroethene	1.6E-01	3.6E-02	9.0E-03	4.0E+00		HEA
1,2-Dichloroethene	5.7E-03	1.3E-03	2.0E-01	6.4E-03		HEA
Ethylbenzene	2.5E-03	5.6E-04	1.0E-01	5.6E-03		HEA
Methylene Chloride	4.5E-02	1.0E-02	9.0E-01	1.1E-02		ATSDR(d)
Tetrachloroethene	3.2E-01	7.1E-02	1.0E-02	7.1E+00		HEA(d)
1,1,1-Trichloroethane	1.5E-01	3.3E-02	3.0E-01	1.1E-01		HEA
Toluene	3.3E-02	7.3E-03	5.0E-01	1.5E-02		HEA(a)
Xylenes (total)	9.5E-03	2.1E-03	9.0E-02	2.4E-02	1.3E+01	HEA(a)
Exposure Pathway: Dermal absorption of chemicals while showering(b,c).						
Acetone	3.6E+04	3.1E-05	5.0E-02	6.3E-04		HEA
Chloroform	2.4E+02	2.1E-07	5.0E-03	4.2E-05		HEA
Carbon Tetrachloride	8.5E+01	7.5E-08	3.5E-04	2.1E-04		HEA
cis-1,3-Dichloropropene	1.4E+02	1.2E-07	1.5E-04	8.0E-04		HEA
1,1-Dichloroethane	2.6E+02	2.3E-07	5.0E-02	4.6E-06		HEA
1,1-Dichloroethene	5.7E+03	5.0E-06	4.5E-03	1.1E-03		HEA
1,2-Dichloroethene	2.0E+02	1.8E-07	1.0E-02	1.8E-05		HEA
Methylene Chloride	1.3E+04	1.1E-05	3.0E-02	3.7E-04		HEA
Tetrachloroethene	1.4E+04	1.2E-05	5.0E-03	2.4E-03		HEA
1,1,1-Trichloroethane	5.9E+03	5.2E-06	4.5E-02	1.1E-04		HEA
Toluene	1.2E+03	1.1E-06	1.5E-01	7.1E-06		HEA
Ethylbenzene	9.1E+01	8.0E-08	5.0E-02	1.6E-06		HEA
Xylenes (total)	3.5E+02	3.1E-07	1.0E+00	3.1E-07	5.7E-03	HEA

TABLE 1-11 (cont.)

Exposure Pathway: Dermal contact with surface soil (b,c).

Tetrachloroethene	8.0E+01	4.0E-04	5.0E-03	2.0E-06		HEA
1,1,1-Trichloroethane	1.0E+00	5.0E-06	4.5E-02	1.0E-04	1.0E-04	HEA

Exposure Pathway: Incidental ingestion of surface soil.

Tetrachloroethene	8.0E+01	3.1E-05	1.0E-02	3.1E-03		HEA
1,1,1-Trichloroethane	1.0E+00	3.8E-07	9.0E-02	4.3E-06	3.1E-03	HEA(a)

Exposure Pathway: Inhalation of VOCs present in ambient air.

Methylene Chloride	1.4E-01	3.5E-03	9.0E-01	3.9E-03		ATSDR(d)
1,1,1-Trichloroethane	2.8E+02	9.6E-04	3.0E-01	3.2E-03	7.1E-03	HEA(a)

TOTAL HAZARD INDEX

7.6E+01

TABLE 1-12

TOTAL NONCARCINOGENIC RISKS FOR CURRENT RESIDENTS AT THE CHEMICAL SALES COMPANY SITE OU1 AREA

Chemical	Conc. in Medium (c)	CDI (mg/kg/day)	Reference Dose (RfD)	Hazard Index (HI)	Total Pathway HI	RfD Source
Exposure Pathway: Ingestion of ground water.						
Acetone	2.3E+01	6.6E-04	1.0E-01	6.6E-03		HEA(a)
1,1-Dichloroethene	1.4E+01	4.0E-04	9.0E-03	4.4E-02		HEA(b)
1,2-Dichloroethene	2.8E+01	8.0E-04	2.0E-02	4.0E-02		HEA(a)
Methylene Chloride	1.3E+02	3.7E-03	6.0E-02	6.2E-02		ATSDR(c)
Tetrachloroethene	5.0E+01	1.4E-03	1.0E-02	1.4E-01		HEA(a)
1,1,1-Trichloroethane	1.1E+01	3.1E-04	9.0E-02	3.5E-03	3.0E-01	HEA(a)
Exposure Pathway: Inhalation of volatile organics while showering						
Acetone	1.4E-04	1.4E-04	1.0E-01	1.4E-03		HEA
1,1-Dichloroethene	4.0E-04	4.0E-04	9.0E-03	4.4E-02		HEA
1,1-Dichloroethane	3.3E-04	3.3E-04	1.0E-01	3.3E-03		HEA(a)
1,2-Dichloroethene	7.8E-04	7.8E-04	2.0E-02	3.9E-02		HEA
Tetrachloroethene	1.2E-03	1.2E-03	1.0E-02	1.2E-01		HEA
1,1,1-Trichloroethane	2.8E-04	2.8E-04	3.0E-01	9.2E-04		HEA(a)
Methylene Chloride	3.6E-03	3.6E-03	9.0E-01	4.0E-03	2.1E-01	HEA
Exposure Pathway: Dermal absorption of chemicals while showering (b,c).						
Acetone	2.3E+01	5.0E-08	5.0E-02	1.0E-06		HEA
1,1-Dichloroethane	1.2E+01	2.6E-08	5.0E-02	5.2E-07		HEA
1,1-Dichloroethene	1.4E+01	3.1E-08	4.5E-03	6.8E-06		HEA
1,2-Dichloroethene	2.8E+01	6.1E-08	1.0E-02	6.1E-06		HEA
Methylene Chloride	1.3E+02	2.8E-07	3.0E-02	9.4E-06		HEA
Tetrachloroethene	5.0E+01	1.1E-07	5.0E-03	2.2E-05		HEA
1,1,1-Trichloroethane	1.1E+01	2.4E-08	4.5E-02	5.3E-07	4.6E-05	HEA
TOTAL HAZARD INDEX:					5.1E-01	

TABLE 1-13

TOTAL NONCARCINOGENIC RISKS FOR FUTURE RESIDENTS AT THE CHEMICAL SALES COMPANY SITE OU1 AREA

Chemical	Conc. in Medium (e)	CDI (mg/kg/day)	Reference Dose (RfD)	Hazard Index (HI)	Total Pathway HI	RfD Source
Exposure Pathway: Ingestion of ground water						
Acetone	3.6E+04	1.0E+00	1.0E-01	1.0E+00		HEA
Chloroform	2.4E+02	6.8E-03	1.0E-02	6.8E-01		HEA(a)
Carbon Tetrachloride	8.5E+01	2.4E-03	7.0E-04	3.5E+00		HEA(a)
cis-1,3-Dichloropropene	1.4E+02	3.9E-03	3.0E-04	1.3E+01		HEA
1,1-Dichloroethene	5.7E+03	1.6E-01	9.0E-03	1.8E+01		HEA(b)
1,1-Dichloroethane	2.6E+02	7.5E-03	1.0E-01	7.5E-02		HEA(b)
1,2-Dichloroethene	2.0E+02	5.8E-03	2.0E-02	2.9E-01		HEA(a)
Ethylbenzene	9.1E+01	2.6E-03	1.0E-01	2.6E-02		HEA(a)
Methylene Chloride	1.3E+04	3.7E-01	6.0E-02	6.1E+00		ATSDR(d)
Tetrachloroethene	1.4E+04	3.9E-01	1.0E-02	3.9E+01		HEA(a)
1,1,1-Trichloroethane	5.9E+03	1.7E-01	9.0E-02	1.9E+00		HEA(a)
Toluene	1.2E+03	3.5E-02	3.0E-01	1.2E-01		HEA(a)
Xylenes (total)	3.5E+02	9.9E-03	2.0E+00	5.0E-03	8.4E+01	HEA(a)
Exposure Pathway: Inhalation of volatile organics while showering						
Acetone	2.2E-01	9.3E-02	1.0E-01	9.3E-01		HEA
1,1-Dichloroethene	1.6E-01	6.9E-02	9.0E-03	7.7E+00		HEA
1,1-Dichloroethane	7.3E-01	3.1E-01	1.0E-01	3.1E+00		HEA(a)
1,2-Dichloroethene	5.7E-03	2.4E-03	2.0E-02	1.2E-01		HEA
Ethylbenzene	2.5E-03	1.1E-03	1.0E-01	1.1E-02		HEA
Methylene Chloride	4.5E-02	1.9E-02	8.6E-01	2.2E-02		ATSDR(d)
Tetrachloroethene	3.2E-01	1.4E-01	1.0E-02	1.4E+01		HEA
1,1,1-Trichloroethane	1.5E-01	6.2E-02	3.0E-01	2.1E-01		HEA(a)
Toluene	3.3E-02	1.4E-02	5.0E-01	2.8E-02		HEA(a)
Xylenes (total)	9.5E-03	4.1E-03	9.0E-02	4.5E-02	2.6E+01	HEA(a)
Exposure Pathway: Dermal absorption of chemicals while showering (b,c).						
Acetone	3.6E+04	7.8E-05	5.0E-02	1.6E-03		HEA
Chloroform	2.4E+02	5.2E-07	5.0E-03	1.0E-04		HEA
Carbon Tetrachloride	8.5E+01	1.9E-07	3.5E-04	5.3E-04		HEA
cis-1,3-Dichloropropene	1.4E+02	3.0E-07	1.5E-04	2.0E-03		HEA
1,1-Dichloroethane	2.6E+02	5.7E-07	5.0E-02	1.1E-05		HEA
1,1-Dichloroethene	5.7E+03	1.2E-05	4.5E-03	2.7E-03		HEA
1,2-Dichloroethene	2.0E+02	4.4E-07	1.0E-02	4.4E-05		HEA
Methylene Chloride	1.3E+04	2.8E-05	3.0E-02	9.3E-04		HEA
Tetrachloroethene	1.4E+04	3.0E-05	5.0E-03	6.0E-03		HEA
1,1,1-Trichloroethane	5.9E+03	1.3E-05	4.5E-02	2.8E-04		HEA
Toluene	1.2E+03	2.7E-06	1.5E-01	1.8E-05		HEA
Ethylbenzene	9.1E+01	2.0E-07	5.0E-02	4.0E-06		HEA
Xylenes (total)	3.5E+02	7.6E-07	1.0E+00	7.6E-07	1.4E-02	HEA

TABLE 1-13 (cont.)

Exposure Pathway: Dermal exposure to surface soil (b,c).

1,1,1-Trichloroethane	1.0E+00	1.8E-05	4.5E-02	4.0E-04		HEA(a)
Tetrachloroethene	8.0E+01	1.5E-03	5.0E-03	3.0E-01	3.0E-01	HEA(a)

Exposure Pathway: Incidental ingestion of surface soil.

1,1,1-Trichloroethane	1.0E+00	3.8E-07	9.0E-02	4.3E-06		HEA(a)
Tetrachloroethene	8.0E+01	3.1E-05	1.0E-02	3.1E-03	3.1E-03	HEA(a)

TOTAL HAZARD INDEX

1.1E+02

TABLE 1-14

TOTAL NONCARCINOGENIC RISKS FOR FUTURE CHILDREN AT THE CHEMICAL SALES COMPANY SITE OU1 AREA

Chemical	Conc. in Medium (e)	CDI (mg/kg/day)	Reference Dose (RfD)	Hazard Index (HI)	Total Pathway HI	RfD Source
Exposure Pathway: Direct contact with surface soil.						
Tetrachloroethene	8.0E+01	2.0E-02	5.0E-03	3.9E+00		HEA(d)
1,1,1-trichloroethane	1.0E+00	2.5E-04	4.5E-02	5.4E-03	3.9E+00	HEA(a)
Exposure Pathway: Incidental ingestion of surface soil.						
Tetrachloroethene	8.0E+01	2.0E-04	1.0E-02	2.0E-02		HEA(a)
1,1,1-trichloroethane	1.0E+00	2.5E-06	9.0E-02	2.8E-05	2.0E-02	HEA(a)
Exposure Pathway: Inhalation of ambient air.						
Methylene Chloride	2.8E-02	6.9E-03	9.0E-01	7.6E-03		ATSDR(d)
1,1,1-Trichloroethane	1.4E-01	1.9E-03	3.0E-01	6.2E-03	1.4E-02	HEA(a)
TOTAL HAZARD INDEX:					4.0E+00	

FOOTNOTES FOR TABLES 1-7 TO 1-14

- (a) Verified and on IRIS, but under review.
 - (b) Note: The dermal absorption pathway exposure assessment is associated with a great deal of uncertainty due to the fact that Cancer Potency Factor (CPF) and Reference Dose (RfD) values are currently unavailable for chemicals for the dermal pathway.
 - (c) RfD was adjusted for dermal absorption as follows:
 - Oral RfD X 0.50 = RfD for dermal absorption (assumes 50% absorption of chemical).
 - Cancer Potency Factors were adjusted for dermal absorption as follows:
 - Oral CPF/0.50 = Dermal CPF (assumes 50% absorption)
 - (d) ATSDR (Agency for Toxic Substances and Disease Registry) (1989)
 - (e) Concentration is the upper 95th percentile of the arithmetic mean for ground water and the maximum detected concentrations for soil and air.
 - (f) Concentrations for shower pathway are mg/kg/shower.
 - HEA = Health Effects Assessment (1990).
 - NA = Not applicable as dermal absorption potency factors were estimated using oral potency factors.
 - (g) EPA Weight-of-Evidence Classification System for Carcinogenicity
 - A - Human Carcinogen
 - B - Probable Human Carcinogen
 - C - Possible Human Carcinogen
 - D - Not Classifiable as to human carcinogenicity
 - E - Evidence of noncarcinogenicity for humans

Note: Notation should be interpreted as follows: 1.3E+04 is equivalent to 13,000.
-

UNCERTAINTIES ASSOCIATED WITH THE CHEMICAL SALES COMPANY SITE OU1 RISK ASSESSMENT

There are several sources of uncertainty associated with the Chemical Sales Company site OU1 site risk assessment. Some are generic to the risk assessment process and include uncertainty related to extrapolation of experimental animal study results to humans, dose-response relationships at high and low doses, and sensitivity of subgroups within the human population to chemicals and mixtures of chemicals. Other sources of uncertainty include uncertainty regarding the validity of models used to estimate exposure, such as the shower model, toxicity information available, and extent of environmental sampling.

In general, for each scenario there are several uncertainties in determining the exposure parameters that go into the scenario and that are ultimately combined with toxicological information to assess risk. For example, a number of uncertainties are associated with estimates of how often, if at all, an individual would come into contact with the chemicals of concern and the period of time over which such exposure would occur. It is likely that these time estimates in this risk assessment will overestimate the estimated risks associated with exposure to contamination in the various areas.

Risks resulting from dermal exposure to soil and groundwater are difficult to assess due to the fact that dermal Cancer Potency Factors and Reference Doses are currently not available for most chemicals. Therefore, oral toxicity values for the chemicals of concern were adjusted in order to assess these pathways. However, this adjustment results in further uncertainty with risk characterization for exposure to chemicals via dermal absorption.

Several items should be noted when considering risks calculated based on ingestion of groundwater and inhalation of dust and volatiles by future residents. First, it should be noted that it was assumed that concentrations of chemicals of potential concern

will not increase or decrease in the future, but rather concentrations currently detected in the groundwater would remain constant over a 70-year lifetime. This assumption may lead to overestimates or underestimates of the risks calculated for these scenarios. In addition, estimates of contaminant concentrations in air conservatively assume that all dust at the facility is composed of particulates from surface soils from the facility.

Dose-response information is a potential source of error in risk assessment in general. There can be major uncertainties in extrapolating both from animals to humans and from high to low doses. There are important species differences in uptake, metabolism, and organ distribution of carcinogens, as well as species and strain differences in target site susceptibility. Human populations are variable with respect to genetic construction, diet, occupational and home environment, activity patterns and other cultural factors.

There is also a great deal of uncertainty in assessing the toxicity of a mixture of chemicals. In this assessment, the effects of exposure to each of the contaminants present in the environmental media have initially been considered separately. However, these substances occur together at the site, and individuals may be exposed to mixtures of the chemicals. Suitable data are not currently available to rigorously characterize the effects of chemical mixtures similar to those present at the CSC OU1 site. Consequently, as recommended by EPA, chemicals present at the CSC OU1 site were assumed to act additively, and potential health risks were evaluated by summing risks.

In addition, it should be noted that the potential future use of this site is somewhat uncertain based on current zoning restrictions which indicate that the site may remain mostly industrial. Based on this information, the future residential use scenario would be unlikely to occur.

As a result of the uncertainties described above, this risk assessment should not be construed as presenting an absolute estimate of risks to human or environmental populations. Rather, it is a generally conservative analysis intended to provide a preliminary indication of the potential for adverse impacts to occur under the exposure conditions assumed.

SUMMARY OF RISKS AT THE CHEMICAL SALES COMPANY OU1 SITE

The objective of the RA for CSC OU1 is to evaluate potential health risks to local residents and workers from exposure to contaminated groundwater, surface soil, and ambient air. The scope of the RA includes both cancer and noncancer health risks which may be associated with long-term exposure (30 years) to chemicals present in these media. Chronic health risk estimates are based on concentrations of chemicals of potential concern (COCs) in groundwater, surface soil, and ambient air measured in the spring and fall of 1990 and assume no change in concentrations will occur over the exposure interval.

The magnitude of potential health risks from inhalation, dermal absorption and ingestion of contaminants in air, soil and groundwater at OU1 are discussed below. Carcinogenic and noncarcinogenic risks will be discussed by exposure pathway for each exposure scenario.

CARCINOGENIC RISKS

Ingestion of Groundwater

For current workers, the upper bound excess lifetime cancer risk associated with ingestion of groundwater is approximately 4×10^{-2} . For current residents, the upper bound excess lifetime cancer risk associated with ingestion of groundwater is approximately 3×10^{-4} . For future residents, the risk estimate is 1×10^{-1} . In each exposure scenario, the largest components of the risk estimate are the contaminants DCE and PCE.

Inhalation of Volatiles Emitted During a Shower

For current workers at the Chemical Sales Company OU1 site, the upper bound excess lifetime cancer risk associated with inhalation of volatiles during showering is approximately

2×10^{-2} , primarily from DCE. For current residents, the upper bound excess lifetime cancer risk associated with inhalation of volatiles emitted during a shower is approximately 4×10^{-4} , due primarily to DCE and TCE. For future residents, the upper bound excess lifetime cancer risk associated with inhalation of volatiles during showering is approximately 9×10^{-2} , primarily from DCE.

Dermal Absorption of Chemicals while Showering

For workers at the Chemical Sales Company OU1 site, the upper bound excess lifetime cancer risk associated with dermal absorption of chemicals while showering is approximately 3×10^{-6} with most of the risk estimate derived from DCE and PCE. The upper bound excess lifetime cancer risk for current residents resulting from exposure to contaminants via dermal absorption is approximately 1×10^{-7} . For future residents, the upper bound excess lifetime cancer risk associated with this pathway is approximately 8×10^{-6} . For all three populations, most of the risk is attributable to DCE and PCE.

Dermal Contact with Surface Soil

For dermal contact with soil, as well as the incidental ingestion pathway described below, the risk estimates are driven exclusively by the extraordinarily high soil levels of PCE. For current workers, the upperbound excess lifetime cancer risk for exposure to VOCs by direct contact with surface soil is approximately 2×10^{-6} . For future residents the upper bound excess lifetime cancer risk that results from direct contact with chemicals in surface soil is approximately 6×10^{-6} . For future children at the site, the upper bound excess lifetime cancer risk, resulting from this exposure pathway is approximately 1×10^{-4} .

Incidental Ingestion of Surface Soil

The upper bound excess lifetime cancer risk that results from incidental ingestion of surface soil is approximately 7×10^{-7} for both workers and future residents. For future children, incidental ingestion of surface soil results in an upper bound excess lifetime cancer risk of approximately 9×10^{-5} . Risks for all populations are due to the presence of tetrachloroethene.

Inhalation of Ambient Air

The estimated risks for this pathway are due to a single chemical, methylene chloride. For current workers, inhalation of ambient air results in an upper bound excess lifetime cancer risk of approximately 5×10^{-5} . For future children, the upper bound excess lifetime cancer risk is approximately 4×10^{-5} for inhalation of ambient air.

NONCARCINOGENIC RISKS

Ingestion of Groundwater

The combined hazard index for all COCs evaluated in this exposure pathway is approximately 60 for workers. The hazard index for current residents is 0.3 for water ingestion, due mostly to PCE. The hazard index for future residents is approximately 80. DCE and PCE are the largest components of the hazard index for all populations evaluated.

Inhalation of Volatiles Emitted During a Shower

The combined hazard index for all COCs evaluated in this exposure pathway is approximately 10 for workers. DCE, DCA and PCE are the largest components of the hazard index. The hazard index for current residents is 0.2 for inhalation of volatiles while

showering, due mostly to PCE. The hazard index for future residents is approximately 25.

Dermal Absorption of Chemicals while Showering

The hazard index associated with dermal absorption of contaminants while showering is considerably less than one for workers, future and current on-site residents. In each case, PCE is the main component of these risk estimates.

Direct Contact with Surface Soil

As previously stated for carcinogenic risks, PCE is the COC upon which the hazard index is based for both dermal contact and incidental ingestion for soil. The hazard indices for current workers and future residents are considerably less than one for the dermal absorption pathway. For children the hazard index is approximately 4.0 with most of the risk due to tetrachloroethane.

Incidental Ingestion of Surface Soil

The hazard index for current workers and future residents, including children, is approximately 0.02 - 0.003 for incidental ingestion of surface soil.

Inhalation of Ambient Air

The hazard index for inhalation of ambient air for workers is 0.007. The hazard index for inhalation of ambient air by future children is 0.01.

INTEGRATION OF EXPOSURE PATHWAYS

It is reasonable to combine exposure pathways within each of the exposure scenarios because the pathways represent normal everyday activities and would be expected to occur regularly. Total risk estimates for carcinogens and noncarcinogens under each of the

three exposure scenarios evaluated in this RA are discussed below.

Current Worker Exposure Scenario

Combination of upper bound cancer risk estimates for all seven exposure pathways results in a total upper bound cancer risk estimate of approximately 5×10^{-2} for the current worker exposure scenario. The COCs which contribute the largest component of this risk estimate are DCE and PCE.

Combination of hazard indices for all seven exposure pathways results in a total hazard index of 75. DCE and PCE are the COCs with the heaviest overall contribution to the total hazard index. Ingestion of groundwater is the major exposure pathway.

Current Residents Exposure Pathway

Combination of upper bound cancer risk estimates for the three exposure pathways evaluated in this exposure scenario results in a total upper bound cancer risk estimate of 7×10^{-4} for the current residents exposure scenario. The COCs which contribute the largest component of this risk estimate are DCE, TCE and PCE. Ingestion of groundwater is the highest exposure pathway.

Combination of hazard indices for these pathways results in a total hazard index of 0.5. PCE is the COC with the heaviest overall contribution to the total hazard index. Ingestion of groundwater and inhalation of volatiles while showering are the major exposure pathways.

Future Residents Exposure Pathway

Combination of upper bound cancer risk estimates for all seven exposure pathways results in a total upper bound cancer risk estimate of approximately 2×10^{-1} for the future residents exposure scenario. The COCs which contribute the largest

component of this risk estimate are DCE and PCE. A subset of risks associated with children playing in contaminated soil in the south part of the site is calculated at 3×10^{-4} .

Combination of hazard indices for all seven exposure pathways results in a total hazard index of 110 for future residents. DCE and PCE are the COCs with the heaviest overall contribution to the total hazard index. Ingestion of groundwater is the major exposure pathway. For future children, the hazard indices for the three soil pathways evaluated is 4.0 with most of the risk due to dermal absorption of TCE in soil.

REFERENCES FOR APPENDIX A

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APPENDIX B

ARARs

CHEMICAL SPECIFIC ARARs ^{a/(1)}		
Citation	Requirement	Evaluation
Groundwater - Volatile Organic Compounds (TCE, Carbon tetrachloride, 1,2-DCE, 1,1,1-TCA, 1,1-DCE, Vinyl Chloride)		
42 U.S.C. §300g	Safe Drinking Water Act	
40 CFR 141 5 CCR 1003-1	National Primary Drinking Water Standards - establishes health-based standards for public water systems [maximum contaminants levels (MCLs)] and Colorado Primary Drinking Water Regulations.	The alluvial aquifer is used a public drinking water source. Regulation is applicable.
Pub.L. No. 94-580 as amended	Resource Conservation and Recovery Act (RCRA)	
40 CFR 144.13(c)	Class IV Injection Wells: addresses waste injection as part of RCRA and CERCLA ^{b/} remediation	Land disposal restriction may be waived if the reinjected water is treated to substantially reduce hazardous constituents and is protective of human health and the environment. Regulation is applicable.
5 CCR 1002-8 Sec. 3.11.0	Colorado Groundwater Standards: establishes water quality standards to protect existing and potential beneficial groundwater users.	The alluvial aquifer is used as a public drinking water source, therefore the regulation is applicable.

CHEMICAL SPECIFIC ARARs ^W (continued)		
Citation	Requirement	Evaluation
Soil - Volatile Organic Compounds (PCE, TCE, 1,1-DCE)		
40 CFR 148	Land Disposal Restrictions: prohibits land disposal of certain contaminated soil and debris.	Variance can be granted on site-specific basis. Regulation is relevant and applicable to contaminated soils.
40 CFR 261	Identification and Listing of Hazardous Waste: specifies Toxicity Characteristic Leaching Procedure (TCLP) and establishes regulatory levels for organic chemicals.	Regulation is relevant and appropriate, establishing maximum soil concentrations of leachable compounds to meet MCLs.
CRS-25-7-101-512	Colorado Air Quality Control Act: sets ambient air standards and air emissions regulations.	Regulation is applicable to vapor extraction and volatile emissions.
5 CCR 1001-14	Colorado Ambient Air Quality Standards	Applicable to vapor extraction and volatile emissions.
CRS-30-20-101 through 118	Colorado Solid Waste Disposal Act: regulates the management of solid waste.	Applicable to any non-hazardous solid waste regulated under this act. Regulation is relevant and appropriate to management of all solid waste.
40 CFR Part 60, Subpart Kb	Performance Standards	Regulation is relevant and appropriate to volatile liquids storage.
Air		
5 CCR 1001-10 Reg. 8	Hazardous Air Pollutants: Regulate emission of seven specific chemicals.	These requirements are applicable to vinyl chloride.

ACTION SPECIFIC ARARs ^{a/}		
Citation	Requirement	Evaluation
29 U.S.C. §§651-678	Occupational Safety and Health Act: regulates worker health and safety.	Applicable to response actions.
49 CFR 107, 171-177	Hazardous Materials Transportation: regulates transportation of hazardous materials.	These requirements are applicable to any transportation of hazardous materials.
40 CFR 260-270	Resource Conservation and Recovery Act: regulates generation, treatment, storage and disposal of hazardous waste.	These requirements are relevant and appropriate to disposal of soil or treatment residue.
5 CCR 1002-2	Regulation for state discharge permit	Sets forth applicable regulations for land treatment and disposal
40 CFR 144-147	Underground Injection Control Program: regulates underground injection wells.	These requirements are applicable to reinjection of treated groundwater.
1 CCR 723-18, HMT 1-9	Rules and Regulations Governing the Transportation of Hazardous Materials Within Colorado: establishes specific requirements for the transportation of hazardous materials within the state.	These requirements are applicable to the transport of hazardous waste.
6 CCR 1007-3 §260 and 270	Colorado Hazardous Waste Regulations: regulates disposal of hazardous waste, TSD ^{c/} facilities, and treatment of residue.	These requirements are applicable to onsite disposal of treatment residue, and may apply to offsite disposal.
5 CCR 1002-8 §3.1.0-3.1.11, 3.11.0	Colorado Water Quality Control Act: regulates discharge to state waters.	These requirements are relevant and appropriate to discharges to surface water.

ACTION SPECIFIC ARARs^W
(continued)

Citation	Requirement	Evaluation
§25-12-103, C.R.S.	Colorado Noise Abatement: establishes standards for controlling noise.	These requirements apply to construction activities.
37-91-104, 106, 110 C.R.S.	Water Well Construction and Pump Installation: Regulates water wells, test holes, and pump installation.	These requirements apply to well construction and groundwater withdrawal.
33 U.S.C §1251-1376	Clean Water Act	
40 CFR 230, 231, 33 CFR 323	Dredge or Fill (Section 404): Requires permit to discharge dredged or fill material into navigable waters or wetlands.	A small area may be a wetland. A permit will not be required pursuant to Section 121(e) of CERCLA, but the substantive requirements may be appropriate for activities involving dredge and fill.
Executive Order No. 11990, 40 CFR 6.302(b)	Protection of Wetlands: requires action to avoid adverse effects, minimize potential harm and preserve and enhance wetlands.	Regulations may be relevant and appropriate to a small wetland area.
5 CCR 1001-5 Reg. 3	Colorado Air Pollution Control Regulations: requires air pollution emission notices (APEN) and permits.	CERCLA Section 121(e) exempts onsite response actions from obtaining permits, but requires compliance with substantive provisions and filing of APEN. Regulations are applicable.

LOCATION SPECIFIC ARARs ^{a/}		
5 CCR 1001-9 Reg. 7	Volatile Organic Compounds: regulates emissions of volatile compounds.	RACT ^{e/} is applicable and is required to control emissions in ozone non-attainment area.
5 CCR 1001-3 Reg. 1	Fugitive Dust Emissions: regulates fugitive dust emissions and opacity limitations. Requires that particulate emissions be minimized, that opacity limitations be observed, and that a particulate emission control plan be filed.	These regulations would apply to construction, excavation and haul roads.
5 CCR 1002-3, § 10.1.0	Discharge of effluent to groundwater	Applicable to treated water discharge.
5 CCR 1001-5 Sec. IVD, Reg. 3	Stationary Emissions: regulates attainment and maintenance of any NAAQS. ^{d/} Also requires air impact analyses for toxic pollutants, and the attainment and maintenance of State standards.	The Operable Unit is in a non-attainment area. The regulations are applicable.
5 CCR 1001-4 Reg. 2	Odor-Free Operation: requires design action to provide odor-free operation.	These are applicable in order to limit nuisance conditions from emission sources.

a/ ARARs = Applicable or Relevant and Appropriate Requirements.

b/ CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act.

c/ TSD = Treatment, storage, and disposal.

d/ NAAQS = National ambient air quality standards.

e/ RACT = Reasonable, available control technique.

(1) Remediation levels are presented in Table 5, pg 53 of the ROD text.



COLORADO
DEPARTMENT
OF HEALTH

ROY ROMER
Governor

JOEL KOHN
Interim Executive Director

Grand Junction Regional Office
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(303) 248-7198

June 25, 1991

Mr. James P. Scherer
Regional Administrator
U.S. Environmental Protection Agency
Region VIII
One Denver Place
999 18th Street, Suite 500
Denver, Colorado 80202-2405

Re: State of Colorado Concurrence on Chemical Sales,
Operable Unit 1 - Record of Decision

Dear Mr. Scherer:

The State of Colorado concurs with the Record of Decision for Operable Unit 1 of Chemical Sales, with the understandings noted below. We would like to congratulate EPA for the speedy and competent manner in which the RI/FS and ROD for the site were developed. We look forward to a continued good working relationship with EPA during the Remedial Design and Remedial Action phases for the cleanup of this source of pollution to the alluvial aquifer.

An additional issue has been raised by the State Engineer's Office that may apply to the project. A ground water augmentation plan may be required for water loss due to evaporation from the air stripping operation. This issue will need to be pursued during the Remedial Design phase.

The State of Colorado concurs with the Record of Decision for Operable Unit 1 of Chemical Sales, with the understanding that although not specifically stated in the ROD, the cumulative risks for the multiple contaminants and multiple pathways present at the site have been assessed and determined to be within EPA's acceptable risk range for the chosen remediation.

Also, we note that although chloroform was not designated as a chemical of concern, it will be removed during the soil vapor extraction and air stripping operations.

Sincerely,

Thomas P. Looby
Assistant Director for Health and
Environmental Protection
Colorado Department of Health

TPL:nr

cc: Ron Cattany
Dave Shelton
John Leary
Charlotte Robinson
Robert Eber
Vickie Peters
Hal Simpson
Nancy Chick

RECORD OF DECISION

CHEMICAL SALES COMPANY SUPERFUND SITE
OPERABLE UNIT 1 - LEYDEN STREET LOCATION
PART 3 - RESPONSIVENESS SUMMARY

BACKGROUND OF COMMUNITY INVOLVEMENT ACTIVITIES

Community interest in the groundwater contamination in south Adams County was very intense in 1985 and 1986 when the problem first became known, and persisted until the permanent water treatment plant started operation in October 1989. The initial blame was placed on the Rocky Mountain Arsenal, which was adjacent to the contaminated public water supply area and already receiving significant media attention. The EPA and the Army responded to numerous public and media inquiries, issued press releases for new developments, and attended public meetings. Community relations activities were coordinated between the EPA, the Army, and the SACWSD. The State conducted a separate program.

In 1984 and 1985, local newspapers were printing stories almost daily concerning the Arsenal cleanup process and groundwater contamination. In the spring and summer of 1985, several local newspapers reported the detection of low levels of trichloroethylene (TCE) in SACWSD supply wells west of the Arsenal. The press quickly built up momentum on the new issue, and collectively published at least 10 articles in July of 1985. EPA personnel responded to numerous questions from reporters and the public, and supplied them with the data.

In response to the press coverage, Citizens Against Contamination (CAC), a local citizen's group, formed and arranged a meeting that was held September 3, 1985. One hundred to 200 people attended, including EPA, Colorado Department of Health (CDH), the Army, SACWSD officials, and local politicians. The meeting was covered by at least KUSA TV, Channel 9.

On November 13, 1985, the Army issued a press release announcing the detection of TCE in wells on the Arsenal property. The Denver Post responded with an article. A public meeting was held on November 25, 1985, in which the Army reported the results of the sampling. The Army stated that they planned to locate the

source of the TCE found in the Arsenal wells and discussed the next steps. They maintained that the available information was not sufficient to determine if the Arsenal was a source of the TCE found in the SACWSD wells.

On December 19, 1985, the EPA issued a press release stating that they were seeking Superfund money for cleanup of the south Adams County water. At least 22 articles appeared in the Denver Post and the Rocky Mountain News in December 1985 and January 1986. The articles focused on EPA's attempts to obtain funding and on the Arsenal as a suspected source. Congresswoman Pat Schroeder was pressuring the Army to pay for treating the water. Robert Duprey of the EPA did a live interview on KDEN radio. On January 24, 1986, Mr. Duprey and others met with CAC and promised to answer their questions, implement suggestions, and provide copies of documents.

CAC arranged a public meeting on February 13, 1986 with speakers from the EPA, the Army, SACWSD, and CDH. The Army offered technical assistance and funding for an interim solution. The EPA passed out a fact sheet listing contacts for information on various topics. There were at least 15 newspaper articles in February concerning the citizens fears and the Army's role.

One predominant issue in the press was that Governor Lamm blamed the Arsenal for the contamination and that the State was ready to sue the Army. The Army issued a press release on February 6, 1986, stating that CDH had agreed to withdraw the State suit. This was followed by an article in the Denver Post.

The CDH issued a health advisory on February 27, 1986, recommending that residents using shallow private wells in a specified area boil their drinking water or use bottled water (the advisory was updated by a second release on March 4, 1986, clarifying the boundaries of the affected area). The advisory resulted in a flurry of newspaper articles (including a headline in the Denver Post) expressing citizen concerns. The agencies

were again flooded with calls from the public, the press, and politicians. A major concern was access to bottled water for children at school. Both the EPA and Senator Gary Hart requested that the Army supply bottled water for the schools. The Army agreed, and the water was delivered in March. Coors also donated bottled water.

The EPA held a press conference on March 4, 1986, and issued a press release on March 5, 1986, reporting levels of TCE in three private wells that were much higher than levels found in water provided by SACWSD. The EPA issued an additional press release on March 5, 1986, stating that the EPA and the Army had agreed in concept to enter into an agreement to transfer funds from the Army to the EPA to pay for water treatment. A number of newspaper articles followed.

CAC held another public meeting on March 6, 1986, which was attended by over 600 people, including representatives of the EPA, the Army, CDH, Tri-County Health (TCH) and SACWSD. There were no formal presentations; just questions and answers. Questions centered on the health effects and the advisory. The CDH passed out a summary of the health advisory with clarifications. Residents using contaminated private wells were urged to connect to the public water system. The EPA stated that their goal was to have an interim water treatment system in place in four to twelve months (this was reiterated by SACWSD). The EPA also hoped to have an agreement with the Army and SACWSD to transfer funds from the Army to SACWSD for the interim system. The Army passed out a letter explaining that the evidence was still insufficient to substantiate the Arsenal as a contributor or the sole source of the TCE contamination.

Heavy newspaper coverage continued following the meeting. A press release issued March 20, 1986, announced an agreement to transfer \$1 million from the Army to the EPA. On April 7, 1986, the Army, the EPA, the State, and SACWSD signed a cooperative agreement to provide funding for the water treatment. The

agreement transferred the funds to SACWSD. Press coverage followed.

On April 23, 1986, the EPA presented an External Award to CAC for steadfast pursuit of safe drinking water and the cleanup of hazardous waste contamination. Also in the spring of 1986, the EPA prepared and widely distributed a videotape that answered common questions residents had regarding the TCE in their water.

On May 1, 1986, EPA issued a press release reporting new data on private wells. The new data gave a clearer indication that sources of TCE in addition to the Arsenal were involved. In May of 1986, six Colorado members of Congress wrote Lee Thomas, EPA Administrator, requesting he make funds available for the cleanup.

CAC held another public meeting on May 22, 1986, at which CAC, the Army, and the EPA presented updates. The EPA passed out a statement describing progress. The EPA was ready to fund the connection of private wells to SACWSD. The meeting was attended by a number of State, local and Federal politicians.

The Summer 1986 issue of SACWSD's newsletter "The Waterspout" announced the installation of the temporary carbon filtration system (May 30, 1986) and urged residents with shallow wells in the area to apply for free hookups. The EPA issued a press release offering the free hookups. A questionnaire was also sent to individual well owners.

Media and public interest subsided in the fall of 1986 after the safe drinking water issue had effectively been addressed via about 200 private well hookups and the start of the temporary water treatment system. EPA issued a fact sheet in August of 1986 containing information about the site (referred to as EPA's Rocky Mountain Arsenal Off-Post Study Area) and a summary of activities in progress. A press release September 11, 1986,

announced that the Army had transferred \$6 million to the EPA to fund a permanent treatment facility.

In the fall of 1986, results of an EPA study in the area of 48th and Leyden streets were brought to public attention. In an October 23, 1986 press conference, EPA specifically named the Chemical Sales site as a source of groundwater contamination in south Adams County.

In December of 1986, the EPA issued another fact sheet discussing the findings of an initial remedial investigation in the EPA Off-Post Arsenal Study Area. Remedial alternatives were presented and a public comment period from December 12, 1986, to January 7, 1987, was announced. Notice of the opportunity to comment was also published in the newspaper on December 10, 1986. Comments were received from CAC, CDH, SACWSD (and consultant), TCH, the City of Commerce City, the Adams County Commission, Adams County School District No. 14, Holme Roberts and Owen, the Army (and contractor), and a number of residents. The majority of commentators supported EPA's preferred alternative, a granular activated carbon filtration system.

In June of 1987, the EPA issued a ROD for the selected remedial alternative, a permanent water treatment plant (the Klein Plant) with a granular activated carbon filtration system. In October of 1987, the Army and the EPA agreed to pay to construct the plant and operate it for 25 years.

The EPA issued a fact sheet for EPA's Off-Post Arsenal Study Area in April of 1988 announcing further field activities for investigation of the contamination. The EPA prepared a Community Relations Plan for the Chemical Sales Site in December of 1988. In August of 1989, the EPA issued a fact sheet stating that the Chemical Sales site had been proposed for inclusion on the National Priorities List (NPL).

The Klein Water Treatment Plant opened on November 17, 1989. EPA, Army, and State officials were honored at both the ground-breaking and opening ceremonies for the Klein Plant. According to SACWSD's newsletter "The Waterspout", a capacity crowd attended the opening ceremonies.

The EPA issued a fact sheet in April of 1990 concerning TCE contamination in the Commerce City Area. The fact sheet discussed the background and the status of the site. In May of 1990, the EPA issued an additional fact sheet covering the status of four south Adams County Superfund Sites, including Chemical Sales.

On May 22, 1990, EPA gave two presentations to brief City and County officials on the Superfund process and sites in south Adams County. Also in May of 1990, the EPA Community Relations Coordinator took approximately 40 EPA management personnel and officials on a tour of the south Adams County Superfund sites.

EPA mailed out Proposed Plans for the three Operable Units at the Chemical Sales Site on February 28, 1991. The Proposed Plans discussed remedial action alternatives for the source and the groundwater contamination, and announced the public comment period. Notice of the public comment period also appeared in four local newspapers between February 27, 1991, and March 5, 1991. A public meeting held March 14, 1991, was attended by 50 to 75 people.

RECORD OF DECISION
CHEMICAL SALES COMPANY SUPERFUND SITE
OPERABLE UNIT 1 - LEYDEN STREET LOCATION

Written comments on the Chemical Sales Company (CSC) OU1 RI/FS were received from Adrian Brown Consultants, Inc. (for Interstate Distribution Center Associates, Ltd., IDCA); the Colorado Department of Health; Parcel, Mauro, Hultin & Spaanstra, P.C. (for CSC); and Department of the Army. Responses to the comments have been prepared and are presented in this section of the ROD. The comments have been grouped by topic and, in some cases, have been combined if they address a common concern. The actual text of the comments has been paraphrased for the purposes of this section, and the complete text is attached to this part of the ROD as Exhibit 1.

1. Department of the Army, Appendix H, Batch Flushing Model, Comments 1-5

A set of comments pertaining to the appropriateness of using a batch flushing model were raised, including concerns of how the model did not account for spatial variability of parameters, assumed clean inflow of water, lacked a sensitivity analysis, and presented inconsistent units.

EPA Response. The batch flushing model represents a simplified means to estimate time required to restore the alluvial aquifer to groundwater remediation levels within OU1 for the various alternatives evaluated in the detailed analysis phase. Due to technical, time and budgetary constraints, it was impracticable to simulate all variations within the CSC OU1 groundwater system. Thus, many generalized assumptions were used in the development of this model.

The simplifying assumptions included (a) that the mass of the contaminant is in chemical equilibrium between the solid (soil) and the liquid phases, (b) the soil-water partitioning isotherm (K_d) is linear and reversible, (c) the concentration of the contaminant in water used to flush the model aquifer is zero, and constant at that value, (d) no other chemical reactions occur that interfere with the adsorption/desorption process, (e) the units cubic centimeter (cc) and milliliters (ml) can be used as equivalent units for water, (f) the bulk density, porosity, distribution coefficient and contaminant concentration are all constant values throughout the model aquifer, and (g) that aquifer flushing estimates are conservatively evaluated under this method by using PCE as the contaminant. Since each evaluated alternative incorporated the same aquifer restoration time estimates based on the aquifer flushing model, the model served as a useful tool for comparing the effectiveness of one alternative with another.

Because the model cannot simulate actual variations in the groundwater system, the time frames presented in the OU1 FS are estimated, and are valid only as a relative comparison of time frames amongst alternatives. The uncertainty associated with these estimates are therefore acceptable for the purposes the CSC OU1 FS. If the model accounted for spatial variability and conducted a sensitivity analysis, the relative effectiveness of the various alternatives would remain unchanged. Additional modeling may be considered during the remedial design to optimize well locations and pumping rates, and during remedial action to evaluate the effectiveness of the system. EPA has evaluated the model for consistency of units and, given the assumption above, requests further clarification on this concern.

2. Adrian Brown Consultants, Inc., General Comment, Page 1, paragraph 1.

Reference to Trammell Crow as the owner of the land and buildings adjacent to the CSC property to the west is incorrect and should be changed to clearly identify Interstate Distribution Center Associates, Ltd. (IDCA) as the owner of this property.

EPA Response. EPA acknowledges this concern. All future references pertaining to the ownership of the 4650 Leyden St. property, including the CSC OU1 Record of Decision, will identify the Interstate Distribution Center Associates, Ltd. as the current owner.

3. Adrian Brown Consultants, Inc., General Comment, Page 16, paragraph 3.

Throughout most of the document, Trammell Crow is misspelled. All references to Trammell Crow should be replaced with IDCA, the owner of the property to the west of CSC.

EPA Response. It is recognized that Trammell Crow is misspelled and also that IDCA is the owner of this property.

4. Adrian Brown Consultants, Inc., General Comment, Page 1, paragraph 2.

Potentially contaminated rinsate waters were disposed on the IDCA property in violation of the General Sampling and Analysis Plan.

EPA Response. The comment is noted.

5. Adrian Brown Consultants, Inc., General Comment, Page 16, paragraph 1.

Reports from the Denver Fire Department and the Colorado Department of Health indicate that on March 28, 1986, CSC

was found discharging chemical wastes onto the ground to the north of the CSC property. Given this incident and the possibility of additional such discharges, it does not appear that the RI sampling and analysis has been adequate to characterize the contamination resulting from such discharges.

EPA Response. A comprehensive soil gas survey was conducted during Phase I of the CSC OU1 RI. The objective of the survey was to focus and streamline data collection activities. Areas exhibiting soil gas detections were further characterized during Phase II and Phase III activities. Soil and soil gas data was collected from the area north of the CSC property during all three phases. These activities are considered to be sufficient to characterize resulting contamination from this release.

6. Adrian Brown Consultants, Inc., Site History Comment, Page 16.

IDCA strongly objects to the inclusion of unsubstantiated claims of historic uncontrolled waste disposal as in paragraph 2 on page 2-1. IDCA also objects to the inclusion of the statement that strong fumes were reported while excavating for the construction of the Trammell Crow building (paragraph 3, page 2-1). This statement is no longer in the RI/FS. EPA has been provided with affidavits stating that the only similar incident that IDCA is aware, was a release from a tanker unloading at CSC.

EPA Response. The affidavits submitted to EPA by IDCA which document that no fumes were reported as a result of building excavation have been incorporated into the EPA Administrative Record of the CSC site. Historical uncontrolled waste disposal was proposed as one of the several possibilities resulting in the observed soil and groundwater contamination. Data collected during the Phase II and Phase III RI, do not confirm the existence of an uncontrolled waste dump on the IDCA property.

7. Adrian Brown Consultants, Inc., Site History Comment, Page 1, paragraph 1.

The RI/FS claims that a very large area which includes OU1 was historically used for uncontrolled dumping. This claim is unsubstantiated in the RI/FS. Nor does the RI/FS identify any disposal activities that coincide with the sources of contamination identified in the RI/FS.

EPA Response. Since the 4650 Leyden St. property was vacant until the early 1970s, and uncontrolled dumping activities have been identified throughout this area, the identification of this type of potential source is deemed

appropriate for recognizance purposes. Data collected during the CSC OU1 FS have not confirmed the presence of uncontrolled dump sites as sources to the observed soil and groundwater contamination.

8. **Adrian Brown Consultants, Inc., Site History Comment, Page 2, paragraph 3.**

Five other spills are noted and requested for inclusion.

EPA Response. The EPA will include this additional information in the CSC OU1 Administrative Record. These spills have also been identified in the CSC OU1 ROD.

9. **Department of the Army, Remedial Investigation, Specific Comment 2.**

The site history indicates that there were several other potential sources of contamination that were not addressed in the report, such as the landfill and the airfield.

EPA Response. Although there is evidence to indicate that landfill and airfield operations may have occurred within a large area indicated in Figure 3-1, a more detailed survey of historical aerial photographs has not shown those activities to have taken place on the CSC property. While these activities could potentially be sources of contamination, the CSC RI/FS was not intended to identify sources beyond the boundaries of the operable unit.

10. **Adrian Brown Consultants, Inc., Source of Contamination Comments, Pages 12 and 13.**

The RI/FS does not accurately address the potential sources of contamination at the site. Aerial photographs indicate the storage of CSC materials on what is now the IDCA property. These same photographs do not support the RI/FS's claim that uncontrolled dumping occurred on the IDCA property.

EPA Response. EPA has included 1978 and 1979 aerial photographs of the CSC and IDCA properties in the CSC Administrative Record. EPA notes IDCA's contention that drums were stored on what is now IDCA property. Assuming these drums may have leaked in the past, EPA is unclear why IDCA so vehemently denies any source materials being on this portion of its property.

11. **Adrian Brown Consultants, Inc., Adequacy of Remedial Investigation Comment, Page 6.**

The RI/FS may not have fully identified all significant sources of contamination upgradient of OU1.

EPA Response. The identification of 87 ppb of TCE, 15 ppb of PCE, 9 ppb of 1,1,1 TCA and 5 ppb of 1,1 DCE in upgradient Well MW 24, indicates that a potential source may exist upgradient of the IDCA and CSC properties. This well only has been sampled once and will be sampled during remedial design to verify these results. The saturated thickness observed in well MW 24, however, is less than one foot, indicating that the total potential mass of contaminants migrating from upgradient onto the IDCA and CSC facility is extremely small. It should be noted that upgradient well MW 1, located on the southeast corner of the CSC property has not detected contamination in three separate sampling rounds. EPA will sample Well MW 1 during the remedial design. A final determination of the presence of upgradient sources will not be made until these results are analyzed. The CSC site will not be extended if upgradient sources are identified.

12. **Adrian Brown Consultants, Inc., Groundwater Contamination Comment, Pages 11 and 12.**

Based on water quality data from well MW-13, it appears that there is a source of contamination upgradient of the IDCA property. However, the RI/FS implies that the potential sources of contamination are near well MW-12.

EPA Response. Although the contamination could have originated from groundwater flowing from upgradient locations, the possibility that a localized source or sources not encountered in the soil borings cannot be completely ruled out. The text does offer other hypotheses. The text also correctly describes the contaminant distributions.

13. **Adrian Brown Consultants, Inc., Site History Comment, Page 2, paragraph 5, 6.**

It is unclear which tank farm is shown to have been expanded in the 1954 photographs. It is also incorrect to state that the fill material used during pad construction for IDCA buildings was imported.

EPA Response. The description of the construction of the pads for the IDCA building in the CSC OU1 ROD have been revised.

14. **Adrian Brown Consultants, Inc., Soil Gas Survey Results Comment, Page 3.**

A lengthy comment was made questioning the usefulness of identifying specific sources using soil gas methods, including the ability of the method to distinguish between soil sources and soil that has become contaminated by volatilization from contaminated groundwater.

EPA Response. The reviewer is apparently confused by the manner in which soil gas results were collected and the purpose of their intended uses. Two sets of data containing soil gas results are presented in the report. The first is presented in Section 4.2.3, Soil Gas Survey Results. This application was intended to serve as a screening tool to delineate approximate areas within OU1 which warranted further investigation. The TCE map (Figure 4.13) delineates an areal distribution of soil gas and provided the basis for hypothesizing several different potential source areas. The second soil gas application, in Section 4.3.1, utilized soil gas as derived from headspace from soil samples collected at approximately 5 foot depth intervals within the designated boreholes. This second application was used to qualitatively discern the vertical and areal distribution of contaminants and delineate those areas in which only soil was contaminated compared to those areas in which soil and groundwater were contaminated.

**15. Adrian Brown Consultants, Inc., Soil Gas Survey Results
Comment, Page 4, paragraph 1.**

A point was made regarding the apparently incorrect distribution of PCE soil gas results near the CSC tank farm and the IDCA building.

EPA Response. Closer examination of the data indicates that the narrative description and the referenced figure for PCE soil gas concentrations are correct as given.

**16. Adrian Brown Consultants, Inc., Quality of Soil Gas Analyses
Comment, Page 24, paragraph 1.**

Concern was raised over the apparent lack of soil gas daily calibration in the Phase III RI.

EPA Response. The text indicating daily calibration refers to the soil gas survey. The Phase III RI involved no such survey, hence the reference is inappropriate.

**17. Department of the Army, Remedial Investigation, Specific
Comment, Page 4-33**

The presence of soil gas slightly upgradient (with respect to groundwater flow) of a groundwater source does not preclude groundwater as the source of the observed soil gas concentrations. Soil gas flow is not governed by groundwater gradients.

EPA Response. The EPA agrees that soil gas flow is not governed by groundwater gradients. The distribution of soil gas, however, often mirrors that of the VOC's in groundwater when contaminated groundwater is the source of the contamination detected in the soil gas. Low levels of VOC's

were recently detected in the CSC upgradient monitoring well. It is possible that this "upgradient" contamination may be at least part of the source of the upgradient soil gas that has been recorded.

18. **Adrian Brown Consultants, Inc., Quality of Soil Gas Analyses Comment, Page 24, paragraph 2.**

Concern was raised regarding the depiction of duplicate results as being generally well matched. The argument was made that the duplicate results are poorly matched when the duplicates for which the compound was (a) not detected and (b) exceeded 10,000 are not included in the evaluation.

EPA Response. The EPA feels it is appropriate to include both ND and >10,000 values in the evaluation of duplicate similarity. With these sets of results included, as they are in the RI/FS report, the duplicate values are indeed well matched.

19. **Adrian Brown Consultants, Inc., Quality of Soil Gas Analyses Comment, Page 25, paragraph 1.**

The data from instrument and syringe blanks was not included in the report.

EPA Response. Data from instrument and syringe blanks were not deemed necessary for inclusion in the CSC OU1 RI/FS. The Gas Chromatograph sampling methodology and field analysis as provided in the CSC Sampling and Analysis Plan is appropriate for DQO Level II data.

20. **Adrian Brown Consultants, Inc., Electrical Resistivity Survey Results Comment, Page 4.**

Adrian Brown Consultants, Inc., Magnetic Survey Results Comment, Page 5, paragraph 2.

The manner in which hypotheses were offered regarding interpretation of the resistivity and magnetic survey results include the possibility of uncontrolled dumping even though there is no data to substantiate the claim that uncontrolled dumping has ever occurred on the IDCA property.

EPA Response. Uncontrolled dumping was identified as one of the several possibilities, (including natural conductivity contrasts), to explain the distributions obtained from the surveys. Since this survey was used as a screening tool to focus data collection activities, the identification of several possibilities contributing to the observed results is appropriate.

21. Adrian Brown Consultants, Inc., Magnetic Survey Results Comment, Page 5, paragraph 1.

Concern was expressed over the statement in the report relating the lateral extent of an anomaly to the area reportedly used for filling operations.

EPA Response. The EPA agrees with this comment.

22. Adrian Brown Consultants, Inc., Field Gas Chromatograph Soil Headspace Interpretations Comment, Page 5.

The discussion of results did not include factors which could affect the concentrations detected in the headspace gases.

EPA Response. Many factors such as temperature, type of vadose zone material and heterogeneity of vadose zone material, effect the magnitude of detected soil gas concentrations. Soil gas, however, was used to the determine the presence or absence of contaminants in the soil. Since this data is used qualitatively (DQO Level II), the identification of factors effecting quantitative analysis is unnecessary.

**23. Department of the Army, General Comment 5
Department of the Army, Specific Comment, Risk Assessment,
Page 1-3**

No corresponding sediment samples were collected along with the surface water samples. The rationale for not collecting the sediment samples was not presented.

EPA Response. Sediment sampling was not deemed to be necessary based on the circumstances at the site. The data indicates that the streams and ditches of concern are losing streams, thus water would be moving from the stream into the groundwater, not vice versa. Since the contaminants of concern are all volatile organic compounds with fairly low sorptive capabilities, stream and ditch sediments are not considered to be likely sites for contaminant concentration.

24. Adrian Brown Consultants, Inc., Assessment of Contamination from Known Releases Comment, Page 6.

Department of the Army, Specific Comment, Page 1-3.

Because no contaminants were found in Sand Creek surface water, the potential for surface water contamination was dismissed. No sediment sampling was discussed in the report. The investigation of the contribution to surface water by contaminated groundwater would be aided by the inclusion of sediment sampling results, if available.

EPA Response. Sediment sampling of Sand Creek was not conducted because it is not expected that volatile organic compounds (VOCs) would be present in sediment. Volatile organic compounds do not readily absorb to sediment particles in a surface water environment. Since no VOCs were detected in surface water in the wetlands from which the ditch empties, it is unlikely that residual VOCs will be detected in the ditch sediments.

25. Adrian Brown Consultants, Inc., Soils Contamination Comment, Pages 6-8.

Concern was raised regarding the depth of soil contamination detected in boring SB-10 and SB-14, located on the IDCA property, and why leaching of contaminants to the water table at these locations is unlikely.

EPA Response. The EPA does not rule out the hypothesis that the absence of detectable contamination below about 20 feet could be due to the low adsorptive capacity of the soils and thus that contaminants could have leached to the groundwater. The arguments given to rule out this hypothesis are weak and unclear. A very low K_d of the sandy soils could easily result in adsorbed VOC concentrations being low enough to be below soil analytical detection limits. Also, the mass balance argument presented does not consider that contaminants may have leached through the vadose zone and into the aquifer in the past.

26. Adrian Brown Consultants, Inc., Soils Contamination Comment, Page 9, paragraph 1.

Compounds identified in groundwater below the IDCA property have not been identified in the soils at the property. These compounds include methylene chloride, cis-1,2-dichloroethene, 1,1-dichloroethane, 1,2-dichloroethane, and vinyl chloride.

EPA Response. With the exception of methylene chloride, the other compounds listed in the comment could and likely are breakdown products of perchloroethene, trichloroethene and/or trichloroethane.

27. Adrian Brown Consultants, Inc., Soil Contamination Comment, Page 9, paragraph 3.

The mass:mass ratios for PCE to TCE in soils is much higher than the ratios for groundwater under the IDCA property.

EPA Response. The EPA considers the ratios to suggest that a source of PCE exists in soils on the IDCA property. The ratio would tend to decrease as biodegradation ensues and dehalogenation occurs, leading to lower concentrations of the more chlorinated compounds and higher concentrations of

the less chlorinated compounds. An additional difference in the soil and groundwater ratios probably relates to the groundwater under the IDCA property being affected by flow from upgradient locations which may have a different mix of compounds.

28. Adrian Brown Consultants, Inc., Direction of Groundwater Flow Comment, Page 10.

The piezometric map (Figure 3.9) misrepresents the bulk of the information pertaining to groundwater flow direction and the RI provides incorrect information by omitting MW-5.

EPA Response. The piezometric surface map shown on the figure is very similar to the piezometric surfaces of other months, and indicates that groundwater flows in a north to northwest direction. The associated text is similarly accurate and correct. The comment was unable to state that a localized westerly flow component apparently existed in the vicinity of the CSC underground tank farm based on measurements collected in March and June, 1990, but not in September 1990. As clearly indicated in a note on the figure, well ES-MW-5 was damaged and unavailable for measurement during the month for which the piezometric surface on the figure portrays. At IDCA's request, water level information from well ES-MW-5 was collected the following month and included in the figure. Because an annual cycle of water level measurements had not been collected and there had been disturbance associated with excavation of the underground storage tanks on the CSC property, it is not known if the highly localized westward component of flow as shown on the March and June piezometric surface maps exists seasonally, is due to measurement errors, or is real.

29. Adrian Brown Consultants, Inc., Risk Assessment Hydrogeology Comment, Page 17.

The groundwater flow direction would be more accurately described as flowing generally to the north but also slowing to the west and northwest in the southern portion of OU1.

EPA Response. The summary of groundwater flow directions presented in the Risk Assessment is for general information purposes and does not supersede the detailed information on piezometric surface configuration presented the RI.

30. Adrian Brown Consultants, Inc., Soil Action Levels Comments, Page 14 and 15.

The approach used in the RI/FS, using MCLs and a dilution/attenuation factor (DAF) appears to be based on a misunderstanding of both the DAF and the physical chemistry of the sorption and leaching.

EPA Response. Some confusion apparently exists over how the soil action levels were established. The goal of setting soil remediation levels is to have the leachate derived from the soils at low enough concentrations such that, after dilution in the aquifer, the resultant groundwater concentrations are at or below groundwater remediation levels. Soil remediation levels were back calculated from groundwater remediation levels. Groundwater remediation levels were multiplied by a dilution factor of 100. This value represents the acceptable leachate concentration for a particular compound. Soil remediation levels were derived by multiplying the acceptable leachate concentrations by the partitioning coefficient for soil contaminants at the CSC facility. Partitioning coefficients were based on site specific studies conducted during the OU2 RI. These values are considered acceptable for establishing soil remediation levels for OU1. The model assumed that the soil column was uniformly contaminated

Partitioning coefficients derived from column or batch studies conducted on the CSC facility would provide more accurate partitioning coefficient values. Since many conservative assumptions were used in the derivation of CSC OU1 soil remediation levels, EPA considers the soil remediation levels presented in this ROD as protective to human health and the environment and does not find it necessary to require the performance of these additional studies. EPA, however, does not want to impede IDCA from conducting these tests. If additional batch or column test are conducted, EPA will revise the soil remediation levels based on data acquired during these studies.

31. Adrian Brown Consultants, Inc., Risk Assessment General Comment, Page 16.

A concern was raised regarding inadequacy of the RI sampling due to discharges of chemical wastes onto the ground north of the CSC property.

EPA Response. CSC conducted an initial soil gas survey to evaluate the extent of VOC contamination and designed its soil boring and well installation program around the survey results and review of areal photographs. In addition, CSC sampled the marsh located north of the CSC property. It is likely that VOC contamination discharged north of the property would have been detected in the soil gas survey, marsh sampling or the groundwater sampling results if the discharge was significant.

32. Adrian Brown Consultants, Inc., Effectiveness of Soil Vapor Extraction System Comment, Page 22.

The comment maintains that the pilot SVE test did not address the ability of system to decrease VOC

concentrations, but simply tested the air-flow hydraulics of the system.

EPA Response. The EPA directs the reviewer to the text again, to read the section on the calculated mass removal that approached several pounds per hour during the test. It is very clear, at least to the EPA, that such mass removal indicates that VOC concentrations in the vadose zone soils have been reduced accordingly. Given the large number of field and laboratory factors that can affect soil VOC concentrations, in addition to the costs to collect and analyze such samples, it is not considered appropriate to have measured soil mass loss during the pilot test in the manner suggested.

33. Adrian Brown Consultants, Inc., Data Quality Comments, Pages 23 and 24.

It is requested that DQOs for the field Gas Chromatograph data collection portion of the investigation be included, and that the QA/QC section be revised per previous EPA comments.

EPA Response. The data quality objective for Gas Chromatograph data are to qualitatively (1) determine the vertical areal extent of soil contamination within CSC OUI and (2) determine the nature of contaminants (i.e. type of compound).

34. Adrian Brown Consultants, Inc., Data Comparability Comment, Page 24.

The reviewer notes that the headspace results were significantly higher than the GC/MS results.

EPA Response. The EPA notes the comment, and questions if the higher headspace results may indicate that fewer VOC losses occur with the headspace method compared to the GC/MS method, leading to the conclusion that the headspace results may yield a more accurate depiction of actual site VOC conditions.

35. Adrian Brown Consultants, Inc., Quality of Field GC Analyses Comment, Page 25-26.

A concern is raised over the high variance associated with the calibration standards and with the check standards.

EPA Response. The comments are noted. The variance associated with the procedure may be acceptable for the DQO level associated with the field Gas Chromatograph analyses. The EPA does not agree with the assertions made regarding the check standards. Except for standards results on two

days, the RPDs are within 20 percent, which is adequate for the purposes of the field method.

36. Adrian Brown Consultants, Inc., Headspace Data Comparability Comment, Page 27-28.

While there is a strong correlation between the laboratory GC/MS and the field headspace analyses for all compounds but TCA.

EPA Response. The EPA notes IDCA's concurrence on page 27 that there is apparently a moderately strong relationship between the field headspace results and the laboratory GC/MS results for PCE and TCE. The relationship for TCA is not as strong, but EPA feels that it is sufficient for the screening application for which it was used.

37. Adrian Brown Consultants, Inc., Field GC Calibration Comment, Page 28, paragraph 1.

The basis for the statement regarding great variation in RSDs due to column degradation is requested.

EPA Response. The variation of RSDs related to a comparison of RSDs between compounds. It is known through laboratory studies conducted at Stanford and elsewhere that the different VOC's have different degradation rates. Degradation is expected to occur through a variety of factors in the laboratory, thus it is not surprising that different amounts of degradation would occur to the different compounds.

38. Adrian Brown Consultants, Inc., Field GC Calibration Comment, Page 28, paragraph 2.

A question arose regarding the classification scheme for the RPD results.

EPA Response. As the text clearly indicates, the good, fair and poor classifications are "for the purposes of this discussion" and are clearly defined in the text.

39. Adrian Brown Consultants, Inc. Field GC Calibration Comment, Page 29.

The number of samples used to calculate the RPDs is requested for inclusion.

EPA Response. Approximately 5 samples were used to calculate RPDs.

40. Adrian Brown Consultants, Inc., Use of Field GC Headspace Data Comment, Page 29.

Concern was raised that the Field Gas Chromatograph headspace results are not a valid method to determine soil contamination.

EPA Response. Since Gas Chromatograph Headspace sampling was more comprehensive and did not allow for loss of volatiles during sampling, the CSC OU1 FS used field Gas Chromatograph Headspace data to qualitatively assess vertical and areal extent of soil VOC contamination. The use of DQO Level II data in determining the extent of contamination is consistent with EPA guidance, Data Quality Objectives for Remedial Response Activities, 1987. Confirmation of the attainment of soil remediation levels, however, will be based on laboratory analytical results (DQO Level IV).

41. Adrian Brown Consultants, Inc., Use of Field GC Headspace Data Comment, Page 30 through 32.

A lengthy presentation of concerns was made again regarding the method used to determine soil action levels, including the conversion of soil headspace to soil solid matrix concentrations.

EPA Response. The FS converted soil headspace levels to laboratory analytical levels in order to approximate the areas requiring remediation of contaminated soils. As stated previously, DQO Level II data is of sufficient quality to qualitatively identify the extent of soil contamination. Laboratory analytical data will be required to confirm the attainment of soil remediation levels presented in this ROD upon completion of remedial action. The EPA also notes IDCA's concurrence on page 32 that the field Gas Chromatograph can appropriately be used in outlining the area of soils requiring remediation.

42. Department of the Army, Specific Comment, Page 1-4.

Based on exposure point concentrations, the future resident scenario did not include residents on site, but did include residents adjacent to the site. It would be useful to include a discussion of the rationale for these scenarios.

Only 1990 data were used, arbitrarily limiting the data base upon which remedial determinations were made. It would be useful to discuss the rationale for this approach.

EPA Response. This comment is incorrect. The future residential scenario is based on current on-site analytical data. Exposure to groundwater is based on concentrations presented in Table 5-2 and exposure to soil is based on

concentrations presented in Table 5-5. These concentrations represent current on-site contamination.

As discussed on page 4-1 of the Chemical Sales Company OU1 Risk Assessment (CDM 1990a), the most current sampling data were used in the risk assessment in order to obtain exposure estimates that reflect current contamination at the site. The use of the most current sampling data is also consistent with risk assessment procedures followed for the Chemical Sales Company OU2 site (CDM 1990b) as well as current EPA guidance (U.S. EPA 1989). The use of previously collected sample data for purposes of risk assessment would not give exposure estimates that reflect current conditions at the site. Since much of the previously collected data had not been validated, it was determined that this data was not of sufficient quality to be used in the OU1 Risk Assessment. EPA Data Quality Objective Guidance recommends that data used in risk assessment be validated.

43. Department of the Army, Risk Assessment, Specific Comment, Page 4-7.

It appears that soil gas concentrations were obtained from the headspace of monitoring wells (see Table 4-4). The RI indicates soil probes were used. If monitoring well headspace was used, the concentrations obtained are not equivalent to soil gas that could enter basements and do not appear to be appropriate in assessing inhalation of volatiles in the basement pathway. It would be useful to clarify this section.

EPA Response. There appears to be some misinterpretation of what type of soil headspace was used for the basement scenario. Headspace data used to evaluate exposure to soil gas in a basement was that obtained from soil borings, not headspace of monitoring wells as stated in the comment above. At the time of the risk assessment was written (June-July 1990), validated data from the vapor extraction analysis was not available. Therefore, the soil headspace data were considered adequate for evaluation of the basement inhalation pathway. A recent comparison of the soil headspace data to the vapor extraction data indicates that the soil headspace values compare favorably to the vapor extraction values (i.e., within an order of magnitude).

44. Department of the Army, Specific Comment, Page 5-1.

No environmental assessment was included in 40 CFR Section 300.430(e)(2)(i)(G). This document provides guidance for conducting environmental evaluations to assess threats to the environment, especially sensitive habitats and critical habitats to species protected under the Endangered Species Act.

EPA Response. There are no known endangered species in the Chemical Sales Company OU1 area. The area is zoned as highly industrial and is currently occupied by several industries and storage facilities making it uninhabitable by most wildlife. Sand Creek is potentially capable of supporting aquatic wildlife, however, and considered a wildlife corridor. An environmental assessment of this corridor is provided in the Chemical Sales Company OU2 Risk Assessment (CDM 1990b).

45. Department of the Army, Specific Comment, Page 5-8.

The method of calculating basement exposures seems incompletely presented, making any verification of the calculation difficult if not impossible.

EPA Response. Using the assumptions described in the text and a soil permeability of 3×10^{-1} cm/sec, Garbesi and Sextro (1989) used a two dimensional, steady-state finite element flow model to simulate the flow of soil gas into a basement. Their results indicated an entry rate of soil gas of 2.5 m³/hr. Coupling this entry rate with the mean VOC concentrations in Table 5-4 provided the fluxes for use in the mass balance model. The mass balance model was used to estimate the VOC concentration which would result in the basement under the assumptions described in the text. The mass balance equation used was:

CA = VOC Concentration in basement air (mg/m³)
F = VOC flux into basement (mg/hr)
T = Time for basement air exchange (hr)
V = Volume of basement (m³)

The value of CA was then used in the intake equation shown in the text.

Due to the large amount of uncertainty associated with quantitative risk estimates from the basement pathway using this model, risk via the basement pathway are presented qualitatively in the CSC ROD. Protectiveness of the remedy, including consideration of updated models, will be examined through the 5-year reviews.

46. Department of the Army, Specific Comment, Table 7-1.

It would be valuable to include explanations for why the future children scenario contains only three pathways.

It appears that the future residents scenario should contain inhalation of ambient air as an exposure pathway.

While chloroform and cis-1,3-dichloropropene contribute to the calculated cancer risk, they were deleted from the FS as chemicals of concern and do not have any remedial action

levels assigned to them. An explanation of the rationale for this decision should be included.

Inappropriate slope factors may have been used since very high cancer risks were observed. It would be useful to clarify this relative to EPA's Integrated Risk Information System instructions.

EPA Response. Due to the significant differences between children and adults for the soil exposure pathways, future children were evaluated separately for the soil pathways only. For purposes of this risk assessment, it is difficult to assess the location of a future residential receptor.

The risk assessment was based on Phase I and II data. Original evaluation of these data indicated that chloroform and cis-1,3-dichloropropene should be considered as COCs based on frequency of detection and toxicity. However, upon receipt of Phase III data, it was determined that, based on frequency of detection, these chemicals may be omitted as COCs.

Chloroform and cis-1,3-dichloropropene were omitted from the FS based on low frequencies of detection and low concentrations at which they were detected. Chloroform was detected in three out of 36 samples (8%) at concentrations of 2J (estimated), 720D (diluted) and 37 µg/L. Two of these values are associated with some uncertainty as indicated by their qualifiers. Cis-1,3-Dichloropropene was detected in only one of 36 (3%) samples at a concentration of 330(D) µg/L. Superfund guidance states that if a chemical is detected in 5% of samples obtained or more, it should be retained as a chemical of concern. For this reason chloroform was retained as a COC in the risk assessment. However, upon consideration of the uncertainty associated with the concentrations detected, it was omitted as a COC in the FS. Cis-1,3-Dichloropropene was only detected in 1% of the samples, and accordingly was dropped in the risk assessment.

Because dermal slope factors are not available for chemicals, dermal slope factors were extrapolated from oral slope factors according to EPA guidance. These slope factors are most likely conservative estimates. Oral and inhalation slope factors were obtained from the HEAST (Second Quarter, 1990) tables and are correct.

47. Department of the Army, Specific Comment, Page 7-4.

All non-carcinogens were grouped together for computation of the hazard index. While RAGS indicates that this may be done for a screening analysis, it appears more appropriate

to group hazard indices by mechanism and target organ system.

EPA Response. In general, the target organs for the COCs are the liver and kidney. All of the COCs are considered to have similar adverse health effects and mechanisms of action. Therefore, it is appropriate to add hazard indices as recommended by EPA guidance (1989).

48. Adrian Brown Consultants, Inc., General Comment, Page 16, paragraph 2.

During recent months, CSC operations have resulted in at least four hazardous chemical releases extending beyond CSC property: February 2, 1990, August 3, 1990, August 7, 1990, and September 11, 1990, and February 16, 1991. In the February incident, the Denver Fire Department responded, evacuated a number of workers from nearby businesses and administered first aid to several of these workers. During the September incident, the Denver Fire Department forced the tenants of the IDCA building to evacuate. The risk assessment should address the potential health consequences of continuing releases from CSC. Since the risk assessment can only address information presented in the RI/FS, these releases need to be discussed in the RI/FS.

EPA Response. A qualitative statement discussing these releases may have been warranted. However, it is not the intent of the RA to speculate on future releases. The quantitative evaluation of contamination and resultant exposures can only be based on validated data obtained from the RI report. In addition, the purpose of the RA is to estimate risks associated with chronic exposure to contaminants present at the site, not acute exposure.

49. Adrian Brown Consultants, Inc., Hydrogeology Comment, Page 17.

The risk assessment contains a statement that groundwater flows in a northerly direction (paragraph 3, page 3-1). It would be more accurate to state that the groundwater flow is generally to the north but also flows to the west and northwest in the southern portion of OU1 (see Figures 5 and 6, enclosed).

EPA Response. EPA does not agree with this interpretation. Groundwater near the CSC property flows in a general north to northwest direction. This is based on water table elevations and migration of groundwater contamination.

50. Adrian Brown Consultants, Inc., Data Evaluation Comment, Page 17, paragraph 1.

This section should include a discussion of the indoor air monitoring data from the IDCA building.

EPA Response. Indoor air monitoring data collected at the IDCA property were never considered in the scope of the RI or RA. The RA is based on data presented in the RI only per EPA guidance (U.S. EPA 1989). These data are, however, discussed on page 7-9.

51. **Adrian Brown Consultants, Inc., Data Evaluation Comment, Page 17, paragraph 2.**

Will data from the Phase II of the RI be included in the final risk assessment?

EPA Response. The baseline risks calculated for pathways associated with the groundwater, surficial soils and soil gas media did not include data collected during the Phase III sampling effort. Results of sampling for these media during Phase III were comparable to results from data collected during Phase II. Risks associated the air media were re-evaluated based on air monitoring conducted subsequent to the release of the OUI RA.

52. **Adrian Brown Consultants, Inc., Data Validation Comment, Page 17, paragraph 3.**

The Risk Assessment mentions, but does not include, the results of the field validation procedure used to evaluate the reliability of the field gas chromatography paragraph 1, page 4-2).

EPA Response. Field validation results were not available at the time the risk assessment was written.

53. **Adrian Brown Consultants, Inc., Summary of Sampling Data Comment, Page 17.**

A section should be included on the indoor air monitoring data from the IDCA building.

EPA Response. Indoor monitoring data collected at the IDCA building were not incorporated into the RI or the RA as those data were not considered in the scope of the RI process. They are, however, discussed on page 7-9 and have been included in EPA's Administrative Record for CSC OUI.

54. **Adrian Brown Consultants, Inc., Identification of Exposure Pathways Comment, Page 17, para 1.**

The Risk Assessment should address the potential health consequences of continuing releases from CSC.

EPA Response. As stated previously, it is not the goal or purpose of a risk assessment to speculate on future releases of contamination at a site.

55. Adrian Brown Consultants, Inc., Identification of Exposure Pathways Comment, Page 17, paragraph 2.

Use of the highest measure concentration of PCE in surface soils (80,000 $\mu\text{g/kg}$ at SSB-10) dramatically overstates the risks for OU1. The concentration of PCE at SSB-10 certainly is not typical. The next highest PCE concentration is 1,900 $\mu\text{g/kg}$ or 42 times less than the SSB-10 value. The arithmetic average of the concentration of PCE in the surface soils, excluding the one high value and the one ND, is 373 $\mu\text{g/kg}$ or 214 times less than the SSB-10 value. Thus, to use the concentration of PCE at this one "hot spot" for the OU1 risk estimate seems to exceed the "reasonable maximum exposure" expected to occur at OU1.

EPA Response. The use of the maximum detected concentration is in accordance with Superfund Guidance (U.S. EPA 1989) which states that when the upper 95th percentile of the mean exceeds the maximum detected concentration, the maximum detected concentration should be used instead.

56. Adrian Brown Consultants, Inc., Quantitative Evaluation of Pathways Comment, Page 17.

There does not appear to be a section specifying the assumptions used in calculating the risks from inhalation of indoor air at the IDCA building.

EPA Response. Table 5-10 (CDM 1990a) presents exposure assumptions used to calculate inhalation of indoor air in a basement.

57. Adrian Brown Consultants, Inc., Inhalation of Volatiles in a Basement Comment, Page 18, paragraph 1.

Because the soil gas data used to calculate basement concentrations are from an unknown mass of soil in a VOA vial with an unknown headspace volume, it is not known how these data relate to the quantities of volatiles that could infiltrate into a basement (paragraph 2, page 5-8).

EPA Response. It is acknowledged that the soil gas data is only of screening level quality. However, it is reasonable to use these data as estimates of soil gas concentrations for the purposes of this RA. Due to many factors including data quality, the risks via the basement pathway are evaluated qualitatively in the CSC OU1 ROD.

58. Adrian Brown Consultants, Inc., Inhalation of Volatiles in a Basement Comment, Page 18, paragraph 2.

The assumed ventilation rate of one air exchange every 6 hours seems unusually low. Our experience is that an air exchange occurs every 1-2 hours (paragraph 2, page 5-8).

EPA Response. This value was selected as a conservative air exchange.

59. **Adrian Brown Consultants, Inc., Direct Contact with Surface Soil Comment, Page 18, paragraph 1.**

The assumption that indoor dust with windblown contaminants contains the same concentration of volatiles as soil overstates the risks from this pathway since most volatiles in soil will certainly be volatilized if windblown (paragraph 1, page 5-11).

EPA Response. The assumption that indoor dust is the same concentration as soil is, most likely, conservative, however, EPA guidance recommends that one should assume 80% (U.S. EPA 1991) of indoor dust is contaminated by windblown soil. Therefore, the use of 100% as an assumption would not result in a significant overestimate of exposure relative to EPA recommendations.

60. **Adrian Brown Consultants, Inc., Direct Contact with Surface Soil Comment, Page 18, paragraph 2.**

The assumption that every time children play outside their legs become covered with soil overstates the risks from this pathway (paragraph 1, page 5-11). Use of the skin adherence factor for kaolin clay (the highest such factor recommended by RAGS) overstates the risks from this pathway since the geologic data show that the surface soils in OU1 are predominantly sandy, with a lower skin adherence factor (paragraph 1, page 5-11).

EPA Response. The assumption that a child's legs may be covered with soil is conservative. However, it is not unlikely that dermal exposure to soils on a child's legs or potentially more of their skin surface area may occur as a result of playing outdoors.

Site-specific soil data were not available, therefore, a conservative adherence factor was used. The soil adherence factors provided by EPA in the Risk Assessment Guidance for Superfund (U.S., EPA 1989) are 1.4 mg/cm² for potting soil and 2.77 mg/cm² for kaolin clay. The difference in these two values is unlikely to have a significant effect on the exposure estimations. Page 5-16 recognizes the conservativeness of this assumption.

61. **Adrian Brown Consultants, Inc., Direct Contact with Surface Soil Comment, Page 18, paragraph 3.**

The Risk Assessment uses a skin absorption factor of 1. This again overstates the risks from this pathway as a significant portion of the volatiles in contact with the skin will volatilize rather than be absorbed through the skin (Table 5-12).

EPA Response. The use of 1 as a dermal absorption factor is a conservative assumption. However, due to lack of chemical specific data, this value was used in order to avoid underestimation of exposures.

62. **Adrian Brown Consultants, Inc., Dermal Contact with Surface Soil Comment, Page 18.**

The risks from dermal contact (and incidental ingestion) of surface soils in OU1 are dramatically overstated. Use of the one "extraordinarily high" PCE soil value to characterize all of OU1 results in unrealistically high risk estimates.

EPA Response. The risks from these pathways may be overestimated for some areas of the site. However, based on the limited soil data set, it cannot be concluded that other hot spots on the site do not exist. As previously stated, the use of the highest concentration is recommended by EPA (1989) in cases where the upper 95th percentile exceed the maximum detected value. This was the case for the soils data, therefore, the highest value for PCE was used to evaluate exposures to soils.

63. **Adrian Brown Consultants, Inc., Integration of Exposure Pathways Comment, Page 18, paragraph 1.**

IDCA is very concerned that the summary statements on risk may be taken out of context. We do not disagree with the technical findings. However, we feel that additional explanation is essential to clarify that the risks (in the southern portion of OU1) relating to groundwater use and inhalation of volatiles in basements are potential risks to which current populations are believed not to be exposed.

EPA Response. This is discussed in Section 7.6.

64. **Adrian Brown Consultants, Inc., Integration of Exposure Pathways Comment, Page 18, paragraph 1.**

IDCA strongly recommends that every time risk estimates are given for such potential risks that a footnote or text be included explaining that these risks could result if groundwater would be used or if basements would be constructed; and that current populations are not subject to such exposures because groundwater is not in use and there are no basements. It is also important to note in each instance where indoor inhalation of volatiles is mentioned, that indoor monitoring (at the IDCA building) has found insignificant levels of chemicals to be present. Following are locations in the Risk Assessment where such clarification is needed:

7.4.1 paragraphs 1 and 2, page 7-6

7.4.2 paragraph 3, page 7-6

7.4.3 paragraph 5, page 7-6

7.7 paragraphs 3 and 4, page 7-10

8.5 paragraph 5, page 8-3; paragraphs 2, 4 and 5, page 8-4

EPA Response. EPA agrees that these pathways represent potential risks. This analysis is discussed in Sections 5.5 and 7.6 and in the CSC OU1 ROD.

65. Adrian Brown Consultants, Inc., Uncertainties in Risk Characterization Comment, Page 19.

As discussed in the Data Quality section of these comments, IDCA has substantial concerns with the quality of some of the data used in the Risk Assessment. The Risk Assessment notes that the field soil gas (and we would add field head space) data do not meet Data Quality Objective Level IV (paragraph 4, page 4-1). It is recommended that all risk estimates using these data should be so noted (paragraph 4, page 5-4; and Table 5-4).

This discussion should be expanded to summarize the nature and extent of uncertainty associated with the models used to estimate exposure, such as the basement inhalation and dermal absorption models, and the extent of environmental sampling, particularly regarding the concentration of PCE in surface soils.

EPA Response. Uncertainties associated with risk calculations conducted are discussed on page 7-8 of the CSC OU1 RA and in Appendix A in the CSC OU1 ROD.

66. Adrian Brown Consultants, Inc., Discussion of Risk Characterization Comment, Page 19, paragraph 1.

The Risk Assessment should mention that the very low concentrations of VOCs measured in the indoor air at the IDCA building could come from common building materials and nearby sources, including CSC (paragraph 2, page 7-9).

EPA Response. Page 7-9 discusses the results of indoor air sampling. There is not enough data to speculate on the source of these chemicals.

67. **Adrian Brown Consultants, Inc., Discussion of Risk Characterization Comment, Page 19, paragraph 2.**

The detection limit for the indoor air analyses in the IDCA building was from sub ppb to low ppb range (paragraph 3, page 7-9).

EPA Response. The RA states "detection limit was low ppb range for all COCs".

68. **Adrian Brown Consultants, Inc., Summary of Potential Health Risks Comment, Page 20, paragraph 1.**

It is important that the presentations of the summary information distinguish between actual exposures and potential exposures (if groundwater is used and if basements were to be constructed) for current and potential future land uses.

EPA Response. The distinction between potential and actual exposures is made frequently throughout the risk assessment document (page 7-7).

69. **Adrian Brown Consultants, Inc., Summary of Potential Health Risks Comment, Page 20, paragraph 2.**

The Risk Assessment should note that the cancer risks to "current" workers are based upon exposure to groundwater, and that this exposure currently does not occur (paragraph 3, page 7-10).

EPA Response. This distinction is mentioned throughout the RA document (page 7-7).

70. **Adrian Brown Consultants, Inc., Summary of Potential Health Risks Comment, Page 20, paragraph 3.**

The Risk Assessment should note that the cancer risks to "current" workers from the inhalation of volatiles present in basements are potential risks since no employees currently work in basements in OU1. It also should be noted that indoor monitoring (at the IDCA building) has found insignificant levels of chemicals to be present (paragraph 4, page 7-10).

EPA Response. Page 7-9 states the low concentrations of chemicals detected inside IDCA building. Page 7-7 states that basements are not currently used at OU1 and that the basement pathway is incomplete.

71. **Adrian Brown Consultants, Inc., Summary of Potential Health Risks Comment, Page 20, paragraph 4.**

It should be noted that the majority of the noncancer risks to "current" workers are from the use of groundwater and

working in basements, neither of which condition currently exists in OU1.

EPA Response. Statements are made on page 7-7.

72. **Adrian Brown Consultants, Inc., Summary of Potential Health Risks Comment, Page 20, paragraph 5.**

The Risk Assessment contains a statement that the indoor air at the IDCA building does not appear to be associated with non-carcinogenic adverse health effects (paragraph 3, page 7-11). The discussion on carcinogenic risks should contain a statement that indoor air at the IDCA building represents low risks (page 7-10).

EPA Response. This is not the case. Cancer risks for workers inhaling VOCs inside of Trammell Crow are 7×10^{-5} .

73. **Adrian Brown Consultants, Inc., (Summary) Potential Chemicals of Concern Comment, Page 20.**

This section should include a discussion of the indoor air monitoring in the IDCA building.

EPA Response. Only data presented in the RI were used for evaluation of COCs. These data are discussed in page 7-9.

74. **Adrian Brown Consultants, Inc., (Summary) Risk Characterization Comment, Page 20, paragraph 1.**

The discussion of Current Land Use - Cancer risks should more clearly state that the high risks are based upon potential exposures that do not now occur (paragraph 5, page 8-3).

EPA Response. EPA identified that the highest risk at the CSC OU1 are from potential pathways on page 7-7.

75. **Adrian Brown Consultants, Inc., (Summary) Risk Characterization Comment, Page 20, paragraph 2.**

The discussion of Current Land use - Noncancer Health Risks should clearly state that the high risks are based upon potential exposures that do not now occur (paragraph 2, page 8-4).

EPA Response. This request is discussed on page 5-1 and page 7-7 of the OU1 RA.

76. **Adrian Brown Consultants, Inc., (Summary) Risk Characterization Comment, Page 20, paragraph 3.**

The discussion of Future Land Use - Cancer Risks and Noncancer Health Risks should clearly state that the high risks to residents are based upon an assumption that OU1

would be residential, although it is expected to remain nearly exclusively industrial (paragraphs 4 and 5, page 8-4).

EPA Response. It is likely that the Chemical Sales Company OU1 site will remain mostly industrial for the area south of East 48th Avenue.

**77. Department of the Army, General Comment 1
Department of the Army, Specific Comment, Remedial
Investigation, Figures 1.1 and 1.2**

The area investigated by the RI is less than the total area of Operable Unit 1. It is unclear why only a portion of the operable unit was investigated.

EPA Response. The areal extent of groundwater contamination was delineated by the 1986-1987 sampling results as shown on sheet 4-5 of the OU2 RI/FS. The western boundary of OU1 has been moved to the east to Forest Street in this ROD to reflect this data. Subsequent sampling at the OU1 site focused on depiction of the source area and heaviest zone of contamination of groundwater.

78. Department of the Army, General Comment 2.

The depth at which surficial soils were collected may not be representative of surficial soil contamination, particularly in regards to dermal contact with contaminated soils. Instead of the 0 - 6 inches or 0 - 12 inches depths that were sampled, a more representative sampling interval would be the 0 - 2 inches interval.

EPA Response. EPA does not agree that a sampling depth of 2 inches is appropriate at this site. Since the contaminants of concern are volatile compounds, the contaminants will volatilize and not be found in the top two inches. Consequently, the greatest concentrations of contaminants in the surficial soils will occur at depths greater than two inches. As an industrial site, the greatest risk of exposure to contaminated soils will occur during any type of excavation or intrusive activities, which generally exceed 2 inches in depth, that disturb the upper soils. Therefore the EPA has determined that it would be more protective of human health if the surficial soils were considered to include soils to depths greater than 2 inches at this site.

**79. Department of the Army, General Comment 3
Department of the Army, General Comment 10
Department of the Army, Remedial Investigation, Specific
Comment Page 8-3.**

The vertical extent of contamination has not been fully characterized, particularly in regard to the presence of Dense Non-Aqueous Phase Liquids (DNAPL) at the site. Due to

the concentrations found dissolved in the groundwater, it is possible that DNAPL could be present at the site. Therefore, assuming that DNAPLs do exist at the site, a standard 'pump-and-treat' system will not effectively remove the DNAPLs. Remediation could take longer than the time calculated.

EPA Response. EPA recognizes that there are some data gaps remaining, particularly in regards to the existence of DNAPLs at the site. DNAPLs are quite elusive and difficult to identify at any given site. Due to EPA's preference for remedial activities to begin as soon as it is practical to do so, EPA has determined that sufficient information is presently available to begin remediation of the groundwater. The number of wells that will be installed during the remediation will greatly increase EPA's ability to determine if DNAPLs are present. A careful review of the RI/FS shows that two alternatives are carried into the detailed analysis phase. These two alternatives differ primarily in their assumptions regarding the presence or absence of DNAPLs. Alternative 3 assumes that there is little or no DNAPL present, and Alternative 5 assumes that there are pockets of DNAPLs in the saturated zone which will require remediation. The differences in the remediation time are also included in these two different alternatives. If, during the design or implementation phases of the remedial alternative, it is determined that DNAPLs are found to be present, then EPA will modify the remedial design as necessary to address the DNAPLs.

80. Department of the Army, General Comment 4

In-situ hydraulic conductivities (K) have not been determined at the site. Only contaminant migration rates and literature values have been used to estimate K values. It is difficult to determine the actual hydraulic characteristics of the aquifer from these data. The influence of Denver Fm./alluvial aquifer interactions, ground-/surface-water interactions, and anisotropy cannot be evaluated.

EPA Response. Hydraulic conductivity values were needed primarily for the purposes of evaluating relative costs of the various remedial alternatives which involved pump and treat systems. Since similar well field configurations were used in sets of alternatives and each used the same K values, the values used were deemed accurate enough for the level of cost comparisons required for the alternative evaluation. Furthermore, the K estimates derived from evaluation of a methylene chloride spill corroborates with the K values selected for use in the conceptual well field designs presented in the FS portion of the report. Finally, the document acknowledges the need to obtain more accurate values of K obtained from on-site aquifer pumping tests prior to actually implementing the selected alternative.

81. Department of the Army, General Comment 6

The rationale for why only three polychlorinated biphenyl (PCB) analyses were conducted at the site should be presented.

EPA Response. PCBs were never suspected as being a contaminant of concern at CSC OU1 based on the nature of the operations at the site and Chemical Sales Company's records of the types chemicals used. Therefore, it was not considered necessary to look for PCBs at this site. However, in an effort to be as thorough as possible in determining the potential threats to human health and the environment, EPA's toxicologists recommended that samples for PCBs be collected in areas where PCBs would most likely be found, such as near transformers. An initial screening of three samples were collected to evaluate this potential threat. The results of this sampling indicated that PCBs, as suspected, were not a contaminant at CSC OU1 and any further sampling for PCBs was not warranted.

82. Department of the Army, General Comment 7

There are a limited number of background samples collected upon which to base the background criteria for metals in the soils at the site.

EPA Response. Metals were not determined to be COCs for CSC OU1. Concentrations of metals in soils were analyzed for all soil samples submitted to the laboratory during Phase II. This included soil samples taken from MW 18 which is upgradient from the site. No tested metal exceeded the maximum concentration recorded for that metal in soil in the western U.S., and most were at the low end of the reported range. Based on a survey of CSC waste handling and storage procedures during the RI/FS scoping, heavy metal soil contamination was not identified as a concern. Thus, one location upgradient of the facility and comparison to Western U.S. data was deemed appropriate for the determination of background concentration for metals.

For all identified COCs at the CSC OU1 site, any detection of soil contaminants were considered to exceed background.

**83. Department of the Army, General Comment 8
Department of the Army, Specific Comment, Remedial
Investigation, Section 7.2.4**

The National Contingency Plan (NCP) states that the 10^{-6} risk level shall be used as the point of departure if ARARs are not available or they are not sufficiently protective due to the presence of multiple contaminants. The FS uses MCLs or proposed MCLs which does appear to be consistent with the

NCP. A clarification of the use of MCLs for a site with multiple contaminants and pathways would be helpful.

EPA Response. EPA's policy on the use of MCLs in establishing groundwater remediation levels (General Policy RCRA, CWA, SDWA Superfund Fact Sheet, 1, OERR 9234-2-01FS) states that generally, MCLs should be used to set remediation levels when available, provided the MCLs are cumulatively within the risk range. Cumulative risks from the ingestion and inhalation of contaminants associated with contaminated groundwater for CSC OU1 COCs is calculated to be 1×10^{-4} which is within the protective risk range. Thus, MCLs have been used at the CSC OU1 site to establish groundwater remediation levels.

84. Department of the Army, General Comment 8
Department of the Army, Feasibility Study, Specific Comment, Table 7-1
Department of the Army, Feasibility Study, Specific Comment, Page 7-9
Department of the Army, Risk Assessment, Specific Comment, Table 7-1

Chloroform and cis-1,2,-dichloropropene, which are carcinogens, have been deleted from the remedial action objectives. Please explain the rationale for not including these chemicals.

EPA Response. Chloroform and cis-1,3-dichloropropene were deleted from the remedial action objectives because they were deleted from the list of COCs for CSC OU1. Chloroform and cis-1,3-dichloropropene were omitted from the FS based on low frequencies of detection and low concentrations at which they were detected. Chloroform was detected in three out of 36 samples (8%) at concentrations of 2J (estimated value), 720 D (sample was diluted for analysis), and 37 ppb. Two of these values are associated with some uncertainty as indicated by their qualifiers. Cis-1,3-dichloropropene was detected in only one of 36 (3%) samples at a concentration of 330D ppb. Superfund guidance states that if a chemical is detected in 5% of samples obtained or more; it should be retained as a chemical of concern. For this reason chloroform was retained as a COC in the risk assessment. However upon consideration of the uncertainty associated with the concentrations detected, it was omitted as a COC in the FS. Cis-1,2-dichloropropene was detected in only 3% of the samples.

85. Department of the Army, General Comment 8

The estimated risk for groundwater ingestion was calculated to be 1.2×10^{-4} which exceeds the 1×10^{-4} risk stated in the remedial action objectives.

EPA Response. The estimated risk associated with groundwater concentration levels for CSC OU1 COCs at their MCL is estimated to be 1×10^{-4} based on the ingestion and inhalation during showering pathways.

86. Department of the Army, General Comment 8

Proportionally extending the risk reduction which was calculated from groundwater ingestion to other groundwater pathways and soil gas leaves a risk of approximately 6×10^{-4} .

EPA Response. Due to the uncertainty associated with the basement model used in the CSC OU1 RA, this pathway is evaluated qualitatively in the CSC OU1 ROD. EPA will continue to review the protectiveness of the remedy, including consideration of updated models, through the five year review.

87. Department of the Army, General Comment 9

Emission controls for the air strippers have not been included to remove volatile organic compounds from the exhaust gasses for the source area.

EPA Response. All remedial alternatives retained for detailed analysis included the use catalytic oxidation to destroy contaminants removed from contaminated soil and groundwater in the source area (i.e. south of East 48th Avenue) during air stripping and soil vapor extraction operations.

88. Department of the Army, Remedial Investigation, Specific Comment, Page 3-23

Wells in the alluvial aquifer do not show a greater amplitude fluctuation than those wells located farther south as evidenced by the much greater amplitude in well LSS-MW11 versus FIT-WP4.

EPA Response. It is correct to state that the amplitude in well LSS-MW11 was greater than in FIT-WP4. However, when all of the wells in the CSC OU1 area are considered, there is a trend to greater amplitude in the northernmost wells as compared to the southern wells. The average water level fluctuation north of E. 50th Avenue is 0.73 feet, while the average fluctuation south of E. 50th Avenue is 0.41 feet. The cause of the large fluctuation that occurred in LSS-MW11 is believed to be in response to the July 9, 1990 precipitation event. It is possible that LSS-MW11's proximity to the disturbed ground at the underground tank storage area may possibly have contributed to a higher influx of surface water than normally occurs at the rest of the site.

89. Department of the Army, Remedial Investigation, Specific Comment, Section 4.2.2

The detailed lithologic interpretations that are presented do not seem to be supported by the resistivity sounding profiles.

EPA Response. The resistivity soundings should not be taken to be the final determination of the lithology present. Geophysical techniques are not known to be 100% precise. They only give an indication of the lithology at any given site.

90. Department of the Army, Feasibility Study, Specific Comment, Table 9-4

Voluntary controls are recommended for the drilling of new wells. The State Engineer is currently limiting water use from new wells in much of this area to domestic use only because of over-appropriation. It may be prudent to consider passing an ordinance restricting drilling of new wells for domestic purposes. A similar ordinance was passed in Aurora for wells near the Lowry Landfill.

EPA Response. Due to the complexity of water rights law, limiting access to groundwater for which water rights are owned by an individual is very difficult to accomplish. The vast majority of the water users in the area are connected to the municipal water supply, which is treated at the Klein Water Treatment Facility. There are only a very few domestic well users located within in the CSC operable units. These well users are to be hooked up to the municipal water system under the ROD for CSC OU3. Therefore, it is questionable how much benefit, if any, would be gained from the massive effort required to pass an ordinance regarding domestic well use.

91. Department of the Army, Groundwater Collection, Specific Comment 2.

Department of the Army, Groundwater Collection, Specific Comment 3.

Department of the Army, Groundwater Collection, Specific Comment 4.

The analysis of the well field arrays does not demonstrate that the contaminated groundwater is captured. Nor does it demonstrate how the well field will maintain capture in the event of one or more of the wells going "off-line". The analysis would be more useful if it addressed these capabilities were demonstrated. The analysis should also include a sensitivity analysis in order to provide an estimate of the number of wells, pumping rates, and capture zones at the site.

EPA Response. The information requested in this comment is very valuable and is necessary to the design of an extraction system. It is EPA's intent to provide this information during the design phase of the remediation program.

92. Department of the Army, Remedial Investigation, Specific Comment Page 9-34

It appears that all soil excavation and aboveground treatment options were screened out based on volatilization during excavation and handling. Aboveground treatment would be technically implementable with proper emissions controls. This alternative should be carried through the initial screening of alternatives.

EPA Response. EPA disagrees that above ground treatment alternatives should be further considered given the current structures and operations on site and the difficulties associated with maintaining proper air emission controls during excavation and handling. The potential risks associated with possible air emissions made the use of above ground treatment alternatives less desirable than in-situ methods, under these circumstances.

93. Department of the Army, Remedial Investigation, Specific Comment, Page 10-7

What is the estimated temperature rise in the soil matrix from the injection of hot gases? Is there enough thermal energy produced to enhance volatilization over 30 years?

EPA Response. For the purposes of this FS, it was not deemed necessary to calculate the exact temperature rise. An estimated temperature rise of 10°F in 3-4 weeks is anticipated based on past experience with thermal enhancement in similar situations with similar contaminants.

94. Department of the Army, Remedial Investigation, Specific Comment, Groundwater Collection 1.

It would be useful to present the assumptions associated with the analytical equation utilized to predict aquifer response to pumping. The results should be discussed in light of the assumptions in order to understand the limitations of the analytical results.

EPA Response. The assumptions associated with the aquifer extraction alternatives are presented in Appendix H of the RI/FS. The following assumptions were used in the calculations:

Saturated thickness (H) = 3 m
Hydraulic conductivity (K) = 10^{-4} m/sec
Drawdown = 2 m
Saturated thickness
during pumping (h_w) = 3.6 ft
Well radius (r_w) = .33 ft

95. State of Colorado, Department of Law, Comment 1.

The effluent limitations set forth in 5 CCR 1002-3, sec. 10.1.0 are applicable to any potential discharge to groundwater.

EPA Response.

EPA concurs with this comment.

96. State of Colorado, Department of Law, Comment 2.

All State groundwater standards apply the groundwater at this site, even though most of the standards are not a problem at the site.

EPA Response. EPA concurs with this comment.

97. State of Colorado, Department of Law, Comment 3.

The Solid Waste Disposal Act is applicable to any management of solid wastes and may be relevant and appropriate to the management of all solid wastes. Also, sections 2.2.5, 2.2.6, 2.4.4, 2.4.5 and all other groundwater provisions in the solid waste regulations are applicable at the site.

EPA Response. EPA concurs with this comment.

98. State of Colorado, Department of Law, Comment 4.

The new source performance standards for volatile organic liquids storage in 40 CFR Part 60, Subpart Kb are relevant and appropriate.

EPA Response.

EPA concurs with this comment.

99. State of Colorado, Department of Law, Comment 5.

Regulation 5 CCR 1002-2, 6.1.0 sets forth requirements regarding land treatment and land disposal. This regulation must be incorporated as applicable.

EPA Response. EPA concurs with this comment.

100. State of Colorado, Department of Law, Comment 6.

Colorado Hazardous Waste Regulation 5 CCR 1007-3, sections 260-270 is applicable to generation, treatment, storage, and disposal of hazardous waste, and may be relevant and appropriate to the management of solid wastes.

EPA Response.

EPA concurs with this comment.

101. State of Colorado, Department of Law, Comment 7.

The narrative standard in 5 CCR 1002-8, section 3.11.0 as well as the numerical standards, are applicable to the groundwater at the site.

EPA Response.

EPA concurs with this comment.

102. State of Colorado, Department of Law, Comment 8.

Colorado Air Pollution Control Regulation 7 should be identified as applicable rather than relevant and appropriate.

EPA Response.

EPA concurs with this comment.

103. Colorado Department of Health (CDH), Air Pollution Control Division (APCD) (Comments 1-2, and 4-8)

CDH APCD stated that the risk assessment point for residential exposure should not be nearest residence, but the maximum impact as modelled on or outside the Chemical Sales' property boundary. In addition, various exposure factors were used which are not consistent with Risk Assessment Guidance for Superfund, Volume 1, Part A (EPA/540/1-89/02), including the use of .6 m2/hr instead of 20m3/day.

EPA Response: For purposes of the FS, the air stripping unit for the plume area does not appear to require controls based on existing land use. This determination will be verified during remedial design.

The location of the air stripping unit for treatment of the plume area is tentatively planned for the area approximately located 550 meters northwest of the CSC building in an open field. Although this location was identified for purposes of the CSC OU1 FS, the use of this land will be confirmed during remedial design. This location may not be appropriate due to access unavailability and final design of system. EPA will require, however, during remedial design that an assessment of risk from uncontrolled emissions for the plume area air stripping unit, be conducted upon final

identification of the specific location for the air stripping unit. EPA will consult with the CDH APCD regarding the adequacy of this assessment, compliance with action specific ARARs for air stripping and the need for air emission limitations and/or controls. EPA will require controls and or emission limitation if this assessment concludes that a risk of greater than 1×10^{-6} exists due to this treatment system. EPA will also require extensive monitoring, during the implementation of the remedial action to ensure compliance.

EPA agrees that 20 m³/hr should be used instead of the .6 m³/hr. This difference, however, does not substantially change the overall risk to site residents and workers. It is important to note, that the assessment assumed that concentrations would remain constant over the 6 year period. This is an extremely conservative assumption since it is anticipated that groundwater concentrations will decrease by close to two orders of magnitude during remedial action.

104. CDH APCD Comment #3.

The risk assessment did not include the 250 gpm air stripping tower, or the soil vapor extraction system.

EPA Response: EPA did not require that a risk assessment be conducted for these units because no emissions will result from the proposed system. Catalytic oxidation will be used to destroy over 97% of VOC emissions. The hot exhaust from the catalytic oxidation unit will be recirculated to the soil in order to raise the temperature within the vadose zone.

References for Responsiveness Summary

- Camp Dress & McKee, Inc. (CDM). 1990a. Remedial Planning Activities at Uncontrolled Hazardous Substance Disposal Sites in A Zone for EPA Regions VI, VII, and VIII, Risk Assessment, Chemical Sales Site, Operable Unit 1. Submitted to U.S. EPA, Document No. 7760-008-RA-BLXP, Contract No. 68-W9-0021.
- _____. 1990b. Remedial Planning Activities at Selected Uncontrolled Hazardous Substance Disposal Sites in A Zone for EPA Regions VI, VII, and VIII, Risk Assessment, Chemical Sales Company Site, Operable Unit 2, Chlorinated Hydrocarbon Groundwater Plume. Submitted to U.S. EPA, Document No. 7760-004-RT-BHNS, Contract No. 68-W9-0021.
- Engineering-Science, Inc. 1991. Remedial Investigation/Feasibility Study - Leyden Street Site, Operable Unit 1.
- Garbesi, K. and R.G. Sextro. 1989. Modeling and Field Evidence of Pressure-driven Entry of Soil Gas into a House Through Permeable Below-Grade Walls. Env. Sci. Tech. 23, p. 1481-1487.