United States
Environmental Protection
Agency

Office of
Emergency and
Remedial Response

EPA/ROD/R08-91/046
June 1991

EPA

Superfund
Record of Decision:

Chemical Sales
(New Location)
(Operable Unit 2), CO

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. EPA/ROD/R08-91/046	2.	3. Recipient's Accession No.

4. Title and Subtitle	5. Report Date
SUPERFUND RECORD OF DECISION Chemical Sales (New Location) (Operable Unit 2), CO Second Remedial Action	06/27/91
	6.
7. Author(s)	8. Performing Organization Rept. No.
9. Performing Orgainization Name and Address	10. Project/Task/Work Unit No.
	11. Contract(C) or Grant(G) No. (C) (G)
12. Sponsoring Organization Name and Address U.S. Environmental Protection Agency 401 M Street, S.W. Washington, D.C. 20460	13. Type of Report & Period Covered 800/000
	14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

The Chemical Sales (New Location) (Operable Unit 2) site is an active chemical sales and storage facility in Commerce City, Adams County, Colorado. Land use in the area is predominantly industrial. The site is a portion of a 4-square-mile-area, which consists of single and multi-family residences, small business, municipal facilities, and agriculture, and undeveloped land. Part of the site lies within the 100-year floodplain of Sand Creek, which borders the site. An estimated 30,000 residents near the site use the alluvial aquifer as their principal source of drinking water. Since 1976, Chemical Sales (CS) has used the site to store and sell a variety of organic chemicals and acids. Onsite features include a warehouse and tank farm, including an associated system of above-ground and underground storage tanks and pipelines. Between 1985 and 1990, three onsite chemical releases of hazardous substances from the CS facility into onsite soil and ground water were documented. First in 1985, approximately 200 gallons of methylene chloride were released during a chemical transfer second, in 1986 VOC-contaminated rain water was discharged into a nearby drainage ditch. And this in 1990, approximately 3,700 gallons of methanol were spilled onto the the ground near the CS tank farm. The site has been divided into

(See Attached Page)

17. Document Analysis a. Descriptors

Record of Decision - Chemical Sales (New Location) (Operable Unit 2), CO
Second Remedial Action
Contaminated Medium: gw
Key Contaminants: VOCs (benzene, PCE, TCE)

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report) None	21. No. of Pages 193
	20. Security Class (This Page) None	22. Price

Abstract (Continued)

three operable units (OUs) for remediation. A previous Record of Decision (ROD) addressed onsite soil and ground water contamination as OU1. This ROD addresses OU2, the VOC-contaminated ground water plume, which is north of Sand Creek. A subsequent ROD will address residential exposure to the contaminated alluvial aquifer. The primary contaminants of concern affecting the ground water are VOCs including benzene, PCE, and TCE.

The selected remedial action for OU2 of this site includes pumping and onsite treatment of ground water using air stripping, followed by onsite reinjection of treated water into the aquifer; annual ground water monitoring; and voluntary abandonment of bedrock wells. The estimated present worth cost for this remedial action is $2,420,000, which includes an annual O&M cost of $223,000 for years 0-8 and $27,000 for years 8-20.

PERFORMANCE STANDARDS OR GOALS: Chemical-specific ground water cleanup goals are based on SDWA MCLs, and include benzene 5 ug/l (MCL), PCE 5 ug/l (MCL), and TCE 5 ug/l (MCL).

RECORD OF DECISION
CHEMICAL SALES COMPANY SUPERFUND SITE
OPERABLE UNIT 2
DECLARATION STATEMENT

SITE NAME AND LOCATION

Chemical Sales Company Site
Adams County, Colorado
Operable Unit 2 - Volatile Organic Compound (VOC) Ground-Water Plume

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial action for the Chemical Sales Company (CSC) Site, Operable Unit (OU) 2 located in Adams County, Colorado.

This remedy was chosen in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

This decision document explains the basis for selecting the remedy for this OU. The information that forms the basis of these remedial action decisions 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 OU2.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from 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 Site has been divided into three operable units: Leyden St. location (OU1); Volatile Organic Compound (VOC) ground-water contamination north of Sand Creek (OU2); and residential exposure to contaminated ground water (OU3). Contaminated soil located on the CSC property and ground-water contamination located south of Sand Creek make up the area known as OU1. Remedial action objectives for OU1 include the control of migration of contaminated ground water from OU1 into OU2. A separate ROD will be prepared for the remediation of OU1. OU3 addresses residential exposure to contaminated ground water through use of private alluvial wells. A separate ROD will be prepared to address this specific pathway. The ROD summaries for both OU2 and OU3 have been incorporated into one document. This document is attached to this Declaration Statement.

The selected remedy presented in this ROD for OU2 addresses ground water that has been contaminated by sources within and outside of OU2. The remedy addresses both the tetrachloroethylene (PCE) plume which originates in the vicinity of 56th Avenue and Quebec Street and a residual plume comprised of several volatile organic compounds, primarily trichloroethylene (TCE) whose source is primarily the CSC property (OU1). The remedial action is intended to prevent migration of contaminated ground water in OU2 and to restore chemical concentrations in ground water in OU2 to acceptable levels for indoor use (i.e., drinking and showering) based on federal and State drinking water standards. The action described addresses ground water only.

The major components of the selected remedy for OU2 include:

- Extraction of contaminated ground water within the PCE plume;
- Treatment of the ground water by air stripping technology;
- Re-injection of the treated ground water by injection wells;
- Monitoring of ground water;
- Continued capture and treatment of PCE and TCE - contaminated ground water by the existing Klein Water Treatment Plant; and
- Voluntary abandonment of bedrock wells.

STATUTORY DETERMINATIONS

The selected remedy for OU2 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 are cost-effective. These remedies utilize permanent solutions and alternative treatment technologies to the maximum extent practicable. No principal threat exists for OU2. High concentrations of ground-water contaminants located near the source of contamination will be extracted, treated and reinjected into the aquifer. Contaminant levels in the remaining downgradient portion of the plume will be reduced. Because of the hydrogeologic conditions in the area, extraction and treatment of the entire VOC ground-water contamination would potentially cause contamination on the western tier of the nearby Rocky Mountain Arsenal (RMA), which is now being captured and treated, to migrate into the CSC OU2 area and affect the availability of water to residents of south Adams County.

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

June 27, 1991
Date

RECORD OF DECISION
CHEMICAL SALES COMPANY SUPERFUND SITE
OPERABLE UNIT 2 - GROUND-WATER CONTAMINATION
OPERABLE UNIT 3 - RESIDENTIAL EXPOSURE

TABLE OF CONTENTS

Section		Page
I.	SITE NAME, LOCATION, AND DESCRIPTION	3
II.	SITE HISTORY AND ENFORCEMENT ACTIVITIES	7
III.	HIGHLIGHTS OF COMMUNITY INVOLVEMENT	11
IV.	SCOPE AND ROLE OF OPERABLE UNIT WITHIN SITE STRATEGY	13
V.	SITE CHARACTERISTICS	14
VI.	SUMMARY OF SITE RISKS	27
VII.	SUMMARY OF ALTERNATIVES	43
VIII.	SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES	66
IX.	SELECTED REMEDY	77
X.	STATUTORY DETERMINATIONS	86
XI.	DOCUMENTATION OF SIGNIFICANT CHANGES	89

REFERENCES 91

APPENDICES

APPENDIX A. ARARs

APPENDIX B. RESPONSIVENESS SUMMARY

APPENDIX C. STATE CONCURRENCE

Page

FIGURES

1. CSC Site Location Map 4

2. SACWSD Wells and Wells of Residences Not Connected to the SACWSD System 5

3. Alluvial Aquifer Water Table Elevation 17

4. Bedrock Surface Elevation 18

5. Saturated Thickness of Aquifer 19

6. TCE Plume 22

7. PCE Plume 23

TABLES

1. Reference Doses and Cancer Potency Factors for CSC OU2 COCs 32

2. Chemical Concentrations Used to Calculate Case 1 Exposure Point Concentrations 35

3. Case 2 (Well SAC-18) Exposure Point Concentrations . 37

4. Exposure Estimates for Case 1 38

5. Exposure Estimates for Case 2 40

6. OU2, Chronic Hazard Index Estimates, Excess Cancer Risk Estimates, Case 1 41

7. OU2, Chronic Hazard Index Estimates, Excess Cancer Risk Estimates, Case 2 42

8. Remediation Levels for CSC OU2 47

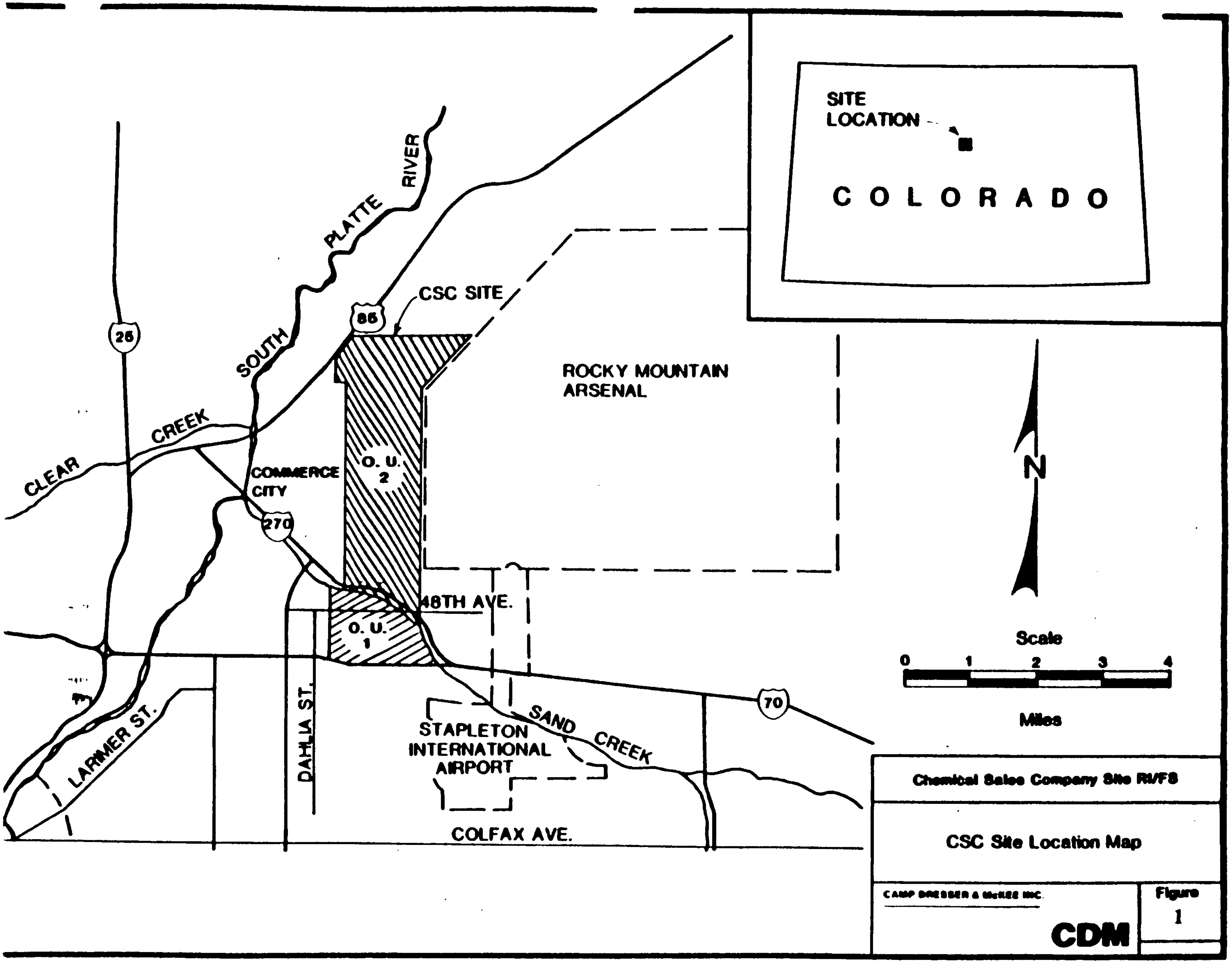
9. Costs of Remedial Alternatives, OU2 74

10. Costs of Remedial Alternatives, OU3 76

I. SITE NAME, LOCATION, AND DESCRIPTION

The Chemical Sales Company (CSC) Superfund Site is located in Commerce City and in north Denver, Colorado, approximately five miles northeast of downtown Denver, Colorado. The Site is divided into three operable units, Operable Unit No. 1 (OU1) and Operable Unit No. 2 (OU2), which are separated by Sand Creek (see Figure 1), and Operable Unit No. 3 (OU3), which addresses residential exposure to contaminated ground water through use of private alluvial wells. OU1 investigations address source control/source removal of contamination identified on, adjacent to, and downgradient of the CSC facility, and OU2 investigations address VOC ground-water contamination north of Sand Creek. The subject of this decision summary is OU2 and OU3. OU2 addresses volatile organic compound ground-water contamination north of Sand Creek. OU3 addresses residential exposure to contaminated ground water within the OU2 area.

OU2 is located north and hydrogeologically downgradient of OU1, extending from Quebec Street to the east, Holly Street to the west, Sand Creek to the south, and East 86th Avenue to the north (Figure 1). These boundaries have been defined by the approximate extent of volatile organic ground-water contamination extending northward from Sand Creek. Existing and potential residential exposure addressed in OU3 occurs through use of private alluvial wells in OU2. Figure 2 describes the location of residences that are dependant on private alluvial wells as their sole source of water for indoor use. OU2 and OU3 are located within Adams County, Colorado, and are mostly contained within Commerce City. A Remedial Investigation (RI) and Feasibility Study (FS) were initiated by EPA for OU2 in June 1989. The OU3 FS was initiated in January 1991. Site characterization data used for the OU3 FS were based on information collected for the OU2 RI.



Chemical Sales Company Site RI/FS

CSC Site Location Map

CAMP DRESSER & McKEE INC.

CDM

Figure 1

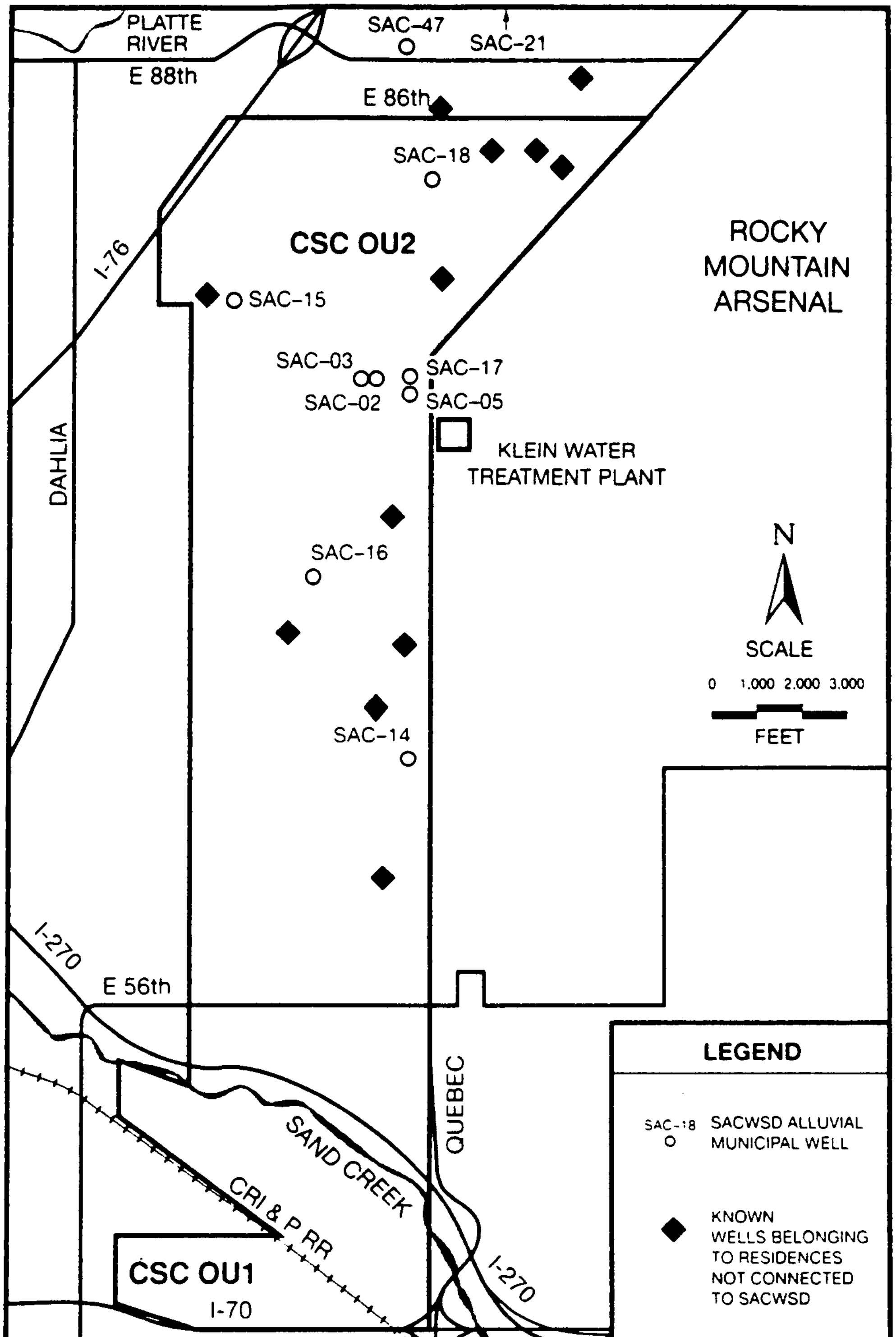


FIGURE 2
SACWSD WELLS AND WELLS OF RESIDENCES NOT CONNECTED TO THE SACWSD SYSTEM

Contaminated soil located on and adjacent to the CSC property and ground-water contamination located south of Sand Creek make up the area known as OU1. OU1 is also known as the Leyden Street location. It is approximately bounded by Forest Street to the west, I-70 to the south, Quebec Street to the east, and Sand Creek to the north. The CSC Site was first developed in 1962 when a warehouse was constructed on the property. CSC purchased the property in 1976 and began installing both above and below ground chemical storage tanks ranging in size from 5,000 to 15,000 gallons and containing a variety of organic chemicals and acids. The CSC facility has been identified as a source of contamination to ground water in OU2 as a result of both documented and undocumented spills related to handling and storage of chemicals. A RI/FS has been conducted for the OU1 Site by the Chemical Sales Company under an EPA Administrative Order on Consent (CERCLA-VIII-90-03, signed September 29, 1989).

CSC OU2 and OU3 comprise approximately four square miles and consist of single and multi-family residences, small businesses, and municipal facilities. Several truck transport operations and light industrial facilities are located in the southern part of the study area. The northern part of the study area contains areas of irrigated agricultural land and undeveloped land. The Site is underlain by an alluvial aquifer which serves as a major water supply.

CSC OU2 and OU3 are located in the piedmont, at the juncture of the Rocky Mountain and High Plains physiographic provinces. The study area for these operable units is contained within the South Platte River Basin. The topography is characterized by low relief with elevations ranging from approximately 5,200 feet at Sand Creek at the southern end of the study area to 5,120 feet at the northwest corner of the study area.

Extensive ground-water contamination by VOCs has been observed in the shallow alluvial aquifer beneath the Site. Most of the SACWSD municipal water supply is developed from this aquifer. The SACWSD supplies about 30,000 customers with water derived from wells. A total of six alluvial aquifer production wells are currently in use within OU2. All of these wells except one, SACWSD Well No. 18, are treated through activated carbon at a permanent treatment facility selected via the EPA Off-post Rocky Moutain Arsenal OU1 ROD.

II. SITE HISTORY AND ENFORCEMENT ACTIVITIES

The history of ground-water contaminant investigations and remediation within CSC OU2 and the surrounding area is very complex. The first contaminant study in the area began in the 1950s, and numerous studies have been conducted since 1980. Boundaries of these various studies have often overlapped and results from one investigation have often led to the initiation of another. Commerce City and adjacent areas grew in response to the rapid post-war proliferation of industry north and east of the city of Denver. A special governmental district, SACWSD was created in 1953 to provide a water supply and sewage treatment to the residents and businesses. The SACWSD supplies approximately 30,000 customers with water from wells completed in alluvium and bedrock. Approximately 85 percent of its water supply is derived from the alluvial aquifer. A total of six SACWSD alluvial production wells are currently in use within the CSC OU2 boundaries (SAC-14, 2, 3, 5, 17, and 18).

In 1981, EPA conducted a random national survey of drinking water systems. Several organic chemicals were detected in SACWSD wells. Additional sampling in 1982 and 1985 confirmed these results. As a result of these findings, EPA began a

RI/FS of an area called "EPA's Off-Post Rocky Mountain Arsenal (RMA) OU1". This area was larger than CSC OU2, extending from Sand Creek to the south, East 80th Avenue to the north, and from the South Platte River to the west to 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 volatile organic compounds in ground water along the eastern portion of the study area. The selected alternative was a permanent water treatment system for SACWSD water. This system, the Klein Water Treatment Plant, began operating in October 1989. It is located near the SACWSD municipal water supply center at East 77th Avenue and Quebec Street. The purpose of the Klein Water Treatment Plant is to treat contaminated alluvial ground water prior to distribution to the community, thereby protecting the health of municipal water supply users. The majority of residents in the area are provided with treated water from the Klein Water Treatment Plant. Concurrent with the RI/FS in 1986, some 400 residents using private wells were connected to the SACWSD municipal water supply under an EPA removal action.

Following completion of the RI/FS for EPA's Off-Post RMA OU1, a second OU was defined with slightly different boundaries. Additional ground-water sampling was conducted in 1987 as part of this continuing investigation. More wells were installed in 1988 and additional ground-water sampling was undertaken.

The adjacent RMA was suspected as one of the potential sources of contaminants in the EPA's Off-Post Rocky Mountain Arsenal Study Area because of the history of waste disposal practices on that site. Further investigation by EPA's Field Investigation Team (FIT) indicated that additional source areas were potentially contributing to ground-water contamination detected within the study area. An EPA soil gas survey conducted in April 1986 of an area near 48th Avenue and

Leyden Street indicated elevated TCE ion flux values in the vicinity of the CSC facility. Ground-water investigations were also undertaken by EPA in August/September 1986 at 48th Avenue and Leyden Street and at East 50th Avenue and Ivy Street, and revealed the presence of volatile organic contaminants in the vicinity of the CSC facility. A soil gas survey conducted by the Chemical Sales Company in August 1987 confirmed the presence of TCE and other chlorinated hydrocarbons near the CSC facility. Ground-water monitoring wells installed on the CSC property have since confirmed CSC as a source of ground-water contamination.

Based on the additional work by EPA to define source areas, the CSC Site was proposed for listing on the National Priorities List (NPL) in June 1988. Responsibility for the RI/FS was then transferred from the EPA Off-post Rocky Mountain Arsenal Study Area to the CSC site studies. The listing was made final in August 1990.

On August 1, 1989, EPA issued CSC a Special Notice Letter requesting CSC to conduct an RI/FS for the entire CSC Site. CSC notified EPA that the company would elect not to conduct an RI/FS for the entire CSC Site. In June 1989, EPA subdivided the ground-water RI/FS activities into two separate OUs for the CSC Site (OU1 and OU2). As a result of this subdivision, EPA initiated RI/FS activities for OU2 and requested that CSC conduct an RI/FS for OU1. On September 9, 1989, EPA and CSC entered into an Administrative Order on Consent requiring CSC to conduct an RI/FS for CSC OU1.

EPA initiated the RI/FS for CSC OU2 in June 1989. The objectives of the RI were to:

- identify the nature and extent of ground-water contamination at the Site;

- identify existing and potential receptors of the contamination;
- assess the potential risks to public health and the environment; and
- evaluate potential contaminant sources impacting the OU2 area.

To meet these objectives, soil borings were drilled, a comprehensive sampling of monitoring of private wells was undertaken, a risk assessment was performed, a laboratory investigation of the fate and transport of the contaminants was conducted, and a ground-water flow and transport model was developed. The FS was then conducted to develop and evaluate remedial alternatives that would effectively minimize the threat to, and provide adequate protection of, public health and the environment from contaminated ground water in OU2.

In order to assess existing and potential receptors to the observed ground-water contamination, a study was conducted by the Colorado Department of Health and Tri-County Health Department to determine the water source of residents potentially at risk from exposure to contaminated ground water. Results of this survey indicate that 12 known residents within the CSC OU2 area are solely dependant on domestic alluvial wells for their principal source of water. In addition, Tri-County Health Department, under direction of EPA, conducted a similar survey within CSC OU1. Although many residents within the OU1 area had domestic wells located on their property, all residents within OU1 were provided treated water from the SACWSD system.

The nearest untreated SACWSD well to the SACWSD pumping center at 77th Avenue and Quebec Street is Well 18, located north of the SACWSD pumping center (Figure 2). Some organic compounds, most notably TCE, have been detected sporadically in this well. The maximum concentration of TCE that has been detected in Well 18 is 12 μg/l. Average concentrations of TCE range from approximately 4 μg/l to 6 μg/l. Although concentrations of TCE fluctuate dramatically, there appears to be an upward trend in concentration. Well 18 is not connected to the Klein Water Treatment Plant, and it is always blended with water that has been treated at the plant before it is put into the SACWSD distribution system. Assuming an average TCE concentration of 3 μg/l from the Klein Water Treatment Facility effluent, the maximum concentration of TCE that can be tolerated in Well No. 18 is 5.7 μg/l in order not to exceed the MCLs. Well 18 is located down gradient of the other SACWSD supply wells. The presence of VOCs in Well 18 water implies that either the current SACWSD municipal supply wells are not capturing the entire plume or the contamination is migrating to Well 18 from other parts of the aquifer. While remediation of Well 18 is not contemplated at this time, EPA will evaluate additional data subsequent to issuance of the RODs for the Site, and if necessary, identify and evaluate alternatives to address Well 18 ground water contamination.

III. HIGHLIGHTS OF COMMUNITY INVOLVEMENT

Community interest in ground-water contamination in south Adams County was very intense in 1985 and early 1986 when the problem first became public. Initially the Rocky Mountain Arsenal, which is adjacent to the contaminated public water supply area and already receiving significant media attention, was thought to be the source. 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 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 treated water was thus made available to the affected residences. In the fall of 1986, EPA named the Chemical Sales Site as a source of ground-water 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 on 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 and was attended by 50-75 people. 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. Details of community involvement throughout the RI/FS are included in the Responsiveness Summary section of this ROD.

In addition, responses to comments received during the pubic comment period on the proposed plan are presented in the Responsiveness Summary.

IV. SCOPE AND ROLE OF OPERABLE UNITS WITHIN SITE STRATEGY

The CSC Site has been divided into three operable units: OU1, which addresses contaminated soil located on and adjacent to the CSC property and ground-water contamination south of Sand Creek; OU2, the subject of this ROD, which addresses ground water contamination by volatile organic compounds north of Sand Creek; and OU3, also the subject of this ROD, which addresses exposure to contaminated ground water through use of private alluvial wells located within OU2. OU1 and OU2 are separated by Sand Creek. OU2 is located north and generally down gradient of OU1. The boundaries of OU2 have been defined by the approximate extent of ground-water contamination north of Sand Creek.

EPA is selecting remedies for OU1 concurrently with the remedies for OU2 and OU3. Contaminated soil and ground water within OU1 provide a major source of contamination to ground water located in OU2. The principal risk at the OU1 Site is ingestion, direct contact and inhalation of ground-water contaminants and direct contact and inhalation of soil contaminants. Contaminated soil is also a principal source of ground-water contamination.

It is assumed that source control of contaminated ground water in CSC OU1 will be undertaken as part of the remedial activities planned for the CSC OU1 Site. Remedial action objectives for the CSC OU1 Site are: 1) to prevent the migration of contaminated ground water into CSC OU2; 2) to restore the ground water in CSC OU1 to concentrations meeting drinking water standards and carcinogenic risk within 10^{-4} to 10^{-6}; 3) to prevent contaminants in the soil from leaching into ground water resulting in the non-attainment of the remedial action objectives for ground water; and 4) prevent inhalation, ingestion and direct contact with soils resulting in a cancer risk in excess of 10^{-6}. Since OU2 is located directly downgradient of OU1, successful attainment of these objectives will result in the reduction of contaminant concentrations in ground water within OU2.

The objective of OU2 is to restore alluvial aquifer to acceptable contaminant levels for indoor use. OU2 addresses the downgradient portion of the TCE ground-water plume and the entire PCE plume.

The objective of OU3 is to ensure that all residents within the CSC Site are provided suitable water for domestic purposes. Currently, 12 properties within the OU2 Site have not been connected to the SACWSD municipal water supply system and rely on their alluvial wells for indoor use. The primary function of this operable unit is to evaluate remedial alternatives which will reduce the risk posed through residential use of domestic water. Remedial alternatives evaluated under OU3 would reduce exposure to contaminated ground water for residents using alluvial wells during the time period required to remediate the aquifer underlying OU1 and OU2.

V. SITE CHARACTERISTICS

Geology

The Site is located within the Denver Basin, a structural depression extending from the Front Range eastward to the

Kansas border, and from Pueblo, Colorado, northward to the Hartville uplift of Wyoming. At least 12,000 feet of sedimentary rocks overlie Precambrian basement rock within the basin, which has undergone episodes of tectonic movement throughout geologic time. The bedrock stratum of interest is the Denver Formation of the Dawson Group, of Upper Cretaceous to Paleocene age. The bedrock strata are overlain by unconsolidated alluvial and eolian deposits of variable thickness.

The Denver Formation is comprised of 600 to 1,000 feet of interbedded shale, claystone, siltstone and sandstone, with abundant fossil remains and coal seams. Surficial deposits which overlie the bedrock Denver formation in the vicinity of the Site consist of alluvial material deposited by the South Platte River system and windblown sand, silt and clay. The thickness of these unconsolidated deposits is variable, ranging from less than 10 feet to over 100 feet in several paleochannel features eroded into the upper surface of the Denver Formation by the ancestral South Platte River and its tributaries. The entire thickness of the unconsolidated sands, gravels, silts, and clays is considered to be a single water-bearing unit throughout the Site. In some areas, the alluvial material may be hydraulically connected with the underlying Denver Formation.

Hydrogeology

The principal migration pathway for the organic contaminants is ground-water flow within the alluvial aquifer. This aquifer is the primary drinking water source for area residents via SACWSD municipal wells. Extensive ground-water contamination by volatile organic compounds has been observed in the alluvium.

Ground water in the alluvial aquifer beneath OU2 generally flows north to northwest toward the South Platte River (Figure 3). The water table in OU2 varies from a few feet below ground surface adjacent to the South Platte River to about 50 feet below ground surface at the eastern boundary of the OU2 Site. The potentiometric surface is characterized by a lower gradient in OU2 and near the South Platte River, and a steeper gradient south and east of OU2. The potentiometric surface configuration is influenced by the location of bedrock paleochannels (Figure 4) and pumpage of SACWSD municipal wells (Figure 2), the RMA Irondale Boundary System and to a lesser extent, private, commercial, and agricultural wells. Ground-water flow converges in the vicinity of the SACWSD pumping center at 77th Avenue and Quebec Street from southeast to southwest, because of convergence of paleochannels in this area. These paleochannels influence the migration of contaminants, and are important with respect to contamination of SACWSD municipal wells, since several of the municipal wells are located in or near paleochannels. The vertical hydraulic gradient within the alluvium is generally downward. The vertical gradient between the underlying bedrock and the alluvium varies from upward to downward across the Site and is generally considered to be insignificant in magnitude.

The saturated thickness of the alluvial aquifer varies widely from localized unsaturated zones to saturated thicknesses of over sixty feet. Depth to the saturated zone ranges from a few feet near the South Platte River to over fifty feet further away from the river (Figure 5). Flow dominates in paleochannels, which contain larger saturated thicknesses and sand and gravel deposits with a relatively higher hydraulic conductivity.

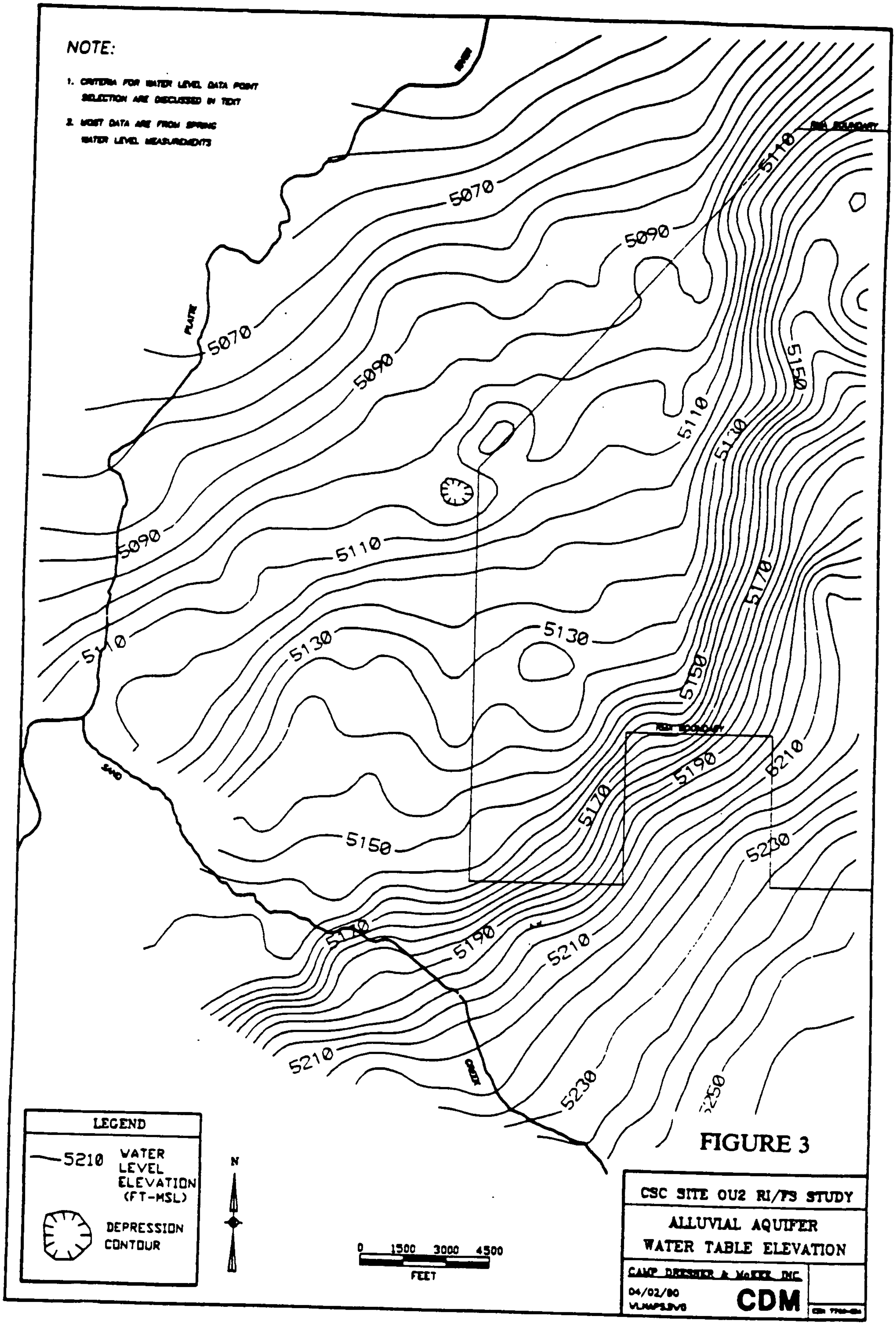

NOTE:
1. CRITERIA FOR WATER LEVEL DATA POINT SELECTION ARE DISCUSSED IN TEXT
2. MOST DATA ARE FROM SPRING WATER LEVEL MEASUREMENTS
PLATTE
SAND
CREEK
5070
5090
5110
5130
5150
5170
5190
5210
5230
5250
LEGEND
5210 WATER LEVEL ELEVATION (FT-MSL)
DEPRESSION CONTOUR
N
0 1500 3000 4500
FEET
CSC SITE OU2 RI/FS STUDY
ALLUVIAL AQUIFER
WATER TABLE ELEVATION
CAMP DRESSER & McKEE INC.
04/02/90
CDM

FIGURE 3

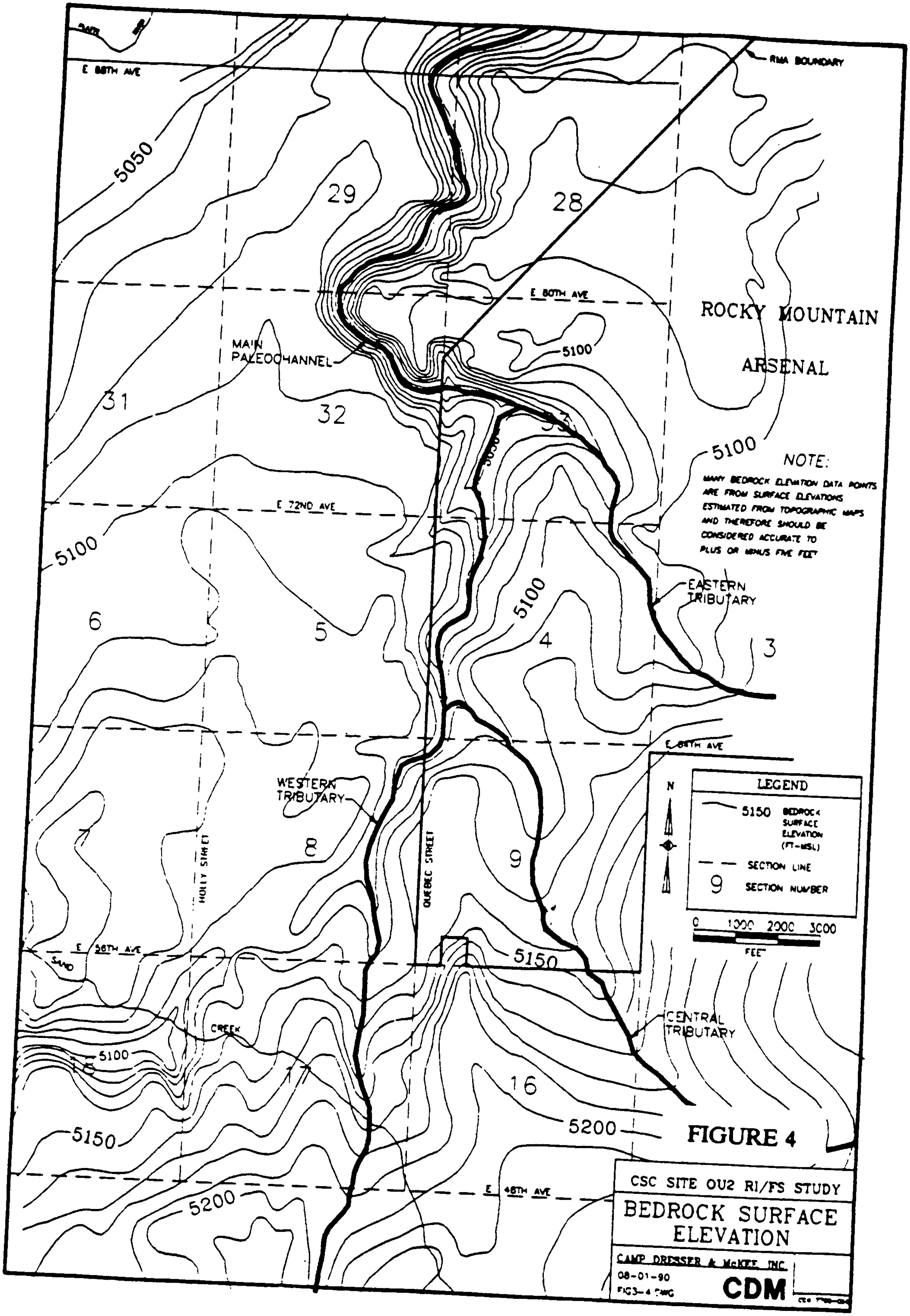


FIGURE 4

CSC SITE OU2 RI/FS STUDY

BEDROCK SURFACE ELEVATION

CAMP DRESSER & McKEE INC.
08-01-90
FIG3-4.DWG
CDM

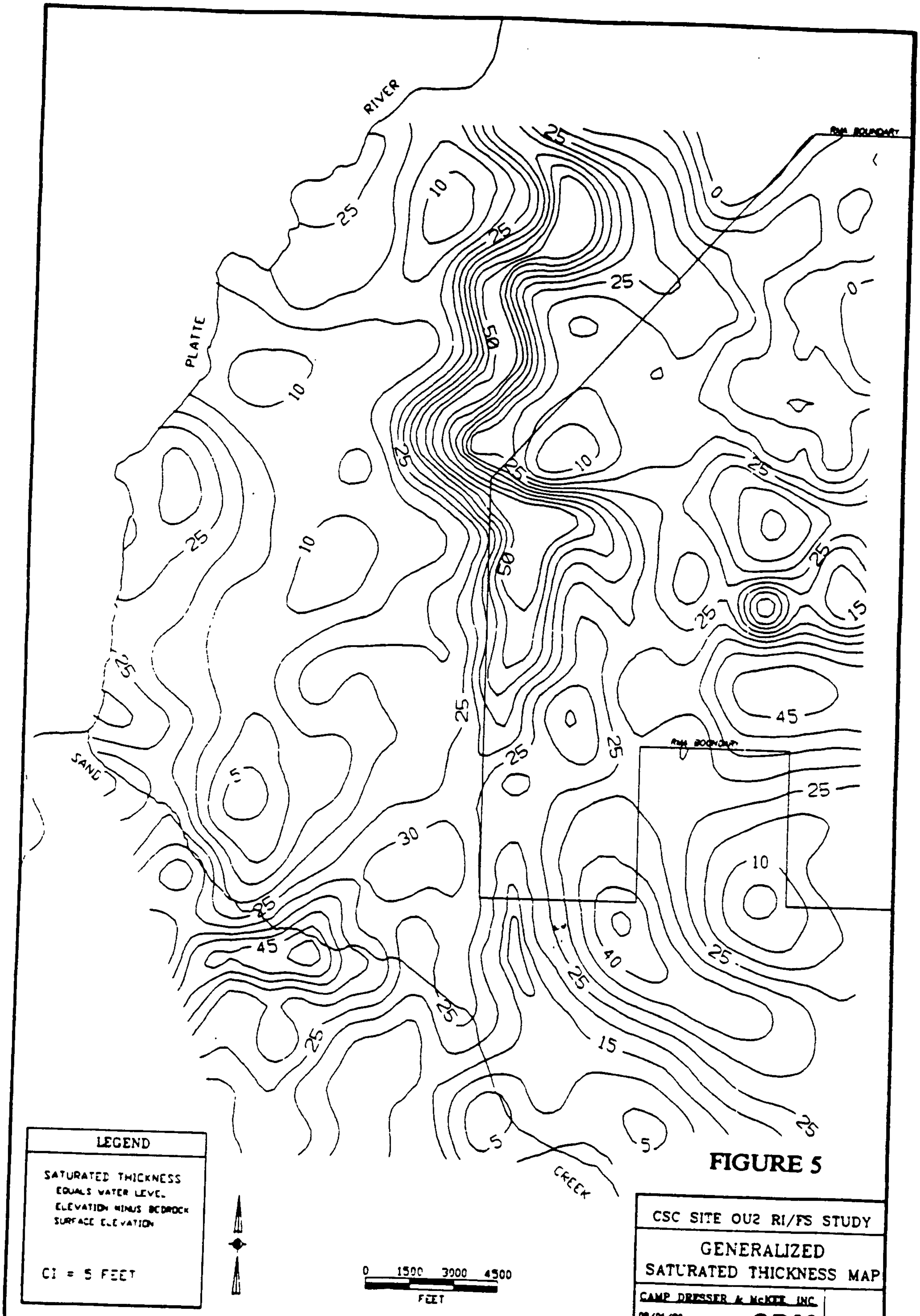


FIGURE 5

CSC SITE OU2 RI/FS STUDY

GENERALIZED SATURATED THICKNESS MAP

CAMP DRESSER & McKEE INC.

08/06/90

CDM

The shallow alluvial aquifer is highly transmissive. Ground-water flow velocity is variable within CSC OU2 (approximately 5 to 12 feet/day), and is locally influenced by the hydraulic gradient, the hydraulic conductivity and the effective porosity of the aquifer. Depending on these factors, travel time from East 48th Avenue to the SACWSD pumping center ranges from 4.8 to 12.1 years. Actual contaminant velocities will be lower due to compound retardation.

Nature and Extent of Contamination

The results of the CSC OU2 RI showed extensive ground water contamination by volatile organic compounds in the study area. Contaminants were not detected in other media. The chemicals of concern in ground water are:

1,1-dichloroethane (DCA)
1,1-dichloroethylene (DCE)
Total 1,2-dichloroethylene (total 1,2-DCE) (the sum of the trans and cis isomers)
1,1,1-trichloromethane (TCA)
Trichloroethylene (TCE)
Tetrachloroethylene (PCE)
Benzene (BZ)
Vinyl Chloride (VC)

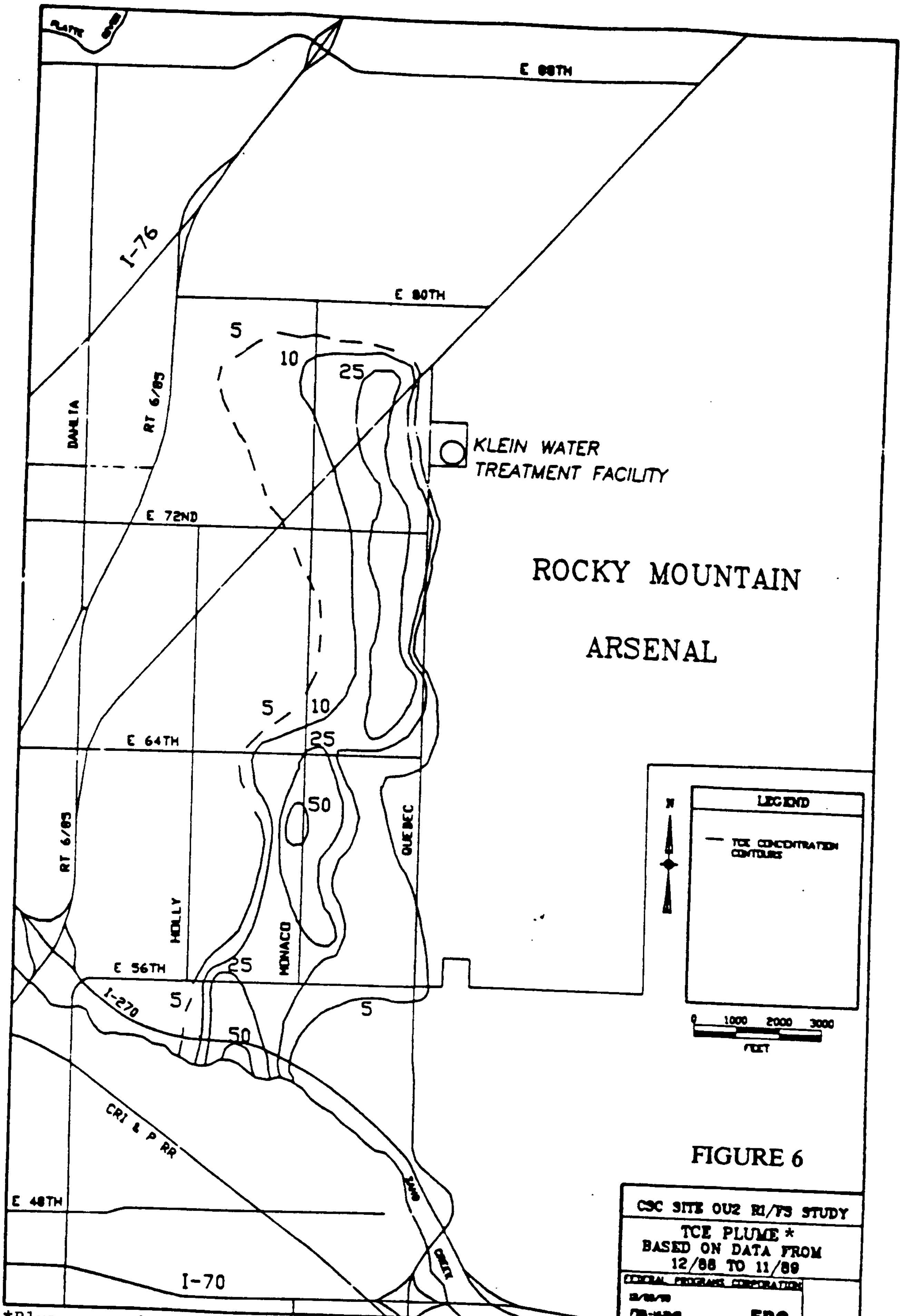
This group of contaminants is generally mobile in ground water. Most of the compounds are central nervous system depressants and either liver or kidney toxins at high doses. Six of the compounds are known to cause carcinogenic effects in animal studies, and of the six, vinyl chloride and benzene are classified by EPA as Class A - Human Carcinogens.

Maximum Contaminant Levels (MCLs) or proposed MCLs were exceeded for five of the eight compounds of concern in CSC OU2 wells during sampling conducted in October 1989. These compounds are PCE, TCE, DCA, DCE and VC. In general, concentrations of contaminants in wells upgradient (south and east) of OU2 are higher than concentrations in wells within OU2. Contaminant concentrations generally decrease from south to north within OU2. North of the East 77th Avenue SACWSD pumping center, most contaminant concentrations are below the MCLs. Maps showing the distributions and concentrations of contaminants and discussions of temporal trends in contaminants may be found in the final RI Report.

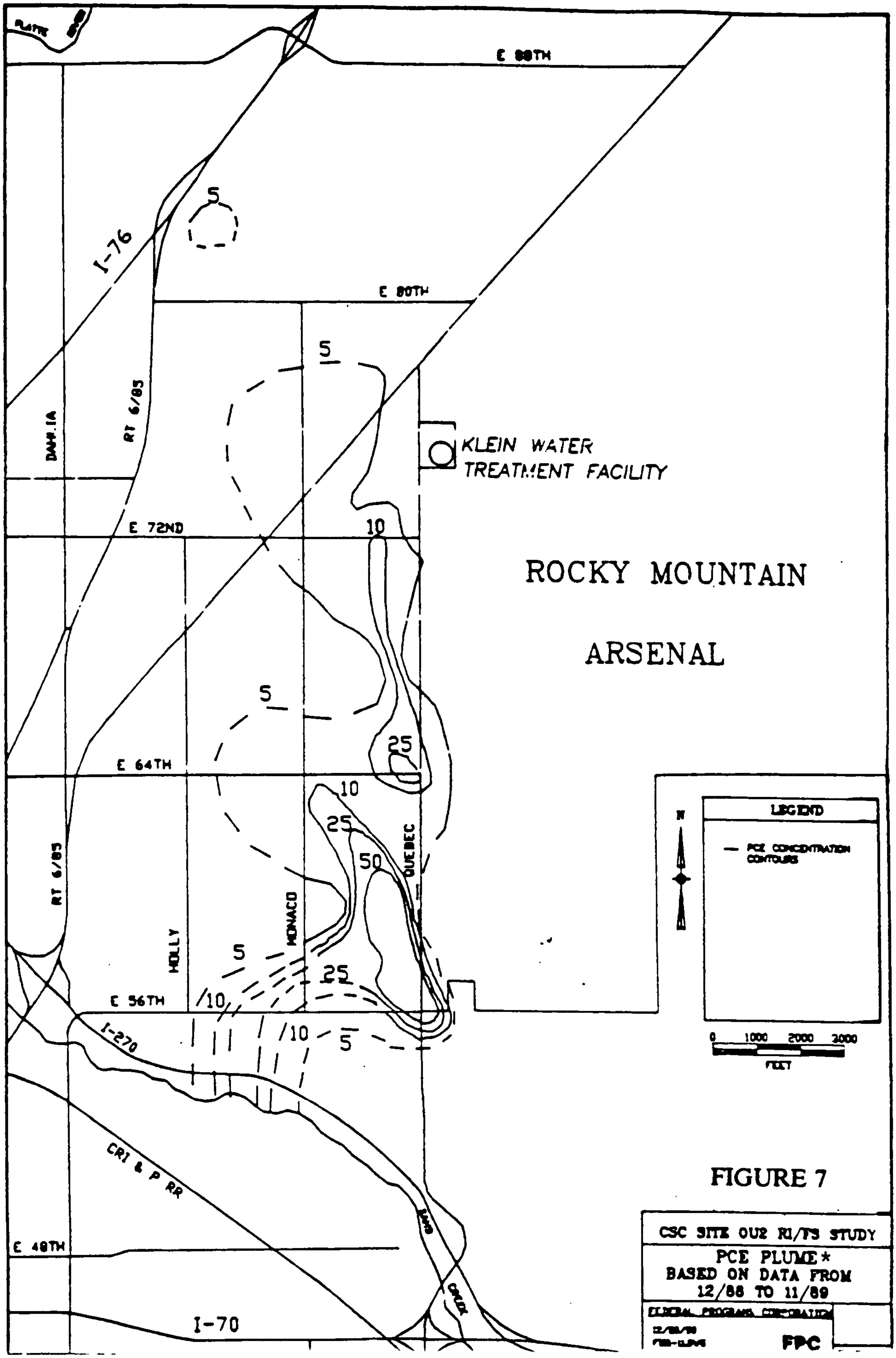
PCE contamination is pervasive throughout the alluvial aquifer in CSC OU2. Mean 1989 concentrations ranged from a high of 110 ug/l north of Sand Creek near 60th Avenue and Quebec Street to less than 10 ug/l near the SACWSD pumping center at 77th Avenue and Quebec Street. High concentrations of PCE found south of 56th Avenue between Holly and Monaco Streets within OU2 appear to be directly related to high concentrations of PCE found south of Sand Creek within OU1. An unidentified source of PCE contamination is believed to be present near 56th Avenue and Quebec Street, where relatively high PCE concentrations have also been identified in ground water.

TCE contamination is also widespread in CSC OU2. In 1989, mean concentrations ranged from below detection to 53 ug/l within OU2. Relatively high concentrations (10-50 ug/l) are distributed from Sand Creek to the SACWSD pumping center.

The TCE and PCE ground-water data summarized above were hand-contoured to illustrate the major plumes of ground-water contamination in CSC OU2. These plumes are presented in Figures 6 and 7. The maps were developed to show general trends in the present contaminant distribution in CSC OU2. Potential sources and temporal



*Plume not shown south of Sand Creek


E 88TH
I-76
E 80TH
DAHLIA
RT 6/85
KLEIN WATER TREATMENT FACILITY
E 72ND
ROCKY MOUNTAIN ARSENAL
E 64TH
QUEBEC
MONACO
HOLLY
E 56TH
I-270
CRI & P RR
E 48TH
I-70
LEGEND
PCE CONCENTRATION CONTOURS
N
0 1000 2000 3000
FEET
FIGURE 7
CSC SITE OU2 RI/FS STUDY
PCE PLUME*
BASED ON DATA FROM
12/88 TO 11/89
FEDERAL PROGRAMS CORPORATION
FPC

trends were not considered in development of these maps, and as such, they can be subject to uncertainty and open to other interpretations.

A distinct plume of ground-water contamination emanating from the CSC facility flows northward from OU1 into OU2. This plume is characterized primarily by relatively high levels of TCE in mean concentrations ranging from greater than 50 ug/l in the upgradient area (south of Sand Creek) to below detection limits in downgradient areas within OU2. PCE, TCA, and 1,2-DCE also occur within the area of this plume. The areal distribution of these contaminants is indicative of a continuous plume from the CSC property in OU1 to north of Sand Creek in OU2. Concentrations decrease steadily downgradient of the CSC property, which is believed to be due to dilution, dispersion, adsorption, and biodegradation. This plume (referred to as the TCE Plume) has migrated northward through most of the CSC OU2 Site, as shown in Figure 6. The presence of the plume was detected as early as 1985, and the Klein Water Treatment Plant was constructed to treat contaminated ground water that was extracted from the aquifer before it was added to the municipal water system.

The second plume begins at approximately East 56th Avenue and Quebec Street (Figure 7), and is characterized primarily by PCE, at a mean concentration of up to 110 ug/l. Monitoring at SACWSD Monitoring Well 08, located on the northwest corner of the intersection of 56th Avenue and Quebec Street, has shown high concentrations of PCE. The source of the PCE plume was not located in CSC OU2 during the RI. EPA Field Investigation Team (FIT) investigations were conducted up-gradient of Monitoring Well 08 on the Denver Engineering Operations

Center (DEOC) property to the southeast of 56th Avenue and Quebec Street. Monitoring wells were installed and a soil gas survey was performed, but the PCE source was not found. Results of the CSC OU2 RI and the FIT investigations indicated that another potential source area for the PCE plume may be located directly south of Monitoring Well 08. Well 08 is located on the northwest corner of the 56th Avenue and Quebec intersection. This was not expected during the previous investigations because the regional ground-water gradient in this area is to the northwest. However, local directions of ground water flow may be different due to local influence from a north-trending paleochannel located along Quebec St. This paleochannel may cause ground water to flow in a more northerly direction.

For the purposes of the FS, a degrading source was assumed because true continuing sources are relatively rare, and a continuing source could not be located during field investigations. If future monitoring indicates that significant source material remains, EPA will again attempt to identify this source and remediate it as quickly as possible.

Both of the plumes described above follow ground-water flow paths which converge upgradient (south) of the SACWSD pumping center at East 77th Avenue and Quebec Street. The future migration of these plumes depends on the major transport and fate processes of dispersion, adsorption, biodegration, and hydrolysis (TCA only) and on the potential for plume interception by the high-discharge SACWSD wells.

In addition to the TCE and PCE plumes located in CSC OU2, a plume consisting of dibromochloropropane (DBCP) and other volatile organic compounds (VOCs), referred to as the "contamination on the western tier of the Arsenal", is present to the east of CSC OU2 on the RMA property. This contamination was detected in Irondale community wells in 1980 and was traced back to the western tier of RMA. A ground-water interception system, known as the Irondale System, was installed at the RMA boundary in December 1981 to prevent this contamination from migrating off of RMA. This system uses wells to extract and inject the ground water and activated carbon to remove the VOC contamination.

Behavior of the contamination on the western tier of the Arsenal is influenced by ground-water extraction practices and schedules in CSC OU2. During normal operations, SACWSD pumps considerably more water from the aquifer during the summer than at other times of the year. There is concern that during periods of high ground-water extraction, the direction of ground-water flow may be altered, causing the contamination on the western tier of the Arsenal to deflect to the south and partially bypass the Irondale System. However, DBCP has not been detected in CSC OU2 in the vicinity of the Irondale system. Improvements to the Irondale System, to ensure that the entire contamination on the western tier of the Arsenal is being captured at all times, are currently being evaluated under CERCLA at the RMA Site. Until those improvements are implemented, the amount of contamination that may periodically bypass the Irondale System is considered to be insignificant compared to the contamination coming from other sources into CSC OU2, and requires no different remedy than that selected for the TCE/PCE plumes.

One of the contaminants detected in the CSC OU2 RI was vinyl chloride. This compound is believed to be a breakdown product of other chlorinated hydrocarbons detected at the Site, such as all forms of DCE. It was detected only sporadically with respect to location and concentration, and it did not appear to define a continuous plume. The focus of this ROD is on the known plumes of chlorinated VOCs, although the remedial actions were also evaluated based on their ability to remove vinyl chloride if it is present. The previous ROD provides the ability to remove vinyl chloride from the SACWSD water supply if it becomes a health threat.

VI. SUMMARY OF SITE RISKS

Actual or threatened releases of hazardous substances from both OU2 and OU3, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare and 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 Risk Assessment (BRA) to evaluate the risk posed by the presence of contaminants at CSC OU2. The risk analysis resulting from EPA's BRA is used for the CSC OU2 and OU3 FS and for this ROD. This BRA was carried out to characterize the current and potential threats to human health and the environment which exist for these OUs in the absence of any remedial action.

The major potential health risk to area residents is associated with the use of ground water contaminated by volatile organic compounds. The majority of ground water from contaminated municipal wells is currently treated prior to distribution to the community. One untreated well, SACWSD Well No. 18 is located within the CSC Site and is currently impacted from contamination at the Site. Approximately 12 remaining residents within the CSC Site are solely dependant on private alluvial wells for indoor use. Environmental risks were not considered except as they pertain to restoring the ground water. Environmental risks for both OU2 and OU3 were not considered because there are no identified exposure pathways by which significant exposure to environmental receptors could occur.

Eight contaminants were identified as chemicals of concern (COCs) based on their toxicity, widespread occurrence, or concentration. These compounds are PCE, TCE, TCA, DCA, DCE, 1,2-DCE, VC and benzene. These contaminants are judged to represent the major potential health risks at the Site for both OU2 and OU3.

The selection criteria used to identify COCs followed the most recent guidance from EPA (Risk Assessment Guidance for Superfund (RAGS), Volume I, Human Health Evaluation Manual (Part A) Interim Final EPA/540/1-89/002, December 1989). A list of all chemicals detected during the 1989 RAS sampling was compiled. The list was reviewed and chemicals were eliminated from further consideration based on QA/QC criteria, laboratory or field blank contamination, or frequency of detection. A detection frequency of less than 10 percent was used in the RA to eliminate chemicals not believed to be representative of site contaminants. Although a 5% detection frequency is recommended by RAGS referenced above, this recommendation allows for professional judgement and modification for specific sites and conditions. In the case of OU2, several years of sampling information consistently detected the chemicals selected as COCs. Other chemicals have been sporadically detected at low concentrations in these sampling efforts, but the eight COCs selected for OU2 are representative of historical and current Site contamination. Furthermore, the chemicals detected at 5-10% frequency, even if they were included in the RA, would have only a marginal effect on the magnitude of potential health risks at the Site.

The eight chemicals remaining after this preliminary review were clearly relevant to the RA based on toxicology, widespread occurrence, or concentration. Therefore, no further selection criteria were applied. Vinyl chloride is included as a chemical of concern even though it was only detected in five percent of the wells because vinyl chloride is a potent human carcinogen and reliability of the sampling results for vinyl chloride is uncertain.

Toxicity Assessment

The COCs are a diverse group of volatile halogenated hydrocarbons and solvents. Most of the COCs are central nervous system depressants and either liver or kidney toxins at high doses. Benzene is toxic to the blood forming system.

Six of the COCs (PCE, TCE, DCE, DCA, VC and Benzene) are known to cause carcinogenic effects in animal studies. Of the six, vinyl chloride and benzene are both classified by EPA as Class A - Human Carcinogens based on the weight-of-evidence for carcinogenicity.

Non-Carcinogenic Effects - TCE is a central nervous system depressant in humans. Inhalation and oral exposure studies in animals indicate that bone marrow, central nervous system, liver, and kidney are the target organs. The principal toxic effects of PCE in humans and animals are central nervous system depression and liver and kidney damage. TCA is a central nervous system depressant at high concentrations and adverse effects on the cardiovascular system have also been reported. Exposure to high concentrations of DCA has been reported to cause cardiac arrhythmia and liver damage in humans. DCE can induce neurotoxicity after short-term inhalation exposure, and DCE is possibly associated with liver and kidney toxicity after repeated, low-level exposure in humans. Benzene has demonstrated toxic effects on the central nervous system, blood-forming system, and immune system in both animals and humans. Long-term inhalation of vinyl chloride by workers is associated with liver damage, central nervous system disturbances, pulmonary insufficiency, cardiovascular toxicity, and osteolysis.

Carcinogenic Effects - TCE is classified as a Group B2 carcinogen (a probable human carcinogen). PCE and DCA are also classified as Group B carcinogens. DCE is classified as a Group C carcinogen (a possible human carcinogen). Benzene and vinyl chloride have been classified as human carcinogens (Group A). Classification into this category means that there is sufficient evidence from epidemiologic studies to support a causal association between the compound and human cancer.

Risk Characterization for OU2 and OU3

Both carcinogenic and non-carcinogenic health risks were characterized for two exposure scenarios. Case 1 represents the maximum range of health risks likely to be encountered by an individual using untreated ground water as a primary domestic water source (OU2). Case 2 is a current estimate of potential health risks associated with an untreated well located at the periphery of the contaminated ground-water plume (OU3). Risks were calculated for each chemical of concern for the two exposure pathways.

Non-Carcinogenic Risks - The potential for non-carcinogenic effects is evaluated by comparing the estimated chemical exposure to the appropriate reference dose (RfD). The RfD is an estimate of a daily exposure level for an individual that is likely to be without an appreciable risk of deleteriouseffects during a lifetime. RfDs for CSC OU2 and OU3 COCs are presented in Table 1. The ratio of exposure to a toxicity value is defined as a hazard index (HI). The hazard index is based on the assumption that there is a level of exposure, the RfD, below which it is unlikely for adverse health effects to occur. If the exposure exceeds the RfD (the HI exceeds 1.0), there may be a concern for potential non-cancer health effects.

Carcinogenic Risks - Potential excess cancer risks are estimated by multiplying an exposure estimate by a cancer potency factor (CPF), which has been derived from either human epidemiology studies or experimental animal studies with the specific chemical under consideration. The CPF for CSC OU2 and OU3 COCs is presented in Table 1. Generally, cancer risks are assumed to be additive, as long as the exposures are for the same individuals and time period. Carcinogenic risks are presented as a probability value, i.e., the increased chance of contracting some form of cancer over a lifetime.

In the risk characterization, the aggregate carcinogenic risk due to indicator contaminants at the Site is compared to an acceptable target risk. Carcinogenic effects are evaluated based on a calculated increase in the risk of contracting cancer that is a direct result of exposure to the COCs at a Site. The EPA has defined an increased risk, exceeding the 10^{-4} to 10^{-6} range, due to exposures at a Site as being unacceptable regarding the protection of public health and the environment. Remediation action objectives are established based on ARARs (i.e. MCLs and MCLG) and acceptable risk levels

TABLE 1

Reference Doses and Cancer Potency Factors for Chemicals of Concern CSC OU2

	Reference Dose, RFD (mg/kg/day)		Cancer Potency Factor $(mg/kg\text{-}day)^{-1}$	
	Oral	Inhalation	Oral	Inhalation
PCE	0.01[a]		0.051[a]	0.0033[c]
TCE	ND[b]		0.011[a]	0.017[c]
TCA	0.09[a]	0.3[a]	ND[d]	ND[d]
DCA	0.1[a]	0.1[a]	0.091[e]	0.091[a]
DCE	0.009[a]		0.60[a]	1.2[a]
1,2-DCE	0.02[a]		ND[d]	ND[d]
VC	ND[b]		2.30[a]	0.295[a]
Benzene	ND[b]		0.029[a]	0.029[a]

[a] IRIS - EPA's Integrated Risk Information System, March 1990.

[b] None determined - No RFD currently avaiable from EPA.

[c] Cancer slope factors have been withdrawn from IRIS pending EPA review.

[d] None determined - No cancer Potency Factor available from EPA.

[e] Oral slope factor used for inhalation risk estimates.

(i.e. 10^{-6}), while ARARs and the 10^{-6} cancer risk point of departure are used as the basis for developing preliminary remediation goals. The chance of one person developing cancer per one million people (or 10^{-6}) is used as a target value or point of departure above which carcinogenic risks may be considered unacceptable. The 10^{-6} point of departure is used for determining remediation goals when ARARs are not available (i.e., no MCLs or proposed MCLs exist for the indicator contaminant) or are not sufficiently protective of human health and the environment because of the existance of multiple contaminants at a site or multiple pathways of exposure.

Exposure Assessment

Only pathways associated with ground water uses were evaluated in the risk assessment, as it is the only contaminated medium at the Site. Two exposure scenarios were developed to describe a range of potential health risks. For Case 1, a Reasonable Maximum Estimate (RME) was developed by calculating exposures from use of a hypothetical private well in OU2 placed within a mixing zone for the existing ground-water plumes. This hypothetical well was assumed to be contaminated with all eight chemicals of concern. The second exposure scenario (Case 2) was developed to provide information regarding the potential health risks associated with SACWSD production well SAC-18. This well is located at the periphery of the ground-water plume and is currently used as a seasonal source of domestic water for part of the community. TCE has been detected at SAC-18. Average concentrations of TCE range from 4 μg/l to 6 μg/l. The maximum concentration of TCE that has been detected at SAC-18 is 12 μg/l. Water from SAC-18 is currently blended with treated water from the Klein Water Treatment Plant to ensure that any potential contaminant concentrations in the untreated water are diluted to safe levels. This scenario provides an estimate of potential health risks if the SAC-18 water were to be used directly.

The two routes or exposure pathways evaluated quantitatively were:

1. ingestion of the water during normal residential use, and
2. inhalation of volatiles during showering.

Basement VOC exposure was not evaluated for two reasons: (1) a validated basement exposure model was not available at the time the risk assessment was prepared and (2) ground-water concentrations were so low within OU2 that the contribution of the pathway was judged to not contribute significantly to the overall risks at the Site. Such potential risks will be reevaluated during the 5 year review to ensure the remedies selected are protective.

Representative exposure point concentrations were developed from the sampling data for the contaminants of concern. For Case 1, the concentrations of individual contaminants in ground water at the hypothetical well were set equal to the arithmetic average of the highest concentrations from 3-5 validated samples from the 1989 sampling for each contaminant of concern. A range of sample numbers was used because there were different numbers of validated samples for each compound. This approach was selected to obtain a RME estimate that reflects potential mixing of different contaminants from various sources within the alluvial aquifer of OU2. Wells with the highest concentrations of individual contaminants and average contaminant concentrations calculated for the Case 1 scenario are presented in Table 2. The best approximation of the RME for Case 1 assumes that all contaminants of concern could be present in a single location but that their respective concentrations would not likely exceed an average

TABLE 2

CHEMICAL SALES COMPANY OU2 RA
CHEMICAL CONCENTRATIONS (ug/L) USED TO CALCULATE CASE 1 EXPOSURE POINT CONCENTRATIONS

Well ID	PCE	TCE	TCA	DCA	1,1-DCE	1,2-DCE	Benzene	Vinyl Chloride
DW-004		37						
DW-029	100							
DW-030		47	9					
DW-051							2 J-C	
DW-062			8				2 J-C	
DW-073			12	16 J	9	19	2 J-C	3 J
DW-076		55		13	9	23		
DW-104				11 J	6	18		2 J
DW-106			8					
SAC-02		37						
SAC-MW-02								
SAC-MW-08	73							
SAC-14	31							
NMW-09								
FIT-IM-MW-02	28	*64						
FIT-IM-WP-01								
FIT-IM-WP-02					6	28		4 J
FIT-IM-WP-03				11		17		
Arithmetic Mean of Highest 3-5 Values	58	48	9.3	13	7.5	21	2	3

Note: Values used are from CDM fall 1989 sampling. The type of analysis is Routine Analytical Services (RAS) through the EPA Contract Laboratory Program (CLP). All results used have been validated. Qualifiers are explained in Table 5-1C.

* Not validated so not included in average
J - The associated numerical value is an estimated quantity because the amount detected is below the required detection limits or because quality control criteria were not met.
C - The value was estimated due to instrument calibration problems.

of the highest detected values. Contaminant concentrations used for calculating Case 2 exposures are presented in Table 3. These are 1989 concentrations measured in Well 18.

Calculations of exposure from ingestion of ground water and inhalation of volatiles were based on standard EPA guidance (Risk Assessment Guidance for Superfund (RAGS), Volume I, Human Health Evaluation Manual (Part A) Interim Final EPA/540/1-89/002, December 1989) and theoretical models. Exposures were calculated based onexposure point concentrations, and the following assumptions for each exposure route:

Ingestion of ground water:

Ingestion rate = 2 liters/day

Exposure frequency = 365 day/year

Exposure duration = 30 years

Body weight = 70 kilograms

Inhalation during showering:

Ventilation rate = 15 liters/minute

Body weight = 70 kilograms

Air exchange rate = 0.008333 minutes^{-1}

Shower duration = 15 minutes

Total time in shower room = 20 minutes

Exposure frequency = 365 days/year

Exposure duration = 30 years

Adsorption rate across lungs = 100%

Exposure estimates for the Case 1 scenario for both exposure routes are summarized in Table 4. The highest chemical

TABLE 3

CHEMICAL SALES COMPANY OU2 RA
CASE 2 (WELL SAC-18) EXPOSURE POINT CONCENTRATIONS[a]

Chemical of Concern	Concentration (μg/L)	Type of Analysis
PCE	0.87 J-C	SAS
TCE	3.1	SAS
TCA	3.6	SAS
DCA	0.61 J-C	SAS
DCE	0.03 J-C	SAS
1,2-DCE	0.49	SAS
Vinyl chloride	1.00 UJ-C[b]	SAS
Benzene	1 J-C	RAS

[a] Values used are from CDM Fall 1989 sampling only. RAS indicates Routine Analytical Services while SAS indicates Special Analytical Services under the EPA Contract Laboratory Program.

[b] A concentration of 0.5 μg/L (one-half the estimated detection limit) was used for the exposure assessment calculations)

U - The material was analyzed for, but was not detected. The associated numerical value is the estimated detection limit.

J - The associated numerical value is an estimated quantity because the amount detected is below the required detection limits or because quality control criteria were not met.

C - The value was estimated due to instrument calibration problems.

TABLE 4

EXPOSURE ESTIMATES FOR CASE 1
CHEMICAL SALES COMPANY OU2 RA[a]

Chemical	Exposure Pathways (mg/kg/day)		
	Ingestion	Shower	Total
DCA	3.7×10^{-4}	3.6×10^{-4}	7.3×10^{-4}
DCE	2.3×10^{-4}	2.3×10^{-4}	4.6×10^{-4}
1,2 DCE	6.0×10^{-4}	5.9×10^{-4}	1.2×10^{-3}
TCA	2.9×10^{-4}	2.5×10^{-4}	5.4×10^{-4}
TCE	1.4×10^{-3}	1.2×10^{-3}	2.6×10^{-3}
PCE	1.7×10^{-3}	1.3×10^{-3}	3.0×10^{-3}
Benzene	5.7×10^{-5}	6.0×10^{-5}	1.2×10^{-4}
Vinyl chloride	8.6×10^{-5}	1.0×10^{-4}	1.9×10^{-4}

[a]Daily exposure during 30 year exposure.

exposures for both routes were from PCE and TCE. Exposure estimates for the Case 2 scenario are presented in Table 5. The highest exposures were due to TCA and TCE.

Results

The chronic HI estimates for Case 1 indicated a very low potential for non-cancer health effects. The HI for each contaminant of concern was less than 1.0. The HI for PCE, however, was considerably higher than for the othercontaminants. This reflects the higher concentration of PCE in ground water. Addition of HIs for specific exposure routes still resulted in a HI of less than 1.0 for each exposure route, with the largest component of the HI for each route due to PCE. The chronic HI estimates for Case 2 indicated an extremely low potential for non-carcinogenic adverse health effects. The aggregate HI for all exposure routes was also summed and did not exceed 1.0. The HIs for individual contaminants were nearly two orders of magnitude lower than for Case 1. The individual and aggregate HI for CSC OU2 COCs is presented in Table 6.

The Risk Assessment revealed that DCE, VC, and TCE pose the most significant carcinogenic risks to human health. For the Case 1 exposure scenario (RME) as shown in Table 6, the total excess cancer risk estimate for all chemicals via ingestion and inhalation while showering was 3.6×10^{-4}. For the Case 2 exposure scenario (Well 18) as shown in Table 7, the total excess cancer risk estimate for all chemicals via both exposure pathway routes was 2.0×10^{-5}.

TABLE 5

EXPOSURE ESTIMATES FOR CASE 2
CHEMICAL SALES COMPANY OU2 RA[a]

Chemical	Ingestion	Exposure Pathways (mg/kg/day)	
		Shower	Total
DCA	1.7×10^{-5}	1.7×10^{-5}	3.4×10^{-5}
DCE	8.6×10^{-7}	8.6×10^{-7}	1.7×10^{-6}
1,2 DCE	1.4×10^{-5}	1.4×10^{-5}	2.8×10^{-5}
TCA	1.0×10^{-4}	1.0×10^{-4}	2.0×10^{-4}
TCE	8.9×10^{-5}	7.8×10^{-5}	1.7×10^{-4}
PCE	2.5×10^{-5}	2.0×10^{-5}	4.5×10^{-5}
Benzene	2.9×10^{-5}	3.0×10^{-5}	5.9×10^{-5}
Vinyl chloride	1.4×10^{-5}	1.7×10^{-5}	3.1×10^{-5}

[a]Daily exposure during 30 year exposure.

TABLE 6

CHEMICAL SALES COMPANY OU2 RA
CHRONIC HAZARD INDEX ESTIMATES[a] - CASE 1

Chemical	Exposure Route		
	Ingestion	Inhalation Shower	Total
PCE	0.2	0.1	0.3
TCA	0.003	0.0008	0.004
DCA	0.003	0.004	0.007
DCE	0.03	0.03	0.06
1,2-DCE	0.03	0.03	0.06
Combined Total	0.27	0.16	0.43

[a] Hazard index calculated by dividing exposure by the RfD.

CHEMICAL SALES COMPANY OU2 RA
EXCESS CANCER RISK ESTIMATES - CASE 1

Chemical	Exposure Route		
	Ingestion	Inhalation Shower	Total
PCE	3.6×10^{-5}	1.8×10^{-6}	3.8×10^{-5}
TCE	6.5×10^{-5}	8.8×10^{-6}	7.4×10^{-5}
DCA	1.5×10^{-5}	1.4×10^{-5}	2.9×10^{-5}
DCE	5.9×10^{-5}	1.2×10^{-4}	1.8×10^{-4}
Vinyl Chloride	8.5×10^{-5}	1.3×10^{-5}	9.8×10^{-5}
Benzene	7.1×10^{-7}	7.5×10^{-7}	1.5×10^{-6}
Combined Total	2.0×10^{-4}	1.6×10^{-4}	3.6×10^{-4}

TABLE 7

CHEMICAL SALES COMPANY OU2 RA
CHRONIC HAZARD INDEX ESTIMATES[a] - CASE 2

Chemical	Exposure Route: Ingestion	Exposure Route: Inhalation Shower	Total
PCE	0.002	0.002	0.004
TCA	0.001	0.0003	0.001
DCA	0.0002	0.0002	0.0004
DCE	0.0001	0.0001	0.0002
1,2-DCE	0.0007	0.0007	0.001
Combined Total	0.004	0.004	0.008

[a] Hazard index calculated by dividing exposure by the RfD.

CHEMICAL SALES COMPANY OU2 RA
EXCESS CANCER RISK ESTIMATES - CASE 2

Chemical	Exposure Route: Ingestion	Exposure Route: Inhalation Shower	Total
PCE	5.5×10^{-7}	2.8×10^{-8}	5.8×10^{-7}
TCE	4.2×10^{-7}	5.7×10^{-7}	9.9×10^{-7}
DCA	6.6×10^{-7}	6.6×10^{-7}	1.3×10^{-6}
DCE	2.2×10^{-7}	4.4×10^{-7}	6.6×10^{-7}
Vinyl Chloride	1.4×10^{-5}	2.2×10^{-6}	1.6×10^{-5}
Benzene	3.6×10^{-7}	3.7×10^{-7}	7.3×10^{-7}
Combined Total	1.6×10^{-5}	4.3×10^{-6}	2.0×10^{-5}

VII. SUMMARY OF ALTERNATIVES

The OU2 FS and OU3 FS were conducted to develop and evaluate remedial alternatives that would effectively minimize threats to and provide adequate protection of public health and the environment from contaminated ground water located within the operable unit boundaries. The OU2 FS and OU3 FS were conducted in three phases: Phase I, development of alternatives; Phase II, screening of alternatives; and Phase III, detailed analysis of alternatives. In Phase I, remedialalternatives were assembled from applicable remedial technology process options. These alternatives were initially evaluated for effectiveness, implementability, and cost in Phase II. The favorable alternatives were then evaluated in detail in Phase III with respect to the following criteria specified in the National Contingency Plan (NCP):

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume
- Short-term effectiveness
- Implementability
- Cost
- State acceptance
- Community acceptance

In addition to the remedial alternatives, the NCP requires that a no-action alternative be considered at every site. The no-action alternative serves primarily as a point of comparison for other alternatives.

A ground-water model was developed for the CSC OU2 Site as a tool to aid in determining the relative effectiveness of the remedial action alternatives. This model was developed to allow comparison of the different alternatives, rather than to define exact aquifer characteristics at future times. The model was not calibrated, and many simplifications were made during its development. The model takes into account contaminant transport by advection, sorption, and dispersion. Contaminant degradation from such processes as biological and chemical breakdown are not accounted for by the model. Output from the model is useful to give a general idea of contaminant transport and removal rates resulting from remedial actions within CSC OU2. This information has been used to compare the effectiveness of the various treatment alternatives. The predicted aquifer restoration time periods derived for the various alternatives evaluated in the OU2 FS were used to estimate duration of residential exposure evaluated in the OU3 FS.

Remedial Action Objectives and Goals

Remedial action objectives for establishing acceptable ground-water remediation and exposure levels were developed from applicable or relevant and appropriate requirements (ARARs) and from risk-based considerations. The standards, requirements, limitations, and criteria that were considered to be applicable or relevant and appropriate for remediation at CSC OU2 and CSC OU3 include chemical, location, and action-specific requirements.

Chemical-specific ARARs pertaining to water quality include requirements from the federal Safe Drinking Water Act (SDWA) and Resource Conservation and Recovery Act (RCRA). State laws that were considered are the State Primary Drinking Water Regulations and the Colorado Water Quality Control Act. Acceptable concentration limits have been established pursuant to these laws and are relevant and appropriate in establishing acceptable concentration levels for the alluvial aquifer in CSC OU2 in order that the aquifer will be restored to a quality that will allow its future beneficial use. These levels are also used in establishing acceptable levels of exposure for indoor use for OU3. The levels established under the SDWA are referred to as Maximum Contaminant Levels (MCLs). MCLs are enforceable drinking water standards that regulate public drinking water supply systems. "Maximum contaminant level goals (MCLGs), established under the Safe Drinking Water Act, 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 § 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 § 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}, criteria in paragraph § 300.400(e)(2)(i)(A) of this section may also be considered when determining the cleanup level to be attained." (40 C.F.R. 300.430 (e)(2)(i)(B)). Under the SDWA, MCLs have been established for DCE, TCA, TCE, benzene and vinyl chloride. Cumulative carcinogenic risk for these compounds associated with the remediation levels through ingestion and inhalation during showering is estimated at 1×10^{-4}. Since this risk is considered to be protective, MCLs for these chemicals are used for establishing acceptable remediation and exposure levels.

If no ARAR covers a particular situation, or if an ARAR is not sufficient to protect public health or the environment, proposed standards, criteria, guidance and advisories are used as "to be considered" or TBCs to provide a standard or goal. Proposed MCLs under the SDWA are considered to be TBCs in establishing acceptable concentration levels for those compounds without a promulgated MCL or state standard. For those contaminants without TBCs, acceptable levels may be derived based on the 10^{-6} risk level. Because clean-up can only be verified down to the laboratory analytical detection limit, it is important that detection limits are either equivalent to or less than the remediation levels for the COCs. For this Site, it was assumed that samples will be analyzed under the Contract Laboratory Program (CLP) using either Routine Analytical Services (RAS) or Special Analytical Services (SAS) protocols, and that method detection limits as suggested by EPA methods will be attainable. Acceptable remediation and exposure levels and appropriate analytical methods and their detection limits for the COCs at this Site are presented in Table 8 along with the governing ARAR (if available).

The following remedial action objectives were identified for both CSC OU2 and OU3:

1. Prevent the ingestion and inhalation through showering of chemicals of concern in excess of levels specified in Table 8 and a total carcinogenic risk in excess of 10^{-4} to 10^{-6}. This remedial action objective will be addressed under CSC OU3.

2. Restore the alluvial aquifer for chemicals of concern to levels specified in Table 8 and to levels which pose a 10^{-4} to 10^{-6} total excess cancer risk. This remedial action objective is addressed under CSC OU2.

3. Prevent migration of contaminants in excess of levels specified in Table 8. This remedial action objective is addressed under CSC OU2.

TABLE 8
REMEDIATION LEVELS FOR CSC OU2

Chemical	Remediation Level (μg/l)	Analytical Method	Analytical Detection Limit (μg/l)	Comments
DCA	5	RAS	5	10^{-6} risk level
1,1-DCE	7	RAS	5	MCL (40 CFR 141)
TCA	200	RAS	5	MCL (40 CFR 141)
PCE	5	RAS	5	MCL (56 FR, No. 20, 1/30/91)
TCE	5	RAS	5	MCL (40 CFR 141)
1,2-DCE (cis and trans)	70	RAS	5	Colorado Basic Standard for Ground Water, effective 9/30/89
Benzene	5	RAS	5	MCL (40 CFR 141)
Vinyl Chloride	2	SAS	2	MCL (40 CFR 141)

Remedial Alternatives

Operable Unit 2 - VOC Ground-water Plume

For Operable Unit 2, three remedial alternatives were considered for detailed evaluation and are described below. All alternatives pertain to ground-water remediation. Three different treatment technologies were evaluated under these alternatives for treating contaminated ground water associated with the PCE plume. In evaluating these alternatives, it was assumed that remedial action objectives for OU1 and OU3 would be met. These objectives include preventing the migration of contaminated ground water from OU1 into OU2, and protecting residents currently using shallow alluvial wells from exposures to contaminated ground water.

Ground-water contamination in CSC OU2 can be viewed as three separate problems: 1) TCE and other VOCs entering the Site from a source to the south, 2) a PCE plume and unknown source near 56th Avenue and Quebec Street, and 3) contamination currently existing in the aquifer. TCE entering the Site from the south will be addressed by the CSC OU1 ROD. It has been assumed in this ROD that the TCE will be prevented from entering the CSC OU2 Site through remedial activities at the CSC OU1 Site. Remedial alternatives that have been identified in the CSC OU1 FS to achieve this objective involve the installation of ground water pump and treat systems at or near the CSC property and at Sand Creek. Because these activities will be conducted under another ROD, alternatives developed in this ROD do not include TCE treatment as it enters the CSC OU2 Site.

The second problem, the PCE plume and unknown source near 56th Avenue and Quebec Street, is addressed by this ROD.

The final problem, remediation of the existing plume in CSC OU2, is already being addressed, in part, by operation of the Klein Water Treatment Plant. Ground water from SACWSD supply wells is pumped to the Klein Water Treatment Plant for treatment before it enters the municipal distribution system. SACWSD supplies nearly all of the residences in CSC OU2 with domestic water and represents by far the largest demand on the aquifer at this Site. To meet the water demand, SACWSD extraction wells have been located in highly transmissive areas of the aquifer, most notably the paleochannel that runs north approximately beneath Quebec Street. Because contaminant plumes in the aquifer will tend to migrate most quickly through these highly transmissive portions of the aquifer, the SACWSD extraction wells are fortuitously optimally located to capture contaminated ground water as well. It would be difficult to locate additional extraction wells throughout CSC OU2 to achieve better contaminant capture than what is currently being done by the SACWSD wells. The Klein plant is also large enough (12 million gallons per day, maximum capacity) that construction of additional treatment facilities will not provide significantly more effective or quicker remediation. Therefore, options for remediating the plume center on increased pumping of SACWSD wells that feed the Klein Water Treatment Plant.

Each remedial alternative includes the following common elements:

- Continued operation of the Klein Water Treatment Plant to protect municipal water users in CSC OU2. The Klein Water Treatment Plant is an activated carbon system that was installed specifically to removed chlorinated hydrocarbons from ground water that is extracted by SACWSD for municipal use.
- Monitoring of selected wells to ensure that the remedial action is effective and to determine when the remedial action can be discontinued based on recovery of the aquifer and elimination of

contaminant migration into OU2.

With the exception of the no-action alternative, each alternative further includes the following common elements:

- Abandonment of bedrock wells. If any bedrock well is determined to cause contamination to flow from the alluvial to the bedrock aquifer, the well would be properly abandoned provided that permission is granted by the well owner. The criteria for bedrock well abandonment will be established in RD.

Alternative 1 - No Action

A no-action remedial alternative is required by the NCP and is used as a baseline for comparison of other alternatives. The no action alternative assumes that no remedial activities will be undertaken beyond activities currently being conducted or currently planned within and outside of CSC OU2. Activities currently being conducted within CSC OU2 include operation of the Klein Water Treatment Plant at its current rate of operation to protect municipal water users in CSC OU2; monitoring of selected wells by SACWSD; and providing alternate water supplies to private alluvial well users in CSC OU2. Ground-water monitoring would continue at a minimum of an annual basis at approximately 15 wells in OU2. Measured concentrations would be used to update the prediction of contaminant migration patterns and impacts on the SACWSD municipal water supply system.

This alternative assumes that remedial action objectives will be met for CSC OU1 and CSC OU3. The CSC OU1 remedial action objectives include preventing contaminated ground water from migrating into CSC OU2 from OU1. It is assumed that this objective will be met and the source of TCE entering CSC OU2 from the south will be remediated by 1993. This allows adequate time for remedial activities to be implemented in OU1. The remedial action objective for CSC OU3 is to reduce risk to acceptable levels posed by domestic use of contaminated ground water from private alluvial wells. It is assumed that this objective will also be met and that residences in CSC OU2 that are currently dependent on shallow alluvial wells will be protected from exposures to contaminated ground water by CSC OU3 remedial actions. This alternative also assumes that the PCE source at 56th Avenue and Quebec Street is a degrading source and will not be remediated.

Under the no action alternative, natural attenuation and ground-water flow aided by normal pumping of the aquifer by SACWSD and operation of the Klein Water Treatment Plant would be the primary means of restoring the aquifer. A portion of the residual contamination in the aquifer would be captured by the SACWSD withdrawals. This water would then be treated at the Klein Water Treatment Plant prior to entering the municipal water supply system.

The model results showed that by the years 2010/2011, 53 percent of the TCE plume and 49 percent of the PCE plume would be captured and remediated before moving out of range of the SACWSD wells feeding the Klein Water Treatment Plant. Model results predicted that TCE and PCE concentrations would be reduced to remediation levels by the year 2015, when the plume would have moved out of the modeled area. Costs for this alternative are summarized below and include annual sampling of 15 existing wells. The life of this alternative was assumed to be approximately 20 years because this is the estimated time required for the plume to reach remediation levels within the modeled area.

Assumed life of the alternative: 20 years

Capital Costs:	$2,600
Annual Costs (sampling & analysis): $27,000	
Present Worth of Annual Costs:	$261,000
Total Capital Cost and Present Worth:	$263,600

To determine present worth of annual costs, please use the following formula where i is the interest rate in decimals and n is the number of years.

$$\text{Present Worth Factor} = [(1+i)^n-1]/[i(1+i)^n]$$

Alternative 2 - PCE Plume Treatment with Hydraulic Containment and Standard Pumping of SACWSD Wells

This alternative includes the extraction of contaminated ground water, treatment of the ground water, and reinjection of the treated water. This alternative also includes the existing and planned activities described in Alternative 1 plus the option to initiate bedrock well abandonment programs. The extraction system would be installed to extract the maximum amount of the PCE plume possible. Ground-water extraction and reinjection would be accomplished through a series of pumping and injection wells whose configuration would be determined during remedial design. The pumped water would be collected in a header pipe and transported to the treatment system, treated to health based levels, as specified in Table 1, and transported to the reinjection wells. The treated ground water would be reinjected into the alluvial aquifer upgradient to enhance flushing of contaminated ground water. This alternative would be operational until the PCE plume was reduced to remediation levels identified for this Site in Table 6. For the purposes of the FS evaluation, and based on model results, it was assumed that the PCE source would be remediated within eight years. Therefore, the life of this pump and treat system was assumed to be eight years.

The model results showed that by the year 2006, 84 percent of the PCE plume would be captured. At this time, the model predicted that PCE concentrations would be below remediation levels for the OU2 Site.

The treated ground water would be sampled as necessary to substantively comply with Underground Injection Control (UIC) requirements (40 CFR 144, and 146, RCRA requirement section 3020 and Colorado Regulations 5 CCR 1002-2, 6.1.0; 5 CCR 1002-3 sec. 10.1.0 and 6 CCR 1007-3 section 100.21(b)). Under these requirements, reinjected ground water must be treated to health based levels (i.e. MCLGs, MCLs, proposed MCLs and 10^{-6} excess cancer risk levels).

The Hazardous and Solid Waste Amendments (HSWA) include specific provisions restricting the land disposal of RCRA hazardous wastes. These land disposal restrictions (LDRs) were adopted to minimize the potential of future risk to human health and the environment by requiring hazardous waste treatment before land disposal. The only on-site portion of the remedial action which would potentially constitute land disposal or "placement" is the discharge of treated water to the injection trench. However, EPA policy (Applicability of Land Disposal Restrictions to RCRA and CERCLA Ground Water 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 ground water. 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.

Costs for this alternative include monitoring and the extraction and injection systems only. Because this system will be used in conjunction with one of the treatment options described below, the cost of the extraction and injection system has been included with the costs for the individual treatment options. These treatment options are presented in the following sub-alternatives. Costs for the extraction and injection system are based on four extraction wells and six injection wells, all approximately 70 feet deep.

<u>Alternative 2A - PCE Plume Treatment Using Carbon Adsorption</u>

In this alternative, activated carbon would be used to treat contaminated ground water. Influent from the extraction wells would be collected in a surge/inlet tank, and then filtered prior to entering the activated carbon contactors. Treated water exiting the contactors would be sent to a pressurized storage tank and then piped to the injection wells. Carbon in the contactors would require regeneration approximately every nine months at an off-Site location. The life of this treatment system was estimated to be eight years.

This type of treatment is effective in treating contaminated ground water to health based levels as presented in Table 8 for all CSC OU2 COCs except vinyl chloride. Vinyl chloride does not readily adsorb to activated carbon.

Costs associated with this alternative are summarized below. Costs for the monitoring activities are shown separately, while the cost of the carbon adsorption system includes the ground-water extraction and injection system.

The capital costs for the carbon treatment system include a packaged Granular Activated Carbon (GAC) system with associated filters, tanks, and pumps; construction equipment and labor; land and site development; building and utilities; contractor's costs; and engineering and design. Annual and periodic costs include operation and maintenance and carbon change-outs. The costs of the monitoring program and the carbon adsorption program are listed below.

Assumed life of the alternative: 20 years

Monitoring Program (20 years)		
Capital Costs:		$2,600
Annual Costs (sampling and analysis):	$27,000	
Present Worth of Annual Costs:		$261,000
Total Present Worth and Capital Costs:		$263,600

Carbon Adsorption Program (8 years)		
Capital Costs:		$1,910,000
Annual and Periodic Costs:	$62,000	
Present Worth of Annual and Periodic Costs:		$1,230,000
Total Present Worth and Capital Costs:		$3,140,000

Alternative 2B - PCE Plume Treatment Using UV-Oxidation

In this alternative, contaminated ground water would be treated by UV-Oxidation. Influent from the extraction wells would be collected in a surge/inlet tank. Hydrogen peroxide would be added to the inlet stream, which would then be filtered prior to entering the treatment vessel. Ozone would be generated from atmospheric air and bubbled through the treatment vessel, and UV lamps would be inserted into the water being treated. Treated water would be routed to a storage tank and then pumped to the injection wells. Excess ozone from the treatment vessel would be sent through an ozone decomposer prior to being discharged to the atmosphere. This type of technology is capable of treating all CSC OU2 COCs to health based levels. Extensive testing, however, would be required to determine appropriate adjustments prior to final design and construction of the system.

Costs associated with this alternative are summarized below. Costs for the monitoring activities are shown separately, while the cost of the UV-oxidation system includes the ground-water extraction and injection system.

The capital costs for the UV-oxidation treatment system include UV-oxidation units with associated filters, tanks, and pumps; construction equipment and labor; land and site development; building and utilities; contractor's costs; and engineering design. Annual costs cover operation and maintenance, including power requirements for operation of the UV lights and ozone generation. The costs of the monitoring program and the UV-oxidation program are listed below.

Assumed life of the alternative: 20 years

Monitoring Program (20 years)		
Capital Costs:		$2,600
Annual costs (sampling and analysis):	$27,000	
Present Worth of Annual Costs:		261,000
Total Present Worth and Capital Costs:		$263,600
UV-Oxidation Program (8 years)		
Capital Costs:		$1,950,000
Annual and Periodic Costs:	$277,000	
Present Worth of Annual and Periodic Costs:		1,310,000
Total Present Worth and Capital Costs:		$3,260,000

Alternative 2C - PCE Plume Treatment Using Air Stripping

This alternative involves treatment of contaminated ground water by air stripping. Influent from the extraction wells would be collected in a surge/inlet tank. Extracted water would be filtered prior to entering two air stripping towers in parallel, where it would flow down the packing by gravity. Treated water would be collected in a storage tank and then pumped to the injection wells. Air would be forced upwards through the columns with an air blower and would be discharged to the atmosphere from the top of the columns.

The CSC OU2 Site is located in an ozone non-attainment area. EPA policy (Control of Air Emissions from Superfund Air Strippers at Superfund Ground-water Sites, OSWER Directive 9355.0-28) recommends controls for air emissions exceeding 3 pounds per hour, 15 pounds per day and 10 tons per year. The maximum uncontrolled Volatile Organic Compound (VOC) emissions rate from an air stripping unit in CSC OU2 is estimated to be 0.03 pounds per hour or about 0.79 pounds per day.

Colorado Air Quality Regulations Nos. 1,2,3,7 and 8 are applicable requirements for this action. 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); (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, requires a Reasonable Available Control Technology (RACT) evaluation for sources emitting greater than one pound per day; (d) 5 CCR 1001-10, Reg. 8, regulates vinyl chloride emissions; and (e) 5 CCR 1001-4, Reg. 2, requires that the design provide for an odor-free operation. Federal ARARs pertaining to this action include National Emission Standards for Hazardous Air Pollutants for regulating vinyl chloride emissions (40 CFR 61). Air emission controls have not been planned for this action as the total VOC emissions are calculated to be less than acceptable emission rate levels allowed by federal and State requirements. However, air emission monitoring will be conducted to verify that emissions do not exceed the standards.

Costs associated with this alternative are summarized below. Costs for the monitoring activities are shown separately, while the cost of the air stripping system includes the ground-water extraction and injection system.

The capital costs for the air stripping system include two air stripping towers with associated filters, tanks and pumps; construction equipment and labor; land and site development; building and utilities; contractor's costs; and engineering and design. Annual and periodic costs include operation and maintenance of the system. The costs of the monitoring program and the air stripping program are listed below:

Assumed life of the alternative: 20 years

Monitoring Program (20 years)		
Capital Costs:		$2,600
Annual costs (sampling and analysis):	$27,000	
Present Worth of Annual Costs:		261,000
Total Present Worth and Capital Costs:		$263,600

Air Stripping Program (8 years)		
Capital Costs:		$1,410,000
Annual and Periodic Costs:	$223,000	
Present Worth of Annual and Periodic Costs:		1,010,000
Total Present Worth and Capital Costs:		$2,420,000

Alternative 5 - PCE Plume Treatment plus Increased Pumping of SACWSD Wells

This alternative combines PCE source treatment (Alternative 2) and increased pumping of SACWSD wells. Under this alternative, contaminated ground water would be extracted to capture the PCE plume, treated by air stripping, and reinjected, as described in Alternative 2C. The existing and planned activities described in Alternative 1 are also assumed in this alternative plus the option to initiate bedrock well abandonment programs. Pumping of the SACWSD production wells presently connected to the Klein Water Treatment Plant would be increased as part of this alternative, thereby accelerating the flushing of contaminants from the aquifer. The extra water would be reinjected in the southern portion of CSC OU2.

The Klein Water Treatment Plant has the capacity to treat 12 million gallons per day (MGD). This capacity is only approached during the summer months (when water demand is high) and is significantly more than what is needed during the fall, winter, and spring. The average annual flow through the Klein Water Treatment Plant is 3.8 MGD. This alternative is based on an increase of the average annual flow to 4.7 MGD. This flow rate represents the maximum pumping capacity of the alluvial aquifer based on ground-water modeling. The increased pumping of the SACWSD wells would be limited to those portions of the fall, winter, and spring months when water demand is low.

During increased pumping periods, all of the extracted water would be treated at the Klein Water Treatment Plant and the extra water would be reinjected in the southern (upgradient) portion of CSC OU2. Reinjection of clean water at this location would aid in flushing contaminated ground water toward the SACWSD extraction wells. Ground-water reinjection would be accomplished by multiple injection wells located to avoid depletion of the aquifer. Treated water would be transported to the injection area via existing SACWSD water mains in the southern portion of CSC OU2. ARARs pertaining to reinjection of contaminated ground water are identical to those identified in Alternative No. 2.

Some problems inherent with this alternative include impacts on the RMA contamination on the western tier of the Arsenal (possible diversion of the plumes around the Irondale System containment), possible depletion of the water supply in the aquifer, the variability of SACWSD pumping rates, and administrative constraints with respect to water rights.

As noted in Section 5.3 of this ROD, contamination on the western tier of the Arsenal is present to the east of CSC OU2 on RMA and is being captured and treated by the Irondale System. There is concern that increased pumping of the SACWSD wells during the summer may temporarily alter the direction of ground-water flow and cause this plume to deflect to the south and partially bypass the Irondale System. Increased pumping of the SACWSD wells during other times of the year may cause the contamination on the western tier of the Arsenal to bypass the Irondale System on a more consistent basis and thereby cause increased contamination of the aquifer in CSC OU2. This situation would be detrimental, rather than beneficial to aquifer remediation efforts.

Possible depletion of the aquifer under this alternative is also of concern. It is believed that current SACWSD pumping rates stress the aquifer to such a degree that the lower pumping rates in fall, winter, and spring are necessary to allow the aquifer to recover from the high summer pumping rates. Increased pumping during low demand periods may not allow sufficient aquifer recovery, even with reinjection of the surplus water upgradient of the extraction wells.

Aquifer depletion could also occur if injection points are not correctly located to return surplus extracted water to the area of the aquifer from which it came. Determination of injection point locations would be extremely difficult due to the presence of paleochannels and variations in the permeability of the alluvial aquifer.

The increased pumping rate of 4.7 MGD was developed with the ground-water model. When the model was run using an average annual extraction rate of 5.4 MGD, it predicted that some areas of the aquifer would become dry. The model was then run at decreasing extraction rates until all portions of the aquifer remained saturated for a period of 15 years. The highest pumping rate that could be maintained without significantly depleting the aquifer was 4.7 MGD. It should be noted that this analysis was based on average annual pumping rates. Daily fluctuations of SACWSD pumping rates may make it difficult to extract and inject surplus water.

A final consideration for this alternative is the impact of water rights. Increased extraction and subsequent injection of surplus water would require a revision of SACWSD's augmentation plan. These revisions must be made through the State of Colorado water court and can become quite lengthy and costly, requiring a minimum of three years to accomplish.

The model was used to evaluate the relative benefits of increasing the pumping rate of SACWSD supply wells when demand is low. The model results showed that by 2010, 66 percent of the TCE plume would be remediated, and concentrations would be reduced to ground-water remediation levels given in Table 8, before moving out of the SACWSD wells area of influence. Increased pumping would also pull the PCE plume through the aquifer faster than with standard SACWSD pumping. Modeling results indicated that PCE concentrations would be reduced to below remediation levels by the year 2007.

Increased pumping also reduces the maximum concentrations of TCE by approximately 5 $\mu g/l$, although it has little impact on the time required to reduce the concentration to ground-water remediation levels.

Costs associated with this alternative are summarized below.

Increased Pumping of the Klein Water Treatment Plant

Capital Costs:		$880,000
Annual and Periodic Costs:	$602,000	
Present Worth of Annual and Periodic Costs:		$2,700,000

Total Present Worth and Capital Costs: $3,580,000

Total Present Worth of Air Stripping (8 years) and Increased Pumping of the Klein Plant (20 years) (No Monitoring): $6,000,000

Operable Unit 3 - Residential Exposure To Contaminated Ground Water

For OU3, three alternatives were evaluated during the detailed analysis phase of the OU3 FS. All of these alternatives address direct exposure to contaminated ground water through ingestion and inhalation during showering. In the OU3 FS, these alternatives assumed that residents already on the SACWSD system were provided with domestic water at concentrations below health-based levels (i.e. MCLs, and proposed MCLs). This assumption was based on data collected by EPA and information provided by SACWSD. However, other residents still directly use untreated ground water and therefore are at risk. Upon request for a well permit within the CSC Site area, the resident would be notified by the Colorado State Engineering Office of the potential health risk associated with the contaminated ground water until ground water is cleaned up to federal and State standards.

Alternative 1 - No Action

The no-action remedial alternative is required by the NCP and is used as a baseline for comparison of other alternatives. This alternative requires no further action beyond that which has already been planned. Activities currently planned include treatment of contaminated soil and ground water within CSC OU1 to acceptable levels for domestic use, prevention of migration of contaminated ground water from OU1 into OU2, and restoration of contaminated ground water to acceptable levels for domestic use within OU2.

Under this alternative, residences with private alluvial wells as the sole source of domestic water will be sampled and analyzed for chemicals of concern on an annual basis to monitor levels of exposure.

Cost associated with this alternative are summarized below:

No Action

Capital Costs:		None
Annual Operation & Maintenance Costs:	$21,600	
Total (30-Year Present Worth) Costs:		$332,000

Alternative 2 - Connection of Homes to the SACWSD Public Water System, and Installation of Home Activated Treatment Units for Homes Not Readily Accessible to SACWSD Water Mains.

This alterative involves connecting private alluvial well users to the SACWSD water system. This activity would entail connecting a service line from the home to the water main and acquiring a tap from SACWSD. A fee would be required to purchase the tap. This fee is used by SACWSD for purchase, treatment, and distribution of water and the installation of a meter and shutoff valve. Currently, all private alluvial well users within the CSC Site boundaries are located within the SACWSD water district and have easy access to SACWSD water mains.

Based on ground-water modeling conducted in the OU2 FS, ground-water contamination within the CSC Site has the potential to continue to actively migrate northward past the current boundaries of the CSC Site. If ground water continues to migrate northward, many residents outside the current Site boundaries may be exposed to contaminated water. Results from the ground-water modeling indicate that approximately 20 years would be required for the last of the ground-water contaminants in OU2 to migrate north/northwest of the current Site boundaries. Many residents outside the current Site boundaries may not be able to be readily connected to the SACWSD system due to unavailability of water mains. The unavailability of water mains may be attributed to the sparse population of residential homes north and northwest of the current CSC boundaries.

If private wells become contaminated in areas where it is not practical to connect users to the SACWSD system due to the sparse population and lack of accessibility to SACWSD water, it is likely that activated carbon treatment units would be installed to treat the contaminated ground water.

This alternative would be effective in preventing private alluvial well users from being exposed to contaminated ground water. This alternative would comply with chemical-specific ARARs. Residents would be provided water from the SACWSD system which is required to comply with federal and State regulation under the Safe Drinking Water Act (SDWA) and the previous EPA ROD. This alternative is considered to be a permanent remedy. It is technically and administratively feasible. Since all existing private alluvial well users with contamination are located near existing water mains, connection to the SACWSD system can be quickly and easily accomplished.

Costs for this alternative include the acquisition of a tap, installation of a service line from the home to the water main, installation of a shut-off valve, and interior plumbing for 12 known residences.

Costs associated with this alternative are summarized below:

Connection of Residences to the SACWSD Water System

Capital Costs:		$36,000
Annual Operation & Maintenance Costs:	$5,520*	
Total (30-Year Present Worth) Costs:		<u>$121,000</u>
Total Present Worth and Capital Costs:		$157,000**

*EPA expects the residents to pay these expenses.

**Future costs for activated carbon treatment units have not been estimated.

<u>Alternative 3 - Individual Home Activated Carbon Treatment Units</u>

This alternative involves the installation of individual home activated carbon treatment units for residences dependant on alluvial wells for domestic purposes. Domestic water used for drinking, cooking, and showering would be treated. It is estimated that the carbon would be required to be replaced approximately three times a year.

The activated carbon treatment units would effectively treat the chemicals of concern except for vinyl chloride. Vinyl chloride has been detected sporadically throughout the CSC OU2 Site. Many of the chemicals of concern for the Site may degrade to vinyl chloride under anaerobic conditions.

Due to the potential for biodegradation of Site contaminants to vinyl chloride and to ensure that units are being replaced in a timely manner, water quality monitoring would be required on a yearly basis. This alternative would not meet chemical-specific ARARs related to vinyl chloride as promulgated under the SDWA.

Individual Home Activated Carbon Treatment Units

Capital Costs:		$24,000
Annual Operation & Maintenance Costs:	$30,600	
Total (30-Year Present Worth) Costs:		<u>$370,000</u>
Total Present Worth and Capital Costs:		$394,000

VIII. SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

The remedial alternatives developed in the OU2 FS and OU3 FS were analyzed in detail using the nine evaluation criteria of the NCP. The resulting strengths and weaknesses of the alternatives were then weighed to identify the alternative for each OU which would provide 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 and evaluated below.

Overall Protection of Human Health and the Environment addresses whether or not a remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced or controlled.

Operable Unit 2. Overall protection of human health would be achieved for all alternatives except Alternative 1 (no action). Although operation of the Klein Water Treatment Plant and remedial activities undertaken in CSC OU3 will ensure that all residents in CSC OU2 are protected from contaminated ground water, there are currently no institutional controls to prohibit future use of the aquifer. Based on an assessment of a Reasonable Maximum Exposure scenario, unacceptable cancer risk of 3×10^{-4} is posed to Site residents. In addition, Alternative 1 does not protect the environment because it does not control, remediate and prevent the PCE plume from migrating further into and beyond CSC OU2 and becoming more dispersed in the aquifer.

Alternative 5 incorporates the most aggressive steps to remediate both the TCE and the PCE plumes, but in the process may cause the contamination on the western tier of the RMA Site to move into CSC OU2. The resulting movement of the contamination on the western tier of the Arsenal would increase the areal extent of the contamination, thereby increasing the potential risks to Site residents and disrupting the remedial actions being taken on the RMA Site. This alternative may also deplete the aquifer by extracting water at such a rate that the aquifer may recover very slowly. Because of these considerations this alternative may not be protective of the environment.

Alternative 2 is protective of the public health and the environment. This alternative addresses the PCE plume without the possibility of influencing the contamination on the western tier of the Arsenal, and therefore represents the most advantageous approach. All the treatment options under consideration are protective and recognize that vinyl chloride will not be removed by Alternative 2A, should it become a problem.

Ground-water contamination associated with the CSC plume (also referred to as the TCE plume) south of Sand Creek will be remediated by activities undertaken in CSC OU1. Subsequent to implementation of remedial action at OU1, ground water migrating into OU2 from OU1 will be below levels cited in Table 8. All of the alternatives for CSC OU2 adequately address remediation of the TCE that currently exists in CSC OU2.

<u>**Operable Unit 3.**</u> Alternative 2 is protective of public health. This alternative achieves the remedial action objectives established for OU3 for all chemicals of concern. Alternative 1 is not protective of public health. The

resultant risk associated with this alternative under a RME scenario is 3 X 10^{-4}. Alternative 3 is not as protective because the carbon filtration units will not effectively treat vinyl chloride.

Compliance with ARARs addresses whether or not a remedy will meet all Federal and State environmental laws and/or provide grounds for a waiver.

Operable Unit 2. Chemical- and action-specific ARARs for CSC OU2 include requirements of the Safe Drinking Water Act, the Underground Injection Control Program, the State of Colorado Water Quality Control Act, and the State of Colorado Air Quality Act. These ARARs require that the aquifer be restored to drinking water quality. Alternative 1 does not comply with these ARARs because the PCE concentrations in the aquifer will increase above proposed federal standards (i.e. the proposed MCL for PCE) in many portions of the aquifer because the PCE plume will continue to migrate northward. As the no action alternative does not include treatment controls, it provides no reduction in risk and would not comply with ARARs. Therefore, it will not be discussed further with regard to Operable Unit 2. Alternatives utilizing air stripping (Alternative 2C), the Klein Water Treatment Facility (Alternative 5) and UV-oxidation (Alterative 2B) are capable of removing all COCs to health based levels and, therefore, would be in compliance with federal and State Underground Injection Control ARARs. Alternative 2A would not comply with these requirements for vinyl chloride. Carbon adsorption (Alternative 2A) cannot effectively treat vinyl chloride to health based levels.

Operable Unit 3. Alternative 2 complies with ARARs for all chemicals of concern based on existing site conditions. Alternative 3 would not comply with SDWA standards for vinyl chloride. Alternative 1 would not comply with ARARs for all chemicals of concern. As the no action alternative (Alternative 1) does not reduce Site risks to acceptable levels and does not comply with ARARs for chemicals of concern, it will not be discussed further for OU3.

Long-term Effectiveness and Permanence refers to the ability of a remedy to provide reliable protection of human health and the environment over time.

Operable Unit 2. Alternatives 2A, 2B, and 2C provide permanent remedies for the PCE plume. These alternatives all provide reliable protection of human health and the environment of the TCE and PCE plumes and minimal residual risk. Ground-water treatment through activated carbon (Alternative 2A) would result in residual waste management of contaminants adsorbed to the spent carbon filters but poses a minimal residual risk. UV oxidation would result in no treatment residual. Risks associated with emissions from air stripping under Alternative 2C would not pose an unacceptable risk to the public (i.e. greater than 1 X 10^{-6}). Alternative 5 results in approximately 5 µg/l reduction in TCE in comparison to Alternative 2. This alternative, however, may result in the migration of the contamination on the western tier of the Arsenal onto CSC OU2, resulting in an increased risk from this plume.

Operable Unit 3. Alternative 2 would result in a permanent remedy. Once residences are connected to SACWSD, no additional activities would be required. Alternative 3 is not a very reliable alternative. Carbon filters would be required to be replaced approximately three times per year.

Reduction of Toxicity, Mobility, or Volume Through Treatment refers to the preference for a remedy that reduces health hazards, the movement of contaminants, or the quantity of contaminants at the Site.

<u>Operable Unit 2.</u> The toxicity, mobility and volume of contaminants will decrease under most alternatives as a result of operation of the Klein Water Treatment Plant and the PCE treatment system. Alternative 5 removes the greatest mass of contamination, closely followed by Alternatives 2A, 2B, and 2C. Under Alternatives 2C and 5 (air stripping), the contaminants removed from the ground water would be emitted to the atmosphere at acceptable emission rates although the toxicity, mobility and volume would not be reduced. The mobility of contaminants treated through activated carbon (Alternative 2A and 5) would be reduced to near zero during treatment. All alternatives include activated carbon treatment because of operation of the Klein Water Treatment Plant, and Alternative 2A includes an additional carbon treatment system to treat the PCE plume. The mobility of the removed contamination is reduced to near zero when it is adsorbed by the carbon and subsequently destroyed during carbon regeneration. The mobility of contamination drops to zero in the UV-oxidation process (Alternative 2B) because contaminants are actually destroyed rather than transferred to another medium.

<u>Operable Unit 3.</u> The treatment of contaminated ground water is documented in the CSC OU1 and OU2 RODs.

Short-term Effectiveness addresses the period of time needed to complete the remedy, and any adverse effects to human health and the environment that may be caused during the construction and implementation of the remedy.

<u>Operable Unit 2.</u> All treatment alternatives promote remediation of the aquifer to some degree. Alternative 5

would remediate the aquifer most quickly and would remove the greatest mass of contamination (92 percent of the PCE) by remediating the PCE plume and increasing the amount of ground water being treated by the Klein Water Treatment Plant. It is estimated that the PCE plume would be remediated in 17 years and the TCE plume would approach remediation levels in 25 years. This alternative, however, has the potential to induce migration of the contamination on the western tier of RMA into CSC OU2, which would have a detrimental effect on ground-water quality in CSC OU2. In addition, Alternative 5 may result in aquifer depletion, which is unacceptable because this aquifer is the principal source of water for Commerce City. Alternatives 2A and 2C provide the greatest degree of short-term effectiveness. Despite the fact that these alternatives require slightly more time to remediate the aquifer than Alternative 5, they will not impact water availabilities or the contamination on the western tier of RMA. Alternative 2B would require conducting pilot and treatability tests to optimize treatment. This would result in a delay in finalizing remedial design plans and initiating remedial action. Approximately 86 percent of the PCE plume would be removed by Alternatives 2A, 2B, and 2C and remediation times are estimated to be 20 years for PCE and 30 years for TCE. Field and construction activities associated with all of these alternatives would not impact human health or the environment during alternative implementation. The adverse impact from emissions to the atmosphere of Alternatives 2C and 5 is judged acceptable by federal and State requirements and EPA policy.

Operable Unit 3. Both Alternative 2 and Alternative 3 can be implemented very quickly (i.e., less than 30 days).

Implementability refers to the technical and administrative feasibility of a remedy. This includes the availability of materials and services needed to carry out a remedy. It also includes coordination of federal, State, and local governments to clean up the Site.

Operable Unit 2. Alternative 2 is the easiest to implement as installation of pump and treat systems is commonly performed on similar Sites. Within the treatment options, carbon adsorption and air stripping will be easier to implement than UV-oxidation, which would require extensive treatability and pilot testing. Finally, Alternative 5 is the most difficult to implement because SACWSD would be required to revise its water augmentation plan and to request approval from the State of Colorado water court, which would require at a minimum 3 years. In addition, technical considerations, primarily depletion of the aquifer, may prevent this alternative from being technically implementable. Increased pumping of the SACWSD extraction wells and the potential for misplaced reinjection points could result in aquifer depletion. Therefore this alternative is also difficult to implement from a technical standpoint.

Operable Unit 3. Alternative 2 and Alternative 3 are readily implementable.

Cost evaluates the estimated capital and operation and maintenance costs of each alternative in comparison to other equally protective alternatives.

Operable Unit 2. The alternative with the greatest capital cost is Alternative 5 ($3,290,000), PCE Plume Treatment with Increased Pumping of the SACWSD Wells. The treatment option with the greatest capital cost is UV-oxidation ($1,950,000), followed by carbon adsorption ($1,910,00) (Alternative 2B and 2A respectively). Alternative 2C, air stripping has the lowest capital costs ($1,410,000). The alternative with the greatest operation and maintenance (O&M) costs is also

Alternative 5, and O&M costs are also greatest for UV-oxidation, followed by carbon adsorption, and air stripping (Alternatives 2B, 2A, and 2C, respectively). The present worth of the alternatives varies in the same manner as capital and O&M costs. Specific capital, O & M, and present worth costs for Alternatives 2A, 2B, 2C and 5 are presented in Table 9.

Operable Unit 3. Based on present worth cost calculations, Alternative 2 is approximately three times less costly thanAlternative 3 because additional monitoring would be required for Alternative 3. The capital costs for Alternative 2 are approximately $36,000. The capital cost for Alternative 3 is slightly less at $24,000. Alternative 2, however, requires no O & M costs, compared to $30,000 per year under Alternative 3, since monitoring would not be required for Alternative 2.

Specific capital, O & M and present worth costs for Alternative 2 and Alternative 3 are presented in Table 10.

State Acceptance indicates whether the State agrees with, opposes, or has no comment on the preferred alternative.

Operable Unit 2. EPA has involved the Colorado Department of Health (CDH) throughout the RI/FS and remedy selection process. CDH was provided the opportunity to comment on the RI/FS document and the Proposed Plan and took part in the public meeting held to inform the public of the Proposed Plan. CDH submitted formal comments to EPA during the public comment period for OU2. In these comments, CDH identified additional State ARARs which were not included in the OU2 FS. Prior to public release of the OU2 proposed plan, the State of Colorado (CDH) informed EPA in writing that the State concurs with EPA's preferred alternative, Alternative 2C. Appendix C

TABLE 9
COSTS OF REMEDIAL ALTERNATIVES

OPERABLE UNIT 2

ALTERNATIVE	CAPITAL COST	ANNUAL OPERATION AND MAINTENANCE COST YEARS 1-6*	ANNUAL OPERATION AND MAINTENANCE COST YEARS 6-20*	TOTAL CAPITAL COST AND PRESENT WORTH
No Action	$2,600	$27,000		$263,600
PCE Plume Treatment, Hydraulic Containment of PCE Plume, Activated Carbon Treatment of Extracted Water	$1,910,000	$262,000	$27,000	$3,400,000
UV-Oxidation Treatment of Extracted Water	$1,950,000	$277,000	$27,000	$3,520,000
Air Stripping Treatment of Extracted Water	$1,410,000	$223,000	$27,000	$2,420,000
PCE Plume Treatment, Hydraulic Containment of PCE Plume, Increased Pumping of South Adams County Water and Sanitation District Wells	$3,290,000	$825,000	$27,000	$6,260,000

contains the State's letter of concurrence with these RODs.

Operable Unit 3. Similar to Operable Unit 2, CDH was provided the opportunity to comment on the RI/FS document and Proposed Plan for Operable Unit 3. CDH submitted formal comments to EPA during the public comment period for OU3. In these comments, CDH requested clarification regarding the identification of specific residences requiring connection to SACWSD. Responses to these specific concerns are provided in the Responsiveness Summary section of the ROD. Prior to public release of the OU3 proposed plan, the State of Colorado informed EPA in writing that the State concurs with EPA's preferred alternative, Alternative 2. Appendix C contains the State's letter of concurrence with these RODs.

Community Acceptance includes determining which components of the alternatives interested persons in the community support, have reservations about, or oppose.

Operable Unit 2. EPA solicited input from the community on the cleanup methods proposed for ground water at CSC OU2. One citizens' group, Citizens Against Contamination (CAC), submitted formal comments to EPA during the public comment period. In their comments, they indicated that they were opposed to the lack of emission controls on the air stripping unit proposed under Alternative 2C. This concern is addressed in the Responsiveness Summary section of this ROD.

Operable Unit 3. Concerns were raised by the South Adams County Water and Sanitation District (SACWSD) regarding the acceptability of water from Well #18. SACWSD provided EPA with additional data on the water quality for Well #18. These data indicated that concentrations of TCE routinely fluctuated above the MCL of 5 $\mu g/l$. The highest reading of TCE was 12 $\mu g/l$. SACWSD would prefer that the selected remedy include

TABLE 10
COSTS OF REMEDIAL ALTERNATIVES

OPERABLE UNIT 3

ALTERNATIVE	CAPITAL COST	ANNUAL OPERATION AND MAINTENANCE COST	TOTAL CAPITAL COST AND PRESENT WORTH
No Action	None	$21,600	$332,000
Connection of Residences to the SACWSD Water System	$36,000	$5,520	$121,000
Individual Home Activated Carbon Treatment Unites	$24,000	$30,600	$370,000

provisions for treatment of water from Well #18. These concerns are addressed in the Responsiveness Summary.

IX. SELECTED REMEDY

EPA has selected CSC OU2 Alternative 2C, PCE Plume Treatment by Air Stripping with Hydraulic Containment and Standard Pumping of SACWSD Wells, and CSC OU3 Alternative 2, connection of homes to the SACWSD water system as the remedies for Chemical Sales Operable Unit 2 and Operable Unit 3. The remedy assumes continued operation of the Klein Treatment Plant.

The remedy for Operable Unit 2 is made up of the following components:

- extraction of contaminated ground water by extraction wells
- treatment of contaminated ground water by air stripping
- reinjection of treated water to the aquifer by injection wells

This remedy also includes:

- monitoring of approximately 15 wells on at least an annual basis
- voluntary abandonment of bedrock wells for which criteria will be established in RD

The ground water extraction system will be installed to extract the maximum amount of the PCE plume possible. The configuration of the extraction and injection wells will be determined during remedial design. The system will operate until contaminant concentrations are reduced to Site remediation levels cited in Table 8.

This alternative assumes that the remedial action objectives for CSC OU1 and CSC OU3 will be met. Thus, contaminated ground water will be prevented from entering OU2 from OU1, and users of shallow alluvial wells in OU2 will be protected. Estimated cost for the selected remedy is $2,683,600 (includes cost of monitoring).

The remedy for Operable Unit 3 consists of the following components:

- Connection of Residences currently using alluvial wells for domestic water to the SACWSD. Currently, all known Site residences can be readily connected to SACWSD water.
- Installation of home activated carbon units for homes not readily accessible to SACWSD. Monitor for vinyl chloride to ensure protection of remedy.
- Notification of potential health treat.

The selection of these remedies is based upon the comparative analysis of alternatives presented in the previous section. These remedies provide the best balance with respect to the nine evaluation criteria, are protective of both human health and the environment, and will comply with all identified State and federal ARARs.

Operable Unit 2

The selected remedial alternative (Alternative 2C) for Operable Unit 2 addresses the PCE plume without influencing the contamination on the western tier of RMA. Air stripping technology is the most effective and implementable technology for removing all the COCs identified for OU2. VOC emissions resulting from air stripping operations will result in minimal risk (i.e. less than 1×10^{-6} risk level). The source of the

Chemical Sales Co. plume (also referred to as the TCE Plume) will be remediated by activities undertaken in CSC OU1. These activities will result in a significant reduction in the mass of alluvial aquifer contamination within OU1. In addition, ground-water contaminants within OU1 will be prevented from migrating into OU2. These actions are considered to be sufficient with regard to addressing ground-water contamination emanating from the CSC facility.

Alternative 2C was selected over Alternative 5 due to administrative and technical implementability problems associated with Alternative 5. These concerns include: (1) a delay in initiating remedial action resulting from administrative difficulties in obtaining the Colorado State Engineer's Office approval for SACWSD water augmentation plan revision; (2) potential depletion of the alluvial aquifer which is the primary source of water to the residents of Commerce City; and, (3) possible migration of the RMA contamination on the western tier of the Arsenal into OU2. Although Alternative 5 would restore the alluvial aquifer within OU2 faster than Alternative 2, Alternative 5 was not selected due to the implementability concerns listed above.

Air stripping was selected as the most appropriate treatment technology because it is the most effective technology to treat CSC OU2 COCs, is readily implementable and is the least costly treatment technology. Despite the fact that UV-oxidation reduces the mobility of contaminants more effectively than air stripping and is permanent, this technology is more costly than air stripping and would require extensive testing to determine appropriate adjustments for treatment.

Under Alternative 2C, the toxicity and volume of contaminants will decrease as a result of operating the Klein Water

Treatment Plant and the PCE treatment system. Approximately 86 percent of the PCE plume will be removed by this alternative. Remediation times are estimated to be 20 years for PCE and 30 years for TCE. This alternative will not result in unacceptable risks to the community during implementation.

The selection of this alterative (Alternative 2C) is in keeping with EPA policy to act quickly and capture as much of the plume as possible, before it dilutes and disperses in the aquifer. Experience has shown that preventing further migration of contamination is an essential objective for any aquifer remediation effort. The monitoring portion of this alternative further reflects EPA's policy that data should continue to be collected at a Site to assess contaminant movement and predict the likely response to extraction. This alternative will meet the remedial action goals and objectives for ground water in CSC OU2 outlined in Section VII of this ROD.

Remediation Goals and Performance Standards for Ground Water

Remedial Action Objectives. Remedial action objectives for this site are presented in Table 8

Area of Attainment. The area of attainment for the ground water remediation shall be the CSC OU2 plumes exceeding ground water remediation levels for all COCs. Low-level contamination not captured by the SACWSD pumping wells will be allowed to flow to the north and northwest, and any users of water exceeding acceptable contaminant concentration levels as defined in Table 8, will be provided with alternate water under OU3. The estimated area that currently exceeds remediation levels is shown on Figures 6 and 7. The TCE and PCE plume areas shown in Figures 6 and 7 currently include 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 20 years for the PCE plume and 30 years for the TCE plume.

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 8 and to levels which present a total carcinogenic risk of less than 10^{-4} to 10^{-6}.

2) Ensure capture of the PCE 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 conducted by EPA. If any excedence 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 standards are again attained in all compliance monitoring wells. This cycle shall continue until quarterly monitoring for one year demonstrates no excedence 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% Remedial Design completion report, and will, at a minimum, include wells upgradient of the plumes, within the plumes, around the plumes, and downgradient of the plumes. Any statistical methods to average well concentrations shall be specified during RD/RA.

The first 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 systems and their 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 plumes. In such a case, either or both of the extraction systems' performance standards and/or 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 approximately 20 years for the PCE plume and 30 years for the TCE plume, during which time the two systems' 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 ground-water extraction, until the remedial action is completed.

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 PCE plume air stripper (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.

- methods to monitor possible migration of contaminants to the north and northwest of the main SACWSD pumping center.

Operable Unit 3

For CSC OU3, continued operation of the Klein Water Treatment Plant (KWTP) and connection of alluvial well users to the SACWSD water system will ensure that all residents in CSC OU2 are protected from exposure to contaminated ground water. Alternative 2 was selected over Alternative 3 because it represents a permanent remedy, is less costly than Alternative 3, and is protective of human health for all COCs. Alternative 3 requires that home carbon filters be changed about three times a year and would not be effective in treating vinyl chloride.

Vinyl chloride has not been detected in ground water extracted by the SACWSD municipal supply wells. If vinyl chloride is detected at the Klein Water Treatement Facility, it will be treated through air stripping under the provisions of the EPA Off-post RMA OU1 Record of Decision.

X. STATUTORY DETERMINATIONS

EPA's primary responsibility at CERCLA Sites is to select remedial actions that are protective of human health and the environment. CERCLA also requires that the selected remedial action for the 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 remedies for CSC OU2 and CSC OU3 meet these statutory requirements.

Protection of Human Health and the Environment

Operable Unit 2. In order to meet the remedial objectives outlined in the previous section, the risk associated with exposure to the contaminated ground water must fall within the acceptable risk for carcinogens. Attainment of MCLs and proposed MCLs will assure Site risk falls within this range. The selected remedy protects human health and the environment by reducing levels of contaminants in the ground water through extraction and treatment.

EPA expects that the aquifer will be completely remediated in 20 to 30 years. The PCE treatment system, together with activities conducted in OU1 and OU3 and operation of the Klein Water Treatment Plant, will reduce to acceptable levels, threats of exposure posed to residents and the environment from contaminated ground water in OU2. The selected alternative provides the best protection to human health without significant adverse impact to the environment. Remedial action objectives and goals will be met. Implementation of the selected remedy will not pose unacceptable short-term risks or cross-media impacts.

Operable Unit 3. During the period of time required to restore the OU2 alluvial aquifer to acceptable levels, a potential exists for residents to be exposed to contaminated ground water. The remedy selected for Operable Unit 3 addresses this exposure. Alternative 2 provides protection to human health by ensuring that residents within the CSC Site are provided with water containing acceptable levels of contaminants, as defined in Table 7. No unacceptable short-term risks or cross-media impacts would be caused by implementing this remedy.

Attainment of Applicable or Relevant and Appropriate Requirements

All ARARs would be met by the selected remedy. ARARs for CSC OU2 were discussed in Section VII of this ROD.

Cost Effectiveness

EPA believes the selected remedies are cost-effective in mitigating the principal risk posed by contaminated ground water 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, against three additional balancing criteria: long-term effectiveness and permanence; reduction of toxicity, mobility or volume through treatment; and short-term effectiveness. The selected remedies meet these criteria and produce the best overall effectiveness in proportion to their cost. The estimated costs for the selected remedies are $2,420,000 for CSC OU2 and $121,000 for CSC OU3.

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

EPA believes the selected remedies represent the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost-effective manner for CSC OU2 and CSC OU3. Of those alternatives that are protective of human health and the environment and comply with ARARs, EPA has determined that the selected remedies provide 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.

Operable Unit 2. The selected alternative (Alternative 2C) provides a permanent, long-term remedy for the PCE plume. Although Alternative 5 would restore the alluvial aquifer to acceptable levels slightly quicker than the Alternative 2C, this alternative potentially is administratively infeasible, and may result in migration of the contamination on the western tier of the RMA onto CSC OU2 and the depletion of a major source of water to the residents of Commerce City.

Toxicity and volume of contaminants will be reduced by the selected alternative as a result of operating the PCE treatment system and the Klein Water Treatment Plant. Alternative 1 is the least effective in providing this reduction. The selected alternative will not impact the contamination on the western tier of the Arsenal or deplete the aquifer, thus provides the greatest degree of short-term effectiveness. The selected alternative was the least costly of alternatives meeting the threshold criteria.

Air stripping was determined to be most the most appropriate treatment technology because it is the most effective treatment for CSC OU2 COCs, the least costly and easiest to implement.

Operable Unit 3. The selected alternative (Alternative 2) provides a permanent remedy at minimal costs. No additional activities will be required subsequent to connection of residences to the Klein Water Treatment facility. The selective remedy was the least costly alternative.

The State of Colorado concurs with selection of Alterative 2C (OU2) and Alternative 2 (OU3). Appendix C contains the State's letter of concurrence with these RODs.

Preference for Treatment as a Principal Element

The selected remedies satisfy the statutory preference for treatment as a principal element. No principal threat exists for either CSC OU2 or CSC OU3.

XI. DOCUMENTATION OF SIGNIFICANT CHANGES

The Proposed Plans for CSC OU2 and CSC OU3 were released for public comment on February 28, 1991. The CSC OU2 Proposed Plan identified Alternative 2C, PCE plume treatment/ hydraulic containment of PCE plume/ air stripping treatment of extracted water, as the Preferred Alternative. The CSC OU3 Proposed Plan identified Alternative 2, connection of residences to SACWSD Water system, as the Preferred Alternative. EPA reviewed all written and verbal comments submitted during the public comment period. No significant changes have been made to the CSC OU2 or OU3 Preferred Alternatives, Alternative 2C, and Alternative 2.

REFERENCES

ARAR's Q's & A's, General Policy, U.S. EPA Superfund Fact Sheet, May 1989.

Chemical Sales Company, EPA Administrative Order on Consent (CERCLA-VIII-90-03, Signed September 29, 1989).

Control of Air Emissions from Superfund Air Strippers at Superfund Ground-water Sites, OSWER Directive 9355.0-28.

Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final, U.S. EPA/540/G-89/004, October 1988.

Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A) Interim Final; U.S. EPA/540/1-89/002, December 1989.

Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions, OSWER Directive 9355.0-30.

Final Remedial Investigation Report, Chemical Sales Company Site, Operable Unit 2, Chlorinated Hydrocarbon Ground Water Plume, October 19, 1990.

Feasibility Study Report, Chemical Sales Company Site, Operable Unit 2, March 1991.

APPENDIX A

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.

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.
4 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[a] (continued)		
Citation	Requirement	Evaluation
25-12-103, C.R.S.	Colorado Noise Abatement: establishes standards for controlling noise.	These requirements apply to construction activities.
7-91-104, 106, 110 .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.
3 U.S.C §1251-1376	Clean Water Act	
0 CFR 230, 231, 3 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.
xecutive Order No. 1990, 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.
CCR 1001-5 eg. 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 8 of the ROD text.

APPENDIX B

CHEMICAL SALES COMPANY OU2 AND OU3
Responsiveness Summary

Background of Community Involvement

SUMMARY OF COMMUNITY RELATIONS ACTIVITIES
CHEMICAL SALES COMPANY

Community interest in the ground-water 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 of 1989. Initially the Rocky Mountain Arsenal, which was adjacent to the contaminated public water supply area was thought to be the source. EPA and the Army responded to numerous public and media inquiries, issued press releases and attended 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.

In 1984 and 1985, local newspapers were printing stories almost daily concerning the Arsenal cleanup process and ground-water contamination. At least 10 articles were published in July of 1985 regarding TCE found in ground water west of the Arsenal. EPA personnel responded to numerous questions from reporters and the public.

In September of 1985, a local citizen's group, Citizens Against Contamination (CAC), held a meeting at which 100 to 200 people attended, including EPA, Colorado Department of Health (CDH), Army, and SACWSD officials, and local elected officials. 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. A public meeting was held on November 25, 1985 at 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, 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 and January 1985. The articles focused on EPA's attempts to obtain funding and the Arsenal as a suspected source. On January 24, 1986, EPA 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 concerns and the Army's role.

The State of Colorado was threatening to sue the Army for the groundwater contamination. The Army issued a press release on February 6, 1986, stating that CDH had agreed to withdraw the State suit.

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 clarifying the boundaries of the affected area). The advisory resulted in a flurry of newspaper articles. 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. The Army agreed to provide bottled water to schools in the area in March. Coors also donated bottled water.

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. EPA issued an additional press release on March 5 stating that EPA and the Army had agreed in concept to enter into an agreement to transfer funds from the Army to EPA to pay for water treatment. A number of newspaper articles followed.

CAC held another public meeting March 6, 1986, which was attended by more than 600 people, including representatives of the EPA, the Army, CDH, Tri-County Health (TCH) and SACWSD. Questions centered on the health effects and the advisory. 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. 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). EPA also said they 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, EPA, the State, and SACWSD signed a cooperative agreement to provided funding for the water treatment. The agreement transferred the funds to SACWSD. Press coverage followed.

On April 23, 1986, EPA presented an award to CAC for their efforts. Also in the spring of 1986, 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 EPA's Administrator requesting he make funds available for the cleanup.

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

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. 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 200 private well owners were hooked up to a 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 EPA to fund a permanent treatment facility.

In an October 23, 1986 press conference, EPA specifically named the Chemical Sales Site as a source of ground-water contamination in south Adams County.

In December of 1986, 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 commentors supported EPA's preferred alternative, a granular activated carbon filtration system.

In June of 1987, EPA issued a Record of Decision (ROD) for the selected remedial alternative, a permanent water treatment plant with a granular activated carbon filtration system. In October of 1987, the Army and the EPA agreed to pay to construct the Klein Water Treatment Plant and operate it for 25 years. The Klein Water Treatment Plant opened on November 17, 1989.

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

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, EPA issued an additional fact sheet covering the status of four south Adams County Superfund Sites, including Chemical Sales.

In May of 1990, EPA's Community Involvement Coordinator took approximately 40 EPA management personnel and officials on a tour of the south Adams County Superfund sites. In June of 1990, EPA gave two presentations to brief City, County, and State officials on the Superfund process and sites in south Adams County.

EPA mailed out Proposed Plans for the three Operable Units at the Chemical Sales Site February 28, 1991. The Proposed Plans discussed remedial action alternatives for the source and the ground-water contamination, and announced the public comment period from February 28, 1991 to April 1, 1991. 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.

Comments and Responses

Comments on the CSC OU2 RI/FS report were received from South Adams County Water and Sanitation District, Department of the Army, Colorado Department of Health, Chemical Sales Company, and Citizens Against Contamination. No written comments were received from individual citizens. The full text of all comments received is included as Exhibit A.

A letter received from SACWSD stated that SACWSD supported EPA's efforts to remediate the aquifer in CSC OU2 and generally agreed with the preferred alternative, although some concerns remained. The concerns focused on the future impact of SACWSD supply Well 18, the predicted operation and maintenance of the Klein Water Treatment Plant, and potential impacts from the proposed remedial activities on SACWSD performance.

The Department of the Army submitted the most extensive comments. These addressed all phases of the RI/FS, including the RI report, the Risk Assessment, the FS report, and the Modeling report.

Colorado Department of Health (CDH) submitted three comments, all of which dealt with the identification and selection of ARARs. No other topics were addressed by CDH.

Citizens Against Contamination is an organized citizens' group that has been closely following activities at hazardous waste sites in the Commerce City area. They submitted only one comment and it was regarding the air stripper.

Comments received from the Chemical Sales Company (CSC) all focused on the RI report. Concerns were raised that insufficient data exist or that the existing data were misinterpreted to identify CSC as a principle responsible party for the CSC OU2 site.

Responses to all comments have been prepared and are presented in this section. The comments have been grouped by topic and, in some cases, have been combined if several comments address a common concern. The topics are: Responses to Citizen Comments, the RI, the Risk Assessment, the FS, the modeling report, ARARs, and Operable Unit 3. Within each topic the comments are generally grouped by author, although there is some overlap when comments from different sources address the same concern. The actual text of the comments has been paraphrased for the purpose of this section of the ROD.

TOPIC I: RESPONSE TO CITIZEN CONCERNS

1. **Citizens Against Contamination Comment**
   Department of the Army, General Comment 7.

These comments address the need for emission controls on the air stripper that is included in the preferred alternative.

EPA Response. It is assumed that "air stripper controls" refers to air emission controls on the air stripper. Both the federal and state governments have regulations that specify maximum allowable emissions into the atmosphere of chemicals such as the chemicals of concern at the CSC OU2 site. The air stripper that will be built for this site will be in compliance with both federal and state standards. It is anticipated that air emission controls will not be needed for the air stripper because the ground water plume being treated in CSC OU2 is fairly dilute. The air stripper will be monitored during operation to ensure that the emissions do not exceed state and federal standards. If monitoring indicates that air emission controls are needed for the air stripper, they will be added at that time. In comparison, the air stripper for CSC OU1 will include air emission controls because the plume in OU1 is much more concentrated and the resulting air emissions would exceed state and federal regulations without the controls.

TOPIC II: RI REPORT

2. **Department of the Army, Specific Comment 1a, p. 1-2.**

It seems inappropriate to define remedial action objectives (RAOs) in the RI. RAOs should be developed in the FS.

EPA Response. The identification of preliminary RAOs during the RI is consistent with EPA RI/FS guidance. The purpose of this identification is to focus and streamline data collection activities conducted during the RI. The preliminary RAOs identified in the RI were formulated based on data collected during the earlier EPA RMA Off-Post RI/FS for Operable Unit 1 and Operable Unit 2 and EPA's Field Investigation Team (FIT) during various site investigations. The amount of data was sufficient to identify COCs for the operable unit. The preliminary RAOs presented helped to focus the remedial investigation data collection by identifying data needs required to address the proposed objectives. The preliminary RAOs were re-evaluated during the CSC OU2 FS.

3. **Department of the Army, Specific Comment 1b, p. 1-2.**

EPA should clarify what is meant by "...important chemicals detected in the shallow aquifer..." And should present criteria used in establishing the "important chemicals."

EPA Response. The term "important chemicals" is used to provide an overview of the site characteristics during the summarization of existing site information. The intent of using this term is to provide the reader a general understanding of the nature of ground-water contamination at OU2. The term "important chemicals" is not synonymous with COCs. COCs were originally identified based on a comprehensive evaluation process conducted during the EPA Off-Post Arsenal RI/FS and confirmed in the OU2 RA.

In Section 1.2.3, Chemicals of Concern in CSC OU2 were listed and it was stated that "A Risk Assessment was performed as part of the RI, resulting in selection of eight chemicals of concern for the site." The COCs identified in the RA were a confirmation of the COCs identified in the EPA RMA Off-Post RI/FS, with minor additions. The identification of CSC OU2 COCs is discussed in the RA, and the responses to comments regarding COC selection are given under Topic II: Risk Assessment (comments 70-81) of this document.

4. **Department of the Army, Specific Comment 2, p. 1-16.**

The text in the last paragraph should be modified to indicate that the CSC property has been identified as a source of contamination to the alluvial aquifer, not as a potential source.

EPA Response. EPA considers the CSC property a source of contamination in ground water at OU2. Ground-water contamination emanating from the CSC facility migrates northward beneath Sand Creek and continues to migrate northward where it impacts SACWSD municipal water supply wells. This interpretation is based on the potentiometric surface maps, water quality data and assessment of the distribution of chemicals (i.e. PCE/TCE ratios) presented in the CSC OU2 RI.

5. **Department of the Army Specific Comment 3a, p. 1-20.**

Significant additional discussion is warranted regarding the scope and status of the RMA off-post activities, which are currently underway.

EPA Response. The Army RMA Off-Post Site north of CSC OU2 is not believed to impact CSC OU2 directly. Additional discussion is not considered to be necessary for the OU2 FS report, although EPA is willing to discuss the RMA off-post activities with concerned parties.

6. **Department of the Army Specific Comment 3b, p. 1-20.**

Chemicals of Concern (COCs) are identified in this section of the report. This seems premature and results in eliminating any discussion on the nature and extent of a number of other contaminants detected in OU1 and OU2 ground water. This report does not appear to fully discuss the nature and extent of contaminants.

EPA Response. An exhaustive analysis of potential COCs was performed for the OU2 Risk Assessment (RA), and the site COCs were identified as part of this evaluation. The identification of COCs utilized all analytical data available within CSC OU2. The RA is the appropriate place for discussing the selection of the identified COCs, and responses to comments regarding the RA are given under Topic II: Risk Assessment (comments 70-81).

The RI evaluation of the nature and extent of contamination is based on the COCs identified in the earlier EPA Off-Post RMA RI/FS. OU1 contamination is a separate RI/FS, and contaminants found in OU1 that do not impact OU2 are not relevant to OU2. EPA disagrees with the comment that the RI report "does not fully discuss the nature and extent of contamination." The nature and extent of contaminants were evaluated in the EPA RMA Off-Post RI, and were refined in the CSC OU2 RI.

7. **Department of the Army Specific Comment 4, p. 1-22.**

Because of other possible cleanup goals at the site (e.g., risk-based standards), it appears that this section should be retitled and refocussed to indicate that the discussion simply presents ARARs. It seems premature for the RI to be discussing "... what concentrations of contaminants are likely to be of concern for the CSC OU2." These issues cannot be developed without fully considering the results of the RA and FS. Additionally it is not clear why ARARs for non-COCs are presented.

EPA Response. The section is introduced with a statement that specific cleanup levels would be determined in the FS, based on a number of factors including ARARs and protection of human health and the environment. This section is meant only as a brief introduction of factors affecting the determination of cleanup levels. Preliminary ARARs are discussed more fully in the FS. Potential ARARs are presented in this section to give the reader a basis for comparison when evaluating the nature and extent of contamination relative to drinking water standards. ARARs for potential COCs were presented in Table 1-1. These included several analytes that were detected within or near CSC OU2, but were determined to not be compounds of concern during the RA. This table was meant to be a comprehensive listing of potential COCs based on evaluation of site analytical data. The table was used to ensure that laboratory detection limits were lower than potential remediation levels. Each of these analytes was evaluated during the RA to confirm the list of COCs identified in the earlier Off-Post RMA RI/FS.

8. **Department of the Army Specific Comment 5, p. 2-8.**

The report continually implies that RMA is a possible source of contaminants to the CSC OU2 ground water. Plume maps presented in the OU3 FS and EPA's proposed plan for OU2 clearly show that plumes migrating north from the CSC site or from other sources off-post of RMA are flowing onto the western boundary of RMA. Additionally, the FS indicates that the ground water plumes in OU2 are principally associated with OU2 or other non-RMA sources. The findings of the OU2 RI indicate that RMA is not a significant source of contaminants to ground water in the OU2 study area, except in the extreme northeastern part of OU2 where low-level ground water contamination may be attributable to RMA sources.

EPA Response. Section 2.2 presents contaminant source investigations potentially relevant to CSC OU2. This section does not apportion sources for contamination in CSC OU2, but summarizes previous investigations. EPA sees no implied apportionment of sources in this section. Section 4.5 evaluates contaminant sources potentially impacting CSC OU2, including RMA. In Section 4.5.1.2, the RMA and the 49th and Havana Street site are evaluated. This section concluded that a portion of the contamination at the SACWSD pumping center at East 77th Avenue and Quebec Street could be attributable to ground water from RMA, and that the RMA appeared to be a very minor source of contamination in CSC OU2. This is not in conflict with the Army comment. Ground-water contamination associated with the CSC "referred to as TCE Plume in OU2 FS," and PCE plume may potentially impact the extreme western edge of the Rocky Mountain Arsenal.

9. **Department of the Army Specific Comment 6, p. 2-17.**

EPA should conduct a reasonable number of long-term (e.g. 24-hour or greater) aquifer pumping tests to adequately characterize the range of hydraulic conductivities for the alluvial aquifer.

EPA Response. EPA considers the hydraulic conductivity values presented in the FS sufficient to adequately characterize the site and evaluate the effectiveness of the various remedial alternatives identified in the OU2 FS. EPA recognizes that hydraulic conductivities cover a range of values over the site, however EPA does not agree that the time and expense required for additional aquifer evaluation is necessary to complete the OU2 FS. EPA agrees that the site data suggest that paleochannel features have substantially higher transmissivities than areas outside of the channels. Previously conducted pump tests at production wells located in paleochannels are believed adequate for characterizing ranges of hydraulic conductivities in these features. Outside of the paleochannels, the aquifer saturated thicknesses are much less and hydraulic conductivities are lower than inside the paleochannels. Evaluation of borehole geologic logs showed that lithologies away from the paleochannels are very heterogeneous, and therefore a large number of pump tests would be required to approximate hydraulic conductivities. Instead of this time-consuming and expensive process, EPA opted to utilize existing pump test data and literature ranges for saturated lithologies based on evaluation of geologic logs.

EPA may require that additional aquifer testing be conducted during remedial design to provide information regarding the number, location and rate of extraction wells that will be installed.

10. **Department of the Army Specific Comment 7, p. 2-20.**

The basis for the frequency of ground water monitoring (e.g. approximately every 14 to 16 months) is not discussed. It would be useful to identify the criteria used to develop this monitoring plan and cite the sampling plan that presents the rationale.

EPA Response. Routine ground water monitoring was not conducted by EPA as such for the CSC OU2 RI/FS; a discrete ground water sampling episode was conducted in 1990 as EPA determined that additional data were needed. The EPA RMA Off-Post RI/FS included a phased sampling approach, and the basis for the sampling interval is given in the EPA RMA Off-Post RI.

11. **Department of the Army Specific Comment 8, p. 2-26.**

The Army agrees that it is important to assess the behavior of contaminants in the ground water. However the RI eliminates some chemicals detected in the ground water, so that the assessment of fate and transport issues does not completely consider all compounds detected. The fate and transport discussion could be expanded to include other chemicals that have been detected, particularly if they fall into classes whose behavior is substantially different from the currently identified COCs.

EPA Response. Environmental fate and transport issues were considered during the selection of the COCs in the RA. EPA RI/FS guidance recommends the evaluation of existing data to focus and streamline data collection activities. Although the use of indicator chemicals serves to focus and streamline the assessment on those chemicals that are likely to be of greatest concern, a final check will be made during remedy selection and the remedial action phase to ensure that the waste management strategy being implemented addresses risks posed by the range of contaminants found at the site. The previous EPA RMA Off-post RI/FS gave a "baseline" characterization of ground water contamination in CSC OU2. It is both prudent and valid to conduct the RI/FS process utilizing all previous investigation results to narrow the scope of investigation.

12. **Department of the Army Specific Comment 8a, p. 2-46.**

There is no explanation for zero values in the database.

EPA Response. The zeros in the site analytical database indicate that the sample was not analyzed for that analyte, or that no usable data exist for that analyte for the given sample. The site database is formatted in DBASE III+ which replaces all blank numeric fields with zeros. Further distributions of the site database will include a statement explaining this feature.

13. **Department of the Army Specific Comment 8b, p. 2-46.**

There are gross inconsistencies between various tables in the report and various appendices. It is not clear why chloroform data contained in Appendix 2D are not also presented in Table 3-10. Additionally, the statistical summary for DCA for well 03002 shown in Appendix 4A is inconsistent with the number of samples and range of values from Appendix 2D.

EPA Response. The confusion over chloroform relates to the types of analytical results presented. EPA studies included the analysis of data under Routine Analytical Services (RAS) and Special Analytical Services (SAS) requests through the EPA's contract lab program. SAS results often have lower detection limits for the analyzed compounds. Due to laboratory problems, many of the SAS results were rejected or were considered suspect. Accordingly, SAS analytical results are found in the database but many are not reported in Table 3-10. These SAS database records are flagged in the database with a field identifying SAS data. Data confidence was considered higher with RAS data than with SAS data, and only RAS data are reported in Table 3-10. The statistical summary in Appendix 4A which includes DCA results for onpost well 03002 was also only for RAS data.

14. **Department of the Army Specific Comment 9, p. 3-1.**

The first paragraph states that the purpose of the investigation is to "...gather information regarding fate and transport of the volatile organic contaminants..." This raises the issue of the overall objectives of the RI and the definition of the COCs. It is our understanding that an RI should not involve focusing on the basis of RA results.

EPA Response. The document clearly states that "the investigations" refer to activities described in Section 2.0, which includes refining EPA's understanding of the ground water flow systems and the contaminants migrating within it. These are clearly appropriate as objectives for an RI. The other purpose of the investigations, cited in the comment, should have been less specific to include non-halogenated as well as halogenated volatile organic compounds. The previous EPA RI/FS identified volatile organic contaminants in the aquifer, of which one (benzene) is non-halogenated. As listed in Section 1.2.3, all of the COC's are volatile organic compounds.

The RI and RA activities interact in an iterative manner throughout the site characterization process. In fact, the RA is included as a section of the OU2 RI. As stated previously, EPA considers it appropriate to refine data collection activities and site characterization based on the identification of COCs in the RA.

15. **Department of the Army Specific Comment 9a, p. 3-21.**

Figure 3-5 is referenced on this page. All wells identified on the map should be labelled with the well name, otherwise the figure may be useless to the reader not having intimate knowledge of the site.

EPA response. The wells in Figure 3-5 are identified in Figure 2-9, "SACWSD Municipal and Monitoring Wells". Future reproduction of this figure will identify well names.

16. **Department of the Army Specific Comment 9b, p. 3-21.**

It is not clear how the database for constructing the water level maps, Figures 3-7 and 3-8, was developed. The text indicates that measurements were taken between 1986 and 1989 (for the potentiometric surface map). This...may not be appropriate.

EPA Response. The database used for the generation of the potentiometric surface map was discussed in Section 2.6.3, "Water Level Elevation Database". As discussed in Section 2.6.3, all SACWSD and CDM well hydrographs were analyzed to assess the effect of mixing water level data from different years and/or seasons for generating the potentiometric surface map. No annual variation was apparent, and effects of hydrologic features (such as Sand Creek and the SACWSD pumping wells) were considered. Seasonal variation in the aquifer (due to seasonal pumping of the SACWSD wells) was determined to be much more significant than annual variation. The proximity to wells and Sand Creek was considered in the use of all data points. A calculation brief is available in the Administrative Record which presents the rationale for including various wells and the thought process for constructing the potentiometric surface map.

17. **Department of the Army Specific Comment 10, p. 3-22.**

It is not clear why the configuration of the water table as depicted in Figure 3-7 needs to be reinterpreted and why it is to be presented in the FS.

EPA Response. Additional field borings and water level measurements collected by the EPA FIT and by CSC provided additional data in the vicinity of Sand Creek. This data became available too late to be included in maps presented in the CSC OU2 RI report. The new data were presented in a FIT report (FIT, 1990) that is included in the Administrative Record.

18. **Department of the Army Specific Comment 11a, p. 3-23.**

It is not clear if Figure 3-10 was constructed using only the data points shown on the figure. If so, the figure should be modified to permit an assessment of the drawdown off-post of RMA.

EPA Response. Figure 3-10 was modified from the U.S. Army Western Study Area Report, and EPA assumes that the Army used only the data control points shown. EPA inadvertently left out a reference in this figure, and apologizes for this oversight. EPA considers this figure adequate for characterization of the drawdown cone caused by the SACWSD pumping center at East 77th Avenue and Quebec Street due to the higher density of control points On-Post in this area, and the larger number of seasonal measurements taken compared to data available in the off-post area.

19. **Department of the Army Specific Comment 11b, p. 3-23.**

The effects of the Irondale Containment System and SACWSD supply wells are apparently not assessed in the RI. It appears appropriate to consider these influences.

EPA Response. The effects Irondale Containment System and SACWSD supply wells were considered for both the RI and the FS. The Irondale Containment System was mentioned in Section 3.1.2.2, potentiometric surface, and in Section 4.5.1.2. Discharge and recharge at this barrier system was evaluated during the development of the ground water model presented in the FS. The effects of the SACWSD wells on the aquifer were addressed in detail in several sections of the RI, including on page 3-23. It is unclear why the Army considers these as "not assessed".

20. **Department of the Army Specific Comment 12 p. 3-32.**

While it is recognized that the ground water flow velocities are certainly variable within the study area, it is not clear where the assumed values were obtained (e.g. references), nor why those numbers were justified. Additionally, a sensitivity analysis should be conducted to ascertain how much variability would be/could be expected given the uncertainty in parameters. It seems inappropriate to present velocity values to two or three significant figures when the uncertainty could be as much as "...an order of magnitude..." as indicated on page 3-32.

EPA Response. Section 3.1.2.7 is entitled "Ground Water Velocity Estimates" and addresses this topic in detail. This section contains a discussion of how each variable for the calculation of particle velocity was obtained. The values obtained by reference were hydraulic conductivity and effective porosity. The hydraulic conductivity values used were obtained as discussed in Section 3.1.2.6. Numerous literature sources were evaluated for ranges of hydraulic conductivities for lithologies found at the site. For hydraulic conductivity, the references for various lithologies are given in Table 3-4 (Freeze and Cherry (1979), McWhorter and Sunada (1981) and Walton (1984)). Considering the aquifer testing done at or near the site, and the heterogeneities of the alluvial aquifer as discussed in comment and response No. 8, a range of hydraulic conductivities was estimated. An average literature value of 0.25 for sandy unconsolidated deposits was considered a reasonable value for effective porosity. No literature references are deemed necessary for effective porosity as standard hydrogeologic sources give similar estimated values for this parameter.

EPA does agree that a sensitivity analysis is useful to show the possible range of particle velocities at the site. The effects of varied average hydraulic conductivities on particle velocity and travel time were presented, indicating a possible range of travel times from 48th Avenue to the pumping center of 4.8 to 12.1 years. The number of significant figures presented for average flow velocities are in excess of what is warranted by the data used and should be rounded to one significant figure. The range of uncertainty, however, based on the highly uncertain hydraulic conductivity is clearly given.

21. **Department of the Army Specific Comment 13 p. 3-50.**

The text would be improved by the inclusion of a discussion of the data quality objectives, which were apparently developed in the CSC OU2 Work Plan. It would be helpful if the report also discussed why some of the data were not validated and clearly identify what, if any, limitations may be appropriate to the use of the data. Currently it appears that no use-limitations were imposed for non-validated data, except that they were not considered in the RA.

EPA Response. As stated in Section 3.2.4, non-validated data were considered to be DQO Level III, and were acceptable for the preparation of point maps and for all data interpretation. The selection of data to be validated was discussed in the EPA RMA Off-Post RI, and in the CSC OU2 Workplan.

Not all data collected during the CSC OU2 RI were validated because several rounds of sampling and analysis had been conducted during the earlier EPA RMA Off-post RI/FS. It was determined that the data collected during the CSC OU2 RI/FS could be compared to the previous data, which had been validated and to determine whether the data was consistent with previous results for the same wells. Based on EPA DQO guidance, a decision was made that Level IV and V data were required for use in the OU2 RA and hence only validated CLP data were used to assess risk.

22. **Department of the Army Specific Comment 14a p. 4-1.**

The first paragraph indicates that the section provides an interpretation of ground water quality data from the regional database, contained in Appendix 2D; however, much of the data contained in that appendix are not discussed because of the identification of COCs from the RA. The report would be improved if it were modified to include a discussion of non-COC data.

EPA Response. The CSC OU2 RI report presents the results of a focussed investigation and is the culmination of studies conducted since 1984 by EPA and others to evaluate the extent of contamination in the area. Previous reports, including the EPA's RMA Offpost RI (December, 1986) presented and discussed ground water quality results for all detected compounds. As many of the non-volatile organic compounds have been detected at low levels, in sporadic areal distributions and have been found to pose no unacceptable risk to human health or the environment, it was deemed unnecessary to present a discussion of non-COC compounds in the current RI.

23. **Department of the Army Specific Comment 14b p. 4-1.**

Please clarify why the distribution of contaminants in the ground water are discussed relative to Safe Drinking Water Act (SDWA) levels. This seems premature because SDWA may or may not be the selected action level.

EPA Response. SDWA standards are relevant and appropriate requirements for establishing ground-water remediation levels at the site (see U.S. EPA, 1991; U.S. EPA, 1989a). SDWA standards are generally used as ground water remediation levels provided they are cumulative within the risk range. Although these standards may not represent the final remediation level, they provide a preliminary target to focus data collection, identify potentially impacted receptors, characterize the extent of ground-water contamination, initiate the evaluation of remedial alternatives and establish detection limit requirements.

24. **Department of the Army Specific Comment 15 p. 4-6.**

The RI report should present a discussion and show distribution maps for non-COC chemicals to permit a separate assessment of the adequacy of the report and interpretations.

EPA Response. See Specific Comment Response 22.

25. **Department of the Army Specific Comment 16 p. 4-6 to 4-26.**

A limited review of these sections and figures was conducted. In general, it was difficult to assess the distributions because plumes were not presented. Instead, only point plots were included in the report. This significantly increases the level of effort necessary to evaluate the information.

EPA Response. EPA considers the review of the areal distribution of contaminants in the CSC OU2 RI to be adequate for the purposes of the FS. Specific comments regarding areal distributions of contaminants will be reviewed. As CSC OU2 covers a large area with a heterogeneous alluvial aquifer and a limited dataset, it was deemed inappropriate to generate isoconcentration (plume) maps. Point maps show laboratory data in an areal context, and allow the readers to make their own interpretations in defining plume configurations. Plume maps at a small scale (large area) are subject to interpretation and debate. Point maps are not.

26. **Department of the Army Specific Comment 17 p. 4-26.**

The statistical assessment of the relationships between concentration and distance seems questionable. Although high correlation coefficients were derived, the approach followed and the assumptions made in conducting this assessment were not fully presented. Additional backup for the statistical procedures used would improve this report.

For example, the use of a T-test requires certain characteristics of the data set (e.g. normality), but no discussion of this requirement was found in this report.

EPA Response. The linear regression relationships discussed in Section 4.2.9 were undertaken as part of an effort to relate VOC compound concentrations along an assumed ground water flow path. The general form of the linear regression equation given on page 4-32 indicated the transformations and other assumptions applied to the data. The transformed data used in the T-tests generally fit the requirements of normality based on an evaluation of probability plots. Omission of this background information from the text was an oversight.

27. **Department of the Army Specific Comment 18 p. 4-35.**

In general, too little data appears available and too much averaging was conducted to permit much interpretation of the average concentration map. Only three sampling events have been conducted and do not necessarily support a detailed assessment of temporal changes in data, beyond some obvious and dramatic changes.

EPA Response. More than three sampling events were used for the evaluation of time trends, as is apparent in reviewing the time trend plots 4-11a through 4-11h. In addition to data collected by EPA for the EPA RMA Off-Post RI/FS and the CSC OU2 RI/FS, data were also collected by SACWSD, the Army, and EPA FIT. All of these data were used as appropriate. The use of the term "significant" trend was included to mean only obvious or dramatic changes. EPA does not agree with the Army's assertion that too little data appear available and too much averaging was conducted.

28. **Department of the Army Specific Comment 19 p. 4-60.**

The source of PCE in the southeast corner of OU2 may be appropriate for further characterization. Such additional characterization could be conducted in the remedial design/ remedial action (RD/RA) phases of site remediation.

EPA Response. EPA agrees that further characterization of the source of contamination in this area may be necessary during remedial design.

29. **Department of the Army Specific Comment 20, Appendix 2A- FIT Investigation of E 56th Ave and Quebec Street Site.**

This appendix reports on the oversight activities performed by Ecology and Environment, Inc. (E&E) Field Investigation Team (FIT) during drilling and well installation conducted within OU2. The appendix generally only presents how drilling and other field activities were conducted and does not discuss major interpretations of the data, except for a general description of possible paleochannels, no comments have been included.

EPA Response. The investigation of the area near East 56th Ave and Quebec Street by FIT was being conducted concurrent to the writing of the CSC OU2 RI report. Further evaluation of this area may be contained in subsequent FIT reports which are part of the CSC OU2 Administrative Record. EPA utilized and incorporated some of the FIT findings in maps and discussions presented in the CSC OU2 RI and FS reports, including water quality results, boring logs, and saturated thickness maps.

30. **Department of the Army Specific Comment 21,Appendix 2B-Geophysical Investigation Methods and Results.**

This appendix reports on the geophysical investigation conducted by E&E and CDM. It is not clear if additional seismic surveys were conducted as recommended.

EPA response. Depth to bedrock interpretations derived from the geophysical investigations were confirmed by the drilling of several boreholes in this area. No additional seismic surveys were undertaken as part of the OU2 investigations.

31. **Department of the Army Specific Comment 22, Appendix 2C-Borehole Logs and Well Completion Diagrams for CDM-600 Series Wells.**

This appendix appears to be a photocopy of a final report entitled Monitoring Well Installation Report, RMA Off-Post Site, prepared by Geoscience Consultants, Ltd. for CDM dated August 31, 1988. However, appendices identified in the table of contents are not included in this appendix. This appendix was only briefly reviewed because the results section contained only general conclusions and appeared reasonable.

EPA Response. The appendices to the above mentioned report are available for review in the Administrative Record, however they were not deemed necessary for inclusion in the RI.

32. **Department of the Army Specific Comment 22, Appendix 2D-Regional South Adams County Databases, Bedrock Elevation, Water Table Elevation, and Water Quality.**

These data were printed and compared to the list of COCs. As discussed previously, much of the data contained in this appendix were only sparingly discussed and presented in the report. There are detections reported in these databases for chemicals that are not COCs. EPA may want to consider issuing a revised RI/FS report.

EPA Response. Please refer to previous responses regarding COCs. EPA considers the evaluation conducted in the RI as adequate in that it represents continued investigations of a former RI/FS site. EPA does not consider issuing a revised RI/FS report to discuss non-COC compounds to be necessary, given the low concentrations and sporadic occurrences of these compounds.

33. **Department of the Army Specific Comment 23a, Appendix 4A-Summary Statistics of Selected VOCs in Ground Water.**

Statistics, consisting of the number of samples, number of detections, maximum concentration, and arithmetic mean, are presented only for COCs introduced in Section 1.0 of the RI report.

EPA Response. Please refer to previous responses regarding COCs. EPA considers the evaluation conducted in the RI to be adequate.

34. **Department of the Army Specific Comment 23b, Appendix 4A-Summary Statistics of Selected VOCs in Ground Water.**

From a statistical standpoint, the number of samples, which generally appears to be in the range of 1 to 3, seems too few to permit much use of the statistical values. It seems clearly appropriate that the standard deviation of the mean or the variance should also be presented. Further, the method for handling non-detections in the calculations should be discussed. A footnote at the bottom of the Table in Appendix 4A indicates that the method for calculating the sample mean is discussed in the text; however the table of contents does not note a section for discussing statistical calculations and such a discussion could not be located during a reasonable level-of-effort scan of the document.

EPA Response. As both the arithmetic mean and maximum detection were reported, EPA does not consider the variance or standard deviation to be very useful for these summary statistics. This is especially true considering the low number of analyses used (which could result in uncharacteristically large or small variance and standard deviation values that could be misleading), and the use of non-detections in generating the arithmetic mean. The statistics presented in Appendix 4A were from the database used to generate the point maps in the RI, and the methods used in averaging data are discussed in Section 2.6.1, Ground Water Quality Database (pages 2-48 to 2-49). The use of non-detections is also discussed in that section. Appendix 4A is not meant to present a detailed statistical analysis of the data; rather it presents a summary of the contaminant vital statistics as presented in the point concentration maps in Section 4.0 of the RI.

35. **Department of the Army Specific Comment 23c, Appendix 4A-Summary Statistics of Selected VOCs in Ground Water.**

It is not clear why the appendix reports statistics for all COCs between 1986 and 1989, but only considers the 1989 data set for identification of the COCs. This approach to data assessment and COC identification seems inconsistent and modification appears appropriate. For example, if the 1989 data set is considered more representative of current site conditions, then the basis for including the earlier data should be discussed. Additionally, the statistics presented provide little useful information regarding trends in the data, which might allow the adequacy of the 1989 data set, or may indicate that earlier data may need to be considered, and, therefore, additional chemicals might be appropriate for inclusion in the list of COCs.

EPA Response. Comments regarding selection of COCs are considered under Topic II: Risk Assessment (comments 71-82). The data sets from different years actually show very little difference in terms of detected contaminants. As stated before, the data in Appendix 4A summarizes data presented in the point concentration maps. Trends in data, both areally and temporally are discussed in other Sections of the RI.

Appendix 4A-1 was intended to show the variation in contaminant concentration over time, with all results for a given well plotted versus time. The 1989 results were considered the most representative and not highly variable from previous results.

36. **Department of the Army Specific Comment 24, Appendix 4A-1-CSC OU2 1990 Ground Water Data Summary.**

This appendix presents plume maps for five chemicals. It is not clear why only these data were presented, and other data excluded. Additionally it is not clear why the actual data were not presented in the appendix for all chemicals in which analyses were performed. It appears that if plume maps can be prepared and included in this report, that the actual data should also be available and included.

EPA Response. The actual title of this appendix is "CSC OU1 RI/FS 1990 Ground Water Data". This appendix was not meant to provide all OU1 ground water data, but to give the reader a brief overview of OU1 data. The appendix includes the title page from the report from which the plume maps were obtained. The reader can use this reference to obtain more data pertaining to CSC OU1. A more appropriate appendix title could be: "Selected CSC OU1 RI/FS Ground Water Plume Maps".

37. **Department of the Army Specific Comment 25, Appendix 4B-Time Trend Plots for Selected SACWSD Production Wells and Private Domestic Wells.**

Except for a number of the SACWSD production wells, most of the time trend plots have only two data points and provide little useful information. These plots are discussed in Section 4.3.2.1. However, it appears that the plots for the monitoring wells actually are of extremely limited value because the results from only two sampling events were available at the time. A discussion of the significance of these plots starts on page 4-42; however, it appears that the use of these plots for assessing temporal changes or evaluating chemical fingerprinting is extremely limited. With only two data points for most of these wells, it seems inappropriate to draw any conclusions regarding the monitoring well data based on the methods contained in this appendix.

EPA Response. As discussed in Section 4.3.2.1, temporal plots with only two data points were used only to assess gross trends, such as the relative proportions of the volatile chlorinated compounds. These plots are meant to be a visual tool for evaluating the data, and not for statistical analysis of the data. EPA considers these plots useful for evaluating gross trends when comparing them in an areal context. The plots were also used to see if the 1989 data were comparable to previous data and therefore representative for use in the RA.

38. **Department of the Army Specific Comment 26, Appendix 4C-Water Quality Results for Bedrock and Alluvial Well Nests on the RMA and Sand Creek Industrial Site.**

Page 4-52 of the report and the title of the table in the appendix suggests that this appendix contains Denver Formation water quality information. However, the appendix title suggests that alluvial data are also included, while the table title indicates only Denver Fm water quality is included. These inconsistencies should be remedied.

EPA Response. Water quality results from alluvial aquifer completions are included for comparison purposes in this table. The text clearly states, "Contaminant concentrations in SACWSD alluvial wells located nearest some of the bedrock wells are also shown on this table for comparison purposes." The table includes a heading entitled "Aquifer" which identifies the zone that each well was completed in, so no confusion should occur over what data are presented.

39. **Chemical Sales Company (CSC), Specific Comment 1, p. 1.**

Page 1. CSC questions the statement, "OU1 has been identified as a potential source of contamination as a result of both documented and undocumented spills from the chemical storage tanks." This statement has been repeated in the OU2 Feasibility Study. As presented in the OU1 documents, CSC has provided all available information with respect to leaks and spills from its operation. No evidence for "undocumented spills" has ever been discovered, except for the presence of contaminated soil and ground water in OU1. The tank inventories and tank testing conducted as part of the OU1 RI did not support the contention that the CSC tanks were the source of contamination. The documented releases from the Chemical Sales facility are insufficient to explain the extent of contamination in OU1 and OU2. The evidence presented in the OU2 documents in support of contamination extending from the CSC property to East 77th Avenue is hypothetical, and is based on average migration rates and technical assumptions.

EPA Response. The use of the phrase "undocumented spills" was meant to include all activities that could have resulted in ground water contamination at the CSC property. As pointed out by the Interstate Distribution Center Associates (IDCA), a number of releases occurred on the CSC property during the course of the RI which were not documented in the CSC OU1 RI. In addition, the EPA admits that spills could have occurred from other sources than the chemical tanks such as from unloading rail tanker cars. Surfical soil contamination has been detected on the CSC property, unrelated to documented releases, indicating releases of hazardous substances during handling or storage of chemical waste. The State of Colorado has also provided notification under RCRA authority to CSC that the company is inappropriately storing hazardous waste on the site. Based on this information and data collected during the OU1 RI, EPA has determined that releases have occurred on the CSC property which have not been previously documented.

40. **Chemical Sales Company (CSC), Specific Comment 2, p. 8.**

Page 8. CSC objects to the following statements, "Assuming ground water flows at a rate of 5 feet per day, and assuming a travel time of 13 years (based on information that CSC began site operations in 1976), a particle of ground water could have traveled at least 4.5 miles from the CSC site, or to north of East 80th Avenue, to date." and "Based on these conservative flow rates and contaminant migration estimates, the CSC facility could account for contamination at the SACWSD pumping center at East 77th Avenue and Quebec Street." The text should note that an estimate based on these assumptions does not prove, in fact, that CSC is the source. The inherent assumptions, not mentioned in this analysis, are: 1) there is a continuous and downgradient flowpath between the CSC site and East 77th Avenue; 2) the migration rate of 0.58 feet per day for the documented 1985 release of methylene chloride from the CSC site, as discussed in the OU1 RI/FS, the contaminants would only migrate 0.5 mile in the 13 year period. This estimate is based on actual release and plume data, whereas the estimate described in the OU2 RI is based on regional studies performed outside the scope of the OU2 RI/FS. The rate of migration estimated by the OU2 RI is just that rate necessary to link CSC to the contamination at East 77th Avenue.

EPA Response. The use of the word "could" is used to indicate that using conservative assumptions and estimates, the CSC facility could account for at least a portion of ground water contamination at the SACWSD pumping center at East 77th Avenue and Quebec Street. The conservative assumptions included low estimates of hydraulic conductivity, not only from area pump tests but also evaluation of borehole lithologies and literature hydraulic conductivity ranges. The hydraulic conductivities in OU2 are considerably greater than those values derived for OU1 south of East 48th Avenue. The EPA considers the VOC distributions sufficient to establish a link between OU2 ground water contamination and the CSC facility area.

41. **Chemical Sales Company (CSC), Specific Comment 3, p. 1-6.**

Page 1-6. Section 1.2.1.3. states, "The southern portion of the study area contains several truck transport operations and light industrial facilities." Such facilities commonly use solvents such as those contaminating OU2, and often have less stringent handling and disposal procedures than chemical distributors. No evidence is provided to show why these facilities could not be sources of OU2 contamination. EPA should specifically identify these facilities, and investigate the use of compounds of concern at these locations.

EPA Response. No statement was made to conclude that the several truck transport operations and light industrial facilities are not potential sources of ground water contamination. One of these type of facilities may be responsible for the observed PCE Plume in OU2. None of these facilities, however, are believed to contribute to the observed TCE contamination within OU2.

42. **Chemical Sales Company (CSC), Specific Comment 4, p. 1-11.**

Page 1-11, top paragraph. The sentence "Ground water monitoring wells installed on the CSC property have since confirmed CSC as a source of ground water contamination." is misleading in that it implies an incorrect assumption. The ground water results for the CSC property show that the property is contaminated. They do not prove that CSC itself is the source of the groundwater contamination.

EPA Response. The relatively high detections of contaminants of concern in ground water and soil at the CSC property indicate that a source of contamination is on the CSC property. The text, however, does not state that CSC is the only source of contamination in the area. For example, the EPA is aware that a monitoring well upgradient of CSC contains several VOC's, and that contaminated soils and ground water exist on the adjacent IDCA property.

43. **Chemical Sales Company (CSC), Specific Comment 5, p. 1-17.**

Page 1-17, second paragraph. The reference to the "an unidentified solvent" in the CSC underground tank farm is a statement in the OU1 RI/FS work plan. Documents submitted to EPA since that time have identified all tank contents, and EPA has been provided with Material Safety Data Sheets for specific compounds. This statement is misleading because it implies compounds of concern may have been stored underground at the CSC facility. None of the chemicals of concern were stored in the CSC underground tank farm.

EPA Response. EPA acknowledges that contamination on the CSC property might not have originated from CSC's underground tanks. However, it is clear that solvent contamination did occur from the CSC property, regardless of the original source. Records show that the CSC company did distribute several of the COCs, even if none were stored in the underground tank farm. In addition, the State of Colorado under RCRA authority has issued CSC a Notice of Violation regarding the storage of hazardous substances.

44. **Chemical Sales Company (CSC), Specific Comment 6, p. 1-17.**

Page 1-17, last paragraph. The statement, "There have been several reported spills on the CSC property." implies a large number of incidents. It would be more appropriate to state that there have been three reported spills, none of which involved PCE or TCE.

EPA Response. The EPA is aware of at least five releases which have occurred on the CSC property since February 1990, that were not reported in the OU1 RI and may have remained unreported. This number of releases within a one year time period suggests operational practices which, if comparable to past practices, could have potentially resulted in a large number of incidents over time. EPA does agree, however, that it would be more precise to state that there have now been eight documented releases between 1985 and 1991, none of which involved PCE or TCE.

45. **Chemical Sales Company (CSC), Specific Comment 7, p. 1-22.**

Page 1-22, third full paragraph. CSC agrees with the statement, "Current data suggest that the chemicals of concern have entered the ground water at several locations upgradient of OU2 and have migrated in the aqueous phase in the alluvium."

EPA Response. No response is required.

46. **Chemical Sales Company (CSC), Specific Comment 8, p. 3-9.**

Page 3-9, Drilling Near Quebec Street and East 56th Avenue. The text states, "The soil gas survey results were largely inconclusive in that no suspected source was located." However, from Appendix B of Appendix 2A, CSC questions the validity of those results, given the method used. The samples were collected with a split spoon sampler, transferred to sample containers, delivered to the laboratory, and analyzed about one week later. Based on the experience in OU1, the lack of soil detections from these analyses is not surprising. Although CLP holding times were met, the OU1 investigation showed that those holding times are inappropriate, and VOC's are lost during the interim. EPA required CSC to conduct additional soil analyses in OU1 because this method resulted in non-detects. The second set of samples, analyzed within 24 hours, detected high concentrations of VOCs, where none had been detected in previous laboratory analyses. Although the text on page 3.9 notes that the results are inconclusive, CSC does not believe that a source at 56th & Quebec can be ruled out on the basis of these results. The methodology used may explain why no source was determined.

EPA Response. EPA disagrees with this statement. Soil vapor concentrations were analyzed on a daily basis by the FIT Field Analytical Support Program (FASP) laboratory, ensuring that volatile loss was minimal.

47. **Chemical Sales Company (CSC), Specific Comment 9, p. 3-13.**

Page 3-13, middle paragraph. The statement, "Simplified sections E2, E3, and E4 (Figures 3-2c through 3-2e) show a similar trend of decreasing clay and increasing sand from east to west, toward the South Platte River." would indicate that the preferred ground water flow direction would also be east to west along East 56th Avenue. Based on this discussion and these figures, flow from the East 48th Avenue and Monaco area would be toward the northwest, not northeastward toward the bedrock high near East 56th & Quebec.

EPA Response. The direction of ground water flow is not dictated by hydraulic conductivity alone, but by a combination of factors including hydraulic gradient, saturated thickness, and hydraulic conductivity. Ground water flows perpendicular to the potentiometric surface. A detailed evaluation of the potentiometric surface indicates that flow diverges north of the CSC facility in the vicinity of East 58th Avenue, with a portion going to the northwest, and a portion going to the northeast. The Sand Creek oil plume located north of Sand Creek in that area indicates that flow from the CSC facility would be oriented to the northeast, north of Sand Creek.

48. **Chemical Sales Company (CSC), Specific Comment 10, p. 3-18.**

Page 3-18, third paragraph and Figure 3-4. As a general note, it would have been very helpful if all figures had been plotted for the same time interval or if better landmarks had been provided, in order to compare one figure to another. However, comparing Figure 3-4 with Figure 3.7 of the OU1 RI (attached to this report) shows that the paleochannel extending northward from the CSC property corresponds to the paleochannel discussed in this paragraph. This paragraph states, "A second major paleochannel originates near the southwest corner of CSC OU2, near approximately Holly and East 56th Avenue, and trends in a southwest direction south of Sand Creek. The effect of this paleochannel on ground water flow within CSC OU2 is minimal". While agreeing that flow from this channel into OU2 is minimal, CSC believes more should be said. Figure 3-4 actually shows this channel to have two southern tributaries originating near 50th & Ivy and 50th & Holly. The eastern tributary (near 50th & Ivy) matches the paleochannel shown on the OU1 RI Figure 3.7. These two tributaries meet near Sand Creek & Holly, and flow west. The CSC paleochannel is shown on Figure 3-4 to flow north to about East 56th & Holly, then meander southwest to Sand Creek, where it joins the other tributary. Based on Figure 3-4, the contaminant flow from OU1 should flow generally north to near Holly & East 56th Avenue, and then west approximately parallel to East 56th Avenue. This could account for the contaminant patterns in this area, as shown on the maps in Section 4 of the OU2 RI, which show contamination from OU1 migrating to about East 56th Avenue and disappearing. It appears from these that the contaminants from OU1 are following this paleochannel meander.

<u>EPA Response</u>. Though paleochannel features will certainly effect flow, they will not determine the direction of flow.

As previously stated, ground water flows perpendicular to the potentiometric surface. Ground water in the vicinity of East 56th Avenue and Holly does not flow to the west based on evaluation of potentiometric surface maps. EPA does not agree with the conclusion that contamination from OU1 turns to the west in the vicinity of East 56th Avenue and Holly Street, then disappears.

49. **Chemical Sales Company (CSC), Specific Comment 11, p. 3-22.**

Page 3-22. The first paragraph states, "The potentiometric surface map was constructed for a large area and the data point spacing was extremely variable, so confidence in the surface configuration should be directly proportional to data point density. Local variation the potentiometric surface could significantly affect ground water flow." Based on this discussion, and the high density of data points in the area of the OU1 plume, the flow lines on Figure 3-9 may be oversimplified. Although correct in large scale, the pattern made by smaller and more concentrated flow lines in that area show the bulk of the flow from OU1 to be northwestward toward an intersection with the Platte River where the 5080-foot contour crosses the river on Figure 3-9. Such a flow pattern is generally consistent with the paleochannel map (Figure 3-4). It should be noted that this area has the highest density of data points on Figure 3-8, and therefore the greatest interpretive confidence.

EPA Response. Though flow does appear to go to the northeast from the CSC facility to Sand Creek the potentiometric surface map indicates that it arcs to the north-northeast north of Sand Creek. This is supported by a relatively high number of data points. An evaluation of flow lines suggests that by skewing flow either slightly east or west, flow from the CSC could either go to the northwest and out of CSC OU2, or to the northeast and to the

SACWSD pumping center at East 77th Avenue and Quebec Street. It is not inconceivable that flow could vary between these directions with seasonal effects of SACWSD pumping wells. The potentiometric surface was constructed from time periods when the SACWSD pumping wells would have the least effect on ground water flow. A greater curvature of flow towards the wells would be expected later in the pumping season.

50. **Chemical Sales Company (CSC), Specific Comment 12, p. 3-23.**

Page 3-23, second paragraph. This paragraph states, "Flow converges in the vicinity of East 77th Avenue and Quebec Street from the southeast to southwest, because of convergence of paleochannels in this area. Several contaminant plumes also appear to converge in this area, and are discussed in Section 4.0." These several plumes and their sources did not appear to be clearly identified in Section 4, but should be thoroughly investigated by EPA.

EPA Response. Potential contaminant plumes converging at the pumping center at east 77th Avenue and Quebec Street consist of the plume in the vicinity of Holly Avenue suspected of at least partially originating in OU1, the plume in the vicinity of 56th Avenue and Quebec Street, and contamination in the Western Study Area of the RMA. Each of these apparent plumes are discussed in Section 4.0 of the report.

51. **Chemical Sales Company (CSC), Specific Comment 13, p. 3-24.**

Page 3-24, second paragraph. It states, "One unsaturated zone was identified in the vicinity of East 56th Avenue and Quebec Street. This unsaturated zone, located just east of Quebec Street, is potentially important due to the suspected presence of a contaminant source in the vicinity." From this it appears that ground water flow from the OU1 plume is not reaching that area. This would be consistent with the flow direction discussed under the comment to page 3-18.

EPA Response. The comment is noted and no response is required.

52. **Chemical Sales Company (CSC), Specific Comment 14, p. 3-31.**

Page 3-31. It is stated on this page, "Table 3-4 presents hydraulic conductivities obtained from various studies conducted in the area and from values cited in the literature that might be expected based on the lithologic units present.", and "Three zones were selected to initially represent the hydraulic conductivities of the saturated alluvial lithologies contained in the CSC OU2 study area for the ground water model (Table 3-4)." Given the heterogeneity of the alluvial aquifer and the generic value of these hydraulic conductivities, CSC questions the accuracy of the contaminant migration rate based on these values, especially for the purpose of implicating CSC in the contaminant plume that extends to East 77th Avenue.

EPA Response. Hydraulic conductivities are inherently variable in a heterogeneous aquifer, therefore a conservative range of values was used in transport calculations. The hydraulic conductivity values used in the models were all based on site-specific aquifer pumping test results conducted in the region and on numerical modeling calibration and sensitivity analyses.

53. **Chemical Sales Company (CSC), Specific Comment 15, p. 3-31.**

Page 3-31, third full paragraph. "Slug tests conducted as part of the CSC OU2 RI effort on several wells in the CDM 600-well series proved to be inconclusive. Hydraulic conductivities ranged from 7 to 44 feet/day (Appendix 2E).

These are one to three orders of magnitude lower than hydraulic conductivities derived from other studies conducted in the area, and are not thought to reflect actual field conditions. Instead, they appear to be measurements of the permeability of the sand pack placed in the screened intervals of the wells." It is unclear why the values from previous investigations summarized on Table 3-5 (ranging from 310 ft/day to 5,626 ft/day) should be more conclusive than the specific tests conducted as part of the OU2 investigation (ranging from 7 ft/day to 44 ft/day). It should be noted that the discounted results all show significantly lower hydraulic conductivities than those used to make the contaminant travel time estimates from the CSC property. CSC could not find an adequate discussion of the reasons for discounting the slug test results, or why the sand pack should have a much lower hydraulic conductivity than the geologic formation. Normally, the opposite is the case. If the slug test values are used in the travel time estimates a totally different picture would emerge, relative to contaminant migration from the CSC property.

EPA Response. Slug tests are inherently less accurate than the results presented in Table 3-5, which are of pump tests using observation wells conducted in or adjacent to CSC OU2. Slug tests can give lower hydraulic conductivities than the actual aquifer hydraulic conductivity due to the order-of-magnitude accuracies typical of such tests. EPA agrees that the sand pack may not have a lower hydraulic conductivity than the aquifer although this potential exists. Based on evaluation of pump tests in the area, borehole lithologies, and literature ranges of hydraulic conductivities for selected lithologies, EPA considers the slug test-derived hydraulic conductivity values to be lower than actual aquifer hydraulic conductivities.

54. **Chemical Sales Company (CSC), Specific Comment 16, p. 3-35.**

Page 3-35, Section 3.1.2.8. This section states "Despite previous studies indicating that ground water from OU1 flows beneath Sand Creek (CDM 1988b), the results of the ground water surface water interaction study described in Section 2.3.3 were largely inconclusive." Page 3-36 states "An apparent net increase in flow was observed in Sand Creek between the upstream and downstream locations." However the increase was determined to be not statistically significant. This seems to leave open the possibility that OU1 contamination is migrating into Sand Creek instead of into OU2. It seems that this issue, which was a major contention of the HRS score, remains unresolved.

EPA Response. EPA agrees that a undetectable amount of the contamination from OU1 may be entering Sand Creek (Sand Creek Industrial RI/FS, 1988) during certain portions of the year. Most of the VOC contamination, however, does continue across Sand Creek. This interpretation is based on the detection of contaminants related to releases from the CSC facility in monitoring wells located near the south and north banks of Sand Creek.

55. **Chemical Sales Company (CSC), Specific Comment 17, p. 3-36.**

Page 3-36, second paragraph. "Transmissivities derived from slug tests showed a range of 3.4×10^{-4} to 5.1×10^{-2} ft^2/sec. The large range in values indicates considerable heterogeneity of the alluvial sediments." Two things are apparent from these sentences. First, these slug test results do not appear to be as "inconclusive" here as was indicated earlier in the document (see comment to page 3-31). Second, the considerable heterogeneity of the alluvium places serious limitations on use of one average hydraulic conductivity to estimate travel time from the CSC property to East 77th Avenue.

EPA Response. EPA agrees that these statements appear to be inconsistent with a previous statement that the slug test results were inconclusive. The slug test results discussed on page 3-36 are of piezometers installed as part of the surface water-ground water interaction study, and are different from slug test results discussed as inconclusive on page 3-31. EPA maintains that the slug tests conducted on monitoring wells within OU2 and discussed on page 3-31 were indeed inconclusive, and therefore the given transmissivity values are of limited use. EPA considered aquifer heterogeneity in transport calculations, and a range of results was given based on the uncertainty of hydraulic conductivity in the aquifer.

56. **Chemical Sales Company (CSC), Specific Comment 18, p. 4-4.**

Page 4-4. This entire discussion presents the limits on the amount of natural biodegradation that is taking place in OU1 or OU2. This consistent with our interpretation.

EPA Response. No response required.

57. **Chemical Sales Company (CSC), Specific Comment 19, p. 4-10.**

Page 4-10, fourth full paragraph. It states "It is difficult to determine whether the 10 μg/L concentration at 64th and Monaco is related to high concentrations of PCE just north of Sand Creek (from OU1) or whether it is related to the PCE plume apparently emanating from the vicinity of 56th Avenue and Quebec Street." CSC believes the 10 ppb detection of PCE near 64th & Monaco can be directly attributed to the source near 56th & Quebec. The PCE concentrations migrating into OU2 from OU1 clearly decrease to less than MCL a short distance north of Sand Creek, and several monitoring points directly between 64th & Monaco and the OU1 plume show decreased concentrations. On the other hand, 64th & Monaco is clearly downgradient from the 56th & Quebec source, with two points between showing similar concentrations (8.5 and 9.3 ppb). It is apparent from this that the PCE concentrations throughout most of OU2 can be related to a source near 56th & Quebec, with a possible secondary source near 64th & Quebec.

EPA Response. EPA does not fully agree with CSC's assertion that contamination from OU1 clearly decreases to below MCL north of Sand Creek. The elevated concentration near East 64th and Monaco could be indicative of an earlier pulse of contamination that has migrated downgradient to the north. Though EPA does agree that at least part of the PCE contamination at the pumping center at East 77th Avenue and Quebec Street is believed to come from the vicinity of East 56th Avenue and Quebec Street, EPA also concludes that a portion of the PCE contamination at the pumping center could be attributable to OU1 contamination.

58. **Chemical Sales Company (CSC), Specific Comment 20, p. 4-11.**

Page 4-11, third paragraph. We do not understand the last sentence in this paragraph, which states, "These data confirm the PCE distribution just described, indicating the plume is slightly more extensive." More extensive than what? The same comment applies to Section 4.2.2.2 on page 4-13, and throughout this section.

EPA Response. EPA agrees that this sentence is unclear. Review of the previous paragraphs show that the sentence is stating that PCE contamination in OU1 was slightly more extensive in 1990 data than in 1989 data.

59. **Chemical Sales Company (CSC), Specific Comment 21, p. 4-12.**

Page 4-12, last sentence. This sentence says, "The location of the TCE contamination is consistent with a source of TCE in OU1, the paleochannels, and ground water flow directions." CSC disagrees with this interpretation, and believes it is unreasonable to attribute the prevalent TCE contamination throughout OU2 to the OU1 plume. Such an interpretation fails to explain how the TCE concentration can increase from 14 ppb at 56th & Monaco to 43 and 53 ppb near 64th & Monaco. The PCE/TCE pattern for OU2 differs considerably from that in OU1. The TCE pattern is consistent with a source near East 56th & Quebec. The prevalent TCE contamination may also be associated with the general use of the compound by the types of industries located within OU2. The EPA interpretation is not consistent with the gradient and paleochannel flow paths, which would indicate the OU1 plume would migrate northwest toward the Platte River, as discussed earlier in this report. Comparing Figure 4-2b with Figure 3-4 shows the TCE plume somewhat west of the paleochannel but directly downgradient of East 56th & Quebec, with a bedrock ridge between this plume and the OU1 plume.

EPA Response. Though EPA agrees that other minor sources of TCE contamination could exist in OU2, the continuity of contamination from OU1 into OU2 is apparent. As discussed in the RI, the decreasing ratio of PCE to TCE can be explained by the higher retardation of PCE. The apparent decrease in TCE concentration between East 56th Avenue and East 64th Avenue can be explained by the data gap discussed in the response to Comment 57 above. The direction of flow was discussed in the response to Comment 49 above.

60. **Chemical Sales Company (CSC), Specific Comment 22, Figure 4-2b.**

Figure 4-2b. From this map there appear to be three distinct sources of TCE: (1) the OU1 plume which extends about 2,000 to 3,000 feet into the southern portion of OU2; (2) an apparent source in the 64th & Monaco area extends to about East 77th Avenue; and (3) a third source appears to be at about East 64th Avenue east of Quebec.

EPA Response. EPA disagrees with this interpretation. Concentration levels and distribution of contaminants detected in the vicinity of 64th and Monaco are consistent with the ground-water contaminants emanating from the CSC facility. Although contaminant concentrations of TCE increase north of 56th and Monaco, these increases are considered to be relatively small and are most likely related to variations within the alluvial ground-water system.

61. **Chemical Sales Company (CSC), Specific Comment 23, p. 4-27.**

Figure 4-27, top paragraph. The statement, "Figures 4-2b and 4-8b suggest a contaminant plume which trends approximately perpendicular to the potentiometric surface contour lines from near the CSC property to at least as far north as the East 77th Avenue SACWSD municipal pumping center." is misleading, and gives the impression that CSC was responsible for all of the contamination in OU2. It would be more correct to state that there are at least three contaminant plumes extending from near the CSC property to East 77th Avenue. Figures 4b and 8b suggest that the OU1 plume ends near East 56th Avenue, as discussed earlier. The main paleochannel, which is admittedly "approximately" perpendicular to the potentiometric surface lines in that area, is not aligned with the gradient in the area of the OU1 plume.

EPA Response. As stated, "It should be noted that this flowpath was selected only for purposes of evaluating fate processes and relationships amongst the COCs." EPA reads no preconceived interpretation in this methodology. The purpose of this evaluation was to assess the transport and fate of contaminants migrating from OU1 into OU2. EPA RI/FS guidance emphasizes the importance of assessing the interaction between various operable units within a given site. Results of this assessment indicate that ground-water contamination associated with releases in the vicinity of the CSC facility appeared to have migrated northward into OU2 and, given the limited areal data, appear to be a likely source of TCE and other select compounds which have had an impact on the SACWSD supply wells. The flowline used was believed to approximate a continuous path. This analysis showed no data to contradict this interpretation.

62. **Chemical Sales Company (CSC), Specific Comment 24, p. 4-27.**

Page 4-27, middle paragraph. The sentences, "The flowpath selected for this evaluation extends from the CSC property (well ES-MW-06) north to the SACWSD municipal pumping center at East 77th Avenue and Pontiac Street (wells SAC-02 and SAC-03). It should be noted that this flowpath was selected only for purposes of evaluating fate processes and relationships amongst the COCs." suggest a preconceived interpretation based on certain assumptions, rather than an unbiased scientific analysis. It is not stated that this flow path may, in fact, be discontinuous. This assumed flowpath is presented in a manner that leads the reader to believe such a flowpath does actually exist.

EPA Response. The EPA feels that the flowpath selected for the subject evaluation is a continuous flowpath.

63. **Chemical Sales Company (CSC), Specific Comment 25, Page 4-28.**

Page 4-28, top paragraph. "The ethanes (TCA and DCA) and benzene were not included on these plots in order to express more clearly the evident relationships due to biodegration." This concept of biodegration should be more fully explained in light of the limited conditions of the aquifer to support biodegration, as discussed in Section 4.1.2.1. CSC is not convinced that significant biodegration is occurring in OU1 or OU2.

EPA Response. EPA believes that biodegradation was sufficiently discussed in the RI. The anaerobic dehalogenation of the chlorinated solvents could play an important role in fate and transport of contaminants in ground water in OU2. Though most of the aquifer is believed to be aerobic, localized anaerobic zones could cause dehalogenation transformations. Detection of vinyl chloride in the OU1 and OU2 alluvial aquifer indicate that certain portions of the aquifer are under anaerobic conditions.

64. **Chemical Sales Company (CSC), Specific Comment 26, Section 4.3.2.1.**

Section 4.3.2.1 Although this section is interesting, it really does not determine anything of significance. It implies that CSC could have caused the OU2 contamination, but also states that it could be caused by other sources. This is clear form the last two sentences in this section, "The changes in contaminant proportions moving downgradient from the CSC facility can be explained by fate processes such as adsorption, biodegradation, and for TCA, hydrolysis. This does not discount the possibility of additional sources in the area, however." In fact, the greater rate of attenuation downgradient would seem to argue against the higher concentrations near 56th & Quebec being related to the OU1 plume.

EPA Response. This section is not meant to "determine anything of significance", but to present the data in such a way that readers can draw their own conclusions. EPA has previously stated that contaminants at East 56th Avenue and Quebec Street are probably unrelated to the OU1 plume.

65. **Chemical Sales Company (CSC), Specific Comment 27, p. 4-59.**

Page 4-59, Section 4.5.1.3. From the statement, "CSC is an unlikely source of ground water contamination detected near East 56th Avenue and Quebec Street, since that area is located cross gradient from the CSC property." it appears that EPA agrees with our interpretation that a source exists near East 56th Avenue & Quebec.

EPA Response. No response required.

66. **Chemical Sales Company (CSC), Specific Comment 28, p. 4-60.**

Page 4-60, third paragraph. "The drilling results showed that the area just southeast of the intersection of 56th Avenue and Quebec Street (DEOC area) is generally unsaturated. This indicates that the source area may be to the southwest of the intersection of 56th Avenue and Quebec Street, and not from either the DEOC or the DBMC." It is unclear why DEOC or DBMC cannot be sources just because the alluvium beneath those sites is unsaturated. Contaminants could have flowed downgradient through unsaturated materials to ground water, especially in view of the statement, "The FIT investigation determined that both facilities used products containing PCE." EPA seems to have assumed that the contamination had to be associated with ground water from an upgradient source.

EPA Response. The statement that the area was unsaturated is meant to indicate that localized high bedrock elevations in the area have no saturated alluvium on top. In such cases, dense non-aqueous phase liquid (DNAPL) transport of the contaminants of concern in this area would be required for the contaminants to reach the adjacent saturated zones. EPA has seen no evidence of DNAPLs in this area, however this possibility cannot be entirely discounted. EPA does not assume that contamination had to be associated with ground water from an upgradient source. EPA will consider further evaluation to locate the source of this contamination.

67. **Chemical Sales Company (CSC), Specific Comment 29, p. 4-60.**

Page 4-60, Section 4.5.2. CSC fails to see the point of the last sentence on this page, "None of these other potential source areas have shown concentrations in ground water comparable to those concentrations detected at the CSC facility." This statement implies that any area having lower contaminant concentrations than CSC cannot be a source.

EPA Response. The statement in question does not imply that there are no other sources of contamination than the CSC facility. It states the fact that no ground water analyses in OU2 have shown contaminant concentration of the same order of magnitude as at the CSC facility.

68. **Chemical Sales Company (CSC), Specific Comment 30, p. 4-62.**

4-62, last paragraph. The theory of clay sorbing and desorbing, stated as "Organic contaminants which entered the ground water at an upgradient location may have sorbed onto the clayey materials in the vicinity of East 62nd Avenue and Monaco Street, and may now be desorbing into the ground water, resulting in the observed contamination." seems to be stretching a point. A separate source in this area would appear to be a more reasonable interpretation. The evidence discussed in this paragraph appears to strongly support such an interpretation, without resorting to the clay hypothesis. Although CSC acknowledges the hypothesis that clays can act essentially as capacitors for organic compounds, it is difficult to imagine contaminants desorbing at such concentrations as are found in that area. This theory also fails to explain why clay in this area should behave in this manner, when such behavior is not observed in similar clays elsewhere in OU1 and OU2.

EPA Response. As previously stated, a separate source, though possible, is not necessary to explain contamination found in the vicinity of East 62nd Avenue and Monaco Street due to the data gap in that area. The "clay hypothesis" was used to explain the possibility of increased anaerobic dehalogenation, as a clay rich environment could be oxygen depleted, and adsorption could facilitate anaerobic dehalogenation transformations. Localized higher organic contents could also contribute to localized anaerobic zones. A combination of adsorption, desorption, and biotransformations could reasonably explain the contaminant distributions found in this area. The subject text also suggests the possibility of separate sources.

69. **Chemical Sales Company (CSC), Specific Comment 31, p. 6-1.**

Page 6-1. Although the second conclusion is true, the statement is misleading. It states "Concentrations of chemicals of concern in wells upgradient (to the south and generally east) of OU2 are higher than concentrations in wells within OU2." This again implies that CSC is one (south) source of OU2 contamination, simply because that property has higher contaminant concentrations.

EPA Response. The CSC facility is upgradient of OU2 and has ground water contamination of up to three orders of magnitude higher than any contamination found in OU2. As flow path analysis and contaminant distributions indicate, the CSC facility is a major source of ground water contamination in OU2. EPA considers discussion of other potential source areas affecting OU2 to be adequate.

70. **Chemical Sales Company (CSC), Specific Comment 32, p. 6-2.**

Page 6-2, item 7. This states "The Chemical Sales Company property appears to be a major source of contaminants affecting ground water quality in the southern portion of CSC OU2." All other possible sources are qualified, and it is unclear why CSC was not, especially since the OU2 study did not include investigation of the CSC property. However, it could follow from this that CSC is not a major source of contamination elsewhere in OU2. It would be more correct to state that OU1 appears to be a source of contaminants in the southwestern portion of OU2.

EPA Response. Based on analysis of the areal extent of contaminants and ground water flow, EPA considers the CSC facility to be a significant source of ground water contamination in OU2.

TOPIC III: RISK ASSESSMENT

71. **Department of the Army, Appendix 5 - Risk Assessment, Section 4, Page 4-1.**

This comments requests justification for use of validated data in risk assessment (RA) and use of both validated and nonvalidated data in the Remedial Investigation (RI). Use of RAS data for Case 1 and SAS data for Case 2 is also questioned.

EPA Response. As discussed in Risk Assessment Guidance for Superfund (USEPA, 1989b) and Guidance for Data Useability in Risk Assessment (USEPA, 1990), the use of validated data is preferred for quantitative risk assessment wherever possible. Due to the generally low and sporadic extent of ground water contamination in OU2, as well as budgetary and time constraints, only a necessary portion of the environmental sampling data were validated. Validation efforts were primarily directed at the samples indicating the highest concentrations, which resulted in protective estimates of ground water concentrations. This protective approach is appropriate for the size of the operable unit and the wide range in contaminant concentrations.

Both validated and unvalidated data were used for the RI to provide a thorough characterization of the extent of contamination, and because data quality objectives are less stringent for the RI than for the RA.

The RAS data for OU2 were selected for use rather than the SAS data because of laboratory difficulties with sample quantitation limits when SAS methods were used, particularly in the case of vinyl chloride. Nevertheless, the SAS data were used for the special instance of Case 2, where the closest well to the contaminant ground water plume was identified for the purpose of evaluating current potential health risks from a nearby, untreated well. In this case, the SAS data were the most recent data available and most appropriate for the specific objectives of this risk assessment.

72. **Department of the Army, Appendix 5 - Risk Assessment, Section 4, Page 4-3.**

Justification is requested for use of a 10% detection frequency rather than 5% to select potential chemicals of concern (COCs).

EPA Response. Although a 5% detection level is recommended by RAGS, this recommendation allows for professional judgment and modification for specific sites and conditions. In the case of OU2, several years of sampling information have consistently detected the chemicals selected as COCs. Other chemicals have been sporadically detected at low concentrations in these sampling efforts, but clearly the eight COCs selected for OU2 are representative of historical and current site contamination. Furthermore, the chemicals detected at 5-10%, even if they were included in the RA, would have only a marginal effect on the magnitude of potential health risks at the site.

73. **Department of the Army, Appendix 5 - Risk Assessment, Section 4, Page 4-4.**

This comment questions the validity of excluding xylene and chloromethane from the COC list on the basis of them being laboratory contaminants.

EPA Response. Both xylene and chloromethane were detected in blanks, so for this site these two chemicals were considered laboratory contaminants. As mentioned previously, the inclusion of these chemicals as COCs would have no significant impact on the potential health risks calculated at the site.

The "most recent guidance from EPA" reference is to Risk Assessment Guidance for Superfund (RAGS) EPA 540/1-89/002 (USEPA, 1989b).

74. **Department of the Army, Appendix 5 - Risk Assessment, Section 5, Page 5-1.**

This comment requests further discussion of soil gas survey results. Further explanation of the statement "no basement exposure model has been validated with empirical data" on p. 5-10 is also requested.

EPA Response. Soil gas surveying was carefully considered for OU2. A soil gas survey was never actually performed at OU2, because, based upon experience gained from OU1, ground water concentrations were judged to be too low to produce significant soil gas concentrations.

The statement regarding exposure models and empirical data was true at the time that the RA was prepared. Since that time, basement exposure models have been developed for radon at Oak Ridge and Lawrence Berkeley Laboratories. However, it is still true that no basement exposure models based on empirical data have been validated for VOCs.

75. **Department of the Army, Appendix 5 - Risk Assessment, Section 5, Page 5-2.**

This comment requests justification of the exposure point concentrations used for Case 1.

EPA Response. The exposure point concentrations for Case 1 were developed to obtain an RME for OU2. The area showed wide temporal and spatial variations in COC presence and concentration. No single collection of well data appeared to provide a reasonable maximum exposure to all COCs. Furthermore, ground water modeling data were not available to predict future concentrations at specific receptor points within the OU2 area. In order to develop an RME, the highest 3-5 validated values from the 1989 sampling round were used to calculate reasonable maximum exposure point concentrations. The maximum values were used without regard to their location or presence with other COCs. This is a protective but reasonable assumption; the area under consideration is large and ground water migration parameters are not fully understood. The selection of 3-5 values was a professional judgment based on the pattern of the data and the size of the validated database. If non-detects were included, the averages or 95% confidence limits would have yielded lower values than this method. Because so few data points were available, no statistical treatment of the data is warranted.

76. **Department of the Army, Appendix 5 - Risk Assessment, Section 5, Page 5-4.**

This comment questions the use of estimated data over nonestimated data for Case 1 exposure point concentration calculations.

EPA Response. Only validated data were used in the RA.

77. **Department of the Army, Appendix 5 - Risk Assessment, Section 5, Page 5-5.**

Clarification is requested regarding whether water from SAC-18 is always or usually blended with treated water.

EPA Response. Water from SAC-18 is always blended with treated water. The statement that SAC-18 water is usually blended with treated water is not correct.

78. **Department of the Army, Appendix 5 - Risk Assessment, Section 5, Page 5-8.**

This comment questions how a value for S (indoor VOC generation rate) is obtained for use in the shower exposure formula.

EPA Response. The formula for calculation of S is described in the work by Foster and Chrostowski (Foster & Chrostowski, 1987).

79. **Department of the Army, Appendix 5 - Risk Assessment, Section 5, Page 5-15.**

This comment addresses VOC inhalation in basements and questions whether this has been addressed.

EPA Response. Basement VOC exposure was not evaluated in OU2 for two reasons; 1) a validated basement exposure model was not available at the time the risk assessment was prepared, and 2) ground water concentrations were so low within OU2 that the contribution of the basement exposure pathway was judged to not contribute significantly to the overall risks at the site. Such potential risks will be reevaluated during the 5-year review to ensure that the selected remedies are protective.

80. **Department of the Army, Appendix 5 - Risk Assessment, Section 6, Page 6-2.**

This comment asks for an explanation of why the oral slope factor was used to calculate inhalation exposure risks when this is inconsistent with EPA guidance (RAGS).

EPA Response. The toxicity assessment was prepared in consultation with USEPA Region VIII toxicologists and USEPA Environmental Criteria Assessment Office, Cincinnati, OH (ECAO). ECAO recommended the cancer slope factors used in the risk assessment because information for the inhalation pathway was not available.

81. **Department of the Army, Appendix 5 - Risk Assessment, Section 6, Page 6-8.**

This comment questions the applicability of oral reference doses for calculating noncarinogenic inhalation risks.

EPA Response. The oral reference doses for PCE, DCE, and 1,2-DCE were used to calculate inhalation hazard indices. This is a reasonable assumption based on the toxicology of the chemicals involved. Since the lung is not the target organ, pharmacodynamics are unlikely to cause a shift in target organ, and there is no reason to believe that toxification or detoxification mechanisms are substantially different as a function of the exposure route.

82. **Department of the Army, Appendix 5 - Risk Assessment, Section 8, Page 8-1.**

The decision not to validate all data, particularly those for vinyl chloride is questioned.

EPA Response. There was no compelling reason to validate the nondetect samples. Due to the method used to derive the maximum exposure point concentrations, (hypothetical well scenario), additional validation would only have lowered the maximum concentrations calculated and thus produced a less conservative scenario. Although there is uncertainty associated with the hypothetical well approach, it is nevertheless a reasonable surrogate for a maximum exposure point concentration.

TOPIC IV: FEASIBILITY STUDY

83. **SACWSD Comment #1**

This comment notes that trichlorofluoromethane (TCFM) has been detected at a maximum concentration of 3.2 ug/l in SACWSD Shallow Wells 3 and 14, and Monitoring Well 5, beginning in 1990. The comment also states that an MCL does not exist for TCFM, so an action level should be developed based on health risks. Two action levels, based on EPA documents, are presented (0.14 ug/l and 2000 ug/l) and EPA is requested to identify the appropriate concentration to use as a clean up level at the Klein Water Treatment Facility (KWTF). Because TCFM is poorly adsorbed by carbon, SACWSD is concerned that a need to remove TCFM at the KWTF will dramatically increase carbon usage. SACWSD then suggests that a program be initiated to establish funding, design, and construction criteria for the addition of air strippers to the KWTF to remove weakly adsorbed compounds such as TCFM and vinyl chloride.

EPA Response. The acceptable level for TCFM is 2000 ug/l, in accordance with the EPA health advisory, published in November, 1990 (USEPA, 1990b). This action level should not adversely affect carbon usage at KWTF. A program to install air strippers will be undertaken if continued monitoring indicates that such equipment is needed, as was provided for in the 1987 EPA ROD.

84. **SACWSD Comment #2**

The average concentrations of 1,1-DCE, 1,2-DCE, and 1,1-DCA recorded in the KWTF influent during 1990 and 1991 ranged between 1-3 ug/l, 1-7 ug/l and 1-7 ug/l, respectively. On page 1-15, the report states that "1,2-DCE may be a useful indicator in predicting VC generation within CSC-OU2". The document should be revised to state that 1,1-DCE, 1,2-DCE and 1,1-DCA may all be useful indicators in predicting VC generation within CSC-OU2 since, as correctly shown on page 1-18, all three chemicals can potentially biodegrade into vinyl chloride.

EPA Response. As stated on page 1-16 of the report, 1,2-DCE is the primary parent compound of vinyl chloride. The diagram on page 1-18 was configured to indicate that 1,2-DCE is the most likely precursor to vinyl chloride. 1,1-DCA is not likely to degrade to vinyl chloride because it would require creation of a double bond between the carbons where only a single bond exists in 1,1-DCA.

85. **SACWSD Comment #3:**

This comment focuses on the PCE source near 56th Avenue and Quebec Street and the source's potential impacts on the KWTF. Concern is expressed that the source is not identified and characterized, and that existing TCE and PCE plumes will continue to degrade into 1,1-DCE, 1,2-DCE, and 1,1-DCA. Because these compounds are only weakly adsorbed by carbon, SACWSD is again concerned that the carbon usage rate at the KWTF will exceed the planned usage rate and thereby drive up operating costs for the plant. It is stated that the report should address provision for additional funding of KWTF if changing aquifer conditions cause operating costs to increase. The possible need for air stripping towers at KWTF to remove vinyl chloride is again presented and identification of a funding mechanism for this addition is requested.

EPA Response. It is true that the actual source of the PCE plume at 56th Avenue and Quebec Street has not been identified. As stated in the report, in March and April of 1990 a FIT investigation was undertaken upgradient of the plume in an attempt to identify the source. This investigation included a soil gas survey (49 samples) ground water sampling (3 wells), and soil borings (3 borings). Although the source was not identified, concentrations of PCE in SACWSD Monitoring Well 08 have shown a slight decreasing trend and the source has been assumed to be a degrading source. Plume monitoring will continue and EPA will make further attempts to identify the source, as possible.

The purpose of the remedial activities in CSC OU2 is to remove as much contamination from the aquifer as is practical. The concern that existing TCE and PCE plumes will degrade into 1,2-DCE, 1,1-DCE and 1,1-DCA and consequently overburden the KWTF is based on the assumption that the pump and treat system will be located at 56th Avenue and Quebec Street. As noted in the description of Alternative 2 (see pages 4-7, 5-10, and 5-11), the actual location and configuration of the extraction system will be determined during remedial design. The system will be designed to capture as much of the existing plume as possible. Some possible design schemes that will be considered include locating the system north of 56th Avenue (near the leading edge of the plume), or installing the extraction and injection wells in a line down the center of the plume. By maximizing plume capture, the amount of contamination remaining in the aquifer is minimized and future loading on the KWTF will remain near expected levels. If continued monitoring indicates that need for air strippers at KWTF, funding will be obtained at that time.

86. **SACWSD Comment #4**
Department of the Army, Specific Comment Page 3-3
Department of the Army, Specific Comment Page 3-4
Department of the Army, Specific Comment Page 5-6
Department of the Army, OU3 General Comment 1
Department of the Army, OU3 Specific Comment, Section 4.2

These comments address SACWSD supply Well 18. SACWSD points out that the maximum measured TCE concentration in Well 18 as presented in the report is incorrect and that water from Well 18 should be treated to allow efficient use of water resources in the CSC OU2 area.

The Army suggests that a remedial alternative addressing VOC contamination in Well 18 is needed. Concerns are raised that portions of the PCE and TCE plumes that are downgradient of the SACWSD pumping center at 77th Avenue and Quebec Street are not addressed.

EPA Response. Based on additional information submitted to EPA by SACWSD during the public comment period, levels of TCE have been detected in Well 18 and are higher than those used in the RI/FS. EPA will evaluate additional information and, if necessary, identify alternatives to address contamination associated with Well 18 in a separate action. One of the alternatives will likely include connecting Well 18 to the KWTF to ensure that residents are provided with water suitable for domestic uses (i.e. showering and drinking). Funding of projects is not a topic that is addressed by an RI/FS. EPA will work with appropriate parties to ensure that funding is available for remedial activities.

87. **SACWSD Comment #5**

The report indicates that it will take 20-30 years for the proposed remedy to remove the bulk of the PCE. The report should therefore address and resolve the O & M funding deficiency that will occur if the proposed remedies for whatever reason fail to prevent substantial additional influent concentrations of PCE and related compounds at KWTF beyond what was contemplated in the 1987 SS/PSA as a basis for estimating long-term O & M costs.

EPA Response. Funding of projects is not a topic that is addressed by the Record of Decision. EPA will be happy to discuss this topic in a different forum.

The proposed pump and treat system is intended specifically to reduce the amount of PCE in the aquifer upgradient of the KWTF and will be designed to meet this objective. It is anticipated that the pump and treat system will operate for approximately 20 to 30 years and during that time will reduce the amount of contamination reaching the KWTF from this portion of the aquifer. Continued monitoring will indicate if the system is operating satisfactorily. Remedial actions are re-evaluated every five years and modifications to improve system performance can be made at those times, if needed. Installation and operation of the pump and treat system should ensure that carbon usage at KWTF is not adversely affected.

88. **SACWSD Comment #6**

Based on the District's understanding that Alternative 2 is the most feasible plan, the District remains concerned that the implementation of the alternative be thoroughly investigated, discussed, and coordinated with the District. The primary issue to be considered is that the alternative not affect the District's water rights. Specific design issues include the location and scheduling of the extraction and injection wells with respect to the location and scheduling of the District's supply wells, changes in water quality due to treatment that may affect the aquifer's geochemistry and hydraulic properties, and the methods to be used for the long-term monitoring and evaluation of impacts on the District's ground water supply.

EPA Response. It is EPA's intention to work closely with SACWSD during design and implementation of this remedial action so that the municipal water supply and distribution are not adversely impacted. It is also realized that SACWSD has an extensive working knowledge of this aquifer and may provide valuable input during design and implementation of this remedial action.

89. **Department of the Army, General Comment 4**
Department of the Army, General Comment 8
Department of the Army, Specific Comment Page 4-2
Department of the Army, Specific Comment Page 4-10

These comments discuss the need for additional remedial alternatives for treating the TCE plume. Specifically, the following options were suggested: (1) no action, (2) partial containment with limited extraction, (3) partial containment with enhanced extraction, (4) plume capture with extraction, and (5) plume capture with enhanced extraction. Concerns are raised that the SACWSD wells are not located advantageously for extraction of contaminated ground water.

EPA Response. Plume remediation at the CSC OU2 site has been adequately addressed by the alternatives presented in the FS. Twelve remedial alternatives were evaluated in the CSC OU1 and OU2 FSs to address the TCE ground-water contamination. These alternatives represent a wide range of hazardous waste management strategies including no action (Alternative 1), partial containment and limited extraction (Alternative 2 - OU1 FS), partial containment with enhanced extraction (Alternatives 3, 4, and 5 - OU1 FS), plume capture with extraction (Alternative 4 and 5 - OU2 FS), and plume capture with enhanced extraction (Alternatives 3, 4, 5 - OU1 FS, combined with Alternative 5 - OU2 FS). These alternatives meet NCP requirements cited in 40 CFR Section 300.430(e)(4).

Ground water extraction is most effectively accomplished in regions of high ground water flow because these areas accommodate the bulk of the ground water that is moving through the aquifer. Plume movement is most pronounced in these areas, therefore, these are the areas that would be targeted for a pump and treat system to maximize the remedial effect. These are also the areas that are targeted for water supply wells to ensure that water is available to meet customer demand. In both cases, extraction well locations are chosen for the same reason (high ground water flow) but for different purposes (aquifer remediation versus municipal water supply). SACWSD supply wells are currently located in areas of high flow and, as stated in the FS report, it would be difficult to design a system to do a better job of extracting contaminated water than the SACWSD wells are currently doing. EPA agrees that it was incorrect to have stated that KWTF was constructed for the purpose of remediating the aquifer. The statement would have been correct if it had stated that the SACWSD wells feeding the KWTF are located advantageously for aquifer remediation.

TCE plume remediation was addressed in the OU1 and OU2 FSs through the evaluation of twelve alternatives. As shown in Figure 1-10 of the FS, the only part of the TCE plume that was not addressed by a pro-active treatment system is the small portion of the plume north of the SACWSD pumping center at 77th Avenue and Quebec Street and south of 80th Avenue. In addition, low concentrations (below action levels) of TCE have been detected north of 80th Avenue as is shown on the TCE point map (Figure 1-9 of the FS). The plume is quite dispersed north of the extraction wells at 77th Avenue and would therefore require an extensive (and correspondingly expensive) extraction and injection system to provide significant TCE removal.

Development of an alternative to treat the limited northern portion of the TCE plume, such as a pump and treat system along 80th Avenue, was not considered to be appropriate because of the high cost and minimal benefits of such a system. A qualitative discussion of why this alternative was not developed is presented below and is based on the nine criteria used in the detailed screening of alternatives.

Treatment of the TCE plume north of 77th Avenue would be protective of human health and the environment, although it would not improve protection of human health beyond the protection offered by the other alternatives developed for the FS. Human health is protected by operation of the KWTF and by activities planned for CSC OU3 remediation. The environment would also be protected to the same extent as it is under the alternatives presented in the FS, although restoration of the aquifer would occur somewhat sooner with additional treatment.

An additional TCE treatment system would be subject to the same ARARs as the other alternatives presented in the FS.

The long-term effectiveness and permanence of additional TCE treatment would be the same as other alternatives presented in the FS. Use of the KWTF will treat the bulk of the TCE plume. The small amount of TCE remaining north of the pumping center is estimated by modeling to reach action levels in approximately 30 years through natural processes. During the recovery period, the water will not be used for domestic purposes unless it is extracted and distributed by the SACWSD system. Water supplied by SACWSD is carefully monitored and managed to ensure that it is in compliance with drinking water quality standards before it is distributed. An additional TCE treatment system would not change the long-term effect of using natural processes and SACWSD wells and the KWTF to remove contaminants from the aquifer; it would, however, accelerate the process. EPA will collect additional groundwater monitoring data for the duration of RD/RA activities and if necessary, identify and evaluate alternatives to address the remaining TCE plume in a separate action. Since any future receptors will be protected through either the OU3 remedy or separate, future actions, there is no advantage to speeding up the remediation.

The toxicity, mobility, and volume of contamination in the aquifer would be reduced slightly by the addition of a TCE treatment system. However, as noted by EPA (U.S. EPA, 1989c), as ground water plumes become more dilute, contaminant removal systems become less successful. Because the TCE plume north of 77th Avenue is dilute, the total mass of contamination removed would be a smaller percentage of the plume than where a plume is more concentrated.

The short-term effectiveness of an additional TCE treatment system would be the same as for the alternatives presented in the FS. Any receptors of contaminated ground water will be protected by either the OU3 remedy or by separate future actions. The aquifer would be remediated more quickly with the additional TCE treatment, but there would be no tangible benefit to accelerating the clean-up.

An additional treatment system would be implementable from a technical as well as an administrative standpoint. However, the larger the system, the more difficult it is to implement, technically and administratively. A system to capture the entire dilute TCE plume at about 80th Avenue would have to be approximately one-half to one mile wide. Acquisition of access to many private properties for the location of the numerous extraction wells, and the extensive piping and pumping that would be required, would increase the difficulty of implementation.

The cost to install such a TCE treatment system was not determined. However, because of the width of the TCE plume, the extraction system (e.g., row of pumping wells), would have to be three to four times as long as the proposed PCE treatment system. The costs would escalate roughly proportionately. As noted above, the benefit of treating the entire TCE plume, in terms of mass of contamination removed and additional protection of public health, would not be significant.

The final two criteria, state acceptance and community acceptance, are expected to be similar to acceptance of the proposed PCE treatment system.

Based on all of the considerations noted above, an alternative to capture the northern fringe of the TCE plume was not considered to be appropriate and was not developed.

EPA will collect additional groundwater monitoring data for the duration of CSC OU2 RD/RA activities and if necessary, will address the remaining plume in a separate action.

90. **Department of the Army, General Comment 5**
Department of the Army, General Comment 6

These comments address the level of detail presented in the FS report. Costing information during the preliminary screening of alternatives and the extent of system design for the detailed screening of alternatives are specifically cited as needing more development.

EPA Response. The FS was written to be consistent with EPA guidance (Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA; USEPA, 1988). Costing for the preliminary screening of alternatives is only developed in enough detail to allow relative comparison between alternatives. At this stage an alternative would only be screened out based on cost if the other two screening criteria (effectiveness and implementability) are equal for the alternatives being considered. The cost criterion was used to eliminate Alternative 3 during the preliminary screening of alternatives. In a similar manner, the level of detail developed for the remedial alternatives was sufficient to choose an appropriate remedial action.

91. **Department of the Army, General Comment 9**
Department of the Army, Specific Comment Page 1-15

These comments raise concerns about the interaction between the alluvial aquifer and the bedrock aquifer. The Army feels that the potential impact on the alluvial system from pumping SACWSD bedrock wells has not been adequately addressed and the conclusion that the vertical gradient between these units varies from upward to downward across the site is questioned.

EPA Response. The SACWSD bedrock wells are all completed in either the Arapahoe or the Laramie-Fox Hills formations; none are completed in the Denver formation. The Denver formation, which has been observed to be made up primarily of shale, acts as a confining layer between the alluvium and the Arapaho and Laramie-Fox Hills formations. Therefore, pumping the SACWSD bedrock wells at the current pumping rate is not expected to impact the alluvial aquifer, and contamination in the alluvial aquifer will not be pulled downward into the bedrock as a result of this pumping.

92. **Department of the Army, Specific Comment Page ES-3**

This comment questions whether the annual monitoring included in the no action alternative is sufficient to track contaminant movement and possible impacts on the SACWSD system.

EPA Response. Annual monitoring conducted by EPA and ongoing SACWSD monitoring of supply wells on a quarterly basis will be sufficient to track contaminant movement. SACWSD conducts a separate, on-going monitoring program of water supply wells to track contamination in the aquifer and the potential impact on the supply system. This program will be continued to ensure that the supply system is in compliance with drinking water standards. SACWSD provides EPA with all acquired data.

93. **Department of the Army, Specific Comment Page 3-2.**

This comment points out that the PCE source near 56th Avenue and Quebec Street has not been identified, but that an assumption has been made that contamination will not enter the CSC OU2 site from CSC OU1. The validity of this assumption is questioned.

EPA Response. EPA has attempted to identify the source of the PCE plume but has not been successful to date. Further attempts to locate the source will be undertaken if continued monitoring indicates that the source is not a degrading source, as has been assumed. EPA has determined that the PCE plume does not originate in OU1. EPA has selected Alternative 5 of the OU1 FS. Successful performance of this alternative will assure that contamination from OU1 will not impact OU2.

The assumption that contamination will not migrate northward from CSC OU1 into CSC OU2 addresses the TCE, rather than the PCE plume. This assumption is based on the remedial activities planned for the CSC OU1 site, which include a pump and treat system at the boundary between CSC OU1 and CSC OU2. It is assumed that this system will be effective in removing TCE from the aquifer before it enters CSC OU2.

94. **Department of the Army, Specific Comment Page 5-6.**

Please explain how Figures 5-1 and 5-2 are appropriate in comparison to Figures 1-10 and 1-11 in assessing the plumes

predicted by the model versus the actual plumes present since the time frames are different.

EPA Response. Figures 5-1 and 5-2 were incorrectly chosen in the FS report. A better comparison can be made between Figures 1-10 and A-3a (in Appendix B) and Figures 1-11 and A-5a (in Appendix B).

95. **Department of the Army, Specific Comment Page 6-11.**

This comment requests clarification of EPA's policy regarding attenuation processes versus pro-active capture actions with respect to dilute contaminant plumes downgradient of source-removal activities. Alternative 2, PCE Plume Treatment with Hydraulic Containment and Standard Pumping of SACWSD Wells, is specifically cited as relying on natural attenuation and degradation to remediate portions of the TCE and PCE plumes that are beyond the influence of the planned remedial activities.

EPA Response. EPA's policy is to act quickly to treat as much of the plume as possible. Alternative 2 includes remediation of the PCE plume that enters CSC OU2 near 56th Avenue and Quebec Street before the plume becomes dispersed. Reliance on the SACWSD extraction wells to capture contamination downgradient of the PCE treatment system is a pro-active approach to plume capture at this site. A more aggressive approach, increased pumping of the SACWSD system, was also considered but was determined to be detrimental to the SACWSD supply system. The alternatives that included the more aggressive use of the SACWSD wells were screened out on both technical and administrative implementability. Standard pumping of the SACWSD wells was therefore determined to be the most active, but still feasible, approach to aquifer remediation.

TOPIC V: FS MODELING REPORT

96. **Department of the Army, Specific Comment, Page 6**
Department of the Army, Specific Comment, Page 9, First Paragraph
Department of the Army, Specific Comment, Page 9, First Paragraph
Department of the Army, Specific Comment, Page 10
Department of the Army, Specific Comment, Page 17
Department of the Army, Specific Comment, Page 29 and 30

These comments raise concerns regarding the lack of model calibration and use of the model in transient, rather than steady state mode. It is stated repeatedly that the model should have been calibrated, regardless of the lack of data in some areas of the aquifer. It is felt that without proper calibration the model did not properly simulate phenomena such as flow rates and capture zones. In addition, the decision to run the model in transient mode is questioned because it is felt that the aquifer generally responds to pumping as a confined system with storativities that are orders of magnitude less than the 0.25 that was used in this study.

EPA Response. The objective of the modeling effort must be kept in mind. The model was developed to provide a basis for comparing the effectiveness of the remedial alternatives developed in the FS. In accordance with this approach, modeling results were not used to exactly determine aquifer characteristics at some future time, but rather to evaluate the relative effectiveness of the alternatives in general terms. For example, one alternative appeared to remediate the aquifer more quickly than others, or one alternative removed a greater quantity of contamination from the aquifer than others. Total remediation times for the alternatives were based on model results, but as stated in the text, these times were considered to be rough estimates. Given the intended purpose of the model, the fact that it is not calibrated does not detrimentally affect the results.

In response to concerns that the model should have been run in steady state mode, it should be noted that initial attempts to run the model were done in steady state mode. The model was equilibrated in steady state mode, a process in which piezometric head values are assigned to the nodes along the perimeter of the model area and the model then generates head values at the internal nodes. Considerable effort was then expended in an attempt to calibrate the model. As a result of this effort it was found that unacceptably large mass balance errors were generated in the process. At that point it was decided that it would be more appropriate to run the model in transient mode rather than steady state. This was appropriate because steady state mode most closely models a confined aquifer with correspondingly low specific yield, while transient mode most closely models an unconfined aquifer with higher specific yield. The aquifer in CSC OU2 is an unconfined aquifer and in addition is subject to extreme pumping particularly in the summer. It is felt that these considerations justify running the model in transient mode. While running the model in this mode it was found that it took at least 12 to 15 years to reach steady state.

Two other ground water modeling studies were cited in the comments as examples of similar models being run in steady state model. The referenced report by Ebasco (Ebasco, 1989) was not reviewed. The referenced report by Morrison-Knudson Engineers (MKE, 1989) stated that their model, which included the western tier of RMA, was run in steady state mode, however, it did not include pumping effects of either the SACWSD extraction wells or the Irondale Boundary System (IBS) wells. These pumping activities were later imposed on the model to determine their effects on flow paths near the IBS. In contrast, the CSC OU2 model included pumping effects in the baseline scenario.

One final point that should be made regarding the MKE model is that the aquifer <u>was</u> modeled as an unconfined system (contrary to statements made in the comments pertaining to pages 6 and 17). Results from this study that most closely modeled actual conditions in the aquifer were obtained when specific yields of 0.2 to 0.3 were used (MKE, 1989, pp 67-69). Specific yields in this range correspond to unconfined aquifers and are in agreement with the value of 0.25 that was used in the CSC OU2 model.

97. **Department of the Army, Specific Comment Page 9, last paragraph**
Department of the Army, Specific Comment Page 9, last paragraph

These questions address the TCE contaminant distribution in CSC OU2. It is stated that the TCE distribution can be partially explained by ground water moving northward under Sand Creek. Vertical variations in permeability are not considered to adequately explain the TCE plume being oriented obliquely to the ground water level contours. It is also stated that vertical variations in hydraulic conductivity can be accounted for in a two-dimensional model through vertical averaging.

EPA Response. EPA agrees that the water table map indicates that ground water moves northward under Sand Creek. However, in the area north of the creek, it is maintained that vertical variations in permeability are the most likely cause of contaminant transport in a more northerly direction than the hydraulic gradient. Vertical averaging is not an acceptable method to represent vertical variation in permeability because a layer of very high permeability, such as a gravel channel, will provide a nearly unobstructed pathway for contaminated ground water to flow. In this case, flow volume and direction will most closely be determined by the highly permeable channel, not by a hypothetical channel of averaged permeability. Evidence of a gravel bed at the base of the aquifer has been found in other parts of the aquifer, such as north of the SACWSD pumping center at 77th Avenue and Quebec Street. It is likely that similar conditions exist in the aquifer just north of Sand Creek, and that these conditions cause the TCE to migrate in a northerly direction.

98. **Department of the Army, Specific Comment, Page 11, Table A-1**
Department of the Army, Specific Comment, Page 22

These comments are primarily concerned with the source loading rates for TCE and PCE. The equations used to arrive at the source loading rates are questioned, as well as discharge at the gravel pits and the units on the TCE and PCE distribution coefficients.

EPA Response. For the purposes of the modeling effort, the TCE and PCE sources were modeled as water sources that contained an elevated concentration of either TCE or PCE. The concentration of TCE and PCE in their respective sources was assumed to be approximately equal to the maximum concentration that has been detected in the aquifer for each contaminant between 11/85 and 11/89. The source loading rate, i.e., the rate at which the contaminated water was injected into the aquifer, was calculated from a simple mass balance. First, the total mass of TCE and PCE present in the aquifer was calculated. Second, the number of years that the sources were active was estimated, based on historical data. Finally, the rate at which the contaminant sources had to be injected was calculated based on the total mass of TCE and PCE in the aquifer, the assumed source concentrations, and the period of time they were active. The equations on page 20 and 23 characterize this approach although the rate equation on page 22 became disarranged during production of the report. The equation should read:

$$RATE = \frac{TOTKG}{TIMYR\ (SECPYR)} \cdot \frac{(10^6 ug/kg)}{CONC_s\ (3.79\ L/gal)(7.48\ gal/Ft^3)}$$

Regarding discharge to the gravel pits, it may be true that locally the aquifer discharges to the pits, however, the general trend is for recharge. In order to simplify the model it was assumed that the pits recharge the aquifer through the length of the canal.

The TCE and PCE distribution coefficients have units of milliliters per gram (ml/g).

99. **Department of the Army, Specific Comment, Page 13**

This comment states that a native recharge rate of 1.48 inches/year appears to be too high and a recharge rate of 0.25 inches/year is suggested. The appropriateness of the EPA HELP model to predict the recharge rate is questioned.

EPA Response. The EPA feels that the recharge rate of 1.48 inches/year is appropriate. This value was predicted by the HELP model and is in close agreement with the 1.54 inches/year used by Konikow (Konikow, 1977).

100. **Department of the Army, Specific Comment, Page 14**

This comment states that while the longitudinal dispersivity is in agreement with Konikow's value, the transverse dispersivity is much less than that used by Konikow.

EPA Response. In the data set that is distributed with MOC, Konikow makes it clear that DLTRAT = 0.30, where DLTRAT is the ratio of transverse to longitudinal dispersivity. This data set was developed by Konikow (Knoikow, 1977) for the adjacent Rocky Mountain Arsenal and was considered to be appropriate for CSC OU2.

101. **Department of the Army, Specific Comment, Page 15**

"The units of the Kd values are not given."

EPA Response. The units of Kd are milliliters per gram (ml/g).

102. **Department of the Army, Specific Comment, Page 19**

This comment states that initial contaminant distributions can be input directly into the MOC model and that this would have been a more accurate approach than the one that was taken. Concern is also expressed that the study was determentally affected by the fact that the source areas for the plumes may not lie within the model boundaries.

EPA Response. A sincere effort was made to insert initial contaminant concentrations into the MOC model. The model was tested using this approach and it was found that the model tried to maintain the concentrations at these nodes as background contamination, and the mass of the contaminant increased over time, resulting in a large error. At that point it was decided that a source loading rate would be a more appropriate approach. The equations on pages 20-23 were used to calculate realistic injection rates.

It is agreed that uncertainties regarding source location and characteristics add to the uncertainty of the results, however, the purpose of the model should be remembered. This model was developed to allow comparison of the effectiveness of the remedial alternatives; it was not intended to be a detailed, calibrated, regional ground water model.

103. **Department of the Army, Specific Comment, Page 23**

Concerns regarding the relationship between desorption times and hydraulic conductivity are raised. It is felt that this topic was not adequately discussed in the text.

EPA Response. Zones of low hydraulic conductivity are associated with longer desorption times for both of the reasons noted in the comment. Organic content is usually higher in zones of low conductivity than in zones of high conductivity, resulting in greater adsorption of organic contaminants. This prolongs the desorption process because of the large mass of contaminants that are adsorbed and because of their affinity for organic material.

The same effect can be seen from a mass flow perspective. Areas of low hydraulic conductivity tend to have a large proportion of dead pore space than areas of high hydraulic conductivity. Contaminants then enter dead pore space by diffusion and then adsorb and desorb to the surrounding matrix. Once the contaminants diffuse into the dead pore spaces they must also exit by diffusion. This is a slower process than that occurring in the open pore spaces where contaminants that have desorbed then migrate as a result of advection rather than diffusion.

104. **Department of the Army, Specific Comment, Page 24**

Clarification of the term "interior nodes" and the assignment of fixed heads to these nodes is requested.

EPA Response. The interior nodes referred to in the text are the nodes immediately interior to the nodes that run along the boundaries of the modeled area (the outside nodes). The MOC model requires that all outside nodes are no flow boundaries. The nodes just interior to these outside nodes were used to set the boundary conditions, which included assigning fixed heads.

TOPIC VI: ARARS

105. **Colorado Department of Health, Comment #1**
Colorado Department of Health, Comment #3

These comments cite regulations and standards that were omitted from the RI/FS reports. These are:

- o Colorado Air Quality Regulations 1, 2, and 3.
- o Regulations for the State Discharge Permit, 5 CCR 1002-2, 6.1.0.

EPA Response. EPA concurs with these comments. The regulations and standards have been added to the ARARs section in the Record of Decision.

106. **Colorado Department of Health, Comment #2**

This comment states that Practical Quantification Limits are not state standards and, therefore, are not ARARs.

EPA Response. EPA concurs with this comment.

Topic VII: OPERABLE UNIT 3

107. **Colorado Department of Health Disease Control Environmental Epidemiology Division (DCEED), Comment #1**
Colorado Department of Health (DCEED), Comment #3
Colorado Department of Health (DCEED), Comment #5

DCEED recommended a door-to-door survey within CSC OU2 to identify all residences where exposure might occur and that additional efforts be made to communicate risk concerns to site residents.

EPA Response. EPA will determine whether any additional survey is required during Remedial Design. EPA will consult with DCEED before any decision is finalized. The appropriateness of connecting businesses will also be determined at this time. EPA agrees that a substantial effort should be made to communicate potential risks to site residents during RD/RA for OU3.

108. **Colorado Department of Health (DCEED), Comment #4.**

DCEED requested clarification regarding whether residents outside the current CSC boundary are covered in the OU3 proposed plan and recommended that if possible, residences outside the current CSC boundary should be connected to SACWSD.

EPA Response: The Site boundaries of CSC OU2 and OU3 are defined by the areal extent of ground-water contamination. If ground contaminants continue to migrate northward, the boundaries of the Site will correspondingly expand. EPA agrees that, if practicable, residences with contamination should be connected to the SACWSD system. Installation of carbon treatment units was included in the OU3 ROD to ensure protection of residences in rural areas where connection to system is not practicable.

109. **Colorado Department of Health (DCEED), Comment #6**
Colorado Department of Health (DCEED), Comment #7

DCEED requested clarification regarding the inclusion of provisions prohibiting the installation of alluvial wells.

EPA Response: As part of the OU3 remedy, individuals requesting well permits to install alluvial aquifer wells within the CSC Site will be notified by the State Engineers Office of potential health risks related to use of the contaminated ground water. Due to water rights considerations, EPA determined that prohibiting use of domestic alluvial wells was not appropriate for CSC OU3 since EPA does not have authority to approve well use permits.

110. **Colorado Department of Health (DCEED), Comment #8**

DCEED requested information regarding a plan to treat vinyl chloride if it is detected at the KWTF.

EPA Response: If vinyl chloride is detected at the KWTF, the air stripping will be used to treat this contaminant. This provision is documented in the EPA Off-Post Arsenal, Operable Unit 1, Record of Decision.

111. **Department of Army, General Comment #2**

This comment states that residents not presently hooked up to the SACWSD municipal water supply and using alluvial wells should be provided an alternative water supply in the interim period before the remedy is implemented.

<u>EPA Response:</u> It is unnecessary to provide an alternative water supply for residents not presently hooked up to the SACWSD municipal water supply and using alluvial wells during the interim period before the remedy is implemented. The risks associated with this contaminated ground water are based on chronic, long term exposure. EPA expects to complete this remedy within 1 year of signing this ROD. Exposure to contaminated ground water during this time period will not significantly increase the risks.

112. **Department of Army, Specific Comment Section 2.0, Page 9**
Department of Army, Specific Comment Page 12-13
Department of Army, Section 5.2

These comments address the CDH/TCH well survey. It was requested that an explanation concerning (1) why residents on systems were not included in developing the list of people potentially at risk, (2) why potentially affected residents were included in this list and (3) the inconsistencies between Figures 2 and 3 in the OU3 FS and Figures 1-10 and 1-11 in the OU2 FS.

<u>EPA Response:</u> Potentially exposed residents were identified based on a list of those residents who are connected to the SACWSD sewage system but not to the SACWSD water system. EPA will evaluate the adequacy of this survey during OU3 Remedial Design. Since ground-water contamination is actively migrating, it is necessary to include potentially affected residents to be connected to the SACWSD system. Figures 2 and 3 in the OU3 FS are based on Figures 1-10 and

1-11 in the OU2 FS. Figure 1-11 of the OU2 FS speculates that PCE contamination from the CSC plume may commingle with the PCE plume. This speculation was not depicted in Figure 3 of the OU3 FS.

113. **Department of Army, Specific Comment Section 5.2**

This comment requests clarification of EPA's position on presenting all potentially applicable technologies (drilling of deep wells) in the first level of screening in an FS. In addition, the comment stated that it is inappropriate to select an alternative that does not protect public health without accounting for exposure to contaminants outside the current Site boundaries.

EPA Response: All potentially applicable technologies should be considered for the first level screening of an FS. Drilling of deep wells was not considered to be potentially applicable due to concerns associated with cross contamination. CSC Site boundaries are based on the areal extent of ground-water contamination. If contaminated ground water continues to migrate to the north, the Site boundaries will correspondingly expand. Residents will be prevented from exposure to contaminated ground water even though they may be located outside the current Site boundaries since these boundaries are dependant on the areal extent of contamination.

References

Camp, Dresser and McKee (CDM), 1988. Remedial Investigation and Site Characterization Report, Sand Creek Industrial Site. Commerce City, Colorado. March 4, 1988. Document No. 203-RI1-RT-ESDW-1.

FIT, 1990. Ecology and Environment, Inc. Report of Sampling Activities, Denver Engineering and Operations Center (Chemical Sales, Operable Unit 2). Field Investigation Team Zone II. EPA ID COD007431620. May, 1990.

Foster, S.A. and P.C. Chrostowski, 1987. Inhalation Exposure to Volatile Organic Contaminants in the Shower. Presentation at the 80th Annual Meeting of the Air Pollution control Association, June 21-26, 1987. New York, N.Y.

Freeze, R.A., and J.A. Cherry, 1979. Ground Water. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

Konikow, L.F., 1977. "Modeling Chloride Movement in the Alluvial Aquifer at the Rocky Mountain Arsenal, Colorado." U.S. Geological Survey Water-Supply Paper 2044, 43 pp.

McWhorter, David B., and D.K. Sunada, 1981. Ground-Water Hydrology and Hydraulics, Water Resources Publications. Ft. Collins, Colorado.

Morrison-Knudsen Engineers, Inc. (MKE), 1989. Impacts of Municipal Well-Field Development on the Operation of the Irondale boundary System at the Rocky Mountain Arsenal. Draft Report. Project 1680, WP-15593. March 7, 1989. RT SHELL 4834.

United States Environmental Protection Agency (U.S. EPA), 1991. "Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions." OSWER Directive 9355.0-30, April 22, 1991.

U.S. EPA 1990a. Guidance for Data Useability in Risk Assessment. Interim Final. OERR Directive: 9285.7-05, October 1990. EPA/540/G-90/008.

U.S. EPA, 1990b. Drinking Water Regulations and Health Advisories. Office of Drinking Water. November 1990.

U.S. EPA, 1989a. "ARARs Questions and Answers." OERR Fact Sheet 9234.2, May, 1989.

U.S. EPA, 1989b. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Interim Final. OERR. December 1989. EPA/540/1-89/002.

U.S. EPA, 1989c. Considerations in Ground Water Remediation at Superfund Sites. OSWER Directive 9355.4-03. October, 1989.

U.S. EPA, 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. LSWER Directive 9355.3-01, October, 1988. EPA/540/G-89/004.

U.S. EPA, 1986. Remedial Investigation for the First Operable Unit, Rocky Mountain Arsenal Off-Post RI/FS Site. December 1986. Document No. 198-RI1-RT-DRLM-1.

Walton, William C. 1984. Practical Aspects of Ground Water Modeling, NWWA.

COLORADO
DEPARTMENT
OF HEALTH

ROY ROMER
Governor

JOEL KOHN
Interim Executive Director

Grand Junction Regional Office
222 S. 6th Street, Room 232
Grand Junction, Colorado 81501-2768

Telefax Number:
(303) 248-7198

June 25, 1991

Mr. James J. 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 Units 2 and 3 - Records of Decision

Dear Mr. Scherer:

The State of Colorado concurs with the Records of Decision (RODs) for Operable Units 2 and 3 of Chemical Sales. However, 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.

We would like to congratulate EPA on the speedy and competent manner in which the RI/FSs and RODs 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.

Sincerely,

Tom Looby

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