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March 1999

EPA Superfund
Record of Decision:

Indian Bend
Washington Area OU 3
Scottsdale, AZ
9/30/1998

RECORD OF DECISION

VOCs in Groundwater
OPERABLE UNIT

Indian Bend Wash Superfund Site, South Area
Tempe, Arizona

U.S. Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, California 94105

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September 1998

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Acronyms and Abbreviations

μg/L	micrograms per liter
A&Ww	aquatic and wildlife (warm water fishery) (water quality criteria for the State of Arizona)
ADEQ	Arizona Department of Environmental Quality
ADOT	Arizona Department of Transportation
ADWR	Arizona Department of Water Resources
APS Octotillo Power Plant	Arizona Public Service Ocotillo Power Plant
ARAR	applicable or relevant and appropriate requirement
ASU	Arizona State University
AT	averaging time
bgs	below ground surface
BW	body weight
C_a	chemical concentration in air
C_w	chemical concentration in water
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended
CFR	Code of Federal Regulations
COC	chemical of concern
COPC	chemical of potential concern
COT	City of Tempe
DC	dual-cast
DCE	dichloroethene
DNAPL	dense nonaqueous-phasee liquid
DO	dissolved oxygen
EC	electrical conductivity
ED	exposure duration
EF	exposure frequency

EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Differences
FS	Feasibility Study
ft/day	feet per day
ft/ft	foot per foot
ft^2/day	square feet per day
GRA	General Response Action
HBGL	Human Health-Based Guidance Levels
HDPE	high-density polyethelyne
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HQ	hazard quotient
IBW-North	Indian Bend Wash Superfund Site-North Area
IBW-South	Indian Bend Wash Superfund Site-South Area
ILCR	increased lifetime cancer risk
Inw	daily water ingestion rate
Ir_a	daily inhalation rate
IRI	Interim Remedial Investigation
IRIS	Integrated Risk Information Service
kg	kilogram
K_p	dermal permeability coefficient
LAU	Lower Alluvial Unit
LGAC	liquid-phase granular activated carbon
m^3/day	cubic meters per day
MAU	Middle Alluvial Unit
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goals
mg/kg-day	milligrams per kilogram per day
mg/L	milligrams per liter
mgd	million gallons per day

MNA	monitored natural attenuation
MTBE	methyl tertiary butyl ether
MW	Monitoring Well
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
O&M	operation and maintenance
OSWER	EPA's Office of Solid Waste and Emergency Response
OU	Operable Unit
PCE	perchloroethene (tetrachloroethene)
ppb	parts per billion
PRG	Preliminary Remediation Goal
PRP	potentially responsible party
QA	quality assurance
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act, 42 USC Sec. 6901, et seq., as amended
RD	Remedial Design
RD/RA	Remedial Design/Remedial Action
RfD	reference dose
RI	Remedial Investigation
RI/FS	Remedial Investigation/ Feasibility Study
RME	reasonable maximum exposure
ROD	Record of Decision
SA	exposed skin surface area
SARA	Superfund Amendments and Reauthorization Act of 1986
SDWA	Safe Drinking Water Act
SRP	Salt River Project
SVE	soil vapor extraction
TBC	to be considered
TCA	trichloroethane
TCE	trichloroethene

TOC	total organic carbon
UAU	Upper Alluvial Unit
UIC	underground injection control
USDW	underground sources of drinking water
VGAC	vapor-phase granular activated carbon
VOC	volatile organic compound

I. DECLARATION

I. Declaration

1. Site Name and Location

This Record of Decision (ROD) is for the Indian Bend Wash Superfund Site, South Area (IBW-South), located in the City of Tempe and Maricopa County, Arizona.

2. Statement of Basis and Purpose

This ROD presents the selected remedial action for volatile organic compounds (VOCs) in groundwater at IBW-South 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, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan, (NCP). The decision in this ROD is based on the Administrative Record for this site.

The U.S. Environmental Protection Agency (EPA) has already addressed VOC contamination in the vadose zone for the soil operable unit (OU) at IBW-South in a ROD issued September 1993. This ROD and the September 1993 ROD constitute the overall final remedy for VOCs in groundwater at the IBW-South Site.

The State of Arizona, acting by and through its Department of Environmental Quality (ADEQ), concurs with the remedy selected in this document.

3. Assessment of the Site

Releases of VOCs, e.g., common industrial solvents such as trichloroethene (TCE), perchloroethene (PCE), and 1,1,1-trichloroethane (1,1,1-TCA), from several individual facilities have contaminated the groundwater at IBW-South. Actual or threatened releases of hazardous substances at or from this site, if not addressed by implementing the response actions selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

IBW-South contains multiple, distinct facilities that are releasing or that have released VOCs into groundwater. VOCs were originally detected in groundwater production wells in the Tempe area in 1982. Since then, EPA has detected VOCs in groundwater production and monitoring wells and in soil at individual properties within the study area. This contamination has moved downward through the soil above the water table and reached groundwater. City of Tempe public water supply wells exist within and surrounding the IBW-South site; however, City of Tempe (City) residents currently receive water from surface-water supplies, not from City of Tempe wells with contaminated groundwater in the IBW-South area. Nonetheless, contamination in the groundwater represents loss of a groundwater resource that is considered a future source of drinking water by the State of Arizona and the City of Tempe. The City has expressed the desire that the groundwater be restored.

4. Description of the Selected Remedy

This ROD presents EPA's remedy and contingency remedy for groundwater. A remedy for the Operable Unit for VOCs in Soils was established in a 1993 ROD. This ROD addresses the Groundwater Operable Unit. Together the 1993 ROD and this ROD form the remedy for VOC contamination at IBW-South.

The Selected Remedy

This remedy addresses VOC contamination in groundwater at IBW-South through the following actions:

- Extraction of the western Upper Alluvial Unit (UAU) area of VOC-contaminated groundwater to attain aquifer cleanup standards and hydraulic containment of the contaminated areas to inhibit both lateral and vertical migration.
- Treatment of extracted water to performance standards using liquid granular activated carbon (LGAC), air stripping with vapor granular activated carbon (VGAC), or ultraviolet light oxidation (UV/Ox)
- Discharge of treated groundwater to the City of Tempe storm drain system leading to Town Lake, the Salt River Project's (SRP) Tempe Canal No. 6, or reinjection.[1]
- Monitored natural attenuation (MNA) of the central and eastern UAU areas of VOC-contaminated groundwater and the Middle Alluvial Unit (MAU) areas of VOC-contaminated groundwater to attain aquifer cleanup standards within those areas, and to prevent migration of groundwater contaminated above the aquifer cleanup standards to and beyond the compliance boundaries established in this ROD.
- The establishment of compliance boundaries for those areas where the MNA remedy is selected. The compliance boundaries represent borders beyond which VOC-contaminated groundwater above aquifer cleanup standards will not be allowed to migrate. The compliance boundary for the central and eastern UAU areas of contamination is located approximately 2,000 feet south of Broadway Road, bounded by Price Road to the east and Dorsey Lane to the west. Sentinel wells will be located in the UAU upgradient of the UAU compliance boundary in an area bounded by Broadway Road to the north, approximately 1,000 feet south of Broadway Road to the south, approximately 1,000 feet east of Price Road to the east, and Dorsey Lane to the west. The location of the compliance boundaries and areas for sentinel wells are shown in Figure 10 in Section 10.0. The sentinel wells will be monitored at least quarterly for the hazardous substances for which aquifer cleanup standards are established (see Section 12.0), and for other substances as appropriate.

  The compliance boundary for the MAU areas of contamination is located approximately 2,000 feet east of the current extent of VOC contamination and is bounded by Rio Salado Parkway to the north and Apache Boulevard to the south. Sentinel wells will be located approximately 1,000 feet upgradient of the MAU compliance boundary, as shown in

[1] Public comments were received during the comment period concerning the discharge to SRP's Tempe Canal No. 6; EPA will consider these comments in determining the discharge and use during the remedial design.

Figure 10 in Section 10.0. The sentinel wells will be monitored at least quarterly for the substances for which cleanup standards are established and for other substances as appropriate.

- Continued monitoring of groundwater to verify the effectiveness of the extraction and treatment and MNA remedies and to ensure that aquifer cleanup goals are met throughout the areas of VOC contamination.
- Institutional controls to protect the public from exposure to contaminated groundwater exceeding aquifer cleanup levels until cleanup levels are met. Institutional controls will include various Arizona well siting, permitting, and construction restrictions, and notices distributed by the Arizona Department of Water Resources, Arizona Department of Health Services, or EPA concerning risks from exposure to contaminated groundwater. Additional institutional controls to prevent interference with EPA's remedial efforts also may be established.
- Sealing or abandonment of Well SRP23E, 2.9N to eliminate this potential path of VOC contaminant migration from the UAU to the MAU. This well is located in an area of shallow contamination and represents a potential conduit for downward contaminant migration. Other monitoring wells that will not be included in the long-term monitoring network will be abandoned as appropriate.

Contingency Remedy

A contingency remedy of extraction and treatment of appropriate target volumes of contaminated groundwater in MNA areas may be triggered to satisfy the following two criteria: (1) attaining aquifer cleanup standards within a reasonable time frame of approximately 30 years, and (2) preventing migration of groundwater contaminated above the aquifer cleanup standards to and beyond the compliance boundaries. The appropriate "target volume" of contaminated groundwater to be extracted and treated will be determined to ensure that these two criteria are met.

For the UAU or MAU, the contingency remedy will be triggered if either one of the following situations occurs:

(a) If verification sampling at the sentinel wells confirms that data collected during quarterly sampling exceed the aquifer cleanup standards, and if the average contaminant concentration collected from the next two consecutive quarterly sampling rounds from this well exceeds the aquifer cleanup standards, then the contingency remedy will be activated. The contingency remedy may be implemented sooner, if needed.

(b) EPA-approved flow and transport modeling will be conducted using data collected during each EPA 5-year review period. If the modeling evaluation indicates that the MNA remedy will not attain aquifer cleanup standards within a reasonable time frame of approximately 30 years from the start of remedial action, then the contingency remedy will be activated.

5. Statutory Determinations

The selected remedy and the contingency remedy for the Groundwater Operable Unit at IBW-South:

- Are protective of human health and the environment;
- Comply with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action;
- Are cost-effective;
- Use permanent solutions and alternative treatment or resource recovery technologies to the maximum extent practicable; and
- Satisfy the statutory preference for remedies that employ treatment that reduces the toxicity, mobility, or volume of contaminants as a principal element.

This remedial action is expected to take more than 5 years to achieve aquifer cleanup levels to allow for unlimited use and unrestricted exposure. Accordingly, by policy, EPA will perform a review not less than 5 years after completion of the construction for all remedial actions at the site, and may continue such reviews until EPA determines that hazardous substances have been reduced to levels protective of human health and the environment.

Keith A. Takata | 9-30-98

Keith A. Takata
Director of Superfund Division
U.S. Environmental Protection Agency, Region IX

Date

II. DECISION SUMMARY

II. Decision Summary

This Decision Summary summarizes the information and approaches used that led to EPA's decision on this remedy. It also establishes the remedy that EPA has selected. This ROD addresses remedial actions to be applied to the VOCs-in-Groundwater Operable Unit at IBW South. A ROD for VOCs in the Vadose Zone at IBW-South was issued in September 1993. Other RODs address various operable units (OUs) at the Indian Bend Wash Superfund Site-North (IBW-North) Site (See Section 3.1, Site History).

1.0 Site Summary

1.1 Site Name, Location, and Description

The Indian Bend Wash Superfund Site includes both North and South Study Areas. This ROD pertains only to the South Study Area. The two study areas, IBW-North and IBW-South, are divided approximately at the Salt River. The overall Indian Bend Wash Superfund Site comprises approximately 13 square miles and is bordered by Chaparral Road in Scottsdale on the north, Apache Boulevard on the south, Rural Road (in Tempe) and Scottsdale Road on the west, and Price Road (in Tempe) and Pima Road (in Scottsdale) on the east.

The IBW-South Study Area comprises approximately 3 square miles in the City of Tempe (COT), Arizona. Some portions of the site lie outside of Tempe in jurisdictional "islands" of Maricopa County. As shown on Figure 1, IBW-South is bounded by Apache Boulevard on the south, Rural/Scottsdale Road on the west, Price Road on the east, and is proximate to Curry Road on the north. IBW-South also includes the Salt River itself, which is ephemeral and flows during storm events and releases from Roosevelt Dam.

The site includes developed land for residential, commercial, and industrial uses. The area between Apache Boulevard and University Drive is primarily residential. North of University Drive, the site is largely retail and commercial, including light-industrial and auto repair/scrap facilities in the area south of the Salt River. The industry in the area includes circuit and electronics manufacturing, metal plating, plastics manufacturing, and dry cleaning.

1.2 Area and Topography

IBW-South encompasses Sections 13 and 14 and the northern halves of Sections 23 and 24, Township 1 North, Range 4 East. The total area of the IBW-South study area is approximately 3 square miles. The Indian Bend Wash is a desert wash that has been converted to a series of urban ponds linked by channels, and the wash meets the Salt River at the northern boundary of the IBW-South study area. The surface topography of the IBW-South area is generally flat. The IBW-South area is broken by buttes of rock and surrounded by mountains at the edges of the valley.

The surface ranges from 1,150 to 1,200 feet above mean sea level. Slopes do not generally exceed 2 percent. Slopes of over 100 percent exist only at the banks of the Salt River. IBW-South is located along the southwestern margin of the Paradise Valley trough.

1.3 Land Use and Demographics

The October 1994 zoning map for the City of Tempe indicates that the southern half of Section 13 is 91 percent industrial. Approximately 8 percent of the section is zoned for agriculture, with 1 percent for commercial developments. The agricultural zoning consists of open lots held for future development; currently no agricultural activities are taking place at the site. The northern half of Section 13 has undergone a number of physical changes over the past 20 years as a result of the ongoing mining of gravel along the southern edge of the Salt River.

A variety of businesses are engaged in various industrial processes within the southern half of Section 13, including manufacturing, reconditioning, metal plating, dry cleaning, and other activities. The majority of the facilities under investigation are within this area. VOCs and inorganic compounds were used by the businesses or were a result of their operations. Some of these compounds have been discharged into soils and groundwater in IBW-South. Contamination of groundwater resources has resulted from contaminant discharge, and the existing situation may pose a future threat to human health.

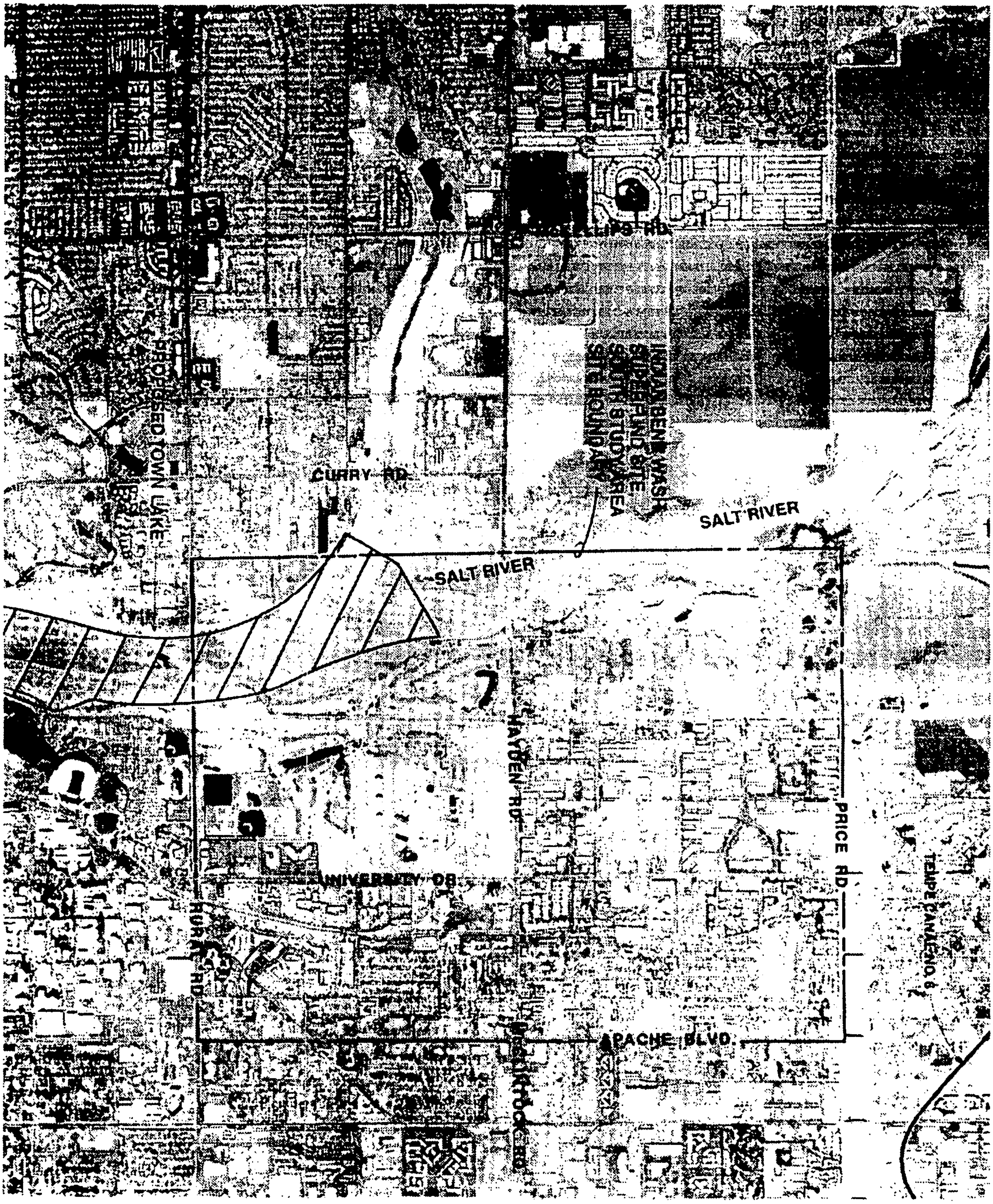
Seven known active or inactive landfills exist in the northern half of Section 13 along the Salt River. Many non-landfill-related businesses have operated or currently are operating on top of landfill material in this area. Therefore, it is possible that both the landfill material and the current businesses may have contributed to contamination at this portion of the site.

Current land use in Section 14 includes industrial, commercial, and recreational activities. The southern half of Section 14 is more than 70 percent industrialized because of the Arizona Public Service (APS) Ocotillo Power Plant. The remaining 30 percent consists of a commercial center, a golf course, and the Arizona State University (ASU) sports practice fields. The northern half of Section 14 is similar to the northern half of Section 13. Many changes have taken place because of gravel mining activities. Two known landfills flank Indian Bend Wash on the north bank of the Salt River; another landfill may exist on the south bank. A portion of the Karsten Golf Course is located in the northern half of Section 14.

The northern halves of Sections 23 and 24 are more than 80 percent residential in the form of apartments, condominiums, and single-family dwellings, occupied primarily by college students. The remaining 10 to 20 percent of land in these sections is light industrial and commercial developments such as restaurants, shops, and service stations.

Some demographics of IBW-South are listed below. The Statistical Report 1993 (City of Tempe, 1993) has a more complete compilation of census data specific to the City of Tempe.

The principal area of investigation within IBW-South lies in Sections 13 and 14. According to 1990 census information, Section 14 is strictly industrial and has a zero population. Section 13 has a population of 112, with most of the residents in this section living in mobile homes or trailers. The median age of the population in Section 13 is difficult to quantify


INDIAN BEND WASH
SUPERFUND SITE
SOUTH STUDY AREA
SITE BOUNDARY
PROPOSED TOWN LAKE
CURRY RD
SALT RIVER
SALT RIVER
HAYDEN RD
PRICE RD
UNIVERSITY DR
RURAL RD
APACHE BLVD

because census figures combine populations by census tract numbers. In this case, Sections 11, 13, and 14 are considered one tract. The majority of the population resides in Section 11. Sixty-six percent of the population in this tract are between the ages of 18 and 59. Nearly 24 percent are under 17 years of age, and the remaining 10 percent are over 60 years of age.

Although only the northern halves of Sections 23 and 24 reside within IBW-South, available census data apply to the entire section. Section 23, with a population of 12,500, is adjacent to ASU and contains a large percentage of the off-campus housing available to resident students. Within Section 23, 86 percent of the population are between 18 and 59 years of age.

The Tempe 2000 General Plan Summary calls for more than 50 acres of land in the northeast corner of Section 23 to be rezoned as mixed use, with a park located within the center of the area. Currently, the area is zoned 90 percent industrial and 10 percent commercial. According to the City of Tempe Long-Range Planning Department, a portion of the mixed use area will be residential because all currently zoned residential areas have been developed.

Portions of the IBW-South are located within the 100-year floodplain of the Salt River.

1.4 General Surface-Water and Groundwater Resources

Surface Water

The Salt River is the primary surface-water body present within IBW-South. Also, two minor surface-water bodies exist within or near the boundaries of IBW-South. The Hayden Canal is a concrete-lined canal/underground pipeline used to distribute irrigation water by the SRP. The City of Mesa operates wastewater recharge ponds offsite from IBW-South to the northeast.

The Salt River flows only about 10 percent of the time, but its flow is unpredictable in any given year. Currently, the Salt River bed is mostly dry within IBW-South. Prior to the 1940s, the Salt River was a perennial stream providing water to the Phoenix area for irrigation and recreation. Following development of the SRP, the river became a dry riverbed for most of the year, flowing only in response to major rainfall. Over the years, sand and gravel extraction from the riverbed and floodplains and the creation of several landfills have dramatically altered the environment and habitat of the Salt River. In response to these developments, the Rio Salado Project was conceived to restore the Salt River through the creation of a series of lakes and streams over a length of 38 miles from Granite Reef Dam to the Gila River. The City of Tempe eventually assumed a leadership role in promoting the Rio Salado Project, focusing on the portion of the Salt River within the City boundaries. This portion of the Salt River restoration is referred to as the Rio Salado Town Lake Project, henceforth referred to as simply Town Lake.

Town Lake was conceived as a project to transform a portion of the dry Salt River bed into an urban lake to provide recreational opportunities and economic benefits. The proposed location of Town Lake near the IBW-South Study Area is shown on the Site Location Map (Figure 1). The 2-mile-long, 200-acre lake will be created by placing air-inflatable dams in the river channel to impound supplied water. The depth of the lake will vary from 6 feet at the upstream end to 19 feet at the downstream end. During seasonal flooding, the dams will be lowered to allow flood waters to pass downstream. When flooding stops, the dams will be raised to impound water for the lake once again.

The downstream dam will consist of a 16-foot-high rubber dam to control the water level in the lake. A smaller, 6-foot-high rubber dam at the upstream end will capture local river discharges and create a wetlands-type riparian enhancement zone while reducing the flow of surface-water pollutants into the lake.

Infiltration from the lake into the surrounding soils will be controlled by a combination of cutoff walls and groundwater extraction/recovery wells. Approximately 10 wells will be used along the upstream (eastern) portion of the lake (in the northwest portion of the IBW-South Study Area) to collect an estimated 20 to 30 million gallons per day (mgd) of infiltrated water and pump the water back into the lake.

A stormwater management system will be constructed to improve the water quality in the lake by reducing the inflow of potential pollutants and contaminants. Stormwater diversions will capture and bypass the "first flush" from several major stormwater discharges to a point either upstream or downstream of the lake. In addition, detention areas will be provided to reduce the potential for spills from the Red Mountain Freeway from entering the lake.

Construction of Town Lake began in late 1997 and is scheduled to be completed in 1999.

Groundwater Resources

Groundwater at IBW-South was used as a drinking water source until contamination was discovered in two wells owned by the City of Tempe. These wells have not served water since 1989; however, one well, COT No. 7, was used once as a backup emergency potable supply.

Currently, the aquifer is used for industrial and agricultural purposes. The largest industrial use is for cooling water by the APS Ocotillo Power Plant.

2.0 Geology and Hydrogeology

This section describes the geology and hydrogeology for the Groundwater Operable Unit at IBW-South.

2.1 Stratigraphy

The materials at the IBW-South site are primarily a thick basin-fill sequence of alluvial sediments derived from surrounding mountains. Igneous rocks may intrude in places, and a crystalline bedrock exists in juxtaposition to the alluvial units as a result of block faulting.

2.2 Geology/Stratigraphy

The complex geological formations underlying IBW-South are generally divided into three layers, designated as alluvial units. Portions of the alluvial units that can store and transmit significant quantities of groundwater are called aquifers. In general, three main alluvial units underlie the IBW-South site: upper, middle, and lower (UAU, MAU, and LAU, respectively). A conceptual geologic cross section is shown on Figure 2. In some locations, the LAU is underlain by the Red Unit, which consists of cemented sands, gravel, and clays.

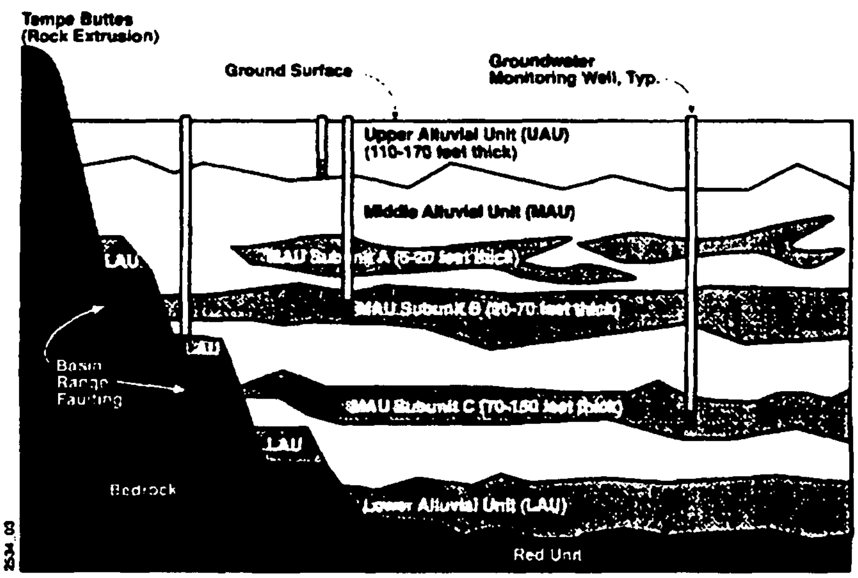


FIGURE 2
CONCEPTUAL GEOLOGIC CROSS SECTION
INDIAN BEND WASH-SOUTH
GROUNDWATER OU ROD

Upper Alluvial Unit

The UAU is distributed across the entire IBW-South study area, and generally has a uniform thickness. The UAU typically is found near or at the ground surface and extends to approximately 110 to 170 feet below ground surface (bgs). The UAU is normally divided into an upper layer of clay and sandy silt and a lower layer dominated by sand, gravel, cobbles, and boulders. The upper layer is typically not present near the Salt River channel, and thickens to more than 20 feet south of the channel.

Transmissivity data for the UAU have been gathered through 36 aquifer tests performed on UAU wells at the site to date. The estimated transmissivity values varied widely from a low of 1,900 square feet per day (ft^2/day) to a high of 73,000 ft^2/day. The range of transmissivities corresponds to hydraulic conductivity values between approximately 30 feet per day (ft/day) and 1,000 ft/day. The results of these tests suggest that no clear spatial trend in transmissivity values can be identified; however, the values obtained appear to be log-normally distributed. This suggests that calculating the geometric mean of the transmissivity values is an appropriate method by which to obtain an average value for the data set. The geometric mean of the UAU transmissivity values is approximately 17,000 ft^2/day.

Middle Alluvial Unit

The MAU consists primarily of clay and sandy silt with significant interbedded layers of sand-gravel mixtures. These coarser-grained interbedded layers generally represent the zones with higher hydraulic conductivity in the MAU. Weak to strong calcium carbonate cementation is also present in the MAU.

The interbedded stratigraphy encountered within the MAU is subdivided into three subunits described below:

- **MAU Subunit A**–Ranges in thickness from 5 to 20 feet and is typically found between 170 to 200 feet bgs. Sand, cemented sand, and silty sand dominate the composition of Subunit A. This subunit tends to be laterally discontinuous and is frequently not encountered in the study area.
- **MAU Subunit B**–Ranges in thickness from 20 to 70 feet and is typically found between 250 and 300 feet bgs. Sand, gravel, and silty sand dominate the composition of MAU Subunit B. MAU Subunit B appears to have the widest extent of all the MAU subunits within the IBW-South study area.
- **MAU Subunit C**–Ranges in thickness from 70 to 150 feet and is typically found between 380 and 550 feet bgs. Sand, gravel, and silty sand dominate the composition of MAU Subunit C.

Aquifer tests have been performed on five monitoring wells screened in MAU Subunit B, and seven wells screened in MAU Subunit C. Transmissivities estimated from the MAU Subunit B tests range from 1,000 to 12,500 ft^2/day. This corresponds to a range of hydraulic conductivities of between 5 ft/day and 250 ft/day. Results from the MAU Subunit C aquifer tests suggest a range of transmissivities between 2,500 and 11,000 ft^2/day. These values correspond to a range of hydraulic conductivities from 45 ft/day to 500 ft/day.

Lower Alluvial Unit

The LAU underlies the MAU and, for most of the study area, exceeds the depths explored during the remedial investigation (RI). The LAU was first encountered at 500 feet bgs in Well SIBW-12L, and the base of the LAU was typically not encountered. Observations of the LAU indicate that the composition of the LAU is a conglomerate, dominated by weakly cemented gravel, sand, silt, and rock fragments. The aquifer test performed in Well SIBW-12L suggests that the transmissivity of the LAU is significantly lower than the other units with a value between 100 and 200 ft^2/day. These data suggest a hydraulic conductivity for the LAU of about 5 ft/day.

Red Unit

The Red Unit is the deepest of the alluvial units, and comprises a wide range of Tertiary sediments with a reddish-brown color and distinctive cementation.

Groundwater is expected to flow through the Red Unit as a continuous porous medium with enhanced flow potential where it has been fractured and faulted. However, the Red Unit was not investigated during the IBW-South RI and is not expected to have a significant role in the movement and distribution of contamination within the study area.

2.3 Groundwater Movement

The following sections provide summary descriptions of the movement of groundwater in the UAU, MAU, and LAU. Groundwater elevations for the UAU measured in October 1994 are shown on Figure 3; groundwater elevations for the MAU and LAU measured in October 1994 are shown on Figure 4. These figures and the text below were presented in the RI. Data collected since the RI support the conclusions presented below.

Groundwater Movement—Upper Alluvial Unit

The following list summarizes conclusions regarding groundwater movement in the UAU within the study area:

- Groundwater flow directions in the UAU are south to southwest during non-riverflow conditions in the Salt River. These flow directions shift to south to southeast during riverflow conditions in the Salt River when recharge influences groundwater flow directions.

- Groundwater flow through the UAU originates mainly from Salt River recharge (during flow events) and lateral inflow moves vertically downward, eventually entering the MAU.

- The horizontal gradient in the UAU ranges from 0.0015 to 0.004 foot per foot (ft/ft) during non-riverflow conditions in the Salt River. Salt River recharge during riverflow conditions increases the horizontal gradient to 0.006 to 0.012 ft/ft.

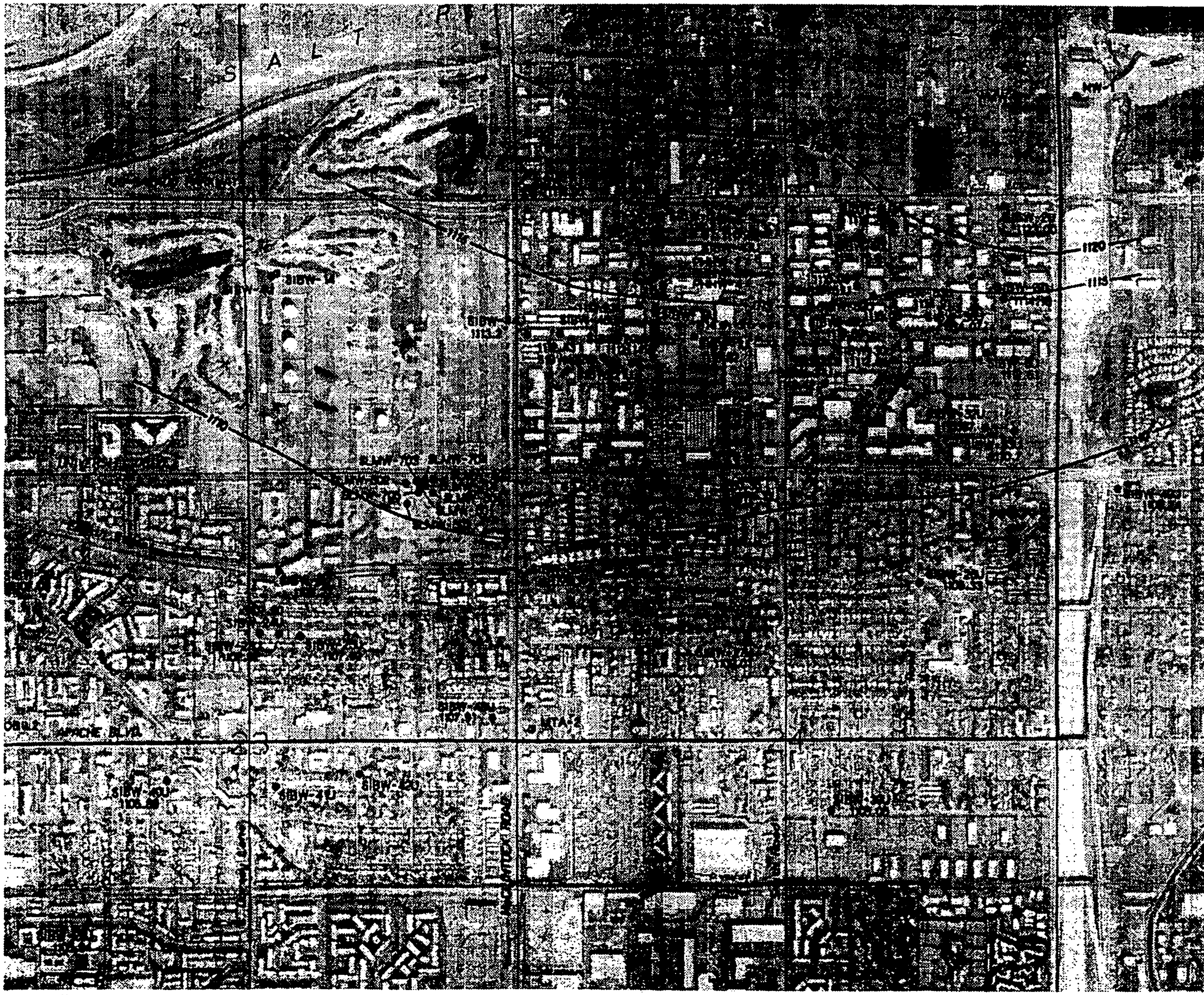
- The vertical gradient from the UAU to the MAU is downward throughout the study area and ranges from 0.15 ft/ft to 0.20 ft/ft without influence from Salt River flows. This downward gradient can increase to as high as 0.27 ft/ft during and directly following riverflow events.

- The Salt River does not function as a groundwater divide during non-riverflow conditions when the river is dry, but becomes a groundwater divide during riverflow events.

- No evidence exists to suggest that groundwater contamination originating from IBW-North has been transmitted to IBW-South, regardless of riverflow conditions.

The following list summarizes conclusions regarding groundwater movement in the MAU and LAU. MAU Subunit A is not included in this discussion because in this area it is very thin and discontinuous. Consequently, no EPA wells are screened in this subunit:

- The groundwater flow direction in MAU Subunit B is generally west to east, but insufficient data exist to fully characterize the flow direction. The groundwater flow direction in MAU Subunit C varies from due north to east, with northeast appearing to be the predominant flow direction.
- According to limited data, the horizontal gradient in MAU Subunit B appears to be approximately 0.001 ft/ft. The horizontal gradient in MAU Subunit C ranges from 0.002 to 0.004 ft/ft.
- The vertical gradient from MAU Subunit B to MAU Subunit C is downward across the study area and ranges from 0.02 to 0.13 ft/ft. Salt River flows do not appear to directly influence vertical gradients from MAU Subunit B to MAU Subunit C.
- Limited data exist to estimate groundwater flow directions in the LAU. The general flow direction is to the east or northeast, similar to the MAU.



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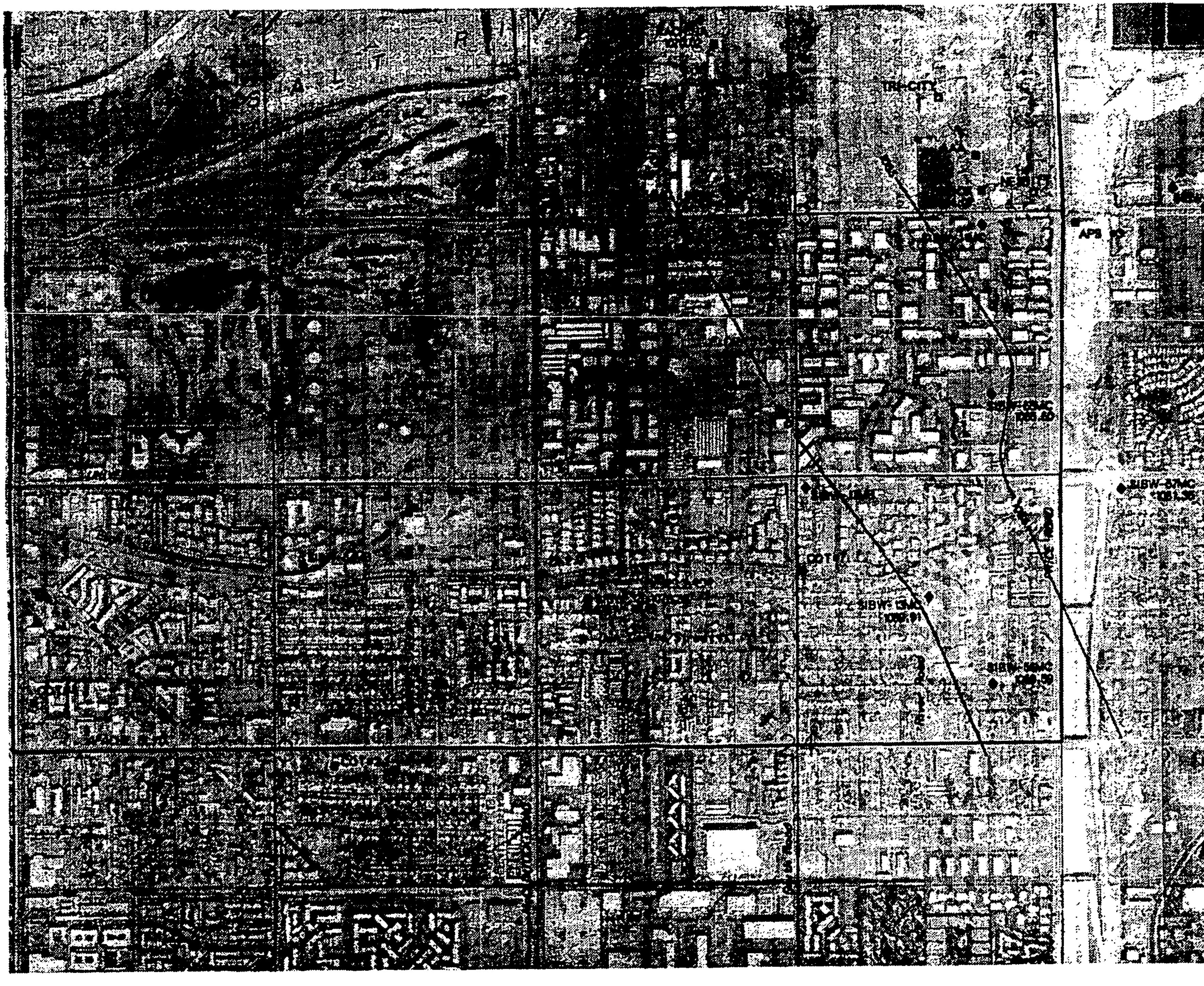
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3.0 Site History and Enforcement Activities

3.1 Site History

Site Discovery and RODs Issued

In 1981, the City of Phoenix sampled water from several wells in Scottsdale and detected VOC contamination. These wells were subsequently taken out of service to protect public health. In 1982, EPA sampled 20 wells belonging to the SRP and the cities of Phoenix, Scottsdale, and Tempe. Chemical analyses determined that 11 of the 20 wells were contaminated with VOCs, and these wells were also shut down. Subsequently, groundwater contamination was detected in wells located in the northern part of Tempe, and these wells were shut down as well. Information from the City of Tempe indicated that COT No. 7 has been used extremely rarely as backup emergency potable water supply wells (once since 1990).

Following the discovery of groundwater contamination in the area, EPA established the Indian Bend Wash Superfund Site on the National Priorities List (NPL) in September 1983. Since that time, EPA has conducted several investigations to determine the nature and extent of soil and groundwater contamination at the site. These investigations concluded that the VOCs of primary concern included TCE; 1,1,1-TCA; 1,1- and 1,2-dichloroethene (1,1- and 1,2-DCE); and PCE. The contamination in IBW-North was found to have originated from a limited number of larger industrial facilities. Conversely, within the IBW-South Study Area, the groundwater contamination appears to have had several sources, from mid-size industrial facilities to small privately owned businesses.

At the beginning of the Superfund remedial investigations in 1984, higher levels of contamination were detected at IBW-North (Scottsdale) than were detected at IBW-South (Tempe). Therefore, EPA allocated more resources to address the greater potential health risk posed at IBW-North, given the limited information available at that time. At the end of 1987, EPA informally split the overall IBW Study Area into the IBW-North and IBW-South areas for more efficient management. This ROD does not address remedial action for IBW-North.

IBW-South has been divided into two OUs, soil and groundwater, in accordance with NCP § 300.430(a)(1)(ii)(A). For IBW-South, EPA issued a ROD for the operable unit pertaining to VOCs in soils in 1993. That ROD established criteria for determining whether soils at a particular location might contribute to future groundwater contamination or public health risk, and selected soil vapor extraction (SVE) as the remedy when those criteria are met. Focused RIs have been and are being performed to determine which subsites would meet, or "plug-in" to, those criteria for potential future contribution to groundwater contamination. If a subsite or property "plugs in," EPA will issue a "Plug-In Determination" for that subsite or facility calling for the SVE remedy.

To date, one Plug-in Determination has been made for the former DCE Circuits subsite, and an SVE system has been constructed and is currently in operation. Focused RI work is continuing at other subsites within IBW-South, and EPA expects to complete the Plug-In Determinations for those subsites once the Focused RI work is complete.

3.2 IBW-South Remedial Investigation for Groundwater

In 1988, EPA began more intensive investigation of contamination in IBW-South after addressing the higher potential risk contamination in IBW-North. The data available at the time indicated that the concentrations of VOCs in groundwater were much lower in IBW-South than in IBW-North, but were still above drinking water standards. All known contaminated groundwater production wells in IBW-South had been shut down to prevent exposures to groundwater contaminated above drinking water standards.

EPA's RI for IBW-South achieved two objectives:

- Performed soil and source investigations; and
- Performed a regional groundwater investigation.

During the source investigations, soil and soil gas sampling were conducted at the facilities representing potential sources of groundwater contamination. A source investigation was conducted at each facility. The facilities investigated during the RI are shown on Figure 5. Preliminary evaluation of data collected during soil gas investigations has resulted in the delineation of eight "subsites" at IBW-South. EPA and ADEQ may refine and further delineate subsite areas that might need further investigation. The source investigation, combined with the regional groundwater investigation, showed that the groundwater contamination at IBW-North did not originate at IBW-South, and vice versa.

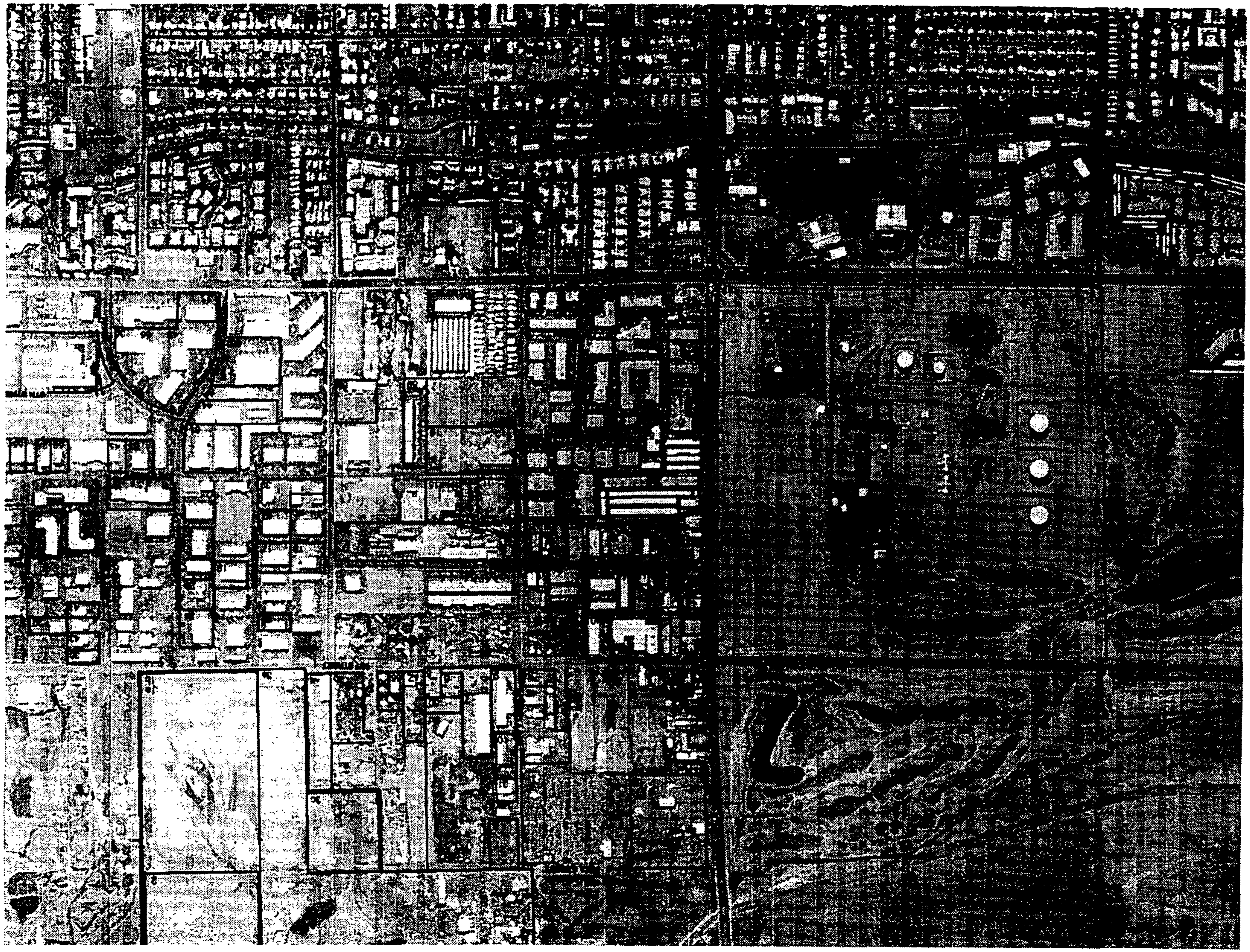
The regional groundwater investigation examined the overall presence of contaminants in groundwater and the movement of groundwater across the entire site. Contamination in the soil or soil gas at a facility can migrate downward and enter groundwater. Once in groundwater, it can flow away from the facility and become more widespread or a potential regional problem. The regional groundwater investigation therefore recognized individual sources, but adopted a regional perspective on contaminant movement.

Soil, soil gas, and groundwater data and interpretations were collectively incorporated into the Final RI Report (EPA, 1997).

3.3 Enforcement Actions

Groundwater

In December 1997 and January 1998, EPA issued general notice letters specifically for the groundwater contamination at IBW-South. These general notice letters were sent to approximately 14 parties associated with 6 facilities or subsites believed to be sources of groundwater contamination at IBW-South. The majority of these parties had already received general notice letters from EPA between 1988 and 1993. EPA will continue to identify potentially responsible parties (PRPs) should additional information come to light.



Soil

EPA issued four Unilateral Administrative Orders (UAOs) under CERCLA §106 and one Administrative Order on Consent (AOC) under CERCLA §122 to PRPs to obtain Focused RIs for soil contamination and to install groundwater monitoring wells that would be included in the overall IBW-South regional groundwater investigation. The orders issued are shown in Table 1.

TABLE 1
Orders Issued for Focused RI Work at IBW-South

Facility	Order Type	Respondents
DCE Circuits (former operator)	UAO	VAFCO (Rudy Vafadari, et al.); Arden Properties
IMC Magnetics	UAO	IMC Magnetics, Arizona Division, Inc.
Prestige Cleaners, Inc.	UAO	Prestige Cleaners, Inc.
Eldon Drapery	UAO	Leibovitz Enterprises Limited Partnership; Y&S, Inc.
Unitog Rental Services	AOC	Unitog Rental Services, Inc.

UAO = Unilateral Administrative Order
AOC = Administrative Order on Consent

EPA is continuing its investigation of potential source areas, and at this time, EPA estimates that approximately eight subsites may be contributing or have contributed VOCs to the environment within the IBW-South study area. These subsites may consist of one or more facilities or properties. These eight subsites are identified in the final RI report for IBW-South (EPA, 1997). The results of the final investigations of these subsites will be presented in Focused RI reports as explained in the ROD issued in September 1993 regarding the VOCs in the Vadose Zone.

EPA has issued information request letters pursuant to CERCLA §104(e) to more than 100 parties within IBW-South. These letters request information about solvent usage and other practices of operation; waste handling and disposal; spills; the presence of tanks, dry wells, drains, leach lines and degreasers; and related matters. EPA used this information to assist in identifying potential sources of VOC contamination.

In 1988 and 1990, EPA issued general notice letters to approximately 30 parties. In June 1993, EPA issued a second general notice letter to about 65 parties informing them of potential liability. Some of the 65 parties who received this notice had also received the original general notice in 1988 or 1990. In addition, EPA has sent approximately 12 letters to parties informing them that unless further data or information becomes available, EPA does not plan to conduct further investigation at their facility and/or property. These 12 parties had previously received general notice letters from EPA.

As EPA identifies which subsites are sources and which facilities will warrant remedial action activities, EPA will continue to gather information to identify those PRPs related to these subsites. As a result of identifying PRPs related to these subsites, EPA may issue additional general notice letters to parties currently associated with these subsites if they have not already received notice from EPA.

4.0 Highlights of Community Participation

Because the IBW-South and IBW-North study areas are part of one overall IBW site, EPA has joined community relations planning and execution for both areas. The Community Relations Program therefore addresses the IBW community as a whole, although a given fact sheet or meeting usually pertains specifically to only one study area.

EPA currently maintains IBW-South information repositories at EPA Region IX Office in San Francisco, and at the Scottsdale, Tempe, and Phoenix Public Libraries. EPA Region IX Office and the Tempe and Scottsdale Public Libraries maintain copies of the Administrative Record file on microfilm; the Phoenix Public Library maintains a collection of selected key documents, including the Interim and Final Remedial Investigation reports, the Feasibility Study (FS), the Proposed Plan, and this ROD. In addition, ADEQ maintains an information repository, with various key documents, in its Phoenix office. EPA also maintains a computerized mailing list database for all of Indian Bend Wash. This list currently contains more than 1,700 addresses. In addition to continually updating the mailing list, EPA sent a fact sheet in December 1990 to approximately 35,000 addresses in the area of the Indian Bend Wash Superfund site in an effort to expand the list. This fact sheet (and all EPA fact sheets for IBW-South) provided a return coupon and telephone numbers that one could use to be placed on the mailing list.

EPA also operates a toll-free information message line (800/231-3075) to enable interested community members to call EPA with questions or concerns about Indian Bend Wash Superfund site activities. The message line is publicized through newspaper notices and the mailing list. EPA has been responding to numerous inquiries about the effects of potential Superfund liability upon residential and small business property located within or near the study area boundaries. Some of these concerns are addressed in the Responsiveness Summary of this ROD.

Table 2 presents a chronological list of other community relations activities that EPA has conducted for IBW-South to ensure community involvement and to comply with the public participation requirements of CERCLA §113(k)(2)(B) and CERCLA §117. Activities that were specific to IBW-North only are excluded from this list.

This ROD presents the selected remedy for the groundwater OU for IBW-South, chosen in accordance with CERCLA, amended by SARA, and, to the extent practicable, the NCP. The decision for IBW-South is based on the Administrative Record, which is available to the public.

TABLE 2
IBW-South Community Participation Highlights

September 1984	Released a community relations plan based upon interviews with Phoenix, Scottsdale, and Tempe residents and state and local officials.
1984 through1988	During this period, community relations activities addressed all interested persons in the IBW community, but information transfer centered on IBW-North.
December 1990	Distributed a fact sheet to all persons on the mailing list providing information on IBW-South and groundwater monitoring and soils investigations.
Throughout 1991	Distributed a flyer to residents near EPA's well drilling activities throughout the study area, which explained the reason for, and nature and context of, the well drilling.
May 1991	Distributed a flyer and held a public meeting to update the community on the findings of the remedial investigation, the type of contamination, movements of groundwater, the potential sources, and EPA's remedial and enforcement strategies; addressed community questions and concerns.
January 1992	Updated the 1984 community relations plan to reflect new site communication strategies and information from residents, officials, and other members of the community.
September 1992	Distributed a fact sheet providing information about investigation activities and Administrative Orders that had been issued, and also announcing a public comment period on a Contingency Plan for Removal of Landfill Materials, which the Arizona Department of Transportation (ADOT) was proposing as part of its work under its agreement with EPA. Held a 30-day public comment period on this issue.
December 1992	Issued a flyer to residents in a surrounding neighborhood of the former DCE Circuits facility where EPA was beginning fieldwork as part of a Focused Remedial Investigation. Flyer explained the reason for, and nature and context of, the activities and gave contact names.
April 1993	Distributed a fact sheet updating the community on activities at IBW-South, including Administrative Orders, groundwater, and an initial description of the Plug-in Approach to be used in the upcoming VOCs-in-Vadose-Zone remedy.
May 1993	Issued a flyer to residents affected by EPA's well drilling activities informing them of the reason for, and nature and context of, the activities.
June 1993	Mailed IBW-South Administrative Record file on microfilm for the Soils ROD and including groundwater information to Scottsdale and Tempe Public Libraries. Hard copies of the IBW-South IRI Report were sent to these libraries and the Phoenix Public Library.
June 1993	Held informal meetings with citizens and PRP groups to present EPA's proposal for VOCs-in-Vadose-Zone remedy and to answer questions and concerns.
June 7, 1993	Distributed the Proposed Plan Fact sheet for the VOCs-in-Vadose-Zone remedy to all persons on the mailing list, to local officials, the state, and to libraries, announcing EPA's proposal for the soils remedy, the comment period, the scheduled public meeting and open house session, and the availability of the Administrative Record file.
June 9, 1993	Issued press releases to the Scottsdale, Tempe, and Phoenix media about the proposed VOCs-in-Vadose-Zone remedy, the scheduled public comment period and open house session, and the availability of the Administrative Record file.

TABLE 2
IBW-South Community Participation Highlights

July 1993	Held an open house session at Gililland Jr. High School in Tempe to present EPA's proposed remedy for VOCs in the Vadose Zone.
July 1993	Extended Public Comment period to August 14, 1993, on VOCs-in-Vadose-Zone remedy.
July 7, 1993	Held a formal public meeting at Gililland Middle School in Tempe, from 7-10 PM, to present EPA's proposed remedy for VOCs in the Vadose Zone, answer questions, and to receive written and oral public comments; all proceedings were recorded and the transcript made part of the Administrative Record file.
August 1996	Issued fact sheet on SVE at the DCE Circuits Site.
September 1997	Issued Proposed Plan for cleanup of contaminated groundwater at the IBW-South Site.
September 1997	Mailed the Administrative Record file for the Groundwater OU remedy to the Scottsdale and Tempe Public Libraries.
September 24, 1997	Held a formal public meeting on Proposed Plan for groundwater remediation held at Gilliland Middle School, Tempe, AZ. The Public Comment Period was set for September 15 to October 14, 1997.
October 1997	Extended Public Comment Period to November 28, 1997, on the Proposed Plan for groundwater cleanup.
February 1998	Held meeting with PRPs and ADEQ to further discuss PRP comments and concerns regarding the Proposed Plan.
May 1998	Met with PRPs to describe additional groundwater data collected and modeling performed since the Groundwater FS cutoff date for data inclusion.
June 1998	Met with City of Tempe for a tour of the Rio Salado Town Lake Project and presented and discussed the additional data and modeling performed since the Groundwater FS cutoff date for data inclusion.
August 1998	Met with stakeholders to describe the ROD contingency plans for the MNA portions of the remedy.

5.0 Scope and Role of Operable Units

This ROD addresses VOC groundwater contamination at IBW-South, and is known as the VOCs in Groundwater Operable Unit ROD. EPA has already addressed VOC contamination in the vadose zone for the soil operable unit at IBW-South in a ROD issued in September 1993. As described in Section 3.1, the Soil OU ROD provides a presumptive remedy of SVE for soil remediation at IBW-South and a set of decision criteria to determine whether a particular subsite meets or "plugs in" to the ROD. One Plug-In Determination has been made to date, and other subsites are in various stages of characterization. The overall final remedy for the IBW-South Area encompasses both RODs for VOCs in soil and groundwater OUs.

EPA's vadose zone OU remedy addresses VOC contaminants in the vadose zone which could migrate to groundwater. That ROD does not address non-VOC contaminants that may be in soils, such as metals. That vadose zone OU remedy, in combination with the active treatment portions of this groundwater remedy, addresses the principal threats posed by VOCs at IBW-South through treatment. Where necessary, EPA will use removal actions, or select other remedies for such contaminants, or modify this or the Vadose Zone OU remedy to address them with an amendment or an explanation of significant differences (ESD).

To ensure that aquifer cleanup standards are met within a reasonable time frame of 30 years and to limit migration of contaminated areas where MNA is the selected remedy, EPA has established a contingency remedy for groundwater. The contingency remedy is extraction and treatment of a "target volume" that is necessary to meet the performance standards. The criteria that will trigger the contingency remedy and the target volume are discussed in Section 11.0 and throughout this ROD.

6.0 Summary of Site Characteristics

This section summarizes the current extent of VOC contamination at IBW-South, and describes the pathways for contaminant migration. Actual routes of exposure and exposure pathways are discussed in Section 7.0.

Over 50 monitoring wells have been installed at IBW-South. Groundwater contamination has been evaluated according to the Safe Drinking Water Act (SDWA) maximum contaminant levels (MCLs). The most consistently detected VOC contaminants in the groundwater are TCE and PCE. The MCLs for both TCE and PCE are 5 micrograms per liter (µg/L). This summary descripton focuses on the two main COCs, PCE and TCE; other VOC contaminants are addressed in the RI.

The RI was conducted over a period of many years, and IRI reports were published in 1991 and 1993. The final RI, published in 1997, presented the following information on groundwater contamination at IBW-South, herein updated to reflect the most current validated groundwater sampling results (April 1998).

6.1 Extent of Contamination

Upper Alluvial Unit

Contamination in the UAU is estimated to form approximately three contaminated areas referred to as the western, central, and eastern contaminated areas, as shown on Figure 6 and described below:

- ***Western area of contamination.*** The highest levels of VOC contamination at IBW-South have been detected here. The contamination consists mainly of TCE and PCE occurring throughout the contaminated area. This area is partially defined, from northeast to southwest, by Wells SIBW-5U, SIBW-23U, SIBW-24U, SIBW-40U, and SIBW-28U. Groundwater contaminated with TCE exists in the vicinity of the DCE Circuits facility and is moving southwest with the prevailing groundwater flow direction. TCE concentrations have been detected as high as 540 µg/L in Well SIBW-5U. The downgradient edge of this contaminated area is undefined to the southwest of Well SIBW-28U. TCE concentrations have decreased in SIBW-5U since 1991. The highest TCE concentration observed between 1994 and 1996 was 90 µg/L in SIBW-5U in October 1994. The TCE concentration in SIBW-5U has decreased to less than 5 µg/L in 1998. Analytical results of samples collected from the farthest downgradient well, SIBW-28U, indicate TCE concentrations have increased from 20 µg/L in October 1994 to 43 µg/L in April 1998.

- ***Central area of contamination.*** A second, central area of PCE- and TCE-contaminated groundwater is found in the vicinity of the IMC Magnetics, Inc., facility. This area is partially defined, from northeast to southwest, by Wells PHHW-2, SIBW-21U, SIBW-3U, and SIBW-48U. TCE concentrations of up to approximately 53 µg/L have been detected in this area. The highest TCE concentration observed between 1994 and 1996 was 26 µg/L in SIBW-3U in July 1994, and the concentrations have decreased to less than 5 µg/L in 1998. The downgradient extent of groundwater contaminated above MCLs in

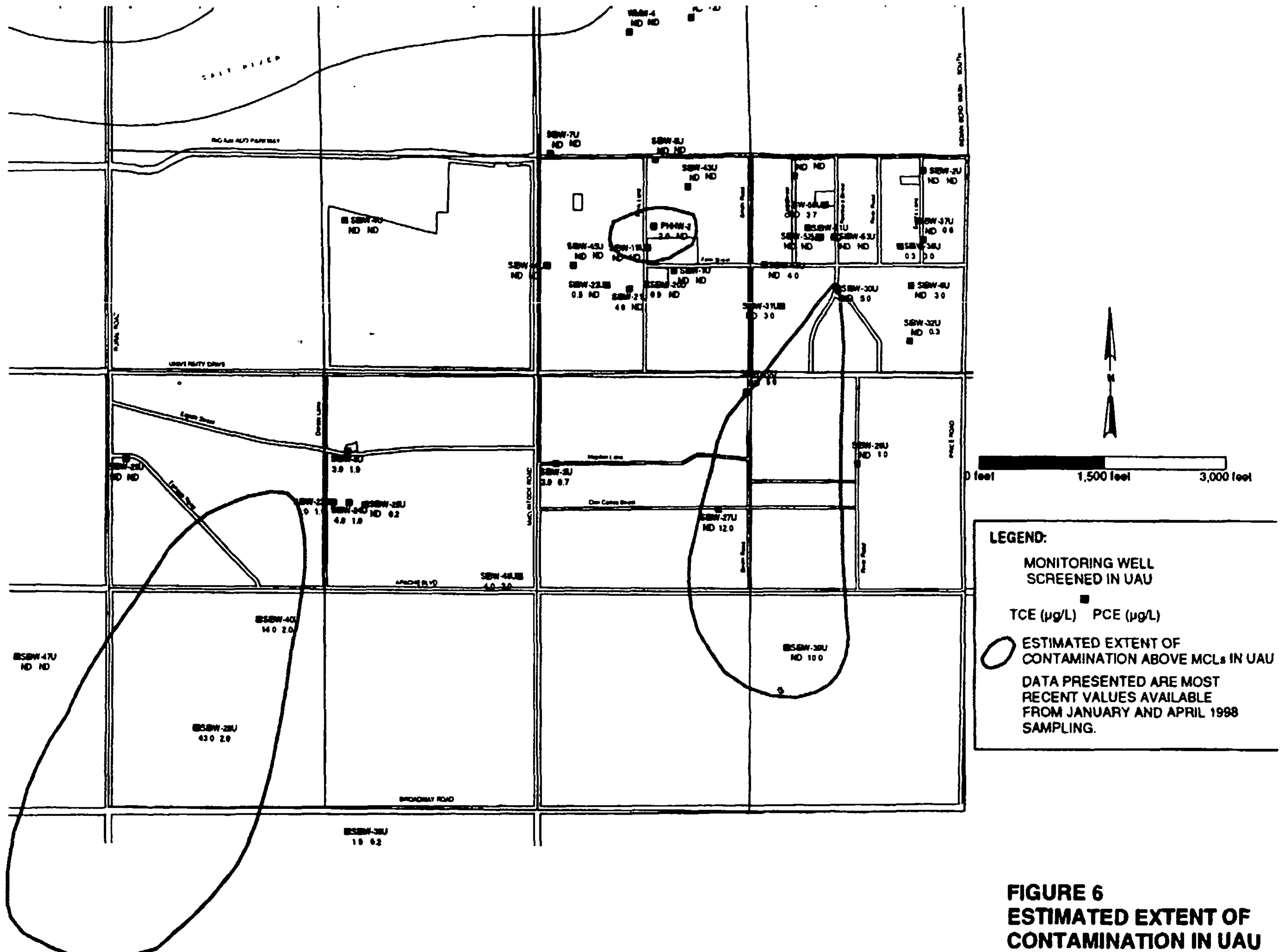


FIGURE 6
ESTIMATED EXTENT OF CONTAMINATION IN UAU
INDIAN BEND WASH-SOUTH GROUNDWATER OU ROD

the central contaminated area appears to be near SIBW-48U. PCE is also detected in Wells SIBW-3U and SIBW-48U. The eastern and western extent of the central contaminated area is not well defined. Methyl tertiary butyl ether (MTBE) recently has been detected at levels significantly above Arizona's Health Based Guidance Level (HBGL) of 35 µg/L and EPA's health advisory range of 20 to 40 µg/L for taste and odor. The higher levels of MTBE are located near the central contaminated area, where ADEQ has issued a corrective action plan under its Leaking Underground Storage Tank (UST) program. If it becomes apparent that ADEQ's UST efforts will not result in the cleanup of MTBE in the aquifer, EPA will evaluate the necessity and appropriateness of remedial action for MTBE.

- *Eastern area of contamination.* A third, relatively broad area of PCE-contaminated groundwater is found in the eastern portion of the study area. This area is partially defined, from northeast to southwest, by Wells SIBW-50U, SIBW-36U, SIBW-46U, SIBW-6U, SIBW-31U, SIBW-10U, SIBW-26U, SIBW-27U, and SIBW-39U. PCE concentrations of 59 µg/L were observed in SIBW-51U in February 1994, and may indicate the well is located near a source of contamination. The downgradient extent of this contamination is undefined. Since 1994, the PCE concentrations have decreased in SIBW-51U to less than 5 µg/L, and have remained relatively constant in most of the other UAU wells in this area. PCE concentrations have equaled or exceeded 10 µg/L in SIBW-39, the farthest downgradient well in this contaminated area from April 1995 to April 1998. As with the western and central contaminated areas, the eastern and western extent of this contaminated area is not well defined.

Middle Alluvial Unit

Two areas of VOC contamination are found in the MAU, one in MAU Subunit B, the other in MAU Subunit C. The MAU subunits primarily are found in, and thus also have been sampled in, the eastern and central areas of IBW-South. PCE was not detected during the April 1998 sampling event in groundwater samples collected from the MAU or LAU. The current interpretation of the extent of the VOC contamination in the MAU, as shown on Figure 7, and LAU is summarized below:

- *Subunit B.* Groundwater contaminated with TCE is found in MAU Subunit B in the vicinity of SIBW-16MB in the south-central portion of the study area. Measured TCE concentrations range from 9 to 4 µg/L. The horizontal extent of this contamination is undefined.

- *Subunit C.* Groundwater contaminated with TCE occurs in MAU Subunit C in the eastern portion of the study area. This low concentration area (up to 12 µg/L) is defined by Wells SIBW-11MC, SIBW-13MC, SIBW-56MC, SIBW-57MC, and SIBW-58MC. The eastern and southern limits of this area of contamination are undefined. The TCE concentrations have not fluctuated significantly in this contaminated area since 1992.

  MAU Subunit C is believed to pinch out directly west of the currently defined TCE area of contamination (approximately 500 to 1,000 feet west of COT No. 7). This suggests that the observed MAU Subunit C contamination may be related to the observed contamination upgradient in MAU Subunit B.

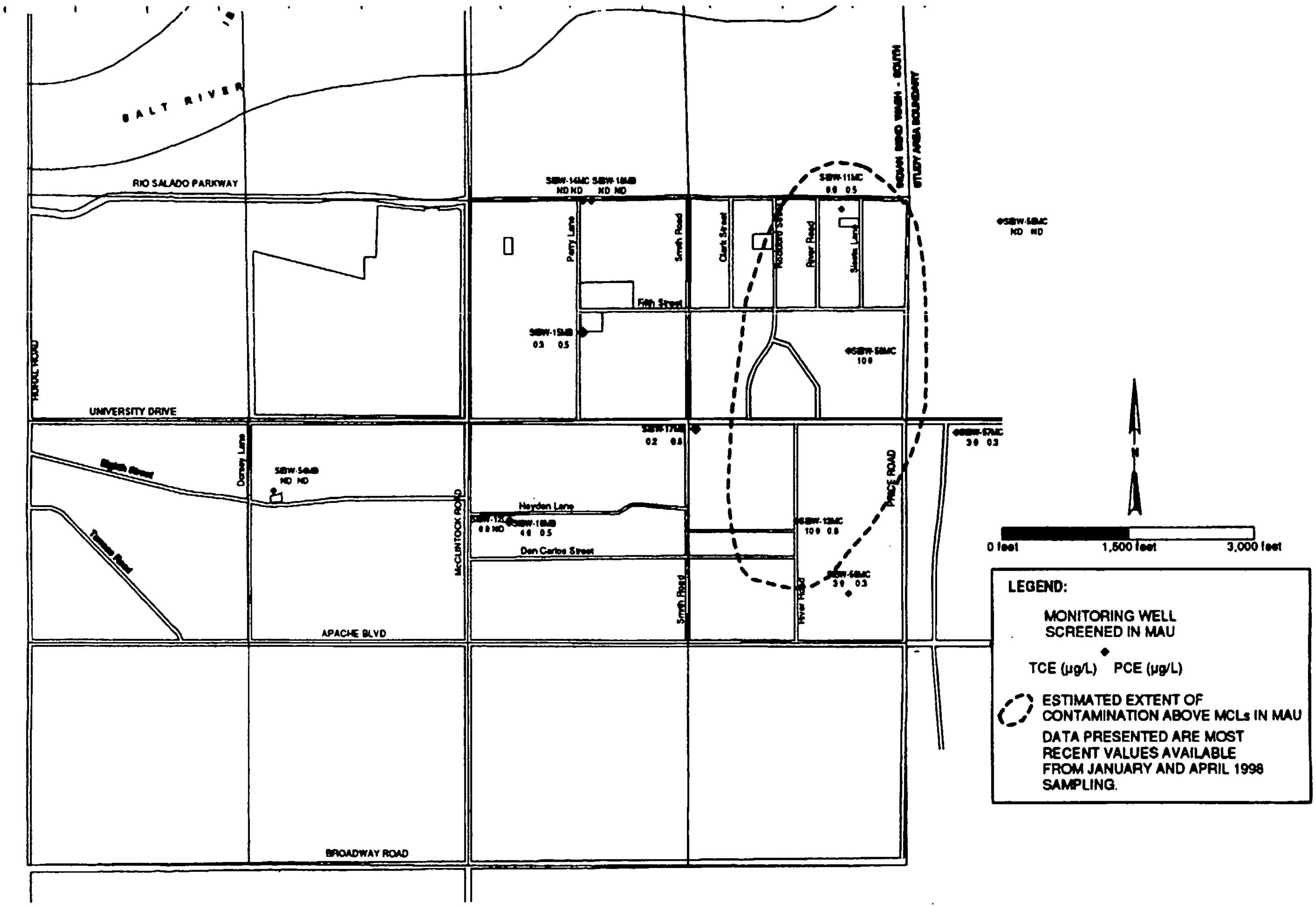


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FIGURE 7
ESTIMATED EXTENT OF CONTAMINATION IN MAU
INDIAN BEND WASH-SOUTH
GROUNDWATER OU ROD

- PCE has not been detected above MCLs in the MAU or LAU since 1985.

Lower Alluvial Unit

Low concentrations of contamination have been detected in the LAU. A 1984 sample from the Kachina well, in the north-central portion of the IBW-South study area, contained PCE at 5 µg/L. Since that sampling event, all samples collected from this well have been below 2 µg/L for PCE. Another well, SRP Well 23E,2.9N, had detected concentrations of TCE, but it is screened across the UAU, MAU and LAU, and is therefore not useful in determining the extent of contamination in the LAU. EPA installed one LAU well, SIBW-12L, in early 1991 in the south-central portion of the IBW-South study area, as part of the RI. Concentrations of PCE and TCE in samples collected from SIBW-12L to date have not exceeded 1 µg/L.

6.2 Migration Pathways

This section describes surface and subsurface migration pathways for the VOCs in groundwater. Figure 8 is a conceptual diagram of the migration pathways for VOCs at IBW-South.

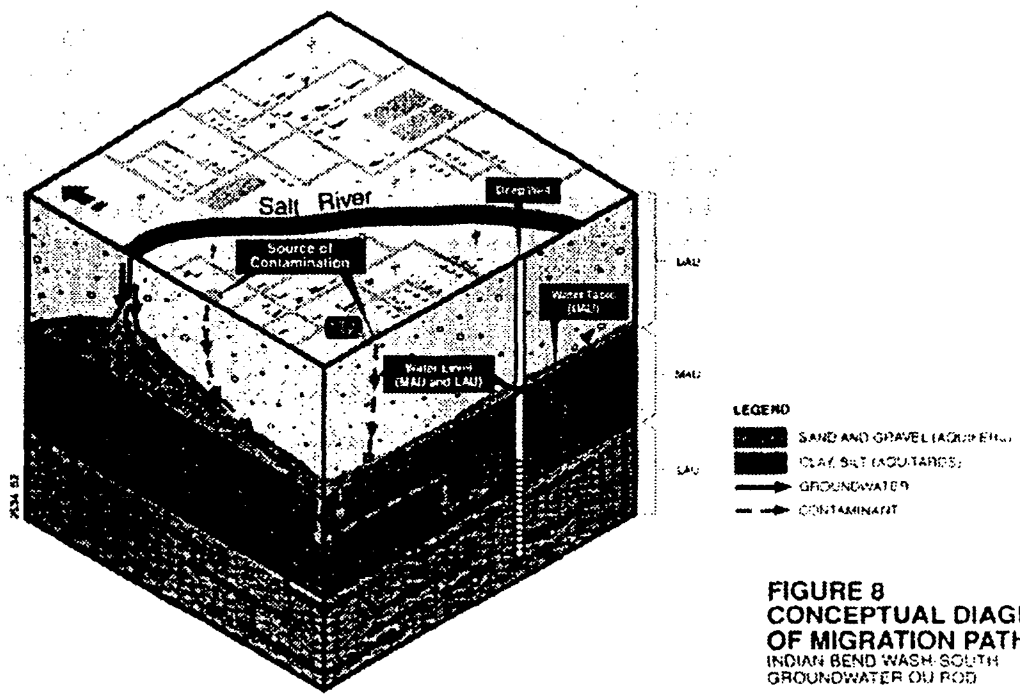


FIGURE 8
CONCEPTUAL DIAGRAM OF MIGRATION PATHWAYS
INDIAN BEND WASH-SOUTH
GROUNDWATER OU ROD

Migration pathways considered the following for VOCs in groundwater at IBW-South:

- Contaminant movement from source areas
- Chemical and biological processes that may degrade contaminants as they move through the IBW-South hydrogeologic system

- Mechanisms that affect contaminant movement through the vadose zone
- Mechanisms that affect movement through the saturated water-bearing zones

Contaminant Movement from Source Areas

A wide variety of manufacturing industries currently operates, or has operated in the past, at IBW-South. Printed electronic circuit-board manufacturing, metal plating, commercial laundry cleaning, engine repair and manufacturing, vehicle repair, jewelry manufacturing, plastics manufacturing, and mortar and grout manufacturing represent some of the industrial activities that have occurred in the past. Landfills currently operate or have operated in the past at IBW-South. Some of these industries used hazardous substances in their manufacturing process that could, if discharged into the ground in sufficient quantity, pose a threat to human health and the environment. Hazardous substances most commonly used by industries at IBW-South include degreasing and dry cleaning solvents, metal plating solutions, acid and base solutions, and fuel oils. When the hazardous substances used by a facility are released into the ground, the facility becomes a source of contamination.

Possible mechanisms for release of hazardous substances into the subsurface at IBW-South are:

- Spills or leakage from drums or other hazardous substances containers
- Disposal of used or unneeded hazardous substances into dry wells, septic systems, or directly onto the ground surface
- Infiltration from industrial wastewater surface impoundments
- Leakage from underground storage tanks

Contaminant Movement in the Vadose Zone

One mechanism that affects contaminant movement in the vadose zone at IBW-South is infiltration from source areas. Contaminants discharged from source areas migrate vertically downward under gravitational forces and may also disperse horizontally as a result of capillary action. Infiltration of precipitation at IBW-South serves to dissolve and/or displace the contaminants and transport them downward toward the groundwater table.

The water table elevation at IBW-South exhibits significant temporal variation (elevation changes of up to 40 feet were observed during 1993). When the water table drops, some of the groundwater contamination may be left behind in the vadose zone, creating a "smear zone" of residual contamination in the vadose zone. Similarly, when the water table rises, some of the contamination adsorbed to sediments near the groundwater table may dissolve into the groundwater.

When contaminants move through the vadose zone, they will partition between mobile phases and relatively immobile phases when the contaminants are either sorbed by organic material or soil minerals. The mobility of contaminants through the vadose zone depends on both the contaminant and the vadose zone chemical and physical properties.

Contaminant Movement in the Upper Alluvial Unit

Groundwater and VOC contaminant movement varies throughout the site and with depth. The following is a brief discussion of the predominant paths of contaminant movement within the shallowest water-bearing unit, the UAU. The UAU mainly comprises permeable, coarse-grained sands and gravel. Contaminants enter the UAU by moving downward through the vadose zone, dissolving, and moving with the groundwater flow. Contaminants can also enter the UAU when the water table rises into contamination in the vadose zone. The contaminants then become soluble and move with prevailing groundwater flow.

Important characteristics of groundwater movement in the UAU at IBW-South are the strong downward vertical hydraulic gradients, changes in groundwater flow directions, and high horizontal hydraulic gradients caused by flow events in the Salt River. The changes in groundwater recharge patterns caused by intermittent flow in the Salt River have significant implications for contaminant transport at IBW-South. The groundwater flow direction in the UAU shifts from south-southwest to south-southeast, and these shifts in flow direction may spread out areas of contamination. Also, the increased horizontal gradient may cause contaminants to move large distances over short time periods.

Future groundwater conditions are expected to be similar to those observed in recent history, e.g., the flow directions and rate of groundwater movement will vary within similar ranges, and will be most affected by the frequency and durations of flow events in the Salt River. The construction of Town Lake is not expected to significantly affect regional groundwater flow patterns. Extraction wells surrounding the upstream (eastern) boundary of the lake will be operated to recirculate water that recharges through the lake bottom. These wells are expected to prevent significant amounts of recharge from impacting the volume of water that flows through the contaminated portions of groundwater at the site.

The groundwater table fluctuates more than 50 feet at the site. These fluctuations in groundwater levels can either leave residual areas of contamination when the water table falls, or cause vadose zone contaminants to become dissolved in the groundwater when the groundwater table rises.

Contaminant Movement in the Middle Alluvial Unit

The MAU is finer-grained than the UAU. Contaminants are introduced into the MAU by downward-migrating groundwater from the UAU moving through relatively finer-grained sediments to the coarser-grained water-producing zones within the MAU. Significant amounts of contamination can also move to the MAU by groundwater flowing or cascading down wells that are screened across both the UAU and MAU. The downward gradients observed at IBW-South can cause contaminant-laden groundwater entering the well in the UAU to move downward and exit the well in the MAU.

The MAU groundwater flow directions and gradients differ from those in the UAU. Current data suggest that the northeast MAU flow direction may be completely opposite to UAU groundwater flow because of naturally and artificially induced regional flow patterns. Vertical hydraulic gradients present in the MAU also tend to move the contaminants downward within the MAU.

Contaminant Transformation and Biodegradation

VOC contaminants will be subject to transformation and degradation via chemical and biological processes. Chlorinated solvents, which are the most commonly detected contaminants in the IBW-South groundwater system, may degrade to produce a variety of products such as alkanes, alcohols, acetates, aldehydes, carbon dioxide, and chloride ions. The VOC contaminants also degrade into other chlorinated solvent species. The measured presence of 1,1-DCA and 1,2-DCE in some groundwater samples collected from IBW-South provides evidence that biodegradation is occurring in limited areas. Biodegradation may be taking place under localized anaerobic conditions. However, estimated rates of biodegradation are not fast enough to prevent contaminated groundwater from migrating.

Natural Attenuation Processes

It appears that dispersion, dilution, and related natural attenuation processes that reduce VOC contaminants are occurring at IBW-South. Contaminant movement patterns and decreasing levels of contaminants in groundwater at source areas indicate the effectiveness of natural attenuation processes at IBW-South. Modeling based on these data trends further supports these observations and is discussed in Section 8.0 of this ROD.

7.0 Site Risks

This section presents a summary of the baseline human health risk assessment presented in Appendix A and Chapter 4.0 of EPA's *Final Groundwater Feasibility Study Report*, dated August 1997. The baseline risk assessment provides the basis for taking action and indicates the exposure pathways that need to be addressed by the remedial action. It serves as the baseline indicating what risks could exist if no action were taken at the site.

7.1 Summary of Site Risks

According to the results of the Baseline Risk Assessment presented as Appendix A in the Groundwater FS (EPA, 1997), exposure to contaminated groundwater might in the future pose levels of risk considered unacceptable under the NCP. The potential exposure pathway includes future use of untreated groundwater at IBW-South for drinking or showering. It must be noted that no exposure pathways currently exist because the groundwater at IBW-South does not serve as a source of water supply at this time. An exception is COT No. 7, which has been used as an emergency backup water supply only once since 1990.

Although the contaminated groundwater at IBW-South is not currently used for drinking water, it is classified as a drinking water source by the State of Arizona. Both the state and the City of Tempe have expressed the desire that the groundwater be restored to this beneficial use, which is consistent with the expectation in the NCP.

Ecological Risk Assessment

An ecological risk assessment evaluates risks posed to ecological receptors. An ecological risk assessment need not be performed for the Groundwater OU at IBW-South because groundwater does not discharge to surface water. No upwelling is known to occur in the vicinity of the Salt River, and vertical gradients are downward. Because no current or future pathways of exposure to VOC-contaminated groundwater exist for ecological receptors at IBW-South, an ecological risk assessment was not performed.

Summary of Human Health Risk Assessment

This section briefly summarizes the results of the human health risk assessment. The baseline risk assessment estimates what risks the site poses if no action is taken. It provides a basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section of the ROD summarizes the results of the baseline risk assessment for this site, which were presented in Appendix A of the Groundwater Feasibility Study (EPA, 1997). This summary of the human health risk assessment includes the following elements:

- Identification of the chemicals of concern (COCs)
- Exposure assessment
- Toxicity assessment
- Risk characterization

Identification of Chemicals of Concern

COCs (i.e., the chemicals that are the most toxic, mobile, persistent, or prevalent of those detected at the site) are selected from among the entire set of chemicals associated with groundwater at IBW-South. The purpose for identifying and selecting the COCs is to focus the risk assessment on the most important chemicals (i.e., those chemicals presenting 99 percent of the total risk) detected at the site.

Monitoring well samples from IBW-South were analyzed for 56 different VOC parameters. Thirty-five of the VOC parameters were detected at least once in the groundwater samples analyzed and 21 of the VOCs were never detected. PCE and TCE were detected most frequently. VOCs other than PCE and TCE were detected; however, they were detected at considerably lower frequencies.

PCE and TCE in groundwater are the COCs at IBW-South. These chlorinated solvents constitute the largest portion of the risk in both the UAU and the MAU/LAU. TCE and PCE were detected in approximately 40 percent of the samples collected between January 1994 and February 1996, and also have been consistently detected in the same monitoring wells over many sampling periods. Because TCE and PCE are frequently detected, the potential for exposure to these contaminants is also higher.

Exposure Assessment

Exposure refers to the potential contact of an individual with a chemical. Human exposure to chemicals is typically evaluated by estimating the amount of chemicals which could come into contact with the lungs, gastrointestinal tract, or skin during a specified period of time. The potential pathways of exposure; frequency and duration of potential exposures; rates of contact with air and water; and the concentrations of chemicals in groundwater are evaluated in the assessment of human intake of COCs.

Groundwater supply wells exist at the IBW-South Site. These wells are owned by the City of Tempe, and contamination discovered in these wells in 1981 (see Site History) is a reason that IBW is listed as a Superfund Site. These wells are not currently used for domestic supply, although COT No. 7 was used as an emergency backup water supply once since the wells were placed out of service in 1989.

The risk assessment therefore evaluated potential future exposures to untreated groundwater for the following domestic uses:

- ***Direct ingestion*** as a drinking water source (i.e., drinking and cooking)
- ***Inhalation and dermal absorption*** of contaminants during bathing and showering and VOCs released to the air during cooking or the use of household appliances such as washing machines.

Ingestion. The magnitude of exposure to contaminants through ingestion depends on the amount of water ingested on a daily basis. This assessment assumed that adult residents consume 2 liters of water per day, 350 days per year for approximately 30 years. The 2-liters-per-day value is close to the 90th percentile for drinking water ingestion (EPA, 1990b). The 30-year exposure duration is considered to be a 90th percentile value for time spent at one residence. The other parameters used in this intake equation also represent reasonable maximum values.

The parameters used for estimating chemical intake from ingestion of contaminants in groundwater are shown in Table 3.

TABLE 3
Parameters for Estimating Chemical Intake From Ingestion of Contaminants in Groundwater

Parameter	Description	Units	Value
Intake	Chemical intake rate	mg/kg-day	Calculated
Cw	Chemical concentration in water	mg/L	modeled or measured value
BW	Body weight	kg	70
AT	Averaging time	years	70 (cancer effects) 30 (noncancer effects)
EF	Exposure frequency	days/years	350
ED	Exposure duration	years	30
Irw	Daily water ingestion rate	L/day	2

A lifetime average intake of a chemical is estimated for carcinogens. This acts to prorate the total cumulative intake over a lifetime. An averaging time of a 70-year lifetime is used for carcinogens. Chemical intake rates for noncarcinogens are calculated using an averaging time that is equal to the exposure duration.

Inhalation. Exposure to VOCs in air in a residential exposure scenario was estimated from an inhalation rate of 15 cubic meters per day (m^3/day). This inhalation rate considers the potential for exposure during household water uses, such as cooking, laundry, bathing, and showering. Activity-specific inhalation rates were combined with time/activity level data for populations that spend a majority of their time at home to derive daily inhalation values. The inhalation rate of 15 m^3/day was found to represent a reasonable upper-bound value for daily, indoor residential activities (EPA, 1991a).

The parameters used for estimating intake from inhalation of VOCs are shown in Table 4.

TABLE 4
Inhalation Parameters

Parameter	Description	Units	Value
Intake	Chemical intake rate	mg/kg-day	calculated
C_a	Chemical concentration in air	mg/m^3	modeled value
BW	Body weight	kg	70
AT	Averaging time	years	70 (cancer effects) 30 (noncancer effects
EF	Exposure frequency	days/year	350
ED	Exposure duration	years	30
Ir_a	Daily inhalation rate	m^3/day	15

Dermal Absorption. Individuals can become exposed through dermal absorption of contaminants in water. The magnitude of potential exposure through this pathway is related to the concentration in water and surface area of exposed skin, the ability of the contaminant to penetrate through the skin, and frequency and duration of exposure.

The parameters used for estimating intake of VOCs from dermal contact with groundwater are shown in Table 5.

TABLE 5
Parameters for Estimating Chemical Absorption from Dermal Contact with Groundwater

Parameter	Description	Units	Value
Absorbed dose	Chemical intake rate	mg/kg-day	Calculated value
Cw	Concentration in water	mg/L	Modeled or measured value
SA	Exposed skin surface area	cm^2/event	23,000
ET	Exposure time	hours/day	0.25
EF	Exposure frequency	event/year	350
ED	Exposure duration	years	30
BW	Body weight	kg	70
AT	Averaging time	years	70 (cancer effects) 30 (noncancer effects)
Kp	Dermal permeability coefficient	cm/hour	Chemical-specific

Toxicity Assessment

The toxicity assessment determines the relationship between the magnitude of exposure to a chemical and the adverse health effects. This assessment provided, where possible, a numerical estimate of the increased likelihood and/or severity of adverse effects associated with chemical exposure. These toxicity values represent the potential magnitude of adverse health effects associated with exposure to chemicals, and are developed by EPA. These values represent allowable levels of exposure based upon the results of toxicity studies or epidemiological studies. The toxicity values are then combined with the exposure estimates (as presented in the previous sections) to develop the numerical estimates of carcinogenic risk and noncarcinogenic health risks. These numerical estimates are then used in the risk characterization process to estimate adverse effects from chemicals potentially originating in groundwater.

Toxicity values (cancer slope factors and reference doses) used in the risk assessment were obtained from these sources:

- The Integrated Risk Information System (IRIS), EPA, 1996, a database available through EPA National Center for Environmental Assessment in Cincinnati, Ohio. IRIS, prepared and maintained by EPA, is an electronic database containing health risk and EPA regulatory information on specific chemicals.

- The Health Effects Assessment Summary Tables (HEAST), provided by EPA's Office of Solid Waste and Emergency Response (OSWER) (EPA, 1995). HEAST is a compilation of toxicity values published in health effects documents issued by EPA. HEAST is for use in Superfund and RCRA programs.

Toxicity information for the COCs at IBW-south is summarized in Table 6.

TABLE 6
Toxicity Information for COCs at IBW-South

Chemical of Concern	Slope Factor Ingestion 1/(mg/kg-d)	Reference Dose, Ingestion (mg/kg-d)	Slope factor Inhalation 1/(mg/kg-d)	Reference Dose Inhalation (mg/kg-d)	Weight of Evidence Classification System for Carcinogenicity
Tetrachloroethene (PCE)	5.1E-02	1.0E-02	2.0E-03	1.0E-02	(Category B2) Probable human carcinogen, based on sufficient evidence in animals and inadequate or no evidence in humans
Trichloroethene (TCE)	1.1E-02	6.0E-03	6.0E-03	6.0E-03	(Category B2) Probable human carcinogen, based on sufficient evidence in animals and inadequate or no evidence in humans

Risk Characterization

Increased lifetime cancer risk (ILCR) estimates and noncancer hazard indexes (HIs) were calculated for all compounds detected in samples collected between January 1994 and February 1996. The data collected between these dates provide the best evaluation of the spatial extent of groundwater contamination. Total ILCR and noncancer HIs were calculated by summing the risk from the ingestion, inhalation, and dermal contact pathways associated with each compound in each sample collected between January 1994 and February 1996.

A summary of the most frequently detected compounds in the UAU and the MAU/LAU is presented in Table 7. This table contains the minimum and maximum concentration detected; the minimum, maximum, and mean total ILCR; and the minimum, maximum, and mean HI for each compound detected.

PCE and TCE were detected most frequently in the UAU and the MAU/LAU wells. The highest ILCR associated with PCE and TCE in the UAU was 5×10^{-5} and 4×10^{-5}, respectively. The highest ILCR associated with PCE and TCE in the MAU/LAU was 8×10^{-7} and 5×10^{-6}, respectively. 1,2-Dibromoethane (ILCR=3×10^{-3}) and benzene (ILCR=2×10^{-4}) have the highest ILCRs. An HI greater than one is also associated with 1,2-dibromoethane (HI=5) and benzene (HI=8).

TABLE 7
Sitewide Risks for VOCs Detected between January 1994 and February 1996 at IBW-South

			Concentration (mg/L)		Risk			Hazard Index		
Parameter	No. of Detects	No. of Samples	Min	Max	Min	Max	Mean	Min	Max	Mean
Upper Alluvial Unit										
1,2-Dibromoethane	8	205	0.0002	0.003	2.1E-04	3.1E-03	1.3E-03	3.6E-01	5.4E+00	2.2E-00
Benzene	12	355	0.002	0.14	3.3E-07	2.3E-04	8.7E-05	1.2E-02	8.4E+00	3.2E+00
Trichloroethene (TCE)	139	354	0.0001	0.09	4.1E-08	3.6E-05	5.7E-06	2.2E-03	2.0E+00	3.1E-01
Tetrachloroethene (PCE)	194	355	0.00006	0.059	4.6E-08	4.6E-05	4.1E-06	8.0E-04	6.5E-01	7.9E-02
Lower and Middle Alluvial Unit										
1,2-Dibromoethane	5	92	0.0006	0.002	6.3E-04	2.1E-03	1.3E-03	1.1E+00	3.6E+00	2.4E+00
Bromodichloromethane	2	243	0.0008	0.002	2.8E-06	6.9E-06	4.9E-06	5.2E-03	1.3E-02	9.1E-03
Trichloroethene	116	258	0.0002	0.0174	8.1E-06	5.3E-06	2.2E-06	4.4E-03	2.9E-01	1.2E-01
1,2-Dichloroethane	4	243	0.0002	0.0014	1.0E-06	2.0E-06	1.4E-06	7.2E-03	1.4E-02	9.6E-03
Tetrachloroethene	96	253	0.0001	0.006	7.7E-08	7.7E-07	3.8E-07	1.3E-03	1.3E-02	6.5E-03
Chloromethane	1	241	0.0008	0.0008	3.5E-07	3.5E-07	3.5E3-05	2.9E-02	2.9E-02	2.9E-02
Benzene	1	238	0.0002	0.0002	3.3E-07	3.3E-07	3.3E-07	1.2E-02	1.2E-02	1.2E-02
Methylene Chloride	9	247	0.0002	0.001	3.3E-08	5.9E-08	5.9E-08	1.2E-04	4.1E-04	2.1E-04

Under the NCP, remediation goals are based on ARARs or other reliable information (NCP, 40 CFR Section 300.430(e)(2)). For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between 1 x 10^{-4} and 1 x 10^{-6} using information on the relationship between dose and response. The 1 x 10^{-6} risk level is a point of departure for determining remediation goals when ARARs are not available or are not sufficiently protective because of the presence of multiple contaminants at a site or multiple exposure pathways. An HI (the ratio of chemical intake to the reference dose) greater than one indicates that some potential exists for adverse noncancer health effects associated with exposure to the contaminants of concern.

If residents were exposed to TCE and PCE in the groundwater through drinking water or routine household uses, the potential for increased cancer risks and noncancer health effects exists. Action is warranted under EPA's risk assessment for that reason and because contamination exceeds MCLs, which are standards adopted for the protection of human health and which are, under the NCP, standards relevant and appropriate for the restoration of drinking water, and because it is expected that the aquifer will be restored to meet drinking water standards.

8.0 Description of Remedial Alternatives

An FS was prepared in August 1997 to evaluate remedial alternatives for VOCs in groundwater at IBW-South. The remedial alternatives were developed to meet the Remedial Action Objectives (RAOs). RAOs are narrative statements that define the extent to which sites require cleanup to meet the underlying objectives of protecting human health and the environment. RAOs reflect COCs, exposure routes and receptors, and acceptable contaminant levels (or a range of acceptable contaminant levels) for each medium. RAOs can be divided into general RAOs that can be applied to all CERCLA sites, and specific RAOs that reflect site-specific conditions at IBW-South.

Remedial Action Objectives

The general RAOs for remedial actions at IBW-South include the following:

- Maintain protection of human health and the environment by reducing the risk of potential exposure to contaminants
- Expedite site cleanup and restoration
- Use permanent solutions to the maximum extent practicable
- Restore contaminated groundwater to the extent practicable to support existing and future uses
- Achieve compliance with applicable or relevant and appropriate requirements (ARARs)
- Minimize untreated waste

The specific RAOs for the groundwater below IBW-South include the following:

- Protect human health by minimizing the potential for human exposure to groundwater exceeding cleanup goals
- Cost-effectively reduce contamination in groundwater to concentrations that meet cleanup goals to return groundwaters to their beneficial uses to the extent practicable within a time frame that is reasonable, given the particular circumstances of the site
- Protect groundwater resources by preventing or reducing migration of groundwater contamination above ARARs.

Action is warranted because groundwater contamination exceeds MCLs, which are associated with unacceptable risk to human health and the environment, and it is expected that the aquifer will be restored to meet these drinking water standards. Thus, remedial actions should minimize the potential for future human exposure to contaminated groundwater.

Given these RAOs, several alternatives were assembled from the applicable remedial technology process options and were screened for their effectiveness, implementability, and cost. The alternatives passing this screening were then evaluated in further detail against the nine criteria required by the NCP. This section provides a description of each alternative that was retained for the detailed screening analyses in the FS. These alternatives consider No Action, as required by the NCP, to provide a point of comparison for other alternatives.

The six alternatives that were retained for detailed analysis in the FS are:

- Alternative 1: No Action
- Alternative 2: Monitored Natural Attenuation
- Alternative 3: Limited Action: Wellhead Treatment at COT No. 7/ COT Potable Water
- Alternative 4: Partial Containment: Extraction Wells/Treatment Plant Air Stripping/Discharge to Town Lake via City of Tempe Storm Drain/Monitored Natural Attenuation
- Alternative 5: Regional Containment: Extraction Wells/Treatment Plant Air Stripping/Discharge to SRP Tempe Canal No. 6
- Alternative 6: Regional Containment: Extraction Wells/Treatment Plant Air Stripping/Aquifer Reinjection

In the Proposed Plan, EPA selected Alternative 4 as the preferred remedy. After reviewing public comments on the Proposed Plan, and after additional data were collected and evaluated, that alternative was modified from that described in the Proposed Plan, although the general components of the preferred remedy remained the same. Section 10.0 provides an explanation of the significant differences between the preferred alternative in the proposed plan and the selected remedy. The components of the selected remedy and the contingency remedy are described in this section, along with the alternatives listed above that were evaluated in the FS and the Proposed Plan. Additional information and analysis of the selected remedy and contingency remedy are provided in Sections 9.0, 10.0, and 11.0.

A description of the cost estimating procedures is provided below, followed by additional information for each alternative.

Cost Estimating Procedures

The alternatives were evaluated in terms of capital costs, annual operation and maintenance (O&M) costs, and present worth costs. Capital costs include the sum of the direct capital costs (materials, equipment, labor, land purchases) and indirect capital costs (engineering, licenses, or permits). Annual costs include the cost for labor, O&M, materials, energy, equipment replacement, disposal, and sampling to operate the treatment facilities. Present worth costs include capital costs and O&M costs calculated over an approximate 30-year period.

The accuracy of costs is subject to substantial variation because the specific design of each alternative (e.g., design details, the bidding climate, changes during construction and operation, interest rates, labor and equipment rates, tax effects, and other similar items) will not be known until the time of actual implementation of the remedy.

Remedial Design efforts may reveal that it is possible to reduce the original project cost estimates. Design assumptions presented here may change. This is acceptable because details of the remedial alternatives presented here are conceptual in nature and subject to refinement during remedial design. Reductions in the estimated costs could be the result of value engineering conducted during Remedial Design (RD). Through the value engineering process, modifications could be made to the functional specifications of the remedy to optimize performance and minimize costs. These changes would fall within the definition of "non-significant modifications," as defined by EPA's guidance for preparing Superfund decision documents. For example, it may be determined that a reduction in costs could be affected by non-significant changes to type, quantity, and/or cost of materials, equipment, facilities, services, and supplies used to implement the remedy. It should be noted that this type of design variance may have a noticeable impact on the estimated cost of the remedy, but will not affect the remedy's ability to comply with the performance standards.

The present worth analysis is used to evaluate expenditures that would occur over an assumed 30-year operation period by discounting all future costs to a common base year. This allows the cost of remedial action alternatives to be compared on the basis of a single figure representing the amount of money that, if invested in the base year and disbursed as scheduled, would be sufficient to cover the costs associated with the remedial alternative over its planned life.

Features Common to All Remedial Alternatives

The five remedial alternatives (other than the No-Action Alternative) evaluated in the FS, and the selected remedy and contingency remedy have common features. The cost estimates for each alternative include costs for each of these features. The common features are listed below:

- **Institutional Controls**–Institutional controls are put in place to protect the public from exposure to contaminated groundwater exceeding aquifer cleanup levels until cleanup goals are met. Institutional controls will include various Arizona well siting, permitting, and construction restrictions, and notices distributed by the Arizona Department of Water Resources, Arizona Department of Health Services, or EPA concerning risks from exposure to contaminated groundwater. Additional institutional controls to prevent interference with EPA's remedial efforts also may be established.

- **Compliance Monitoring**–To ensure that the performance standards are met for groundwater, a long-term monitoring program was included in each alternative and the selected remedy and contingency remedy. The monitoring program will be designed and implemented during Remedial Design/Remedial Action (RD/RA) and will continue throughout the implementation of the selected groundwater remedy. The monitoring program will assess compliance with the remediation levels in the groundwater system, monitor effluent chemical concentrations after VOC treatment, and evaluate the horizontal and vertical migration of contamination. Details of the monitoring program will be determined by EPA during the RD. The monitoring program will include, at a minimum, the following: analytical parameters and methods; indicator parameters; monitoring locations; monitoring frequency and duration; sampling methods; well installation, and maintenance and abandonment procedures; reporting methods and procedures for tracking and maintaining sample records; and quality assurance (QA) methods.

- **Well Sealing or Abandonment**–Well SRP23E,2.9N will be sealed to eliminate this potential path of VOC contamination from the UAU to the MAU. In addition, other monitoring wells that are not required for compliance or natural attenuation monitoring will be properly abandoned as appropriate.

Another common feature to all alternatives is the Five-Year Review. The cost of this review was not included in the alternatives. Five-year reviews will be conducted as a matter of policy, because it will take more than 5 years to achieve aquifer cleanup levels to allow for unlimited use and unrestricted exposure. EPA will conduct a 5-year review within 5 years of construction completion to ensure protection of human health and the environment. This review will evaluate the effectiveness of the remedy and institutional controls. An additional purpose for the review is to evaluate whether the performance standards specified in this ROD remain protective of human health and the environment. EPA will continue the reviews until no hazardous substances, pollutants, or contaminants remain at IBW-South above aquifer cleanup standards.

Groundwater Treatment Component

A common feature to Alternatives 4, 5, and 6 is the use of a representative treatment process option for the ex-situ treatment component of the groundwater remedy. Air stripping with vapor-phase granular activated carbon (VGAC) for offgas treatment was selected as the representative treatment process option, as described in Section 6.2.3 and Appendix C of the Groundwater FS (EPA, 1997.) A representative process option was selected to simplify the subsequent development and evaluation of alternatives and the cost estimate. The treatment component of the remedy will use presumptive technologies identified in OSWER Directive 9283.1-12. One or a combination of those technologies will be used for VOCs in extracted groundwater. The specific treatment process will be finalized during the remedial design phase, based on information to be gathered at that time..

The following treatment processes passed the screening of treatment options using the criteria of effectiveness, implementability, and cost: liquid-phase granular activated carbon (LGAC), air stripping with VGAC, and Ultraviolet Light Oxidation (UV/Ox). Each of these treatment processes could be used for groundwater remediation at IBW-South. A brief description of each treatment is provided below:

- LGAC—This process option uses direct contact of the contaminated water with activated-carbon to promote adsorption of contaminants onto the carbon.
- Air Stripping/VGAC Offgas Treatment—This process option combination uses air-water contacting towers to promote transfer of contaminants from the water into an airstream. The airstream is then passed through an activated carbon bed where the contaminants adsorb onto the carbon.
- UV/Ox—This process option uses a chemical reagent and UV light to oxidize the contaminants. The reagent used is an aqueous solution of hydrogen peroxide or ozone.

Each of these technologies, if selected, would be designed to attain chemical-specific discharge requirements and to maximize long-term effectiveness and reliability while minimizing long-term operating costs.

Table 8 describes the components, cost, and estimated restoration time frame for the alternatives evaluated in the FS. The selected remedy and contingency remedy are also described. The area that will be hydraulically contained is listed in addition to the treatment technology and discharge location. Table 8 provides the number of new monitoring and extraction wells included in each alternative, and the total annual extraction rate. The capital cost, annual O&M cost, and 30-year present worth costs are provided. The estimated total lengths of conveyance

TABLE 8

Components of Selected Remedy, Contingency Remedy, and Alternatives Evaluated in Feasibility Study

Component	Alternative 1[a]	Alternative 2	Alternative 3	Alternative 4 (Selected Remedy)	Contingency Remedy[b]	Alternative 5	Alternative 6
Estimated Restoration Time Frame (years)[c]	>50	>50	>50	<30	<30	<30	<30
Containment[d]	None	None	None	Partial	Partial	Complete	Complete
Treatment[e]	None	None	Wellhead air stripping at COT No. 7 with offgas treatment by VGAC	Air stripping with offgas treatment by VGAC	Air stripping with offgas treatment by VGAC (1 additional tower)	Air stripping with offgas treatment by VGAC	Air stripping with offgas treatment by VGAC
Discharge End Use[f]	None	None	City of Tempe Potable Water Distribution System by pipeline	To be determined[c]	To be determined[c]	SRP Tempe Canal No. 6 by pipeline	Aquifer reinjection to MAU
Number of New Monitoring and Extraction Wells[g]	0	Five monitoring wells		Three UAU extraction wells, 10 UAU monitoring wells	To be determined during Remedial Design for the contingency	Twelve extraction wells; five monitoring wells	Twelve extraction wells, eight monitoring wells
Total Extraction Rate (ac-ft/yr)	0	0	Negligible	4,740	2,420	14,070	15,680
Capital Cost ($)	0	890,000	1,240,000	6,170,000	2,410,000	12,600,000	21,260,000
Annual O&M cost ($)	0	100,000	440,000	1,060,000	10,000	1,540,000	1,800,000
30-year Present Worth Cost ($)	0	2,580,000	8,000,000	22,460,000	2,570,000	36,270,000	48,930,000
Conveyance Pipeline Length from Extraction Wells to Treatment Plant (linear feet)	None	None	None	10,900	11,300	20,240	31,240
Distribution Pipeline Length from Treatment Plant to Discharge Location (linear feet)	None	None	None	50	0	3,600	27,000

[a] Alternative 1: No action.
Alternative 2: Monitored Natural Attenuation
Alternative 3: Limited Action: Wellhead Treatment at City of Tempe Well No. 7 /City of Tempe Potable Water
Alternative 4: Partial Containment: Extraction Wells/Treatment Plant Air Stripping/ Discharge to Town Lake via City of Tempe Storm Drain/Monitored Natural Attenuation
Alternative 5: Regional Containment: Extraction Wells/Treatment Plant Air Stripping/ Discharge to SRP Tempe Canal No. 6
Alternative 6: Regional Containment: Extraction Wells/Treatment Plant Air Stripping/Aquifer Reinjection

[b] Only the components that need to be added to the selected remedy are listed, i.e., only the additional cost is shown, not the total cost of the selected and contingency remedies.

[c] As described in Table 9.

[d] Partial containment refers to a volume of groundwater contaminated above MCLs that is less than the total volume of contaminated groundwater at the site, and includes only contamination in the upper aquifer (UAU). Complete containment refers to the entire volume of contamination above MCLs both in the UAU and MAU.

[e] Another treatment option may be implemented as described in the Proposed Plan, either LGAC or UV/Ox.

[f] The final discharge end use will be determined during Remedial Design, and will be to one of the end uses evaluated in the FS and Proposed Plan, specifically Town Lake, SRP Tempe Canal No. 6, and/or aquifer reinjection to the MAU. For costing purposes, Town Lake was assumed to be the discharge location.

[g] The number of new monitoring and extraction wells is an estimate and may increase or decrease depending on site conditions during Remedial Design.

and distribution pipeline that must be constructed are also included in the table. The estimated restoration time frame is provided, which is the number of years estimated for groundwater concentrations to reach MCLs throughout the entire contaminated areas. These numbers were estimated using a groundwater flow and solute transport model documented in the Technical Memorandum re *Documentation of the Indian Bend Wash-South Groundwater Flow and Solute Transport Models* (EPA, 1998), which is part of the Administrative Record.

Included in the description of each alternative below is a discussion of whether the RAOs would be met by the alternative. A component in the evaluation of overall protection of human health and the environment is the prediction of how far the contaminated areas will migrate. A groundwater flow model and a solute transport model were used to simulate migration of the contaminant plumes. The results were presented in Appendix E of the Groundwater FS (EPA, 1997c). The model simulations required an initial concentration for the contaminant being modeled. In the FS, these initial concentrations were specified using water quality data through July 1994.

An updated solute transport analysis was performed subsequent to the publication of the Proposed Plan. The update incorporated more recent water quality data collected as of October 1997. The results of the updated solute transport analysis were presented in a technical memorandum (EPA, 1998), and were used to answer the following two questions for each alternative:

- Will MCLs (in situ groundwater cleanup ARARs) be met within a reasonable time?
- Does the MCL target volume expand before remediation goals are met?

The answers to these two questions for each alternative are summarized in Table 9 and will be discussed in more detail below in each alternative description.

8.1 Description of No-Action Alternative

Evaluation of the No-Action Alternative is required under CERCLA because it is used as a baseline to compare alternatives. Under this alternative, no remedial action would be undertaken to treat, contain, or remove contaminated groundwater at IBW-South. No monitoring would be conducted and no institutional controls established.

Some reduction in the volume, toxicity, or mobility of the contaminants would occur as a result of unmonitored natural attenuation processes.

No treatment or containment components would be associated with this alternative. Under the No-Action Alternative, some reduction in risk would occur but it would be unmonitored. The RAOs would not be met for this alternative because contaminants would migrate offsite without reaching MCLs within a reasonable time frame, and protection of human health and the environment would not be achieved.

In addition, chemical-, location-, and action-specific ARARs would not be met.

8.2 Alternative 2–Monitored Natural Attenuation

Under Alternative 2, contamination in the groundwater would be reduced by natural attenuation alone. Groundwater contaminants would be allowed to degrade, dilute, or disperse through naturally occurring physical, chemical, and biological processes. Monitoring to verify

TABLE 9
Results of Solute Transport Analysis for TCE and PCE
1. Will MCLs (in situ groundwater cleanup ARARs) be met within a reasonable time?
2. Does the MCL target volume expand before remediation goals are met?

Contaminant Area	Alternatives 1, 2, 3 No Action, Natural Attenuation, and Limited Action at COT Well No. 7	Alternative 4 Selected Remedy	Alternatives 5, 6 Groundwater Extraction and Treatment of Entire Contaminant Areas in UAU and MAU
UAU Western Contaminant Area (TCE)	1. No. MCLs will not be met within approximately 30 years. 2. The westernmost contaminant area would migrate at least 7,000 feet downgradient.	1. Yes. MCLs could be met within less than approximately 30 years. 2. Contaminant area does not expand.	1. Yes. MCLs are achieved in less than approximately 30 years. 2. Contaminant area does not expand.
UAU Central Contaminant Area (TCE)	1. Yes. MCLs will be met in less than approximately 30 years. 2. Contaminant area would expand less than 500 feet.	1. Same results as Alternatives 1, 2, and 3. 2. Same results as Alternatives 1, 2, and 3.	1. Yes. MCLs are achieved in less than approximately 30 years. 2. Contaminant area does not expand.
UAU Eastern Contaminant Area (PCE)	1. Yes. MCLs will be met within a reasonable time. 2. Contaminant area migrates about 2,000 feet in the UAU.	1.Yes. MCLs could be met in less than approximately 30 years within the entire contaminant area. 2. A portion of the contaminant area migrates approximately 2,000 feet before it reaches MCLs.	1. Yes. MCLs can be met in less than approximately 30 years. 2. Contaminant area does not expand.
MAU-B (TCE)	1. Yes. TCE concentrations would reduce from 11 ppb to below 5 ppb in less than approximately 30 years. 2. MCL contaminant area in MAU-B would expand downgradient less than 2,000 feet.	1. Same results as Alternatives 1, 2, and 3. 2. Same results as Alternatives 1, 2, and 3.	1. Yes. MCLs can be met in less than approximately 30 years. 2. Contaminant area does not expand.
MAU-C (TCE)	1. Yes. TCE concentrations would reduce from 7 ppb to below 5 ppb in less than approximately 30 years. 2. MCL contaminant area in MAU-C would expand downgradient less than 2,000 feet.	1. Same results as Alternatives 1, 2, and 3. 2. Same results as Alternatives 1, 2, and 3.	1. Yes. MCLs can be met in less than approximately 30 years. 2. Contaminant area does not expand.

that these processes are occurring is included in this alternative. The potential for the biological component of the natural attenuation process to be occurring at IBW-South was evaluated in the Groundwater FS. There is not evidence that widespread biodegradation is occurring. The physical processes of dilution and dispersion are the most significant components of natural attenuation at the site.

Groundwater monitoring would be conducted to assess and verify the effectiveness of the natural attenuation processes. Institutional controls would be needed to protect the public from exposure to contaminated groundwater while natural attenuation was taking place. Approximately 50 existing wells would be in the monitoring network. The monitoring program for natural attenuation in this alternative, and as a component in the remaining alternatives, will follow EPA's interim final OSWER Directive 9200.4-17.

Data that may be required as part of a natural attenuation verification program include the following: VOCs; dissolved oxygen (DO); nitrate; ferrous iron (Iron II); dissolved manganese; sulfate; sulfide; methane, ethane, and ethene; alkalinity; oxidation/reduction potential (Redox); pH; temperature; electrical conductivity (EC); chloride; and total organic carbon (TOC).

ARARs would eventually be met in most of the contaminated areas; however, the aquifer cleanup goals would not be met within a reasonable time frame in the western contaminated area. The contaminated area in the MAU would migrate approximately 2,000 feet before TCE concentrations were reduced to the MCL of 5 µg/L. The eastern UAU area of contamination would migrate approximately 2,000 feet before PCE concentrations were reduced to MCLs. The western area of contamination would migrate greater than 7,000 feet before TCE concentrations were reduced to MCLs.

8.3 Alternative 3–Limited Action: Wellhead Treatment at COT No.7/COT Potable Water

The objective of Alternative 3 is to provide a limited action that would allow the City of Tempe to use COT No. 7 to provide water meeting drinking water standards for public water supplies on an as-needed basis.

Under Alternative 3, the well would be used intermittently, and wellhead air stripping would be conducted to remove VOCs from the existing COT No. 7. Following treatment, the treated water would be conveyed by pipeline to the City of Tempe potable water distribution system. Offgas generated from the air stripping process would be treated using VGAC. Routine monitoring of the influent to and effluent from the treatment unit would be conducted to assess operational conditions and to ensure that drinking water standards were achieved. No additional monitoring of the contaminated areas, or of MNA, would be performed. The major components of Alternative 3 are provided in Table 8.

Similar to Alternative 2, ARARs related to drinking water source protection would not be met because the migrating areas of contamination would exceed MCLs in currently uncontaminated areas,and the western area of contamination would not reach MCLs within a reasonable time frame. The migration of the areas of contamination and the risk reduction would be the same as in Alternative 2. The extent of contaminant migration was described in Table 9.

8.4 Alternative 4–Partial Containment: Extraction Wells/ Treatment Plant Air Stripping/Discharge to Town Lake via City of Tempe Storm Drain/Monitored Natural Attenuation

As Described in Proposed Plan

This alternative included extraction of a partial target volume, which was defined as the area of highest VOC-contaminated groundwater from the UAU aquifer in the central and eastern contaminated areas where concentrations are above 20 to 30 µg/L and the entire western UAU contaminated area where VOCs are above MCLs. The partial target volume was developed to establish a volume of water that is less than the regional target volume (defined as groundwater in which VOC concentrations are above the MCLs) which, when pumped and treated and combined with natural attenuation of the remaining portions of the regional target volume, would meet cleanup levels within a reasonable time frame. The partial target volume was established based on extracting the highest levels of contamination in the UAU and performing groundwater modeling to determine if this volume is sufficient to ensure that groundwater MCLs will be met within a reasonable time frame (less than 100 years, as described in the Proposed Plan) without migrating a far distance before cleanup levels are met.

The extracted groundwater within the partial target volume is piped to a centralized treatment system and the VOCs are removed from the groundwater by air stripping. VOC-contaminated offgas from air stripping is treated by using VGAC vessels. The treated water would then be delivered to the City of Tempe storm drain system, the SRP Tempe Canal No. 6, or reinjected to the MAU aquifer. The Proposed Plan stated that the exact end use for the treated groundwater would be determined during remedial design for the remedy.

Routine monitoring of the groundwater before and after treatment would be conducted to assess operational conditions and ensure cleanup goals are met. The portion of the UAU that is not actively pumped and treated, and the MAU aquifer, would migrate a short distance and naturally attenuate to MCLs within a reasonable time frame. EPA had conducted modeling to determine how far portions of the VOC-contaminated areas not treated by air stripping could migrate before reaching cleanup goals through natural attenuation processes. The results, as presented in the FS, were as follows:

- Western UAU contaminated area–The entire contaminated area is hydraulically contained, and therefore does not migrate;
- Central UAU contaminated area–Migrates less than 2,000 feet before meeting MCLs throughout the contaminated area in less than approximately 30 years;
- Eastern UAU contaminated area–Migrates approximately 2,000 feet before meeting MCLs throughout the contaminated area in less than approximately 30 years;
- MAU contaminated area (Subunits B and C)–Migrates less than 2,000 feet before meeting MCLs throughout the contaminated area in less than approximately 30 years.

Newly installed wells, in addition to existing monitoring wells, are sampled to monitor the progress of the decreases in VOC concentrations during the natural attenuation process to ensure that cleanup levels are met.

In situ cleanup ARARs would be met within the portions of the contaminated areas that would be hydraulically contained. Chemical-specific discharge requirements, presented in Table 12, will be met prior to discharge to any one of the three potential end uses. Location-specific ARARs, air quality standards, and waste management ARARs can be met.

Using the validated data through July 1994, ARARs could be met only if a portion of each of the three contaminated areas in the UAU were extracted. However, as described in the following section, extraction is not needed in all three areas when the more recent data are evaluated. The following section describes the selected remedy.

Selected Remedy–Partial Containment: Extraction Wells/Treatment Plant Air Stripping/Discharge to Town Lake, SRP Tempe Canal No. 6, or Aquifer Reinjection/Monitored Natural Attenuation

A brief description of the selected remedy is provided here. Additional information is provided in Sections 9.0, 10.0, and 11.0. As described in those sections, the selected remedy is Alternative 4, as modified on the basis of public comments on the Proposed Plan and results of the groundwater evaluation using data collected through October 1997. Major components of the selected remedy are described in Table 8. Contaminated groundwater will be extracted only from the western contaminated area in the UAU. MNA will be used to meet the RAOs in the remaining portions of the central and eastern contaminated areas in the UAU, and for the entire contaminated area within the MAU.

The exact location of the treatment plant, and the exact end use for extracted groundwater will be determined during remedial design.

All ARARs are expected to be met. The contaminated areas that will not be hydraulically contained are expected to migrate less than 2,000 feet before reaching MCLs, and all groundwater concentrations are expected to reach MCLs within approximately 30 years.

Contingency Remedy–Additional Groundwater Extraction and Treatment

As described in Section 11.0, a contingency remedy exists for the situation in which the MNA portion of the selected remedy does not perform as expected. This contingency remedy will be activated according to the criteria presented in Section 11.0. A brief description of the contingency remedy is provided here. Additional information is provided in Sections 9.0, 10.0, and 11.0. As described in those sections, public comments on the Proposed Plan and the results of the groundwater evaluation using data collected through October 1997 provided the basis for the contingency remedy. Major components of the contingency remedy are described in Table 8.

In addition to the contaminated groundwater that will be extracted from the western contaminated area in the UAU, groundwater will also be extracted from portions of the eastern contaminant area of the UAU or MAU. The area and volume of additional groundwater to be extracted will depend on which of the trigger criteria are exceeded. For costing purposes, it was assumed that a portion of the eastern contaminated area would be extracted and treated. Additional assumptions regarding the cost estimate for the contingency remedy are provided in Appendix A of this *ROD*. MNA may still be used to meet the RAOs in some portions of the contaminated areas.

The exact location of any additional treatment plant(s), and the exact end use of the additional groundwater that will be extracted, will be determined during remedial design for the contingency remedy.

All ARARs are expected to be met for the contingency remedy. Table 9 lists the estimated cleanup times and migration distances for the contingency remedy.

8.5 Alternative 5—Regional Containment: Extraction Wells/ Treatment Plant Air Stripping/Discharge to SRP Tempe Canal No. 6

The objective of this alternative was to reach aquifer cleanup goals by extraction and treatment of all of the groundwater contaminated above MCLs in each contaminated area. This alternative incorporates discharge of treated water to the SRP Tempe Canal No. 6.

The major components of Alternative 5 are described in Table 8. The conceptual design for Alternative 5 includes eight extraction wells in the UAU and four in the MAU. Similar to Alternative 4, contaminated groundwater would be conveyed by pipeline to a centralized air stripping treatment plant, and offgas would be treated using VGAC. The treated groundwater would be conveyed by pipeline to the SRP Tempe Canal No. 6 for discharge. Routine monitoring of the groundwater before and after treatment would be conducted to assess operational conditions, to ensure that discharge criteria were achieved, and to monitor progress of remediation.

As indicated in Table 9, contaminated groundwater within the areas of contamination is expected to meet cleanup standards within a reasonable time frame of less than approximately 30 years. Groundwater that is extracted will be treated to chemical-specific discharge requirements prior to discharge to SRP Tempe Canal No. 6. The alternative is protective of human health and the environment because the areas of contamination are hydraulically contained and do not migrate. Location-specific ARARs, air quality standards, and waste management ARARs can be met.

8.6 Alternative 6–Regional Containment: Extraction Wells/ Treatment Plant Air Stripping/Aquifer Reinjection

Alternative 6 is similar to Alternative 5, except that the end use of treated groundwater would be reinjection into the MAU. The major components of Alternative 6 are listed in Table 8. Eight reinjection wells would inject the treated groundwater into the MAU. As in Alternative 5, the contaminated groundwater would be conveyed via a new pipeline to a centralized air stripping treatment plant. The offgas would be treated using VGAC. Routine monitoring of the groundwater before and after treatment would be conducted to assess operational conditions and to ensure that cleanup goals were achieved.

As in Alternative 5, all ARARs would be met.

9.0 Comparative Analysis of Alternatives

The Groundwater FS presented the detailed evaluation of each alternative using the nine evaluation criteria listed below. Each of the three potential end-use options was evaluated and included in the selected remedy presented in Section 8 of the Groundwater FS (EPA, 1997c). This section compares the remedial alternatives described in Section 8.0 of this ROD. The comparative analysis provides the basis for determining which alternative presents the best balance among EPA's nine evaluation criteria listed below. The first two cleanup evaluation criteria are considered threshold criteria that must be met by the selected remedial action. The next five criteria are balanced to achieve the best overall solution. The final two modifying criteria that are considered in remedy selection are state acceptance and community acceptance.

- **Threshold Criteria**

  1. *Overall Protection of Human Health and the Environment* addresses whether a remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced, or controlled.

  2. *Compliance with Applicable or Relevant and Appropriate Requirements* addresses whether a remedy will meet all federal and state environmental laws and/or provide grounds for a waiver.

- **Primary Balancing Criteria**

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

  4. *Reduction of Toxicity, Mobility, or Volume through Treatment* refers to the preference for a remedy that reduces health hazards of contaminants, the movement of contaminants, or the quantity of contaminants through treatment.

  5. *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.

  6. *Implementability* refers to the technical and administrative feasibility of an alternative or 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 government efforts.

  7. *Cost* evaluates the estimated capital and O&M costs of each alternative in comparison to other equally protective alternatives.

- **Modifying Criteria**

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

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

The strengths and weaknesses of the alternatives and the contingency remedy were weighed to identify the alternative providing the best balance among the nine evaluation criteria. The comparative analysis of the alternatives is provided in the following discussion.

A summary of the results of the comparative analysis of the alternatives and the contingency remedy is provided in Table 10. The comparative cost of each alternative is also depicted graphically in Figure 9. The comparative analysis discussions are organized from the best performing alternatives to the worst performing alternatives within each criterion. Only those factors where there are substantial differences among the alternatives are discussed.

9.1 Threshold Criteria

Overall Protection of Human Health and the Environment

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

Table 10 presented the estimated distances each contaminated area would migrate for each alternative. The table also indicated whether the aquifer could be restored to the MCLs for TCE and PCE, the two main COCs, within a reasonable time frame of approximately 30 years. Alternatives 5 and 6 are marginally more protective of human health and the environment (i.e., the groundwater resource). Under these alternatives, all groundwater contamination exceeding aquifer cleanup standards, the majority of which are MCLs, is hydraulically contained by pumping from extraction wells, and groundwater is restored within a reasonable time frame and more rapidly than other alternatives. No new areas of groundwater would be impacted.

Alternative 4, the selected remedy, is also protective of human health and the environment. Contamination in the western area will be remediated by extraction and treatment within a reasonable time frame. Some portions of groundwater contaminated areas that exceed aquifer cleanup standards will migrate downgradient. However, MNA is expected to reduce contaminant concentrations in those portions of the groundwater so that the groundwater is restored and site risks are reduced within a reasonable time frame. Groundwater monitoring and institutional controls will provide protection of human health and the environment. No currently used groundwater wells are impaired, and aquifer cleanup standards will be reached in approximately 30 years sitewide.

Alternative 2 is less protective than the active remediation actions taken under Alternatives 4, 5, and 6. Alternative 2 relies entirely on MNA and institutional controls to achieve protection of human health and the environment. Under this alternative, more extensive migration into currently uncontaminated areas of the aquifer would occur, and the aquifer would not be restored within a reasonable time frame. Institutional controls would be required over a larger area than in Alternative 4. Alternative 3 provides a very similar level of protection as Alternative 2. The primary difference is the lack of monitoring for Alternative 3.

The No-Action Alternative provides no overall protection to human health or the environment because no monitoring is performed and no institutional controls are put in place to protect the public from exposure to contaminated groundwater.

The contingency remedy is also protective of human health and the environment. It will ensure that migration of contaminants in natural attenuation areas is limited, if necessary, and that aquifer cleanup levels are achieved in a reasonable time frame.

Compliance with ARARs

Section 121(d) of CERCLA requires that remedial actions at CERCLA sites attain legally applicable or relevant and appropriate federal and state requirements, standards, criteria, and limitations which are collectively referred to as "ARARs," unless such ARARs are waived under CERCLA Section 121(d)(4).

Applicable requirements are those substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address hazardous substances, the remedial action to be implemented at the site, the location of the site, or other circumstances present at the site. *Relevant and appropriate requirements* are those substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law which, while not applicable to the hazardous materials found at the site, the remedial action itself, the site location or other circumstances at the site, nevertheless address problems or situations sufficiently similar to those encountered at the site that their use is well-suited to the site.

As indicated in Table 10, Alternatives 4 (selected remedy), 5, and 6, and the contingency remedy would fully comply with all ARARs (chemical-, location-, and action-specific). Chemical-specific ARARs for aquifer remediation would be achieved within a reasonable time for each of these alternatives.

Aquifer cleanup standards would not be met in a reasonable time for Alternative 2 in the western contaminated area. Modeling indicates that MCLs would be met within a reasonable time frame for the central and eastern areas of UAU contamination and in the MAU. The majority of aquifer cleanup standards are MCLs for the COCs. Alternative 3 is similar to Alternative 2 in its level of compliance with ARARs.

The No-Action Alternative is similar in performance to Alternatives 2 and 3 and would not comply with ARARs. The No-Action Alternative provides the least compliance with ARARs because no institutional controls would be in place to protect the public from groundwater contaminated above regulatory limits, and no monitoring is performed, so the areas of contamination would migrate unchecked. Each of the three potential groundwater end uses and each of the three potential treatment process options would meet ARARs.

Each of the three potential groundwater end uses and each of the potential treatment process options would meet ARARs. The contingency remedy would also comply with ARARs.

9.2 Primary Balancing Criteria

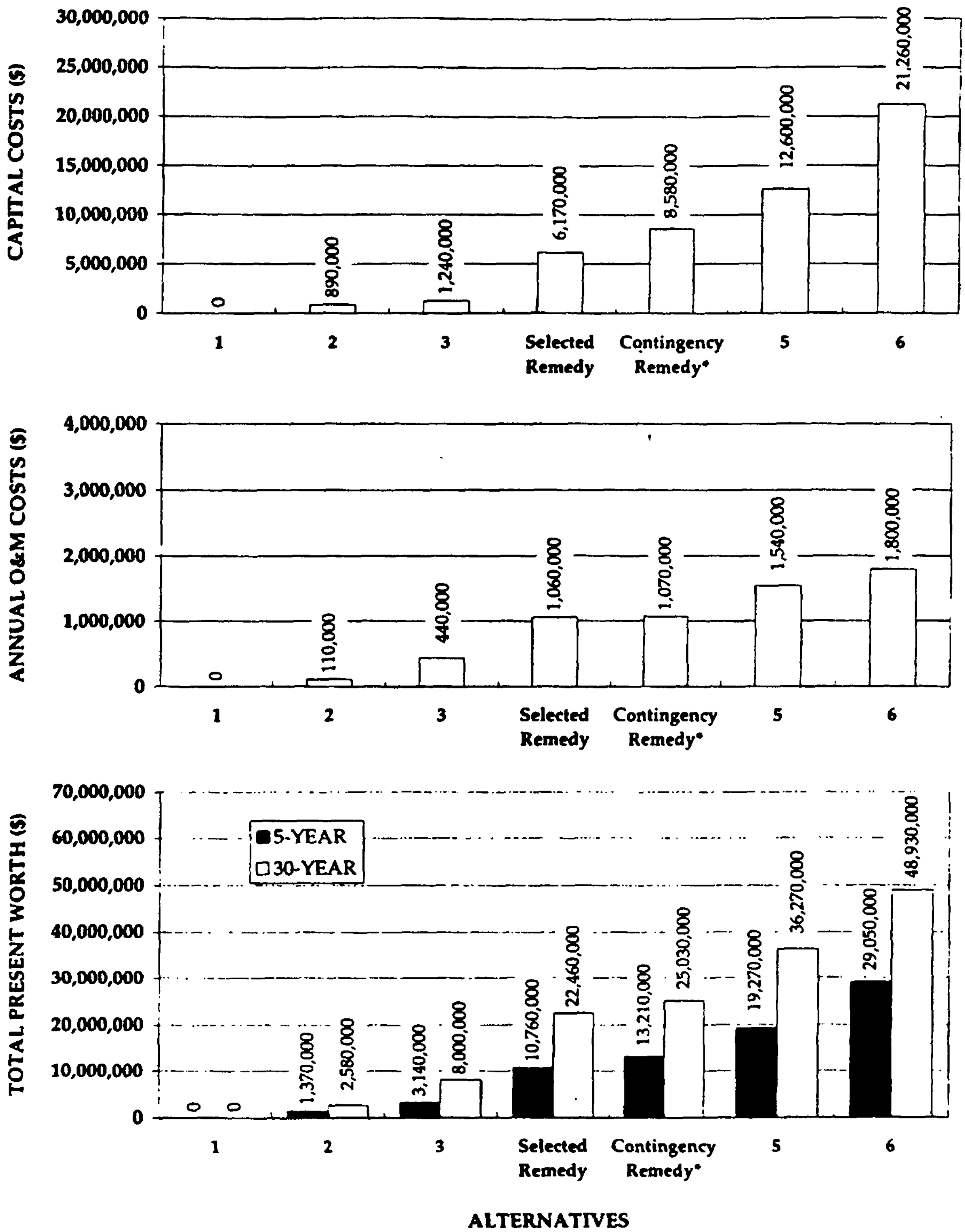
Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. This criterion includes the consideration of residual risk and the adequacy and reliability of controls.

\lternatives with EPA's Nine Evaluation Criteria

:riteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4 (EPA's Selected Remedy)	Contingency Remedy	Alternative !
ption	No-Action	Natural Attenuation: Well Permit Requirements/ Groundwater Use Restrictions/ Groundwater and Verification Monitoring	Limited Action: Wellhead Treatment at COT No. 7/ COT Potable Water: Well Permit Requirements/ Groundwater Use Restrictions/Groundwater Monitoring	Partial Containment/ Treatment/COT Storm Drain leading to Town Lake/ Natural Attenuation Well Permit Requirements/ Groundwater Use Restrictions/Groundwater Monitoring	Additional extraction and treatment	Regional Containme Treatment/Tempe C. No. 6 Well Permit Requirements/ Grou Use Restrictions/ Groundwater Monito
i of Human ıvironment	No	No; aquifer cleanup standards will not be met in the UAU in a reasonable time frame.	No; treated drinking water from COT No. 7 would pose no risks, but contaminated areas will migrate and will not be monitored.	Yes; groundwater extraction and MNA will limit migration, and aquifer cleanup standards will be met in a reasonable time frame.	Same as Alternative 4.	Same as Alternative
\RARs	No	No; aquifer cleanup standards will not be met in the UAU in a reasonable time frame.	No; same as Alternative 2.	Yes.	Yes	Yes
veness	No, does not reduce long-term risk	No; same as Alternative 1	No; same as Alternative 1.	Yes; long-term risks are greatly reduced.	Same as Alternative 4.	Same as Alternative
:ity, e through	None	None	Very little reduction of toxicity, mobility, or volume when treatment occurs at COT No. 7.	Yes; toxicity and volume are greatly reduced throughout the contaminated area. Mobility is greatly reduced in the area of highest contamination.	Yes; toxicity and volume are greatly reduced throughout the contaminated area. Mobility is greatly reduced in the area of highest contamination.	Yes; toxicity, mobility volume throughout contaminated area aı reduced.
iveness	Not applicable	Construction-related risks can be minimized.	Same as Alternative 2.	Additional short-term risks from construction of treatment plant and piping.	Slightly more construction than Alternative 4, but less than Alternatives 5 and 6.	Short-term risks grea Alternative 4 resulting larger treatment plant more piping.
	Not applicable	Yes; equipment and services are readily available.	Yes; the treatment technology is proven, reliable, and readily available.	Yes; the treatment technology is proven, reliable, and readily available. Installation of pipeline may be difficult because of existing conditions.	Same as Alternative 4.	Yes; Same as Alterna except that the Pipeli more extensive and w result in greater consi impacts than Alternati and the contingency remedy.
 ɔst ıt Worth	$0 $0 $0	$890,000 $110,000 $13,950,000	$1,240,000 $440,000 $8,000,000	$6,170,000 $1,060,000 $22,460,000	$2,410,000 (additional)[a] $10,000 (additional)[a] $2,570,000 (additional)[a]	$12,500,000 $1,540,000 $36,270,000

ɔst of Alternative 4, the selected remedy.



Note: *Costs presented fo the Contingency Remedy represent the total combined costs for Alternative 4 (Selected Remedy) and the additional costs for the Contingency Remedy

FIGURE 9
COMPARATIVE COST OF ALTERNATIVES
INDIAN BEND WASH-SOUTH GROUNDWATER OU ROD

Magnitude of Residual Risk—Alternatives 4, 5, and 6, and the contingency remedy have the lowest magnitude of residual risk. Under these alternatives, extraction and treatment and MNA of contaminated groundwater exceeding aquifer cleanup standards will reduce residual risk to acceptable levels within a reasonable time of approximately 30 years. Untreated residual contamination in groundwater will not pose a risk to human health.

Alternative 2 is higher than Alternative 4 in the magnitude of residual risk during the life of the remedy because no contaminated groundwater is extracted and treated. Alternative 2 relies entirely on natural attenuation to reduce contaminant concentrations, and they will not be met in the western area of contamination within a reasonable time frame. Similar to the other alternatives, the untreated residual contamination will not pose a risk to human health because monitoring and institutional controls will be implemented.

Alternative 3 is similar to Alternative 2 in the magnitude of residual risk.

The magnitude of residual risk under the No-Action Alternative is higher than for the other alternatives because no actions are taken to remediate contamination, and no monitoring or institutional controls would be in place to protect the public from exposure to contaminated groundwater.

Adequacy and Reliability of Controls–Alternatives 4, 5, and 6, and the contingency remedy use pump and treat processes that are well-established, reliable, and capable of meeting performance requirements. No difficulties associated with the long-term operation of these alternatives are anticipated. VGAC carbon replacement and routine maintenance of air stripping towers, UV/Ox systems, and extraction wells will be required, but these are standard operating procedures. Long-term monitoring will assess and ensure the adequacy of the alternatives at meeting cleanup objectives. The long-term reliability of institutional controls is somewhat less certain. Institutional controls are subject to changes in political jurisdiction, legal interpretation, and enforcement.

Under Alternatives 2 and 4, the adequacy and reliability of the MNA portion of each alternative to meet cleanup goals is somewhat less certain than the pump and treat actions taken under Alternatives 5 and 6, but MNA is expected to reach cleanup levels in a reasonable time frame in the central and eastern contaminated areas. However, by setting the contingency criteria to activate pump and treat, Alternative 4 is more reliable in meeting cleanup goals if MNA fails. Alternative 2 is less reliable because, unlike Alternative 4, it does not include extraction in the western contaminated area.

Alternative 3 is similar to Alternatives 4, 5, and 6 with respect to the pump and treat aspect of the alternative. Wellhead air stripping and VGAC treatment of offgas are well-established and reliable processes. However, Alternative 3 only addresses contaminated groundwater at COT No. 7 (a much smaller volume) and not overall groundwater contamination at IBW-South, and would be operated only sporadically.

The No-Action Alternative is inadequate and not reliable because no actions are taken, and no monitoring is conducted.

Reduction of Toxicity, Mobility, or Volume through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy.

Treatment Processes Used and Materials Treated–Alternatives 4, 5, and 6 and the contingency remedy would use treatment trains which may consist of air stripping with VGAC, LGAC, or UV/Ox. Alternative 3 would use a treatment train assumed to consist of air stripping and VGAC treatment of offgas to treat VOC-contaminated groundwater.

Under the No-Action Alternative and Alternative 2, no treatment processes are used.

Degree of Expected Reductions in Toxicity, Mobility, or Volume–Under Alternatives 4, 5, and 6, and the contingency remedy, air stripping, LGAC, or UV/Ox will remove 99.9 percent of the VOCs in the groundwater extracted from the aquifer. The volume of contaminated groundwater at concentrations exceeding aquifer cleanup standards is hydraulically contained and gradually reduced through groundwater pumping.

Alternative 3 is a limited action that will not provide significant reductions in the toxicity, mobility, or volume of groundwater contamination at IBW-South. This alternative will provide some minor reduction in the volume of contaminants through occasional pumping of COT No. 7 and operation of the treatment system, but this is considered insignificant. Alternative 3 is similar to Alternative 2, in that the majority of reductions in contaminant toxicity in the aquifer will only occur as the result of naturally occurring processes. Migration of contaminated groundwater will be similar to Alternative 2.

The No-Action Alternative does not provide any reduction in toxicity, mobility, or volume through active treatment.

Degree to Which Treatment is Irreversible–Under Alternative 3, air stripping with VGAC, and under Alternatives 4, 5, and 6, air stripping with VGAC adsorption of contaminants in the offgas, LGAC treatment are inherently irreversible treatment processes as long as the spent carbon is properly disposed of offsite.

Type and Quantity of Treatment Residual–Under Alternatives 3, 4, 5, and 6, it is assumed that air stripping treatment would transfer VOCs to air, and this offgas generated from the air stripping would be treated using VGAC. It is possible that LGAC, UV/Ox may be used as the treatment option for the selected alternative. However, the calculations of spent carbon for the alternatives is based on use of air stripping with VGAC offgas treatment. The quantity of spent carbon under each alternative is as follows, in declining order:

- Alternative 6–160,000 pounds per year
- Alternative 5–150,000 pounds per year
- Contingency remedy–67,000 pounds per year
- Alternative 4 (selected remedy)–44,000 pounds per year
- Alternative 3–unknown, because the amount of intermittent pumping at COT No. 7 cannot be estimated (but it is much less than the quantity generated under Alternative 4)
- No treatment residuals are generated under the No-Action Alternative and Alternative 2.

Short-Term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers and the community during construction and operation of the remedy until cleanup goals are achieved.

Protection of Community and Workers During Remedial Action—Alternative 2 poses only minimal risks to the community and workers associated with the installation of natural attenuation monitoring wells.

Alternative 3 involves construction of a wellhead treatment unit, consisting of an air stripper and VGAC adsorption vessels, at the COT No. 7. The minimal risk posed to the community is similar to that posed by Alternative 2. Discharges from the treatment unit will meet local air district emissions requirements..

Because of the additional construction activities under Alternatives 4, 5, and 6, slightly higher risks are posed than under Alternatives 2 and 3. However, the risks to the community are still fairly minimal if proper health and safety procedures are followed. Alternative 4 and the contingency remedy pose less risk than Alternatives 5 and 6 because there is less construction.

Environmental Impacts—Alternatives 2 and 3 pose only minimal risks to the environment associated with the installation of natural attenuation monitoring wells. Good work practices will provide environmental protection during remedial action activities. Discharges from the treatment unit installed for Alternative 3 will meet local air district emissions requirements that are set to be protective of the environment.

Alternatives 4, 5, and 6, and the contingency remedy all involve construction of a treatment plant(s) using air stripping/VGAC, LGAC, or UV/Ox treatment, installation of conveyance pipeline, and installation of extraction and monitoring wells. Because of the additional complexity and scope of these alternatives, slightly higher environmental risks are posed than under the simpler actions taken under Alternatives 2 and 3. However, similar to Alternatives 2 and 3, the risks to the environment are still expected to be minimal. Risks posed by Alternative 4 would be slightly less than Alternatives 5 and 6 because there is less construction. Alternative 6 may pose more risks than Alternative 5 because it requires construction of an injection well. Discharges from the treatment unit will meet local air district emissions requirements that are set to be protective of the environment. Similarly, discharge of treated groundwater will comply with appropriate regulations for discharge to surface water or aquifer reinjection.

Alternative 4 has fewer short-term environmental impacts because a considerably smaller volume of groundwater is extracted, treated, and disposed of. Therefore, less groundwater is disturbed, less energy is used in treating it, fewer treatment residuals are created, and less disposal capacity is used.

Time Until Remedial Objectives are Achieved–The estimated times until cleanup goals will be achieved under each alternative were presented in Table 10 and are as follows:

- Alternatives 4, 5, and 6–less than approximately 30 years for UAU and MAU
- Alternative 2–The western area of contamination UAU will require more than 100 years to meet MCLs; MCLs will be met in the MAU within approximately 30 years.

- Alternative 3 and the No-Action Alternative–similar to Alternative 2, except no monitoring is conducted to assess progress towards cleanup.

Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

Ability to Construct and Operate the Technology and Reliability of the Technology–All of the alternatives are expected to be readily constructed and operated using reliable technologies. Although the natural attenuation technology is less proven than the pump and treat technologies, it is expected to be reliable.

Alternatives 4, 5, and 6, and the contingency remedy all involve construction of air stripping/VGAC, LGAC, or UV/Ox treatment plant, installation of conveyance pipelines, and installation of extraction and monitoring wells. Alternative 6 also involves installation of groundwater injection wells. Because of the additional complexity and scope of these alternatives, more difficulties during construction will likely be encountered than under the simpler actions taken under Alternatives 2 and 3. Alternative 4 presents fewer implementation problems than Alternatives 5 and 6 because considerably less construction is necessary in MNA areas. However, the active treatment components of Alternatives 4, 5, and 6 are commonly employed and not exceptionally difficult to construct or operate. Because IBW-South is in a developed industrial/commercial area, difficulties may arise associated with the installation of conveyance pipelines. Complications caused by obtaining required utility clearances, implementing traffic controls, and obtaining easements may also be encountered. Such implementability difficulties are likely to be somewhat more significant for Alternatives 5 and 6 than Alternative 4 because active measures and pipeline cover greater area.

Pilot testing of the groundwater injection wells installed under Alternative 6 may be required. Operation of the extraction/treatment/aquifer reinjection system under Alternative 6 makes this alternative the most difficult to construct and operate.

Ability to Monitor Effectiveness of Remedy–No difficulties in the ability to monitor the effectiveness of the remedy are anticipated under Alternatives 2, 4, 5, and 6, and the contingency remedy. Groundwater monitoring will be conducted to monitor the effectiveness of the remedy at reducing contaminant concentrations. For Alternatives 3, 4, 5, and 6, treatment plant air and water effluent monitoring will be conducted without significant difficulty to ensure that discharge requirements are met. For Alternative 6, water level measurements will also be routinely collected to evaluate the extent of groundwater mounding near injection wells.

Alternative 3 is a limited action with limited monitoring compared with that conducted under Alternatives 2, 4, 5, and 6, and the contingency remedy. No difficulties are anticipated in conducting this monitoring. Wellhead treatment plant air and water effluent monitoring will be conducted to ensure that discharge requirements are met.

Coordination with Other Agencies–Under each of the other alternatives, considerable coordination between EPA, ADEQ, ADWR, City of Tempe, and SRP will be required. The level of effort required to accomplish this coordination for each alternative is uncertain. The interagency coordination issues include the following.

Under Alternative 2, EPA will need to coordinate with state and local agencies including ADWR, ADEQ, and the City of Tempe (e.g., to obtain necessary substantive permit requirements). Natural attenuation engineering evaluations will be performed and provided to agencies to ensure that future institutional controls are considered and implemented by state and local authorities to protect the public from VOC-contaminated groundwater.

Under Alternative 3, EPA will need to coordinate with state and local agencies including ADWR, ADEQ, and City of Tempe with regard to the community water supply that may be provided from COT No. 7 in the event of an emergency.

Under Alternatives 4, 5, 6, and the contingency remedy, the above coordination as described in Alternative 2 is required. In addition, if groundwater is extracted from within the SRP service area and used outside the service area (i.e., Town Lake), discussions will be held with SRP to consider water quality issues, water rights, water accounting, cost, liability, and operational concerns. These water rights issues will not affect implementation of the alternative, but could affect budget and schedule. Coordination between EPA and ADEQ will be required concerning substantive water quality requirements for discharge to Town Lake, if this is the end use determined during remedial design. Coordination between SRP and EPA will be required concerning substantive water quality requirements for discharge of treated groundwater to SRP Tempe Canal No. 6. Coordination between SRP and EPA will be required if treated groundwater is injected within the SRP service area. Additional coordination with ADEQ and DWR may be required on groundwater resource protection issues.

Availability of Offsite Treatment, Storage, and Disposal Services and Capacity–Under Alternatives 2, 4, 5, and 6, and the contingency remedy, contaminated groundwater that is purged from monitoring wells during verification sampling will be disposed of in the City of Tempe sanitary sewer system if the discharge requirements are met.

For Alternatives 3, 4, 5, and 6, a vendor will be used to remove, transport, and dispose of spent carbon from VGAC or LGAC units. These types of vendors are readily available and have sufficient capacity to handle the volume of carbon to be used at IBW-South.

The amount of treated groundwater to be discharged under Alternative 4 and the contingency remedy is potentially less than that for Alternatives 5 and 6. The discharge end-use options under consideration will be able to accommodate the maximum estimated flow rate from the treatment plant(s) under normal conditions. However, if Town Lake is selected as the end use of Alternative 4 (selected remedy), the capacity of the existing storm sewer system to convey treated groundwater to Town Lake may be reduced during storm events, potentially affecting full flow capacity for storm runoff.

Cost

Table 11 lists the capital, annual O&M, and present worth costs for each alternative. The estimated 30-year present worth for the alternatives, not including the No-Action Alternative, ranges from $2.6 million for Alternative 2 to $48.9 million for Alternative 6.

TABLE 11
Cost

	Capital Cost ($)	Annual O&M Cost ($)	30-Year Total Present Worth ($)	5-year Total Present Worth ($)
Alternative 1	0	0	0	0
Alternative 2	890,000	100,000	2,580,000	1,370,000
Alternative 3	1,240,000	440,000	8,000,000	3,140,000
Alternative 4 (Selected Remedy)	6,170,000	1,060,000	22,460,000	10,760,000
Alternative 5	12,600,000	1,540,000	36,270,000	19,270,000
Alternative 6	21,260,000	1,800,000	48,930,000	29,050,000
Contingency Remedy[a]	2,410,000	10,000	2,570,000	2,450,000

[a] The cost of the components that would be in addition to the cost of Alternative 4, the selected remedy.

The cost of each alternative increases as the volume of groundwater to be extracted and treated increases. Alternatives 5 and 6 do not provide a significant increase in protectiveness over Alternative 4; the portions of contaminated groundwater that will not be extracted with the selected remedy will be remediated using MNA. The MNA in central and eastern areas will meet the same RAOs in the same time period, and will be equally protective, as Alternatives 5 and 6, but at a greatly reduced cost. The selected alternative costs approximately $14 million less than Alternative 5.

9.3 Modifying Criteria

State Acceptance–The State of Arizona prefers Alternative 4 (selected remedy) with the option to employ the contingency remedy, as needed, over the remaining alternatives because this alternative restores the groundwater resource without extracting large quantities of groundwater and because it is more cost-effective than Alternatives 5 and 6, while still being protective of human health and the environment and meeting ARARs within a reasonable time frame of approximately 30 years.

Community Acceptance–The community has expressed concern about using the SRP Tempe Canal No. 6 as an end use for treated groundwater. The community generally supports Alternative 4 more than Alternatives 5 and 6 because it is more cost-effective, and it extracts a smaller volume of groundwater while still meeting aquifer cleanup goals within a reasonable time frame of approximately 30 years and at a reduced cost.

10.0 Explanation of Significant Differences

10.1 Difference in Selected Remedy

The selected remedy is Alternative 4 (presented in the FS) with minor modifications. The selected remedy differs from Alternative 4 with adjustments in the volume and area of the partial target volume to be extracted and treated, the addition of a contingency remedy, the revision of the time period in which EPA expects the groundwater to meet aquifer cleanup goals, and a lower cost. EPA's modeling has shown that it is no longer necessary to include portions of the central and eastern areas of contamination in the partial target volume for extraction and treatment. MNA alone should be sufficient to meet EPA cleanup objectives in these areas.

In the groundwater FS, EPA estimated partial and regional target volumes to evaluate a range of alternatives that might achieve EPA's remedial action objectives. The regional target volume represents the volume of groundwater in the UAU and MAU areas of contamination estimated to be above MCL concentrations. The partial target volume represented a volume that would be necessary to extract and treat, when combined with MNA of lesser contaminated areas of groundwater, that would meet MCLs within a reasonable time frame of 30 to 50 years with limited migration to 2,000 feet beyond the estimated extent of the central and eastern areas of contamination.

The preferred remedy of Alternative 4 in the Proposed Plan specified extraction and treatment of the partial target volume that included all of the western area of contamination above 5 ppb, the MCLs for TCE and PCE, and extraction and treatment of only the most highly VOC-contaminated portions of the central and eastern areas of contamination. The partial target volumes presented in the Proposed Plan were based on groundwater data collected through July 1994. EPA stated in the Proposed Plan that the target volumes were based on modeling performed in the FS and that additional work would be necessary during remedial design to further refine the target volumes.

EPA received several comments on the Proposed Plan centered around the use of older data (data collected through July 1994) to model target volumes of VOC-contaminated groundwater for extraction and treatment and areas for MNA. EPA anticipated the need to modify the partial target volumes during remedial design, but because of the lapse of time between release of the FS and the issuance of this ROD, EPA performed modeling to evaluate more recent data. EPA has presented these results here in this ROD and in the Technical Memorandum *Documentation of the Indian Bend Wash-South Groundwater Flow and Solute Transport Models*, dated August 12, 1998, which is available in the site Administrative Record.

The results of the updated modeling effort show that extraction and treatment are still necessary for all of the western area of contamination. However, MNA of the central and eastern areas of contamination in the UAU will be sufficient to meet MCLs within a reasonable time frame of approximately 30 years and will allow only limited migration of contaminated groundwater to approximately 2,000 feet.

As a result of this review and modeling of more current data, EPA therefore has modified Alternative 4 by changing the volume of contaminated groundwater that will be extracted and treated. The selected remedy eliminates the extraction of groundwater from the central and eastern areas of contamination. Those areas will be remediated by MNA.

EPA has revised the time period to meet cleanup objectives to approximately 30 years based on comments submitted during the public comment period, because all modeling evidence indicates that cleanup levels can be met within this time frame. EPA believes this is a reasonable time given the current contaminant concentrations and other circumstances at the site in which to expect aquifer cleanup goals to be met.

Another change to the preferred remedy set forth in the Proposed Plan is the addition of a contingency remedy to ensure that cleanup goals are met within the central and eastern UAU areas of contamination and the MAU, where MNA is the remedy. EPA has developed a contingency remedy and specific criteria which, if exceeded, will activate the contingency remedy of extraction and treatment of partial target volumes of the central and/or eastern UAU areas of contamination and/or the MAU areas of contamination to meet the performance standards.

Contingency Remedy

A contingency remedy of extraction and treatment of appropriate target volumes of contaminated groundwater in MNA areas will be triggered to satisfy the following two criteria: (1) attaining aquifer cleanup standards within a reasonable time frame of approximately 30 years, and (2) preventing migration of groundwater contaminated above the aquifer cleanup standards to and beyond the compliance boundaries. The appropriate "target volume" of contaminated groundwater to be extracted and treated will be determined to ensure that these two criteria are met.

The compliance boundary for the central and eastern UAU areas of contamination is located approximately 2,000 feet south of Broadway Road, bounded by Price Road to the east and Dorsey Lane to the west. Sentinel wells will be located in the UAU upgradient of the UAU compliance boundary in an area bounded by Broadway Road to the north, approximately 1,000 feet south of Broadway Road to the south, approximately 1,000 feet east of Price Road to the east, and Dorsey Lane to the west. The compliance boundaries are shown on Figure 10.

The compliance boundary for the MAU areas of contamination is located approximately 2,000 feet east of the current extent of VOC contamination and is bounded by Rio Salado Parkway to the north and Apache Boulevard to the south. Sentinel wells will be located approximately 1,000 feet upgradient of the MAU compliance boundary, as shown on Figure 10. The sentinel wells will be monitored at least quarterly.

For the UAU or MAU, the contingency remedy will be triggered if either one of the following situations occurs:

(a) If verification sampling at the sentinel wells confirms that data collected during quarterly sampling exceed the aquifer cleanup standards, and if the average contaminant concentration collected from the next two consecutive quarterly sampling rounds from this well exceeds the aquifer cleanup standards, then the contingency remedy will be activated. The contingency remedy may be implemented sooner, if needed.

(b) EPA-approved flow and transport modeling will be conducted using data collected during each EPA 5-year review period. If the modeling evaluation indicates that the MNA remedy will not attain aquifer cleanup standards within a reasonable time frame of approximately 30 years from the start of remedial action, then the contingency remedy will be activated.

10.2 Differences in Cost

Modifying the remedy presented in the Proposed Plan with a potential contingency remedy to allow for MNA in the central and eastern UAU areas of contamination has allowed the costs for the selected remedy to be reduced as follows.

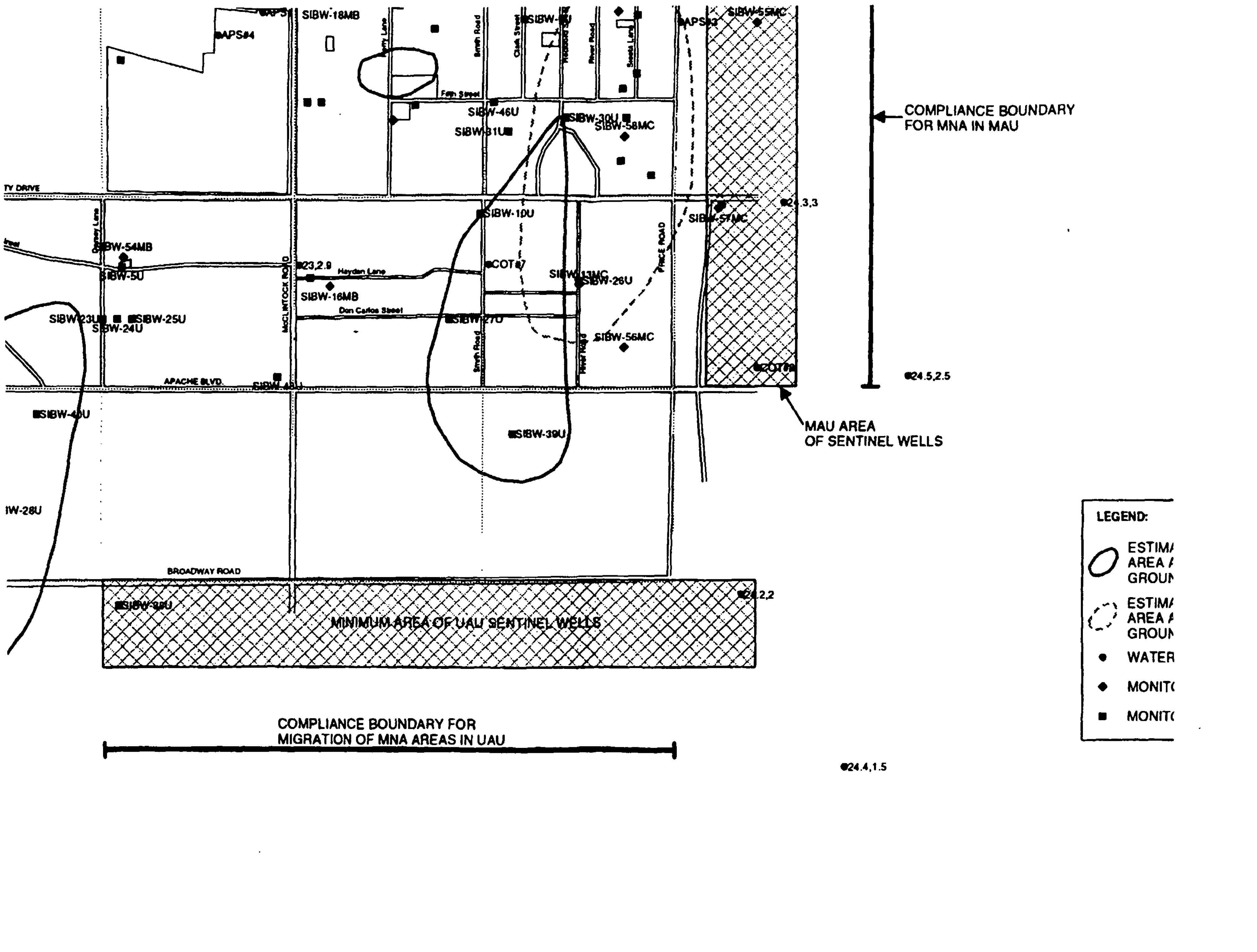
The capital cost of the selected remedy decreased by $2.15 million (from $8.32 million to $6.17 million) because of the reduction in the number of extraction wells, the length of conveyance piping, and the changes in the treatment requirements. The annual O&M cost decreased by $240,000 (from $1.3 million to $1.06 million) because of lower power requirements and less O&M required for the extraction wells. The 30-year total present worth cost decreased by more than 20 percent, from $28.3 million to $22.46 million.

The costs for the contingency remedy were not presented in the FS. These costs are discussed in Chapters 9.0 and 11.0 of this ROD.

10.3 Potential Differences in End Use of Treated Water

In the Alternative 4 presented in the Proposed Plan, the name of the alternative included Town Lake as the discharge location. The Proposed Plan did state that the exact end use would be determined during remedial design. EPA has proposed in the selected remedy to discharge extracted groundwater, once it has been treated to health-based levels, to one of the following three places: City of Tempe Town Lake, groundwater reinjection to the MAU, and the SRP Tempe Canal No. 6.

Several comments were received during the comment period concerning discharge of the treated groundwater to the SRP Tempe Canal No. 6 because of the potential for water from this canal to be used as a source of drinking water. Groundwater would be treated to meet the standards for protection of drinking water sources as specified in Section 12 before it enters the canal. EPA will consider eliminating this discharge option from the list of possible end-use options when the end-use determination is made during the remedial design phase. EPA intends to keep the community involved during the selection of end use of treated groundwater.



SIBW-18MB
APS#4
APS#3
SIBW-55MC
Fifth Street
SIBW-46U
SIBW-30U
SIBW-58MC
SIBW-31U
COMPLIANCE BOUNDARY
FOR MNA IN MAU
SIBW-10U
SIBW-57MC
24,3,3
SIBW-54MB
SIBW-5U
23,2,9
Haydan Lane
COT#7
SIBW-26U
PRICE ROAD
SIBW-16MB
Don Carlos Street
SIBW-27U
SIBW-25U
SIBW-24U
McCLINTOCK ROAD
SIBW-56MC
APACHE BLVD.
24.5,2.5
SIBW-40U
MAU AREA
OF SENTINEL WELLS
SIBW-39U
BROADWAY ROAD
24,2,2
MINIMUM AREA OF UAU SENTINEL WELLS
COMPLIANCE BOUNDARY FOR
MIGRATION OF MNA AREAS IN UAU
24.4,1.5
LEGEND:

11.0 Selected Remedy

After considering CERCLA's statutory requirements, the detailed analysis of alternatives for IBW-South, and the public comments on the Proposed Plan, EPA, in consultation with the State of Arizona, has determined that the most appropriate remedy for VOCs in groundwater at IBW-South includes the following:

- Extraction of the western UAU area of VOC-contaminated groundwater to attain aquifer cleanup standards and hydraulic containment of the contaminated areas to inhibit both lateral and vertical migration
- Treatment of extracted water to performance standards using liquid granular activated carbon (LGAC), air stripping with vapor granular activated carbon (VGAC), or ultraviolet light oxidation (UV/Ox)
- Discharge of treated groundwater to the City of Tempe storm drain system leading to Town Lake, the SRP Tempe Canal No. 6, or reinjection.
- MNA of the central and eastern UAU areas of VOC-contaminated groundwater and the MAU areas of VOC-contaminated groundwater to attain aquifer cleanup standards within those areas, and to prevent migration of groundwater contaminated above the aquifer cleanup standards to and beyond the compliance boundaries established in this ROD.
- The establishment of compliance boundaries for those areas where the MNA remedy is selected. The compliance boundaries represent borders beyond which VOC-contaminated groundwater above aquifer cleanup standards will not be allowed to migrate. The compliance boundary for the central and eastern UAU areas of contamination is located approximately 2,000 feet south of Broadway Road, bounded by Price Road to the east and Dorsey Lane to the west. Sentinel wells will be located in the UAU upgradient of the UAU compliance boundary in an area bounded by Broadway Road to the north, approximately 1,000 feet south of Broadway Road to the south, approximately 1,000 feet east of Price Road to the east, and Dorsey Lane to the west. The location of the compliance boundaries and areas for sentinel wells are shown in Figure 10 in Section 10.0. The sentinel wells will be monitored at least quarterly for the hazardous substances for which aquifer cleanup standards are established (see Section 12.0), and for other substances as appropriate.

  The compliance boundary for the MAU areas of contamination is located approximately 2,000 feet east of the current extent of VOC contamination and is bounded by Rio Salado Parkway to the north and Apache Boulevard to the south. Sentinel wells will be located approximately 1,000 feet upgradient of the MAU compliance boundary, as shown in Figure 10 in Section 10.0. The sentinel wells will be monitored at least quarterly for the chemicals for which aquifer cleanup standards are established (see Section 12.0), and for other substances as appropriate.
- Continued monitoring of groundwater to verify the effectiveness of the extraction and treatment and MNA remedies and to ensure that aquifer cleanup goals are met throughout the areas of VOC contamination.
- Institutional controls to protect the public from exposure to contaminated groundwater exceeding aquifer cleanup levels until cleanup levels are met. Institutional controls will

include various Arizona well siting, permitting, and construction restrictions, and notices distributed by the ADWR, Arizona Department of Health Services, or EPA concerning risks from exposure to contaminated groundwater. Additional institutional controls to prevent interference with EPA's remedial efforts also may be established.

- Sealing or abandonment of Well SRP23E, 2.9N to eliminate this potential path of VOC contaminant migration from the UAU to the MAU. This well is located in an area of shallow contamination and represents a potential conduit for downward contaminant migration. Other monitoring wells that will not be included in the long-term monitoring network will be abandoned as appropriate.

Contingency Remedy

A contingency remedy of extraction and treatment of appropriate target volumes of contaminated groundwater in MNA areas may be triggered to satisfy the following two criteria: (1) attaining aquifer cleanup standards within a reasonable time frame of approximately 30 years, and (2) preventing migration of groundwater contaminated above the aquifer cleanup standards to and beyond the compliance boundaries. The appropriate "target volume" of contaminated groundwater to be extracted and treated will be determined to ensure that these two criteria are met.

For the UAU or MAU, the contingency remedy will be triggered if either one of the following situations occurs:

(a) If verification sampling at the sentinel wells confirms that data collected during quarterly sampling exceed the aquifer cleanup standards, and if the average contaminant concentration collected from the next two consecutive quarterly sampling rounds from this well exceeds the aquifer cleanup standards, then the contingency remedy will be activated. The contingency remedy may be implemented sooner, if needed.

(b) EPA-approved flow and transport modeling will be conducted using data collected during each EPA 5-year review period. If the modeling evaluation indicates that the MNA remedy will not attain aquifer cleanup standards within a reasonable time frame of approximately 30 years from the start of remedial action, then the contingency remedy will be activated.

Both the selected groundwater remedy and the contingency remedy meet the two NCP threshold evaluation criteria of overall protection of human health and the environment and compliance with ARARs, provide the best balance of tradeoffs based on the primary balancing criteria, and are acceptable to the State of Arizona and the community.

The groundwater cleanup (including groundwater extraction and MNA), treatment and discharge, and additional components of the selected remedy and the contingency remedy are described in the following subsections. The ARARs for the selected remedy are described in Section 12.

11.1 Groundwater Restoration Component

This section describes the groundwater restoration components of the selected remedy. Both groundwater extraction and MNA are described in this section, along with associated performance standards and contingency actions.

Groundwater Extraction

The groundwater extraction component of the selected remedy addresses containment and cleanup of VOC-contaminated groundwater in the western area of the UAU. Groundwater extraction will be used to remediate groundwater that is contaminated in excess of groundwater cleanup standards. It will also prevent migration of the contaminated area. Approximately three wells will be installed and screened in the UAU to extract contaminated groundwater. Modeling reported in the FS and more recent modeling show that without extraction and treatment, PCE and TCE, the main COCs, would migrate 7,000 feet.

Performance Standards and Compliance Monitoring

The groundwater extraction component of the groundwater remedy will be operated until groundwater no longer exceeds the aquifer cleanup standards throughout the contaminated area. Groundwatr extraction will also contain the plume, and the compliance boundary for this portion of the remedy is the extent of contaminated groundwater above the aquifer cleanup standards throughout the western UAU contaminated area.

Water levels will be monitored in monitoring wells to show that the groundwater extraction system is controlling the horizontal and vertical migration of groundwater contaminated above aquifer cleanup levels. If the groundwater extraction containment system is not effective in the western UAU, additional measures will be implemented to ensure that performance standards are met. Examples of such measures may include, but are not limited to, any of the following: more closely spaced extraction wells to facilitate containment or higher extraction rates to increase hydraulic control and expedite restoration. EPA may also determine that more extensive groundwater monitoring is required to ensure that downgradient VOC concentrations in currently clean areas are not increasing.

Monitored Natural Attenuation

As described in Section 10.0, EPA's modeling has shown that MNA alone should be sufficient to meet EPA cleanup objectives in the central and eastern UAU and MAU areas of contamination.

The objective of the MNA component of the remedy is to allow contaminant concentrations in groundwater in the eastern and central UAU and the MAU areas of contamination to be reduced to groundwater cleanup standards within all contaminated areas above aquifer cleanup standards and within a reasonable time frame of approximately 30 years. Natural attenuation reduces contaminant concentrations by dispersion, dilution, biodegradation, and related natural processes. As discussed below, it is anticipated that MNA will accomplish these goals before contaminated groundwater above aquifer cleanup standards reaches the compliance boundaries. The compliance boundaries represent borders beyond which VOC-contaminated groundwater above aquifer cleanup standards will not be allowed to migrate. The compliance boundary for the central and eastern UAU areas of contamination is located approximately 2,000 feet south of Broadway Road, bounded by Price Road to the east and Dorsey Lane to the west. The compliance boundary for the MAU areas of contamination is located approximately 2,000 feet east from the current downgradient extent of VOC contamination at the MCLs and is bounded by Rio Salado Parkway to the north and Apache Boulevard to the south. These boundaries are depicted in Figure 10 in Section 10.

For the contaminated areas where MNA will be implemented, the following are estimates based on EPA modeling presented in this ROD of how far the contamination may migrate beyond its current extent and when the groundwater will meet MCLs for TCE and PCE, the two main COCs:

- Central UAU area of contamination–Recent data indicate that groundwater concentrations do not exceed MCLs.
- Eastern UAU area of contamination–Migrates approximately 2,000 feet before meeting MCLs throughout the area in less than approximately 30 years
- MAU area of contamination (Subunits B and C)–Migrates less than 2,000 feet before meeting MCLs throughout the area in less than approximately 30 years.

New and existing monitoring wells will be sampled to monitor the progress of the decreases in VOC concentrations during the natural attenuation process to ensure that cleanup levels are met and to determine if the contingency remedy trigger criteria (described below) have been exceeded.

MNA will encompass EPA's guidelines on *Use of Monitored Attenuation at Superfund, RCRA Corrective Action and Underground Storage Tank Sites* (OSWER Directive 9200.4-18 Interim Final as published in the Federal Register December 8, 1997.

Performance Standards and Compliance Monitoring

For the MNA component of the remedy to meet the performance requirements, VOC concentrations in groundwater must be reduced to aquifer cleanup standards in approximately 30 years or less and groundwater exceeding cleanup standards must not reach the compliance boundaries established for the central and eastern UAU and MAU. Specific trigger criteria have been developed to determine if natural attenuation is progressing as expected and will meet the cleanup objectives. These are described below.

Contingency Trigger Criteria for UAU

Sentinel wells will be located in the UAU upgradient of the UAU compliance boundary in an area bounded by Broadway Road to the north, approximately 1,000 feet south of Broadway Road to the south, approximately 1,000 feet east of Price Road to the East, and Dorsey Lane to the west. For the UAU, the contingency remedy will be triggered if either one of the following situations occurs:

(a) If verification sampling at the sentinel wells confirms that data collected during quarterly sampling exceed the aquifer cleanup standards, and if the average contaminant concentration collected from the next two consecutive sampling rounds from this well exceeds the aquifer cleanup standards, then the contingency remedy will be activated. The contingency remedy may be implemented sooner, if needed.

(b) EPA-approved flow and transport modeling will be conducted using data collected during each EPA 5-year review period. If the modeling evaluation indicates that the MNA remedy will not attain aquifer cleanup standards within a reasonable time frame of approximately 30 years from the start of remedial action, then the contingency remedy will be activated.

Contingency Trigger Criteria for MAU

Sentinel wells will be located approximately 1,000 feet upgradient of the MAU compliance boundary. For the MAU, the contingency remedy will be triggered if either one of the following situations occurs:

(a) If verification sampling of the sentinel wells confirms that data collected during quarterly sampling exceed the aquifer cleanup standards, and if the average contaminant concentration collected from the next two consecutive sampling rounds from this well exceeds the aquifer cleanup standards, then the contingency remedy will be activated. The contingency remedy may be implemented sooner, if needed.

(b) EPA-approved flow and transport modeling will be conducted using data collected during each EPA 5-year review period. If the modeling evaluation indicates that the MNA remedy will not attain aquifer cleanup standards within a reasonable time frame of approximately 30 years from the start of remedial action, then the contingency remedy will be activated.

Contingency Remedy – Additional Extraction and Treatment

If the MNA does not perform as expected and the trigger criteria described above are exceeded, the contingency remedy will be implemented. The contingency remedy will include groundwater extraction in the central and/or eastern UAU or the MAU of a target volume of contaminated groundwater, followed by groundwater treatment, and treated water discharge.

The location and magnitude of groundwater extraction for the target volume required will be determined on the basis of groundwater conditions at the time the trigger criteria are exceeded. The groundwater extraction of the target volume implemented as part of the contingency action must be sufficient to ensure that groundwater cleanup standards are not exceeded at the compliance boundary and that the time to meet aquifer cleanup standards is not exceeded. If appropriate, the monitored natural attenuation remedy may still be in use in portions of the central and/or eastern UAU and the MAU even as active extraction is occurring in other portions of these areas.

Groundwater treatment and treated water discharge under the contingency remedy would have the same components, performance standards and monitoring requirements as described below in Section 11.2 for the western area of contamination in the selected remedy. The location of any additional treatment plant(s) and the end use of the additional treated water will be determined during the remedial design phase of the contingency action.

11.2 Groundwater Treatment and Discharge Component

This section describes the treatment of the contaminated groundwater and discharge of the treated water. This includes the treatment of the western UAU area of contamination, as well as any target volume of the central and/or eastern UAU and MAU areas of contamination treated because of activation of the contingency remedy.

The groundwater extracted as part of any groundwater remedial action will be piped to a treatment system for VOC removal. It is expected that the VOCs will be removed from the groundwater by air stripping with offgas treatment using VGAC vessels. However, the LGAC or UV/Ox treatment processes may also be used if more cost-effective. A more detailed description of these three groundwater treatment processes is provided in Section 8 of this ROD and in the FS (EPA, 1997). The appropriate treatment process will be selected during remedial design when more is known about the anticipated influent flow rates and contaminant concentrations of the target volumes to be extracted.

The treated water will be discharged to either the City of Tempe storm drain system leading to Town Lake, the SRP Tempe Canal No. 6, or to the MAU aquifer through reinjection. EPA will determine the selected end-use option for the treated groundwater during remedial design and will consider the input provided by the community during the public comment period.

Performance Standards

The treatment plant discharge performance standards will vary with the different discharge options considered for the treated groundwater, as further defined in the ARARs section of this ROD (Section 12.0). The treatment plant(s) will be capable of meeting the effluent discharge standards. If discharge of the treated groundwater is to Town Lake, then aquatic and wildlife standards for a warm water fishery would be met. If discharge is to Tempe Canal or reinjection to the MAU, then the MCL or human health-based guidance level (HBGL) listed in Table 12 of the ARARs section (Section 12) would be met.

11.3 Additional Components

This section describes additional components of the selected remedy, including well abandonment, institutional controls, and groundwater monitoring.

Well Sealing or Abandonment

The selected remedy includes sealing or abandonment of Well SRP23E, 2.9N to eliminate this potential path of VOC contaminant migration from the UAU to the MAU. This well is located in an area of shallow contamination and represents a potential conduit for downward contaminant migration. The sealing or abandonment will be done in accordance with appropriate State of Arizona guidelines. In addition, other monitoring wells that will not be included in the long-term monitoring network will be abandoned, as appropriate, in accordance with State of Arizona guidelines.

Institutional Controls

Institutional controls will be established to protect the public from exposure to contaminated groundwater exceeding aquifer cleanup levels until aquifer cleanup goals are met. Institutional controls will include various Arizona well siting, permitting, and construction restrictions, and notices distributed by the ADWR, Arizona Department of Health Services, or EPA concerning risks from exposure to contaminated groundwater. Additional institutional controls to prevent interference with EPA's remedial efforts also may be established.

Groundwater Monitoring

Continued monitoring of groundwater will be performed to verify the effectiveness of the extraction and treatment and MNA remedies and to ensure that aquifer cleanup goals are met throughout the areas of VOC contamination. A long-term monitoring program will be designed and implemented during the RD/RA and will continue as long as contamination remains above cleanup standards. The monitoring program will assess performance of the groundwater containment system or systems, monitor the progress of natural attenuation in areas without active groundwater extraction, monitor to determine if the contingency remedy trigger criteria are exceeded, and monitor effluent chemical concentrations from the treatment system.

11.4 5-Year Review

This remedial action is expected to take more than 5 years to achieve aquifer cleanup levels. Accordingly, by policy, EPA will perform a review of the selected remedy no less than 5 years after completion of the construction for all remedial actions at the site. This review will ensure that the remedy is operating and functioning as designed, that institutional controls are in place and are protective, and that natural attenuation is progressing as expected. An additional purpose for the review is to evaluate whether the performance standards specified in this ROD remain protective of human health and the environment. EPA will continue the reviews until no hazardous substances, pollutants, or contaminants remain at IBW-South above levels that allow for unrestricted use and unlimited exposure to groundwater.

11.5 Conceptual Design

The conceptual design for the extraction and treatment components of the selected remedy is shown in Figure 11.

The extent of UAU contamination at the western area would be contained and restored using three extraction wells positioned approximately along the downgradient edge of the area contaminated above aquifer cleanup standards.

The well locations shown on Figure 11 were selected during the FS and are based on the extent of contamination using data through February 1995. The revised extent of contamination using data through April 1998 is also shown on Figure 11. The well locations and pipe routing were not revised to prepare the cost estimate because further modifications will be required based on the location of the highest contaminated area during remedial design.

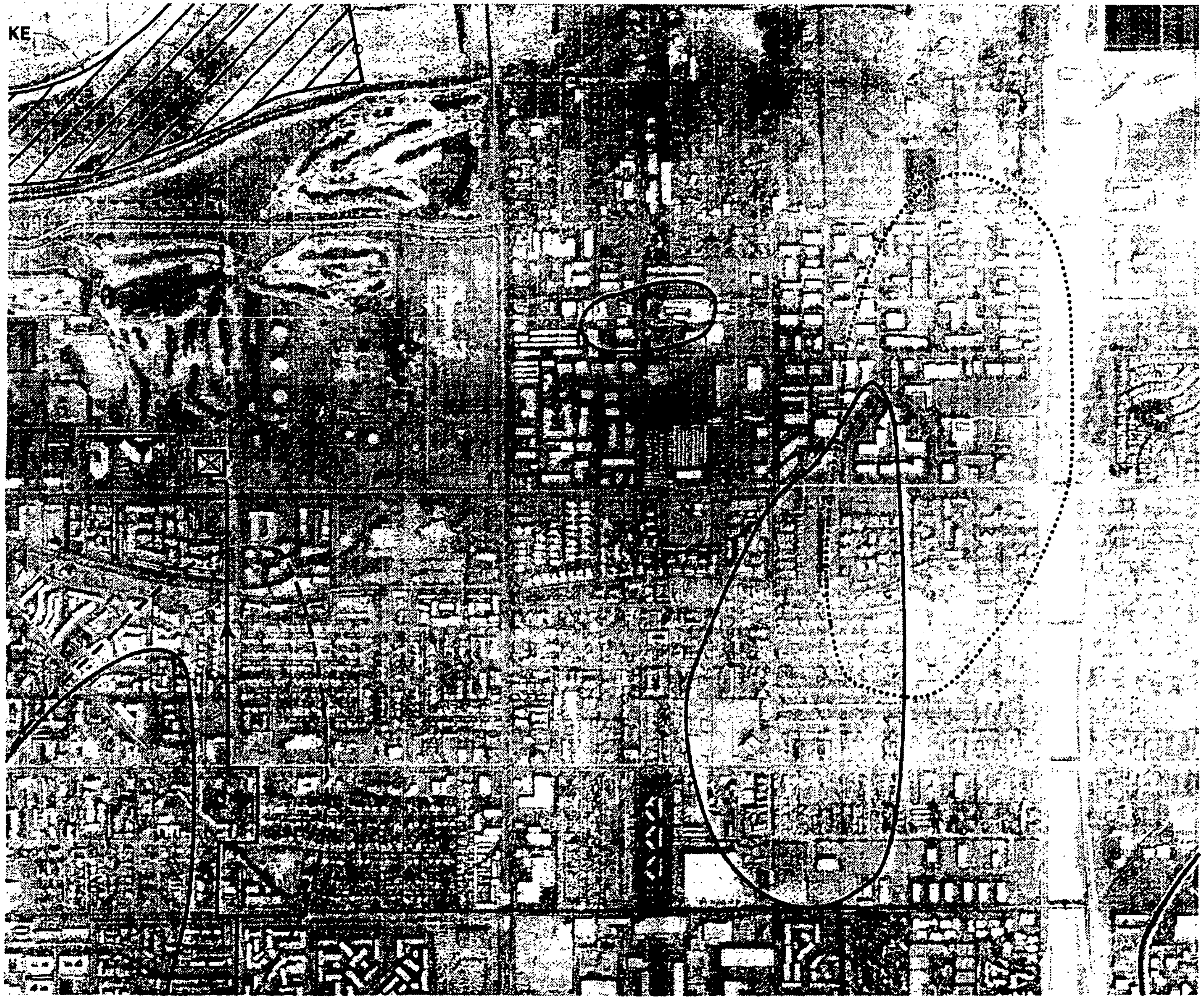
The extracted groundwater is piped to a centralized treatment system and the VOCs are removed from the groundwater by air stripping (or other treatment). VOC-contaminated offgas from air stripping is treated by using VGAC vessels. The treated water would then be delivered to the City of Tempe storm drain system leading to Town Lake, the SRP Tempe Canal No. 6, or reinjected to the MAU aquifer. The Proposed Plan stated that the exact end use for the treated groundwater will be determined after EPA considered all comments received on the Proposed Plan and performed remedial design work for the remedy.

Groundwater contamination in the MAU and those portions of the central and eastern areas of the UAU that are not contained by the extraction wells would be allowed to naturally attenuate. Additional monitoring wells and verification monitoring will be performed to verify the natural attenuation process.

The costs for the selected remedy were estimated assuming the following components and are discussed in Appendix A.

- Three extraction wells installed in the UAU
  - Total depth = 170 feet
  - Screened Interval = 46 to 126 feet bgs
  - Total flow rate = 2,940 gallons per minute (gpm)
  - Three telemetry systems (one per extraction well)
  - Three electrical hookups (one per extraction well)
- Treatment plant
  - One air stripping tower (height = 28 feet)
  - Two VGAC offgas treatment units (capacity of each = 9,830 standard cubic feet per minute [scfm])
- Number of samples
  - 106 bi-monthly VOC air samples
  - 53 bi-monthly VOC water samples
  - 14 annual general chemistry water samples.

  The number of samples also includes quality control samples at 10 percent frequency.
- Conveyance pipeline, between extraction wells and treatment plant, made of high-density polyethylene (HDPE) dual-cast (DC) pipe
  - 4,400 linear feet of 10-inch-diameter
  - 1,000 linear feet of 12-inch-diameter
  - 5,500 linear feet of 14-inch-diameter
- Distribution pipeline, between treatment plant and Town Lake, made of HDPE DC pipe
  - 50 linear feet of 16-inch-diameter (connection to COT storm drain)
- One distribution pump station (60 hp) located within the treatment plant boundary
- One outfall structure



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- Ten new monitoring wells (total depth 170 feet each)
- 176 VOC monitoring samples per year
- 53 general chemistry monitoring samples per year
- Annual sampling for general chemistry
  - 43 existing monitoring wells
  - 10 new monitoring wells
- Sampling for VOCs
  - Quarterly at 26 existing and 10 new monitoring wells
  - Semi-annually at 3 existing monitoring wells
  - Annually at 22 existing monitoring wells
  - Every other year at 8 existing monitoring wells

  The number of samples also includes quality control samples at 10 percent frequency.
- Sealing of screen interval at Well SRP23E,2.9N in the UAU.

Contingency Remedy

The costs for the contingency remedy were estimated assuming the components in the list below were added to the selected remedy. Details of the cost estimate for the contingency remedy are provided in Appendix A of this ROD.

- Three additional extraction wells installed in the UAU
  - Total depth = 170 feet
  - Screened Interval = 46 to 126 feet bgs
  - Total flow rate = 2,940 gpm
  - Three telemetry systems (one per extraction well)
  - Three electrical hookups (one per extraction well)
- Treatment plant
  - One additional air stripping tower (height = 28 feet)
  - Two additional VGAC offgas treatment units (capacity of each = 7,420 scfm)
- Number of additional samples
  - 106 bi-monthly VOC air samples
  - 53 bi-monthly VOC water samples
  - 14 annual general chemistry water samples.

  The number of samples also includes quality control samples at 10 percent frequency.

- Additional conveyance pipeline, between extraction wells in eastern contaminated area and conveyance pipeline included in selected remedy, made of HDPE DC pipe

- 8,200 linear feet of 12-inch-diameter
- 3,100 linear feet of 8-inch-diameter

11.6 Cost of the Selected Remedy and Contingency Remedy

The approach used to estimate costs for the alternatives in the FS and the selected and contingency remedies were presented in Section 8.0 and Appendix A of this ROD and in Appendix D of the FS.

Selected Remedy

Estimated costs of the selected remedy are:

- Capital Costs $ 6,170,000
- Annual O&M Costs $ 1,060,000
- Present Worth Cost (30 years) $22,460,000

These costs are based on the conceptual design for this remedy as described above.

Contingency Remedy

The estimated increase in cost if the contingency remedy is implemented is:

- Capital costs $2,410,000
- Annual O&M costs $10,000
- Present worth cost (30 years) $2,570,000

12.0 ARARs for Indian Bend Wash-South

Section 121(d) of CERCLA requires that remedial actions at CERCLA sites must attain (or justify the waiver of) any federal or more stringent state environmental standards, criteria, or limitations that are determined to be ARARs. Applicable requirements are those cleanup standards, criteria, or limitations promulgated under federal or state law that specifically address the situation at a CERCLA site. A requirement is applicable if the jurisdictional prerequisites of the environmental standard show a direct correspondence when objectively compared with the conditions at the site.

If a requirement is not legally applicable, the requirement is evaluated to determine whether it is relevant and appropriate. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not applicable, address problems or situations sufficiently similar to the circumstances of the proposed response action and are well-suited to the conditions of the site. The criteria for determining relevance and appropriateness are listed in Title 40, Code of Federal Regulations (CFR), Section 300.400(g)(2) (40 CFR 300.400[g][2]). If no specific ARAR exists, then other guidelines or criteria "to be considered" (TBC) may be identified and used to ensure protection of human health and the environment.

ARARs are divided into three categories: chemical-specific, location-specific, and action-specific requirements. The chemical-specific ARARs are health- or risk-based concentration limits, numerical values, and methodologies for contaminant media. The chemical-specific ARARs for the IBW-South remedial actions define the concentration levels for contaminants in the groundwater that determine whether a problem exists at the site and the subsequent cleanup criteria. Chemical-specific ARARs also define the concentration levels required for satisfactory groundwater treatment and implementation of the end-use alternatives for the treated groundwater. Location-specific ARARs relate to the geographical or physical location of the site, and may limit what actions can be taken, given the specific geographic characteristics of the site. Action-specific ARARs are technology- or activity-based requirements triggered by the type of remedial activity being conducted. Examples are requirements that define acceptable treatment and disposal procedures for hazardous substances. A detailed discussion of the potential ARARs identified for the IBW-South site is provided in the IBW-South 1997 FS.

The ARARs for the IBW-South site have been identified in a sequential manner. First, the ARARs that impact remedial goals, independent of the remedial alternatives, were identified. These are the chemical- and location-specific regulations and objectives that govern the release and need for remediation of specific hazardous substances and present how the physical location of the site can determine where and how facilities can be constructed and operated. Next, the action-specific ARARs are identified for each alternative. These define the performance requirements of the system and may impact cost and implementability of the alternative. The State of Arizona identified proposed ARARs to EPA.

ARARs include only the substantive, not the administrative, requirements of a statute or regulation. The substantive portions of the regulation are those requirements that pertain directly to actions or conditions in the environment. Examples of substantive requirements include quantitative health- or risk-based restrictions upon exposure to types of hazardous substances. Administrative requirements are the mechanisms that facilitate implementation of the substantive requirements. Administrative requirements include issuance of permits, documentation, reporting, recordkeeping, and enforcement. Thus, in determining the extent to which onsite CERCLA response actions must comply with environmental laws, a distinction must be made between substantive requirements, which may be ARARs, and administrative requirements, which are not.

The ARARs provision in CERCLA applies only to onsite actions. "Onsite" is defined as the areal extent of contamination and areas in proximity to it necessary for the implementation of the remedy. According to CERCLA §121(e), a remedial response action that takes place entirely onsite is exempt from administrative portions of ARARs and may proceed without obtaining permits.

A requirement may not meet the definition of an ARAR as defined above, but may still be useful in determining whether to take action at a site and/or to what degree action is necessary. This can be particularly true when there are no ARARs for a site or a particular contaminant. Such requirements are TBC requirements. TBC materials are nonpromulgated advisories or guidance documents issued by federal or state government that are not legally binding, but that may provide useful information or recommended procedures for remedial action. Although TBCs do not have the status of ARARs, they may be considered together with ARARs to establish the required level of cleanup for protection of human health and the environment.

The federal and state statutes and requirements examined for EPA's ARARs analysis for IBW-South are identified in Appendix B to the IBW-South 1997 Feasibility Study.

12.1 Chemical-Specific ARARs

The chemical-specific ARARs that have been identified for IBW-South are those that: (1) affect groundwater remedial goals, and (2) determine to what degree groundwater should be treated prior to discharge. The major statutes and regulations that contribute to the list of potential chemical-specific ARARs are the Clean Water Act (CWA), the Safe Drinking Water Act (SDWA), Arizona Water Quality Standards for Navigable Waters, and Arizona Aquifer Protection Standards. The chemical-specific TBCs for the IBW-South site consider the ADHS HBGLs for Contaminants in Drinking Water. Chemical-specific ARARs for the more commonly detected organic compounds at IBW-South are summarized in Table 12. SDWA MCLs and nonzero MCLGs are the standards for aquifer cleanup, unless otherwise noted. Inorganic compounds are not considered COCs for IBW-South groundwater; however, they are included in Table 12 because inorganics will need to be considered in treating groundwater for discharge.

Chemical-Specific ARARs for Groundwater Remedial Goals

This section addresses the chemical-specific ARARs for aquifer remediation. The presence of contaminants above SDWA MCLs has degraded the beneficial uses of the groundwater at IBW-South; therefore, remedial actions will need to restore the contaminated groundwater and protect groundwater outside of the area of contamination.

The numerical values in the SDWA MCL standards are enforceable, health-based concentration limits formulated to protect water for human consumption for drinking, cooking, bathing, and other water-contact activities. MCLs are applicable to the quality of drinking water at the tap pursuant to the SDWA. Pursuant to 40 CFR Section 300.430(e)(2)(i)(B), MCLs and non-zero Maximum Contaminant Level Goals (MCLGs) may be relevant and appropriate as in situ

TABLE 12
Chemical-Specific ARARs for the IBW-South Site (concentrations in µg/L)

Parameter	Aquifer Cleanup Standard (MCL or HBGL)	Discharge Limits for Tempe Canal and Re-injection (MCL or HBGL)	Discharge Limits for Town Lake (A&Wwa Acute)	Discharge Limits for Town Lake (A&Wwa Chronic)
Organics				
Benzene	5[b]	5[b]	2,700	180
Bromodichloromethane	100[b,c]	100[b,c]	-	-
Chloromethane	2.7[d]	2.7[d]	270,000	15,000
Chloroform	100[b,c]	100[b,c]	14,000	900
1,2-Dibromoethane	0.05[b]	0.05[b]	-	-
1,2-Dichloroethane	5[b]	5[b]	59,000	41,000
1,1-Dichloroethene	7[b,e]	7[b,e]	15,000	950
1,2-Dichloropropane	5[b]	5[b]	26,000	9,200
Methylene Chloride	5[b]	5[b]	97,000	5,500
1,1,2,2-Tetrachloroethane	0.18[d]	0.17[i]	4,700	3,200
Tetrachloroethene (PCE)	5[b]	5[b]	6,500	680
Trichloroethene (TCE)	5[b]	5[b]	20,000	1,300
Inorganics				
Antimony		6[b]	88	30
Arsenic		50[f]	360	190
Barium		2,000[b]	-	-
Beryllium		4[b]	65	5.3
Cadmium		5[b]	-[h]	-[h]
Chromium (total)		100[b]	-	-
Copper		1,300[b,g]	-[h]	-[g]
Cyanide		200[b]	41[i]	9.7[i]
Lead		15[b,g]	-[h]	-[g]
Mercury		2[b]	2.4	0.01
Nickel		100[f]	-[h]	-[g]
Selenium		50[b]	20	2.0
Thallium		2[b]	700	150
Zinc		2,100[d]	-[g]	-[g]

[a] Aquatic and Wildlife (warm water fishery).
[b] Maximum Contaminant Level (MCL).
[c] For total trihalomethanes.
[d] Human Health-Based Guidance Level (HBGL) for drinking water (December 1997 Update).
[e] Maximum Contaminant Level Goal is identical to the MCL.
[f] Arizona state MCL.
[g] Action level, not to be exceeded in more than 10 percent of samples.
[h] Concentrations vary depending on the hardness of the receiving water body.
[i] Arizona water quality standard for drinking water sources.

Note: The Arizona Aquifer Water Quality Standards for benzene, 1-2 dichloroethane, 1,1-dichloroethene, 1,2-dichloropropane, PCE, total trihalomethanes, TCE, antimony, barium, beryllium, cadmium, chromium, cyanide, selenium, and thallium are identical to the federal MCLs; identical to the state MCL for nickel; and 50 µg/L for lead.

aquifer cleanup standards for groundwater that is or may be used for drinking water. The MCLs and non-zero MCLGs are relevant and appropriate standards for the groundwater restoration at IBW-South because the beneficial uses of the groundwater aquifers include being potential drinking water supplies under ARS §49-224 and AAC §R18-11-407. The MCLs and non-zero MCLGs for the most common VOCs at IBW-South are presented in Table 12 under the aquifer cleanup standards heading. The state MCLs, found in AAC §R18-4-205 and 211 are listed in Table 12 only if they are more stringent than the federal MCLs or non-zero MCLGs.

For the main COCs, TCE and PCE, the MCL and the aquifer cleanup standard are 5 µg/L. The aquifer cleanup standards for the other most commonly detected VOCs, including PCE and TCE, are shown in Table 12.

The Arizona Aquifer Water Quality Standards (AAC §R18-11-406) are standards developed to protect groundwater by preventing discharges of pollutants that are above certain concentrations to aquifers, that endanger human health, or that impair the uses of the aquifer. In Arizona, all aquifers are identified as drinking water source aquifers unless specifically exempt (ARS §49-224). The Aquifer Water Quality Standards that are applied to aquifers classified as sources of drinking water are currently identical to the federal SDWA MCLs. The federal MCLs or the federal non-zero MCLGs for some hazardous substances are selected as ARARs because the state standards are not more stringent than the federal MCLs.

TBCs that have been evaluated for some substances at the IBW-South site include the ADEQ HBGLs which are health-based levels for drinking water. These levels, although set forth in Arizona regulations, are not "promulgated" in the sense of being legally enforceable and generally applicable. They are useful, however, for determining potential cleanup levels for groundwater at IBW-South for compounds that do not have federal or state MCLs.

EPA has not selected HBGLs as cleanup standards for any hazardous substance for which there is an MCL or non-zero MCLG because MCLs and MCLGs are health-based standards and are thus adequately protective. Moreover, the Arizona Aquifer Water Quality Standards are generally identical to the MCLs and they, rather than the HBGLs, are the state's promulgated aquifer standards. The HBGLs to be considered for the groundwater remedy pertain only to those hazardous substances for which no MCL or MCLG has been established: chloromethane, 1,1,2,2-tetrachloroethane, and zinc. These HBGLs are also included in Table 12.

The following chemicals have been detected more than three times at IBW-South but only at concentrations significantly less than the MCL (or HBGL for chemicals without an MCL): acetone, 2-butanone, carbon disulfide, cis-1,2,-dichloroethene; trans-1,2-dichloroethene, 1,1,1-trichloroethane, and vinyl chloride. Accordingly, EPA has not included these substances in Table 12. Additionally, ethyl benzene, toluene, styrene, and total xylenes have been detected above MCLs at wells installed as part of State Leaking Underground Storage Tank (LUST) investigations (e.g., MOBIL2-1). Although initially detected at concentrations higher than the corresponding MCL, none of these chemicals has been detected above the MCL since 1996. Therefore, EPA has not included these substances in Table 12.

This ROD does not address either the remediation approach or cleanup standards for methyl tertiary butyl ether (MTBE). Only recently has MTBE been detected at IBW-South at levels significantly above the Arizona HBGL of 35 µg/L and EPA's health advisory range of 20 to 40 µg/L for taste and odor. Given the recent detection of significant levels of MTBE, limited toxicity data available, and other factors, MTBE was not determined to be a chemical of concern in EPA's 1997 Risk Assessment. The elevated levels of MTBE are located in a small part of the central contaminated area, which is covered by a corrective action plan issued by the ADEQ Leaking Underground Storage Tank (UST) program. If it becomes apparent that ADEQ's UST efforts will not result in the cleanup of MTBE in the aquifer, EPA will evaluate the necessity and appropriateness of remedial action for MTBE. Additionally, if the contingency remedy is activated for the VOCs where MTBE is found, and if MTBE thus would be present in extracted groundwater, EPA would evaluate treatment systems and seek to treat the extracted groundwater to the appropriate discharge level considering the end use of the treated groundwater and other relevant circumstances.

Other chemicals have been detected but are not expected to be present in extracted groundwater for a variety of reasons, including infrequent detections or detections at very low concentrations. Such chemicals have not been identified as chemicals of potential concern (COPCs) or COCs because of their infrequent detection and low levels; thus, EPA need not establish aquifer cleanup standards for these chemicals and has not included them in Table 12.

ARARs Regulating Groundwater Discharge Concentrations

This section addresses chemical-specific ARARs for the onsite treatment of extracted groundwater.

Section 304 of the CWA requires EPA to publish water quality criteria for specific pollutants or their by-products. The Federal Clean Water Act, 33 U.S.C. § 1251, *et seq.*, and its implementing regulations, the National Pollutant Discharge Elimination System (NPDES), 40 CFR Parts 122-125, require direct discharges from CERCLA sites to surface waters to meet substantive Clean Water Act limitations. EPA develops two kinds of water quality criteria: one for the protection of human health and another for the protection of aquatic life. Federal water quality criteria are non-enforceable guidelines used by the states to set water quality standards for surface water. The states develop water quality standards to protect existing and attainable uses of the receiving water.

The limits for extracted groundwater quality will vary with the end use, which is to be finalized during Remedial Design. If discharge is to surface waters, state water quality standards will generally be ARARs; if discharge is to groundwaters, other standards are triggered. The possible end-use ARARs are discussed below.

Discharge to Tempe Canal No. 6

In Arizona, the narrative and numerical water quality standards promulgated pursuant to the Clean Water Act discussed above, found in ARS §49 - 222 and AAC §R18-11-108 and 109, are applicable to discharges to surface waters to protect the beneficial uses of the water. These standards vary with the designated beneficial use of the receiving water, pursuant to AAC R18-11-104. The beneficial uses may include domestic water source, full body contact, partial body contact, fish consumption, use by aquatic organisms and wildlife, agriculture irrigation, and agriculture livestock watering. If treated groundwater is discharged to SRP Tempe Canal No. 6, then it must meet the standards for the protection of domestic water sources because the water in the canal is used as a source of drinking water. The drinking water source numeric water quality standards are identical to the federal SDWA MCLs for the following substances: benzene, 1,2-dibromoethane, 1,2-dichloroethane, 1,1-dichloroethene, 1,2-dichloropropane, TCE, bromodichloromethane, and chloroform (AAC Title 18, Chapter 11, Section R18-11-109 and Appendix A). For 1,1,2,2-tetrachloroethane, the Arizona Standard is

0.17 µg/L. Because state limits are not more stringent, the federal MCLs will be applicable, unless otherwise indicated in Table 12. The MCLs and other standards are presented in Table 12. The water quality standards that the treated groundwater would have to meet prior to discharge to Tempe Canal No. 6 would typically be presented in the NPDES substantive requirements.

Arizona's antidegradation policy for navigable waters is applicable to the discharge of treated groundwater to navigable water (AAC §R18-11-107). This regulation states that where existing water quality in a navigable water does not meet applicable water quality standards, degradation of the water is not allowed. Where the existing water quality exceeds applicable standards, the existing quality will be maintained and protected. According to SRP personnel, Tempe Canal No. 6 is considered a navigable water; therefore, the antidegradation policy applies to discharges of treated groundwater to the canal.

Discharge to Town Lake

If treated groundwater is discharged to Town Lake, then the numerical water quality standards, both acute and chronic, for Aquatic and Wildlife (warm water fishery) (A&Ww) would be applicable to protect the beneficial uses of Town Lake. These beneficial uses include use of the surface-water body by animals, plants, or other organisms (excluding salmonids) for habitation, growth, or propagation. According to COT and ADEQ personnel, the beneficial uses of Town Lake do not include domestic water supply or swimming; therefore, the water quality standards for full or partial body contact and drinking water do not apply. These A&Ww standards are presented in Table 12. Although not an ARAR, NPDES requirements would apply to the offsite discharge of treated groundwater to Town Lake.

Reinjection

As discussed above, the Arizona Aquifer Water Quality Standards (AAC §R18-11-401 *et seq.*) are standards developed to protect human health and the uses of the aquifer by preventing discharges, including treated groundwater that is reinjected to groundwater above certain concentrations. These standards are currently identical to the SDWA MCLs and state MCLs; thus, federal MCLs (and more stringent state MCLs) are the relevant and appropriate ARARs for reinjection. If treated groundwater is reinjected into a contaminated aquifer, then the reinjection cannot cause additional degradation of the aquifer.

12.2 Location-Specific ARARs

Location-specific ARARs differ from chemical-specific or action-specific ARARs in that they are not closely related to the characteristics of the wastes at the site or to the specific remedial action being taken. Location-specific ARARs are concerned with the area in which the site is located. Actions may be required to preserve or protect aspects of the environment or cultural resources of the area that may be threatened by the existence of the site or by the remedial actions to be undertaken at the site. Location-specific ARARs for the IBW-South site are listed in Table 13.

Extraction of contaminated groundwater at the IBW-South site may occur within the SRP service area as part of the remedial action. If groundwater is extracted from within the SRP service area, substantive requirements will be obtained from SRP as necessary. In addition, if groundwater is extracted from within the SRP service area and used outside the service area (i.e., Town Lake), discussions with SRP will be conducted to consider such issues as water quality, water rights, water accounting, cost, liability, and operational concerns.

12.3 Action-Specific ARARs

Action-specific ARARs have been identified for the implementation of the remedial action. A description of the requirements associated with some of the significant ARARs and a discussion of the conditions under which the ARAR is applicable or relevant and appropriate is included below. The actions addressed include components of the extraction, treatment, and groundwater end-use options for the remedial action. Action-specific ARARs for the IBW-South site are presented in Table 13.

Hazardous Waste Management ARARs Under RCRA

The Resources Conservation and Recovery Act (RCRA), as amended, regulates the management, treatment, storage, and disposal of solid and hazardous wastes. The RCRA program is a delegable program: the states may manage the program in lieu of EPA if the state statutes and regulations are equivalent to or more stringent than the federal statutes and regulations. EPA authorized Arizona to run the RCRA hazardous waste program; therefore, the relevant provisions of the state statutes and regulations are treated as the federal requirements, in lieu of the federal statutes and regulations. Arizona requirements that exceed the scope of the federal requirements for these programs are treated as state requirements. Therefore, in some cases the applicable or relevant and appropriate RCRA requirement will be cited as state law and in other cases as federal law.

At the IBW-South site, the contaminated groundwater is not a listed RCRA hazardous waste because insufficient information exists at this time on the genesis of the groundwater contamination to determine whether the groundwater could be listed. The groundwater is not a characteristic hazardous waste because the contaminants in the groundwater are below the levels established for the characteristic of toxicity. Consequently, the RCRA requirements that are triggered by the hazardous nature of waste are not applicable to the untreated groundwater, but are relevant and appropriate. For these same reasons and because of EPA's exception for contaminated media (e.g., memorandum from Silvia K. Lowrance to Jeff Zelikson, January 24, 1989), the groundwater that has been treated to health-based standard (i.e., MCLs) would not be a RCRA hazardous waste, and the RCRA requirements would not be triggered. Some RCRA requirements are applicable or relevant and appropriate to excavated soils, spent carbon, or other wastes resulting from the remedial efforts (if such materials are characterized as hazardous waste) and are discussed below.

Storage and Handling

The substantive requirements for storage of hazardous waste of RCRA's regulations found in 40 CFR 264, as incorporated into or modified by AAC R18-8-264, are applicable to the storage of hazardous wastes generated onsite, such as contaminated carbon. These include requirements for container storage, management, and secondary containment; they are summarized in

TABLE 13
Location-Specific and Action-Specific ARARs for the IBW-South Site

Location	Requirement	Prerequisite(s)	Citation	Classification	Comments
Location – Specific ARARs					
Within 100-year floodplain	Facility must be designed, constructed, operated, and maintained to avoid washout.	RCRA hazardous waste; treatment, storage, or disposal.	40 Code of Federal Regulation (CFR) §264.18(b) (R18-8-264)	Relevant and Appropriate	Portions of the IBW-South site are located within a 100-year floodplain. A RCRA facility located in a 100-year floodplain must be designed, constructed, operated, and maintained to prevent washout of any hazardous waste by a 100-year flood.
Within floodplain	Action to avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values.	Action that will occur in a floodplain, i.e., lowlands, and relatively flat areas adjoining inland and coastal waters and other flood-prone areas.	Executive Order 11988, Protection of Floodplains (40 CFR §6.302(b))	Applicable	Federal agencies are directed to ensure that planning programs and budget requests reflect consideration of floodplain management, including the restoration and preservation of such land as natural undeveloped floodplains. If newly constructed facilities are to be located in a floodplain, accepted floodproofing and other flood control measures shall be undertaken to achieve flood protection. Whenever practical, structures shall be elevated above the base flood level rather than filling land. As part of any federal plan or action, the potential for restoring and preserving floodplains so their natural beneficial values can be realized must be considered. Crossing of the IBW-South site with piping or location of wells in the 100-year floodplain would need to be designed to result in no impact to flood surface profiles.
Wetlands	Action to minimize the destruction, loss, or degradation of wetlands.	Wetland as defined by Executive Order 11990 Section 7; actions involving construction or management of property.	Executive Order 11990, Protection of Wetlands (40 CFR Part 6, Appendix A). Clean Water Act Section 404; 40 CFR Parts 230.10	Potentially applicable	If wetlands are located within the area of proposed federal activities, the agency must conduct a Wetlands Assessment to identify wetlands and potential means of minimizing impacts. If there is no practical alternative to locating in or affecting the wetland, the Agency shall act to minimize potential harm to the wetland.
Aquifer of the State of Arizona	Unless specifically excluded, all aquifers of the State of Arizona are classified as potential drinking waters.	Aquifers of the State.	ARS of Section 49-224	Applicable	

TABLE 13
Location-Specific and Action-Specific ARARs for the IBW-South Site

Location	Requirement	Prerequisite(s)	Citation	Classification	Comments
Location – Specific ARARs					
Within area where action may cause irreparable harm, loss, or destruction of significant artifacts	Action to recover and preserve artifacts.	Alteration of terrain that threatens significant scientific, prehistoric, historic, or archaeological data.	National Archaeological and Historical Preservation Act (16 USC Section 469); 36 CFR Part 65	Applicable	The IBW-South site is essentially completely developed. However, artifacts have been located in areas near IBW-South. The potential for impacts to artifacts will need to be considered and addressed during the design and implementation of the remedial action.
Place where artifacts, human remains, or funerary objects are discovered.	Requirements for archeological discovery and preservation.	Discovery of artifacts, human remains, or funerary objects.	ARS Section 41-841 through 41-844	Applicable	Archaeological objects have been discovered, according to the State of Arizona, near the site.
Historic project owned or controlled by federal agency	Action to preserve historic properties; planning of action to minimize harm to National Historic Landmarks.	Property included in or eligible for the National Register of Historic Places.	National Historic Preservation Act Section 106 (16 USC 470 *et seq.*); 36 CFR Part 800, 40 CFR §6.301	Applicable	The DCE Circuits Building is included in the National Register of Historic Places (Inventory No. 151). The groundwater remedy will not impact this building.
Critical habitat upon which endangered species or threatened species depend	Action to conserve endangered species or threatened species, including consultation with the Department of the Interior. Lists species of birds protected by four treaties between the U.S., Canada, Mexico, Japan, and Russia.	Potential presence of endangered species or threatened species or migratory birds.	Endangered Species Act of 1973 (16 USC 1531 *et seq.*); 50 CFR Part 200, 50 CFR Part 402, Migratory Bird Treaty Act (16 USC 703-712)	Potentially applicable	Applicable if critical habitats are discovered. No endangered species are currently known to exist on the IBW-South site. Migratory birds must be protected from poisoning at hazardous waste sites. The remedy will not expose migratory birds to hazardous materials.

TABLE 13
Location-Specific and Action-Specific ARARs for the IBW-South Site

Action	Requirements	Prerequisite(s)	Citation	Classification	Comments
Action-Specific ARARs					
Container storage (onsite)	Containers of hazardous waste must be: maintained in good condition; compatible with hazardous waste to be stored; and closed during storage (except to add or remove waste). Place containers on a sloped, sufficiently impervious crack-free base, and protect from contact with an accumulated liquid. Provide containment system with a minimum capacity of 24-hour, 25-year storm plus 10 percent of the volume of containers of free liquids or the volume of the largest container, whichever is greater. Remove spilled or leaked waste in a timely manner to prevent overflow of the containment system. At closure, remove all hazardous waste and residues from the containment system, and decontaminate or remove all containers and liners.	RCRA hazardous waste held for a temporary period before treatment, disposal, or storage elsewhere, in a container (i.e., any portable device in which a material is stored, transported, disposed of, or handled).	Containers used for storage of hazardous waste onsite for more than 90 days must be: • Maintained in good condition (R18-8-264.171) • Compatible with other stored wastes (R18-8-264.172) • Closed during storage (R18-8-264.173) • Placed on a sloped, crack-free base with containment system in place capable of handling 10 percent of the free liquids stored (R18-8-264.175) • At closure, all hazardous wastes and residues from containment system must be removed (R18-8-264.178) • Secondary containment is required for storage of hazardous wastes over 90 days (R18-8-264.175). • Prior to transportation, containers should be packaged, labeled, marked, and placarded in accordance with RCRA and DOT requirements (R18-8-262.30 through R18-8-262.33).	Applicable to hazardous waste	These requirements are applicable or relevant and appropriate for untreated soil, groundwater, or treatment system residuals (e.g., contaminated carbon) that is a RCRA characteristic hazardous waste that might be containerized and stored onsite prior to treatment or final disposal. Currently, the untreated groundwater is not a RCRA hazardous waste, but these RCRA requirements are relevant and appropriate to it.

TABLE 13
Location-Specific and Action-Specific ARARs for the IBW-South Site

Action	Requirements	Prerequisite(s)	Citation	Classification	Comments
Action-Specific ARARs					
Storage of hazardous wastes subject to land disposal restrictions	Restrictions on storage, and requirements for marking and dating drums, tanks, etc.	Wastes subject to land disposal restrictions (LDR) that do not meet the treatment standards.	40 CFR Section 268.50	Applicable if any hazardous wastes are subject to LDRs	
Control of fugitive dust	Decrease emissions of fugitive dust from construction activities.	Construction activities that generate dust.	Maricopa County Rule 310	Applicable	Limits fugitive dust emissions during construction.
Processing, storing, using, or transporting of solvents or volatile compounds; activities that can emit odors or other gaseous air contaminants.	To adopt available means to effectively reduce the contribution to air pollution from evaporation, leakage, discharge or materials.	Construction or other activities that could emit odors or other gaseous contaminants.	Maricopa County Rule 320	Applicable	Where means are available to reduce air pollution from leaks, discharge, or evaporation, the use of such controls is mandatory.
Air Stripping	Control of air emissions of volatile organics and gaseous contaminants.	Emissions of VOCs or gaseous air contaminants.	Maricopa County Rules 200, 270, and 330	Applicable	Rules to control air emissions for the air stripping and vapor-phase activated carbon offgas treatment option for the remedial action.
	Control of air emissions from air strippers at Superfund sites.	Groundwater remedial actions.	OSWER Directive No. 9355.0-28	TBC	
Treatment (miscellaneous)	Standards for miscellaneous units require new units to satisfy environmental performance standards for protection of groundwater, surface water, and air quality, and by limiting surface and subsurface migration.	Treatment of hazardous wastes in units not regulated elsewhere under RCRA (e.g., air strippers).	40 CFR §264.601	Relevant and Appropriate	The substantive portions of these requirements may be relevant and appropriate to the construction, operation, maintenance, and closure of any miscellaneous treatment unit (a treatment unit that is not elsewhere regulated) constructed on the IBW-South site for treatment of groundwater.

TABLE 13
Location-Specific and Action-Specific ARARs for the IBW-South Site

Action	Requirements	Prerequisite(s)	Citation	Classification	Comments
Action-Specific ARARs					
Underground injection of wastes and treated groundwater	Underground Injection Control (UIC) program prohibits: • Injection activities that allow the movement of contaminants into underground sources of drinking water (USDW) and result in violation of MCLs or adversely affect health. • Construction of new Class IV wells and operation and maintenance of existing wells except wells used to reinject treated groundwater as part of a CERCLA action. Injection pressure may not exceed a maximum level designed to ensure that injection does not initiate new fractures or propagate existing ones and cause the movement of fluids into a USDW. Continued monitoring of injection pressure, flow rate, and volume is required. Reinjection with Class V wells shall not cause a violation of primary MCLs in the receiving aquifer. Continued monitoring of injection pressure, flow rate, and volume is required.	Underground injection of treated hazardous waste.	40 CFR §144.12 – 16 Substantive requirements of the Aquifer Protection Permit Program, including AAC §R18-9-108, -111, and -112..	Applicable or Relevant and Appropriate if reinjection is selected as discharge option.	Certain substantive requirements of the UIC program will not apply to onsite reinjection of treated groundwater, including those governing Class IV wells (wells used for the reinjection of extracted and treated groundwater) because both extracted and treated groundwater at the site are not considered RCRA hazardous wastes. Such requirements are relevant and appropriate if reinjection is selected as the end use for treated groundwater. Substantive requirements of the Arizona Aquifer Protection Permit Program, including recharge, poor quality groundwater withdrawal, and well installation requirements are applicable.

TABLE 13
Location-Specific and Action-Specific ARARs for the IBW-South Site

Action	Requirements	Prerequisite(s)	Citation	Classification	Comments
Action-Specific ARARs					
New well construction and withdrawal, treatment, and reinjection of extracted groundwater occurring as part of a CERCLA remedial action.	Specific requirements for wells, groundwater withdrawal, treatment, and reinjection.	CERCLA remedial action	ARS §45-454.01	Applicable	Exempts new well construction, withdrawal, treatment, and reinjection into the aquifer of groundwater that occur as part of a CERCLA remedial action from requirements of Arizona Groundwater Code, except that they must comply with the substantive requiremens of: • ARS 45-594 (well construction standards) • ARS 45-595 (well construction requirements) • ARS 45-596 (notice of intenton to drill well) • ARS 45-600 (filing of log by driller of well) In addition, this statute requires that uses of extracted groundwater be consistent with various articles of Chapter 2 of the Groundwater Code, which are discussed in the text.

Table 13. In addition, some requirements pertaining to the handling of hazardous wastes in R18-8-262.30 through R18-8-262.33 are applicable to any hazardous wastes generated onsite.

Treatment

The substantive requirements for miscellaneous RCRA units may be considered relevant and appropriate to air stripping towers and offgas treatment units managing or treating hazardous wastes even though the site and remedial efforts are not a treatment, storage, or disposal facility. These include the substantive requirements of 40 CFR 264.601, which regulate the design, operation, and maintenance of miscellaneous units.

Reinjection ARARs

If reinjection to the aquifer of extracted, treated groundwater is selected as the end use for the treated groundwater, certain additional action-specific ARARs will be implemented. (The chemical-specific ARARs are discussed above, under Reinjection.)

Federal regulations that govern underground injection programs are found in 40 CFR 144.12 and 144.13. According to these regulations, the injection of treated groundwater cannot allow movement of contaminants into underground sources of drinking water which may result in violations of MCLs or adversely affect health. Reinjection of treated groundwater into the same formation it was withdrawn from is allowed as part of a CERCLA action.

If treated groundwater is reinjected into an aquifer, substantive requirements concerning recharge, poor quality groundwater withdrawal, and well installation will be applicable (Arizona Aquifer Protection Permit program [AAC §R18-9-108, -111, and -112]).

Groundwater Remediation Action-Specific ARARs

Arizona's state Superfund program, known as the Water Quality Assurance Revolving Fund (WQARF), provides for cleanup of hazardous substances in groundwater (ARS § 49-281 *et seq.*). Section 49-282.06 of WQARF, as recently amended, requires groundwater remedial actions to ensure the protection of public health, welfare, and the environment; to manage and cleanup hazardous substances, to the extent practicable, so as to allow for the maximum beneficial uses of the waters of the state; and to be reasonable, necessary, cost-effective, and technically feasible. These criteria are very similar to criteria applicable to response actions under CERCLA and the NCP. Those authorities require that remediations be protective of human health and the environment, meet ARARs, and consider advancing numerous other factors, including long-term permanence, the reduction of toxicity, mobility or volume; implementability, and cost-effectiveness. In addition, the NCP requires that groundwater remedial actions generally attain federal MCLs and non-zero MGCLs, where relevant and appropriate; the NCP also requires remedial alternatives developed to take into account the expectation that the remedial action will return groundwater to beneficial uses wherever practicable within a reasonable time frame for the site circumstances.

The WQARF provision does not appear to be more stringent than those in the NCP and therefore its requirements are not ARARs. Nonetheless, any remedy EPA selects will meet the WQARF statutory criteria by meeting the NCP requirements.

A WQARF regulation, Section R18-7-109, addresses remedial action requirements. That regulation incorporates many of the requirements of WQARF Section 49-282.06 discussed above, and incorporates by reference provisions of state law establishing that all definable aquifers are drinking water aquifers unless they qualify for an exemption, and that establish water quality standards for discharges to aquifers. Section R18-7-109 is not more stringent than the requirements in the NCP and is therefore not an ARAR. However, the regulation requires remedies to be consistent with provisions of the Arizona Groundwater Code. Section 45-454.01 of the Arizona Groundwater Code, the substantive requirements of which would apply to the site, exempts from the Groundwater Code's requirements onsite construction of wells, and the withdrawal, reinjection, and treatment of groundwater occurring as part of and on the site of CERCLA remedial actions, with few exceptions. These exceptions include the substantive provisions of the following Arizona statutes, the substantive requirements of which are applicable to the installation of groundwater extraction or reinjection wells.

- ARS § 45-594 (well construction standards)
- ARS § 45-595 (well construction requirements)
- ARS § 45-596 (notice of intention to drill well)
- ARS § 45-600 (filing of log by driller of well)

In addition, ARS Section 45-454.01 requires that the uses of extracted groundwater at the site be consistent with the following articles of the Arizona Groundwater Code, Title 45, Chapter 2:

- Article 5 (grandfathered groundwater rights)
- Article 6 (groundwater rights)
- Article 7 (groundwater withdrawal permits)
- Article 8 (transportation of groundwater)
- Article 8.1 (withdrawal of groundwater for transportation for active management area)
- Article 9 (groundwater management)
- Article 10 (wells)

Air Emissions Requirements

The federal Clean Air Act (CAA), 40 CFR 7401, *et seq.*, implemented through its regulations at 40 CFR Parts 50-99, establish National Ambient Air Quality Standards (NAAQS). The Clean Air Act's NAAQS are not ARARs because they are not enforceable as applied to individual sources. Rather, the NAAQS are implemented through State Implementation Plans (SIPs).

Maricopa County has issued air pollution control rules, the substantive requirements of which apply to the air stripper that may be used to treat extracted groundwater at IBW-South, and are discussed below:

1. Maricopa County Rule 200, Permit Requirements—Specifies general requirements for major sources of air emissions. Major sources are defined as those sources capable of emitting 100 tons per year or more of any regulated air pollutant. Rule 200 exempts sources where total uncontrolled VOC air emission would be less than 3 pounds per day. The IBW-South groundwater treatment site is not expected to be a major source of VOC emissions; however, the pretreated airstream from the air stripping tower may require treatment or control of the offgas if found to exceed 3 pounds of VOC emissions per day.

2. Rule 270, Performance Tests—Establishes performance testing requirements for owners and operators of stationary sources to determine compliance with emission standards.

3. Rule 310, Open Fugitive Dust Emissions—This regulation will apply to construction of the treatment system. It imposes limits on the emission of particulate matter for any action, including construction activities, that can cause open fugitive dust emissions.

4. Rule 330, Volatile Organic Compounds—VOC emissions are limited to no more than 40 pounds per day. If this limitation is exceeded, emission of VOCs to the atmosphere must be reduced by specified methods including incineration, adsorption, or other processes not less effective than incineration or adsorption. Rule 330 includes efficiency requirements for the reduction process, and monitoring and testing requirements for VOC emissions.

Additional performance standards are addressed in Table 12.

13.0 Statutory Determinations

Under CERCLA Section 121, EPA must select remedies that are protective of human health and the environment, comply with ARARs, are cost-effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element. The following sections discuss how the selected remedy and the contingency remedy meet these statutory requirements.

13.1 Protection of Human Health and the Environment

The selected remedy and contingency remedy will protect human health and the environment by extracting and treating VOC-contaminated groundwater and MNA to ensure that the existing contamination does not migrate to groundwater users and that VOC contamination is reduced to groundwater cleanup standards in a reasonable time frame of approximately 30 years. Institutional controls will be enforced to protect the public from exposure to contaminated groundwater in the IBW-South area until cleanup standards are achieved.

The combination of groundwater extraction and natural attenuation will reduce the VOC concentrations in groundwater at the IBW-South site. Groundwater at the IBW-South site is currently used for industrial supply. Inactive municipal wells are also present. PCE and TCE were detected most frequently in the UAU and the MAU/LAU wells.

The selected remedy and contingency remedy will reduce the VOC contaminant levels to protective ARAR levels to restore groundwater to its beneficial use. The selected and contingency remedies will protect the groundwater resource by ensuring that VOC contamination in excess of aquifer cleanup standards does not migrate beyond compliance boundaries established in this ROD.

No short-term threats are associated with the selected remedy and contingency remedy that cannot be readily controlled. In addition, no adverse cross-media impacts are expected from the selected and contingency remedies.

13.2 Compliance With Applicable or Relevant and Appropriate Requirements

The selected remedy and contingency remedy of groundwater extraction and treatment and MNA will comply with all ARARs identified for this action at the IBW-South site. The groundwater extraction, treatment, and MNA in selected areas will reduce the groundwater concentrations to chemical-specific ARARs within a reasonable time frame and ensure that additional migration of contaminated groundwater is limited. The ARARs for the selected remedy and contingency remedy are presented in detail in Section 12.0.

13.3 Cost-Effectiveness

The selected remedy and contingency remedy are cost-effective for mitigating the risks posed by VOC-contaminated groundwater at the IBW-South site. Section 300.430(f)(1)(ii)(D) of the NCP requires EPA to determine cost-effectiveness by evaluating the cost of an alternative relative to its overall effectiveness. Effectiveness is defined by three of the five balancing criteria: long-term effectiveness, short-term effectiveness, and reduction of toxicity, mobility, and volume of the contamination through treatment. The overall effectiveness is then compared to cost to ensure that the selected remedy is cost-effective.

The selected remedy will have long-term effectiveness because, by extraction and MNA, it will reduce contaminant levels to aquifer cleanup standards and maintain them. The selected remedy will have short-term effectiveness because there are minimal adverse impacts to the community, workers, and the environment during the implementation of the remedial action. The selected remedy will achieve a reduction in toxicity, mobility, and volume through treatment where treatment is warranted. Relative to the cost of the remedy, these results will provide a good value and will be cost-effective.

The estimated present worth cost of the selected remedy is $22,460,000. Although lower cost alternatives were evaluated (Alternatives 1 through 3), these alternatives are not effective and do not adequately meet EPA's threshold criteria of overall protection of human health and the environment and compliance with ARARs, nor do they ensure as much short-term effectiveness or reduction of toxicity, mobility, and volume of contamination through treatment. Alternatives 5 and 6 may somewhat speed the groundwater restoration, but these alternatives cost approximately $14 million and $26 million more than the selected remedy, respectively, and pose greater implementability difficulties than does Alternative 4. The costs represent increases of 64 percent and 115 percent, respectively. The selected remedy (Alternative 4) is the lowest cost remedy that is also effective and achieves EPA's remediation goals within a reasonable time frame. Therefore, the selected remedy is the most cost-effective remedy for remediation of VOC-contaminated groundwater at the IBW-South site.

The additional cost of the contingency remedy of extraction and treatment in MNA areas is estimated at $2,570,000. The contingency remedy will have the same effectiveness as the extraction component of the selected remedy, and is thus cost-effective.

13.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

EPA has determined that the selected remedy and the contingency remedy represent the maximum extent to which permanent solutions and treatment technologies can be used in a practicable manner at the IBW-South site. Of those alternatives that are protective of human health and the environment and comply with ARARs (Alternatives 4, 5, and 6), EPA has determined that the selected remedy and contingency remedy provide the best balance of tradeoffs in terms of the five balancing criteria, while also considering the statutory preference for treatment as a principal element and considering State and community acceptance.

The selected remedy and contingency remedy treat the threats posed by the site, achieving significant reductions in VOC concentrations in groundwater. The selected remedy and contingency remedy satisfy the criteria for long-term effectiveness by reducing VOC contamination in groundwater through extraction and MNA and destroying the VOCs during regeneration of the offgas system carbon or other treatment residual. Groundwater containment will effectively reduce the mobility of the VOCs in groundwater; extraction, natural attenuation, and treatment will reduce the toxicity and volume of VOC-contaminated groundwater. The selected remedy and contingency remedy do not present short-term risks different from other alternatives that incorporate treatment. No special implementability issues set the selected and contingency remedies apart from the other alternatives evaluated.

13.5 Preference for Treatment as a Principal Element

The selected remedy includes extraction and treatment of the contaminated groundwater in the western UAU area of contamination (and potentially other areas if the contingency remedy is implemented) through air stripping and carbon adsorption, or an alternate treatment option to be selected during remedial design. In combination with the remedy selected in the Vadose Zone OU ROD, the selected remedy and contingency remedy address the principal threats posed by the IBW-South site through the use of treatment technologies. By using treatment as a significant portion of the remedy, the statutory preference for remedies that employ treatment as a principal element is satisfied.

13.6 Five-Year Review Requirements

This remedial action is expected to take more than 5 years to achieve aquifer cleanup levels to allow for unlimited use and unrestricted exposure. Accordingly, by policy, EPA will perform a review not less than 5 years after completion of the construction for all remedial actions at the site, and may continue such reviews until EPA determines that hazardous substances have been reduced to levels protective of human health and the environment.

13.7 Implementability

The selected remedy is considered to be administratively and technically implementable. The services and materials required to implement this remedy are readily available and use current technologies.

13.8 Cost

The selected remedy is not the least costly of the alternatives considered, but it has significant advantages over less costly alternatives. In particular, unlike those alternatives that are less expensive, the selected remedy will result in cleanup levels being met within a reasonable time frame of approximately 30 years through active extracting and treating of groundwater and through MNA processes.

13.9 State Acceptance

The State of Arizona concurs with the selected remedy for IBW-South.

13.10 Community Acceptance

In general, comments on the Proposed Plan for IBW-South have indicated that the community supports the selected remedy for VOCs in groundwater.

Comments from some PRPs opposed EPA's preferred alternative for groundwater because they felt that MNA could be implemented without any groundwater extraction and treatment. In response to these concerns, EPA performed additional groundwater modeling but still finds that ARARs cannot be achieved within a reasonable time frame without active treatment in the western contaminated area. Extraction and treatment are therefore required, and the specific target volume of groundwater to be extracted will be determined during remedial design.

The community has expressed concern about the SRP Tempe Canal No. 6 as an end use. The community and some government agencies generally support Alternative 4 more than Alternatives 5 and 6 because it is more cost-effective and it extracts a smaller volume of groundwater.

Appendix A
Cost Evaluation

APPENDIX A

Cost Evaluation

A.1 Introduction

The purpose of this appendix is to document the estimated capital, annual operation and maintenance (O&M), and present worth (PW) costs associated with the selected remedy and contingency remedy for the Indian Bend Wash- South Superfund Site. These cost estimates are order-of-magnitude estimates and are expected to be accurate within +50 to -30 percent. The summary of the costs for the selected and contingency remedy is presented in Table A-1.

TABLE A-1
Costs for the Selected Remedy and the Contingency Remedy

Cost	Selected Remedy	Contingency Remedy
Capital	6,170,000	8,580,000
Annual O&M	1,060,000	1,070,000
30-Year Present Worth	22,460,000	25,030,000
5-Year Present Worth	10,760,000	13,210,000

The components for each remedy consist of containment, treatment, end use, and monitoring. The selected remedy consists of partial containment with three new UAU extraction wells and a total flow of 2,940 gallons per minute (gpm). The contingency remedy consists of partial containment with three additional new UAU extraction wells, as well as those used in the selected remedy, and a total flow of 4,440 gpm. Appendix D of the FS contains all the detailed information regarding the cost estimating procedures and assumptions. Table A-2 in this Appendix shows the detailed parts for the components for each remedy.

For cost comparison, a PW cost was calculated. The PW is the present value of the remedy at some defined period in the future. Because the length of time to achieve remediation of groundwater is undefined, the PW is calculated for a 5-year and a 30-year time period, both at an interest rate of 5 percent. The analysis of each remedy's power requirements and costs are provided in Attachment A-1. Attachment A-2 summarizes the capital and O&M costs for the treatment component of each remedy. The detailed capital and O&M costs for each remedy are presented in Attachment A-3.

Table A-2

Component Details for the Selected Remedy and Contingency Remedy

Alternative	Selected Remedy	Contingency Remedy
Flow (gpm)	2,940	4,440
Components		
Containment		
Number of UAU Extraction Wells	3	6
Number of MAU Extraction Wells	0	0
Number of Existing COT Municipal Wells	0	0
Number of Additional Monitoring Wells	10	10
Number of Telemetry Systems for each Extraction & Reinjection Well	3	6
Number of Site Electricity Setups for each Extraction Well	3	6
Treatment		
Treatment Plant		
Number of Air Stripping Towers	1	2
Number of VGAC Units	2	4
Linear Feet of Conveyance Pipeline:		
6" Diameter	0	0
8" Diameter	0	0
10" Diameter	4,400	7,400
12" Diameter	1,000	9,500
14" Diameter	5,500	5,500
16" Diameter	0	0
18" Diameter	0	0
20" Diameter	0	0
24" Diameter	0	0
28" Diameter	0	0
30" Diameter	0	0
End Use		
Linear Feet of Distribution Pipeline:		
6" Diameter	0	0
8" Diameter	0	0
10" Diameter	0	0
12" Diameter	0	0
14" Diameter	0	0
16" Diameter	50	50
18" Diameter	0	0
20" Diameter	0	0
24" Diameter	0	0
28" Diameter	0	0
30" Diameter	0	0
Distribution Pump Station (HP)	60	60
Number of Outfall Structures	1	1
Number of UAU Reinjection Wells	0	0
Number of MAU Reinjection Wells	0	0
Monitoring		
Monitoring Samples per Year	252	252

Attachment A-1

Pump Station and Power Cost Calculations

Parameter	Power Cost ($/kWh)	Pump/Motor Efficiency	Treatment Plant Residual Head (ft)	End Use Residual Head (ft)	Elevation Head (ft)
Assumed Value	0.09	1	30	10	20

Selected Remedy

End Use—Town Lake

Conveyance Pipeline and Pumping

Extraction Well			Pipeline		Extraction Well Pump		
Extraction Well	Pumping Rate (gpm)	Static Lift (ft)	Length (ft)	Friction Loss (ft)	TDH (ft)	Calculated HP	Installed HP
EWA-1	990	75	9,600	86	211	76	80
EWA-2	870	75	6,600	59	184	58	60
EWA-3	1,080	75	5,200	47	172	67	75
Total Flow	2,940						

Distribution Pipeline and Pumping

	Pumping Rate (gpm)	Static Lift (ft)	Length (ft)	Friction Loss (ft)	TDH (ft)	Calculated HP	Installed HP
	2,940	0	50	0	50	54	60

Total HP Required =	254
Annual kWh =	1,660,469
Annual Power Cost =	149,442

Contingency Remedy

End Use—Town Lake

Conveyance Pipeline and Pumping

Extraction Well			Pipeline		Extraction Well Pump		
Extraction Well	Pumping Rate (gpm)	Static Lift (ft)	Length (ft)	Friction Loss (ft)	TDH (ft)	Calculated HP	Installed HP
EWA-1	990	75	9,600	86	211	76	80
EWA-2	870	75	6,600	59	184	58	60
EWA-3	1,080	75	5,200	47	172	67	75
EWA-4a	500	75	9,300	84	209	38	80
EWA-5a	500	75	9,700	87	212	38	60
EWA-6a	500	75	9,700	87	212	38	75
Total Flow	4,440						

Distribution Pipeline and Pumping

	Pumping Rate (gpm)	Static Lift (ft)	Length (ft)	Friction Loss (ft)	TDH (ft)	Calculated HP	Installed HP
	4,440	0	50	0	50	81	60

Total HP Required =	281
Annual kWh =	1,839,064
Annual Power Cost =	165,516

Attachment A-2

Summary of Treatment Costs

Alternative	Treatment Plant	Flow (gpm)	Flow-weighted Concentrations TCE (µg/L)	PCE (µg/L)	Capital Cost ($)	Annual O&M ($)
Selected Remedy	1	2,940	17	0	1,089,606	773,737
Contingency Remedy	1	4,440	15	0	1,279,536	774,951

Attachment A-3
Estimated Capital and O&M Costs for the Selected Remedy and Contingency Remedy

Assumptions	
1. Conveyance Pipe Cost	5 per diam-in/LF
2. Distribution Pipe Cost	5 per diam-in/LF
3. Pipeline Appurtenances	15% of pipe capital cost subtotal
4. Expected life of	
Pipeline	40 years
Pumps	15 years
Wells	30 years
Treatment Plants	30 years
Telemetry	30 years
Site Electric	30 years
Outfall Structure	40 years
5. O&M Costs	
Extraction Wells	1% of capital
Pipeline & Appurt.	0.5% of capital
Distribution Pumps	5% of capital
Reinjection Wells	2% of capital
Outfall Structure	3% of capital
Telemetry	2% of capital
Site Electrical	2% of capital
6. Pump Station Costs	1,200 per motor HP
7. Lump Sums for following capital costs:	
Telemetry for Ex. & Reinj. Wells	20,000 per well
Site Electric. for Ex. Wells	30,000 per well
Discharge Structure	50,000 each
MAU Reinjection Wells	210,000 each
UAU Extraction Wells	78,000 each
MAU Extraction Wells	170,000 each
Additional UAU Monitoring Wells	78,000 each
Cement liner for SRP23E, 2.9N	150,000 each
8. VOC Analytical Costs	300 per sample
9. Physical Properties Analytical Costs	135 per sample
10. QA/QC Frequency	10% of total number of samples
11. Construction Allowance	12%
12. Bid Contingency	20%
13. Scope Contingency	20% Extraction, Reinjection, Conveyance
14. Legal Fees, Permitting Fees, etc.	2%
15. Services during construction	6%
16. Engineering Design	15%

17. Extraction and reinjection well costs include drilling, development, pump, and motor costs.

Attachment A-3
Estimated Capital and O&M Costs for the Selected Remedy and Contingency Remedy

Alternative	**Selected Remedy**
End Use	**Discharge to Town Lake**
Containment Scenario	**Partial**
Number of Treatment Plants	**One**

Facilities	Estimated Quantity	Unit	Unit Price ($)	Extended Capital Cost ($)	O&M Cost ($)
UAU Extraction Wells	3	Each	$76,000	228,000	2,280
MAU Extraction Wells	0	Each	$170,000	0	0
Additional UAU Monitoring Wells	10	Each	$76,000	760,000	7,600
Cement Liner for SRP23E, 2.9 N	1		$150,000	150,000	0
Treatment Plant 1		LS		1,089,606	773,737
No. Towers	1				
No. VGAC Units	2				
Treatment Plant 2	NA	LS			
Conveyance Pipeline (dia-in)					
6	0	LF	30	0	0
8	0	LF	40	0	0
10	4,400	LF	50	220,000	1,100
12	1,000	LF	60	60,000	300
14	5,500	LF	70	385,000	1,925
16	0	LF	80	0	0
18	0	LF	90	0	0
20	0	LF	100	0	0
24	0	LF	120	0	0
28	0	LF	140	0	0
30	0	LF	150	0	0
Subtotal	10,900			665,000	3,325
Appurtenances		LS		99,750	499
Distribution Pipeline					
6	0	LF	30	0	0
8	0	LF	40	0	0
10	0	LF	50	0	0
12	0	LF	60	0	0
14	0	LF	70	0	0
16	50	LF	80	4,000	20
18	0	LF	90	0	0
20	0	LF	100	0	0
24	0	LF	120	0	0
28	0	LF	140	0	0
30	0	LF	150	0	0
Subtotal	50			4,000	20
Appurtenances		LS		600	3
Power					149,442
Distribution Pump Station (TP 1)	60	HP	1200	72,000	3,600
Distribution Pump Station (TP 2)	0	HP	1200	0	0
Telemetry for Ex. & Reinj. Wells	3	Each	20,000	60,000	1,200
Site Electric. for Ex. Wells	3	Each	30,000	90,000	1,800
Outfall Structure	1	Each	50,000	50,000	1,500
MAU Reinjection Wells	0	Each	210,000	0	0
Monitoring	194	VOC samples per year	300		58,200
	58	Property samples per year	135		7,830
Annual Reporting/Data Evaluation					50,000
Subtotal Capital Cost				3,268,956	
Construction Allowance				392,275	
Bid Contingency				653,791	
Scope Contingency				653,791	
Total Construction Cost				4,968,813	
Legal Fees, Permitting Fees, etc.				99,376	
Services During Construction				298,129	
Total Implementation Cost				5,366,318	
Engineering Design Costs				804,948	
Alternative Total Cost				$6,170,000	$1,060,000

Attachment A-3

Estimated Capital and O&M Costs for the Selected Remedy and Contingency Remedy

Alternative	**Contingency Remedy**
End Use	**Discharge to Town Lake**
Containment Scenario	**Partial**
Number of Treatment Plants	**One**

Facilities	Estimated Quantity	Unit	Unit Price ($)	Extended Capital Cost ($)	O&M Cost ($)
UAU Extraction Wells	6	Each	$76,000	456,000	4,560
MAU Extraction Wells	0	Each	$170,000	0	0
Additional UAU Monitoring Wells	10	Each	$76,000	760,000	7,600
Cement Liner for SRP23E, 2.9 N	1		$150,000	150,000	0
Treatment Plant 1		LS		1,279,536	774,951
No. Towers	2				
No. VGAC Units	4				
Treatment Plant 2	NA	LS			
Conveyance Pipeline (dia-in)					
6	0	LF	30	0	0
8	3,100	LF	40	124,000	620
10	4,400	LF	50	220,000	1,100
12	9,200	LF	60	552,000	2,760
14	5,500	LF	70	385,000	1,925
16	0	LF	80	0	0
18	0	LF	90	0	0
20	0	LF	100	0	0
24	0	LF	120	0	0
28	0	LF	140	0	0
30	0	LF	150	0	0
Subtotal	22,200			1,281,000	6,405
Appurtenances		LS		192,150	961
Distribution Pipeline					
6	0	LF	30	0	0
8	0	LF	40	0	0
10	0	LF	50	0	0
12	0	LF	60	0	0
14	0	LF	70	0	0
16	50	LF	80	4,000	20
18	0	LF	90	0	0
20	0	LF	100	0	0
24	0	LF	120	0	0
28	0	LF	140	0	0
30	0	LF	150	0	0
Subtotal	50			4,000	20
Appurtenances		LS		600	3
Power					149,442
Distribution Pump Station (TP 1)	60	HP	1200	72,000	3,600
Distribution Pump Station (TP 2)	0	HP	1200	0	0
Telemetry for Ex. & Reinj. Wells	6	Each	20,000	120,000	2,400
Site Electric. for Ex. Wells	6	Each	30,000	180,000	3,600
Outfall Structure	1	Each	50,000	50,000	1,500
MAU Reinjection Wells	0	Each	210,000	0	0
Monitoring	194	VOC samples per year	300		58,200
	58	Property samples per year	135		7,830
Annual Reporting/Data Evaluation					50,000
Subtotal Capital Cost				4,545,286	
Construction Allowance				545,434	
Bid Contingency				909,057	
Scope Contingency				909,057	
Total Construction Cost				6,908,835	
Legal Fees, Permitting Fees, etc.				138,177	
Services During Construction				414,530	
Total Implementation Cost				7,461,541	
Engineering Design Costs				1,119,231	
Alternative Total Cost				$8,580,000	$1,070,000