

**Interim Record of Decision Amendment
Tucson International Airport Area
Superfund Site Area A
North of Los Reales Road
Tucson, Arizona**

March 2023



U.S. Environmental Protection Agency, Region 9
ID: AZD980737530
75 Hawthorne Street
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Acronyms and Abbreviations

µg/L	microgram per liter
ADEQ	Arizona Department of Environmental Quality
AFP44	Air Force Plant 44
AOP	advanced oxidation process
ARAR	Applicable or Relevant and Appropriate Requirement
Area A	TIAA Superfund Site Area A
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	contaminant of concern
CTWD	City of Tucson Water Department
EPA	U.S. Environmental Protection Agency
FBHHRA	Focused Baseline Human Health Risk Assessment
FFS	Focused Feasibility Study
GAC	granular-activated carbon
gpm	gallon per minute
GWTP	groundwater treatment plant
IC	institutional control
ISB	in situ bioremediation
ISCO	in situ chemical oxidation
KMnO ₄	potassium permanganate
LZ	Lower Aquifer Zone
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MNA	monitored natural attenuation
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOI	Notice of Intent
NWF	North Well Field
OU	operable unit
PCA	packed column aeration
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SASR	Semi-annual Status Report
SDWA	Safe Drinking Water Act
SWF	South Well Field
TARP	Tucson Airport Remediation Project
TCE	trichloroethylene
TIAA	Tucson International Airport Area
UFHHRA	Unified Focused Human Health Risk Assessment
USAF	U.S. Air Force
UV	ultraviolet light
UV-AOP	ultraviolet light peroxide advanced oxidation process
UZ	Upper Aquifer Zone
VOC	volatile organic compound
WTP	water treatment plant

1.0 PART I: DECLARATION FOR THE RECORD OF DECISION AMENDMENT

1.1 Site Name and Location

The following lists site information:

- Tucson International Airport Area Superfund Site (herein referred to as TIAA Superfund Site or Site).
- Superfund Enterprise Management System (SEMS) Identification: AZD980737530.
- TIAA Superfund Site Area A consists of the groundwater project areas north of Los Reales Road and both airport property (including Tucson International Airport and Three Hangars Building) and the Tucson Airport Remediation Project (TARP).

1.2 Statement of Basis and Purpose

This interim Record of Decision (ROD) Amendment presents fundamental changes to the August 22, 1988 Record of Decision (ROD) for the Site's Area A north of Los Reales Road. The U.S. Environmental Protection Agency (EPA) considered and approved this ROD Amendment in accordance with Section 117 of Comprehensive Response, Compensation and Liability Act (CERCLA) and Section 300.435(c)(2)(ii) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), which require the amendment of a ROD when making fundamental changes to the remedy. The ROD Amendment is based on the information contained in the Administrative Record for this Site. The ROD Amendment will become part of the Administrative Record file (in accordance with Section 300.825(a)(2) of the NCP).

The 1988 ROD and this ROD Amendment respond to specific volatile organic compounds (VOCs) and 1,4-dioxane, which are hazardous substances under CERCLA. Within recent years, EPA has also identified pollutants and contaminants, which will be addressed in a future decision document.

The lead agency is EPA, and the support agency is the Arizona Department of Environmental Quality (ADEQ). The State of Arizona concurs.

1.3 Assessment of the Site

The response action selected in this ROD Amendment is necessary to protect human health from actual or threatened releases of hazardous substances into the environment.

1.4 Description of the Revised Remedy

On August 22, 1988, the U.S. Environmental Protection Agency (EPA) signed a Record of Decision (ROD) selecting the remedy for groundwater contamination north of Los Reales Road, which includes Area A (and Area B). The 1988 ROD addressed certain VOCs: trichloroethylene (TCE), as well as 1,1-dichloroethene, trans-1,2-dichloroethene, and chloroform.

The main components of the remedy documented in the 1988 ROD, which applied to Area A, included the following:

- Control of groundwater contamination through extraction wells.
- Treatment of contaminated groundwater using packed column aeration (PCA; air stripping).
- Treatment of generated off-gas using reasonably available control technology (in this case, granular-activated carbon [GAC]).
- Beneficial use of treated groundwater as drinking water to the City of Tucson potable water distribution system.
- Groundwater monitoring.

Following the implementation of the 1988 EPA ROD, the City of Tucson Water Department (CTWD) constructed a water treatment plant (WTP) utilizing PCA to treat volatile organic compounds (VOCs) extracted from the aquifer. The system is collectively known as the Tucson Area Remediation Project (TARP). Following the discovery of 1,4-dioxane in the groundwater in 2002, and EPA's publishing of a reduced Drinking Water Health Advisory for 1,4-dioxane in 2011, the City of Tucson proactively modified the on-site WTP to include an advanced oxidation process (AOP) treatment system using ultraviolet (UV) light and hydrogen peroxide to create the oxidants (CTWD 2014). The UV-AOP system is capable of reducing concentrations of VOCs, primarily TCE, and the more recently discovered 1,4-dioxane to below target treatment levels for drinking water (EGC, Inc. 2016a and 2016b). The excess hydrogen peroxide from the UV-AOP system is quenched using GAC. The redundant operation of both the UV-AOP and the PCA towers at the WTP continued from startup of the UV-AOP system in February 2014 through April 2020. Over this six-year operation period, treated water quality data demonstrated that the UV-AOP system is capable of meeting all obligations under the 1990 Consent Decree and treating 1,4-dioxane in water from the TARP remediation well fields to levels below its 0.1 micrograms per liter (µg/L) detection limit.

In early 2017, EPA published a Proposed Plan and provided a public comment period, which proposed fundamental changes to the remedy. In September 2021, EPA signed a Minor Changes Memorandum to remove the specification of the end use of treated water, but made no other changes to the remedy.

This Interim ROD Amendment revises the remedy for the Site's Area A as follows:

- Treatment of the groundwater for 1,4-dioxane using the ultraviolet light-hydrogen peroxide advanced oxidation process (UV-AOP) system, which is already in place at TARP, and elimination of the PCA system.
- Enhancement of the current remedy by installation of an additional remediation/extraction well to further reduce contaminant mass.
- Continued monitoring of treated groundwater at TARP to ensure cleanup levels are met.
- Alternate options for beneficial use of the water other than as drinking water, including discharge to the City of Tucson recycled water system.
- Continued long-term monitoring of the groundwater contamination.

2.0 STATUTORY DETERMINATIONS

This interim action is protective of human health and the environment in the short term and is intended to provide adequate protection until a final ROD is signed; complies with (or waives) those federal and state requirements that are applicable or relevant and appropriate for this limited-scope action; and is cost-effective. Although this interim action is not intended to address fully the statutory mandate for permanence and treatment to the maximum practicable, this interim action does utilize treatment and thus supports that statutory mandate. Because this action does not constitute the final remedy for Area A of the Site, the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element will be addressed by the final response action. Subsequent actions planned to address fully the threats posed by conditions will be addressed by the final response action. Because this remedy will result in hazardous substances remaining on-site above health-based values, a review will be conducted to ensure that the remedy continues to provide adequate protection of human health and the environment within five years after commencement of the remedial action.

Because this is an interim action ROD, review of this site and remedy will be ongoing.

3.0 ROD DATA CERTIFICATION CHECKLIST

The following information is included in Section 4.0, “Part II: Decision Summary” of this ROD Amendment:

- COCs and their respective concentrations. This interim action decision is only addressing CERCLA hazardous substances, specifically VOCs and 1,4-dioxane. The term COCs used herein refers to hazardous substances. Not addressed in this interim decision document are substances that are “pollutants and contaminants,” such as per-and polyfluorinated substances, which will be addressed in a future decision document.
- Baseline risk represented by the COCs.
- Cleanup levels established for COCs and the basis for these levels.
- How source materials constituting principal threats are addressed.
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and ROD Amendment.
- Potential land and groundwater use that will be available at the Site as a result of the selected remedy.
- Estimated capital, annual operation and maintenance, total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected.
- Key factor(s) that led to selecting the amended remedy (i.e., describe how the selected remedy provides the best balance of trade-offs with respect to the balancing and modifying criteria, and highlight the criteria significant to the decision).

Additional information can be found in the Administrative Record file for this Site.

3.1 Authorizing Signature

MARTHA ACEVES

Digitally signed by MARTHA
ACEVES
Date: 2023.03.21 11:25:03 -07'00'

Martha Guzman
Regional Administrator
U.S. Environmental Protection Agency, Region 9

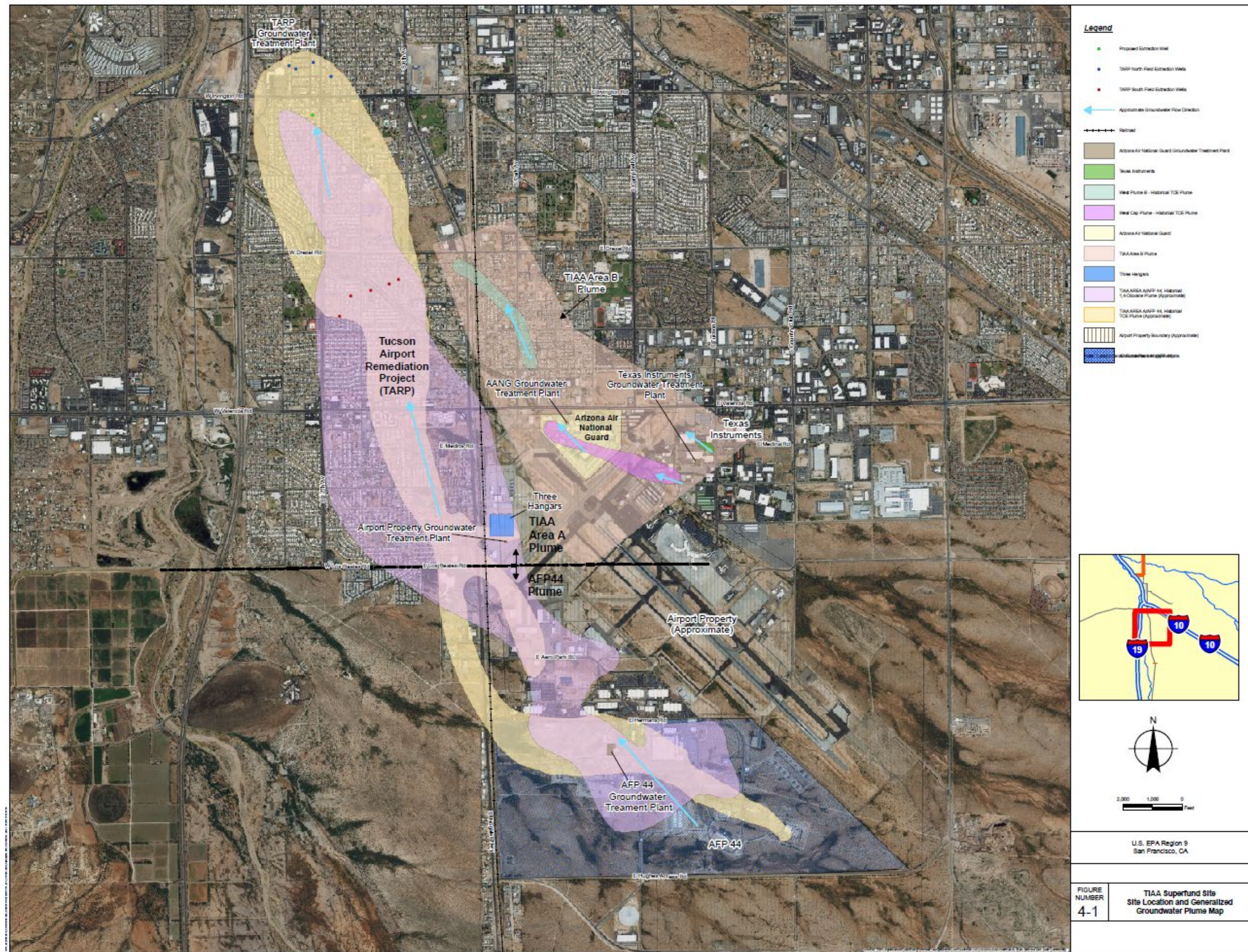
Date

4.0 PART II: DECISION SUMMARY

This decision summary provides a description of TIAA Superfund Site Area A and the analyses that led to the amendment of the selected remedy for the Site. This section includes background information about the Site, the nature and extent of contamination found at the Site, the assessment of human health and environmental risks posed by the contaminants at the Site, and the identification and evaluation of remedial action alternatives for the Site.

4.1 Site Name, Location, and Brief Description

In 1981, VOCs were detected in the City of Tucson drinking water wells in the vicinity of Tucson International Airport, which resulted in the establishment of the TIAA Superfund Site (Figure 4-1). EPA divided the Site into two geographic areas: (1) Area A, which comprises the main groundwater contamination plume located to the west of the Airport, and (2) Area B, which includes the West Plume B, an Arizona Air National Guard facility, a former Texas Instruments facility, and the former West-Cap project area, located to the north and east of the airport. This ROD Amendment is restricted to the portion of Area A north of Los Reales Road. EPA is the lead agency for TIAA Superfund Site Area A, with the Arizona Department of Environmental Quality (ADEQ) in the support role. The Comprehensive Environmental Response, Compensation, and Liability Information System Identification is AZD980737530.



4.2 Site History and Enforcement Activities

From the 1940s through the mid-1970s, defense and industrial operators stored, handled, and disposed of hazardous materials in a manner that caused releases into the environment. In the early 1950s, residents within the present-day Site complained that water from private wells had a foul odor (EGC, Inc. 2016a). Chromium was identified as a contaminant in a municipal water supply well located near Air Force Plant 44 (AFP44) in the late 1950s. In 1976, the State of Arizona closed one well at AFP44 because of a high chromium concentration (EGC, Inc. 2016b). Starting in 1981, the City of Tucson and EPA collected and analyzed water from municipal wells within the main plume of groundwater contamination (EGC, Inc. 2016b). The investigation discovered VOC contamination in excess of safe drinking water levels. Subsequent investigations defined the main plume of groundwater contamination as containing TCE and other chlorinated VOCs. To avoid exposure to the contamination, 11 city and several private household wells were shut down (EGC, Inc. 2016b).

The Site was placed on the preliminary EPA National Priorities List (NPL) in July 1982 (Arizona Department of Health Services 1985) to address VOC and chromium contamination in groundwater. It was declared a Superfund site and placed on the final National Priorities List in September 1983 (EPA 2013). Environmental response actions are conducted in accordance with CERCLA, as amended and as implemented under the U.S. Air Force (USAF) Installation Restoration Program or Defense Environmental Restoration Program. Substantive corrective action requirements under the Resource Conservation and Recovery Act (RCRA) were integrated through the ARARs process.

In 1985, the USAF adopted a remedy to address the groundwater contamination associated with AFP44, which is located south of Los Reales Road. Three years later, on August 22, 1988, EPA signed a ROD to address the regional groundwater contamination in Area A (and in some Area B locations) at the TIAA Superfund Site (EPA 1988).

The TARP groundwater plume and treatment system are the major focus of this ROD Amendment. While not part of TIAA Superfund Site Area A, the AFP44 groundwater treatment plant (GWTP) treats and controls groundwater south of Los Reales Road, and is discussed in the context of TIAA Superfund Site Area A because the plant owner, the USAF, has been identified as a responsible party for the Area A groundwater plume both north and south of Los Reales Road.

The WTP is currently operated by the CTWD to supply public water to the City of Tucson and to perform the remedial action at this site, as documented in the 1988 EPA ROD. The WTP is used to capture and treat contaminated groundwater at the leading edge of the groundwater plume to prevent further migration to the north. The WTP consists of nine extraction wells (from two separate well fields) currently used to pump approximately 5,000 gallons per minute (gpm) from the regional aquifer to the packed column aeration system, which was designed to use PCA towers with GAC for off-gas treatment of TCE and other VOCs (EGC, Inc. 2016a).

Table 4-1 summarizes the major CERCLA milestones for the Area A portion of the TIAA Superfund Site work. The histories of the individual areas associated with the TIAA Superfund Site Area A follow.

Table 4-1
Summary of CERCLA Milestones for TIAA Superfund Site Area A North of Los Reales Road

Year	Document or Milestone	Key Points
1988	Record of Decision for the TIAA Superfund Site	Pump-and-treat technology was selected as the remedial action for treatment of VOCs prior to discharging treated groundwater to the municipal water distribution system.
1994	TARP Remedial Action	TARP treatment plant begins operation.
1996	Airport Property Remedial Investigation (RI)	RI characterized extent of contamination in shallow groundwater zone and vadose zone.
1997	Airport Property Remedial Action	Polychlorinated biphenyls-contaminated soil is excavated.
1997	Airport Property Feasibility Study	Feasibility Study presented remedial technologies which might be applicable to the site.
1997	Airport Property ROD	EPA issued a ROD for the selected remedial alternative.
2002	TARP, Airport Property, and AFP44	1,4-dioxane is discovered in the groundwater.
2002	Airport Property Remedial Action	Installed five extraction wells to cut off shallow groundwater zone from TARP plume.
2004	Airport Property Remedial Design	Finalized the shallow groundwater zone remedy and soil-vapor extraction remedy design report and remedial action work plan.
2006	Airport Property Remedial Action	ISCO using potassium permanganate to treat VOCs in soil and groundwater.
2010	TARP's UV-Peroxide AOP Treatment Pilot System	Pilot test confirmed that UV-peroxide AOP treatment is the preferred technology for treatment of 1,4-dioxane in groundwater.
2014	TARP's UV-Peroxide AOP Treatment; Operation Begins by Tucson Water	TARP begins operation of UV-peroxide AOP treatment system in addition to operation of the WTP.
Ongoing	All Project Areas	Groundwater sampling of both the groundwater plume and effluent of the groundwater treatment systems is ongoing.

4.3 TARP Project Area

Historical industrial and defense-related activities at the airport property and at AFP44 led to the presence of TCE and related compounds in the regional aquifer within Area A north of Los Reales Road. Because this portion of the plume contained contaminants from multiple parties, a Consent Decree was signed in June 1991 to establish the work responsibilities of each party and to provide funding to implement the 1988 EPA ROD for groundwater remediation north of Los Reales Road. The signing parties included the United States (on behalf of the USAF and EPA), Raytheon Company (then Hughes Aircraft Company), Tucson Airport Authority, City of Tucson, and the Boeing Company (then McDonnell Douglas Corporation). In 1994, as part of the implementation of the 1988 EPA ROD, a groundwater remediation system consisting of five extraction wells in the south well field (SWF) and four in the north well field (NWF) was constructed to provide hydraulic capture and control, and remediation of groundwater at the TIAA Superfund Site Area

A plume north of Los Reales Road (Figure 4-1). This system, known as TARP, used PCA or air stripping with vapor-phase GAC to remove chlorinated VOCs in the exhaust from the PCA towers (EGC, Inc. 2016a).

In 2002, 1,4-dioxane was detected in groundwater samples collected from monitoring and remediation wells within the TIAA Superfund Site Area A plume. The concentrations of 1,4-dioxane are likely from 1,1,1-trichloroethane solutions that were used as solvent stabilizers at AFP44 and the airport property (EGC, Inc. 2016b). The PCA towers used at the WTP were not designed to treat 1,4-dioxane. In January 2014, CTWD built the new UV-AOP system, which it currently operates. The UV-AOP system removes 1,4-dioxane and VOCs in groundwater before the water is filtered through GAC to quench residual hydrogen peroxide. Once treated by the UV-AOP system, the treated water was passed through the PCA towers in compliance with the 1990 Consent Decree. The City of Tucson, citing EPA's Drinking Water Health Advisory for 1,4-dioxane, had used 0.35 µg/L as its interim treatment goal in the absence of an MCL (CTWD 2014). The UV-AOP system reduces 1,4-dioxane and TCE concentrations to non-detect at a detection limits of 0.10 µg/L and 0.5 µg/L, respectively, even before the water was passed through the air stripping towers. Prior to the 2014 construction of the UV-AOP system to remove 1,4-dioxane, the CTWD blended water from the City's Southside Well Field and from other portions of the system with the effluent from the PCA WTP prior to delivery to the potable water distribution system at the Santa Cruz Lane Reservoir. The City of Tucson began a program of collecting samples directly from the distribution system and analyzing the samples for 1,4-dioxane. Results indicated that 1,4-dioxane concentration in served water was less than 0.35 µg/L. Samples were collected on a weekly basis at the WTP input and output locations, and at the blended point-of-entry to the potable water distribution system. With the implementation of the UV-AOP, a blending strategy was no longer needed.

On March 30, 2017, EPA and CTWD participated in a public meeting presenting the Proposed Plan for the remedy of 1,4-dioxane in groundwater of the Area A plume north of Los Reales Road. The Proposed Plan recommended continuing remediation of the plume using the UV-AOP facility at the TARP WTP as described in Alternative 3 of the Focused Feasibility Study (FFS) for 1,4-Dioxane North of Los Reales Road (EGC, 2016c). Some public comments were focused on alternatives including *in situ* bioremediation (ISB; Alternative 5 of the FFS) and *in situ* chemical oxidation (ISCO; Alternative 6 of the FFS) approaches because of claims to reduce the duration of the remedy by 10 years. The *in situ* remediation approaches were proposed in the FFS for the portion of the TARP plume north of Los Reales Road and south of Valencia Road, as illustrated on Figure 4-1, which is nearest to the groundwater contamination source areas at AFP44 and the Three Hangers site at the Tucson Airport Property. Groundwater quality data collected on a quarterly basis each year from the plume are documented in the TARP Semi-annual Status Reports (SASRs). Groundwater quality data collected from 2011 through 2022 demonstrate significant reductions in contaminant concentrations in this portion of the plume between Los Reales Road and the SWF. Due to the greatly reduced mass of contaminants in groundwater of this portion of the plume, little benefit would be gained by *in situ* treatment of groundwater in this area as described in Alternatives 5 and 6 of the FFS (EGC, 2016c).

Due to the public's desire for a faster conclusion to the remedial action for TCE and 1,4-dioxane at TARP, the City of Tucson developed an approach that would accelerate the remedy. Years of monitoring data documented in the SASRs for TARP reveal that although contaminant concentrations in groundwater in the southern portion of the TARP plume have decreased significantly, the mass of contaminants in the

Regional Undivided Aquifer has remained relatively unchanged over the 30-year operation of the TARP remedy. As part of this remedy, EPA and the City of Tucson proposed installation of a new remediation well south of Irvington Road and west of 12th Avenue in the portion of the plume with the highest current levels of chemical contamination. Extraction of groundwater from the new well increases the removal of contaminant mass and, therefore, will reduce the duration of the remedy. The design concepts and cost estimates associated with the additional remediation well were documented in a technical memorandum to EPA (Carollo, 2018). To accommodate the public's desire for a more aggressive remedy and the City of Tucson's desire to have flexibility in managing water resources, the EPA completed an FFS Addendum that included enhancements to the preferred alternative, Alternative 3 (Carollo 2021). The enhancements to Alternative 3 included a new remediation well and infrastructure to deliver treated water from the TARP WTP to the City's recycled water system and the Santa Cruz River (Carollo, 2021).

4.4 Air Force Plant 44 Project Area

AFP44 is a Government-owned, contractor-operated defense industrial plant used for the production of weapons systems since its inception in 1951. Historical industrial processes conducted at AFP44, in conjunction with the production, maintenance, and modification of weapons systems, have included cleaning and degreasing, plating, anodizing, chemical milling, chemical etching, printed circuit board production, heat treating, and painting. These processes generated wastewater and general industrial wastes such as solvents, paint sludge, and thinners, many of which contained VOCs. In 1983 and 1984, the USAF/Hughes Aircraft Company conducted studies that defined an off-site TCE groundwater contamination plume substantially attributable to AFP44 that extended off site to the northwest from the center of AFP44. In 1986, the USAF issued a Final AFP44 Remedial Action Plan and ROD for a groundwater extraction, treatment, and reinjection system to address the contamination south of Los Reales Road (USAF 1986). In April 1987, the GWTP began to extract, treat (using air stripping/sparging with GAC vapor emissions treatment), and re-inject treated groundwater into the aquifer. An extensive series of reports detailing the GWTP operations from startup until the present time are available in the Administrative Record for AFP44 (EGC, Inc. 2016a).

The discovery of 1,4-dioxane in 2002 resulted from development and implementation of improved analytical methods (AECOM 2010). The existing air stripping system at AFP44 was not a viable treatment technology for 1,4-dioxane, as shown by sampling of the GWTP's input and output (EGC, Inc. 2016a). The USAF took several actions to respond to 1,4-dioxane, including initiating studies of possible treatment technologies, programming funding to upgrade the GWTP, conducting weekly sampling, and modifying the pumping and recharge schemes used in the regional aquifer system to minimize spreading 1,4-dioxane through the AFP44 project area. In 2004, the USAF conducted a technology evaluation (Earth Tech, Inc. 2004) that determined that an AOP system could treat both chlorinated VOCs and 1,4-dioxane for roughly the same annual cost as the system then in place. Based on the recommendations of the technology evaluation, the USAF programmed funds to design and install an AOP system at the GWTP for completion in Fiscal Year 2009. EPA issued an Administrative Order, which required installation of an AOP system capable replacing the existing treatment system, to the USAF and Raytheon Company in July 2007 under Section 1431 of the Safe Drinking Water Act (SDWA) (EPA 2007).

The original groundwater extraction system and GWTP went off-line in November 2008 to allow construction of the AOP system. The system upgrades, necessary repairs, and startup testing were completed, and the system was brought on-line in September 2009. This system has been functioning since 2009 to treat TCE and 1,4- dioxane. On September 30, 2009, EPA issued a Notice of Completion to the USAF, which stated that the work set forth in the 2007 Administrative Order had been completed to EPA's satisfaction. EPA, ADEQ, and the USAF signed a Federal Facilities Agreement in 2011.

In a separate action, in 2013, the USAF enacted an Optimized Exit Strategy plan to address contaminated groundwater south of Los Reales Road at the AFP44 site. The plan included:

1. Continued operation of the groundwater extraction system using the existing extraction wells and AOP system.
2. Institute a focused treatability study of remediating hot spots in soil and shallow groundwater using ISB.
3. Conduct a technical and economic feasibility analysis of remediating contamination in the shallow groundwater zone hot spots at AFP44.

In 2014 and 2015, the USAF completed 131 injection wells at three groundwater hot spot locations across AFP44. Hydrofracturing technology was used to create fissures in tight subsurface formations by injecting a slurry of sand and chemical reagents to allow treatment in non-permeable formations where traditional in situ methods do not perform well. Post-injection monitoring has demonstrated significant reductions of VOCs, 1,4-dioxane and chromium in treated hot spot locations. A ROD was issued by the USAF in August 2020 entitled "ROD for Site OT012 AFP 44 Tucson, Arizona" which implemented ISB and ISCO remediation at AFP44 property while maintaining operation of the groundwater remediation system to control migration of contaminants north of Los Reales Road.

4.5 Airport Property Project Area

Airport property includes all portions of the TIAA Superfund Site that are, or were owned by, leased to, or otherwise operated or controlled by the Tucson Airport Authority, or its predecessors. Additionally, any areas onto or into which contaminants from such property may have come to be located, and any other areas necessary for the response action outlined in the 1998 EPA ROD are included. The airport property housed defense and industrial-related activities from the 1950s to the 1970s. These activities included the handling, use, and disposal of hazardous materials in a manner consistent with widely accepted industry practices of the time. These materials included solvents used as degreasers and fuels for aircraft and ground vehicles. Operations at this location resulted in soil and groundwater contamination, primarily in the area of three large hangars (Figure 4-1) (EGC, Inc. 2016a). Several parties were involved in the operation and management of this area, including the USAF, the Tucson Airport Authority, and defense contractors. Following investigations of potential sources of contamination and affected areas, a Remedial Investigation Report (Daniel B. Stephens & Associates, Inc. 1996) was prepared and submitted to EPA for the airport property. EPA issued a ROD selecting remedial actions for the airport property (EPA 1998). The final Soils Consent Decree, effective 2000 (EPA 1999), specified four separate remedies for the site: 1) a soil-vapor extraction remedy to remove VOCs from soil, 2) a pump- and-treat system to remove VOCs from the shallow groundwater zone, 3) a remedy for excavation and removal of soil contaminated with

polychlorinated biphenyls and metals, and 4) a remedy for the closure of the inactive construction landfill at the airport, including capping and long-term monitoring (EGC, Inc. 2016a).

In 2002, 1,4-dioxane was detected in the regional aquifer monitoring wells at the airport property site at concentrations up to approximately 12 µg/L. In 2004, 2006, and 2011, groundwater sampling programs were conducted to further delineate the presence and extent of 1,4-dioxane at the site (EGC, Inc. 2016a).

4.6 Community Participation

A Proposed Plan that detailed the proposed site remedy was issued by EPA in March 2017. In conjunction with issuance of the Proposed Plan, EPA completed a summary fact sheet of the Proposed Plan, which was mailed hard copy to the established TIAA mailing list of 137 people. The fact sheet was also delivered electronically to an additional 71 people. The Proposed Plan meeting and comment extension period were advertised in both the Arizona Daily Star (March 21 and May 1, 2017) and hard copies were placed in the Pima County Public Library-Valencia Branch. Additionally, the fact sheet was translated into Spanish and distributed by both hard copy and electronic copy to the TIAA mailing list. The meeting notices and comment extension period were advertised in the Spanish publication La Estrella de Tucson on March 24 and May 5, 2017. The Public Meeting took place on March 30, 2017.

In addition, EPA actively participates in regular quarterly Unified Community Advisory Board meetings. These meetings are advertised locally in both English and Spanish newspapers and a Spanish translator is available at many meetings. These meetings are usually very well attended.

Sometime during 2019, the City of Tucson requested that the beneficial end use of the water, which had been limited to drinking water use via the City's water system, to also include distribution via the City's recycled water system and discharge to the Santa Cruz River for the purpose of aquifer recharge. After several months of negotiation and meetings with EPA headquarters, the EPA issued a memorandum to file dated September 21, 2021, which removed the specification of the end use of the treated water from the ROD. In addition, a focused feasibility study was prepared and approved, and engineering design and construction was implemented, adding approximately four years to complete the process.

4.7 Scope and Role of Response Action

The response action presented in this ROD Amendment is a modification to the Area A portion of the selected remedy described in the 1988 EPA ROD (EPA 1988). This document is an interim ROD Amendment that provides for containment and treatment of 1,4-dioxane, based on the original 1988 EPA ROD that provides for containment and treatment of VOCs including TCE, 1,1-dichloroethylene, trans-1,2-dichloroethylene, benzene, and chloroform. A final ROD Amendment will be prepared in the future, when an MCL is established for 1,4-dioxane by EPA or the State of Arizona. The goals of this action are to address the residual contamination that exists in the groundwater, prevent migration of contaminants, and treat extracted groundwater prior to reuse. The selected modified remedy continues the operation of the current groundwater remediation well network, but modifies the water treatment approach to rely solely on UV-AOP instead of both UV-AOP and the packed column aeration WTP and enhances the recovery network with installation of an additional remediation/extraction well. In addition, the modified remedy provides for alternate options for the end-use of the treated water other than as drinking water, including

discharge to the Tucson Water recycled water system. The remedy will also continue monitoring of the groundwater plume. This interim action will neither be inconsistent with, nor preclude, implementation of the final remedy.

4.8 Site Characteristics

A summary of site characteristics is presented below.

4.8.1 Physical Characteristics

Based on historical data, the total length of the axis of the Area A Site as it is currently understood is over 3 miles long. It is located to the west of the Tucson International Airport and north of Los Reales Road; it continues to the northwest towards the packed column aeration WTP. The Area A plume is over 1 mile wide at its widest point and approximately 2,000 feet wide at its narrowest point (Figure 4-1).

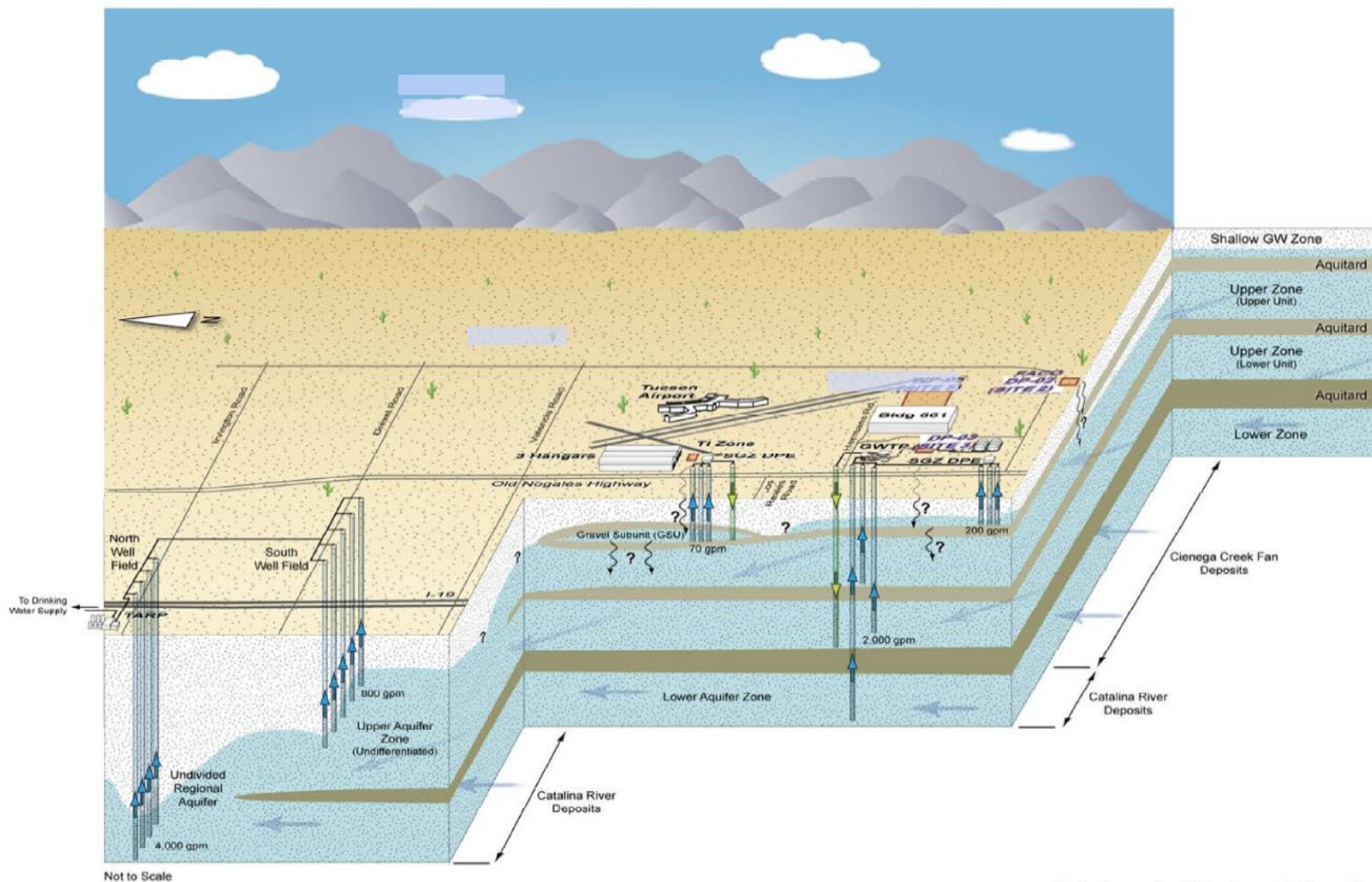
4.8.2 Site Hydrogeology

The Tucson Basin is described as saturated alluvial sediments that compose a single regional aquifer system, and all aquifers are considered to be potential drinking water aquifers in the State of Arizona. In the vicinity of the Site, the regional aquifer system is hydrogeologically complex because of lateral and vertical stratigraphic changes. The stratigraphy within the Area A plume is dominated by a thick clay layer that acts as an aquitard dividing the regional aquifer into two groundwater-bearing units: the Upper Aquifer Zone (UZ) and the Lower Aquifer Zone (LZ). Figure 4-2 provides an illustration of the stratigraphy of the Area A plume with the divided aquifer to the south and east and the Regional Undivided Aquifer to the north and west. The clay aquitard pinches out to the north and west within the Area A plume creating a single groundwater-bearing unit at the northern end of the Area A plume: Regional Undivided Aquifer. The approximate location of the demarcation between the Regional Undivided Aquifer and the UZ and LZ of the Divided Aquifer is illustrated in Figure 4-3.

The UZ consists of sands and gravels with clayey sand and clays to a depth of approximately 200 feet below ground surface (bgs), and ranges in thickness from approximately 60 to 100 feet (Earth Tech, Inc. 1992). Groundwater of the UZ occurs at depths of approximately 100 to 200 feet bgs. In general, the UZ shows a gradual coarsening of sediments from east to west. The UZ in the southern portion of the Area A plume can also be divided into an upper and a lower unit separated by a second, discontinuous clay aquitard. This clay aquitard varies in thickness across AFP44 and begins to pinch-out west of Nogales Highway, trending south-north from AFP44 towards the TARP area. The second clay aquitard is not present to a significant degree in the Area A plume north of Los Reales Road with the line of demarcation between the UZ and the shallow groundwater units located in the southern portion of the plume near the Three Hangers site as seen on Figure 4-3.

The clay aquitard separating the UZ and LZ is generally thicker and finer-grained than the second aquitard separating the upper and lower units of the UZ. The lithology of the regional undivided aquifer, which underlies the LZ, does not vary much from east to west in comparison to the regional divided aquifer's UZ; the majority of sediments are coarse-grained. Once the thicker clay aquitard pinches-out, groundwater flows from the UZ and the LZ into the Regional Undivided Aquifer. The groundwater elevation of the UZ level drops dramatically to join the groundwater elevation of the Regional Undivided Aquifer, causing steep hydraulic head gradients in the transition zone from the divided aquifer to the Regional Undivided Aquifer. The steepening water level or hydraulic head gradient may also be due in part to the operation of the TARP North Well Field as illustrated on Figure 4-2.

In general, the LZ is more cemented than the UZ. Groundwater occurs in the LZ under semi-confined conditions and at depths of approximately 300 feet bgs. The total depth of the LZ has not been well established, but existing data suggest it reaches depths of up to 600 feet bgs (Daniel B. Stephens & Associates 1993). The permeability of the LZ is one to two orders of magnitude less than the permeability of the UZ because it contains more clay and is more heavily cemented than the UZ sediments (Hughes Missile Systems Company 1995). Aquifer pumping tests have shown no interconnection between groundwater in the UZ and LZ. The LZ is substantially less contaminated than the groundwater of the UZ in the vicinity of the contaminant sources at AFP44 and the Three Hangers site. The LZ discharges directly to the Regional Undivided Aquifer at the northern end of the TARP plume. A majority of contaminant mass in groundwater of the TARP plume is located in the Regional Undivided Aquifer at the line of demarcation with the LZ of the Divided Aquifer, as illustrated in Figure 4-3.



Note: Proposed additional remediation well not included on figure.



SUMMARY CONCEPTUAL SITE MODEL

AFCEE/ASC
U.S. AIR FORCE PLANT 44
TUCSON, ARIZONA

Project Number

Sheet Title

Figure 4-2

4.8.3 Contaminant Distribution

Several remedial investigations and remedial actions have been performed since 1982 to establish the COCs for the Site and their distribution within the Area A plume (ECG, Inc. 2016a). The COCs for the TARP include both the first identified historic COCs, including TCE, benzene, and xylenes (identified in the 1988 EPA ROD) and newly identified COCs (principally 1,4-dioxane). Table 4-2 summarizes the COCs that have been detected in the regional groundwater above their respective treated water and in-situ groundwater cleanup levels within the past 2 years. The treated water and in-situ groundwater cleanup levels are a conservative combination of SDWA maximum contaminant levels (MCLs), maximum contaminant level goals (MCLGs), cumulative VOC risk-based concentrations, or, in the case of 1,4-dioxane, a Drinking Water Health Advisory. There is currently no established MCL or MCLG for 1,4-dioxane. EPA has published a Drinking Water Health Advisory range for 1,4-dioxane of 0.35 to 35 µg/L that corresponds to an excess lifetime cancer risk range of 10^{-6} to 10^{-4} , respectively. The UFHRA (EPA and Air Force Civil Engineer Center, 2015) recommended 0.35 µg/L treatment level (10^{-6} risk level). The two most prevalent COCs at the Site are TCE and 1,4-dioxane. The TCE plume extends from AFP44 and the airport property to north of Irvington Road. The TARP packed column aeration WTP was placed at the end of the plume. Figure 4-3 shows the concentrations of TCE are between 5 µg/L and 80 µg/L in the area north of Los Reales Road. Currently, the majority of the mass of TCE in groundwater of the Area A plume resides in the Regional Undivided Aquifer in the vicinity of the demarcation line with the LZ of the Divided Aquifer as illustrated on Figure 4-3. The 1,4-dioxane groundwater plume extends from AFP44 to the TARP northern well field at concentrations greater than 3 µg/L (Figure 4-3). The plume north of Los Reales Road contains concentrations in the 3 to 8 µg/L range, but concentrations greater than 6 µg/L are not extensive or contiguous. Based on groundwater data collected from new wells installed near the eastern and western plume boundaries, the lateral extent of the 1,4-dioxane plume is defined in the UZ of the Divided Aquifer and the Regional Undivided Aquifer and LZ near the demarcation line of the two aquifers, as illustrated in Figure 4-3.

Table 4-2
Treatment and Cleanup Levels for Primary Contaminants of Concern

Chemical of Concern	Treatment and Cleanup Levels (µg/L) ¹	Basis
TCE ²	1.5 µg/L (treatment level)	Indicator of cumulative VOC risk as described in the 1988 EPA ROD and 1990 Consent Decree (CD)
	5 µg/L (cleanup level)	1990 CD (MCL based)
1,1-DCE	7 µg/L (cleanup level)	1990 CD (MCL based)
trans-1,2-DCE	100 µg/L (cleanup level)	1990 CD (MCL based)
1,4-dioxane ³	0.35 (treatment level) ⁴	November 2015 Final Unified Focused Human Health Risk Assessment
Chloroform	70 µg/L ⁵ (cleanup level)	1990 CD (MCL based)

Table 4-2 (continued)
Cleanup Levels for Primary Contaminants of Concern

Notes:

¹ Table is amended from the Volume I Final Focused Feasibility Study for 1,4-Dioxane North of Los Reales Road (EGC, Inc. 2016c).

² The water distributed from the TARP plant has a lower treatment level as it is intended for direct drinking water usage (EPA 1998).

³ A groundwater cleanup level will be established when a maximum contaminant level (MCL) for 1,4-dioxane has been established by the federal government or the State of Arizona.

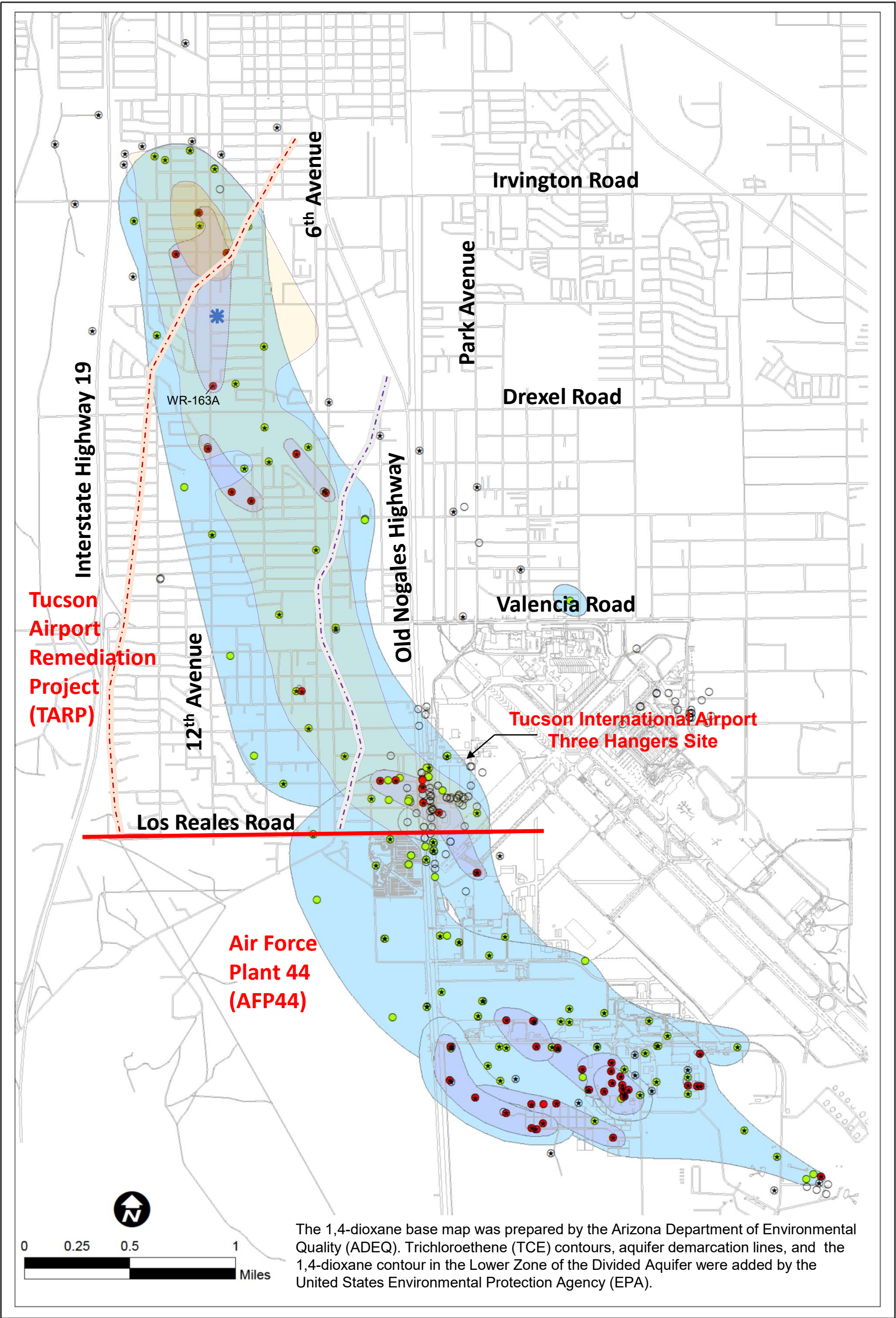
⁴ This treatment level is supported by U.S. Environmental Protection Agency (EPA) as documented in the Final Unified Focused Human Health Risk Assessment, Focused Remedial Investigation and Feasibility Study for 1,4-Dioxane North of Los Reales Road, Tucson International Airport Area Superfund Site Area A (EPA, 2015).

⁵ In addition to the maximum contaminant level goal (MCLG), as listed, that needs to be met since the groundwater is a source of drinking water, chloroform is also a trihalomethane. The total trihalomethanes (sum of the concentrations of four trihalomethanes as an annual average) MCL is 80 µg/L. Both levels apply since the regional groundwater is a drinking water source, and chloroform is generated when drinking water is disinfected.

Although chloroform is listed as a COC, chloroform is currently not present in groundwater above its cleanup level at the TARP packed column aeration WTP. Chloroform is only present above its cleanup level in the airport property shallow groundwater zone (Figure 4-3). A more detailed evaluation of these COCs and an evaluation regarding other potential COCs is provided in the conceptual site model (EGC, Inc. 2016b).

4.9 Current and Future Site and Resource Use

TIAA Superfund Site Area A contains a mix of industrial, commercial, and residential land uses. The areas north of Los Reales Road are more residential, while the areas to the south are industrial. The Site overlies the Tucson groundwater basin, which is designated as a Sole Source Aquifer by EPA under the Safe Drinking Water Act and is a critical water resource for residents of the City of Tucson and surrounding communities. In addition to the municipal supply of drinking water, there are private wells found throughout the area in and near the City of Tucson. The reasonably anticipated future land use is the same as the current use. Figure 4-4 shows the general land use zoning classifications.



LEGEND

- 1,4-Dioxane > 0.35 ug/l
- 1,4-Dioxane > 3.5 ug/l
- TCE > 5.0 ug/l
- TCE > 50 ug/l

ug/l – Micrograms per liter

★ Data from 2019 to 2022 (unstarred data collected prior to 2019).

○ 1,4-Dioxane < 0.35 ug/l

● 1,4-Dioxane > 0.35 < 3.5 ug/l

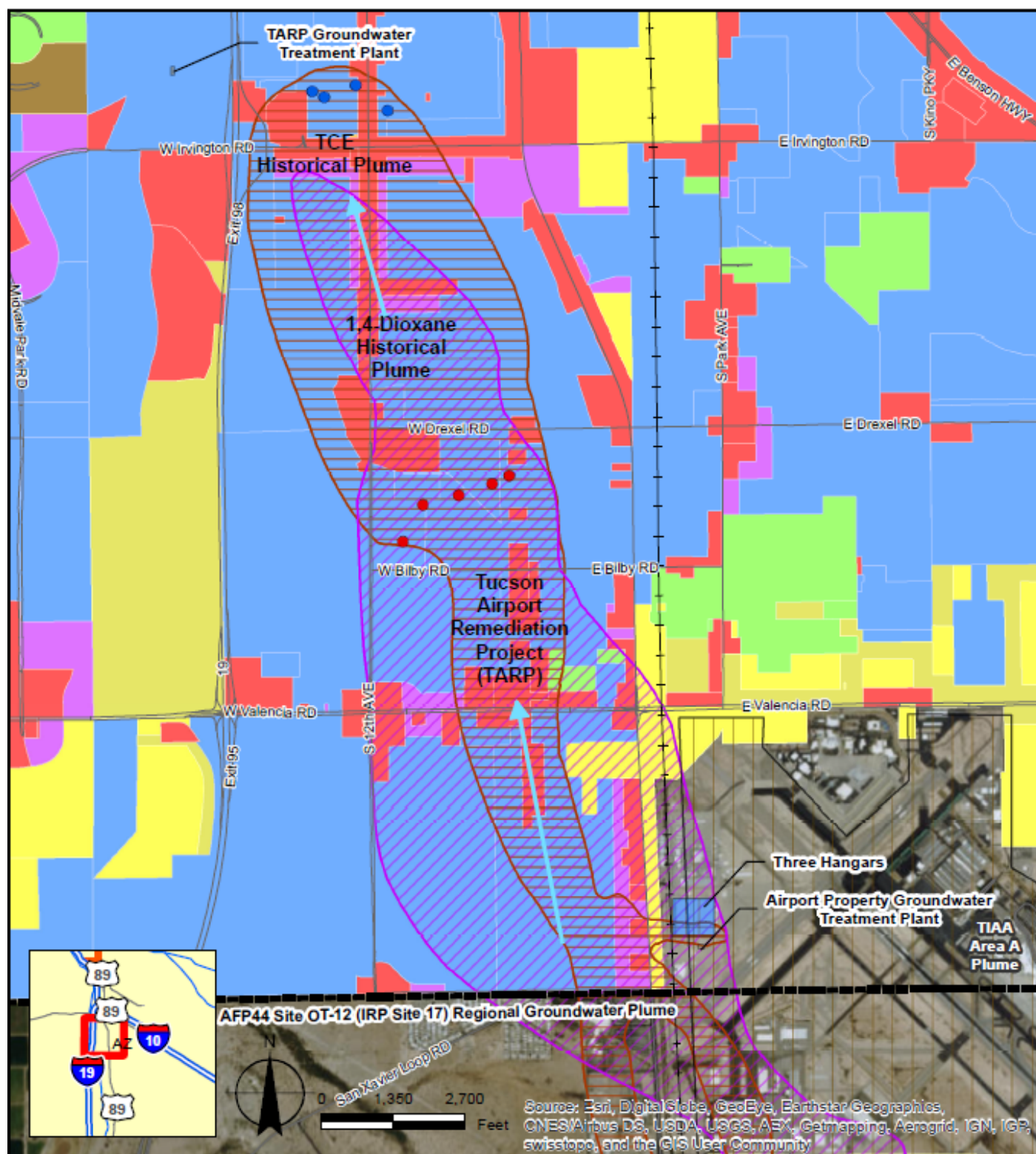
● 1,4-Dioxane > 03.5 ug/l

--- Demarcation line between Regional Undivided Aquifer and Divided Aquifer.

--- Demarcation line between Upper Zone of Divided Aquifer and shallow groundwater units.

★ Data from WR-163A used to complete 1,4-dioxane contour in Lower Zone of the Divided Aquifer by USEPA.

Figure 4-3
1,4-Dioxane and
TCE Concentration
Contour Map



Legend

- | | |
|--|-------------------------------|
| ● Wells TARP North Field | TIAA AREA A/AFP44, Historical |
| ● Wells TARP South Field | TCE Plume (Approximate) |
| → Approximate Groundwater Flow Direction | Commercial Zone |
| — Railroad | Industrial Zone |
| Groundwater Treatment | Mobile Home Zone |
| Three Hangars | Office Zone |
| TIAA Property Boundary (Approximate) | Park Industrial Zone |
| TIAA AREA A/AFP44, Historical | Parking Zone |
| 1,4-Dioxane Plume (Approximate) | Recreational Vehicle Zone |
| | Residence Zone |

REFERENCE:

PROJECTION: NAD_1983_StatePlane_Arizona_Central_FIPS_0202_Feet_Intl

U.S. EPA Region 9
San Francisco, CA

FIGURE
NUMBER

4-4

General Land Use Zoning Classifications
Tucson International Airport Area
Superfund Site - Area A

4.10 Summary of Site Risks

A *Unified Focused Human Health Risk Assessment, Focused Remedial Investigation and Feasibility Study for 1,4-Dioxane North of Los Reales Road, Tucson International Airport Area Superfund Site Area A* (UFHHRA) was conducted by EPA and the USAF Civil Engineer Command Center (EPA/Air Force Civil Engineer Center 2015) to support the Focused Remedial Investigation/Feasibility Study (RI/FS) (EGC, Inc. 2016a and 2016c). The UFHHRA combines the results of the *Revised Limited Risk Assessment for 1,4- Dioxane and Trichloroethylene in Groundwater at the Tucson International Airport Area Superfund Site* (EPA 2015) and the Focused Baseline Human Health Risk Assessment (FBHHRA; EGC, Inc. 2015). The UFHHRA found potential risk due to 1,4-dioxane and TCE exposure exceeding the 1 in 10,000 excess lifetime cancer risk and the non-cancer hazard index of 1.0. Table 4-3 includes the risk for each exposure point for each COC. The FBHHRA assessed potential pathways of exposure to current and hypothetical future residents from contaminants in groundwater by direct contact (i.e., ingestion of groundwater, dermal absorption, and inhalation of vapors from groundwater during dishwashing, showering, etc.), and volatilization of groundwater to indoor air. The COCs are limited to 1,4-dioxane and TCE, and exposure pathways are limited to groundwater produced either by the CTWD commercial water supply or by private wells.

The Final Revision 1 Baseline Human Health Risk Assessment Work Plan (AECOM 2013), Focused RI/FS for 1,4-Dioxane North of Los Reales Road (EGC, Inc. 2016a, 2016b, and 2016c), and Draft Baseline Human Health Risk Assessment for 1,4-Dioxane North of Los Reales Road (AECOM 2014a) were conducted to support the Focused RI/FS (EGC, Inc. 2016a and 2016c). Based on discussions among the USAF, EPA, and ADEQ (EPA 2014), the Draft Baseline Human Health Risk Assessment (AECOM 2014a) was revised and renamed as the Draft Final FBHHRA for 1,4-Dioxane and Trichloroethylene (AECOM 2014b). EPA and USAF concluded that an additional EPA risk assessment would provide another line of evidence regarding potential risks to human health from groundwater contamination at the Site, and that a summary of both risk assessments jointly written by EPA and Air Force Civil Engineer Center as a Unified FBHHRA (EPA/Air Force Civil Engineer Center 2015) would be the appropriate document to support the Focused RI/FS.

EPA focused on a lifetime exposure of 70 years because, as stated in the Unified FBHHRA, “(i) demographic information indicates that people in Southside Tucson, the most impacted community, move less frequently (at Unified Community Advisory Board meetings we have heard of/from a number of lifetime residents), and (ii) since the treated water is being served via the Tucson Water distribution system, an individual may consume the same water even though he/she moves to a different location within the city.” (EPA/Air Force Civil Engineer Center 2015).

Table 4-3
Groundwater Risk Evaluation

Location	EPC (µg/L)		30-Year RME Cancer Risk			70-Year RME Cancer Risk			Non-Cancer Hazard Quotient		Non-Cancer Hazard Index*
	1,4-Dioxane	TCE	1,4-Dioxane	TCE	Total	1,4-Dioxane	TCE	Total	1,4-Dioxane	TCE	Total
Hypothetical Future Well	13.4	27.5	2.00E-05	6.20E-05	8.20E-05	4.10E-05	1.80E-04	2.20E-04	0.02	9.8	9.8
Private Wells	0.5 - 7.3	0.8 - 14.7	7.5E-07 - 1.1E-05	1.8E-06 - 3.3E-05	3.5E-06 - 4.4E-05	1.5E-06 - 2.2E-05	5.3E-06 - 9.8E-05	9.5E-06 - 1.2E-04	0.0008 - 0.01	0.3 - 1.9	0.3 - 1.9
South Well Field	6.8 - 8.1	8.0 - 60.3	1.0E-05 - 1.2E-05	1.8E-05 - 1.4E-04	2.8E-05 - 1.5E-04	2.1E-05 - 2.4E-05	5.3E-05 - 4.0E-04	7.4E-05 - 4.3E-04	0.01	2.9 - 21.5	2.9 - 21.5
North Well Field	0.25	3.5 -22.8	3.7E-07	8.0E-06 - 5.2E-05	8.3E-06 - 5.2E-05	7.6E-07	2.3E-05 - 1.5E-04	2.4E-05 - 1.5E-04	0.0004	1.2 - 8.1	1.2 - 8.1
Tap Water Screening Levels	----	----	0.67 µg/L	0.44 µg/L	----	0.33 µg/L	0.15 µg/L	----	600 µg/L	2.8 µg/L	----

Notes:

* Since both TCE and 1,4-dioxane have the potential to produce liver and kidney non-cancer toxicities, their non-cancer hazard quotients were summed to calculate a cumulative non-cancer hazard index.

Tap water screening levels represent the levels used in this assessment.

The Hypothetical Future Well would be located near the intersection of Los Reales Road and Nogales Highway.

The South Well Field is part of the Tucson Airport Remediation Project system and, following treatment, supplies the Tucson Water public drinking water system.

The North Well Field is part of the Tucson Airport Remediation Project system and, following treatment, supplies the Tucson Water public drinking water system.

The risk data provided for the private wells, South Well Field, and North Well Field present a risk range based on the analytical data range collected from each of the well groups.

The risk data presented in this table were presented in the Revised Limited Risk Assessment for 1,4-Dioxane and Trichloroethylene in Groundwater at the Tucson International Airport Superfund Site (EPA 2015).

EPC exposure point concentration

TCE trichloroethylene

RME reasonable maximum exposure

4.11 Remedial Action Objectives

The 1988 EPA ROD states that the groundwater remedy selected by the Air Force in 1987 for AFP44 and EPA's 1988 groundwater remedy, together provide the strategy to restore the Sole Source Aquifer of the Tucson Basin. The 1988 EPA ROD developed objectives for the response actions in the TIAA. These objectives included:

- To manage migration of contaminants (i.e., containment).
- To achieve public acceptance of the remedy.
- To protect public health and the environment.
- To attain consistency with ARARs.
- To determine the most environmentally sound, technically feasible, and cost-effective remedy, which can be implemented in a timely manner.
- To ensure consistency with AFP44 remedial actions.

For the purposes of this Interim ROD Amendment, the RAOs for groundwater are as follows:

- Prevent human ingestion, inhalation, and/or direct contact exposure to COCs in groundwater above levels that would pose an acceptable health risk.
- Prevent migration of 1,4-dioxane in groundwater that would pose an unacceptable risk to human receptors.
- Restore contaminated groundwater throughout the VOC plume to levels that allow for beneficial use (i.e., drinking water).

EPA completed a Focused Feasibility Study (FFS) Addendum that evaluated alternative end uses of treated water from TARP other than as drinking water; these included discharge to the Tucson Water recycled water system (Carollo Engineers, Inc. 2021).

4.12 Description of Alternatives

CERCLA requires that each selected remedial alternative: a) be protective of human health and the environment, b) be cost-effective, c) comply with all applicable or relevant and appropriate requirements, and d) use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, the statute includes a preference for the use of treatment as a principal element of the remedy which significantly reduces the toxicity, mobility, or volume of hazardous substances. The estimated cost for the alternatives below is estimated as a net present value cost as defined in the Focused FS (ECG, Inc. 2016c) and the cost opinion for FFS Addendum for management of treated water (Carollo Engineers, Inc., 2021).

EPA evaluated six alternatives in this revised remedy:

- Alternative 1: No Further Action.
- Alternative 2: Monitored Natural Attenuation (MNA) and Institutional Controls (ICs).
- Alternative 3: Enhanced Existing Pump-and-Treat System with UV-Peroxide Plus Long-term Monitoring and ICs (EPA's preferred alternative).
- Alternative 4: Optimized Pump-and-Treat with UV-Peroxide and Partial Management of Water by Reinjection to the Regional Aquifer Plus MNA and ICs.
- Alternative 5: Existing Pump-and-Treat with UV-Peroxide Plus In Situ Bioremediation (ISB) and MNA and ICs.
- Alternative 6: Existing Pump-and-Treat with UV-Peroxide Plus In Situ Chemical Oxidation (ISCO) and MNA and ICs.

Common Elements: With the exception of the Alternative 1, "No Further Action," and Alternative 2, "MNA," all of the alternatives evaluated include common elements. All alternatives include active pump and treatment of the VOCs and 1,4-dioxane groundwater plume, as follows:

- Alternative 3: Pump-and-treat utilizing ten remediation wells and UV-peroxide AOP.
- Alternatives 4, 5, and 6: Pump and treat utilizing nine remediation wells and UV-peroxide AOP.

Attenuation parameters outside of the in-situ treatment zones would be monitored to ensure the effectiveness of the remedies for Alternatives 5 and 6. All active alternatives, except for Alternatives 1 and 2, are expected to attain the RAO's objectives. Finally, other than the No Further Action alternative, all alternatives evaluated here contain long-term monitoring for TIAA Superfund Site Area A. These common elements are consistent with the 1988 EPA ROD, which proposed that cleanup efforts manage migration of contaminants in groundwater at TIAA Superfund Site Area A.

4.12.1 Alternative 1: No Further Action

EPA is required to consider the No Further Action alternative to provide a baseline for the purpose of comparison to other alternatives. Under this alternative, no additional treatment would be implemented, and monitoring would cease (EGC, Inc. 2016c). The estimated cost for this alternative is \$0, and this alternative is not anticipated to achieve RAOs within the balanced timeframe of 30 years.

4.12.2 Alternative 2: Monitored Natural Attenuation and Institutional Controls

This alternative relies on natural attenuation processes for remediation of contaminants to an appropriate degree and within a reasonable timeframe based on site-specific objectives. MNA includes no active remediation, but does include groundwater monitoring to document the reduction in contaminant concentrations in groundwater over time. MNA is discussed in further detail in the common elements of the alternatives in this section. The net present value for this alternative is \$3.2 million (Table 4-4), and

this alternative does not achieve either containment or restoration and does not meet RAOs within a reasonable 30-year timeframe (EGC, Inc. 2016c).

**Table 4-4
Remedy Alternatives and Estimated Cost**

Alternative	Total Capital*	Total Operation and Maintenance	Total Cost	Net Present Value ** (7% Discount Rate)
Alternative 2	\$13,000	\$7,710,000	\$7,723,000	\$3,205,000
Alternative 3	\$38,870,000	\$85,860,000	\$124,730,000	\$53,000,000
Alternative 4	\$258,000	\$88,240,000	\$88,499,000	\$37,887,000
Alternative 5	\$6,498,000	\$161,913,000	\$168,411,000	\$75,390,000
Alternative 6	\$4,040,000	\$104,327,000	\$108,367,000	\$49,880,000

Notes:

* Total capital construction cost for Alternative 3 is presented in the FFS Addendum (Carollo, 2021), including infrastructure to deliver treated water to the recycled water system (RWS) and Santa Cruz River outfall. Total capital costs for Alternatives 2, 4, 5, and 6 are presented in Table 7-1 of the Volume III Final Focused Feasibility Study for 1,4-Dioxane North of Los Reales Road (EGC, Inc. 2016c). These alternatives were developed assuming delivery of treated water to the potable water system only, without infrastructure for delivery to RWS or outfall to the Santa Cruz River.

** Net present value is the difference between the present value of cash flow and the value of the cash flow over time, taking into account the estimated 30-year time frame for implementation of the remedy. The net present value discount rate of 7 percent is based on Circular A-94, U.S. Office of Management and Budget (October 1992), discount rate policy for Base-Case Analysis. Net present values at the 7 percent discount rate are presented in Appendix A for Alternatives 2 through 6.

Alternative 1 (No Further Action) is not included in this analysis because there is no cost associated with this alternative, and it does not meet the threshold criteria.

All costs are rounded to the nearest \$1,000.

4.12.3 Alternative 3: Enhanced Existing Pump-and-Treat System with UV-Peroxide Plus Long-Term Monitoring and ICs (EPA's Preferred Alternative)

Alternative 3 involves continued pump and treatment using the existing pump-and-treat system for TIAA Superfund Site Area A (consisting of nine extraction wells) in addition to optimizing the existing system with installation of one additional high-capacity remediation well and expanding the existing AOP system. The new well will be located within the area of largest contaminant mass of the plume just south of TARP North Well Field. The new well will be designed and constructed for a pumping capacity of approximately 1,300 gpm to enhance the removal of contaminant mass from the aquifer and reducing the remedy duration. The AOP system will be upgraded with installation of a third pair of UV-reactors, four additional GAC contactors, an additional desander unit, an outfall to the Santa Cruz River, and reservoir/booster station for delivery of treated water to the Tucson Water recycled water system (Carollo Engineers, Inc. 2021). The groundwater extraction system currently pumps groundwater to the TARP WTP and UV-AOP facility in addition to the original air strippers. Since the UV-AOP has effectively demonstrated that it meets all treatment objectives for both 1,4-dioxane and VOC contaminants, this alternative would eliminate the packed column aeration from the TARP WTP (Arcadis 2016). The end use of treated water from TARP will include the options to discharge the water to the Santa Cruz River and the City of Tucson recycled water system, in addition to the current option of the drinking water distribution system. The recycled water system includes use as turf and landscape irrigation water for golf courses, parks, and some

residences; additional managed discharge to the Santa Cruz River channel as aquifer recharge and hydriparian habitat; and constructed aquifer recharge projects.

This alternative would also include long-term monitoring of the plume contamination levels. This alternative will evaluate the currently used technologies (including current monitoring and controls) for the enhanced TARP remediation system at TIAA Superfund Site Area A.

Although the existing pump-and-treat system will likely operate for a longer period of time, cost-estimating is provided for a 30-year operating period. In addition to the current pump-and-treat system, long-term monitoring will be applied over portions of the plume to monitor reduction in dissolved-phase concentrations in groundwater, and investigate if the plume is stable or decreasing over the 30-year timeframe. The net present value for this alternative is approximately \$51 million (Table 4-4). The duration of the remedy is assumed to be 30 years for estimation of operation costs. Alternative 3 would likely require several decades to meet RAOs (EGC, Inc. 2016c).

4.12.4 Alternative 4: Optimized Pump-and-Treat with UV-Peroxide and Partial Management of Water by Reinjection to the Regional Aquifer Plus MNA and ICs

Alternative 4 is similar to Alternative 3 with optimized pump and treatment using the operations of the existing TARP system and removal of TCE and 1,4-dioxane in groundwater using UV-AOP and air stripping. Alternative 4 would also include partial reinjection (approximately 1,200 gpm) of the treated groundwater back into the regional aquifer to help control plume migration. The remaining flow (approximately 3,800 gpm) would continue to be sent to the City of Tucson drinking water distribution system.

In addition to the pump and treatment, MNA would be applied to portions of the plume to monitor reduction in dissolved-phase concentrations in groundwater, and to show that the plume is stable or decreasing over a 30-year timeframe. The net present value for this alternative is estimated at \$38 million (Table 4-4) (EGC, Inc. 2016c). Although the pump-and-treat system will likely operate for a longer period of time, cost-estimating is provided for a 30-year operating period. Alternative 4 would not likely meet RAOs sooner than the 30-year timeframe (EGC, Inc. 2016c).

4.12.5 Alternative 5: Existing Pump-and-Treat with UV-Peroxide Plus In Situ Bioremediation and MNA and ICs

Alternative 5 is similar to Alternative 3, as it involves continued use of the pump-and-treat system with treatment by the existing TARP plant including the UV-AOP system. However, under Alternative 5, ISB injection wells would be installed in the UZ between Los Reales Road and Valencia Road throughout the middle of the 1,4-dioxane groundwater plume. Active treatment would be maintained until groundwater concentration criteria are met, which this alternative assumes will occur after 20 years. The exact method and delivery of ISB would be determined in the subsequent remedial design documents. Alternative 5 also includes MNA over portions of the plume to confirm treatment progress and plume stability, or to monitor reduction. The estimated net present value for this alternative is approximately \$75 million (Table 4-4), and the estimated time to achieve RAOs is 20 years for the ISB and pump-and-treat components, and 30 years for MNA for the mass of contaminant in the UZ (EGC, Inc. 2016c). The previously described 30-year operating period is assumed for the contaminant mass in the Regional Undivided Aquifer.

4.12.6 Alternative 6: Existing Pump-and-Treat with UV-Peroxide Plus In Situ Chemical Oxidation and MNA and ICs

Alternative 6 is similar to Alternative 3, as it involves continued use of the pump-and-treat system with treatment by the existing TARP plant including the UV-AOP system. However, under Alternative 6, ISCO injection wells would be installed throughout the 1,4-dioxane groundwater plume, and a chemical oxidant injected on a semi-annual basis. Active treatment would be maintained until groundwater concentration criteria are met, which this alternative assumes will occur after 10 years. The exact method and delivery of ISCO would be determined in the subsequent remedial design documents. Alternative 6 also includes MNA, which would be extended for 10 years following ISCO implementation. The estimated net present value for this alternative is approximately \$50 million (Table 4-4), and the estimated time to achieve RAOs is 10 years for the ISCO and pump-and-treat components, and 20 years for MNA (EGC, Inc. 2016c). The previously described 30-year operating period is assumed for the contaminant mass in the Regional Undivided Aquifer.

4.13 Comparative Analysis of Alternatives

EPA evaluates each of the alternatives based on nine standard criteria. The first two criteria are *threshold criteria*: overall protection of human health and the environment, and compliance with ARARs. The next five criteria are *balancing criteria*: long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost. The final two criteria are *modifying criteria*: State acceptance and community acceptance, which were evaluated after the close of the public comment period on the proposed remedy. Table 4-5 illustrates comparative analysis of the alternatives, not including the modifying criteria.

Table 4-5
Comparative Analysis of Alternatives (Excluding State and Community Acceptance)

Alternative	Overall Protection of Human Health and the Environment	Compliance with Federal and State ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, and/or Volume	Short-Term Effectiveness	Implementability	Cost*
No Further Action	No - Future exposure to impacted groundwater is not prevented under this alternative; therefore, existing risks from impacted media will remain. This alternative will not be protective of human health or the environment.	No - Chemical-specific ARARs may be met over a long time frame. However, without monitoring this cannot be confirmed. There are no location or action-specific ARARs for this alternative.	Low - Impacted groundwater would remain in place. No Action has a low degree of long-term effectiveness in ensuring the continued protection of human health and the environment.	Low - Only reduction of toxicity, mobility, and volume would be through natural attenuation.	Low - Impacted groundwater would remain in place. No treatment is implemented; therefore, short-term effectiveness is not relevant to this alternative.	High - No construction or operation would be required; therefore, issues regarding technology availability, agency approvals, constructability, and reliability are not applicable. Remedial effectiveness cannot be determined due to lack of any monitoring program.	No Cost
2. Monitored Natural Attenuation	No - Institutional controls provide protection of human health by preventing use of groundwater. The institutional controls would be applied to the areas impacted by the groundwater plume. Groundwater monitoring would allow the identification and control of any future risks that would result from constituent migration; however, dissolved-plume may migrate without P&T or other active remedy (e.g., ISCO or ISB).	No - Chemical-specific ARARs for groundwater may be met over a long time frame. There are no location-specific ARARs for this alternative. Action-specific ARARs will be met through proper design, planning, and implementation.	Low - Non-destructive MNA mechanisms: dispersion, sorption and diffusion, are known to be active in groundwater at AFP 44 and should also exist at TARP Area A. Studies are in progress to further evaluate MNA effectiveness for TCE and 1,4-dioxane at AFP 44. No action would be performed beyond monitoring. Contaminants would remain in the aquifer above MCLs for an indefinite period (likely longer than 30 years).	Low - Only reduction of toxicity, mobility, and volume would be through natural attenuation.	Low - Low for TCE and 1,4-dioxane. There is field evidence that local microorganisms can degrade 1,4-dioxane and TCE at AFP 44 and the same microorganisms should exist at Area A. Natural degradation rates are not known but are thought to be very slow for TCE and 1,4-dioxane.	High - Little construction and no operation would be required; therefore issues regarding constructability and implementability are not applicable. Remedial effectiveness determined by monitoring program.	Low Cost
3. Enhanced Existing P&T System with UV-Peroxide plus Long-Term Monitoring	Yes - Hydraulic containment and reduction in contaminant detections in the aquifer and pumping from higher-concentration zone and active treatment will meet RAOs, thereby reducing risk to human health and the environment. Includes ICs to prevent exposure.	Yes (compliance with ARARs) - Chemical-specific ARARs for groundwater will be met over time. There are no location-specific ARARs for this alternative. Action-specific ARARs will be met through proper design, planning, and implementation.	High - Existing system P&T has been in operation since 1994, and has demonstrated long-term hydraulic containment and removal of contaminants from the groundwater, but long-term effectiveness has been limited by source removal through dissolved-phase only. The addition of a new remediation well will increase source removal through the northern portion of the plume.	Moderate - The existing P&T system's mass reduction only occurs through dissolved-phase groundwater extraction and is back-diffusion limited. Mobility of 1,4-dioxane impacted groundwater is reduced through groundwater pumping for 30 years. Toxicity and volume of COC-impacted groundwater would decrease in the future as the concentrations attenuate, albeit over long-periods of time.	High - The existing P&T system and installation of one additional remediation well and associated piping has low short-term risk to human health and the environment.	Moderate - Treatment system in place and in use, upgrades would be required to treat additional extracted water. New remediation well and piping would be required. New infrastructure to discharge treated water to the recycled water system would be required.	Moderate Cost
4. Optimized Pump-and-Treat with UV-Peroxide and Partial Management of Water by Reinjection to the Regional Aquifer plus MNA	Yes - Hydraulic containment and reduction in contaminant detections in the aquifer and pumping from higher-concentration zones and active treatment will meet RAOs, thereby reducing risk to human health and the environment. Includes ICs to prevent exposure.	Yes (compliance with ARARs) - Chemical-specific ARARs for groundwater will be met over time. There are no location-specific ARARs for this alternative. Action-specific ARARs will be met through proper design, planning, and implementation.	Moderate - P&T removal of contaminants from the groundwater will meet RAOs and restore the aquifer to its beneficial use, but back-diffusion limited source removal through dissolved-phase only (likely longer than 30 years).	Low/Moderate - Mass and volume reduction only through dissolved-phase groundwater extraction. Concentrations would remain because sources are back-diffusion limited. Mobility of 1,4-dioxane impacted groundwater is reduced through groundwater pumping for 30 years and MNA processes for 30 years. Toxicity and volume of COC-impacted groundwater would decrease in the future as the concentrations attenuate via MNA.	High- the existing treatment system has low short-term risk to human health and the environment. The chemicals used for treatment provide a potential risk to workers if not properly handled and disposed. Low risk to workers during installation of new recovery wells and piping.	Moderate - Treatment system in place and in use, no construction or operation would be required. New injection wells and piping will be required.	Moderate Cost

Table 4-5 (continued)
Comparative Analysis of Alternatives (Excluding State and Community Acceptance)

Alternative	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, and/or Volume	Short-Term Effectiveness	Implementability	Cost*
5. Pump-and-Treat with UV-Peroxide plus ISB and MNA	Yes - P&T with ISB reduction of contaminants in aquifer will meet RAOs, thereby reducing risk to human health and the environment. Includes ICs to prevent groundwater use.	Yes (compliance with ARARs) - Chemical-specific ARARs for groundwater will be met over time. There are no location-specific ARARs for this alternative. Action- specific ARARs will be met through proper design, planning, and implementation.	Moderate – Groundwater P&T will meet RAOs and restore the aquifer to its beneficial use. ISB can reduce plume longevity if conducted within a contamination source area, but the location of the ISB in this alternative is in the UZ, which is not a source area, and no study has been conducted to determine the efficacy of ISB at this site. This location was proposed prior to source treatment at AFP 44, which has decreased the concentrations in the proposed location. Therefore, ISB will not address the majority of the contaminant mass in the Regional Divided Aquifer.	Low – Studies have shown that ISB will remove groundwater contaminants and reduce contaminant mass, volume, and toxicity when applied at contamination source areas. The ISB location in this alternative is not a source area. Back-diffusion limited sources and migration from the airport could extend the plume longevity. The AFP 44 source treatment has reduced contaminant migration north of Los Reales Road, thereby limiting the effectiveness of active treatment in the proposed location.	Low – The chemicals used for in situ treatment (i.e., propane) provide a potential risk to workers if not properly handled and disposed. Moderate risk to workers during installation of new injection wells and piping which would impact a treatment area of 253 acres and installation of 156 injection points within the public right-of-way. Construction would impact a densely-populated and long-established residential area.	Low – New construction would be required. New wells and piping will be required for injection points and co-metabolites. This construction would require a large number of wells in a densely populated and long-established residential area that is not a source area for 1,4-dioxane, resulting in disruptions to the community without assurance of effectiveness.	Highest Cost
6. Pump-and-Treat with UV-Peroxide plus ISCO and MNA	Yes – P&T with ISCO reduction of contaminants in aquifer will meet RAOs, thereby reducing risk to human health and the environment. Includes ICs to prevent groundwater use.	Yes (compliance with ARARs) – Chemical-specific ARARs for groundwater will be met over time. There are no location-specific ARARs for this alternative. Action- specific ARARs will be met through proper design, planning, and implementation.	Moderate – Groundwater P&T will meet RAOs and restore the aquifer to its beneficial use. ISCO can reduce plume longevity if conducted within a contamination source area, but the ISCO location in this alternative is not a source area, and no study has been conducted to determine the efficacy of ISCO at this site. This location was proposed prior to source treatment at AFP 44, which has decreased the concentrations in the proposed location. Therefore, ISCO will not address the majority of the contaminant mass in the Regional Divided Aquifer.	Low - Studies have shown that ISCO will remove groundwater contaminants and reduce contaminant mass, volume, and toxicity when applied at contamination source areas. The ISCO location in this alternative is not a source area. Back-diffusion limited sources and migration from the airport could extend the plume longevity. The AFP 44 source treatment has reduced contaminant migration north of Los Reales Road, thereby limiting the effectiveness of active treatment in the proposed location.	Low - The existing treatment system has low short-term risk to human health and the environment. The chemicals used for treatment (i.e., Na2S2O8) provide a potential risk to workers if not properly handled and disposed. Moderate risk to workers during installation of new injection wells and piping which would impact a treatment area of 253 acres and installation of 156 injection points within the public right-of-way. Construction would impact a densely-populated and long-established residential area.	Low - New construction would be required. New wells will be required for in situ chem-ox. This construction would require a large number of wells in a densely populated and long-established residential area that is not a source area for 1,4-dioxane, resulting in disruptions to the community without assurance of effectiveness.	Moderate Cost

Notes:
The table has been modified from Table 7-1 of the Focused Feasibility Study. Alternative 3 has been updated and Alternatives 5 and 6 were evaluated within the context of how effective the active remediation technologies (ISB and ISCO) would be once implemented across a large diffused groundwater plume rather than within a contamination source area.
* A detailed summary of alternative costs are presented in Table 4-4.

ARAR	Applicable or Relevant and Appropriate Requirement
COC	contaminant of concern
GW	groundwater
IC	institutional control
ISB	in situ bioremediation
ISCO	in situ chemical oxidation
MCL	maximum contaminant level
MNA	monitored natural attenuation
P&T	pump-and-treat
RAO	remedial action objective
TARP	Tucson Airport Remediation Project
TCE	trichloroethylene
UV	ultraviolet light

4.13.1 Threshold Criteria

Overall Protection of Human Health and Environment

Overall protection of human health and the environment criterion is the final and determining assessment of an alternative's ability to satisfy the protectiveness requirement. To be deemed protective, an alternative must meet the RAOs, reduce risks to acceptable levels, meet ARARs, and generally satisfy the balancing criteria.

Alternative 1, "No Further Action," and Alternative 2, "MNA," are not protective, because they do not treat source areas and prevent plume migration. The other four alternatives provide for treatment of TCE and 1,4-dioxane and are protective of human health and environment.

Compliance with Federal and State ARARs

Section 121(d) of CERCLA and NCP § 300.430(f)(1)(ii)(B) require that remedial actions at CERCLA sites at least attain ARARs unless such ARARs are waived under CERCLA section 121(d)(4). Compliance with ARARs is based on an alternative's ability to the ARARs. ARARs can be chemical-specific, action-specific, or location-specific. Chemical-specific and action-specific ARARs are presented in Tables 4-6 and 4-7, respectively, in Section 4.18. There are no location-specific ARARs associated with the alternatives in this interim ROD Amendment.

The No Further Action alternative does not comply with ARARs because that alternative does not include monitoring, and there would be no way to determine when or if groundwater cleanup levels were achieved. For Alternative 2, because the source of the TCE and 1,4-dioxane in groundwater may still be present in the aquifer south of Los Reales Road and at the Three Hangars Building, natural attenuation of the groundwater contaminants could take decades and would not meet ARARs in a reasonable 30-year timeframe. Alternatives 3 and 4 both include existing groundwater pump-and-treat systems that would achieve compliance with ARARs by hydraulically containing the plume while gradually reducing concentrations of contamination in groundwater. Alternatives 5 and 6 assume the TARP groundwater pump-and-treat and UV-AOP systems as well as the proposed in situ treatment of wells will also meet ARARs based on currently available information.

4.13.2 Balancing Criteria

Long-Term Effectiveness and Permanence

This criterion connotes the level of protection afforded by an alternative after completion of the proposed remedial actions. EPA must assess the anticipated effectiveness of the remedy in controlling potential residual risks due to untreated materials, or treatment of residuals remaining on site after completion of the remedial actions. This assessment includes a judgment regarding the potential for realizing long-term improvements in environmental quality resulting from the alternative. Factors considered under the long-term effectiveness evaluation include the following:

- The magnitude of residual risks upon completion of the remedy, such as the volume, toxicity, mobility, and potential for bioaccumulation of COCs remaining on site.
- The expected adequacy and reliability of engineering controls performed under the alternative, including the suitability and continued effectiveness of controls used to manage the residual risks after the RAO has been met.

Alternative 1 has the lowest long-term effectiveness and permanence because potential exposures to known areas of contamination would not be controlled. For Alternative 2, an MNA assessment would need to be made to demonstrate protectiveness, and then a contingency plan would need to be included. Additionally, the rate of natural attenuation and plume longevity for the groundwater plume north of Los Reales Road is unknown; therefore, it is also unknown if the rate of natural attenuation meets or exceeds the rate of groundwater migration. Alternative 2 would require ICs to prohibit the use of aquifers as a source of drinking water, plus monitoring to confirm the plume is not migrating over time.

Alternative 3 involves both groundwater pumping, which would continue to provide hydraulic containment of the groundwater plume, in addition to installation of a new remediation well which increases mass removal within the plume. Alternative 4, which also involves groundwater pumping, would only provide hydraulic containment with limited mass removal and would require more time to meet site closure than Alternative 3. The new remediation well in Alternative 3 was designed to remove the mass from the most contaminated portion of the aquifer. Operation of this well, therefore, will achieve RAOs quicker than all other alternatives. Both Alternatives 3 and 4 would be moderately to highly effective in achieving long-term effectiveness and permanence because they would provide hydraulic containment while minimizing exposure to contaminated groundwater for a period of 30 years.

Alternative 5 uses ISB to treat 1,4-dioxane and TCE in groundwater north of Los Reales Road. An additional study would be required to provide evidence to support natural attenuation of 1,4-dioxane, and to validate natural and engineered ISB. Until additional studies are conducted, it is unknown if Alternative 5 would provide long-term effectiveness and permanence with currently available treatment technologies. The proposed location for ISB is within the UZ of Plume A, which would not impact the long-term effectiveness of Alternative 5 to address the large mass of contaminant in the Regional Undivided Aquifer. Actual ISB treatments have been conducted at the source location on AFP44 and have been included in the 2020 ROD prepared by the USAF.

Alternative 6 includes ISCO for plume treatment in groundwater and destruction of 1,4-dioxane and TCE. Currently, available chemicals such as sodium persulfate have been shown to be effective in the destruction of 1,4-dioxane and TCE and would have high long-term effectiveness and permanence addressing contamination in the UZ of Plume A. The long-term effectiveness of ISCO treatment on groundwater of the UZ would lower for the contaminant mass in groundwater of the Regional Undivided Aquifer. Alternative 6 would require ICs to adequately protect workers who may come into contact with contaminated groundwater.

Reduction in Toxicity, Mobility, or Volume through Treatment

The NCP states a preference for remedies that reduce toxicity, mobility, or volume of through treatment (which is an active process). The degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume are assessed, including how treatment is used to address the principal threats posed by the site. Factors used in deciding if the extent to which each alternative meets this criterion include the following, to the extent appropriate:

- The treatment or recycling processes the alternatives employ and materials they will treat.
- The amount of hazardous substances, pollutants, or contaminants that will be destroyed treated, or recycled.

- The degree of expected reduction in toxicity, mobility, or volume of the waste due to treatment or recycling and the specification of which reduction(s) are occurring.
- The degree to which the treatment is irreversible.
- The type and quantity of residuals that will remain following treatment, considering the persistence, toxicity, mobility, and propensity to bioaccumulate of such hazardous substances and their constituents.
- The degree to which treatment reduces the inherent hazards posed by principal threats at the site.

Alternative 1 does not meet any of the criteria and would not reduce toxicity, as there is no treatment. Alternative 2, which also eschews active treatment, would rely on reduction in toxicity, mobility, or volume of contaminated groundwater through natural attenuation mechanisms.

Due to the scale of the diffused groundwater plume and the multiple aquifers, Alternatives 3 and 4 are expected to have moderate reductions in mobility and toxicity of contaminants over the 30-year period. These alternatives will treat the COCs, is irreversible, over time will eliminate residuals, and eliminate the hazards inherent to the site.

Alternatives 5 and 6 would reduce the volume of contaminated groundwater through treatment of elevated concentration areas. The degree of effectiveness of source treatment and reduction in dissolved-phase plume longevity would require further testing to quantify those processes. These alternatives have the potential to cause residual chemicals used in the injections to persist in the aquifer or be extracted by the remediation wells and delivered to the TARP treatment system.

Short-Term Effectiveness

This criterion addresses the potential impacts an alternative might have on human health or the environment during the construction or implementation phase, through and up to the time the RAO is achieved. The following factors are considered in the short-term effectiveness assessment:

- Short-term risks that might be posed to the community during implementation of an alternative.
- Potential impacts on works during remedial action and the effectiveness and reliability of protective measures.
- The potential impacts on the environment during construction or implementation, and the reliability of mitigation measures for preventing or reducing these potential impacts.
- The time required to implement the proposed remedial measures and achieve the RAO.

Alternatives 1 and 2 would have the lowest relative short-term effectiveness because they do not meet RAOs. Alternatives 3 and 4 would require less disruption to the surrounding community than Alternatives 5 and 6, and are expected to have high short-term effectiveness due to the site history of pump and treatment and the demonstrated effectiveness of the technology.

Alternatives 5 and 6 would have the highest short-term risk and, therefore, the lowest short-term effectiveness to workers and the surrounding community because the remedy involves installation of in-situ treatment wells in a densely populated residential area, which would increase the risk of exposure to dust, noise, and increased traffic. Both Alternatives 5 and 6 would affect a treatment area of approximately 253 acres and would include construction and installation of approximately 156 injection points within the public right-of-way. Because of the elevated risks and longer construction duration of Alternatives 5 and 6, their short-term effectiveness are lower than for Alternatives 3 and 4.

Implementability

The implementability criterion is a measure of the ease or difficulty of implementing the alternatives to be assessed by considering the following types of factors, as appropriate:

- Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, the reliability of the technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy.
- Administrative feasibility, including activities needed to coordinate with other offices and agencies and the ability and time required to obtain any necessary approvals and permits from other agencies (for off-site actions).
- Availability of services and materials, including the availability of adequate off-site treatment, storage capacity, and disposal capacity and services; the availability of necessary equipment and specialists, and provisions to ensure any necessary additional resources; the availability of services and materials; and availability of prospective technologies.

The scale of the dissolved-phase plume, complexities of the multiple aquifers, and the effect of back-diffusion from sources of dissolved-phase contaminants make any technology difficult to implement at the Site. Other potential complications with implementability of a remedy include proximity of the plume to potential receptors and limited right-of-way access due to existing building, foundations or roadways. Additionally, there could be detrimental effects on the community caused during implementation of the remedy, including waste transportation through neighborhoods, mobilization and demobilization of construction equipment, drilling, excavating, and road closures (ECG, Inc. 2016c).

Alternatives 1 and 2 are highly implementable. For the remaining alternatives, Alternative 3 followed by Alternative 4 are moderately easy to implement because they involve the least amount of construction activities and materials and supplies are readily available. Alternatives 5 and 6 are the least easy to implement because they would require extensive construction activities and specialty equipment and chemicals as detailed in the paragraph above.

Cost

EPA compares each alternative based on upfront capital costs (including both direct and indirect costs); annual operation and maintenance cost; and overall net present value of capital and O&M costs, which is a measure of the total future project cost over a 30-year timeframe.

There is no cost for Alternative 1. Since Alternatives 1 and 2 do not meet the RAOs, the next least costly alternative is Alternative 4. Alternative 3 and Alternative 6 have moderate costs. Alternative 5 is the most costly of all alternatives. Table 4-4 summarizes the estimated costs of each of the remedy alternatives for the site.

4.13.3 Modifying Criteria

State Acceptance

This criterion considers whether the State agrees with the analyses and recommendations, as described in the Focused RI/FS and Proposed Plan.

In a letter dated March 16, 2023, from ADEQ's Remedial Projects Section to EPA, ADEQ provided its concurrence for the Preferred Alternative stating "ADEQ supports the Proposed Plan and Draft Interim Record of Decision Amendment for the TARP remedy."

Community Acceptance

This criterion considers whether the local community agrees with EPA's analyses and Preferred Alternative. Comments received on the Proposed Plan are an important indicator of community acceptance.

The community includes residents of the City of Tucson and City of South Tucson, the Unified Community Advisory Board (UCAB), and all the various stakeholders. The UCAB has been in existence for more than 25 years and original members were South Tucson residents. There are quarterly UCAB meetings where members, residents, and stakeholders are kept apprised of the status of the site. The UCAB is a collaborative relationship with EPA, the City, and ADEQ. Members of the UCAB expressed support for the Preferred Alternative, as referenced in Part III (Section 5.0) of this ROD Amendment, Responsiveness Summary.

During the public comment period, EPA received a number of comments from the community. EPA received oral comments from members of the public who attended the March 30, 2017 Public Meeting, and the entire transcript of the public comments is included in the Administrative Record file for this ROD Amendment. EPA also received written and oral comments from UCAB members, City of Tucson Water Department, and the community, including residents, property owners, and stakeholders.

The City of Tucson Water Department operates the groundwater treatment facility and delivers the treated water to the public water supply system. In a letter dated June 8, 2017, Tucson Water stated its support for the Preferred Alternative. The letter stated "Alternative 3 has been in use since early 2014 and has proven to be protective of human health and the environment."

The community, in particular the UCAB, generally supports the Preferred Alternative, and has expressed support throughout the process during the quarterly meetings and public meetings related to the Proposed Plan. During the public meetings some citizens expressed that the site was not being cleaned up quick enough. Therefore, EPA added the enhancements of the additional extraction well to increase the mass of contaminants being removed and upgrades to the AOP facility to treat the additional extracted volume of groundwater. The City of Tucson requested that alternative end-uses of the treated water be considered, including conveyance to the recycled water system which includes discharge to the Santa Cruz

River. The proposal of these enhancements has been well-received by the citizens, the Mayor, the City Council for Tucson, and the UCAB. (See Section 4.26, Documentation of Significant Change). We acknowledge that some commenters expressed a preference for Alternative 5 and/or Alternative 6 prior to the enhancements were added to Alternative 3.

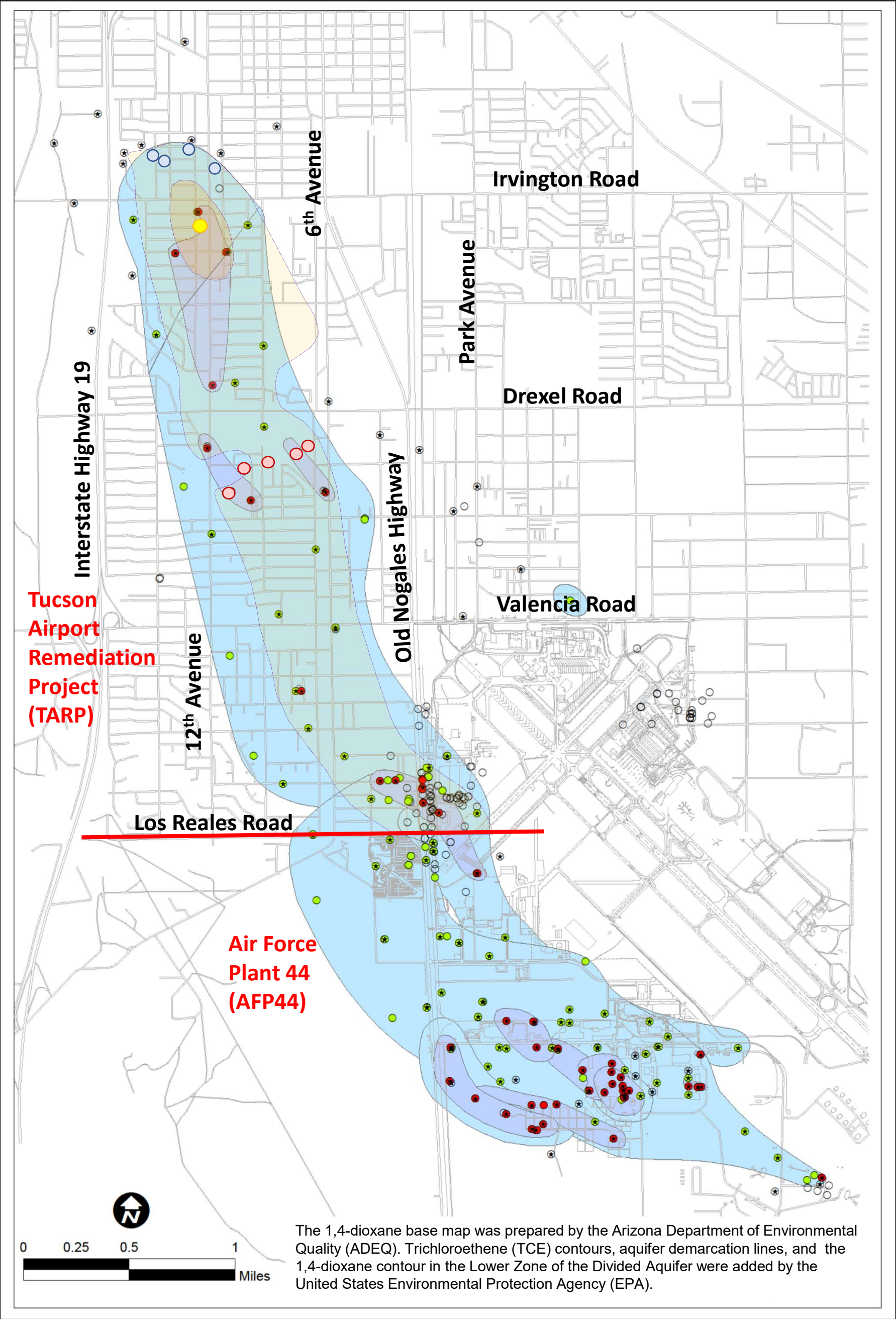
The comments provided to EPA during the public comment period and EPA's responses to comments are addressed in Part III (Section 5.0) of this ROD Amendment, Responsiveness Summary.

4.14 Principal Threat Waste

The NCP establishes an expectation that EPA will use treatment to address the principal threats posed by a Site wherever practicable. The principal threat concept is applied to the characterization of source materials at a Superfund site. Source material is material that includes or contains hazardous substances, pollutants or contaminants that act as a reservoir for migration of contamination to ground water, surface water or air, or acts as a source for direct exposure. Contaminated ground water generally is not considered to be a source material. Contaminated groundwater, as addressed by the six alternatives, does not constitute a principal threat waste at this Site.

4.15 Selected Remedy

Based on information currently available, EPA believes Alternative 3 meets the threshold criteria and provides the best balance of trade-offs among the other alternatives with respect to the balancing and modifying criteria. EPA expects the selected remedy to satisfy the following statutory requirements of CERCLA §121(b): 1) be protective of human health and the environment, 2) comply with ARARs; 3) be cost-effective, 4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable, and 5) satisfy the preference for treatment as a principal element. Figure 4-5 shows a conceptual design of Alternative 3. This remedy provides for containment and treatment of 1,4-dioxane, based on the original 1988 EPA ROD that provides for containment and treatment of TCE.



LEGEND

- 1,4-Dioxane > 0.35 ug/l
 - 1,4-Dioxane > 3.5 ug/l
 - TCE > 5.0 ug/l
 - TCE > 50 ug/l
- ug/l – Micrograms per liter

- ★ Data from 2019 to 2022 (unstarred data collected prior to 2019).
- 1,4-Dioxane < 0.35 ug/l
- 1,4-Dioxane > 0.35 < 3.5 ug/l
- 1,4-Dioxane > 03.5 ug/l
- North Well Field (NWF) Remediation Well
- South Well Field (SWF) Remediation Well
- New Remediation Well

**Figure 4-5
Alternative 3
Site Map**

4.16 Statutory Determinations

This interim action (the Selected Remedy) should protect human health and the environment until a final ROD is implemented, complies with ARARs, and is cost-effective. This interim action is not designed or expected to be final. But this interim action represents the best balance of trade-offs among alternatives with respect to pertinent criteria, given the limited scope of the action. This interim action also supports permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, this interim action supports a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous substances, pollutants, or contaminants as a principal element, and a bias against off-site disposal of untreated wastes.

4.17 Protection of Human Health and Environment

Exposure to the public of contaminated groundwater through public water supplies or private water wells is the potential risk. The selected remedy will be protective of human health by reducing the COCs in groundwater through treatment to meet drinking water standards, which will be in place until remedial action objectives are achieved. ICs will protect human health by reducing or managing the likelihood of humans coming into contact with contaminated groundwater as outlined below. 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, ADEQ, or EPA concerning risks from exposure to contaminated groundwater. The remedy will not have detrimental cross-media impacts such as air emissions or contaminated surface water discharges.

The State of Arizona can impose restrictions with respect to registration of wells and drilling within the groundwater plume area. As provided in Arizona Revised Statutes 45, Chapter 2, Article 10, drilling a well in Arizona must meet administrative requirements that the well is drilled by a licensed contractor, the contractor will use approved well construction methods, a Notice of Intent (NOI) will be filed with Arizona Department of Water Resources, and its staff will review the NOI for proximity to a contaminated site and confer with ADEQ before approving the NOI.

In addition to State of Arizona restrictions on installation or modifications of wells, Pima County monitors and inspects all private wells within the TCE groundwater plume footprint and provide reports to the public, ADEQ, and EPA.

4.18 Compliance with Applicable or Relevant and Appropriate Requirements

The following sections describe the chemical-specific and action-specific ARARs for the Selected Remedy. There are no location-specific ARARs. Tables 4-6 and 4-7 present the chemical-specific and action-specific ARARs, respectively. This is in compliance with NCP § 300.430(f)(5)(ii)(B) & (C). All ARARs will be met upon completion of the selected remedy, and no ARARs are being waived.

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

Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that, while not “applicable” to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site.

To Be Considered Criteria: in addition to legally binding laws and regulations, many Federal and State environmental and public health programs also develop criteria, advisories, guidance, and proposed standards that are not legally binding, but that may provide useful information or recommended procedures. These materials are not potential ARARs but are evaluated along with ARARs, as part of the risk assessment conducted for each CERCLA site, to set protective cleanup level targets. Chemical-specific TBC values such as health advisories and reference doses will be used in the absence of ARARs or where ARARs are not sufficiently protective to develop cleanup goals. In addition, other TBC materials such as guidance or policy documents developed to implement regulations may be considered and used as appropriate, where necessary to ensure protectiveness.

Table 4-6
Chemical-Specific ARARs for 1,4-Dioxane and VOC-Contaminated Regional Groundwater

Source	Standard, Requirement, Criteria, or Limitation	ARAR/TBC Status	Description of Standard, Requirement, Criteria or Limitation	Manner in which ARAR Applies to Alternative
Arizona Aquifer Boundary Protected Use	AAC Title R18-11-501 to - 506 ARS 49-224	Applicable	Classifies Arizona waters as “drinking water protected” use and establishes the procedure to petition for reclassifying aquifer to a “nondrinking water protected” use classification.	Groundwater concentrations must meet any drinking water standard.
Safe Drinking Water Act	42 U.S.C. § 300g-1; 40 C.F.R. Part 141, Subpart G	Relevant and Appropriate	MCLs for certain contaminants in drinking water to protect human health.	TARP-treated water delivered to EPTDS shall meet MCLs.
Arizona Class A Reclaimed Water	A.A.C § R18-11-304	Relevant and Appropriate	Class A reclaimed water shall meet treatment and water quality requirements.	The RWS distributes Class A reclaimed water and will meet the treatment and water quality requirements.
Arizona Aquifer Water Quality Standards	A.R.S. § 49-223; A.A.C. Title 18, Chapter 11, Article 4	Relevant and Appropriate	Standards for drinking water use of Arizona aquifers.	On-site discharge from the RWS be protective of the aquifer water quality standards.
Arizona Surface Water Quality Standards	A.R.S. § 49-222; A.A.C. Title 18, Chapter 11, Article 1	Relevant and Appropriate	Standards for certain surface waters to protect designated uses.	On-site discharge from the RWS certain surface waters shall be protective of designated uses.
Safe Drinking Water Act MCLGs	40 CFR Part 141 Subpart F 40 CFR § 300.430(e)(2)	TBC	EPA identifies the level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals. Relevant and appropriate non-zero MCLGs shall be attained by groundwater remedial actions that are current or potential sources of drinking water.	These goals are not enforceable should be considered for any constituent with a non-zero MCL For example, chloroform has a MCLG of 70 µg/L.

Notes:

- (1) ARAR = Applicable or Relevant and Appropriate Requirement
- (2) TBC = To Be Considered
- (3) MCL = Maximum Contaminant Level
- (4) MCLG = maximum contaminant level goal
- (5) RSL = regional screening level
- (6) µg/L = microgram per liter
- (7) COC = contaminant of concern
- (8) EPA = U.S. Environmental Protection Agency
- (9) TCE = trichloroethene
- (10) VOC = volatile organic compound
- (11) U.S.C. = United States Code
- (12) C.F.R. = Code of Federal Regulations
- (13) A.R.S. = Arizona Revised Statutes
- (14) A.A.C. = Arizona Administrative Code
- (15) EPTDS = Entry Point to the Distribution System

Table 4-7
Action-Specific ARARs for 1,4-Dioxane and VOC-Contaminated Regional Groundwater

Source	Standard, Requirement, Criteria, or Limitation	Applicable or Relevant and Appropriate	Description of Standard, Requirement, Criteria or Limitation	Manner in Which ARAR Applies to Alternative
Stationary Air Pollution Source (Pima County Department of Environmental Quality and ADEQ Air Pollution Control)	Pima County Ordinance Chapter 17.12 and AAC R18-2 Articles 3, 5, and 6	Relevant and Appropriate if remedial alternative has a source that discharges to air.	Requires stationary air pollution sources to obtain an air permit prior to construction or alteration so overseeing agency can establish requirements and limitations. Regulations have established air quality standards and requirements for reasonable available control technology for sources that emit hazardous air pollutants.	Although CERCLA exempts facilities from obtaining permits for on-site remedial actions, the Site will comply with the substantive requirements of these regulations.
Mobile and Non-Point Source (Pima County Department of Environmental Quality and ADEQ Air Pollution Control)	Pima County Ordinance Chapter 17.16 and AAC R18-2 Articles 6	To Be Considered during construction/modification activities.	Requires non-stationary sources to minimize visible emissions and odor. Abatement equipment may be required if adjoining property is impacted with pollution.	Reasonable precautions, such as wetting or covering, must be taken for dust-producing sources (e.g., machinery or storage piles) to minimize fugitive dust.
ANSI Standards – Arizona Safe Drinking Water Act	AAC R18-4-213	Relevant and Appropriate if products are added to TARP water during treatment.	Each product added directly to water during treatment must conform to ANSI/National Sanitation Foundation (NSF) Standard 60. Material or products (e.g., granular-activated carbon or pipes) that come into contact with water must conform to ANSI/NSF Standard 61.	Added products (e.g., peroxide or new piping) shall have a seal of the certifying entity that it is accredited by ANSI. If they are not certified, regulation lists other steps that the TARP plan can take to meet the requirement.
Blending – Arizona Safe Drinking Water Act	AAC R18-4-217	Relevant and Appropriate if TARP water continues to incorporate blending.	Public water system may use a blending technique to achieve MCL compliance after it obtains ADEQ's approval for a blending plan and quarterly monitoring program.	The TARP water has historically been blended to meet the Health Advisory for 1,4-dioxane (no MCL for 1,4-dioxane currently exists). Currently, water is treated by the AOP system and water is not being blended following treatment. If the implemented alternative requires blending, the TARP plan shall submit an amended blending plan to confirm the new blend achieves compliance.
Construction Arizona Pollution Discharge Elimination System Storm Water Permit	Tucson City Ordinance 26-23 and AAC R18-9-A9	To Be Considered if construction activities disturb an acre or more of land.	The Arizona Pollution Discharge Elimination System regulations establish overall requirements and standards for discharge of storm water to navigable waters. The City of Tucson further defines discharges to include generated or naturally-occurring runoff or flow into, or through, the City's municipal separate storm sewer or water of the United States.	Although CERCLA exempts facilities from obtaining permits for on-site remedial actions, the Site will comply with the substantive requirements of these regulations.
Hazardous Waste Management/RCRA Requirements	Title 40 CFR Part 262 Subparts A-D, Part 273 Subpart B and/or C, and Part 279 Subpart C	Applicable if TARP generates waste material (e.g., hazardous waste, universal waste, and used oil) during remediation activities.	Substantive, but not administrative, parts of RCRA requirements must be met on a CERCLA site.	Requires waste analysis, inspection, training, and handling and storage requirements.
Hazardous Materials Transportation Regulations	Title 49 CFR Part 172 Subparts C-H and Part 173 Subparts A, B, D and E	Applicable if shipping wastes to another site.	Covers requirements for marking, labeling, and placarding of shipping containers. If waste is identified as hazardous, recordkeeping and manifesting are required.	Requires marking and labeling investigative-derived waste and other hazardous material shipments before shipping off site.

Table 4-7 (continued)
Action-Specific ARARs for 1,4-Dioxane and VOC-Contaminated Regional Groundwater

Source	Standard, Requirement, Criteria, or Limitation	Applicable or Relevant and Appropriate	Description of Standard, Requirement, Criteria or Limitation	Manner in Which ARAR Applies to Alternative
Well Construction and Abandonment Standards	Arizona Administrative Code, Title 12, Chapter 15, Article 8: ell construction and abandonment regulations (these are regulations promulgated pursuant to A.R.S. 45-594, under the Arizona Groundwater Management Act): R12-15-811 (Minimum Well Construction Requirements) R12-15-813 (Unattended Wells) R12-15-816(G, H, I, and J) (Abandonment of Wells) R12-15-822. Capping of Open Wells.	Applicable	Well construction and well abandonment will comply with the substantive requirements within the regulations Those regulations include: R12-15-811, Minimum Wells Construction Requirements. R12-15-813, Unattended Wells: “All wells, when unattended during well drilling, shall be securely covered for safety purposes and to prevent the introduction of foreign substances into the well.” R12-15-816(G, H, I, and J), Abandonment of Wells R-12-15-822, Capping of Open Wells	Applies to construction of new wells or replacement wells; unattended wells; abandonment of wells, and open wells.
Pipeline Conveyances of Reclaimed Water	A.A.C. § R18-9-B702(J)	Relevant and Appropriate	Engineering standards for pipeline conveyances of reclaimed water.	Reclaimed water conveyances shall be constructed according to the standards.
Aquifer Protection	A.R.S. § 49-243(B)	Relevant and Appropriate	A person who discharges shall obtain an Aquifer Protection Permit (APP). APPs implement technology standards and aquifer water quality standards. Remedial actions are exempt from the requirement to obtain this permit, under A.R.S. §49-250 and CERCLA §121(e).	On-site discharges shall meet the substantive standards at the point of compliance.
Arizona Pollutant Discharge Elimination System	A.R.S. § 49-255.01; A.A.C. Title 18, Chapter 9, Article 9	Applicable	A person who discharges to certain surface waters shall obtain an AZPDES permit. AZPDES permits implement surface water quality standards. CERCLA actions are exempt from obtaining a permit and other procedural requirements AZPDES under CERCLA § 121(e) unless discharge is considered to be off-site.	An AZPDES permit will be obtained for discharges to the Santa Cruz River.
Arizona Type 3 Recycled Water Blending	A.R.S. §49-203(A)(6), A.A.C. Title 18, Chapter 9, Article 7 (Use of Recycled Water), Part B (Reclaimed Water)	Applicable	Blending of reclaimed water with other water may be authorized, and blended water quality must meet the water quality standards for reclaimed water.	Type 3 Recycled Water Blending Permit will be obtained for the introduction of treated water from TARP WTP to the RWS.

- Notes:
- AAC

Arizona Administrative Code
- ADEQ

Arizona Department of Environmental Quality
- ANSI

American National Standards Institute
- AOP

advanced oxidation process
- ARAR

Applicable or Relevant and Appropriate Requirements
- ARS

Arizona Revised Statute
- CERCLA

Comprehensive Environmental Response, Compensation, and Liability Act of 1980
- CFR

Code of Federal Regulations
- EPA

U.S. Environmental Protection Agency
- NSF

National Sanitation Foundation
- RCRA

Resource Conservation and Recovery Act
- TARP

Tucson Airport Remediation Project
- TBC

To Be Considered
- VOC

volatile organic compound

Section 121 (e) of CERCLA, 42 U.S.C § 9621(e), states that no federal, state, or local permit is required for remedial actions conducted entirely on site. Actions conducted entirely on site must meet substantive ARARs, but not administrative requirements. Any action conducted off site is subject to the full requirements of federal, state, and local regulations.

The most significant ARARs are discussed below.

4.19 Chemical-Specific Applicable or Relevant and Appropriate Requirements

The major statutes and regulations that contribute to the list of potential chemical-specific ARARs are the SDWA and the Arizona Water Quality Standards (Arizona Administrative Code Title 18, Chapter 11). If an MCL does not exist for a specific compound, EPA will consider as standards the Region 9 screening levels for contaminants at Superfund Sites, the EPA Integrated Risk Information System assessment, or the SDWA MCLGs. A list of site-specific cleanup levels for primary COCs is presented in Table 4-2, using the most appropriate standard among the MCL, MCLG, regional screening levels, or Health Advisory value. The chemical-specific ARARs that have been evaluated are those that affect drinking water.

The cleanup levels address the quality of drinking water at the tap pursuant to the SDWA and are ARARs for treated groundwater when the end use is for purposes of human consumption. Pursuant to 40 C.F.R.

§§ 300.430(e)(2)(i)(A)(D), cleanup levels are relevant and appropriate as in situ aquifer standards for groundwater that is or may be used for drinking water. The State of Arizona has adopted the federal MCLs by reference as stated in Arizona Administrative Code §§ 18-4-108 & 109. Table 4-2 presents the cleanup levels.

Five contaminants are identified as COCs for this Site. Table 4-6 presents the chemical-specific ARARs for VOC-contaminated regional groundwater.

4.20 Location-Specific Applicable or Relevant and Appropriate Requirements

Location-specific ARARs differ from chemical-specific or action-specific ARARs in that they are not closely related to the characteristics of the contaminants at the Site, or to the specific remedial alternative under consideration. 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 could be threatened by the existence of the Site, or by the remedial actions to be undertaken at the Site. As stated in Section 4.13.1, there are no location-specific ARARs associated with the alternatives in this interim ROD Amendment.

4.21 Action-Specific Applicable or Relevant and Appropriate Requirements

Table 4-8 lists the action-specific ARARs for this Site. These ARARs include well construction and abandonment requirements, discharge requirements, blending of drinking water if necessary, and air discharge requirements. RCRA is a federal statute passed in 1976 to meet three goals: 1) to protect human health and the environment, 2) to reduce waste and to conserve energy and natural resources, and 3) to eliminate the generation of hazardous waste as expeditiously as possible. The Hazardous and Solid Waste Amendments of 1984 significantly expanded the scope of RCRA by adding new corrective action requirements, land disposal restrictions, and technical requirements. Substantive RCRA requirements are applicable to response actions at CERCLA sites if contaminants are characterized as hazardous waste.

Untreated groundwater containing VOCs at the Site is not a listed waste. The groundwater is not a characteristic waste because the contaminants in the groundwater are below the levels established for the characteristic of toxicity. Consequently, the RCRA requirements triggered by the hazardous nature of waste are not applicable, and not relevant and appropriate with respect to the groundwater.

4.22 Cost-Effectiveness

A cost-effective remedy is defined as one in which “costs are proportional to its overall effectiveness” (Title 40 Code of Federal Regulations § 300.430(f)(1)(ii)(D)). Assessing cost-effectiveness involves comparing costs to overall effectiveness, which is determined by evaluating the following three of the five balancing criteria: 1) longer term effectiveness and permanence, 2) reduction in toxicity, mobility, or volume through treatment, and 3) short-term effectiveness.

The selected remedy is cost-effective and has a high level of long-term effectiveness and permanence because much of the infrastructure for the remedy is already in place and can be expanded relatively easily to increase the volume of extracted and treated water, and provides for alternative end uses of the treated water including discharge to the Santa Cruz River.

4.23 Utilization of Permanent Solutions and Alternative Treatment Technologies

EPA has determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be used in a practicable manner in Area A. Of the alternatives that are protective of human health and the environment and comply with ARARs, EPA has determined that the selected remedy provides the best balance in terms of the five criteria, the statutory preference for treatment, and state and community acceptance. All of the groundwater treatment will take place at the TARP. The selected remedy will treat the groundwater contaminants before they are conveyed to the City of Tucson drinking water or recycled water distribution systems.

4.24 Preference for Treatment as a Principal Element

EPA has determined that the selected remedy meets the statutory preference for treatment as a principal element. The contamination is not highly toxic when compared to the EPA standard definition of principal threat waste. However, the selected remedy does employ pump and treatment with the UV- AOP system, which meets the preference for treatment as a principal element.

4.25 Five-Year Review Requirements

NCP § 300.430(f)(4)(ii) requires a five-year review if the remedial action selected results in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure. A previous five-year review was conducted in 2013 and focused on Operable Unit (OU)-1 (TARP area-wide groundwater), OU-2 (airport property), and OU-3 (AFP44/Raytheon) as part of the TIAA Superfund Site. The 2013 Five-Year Review determined that the remedy for OU-1 was currently protective of human health and the environment for historically identified COCs; however, the RAOs written in the 1988 EPA ROD are unclear and the decision document should be revised as part of future amendments, and the treatment goal of 1×10^{-6} excess cancer risk should be reviewed for technical feasibility to assure that long-term-protectiveness can be achieved. The 2018 Five-Year Review also focused on OU-1, OU-2, and OU-3 with OU-1 divided into Area A and Area B groundwater plumes. The 2018 Five-Year Review determined that OU-1 is currently protective of human health and environment. COCs are being contained and groundwater treatment systems are operating to treat contaminated groundwater to below MCLs and to reduce groundwater contaminant concentrations. The Five-Year Review notes that for the remedy to be protective in the long-term, the following actions need to be taken to ensure protectiveness: re-evaluate the operation of the remedy, if groundwater levels continue to rise; and investigate the extent of perfluorinated compounds in groundwater (EPA 2018). Tucson Water is currently testing water in TIAA Area A for perfluorinated compounds and the remedy will be continuously evaluated.

Because the Selected Remedy will result in hazardous substances remaining on-site above levels that allow for unlimited use and unrestricted exposure, further five-year reviews will be conducted to ensure that the remedy is, or will be, protective of human health and the environment.

4.26 Documentation of Significant Changes

The Proposed Plan, which was issued by EPA in March 2017, identified pump and treatment using the existing UV-AOP system combined with MNA for the Area A groundwater plume as the preferred alternative for groundwater remediation. EPA reviewed all written and verbal comments submitted during the public comment period. Section 5 includes a response to those comments. Changes to the proposed alternative that occurred after and in response to the public comment period following the March 2017 Proposed Plan are outlined below.

1. The Selected Remedy modifies the preferred remedy (Alternative 3) by removal of MNA and inclusion of long-term monitoring during the ROD phase.
2. The Selected Remedy enhances the preferred remedy outlined in the March 2017 Proposed Plan with installation of another remediation/extraction well within the groundwater plume and upgrades to the AOP system. The remediation well will help to further capture and remove COCs; thereby, increasing total mass removal.
3. This interim ROD Amendment provides for containment and treatment of contaminated groundwater, not restoration of the aquifer for 1,4-dioxane. A final restoration ROD Amendment will be completed in the future that will provide for aquifer restoration with cleanup levels when an MCL is determined for 1,4-dioxane.
4. Alternative end uses for the treated water from TARP other than as drinking water will be employed, including discharge to the Tucson Water recycled water distribution system.
5. The UFHHRA (EPA and Air Force Civil Engineer Center, 2015) recommended the 0.35 µg/L treatment level (10^{-6} risk level) for 1,4-dioxane in water from the Area A plume north of Los Reales Road. A groundwater cleanup level will be established in a future decision document.

No other significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate. The public was able to reasonably anticipate any significant changes.

5.0 PART III: RESPONSIVENESS SUMMARY

Proposed Plan for Tucson International Airport Area, Superfund Site Area A, North of Los Reales Road, Tucson, Arizona dated March 2017

Comment No.	Comment	Response
Spoken Comments by Debra Serrano at the public meeting held on March 30, 2017		
1	First of all, I wanted to ask about the pipelines because I do know that certain chemicals do stay in the pipelines, even though they have been cleaned with certain chemicals to solutionize and clean out all the whatever contaminants there is. But no one so far that I know of, that I've researched on, which is hardly any good research anyways because I do it on my own, but has cleaned out the pipelines, the actual south side pipelines. You know, who's to say that there is chemicals still in a pocket somewhere, or being leaked out every so often in certain areas, or what. But who is coming over and checking those pipelines to see, you know, what kind of contaminants are -- remain in those lines?	The U.S. Environmental Protection Agency (EPA) has received a number of comments expressing concern about possible residual contamination in the treatment system and/or the public water distribution system, including piping used to transport contaminated water to the treatment plant. The treatment system piping and treatment plant were constructed so that there is <u>no</u> connection between the system and the Tucson public water supply until after contaminated water has been treated to remove contamination at the Tucson Airport Remediation Project (TARP) treatment plant. EPA believes it is unlikely that any "pockets" or deposits of contamination remain within the system piping that could affect the health of area residents. In making this observation, EPA notes that routine periodic testing of water supplied by the TARP treatment plant to the public water supply shows that the plant meets existing and proposed clean up levels for groundwater contaminants and also meets drinking water standards set under the Safe Drinking Water Act. It is EPA's understanding that the City of Tucson Water Department (herein referred to as Tucson Water) is planning an investigation of this piping within the area of the Superfund Site and EPA will assist where possible in that investigation. If you have questions about the quality of the water at your home, you are encouraged to contact the Tucson Water Quality & Pressure Hotline at (520) 791-5945.
2	And then third of all, there has to be something done about the south side water because not only my whole family and my six sisters all have pain came down one	EPA has received a number of comments from individuals who feel their health problems, or those of family members, may be

Comment No.	Comment	Response
	after another. And currently still, my sister, bless her heart, is getting surgery today, Sonya, and in and out of the hospital with cancer. My sister, Jenny, here, my sister, Terry. We just lost my nephew. And this is on and on, going on ever since we moved to the south side. We were healthy, young, blemishing young people then. And we moved to the south side, all of us, since we were in grade school. Each of us -- each one of us in our family is with cancer or has a limb missing from cancer and stuff. And it's been ever since we moved to the south side. You know, who's responsible, what's being done, and who's hearing us? You know, who's backing us up on all this, you know. That's -- those are my questions, and that's -- you know, I'm just trying to get -- let everybody know that. You know, let's try to stick together, and let's tell our neighbors, let's get everybody. Even if we have to stand out here day and night, try to get as many people as we can that have people, members of their family from the south side that are suffering from these unknown illnesses, you know, leukemia, fibromyalgia, lupus, all these other symptoms that are coming out that, you know, that are being due from chemicals and all that. Let's do something about it and find out why they did research in the first place so it won't get this far.	related to contamination at the Tucson International Airport Area (TIAA) Superfund Site. Unfortunately, in the past there was documented exposure to site-related contamination, primarily due to use of contaminated groundwater as a source of drinking water and water used for cooking, bathing, and other home uses. This unfortunate situation prompted EPA to become involved and declare a Superfund Site. As a result of actions taken by the Arizona Department of Environmental Quality (ADEQ), City of Tucson, EPA and others, EPA believes that there is no current exposure. Pima County continues to annually monitor private wells. EPA sympathizes with anyone experiencing health issues and understands the worry, stress, and difficulties that a family experiences when a loved one develops serious health issues. EPA is committed to protecting human health at Superfund sites, such as TIAA. Based in part on public comment and concern, EPA is enhancing the selected remedy (Alternative 3) by adding an additional remediation well, which will extract additional contaminated groundwater and treat it at the TARP advanced oxidation process (AOP) system. The installation of this additional well will assist with containing the groundwater plume and removing additional contamination from the plume. EPA feels that this enhancement of the remedial action will help ensure that people living in the area and/or using treated tap water continue to be protected from site-related contamination. For additional information concerning water quality concerns at TIAA, please reference Comment #1. With regard to information on health impacts in the Tucson community, please refer to the Arizona Department of Health Services (ADHS) or the Pima County Health Department. Public health assessments and reports conducted by ADHS on the groundwater contaminants at TIAA Area A can be referenced here: http://www.azdhs.gov/preparedness/epidemiology-disease-control/environmental-toxicology/index.php#assessments-reports.

Comment No.	Comment	Response
Spoken Comments by Linda Shosie at the public meeting held on March 30, 2017		
3	So my comment today is I'm asking EPA to shut down the wells, the pipelines. Take them somewhere else, give them to somebody else, but don't feed them to us, and don't feed them to any person or any human beings. You do your stuff, you clean up because it's your problem, not ours. You clean it up, you pay for it. It's your responsibility, and that's enough. Enough is enough. Too many of our children have died. We are tired of having to pay these funeral costs and having to bear the grieving of our family, and our family members, and our children, and now our grandchildren, with these illnesses. And you guys know exactly what's going on. So what my comment here today is that you shut down the wells on the north well field, the south well field. Take your TARP, take your AOP, and take it to your own -- your own properties, but keep them out of our south side. Get them out of our communities.	Removing the wells or associated pipelines could allow contaminants to enter the drinking water of Tucson residents and allow contaminated groundwater to spread farther without any means to stop its spread. At this time, the wells and associated pipelines are an integral part of the groundwater cleanup program and cannot be removed.
Spoken Comments by Bill Jeffers at the public meeting held on March 30, 2017		
4	I just wanted to say that I'm Bill Jeffers. I'm a member of the UCAB. I just wanted to say that plans in the back of the room, very, very good. I've toured all of them before I came up to sit down, and very informative, very clear, very concise, outstanding. That's my comment.	EPA appreciates the feedback on the posters presented at the Proposed Plan meeting.
Spoken Comments by Eduardo Quintana at the public meeting held on March 30, 2017		
5	In the summer of 1985, if I recall correctly, there was a series of articles in the Arizona Daily Star by a reporter. Her name was Janey Kay (phonetic), who had just discovered that there was an abnormal incidence of cancer clusters on the south side. In just one block of Elvira there were 25 cancers in just one block. And when we started looking around, we saw that the pattern duplicated itself in other parts of the south side. So at that time we began organizing. We organized Tucsonans for a Clean Environment, known as the TCE Committee, which had held news conferences, and rallies, and what we felt was a big, big issue, the TCE contamination that needed to be addressed. At that time we had to struggle against all the regulatory agencies. You know, the main function of a government is to protect the people, and the regulatory agencies are supposed to serve that service by making sure that industry is regulated so it doesn't poison the population. But the regulatory agencies instead fought us. They said we didn't know what we were talking about, there was no TCE in the groundwater. If there was any TCE in the groundwater, it was so minimal it couldn't possibly hurt anyone. The regulatory agencies failed us. They failed in protecting the public health. They failed in protecting the health of our children, and the generations that were to come.	EPA sympathizes with anyone experiencing health issues and understands the worry, stress, and difficulties that a family experiences when a loved one develops serious health issues. The Agency is committed to protecting human health at Superfund sites, such as TIAA. Your concerns are best addressed by the public health agencies. For further information on health impacts in Tucson, please refer to Comment 2.

Comment No.	Comment	Response
	We warned at the time that unless those issues were addressed, that they could expect -- so 1985 we would be seeing the same problem duplicated. And I'm real disappointed that here we are 30 years later, and now grandchildren are coming down with all kinds of exotic diseases. This is not normal, in spite of the propaganda that's out in the newspapers saying that a lot of cancers are just chance mutations. That's preposterous. So I'd like to thank everyone for being here tonight. I'd like to thank the hardworking engineers that work for some of these regulatory agencies. I know that you -- a lot of you have the same obstacles that we have. But, you know, there's a rumor out there that comments that Donald Trump, the new President, is going to eliminate the EPA. And that would be -- that would be a shame. But in the case of Tucson, I don't know that we would notice the difference. I think there's very little difference between 1985 when we fought the regulatory agencies to admit that there was a problem to today. We're getting the same answers. EPA does not address the health concerns of the people. Who else is there to address? You clean up the water, remediate the aquifer, but don't address the health of the people. That's preposterous.	

Written Comments by Nicole Fyffe received on April 21, 2017 via email

6	Ms. Aycock, the past weekend I read 2 articles in the Arizona Daily Star on this issue. I had heard generally of the issue before, but had no idea that the treated water was being delivered to households in Tucson, one of which is mine. Until now, I thought my households water came from the recharge facilities in Avra Valley, which is a combo of Colorado River Water and ground water. From the little I learned since this weekend, my understanding is that as part of some type of agreement or settlement, Tucson Water is required to put this treated water to "beneficial use", which they or someone determined to be the Tucson water distribution system. I do not understand why it could not be beneficially used by either reinjecting it into the ground water in that area or distributing it to industrial users (mines, etc.) that would not be drinking it. I trust that the EPA and Tucson Water do believe the risks are low enough to serve us this water. But, just like with the recent discovery of 1,4-dioxane, I can imagine that that there is a likelihood that other contaminants may be discovered in this plume years from now. Why should we have to drink this water when there are plenty of other potential users for this water? Why couldn't Tucson Water exchange this water for a share of CAP water being used by one of the mines and pump this water down to the mines? I'm guessing it has to do with infrastructure costs. Or why could Tucson Water not treat it like reclaimed water and only deliver it to parks and landscaped areas? These did not appear to be one of the alternatives that EPA evaluated, so I can't see what those alternatives would have cost. Were those alternatives considered early on, but dismissed?	The EPA Record of Decision (ROD) signed in 1988 mandated that treated water from the TIAA Superfund area be reused for drinking water under the beneficial reuse clause. Per the 1988 ROD, the impacted aquifer had been designated a Sole Source Aquifer under the Safe Drinking Water Act. According to the Groundwater Management Plans for the Tucson Active Management Area, any water withdrawn from the aquifer had to be put to its highest beneficial use, which limited the end-use options to direct drinking water use, or reinjection for drinking water use at a later time. These criteria were used in the evaluation of all alternatives in both the original Feasibility Study conducted by Arizona Department of Water Resources (Malcolm Pirnie 1988) and the Focused Feasibility Study (EGC 2016). However, in the modified remedy, the end use of treated water from TARP will include the option to discharge the water to the Tucson Water recycled water system, in addition to the current option of the drinking water distribution system. The recycled water system includes use as turf and landscape irrigation water for golf courses and parks, managed discharge to the Santa
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Comment No.	Comment	Response
		Cruz River channel as aquifer recharge and hydriparian habitat, and constructed aquifer recharge projects. Currently, treated groundwater is tested by the City of Tucson and meets the requirements of the Safe Drinking Water Act and City of Tucson target treatment levels.
Written Comments by the students at The University of Arizona undergraduate “Ecological Anthropology” course received via email on April 24, 2017		
7	The presentation of the proposed plan in its current format is complicated to understand as a non-expert community member. The plan claims to “provide the public with background information” on the state of the area’s groundwater. However, the complicated language and scientific jargon utilized in the Plan would likely be unclear to most Tucson citizens. Discussions of specific scientific terms, the mechanics of the water remediation system, and the potential risks and benefits of altering the current system of water remediation was difficult for our class to understand, and is therefore likely incomprehensible to a majority of the public it aims to address. For example, when comparing the costs of each alternative, Presented Worth and Value Cost are undefined, making it extremely difficult to accurately compare the options without consulting experts. In addition, it was unclear to us what entity is paying for the costs. This is vital information to have when forming an opinion on the matter. In summary, terms and language throughout the report are confusing and undefined. The heavily reliance on acronyms causes confusion and lack of clarity (despite the inclusion of a glossary). There is no real comprehensive way for an average Tucson citizen to understand this document.	EPA understands the concern that the Proposed Plan is difficult to understand because of the complicated language, acronyms, and scientific jargon. EPA follows national Superfund guidance when preparing CERCLA documents. EPA reviews every Proposed Plan in an effort to make it as easy to read and understand for the general public while still being technically and scientifically correct in its descriptions. Many residents of the area of Tucson encompassed by the site are actively involved in attending the regular Unified Community Advisory Board (UCAB) meetings, and find it a good opportunity for asking questions and gaining a better understanding of current treatment systems. In accordance with standard EPA procedures, community meetings are advertised locally in English and Spanish newspapers and take place on a quarterly basis, the third Wednesday in January, April, July, and October. If you are interested in attending any meetings in the future and would like to be added to the site mailing or email list, please contact the EPA community outreach coordinator, David Yogi, at yogi.david@epa.gov. The responsible parties (U.S. Air Force, City of Tucson, Tucson Airport Authority [TAA], Hughes Aircraft Company, and McDonnell Douglas Corporation) are listed on Page 1 of the Proposed Plan and are ultimately responsible for paying for the cleanup.
8	Another factor compounds the inaccessibility of the document. By incorporating an anthropological perspective, we have isolated one of the deficiencies in your plan and implementation, which is the accommodation the EPA has made for Spanish speakers in the community impacted. Although translation services were offered at the meeting,	EPA understands that many of the citizens who live in the area around the Superfund Site are Spanish speakers and believes that the Spanish-speaking community was adequately engaged in the Proposed Plan process as described below:

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	and a pamphlet about the plan was administered in Spanish, the pamphlet is not informational enough to allow individuals to make an informed decision about picking an alternative. We are also concerned about the accessibility of this meeting, and whether or not it was circulated in the impacted communities. This is a valid concern because the demographics of the zip codes surrounding the Superfund site indicate that a majority of the individuals in those areas are linguistically isolated, and are not English speakers. According to the EPA's Environmental Justice Survey Tool, for the zip codes closest to the Superfund Site (85746 and 85706), these areas were 80% and 91% linguistically isolated respectively, and about half of the population there did not speak English "Well" or "Very well". We are concerned that this demographic is not being included and fully represented by the EPA. We are also concerned that these individuals would not be able to access the materials through other means because of their inaccessibility. According to the 2015 American Community Survey, out of the 206,448 people listed in the Tucson population, 25,171 individuals do not have access to a computer and 24,989 do not have an internet subscription. This means that the entire population does not have equal accessibility to these materials, so do not have the means to actively participate in the discussion of choosing an alternative that would work best for the community. The point of this EPA Proposal Plan Meeting was to give some agency to the communities adversely affected by environmental toxins (in which the health disparities they are experiencing are the fault of the Tucson International Airport, Hughes Aircraft Company, and the United States Air Force). By limiting the means of information sharing to the internet (and not handing this information out directly to communities), and by not presenting the information as completely in Spanish (or advertising for this meeting in Spanish in affected communities) these individuals are not actually granted agency because they are not given the means to contribute and participate in deciding the route of implementation for the proposed plan.	EPA developed a summary fact sheet of the Proposed Plan, which was translated into Spanish and mailed to 137 people on the EPA mailing list developed for the Superfund Site. Additionally, EPA emailed the fact sheets to an additional 71 people. The Proposed Plan meeting announcement and the comment extension period were advertised in both the Arizona Daily Star (March 21 and May 1, 2017) and translated into Spanish for publication in La Estrella de Tucson (March 24 and May 5, 2017) newspapers. Additionally, Spanish-speaking translators were available to assist community members at the public meeting. The fact sheet and copies of the Proposed Plan in Spanish and English were also placed in the Pima County Public Library—Valencia Branch for people who do not have their own computer or access to internet services.
9	An additional flaw within the Proposed Plan is that it clearly biases the reader in favor of Alternative 3 from the beginning. The very language of the Plan—the use of the positive “preferred” rather than “selected”, speaking of “community acceptance of the Preferred Alternative” rather than a more neutral “community response to”—generates positive associations in the reader’s mind. While mere connotation may be overlooked, the constant bolding and color emphasis of “Preferred Plan” draws attention to Alternative 3 throughout the Plan. These factors, and the way that the document dedicates an individual section to Alternative 3 on page 1 and a lengthy section to Alternative 3 on page 11, it seems that any reader, regardless of comprehension level,	The Proposed Plan was written in accordance with the EPA document, <i>A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents</i>, July 1999. The use of the term “Preferred Alternative” and the appropriate discussion of the Preferred Alternative are in accordance with the guidance document and with legal requirements, including in Title 40 Code of Regulations 300.430(f).

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	would come away from this Plan with Alternative 3 fixed firmly in their mind. Given the inadequacy of this document to provide an unbiased, accessible Proposed Plan for public readership, it was difficult for us to choose an alternative. However, after some additional research and much debate we would like to encourage the EPA to not accept the minimal alleviation of risk, but instead move forward with Alternative 5. Alternative 5 has been proven to be effective. A case study by Palumbo et al., entitled "Influence of nitrogen and phosphorus on the in situ bioremediation of trichloroethylene," states: "In the field, the addition of TEP+N2O to the pulsed injection of CH4 resulted in dramatic stimulation of TCE-degrading potentials observed in ground water enrichments" (1). Another set of researchers, Travis and Rosenberg, explain the process a little more simply, writing "an in situ bioremediation field demonstration was performed at the U.S. DOE's Savannah River site in 1992–1993 to remediate subsurface TCE contamination. This demonstration involved stimulating indigenous methanotrophic bacteria with injection of methane, air, and air-phase nutrients below the water table and vacuum extraction in the vadose zone" (2). This case study in Aiken, South Carolina, demonstrates that in-situ (on-site) remediation can be successful, creating optimal conditions for microbes to break down the toxic chemical solvents we've used in the past. We have surpassed the point of allowing these processes to break down naturally, because without the help of microbes biogeochemical time is too slow for Tucson citizens already ingesting contaminated water.	EPA received several comments expressing a preference for Alternative 5 and has reviewed the case studies cited in the letter. While active remediation strategies have shown to reduce concentrations of trichloroethylene (TCE) and 1,4-dioxane at localized areas of concentrated sources in subsurface groundwater, the studies do not focus on the type of widespread diffused TCE and 1,4-dioxane contamination generally found in the Area A aquifer. One source area is located at Air Force Plant 44 (AFP44), and that source area is being treated separately using technologies similar to those outlined in Alternatives 5 and 6 and is not part of the remedy outlined in the Proposed Plan. The USAF issued a ROD in August 2020, which implemented ISCO and ISB within hot spot source areas at AFP44. This remedy has significantly reduced concentrations of VOCs and 1,4-dioxane in shallow groundwater source areas. Despite the timeframes projected by the preparer of the focused feasibility study (ECG, Inc. 2016), information developed after the 2016 study indicate in-situ treatment of contamination in groundwater of the Area A plume south of Valencia Road will not address the largest existing mass of contamination in the Regional Undivided Aquifer. The active remediation strategies evaluated in Alternatives 5 and 6 are not as effective at treating large dissolved groundwater plumes with relatively low concentrations of contaminants like the one in Area A compared to smaller source areas with relatively high concentrations. Other data gaps and uncertainties associated with Alternatives 5 and 6 are outlined in Section 8 of the Focused Feasibility Study (EGC, Inc., 2016). The data gaps identified for Alternatives 5 and 6 are extensive, and it would take several more years and various studies to resolve the issues. Based in part on public comment and concern, EPA is enhancing the selected remedy (Alternative 3) by adding an additional remediation well, which will extract additional contaminated groundwater and treat it at the TARP AOP system. The installation of this additional well will assist with containing the groundwater plume and removing additional contamination from the plume.

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		In addition, for the modified remedy, the end use of treated water from TARP will include the option to discharge the water to the Tucson Water recycled water system, in addition to the current option of the drinking water distribution system. The recycled water system includes use as turf and landscape irrigation water for golf courses and parks, managed discharge to the Santa Cruz River channel as aquifer recharge and hydriparian habitat, and constructed aquifer recharge projects. EPA is tasked with selecting a remedy that is implementable and effective. As the data gaps and uncertainties identified in the Focused Feasibility Study are addressed, and if a source area within Area A is identified, EPA will re-evaluate conditions at the site and propose additional remediation activities for removing the contaminants in groundwater. This ROD Amendment will be an interim decision document that addresses containment and treatment of 1,4-dioxane, not restoration of the aquifer. The groundwater cleanup level for 1,4-dioxane will be evaluated by EPA and State of Arizona when an MCL is established, and a final ROD Amendment will address insitu groundwater addressing restoration options. In addition, EPA must also take into account extenuating factors not discussed in the case studies such as community impact from construction activities; long-term impact of additional widespread wells, pumps, equipment, and maintenance to the surrounding community; overall treatment effectiveness; long-term impact to a drinking water aquifer; cost; and city, state, and community acceptance before choosing a Preferred Alternative. In response to the final sentence of the comment, City of Tucson is providing tap water that meets the standards of the Safe Drinking Water Act and the existing and proposed cleanup standards for the TIAA Superfund Site.

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Written Comments by Gerardo Sanchez received on April 18, 2017 via email		
10	I am very concerned of this proposed plan because I have being [sic] living in the area drinking the water. I think the alternative 5 is a good start, but plans need to be created on actually cleaning the contaminated ground soil. Also plans need to be approved on rerouting the wells and aftercare for future aliments for me and my offspring as a result of this situation. I also have had my parents died of cancers that could be linked to this situation. Please keep me advised of your status concerning the cleanup, after care and results of your clean up alternatives with this situation.	EPA sympathizes with anyone experiencing health issues and understands the worry, stress, and difficulties that a family experiences when a loved one develops serious health issues. The Agency is committed to protecting human health at Superfund sites, such as TIAA. Alternative 3 has been evaluated and will be enhanced with the addition of another remediation well in the groundwater plume. The alternative would continue to provide drinking water or water for Santa Cruz River discharge and the City of Tucson's recycled water system with only a relatively small immediate impact from construction activities to install the remediation well. For additional information on Alternative 5 and the data gaps and uncertainties associated with this alternative as it relates to the groundwater contamination at Area A, please refer to Comment 9. With regard to information on health impacts in the Tucson community, please refer to Comment 2.

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Written Comments by Barbara A. Sanchez received on April 18, 2017 via email		
11	I am very concerned of this proposed plan because I have being [sic] living in the area drinking the water. I think the alternative 5 is a good start, but plans need to be created on actually cleaning the contaminated ground soil. Also plans need to be approved on rerouting the wells and aftercare for future aliments for me and my offspring as a result of this situation. I also have had my parents died of autoimmune and kidney diseases that could be linked to this situation. I am current suffering from autoimmune diseases. Please keep me advised of your status concerning the cleanup, after care and results of your clean up alternatives of this situation.	EPA sympathizes with anyone experiencing health issues and understands the worry, stress and difficulties that a family experiences when a loved one develops serious health issues. The Agency is committed to protecting human health at Superfund sites, such as TIAA. Please refer to Comments 2, 9, and 10 for additional information on health resources and alternative selections, respectively.
Written Comments by Michael List received on April 21, 2017 via email		
12	I strongly oppose the closing of the TARP. The combined TARP/AOP process (while <i>possibly</i> redundant) provides greater assurance to the citizens of Tucson that are served by this treated water.	The TARP plant is not being closed. The AOP process has been proven to be effective and efficient at treating groundwater contaminants to levels below the existing and proposed treatment standards. Only the aging packed column aeration process is being taken out of service, as its purpose is addressed by the AOP, which fully destroys contaminants.
Written Comments by Linda Shosie received on March 30, 2017 via comment card at Proposed Plan public meeting		
13	Re-route pipelines and shut down	Please see response to Comment 3.
Written Comments by Bill Jeffers received on March 30, 2017 via comment card at Proposed Plan public meeting		
14	Placards were outstanding, very clear, concise, and to the point. Very informative. Hostess is outstanding in every way!	EPA appreciates the feedback on the Proposed Plan public meeting.
Written Comments by Eduardo Quintana received on March 30, 2017 via comment card at Proposed Plan public meeting		
15	What is being done to remediate/restore the people who have been exposed to contamination?	The comment is best addressed by a public health agency. Please refer to Comment 2 for additional information on public health assessments and appropriate contact agencies.

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16	Why does the EPA charter or mandate not include the input on the health of the people exposed to contamination?	EPA's basic mission under the CERCLA law is remediate environmental contamination in order to protect human health and the environment—air, water, and land. EPA, state, local and tribal agencies work together to ensure compliance with environmental laws passed by Congress, state legislatures and tribal governments. Other agencies such as the Agency for Toxic Substances and Disease Registry (ATSDR) have responsibility for evaluating the health of individuals who may have been exposed to contamination. ATSDR is a federal public health agency within the United States Department of Health and Human Services. This agency focuses on minimizing human health risks associated with exposure to hazardous substances. In Arizona, the ADHS can help. Their mission is to promote, protect, and improve the health and wellness of individuals and communities in Arizona. In Pima County, the Pima County Health Department has a similar mission to ensure the health, safety, and well- being of the community.
Written Comments by Patricia Velasquez received on March 30, 2017 via comment card at Proposed Plan public meeting		
17	The water needs to get cleaned up. Our children are now living in the area and raising their children. We need the routine to stop so we must clean up the water ASAP so our grandkids don't have any drama due to the problem/contaminated water. The psycho [cycle] must stop clean up the water is a must.	EPA is committed to cleaning up the groundwater at the TIAA Superfund Site. Additionally, EPA is working to identify long- term solutions and a remedy for the groundwater contamination within Area A.
Written Comments by Eva Carrillo Dong received on March 30, 2017 via comment card at Proposed Plan public meeting		
18	Since my childhood, I have lost many family members and classmates to this contamination of our water. The losses have been very difficult. Just as difficult has been watching my family members and friends suffer in their daily lives with illnesses brought on by this contamination. Our quality of life, longevity in our ancestors, has all been dramatically changed. When the contamination first occurred, I expected EPA to install a process that would as quickly as possible remove the contamination from my community. I am extremely disappointed to see and hear how much of our community is still under contamination. I must insist that EPA and ADEQ choose the treatment that will clean up our water as swiftly as possible. We do not want to wait for more decades to pass regardless of cost. Our children depend on this.	EPA sympathizes with anyone experiencing health issues and understands the worry, stress, and difficulties that a family experiences when a loved one develops serious health issues. The Agency is committed to protecting human health at Superfund sites, such as TIAA. The Superfund law requires that alternatives be evaluated using all of the nine criteria explained in the Proposed Plan. For additional information on the other active treatment alternatives and a description of the enhanced Alternative 3, please refer to Comment 9.

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Written Comments by Joseph Jaramillo received on May 11, 2017 via email		
19	I will be going with choice number 5.	Thank you for your comment. For additional information on the active treatment alternatives and a description of the enhanced Alternative 3, please refer to Comment 9.
Written Comments by Georgina L. Gomez received on May 14, 2017 via email		
20	My name is Georgina L. Gomez. I have lived on the southside of Tucson AZ for 55 yrs; where a few of the wells were closed due to TCE contamination. In 1992 I was diagnosed with Lupus. In 2009 was diagnosed with two brain tumors. I had benign tumor on left side next to brain stem removed. The tumor on right side of brain stem is being monitored.	EPA sympathizes with anyone experiencing health issues and understands the worry, stress, and difficulties that a family experiences when a loved one develops serious health issues. The Agency is committed to protecting human health at Superfund sites, such as TIAA. Please refer to Comment 2 for additional information on public health assessments and appropriate contact agencies.
Written Comments by Edna San Miguel received on May 8, 2017 via email		
21	My name is Ms. Edna San Miguel and I am writing to you today to respectfully request that The United States Environmental Protection Agency extend its comment period for the Proposed Plan of the Tucson International Airport Area Superfund Site Area A, North of Los Reales Road Tucson, Arizona. I want to bring your attention the 30 day Public comment period of March 30, 2017, in which a rather rapid period of time was allotted so as to submit letters of concern and poignant questions by Tucson's concerned citizens. Am I also correct to state that this meeting took place at the El Pueblo Neighborhood Center? The EPA Proposed plan states that the Public comment period started March 22, 2017 and was ending on set date of April 21, 2017, but according to my calculations, this is an inappropriate time constraint placed upon concerned Tucson citizens for a proper response period. Our community is being rushed through your set of time constraints and was also given negative eight days whereas to respond on the matter. Am I correct to state that April 24, 2017 is the cutoff date, according to the EPA Fact sheet, and whereas community members comments and questions are to be submitted via e-mail or through the United States U.S. Postal Service, and any other delivery services as such?	EPA concurred with the request to extend the comment period. The Proposed Plan comment period was extended from April 24, 2017 to May 21, 2017. It is correct that the Public Meeting, which occurred on March 30, 2017, took place at the El Pueblo Activities Center.

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	At this time it is inevitable time constraints restricts proper community response time and should be deemed as unattainable. Respectfully please members of the United States Environmental Protection Agency, honor my request for a time extension on the matter of the Proposed Plan for the Tucson International Airport Area, Superfund Site Area A. It would be most appreciated and worry less to community.	
Written Comments by Yolanda Herrera received on May 16, 2017 via email		
22	Can you please send a PDF to all I have copied regarding the Proposed Plan/Public Meeting/Comment? I shared the hard copy I had during a tour of the TW facilities Lab/TARP/AOP Saturday 5/13/17. And for the record, I support the "preferred alternative", shutting down TARP and continuing using the AOP to remove TCE/1,4-Dioxane and continue to monitor natural attenuation of the groundwater plume so COT can continue to provide safe drinking water. The Unified Community Advisory Committee -UCAB- will continue to provide oversight and community outreach.	EPA has submitted a PDF copy of the Proposed Plan to all individuals in the email as requested. EPA appreciates the feedback from the Unified Community Advisory Committee with regards to the selection of the preferred alternative.
Written Comments by Roberto S. Jaramillo received on May 20, 2017 via email		
23	I, have read the 13 page Proposed Plan EPA has given the community to take into consideration and comment on it as well. I feel what is being recommended by EPA and other agencies is NOT what our community needs or desires. On page 10 it states on 4.Reduction of Toxicity, Mobility, and/or Volume through Treatment: Alternatives 3 and 4 are strictly Pump-and-Treat technologies, which are expected to have MINIMAL REDUCTION in toxicity, mobility, and volume of contaminants in our groundwater. Alternatives 5 and 6 could POTENTIALLY REDUCE the toxicity, mobility, and volume through source treatment by using either in situ bioremediation or in situ chemical oxidation. I, ask EPA why would they recommend and propose that Alternatives 3 and 4 be the BEST solution to consider and has MINIMAL REDUCTION in toxicity, mobility, and volume of contaminants in our groundwater. I, would ask EPA to take into consideration Alternatives 5 and 6 as these could POTENTIALLY REDUCE the toxicity, mobility, and volume of contaminants in our groundwater. I know cost is a BIG factor and when it comes to Healthy Living it should not be taken into consideration! I've lived in this community for over 60 years and have seen first what the effects of contaminated water has had on our families, friends, classmates and coworkers. It has NOT been a VERY pleasant experience. I, HOPE EPA will do what is BEST for the community.	The AOP pump-and-treat technology referred to in Alternative 3 does reduce the toxicity, mobility, and volume of the groundwater contaminants in the groundwater plume. Based in part on public comment and concern, EPA is enhancing the selected remedy (Alternative 3) by adding an additional remediation well, which will extract additional contaminated groundwater and treat it at the TARP AOP system. The installation of this additional well will assist with containing the groundwater plume and removing additional contamination from the plume. Alternatives 5 and 6 are more appropriate for addressing concentrated source areas. The USAF issued a ROD in August 2020, which implemented ISCO and ISB within hot spot source areas at AFP44. This remedy has significantly reduced concentrations of VOCs and 1,4-dioxane in shallow groundwater areas with high levels of contamination. For further information on why EPA prefers enhanced Alternative 3 over Alternatives 5 and 6, please refer to Comment 9. While cost is one component used to evaluate all the alternatives, it is neither the only nor the most important factor when EPA chooses a preferred alternative.

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Written Comments by Carmen Aguayo Touhey received on May 20, 2017 via email		
24	This email is in response to the requested public comment regarding TARP. Looking at the proposed remediation does not make me or anyone I have spoken to feel very satisfied. If we have to choose then our desire would be # 5. The first 3, qualify only as a band-aid on gangrene. I still have no idea why this as important as it is, was not publicized in a manner that would have truly gotten the word out to the public. This should have been on every free spot available as a public service on the radio. tv newspaper and whatever other methods available. I also feel that the old water pipes and ground was never cleaned, and so cleaning the water and then putting it thru the contaminated water system, that is often compromised by broken lines and the contaminated ground that surrounds it is not healthy. We need to stop going thru the motions of doing something, knowing full well is not good enough. I have spoken to many in our community that are really discouraged by the way all this had been handled. Please protect the public not the culprits of this mess. Way too many are dying and some are really ill and negating responsibility is just plain out wrong.	EPA disagrees that responsibility has been negated; the responsible parties are listed in the Proposed Plan and are being held accountable for the cleanup. With respect to outreach conducted as part of the Proposed Plan process, please refer to Comment 8. Additionally, information on the water pipes is included in Comments 1 and 3. The USAF issued a ROD in August 2020, which implemented ISCO and ISB within hot spot source areas at AFP44. This remedy has significantly reduced concentrations of VOCs and 1,4-dioxane in shallow groundwater areas with high levels of contamination. For further information on why EPA prefers enhanced Alternative 3 over Alternatives 5 and 6, please refer to Comment 9.
Written Comments by Eva Carrillo Dong received on May 21, 2017 via email		
25	Although EPA prefers number three as presented, I do not feel that this is sufficient nor will it address our needs. I prefer number 5 with the existing Pump and Treat with UV Peroxide Plus In Stu. Please take this alternative into consideration for the sake of our community and all that they have gone through already.	For further information on why EPA prefers enhanced Alternative 3 over Alternatives 5 and 6, please refer to Comment 9.
Written Comments from “Tucsonans for a Clean Environment” Environmental Justice Task Force & Concerned Southside Tucson Residents received on May 21, 2017 via email		
26	The proposed plan does nothing to contribute to the actual cleanup of the subsurface regions above our aquifer, in fact Preferred Alternative #3 is simply business as usual. We appreciate the EPA's acknowledgement of 1,4 Dioxane as a contaminant in the Superfund site, however, TCA (of which 1,4 Dioxane is a byproduct, according to the EPA) was known to be part of the slurry of contaminants discovered in the early 1980's and detailed in a 1988 EPA assessment.	Enhanced Alternative 3 includes a pump-and-treat system, installation of one new remediation well, and continues operation of the current on-site treatment plant. 1,4-dioxane is typically found in association with 1,1,1-trichloroethane (TCA); however, as documented in the 1988 ROD, TCA had only been detected twice while TCE was

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	Why was cleanup of TCA and 1,4 Dioxane not included in the 1988 ROD? Why did Tucson Water only start testing for 1,4 Dioxane in 2002? As far as we can tell the EPA failed to protect human health and the environment from the very beginning of its investigation and management of the TIAA site. Because it has taken the EPA nearly 30 years to address this contaminant and offer this proposed plan, notwithstanding the development of the treatment systems in the 1990's and 2000's and their operation to this day, we the community do not have confidence in the EPA's ability to effectively cleanup the contamination, be it TCE, DCE, trans-1,2-DCE, TCA, chloroform, 1,4 Dioxane, or any of the other number of chemicals that were illicitly dumped and ultimately contaminated our subsurface zones and aquifer.	detected 435 times. Due to the low number of detections and the concentrations that were below the cleanup standards, TCA was not identified as a site contaminant of concern. In addition to the identified chemicals of concern at the site, TCA is still sampled for, and current results can be referenced in the TARP Semi-Annual Status Reports; these reports are present at the Pima County Public Library—Valencia Branch. As documented in the Focused Remedial Investigation, 1,4-dioxane was sampled at AFP44 (an original contributing source to the groundwater contamination found in Area A) in the 1990s, but no detections were noted. An improved and more accurate analysis method was developed and subsequently allowed for a lower detection limit. Using the new analytical method, 1,4-dioxane was discovered in monitoring wells at AFP 44, the Airport Property, and at TARP in 2002. Eventually, in 2011, EPA reduced its Drinking Water Health Advisory, which prompted implementation of AOP treatment at TARP.
27	As it reads, the Proposed Plan is an all-or-nothing plan lacking specifics on each of the alternatives it offers. For instance, the specific long-term effectiveness of Alternative #5 is not mentioned under Balancing Criteria #3 Long-term Effectiveness. Rather, it is lumped together with Alternatives 3,4 and 6. <i>This is perhaps disingenuous</i>, especially because Alternative #5's "Short-Term Effectiveness" is presented <i>in detail</i> as posing short-term risks to the community and workers involved in that process. Somehow this feels forced.	The Proposed Plan is intended to be a summary of the proposed alternatives, which are originally presented in the Focused Feasibility Study. Based in part on public comment and concern, EPA will enhance Alternative 3 by installing an additional remediation well within the groundwater plume. Additional in-depth discussion of the alternatives and their application to the evaluation criteria is contained in the Focused Feasibility Study dated March 2016. This document can be found at the Pima County Public Library—Valencia Branch.
28	Also, Alternative #3 is, "Expected to have minimal reduction in toxicity, mobility, and volume of contaminants in groundwater." Whereas, Alternative #5, "Could potentially reduce the toxicity, mobility, and volume" of contaminants in the groundwater and soil through the use of in situ bioremediation. "Expected to" and "Could Potentially" are not phrases indicating confidence in either of the alternatives. How can the public be confident in voicing their opinions and suggestions if the proposed plan is deficient in assertive and balanced information? Isn't it part of the EPA's mission is that, "all parts of society -- communities, individuals, businesses, and state, local and tribal governments—have access to accurate information sufficient to effectively participate in managing human health and environmental risks?"	EPA recognizes your concern with how the evaluation of remediation technologies is described. When evaluating how processes, reactions, or methods will work in the natural environment, the expected outcome cannot be 100 percent guaranteed; therefore, the language in these documents must reflect a certain level of uncertainty. The Proposed Plan was prepared in accordance with EPA guidance documents, and the guidance requires the use of phrases such as "Expected to" and "Could Potentially" to qualify certain statements. Enhanced Alternative 3 is expected to create a moderate reduction in the toxicity, mobility, and volume of the

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	Notwithstanding the lack of confidence in the proposal language, Alternative #3 is expected to <i>have minimal reduction in toxicity, mobility, and volume of contaminants in groundwater.</i> And this is the EPA's preferred alternative?! We the people affected by this contamination are not accepting of the EPA's complacent approach to "managing" the contaminants. <i>We want the contamination cleaned up!</i>	contamination, and will continue to remove groundwater contaminants to levels that are safe for human consumption. Over time, concentrations of TCE and 1,4-dioxane have declined in Area A; thus, indicating that cleanup is occurring. To monitor the effectiveness of the preferred remedy, routine periodic monitoring of the groundwater and tap water will continue to be performed. For additional information on why enhanced Alternative 3 is preferred over Alternatives 5 and 6, please refer to Comment 9.
29	This Proposed Plan is ineffective at addressing the needs of the community to make an informed decision. It is skewed in favor of the Preferred Alternative #3 which is nothing more than business as usual, and the "cheapest" option. And it does not address the long-term sustainability of the regions subsurface zones and aquifer. This Proposed Plan is deficient in informing the public about the long-term effectiveness of any of the alternatives being considered, therefore, the plan needs to be reconsidered in light of this deficiency, modified and resubmitted to the public for comment. The long-term viability of Tucson's aquifer is paramount in this decision. The uncertainty presented in this proposed plan does not bode well for the long-term sustainability of the regional aquifer. Regardless of what other sources of water we may have access to (CAP) or how fast the aquifer is being recharged, <i>it is the only one we have.</i>	The purpose of the Proposed Plan is to evaluate all alternatives and propose the preferred alternative. Total costs for Alternative 3 are not the lowest among the alternatives, and cost is only one component used to evaluate alternatives before EPA chooses a preferred alternative. As noted in Comment 9, additional detail concerning the long-term effectiveness of the various alternatives can be referenced in the 2016 Focused Feasibility Study.
30	We would like to see an alternative that addresses the <i>actual cleanup of the contamination.</i> Perhaps a hybrid of Alternatives #3 and #5, where in situ bioremediation is piloted on a small scale to test its effectiveness. Anything short of actually cleaning up the contamination will be met with fierce opposition by the community. We do not want to go another 30 years before hearing about another contaminant and its proposed cleanup. We are understanding of the current political climate and how it may affect the EPA's ability to effectively do its job but this issue is over 30 years old and, from our perspective, so far it has not been an effort that has protected human health and the environment in the region.	Per the 1990 Consent Decree, any source areas identified will be investigated and remediated. Until a defined source (high concentration) area is identified, Alternative 5 or a similar pilot test would be premature. However, EPA is open to the conductance of pilot tests at any time in the future when a source area is identified, and an appropriate technology could be applied. As outlined in Comment 9, bioremediation is currently being utilized at AFP44 which has a concentrated source.
Written Comments from the TAA and The Boeing Company received on May 20, 2017 via email		
31	The Airport Property (including the Tucson International Airport and Three	The 1988 ROD presented the selected groundwater remedial

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	Hangars Building) is not part of TIAA Superfund Site Area A, nor is it a “covered matter” under the 1988 TARP Record of Decision (ROD) and 1991 TARP Consent Decree. EXECUTIVE SUMMARY (Page 1): The text states “TIAA Superfund Site Area A is the area north of Los Reales Road and consists of the Airport Property (which includes the Tucson International Airport and Three Hangars [sic] Building) and the Tucson Airport Remediation Project (TARP), as shown on Figure 1”. As indicated in the following excerpts from the 1988 TARP ROD and 1991 TARP Consent Decree, TIAA Superfund Site Area A is associated with the groundwater remedy for the regional aquifer located north of Los Reales Road: TARP ROD Page iii, Statement of Basis and Purpose: This decision document presents the selected groundwater remedial action for the portion of the Tucson International Airport Area Site that lies north of Los Reales Road. TARP ROD Page iii, Description of the Remedy: The selected groundwater remedy for Area A includes control of groundwater contamination through segregation of the upper and lower divided aquifers and through extraction from both the upper divided aquifer and the regional undivided aquifer (all north of Los Reales Road). TARP Consent Decree Page 4, Definitions: “Covered Matters” shall mean the Remedial Action, Oversight Costs associated with the performance of the Remedial Action and all Response Costs, including interest accrued thereon. The Airport Property (including the Tucson International Airport and Three Hangars Building) is addressed under a 1997 ROD and 1999 Soils Consent Decree. Furthermore, page 13 of the 1999 Soils Consent Decree states: “Site” shall mean the areas within the TIAA Superfund Site that were identified during the Remedial Investigation as Zones A through F and are generally depicted in their areal extent on the figure attached hereto as Appendix C. The Site does not include the Regional Aquifer or any Covered Matter, as that term is defined in the TARP (Tucson Airport Remediation Project) Consent Decree”. TAA and Boeing request that statements indicating and/or implying that the Airport Property (including the Tucson International Airport and Three Hangars Building) is part of TIAA Superfund Site Area A be removed from all TIAA Superfund Site documents.	action for the portion of TIAA Superfund Site that lies north of Los Reales Road, and included Areas A and Area B of the site “not currently addressed by the Air Force’s action.” Tucson International Airport is specifically included in the TIAA per the Site Location and Description section on Page 1. Additionally, Figure 4 of the ROD identified potential sources of groundwater contamination, and it includes the TAA Hangar Area, Runway Dump, TAA Landfill, and TAA Drainage Channels. Portions of Airport Property extend geographically over the 1,4-dioxane plume as currently identified.
32	The Proposed Plan does not “reinforce the original remedy”. Rather, the Proposed Plan contradicts the original remedy for groundwater cleanup as	The original remedy outlined in the 1988 EPA ROD as documented on page iii, is summarized as follows:

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	described in the 1988 TARP ROD and associated 1991 TARP Consent Decree. EXECUTIVE SUMMARY (Page 1): The text states <i>“Currently, the remedy for groundwater cleanup at the TIAA Superfund Site Area A was documented in an EPA Record of Decision (ROD) signed in 1988. The alternatives in this Proposed Plan add to and reinforce the original remedy...”</i>	Control groundwater contamination in the various aquifers via segregation and extraction Treat groundwater using packed-column aeration Treat groundwater to an overall cancer risk level (for all contaminants combined) of 10^{-6} which requires treatment of TCE concentrations to approximately 1.5 parts per billion. Implement reasonably available control technology for reduction of air emissions if needed Deliver treated groundwater to the municipal water distribution system The new remedy outlined in the Proposed Plan reinforces some of the components of the original remedy in bullets 1, 3, and 5 above. Based in part on public comment and concern, EPA is enhancing the selected remedy (Alternative 3) by adding an additional remediation well, which will extract additional contaminated groundwater and treat it at the TARP AOP system. The installation of this additional well will assist with containing the groundwater plume and removing additional contamination from the plume. In addition, the text of the ROD Amendment does not use the phrase “reinforces” in the description of the remedy.
32A	Dr. Hiatt’s statements regarding the remediation goals fail to distinguish between the <i>insitu</i> groundwater remediation goal and the goal for the effluent of the TARP treatment system. On March 23, 2017 TAA received a copy of a letter from M. Aycock (EPA) addressed to G. Warner (USAF) regarding “Remediation Goal for 1,4-dioxane, TIAA Superfund Site Area A ROD Amendment, Tucson, Arizona”. The purpose of the letter was <i>“to provide details about the process EPA uses to determine remediation goals at a Superfund site and how this process led EPA Region 9 to set a 0.35 micrograms per liter (µg/L) remediation goal for 1,4-dioxane in contaminated groundwater at Area A of the TIAA site”</i>. Attached to the letter was a “remediation goal analysis” prepared by Dr. Gerald Hiatt of EPA Region 9. Below is an excerpt from Dr. Hiatt’s analysis: <i>The remediation goal was set to be protective at a 1×10^{-6} excess lifetime cancer risk. This determination was made to be consistent with a precedent for the site established</i>	The ROD documents that the EPA’s selected target treatment level for 1,4-dioxane is 0.35 µg/L in drinking water served to the public. This ROD Amendment will be an interim decision document that addresses containment and treatment of 1,4-dioxane, not restoration of the aquifer. EPA is not establishing an in situ groundwater cleanup level at this time. The groundwater cleanup level for 1,4-dioxane will be evaluated by EPA and State of Arizona when an MCL is established, and a final ROD Amendment will address insitu groundwater.

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	<i>in the 1988 ROD addressing contamination north of Los Reales Road.</i> The above statement from Dr. Hiatt's analysis is incorrect. The treatment goal of groundwater leaving the TARP treatment system and entering the Tucson Water potable water distribution system was set at 1.5 micrograms per liter (µg/l) corresponding to a 1x10⁻⁶ excess lifetime cancer risk. However, the <i>insitu</i> groundwater remediation goal established in the 1988 ROD was not set to a 1x10⁻⁶ excess lifetime cancer risk. Rather, the <i>insitu</i> groundwater remediation goal was set at 5 µg/l corresponding to the MCL for TCE. The distinction between an <i>insitu</i> groundwater remediation goal and a TARP treatment system goal is clearly explained in the follow excerpt from the 1991 TARP Consent Decree, Section V. Obligations for the Remedial Action: <i>Notwithstanding any approvals which may be granted by the EPA or other governmental entities, the Settling Parties shall remain liable for attainment of each of the performance objectives set forth in the ROD. Those objectives are as follows:</i> <i>Control Contaminant Migration. To control the migration of groundwater contamination at the Site by extracting all groundwater in Area A that contains volatile organic compounds (VOCs) at levels above their respective MCLs. Groundwater shall be extracted at such locations and rates as is necessary to prevent groundwater containing VOCs at concentrations greater than MCLs within Area A from migrating beyond the area of capture of the well field designed as part of the Remedial Action.</i> <i>Aquifer Remediation. To restore the aquifer water quality in Area A by reducing chemical contaminant concentrations in Area A to no more than the MCLs.</i> <i>Treatment of Extracted Groundwater. To treat extracted groundwater with packed-column aeration to a TCE concentration not to exceed 1.5 micrograms per liter (parts per billion), a level that EPA believes will achieve an overall excess cancer risk level of 1X10⁻⁶ for chemical contaminants in the treated water.</i> The above excerpts from the 1991 TARP Consent Decree clearly differentiate between the TCE <i>insitu</i> groundwater remediation goal of 5.0 µg/l (i.e., the MCL for TCE) and the TCE TARP treatment system goal of 1.5 µg/l. By setting the <i>insitu</i> groundwater DX remediation goal equal to the TARP treatment system goal, the Proposed Plan is inconsistent with, and contradicts the 1988 TARP ROD. The Final Unified Focused Human Health Risk Assessment for 1,4-Dioxane North of Los Reales Road, Tucson International Airport Area Superfund Site Area A, Tucson Arizona (EPA and EGC, 2015) repeats the same error as described above when it states:	

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	<i>The 1988 ROD set a risk-based remediation goal for cleanup of the groundwater north of Los Reales Road and supplying the TARP plant which feeds the public water system for the City of Tucson.</i> The 1988 ROD set a risk-based TCE treatment system goal of 1.5 µg/l for TARP effluent that feeds the City of Tucson public water system. However, the 1988 ROD did not set a risk-based <i>insitu</i> groundwater remediation goal for TCE. Rather, the 1988 ROD adopted the TCE MCL of 5 µg/l for the remediation goal for <i>insitu</i> groundwater. TAA and Boeing request the Agencies 1) acknowledge that setting the DX <i>insitu</i> groundwater remediation goal equal to the DX TARP treatment system goal is inconsistent with, and contradicts the 1988 ROD and 1991 TARP Consent Decree, and 2) revise the Proposed Plan and associated risk assessments to be consistent with the 1988 ROD and 1991 TARP Consent Decree.	
32B	The <i>insitu</i> groundwater remediation goal proposed in the Proposed Plan is inconsistent with and contradicts the 1988 TARP ROD and 1991 TARP Consent Decree. The Revised Limited Risk Assessment for 1,4-Dioxane and Trichloroethylene in Groundwater at the Tucson International Airport Area Superfund Site (EPA, 2015) indicates the excess lifetime cancer risk (ELCR) corresponds to TCE concentrations in drinking water as follows: TCE concentration of 50 µg/l equates to a ELCR of 1X10⁻⁴, TCE concentration of 5.0 µg/l equates to a ELCR of 1X10⁻⁵, TCE concentration of 0.5 µg/l equates to a ELCR of 1X10⁻⁶ Therefore, the <i>insitu</i> groundwater remediation goal of 5.0 µg/l established for TCE in the 1988 TARP ROD and 1991 TARP Consent Decree corresponds to a ELCR of 1X10⁻⁵. TAA and Boeing request the Agencies 1) acknowledge that setting the DX <i>insitu</i> groundwater remediation goal equal to an ELCR of 1X10⁻⁶ is inconsistent with and contradicts the 1988 ROD and 1991 TARP Consent Decree, and 2) revise the Proposed Plan and associated risk assessments to be consistent with the 1988 TARP ROD and 1991 TARP Consent Decree.	See response to Comment 32A.
32C	The Risk Assessments referenced in the Proposed Plan greatly overestimate the actual risks associated with TIAA Superfund Site groundwater contaminants, and indicate the proposed <i>insitu</i> groundwater remediation cleanup goals are not	The risk assessments referenced in the Proposed Plan follow standard Superfund risk assessment guidance, are consistent with risk assessments typical for Superfund sites nationwide,

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	realistic or achievable. The above-referenced "remediation goal analysis" prepared by Dr. Gerald Hiatt of EPA Region 9 states: <i>If no federal or state MCL is available for identification as an ARAR-based remediation goal, the NCP defines a health protective remediation goal for carcinogens thusly: "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 10-4 and 10-6 ... The 10-6 risk level shall be used as the point of departure for determining remediation goals for alternatives when ARARs are not available ..."</i> The following is an expanded excerpt from the NCP: <i>Final remediation goals will be determined when the remedy is selected. Remediation goals shall establish acceptable exposure levels that are protective of human health and the environment and shall be developed by considering the following:</i> <i>Applicable or relevant and appropriate requirements under federal environmental or state environmental or facility siting laws, if available, and the following factors:</i> <i>(1) For systemic toxicants, acceptable exposure levels shall represent concentration levels to which the human population, including sensitive subgroups, may be exposed without adverse effect during a lifetime or part of a lifetime, incorporating an adequate margin of safety;</i> <i>(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 10-4 and 10-6 using information on the relationship between dose and response. The 10-6 risk level shall be used as the point of departure for determining remediation goals for alternatives when ARARs are not available or are not sufficiently protective because of the presence of multiple contaminants at a site or multiple pathways of exposure;</i> <i>(3) Factors related to technical limitations such as detection/quantification limits for contaminants;</i> <i>(4) Factors related to uncertainty; and</i> <i>(5) Other pertinent information.</i> The expanded excerpt clearly indicates the 10-6 is the conservative point of departure prior to considering other factors that may move the acceptable exposure levels away	and are based on actual groundwater contaminant concentration data collected at the site. EPA's target treatment level for 1,4-dioxane in treated water is consistent with the National Contingency Plan's guidance to use the 10⁻⁶ risk level as a point of departure when no Applicable or Relevant and Appropriate Requirement is available. Therefore, the risk assessments will not be revised to modify the risk scenarios. See also response to Comment 32A.

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	from 10-6 and toward 10-4 ELCR. “Other pertinent information” includes data indicating the proposed cleanup levels are achievable. Operational data exist that show the TARP treatment system can remove DX from extracted groundwater to concentrations that meet the 10-6 ELCR. However, EPA has not provided data that show a 10-6 <i>insitu</i> groundwater cleanup level is achievable. In fact, the Revised Limited Risk Assessment for 1,4-Dioxane and Trichloroethylene for the Groundwater at the Tucson International Superfund Site (EPA, 2015) calculates risks based on the assumption that the DX and TCE groundwater concentrations remain constant indefinitely (i.e., the concentrations never decrease). The following is an excerpt from the Revised Limited Risk Assessment for 1,4-Dioxane and Trichloroethylene for the Groundwater at the Tucson International Superfund Site (EPA, 2015): <i>This limited risk assessment does not rely on groundwater modeling to predict future concentrations at the various points of exposure—developing a groundwater model sufficiently robust to make such predictions at the site has proven a significant challenge. Rather, by using groundwater concentrations from a limited period of sampling and analysis, the risk assessment inherently assumes the EPCs (exposure point concentrations) will remain constant over the exposure periods assessed herein.</i> By assuming the contaminant concentrations never decrease, the risk assessment 1) greatly overestimates the actual risks associated with TIAA Superfund Site groundwater contaminants, and 2) indicates the proposed <i>insitu</i> groundwater remediation cleanup goals are not realistic or achievable. TAA and Boeing request the Agencies 1) revise the TARP risk assessments and evaluate risks based on realistic conditions and 2) select <i>insitu</i> groundwater cleanup standards that are achievable.	
32D	The <i>insitu</i> groundwater remediation goal proposed in the Proposed Plan was derived in a manner inconsistent with the process for establishing enforceable groundwater remediation goals. The above-referenced “remediation goal analysis” prepared by Dr. Gerald Hiatt of EPA Region 9 states: <i>Taking these 2 factors into consideration, the Region arrived at a proposed remediation goal for 1,4-dioxane of 0.35 micrograms per liter (µg/L). The 0.35 µg/L concentration for 1,4-dioxane is the 10-6 excess lifetime cancer risk (ELCR level specified in the Integrated Risk Information System (IRIS) file for lifetime (70 year) consumption of drinking water containing 1,4-dioxane. It is also the EPA Office of Water Health Advisory value for a lifetime 10-6 ELCR (see 2012 Edition of Drinking</i>	See responses to Comment 32C and 32A.

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	<i>Water Standards and Health Advisories published by Office of Water, but note that the value in the table is for a 10-4 risk and therefore must be divided by 100 for the 10-6 value).</i> As shown in the attached Table 5 Chemical-Specific ARARs for VOC-Contaminated Regional Groundwater (see Attachment A), the EPA IRIS numbers, EPA Office of Water Health Advisory Values, and EPA Region 9 Regional Screening Levels for DX are not enforceable aquifer remediation standards. MCLs established through the Safe Drinking Water Act (SDWA) are enforceable groundwater remediation standards. The process of establishing MCLs includes identifying the 10-6 risk level. Other pertinent information is then incorporated prior to establishing an enforceable cleanup standard. TAA and Boeing request the Agencies follow established processes in accordance with the Safe Drinking Water Act and EPA guidance/policies; move beyond the initial 10-6 point of departure; and incorporate other pertinent information prior to selecting <i>insitu</i> aquifer cleanup standards for the TARP regional aquifer.	
32E	Risks at the TIAA Superfund Site should not be calculated based on a 70- year lifetime exposure. The above-referenced “remediation goal analysis” prepared by Dr. Gerald Hiatt of EPA Region 9 states: <i>The remediation goal was set to be protective for a 70 year Reasonable Maximum Exposure (RME) residential exposure scenario. At most Superfund sites, remediation goals for residential exposures (such as drinking water consumption) are based on levels protective for a 26 to 30 year exposure period (this is because most people are assumed to move away from the site within that timeframe and hence are no longer exposed). However, at Tucson, the Region focused on a lifetime (70 year) exposure assumption for 2 reasons: (i) demographic information indicates that people in Southside Tucson, the most impacted community, move less frequently (at Unified Community Advisory Board meetings we have heard of/from a number of lifetime residents) and (ii) since the treated water is being served via the Tucson Water distribution system, an individual may consume the same water even though he/she moves to a different location within the city (Unified Focused Human Health Risk Assessment, EPA/Air Force Civil Engineer Center, 2015).</i> The above statement is incorrect and misleading. It is an established fact that the treated TARP effluent is not served to residents in Southside Tucson. Rather, the treated TARP effluent is served to a well-defined area in north and northwest Tucson. Therefore, “demographic information indicating people in the Southside Tucson move	Superfund risk assessment guidance provides the option to use site-specific exposure assumptions, including exposure duration, in assessing risks and setting remediation goals for contaminants at a Superfund site. In the present case, EPA determined that 70 years is an appropriate site-specific exposure duration assumption. Therefore, the Proposed Plan and risk assessments will not be revised to modify the lifetime exposure scenario.

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	less frequently” is irrelevant for TIAA Superfund Site Area A risk assessment purposes. In addition, there are no demographic data indicating the people in north and northwest Tucson do not move away from the these areas within a 26 to 30 year timeframe. TAA and Boeing request the Agencies 1) acknowledge that calculating risks based on a 70-year lifetime exposure in not applicable to the TIAA Superfund Site, and 2) revise the Proposed Plan and associated risk assessments and base risks on standard 30 lifetime exposure data.	
33	The March 2016 Focused Remedial Investigation/Feasibility Study for 1,4- Dioxane North of Los Reales Road (FRI/FS) contains errors, inconsistencies, omissions, and scientifically unsupported interpretations and conclusions. The FRI/FS, in its current state, is 1) unsubstantiated and thereby fundamentally flawed, and 2) unfit to serve as the basis for the Proposed Plan, the proposed TARP ROD Amendment, or the proposed TARP Consent Decree modifications. EPA ANNOUNCES PROPOSED PLAN (Page 3): The text states “<i>This Proposed Plan summarizes the information that is presented in detail in the Focused Remedial Investigation/Feasibility Study (RI/FS) completed by EGC, Inc. on behalf of the USAF in 2016, and other documents in the TIAA Superfund Site Administrative Record File</i>”. Below is a timeline associated with the FRI/FS: 2008—2016: The United States Air Force (USAF) conducted investigatory actions, culminating in the preparation of the Focused Remedial Investigation and Feasibility Study for 1,4-Dioxane North of Los Reales Road. Feb. 2016: In letter from M. Aycock (EPA) addressed to G. Warner (USAF) dated February 3, 2016, EPA states that “the Agencies (EPA and Arizona Department of Environmental Quality [ADEQ]) concur that the AF (Air Force) has addressed all the comments and revised the text in accordance with the agreed upon responses. Please finalize these documents.” May 2016: TAA and the Airport Property Settling Parties (SP) are given an opportunity to review and provide comments on the FRI/FS. September 2, 2016: TAA submits comments to EPA on the FRI/FS. November 22, 2016: The Agencies (EPA and ADEQ) provide responses to TAA comments on the FRI/FS. Note: Although TAA FRI/FS comments were submitted directly to EPA on September 2, 2016, EPA’s November 22, 2016 response to comments combined TAA’s comments with comments submitted to EPA separately by the SP on September 20, 2016.	EPA does not agree with the TAA and Boeing interpretation of the data and information in the Focused Remedial Investigation/Feasibility Study (Focused RI/FS); therefore, disagrees that the document is fundamentally flawed or unfit to serve as the basis for the Proposed Plan, ROD Amendment, or Consent Decree modifications. EPA’s responses to the TAA comments to the Focused RI/FS were grouped where a common response applied for clarity purposes. EPA has convened multiple joint meetings between the Air Force and TAA with ADEQ and contractor support to develop a consensus on the nature and extent of groundwater contamination and the Conceptual Site Model in the vicinity of Los Reales Road. The Air Force is evaluating the need for additional groundwater monitoring and/or extraction wells south of Los Reales Road and has made significant upgrades to the groundwater treatment plant at AFP 44 to further enable plume capture. The TAA has been provided responses to the comments to the Focused RI/FS received in September 2016.

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	December 19, 2016: A teleconference was held with the TAA, SP, EPA, ADEQ, USAF, and respective consultants to discuss the FRI/FS and associated comments. TAA and SP comments submitted to EPA on September 2, 2016 and September 20, 2016, respectively, identified numerous deficiencies in the FRI/FS including 1) unsupported assumptions that the existing groundwater remediation system located at U.S. Air Force Plant 44 (AFP-44) is sufficiently controlling DX source areas and thereby preventing DX migration into the aquifer located north of Los Reales Road, 2) the unsubstantiated claim that the Airport Property is a primary source of DX), 3) inadequate characterization of DX source areas including the Inactive Drainage Channel Disposal Pits (DP-03) and Sludge Drying Beds (WP-05) located on AFP-44 property, 4) lack of fate and transport analysis of DX re-injected into wells (with gravel/filter packs extending within 20 feet of land surface) adjacent to Airport Property from 1987 to 2004. In the Agencies November 22, 2016 response to TAA comments, the Agencies agreed with TAA that "...the Airport Property has not been identified by the Agencies as a primary source of DX to the regional aquifer" and "...AFP-44 is a primary source of DX in the regional aquifer" thus concurring that the Airport Property should not be referred to as a primary DX source area. As noted above, a teleconference was scheduled for December 19, 2016 to provide an opportunity for TAA, SP, EPA, ADEQ, USAF, and EGC (USAF's consultant and author of the FRI/FS) to discuss the FRI/FS. However, during the teleconference, TAA and the SP were informed by the USAF and EPA that EGC was no longer on contract with the USAF and were therefore unavailable to participate in the teleconference, discuss investigative data, and explain FRI/FS claims and conclusions. Consequently, the FRI/FS accepted as final by EPA on February 3, 2016 continues to contain significant errors and inaccuracies including but not limited to: Unsupported assumptions that the AFP-44 groundwater remediation system is sufficiently controlling DX source areas and thereby preventing DX migration into the aquifer located north of Los Reales Road. Unsubstantiated claims that the Airport Property is a primary source of DX. No evaluation of the fate and transport of DX re-injected into wells (with gravel/filter packs extending within 20 feet of land surface) adjacent to Airport Property from 1987 to 2004. Inaccurate plume maps.	

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	Inadequate characterization of DX source areas including the Inactive Drainage Channel Disposal Pits (DP-03) and Sludge Drying Beds (WP-05) located on AFP-44 property. Errors, inconsistencies, omissions, and scientifically unsupported interpretations and conclusions. As noted above, TAA submitted comments on the FRI/FS to EPA on September 2, 2016. Although TAA submitted 44 comments, the Agencies November 22, 2016 response states: <i>Review of the submittals indicates that the comments belong to one of two general categories: Conceptual Site Model and Nature and Extent of Contamination issues, and Remedy Selection issues.</i> Based on this gross oversimplification, the Agencies responded to multiple TAA comments with a single response. The following is an excerpt from the Agencies response to TAA comments 1, 2, 3, 4, 5, 14, 19, 20, 22, 26, 30, and 39: <i>The Air Force has completed the Fall 2016 semi-annual sampling event and a report with the results of that sampling will be available in December 2016. The results will show that the Air Force has begun to control the migration of DX north of Los Reales Road, and the Agencies viewed figures during the October 2016 Air Force quarterly meeting that showed DX was being contained.</i> As described below, US Geological Survey (USGS) DX groundwater sampling results clearly show the AFP-44 groundwater treatment system and network of extraction wells have not, and are not, preventing DX from migrating to the aquifer located north of Los Reales Road. The following is an excerpt from the Agencies response to TAA comments 6, 7, 8, 9, 11, 12, 13, 15, 16, 17, 18, 25, and 38: <i>The Source Area comments will be incorporated as appropriate into the ROD Amendment and PP; the documents will be revised to indicate that AFP 44 was a primary source of DX in the Regional Aquifer and plume containment on AFP 44 property is addressing that source.</i> The Proposed Plan does not indicate that 1) AFP-44 was a primary source of DX in the Regional Aquifer, or 2) plume containment on AFP-44 property is addressing that source.	

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	In the above referenced November 22, 2016 letter responding to TAA and SP comments on the FRI/FS, the Agencies state: <i>The Agencies have determined that the Final FRI/FFS (sic) documents will not be revised; rather, the TAA and SP comments will be addressed and incorporated as appropriate in revised Record of Decision (ROD) Amendment and Proposed Plan (PP) documents prior to those documents being submitted to the public for review.</i> As documented by the above excerpts, the Proposed Plan does not appropriately address or incorporate TAA and SP comments on the FRI/FS. The Agencies may believe they have adequately responded to and addressed TAA and SP comments on the FRI/FS in the Agencies' November 22, 2016 letter. However, as noted above, EGC are the subject matter experts who compiled, evaluated, and drew conclusions based on the data provided in the FRI/FS. Because the Agencies did not perform the investigative work or prepare the resulting FRI/FS, they cannot with authority respond to TAA and SP comments on behalf of EGC. TAA and Boeing hereby reassert requests that EGC be made available to respond to TAA and SP comments, concerns, and questions. Until EGC subject matter experts explain how they reached their conclusions and provide the data upon which the conclusion were made, the FRI/FS should be considered unsubstantiated and thereby fundamentally flawed. Consequently, the FRI/FS in its current state, is unfit serve as the basis for the Proposed Plan, the proposed TARP ROD Amendment, or the proposed TARP Consent Decree modifications.	
34	The aquifer in TIAA Superfund Site Area A north of Los Reales Road is being contaminated by DX-impacted groundwater from source areas located south of Los Reales Road. SITE BACKGROUND AND CHARACTERISTICS (Page 3): The text states "<i>The groundwater plumes associated with Area B and Air Force Plant 44 are not summarized as part of this Proposed Plan and are being addressed in separate decision documents</i>". Although the groundwater plumes associated with AFP-44 are addressed in separate decision documents, the Proposed Plan should, in fact, address the DX entering the TIAA Superfund Site Area A, from the aquifer south of Los Reales Road. The 2017 USGS DX groundwater sampling results clearly show DX contamination migrating from the aquifer south of Los Reales Road into the TIAA Superfund Site Area A north of Los Reales Road (see Attachment B). In fact, water quality data collected since 2007 from monitor well WR-075S show movement of DX at concentrations one to two orders of	Historical site data shows that higher levels of contaminants migrated into Area A at some time in the past; however, there is historical information, which documents the use of TCA in other locations within Area A. One of the breakdown products of TCA is 1,4-dioxane.

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	magnitude greater than EPA's proposed in situ aquifer cleanup level of 0.35 micrograms per liter (µg/l) from the aquifer south of Los Reales Road into the TIAA Superfund Site Area A north of Los Reales Road. In the above-referenced November 22, 2016 response to comments, the Agencies state "AFP-44 plume containment is being achieved". However, water quality data clearly show wide-spread movement of DX at concentrations well above EPA's proposed in situ aquifer cleanup level of 0.35 µg/l, from the aquifer south of Los Reales Road into the TIAA Superfund Site Area A north of Los Reales Road (Attachment B). The Agencies' claim that "AFP-44 plume containment is being achieved" is contradicted by water quality data. TAA and Boeing request the Agencies acknowledge and address the ongoing contamination of the aquifer in TIAA Superfund Site Area A north of Los Reales Road by DX-impacted groundwater and source areas located south of Los Reales Road.	
35	The Proposed Plan is proposing to obligate the TARP Responsible Parties north of Los Reales Road to remediate <i>insitu</i> groundwater and contain DX in the aquifer north of Los Reales Road, while the USAF is not required to remediate <i>insitu</i> groundwater or contain the DX present in the aquifer south of Los Reales Road (i.e., the Source Area for DX found in the regional aquifer). SITE BACKGROUND AND CHARACTERISTICS (Page 3): The text states "<i>The groundwater plumes associated with Area B and Air Force Plant 44 are not summarized as part of this Proposed Plan and are being addressed in separate decision documents</i>". On July 13, 2007, EPA issued an administrative order directing the USAF to install an Advanced Oxidation Process (AOP) system to treat DX in extracted groundwater. The administrative order's Scope of Work (SOW) established the following Groundwater Treatment AOP Performance Standard: <i>Treated groundwater at the site shall be reinjected in to the regional aquifer. The modified AOP groundwater treatment system will have removal efficiency of 90%, but not to discharge more the 3 ppb (parts per billion or µg/l) DX into the regional aquifer.</i> Although the administrative order and associated SOW directed the USAF to treat DX to a concentration no greater than 3 µg/l, the administrative order and associated SOW did not direct the USAF to remediate the in situ aquifer. Consequently, the USAF is not currently obligated to prevent DX, at any concentration, from migrating from the aquifer south of Los Reales Road into the TIAA Superfund Site Area A aquifer north of Los Reales Road.	As noted in the response to Comment 32A, the groundwater cleanup level for 1,4-dioxane will be evaluated by EPA and the State of Arizona when an MCL is established.

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	TAA and Boeing request the Agencies explain why they are proposing to obligate the TARP Responsible Parties north of Los Reales Road to remediate <i>insitu</i> groundwater and contain DX in the aquifer north of Los Reales Road, when the USAF is not required to remediate <i>insitu</i> groundwater or contain the DX present in the aquifer south of Los Reales Road (i.e., the Source Area for DX found in the regional aquifer).	
36	The FRI/FS and Proposed Plan do not include alternatives that adequately address the ongoing DX contamination emanating from the aquifer south of Los Reales Road into the TIAA Superfund Site Area A aquifer north of Los Reales Road. SUMMARY OF REMEDIAL ALTERNATIVES (Page 6). The text states “EPA developed remedial alternatives to achieve remediation of groundwater to the cleanup levels identified in Table 1, as summarized below. A more detailed evaluation of the alternatives is included in the <i>Focused RI/FS</i>.” TAA and Boeing request that the FRI/FS and Proposed Plan be revised to include an alternative that adequately addresses the ongoing DX contamination (at concentrations greater than EPA’s proposed in situ aquifer cleanup standard of 0.35 µg/l) emanating from the aquifer south of Los Reales Road into the TIAA Superfund Site Area A aquifer north of Los Reales Road.	It is correct that the Focused RI/FS and Proposed Plan do not include alternatives that address contamination south of Los Reales Road because that part of the site is the responsibility of the Air Force. The cleanup south of Los Reales Road is addressed under the Air Force decision documents. Please see response to Comments 34 and 35 above. The Air Force completed a Feasibility Study for the cleanup of the regional groundwater south of Los Reales Road in 2017, and a recent Proposed Plan was reviewed by EPA and ADEQ that covered the evaluation of alternatives for continuing to clean up source areas on AFP44 and to control and cleanup up the regional groundwater plume south of Los Reales Road.
37	The Preferred Alternative identified in the Proposed Plan does not meet Evaluation Criteria for Superfund Remedial Alternatives. EVALUATION OF ALTERNATIVES (Page 9). The text states “<i>This section of the Proposed Plan profiles the relative performance of each alternative against the nine criteria, noting how each compares to the other options under consideration. The “Detailed Analysis of Alternatives” is presented in the 2016 Focused RI/FS.</i>” There are no federal or state ARARs for DX. Therefore, the Proposed Plan needs to be revised to indicate that the Threshold Criteria “Compliance with Federal and State Applicable or Relevant and Appropriate Requirements” is not applicable for DX. The Preferred Alternative identified in the Proposed Plan is not effective in the long-term due to the lack of treatment and containment of DX contamination (at concentrations greater than EPA’s proposed in situ aquifer cleanup standard of 0.35 µg/l) emanating from the aquifer south of Los Reales Road into the TIAA Superfund Site Area A aquifer north of Los Reales Road. In addition, as noted above, the Revised	There is no established MCL for 1,4-dioxane; however, the target treatment level has been established by EPA for treated groundwater. A groundwater cleanup level for 1,4-dioxane will be established when an MCL is adopted by the State of Arizona or EPA. The Preferred Alternative is effective in the long-term because it contains the plume north of Los Reales Road and is reducing concentrations of TCE and 1,4-dioxane. Please see response to Comment 34 regarding contamination south of Los Reales Road. Please see response to Comment 23 regarding reduction of toxicity, mobility, and/or volume and contamination south of Los Reales Road. Please see response to Comment 34 regarding calculation of costs as it relates to contamination south of Los Reales Road.

Comment No.	Comment	Response
	Limited Risk Assessment for 1,4-Dioxane and Trichloroethylene for the Groundwater at the Tucson International Superfund Site (EPA, 2015) assumes the DX and TCE groundwater concentrations remain constant indefinitely. This indicates the <i>insitu</i> aquifer cleanup standards identified in the Proposed Plan are not achievable. Consequently, the Preferred Alternative identified in the Proposed Plan does not meet the Balancing Criteria “Long-Term Effectiveness.” The Preferred Alternative identified in the Proposed Plan does not reduce the toxicity, mobility, and/or volume due to the lack of treatment and containment of DX contamination (at concentrations greater than EPA’s proposed in situ aquifer cleanup standard of 0.35 µg/l) emanating from the aquifer south of Los Reales Road into the TIAA Superfund Site Area A aquifer north of Los Reales Road. In addition, as noted above, the Revised Limited Risk Assessment for 1,4-Dioxane and Trichloroethylene for the Groundwater at the Tucson International Superfund Site (EPA, 2015) assumes the DX and TCE groundwater concentrations remain constant indefinitely. This indicates the <i>insitu</i> aquifer cleanup standards identified in the Proposed Plan are not achievable. Consequently, the Preferred Alternative identified in the Proposed Plan does not meet the Balancing Criteria “Reduction of Toxicity, Mobility, and/or Volume through Treatment.” Costs cannot be estimated for the Preferred Alternative identified in the Proposed Plan due to the ongoing DX contamination (at concentrations greater than EPA’s proposed insitu aquifer cleanup standard of 0.35 µg/l) emanating from the aquifer south of Los Reales Road into the TIAA Superfund Site Area A aquifer north of Los Reales Road. In addition, as noted above, the Revised Limited Risk Assessment for 1,4-Dioxane and Trichloroethylene for the Groundwater at the Tucson International Superfund Site (EPA, 2015) assumes the DX and TCE groundwater concentrations remain constant indefinitely. However, cost estimates in the Proposed Plan and FRI/FS are based on a finite 30 year aquifer cleanup timeframe. Cost cannot be estimated until 1) the USAF is obligated to contain DX in the aquifer south of Los Reales Road, and 2) EPA selects an insitu aquifer cleanup standard that is achievable. Consequently, the Preferred Alternative identified in the Proposed Plan does not meet the Balancing Criteria “Cost.” TAA and Boeing request that the FRI/FS and Proposed Plan be revised to include a preferred alternative that meets all nine Evaluation Criteria for Superfund Remedial Alternatives.	Accordingly, the Focused RI/FS does not require revision to address the alternative evaluations. The new enhanced Alternative 3 is summarized in this responsiveness summary and recorded in greater detail in the ROD Amendment.

Comment No.	Comment	Response
Written Comments from the Sierra Club Rincon Group received on May 25, 2017 via email		
38	The Sierra Club Rincon Group strongly recommends that the Environmental Protection Agency adopt Alternative 6 or Alternative 5 for cleaning 1,4-dioxane and other toxic solvents from groundwater in the Tucson International Airport Area Superfund Site. While these alternatives are the most expensive initially of the six the agency suggests for this Superfund Site, they would clean up the contamination much more quickly than the other alternatives and thus are likely to save money in the long run. The Sierra Club Rincon Group has more than 4,000 members in Tucson and Pima, Santa Cruz and Cochise counties. We are concerned about all aspects of our physical environment, including the disastrous contamination of ground water on Tucson's southside, where many thousands of people over the years have suffered or died prematurely as a result of their exposure to this toxic pollution. Available information about the cleanup methods proposed in the EPA's six alternatives indicates that in situ bioremediation and in situ chemical oxidation would clean the contamination more swiftly than the preferred alternative, Existing Pump and Treat with UV Peroxide, which is likely to require additional decades of operation to complete the task. In contrast, information about alternatives 5 and 6 indicate they could accomplish the contamination clean up in just a few years. And the literature states the EPA and other agencies and responsible parties are employing these two cleanup methods at numerous contamination sites, many of them Superfund sites, so they are viable and affordable. The folks whose health is impacted have been exposed to this contaminated water via ingestion, bathing and the operation of evaporative coolers for many decades already. They deserve the swiftest relief available. We implore the EPA to select Alternative 6 or Alternative 5 when it makes a final decision on how to proceed with cleaning this Superfund site.	EPA appreciates the input from the Sierra Club. Please refer to Comment 9 for additional information on Alternatives 5 and 6.

Comment No.	Comment	Response
Spoken Comments by Ms. Yolanda Herrera, Community Co-Chair of the Unified Community Advisory Board (UCAB) for the TIAA Superfund Site at the public meeting held on March 30, 2017		
39	Ms. Herrera, current Co-Chair and a member since 1995 of the UCAB, recommends that the United States Environmental Protection Agency adopt Alternative 3: Enhanced Existing Pump-and-Treat System with UV-Peroxide Plus Long-Term Monitoring and Institutional Controls for cleaning 1,4-dioxane and other toxic solvents from groundwater in the Tucson International Airport Area Superfund Site.	EPA appreciates the input from Ms.Herrera and her support for Alternative 3: Enhanced Existing Pump-and-Treat System with UV- Peroxide Plus Long-Term Monitoring and ICs (EPA's Preferred Alternative).

Comment No.	Comment	Response
Written Comments from the City of Tucson Water Department received on June 8, 2017 via email		
40	Full text of letter received from City of Tucson Water Department: June 8, 2017 Ms. Mary T. Aycock Remedial Project Manager United States Environmental Protection Agency, Region IX 7 5 Hawthorne Street San Francisco, CA 94105 Re: Proposed Plan, Tucson International Airport Area Superfund Site Area A - North of Los Reales Road (U.S. EPA, October 2016) Dear Ms. Aycock: The City of Tucson provided comments to EPA on the draft Proposed Plan via email on September 9, 2016. Accordingly, the City did not submit additional feedback during the public comment period for the referenced document. We would, however, like to reiterate our previously communicated support for EPA's adoption of Alternative 3 - <i>Existing Pump and Treat System (Status Quo) with Ultraviolet (UV)-Peroxide plus Monitored Natural Attenuation (MNA)</i> for remediation of volatile organic compounds (VOCs) and 1,4-dioxane in groundwater of Area A. As previously indicated in our email comments, Alternative 3 has been in use since early 2014 and has proven to be protective of human health and the environment. The City agrees with EPA's assessment resulting in elimination of Alternatives 1, 2, 4, 5, and 6. We also previously expressed specific concerns regarding use of the additional technologies included in Alternative 5 - <i>Pump and Treat with UV-Peroxide plus In-situ Bioremediation (ISB)</i> and Alternative 6 - <i>Pump and Treat with UV-Peroxide plus In-situ Chemical Oxidation (ISCO)</i>. Both of those alternatives would include construction of over 150 injection wells and introduction of chemical agents into the regional potable aquifer. Tucson Water is familiar with the use of ISB and ISCO approaches to remediating groundwater impacted by high concentrations of VOCs in perched groundwater and shallow aquifers as a strategy to control the source of contamination to potable groundwater resources. However, we are not aware of projects using these approaches to remediate large, diffuse VOC plumes in aquifers serving as active sources of potable water to the public. There is a large degree of uncertainty in the impact to future groundwater quality in Area A north of Los Reales Road associated with the injection of chemical agents into the regional aquifer. Additionally, there is uncertainty on future aquifer water levels as Tucson Water continues to reduce groundwater pumpage. Could this "Re-Wet" the Vadose Zone and mobilize these injected chemicals? Site-specific pilot studies would	EPA appreciates the input from the City of Tucson and the support for Alternative 3: Enhanced Existing Pump-and-Treat System with UV- Peroxide Plus Long-Term Monitoring and ICs (EPA's Preferred Alternative).

Comment No.	Comment	Response
	be required to determine the effectiveness of in-situ approaches for remediation of relatively low levels of VOCs in groundwater and the potential for mobilization of contaminants from soil. In addition, Alternatives 5 and 6 would have a large impact on the local community due to private land acquisition requirements and disruptions from the construction and operation of 150 injection wells within the affected neighborhoods. These impacts to residents and businesses would likely include restricted access, detours, and traffic congestion associated with extensive injection well drilling/construction activities. For these reasons, Tucson Water continues to support EPA's adoption of Alternative 3. This approach is protective of public health and the environment without introducing uncertainty in future groundwater quality impacts or causing disruptions to the affected neighborhoods. We continue to appreciate the opportunity to participate in this process. Sincerely, Jeff B. Biggs Administrator Strategic Initiatives Division Tucson Water Department cc: Albert Elias, Assistant City Manger Timothy M. Thomure, Tucson Water Director Mike Rankin, City Attorney	

Comment No.	Comment	Response
Written Comments from ADEQ received on March 2, 2018 via email		
41	Full text of letter received from ADEQ: March 2, 2018 Ms. Angeles Herrera Branch Chief, Federal Facilities U.S. Environmental Protection Agency (EPA), Region 9 Mail Code SFD-8-1 75 Hawthorne Street San Francisco, California 94105-3901 Re: Concurrence with Proposed Plan and Draft Record of Decision Amendment for the Tucson International Airport Area (TIAA) Superfund Site Area A, North of Los Reales Road, Tucson, Arizona Dear Ms. Herrera: As you are aware, the Arizona Department of Environmental Quality (ADEQ) has been closely involved with the TIAA site for well over 20 years. We appreciate the opportunity to partner with U.S. EPA in the important work of investigating and cleaning up this site. Undoubtedly, the most significant event that has occurred at this site in the past 20 years was the discovery in 2002 of 1,4-dioxane throughout the regional aquifer from U.S. Air Force Plant 44 (AFP-44) in the south to Irvington Road in the north. Groundwater treatment systems were already operational to pump and treat TCE contaminated groundwater from the regional aquifer at both AFP-44 and at the Tucson Airport Remediation Project (TARP) at the downgradient northern end of site, but with the discovery of 1,4-dioxane these treatment systems became obsolete. Therefore, the Air Force initially modified their pumping strategy at AFP-44 to limit the off-site migration of 1,4-dioxane. Then in 2009, the Air Force installed an advanced oxidation treatment system that was capable of treating 1,4-dioxane so that their goal of containing groundwater contamination south of Los Reales Road could resume. To the north, the treatment system at TARP continued to use air stripping technology and the City of Tucson Water Department (Tucson Water) modified the operation of the TARP extraction wells to minimize the amount of 1,4-dioxane entering their treatment plant which delivers treated water to the public water supply. This strategy proved to only be a temporary solution though because the Regional Screening Level (RSL) for 1,4-dioxane was lowered in 2011 to 0.35 µg/L and Tucson Water could no longer serve water from the TARP system that met the new RSL. Therefore, in 2013 and 2014 Tucson Water constructed an advanced oxidation treatment plant that could effectively treat both TCE and 1,4-dioxane. The advanced oxidation treatment plant at TARP has been operating effectively since 2014.	EPA appreciates the input from ADEQ and the support for Alternative 3: Enhanced Existing Pump-and-Treat System with UV- Peroxide Plus Long-Term Monitoring and ICs (EPA's Preferred Alternative).

Comment No.	Comment	Response
	The Proposed Plan and Draft Record of Decision Amendment proposed by U.S. EPA formally modifies the TARP remedy to treat TCE and 1,4-dioxane contaminated groundwater using the advanced oxidation process that is already in place. ADEQ fully supports this change to the TARP remedy. If you have any questions, I can be reached at 520-770-3127 or at TL1@azdeg.gov. Sincerely, Tina LePage, Manager Remedial Project Section cc: ADEQ-FPU reading file Brian Stonebrink, ADEQ Federal Programs Unit Manager (email) Mary Aycock, Remedial Project Manager, U.S. EPA Region IX (email) William Ellett, ADEQ Associate Hydrogeologist (email)	

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APPENDIX A

Present Value of Cash Flow and Value of Cash Flow Over Time Calculation Summary Tables

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ATTACHMENT A-1

Record of Decision Amendment
TARP Plume: Area A North of Los Reales Road
Alternative Name: AFP44 FS LR North Alternative 2 - Monitored Natural Attenuation (MNA) and Institutional Controls (IC)

Phase Type	Phase Name	Fiscal Year 1 2014		Fiscal Year 2 2015		Fiscal Year 3 2016		Fiscal Year 4 2017		Fiscal Year 5 2018	
Design	AFP44 FS LR North Alternative 2 MNA Design ¹	\$	13,106								
Remedial Action	AFP44 FS LR North Alternative 2 MNA LTM ²			\$	263,188	\$	256,772	\$	256,772	\$	256,772
Total		\$	13,106	\$	263,188	\$	256,772	\$	256,772	\$	256,772
Year			0		1		2		3		4
1.9 % Present Value Discount Rate ³	1.9%				0.9814		0.9631		0.9451		0.9275
Net Present Value		\$	13,106	\$	258,281	\$	247,286	\$	242,675	\$	238,150
7% Present Value Discount Rate ⁴	7.0%				0.9346		0.8734		0.8163		0.7629
Net Present Value		\$	13,106	\$	245,970	\$	224,275	\$	209,602	\$	195,890

Notes:
1 - Fiscal Year (FY) 2014 cost based on USAF RI/FS cost for design of monitoring program presented in Alternative Cost Over Time, AFP44 FS LR North Alternative 2, Appendix B, Volume III Final Feasibility Study for 1,4-Dioxane North of Los Reales Road (EGC, 2016).
2 - LTM Based on USAF RI/FS cost for Monitored Natural Attenuation presented in Alternative Cost Over Time, AFP44 FS LR North Alternative 2, Appendix B, Volume III Final Feasibility Study for 1,4-Dioxane. North of Los Reales Road (EGC, 2016).
3 - Air Force Present value calculations based on assumptions in RI/FS of 30-year term at 1.9% (Appendix C OMB Circular-94 for 2014)as presented in Appendix B, Final FFS 1,4-Dioxane NLRR (EGC, 2016).
4 - Based on Circular-94, U.S. Office of discount rate of Management and Budget (OMB) 7% discount rate for base case analysis.

Record of Decision Amendment
TARP Plume: Area A North of Los Real
Alternative Name: AFP44 FS LR North

Phase Type	Fiscal Year 6 2019		Fiscal Year 7 2020		Fiscal Year 8 2021		Fiscal Year 9 2022		Fiscal Year 10 2023		Fiscal Year 11 2024		Fiscal Year 12 2025		Fiscal Year 13 2026		Fiscal Year 14 2027	
Design																		
Remedial Action	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772
Total	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772
Year		5		6		7		8		9		10		11		12		13
1.9 % Present Value Discount Rate ³		0.9102		0.8932		0.8766		0.8602		0.8442		0.8284		0.8130		0.7978		0.7830
Net Present Value	\$	233,710	\$	229,352	\$	225,076	\$	220,879	\$	216,760	\$	212,719	\$	208,752	\$	204,860	\$	201,040
7% Present Value Discount Rate ⁴		0.7130		0.6663		0.6227		0.5820		0.5439		0.5083		0.4751		0.4440		0.4150
Net Present Value	\$	183,075	\$	171,098	\$	159,905	\$	149,444	\$	139,667	\$	130,530	\$	121,991	\$	114,010	\$	106,551

Record of Decision Amendment
TARP Plume: Area A North of Los Real
Alternative Name: AFP44 FS LR North

Phase Type	Fiscal Year 15 2028		Fiscal Year 16 2029		Fiscal Year 17 2030		Fiscal Year 18 2031		Fiscal Year 19 2032		Fiscal Year 20 2033		Fiscal Year 21 2034		Fiscal Year 22 2035		Fiscal Year 23 2036	
Design																		
Remedial Action	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772
Total	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772
Year		14		15		16		17		18		19		20		21		22
1.9 % Present Value Discount Rate ³		0.7684		0.7540		0.7400		0.7262		0.7126		0.6993		0.6863		0.6735		0.6609
Net Present Value	\$	197,292	\$	193,613	\$	190,003	\$	186,460	\$	182,984	\$	179,572	\$	176,224	\$	172,938	\$	169,713
7% Present Value Discount Rate ⁴		0.3878		0.3624		0.3387		0.3166		0.2959		0.2765		0.2584		0.2415		0.2257
Net Present Value	\$	99,581	\$	93,066	\$	86,978	\$	81,287	\$	75,970	\$	71,000	\$	66,355	\$	62,014	\$	57,957

ALTERNATIVE 2

March 2023

Record of Decision Amendment
TARP Plume: Area A North of Los Real
Alternative Name: AFP44 FS LR North

Phase Type	Fiscal Year 24 2037		Fiscal Year 25 2038		Fiscal Year 26 2039		Fiscal Year 27 2040		Fiscal Year 28 2041		Fiscal Year 29 2042		Fiscal Year 30 2043		Fiscal Year 31 2044		Total	
Design																\$	13,106	
Remedial Action	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	7,709,576
Total	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	7,722,682
Year		23		24		25		26		27		28		29		30		
1.9 % Present Value Discount Rate ³		0.6486		0.6365		0.6247		0.6130		0.6016		0.5904		0.5794		0.5686		
Net Present Value	\$	166,549	\$	163,443	\$	160,396	\$	157,405	\$	154,470	\$	151,590	\$	148,763	\$	145,990	\$	5,850,051
7% Present Value Discount Rate ⁴		0.2109		0.1971		0.1842		0.1722		0.1609		0.1504		0.1406		0.1314		
Net Present Value	\$	54,165	\$	50,622	\$	47,310	\$	44,215	\$	41,322	\$	38,619	\$	36,093	\$	33,731	\$	3,205,397

ATTACHMENT A-2

Record of Decision Amendment
TARP Plume: Area A North of Los Reales Road
Alternative Name: AFP44 FS LR North Alternative 3 - Enhanced Existing Pump & Treat w/UV-Peroxide, LTM, and IC

Phase Type	Phase Name	Fiscal Year 1 2014	Fiscal Year 2 2015	Fiscal Year 3 2016	Fiscal Year 4 2017	Fiscal Year 5 2018
Design	AFP44 FS LR North Enhanced Alternative 3 Design ¹	\$ 13,700				
Remedial Action	AFP44 FS LR North Enhanced Alternative 3 Capital Cost ²					
Remedial Action	AFP44 FS LR North Enhanced Alternative 3 LTM ³	\$ 286,000	\$ 286,000	\$ 286,000	\$ 286,000	\$ 286,000
Remedial Action	AFP44 FSA LR North Enhanced Alternative 3 Recycled Water System and Outfall ⁴					
Operations and Maintenance	AFP44 FS LR North Enhanced Alternative 3 AOP O&M 2014-2044 ⁵	\$ 977,000	\$ 977,000	\$ 977,000	\$ 977,000	\$ 977,000
Operations and Maintenance	AFP44 FS LR North Enhanced Alternative 3 PCA O&M 2014-2044 ⁶	\$ 405,000	\$ 405,000	\$ 405,000	\$ 405,000	\$ 405,000
Operations and Maintenance	AFP44 FS LR North Enhanced Alternative 3 TARP Well O&M 2014-2044 ⁷	\$ 735,000	\$ 735,000	\$ 735,000	\$ 735,000	\$ 735,000
Operations and Maintenance	AFP44 FS LR North Enhanced Alternative 3 AOP Ballast and GAC Replacement ⁸					
Operations and Maintenance	AFP44 FS LR North Enhanced Alternative 3 Remediation Well Replacement ⁹				\$	1,200,000
Operations and Maintenance	AFP44 FSA LR North Enhanced Alternative 3 Recycled Water System and outfall ¹⁰					
Total		\$ 2,417,000	\$ 2,403,000	\$ 2,403,000	\$ 2,403,000	\$ 3,603,000
Year		0	1	2	3	4
1.9% Present Value Discount Rate ¹¹	1.9%		0.9814	0.9631	0.9451	0.9275
Net Present Value		\$ 2,417,000	\$ 2,358,000	\$ 2,314,000	\$ 2,271,000	\$ 3,342,000
7% Present Value Discount Rate ¹²	7.0%		0.9346	0.8734	0.8163	0.7629
Net Present Value		\$ 2,417,000	\$ 2,204,000	\$ 2,021,000	\$ 1,854,000	\$ 2,550,000

Notes:

1 - Fiscal Year (FY) 2014 cost based on USAF RI/FS cost for design of monitoring program, FY 2019 and 2021 cost based on design, bidding, construction administration, and records for capital construction costs of Enhanced Alternative 3 (Appendix B, FocusedFeasibility Study Amendment, Carollo, 2021).

2 - Capital cost of remediation well and pipeline construction and AOP plant upgrades as presented in Table 1B (Appendix B, Focused Feasibility Study Amendment Carollo, 2021) is based on actual contracted costs.

3 - LTM Based on USAF RI/FS cost for Monitored Natural Attenuation (Appendix B, Final FFS 1,4-Dioxane NLRR, EGC, 2016).

4 - Capital cost of recycled water system delivery booster station, pipeline, and outfall on Santa Cruz River as presented in Table B4 (Appendix B, Focused Feasibility Study Amendment Carollo, 2021).

5 - AOP O&M costs based on operations associated with three trains with three reactor pairs per train and H₂O₂ at 35 percent as presented in Table B2 (Appendix B, Focused Feasibility Study Amendment, (Carollo, 2021).

6 - Costs for operations of PCA process as presented in Table B2 (Appendix B, Focused Feasibility Study Amendment Carollo, 2021) assumed to terminate after acceptance of amended Record of Decision assumed in 2020.

7 - Well O&M based on 9 remediation wells from 2014 through 2018 and 10 remediation wells 2019 through 2044 as summarized in Table B2 (Appendix B, Focused Feasibility Study Amendment Carollo, 2021).

8 - Assumed Ballast replacements every 5 years at an approximate cost of \$400,000 per change out and GAC replacement at approximately \$600,000 per replacement based on operational data.

9 - Remediation well replacement program is assumed to proceed as planned by Tucson Water with the remaining North Well Field replacement costing approximately \$1,200.000 in 2020 and replacement of South Well Field wells at 2-year intervals and approximately \$600,000 in cost.

10 - Costs for operations of recycled water system booster station as presented in Table B5 (Appendix B, Focused Feasibility Study Amendment Carollo, 2021).

11 - Air Force Present value calculations based on assumptions in RI/FS of 30-year term at 1.9% (Appendix C OMB Circular-94 for 2014)as presented in Appendix B, Final FFS 1,4-Dioxane NLRR (EGC, 2016).

12 - Based on Circular-94, U.S. Office of discount rate of Management and Budget (OMB) 7% discount rate for base case analysis.

Record of Decision Amendment
TARP Plume: Area A North of Los Reales |
Alternative Name: AFP44 FS LR North Alt

Phase Type	Fiscal Year 6 2019		Fiscal Year 7 2020		Fiscal Year 8 2021		Fiscal Year 9 2022		Fiscal Year 10 2023		Fiscal Year 11 2024		Fiscal Year 12 2025		Fiscal Year 13 2026		Fiscal Year 14 2027	
Design	\$	3,726,000			\$	3,357,000												
Remedial Action			\$	14,982,000														
Remedial Action	\$	286,000	\$	286,000	\$	286,000	\$	286,000	\$	286,000	\$	286,000	\$	286,000	\$	286,000	\$	286,000
Remedial Action							\$	16,785,000										
Operations and Maintenance	\$	977,000	\$	1,257,000	\$	1,257,000	\$	1,257,000	\$	1,257,000	\$	1,257,000	\$	1,257,000	\$	1,257,000	\$	1,257,000
Operations and Maintenance	\$	405,000	\$	405,000														
Operations and Maintenance	\$	735,000	\$	849,000	\$	849,000	\$	849,000	\$	849,000	\$	849,000	\$	849,000	\$	849,000	\$	849,000
Operations and Maintenance	\$	600,000			\$	400,000					\$	600,000			\$	400,000		
Operations and Maintenance							\$	1,200,000			\$	1,200,000			\$	600,000		
Operations and Maintenance					\$	34,000	\$	34,000	\$	34,000	\$	34,000	\$	34,000	\$	34,000	\$	34,000
Total	\$	6,729,000	\$	17,779,000	\$	6,183,000	\$	20,411,000	\$	2,426,000	\$	4,226,000	\$	2,426,000	\$	3,426,000	\$	2,426,000
Year		5		6		7		8		9		10		11		12		13
1.9% Present Value Discount Rate ¹¹		0.9102		0.8932		0.8766		0.8602		0.8442		0.8284		0.8130		0.7978		0.7830
Net Present Value	\$	6,125,000	\$	15,880,000	\$	5,420,000	\$	17,558,000	\$	2,048,000	\$	3,501,000	\$	1,972,000	\$	2,733,000	\$	1,899,000
7% Present Value Discount Rate ¹²		0.7130		0.6663		0.6227		0.5820		0.5439		0.5083		0.4751		0.4440		0.4150
Net Present Value	\$	4,367,000	\$	10,582,000	\$	3,375,000	\$	10,219,000	\$	1,114,000	\$	1,780,000	\$	937,000	\$	1,213,000	\$	788,000

ALTERNATIVE 3

March 2023

Record of Decision Amendment
TARP Plume: Area A North of Los Reales |
Alternative Name: AFP44 FS LR North Alt

Phase Type	Fiscal Year 15 2028		Fiscal Year 16 2029		Fiscal Year 17 2030		Fiscal Year 18 2031		Fiscal Year 19 2032		Fiscal Year 20 2033		Fiscal Year 21 2034		Fiscal Year 22 2035		Fiscal Year 23 2036	
Design																		
Remedial Action																		
Remedial Action	\$	286,000	\$	286,000	\$	286,000	\$	286,000	\$	286,000	\$	286,000	\$	286,000	\$	286,000	\$	286,000
Remedial Action																		
Operations and Maintenance	\$	1,257,000	\$	1,257,000	\$	1,257,000	\$	1,257,000	\$	1,257,000	\$	1,257,000	\$	1,257,000	\$	1,257,000	\$	1,257,000
Operations and Maintenance																		
Operations and Maintenance	\$	849,000	\$	849,000	\$	849,000	\$	849,000	\$	849,000	\$	849,000	\$	849,000	\$	849,000	\$	849,000
Operations and Maintenance			\$	600,000			\$	400,000					\$	600,000			\$	400,000
Operations and Maintenance	\$	600,000			\$	600,000												
Operations and Maintenance	\$	34,000	\$	34,000	\$	34,000	\$	34,000	\$	34,000	\$	34,000	\$	34,000	\$	34,000	\$	34,000
Total	\$	3,026,000	\$	3,026,000	\$	3,026,000	\$	2,826,000	\$	2,426,000	\$	2,426,000	\$	3,026,000	\$	2,426,000	\$	2,826,000
Year		14		15		16		17		18		19		20		21		22
1.9% Present Value Discount Rate ¹¹		0.7684		0.7540		0.7400		0.7262		0.7126		0.6993		0.6863		0.6735		0.6609
Net Present Value	\$	2,325,000	\$	2,282,000	\$	2,239,000	\$	2,052,000	\$	1,729,000	\$	1,697,000	\$	2,077,000	\$	1,634,000	\$	1,868,000
7% Present Value Discount Rate ¹²		0.3878		0.3624		0.3387		0.3166		0.2959		0.2765		0.2584		0.2415		0.2257
Net Present Value	\$	902,000	\$	827,000	\$	758,000	\$	650,000	\$	512,000	\$	469,000	\$	537,000	\$	395,000	\$	422,000

ALTERNATIVE 3

March 2023

Record of Decision Amendment
TARP Plume: Area A North of Los Reales |
Alternative Name: AFP44 FS LR North Alt

Phase Type	Fiscal Year 24 2037		Fiscal Year 25 2038		Fiscal Year 26 2039		Fiscal Year 27 2040		Fiscal Year 28 2041		Fiscal Year 29 2042		Fiscal Year 30 2043		Fiscal Year 31 2044		Total
Design																	\$ 7,100,000
Remedial Action																	\$ 14,980,000
Remedial Action	\$	286,000	\$	286,000	\$	286,000	\$	286,000	\$	286,000	\$	286,000	\$	286,000	\$	286,000	\$ 8,870,000
Remedial Action																	\$ 16,790,000
Operations and Maintenance	\$	1,257,000	\$	1,257,000	\$	1,257,000	\$	1,257,000	\$	1,257,000	\$	1,257,000	\$	1,257,000	\$	1,257,000	\$ 37,290,000
Operations and Maintenance																	\$ 2,840,000
Operations and Maintenance	\$	849,000	\$	849,000	\$	849,000	\$	849,000	\$	849,000	\$	849,000	\$	849,000	\$	849,000	\$ 25,640,000
Operations and Maintenance							\$	600,000	\$	400,000							\$ 5,000,000
Operations and Maintenance																	\$ 5,400,000
Operations and Maintenance	\$	34,000	\$	34,000	\$	34,000	\$	34,000	\$	34,000	\$	34,000	\$	34,000	\$	34,000	\$ 820,000
Total	\$	2,426,000	\$	2,426,000	\$	2,426,000	\$	3,026,000	\$	2,826,000	\$	2,426,000	\$	2,426,000	\$	2,426,000	\$ 124,730,000
Year		23		24		25		26		27		28		29		30	
1.9% Present Value Discount Rate ¹¹		0.6486		0.6365		0.6247		0.6130		0.6016		0.5904		0.5794		0.5686	
Net Present Value	\$	1,574,000	\$	1,544,000	\$	1,515,000	\$	1,855,000	\$	1,700,000	\$	1,432,000	\$	1,406,000	\$	1,379,000	\$ 100,000,000
7% Present Value Discount Rate ¹²		0.2109		0.1971		0.1842		0.1722		0.1609		0.1504		0.1406		0.1314	
Net Present Value	\$	332,000	\$	304,000	\$	279,000	\$	319,000	\$	274,000	\$	215,000	\$	198,000	\$	181,000	\$ 53,000,000

ATTACHMENT A-3

ALTERNATIVE 4

March 2023

Record of Decision Amendment
TARP Plume: Area A North of Los Reales Road
Alternative Name: AFP44 FS LR North Alternative 4 - Optimized Pump & Treat w/UV-Peroxide, Partial Management of Water by Reinjection, MNA, and ICs

Phase Type	Phase Name	Fiscal Year 1 2014	Fiscal Year 2 2015	Fiscal Year 3 2016	Fiscal Year 4 2017	Fiscal Year 5 2018
Design	AFP44 FS LR North Alternative 4 Design ¹	\$ 258,452				
Remedial Action	AFP44 FS LR North Alternative 4 MNA, LTM, & Injection Well Installation ²	\$ 3,649,898	\$ 256,772	\$ 256,772	\$ 256,772	\$ 256,772
Operations & Maintenance	AFP44 FS LR North Alternative 4 Groundwater Reinjection O&M ³	\$ 18,406	\$ 18,406	\$ 18,406	\$ 18,406	\$ 18,406
Operations & Maintenance	AFP44 FS LR North Alternative 4 AOP O&M ³	\$ 927,200	\$ 927,200	\$ 927,200	\$ 927,200	\$ 927,200
Operations & Maintenance	AFP44 FS LR North Alternative 4 TARP O&M ³	\$ 1,494,500	\$ 1,494,500	\$ 1,494,500	\$ 1,494,500	\$ 1,494,500
Operations & Maintenance	AFP44 FS LR North Alternative 4 O&M 2030 ³					
Operations & Maintenance	AFP44 FS LR North Alternative 4 O&M 2035 ³					
Total		\$ 258,452	\$ 6,090,004	\$ 2,696,878	\$ 2,696,878	\$ 2,696,878
Year		0	1	2	3	4
Present Value Discount Rate ⁴	1.9%		0.9814	0.9631	0.9451	0.9275
Net Present Value		\$ 258,452	\$ 5,976,451	\$ 2,597,245	\$ 2,548,818	\$ 2,501,293
Present Value Discount Rate ⁵	7.0%		0.9346	0.8734	0.8163	0.7629
Net Present Value		\$ 258,452	\$ 5,691,593	\$ 2,355,558	\$ 2,201,456	\$ 2,057,435

Notes:

1 - Fiscal Year (FY) 2014 cost based on USAF RI/FS cost for design of monitoring program presented in Alternative Cost Over Time, AFP44 FS LR North Alternative 2, Appendix B, Volume III Final Feasibility Study for 1,4-Dioxane North of Los Reales Road (EGC, 2016).

2 - Remedial Action costs based on USAF RI/FS information presented in Alternative Cost Over Time, AFP44 FS LR North Alternative 3, Appendix B, Volume III Final Feasibility Study for 1,4-Dioxane. North of Los Reales Road (EGC, 2016).

3 - Operations and maintenance costs based on USAF RI/FS information presented in Alternative Cost Over Time, AFP44 FS LR North Alternative 3, Appendix B, Volume III Final Feasibility Study for 1,4-Dioxane. North of Los Reales Road (EGC, 2016).

4 - Air Force Present value calculations based on assumptions in RI/FS of 30-year term at 1.9% (Appendix C OMB Circular-94 for 2014)as presented in Appendix B, Final FFS 1,4-Dioxane NLRR (EGC, 2016).

5 - Based on Circular-94, U.S. Office of discount rate of Management and Budget (OMB) 7% discount rate for base case analysis.

ALTERNATIVE 4

March 2023

Record of Decision Amendment
TARP Plume: Area A North of Los
Alternative Name: AFP44 FS LR N

Phase Type	Fiscal Year 6 2019		Fiscal Year 7 2020		Fiscal Year 8 2021		Fiscal Year 9 2022		Fiscal Year 10 2023		Fiscal Year 11 2024		Fiscal Year 12 2025		Fiscal Year 13 2026		Fiscal Year 14 2027	
Design																		
Remedial Action	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772
Operations & Maintenance	\$	18,406	\$	18,406	\$	18,406	\$	18,406	\$	18,406	\$	18,406	\$	18,406	\$	18,406	\$	18,406
Operations & Maintenance	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200
Operations & Maintenance	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500
Operations & Maintenance																		
Operations & Maintenance																		
Total	\$	2,696,878	\$	2,696,878	\$	2,696,878	\$	2,696,878	\$	2,696,878	\$	2,696,878	\$	2,696,878	\$	2,696,878	\$	2,696,878
Year		5		6		7		8		9		10		11		12		13
Present Value Discount Rate ⁴		0.9102		0.8932		0.8766		0.8602		0.8442		0.8284		0.8130		0.7978		0.7830
Net Present Value	\$	2,454,655	\$	2,408,886	\$	2,363,970	\$	2,319,892	\$	2,276,636	\$	2,234,187	\$	2,192,529	\$	2,151,647	\$	2,111,528
Present Value Discount Rate ⁵		0.7130		0.6663		0.6227		0.5820		0.5439		0.5083		0.4751		0.4440		0.4150
Net Present Value	\$	1,922,837	\$	1,797,044	\$	1,679,480	\$	1,569,608	\$	1,466,923	\$	1,370,956	\$	1,281,267	\$	1,197,446	\$	1,119,108

ALTERNATIVE 4

March 2023

Record of Decision Amendment
TARP Plume: Area A North of Los
Alternative Name: AFP44 FS LR N

Phase Type	Fiscal Year 15 2028		Fiscal Year 16 2029		Fiscal Year 17 2030		Fiscal Year 18 2031		Fiscal Year 19 2032		Fiscal Year 20 2033		Fiscal Year 21 2034		Fiscal Year 22 2035		Fiscal Year 23 2036	
Design																		
Remedial Action	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772
Operations & Maintenance	\$	18,406	\$	18,406	\$	18,406	\$	18,406	\$	18,406	\$	18,406	\$	18,406	\$	18,406	\$	18,406
Operations & Maintenance	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200
Operations & Maintenance	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500
Operations & Maintenance					\$	411,000												
Operations & Maintenance														\$	3,530,000			
Total	\$	2,696,878	\$	2,696,878	\$	3,107,878	\$	2,696,878	\$	2,696,878	\$	2,696,878	\$	2,696,878	\$	6,226,878	\$	2,696,878
Year		14		15		16		17		18		19		20		21		22
Present Value Discount Rate ⁴		0.7684		0.7540		0.7400		0.7262		0.7126		0.6993		0.6863		0.6735		0.6609
Net Present Value	\$	2,072,157	\$	2,033,520	\$	2,299,731	\$	1,958,394	\$	1,921,879	\$	1,886,044	\$	1,850,877	\$	4,193,846	\$	1,782,499
Present Value Discount Rate ⁵		0.3878		0.3624		0.3387		0.3166		0.2959		0.2765		0.2584		0.2415		0.2257
Net Present Value	\$	1,045,896	\$	977,473	\$	1,052,746	\$	853,763	\$	797,909	\$	745,709	\$	696,925	\$	1,503,873	\$	608,721

ALTERNATIVE 4

March 2023

Record of Decision Amendment
TARP Plume: Area A North of Los
Alternative Name: AFP44 FS LR N

Phase Type	Fiscal Year 24 2037		Fiscal Year 25 2038		Fiscal Year 26 2039		Fiscal Year 27 2040		Fiscal Year 28 2041		Fiscal Year 29 2042		Fiscal Year 30 2043		Fiscal Year 31 2044		Total
Design																	\$ 258,452
Remedial Action	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$ 11,096,286
Operations & Maintenance	\$	18,406	\$	18,406	\$	18,406	\$	18,406	\$	18,406	\$	18,406	\$	18,406	\$	18,406	\$ 552,180
Operations & Maintenance	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$ 27,816,000
Operations & Maintenance	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$ 44,835,000
Operations & Maintenance																	\$ 411,000
Operations & Maintenance																	\$ 3,530,000
Total	\$	2,696,878	\$	2,696,878	\$	2,696,878	\$	2,696,878	\$	2,696,878	\$	2,696,878	\$	2,696,878	\$	2,696,878	\$ 88,498,918
Year		23		24		25		26		27		28		29		30	
Present Value Discount Rate ⁴		0.6486		0.6365		0.6247		0.6130		0.6016		0.5904		0.5794		0.5686	
Net Present Value	\$	1,749,263	\$	1,716,647	\$	1,684,638	\$	1,653,227	\$	1,622,401	\$	1,592,151	\$	1,562,464	\$	1,533,331	\$ 67,509,258
Present Value Discount Rate ⁵		0.2109		0.1971		0.1842		0.1722		0.1609		0.1504		0.1406		0.1314	
Net Present Value	\$	568,898	\$	531,680	\$	496,898	\$	464,390	\$	434,010	\$	405,616	\$	379,081	\$	354,281	\$ 37,887,029

ATTACHMENT A-4

ALTERNATIVE 5

March 2023

Record of Decision Amendment
 TARP Plume: Area A North of Los Reales Road
 Alternative Name: AFP44 FS LR North Alternative 5 - Existing Pump & Treat w/UV-Peroxide, In-situ Bioremediation, MNA, and ICs

Phase Type	Phase Name	Fiscal Year 1 2014	Fiscal Year 2 2015	Fiscal Year 3 2016	Fiscal Year 4 2017	Fiscal Year 5 2018
Design	AFP44 FS LR North Alternative 5 Design ¹	\$ 550,104				
Remedial Action	AFP44 FS LR North Alternative 5 MNA ²		\$ 265,609	\$ 256,772	\$ 256,772	\$ 256,772
Remedial Action	AFP44 FS LR North Alternative 5 ISB System Install ²			\$ 5,948,144		
Operations & Maintenance	AFP44 FS LR North Alternative 5 AOP O&M ³		\$ 927,200	\$ 927,200	\$ 927,200	\$ 927,200
Operations & Maintenance	AFP44 FS LR North Alternative 5 TARP O&M ³		\$ 1,494,500	\$ 1,494,500	\$ 1,494,500	\$ 1,494,500
Operations & Maintenance	AFP44 FS LR North Alternative 5 O&M ISB System ³				\$ 3,791,030	\$ 3,790,817
Operations & Maintenance	AFP44 FS LR North Alternative 5 O&M 2030 ³					
Operations & Maintenance	AFP44 FS LR North Alternative 5 O&M 2035 ³					
Site Closeout	AFP44 FS LR North Alternative 5 Well Abandonment ³					
Total Year		\$ 550,104	\$ 2,687,309	\$ 8,626,616	\$ 6,469,502	\$ 6,469,289
		0	1	2	3	4
Present Value Discount Rate⁴	1.9%		0.9814	0.9631	0.9451	0.9275
Net Present Value		\$ 550,104	\$ 2,637,202	\$ 8,307,916	\$ 6,114,322	\$ 6,000,118
Present Value Discount Rate⁵	7.0%		0.9346	0.8734	0.8163	0.7629
Net Present Value		\$ 550,104	\$ 2,511,504	\$ 7,534,821	\$ 5,281,041	\$ 4,935,390

Notes:
 1 - Fiscal Year (FY) 2014 cost based on USAF RI/FS cost for design of monitoring program presented in Alternative Cost Over Time, AFP44 FS LR North Alternative 2, Appendix B, Volume III Final Feasibility Study for 1,4-Dioxane North of Los Reales Road (EGC, 2016).
 2 - Remedial Action costs based on USAF RI/FS information presented in Alternative Cost Over Time, AFP44 FS LR North Alternative 3, Appendix B, Volume III Final Feasibility Study for 1,4-Dioxane. North of Los Reales Road (EGC, 2016).
 3 - Operations and maintenance costs based on USAF RI/FS information presented in Alternative Cost Over Time, AFP44 FS LR North Alternative 3, Appendix B, Volume III Final Feasibility Study for 1,4-Dioxane. North of Los Reales Road (EGC, 2016).
 4 - Air Force Present value calculations based on assumptions in RI/FS of 30-year term at 1.9% (Appendix C OMB Circular-94 for 2014)as presented in Appendix B, Final FFS 1,4-Dioxane NLRR (EGC, 2016).
 5 - Based on Circular-94, U.S. Office of discount rate of Management and Budget (OMB) 7% discount rate for base case analysis.

ALTERNATIVE 5

March 2023

Record of Decision Amendment
TARP Plume: Area A North of Los R
Alternative Name: AFP44 FS LR Nor

Phase Type	Fiscal Year 6 2019		Fiscal Year 7 2020		Fiscal Year 8 2021		Fiscal Year 9 2022		Fiscal Year 10 2023		Fiscal Year 11 2024		Fiscal Year 12 2025		Fiscal Year 13 2026		Fiscal Year 14 2027	
Design																		
Remedial Action	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772
Remedial Action																		
Operations & Maintenance	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200
Operations & Maintenance	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500
Operations & Maintenance	\$	3,790,817	\$	3,790,817	\$	3,790,817	\$	3,770,107	\$	3,770,107	\$	3,770,107	\$	3,770,107	\$	3,770,107	\$	3,770,107
Operations & Maintenance																		
Operations & Maintenance																		
Site Closeout																		
Total	\$	6,469,289	\$	6,469,289	\$	6,469,289	\$	6,448,579	\$	6,448,579	\$	6,448,579	\$	6,448,579	\$	6,448,579	\$	6,448,579
Year		5		6		7		8		9		10		11		12		13
Present Value Discount Rate ⁴		0.9102		0.8932		0.8766		0.8602		0.8442		0.8284		0.8130		0.7978		0.7830
Net Present Value	\$	5,888,242	\$	5,778,451	\$	5,670,708	\$	5,547,158	\$	5,443,727	\$	5,342,225	\$	5,242,615	\$	5,144,863	\$	5,048,933
Present Value Discount Rate ⁵		0.7130		0.6663		0.6227		0.5820		0.5439		0.5083		0.4751		0.4440		0.4150
Net Present Value	\$	4,612,514	\$	4,310,760	\$	4,028,748	\$	3,753,132	\$	3,507,600	\$	3,278,131	\$	3,063,673	\$	2,863,246	\$	2,675,931

ALTERNATIVE 5

March 2023

Record of Decision Amendment
TARP Plume: Area A North of Los R
Alternative Name: AFP44 FS LR Nor

Phase Type	Fiscal Year 15 2028		Fiscal Year 16 2029		Fiscal Year 17 2030		Fiscal Year 18 2031		Fiscal Year 19 2032		Fiscal Year 20 2033		Fiscal Year 21 2034		Fiscal Year 22 2035		Fiscal Year 23 2036	
Design																		
Remedial Action	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772
Remedial Action																		
Operations & Maintenance	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200
Operations & Maintenance	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500
Operations & Maintenance	\$	3,770,107	\$	3,770,107	\$	3,770,107	\$	3,770,107	\$	3,786,727	\$	3,786,727	\$	3,786,727	\$	3,786,727	\$	3,786,727
Operations & Maintenance					\$	411,000												
Operations & Maintenance													\$	3,530,000				
Site Closeout																		
Total	\$	6,448,579	\$	6,448,579	\$	6,859,579	\$	6,448,579	\$	6,465,199	\$	6,465,199	\$	6,465,199	\$	9,995,199	\$	6,465,199
Year		14		15		16		17		18		19		20		21		22
Present Value Discount Rate ⁴		0.7684		0.7540		0.7400		0.7262		0.7126		0.6993		0.6863		0.6735		0.6609
Net Present Value	\$	4,954,792	\$	4,862,407	\$	5,075,870	\$	4,682,771	\$	4,607,301	\$	4,521,394	\$	4,437,090	\$	6,731,837	\$	4,273,167
Present Value Discount Rate ⁵		0.3878		0.3624		0.3387		0.3166		0.2959		0.2765		0.2584		0.2415		0.2257
Net Present Value	\$	2,500,870	\$	2,337,262	\$	2,323,577	\$	2,041,455	\$	1,912,819	\$	1,787,681	\$	1,670,730	\$	2,413,971	\$	1,459,281

ALTERNATIVE 5

March 2023

Record of Decision Amendment
TARP Plume: Area A North of Los R
Alternative Name: AFP44 FS LR Nor

Phase Type	Fiscal Year 24 2037		Fiscal Year 25 2038		Fiscal Year 26 2039		Fiscal Year 27 2040		Fiscal Year 28 2041		Fiscal Year 29 2042		Fiscal Year 30 2043		Fiscal Year 31 2044		Total
Design																	\$ 550,104
Remedial Action	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$ 7,711,997
Remedial Action																	\$ 5,948,144
Operations & Maintenance	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$ 27,816,000
Operations & Maintenance	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$ 44,835,000
Operations & Maintenance																	\$ 75,589,003
Operations & Maintenance																	\$ 411,000
Operations & Maintenance																	\$ 3,530,000
Site Closeout	\$	2,019,644															\$ 2,019,644
Total	\$	4,698,116	\$	2,678,472	\$	2,678,472	\$	2,678,472	\$	2,678,472	\$	2,678,472	\$	2,678,472	\$	2,678,472	\$ 168,410,892
Year		23		24		25		26		27		28		29		30	
Present Value Discount Rate ⁴		0.6486		0.6365		0.6247		0.6130		0.6016		0.5904		0.5794		0.5686	
Net Present Value	\$	3,047,316	\$	1,704,931	\$	1,673,141	\$	1,641,944	\$	1,611,329	\$	1,581,284	\$	1,551,800	\$	1,522,866	\$ 131,197,825
Present Value Discount Rate ⁵		0.2109		0.1971		0.1842		0.1722		0.1609		0.1504		0.1406		0.1314	
Net Present Value	\$	991,053	\$	528,052	\$	493,506	\$	461,221	\$	431,047	\$	402,848	\$	376,494	\$	351,863	\$ 75,390,324

ATTACHMENT A-5

ALTERNATIVE 6

March 2023

Record of Decision Amendment
 TARP Plume: Area A North of Los Reales Road
 Alternative Name: AFP44 FS LR North Alternative 6 - Existing Pump & Treat w/UV-Peroxide, In-situ Chemical Oxidation, MNA, and ICs

Phase Type	Phase Name	Fiscal Year 1 2014	Fiscal Year 2 2015	Fiscal Year 3 2016	Fiscal Year 4 2017	Fiscal Year 5 2018
Design	AFP44 FS LR North Alternative 6 Design ¹	\$ 550,104				
Remedial Action	AFP44 FS LR North Alternative 6 MNA ²		\$ 265,609	\$ 256,772	\$ 256,772	\$ 256,772
Remedial Action	AFP44 FS LR North Alternative 6 ISCO System Install ²			\$ 3,489,573		
Remedial Action	AFP44 FS LR North Alternative 6 ISCO 1st Yr Injection ²				\$ 2,093,708	
Operations & Maintenance	AFP44 FS LR North Alternative 6 AOP O&M ³		\$ 927,200	\$ 927,200	\$ 927,200	\$ 927,200
Operations & Maintenance	AFP44 FS LR North Alternative 6 TARP O&M ³		\$ 1,494,500	\$ 1,494,500	\$ 1,494,500	\$ 1,494,500
Operations & Maintenance	AFP44 FS LR North Alternative 6 O&M ISCO System ³					\$ 1,795,633
Operations & Maintenance	AFP44 FS LR North Alternative 6 O&M 2030 ³					
Operations & Maintenance	AFP44 FS LR North Alternative 6 O&M 2035 ³					
Site Closeout	AFP44 FS LR North Alternative 5 Well Abandonment ³					
Total		\$ 550,104	\$ 2,687,309	\$ 6,168,045	\$ 4,772,180	\$ 4,474,105
Year		0	1	2	3	4
Present Value Discount Rate⁴	1.9%		0.9814	0.9631	0.9451	0.9275
Net Present Value		\$ 550,104	\$ 2,637,202	\$ 5,940,174	\$ 4,510,184	\$ 4,149,631
Present Value Discount Rate⁵	7.0%		0.9346	0.8734	0.8163	0.7629
Net Present Value		\$ 550,104	\$ 2,511,504	\$ 5,387,409	\$ 3,895,520	\$ 3,413,273

Notes:
 1 - Fiscal Year (FY) 2014 cost based on USAF RI/FS cost for design of monitoring program presented in Alternative Cost Over Time, AFP44 FS LR North Alternative 2, Appendix B, Volume III Final Feasibility Study for 1,4-Dioxane North of Los Reales Road (EGC, 2016).
 2 - Remedial Action costs based on USAF RI/FS information presented in Alternative Cost Over Time, AFP44 FS LR North Alternative 3, Appendix B, Volume III Final Feasibility Study for 1,4-Dioxane. North of Los Reales Road (EGC, 2016).
 3 - Operations and maintenance costs based on USAF RI/FS information presented in Alternative Cost Over Time, AFP44 FS LR North Alternative 3, Appendix B, Volume III Final Feasibility Study for 1,4-Dioxane. North of Los Reales Road (EGC, 2016).
 4 - Air Force Present value calculations based on assumptions in RI/FS of 30-year term at 1.9% (Appendix C OMB Circular-94 for 2014)as presented in Appendix B, Final FFS 1,4-Dioxane NLRR (EGC, 2016).
 5 - Based on Circular-94, U.S. Office of discount rate of Management and Budget (OMB) 7% discount rate for base case analysis.

ALTERNATIVE 6

March 2023

Record of Decision Amendment
TARP Plume: Area A North of Los
Alternative Name: AFP44 FS LR No

Phase Type	Fiscal Year 6 2019		Fiscal Year 7 2020		Fiscal Year 8 2021		Fiscal Year 9 2022		Fiscal Year 10 2023		Fiscal Year 11 2024		Fiscal Year 12 2025		Fiscal Year 13 2026		Fiscal Year 14 2027	
Design																		
Remedial Action	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772
Remedial Action																		
Remedial Action																		
Operations & Maintenance	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200
Operations & Maintenance	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500
Operations & Maintenance	\$	1,795,633	\$	1,795,633	\$	1,795,633	\$	1,795,633	\$	1,795,633	\$	1,795,633	\$	1,795,633	\$	1,795,633		
Operations & Maintenance																		
Operations & Maintenance																		
Site Closeout													\$	1,768,829				
Total	\$	4,474,105	\$	4,474,105	\$	4,474,105	\$	4,474,105	\$	4,474,105	\$	4,474,105	\$	4,474,105	\$	6,242,934	\$	2,678,472
Year		5		6		7		8		9		10		11		12		13
Present Value Discount Rate ⁴		0.9102		0.8932		0.8766		0.8602		0.8442		0.8284		0.8130		0.7978		0.7830
Net Present Value	\$	4,072,258	\$	3,996,327	\$	3,921,813	\$	3,848,688	\$	3,776,926	\$	3,706,503	\$	3,637,392	\$	4,980,793	\$	2,097,117
Present Value Discount Rate ⁵		0.7130		0.6663		0.6227		0.5820		0.5439		0.5083		0.4751		0.4440		0.4150
Net Present Value	\$	3,189,975	\$	2,981,285	\$	2,786,248	\$	2,603,970	\$	2,433,617	\$	2,274,408	\$	2,125,615	\$	2,771,937	\$	1,111,471

ALTERNATIVE 6

March 2023

Record of Decision Amendment
TARP Plume: Area A North of Los
Alternative Name: AFP44 FS LR No

Phase Type	Fiscal Year 15 2028		Fiscal Year 16 2029		Fiscal Year 17 2030		Fiscal Year 18 2031		Fiscal Year 19 2032		Fiscal Year 20 2033		Fiscal Year 21 2034		Fiscal Year 22 2035		Fiscal Year 23 2036	
Design																		
Remedial Action	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772
Remedial Action																		
Remedial Action																		
Operations & Maintenance	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200
Operations & Maintenance	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500
Operations & Maintenance																		
Operations & Maintenance					\$	411,000												
Operations & Maintenance													\$	3,530,000				
Site Closeout																		
Total	\$	2,678,472	\$	2,678,472	\$	3,089,472	\$	2,678,472	\$	2,678,472	\$	2,678,472	\$	2,678,472	\$	6,208,472	\$	2,678,472
Year		14		15		16		17		18		19		20		21		22
Present Value Discount Rate ⁴		0.7684		0.7540		0.7400		0.7262		0.7126		0.6993		0.6863		0.6735		0.6609
Net Present Value	\$	2,058,015	\$	2,019,642	\$	2,286,111	\$	1,945,029	\$	1,908,762	\$	1,873,172	\$	1,838,245	\$	4,181,450	\$	1,770,333
Present Value Discount Rate ⁵		0.3878		0.3624		0.3387		0.3166		0.2959		0.2765		0.2584		0.2415		0.2257
Net Present Value	\$	1,038,758	\$	970,802	\$	1,046,511	\$	847,936	\$	792,463	\$	740,620	\$	692,168	\$	1,499,427	\$	604,566

Record of Decision Amendment
TARP Plume: Area A North of Los
Alternative Name: AFP44 FS LR N

Phase Type	Fiscal Year 24 2037		Fiscal Year 25 2038		Fiscal Year 26 2039		Fiscal Year 27 2040		Fiscal Year 28 2041		Fiscal Year 29 2042		Fiscal Year 30 2043		Fiscal Year 31 2044		Total
Design																	\$ 550,104
Remedial Action	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$	256,772	\$ 7,711,997
Remedial Action																	\$ 3,489,573
Remedial Action																	\$ 2,093,708
Operations & Maintenance	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$	927,200	\$ 27,816,000
Operations & Maintenance	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$	1,494,500	\$ 44,835,000
Operations & Maintenance																	\$ 16,160,697
Operations & Maintenance																	\$ 411,000
Operations & Maintenance																	\$ 3,530,000
Site Closeout																	\$ 1,768,829
Total	\$	2,678,472	\$	2,678,472	\$	2,678,472	\$	2,678,472	\$	2,678,472	\$	2,678,472	\$	2,678,472	\$	2,678,472	\$ 108,366,908
Year		23		24		25		26		27		28		29		30	
Present Value Discount Rate ⁴		0.6486		0.6365		0.6247		0.6130		0.6016		0.5904		0.5794		0.5686	
Net Present Value	\$	1,737,324	\$	1,704,931	\$	1,673,141	\$	1,641,944	\$	1,611,329	\$	1,581,284	\$	1,551,800	\$	1,522,866	\$ 84,730,490
Present Value Discount Rate ⁵		0.2109		0.1971		0.1842		0.1722		0.1609		0.1504		0.1406		0.1314	
Net Present Value	\$	565,015	\$	528,052	\$	493,506	\$	461,221	\$	431,047	\$	402,848	\$	376,494	\$	351,863	\$ 49,879,633