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FINAL

RECORD OF DECISION
OPERABLE UNIT 2

WILLIAMS AIR FORCE BASE
PHOENIX, ARIZONA

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List of Acronyms

ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Department of Water Resources
AFB	Air Force Base
ARAR	applicable or relevant and appropriate requirement
ATC	Air Training Command
AV	Aero Vironment, Inc.
AVGAS	aviation gas
BTEX	benzene, toluene, ethyl benzene
BTU	British thermal unit
CAG	Carcinogen Assessment Group
CDI	chronic daily intake
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfm	cubic feet per minute
CFR	Code of Federal Regulations
CPF	carcinogenic potency factor
ES	Engineering-Science
Energy Systems	Martin Marietta Energy Systems, Inc.
FFA	Federal Facilities Agreement
FS	feasibility study
gpm	gallons per minute
HBGL	Health-Based Guidance Levels
HI	hazard indices
ILCR	incremental lifetime cancer risk
IRP	Installation Restoration Program
IT	IT Corporation
JP-4	Jet Propulsion Fuel Grade 4
LFSA	Liquid Fuels Storage Area
LOEL	lowest observed effect level
MAG	Maricopa Association of Governments
MCL	Maximum Contaminant Level
MOC	methods of characterization
msl	mean seal level
NCP	National Contingency Plan
NOAA	National Oceanographic and Atmospheric Association
NOEL	no observed effect level
NPL	National Priority List
O&M	operation and maintenance
OU-1	Operable Unit 1
OU-2	Operable Unit 2
OU-3	Operable Unit 3
ppb	parts per billion
ppm	parts per million
QAPP	quality assurance project plan
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RI	remedial investigation
RME	reasonable maximum exposure
ROD	record of decision
RWCD	Roosevelt Water Control District
SARA	Superfund Amendments and Reauthorization Act
SOV	soil organic vapor
SVE	soil vapor extraction
TBC	to be considered
TOX	total organic halogens
TPH	total petroleum hydrocarbons
USAF	U.S. Air Force
U.S. EPA	U.S. Environmental Protection Agency
UST	underground storage tank
VOC	volatile organic compounds

1.0 Declaration

1.1 Site Name and Location

Williams Air Force Base (AFB) is located in Maricopa County, east of the City of Chandler, Arizona. Operable Unit 2 (OU-2) of the Williams AFB National Priority List (NPL) site is located at the Base's Liquid Fuels Storage Area (LFSA), which is also referred to by its site designation "ST-12".

1.2 Statement of Basis and Purpose

This Record of Decision (ROD) selects a remedial action for site cleanup of OU-2, which is defined as groundwater and the first 25 feet of soil at ST-12. Soil below 25 feet will be investigated as a separate operable unit because impact on human health and the environment has not been completely determined.

A total of 14 areas with potential contamination, including ST-12, are identified on Williams AFB for remedial investigation. Environmental cleanup of groundwater and the top 25 feet of soil at ST-12 only pertains to OU-2, while cleanup of the remaining 13 areas and soil below 25 feet at ST-12 will be completed under other operable units. Upon completion of Remedial Investigations (RI) of all areas, a Base-wide Feasibility Study (FS) will be performed, a Base-wide Proposed Plan will be presented, and a Basewide Record of Decision (ROD) will be issued that ensures all necessary and selected remedial measures are integrated into the selected Base-wide remedies.

The U.S. Air Force (USAF) has investigated OU-2 for potential contamination in the top 25 feet of soil and in groundwater. The 13 other areas and soil below 25 feet in depth at ST-12 are addressed in Operable Unit 1 (OU-1) and Operable Unit 3 (OU-3). OU-2 is being addressed first for remedial action in order to expedite cleanup of what is believed to be the most contaminated portion of the Base.

The USAF has chosen the remedial action for OU-2 in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. Section 9601 et seq., as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, Pub. L. No. 99-499, 100 Stat 1613 (1986), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), Title 40 Code of Federal Regulations (CFR) Part 300. Data were collected at OU-2 and analyzed in accordance with a Work Plan (IT, 1991a), Quality Assurance Project Plan (QAPP, IT, 1991b), and Field Sampling Plan (IT, 1991c) approved by the U.S. Environmental Protection Agency (U.S. EPA), Arizona Department of Environmental Quality (ADEQ), and Arizona Department of Water Resources (ADWR).

The summaries and discussion presented in this ROD concerning the presence of chemical contamination at OU-2, potential exposure, human health risks, and remedial alternatives selected for site restoration are based on data extracted from three reports: "Final Proposed Plan, Operable Unit 2, Williams AFB, Phoenix, Arizona, April 1992," "Final Feasibility Study, Operable Unit 2, Williams AFB, Phoenix, Arizona, April 1992," and "Final Remedial Investigation, Operable Unit 2, Williams AFB, Phoenix, Arizona, January 1992." These reports were also the basis on which the USAF selected the proposed remedial alternative and are available for review in the Administrative Record for Williams AFB.

The U.S. EPA and the State of Arizona concur with the selected remedy for OU-2.

1.3 Assessment of the Site

Releases of Jet Propulsion Fuel Grade 4 (JP-4) and aviation gasoline (AVGAS) have contaminated soils and groundwater at OU-2. A variety of nonpetroleum related CERCLA hazardous substances were also detected in OU-2 soils and groundwater. Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response actions selected in this ROD, may present an imminent and substantial endangerment to public health and the environment. Benzene, which is present in JP-4, is the most prevalent and mobile of the contaminants at OU-2. Where benzene or JP-4 is referred to in this ROD, all of the chemicals of potential concern exceeding action levels are also included by reference and will be treated by the selected remedy.

1.4 Description of the Selected Remedy

The data gathered for OU-2 indicate that the concentration of contaminants present in the surface soils (first foot of soil) do not require further action, but the concentration of contaminants present in the subsurface soils (soils below one foot) to 25 feet in depth and in the groundwater warrant further action. The JP-4 floating on and dissolved in the groundwater will continue to contaminate groundwater for many years, as discussed in the OU-2 RI Report, Section 5.0, Contaminant Fate and Transport. The subsurface soils below the 25-foot depth have been placed in OU-3 for further investigation at a later date.

The major actions of the selected remedy are:

- Free-phase product and groundwater will be extracted using an estimated series of up to 2 horizontal or 16 vertical extraction wells. The exact number, type, and location of wells will be determined during the remedial design phase as a result of aquifer tests conducted after well installations. There is approximately 0.65 to 1.4 million gallons of free-phase product floating on top of the aquifer. Total fluids pumping will be conducted at estimated flow rates between 30 and 60 gallons per minute (gpm) from the shallow aquifer using the extraction wells to maintain hydraulic control of the plume and to reduce contaminant concentrations. There is approximately 170 million gallons of groundwater contaminated with benzene above the drinking water action level of 0.005 mg/L.

- Fluids extracted from the ground will be passed through an oil/water separator in order to capture all free-phase product prior to treatment of the water. Free-phase product will either be reused by an approved vendor or disposed of at an authorized offsite disposal facility.

- Pretreatment, as needed, of the extracted groundwater will be conducted (e.g., precipitation, flocculation, clarification, filtration, acid treatment, etc.) to remove solids that may potentially interfere with the treatment for contaminants. The specific system specifications will be developed from treatability studies conducted during the remedial design phase, if required.

- Pretreatment, as needed, of the extracted groundwater will be conducted (e.g., precipitation, flocculation, clarification, filtration, ion exchange, etc.) to reduce the concentration of metals to action levels identified in Chapter 6.0 and Appendix A of this document. Section 6.1.1 provides details for including this treatment contingency. The detection of certain metals during the remedial investigation may have been erroneous and additional sampling during the remedial design phase will confirm or eliminate the need for this treatment. Treatment system specifications will be developed from treatability studies conducted during the remedial design phase, if this treatment is required.

- Treatment of the extracted groundwater will be provided by twin air stripping columns in series to reduce volatile contaminant concentrations to action levels identified in Section 6 and Appendix A of this document. Contaminant concentrations in groundwater requiring treatment are identified in Chapter 6.0 and Appendix A. Treatment will achieve greater than 99 percent removal of volatile contaminants. The columns will be 2.5 feet in diameter with 18 feet of packing each and 500 cubic feet per minute (cfm) of air flow each.

- Posttreatment, as needed, of the extracted groundwater will be conducted (e.g., liquid-phase carbon adsorption) to reduce semi-volatile organic concentrations to cleanup levels identified in Chapter 6.0 and Appendix A of this document. Section 6.1.1 provides details for including this treatment contingency. The detection of certain phthalate compounds during the remedial investigation may have been erroneous and additional sampling during the remedial design phase will confirm or eliminate the need for this treatment. Treatment system specifications will be developed from treatability studies conducted during the remedial design phase, if this treatment is required.

- Treated groundwater will either be injected back into the shallow aquifer to assist in maintaining hydraulic control and to avoid depletion of the aquifer or will be discharged to the Base wastewater treatment plant for beneficial use on the Base golf course. A number of factors will be evaluated to yield a decision by Parties to the Federal Facility Agreement (FFA) to inject treated groundwater back into the aquifer and/or to discharge the treated groundwater into the Base sanitary sewer for beneficial use on the Base golf course. These factors include, but are not limited to the following: (1) the results of aquifer measurements made during a given remediation period; (2) the ability of injection wells to accommodate the extraction rate; and (3) identified need for irrigation of the Base golf course. Based on current estimates, four injection wells are planned. Their exact number, type, and location will be determined during the remedial design phase.

- Soil treatment of the first 25 feet of soil (54,000 cubic yards) using bioenhanced soil vapor extraction (SVE) will be provided. Vapor-phase nutrients will be introduced to enhance biodegradation of soil contaminants. Other biological enhancements (introduction of aerobic microbes, anaerobic microbes, aerophilic microbes, liquid-phase nutrients, enzymes, and etc.) may be used if appropriate treatability studies or equivalent data are reviewed and indicate that significant remedial benefits would be accrued.

- SVE will be implemented using approximately 64 extraction wells, 32 passive vent wells, a vacuum system to remove 500 cfm of air from wells, and a nutrient addition system. Contaminant concentrations in soil requiring treatment are identified in Chapter 6.0 and Appendix A. Bioenhanced SVE will achieve greater than 94 percent reduction of benzene, and 64 percent reduction of 1,4-dichlorobenzene. The exact number of wells will be determined during remedialdesign.

- Treatment of SVE and air stripping emissions will be provided using fume incineration to meet ambient air quality and destruction and capture requirements. Treatment will achieve greater than 99 percent reduction of benzene, 1,4-dichlorobenze, naphthalene, and toluene. In the event that the fume incinerator cannot technically achieve an acceptable emission level of less than three pounds per day of organic vapors, then a vapor-phase carbon adsorption unit will be installed and used instead of the fume incinerator. Process details for these alternative air emission treatment systems include:

    - Air stripping abatement by carbon - each stripping column would have dual-bed, series adsorbers each containing 2,000 pounds of carbon with carbon usage at 300 pounds/day
    - Air stripping abatement by fume incineration - unit would be rated at 1.2 million British thermal units (BTU)/hr, 1000 cfm, with fuel usage at 33.6 million BTU/day
    - SVE abatement by carbon - SVE system would have 2 dual bed systems with each bed containing 11,000 pounds and using 6,800 pounds of carbon per day in the first year, 1,500 pounds per day in the second year, and 1,200 pounds per day in the third year.
    - SVE abatement by fume incineration - unit would be rated at 0.6 million BTU/hr, 500 cfm, with fuel usage at 11 million BTU/day in the first year, 5.5 million BTU/day for the second and third years.

- Institutional activities will be taken to impose restrictions on installation of new wells and limiting soil excavation to 10 feet in depth at the ST-12 site.

This remedy will include adding several new groundwater monitoring wells to evaluate the extraction system effectiveness in containing and remediating contaminants in the groundwater. It will also require soil monitoring to evaluate the removal of contaminants from the soils.

1.5 Declaration

The selected remedy for OU-2 is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial actions, and is cost effective. The OU-2 remedy utilizes permanent solutions and alternative treatment or resource recovery technologies to the maximum extent practicable and satisfies the statutory preference for remedies that employ treatments to reduce toxicity, mobility, or volume as principal elements.

This remedy is part of a larger Base-wide remedial action and is consistent with such an action. Additional operable units will be designated to fully address other areas of potential contamination at the Base. The USAF is conducting remedial investigations at Williams AFB to determine the presence and extent of contaminants and will be developing final remedial alternatives for Base-wide remedial action. Because hazardous substances will remain on-Base above health-based levels while groundwater and soil treatment occurs at OU-2, a review will be conducted within 5 years after commencement of the remedial actions selected in this ROD to ensure the remedy continues to provide adequate protection of human health and the environment.

This Record of Decision for Operable Unit Number Two at Williams Air Force Base, Arizona may be executed and delivered in any number of counterparts, each of which when executed and delivered shall be deemed to be an original, but such counterparts shall together constitute one and the same document.

2.0 Decision Summary

2.1 Site Name, Location, and Description

Williams AFB is a flight training base located in Maricopa County, Arizona approximately 30 miles southeast of Phoenix and just east of Chandler (See Figure 2-1). The Base, commissioned as a flight training school, was constructed on 4,127 acres of government land in 1941. There are runway and airfield operations, industrial areas, housing, and recreational facilities on the Base. Training activities started after construction with jet aircraft training starting in 1949. The Base is currently active, but Base closure is programmed for the future.

This ROD addresses remedial actions for OU-2, which is a partially decommissioned LFSA (ST-12) on Williams AFB covering approximately 4.4 acres (Figure 2-2). The OU-2 RI focused primarily on approximately 2.8 acres in the vicinity of distribution lines and tanks where AVGAS and JP-4spills and leaks have occurred. A portion of the 2.8 acres investigated lies beyond the surface boundary of OU-2 shown in Figure 2-2 due to the aerial extent of the groundwater contaminant plume.

Williams AFB is relatively isolated from any large metropolitan area - it is surrounded primarily by agricultural land. This land lies in a valley that has had a long history of intensive agricultural use, predominantly for crops of citrus, cotton, and alfalfa. Smaller urban areas such as Mesa, Chandler, Gilbert, and Apache Junction are located 5 to 15 miles northeast and northwest of the Base. The Queen Creek and Chandler Heights areas are approximately 5 miles south and west of the Base boundary. Table 2-1 lists these towns and others by distance and direction from William AFB. These areas are separated from the Base by cultivated and uncultivated land.

There are 3,029 military personnel and 869 civilian employees stationed at the Base. Many of the military personnel live off Base in one of the surrounding areas. The total population actually living on Base, including dependents, is approximately 2,700. On an average workday, the population of the Base increases to more than 5,000 because of the influx of both civilian employees and military personnel who live off base (Cost Branch Controller Division, 1987).

A development plan for the region (Sunregion, 1987), if implemented, will dramatically alter the region surrounding Williams AFB. The portions of the development plan of most importance to the Base are the East Mesa Subarea Plan and the Queen Creek-Chandler Heights Plan. The former proposes development for portions of the City of Mesa, the Town of Gilbert, the City of Apache Junction, and the land area north of Williams AFB. The proposed land area for the Queen Creek-Chandler Heights Plan is east of Chandler, just south of the Base in the approximate location of the Town of Queen Creek. The plan is to develop the proposed area residentially and commercially for a 25-year period. If implemented, this development will dramatically impact the demographics and population around the Base. In addition, Williams AFB is currently scheduled for closure, and this action could also impact the region.

This development plan may be altered by the recommendations of a noise exposure and land use compatibility study sponsored by the Maricopa Association of Governments (MAG) (Barnard Dunkelberg & Company, 1988). After analysis of existing and projected noise contours resulting from Base operations, recommendations were made for mitigating noise impacts in the area. These recommendations will preclude new residential development within 1 to 4 miles beyond the east, southeast, and northwest boundaries of the Base. Restricted development is recommended for areas within 1 to 6 miles beyond the boundary of the Base in all directions; however, land use limitations due to noise impacts within these areas will be lifted if Base closure occurs and flight operations at the Base end.

There are no major surface water bodies within a 10-mile radius of the Base. The Base lies between the 100-year and 500-year flood level for streams in the Gila River Basin (U.S. Department of Housing and Urban Development, 1979). Storm drainage on the Base is directed to a combination of open channels used to drain most of the Base and underground drainage structures. Storm drainage from the Base flows either to the Roosevelt Water Control District (RWCD) floodway that flows southward in the vicinity of the Base or directly to the floodway west of the Base, or into the wastewater treatment plant. OU-2 does not connect to the storm runoff ditch systems at the Base. There are at least 90 domestic permitted wells within a 3-mile radius of the Base. These wells are not affected by the contamination at OU-2. The Base currently performs quarterly monitoring of wells on the Base in the vicinity of OU-2.

The climate of Williams AFB is similar to that of Phoenix and the rest of the Salt River Valley. The temperature ranges from very hot in the summer to mild in winter. Rain comes mostly in two seasons - from late November until early April and in July and August. Average annual precipitation is approximately 7.1 inches. Humidities range from approximately 30 percent in winter to 10 percent in summer. Williams AFB is also characterized by light winds. Evapotranspiration rates in the area exceed -65 inches per year.

Williams AFB lies in the eastern portion of the Basin and Range Physiographic Lowlands Province of south central Arizona, which is located in the Salt Rivery Valley. The local topography is controlled by large-scale normal faulting that has resulted in the formation of broad, flat, alluvial-filled valleys separated by steep isolated hills and mountain ranges. ADWR's hydrologic maps show the Base bounded to the north by the Usery Mountains, to the east by the Superstition Mountains, to the south by the Santan Mountains, and to the west by South Mountain.

The topography of the Base slopes gently to the west with a generally less than 1 percent grade. Elevations range from 1,326 feet above mean sea level (msl) on the west side of the Base to 1,390 feet above msl at the southeast corner of the Base.

According to Laney and Hahn (1986), the area of the Base is underlain by six geologic units: crystalline rocks, extrusive rocks, red unit, lower unit, middle unit, and upper unit. The crystalline and extrusive rocks comprise the surrounding mountains and the basement complex underlying the consolidated and unconsolidated sediments of the valley. The four units overlying the basement complex are of sedimentary origin and have the surrounding mountains and local drainage as their source areas.

The red unit immediately overlies the basement complex and is composed of well-cemented breccia, conglomerate, sandstone, and siltstone of continental origin with interbedded extrusive flow rocks.

The lower unit overlies the red unit and consists of playa, alluvial fan, and fluvial deposits with evaporites and interbedded basaltic flows present in lower sections (Laney and Hahn, 1986).

The middle unit overlies the lower unit and is composed of playa, alluvial fan, and fluvial deposits with no associated evaporites. The middle unit received its sediment primarily from the Salt River, whereas the lower units had the local mountains as the principal source.

The youngest unit in the stratigraphic sequence is referred to as the upper unit. The unit consists of channel, floodplain, terrace, and alluvial fan deposits of largely unconsolidated gravel, sand, silt, and clay.

Geological conditions beneath OU-2 were characterized by using a combination of continuous coring and geophysics. The deposits encountered during drilling at OU-2 are correlative to the upper unit of Laney and Hahn (1986) and possibly to the extreme upper section of their middle unit.

There are two major soil associations found in the vicinity of Williams AFB. The Mohall-Contine Association is found over much of the Base, and the Gillman-Estrella-Avondale Association is found at the southern boundary of the Base. The Mohall-Contine and the Gillman-Estrella-Avondale Associations have generally the same characteristics, being well drained and nearly level with slopes of less than 1 percent.

Because of a decline in the water table produced by excessive irrigation withdrawals over the past 50 years, an extensive vadose zone has been produced in the vicinity of Williams AFB. Presently beneath OU-2, the vadose zone extends to approximately 220 feet below ground surface (the depth to the water table). The low rainfall and high evapotranspiration rate of the area result in a very low potential for recharge to occur through the soil comprising the vadose zone. To the west and south of the Base, extensive irrigation results in a potentially significant amount of recharge to the uppermost aquifer through these sediments.

The hydrogeology of the sediments investigated immediately beneath ST-12 is characterized by the presence of two unconnected saturated zones. Only the uppermost aquifer is included in OU-2 because the deep aquifer has not been affected by the contamination. Although these two saturated zones are not connected beneath OU-2, they are part of a thick multi-aquifer system that is interconnected to various degrees in a broader geographical perspective. Beneath the uppermost saturated zone is a very low permeability, laterally extensive, fine-grained layer approximately 20 feet thick. This layer is interpreted as the lower confining layer for the uppermost saturated zone.

Groundwater flow in both aquifers is predominantly to the east and southeast.

2.2 Site History and Enforcement Activities

Williams AFB is a flight training base that opened in 1942. It was immediately commissioned as a flight training school and training activities with jet aircraft were started in 1949. Throughout its history, pilot training has been the primary activity at Williams AFB. At various times, bombardier, bomber pilot, instrument bombing specialist, and fighter gunnery training schools were also housed on Base. Over the years, a wide variety and large number of aircraft have been based at Williams AFB, including the current training aircraft, the T-37 and T-38.

2.2.1 Site History

Liquid fuels have been stored at OU-2 since 1942. Primary storage was in a series of underground storage tanks (UST) at Facilities 688, 514, 538, and 548. Aboveground storage tanks located at Facilities 556 and 557 were constructed in 1962 and 1954, respectively.

OU-2 was investigated because of fuel leaks and the age of the system. It was closed in August 1988 except for the aboveground tanks at Facilities 556 and 557. During late 1990 and early 1991, fourteen underground tanks at Facilities 688, 514, 538, and 548 were removed along with the distribution lines leading to them. In addition, 5 steel tanks were discovered and removed, bringing the total to 19 underground tanks.

Eight soil borings were installed by Aero Vironment, Inc. (AV) in 1984. During the next phase of the investigation in 1986, soil organic vapor (SOV) surveys were conducted along distribution lines and near buried tanks to determine if there was evidence of leakage. Thirty-eight soil borings were then installed by AV as a result of the SOV survey.

IT Corporation (IT) completed two SOV surveys in 1989, collecting and analyzing 52 vapor samples. The results of these surveys were used to establish the location of five soil borings that were installed to collect subsurface soil data in 1989. Ten surface soil samples were collected and analyzed in August 1991 to further characterize OU-2. The soil boring and SOV survey locations are shown in Figure 2-3.

Thirty-six groundwater monitoring wells had been installed at OU-2 as of October 1991. An initial groundwater sampling round was performed by AV, followed by subsequent groundwater sampling by IT. During the period groundwater sampling was performed, floating free-phase product was measured in monitoring wells. The free-phase product thickness varied from a sheen to approximately 15 feet in 5 monitoring wells. The location of the monitoring wells are shown in Figure 24.

Results of these historical sampling activities can be found in Section 4.0.

2.2.2 Enforcement Activities

Installation Restoration Program (IRP) guidance was received for Williams AFB in July 1983 and the initial assessment study was completed by Engineering-Science (ES) in 1984. Based on a review of available records pertaining to chemical handling and disposal practices, interviews with site personnel, and a site survey of activities at Williams AFB, several potential sites where hazardous materials had been handled or disposed were identified.

AV performed an investigation from September 1984 to December 1985, which was initiated to confirm the information in the ES report and to verify the presence and quantify the extent of contamination. In 1987 AV completed an additional investigation to define the most likely pathways for contaminant migration from each site and to confirm the presence or absence of contamination along those pathways.

In October 1988, the Air Training Command (ATC) contracted Martin Marietta Energy Systems, Inc. (Energy Systems) and its subcontractor, IT, to complete the OU-2 RI/FS, proposed plan, and ROD at Williams AFB. These actions were initiated later in 1988.

Williams AFB was added to the NPL on November 21, 1989. As a consequence of inclusion on the NPL listing, negotiations were initiated and completed on a FFA for Williams AFB, which was signed on September 21, 1990 by the U.S. EPA, USAF, ADEQ, and ADWR (U.S. EPA, 1990b).

2.3 Highlights of Community Participation

A community relations plan for the Base was finalized in February 1991 (IT, 1991d). This plan lists contacts and interested parties throughout the USAF, government, and local community. It also established communication pathways to ensure timely dissemination of pertinent information through mailings, public announcements in the local paper, and local information repositories.

The OU-2 RI/FS was released for public review in May of 1992. This was followed by announcement in the Arizona Republic/Phoenix Gazette of the issuance of an OU-2 proposed plan for public comment and a public meeting. The 30-day public comment period on the proposed plan began on June 1, 1992, and the public meeting was held on June 16, 1992 in the City of Mesa, Arizona, to discuss the proposed groundwater and soil cleanup alternatives. All comments received during the public comment period are included in the Responsiveness Summary (Chapter 10.0), which also includes a response prepared by the USAF.

Technical Review Committee meetings are held periodically with representatives of the USAF, regulatory agencies, and the community. The meetings provide a forum for members of the community serving on this committee to be involved in decisions regarding investigation and Base cleanup activities.

An Administrative Record that contains the documents relating to investigations and cleanup activities proposed for the Base has been established and is available for public inspection at the Chandler and the Williams AFB Libraries. Additional information is available through the Williams AFB Public Affairs Office.

3.0 Scope and Role of Operable Unit

Currently three operable units have been identified at the Base. The groundwater and soil to a depth of 25 feet at ST-12 comprise OU-2. Groundwater and soil at 12 of the 13 other areas of the Base comprise OU-2. The contaminated soil below 25 feet at ST-12 and groundwater and soil at theremaining area will be addressed in OU-3. OU-2 is addressed by this ROD while the remainder of the sites will be addressed in the OU-1 and OU-3 RODs. The Base-wide remedy will be addressed in the Base-wide OU-3 ROD.

The principal potential risk to human health and the environment at OU-2 is from JP-4 contamination of groundwater. Delays in remediating the groundwater in the upper aquifer could potentially allow contamination to spread to a deeper aquifer, making remediation more difficult and costly. Another potential risk to human health and the environment is from JP-4 contamination of soil to a depth of 25 feet at OU-2.

Data have shown that chemical-specific applicable or relevant and appropriate requirements (ARAR), Arizona Health-Based Guidance Levels (HBGL) for soil, or other risk-based levels to be considered have been exceeded in the groundwater and the first 25 feet of soils at OU-2. Because of this the groundwater and top 25 feet of soil ST-12 was designated as an operable unit to more responsively initiate action to mitigate potential threats to human health and the environment. The remedy selected in this ROD is designed to be consistent with any subsequent remedies and planned future actions at the Base proposed in all subsequent RODs.

4.0 Summary of Site Characteristics

Based on investigations that began in 1984 and continued through February 1992, a number of contaminants were detected in both the first 25 feet of soil and in the groundwater at ST-12 (also called OU-2). The occurrence of these chemicals are summarized in Table 4-1 through 4-4. The soils below 25 feet at ST-12 are not included in OU-2 and will be addressed at a future date as part of OU-3.

The OU-2 RI data document releases of petroleum products to the environment from underground pipelines and tanks at OU-2. The principal environmental concerns at OU-2 are associated with (1) jet fuel constituents that remain in the top 25 feet of soil, and (2) jet fuel constituents that have migrated into the groundwater.

The remainder of this section summarizes the chronology and findings of remedial investigations at OU-2. Potential routes of exposure and risks to human health and the environment from the contaminated soil and groundwater are summarized in Chapter 5.0. Detailed presentations of both the findings of the remedial investigation and the risk assessment can be found in the OU-2 RI report. Applicable or relevant and appropriate requirements (ARAR) and other criteria to be considered (TBC) are presented in Appendix A. Taken together, Chapters 4 and 5 and Appendix A establish the comprehensive list of chemicals of potential concern for surface soil, subsurface soil, and groundwater at OU-2 and their respective action levels. Chapters 6, 7, and 8 detail the FS, including the alternatives considered, and present the selected remedy.

4.1 Soil Contamination

Soil investigations at OU-2 unfolded in essentially four stages. The first two phases were conducted by AV in 1984 and 1986. The last two stages were conducted by IT in 1989 and 1991.

Chemicals and metals were detected in the first 25 feet of soil at OU-2. Subsurface (i.e., below 1 foot in depth) soil samples from eight borings installed by AV in 1984 showed levels of total organic halogens (TOX), oil and grease, lead, and phenol above detection limits or above generally considered background levels. During the next phase of the investigation in 1986, SOV surveys were conducted by AV along distribution lines and near buried tanks to determine if there was evidence of leakage. Nine areas, five exhibiting levels of benzene, toluene, ethyl benzene, and xylene (BTEX) above detection levels, were identified by AV as indicating possible leaks in lines and tanks. Subsurface soil samples from the first 25 feet of soil from some of the 38 soil borings installed by AV showed levels exceeding detection limits for nine organic chemicals, heavy metals, and total petroleum hydrocarbons (TPH) (Table 4-1). Most borings were drilled to less than 50 feet, but one drilled to 210 feet detected contamination throughout its entire depth.

IT completed two SOV surveys in 1989, collecting and analyzing 52 vapor samples. Readings near Facility 555 above detection levels led to the discovery of a leak in a distribution line. The results of these surveys guided the location of five borings that were installed by IT to a maximum depth of 100 feet. Twenty-four organic chemicals, heavy metals, and TPH were detected in subsurface soil samples taken from these borings (Table 4-2).

Ten surface soil samples were collected and analyzed in August 1991 by IT. The results of these surface soil analyses indicate that the fuel related contamination is not generally present at the surface. Table 4-3 shows the 29 organic chemicals, heavy metals, and TPH that were detected in surface soil samples collected by IT, along with ranges of background concentrations. Note that results are either below action levels identified in Appendix A, Table A-2, or within background ranges. The results of the 4 phases of soil investigations allowed the areas of possible soil contamination to be delineated near Facility 548, along the fuel distribution line near Facility 555, along the distribution line southwest of Facility 514, and at Facility 688. Using cleanup levels established in Appendix A, Table A-4, the contamination found in OU-2 soils is estimated to be approximately 54,000 cubic yards of contaminated soils in four areas as shown in Figure 4-1.

4.2 Groundwater Contamination

Thirty-six monitoring wells (both shallow and deep) have been installed at OU-2 as of February 1992. Organic vapors were detected during the installation of several of these wells, which, in one instance, led to locating a leak in a distribution line near Facility 514. Eight organic chemicals and metals were detected in initial groundwater sampling by AV; 33 organic chemicals, metals, and TPH were detected in subsequent sampling by IT. A groundwater sampling data summary is provided as Table 4-4, which includes TPH and 36 organic chemicals and heavy metals as chemicals identified by AV and IT in the groundwater monitoring wells at OU-2.

Floating free-phase product was measured in five of the wells sampled, varying from a sheen to a thickness of approximately 15 feet. The estimated extent of the free-phase floating JP-4 plume beneath OU-2 is shown in Figure 4-2 based on measured product in July 1991 and modeling. The magnitude of the free product plume has been estimated to be between 650,000 and 1,400,000 gallons.

The estimated extent of the dissolved plume also shown on Figure 42 is based on July 1991 benzene concentration data. The extent of the plume delineated at less than 5 parts per billion (ppb) in all directions has not been estimated at this time. The dashed line on the figure indicates the areas of uncertainty in the plume boundary. Benzene was chosen as an indicator for defining the boundary of the groundwater contamination plume because it poses the greatest danger to human health and the environment of the organic chemicals and heavy metals that were detected in groundwater at OU-2. The 5 ppb level is the drinking water standard for benzene promulgated by the National Primary Drinking Water Regulations. The volume of contaminated groundwater within the 5 ppb line is approximately 170 million gallons.

4.3 Contaminant Fate and Transport

Contaminant fate and transport was addressed in the OU-2 RI report, Section 5.0. A brief synopsis is presented below.

4.3.1 Chemical Persistence

The mobility of organic compounds within the saturated zone is affected by chemical processes that are in part dependent on their volatility, the octanol-water partitions coefficient (K[ow]), the water solubility, and the concentration. In general, the more water insoluble an organic compound is, the more hydrophobic it is and the more likely it is to be absorbed on a sediment or organic surface. These compounds also have a tendency toward self association in a polar medium such as water. Hydrophobic compounds tend to have a higher K[ow] and a greater affinity to organic matter contained within the sediment matrix. Compounds such as benzene with high aqueous solubilities have relatively low K[ow]s. Migration of these compounds tends to be more rapid than compounds such as phthalate, pesticides, or large aromatic compounds that have low solubilities and high K[ow]s. Even compounds with relatively low K[ow]s will, however, exhibit some attenuation if the organic content of the soil/aquifer matrix is high. However, the organic content of the soil/aquifer matrix at Williams AFB is relatively low.

For several groups of compounds, including phenols, phthalate, and monocyclic aromatics (benzene, toluene, and xylene), volatilization, sorption, and biodegradation are all prominent processes. Generally, in surface waters volatilization dominates, whereas in the subsurface environment, biodegradation or sorption will dominate depending on the amount of natural humic material in the receiving soils and the availability of oxygen.

For information concerning persistence in the environment for specific chemicals, see Section 5.2 in the OU-2 RI Report.

4.3.2 Contaminant Migration

Contaminant transport modeling of the dissolved-phase contaminants was carried out using the two-dimensional, finite difference solute transport (Methods of Characteristics, MOC) computer model developed by Konikow and Bredehoeft (1978). This modeling was carried out to establish the transport characteristics of the uppermost aquifer and to provide an estimate of contaminant concentrations and gradients for the BTEX compounds in support of a baseline risk assessment.

The plume area predicted by the model was in agreement with the historical distribution of benzene over much of the site; however, the distribution of toluene, ethyl benzene, and xylene was overestimated in most cases, especially at the plume edges.

This modeling investigation predicted that concentrations of BTEX compounds in groundwater resulting after 70 years of contamination from a continuous, nondiminishing source would be approximately 20 ppm for benzene and toluene, and between 1 and 4 ppm for ethyl benzene and xylene. The plume periphery for each of these compounds would have migrated far beyond the boundary of OU-2. These results showed that groundwater in the area would be significantly affected over the long term if no remediation is initiated.

For information or modeling specifics concerning contaminant migration, see Section 5.3 in the OU-2 RI Report.

5.0 Summary of Potential Site Risks

5.1 Chemicals of Potential Concern

The baseline risk assessment identified the chemicals of potential concern at OU-2. This identification process included summarizing the analytical data for OU-2 and evaluating the data according to U.S. EPA guidelines for CERCLA risk assessments (U.S. EPA, 1989). Chemicals of potential concern were selected from the list of all detected constituents based on the following:

- Frequency of detection - if chemicals were detected at greater than 5 percent frequency

- Comparison to method blanks - if sample concentrations exceeded laboratory blank concentrations by 10 times for common laboratory contaminants and 5 times for all other analytes

- Comparison to background - if the range of concentrations from OU-2 samples exceeded the range of background values.

This evaluation and selection process is discussed in greater detail in the OU-2 RI Report. Section 6.2. All organic chemicals and metals selected as chemicals of potential concern were carried forward through the risk assessment calculations.

5.1.1 Groundwater

Of the 36 organic chemicals and metals detected in the groundwater, 21 were identified as chemicals of potential concern and are presented in Table 5-1. The list includes nine potentially fuel-related organics (benzene, ethyl benzene, 2-methylnaphthalene, 2-methylphenol, 4-methylphenol, naphthalene, phenol, toluene, and xylene), five non-fuel related organics (bis[2-ethylhexyl]phthalate, 1,2-dichloroethane, methylene chloride, tetrachloroethene, and trichlorofluoromethane) and seven metals (antimony, chromium, copper, lead, nickel, silver, and zinc). These metals are unlikely to be site-related; however, due to the difficulty in obtaining representative background concentrations for comparison, they were carried into the risk assessment.

5.1.2 Soil

Of the 28 organic chemicals and metals detected in subsurface soil at OU-2, including soils below 25 feet, 19 were identified as chemicals of potential concern and are presented in Table 5-2. The list includes twelve potentially fuel-related organics (benzene, chlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4dichlorobenzene, ethylbenzene, 2-methylnaphthalene, 4-methyl-2-pentanone, naphthalene, phenol, toluene, and xylene), four non fuel-related organics (acetone, bis[2-ethylhexyl] phthalate, 2-hexanone, and methylene chloride), and three metals (cadmium, antimony, and lead). Of the above, 2-Hexanone, 2methylnaphthalene, 4-methyl-2-pentanone, naphthalene, phenol, and cadmium were detected at depths below 25 feet and will be addressed as part of the OU-3 remedial investigation, not as part of this OU-2 ROD.

Of the 29 organic chemicals and metals detected in the surface soil (first foot of soils) samples, 6 were identified as chemicals of potential concern and are presented in Table 5-3. These six organic chemicals and metals (acetone, beryllium, bis[2-ethylhexyl] phthalate, cadmium, diethylphthalate, and di-n-butylphthalate) are not fuel-related and are probably not site-related, as supported below.

Acetone and the phthalate compounds are common sampling and analytical contaminants and are ubiquitous in environmental sampling efforts. To be health protective, they are included in the risk assessment because blank contamination for these chemicals could not be conclusively documented. Section 5.4 documents that they do not represent risk at levels of concern.

Beryllium and cadmium were the only two metals not eliminated from the list of chemicals of potential concern based on background concentrations. Cadmium could not be excluded from the list of chemicals of potential concern because no background concentration data was available for this metal; however, cadmium in surface soils does not present a significant risk, as discussed in Section 5.4. The beryllium background concentrations from the Phoenix area range from 1.0 to 1.5 ppm. The range of detected beryllium concentrations (2.3 to 3.5 ppm) was only slightly above this background concentration range. It is also documented that beryllium is released to the atmosphere during the combustion of fossil fuels, such as flight operations at the Base, and it subsequently deposits on the ground surface. Therefore, background levels of beryllium in surface soils could be elevated due to the nearby combustion of fossil fuels (U.S. EPA, 1984). There are uncertainties to consider with the comparison to background data (i.e., sufficient background data were not available for a statistical comparison to be made) and the available background data are regional published data rather than site-specific data. These considerations were included in the evaluation of the potential risks associated with exposure to surface soil along with the fact that the measured beryllium levels were nearly equivalent to background.

5.2 Exposure Assessment

Under the current land-use scenario, the potential exposure pathways evaluated include incidental ingestion of soil, dermal contact with soil, and inhalation of fugitive dust. The receptor evaluated for these pathways was an on-site Base worker. Because there are currently no production wells in the contaminated area, no pathways were evaluated for groundwater under the current land-use scenario.

The potential exposure pathways evaluated under the future land-use scenario include ingestion of groundwater, inhalation of chemicals volatilized from groundwater during household water use, incidental ingestion of soil, and dermal contact with soil. Because residential development is possible in the future, a residential receptor was evaluated for these pathways.

5.2.1 Groundwater

The chemicals detected in the groundwater at OU-2 have not been detected in any on- or off-Base production wells. This groundwater does not discharge to the surface anywhere in the area; therefore, there is currently no contact point for human or environmental exposure to these chemicals in groundwater.

Potential future migration of the chemicals present in the groundwater at OU-2 has been modeled. The results of this modeling indicate that the site-related chemicals are not expected to affect any existing Base production wells since these wells (BP-05, BP-06, and BP-08) are located upgradient (west) of the contaminant plume. The shallow aquifer that exists at OU-2 does not appear to exist in the eastern portion of the Base where Base production well BP-07 is located. Any constituents that reach the eastern-most extent of the shallow aquifer or any contaminants currently in the deep aquifer would be expected to travel north in the deep aquifer from this point rather than continuing east. If, under a future land use scenario, a production well were to be developed inside the plume, the risks to residential receptors have been evaluated and are presented in the baseline risk assessment. The parameters used for this evaluation are an adult exposure of 30 years, a body weight of 70 kg, and an ingestion rate of 1.4 L/day. Exposure point concentrations can be found in the OU-2 RI Report, Table 6-10.

5.2.2 Surface Soil

Access to chemicals in soil at OU-2 is currently limited by fencing. Therefore, juvenile and adult residents and visitors to the Base are prevented from contacting the soil. Because this is a fenced area on an active military base, the potential for a trespasser to contact this area is extremely low, and the potential for repeated contact is negligible. For these reasons, the trespasser scenario was not evaluated in the risk assessment. It is possible that workers in these areas may contact the soil and may be exposed to site-related chemicals via ingestion and dermal contact. In the future, after the Base is closed, it could be possible for both children and residents to come into contact with the soil. This could result in exposure via ingestion and dermal contact with soil. The parameters used for the evaluation of residential exposure include a 30-year exposure period divided between a 6-year juvenile exposure and a 24-year adult exposure. Body weights used were 16 kg for a juvenile and 70 kg for an adult. Ingestion rates used were 200 mg/day for juveniles and 100 mg/day for adults.

Future residential development could result in exposure via uptake of chemicals from the surface soil into homegrown vegetables. Because this pathway has a much greater level of uncertainty than direct ingestion, it was addressed qualitatively in the risk assessment. Given the negligible risks estimated for incidental ingestion and dermal adsorption, the addition of this pathway was not expected to result in an unacceptable risk. To substantiate this position, Table 5-4 presents the estimated exposure to chemicals in surface soils through a vegetable ingestion pathway. (Acetone is not shown in the table because it was assumed that it would volatilize before it could be taken up by vegetables.) The tables shows that the potential for adverse impacts due to ingestion of homegrown vegetables is negligible.

Base personnel who work at ST-12 may also be currently exposed to volatile organic compounds (VOCs) and fugitive dust. The only volatile compound detected in surface soil was acetone in samples at concentrations of 2 to 33 ppb. Therefore, inhalation of volatiles was not considered to be a significant potential pathway for exposure at OU-2. Nonvolatile chemicals may become airborne via fugitive dust. This pathway was evaluated for these chemicals. Other potential receptors (residents, visitors, and other Base personnel) may also be exposed to airborne chemicals; however, airborne concentrations will decrease rapidly outside the site boundary, and these receptors will tend to be transient (i.e., they will not remain at the fence line for prolonged periods). Because evaluation of the dispersion of fugitive dust on site resulted in negligible potential airborne chemical concentrations, off-site residential exposure was not quantified for this pathway.

A screening approach was taken to verify the assumption that inhalation is not a significant pathway for chemicals detected in surface soil at OU-2. The potential airborne concentration of vapor-phase acetone was evaluated for an on-site worker and a resident at the nearest on-base housing (approximately 150 meters southwest of OU-2). Acetone was used because it was the only volatile compound detected in the surface soil at OU-2. The potential airborne concentration of beryllium as fugitive dust was evaluated for an on-site worker and a resident of on-Base housing. Beryllium was used because it was found at the highest concentration of any carcinogen in the surface soil at OU-2. The evaluation showed that this pathway is a negligible contributor to the total potential exposure at OU-2.

5.2.3 Subsurface Soil

There is currently no potential for contact of subsurface soils to receptors. VOCs may volatilize into pore spaces and migrate upward toward the surface. Due to the depth of the contamination and the distance to the nearest residential area, this is not considered a significant potential exposure pathway. The potential airborne concentration of benzene was evaluated for an on-site worker and a resident at the nearest on-Base housing (approximately 150 meters southwest of OU-2) to verify this assumption. Benzene was used because it was found at the highest concentration of any volatile carcinogen at OU-2. The evaluation showed that this pathway is an insignificant contributor to the total potential exposure.

Chemicals present in subsurface soils may become available to receptors in the future as a result of leaching to groundwater (assuming a production well is installed in the area) or deep excavation of the area. Because pan evaporation in Phoenix exceeds precipitation, no net infiltration of rainfall into the soil is expected to occur. Without infiltration, leachate cannot form and any petroleum hydrocarbon residue adhering to the soil will tend to remain in place. The petroleum hydrocarbons that have reached the groundwater appear to have originated from subsurface leaks in petroleum pipelines or tanks and flowed downward from that point to the water table. These pipelines and tanks have been removed, so no additional petroleum hydrocarbons are expected to reach groundwater from this source (i.e., the pipeline leaks). Possible leaching of the hydrocarbons in the ST-12 soils below 25 feet into the groundwater may occur and will be addressed in OU-3.

Future land use after Base closure could include irrigating agriculture, but infiltration to the water table would not occur unless the annual irrigation rate exceeds 72 inches (NOAA, 1968, 1983). If there was infiltration of water through the soil to the water table, the residual hydrocarbon in the soils would be dissolved by the infiltrating water and could leach to the water table.

Direct contact is not expected for soils deeper than 10 feet under a future residential development scenario (Reynolds et al., 1990). Based on data gathered from the site, the majority of the contamination at the site is below 10 feet deep.

5.3 Contaminant Toxicity Information

This section provides information regarding the type and severity of adverse health effects associated with exposure to the chemicals of potential concern in groundwater and soil and a measure of the dose/response relationship for each. These dose/response relationships are provided in the form of U.S. EPA-approved reference doses (RfD) and cancer potency factors (CPF). This information is summarized in Tables 5-5 through 5-8. RfD in this context refers to the chronic reference dose, which is an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects for long-term exposures to a compound. The CPF (or slope factor) is an estimate of the probability of a response (cancer) per unit intake of a potential carcinogen over a lifetime. The CPF is used to estimate an upper-bound probability of an individual developing cancer from a lifetime exposure to a particular dose of a potential carcinogen (U.S. EPA, 1989a). Further detailed information concerning the toxicity of individual chemicals is presented in Section 6.4 of the OU-2 RI Report.

Uncertainties associated with the RfDs for each chemical are addressed by U.S. EPA by modifying the results of animal and human studies by factors of 10, 100, or 1,000. An uncertainty factor of 10 is used when the RfD is based on chronic human studies. An uncertainty factor of 100 is used to account for the extrapolation of animals to humans when the RfD is based on experimental animal data. An uncertainty factor of 1,000 is used when the RfD is based on an animals' lowest observed effect level (LOEL) instead of a no observed effect level (NOEL). These uncertainty factors are designed to overestimate, rather than underestimate threshold limits for humans.

There are also several sources of uncertainty inherent in cancer slope factors. The weight-of-evidence classification is a qualitative estimate of the likelihood that a chemical will induce cancer in humans. These range from Group A (human carcinogen - sufficient evidence of carcinogenicity in humans) to Group E (evidence of noncarcinogenicity in adequate studies). Other uncertainties, as with RfDs, arise from high to low dose extrapolations, animal to human extrapolations, and intraspecies variation in experimental animals or human populations.

5.4 Risk Characterization

This section addresses the potential for adverse health effects (both cancer and other toxic effects) based on a quantitative characterization of risk. The risk characterization takes into account the magnitude of exposure to a chemical of potential concern (dose), as discussed in Section 5.2, and the chemicals' toxicity (Section 5.3). Risks are characterized for carcinogenic chemicals in terms of incremental lifetime cancer risk (ILCR), and for noncarcinogenic chemicals with other toxic effects in terms of a hazard index (HI). Both of these are discussed below.

5.4.1 Carcinogenic Effects

ILCRs were estimated for each carcinogenic chemical of potential concern and are expressed in terms of additional cancers that might be anticipated as a result of specific exposure to an external influence. Thus, a 1 x 10[-6] ILCR indicates that one additional person in one million is likely to develop some form of cancer. Estimation of ILCR is given by:

ILCR = (CPF)(CDI)

where:
ILCR = Incremental lifetime cancer risk (unitless)
CPF = Carcinogenic potency factor [(mg/kg/day)[-1]]
CDI = Chronic daily intake (mg/kg/day), equivalent to average daily intake.

The CPFs used are the most recent values developed by the Carcinogen Assessment Group (CAG) of U.S. EPA as cited in their Integrated Risk Information System (IRIS) data base (U.S. EPA, 1991a) and Health Effects Assessment Summary Tables (U.S. EPA, 1990c). The U.S. EPA recommends the use of an acceptable risk range (de minimis level) of 1 x 10[-4] to 1 x 10[-6] for CERCLA sites (U.S. EPA, 1990b). The results of the quantitative risk characterization for carcinogenic chemicals are shown in Tables 5-5 and 5-6.

For the current land use scenario (i.e., continued normal Base operations), the greatest ILCR associated with chemicals in the surface soil at OU-2 is from beryllium via incidental ingestion of soil (5.9 x 10[-6]). This is within the de minimis level of 1 x 10[-4] to 1 x 10[-6] set by the U.S. EPA in the NCP. In addition, the potential ILCR associated with naturally occurring beryllium in surface soils is 2.5 x 10[-6] in this area; therefore, the increased risk associated with beryllium in surface soils at OU-2 is not considered significantly elevated when compared to background and is considered essentially equivalent to the risk associated with the background levels. The next highest potential ILCR at OU-2 is associated with bis(2ethylhexyl)phthalate via incidental soil ingestion (1 10[-9]). For the current land use scenario, there are no potential exposure pathways from subsurface soils or groundwater, as stated earlier in this section.

If OU-2 becomes a residential area after Williams AFB is closed, the greatest potential ILCR associated with residential exposure to the soil (surface and subsurface were evaluated together as soil) is a result of beryllium via incidental ingestion of soil (1.2 x 10[-5]). Again, the ILCR estimated for beryllium is not significantly greater than that associated with naturally occurring background concentrations of this metal (background ILCR = 5.2 x 10[-6]), and the next higher ILCR, bis(2-ethylhexyl) phthalate via incidental soil ingestion (2 x 10[-9]), is below the de minimis level.

The potential for future development of production wells in the plume is small even after the Base is closed. A future residential scenario has been evaluated to provide an upper-bound estimate of potential risks associated with exposure to this groundwater. The greatest ILCR (6 x 10[-5]) associated with this scenario is from benzene in drinking water. The total ILCR associated with domestic use of groundwater from OU-2 by a residential population is 6 x 10[-5]. These potential risks would only exist if, after the Base is closed, a residential well is completed within the unremediated plume at OU2, a resident uses the groundwater at the levels assumed for 30 years, and there are no institutional controls such as deed restrictions.

5.4.2 Noncarcinogenic Effects

Chemicals that produce health effects other than cancer were evaluated in terms of their relative hazard when compared to acceptable exposure levels. The HI for exposure to noncarcinogens based on the ratio of the estimated daily intake to an acceptable daily exposure is as follows:

HI[i,p] = D[i,p]/RfD[i]

where:
HI[i,p] = Individual hazard index for exposure to constituent i through exposure pathway p
D[i,p] = Daily intake via a specific pathway for constituent i (mg/kg-day) RfD[i] = Reference dose for exposure by the specific pathway for i (mg/kg-day).

The HI does not define intake response relationships and its numerical value should not be construed to be a direct estimate of risk. It is a numerical nearness to acceptable limits of exposure or the degree to which acceptable exposure levels are exceeded. As this index approaches unity, concern for the potential hazard of the constituent increases. Exceeding unity does not in itself imply a potential hazard; however, it does suggest that a given situation be more closely evaluated. The results of the quantitative risk characterization for health risks other than cancer are shown in Tables 5-7 and 5-8. For the current land use scenario (i.e., continued normal Base operations), the highest potential HI is associated with cadmium via incidental soil ingestion (5 x 10[-3]). The total soil HI associated with current land use is 6 x 10[-3]. Because this value does not exceed one, the risk to human health due to non-carcinogens in surface soil is not significant under a current land use scenario. For the current land use scenario, there are no potential exposure pathways from subsurface soils or groundwater, as stated earlier in this section.

If OU-2 becomes a residential area when Williams AFB is closed, the highest HI for soil is cadmium via incidental ingestion (1.1 x 10[-2]). The total soil HI associated with future land use is 1.2 x 10[-2]. Because this value does not exceed one, the risk to human health due to non-carcinogens in soils is not significant under a future land use scenario.

The potential for future development of production wells in the plume is small even after the Base is closed. A future residential scenario has been evaluated to provide an upper-bound estimate of potential risks associated with exposure to this groundwater. The individual HIs associated with domestic use of groundwater from OU-2 by a residential population are greater than one for three chemicals: naphthalene (1.8), antimony (1.8), and chromium (7.8). As mentioned previously, the metals are not likely to be site-related; however, naphthalene is not naturally occurring. The total groundwater HI associated with future land use is 12. Because this value exceeds one, the risk to human health due to non-carcinogens in groundwater is considered significant under a future land use scenario. These potential risks would only exist if, after the Base is closed, a residential well is completed within the unremediated plume at OU-2, a resident uses the groundwater at the levels assumed for 30 years, and there are no institutional controls such as deed restrictions.

5.5 Environmental Evaluation

The purpose of the environmental assessment portion of the baseline risk assessment was to evaluate if site-related contamination would damage an environmental resource that is highly important or irreplaceable (e.g. endangered species or sensitive habitat). Environmental assessment objectives at OU-2 can be met by a qualitative evaluation of the potential for exposure of critical receptors; however, a comprehensive environmental risk assessment will be performed at Williams AFB as part of future operable unit investigation and presented in the comprehensive Base-wide RI results.

OU-2 and the area around it is already highly disturbed due to normal Base operations. After Base closure this area will likely become residential or possibly agricultural, with the exception of the remedial action area, which will remain industrial. It is not expected to revert back to natural habitat. The area around Williams AFB is also highly disturbed by development and agriculture, therefore, there are no undisturbed areas nearby with which to compare the species diversity at OU-2. OU-2 also does not provide any significant or unique habitats because it is developed. None of the endangered species in the Base area were found to live at or near OU-2, according to observations of Base personnel. This was expected due to the lack of habitats or prey at OU-2 and confirmed during a site inspection. It is possible that some endangered or threatened birds of prey may hunt at OU-2; however, the small size and low number of animals in this area will preclude them from obtaining more than a small portion of their diet from OU-2. The environmental assessment performed as part of the future comprehensive environmental risk assessment will address the potential for environment receptors to be impacted by all of the identified sites at Williams AFB.

After the Base is closed, animals such as reptiles and ground squirrels may be more likely to frequent OU-2. Exposure to chemicals in soil may occur via ingestion, inhalation of fugitive dust, or ingestion of vegetation grown in the soil. For nonthreatened or nonendangered species, individual risk is not generally considered. Risks to the population or community of environmental receptors are evaluated instead. Due to the low concentrations of contaminants detected in surface soils at OU-2 and its small area, contact with surface soil is not considered a significant exposure pathway for population risk. Sensitive species in the area, such as the peregrine falcon and Swainson's hawk, should not spend a significant amount of time at OU-2. This observation will be confirmed during the comprehensive environmental risk assessment previously mentioned.

If, in the future, an irrigation well is completed in the contaminant plume, environmental receptors could be exposed to contaminated groundwater via ingestion of the water, crops irrigated with this water, or ingestion by carnivores of smaller animals exposed to the water (e.g., ingestion of water by a ground squirrel followed by ingestion of the squirrel by a hawk). The primary chemicals present in the groundwater of OU-2 are the fuel-related organics. These compounds are highly volatile and will probably be lost to volatilization during irrigation. The other chemicals of potential concern in groundwater at OU-2 have been detected at a lower frequency and at low concentrations. Eight of these other chemicals of potential concern appear to be associated with field or laboratory contamination (phthalate and naphthalene compounds) or are naturally occurring (metals). There are no sensitive environmental receptors present at OU-2. The endangered species of predatory hawks and eagles in the area could be exposed to chemicals in groundwater via ingestion of smaller animals that may inhabit agricultural land (i.e., ground squirrels, mice). The contribution of prey from one area is dependent on the size of the affected area.

6.0 Description of Alternatives

Under CERCLA, a process has been established to develop, screen, and evaluate appropriate remedial alternatives. A wide range of cleanup options have been considered for the remediation of OU-2.

The cleanup options that remained following the preliminary screening were assembled into appropriate remedial alternatives. These alternatives were developed based on site-specific needs and evaluated using nine criteria developed by the U.S. EPA to address CERCLA requirements. The evaluation criteria are used to determine the most appropriate alternative. A list of the nine criteria is provided below.

- Overall Protection of Human Health and the Environment
- Compliance with ARARs
- Long-Term Effectiveness and Permanence
- Reduction of Toxicity, Mobility, or Volume
- Short-Term Effectiveness
- Implementability
- Cost
- State Acceptance
- Community Acceptance.

After screening and evaluation of the initial alternatives, the following four remedial alternatives remained under consideration for groundwater and soils at OU-2:

- Alternative A - No Action
- Alternative B - Institutional Action and Capping
- Alternative C - Groundwater Extraction, Treatment with Air Stripping, and Injection plus Soil Vapor Extraction with In Situ Bioremediation
- Alternative D - Groundwater Extraction, Air Stripping andInjection plus On-Site Soil Incineration.

Alternative A represents the baseline as required by CERCLA.

6.1 Selection of Chemicals Requiring Treatment

To evaluate groundwater, surface soil, and subsurface soil remedial technologies, the chemicals of potential concern identified during the baseline risk assessment were evaluated in the FS Report for OU-2 to determine which of them would require treatment to meet the action levels presented in Appendix A. The methods for this evaluation are presented in the FS Report for OU-2 and are summarized in Tables 6-1 and 6-2.

6.1.1 Groundwater

Data from groundwater monitoring wells as well as modeling used to predict approximate locations and flows from extraction wells were used to estimate the influent concentration of each of the chemicals of potential concern at an on site treatment unit. The results of the evaluation process (performed during the FS process) are summarized in Table 6-1. This table reports chemicals of potential concern in groundwater and their detection frequency, maximum detected concentration, action level, and average treatment system concentrations. The results from the evaluation show that only three chemicals (benzene, naphthalene, and toluene) in groundwater will require treatment. These chemicals were carried forward through the FS process as the basis for screening and selecting the groundwater treatment technologies. TPH measurements were also included in the FS process as a helpful indicator of overall fuel contamination. No action level has been established for TPH. Rather, individual action levels were established for the specific components that were detected and are among the compounds that comprise the class of chemicals reported as TPH. All evaluations of the groundwater technologies were based on the effectiveness of remediating the three specific contaminants. This approach is considered conservative because the treatment alternatives considered are coincidentally effective for treating all of the volatile compounds detected.

Although only a limited number of chemicals of potential concern were evaluated as needing treatment, monitoring for all the chemicals of potential concern will continue throughout remedial design and remedial action. During the remedial investigation, there were detections of four compounds (antimony, bis[2-ethylhexyl]phthalate, chromium, and nickel) in groundwater that are suspected as erroneous detections. The evidence supporting these conclusions for each of the compounds is presented below, along with continued monitoring activities.

Antimony was detected in only a few delivery groups of samples sent to the analytical laboratory. The laboratory did report errors associated with the analyses of antimony in unrelated samples for other projects during the same period when the delivery groups from Williams AFB were analyzed; however, the laboratory was unable to identify any problem with results for antimony samples from Williams AFB. This unresolved issue warrants additional confirmatory sampling.

Bis(2-ethylhexyl)phthalate was detected in early sampling rounds; however, it ceased to be detected after the use of Teflon[TM] liners in plastic caps was instituted. Bis(2-ethylhexyl) phthalate is present in the plastic cap material. It is reasonable to conclude that this chemical leached into the samples from the unlined caps used in the collection, shipment, and storage of the samples.

Neither antimony nor bis(2-ethylhexyl)phthalate are added to or naturally occur in jet fuels and there is no reason to believe that they are site related. In addition, contract laboratory procedure (CLP) detection limits for these two chemicals exceed the action levels that were ultimately established for these chemicals (Federal Maximum Contaminant Levels [MCL] to be enacted in 1994 - see Appendix A, Table A-3). Having a higher detection limit than an action level results in difficulties with establishing a defensible treatment requirement for the two chemicals. Even if neither chemical had been detected at the site, there would still be difficulties in defending a no treatment scenario because the detection limit is still larger than the action level. To accommodate this dilemma, this ROD selects that treatment for these two chemicals will be provided contingent on the results of confirmatory sampling conducted during the remedial design phase using appropriate specialized analyses with lower detection limits. If the average groundwater treatment system concentrations of these two chemicals exceed action levels established in Appendix A, USAF will select additional treatment in an Explanation of Significant Differences. Such treatment will be provided in addition to the remedy selected in this ROD and will reduce concentrations for either or both of the chemicals to below the established action levels.

Chromium and nickel detected in several groundwater samples are also likely to be erroneous. Statistically, the data indicate that elevated chromium and nickel results are associated with wells installed by IT as opposed to wells installed by AV. For example, wells SS-01-W-19 and SS-01-W-22, sampled on the same day in December 1990, gave uncharacteristically elevated levels for chromium and nickel. Wells installed by IT share a common characteristic of stainless steel well construction materials. The materials of construction for the well screens and riser casings in those wells are #304 stainless steel. Chromium and nickel are both alloyed in #304 stainless steel.

Neither chromium nor nickel are added to or naturally occur in jet fuels and there is no reason to believe that they are site related. The ROD selects that treatment for these two chemicals will be provided contingent on the results of confirmatory sampling conducted during the remedial design phase. If the average groundwater treatment system concentration of either of these two chemicals exceed the levels established in Appendix A, then the USAF will select additional treatment in an Explanation of Significant Differences. Such treatment will be provided in addition to the remedy selected in this ROD and will reduce concentrations for either or both of the chemicals to below the established action levels.

6.1.2 Soil

An evaluation of potential chemicals of concern in surface soils indicates that no remedial action is required to meet action levels (established in Appendix A) in the top one foot of soil. For subsurface soil (between one foot in depth to twenty-five feet deep) only two chemicals (benzene and 1,4dichlorobenzene) require remediation to meet action levels. Benzene and 1,4dichlorobenzene were carried forward through the FS evaluation process as the basis for screening and selecting the treatment technologies for subsurface soil. TPH measurements were also in the FS process as a helpful indicator of overall fuel contamination. No action level has been established for TPH. Rather, individual action levels are established for the specific components that were detected and are among the compounds that comprise the class of chemicals reported as TPH. All evaluations of the groundwater technologies were based on the effectiveness of remediating the two specific contaminants.

6.2 Alternative Description

Alternative A: No Action

The no-action alternative provides no remediation and leaves the free-phase product and contaminated groundwater unaffected. The no-action alternative for contaminated soils would not alter site conditions; all areas having concentrations of contaminants exceeding action levels would remain as is. This alternative includes long-term monitoring of both groundwater and soils in order to detect changes in the contaminant levels in the designated areas to determine if there have been reductions below the action levels due to natural degradation of contaminants. Monitoring would be through soil borings and sampling at selected groundwater monitoring wells at OU-2. Reassessment of site conditions would be performed every 5 years in accordance with CERCLA Section 121(c).

This alternative does not reduce the potential human health risk posed by ingestion of contaminated groundwater from the upper aquifer beneath OU-2 and may increase the potential for human exposure by increasing the long-term potential for contamination of the lower aquifer. Although the lower aquifer is not currently contaminated, a connection between the aquifers may lead to migration of contaminants into the lower aquifer east of OU-2. Base production wells, which are upgradient of the plume, are not expected to become contaminated based on fate and transport modeling. Dispersion of the free-phase and contaminated shallow groundwater plumes may impact the lower aquifer east of OU-2 because the upper and lower aquifers may become connected due to the dissipation of the confining layer. Future land use such as residential housing on Base property following decommissioning could result in an increase in potential human health exposure due to the use of contaminated groundwater from the upper aquifer or from the use of the lower aquifer that may become contaminated in the long term.

This alternative would also not control exposure to the contaminated soil or reduce the potential human health risk associated with this exposure. Migration of the contaminants from soil to groundwater via infiltration should not adversely affect groundwater or surface water quality because of the dry weather conditions (evaporation exceeds precipitation) at OU-2.

Migration via surface water runoff is not anticipated because benzene was not detected in surface soils. Remedial response objectives may eventually be met due to natural contaminant attenuation processes; however, the presence of significant volumes of contaminated soil below the upper 25-foot soil layer poses a long-term source of contaminants that would be included in any assessment of potential natural contaminant attenuation.

The residual risk, therefore, at the completion of this alternative could be equal to or greater than the current risk for the future land use scenarios used in the baseline risk assessment.

The estimated present worth cost is $1.6 million based on $78,000 in capital and $314,000 in yearly operation and maintenance (O&M) costs over a period of 30 years. Time to implement this alternative is less than one month. The costs relate primarily to monitoring.

Alternative B: Institutional Actions and Capping

Institutional actions would include deed restrictions on potential transfers of affected Base property for future land use and restrictions on construction of new water wells. This alternative would also include periodic monitoring of existing groundwater wells. This alternative would also install a concrete barrier over the four areas of contaminated soil at OU-2 (76,000 square feet), thus limiting exposure by potential receptors. There would be deed restrictions on land use, and signs would be placed as additional institutional measures warning the community of potential dangers. Reviews would be performed every 5 years as required by CERCLA Section 121(c) as long as contamination remains.

This alternative will provide a means of protecting the public from exposure to contaminated groundwater by restricting use of the aquifers. Institutional actions have a limited effectiveness, however, particularly for the long term because restrictions on land use or well installation can be circumvented or not be enforced over time. It will not protect the environment because the contaminants will spread and additional portions of the aquifer may, without treatment, become unusable for drinking water. Because there is no discharge of groundwater to surface water, environmental impact will be limited. It is possible that natural attenuation will ultimately result in groundwater quality that meets action levels.

This alternative would provide a barrier against exposure to surface and subsurface soils and would limit the potential for excavation or other soil disturbance activities that could result in receptors contacting subsurface soils. This alternative would provide long-term protection if the concrete cap is maintained periodically and if means are taken to avoid damage or removal of capping. Because the contamination would not be removed or treated, there would be continuing potential liability that exposure to contaminated soil could occur.

The residual risk after implementing this alternative would be equivalent to the risks estimated under the current land use scenario used in the baseline risk assessment.

The estimated present worth cost is $2.3 million, based on capital costs of $0.731 million and annual O&M costs of $0.314 million over a period of 30 years. Time to implement this alternative is less than six months.

Alternative C: Groundwater Extraction, Air Stripping, and Injection plus Soil Vapor Extraction with In Situ Bioremediation

This alternative would consist of the following components:

- Free-phase product and groundwater will be extracted using an estimated series of up to 2 horizontal or 16 vertical extraction wells. The exact number, type, and location of wells will be determined during the remedial design phase as a result of aquifer tests conducted after well installations. There is approximately 0.65 to 1.4 million gallons of free-phase product floating on top of the aquifer. Total fluids pumping will be conducted at estimated flow rates between 30 and 60 gpm from the shallow aquifer using the extraction wells to maintain hydraulic control of the plume and to reduce contaminant concentrations. There is approximately 170 million gallons of groundwater contaminated with benzene above the drinking water action level of 0.005 mg/L.

- Fluids extracted from the ground will be passed through an oil/water separator in order to capture all free-phase product prior to treatment of the water. Free-phase product will either be reused by an approved vendor or disposed of at an authorized offsite disposal facility.

- Pretreatment, as needed, of the extracted groundwater will be conducted (e.g., precipitation, flocculation, clarification, filtration, acid treatment, etc.) to remove solids that may potentially interfere with the treatment for contaminants. The specific system specifications will be developed from treatability studies conducted during the remedial design phase, if required.

- Pretreatment, as needed, of the extracted groundwater will be conducted (e.g., precipitation, flocculation, clarification, filtration, ion exchange, etc.) to reduce the concentration of metals to action levels identified in Chapter 6.0 and Appendix A of this document. Section 6.1.1 provides details for including this treatment contingency. The detection of certain metals during the remedial investigation may have been erroneous and additional sampling during the remedial design phase will confirm or eliminate the need for this treatment. Treatment system specifications will be developed from treatability studies conducted during the remedial design phase, if this treatment is required.

- Treatment of the extracted groundwater will be provided by twin air stripping columns in series to reduce volatile contaminant concentrations to action levels identified in Section 6 and Appendix A of this document. Contaminant concentrations in groundwater requiring treatment are identified in Chapter 6.0 and Appendix A. Treatment will achieve greater than 99 percent removal of volatile contaminants. The columns will be 2.5 feet in diameter with 18 feet of packing each and 500 cfm of air flow each.

- Posttreatment, as needed, of the extracted groundwater will be conducted (e.g., liquid-phase carbon adsorption) to reduce semi-volatile organic concentrations to cleanup levels identified in Chapter 6.0 and Appendix A of this document. Section 6.1.1 provides details for including this treatment contingency. The detection of certain phthalate compounds during the remedial investigation may have been erroneous and additional sampling during the remedial design phase will confirm or eliminate the need for this treatment. Treatment system specifications will be developed from treatability studies conducted during the remedial design phase, if this treatment is required.

- Treated groundwater will either be injected back into the shallow aquifer to assist in maintaining hydraulic control and to avoid depletion of the aquifer or will be discharged to the Base wastewater treatment plant. A number of factors will be evaluated to yield a decision by Parties to the FFA to inject treated groundwater back into the aquifer and/or to discharge the treated groundwater into the Base sanitary sewer for beneficial use on the Base golf course. These factors include, but are not limited to the following: (1) the results of aquifer measurements made during a given remediation period; (2) the ability of injection wells to accommodate the extraction rate; and (3) identified need for irrigation of the Base golf course. Based on current estimates, four injection wells are planned. Their exact number, type, and location will be determined during the remedial design phase.

- Soil treatment of the first 25 feet of soil (54,000 cubic yards) using bioenhanced SVE will be provided. Vapor-phase nutrients will be introduced to enhance biodegradation of soil contaminants. Other biological enhancements (introduction of aerobic microbes, anaerobic microbes, aerophilic microbes, liquid-phase nutrients, enzymes, and etc.) may be used if appropriate treatability studies or equivalent data are reviewed and indicate that significant remedial benefits would be accrued.

- SVE will be implemented using approximately 64 extraction wells, 32 passive vent wells, a vacuum system to remove 500 cfm of air from wells, and a nutrient addition system. Contaminant concentrations in soil requiring treatment are identified in Chapter 6.0 and Appendix A. Bioenhanced SVE will achieve greater than 94 percent reduction of benzene, and 64 percent reduction of 1,4-dichlorobenzene. The exact number of wells will be determined during remedial design.

- Treatment of SVE and air stripping emissions will be provided using fume incineration to meet ambient air quality and destruction and capture requirements. Treatment will achieve greater than 99 percent reduction of benzene, 1,4-dichlorobenzene, naphthalene, and toluene. In the event that the fume incinerator cannot technically achieve an acceptable emission level of less than three pounds per day of organic vapors, then a vapor-phase carbon adsorption unit will be installed and used instead of the fume incinerator. Process details for these alternative air emission treatment systems include:

  - Air stripping abatement by carbon - each stripping column would have dual-bed, series adsorbers each containing 2,000 pounds of carbon with carbon usage at 300 pounds/day

  - Air stripping abatement by fume incineration - unit would be rated at 1.2 million BTU/hr, 1,000 cfm, with fuel usage at 33.6 million BTU/day

  - SVE abatement by carbon - SVE system would have 2 dual bed systems with each bed containing 11,000 pounds and using 6,800 pounds of carbon per day in the first year, 1,500 pounds per day in the second year, and 1,200 pounds per day in the third year

  - SVE abatement by fume incineration - unit would be rated at 0.6 million BTU/hr, 500 cfm, with fuel usage at 11 million BTU/day in the first year, 5.5 million BTU/day for the second and third years.

- Institutional activities will be taken to impose restrictions on installation of new wells and limiting soil excavation to 10 feet in depth at the ST-12 site.

Figure 6-1 presents a conceptual schematic of the treatment system depicting a vertical extraction well for representative purposes. Monitoring of the treatment system (including but not limited to all chemicals of potential concern) will be conducted and additional treatment capacity will be added if contaminants not now believed to need treatment are detected at levels above established action levels. The specific compliance monitoring procedures will be developed during the remedial design phase by the USAF and regulatory agencies to identify and trigger the need for any additional treatment. Monitoring of both the groundwater and soil remediations will be performed to ensure that the contaminated zones are being remediated.

This alternative would also include the institutional actions of imposing restrictions on installation of new wells and limiting soil excavation to 10 feet in depth.

A pilot demonstration test has been initiated to determine the effectiveness and implementability of horizontal wells and a treatability test initiated to determine the effectiveness of anaerobic degradation of the contaminants.

More testing may be required for the emission abatement and the bioremediation portions of this alternative.

Because of the volume of free-phase product and contaminated groundwater that may remain after 5 years, a reevaluation would be performed at five year intervals in accordance with CERCLA Section 121(c).

This alternative would substantially reduce the potential threat to human health posed by exposure to contaminated groundwater at OU-2 by reducing levels of the chemicals of

potential concern in the groundwater. It would also prevent further environmental degradation by arresting the spread of contaminants through the shallow aquifer and minimizing any potential impact to the lower aquifer.

SVE with in situ bioremediation would reduce the levels of the chemicals of potential concern in the 25 feet of soil, thus reducing the potential for human exposure and risk associated with exposure to contaminated surface and subsurface soil. The concentration of the chemicals of potential concern will meet action levels.

The residual risks for both groundwater and soil, as a result of this alternative, will pose a HI of less than one and an ILCR within the target range 10[-4] to 10[-6], which will meet action levels as specified in Appendix A.

Estimated present worth costs range from $7.9 to $21.1 million. Initial capital costs range from $3.5 to $5.4 million, and annual O&M costs range from $0.6 to $8.0 million. Costs are based on operating periods of 30 years for groundwater remediation and 3 years for soil remediation. Differences in costs are due to variations in the extraction technology (vertical or horizontal wells) and air pollution control technology (vapor-phase carbon adsorption or fume incineration) that would be employed. Estimated time to implement this alternative is approximately 18 to 24 months. Details of these cost estimates are provided in the OU-2 FS Report.

Alternative D: Groundwater Extraction, Air Stripping and Injection plus On-Site Soil Incineration This alternative would consist of the following components:

- Free-phase product and groundwater will be extracted using an estimated series of up to 2 horizontal or 16 vertical extraction wells. The exact number, type, and location of wells will be determined during the remedial design phase as a result of aquifer tests conducted after well installations. There is approximately 0.65 to 1.4 million gallons of free-phase product floating on top of the aquifer. Total fluids pumping will be conducted at estimated flow rates between 30 and 60 gpm from the shallow aquifer using the extraction wells to maintain hydraulic control of the plume and to reduce contaminant concentrations. There is approximately 170 million gallons of groundwater contaminated with benzene above the drinking water action level of 0.005 mg/L.

- Fluids extracted from the ground will be passed through an oil/water separator in order to capture all free-phase product prior to treatment of the water. Free-phase product will either be reused by an approved vendor or disposed of at an authorized offsite disposal facility.

- Pretreatment, as needed, of the extracted groundwater will be conducted (e.g., precipitation, flocculation, clarification, filtration, acid treatment, etc.) to remove solids that may potentially interfere with the treatment for contaminants. The specific system specifications will be developed from treatability studies conducted during the remedial design phase, if required.

- Pretreatment, as needed, of the extracted groundwater will be conducted (e.g., precipitation, flocculation, clarification, filtration, ion exchange, etc.) to reduce the concentration of metals to action levels identified in Chapter 6.0 and Appendix A of this document. Section 6.1.1 provides details for including this treatment contingency. The detection of certain metals during the remedial investigation may have been erroneous and additional sampling during the remedial design phase will confirm or eliminate the need for this treatment. Treatment system specifications will be developed from treatability studies conducted during the remedial design phase, if this treatment is required.

- Treatment of the extracted groundwater will be provided by twin air stripping columns in series to reduce volatile contaminant concentrations to action levels identified in Section 6 and Appendix A of this document. Contaminant concentrations in groundwater requiring treatment are identified in Chapter 6.0 and Appendix A. Treatment will achieve greater than 99 percent removal of volatile contaminants. The columns will be 2.5 feet in diameter with 18 feet of packing each and 500 cfm of air flow each.

- Posttreatment, as needed, of the extracted groundwater will be conducted (e.g., liquid-phase carbon adsorption) to reduce semi-volatile organic concentrations to cleanup levels identified in Chapter 6.0 and Appendix A of this document. Section 6.1.1 provides details for including this treatment contingency. The detection of certain phthalate compounds during the remedial investigation may have been erroneous and additional sampling during the remedial design phase will confirm or eliminate the need for this treatment. Treatment system specifications will be developed from treatability studies conducted during the remedial design phase, if this treatment is required.

- Treated groundwater will either be injected back into the shallow aquifer to assist in maintaining hydraulic control and to avoid depletion of the aquifer or will be discharged to the Base wastewater treatment plant for beneficial use on the Base golf course. A number of factors will be evaluated to yield a decision by Parties to the FFA to inject treated groundwater back into the aquifer and/or to discharge the treated groundwater into the Base sanitary sewer for beneficial use on the Base golf course. These factors include, but are not limited to the following: (1) the results of aquifer measurements made during a given remediation period; (2)the ability of injection wells to accommodate the extraction rate; and (3)identified need for irrigation of the Base golf course. Based on current estimates, four injection wells are planned. Their exact number, type, and location will be determined during the remedial design phase.

- Treatment of air stripping emissions will be provided using fume incineration to meet ambient air quality and destruction and capture requirements. Treatment will achieve greater 99 percent reduction of benzene, 1,4-dichlorobenzene, naphthalene, and toluene. In the event that the fume incinerator cannot technically achieve an acceptable emission level of less than three pounds per day of organic vapors, then a vapor-phase carbon adsorption unit will be installed and used instead of the fume incinerator. Process details for these alternative air emission treatment systems include:

    - Air stripping abatement by carbon - each stripping column would have dual-bed, series adsorbers each containing 2,000 pounds of carbon with carbon usage at 300 pounds/day

    - Air stripping abatement by fume incineration - unit would be rated at 1.2 million BTU/hr, 1,000 cfm, with fuel usage at 33.6 million BTU/day.

- Soil to a depth of 25 feet will be excavated and thermally treated in a transportable direct-fired rotary kiln. Contaminated soil constitutes 54,000 cubic yards in place (67,000 cubic yards when excavated). It will be necessary to excavate an additional 79,000 cubic yards of clean soil to achieve a 1.0 to 1.5 slope on the sides of the excavation. The transportable rotary kiln will have a feed rate of 10 tons per hour and will consume 200 to 500gallons of fuel per day to remove organic contaminants. Contaminant concentrations in soil requiring treatment are listed in Table 6-2. Treatment will achieve greater than 99 percent reduction in contaminant levels.

- Institutional activities will be taken to impose restrictions on installation of new wells and limiting soil excavation to 10 feet in depth at the ST-12 site.

Figure 6-2 presents a conceptual schematic of the treatment system depicting a vertical extraction well for representative purposes. A transportable thermal treatment system would be used. Before initiating treatment of the soil, a test burn would be performed to demonstrate that air pollution control permit limitations are being met. Monitoring of the treatment system (including but not limited to all chemicals of potential concern) will be conducted and additional treatment capacity will be added if contaminants not now believed to need treatment are detected at levels above established action levels. The specific compliance monitoring procedures will be developed during the remedial design phase by the USAF and regulatory agencies to identify and trigger the need for any additional treatment.

Monitoring of both the groundwater and soil remediations would be performed to ensure that the contaminated zones are being remediated.

This alternative would also include the institutional actions of imposing restrictions on installation of new wells and limiting soil excavation to 10 feet.

A pilot demonstration test has been initiated to determine the effectiveness and implementability of horizontal wells. More testing may be required for the emission abatement portion of this alternative.

Because of the volume of free-phase product and contaminated groundwater that may remain after 5 years, a reevaluation would be performed at five year intervals in accordance with CERCLA Section 121(c).

This alternative would substantially reduce the potential threat to human health posed by exposure to contaminated groundwater at OU-2 by reducing levels of the chemicals of potential concern in the groundwater. It would also prevent further environmental degradation by arresting the spread of contaminants through the shallow aquifer and minimizing any potential impact to the lower aquifer.

This alternative protects human health and the environment by providing a long-term, permanent reduction in surface and subsurface soil contamination through removal and incineration of contaminated surface and subsurface soils. This would essentially eliminate organic contaminants in the 25 foot soil layer in OU-2 and avoid any potential future exposure.

The residual risks for both groundwater and soil, as a result of this alternative, will pose a HI of less than one and an ILCR within the target range 10[-4] to 10[-6], which will meet action levels as specified in Appendix A.

Estimated present worth costs range from $20.8 to $24.3 million. Initial capital costs range from $16.8 to $18.5 million, and annual O&M costs range from $0.4 to $0.6 million. Costs are based on operating periods of 30 years for groundwater remediation and less than one year for soil remediation. Differences in costs are due to variations in the extraction technology (vertical or horizontal wells) and air pollution control technology (vapor-phase carbon adsorption or fume incineration) that would be employed. Estimated time to implement this alternative is approximately 24 to 36 months. Details of these cost estimates are provided in the OU-2 FS Report.

7.0 Comparative Analysis of Alternatives

The final phase in the evaluation of remedial alternatives involved a comparison of the various alternatives against each other. The advantages and disadvantages of each alternative are reviewed relative to each of the nine U.S. EPA evaluation criteria used in the previous detailed analyses. Table 7-1 summarizes the evaluation process. For each criterion discussed below, the apparent best alternative is identified first.

7.1 Overall Protection of Human Health and the Environment

Alternatives C and D provide adequate protection for human health and the environment by reducing the volume of contaminants in both groundwater and surface and subsurface soil. Alternatives A and B do not provide long-term protection of human health and the environment because neither would reduce the contamination in either medium nor prevent migration of contamination within the media. By instituting site access controls, Alternative B does provide greater protection than Alternative A because Alternative A provides no treatment or controls.

7.2 Compliance with ARARs

ARARs for OU-2 are presented in Appendix A. Alternatives C and D would comply with location-specific and action-specific ARARs as well as chemical-specific ARARs for the chemicals of potential concern after sufficient treatment time has elapsed. Alternative B would not meet ARARs for the chemicals of potential concern because there would be no remediation of either surface and subsurface soil or groundwater. An ARARs analysis is not required for Alternative A, a no action alternative.

7.3 Long-Term Effectiveness and Permanence

Alternatives C and D would achieve the highest degree of long-term effectiveness because chemicals of potential concern would be removed from the surface and subsurface soil and groundwater and destroyed by thermal oxidation or biodegradation, either on site as part of the remediation effort, or off site through use of recovered hydrocarbons from groundwater as fuel.

Alternatives A and B do not provide long-term protection of human health and the environment because neither would reduce the contamination in either groundwater or soil nor prevent migration of contamination within the media. By instituting site access controls, Alternative B does provide greater protection than Alternative A because Alternative A provides no treatment or controls. Alternative B would not reduce contaminants at OU-2 and would rely solely on a cap and institutional controls to prevent exposure by blocking a pathway to receptors. A concrete cap, although a relatively permanent means of preventing exposure to surface and subsurface soil by workers and the general public if properly installed and maintained, would not be as reliable in the long term as removing the contaminants.

Long-term management and monitoring of OU-2 would be comparable for Alternatives C and D. Operation of the groundwater extraction and treatment system would be required for at least 30 years in either instance. Monitoring combined with institutional actions would also be necessary to prevent use of groundwater in the area prior to achieving cleanup goals. The reliability of the groundwater remediation for both alternatives is the same because the same technologies would be employed for the same duration. Reducing the level of contaminants in groundwater to action levels throughout the shallow aquifer will depend on the rate of release/dissolution of contaminants from the soil matrix that is currently saturated with the free-phase hydrocarbon layer for either Alternative C or D. Review of either alternative would be necessary at 5-year intervals to reassess the effectiveness and determine a projected time to complete remediation.

7.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternatives C and D would reduce the toxicity, mobility, and volume of contamination in both groundwater and surface and subsurface soil versus Alternatives A and B, which would not. For groundwater, the reduction in contaminant mass through thermal destruction or adsorption and the reduction in volume of contaminated media through extraction would be the same for Alternatives C and D because the same technologies would be employed for the same duration. Increasing the rate at which groundwater could be extracted could reduce the duration for either alternative. Alternative D, which uses thermal treatment for surface and subsurface soil, would achieve a greater reduction in contaminant mass than Alternative C, using SVE with bioremediation, because the thermal treatment is more effective in removing nonvolatile organics processing of excavated soils is often more reliable than in situ techniques. Both these alternatives would achieve the same reduction in volume of surface and subsurface soil contaminated above action levels. Neither Alternatives A nor B accomplish a reduction in toxicity, mobility, or volume of contaminants because neither treat the media.

7.5 Short-Term Effectiveness

Alternative B can be implemented in the shortest time and technically, therefore, provides the best short-term effectiveness. With respect to soils, Alternatives C and D have comparable time periods of approximately 1.5 to 3 years for implementation. The actual on-site treatment time for Alternative D, thermal treatment, may be shorter than the time for Alternative C, which would use a bioenhanced SVE system, to reduce surface and subsurface soil contamination to health-based soil action levels. Both alternatives will be in compliance with state and county air pollution control regulations. The incineration of vapor from soil is not required to meet all substantive requirements of the Resource Conservation and Recovery Act (RCRA) for an incinerator because the vapor-phase volatiles do not meet the definition of a RCRA hazardous waste. The substantive RCRA incinerator requirements will apply for the on-site incineration of soil that meets the RCRA definition of a hazardous waste. This additional requirement will most likely lengthen the time required to meet all requirements. The total time required to mobilize, install, and obtain approvals for Alternative D is expected to be longer but would be offset by the longer operational period for Alternative C. With respect to groundwater contamination, Alternatives C and D will take the same amount of time to implement.

For Alternative B, dust and volatile organic emissions during cap installation would be minimal because no major disturbance of the contaminated surface and subsurface soil would be anticipated; however, if such disturbance did occur, preventative measures would be taken to minimize fugitive dust emissions. Alternative C, using bioenhanced SVE, would pose somewhat higher risks to workers due to boring in contaminated soil and a minor potential risk during operation due to temporary volatile emissions if the fume incineration system or carbon adsorption system malfunctions. Alternative D would involve major excavation that could release contaminants and would require controls to minimize exposure to workers and Base personnel.

Alternative D, thermal treatment, has the potential, although considered to be very low, of releasing contaminants from the stack if incomplete combustion occurs. Incineration also would pose a greater risk to workers than SVE and in situ bioremediation because of the complexity, mechanical components, high temperatures of the incinerator system, the storage and handling of liquid or gaseous auxiliary fuel, and the physical hazards associated with excavation activities. There would be a minor risk related to groundwater remediation for Alternatives C and D due to the potential temporary release of volatiles if the fume incinerator or the vapor-phase carbon adsorption system on the air stripper exhaust malfunctioned, and due to potential fire or explosion related to storage and handling of recovered hydrocarbons or fuel for the fume incinerator.

7.6 Implementability

Alternative A would require no implementation because it is the no-action alternative.

Alternative B would be the most easily implemented because design and placement of concrete caps is a normal construction method. The caps could be expanded if additional site monitoring data indicated the need. Periodic maintenance would be minimal for concrete capping at OU-2.

Alternatives C and D are comparable in terms of implementability and the groundwater remediation component of each is the same. The technical feasibility of installing a successful extraction/injection well network and treatment system is rated moderate because there are no known site or waste characteristics that represent significant problems for the proposed technologies. The presence of certain mineral or organic constituents in the groundwater could require either conditioning of the groundwater prior to air stripping or use of an air stripper configuration that is more tolerant to fouling. Specific localized geologic conditions could also affect the design and operation of the SVE system. Additional groundwater composition data and geologic data would be necessary to verify specific detailed design requirements that would ensure reliable operation. The equipment and materials for the extraction and treatment systems are commercially available. Horizontal wells could present some technical difficulties, as noted in Section 3.0 of the OU-2 FS Report. The technology that is recommended after the groundwater is extracted is a commercially available technology. Only limited treatability or pilot testing appears to be required to implement the groundwater components of Alternatives C or D as noted above. Treatability or pilot test results from extraction methods using vertical and horizontal wells will aid in designing the most cost-effective extraction system. Such a treatability study is already under way at the site. The issues that could affect successful implementation of the surface and subsurface soil remediation component of Alternatives C and D are similar. Both alternatives will require space for construction and operation of installed systems. Alternative D would be more complex than Alternative C due to excavation and soil handling. Additionally, excavation required in Alternate D would delay the installation of the groundwater treatment system and would delay the extraction of the free product. Treatability or pilot testing would be beneficial to optimize the SVE and in situ bioremediation system for Alternative C. The equipment, materials, and other resources for both these alternatives are available, although the SVE and in situ bioremediation system components for Alternative C would be less specialized than those for Alternative D. Alternative D would have the most complex operational requirements, including considerable labor for material handling and incinerator operation and maintenance and utilities, particularly fuel; however, incineration offers the opportunity to treat recovered hydrocarbons and avoid off-site shipment to a reclaimer or other user. Alternative D could require treatability testing to verify processing requirements.

7.7 Cost

Table 7-2 summarizes the estimated capital, O&M cost, and present worth cost for each of the four alternatives. The present worth ranges from $1.6 to $24.3 million. Present worth costs for the groundwater remediation component range from 31 to 83 percent of the total.

Alternative B would have a present worth of $2.3 million, which is approximately $0.7 million higher than Alternative A, the no-action alternative, due to the cap construction cost. Both alternatives would require long-term groundwater and periodic surface and subsurface soil monitoring. Groundwater monitoring would be the major cost element. Both Alternatives A and B would be less expensive than Alternative C, the next highest cost alternative; however, potential future cost impacts associated with loss of aquifer use in the area and restrictions on land use if chosen would greatly increase the Alternative A and B costs. Estimates of aquifer and land use cost impacts are not within the scope of this investigation.

Alternative C would cost considerably less ($7.9 to $21.1 versus $20.8 to $24.3 million) than Alternative D due to the relatively high processing (unit) cost for soils in an on-site incinerator. The cost for groundwater remediation would be the same ($6.4 to $9.9 million) for both alternatives. Capital cost for the extraction/injection well systems and treatment system would represent approximately 29 to 52 percent of the estimated present worth for the groundwater remediation component. The range of costs and percentages are due to the variations in cost for vertical and horizontal extraction wells and the cost for fume incineration and vapor-phase carbon adsorption.

A cost comparison of the two air pollution abatement methods for both soil and groundwater treatment showed the following:

- Vapor-phase carbon adsorption O&M costs were higher than fume incineration O&M costs for both soil and groundwater treatments

- Vapor-phase carbon adsorption capital costs were higher than fume incineration capital costs for soil treatment, but lower than fume incineration for groundwater treatment. Specifically:

    - O&M costs for carbon are 60% higher than fume incineration for groundwater

    - O&M costs for carbon are 300% higher than fume incineration for soil

    - Capital costs for fume incineration are 3% higher than carbon for groundwater

    - Capital costs for carbon are 42% higher than fume incineration for soil.

Table 7-2 presents a summary of remediation alternative cost estimates.

The cost for excavation and incineration for Alternative D would be approximately proportional to the surface and subsurface soil volume. On the other hand, the cost sensitivity of Alternative C does not relate directly to surface and subsurface soil volume because most of the cost is fixed at the time of installation. Unit costs for Alternative D are more uncertain than those for Alternative C. Reported cost experience on other similar projects indicates that the unit cost for thermal treatment could range from 50 percent. A moderate change in the area over which surface and subsurface soil must be treated would greatly affect the total cost of Alternative D while moderately affecting the cost for Alternative C. These factors would be of importance for possible large variations in surface and subsurface soil treatment volumes.

7.8 State Acceptance

U.S. EPA Region IX, ADWR, and ADEQ have been involved in the technical review of the OU-2 FS and the development of the proposed plan and ROD. The U.S. EPA and the State agree with the selected alternative as presented in this decision document.

7.9 Community Acceptance

Community reaction to the selected remedial action has been positive. During the public comment period, several comment letters were received. The comments, along with questions raised during the public meeting, primarily addressed cleanup extent and methods. The community seemed most concerned about:

- The use of bioremediation to remediate the soils

- Limiting soil cleanup to 25 feet

- The selection or elimination of certain technologies or processes

- The extraction process to be employed for groundwater removal from the aquifer

- The role that the public will play in the remedial action process.

The Responsiveness Summary (Chapter 10.0) provides a thorough review of the public comments received on the Proposed Plan and the Feasibility Study, and on the USAF's responses to the comments received.

8.0 The Selected Remedy

The selected overall remedy for this ROD is Alternative C. The specific components of the alternative were presented in Section 6.2. It meets all nine evaluation criteria, as shown in Table 7-1. Details of the selected remedy will be finalized during the remedial design phase.

The selected remedy will provide the greatest level of effectiveness that is technically and economically feasible. The criterion of protection of human health and the environment is appropriately balanced with both effectiveness and technical/economic feasibility. Appendix B contains the preliminary estimates of capital costs and O&M costs of the selected remedy (Alternative C). Final cost estimates may vary from the estimates presented due to changes that may occur as a result of treatability tests and differences between assumed and actual environmental factors at the time of remedial action design and construction. These data, in general, will result in modifications during the engineering design process. The hydraulic gradient control system and system performance evaluation and schedule will be developed during the remedial design process.

Residual risk from this selected alternative, although qualitatively addressed in this ROD in Sections 6.0 and 7.0, will be addressed quantitatively during the comprehensive baseline risk assessment for the entire Base to be presented in the Base-wide RI/FS reports and the ROD.

Several contingency issues are associated with this selected alternative. These are broken into issues dealing with the groundwater portion of this alternative and issues dealing with the soil portion of this alternative. The following sections address these contingencies.

8.1 Groundwater Remediation

The selected alternative will remove free-phase product and contaminated groundwater via extraction wells, treat the groundwater via air stripping to reduce concentrations of chemicals of potential concern to below action levels established in Appendix A, Table A-3, and inject treated groundwater back into the aquifer through injection wells and/or discharge it to the Base sanitary sewer for beneficial use on the Base golf course. Figure 6-1 shows the conceptual schematic of this process. The decision-making process to determine specific contingencies is specified below.

8.1.2.3 Emission Abatement

The selected remedy will control emissions from the stripping column with fume incineration. However, the selected remedy calls for the contingent use of vapor-phase carbon adsorption to control emissions in the event that the fume incinerator cannot technically achieve an acceptable emission level of less than three pounds per day of organic vapors. Figure 8-1 depicts this decision point. In the event that vapor-phase carbon adsorption is used, design considerations will be based on data collected during the pilot demonstration. This data includes O&M requirements, loading rates, untreated vapor concentrations, and stack emissions.

8.1.2.4 Posttreatment

Posttreatment of groundwater after air stripping to remove semivolatile contaminants is not planned; however, sampling will be conducted during the remedial design phase to ascertain the need for posttreatment. As detailed in Section 6.1.1, the need to provide posttreatment for phthalate compounds is questionable because the results of prior sampling may be erroneous or inconclusive. Specific sampling will be conducted during pilot studies to confirm the concentrations of this potential contaminant. Figure 8-1 is a flow diagram showing these decisions points in the process.

8.1.2.5 Injection

The selected remedy calls for treated groundwater to be injected into a series of wells or, with the concurrence of the Parties to the FFA, discharged into the Base's sanitary sewer for beneficial use on the Base golf course. A number of factors will require evaluation in the event that discharge to the sewer is proposed for all or a portion of the treated water for a stated period of time. These factors include, but are not limited to the following: (1) the results of aquifer measurements made during a given remediation period; (2) the ability of injection wells to accommodate the extraction rate; and (3) identified need for irrigation of the Base golf course. The number, configuration, and specific locations of the injection wells will be determined with data acquired during the pilot demonstration study. Figure 8-1 shows this decision node.

8.1.3 Information Summary

Data from the OU-2 RI/FS and a pilot demonstration will be used to make the above decisions. Additional information needed to fill data gaps will be collected. This data will be used during the remedial design phase. The USAF will continue to collect data during the

8.1.2.3 Emission Abatement

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8.1.2.4 Posttreatment

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8.1.2.5 Injection

The selected remedy calls for treated groundwater to be injected into a series of wells or, with the concurrence of the Parties to the FFA, discharged into the Base's sanitary sewer. A number of factors will require evaluation in the event that discharge to the sewer is proposed for all or a portion of the treated water for a stated period of time. These factors include, but are not limited to the following: (1) the results of aquifer measurements made during a given remediation period; (2) the ability of injection wells to accommodate the extraction rate; (3) the minimum volume of water needed at the Base's wastewater treatment plant to remain in operation; and (4) identified Base treated wastewater reuse needs, such as irrigation of the Base golf course. The number, configuration, and specific locations of the injection wells will be determined with data acquired during the pilot demonstration study. Figure 81 shows this decision node.

8.1.3 Information Summary

Data from the OU-2 RI/FS and a pilot demonstration will be used to make the above decisions. Additional information needed to fill data gaps will be collected. This data will be used during the remedial design phase. The USAF will continue to collect data during the operation of the selected remedy to be used in evaluations for the most effective and beneficial disposal method for the treated water.

8.2 Soil Remediation

SVE with bioenhancement, as shown in the Figure 6-1 conceptual schematic, is the selected remedy for soil remediation. The remedy will use in situ treatment technologies to reduce contaminant levels in the top 25 feet of soil to below action levels. To optimize the treatment, biological enhancements (introduction of aerobic microbes, anaerobic microbes, aerophilic microbes, liquid-phase nutrients, enzymes, and etc.), in addition to the introduction of vapor-phase nutrients, may be used if appropriate treatability studies or equivalent data are reviewed and indicate that significant remedial benefits would be accrued. As a result, several decision points, depicted on Figure 8-2, show minor variations on the same fundamental treatment processes. Decisions regarding which, if any, of these variations will be used will be made during remedial design phase based on feasibility, implementability, economics presented in the FS, the data resulting from a bioremediation treatability studies, and other data that may be appropriate.

8.2.1 Decision Process

Figure 8-2 shows the decision process for treatment of contaminated soils shallower than 25 feet in depth. This figure also shows the decision points that will be considered during the design phase for soil treatment remediation. Each decision point requires data that has been collected in the OU-2 RI/FS, the treatability study, or will be independently gathered.

There are approximately 54,000 cubic yards of soil from the surface to a depth of 25 feet that is contaminated with constituents of JP-4 and will require remediation. In situ SVE with bioenhancement will be the specific type of treatment but there will be several decision points during the design phase to optimize the effectiveness of the design. Currently there is a treatability study underway to determine the effectiveness of bioremediation of these soils. The results of this study will be used during the remedial design phase to finalize the implemented remediation.

8.2.2 Decision Points

8.2.2.1 Microbe Selection

Aerobic, naturally-occurring microbes are specified at this time for biotreatment; however, a decision point has been established to determine if anaerobic microorganisms might be a more effective degradation option. Data from the ongoing treatability study at the Base will be used to aid in this evaluation. In addition, either type of microbe could be utilized by either stimulating naturally-occurring microorganisms or by inoculation of additional microbial strains to potentially make treatment more effective by accelerating treatment time or decreasing final contaminant concentrations. A determination of whether to use aerobic or anaerobic microbes to degrade the contaminants and whether those microbes are naturally-occurring or inoculated will be made considering data for the microorganism's effectiveness in degrading the contaminants and on the implementability of delivering adequate nutrients to the microorganisms in the type of soil to be treated. Due to biological constraints, aerobic and anaerobic microbes cannot flourish under the same conditions, so a selection of one or the other will be made. Additional data as needed will be acquired through laboratory tests.

8.2.2.2 Nutrient Delivery System

Nutrients will be delivered to the microbes via either a vaporphase delivery system, as currently selected, or via a liquid-phase delivery system. There will be a decision point regarding the delivery of nutrients to the matrix containing the microorganisms and the contaminants as shown in Figure 6-3. The use of anaerobic microorganisms would only use liquid-phase delivery due to the nature of the nutrients required. The use of aerobic microorganisms can use either liquid- or vapor-phase delivery. A determination of the most effective delivery method will be based on the type of microorganism to be stimulated and the delivery requirements, effectiveness, availability of the nutrients, and economics. Data to make this decision will be acquired through treatability and/or laboratory tests.

8.2.2.3 Enhancement Addition

No addition of enhancing agents is now required for the chosen alternative. The USAF will consider the benefit of adding an enhancement agent to accelerate the bioremediation process. This enhancement agent could be enzymes, additional microbes, chelants, surfactants, etc. Additional microbial strains to enhance the already stimulated naturally-occurring microbes would be considered an enhancement, not a selection of microbes. Determination of the effectiveness and economics of using enhancement agents will be made during the remedial design phase and it will be based on data acquired through treatability and/or laboratory tests.

8.2.2.4 Emission Abatement

The selected remedy will control emissions from SVE treatment with fume incineration; however, the selected remedy also calls for the contingent use of vapor-phase carbon adsorption to control emissions in the event that the fume incinerator cannot technically achieve an acceptable emission level of less than three pounds per day of organic vapors. Figure 8-2 depicts this decision point. In the event that vapor-phase carbon adsorption is used, design considerations will be based on data collected during the pilot demonstration. This data includes O&M requirements, loading rates, untreated vapor concentrations, and stack emissions.

8.2.3 Information Summary

Data from the OU-2 RI/FS, a pilot demonstration, and laboratory and treatability studies will be used to make the above decisions. Additional information needed to fill data gaps will be collected. This data will be used during the remedial design phase. The USAF will continue to collect data during the operation of the selected remedy to direct process refinements.

9.0 Statutory Determinations

Under Section 121 of CERCLA, the selected remedy must be protective of human health and the environment and must comply with all ARARs.

The selected remedy also must be cost-effective and utilize permanent solutions and alternative treatment technologies to the maximum extent practicable. Remedies that employ treatment that permanently and significantly reduce the volume, toxicity, or mobility of hazardous wastes as a major part of the remedy are preferable. How the selected remedy meets these requirements is discussed below.

The selected remedy represents the best balance of trade-offs among alternatives with respect to pertinent criteria, given the scope of this action.

9.1 Protection of Human Health and the Environment

The selected remedy protects human health and the environment through extraction of contaminated groundwater and free-phase product and removal/treatment of VOCs by air stripping and by remediating the first 25 feet of soils with SVE and bioremediation. The volatile contaminants from the air stripper and the SVE system will be transferred to the air, removed by either carbon adsorption or fume incineration, then disposed of either at an approved carbon regeneration facility or by combustion in the fume incinerator. The recovered free-phase product will be disposed of at an approved disposal/recycling facility. No adverse affects as a result of cross media transfer are expected. Control of emissions using either vapor-phase carbon adsorption or fume incineration will adequately control any potential exposure risk.

Extraction and treatment of groundwater will eventually reduce concentrations of contaminants in groundwater to levels at or below the action levels. SVE with in situ bioremediation will also eventually reduce concentrations of contaminants in the top 25 feet of soil to levels at or below the action levels. Because the action levels are intended to be protective of human health and the environment, the magnitude of residual risk from exposure to groundwater and soil should be reduced from those levels presented in the baseline risk assessment for future land use (Tables 5-3 and 5-5) to acceptable levels. The task-based action levels (presented in Appendix A) are based on a residential exposure model and are calculated based on a cancer risk not to exceed 1 x 10[-6] or a HI not to exceed 0.25 for individual chemicals. These target risk levels are used to account for the possibility of exposure to multiple chemicals of potential concern from other pathways and sources.

9.2 Attainment of ARARs

The selected remedy will achieve the ARARs for the groundwater, soils, and air emissions. These ARARs are presented in detail in Appendix A.

9.3 Cost Effectiveness

The selected remedy (Alternative C) was evaluated for cost effectiveness against the other three alternatives (A, B, and D). The selected remedy would require an overall shorter period of time (including implementation and remediation) and should cost considerably less than Alternative D, the only other alternative that provides overall protection of human health and the environment and complies with ARARs (Table 7-1). The remedy will provide effectiveness proportional to the cost of the remedy given the operation and maintenance and present worth cost for the protection of human health and the environment.

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

The selected remedy is the design concept that best represents the tradeoffs among alternatives with respect to the pertinent criteria, especially the balancing criteria of implementability, short-term effectiveness and cost. Contingencies addressed in the selected remedy (Section 6.1.1) are compatible with its conceptual design; detailed design issues will be resolved during the remedial design phase. Contaminants will be permanently removed and eliminated by groundwater extraction and surface treatment. Contaminants will be disposed off-site at an approved regeneration facility or destroyed through the fume incineration process.

Resources will be conserved to the maximum extent possible using the selected remedy. Treated water will be injected back into the shallow aquifer and/or discharged to the Base wastewater treatment plant. Contaminant recovery will be implemented to the maximum extent possible without losing the removal efficiency of the abatement unit.

9.5 Preference for Treatment as a Principal Element

The requirement that treatment be a principal element of the remedy is satisfied. This operable unit action is consistent with planned future actions, to the extent possible.

Appendix A
Applicable or Relevant and Appropriate Requirements (ARARs)

ARARs Update

The chemical-specific, action-specific, and location-specific ARAR tables that were presented in the OU-2 FS Report and Proposed Plan have been revised. The most recent versions are presented in this appendix of the OU-2 ROD. The specific ARAR values affected include the Arizona HBGL for Ingestion of Contaminants in Soil and Groundwater, which were in a preliminary draft stage when the previous documents were published. These HBGLs have now been issued final and the ARAR tables in Appendix A have been revised to show the final values. In addition, values for several Federal and State MCLs, promulgated or proposed, have been included.

The current versions of these tables supercede any previous versions issued in other documents, including the OU-2 FS and Proposed Plan. The only value change that affected the chemicals of potential concern and the subsequent evaluation of alternatives was the lowering of the groundwater action level of naphthalene from 0.69 mg/L to 0.028 mg/L. This new value was included in the evaluation of the alternatives, but did not change any conclusions. The conceptual process design used to determine cost for groundwater remediation may require revision prior to remedial design to expand the air stripping system to remove the incremental concentrations of naphthalene.

Appendix B
Cost Estimates for Selected Alternative

Alternative C
Letters Recommending Methods and Products

PROBIOTIC
SOLUTIONS

June 22, 1992

Mr. Willard S. Carter
Project Manager
International Technology Corporation
312 Directors Drive
Knoxville, TN 37923

RE: Williams AFB OU-2 site remediation

Dear Mr. Carter:

I was pleased to meet you at the public meeting in Mesa, Arizona June 16, 1992. I feel that Alternative C utilizing In Situ Bioremediation is certainly the preferred alternative at this location.

Our company has developed bioremediation products which enhance biological degradation of contaminants. This probiotic technology was developed first for agriculture beginning in 1973 and has been adapted for bioremediation of contaminants in a wide range of applications.

Our probiotic products contain complexing agents, organic acids, buffers, biological systems and nutrients which enhance biological degradation. These biological systems adapt to the contaminant substrate reducing the compound economically and expeditiously. Our probiotic products are concentrated, contain no toxic materials, and are easy to use.

I am enclosing some information to familiarize you with our company and products. We have contractors in the field who have developed soil vapor extraction procedures using our probiotic products which are very effective and economical. I will send copies of these reports if you would like to review them.

We would like to show you how our technology will fit into your Alternative C plan at your earliest convenience. I will contact you after you have a chance to review the enclosed information to determine how our technology can enhance this project.

Sincerely,

Ken Martin
Director

CC: Maureen Levitz, David R. Annis, Bill Pehlivanian, Mike Van Fleteren, William Lopp

INTERNATIONAL TECHNOLOGY CORPORATION

July 9, 1992

Mr. Ken Martin, Director
Probiotic Solutions
3 N. Roosevelt Avenue
Chandler, AZ 85226

Reference: Your Letter of June 22, 1992
Subject: Williams AFB, Project No. 409735, In Situ Bioremediation

Dear Mr. Martin:

We appreciate your information concerning Probiotics and its products. We are reviewing its application to the soil vapor extraction process at Williams AFB but any final determination will have to await initiation and funding of the remedial design phase for Operable Unit 2.

We appreciate your interest in providing a cost-effective solution to cleanup of Operable Unit 2 at the Williams AFB site. Please contact me if there are other questions. Your interest and address are being retained.

Sincerely,

Greg Sergent
Senior Contracts Administrator

cc: Maureen Leavitt
David Annis
Bill Pahlivanian
Mike Van Fleteren
William Lopp
Will Carter

Mesa, Arizona
June 25, 1992

International Technology Corporation
312 Directors Drive
Knoxville, Tennessee 37923

Williard S. "Will" Carter
Project Manager

Teresa Kovalcson
Chemist

Re: Williams Air Force Base Clean-Up

I am writing about the clean-up proposal I talked to you about, recently in Mesa, Arizona. I do want this letter to become a part of the official report.

OU-2 ALTERNATIVE-STEVEN A. TALLEY: SOIL WASHING

This alternative would involve soil boring 0 to 25 feet in order to provide a reasonable and equitable distribution of the soil washing cleaning compound mixed with water. A total of 121,000 cubic yards would be processed by contacting the contaminated soil with the washing fluid. ITC reports only 67,000 cubic yards would be excavated and washed instead of the 121,000 yards I claim needs washing.

The washing fluid, containing water, is a solvent type: The solvent type cleaner utilizes a solvent extracted from food products; in addition, various detergents (chemicals that act as soaps) are added. Safe surfactants are also used to reduce the surface tension to allow the ALKALI products to work (clean) more effectively.

The above described washing fluid product is proprietary. The material safety data sheets have been prepared and issued in accordance with (IAW) CFR 29 1910.1200.

The washing step is to be done in three stages. Each stage of the washing will either emulsify the contaminant and convert it into soap or protein for the soil bacteria to eat or else it will chelate or encapsulate the contaminant and convert it from toxic to non-toxic particles, thus eliminating the need to remove any toxic residuals.

As a matter of information, the founder, inventor and chemist of HDI was at one time an inspector (POL) at Williams Field for 5 1/2 years. He knew first hand of the draining of the JP-4 tanks and Aviation gasoline directly on the ground. I have permission to use his name - George Aboud, Sr. He knows exactly what was put into the ground and, using his patented products, I can change the contaminants into non-toxic particles and protein for the soil bacteria food chain.

COST

The estimated present worth cost of the OU-2 ALTERNATIVE - STEVEN A. TALLEY: SOIL WASHING is $12.85 million with the principal cost being equipment charges, operating labor, and the solvent costs. According to my calculations, the projected quantity of surface and subsurface soil to be treated is larger than what the ITC proposes - 121,000 cubic yards versus your 67,000 cubic yards. My proposal is about half the cost for almost twice the amount of soil.

I would be very interested in knowing the results of the tests I propose that you complete. I know we both want the most effective clean-up for the minimum cost.

If you have any questions regarding the above proposal, please call me at (602) 962-8282.

Sincerely,

Steven A. Talley
2043 E. 7th Ave
Mesa, Arizona 85204

Enclosures

cc: Senator John McCain
Senator Dennis DeConcini
Capt. Mary Feltault
Mr. David R. Annis
Mr. William B. Lopp
Capt. Sally Watson
Mr. Mike Van Fleteran
Col. Tim Peppe
Mr. Bill Pehlivanian

INTERNATIONAL
TECHNOLOGY
CORPORATION

July 9, 1992

Mr. Stephen A. Tally
2043 East 7th Avenue
Mesa, AZ 85204

Subject: Your Letter of June 25, 1992
Williams AFB, Project 409735, Soil Washing

Dear Mr. Tally:

We appreciate your proposal for use of a heavy duty industrial degreaser (HDI) in washing the soil at Williams AFB Operable Unit 2. Currently we are examining the cost comparison. A determination of the effectiveness of your product will have to await initiation and funding of the remedial design phase for Williams AFB.

Please notify me if you have any further questions. Your interest and address are being retained.

Sincerely,

Greg Sergent
Senior Contracts Administrator

cc: Senator John McCain
Capt. Mary Feltault
Mr. William B. Lopp
Mr. Mike Van Fleteren
Mr. Bill Pehlivanian
Will Carter
Senator Dennis DeConcini
Mr. David R. Annis
Capt. Sally Watson
Col. Tim Peppe
Mr. Jack Koelsch

INTERNATIONAL TECHNOLOGY CORPORATION

RECORD OF TELEPHONE CALL

DATE: July 10, 1992
TIME:

Project Name: Williams AFB

Project Number: 409735

Call from: Will Carter

Call to: Steve Talley

Summary (Decisions/Specific Actions)

I returned Mr. Talley's call and informed him that we had received the information and product that he had sent and said that there would be no formal response until the responsiveness summary. I also notified him that there could be no assured action accepting or rejecting his proposed product until the remedial design for OU-2 was funded and initiated. I indicated that IT was doing a cursory examination of his product for its potential use on this and other jobs but that this was not a part of our scope with Williams AFB. I, therefore, told him that he should not rely specifically on our efforts to either accept or reject his product for future use. I also notified him that his interest, product, and name would be transmitted to other agencies who might be engaged in the remedial design process.

Required Action:

Prepared By: Will Carter

Distribution: Jack Koelsch
Bill Mabson
Bill Lopp

ECOLOGY TECHNOLOGIES INTERNATIONAL

Mr. William Lopp (H-9-1)
U.S.Environmentlal Protection Agency
75 Hawthorne Street
Federal Enforcement Section
San Francisco, California 94105

17 June, 1992

Dear Mr. Lopp,

It was a pleasure to attend the well-organized and presented meeting held at the Rendezvous Center the 16th of June. I appreciate your "sidewalk consultation" regarding the potential for use of FyreZyme in this and other petroleum product spill sites. Our informational packet is enclosed.

I have submitted a request that our new product, FyreZyme, be selected as the nutrient for the bioremediation component of OU-2 at WAFB. FyreZyme, as the enclosed literature explains, serves as a rich source of biologic metabolic enzymes to initiate the oxidation of benzene and other contaminants. FyreZyme's sugars and amino acids stimulate bacterial growth; by Darwinian selection, those bacteria capable of continuing the metabolism of petroleum product increase in relative and actual numbers by several orders of magnitude.

FyreZyme also contains naturally-produced bioemulsifiers which help increase the surface area of the petroleum aggregates. An integral biodegradable surfactant moiety increases the penetration of FyreZyme into less-than-ideal soil environments such as are present in OU-2, and also helps mobilize petroleum product within the soil pore spaces.

The positive feedback bioremediation system which develops with the utilization of FyreZyme, water, and atmospheric oxygen has been proven in both bench and field tests. Toxicity studies verify the wide margin of safety of FyreZyme. FyreZyme is the least expensive of all currently available environmentally "friendly" bioremediation enhancing agents. FyreZyme has proven highly effective in suppressing VOC release, and we are in the process of developing off-gas treatment methodologies which will dramatically decrease the cost of air pollution control. Our field testing of VOC control may not be completed by July 7, so I would like to keep that door open for further communication.

Ecology Technologies International, Inc. would like to offer our services in further petroleum-spill remediation in State and Federal sites, and would appreciate an opportunity to discuss the technology in person with you and your technical staff. Your guidance as to how we can participate in field demonstrations and testing as well as in actual site work would be most valuable. Tom Schruben has advised us to meet with representatives within the Regions, and we would be pleased to come to San Francisco for such a "brainstorming" session.

Sincerely,

Robert H. Meaders MD
Research Director

IN-SITU FIXATION COMPANY
Division of the Richard P. Murray Co., Inc.
Environmental Contractors
P.O. Box 516 · Chandler, Arizona 85224-0516 · (602) 821-0409

July 1, 1992

Mr. William Lopp (H-9-1)
U.S. Environmental Protection Agency
75 Hawthorne Street
Federal Enforcement Section
San Francisco, California 94105

Ref: Public Meeting-Proposed Cleanup, Operable Unit 2, WAFB
Subj: Recommendation for Alternative Cleanup Technology

Dear Mr. Lopp:

Enclosed with this letter, please find our Company brochure and a video tape describing our in-situ bioremediation technology methods and equipment. The reason for this letter is to present our in-situ soil bioremediation Dual Auger System Technology as an alternative cleanup method for the Liquid Fuel Storage Area, Operable Unit 2, Williams Air Force Base.

The current proposed soil remediation plan, as presented at the June 16, 1992 meeting, is to construct injection wells to a depth of 25' on an as yet undetermined spacing pattern. An as yet undetermined liquid nutrient is proposed to be injected into the soil under pressure, via the injection wells. I would request that you evaluate our in-situ injection and mixing technology, in lieu of the currently proposed injection well system. The proposed method of in-situ bioremediation treatment is not the most efficient or cost effective in-situ soil bioremediation method available today, as exhibited by the results of past and current direct injection demonstration projects. The current S.I.T.E. Demonstration Project presently taking place at Williams AFB has shown that the lateral/horizontal movement is limited. The soil types encountered at Williams AFB will not allow for the uniform lateral/horizontal movement of the injected liquid reagents and, thus will not uniformly remediate the soil and will leave "hot" spots.

Our technology, as described in the enclosed brochure and video tape, has been accepted into the U.S.E.P.A.'s S.I.T.E. Program for just this type of contamination. Additionally, later this summer, working under a contract with the U.S.A.F., we will demonstrate the unique and efficient injection and mixing feature of our Dual Auger System Technology.

We are aware that it is the intention of all parties concerned, that the cleanup at Williams AFB be successfully remediated and at the lowest possible cost to the American taxpayer. As a local Arizona company, we would like to recommend a full scale pilot program, utilizing our technology vs. the proposed injection well method. The magnitude of the cleanup project at William AFB would certainly justify such a full scale pilot test program.

I would very much appreciate hearing from you at your earliest convenience.

Sincerely,

Richard P. Murray
C.E.O.

cc: Mr. Robert A. Olexsey, Director, Superfund Technology
Demonstration Division
Mr. Ed Opatken, U.S.E.P.A. Project Manager
Senator John McCain
Representative William Mundell

RPM:jks

Enclosures

SOIL REMEDIATION by THERMAL DESORPTION
On-site soil remediation, thermal desorption service

DUSTCOATING, INC.

July 6, 1992

Captain Mary Feltault
Public Affairs Office
Williams Air Force Base, Arizona 85240
Mr. Mike Van Fleteren
Arizona Department of Environmental Quality
3003 N. Central Avenue, Suite 502
Phoenix, Arizona 85012

Mr. William Lopp (H-9-1)
U.S. Environmental Protection Agency
75 Hawthorne Street
Federal Enforcement Section
San Francisco, California 94105

RE: PUBLIC COMMENT-PROPOSED PLAN FOR OPERABLE UNIT 2, WILLIAMS AFB, ARIZONA

Dear Captain Feltault and Messrs. Van Fleteren and Lopp:

This letter is in response to the proposed plan for the cleanup of groundwater and soil contamination at Williams Air Force Base Operable Unit Number 2 (OU-2). After attending the public meeting of June 16, 1992, we feel compelled to comment publicly regarding the proposed plan. Specifically, our comments relate to the rationale of the soil cleanup levels and the estimated costs associated with the potential remedial method Alternative D, on-site Thermal treatment.

SOIL CLEANUP ACTION LEVELS

According to the Feasibility Study (FS) prepared for OU-2, the average Benzene concentration at the site is 27.1 mg/kg. The Summary of Contamination in the Proposed Plan for OU-2 states that the objective of the corrective action is to treat soil to a 26 mg/kg action level for Benzene, while the current draft Arizona cleanup level for Benzene in soil is 130 ug/kg. The action level selected for OU-2 (which was derived by comparing State action levels with risk-based concentrations calculated by the Air Force) is over 200 times higher than the current draft State level itself. The proposed plan further states that the Benzene cleanup goal of 26 mg/kg is a "health-based protective level." As Benzene is a known carcinogen, it is contradictory to state that the 28 mg/kg Benzene cleanup level is in fact a health-based protective level. Alternative C calls for millions of dollars of expenditures over a minimum three year period. If Alternative C is successful in reaching the soil action level for Benzene this will equate to only a four percent reduction in the concentration of that compound in the soil.

The FS further states that the average Total Petroleum Hydrocarbon (TPH) concentration for soil at OU-2 is 2,842.9 mg/kg. While the current draft State cleanup level for TPH is 100 mg/kg, there is no mention of a TPH cleanup level in the proposed plan for OU-2. As the bulk of the contamination at OU-2 consists of JP-4 TPH, the cleanup alternative selected should also include an action level for TPH.

ALTERNATIVE D SOIL CLEANUP COSTS

Low temperature thermal desorption (LTTD) soil treatment is capable of completely removing Benzene from soil along with reducing TPH levels to less than 25 parts per million. These treatment levels can be achieved rapidly and cost effectively without harm to human health or the environment.

The remedial alternative evaluation in the proposed plan for OU-2 is correct in stating that Alternative D soil remediation with LTTD technology would result in a permanent solution, reduce toxicity and be protective of the environment. The analysis is flawed though regarding the estimated costs and the associated time required to complete thermal treatment. The thermal treatment option was evaluated based on utilizing a treatment unit with a production rate of 10 tons per hour, processing approximately 70,000 cubic yards of impacted soil over a period of about two years, at a total cost of roughly 14 million dollars. These costs and assumptions are inflated and unrealistic.

While it will be necessary to over-excavate a correspondingly large volume of clean soil to successfully remove the JP-4 impacted areas down to a depth of 25 feet, a mobile LTTD unit with a capacity properly sized to complete the job at hand would have a production rate at least 3 times higher than what was used in the feasibility analysis estimate. An estimated time frame to complete the thermal portion only would be 10 to 12 months with a more realistic per ton treatment cost in the neighborhood of $50 per ton. This would equate to approximately $4 to $5 million. By including an additional $4 million for misc site preparations, soil excavation and handling, fugitive emission controls, soil analytical testing to verify treatment and backfilling, it is really quite difficult to inflate the total cost estimate for thermal soil treatment to more than $9 million dollars.

Based on the other alternatives, LTTD technology is quicker and more cost effective and provides for a true environmental cleanup with toxicity reductions in excess of 98 percent. The toxicity reductions for alternative C are on the order of less than 10%, ultimately with a much higher bottom line cost. There are multiple unknowns related to the site-wide implementation and effectiveness of in-situ bioremediation. There are also loosely defined longterm operational and maintenance (O&M) expenses to be incurred, which encompassed a rather broad range as defined in the FS. The broad range of the O&M costs themselves implies a high degree of uncertainty as to what the costs will ultimately be.

Dustcoating has been in the thermal desorption business for over four years. We have helped pioneer the industry. We own and operate mobile, low temperature thermal desorption units on a nationwide bases. We have successfully completed jobs in both the public and private sector and have a real understanding of the costs associated with thermal desorption treatment from both a unit price and a "turnkey" perspective. We also understand how these costs can vary depending on the geographical location of the job site, and also how variations in cleanup levels and permit requirements affect cleanup costs. These are variables that are thoroughly addressed during the initial bidding and later permit process as a project evolves.

In summary, the feasibility analysis for thermal treatment at OU-2 failed to effectively demonstrate the inherent strong points that make LTTD technology so effective on hydrocarbon cleanups within the current environmental climate. Namely, the process is rapid and thorough, cost effective, without harm to human health or the environment, soil TPH concentrations are reduced to levels that make the material suitable for virtually any use without institutional controls or limits as to the re-use applications of the material itself.

There are no unknowns after the completion of thermal desorption, the results are proof-positive. After several years of corrective action as outlined in the proposed Alternative C, whether the cleanup levels are met or not, the money will still get spent.

Respectfully Submitted,
Dustcoating Incorporated

Larry Johnson
President

Rick Heetland
Arizona Representative

cc: Mr Mike Breazeale
Mr Dale Libe
Capt. Kurt Mallery
Capt. Micheal Schanck
Mr William Mabson
Col. Dave R Love
Mr William Pehlivanian