FIVE-YEAR REVIEW REPORT
FOR THE
SAND SPRINGS PETROCHEMICAL COMPLEX SUPERFUND SITE
SAND SPRINGS, TULSA COUNTY, OKLAHOMA

SEPTEMBER 2005

Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION 6
DALLAS, TEXAS

Prepared by

TETRA TECH EM INC.
Contract No. 68-W6-0037
Work Assignment No. 123-FRFE-06ZZ

Determinations

I have determined that the selected remedy for the Sand Springs Petrochemical Complex (Sand Springs) Superfund Site is protective of human health and the environment and will remain so provided that the landfill cap, including the leachate collection system are maintained, groundwater monitoring data are evaluated to determine if the protection of groundwater is occurring, and access restrictions are enforced.

for Samuel Coleman, P.E.
Director
Superfund Division
U.S. Environmental Protection Agency Region 6

9/8/05
Date

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SAND SPRINGS PETROCHEMICAL COMPLEX SUPERFUND SITE
EPA ID No. OKD980748446

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ACRONYMS AND ABBREVIATIONS

§	Section
ALR	Action leakage rate
ARAR	Applicable or relevant and appropriate requirement
ARCO	Atlantic Richfield Company
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Corps	U.S. Army Corps of Engineers
CWA	Clean Water Act
EPA	U.S. Environmental Protection Agency Region 6
FS	Feasibility study
FWCA	Fish and Wildlife Coordination Act
GPAD	Gallons per acre per day
LNAPL	Light nonaqueous phase liquid
NAAQS	National Ambient Air Quality Standards
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOID	Notice of Intent to Delete
NPDES	National Pollution Discharge Elimination System
NPL	National Priorities List
ODEQ	Oklahoma Department of Environmental Quality
O&M	Operation and maintenance
OU	Operable unit
POTW	Publicly Owned Treatment Works
PRP	Potentially responsible party
RA	Remedial action
RAO	Remedial action objective
RCRA	Resource Conservation and Recovery Act
RI	Remedial investigation
ROD	Record of Decision
Sand Springs	Sand Springs Petrochemical Complex
SS	Solidification/stabilization
Tetra Tech	Tetra Tech EM Inc.
TTU	Transportable treatment unit
µg/L	Micrograms per liter

EXECUTIVE SUMMARY

The U.S. Environmental Protection Agency Region 6 (EPA) has conducted the second five-year review of the remedial action (RA) implemented at the Sand Springs Petrochemical Complex (Sand Springs) Superfund site in Sand Springs, Oklahoma. The purpose of this five-year review was to determine whether the selected remedy for the site continues to protect human health and the environment. This review was conducted from February 2005 to June 2005, and its findings and conclusions are documented in this report. The first five-year review of the RA was completed in September 2000. The second five-year review period extended from 2000 to 2005.

During routine operation and maintenance (O&M) activities in May 2001, seeps of black sludge were observed near the former acid sludge disposal pit along the northern bank of the Arkansas River. In June 2002, ARCO, along with EPA oversight, conducted an investigation at the site. This investigation identified several seeps. Some appeared to have flowed to the surface, while others were exposed as layers of contamination along the cut bank. Test pits excavated near the former sludge pit encountered significant sludge and contaminated soil at depths of approximately 14 feet below ground surface. Sludge materials were identified in six areas on the site. In November 2002, ARCO submitted an assessment report and analytical results for the test pit investigation, along with a recommendation for cleanup. An additional site characterization report was completed in July 2003.

In September 2004, Atlantic Richfield prepared a work plan for excavating the sludge materials from the six areas. According to the work plan, all sludge plus one foot of soil below the soil/sludge interface will be excavated and disposed of to remain consistent with the original soil cleanup criteria established for the Superfund RA. Observations and confirmation sampling will be used to verify the delineation of the excavated materials. The total volume of material, including sludge, mixed soil, neutralizing lime, and debris that will be disposed of at a Subtitle D Landfill is estimated to be 16,000 to 20,000 cubic yards.

After all waste is removed, the site will be backfilled and graded, and grass sod will be applied to provide a vegetative cover. A portion of the north bank of the Arkansas River will be rip rapped to prevent erosion by the Arkansas River. These activities are scheduled to occur during Summer 2005.

Several documents were reviewed as part of this five-year review, including those containing the following data: (1) leachate collection system summaries from 2001 through 2004, (2) monitoring well

water levels and detected light nonaqueous phase liquid (LNAPL) thickness data, (3) analytical sampling results, and (4) quarterly inspection summaries.

The Sand Springs site was listed on the National Priorities List (NPL) in June 1986. EPA divided the site into two operable units: the Source Control Operable Unit (OU 01), which included all waste pits and contaminated soils, and the Main Site Operable Unit (OU 02), which included ground water. EPA signed the Record of Decision (ROD) for the Source Control OU on September 29, 1987. The ROD for the Main Site OU was signed on June 28, 1988. The remedial action objectives (RAO), selected remedy, and implementation status for the Source Control OU and the Main Site OU are discussed in the following paragraphs.

Source Control Operable Unit Action, OU 01

The ROD for OU 01 stated that, in EPA's judgment, Alternative 2 (on-site thermal destruction) appeared to meet more statutory selection criteria than the other remedies evaluated, but has serious implementation problems. During the comment period, the Atlantic Richfield Petroleum Products Company, a division of Atlantic Richfield Company (ARCO), one of the potentially responsible parties (PRP) for the site, made written and oral proposals for a privately financed remedy for the site. The EPA concluded that the ARCO proposal provided a remedy comparable to Alternative 2. EPA accepted this remedy provided that the effectiveness of the proposal was adequately assured or that ARCO would undertake the corrective actions deemed appropriate by EPA if the ARCO proposed remedy failed. The ROD described the remedy as follows:

1) Excavation and off-site thermal destruction of sludges, at least to the sludge/soil interface, from the portion of the site identified as the North and South Glenn Wynn Lagoons.

2) Solidification and/or stabilization of all remaining sludges and containment of the resulting matrix in a Resource Conservation and Recovery Act (RCRA) hazardous waste cell to be constructed on-site; this cell (or cells) had to meet the minimum technological requirements of Subtitle C of the Solid Waste Disposal Act.

3) Demonstration that the solidification technology utilized during the remedial action met EPA's approved criteria; including chemical and physical testing requirements. In the event that the solidification technology failed these criteria, thermal destruction would have been the remedy for the above-mentioned operable unit.

4) No liability release from the site or from future maintenance and monitoring.

5) Repair or restoration of the RCRA Subtitle C landfill to ensure no migration from the unit or destruction or treatment of all or a portion of its contents, as EPA shall deem

appropriate, if the monitoring should show that the solidification and/or stabilization remedy has failed.

Main Site Operable Unit, OU 02

EPA signed the ROD for OU 02 on June 28, 1988. The ROD stated that in EPA's judgment, Alternative 1, No Action (monitoring following the Source Control Remedial Action) met the statutory selection criteria. Factors supporting this decision included: after the Source Control Remedial Action, a natural flushing action will have decreased the level of contamination over time; the ground water and the Arkansas River are not sources of drinking water; and there is no public health threats from the minimally contaminated soil. The State of Oklahoma concurred with this remedy. The ROD listed the following requirements for the remedy:

1) Place appropriate warning signs;
2) Restrict access; and,
3) Collect and analyze ground water for a period of at least 30 years.

EPA determined that this alternative is protective of human health and the environment, attains federal and state requirements that are applicable or relevant and appropriate, is cost-effective compared to equally environmentally protective alternatives, and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable.

Additional Information

During routine operation and maintenance (O&M) in May 2001, seeps of black sludge were observed near the former acid sludge disposal pit along the bank of the Arkansas River. An investigation of the seep was conducted in June 2002. Several seeps were observed at the site; some seeps appeared to have flowed to the surface, while others were exposed as layers of contamination along the cut bank. Test pits excavated near the former sludge pit encountered significant sludge and contaminated soil at depths to approximately 14 feet. In November 2002, ARCO submitted an assessment report and analytical results for the test pit investigation, along with a recommendation for cleanup.

In September 2004, Atlantic Richfield prepared a work plan for excavating the sludge materials from the six areas. According to the work plan, all sludge plus one foot of soil below the soil/sludge interface will be excavated and disposed of to remain consistent with the original soil cleanup criteria established for the Superfund RA. Observations and confirmation sampling will be used to verify the delineation of the

excavated materials. The total volume of material, including sludge, mixed soil, neutralizing lime, and debris that will be disposed of at a Subtitle D Landfill is estimated to be 16,000 to 20,000 cubic yards.

After all waste is removed, the site will be backfilled and graded, and grass sod will be applied to provide a vegetative cover. A portion of the north bank of the Arkansas River will be rip rapped to prevent erosion by the Arkansas River. These activities are scheduled to occur during Summer 2005.

The second five-year review focused on data obtained during annual inspections conducted at the Sand Springs site. This review included the ground water monitoring activities, leachate collection activities, and general landfill maintenance performed from 2001 through 2004. At this time, the selected remedy appears to be performing as intended.

The following issues were noted.

1. **Operation and Maintenance Plan –** The Post Closure Plan and the Ground Water Monitoring Plan were written prior to the completion of the remedial action for the site. As a result, the documents are out-of-date and many of the items listed in the plans are no longer applicable.

2. **Small areas of subsidence –** Small areas of subsidence were noted in the southwest corner, inside the perimeter fence during the December 2003 inspection.

3. **Rainwater ponding within vaults –** Rainwater appears to be ponding and infiltrating into the leachate collection/detection system according to the Annual Inspection reports.

4. **Minor erosion at stormwater pipe –** Stormwater pipe located west of the landfill, near leachate sump #3, at the perimeter fence has minor erosion below the opening of the pipe.

5. **Animal activity noted –** Minor/shallow tunnels caused by burrowing animals were noted near the top of the cap. In addition, one of the vent caps at the apex of the cell was partially filled with loose soil apparently caused by burrowing activities.

6. **Overgrowth of vegetation –** Sand Springs Home mentioned that to their understanding the landfill was to be kept mowed.

7. **Institutional Controls –** No institutional controls are currently in place at the site.

The following actions are needed in response to these issues:

1. The Operation and Maintenance Plans need to be revised to make them applicable to the current site conditions.

2. Continue to monitor the areas of the site experiencing ground surface subsidence, and engage in repair when appropriate to prevent impact upon the landfill.

3. Drainage pipes have been installed in some of the leachate collection/detection vaults. Drainage pipes should be installed in the remaining vaults on an as-need basis.

4. Repair the area of erosion located under the opening of the stormwater pipe to prevent further erosion from occurring.

5. Remove or exterminate rodents by means approved by the State of Oklahoma, and repair the burrowed cap areas and the vent pipe areas.

6. Inform Sand Springs Homes that the landfill is mowed once a year in the late fall or early winter to allow the grasses on the landfill cap to go to seed and perpetuate a sufficient amount of cover.

7. Institutional controls should be established to protect human health and the environment and to facilitate potential property transfers for redevelopment and land reuse activities.

At this time, based on the information available during the second five-year review, the selected remedy appears to be protective of human health and the environment, and will remain so provided that the landfill cap, including the leachate collection system, are maintained; ground water monitoring data are evaluated to determine if the protection of ground water is occurring; and access restrictions are enforced.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name (from WasteLAN): Sand Springs Petrochemical Complex Site		
EPA ID (from WasteLAN): OKD980748446		
Region: 6	**State:** Oklahoma	**City/County:** Sand Springs/Tulsa County

SITE STATUS

NPL Status: ☐ Final ☒ Deleted ☐ Other (specify) _____

Remediation Status (choose all that apply): ☐ Under Construction ☐ Operating ☒ Complete

Multiple OUs?* ☒ YES ☐ NO **Construction Completion Date:** August 1995

Has site been put into reuse? ☐ YES ☒ NO

REVIEW STATUS

Reviewing Agency: ☒ EPA ☐ State ☐ Tribe ☐ Other Federal Agency _____

Author Name: Michael Hebert

Author Title: Remedial Project Manager **Author Affiliation:** EPA Region 6

Review Period:** 9/2000 to 3/2005

Date(s) of Site Inspection: 03/14/2005

Type of Review: ☒ Statutory
☐ Policy ☐ Post-SARA ☐ Pre-SARA ☐ NPL-Removal only
☐ Non-NPL Remedial Action Site ☐ NPL State/Tribe-lead
☐ Regional Discretion

Review Number: ☐ 1 (first) ☒ 2 (second) ☐ 3 (third) ☐ Other (specify) _____

Triggering Action:
☐ Actual RA On-site Construction at OU ☐ Actual RA Start
☐ Construction Completion ☒ Previous Five-Year Review Report
☐ Other (specify)_____

Triggering Action Date (from WasteLAN): 09/2000

Due Date (Five Years After Triggering Action Date): 09/2005

* "OU" refers to operable unit.

** The review period refers to the period during which the five-year review was conducted.

Five-Year Review Summary Form (Continued)

Issues:

1. **Operation and Maintenance Plan –** The Post Closure Plan and the Ground Water Monitoring Plan were written prior to the completion of the remedial action for the site. As a result, the documents are out-of-date and many of the items listed in the plans are no longer applicable.

2. **Small areas of subsidence –** Small areas of subsidence were noted in the southwest corner, inside the perimeter fence during the December 2003 inspection.

3. **Rainwater ponding within vaults –** Rainwater appears to be ponding and infiltrating into the leachate collection/detection system according to the Annual Inspection reports.

4. **Minor erosion at stormwater pipe –** Stormwater pipe located west of the landfill, near leachate sump #3, at the perimeter fence has minor erosion below the opening of the pipe.

5. **Animal activity noted –** Minor/shallow tunnels caused by burrowing animals were noted near the top of the cap. In addition, one of the vent caps at the apex of the cell was partially filled with loose soil apparently caused by burrowing activities.

6. **Overgrowth of vegetation –** The Sand Springs Home mentioned that to their understanding the landfill was to be kept mowed (on a regular basis).

7. **Institutional Controls –** No institutional controls are currently in place at the site.

Recommendations and Follow-up Actions:

1. The Operation and Maintenance Plans need to be revised to make them applicable to the current conditions at the site.

2. Continue to monitor the areas of the site experiencing ground surface subsidence, and engage in repair when appropriate to prevent impact upon the landfill.

3. Drainage pipes have been installed in some of the leachate collection/detection vaults. Drainage pipes should be installed in the remaining vaults on an as-need basis.

4. Repair the area of erosion located under the opening of the stormwater pipe to prevent further erosion from occurring.

5. Remove or exterminate rodents by means approved by the State of Oklahoma, and repair the burrowed cap areas and the vent pipe areas.

6. Inform Sand Springs Homes that the landfill is mowed once a year in the late fall or early winter to allow the grasses on the landfill cap to go to seed and perpetuate a sufficient amount of cover.

7. Institutional controls should be established to protect human health and the environment and to facilitate potential property transfers for redevelopment and land reuse activities.

Protectiveness Statement:

The remedial action at the Source Control Operable Unit (OU 01) and the Main Site Operable Unit (OU 02) are protective of human health and the environment. Since both operable units are protective, the remedy for the site is protective of human health and the environment.

Long-Term Protectiveness:

At this time, the second five-year review indicates that the selected remedy appears to be performing as intended, and is protective of human health and the environment. For the remedy to be protective in the long term, the landfill should continue to be inspected and operated and maintained in accordance with approved plans. Additionally, the ground water monitoring wells established around the landfill will need to continue being monitored. Ground water samples will need to continue being collected and analyzed annually for the list of chemicals specified by the plans.

1.0 INTRODUCTION

The U.S. Environmental Protection Agency Region 6 (EPA), with assistance from Tetra Tech EM Inc. (Tetra Tech) and in coordination with the Oklahoma Department of Environmental Quality (ODEQ), Atlantic Richfield Company (ARCO), U.S. Army Corp of Engineers (Corps), and Stallion Environmental conducted a five-year review of the remedial action (RA) implemented at the Sand Springs Petrochemical Complex (Sand Springs) Superfund site in Sand Springs, Oklahoma. The purpose of a five-year review is to determine whether the remedy at a site is protective of human health and the environment.

The five-year review process is required by federal statute. EPA must implement five-year reviews consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). CERCLA Section (§)121(c), as amended, states the following:

> "If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented."

NCP §300.430(f)(4)(ii) states the following:

> "If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action."

Because hazardous substances, pollutants, or contaminants remain at the Sand Springs site above levels that allow for unlimited use and unrestricted exposure, a five-year review is required.

The Sand Springs site includes two operable units: (1) the Source Control Operable Unit (OU 01), which included all waste pits and contaminated soil, and (2) the Main Site Operable Unit (OU 02), which included ground water. This second five-year review addresses the entire site. The period addressed by the five-year review for Sand Springs extended from 2000 to 2005. The triggering action for this review was the completion of the first five-year review in September 2000. The second five-year review was conducted from February to June 2005, and its methods, findings, conclusions, and recommendations are documented in this report.

This report documents the five-year review for the Sand Springs site by providing the following information: site chronology (Section 2.0), background information (Section 3.0), an overview of the EPA RA (Section 4.0), five-year review progress (Section 5.0), the five-year review process (Section 6.0), technical assessment of the site (Section 7.0), issues identified (Section 8.0), and recommendations and follow-up activities (Section 9.0). The report also provides a protectiveness statement (Section 10.0) and discusses the next review (Section 11.0). Appendix A provides a list of documents reviewed, and Appendix B is the site visit report. The public notice is provided in Appendix C, and a summary table of laboratory analytical results is provided in Appendix D.

2.0 SITE CHRONOLOGY

A chronology of site events for the Sand Springs site is provided in Table 1. Additional historical information for the site is available on line at: http://www.epa.gov/earth1r6/6sf/pdffiles/0601357.pdf (EPA 2003).

3.0 BACKGROUND

This section discusses the site's physical characteristics, land and resource use near the site, the history of site contamination, the initial response to the site, and the basis for the response.

3.1 PHYSICAL CHARACTERISTICS

The Sand Springs Superfund Site is located within the city limits of Sand Springs, Oklahoma in Tulsa County (see Figure 1). The site is located on the north bank of the Arkansas River and comprises approximately 235 acres. The area is designated as industrial, and the site is situated on the alluvial flood plain of the Arkansas River. Approximately 25 to 40 feet of alluvial deposits compose the alluvial aquifer, which overlies 205 feet of shale bedrock. In situ aquifer tests performed at the site indicate the alluvial aquifer has a high hydraulic conductivity. These aquifer tests and water levels within the on-site monitoring wells indicate that ground water moves rapidly and discharges to the Arkansas River.

TABLE 1

CHRONOLOGY OF SITE EVENTS
SAND SPRING PETROCHEMICAL COMPLEX

Date	Event
Early 1900s	Pierce Petroleum begins to refine oil on the site
1930	Sinclair Oil purchases the Pierce Petroleum Refinery
1948	Sinclair Oil Refinery is shut down and dismantling begins
1953	Sinclair Oil conveys property to the Sand Springs Home, but retains 38 acres
1964	Sand Springs Home leases 5.5 acres of its property to Glenn Wynn
1969	Sinclair Oil merges with Atlantic Richfield Company (ARCO)
December 1980	U.S. Environmental Protection Agency (EPA) Region 6 investigates ground water contamination at the site
September 1983	EPA proposes Sand Springs site for inclusion on the National Priorities List (NPL)
August 1984	EPA orders potentially responsible parties to conduct emergency removal of drums and tanks
June 1986	EPA promulgates Sand Springs site for inclusion on the NPL
May 1987	Oklahoma State Department of Health in cooperative agreement with EPA completes the Remedial Investigation (RI) / Feasibility Study (FS) for the Source Control and Groundwater Operable Units
June 1987	ARCO and citizens comment on the Source Control RI/FS; ARCO begins treatability studies pursuant to an Administrative Order on Consent with EPA
September 1987	EPA issues the Record of Decision (ROD) for the Source Control Operable Unit (OU 01)
June 1988	EPA issues the ROD for the Groundwater Operable Unit (OU 02)
September 1991	Tank Bottom Pit sludge moved to the Small Acid Pit
July 1992	ARCO completes treatability studies
August 1992	Remedial action (RA) on the Glenn Wynn portion of the site begins
November 1992	RA on the Glenn Wynn portion of the site is completed
July 1993	RA on the acid tar wastes begins, initiation of landfill construction
April 1994	Solidification/stabilization (SS) treatment of waste begins
January 1995	Excavation and neutralization of all waste at site completed
April 1995	Landfill cap installation initiated

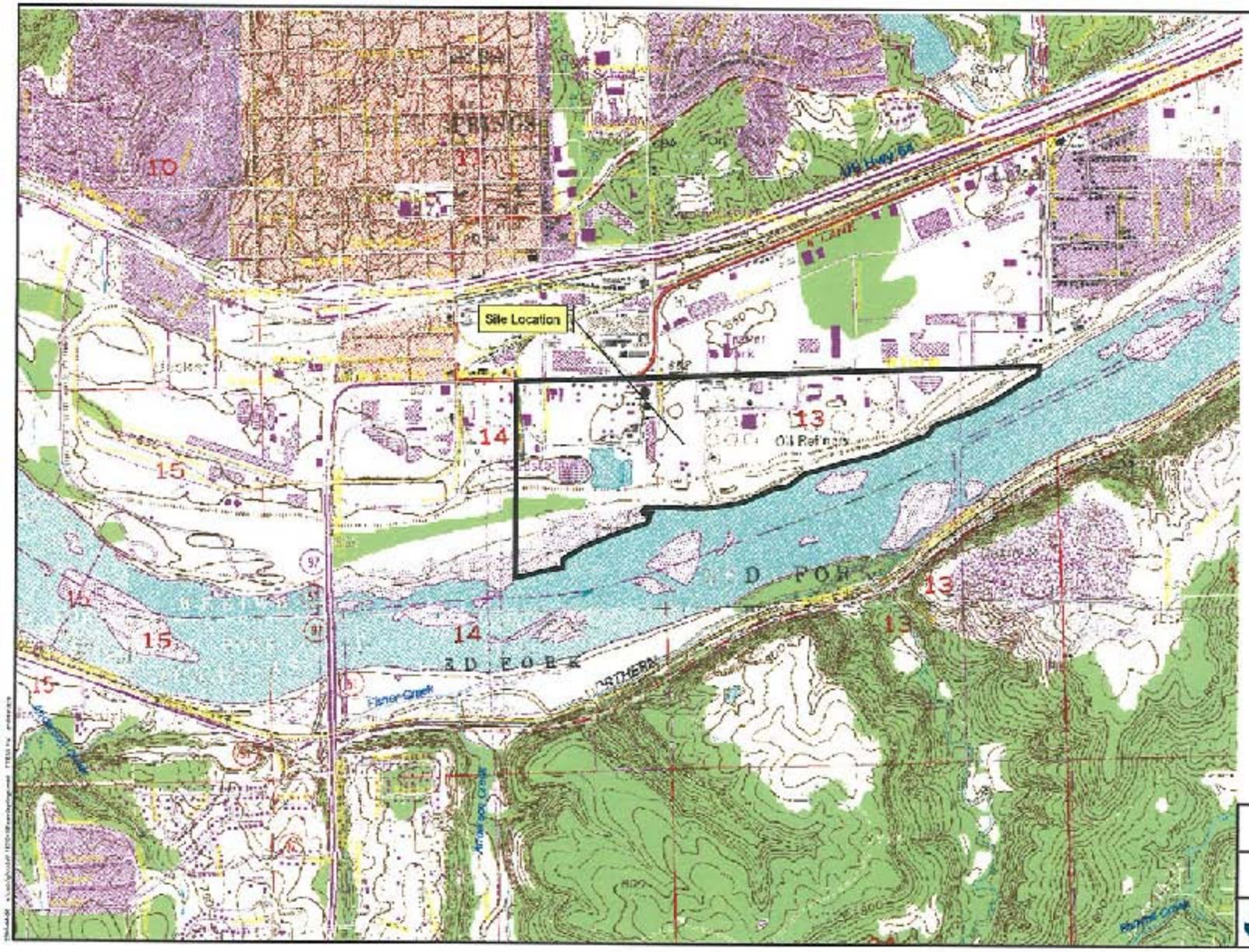
TABLE 1 (Continued)

CHRONOLOGY OF SITE EVENTS
SAND SPRING PETROCHEMICAL COMPLEX

Date	Event
August 22, 1995	Treatment completed and landfill closed
August 29, 1995	RA Completion Ceremony held
October 1995	Ground water quarterly sampling and operation and maintenance (O&M) activities initiated
September 30, 1997	Closeout report signifying end of construction is signed
August 1999	Notice of Intent to Delete (NOID) submitted for public comment
March 17, 2000	Site deleted from NPL (Federal Register/Vol. 65, No. 53, page 14475)
September 2000	First five-year review completed
May 2001	Petroleum material was observed on the surface between the Arkansas River Levee and the Arkansas River
June 2002	Work plan developed and implemented to investigate the nature and extent of seeps of black sludge observed on the north bank of the Arkansas River
July 2003	Additional Site Characterization Report completed
October 2004	Initiation of Work Plan to remove observed petroleum tars, including excavation and removal of material
October 2005	Removal activities scheduled to be completed

Notes:

ARCO Atlantic Richfield Company
EPA U.S. Environmental Protection Agency
FS Feasibility study
NPL National Priorities List
NOID Notice of Intent to Delete
O&M Operations and maintenance
OU Operable unit
RI Remedial investigation
RA Remedial action
ROD Record of decision
SS Solidification/stabilization



SOURCE: MODIFIED FROM USGS, 1995.

SAND SPRINGS PETROCHEMICAL SITE
SAND SPRINGS, OKLAHOMA

FIGURE 1
SITE LOCATION MAP

EPA

Tetra Tech EM Inc.

3.2 LAND AND RESOURCE USE

Historical land use is unknown prior to the establishment of refinery operations in the early 1900s. Initially, Pierce Petroleum Refinery occupied the site. The refinery was subsequently acquired by the Sinclair Oil Corporation in the early 1930s and continued to operate until 1948 when most of the refinery operations were shut down. Dismantling of the refinery commenced shortly thereafter, and all remaining operations ceased in 1952. By October of 1953, Sinclair had conveyed all but approximately 38 acres of the refinery property to the Sand Springs Home. Since 1953, a variety of industries leased or purchased property from Sand Springs Home. In 1969, Sinclair merged with ARCO and the 38-acre tract of land was absorbed in the merger.

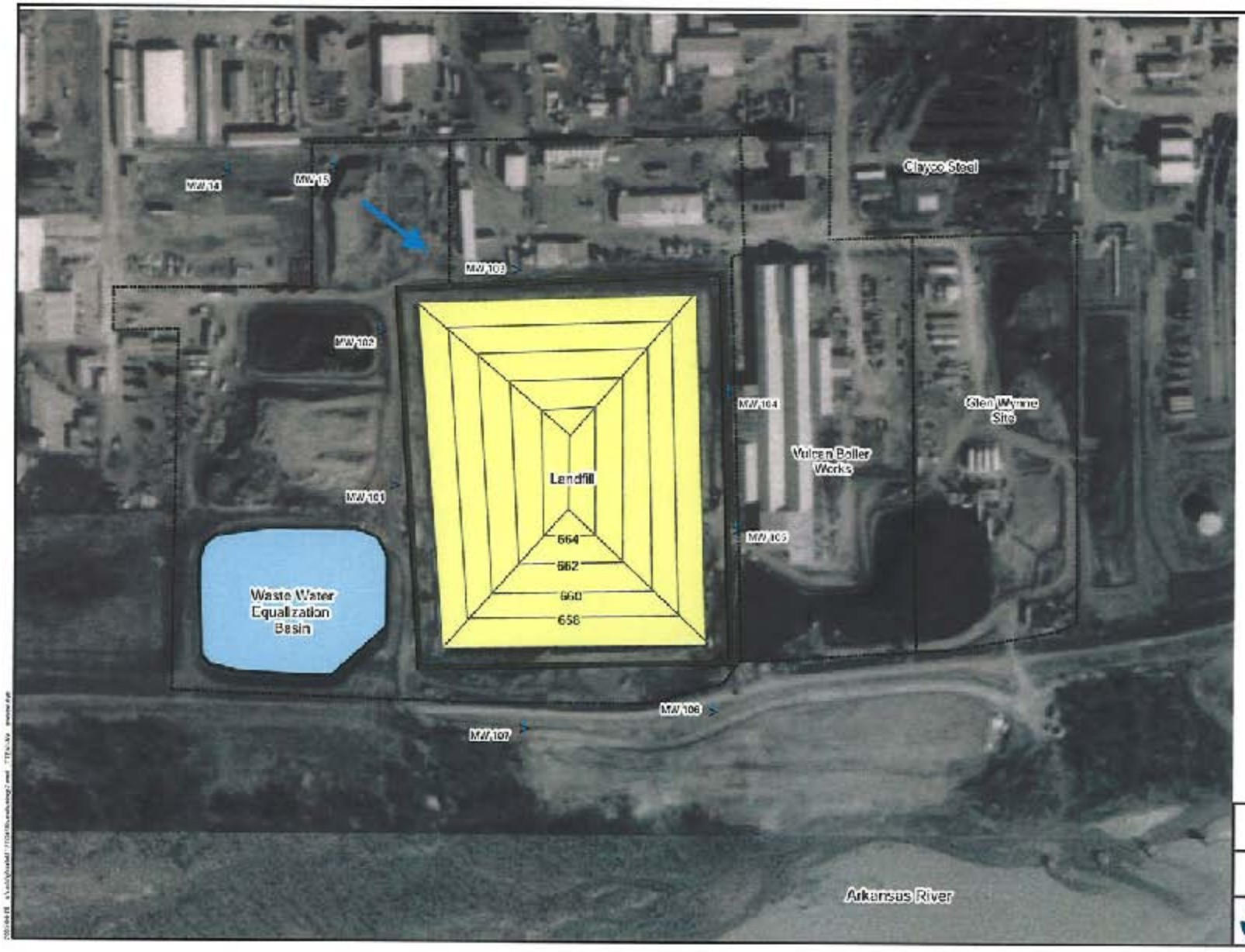
The district surrounding the Sand Springs site is primarily zoned as industrial, with some commercial facilities located within close proximity of the site. A site layout map is available as Figure 2.

3.3 HISTORY OF CONTAMINATION

Several solvent and oil recycling facilities operated on a 5.5-acre portion of the Sand Springs site from 1964 through 1983. This 5.5-acre area is referred to as the Glenn Wynn area. Two unlined pits, numerous tanks and drums, and contaminated soils from accidental spills remained on site from the previous recycling operations. In December 1980, EPA and state agencies became concerned about the possible contamination at the site. Over the next 3 years, water and soil samples were collected and analyzed to determine any potential risks to human health or the environment. Results of the tests indicated that contact with the sludge and contaminated soils posed a human health risk, and CERCLA, commonly known as Superfund, would be utilized to address contamination at the site. The Sand Springs site was proposed for inclusion on the National Priorities List (NPL) in September 1983, and the site was officially added to the NPL in June 1986.

In August 1984, EPA ordered the owner and three lessees of the Glenn Wynn portion of the site to conduct an emergency removal of contained drums and tanks. Only the property owner complied with the order and the removal action was completed in 1987.

EPA subsequently divided the site into two operable units, the Source Control Operable Unit, OU 01, which included all waste pits and contaminated soils, and the Main Site Operable Unit, OU 02, which included ground water. Under a cooperative agreement with EPA, the Oklahoma State Department of



Estimated Direction of Ground Water Flow

Approximate Site Boundary

Fenced Area

0 125 250 Feet

SOURCE: MODIFIED FROM USGS 1995.

SAND SPRINGS PETROCHEMICAL SITE
SAND SPRINGS, OKLAHOMA

FIGURE 2
SITE LAYOUT MAP

EPA

Tetra Tech EM Inc.

Health began the remedial investigation (RI) and remedial design for the operable units. The RI and feasibility study (FS) for OU 01 were completed in May 1987, with a Record of Decision (ROD) published on September 29, 1987. The RI/FS for OU 02 were completed in March 1988, with the ROD for OU 02 published on June 28, 1988.

The RA involved excavation of petroleum waste material, S/S of the waste, and placement of approximately 206,500 cubic yards of stabilized material in an on-site landfill designed to meet the requirements of a Resource Conservation and Recovery Act (RCRA) Subtitle C Landfill. Treatment of the waste material was completed and the landfill was closed on August 22, 1995. An RA completion ceremony was held at the Sand Springs Petrochemical Complex on August 29, 1995.

During routine operation and maintenance (O&M) activities in May 2001, seeps of black sludge were observed near the former acid sludge disposal pit along the northern bank of the Arkansas River. In June 2002, ARCO, along with EPA oversight, conducted an investigation at the site. This investigation identified several seeps. Some appeared to have flowed to the surface, while others were exposed as layers of contamination along the cut bank. Test pits excavated near the former sludge pit encountered significant sludge and contaminated soil at depths of approximately 14 feet below ground surface. Sludge materials were identified in six areas on the site. In November 2002, ARCO submitted an assessment report and analytical results for the test pit investigation, along with a recommendation for cleanup. An additional site characterization report was completed in July 2003.

In September 2004, Atlantic Richfield prepared a work plan for excavating the sludge materials from the six areas. According to the work plan, all sludge plus one foot of soil below the soil/sludge interface will be excavated and disposed of to remain consistent with the original soil cleanup criteria established for the Superfund RA. Observations and confirmation sampling will be used to verify the delineation of the excavated materials. The total volume of material, including sludge, mixed soil, neutralizing lime, and debris that will be disposed of at a Subtitle D Landfill is estimated to be 16,000 to 20,000 cubic yards.

After all waste is removed, the site will be backfilled and graded, and grass sod will be applied to provide a vegetative cover. A portion of the north bank of the Arkansas River will be rip rapped to prevent erosion by the Arkansas River. These activities are scheduled to occur during Summer 2005.

3.4 INITIAL RESPONSE

Based on the results from preliminary assessments and sampling, the Oklahoma State Department of Health, in cooperative agreement with EPA, initiated RI/FS activities at the Sand Springs site to determine the nature and extent of the contamination. The RI/FS activities for the portion identified as the Source Control Operable Unit, OU 01, were completed in May 1987. In September 1987, EPA announced the ROD for OU 01 of the Sand Springs site. The RI/FS activities for the portion identified as Ground Water Operational Unit, OU 02, were completed in March 1988. In June 1988, EPA announced the ROD for OU 02 of the Sand Springs site.

3.5 BASIS FOR RESPONSE

Based on the data collected during the RI, it was determined that if the remedies selected in the ROD were not implemented, hazardous substances could be released from the Sand Springs site and endanger public health, welfare, or the environment. The most significant risks to human health and the environment included the following:

(1) Direct contact – many of the organic compounds found on the site have been determined to be carcinogens. Absorption through the skin or other routes of inadvertent ingestion therefore pose potential health risks. In addition, the wastes and surface waters were found to be highly acidic (EPA 1987).

(2) Air emissions – consisting of acid fumes and volatile organic compounds also pose potential health threats.

(3) Surface waters – pollution caused by the runoff from the site.

(4) Ground water – contamination directly by the Glen Wynn lagoons and indirectly by runoff from the main site.

4.0 REMEDIAL ACTION

This section discusses the selected remedy, remedy implementation, O&M activities, and O&M costs.

4.1 SELECTED REMEDY

Source Control Operable Unit, OU 01

EPA signed the ROD for OU 01 on September 29, 1987. The ROD stated that, in EPA's judgment Alternative 2 (on-site thermal destruction) appeared to meet more statutory selection criteria than the other remedies evaluated, but has serious implementation problems. During the comment period, the Atlantic Richfield Petroleum Products Company, a division of ARCO, one of the potentially responsible parties for the site, made written and oral proposals for a privately financed remedy for the site. EPA concluded that the ARCO proposal provided a remedy comparable to Alternative 2. EPA accepted this remedy provided that the effectiveness of the proposal was adequately assured or that ARCO would undertake the corrective actions deemed appropriate by the EPA if the ARCO proposed remedy failed. The ROD described the remedy as follows:

(1) The excavation and off-site thermal destruction of sludges, at least to the sludge/soil interface, from the portion of the site identified as the North and South Glen Wynn Lagoons.

(2) Solidification and/or stabilization of all remaining sludges and containment of the resulting matrix in a hazardous waste RCRA cell to be constructed on-site. This cell (or cells) is to meet the minimum technological requirements of Subtitle C of the Solid Waste Disposal Act.

(3) As part of the remedial design, ARCO will demonstrate that the solidification technology will meet EPA approved criteria. This criteria will include both chemical and physical testing requirements. Should the solidification technology fail these criteria, thermal destruction will be the remedy for the above-mentioned operable unit.

(4) No liability release from the site or from future maintenance and monitoring.

(5) Repair or restoration of the RCRA cell to ensure no migration from the unit or destruction or treatment of all or a portion of its contents, as EPA deems appropriate, should monitoring show that the solidification and/or stabilization remedy fails.

Main Site Operable Unit, OU 02

EPA signed the ROD for OU 02 on June 28, 1988. The ROD stated that in EPA's judgment, Alternative 1, No Action (monitoring following the Source Control Remedial Action) met the statutory selection criteria. Factors supporting this decision included: after the Source Control Remedial Action, a natural flushing action will have decreased the level of contamination over time; the ground water and the Arkansas River are not sources of drinking water; and there is no public health threats from the minimally contaminated soil. The State of Oklahoma concurred with this remedy. The ROD listed the following requirements for the remedy:

1) Place appropriate warning signs;
2) Restrict access; and,
3) Collect and analyze ground water for a period of at least 30 years.

EPA determined that this alternative is protective of human health and the environment, attains federal and state requirements that are applicable or relevant and appropriate, is cost-effective compared to equally environmentally protective alternatives, and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable.

4.2 REMEDY IMPLEMENTATION

ARCO managed the full remediation activities for the Sand Springs site. The Tulsa District Corps provided oversight for EPA during the Additional Site Characterization, remedial design, and RA, and continues in this function during the O&M phase. Remedial activities have been completed in phases.

Source Control Operable Unit, OU 01

Glenn Wynn Site

Remedial activities for the Glenn Wynn portion of the Sand Springs site commenced in August 1992. The remediation included the following six areas within the site: North Lagoon, South Lagoon, Drum Area, T-5 Area, L-Shaped Area, and Pump House.

Except for the Pump House, remediation of the sites consisted of excavating contaminated material and transporting this material to off-site hazardous waste incinerators. After excavation areas were completed, the excavations were backfilled and compacted with either stockpiled soil from the site or with clean fill from off site sources. Contaminated debris, generated during the remediation, was transported to the Lone Mountain Hazardous Waste facility located in Major County, Oklahoma.

The Pump House contained drums of drill cuttings, drums of monitor well purge water, and plastic bags of personal protective equipment. This material was generated from previous investigations at the Sand Springs site. All solid material was tested and either incinerated with other site wastes, stockpiled for later treatment, or transported to the Lone Mountain Hazardous Waste Facility. All water was treated on-site at the temporary wastewater treatment plant. Final site grading and seeding occurred in December 1992.

Wastewater Treatment

A wastewater treatment plant was constructed on the site to treat water pumped from the retention pond and to treat stormwater runoff that contacted the sludge pits. The retention pond was located between the large acid sludge pit and the small acid sludge pit. After completion of the RA, the wastewater treatment plant was dismantled.

Refinery Wastes

During the RI and subsequent additional site characterization activities, six petroleum waste pits were identified that required excavation, treatment, and placement into the on-site landfill. The six pits were: Large Acid Pit, Small Acid Pit, Round River Pit, Levee Pit, Tank Bottom Pit (TBP), and Con-Rad Sludge Area. Excavated areas included the contaminated soils adjacent to these pits, and the Surface Impoundment located between the Large and Small Acid Pits.

Treatment consisted of mixing neutralized waste with stabilizing additives in a transportable treatment unit (TTU). This produced a stabilized material that was then placed within the on-site RCRA Subtitle C landfill. The following operations were conducted as part of the remediation:

1. Acid material was neutralized in-place by mixing a lime slurry into the sludge;
2. The neutralized waste was then excavated and hauled to a stockpile adjacent to the TTU;
3. Excavation continued to a total depth of one foot below the sludge-soil interface;

4. Treatment of stabilized waste in the TTU to achieve the physical and chemical properties required by the ROD;

5. Placement of the neutralized treated waste into the landfill cells; and,

6. Construction of the landfill cover.

The RCRA landfill was constructed of eight separate cells. Each cell contained a separate pipe system for leachate collection and leachate detection. A perimeter drain surrounds the landfill and two gas vents were installed at the top of the landfill cap. A security fence was placed around the perimeter of the landfill.

Approximately 206,500 cubic yards of solidified sludge and soil were excavated, treated in the TTU, and placed in the landfill. The remedial activities were completed on August 22, 1995.

Main Site Operable Unit, OU 02

Remediation activities for OU 02 consisted of installing seven new monitoring wells (MW-101 to MW-107) and utilizing two existing wells (MW-14 and MW-15) installed during the RI. The seven new wells are located around the landfill and consist of three normal upgradient wells (MW-101 through MW-103) and four normal downgradient wells (MW-104 through MW-107). The two existing wells, MW-14 and MW-15, are located upgradient of the landfill. Two of the new wells (MW-106 and MW-107) were installed on the levee, and were utilized for downgradient pre-closure monitoring.

Monitoring of the ground water was divided into pre-closure and post-closure monitoring. Pre-closure monitoring consisted of collecting samples on a quarterly basis for a period of one year from MW-14, MW-15, MW-106, and MW-107. After closure of the landfill, a baseline monitoring period was initiated. Seven monitoring wells (MW-101 through MW-107), were sampled quarterly during the first year after the cell closure. At the end of the one-year baseline period, the remainder of the 30-year post-closure monitoring was initiated. Post-closure monitoring was established as one year of semiannual sampling, then eight years of annual sampling, followed by sampling on a 5-year cycle.

4.3 OPERATION AND MAINTENANCE

After the construction phase of the RA was completed, the maintenance of the monitor wells and the landfill was initiated in accordance with the Post-Closure Plan and the Landfill Groundwater Monitoring Plan. The property owner, Sand Springs Home, granted the ODEQ access to the property for maintenance oversight and inspection activities. Under this agreement, ARCO is conducting the O&M activities.

O&M activities for the landfill included the following activities:

1. Inspect the landfill cap and side slopes for physical deformities and vegetative cover;
2. Inspect the perimeter roads, perimeter security fence, and perimeter drain system;
3. Inspect the landfill vents, monitor wells, and leachate collection system;
4. Sample the on-site monitor wells in accordance with the post-closure monitoring schedule; and,
5. Measure and remove leachate from the leachate collection and leachate detection system.

Landfill Maintenance

Maintenance of the landfill generally consists of annual mowing, minor erosion repair of the perimeter road and side slopes, and maintenance of the perimeter fence. Contractors for ARCO conduct these maintenance activities during quarterly site inspections of the Sand Springs site. In addition, the contractors sample the monitoring wells on an annual basis. Annual inspection reports, which consolidate the quarterly inspection reports; annual sampling laboratory reports; and leachate collection logs are submitted to EPA, ODEQ and the Corps. Dates and noted major observations from the O&M quarterly inspection reports are as follows for the years 2000 to 2004:

- **August 25, 2000**. Condition of Gates: Main gate has slight bend in frame member. Side Slopes (area outside perimeter road): Erosional gullies noted on the south and west side slopes. Other observations of the landfill, or surrounding area that may impact the landfill: North slope of Arkansas River levee remains bare. Vent Casings: North vent casing is filled with dirt.

- **April 9, 2001**. Condition of Fencing: North perimeter fence post bent. Surface Vegetation: Generally cover is good; however, two bare areas were observed. One bare spot, approximately 6 feet square in size, was located just south of the south vent. The second bare spot, approximately 5 square feet in size was located midway on the south side of the landfill cap. Evidence of Burrowing Animals: One area adjacent to north vent. Hole has been burrowed next to the corrugated pipe riser that is the protective casing for the north vent. A large number of old mole hills were observed on the south and east side of the landfill cap. New activity was not observed.

- **June 29, 2001**. Condition of Gates: Lock hasp came apart on the south gate and was not repairable. It was replaced with a locally available lock, however, this lock is unsuitable for long term and will be replaced with a secure combination lock. Other observations of the landfill, or surrounding area that may impact the landfill: The barren area on the north side of the levee has been repaired, and this should alleviate any potential problem from eroded soil clogging the perimeter drains.

- **March 4, 2002**. Condition of Gate: Gates were locked and in fair condition. The bottom of the south gate has been covered with sand from the adjacent sand blasting operation. Both gates were blocked by trucks making access to the landfill difficult. Road Surface Material: Entrance road along the east fence needs repair. Additional gravel needs to be added to prevent the road from rutting. Evidence of Burrowing Animals: Mole hills and burrows were noted on the east slope of the landfill cap. No significant damage was observed. The burrows will be repaired with dirt as necessary to prevent erosion.

- **June 28, 2002**. Condition of Fencing: East perimeter fencing is damaged. It will be repaired during the next quarter. Condition of the Gate: The bottom of the southeast gate has been covered with sand from the adjacent sand blasting operation. The southeast gate is no longer usable due to adjacent industry changes. The northeast gate will be made into a double gate to allow trucks to enter the landfill. Road Surface Material: The area along the entrance road contains stored material from the test pit excavations. This material will be removed next quarter. After removal, the entrance road will be repaired. Additional gravel needs to be added to prevent the road from rutting. Evidence of Burrowing Animals: Mole hills and burrows were noted on the east slope of the landfill cap. No significant damage was observed. The burrows will be repaired with dirt as necessary to prevent erosion. Condition of Pumping System: Cell 1 and Cell 2 – Detection pumps stuck and need disassembly and cleaning.

- **September 24, 2002**. Condition of Gate: The north gate was made into a double gate to allow large trucks to enter. Road Surface Material: Stored material from the test pit excavations was removed in September 2002. However, new material was placed in a new stockpile at the same location along the entrance road. This material will be removed next quarter. After removal, the entrance road will be repaired. Condition of Pumping System: Cell 1, Cell 2, Cell 5 and Cell 7 – Stuck detection pumps were disassembled and cleaned.

- **December 10, 2002**. Road Surface Material: Entrance road was repaired this quarter and is in good condition.

- **March 11, 2004**. Side Slopes (area outside perimeter road): South-Small subsiding holes were observed last quarter in the southwest corner just inside the perimeter fence. It is possible that soil is being washed into the perimeter drain system causing the small subsidence holes to occur. There is no impact to the landfill and the subsidence will be investigated. The subsidence did not increase over the winter months. Other observations of the landfill, or surrounding area that may impact the landfill: Construction activities are occurring on the outside of the perimeter fence in an area adjacent to the northwest corner of the perimeter fence. Construction should not impact the landfill or areas inside the perimeter fence, but background monitor well MW-15 is located on the north edge of the construction and dirt has been scraped next to the south side of the concrete well pad. Construction should be completed during the summer. Brenntag SW (chemical company) is the current landowner for the property and the construction is to erect a 30,000 square foot warehouse on the property. The warehouse is an extension of the main chemical facility located immediately north of the property. During this inspection, the MW-15 monitor well was still intact and should be operational after construction is complete.

- **December 31, 2004**. Leachate Collection System (Vaults): All vaults were in good condition, labels for cell numbers and sump type were intact and in good condition. There has been some difficulty with rain water getting into the leachate collection system by ponding up in the vaults. Drain pipes were installed in three vaults to eliminate the problem. Eventually all vaults will be fitted with drain pipes.

Leachate Collection System

The leachate collection system consists of a separate leachate collection and leachate detection system. The system is operated on an as-need basis to remove leachate that accumulates in the leachate collection sumps. The system is functioning as designed, and only minor equipment problems were identified and corrected as reported in the annual inspection summaries provided in the previous section. The amount of leachate pumped is recorded during removal, and the data is provided in the annual inspection reports. Table 2 is a summary of the leachate collection system pumping data for 2001 to 2004. It is expected that the amount of leachate removed will be significantly different for the separate cells. This is due to the fact that each cell was closed at different times and rainfall conditions varied prior to each cell being closed.

TABLE 2

LEACHATE COLLECTION/DETECTION SYSTEM PUMPING DATA SUMMARY
SAND SPRINGS PETROCHEMICAL COMPLEX SITE

Cell Number	Type	2001 Leachate Collection Event Totals		2002 Leachate Collection Event Totals		2003 Leachate Collection Event Totals		2004 Leachate Collection Events	
		Last Date Serviced	Gallons per Cell	Last Date Serviced	Gallons per Cell	Last Date Serviced	Gallons per Cell	Last Date Serviced	Gallons per Cell
1	Collection	6/28/01	374	7/12/02	1,088	11/3/03	1,132	11/2/04	0
1	Detection	6/28/01	0	8/22/02	196	11/3/03	664	11/2/04	100
2	Collection	6/28/01	181	7/12/02	667	11/3/03	431	11/2/04	0
2	Detection	6/28/01	0	8/22/02	0	11/3/03	0	11/2/04	0
3	Collection	6/28/01	191	7/12/02	529	11/3/03	1,124	11/2/04	340
3	Detection	6/28/01	0	7/12/02	386	11/3/03	1,250	11/2/04	749
4	Collection	6/28/01	300	7/11/02	591	11/3/03	262	11/2/04	666
4	Detection	6/28/01	0	7/11/02	0	11/3/03	74	11/2/04	0
5	Collection	6/28/01	427	8/22/02	0	11/3/03	0	11/2/04	10
5	Detection	6/28/01	13	7/12/02	59	11/3/03	0	11/2/04	0
6	Collection	6/28/01	135	7/11/02	214	11/3/03	10	11/2/04	132
6	Detection	6/28/01	55	7/11/02	33	11/3/03	59	11/2/04	68
7	Collection	6/28/01	0	8/22/02	0	11/3/03	0	11/2/04	208
7	Detection	6/28/01	0	7/12/02	0	11/3/03	0	11/2/04	0
8	Collection	6/28/01	1,730	7/11/02	1,769	11/3/03	2,023	11/2/04	2,194
8	Detection	6/28/01	0	7/11/02	11	11/3/03	0	11/2/04	13
Total Gallons			**3,406**		**5,543**		**7,029**		**4,480**

Leachate collection occurred annually for the years 2001 and 2002. The total amounts of collected leachate were 3,406 gallons and 5,543 gallons respectively for each year. Four separate leachate collection events occurred at the Sand Springs site in 2003 and 2004. The total amount of collected leachate for each year was 7,029 gallons, and 4,480 gallons, respectively.

The Post Closure plan specifies an action leakage rate (ALR) of 560 gallons per acre per day, which is the maximum allowable amount of leachate that can be collected from the leachate detection sumps. Leachate from sumps that exceeds the ALR indicate that leaking is occurring within the system, and corrective action will be necessary to diminish the excessive leachate.

The amount of leachate is calculated for all cells in gallons per acre per day (GPAD). The calculation of the GPAD is as follows:

GPAD = total gallons removed ÷ acre values for each cell ÷ total decimal days

Total decimal days = number of days leachate accumulated

The amount of leachate removed from the leachate detection system for the years 2001, 2002, 2003, and 2004 is below the GPAD requirements. Table 3 provides a summary of the leachate detection system GPAD calculation results.

TABLE 3
LEACHATE DETECTION SYSTEM GPAD CALCULATIONS SUMMARY
MAXIMUM ACTION LEAKAGE RATE = 560 GPAD
SAND SPRINGS PETROCHEMICAL COMPLEX SITE

			2001			2002			2003			2004		
Cell Number	System	Area (Acres)	Gallons	Days	GPAD	Gallons	Days	GPAD	Gallons	Days	GPAD	Gallons	Days	GPAD
1	Collection	1.135	374	238	1.38	1,088	378	2.54	1,132	480	2.08	0	365	0
1	Detection	1.135	0	238	0.00	196	420	0.41	664	438	1.34	100	365	0.24
2	Collection	1.139	181	238	0.67	667	379	1.55	431	479	0.79	0	365	0
2	Detection	1.139	0	238	0.00	0	420	0.00	0	438	0.00	0	365	0
3	Collection	0.89	191	238	0.90	529	379	1.57	1,124	479	2.64	340	365	1.04
3	Detection	0.89	0	238	0.00	386	379	1.14	1,205	479	2.93	749	365	2.31
4	Collection	0.899	300	238	1.40	591	378	1.74	262	480	0.61	666	365	2.03
4	Detection	0.899	0	238	0.00	0	378	0.00	74	480	0.17	0	365	0
5	Collection	0.869	427	238	2.06	0	420	0.00	0	438	0.00	10	365	0.03
5	Detection	0.869	13	238	0.06	59	379	0.18	0	479	0.02	0	365	0
6	Collection	0.881	135	238	0.64	214	378	0.64	10	480	0.02	132	365	0.41
6	Detection	0.881	55	238	0.26	33	378	0.10	59	480	0.14	68	365	0.21
7	Collection	1.113	0	238	0.00	0	420	0.00	0	438	0.00	208	365	0.51
7	Detection	1.113	0	238	0.00	0	379	0.00	0	479	0.00	0	365	0
8	Collection	1.108	1,730	238	6.56	1,769	378	4.22	2,023	480	3.80	2,194	365	5.43
8	Detection	1.108	0	238	0.00	11	378	0.03	0	480	0.00	13	365	0.03

Monitor Well Sampling

Monitor wells are currently being sampled on an annual basis as specified by the Landfill Groundwater Monitoring Plan. The wells are sampled for the list of constituents shown in Table 4.

TABLE 4
LIST OF CONSITUENTS FOR GROUND WATER MONITORING
SAND SPRINGS PETROCHEMICAL COMPLEX SITE

Metals	Volatile Organic Compounds	Base-neutral Extractable Organic Compounds	Acid Extractable Organic Compounds
Arsenic	1,2-Dichloropropane	2-Methylnaphthalene	2,4-Dinitrophenol
Antimony	1,1-Dichloroethane	Anthracene	4,6-Dinitro-o-cresol
Barium	1,1-Dichloroethene	Benzo(a)anthracene	P-Chloro-m-cresol
Beryllium	1,2-Dichloroethane	Benzo(a)pyrene	Benzoic acid
Cadmium	1,2-Trans	Benzo(b)fluoranthene	Phenol
Chromium	1,1,1-Trichloroethane	Benzo(k)fluoranthene	**Indicator Parameters**
Chromium VI	1,1,2-Trichloroethane	Bis(2-ethylhexyl)phthalate	
Copper	Acetone	Chrysene	Total organic carbon
Lead	Benzene	Dibenzofuran	Total dissolved solids
Mercury	Chloroethane	Dimethyl phthalate	**Field Parameters**
Nickel	Chloroform	Di-n-butylphthalate	
Cobalt	Chloromethane	Fluorene	pH
Selenium	Dichloroethene	Naphthalene	Specific conductance
Silver	Ethylbenzene	Phenanthrene	Temperature
Zinc	Methylene chloride	Pyrene	
	Tetrachloroethylene		
	Trichloroethene		
	Toluene		
	Vinyl chloride		
	Xylenes		

A summary table for the sampling results from the Landfill Ground Water Monitoring Program has been compiled for the 1995 through 2004 sampling events (Appendix D). The analytical results generally show unchanged to decreasing concentrations depending on the monitoring well and the analyte.

Metals have shown slightly decreasing to unchanged concentration trends in most wells. Laboratory results from 2002 indicated that hexavalent chromium was detected in MW-101 at 12.7 micrograms per liter (µg/L) and MW-107 at 28.2 µg/L. Hexavalent chromium was not detected in any 2003 or 2004 monitor well samples, indicating that the hexavalent chromium detected in 2002 was probably a laboratory error.

Monitor wells MW-104 and MW-105

LNAPL continues to be observed in monitoring wells MW-104 and MW-105, located on the east perimeter of the landfill. A hydrocarbon sheen has been observed in MW-105 since 1998, while a measurable thickness of LNAPL in MW-104 has been and continues to be recorded since 1998. Table 5 provides the thickness of LNAPL in MW-104. The LNAPL is described as having a diesel odor and is dark in color. An attempt was made to analyze the LNAPL in 2001. The results suggested that 45 percent of the sample fell in the diesel range. The remainder of the sample could not be determined conclusively from the laboratory data.

TABLE 5
MW-104 LNAPL THICKNESS READING
SAND SPRINGS PETROCHEMICAL COMPLEX SITE

Year	Reading (Feet)
1998	1.62
1999	1.14
2000	0.70
2001	0.62
2002	0.51
2003	0.83
2004	1.23

The thickness of the LNAPL in monitor well MW-104 consistently decreased over the years until 2003. Currently, the thickness of the LNAPL appears to be increasing, with a thickness of 0.83 feet in 2003 and 1.23 feet in 2004. The Annual Inspection Report prepared by Stallion Environmental (2004) stated that the source of the hydrocarbons impacting monitor wells MW-104 and MW-105 is unknown and has been present since construction of the landfill. The report further stated that the hydrocarbons are not associated with the treated material contained in the landfill cells and do not reflect negatively on its performance.

The concentrations of typical LNAPL hydrocarbon constituents do not occur to a significant extent in the aqueous phase samples of MW-104 and MW-105. According the 2004 Annual Inspection Report (Stallion Environmental 2004), the contaminants appear to be highly degraded and naturally attenuating. Monitoring results from the Landfill Groundwater Monitoring Program suggest that the concentrations of contaminants and LNAPL are generally decreasing. The source of the hyrocarbons impacting monitoring

wells MW-104 and MW-105 is unknown and has been present since construction of the landfill. The hydrocarbons are not associated with the treated material contained within the Subtitle C landfill cells.

4.4 OPERATION AND MAINTENANCE COST

ARCO provided approximate associated costs for the Sand Springs site. The costs include the following:

- Operate and maintain the leachate collection system, landfill, perimeter road and fencing
- Conduct sampling, analysis, and LNAPL disposal
- Additional labor costs (outside normal operating conditions)

Table 6 provides the approximate costs for the years stated. The column containing reported costs were provided by Mr. Terry Moore with ARCO, while the estimated costs were obtained from the cost summary table provided in the 1987 Sand Springs ROD.

TABLE 6
ANNUAL OPERATION AND MAINTENANCE COSTS
SAND SPRINGS PETROCHEMICAL COMPLEX SITE

Dates		Total cost rounded to nearest $1,000	
From	**To**	**Reported Costs**	**Estimated***
2000	2001	$65,000	$15,000
2001	2002	$65,000	$15,000
2002	2003	$65,000	$15,000
2003	2004	$65,000	$15,000

Notes:
* Information obtained from the Sand Springs ROD 1987

5.0 FIVE-YEAR REVIEW PROGRESS

This is the second five-year review for the Sand Springs site. The first five-year report was conducted in September 2000. The site appears to have been properly maintained during the period between reports. The next five-year report will be conducted by September 2010.

6.0 FIVE-YEAR REVIEW PROCESS

This section presents the process and findings of the second five-year review. Specifically, this section

presents the findings of surveys, a site inspection, an applicable or relevant and appropriate requirements (ARAR) review, and a data review.

6.1 ADMINISTRATIVE COMPONENTS

The Sand Springs Five-year Review team was lead by Mr. Michael Hebert of EPA, Remedial Project Manager for the Sand Springs site. Mr. Eric Johnstone and Ms. April Ballweg, representatives from Tetra Tech, assisted in the review process.

In March 2005, the review team established the review schedule, which included the following components:

- Community Involvement
- Site Inspection
- Local Interviews
- ARAR Review
- Data Review
- Five-Year Review Report Development and Review

6.2 COMMUNITY INVOLVEMENT

Activities to involve the community in the five-year review were initiated with a public notice published in the local bi-weekly newspaper, Sand Springs Leader, located in the City of Sand Springs, Tulsa County, Oklahoma. This newspaper is qualified to publish legal notices, advertisements, and publications as provided in Section 106 of Title 25, Oklahoma Statutes 1971 and 1983, as amended. This notice informed the public that a five-year review was to be conducted and that the results of the review would be made available to the public at the information repository, the Charles Page Library. The 3 ¼-inch by 5-inch notice ran for one day, Sunday, March 6, 2005. A copy of the public notice and the Affidavit of Publication is available in Appendix C.

6.3 SITE INSPECTION

A site inspection was conducted on March 14, 2005, to assess the condition of the site and the measures employed to protect human health and the environment from the contaminants still present at the site. Attendees included (1) Michael Hebert of EPA; (2) Dennis Datin of ODEQ; (3) Penni Walker of the Tulsa District Corps; (4) Terry Moore of ARCO; (5) Dennis Hrebec of Stallion Environmental; and (6) Eric Johnstone and April Ballweg of Tetra Tech. The site visit report, which includes a site inspection checklist (Exhibit A), photographic log of the inspection (Exhibit B), and site survey forms (Exhibit C) is provided in Appendix B.

No evidence of contamination was visible at the site. The site's general appearance is good, with a stand of winterized vegetation, and new spring vegetation appearing. The inspection team investigated the perimeter and top of the landfill including the perimeter road, the leachate collection vaults and vent caps, and the levee along the Arkansas River where remedial activities have been initiated but are currently on hold due to the water level of the river. In addition, the team observed the ground water monitoring wells, including a recently discovered monitor well identified as MW-19 located on the south side of the Arkansas River levee.

The vegetation at the site appeared to be in good condition. The leachate collection vaults were in good condition and the pumps appeared to be in working order. Three vaults had been modified with drainage pipe outlets to prevent surface stormwater from accumulating within the vaults. The remaining vaults will be modified as necessary according to Dennis Hrebec, with Stallion Environmental. Site access appeared to be sufficiently restricted because no vandalism was observed and the lock, gate, and perimeter fence were in good condition. The gravel road around the edge of the landfill was also in good condition. Some minor rodent tunneling activities were noted around the top portion of the landfill causing small holes in the topsoil. In addition, rodent activities were noted within one of the vent caps, which was partially filled with disturbed topsoil. Minor erosion was noted at the outlet of a corrugated stormwater pipe located along the west side of the perimeter fence.

6.4 LOCAL INTERVIEWS

In accordance with the community involvement requirements of the five-year review process, key individuals to be surveyed were identified by EPA. Completed survey forms for the following people are included in Appendix B, Exhibit B:

- Dennis L. Datin, ODEQ
- Dennis J. Hrebec, Stallion Environmental
- Terry Moore, ARCO
- Penni Walker, U.S. Corp of Engineers (COE)
- Joe A. Williams, Sand Springs Home

A list of continuing or unresolved issues discovered during the interview process are as follows:

- Mr. Dennis Hrebec, Stallion Environmental, stated that the plans for the site are currently out-of-date, with many of the items listed in the plans no longer applicable.
- Rainwater appears to be infiltrating into the leachate vaults according to Mr. Hrebec.
- Mr. Joe Williams, Sand Springs Home, mentioned that to their understanding the landfill was to be kept mowed.

6.5 ARAR REVIEW

The 1987 Source Control Record of Decision for the Sand Springs Petrochemical Complex site identified Federal and State ARARs. The 1988 Ground Water Record of Decision for the Sand Springs Petrochemical Complex site selected no action and therefore, no ARARs are identified for the ground water remedial action.

The following Federal ARARs were listed for the source control selected remedy:

- Resource Conservation and Recovery Act (RCRA)
- DOT Hazardous Materials Transport Rules
- Clean Air Act (CAA) and National Ambient Air Quality Standards (NAAQS)
- National Pollution Discharge Elimination System (NPDES) Requirements
- Clean Water Act (CWA)
- Executive Orders for Flood Plains (11988)
- Fish and Wildlife Coordination Act (FWCA)

The following State ARARs were listed for the selected remedy:

- Oklahoma Solid Waste Regulations
- Oklahoma Clean Air Act
- Oklahoma Water Quality Standards

6.5.1 Federal ARARs

Of the Federal ARARs listed above, only two continue to be in effect for the RA: RCRA and CWA. The other federal ARARs listed were complied with during the RA but continued compliance is not necessary. The RCRA Subtitle C landfill constructed on-site continues to meet ARARs. The RCRA ARARs still in effect include post closure and monitoring requirements for the landfill. The landfill's ALR is below the level of 560 GPAD established in the Post Closure Plan. The landfill is inspected, operated, and maintained in accordance with approved plans. Leachate generated from individual cells in the landfill is collected periodically from the leachate sumps and disposed of to the Sand Springs publicly owned treatment works (POTW). A system of ground water monitoring wells was established around the landfill to monitor landfill performance in accordance with the Landfill Groundwater Monitoring Plan. Ground water samples are collected and analyzed annually for a list of chemicals specified in the Landfill Groundwater Monitoring plan. Analytical data from the monitoring wells indicates that the remedy is functioning as designed.

The remedy complies with the CWA through the disposal of the leachate collected from the leachate sumps. Leachate is periodically removed from the sumps into a truck mounted holding tank. The pH of each batch in the holding tank is measured. The pH of the leachate is adjusted to between six and nine, if necessary, prior to release to the Sand Springs POTW in accordance with the permit requirements for the City of Sand Springs industrial pretreatment program. The industrial pretreatment program is authorized under the CWA.

6.5.2 State ARARs

By complying with the more stringent RCRA Subtitle C Landfill regulations and the CWA, the source control remedial action also complies with the Oklahoma Solid Waste Regulations and Oklahoma Water Quality Regulations. Compliance with the Oklahoma Clean Air Act is no longer required because that portion of the source control remedy has been completed.

6.5.3 Newly Promulgated Potential ARARs

No newly promulgated federal laws or regulations are considered potential ARARs for RA at the Sand Springs Petrochemical Complex site. Changes to the regulations under RCRA and CWA have occurred since the RODs were signed in 1987 and 1988, but these changes do not impact the RA implemented at the site. Changes to maximum contaminant levels under the Safe Drinking Water Act do not apply to the groundwater contamination because the affected groundwater is not used for drinking water and according to the 1988 ROD, the affected groundwater unit could be classified as a Class III aquifer.

The State of Oklahoma is proposing to amend Title 27A Environmental and Natural Resources, Chapter 2 Oklahoma Environmental Quality Code, Article VII Hazardous Waste Management, Section 2-107-123 to require that the Department of Environmental Quality file a recordable notice of remediation that identifies all engineering controls used to ensure the effectiveness of the remediation taken at CERCLA sites in the county in which the site is located. The notice must contain a prohibition against engaging in any activities that could cause damage to the remediation or the engineering controls or could cause recontamination of the soil or groundwater. The notice must also contain any appropriate restriction on land use or other activities that are incompatible with the cleanup. If enacted, these amendments to the existing statute will strengthen the institutional controls in place for the site property.

6.6 DATA REVIEW

Review of annual inspection reports from November 2001 to December 2004 indicate approximately 5,100 gallons of leachate has been collected from the landfill collection/detection system annually and released to the Sand Springs POTW under a permit issued by the Sand Springs Pre-Industrial Treatment Program. The amount of leachate collected from the site significantly decreased since the first five-year report, which had an approximate annual release volume of 8,000 gallons per year.

Analytical results for the years 1995 to 2004 generally show unchanged to decreasing concentrations of chemicals depending on the monitoring well and the analyte. Metals have shown slightly decreasing to unchanged concentration trends in most wells. The following metals were not detected in any of the wells during the latest round of sampling: beryllium, cadmium, hexavalent chromium, and mercury. Barium, a naturally occurring mineral in the sediments of the area, was noted within five of the nine wells at decreasing concentrations. Arsenic was noted in all of the wells in 2003, but only four of the wells in 2004; the concentrations appear to be decreasing. Laboratory results from 2002 indicated that hexavalent chromium was detected in MW-101 at 12.7 µg/L and MW-107 at 28.2 µg/L. However, it was strongly believed that hexavalent chromium could not exist in the groundwater environment at the Sand Springs Petrochemical Complex. Therefore, the 2002 hexavalent chromium detected values were believed to be lab contamination. Hexavalent chromium was not detected in any 2003 or 2004 monitor well sample, indicating that the hexavalent chromiun detected in 2002 was probably a laboratory error. Two upgradient wells, MW-14 and MW-15, have shown a slight increase in some of the metal compounds, including chromium, copper, lead, and selenium. As MW-14 and MW-15 are upgradient of the landfill, these compounds do not appear to indicate an issue with the performance of the landfill.

Various volatile organic compounds have been detected in the monitor wells. Monitoring wells MW-104 and MW-105 have shown some fluctuations but mostly decreasing concentrations.

Semivolatile organic compounds were noted in monitoring well MW-105 in 2002, but were undetected in 2003 or 2004. Monitoring well MW-104 has a decreasing concentration of 2-methylnapthalene, and was nondetect in 2004. No other monitoring wells had any concentration detections for semivolatile organic compounds.

Information of the site activities, monitor well data, leachate collection data, and LNAPL thickness data were summarized in the following reports:

- "Annual Inspection Report for the Sand Springs Petrochemical Complex Landfill" (D&B 2001).
- "Annual Inspection Report for the Sand Springs Petrochemical Complex Landfill" (D&B 2002).
- "Annual Inspection Report for the Sand Springs Petrochemical Complex Landfill" (D&B 2003).

- "Annual Inspection Report for the Sand Springs Petrochemical Complex Landfill." (Stallion Environmental 2004).

Based on the 2003 and 2004 reporting periods, LNAPL from monitoring well MW-104 has increased 0.32 feet and 0.40 feet from the previous year, respectively.

6.7 DOCUMENT REVIEW

The Record of Decision for the Sand Springs Site did not include the need for institutional controls at the site (EPA 1987). Institutional controls are currently required to enhance the remedy by providing further protection of human health and the environment and to facilitate potential property transfers for redevelopment and land reuse activities.

The complete list of documents reviewed during this five-year review process is provided in Appendix A.

7.0 TECHNICAL ASSESSMENT

The conclusions presented in this section support the determination that the selected remedy for the Sand Springs site is currently protective of human health and the environment. EPA Guidance indicates that to assess the protectiveness of a remedy, three questions shall be answered.

Question A: Is the remedy functioning as intended by the decision documents?

- **RA performance** – Based on review of documents, ARARs, and the site inspection, the selected remedy for OU 01 (1987 ROD) and OU 02 (1988 ROD) has been completed in accordance with both RODs. Cleanup goals and performance standards were achieved as documented by the annual inspection reports.

- **Cost of system and O&M** – O&M cost information for the fiscal years 2001 through 2004, was approximately $65,000, annually. Current O&M activities (as described in Section 4.3) appear sufficient to maintain the effectiveness of the current remedy.

- **Opportunities for optimization** – In addition to conducting maintenance activities associated with the issues identified during the site inspection, an updated O&M manual will be more relevant for the activities at the site.

- **Early indicators of potential issues** – There is no indication of remedy failure. The landfill is inspected on a regular basis and O&M activities are performed on the landfill as required.

- **Implementation of institutional controls and other measures** – Institutional controls have not been implemented at the site. Fencing has been placed around the site to

prevent human contact with the landfill. As discussed in Section 6.7, the ROD for the site does not include institutional controls for the site. Institutional controls are needed at the site to ensure protection of human health and the environment and to facilitate any potential land use activities. Institutional controls, including deed restrictions, are currently under investigation.

Question B: Are the assumptions used at the time of remedy selection still valid?

- **Changes in standards and to be considered** – There have been no changes that bear on the protectiveness of the selected remedy.

- **Changes in exposure pathways** – There have been no changes that bear on the protectiveness of the selected remedy. Land use at the site could potentially change as further development increases in the area of the site. The implementation of institutional controls at the site would help inform potential property users and help further protect human health and the environment.

- **Changes in toxicity and other contaminant characteristics** – There have been no changes that bear on the protectiveness of the selected remedy.

- **Changes in risk assessment methodologies** – There have been no changes that bear on the protectiveness of the selected remedy.

- **Expected progress toward meeting RAOs** – The remedial action objectives (RAO) relating to contaminated soil have been met. Monitoring is needed to establish that the ground water RAO is being met. Fencing is currently in place to restrict access to the site. Institutional controls are required to further protect human health and the environment.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

- No other information has been identified that calls the protectiveness of the selected remedy into question.

Technical Summary

According to documents and data reviewed, the site inspection, and the interviews, the remedy appears to be functioning as intended by the 1987 and 1988 RODs. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. The ARARs cited in the RODs have been met. There have been no changes in toxicity factors for the primary contaminants of concern and there has been no change to the standardized risk assessment methodology that could affect the protectiveness of the remedy. The implementation of institutional controls at the site would enhance potential reuse of the site and help further protect human health and the environment. There is no other information that calls into question the protectiveness of the remedy.

8.0 ISSUES

This section describes issues associated with the Sand Springs site identified during the five-year review.

1. **Operation and Maintenance Plan –** The Post Closure Plan and the Ground Water Monitoring Plan were written prior to the completion of the remedial action for the site. As a result, the documents are out-of-date and many of the items listed in the plans are no longer applicable.

2. **Small areas of subsidence –** Small holes resulting from subsurface subsidence were noted in the southwest corner, inside the perimeter fence during the December 2003 inspection.

3. **Rainwater ponding within vaults –** Rainwater appears to be infiltrating into the leachate collection/detection system according to the Annual Inspection reports.

4. **Minor erosion at stormwater pipe –** Stormwater pipe located west of the landfill, near leachate sump #3, along the perimeter fence has minor erosion below the opening of the pipe.

5. **Animal activity noted –** Minor/shallow tunnels caused by burrowing animals were noted near the top of the cap. In addition, one of the vent caps at the apex of the cell was partially filled with loose soil apparently caused by burrowing activities.

6. **Overgrowth of vegetation –** Sand Springs Home mentioned that to their understanding the landfill was to be kept mowed (on a regular basis).

7. **Institutional Controls –** No institutional controls are currently in place at the site.

A summary table of issues identified and if they currently affect the remedy protectiveness (Table 7) is provided below.

TABLE 7
IDENTIFIED ISSUES
SAND SPRINGS PETROCHEMICAL COMPLEX SITE

Issue	Currently Affects Remedy Protectiveness (Yes/No)
Operations and Maintenance Plan	No
Small areas of subsidence	No
Rainwater Ponding within vaults	No
Minor erosion at stormwater pipe	No
Animal activity noted	No
Overgrowth of vegetation	No
Institutional Controls	Yes

9.0 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Table 8 summarizes recommendations and follow-up actions for the Sand Springs site. ARCO is responsible for conducting follow-up actions, and EPA will provide oversight.

10.0 PROTECTIVENESS STATEMENT

Based on the information available during the second five-year review, the selected remedy for the Sand Springs site appears to be performing as intended. The RA at the Source Control Operable Unit (OU 01) and the Main Site Operable Unit (OU 02) are protective of human health and the environment. Since both operable units are protective, the remedy for the site is protective of human health and the environment.

TABLE 8

RECOMMENDATIONS AND FOLLOW-UP ACTIONS
SAND SPRINGS PETROCHEMICAL COMPLEX SITE

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Follow-up Actions Affect Long-Term Remedy Protectiveness (Yes/No)
Operations and Maintenance Plans	Revise/update the O&M plans to make them applicable to the current conditions at the site.	ARCO	EPA	Within 1 year of submittal of this report	No
Small areas of subsidence	Continue to monitor the subsiding holes and engage in repair when necessary to prevent detrimental impacts upon the landfill.	ARCO	EPA	Within 1 year of submittal of this report	No
Rainwater ponding within vaults	Install drainage pipes in the remaining vaults on an as-need basis.	ARCO	EPA	Within 1 year of submittal of this report	No
Minor erosion at stormwater pipe	Repair the area of erosion located under the opening of the pipe to prevent further erosion.	ARCO	EPA	Within 1 year of submittal of this report	No
Animal activity noted	Remove or exterminate rodents by means approved by the State of Oklahoma and repair the areas where burrows are located, as well as the vent pipes.	ARCO	EPA	Within 1 year of submittal of this report	No
Overgrowth of vegetation	Inform Sand Springs Home of the annual mowing status for the landfill, and the need to allow grasses on the landfill to go to seed.	ARCO	EPA	Within 1 year of submittal of this report	No
Institutional Controls	Institutional controls (including deed restrictions) should be implemented to help protect human health and the environment and facilitate future land us.	ARCO/ODEQ/ EPA	EPA	Within 1 year of submittal of this report	Yes

Notes:

ARCO Atlantic Richfield Company
EPA U.S. Environmental Protection Agency
ODEQ Oklahoma Department of Environmental Quality
O&M Operations and maintenance

11.0 NEXT REVIEW

The Sand Springs site requires ongoing five-year reviews. The next review will be conducted within the next five years, but no later than September 2010.

APPENDIX A

DOCUMENTS REVIEWED

(One Page)

DOCUMENTS REVIEWED

Atlantic Richfield Company (ARCO). 1993. "Landfill Groundwater Monitoring Plan." August.

Morrison Knudsen Corporation (MKC). 1993. "Consolidation Final Design Report, Volume XII, Post-Closure Plan." September.

D&B Construction (D&B). 2001. "Annual Inspection Report for the Sand Springs Petrochemical Complex Landfill." November.

D&B. 2002. "Annual Inspection Report for the Sand Springs Petrochemical Complex Landfill." December.

D&B. 2003. "Annual Inspection Report for the Sand Springs Petrochemical Complex Landfill." December.

U.S. Environmental Protection Agency (EPA). 1987. "EPA Superfund Record of Decision: Sand Springs Petrochemical Complex, EPA ID: OKD980748446, OU 01, Sand Springs, OK." EPA/ROD/R06-87/024. September 29.

EPA. 1988. "EPA Superfund Record of Decision: Sand Springs Petrochemical Complex, EPA ID: OKD980748446, OU 02, Sand Springs, OK." EPA/ROD/R06-88/033. June 28.

EPA. 2000. "First Five-Year Review Report for Sand Springs Petrochemical Complex, City of Sand Springs, Tulsa County, Oklahoma." September.

EPA. 2001. "Statement of Work for Test Pit Investigation: Sand Springs Petrochemical Complex, City of Sand Springs, Tulsa County, Oklahoma." July.

EPA. 2003. "Additional Site Characterization 2002, Sand Springs Petrochemical Complex, Sand Springs, Oklahoma." July.

EPA. 2003. "Sand Springs Petrochemical Complex, Oklahoma, EPA ID# 980748446, Site ID: 0601357." On-line Address: http://www.epa.gov/earth1r6/6sf/pdffiles/0601357.pdf. Accessed April 4, 2005. Publication date: September 17.

EPA. 2004. "Phase II Work Plan to Perform Test Pits, Sand Springs Petrochemical Complex, Sand Springs, Oklahoma." April.

EPA. 2004. "Workplan and Design for Riverbank Sludge Removal, Sand Springs Petrochemical Complex, Sand Springs, Oklahoma." September.

Stallion Environmental. 2004. "Annual Inspection Report for the Sand Springs Petrochemical Complex Landfill." December.

APPENDIX B

SITE VISIT REPORT

(Eight Pages)

SITE VISIT REPORT FOR SECOND FIVE-YEAR REVIEW FOR SAND SPRINGS PETROCHEMICAL COMPLEX SUPERFUND SITE SAND SPRING, TULSA COUNTY, OKLAHOMA

Prepared for

United States Environmental Protection Agency
Region 6
Dallas, Texas

Contract No.	:	68-W6-0037
Work Assignment No.	:	123-FRFE-06ZZ
Date Prepared	:	May 23, 2005
Prepared by	:	April Ballweg, Tetra Tech EM Inc.
Telephone No.	:	(214) 740-2038
EPA Remedial Project Manager	:	Mr. Michael Hebert
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C SURVEYS

ACRONYMS AND ABBREVIATIONS

ARCO	Atlantic Richfield Company
D&B	D & B Construction
Corps	Corps of Engineer's
EPA	U.S. Environmental Protection Agency Region 6
ODEQ	Oklahoma Department of Environmental Quality
NPL	National Priorities List
O&M	Operation and maintenance
OU	Operable unit
PRP	Potentially responsible party
RA	Remedial action
RAC	Response Action Contract
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
Sand Springs	Sand Springs Petrochemical Complex
Tetra Tech	Tetra Tech EM Inc.

1.0 INTRODUCTION

Tetra Tech EM Inc. (Tetra Tech) received Work Assignment No. 123-FRFE-06ZZ from U.S. Environmental Protection Agency Region 6 (EPA) under Response Action Contract (RAC) No. 68-W6-037. Under this work assignment, Tetra Tech was directed to conduct the second five-year review of the remedial action (RA) implemented at the Sand Springs Petrochemical Complex (Sand Springs) Superfund site in Sand Springs, Oklahoma.

Tetra Tech visited the site on March 14, 2005, to assess whether all components of the selected remedy are operating in accordance with criteria established in the September 1987 and June 1988 Records of Decision (ROD). This report provides background information on the site, summarizes site visit activities, and presents Tetra Tech's findings. References cited are listed at the end of this text. Exhibit A contains photographs taken during the site visit, and Exhibit B contains the five-year review site visit checklist completed by Tetra Tech. Exhibit C contains surveys that document interviews that were conducted during the site inspection and throughout the five-year review process. Exhibit D contains a copy of the routine checklist used by ARCO.

2.0 BACKGROUND

The Sand Springs site is located approximately 1 mile south of downtown Sand Springs, Tulsa County, Oklahoma. The site is located on the north bank of the Arkansas River and covers approximately 235 acres.

The site was the operating location of the Pierce Petroleum Refinery from the early 1900's to 1930, and the Sinclair Refining Company from 1930 to 1948. In 1948, the refinery was shut down and was subsequently dismantled. In 1969, Sinclair merged with Atlantic Richfield.

The district surrounding the Sand Springs site is primarily zoned industrial. Commercial facilities are located north of the site, while residential subdivisions are located across the river to the south of the site.

The Sand Springs site was placed on the National Priorities List (NPL) in June 1986. The site was subsequently divided into two operable units, the Source Control Operable Unit (OU 01), and the Main Site Unit (OU 02). A Superfund Remedial Action was implemented for the site and was completed in 1995. The site was delisted from the NPL in 2000. The remedial action involved excavation of

petroleum waste material, stabilization/solidification of the waste, and placement of approximately 180,000 cubic yards of stabilized material in an on-site landfill designed to meet the requirements of a Resource Conservation and Recovery Act (RCRA) Subtitle C Landfill.

In May 2001, a "tar-like" sludge material was observed on the north bank of the Arkansas River. This material appeared to be associated with the former Sinclair Refinery, and was exposed by erosion in a feature along the north bank of the Arkansas River. A work plan was prepared to conduct an investigation of the materials and was implemented in June 2002. A Work Plan was developed and a remedial action was initiated in 2004 to excavate and remove observed petroleum tars along the banks of the Arkansas River. The remedial action was initiated in 2005 but is currently on hold, due to the high water levels within the river.

OU 01, Source Control Operable Unit

The ROD (EPA 1987) for OU 01 stated that, in EPA's judgment Alternative 2 (on-site thermal destruction) appeared to meet more statutory selection criteria than the other remedies evaluated, but has serious implementation problems. During the comment period, the Atlantic Richfield Petroleum Products Company, a division of Atlantic Richfield Company (ARCO), one of the potentially responsible parties (PRP) for the site, made written and oral proposals for a privately financed remedy for the site. The EPA concluded that the ARCO proposal provided a remedy comparable to Alternative 2. The EPA accepted this remedy provided that the effectiveness of the proposal was adequately assured or that ARCO would undertake the corrective actions deemed appropriate by the EPA if the ARCO proposed remedy failed. The ROD listed the following in the description of the remedy:

1) Excavation and off-site thermal destruction of sludges, at least to the sludge/soil interface, from the portion of the site identified as the North and South Glenn Wynn Lagoons.
2) Solidification and/or stabilization of all remaining sludges and containment of the resulting matrix in a Resource Conservation and Recovery Act (RCRA) hazardous waste cell to be constructed on-site; this cell (or cells) had to meet the minimum technological requirements of Subtitle C of the Solid Waste Disposal Act.
3) Demonstration that the solidification technology utilized during the remedial action met EPA's approved criteria; including chemical and physical testing requirements. In the event that the solidification technology failed these criteria, thermal destruction would have been the remedy for the above-mentioned operable unit.
4) No liability release from the site or from future maintenance and monitoring.

5) Repair or restoration of the RCRA Subtitle C landfill to ensure no migration from the unit or destruction or treatment of all or a portion of its contents, as EPA shall deem appropriate, if the monitoring should show that the solidification and/or stabilization remedy has failed.

Main Site Operable Unit, OU 02

The ROD (EPA 1988) stated that in EPA's judgment Alternative 1, No Action (monitoring following the Source Control Remedial Action) met the statutory selection criteria. Factors supporting this decision included: after the Source Control Remedial Action, a natural flushing action will have decreased the level of contamination over time; the ground water and the Arkansas River are not sources of drinking water; and there is no public health threats from the minimally contaminated soil. The State of Oklahoma concurred with this remedy. The ROD listed the following requirements in the description of the remedy:

1) Place appropriate warning signs;
2) Restrict access; and,
3) Collecting and analyzing ground water for a period of at least 30 years.

The EPA determined that this alternative is protective of human health and the environment, attains federal and state requirements that are applicable or relevant and appropriate, is cost-effective compared to equally environmentally protective alternatives, and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable.

3.0 SITE VISIT ACTIVITIES

A site visit was conducted on March 14, 2005, to assess the condition of the site and the protective measures employed to protect human health and the environment from the contaminants still present at the site.

The following key individuals identified by EPA participated in the site visit:

- Michael Hebert, EPA
- Dennis Datin, Oklahoma Department of Environmental Quality (ODEQ)
- Penni Walker, Corps of Engineer's
- Dennis Hrebec, Stallion Environmental
- Terry Moore, ARCO

- Eric Johnstone, Tetra Tech
- April Ballweg, Tetra Tech

The site visit included evaluation of the RCRA Subtitle C Landfill, including the equipment, monitoring wells, leachate collection vaults, postings, and site fencing. Photographs taken during the site visit are presented in Exhibit A, the completed five-year review site visit checklist is presented in Exhibit B, and survey forms are presented in Exhibit C. Exhibit D contains a copy of the routine checklist used by ARCO. The site visit is summarized below.

The weather during the site visit was cloudy and cool, with winds coming from the north at 5 to 10 miles per hour. No evidence of contamination was visible at the site. The site's general appearance is good, with a stand of winterized vegetation, and new spring vegetation appearing. The vegetation along the perimeter fencing appeared to be tall and dense. The inspection team investigated the perimeter and top of the landfill including the perimeter road, the leachate collection vaults and the vent caps, and the levy along the Arkansas River where remedial activities have been initiated but are currently on hold. In addition, the team inspected the ground water monitoring wells, including a newly discover monitor well identified as MW-19 located on the south side of the Arkansas River levy, and the Glenn Wynn site.

4.0 FINDINGS

No evidence of contamination was visible at the site. The vegetation at the site appeared to be similar to that in typical surrounding areas. The leachate collection vaults were in order and appeared to be running properly. The vaults are currently being modified with drainage pipes to prevent surface stormwater from ponding within the vaults. Currently three vaults have been modified, with the remaining vaults being modified on an as-needed basis, according to Dennis Hrebec, with Stallion Environmental. Site access appeared to be sufficiently restricted because no vandalism was observed and the gate and fencing were in good condition. The gravel road around the landfill was in good condition as well. Some minor rodent tunneling activities were noted around the top portion of the landfill causing small holes in the topsoil. In addition, rodent activities were noted within one of the vent caps which was partially filled with disturbed topsoil. Minor erosion was noted at the outlet of a corrugated stormwater pipe located along the perimeter fence.

REFERENCES

D&B Construction. (D&B). 2003. "Annual Inspection Report for the Sand Springs Petrochemical Complex Landfill." December.

U.S. Environmental Protection Agency (EPA). 1987. "Superfund Record of Decision: Sand Springs Petrochemical Complex, EPA ID: OKD980748446, OU 01, Sand Springs, OK." EPA/ROD/R06-87/024. September 29.

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EPA. 2000. "First Five-Year Review Report for Sand Springs Petrochemical Complex, City of Sand Springs, Tulsa County, Oklahoma. September.

EXHIBIT A

PHOTOGRAPHS

(Eight Pages)

Photograph No. 1 Site: Sand Springs Superfund Site
Orientation: West Date: March 14, 2005
Description: Entrance gate to landfill with warning sign

Photograph No. 2 Site: Sand Springs Superfund Site
Orientation: Southwest Date: March 14, 2005
Description: Landfill cap with perimeter road

Photograph No. 3 Site: Sand Springs Superfund Site
Orientation: Down Date: March 14, 2005
Description: Leachate collection vault with pump

Photograph No. 4 Site: Sand Springs Superfund Site
Orientation: East Date: March 14, 2005
Description: Monitor well MW104, with storage drums for collection of light nonaqueous phase liquid extracted from well

Photograph No. 5 Site: Sand Springs Superfund Site
Orientation: East Date: March 14, 2005
Description: Monitor well, MW105

Photograph No. 6 Site: Sand Springs Superfund Site
Orientation: Northwest Date: March 14, 2005
Description: Top of landfill cap, corrugated vent pipe in center

Photograph No. 7 Site: Sand Springs Superfund Site
Orientation: Down Date: March 14, 2005
Description: Interior of vent cap, note vent is partially filled with loose dirt due to rodent activities

Photograph No. 8 Site: Sand Springs Superfund Site
Orientation: North Date: March 14, 2005
Description: Stormwater drain along perimeter of landfill

Photograph No. 9 Site: Sand Springs Superfund Site
Orientation: South Date: March 14, 2005
Description: Stockpile of soil due to removal activities along the Arkansas River levee

Photograph No. 10 Site: Sand Springs Superfund Site
Orientation: Southeast Date: March 14, 2005
Description: Temporary road located between levee and the Arkansas River, note concrete pad for decontamination activities during the remedial action

Photograph No. 11 Site: Sand Springs Superfund Site
Orientation: South Date: March 14, 2005
Description: Material removal area along the Arkansas River

Photograph No. 12 Site: Sand Springs Superfund Site
Orientation: Down Date: March 14, 2005
Description: Monitor well located on levee, MW107

Photograph No. 13 Site: Sand Springs Superfund Site
Orientation: Southwest Date: March 14, 2005
Description: Newly discovered monitor well located south of the levee, MW19

Photograph No. 14 Site: Sand Springs Superfund Site
Orientation: Down Date: March 14, 2005
Description: Monitor well located within yard of lumber company northwest of landfill, MW14

Photograph No. 15 Site: Sand Springs Superfund Site
Orientation: Southeast Date: March 14, 2005
Description: Monitor well located on Brentag Chemical property, northwest of the landfill, MW15

EXHIBIT B

SITE VISIT CHECKLIST

(11 PAGES)

FIVE-YEAR REVIEW SITE VISIT CHECKLIST

I. SITE INFORMATION

Site Name: Sand Springs Petrochemical Complex	**Date of Inspection:** March 14, 2005
Location and Region: Sand Springs, Oklahoma	**EPA ID:** OKD980748446
Agency, office, or company leading the five-year review: EPA Region 6	**Weather/temperature:** Mostly cloudy, winds NE 2-5 mph, 55-60 °F

Remedy Includes: (Check all that apply)

- ☒ Landfill cover/containment
- ☒ Access controls
- ☒ Institutional controls
- ☐ Ground water pump and treatment
- ☐ Surface water collection and treatment
- ☒ Other-Leachate collection and treatment

Attachments: ☒ Inspection team roster attached ☒ Site map attached

II. INTERVIEWS (Check all that apply)

1. O&M Site Manager Dennis Hrebec Operations Manager, Stallion Environmental 3/14/2005
Name Title Date

Interviewed: ☐ by mail ☒ at site ☐ by phone Phone no. 417-686-8330
Problems, suggestions: ☒ Report attached Survey form

2. O&M Staff N/A
Name Title Date

Interviewed: ☐ by mail ☐ at office ☐ by phone Phone no. _____
Problems, suggestions: ☐ Report attached

3. Local regulatory authorities and response agencies (i.e.; State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.). Fill in all that apply.

Agency Oklahoma Department of Environmental Quality (ODEQ)

Contact Dennis Datin Engineer 3/14/2005 (405) 702-5125
Name Title Date Phone no.

Problems, suggestions: ☒ Report attached Survey form

Agency U.S. Corps of Engineers, Tulsa District

Contact Penni Walker Project Engineer 3/14/2005 (918) 669-7074
Name Title Date Phone no.

Problems, suggestions: ☒ Report attached Survey form

4. Other interviews (optional): ☒ Report attached Survey forms (2)

Terry Moore, Atlantic Richfield (ARCO), PRP, survey form attached

Joe Williams, Sand Springs Home, property owner, survey form attached

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. O&M Documents

☒ O&M manual (long term monitoring plan)	☐ Readily available	☐ Up to date	☐ N/A
☒ As-built drawings	☐ Readily available	☐ Up to date	☐ N/A
☒ Maintenance logs (semi-annual well inspection sheets)	☐ Readily available	☐ Up to date	☐ N/A

Remarks: O&M documents are usually located within the O&M manager's vehicle, but not available at time of site visit

2. Site-Specific Health and Safety Plan	☐ Readily available	☐ Up to date	☐ N/A
☒ Contingency plan/emergency response plan	☐ Readily available	☐ Up to date	☐ N/A

Remarks: O&M documents are usually located within the O&M manager's vehicle, but not available at time of site visit

3. O&M and OSHA Training Records	☐ Readily available	☐ Up to date	☐ N/A

Remarks: O&M documents are usually located within the O&M manager's vehicle, but not available at time of site visit

4. Permits and Service Agreements

☐ Air discharge permit	☐ Readily available	☐ Up to date	☒ N/A
☐ Effluent discharge	☐ Readily available	☐ Up to date	☒ N/A
☒ Waste disposal, POTW	☐ Readily available	☐ Up to date	☐ N/A
☐ Other permits _____	☐ Readily available	☐ Up to date	☒ N/A

Remarks: O&M documents are usually located within the O&M manager's vehicle, but not available at time of site visit

5. Gas Generation Records	☐ Readily available	☐ Up to date	☒ N/A
6. Settlement Monument Records	☐ Readily available	☐ Up to date	☒ N/A
7. Ground Water Monitoring Records	☒ Readily available	☐ Up to date	☐ N/A
8. Leachate Extraction Records	☒ Readily available	☐ Up to date	☐ N/A

9. Discharge Compliance Records

☐ Air	☐ Readily available	☐ Up to date	☒ N/A
☒ Water (effluent)	☐ Readily available	☐ Up to date	☐ N/A

Remarks: O&M documents are usually located within the O&M manager's vehicle, but not available at time of site visit

10. Daily Access/Security Logs	☐ Readily available	☐ Up to date	☐ N/A

Remarks: O&M documents are usually located within the O&M manager's vehicle, but not available at time of site visit

IV. O&M COSTS

1. O&M Organization

☐ State in-house ☐ Contractor for State ☐ PRP in-house

☒ Contractor for PRP ☐ Other _____

2. O&M Cost Records (O&M cost information provided by ARCO in email, 4/13, 2005)

☒ Readily available ☐ Up to date ☒ Funding mechanism/agreement in place

☐ Original O&M cost estimate ☐ Breakdown attached

Total annual cost by year for review period, if available

Date	Date	Total Cost		
From 2000	to 2001	$65,000	-	☐ Breakdown attached
From 2001	to 2002	$65,000	-	☐ Breakdown attached
From 2002	to 2003	$65,000	-	☐ Breakdown attached
From 2003	to 2004	$65,000	-	☐ Breakdown attached
From	to		-	☐ Breakdown attached
From	to		-	☐ Breakdown attached
From	to		-	☐ Breakdown attached
From	to		-	☐ Breakdown attached

3. Unanticipated or Unusually High O&M Costs During Review Period

O&M cost records not available during inspection. Email (4/13/05) of annual expenses provided by Moore (ARCO)

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. Fencing damaged ☐ Location shown on site map ☒ Gates secured ☐ N/A

Remarks: _____

B. Other Access Restrictions

1. Signs and other security measures ☐ Location shown on site map ☐ N/A

Remarks: The landfill is surrounded by chain link fence topped with 3-strand barbed wire. The double gate with 3-strand barbed wire was closed and secure at the time of the site inspection.

C. Institutional Controls

1. Implementation and enforcement

Site conditions imply ICs not properly implemented ☐ Yes ☒ No ☐ N/A
Site conditions imply ICs not being fully enforced ☐ Yes ☒ No ☐ N/A

Type of monitoring (e.g., self-reporting, drive by) Annually monitored during site inspections
Frequency Annually
Responsible party/agency Atlantic Richfield Company (ARCO)
Contact Terry Moore Environmental Business Manager 3/14/05 972-509-7006
Name Title Date Phone no.

Reporting is up-to-date ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency ☒ Yes ☐ No ☐ N/A
Specific requirements in deed or decision documents have been met ☐ Yes ☒ No ☐ N/A
Violations have been reported ☐ Yes ☒ No ☐ N/A

Other problems or suggestions: ☐ Report attached
Restrictions are being reviewed for the property, due to parties potentially interested in purchasing land that is part of the superfund site (Glenn Wynn section).

2. Adequacy ☐ ICs are adequate ☒ ICs are inadequate ☐ N/A

Remarks: Restrictions are being reviewed for the property, due to parties potentially interested in purchasing land that is part of the superfund site (Glenn Wynn section).

D. General

1. Vandalism/trespassing ☐ Location shown on site map ☒ No vandalism evident

Remarks:

2. Land use changes onsite ☒ N/A

Remarks:

3. Land use changes offsite ☐ N/A

Remarks: Remedial activities occurring south of the landfill, located between the levee and the Arkansas River.

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

Remarks: Gravel road around the perimeter of the site is in fair condition.

B. Other Site Conditions

Remarks:

VII. LANDFILL COVERS ☒ Applicable ☐ N/A

A. Landfill Surface

1. Settlement (Low spots) ☐ Location shown on site map ☒ Settlement not evident
Areal extent _____ Depth _____
Remarks: _____

2. Cracks ☐ Location shown on site map ☒ Cracking not evident
Lengths _____ Widths _____ Depths _____
Remarks: _____

3. Erosion ☐ Location shown on site map ☒ Erosion not evident
Areal extent _____ Depth _____
Remarks: _____

4. Holes ☒ Holes evident ☐ Holes not evident
Areal extent _____ Depth _____
Remarks: Minor holes caused by burrowing animals were evident near the top of the cap.

5. Vegetative Cover ☒ Grass ☒ Cover properly established ☒ No signs of stress
☐ Trees/Shrubs (indicate size and locations on a diagram) (None)
Remarks: Vegetative cover was sufficient and consisted of dry winterized grasses. New spring growth was apparent at the base of the vegetative cover.

6. Alternative Cover (armored rock, concrete, etc.) ☒ N/A
Remarks: _____

7. Bulges ☐ Location shown on site map ☒ Bulges not evident
Areal extent _____ Depth _____
Remarks: _____

8. Wet Areas/Water Damage ☒ Wet areas/water damage not evident

☐ Wet areas	☐ Location shown on site map	☐ Areal extent _____
☐ Ponding	☐ Location shown on site map	☐ Areal extent _____
☐ Seeps	☐ Location shown on site map	☐ Areal extent _____
☐ Soft subgrade	☐ Location shown on site map	☐ Areal extent _____

Remarks: _____

9. Slope Instability ☐ Slides ☐ Location shown on site map
☒ No evidence of slope instability Areal extent _____
Remarks: _____

B. Benches ☐ Applicable ☒ N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. Flows Bypass Bench ☐ Location shown on site map ☐ N/A or okay

Remarks: _____

2. Bench Breached ☐ Location shown on site map ☐ N/A or okay

Remarks: _____

3. Bench Overtopped ☐ Location shown on site map ☐ N/A or okay

Remarks: _____

C. Letdown Channels ☐ Applicable ☒ N/A

(Channel lined with erosion control mats, rip rap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. Settlement ☐ Location shown on site map ☐ No evidence of settlement

Areal extent _____ Depth _____

Remarks: _____

2. Material Degradation ☐ Location shown on site map ☐ No evidence of degradation

Material type _____ Areal extent _____

Remarks: _____

3. Erosion ☐ Location shown on site map ☐ No evidence of erosion

Areal extent _____ Depth _____

Remarks: _____

4. Undercutting ☐ Location shown on site map ☐ No evidence of undercutting

Areal extent _____ Depth _____

Remarks: _____

5. Obstructions Type _____

☐ No obstructions ☐ Location shown on site map

Areal extent _____ Size _____

Remarks: _____

6. Excessive Vegetative Growth Type _____

☐ No evidence of excessive growth ☐ Vegetation in channels does not obstruct flow

☐ Location shown on site map Areal extent _____

Remarks: _____

D. Cover Penetrations ☒ Applicable ☐ N/A

1. Gas Vents ☐ Active ☒ Passive
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☒ Good condition
☐ Evidence of leakage at penetration ☒ Needs O&M ☐ N/A
Remarks: Some loose soil caused by burrowing animals was noted within one of the vents, removal of the loose soil recommended to prevent blockage of the vent.

2. Gas Monitoring Probes
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs O&M ☒ N/A
Remarks: _____

3. Monitoring Wells (within surface area of landfill)
☐ Evidence of leakage at penetration ☐ Needs O&M ☒ N/A
Remarks: _____

4. Leachate Extraction Wells
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☐ Evidence of leakage at penetration ☐ Needs O&M ☐ N/A
Remarks: Drainage pipes are being installed as needed to prevent stormwater from ponding within the leachate collection/detection vaults.

5. Settlement Monuments ☐ Located ☐ Routinely surveyed ☒ N/A
Remarks: _____

E. Gas Collection and Treatment ☐ Applicable ☒ N/A

1. Gas Treatment Facilities
☐ Flaring ☐ Thermal destruction ☐ Collection for reuse
☐ Good condition ☐ Needs O&M
Remarks: _____

2. Gas Collection Wells, Manifolds, and Piping ☐ Good condition ☐ Needs O&M
Remarks: _____

3. Gas Monitoring Facilities (e.g., gas monitoring of adjacent homes or buildings)
☐ Good condition ☐ Needs O&M ☐ N/A
Remarks: _____

F. Cover Drainage Layer ☐ Applicable ☒ N/A

1. Outlet Pipes Inspected ☐ Functioning ☐ N/A
Remarks: _____

2. Outlet Rock Inspected ☐ Functioning ☐ N/A
Remarks: _____

G. Detention/Sedimentation Ponds ☐ Applicable ☒ N/A

1. Siltation Areal extent _____ Size _____

☐ N/A ☐ Siltation not evident

Remarks: _____

2. Erosion Areal extent _____ Depth _____

☐ Erosion not evident

Remarks: _____

3. Outlet Works ☐ Functioning ☒ N/A

Remarks: _____

4. Dam ☐ Functioning ☒ N/A

Remarks: _____

H. Retaining Walls ☐ Applicable ☒ N/A

1. Deformations ☐ Location shown on site map ☐ Deformation not evident

Horizontal displacement _____ Vertical displacement _____

Rotational displacement _____

Remarks: _____

2. Degradation ☐ Location shown on site map ☐ Degradation not evident

Remarks: _____

I. Perimeter Ditches/Off-Site Discharge ☐ Applicable ☒ N/A

1. Siltation ☐ Location shown on site map ☐ Siltation not evident

Areal extent _____ Depth _____

Remarks: _____

2. Vegetative Growth ☐ Location shown on site map ☐ N/A

☐ Vegetation does not impede flow

Areal extent _____ Type _____

Remarks: _____

3. Erosion ☐ Location shown on site map ☐ Erosion not evident

Areal extent _____ Depth _____

Remarks: _____

4. Discharge Structure ☐ Functioning ☐ N/A

Remarks: _____

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

1. Settlement ☐ Location shown on site map ☐ Settlement not evident

Areal extent _____ Depth _____

Remarks: _____

2. Performance Monitoring Type of monitoring _____

☐ Performance not monitored Frequency _____ ☐ Evidence of breaching

Head differential _____

Remarks: _____

IX. GROUND WATER/SURFACE WATER REMEDIES ☐ Applicable ☒ N/A

A. Ground Water Extraction Wells, Pumps, and Pipelines ☐ Applicable ☒ N/A

1. Pumps, Wellhead Plumbing, and Electrical

☐ Good condition ☐ All required wells located ☐ Needs O&M ☐ N/A

Remarks: _____

2. Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances

☐ Good condition ☐ Needs O&M

Remarks: _____

3. Spare Parts and Equipment

☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided

Remarks: _____

B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☒ N/A

1. Collection Structures, Pumps, and Electrical

☐ Good condition ☐ Needs O&M

Remarks: _____

2. Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances

☐ Good condition ☐ Needs O&M

Remarks: _____

3. Spare Parts and Equipment

☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided

Remarks: _____

C. Treatment System ☐ Applicable ☒ N/A

1. Treatment Train (Check components that apply)

☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
☐ Air stripping ☐ Carbon absorbers
☐ Filters _____
☐ Additive (e.g., chelation agent, flocculent) _____
☐ Others _____
☐ Good condition ☐ Needs O&M
☐ Sampling ports properly marked and functional
☐ Sampling/maintenance log displayed and up to date
☐ Equipment properly identified
☐ Quantity of ground water treated annually _____
☐ Quantity of surface water treated annually _____

Remarks: _____

2. Electrical Enclosures and Panels (Properly rated and functional)

☐ N/A ☐ Good condition ☐ Needs O&M

Remarks: _____

3. Tanks, Vaults, Storage Vessels

☐ N/A ☐ Good condition ☐ Proper secondary containment ☐ Needs O&M

Remarks: _____

4. Discharge Structure and Appurtenances

☐ N/A ☐ Good condition ☐ Needs O&M

Remarks: _____

5. Treatment Building(s)

☐ N/A ☐ Good condition (esp. roof and doorways) ☐ Needs repair
☐ Chemicals and equipment properly stored

Remarks: _____

6. Monitoring Wells (Pump and treatment remedy)

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ All required wells located ☐ Needs O&M ☐ N/A

Remarks: _____

D. Monitored Natural Attenuation ☒ Applicable ☐ N/A

1. Monitoring Wells (Natural attenuation remedy)

☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☒ All required wells located ☐ Needs O&M ☐ N/A

Remarks: One additional well (MW-19) located south of the levee was found recently.

X. OTHER REMEDIES

If there are remedies applied at the site that are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

The goal of the remedy is solidification/stabilization of the sludge-like material and contain it within a RCRA Subtitle C type landfill, in addition to monitoring of the natural attenuation of the ground water at the site.

B. Adequacy of O&M

O&M appeared to be adequate. Additional institutional controls are being investigated (deed restrictions).

C. Early Indicators of Potential Remedy Failure

There were no early indicators of potential remedy failure noted at the time of the site inspection.

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Update the O&M manual and incorporate the new monitoring well into the O&M manual.

EXHIBIT C

SITE SURVEYS

(11 PAGES)

SUPERFUND SITE SURVEY - FORM D		
Site Name: Sand Springs Petrochemical Complex Site		**EPA Work Assignment No.:** 123-FRFE-06ZZ
Subject: 5-Year Review Information Survey		**Date: 9 March 2005**
Contact Made By:		
Name: Michael Hebert	**Title:** Remedial Project Manager	**Organization:** U.S. EPA
Telephone No.: (214) 665-8315 **E-Mail:** hebert.michael@epa.gov	**Street Address:** 1455 Ross Avenue, Suite 1200 **City, State, Zip:** Dallas, Texas 75202	
Name: Eric Johnstone	**Title:** Project Manager	**Organization:** Tetra Tech EM Inc.
Telephone No.: (214) 740-2001 **E-Mail:**eric.johnstone@ttemi.com	**Street Address:** 350 N. St. Paul Street, Suite 2600 **City, State, Zip:** Dallas, Texas 75201	
Individual Contacted:		
Name: Penni Walker	**Title: Project Engineer**	**Organization: COE**
Telephone No.: 918 669-7074 **E-Mail Address:**	**Street Address: 1645 South 101st East Avenue** **City, State, Zip: Tulsa, OK 74128**	

Survey Questions

1. What is your impression of the project (general sentiment)?

   The overall project has been worthwhile. Continuing maintenance of the site will be a priority, due to the high probability/possibility for erosion on site.

2. Has your office conducted routine communications or activities (site visits, inspections, reporting activities, etc.) regarding the site? If so, please provide the purpose and results?

   The Corps of Engineers has assisted in the yearly inspections and maintenance of the site every year since the closure of the site. During the first several years, concerns identified were usually limited to repair of erosional gullies and re-vegetation of areas that had not been properly covered. Additionally, three years ago, sludge was identified in the erosional gullies adjacent to the river. During the removal operations initiated to remove the sludge, the Corps of Engineers worked on the site as quality assurance. Work was completed according to the established Scope of Work.

SUPERFUND SITE SURVEY - FORM D (continued)	
Site Name: Sand Springs Petrochemical Complex Site	**EPA Work Assignment No.:** 123-FRFE-06ZZ
Subject: 5-Year Review Information Survey	**Date: 9 March 2005**

Survey Questions (Cont.)

3. Have there been any complaints, violations, or other incidents related to the site reported to your office? If so, please provide details.

   The identification of sludge during the inspection tour three years ago is the only violation of which I am aware.

4. Do you feel well informed about the site's activities and progress?

   I have been at least loosely affiliated with this site since the middle of the corrective action, approximately 1997.

5. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

   Continued observation of the on-going removal action is recommended.

SUPERFUND SITE SURVEY - FORM B	
Site Name: Sand Springs Petrochemical Complex Site	**EPA Work Assignment No.:** 123-FRFE-06ZZ
Subject: 5-Year Review Local Authority Survey	**Date:** March 11, 2005

Contact Made By:		
Name: Michael Hebert	**Title:** Remedial Project Manager	**Organization:** U.S. EPA
Telephone No.: (214) 665-8315 **E-Mail:** hebert.michael@epa.gov	**Street Address:** 1455 Ross Avenue, Suite 1200 **City, State, Zip:** Dallas, Texas 75202	
Name: Eric Johnstone	**Title:** Project Manager	**Organization:** Tetra Tech EM Inc.
Telephone No.: (214) 740-2001 **E-Mail:** eric.johnstone@ttemi.com	**Street Address:** 350 N. St. Paul Street, Suite 2600 **City, State, Zip:** Dallas, Texas 75201	

Individual Contacted:		
Name: Dennis L. Datin	**Title:** Environmental Engineer	**Organization:** ODEQ
Telephone No.: 405-702-5125 **E-Mail Address** dennis.datin@deq.state.ok.us	**Street Address:** 707 N. Robinson **City, State, Zip:** 73102	

Survey Questions

1. What is your impression of the project (general sentiment)?

   It went very well.

2. Has your office conducted routine communications or activities (site visits, inspections, reporting activities, etc.) regarding the site? If so, please provide the purpose and results.

   Only in regard to the EPA or Corps doing their inspections.

3. Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please provide details of the events and the results of the responses.

   One complaint regarding the TTU and its potential for contamination. Responded by contacting Terry Moore with Atlantic Richfield about the unit and then sending a letter saying that the unit was decontaminated and posed no problem relative to the site.

SUPERFUND SITE SURVEY - FORM B (continued)	
Site Name: Sand Springs Petrochemical Complex Site	**EPA Work Assignment No.:** 123-FRFE-06ZZ
Subject: 5-Year Review Local Authority Survey	**Date:** March 11, 2005

Survey Questions (Cont.)

4. Do you feel well informed about the site's activities and progress?

   Yes

5. Have there been any changes in State laws and regulations that may impact the protectiveness of the ground water or soil remedies?

   One law has changed that relates to the notice to the deed in which it is now required. A copy of the law is attached.

6. Has the site been in compliance with permitting and reporting requirements?

   Yes

7. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

   No.

SUPERFUND SITE SURVEY - FORM C	
Site Name: Sand Springs Petrochemical Complex Site	**EPA Work Assignment No.:** 123-FRFE-06ZZ
Subject: 5-Year Review Operation and Maintenance	**Date:** 3/15/05

Contact Made By:		
Name: Michael Hebert	**Title:** Remedial Project Manager	**Organization:** U.S. EPA
Telephone No.: (214) 665-8315 **E-Mail:** hebert.michael@epa.gov	**Street Address:** 1455 Ross Avenue, Suite 1200 **City, State, Zip:** Dallas, Texas 75202	
Name: Eric Johnstone	**Title:** Project Manager	**Organization:** Tetra Tech EM Inc.
Telephone No.: (214) 740-2004 **E-Mail:** eric.johnstone@ttemi.com	**Street Address:** 350 N. St. Paul Street, Suite 2600 **City, State, Zip:** Dallas, Texas 75201	

Individual Contacted:		
Name: Terry Moore	**Title:** Environmental Business Manager	**Organization: Atlantic Richfield**
Telephone No.: 972-509-7006 **E-Mail Address:** mooretjl@bp.com	**Street Address:** 1701 Summit Avenue, Suite 2 **City, State, Zip:** Plano, TX 75074	

Survey Questions

1. What is your impression of the project (general sentiment)?

   The project has, for the most part, progressed according to plan. The landfill has performed as the design predicted. The encroachment of the river into the bank sediments revealed some additional wastes that were missed during our first remediation effort, but these are being taken care of through additional remediation. Atlantic Richfield and the agencies are working cooperatively ensure that the goals of the Order are met.

2. Please describe the on-site operation and maintenance (O&M) presence, including staff, frequency of site inspections, and (O&M) activities.

   The routine O&M for the site involves about 15 to 20 days per year of site work. Inspections, mowing, road and fence repair, leachate recovery and disposal, and monitor well sampling and analysis constitute the bulk of field work. This last year we added a few drains to prevent rainwater migration into the landfill sumps. Inspections and maintenance are conducted quarterly and groundwater monitoring is conducted annually. Leachate collection frequency is a function of the rate of leachate generation. Some leachate collection points generate leachate at a rate that requires maintenance more frequently than quarterly and some require less frequent attention. We monitor the rates of leachate generation, but they have always been well below the action level of 560 gallons per acre per day. Our O&M Checklist (including frequency) is Attached.

   The recent removal action is considered a large-scale maintenance activity. Construction activities were performed from October 11, 2004 until February 11, 2005. The action involved excavation, staging, sampling and analysis, transportation, and disposal of approximately 18,000 tons of waste thus far. The activity was suspended temporarily on February 11th, 2005, due to continued wet conditions and a high river stage. The project will be restarted in September, when the weather and river conditions will be conducive to removal of the remainder of the waste.

SUPERFUND SITE SURVEY - FORM C	
Site Name: Sand Springs Petrochemical Complex Site	**EPA Work Assignment No.:** 123-FRFE-06ZZ
Subject: 5-Year Review Operation & Maintenance Survey	**Date:**

Survey Questions (Continued)

3. Please describe any significant changes in the O&M requirements, maintenance schedules, or sampling routines since start-up or in the last 5 years. Do they affect the protectiveness or effectiveness of the remedy?

   None of the routine O&M has changed appreciably since the last 5-year review.

   The removal action project was not even contemplated at the time of the last 5-year review. Since that time, the contamination was identified, studies were undertaken to delineate the problem, remediation work plans were developed and approved, and the bulk of the waste has been excavated, tested, transported and disposed of at the Quarry Landfill in Tulsa, Oklahoma

4. Have there been unexpected O&M difficulties or costs at the site since start-up or in the last 5 years? If so, please provide details.

   The removal action has been an unexpected item to deal with since the last 5-year review. As described above, approximately 18,000 tons of petroleum wastes was collected from between the Arkansas River and the Arkansas River Levee. The materials were discovered when the river eroded sand from the riverbank, exposing the old waste deposits. The removal action was suspended on February 11, 2005, due to wet conditions and a high river stage that prevented access of the petroleum materials in the edge of the Arkansas River. The removal action will be restarted in September, when the river stage and weather are conducive to completing the project

5. Is it anticipated that the current remedial action activities will effect the O&M activities? If so, please describe how.

   The current removal action will only slightly affect the future O&M plans for the site. A more comprehensive O&M plan will be finalized to include both operable units and the recent removal action site. Additional O&M to address the current removal action site will only involve inspections to ensure that bank stability remains in tact.

6. Can you provide insight to potential O&M problems?

   The site has been monitored and maintained for ten years and is relatively predictable. We do not see additional O&M problems in the future.

SUPERFUND SITE SURVEY - FORM C	
Site Name: Sand Springs Petrochemical Complex Site	**EPA Work Assignment No.:** 123-FRFE-06ZZ
Subject: 5-Year Review Operation & Maintenance Survey	**Date:**

Survey Questions (Continued)

7. Do you have any comments, suggestions, or recommendations regarding the project?

None.

SUPERFUND SITE SURVEY - FORM C	
Site Name: Sand Springs Petrochemical Complex Site	**EPA Work Assignment No.:** 123-FRFE-06ZZ
Subject: 5-Year Review Operation and Maintenance	**Date:**

Contact Made By:		
Name: Michael Hebert	**Title:** Remedial Project Manager	**Organization:** U.S. EPA
Telephone No.: (214) 665-8315 **E-Mail:** hebert.michael@epa.gov	**Street Address:** 1455 Ross Avenue, Suite 1200 **City, State, Zip:** Dallas, Texas 75202	
Name: Eric Johnstone	**Title:** Project Manager	**Organization:** Tetra Tech EM Inc.
Telephone No.: (214) 740-2004 **E-Mail:** eric.johnstone@ttemi.com	**Street Address:** 350 N. St. Paul Street, Suite 2600 **City, State, Zip:** Dallas, Texas 75201	

Individual Contacted:		
Name: Dennis J. Hrebec	**Title:** Director	**Organization: Stallion Environmental**
Telephone No.: 417-868-8330 **E-Mail Address:** djhmo1@lyrical.net	**Street Address:** 535 N. Orchard Crest Ave. **City, State, Zip:** Springfield, MO 65802	

Survey Questions

1. What is your impression of the project (general sentiment)?

   Operation and maintenance of the landfill has performed as designed. The landfill appears to be protective and has no physical or leakage problems.

2. Please describe the on-site operation and maintenance (O&M) presence, including staff, frequency of site inspections, and (O&M) activities.

   On-site operation and maintenance activities are directed by Dennis Hrebec according to schedules that were set in the Post Closure Plan. Formal site inspections are completed quarterly and are documented in quarterly reports. Additional site visits are conducted in conjunction with annual monitoring and other intervals in conjunction with leachate collection removal. Fence inspections are performed at irregular times when personnel are in the area.

SUPERFUND SITE SURVEY - FORM C	
Site Name: Sand Springs Petrochemical Complex Site	**EPA Work Assignment No.:** 123-FRFE-06ZZ
Subject: 5-Year Review Operation & Maintenance Survey	**Date:**

Survey Questions (Continued)

3. Please describe any significant changes in the O&M requirements, maintenance schedules, or sampling routines since start-up or in the last 5 years. Do they affect the protectiveness or effectiveness of the remedy?

   Maintenance schedules are in accordance with the post closure plan. No significant changes have been observed in the operation and maintenance requirements in the last 5 years. The remedy has been effective in containing the stabilized material.

4. Have there been unexpected O&M difficulties or costs at the site since start-up or in the last 5 years? If so, please provide details.

   Imported soil on the top of the landfill cap proved to be incapable of providing dense vegetation cover due to excessive levels of salt in the soil. The top 6 inches of soil was subsequently removed and replaced with new soil, and the area was sodded with Bermuda sod. This is the only area of unexpected costs that has occurred within the landfill perimeter fence.

SUPERFUND SITE SURVEY - FORM C	
Site Name: Sand Springs Petrochemical Complex Site	**EPA Work Assignment No.:** 123-FRFE-06ZZ
Subject: 5-Year Review Operation & Maintenance Survey	**Date:**

Survey Questions (Continued)

5. Is it anticipated that the current remedial action activities will effect the O&M activities? If so, please describe how.

None of the activities that will take place during the anticipated remedial action will affect the area within the landfill perimeter fence. After the remedial action is completed, it is anticipated that O&M inspections will be extended to the completed remedial action area to insure that the rip rap area and the revegetated areas are performed properly.

6. Can you provide insight to potential O&M problems?

No potential problems are anticipated.

SUPERFUND SITE SURVEY - FORM C	
Site Name: Sand Springs Petrochemical Complex Site	**EPA Work Assignment No.:** 123-FRFE-06ZZ
Subject: 5-Year Review Operation & Maintenance Survey	**Date:**

Survey Questions (Continued)

7. Do you have any comments, suggestions, or recommendations regarding the project?

The Post Closure Plan and the Ground Water Monitoring Plan were written prior to the completion of the remedial action for the site. As a result, the documents are out-of-date and many of the items listed in the plans are no longer applicable. The documents are in need of revision to make them applicable to the current conditions.

APPENDIX C

PUBLIC NOTICE

(One Page)

Affidavit Of Publication

SAND SPRINGS LEADER

STATE OF OKLAHOMA, TULSA COUNTY, ss:

Bill R. Retherford, of lawful age, being duly sworn and authorized, says that he is the publisher of the Sand Springs Leader, a bi-weekly newspaper published in the City of Sand Springs, Tulsa County, Oklahoma, a newspaper qualified to publish legal notices, advertisements and publications as provided in Section 106 of Title 25, Oklahoma Statutes 1971 and 1983 as amended, and thereafter, and complies with all other requirements of the laws of Oklahoma with reference to legal publications.

That said notice, a true copy of which is attached hereto, was published in the regular edition of said newspaper during the period and time of publications and not in a supplement, on the following dates:

MARCH 6TH, 2005

Bill R. Retherford

Subscribed and sworn to before me this 7TH

day of MARCH, 2005

Linda K. Purdom

Notary Public

My Commission expires:

Notary Public Oklahoma
OFFICIAL SEAL
LINDA K. PURDOM
Tulsa County
COMMISSION EXPIRES 8-11-2005

PUBLISHERS'S FEE $ 168.00

Published in the Sand Springs Leader, Sand Springs, Tulsa County, Oklahoma, March 6, 2005.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

SAND SPRINGS PETROCHEMICAL COMPLEX SUPERFUND SITE PUBLIC NOTICE

U.S. EPA Region 6 Begins Second Five-Year Review of Site Remedy

The U.S. Environmental Protection Agency (EPA) Region 6 has begun a Five-Year Review of the remedy for the Sand Springs Petrochemical Complex Superfund Site (site). The site is located in Sand Springs, Oklahoma, near the Arkansas River. The review will evaluate the implementation and performance of the remedy in order to determine the protectiveness to the public health and the environment and is scheduled to be completed by September 2005. Old petroleum refinery sludges were treated by a chemical solidification/stabilization process and placed in an on-site Resource Conservation and Recovery Act (RCRA) Subtitle C landfill. Groundwater at the site was impacted by unknown historical sources upgradient of the site and was scheduled to be monitored for 30 years. Once completed, the results of the Five-Year Review will be made available to the public at the following information repository:

Charles Page Library
551 East Fourth Street
Sand Springs, Oklahoma 74063

Information about the Site also is available on the Internet at www.epa.gov/region6/superfund.

For more information about the Site, contact:

Mr. Michael Hebert
Remedial Project Manager
(Mail Code 6SF-LP)
U.S. Environmental Protection Agency, Region 6
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733
hebert.michael@epa.gov
(214) 665-8315 or you may call EPA's toll free number in Dallas at (800) 533-3508

Mr. Denis Datin
Oklahoma Department of Environmental Quality
707 N. Robinson
Oklahoma City, Oklahoma 73102
(225) 219-3198
dennis.datin@deq.state.ok.us

SUMMARY OF LABORATORY ANALYTICAL RESULTS
SAND SPRINGS PETROCHEMICAL COMPLEX

VOLATILE ORGANICS (µg/L)										
Analyte	**Date**	**MW14**	**MW15**	**MW101**	**MW102**	**MW103**	**MW104**	**MW105**	**MW106**	**MW107**
Acetone	12/95	--	--	--	--	--	--	--	--	--
	3/96	--	--	--	--	--	--	--	--	--
	6/97	--	--	--	--	--	--	--	--	--
	6/98	--	--	--	--	--	--	--	--	--
	6/99	--	--	--	--	--	--	--	--	--
	6/00	--	--	--	--	--	--	--	--	--
	6/01	--	--	--	--	--	--	--	--	--
	7/02	--	--	--	--	--	35	--	--	--
	6/03	--	--	--	--	--	--	15.1	3.60	--
	6/04	--	--	--	--	13.0	--	--	15.8	15.4
Benzene	12/95	NA	NA	--	--	--	14	--	--	--
	3/96	--	--	--	--	--	18	--	--	--
	6/97	--	--	--	--	--	--	--	--	--
	6/98	--	--	--	--	--	--	--	--	--
	6/99	--	--	--	--	--	2.9	--	--	--
	6/00	--	--	--	--	--	--	11.5	--	--
	6/01	--	--	--	--	--	5	6.5	--	--
	7/02	--	--	--	--	--	1.1	4.5	5.9	--
	6/03	--	--	--	--	--	--	--	--	--
	6/04	--	--	--	--	--	--	--	--	--
Chloroethane	12/95	NA	NA	--	--	78	1800	--	--	--
	3/96	--	--	--	--	--	1600	--	--	--
	6/97	--	--	--	--	160	310	--	--	--
	6/98	--	--	--	--	64(H)	400	--	--	--
	6/99	--	--	--	--	--	230	--	--	--
	6/00	--	--	--	--	31.7	252	442	--	--
	6/01	--	--	--	--	33.5	210	51.8	--	--
	7/02	--	--	--	--	97	74	--	--	--
	6/03	--	--	--	--	27.5	--	21.5	--	--
	6/04	--	--	--	--	28.0	5.02	376	--	--
Chloroform	12/95	--	--	--	--	--	--	--	--	--
	3/96	--	--	--	--	--	--	--	--	--
	6/97	--	--	--	--	--	--	--	--	--
	6/98	--	--	--	--	--	--	--	--	--
	6/99	--	--	--	--	--	--	--	--	--
	6/00	--	--	--	--	--	--	--	--	--
	6/01	--	--	--	--	--	--	--	--	--
	7/02	--	--	--	--	--	--	--	--	1.4
	6/03	--	--	--	--	--	--	--	--	--
	6/04	--	--	--	--	--	--	--	--	--

SUMMARY OF LABORATORY ANALYTICAL RESULTS
SAND SPRINGS PETROCHEMICAL COMPLEX

VOLATILE ORGANICS (µg/L)										
Analyte	**Date**	**MW14**	**MW15**	**MW101**	**MW102**	**MW103**	**MW104**	**MW105**	**MW106**	**MW107**
1,1-Dichloroethane	12/95	NA	NA	--	--	160	25	36	11	--
	3/96	--	--	--	--	--	30	47	9	14
	6/97	--	--	--	--	--	--	--	--	--
	6/98	--	--	--	--	39	--	22	11	--
	6/99	--	--	--	15.6	17.8	10.5	19.7	10.1	2.2
	6/00	--	--	--	--	14.5	--	32.5	--	--
	6/01	--	--	--	--	23.9	8.6	13.9	32.9	--
	7/02	--	2.3	--	--	16	15	--	56	1.2
	6/03	--	--	--	--	12.4	--	--	32.2	1.30
	6/04	--	--	--	--	--	--	--	--	--
1,2-Dichloroethane	12/95	NA	NA	--	--	--	--	10	--	--
	3/96	--	--	--	--	--	5	10	--	--
	6/97	--	--	--	--	--	--	--	--	--
	6/98	--	--	--	--	--	--	--	--	--
	6/99	--	--	--	--	--	--	3	--	--
	6/00	--	--	--	--	--	--	--	--	--
	6/01	--	--	--	--	11.4	--	--	2.4	--
	7/02	--	--	--	--	5.7	--	--	5.9	--
	6/03	--	3.50	--	1.50	1.20	--	--	3.1	--
	6/04	--	--	--	--	--	--	--	7.75	--
1,1-Dichloroethene	12/95	NA	NA	--	--	--	--	--	7	--
	3/96	--	--	--	--	--	--	--	7	--
	6/97	--	--	--	--	76	--	--	--	--
	6/98	--	--	--	--	--	--	--	--	--
	6/99	--	--	--	--	--	--	--	--	--
	6/00	--	--	--	--	--	--	--	--	--
	6/01	--	--	--	--	--	--	--	--	--
	7/02	--	2.7	--	1.1	--	--	--	1.6	--
	6/03	--	2	--	1.1	--	--	--	--	--
	6/04	--	--	--	--	--	--	--	--	--
Methylene chloride	12/95	NA	NA	--	--	--	12	--	--	--
	3/96	--	--	--	--	--	13	--	--	--
	6/97	--	--	--	--	--	--	--	--	--
	6/98	--	--	--	--	--	--	--	--	--
	6/99	--	--	--	--	--	--	--	--	--
	6/00	--	--	--	--	--	--	--	--	--
	6/01	--	--	--	--	--	--	--	--	--
	7/02	--	--	--	--	--	--	--	--	--
	6/03	--	--	--	--	--	--	--	--	--
	6/04	--	--	--	--	--	--	--	--	--

APPENDIX D

SUMMARY OF LABORATORY RESULTS

(Ten Pages)

SUMMARY OF LABORATORY ANALYTICAL RESULTS
SAND SPRINGS PETROCHEMICAL COMPLEX

VOLATILE ORGANICS (µg/L)										
Analyte	**Date**	**MW14**	**MW15**	**MW101**	**MW102**	**MW103**	**MW104**	**MW105**	**MW106**	**MW107**
Tetrachloroethene (PCE)	12/95	NA	NA	--	--	--	--	33	--	--
	3/96	--	--	--	--	--	--	96	--	--
	6/97	--	--	--	--	--	--	17	--	--
	6/98	--	--	--	--	--	--	6	--	--
	6/99	--	--	--	10.5	11.7	--	12.9	--	--
	6/00	--	--	--	--	--	--	--	--	--
	6/01	--	--	--	--	2.4	--	--	6.1	--
	7/02	--	--	--	--	2	2.6	--	15	--
	6/03	--	--	--	--	--	--	--	7.3	--
	6/04	--	--	--	--	7.14	--	--	12.0	--
Toluene	12/95	NA	NA	--	--	36	--	--	--	--
	3/96	--	--	--	--	7	--	--	--	--
	6/97	--	--	--	--	--	--	--	--	--
	6/98	--	--	--	--	--	--	--	--	--
	6/99	--	--	--	--	--	--	--	--	--
	6/00	--	--	--	--	--	--	--	--	--
	6/01	--	--	--	--	--	--	--	--	--
	7/02	--	--	--	--	--	--	--	--	--
	6/03	--	--	--	--	--	--	--	--	--
	6/04	--	--	--	--	--	--	--	--	--
1,1,1-Trichloro-ethane (TCA)	12/95	NA	NA	--	--	--	--	--	--	--
	3/96	--	--	--	--	--	--	--	5	--
	6/97	--	--	--	--	--	17	28	14	--
	6/98	--	--	--	--	--	--	--	--	--
	6/99	--	--	--	--	--	--	--	2.2	--
	6/00	--	3.6	--	--	--	--	--	--	--
	6/01	--	--	--	--	--	--	--	5.7	--
	7/02	--	2	--	1.2	--	--	--	11	1.6
	6/03	--	--	--	--	--	--	--	3.2	1
	6/04	--	--	--	--	--	--	--	8.04	--
	12/95	NA	NA	--	--	--	--	13	--	--
1,1,2-Trichloroethane	3/96	--	--	--	--	--	--	11	--	--
	6/97	--	--	--	--	--	--	--	--	--
	6/98	--	--	--	--	--	--	--	--	--
	6/99	--	--	--	--	--	--	4.8	--	--
	6/00	--	--	--	--	--	--	--	--	--
	6/01	--	--	--	--	--	--	--	11.4	--
	7/02	--	--	--	--	--	--	--	27	--
	6/03	--	--	--	--	--	--	--	6.8	--
	6/04	--	--	--	--	--	--	--	--	--

SUMMARY OF LABORATORY ANALYTICAL RESULTS
SAND SPRINGS PETROCHEMICAL COMPLEX

VOLATILE ORGANICS (µg/L)										
Analyte	**Date**	**MW14**	**MW15**	**MW101**	**MW102**	**MW103**	**MW104**	**MW105**	**MW106**	**MW107**
	12/95	NA	NA	--	--	--	--	26	7	--
Trichloroethene (TCE)	3/96	--	--	--	--	--	--	110	6	--
	6/97	--	--	--	--	8	--	44	6	--
	6/98	--	--	--	9	6	--	35	--	--
	6/99	--	--	--	--	9.9	--	71	27	--
	6/00	--	--	--	--	--	--	--	--	--
	6/01	--	--	--	--	3	--	--	4	--
	7/02	--	--	--	--	2.5	1.3	--	6.7	--
	6/03	--	--	--	--	3.7	--	--	4.7	--
	6/04	--	--	--	--	--	--	--	--	--
Vinyl chloride	12/95	NA	NA	--	--	--	--	31	--	--
	3/96	--	--	--	--	--	--	72	--	--
	6/97	--	--	--	--	--	--	19	--	--
	6/98	--	--	--	24.6	14	--	35	--	--
	6/99	--	--	--	--	--	3.1	40.7	--	--
	6/00	--	--	--	--	--	--	--	--	--
	6/01	--	--	--	--	58.6	--	--	--	--
	7/02	--	--	--	--	--	4.5	--	3.8	--
	6/03	--	--	--	--	--	--	9.9	2	--
	6/04	--	--	--	--	--	--	5.8	--	--

Notes:

"--" — Analyte was nondetect

µg/L — Micrograms per liter

MW — Monitor well

NA — Not analyzed

SUMMARY OF LABORATORY ANALYTICAL RESULTS
SAND SPRINGS PETROCHEMICAL COMPLEX

METALS Micrograms per liter (µg/L)										
Analyte	**Date**	**MW14**	**MW15**	**MW101**	**MW102**	**MW103**	**MW104**	**MW105**	**MW106**	**MW107**
Arsenic	12/95	NA	NA	--	--	17	6	55	--	13
	3/96	--	--	7	--	5	16	36	--	5
	6/97	--	--	--	--	12	--	10	--	--
	6/98	--	--	--	--	26	8	30	--	--
	6/99	--	--	--	47	32	7	25	--	6
	6/00	9	--	--	--	6	7	17	--	25
	6/01	10	6	--	--	18	12	36	--	26
	7/02	--	--	--	--	--	--	--	--	--
	6/03	11	25.6	9.38	9.44	311	21	51.2	15.2	22
	6/04	--	12.0	--	--	26.4	18.0	20.0	--	--
Barium	12/95	NA	NA	1550	129	1630	1620	1520	153	212
	3/96	439	228	801	143	843	3680	1660	65	137
	6/97	232	182	187	117	298	763	78	29	78
	6/98	283	179	149	214	509	822	303	128	51
	6/99	224	131	114	726	540	730	260	40	33
	6/00	696	179	113	147	502	756	328	135	260
	6/01	269	213	102	228	386	906	131	50	307
	7/02	683	272	153	154	667	96.4	859	39	44.7
	6/03	507	499	235	176	2550	926	207	32.6	33.4
	6/04	307	507	--	205	429	880	--	--	--
Beryllium	12/95	NA	NA	--	--	--	--	--	--	--
	3/96	--	--	--	--	--	--	--	--	--
	6/97	--	--	--	--	--	--	--	--	--
	6/98	--	--	--	--	--	--	--	--	--
	6/99	--	--	--	--	--	--	--	--	5
	6/00	--	--	--	--	--	--	--	--	--
	6/01	--	--	--	--	--	--	--	--	--
	7/02	1.2	--	1.31	--	1.86	9.43	--	--	1.46
	6/03	1.23	1.71	1.89	--	3.55	--	1.64	1.3	2.78
	6/04	--	--	--	--	--	--	--	--	--
Cadmium	12/95	NA	NA	0.6	--	1.7	2.8	1.7	3	1.9
	3/96	5.9	--	--	--	--	13	1.2	2.4	1.2
	6/97	1.1	--	--	--	--	--	0.6	2	0.7
	6/98	6	--	--	--	--	--	--	6	--
	6/99	11	--	--	--	--	--	--	--	--
	6/00	7	--	--	--	--	--	--	4	--
	6/01	1	--	--	--	--	--	1	2.5	--
	7/02	--	--	--	--	--	9.03	--	--	--
	6/03	2.27	--	--	--	11.1	--	--	--	--
	6/04	--	--	--	--	--	--	--	--	--

SUMMARY OF LABORATORY ANALYTICAL RESULTS
SAND SPRINGS PETROCHEMICAL COMPLEX

METALS Micrograms per liter (µg/L)										
Analyte	**Date**	**MW14**	**MW15**	**MW101**	**MW102**	**MW103**	**MW104**	**MW105**	**MW106**	**MW107**
Chromium	12/95	NA	NA	31	--	38	8	78	--	--
	3/96	10	--	15	--	18	47	75	--	--
	6/97	12	--	--	--	--	--	--	--	--
	6/98	--	8	--	--	--	--	18	--	--
	6/99	9	--	--	24	11	--	--	--	--
	6/00	42	5	--	--	10	--	--	6	8
	6/01	21	8	--	--	8	--	14	--	10
	7/02	10.3	--	--	--	--	40.4	--	--	--
	6/03	40.2	36.4	--	--	23.3	--	18.9	--	--
	6/04	22.9	42.2	--	--	--	--	--	--	--
Hexavalent Chromium	12/95	NA	NA	--	--	--	--	--	--	--
	3/96	--	--	--	--	--	--	--	--	--
	6/97	--	--	--	--	--	--	--	--	--
	6/98	--	--	--	--	--	--	16	--	--
	8/98	MW-105 was resampled for hexavalent chromium, results were nondetect								
	6/99	--	--	--	--	--	--	--	--	--
	6/00	--	--	--	--	--	--	--	--	--
	6/01	--	--	--	--	--	--	--	--	--
	7/02	--	--	12.7	--	--	--	--	--	28.2
	6/03	--	--	--	--	--	--	--	--	--
	6/04	--	--	--	--	--	--	--	--	--
Copper	12/95	NA	NA	25	--	41	22	35	--	--
	3/96	10	--	14	--	16	67	36	--	--
	6/97	--	--	--	--	--	--	--	--	--
	6/98	--	--	--	--	--	--	10	--	--
	6/99	--	--	--	--	--	--	--	--	--
	6/00	--	--	--	--	--	--	--	--	--
	6/01	12	--	--	--	--	--	--	--	--
	7/02	18.8	--	--	--	10.3	51.4	--	10.5	--
	6/03	26.5	20.3	--	--	51.7	--	35.3	6.1	--
	6/04	16.1	25.1	--	--	--	--	--	--	--
Lead	12/95	NA	NA	62	--	36	15	43	3	5
	3/96	17	28	33	--	12	47	43	2	3
	6/97	10	8	3	--	--	--	--	--	--
	6/98	11	7	--	4	0.9	--	0.5	3	--
	6/99	14	4	--	10	6	--	--	--	--
	6/00	69	4	--	--	--	--	--	4	--
	6/01	21	10	--	--	--	--	--	--	--
	7/02	--	--	--	--	--	--	--	--	--
	6/03	31	38.3	--	--	5.12	--	4.09	--	--
	6/04	19.3	49.8	3.2	--	4.2	--	--	--	--

SUMMARY OF LABORATORY ANALYTICAL RESULTS
SAND SPRINGS PETROCHEMICAL COMPLEX

METALS Micrograms per liter (µg/L)										
Analyte	**Date**	**MW14**	**MW15**	**MW101**	**MW102**	**MW103**	**MW104**	**MW105**	**MW106**	**MW107**
Mercury	12/95	NA	NA	--	--	--	--	--	--	--
	3/96	--	--	--	--	--	--	--	--	--
	6/97	--	--	--	--	--	--	--	--	--
	6/98	--	0.6	--	--	--	--	--	--	--
	8/98	MW15 was resampled for mercury, results were nondetect								
	6/99	--	--	--	--	--	--	--	--	--
	6/00	--	--	--	--	--	--	--	--	--
	6/01	--	--	--	--	--	--	--	--	--
	7/02	--	--	--	--	--	--	--	--	--
	6/03	--	--	--	--	--	--	--	--	--
	6/04	--	--	--	--	--	--	--	--	--
Nickel	12/95	NA	NA	43	--	64	--	43	50	98
	3/96	46	--	25	--	32	47	51	53	75
	6/97	--	--	--	--	--	--	50	27	35
	6/98	22	--	--	--	--	--	33	196	79
	6/99	19	--	18	27	14	--	--	103	77
	6/00	--	--	--	--	--	--	--	--	--
	6/01	28	11	--	--	--	--	25	68	32
	7/02	74.6	--	--	--	--	176	--	46	--
	6/03	56.2	54.6	12.2	--	39.7	--	10.1	23.1	18.4
	6/04	--	56.5	--	--	--	--	--	--	--
Selenium	12/95	NA	NA	--	8	--	--	--	--	--
	3/96	--	--	--	--	--	--	--	--	--
	6/97	--	--	--	--	--	--	--	--	--
	6/98	--	--	--	--	--	--	--	--	--
	6/99	8	--	--	--	--	--	--	--	--
	6/00	12	6	7	9	--	--	--	6	9
	6/01	--	11	--	14	--	--	--	--	--
	7/02	--	--	--	--	--	--	--	--	--
	6/03	9.56	7.78	6.3	6.97	--	--	--	9.3	11.2
	6/04	27.9	33.7	13.2	32.4	22.9	17.4	--	23.0	17.3
Zinc	12/95	NA	NA	196	--	139	46	227	725	90
	3/96	66	37	85	--	60	159	222	475	76
	6/97	45	22	42	--	--	--	96	366	45
	6/98	58	28	204	16	--	--	152	445	56
	6/99	91	35	--	45	29	--	67	232	133
	6/00	--	--	--	--	--	--	--	--	--
	6/01	92	54	104	--	--	--	59	188	53
	7/02	--	--	--	--	--	468	--	103	--
	6/03	140	147	65.7	8.14	65.5	--	71.9	36.8	24.7
	6/04	79.1	134	46.3	21.9	--	46.8	31.6	32.9	22.1

SUMMARY OF LABORATORY ANALYTICAL RESULTS
SAND SPRINGS PETROCHEMICAL COMPLEX

METALS Micrograms per liter (µg/L)										
Analyte	**Date**	**MW14**	**MW15**	**MW101**	**MW102**	**MW103**	**MW104**	**MW105**	**MW106**	**MW107**

Notes:

"--" — Analyte was nondetect

µg/L — Micrograms per liter

MW — Monitor well

NA — Not analyzed

SUMMARY OF LABORATORY ANALYTICAL RESULTS
SAND SPRINGS PETROCHEMICAL COMPLEX

SEMIVOLATILE ORGANICS (µg/L)										
Analyte	**Date**	**MW14**	**MW15**	**MW101**	**MW102**	**MW103**	**MW104**	**MW105**	**MW106**	**MW107**
Anthracene	12/95	--	--	--	--	--	--	--	--	--
	3/96	--	--	--	--	--	--	--	--	--
	6/97	--	--	--	--	--	--	--	--	--
	6/98	--	--	--	--	--	--	--	--	--
	6/99	--	--	--	--	--	--	--	--	--
	6/00	--	--	--	--	--	--	--	--	--
	6/01	--	--	--	--	--	--	--	--	--
	7/02	--	--	--	--	--	--	38.6	--	--
	6/03	--	--	--	--	--	--	--	--	--
	6/04	--	--	--	--	--	--	--	--	--
Chrysene	12/95	--	--	--	--	--	--	--	--	--
	3/96	--	--	--	--	--	--	--	--	--
	6/97	--	--	--	--	--	--	--	--	--
	6/98	--	--	--	--	--	--	--	--	--
	6/99	--	--	--	--	--	--	--	--	--
	6/00	--	--	--	--	--	--	--	--	--
	6/01	--	--	--	--	--	--	--	--	--
	7/02	--	--	--	--	--	--	1030	--	--
	6/03	--	--	--	--	--	--	--	--	--
	6/04	--	--	--	--	--	--	--	--	--
Fluorene	12/95	--	--	--	--	--	--	--	--	--
	3/96	--	--	--	--	--	--	--	--	--
	6/97	--	--	--	--	--	--	--	--	--
	6/98	--	--	--	--	--	--	--	--	--
	6/99	--	--	--	--	--	--	--	--	--
	6/00	--	--	--	--	--	--	--	--	--
	6/01	--	--	--	--	--	--	--	--	--
	7/02	--	--	--	--	--	--	15	--	--
	6/03	--	--	--	--	--	--	--	--	--
	6/04	--	--	--	--	--	--	--	--	--
2-Methyl-	12/95	--	--	--	--	--	100	--	--	--
napthalene	3/96	--	--	--	--	--	--	--	--	--
	6/97	--	--	--	--	--	18	--	--	--
	6/98	--	--	--	--	--	110	--	--	--
	6/99	--	--	--	--	--	520.8	--	--	--
	6/00	--	--	--	--	--	--	--	--	--
	6/01	--	--	--	--	--	--	--	--	--
	7/02	--	--	--	--	--	--	--	--	--
	6/03	--	--	--	--	--	11.9	--	--	--
	6/04	--	--	--	--	--	--	--	--	--

SUMMARY OF LABORATORY ANALYTICAL RESULTS
SAND SPRINGS PETROCHEMICAL COMPLEX

SEMIVOLATILE ORGANICS (µg/L)										
Analyte	**Date**	**MW14**	**MW15**	**MW101**	**MW102**	**MW103**	**MW104**	**MW105**	**MW106**	**MW107**
Naphthalene	12/95	--	--	--	--	--	--	--	--	--
	3/96	--	--	--	--	--	--	--	--	--
	6/97	--	--	--	--	--	--	--	--	--
	6/98	--	--	--	--	--	--	--	--	--
	6/99	--	--	--	--	--	--	--	--	--
	6/00	--	--	--	--	--	--	--	--	--
	6/01	--	--	--	--	--	--	--	--	--
	7/02	--	--	--	--	--	--	11.7	--	--
	6/03	--	--	--	--	--	--	--	--	--
	6/04	--	--	--	--	--	--	--	--	--
Phenanthrene	12/95	--	--	--	--	--	--	--	--	--
	3/96	--	--	--	--	--	--	--	--	--
	6/97	--	--	--	--	--	--	--	--	--
	6/98	--	--	--	--	--	--	--	--	--
	6/99	--	--	--	--	--	--	--	--	--
	6/00	--	--	--	--	--	--	--	--	--
	6/01	--	--	--	--	--	--	--	--	--
	7/02	--	--	--	--	--	--	38.9	--	--
	6/03	--	--	--	--	--	--	--	--	--
	6/04	--	--	--	--	--	--	--	--	--

Notes:

"--" — Analyte was nondetect

µg/L — Micrograms per liter

MW — Monitor well