Luke Waterdog Recreation Annex

Department of Defense (DoD) Site

Boundaries:

Luke Waterdog Recreational Annex (Waterdog) (the Site) is located on 26 acres of land on the east side of Apache Lake in Maricopa County, Arizona approximately 0.5-mile west of Arizona Highway 88 (Apache Trail). The site is located at approximately 1,940 feet above mean sea level (AMSL); normal lake elevation is reported at 1,914 feet AMSL.

Site of Former Water Dog Boat Docks

Site Status Update:

While Luke Air Force Base (AFB), which is currently responsible for the Site, is not eligible for Leaking Underground Storage Tank (LUST) program case closure or the monitored natural attenuation (MNA) program because it is a government entity, it is proceeding on a voluntary basis to meet the intent and follow procedures as outlined in the MNA program. To document that natural attenuation is occurring at the Waterdog Site, the groundwater plume will be adequately characterized with groundwater sampling that reflects historic changes and trends in the contaminants of concern (COC) concentrations, and a determination that decreasing COC concentrations are due to natural attenuation and not due to water table fluctuations. To support this effort, new groundwater monitor wells will be installed in the project area.

Community Involvement Activities:

There is no community involvement activity associated with this site at this time.

Site History:

1957-1958: Williams Air Force Base (Williams AFB) received a special use permit for the Waterdog property in 1957 from the National Forest Service (NFS) to be used for the enjoyment of military personnel stationed at the base. Several buildings, including the recreational building, 21 cabins, the maintenance building, two maintenance sheds, and the old water treatment shed were built in 1958. A floating dock was constructed at the lake shore directly in front of the recreational building. A fuel pump was located near the floating dock for boat refueling.

1979-1984: Four underground storage tanks (USTs) with piping to the boat dock were constructed and added to the complex. The USTs were used to store gasoline and pre-mix for the

boating operation and consisted of one 3,750-gallon regular gasoline UST, one 2,000 - gallon mixed gas/oil UST, and two 550-gallon mixed gas/oil USTs. Two aboveground storage tanks (ASTs) were located approximately 500 feet east-southeast of the USTs. In the early 1980s, 18 of the 21 cabins were torn down, and new slump block cabins were built in their place.

1991: In June, Williams AFB personnel noticed a strong fuel odor and sheen on Apache Lake, as well as stained soil within the UST valve vault. Sorbent booms were installed to contain any fuel that may have leached into the lake. The release was reported to the Arizona Department of Environmental Quality (ADEQ) (Report Number 91-056-A) and a leaking underground storage tank (LUST) number (LUST 4715.1933.01 to 03) assigned. In December, approximately 135 cubic yards of petroleum contaminated soil were excavated, disposed at a licensed disposal facility (Century Materials), and the excavation was backfilled with clean fill.

1993: Williams AFB was Congressionally-mandated to close on September 30. Waterdog was then closed to visitors and Luke AFB assumed responsibility for the complex.

1994: A field investigation was completed at the Site to determine the extent of soil contamination. The investigation consisted of a soil gas survey, drilling, and sampling of soil borings. This investigation indicated subsurface petroleum hydrocarbon soil contamination exists. 30 soil gas survey points were sampled at the UST and AST sites, each point were analyzed for BTEX. Based on results of the soil gas survey, a total of five boreholes (four at UST site and one at the AST site) were drilled and then sampled. A Preliminary Site Characterization report, was issued in May.

1995 – 1996: In order to remediate the contaminated soils at the site a soil bioventing system was installed, and operated. Remediation of the soils at the site using bioventing began in June 1995. The bioventing system consisted of a single air injection well, one background well, and two vapor monitoring wells. The injection well was 15 feet deep. The bioventing system operated from June 1995 to January 1996.

In January 1996, groundwater and surface water samples were collected from monitoring wells and Apache Lake. The samples were analyzed for BTEX. Benzene was detected above state standards in one of the wells. BTEX compounds were not detected in the surface water sample.

1997: In March, the bioventing system was converted to a soil vapor extraction (SVE) system and operated until May. Soil vapors were extracted at a rate of 34 standard cubic feet per minute (scfm) for 35 days. After 35 days, vapor samples were collected and no volatiles were detected in the vapors. The soil bioventing/SVE system was shut down in May.

1999: On July 30, groundwater samples were analyzed for BTEX, total petroleum hydrocarbons (TPHs), and attenuation parameters (nitrate, sulfate, and alkalinity). The results indicated that the sampled monitoring wells had TPH concentrations in excess of Arizona Aquifer Water Quality Standards (AWQS). Methane levels were found to be elevated in all wells, which may indicate that degradation of hydrocarbons due to aerobic activity was occurring at the site.

Weathered Granite at Water Dog

2001: A passive soil gas survey was conducted in February and March. The primary goal of the survey was to screen locations for additional monitoring wells. In general, the survey results documented low levels of hydrocarbons in the soil gas. Based on these results, three additional monitoring well locations were selected at distances 150-200 feet from the former LUST. Three additional groundwater monitoring wells were installed at the site in April.

Installation of the SVE system was initiated on June 5. The SVE design included a 100 cfm electric catalytic oxidation unit (catox), along with well head modifications, three pneumatic groundwater submersible pumps, air compressor, two-inch PVC surface piping, and one-inch air line and water line piping. The SVE was intended to operate in conjunction with groundwater pumping, in order to influence the bedrock aquifer. Based on groundwater monitoring results, and historic lake level information, it was believed that gasoline hydrocarbons had become smeared in the weathered/fractured bedrock below the water table. At that time, the smear zone was submerged, and acted as a continuing source of dissolved benzene. Groundwater pumping was intended to dewater the bedrock, allowing vacuum flow to volatilize and capture hydrocarbon vapors within the system's radius of vacuum influence (ROI). The vapors would be oxidized by the catox unit, which was the primary component of the SVE system.

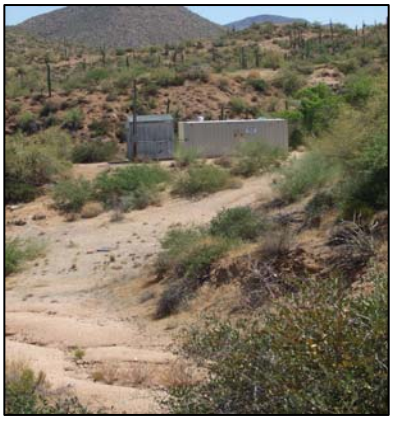
In October, an electric catox unit, air compressor, and power drop were installed at site. The system was started in November. At start up, the initial influent air concentrations contained approximately 500 parts per million per unit volume (ppmv) volatile fuel hydrocarbons (VFH).

2002: The system operated using the submersible pumps through the second quarter of the year. Influent concentrations ranged from 300-500 ppmv VFHs. The system proved effective at the site; however its efficiency was greatly dependent on the dewatering component, which was limited by the depths of available wells. As a result, only a fraction of the smear zone could be dewatered.

The second system configuration involved SVE and dewatering was implemented in the third quarter of the year. Under this configuration, atmospheric air was drawn into the drop tube using formation vacuum. The sparge configuration results were mixed. The initial response was effective due to the temporary volatilization of dissolved phase contaminants which increased influent vapor concentrations. However, the sparge tubes could be submerged no deeper that 15-17 inches in each well, due to limited total vacuum.

A Complex Resistivity (CR) survey was conducted in November. Resistivity was mapped in ten foot "slices" of the aquifer from depths of 25 to 55 feet bgs. The results of this mapping identified preferentially fractured zones near the former UST location. These zones were targeted for installation of monitoring wells, and MW-8 and MW-9. MW-8 and MW-9 were installed in

December. Optical televiewer logs were run in both wells to identify lithology, degree of fracturing, and orientation of fracturing.



SVE System

2003 - 2005: Two Phase Extraction (TPE) (Bioslurper) system component was installed in March of 2003, was fully operational in October 2003, and continued to operate until September 2005. The TPE component included a five horsepower liquid ring pump, slurp tubes, surface piping, manifold and controls. A liquid ring pump is essentially a highly efficient blower, capable of gas and simultaneous fluid (water and LNAPL) extraction.

In an effort to quantify aquifer parameters and LNAPL behavior, a bail down testing was conducted. Bail down testing for LNAPL thickness recovery was conducted in March 2003.

In accordance with Maricopa County Air Permit air sampling was conducted in February & May 2005. The system oxidized approximately 53 pounds of hydrocarbons in 2005. During 2005, four wells were plumbed to the SVE system. Two wells were plumbed to the TPE "slurping" component.

2007: In February, four 120-foot long refraction seismic surveys were completed. A 12-channel signal enhancement seismograph and geophone array was deployed at 10-foot spacings. Both compression (p-wave) seismic refraction data and surface wave for shear wave (s-wave) refraction microtremor (Remi) data was collected. In general, a layer of low velocity material is indicated to be present across the site to depths of about 1 to 20 feet. Results were consistent with a deeper horizon within the alluvium that is more highly weathered and fractured, or perhaps even faulted, than the overlying portion of the weathered rock mass.

Luke AFB and the Air Force Center for Engineering and the Environment (AFCEE) planned to implement a blast-enhanced fracturing (BEF) program at Waterdog to increase the connectivity and conductivity of the fractured bedrock formation underlying the Site. The BEF approach utilized explosive charges installed in strategically located borings at the site which, when detonated, would cause the rock to crumble and crack, creating a greater hydraulic and pneumatic transmissivity. A Remedial Action Work Plan (RAWP) was prepared for these activities and submitted to ADEQ late in 2006 for review and approval. After extensive discussion between ADEQ and Luke AFB, it was subsequently decided that a BEF program would not be executed and other remediation strategies would be evaluated.

2008 - 2009: Luke AFB and ADEQ agreed upon a No Further Action (NFA) with Monitored Natural Attenuation (MNA) project approach going forward that included two initial phases of site characterization fieldwork, followed by eight quarters of long-term groundwater monitoring. A Site Characterization Work Plan (SCWP), Sampling and Analysis Plan (SAP) and Health and Safety Plan (HASP) that addressed the performance of the following tasks was submitted:

- Monitoring well maintenance and replacement program
- Soil boring installation and soil sampling and analysis
- Installation of additional monitoring wells

- Groundwater sampling and analysis
- Surface water sampling and analysis

2010: Additional groundwater monitoring wells were installed at the Site to further define the release of petroleum hydrocarbons. Further soil and sediment samples from Apache Lake were collected in the effort to comply with the UST closure requirements. The leaked fuel is primarily contained in fractured granite bedrock that exists below the site. (The well network will be integral in evaluating natural attenuation of the hydrocarbons at the site.

Contaminants:

The current contaminants of concern in groundwater are TPH, benzene, toluene, ethylbenzene, and xylenes (BTEX). Contaminants of concern at the site may change as new data become available.

Public Health Impact:

There is no known risk to human health at this time. All exposure pathways have been eliminated through remediation or restricted access/use.

Site Hydrogeology/Geology:

Depth to groundwater at the Site ranges from 14 to 27 feet bgs, and likely fluctuates according to the rise and fall of the water level in Apache Lake. Based on the topography of the Site, and the close proximity of the lake, groundwater flow direction at the site is likely dependent on the elevation of the lake. The groundwater elevation contour map generated from data gathered during this investigation indicates that groundwater flows to the southeast, away from the lake. Apache Lake is therefore, a "losing" lake.

Waterdog is situated on granitic bedrock and weathered granite. Based on the drilling logs, the local geology consists of approximately 4 to 7 feet of silt and/or sand, underlain by alternating weathered and less weathered granitic bedrock. The bedrock has no primary permeability and moderate to high secondary permeability from fractures.

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Information Repository:

Interested parties can review site documents at ADEQ Main Office located at 1110 W. Washington Street in Phoenix. Please contact (602) 771-4380 or (800) 234-5677 to schedule an appointment with 24-hour notice to review these documents. Once all documents requested have been collected, you will be contacted for a review Monday through Friday from 8:30 a.m. to 4:30 p.m. at the ADEQ Records Management Center, 1110 W. Washington Street in Phoenix, AZ.