1225742

Final
RECORD OF DECISION AMENDMENT

OPERABLE UNIT 11/BASEWIDE GROUNDWATER

For Remedial Action at:

Ellsworth Air Force Base, South Dakota

Prepared by:

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February 2012

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1.0 INTRODUCTION

1.1 STATEMENT OF PURPOSE

This Record of Decision (ROD) Amendment presents changes to the remedial decisions documented in the 1997 ROD (United States Air Force [USAF], 1997) for remedial action at Operable Unit (OU) 11, Basewide Groundwater. The selected remedy in the 1997 ROD is amended in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986, and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

The primary remedial technology for on-Base groundwater treatment at OU-11, as documented by the 1997 ROD (USAF 1997), groundwater extraction and treatment, has limited capability to reduce contaminant concentrations in the groundwater plumes. In-situ bioremediation was implemented on a full scale basis in accordance with a 2007 Explanation of Significant Difference (ESD) (USAF 2007) and has been shown to be an effective remedy for the contaminants in groundwater at Ellsworth Air Force Base (AFB). The Air Force, South Dakota Department of Environment and Natural Resources (SDDENR),and the United States Environmental Protection Agency (EPA) Region 8 recommend that the remedy for OU-11 Basewide Groundwater be changed from active treatment with in-situ reductive treatment (IRT) and monitored natural attenuation (MNA) to IRT and MNA.

1.2 SITE NAME AND LOCATION

Ellsworth AFB is a USAF Air Combat Command installation located 12 miles east of Rapid City, South Dakota and adjacent to the City of Box Elder (see Figure 1-1). The Base is situated on approximately 4,858 acres in Meade and Pennington Counties, and includes runways, airfield operations, industrial areas, housing, and recreational facilities. Open land containing individual residences lies to the north, south, and west of Ellsworth AFB, while residential and commercial areas lie to the east.

The location of the OU-11 Basewide Groundwater Plumes is shown on Figure 1-2. A site description is provided in Section 2 of this ROD Amendment.

1.3 LEAD AND SUPPORT AGENCIES

The USAF is the lead agency. EPA Region 8 is the lead regulatory agency and a support agency and SDDENR is a support agency.

1.4 STATUTORY CITATION FOR A RECORD OF DECISION AMENDMENT

Section 117(c) of CERCLA, 42 United States Code (USC) §9617(c), and the NCP at Title 40 Code of Federal Regulations (40 CFR) §300.435(c)(2)(ii), require that when a fundamental change is made to the basic features of the remedy selected in a ROD with respect to scope, performance, or cost, the lead agency is required to develop and document the change consistent with the ROD process. This entails the issuance of a revised Proposed Plan that highlights the proposed changes. This amended ROD that documents the changes follows the Proposed Plan.

1.5 DATE OF RECORD OF DECISION

The ROD for OU-11 was issued in April 1997 (USAF 1997). The OU-11 ROD was signed by the USAF on April 23, 1997; by the EPA on April 28, 1997; and by the SDDENR on April 29, 1997.

1.6 ADMINISTRATIVE RECORD

This ROD Amendment is supported by and, when issued, will become part of the Administrative Record file for the Base, in accordance with the NCP at 40 CFR §300.825(a)(2).

The Administrative Record is available to the public Monday through Friday from 7 a.m. to 4 p.m. at:

South Dakota Air & Space Museum
2890 Davis Drive, Bldg 5208
Ellsworth AFB, SD 57706
605-385-5188

Or by appointment at the Base environmental office:

Ellsworth AFB Environmental Restoration Program
28th Civil Engineer Squadron Office
2125 Scott Drive, Building 8225
Ellsworth AFB, SD 57706
605-385-2677

2.0 SITE HISTORY AND SELECTED REMEDY

The USAF initiated environmental investigations at Ellsworth AFB in 1985. On August 30, 1990 (55 FR 35509), Ellsworth AFB was listed on the EPA's National Priorities List (NPL). A Federal Facilities Agreement (FFA) was signed in January 1992 and went into effect on April 1, 1992 (USEPA 1992). Parties to the FFA include the USAF, EPA Region 8, and the State of South Dakota.

A total of 12 OUs were identified at Ellsworth AFB, including OU-11 Basewide Groundwater. The following discussions summarize information from the 2011 OU-11 Basewide Groundwater Focused Feasibility Study (FFS) (URS 2011c) and present the site history, nature and extent of contamination at OU-11 Basewide Groundwater as well as the selected remedy from the OU-11 ROD.

2.1 SITE HISTORY AND CONTAMINATION

OU-11 originally provided for a study of the overall Base groundwater quality and characteristics. Investigations and remedial action decisions for groundwater contamination at several sites not specifically included in other OUs were included in OU-11. Groundwater from OU-9 (Old Auto Hobby Shop) and OU-10 (North Hanger Complex) was assigned to OU-11 as documented in the RODs for OU-9 (USAF 1996b) and OU-10 (USAF 1996c).

The April 1997 OU-11 ROD divided OU-11 into Area 1 (the South Docks Study Area in the central portion of the Base) and Area 2 (the BG04 Study Area at the northeast edge of the Base and the BG05 Study Area in a housing area in the east central portion of the Base). The current groundwater plume associated with Area 1 is the Pride Hangar/South Docks Main plume. Current groundwater plumes associated with Area 2 are the Small Arms Range (SAR), BG04, Spearfish Avenue, Scott Drive and Twining/Risner-BG05 Plumes. Since all of the groundwater contaminant plumes are now addressed under OU-11, they will be identified as individual plumes within OU-11and the plumes will no longer be assigned to Area 1 or Area 2.

A Memorandum for Record in July 2005 (USAF 2005a) and an ESD in 2007 (USAF 2007) officially transferred groundwater from all other areas of the site to OU-11. The groundwater transfer to OU-11 involved the following OUs at Ellsworth AFB (see Figure 2-1 for OU locations):

- OU-1 (Fire Protection Training Area)
- OU-2 (Landfills No. 1 and No. 6)
- OU-3 (Landfill No. 2)
- OU-4 (Landfill No. 3)
- OU-5 (Landfill No. 4)
- OU-6 (Landfill No. 5)

- OU-7 (Weapons Storage Area)
- OU-8 (Explosives Ordnance Disposal Area)
- OU-12 (Hardfill No. 1)

The 2007 ESD focused on remediation of groundwater containing chlorinated volatile organic compounds (VOCs) at Ellsworth AFB. Trichloroethene (TCE) and cis-1,2-dichloroethene (cis-1,2-DCE) are the most frequently reported chlorinated VOCs in groundwater at Ellsworth AFB. In the past, TCE was used as a cleaning solvent, and cis-1,2-DCE is a degradation product produced by the degradation of TCE. Other, less frequently detected chlorinated VOCs, including tetrachloroethene (PCE), 1,1-DCE, and vinyl chloride (VC), have been detected in some groundwater samples at the Base.

In addition to the chlorinated plumes at OU-11, the OU-1 Main groundwater plume contains a mix of solvent related contaminants and fuel related contaminants. Fuel related contaminants at the OU-1 Main plume include benzene, toluene, ethylbenzene, xylene (BTEX) and total petroleum hydrocarbons.

The locations, as shown on Figure 1-2, of the chlorinated VOC and mixed solvent/fuel related plumes in groundwater at OU-11 include:

- OU-1 Main and East Plumes
- OU-2 Plume
- OU-4 Centerline and South Plumes
- OU-7 Plume
- Small Arms Range Plume
- BG04 Plume
- Spearfish Avenue Plume
- Scott Drive Plume
- Twining/Risner-BG05 Plume
- Pride Hangar/South Docks Main Plume
- OU-12 Plume
- OU-11 Off-Base Plume

Site descriptions for groundwater that is part of OU-11 are provided in the following sections.

2.1.1 OU-1 Main Plume and OU-1 East Plume

2.1.1.1 OU-1 Background

OU-1 covers an area of approximately 10 acres and is located in the southwestern portion of Ellsworth AFB (see Figure 2-1). The site includes the closed Fire Protection Training Area (FPTA), Pond 001, and a portion of the drainage channel that leads to Pond 001. OU-1 is situated on a local topographic high, and the site is currently vegetated with grass and contains numerous wells for remediation and monitoring. OU-1 is bordered to the north by the new FPTA, to the east by the Alert Apron, to the west by OU-4 (a landfill site), and to the south by OU-2 (a landfill site). The current land use at OU-1 is listed as airfield clearance. Future land use is listed as aircraft operations and maintenance. Groundwater at the site is not currently used as a drinking water source.

OU-1 is the Base's FPTA that operated from 1942 to 1990. The FPTA consisted of a centrally-located, unlined, and bermed burn pit with a steel aircraft mockup, and a second, smaller shallow burn pit in the southwest corner, all enclosed by a perimeter fence. The location of the burn pits changed several times over the years, based on review of aerial photographs. The fire training exercises involved simulation of spills and aircraft fires whereby fuel was dispensed into a shallow burn pit, ignited, and extinguished. The fuel used in these exercises prior to 1984 consisted primarily of waste Jet Propulsion Fuel No. 4 (JP-4), but also included waste oils that apparently contained small amounts of solvents. Clean JP-4 fuel was reportedly used between 1984 and 1990. Extinguishing chemicals used during the fire training exercises have included aqueous film-forming foam, Halon, protein foams, carbon dioxide, dry chemicals, and chlorobromomethane.

A new FPTA was constructed to the northeast of the OU in 1992; however, this was not done as a remedial response action. The tanks and pipelines associated with the old FPTA were removed at this time.

2.1.1.2 Nature and Extent of Contamination

Two groundwater contaminant plumes have been historically recognized at OU-1. The OU-1 Main Plume is the larger of the two plumes at OU-1 and is the primary area of groundwater contamination at the FPTA. Groundwater in the plume contains dissolved fuel and solvent-related contaminants. The plume length is 950 feet along an axis which trends from north to south and a downgradient plume finger extends to the southeast. The plume is 450 feet wide at the north end and 75 feet wide at the downgradient plume finger.

A smaller OU-1 East Plume has been recognized near monitoring well MW930107. Groundwater in the plume contains solvent related contaminants. The plume is 100 feet long and nearly symmetrical with an axis trending from north-northwest to south-southeast.
The VOC and fuel-related contaminant concentrations from the April 2011 long term monitoring (LTM) event are shown on Figures 2-2 through 2-4.

2.1.1.3 Remedial Actions

Several remedial technologies have been implemented at OU-1, including:

- Dual-phase extraction (DPE)/groundwater extraction
- Soil vapor extraction (SVE)

- High vacuum extraction (HVE)
- Collection trenches
- Groundwater treatment, including air stripping and granular activated carbon (GAC)
- Institutional controls (IC)
- Long-term groundwater monitoring
- IRT
- Bioventing
- Biosparging
- Oxygen infusion
- Re-injection trenches

The interim remedial action (IRA) for OU-1 was constructed between July 1995 and May 1996. The final regulatory inspection of the system was on 2 July 1996 and the EPA determined that the IRA was functional and operational. The IRA consisted of four DPE wells, eight SVE wells and a groundwater interceptor trench. Groundwater from the extraction wells (EWs) and trench are conveyed to a treatment system in Building 6908. The IRA treatment system consisted of oil/water separation, equalization/staging, air stripping, a thermal oxidizer, and GAC. The January through March 2010 Remedial Action – Operations (RA-O) Report (URS 2011d) includes the monthly average influent flow rates and concentrations, which are summarized over the past year of operation.

The Final Remedial Action expanded on the existing IRA system with construction occurring between September 1996 and January 1997. Components added during the Final Remedial Action include four additional DPE wells, 13 additional groundwater EWs, four additional SVE wells, and installation of a DPE trench. An additional two groundwater EWs were installed between July 2003 and November 2003. The 2007 ESD allowed the use of additional treatment technologies such as IRT, bioventing, biosparging, and oxygen infusion.

2.1.2 OU-2 Plume

2.1.2.1 OU-2 Background

OU-2 consists of two Landfills (No. 1 and No. 6, both closed) that were combined into a single OU because of their proximity (Figure 2-5).

Landfill No. 1 covers an area of approximately 20 acres and is located along the southern boundary of Ellsworth AFB, south of the Alert Apron. The landfill is grass covered. Pond 001 is located on the south edge of OU-1 just northwest of OU-2, and drainage from Pond 001 flows through a ditch along the west side of Landfill No. 1 and then south off Base. Surface water drainage from Landfill No. 1 is mostly to the ditch along the west side of the landfill. Drainage from Pond 001 and Landfill No. 1 ultimately flows into Box Elder Creek. Landfill No. 1 was

active from the early 1940s to 1964 and included disposal of a variety of wastes including Base refuse, incinerator ash, sludge, oil, and possibly liquid industrial wastes. Hardfill debris was also disposed of at Landfill No. 1. Waste at Landfill No. 1 remains in place.

Landfill No. 6 covers an area of approximately 0.5 acre and is located south of the Alert Apron. The western 10 percent of the site is under an asphalt parking lot. The part of Landfill No. 6 that is not covered by asphalt is grass covered. Landfill No. 6 is northeast of Landfill No. 1 and west of Pond 002. Drainage from Pond 002 and Landfill No. 6 is ultimately to Box Elder Creek. Landfill No. 6 was active from 1962 to 1965 and primarily received general Base refuse. Waste at Landfill No. 6 remains in place.

Current use is listed as airfield clearance. Future land use is listed as industrial. Groundwater at the site is not currently used as a drinking water source.

Wetlands are present and consist of a retention pond (Pond 002) located east of Landfill No. 6 and the drainage from Pond 001 located along the west edge of Landfill No. 1. The United States (U.S.) Fish and Wildlife Service (2009) national wetland inventory classified the wetland community types present on OU-2 as Palustrine Emergent Seasonally Flooded and Palustrine Aquatic Bed Semi-permanently Flooded.

2.1.2.2 Nature and Extent of Contamination

A small groundwater plume at Landfill No. 1 is the primary area of contamination. This plume contains dissolved TCE and its degradation products. The axis of the plume extends 400 feet from the north central area of Landfill No. 1, south-southeast toward the southern boundary of Landfill No.1. The plume width varies from 100 to 200 feet wide.

There is no groundwater contamination associated with Landfill No. 6.

All chemicals detected in groundwater or surface water during the April 2011 LTM event are shown on Figure 2-5.

2.1.2.3 Remedial Actions

Groundwater remediation was not part of the selected remedy at OU-2; however, the presence of TCE in groundwater at Landfill No. 1 was addressed by the installation of three groundwater EWs (EW0114, EW0115, and EW0116) downgradient (south) of the OU-2 Plume. These EWs were installed in March 2004 as an extension of the OU-1 groundwater extraction and treatment system. The groundwater was pumped to the treatment system at Building 6908. All three EWs are currently off and rebound monitoring is in progress, with the most recent samples collected in October 2010.

A long-term groundwater monitoring plan, that was reviewed and approved by the EPA and the State of South Dakota, was implemented beginning in April 1997. Long-term groundwater monitoring has been ongoing since April 1997 and the LTM plan was updated in 2010 (URS 2010a). Although there is no groundwater contamination associated with Landfill No. 6, groundwater and surface water monitoring is conducted to evaluate the effectiveness of the landfill cover.

As allowed by the 2007 ESD, an IRT zone and wall were established in 2008 at OU-2 using direct push technology (URS 2009a). An additional IRT zone was established along the southern boundary of OU-2 in 2011. The locations of the IRT zones are shown on Figure 2-5.

In addition, a fuel line rupture occurred immediately south of Landfill No. 1 in 1989. The rupture and fuel release were unrelated to landfill activities. This spill was cleaned up under South Dakota petroleum release regulations. Elements of the remediation system remain in place. Dual phase and soil vapor extraction wells, and piping are planned for abandonment in 2011, along with demolition of the blower building.

2.1.3 Groundwater at OU-3 (Landfill No. 2)

2.1.3.1 OU-3 Background

OU-3 consists of a closed landfill (Landfill No. 2) and includes a burn pit and fill area approximately one acre in size, and four landfill trenches immediately north of the burn pit (Figure 2-6). The area is located in the northeast portion of the Base. The land surface slopes east, and ephemeral drainages carry intermittent runoff to Elk Creek to the north. OU-3 is undeveloped and is covered by relatively undisturbed grassland.

Access is restricted to Base personnel and contractors. Current land use is listed as open space/buffer zone. Future land use is listed as open space. Groundwater is not used at OU-3.

Landfill No. 2 was active for approximately one year (1964-1965) and included disposal of metal, industrial and household refuse in the fill area and landfill trenches. Combustible trash described as shop waste was burned daily in a burn pit. Waste at Landfill No. 2 remains in place.

2.1.3.2 Nature and Extent of Contamination

Soil samples collected from OU-3 during the OU-3 Remedial Investigation (RI) (USAF 1995b) contained acetone, acetonitrile, benzene, TCE, 1,1-dichloroethane (1,1-DCA), DCE, VC, jet fuel, semi-volatile organic compounds (SVOCs), and pesticides. Groundwater samples contained PCE, TCE, DCE, and BTEX at concentrations below maximum contaminant levels (MCL), and VC and 1,2-dichloroethane (1,2-DCA) at concentrations that exceeded their respective MCLs. Sporadic reported concentrations of VOCs did not support existence of groundwater plumes. Groundwater sampling was selected to monitor the degradation of VOCs in the groundwater. Selenium was detected in groundwater at one sample location at a concentration above its MCL, and arsenic was detected at a concentration that exceeded its background concentration. Both arsenic and selenium were considered to be naturally occurring compounds unrelated to landfill operations but they were included in risk calculations. There is no groundwater plume associated with Landfill No. 2.

Four monitoring wells were sampled and analyzed for VOCs as part of the April 2010 LTM sampling event. No chemicals of concern (COCs) were detected in the analyses. Results and monitoring wells are shown on Figure 2-6. Groundwater is collected and analyzed on a biennial basis; therefore, no analytical results are available from April 2011.

2.1.4 OU-4 Plumes (OU-4 South, OU-4 Southwest & OU-4 Centerline)

2.1.4.1 OU-4 Background

OU-4 consists of a closed landfill (Landfill No. 3) and occupies approximately 40 acres in the southwest part of the Base (Figure 2-7). The ground surface is fairly level with a slight slope to the south and east. The western part of OU-4 slopes slightly to the west. Landfill No. 3 is covered by grasses. Surface drainage is primarily off Base toward the south. The surface drainage to the west is mostly sheet flow that collects in a roadside ditch along Kenney Road. Surface drainage to the south is also mostly sheet flow off Base to a small unnamed ephemeral stream that has a holding pond behind a small dam approximately 750 feet south of the Base boundary. All surface drainage from Landfill No. 3 ultimately flows to Box Elder Creek.

Access to Landfill No. 3 is restricted to Base personnel and contractors responsible for the maintenance of the landfill cover and operation of the remedial systems. Current land use is listed as open space/buffer zone. Future land use is listed as industrial. Groundwater is not used at OU-4. Landfill No. 3 is predominately grassland habitat, much of which has been disturbed by human activities such as past landfill operation and current maintenance.

Landfill No. 3 was operated from 1965 to 1976 using trench and fill methods. For the first few years, wastes were burned prior to burial. Disposal trenches were approximately 13 feet to 15 feet deep. Shops waste (liquids and paints), industrial sewer sludge and oils, and miscellaneous refuse were disposed in the landfill. During the mid-1970s, a waste oil pit was located in the southwest corner of the landfill. The contents of approximately 100 55-gallon drums containing waste oil and diesel fuel were placed in the waste oil pit. Prior to 1982, the southwest corner of Landfill No. 3 was also used as a staging area for 55-gallon drums containing waste oil and fuel. The exact locations of the waste oil pit and the drum staging area are not known but it was assumed that both were in the vicinity of a waste asphalt pile (removed from OU-4 in 1993). During 1982 and 1983, Landfill No. 3 was used as a disposal site for soils containing sodium chromate and the herbicide Pramitol™ (chemical name prometon). Wastes at OU-4 remain in place.

2.1.4.2 Nature and Extent of Contamination

Three groundwater contaminant plumes have historically been recognized at OU-4: the OU-4 South Plume, the OU-4 Southwest Plume and the OU-4 Centerline Plume.

The OU-4 South Plume emanates from the southeast corner of the landfill (Figure 2-7) and contains dissolved chlorinated VOCs, primarily TCE and cis-1,2-DCE. The groundwater plume is 3,500 feet long and generally less than 300 feet wide, with a north-south axis from Landfill No. 3 south for 2,000 feet and a southeast axis continuing 1,500 feet to the terminus of the plume. The distal end of the plume extends up to 400 feet east of the Base boundary onto private property.

The OU-4 Southwest Plume extended approximately 400 feet south-southwest of the southwest corner of the landfill onto private property and contained dissolved chlorinated VOCs. The wells used to monitor the Southwest Plume no longer exceeded MCLs for TCE or VC as of the April 2005 LTM Report. Extraction wells EW0401 through EW0408, located at the west end of the southern boundary of Landfill No. 3, were permanently shut off as of February 2003.

The OU-4 Centerline Plume is centered on EW0410 (Figure 2-7), near the center of the southern boundary of Landfill No. 3 and contains primarily dissolved cis-1,2-DCE. The plume is 200 feet long and 100 feet wide with a north-south axis.

The chemicals detected during the April 2011 LTM event and concentration contours for TCE are shown on Figure 2-8.

2.1.4.3 Remedial Actions

Remedial technologies that have been implemented at OU-4 Plumes include:

- Groundwater extraction
- Groundwater treatment, including air stripping and GAC
- ICs
- Long-term groundwater monitoring
- IRT

The IRA for OU-4 was constructed between June 1995 and August 1996 and included eight EWs and IC implementation. Groundwater from the EWs is conveyed to a treatment system in Building 6908 as described for OU-1. The Final Remedial Action expanded the existing IRA extraction system with 17 additional EWs, landfill cap and fencing, implementation of ICs, and property acquisition. Construction of the Final Remedial Action began in June 1996 with the remedial action final construction inspection in April of 1997.

A treatability study began at OU-4 in 2005 (Earth Tech 2006). The results of this study indicated the IRT process was a viable remediation technique. Additional treatability study work was completed that included bench and field testing (URS 2007c). Field tests were completed at three locations, including one location at OU-4. As allowed by the 2007 ESD, full-scale IRT implementation began in 2007 and was expanded in 2008. There are currently 10 IRT zones at OU-4. Many IRTs have had re-injections to maintain the effectiveness and others have had extensions to the original IRT based on LTM and performance monitoring results. IRT Remedial Action Work Plan (RAWP) 5 provides details for re-injection at several existing IRT walls to enhance their performance (URS 2009a). The locations of the IRTs for the OU-4 Plumes are shown on Figure 2-7.

2.1.5 Groundwater at OU-5 (Landfill No. 4)

2.1.5.1 OU-5 Background

OU-5 consists of a closed landfill (Landfill No. 4) and covers approximately 10 acres in the northeast portion of the Base (Figure 2-9). The southern part of the landfill slopes to the south, the northern part slopes steeply to the northeast, and the western part slopes to the west. The area is grass covered. Several incised valleys are immediately north and east of Landfill No. 4. These carry surface runoff north and northeast to several unnamed ephemeral tributaries of Elk Creek.

Access is restricted to Base personnel and contractors. Current land use is listed as open space/buffer zone. Future land use is listed as open space. Groundwater is not used at OU-5.

Landfill No. 4 is an abandoned gravel pit that has been filled with mostly construction rubble and debris. However, it was reported that the landfill was also used for disposal of general refuse and drums. The landfill was active from the 1940s to 1990. Waste disposed of in the landfill remains in place.

2.1.5.2 Nature and Extent of Contamination

Jet fuel, polynuclear aromatic hydrocarbons, and pesticides were reported in soil samples collected at OU-5 during the RI (USAF 1995c). Three VOC compounds and two SVOC compounds were reported in groundwater samples collected at OU-5, and none of the detected concentrations exceeded a MCL. Several inorganic compounds, including manganese and arsenic, were detected in soil and groundwater. These metals are believed to be naturally occurring, and are not related to landfill activities. No groundwater plume is associated with this site.

Four monitoring wells were sampled and analyzed for VOCs as part of the April 2011 LTM sampling event. No COCs were detected in the analyses. Results are shown on Figure 2-9.

2.1.6 Groundwater at OU-6 (Landfill No. 5)

2.1.6.1 OU-6 Background

OU-6 consists of an approximately seven acre closed landfill (Landfill No. 5) located in the southeastern corner of the Base (Figure 2-10) immediately south of the Base Waste Water Treatment Plant (WWTP). The ground surface generally slopes to the east. The landfill is grass covered. A north-to-south drainage way is located along the east side of the landfill, and a west-to-east drainage way is located along the south side of the landfill. The southern drainage way is a tributary to the eastern drainage way, and receives discharge from a buried storm drain that receives runoff from the fuel storage area to the northwest. The eastern drainage way is fed by discharge from Gateway Lake, which receives storm water runoff from the eastern two-thirds of the Base, and by discharge from the WWTP. All runoff from the landfill and from the two storm water drainage ways is south to Box Elder Creek.

The eastern part of Landfill No. 5 is used as part of the Base golf course, and the rest of the landfill is currently designated for use as outdoor recreation. The west-to-east and north-to-south drainage ways provide wetland habitat for wildlife. Future use is listed as airfield clearance and outdoor recreation. Groundwater is not used at OU-6.

From 1960 to 1980, demolition debris and hardfill material, including broken concrete, broken brick, asphalt, and wood, were disposed in Landfill No. 5. Miscellaneous refuse, dried sewage sludge, and possibly shop wastes were also disposed. The landfill was also used for stockpiling WWTP sludge in the past. Waste at the landfill remains in place.

2.1.6.2 Nature and Extent of Contamination

TCE and metals were detected in groundwater during the OU-6 RI (USAF 1994). TCE was detected in a monitoring well upgradient from the landfill, so it was determined that landfill operations were not responsible for its presence. Metals concentrations in groundwater were determined to be within the background range. Further investigation of groundwater upgradient

of OU-6 was completed as part of the OU-11 RI (USAF 1996a). No groundwater contaminant plume is associated with this site.

Three monitoring wells and one surface water location were sampled and analyzed for VOCs as part of the April 2011 LTM sampling event. None of the analytical results exceeded screening level criteria. Results are shown on Figure 2-10.

2.1.7 OU-7 Plume

2.1.7.1 OU-7 Background

OU-7 is the Weapons Storage Area, now known as the Munitions Storage Area (MSA). It is located in the northwest part of the Base (Figure 2-1 and Figure 2-11) and covers approximately 65 acres. The ground surface at the MSA slopes gently toward the west and southwest away from the edge of the plateau located north of OU-7. East of the MSA, the ground surface slopes to the east toward a small northwest-to-southeast trending valley. Surface water flow from the MSA is to drainage ways that eventually flow to Box Elder Creek.

The MSA is an industrial area with restricted access. Current land use is listed as airfield clearance. Future land use is listed as industrial. Groundwater is not used at the MSA.

From 1952 to 1962, radioactive wastes were generated at the MSA by the Atomic Energy Commission (AEC). At that time, the MSA was known as the Rushmore Air Force Station. After 1962, all activities at the MSA were transferred to the Air Force.

Wastes were generated during wash-down and cleaning of nuclear weapons. Five underground storage tanks (USTs) were used as wash-down water overflow tanks. The tanks were not known to be used for any other disposal activities. The USTs had capacities of 1,000 gallons to 5,000 gallons each, and all were full of water when they were removed in 1993 as part of a UST closure program. In addition, two trenches are believed to have been used to dispose low level radioactive waste. Material disposed in the trenches may include unidentified waste and two large boxes containing radioactive clothing and rags. The exact locations of the two trenches are not known. A removal action for low-level radiological waste was completed in 1997.

TCE above the MCL of 5 micrograms per liter (µg/L) was detected in groundwater at the northeast corner of the MSA during the OU-7 RI. Further investigation of the groundwater contamination was conducted during the OU-11 RI and additional monitoring wells were installed in 1998. A direct push investigation in 2001 further defined the extent of the plume and monitoring wells were installed in 2002. Additionally, monitoring a suspected spring location north of the plume was recommended (Earth Tech 2002); however, sufficient spring water in this location has never been available for sampling.

2.1.7.2 Nature and Extent of Contamination

The groundwater plume at OU-7 is located in the northeast corner of the MSA and contains TCE. The length of the plume is 1,000 feet along a northwest to southeast axis. The width of the plume is 300 feet. The detected analytes, along with a map depicting the contaminant plume, are shown on Figure 2-11.

2.1.7.3 Remedial Actions

ICs were implemented to restrict future groundwater use at the OU-7 Plume. A groundwater monitoring network is in place at the OU-7 Plume. MNA was the selected remedy and concentration trends indicate the contaminant concentrations in the plume are slowly decreasing.

2.1.8 Groundwater at OU-8 (Explosive Ordnance Disposal Area)

2.1.8.1 OU-8 Background

OU-8 is an Explosive Ordnance Disposal (EOD) area and a debris burial area (DBA). Both are located at the north edge of the Base (Figure 2-1 and Figure 2-12). The EOD area is approximately 14 acres in size and is located on incised, steeply sloping land. Individual features within the EOD area include a burn furnace, a burn pit, and a detonation site. The DBA is just over one acre in size and is located about 1,000 feet south of the EOD area and immediately northeast of the SAR. The DBA is at the edge of a plateau and the ground surface is relatively flat. Surface run/off from the EOD area, and from much of the DBA, is to the north via ephemeral streams. These eventually drain to Elk Creek. Both areas in OU-8 are generally grass covered. The EOD area and the land immediately to the north have two drainage ways that have wetland habitat. Small earthen dams have been built across the drainages, and these have created additional wetland habitat.

Current land use is listed as airfield clearance and open space/buffer zone. Future land use is listed as open space. Groundwater is not used at OU-8.

The RI for OU-8 (USAF 1995d) does not indicate when disposal activities at OU-8 began. The RI does indicate that by 1995, OU-8 was no longer being used for disposal, and it was being used for training purposes only. During use as a disposal site, three processes were used to destroy munitions: open detonation, open burning, and detonation in a burn furnace. Residue from the open detonation, burn pit, and burn furnace operations were transferred to the DBA for disposal. Off-specification munitions are now shipped off Base for treatment and disposal as hazardous waste. Chemicals at the EOD area and debris at the DBA remain in place.

In addition to the munitions disposal activities, approximately 100 gallons of the herbicide Pramitol™ (chemical name prometon) were spilled in the EOD area in May 1982. The release area was about 300 feet northeast of the burn pit. In June 1982, approximately 200 cubic yards of prometon-impacted soil were excavated from the spill site and transported to Landfill No. 3 (OU-4) for disposal. In 1983, earthen dams were constructed across the drainage way that receives surface runoff from the spill site. This was done to prevent off-site transport of prometon-impacted soil eroded from the spill site.

2.1.8.2 Nature and Extent of Contamination

Groundwater sampled during the RI was found to contain detectable concentrations of one tentatively identified VOC, three SVOCs, and metals. Concentrations of antimony and selenium were reported in four groundwater samples that exceeded the respective MCLs for these metals.

Metals detected in soil, sediment and groundwater that could drive risk evaluations, including antimony, arsenic, manganese, and selenium were determined to be naturally occurring, but they were included in risk calculations. Explosives compounds were not detected in any media.

Groundwater is not a concern at the Explosive Ordnance Disposal Area. The only remaining concern at this site is the potential for migration of dibenzodioxin/dibenzofuran congeners to sediment.

2.1.9 OU-9/OU-10 Groundwater

2.1.9.1 Background

The OU-9 study area consisted of 90 acres located in the south-central section of the Base including the Old Auto Hobby Shop and the surrounding area. Groundwater from OU-9 and the fish-ingestion exposure pathway were assigned to OU-11 and no-action was proposed for surface water, soil, and sediment in the OU-9 ROD (USAF 1996b).

OU-10 is the North Hangar Complex, a 75-acre site located in the central portion of the Base, northeast of the primary instrument runway. Groundwater at OU-10 was assigned to OU-11 and no-action was proposed for surface water, soil and sediment in the OU-10 ROD (USAF 1996c).

2.1.9.2 OU-9 Fish Ingestion

The OU-9 risk assessment (USAF 1995a) had calculated a hazard index (HI) for chronic non-carcinogenic risk for the recreational fisherman of 1.22, with mercury contributing most of the risk. The HI of 1.22 was based on total mercury concentrations in surface water from the drainage way above Gateway Lake and based on fish tissue concentrations modeled from the surface water concentrations. The calculated HI of 1.22 exceeded the acceptable HI of one. There were no other unacceptable risks at OU-9, except those associated with VOCs in groundwater. The fish ingestion pathway was transferred along with groundwater from OU-9 to OU-11 by the OU-9 ROD, but was not specifically addressed in the OU-11 ROD.

The OU-11 RI (USAF 1996a) included a Basewide ecological risk assessment, and sufficient data was collected to eliminate fish ingestion as a pathway of concern. The 2010 Five-Year Review recommended this determination be formalized in a decision document (URS 2010c). The maximum detected concentration of total mercury in fish tissue samples collected during the OU-11 RI was 280 microgram per kilogram (µg/kg), which was four times lower than the model-estimated concentration of 1,186 µg/kg used in the OU-9 risk assessment. Based on the fish tissue concentration of mercury and following assumptions made in the OU-9 RI, the HI for the fish ingestion exposure pathway would be 0.33. The possible human risk identified by the OU-9 RI from fish ingestion was over estimated and the actual risk is not above the acceptable risk range, eliminating fish ingestion as a significant pathway at OU-9 and eliminating OU-9 from further consideration under the CERCLA process (URS 2011a).

2.1.10 Small Arms Range Plume

2.1.10.1 Background

The SAR is located in the northeast part of the Base and covers approximately 50 acres (Figure 2-13). The ground surface at the SAR slopes gently to the south-southwest and ranges from open-grassed areas to operational areas with roads, buildings and pavement. Current land use at the SAR is operations and air field clearance.

The SAR is located at the former munitions storage area (FMSA) which was initially developed between 1952 and 1954. Buildings 9002 and 9008 were photographed in 1954 with 55-gallon

barrels on either side of the building entrances. Interviews suggest that these barrels existed on the FMSA until the mid 1980's and contained a chlorinated solvent (likely a mix solvent including TCE) (RUST 1998).

2.1.10.2 Nature and Extent of Contamination

The groundwater plume is located in the northwestern area of the SAR and contains solvent related chemicals. The plume extends 400 feet along an axis south-southwest from MW98SR01 and is 100 feet wide.

2.1.10.3 Remedial Actions

IRT was implemented at the SAR plume in the summer of 2008 with the injection of an organic substrate followed by bioaugmentation in late 2008. LTM continues at the site to monitor the effectiveness of the IRT. Analytes detected during the April 2010 LTM sampling event, along with a map depicting the contaminant plume, are shown on Figure 2-14.

2.1.11 BG04 Plume

2.1.11.1 Background

The BG04 Study Area is located in an open area at the northeast edge of Ellsworth AFB, approximately 1,500 feet south of the EOD debris burial area perimeter (OU-8). The BG04 area is largely open grassy areas extending from west of the North Docks area to the eastern boundary of the Base, intercepting the northern area of a residential area and continuing off-Base to the east (Figure 2-13).

Monitoring well MW93BG04 was installed during the OU-6 RI as a background monitoring well. This location was believed to have no impact from Base operations; however, TCE was detected in MW93BG04 above the MCL of 5 µg/L. At the time, there were no known sources of contaminants in the immediate vicinity of MW93BG04. A firing range is located approximately 1,200 feet to the northwest and a housing tract is located approximately 800 feet east of MW93BG04. The TCE plume identified at this location became known as the BG04 Plume. The OU-11 RI documented a plume of TCE-impacted groundwater that extended across much of the northern part of the Base to the Base boundary where the detected concentrations exceeded the MCL for TCE (USAF 1996a).

The investigation of the BG04 plume was later expanded to include AOC 24, now called the Off-Base Plume (Rust 1998). A data gaps investigation was completed for BG04, which changed the size and shape of the BG04 plume and identified the apparent source of the BG04 plume as a former liquid oxygen (LOX) production facility (URS 2007a). TCE was commonly used at LOX facilities to clean piping and couplings because it is non-reactive with the highly flammable LOX.

2.1.11.2 Nature and Extent of Contamination

The BG04 plume contains solvent related chemicals. The plume extends along a general easterly axis from the location of the former LOX plant east-northeast of Fuels Area D 8,500 feet to the east Base boundary. The detected analytes from the April 2011 LTM sampling event, along with a map depicting the contaminant plume, are shown on Figure 2-14.

2.1.11.3 Remedial Actions

Remedial technologies that have been implemented at the BG04 Plume include:

- Groundwater extraction
- Groundwater treatment at BG04 West with air stripping and discharge to sanitary sewer
- Groundwater treatment at BG04 Base Boundary with GAC and discharge to reinjection trench at the Base boundary
- ICs
- Long-term groundwater monitoring
- IRT
- Re-injection trench

Two groundwater extraction and treatment systems are located within the BG04 plume, one at BG04 West and one at BG04 Base Boundary. The BG04 West extraction and treatment system includes four EWs and a groundwater treatment system consisting of air stripping which discharges to the sanitary sewer. The groundwater extraction and treatment system has remained shut down since 2006 when the IRT treatability study began.

The BG04 Base boundary system consists of four EWs and a groundwater treatment system consisting of GAC treatment with discharge to a reinjection trench at the Base boundary. Three of the four extraction wells have been shut down due to low contaminant concentrations in the wells. The January through March 2010 RA-O Report (URS 2011d) includes the monthly average influent flow rates and concentrations, which are summarized over the past year of operation.

Full-scale IRT implementation at the BG04 Plume began during the summer and fall 2007. The IRT system at BG04 was expanded during the summer of 2008 (URS 2008a). There are currently 10 IRTs. Many of these IRTs have had re-injections to maintain the effectiveness, and others have had extensions to the original IRT based on LTM and performance monitoring results. IRT RAWP Addendum 5 provides details for re-injection at several existing IRT walls to enhance their performance (URS 2009a). The locations of the IRTs for the BG04 plume are shown on Figure 2-14.

2.1.12 Spearfish Avenue Plume

2.1.12.1 Background

The Spearfish Avenue Plume is located in the northeast part of the Base (Figure 2-13 and Figure 2-15) in an area whose current land use is housing. TCE in groundwater was documented at this location by direct push groundwater sampling in 2004 and the plume was defined during direct push groundwater sampling in 2006 (URS 2007a).

2.1.12.2 Nature and Extent of Contamination

The groundwater at the Spearfish Avenue Plume contains solvent related chemicals. The plume is centered on MW071106 and is approximately 200 feet in diameter.

2.1.12.3 Remedial Action

MNA as a remedial action has been implemented at the Spearfish Avenue Plume. As adequate data become available, contaminant trends at the Spearfish Avenue Plume will be evaluated.

2.1.13 Scott Drive Plume

2.1.13.1 Background

The Scott Drive Plume is located between the BG04 and BG05-Twining/Risner Plume east of Ellsworth Drive as shown on Figure 2-13. The area is largely open grassy areas with current land use designated as open area. The plume was initially associated with the BG05 Plume. During a data gaps investigation completed for BG04 and BG05 (URS 2007a), and following investigations to define the Twining/Risner-BG05 plume in 2008 (URS 2008b) and 2009 (URS 2009b), the Scott Drive Plume was found to be a separate plume.

2.1.13.2 Nature and Extent of Contamination

The groundwater at the Scott Drive Plume contains solvent related chemicals. The plume extends 2,000 feet east-southeast along an axis from MW09BG502 to MW09BG501 and is approximately 100 feet in width as shown on Figure 2-15.

2.1.13.3 Remedial Action

MNA as a remedial action has been implemented at the Scott Drive Plume. As adequate data become available, contaminant trends at the Scott Drive Plume will be evaluated.

2.1.14 Twining/Risner-BG05 Plume

2.1.14.1 Background

The BG05 Study Area is located in a housing area in the east-central portion of Ellsworth AFB, approximately 300 feet east of Lemay Boulevard and continues off-Base to the east. Monitoring well MW93BG05 was installed during the OU-6 RI as a background monitoring well. This location was believed to have no impact from Base operations; however, TCE was detected in MW93BG05 above the MCL of 5 µg/L. The area around MW93BG05 became known as the "BG05 Study Area". There are no known sources in the immediate vicinity of well MW93BG05.

The investigation of the BG05 plume was later expanded to include AOC 24 and now called the Off-Base Plume. A data gaps investigation was completed for BG05 (URS 2007a) but was inconclusive as to a source area for BG05.

During 2008, a groundwater investigation near PZ941116 identified a TCE plume in that area tentatively called the Twining/Risner Plume (URS 2008b). To fully delineate this plume, additional direct push sample locations were completed in 2009, and three monitoring wells were installed in preparation for injection at three IRT walls. The Twining/Risner plume was found to be continuous with the BG05 plume. The apparent source of the Twining/Risner-BG05 plume was maintenance activities on a World War II era runway that was formerly located near PZ941116.

2.1.14.2 Nature and Extent of Contamination

Contamination in the Twining/Risner-BG05 Plume is solvent related chemicals. The plume extends east along a primarily easterly axis from south of Building 7520, 6,500 feet, to the eastern Base boundary. The plume width varies from 200 to 700 feet wide. Results of the April

2011 LTM event for the Twining/Risner-BG05, Scott Drive, and Spearfish Avenue plumes are shown on Figure 2-15.

2.1.14.3 Remedial Actions

Remedial technologies that have been implemented at the Twining/Risner-BG05 Plume include:

- Groundwater extraction
- Groundwater treatment at BG05 Base Boundary with GAC and discharge to reinjection trench at the Base boundary
- ICs
- Long-term groundwater monitoring
- IRT
- Re-injection trench

One groundwater extraction and treatment system is located within the Twining/Risner-BG05 Plume at the Base boundary. The BG05 Base boundary system consists of five EWs and a groundwater treatment system consisting of GAC treatment with discharge to a reinjection trench at the Base boundary. Two out of the five EWs have been shut down due to low contaminant concentrations in the wells. The January through March 2010 RA-O Report (URS 2011d) includes the monthly average influent flow rates and concentrations, which are summarized over the past year of operation.

During the summer of 2008, full scale IRT implementation began at BG05 (URS 2008a) at 3 locations. IRT was implemented in the Twining/Risner area in 2009 at 3 locations. Two BG05 IRTs were re-injected in 2010 to maintain effectiveness, and one IRT at BG05 had an extension to the original IRT based on LTM and performance monitoring results. IRT RAWP Addendum 5 (URS 2009a) provides details for re-injection at several existing IRT walls to enhance their performance. The locations of the IRTs for the Twining/Risner-BG05 Plume are shown on Figure 2-13.

2.1.15 Pride Hangar/South Docks Main Plume

2.1.15.1 Background

The South Docks Area is located in the central part of the Base between OU-9, OU-10, and the flightline area as shown on Figure 2-16. Buildings of interest in this general vicinity include the Pride Hangar and hangars in Rows 20, 30, 40, and 50.

Historical aerial photographs indicate that the Pride Hangar and the hangars in the South Docks Area have been in place since the late 1940s to early 1950s. Historically, the hangars have been used for docking and maintenance of aircraft. The Pride Hangar is now used for storage and maintenance of missile-support equipment and for offices and meeting rooms. Two side-by-side waste solvent USTs were located just outside the northwest corner of the Pride Hangar. These tanks were removed in 1992 and are believed to be the primary source of the Pride Hangar Plume. Hangars in the South Docks are now used for storage and maintenance of

various support equipment, including aircraft refueling vehicles, fire-fighting vehicles, grounds-keeping equipment, and periodic parking for aircraft.

2.1.15.2 Nature and Extent of Contamination

The Pride Hangar/South Docks Main (SDM) Plume contains solvent-related chemicals, primarily TCE and its degradation products. The plume extends from the northwest corner of Building 7504 (Pride Hangar) along an axis southeast to northeast of the intersection of Twining and George Streets. The plume is 4600 feet long and varies from 300 to 700 feet wide. Results of the April 2011 LTM sampling event are shown on Figure 2-17.

2.1.15.3 Remedial Actions

There is one treatment facility, known as Flightline Refueling Area – Pumphouse 1 (FRA-PH1), operating within the Pride Hangar/SDM Plume. The FRA-PH1 facility treats groundwater from the following locations:

- Pride Hangar (vacuum extraction system is currently shut down).
- 30 Row (extraction system is currently shut down).
- SDM (7 of 12 EWs are currently operated).
- FRA-PH1 Trench (petroleum only and not part of OU-11, currently shutdown).
- South Flightline Drain lift station. Discharge was diverted to the Base sanitary sewer on 4 November 2010. The Base Waste Water Treatment System is operated under Surface Water Discharge Permit No. SD0000281, which is active through 31 December 2014.

Detailed information concerning the operation of the extraction and treatment system at the Pride Hangar/SDM Plume, including the EW shut down schedule, is reported quarterly in remedial action operations reports under the FRA-PH1 Groundwater Treatment System. The January through March 2010 RA-O Report (URS 2011d) includes the monthly average influent flow rates and concentrations, which are summarized over the past year of operation.

Full-scale IRT implementation at Pride Hangar and SDM began during the summer and fall 2007. Expansion of the IRT system at Pride Hangar and SDM was completed during the summer of 2008 (URS 2008a). Figure 2-16 shows the locations of four IRT walls installed at Pride Hangar and four IRT walls installed at SDM.

2.1.16 OU-12 Plume

2.1.16.1 OU-12 Background

OU-12 consists of Hardfill No. 1 (closed) which is approximately 14 acres in size and is located in the south-central part of the Base, immediately north of the Alert Apron and southwest of the primary instrument runway (Figure 2-1 and Figure 2-18). A north-to-south surface drainage way divides OU-12 into a west and an east part. On the west, the ground surface slopes gently to the east; and on the east, the ground surface slopes gently to the west. The drainage way receives storm water runoff at its north end from underground drain lines that drain runoff from the hangar rows north of the runway.

Current and anticipated future use of OU-12 is as airfield and for aircraft operations and maintenance. Groundwater is not used at OU-12.

Historical aerial photographs indicate that Hardfill No. 1 has been used for disposal of construction debris, such as wood, metal, concrete and asphalt since the 1940s. The disposed material was generated by building and road demolition and from maintenance and repair activities on the Base. Waste remains in place at Hardfill No. 1. In addition, an area located about 600 feet north of the Alert Apron that was about 150 feet in diameter was used to temporarily stockpile soil removed from UST excavations and from an area southwest of the Pride Hangar. These soils were removed to the Base soil farming area (that was located east and northeast of the control tower) for treatment.

2.1.16.2 Nature and Extent of Contamination

During the RI for OU-12 (USAF 1995e), VOCs, SVOCs, pesticides, and metals were detected in groundwater samples. Pesticide concentrations were very low and TCE was the only detected VOC to exceed its MCL, and this detection was from a monitoring well located upgradient from the hardfill areas. The SVOCs, pesticides, and metals were determined to not be COCs in groundwater. An additional investigation of groundwater upgradient of Hardfill No. 1 was conducted as part of the OU-11 RI (USAF 1996a).

The OU-12 Plume consists of groundwater contaminated with TCE northwest of the OU-12 boundary. The length of the plume is 450 feet along a north-south axis. The plume width varies from 100 to 200 feet wide. The OU-12 Plume does not emanate from Hardfill No.1 and the contamination is not attributed to wastes within Hardfill No. 1. The OU-12 Plume is named because of its proximity to OU-12.

Results of the April 2011 LTM sampling are shown on Figure 2-18

2.1.16.3 Remedial Actions

A groundwater monitoring network is in place at the OU-12 Plume. MNA was the selected remedy and concentration trends indicate the contaminant concentrations in the plume are slowly decreasing and the plume is not expanding.

2.1.17 OU-11 Off-Base Plume

2.1.17.1 OU-11 Off-Base Background

During the RI for OU-11, groundwater contaminant plumes were identified on-Base in areas then known as the “MW93BG04 Study Area” and the “MW93BG05 Study Area” (EA 1996). Two plumes identified in these areas became known as the “BG04 Plume” and the “BG05 Plume”. It was recognized that off-Base groundwater impacts were likely because TCE was detected at the Base boundary at a concentration of 25 µg/L. As required by the OU-11 ROD (USAF 1997), additional investigations were performed to determine the eastern extent of the Off-Base Groundwater Plume. These investigations revealed a chlorinated solvent contaminant plume, primarily TCE that extended 4.5 miles southeast from the Base boundary to the vicinity of Custer Springs.

The OU-11 Off-Base Plume is located on private property consisting of open land containing individual residences and agricultural areas.

2.1.17.2 Nature and Extent of Contamination

The OU-11 Off-Base Plume consists of groundwater contaminated with TCE that had at one time extended from the Base boundary to 5 miles east-southeast of Ellsworth AFB. Currently, the plume extends from a point off-Base 1350 feet east of MW972408 southeast approximately two miles to an area near MW982415. The plume width varies from 300 feet wide east of M972408, to 2000 feet wide at MW09OB05, to 150-300 feet wide north of MW982415.

Results of the April 2011 LTM sampling are shown on Figure 2-19.

2.1.17.3 Remedial Actions

The OU-11 ROD specified MNA for the off-Base plume and concentration trends indicate the contaminant concentrations in the plume are decreasing. In 1996, Ellsworth AFB began providing water to off-Base residents affected by contamination coming from the Base. This originally consisted of providing bottled water to 18 residences and extending a Base waterline to nine residences. By 1999, the waterline had been extended to provide a permanent alternative water supply to affected off-Base residents. Each resident connected to the waterline entered into a Memorandum of Agreement (MOA) with Ellsworth AFB, which restricted groundwater use in the contaminant plume and the surrounding buffer area (URS 2010b).

Two groundwater pump and treat systems were installed at the Base boundary to treat the BG04 and BG05 contaminants plumes. Treated water is re-injected into the aquifer.

An April 2011 ESD for OU-11 (USAF 2011) modified the third remedial action objective (RAO) of the OU-11 ROD in accordance with the Final Exit Strategy Report (URS 2010b) to read:

- Prevent human exposure to off-Base groundwater with contaminants at concentration that pose an unacceptable risk to human health.

The April 2011 ESD also allowed modification of the current ICs enforced through MOAs with private landowners. The USAF can allow landowners to install new wells or use existing wells within the off-Base plume, and pump the groundwater for non-potable purposes such as landscape irrigation, garden irrigation, and swimming.

2.2 OU-11 ROD SELECTED REMEDY

The selected remedy for OU-11 was described in the OU-11 ROD (USAF 1997). The remedial action objectives for OU-11, per the OU-11 ROD, are:

- Prevent future human exposure to on-Base groundwater with contaminants exceeding State of South Dakota Ground-Water Quality Standards and Federal MCLs.
- Prevent additional groundwater containing contaminants above State of South Dakota Ground-Water Quality Standards and Federal MCLs from moving off-Base.
- Prevent human exposure to off-Base groundwater with contaminants exceeding State of South Dakota Ground-Water Quality Standards and Federal MCLs.

The OU-11 ROD selected separate alternatives for Area 1 and Area 2 of OU-11.

The selected remedy for OU-11 Area 1 was groundwater extraction and treatment, and includes the following major components:

- Removal and containment of groundwater containing contaminants at concentrations above MCLs.
- Groundwater treatment and discharge.
- ICs and long-term monitoring.

The selected remedy for OU-11 Area 2 is groundwater containment/extraction and treatment, and includes the following major components:

- Groundwater removal and treatment along the northeast Base boundary and at areas of high contaminant concentrations on Base.
- Natural attenuation of low contaminant concentration areas, primarily off Base.
- Alternative water supply to residents affected by contamination coming from the Base.
- Additional investigation to determine the eastern extent of off-Base groundwater contamination.
- ICs and long-term monitoring.

3.0 BASIS FOR RECORD OF DECISION AMENDMENT

Several groundwater contaminant plumes containing chlorinated volatile organic compounds are present at Ellsworth AFB. TCE and cis-1,2-DCE are the most frequently reported chlorinated VOCs. The remedies selected in the RODs for groundwater treatment at the Base use groundwater extraction and treatment, soil vapor extraction, and dual phase extraction for containment of the contaminated groundwater and removal of contaminants. Since the groundwater extraction treatment remedy has limited capability to reduce TCE mass, operation of the extraction systems may extend indefinitely into the future to maintain protectiveness. Therefore, the use of in-situ bioremediation to treat the groundwater contaminants was recommended in the 2005 Five-Year Review (USAF 2005b). The 2005 Five-Year Review considered biodechlorination a potentially valuable supplement to the existing groundwater pump and treat systems at the Ellsworth AFB sites.

In-situ biodechlorination pilot test injections using an emulsified oil substrate mixed with water at 1.5 to 10 percent were injected into permeable reductive treatment zones that spanned the contaminant plumes at the OU-4, Pride Hangar, and BG04 plumes in 2006. The injections were completed using direct push technology. Performance monitoring of the pilot IRT zones began one month after injection and highly reducing conditions were present at the OU-4 and Pride Hangar test sites. Lower reducing conditions were present at the BG-04 site due to lower concentrations of emulsified oil product and a single row of injection points. Dechlorination of TCE to cis-1,2-DCE occurred at Pride Hangar. Dechlorination bacteria, if present, were at very low concentrations at the three test sites.

A bench scale test using the same emulsified oil as the pilot test was completed between May 2006 and December 2006 using soil and groundwater from BG04. The bench scale test showed complete dechlorination of TCE to ethane when the KB-1 microbial consortium was added. Based on the results of the bench scale study, KB-1 was injected into the pilot test treatment zones at OU-4 and the Pride Hangar in 2007 (URS 2007b). A detailed discussion on the IRT technology is contained in the Final IRT RAWP (URS 2007b).

In-situ biodechlorination was allowed for use at OU-11 in conjunction with groundwater extraction and treatment in the 2007 ESD for OU-11 Basewide Groundwater (USAF 2007). Full scale implementation of in-situ biodechlorination at the OU-1 Main, OU-2, OU-4 South and Centerline, SAR, BG04, Twining Risner/BG05 Plume and Pride Hangar/South Docks Main Plumes took place in 2007 and 2008.

IRT of dissolved chlorinated solvents at OU-11 plumes has been implemented as follows:

- OU-1 Main Plume: Two IRT zones, OU1-IRT1 and OU1-IRT2 (Figure 2-3). Initial substrate injection July 2008 (OU1-IRT2) and September 2008 (OU1-IRT2) and bioaugmentation at the IRT zones in November and December 2008. One supplemental organic substrate injection at OU1-IRT1 in July 2010.

- OU-2 Plume: Two IRT zones, OU-2 IRT1 and OU-2 IRT 2 (Figure 2-5). Initial substrate injection in July 2008 and subsequent bioaugmentation at OU-2 IRT 1 in November 2008. Two supplemental organic substrate injections at OU-2 IRT1 in 2009 and 2010. OU-2 IRT 2 established along southern boundary in 2011.

- OU-4 South and Centerline Plumes: 10 IRT zones are in place (OU4-IRT1 through OU4-IRT10) (Figure 2-7). Initial substrate injection at OU4-IRT1 to IRT4 in August 2007 with bioaugmentation in October and November 2007. In August 2008, OU4-IRT3 was extended and initial substrate injection at OU4-IRT5 to OU4-IRT10 with bioaugmentation in November 2008. Additional organic substrate injections at IRT3, IRT4, IRT5 and IRT9 in 2009. Additional organic substrate injections at IRT4 and IRT8 in 2010.

- SAR Plume: One IRT zone, SAR-IRT1 (Figure 2-13). Initial substrate injection in July and August 2008 with bioaugmentation in November and December 2008.

- BG04 Plume: Ten IRT zones, BG04-IRT1 through BG04-IRT10 (Figure 2-13). Treatability study of biodechlorination in 2006. Full scale substrate injections at BG04-IRT1 through BG04-IRT7 in June and July 2007 with bioaugmentation in October 2007. Substrate injections at BG04-IRT8 through IRT9 in July and August 2008 with bioaugmentation in November and December 2008. Additional substrate injections at BG04-IRT1, IRT2, and IRT5 in August 2008. Additional substrate injections at BG04-IRT9 and IRT10 in 2009. Additional substrate injections at BG04-IRT1, IRT2, IRT7, IRT4 and IRT9 in August 2010.

- Twining/Risner-BG05 Plume: Six IRT zones, TR-IRT1 through TR-IRT3 and BG05-IRT1 through BG05-IRT3 (Figure 2-13). Initial substrate injection at BG05-IRT1 through BG05-IRT3 in July and August 2008 with bioaugmentation in November 2008. Initial substrate injections at TR-IRT1 through TR-IRT3 in September and October 2009 with bioaugmentation injections in January 2010. Additional substrate injection at BG05-IRT1 and BG05-IRT3 in July and August 2010. Substrate injection at BG05-IRT2 Extension in December 2010.

- Pride Hangar/South Docks Main Plume: Eight IRT zones PH-IRT1 through PH-IRT4 and SDM-IRT1 through SDM-IRT4 (Figure 2-16). Treatability study of biodechlorination at Pride Hangar in 2004 and 2006. Full scale substrate injection at PH-IRT1, PH-IRT2, PH-IRT3, SDM-IRT1, and SDM-IRT2 in July and August 2007 with bioaugmentation in October and November 2007. Additional substrate injection at PH-IRT2 Extension, PH-IRT3, PH-IRT4, SDM-IRT1 Extension, and SDM-IRT2 through SDM-IRT4 in August and September 2008. Bioaugmentation injection at PH-IRT2 and SDM-IRT1 Extension in November and December 2008. Additional substrate injection at SDM-IRT4 in October 2010. Additional substrate injection at SDM-IRT1 and PH-IRT3 in August 2010.

To date, 39 IRT zones, each with its own performance monitoring point or network, have been established. Performance monitoring is on-going at each of the IRT zones. IRT treatment has been implemented throughout the large on-Base groundwater plumes, reducing the demand for active treatment at the Base boundary.

The OU-11 Basewide Groundwater FFS was completed in 2011 (URS 2011c) to evaluate the remedy as stated in the OU-11 ROD (active treatment and MNA), the current conditions following the 2007 ESD (active treatment, IRT and MNA) and a proposed remedy (IRT and MNA]). The FFS provides the basis for this amendment.

4.0 DESCRIPTION OF NEW ALTERNATIVES

4.1 NEW REMEDIAL ACTION OBJECTIVES

RODs were signed between October 1995 and April 1997 that address all 12 of the OUs at Ellsworth AFB. Remedial action objectives, the selected response action, and performance standards as described in the individual RODs, are listed in Table 4-7 at the end of this section. The wording of the remedial action objectives varies between the OU RODs and many of the remedial action objectives do not apply to Basewide groundwater. Therefore, the new remedial action objectives for OU-11 Basewide Groundwater are:

- Prevent current and future human exposure to on-Base groundwater with COCs exceeding South Dakota Groundwater Quality Standards and Federal MCLs.
- Prevent additional groundwater containing COCs above South Dakota Groundwater Quality Standards and Federal MCLs from moving off-Base.
- Prevent human exposure to off-Base groundwater with COCs at concentrations that pose an unacceptable risk to human health.
- Attain South Dakota Groundwater Quality Standards and Federal MCLs throughout the plumes.

4.2 ALTERNATIVE DESCRIPTIONS

Three alternatives for remedial action were evaluated as part of the FFS for OU-11 Basewide Groundwater. The three alternatives are:

- Alternative 1: Active Treatment and MNA
- Alternative 2: Active Treatment, IRT, and MNA
- Alternative 3: IRT and MNA

A “No Action” alternative is typically evaluated in an FFS. However, RODs that are in place require action for the contamination associated with OU-11. Therefore, the “No Action” alternative was not evaluated in the FFS.

The components of the three alternatives are summarized in the following table:

Table 4-1 Summary of Alternatives to be Evaluated

Alternative Component	Alternative 1 – Active Treatment and MNA	Alternative 2 – Active Treatment, IRT, and MNA	Alternative 3 – IRT and MNA
Groundwater Extraction with Treatment	X	X	
MNA	X	X	X
LTM	X	X	X
Maintenance of landfill caps	X	X	X
Direct push groundwater sampling		X	X
ICs	X	X	X
Treatment with IRTs		X	X
Installation of new active treatment systems	X		
Contingency for reactivation of existing active treatment systems			X

4.2.1 Alternative Components Common to more than One Alternative

Components of the alternatives that are common in two or three of the alternatives are described in this section to avoid repetition. The components discussed here include:

- Groundwater Extraction with Treatment
- MNA
- LTM
- Maintenance of landfill caps
- Direct push groundwater sampling
- ICs
- Treatment with IRTs

4.2.1.1 Groundwater Extraction with Treatment

Groundwater contaminant plumes have groundwater extraction and treatment systems as summarized in the following table:

Table 4-2 Summary of Groundwater Extraction and Treatment Systems

Treatment System	Treatment Description	Extraction System	Extraction Wells/Trenches
Building 6908	Air stripping, micron filters, and carbon units	OU-1	22 EWs, IT trench
		OU-2	3 EWs
		OU-4	28 EWs
FRA-PH1	Air stripping	Pride Hangar	8 EWs
		30 Row	3 EWs
		South Docks Main	12 EWs
Base wastewater treatment plant	Trickling filter process and anaerobic digesters	South Flight Line Drain Lift Station	Active
BG04 Base Boundary	Micron filters and carbon units	BG04 Base Boundary	4 EWs
BG04 West	Air stripping	BG04 West	4 EWs
BG05 Base Boundary	Micron filters and carbon units	BG05 Base Boundary	5 EWs

Operation of the existing active treatment systems is part of Alternatives 1 and 2. However, there are differences in the operation of these systems between the two alternatives. Under Alternative 1, many of the EWs that have been turned off over the past 5 years during the implementation of the IRT pilot test and full-scale IRT zones would be reactivated. These changes are discussed under Alternative 1. Under Alternative 2, there would be no immediate changes to the current operation of the systems.

4.2.1.2 Monitored Natural Attenuation

MNA is proposed at four low concentration on-Base plumes (i.e., OU-7 Plume, Scott Drive Plume, Spearfish Avenue Plume, and OU-12 Plume) and the OU-11 Off-Base Plume. No high level TCE concentrations have been detected at any of these five plumes that would suggest

continued source loading to the plume, and monitoring data suggest these plumes are or may be attenuating.

Two of the plumes (the OU-7 Plume and the OU-12 Plume) have monitoring results, some of which date back over 10 years that indicate long term TCE concentrations are decreasing and that the downgradient extent is not expanding. TCE concentrations at the OU-7 and OU-12 Plumes are shown on Table 4-3. The sampling data provided in Table 4-3 are from selected monitoring events and at selected key monitoring wells located within the plumes. The April 2011 plume definition and groundwater monitoring concentrations are shown on Figure 2-11 for the OU-7 Plume and Figure 2-18 for the OU-12 Plume.

Table 4-3 Contaminant Concentrations at OU-7 and OU-12 Plumes

OU-7 Plume	October 1998	April 2005	April 2011
MW980702 (upgradient part of plume) TCE (µg/L)	5.3	1.8	0.9
MW980701 (downgradient part of plume) TCE (µg/L)	30	14	11
OU-12 Plume	**July 2004**	**April 2007**	**April 2011**
MW931201 (interior of plume) TCE (µg/L) / cis-DCE (µg/L)	13 / 12	11 / 5.3	7.7 / 1.1

The other two on-Base plumes proposed for MNA (Spearfish Avenue Plume and Scott Drive Plume) have more recently been delineated and do not have a long record of monitoring results. TCE concentrations at the Spearfish Avenue Plume and TCE/PCE concentrations at the Scott Drive Plume are shown on Table 4-4. The sampling data provided in Table 4-4 are from selected monitoring events and at selected key monitoring points located within the plumes. The April 2011 plume definition and groundwater monitoring concentrations are shown on Figure 2-15.

Table 4-4 Contaminant Concentrations at Spearfish Avenue and Scott Drive Plumes

Spearfish Avenue Plume	April 2008	April 2011
MW071106 (interior of plume) TCE (µg/L)	40	22
Scott Drive Plume	**2004 Direct Push**	**April 2011**
MW09BG502 (upgradient part of plume) TCE (µg/L) / PCE (µg/L)	12.2 / 29.5	7.5 / 21
MW09BG501 (downgradient part of plume) TCE (µg/L) / PCE (µg/L)	9.4 / 0.6	7.4 / 1.8

The Off-Base Plume has monitoring results over the last twelve years that indicate long term TCE concentrations are decreasing and that the downgradient extent is not expanding. TCE concentrations at the Off-Base Plume are shown on Table 4-5. The sampling data provided in Table 4-5 are from selected monitoring events and at selected key monitoring wells located within the plumes. The April 2011 plume definition and groundwater monitoring concentrations are shown on Figure 2-19.

Table 4-5 Contaminant Concentrations at Off-Base Plume

Off-Base Plume	October 2000	April 2005	April 2011
MW96BG0408 (upgradient northwest) TCE (µg/L)	13	4.3	1.6
MW972408 (centerline of plume) TCE (µg/L)	6.5	5	3.1
MW982416 (centerline of plume) TCE (µg/L)	11	9.2	4.6
MW002422 (downgradient southeast) TCE (µg/L)	4.8	4.8	3

MNA relies on naturally-occurring physical, chemical, and biological processes to reduce contaminant concentrations until cleanup levels are met. MNA is generally a long-term response action that continues until cleanup levels have been attained through the area of attainment, at which time, the site can be removed from the NPL (USEPA 1988). MNA as a remedy is considered appropriate if the contaminants are likely to be effectively addressed by natural attenuation processes, the groundwater plumes are no longer increasing in extent or are shrinking, and there is no potential for unacceptable risks to human health or environmental resources by the contamination.

LTM is a key component of MNA to address the multiple evaluation factors listed below:

- Determine if natural attenuation is occurring according to expectations.
- Detect changes in environmental conditions that may reduce the efficacy of any of the natural attenuation processes.
- Identify any potentially toxic and/or mobile transformation products.
- Verify that the plumes are not expanding.
- Verify there is no unacceptable impact to downgradient receptors.
- Detect new releases of contaminants to the environment that could impact the effectiveness of the MNA.
- Demonstrate the efficacy of ICs that were put in place to protect potential receptors and verify attainment of RAOs.

The schedule of groundwater monitoring for the MNA plume monitoring well networks will be specified in the Final 2011 Update to the Long Term Monitoring Plan (URS 2011b) In addition to analyzing groundwater samples for chlorinated VOC analysis, field parameters including temperature, pH, specific conductivity, dissolved oxygen (DO) and oxidation reduction potential will be measured.

The Air Force may, in the future, decide to accelerate cleanup of a plume to eliminate the need for LTM. Also, future LTM results may show that the monitoring program is not adequate. Criteria for future LTM that could be used to increase monitoring frequency and/or implement IRT include:

- Increasing concentration trends over a period of time could trigger more frequent monitoring and/or IRT treatment.

- Concentrations that are not decreasing as expected or not decreasing at all over a period of time could trigger IRT treatment.

4.2.1.3 Long-Term Monitoring

LTM is required to monitor the performance of the selected remedy and ensure continued protection of human health and the environment. LTM for the three alternatives includes a combination of plume monitoring, IRT monitoring, oxygen diffusion performance monitoring, rebound monitoring, landfill monitoring, and groundwater level/free product thickness monitoring. A description of the different types of monitoring and their purpose is provided in the Final 2011 Update to the Long Term Monitoring Plan (URS 2011b). A detailed list of all wells in the LTM program, their purpose (rebound monitoring, plume monitoring, IRT monitoring, etc.), and analysis depending on monitoring status is also provided in the Final 2011 Update to the Long Term Monitoring Plan (URS 2011b).

LTM would also include inspection and maintenance of the monitoring well network. Annual inspections would include visual observations of the well casings, covers, bollards, concrete pads, locks, and paint. Maintenance would include repairs of noted deficiencies.

To determine when cleanup has been achieved and when LTM sampling can stop, a site closeout process was developed for the off-Base plume and is described in Section 4 of the Final Exit Strategy Report for OT-20, Off-Base Groundwater Plume (URS 2010b). The site closeout process will also be used to determine when cleanup of the on-Base plumes has been achieved. The site closeout process is described in Section 5 of the Final 2011 Update to the Long Term Monitoring Plan (URS 2011b).

4.2.1.4 Maintenance of Landfill Caps

Visual inspections of Landfill Numbers 1 (OU-2), 2 (OU-3), 3 (OU-4), 4 (OU-5), 5 (OU-6), 6 (OU-2), 7 (OU-12) and the Explosive Ordnance Disposal Area (OU-8) and Debris Burial Area (OU-8) will be completed semi-annually, at the same time as the semi-annual LTM sampling rounds. Integrity of the cover is important to groundwater quality. These inspections will assess the physical condition of existing soil covers to determine whether any conditions exist that may require repair or maintenance actions. The inspections will be documented using the Landfill Cover Inspection Report form (URS 2011b). Any conditions that may require repair or maintenance actions will be photographed, and the photographs will be attached to the Landfill Cover Inspection Report (URS 2011b).

4.2.1.5 Direct Push Groundwater Sampling

Direct push groundwater sampling would be performed within the groundwater plumes downgradient of IRT zones for VOCs at an estimated 100 locations. The purpose of the direct push groundwater sampling would be to enhance the monitoring well network for plume monitoring and show the effectiveness of the IRTs. This monitoring would be performed the year before each 5-year review in years 2015 and 2020.

4.2.1.6 Institutional Controls

The OU-11 groundwater contaminant plumes were evaluated in a human health risk assessment in which human populations under current and future land use conditions may be exposed to COCs (primarily TCE) in groundwater. In the absence of current uses of shallow groundwater at Ellsworth AFB, the discussion of on-Base risk was limited to hypothetical future risks from residential land use where shallow groundwater was assumed to be potable and used as a primary drinking water source. The total carcinogenic risk to potential future residents from ingestion, inhalation, and dermal contact with contaminated groundwater at the South Docks (Area 1) was 1.77×10^{-4}, exceeding the acceptable risk range of 1×10^{-4} to 1×10^{-6}. An unacceptable risk to human health from exposure to contaminated groundwater was identified for the future use of on-Base groundwater. The total carcinogenic risk at BG04/BG05 (Area 2) was 2.27×10^{-5}, within the acceptable risk range; however, groundwater with concentrations of COCs greater than MCLs had migrated off Base. Remedial action objectives in the 1997 ROD included prevention of human exposure to on-Base and off-Base groundwater at concentrations greater than MCLs (USAF 1997).

For all three alternatives, the ICs will apply to OU-11 on-Base groundwater plumes and the off-Base plume as shown on Figure 1-2. Surface soil, unsaturated subsurface soil, surface water and sediments have already been deleted from the Ellsworth AFB site with the exception of OU-1, the Gateway Lake Ash Study Area, and the Pride Hangar Study Area. The surface soil, unsaturated subsurface soil, surface water and sediments in these three areas are currently in the process of being deleted.

The performance objective of the ICs is to prevent access or use of groundwater until COCs achieve levels consistent with the remedial action objectives listed in Section 4.1. For the on-Base plume, the groundwater access or use will be prevented until COCs are at or below federal MCLs and South Dakota Groundwater Quality Standards. For the off-Base plume, non-potable use of the groundwater is allowed for concentrations of TCE at or below 18 ug/L in accordance with the Final Exit Strategy Report for the off-Base Groundwater Plume (URS 2010b), and potable use will be prevented until COCs are below federal MCLs and South Dakota Groundwater Quality Standards. The ICs will therefore be maintained until concentrations of COCs in groundwater are at such levels to allow for unrestricted use and unlimited exposure.

The on-Base ICs consist of a continuing order, “Land Use Restrictions at Environmental Restoration Sites” (USAF, 2010), issued by the Ellsworth AFB commander on August 5, 2010 restricting activities that could potentially expose on-Base personnel to contaminants in groundwater. A copy of the continuing order is attached to the 2010 Five Year Review (URS 2010c) and is reauthorized every five years. The contractor or any base organization conducting intrusive work is responsible for coordinating a government supplied, Base Civil Engineer Work Clearance Request (AF Form 103) prior to performing digging of any type on base. The contractor or the base organization performing the work are required to process the

digging permit by coordinating with and obtaining signatures from responsible representatives of the organizations listed on the AF Form 103 prior to obtaining final approval from the Air Force Base Civil Engineer or his approved representative. The Base Restoration Program Manager (RPM) is one of the responsible representatives required to coordinate on the AF Form 103. This process helps to lessen the chance of inadvertent exposures and ensure that the continuing order is complied with.

The off-Base ICs consist of MOAs that restrict groundwater use in the Off-Base Plume and the surrounding buffer area. Current MOAs are kept in the Ellsworth AFB Real Estate File Plan (Cabinet 6, Drawer 2, 9A-Ingrats-MOA). Example MOAs are included in Appendix A for two scenarios; where the USAF provides free water and where the owner pays for water. In both examples, the USAF provided an alternative potable water source to the residents by extending a main water supply line to each property. Once the alternative water source was installed and operational, the owners agreed to discontinue pumping water from existing wells for potable uses. The USAF will notify the EPA and SDDENR prior to any changes to the continuing order and/or MOAs. The institutional controls, objectives and rationale for implementing the institutional controls are summarized in Table 4-6.

Table 4-6 Institutional Controls for OU-11 Basewide Groundwater

Controls	Use Restrictions
1	A continuing order issued by Ellsworth AFB commander restricting activities that could potentially expose on-Base personnel to contaminants in groundwater. • *Objective*: Prevent access or use of groundwater until COC concentrations achieve MCLs • *Rationale*: Unacceptable risk to human health from exposure to contaminated groundwater.
2	MOAs that restrict groundwater use in the off-Base plume and the surrounding buffer area. • *Objective*: Prevent potable use of groundwater until COC concentrations achieve MCLs. Allow non-potable use of the groundwater for concentrations of TCE at or below 18 ug/L in accordance with the Final Exit Strategy Report for the off-Base Groundwater Plume (URS 2010b) • *Rationale*: Unacceptable risk to human health from exposure to contaminated groundwater.

The USAF is responsible for implementing, maintaining, monitoring, reporting on, and enforcing ICs. Although the USAF may later transfer these procedural responsibilities to another party by contract, property transfer agreement, or through other means, the USAF shall retain ultimate responsibility for remedy integrity. Any activity that is inconsistent with the IC objectives or use restrictions, or any other action that may interfere with the effectiveness of the ICs will be

addressed by the USAF as soon as practicable, but in no case will the process be initiated later than 10 days after the USAF becomes aware of the breach.

The USAF will notify EPA and SDDENR as soon as practicable but no longer than 10 days after discovery of any activity that is inconsistent with the IC objectives or use restrictions, or any other action that may interfere with the effectiveness of the ICs The USAF will notify EPA and SDDENR regarding how the USAF has addressed or will address the breach within 10 days of sending EPA and SDDENR notification of the breach. The USAF will notify the EPA and SDDENR 45 days in advance of any proposed land use changes that are inconsistent with IC objectives or the selected remedy.

The USAF will provide notice to EPA and SDDENR at least six months prior to any transfer or sale of OU-1, OU-2, OU-3, OU-4, OU-5, OU-6, OU-7, OU-8, OU-9, OU-10, OU-11 or OU-12 so that EPA and SDDENR can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective ICs. If it is not possible for the facility to notify EPA and SDDENR at least six months prior to any transfer or sale, then the facility will notify EPA and SDDENR as soon as possible but no later than 60 days prior to the transfer or sale of any property subject to ICs. In addition to the land transfer notice and discussion provisions above, the USAF further agrees to provide EPA and SDDENR with similar notice, within the same time frames, as to federal-to-federal transfer of property. The USAF shall provide a copy of executed deed or transfer assembly to EPA and SDDENR.

The USAF shall not modify or terminate ICs, implementation actions, or modify land use without approval by EPA and the SDDENR. The USAF shall seek prior concurrence before any anticipated action that may disrupt the effectiveness of the ICs or any action that may alter or negate the need for ICs.

Monitoring of the environmental use restrictions and controls will be conducted annually by the USAF. The monitoring results will be included in a separate report or as a section of another environmental report, if appropriate, and provided to the EPA and the SDDENR. The annual monitoring reports will be used in preparation of the Five Year Review to evaluate the effectiveness of the remedy.

The annual monitoring report, submitted to the regulatory agencies by USAF, will evaluate the status of the ICs and how any IC deficiencies or inconsistent uses have been addressed. The annual evaluation will address whether the use restrictions and controls referenced above were communicated in the deed(s), whether the owners and state and local agencies were notified of the use restrictions and controls affecting the property, and whether use of the property has conformed with such restrictions and controls.

4.2.1.7 Treatment with IRT Zones

This section summarizes the IRT technology and maintenance of the existing IRTs. The injection of food-grade substances into the subsurface is regulated under the Underground Injection Control Program. The injection of food-grade substances has been “authorized by rule” in accordance with 40 CFR Sections 144.24 and 144.84(a). This authorization has been approved for all of the IRTs currently in place within OU-11. Any changes to the current locations or the substances that have been approved would require an additional request for approval.

The IRTs at Ellsworth AFB use biodechlorination to treat the chlorinated plumes. Biodechlorination is a process whereby chlorinated VOCs in contaminated soil and groundwater can be destroyed by biological mechanisms, including microorganisms (e.g. yeast, fungi, or bacteria). Biodechlorination of chlorinated aliphatic hydrocarbons can occur through aerobic oxidation (DO concentration > 2 mg/L) or anaerobic reductive dechlorination (DO concentration < 0.5 mg/L). PCE is only degradable through anaerobic processes, whereas TCE, cis-1,2-DCE, and VC can be degraded through both aerobic and anaerobic processes. Reductive dechlorination, under anaerobic conditions, is the process that is used at Ellsworth AFB. A detailed discussion on the IRT technology is contained in the Final IRT RAWP (URS 2007b). The locations and performance monitoring locations for the 38 IRT zones at Ellsworth AFB are as described in Section 3.0 of this ROD amendment.

Biostimulant is consumed as part of the IRT process; therefore, the biostimulant needs to be replenished periodically. Based on experience at Ellsworth AFB and other sites where this technology has been used, the average time for re-injection of additional biostimulant is 2 years to 3 years.

4.2.2 Alternative 1 – Active Treatment and MNA

Components of Alternative 1 (active treatment and MNA) are operation of the active treatment systems, installation of additional active treatment systems, MNA, ICs, landfill cover maintenance, and LTM.

4.2.2.1 Treatment and Containment Components

Operation of Existing Treatment Systems

Operation of the existing active treatment systems described in Section 4.2.1.1 is part of Alternative 1. As part of implementing IRT pilot tests and full-scale IRT zones over the past 5 years, many of the EWs have been turned off. Many of the EWs that are currently turned off would be reactivated. Base boundary extraction systems would prevent groundwater containing COCs above Federal MCLs and South Dakota Groundwater Quality Standards from moving off Base.

These systems require continued operation, maintenance, and monitoring (OM&M). OM&M would include maintenance of air strippers, pumps, blowers, system piping and valves, replacement of carbon units and micron filters, influent and effluent sampling and analysis to ensure the systems are performing as intended and meeting discharge standards, and replacement of oxygen cylinders for the oxygen infusion wells.

Install Additional Active Treatment Systems

Since the IRT zones at the Twining/Risner-BG05 plume would not be maintained under Alternative 1, active groundwater treatment systems (pump and treat) would be installed at each of the three current IRT transects. A new treatment system would also be added to the BG04 Plume source area. The new treatment systems would be similar to those at the BG04 and BG05 Base boundary treatment plants with each system consisting of a heated building, carbon adsorption units, EWs and injection wells and all associated site work, piping and electrical.

MNA

MNA as described in Section 4.2.1.2 would be implemented.

4.2.2.2 General Components

Maintenance of landfill caps and ICs as described in Sections 4.2.1.4 and 4.2.1.6 would be implemented.

LTM would be implemented as discussed in Section 4.1.1.3. The types of monitoring included in Alternative 1 are plume monitoring, oxygen diffusion performance monitoring, rebound monitoring, landfill monitoring, MNA monitoring, and groundwater level / free product thickness monitoring. The purpose of some of the monitoring wells currently used for IRT performance monitoring would be changed to plume monitoring and groundwater levels.

4.2.2.3 Key ARARs

A comprehensive list of chemical-specific, action-specific and location specific Applicable or Relevant and Appropriate Requirements (ARARs) is presented in Table 4-8 at the end of this section. Groundwater would be treated until MCLs are met for COCs in groundwater meeting the requirements of Safe Drinking Water Act and South Dakota Ground Water Quality Standards. Treated groundwater would meet established effluent requirements satisfying Clean Water Act and South Dakota surface water discharge requirements. Off-gas from air strippers would be treated, if necessary, to meet requirements of the Clean Air Act and State air quality standards. Waste generated (e.g. drill cuttings) during implementation would be disposed of in accordance with Resource Conservation and Recovery Act (RCRA) Hazardous Waste requirements, if necessary.

4.2.3 Alternative 2 – Active Treatment, IRT, and MNA

Components of Alternative 2 (Active Treatment, IRT and MNA) are active treatment systems, treatment with IRTs, MNA, ICs, landfill cover maintenance, direct push groundwater sampling, and LTM. This alternative represents current conditions and is the same as Alternative 1 with the addition of treatment with IRTs and not installing additional active groundwater treatment systems.

4.2.3.1 Treatment and Containment Components

Operation of Existing Treatment Systems

The active groundwater treatment systems are described in Section 4.2.1.1 and under Alternative 2 there would be no immediate changes to the current systems. A combination of Base boundary extraction systems and IRT treatment zones would prevent groundwater containing COCs above Federal MCLs and South Dakota Groundwater Quality Standards from moving off-Base.

Treatment with IRT

In-situ biodechlorination in IRT zones as described in 4.2.1.7 would be continued.

MNA

MNA as described in Section 4.2.1.2 would be implemented.

4.2.3.2 General Components

Maintenance of landfill caps, direct push groundwater sampling, and ICs as described in Sections 4.2.1.4, 4.2.1.5, and 4.2.1.6 would be implemented.

LTM would be implemented as discussed in Section 4.1.1.3. The types of monitoring included in Alternative 2 are plume monitoring, IRT performance monitoring, oxygen diffusion performance monitoring, rebound monitoring, landfill monitoring, MNA monitoring, and groundwater level / free product thickness monitoring.

4.2.3.3 Key ARARs

A comprehensive list of chemical-specific, action-specific, and location specific ARARs is presented in Table 4-8 at the end of this section. Groundwater would be treated until MCLs are met for COCs in groundwater meeting the requirements of Safe Drinking Water Act and South Dakota Ground Water Quality Standards. Treated groundwater would meet established effluent requirements satisfying Clean Water Act and South Dakota surface water discharge requirements. Off-gas from air strippers would be treated, if necessary, to meet requirements of the Clean Air Act and State air quality standards. Waste generated (e.g. drill cuttings) generated during implementation would be disposed of in accordance with RCRA Hazardous Waste requirements, if necessary.

4.2.4 Alternative 3 – IRT and MNA, The Selected Alternative

Components of Alternative 3 (IRT and MNA), the selected alternative, are treatment with IRTs, MNA, ICs, landfill cover maintenance, direct push groundwater sampling, LTM, and a contingency for reactivation of the active groundwater treatment systems. This alternative is the same as Alternative 2 with the deletion of active groundwater treatment.

4.2.4.1 Treatment and Containment Components

Treatment with IRT

In-situ biodechlorination in IRT zones as described in 4.2.1.7 would be continued. The transition period between the use of pump and treat and using only IRTs will be considered complete when the IRTs are shown to meet the applicable RAO at the Base Boundary. This transition period began when the IRTs were first installed and is expected to be complete by the beginning of 2012. Once the transition period is complete, although the pump and treat systems will be maintained, the systems are not expected to be turned back on. Continuing maintenance of the IRT treatment zones is expected to prevent groundwater containing COCs above Federal MCLs and South Dakota Groundwater Quality Standards from moving off Base following the transition period.

MNA

MNA as described in Section 4.2.1.2 would be implemented.

4.2.4.2 General Components

Maintenance of landfill caps, direct push groundwater sampling, and ICs as described in Sections 4.2.1.4, 4.2.1.5, and 4.2.1.6 would be implemented.

LTM would be implemented as discussed in Section 4.1.1.3. The types of monitoring included in Alternative 3 are plume monitoring, IRT performance monitoring, landfill monitoring, MNA monitoring, and groundwater level / free product thickness monitoring.

4.2.4.3 Contingency for Alternative 3

The use of IRTs is a relatively new technology compared to pump-and-treat technologies. Based on the performance of IRTs at Ellsworth AFB and other AFBs, the IRTs are expected to perform as intended with proper maintenance. However, as a contingency, the active systems already in place at Ellsworth AFB would remain in place in the event they are required in the future. These systems would require periodic maintenance to ensure they remain operational. During annual LTM events, the systems would be inspected for damage and repaired as necessary. The systems would then be reactivated for several hours to keep pumps and blowers operational, and all valves would be exercised.

Methods of in-situ treatment exist for the treatment of the contaminants in groundwater in addition to IRT, and additional in-situ treatment technology may develop over time. As an additional contingency, other methods of in-situ treatment may be implemented in the future as appropriate.

4.2.4.4 Key ARARs

A comprehensive list of chemical-specific, action-specific and location specific ARARs is presented in Table 4-8 at the end of this section. Groundwater would be treated until MCLs are met for COCs in groundwater meeting the requirements of Safe Drinking Water Act and South Dakota Ground Water Quality Standards. In the event active groundwater treatment is restarted, treated groundwater would meet established effluent requirements satisfying Clean Water Act and South Dakota surface water discharge requirements. Off-gas from air strippers would be treated, if necessary, to meet requirements of the Clean Air Act and State air quality standards. Waste generated (e.g. drill cuttings) generated during implementation would be disposed of in accordance with RCRA Hazardous Waste requirements, if necessary.

4.3 EXPECTED OUTCOMES

The Air Force recommends that the remedy for OU-11 Basewide Groundwater be changed from active treatment with IRT and MNA (the current remedy following 2007 ESD) to IRT and MNA (the new selected remedy), because the IRT and MNA remedy would achieve the same objectives as groundwater extraction and treatment at less cost and in a shorter period of time. Cleanup levels of contaminants of concern are not changed, with the exception of an error correction for the 1,1,1-trichloroethane (1,1,1-TCA) standard. As shown in Table 4-7, the 1,1,1-TCA standard listed in the 1996 OU-1 ROD is 5 µg/L but should be 200 µg/L. Time to meet RAOs throughout the plumes is estimated at 30 years. Implementation of Alternative 3 is considered to be a fundamental change to the current ROD; therefore, this ROD amendment is necessary to change the remedy.

A groundwater monitoring program has been developed for the on-Base groundwater plumes and the off-Base groundwater plume (URS 2011b), and it includes a decision process to evaluate when cleanup has been achieved for individual plumes. This process is consistent with the 2011 ESD for OU-11 Basewide Groundwater and with the Exit Strategy Report for the Off-Base Groundwater Plume (URS 2010b). It is expected that individual plumes, both on-Base and off-Base, will be partially deleted as they meet the defined cleanup criteria.

TABLE 4-7
SUMMARY OF APPLICABLE RECORDS OF DECISION

Operable Unit	CERCLA Status	Remedial Action Objectives	Selected Response Action in ROD	Performance Standards
OU-1 Fire Protection Training Area No. 1	• IRA ROD May 1995 • ROD May 10, 1996 • ESD July 17, 2007	• Cleanup of groundwater to regulatory levels[1] and, for contaminants where regulatory levels are not available, to levels considered safe for public drinking water. • Clean up source area soils to levels that would not pose a threat of contaminating groundwater.	• SVE for source soils. • Dual wells and extraction wells for groundwater. • Soil vapor and groundwater treatment. • ICs (including deed and land use restrictions). • LTO/LTM.	• Attainment of MCLs for groundwater. • Attainment of infiltration model calculated cleanup concentrations for soil.
OU-2 Landfills No. 1 and No. 6	• ROD May 15, 1996 • ESD July 17, 2007	• Provide protection against direct contact with contents of the landfills. • Provide protection against ingestion of contaminated groundwater at concentrations exceeding regulatory or risk-based goals. • Minimize the potential for transport of contaminants in the soils and groundwater beyond the boundaries of the landfills. • Three areas of concern: LF1, LF6, surface water bodies.	• Install an earth cover. • Install a perimeter fence and post warning signs. • ICs (including deed and land use restrictions). • LTM.	• Maintain the earth cover, fencing and ICs. • Maintain groundwater regulatory standards at the downgradient landfill boundaries.
OU-3 Landfill No. 2	• ROD June 7, 1996 • ESD July 17, 2007	• To reduce the potential risks posed by contaminants in surface soils. • To reduce the mobility of potential contaminants in the landfill through containment. • Does not address Leachate remediation since identified wastes placed in the landfill do not typify that which would normally be associated with Leachate production. Groundwater monitoring will identify whether Leachate is being produced in the future.	• Install an earth cover. • Install a perimeter fence and post warning signs. • ICs (including deed and land use restrictions). • LTM.	• Maintain the earth cover, fencing and ICs. • Maintain groundwater regulatory standards at the downgradient landfill boundary.
OU-4 Landfill	• IRA ROD May 1995 • ROD May 15, 1996 • ESD July 17, 2007	• Reduce the potential risks posed by contaminants in surface soils and groundwater. • To reduce the mobility of potential contaminants in the landfill through containment. • To prevent ingestion of contaminated groundwater.	• Install an earth cover. • Install a perimeter fence and post warning signs. • ICs (including deed and land use restrictions). • Extraction wells for groundwater. • Groundwater treatment. • LTO/LTM.	• Maintain the earth cover, fencing and ICs. • Maintain groundwater regulatory standards at the downgradient Base boundary. • Attain MCLs for groundwater.
OU-5 Landfill No. 4	• ROD June 19, 1996 • ESD July 17, 2007	• To reduce the potential risks posed by contaminants in surface soils. • To reduce the mobility of potential contaminants in the landfill through containment.	• Install an earth cover. • Install a perimeter fence and post warning signs. • ICs (including deed and land use restrictions). • LTM.	• Maintain the earth cover, fencing and ICs. • Maintain groundwater regulatory standards at the downgradient landfill boundary.
OU-6 Landfill No. 5	• ROD October 10, 1995 • ESD July 17, 2007	• To reduce the potential risks posed by contaminants in surface soils. • To reduce the mobility of potential contaminants in the landfill through containment. • To prevent ingestion of sediments within OU-6.	• Install an earth cover. • Install a perimeter fence and post warning signs. • ICs (including deed and land use restrictions). • LTM.	• Maintain the earth cover, fencing and ICs. • Maintain groundwater regulatory standards at the downgradient landfill boundary.
OU-7 Weapons Storage Area	• ROD June 19, 1996 • ESD July 17, 2007	• To reduce the potential risks posed by contaminants in soils. • To prevent ingestion of groundwater containing chemicals that are risk drivers at concentrations exceeding MCLs.	• ICs (including deed and land use restrictions). • LTM.	• Maintain the ICs. • Attain MCLs for groundwater.

TABLE 4-7
SUMMARY OF APPLICABLE RECORDS OF DECISION

Operable Unit	CERCLA Status	Remedial Action Objectives	Selected Response Action in ROD	Performance Standards
OU-8 Explosive Ordnance Disposal Area	• ROD June 19, 1996 • ESD July 17, 2007	• To reduce the potential risks posed by contaminants in surface soils. • To reduce the mobility of potential contaminants in the landfill through containment.	• Install an earth cover. • Install a perimeter fence and post warning signs. • ICs (including deed and land use restrictions). • LTM.	• Maintain the earth cover, fencing and ICs. • Monitor contaminant concentrations in adjacent and downgradient drainages to evaluate the effectiveness of the cover.
OU-11	• ROD April 1997 • ESD July 17, 2007	• Prevent future human exposure to on-Base groundwater with contaminants exceeding State of South Dakota Ground Water Quality Standards (SDGWQS) and Maximum Containment Levels (MCLs). • Prevent additional groundwater containing contaminants above SDGWQS and MCLs from moving off Base. • Prevent human exposure to off-Base groundwater with contaminants exceeding SDGWQS and MCLs.	• Removal and containment of groundwater with • Groundwater treatment. • ICs (including deed and land use restrictions). • LTO/LTM. • NA for off-Base groundwater east of the Base. • Construction of a water supply line in the area of the off-Base groundwater plume east of the Base to supply residents with an alternative potable water supply. • Biodechlorination was added as a treatment technology in the 2007 ESD.	• Maintain the ICs. • Attain MCLs for groundwater.
OU-12 Hardfill No. 1	• ROD May 15, 1996 • ESD July 17, 2007	• To reduce the potential risks posed by contaminants in surface soils. • To reduce the mobility of potential contaminants in the hardfill through containment.	• Install an earth cover. • Install a perimeter fence and post warning signs. • ICs (including land use restrictions). • LTM.	• Maintain the earth cover, fencing and ICs. • Maintain groundwater and sediment regulatory standards at the downgradient hardfill boundary. • Attain MCLs for groundwater.

Notes:

1 = The OU-1 1996 ROD refers to cleanup goals in Table 2-1 of the OU-1 1996 ROD. The standard for 1,1,1-trichloroethane listed in Table 2-1 of the OU-1 1996 ROD is 5 but should be 200 µg/L.
ESD = Explanation of Significant Differences
ICs = Institutional Controls
IRA = Interim Remedial Action
LTM = Long Term Monitoring
LTO = Long Term Operation
MCL = Maximum Contaminant Level
NA = Natural Attenuation
No. = Number
OU = Operable Unit
PCE = Tetrachloroethene
ROD = Record of Decision
SDGWQS = South Dakota Ground Water Quality Standard
SVE = Soil Vapor Extraction
TCE = Trichloroethene
TPH = Total Petroleum Hydrocarbons
VC = Vinyl Chloride
VOCs = Volatile Organic Compounds

TABLE 4-8
FEDERAL AND STATE ARARS APPLIED TO ELLSWORTH AFB, SOUTH DAKOTA

Standard Requirement, Criteria, or Limitation	Citations	Description	ARAR Type	Applicability to EAFB
A. Applicable or Relevant and Appropriate Federal Standards, Requirements, Criteria, and Limitations				
National Primary Drinking Water Regulations	40 CFR Part 141.11-12	Specifies MCLs of public water systems.	Chemical	Relevant and appropriate for Federal Class II aquifer.
National Secondary Drinking Water Standards	40 CFR Part 143.03	Establishes SMCLs for public water systems. These are federally non-enforceable standards, which regulate contaminants in drinking water that primarily affect the qualities.	Chemical	Relevant and appropriate.
Maximum Contaminant Level Goals	40 CFR Part 141. 50 & Pub. L. No. 99-330, 100 Stat. 642 (1986)	Establishes drinking water quality goals set at levels of unknown or anticipated adverse health effects, with an adequate margin of safety.	Chemical	Relevant and appropriate.
Water Quality Criteria	40 CFR Part 131.1-22	Sets criteria for water quality based on toxicity to aquatic organisms and human health.	Chemical	Relevant and appropriate. Aquifer may be a Federal Class IIA (discharge to surface water).
Criteria and Standards for the National Pollutant Discharge Elimination	40 CFR 125.1-3	Establishes criteria and standards for technology-based requirements in permits under the Sections 301(b) and 402 of the CWA. The State standards in ARSD 74:52:07:01 are equivalent.	Chemical	Applicable for groundwater treated and discharged to EAFB WWTP.
General Pretreatment Regulations for Existing and New Sources of Pollution	40 CFR 403.1-4, 8-11, 1B 40 CFR 403.5-7, 13, 15	Establishes responsibilities of federal, state, and local government and of the POTW in providing guidelines for and developing, submitting, approving, and modifying state pretreatment programs. Specifies standards for pretreatment. The State Standards in ARSD 74:52:11:15 are equivalent.	Action	Applicable for groundwater treated and discharged to EAFB WWTP.
Promulgated Guidelines Establishing Test Procedures for the Analysis of Pollutants	40 CFR 136.1-5 and Appendices A-C	Specifies analytical procedures for NPDES applications and reports.	Action	Applicable for treatment and discharge of groundwater.
National Primary and Secondary Ambient Air Quality Standard	40 CFR Part 50.1-6, 8,9,11,12, and Appendices A, H, J, K	Establishes national primary and secondary ambient air quality standards to protect public health and welfare. The State standards in ARSD 74:36:02:02 are equivalent.	Action	Applicable.

TABLE 4-8
FEDERAL AND STATE ARARS APPLIED TO ELLSWORTH AFB, SOUTH DAKOTA

Standard Requirement, Criteria, or Limitation	Citations	Description	ARAR Type	Applicability to EAFB
National Emission Standards for Hazardous Air Pollutants	40 CFR Part 61.01	Establishes regulatory standard for specific air pollutants.	Action	Applicable for alternatives that would discharge to the air following treatment.
Solid Waste Disposal Facility Criteria	40 CFR Parts 257.21-30 and 258.50-75	Sets forth revised minimum federal criteria for Municipal Solid Waste Landfills for existing and new units. The State standards in ARSD 74:27:15:09 are equivalent.	Action	Relevant and appropriate for addressing landfill closure performance standards.
Executive Order 11990 on Protection of Wetlands	EO: 42 Fed. Reg. 26961 (May 24,1977)	Requires federal agencies to avoid, to the extent possible, the adverse impacts associated with the destruction or loss of wetlands and to avoid support of new construction in wetlands if a practicable alternative exists.	Action/Location	Applicable. EAFB has identified wetland areas adjacent to sites where RAs were completed.
Underground Injection Control Program	40 CFR 144.24-27	Sets forth requirements for Class V injection well authorization by rule.	Action	Applicable for injection wells installed for aquifer remediation at EAFB.
B. Applicable or Relevant and Appropriate State Standards, Requirements, Criteria, and Limitations				
South Dakota Solid Waste Rules	ARSD 74:27:15:03	Defines requirements for closure of solid waste disposal facilities.	Action	Relevant and appropriate for landfill closure performance guidelines.
South Dakota Hazardous Waste Identification and Listing Rules	ARSD 74:28:22:01	Defines solid wastes which are subject to regulation as hazardous wastes.	Action	Applicable for identifying hazardous waste.
South Dakota Hazardous Waste Standards for Generators	ARSD 74:28:23:01	Establishes standards for generators of hazardous waste.	Action	Applicable to alternatives relating to removal or off site transport of a hazardous material.
South Dakota Hazardous Waste Standards for Treatment, Storage and Disposal	ARSD 74:28:25:01	Establishes standards for hazardous waste treatment, storage, and disposal facilities.	Action	Relevant and appropriate for performance guidelines for landfill closure.

TABLE 4-8
FEDERAL AND STATE ARARS APPLIED TO ELLSWORTH AFB, SOUTH DAKOTA

Standard Requirement, Criteria, or Limitation	Citations	Description	ARAR Type	Applicability to EAFB
South Dakota Surface Water Discharge Permit Rules	ARSD 74:52:03:13 ARSD 74:52:08:01	Establishes surface water permit conditions. Establishes toxic pollutant effluent standards for surface water discharge permits.	Action	Applicable for any groundwater treatment discharge.
South Dakota Surface Water Quality Rules	ARSD 74:51: 03:11	Defines use of Box Elder Creek and certain tributaries.	Action	Applicable for any groundwater treatment discharge.
South Dakota Ground Water Quality Standards	ARSD 74:54:01:03-05	Defines ground water classifications by beneficial use and sets chemical standards.	Chemical	Applicable.

Notes:

ARAR = Applicable or Relevant and Appropriate Requirements
ARSD = Administrative Rules of South Dakota
CFR = Code of Federal Regulations
CWA = Clean Water Act
EAFB = Ellsworth Air Force Base
MCCL = Maximum Chemical Contaminant Levels
MSWLF = Municipal Solid Waste Landfills
NPDES = National Pollution Discharge Elimination System
POTW = Publicly Owned Treatment Works
SMCL = Secondary Maximum Containment Levels
TSDF = Treatment, Storage, and Disposal Facilities
U.S. = United States
USC = United States Code
WWTP = Wastewater Treatment Plant

5.0 EVALUATION OF ALTERNATIVES

5.1 DETAILED ANALYSIS OF ALTERNATIVES

Pursuant to Section 300.430(e)(9)(iii) of the EPA's revised NCP, the remedial action alternatives for OU-11 were evaluated in detail using nine criteria that were developed to address CERCLA requirements and considerations. The nine criteria fall into three groups: threshold criteria, primary balancing criteria, and modifying criteria.

- Threshold criteria are requirements that each alternative must meet in order to be eligible for selection.
- Primary balancing criteria, which are used to weigh major trade-offs among alternatives.
- Modifying criteria, which may be considered to the extent that information is available during the FFS, but can be fully considered only after public comment is received on the Proposed Plan. In the final balancing of trade-offs between alternative upon which the final remedy selection is based, modifying criteria are of equal importance to the balancing criteria.

Evaluation Criteria for Superfund Remedial Alternatives
THRESHOLD CRITERIA
Overall Protectiveness of Human Health and the Environment determines whether an alternative eliminates, reduces, or controls threats to public health and the environment through institutional controls, engineering controls, or treatment.
Compliance with ARARs evaluates whether the alternative meets Federal and State environmental statutes, regulations, and other requirements that pertain to the site, or whether a waiver is justified.
PRIMARY BALANCING CRITERIA
Long-term Effectiveness and Permanence considers the ability of an alternative to maintain protection of human health and the environment over time.
Reduction of Toxicity, Mobility, or Volume (TMV) of Contaminants through Treatment evaluates an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of contamination present.
Short-term Effectiveness considers the length of time needed to implement an alternative and the risks the alternative poses to workers, residents, and the environment during implementation.
Implementability considers the technical and administrative feasibility of implementing the alternative, including factors such as the relative availability of goods and services.
Cost includes estimated capital and annual operations and maintenance costs, as well as present worth cost. Present worth cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30 percent.
MODIFYING CRITERIA
State and EPA Acceptance considers whether the EPA and State agrees with the USAF's analyses and recommendations, as described in the RI/FS and Proposed Plan.
Community Acceptance considers whether the local community agrees with USAF's analyses and preferred alternative. Comments received on the Proposed Plan are an important indicator of community acceptance.

The three alternatives under consideration for OU-11 to treat Basewide groundwater at Ellsworth AFB are:

Alternative 1 – Active Treatment and MNA

Alternative 2 – Active Treatment, IRT, and MNA

Alternative 3 – IRT and MNA

5.1.1 Overall Protection of Human Health and the Environment

This criterion provides a final check to assess whether each alternative provides adequate protection of human health and the environment, focusing on how each risk and associated pathway are eliminated, reduced, or controlled. The assessment on overall protection draws from the assessments done under other criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs. This evaluation allows for consideration of whether an alternative poses any unacceptable short-term or cross-media impacts resulting from remediation.

All three alternatives have been shown to be protective of human health and the environment. For the OUs with landfill covers, continued inspections and maintenance of the ICs would be required. All three alternatives comply with ARARs and are expected to meet MCLs at the Base boundary by 2012 and meet all RAOs over time and reduce contaminant mass in the groundwater.

5.1.2 Compliance with ARARs

This criterion is used to determine whether each alternative will meet Federal and State ARARs. A description of ARARs is provided in Section 4.1 of the OU-11 Basewide Groundwater FFS (URS 2011c). If an identified ARAR is not met by an alternative, then an evaluation on the appropriateness of a waiver should be made. Waivers could be applied in any of six circumstances identified in CERCLA Section 121 (d)(4) including: interim measure; greater risk to health and environment; technical impractibility; equivalent standard of performance; inconsistent application of State requirements; and in the case of a remedial action undertaken solely using the Fund, Fund-balancing.

All of the remedy components of the three alternatives being evaluated have been used at Ellsworth AFB and meet the ARARs listed in Table 4-8.

5.1.3 Long-Term Effectiveness and Permanence

This criterion addresses the risk remaining at the site associated with each alternative after remedial action has taken place and objectives have been met. The focus is on risk posed by residuals and/or untreated wastes after the cleanup criteria have been reached. The primary components of this criterion include consideration of the magnitude of residual risk and the adequacy and reliability of controls.

Alternative 1 permanently removes the contaminants from groundwater. Once RAOs are met, the residual contaminants remaining in groundwater would not pose an unacceptable threat to human health.

Alternative 2 permanently removes the contaminants from groundwater through active systems and through enhanced biological processes. Once RAOs are met, the residual contaminants remaining in groundwater would not pose an unacceptable threat to human health.

Alternative 3 uses enhanced biological processes to permanently and irreversibly degrade the contaminants to innocuous compounds as groundwater passes through the IRT zones. Additionally, since this technology requires very little energy to operate and maintain; it complies with the EPA and AFCEE guidelines for green and sustainable remediation, which minimizes the impact on the environment.

5.1.4 Reduction of TMV through Treatment

This criterion addresses the statutory preference of CERCLA for remedial actions involving treatment technologies that permanently and significantly reduces TMV of the principal hazardous substances at a site. This preference is satisfied when irreversibly-reducing contaminant toxicity, mobility, or reducing the total volume of contaminated media.

The reduction of TMV through treatment is achieved by all three alternatives by either physical or biochemical processes.

Alternative 1 uses pump and treat technology to physically extract groundwater from the subsurface and pump it to a treatment facility. Treatment systems at Ellsworth AFB include air strippers, micron filters, and activated carbon. These types of systems permanently remove the contaminants from the groundwater but do not actually destroy the contaminants. The air stripping process transfers most of the VOCs from groundwater to the atmosphere.

Alternative 2 uses pump and treat technology to physically extract groundwater from the subsurface and pump it to a treatment facility. Treatment systems at Ellsworth AFB include air strippers, micron filters, and activated carbon. These types of systems permanently remove the contaminants from the groundwater but do not actually destroy the contaminants. The air stripping process transfers most of the VOCs from groundwater to the atmosphere. Alternative 2 also uses enhanced biological processes to permanently and irreversibly degrade the contaminants to innocuous compounds as groundwater passes through the IRT zones. This process effectively reduces toxicity and volume of contaminants.

Alternative 3 uses enhanced biological processes to permanently and irreversibly degrade the contaminants to innocuous compounds as groundwater passes through the IRT zones. This process effectively reduces toxicity and volume of contaminants.

5.1.5 Short-Term Effectiveness

This criterion assesses the short-term effectiveness of each alternative by assessing the risk to the community, workers, and environment during the construction and implementation of the remedial action, and the time required to achieve the RAOs.

The risk to the community, workers, and the environment during construction is minimal for Alternative 1. Most of the active treatment systems in Alternative 1 have been constructed and construction of the three small treatment systems for Twining/Risner-BG05 and the system for BG04 source area would pose minimal threats to the community and workers.

There is no construction associated with Alternatives 2 or 3.

Risks associated with all alternatives include working around pressurized pipelines and hoses, working near rotating machinery, and exposure to COCs. These risks are considered minimal and are addressed through the implementation of a Site Safety and Health Plan.

The estimated time for Alternative 1 to reach RAOs is 30 years or greater based on experience with similar pump and treat systems. The estimated time for Alternative 2 to reach RAOs is 10 years downgradient of the IRT zones and 30 years or greater in the source areas where active treatment is ongoing. The estimated time for Alternative 3 to reach RAOs is 10 years downgradient of the IRT zones and 30 years or greater in the source zones.

IRTs just downgradient of the source areas would be maintained until the source areas have been cleaned up. Clean-up time for the on-Base TCE plumes using the IRT process was estimated using site-specific estimates of groundwater flow velocities and TCE degradation rates. Flow velocities were estimated from slug-test estimates of aquifer hydraulic conductivity, measured hydraulic gradients, and assumed effective porosity values. A detailed discussion on the estimated cleanup time for Alternatives 2 and 3 is provided in Appendix B of the FFS (URS 2011c).

5.1.6 Implementability

Implementability is evaluated in terms of technical feasibility, administrative feasibility, and availability of services and materials. Technical feasibility assesses the ability to construct, operate, monitor and, if needed, expand an alternative. Administrative feasibility assesses the activities needed to coordinate with other agencies or obtain permits. Availability of services and materials considers locally available resources and availability of technologies.

Both active treatment and IRT zones have been implemented successfully at Ellsworth AFB. Materials, equipment, and labor to maintain either technology are readily available.

5.1.7 Cost

The cost of each alternative is evaluated by considering the capital cost, operations and maintenance cost, and total present worth cost. The present worth costs provide a common basis for comparing alternatives.

The cost of each alternative is developed as the sum of capital costs, operations and maintenance (O&M) costs, and periodic costs. The feasibility-level cost analysis is provided in Appendix A of the FFS (URS 2011c). Present value is the amount of money needed in the base year to cover the future costs associated with a particular time period at a particular interest or discount rate. Present value is developed at a discount rate of 2.7 percent, as specified in the current U.S. Office of Management and Budget (OMB) guidance (OMB 2009), for each

alternative to provide a common basis for comparing alternatives. A feasibility-level cost estimate, intended to provide an accuracy range of -30 to +50 percent of actual cost, was prepared for each alternative using recent guidance (USEPA 2000). The final project cost of the selected alternative will depend on actual labor and material cost, productivity, competitive market conditions, final project scope and schedule, and other variable factors.

The estimated capital costs, annual O&M costs, periodic costs, total present value, and project duration of each alternative are summarized below.

Alternative Cost Summary

Table 5-1 Alternative Cost Summary OU-11 Basewide Groundwater

Description	Alternative 1 Active Treatment and MNA	Alternative 2 Active Treatment, IRT, and MNA	Alternative 3 IRT and MNA
Total Project Duration (Years)	30	30	30
Capital Cost	$1,260,000	$0	$0
Total Annual O&M Cost	$19,700,000	$20,900,000	$4,330,000
Total Periodic Cost	$224,000	$1,770,000	$1,770,000
Total Cost of Alternative	$21,200,000	$22,700,000	$6,180,000
Total Escalated Cost of Alternative	$28,300,000	$30,500,000	$7,500,000
Total Present Value (at 2.7% discount rate [OMB 2009])	$15,500,000	$16,100,000	$5,060,000

5.1.8 State and EPA Acceptance

At NPL facilities, both the USAF and EPA must agree on the selected remedy and the State must be given the opportunity to review, comment on, and concur with the selected remedy. The USAF consulted with EPA Region 8 and the SDDENR during the preparation of this ROD amendment. This ROD amendment was drafted with their cooperation and support. All regulatory agency comments have been addressed and incorporated into this document. EPA Region 8 and SDDENR concur with the amended remedy for OU-11 Basewide Groundwater. Pursuant to CERCLA Section 117 (42 USC Section 9617) and the NCP at 40 CFR 300.435(c)(2)(ii), this document amends the 1997 ROD for OU-11 Basewide Groundwater.

5.1.9 Community Acceptance

In accordance with 40 CFR Section 300.435(c)(2)(ii), a public comment period was offered from 20 June 2011 to 19 July 2011. A public meeting was held on 13 July 2011 at the South Dakota Air and Space Museum, just outside the main gate at Ellsworth AFB, South Dakota. No written or verbal comments were received during the comment period.

5.2 SUMMARY OF DETAILED ANALYSIS

Based on the detailed analysis of the three alternatives, the following comparisons can be made:

- All alternatives would be protective of human health and the environment.
- All alternatives would be in compliance with ARARs.
- All alternatives would provide long-term and short-term effectiveness and reduce TMV.
- All alternatives have been implemented successfully at Ellsworth AFB.

The Air Force recommends that the remedy for OU-11 Basewide Groundwater be changed from active treatment with IRT and MNA (the current remedy following the 2007 ESD) to Alternative 3, IRT and MNA (the new selected remedy), because the IRT and MNA remedy would achieve the same objectives as groundwater extraction and treatment at less cost and in a shorter time period. Cleanup levels of COCs are not changed, with the exception of an error correction for the 1,1,1-TCA standard. As shown in Table 4-7, the 1,1,1-TCA standard listed in the 1996 OU-1 ROD is 5 µg/L but should be 200 µg/L. Time to meet RAOs throughout the plumes is estimated at 30 years. Five year reviews will continue until no hazardous substances, pollutants, or contaminants remain in place above unlimited or unrestricted exposure.

6.0 SUPPORT AGENCY COMMENTS ON RECORD OF DECISION AMENDMENT

The USAF consulted with EPA Region 8 and the SDDENR during the preparation of this ROD amendment. This ROD amendment was drafted with their cooperation and support. All regulatory agency comments have been addressed and incorporated into this document. The EPA Region 8 and SDDENR concur with this ROD amendment.

7.0 STATUTORY DETERMINATION

This ROD amendment changes the remedy for OU-11 Basewide Groundwater from active treatment with IRT and MNA to IRT and MNA. It is consistent with CERCLA §121 (42 USC §9621) and the NCP (40 CFR §300). The selected remedy is protective of human health and the environment; complies with Federal and State ARARs identified in the ROD, and is cost-effective.

8.0 PUBLIC PARTICIPATION COMPLIANCE AND RESPONSIVENESS SURVEY

In accordance with 40 CFR Section 300.435(c)(2)(ii), a public comment period was offered from 20 June 2011 to 19 July 2011 to allow for comment on the Revised Proposed Plan for OU-11 Basewide Groundwater. A public meeting was held on 13 July 2011 at the South Dakota Air and Space Museum, just outside the main gate at Ellsworth Air Force Base, South Dakota.

At the time of the public review period, the USAF had selected Alternative 3 (IRT and MNA) as the preferred alternative for OU-11 Basewide Groundwater. No written or verbal comments were received during the public comment period.

9.0 REFERENCES

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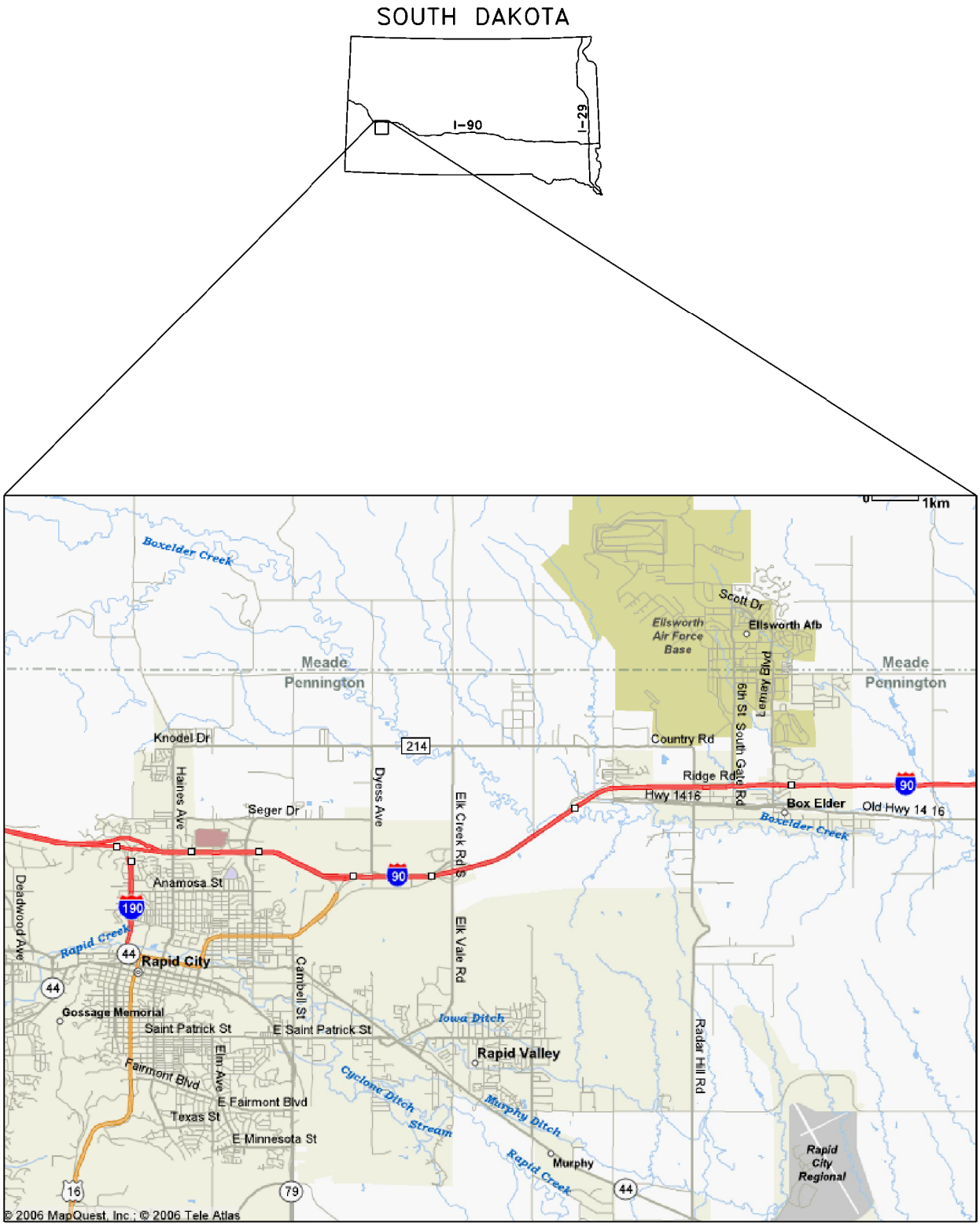
10.0 ACRONYMS AND ABBREVIATIONS

AEC	Atomic Energy Commission
AFB	Air Force Base
ARARs	Applicable or Relevant and Appropriate Requirements
BTEX	benzene, toluene, ethylbenzene, xylene
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
COCs	chemicals of concern
DBA	debris burial area
DCA	dichloroethane
DCE	dichloroethene
DO	dissolved oxygen
DPE	dual phase extraction
EOD	explosive ordnance disposal
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Differences
EW	extraction well
FFA	Federal Facilities Agreement
FFS	Focused Feasibility Study
FMSA	former munitions storage area
FRA – PH1	Flightline Refueling Area – Pumphouse 1
FPTA	Fire Protection Training Area
GAC	granulated activated carbon
HI	hazard index
HVE	high vacuum extraction
IC	Institutional Control
IRA	interim remedial action
IRT	in-situ reductive treatment
JP-4	Jet Propulsion Fuel No. 4
LOX	liquid oxygen
LTM	long term monitoring
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
MCL	Maximum Contaminant Level
MNA	monitored natural attenuation
MOA	Memoranda of Agreement
MSA	Munitions Storage Area
NCP	National Contingency Plan
NPL	National Priorities List
OMB	U.S. Office of Management and Budget
O&M	operations and maintenance
OM&M	operation, maintenance, and monitoring
OU	Operable Unit
PCE	tetrachloroethene
RAO	remedial action objective

RA-O	Remedial Action - Operations
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RPM	Restoration Program Manager
ROD	Record of Decision
SAR	Small Arms Range
SDDENR	South Dakota Department of Environment and Natural Resources
SDM	South Docks Main
SVE	soil vapor extraction
SVOC	semi-volatile organic chemical
TCA	1,1,1-trichloroethane
TCE	Trichloroethene
TMV	toxicity, mobility or volume
U.S.	United States
USC	United States Code
USAF	United States Air Force
UST	underground storage tank
VC	vinyl chloride
VOC	volatile organic compounds
WWTP	Waste Water Treatment Plant

FIGURES



BASE LOCATION MAP
OU-11 BASEWIDE GROUNDWATER ROD AMENDMENT
ELLSWORTH AFB, SOUTH DAKOTA

DRN. BY: TMS	DATE: 07/02/10	PROJECT NO. 16169962	FIG. NO. 1-1
CHK'D. BY: DO	DATE: 07/02/10		

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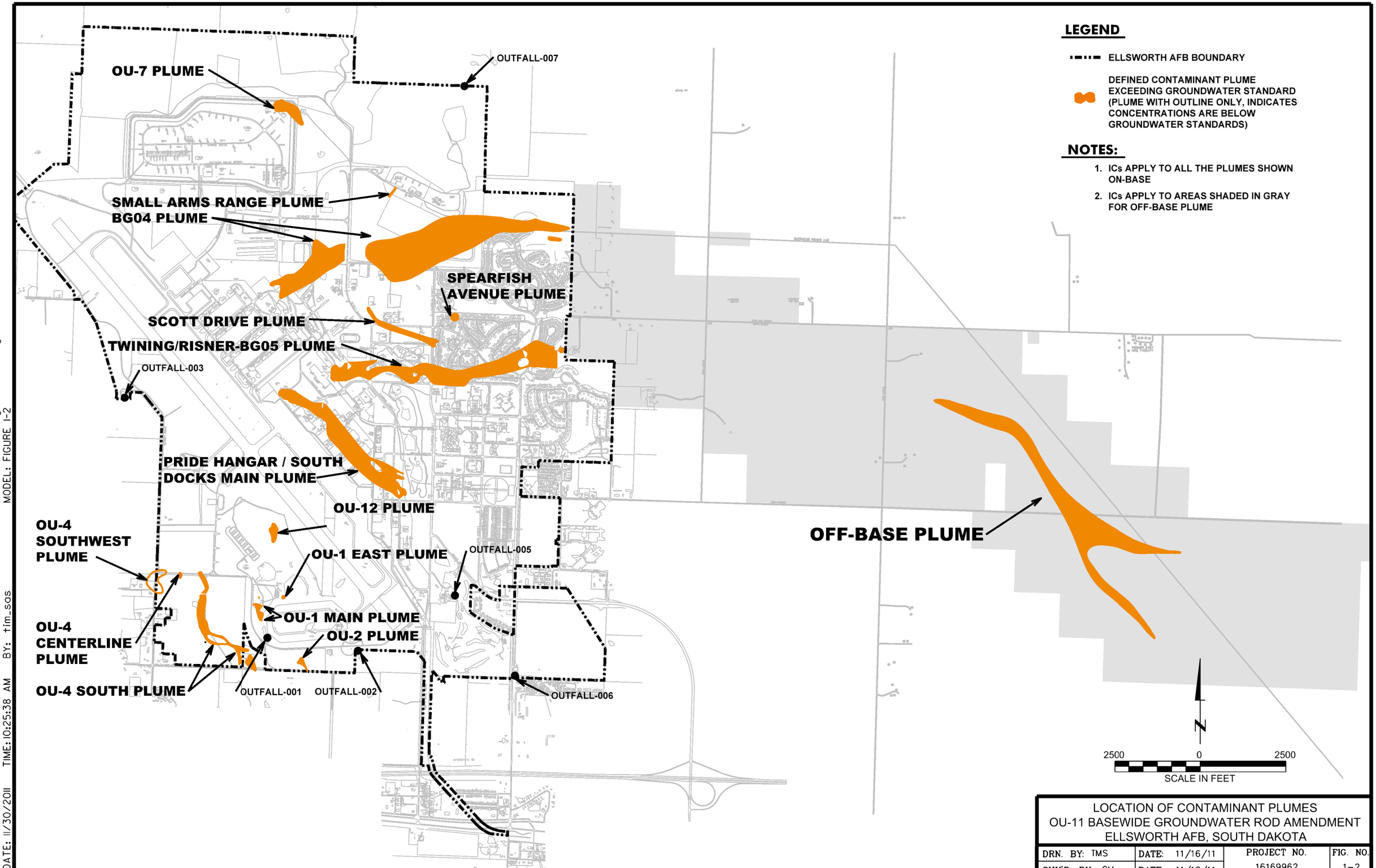
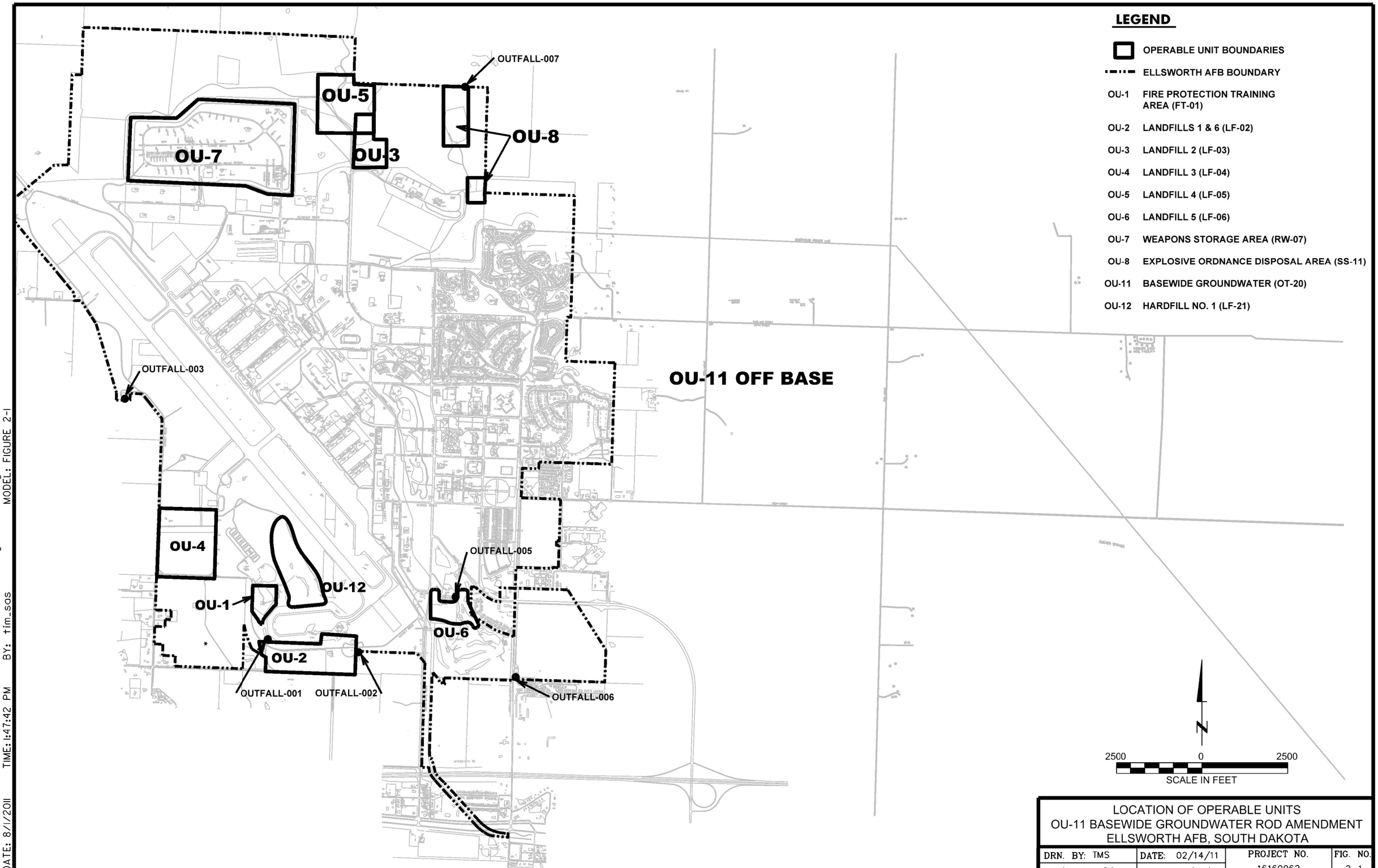
DATE: 7/21/2011 TIME: 9:53:09 AM BY: tim_sas



LOCATION OF CONTAMINANT PLUMES
OU-11 BASEWIDE GROUNDWATER ROD AMENDMENT
ELLSWORTH AFB, SOUTH DAKOTA

DRN. BY: TMS	DATE: 11/16/11	PROJECT NO. 16169962	FIG. NO. 1-2
CHK'D. BY: CM	DATE: 11/16/11		

FILE: T:\ellsworth\16169962\12033\OU-11 Basewide Groundwater Rod Amendment\Figure 01-02.dgn
DATE: 11/30/2011 TIME: 10:25:38 AM BY: tim_sas MODEL: FIGURE 1-2



LOCATION OF OPERABLE UNITS
OU-11 BASEWIDE GROUNDWATER ROD AMENDMENT
ELLSWORTH AFB, SOUTH DAKOTA

DRN. BY: TMS	DATE: 02/14/11	PROJECT NO.	FIG. NO.
CHK'D. BY: DO	DATE: 02/14/11	16169962	2-1

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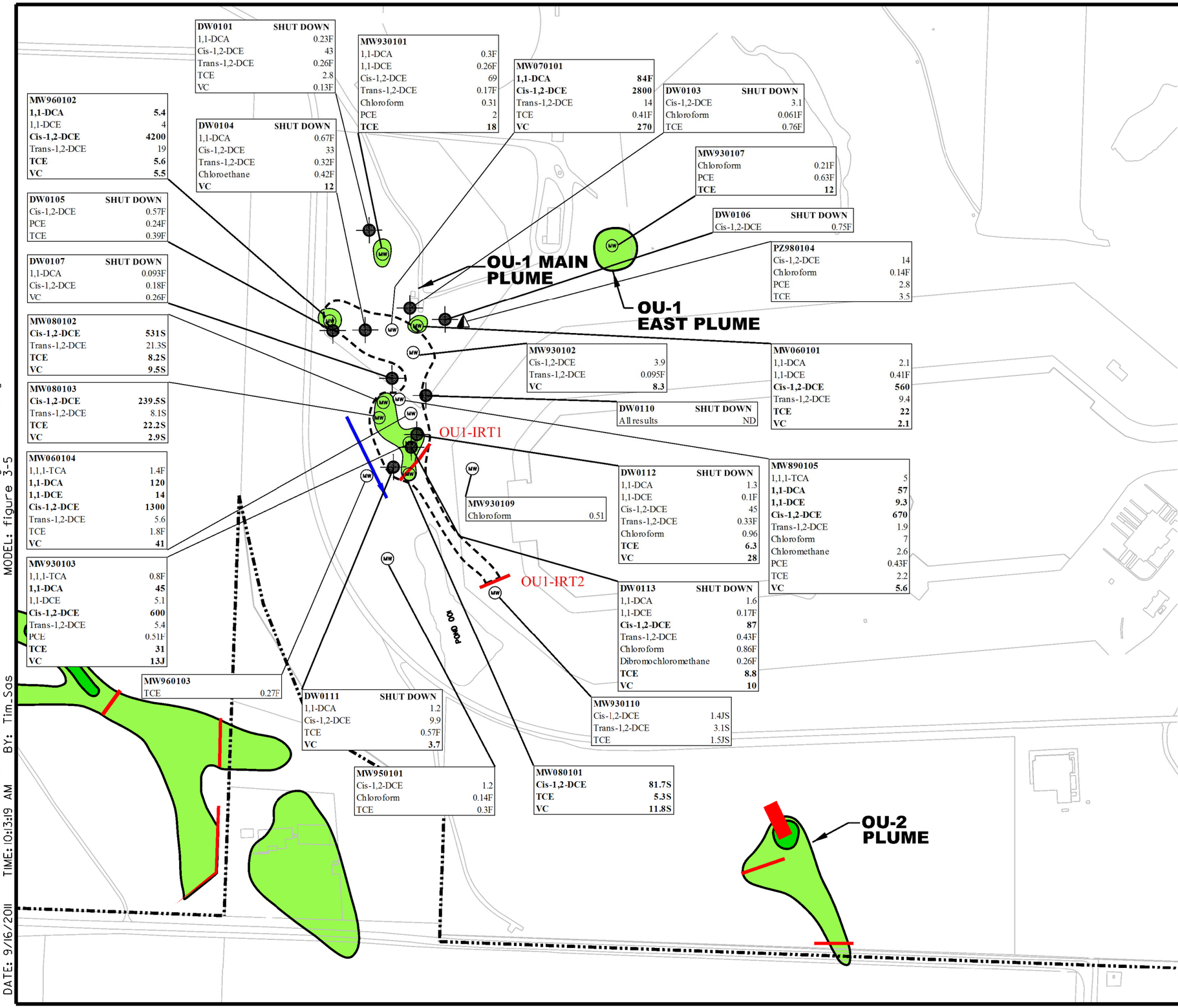

LEGEND

- GROUNDWATER MONITORING WELL SAMPLE
- DUAL PHASE EXTRACTION WELL LOCATION
- BASE BOUNDARY
- AREA WHERE GROUNDWATER EXCEEDS THE VINYL CHLORIDE STANDARD
- IRT WALL
- 5 ug/L TCE
- 50 ug/L TCE
- DETECTED COMPOUNDS
- **BOLD** EXCEEDS A SCREENING LEVEL

DCA	DICHLOROETHANE
DCE	DICHLOROETHENE
PCE	TETRACHLOROETHENE
TCA	TRICHLOROETHANE
TCE	TRICHLOROETHENE
VC	VINYLCHLORIDE
ND	NOT DETECTED

- GROUNDWATER FLOW DIRECTION

NOTES :

1. ALL RESULTS ARE IN MICROGRAMS PER LITER
2. THE GROUNDWATER MEDIUM WAS TRANSFERRED TO OU-II BASEWIDE GROUNDWATER ON JULY 7, 2005. THE GROUNDWATER PLUMES WILL RETAIN PREVIOUS NOMENCLATURE.
3. PLUME INTERPRETATION IS BASED ON GROUNDWATER SAMPLING DATA COLLECTED FROM THE REMEDIAL INVESTIGATION (1992 THROUGH 1995) THROUGH THE CURRENT ROUND OF SAMPLING.
4. EXTRACTION WELL STATUS IS SHOWN FOR THE TIME OF LTM SAMPLING.

OU-1, CHLORINATED VOC CONCENTRATIONS AND TCE CONTOURS APRIL 2011 EVENT
OU-11 BASEWIDE GROUNDWATER ROD AMENDMENT
ELLSWORTH AFB, SOUTH DAKOTA

DRN. BY: TMS	DATE: 09/16/11	PROJECT NO.	FIG. NO.
CHK'D. BY: BG	DATE: 09/16/11	16169962	2-2

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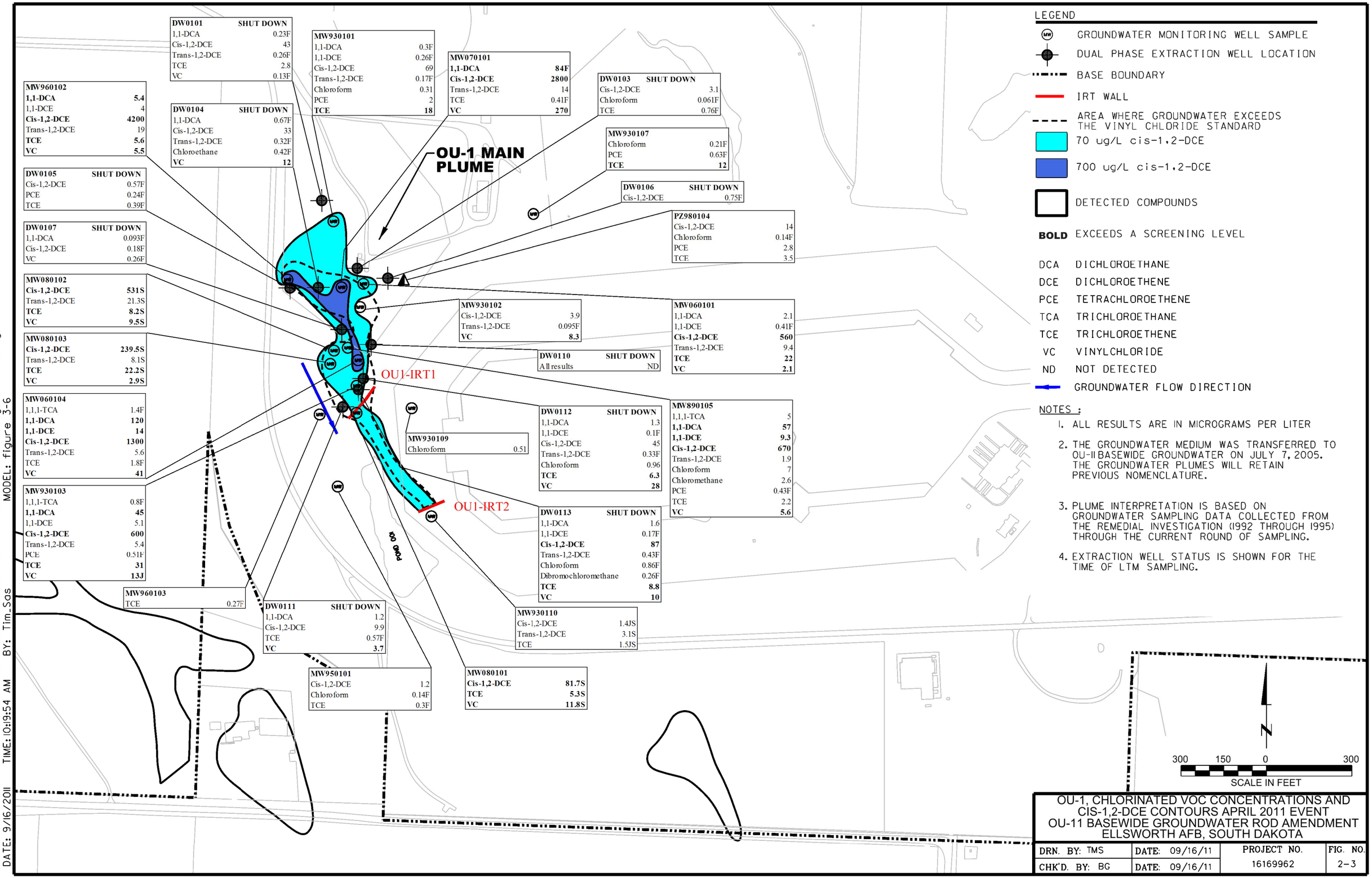
OU-1 MAIN PLUME
OU1-IRT1
OU1-IRT2
POND 001
DW0101 SHUT DOWN
1,1-DCA 0.23F
Cis-1,2-DCE 43
Trans-1,2-DCE 0.26F
TCE 2.8
VC 0.13F
MW930101
1,1-DCA 0.3F
1,1-DCE 0.26F
Cis-1,2-DCE 69
Trans-1,2-DCE 0.17F
Chloroform 0.31
PCE 2
TCE 18
MW070101
1,1-DCA 84F
Cis-1,2-DCE 2800
Trans-1,2-DCE 14
TCE 0.41F
VC 270
DW0103 SHUT DOWN
Cis-1,2-DCE 3.1
Chloroform 0.061F
TCE 0.76F
MW960102
1,1-DCA 5.4
1,1-DCE 4
Cis-1,2-DCE 4200
Trans-1,2-DCE 19
TCE 5.6
VC 5.5
DW0104 SHUT DOWN
1,1-DCA 0.67F
Cis-1,2-DCE 33
Trans-1,2-DCE 0.32F
Chloroethane 0.42F
VC 12
MW930107
Chloroform 0.21F
PCE 0.63F
TCE 12
DW0105 SHUT DOWN
Cis-1,2-DCE 0.57F
PCE 0.24F
TCE 0.39F
DW0106 SHUT DOWN
Cis-1,2-DCE 0.75F
PZ980104
Cis-1,2-DCE 14
Chloroform 0.14F
PCE 2.8
TCE 3.5
DW0107 SHUT DOWN
1,1-DCA 0.093F
Cis-1,2-DCE 0.18F
VC 0.26F
MW080102
Cis-1,2-DCE 531S
Trans-1,2-DCE 21.3S
TCE 8.2S
VC 9.5S
MW930102
Cis-1,2-DCE 3.9
Trans-1,2-DCE 0.095F
VC 8.3
MW060101
1,1-DCA 2.1
1,1-DCE 0.41F
Cis-1,2-DCE 560
Trans-1,2-DCE 9.4
TCE 22
VC 2.1
DW0110 SHUT DOWN
All results ND
MW080103
Cis-1,2-DCE 239.5S
Trans-1,2-DCE 8.1S
TCE 22.2S
VC 2.9S
MW060104
1,1,1-TCA 1.4F
1,1-DCA 120
1,1-DCE 14
Cis-1,2-DCE 1300
Trans-1,2-DCE 5.6
TCE 1.8F
VC 41
DW0112 SHUT DOWN
1,1-DCA 1.3
1,1-DCE 0.1F
Cis-1,2-DCE 45
Trans-1,2-DCE 0.33F
Chloroform 0.96
TCE 6.3
VC 28
MW890105
1,1,1-TCA 5
1,1-DCA 57
1,1-DCE 9.3
Cis-1,2-DCE 670
Trans-1,2-DCE 1.9
Chloroform 7
Chloromethane 2.6
PCE 0.43F
TCE 2.2
VC 5.6
MW930109
Chloroform 0.51
MW930103
1,1,1-TCA 0.8F
1,1-DCA 45
1,1-DCE 5.1
Cis-1,2-DCE 600
Trans-1,2-DCE 5.4
PCE 0.51F
TCE 31
VC 13J
DW0113 SHUT DOWN
1,1-DCA 1.6
1,1-DCE 0.17F
Cis-1,2-DCE 87
Trans-1,2-DCE 0.43F
Chloroform 0.86F
Dibromochloromethane 0.26F
TCE 8.8
VC 10
MW960103
TCE 0.27F
DW0111 SHUT DOWN
1,1-DCA 1.2
Cis-1,2-DCE 9.9
TCE 0.57F
VC 3.7
MW930110
Cis-1,2-DCE 1.4JS
Trans-1,2-DCE 3.1S
TCE 1.5JS
MW950101
Cis-1,2-DCE 1.2
Chloroform 0.14F
TCE 0.3F
MW080101
Cis-1,2-DCE 81.7S
TCE 5.3S
VC 11.8S
LEGEND
GROUNDWATER MONITORING WELL SAMPLE
DUAL PHASE EXTRACTION WELL LOCATION
BASE BOUNDARY
IRT WALL
AREA WHERE GROUNDWATER EXCEEDS THE VINYL CHLORIDE STANDARD
70 ug/L cis-1,2-DCE
700 ug/L cis-1,2-DCE
DETECTED COMPOUNDS
BOLD EXCEEDS A SCREENING LEVEL
DCA DICHLOROETHANE
DCE DICHLOROETHENE
PCE TETRACHLOROETHENE
TCA TRICHLOROETHANE
TCE TRICHLOROETHENE
VC VINYLCHLORIDE
ND NOT DETECTED
GROUNDWATER FLOW DIRECTION
NOTES :
1. ALL RESULTS ARE IN MICROGRAMS PER LITER
2. THE GROUNDWATER MEDIUM WAS TRANSFERRED TO OU-II BASEWIDE GROUNDWATER ON JULY 7, 2005. THE GROUNDWATER PLUMES WILL RETAIN PREVIOUS NOMENCLATURE.
3. PLUME INTERPRETATION IS BASED ON GROUNDWATER SAMPLING DATA COLLECTED FROM THE REMEDIAL INVESTIGATION (1992 THROUGH 1995) THROUGH THE CURRENT ROUND OF SAMPLING.
4. EXTRACTION WELL STATUS IS SHOWN FOR THE TIME OF LTM SAMPLING.
N
300 150 0 300
SCALE IN FEET
OU-1, CHLORINATED VOC CONCENTRATIONS AND CIS-1,2-DCE CONTOURS APRIL 2011 EVENT
OU-11 BASEWIDE GROUNDWATER ROD AMENDMENT
ELLSWORTH AFB, SOUTH DAKOTA
DRN. BY: TMS
DATE: 09/16/11
CHK'D. BY: BG
DATE: 09/16/11
PROJECT NO. 16169962
FIG. NO. 2-3
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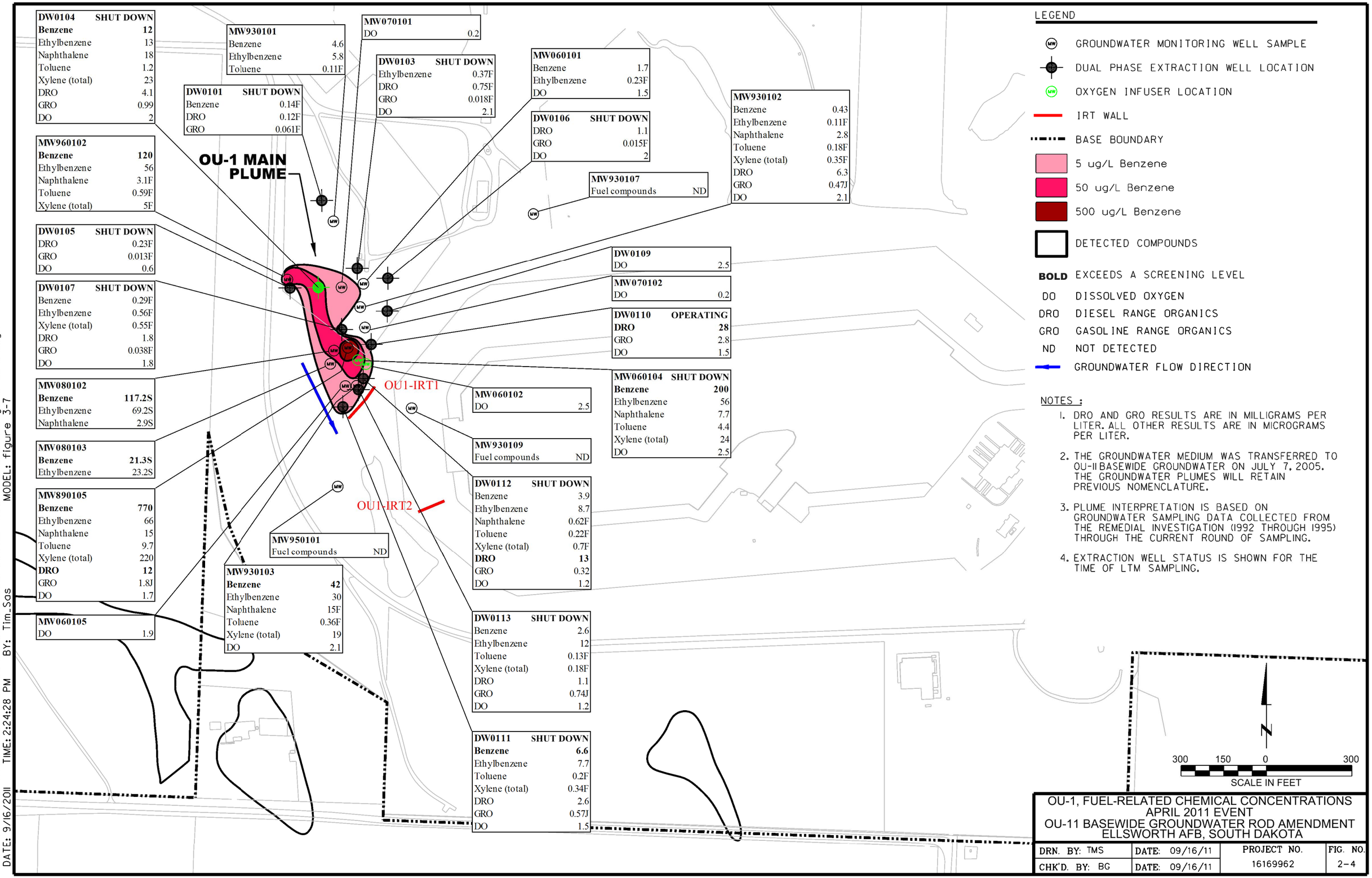
DATE: 9/16/2011 TIME: 10:19:54 AM BY: Tim.Sas MODEL: figure 3-6


DW0104 SHUT DOWN
Benzene 12
Ethylbenzene 13
Naphthalene 18
Toluene 1.2
Xylene (total) 23
DRO 4.1
GRO 0.99
DO 2
MW930101
Benzene 4.6
Ethylbenzene 5.8
Toluene 0.11F
MW070101
DO 0.2
DW0103 SHUT DOWN
Ethylbenzene 0.37F
DRO 0.75F
GRO 0.018F
DO 2.1
MW060101
Benzene 1.7
Ethylbenzene 0.23F
DO 1.5
DW0101 SHUT DOWN
Benzene 0.14F
DRO 0.12F
GRO 0.061F
DW0106 SHUT DOWN
DRO 1.1
GRO 0.015F
DO 2
MW930102
Benzene 0.43
Ethylbenzene 0.11F
Naphthalene 2.8
Toluene 0.18F
Xylene (total) 0.35F
DRO 6.3
GRO 0.47J
DO 2.1
MW960102
Benzene 120
Ethylbenzene 56
Naphthalene 3.1F
Toluene 0.59F
Xylene (total) 5F
OU-1 MAIN PLUME
MW930107
Fuel compounds ND
DW0105 SHUT DOWN
DRO 0.23F
GRO 0.013F
DO 0.6
DW0109
DO 2.5
MW070102
DO 0.2
DW0107 SHUT DOWN
Benzene 0.29F
Ethylbenzene 0.56F
Xylene (total) 0.55F
DRO 1.8
GRO 0.038F
DO 1.8
DW0110 OPERATING
DRO 28
GRO 2.8
DO 1.5
MW080102
Benzene 117.2S
Ethylbenzene 69.2S
Naphthalene 2.9S
OU1-IRT1
MW060104 SHUT DOWN
Benzene 200
Ethylbenzene 56
Naphthalene 7.7
Toluene 4.4
Xylene (total) 24
DO 2.5
MW060102
DO 2.5
MW080103
Benzene 21.3S
Ethylbenzene 23.2S
MW930109
Fuel compounds ND
DW0112 SHUT DOWN
Benzene 3.9
Ethylbenzene 8.7
Naphthalene 0.62F
Toluene 0.22F
Xylene (total) 0.7F
DRO 13
GRO 0.32
DO 1.2
OU1-IRT2
MW890105
Benzene 770
Ethylbenzene 66
Naphthalene 15
Toluene 9.7
Xylene (total) 220
DRO 12
GRO 1.8J
DO 1.7
MW950101
Fuel compounds ND
MW930103
Benzene 42
Ethylbenzene 30
Naphthalene 15F
Toluene 0.36F
Xylene (total) 19
DO 2.1
MW060105
DO 1.9
DW0113 SHUT DOWN
Benzene 2.6
Ethylbenzene 12
Toluene 0.13F
Xylene (total) 0.18F
DRO 1.1
GRO 0.74J
DO 1.2
DW0111 SHUT DOWN
Benzene 6.6
Ethylbenzene 7.7
Toluene 0.2F
Xylene (total) 0.34F
DRO 2.6
GRO 0.57J
DO 1.5
LEGEND
GROUNDWATER MONITORING WELL SAMPLE
DUAL PHASE EXTRACTION WELL LOCATION
OXYGEN INFUSER LOCATION
IRT WALL
BASE BOUNDARY
5 ug/L Benzene
50 ug/L Benzene
500 ug/L Benzene
DETECTED COMPOUNDS
BOLD EXCEEDS A SCREENING LEVEL
DO DISSOLVED OXYGEN
DRO DIESEL RANGE ORGANICS
GRO GASOLINE RANGE ORGANICS
ND NOT DETECTED
GROUNDWATER FLOW DIRECTION
NOTES :
1. DRO AND GRO RESULTS ARE IN MILLIGRAMS PER LITER. ALL OTHER RESULTS ARE IN MICROGRAMS PER LITER.
2. THE GROUNDWATER MEDIUM WAS TRANSFERRED TO OU-11 BASEWIDE GROUNDWATER ON JULY 7, 2005. THE GROUNDWATER PLUMES WILL RETAIN PREVIOUS NOMENCLATURE.
3. PLUME INTERPRETATION IS BASED ON GROUNDWATER SAMPLING DATA COLLECTED FROM THE REMEDIAL INVESTIGATION (1992 THROUGH 1995) THROUGH THE CURRENT ROUND OF SAMPLING.
4. EXTRACTION WELL STATUS IS SHOWN FOR THE TIME OF LTM SAMPLING.
N
300 150 0 300
SCALE IN FEET
OU-1, FUEL-RELATED CHEMICAL CONCENTRATIONS
APRIL 2011 EVENT
OU-11 BASEWIDE GROUNDWATER ROD AMENDMENT
ELLSWORTH AFB, SOUTH DAKOTA
DRN. BY: TMS
DATE: 09/16/11
CHK'D. BY: BG
DATE: 09/16/11
PROJECT NO. 16169962
FIG. NO. 2-4
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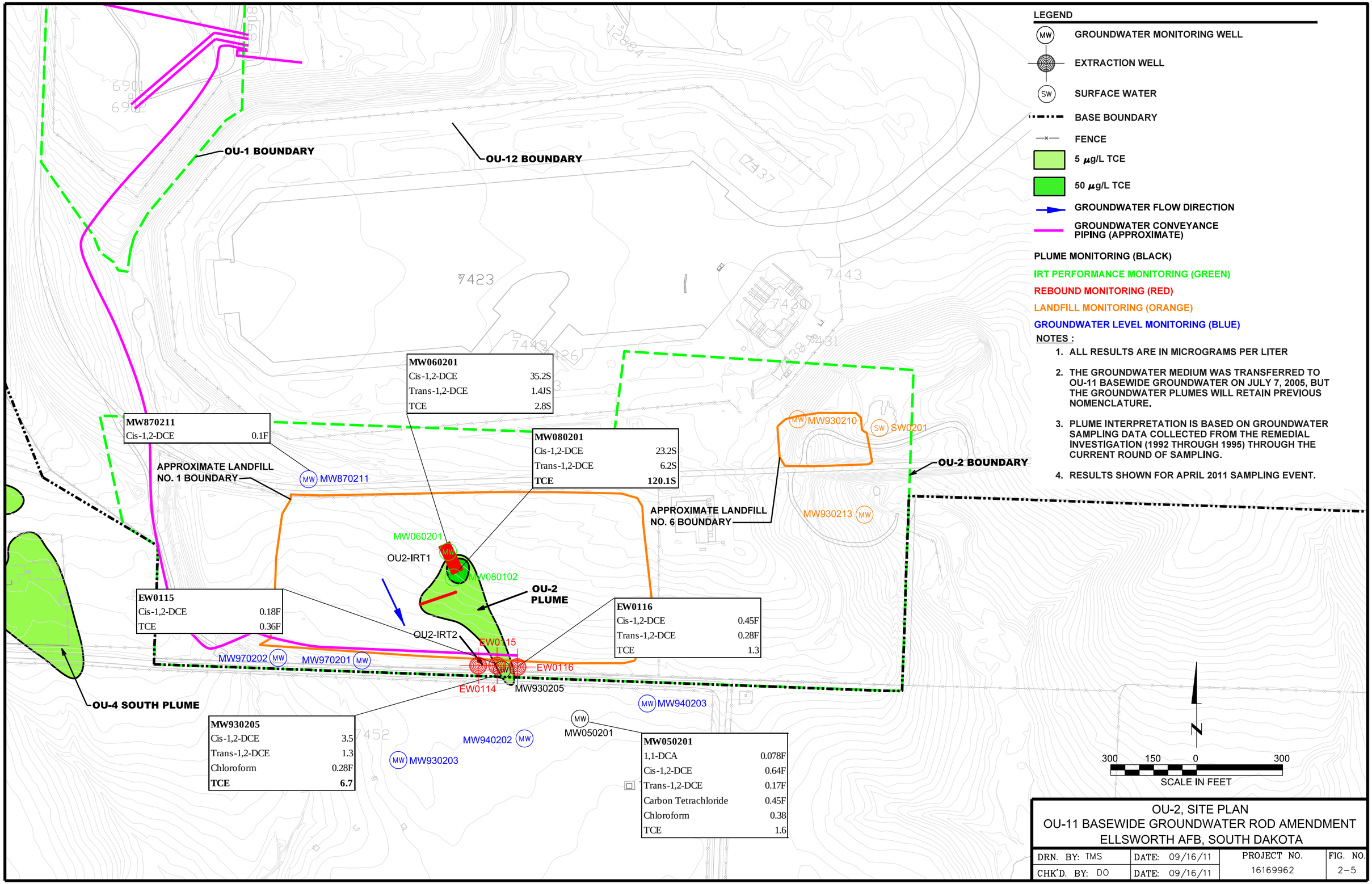

OU-2, SITE PLAN
OU-11 BASEWIDE GROUNDWATER ROD AMENDMENT
ELLSWORTH AFB, SOUTH DAKOTA

DRN. BY: TMS	DATE: 09/16/11	PROJECT NO.	FIG. NO.
CHK'D. BY: DO	DATE: 09/16/11	16169962	2-5

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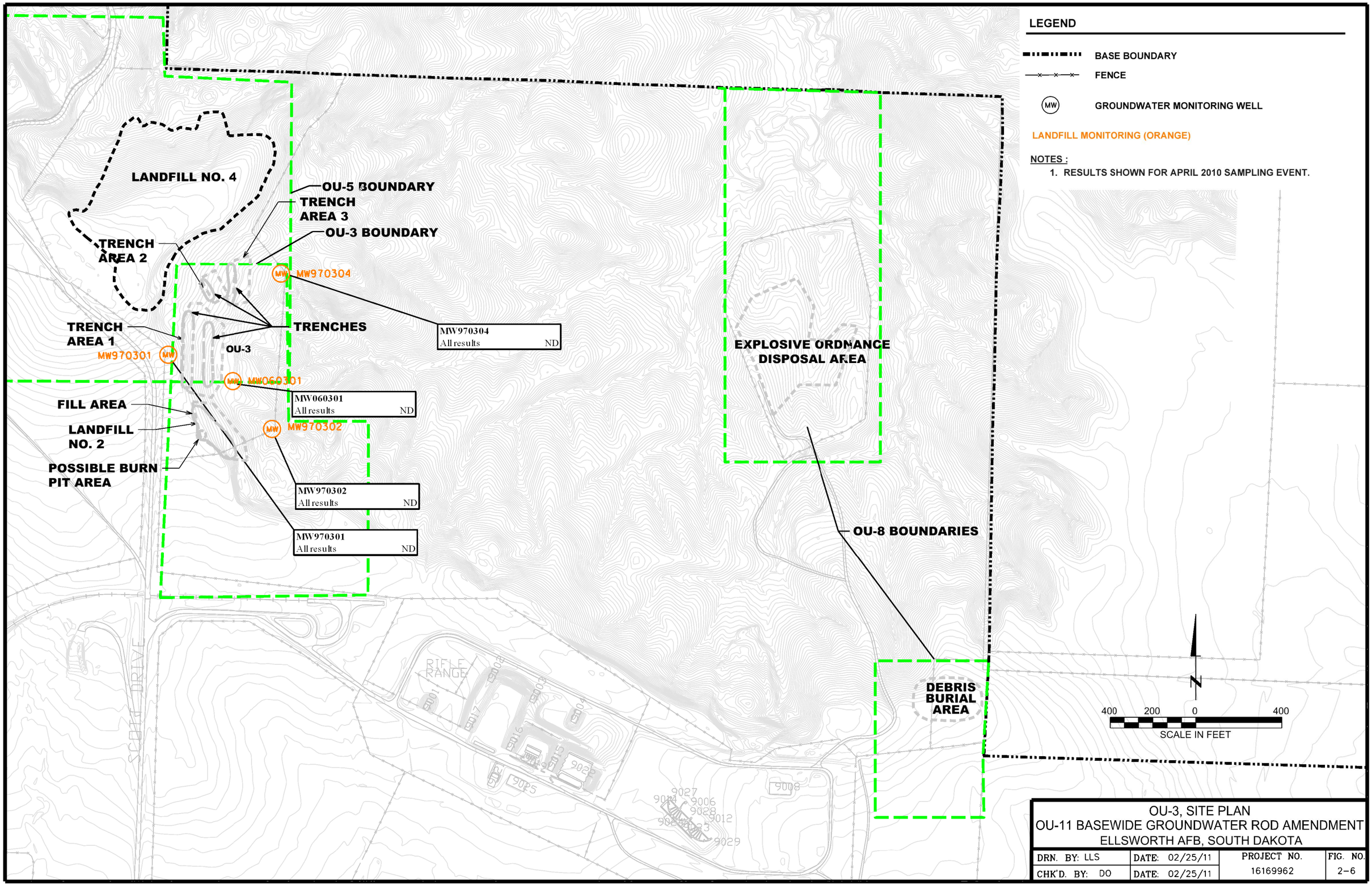

OU-3, SITE PLAN
OU-11 BASEWIDE GROUNDWATER ROD AMENDMENT
ELLSWORTH AFB, SOUTH DAKOTA

DRN. BY: LLS	DATE: 02/25/11	PROJECT NO.	FIG. NO.
CHK'D. BY: DO	DATE: 02/25/11	16169962	2-6

FILE: T:\ellsworth\16169962\2022\OU-11ROD Amendment\Figure 02-06.dgn MODEL: figure 2-6
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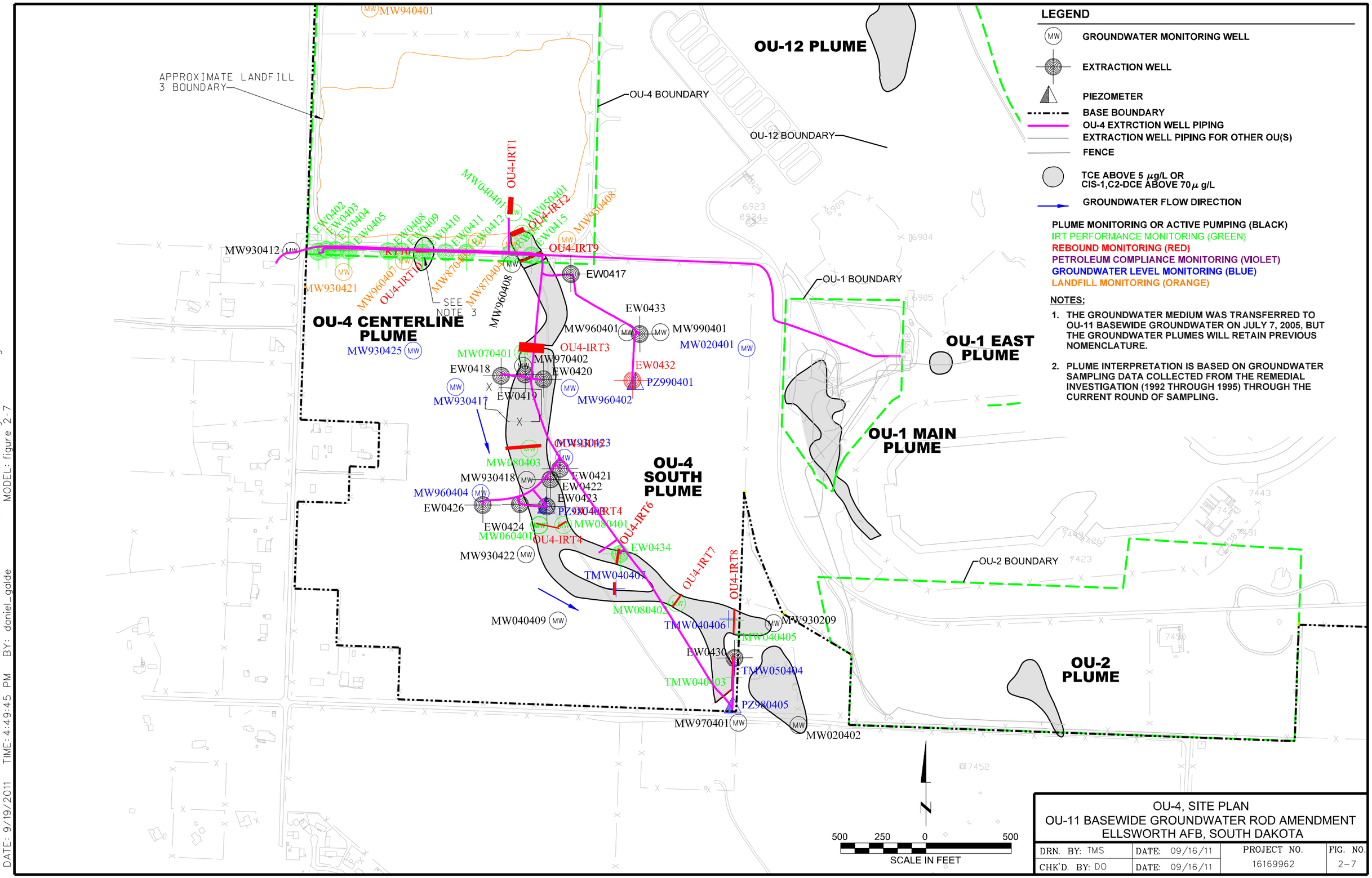
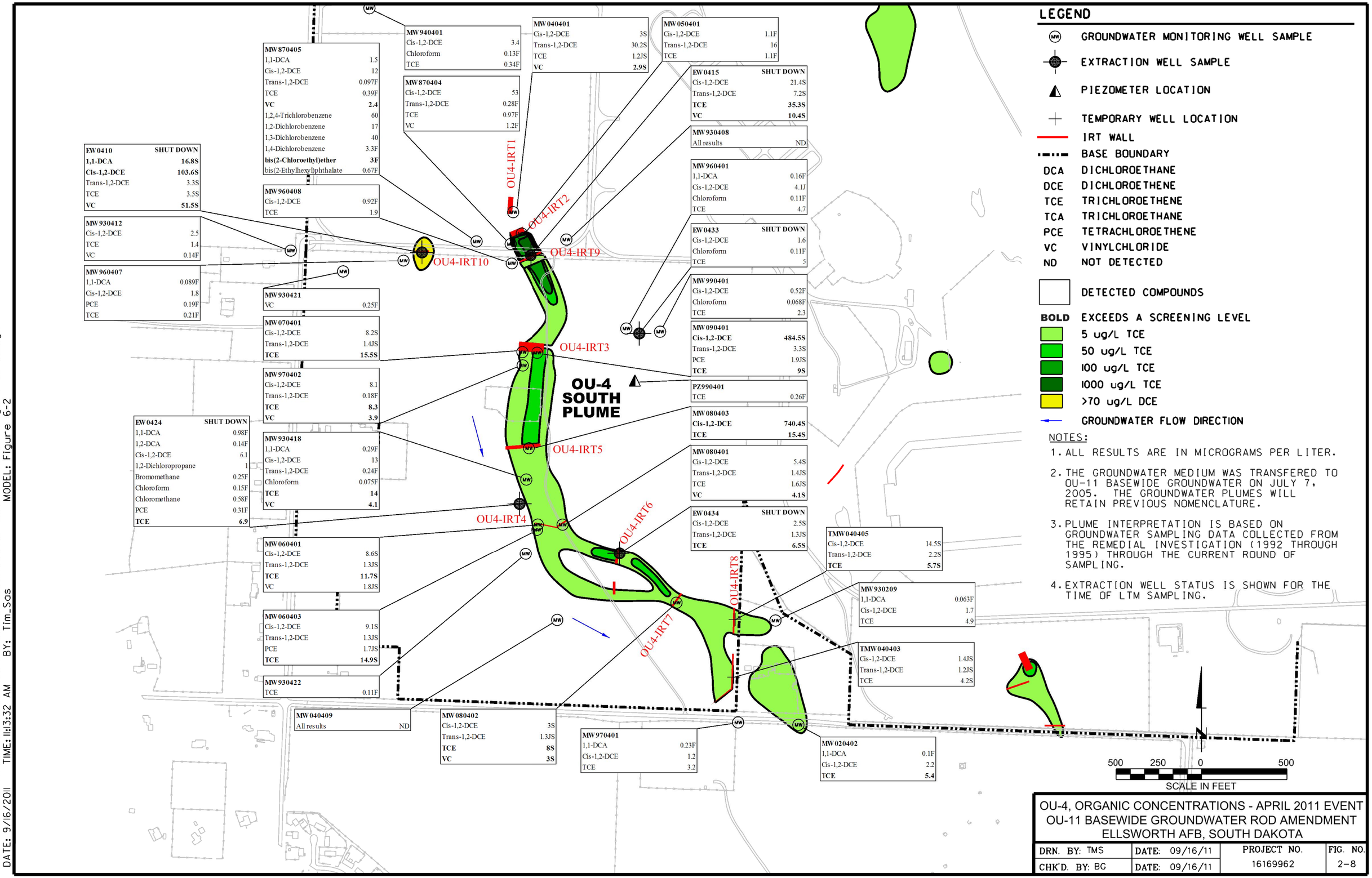


OU-4, SITE PLAN
OU-11 BASEWIDE GROUNDWATER ROD AMENDMENT
ELLSWORTH AFB, SOUTH DAKOTA

DRN. BY: TMS	DATE: 09/16/11	PROJECT NO. 16169962	FIG. NO. 2-7
CHK'D. BY: DO	DATE: 09/16/11		

FILE: T:\ellsworth\16169962\12033\OU-11 Basewide Goundwater Rod Amendment\Figure 02-07.dgn
DATE: 9/19/2011 TIME: 4:49:45 PM BY: daniel_galde MODEL: figure 2-7



LEGEND

- GROUNDWATER MONITORING WELL SAMPLE
- EXTRACTION WELL SAMPLE
- PIEZOMETER LOCATION
- TEMPORARY WELL LOCATION
- IRT WALL
- BASE BOUNDARY
- DCA DICHLOROETHANE
- DCE DICHLOROETHENE
- TCE TRICHLOROETHENE
- TCA TRICHLOROETHANE
- PCE TETRACHLOROETHENE
- VC VINYLCHLORIDE
- ND NOT DETECTED
- DETECTED COMPOUNDS
- **BOLD** EXCEEDS A SCREENING LEVEL
- 5 ug/L TCE
- 50 ug/L TCE
- 100 ug/L TCE
- 1000 ug/L TCE
- >70 ug/L DCE
- GROUNDWATER FLOW DIRECTION

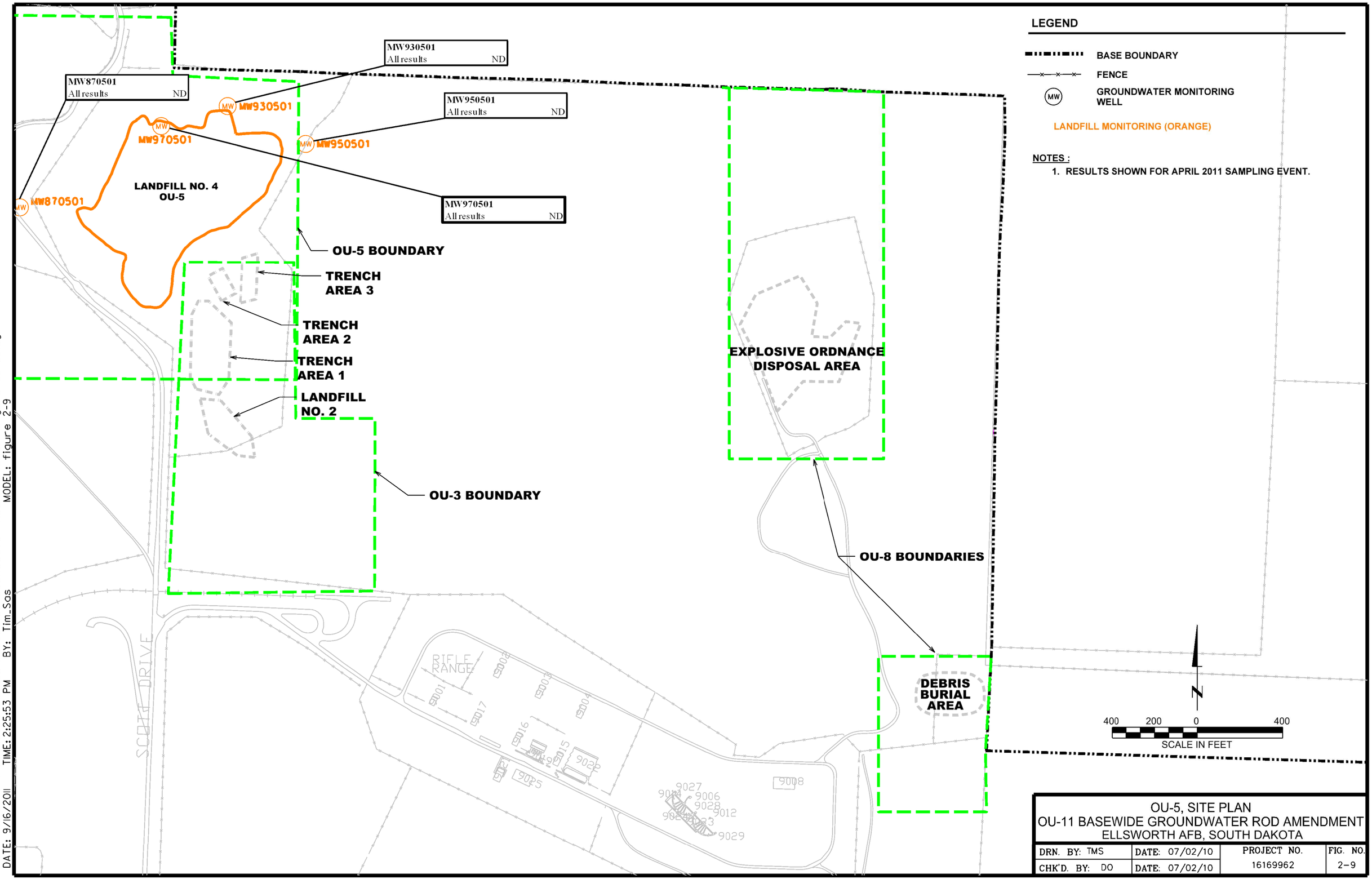
NOTES:

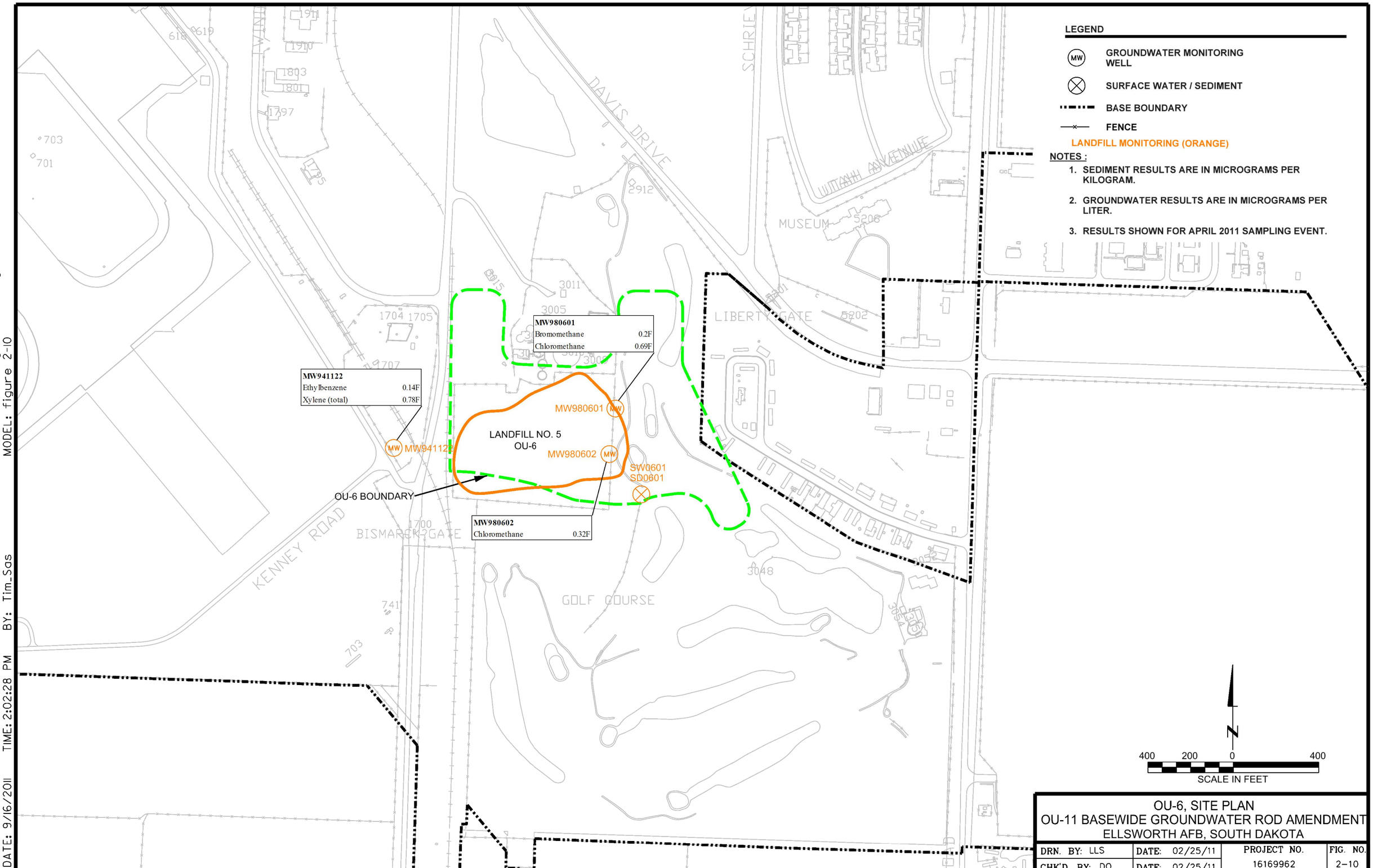
1. ALL RESULTS ARE IN MICROGRAMS PER LITER.
2. THE GROUNDWATER MEDIUM WAS TRANSFERED TO OU-11 BASEWIDE GROUNDWATER ON JULY 7, 2005. THE GROUNDWATER PLUMES WILL RETAIN PREVIOUS NOMENCLATURE.
3. PLUME INTERPRETATION IS BASED ON GROUNDWATER SAMPLING DATA COLLECTED FROM THE REMEDIAL INVESTIGATION (1992 THROUGH 1995) THROUGH THE CURRENT ROUND OF SAMPLING.
4. EXTRACTION WELL STATUS IS SHOWN FOR THE TIME OF LTM SAMPLING.

OU-4, ORGANIC CONCENTRATIONS - APRIL 2011 EVENT
OU-11 BASEWIDE GROUNDWATER ROD AMENDMENT
ELLSWORTH AFB, SOUTH DAKOTA

DRN. BY: TMS	DATE: 09/16/11	PROJECT NO.	FIG. NO.
CHK'D. BY: BG	DATE: 09/16/11	16169962	2-8

FILE: T:\ellsworth\16169962\2033\OU-11Basewide Groundwater Rod Amendment\Figure 02-08.dgn
DATE: 9/16/2011 TIME: 11:13:32 AM BY: Tim.Sas MODEL: Figure 6-2

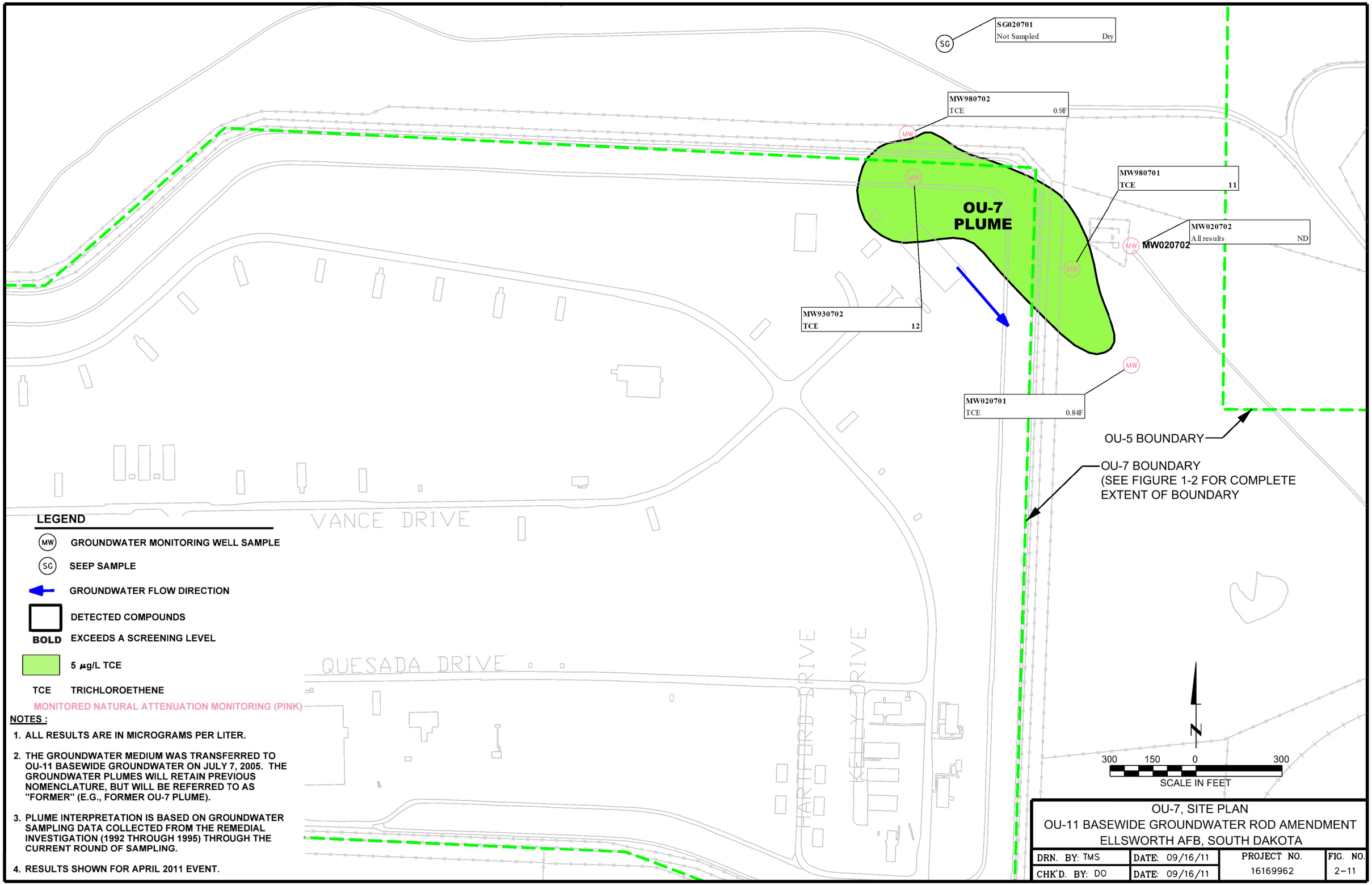

LEGEND
BASE BOUNDARY
FENCE
GROUNDWATER MONITORING WELL
LANDFILL MONITORING (ORANGE)
NOTES :
1. RESULTS SHOWN FOR APRIL 2011 SAMPLING EVENT.
MW930501
All results ND
MW870501
All results ND
MW950501
All results ND
MW970501
All results ND
MW930501
MW970501
MW950501
MW870501
LANDFILL NO. 4
OU-5
OU-5 BOUNDARY
TRENCH AREA 3
TRENCH AREA 2
TRENCH AREA 1
LANDFILL NO. 2
OU-3 BOUNDARY
EXPLOSIVE ORDNANCE DISPOSAL AREA
OU-8 BOUNDARIES
DEBRIS BURIAL AREA
RIFLE RANGE
SCOTT DRIVE
N
400 200 0 400
SCALE IN FEET
OU-5, SITE PLAN
OU-11 BASEWIDE GROUNDWATER ROD AMENDMENT
ELLSWORTH AFB, SOUTH DAKOTA
DRN. BY: TMS
DATE: 07/02/10
CHK'D. BY: DO
DATE: 07/02/10
PROJECT NO. 16169962
FIG. NO. 2-9
FILE: T:\ellsworth\16169962\12033\OU-11Basewide Goundwater Rod Amendment\Figure 02-09.dgn
MODEL: figure 2-9
DATE: 9/16/2011 TIME: 2:25:53 PM BY: Tim_Sas



OU-6, SITE PLAN
OU-11 BASEWIDE GROUNDWATER ROD AMENDMENT
ELLSWORTH AFB, SOUTH DAKOTA

DRN. BY: LLS	DATE: 02/25/11	PROJECT NO. 16169962	FIG. NO. 2-10
CHK'D. BY: DO	DATE: 02/25/11		

FILE: T:\ellsworth\16169962\12033\OU-11 Basewide Goundwater Rod Amendment\Figure 02-10.dgn
DATE: 9/16/2011 TIME: 2:02:28 PM BY: Tim_Sas MODEL: figure 2-10



LEGEND

- (MW) GROUNDWATER MONITORING WELL SAMPLE
- (SG) SEEP SAMPLE
- GROUNDWATER FLOW DIRECTION
- DETECTED COMPOUNDS
- **BOLD** EXCEEDS A SCREENING LEVEL
- 5 µg/L TCE
- TCE TRICHLOROETHENE
- MONITORED NATURAL ATTENUATION MONITORING (PINK)

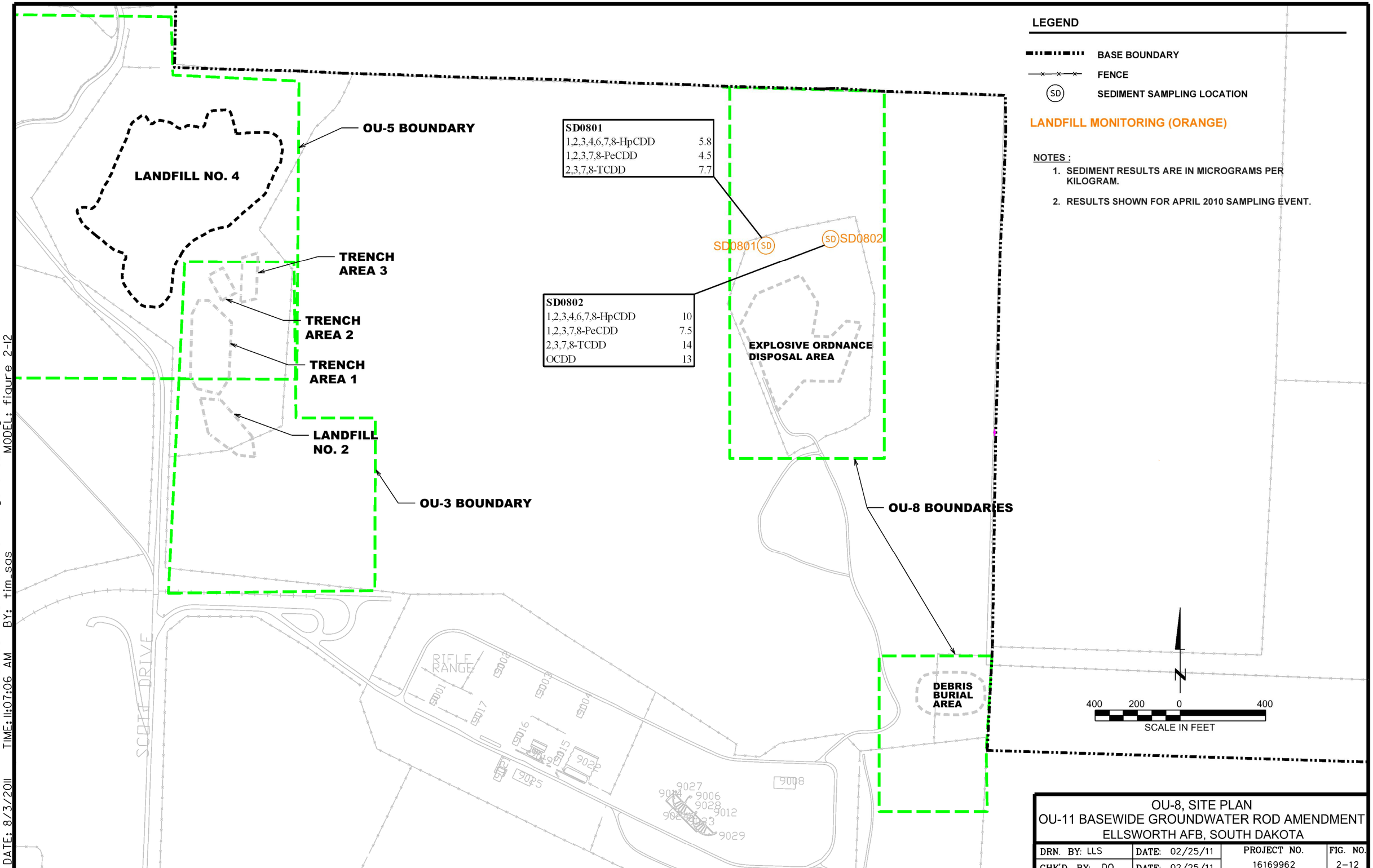
NOTES :

1. ALL RESULTS ARE IN MICROGRAMS PER LITER.
2. THE GROUNDWATER MEDIUM WAS TRANSFERRED TO OU-11 BASEWIDE GROUNDWATER ON JULY 7, 2005. THE GROUNDWATER PLUMES WILL RETAIN PREVIOUS NOMENCLATURE, BUT WILL BE REFERRED TO AS "FORMER" (E.G., FORMER OU-7 PLUME).
3. PLUME INTERPRETATION IS BASED ON GROUNDWATER SAMPLING DATA COLLECTED FROM THE REMEDIAL INVESTIGATION (1992 THROUGH 1995) THROUGH THE CURRENT ROUND OF SAMPLING.
4. RESULTS SHOWN FOR APRIL 2011 EVENT.

OU-7, SITE PLAN
OU-11 BASEWIDE GROUNDWATER ROD AMENDMENT
ELLSWORTH AFB, SOUTH DAKOTA

DRN. BY: TMS	DATE: 09/16/11	PROJECT NO.	FIG. NO.
CHK'D. BY: DO	DATE: 09/16/11	16169962	2-11

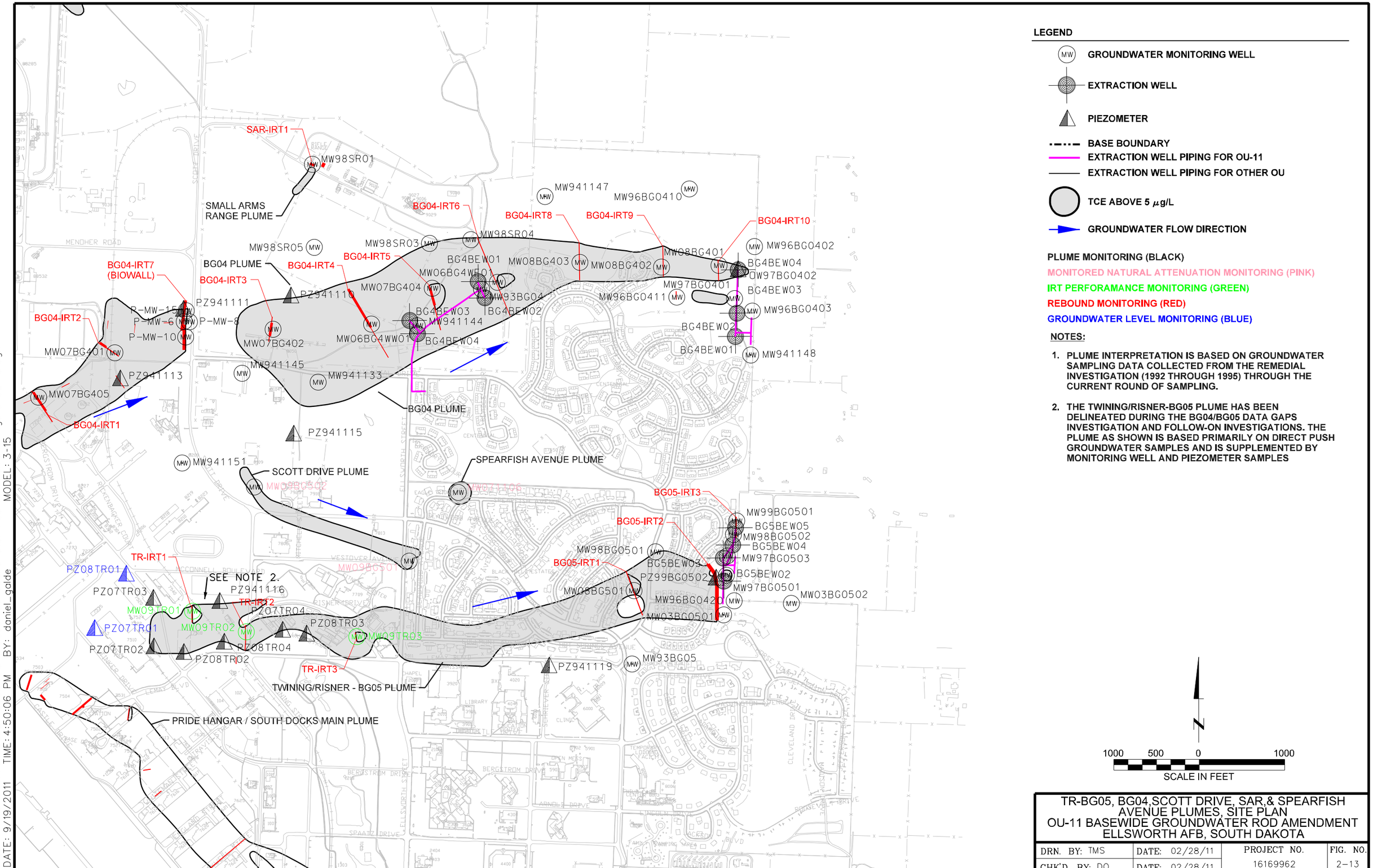
FILE: T:\ellsworth\16169962\12033\OU-11Basewide Goundwater Rod Amendment\Figure 02-11.dgn
DATE: 9/16/2011 TIME: 2:40:17 PM BY: Tim_Sas MODEL: figure 2-11



OU-8, SITE PLAN
OU-11 BASEWIDE GROUNDWATER ROD AMENDMENT
ELLSWORTH AFB, SOUTH DAKOTA

DRN. BY: LLS	DATE: 02/25/11	PROJECT NO.	FIG. NO.
CHK'D. BY: DO	DATE: 02/25/11	16169962	2-12

FILE: T:\ellsworth\16169962\2022\OU-11ROD Amendment\Figure 02-12.dgn MODEL: figure 2-12
DATE: 8/3/2011 TIME: 11:07:06 AM BY: tim_sas



LEGEND

- GROUNDWATER MONITORING WELL
- EXTRACTION WELL
- PIEZOMETER
- BASE BOUNDARY
- EXTRACTION WELL PIPING FOR OU-11
- EXTRACTION WELL PIPING FOR OTHER OU
- TCE ABOVE 5 μg/L
- GROUNDWATER FLOW DIRECTION

PLUME MONITORING (BLACK)
MONITORED NATURAL ATTENUATION MONITORING (PINK)
IRT PERFORAMANCE MONITORING (GREEN)
REBOUND MONITORING (RED)
GROUNDWATER LEVEL MONITORING (BLUE)

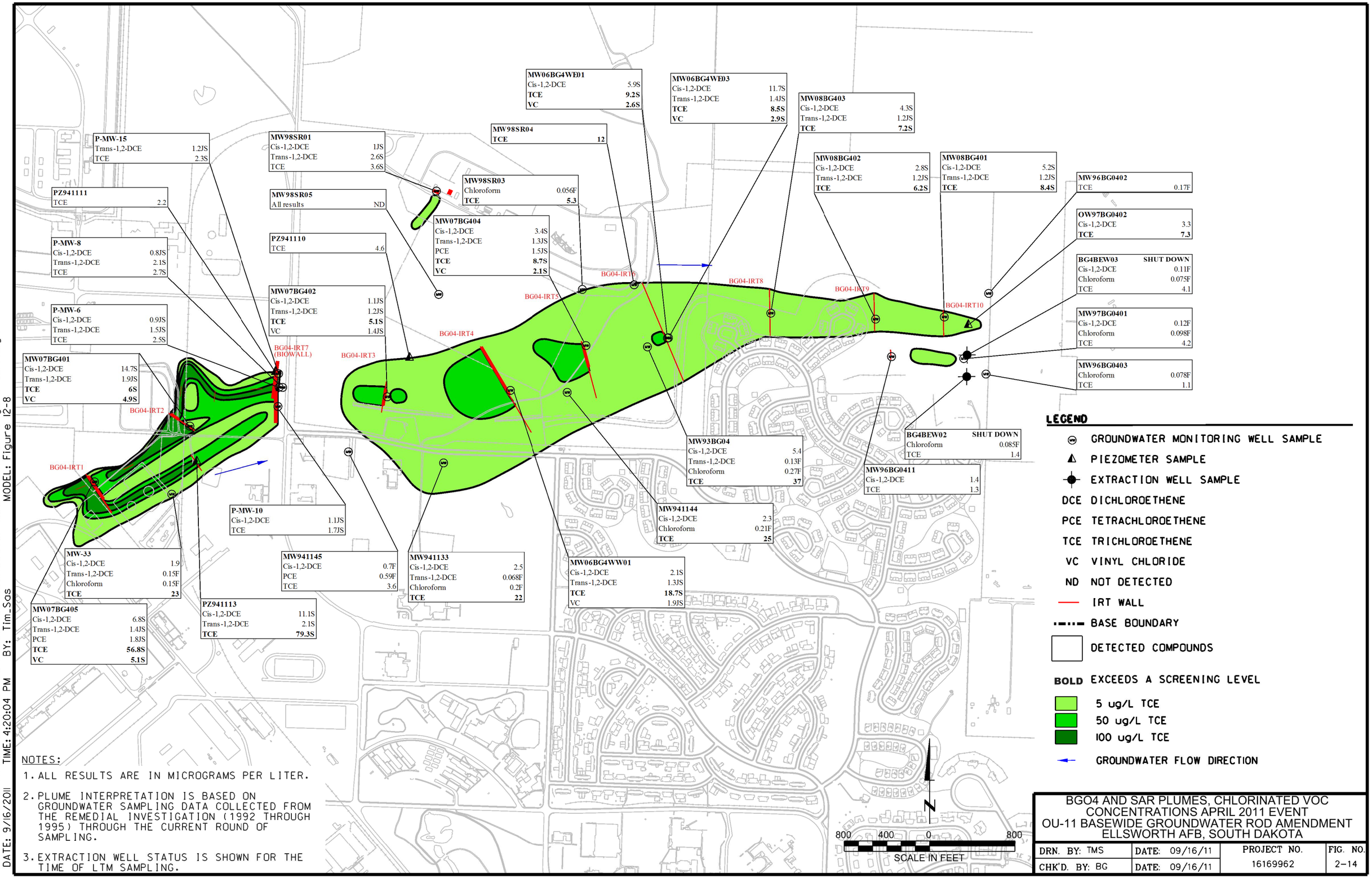
NOTES:

1. PLUME INTERPRETATION IS BASED ON GROUNDWATER SAMPLING DATA COLLECTED FROM THE REMEDIAL INVESTIGATION (1992 THROUGH 1995) THROUGH THE CURRENT ROUND OF SAMPLING.
2. THE TWINING/RISNER-BG05 PLUME HAS BEEN DELINEATED DURING THE BG04/BG05 DATA GAPS INVESTIGATION AND FOLLOW-ON INVESTIGATIONS. THE PLUME AS SHOWN IS BASED PRIMARILY ON DIRECT PUSH GROUNDWATER SAMPLES AND IS SUPPLEMENTED BY MONITORING WELL AND PIEZOMETER SAMPLES

TR-BG05, BG04,SCOTT DRIVE, SAR,& SPEARFISH AVENUE PLUMES, SITE PLAN
OU-11 BASEWIDE GROUNDWATER ROD AMENDMENT
ELLSWORTH AFB, SOUTH DAKOTA

DRN. BY: TMS	DATE: 02/28/11	PROJECT NO.	FIG. NO.
CHK'D. BY: DO	DATE: 02/28/11	16169962	2-13

FILE: T:\ellsworth\16169962\12033\OU-11 Basewide Goundwater Rod Amendment\Figure 02-13.dgn
DATE: 9/19/2011 TIME: 4:50:06 PM BY: daniel_galde MODEL: 3-15



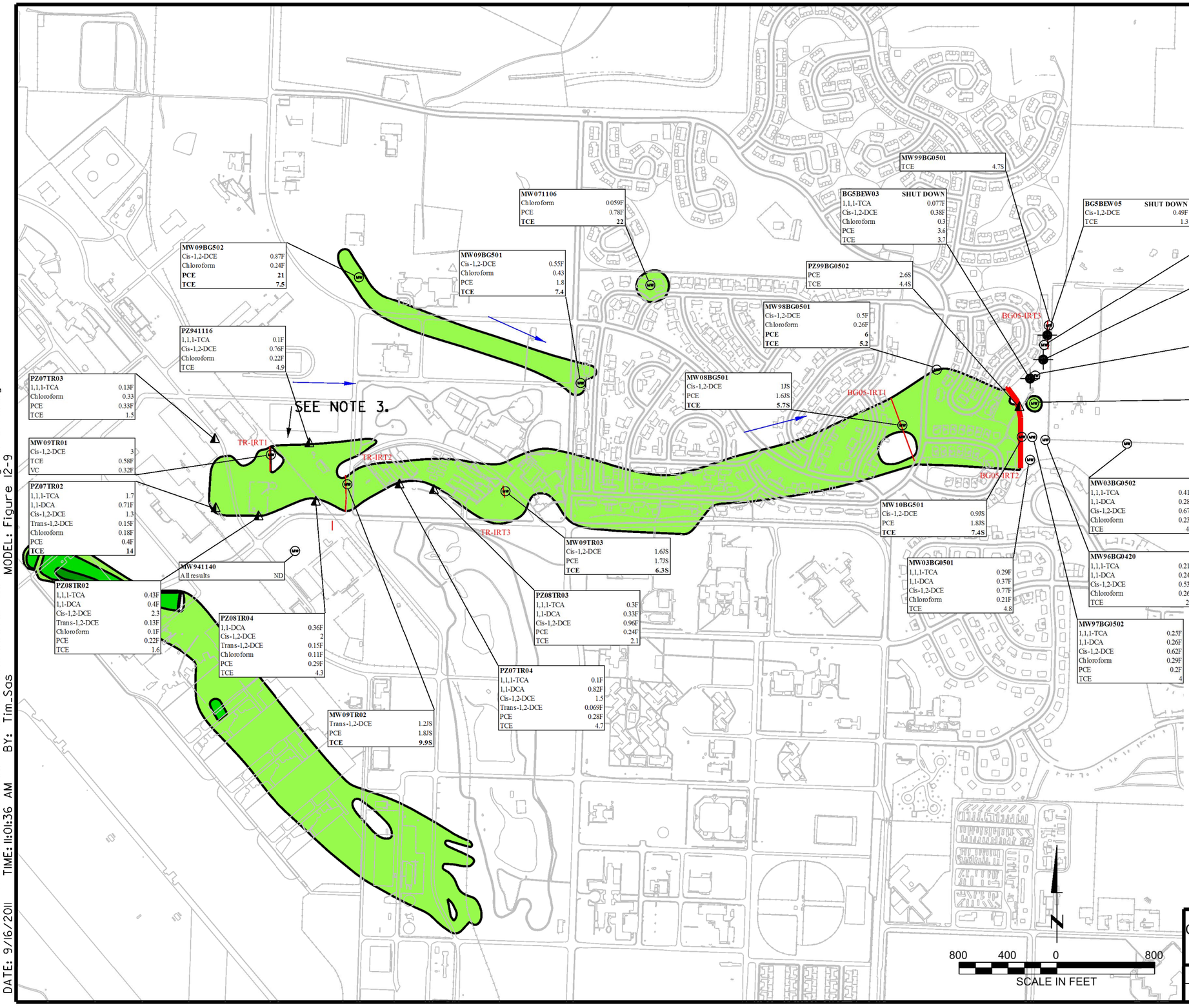
NOTES:

1. ALL RESULTS ARE IN MICROGRAMS PER LITER.
2. PLUME INTERPRETATION IS BASED ON GROUNDWATER SAMPLING DATA COLLECTED FROM THE REMEDIAL INVESTIGATION (1992 THROUGH 1995) THROUGH THE CURRENT ROUND OF SAMPLING.
3. EXTRACTION WELL STATUS IS SHOWN FOR THE TIME OF LTM SAMPLING.

BGO4 AND SAR PLUMES, CHLORINATED VOC CONCENTRATIONS APRIL 2011 EVENT
OU-11 BASEWIDE GROUNDWATER ROD AMENDMENT
ELLSWORTH AFB, SOUTH DAKOTA

DRN. BY: TMS	DATE: 09/16/11	PROJECT NO. 16169962	FIG. NO. 2-14
CHK'D. BY: BG	DATE: 09/16/11		

FILE: T:\ellsworth\16169962\2033\OU-11Basewide Groundwater Rod Amendment\Figure 02-14.dgn
DATE: 9/16/2011 TIME: 4:20:04 PM BY: Tim.Sas MODEL: Figure 12-8



NOTES:

1. ALL RESULTS ARE IN MICROGRAMS PER LITER.
2. PLUME INTERPRETATION IS BASED ON GROUNDWATER SAMPLING DATA COLLECTED FROM THE REMEDIAL INVESTIGATION (1992 THROUGH 1995) THROUGH THE CURRENT ROUND OF SAMPLING.
3. THE TWINING/RISNER PLUME HAS BEEN DELINEATED DURING THE BG04/BG05 DATA GAPS INVESTIGATION AND FOLLOW-ON INVESTIGATIONS. THE PLUME AS SHOWN IS BASED PRIMARILY ON DIRECT PUSH GROUNDWATER SAMPLES AND IS SUPPLEMENTED BY MONITORING WELL AND PIEZOMETER SAMPLES
4. EXTRACTION WELL STATUS IS SHOWN FOR THE TIME OF LTM SAMPLING.

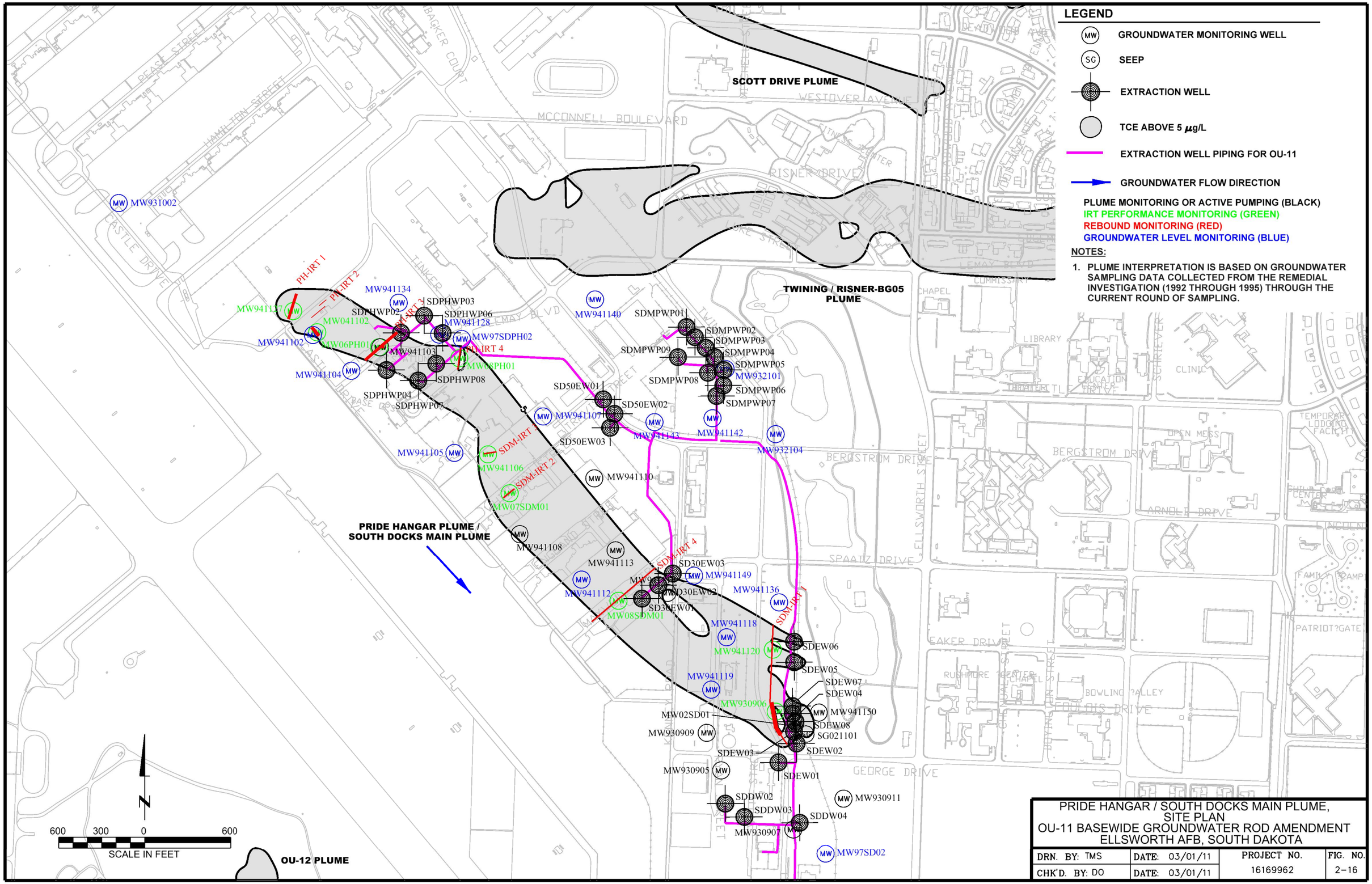
LEGEND

- GROUNDWATER MONITORING WELL SAMPLE
- PIEZOMETER SAMPLE
- DCA DICHLOROETHANE
- DCE DICHLOROETHENE
- PCE TETRACHLOROETHENE
- TCA TRICHLOROETHANE
- TCE TRICHLOROETHENE
- VC VINYL CHLORIDE
- ND NOT DETECTED
- BASE BOUNDARY
- DETECTED COMPOUNDS
- **BOLD** EXCEEDS A SCREENING LEVEL
- 5 ug/L TCE
- 50 ug/L TCE
- 100 ug/L TCE
- GROUNDWATER FLOW DIRECTION
- IRT WALL

TR-BG05,SCOTT DRIVE & SPEAR FISH AVENUE
CHLORINATED VOC CONCENTRATIONS APRIL 2011 EVENT
OU-11 BASEWIDE GROUNDWATER ROD AMENDMENT
ELLSWORTH AFB, SOUTH DAKOTA

DRN. BY: TMS	DATE: 09/16/11	PROJECT NO.	FIG. NO.
CHK'D. BY: BG	DATE: 09/16/11	16169962	2-15

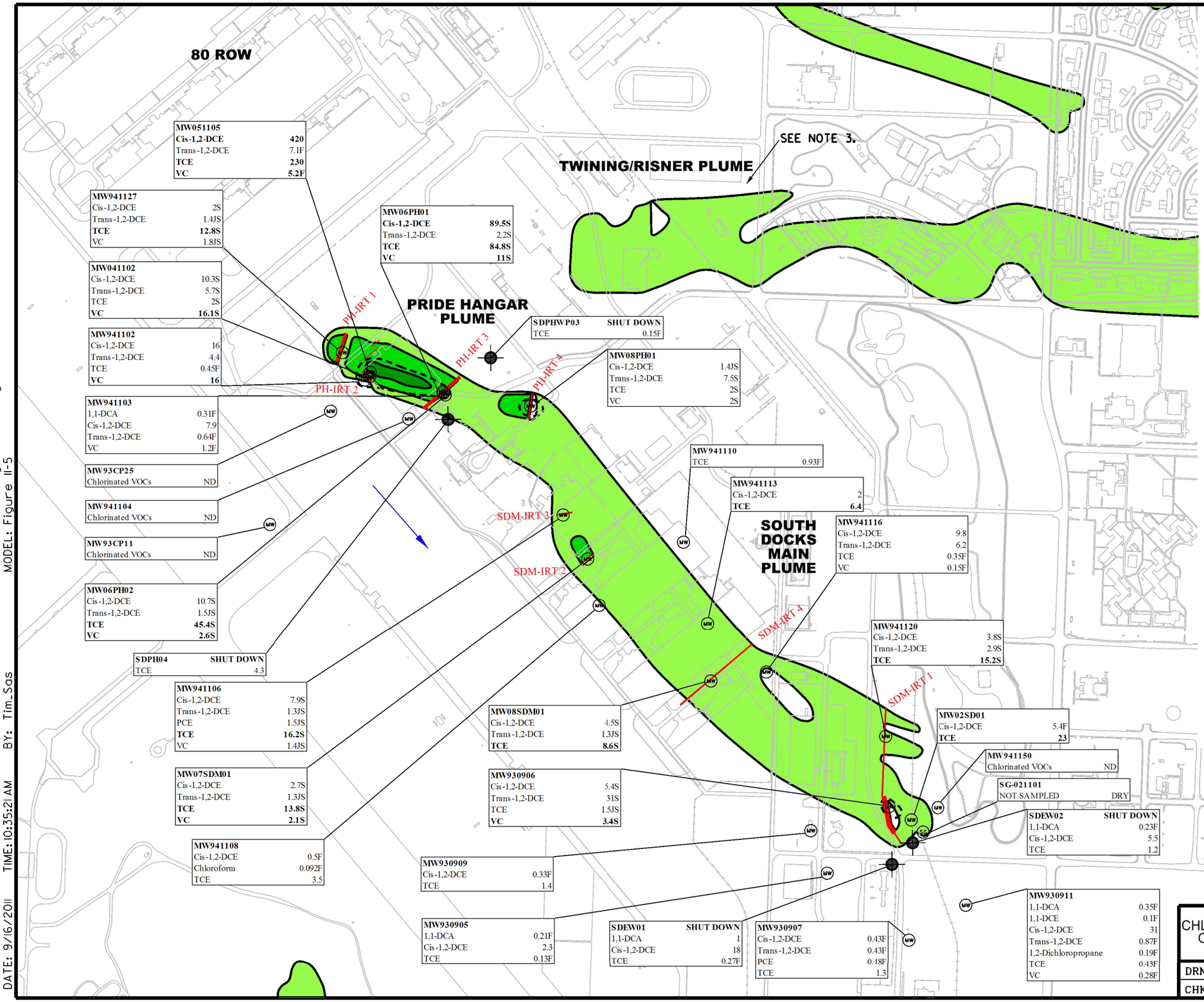
FILE: T:\ellsworth\16169962\12033\OU-11Basewide Groundwater Rod Amendment\Figure 02-15.dgn
DATE: 9/16/2011 TIME: 11:01:36 AM BY: Tim_Sas MODEL: Figure 12-9



PRIDE HANGAR / SOUTH DOCKS MAIN PLUME, SITE PLAN
OU-11 BASEWIDE GROUNDWATER ROD AMENDMENT
ELLSWORTH AFB, SOUTH DAKOTA

DRN. BY: TMS	DATE: 03/01/11	PROJECT NO.	FIG. NO.
CHK'D. BY: DO	DATE: 03/01/11	16169962	2-16

FILE: T:\ellsworth\16169962\2022\OU-11ROD Amendment\Figure 02-16.dgn MODEL: 2-16
DATE: 7/21/2011 TIME: 11:24:15 AM BY: tim_sas



LEGEND

- GROUNDWATER MONITORING WELL SAMPLE
- SEEP SAMPLE
- EXTRACTION WELL SAMPLE
- IRT WALL
- AREA WHERE GROUNDWATER EXCEEDS THE VINYL CHLORIDE STANDARD
- DETECTED COMPOUNDS
- **BOLD** EXCEEDS A SCREENING LEVEL
- 5 ug/L TCE
- 50 ug/L TCE
- 100 ug/L TCE
- DCA DICHLOROETHANE
- DCE DICHLOROETHENE
- PCE TETRACHLOROETHENE
- TCE TRICHLOROETHENE
- VC VINYL CHLORIDE
- ND NOT DETECTED
- GROUNDWATER FLOW DIRECTION

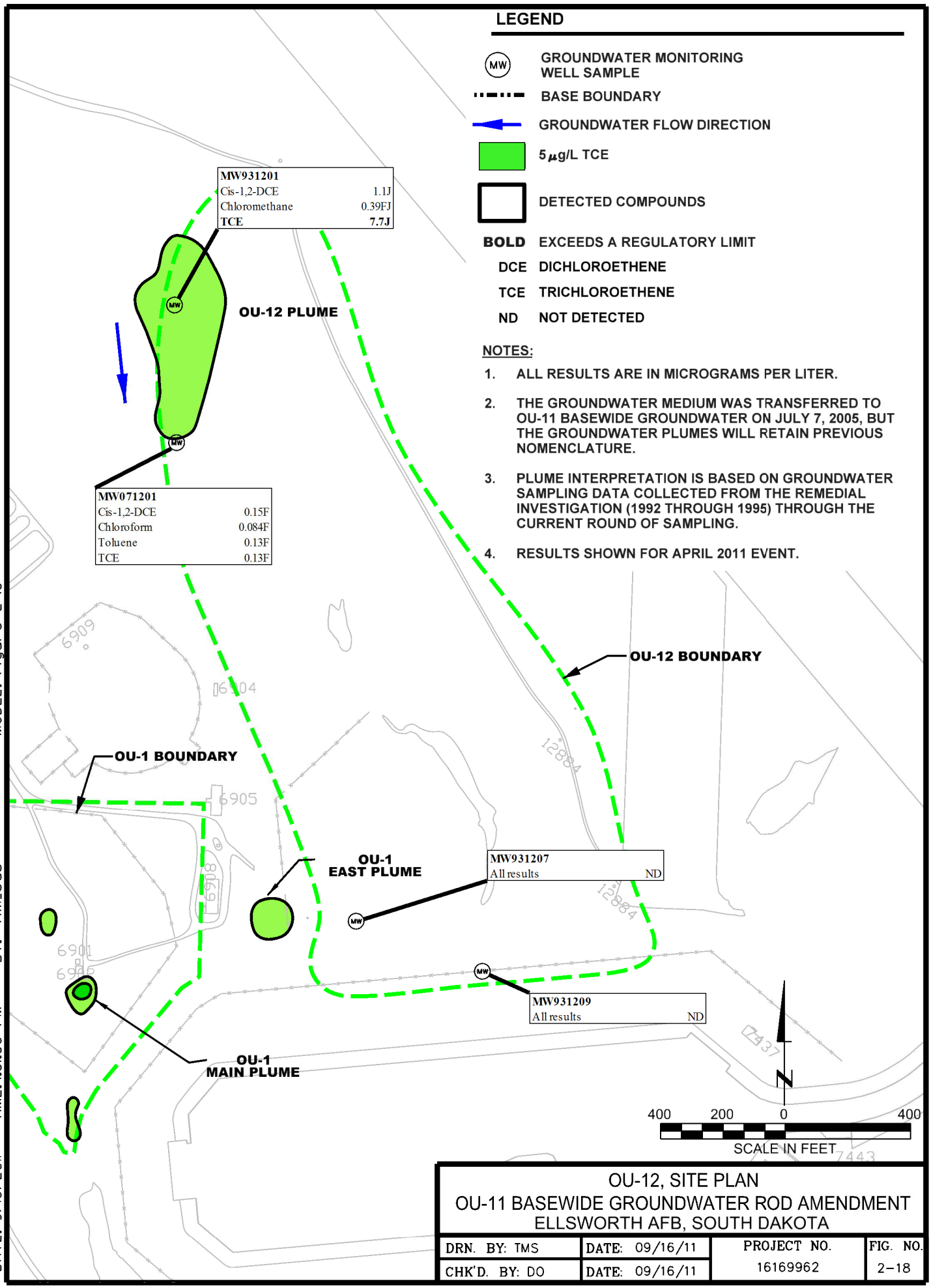
NOTES:

1. ALL RESULTS ARE IN MICROGRAMS PER LITER.
2. PLUME INTERPRETATION IS BASED ON GROUNDWATER SAMPLING DATA COLLECTED FROM THE REMEDIAL INVESTIGATION (1992 THROUGH 1995) THROUGH THE CURRENT ROUND OF SAMPLING.
3. THE TWINING/RISNER PLUME HAS BEEN DELINEATED DURING THE BG04/BG05 DATA GAPS INVESTIGATION AND FOLLOW-ON INVESTIGATIONS. THE PLUME AS SHOWN IS BASED PRIMARILY ON DIRECT PUSH GROUNDWATER SAMPLES AND IS SUPPLEMENTED BY MONITORING WELL AND PIEZOMETER SAMPLES
4. EXTRACTION WELL STATUS IS SHOWN FOR THE TIME OF LTM SAMPLING.

PRIDE HANGAR/SOUTH DOCKS MAIN PLUME, CHLORINATED VOC CONCENTRATIONS APRIL 2011 EVENT
OU-11 BASEWIDE GROUNDWATER ROD AMENDMENT
ELLSWORTH AFB, SOUTH DAKOTA

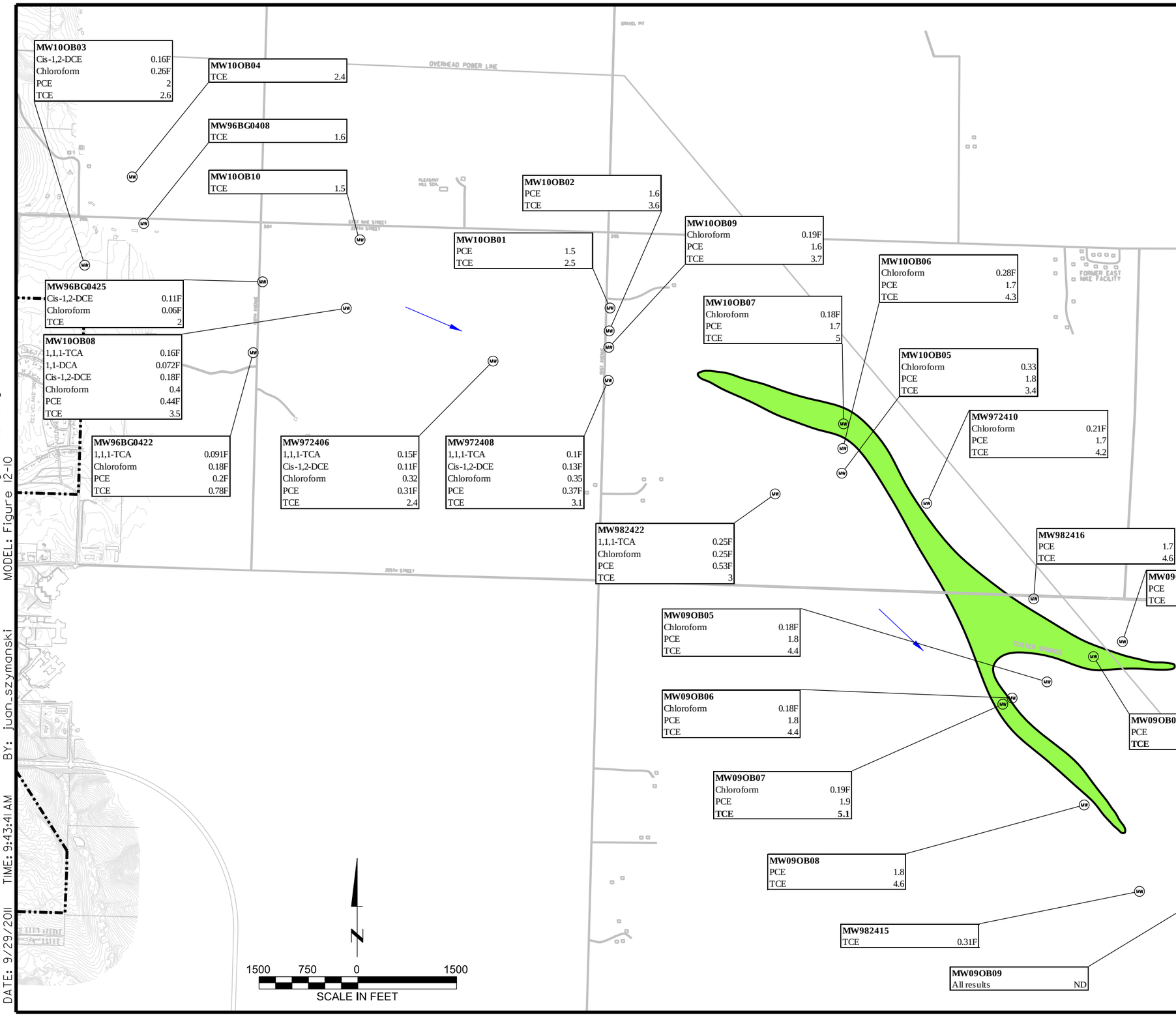
DRN. BY: TMS	DATE: 09/16/11	PROJECT NO.	FIG. NO.
CHK'D. BY: BG	DATE: 09/16/11	16169962	2-17

FILE: T:\ellsworth\16169962\12033\OU-11 Basewide Groundwater Rod Amendment\Figure 02-17.dgn
DATE: 9/16/2011 TIME: 10:35:21 AM BY: Tim_Sas MODEL: Figure II-5



OU-12, SITE PLAN
OU-11 BASEWIDE GROUNDWATER ROD AMENDMENT
ELLSWORTH AFB, SOUTH DAKOTA

DRN. BY: TMS	DATE: 09/16/11	PROJECT NO. 16169962	FIG. NO. 2-18
CHK'D. BY: DO	DATE: 09/16/11		



LEGEND

(MW)	GROUNDWATER MONITORING WELL SAMPLE
DCA	DICHLOROETHANE
DCE	DICHLOROETHENE
PCE	TETRACHLOROETHENE
TCA	TRICHLOROETHANE
TCE	TRICHLOROETHENE
ND	NOT DETECTED
	DETECTED COMPOUNDS
BOLD	EXCEEDS A SCREENING LEVEL
	BASE BOUNDARY
	5 ug/L TCE
	GROUNDWATER FLOW DIRECTION

NOTES:

1. ALL RESULTS ARE IN MICROGRAMS PER LITER.
2. PLUME INTERPRETATION IS BASED ON GROUNDWATER SAMPLING DATA COLLECTED FROM 1996 THROUGH THE CURRENT ROUND OF SAMPLING.
3. RESULTS FOR MW09 AND MW10 WELLS ARE FOR SAMPLES COLLECTED IN JANUARY AND FEBRUARY 2010.

OU-11 OFF-BASE PLUME, CHLORINATED VOC CONCENTRATIONS, APRIL 2011 EVENT
OU-11 BASEWIDE GROUNDWATER ROD AMENDMENT
ELLSWORTH AFB, SOUTH DAKOTA

DRN. BY: TMS	DATE: 09/16/11	PROJECT NO.	FIG. NO.
CHK'D. BY: BG	DATE: 09/16/11	16169962	2-19

FILE: T:\ellsworth\16169962\2033\OU-11 Basewide Goundwater Rod Amendment\Figure 02-19.dgn
DATE: 9/29/2011 TIME: 9:43:41 AM BY: juan_szymanski MODEL: Figure 12-10

APPENDIX A

EXAMPLE MEMORANDUMS OF AGREEMENT

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05/22/2000 04:27p 24.00
Lisa Webster Misc Real Est

DEPARTMENT OF THE AIR FORCE

MEMORANDUM OF AGREEMENT TO SUPPLY WATER FOR UNDEVELOPED LAND

I. PARTIES:

The parties to this Memorandum of Agreement (MOA) are Ellsworth Air Force Base, hereinafter referred to as the "Government," and _____ hereinafter referred to as the "Owners."

II. PURPOSE AND AUTHORITY:

a. Whereas a potentially contaminated plume has been discovered in or around the Owners' land; and whereas the Government has initiated clean-up of said plume pursuant to the final Record of Decision for Operable Unit 11, dated April 1997; and whereas the Government's clean-up efforts require the plume to be isolated, precluding its use by Owners as a source of water for household use; and whereas the Government is willing to provide an alternative source of potable water to the Owners under the terms described below; the parties hereby enter into this MOA to establish the rights and obligations of both parties regarding the provision of a source of potable water by the Government.

b. The Government enters into this Memorandum of Agreement pursuant to 42 U.S.C. Sections 9601(23), 9604(a), and 9620, Executive Order 12580 of January 23, 1987, 10 U.S.C. 2701 et seq, 10 U.S.C. 2481, and Air Force Instruction 32-1061.

III. LIMITED USE OF MEMORANDUM OF AGREEMENT

It is understood and agreed that this Memorandum of Agreement shall not be cited, used, or referred to in any manner by the Owners, their agents, tenants, representatives, heirs, or assigns in any legal or administrative proceeding against the Government, its agents, or representatives for the purpose of establishing by any means, however remote, Government liability or responsibility for the presence of trichloroethylene (TCE), any hazardous substance, hazardous waste, constituent, or other contaminant or pollutant on the Owners' property, regardless of whether the Government, its agents, or representatives are parties to any such proceedings. The Owners agree to use this MOA for no other purpose than to receive an alternate water source from the Government under the terms described below, and that the MOA in no way constitutes an admission of Government liability. The Owners further agree to keep this MOA confidential until such time as it is filed with the county and made part of the public record.

Journal No. 2000006283

IV. RIGHTS AND OBLIGATIONS:

a. The Government shall provide an alternate water source to the Owners by extending a water supply line to the Owners' property described in Section VII, paragraph a, herein. The Government shall provide one branch line from the main water line for the property described in Section VII, paragraph a, for the use of Owners. The Government shall install a six-inch branch water supply line on Owners' property to be located approximately 12 feet south of the half-section line of Section 13, Township 2 North, Range 9 East, Black Hills Meridian, Pennington County, South Dakota, and to extend approximately one-half mile east along said half-section line. The Government shall provide Owners seven hookups to the branch line described above. "Hookup" is defined as the right to access the branch water supply line. The Owners are responsible for constructing any further water supply lines that the Owners may find necessary, such as lateral water lines or other equipment to transport water from the branch water supply line. Should Owners desire additional hookups for said property in the future, any additional hookups will be granted at the sole discretion of the Government, and if granted by the Government, all expenses associated with the installation of any additional lateral water lines, including curb stops, and the cost of any water for those additional lines, shall be at the sole expense of the Owners. Any additional hookups granted by the Government shall be on the basis of one per household, and Owners shall not use one hook-up to supply multiple residences on the subject property. Additionally, Owners agree that in consideration for the one-half mile branch water supply line, Owners shall grant the Government an easement in perpetuity to allow for future maintenance and repair of the branch water supply line located on Owners' property. Said easement shall be 24 feet in width, with approximately 12 feet on each side of the location of the branch water supply line, and shall extend one-half mile, the length of the branch water supply line, which easement shall be described as the north 24 feet of the southwest quarter of Section 13, Township 2 North, Range 9 East, Black Hills Meridian, Pennington County, South Dakota. Owners shall execute the easement instrument provided by the Government at the Government's request.

b. The Owners shall pay for the use of any water. The rate charged for the use of the water shall be the local prevailing rate for similar service, but not less than the cost to the Government for supplying the utility service. The local prevailing rate is the rate the Owners would pay for a particular class of service if the Owners could obtain the service directly from the nearest off-base utility supplier.

c. The Owners further understand and agree that the alternate water source described in this MOA will be provided at the Government's discretion in accordance with this MOA. If the Government determines, for whatever reason, that it will not continue to furnish water to the Owners in the manner provided for in Section IV, paragraph a, above, the Government will give the Owners written notice sixty (60) days before the termination of service. Such notice does not relieve the Government of its obligation to provide water to the Owners by different means of the Government's choosing, unless the requirement to provide water is terminated for any of the conditions listed in Section VI of this MOA.

d. The Government shall bear all expenses related to installing all equipment necessary to establish seven operable water hookups and curb stops on the Owners' property. Once such water sources are

installed and operable, the Government shall abandon the curb stops and related equipment that then exist on Owners' property, with the exception of the branch water supply line. The Owners are solely responsible to ensure the curb stops are kept in good working condition. The Government shall conduct a final inspection on the construction of the curb stops. The Government shall provide a one-year warranty of construction on the curb stops, beginning the date of the final inspection. Upon expiration of this one-year period, it shall become the Owners' sole responsibility to provide any and all maintenance, repair or replacement of such curb stops as may be required.

e. Until the Government's obligations under this MOA are terminated pursuant to Section VI, the Government, shall bear all responsibility for, and costs of, maintaining a water supply from the point of connection with the main water supply line to the termination of the branch water supply line on the Owners' property. The Government shall be responsible for maintenance and repair of the main water supply line and related equipment which may cross a county or city roadway or right-of-way or easement not belonging to the Owners, and for the branch water supply line on Owners' property. The Owners shall be responsible for any maintenance, repair or replacement of the curb stops that may be required following expiration of the one-year warranty of construction period.

f. Once a water source is installed and operable, and for the term of this MOA, the Owners agree to discontinue pumping water from and utilizing Owners' existing wells for domestic use, which includes drinking water or watering of gardens. The owners are permitted to use the existing well(s) on the property for other non-potable uses (i.e. production of livestock and landscape irrigation). The Owners shall not use defunct well site(s) for disposal of any materials that may contaminate the groundwater. The Government shall not be responsible for restoration of any wells, pumps or other equipment that may be damaged or rendered inoperable as a result of decreased use or nonuse. The Government shall not be responsible for any current or future costs associated with closing existing wells or drilling and installing new wells at the termination of this MOA. The Owners shall not use any defunct well site for disposal of any materials that may contaminate the groundwater.

g. Once a water source is installed and operable, the Owners shall be responsible for the correction of any water flow malfunctions that occur on the Owners' property. The Government shall be responsible for the correction of any water flow malfunctions which occur on Government property or on county or city roadways or rights-of-way or easements not belonging to the Owners, unless such malfunction is caused by the Owners, their agents, representatives, assigns, heirs, or tenants, in which case the Owners are solely responsible.

V. LIABILITY FOR PROPERTY DAMAGE, PERSONAL INJURY, OR DEATH

a. The Owners shall be liable for damage, personal injury, or death caused by the acts of the Owners, their agents, representatives, assigns, heirs, or tenants to Government property or personnel pursuant to this MOA and according to the applicable laws of the State of South Dakota and the United States.

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05/22/2000 04:27P 24.00
Lisa Webster Misc Real Est

b. The Government agrees to be responsible for damages arising from the negligent activity of its officers, employees or agents acting within the scope of their employment, under the Federal Tort Claims Act or other applicable federal statute in the exercise of rights or in the performance of obligations under this MOA, either by repairing such damage or, at the option of the Government, through the claims process.

VI. TERMINATION

a. The Government shall continue to provide water in the manner set forth in the MOA until such time as:

(1) The cleanup activities on Owners' land are completed, which shall be defined as satisfaction of the final Record of Decision (ROD) for operable unit eleven (OU-11) dated April 1997 or its subsequent amendments; or

(2) The Owners obtain and acquire suitable water from a source other than wells on Owners' property at Owners' own expense; or

(3) The Government is unable to provide such water as a matter of law, national emergency, or military necessity, or should the Government discontinue operation of a water supply system at Ellsworth Air Force Base, South Dakota. In such a case, if the ROD has not been terminated or otherwise satisfied, the Government will continue to be bound to the terms of the ROD; or

(4) The Government is otherwise authorized by law or regulation to terminate service; or

(5) The Owners, in their discretion, terminates the provision of water by serving the Government with written notice. This will not relieve Owners from strict compliance with the provisions of Section IV, paragraph f; or

(6) The parties choose to terminate this MOA by mutual and written agreement.

b. All terms, promises, provisions, and conditions contained in this MOA shall immediately terminate at the option of the Government in the event Owners operate current wells on Owners' property or Owners install new wells on Owners' property. In such event, the Government shall initiate court action to enjoin Owners' activity, and shall seek any and all other remedies available to the Government by law.

VII. ADDITIONAL TERMS

a. The land affected by this MOA is located in Pennington County, South Dakota, and is described as follows:

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The East Half of the Southeast Quarter (E½SE¼) of Section 14; the Southwest Quarter (SW¼); and the Southeast Quarter (SE¼) less the South 1867 feet of the East 1867 feet of Section 13, all in Township 2 North, Range 9 East, Black Hills Meridian, Pennington County, South Dakota.

A map of said property showing its location is attached hereto and incorporated herein as Attachment 1; the boundaries of said property are highlighted in red.

b. No member or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this MOA, or to any benefit that may arise therefrom.

c. It is understood and agreed that the Government will retain no liability for repair or maintenance of water lines, pipes, or related equipment once abandoned pursuant to the terms of this MOA, unless otherwise expressly provided herein. Neither shall the Government be liable for any damages to personal property nor for personal injury caused by the presence of such water lines, pipes, or related equipment once abandoned unless such damage or injury is proximately caused by the negligence of the Government or its agent following such abandonment.

d. All notices required by this MOA shall be provided by and to the Deputy Base Civil Engineer, Attention Realty Officer, 2116 Scott Drive, Suite 1, Ellsworth Air Force Base, South Dakota 57706-4709.

e. Except as provided herein, nothing in this MOA is intended to waive or otherwise restrict the exercise by the parties of any rights, remedies, or redress to which they may lawfully be entitled.

f. All the terms, provisions, and conditions in this MOA contained shall be binding upon and inure to the benefit of each of the parties hereto.

g. All of the covenants, conditions, and obligations contained in this MOA shall be binding upon and inure to the benefit of the respective successors, assignees, transferees, mortgagees, and lessees of the parties to the same extent as if each successor, assignee, transferee, mortgagee, and lessee were in each case named as a party to this MOA. Any person, corporation, or other legal entity acquiring any or all of the rights, title, or interest of the Owners in and to the premises shall thereby become liable under, and be fully bound by all of the provisions of this MOA.

h. This instrument, along with those documents incorporated herein and attached as Exhibits hereto, embodies the whole of the agreement of the parties. There are no other promises, terms, conditions, or obligations other than those contained herein; and this Memorandum of Agreement shall supersede all previous communications, representations, or agreements concerning the provision of potable water by the Government to the Owners, either verbal or written, between the parties hereto. This Memorandum of Agreement may be modified or amended only by written mutual agreement signed by the parties hereto.

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Lisa Webster Misc Real Est

The signing parties hereto PROMISE AND AGREE to fulfill the terms and conditions of this Memorandum of Agreement.

OWNER

17 Mar 00
(Date)

OWNER

3-17-00
(Date)

State of South Dakota, County of Pennington. On this the 17 day of March, 2000. before me JoAnn Sheffield, the undersigned officer, personally appeared _____ known to me or satisfactorily proved to be the persons whose names subscribed to the within instrument and acknowledged that he executed the same for the purposes herein contained.

In witness whereof I hereunto set my hand and official seal

JoAnn Sheffield
Notary Public

My commission expires Sept. 29, 2004.

UNITED STATES AIR FORCE

23MAR00
(Date)

ANTHONY F. PRZYBYSLAWSKI, Colonel, USAF
Commander, 28th Bomb Wing

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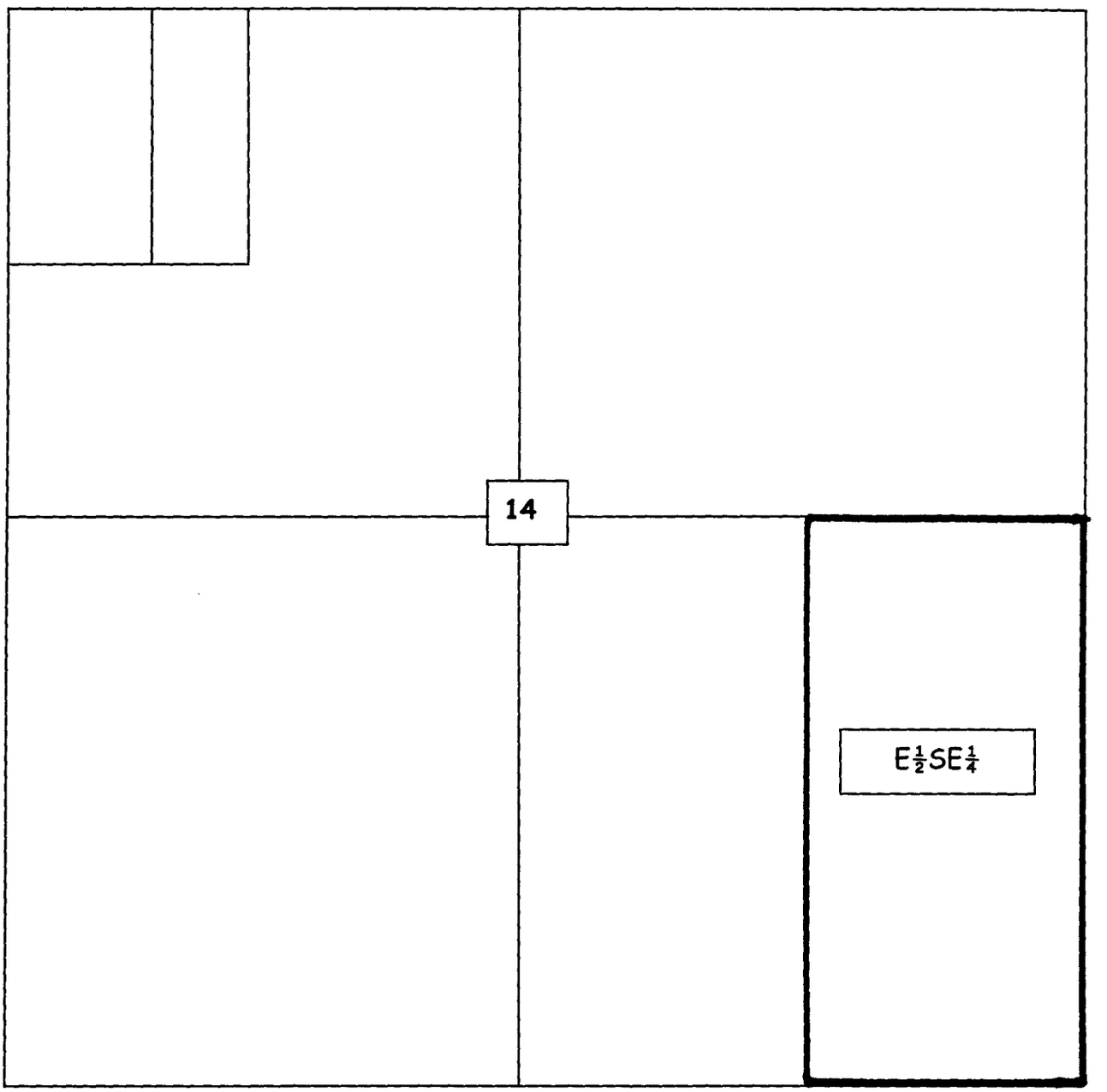
Lisa Webster Misc Real Est

USAF-ACC-ELS-9-99-462

ATTACHMENT 1



Section 14 T2N R9E
80.0 acres, more or less

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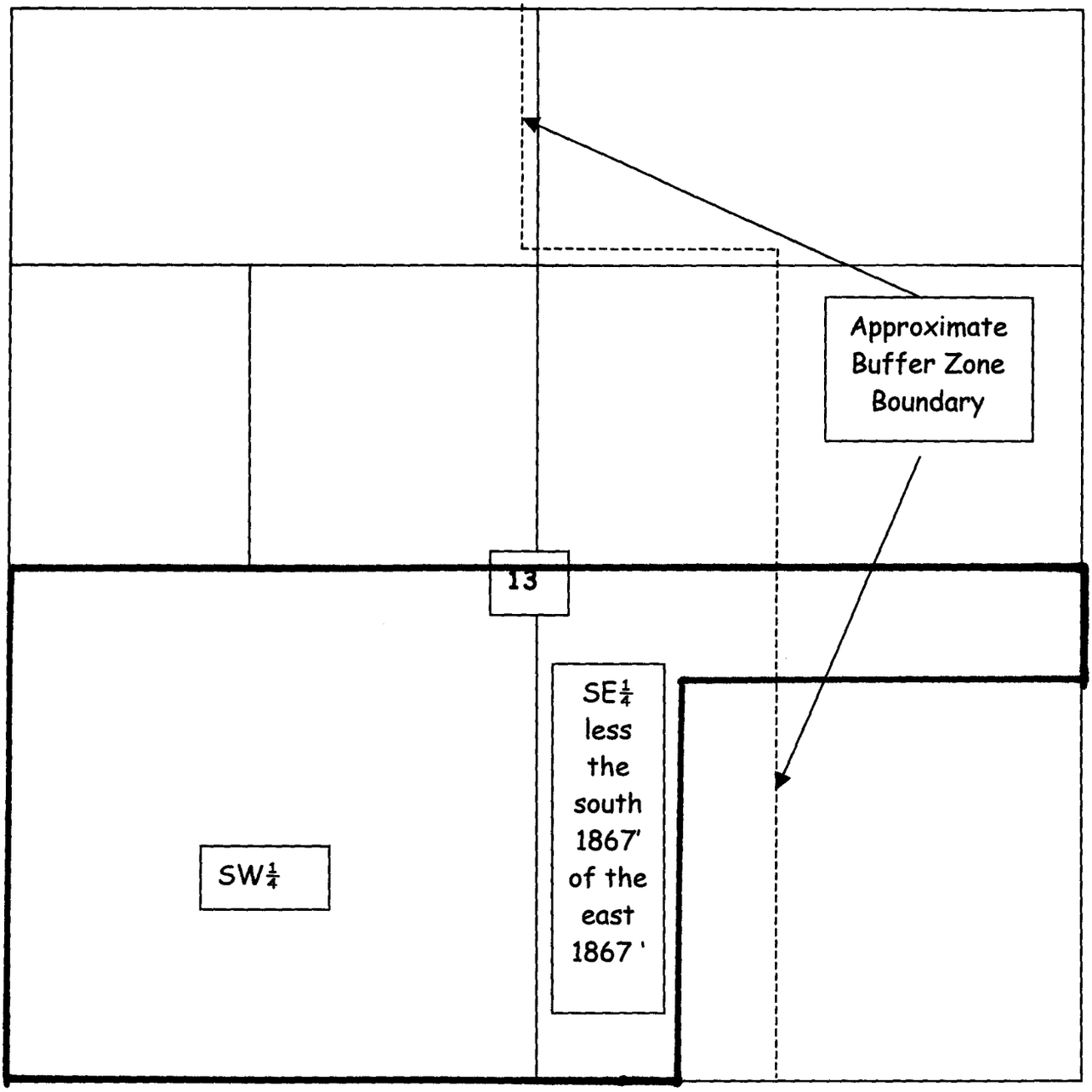
REGISTER OF DEEDS SEAL PENNINGTON COUNTY SOUTH DAKOTA

USAF-ACC-ELS-9-99-462

ATTACHMENT 1



Section 13 T2N R9E
240.0 acres, more or less

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Donna M. Mayer Misc Real Est

DEPARTMENT OF THE AIR FORCE

MEMORANDUM OF AGREEMENT TO SUPPLY WATER FOR DEVELOPED LAND

I. PARTIES:

The parties to this Memorandum of Agreement (MOA) are Ellsworth Air Force Base, hereinafter referred to as the "Government," and _____hereinafter referred to as the "Owners."

II. PURPOSE:

Whereas a potentially contaminated plume has been discovered in or around the Owners' land; and whereas the Government has initiated clean-up of said plume pursuant to the final Record of Decision for Operable Unit 11 dated April 1997; and whereas the Government's clean-up efforts require the plume to be isolated, precluding its use by Owners as a source of water; and whereas the Government is willing to provide an alternative source of potable water to the Owner under the terms described below; the parties hereby enter into this MOA to establish the rights and obligations of both parties regarding the provision of a source of potable water by the Government. The purpose of this Agreement is to provide a potable source of water to the Owners. This Agreement does not constitute an admission of liability by the Government for contamination of the plume or for any injury to person or property that may be alleged to arise therefrom.

III. AUTHORITY:

The Government enters into this Memorandum of Agreement pursuant to 42 U.S.C. Sections 9601(23), 9604(a), and 9620, Executive Order 12580 of January 23, 1987, 10 U.S.C. 2701 et seq, 10 U.S.C. 2481, and Air Force Instruction 32-1061.

IV. RIGHTS AND OBLIGATIONS:

a. The Government shall provide an alternate water source to the Owners by extending a main water supply line to the Owners' property described in Section VII, paragraph a, herein. The Government shall provide one hookup to the main water line for the property described in Section VII, paragraph a, for the use of the Owners. "Hookup" is defined as the right to access the main water supply line. Additionally, the Government shall construct a curb stop and a lateral water line connecting the main water supply line to the Owners' plumbing system in Owners' home, located on the property described in Section VII, paragraph a. "Lateral water line" is defined as the water line through which water is supplied to Owners' house from the main water supply line.

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b. The Government shall provide water to the Owners free of charge as described in this paragraph for the sole use of the Owners on the property described in Section VII, paragraph a, herein. The amount of water the Government is required to provide under this MOA shall not exceed an average of 500 gallons per day as computed over a calendar year. Such water shall be for residential, domestic use to include drinking water, watering of gardens, lawns, trees, and any other common domestic use of the Owners, and shall not be sold or otherwise transferred by Owners. Owners must practice water conservation in the use of the water. Should the Owners' use exceed the average 500 gallons per day, the Government reserves the right, at its discretion, to charge the Owners for use of quantities exceeding the 500 gallons per day average at the non-federal agency rate pursuant to Air Force Instruction 32-1061 or its successor regulation. The right to receive water free of charge is limited to the Owners named in this MOA. The right to receive free water is, however, transferable to the successor, assignee, or transferee of Owners' land, described in Section VII, paragraph a. Transfer of the right to receive water free of charge is expressly contingent upon the transferee entering into a Memorandum of Agreement with the Government which shall be substantially similar to this MOA. It shall be the responsibility of the Owners and the transferee to notify the Government of any intent to transfer this right and to provide any information requested by the Government to effectuate said transfer. The failure or refusal of transferee to sign a MOA with the Government shall result in the immediate termination of the right to receive water free of charge.

c. The Owners further understand and agree that the alternate water source described in this MOA will be provided at the Government's discretion in accordance with this MOA. If the Government determines, for whatever reason, that it will not continue to furnish water to the Owners in the manner provided for in Section IV, paragraph a, above, the Government will give the Owners written notice sixty (60) days before the termination of service. Such notice does not relieve the Government of its obligation to provide water to the Owners by different means of the Government's choosing, unless the requirement to provide water is terminated for any of the conditions listed in Section VI of this MOA.

d. The Government shall bear all expenses related to installing all equipment necessary to establish one operable water hookup, curb stop and associated lateral water line on the Owners' property. Such water equipment shall be installed in accordance with the Right of Entry for Survey and Installation, USAF-ACC-FXBM-9-00-422, which is to be attached hereto and incorporated herein as Exhibit A when the installation is accomplished. Once such a water source is installed and operable, the Government shall abandon the curb stop and lateral water line and related equipment that then exist within the boundaries of the Owners' property. The Owners are solely responsible to ensure the curb stop and lateral waterline are kept in good working condition. The Government shall conduct a final inspection on the construction of the curb stop and lateral water line. The Government shall provide a one-year warranty of construction on the curb stop and lateral water line, beginning the date of the final inspection. Upon expiration of this one-year period, it shall become the Owners' sole responsibility to provide any and all maintenance, repair or replacement of such curb stop and lateral water line as may be required.

e. Until the Government's obligations under this MOA are terminated pursuant to Section VI, the Government shall bear all responsibility for, and costs of, maintaining a water supply from the point of connection with the main water supply line to its connection on the Owners' property. The Government

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shall be responsible for maintenance and repair of the water supply line and related equipment, which may cross a county or city roadway or right-of-way or easement not belonging to the Owners. The Owners shall be responsible for any maintenance, repair or replacement of the curb stop and the lateral water line that may be required following expiration of the one-year warranty of construction period.

f. Once a water source is installed and operable, and for the term of this MOA, the Owners agree that any water from wells on the subject property shall be used for non-potable purposes only (watering landscaping, livestock, washing sand and gravel etc.) including the existing well identified as PW982425. The Owners are permitted to dig additional wells for non-potable uses on property that is subject to this MOA. Should the Owners discontinue use of any wells during the term of this MOA, the Owners shall not use the defunct well site for disposal of any materials that may contaminate the groundwater. Should Owners discontinue use of any wells during the term of this MOA, the Government shall not be responsible for restoration of any such wells, pumps or other equipment that may be damaged or rendered inoperable as a result of discontinuation of use. The Government shall not be responsible for any current or future costs associated with closing existing wells or drilling and installing new wells at the termination of this MOA.

g. Once a water source is installed and operable, the Owners shall be responsible for the correction of any water flow malfunctions that occur on the Owners' property. The Government shall be responsible for the correction of any water flow malfunctions which occur on Government property or on county or city roadways or rights-of-way or easements not belonging to the Owners, unless such malfunction is caused by the Owners, their agents, representatives, assigns, heirs, or tenants, in which case the Owners are solely responsible.

V. LIABILITY FOR PROPERTY DAMAGE, PERSONAL INJURY, OR DEATH

a. The Owners shall be liable for damage, personal injury, or death caused by the acts of the Owners, their agents, representatives, assigns, heirs, or tenants to Government property or personnel pursuant to this MOA and according to the applicable laws of the State of South Dakota and the United States.

b. The Government agrees to be responsible for damages arising from the negligent activity of its officers, employees or agents acting within the scope of their employment, under the Federal Tort Claims Act or other applicable federal statute in the exercise of rights or in the performance of obligations under this MOA, either by repairing such damage or, at the option of the Government, through the claims process.

VI. TERMINATION

a. The Government shall continue to provide water in the manner set forth in the MOA until such time as:

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(1) The cleanup activities on Owners' land are completed, which shall be defined as satisfaction of the final Record of Decision (ROD) for operable unit eleven (OU-11) dated April 1997 or its subsequent amendments; or

(2) The Owners obtain and acquire suitable water from a source other than wells on Owners' property at Owners' own expense; or

(3) The Government is unable to provide such water as a matter of law, national emergency, or military necessity, or should the Government discontinue operation of a water supply system at Ellsworth Air Force Base, South Dakota. In such a case, if the ROD has not been terminated or otherwise satisfied, the Government will continue to be bound to the terms of the ROD; or

(4) The Government is otherwise authorized by law or regulation to terminate service; or

(5) The Owners, in their discretion, terminates the provision of water by serving the Government with written notice. This will not relieve Owners from strict compliance with the provisions of Section IV, paragraph f; or

(6) The parties choose to terminate this MOA by mutual and written agreement.

b. All terms, promises, provisions, and conditions contained in this MOA shall immediately terminate at the option of the Government in the event Owners operate current wells on Owners' property or Owners install new wells on Owners' property, except as allowed by Section IV, paragraph f. In such event, the Government shall initiate court action to enjoin Owners' activity, and shall seek any and all other remedies available to the Government by law.

VII. ADDITIONAL TERMS

a. The land affected by this MOA is located in Pennington County, South Dakota, and is described as follows:

The Northeast Quarter (NE¼) less 1 acre in the Southeast Quarter (SE¼) of the Northeast Quarter (NE¼) of Section 14, Township 2 North, Range 9 East, Black Hills Meridian, Pennington County, South Dakota.

A map of said property showing its location is attached hereto and incorporated herein as Attachment 1; the boundaries of said property are highlighted in red.

b. No member or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this MOA, or to any benefit that may arise therefrom.

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c. It is understood and agreed that the Government will retain no liability for repair or maintenance of water lines, pipes, or related equipment once abandoned pursuant to the terms or this MOA unless otherwise expressly provided herein. Neither shall the Government be liable for any damages to personal property nor for personal injury caused by the presence of such water lines, pipes, or related equipment once abandoned unless such damage or injury is proximately caused by the negligence of the Government or its agent following such abandonment.

d. The Owners agree that notice will be given to the Government by 01 February 2001 of the location for the installation of all curb stops associated with MOAs USAF-ACC-FXBM-9-00-441, USAF-ACC-FXBM-9-00-421, USAF-ACC-FXBM-9-00-453, and USAF-ACC-FXBM-9-00-442. If placement of the curb stops is unknown to the Owners after 01 February 2001, the Government shall give the Owner possession of all curb stops subject to these MOAs to be installed at a later time at the Owners expense thus extinguishing any obligations of the Government to install the curb stops.

e. All notices required by this MOA shall be provided by and to the Deputy Base Civil Engineer, Attention Realty Officer, 2116 Scott Drive, Suite 1, Ellsworth Air Force Base, South Dakota 57706-4709.

f. Except as provided herein, nothing in this MOA is intended to waive or otherwise restrict the exercise by the parties of any rights, remedies, or redress to which they may lawfully be entitled.

g. All the terms, provisions, and conditions in this MOA contained shall be binding upon and inure to the benefit of each of the parties hereto.

h. Except as stated in Section IV, paragraph b of this MOA with regard to the right to receive water free of charge from the Government, all of the covenants, conditions, and obligations contained in this MOA shall be binding upon and inure to the benefit of the respective successors, assignees, transferees, mortgagees, and lessees of the parties to the same extent as if each successor, assignee, transferee, mortgagee, and lessee were in each case named as a party to this MOA. Any person, corporation, or other legal entity acquiring any or all of the rights, title, or interest of the Owner in and to the premises shall thereby become liable under, and be fully bound by all of the provisions of this MOA.

i. This instrument, along with those documents incorporated herein and attached as Exhibits hereto, embodies the whole of the agreement of the parties. There are no other promises, terms, conditions, or obligations other than those contained herein; and this Memorandum of Agreement shall supersede all previous communications, representations, or agreements concerning the provision of potable water by the Government to the Owners, either verbal or written, between the parties hereto. This Memorandum of Agreement may be modified or amended only by written mutual agreement signed by the parties hereto.

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Donna M. Mayer Misc Real Est

The signing parties hereto PROMISE AND AGREE to fulfill the terms and conditions of this Memorandum of Agreement.

OWNERS

20 Dec 00
(Date)

12/20/00
(Date)

State of South Dakota, County of Pennington. On this the 20 day of December, 2000, before me LINDEN R. EVANS, the undersigned officer, personally appeared _____, known to me or satisfactorily proven to be the persons whose names are subscribed to the within instrument and acknowledged that they executed the same for the purposes therein contained.

In witness whereof I hereunto set my hand and official seal

Notary Public

My commission expires 6/6/03.

UNITED STATES AIR FORCE

26 JAN 01
(Date)

EDWARD A. RICE, JR., Colonel, USAF
Commander, 28th Bomb Wing

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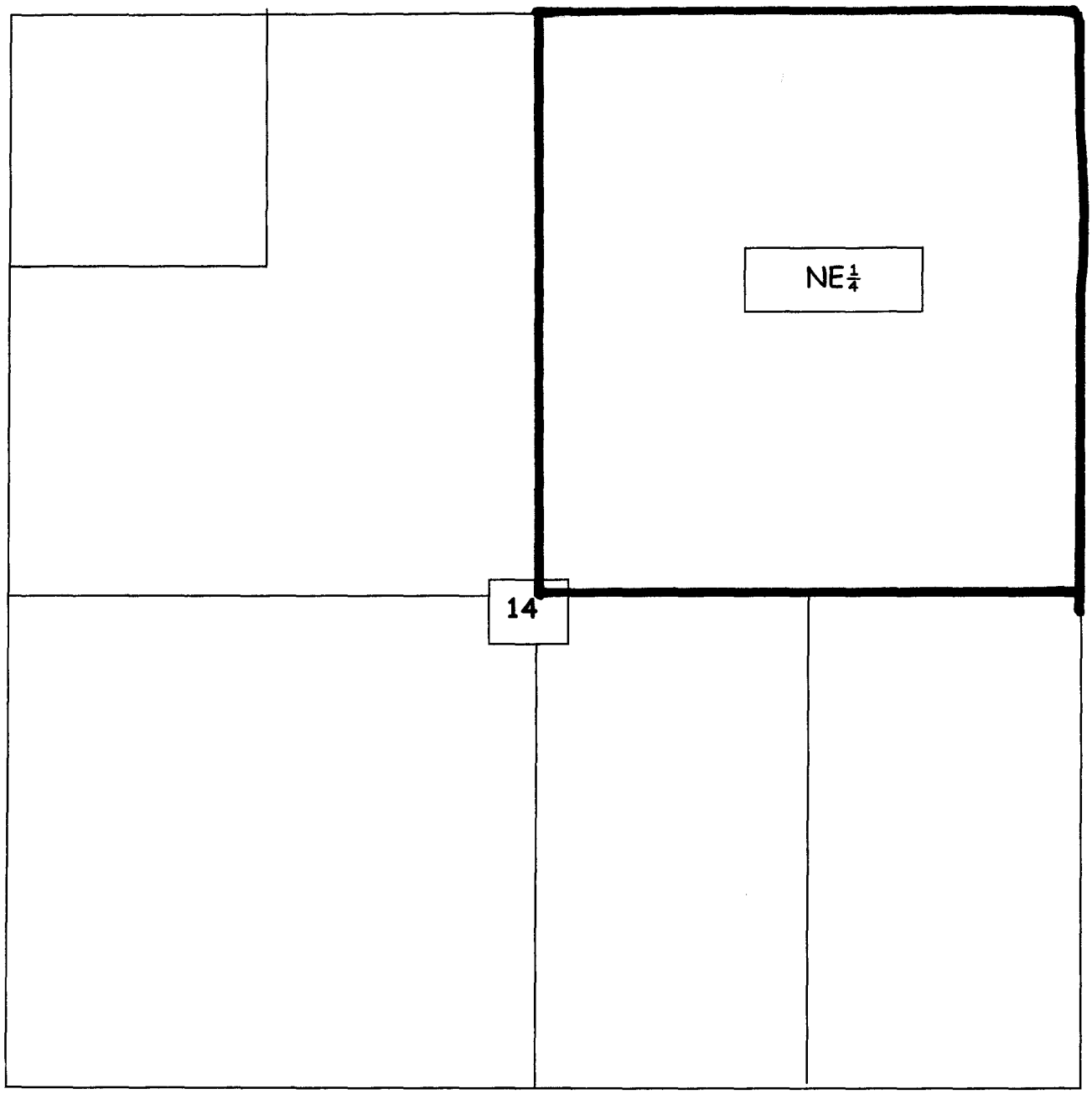
Donna M. Mayer Misc Real Est

USAF-ACC-FXBM-9-00-421

ATTACHMENT 1



NE¼ of Section 14 T2N R9E
159.0 acres, more or less

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