BASEWIDE REMEDIAL INVESTIGATION/FEASIBILITY STUDY AQUIFER TESTING WORK PLAN ADDENDUM KANSAS CITY MO

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CH2M HILL

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Richards-Gebaur AFB Basewide RI/FS Aquifer Testing Work Plan Addendum

Prepared for

Air Force Center for Environmental Excellence Brooks AFB, San Antonio TX

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Richards-Gebaur AFB Basewide RI/FS Aquifer Testing Work Plan Addendum

1.0 Introduction

The Aquifer Testing Work Plan Addendum (ATWPA) for Richards-Gebaur Air Force Base (AFB), Kansas City, Missouri, has been prepared under CH2M HILL's prime contract with the Air Force Center for Environmental Excellence (AFCEE) No. F41624-97-D-8019. The additional work will be performed as a supplement to the original Remedial Investigation (RI) field work completed in November 1999. The ATWPA will be executed under Delivery Order (DO) 0090 - Modified, dated May 24, 1999, entitled, *Basewide Remedial Investigation/Feasibility Study at Richards-Gebaur AFB, Missouri.*

This document serves as a supplement to the Basewide RI/FS Work Plan for Richards-Gebaur AFB, submitted by CH2M HILL to the Air Force in October 1999. The ATWPA is not intended to serve as a stand-alone document and incorporates by reference the field methodologies, environmental sampling procedures, sample handling, sample custody, field measurements, and record keeping set forth in the October 1999 Basewide RI/FS Work Plan for Richards-Gebaur AFB. Additionally, all laboratory procedures and Data Quality Objectives outlined in the 1999 Work Plan will apply, as appropriate, to the tasks described in the ATWPA.

2.0 Background

Between October and December 1999, CH2M HILL conducted a Basewide RI at Richards-Gebaur AFB. The RI comprised the following16 sites:

- AOC 001: Central Drainage Area
- AOC 002: North Drainage Area
- AOC 010: Building 918 Parking Lot
- CS 001: Fuel Line – 942 Section
- CS 002: Oil / Water Separator at Building 704
- CS 004: UST 620A
- FT 002: North Burn Pit (FTA)
- OT 010 Firing Range *(Note: formerly referred to as AOC 003)*
- SS 003: Oil Saturated Area
- SS 004: Hazardous Waste Drum Storage Area
- SS 006: Hazardous Material Storage Area
- SS 008: Test Cell Area
- SS 009: Fire Valve Area
- ST 005: Petroleum, Oil, and Lubricants (POL) Storage Yard
- ST 007: Former UST Area
- XO 001: Belton Training Complex (BTC)

Field investigations were completed at each site and consisted of one or more of the following activities:

- installing groundwater monitoring wells
- logging subsurface geological conditions
- collecting surface and subsurface soil samples
- collecting groundwater samples (in areas where groundwater was present)
- collecting surface water samples
- collecting sediment samples

Environmental samples collected during the RI were analyzed for various contaminants of concern (COC) that had been identified in previous site investigations at Richards-Gebaur AFB. These previous investigations were summarized in the 1999 Evaluation and Consolidation Study (ECS) Report. In addition to investigating 16 RI/FS sites, the above field activities were also completed at select background locations agreed upon jointly by the Air Force and the Missouri Department of Natural Resources (MDNR). The purpose of the background samples was to determine representative concentrations of naturally occurring metals and anthropogenic chemicals in soil, groundwater, surface water, and sediment.

The RI field work was completed in December 1999. The samples were analyzed between November 1999 and January 2000. Data validation was completed in March 2000. Based on a preliminary assessment of analytical results, five sites were found to contain concentrations of chlorinated hydrocarbons in groundwater above applicable MDNR Groundwater Target Cleanup (GTARC) levels which typically correspond to federal Maximum Contaminant Levels (MCLs). In response to these data, the Air Force identified additional data needs at the five RI sites; that is, the nature and extent of the groundwater contamination required further delineation.

The five sites in question were CS 004, SS003, SS006, SS009, and ST005.

A supplemental field investigation was conducted in accordance with March 2000 RI/FS Work Plan Addendum (WPA). The field work consisted of installing shallow and deep monitoring wells at each of the above five sites. In general, shallow overburden monitoring wells were designed to screen the overburden/bedrock interval that corresponds to the screened interval of existing wells with chlorinated hydrocarbon detections. Deep wells were installed to straddle the deeper limestone/shale interface.

Because chlorinated hydrocarbons are heavier than water, they will tend to sink through the groundwater column and pool at impermeable horizons. At Richards-Gebaur AFB, the underlying shale units act as vertical barriers to groundwater flow and are therefore potential horizons where dense non-aqueous phase liquids (DNAPLs), such as trichloroethene (TCE), can collect. The deep wells were installed to monitor potential DNAPL accumulations at the limestone /shale interface.

Shallow and deep monitoring well pairs were installed at three sites: CS 004, SS 009, and ST 005. The approach is designed to ensure that monitoring wells are screened across the deeper limestone/shale interface to intercept any DNAPLs that may have accumulated on top of the impermeable shale This allows the shallow (unconsolidated/bedrock) and deep (limestone/shale) interface zones to be screened and sampled independently.

Based upon drilling logs and rock cores, CS 004, SS 009, and ST 005 are underlain by several feet of weathered Raytown Limestone overlying the Chanute Shale formation. Figure 2.1 is a schematic of the shallow and deep well nested pair construction.

At site SS 003, the uppermost bedrock unit is the relatively impermeable Lane Shale. Consequently DNAPLs would not be expected to migrate downward through this stratum, and drilling through it would be ill-advised, potentially providing an unwanted vertical pathway for groundwater movement. Therefore, shallow and deep wells were not installed at this site.

At site SS 006, the uppermost bedrock unit is the Argentine Limestone. The bedrock outcrops near or at the ground surface, precluding construction of a shallow overburden/top of limestone monitoring well. The wells at the site are drilled through the Argentine Limestone and screened to straddle the base of Argentine Limestone/top of Lane Shale interface.

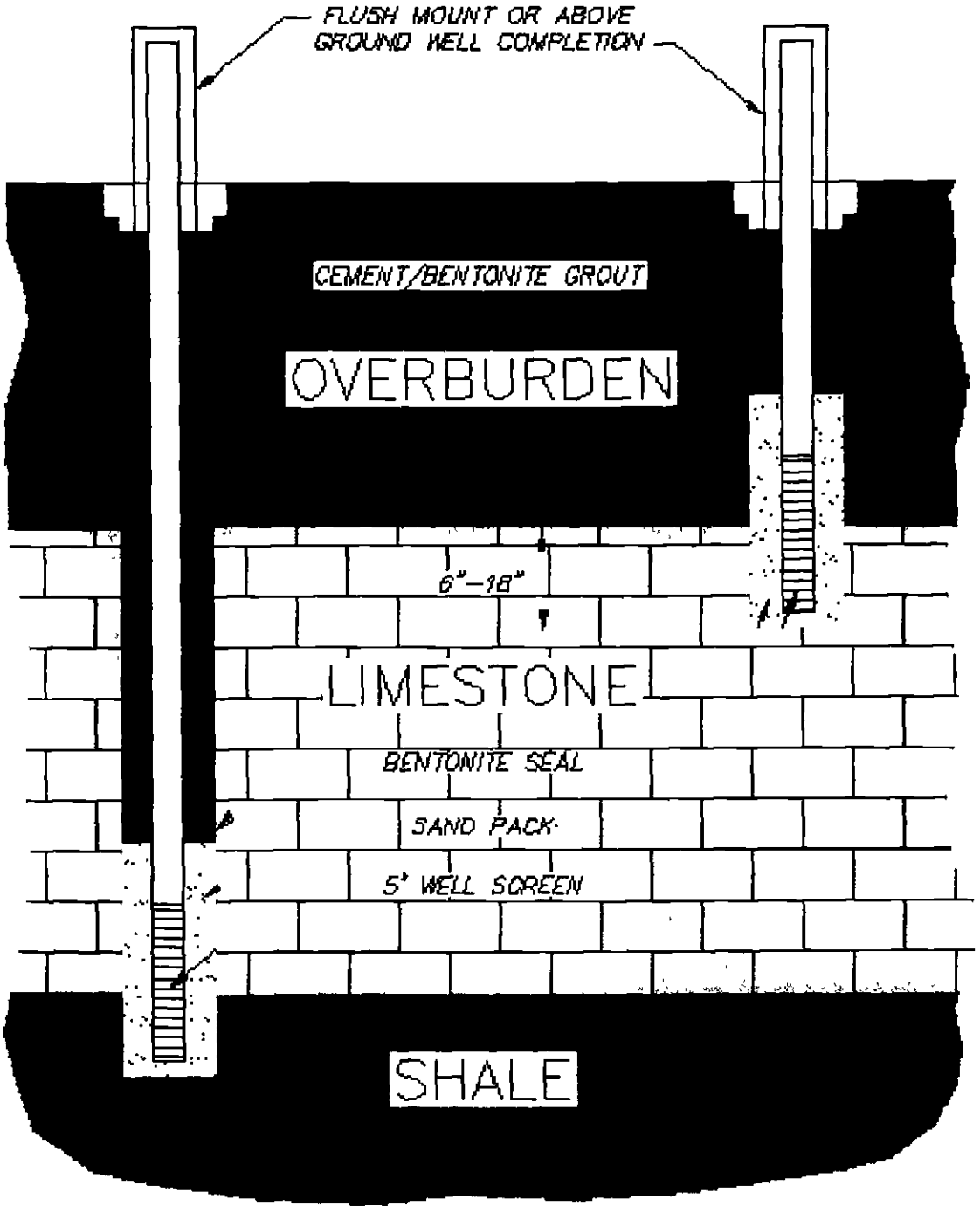

FIGURE 2.1
Schematic of Nested Monitoring Wells

3.0 Objectives and Scope

The additional field work is required because the RI sampling results indicated that chlorinated hydrocarbons were present in groundwater at five separate sites. The chemicals - principally trichloroethene (TCE), cis 1,2-dichloroethene (DCE), and vinyl chloride (VC) - were locally detected at concentrations exceeding applicable groundwater cleanup criteria, as set forth in the State's Cleanup Levels for Missouri (CALM) Guidance. The elevated chemical concentrations were detected in groundwater samples collected from six monitoring wells located at five sites: CS 004, SS 003, SS 006, SS 009, and ST 005.

The objectives of the aquifer testing at the five sites exhibiting evidence of chlorinated hydrocarbons in groundwater are to:

- assess the degree of hydraulic connection between the overburden/top of limestone interface and the base of limestone/shale interface
- estimate the vertical hydraulic gradient
- estimate the horizontal hydraulic conductivity in the shallow, weathered Raytown Limestone and in the deep, relatively unweathered Raytown Limestone (CS 004, SS 009, ST 005)
- estimate the hydraulic conductivity in the weathered Lane Shale (SS 003)
- estimate the hydraulic conductivity in the Argentiine Limestone SS 006)
- assess the groundwater flow direction and flow rate at individual sites
- refine the basewide Conceptual Site Model (CSM) based upon new data

Please note that because of low permeability site conditions – clay soils overlying limestone and shale – and the correspondingly low yield of site monitoring wells, it may not be possible to satisfy all the above objectives.

Several methods of aquifer testing are available, including constant-rate pumping tests and slug tests. Constant-rate pumping tests employ several wells. A pump is used to maintain a steady discharge at the test well and resulting drawdowns at the test well and nearby observation wells are measured over time. These tests are desirable because they typically provide sufficient data (drawdown vs. time; drawdown vs. distance) to allow computation of key aquifer parameters such as hydraulic conductivity and transmissivity.

Aquifer slug tests, however, use only one well. The test involves removing a known volume of water – a 'slug' – from a single well, and recording the resulting rate of recharge as the water level rebounds and rises to its original elevation. Compared with the constant-rate aquifer test, the data from a slug test is limited because it describes only the characteristics of the aquifer in the immediate vicinity of the test well, and may not be representative of site-wide conditions.

Based on historical data, field observations, and well development records, the wells at Richards-Gebaur rapidly become dry when bailed (with the possible exception of some wells at CS 004). Consequently, pumps cannot be used to maintain a constant discharge because the wells do not recharge sufficiently fast enough to support pumping. As a result, constant rate aquifer tests are impracticable for wells at Richards-Gebaur AFB.

However, the known low-conductivity conditions also mean that the corresponding radius of influence of a test should be large – in other words, a considerable volume of aquifer matrix is likely necessary to supply the water needed to replenish a test well that is purged dry Accordingly, if a test well is purged dry, then the effects of this could be manifest in observation wells several tens of feet distant

It is therefore proposed to purge the test well dry and record changes in pre-test static water levels in five nearby observation wells. The recovery of the 'slugged' well will also be measured simultaneously with the observation wells The changes in water levels will be recorded electronically using electronic transducers that are placed below the static water levels in each well prior to the onset of testing.

The object of the test is to impose sufficient hydraulic stress on the aquifer via the test well such that measurable differences in water levels can be detected in neighboring monitoring wells If the amount of water removed from a well is small, then the resulting stress on the water-bearing units may be negligible, especially in monitoring wells several tens of feet distant from the test well. To address this concern, in the event that a test well yields less than 2 gallons of water before becoming fully purged, CH2M HILL will adapt the aquifer testing methodology from rising head to falling head. This will be accomplished by adding sufficient tap water to fill the height of the test well casing immediately prior to beginning test data logging. The volume of added water will be recorded in the field test log book. The remainder of the test proceeds in a similar fashion to a rising head slug test..

For sites with nested well pairs – CS 004, SS 009, and ST 005 – two separate tests will be conducted. one for a deep well and one for a shallow well. The second test will not commence until wells have recovered to pre-test static water levels. At the remaining two sites – SS 003 and SS 006 – a single test will be performed since all the wells screen the same lithological interval. Further details are provided below in Section 5. Table 3-1 summarizes the proposed monitoring network for the aquifer tests.

The results of the aquifer testing will be used to evaluate potential health and ecological risks associated with potential exposure to the residual chlorinated hydrocarbons in the groundwater, and may be used to help design future remedial strategies for groundwater, if appropriate. Historical data and a survey of groundwater use in the vicinity of the Base point to the fact that, locally, groundwater is unpotable because of low yield and high salinity The aquifer tests - and associated water quality analyses being performed under the RI - are designed to quantify the current understanding

Table 3.1
Monitoring Well Network for Aquifer Tests

Monitoring Well ID	Screened Depth Interval (feet bgs)	Screened Formation	Installation Contractor and Date	Role of Well in Aquifer Test
CS004-MW001	11 - 16	silty clay	CH2M HILL (1999)	Observation Well
CS004-MW002	11 - 16	silty clay	CH2M HILL (1999)	Observation Well
CS004-MW003	11 - 16	silty clay	CH2M HILL (1999)	Test Well
CS004-MW004	17 3 - 22 3	limestone / shale interface	CH2M HILL (1999)	
CS004-MW005	12 7 - 17 7	silty clay	CH2M HILL (2000)	
CS004-MW006	20 - 23	limestone / shale interface	CH2M HILL (2000)	Observation Well
CS004-MW007	20 5 - 23 5	limestone / shale interface	CH2M HILL (2000)	Test Well
CS004-MW008	20 - 23	limestone / shale interface	CH2M HILL (2000)	Observation Well
CS004-MW009	13 5 - 18 5	silty clay and weathered shale	CH2M HILL (2000)	
CS004-MW010	19 5 - 22 5	limestone / shale interface	CH2M HILL (2000)	
CS004-MW011	19 5 - 22 5	limestone / shale interface	CH2M HILL (2000)	
CS004-MW012	12 5 - 17 5	silty clay and weathered shale	CH2M HILL (2000)	
SS003-MW001	9 5 - 19 5	silty clay	Versar (1996)	
SS003-MW002	22 9 - 32 9	shale / limestone interface	Versar (1996)	
SS003-MW003	21 5 - 31 5	shale / limestone interface	Versar (1996)	
SS003-MW004	14 - 24	silty clay and weathered shale	CH2M HILL (1999)	Observation Well
SS003-MW005	17 - 27	silty clay and weathered shale	CH2M HILL (2000)	
SS003-MW006	11 5 - 21 5	silty clay and weathered shale	CH2M HILL (2000)	Observation Well
SS003-MW007	13 - 23	silty clay and weathered shale	CH2M HILL (2000)	Test Well
SS003-MW008	11 - 21	silty clay and weathered shale	CH2M HILL (2000)	
CS002-MW002R	12 5 - 22 5	silty clay and weathered shale	CH2M HILL (2000)	Observation Well
CS002-MW004	14 7 - 24 2	silty clay and weathered shale	CH2M HILL (1999)	Observation Well
SS006-MW001	5 8 - 15 8	limestone, shale	Versar (1996)	Test Well
SS006-MW005	7 2 - 12 2	limestone, shale	CH2M HILL (2000)	Observation Well
SS006-MW006	7 2 - 12 2	silty clay, limestone, shale	CH2M HILL (2000)	Observation Well
SS006-MW007	6 7 - 11 7	shale, limestone, shale	CH2M HILL (2000)	Observation Well
SS006-MW008	5 7 - 10 7	silty clay, limestone, shale	CH2M HILL (2000)	Observation Well
SS009-MW002	8 5 - 13 5	silty clay	CH2M HILL (1999)	
SS009-MW003	8 5 - 13 5	silty clay	CH2M HILL (1999)	Test Well
SS009-MW004	18 7 - 23 7	limestone / shale interface	CH2M HILL (2000)	Observation Well
SS009-MW005	9 2 - 14 2	silty clay and weathered shale	CH2M HILL (2000)	Observation Well
SS009-MW006	18 7 - 23 7	limestone / shale interface	CH2M HILL (2000)	Test Well
SS009-MW007	19 2 - 24.2	limestone / shale interface	CH2M HILL (2000)	
SS009-MW008	18 7 - 23 7	limestone / shale interface	CH2M HILL (2000)	
SS009-MW009	11 2 - 16 2	silty clay	CH2M HILL (2000)	
SS009-MW010	18 - 23	limestone / shale interface	CH2M HILL (2000)	Observation Well
SS009-MW011	9 7 - 14 7	silty clay	CH2M HILL (2000)	Observation Well
ST005-MW003	5 0 - 12 5	silty clay and weathered shale	Burns & McDonnell (1992)	Test Well
ST005-MW010	17 2 - 22 2	limestone / shale interface	CH2M HILL (2000)	Test Well
ST005-MW011	17 2 - 22 2	limestone / shale interface	CH2M HILL (2000)	
ST005-MW012	6 2 - 11 2	silty clay and weathered shale	CH2M HILL (2000)	
ST005-MW013	19 2 - 24 2	limestone / shale interface	CH2M HILL (2000)	
ST005-MW014	7 7 - 12 7	silty clay and weathered shale	CH2M HILL (2000)	
ST005-MW015	19 7 - 24 7	limestone / shale interface	CH2M HILL (2000)	Observation Well
ST005-MW016	9 2 - 14 2	silty clay and weathered shale	CH2M HILL (2000)	Observation Well
ST005-MW017	25 7 - 30 7	limestone / shale interface	CH2M HILL (2000)	Observation Well
ST005-MW018	15 2 - 20 2	weathered shale	CH2M HILL (2000)	Observation Well

4.0 Summary of Individual Site Conditions

The following sections briefly describe the setting and history of the five sites addressed in the ATWPA. Further details are available in the 1999 Evaluation and Consolidation Study (ECS) Report.

4.1 Site Description – CS 004

CS 004 is the site of a former UST located at the northwest corner of Building 620. The UST was used to store waste liquids from Air Force fuel testing laboratories housed in Building 620 between 1966 and 1988. The capacity of the tank was 550 gallons. The composition of the net waste stream stored in this tank was estimated by Air Force personnel to be approximately 70% fuel, 28% water, and 2% acid (Esch, 1996). The site is about 400 square feet in area, flat, and unpaved. It is not located in a floodplain, and no surface water bodies or sediments are present onsite.

As part of a 1988 Air Force project, the UST was removed. Low levels of TPH – 39 ppm (below MDNR's action level of 50 ppm) - were measured in a single soil sample collected from the excavation during the tank removal. Additional soil samples were collected in 1993 as part of the UST closure activities for the Base at large (Burns & McDonnell, 1994b). In order to confirm that the UST had been removed, and not abandoned in place as had been reported in a previous closure report, several more soil samples were collected in 1995. The investigation verified that the tank had indeed been removed, but soil sample analytical results indicated that the former UST area contained TPH constituent concentrations in soil above the applicable MDNR UST action level of 50 ppm. In response to the indications of residual soil contamination, about 500 cubic yards of soil was excavated in 1995 (Dames & Moore, 1996b). Three post-excavation soil samples were collected at this time. Two more soil samples were collected at the site to document subsurface conditions as part of a Subsurface Assessment in 1996 (HDB, 1996).

During the 1999 Basewide RI at Richards-Gebaur AFB, CH2M HILL installed three monitoring wells, MW-1, MW-2, and MW-3, at CS 004. Groundwater samples collected from MW-1 and MW-3 contained cis-1,2 dichloroethene (cis-1,2 DCE) at concentrations of 92.6 ug/l and 211.1 ug/l, exceeding the CALM GTARC of 70 ug/L.

As part of the 2000 WPA effort, nine additional monitoring wells were installed. Existing monitoring well locations are shown in Figure 4.1. The proposed test well and observation wells are highlighted.

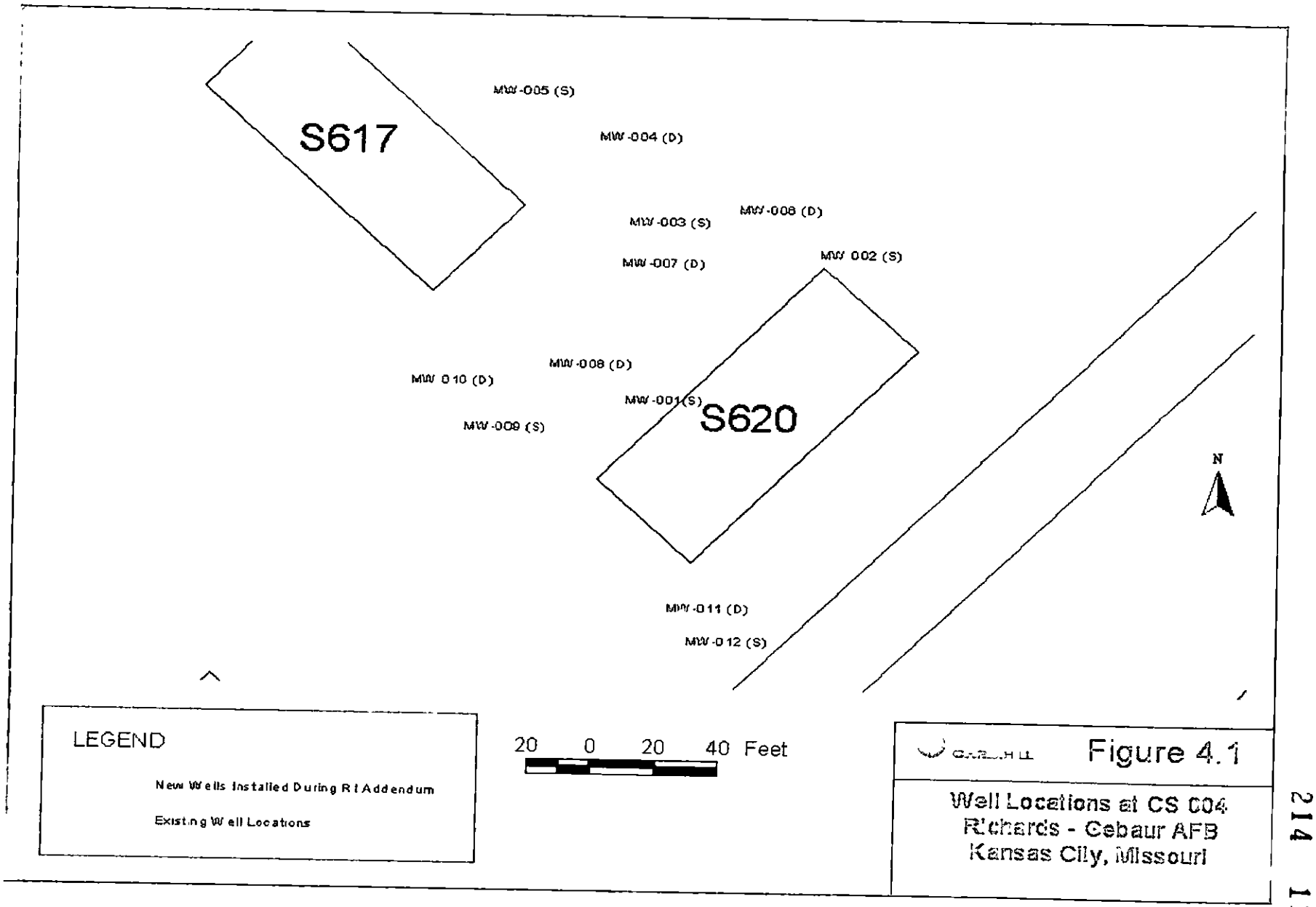

Figure 4.1

Well Locations at CS 004
Richards - Gebaur AFB
Kansas City, Missouri

4.2 Site Description – SS 003

SS 003, the Oil Saturated Area, is located south of 155th Street, southwest of Building 704. It was used to store waste oil products generated from the mid-1950s to the late 1980s by routine maintenance of the Motor Pool vehicles (USAF, 1994a). The site is part of the former waste oil storage area and originally covered approximately 1,600 square feet (Versar, 1996d). The site is paved and flat. A grassy swale runs parallel to the west and south fencelines. The site is on a small hill and is not located in or near a floodplain.

SS 003 was initially identified during a Phase I Records Search of the Air Force Base (CH2M HILL, 1983). The site was recognized at that time as being oil stained. The site was further investigated in 1986 and soil and surface water samples were collected and analyzed (Ecology and Environment, 1988). Two additional field samples were collected in 1989 as part of a Remedial Investigation (O'Brien and Gere, 1991). In 1991, approximately 42 cubic yards of contaminated soil was removed from SS 003 (Burns and McDonnell, 1992). In 1996 a groundwater assessment was conducted at the site (Versar, 1996d).

During the 1999 Basewide RI at Richards-Gebaur AFB, CH2M HILL installed four monitoring wells, MW-1 through MW-4, at SS 003. A groundwater sample collected from MW-4 contained TCE at a concentration of 71.2 ug/l, exceeding the applicable CALM Groundwater Target Concentration (GTARC) of 5 ug/L.

As part of the 2000 WPA effort, five additional monitoring wells were installed at the site. Existing monitoring well locations are shown in Figure 4.2. The proposed test well and observation wells are highlighted.

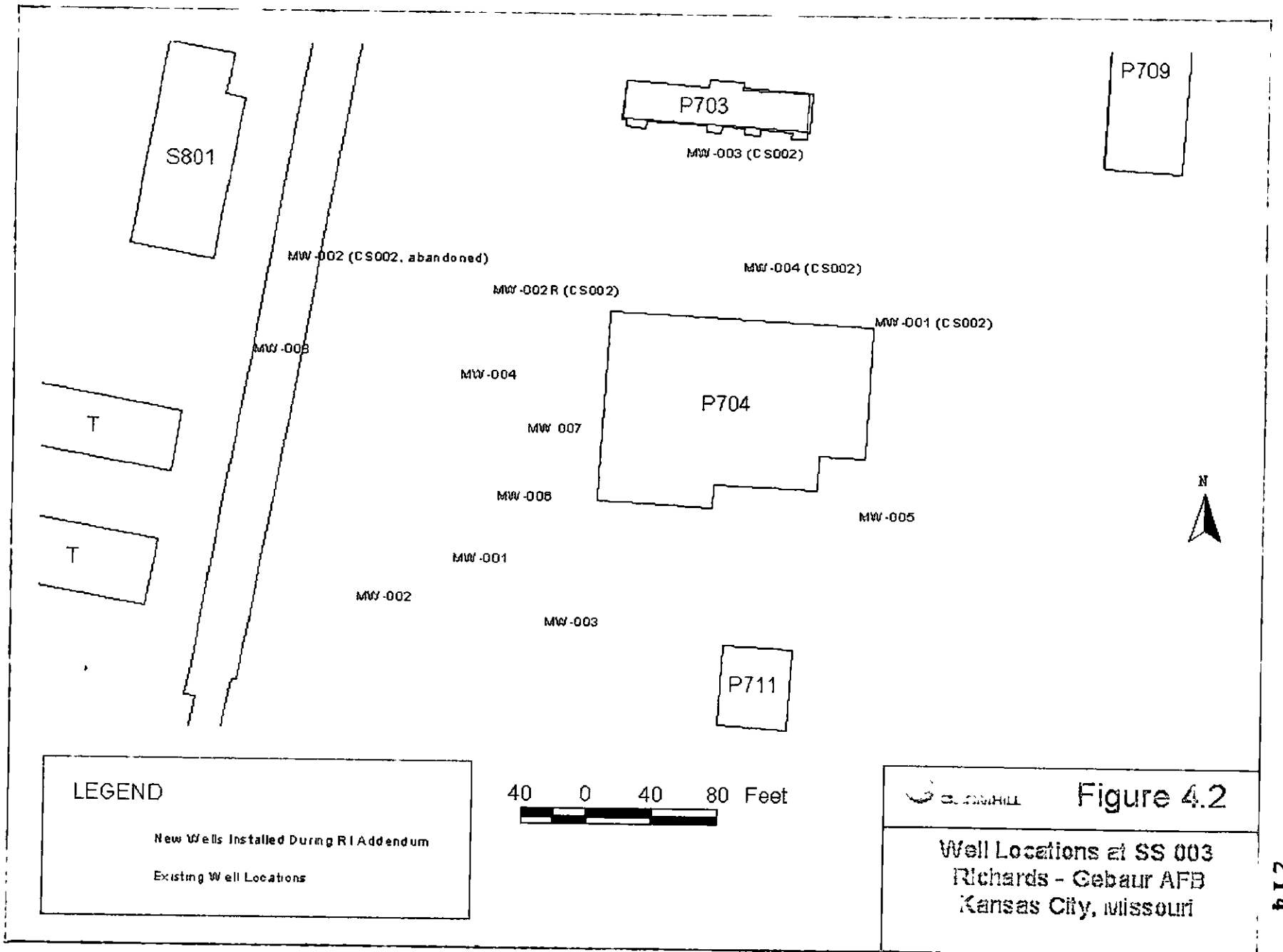

Figure 4.2

Well Locations at SS 003
Richards - Gebaur AFB
Kansas City, Missouri

4.3 Site Description – SS 006

SS 006, the Hazardous Material Storage Area, is located east of Building 927, east of Hanger Road, north of 155th Street. Building 927 was used as an aircraft engine and propeller maintenance shop from 1957 to 1994. An area outside the rear of the building was used to keep bulk supplies of degreasers, solvents, oils and other common workshop materials. The materials were routinely stored in 55-gallon drums or other containers and placed off the ground on racks. The racks were located at the top of a grass embankment.

SS 006 is flat lying, although there is a steep downhill embankment immediately east of the storage area. The site's surface drainage is separated from the building drainage by a six-inch high curb (Versar, 1996a). The site is approximately 600 square feet in area and is situated at one of the highest parts of the Base, near the airfield. The site is not located in a floodplain, and no surface water bodies or sediments are present onsite.

The aircraft maintenance workers in Building 927 used SS 006 in the past to store common machine shop materials. Degreasers, solvents, oils, and lubricants were stored on racks outside at the rear of the building. The site was initially identified during a Site Inspection in 1990. According to records, the grass immediately behind the storage racks was discolored and showed signs of stress. In response, two surface soil samples were collected as part of a Preliminary Assessment (PA) of the site (O'Brien and Gere, 1991). Additional field samples were collected in 1991 during an IRP Site Inspection (Burns and McDonnell, 1993d and 1993e). At this time, the storage rack had been removed and signs of stressed vegetation were now absent. Subsequently, in 1993, approximately 40 cubic yards of contaminated soil was removed from SS 006 (Burns and McDonnell, 1993d).

Following the soil removal, a groundwater assessment was conducted at the site (Versar, 1996a). A groundwater sample was collected from MW-1 and analyzed for metals, VOCs, SVOCs, and TPH. Metal concentrations were below applicable MDNR action levels. Three VOCs (vinyl chloride, cis-1, 2-dichloroethene, and trichloroethene) exceeded the respective State MCLs. One SVOC, bis(2-ethyhexyl)phthalate, was detected at a concentration of 10 ppb, slightly above the State MCL of 6 ppb. The constituent is a common artifact of environmental sampling, particularly in PVC-constructed wells. No TPH constituents were detected in the samples.

During the 1999 Basewide RI at Richards-Gebaur AFB, CH2M HILL attempted to install three monitoring wells at SS 006. However, each monitoring well borehole was terminated within a few feet of the ground surface because of the presence of hard limestone that would not permit continued drilling with hollow-stem augers. A groundwater sample was collected from MW-1, the only existing monitoring well at SS 006, and was found to contain TCE at a concentration of 56.2 ug/l, exceeding the applicable CALM GTARC of 5 ug/L. No SVOCs – including bis(2-ethylhexyl)phthalate – were detected.

Subsequently, as part of the 2000 WPA field effort, four monitoring wells were successfully installed at the site. The locations of the existing monitoring wells are shown in Figure 4.3. The proposed test well and observation wells are highlighted.

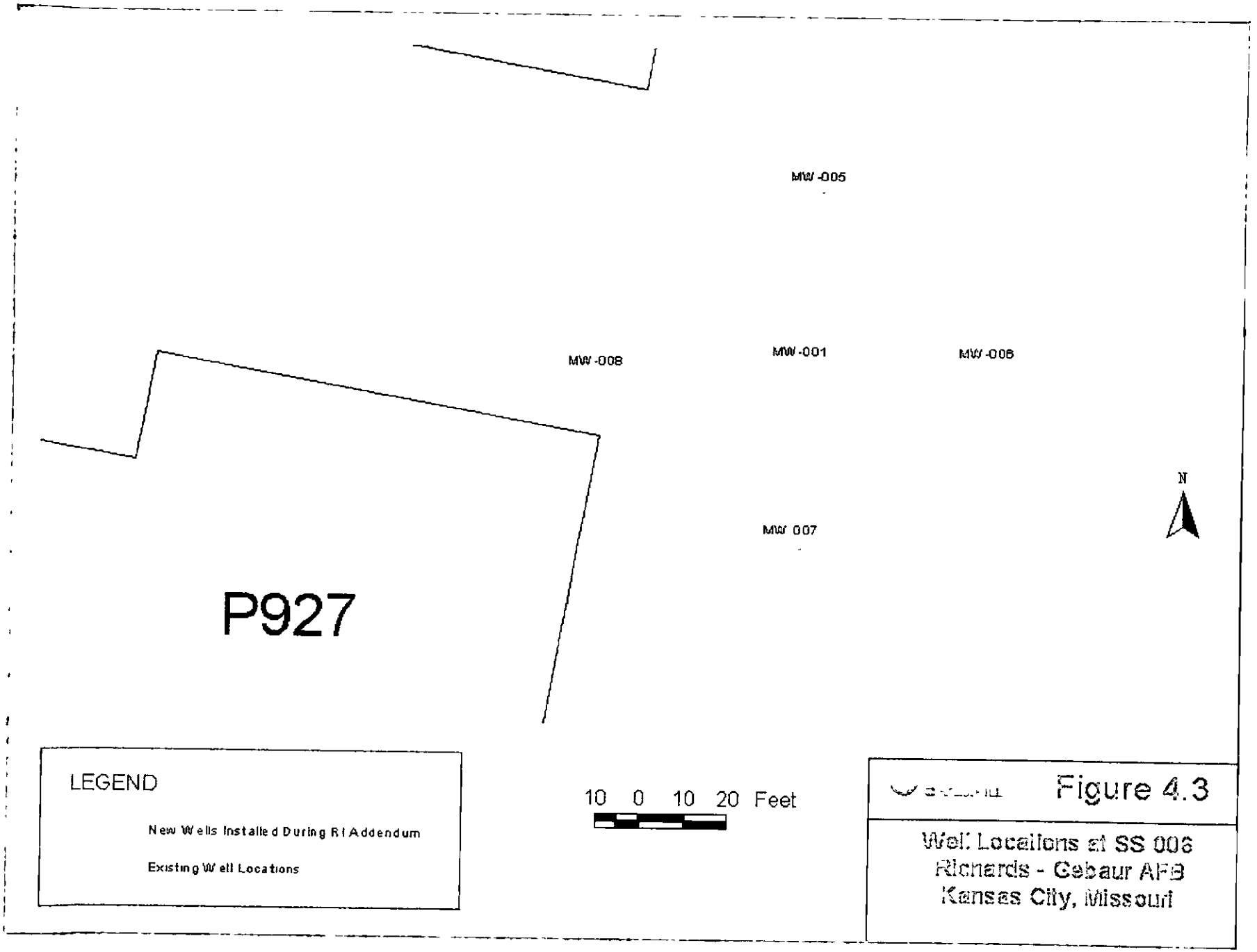

Figure 4.3

Well Locations at SS 006
Richards - Gebaur AFB
Kansas City, Missouri

4.4 Site Description – SS 009

SS 009 is located on Richards-Gebaur AFB directly on the southwest side of Building 605 on Corkill Road, southeast of the intersection of Westover and Corkill Roads. Building 605 was used by the Air Force as part of the Civil Engineering Complex from 1953 to 1996. The building was used for various purposes during this period, including a Carpenter Shop, Interior and Exterior Heat Shop, Roads and Grounds Shop, and Sanitation Shop (Tetra Tech, 1995c). Reportedly, no activities at the complex involved the storage or handling of bulk hazardous waste materials (USAF, 1993).

The site is located on the far side of a paved parking lot next to a fire valve and adjacent to a small grass drainage swale. It occupies approximately 400 square feet in area and is generally flat. The site is not located in a floodplain.

The site was initially identified in 1992 when petroleum product was reported by an Air Force contractor who was digging a ditch to repair an underground water main valve (USAF, 1993). As a consequence, 10 cubic yards of petroleum-contaminated soil was excavated from the trench to a depth of approximately five feet below ground surface in 1993.

In 1994, a total of 70 soil samples were collected from the site for possible laboratory analyses during a Preliminary Assessment /Site Investigation (PA/SI) (Tetra Tech, 1995c). A groundwater assessment was conducted at the site to evaluate the potential adverse impacts to local shallow groundwater (Versar, 1996a). No TPH constituents were detected in the samples. No SVOCs were detected above applicable MCLs. Four VOCs were detected with concentrations that exceeded their respective MCLs. The VOCs detected were 1,1-dichloroethene (17 ppb, 16 ppb), tetrachloroethene (12 ppb, 33 ppb), trichloroethene (8.8 ppb, 11 ppb), and vinyl chloride (4.6 ppb, 21 ppb).

Several metals were also detected in the total metals analysis at concentrations above their respective MCLs. The metals detected included arsenic (63.1 ppb), barium (5,240 ppb), cadmium (5.3 ppb), chromium (157 ppb, 227 ppb), and lead (56.4 ppb, 184 ppb). The dissolved metals analytical results, however, were all below the applicable MCLs. PCB results are considered inconclusive because the detection limit of 1.1 ppb was higher than the corresponding MCL of 0.5 ppb.

During the 1999 Basewide RI at Richards-Gebaur AFB, CH2M HILL attempted to install three monitoring wells at SS 009. Two of the wells were installed successfully; however, the borehole for proposed MW-1 was abandoned because it failed to produce water within 48 hours after drilling. A groundwater sample collected from MW-3 contained TCE at a concentration of 34.9 ug/l, exceeding the CALM GTARC of 5 ug/L. MW-3 also contained cis-1,2 DCE at a concentration of 241.9 ug/l, exceeding the CALM GTARC of 70 ug/l. In addition, PCBs were not detected in any soil samples collected from the three well borings.

As part of the 2000 WPA, eight additional wells were installed at the site. The locations of existing monitoring wells at SS 009 are shown in Figure 7.1.

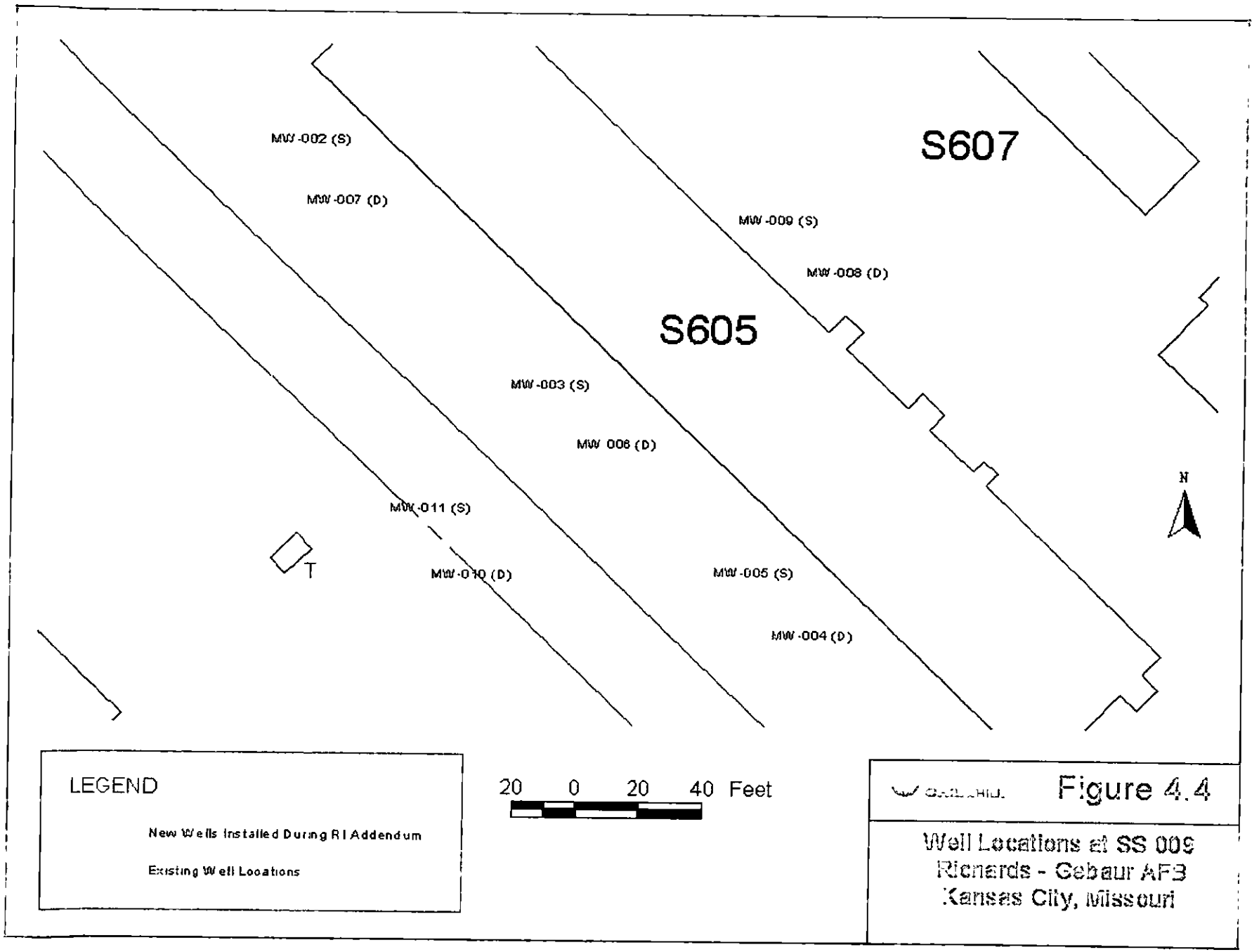

Figure 4.4

Well Locations at SS 009
Richards - Gebaur AFB
Kansas City, Missouri

4.5 Site Description – ST 005

ST 005, the Petroleum, Oil, and Lubricants (POL) storage yard is a former aboveground tank farm located east of the flight line and west of Andrews Road. The POL Yard is 12 acres in size and was in use from 1954 to 1988. The POL Yard was used to store and dispense jet fuel (JP-4), fuel oil and motor gasoline (MOGAS) to the Base. Most of the structures formerly at the site were removed in 1996.

The POL Yard began operations in 1954. In 1985, an aboveground storage tank (Facility 956) and a pump house (Facility 959) were sold to the City of Kansas City, and remain in place today. The POL Yard was decommissioned in 1996.

Numerous soil and groundwater investigations were performed at ST 005 prior to the 1999 RI. Results obtained from these investigations are described in the 1999 RI/FS Work Plan.

During the 1999 Basewide RI/FS at Richards-Gebaur AFB, CH2M HILL collected groundwater samples from 17 monitoring wells located throughout ST 005. A single groundwater sample, again collected from MW-3, contained TCE at a concentration of 189.1 ug/l, exceeding the CALM GTARC standard of 5 ug/L. MW-3 was previously sampled in 1991 and found to contain TCE at a concentration of 44.4 ug/l. Chlorinated solvents have not been detected in any other wells at the site.

As part of the 2000 WPA effort, nine additional monitoring wells were installed at the site. The locations of the existing monitoring wells are shown in Figure 4.5.

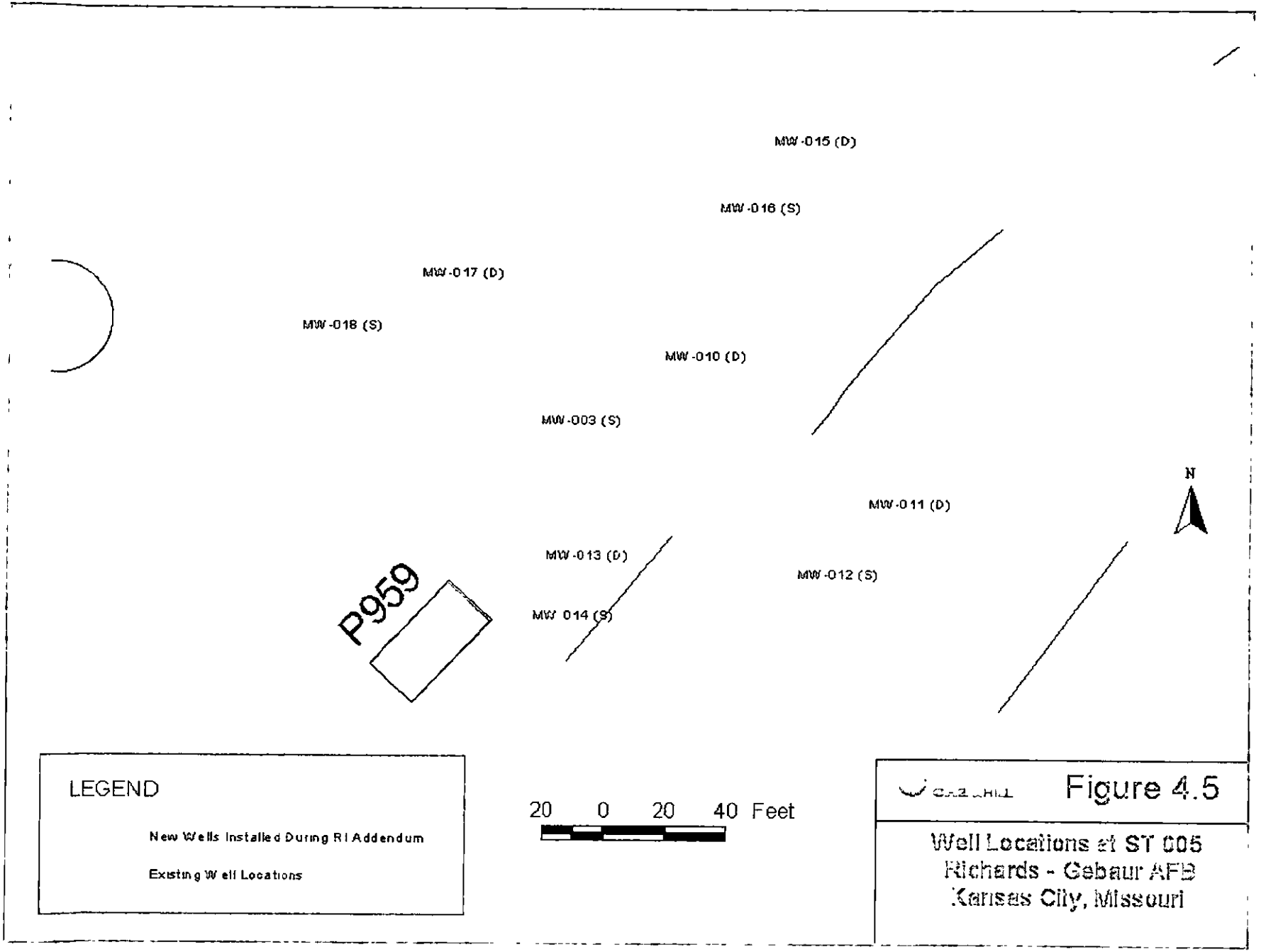

Figure 4.5

Well Locations at ST 005
Richards - Gebaur AFB
Kansas City, Missouri

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5.0 Aquifer Testing Methodology

Aquifer tests will be conducted in a similar fashion for each of the five sites that are being investigated. This approach will help provide a consistent quality of data and allow for meaningful comparison of results within and between each site. Where reasonable and scientifically defensible, extrapolations from a site-specific scale to a Basewide scale may be used in the future to help refine the overall conceptual site model, a crucial component of the RI/FS study.

Standard Operating Procedures (SOPs) exist for conducting slug testing (ASTM D-4044-96) and analyzing slug test data (ASTM D-5912-96). The proposed tests will generally comply with these SOPs but will also contain variations because of the low-conductivity site conditions and the use of downhole mini-troll transducer/data-loggers. Detailed field logs will be kept and variations from standard procedures will be recorded.

Selection of Test Well

The selection of the test well which will be purged dry will be based on the volume of water available for removal – the larger the volume, the greater the effect on the surrounding aquifer, and the greater the likelihood that effects can be measured at the observation wells. Well-water volumes were recorded by CH2M Hill during well development and a detailed record of the behavior of each well exists. A second consideration is the ability of the well to recharge in a reasonable time – i.e. within 72 hours

Wells at sites SS 003 and SS 006 did not require shallow and deep nesting. At SS 003 the wells are installed in shale, and at SS 006, limestone is within two feet of the ground surface and the wells are installed to the limestone/shale interface. In these cases, the well with the largest volume of static water and the best ability to recharge will be used as the test well.

At sites ST 005, CS 004, And SS 009, where shallow and deep well pairs are in place, two tests will be performed – one using the shallow well with the highest recharge rate, the other using the deeper well with the highest recharge rate.

Appendix A presents a table showing the well development characteristics of the monitoring wells installed during the WPA field effort. The proposed test wells for each site are highlighted.

Selection of Observation Wells

Because of the known low permeability conditions at the sites, it is advisable to select the monitoring wells closest to the test well as observation wells. At sites where shallow and deep nested pairs exist, the two pairs closest to the test well will be monitored. Because it is known that the upper limestone unit is fractured almost at right-angles by regional jointing, observation wells will be selected in two radial direction from the test well corresponding to a 90-degree difference in direction (in other words, if one pair of observation wells is north of the test well, the other pair will be either west or east of the test well).

At sites SS 003 and SS 006 (where wells are installed into shale or shallow limestone and are therefore not nested shallow and deep) the four closest wells will be selected as observation wells.

Equipment

Because of the poor recharge characteristics of wells at these sites, wells will quickly become dry if pumped, consequently, a constant-rate aquifer test is not feasible. Therefore, it is proposed to use a bailer to remove the necessary slug of groundwater from the test well. However, a peristaltic or submersible pump will be available onsite should bailing be insufficient to purge a test well dry.

The drawdown and recovery of the test wells and observation wells will be electronically recorded using *In Situ's Mini-Troll* technology. This equipment consists of individual, self-contained pressure transducers that record data samples at a pre-programmed frequency. Data will be logged at intervals of 1 second for the initial ten minutes; and every 10 seconds for the next 50 minutes Subsequent data measurements will be based upon the observed well responses. The instruments are dedicated to a given well and will continuously record water levels for several weeks or longer. Data will be retrieved by connecting a lap-top computer directly to the transducer cable. Data collection can continue during data retrieval, allowing data collection to continue unbroken for extended periods of time.

Test Duration

The tests are scheduled to run until water in the test well has recovered to 95% of its pre-test static water level but will not run longer than one week. Actual test durations may be adjusted in the field based upon recovered data and well behavior. A total of two weeks has been scheduled for completing the five aquifer tests. Because each site will be equipped with transducers prior to starting the aquifer tests, the tests can be performed quickly in sequence, proceeding from one site too the next following the successful purging of water from the test well.

Data Reduction and Evaluation

The data will be available for downloading and analysis at any time during the tests. Conventional analytical methods – such as the method developed by Bouwer and Rice - will be used to evaluate aquifer characteristics near the test wells. The degree of hydraulic communication between shallow and deep wells will be assessed based on observed drawdown data, and ranges of hydraulic conductivities within similar horizontal strata will be estimated. Hydraulic gradients and ground water flow rates will be evaluated on a case-by-case basis, based upon the available data.

Appendix A

Well Development Data for Wells Installed During RI Addendum
Richards-Gebaur AFB
June 2000

Monitoring Well ID	Total Depth (feet BTOC)	Static Water Level (feet BTOC)	Average Pump Rate During Development (gpm)	Total Water Removed (gallons)	# Well Volumes Removed	Purged Dry?	Comments
CS004-MW004	21 75	8 25	0.435	10	4 5	yes	
CS004-MW005	19 63	9 04	0 305	6 1	3 5	yes	
CS004-MW006	23.2	7.75	0 5	12 5	5 0	no	
CS004-MW007	23.5	8 22	0 242	11 6	4 7	no	
CS004-MW008	22.4	9 01	0 46	11 5	5 3	no	
CS004-MW009	19 12	9 17	0 533	16	9 9	no	
CS004-MW010	22.52	10 55	0 278	10	5 1	no	
CS004-MW011	21.6	10.63	0 415	10 8	6 0	no	
CS004-MW012	17 88	10 79	0 3	3 3	2 9	no	
SS003-MW005	27	11 8	0 208	15	6 0	yes	
SS003-MW006	21 6	11.82	0 2	5	3 1	yes	
SS003-MW007	23	7 2	0 2	10.5	4.1	yes	
SS003-MW008	24.3	18.05	0 227	2 5	2 5	yes	
SS006-MW005	18.66	10 81	0 168	3 2	2.5	yes	
SS006-MW006	15 33	8.36	0 275	6	5 3	yes	
SS006-MW007	14.95	8 19	0 375	3	2 7	yes	
SS006-MW008	10 45	7 15	0 214	1 5	2.8	yes	
SS009-MW004	23 52	11 13	0.2	5 5	2 7	yes	SWL = 21 4 ft BTOC @ 21 hr
SS009-MW005	14 5	14 2					Well is dry
SS009-MW006	23 62	11.52	0 375	5	2.5	yes	SWL = 20 57 ft BTOC @ 21 hr
SS009-MW007	23 56	6 22	0 204	5 3	1.9	yes	SWL = 21 5 ft BTOC @ 24 hr
SS009-MW008	25 25	10.32	0 265	5 3	2 2	yes	SWL = 9 45 ft BTOC @ 17 hr
SS009-MW009	15.45	11.74	0 133	2	3 3	yes	SWL = 9 86 ft BTOC @ 18 hr
SS009-MW010	25 5	7.32	0 2	5 2	1 8	yes	SWL = 20 65 ft BTOC @ 18 hr
SS009-MW011	14.9	14 9					Well is dry
ST005-MW010	25 5	7 32	0.35	7	2.4	yes	SWL = 7 64 ft BTOC @ 29 hr
ST005-MW011	25.5	15 2	0.172	4 3	2.6	yes	SWL = 23 45 ft BTOC @ 26 hr
ST005-MW012	14.65	8.73	0.19	3 8	3 9	yes	SWL = 12 33 ft BTOC @ 26 hr
ST005-MW013	27.35	20.65	0 25	3 8	3 5	yes	SWL = 25 73 ft BTOC @ 30 hr
ST005-MW014	15 42	7.71	0 136	4 5	3 6	yes	SWL = 9.15 ft BTOC @ 31 hr
ST005-MW015	28 2	7 6	0 5	7.5	2 2	yes	SWL = 13.02 ft BTOC @ 24 hr
ST005-MW016	17 4	11.69	0 417	2 5	2.7	yes	SWL = 15 56 ft BTOC @ 25 hr
ST005-MW017	33 1	24.48	0 55	3 3	2 3	yes	
ST005-MW018	23 55	12.69	0 76	3 8	2.1	yes	

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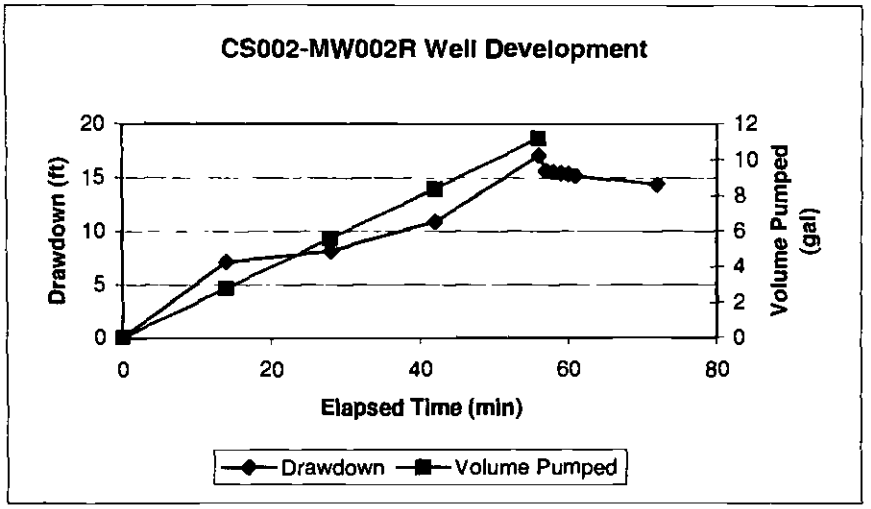
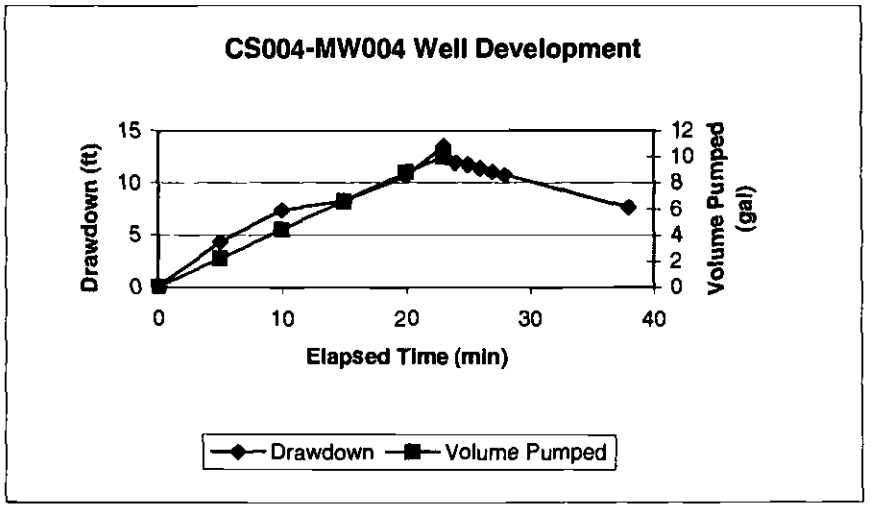
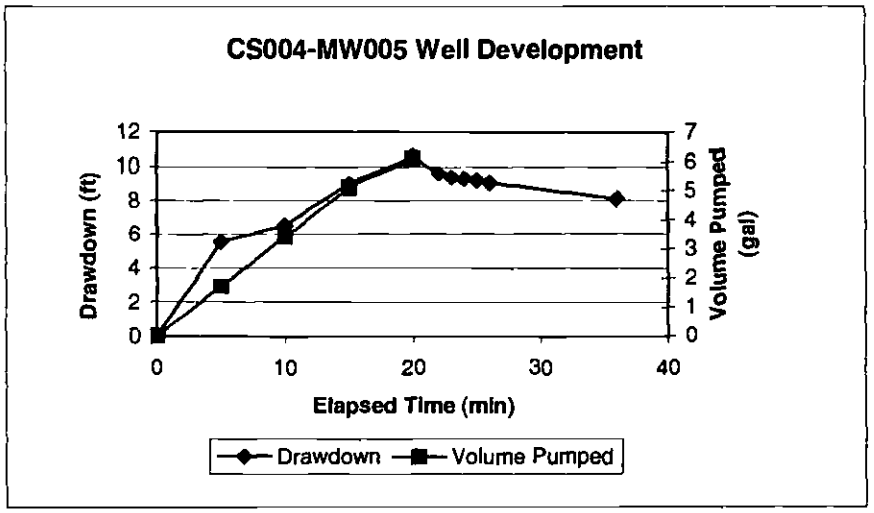
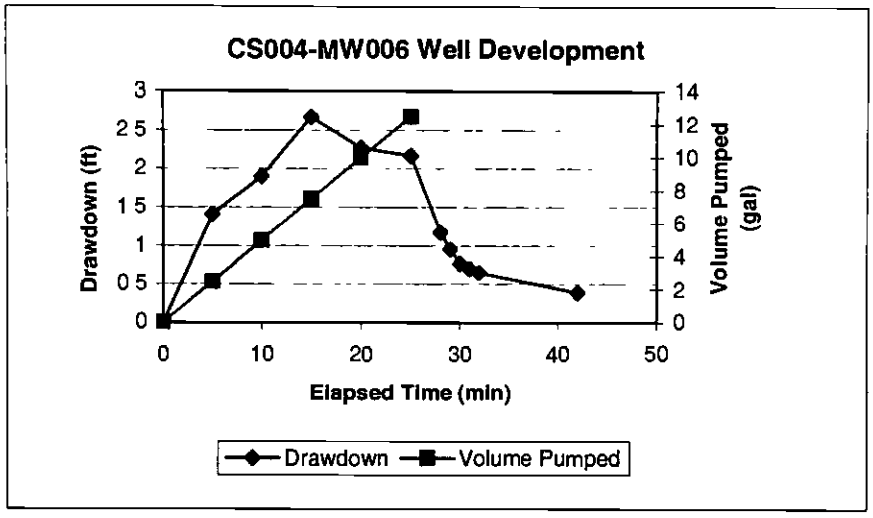
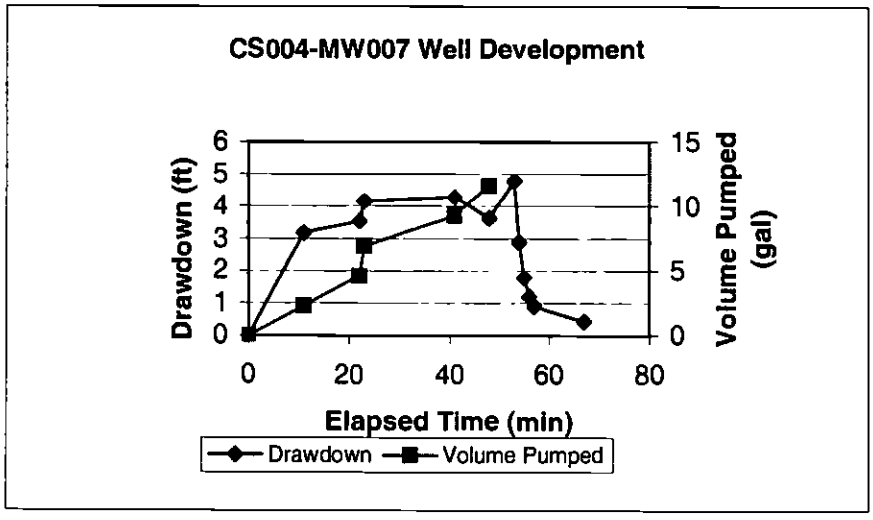
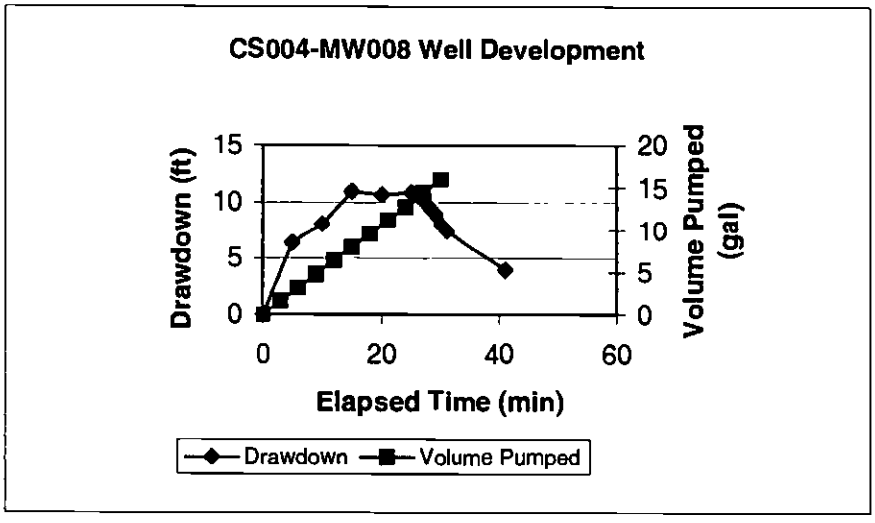

CS002-MW002R Well Development
Drawdown (ft)
Volume Pumped (gal)
Elapsed Time (min)
Drawdown
Volume Pumped

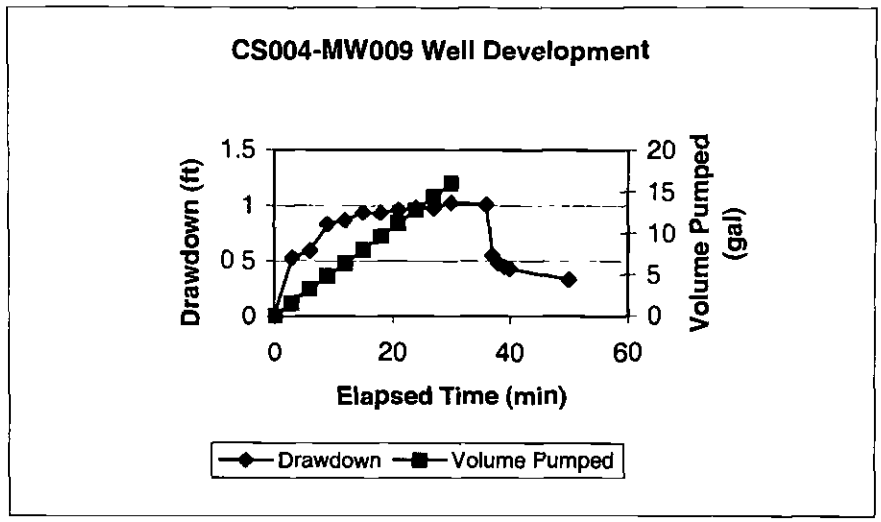

CS004-MW004 Well Development
Drawdown (ft)
Volume Pumped (gal)
Elapsed Time (min)
Drawdown
Volume Pumped

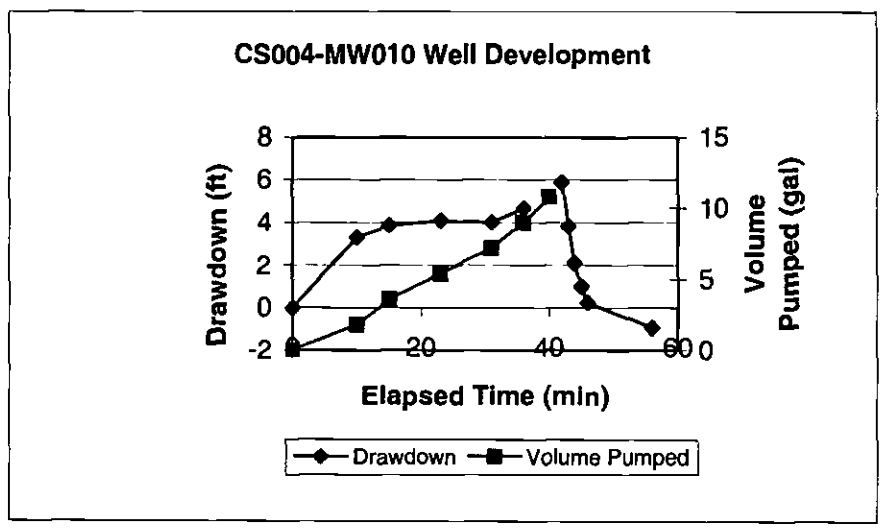

CS004-MW005 Well Development
Drawdown (ft)
Volume Pumped (gal)
Elapsed Time (min)
Drawdown
Volume Pumped

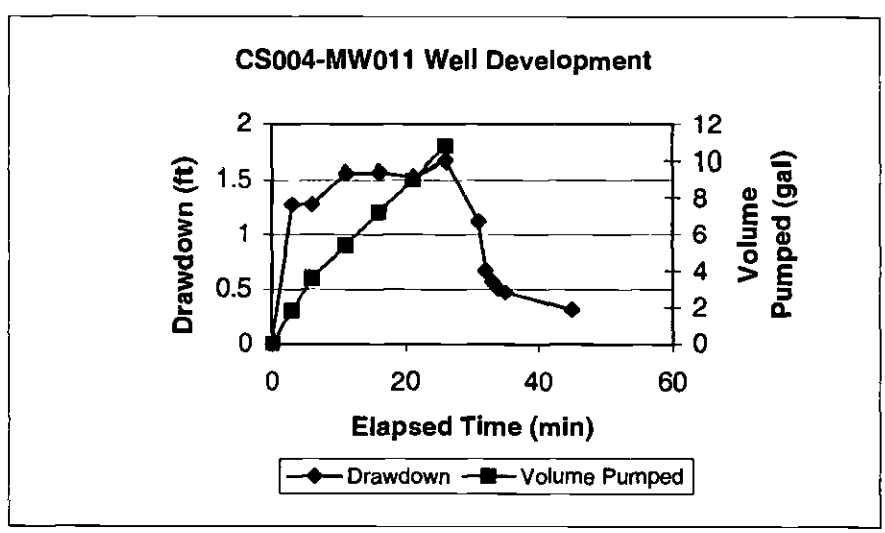

CS004-MW006 Well Development
Drawdown (ft)
Volume Pumped (gal)
Elapsed Time (min)
Drawdown
Volume Pumped

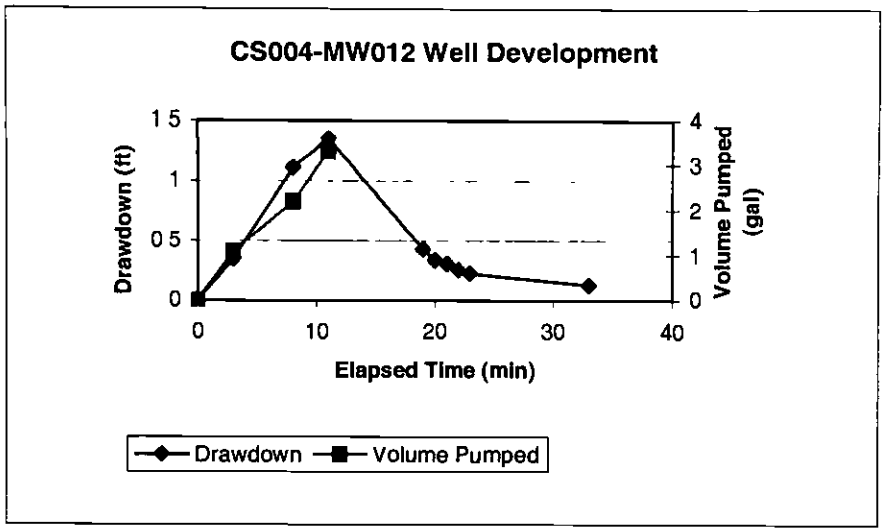

CS004-MW007 Well Development
Drawdown (ft)
Volume Pumped (gal)
Elapsed Time (min)
Drawdown
Volume Pumped

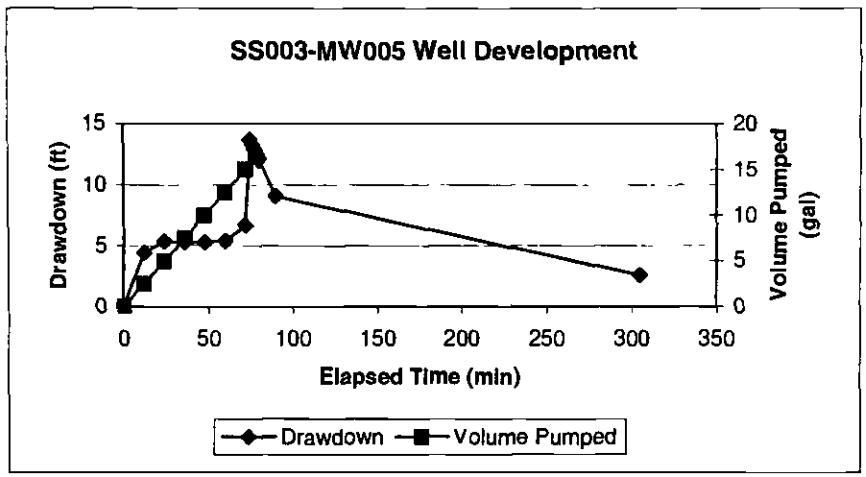

CS004-MW008 Well Development
Drawdown (ft)
Volume Pumped (gal)
Elapsed Time (min)
Drawdown
Volume Pumped

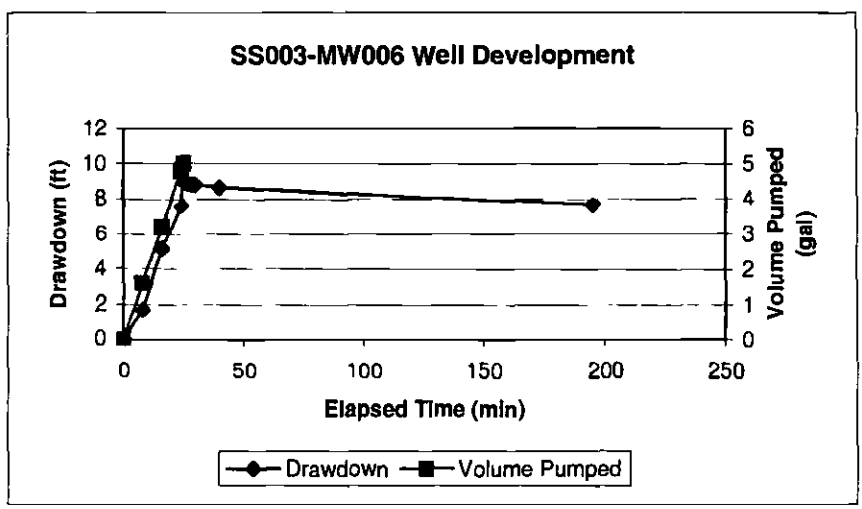

CS004-MW009 Well Development
Drawdown (ft)
1.5
1
0.5
0
0
20
40
60
Elapsed Time (min)
20
15
10
5
0
Volume Pumped (gal)
Drawdown
Volume Pumped

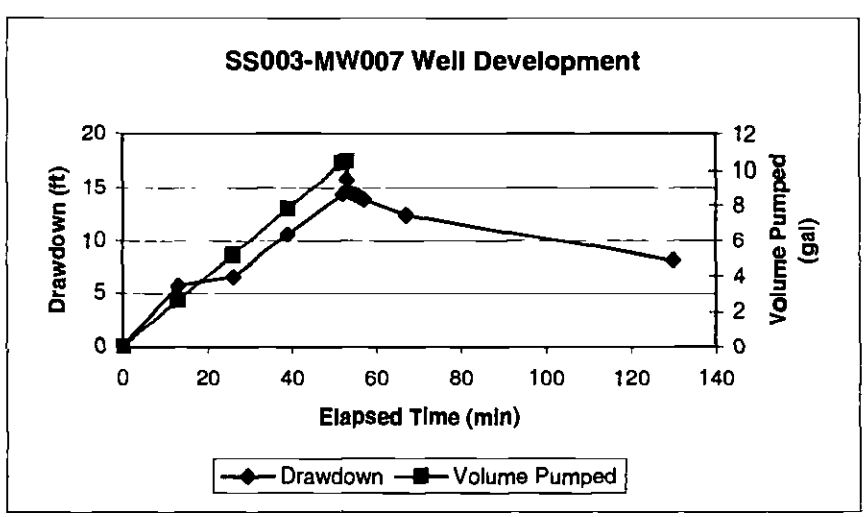

CS004-MW010 Well Development
Drawdown (ft)
8
6
4
2
0
-2
20
40
60
Elapsed Time (min)
15
10
5
0
Volume Pumped (gal)
Drawdown
Volume Pumped

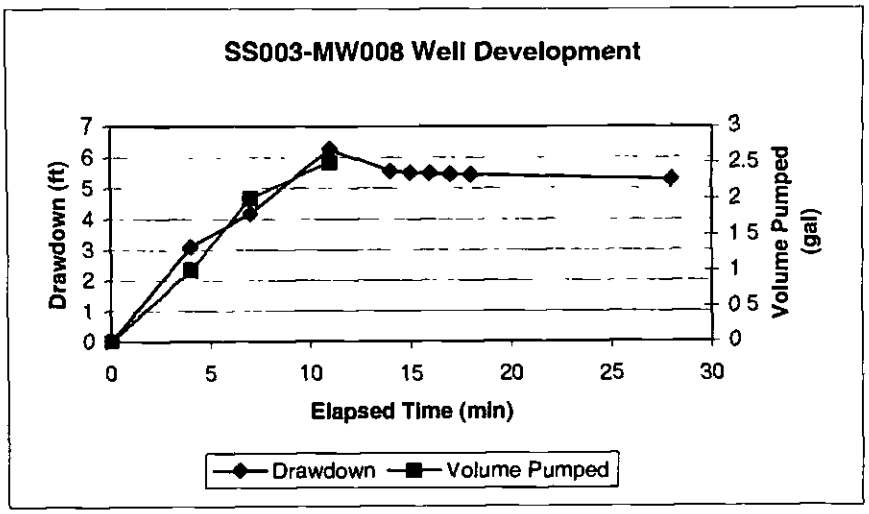

CS004-MW011 Well Development
Drawdown (ft)
2
1.5
1
0.5
0
0
20
40
60
Elapsed Time (min)
12
10
8
6
4
2
0
Volume Pumped (gal)
Drawdown
Volume Pumped

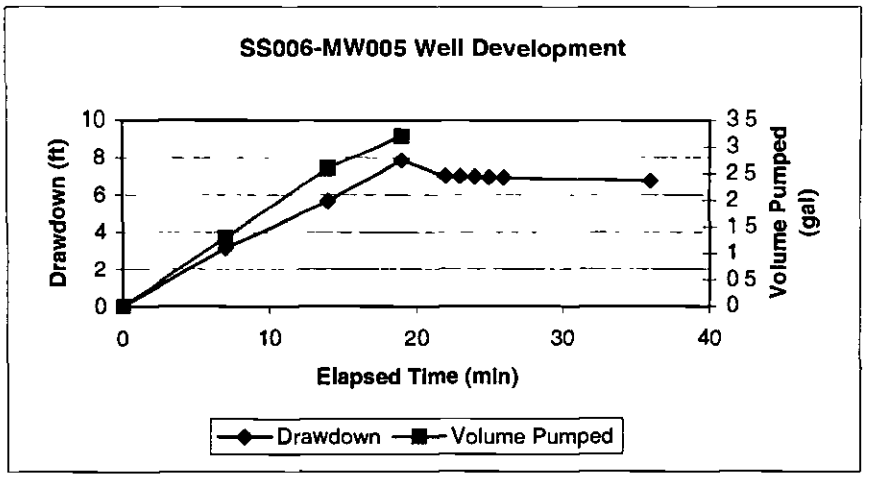

CS004-MW012 Well Development
Drawdown (ft)
1 5
1
0 5
0
Volume Pumped (gal)
4
3
2
1
0
0
10
20
30
40
Elapsed Time (min)
Drawdown
Volume Pumped

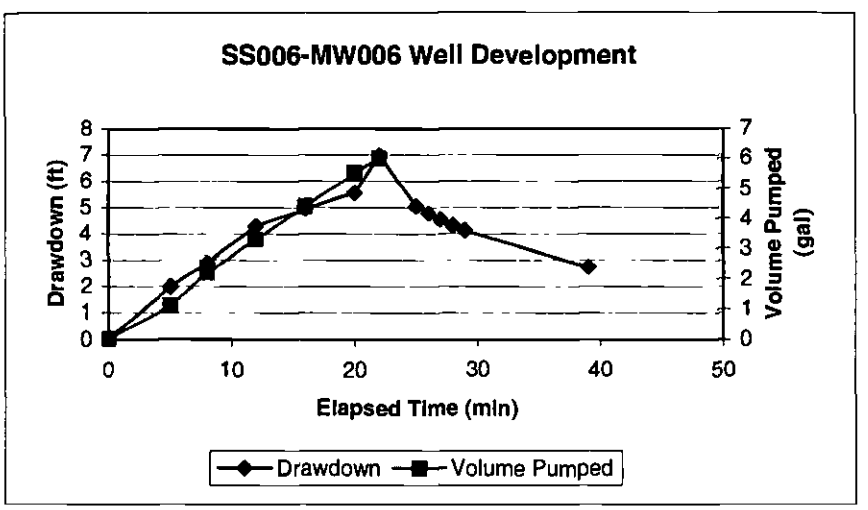

SS003-MW005 Well Development
Drawdown (ft)
Volume Pumped (gal)
Elapsed Time (min)
Drawdown
Volume Pumped


SS003-MW006 Well Development
Drawdown (ft)
Volume Pumped (gal)
Elapsed Time (min)
Drawdown
Volume Pumped


SS003-MW007 Well Development
Drawdown (ft)
Volume Pumped (gal)
Elapsed Time (min)
Drawdown
Volume Pumped


SS003-MW008 Well Development
Drawdown (ft)
Volume Pumped (gal)
Elapsed Time (min)
Drawdown
Volume Pumped


SS006-MW005 Well Development
Drawdown (ft)
Volume Pumped (gal)
Elapsed Time (min)
Drawdown
Volume Pumped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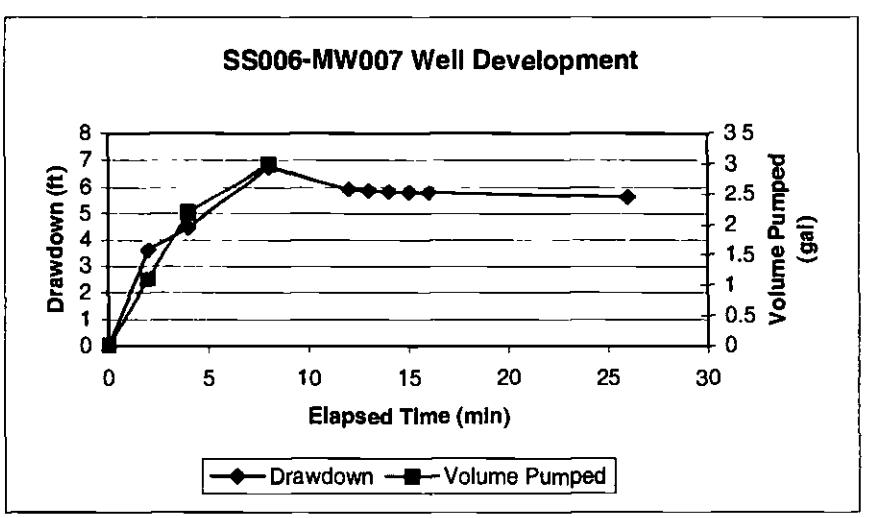
Drawdown (ft)
Volume Pumped (gal)
Elapsed Time (min)
Drawdown
Volume Pumped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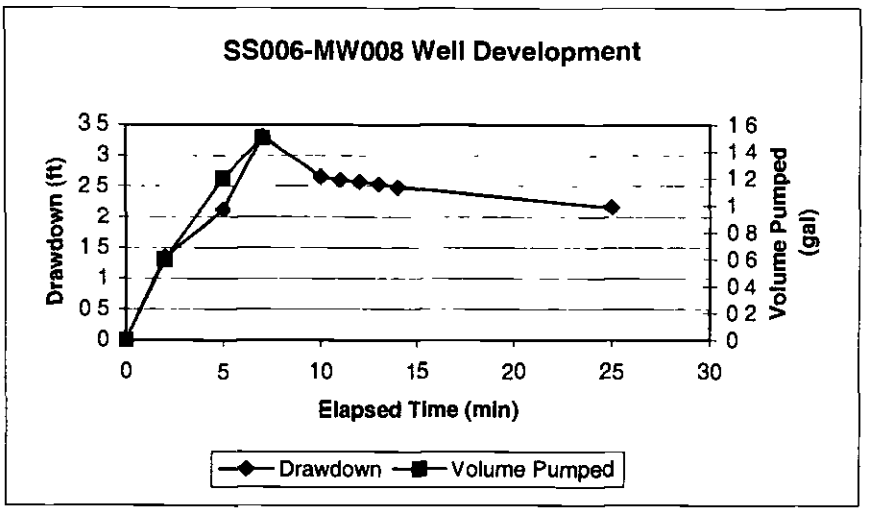
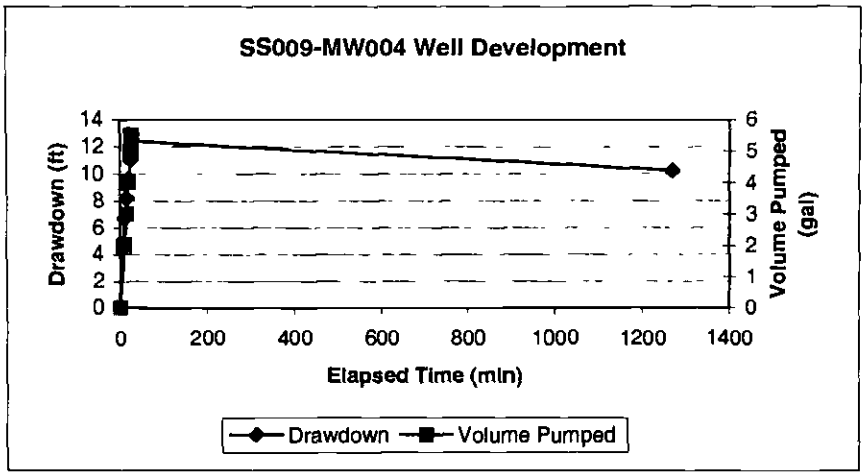
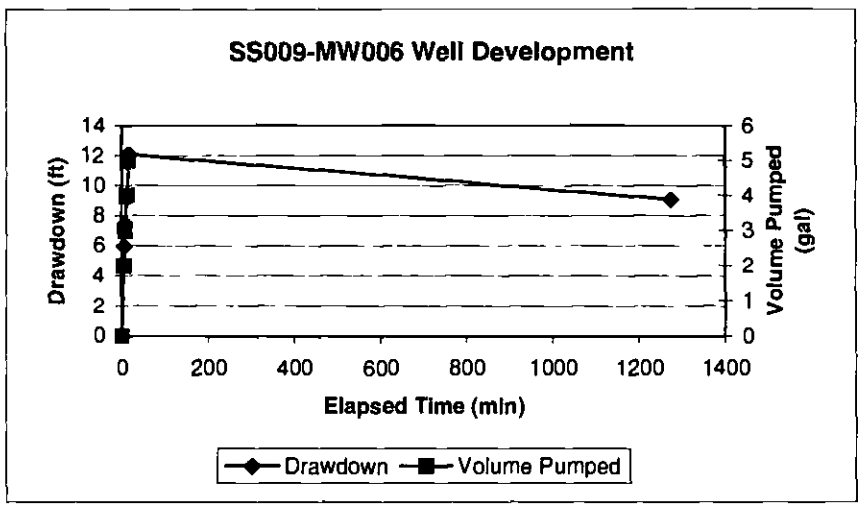
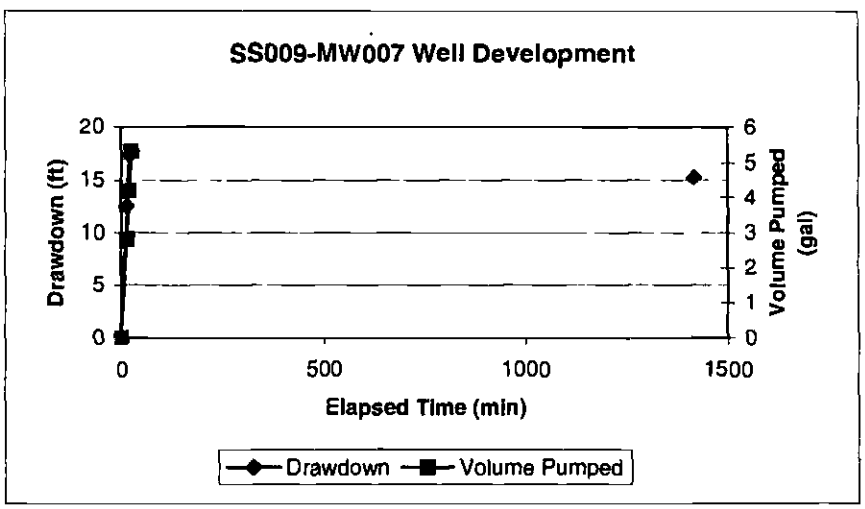
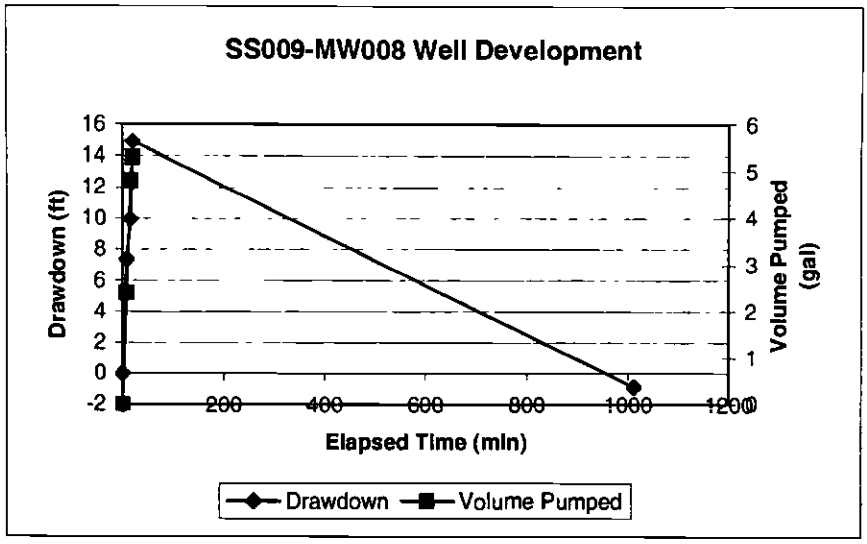
Drawdown (ft)
Volume Pumped (gal)
Elapsed Time (min)
Drawdown
Volume Pumped

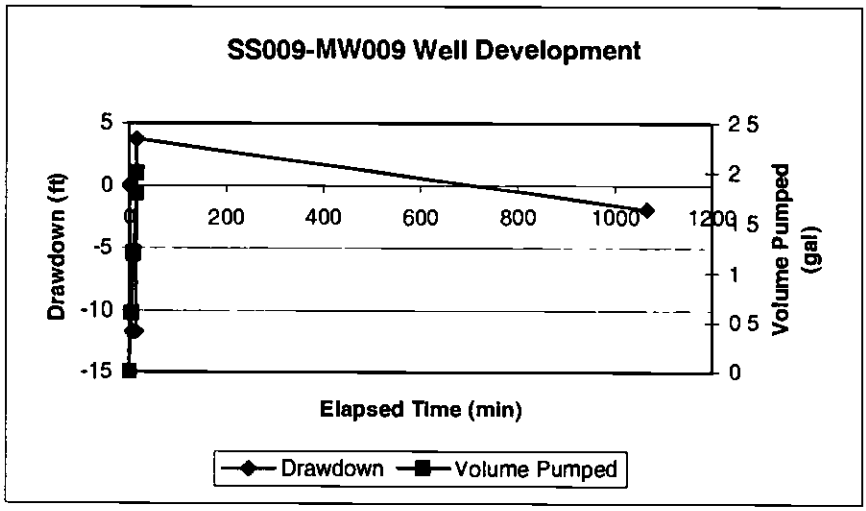

SS006-MW008 Well Development
Drawdown (ft)
35
3
25
2
15
1
05
0
Volume Pumped (gal)
16
14
12
1
08
06
04
02
0
0
5
10
15
20
25
30
Elapsed Time (min)
Drawdown
Volume Pumped

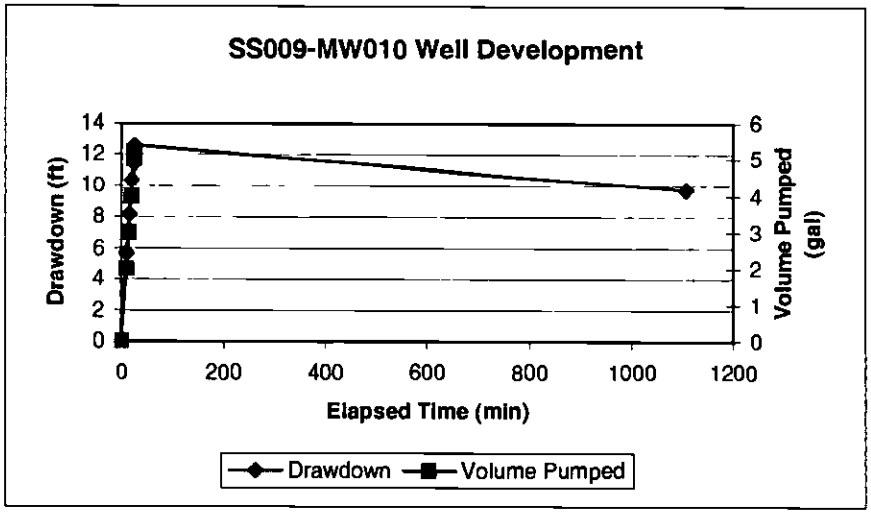

SS009-MW004 Well Development
Drawdown (ft)
Volume Pumped (gal)
Elapsed Time (min)
Drawdown
Volume Pumped

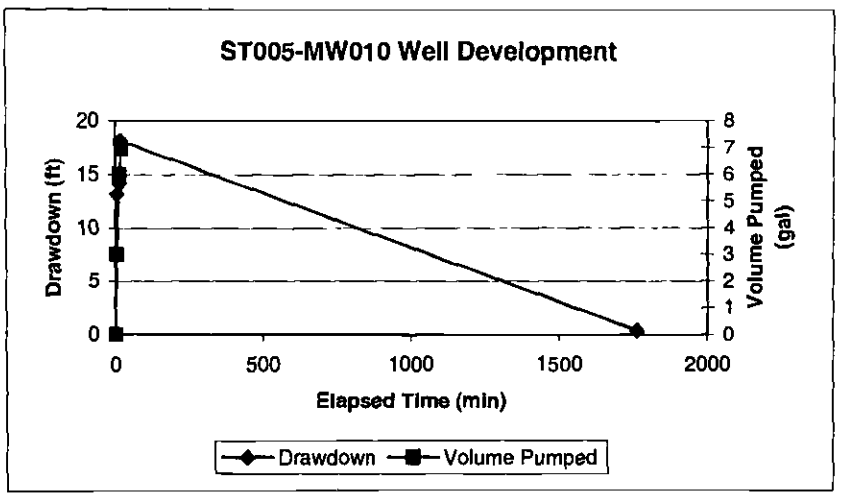

SS009-MW006 Well Development
Drawdown (ft)
Volume Pumped (gal)
Elapsed Time (min)
Drawdown
Volume Pumped

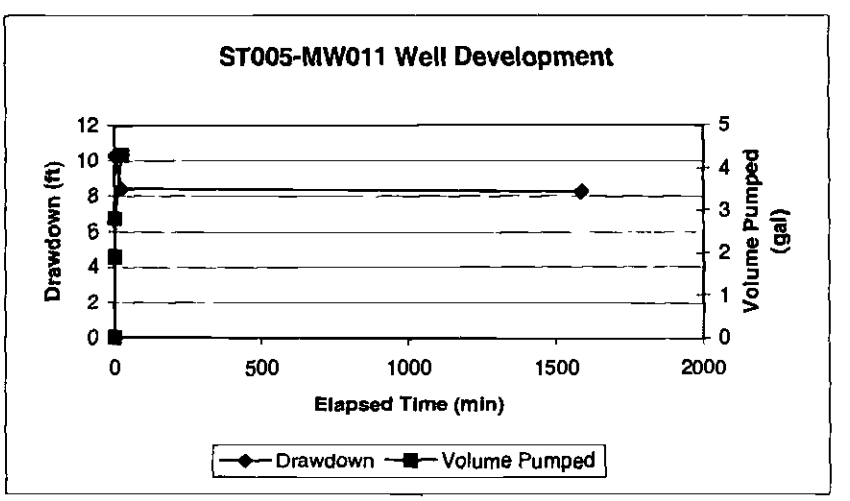

SS009-MW007 Well Development
Drawdown (ft)
Volume Pumped (gal)
Elapsed Time (min)
Drawdown
Volume Pumped

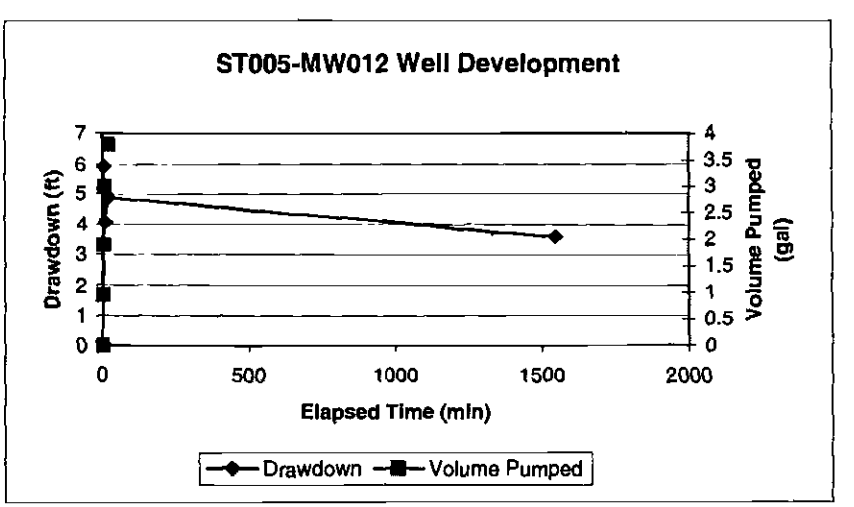

SS009-MW008 Well Development
Drawdown (ft)
Volume Pumped (gal)
Elapsed Time (min)
Drawdown
Volume Pumped

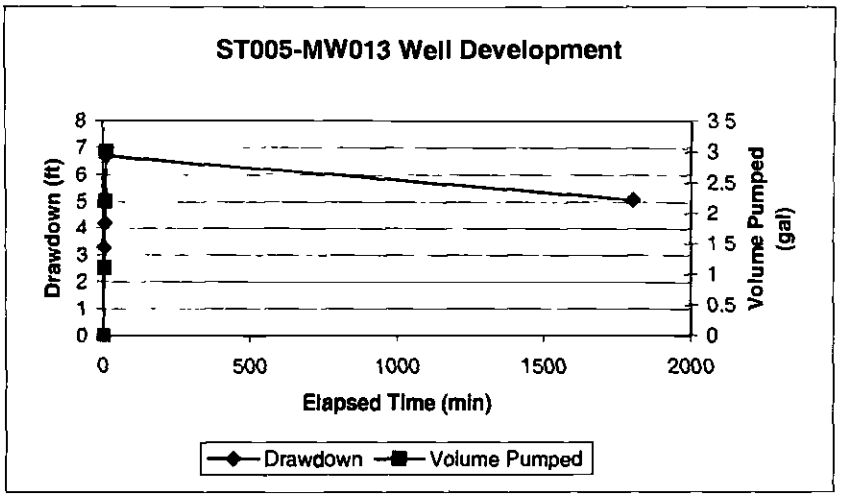

SS009-MW009 Well Development
Drawdown (ft)
Volume Pumped (gal)
Elapsed Time (min)
Drawdown
Volume Pumped


SS009-MW010 Well Development
Drawdown (ft)
Volume Pumped (gal)
Elapsed Time (min)
Drawdown
Volume Pumped


ST005-MW010 Well Development
Drawdown (ft)
Volume Pumped (gal)
Elapsed Time (min)
Drawdown
Volume Pumped


ST005-MW011 Well Development
Drawdown (ft)
Volume Pumped (gal)
Elapsed Time (min)
Drawdown
Volume Pumped


ST005-MW012 Well Development
Drawdown (ft)
Volume Pumped (gal)
Elapsed Time (min)
Drawdown
Volume Pumped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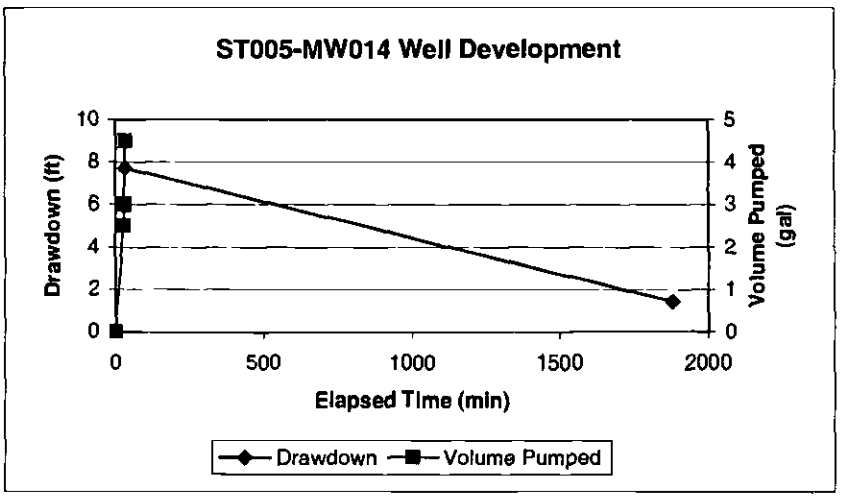
Drawdown (ft)
Volume Pumped (gal)
Elapsed Time (min)
Drawdown
Volume Pumped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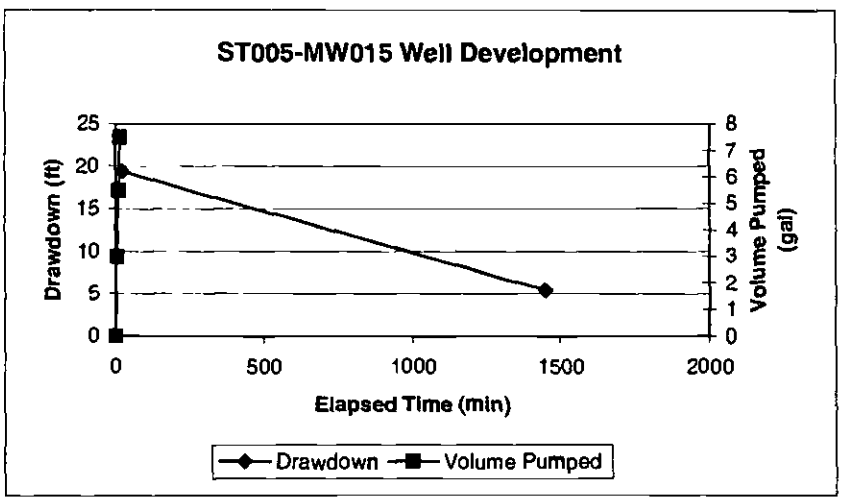
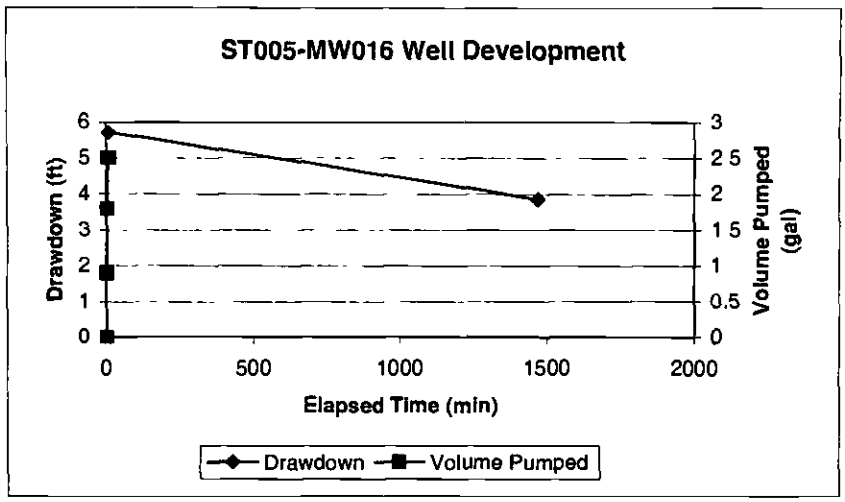
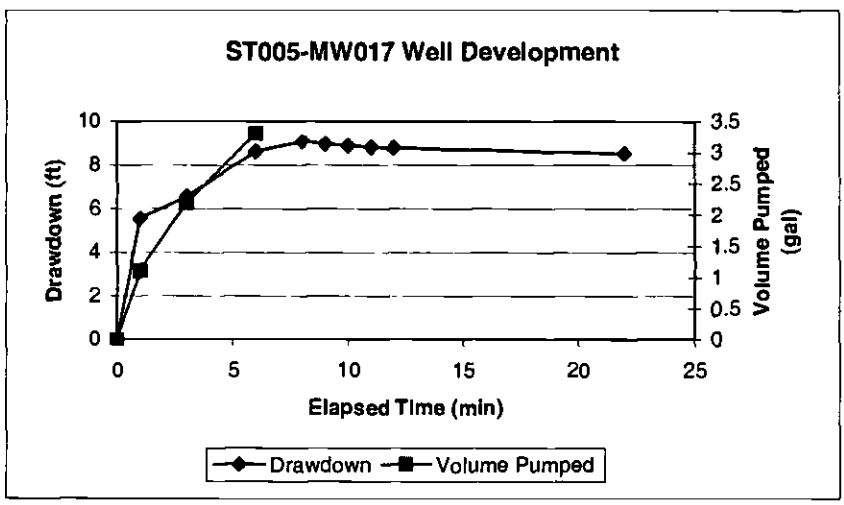
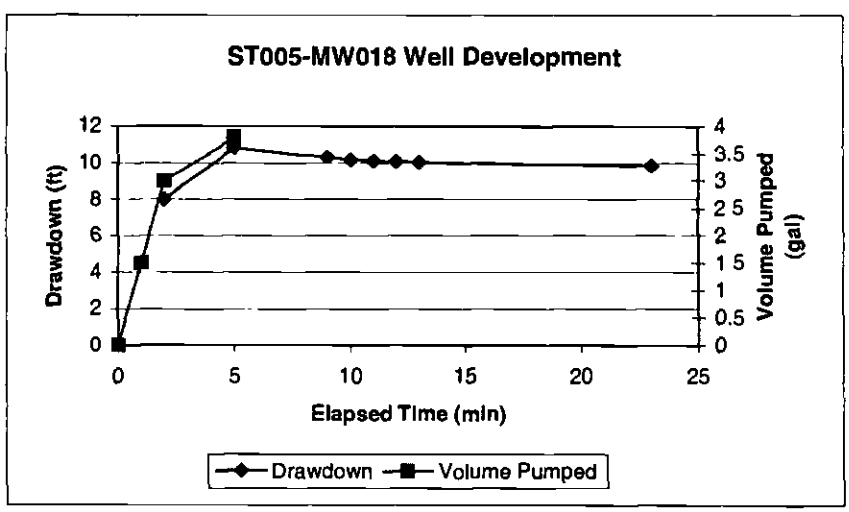
Drawdown (ft)
Volume Pumped (gal)
Elapsed Time (min)
Drawdown
Volume Pumped


ST005-MW015 Well Development
Drawdown (ft)
Volume Pumped (gal)
Elapsed Time (min)
Drawdown
Volume Pumped


ST005-MW016 Well Development
Drawdown (ft)
Volume Pumped (gal)
Elapsed Time (min)
Drawdown
Volume Pumped


ST005-MW017 Well Development
Drawdown (ft)
Volume Pumped (gal)
Elapsed Time (min)
Drawdown
Volume Pumped


ST005-MW018 Well Development
Drawdown (ft)
Volume Pumped (gal)
Elapsed Time (min)
Drawdown
Volume Pumped

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