

UMON000408

GWMON 1.12-1



Ground Water Pumping and Monitoring Plan for the Land Farm Pilot Test

Monument Valley, Arizona

August 2000

Prepared by the
U.S. Department of Energy
Grand Junction Office



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U.S. Department of Energy
UMTRA Ground Water Project

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Project Number UGW-511-0015-21-000
Document Number U0106701

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1.0 Introduction

A detailed evaluation of treatment alternatives has identified land farming as the preferred compliance strategy for the nitrate plume within the surficial aquifer at the UMTRA Monument Valley site (DOE 2000a). However, before land farming can be selected as the final treatment alternative a pilot test is required to address several uncertainties associated with implementing this option. Some of the uncertainties pertain to the consumptive use pumping strategy selected to supply irrigation water to the land farm:

- Uncertainty as to the affect on the surficial aquifer with the loss of half a billion gallons of water.
- Uncertainty in the maximum amount of ground water that can be extracted from the surficial aquifer for which the consequences are considered acceptable.
- Uncertainty as to the impact on withdrawal of a large amount of ground water on the frog pond and discharge areas along Cane Valley Wash.

Changes to the ground water system are an unavoidable consequence for any pumping strategy. However, some of the changes resulting in withdrawing a large volume of water over an extended time period may be undesirable. Monitoring the aquifer response while ground water is extracted during the pilot test for irrigation purposes will be used to address uncertainties in the consumptive use pumping strategy. Observations and results from the pilot test will be used to refine the wellfield configuration that will be used for the final treatment alternative when it is selected after the 3-year pilot test is completed.

2.0 Purpose and Scope

A separate work plan, to address uncertainties associated with forage crop production, is presented in the alternative evaluation report (see Appendix B DOE 2000a). The referenced work plan is currently being updated to include more detail regarding the feasibility, data needs, and experimental design for the pilot land farm. Also included in the land farm work plan will be preliminary design drawings of the infrastructure (fences, control building, roads, etc.).

The primary objectives of this plan are two fold; 1) define the extraction well locations and pumping rates required to achieve the desired nitrate concentrations in the irrigation water for the land farm pilot-test, and 2) outline the measurement methodology and procedures that will be used to monitor the aquifer response to the ground water extraction system during the first year of operation. After the first year of operation the plan may be revised as necessary based on the collected data. Monitoring the ground water pumping activities will be limited to the following different measurement methods:

- Pressure transducers to measure daily changes in ground water elevation in monitor wells installed in the surficial aquifer located within and surrounding the nitrate plume.

- Pressure transducers to measure daily changes in surface water elevation in a new stilling well to be installed east of the plume at the frog pond, which is the only permanent surface water near the site.
- Hand-held water level indicators to measure ground water elevations in all surficial and stilling wells on a quarterly basis.
- Instantaneous measurements of the volume (cfs) and nitrate concentration (mg/L) in ground water extracted from each extraction well through the use of in-situ flow meters and nitrate probes, respectively.
- Laboratory analysis of nitrate, sulfate, and chloride concentrations in ground water samples collected from surrounding surficial aquifer wells to monitor mass removal and migration of the plume affected by the pumping activities.

3.0 Pilot-Test Extraction Wellfield

An extraction wellfield is required to supply irrigation water to the pilot-test land farm with nitrate concentrations ranging from 200 mg/L to 800 mg/L (DOE 2000a). Two extraction wells proposed for Phase I (EXT1-1 and 1-2), one extraction well proposed for Phase II (EXT2-2), and three existing wells (MON-648, -649, and -778) will be used to provide the range in nitrate concentration. A description of the Phase I and Phase II extraction wells is provided in the alternative evaluation report for active treatment technologies at the Monument Valley site (DOE 2000a). The two new Phase I wells and the one new Phase II well will be installed in the fall of 2000. Each extraction well location with respect to the nitrate plume is shown in Figure 3-1.

Pilot farming a 4.6-acre test plot is scheduled to begin in the spring of 2001. An extraction wellfield using the six pumping wells shown in Figure 3-1 will be used to supply irrigation water during the growing season to the test plot. Extraction rates are estimated to range from approximately 3.0 to 30 gallons per minute (gpm) for each individual well that is included in this pilot system. The total flow required for the entire pilot system is approximately 38.5 gpm.

Varying the pumping rates for wells having different nitrate concentrations will be used to adjust the irrigation water to the required levels for the pilot test farm. Expected nitrate concentrations extracted in the ground water for each pumping well in the pilot wellfield is shown in Table 3-1.

Table 3-1. Expected Nitrate Concentrations in Ground Water for the Six Pilot Extraction Wells

Extraction Well ID	780 (EXT2-2)	648	778	649	782 (EXT1-2)	781 (EXT1-1)
Nitrate (mg/L)	100	100	450	500	800	1000

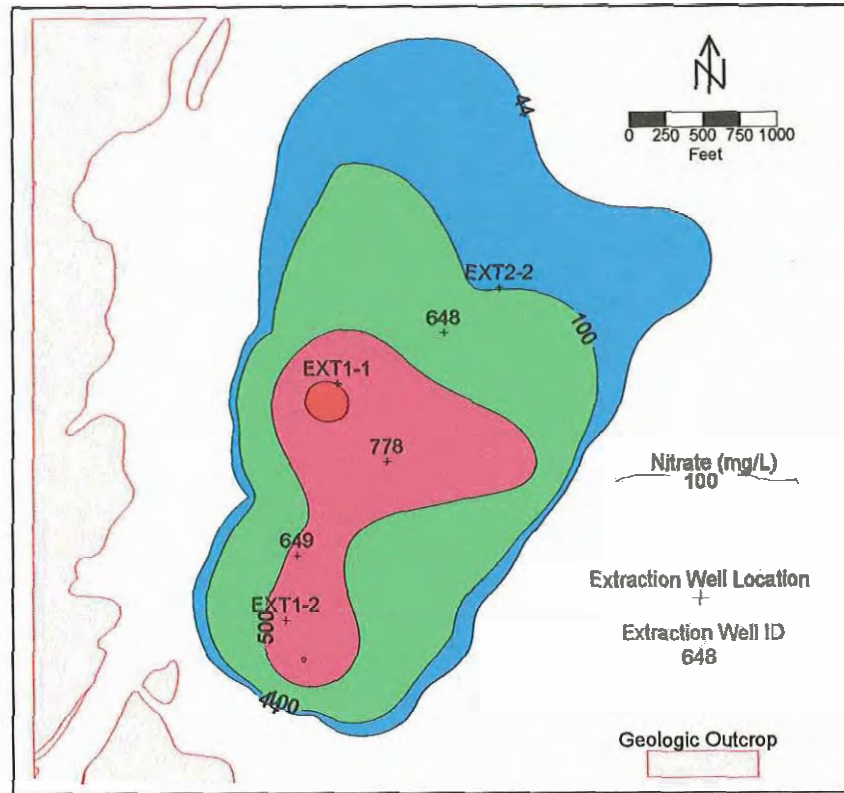


Figure 3-1. Location of the Six Pilot-Test Extraction Wells

An example of one possible pumping scheme using two of the six extraction wells to provide a treatment concentration of 200 mg/L at 38.5 gpm is shown in Table 3-2. Similar pumping schemes will be developed for other desired nitrate concentrations as per the requirements defined in the *Pilot Test Work Plan for Forage Crop Production by Phytoremediation of Nitrate in Ground Water at the Monument Valley UMTRA Site* (Appendix B DOE 2000a).

Table 3-2. Example of a Two Extraction Well Pumping Scheme to Mix Plume Water to the Desired Nitrate Concentration for the Pilot-Test Farm

Extraction Well ID	Nitrate in Ground Water (mg/L)	Pumping Rate (gpm)	Nitrate x Pumping Rate	Weighted Average Nitrate in Irrigation Water (mg/L)
781 (EXT1-1)	1,000	4.3	4277.8	
648	100	34.2	3422.2	
		sum 38.5	sum 7700.0	200

The capture zone for the pumping scheme presented in Table 3-2 was evaluated using the USGS MODFLOW and MODPATH computer codes. Details regarding the ground water flow model are presented in the Monument Valley flow model calibration report (DOE 2000b, Calculation Number U0084800). Simulated ground water drawdown and particle tracking results presented in Figure 3-2 provides an estimate of the probable capture zone for this particular pumping scheme. As evident from the contoured drawdown data and the particle tracks presented in Figure 3-2, the capture zone is expected to be contained within the plume boundary.

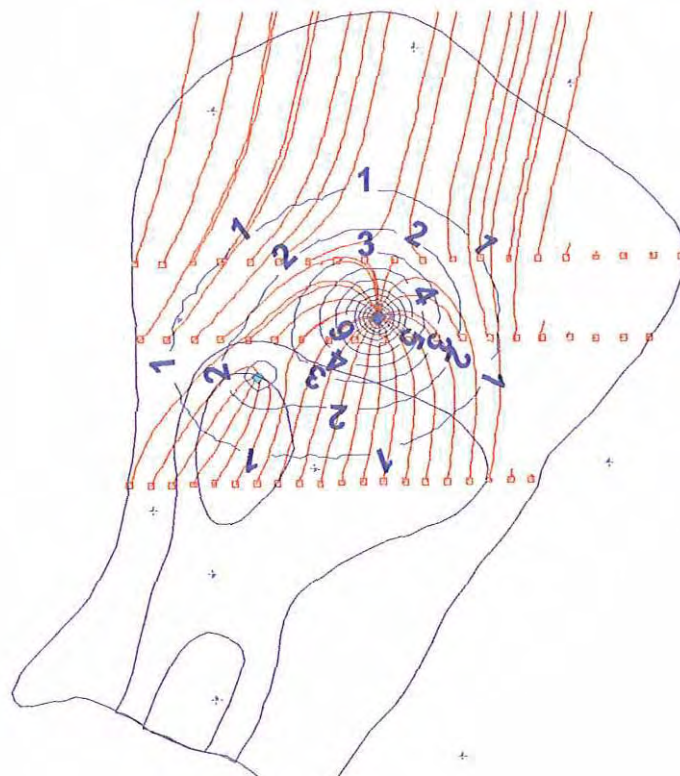


Figure 3-2. Simulated Ground Water Drawdown Contours (ft) and Particle Capture

4.0 Water Elevation Measurements and Monitoring

As a result of the withdrawal of ground water from the surficial aquifer, it is necessary to monitor the extent of the area from which the ground water is removed, which represents the extraction system's capture zone. Water level elevations collected from surficial monitor wells located within and surrounding the nitrate plume will assist in defining the extent of this capture zone. In addition, monitoring the surface water elevation at the frog pond and ground water elevations from surficial aquifer monitor wells established between the plume and the frog pond will assist in the evaluation of any potential impacts to this ground water discharge area.

Installation of pressure transducers will allow for the collection of water level data on a daily basis over an extended period of time. Existing ground water monitor wells installed in the surficial aquifer that will be equipped with pressure transducers, their location, and the purpose of the monitoring are listed in Table 4-1. Also presented in Table 4-1 are two new monitor wells (MON-786 and -787) that will be installed during the fall of 2000. Monitor well MON-786 will be located east of the plume along Cane Valley Wash (between the plume and the frog pond) and MON-787 will be located at the frog pond. The two new monitoring locations have been chosen to detect if prolonged pumping will expand the capture zone to the east of the plume and drawdown the surface water at the frog pond. If significant drawdown (greater than 1-ft) is measured at the frog pond then the pumping rates for the ground water extraction system will be modified. Monitor well locations to be equipped with pressure transducers are shown in Figure 4-1.

Table 4–1. Monitor Wells To Be Equipped With Pressure Transducers for Ground Water Elevation Measurements

Well Number (MON–)	Location	Monitoring Purpose
606	Within plume	Drawdown within capture zone
653	Within plume	Drawdown within capture zone
655	Within plume	Drawdown within capture zone
770	Within plume	Drawdown within capture zone
779	Within plume	Drawdown within capture zone
760	Downgradient edge of plume	Determine northern extent of capture zone
761	Downgradient edge of plume	Determine northern extent of capture zone
762	Downgradient edge of plume	Determine northern extent of capture zone
767	Downgradient edge of plume	Determine northern extent of capture zone
604	Between pond and east edge of plume	Determine eastern extent of capture zone
605	Between pond and east edge of plume	Determine eastern extent of capture zone
654	Between pond and east edge of plume	Determine eastern extent of capture zone
768	Between pond and east edge of plume	Determine eastern extent of capture zone
786^a	Between pond and east edge of plume	Determine eastern extent of capture zone
669	Western edge of plume	Determine western extent of capture zone
764	Western edge of plume	Determine western extent of capture zone
787^b	Frog pond	Permanent surface water

^a MON –786 is a new surficial monitor well to be installed in 2000 located along Cane Valley Wash

^b MON –787 is a new stilling well to be installed in 2000 to monitor the surface water elevation at the frog pond

Hand-held water level indicators will be used to collect water level elevations on a quarterly basis in addition to the daily pressure transducer measurements. These quarterly water level measurements will be collected at all the surficial monitor and extraction wells, including those equipped with pressure transducers. Results of the hand measurements with water level indicators will be used to confirm the data collected with the pressure transducers is representative. Monitor and extraction well locations are shown in Figure 4–1.

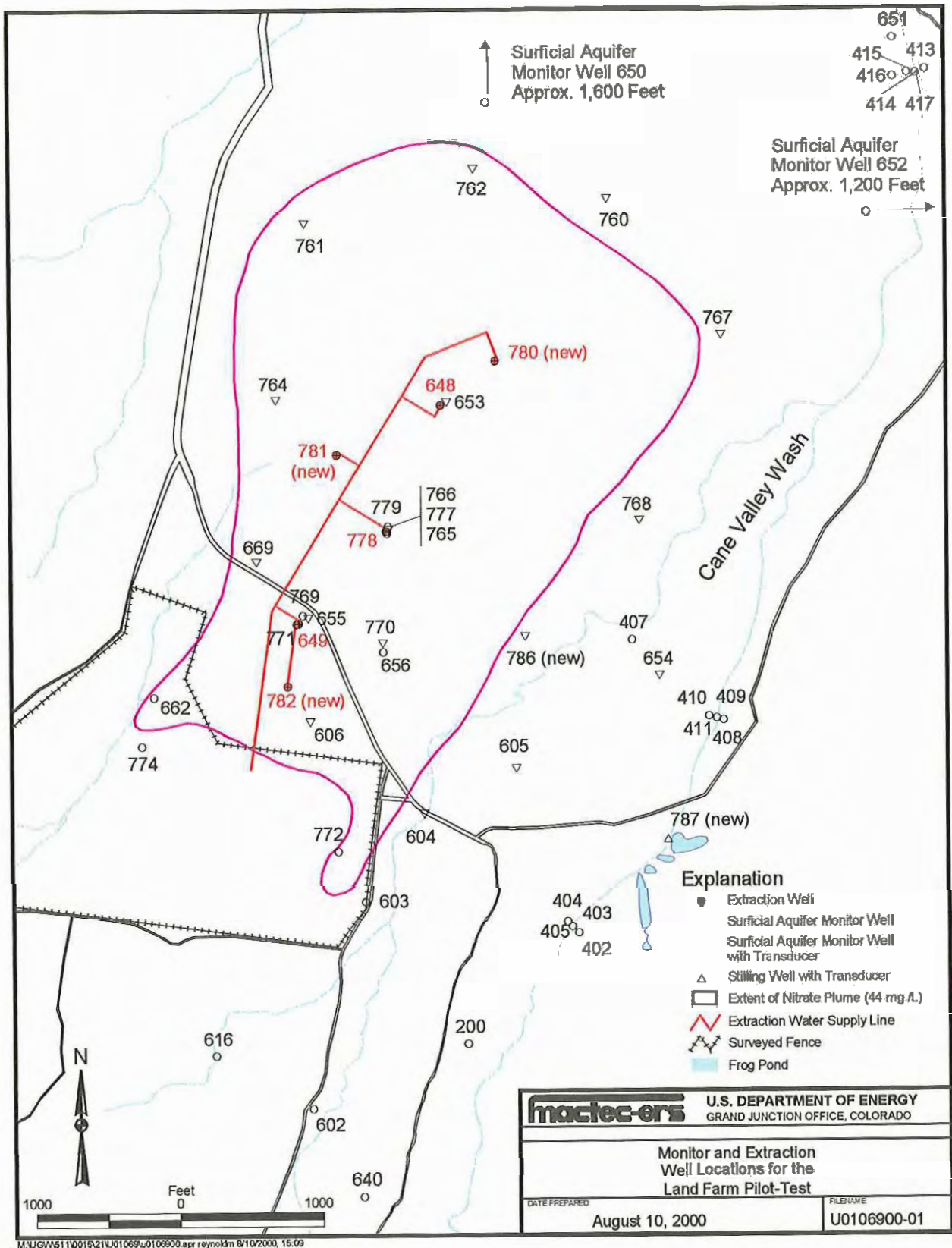


Figure 4-1. Monitor and Extraction Well Locations for the Land Farm Pilot-Test

5.0 Ground Water Extraction Volume Monitoring

Each extraction well shown in Figure 4-1 will be equipped with a flow meter to monitor the volume of ground water removed by each well. Each extraction well will also be equipped with a nitrate probe to measure the concentration of nitrate contained in the withdrawn ground water. As a result, the volume and quality of water supplied to the area to be irrigated can be measured in real-time.

6.0 Ground Water Quality Monitoring

Ground water sampling and analysis requirements have been previously discussed in the Site Observational Work Plan (DOE 1999a) and more recently in the document *UMTRA Groundwater Project FY 2000 Sampling Frequencies and Analyses* (DOE 1999b). These requirements have been reviewed and updated in Table 6-1 to reflect the addition of new extraction and monitoring wells that will be installed in the fall of 2000 to support the land farm pilot test. This inclusive table provides an overall summary of the frequency and analyte list for all the ground water sampling at the Monument Valley site.

Ground water samples will be collected for laboratory analysis from selected surficial monitor and extraction wells to evaluate the affects of pumping on the nitrate plume, such as plume migration and contaminant reductions. These wells are listed in Table 6-1 and will be sampled on a semiannual basis for nitrate, sulfate, and chloride. The first semiannual sample will be collected in April before the irrigation season begins. The second semiannual sample will be collected in September after the irrigation season is completed and ground water elevations have re-established to the natural gradient.

Table 6-1. Ground Water Sampling Frequency and Analyte List

Monitor Well	Aquifer	Monitoring Purpose	Analyte	Frequency
604, 662, 669, 764, 767, 768, 786 ^a	Surficial	lateral boundary of plume	nitrate, sulfate, chloride	Semiannual
760, 761, and 762	Surficial	leading edge of plume	nitrate, sulfate, chloride	Semiannual
650	Surficial	most down gradient location	nitrate, sulfate, chloride	Semiannual
655, 656, 770, 765, 771, 777, 780 ^a , 781 ^a	Surficial	Center of plume and vertical contaminant profile	ammonium, nitrate, sulfate, chloride	Semiannual
606, 772, 774, and 782 ^a	Surficial	on and near site	ammonium, nitrate, sulfate, and chloride plus uranium at location 774	Semiannual
Group I: 200, 400, and 402	Surficial	natural background	nitrate, sulfate, chloride	Annual ^b
Group II: 403, 602, and 640	Surficial	natural background	nitrate, sulfate, chloride	Annual ^c
619, 776, 657, and 775	De Chelly	Point-source of uranium in the De Chelly	uranium	Annual

^aNew well to be installed in 2000

^bEven year

^cOdd year

Also included in Table 6-1 is information regarding monitoring requirements for uranium and ammonium. MON-774 is the only monitor well installed in the surficial aquifer that will be sampled and analyzed for uranium. Monitor well MON-774 is located in an area where an isolated uranium occurrence slightly exceeds the MCL. Several monitor wells in the same area installed in the underlying De Chelly bedrock aquifer will also be monitored for uranium.

Ammonium will be monitored only at selected locations close to the former source areas where relatively high ammonium concentrations have been detected in previously collected samples. This area is currently undergoing phytoremediation in the subpile soil.

Based on the data collected during the first year of the pilot land farm operation, sampling frequency may change or wells may be added and or subtracted from this list for the second and third year.

7.0 Compliance Requirements

The entire area has had surveys and investigations completed. No additional cultural resources or T&E Surveys are required. Some cultural sites are located in the general vicinity of the proposed work. Care will be taken not to adversely affect such sites. Well permits and water use permits will be obtained prior to drilling wells. DOE has categorically excluded the activities in this plan from further NEPA review. The need for further NEPA documentation will be determined upon completion of the pilot study, and prior to remedial action.

8.0 References

U.S. Department of Energy, 1999. *Final Site Observational Work Plan for the UMTRA Project Site at Monument Valley, Arizona*, MAC-GWMON 1.1, prepared by U.S. Department of Energy, Grand Junction Office, Grand Junction, Colorado, April.

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———, 2000. *Monument Valley Flow Model Calibration*, Calculation Number U0084800, prepared by U.S. Department of Energy, Grand Junction Office, Grand Junction, Colorado, February.