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NUMERICAL MODELING OF GROUNDWATER CONDITIONS RELATED TO INSITU RECOVERY AT THE MOORE RANCH URANIUM PROJECT, WYOMING

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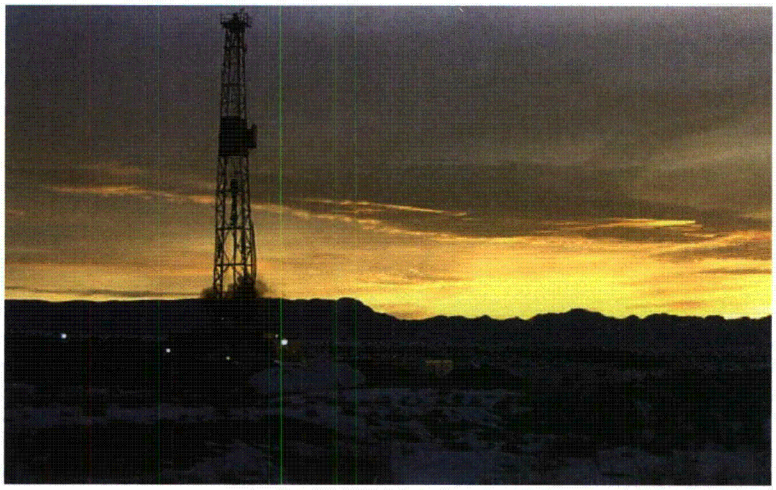

MOORE RANCH PROJECT

CAMPBELL COUNTY, WY

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TABLE OF CONTENTS

FIGURES

TABLES

NUMERICAL MODELING OF GROUNDWATER CONDITIONS RELATED TO INSITU RECOVERY AT THE MOORE RANCH URANIUM PROJECT, WYOMING

Introduction

Uranium One has submitted an application to the U.S. Nuclear Regulatory Commission (NRC) for a Source Materials License (SML) to conduct in-situ recovery (ISR) of uranium from the Moore Ranch Project in Wyoming (Energy Metals, Inc., 2007). The target ore zone is designated as the 70 Sand. Aquifer conditions within the 70 Sand transition from unconfined to confined from south to north across the Permit Area.

A numerical groundwater flow model was developed using site-specific data to evaluate wellfield scale issues related to ISR production and restoration operations at the site. This report describes the development of the numerical model and summarizes the results of numerical simulations used to address Uranium One and NRC concerns regarding ISR operations in the 70 Sand aquifer.

Purpose and Objectives

The numerical groundwater flow model was developed to support Uranium One in planning and operation of the ISR project. The numerical model is used to assess impacts of ISR mining on the 70 Sand aquifer. Model simulations were developed to:

- assess the amount of dewatering that may occur, if any, during production and restoration phases of the project,
- estimate flare during wellfield production,
- determine the degree of interference between wellfields that could occur with simultaneous production and restoration operations, and
- design a hydrologic testing program that will verify hydraulic communication with monitor ring wells prior to mining.

The model was developed to allow adequate discretization within the wellfields such that the impacts of individual wells can be discerned. This feature of the model will enable its use as a tool to assist Uranium One in the day-to-day operation of the ISR project.

Conceptual Model

Detailed description of the geology and hydrogeology of the Permit Area can be found in the SML application (Energy Metals, Inc 2007). A conceptual hydrologic model for the Moore Ranch Project area is summarized below.

The aquifer being simulated is the 70 Sand, which is the uranium production zone for the Moore Ranch Project. The 70 Sand ranges from 50 to 120 feet thick within the Permit Area, with an average of 80 feet. The 70 Sand dips north northwesterly at 0.5 to 1 degree. The 70 Sand aquifer is unconfined in the southern portion of the Permit Area, becoming confined to the north. The potentiometric surface of the 70 Sand across the Permit Area has a hydraulic gradient of approximately 0.004 ft/ft (26.6 ft/mile) toward the north. Transmissivity of the 70 Sand ranges from 23 to 735 ft^2/d (172 to 5,500 gpd/ft) based on pumping tests conducted by Conoco (1982) and Petrotek (2007 and 2008). However, as described in the 5 Spot Hydrologic Test Report, a range of 270 to 400 ft^2/d (2,020 to 3,000 gpd/ft) is considered representative of site conditions (Petrotek 2008). Hydraulic conductivity estimates from pumping tests ranged from 0.38 to 18.3 ft/d (Conoco 1982, Petrotek 2007 and 2008). A range of 3.8 to 5.5 ft/d is considered most representative of site conditions (Petrotek 2008).

Total porosity of the 70 Sand is estimated at 26 percent. Specific yield estimated from the 5-Spot Hydrologic Test, ranges from 0.01 to 0.04. Storativity estimated from other hydrologic testing conducted within the 70 Sand in the vicinity of the Moore Ranch indicates a range of 2.4×10^{-4} to 4.4×10^{-3} for the aquifer.

Within the Permit Area, the 70 Sand is generally bounded above and below by low permeability clays and silts that act as confining units. The 70 Sand is overlain by a 30 to 40 foot thick confining unit. Water level differences between the 70 Sand and overlying aquifer (72 Sand) range from 50 to 60 feet with the higher levels within the 72 Sand. The unsaturated upper portion of the 70 Sand and the large head difference between the 70 and 72 Sands conclusively demonstrate that the overlying aquifer is not in communication with the production zone aquifer. Water levels between the underlying aquifer (68 Sand) and the production zone aquifer are similar. There is evidence of discontinuity in the confining unit between the 68 and 70 Sands in portions of Wellfield Two. However, recent testing in the area indicated no response in the underlying 68 Sand during extensive pumping of the 70 Sand (Petrotek 2008). The focus of this model is on operational issues specific to ISR of uranium within the 70 Sand, which transitions from unconfined to confined conditions toward the north. Therefore, for purposes of this modeling exercise, the 68 Sand is not considered or included in the model.

The 70 Sand crops out to the south of the Permit Area. This is an area of direct recharge to the aquifer. Geologic dip and hydraulic gradient are both toward the north. Therefore water passing through the 70 Sand beneath the Permit Area most likely originates from recharge from the outcrop area to the south. Vertical hydraulic gradients do not exhibit a strong upward potential that would suggest recharge of the 70 Sand from deeper aquifers. Furthermore, water levels have remained relatively constant from the early 1980's to the present based on water levels in wells that have been monitored during both periods. Therefore, recharge must be sufficient to maintain water levels in the 70 Sand at near equilibrium levels since the 1980's. The flux across the Permit Area is calculated, using an average thickness of 80 feet, a width of 4 miles (21,120 ft), a hydraulic conductivity of 4 ft/d and a hydraulic gradient of 0.004 ft/ft. The calculated flux is 27,034 ft^3/d or 140 gpm. The recharge rate updip of the Permit Area must be approximately equivalent to this flux in order for the water levels to maintain their present levels. There are no known discharge areas from the 70 Sand within the Permit Area.

Average groundwater velocity under the stated aquifer conditions of hydraulic conductivity of 4 ft/d, hydraulic gradient of 0.004 ft/ft and porosity of 26 percent is 0.006 ft/d or 22.5 ft/yr.

Uranium One has identified two wellfields that it intends to produce uranium from. Wellfield One is located to the west. Uranium One has estimated that wellfield one will require 160 well patterns to develop. The area that will be under pattern in Wellfield One is approximately 37 acres (1,611,720 ft^2). Wellfield One includes eight header houses. Each header house controls approximately 20 well patterns. Wellfield Two, located east of Wellfield One, will require approximately 229 well patterns to develop, covering an area of 51.6 acres (2,247,696 ft^2). There are 11 header houses in Wellfield Two.

Average ore zone thickness is estimated at 20 feet (Uranium One, personnel communication 2008). Anticipated production rates will be 20 gpm per well pattern with a net 1 to 1.5 percent bleed (overproduction).

Model Code

The model code used to simulate the Moore Ranch ISR project was MODFLOW-SURFACT, Versions 2.2 and 3.0 (SURFACT), developed by HydroGeologic, Inc. (1996 and 2006). SURFACT is a proprietary version of the widely used and public domain MODFLOW code developed by the U.S. Geological Survey (McDonald, 1988, 1996). MODFLOW simulates groundwater flow using a block-centered, finite-difference approach that is capable of a wide array of boundary conditions. The code can simulate aquifer conditions as unconfined, confined, or a combination of the two. MODFLOW also supports variable thickness layers (i.e. variable aquifer bottoms and tops. Documentation of all aspects of the MODFLOW code is provided in the users manuals (McDonald, 1988 and 1996).

SURFACT was designed to enhance the groundwater flow modeling capabilities of MODFLOW. SURFACT provides significant improvements over the original MODFLOW code with respect to unconfined and unsaturated flow, dewatering and rewetting of cells within the model, and simulation of wells. Similar to the MODFLOW code, SURFACT is modular by design so that specific modules can be incorporated into the model simulation to address characteristics and physical processes of the site being modeled. These modules, or packages, work in conjunction with the original MODFLOW code. Only modules that address specifics of the site need be included in the simulation. Full description of the SURFACT packages, including verification examples, is provided in the MODFLOW-SURFACT Software (Version 2.2) Documentation (HydroGeologic, Inc, 1996). Specific modules of SURFACT employed in the Permit Area Model include the following:

- BCF4 – The block center flow package available in SURFACT provides rigorous treatment of unconfined flow using a variably saturated formulation with psuedo-soil functions. The BCF4 package is superior to earlier versions of block centered flow packages in handling dewatering and rewetting of cells within the model simulation. The formulation has been designed to provide accurate delineation of the water table and capture the delayed yield response of an unconfined system to pumping and recharge

- FWL4 – The SURFACT fracture well package provides rigorous treatment of well withdrawal ((or injection) conditions using one-dimensional fracture tube elements to emulate a well. This package allows accurate representation of wells screened across multi-layers, apportioning flow based on transmissivity and available head in each layer. The package also automatically adjusts flow rate when overpumpage of an unconfined aquifer occurs to prevent dewatering of the aquifer and can also simulate well bore storage. This package couples with the BCF4 package previously described to define unsaturated flow behavior in well cells such that the water table condition within a well cell is accurately represented.

- ATO4-This adaptive time stepping package provided with SURFACT automatically controls time step size and simulation output. This package allows a simulation to be performed more efficiently and outputs to be reported at specific desired times of the simulation.

- PCG4–SURFACT includes the option of using this Preconditioned Conjuguate Gradient solver. Earlier versions of PCG solvers are available with MODFLOW, however the PCG4 solver is more efficient and robust (HydroGeologic, 1996).

A particle-tracking code was utilized that could readily incorporate information collected from the MODFLOW/SURFACT groundwater flow model. The code chosen was MODPATH, Version 3 (Pollock, 1994), which was designed to use the output head files from MODFLOW (or SURFACT) to calculate particle velocity changes over time in three dimensions. MODPATH was used to provide computations of groundwater seepage velocities and groundwater flow directions at the site. MODPATH is also a public domain code that is well accepted in the scientific community. Full documentation of the MODPATH code is provided in the MODPATH users guide (Pollock, 1994).

The pre/post-processor Groundwater Vistas (Environmental Simulations, Versions 4 and 5, 2004 and 2007) was used to assist with input of model parameters and output of model results. Groundwater Vistas serves as a direct interface with MODFLOW, SURFACT and MODPATH. Groundwater Vistas provides an extensive set of tools for developing, modifying and calibrating numerical models and allows for ease of transition between the groundwater flow and particle tracking codes. Full description of the Groundwater Vistas program is provided in the Users Guide to Groundwater Vistas, Version 4.0 and 5.0 (Environmental Simulations, Inc. 2004, 2007).

Model Domain and Grid

The model domain encompasses an area of 100 square miles with north-south and east-west dimensions of 52,800 ft (10 miles). The model grid is centered over the Permit Area in the east west dimension. The south edge of the model generally correlates to the updip limit of the 70 Sand located approximately 1 to 2 miles south of the proposed wellfields. The southern portion of the model corresponds with the area where the 70 Sand is present in outcrop and receives recharge from surface infiltration. The extent of the model domain is illustrated in Figure 1.

The model grid was designed to provide adequate spatial resolution within the Permit Area in order to simulate response of the aquifer to typical extraction and injection rates anticipated for the Moore Ranch uranium project. The model grid was extended a considerable distance from the wellfield boundaries to minimize impacts of exterior boundary conditions on the model solution in the area of interest.

Cell dimensions within the area of the two proposed wellfields are 25 foot by 25 foot. Cell dimensions are gradually increased to a maximum size of 200 feet by 200 feet near the edges of the model. The model consists of 570 rows and 613 columns and contains 349,410 active cells.

Because of the presence of overlying and underlying confining units, only the 70 Sand was simulated. It has been postulated that hydraulic communication may exist between the 70 sand and overlying or underlying units. However, existing water level and pump test data do not indicate that there is hydraulic communication between the production zone aquifer and the overlying and underlying aquifers. If hydraulic communication is observed during additional hydrologic testing, appropriate monitoring and engineering will be employed to ensure that non-production zone aquifers will be not be adversely impacted. For purposes of this modeling effort, the model contains a single layer representing the 70 Sand. The base of the model and the top of the model are no flow boundaries that simulate the overlying and underlying confining units. The top and bottom elevation of the 70 Sand correspond the top and base of the model, respectively. Figures 2 and 3 show the top and bottom elevation of the 70 Sand used as model inputs. The data within the Permit Area are based on site borings. The geologic dip of the surfaces are projected out to the model limits

Further evaluation of potential ISR impacts resulting from hydraulic communication between the production zone and overlying or underlying aquifers will be performed as additional data are developed (primarily from the wellfield scale pumping tests).

Boundary Conditions

Boundary conditions imposed on a numerical model define the external geometry of the groundwater flow system being studied as well as internal sources and sinks. Boundary conditions assigned in the model were determined from observed conditions. Descriptions of the types of boundary conditions that can be implemented with the MODFLOW and SURFACT code are found in McDonald and Harbaugh (1988) and HydroGeologic Inc., (1996). Boundary conditions used to represent hydrologic conditions at the Moore Ranch site included general-head (GHB), areal recharge and wells. The locations of the GHB and recharge boundary conditions within the model are illustrated in Figure 1. Discussion of the placement and values for these boundary conditions is provided below. The placement and values for the well boundary conditions are described under the simulation discussion.

The GHB was used in the Moore Ranch Permit Area model to account for inflow and outflow from the model domain. GHBs were assigned along the edges of the model domain where available water-level data suggest the aquifer is being recharged from, or discharging to, a source external to the model domain. GHBs were used because the groundwater elevation at those boundaries can change in response to simulated stresses. In the Permit Area model, GHBs were assigned to the west, east and north boundaries of the model. The values of head assigned to the GHBs ranged from 5,232.9 ft along the south edge of the model 5,021.5 ft, along the north edge. This configuration represents a hydraulic gradient of 0.0040 ft/ft to the north, consistent with water levels measured in the 70 Sand monitor wells.

As previously described, the 70 Sand crops out to the south of the Permit Area. This is an area of direct recharge to the aquifer. Recharge to the 70 Sand aquifer upgradient of the Permit Area must be approximately equal to the flux across the Permit boundary. The flux was previously calculated as 140 gpm across a 4 mile cross-section (35 gpm/mi). A zone of recharge was applied the south edge of the model domain to represent infiltration recharge to the 70 Sand in the area where the unit crops out or is very close to ground surface. Recharge was used to calibrate the model under steady state because there are no significant stresses applied within the model domain under non-pumping conditions.

The SURFACT well package (FWL4) was used to simulate extraction and injection wells of the ISR project. The well configuration includes a series of 5-spot well patterns with an extraction well located in the center, surrounded by four injection wells. Each well pattern is approximately 100 feet on a side. Extraction and injection rates applied to the wells are described under the simulation discussions of this report.

The model domain was extended a suitable distance from the location of the proposed production wellfields to minimize perimeter boundary effects on the interior of the model where the hydraulic stresses were applied.

Aquifer Properties

Input parameters used in the model to simulate aquifer properties are consistent with site-derived data including; top and bottom elevations of the 70 Sand, saturated thickness, hydraulic gradient, hydraulic conductivity, specific yield, specific storage and porosity.

The top and bottom elevations of the 70 Sand were determined from picks in over 250 borings provided by Uranium One. Gridded contour maps were generated using the contouring program Surfer, Version 8.0 (Golden Software, 2002). The maps were imported into Groundwater Vistas to represent the top and bottom elevations of the 70 Sand (Figure 2 and 3). The initial saturated thickness and potentiometric surface of the 70 Sand were determined from average depth to water measurements in the baseline monitor wells. Those values are provided in Table 2. A contour map of that surface was also generated in Surfer and used as initial conditions in the model simulations (Figure 4).

Hydraulic conductivity determined from recently conducted site pumping tests ranged from 2.5 to 9.5 ft/d. As described in the 5-Spot Hydrologic Test Report (Petrotek 2008), a hydraulic conductivity of 4.0 ft/d provided the best calibration to simulation of a series of closely monitored extraction and extraction and injection test conducted in Wellfield 2.

Specific yield and specific storage are also aquifer properties of interest with respect to the response of an aquifer to extraction or injection. Specific yield is the storage term used for unconfined aquifers. Specific yield accounts for the physical draining of the aquifer that occurs in response to lowering of the water table and subsequent dewatering of pore space in the aquifer matrix. Specific yield is equivalent to the drainable porosity within an aquifer and typically ranges from 0.01 to 0.30 (Freeze, 1979). Specific yield calculated from the 5-Spot Hydrologic test ranged from 0.011 to 0.039. A value of 0.28 was used for these model simulations

Specific storage is a measure of the water released from storage due to compaction of the aquifer and expansion of water in response to a decline in head. Specific storage is the storage term used for confined aquifers, where lowering of the potentiometric surface in response to pumping does not result in physical dewatering of the aquifer. Specific storage multiplied by the saturated thickness of an aquifer is referred to as storativity or storage coefficient. Storativity of a confined aquifer system is typically in the range of $5x10^{-3}$ to 10^{-6} or less. Comparison of the magnitude of the values for specific yield and specific storage indicates that in an unconfined aquifer, the bulk of the water produced is the result of physical dewatering of the aquifer. The range of storativity calculated from site pumping tests was from 2.5 E-04 to 4.5 E-03. A value of 5.0 E-04 was used for the Permit Area model simulations.

Porosity of the aquifer is used in the model to estimate groundwater velocity. Groundwater velocity is calculated from the Darcy equation as follows:

$$v = ki/n$$

where

v = average interstitial groundwater velocity
k = hydraulic conductivity
i – hydraulic gradient
n = porosity (effective)

The porosity for the 70 Sand in the 5-Spot Test area is estimated from site data as 26 percent. However, for purposes of groundwater velocity calculations, the parameter required is effective (essentially interconnected) porosity. For the 5-Spot Test Model, the effective porosity is estimated to be between 15 and 20 percent.

Calibration Simulation

Groundwater flow model calibration is an integral component of groundwater modeling applications. Calibration of a numerical groundwater flow model is the process of adjusting model parameters to obtain a reasonable match between field measured values and model predicted values of heads and fluxes (Woessner and Anderson, 1992). The calibration procedure is generally performed by varying estimates of model parameters (hydraulic properties) and/or boundary condition values from a set of initial estimates until an acceptable match of simulated and observed water levels and/or flux is achieved. Calibration can be accomplished using trial and error methods or automated techniques (often referred to as inverse modeling).

Because the hydraulic conductivity and specific yield values had been calibrated to the smaller scale 5-Spot Hydrologic Test model (Petrotek 2008) no attempt was made to adjust these parameters for the Permit Area model. Additional information that will be derived from the Wellfield Hydrologic Tests will be incorporated into this model when available. The focus of this model is on the response of the aquifer to hydraulic stresses imposed on a wellfield scale. .representation of site conditions. The variable that was used to calibrate the model to steady state conditions was recharge along the southern boundary of the model. As previously described, the 70 Sand crops out in this area and is subject to direct recharge from infiltration of precipitation and surface runoff.

The adequacy of model calibration is judged by examining model residuals. A residual, as defined for use in this modeling report, is the difference between the observed change in groundwater elevation and the change in groundwater elevation predicted by the model. The objective of model calibration should be the minimization of the residual mean, residual standard deviation, and residual sum of squares (RSS) (Duffield, et al, 1990). The mean residual is the arithmetic average of all the differences between observed and computed water levels. A positive sign indicates that the model has underpredicted the observed drawdown level and a negative sign indicates overprediction. The residual standard deviation quantifies the spread of the differences between observed and predicted drawdown around the mean residual. The ratio of residual standard deviation to the total head change across the model domain should be small, indicating the residual errors are only a small part of the overall model response (Anderson and Woessner, 1992). The RSS is computed by adding the square of each residual and is another measure of overall variability. For a statistically accurate model calibration, the residuals and the statistics based on the residual should approach zero.

Calibration was achieved by comparing field-measured (observed) water levels in the baseline monitor wells with heads predicted by MODFLOW-SURFACT for the same wells under simulated steady state conditions of the 70 Sand aquifer. The Recharge area (Figure 1) was adjusted until the best fit to the average potentiometric surface observed in the baseline monitor wells was achieved. The potentiometric surface of that simulation is shown in Figure 4. Calibration residuals are presented in Figure 4a. Calibration statistics from that simulation are listed in Table 3.

Model Simulations

This numerical groundwater flow model was developed to evaluate the impacts of ISR operations on the 70 Sand during typical ISR operations. Simulations were performed using the numerical model to address requests for additional information posed by the NRC in response to the SML license application. The simulations described in this report provide:

- a demonstration of the hydraulic impacts that the ISR operation will have on the 70 Sand aquifer, including the sustainability of anticipated production and restoration rates,
- the degree of interference between wellfield that are operating simultaneously,

- estimate of horizontal wellfield flare factor under typical operating rates, and
- a hydrologic test design to demonstrate hydraulic communication between a pumping well within the wellfield and the monitor well ring at a proposed distance of 500 feet from the wellfield.

Initial Conditions

The initial condition for the simulations was based on the average potentiometric surface determined from the baseline wells. As previously stated, the recharge value was adjusted under a steady state model until a reasonable match was achieved between the simulated and observed target values. The potentiometric surface for that simulation is shown in Figure 4.

Hydraulic Impacts of ISR Production

A model simulation was run to represent the full cycle of ISR production and restoration. The operational parameters for this simulation are summarized in Table 3. The configuration of the header houses, extraction and injection wells for Wellfields One and Two are illustrated on Figures 5 and 6, respectively.

Production is initiated in Wellfield Two at a production rate of 2,960 gpm. Seven of the eleven header houses are included in the first phase of production (148 production wells). The net bleed during this phase was 0.8 percent. The production is run for a period of 18 months. The potentiometric surface at the end of the first production phase is shown in Figure 7. Drawdown at the end of the first phase is shown in Figure 8. The overall drawdown across the wellfield is over 1 foot. The maximum drawdown within the wellfield is 16.5 feet. Figure 9 shows a more detailed view of the drawdown within Wellfield Two at the end of the first phase. The impacts of individual wells can be observed at this scale. At the end of the first production phase, the wells in the first seven header houses are shut in.

The remaining four header houses (81 production wells) in Wellfield Two and three header houses (61 production wells) in Wellfield One are turned on to begin the second production phase. The total production rate for this phase is 2,840 gpm. The net bleed for Wellfield Two during the second phase is 1.3 percent. For Wellfield One the net bleed was 1.1 percent. The second phase is run for a period of 18 months and then the wells are shut in. The potentiometric surface across the wellfield at the end the second phase is shown on Figure 10. Drawdown is illustrated in Figure 11. Maximum drawdown at the end of the second stage is 21.1 feet in Wellfield Two and 17.6 feet in Wellfield One. Detailed views of drawdown in Wellfields Two and One are shown on Figures 12 and 13, respectively.

The third stage includes the remaining five header houses (99 production wells) in Wellfield One at a total production rate of 1,980 gpm with a net bleed of 1.0 percent. However, in order to avoid pulling water from Wellfield Two outside of the monitor ring and toward Wellfield One, groundwater sweep was simulated in Wellfield Two. The rate of withdrawal from Wellfield Two during the third production phase was 20 gpm. The potentiometric surface and drawdown at the end of the third production phase are shown on Figures 14 and 15, respectively. Detailed drawdown in Wellfield One at the end of the third production phase is illustrated on Figure 16. Maximum drawdown in Wellfield One was 21.8 feet. Table 4 provides a summary of the production and injection rates simulated for each of the three production phases.

Wellfield Flare Factor

Results of the production simulation were used to demonstrate the amount of horizontal flare that can be expected during typical ISR operations. Particle tracking was used to illustrate the movement of water from the outer injection wells. Particles were placed at the locations of all injection wells located on the perimeter of each wellfield. The particles associated with wells that were in production during the first phase were initiated at the beginning of that production phase. The particles associated with wells of the second phase of production were initiated when the second phase began and the particles associated with the third phase were initiated when the third phase began.

Figure 17 shows the results of the particle tracking for Wellfield One. An area was circumscribed around the outermost extent of all the particles from the wellfield. The ratio of the area circumscribing the particles to the area under pattern provides the horizontal wellfield flare factor. For Wellfield One, the flare factor is calculated as 1.18. Particle tracking for Wellfield Two is illustrated in Figure 18. The flare factor calculated for Wellfield Two is 1.17.

The simulated horizontal flare factor is similar to 1.2 factor used by Wyoming Department of Environmental Quality in calculating Wellfield Pore Volumes.

Hydraulic Impacts of ISR Restoration

The operations simulation was continued to assess the hydraulic impacts of restoration on the 70 Sand aquifer. Groundwater sweep was only employed on a limited basis in Wellfield Two while production was finishing in Wellfield One. The reason that groundwater sweep is not being utilized in this restoration simulation is because the rates that would be necessary to remove a pore volume within a one year period would result in localized dewatering of the aquifer. Table 4 shows that to achieve 1 PV removal with 1 year of restoration would require rates of 172 gpm for Wellfield One and 240 gpm for Wellfield Two. Application of these rates would dewater large portions of the wellfields, even if performed sequentially.

Restoration will be accomplished primarily through treatment of extracted groundwater by Reverse Osmosis (RO) and reinjection of treated water into the aquifer. The plant will have the capacity to treat approximately 500 gpm of water.

This equates to 250 gpm per wellfield if concurrent restoration of the two wellfields is employed. Approximately 20% of the treated water will be reject brine that will be disposed of in a deep disposal well or through some other waste disposal methods. This results in a net loss of approximately 50 gpm per wellfield during restoration.

Rather than assign extraction and injection rates to select wells to simulate extraction of 250 gpm and reinjection of 200 gpm, the 50 gpm net loss was distributed over all the well patterns within each wellfield. The simulation was run long enough to remove slightly more than six pore volumes (at the 250 gpm rate) from each wellfield. The simulation was run for 4.3 years with both wells in restoration. Figure 19 shows the drawdown at the end of that time. Wellfield One was then shut in and Wellfield Two continued restoration for another 1.7 years. Drawdown at the end of restoration in Wellfield Two is depicted in Figure 20.

Hydrologic Test Design Simulation

A hydrologic testing program is required to demonstrate that the monitor well ring that surrounds the wellfield is hydraulically connected to the production zone before ISR operations can commence. The unconfined conditions present in portions of the production zone aquifer may limit the horizontal extent of measurable hydraulic response to pumping. A numerical simulation was set up to evaluate the amount of drawdown that could be expected at monitor ring well locations using pumping rates that can be sustained from a single extraction location. Because of the limited extent of drawdown from a single well, it will require several pumping tests to demonstrate hydraulic communication across the entire wellfield. A simulation that demonstrates a sequence of pumping tests was run. The simulation includes a total of six pumping wells within Wellfield 1. There are 24 monitor ring wells, located approximately 500 feet from the outer boundary of Wellfield 1. The well configuration is illustrated in Figure 21.

Unconfined conditions are prevalent in the southern portion of the wellfield and confined conditions are present in the northern portion of the wellfield. Therefore, it is anticipated that the radius of influence for pumping wells in the northern portion of the site will be considerably greater than in the south. Each of the pumping wells was operated for a period of 5 days at a rate of 40 gpm. For wells in the unconfined portion of the site, two to three wells were pumped simultaneously on opposite sides of the wellfield.

The northernmost well, located in the confined portion of the aquifer, was pumped first in the simulation. The well is designated as PW1 on Figure 21. The drawdown at the end of the first pumping test is shown in Figure 22. The simulation indicates that 10 of the 24 monitor ring wells have at approximately 1 foot of drawdown or more at the end of the 5-day test. A 10-day recovery period is simulated prior to beginning the second pumping phase. At the end of the 10 days the residual drawdown in the immediate area of the pumping well is less than 0.6 feet (Figure 23).

The second pumping phase was initiated with pumping at wells PW3, and PW6, both located in the unconfined portion of the wellfield (Figure 21). The drawdown after 5 days of pumping is shown on Figure 24. The difference between the unconfined and confined aquifer response is clearly demonstrated. Each of the pumping wells creates drawdown of 0.5 feet or more at only three monitor wells. The residual drawdown after the second 10-day recovery period is shown in Figure 25.

The third pumping phase was initiated with pumping at wells PW2, PW4 and PW5 (Figure 21). Well PW4 is located at the southern end of the wellfield and is within the unconfined portion of the aquifer. Wells PW2 and PW5 are located near the transition to confining conditions. Figure 26 shows the drawdown after 5 days of pumping each well at 40 gpm. At the end of the third pumping phase, all of the monitor ring wells have shown close to a foot of drawdown at some point in the testing.

Discussion and Summary

A numerical model was developed to evaluate the response of the 70 Sand aquifer to hydraulic stresses imposed by operation of the Moore Ranch ISR uranium project. The model is an expansion of a smaller scale model that was calibrated to a closely monitored 5-Spot Hydrologic Test. The model was developed using site-specific data regarding top and bottom aquifer elevations, saturated thickness, potentiometric surface and hydraulic gradient, hydraulic conductivity, specific yield, storativity and porosity of the 70 Sand aquifer.

The model was used to simulate the complete operational cycle of the Moore Ranch ISR uranium project, from production through restoration, of two delineated wellfields. Results of the model simulations indicate the following.

- Production at the projected rates of up to 3,000 gpm (20 gpm per well pattern) with a 1 to 1.5 percent bleed for a period of 4.5 years will not result in dewatering of the aquifer.
- Horizontal wellfield flare factor, determined from the rates simulated above, is slightly less than 1.2, consistent with industry projections. Although not simulated in this model, it is assumed that vertical flare will be similar, resulting in a total wellfield flare factor of approximately 1.4 to 1.5.
- Restoration using RO at the projected rates of 250 gpm per wellfield with a 20 percent reject rate can be sustained throughout the restoration cycle of six pore volumes of removal (4.3 years at Wellfield One and 6.0 years at Wellfield Two).
- Groundwater sweep at rates that will result in removal of a Pore Volume within one year (172 gpm at Wellfield One and 240 gpm at Wellfield Two) will not be sustainable and will result in localized dewatering of the aquifer

and inefficient operation and fluid recovery. Therefore, it is recommended that RO be the primary restoration method utilized.

- Wellfield balancing will be required to prevent fluids from being drawn from one wellfield to another during the project life.
- Hydrologic Test design simulations indicate that it may take six or more individual pump tests per wellfield to adequately demonstrate hydraulic communication between the monitor ring and the production zone.

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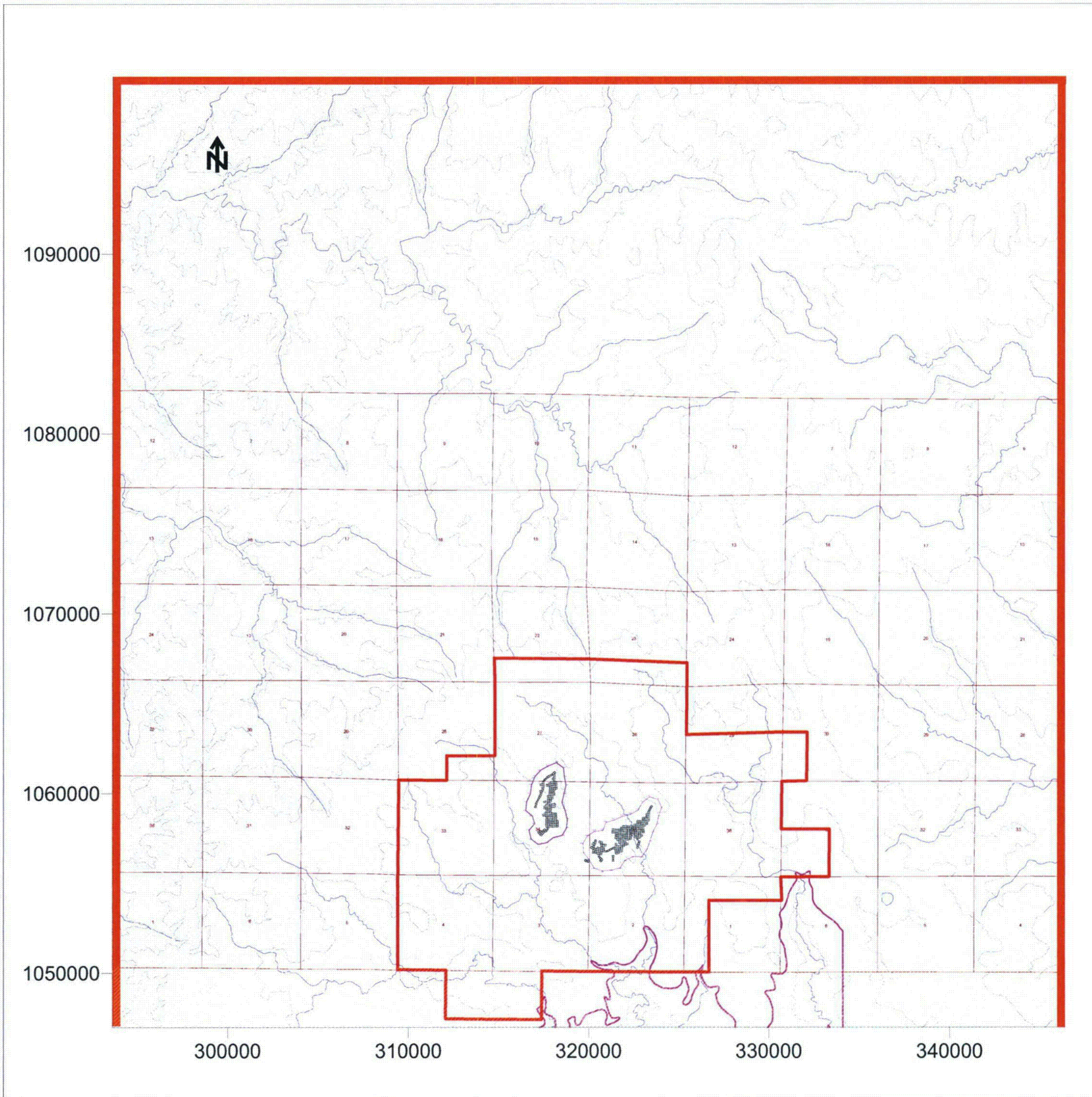

Permit Area Boundary

Outcrop of 70 Sand

Topographic Surface
C.I. = 20 feet

Wellfield Patterns

Monitor Well Ring

Boundary Conditions

General Head

Recharge

0 5000 10000
Feet

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Figure 1. Permit Area Model Domain and Boundary Conditions Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig1MRmodel.srf Date: 9/19/08

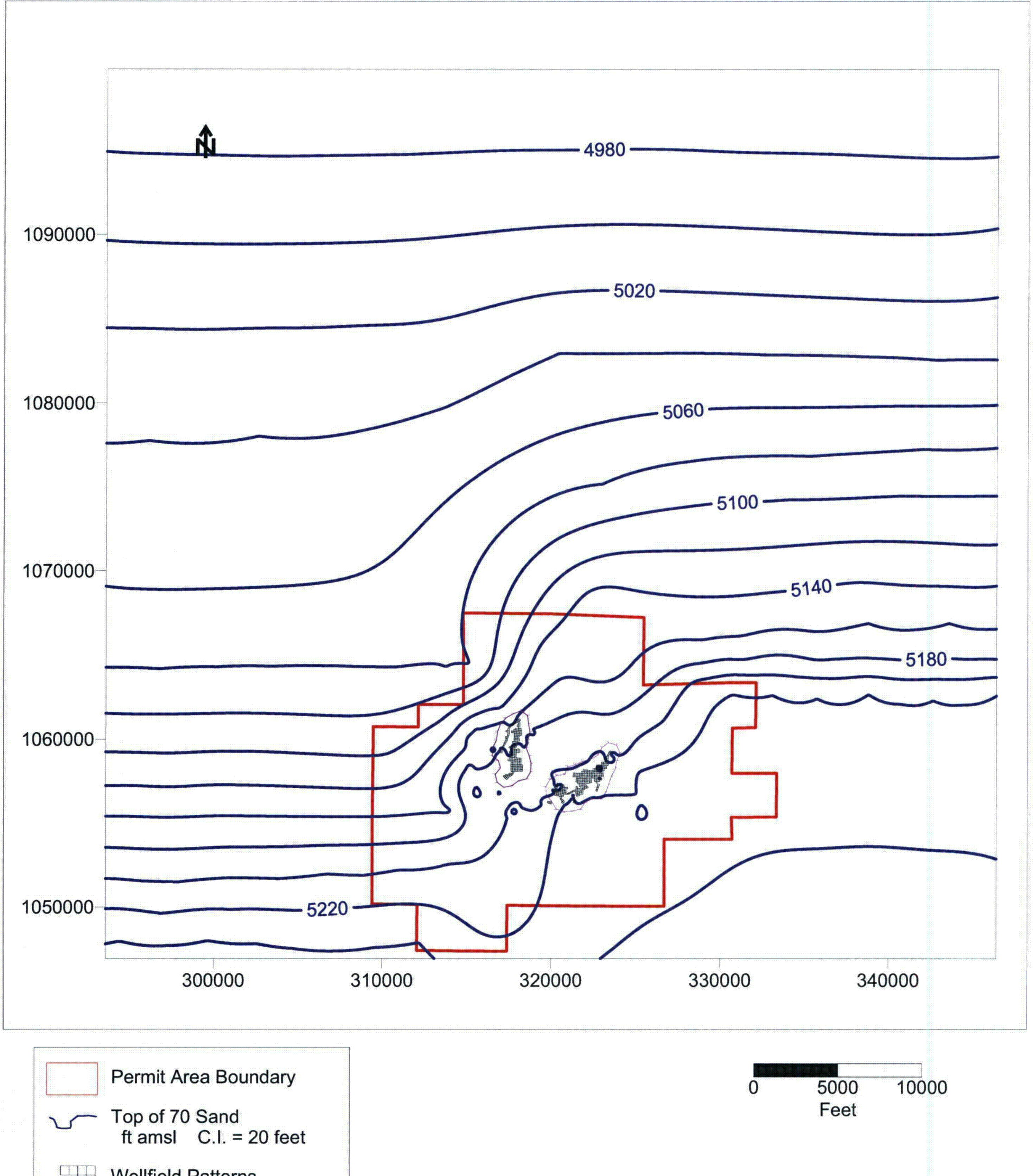

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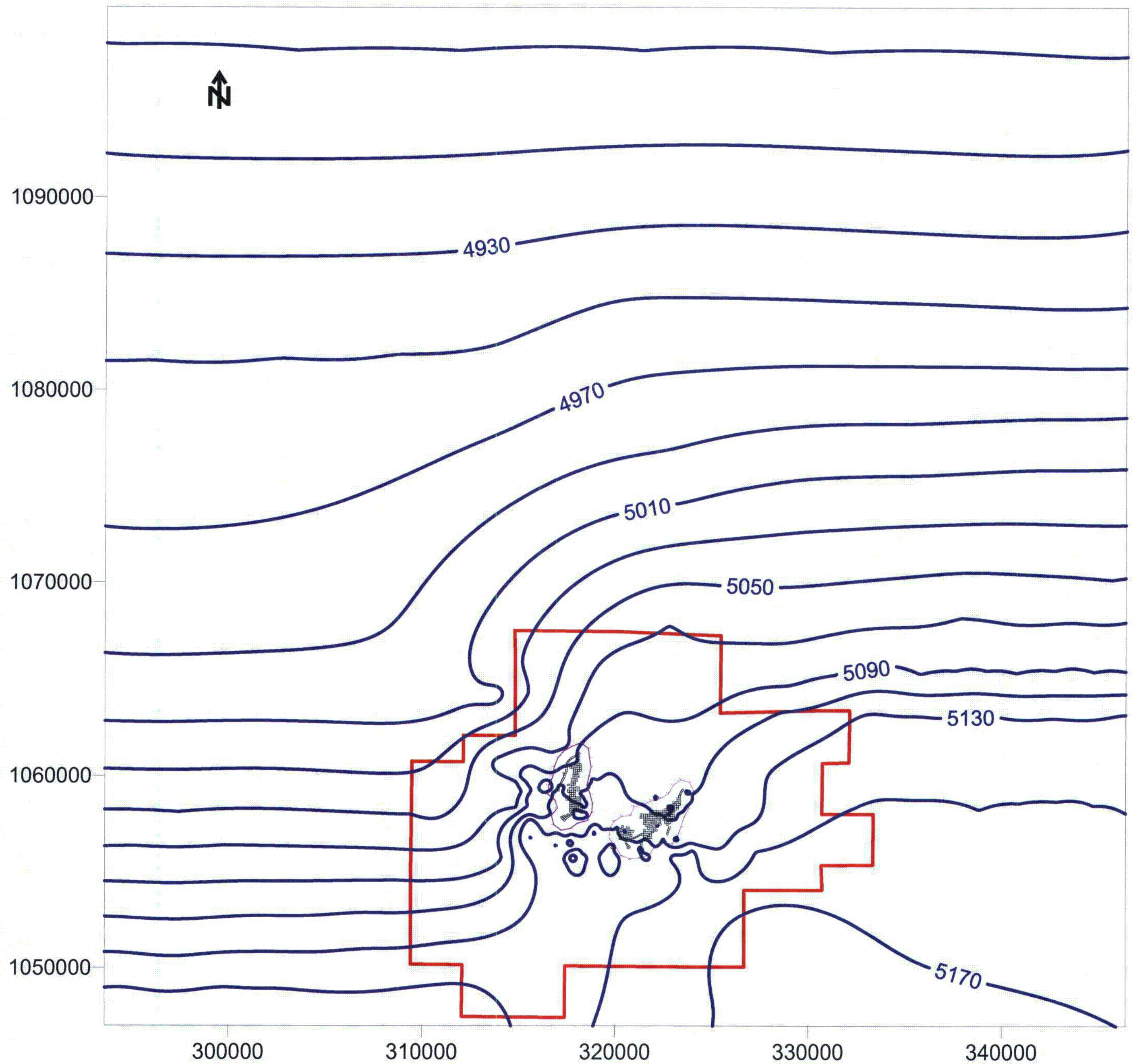
Figure 2. Structure Map - Top of 70 Sand
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig2MRtop70.srf Date: 9/19/08



Permit Area Boundary

Bottom of 70 Sand
ft amsl C.I. = 20 feet

Wellfield Patterns

Monitor Well Ring

0 5000 10000
Feet

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URANIUM ONE

Figure 3. Structure Map - Bottom of 70 Sand
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig3MRbot70.srf Date: 9/19/08

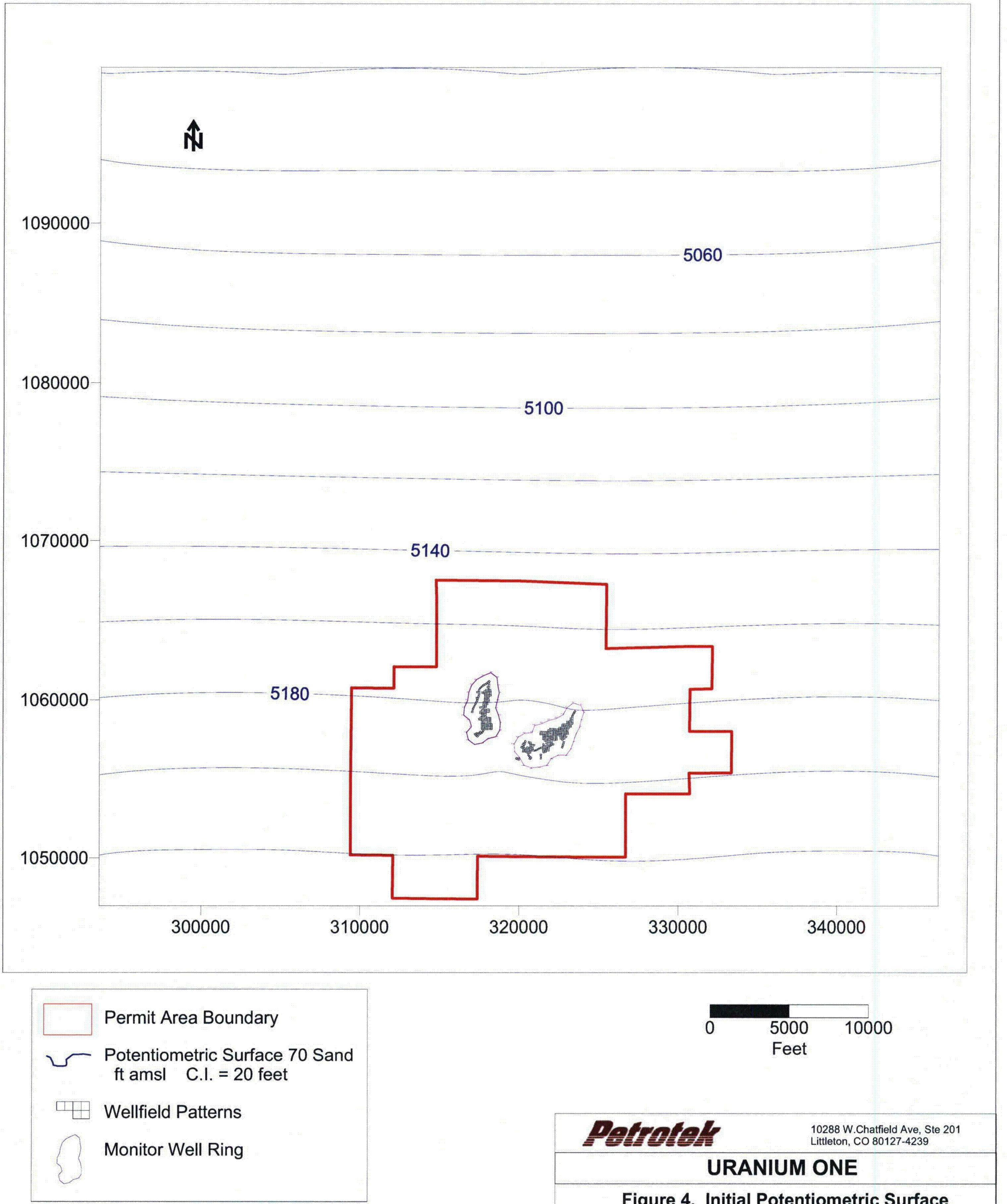

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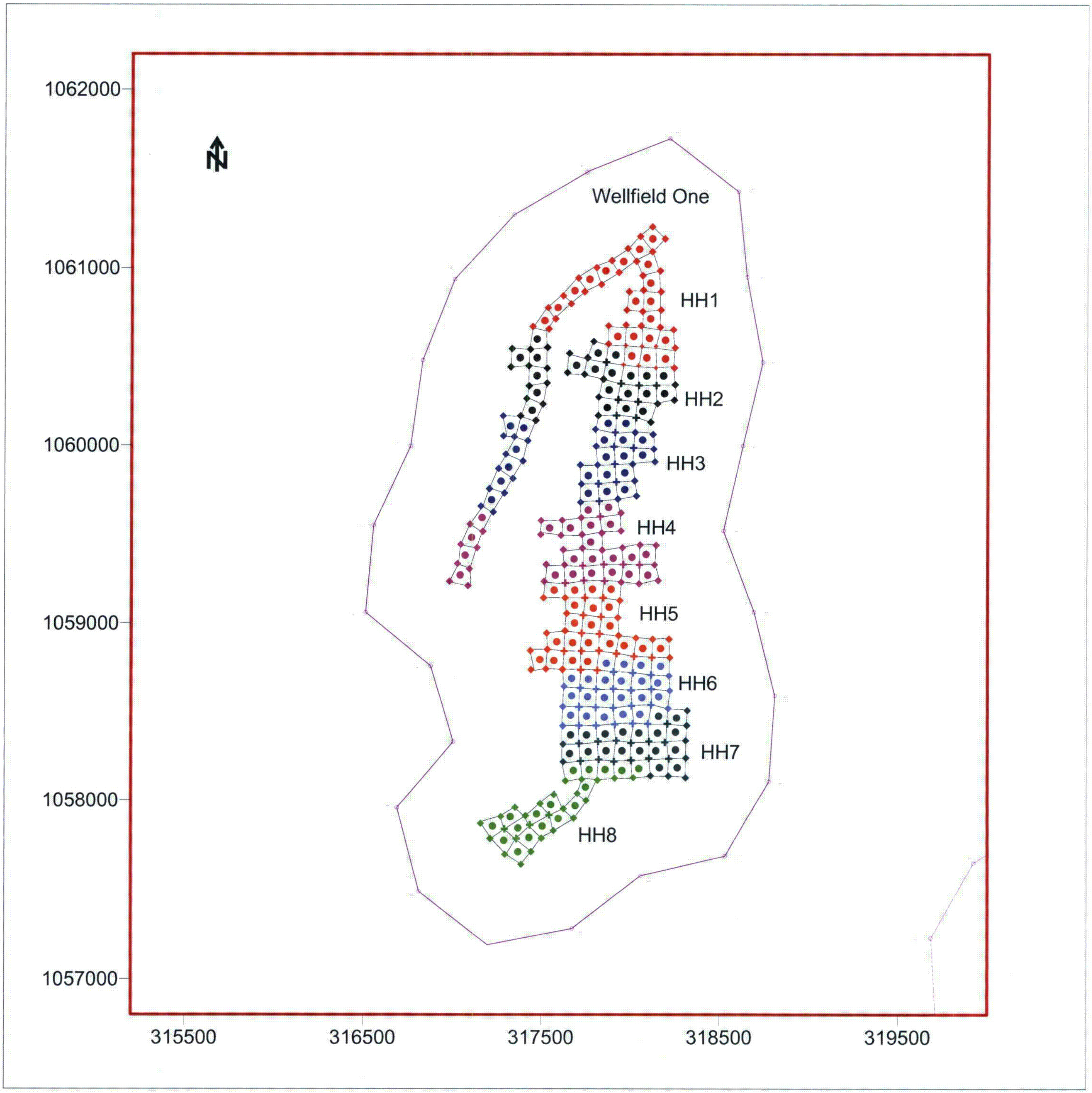
Figure 4. Initial Potentiometric Surface
70 Sand
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig4MRinitialhds.srf Date: 9/19/08



Extraction Well

Interior Injection Well

Exterior Injection Well

HH1 Header House Separate colors denote wells grouped to a single header house

Wellfield Patterns

Monitor Well Ring

0 500 1000

Feet

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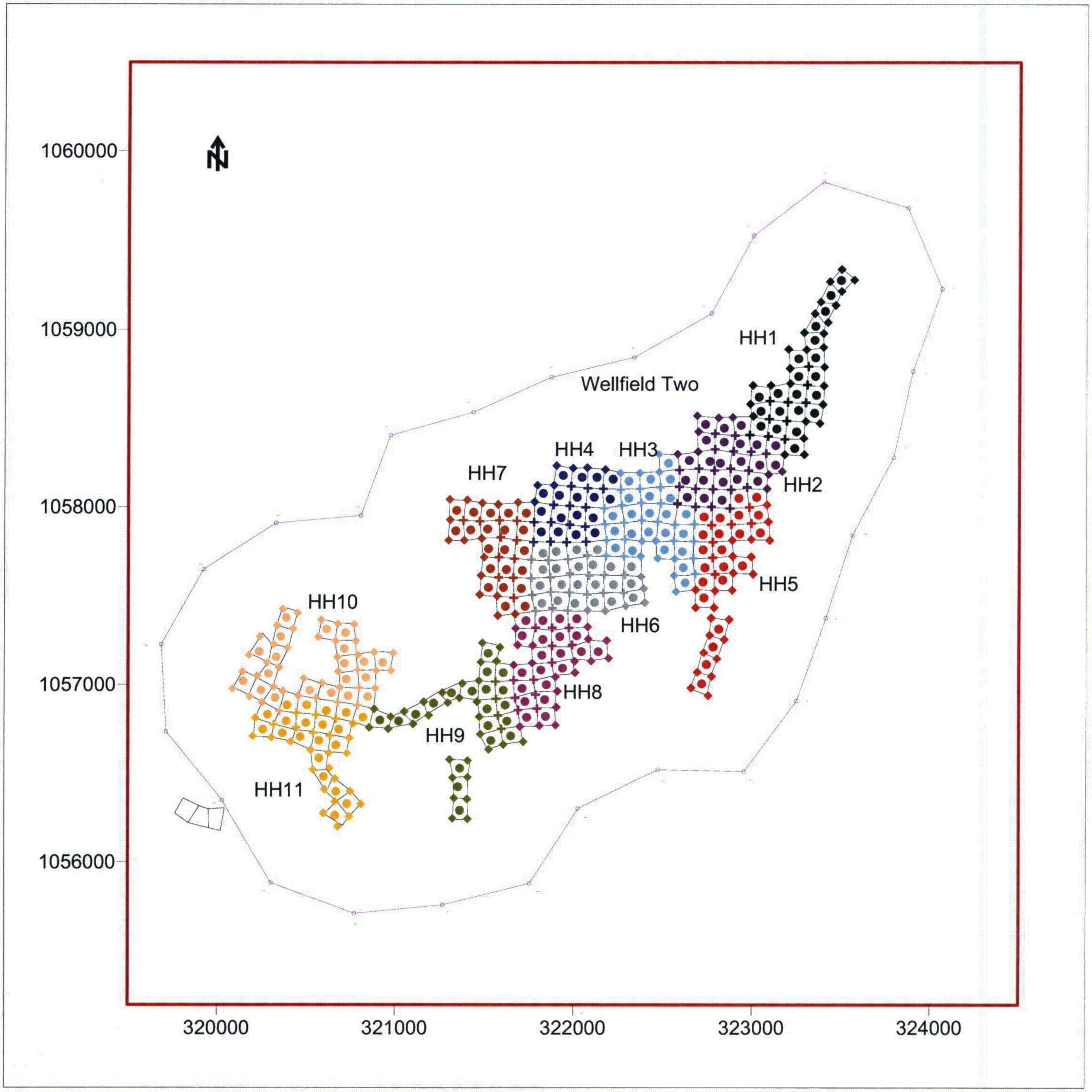
URANIUM ONE

**Figure 5. Wellfield One-
Header Houses and Well Patterns
Moore Ranch Uranium Project, Wyoming**

By: EPL Checked: HD File ID:fig5MRWF1wells.srf Date: 9/19/08



- ● Extraction Well
- + Interior Injection Well
- ◆ Exterior Injection Well
- HH1 Header House — Separate colors denote wells grouped to a single header house
- Wellfield Patterns
- Monitor Well Ring

0 500 1000
Feet

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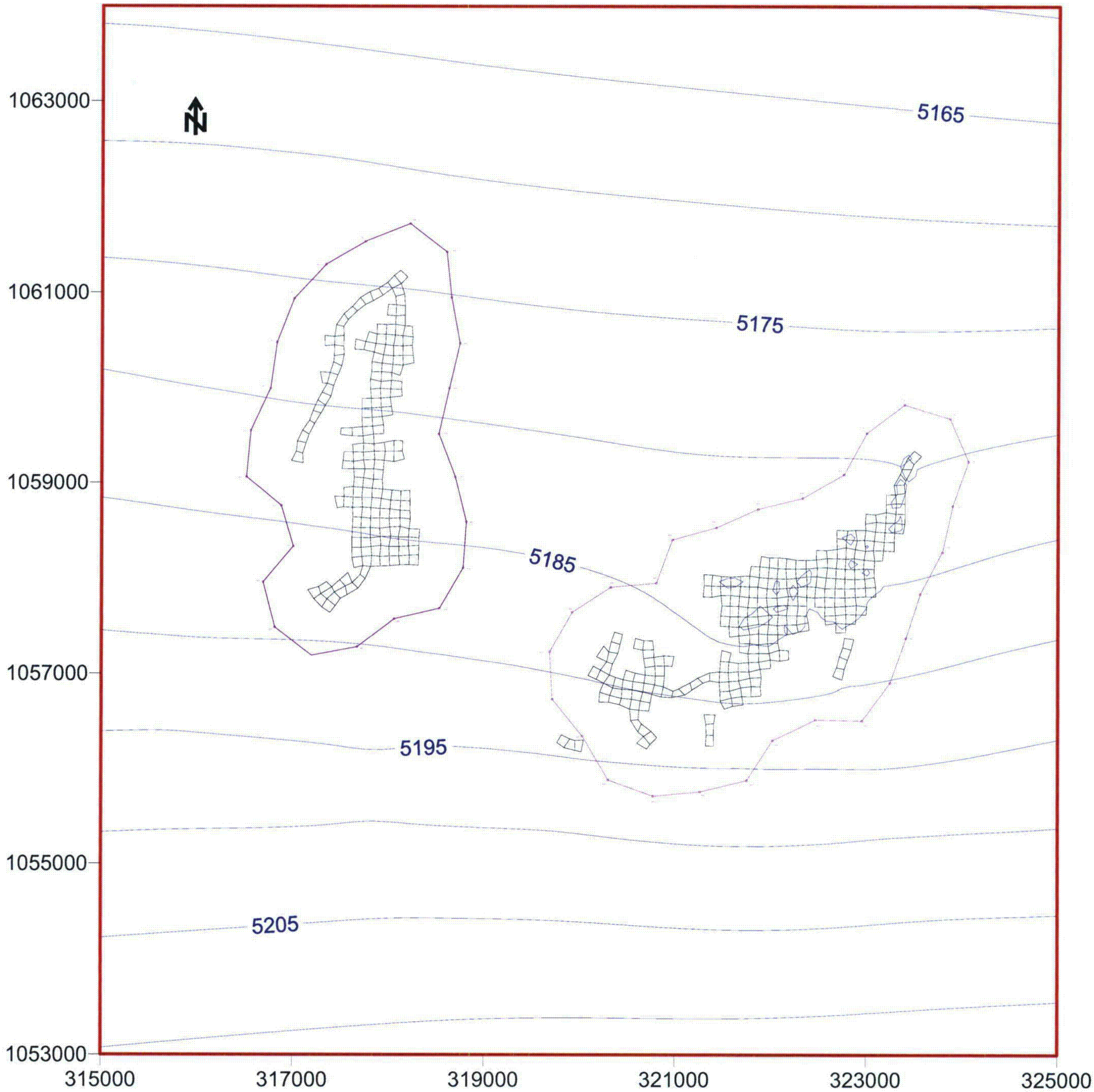
**Figure 6. Wellfield Two
Header Houses and Well Patterns
Moore Ranch Uranium Project, Wyoming**

By: EPL Checked: HD File ID:fig6MRWF2wells.srf Date: 9/19/08



Potentiometric Surface - 70 Sand
feet amsl C.I. = 5 feet

Wellfield Patterns

Monitor Well Ring

0 1000 2000
Feet

Simulation of Production From Wellfield Two
8 Header Houses, 148 Well Patterns
Production Rate of 2960 gpm for 18 months
Net 0.8% Bleed

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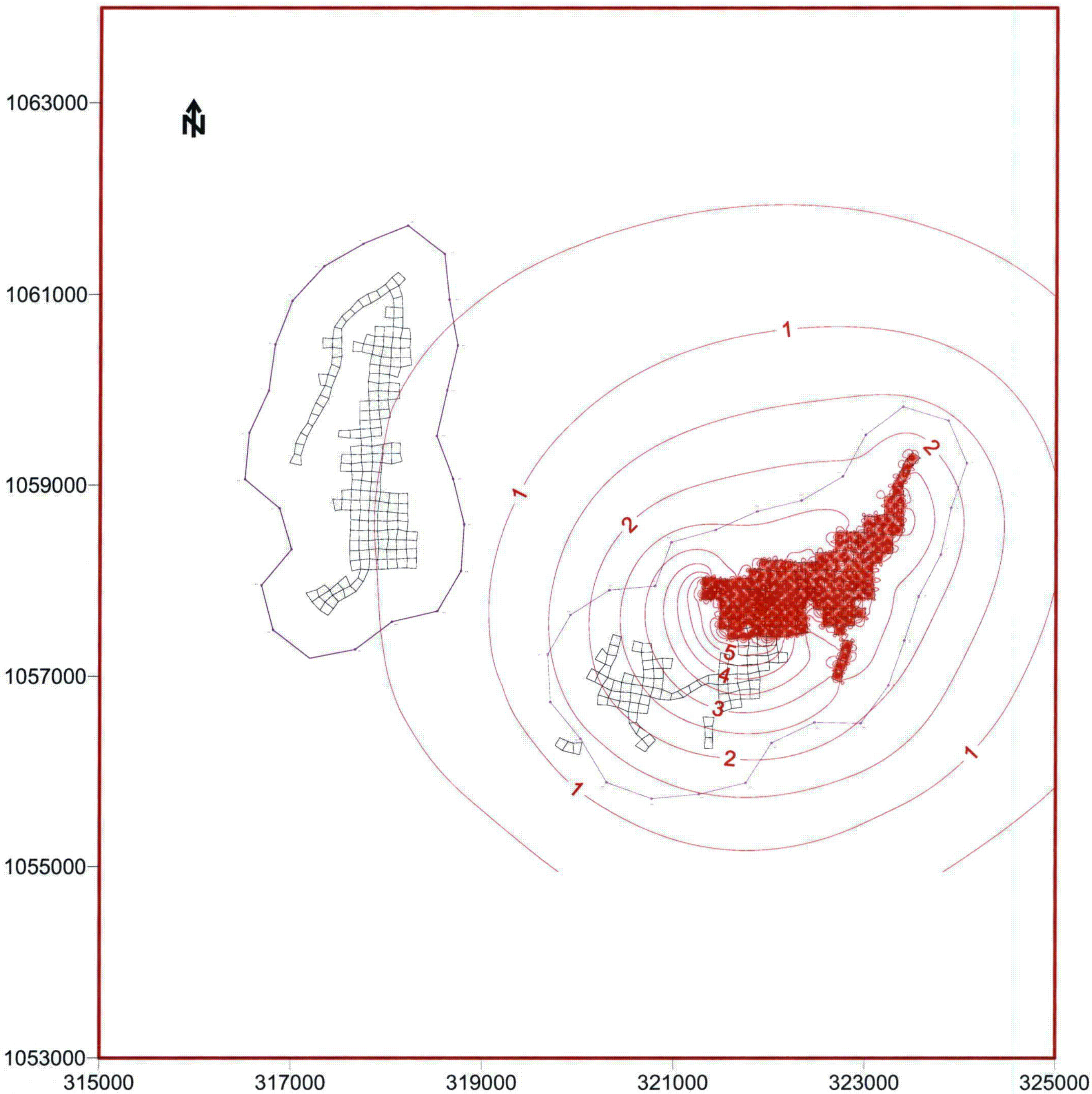
URANIUM ONE

Figure 7. Potentiometric Surface - 70 Sand
End of First Production Phase
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig7MRProd1.srf Date: 9/19/08



Drawdown - 70 Sand
C.I. = 0.5 feet

Wellfield Patterns

Monitor Well Ring

Simulation of Production From Wellfield Two
8 Header Houses, 148 Well Patterns
Production Rate of 2960 gpm for 18 months
Net 0.8% Bleed

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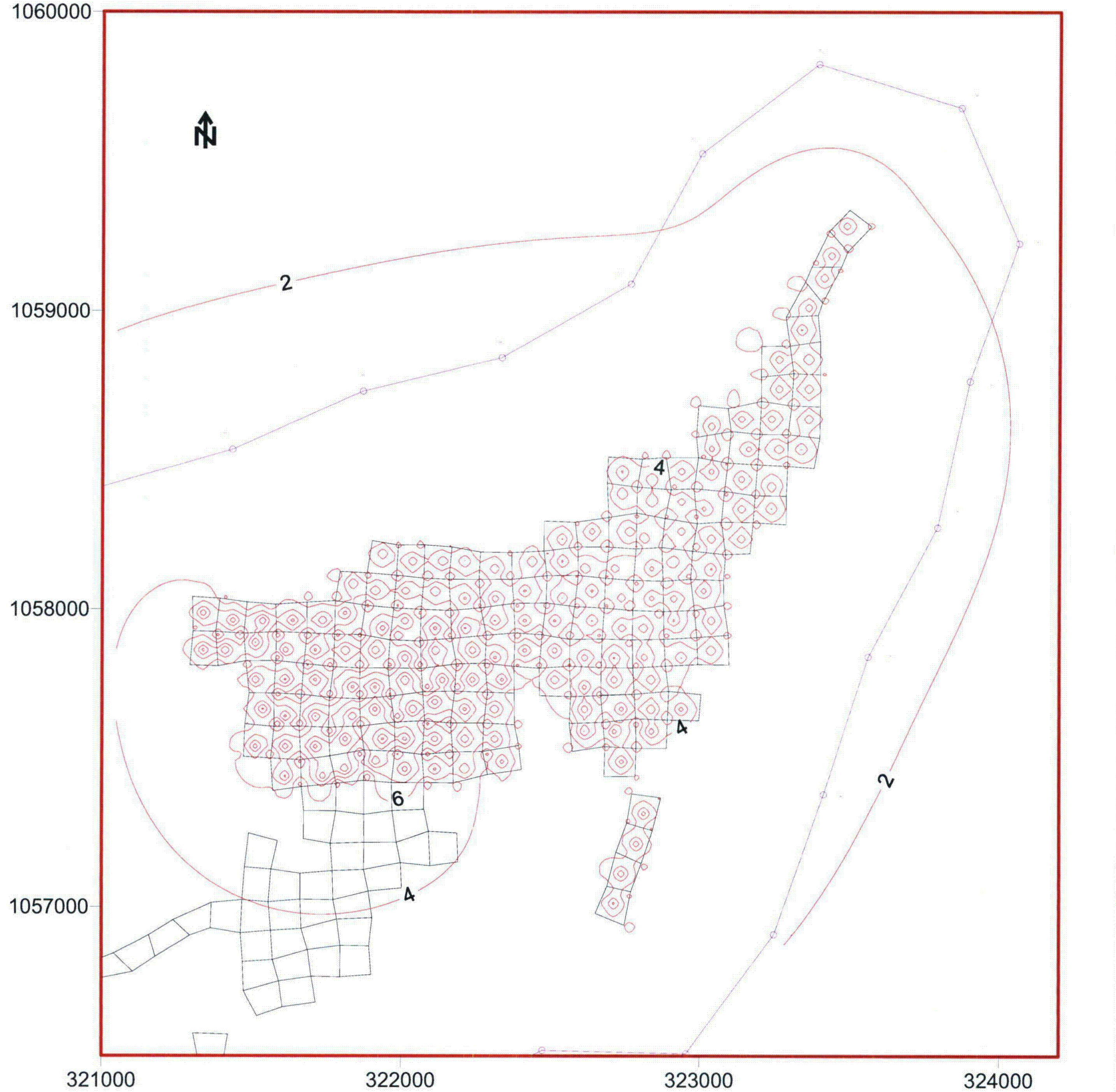
URANIUM ONE

Figure 8. Drawdown - 70 Sand
End of First Production Phase Wellfield Two
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig8MRProd1.srf Date: 9/19/08



0 500 1000
Feet

Drawdown - 70 Sand
C.I. = 2 feet

Wellfield Patterns

Monitor Well Ring

Simulation of Production From Wellfield Two
8 Header Houses, 148 Well Patterns
Production Rate of 2960 gpm for 18 months
Net 0.8% Bleed

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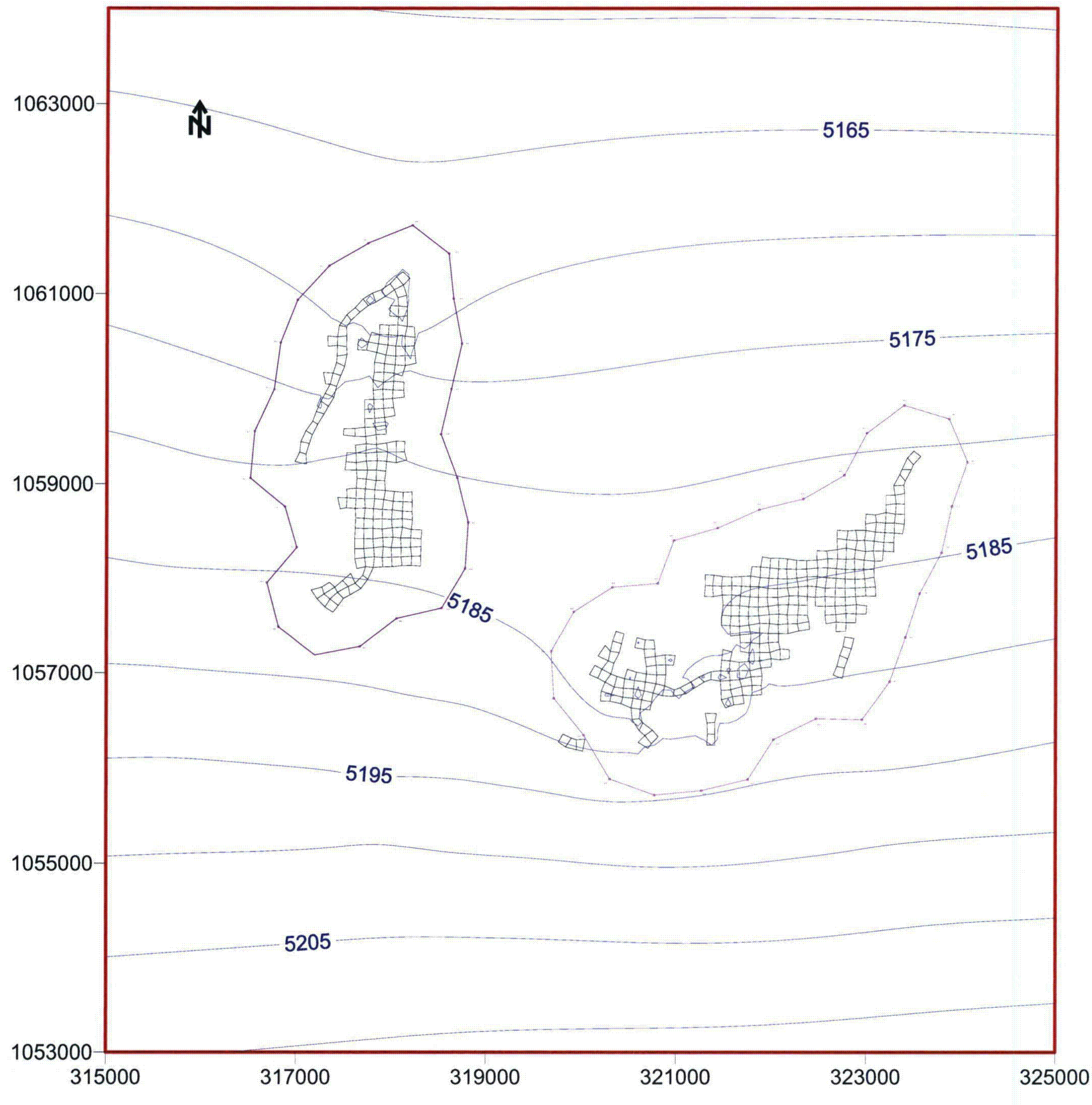
Figure 9. Wellfield Two Drawdown (Detail)
End of First Production Phase
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig9MRProd1.srf Date: 9/19/08



Potentiometric Surface - 70 Sand feet amsl C.I. = 5 feet

Wellfield Patterns

Monitor Well Ring

0 1000 2000
Feet

Simulation of Production From Wellfields One and Two
7 Header Houses, 142 Well Patterns
Production Rate of 2840 gpm for 18 months
Net 1.4% Bleed

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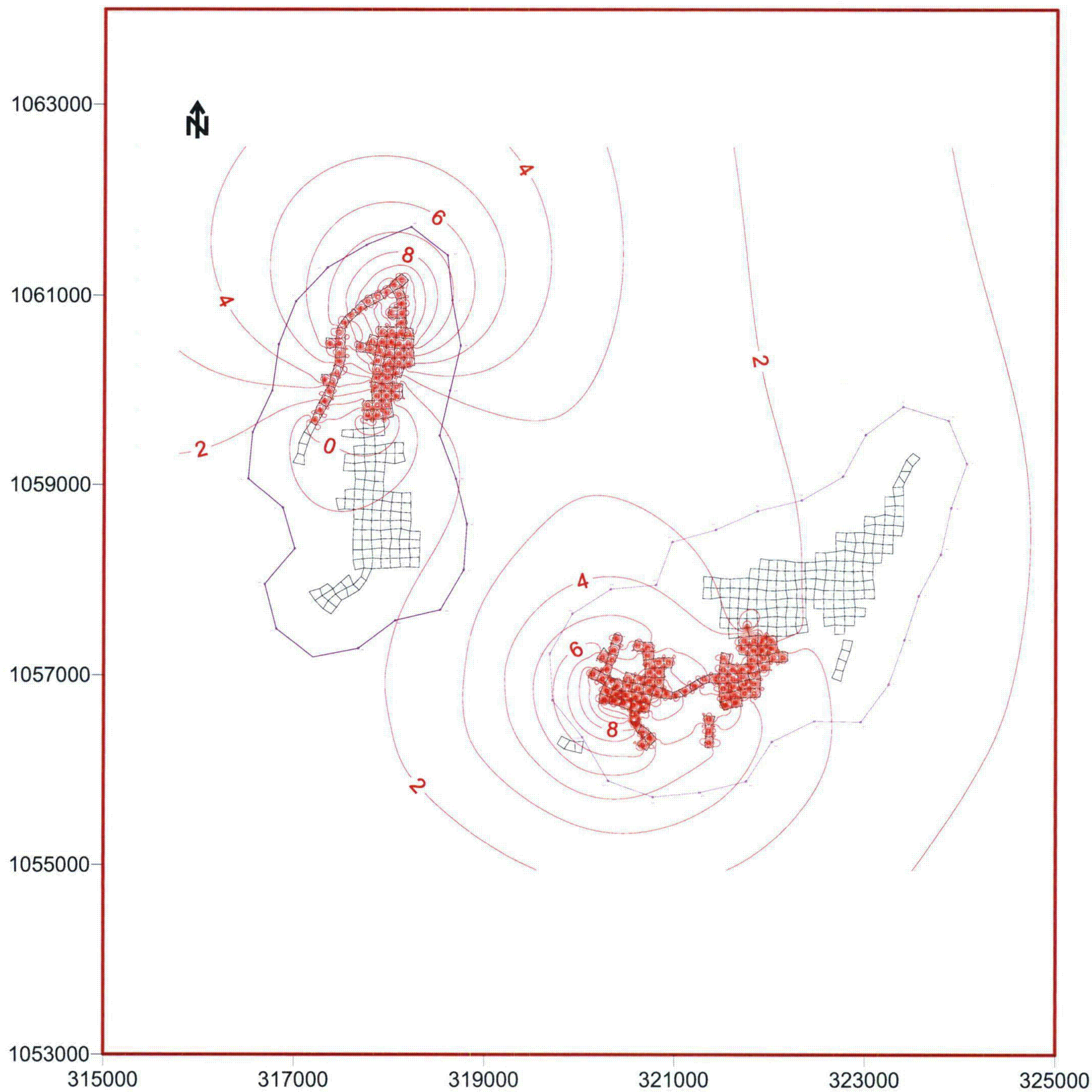
Figure 10. Potentiometric Surface - 70 Sand
End of Second Production Phase
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig10MRProd2.srf Date: 9/19/08



Drawdown - 70 Sand
C.I. = 1 foot

Wellfield Patterns

Monitor Well Ring

0 1000 2000
Feet

Simulation of Production From Wellfields One and Two
7 Header Houses, 142 Well Patterns
Production Rate of 2840 gpm for 18 months
Net 1.4% Bleed

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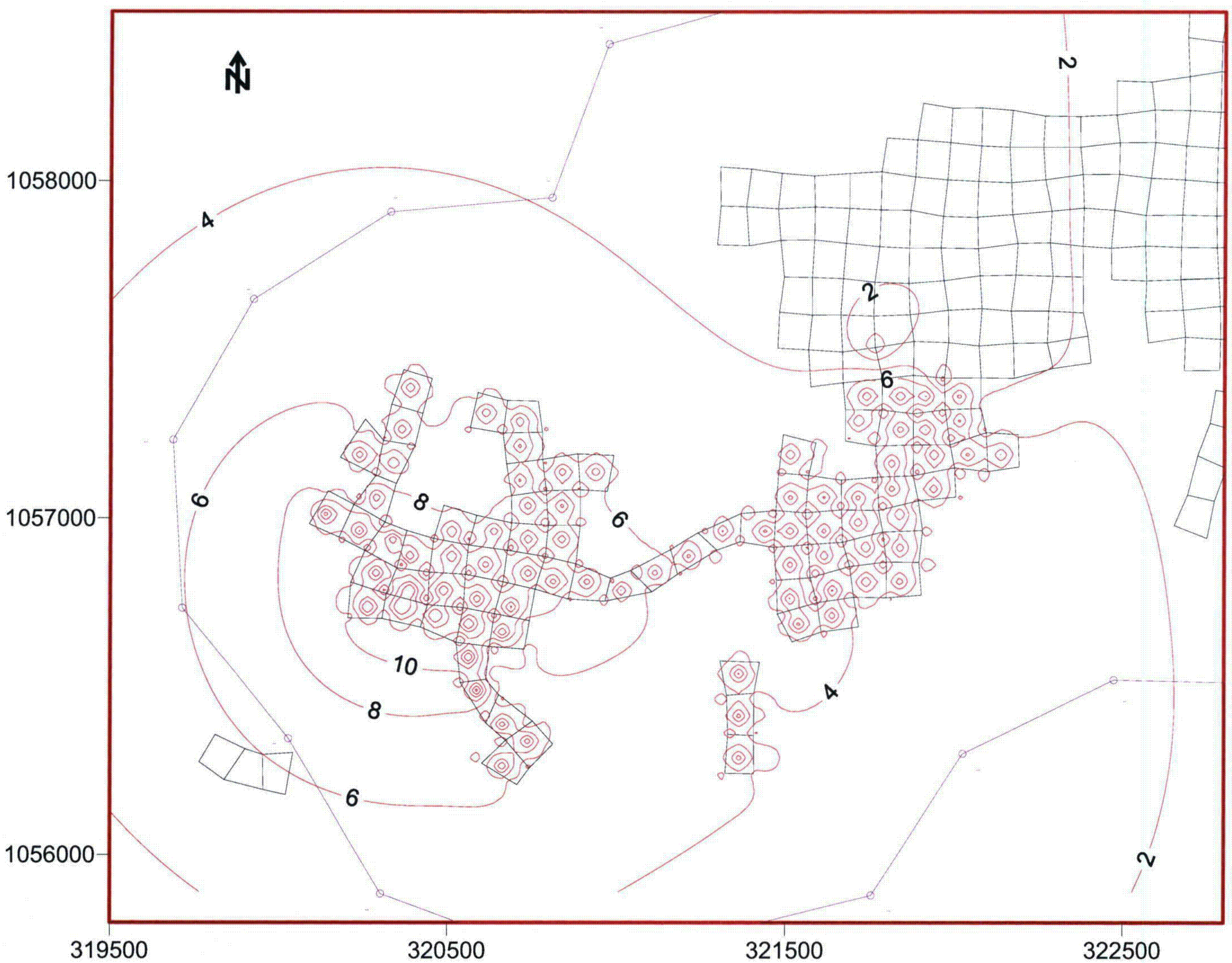
Figure 11. Drawdown - 70 Sand
End of Second Production Phase
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig11MRProd2.srf Date: 9/19/08



Simulation of Production From Wellfield Two
4 Header Houses, 81 Well Patterns
Production Rate of 1620 gpm for 18 months
Net 1.4% Bleed

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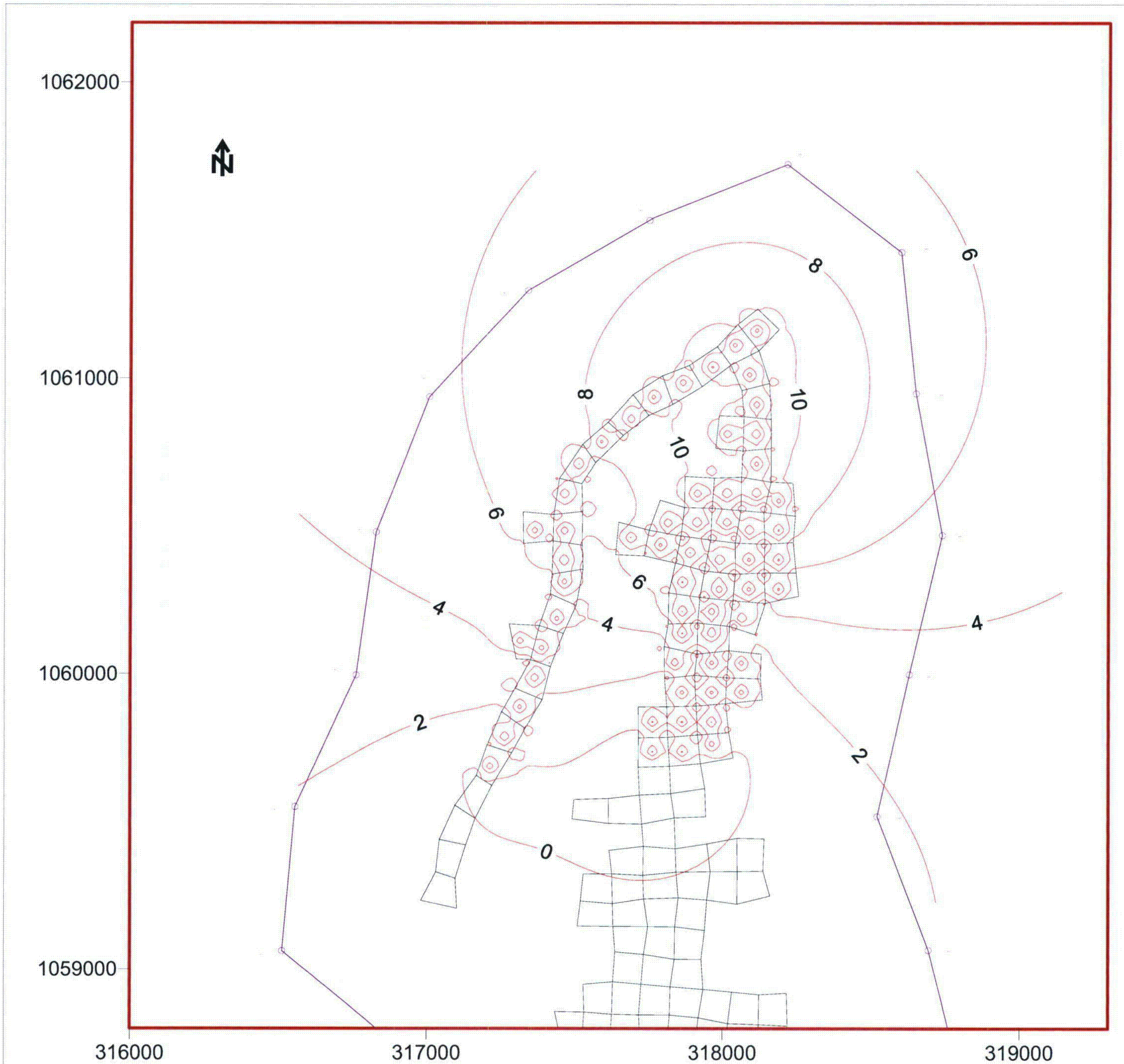
Figure 12. Wellfield Two Drawdown (Detail)
End of Second Production Phase
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig9MRProd1.srf Date: 9/19/08



Drawdown - 70 Sand
C.I. = 2 feet

Wellfield Patterns

Monitor Well Ring

0 500 1000
Feet

Simulation of Production From Wellfield One
3 Header Houses, 61 Well Patterns
Production Rate of 1220 gpm for 18 months
Net 1.4% Bleed

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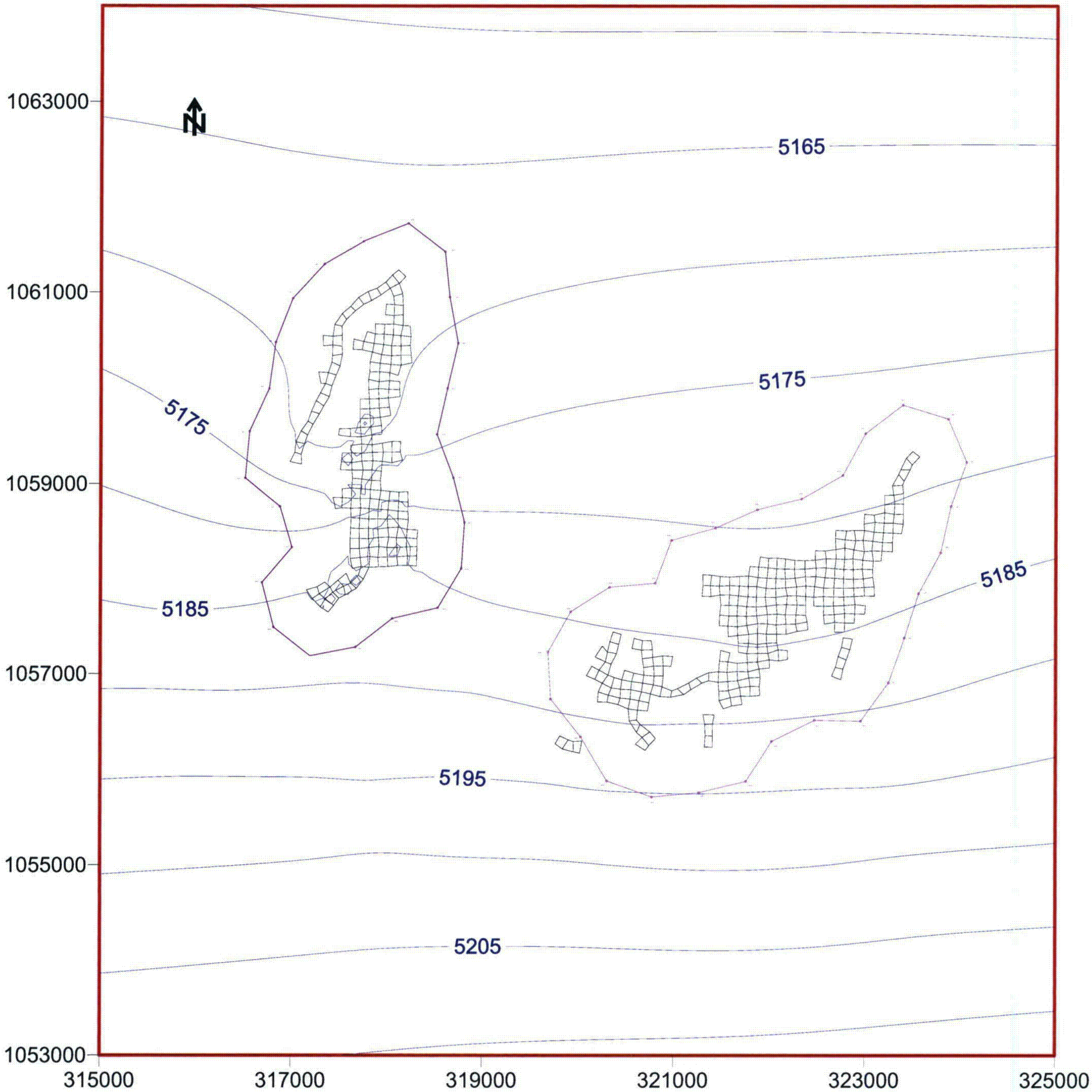
URANIUM ONE

Figure 13. Wellfield One Drawdown (Detail)
End of Second Production Phase
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig13MRProd2.srf Date: 9/19/08



Potentiometric Surface - 70 Sand feet amsl C.I. = 5 feet

Wellfield Patterns

Monitor Well Ring

Simulation of Production From Wellfield One
5 Header Houses, 100 Well Patterns
Production Rate of 2000 gpm for 18 months
Net 1.7% Bleed

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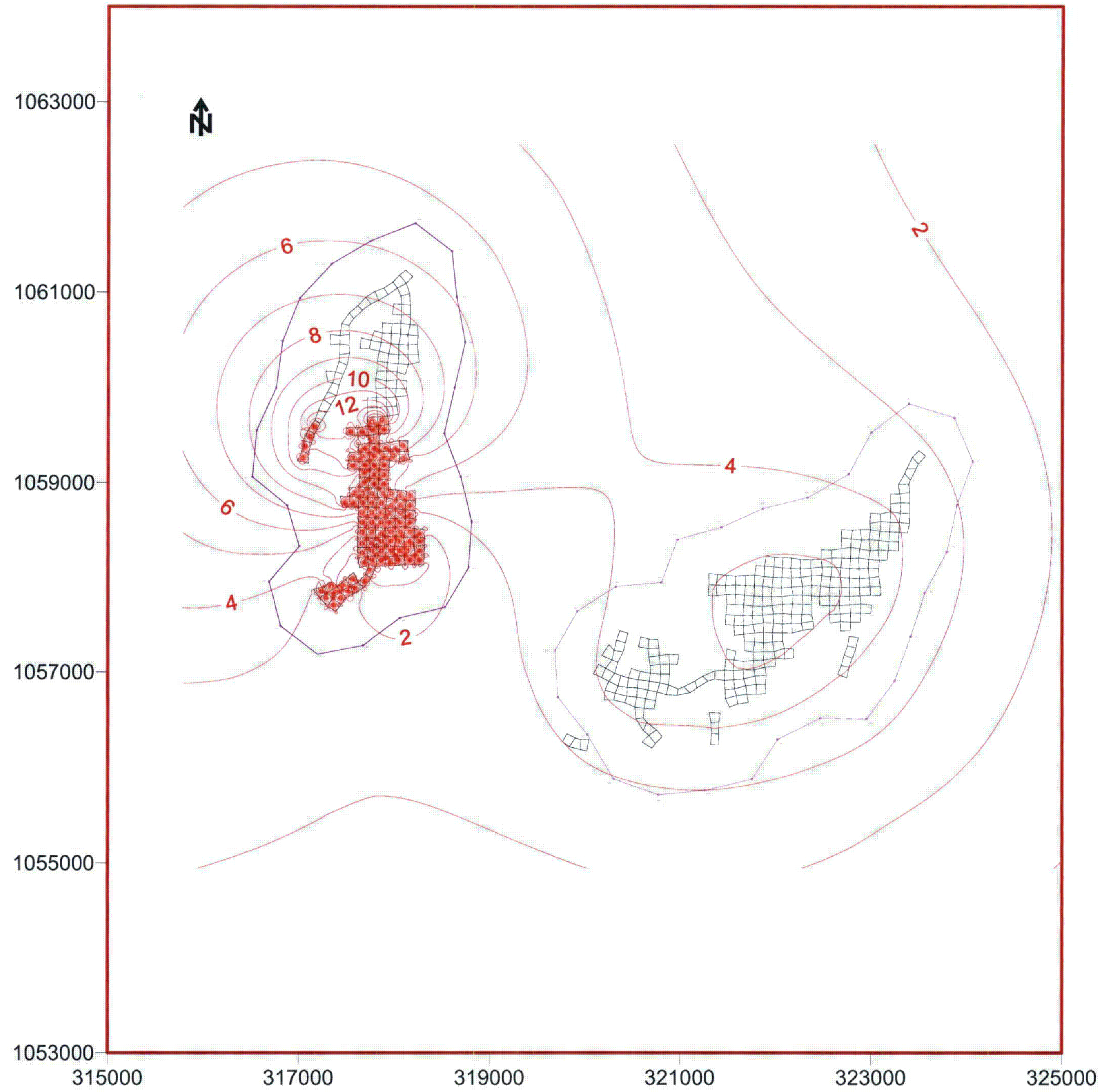
URANIUM ONE

Figure 14. Potentiometric Surface - 70 Sand
End of Third Production Phase
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig14MRProd3.srf Date: 9/19/08



Drawdown - 70 Sand
C.I. = 1 foot

Wellfield Patterns

Monitor Well Ring

Simulation of Production From Wellfield One
5 Header Houses, 100 Well Patterns
Production Rate of 2000 gpm for 18 months
Net 1.7% Bleed

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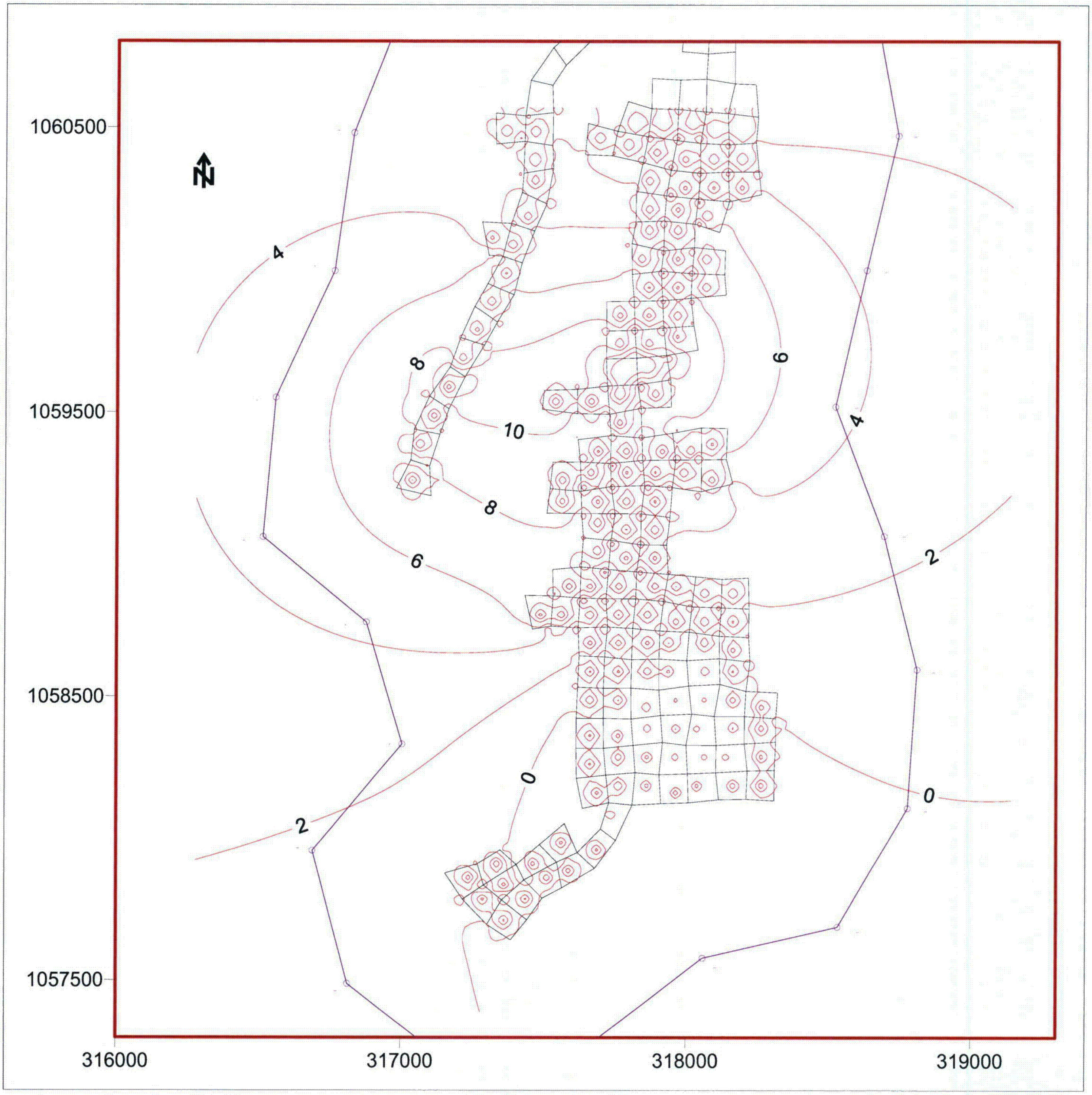
Figure 15. Drawdown - 70 Sand
End of Third Production Phase
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig15MRProd3.srf Date: 9/19/08



Drawdown - 70 Sand
C.I. = 2 feet

Wellfield Patterns

Monitor Well Ring

Simulation of Production From Wellfield One
5 Header Houses, 100 Well Patterns
Production Rate of 2000 gpm for 18 months
Net 1.7% Bleed

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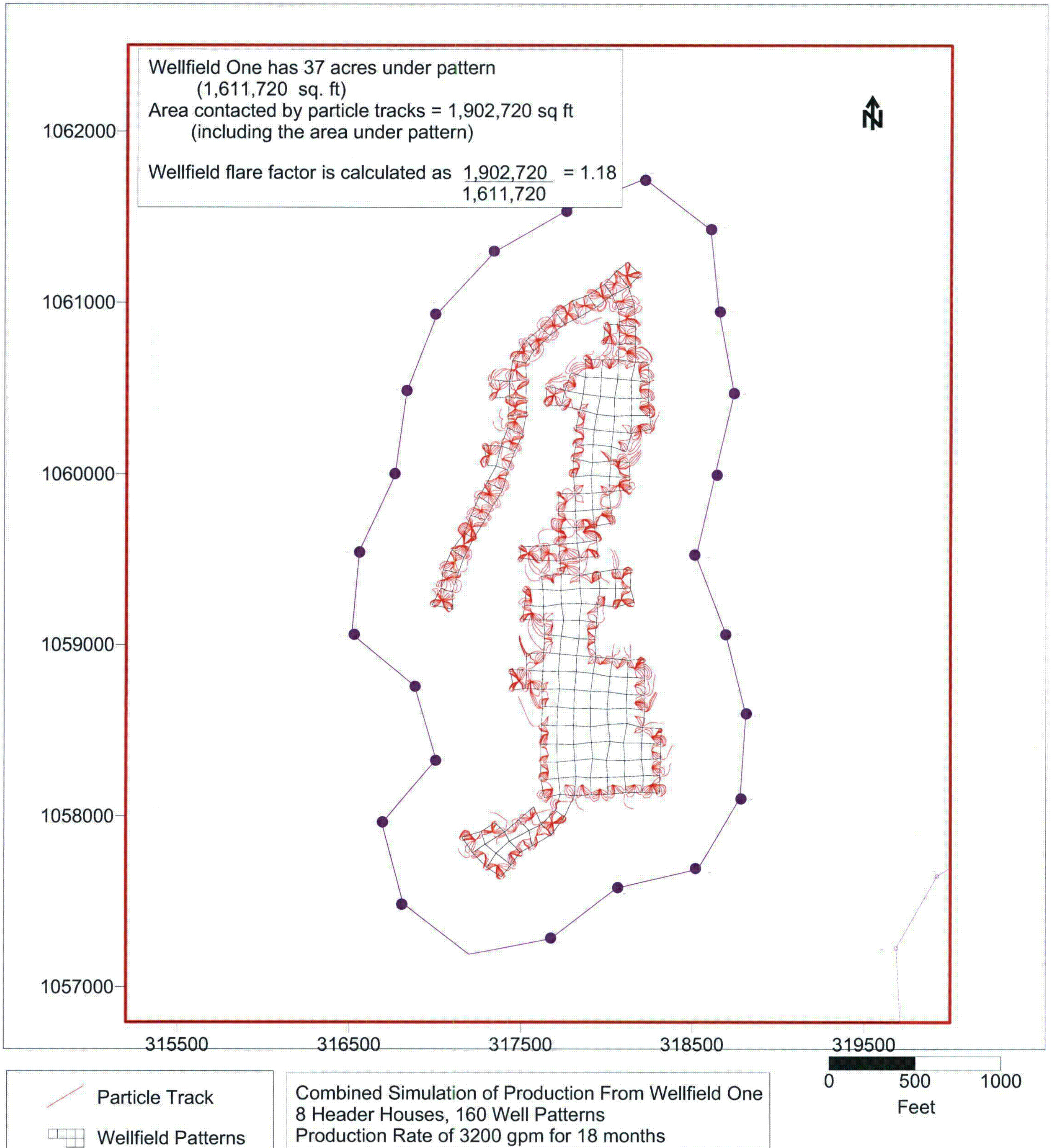
URANIUM ONE

Figure 16. Wellfield One Drawdown (Detail)
End of Third Production Phase
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig13MRProd2.srf Date: 9/19/08



Particle Track
Wellfield Patterns
Monitor Well Ring

Combined Simulation of Production From Wellfield One
8 Header Houses, 160 Well Patterns
Production Rate of 3200 gpm for 18 months

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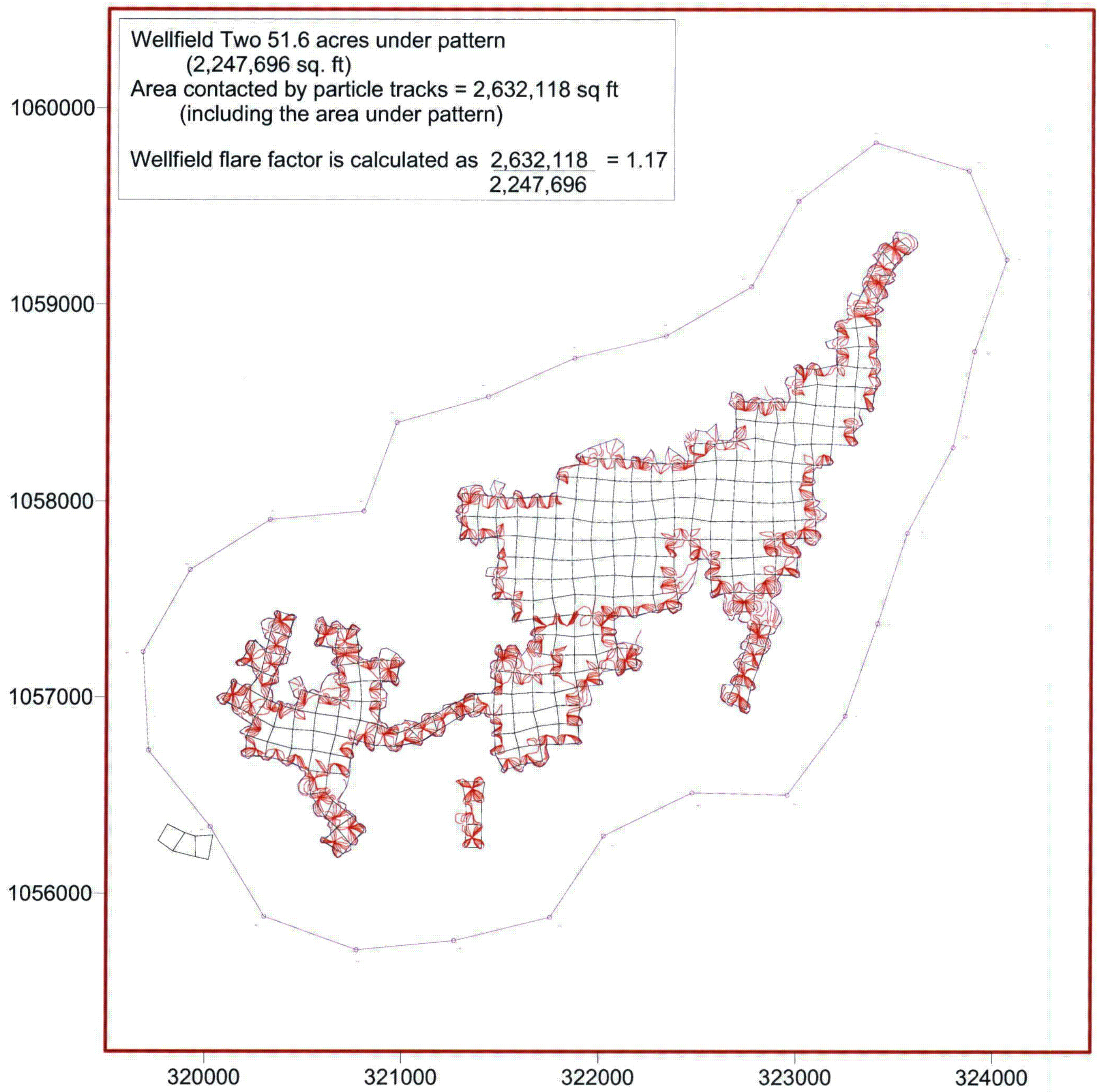
URANIUM ONE

Figure 17 Wellfield One Flare
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig17MRWF1flare.srf Date: 9/19/08



Particle Track
Wellfield Patterns
Monitor Well Ring

0 500 1000
Feet

Combined Simulation of Production From Wellfield Two
11 Header Houses, 229 Well Patterns
Production Rate of 4580 gpm for 18 months

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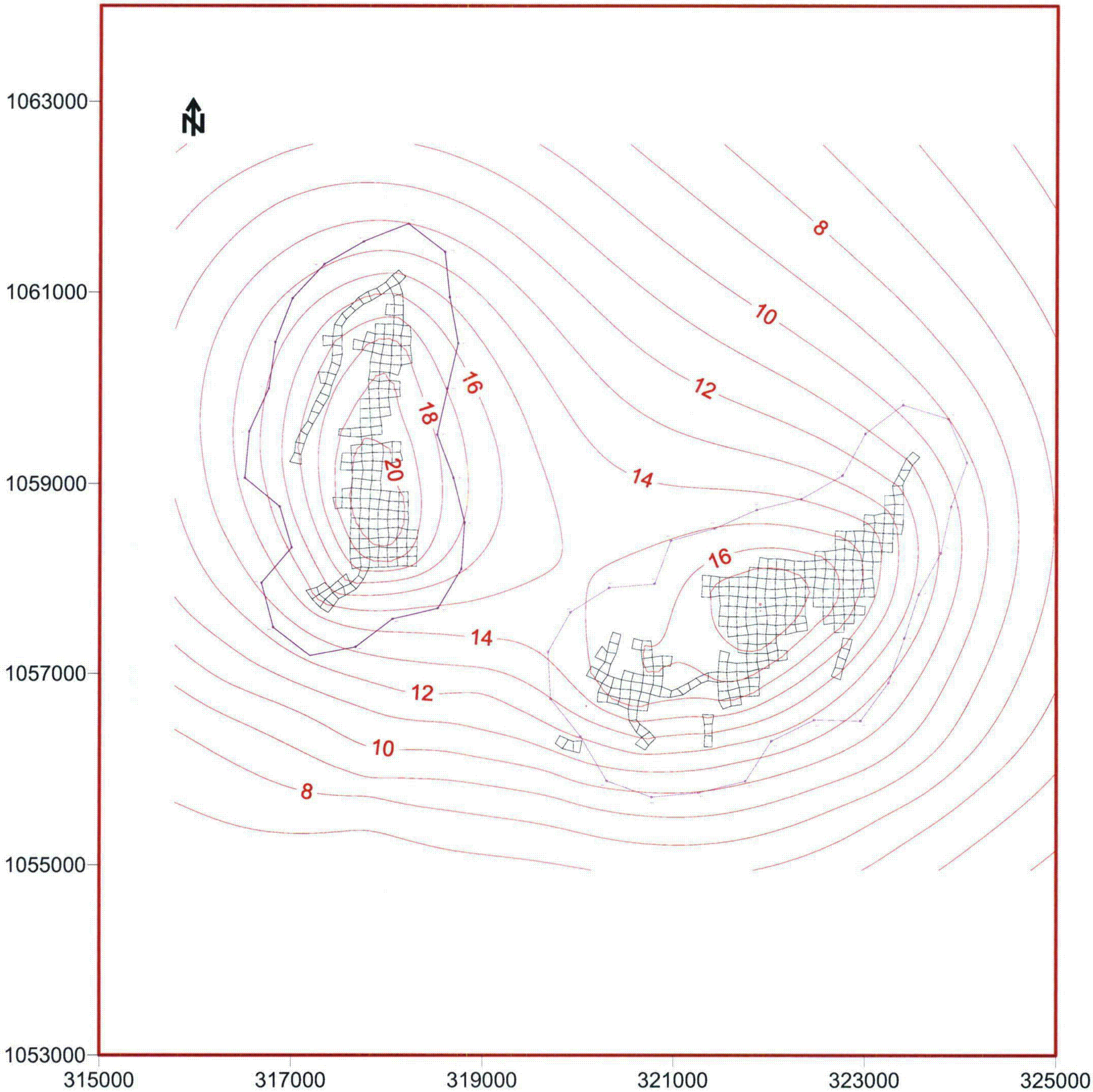
URANIUM ONE

Figure 18. Wellfield Two Flare
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig18MRWF2flare.srf Date: 9/19/08



Drawdown - 70 Sand
C.I. = 1 foot

Wellfield Patterns

Monitor Well Ring

0 1000 2000
Feet

Simulation of Restoration From Wellfields One and Two
Net Withdrawal of 50 gpm per wellfield for 4.33 years

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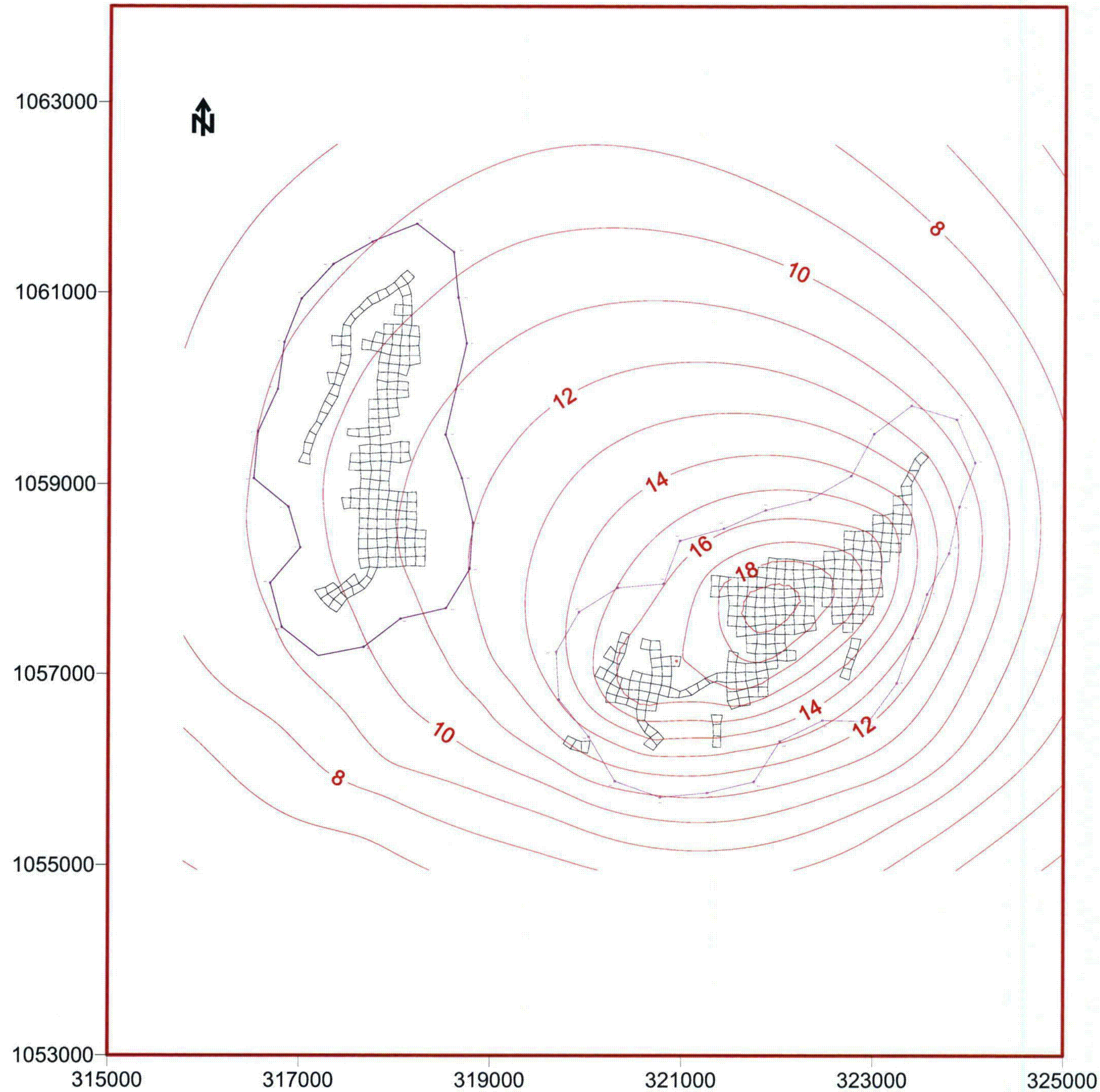
URANIUM ONE

Figure 19. Drawdown - 70 Sand
End of Restoration of Wellfield One
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig19MRRest1.srf Date: 9/19/08



Drawdown - 70 Sand
C.I. = 1 foot

Wellfield Patterns

Monitor Well Ring

0 1000 2000
Feet

Simulation of Restoration From Wellfield Two
Net Withdrawal of 50 gpm for 1.67 years

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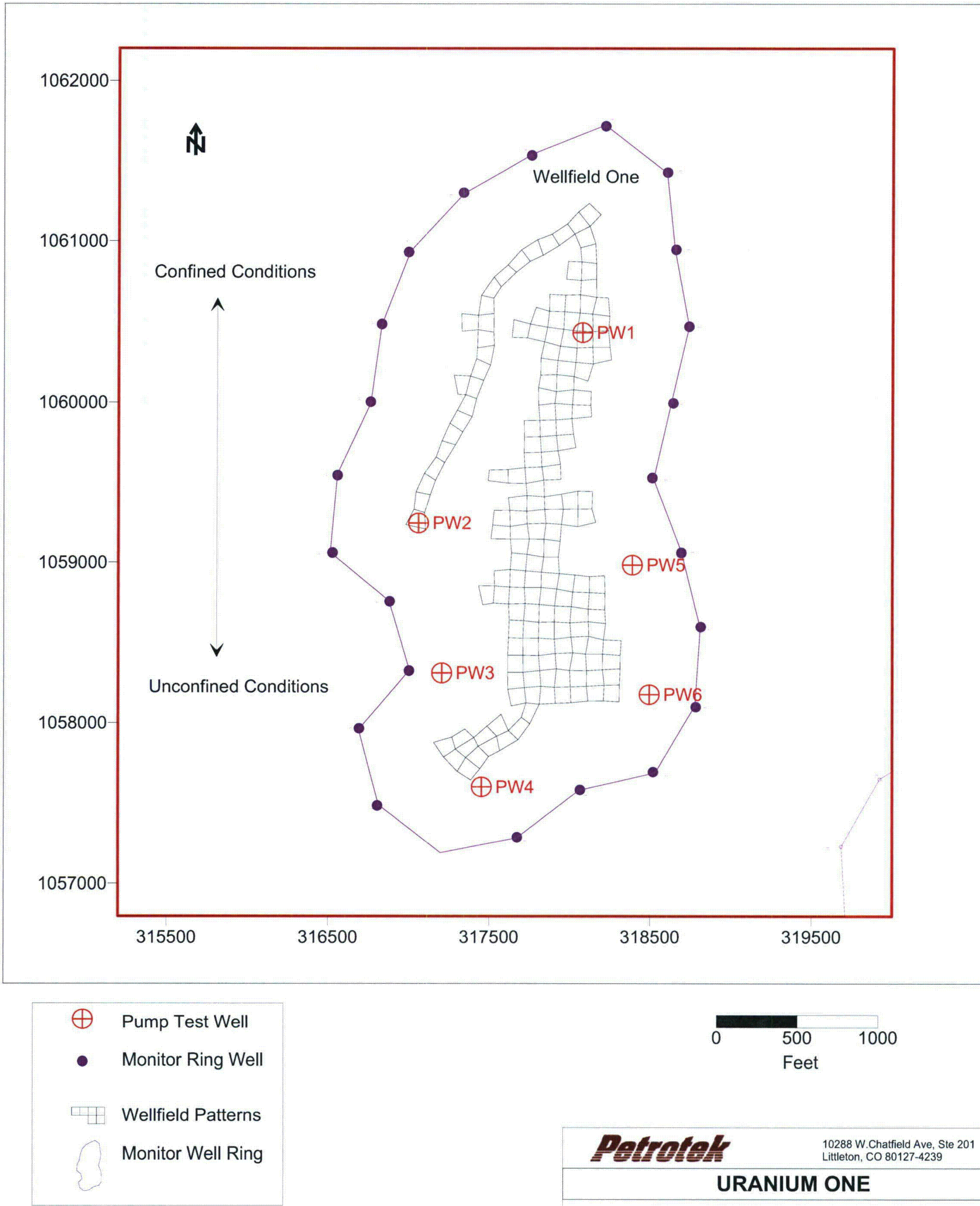
URANIUM ONE

Figure 20. Drawdown - 70 Sand
End of Restoration of Wellfield Two
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig20MRRest2.srf Date: 9/19/08



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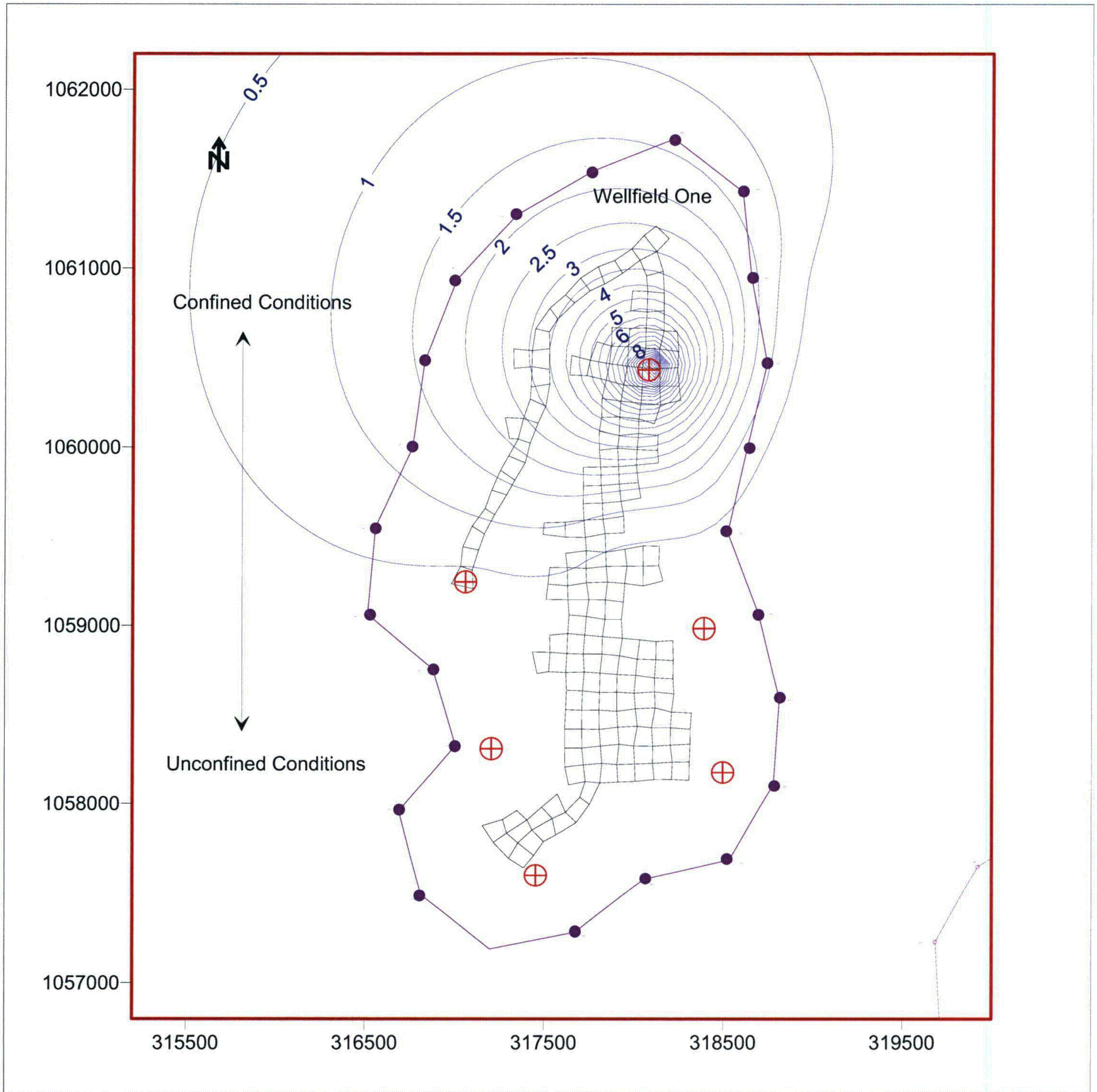
URANIUM ONE

Figure 21. Hydrologic Test Design
Pumping and Monitoring Well Layout
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig21MRWF1HT.srf Date: 9/19/08



- Pump Test Well
- Monitor Ring Well
- Drawdown - End of Test C.I. = 0.5 feet
- Wellfield Patterns
- Monitor Well Ring

0 500 1000
Feet

Simulated Pump Test of One Well at 40 gpm for 5 Days

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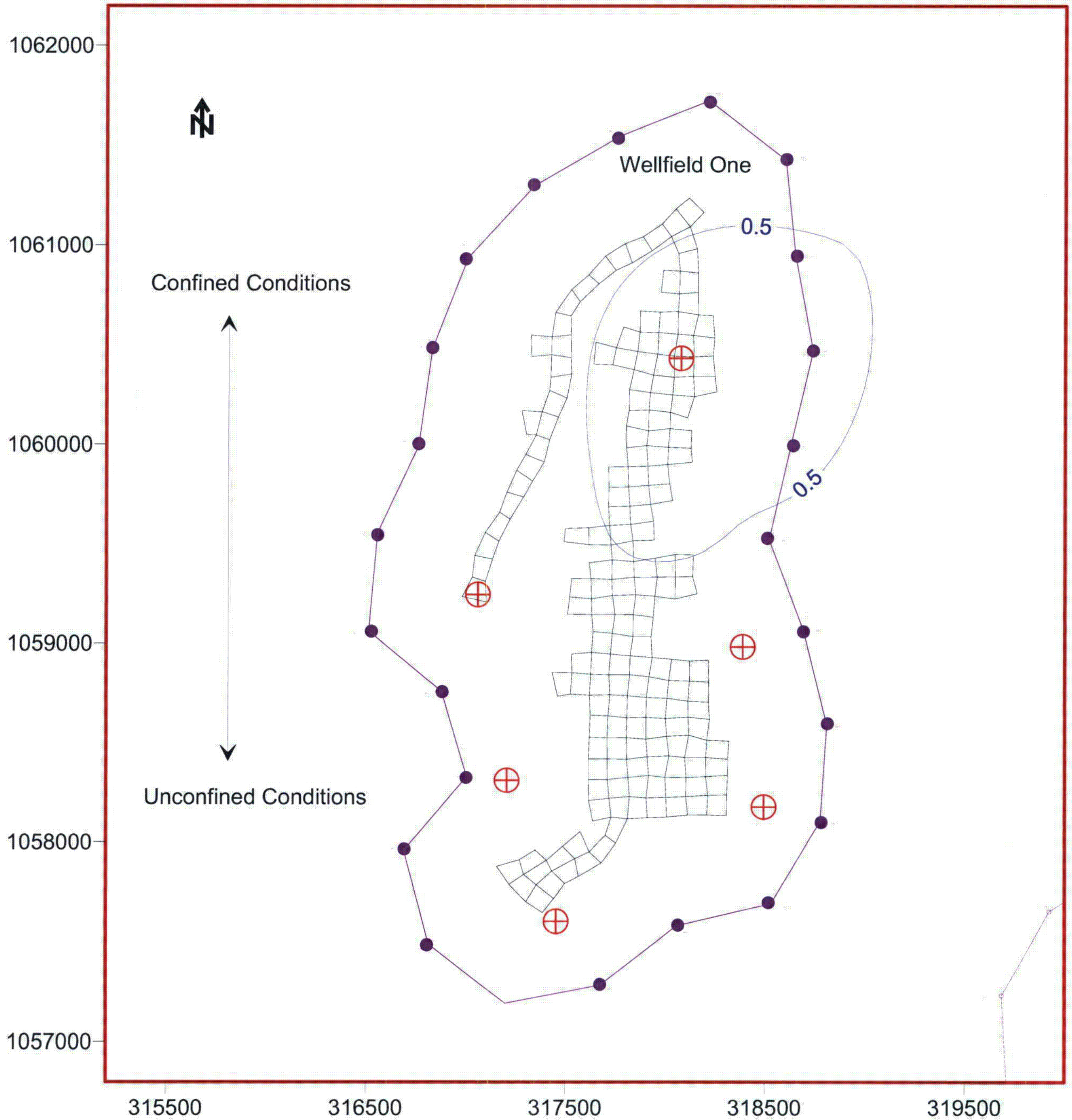
URANIUM ONE

Figure 22. Hydrologic Test Design
Drawdown - End of First Test
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig22MRWF1HT.srf Date: 9/19/08



Pump Test Well

Monitor Ring Well

Drawdown - End of Test
C.I. = 0.5 feet

Wellfield Patterns

Monitor Well Ring

0 500 1000
Feet

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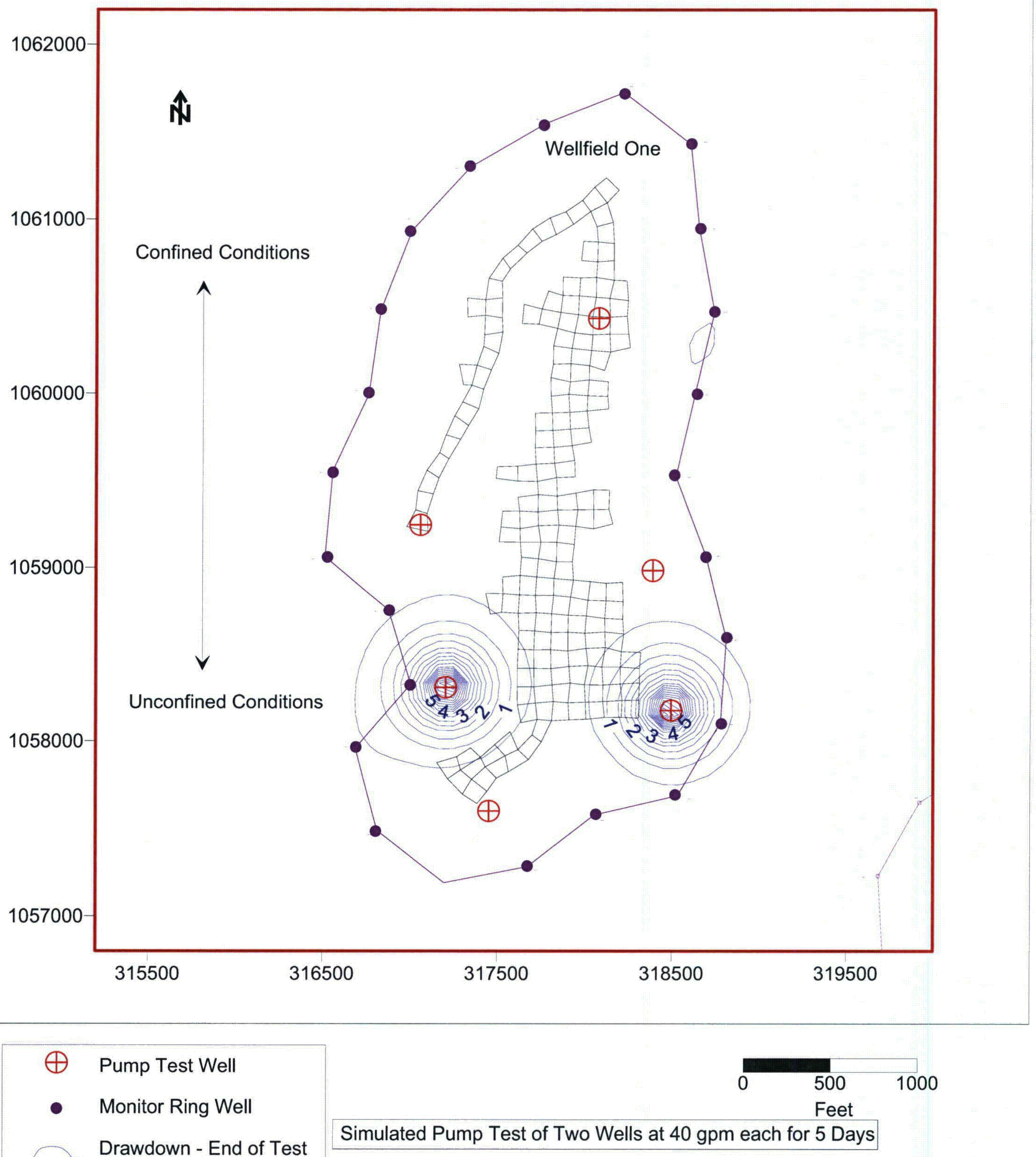
URANIUM ONE

Figure 23. Hydrologic Test Design
Residual Drawdown - End of First Recovery Period
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig23MRWF1HT.srf Date: 9/19/08



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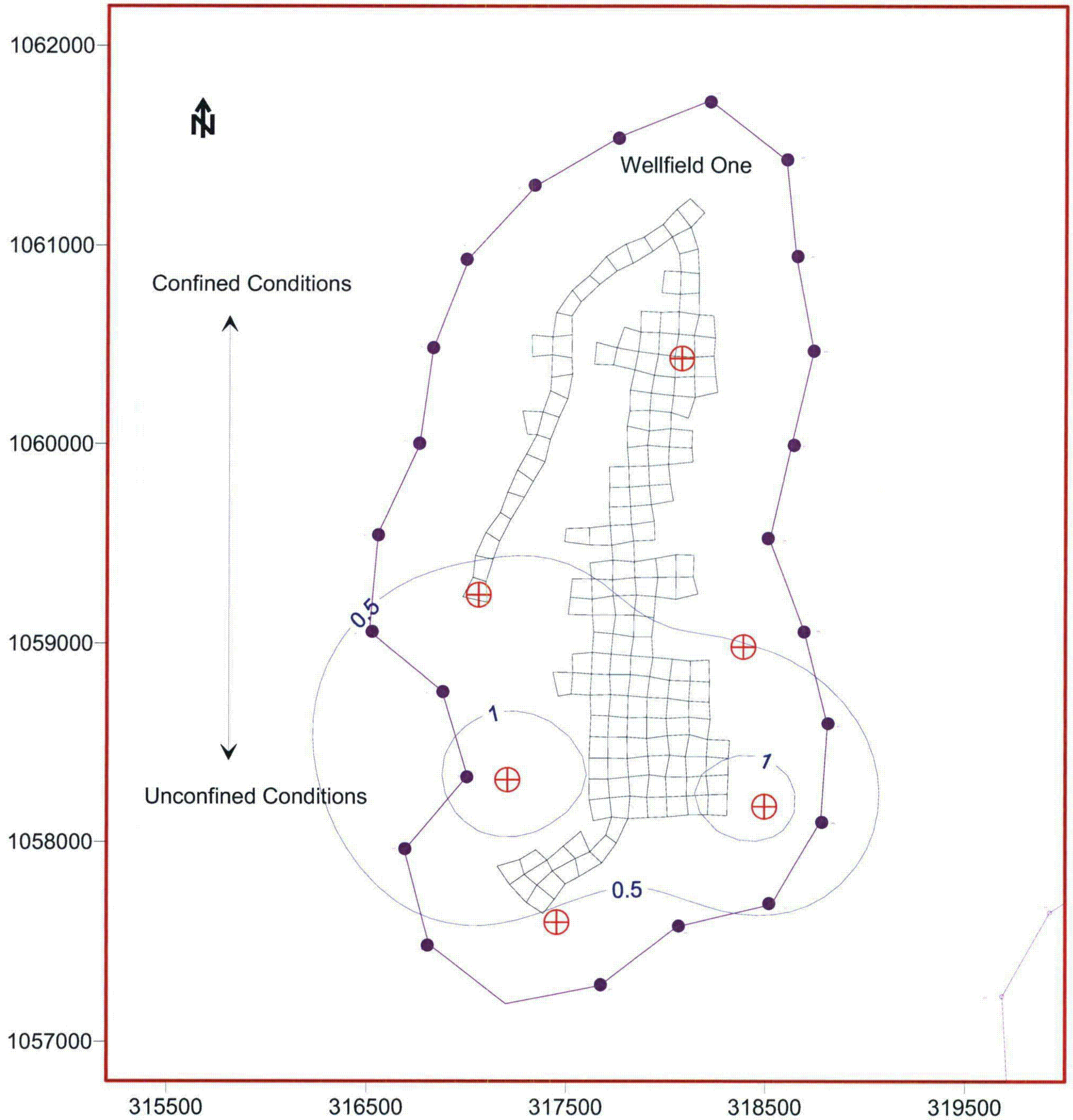
URANIUM ONE

Figure 24. Hydrologic Test Design
Drawdown - End of Second Test
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig24MRWF1HT.srf Date: 9/19/08



Pump Test Well

Monitor Ring Well

Drawdown - End of Test
C.I. = 0.5 feet

Wellfield Patterns

Monitor Well Ring

0 500 1000
Feet

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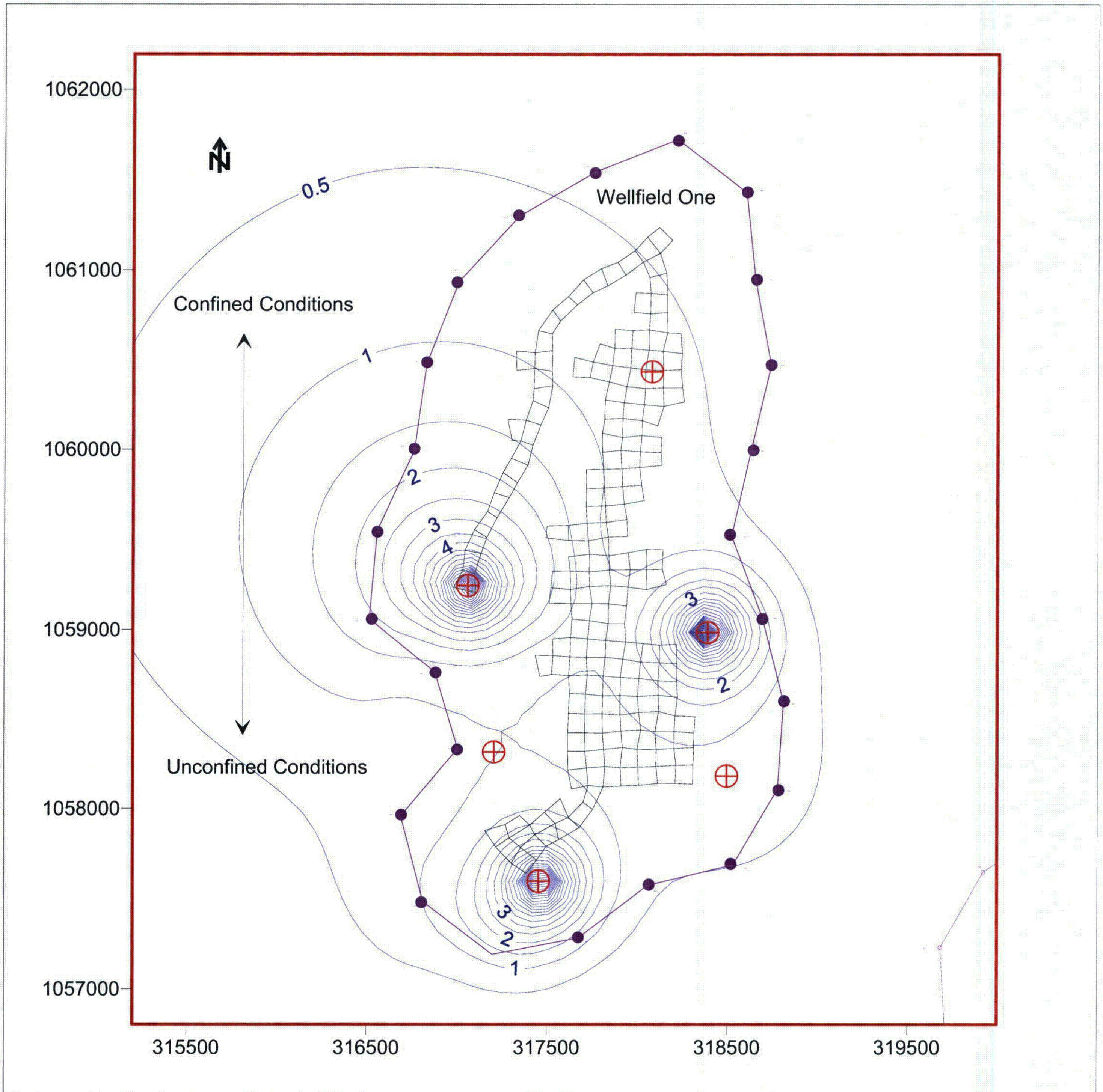
URANIUM ONE

Figure 25. Hydrologic Test Design
Residual Drawdown - End of Second Recovery Period
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig25MRWF1HT.srf Date: 9/19/08



Pump Test Well

Monitor Ring Well

Drawdown - End of Test
C.I. = 0.5 feet

Wellfield Patterns

Monitor Well Ring

0 500 1000
Feet

Simulated Pump Test of Three Wells at 40 gpm each for 5 Days

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URANIUM ONE

Figure 26. Hydrologic Test Design
Drawdown - End of Third Test
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig26MRWF1HT.srf Date: 9/19/08

Table 1. 70 Sand -Top and Bottom Elevation Data from Site Boring Logs
Moore Ranch Uranium Project, Wyoming

Boring ID	Easting	Northing	Surface Elevation	Depth to Top 70 Sand	Depth to Bottom 70 Sand	Elevation Top 70 Sand	Elevation Bottom 70 Sand
1	322735	1052684	5261.0	4	69	5257.0	5192.0
2	319217	1058115	5382.5	195	268	5187.5	5114.5
3	313835	1060651	5372.6	243	298	5129.6	5074.6
4	320145	1057626	5372.9	173	252	5199.9	5120.9
8	313968	1055770	5344.8	186	259	5158.8	5085.8
9	322776	1068012	5424.3	273	355	5151.3	5069.3
17	322123	1058845	5315.0	118	227	5197.0	5088.0
28	314038	1052228	5328.3	124	201	5204.3	5127.3
43	318920	1057050	5350.0	150	196	5200.0	5154.0
62	322922	1059253	5354.0	153	252	5201.0	5102.0
66	315787	1043991	5294.3	50	150	5244.3	5144.3
103	317740	1056850	5303.0	104	169	5199.0	5134.0
106	318140	1056655	5328.0	135	186	5193.0	5142.0
108	317780	1055750	5335.0	107	154	5228.0	5181.0
110	317340	1056650	5308.0	115	175	5193.0	5133.0
111	314794	1059619	5347.0	189	282	5158.0	5065.0
112	315189	1059996	5345.0	181	250	5164.0	5095.0
113	315190	1059193	5337.0	173	266	5164.0	5071.0
115	315178	1058389	5345.0	160	260	5185.0	5085.0
116	314803	1058423	5357.4	185	290	5172.4	5067.4
121	317525	1057458	5316.6	125	196	5191.6	5120.6
124	319924	1057258	5388.4	195	260	5193.4	5128.4
127	319120	1056650	5330.0	144	195	5186.0	5135.0
128	318720	1056650	5330.0	133	185	5197.0	5145.0
129	318525	1056258	5312.5	113	166	5199.5	5146.5
133	319520	1055650	5330.0	122	175	5208.0	5155.0
135	319920	1055850	5350.0	140	190	5210.0	5160.0
182	320334	1057354	5362.2	159	238	5203.2	5124.2
250	322927	1058554	5359.0	140	258	5219.0	5101.0
264	322232	1057551	5305.0	96	184	5209.0	5121.0
269	321426	1057447	5321.0	112	192	5209.0	5129.0
276	317520	1059150	5373.0	196	270	5177.0	5103.0
278	323422	1059157	5368.0	172	264	5196.0	5104.0
324	320926	1056451	5331.0	120	196	5211.0	5135.0
339	322025	1057052	5313.0	96	192	5217.0	5121.0
350	322724	1057453	5310.0	100	182	5210.0	5128.0
367	325321	1055452	5336.0	118	200	5218.0	5136.0
368	325343	1059499	5343.0	134	223	5209.0	5120.0
381	324346	1056708	5345.0	125	227	5220.0	5118.0
382	325325	1056657	5364.0	144	239	5220.0	5125.0
383	317723	1056452	5301.0	109	176	5192.0	5125.0
398	317219	1057958	5327.5	131	198	5196.5	5129.5
433	319924	1056354	5360.0	151	208	5209.0	5152.0
438	316924	1056846	5311.0	108	174	5203.0	5137.0
439	316934	1056438	5303.0	115	174	5188.0	5129.0
441	317322	1056048	5294.0	105	155	5189.0	5139.0
446	322072	1058048	5312.0	105	205	5207.0	5107.0
463	322378	1057764	5306.6	91	183	5215.6	5123.6
497	322877	1057708	5320.3	98	209	5222.3	5111.3
512	318320	1056050	5310.0	115	163	5195.0	5147.0
524	316420	1058800	5325.0	153	229	5172.0	5096.0
525	316820	1058010	5329.3	143	218	5186.3	5111.3

Boring ID	Easting	Northing	Surface Elevation	Depth to Top 70 Sand	Depth to Bottom 70 Sand	Elevation Top 70 Sand	Elevation Bottom 70 Sand
527	316420	1057200	5300.0	119	178	5181.0	5122.0
529	315620	1058400	5330.0	155	240	5175.0	5090.0
531	315620	1056800	5345.0	141	194	5204.0	5151.0
532	315620	1057600	5335.0	135	192	5200.0	5143.0
534	315620	1059200	5325.0	155	235	5170.0	5090.0
543	317520	1059560	5391.4	216	283	5175.4	5108.4
567	315620	1058800	5330.0	159	227	5171.0	5103.0
569	317920	1056050	5330.0	119	169	5211.0	5161.0
622	316028	1058008	5327.6	140	228	5187.6	5099.6
649	322379	1057557	5303.2	89	195	5214.2	5108.2
714	322376	1058105	5304.0	97	202	5207.0	5102.0
759	322167	1057430	5318.7	115	212	5203.7	5106.7
833	317667	1059555	5389.3	209	279	5180.3	5110.3
837	323224	1058208	5343.0	126	235	5217.0	5108.0
840	316422	1058397	5329.0	145	221	5184.0	5108.0
851	316434	1059929	5365.0	195	273	5170.0	5092.0
852	316826	1058310	5329.0	140	215	5189.0	5114.0
864	318025	1057649	5332.0	136	206	5196.0	5126.0
872	320130	1056765	5370.8	171	233	5199.8	5137.8
890	323180	1057711	5340.6	141	230	5199.6	5110.6
944	320124	1056908	5375.7	176	240	5199.7	5135.7
1019	322974	1057253	5323.0	110	200	5213.0	5123.0
1059	323370	1058810	5375.9	183	277	5192.9	5098.9
1207	321827	1058206	5328.0	123	217	5205.0	5111.0
1213	321422	1057107	5324.8	120	207	5204.8	5117.8
1238	320120	1056150	5350.0	147	215	5203.0	5135.0
1287	323570	1057710	5342.8	124	221	5218.8	5121.8
1292	323820	1058750	5385.0	184	279	5201.0	5106.0
1361	320770	1056100	5340.0	120	199	5220.0	5141.0
1366	322520	1056700	5320.0	102	189	5218.0	5131.0
1462	321520	1056350	5320.0	108	175	5212.0	5145.0
1474	321920	1056150	5340.0	87	176	5253.0	5164.0
1522	320670	1057350	5340.0	140	227	5200.0	5113.0
1580	320520	1055960	5348.2	132	204	5216.2	5144.2
1603	320420	1057150	5345.0	152	237	5193.0	5108.0
1621	322170	1055700	5320.0	83	187	5237.0	5133.0
1634	324020	1056061	5329.3	101	176	5228.3	5153.3
1642	321370	1056250	5340.0	110	213	5230.0	5127.0
1713	323164	1056686	5303.0	83	197	5220.0	5106.0
1731	322079	1056590	5316.0	99	193	5217.0	5123.0
4001	321925	1060396	5364.0	168	263	5196.0	5101.0
4005	322346	1059785	5368.0	178	269	5190.0	5099.0
4008	322625	1059558	5375.0	180	266	5195.0	5109.0
4009	323271	1059465	5378.0	181	272	5197.0	5106.0
4012	323580	1059561	5388.0	194	281	5194.0	5107.0
4013	323719	1059167	5389.0	187	277	5202.0	5112.0
4014	323567	1059169	5380.2	179	273	5201.2	5107.2
4016	323123	1058964	5358.0	156	247	5202.0	5111.0
4018	323171	1058520	5370.7	158	268	5212.7	5102.7
4019	323075	1058420	5372.2	165	270	5207.2	5102.2
4021	323025	1058313	5364.2	154	268	5210.2	5096.2
4022	322978	1058210	5352.2	138	251	5214.2	5101.2

Table 1. 70 Sand -Top and Bottom Elevation Data from Site Boring Logs
Moore Ranch Uranium Project, Wyoming

Boring ID	Easting	Northing	Surface Elevation	Depth to Top 70 Sand	Depth to Bottom 70 Sand	Elevation Top 70 Sand	Elevation Bottom 70 Sand
4023	322778	1058206	5338.0	130	233	5208.0	5105.0
4025	322775	1058009	5334.0	121	249	5213.0	5085.0
4028	322673	1057915	5326.5	110	229	5216.5	5097.5
4029	322474	1057908	5319.0	114	204	5205.0	5115.0
4031	322813	1056965	5298.0	89	180	5209.0	5118.0
4032	322466	1057109	5306.0	91	179	5215.0	5127.0
4034	322378	1057308	5308.0	92	187	5216.0	5121.0
4036	321774	1057815	5336.8	125	219	5211.8	5117.8
4037	321576	1057813	5327.7	120	202	5207.7	5125.7
4040	321325	1056708	5334.0	113	206	5221.0	5128.0
4041	321056	1056808	5343.0	128	220	5215.0	5123.0
4043	320676	1056810	5352.0	143	230	5209.0	5122.0
4044	320572	1056760	5352.0	142	229	5210.0	5123.0
4046	320629	1056358	5343.0	133	208	5210.0	5135.0
4048	320519	1055558	5351.4	130	207	5221.4	5144.4
4049	320196	1056735	5368.0	161	231	5207.0	5137.0
4050	322521	1058364	5322.0	111	214	5211.0	5108.0
4054	322891	1058257	5300.0	145	257	5155.0	5043.0
4057	322062	1057821	5318.0	106	196	5212.0	5122.0
4059	321710	1056986	5314.0	103	201	5211.0	5113.0
4061	321362	1056855	5332.0	118	205	5214.0	5127.0
4064	321675	1056763	5317.0	99	189	5218.0	5128.0
4065	321716	1057220	5321.8	107	205	5214.8	5116.8
4066	320979	1057010	5352.7	141	230	5211.7	5122.7
4071	320676	1057711	5348.0	144	233	5204.0	5115.0
4072	320131	1057300	5376.6	178	245	5198.6	5131.6
4074	318069	1058710	5374.5	187	273	5187.5	5101.5
4079	317921	1058205	5344.4	159	209	5185.4	5135.4
4086	317126	1059440	5371.0	190	257	5181.0	5114.0
4089	317874	1059855	5407.8	230	298	5177.8	5109.8
4090	317874	1059963	5412.4	235	309	5177.4	5103.4
4091	320099	1057060	5378.9	178	245	5200.9	5133.9
4091	317867	1060110	5416.6	240	316	5176.6	5100.6
4092	317971	1060201	5424.1	250	324	5174.1	5100.1
4097	317894	1060732	5423.5	260	335	5163.5	5088.5
4100	318289	1060745	5407.4	238	316	5169.4	5091.4
4117	317966	1061116	5413.1	252	325	5161.1	5088.1
4128	318627	1060160	5392.0	210	283	5182.0	5109.0
4129	318906	1060121	5392.0	206	291	5186.0	5101.0
4130	318932	1060317	5397.1	219	292	5178.1	5105.1
4131	318966	1060607	5394.5	214	286	5180.5	5108.5
4132	318851	1059823	5392.3	209	280	5183.3	5112.3
4133	318819	1059631	5398.1	212	287	5186.1	5111.1
4134	319121	1059546	5395.0	208	284	5187.0	5111.0
4135	319071	1059380	5393.1	205	282	5188.1	5111.1
4136	319254	1059331	5394.1	206	268	5188.1	5126.1
4137	319216	1059143	5389.0	202	276	5187.0	5113.0
4138	320572	1056485	5347.0	138	198	5209.0	5149.0
4144	318235	1057967	5345.9	153	209	5192.9	5136.9
4145	319813	1056819	5368.3	173	226	5195.3	5142.3
4146	319427	1056804	5351.0	159	210	5192.0	5141.0
4148	317507	1057979	5331.9	133	204	5198.9	5127.9

Table 1. 70 Sand -Top and Bottom Elevation Data from Site Boring Logs
Moore Ranch Uranium Project, Wyoming

Boring ID	Easting	Northing	Surface Elevation	Depth to Top 70 Sand	Depth to Bottom 70 Sand	Elevation Top 70 Sand	Elevation Bottom 70 Sand
4157	320586	1056926	5351.6	144	239	5207.6	5112.6
4160	317998	1058814	5370.5	182	271	5188.5	5099.5
4162	317806	1059590	5392.2	210	285	5182.2	5107.2
4163	317948	1060311	5423.4	253	327	5170.4	5096.4
4206	319520	1056360	5344.2	138	196	5206.2	5148.2
4208	319420	1056160	5336.2	137	186	5199.2	5150.2
4210	319720	1056160	5350.8	140	190	5210.8	5160.8
4212	318920	1056560	5326.2	140	195	5186.2	5131.2
4213	318320	1057057	5322.3	143	204	5179.3	5118.3
4222	317323	1057358	5327.9	144	210	5183.9	5117.9
4227	317671	1058209	5342.6	149	228	5193.6	5114.6
4230	318372	1058358	5367.8	176	260	5191.8	5107.8
4234	317973	1058532	5360.7	167	245	5193.7	5115.7
4235	317470	1058609	5359.4	170	235	5189.4	5124.4
4237	317672	1058777	5359.3	174	250	5185.3	5109.3
4244	317869	1059375	5387.1	203	282	5184.1	5105.1
4248	317952	1059554	5396.1	216	302	5180.1	5094.1
4253	318330	1060312	5405.9	232	304	5173.9	5101.9
4265	317547	1060755	5424.4	263	338	5161.4	5086.4
4280	316819	1059107	5352.6	167	238	5185.6	5114.6
4282	317113	1058708	5359.5	171	245	5188.5	5114.5
4283	316700	1058619	5338.3	147	222	5191.3	5116.3
4299	317872	1059055	5375.1	191	265	5184.1	5110.1
4322	317465	1059958	5393.5	220	292	5173.5	5101.5
4325	320326	1057553	5365.0	164	243	5201.0	5122.0
4327	321125	1057761	5337.7	133	215	5204.7	5122.7
4330	321476	1058058	5338.0	135	212	5203.0	5126.0
4331	321878	1057900	5334.0	122	215	5212.0	5119.0
4343	323379	1058359	5359.0	148	262	5211.0	5097.0
4346	321571	1055809	5320.0	93	193	5227.0	5127.0
4347	321731	1057501	5333.0	120	213	5213.0	5120.0
4360	318325	1061154	5398.2	230	294	5168.2	5104.2
4370	318320	1059155	5391.6	210	279	5181.6	5112.6
4371	318095	1059040	5379.5	196	270	5183.5	5109.5
4377	318275	1060215	5408.6	233	308	5175.6	5100.6
4378	317498	1061055	5425.8	269	340	5156.8	5085.8
4380	315600	1060540	5359.0	197	269	5162.0	5090.0
4381	315800	1060540	5364.1	203	275	5161.1	5089.1
4382	322350	1060399	5378.0	189	274	5189.0	5104.0
4383	317110	1060350	5393.4	220	303	5173.4	5090.4
4386	317110	1059950	5386.6	212	292	5174.6	5094.6
4388	316931	1059489	5363.3	184	258	5179.3	5105.3
4389	318240	1059925	5420.3	245	318	5175.3	5102.3
4402	318400	1060948	5400.3	230	302	5170.3	5098.3
4407	318416	1058050	5357.4	172	221	5185.4	5136.4
4410	318415	1057525	5341.3	143	225	5198.3	5116.3
4412	318643	1059756	5402.8	222	296	5180.8	5106.8
4413	318814	1059445	5391.3	208	274	5183.3	5117.3
4414	318517	1059406	5403.1	221	298	5182.1	5105.1
4415	318622	1059261	5393.6	209	278	5184.6	5115.6
4419	318420	1058750	5381.3	192	271	5189.3	5110.3
4420	317250	1060755	5411.3	248	324	5163.3	5087.3

Table 1. 70 Sand -Top and Bottom Elevation Data from Site Boring Logs
Moore Ranch Uranium Project, Wyoming

Boring ID	Easting	Northing	Surface Elevation	Depth to Top 70 Sand	Depth to Bottom 70 Sand	Elevation Top 70 Sand	Elevation Bottom 70 Sand
4421	316850	1060755	5400.4	238	318	5162.4	5082.4
4422	317250	1061155	5419.3	260	335	5159.3	5084.3
4423	317251	1061655	5438.7	288	382	5150.7	5056.7
4424	316850	1061655	5441.1	292	386	5149.1	5055.1
4425	316850	1062055	5444.2	312	374	5132.2	5070.2
4446	316651	1062455	5453.0	321	392	5132.0	5061.0
4500	326990	1060668	5334.5	130	208	5204.5	5126.5
4501	326990	1063059	5356.3	167	252	5189.3	5104.3
4502	328607	1063059	5358.5	150	245	5208.5	5113.5
4503	330677	1063056	5349.2	132	231	5217.2	5118.2
4504	326990	1058013	5333.8	110	210	5223.8	5123.8
4505	330500	1058010	5315.4	72	183	5243.4	5132.4
196C	322896	1058086	5333.2	127	240	5206.2	5093.2
4051C	320554	1056623	5350.0	141	211	5209.0	5139.0
584C	321968	1057316	5322.7	108	205	5214.7	5117.7
CBMS-12-12	325953	1048026	5220.0		48		5172.0
CBMS-14	327346	1056005	5318.9	89	168	5229.9	5150.9
CBMS-2	328962	1065170	5367.5	200	285	5167.5	5082.5
CBMS-21-11	321712	1049529	5231.0		49		5182.0
CBMS-23-1	327138	1051568	5306.0	70	125	5236.0	5181.0
CBMS-3	316744	1049529	5244.6	35	105	5209.6	5139.6
CBMS-5	315392	1064308	5482.5	402	454	5080.5	5028.5
JWX-1	313789	1065183	5478.3	399	451	5079.3	5027.3
JWX-2	320048	1065002	5430.7	277	346	5153.7	5084.7
KM-1	323861	1059578	5399.8	212	299	5187.8	5100.8
KM-1	315656	1059616	5344.0	181	248	5163.0	5096.0
KM-12	322027	1059891	5374.0	181	278	5193.0	5096.0
KM-2	318367	1059621	5412.9	234	306	5178.9	5106.9
KM-3	316030	1059399	5350.0	176	260	5174.0	5090.0
KM-3	323757	1057163	5328.0	114	205	5214.0	5123.0
KM-4	316616	1059376	5325.0	172	245	5153.0	5080.0
KM-6	310638	1058455	5381.2	255	340	5126.2	5041.2
KM-7	318110	1059641	5384.6	201	294	5183.6	5090.6
KM-8	321100	1059298	5350.0	160	252	5190.0	5098.0
MW-10	320118	1059390	5367.0	178	252	5189.0	5115.0
MW-5	321453	1056690	5329.0	112	199	5217.0	5130.0
MW-6	323791	1058288	5352.0	150	235	5202.0	5117.0
MW-7	322537	1056310	5312.0	87	177	5225.0	5135.0
MW-8	317925	1057973	5338.2	146	206	5192.2	5132.2
MW-9	317102	1059208	5366.8	182	255	5184.8	5111.8
SW-43	323146	1064510	5403.5	257	330	5146.5	5073.5
UMW-1	320113	1057971	5381.6	180	256	5201.6	5125.6
UMW-2	322645	1057720	5313.1	100	200	5213.1	5113.1
UMW-3	317959	1060551	5429.0	258	334	5171.0	5095.0
UMW-4	318709	1056283	5314.4	118	166	5196.4	5148.4
UMW-6	322725	1055350	5291.8	60	157	5231.8	5134.8
UMW-7	321375	1055351	5339.1	110	203	5229.1	5136.1
UMW-8	318700	1055350	5305.1	102	162	5203.1	5143.1
UMW-9	317400	1055350	5289.5	90	145	5199.5	5144.5
WW-1	323056	1055695	5288.0	51	129	5237.0	5159.0

Table 2. Average Water Level Data, Baseline Monitor Wells
Moore Ranch Uranium Project, Wyoming

Well	Easting (x)	Northing (y)	TOC Elevation	Average DTW	Average WL Elevation
MW-1	320100	1057961	5379.28	191.74	5187.54
MW-2	322635	1057708	5312.40	124.91	5187.49
MW-3	317948	1060543	5428.19	250.87	5177.32
MW-4	318697	1056272	5312.59	115.93	5196.66
MW-5	321452	1056678	5328.85	135.44	5193.41
MW-6	323791	1058277	5352.34	168.95	5183.39
MW-7	322535	1056299	5311.73	118.51	5193.22
MW-8	317921	1057961	5336.06	153.91	5182.15
MW-9	317099	1059198	5366.78	184.83	5181.95
MW-10	320115	1059378	5367.28	185.11	5182.17
MW-11	317693	1061868	5414.43	242.28	5172.15
PW-1	320209	1057961	5373.88	186.77	5187.11
885	317898	1058399	5350.00	164.80	5185.20
888	317910	1058398	5352.00	168.58	5183.43
893	317890	1058318	5348.00	164.64	5183.37
1805	322638	1058047	5332.50	145.59	5186.92
1806	322578	1057946	5324.00	132.87	5191.13
1814	320620	1056541	5345.00	151.43	5193.57
1816	320701	1056501	5343.00	149.34	5193.67
1817	320610	1056752	5350.00	156.63	5193.37

Table 3 Calibration Statistics, Permit Area Model, Moore Ranch Uranium Project, Wyoming

Name	X	Y	Observed	Computed	Weight	Residual
BMW-1	320100	1057961	5188.01	5187.41	1	0.60
BMW-2	322635	1057708	5188.34	5188.38	1	-0.04
BMW-3	317948	1060543	5177.78	5177.42	1	0.36
BMW-4	318697	1056272	5197.17	5195.36	1	1.81
BMW-5	321452	1056678	5193.96	5193.23	1	0.73
BMW-6	323791	1058277	5184.05	5186.20	1	-2.15
BMW-7	322535	1056314	5193.39	5195.00	1	-1.61
BMW-8	317921	1057961	5182.99	5187.64	1	-4.65
BMW-9	317099	1059198	5182.07	5182.90	1	-0.83
BMW-10	320115	1059378	5182.79	5181.51	1	1.28
BMW-11	317693	1061868	5172.42	5172.37	1	0.05
PW-1	320209	1057961	5187.53	5187.42	1	0.11
MW885	317898	1058399	5185.20	5185.67	1	-0.47
MW888	317910	1058398	5183.43	5185.67	1	-2.24
MW893	317890	1058318	5183.37	5186.01	1	-2.64
MW1805	322638	1058047	5185.42	5186.94	1	-1.52
MW1806	322578	1057946	5191.13	5187.34	1	3.79
MW1814	320620	1056541	5193.57	5193.81	1	-0.24
MW1816	320701	1056501	5193.67	5194.06	1	-0.39
MW1817	320610	1056752	5193.37	5192.70	1	0.67

Residual Mean	-0.37
Res. Std. Dev.	1.76
Sum of Squares	64.99
Abs. Res. Mean	1.31
Min. Residual	-4.65
Max. Residual	3.79
Range in Target Values	24.75
Std. Dev./Range	0.07

Table 4. Operational Rates for ISR Production and Restoration Simulation, Moore Ranch Uranium Project, Wyoming

Simulation	Wellfield	Injection Rate	Production Rate	Net Bleed	Bleed (%)	Injection Rate	Production Rate	Net Bleed
		(ft3/d)	(ft3/d)	(ft3/d)		(gpm)	(gpm)	(gpm)
Phase 1 Production	Two	565129	569800	4671	0.8%	2935.5	2959.8	24.3
Phase 2 Production	Two	307788	311850	4062	1.3%	1598.8	1619.9	21.1
Phase 2 Production	One	232253	234850	2597	1.1%	1206.4	1219.9	13.5
Phase 3 Production	One	377229	381150	3921	1.0%	1959.5	1979.9	20.4
Phase 1 Restoration	Two	-	9625	-	-	-	-	-
Phase 1 Restoration	One	-	9625	-	-	-	-	-
Phase 2 Restoration	Two	-	9625	-	-	-	-	-

Table 5. Pore Volume Calculations and Estimates of Restoration Times, Moore Ranch Uranium Project, Wyoming

	Acres	Area (ft^2)	Thickness (ft)	Porosity	Flare Factor	1 PV (ft^3)	1 PV (gal)
Wellfield 1 - 37 acres under pattern	37	1611720	20	0.26	1.44	12,068,559	90,272,824
Wellfield 2 - 51.6 acres under pattern	51.6	2247696	20	0.26	1.44	16,830,748	125,893,992

Assumptions:

Pay Thickness = 20 feet

Porosity = 26%

Flare Factor = 1.44

RO generates 20% reject fluids

Wellfield Production operates at 1% bleed

		WF1	WF2
Rate to Extract 1 PV in 1 year (GWS)	gpm	171.8	239.5
Time to Extract 1 PV at 250 gpm (RO)	years	0.69	0.96
Time to Extract 6 PV at 250 gpm (RO)	years	4.12	5.75

Conversion factors

1 ft^3 = 7.48 gallons

1 acre = 43,560 ft^2