# ADDENDUM 3C:

# HANK NUMERICAL GROUNDWATER MODELING

**July 2010**

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# Acronyms and Abbreviations

| | |
|---|---|
| gpd | gallons per day |
| gpm | gallons per minute |
| ID | inner (inside) diameter |
| ISR | In-Situ Recovery |
| UZF | unsaturated zone flow |
| WDEQ | Wyoming Department of Environmental Quality |
| WY | Wyoming |

# MPH.1 HANK SITE NUMERICAL GROUND-WATER MODELING

Several modeling techniques were employed to evaluate ground-water impacts by the proposed ISR mining operations. The products of this modeling included predictions of operational drawdown, gradient changes, recovery, horizontal wellfield flare, and vertical flare.

The primary modeling approach used a version of the MODFLOW model to evaluate ground-water flow and drawdown resulting from the planned mining operations. The MODFLOW model was developed by the USGS in 1988 and has been updated and revised several times. MODFLOW-2005 (Harbaugh, 2005) was used for modeling of the ground-water system at the Hank Project. MODFLOW-2005 was used for the Hank Project because it has provisions for modeling of unsaturated zone flow (UZF) under unconfined conditions. The names MODFLOW and MODFLOW-2005 are used interchangeably in the remainder of the addendum.

The horizontal flare from an operating ISR wellfield was evaluated with the contaminant transport model MT3DMS (Zheng and Wang, 2006) which utilizes cell by cell flow terms produced by the MODFLOW model. With this coupling to the MODFLOW model, MT3DMS and MODFLOW use a common model domain and configuration to evaluate the transport flare of mining solutions during conveyance between ISR injection and production wells. The use of a convection dispersion equation based numerical transport model allows a fairly sophisticated interpretation of the expected flare that will occur with the proposed injection and collection well operation.

The vertical flare of mining solution was evaluated by compiling multiple runs of an analytical radial well flow model (WTAQ (Barlow and Moench, 1999)) into a spreadsheet based matrix representing a paired ISR injection and extraction well. The WTAQ model incorporates partial penetration of both the injection and extraction wells, allows a large degree of anisotropy in the ratio of vertical to horizontal hydraulic conductivity and utilizes an implementation of the Neuman (1972) solution for unconfined aquifers. Predicted drawdowns from the WTAQ model were then compiled in a spreadsheet, and, using some additional programming to interpret the WTAQ model output, the results were converted to a matrix of heads and velocities for the aquifer interval between the paired wells.

The numerical model was also used to evaluate the potential for retrieval of excursions and the sufficiency of the monitor well spacing. Well stress rates for a local area were adjusted slightly to produce a stronger gradient reversal in simulating the proposed response to a local excursion. The magnitude of the gradient reversal was then compared with baseline simulations to evaluate the effectiveness in retrieval of an excursion.

## MPH.1.1 Hank Project Modeling

MODFLOW-2005 was used to model the ground-water flow prior to, during and after operation of the wellfield(s). A model grid was developed to cover the proposed mine area with a relatively fine grid (30 foot by 30 foot cells) and extending the modeled area with increased cell size to encompass approximately 283 square miles. Injection and production wells were included as well stresses within the fine grid area. MODFLOW-2005 has the capability of modeling partially saturated flow through an unsaturated zone flow (UZF) module, and this was used for the single layer unconfined aquifer Hank model in the area around the active ISR mining. This module allowed incorporation of delayed drainage from the zone above the water table for the aquifer under unconfined conditions.

### MPH.1.1.1 Model Configuration

The single layer model utilized an unconfined aquifer type, with a series of general head boundaries on the perimeter of the model grid. The initial potentiometric head in the ore sand was approximated as a uniform gradient across the model grid areas. This surface was developed using the typical gradient of 0.005 feet/feet and the general gradient is from east to west. The base of the aquifer in the immediate mine area was determined from drill hole based structural mapping. Outside of the mine area, the elevation of the base of the aquifer was extrapolated based on typical structural dip from the available structural mapping. The thickness of the aquifer was established as the typical thickness of 90 feet.

On the periphery of the model grid, selected cells were designated as general head boundary cells to stabilize the potentiometric surface. The head in each of the 106 designated general head boundary cells was set at the initial model head and the cell conductance was set at a relatively high level to provide a generally stable regional potentiometric surface.

#### *MPH.1.1.1.1 Model Grid*

The model grid consists of 274 rows by 98 columns and is rotated approximately 10.5 degrees counterclockwise from the orthogonal directions. The smallest cell dimension is 30 feet by 30 feet, and the largest cell dimension is 13,500 feet by 13,500 feet as shown in Figure MPH.1-1.

#### *MPH.1.1.1.2 Aquifer Properties*

The primary aquifer properties information used in the model included hydraulic conductivity and specific yield. The hydraulic conductivity was set at 1.0 foot/day and an effective specific yield of 0.14. The water level is near the overlying confining layer in some areas of the planned wellfields, and it is likely that a significant portion of the wellfield area will be under unconfined conditions both prior to and during mining. This results in a condition where there is potentially an impact by vertical partially saturated flow from areas where the wellfield bleed causes significant drawdown in the aquifer.

The partially saturated flow conditions require additional definition of hydraulic properties. The UZF module in MODFLOW-2005 utilizes the ratio of vertical to horizontal hydraulic conductivity and a Brooks-Corey function to approximate the hydraulic conductivity under partially saturated conditions. The ratio of vertical to horizontal hydraulic conductivity was estimated at 0.085. The Brooks-Corey function uses an exponent (epsilon) to define the shape of the partially saturated hydraulic conductivity as a function of volumetric moisture content and that was set at 3.5. The effective saturated volumetric moisture content was set at 0.30 and the UZF module uses the specific yield of 0.14 to approximate residual saturation.

#### *MPH.1.1.1.3 Wellfield Configuration*

The proposed mining sequence includes two distinct wellfields with an anticipated mining period of 1½ years for each wellfield. Each wellfield consists of a combination of staggered production and injection wells arranged generally in a line drive layout for the sinuous ore body. The number of wells and well locations are preliminary and will be refined with further definition of the ore body. Because the natural gradient is from east to west, the well arrangement for the typically narrow ore body places the injection wells on the upgradient side of the ore zone with the production wells on the downgradient side of the ore zone. Several model runs were conducted to evaluate horizontal flare, general wellfield operation, and post mining recovery. The model runs and wellfield configuration for the horizontal flare evaluation are described in a following section. Figure MPH.1-2 presents the wellfield #1 production and injection well layout. Figure MPH.1-3 presents the wellfield #2 production and injection well layout.

#### *MPH.1.1.1.4 Operational Parameters*

The anticipated production rates from the wellfield #1 wells range from 12.5 to 12.7 gpm. A total of 198 production wells were included in the full wellfield #1 operation. Total production rate was 2,500 gpm. Injection well operational rates ranged from 5.2 to 12.7 gpm with a total of 271 injection wells. Excess production or bleed rate was set at 3% of total production with a resulting injection rate of 2,425 gpm.

The anticipated production rate from the 93 production wells in wellfield #2 is 26.9 gpm with a resulting total production rate of 2,500 gpm. Injection well operational rates ranged from 15.6 to 20 gpm with a total of 119 injection wells. Excess production or bleed rate was set at 3% of total production with a resulting injection rate of 2,425 gpm.

#### *MPH.1.1.1.5 Stress Periods*

Numerous stress periods were included to allow comparison of predicted aquifer response to the wellfield operations at several times during the simulation period. A transient simulation also requires very small computational time steps after each significant change in aquifer stresses including startup or shutdown of well operation. This is necessary to prevent a failure to converge in the model computation. The initial stress period and time steps were set at a very small value (0.0001 day with 5 time steps) to produce a model output result that essentially reflects initial head conditions. The stress period lengths were then gradually increased until there was a significant change in model stresses, at which the sequence reverted to a short stress period followed by gradually increasing stress period lengths. A total of 12 stress periods were used in a total simulation period of six years which included 1.5 years of operation of each wellfield followed by a three year period of post-mining recovery.

### MPH.1.1.2 Model Results

The MODFLOW model produces output in terms of predicted drawdown or predicted head at selected times within the simulation. The drawdown or water-level rise is calculated as the difference between head at a selected time and the initial head for the aquifer at the start of the simulation. Both results are useful in the interpretation of aquifer response to the mining and are used to evaluate the modeling predictions.

#### *MPH.1.1.2.1 Wellfield #1*

The configuration for wellfield #1 is show in Figure MPH.1-2. The modeled potentiometric surface prior to the start of mining is presented Figure MPH.1-4. The mining operation of the production and injection wells is expected to continue for 18 months, after which mining of wellfield #2 begins. Figure MPH.1-5 presents the predicted drawdown contours for wellfield #1 after one year of operation. Figure MPH.1-6 presents the predicted water-level elevation contours for wellfield #1 after one year of operation. The operation of the wellfield at a bleed rate of 3% of the planned 2,500 gpm production rate has resulted in development of a significant cone of depression around the operating wellfield. The area of gradient reversal extends approximately 800 to 1,300 feet to the west of wellfield #1.

#### *MPH.1.1.2.2 Wellfield #2*

The configuration for wellfield #2 is show in Figure MPH.1-3. The operation of wellfield #2 will begin after mining is completed in wellfield #1. Figure MPH.1-7 presents the predicted drawdown contours for the mine area after 18 months of operation of wellfield #1 and 18 months of operation of wellfield #2. The drawdown calculation is based on water level change from the pre-mining potentiometric surface and this drawdown reflects significant residual drawdown from the operation of wellfield #1. The drawdown at the end of mining shown in Figure MPH.1-7 is very similar to drawdown predictions produced by the analytical model. This similarity between the numerical and analytical model results demonstrates the adequacy of analytical modeling with an appropriate configuration. Figure MPH.1-8 presents the predicted water-level elevation contours for the mine area at the end of mining in wellfield #2. Wellfield #2 is planned to be operated at a bleed rate of 3% of the planned 2,500 gpm production rate. The area of gradient reversal extends approximately 1,200 to 1,600 feet to the west of wellfield #2.

#### *MPH.1.1.2.3 End of Mining*

The end of mining water level changes are reflected in Figures MPH.1-7 and MPH.1-8 as described in the previous section. The planned Hank area ISR project includes two adjacent wellfields operated in sequence for a period of 18 months per wellfield. Wellfield #1 encompasses a larger area, but the effective stress rate of 75 gpm still produces a significant impact on the potentiometric surface. Following cessation of mining in wellfield #1, the potentiometric surface exhibits some recovery in the northern portion of the mining project. Simultaneously, the operation of wellfield #2 causes drawdown in the southern portion of the project area.

## MPH.1.2 Horizontal Flare Evaluation

Horizontal flare around the operating well field was evaluated by modeling transport of a generic solute that was introduced into the injection wells. The MODFLOW-2005 results for a selected ore zone within wellfield #1 were used as a basis for simulating flare of the lixiviant in the operating wellfield.

### MPH.1.2.1 MT3DMS Modeling

The MT3DMS model is a convection-dispersion equation (CDE) based model that utilizes ground-water flow output from the MODFLOW model to simulate solute transport. This is accomplished using a routine in MODFLOW that produces a transfer file that includes cell by cell flow terms. This transfer file is then read by MT3DMS, and the solute transport processes are "superimposed" on the ground-water flow. The MT3DMS has features for solute adsorption, retardation, transformation, degradation, etc., but for this application, the solute was assumed to be conservatively transported and these features were not used.

In order to evaluate the flare, a generic solute was used with an elevated concentration of the lixiviant injectate. The ratio of lixiviant concentration to background concentration was 5, and the background concentration was set at 1.0 for simplicity. The lixiviant concentration was set at 5.0, and the increase in concentration in the area surrounding injection wells was used as the indicator of flare. Because the solute was generic and the magnitude of concentration changes is used to quantify flare, the units of concentration do not affect the evaluation.

#### *MPH.1.2.1.1 Transport Model Configuration*

The model grid, dimensions, and layout are the same as those established in the MODFLOW-2005 modeling.

#### *MPH.1.2.1.2 Wellfield Configuration*

The wellfield utilized in the MODFLOW-2005/MT3DMS modeling was limited to the lower ore zone of wellfield #1, This subset of wellfield #1 included 88 production wells operating at a rate of 12.5 gpm, and 125 injection wells operating at a rate ranging from 5.2 to 12.7 gpm. There was a 3% bleed in the well field operation with a resulting net extraction stress of approximately 33 gpm. The wells included in the horizontal flare modeling are shown along with the approximate boundary of the identified ore body in Figure MPH.1-9

#### *MPH.1.2.1.3 Stress Periods*

Because MT3DMS and MODFLOW-2005 are coupled through a transfer file, the stress periods for MT3DMS are the same as those used in MODFLOW-2005. A modeling period of 120 days was used in the interpretation of horizontal flare. This modeling period was selected as being sufficient to allow establishment of pseudo steady-state solution flow paths and gradients within the operating wellfield, while being a short enough period that the increased gradient reversal with longer operation will not appreciably change or reduce the flare zone. With only a subset of wellfield #1 included in the stress rate, total magnitude of drawdown and corresponding gradient reversal to the wellfield is also conservatively small so there should also be some degree of conservatism in the estimation of flare.

#### *MPH.1.2.1.4 MT3DMS Inputs*

The typical aquifer thickness for the MODFLOW-2005 modeling is 90 feet, but the anticipated completion interval for an ore body is roughly 15 feet. A cell thickness of 15 feet was specified in the MT3DMS model to represent the typical anticipated completion thickness. The effective porosity of the ore zone was estimated at 30%. The dispersivity was set at 2 feet, but it is not considered a critical factor because ISR mining is primarily a pseudo steady-state convection dominated process. The diffusion coefficient was set at zero. As discussed previously, the background generic solute concentration was set at one, with a lixiviant injectate concentration of five.

### MPH.1.2.2 Model Results

The development of the drawdown around the operating wellfield area with the 120 day simulation period results in gradient reversal to the wellfield. Figure MPH.1-10 presents the predicted potentiometric surface for the horizontal flare wellfield operation. On the west side of the wellfield, the zone of gradient reversal generally extends a few hundred feet after 120 days of operation. Since the ore body is irregularly shaped and consists of two separate zones, the potentiometric surface is complex.

The MT3DMS simulation utilized the ground-water flow predictions from MODFLOW-2005 to simulate the transport of the generic solute from the injection wells to the production wells. The results of this simulation are presented in Figure MPH.1-11 as concentration contours centered around the operating injection wells. The contour interval is 0.5 units, and the outer contour is 1.5 times the natural background concentration of the aquifer. This is interpreted as a concentration change representing the extent of the lixiviant flare. In the model cells containing an active injection well, the concentration approaches the injectate concentration of five.

#### *MPH.1.2.2.1 Flare Evaluation*

As shown in Figure MPH.1-11, the combination of radial flow of the lixiviant immediately around the injection wells and the radial capture zone around production wells results in flow paths that extend throughout and slightly beyond the ore body. This horizontal flare is quantified as the ratio of the area contacted by the injectate to the area of the ore body under wellfield pattern (see Figure MPH.1-9). The area contacted by the injectate is represented by the contour line where there is a 0.5 unit concentration increase over the background concentration of 1.0. The ratio of the area within the 1.5 concentration contour to the area of the ore body within the well pattern is 1.39 and this is considered the horizontal flare factor. This flare factor is larger than a more typical estimate of 1.25, and this reflects the relatively narrow linear nature of the ore body and wellfield.

### MPH.1.3 Vertical Flare Evaluation

The vertical flare was estimated using a combination of the WTAQ program to calculate heads through a cross section of the aquifer and a spreadsheet for compositing the heads to evaluate the resulting velocity field. The WTAQ program incorporates a two-dimensional analytic solution for axial-symmetric ground-water flow in both confined and unconfined aquifers. The solution allows simulation of partially penetrating wells for an unconfined aquifer, which is directly applicable for the Hank ISR mining project.

The product of the WTAQ model is prediction of observation well drawdown at specified time(s) after pump start and at specified distance(s) from the pumping well. For an injection well, the drawdown predictions are simply inverted to represent water-level rise. The WTAQ program was run multiple times and the results composited to generate a matrix of drawdown predictions with matrix rows representing one foot of vertical thickness and matrix columns representing radial distance from the well in increments of one foot. The matrix dimensions were 90 rows (90 feet aquifer thickness) by 68 columns (69 feet radial distance from well). The matrix was basically mirrored on a vertical axis to provide a matrix for both an operating injection and production well. The resulting matrices were then incorporated into the spreadsheet to represent a combination of an ISR injection and production well pair at a spacing of 69 feet in a 90 feet thick aquifer.

### MPH.1.3.1 WTAQ Modeling

Inputs to the WATQ model define the completion interval for the simulated production and injection wells, and the required aquifer properties for the solution. Both the production and injection wells were located within a 90 foot thick water table aquifer. Horizontal hydraulic conductivity was 1.0 feet per day, and the ratio of vertical to horizontal hydraulic conductivity was 0.085. The aquifer storage properties included a storage coefficient of 2.1E-06 (ft/ft) and a specific yield of 0.14. The wells were assumed to be completed from a depth of 76 to 85 feet (inclusive) below the top of the aquifer for a ten foot ore body. This represents a likely configuration for a major ore body at the Hank site.

The observation well which represents the general aquifer was assumed to be fully penetrating. Drawdown was simulated for both 10 and 30 days since the start of injection, but only the 30 day simulation was used in the vertical flare analysis. This was considered sufficient time for development of the flow regime. Because the paired well arrangement reduces a typical wellfield arrangement to a simple pair of wells rather than a production well surrounded by multiple injection wells, the anticipated well production rate was reduced to approximately 6.2 gpm to represent the simplified configuration. The multiple runs of the WTAQ program were accomplished with an external shell program that incremented through the depth and distance from the well while compiling the predicted drawdown into the matrix. The matrices were then incorporated into the vertical flare spreadsheet.

### MPH.1.3.2 Vertical Flare Spreadsheet

With the product of the WTAQ program in a matrix of predicted drawdown at one foot intervals in both horizontal and vertical dimensions for the hypothetical vertical cross section, an EXCEL spreadsheet with additional Visual Basic programming was used to evaluate the vertical flare. The matrix of drawdown values was inserted into the spreadsheet to represent the propagation of drawdown from a production well after 30 days of operation. A mirror image of the matrix was used to represent the injection well water-level rise. The summation of the drawdown due to the production well and water-level rise represents the head change in each cell representing a square foot of the aquifer between the wells.

An arbitrary water-level elevation value of 90 feet was added to the water-level change in order to produce a "head" matrix for the cross section between the two wells. This head matrix then allowed calculation of both a horizontal and vertical ground-water velocity for each cell using the head in surrounding cells to calculate a gradient. When combined with the horizontal and vertical hydraulic conductivities of 1.0 ft/day and 0.085 ft/day, respectively, the horizontal and vertical Darcy velocities can be calculated.

#### *MPH.1.3.2.1 Velocity Field*

The velocity field for the simple well configuration is used to interpret vertical flare. Because the differential between horizontal and vertical hydraulic conductivity is large, the vertical velocity is reduced very quickly with small vertical distance from the completion interval. The horizontal and vertical ground-water velocity tabulations in the two dimensional field are presented in Figure MPH.1-12. The tabulations are abbreviated to show only the lower portion of the aquifer where there is active injection and production. The vertical and horizontal velocities are presented in units of feet per day. The well completion is shown as the larger diameter interval in the schematic at each end of the section.

The direction of the vertical velocity is indicated by the sign with a positive value indicating upward flow and a negative value indicating downward flow. In close proximity to the injection well, the larger head values within the completion interval produce upward and downward flare. With increasing distance from the injection well, there is a gradual convergence from intervals above and below the completion interval to the completion interval. Near the production well, the vertical convergence to the completion interval becomes stronger.

The horizontal ground-water movement is from the injection well to the production well. The horizontal velocities are greatest near the injection and production wells because of the radial flow representation of the drawdown values produced by WTAQ. The radial flow calculation also results in a variable area represented by each column in the matrix. Each column can be viewed as one-half of a cylinder with a radius of the distance from the nearest of the two wells, and this makes the area proportional to the square of the radius. Hence, the calculation of composite flare is weighted to the square of the radius from the wells.

#### *MPH.1.3.2.2 Flare Evaluation*

The vertical flare is calculated as a ratio of the area (or volume) of the aquifer wherein there is a significant vertical velocity away from the completion interval to the actual completion interval. This area or volume is calculated as the thickness of cells in each column where the magnitude of the vertical velocity is significant multiplied by the fraction of the area/volume represented by each column in the matrix. Figure MPH.1-12 presents the vertical velocity matrix with a red boundary line indicating the 10 foot thick ore zone and cells above and below the ore zone where the velocity is 0.05 feet/day or greater away from the ore zone. Horizontal velocity is typically an order of magnitude or more larger than the vertical velocity and the threshold velocity boundary shown for a velocity is 0.50 feet/day or larger. The bounded area for horizontal velocity also includes the entire 10 foot thick ore zone, but does not include horizontal velocity greater than 0.50 feet/day where the vertical flow is convergent to the ore zone.

The proportional area/volume represented by each column increases with distance from the injection well or production well to a maximum at the midpoint between the injection and production wells. The column closest to the injection well represents only 0.043% of the area/volume included in the model, and each of the two columns bridging the midpoint between the wells represents 2.9% of the area/volume.

The number of cells included in each column that were within one or both of the bounded areas shown on Figure MPH.1-12 were summed and then multiplied by the fraction of the area/volume represented by the column. These products of cell counts and fractional area/volume where then summed and divided by the corresponded cell counts for the ore zone only. This ratio represents the estimated vertical flare for the specified configuration, and was calculated as 1.22. This is similar to the industry standard vertical flare of 1.25. Although there are necessary simplifications and uncertainties involved in this simulation approach, the results are reasonable and consistent with vertical flare estimates from existing ISR operations.

### MPH.1.4 Excursion Control and Retrieval

The potential for excursion was considered in a MODFLOW-2005 modeling scenario by adjusting modeling parameters to produce a temporary and local imbalance in wellfield operation. The imbalance involves either insufficient production rate or excess injection rate for a local area such that the local bleed rate is zero or actually negative representing more injection than production. Limiting this condition to a local area of a few wells is considered appropriate because a wider scale imbalance with insufficient bleed is unlikely given continuous monitoring of production and injection rates.

Simulation of retrieval of an excursion is essentially a reversal of the process that created the excursion. Increasing the effective bleed rate for a local area will increase the local drawdown and cause an expansion of the area of gradient reversal. Within this zone of gradient reversal, ground water will be flowing to the production wells and any ground water that has been impacted by mining fluids will be retrieved.

#### MPH.1.4.1 MODFLOW Modeling Changes

The MODFLOW-2005 modeling configuration described in Section MPH.1.2 was used for the simulation of excursion and retrieval. The model included a wellfield for the lowest ore zone and consisted of 88 production wells operating at a rate of 12.5 gpm, and 125 injection wells operating at a rate ranging from 5.2 to 12.7 gpm. There was a 3% bleed in the well field operation with a resulting net extraction stress of approximately 33 gpm.

In order to simulate a local imbalance, the extraction rate for the four southernmost production wells was adjusted for two separate simulations. The first simulation included operation of the wellfield in a balanced condition for 30 days, followed by 30 days of operation with reduced production rates for the four southernmost production wells to produce a local imbalance. This was in turn followed by a 30 day period with increased production in the four designated wells to affect retrieval and restore gradient reversal. The magnitude of rate changes (both decrease and increase) was 1.04 gpm for each of the four wells. This is approximately an 8% change in the well production rate for the four wells, but only resulted in a wellfield bleed rate range of 2.6 to 3.4% of total wellfield production. The second simulation used the same sequence of balanced, decreased production, and increased production from the wellfield, but utilized a 60 day period for each of the phases.

#### MPH.1.4.2 30 Day Excursion and Retrieval Simulation

The results of a MODFLOW-2005 simulation of 30 days of normal wellfield operation are presented in Figure MPH.1-13. The cone of depression around the wellfield is expanding, and on the west side of the southern end of the wellfield, the area of gradient reversal extends more than 400 feet from the wellfield. At the end of the initial 30 day period, the production rates were reduced for four wells on the southern end of the wellfield. The potentiometric surface after 30 days of operation with this local imbalance is presented in Figure MPH.1-14. The reduction of production rates for this simulation has resulted in loss of the gradient reversal and a very flat potentiometric surface west of the southern end of the wellfield. The width of the zone where the gradient reversal is lost is more than 500 feet, and based on the very small ground-water gradient in this area, an excursion is possible but movement rates would be extremely slow. Based on the surface presented in Figure MPH.1-14, the potential excursion of mining fluids would also be spread over a width that is approaching the width of the interval where gradient reversal is lost. Figure MPH.1-15 presents the potentiometric surface after an additional 30 day stress period with increased well production rates. The gradient reversal has been regained and extends approximately 400 feet to the west of the wellfield. This indicates that retrieval will be effective, but the gradient reversal is still relatively mild and the rates of both excursion and retrieval will be slow.

### MPH.1.4.3 60 Day Excursion and Retrieval Simulation

The second simulation used a period of 60 days for normal wellfield operation followed by 60 days with a local wellfield imbalance with a subsequent 60 days of overproduction in the affected area. After 60 days of balanced wellfield operation, there is distinct gradient reversal west of the wellfield. After an additional 60 days with local imbalance the potentiometric surface shown in Figure MPH.1-16 indicates that gradient reversal has been lost and that a very flat potentiometric surface extends for approximately 400 feet west of the southern end of the wellfield. When the production rates are increased to retrieve any mining fluid impacted ground water moving to the west of the wellfield, gradient reversal is regained within 60 days as shown in Figure MPH.1-17. The zone of restored gradient reversal extends beyond 500 feet from the edge of the wellfield.

### MPH.1.4.4 Discussion of Excursion Model Results

The excursion and retrieval simulations indicate that development of excursion conditions under moderately imbalanced wellfield conditions will be relatively slow, and that regaining gradient reversal will also be a slow process. This is attributed in large part to the expected unconfined conditions for the Hank wellfield areas. The large volume of ground water released or stored with a unit change in head greatly extends the time frame for significant gradient changes. The width of the zone over which gradient reversal is lost is also relatively wide at approximately 500 feet. Mining fluids that are migrating away from the active wellfield will be spread over a width that is approaching the width of the area where gradient reversal is lost, and there will be additional flare as the impacted ground water moves away from the wellfield. This indicates that the anticipated monitoring ring well spacing of 500 feet will be sufficient to detect potential excursions.

## MPH.2 REFERENCES

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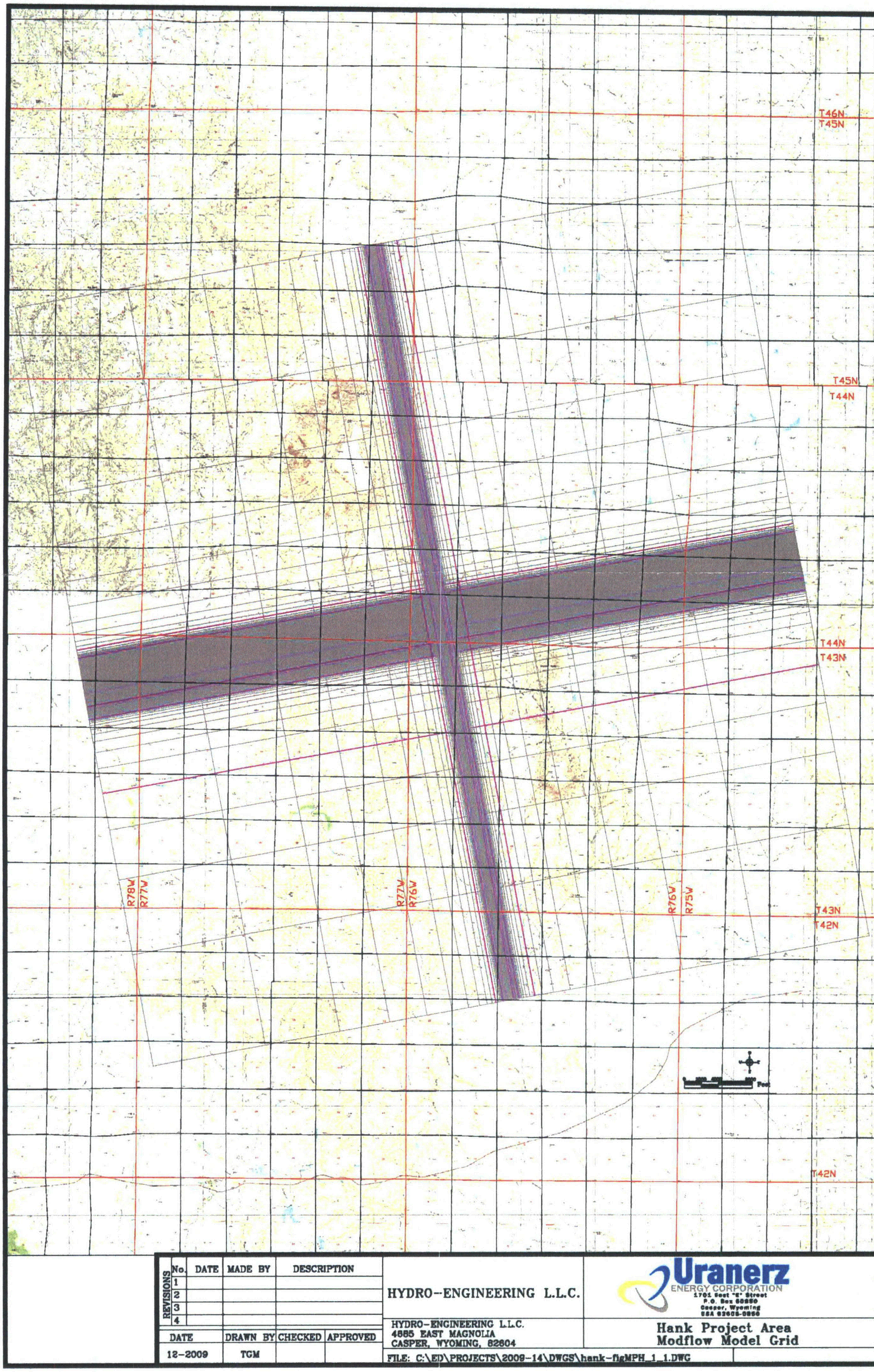



Figure MPH.1-1. Hank Project Area Modflow Model Grid

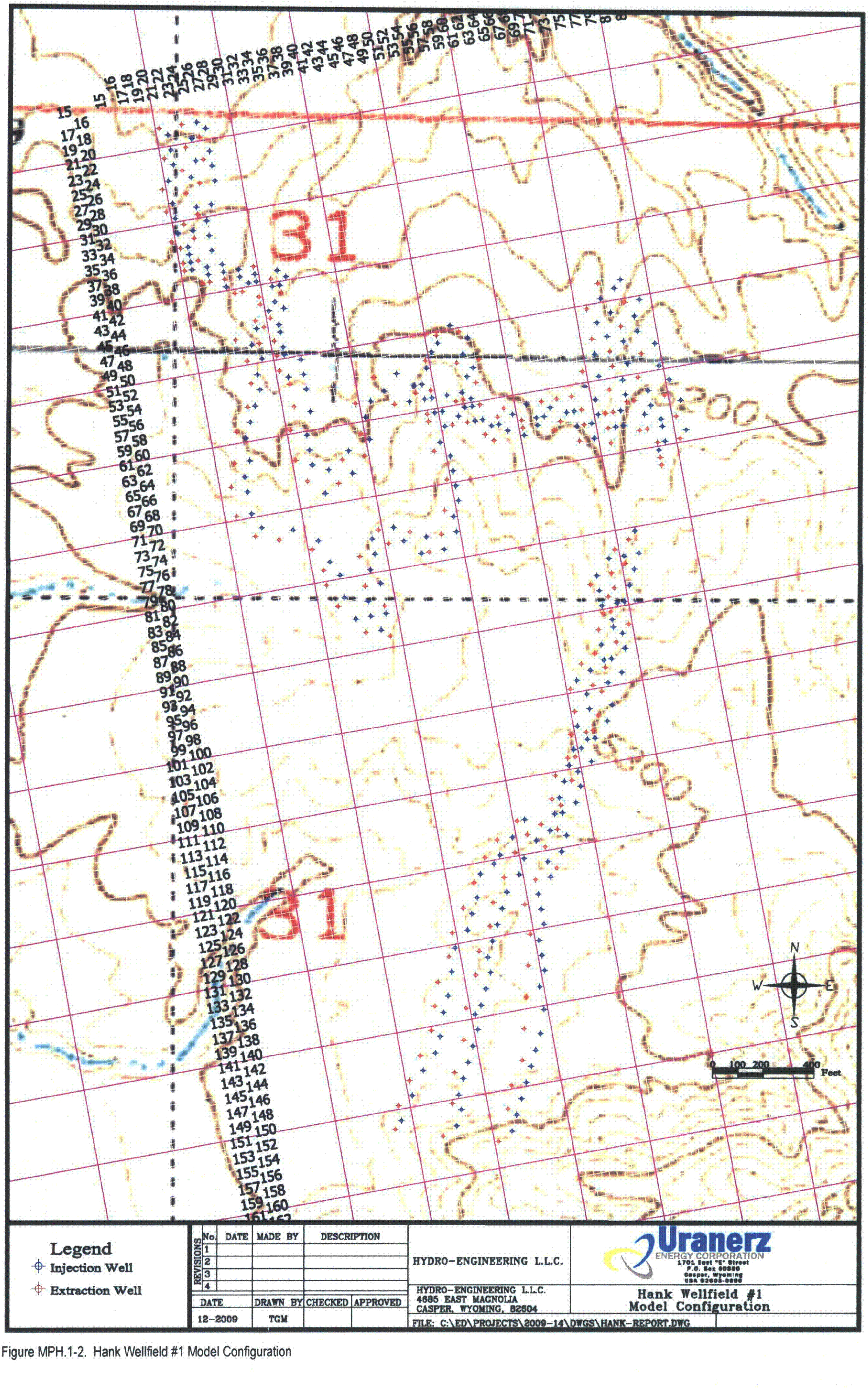



Figure MPH.1-2. Hank Wellfield #1 Model Configuration

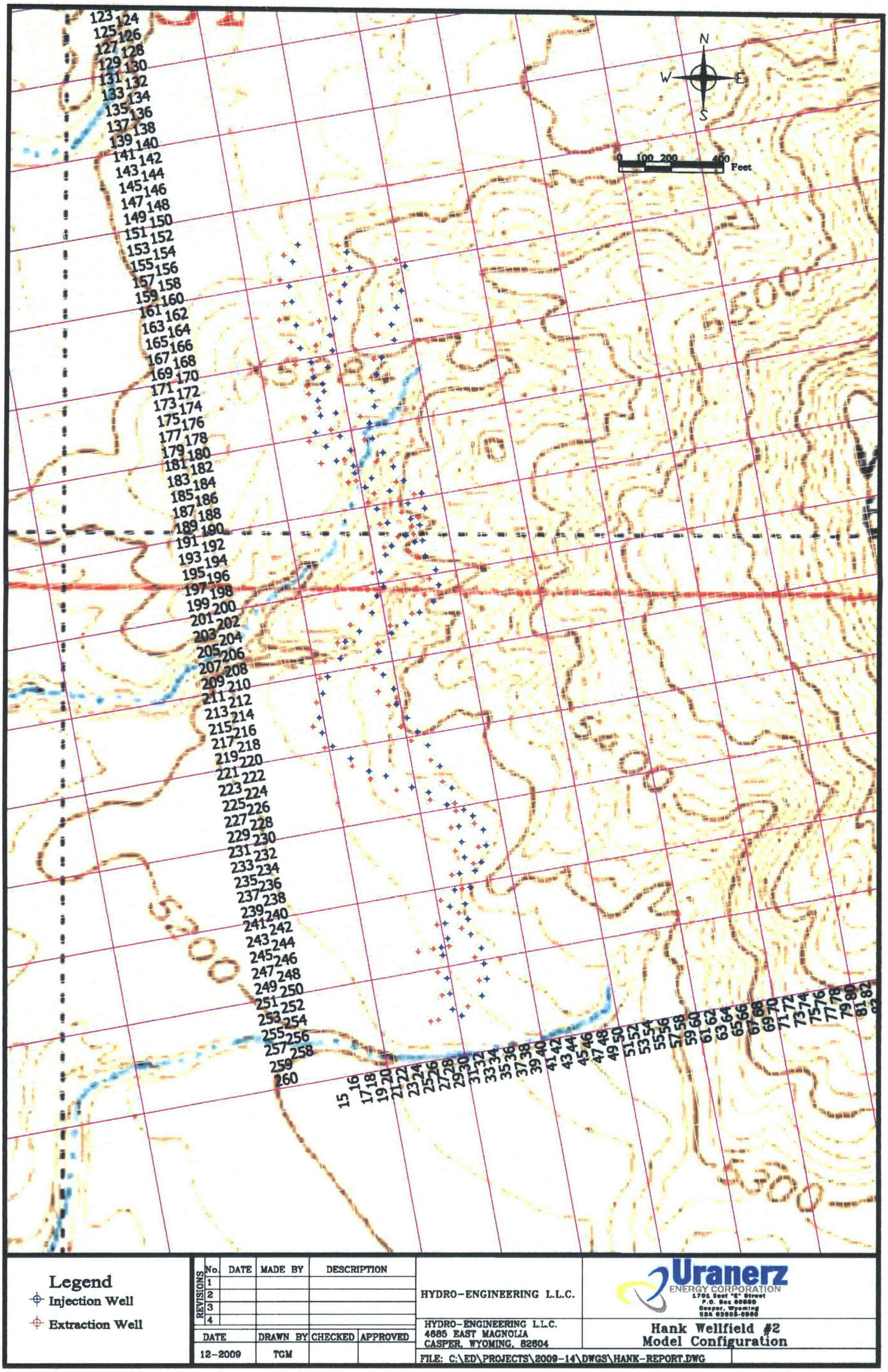
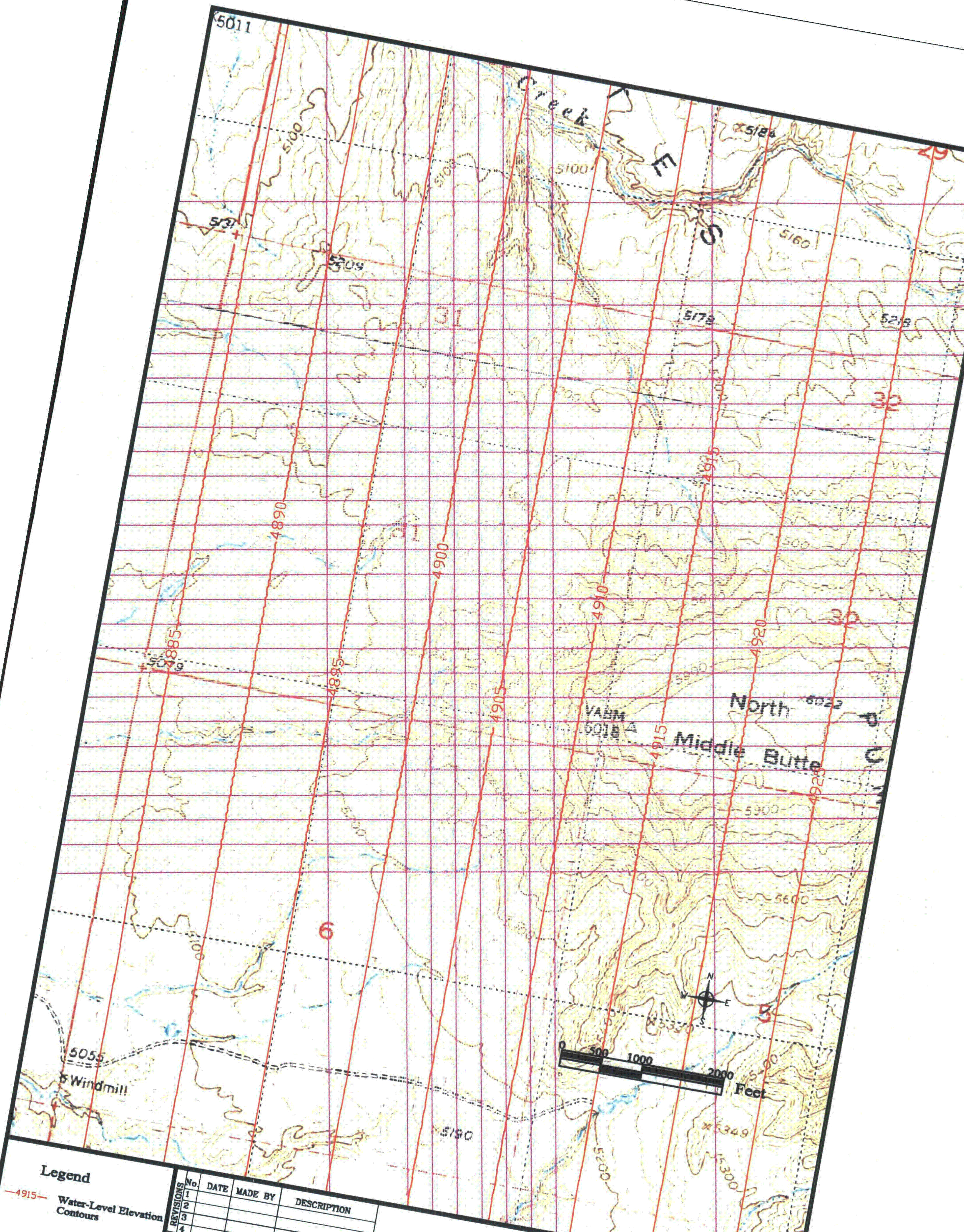



Figure MPH.1-3. Hank Wellfield #2 Model Configuration




...re MPH.1-4. Initial Hank Area Potentiometric Surface

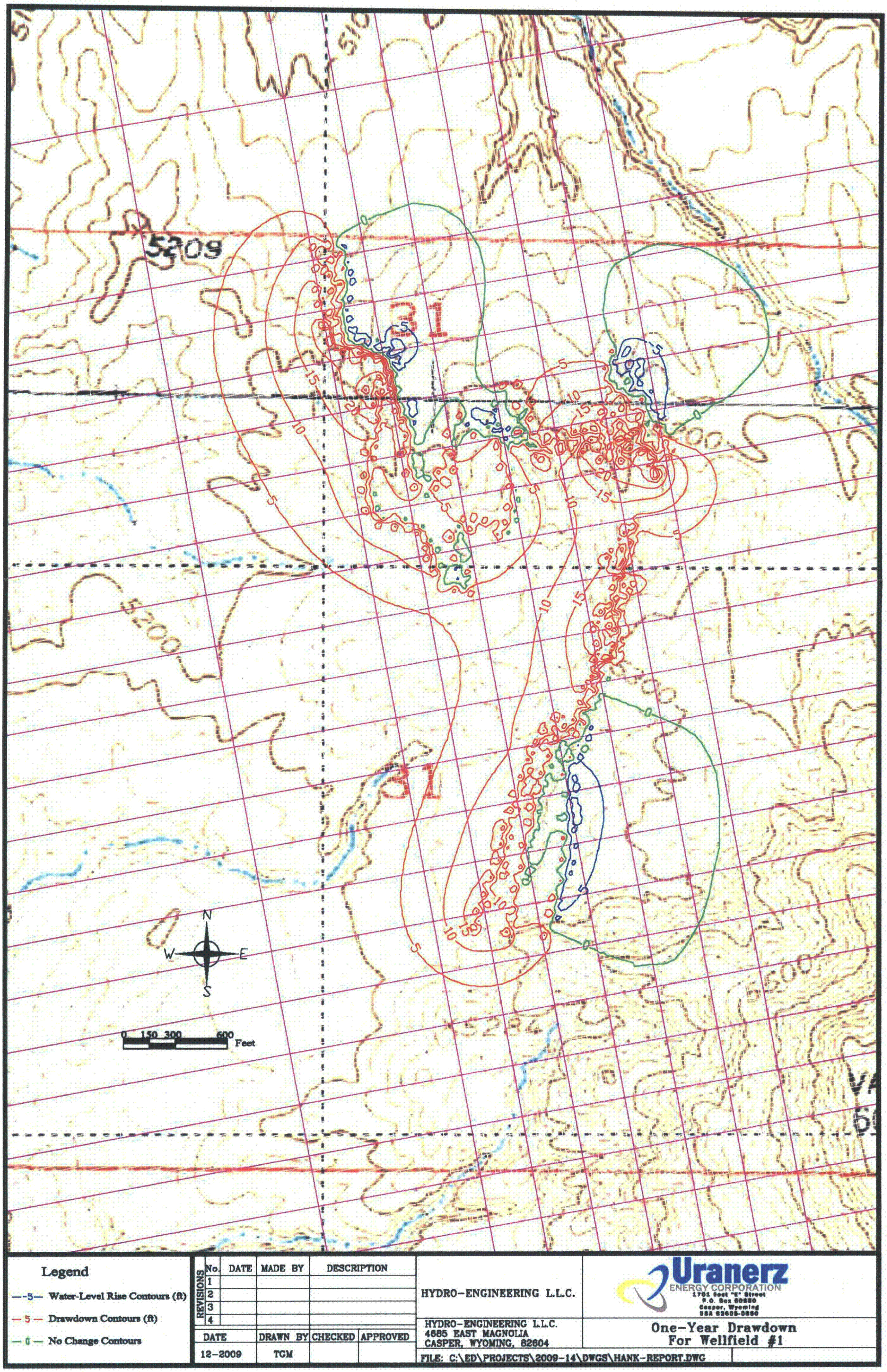
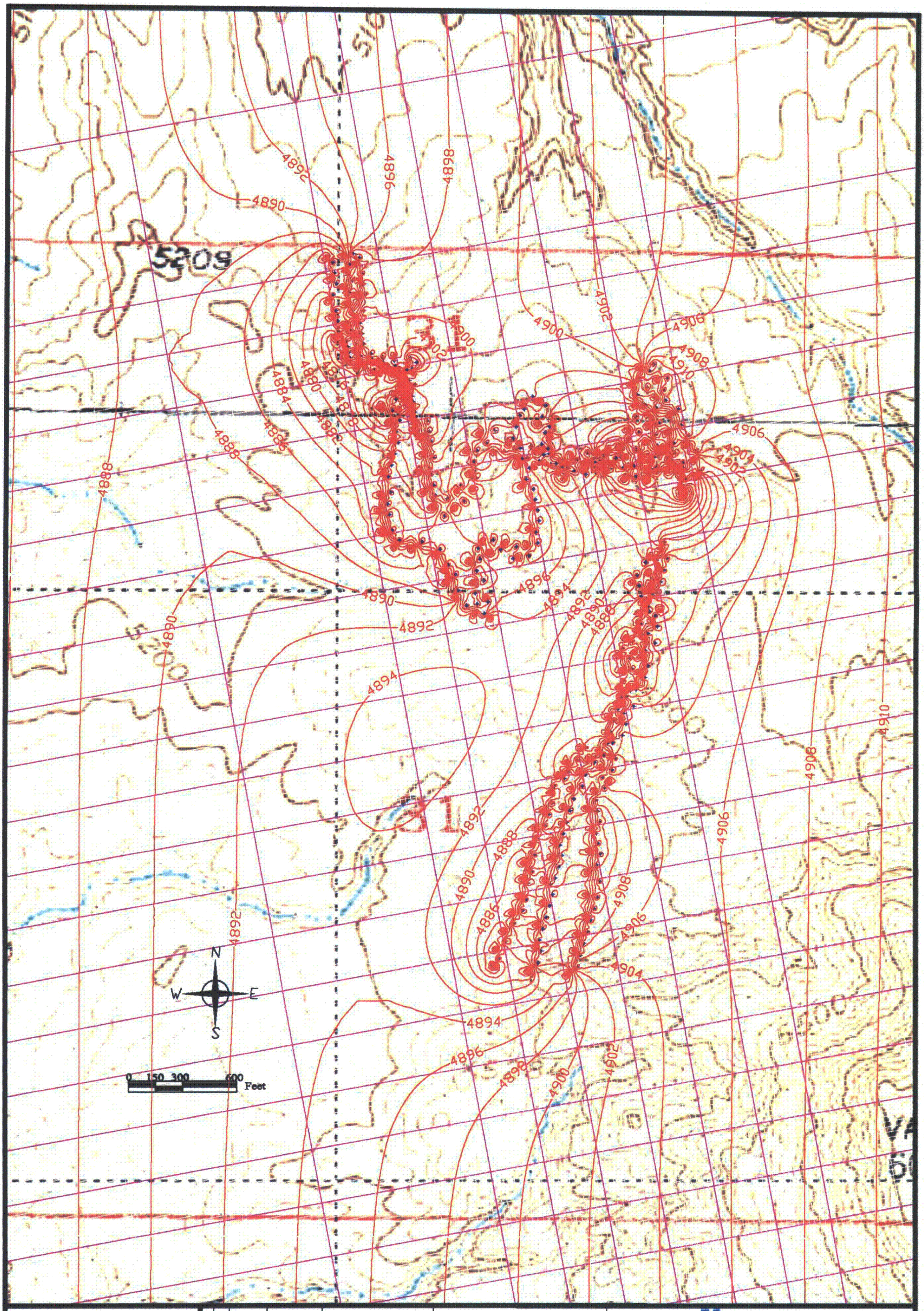



Figure MPH.1-5. One-Year Drawdown for Wellfield #1




| Legend | REVISIONS | | | | HYDRO-ENGINEERING L.L.C. | Uranerz ENERGY CORPORATION 1701 East "E" Street P.O. Box 50850 Casper, Wyoming USA 82605-0850 |
|---|---|---|---|---|---|---|
| —4915— Water-Level Elevation Contours | No. | DATE | MADE BY | DESCRIPTION | | |
| | 1 | | | | | |
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| | 4 | | | | | |
| | DATE | DRAWN BY | CHECKED | APPROVED | HYDRO-ENGINEERING L.L.C. 4685 EAST MAGNOLIA CASPER, WYOMING, 82604 | Potentiometric Surface For Wellfield #1 After One Year of Mining |
| | 11-2009 | TGM | | | FILE: C:\ED\PROJECTS\2009-14\DWGS\HANK-REPORT.DWG | |

Figure MPH.1-6. Potentiometric Surface for Wellfield #1 After One Year of Mining

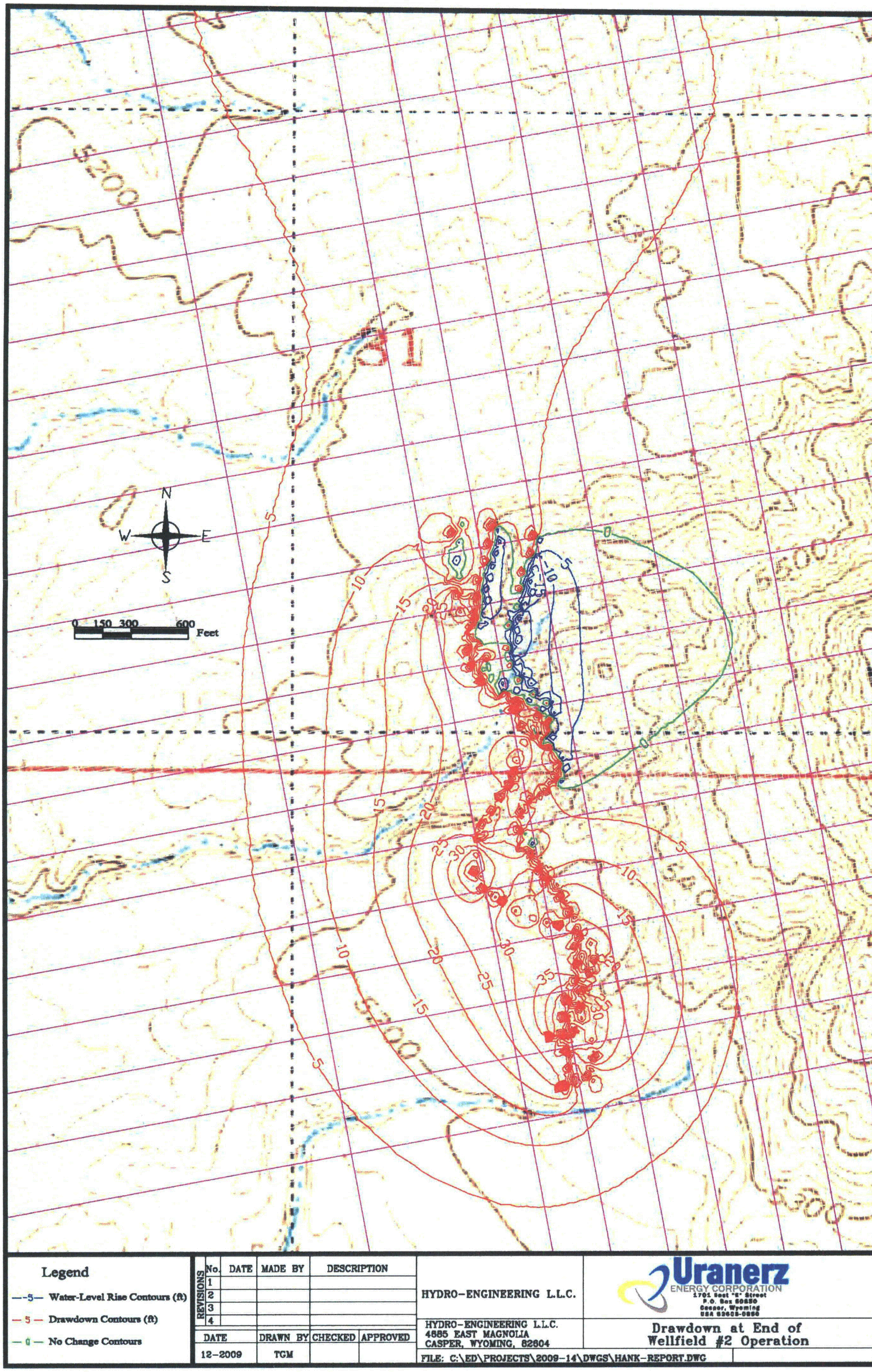
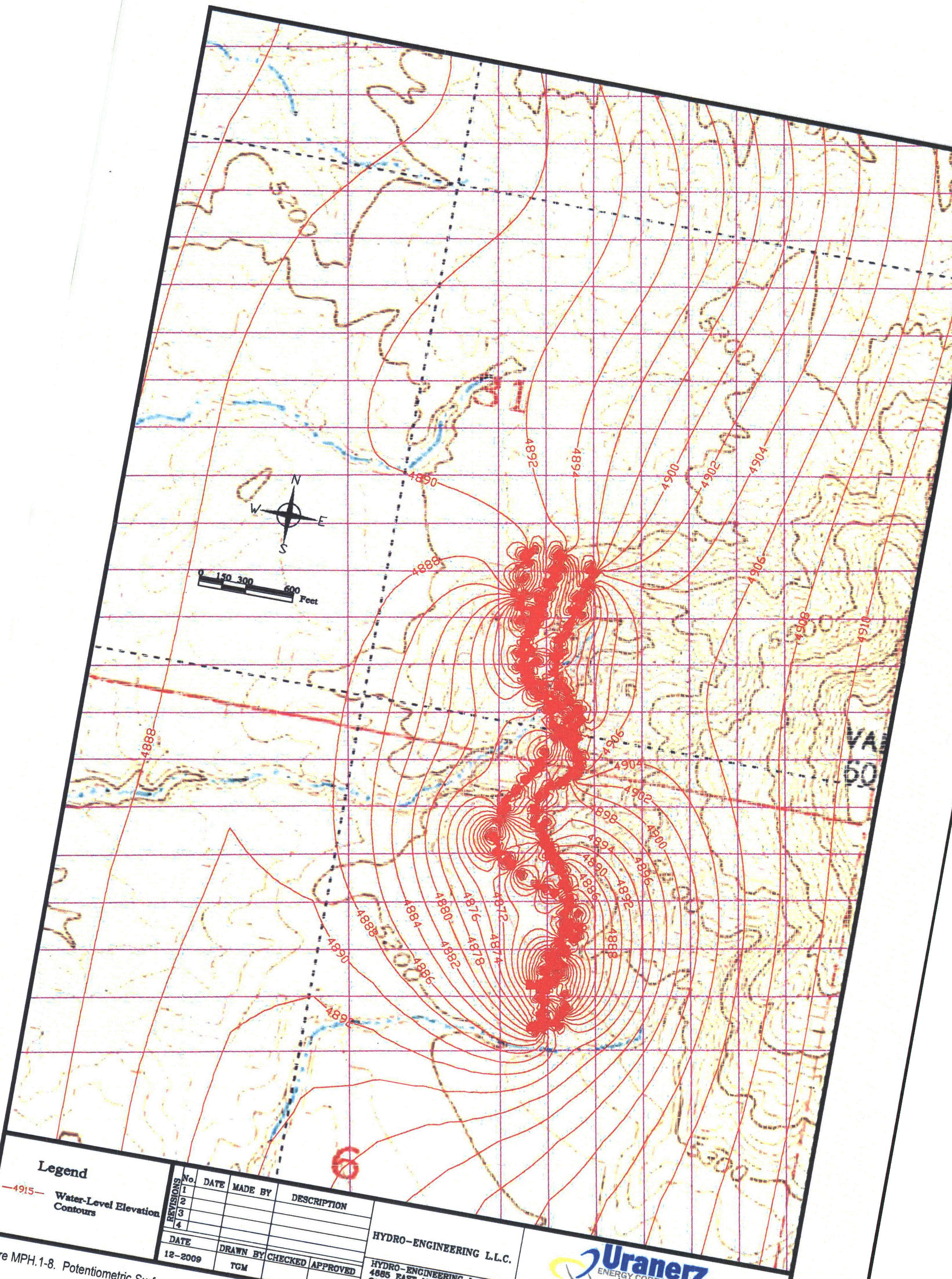



Figure MPH.1-7. Drawdown at End of Wellfield #2 Operation




re MPH.1-8. Potentiometric Surface at End of Wellfield #2 Operation

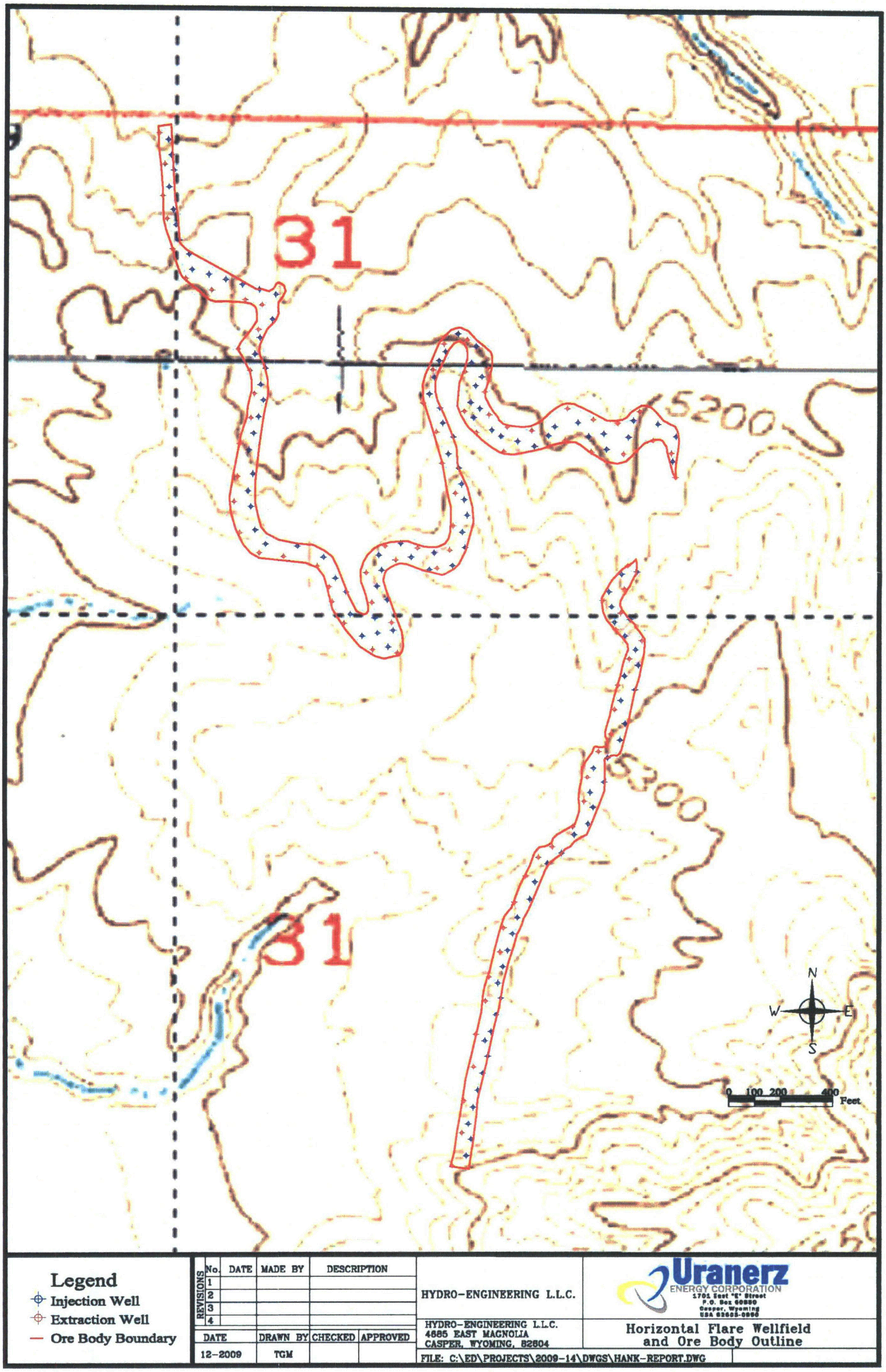



Figure MPH.1-9. Horizontal Flare Wellfield and Ore Body Outline

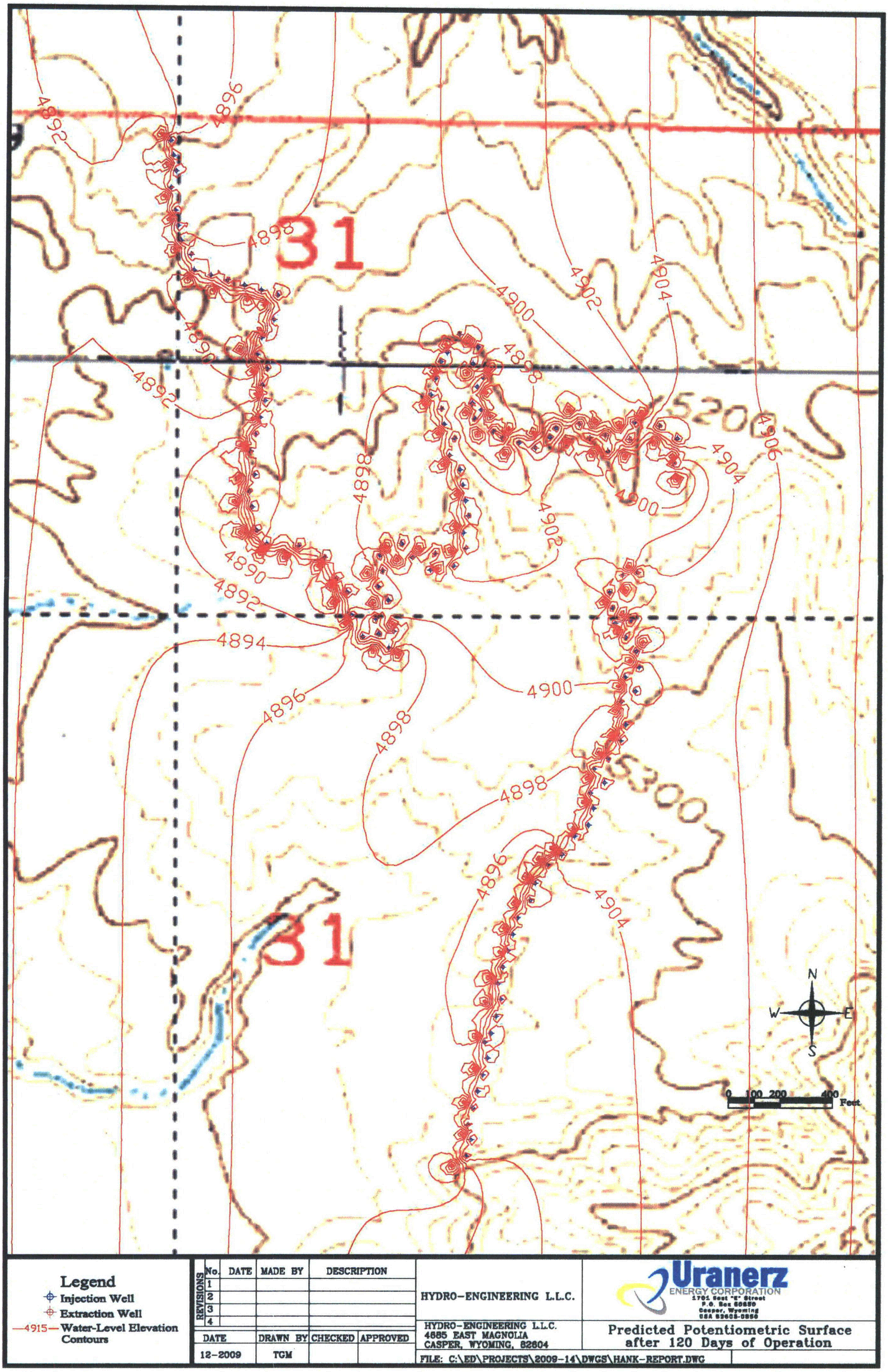



Figure MPH.1-10. Predicted Potentiometric Surface after 120 Days of Operation

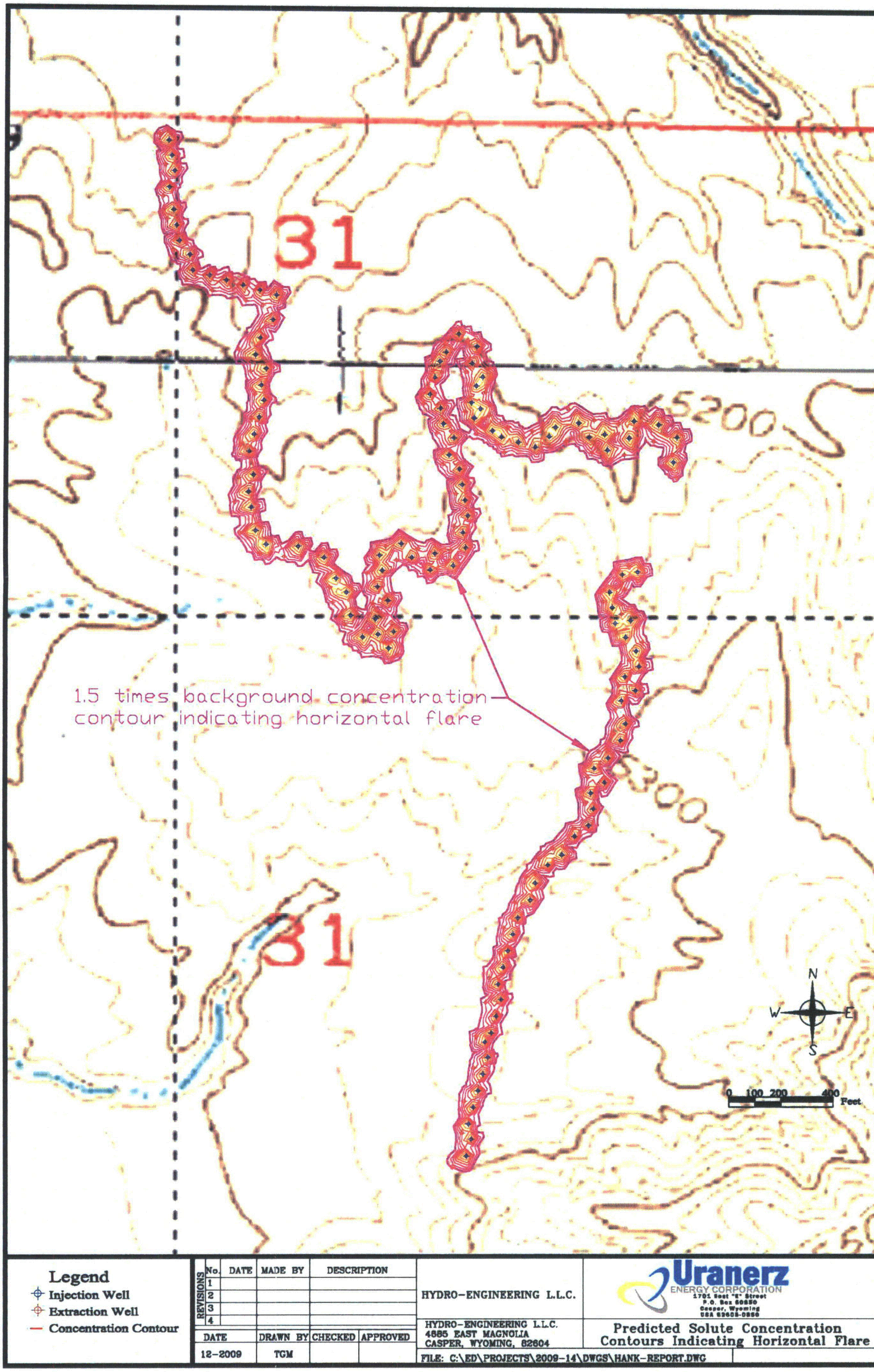



Figure MPH.1-11. Predicted Solute Concentration Contours Indicating Horizontal Flare

Figure MPH.1-12. Predicted Vertical and Horizontal Velocity Fields For Well Pair Simulation

## Vertical Darcy Velocity Matrix

Column Count from Injection Well (Injection Well at left)

| Depth Below Top of Aquifer (feet) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 62 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 63 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 64 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 65 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| 66 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| 67 | 0.05 | 0.05 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 |
| 68 | 0.06 | 0.06 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 |
| 69 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.04 | 0.04 | 0.04 | 0.04 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 |
| 70 | 0.09 | 0.09 | 0.09 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.07 | 0.07 | 0.07 | 0.06 | 0.06 | 0.06 | 0.05 | 0.05 | 0.05 | 0.05 | 0.04 | 0.04 | 0.04 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 |
| 71 | 0.12 | 0.11 | 0.11 | 0.11 | 0.11 | 0.10 | 0.10 | 0.10 | 0.09 | 0.09 | 0.08 | 0.08 | 0.07 | 0.07 | 0.07 | 0.06 | 0.06 | 0.05 | 0.05 | 0.05 | 0.04 | 0.04 | 0.04 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 |
| 72 | 0.16 | 0.16 | 0.15 | 0.15 | 0.14 | 0.14 | 0.13 | 0.12 | 0.12 | 0.11 | 0.10 | 0.10 | 0.09 | 0.08 | 0.08 | 0.07 | 0.07 | 0.06 | 0.06 | 0.05 | 0.05 | 0.04 | 0.04 | 0.04 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 |
| 73 | 0.23 | 0.23 | 0.22 | 0.21 | 0.20 | 0.19 | 0.18 | 0.16 | 0.15 | 0.14 | 0.13 | 0.12 | 0.11 | 0.10 | 0.09 | 0.09 | 0.08 | 0.07 | 0.07 | 0.06 | 0.05 | 0.05 | 0.04 | 0.04 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.00 |
| 74 | 0.40 | 0.38 | 0.35 | 0.32 | 0.29 | 0.26 | 0.24 | 0.21 | 0.19 | 0.17 | 0.16 | 0.14 | 0.13 | 0.12 | 0.11 | 0.10 | 0.09 | 0.08 | 0.07 | 0.06 | 0.06 | 0.05 | 0.05 | 0.04 | 0.04 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.00 |
| 75 | 1.10 | 0.79 | 0.62 | 0.50 | 0.42 | 0.35 | 0.30 | 0.26 | 0.23 | 0.20 | 0.18 | 0.16 | 0.14 | 0.13 | 0.11 | 0.10 | 0.09 | 0.08 | 0.07 | 0.07 | 0.06 | 0.05 | 0.05 | 0.04 | 0.04 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.00 |
| 76 | 1.67 | 1.09 | 0.79 | 0.61 | 0.48 | 0.40 | 0.33 | 0.28 | 0.24 | 0.21 | 0.18 | 0.16 | 0.14 | 0.13 | 0.11 | 0.10 | 0.09 | 0.08 | 0.07 | 0.06 | 0.06 | 0.05 | 0.05 | 0.04 | 0.04 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.00 | 0.00 |
| 77 | 1.08 | 0.77 | 0.60 | 0.48 | 0.40 | 0.34 | 0.29 | 0.25 | 0.21 | 0.19 | 0.16 | 0.14 | 0.13 | 0.11 | 0.10 | 0.09 | 0.08 | 0.07 | 0.07 | 0.06 | 0.05 | 0.05 | 0.04 | 0.04 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 |
| 78 | 0.36 | 0.34 | 0.31 | 0.28 | 0.25 | 0.23 | 0.20 | 0.18 | 0.16 | 0.14 | 0.13 | 0.11 | 0.10 | 0.09 | 0.08 | 0.07 | 0.07 | 0.06 | 0.05 | 0.05 | 0.04 | 0.04 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 |
| 79 | 0.17 | 0.17 | 0.16 | 0.15 | 0.14 | 0.13 | 0.12 | 0.11 | 0.10 | 0.09 | 0.08 | 0.07 | 0.07 | 0.06 | 0.05 | 0.05 | 0.04 | 0.04 | 0.04 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 |
| 80 | 0.06 | 0.06 | 0.06 | 0.06 | 0.05 | 0.05 | 0.05 | 0.05 | 0.04 | 0.04 | 0.04 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 81 | -0.03 | -0.03 | -0.03 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 82 | -0.14 | -0.13 | -0.13 | -0.12 | -0.11 | -0.10 | -0.09 | -0.08 | -0.07 | -0.06 | -0.05 | -0.05 | -0.04 | -0.04 | -0.03 | -0.03 | -0.02 | -0.02 | -0.02 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 83 | -0.33 | -0.31 | -0.28 | -0.25 | -0.22 | -0.19 | -0.17 | -0.15 | -0.13 | -0.11 | -0.10 | -0.08 | -0.07 | -0.06 | -0.06 | -0.05 | -0.04 | -0.04 | -0.03 | -0.03 | -0.02 | -0.02 | -0.02 | -0.02 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| 84 | -1.04 | -0.73 | -0.56 | -0.45 | -0.36 | -0.30 | -0.25 | -0.21 | -0.18 | -0.15 | -0.13 | -0.11 | -0.10 | -0.09 | -0.07 | -0.06 | -0.06 | -0.05 | -0.04 | -0.04 | -0.03 | -0.03 | -0.02 | -0.02 | -0.02 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | 0.00 | 0.00 | 0.00 |
| 85 | -1.62 | -1.04 | -0.75 | -0.56 | -0.44 | -0.36 | -0.29 | -0.24 | -0.20 | -0.17 | -0.15 | -0.13 | -0.11 | -0.09 | -0.08 | -0.07 | -0.06 | -0.05 | -0.05 | -0.04 | -0.04 | -0.03 | -0.03 | -0.02 | -0.02 | -0.02 | -0.02 | -0.01 | -0.01 | -0.01 | -0.01 | 0.00 | 0.00 | 0.00 |
| 86 | -1.05 | -0.74 | -0.57 | -0.45 | -0.37 | -0.31 | -0.26 | -0.22 | -0.19 | -0.16 | -0.14 | -0.12 | -0.10 | -0.09 | -0.08 | -0.07 | -0.06 | -0.05 | -0.05 | -0.04 | -0.04 | -0.03 | -0.03 | -0.02 | -0.02 | -0.02 | -0.02 | -0.01 | -0.01 | -0.01 | -0.01 | 0.00 | 0.00 | 0.00 |
| 87 | -0.34 | -0.32 | -0.30 | -0.27 | -0.24 | -0.21 | -0.18 | -0.16 | -0.14 | -0.12 | -0.11 | -0.10 | -0.08 | -0.07 | -0.07 | -0.06 | -0.05 | -0.05 | -0.04 | -0.04 | -0.03 | -0.03 | -0.03 | -0.02 | -0.02 | -0.02 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | 0.00 | 0.00 | 0.00 |
| 88 | -0.16 | -0.16 | -0.15 | -0.14 | -0.13 | -0.12 | -0.11 | -0.10 | -0.09 | -0.08 | -0.08 | -0.07 | -0.07 | -0.06 | -0.05 | -0.05 | -0.04 | -0.04 | -0.03 | -0.03 | -0.03 | -0.02 | -0.02 | -0.02 | -0.02 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| 89 | -0.07 | -0.07 | -0.07 | -0.06 | -0.06 | -0.06 | -0.05 | -0.05 | -0.04 | -0.04 | -0.04 | -0.03 | -0.03 | -0.03 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 90 | -0.04 | -0.03 | -0.03 | -0.03 | -0.03 | -0.03 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Column Count from Production Well (Production Well at right)

| Depth Below Top of Aquifer (feet) | 34 | 33 | 32 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 |
| 62 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 |
| 63 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 |
| 64 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.03 | -0.03 | -0.03 | -0.03 | -0.03 | -0.03 |
| 65 | 0.00 | 0.00 | 0.00 | 0.00 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.03 | -0.03 | -0.03 | -0.03 | -0.03 | -0.03 | -0.03 | -0.03 | -0.03 | -0.03 | -0.03 | -0.03 |
| 66 | 0.00 | 0.00 | 0.00 | 0.00 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.03 | -0.03 | -0.03 | -0.03 | -0.03 | -0.03 | -0.03 | -0.03 | -0.03 | -0.03 | -0.04 | -0.04 | -0.04 | -0.04 | -0.04 | -0.04 |
| 67 | 0.00 | 0.00 | 0.00 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.03 | -0.03 | -0.03 | -0.03 | -0.03 | -0.03 | -0.03 | -0.04 | -0.04 | -0.04 | -0.04 | -0.04 | -0.04 | -0.04 | -0.04 | -0.04 | -0.04 | -0.05 | -0.05 |
| 68 | 0.00 | 0.00 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.03 | -0.03 | -0.03 | -0.03 | -0.03 | -0.04 | -0.04 | -0.04 | -0.04 | -0.04 | -0.05 | -0.05 | -0.05 | -0.05 | -0.05 | -0.05 | -0.05 | -0.05 | -0.05 | -0.06 | -0.06 |
| 69 | 0.00 | 0.00 | -0.01 | -0.01 | -0.01 | -0.01 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.03 | -0.03 | -0.03 | -0.03 | -0.04 | -0.04 | -0.04 | -0.04 | -0.05 | -0.05 | -0.05 | -0.05 | -0.05 | -0.06 | -0.06 | -0.06 | -0.06 | -0.06 | -0.07 | -0.07 | -0.07 | -0.07 | -0.07 |
| 70 | 0.00 | 0.00 | -0.01 | -0.01 | -0.01 | -0.01 | -0.02 | -0.02 | -0.02 | -0.03 | -0.03 | -0.03 | -0.03 | -0.04 | -0.04 | -0.04 | -0.05 | -0.05 | -0.05 | -0.05 | -0.06 | -0.06 | -0.06 | -0.07 | -0.07 | -0.07 | -0.08 | -0.08 | -0.08 | -0.08 | -0.08 | -0.09 | -0.09 | -0.09 |
| 71 | 0.00 | 0.00 | -0.01 | -0.01 | -0.01 | -0.02 | -0.02 | -0.02 | -0.03 | -0.03 | -0.03 | -0.04 | -0.04 | -0.04 | -0.05 | -0.05 | -0.05 | -0.06 | -0.06 | -0.07 | -0.07 | -0.07 | -0.08 | -0.08 | -0.09 | -0.09 | -0.10 | -0.10 | -0.10 | -0.11 | -0.11 | -0.11 | -0.11 | -0.12 |
| 72 | 0.00 | 0.00 | -0.01 | -0.01 | -0.01 | -0.02 | -0.02 | -0.02 | -0.03 | -0.03 | -0.04 | -0.04 | -0.04 | -0.05 | -0.05 | -0.06 | -0.06 | -0.07 | -0.07 | -0.08 | -0.08 | -0.09 | -0.10 | -0.10 | -0.11 | -0.12 | -0.12 | -0.13 | -0.14 | -0.14 | -0.15 | -0.15 | -0.16 | -0.16 |
| 73 | 0.00 | -0.01 | -0.01 | -0.01 | -0.02 | -0.02 | -0.02 | -0.03 | -0.03 | -0.03 | -0.04 | -0.04 | -0.05 | -0.05 | -0.06 | -0.07 | -0.07 | -0.08 | -0.09 | -0.09 | -0.10 | -0.11 | -0.12 | -0.13 | -0.14 | -0.15 | -0.16 | -0.18 | -0.19 | -0.20 | -0.21 | -0.22 | -0.23 | -0.23 |
| 74 | 0.00 | -0.01 | -0.01 | -0.01 | -0.02 | -0.02 | -0.02 | -0.03 | -0.03 | -0.04 | -0.04 | -0.05 | -0.05 | -0.06 | -0.06 | -0.07 | -0.08 | -0.09 | -0.10 | -0.11 | -0.12 | -0.13 | -0.14 | -0.16 | -0.17 | -0.19 | -0.21 | -0.24 | -0.26 | -0.29 | -0.32 | -0.35 | -0.38 | -0.40 |
| 75 | 0.00 | -0.01 | -0.01 | -0.01 | -0.02 | -0.02 | -0.02 | -0.03 | -0.03 | -0.04 | -0.04 | -0.05 | -0.05 | -0.06 | -0.07 | -0.07 | -0.08 | -0.09 | -0.10 | -0.11 | -0.13 | -0.14 | -0.16 | -0.18 | -0.20 | -0.23 | -0.26 | -0.30 | -0.35 | -0.42 | -0.50 | -0.62 | -0.79 | -1.10 |
| 76 | 0.00 | 0.00 | -0.01 | -0.01 | -0.02 | -0.02 | -0.02 | -0.03 | -0.03 | -0.04 | -0.04 | -0.05 | -0.05 | -0.06 | -0.06 | -0.07 | -0.08 | -0.09 | -0.10 | -0.11 | -0.13 | -0.14 | -0.16 | -0.18 | -0.21 | -0.24 | -0.28 | -0.33 | -0.40 | -0.48 | -0.61 | -0.79 | -1.09 | -1.67 |
| 77 | 0.00 | 0.00 | -0.01 | -0.01 | -0.01 | -0.02 | -0.02 | -0.02 | -0.03 | -0.03 | -0.04 | -0.04 | -0.05 | -0.05 | -0.06 | -0.07 | -0.07 | -0.08 | -0.09 | -0.10 | -0.11 | -0.13 | -0.14 | -0.16 | -0.19 | -0.21 | -0.25 | -0.29 | -0.34 | -0.40 | -0.48 | -0.60 | -0.77 | -1.08 |
| 78 | 0.00 | 0.00 | -0.01 | -0.01 | -0.01 | -0.01 | -0.02 | -0.02 | -0.02 | -0.03 | -0.03 | -0.03 | -0.04 | -0.04 | -0.05 | -0.05 | -0.06 | -0.07 | -0.07 | -0.08 | -0.09 | -0.10 | -0.11 | -0.13 | -0.14 | -0.16 | -0.18 | -0.20 | -0.23 | -0.25 | -0.28 | -0.31 | -0.34 | -0.36 |
| 79 | 0.00 | 0.00 | 0.00 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.02 | -0.02 | -0.02 | -0.02 | -0.03 | -0.03 | -0.03 | -0.04 | -0.04 | -0.04 | -0.05 | -0.05 | -0.06 | -0.07 | -0.07 | -0.08 | -0.09 | -0.10 | -0.11 | -0.12 | -0.13 | -0.14 | -0.15 | -0.16 | -0.17 | -0.17 |
| 80 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.03 | -0.03 | -0.03 | -0.03 | -0.04 | -0.04 | -0.04 | -0.05 | -0.05 | -0.05 | -0.05 | -0.06 | -0.06 | -0.06 | -0.06 |
| 81 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 |
| 82 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | 0.04 | 0.04 | 0.05 | 0.05 | 0.06 | 0.07 | 0.08 | 0.09 | 0.10 | 0.11 | 0.12 | 0.13 | 0.13 | 0.14 |
| 83 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | 0.04 | 0.04 | 0.05 | 0.06 | 0.06 | 0.07 | 0.08 | 0.10 | 0.11 | 0.13 | 0.15 | 0.17 | 0.19 | 0.22 | 0.25 | 0.28 | 0.31 | 0.33 |
| 84 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | 0.04 | 0.04 | 0.05 | 0.06 | 0.06 | 0.07 | 0.09 | 0.10 | 0.11 | 0.13 | 0.15 | 0.18 | 0.21 | 0.25 | 0.30 | 0.36 | 0.45 | 0.56 | 0.73 | 1.04 |
| 85 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | 0.04 | 0.04 | 0.05 | 0.05 | 0.06 | 0.07 | 0.08 | 0.09 | 0.11 | 0.13 | 0.15 | 0.17 | 0.20 | 0.24 | 0.29 | 0.36 | 0.44 | 0.56 | 0.75 | 1.04 | 1.62 |
| 86 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | 0.04 | 0.04 | 0.05 | 0.05 | 0.06 | 0.07 | 0.08 | 0.09 | 0.10 | 0.12 | 0.14 | 0.16 | 0.19 | 0.22 | 0.26 | 0.31 | 0.37 | 0.45 | 0.57 | 0.74 | 1.05 |
| 87 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 | 0.04 | 0.04 | 0.05 | 0.05 | 0.06 | 0.07 | 0.07 | 0.08 | 0.10 | 0.11 | 0.12 | 0.14 | 0.16 | 0.18 | 0.21 | 0.24 | 0.27 | 0.30 | 0.32 | 0.34 |
| 88 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 | 0.04 | 0.04 | 0.05 | 0.05 | 0.06 | 0.07 | 0.07 | 0.08 | 0.08 | 0.09 | 0.10 | 0.11 | 0.12 | 0.13 | 0.14 | 0.15 | 0.16 | 0.16 |
| 89 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 | 0.04 | 0.04 | 0.04 | 0.05 | 0.05 | 0.06 | 0.06 | 0.06 | 0.07 | 0.07 | 0.07 |
| 90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.04 |

## Horizontal Darcy Velocity Matrix

Column Count from Injection Well (Injection Well at left)

| Depth Below Top of Aquifer (feet) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61 | 0.02 | 0.03 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.05 | 0.05 | 0.04 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.07 | 0.07 | 0.06 |
| 62 | 0.04 | 0.04 | 0.04 | 0.04 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.06 | 0.05 | 0.05 | 0.05 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.07 | 0.07 | 0.07 | 0.06 | 0.06 | 0.07 | 0.07 | 0.08 | 0.07 | 0.07 | 0.07 | 0.07 | 0.08 | 0.07 | 0.08 |
| 63 | 0.05 | 0.05 | 0.04 | 0.05 | 0.05 | 0.04 | 0.05 | 0.05 | 0.05 | 0.06 | 0.07 | 0.06 | 0.06 | 0.07 | 0.07 | 0.06 | 0.07 | 0.08 | 0.07 | 0.07 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.09 | 0.09 | 0.08 | 0.08 | 0.09 | 0.08 | 0.08 |
| 64 | 0.04 | 0.04 | 0.05 | 0.05 | 0.05 | 0.05 | 0.06 | 0.06 | 0.06 | 0.07 | 0.06 | 0.07 | 0.08 | 0.08 | 0.07 | 0.08 | 0.09 | 0.08 | 0.08 | 0.09 | 0.08 | 0.08 | 0.08 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.10 | 0.09 |
| 65 | 0.05 | 0.05 | 0.05 | 0.06 | 0.06 | 0.06 | 0.06 | 0.07 | 0.07 | 0.07 | 0.08 | 0.08 | 0.08 | 0.09 | 0.09 | 0.09 | 0.09 | 0.10 | 0.09 | 0.09 | 0.10 | 0.09 | 0.10 | 0.10 | 0.10 | 0.11 | 0.10 | 0.10 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.10 |
| 66 | 0.07 | 0.06 | 0.05 | 0.06 | 0.07 | 0.07 | 0.07 | 0.08 | 0.09 | 0.08 | 0.08 | 0.09 | 0.10 | 0.09 | 0.10 | 0.11 | 0.11 | 0.11 | 0.10 | 0.10 | 0.12 | 0.12 | 0.12 | 0.11 | 0.11 | 0.12 | 0.13 | 0.13 | 0.12 | 0.12 | 0.12 | 0.12 | 0.13 | 0.13 |
| 67 | 0.06 | 0.06 | 0.06 | 0.07 | 0.08 | 0.08 | 0.09 | 0.09 | 0.09 | 0.10 | 0.11 | 0.10 | 0.10 | 0.11 | 0.12 | 0.12 | 0.12 | 0.13 | 0.13 | 0.12 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.14 | 0.13 | 0.13 | 0.14 | 0.15 | 0.15 | 0.14 | 0.14 | 0.14 |
| 68 | 0.06 | 0.06 | 0.07 | 0.08 | 0.09 | 0.09 | 0.10 | 0.10 | 0.10 | 0.12 | 0.12 | 0.11 | 0.13 | 0.13 | 0.13 | 0.15 | 0.14 | 0.13 | 0.14 | 0.15 | 0.15 | 0.15 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 |
| 69 | 0.07 | 0.08 | 0.09 | 0.09 | 0.10 | 0.11 | 0.12 | 0.12 | 0.13 | 0.13 | 0.14 | 0.15 | 0.15 | 0.15 | 0.16 | 0.16 | 0.16 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.18 | 0.18 | 0.18 | 0.18 | 0.19 | 0.19 | 0.18 | 0.18 | 0.19 | 0.19 | 0.19 | 0.19 |
| 70 | 0.08 | 0.09 | 0.10 | 0.10 | 0.12 | 0.13 | 0.13 | 0.14 | 0.16 | 0.16 | 0.17 | 0.17 | 0.18 | 0.19 | 0.19 | 0.19 | 0.20 | 0.21 | 0.21 | 0.20 | 0.20 | 0.20 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 | 0.21 |
| 71 | 0.08 | 0.09 | 0.11 | 0.13 | 0.14 | 0.15 | 0.17 | 0.19 | 0.19 | 0.20 | 0.22 | 0.22 | 0.22 | 0.23 | 0.23 | 0.23 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.25 | 0.25 | 0.25 | 0.25 | 0.24 | 0.24 | 0.24 | 0.24 | 0.25 | 0.25 | 0.25 |
| 72 | 0.12 | 0.13 | 0.14 | 0.16 | 0.19 | 0.22 | 0.23 | 0.24 | 0.25 | 0.27 | 0.27 | 0.28 | 0.28 | 0.28 | 0.30 | 0.30 | 0.29 | 0.29 | 0.29 | 0.30 | 0.30 | 0.29 | 0.29 | 0.29 | 0.29 | 0.29 | 0.28 | 0.28 | 0.29 | 0.29 | 0.28 | 0.28 | 0.28 | 0.28 |
| 73 | 0.17 | 0.17 | 0.21 | 0.25 | 0.27 | 0.30 | 0.32 | 0.35 | 0.36 | 0.36 | 0.36 | 0.37 | 0.37 | 0.37 | 0.37 | 0.37 | 0.36 | 0.36 | 0.36 | 0.36 | 0.34 | 0.34 | 0.34 | 0.34 | 0.34 | 0.33 | 0.33 | 0.33 | 0.32 | 0.32 | 0.33 | 0.32 | 0.32 | 0.32 |
| 74 | 0.21 | 0.26 | 0.35 | 0.42 | 0.47 | 0.50 | 0.52 | 0.53 | 0.52 | 0.52 | 0.52 | 0.51 | 0.50 | 0.48 | 0.48 | 0.47 | 0.45 | 0.44 | 0.43 | 0.43 | 0.41 | 0.41 | 0.41 | 0.40 | 0.38 | 0.38 | 0.38 | 0.38 | 0.37 | 0.37 | 0.37 | 0.36 | 0.36 | 0.36 |
| 75 | 0.63 | 0.76 | 0.92 | 0.97 | 0.98 | 0.95 | 0.91 | 0.87 | 0.82 | 0.77 | 0.75 | 0.70 | 0.66 | 0.64 | 0.61 | 0.58 | 0.56 | 0.54 | 0.52 | 0.51 | 0.49 | 0.48 | 0.47 | 0.45 | 0.44 | 0.44 | 0.43 | 0.42 | 0.42 | 0.41 | 0.41 | 0.41 | 0.41 | 0.41 |
| 76 | 7.44 | 5.92 | 3.75 | 2.78 | 2.22 | 1.85 | 1.59 | 1.40 | 1.25 | 1.12 | 1.02 | 0.95 | 0.88 | 0.82 | 0.77 | 0.72 | 0.69 | 0.65 | 0.61 | 0.59 | 0.57 | 0.55 | 0.53 | 0.52 | 0.51 | 0.49 | 0.48 | 0.47 | 0.47 | 0.46 | 0.45 | 0.45 | 0.45 | 0.45 |
| 77 | 14.22 | 11.05 | 6.58 | 4.59 | 3.46 | 2.75 | 2.27 | 1.92 | 1.66 | 1.47 | 1.31 | 1.18 | 1.08 | 0.99 | 0.91 | 0.85 | 0.80 | 0.75 | 0.71 | 0.68 | 0.64 | 0.62 | 0.59 | 0.57 | 0.56 | 0.54 | 0.53 | 0.52 | 0.51 | 0.50 | 0.48 | 0.49 | 0.49 | 0.48 |
| 78 | 14.64 | 11.54 | 7.15 | 5.13 | 3.96 | 3.19 | 2.65 | 2.25 | 1.94 | 1.72 | 1.52 | 1.36 | 1.24 | 1.13 | 1.04 | 0.96 | 0.89 | 0.84 | 0.79 | 0.75 | 0.71 | 0.67 | 0.65 | 0.63 | 0.60 | 0.58 | 0.56 | 0.56 | 0.55 | 0.53 | 0.53 | 0.52 | 0.52 | 0.52 |
| 79 | 14.69 | 11.64 | 7.27 | 5.29 | 4.15 | 3.36 | 2.83 | 2.42 | 2.10 | 1.85 | 1.65 | 1.48 | 1.34 | 1.22 | 1.12 | 1.04 | 0.96 | 0.90 | 0.84 | 0.80 | 0.76 | 0.72 | 0.69 | 0.66 | 0.63 | 0.62 | 0.60 | 0.58 | 0.57 | 0.56 | 0.55 | 0.55 | 0.55 | 0.54 |
| 80 | 14.74 | 11.67 | 7.33 | 5.36 | 4.20 | 3.44 | 2.90 | 2.48 | 2.17 | 1.92 | 1.71 | 1.54 | 1.39 | 1.27 | 1.17 | 1.08 | 1.00 | 0.94 | 0.88 | 0.82 | 0.79 | 0.74 | 0.71 | 0.69 | 0.66 | 0.63 | 0.62 | 0.60 | 0.58 | 0.58 | 0.57 | 0.56 | 0.56 | 0.56 |
| 81 | 14.74 | 11.67 | 7.33 | 5.36 | 4.21 | 3.44 | 2.89 | 2.49 | 2.18 | 1.92 | 1.71 | 1.55 | 1.40 | 1.28 | 1.18 | 1.08 | 1.01 | 0.95 | 0.88 | 0.83 | 0.78 | 0.76 | 0.72 | 0.69 | 0.67 | 0.65 | 0.62 | 0.61 | 0.60 | 0.58 | 0.57 | 0.58 | 0.57 | 0.56 |
| 82 | 14.70 | 11.64 | 7.29 | 5.30 | 4.15 | 3.39 | 2.84 | 2.43 | 2.12 | 1.86 | 1.66 | 1.50 | 1.36 | 1.24 | 1.14 | 1.06 | 0.98 | 0.92 | 0.87 | 0.82 | 0.77 | 0.74 | 0.71 | 0.68 | 0.66 | 0.63 | 0.62 | 0.61 | 0.59 | 0.58 | 0.57 | 0.57 | 0.57 | 0.56 |
| 83 | 14.65 | 11.55 | 7.16 | 5.15 | 3.97 | 3.21 | 2.67 | 2.28 | 1.97 | 1.73 | 1.54 | 1.39 | 1.27 | 1.16 | 1.07 | 0.99 | 0.92 | 0.87 | 0.83 | 0.78 | 0.74 | 0.71 | 0.68 | 0.66 | 0.64 | 0.62 | 0.60 | 0.59 | 0.58 | 0.57 | 0.56 | 0.56 | 0.56 | 0.56 |
| 84 | 14.25 | 11.07 | 6.60 | 4.61 | 3.48 | 2.78 | 2.30 | 1.95 | 1.70 | 1.50 | 1.35 | 1.22 | 1.12 | 1.03 | 0.96 | 0.90 | 0.84 | 0.80 | 0.76 | 0.73 | 0.70 | 0.67 | 0.64 | 0.63 | 0.61 | 0.59 | 0.58 | 0.56 | 0.56 | 0.56 | 0.55 | 0.54 | 0.54 | 0.54 |
| 85 | 7.47 | 5.94 | 3.78 | 2.81 | 2.25 | 1.89 | 1.63 | 1.44 | 1.29 | 1.17 | 1.07 | 1.00 | 0.93 | 0.87 | 0.82 | 0.78 | 0.74 | 0.71 | 0.69 | 0.66 | 0.63 | 0.62 | 0.60 | 0.59 | 0.57 | 0.56 | 0.55 | 0.55 | 0.55 | 0.53 | 0.52 | 0.52 | 0.52 | 0.52 |
| 86 | 0.67 | 0.79 | 0.95 | 1.02 | 1.02 | 0.99 | 0.96 | 0.92 | 0.88 | 0.84 | 0.81 | 0.77 | 0.73 | 0.72 | 0.68 | 0.66 | 0.64 | 0.62 | 0.61 | 0.59 | 0.57 | 0.57 | 0.56 | 0.54 | 0.53 | 0.53 | 0.52 | 0.52 | 0.51 | 0.51 | 0.51 | 0.50 | 0.50 | 0.50 |
| 87 | 0.24 | 0.30 | 0.39 | 0.47 | 0.53 | 0.56 | 0.58 | 0.59 | 0.60 | 0.60 | 0.60 | 0.59 | 0.58 | 0.57 | 0.57 | 0.56 | 0.56 | 0.55 | 0.54 | 0.53 | 0.53 | 0.52 | 0.52 | 0.51 | 0.50 | 0.50 | 0.49 | 0.49 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 |
| 88 | 0.21 | 0.22 | 0.25 | 0.31 | 0.34 | 0.37 | 0.41 | 0.43 | 0.45 | 0.46 | 0.47 | 0.48 | 0.49 | 0.49 | 0.48 | 0.49 | 0.49 | 0.48 | 0.48 | 0.49 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 0.47 | 0.48 | 0.46 | 0.47 | 0.47 | 0.47 | 0.46 | 0.46 | 0.47 |
| 89 | 0.17 | 0.18 | 0.21 | 0.24 | 0.27 | 0.31 | 0.34 | 0.35 | 0.38 | 0.39 | 0.40 | 0.41 | 0.43 | 0.44 | 0.44 | 0.45 | 0.45 | 0.46 | 0.46 | 0.45 | 0.46 | 0.46 | 0.46 | 0.45 | 0.46 | 0.47 | 0.46 | 0.45 | 0.46 | 0.46 | 0.45 | 0.46 | 0.45 | 0.46 |
| 90 | 0.13 | 0.15 | 0.20 | 0.23 | 0.26 | 0.28 | 0.31 | 0.34 | 0.35 | 0.37 | 0.38 | 0.40 | 0.41 | 0.41 | 0.43 | 0.44 | 0.43 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.46 | 0.45 | 0.45 | 0.45 | 0.45 | 0.46 | 0.45 | 0.45 |

Column Count from Production Well (Production Well at right)

| Depth Below Top of Aquifer (feet) | 34 | 33 | 32 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61 | 0.06 | 0.07 | 0.07 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.04 | 0.05 | 0.05 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.03 | 0.02 |
| 62 | 0.08 | 0.07 | 0.08 | 0.07 | 0.07 | 0.07 | 0.07 | 0.08 | 0.07 | 0.07 | 0.06 | 0.06 | 0.07 | 0.07 | 0.07 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.05 | 0.05 | 0.05 | 0.06 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.04 | 0.04 | 0.04 | 0.04 |
| 63 | 0.08 | 0.08 | 0.09 | 0.08 | 0.08 | 0.09 | 0.09 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.07 | 0.07 | 0.08 | 0.07 | 0.06 | 0.07 | 0.07 | 0.06 | 0.06 | 0.07 | 0.06 | 0.05 | 0.05 | 0.05 | 0.04 | 0.05 | 0.05 | 0.04 | 0.05 | 0.05 |
| 64 | 0.09 | 0.10 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.08 | 0.08 | 0.08 | 0.09 | 0.08 | 0.08 | 0.09 | 0.08 | 0.07 | 0.08 | 0.08 | 0.07 | 0.06 | 0.07 | 0.06 | 0.06 | 0.06 | 0.05 | 0.05 | 0.05 | 0.05 | 0.04 | 0.04 |
| 65 | 0.10 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.10 | 0.10 | 0.11 | 0.10 | 0.10 | 0.10 | 0.09 | 0.10 | 0.09 | 0.09 | 0.10 | 0.09 | 0.09 | 0.09 | 0.09 | 0.08 | 0.08 | 0.08 | 0.07 | 0.07 | 0.07 | 0.06 | 0.06 | 0.06 | 0.06 | 0.05 | 0.05 | 0.05 |
| 66 | 0.13 | 0.13 | 0.12 | 0.12 | 0.12 | 0.12 | 0.13 | 0.13 | 0.12 | 0.11 | 0.11 | 0.12 | 0.12 | 0.12 | 0.10 | 0.10 | 0.11 | 0.11 | 0.11 | 0.10 | 0.09 | 0.10 | 0.09 | 0.08 | 0.08 | 0.09 | 0.08 | 0.07 | 0.07 | 0.07 | 0.06 | 0.05 | 0.06 | 0.07 |
| 67 | 0.14 | 0.14 | 0.14 | 0.15 | 0.15 | 0.14 | 0.13 | 0.13 | 0.14 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.12 | 0.13 | 0.13 | 0.12 | 0.12 | 0.12 | 0.11 | 0.10 | 0.10 | 0.11 | 0.10 | 0.09 | 0.09 | 0.09 | 0.08 | 0.08 | 0.07 | 0.06 | 0.06 | 0.06 |
| 68 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.15 | 0.15 | 0.15 | 0.14 | 0.13 | 0.14 | 0.15 | 0.13 | 0.13 | 0.13 | 0.11 | 0.12 | 0.12 | 0.10 | 0.10 | 0.10 | 0.09 | 0.09 | 0.08 | 0.07 | 0.06 | 0.06 |
| 69 | 0.19 | 0.19 | 0.19 | 0.19 | 0.18 | 0.18 | 0.19 | 0.19 | 0.18 | 0.18 | 0.18 | 0.18 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.16 | 0.16 | 0.16 | 0.15 | 0.15 | 0.15 | 0.14 | 0.13 | 0.13 | 0.12 | 0.12 | 0.11 | 0.10 | 0.09 | 0.09 | 0.08 | 0.07 |
| 70 | 0.21 | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.20 | 0.20 | 0.20 | 0.21 | 0.21 | 0.20 | 0.19 | 0.19 | 0.19 | 0.18 | 0.17 | 0.17 | 0.16 | 0.16 | 0.14 | 0.13 | 0.13 | 0.12 | 0.10 | 0.10 | 0.09 | 0.08 |
| 71 | 0.25 | 0.25 | 0.25 | 0.24 | 0.24 | 0.24 | 0.24 | 0.25 | 0.25 | 0.25 | 0.25 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.23 | 0.23 | 0.23 | 0.22 | 0.22 | 0.22 | 0.20 | 0.19 | 0.19 | 0.17 | 0.15 | 0.14 | 0.13 | 0.11 | 0.09 | 0.08 |
| 72 | 0.28 | 0.28 | 0.28 | 0.28 | 0.29 | 0.29 | 0.28 | 0.28 | 0.29 | 0.29 | 0.29 | 0.29 | 0.29 | 0.30 | 0.30 | 0.29 | 0.29 | 0.29 | 0.30 | 0.30 | 0.28 | 0.28 | 0.28 | 0.27 | 0.27 | 0.25 | 0.24 | 0.23 | 0.22 | 0.19 | 0.16 | 0.14 | 0.13 | 0.12 |
| 73 | 0.32 | 0.32 | 0.32 | 0.33 | 0.32 | 0.32 | 0.33 | 0.33 | 0.33 | 0.34 | 0.34 | 0.34 | 0.34 | 0.34 | 0.36 | 0.36 | 0.36 | 0.36 | 0.37 | 0.37 | 0.37 | 0.37 | 0.37 | 0.36 | 0.36 | 0.36 | 0.35 | 0.32 | 0.30 | 0.27 | 0.25 | 0.21 | 0.17 | 0.17 |
| 74 | 0.36 | 0.36 | 0.36 | 0.37 | 0.37 | 0.37 | 0.38 | 0.38 | 0.38 | 0.38 | 0.40 | 0.41 | 0.41 | 0.41 | 0.43 | 0.43 | 0.44 | 0.45 | 0.47 | 0.48 | 0.48 | 0.50 | 0.51 | 0.52 | 0.52 | 0.52 | 0.53 | 0.52 | 0.50 | 0.47 | 0.42 | 0.35 | 0.26 | 0.21 |
| 75 | 0.41 | 0.41 | 0.41 | 0.41 | 0.41 | 0.42 | 0.42 | 0.43 | 0.44 | 0.44 | 0.45 | 0.47 | 0.48 | 0.49 | 0.51 | 0.52 | 0.54 | 0.56 | 0.58 | 0.61 | 0.64 | 0.66 | 0.70 | 0.75 | 0.77 | 0.82 | 0.87 | 0.91 | 0.95 | 0.98 | 0.97 | 0.92 | 0.76 | 0.63 |
| 76 | 0.45 | 0.45 | 0.45 | 0.45 | 0.46 | 0.47 | 0.47 | 0.48 | 0.49 | 0.51 | 0.52 | 0.53 | 0.55 | 0.57 | 0.59 | 0.61 | 0.65 | 0.69 | 0.72 | 0.77 | 0.82 | 0.88 | 0.95 | 1.02 | 1.12 | 1.25 | 1.40 | 1.59 | 1.85 | 2.22 | 2.78 | 3.75 | 5.92 | 7.44 |
| 77 | 0.48 | 0.49 | 0.49 | 0.48 | 0.50 | 0.51 | 0.52 | 0.53 | 0.54 | 0.56 | 0.57 | 0.59 | 0.62 | 0.64 | 0.68 | 0.71 | 0.75 | 0.80 | 0.85 | 0.91 | 0.99 | 1.08 | 1.18 | 1.31 | 1.47 | 1.66 | 1.92 | 2.27 | 2.75 | 3.46 | 4.59 | 6.58 | 11.05 | 14.22 |
| 78 | 0.52 | 0.52 | 0.52 | 0.53 | 0.53 | 0.55 | 0.56 | 0.56 | 0.58 | 0.60 | 0.63 | 0.65 | 0.67 | 0.71 | 0.75 | 0.79 | 0.84 | 0.89 | 0.96 | 1.04 | 1.13 | 1.24 | 1.36 | 1.52 | 1.72 | 1.94 | 2.25 | 2.65 | 3.19 | 3.96 | 5.14 | 7.15 | 11.54 | 14.64 |
| 79 | 0.54 | 0.55 | 0.55 | 0.55 | 0.56 | 0.57 | 0.58 | 0.60 | 0.62 | 0.63 | 0.66 | 0.69 | 0.72 | 0.76 | 0.80 | 0.84 | 0.90 | 0.96 | 1.04 | 1.12 | 1.22 | 1.34 | 1.48 | 1.65 | 1.85 | 2.10 | 2.42 | 2.83 | 3.37 | 4.15 | 5.29 | 7.28 | 11.64 | 14.69 |
| 80 | 0.56 | 0.56 | 0.56 | 0.57 | 0.58 | 0.58 | 0.60 | 0.62 | 0.63 | 0.66 | 0.69 | 0.71 | 0.74 | 0.79 | 0.82 | 0.88 | 0.94 | 1.00 | 1.08 | 1.17 | 1.27 | 1.39 | 1.54 | 1.71 | 1.92 | 2.17 | 2.48 | 2.90 | 3.44 | 4.20 | 5.36 | 7.33 | 11.67 | 14.74 |
| 81 | 0.56 | 0.57 | 0.58 | 0.57 | 0.58 | 0.60 | 0.61 | 0.62 | 0.65 | 0.67 | 0.69 | 0.72 | 0.76 | 0.78 | 0.83 | 0.88 | 0.95 | 1.01 | 1.08 | 1.18 | 1.28 | 1.40 | 1.55 | 1.71 | 1.92 | 2.18 | 2.49 | 2.89 | 3.44 | 4.21 | 5.36 | 7.33 | 11.67 | 14.74 |
| 82 | 0.56 | 0.57 | 0.57 | 0.57 | 0.58 | 0.59 | 0.61 | 0.62 | 0.63 | 0.66 | 0.68 | 0.71 | 0.74 | 0.77 | 0.82 | 0.87 | 0.92 | 0.98 | 1.06 | 1.14 | 1.24 | 1.36 | 1.50 | 1.66 | 1.86 | 2.12 | 2.43 | 2.84 | 3.39 | 4.15 | 5.30 | 7.29 | 11.64 | 14.70 |
| 83 | 0.56 | 0.56 | 0.56 | 0.56 | 0.57 | 0.58 | 0.59 | 0.60 | 0.62 | 0.64 | 0.66 | 0.68 | 0.71 | 0.74 | 0.78 | 0.83 | 0.87 | 0.92 | 0.99 | 1.07 | 1.16 | 1.27 | 1.39 | 1.54 | 1.73 | 1.97 | 2.28 | 2.67 | 3.21 | 3.97 | 5.15 | 7.16 | 11.55 | 14.65 |
| 84 | 0.54 | 0.54 | 0.54 | 0.55 | 0.56 | 0.56 | 0.58 | 0.58 | 0.59 | 0.61 | 0.63 | 0.64 | 0.67 | 0.70 | 0.73 | 0.76 | 0.80 | 0.84 | 0.90 | 0.96 | 1.03 | 1.12 | 1.22 | 1.35 | 1.50 | 1.70 | 1.95 | 2.30 | 2.78 | 3.48 | 4.61 | 6.60 | 11.07 | 14.25 |
| 85 | 0.52 | 0.52 | 0.52 | 0.52 | 0.53 | 0.55 | 0.55 | 0.55 | 0.56 | 0.57 | 0.59 | 0.60 | 0.62 | 0.63 | 0.66 | 0.69 | 0.71 | 0.74 | 0.78 | 0.82 | 0.87 | 0.93 | 1.00 | 1.07 | 1.17 | 1.29 | 1.44 | 1.63 | 1.89 | 2.25 | 2.81 | 3.78 | 5.94 | 7.47 |
| 86 | 0.50 | 0.50 | 0.50 | 0.51 | 0.51 | 0.51 | 0.52 | 0.52 | 0.53 | 0.53 | 0.54 | 0.56 | 0.57 | 0.57 | 0.59 | 0.61 | 0.62 | 0.64 | 0.66 | 0.69 | 0.72 | 0.73 | 0.77 | 0.81 | 0.84 | 0.88 | 0.92 | 0.96 | 0.99 | 1.02 | 1.02 | 0.95 | 0.79 | 0.67 |
| 87 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 0.49 | 0.49 | 0.50 | 0.50 | 0.51 | 0.52 | 0.52 | 0.53 | 0.53 | 0.54 | 0.55 | 0.56 | 0.56 | 0.57 | 0.57 | 0.58 | 0.59 | 0.60 | 0.60 | 0.60 | 0.59 | 0.58 | 0.56 | 0.53 | 0.47 | 0.39 | 0.30 | 0.24 |
| 88 | 0.47 | 0.46 | 0.46 | 0.47 | 0.47 | 0.47 | 0.46 | 0.48 | 0.47 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 0.49 | 0.48 | 0.48 | 0.49 | 0.49 | 0.48 | 0.49 | 0.49 | 0.48 | 0.47 | 0.46 | 0.45 | 0.43 | 0.41 | 0.37 | 0.34 | 0.31 | 0.25 | 0.22 | 0.21 |
| 89 | 0.46 | 0.45 | 0.46 | 0.45 | 0.46 | 0.46 | 0.45 | 0.46 | 0.47 | 0.46 | 0.45 | 0.46 | 0.46 | 0.46 | 0.45 | 0.46 | 0.46 | 0.45 | 0.45 | 0.44 | 0.44 | 0.43 | 0.41 | 0.40 | 0.39 | 0.38 | 0.35 | 0.34 | 0.31 | 0.27 | 0.24 | 0.21 | 0.18 | 0.17 |
| 90 | 0.45 | 0.45 | 0.46 | 0.45 | 0.45 | 0.45 | 0.45 | 0.46 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.43 | 0.44 | 0.43 | 0.41 | 0.41 | 0.40 | 0.38 | 0.37 | 0.35 | 0.34 | 0.31 | 0.28 | 0.26 | 0.23 | 0.20 | 0.15 | 0.13 |

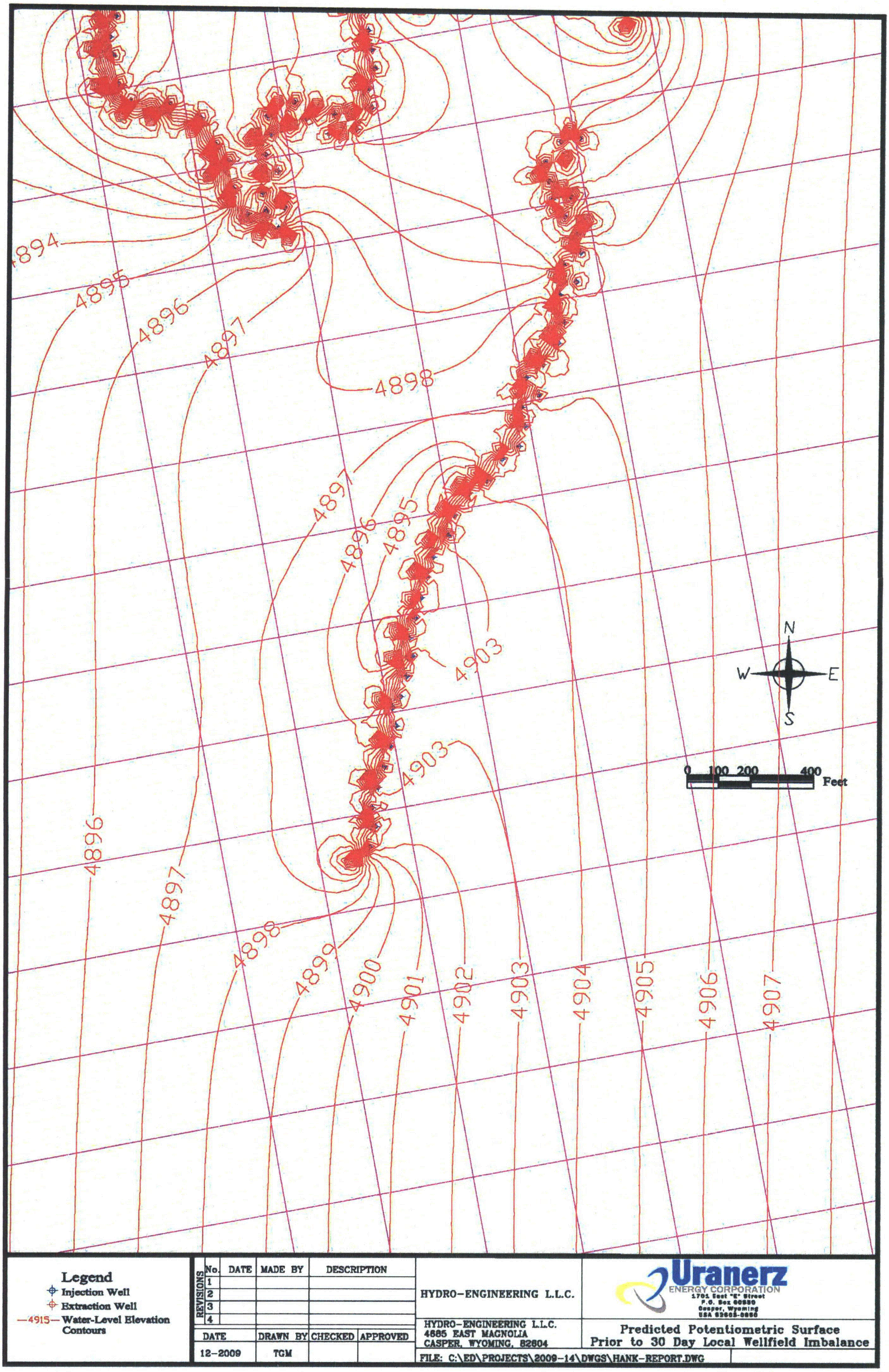



Figure MPH.1-13. Predicted Potentiometric Surface Prior to 30 Day Local Wellfield Imbalance

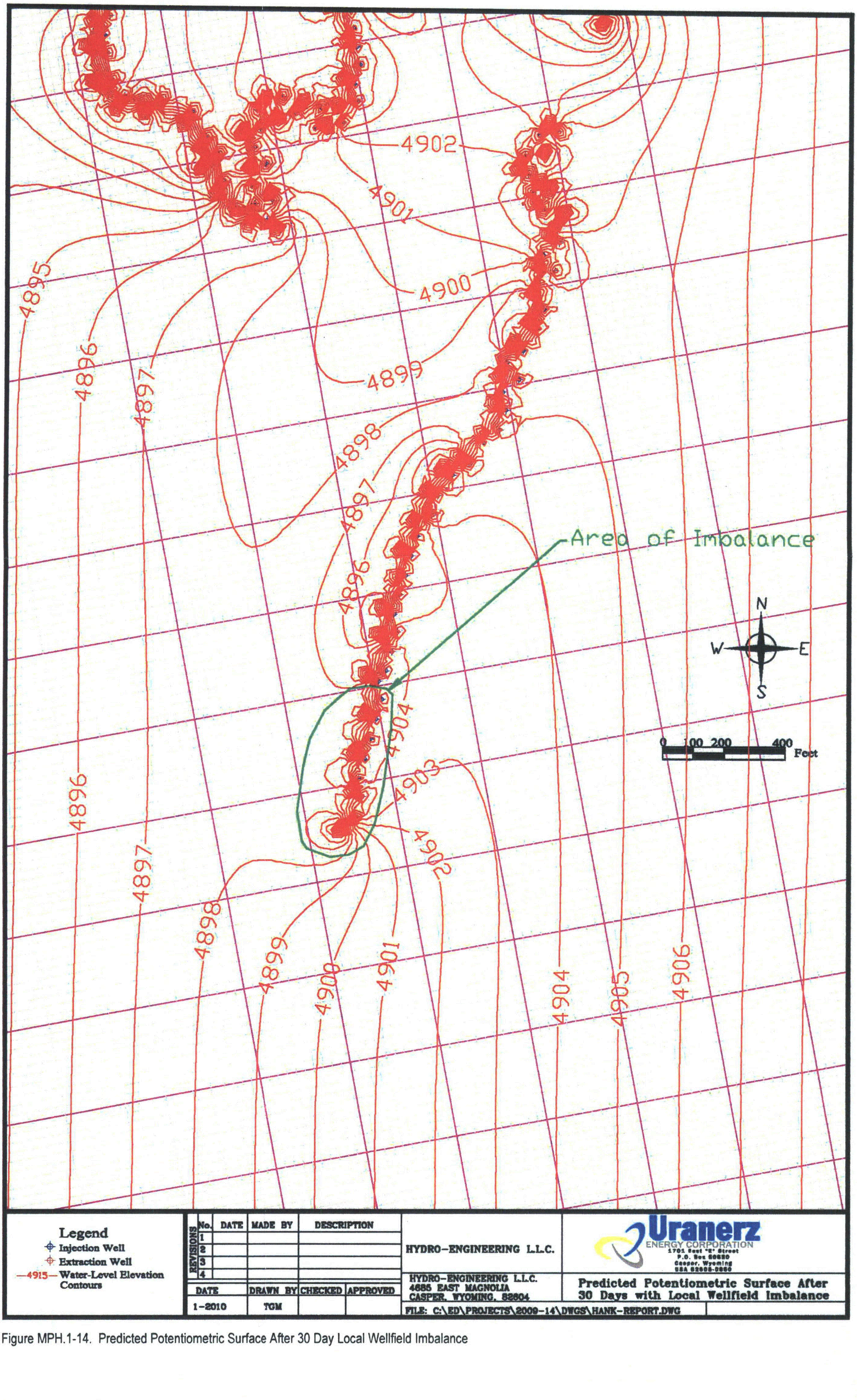



Figure MPH.1-14. Predicted Potentiometric Surface After 30 Day Local Wellfield Imbalance

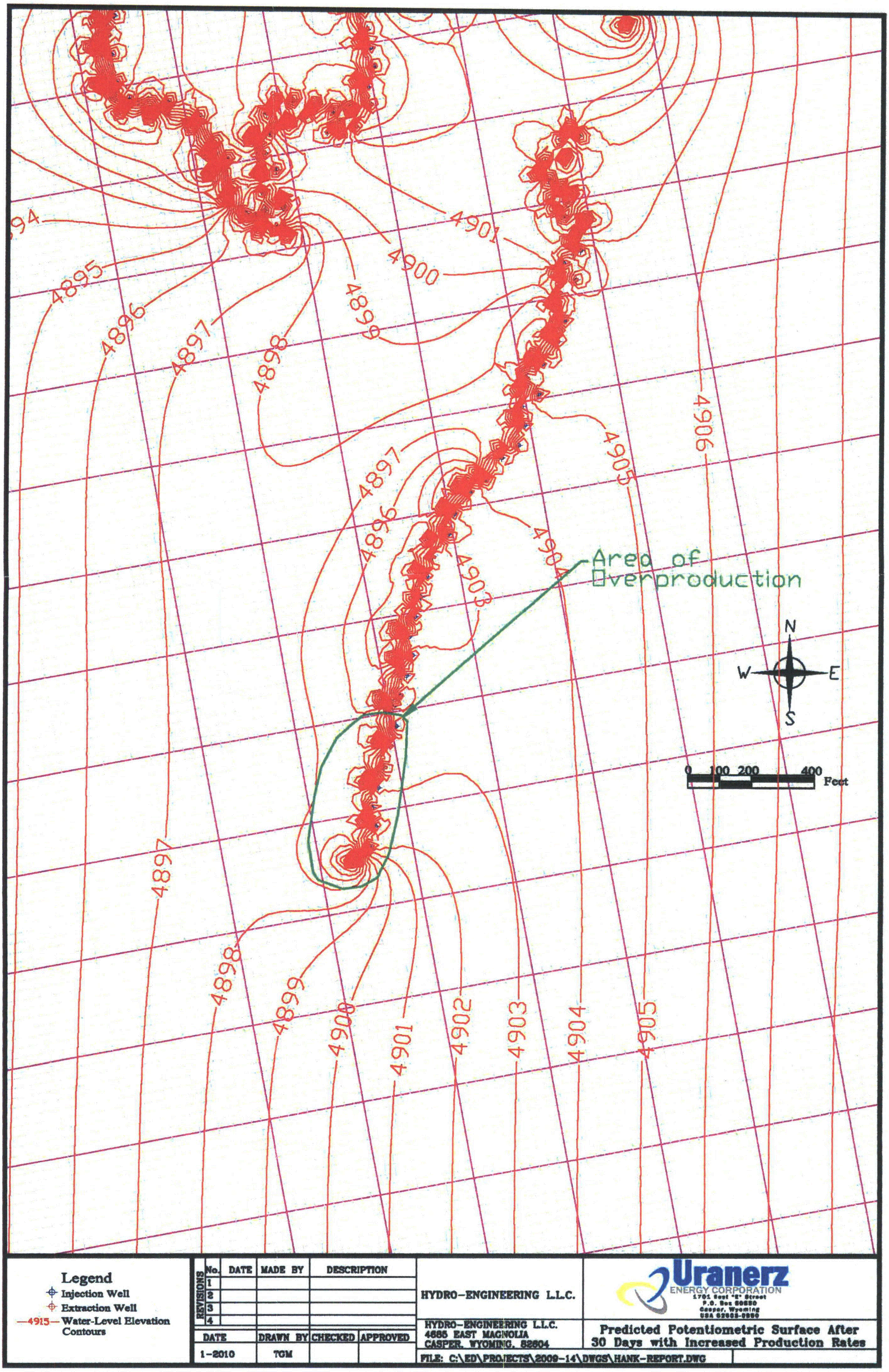



Figure MPH.1-15. Predicted Potentiometric Surface After 30 Days with Increased Production Rates

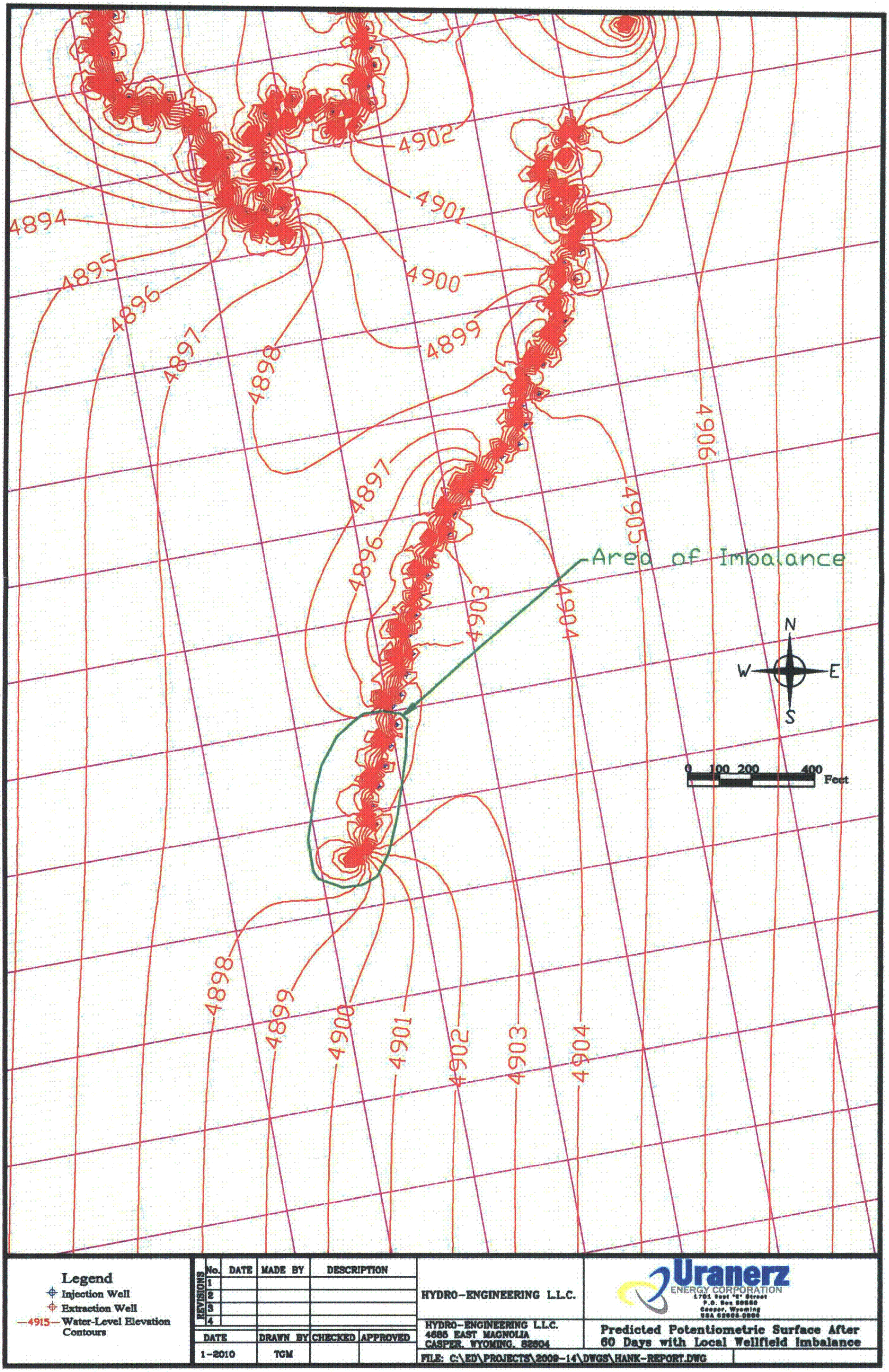



Figure MPH.1-16. Predicted Potentiometric Surface After 60 Day Local Wellfield Imbalance

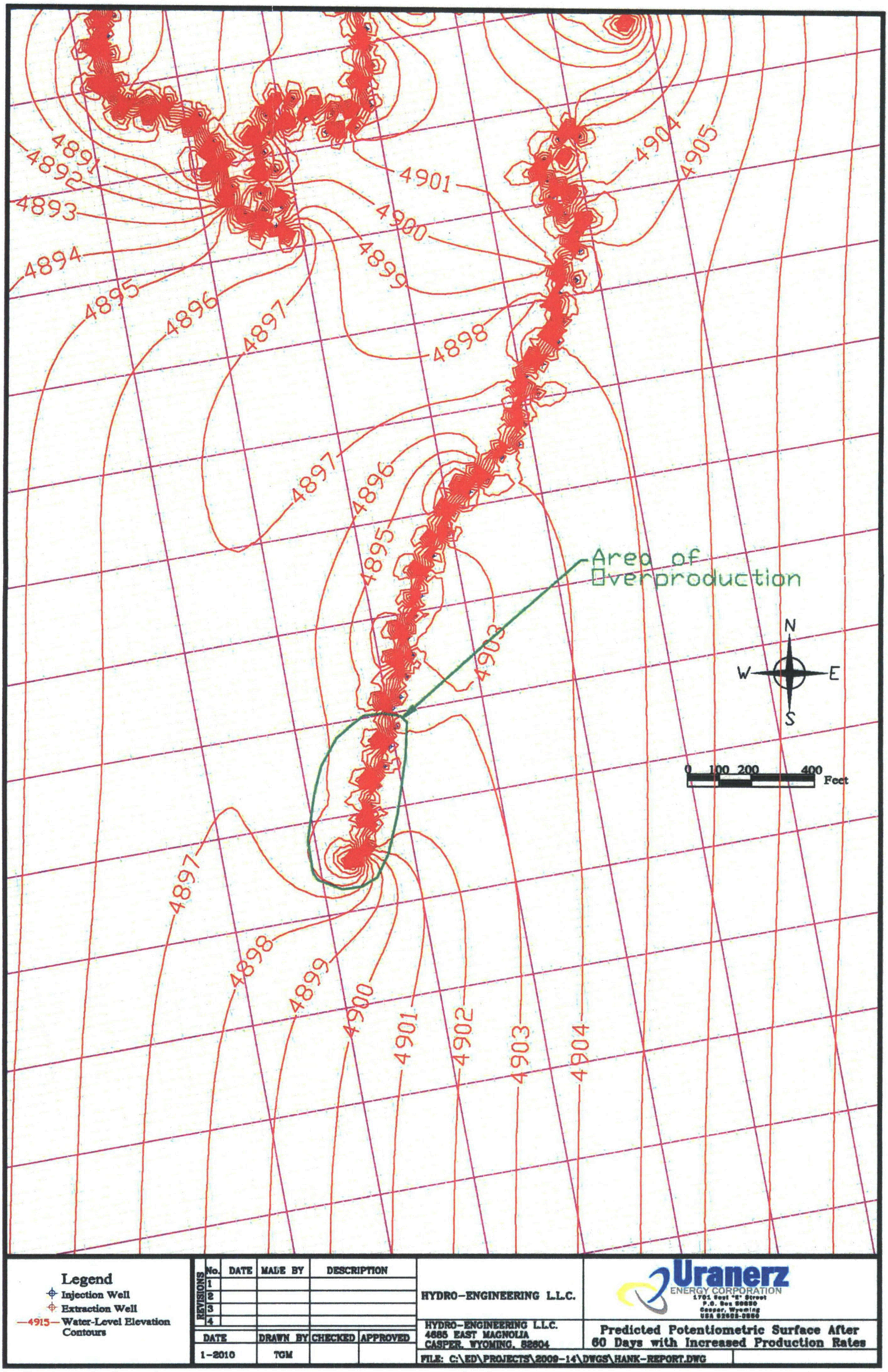



Figure MPH.1-17. Predicted Potentiometric Surface After 60 Days with Increased Production Rates

# ADDENDUM 6B:

# NICHOLS RANCH ISR PROJECT SURETY ESTIMATE

**June 2010**

Uranerz
ENERGY CORPORATION

# Surety Estimate
# First Year of Operation
# Nichols Ranch In-Situ Recovery Project
# Uranerz Energy Corporation

**Total Restoration and Reclamation Cost Estimates**

| No. | Cost Item | Cost |
|---|---|---|
| 1 | GROUNDWATER RESTORATION COST | $2,955,240 |
| 2a | PLANT EQUIPMENT REMOVAL AND DISPOSAL COST | $213,150 |
| 2b | BUILDING DEMOLITION AND DISPOSAL COST | $911,292 |
| 3 | SOIL REMOVAL & DISPOSAL COST | $234,300 |
| 4 | TOTAL WELL ABANDONMENT COST | $319,234 |
| 5 | WELLFIELD EQUIPMENT REMOVAL & DISPOSAL COST | $335,643 |
| 6 | TOPSOIL REPLACEMENT & REVEGETATION COST | $313,978 |
| 7 | MISCELLANEOUS RECLAMATION COST | $3,335 |
| | Subtotal Restoration and Reclamation Cost Estimate | $5,286,171 |
| | Subtotal | $5,286,171 |
| | Administration,Overhead and Contingency (25%) | $1,321,543 |
| | Total | $6,607,714 |
| | TOTAL CALCULATED IN 2010 DOLLARS | $6,607,714 |

**US DEPT. of COMMERCE PRODUCER PRICE INDEX ADJUSMENT 2007 to 2010** **5.78%**
**US DEPT. of COMMERCE PRODUCER PRICE INDEX ADJUSMENT 2009 to 2010** **5.31%**

Note: Unit costs presented in the various worksheets in this estimate originally incorporated 2007 values. Subsequently, where available, unit costs from the latest version (2009) of WDEQ Guideline 12, App K were included. All unit costs, whether 2007 or 2009, were adjusted by the Producer Price Index factor for the respective data. Note that PPI was used rather than Consumer Price Index as identified during WDEQ review, as changes in producer prices are more appropriate for industrial applications than a consumer price index.

**Surety Estimate**
**First Year of Operation**
**Nichols Ranch ISR Project**
**Uranerz Energy Corporation**

**Worksheet 1, No. I --**
**GROUNDWATER RESTORATION**

| Cost Item | Mining Unit<br>Nichols #1 | Notes |
|---|---|---|
| **Technical Assumptions** | | |
| Wellfield Area ($Ft^2$) | 1,551,650 | |
| Wellfield Area (Acres) | 35.62 | 66.21 Ac at Nichols, 45.56 at Hank per URZ permit |
| Affected Ore Zone Area ($Ft^2$) | 1,551,650 | |
| Avg Completed Thickness (Ft) | 7.27 | |
| Factor for Flare | 1.45 | |
| Affected Volume: | 16,356,717 | |
| Porosity | 0.3 | |
| Gallons per Cubic Foot | 7.48 | |
| Gallon per Pore Volume | 36,704,474 | |
| Number of Wells in Unit(s) | | |
| Recovery Wells | 233 | |
| Injection Wells | 259 | |
| Monitor Wells | 33 | |
| Average Well Spacing (Ft) | 100 | |
| Average Well Depth (Ft) | 550 | |
| **I Groundwater Sweep** | | |
| A. Plant & Office | | |
| Operating Assumptions: | | |
| Flowrate (gpm) | 50 | |
| PV's Required | 1.00 | |
| Total Gallons for Treatment | 36,704,474 | |
| Total Kgals for Treatment | 36,704 | |
| Cost Assumptions: | | |
| Power | | |
| Avg Connected Hp | 15 | |
| Kwh's/Hp | 0.9325 | |
| $/Kwh | 0.05 | $.02 plus demand charges per quote |
| Gallons per Minute | 50 | |
| Gallons per Hour | 3000 | |
| Cost per Hour | $0.74 | |
| Cost per Kgal ($) | $0.247 | |
| Chemicals | | |
| Barium Chloride ($/Kgals) | $0.043 | Costs from operating ISR facility experience (Cogema) |
| Antiscalent ($/Kgals) | $0.000 | Costs from operating ISR facility experience (Cogema) |
| Elution ($/Kgals) | $0.105 | Costs from operating ISR facility experience (Cogema) |
| Repair & Maintenance ($/Kgals) | $0.065 | Costs from operating ISR facility experience (Cogema) |
| Analysis ($/Kgals) | $0.173 | Costs from operating ISR facility experience (Cogema) |
| Total Cost per Kgal | $0.63 | |
| Total Treatment Cost | $23,223 | |
| Utilities | | |
| Power ($/Month) | 1,904 | |
| Propane ($/Month) | 846 | |
| Time for Treatment | | |
| Minutes for Treatment | 734,089 | |
| Hours for Treatment | 12,235 | |
| Days for Treatment | 510 | |
| Average Days per Month | 30 | |
| Months for Treatment | 17.0 | |
| Years for Treatment | 1.42 | |
| Utilities Cost ($) | $46,735 | |
| **TOTAL PLANT & OFFICE COST** | **$69,958** | |
| B. WELLFIELD | | |
| Cost Assumptions: | | |
| Power | | |
| Avg Flow/Pump (gpm) | 1 | |
| Avg Hp/Pump | 1.5 | |
| Avg # of Pumps Required | 50 | |
| Avg Connected Hp | 75 | |
| Kwh's/Hp | 0.9325 | |
| $/Kwh | 0.05289 | |
| Gallons per Minute | 50 | |
| Gallons per Hour | 3000 | |
| Costs per Hour ($) | $3.70 | |
| Costs per Gallon ($) | $0.0012 | |
| Costs per Kgal ($) | $1.23 | |
| Repair & Maintenance ($/Kgals) | $0.017 | |
| Total Cost per Kgal | $1.250 | |
| TOTAL WELLFIELD COST | $45,878 | |
| **TOTAL GROUNDWATER SWEEP COST** | **$115,836** | |

Surety Estimate
First Year of Operation
Nichols Ranch ISR Project
Uranerz Energy Corporation

**Worksheet 1, No. II**
**GROUNDWATER RESTORATION**

| Cost Item | Mining Unit Nichols #1 | Notes |
|---|---|---|
| **II REVERSE OSMOSIS** | | |
| A. PLANT & OFFICE | | |
| Operating Assumptions: | | |
| Flowrate (gpm) | 50 | |
| PV's Required | 6.00 | |
| Total Gallons for Treatment | 220,226,842 | |
| Total Kgals for Treatment | 220,227 | |
| Feed to RO (gpm) | 50 | |
| Permeate Flow (gpm) | 40 | |
| Brine Flow (gpm) | 10 | |
| Average RO Recovery | 80% | |
| Cost Assumptions: | | |
| Power | | |
| Avg Connected Hp | 20 | |
| kWh/Hp | 0.9325 | |
| $/Kwh | 0.05289 | $.02 plus demand charges per quote |
| Gallons per Minute | 50 | |
| Gallons per Hour | 3000 | |
| Cost per Hour ($) | $0.99 | |
| Cost per Gallon ($) | $0.0003 | |
| Cost per Kgal ($) | $0.33 | |
| Chemicals | | |
| Sulfuric Acid ($/Kgals) | $0.080 | Costs from operating ISR facility experience (Cogema) |
| Caustic Soda ($/Kgals) | $0.117 | Costs from operating ISR facility experience (Cogema) |
| Hydrochloric Acid ($Kgals) | $0.010 | Costs from operating ISR facility experience (Cogema) |
| Hydrochloric Sulfide ($Kgals) | $0.322 | Costs from operating ISR facility experience (Cogema) |
| Repair & Maintenance ($Kgals) | $0.295 | Costs from operating ISR facility experience (Cogema) |
| Sampling & Analysis ($/Kgals) | $0.173 | Costs from operating ISR facility experience (Cogema) |
| Total Cost per Kgal ($) | $1.33 | |
| Total Pumping Cost ($) | $292,088 | |
| Utilities | | |
| Power ($/Month) | 1,904 | |
| Propane ($/Month) | 846 | |
| Time for Treatment | 0 | |
| Minutes for Treatment | 4,404,537 | |
| Hours for Treatment | 73,409 | |
| Days for Treatment | 3,059 | |
| Average Days per Month | 30 | |
| Months for Treatment | 101 | |
| Utilities Cost ($) | $276,720 | |
| **TOTAL PLANT & OFFICE COST** | **$568,808** | |
| B. WELLFIELD | | |
| Cost Assumptions: | | |
| Power | | |
| Avg Flow/Pump (gpm) | 1 | |
| Avg Hp/Pump | 1.5 | |
| Avg # of Pumps Required | 72.5 | |
| Avg Connected Hp | 108.75 | |
| Kwh's/Hp | 0.9325 | |
| $/Kwh | 0.053 | |
| Gallons per Minute | 72.5 | |
| Gallons per Hour | 4350 | |
| Costs per Hour ($) | $5.36 | |
| Costs per Gallon ($) | $0.0012 | |
| Costs per Kgal ($) | $1.23 | |
| Repair & Maintenance ($/Kgals) | $0.017 | |
| Total Cost per Kgal | $1.250 | |
| **TOTAL WELLFIELD COST** | **$275,267** | |
| **TOTAL REVERSE OSMOSIS COST** | **$844,075** | |

Surety Estimate
First Year of Operation
Nichols Ranch ISR Project
Uranerz Energy Corporation

Worksheet 1, No III --
GROUNDWATER RESTORATION

| | Mining Unit | |
|---|---|---|
| **Cost Item** | Nichols #1 | **Notes** |
| **III Deep Disposal Well** | | |
| Operating Assumptions: | | |
| Total Disposal Requirement | | |
| RO Brine Total Gallons | 44,045,368 | |
| RO Brine Total Kgallons | 44,045 | |
| Brine Concentration Factor | 1 | |
| Total Concentrated Brine (Gals) | 44,045,368 | |
| Months of RO Operation | 17.0 | |
| Average Monthly Reqm't (Gallons) | 2,592,000 | |
| Average Brine Flow (gpm) | 60.0 | |
| | | |
| Total DDW Disposal (Gallons) | 44,045,368 | |
| Total DDW Disposal (Kgallons) | 44,045 | |
| Cost Assumptions: | | |
| Avg Connected Hp | 20 | |
| Kwh's/Hp | 0.9325 | |
| $/Kwh | 0.053 | $.02 plus demand charges per quote |
| Gallons per Minute | 60.0 | |
| Gallons per Hour | 3600 | |
| Cost per Hour ($) | $0.99 | |
| Cost per Gallon ($) | $0.0003 | |
| Cost per Kgal ($) | $0.27 | |
| Chemicals | | |
| RO Antiscalent ($/Kgals) | $0.203 | Costs from operating ISR facility experience (Cogema) |
| WDW Antiscalent ($/Kgals) | $0.239 | Costs from operating ISR facility experience (Cogema) |
| Sulfuric Acid ($/Kgals) | $0.296 | Costs from operating ISR facility experience (Cogema) |
| Corrosion Inhibitor | $0.230 | Costs from operating ISR facility experience (Cogema) |
| Algacide | $0.085 | Costs from operating ISR facility experience (Cogema) |
| Other | $0.000 | Costs from operating ISR facility experience (Cogema) |
| Repair & Maint. ($/Kgals) | $0.243 | Costs from operating ISR facility experience (Cogema) |
| Total Cost per Kgal | $1.570 | |
| **TOTAL DEEP DISPOSAL WELL COST** | **$69,143** | |

**Worksheet 1, Nos. IV & V --**
**GROUNDWATER RESTORATION**

| Cost Item | Mining Unit Nichols #1 | Labor Cost Factors | | | Notes |
|---|---|---|---|---|---|
| **IV STABILIZATION MONITORING** | | | | | |
| Operating Assumptions: | | | | | |
| Time of Stabilization (mos) | 17.0 | | | | |
| Frequency of Analysis (mos) | 3 | | | | |
| Total Sets of Analysis | 6 | | | | |
| Cost Assumptions: | | | | | |
| Power ($/Month) | $0 | | | | No add'l power required to sample |
| Total Power Cost | $0 | | | | |
| Quantity of Monitoring Wells | 12 | | | | |
| Cost per Event | $349 | | | | |
| Sampling & Analysis (each set) | $4,189 | | | | 12 Monitoring Wells @ $330 per event |
| Total Sampling & Analysis Cost ($) | $25,133 | | | | |
| Utilities ($/Month) | $0 | | | | No add'l utilities required to sample |
| Total Utilities Cost ($) | $0 | | | | |
| **TOTAL STABILIZATION COST** | $25,133 | | | | |
| | | | | | |
| **V LABOR** | | | | | |
| Cost Assumptions: | No. | Cost/Hour | Hours/Year | Cost | |
| Crew: | | | | | |
| 1. Supervisor | 1 | 29 | 2080 | $60,320 | |
| 2. Operators | 4 | 22 | 2080 | $183,040 | |
| 3. Maintenance | 2 | 20 | 2080 | $83,200 | |
| 4. Vehicles | 2 | 10 | 2080 | $41,600 | |
| Cost per Year | | | | $368,160 | |
| Time Required - Years | 5.02 | | | | |
| **TOTAL RESTORATION LABOR COST** | **$1,848,163** | | | | |

Surety Estimate
First Year of Operation
Nichols Ranch ISR Project
Uranerz Energy Corporation

**Worksheet 1, Nos. VI, VII & Summary --**
**GROUNDWATER RESTORATION**

| Cost Item | Mining Unit Nichols #1 | Notes |
|---|---|---|
| **VI RESTORATION CAPITAL REQUIREMENTS** | | |
| I Deep Disposal Well(s) | 1 | |
| II Plug and Abandon DDW | $52,890 | |
| III Reverse Osmosis Unit | $0 | Already in Processing Plant |
| **TOTAL RESTORATION CAPITAL REQUIREMENTS** | **$52,890** | |
| **VII RESTORATION OF EXCURSION WELLS** | | |
| I Shallow Sand Well(s) | | |
| Total Wells in Excursion | 0 | Assume no excursions during Year 1 |
| Cost of Clean-Up | $0 | |
| Total Shallow Sand Cleanup | $0 | |
| II Ore Zone Wells | | |
| Total Wells in Excursion | 0 | |
| Cost of Clean-Up | $0 | |
| Total Ore Zone Cleanup | $0 | |
| III Deep Zone Wells | | |
| Total Wells in Excursion | 0 | |
| Cost of Clean-Up | $0 | |
| Total Deep Zone Cleanup | $0 | |
| TOTAL WELLFIELD COST | | |
| **TOTAL EXCURSION CLEANUP COST** | **$0** | |
| **SUMMARY:** | | |
| I GROUNDWATER SWEEP | $115,836 | |
| II REVERSE OSMOSIS | $844,075 | |
| III WASTE DISPOSAL WELL | $69,143 | |
| IV STABILIZATION | $25,133 | |
| SUB TOTAL | $1,054,186 | |
| V LABOR | $1,848,163 | |
| VI CAPITAL | $52,890 | |
| VII EXCURSION CLEANUP | $0 | |
| **TOTAL GROUNDWATER RESTORATION COST** | **$2,955,240** | |

*Worksheet 2 a*
**PLANT EQUIPMENT REMOVAL AND DISPOSAL**

| Cost Item | Nichols Mine Unit | | | | | | | Notes |
|---|---|---|---|---|---|---|---|---|
| | Office & Laboratory | Main Process Building | Maintenance Building | Resin + Sand Filter Media | External Tanks | Header Houses | Sub Total | |
| Volume (Yds$^3$) | 40 | 200 | 45 | 110 | 109 | 240 | | add 4 add'l 17,000 gal tanks. 84 cy each crushed to 21 cy. |
| Quantity per Truck Load (Yds$^3$) | 20 | 20 | 20 | 20 | 20 | 20 | | |
| Number of Truck Loads | 2 | 10 | 2.25 | 5.5 | 5.45 | 12 | | |
| I Decontamination Cost | | | | | | | | |
| Decontamination Cost ($/Load) | 634.68 | 634.68 | 634.68 | 634.68 | 634.68 | 634.68 | | |
| Percent Requiring Decontamination | 20% | 100% | 20% | 0% | 50% | 100% | | |
| Total Cost | $254 | $6,347 | $286 | $0 | $1,730 | $7,616 | | |
| II Dismantle and Loading Cost | | | | | | | | |
| Cost per Truck Load ($) | $846 | $846 | $846 | $846 | $846 | $846 | | |
| Total Cost | $1,692 | $8,462 | $1,904 | $4,654 | $4,612 | $10,155 | | |
| III Oversize Charges | | | | | | | | |
| Percent Requiring Permits | 40% | 40% | 40% | 0% | 50% | 40% | | |
| Cost per Truck Load ($) | $423 | $423 | $423 | $423 | $423 | $423 | | |
| Total Cost | $338 | $1,692 | $381 | $0 | $1,153 | $2,031 | | |
| IV Transportation & Disposal | | | | | | | | |
| A. Landfill | | | | | | | | |
| Percent to be Shipped | 90% | 80% | 90% | 0% | 100% | 80% | | |
| Distance (Miles) | 75 | 75 | 75 | 75 | 75 | 75 | | |
| Transport Cost ($/Ton-Mile) | $0.16 | $0.16 | $0.16 | $0.16 | $0.16 | $0.16 | | |
| Transportation Cost | $463 | $2,056 | $521 | $0 | $1,401 | $2,468 | | |
| Disposal Fee per Cubic Yard | $65 | $65 | $65 | $65 | $65 | $65 | | |
| Disposal Cost ($) | $2,323 | $10,324 | $2,613 | $0 | $7,033 | $12,389 | | |
| Total Cost | $2,786 | $12,380 | $3,134 | $0 | $8,434 | $14,857 | | |
| B. Licensed Site | | | | | | | | |
| Percent to be Shipped | 10% | 20% | 10% | 100% | 0% | 20% | | |
| Distance (Miles) | 160 | 160 | 160 | 160 | 160 | 160 | | |
| Transport Cost ($/Ton-Mile) | $0.16 | $0.16 | $0.16 | $0.16 | $0.16 | $0.16 | | |
| Transport Cost | $691 | $6,912 | $778 | $19,008 | $0 | $8,294 | | |
| Disposal Cost ($/Ton) | $370 | $370 | $370 | $370 | $370 | $370 | | |
| Quantity per Truck Load (Yds$^3$) | 20 | 20 | 20 | 20 | 20 | 20 | | |
| Quantity per Truck Load (Tons) | 21.6 | 21.6 | 21.6 | 21.6 | 21.6 | 21.6 | | Based on avg 80lbs per cf |
| Disposal Cost | $1,599 | $15,994 | $1,799 | $43,983 | $0 | $19,193 | | |
| Total Cost | $2,291 | $22,906 | $2,577 | $62,991 | $0 | $27,487 | | |
| Total Cost | $5,076 | $35,286 | $5,711 | $62,991 | $8,434 | $42,344 | | |
| **TOTAL COST NICHOLS RANCH MINE** | **$7,361** | **$51,788** | **$8,281** | **$67,646** | **$15,929** | **$62,146** | **$213,150** | |

**Surety Estimate**
**First Year of Operation**
**Nichols Ranch ISR Project**
**Uranerz Energy Corporation**

**Worksheet 2 b --**
**BUILDING DEMOLITION AND DISPOSAL**

| | Nichols Mine Unit | | | | | |
|---|---|---|---|---|---|---|
| **Cost Item** | Office & Laboratory | Main Process Building | Maintenance Building | Header Houses | Sub Total | **Notes** |
| **STRUCTURE DEMOLITION & DISPOSAL** | | | | | | |
| Structural Character | | | | | | |
| Demolition Volume ($Ft^3$) | 90,000 | 1,188,000 | 144,000 | 3,000 | | |
| Unit Cost of Demolition ($/ $Ft^3$) | $0.257 | $0.257 | $0.257 | $0.257 | | Demolition Unit Cost per WDEQ Guideline No.12, App. K ($/ft3) |
| Total Demolition Cost | $23,126 | $305,264 | $37,002 | $771 | | |
| Weight of Disposal Material in Tons | 41 | 535 | 65 | 1 | | |
| Factor for Gutting | 0.1 | 0.3 | 0.2 | 0.25 | | |
| Cost for Gutting ($) | $2,313 | $91,579 | $7,400 | $193 | | |
| Quantity per Truck Load (Ton) | 21.6 | 21.6 | 21.6 | 21.6 | | |
| Number of Truckloads | 1.9 | 24.8 | 3.0 | 0.1 | | |
| Distance to Landfill | 75 | 75 | 75 | 75 | | |
| Unit Cost (Ton-Mile) | $0.16 | $0.16 | $0.16 | $0.16 | | |
| Transportation Cost | $481.96 | $6,361.87 | $771.14 | $16.07 | | |
| Disposal Cost ($/ton) | $102.89 | $102.89 | $102.89 | $102.89 | | Demolition Unit Cost per WDEQ Guideline No.12, App. K, Adjusted Cost per Unit |
| Disposal Cost ($) | $4,166.96 | $55,003.86 | $6,667.13 | $138.90 | | |
| **TOTAL STRUCTURE DEMO & DISPOSAL** | **$30,088** | **$458,209** | **$51,840** | **$1,119** | **$541,256** | |
| **CONCRETE DECONTAMINATION, DEMO & DISPOSAL** | | | | | | |
| Area | 9000 | 29700 | 8000 | 3000 | | 12 header houses @250 sq ft each |
| Average Thickness (Ft) | 0.5 | 0.5 | 0.5 | 0.5 | | |
| Volume ($Ft^3$) | 4500 | 14850 | 4000 | 1500 | | |
| Weight of Disposal Concrete Assuming 145lbs/cubic foot | 652,500 | 2,153,250 | 580,000 | 217,500 | | |
| Weight of Disposal in Tons | 326 | 1077 | 290 | 109 | | |
| Percent Requiring Decontamination | 0% | 100% | 0% | 10% | | |
| Volume Decontaminated ($Ft^2$) | 0 | 14,850 | 0 | 150 | | |
| Decontamination ($/$Ft^2$) | $0.301 | $0.301 | $0.301 | $0.301 | | Decontamination by Steam Cleaning (137.5 ft2/hr) ECHOS Unit Cost Book |
| Decontamination Cost | $0 | $4,469 | $0 | $45 | | |
| Demolition ($/$Ft^2$) | $5.05 | $5.05 | $5.05 | $5.05 | | Demolition Unit Cost per WDEQ Guideline No.12, App. K, Adjusted Cost per Unit |
| Demolition Cost | $45,494 | $150,130 | $40,439 | $15,165 | | |
| Transportation & Disposal | | | | | | |
| A. Onsite Disposal | | | | | | |
| Percent to be Disposed Onsite | 100% | 75% | 100% | 100% | | |
| Transportation Cost | $0 | $0 | $0 | $0 | | |
| Disposal Cost per Cubic Yard ($) | $8.49 | $8.49 | $8.49 | $8.49 | | Demolition Unit Cost per WDEQ Guideline No.12, App. K, Adjusted Cost per Unit |
| Disposal Cost ($) | $1,415 | $4,668 | $1,257 | $472 | | |
| B. Licensed Site | | | | | | |
| Percent to be Shipped | 0% | 25% | 0% | 0% | | |
| Distance (Miles) | 160 | 160 | 160 | 160 | | |
| Unit Cost (Ton-Mile) | $0.16 | $0.16 | $0.16 | $0.16 | | |
| Transportation Cost ($) | $0 | $6,833 | $0 | $0 | | |
| Disposal Cost ($/Ton) | $370 | $370 | $370 | $370 | | |
| Disposal Cost ($) | $0 | $99,650 | $0 | $0 | | |
| **TOTAL TRANSPORT & DISPOSAL COST** | **$46,909** | **$265,750** | **$41,697** | **$15,681** | **$370,037** | |
| **TOTAL BUILDING DEMO & DISPOSAL COST** | **$76,996** | **$723,959** | **$93,537** | **$16,800** | **$911,292** | |

Worksheet 3 b --
SOIL REMOVAL & DISPOSAL

| Cost Item | Nichols Mine Unit: Office & Laboratory | Main Process Building | Maintenance Building | Header Houses | Sub Total | Notes |
|---|---|---|---|---|---|---|
| **SOIL EXCAVATION, TRANSPORT & DISPOSAL** | | | | | | |
| Removal Under Building Footprints | | | | | | |
| Excavation, Front End Loader | $52 | $172 | $46 | $17 | | $89.04/hr per WDEQ Guideline12 and 150 cy/hr |
| Quantity to be Shipped ($Ft^3$) | 2,250 | 7,425 | 2,000 | 750 | | Assume removal of 3" of Contaminated Soil under Primary Areas, Disposal at a Licensed facility (ft3) |
| Weight in Tons | 112.5 | 371.25 | 100 | 37.5 | | |
| Distance (Miles) | 160 | 160 | 160 | 160 | | |
| Transportation Unit Cost (Ton/Mile) | $0.16 | $0.16 | $0.16 | $0.16 | | |
| Transportation Cost | $2,856 | $9,425 | $2,539 | $952 | | |
| Disposal Fee ($/Ton) | $370 | $370 | $370 | $370 | | |
| Disposal Cost ($) | $41,651 | $137,448 | $37,023 | $13,884 | $230,005 | |
| Removal NPDES Pts. | | | | | | |
| Quantity to be Shipped ($Ft^3$) | 0 | 0 | 0 | 0 | | Zero discharge facility |
| Weight in Tons | 0 | 0 | 0 | 0 | | |
| Distance (Miles) | 160 | 160 | 160 | 160 | | |
| Transportation Cost Ton/Mile ($) | $0.16 | $0.16 | $0.16 | $0.16 | | |
| Transportation Cost | $0 | $0 | $0 | $0 | | |
| Disposal Fee ($/Ton) | $370 | $370 | $370 | $370 | | |
| Disposal Cost ($) | $0 | $0 | $0 | $0 | | |
| Total NPDES Removal Cost | $0 | $0 | $0 | $0 | $0 | |
| **TOTAL SOILS EXC., TRANSPORT & DISPOSAL** | **$41,651** | **$137,448** | **$37,023** | **$13,884** | **$230,005** | |
| **RADIATION SURVEY** | | | | | | |
| Area Required (Acres) | 0.21 | 0.68 | 0.18 | 0.07 | | |
| Survey Cost ($/Acre) | $635 | $635 | $635 | $635 | | |
| Number of Structures | 1 | 1 | 1 | 12 | | |
| Cost per Structure ($) | $238 | $238 | $238 | $238 | | |
| **TOTAL RAD SURVEY COST** | **$369** | **$671** | **$355** | **$2,900** | **$4,294** | |
| **TOTAL SOIL REMOVAL & DISPOSAL COST** | **$42,020** | **$138,119** | **$37,378** | **$16,783** | **$234,300** | |

**Surety Estimate**
**First Year of Operation**
**Nichols Ranch ISR Project**
**Uranerz Energy Corporation**

**Worksheet 4 --**
**Well Abandonment**

| Cost Item | Mining Unit Nichols #1 | Notes |
|---|---|---|
| Number of Wells | 515 | Includes injection, recovery and monitor wells. |
| Average Depth (ft) | 550 | |
| Average Diameter (inch) | 5 | |
| Area of Annulus ($ft^2$) | 0.1364 | |
| Materials | | |
| Bentonite Chips Required ($Ft^3$/Well) | 40.9 | 300 feet of clay above water |
| Bags of Chips Required/Well | 55 | |
| Cost per Bag ($) | $6.82 | |
| Cost/Well Bentonite Chips ($) | $375 | |
| Gravel Fill Required ($Ft^3$/Well) | 34.1 | Avg depth less 300 feet filled w/ gravel |
| Cost of Gravel/$Yd^3$ ($) | $21 | |
| Cost/Well Gravel Fill ($) | $27 | |
| Cement Cone/Markers Req'd/Well | 1 | |
| Cost of Cement Cones Markers ($) | $6.35 | |
| Total Materials Cost per Well | $408 | |
| Labor | | |
| Hours Required per Well | 2 | |
| Labor Cost per Hour | $74 | |
| Total Labor Cost per Well ($) | 148.092 | |
| Equipment Rental | | |
| Hours Required per Well | 1 | |
| Backhoe w/Operator Cost/Hr ($) | $63 | |
| Total Equipment Cost per Well ($) | $63 | |
| Total Cost per Well ($) | $620 | |
| **TOTAL WELL ABANDONMENT COST ($)** | **$319,234** | |

**Worksheet 5, No. I --**
**WELLFIELD EQUIPMENT REMOVAL & DISPOSAL**

| Cost Item | Mining Unit<br>Nichols #1 | Notes |
|---|---|---|
| **I Wellfield Piping** | | |
| A. Removal | | |
| Total Number of Wells | 482 | Includes total injection and recovery wells |
| Feeder lines from HH to Injection wells 1" HDPE (Ft) | 71,560 | From Preliminary Design |
| Pregnant solution feeder lines from production wells to HH 1" HDPE (Ft) | 50,427 | From Preliminary Design |
| Total Quantity of 1" HDPE Piping (Ft) | 121,987 | |
| Plastic Volume ($Ft^3$) | 400.05 | Thickness Based on WL Plastics Corp PSI 160 (R1=.05479', R2=.04425') |
| Chipped Volume Assuming 30% Void Space ($Ft^3$) | 520.07 | |
| Disposal Weight (tons) | 20.80 | Year 1 buildout only to include Nichols 1 |
| Quantity per Truck Load (Tons) | 21.6 | Based on 20 cy per truckload and 80lbs per cf |
| Total Number of Truck Loads | 1 | |
| Total Length of Feeder line Trench (ft) | 40,765 | Includes Shared Trenches |
| Pipeline Removal Unit Cost ($/ft of trench) | $2.38 | Quote - Jordan Construction |
| Total Cost for Trunkline Removal ($) | $97,022 | |
| Total Cost - Removal | $97,022 | |
| B. Survey & Decontamination | | |
| Percent Requiring Decontamination | 0 | No survey or decon needed. Total volume to low level disposal |
| Loads for Decontamination | 0 | |
| Cost for Decontamination ($/Load) | $635 | |
| Cost for Decontamination ($) | $0 | |
| C. Transport & Disposal | | |
| 1.) Landfill | | |
| a. Transportation | | |
| Percent to be Shipped | 0% | |
| Loads to be Shipped | 0 | |
| Distance (Miles) | 75 | |
| Transportation Cost (Ton/Mile) ($) | $0.16 | |
| Transportation Cost ($) | $0 | |
| b. Disposal | | |
| Disposal Fee per $Yd^3$ | $65 | |
| $Yds^3$ per Load | 20 | |
| Disposal Cost ($) | $0 | |
| Total Cost - Landfill | $0 | |
| 2.) Licensed Site | | |
| a. Transportation | | |
| Percent to be Shipped | 100% | |
| Loads to be Shipped | 1 | |
| Tons to be Shipped | 20.80 | |
| Distance (Miles) | 160 | |
| Transportation Ton/Mile ($) | $0.16 | |
| Transportation Cost ($) | $528 | |
| b. Disposal | | |
| Disposal Fee per ton | $370 | |
| Disposal Cost ($) | $7,702 | |
| Total Cost - Licensed Site | $8,230 | |
| Total Cost - Transport & Disposal | $8,230 | |
| **Total Cost - WF Piping Removal & Disposal** | **$105,251** | |

Worksheet 5, No. II
WELLFIELD EQUIPMENT REMOVAL & DISPOSAL

| Cost Item | Mining Unit Nichols #1 | Notes |
|---|---|---|
| **II Production Well Pumps** | | |
| A. Pump and Tubing Removal | | |
| Number of Production Wells | 233 | |
| Cost of Removal ($/well) | $42 | |
| Cost of Removal ($) | $9,859 | |
| Number of Pumps per Truck Load | 180 | |
| Number of Truck Loads (Pumps) | 1.29 | |
| Weight of Pumps | 21.29 | Assume 20 T per truck |
| B. Survey & Decontamination (Pumps) | | |
| Percent Requiring Decontamination | 50% | |
| Loads for Decontamination | 0.65 | |
| Cost for Decontamination ($/Load) | $635 | |
| Cost for Decontamination ($) | $411 | |
| C. Tubing Volume Reduction & Loading | | |
| Length per Well (Ft) | 300 | |
| Total Quantity ($Ft^3$) | 229.2 | Thickness Based on WL Plastics Corp PSI 160 (R1=.05479', R2=.04425') |
| Chipped Volume Assuming 30% Void Space ($Ft^3$) | 298.0 | |
| Cost of Removal ($/Ft) | $0.03 | |
| Cost of Removal ($) | $9.52 | |
| Quantity per Truck Load ($Ft^3$) | 540 | |
| Number of Truck Loads | 0.42 | |
| D. Transport & Disposal | | |
| 1.) Landfill | | |
| a. Transportation | | |
| Percent to be Shipped (Pumps) | 50% | |
| Loads to be Shipped | 0.6 | |
| Distance (Miles) | 75 | |
| Transportation Ton/Mile ($) | $0.16 | |
| Transportation Cost ($) | $166 | |
| b. Disposal | | |
| Disposal Fee per $Yd^3$ | $65 | |
| $Yds^3$ per Load | 20 | |
| Disposal Cost ($) | $835 | |
| Total Cost - Landfill | $1,002 | |
| 2.) Licensed Site | | |
| a. Transportation | | |
| Percent to be Shipped (Pumps) | 50% | |
| Percent to be Shipped (Tubing) | 100% | |
| Loads to be Shipped | 1.07 | |
| Distance (Miles) | 160 | |
| Transportation Ton/Mile ($) | $0.16 | |
| Transportation Cost ($) | $588 | |
| b. Disposal | | |
| Disposal Cost per $Yd^3$ | $18.51 | |
| Disposal Volume per Load (cy) | 20 | |
| Disposal Cost | $397 | |
| Total Cost - Licensed Site | $984 | |
| Total Cost - Transport & Disposal | $1,986 | |
| **Total Cost - Pump Removal & Disposal** | **$12,265** | |

Worksheet 5, No. III
WELLFIELD EQUIPMENT REMOVAL & DISPOSAL

| Cost Item | Mining Unit Nichols #1 | Notes |
|---|---|---|
| **III Buried Trunkline** | | |
| A. Removal | | |
| Trunk lines from Resin Plant to HH 8" HDPE Pipe (Ft) | 38,473 | |
| Pregnant solution trunk lines form HH to Resin Plant 8" HDPE Pipe (Ft) | 38,473 | |
| Total Quantity of 8" HDPE Piping (Ft) | 76,946 | |
| Plastic Volume ($Ft^3$) | 51,906 | Thickness Based on WL Plastics Corp PSI 160 (R1=.7188', R2=.5494') |
| Chipped Volume Assuming 30% Void Space ($Ft^3$) | 67,478 | |
| Disposal Tons | 320 | 8.315lb/ft per WL Plastics |
| Quantity per Truck Load (Tons) | 21.6 | |
| Total Number of Truck Loads | 15 | |
| Total Length of Trunkline Trench (ft) | 38,473 | |
| Pipeline Removal Unit Cost ($/ft of trench) | $2.38 | Quote Jordan Construction |
| Total Cost for Trunkline Removal ($) | $91,568 | |
| B. Survey & Decontamination | | |
| Percent Requiring Decontamination | 0 | No survey or decon needed. Total volume to low level disposal |
| Loads for Decontamination | 0 | |
| Cost for Decontamination ($/Load) | $635 | |
| Cost for Survey & Decontamination ($) | $0 | |
| C. Transportation & Disposal | | |
| 1.) Landfill | | |
| a. Transportation | | |
| Percent to be Shipped | 0% | |
| Loads to be Shipped | 0 | |
| Distance (Miles) | 75 | |
| Transportation Cost (Ton/Mile) ($) | $0.16 | |
| Transportation Cost ($) | $0 | |
| b. Disposal | | |
| Disposal Fee per $Yd^3$ | $65 | |
| $Yds^3$ per Load | 20 | |
| Disposal Cost ($) | $0 | |
| Total Cost - Landfill | $0 | |
| 2.) Licensed Site | | |
| a. Transportation | | |
| Percent to be Shipped | 100% | |
| Loads to be Shipped | 15 | |
| Tons to be Shipped | 319.90 | |
| Distance (Miles) | 160 | |
| Transportation Ton/Mile ($) | $0.159 | |
| Transportation Cost ($) | $8,121 | |
| b. Disposal | | |
| Disposal Fee per ton | $370 | |
| Disposal Cost ($) | $118,438 | |
| Total Cost - Licensed Site | $126,559 | |
| **Total Cost Transportation & Disposal** | **$126,559** | |
| **Total Cost - Buried Trunkline Removal & Disposal** | **$218,127** | |
| **TOTAL WELLFIELD EQUIPMENT REMOVAL & DISPOSAL COST** | **$335,643** | |

**Surety Estimate**
**First Year of Operation**
**Nichols Ranch ISR Project**
**Uranerz Energy Corporation**

**Worksheet 6, No. I**
**TOPSOIL REPLACEMENT & REVEGETATION**

| | Mining Unit | |
|---|---|---|
| **Cost Item** | Nichols #1 | **Notes** |
| **I Process Plant and Office Building** | | |
| A. Topsoil Handling & Grading | | |
| Affected Area (Acres) | 5.2 | Plant site is 475' by 475' |
| Average Affected Thickness (Ins) | 12 | |
| Topsoil Volume ($Yds^3$) | 8,356 | |
| Unit Cost ($/cy) | $5 | Price from Dragstrip Soil Cover Project MT |
| Sub Total - Topsoil | $44,197 | |
| B. Radiation Survey & Soil Analysis | | |
| Unit Cost ($/Ac) | $635 | |
| Sub Total - Survey & Analysis | $3,287 | |
| C. Revegation | | |
| Fertilizer ($/Ac) | $245.41 | Price from Dragstrip Soil Cover Project MT |
| Seeding Prep & Seeding ($/Ac) | $240.12 | Price from Dragstrip Soil Cover Project MT |
| Mulching & Crimping ($/Ac) | $105.78 | Price from Dragstrip Soil Cover Project MT |
| Sub Total Cost/Acre | $591.31 | |
| Sub Total Revegation | $3,063 | |
| **TOTAL PLANT AND OFFICE BUILDING TOPSOIL REPLACEMENT & REVEG COST** | **$50,548** | |

**Surety Estimate**
**First Year of Operation**
**Nichols Ranch ISR Project**
**Uranerz Energy Corporation**

**Worksheet 6, Nos. II & III**
**TOPSOIL REPLACEMENT & REVEGETATION**

| Cost Item | Mining Unit<br>Nichols #1 | Notes |
|---|---|---|
| **II Wellfields** | | |
| A. Topsoil Handling & Grading | | |
| Affected Area (Acres) | 22 | Equals trench length times 12 feet wide |
| Average Affected Thickness (Inch) | 12 | |
| Topsoil Volume (Yds$^3$) | 35,217 | |
| Unit Cost - Haul/Place/Grading ($/cy) | $5.29 | Price from Dragstrip Soil Cover Project MT |
| Sub Total - Topsoil | $186,261 | |
| B. Radiation Survey & Soil Analysis | | |
| Unit Cost ($/Ac) | $635 | |
| Sub Total - Survey & Analysis | $13,854 | |
| C. Spill Cleanup | | |
| Affected Area (Acres) | 0 | |
| Affected Area (Ft$^2$) | 0 | |
| Affected Area Thickness (Ft) | 0.25 | |
| Affected Volume (Ft$^3$) | 0 | |
| Quantity per Truckload (Ft$^3$) | 540 | |
| Quantity to be Shipped (Loads) | 0 | |
| Distance (Miles) | 160 | |
| Transportation Cost (Ton/Mile) ($) | $0.16 | |
| Transportation Cost ($) | $0 | |
| Handling Cost ($/Load) | $212 | |
| Handling Cost ($) | $0 | |
| Disposal Fee ($/Ton) | $370 | |
| Disposal Cost ($) | $0 | |
| Sub Total - Spill Cleanup | $0 | |
| D. Revegation | | |
| Fertilizer ($/Ac) | $245.41 | Price from Dragstrip Soil Cover Project MT |
| Seeding Prep & Seeding ($/Ac) | $240.12 | Price from Dragstrip Soil Cover Project MT |
| Mulching & Crimping ($/Ac) | $105.78 | Price from Dragstrip Soil Cover Project MT |
| Sub Total Cost/Acre | $591.31 | |
| Sub Total Revegation | $12,907 | |
| **Sub Total - Wellfields** | $213,023 | |
| **TOTAL WELLFIELDS COST** | **$213,023** | |
| **III Roads** | | |
| A. Topsoil Handling & Grading | | |
| Affected Area (Acres) | 5.17 | 3750 feet by 60 feet wide |
| Average Affected Thickness (Ins) | 12 | |
| Topsoil Volume (Yds$^3$) | 8,333 | |
| Unit Cost - Haul/Place/Grading ($/cy) | $5.29 | Price from Dragstrip Soil Cover Project MT |
| Sub Total - Topsoil | $44,075 | |
| B. Radiation Survey & Soil Analysis | | |
| Unit Cost ($/Ac) | $635 | |
| Sub Total - Survey & Analysis | $3,278 | |
| C. Revegation | | |
| Fertilizer ($/Ac) | $245 | Price from Dragstrip Soil Cover Project MT |
| Seeding Prep & Seeding ($/Ac) | $240 | Price from Dragstrip Soil Cover Project MT |
| Mulching & Crimping ($/Ac) | $106 | Price from Dragstrip Soil Cover Project MT |
| Sub Total Cost/Acre | $591 | |
| Sub Total Revegation | $3,054 | |
| Sub Total - Roads | $50,408 | |
| **TOTAL ROADS COST** | **$50,407.59** | |

**Surety Estimate**
**First Year of Operation**
**Nichols Ranch ISR Project**
**Uranerz Energy Corporation**

**Worksheet 6, Nos IV & V**
**TOPSOIL REPLACEMENT & REVEGETATION**

| Cost Item | Mining Unit<br>Nichols #1 | Notes |
|---|---|---|
| **IV Other** | | |
| A. Topsoil Handling & Grading | | |
| Affected Area (Acres) | 0 | |
| Average Affected Thickness (Ins) | 3 | |
| Topsoil Volume ($Yds^3$) | 0 | |
| Unit Cost - Haul/Place/Grading ($/Ac) | $5.29 | Price from Dragstrip Soil Cover Project MT |
| Sub Total - Topsoil | $0 | |
| B. Radiation Survey & Soil Analysis | | |
| Unit Cost ($/Ac) | $635 | |
| Sub Total - Survey & Analysis | $0 | |
| C. Revegation | | |
| Fertilizer ($/Ac) | $245.41 | Price from Dragstrip Soil Cover Project MT |
| Seeding Prep & Seeding ($/Ac) | $240.12 | Price from Dragstrip Soil Cover Project MT |
| Mulching & Crimping ($/Ac) | $105.78 | Price from Dragstrip Soil Cover Project MT |
| Sub Total Cost/Acre | $591.31 | |
| Sub Total Revegation | $0 | |
| Sub Total - Other | $0 | |
| **TOTAL OTHER COST** | **$0** | |
| **V Remedial Action** | | |
| A. Topsoil Handling & Grading | | |
| Affected Area (Acres) | 0 | Assume no excursions/spills |
| Average Affected Thickness (Ins) | 3 | |
| Topsoil Volume ($Yds^3$) | 0 | |
| Unit Cost - Haul/Place/Grading ($/cy) | $5.29 | Price from Dragstrip Soil Cover Project MT |
| Sub Total - Topsoil | $0 | |
| B. Radiation Survey & Soil Analysis | | |
| Unit Cost ($/Ac) | $635 | |
| Sub Total - Survey & Analysis | $0 | |
| C. Revegation | | |
| Fertilizer ($/Ac) | $245.41 | Price from Dragstrip Soil Cover Project MT |
| Seeding Prep & Seeding ($/Ac) | $240.12 | Price from Dragstrip Soil Cover Project MT |
| Mulching & Crimping ($/Ac) | $105.78 | Price from Dragstrip Soil Cover Project MT |
| Sub Total Cost/Acre | $591.31 | |
| Sub Total Revegation | $0 | |
| **TOTAL REMEDIAL ACTION** | **$0** | |
| **TOTAL TOPSOIL REPLACEMENT & REVEGETATION COST (Total of 7I through 7V)** | **$313,978** | |

**Surety Estimate**
**First Year of Operation**
**Nichols Ranch ISR Project**
**Uranerz Energy Corporation**

**Worksheet 7, Nos I - VII**
**MISCELLANEOUS RECLAMATION**

| | Cost Item | Mining Unit<br>Nichols #1 | Notes |
|---|---|---|---|
| I | **Fence Removal & Disposal** | | |
| | Quantity (Ft) | 8,558 | |
| | Cost of Removal/Disposal ($/Ft) | $0.39 | Demolition Unit Cost per WDEQ Guideline No.12, App. H |
| | Cost of Removal/Disposal ($) | $3,335 | |
| II | **Powerline Removal & Disposal** | | |
| | Quantity (Ft) | 160,460 | Power to Wells, header houses. Other power already in place by CBM companies |
| | Cost of Removal/Disposal ($/Ft) | $0 | Lines buried in pipe trenches. Excavation costs covered on Sheets 6I and 6III. Assume salvage of wire at no cost. |
| | Cost of Removal/Disposal ($) | $0 | |
| III | **Powerpole Removal & Disposal** | | |
| | Quantity | 0 | Overhead powerpoles and lines will remain in place for future gas production |
| | Cost of Removal/Disposal ($/Each) | 0 | |
| | Cost of Removal/Disposal ($) | $0.00 | |
| IV | **Transformer Removal & Disposal** | | |
| | Quantity | 0 | |
| | Cost of Removal/Disposal ($/Each) | 0 | Tri-County Electric will remove at no cost, WDEQ Guideline No.12, App. H |
| | Cost of Removal/Disposal ($) | 0 | |
| V | **Culvert Removal & Disposal** | | |
| | Quantity (Ft) | 0 | None |
| | Cost of Removal/Disposal ($/Ft) | $5.33 | ($101.21/20') WDEQ Guideline No.12, App. J |
| | Cost of Removal/Disposal ($) | $0.00 | |
| VI | **Guardrail Removal** | | |
| | Quantity (Ft) | 0 | None |
| | Cost of Removal/Disposal ($/Ft) | $6.88 | |
| | Cost of Removal/Disposal ($) | $0 | |
| VII | **Low Water Stream Crossing** | | |
| | Quantity | 0 | None |
| | Cost of Removal/Disposal ($/Each) | $8,462 | |
| | Cost of Removal/Disposal ($) | $0 | |
| | **TOTAL MISCELLANEOUS COST** | **$3,335** | |