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JAN 23 2009
DEPARTMENT OF
WATER RESOURCES

Before the Department of Water Resources – State of Idaho

In the matter of application for permit No. 63-32573 in the Name of M3 Eagle LLC

Certificate of Service

I certify that on this 23rd day of January 2009, I caused to be served a true and correct copy of the following documents on the following by the method indicated. This notice also identifies that NACGU after consulting with Dr Ralston, of Ralston Hydrologic Services, will not be submitting any further rebuttal reports associated with M3 Hydrologic INC's report on the SV 7 Pump Test. This allows for Dr Ralston to complete his deposition by M3 on February 3, 2009.

NACGUA's service of Ralston Hydrologic Services expert report: Hydrologic Analysis of the M3 Site – Expert Report Prepared for the North Ada County Groundwater Users Association, January 2009

NACGUA's service of Ralston Hydrologic Services expert report: Hydrologic Analysis of the M3 Site: Supplement #1 Comments from Review of Geochemistry Report - Expert Report Prepared for the North Ada County Groundwater Users Association, January 2009

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HYDROGEOLOGIC ANALYSIS OF THE M3 EAGLE SITE

PROFESSIONAL ENGINEER REGISTERED 2004 STATE OF IDAHO DALE R. RALSTON
January 19, 2009

REGISTERED PROFESSIONAL GEOLOGIST DALE R. RALSTON 55 STATE OF IDAHO
January 19, 2009

Expert Report Prepared for the
North Ada County
Groundwater Users Association

January 2009

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HYDROGEOLOGIC ANALYSIS OF THE M3 EAGLE SITE

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INTRODUCTION

The purpose of this report is to provide a hydrogeologic analysis of the M3 Eagle project with particular emphasis on potential impacts to owners of nearby private wells. The report has been prepared for the North Ada County Groundwater Users Association. This analysis is based on the review of M3 Eagle documents and supporting information on the area. My initial hydrogeologic analysis of the M3 Eagle site is presented in a memo to Jo Beeman dated November 6, 2008 (Ralston, 2008).

Three published M3 Eagle documents provide the bulk of the hydrogeologic information that has been collected in the immediate area. An additional memo prepared by Ed Squires plus unpublished tables and figures were provided in December 2008 and are cited as such.

- Hydro Logic, Inc., 2007, M3 Eagle Regional Hydrogeologic Characterization, North Ada, Canyon and Gem Counties, Idaho, Year-One Progress Report; Consulting report prepared for M3 Eagle, LLC; May 4.
- Hydro Logic, Inc., 2008a, Re-Analysis of 16 Aquifer tests in the Greater Eagle-Star Area of North Ada County, Idaho; Consulting report prepared for M3 Eagle, LLC; July 4.
- Hydro Logic, Inc., 2008b, Modeling of Ground-Water Flow in the Pierce Gulch Sand Aquifer: Five Models: History, Updates, and Predictions of Impacts Caused by Pumping at the M3 Eagle Planned Residential Community, Ada County, Idaho; Consulting report prepared for M3 Eagle, LLC; November 26.
- Squires, Ed, 2008, Surveyed Water level Measurements of Wells in the Northern Ada County/Eagle Area, for the M3 Eagle Hydrogeologic Characterization: Hydro Logic Inc. Technical Memorandum sent to Dennis Owsley of the Idaho Department of Water Resources on March 17.

This expert report is divided into six sections entitled as follows: 1) Summary of M3 Eagle Hydrogeologic Information, 2) Analysis of the Hydrogeologic Conceptual Model, 3) Analysis of the Ground-Water Flow System, 4) Analysis of the Numerical Model, 5) Discussion and 6) Conclusions and Recommendations.

SUMMARY OF M3 EAGLE HYDROGEOLOGIC INFORMATION

Hydrogeologic Conceptual Model

The ground-water system underlying the M3 Eagle site is described as follows in the 2007 Hydro Logic Inc. report.

> "Hydrogeologic studies commissioned by M3 Eagle in the North Ada County area have delineated a highly productive regional sand aquifer with good quality water that underlies the area near Eagle and Star and the proposed M3 Eagle planned community. This aquifer, herein named the Pierce Gulch Sand Aquifer, underlies the north Ada County Foothills where it extends continuously from the Eagle-Star area to the Payette River Valley. Because the Payette Valley near Letha is almost 300 feet lower than the Boise Valley near Eagle, ground water flows out of the Boise River Basin and into the Payette River Basin through the

> sands of this aquifer.... The ground water proposed to be withdrawn by M3 Eagle for its development will be from subsurface flow that has already departed the Boise Basin, on its way to the Payette Basin, so that impacts to existing area water users in the lowlands near Eagle are predicted to be small" (page 1).
>
> "The Pierce Gulch Sand Aquifer consists of a 150-to-275-foot thick sequence of stratified sand layers with inter-bedded thin and locally discontinuous layers of silt and clay. The base of the dipping aquifer is typically 480-to-700 feet deep beneath land surface of the M3 Eagle site. The aquifer sand thickens and descends deeper beneath of land surface to the south and southwest in the Eagle-Star-Meridian area and is believed to do the same to the northwest toward Payette River" (page 3).
>
> "The Pierce Gulch Sand Aquifer is bounded on its northeast side by the geologic fault system ... originally named the West Boise-Eagle fault by Wood and Anderson (1981). The base of the aquifer is underlain (and bounded) by the thick clays and mudstones of the Terteling Springs Formation. This structural dip explains why the municipals wells in Star are deeper than they are in Eagle. In the Boise River Valley near Eagle and Star, the Pierce Gulch Sand Aquifer is overlain by clays, some other minor sand aquifers, and a shallow surficial flood-plain-gravel aquifer (the present day floodplain of the Boise River). Beneath most of the M3 Eagle site, the aquifer is overlain by clay layers with no shallow surficial aquifer present" (pages 3 and 4).

Two figures from the 2007 Hydro Logic Inc. report illustrate the lateral extent of what is termed the Pierce Gulch Sand Aquifer. The attached Figure 1 (Figure 3 of the 2007 report) is a plan view map of the M3 Eagle area and shows the following features: 1) locations of selected wells, 2) the inferred location of the West Boise – Eagle Fault (dashed red line), 3) elevation contours of the bottom of the aquifer (solid black lines) and 4) the unsaturated aquifer boundary where the water-level elevation is equal to the elevation of the bottom of the aquifer (noted on Figure 1 as the geologic contact between the aquifer and the underlying mudstone facies of the Terteling Springs Formation and shown as a solid and dashed green line). The attached Figure 2 (Figure 5 of the 2007 report) is a hydrogeologic cross section oriented southwest to northeast through the M3 Eagle site. The following features are shown on Figure 2: 1) geologic logs and construction details for selected wells, 2) depiction of the Pierce Gulch Sand Aquifer showing the dip to the southwest and the unsaturated aquifer boundary to the northeast, 3) depiction of the Willow Creek Aquifer and 4) the location and approximate dip of the West Boise – Eagle Fault.

The following description of the aquifer is presented in the July 2008 report (Hydro Logic Inc., 2008a, page iv).

> "In the HCL analyses we considered whether the Pierce Gulch Sand Aquifer behaves as one aquifer or as a system of discrete aquifers separated by continuous, leaky aquitards. Although it is certain that the Pierce Gulch Sand Aquifer *is* overlain by shallower, district aquifers at some locations in the study area, we believe the continuous "sand sheet" we have identified as the Pierce Gulch Sand Aquifer behaves as, and is best conceptualized as, one continuous

heterogeneous aquifer. Certainly, and as with all natural depositional processes, the Pierce Gulch Sand Aquifer exhibits lateral and vertical variations in hydraulic conductivity and thickness. However, the observations and lines of evidence supporting a single aquifer concept are compelling".

The July 2008 report describes other hydrogeologic units in the M3 Eagle area. Summary descriptions of these units are given below (Hydro Logic Inc., 2008a, pages 4-6).

- The Terteling Springs aquitard is a mudstone facies that underlies the Pierce Gulch Sand Aquifer.
- The unnamed fluvial sand aquifer overlies and is separated in most locations from the Pierce Gulch Sand Aquifer by a sequence consisting mostly of clay and silt.
- The Boise river gravels are located on the lowland area and are hydraulically connected to the Boise River.
- The eastern upland mixed sediment/bedrock aquifers are located at higher elevation areas to the northeast of Eagle.
- The eastern upland bounded sand and gravel aquifers overlie the bedrock east of the M3 Eagle site. These units have been informally called the Sandy Hill Aquifer and the Willow Creek Aquifer.

Maps are presented that show the pattern of water-level elevations in the various hydrogeologic units in the general M3 Eagle area. The attached Figure 3 (Figure 6 of the 2007 report) shows contours of water-level elevations in 2006 in the following units: 1) the Pierce Gulch Sand Aquifer, 2) the Willow Creek Aquifer, 3) undifferentiated and local aquifers within volcanic bedrock and sediment and 4) the aquifer underlying the valley floor of the Payette River. The following characteristics are shown on Figure 3.

- Ground-water elevations shown on Figure 3 are lower in the Pierce Gulch Sand Aquifer than in the eastern upland sediment/bedrock aquifers located on the east side of the West Boise – Eagle Fault (shown as a red dashed line). This indicates that there is a hydraulic gradient from the upland sediment/bedrock aquifers to the Pierce Gulch Sand Aquifer.
- The ground-water elevations shown on Figure 3 in the Pierce Gulch Sand Aquifer are higher than in the Willow Creek Aquifer across the unsaturated aquifer boundary (shown as a solid or dashed green line). This indicates that there is a hydraulic gradient from the Pierce Gulch Sand Aquifer to the Willow Creek Aquifer.
- The ground-water elevations shown on Figure 3 in the Willow Creek Aquifer are higher than in the aquifer underlying the valley floor of the Payette River. This indicates that there is a hydraulic gradient from the Willow Creek Aquifer to the aquifer underlying the valley floor of the Payette River.
- The ground-water elevations shown on Figure 3 in the Pierce Gulch Sand Aquifer are higher than in the aquifer underlying the valley floor of the Payette River.

This indicates that there is a hydraulic gradient from the Pierce Gulch Sand Aquifer to the aquifer underlying the valley floor of the Payette River.

- The approximate locations of wells used in the creation of the water-level contour map are shown for each of the hydrogeologic units. The density of control wells is greater in the area south of the M3 Eagle area than in other portions of the mapped area.

Squires (2008) presents a water-level contour map based on 2007 field measurements. The attached Figures 4 and 5 show the 2007 water-level contour map and the locations of wells where measurements were used to create the map. Water-level contours are given for the Pierce Gulch Sand Aquifer, the Willow Creek Aquifer and the aquifer underlying the valley floor of the Payette River. Fewer control wells were used for the 2007 map and the water-level contours are more generalized than for the 2006 map. Also, the water-level elevation contours for the Pierce Gulch Sand Aquifer are controlled in part by what appears to be the termination of the unsaturated flow boundary (green line) about three miles west-northwest of the M3 Eagle property.

Aquifer Parameters

The May 2008 report includes analysis of 16 aquifer tests that have been conducted in the general M3 Eagle area (Hydro Logic Inc., 2008a). Summary statements regarding the results of this analysis are presented below.

> "The analyses of the pumping tests conducted in the Pierce Gulch Sand Aquifer indicate a highly-productive and extensive, regional-scale aquifer capable of supplying large ground-water withdrawals from beneath both the lowlands of the Boise River Valley and beneath the western portion of the north Ada County foothills..." (page iii).
>
> "Our analyses indicate that the Pierce Gulch Sand Aquifer is highly transmissive, with transmissivities typically ranging from around 40,000 gpd/ft... to over 500,000 gpd/ft. Some localized portions of the Pierce Gulch Sand Aquifer appear to have transmissivities on the order of 800,000 gpd/ft. The overall average (mean) of the valid transmissivities calculated in this study for the Pierce Gulch Sand Aquifer, to two significant figures, is 210,000 gpd/ft. This relatively large value confirms the role of the Pierce Gulch Sand Aquifer in transmitting large volumes of water as the major, regional ground water supply aquifer in the study area" (page iii).
>
> "Many of the recalculated transmissivity values are significantly higher than those reported by previous workers. The mean of the values calculated by these workers... is 140,000 gpd/ft, or about one-third lower than the recalculated mean. We attribute the lower, previously-reported values to the fact that the earlier workers did not recognize the full thickness of the Pierce Gulch Sand Aquifer and in some situations, used analytical methods that derivative analyses indicate are invalid" (pages iii and iv).
>
> "Calculated storativities in the Pierce Gulch Sand Aquifer ranged from 0.02 to $2x10^{-4}$ (unitless).... When pumped sufficiently long, ... The aquifer demonstrates 'delayed yield effects'... (page iv).

An additional aquifer test was conducted in 2008 using SVR #7 as the pumping well. A report describing the operation and results of the 2008 aquifer test is in preparation by Hydro Logic Inc. but has not been released. Draft forms of figures and tables from the 2008 aquifer test report are available as part of M3 Eagle's Technical Reports and Supporting Documentation (as of Nov. 26, 2008) and were reviewed as part of preparation of this expert report. The overview portion of the draft text for the SVR #7 aquifer test was made available for review on January 12, 2009. The following is a summary statement from the overview portion of the draft text.

> "Analysis of the test data by HLI demonstrates that the Pierce Gulch Sand Aquifer beneath the foothills areas north of the City of Eagle is more transmissivity than previously believed with a mean aquifer transmissivity of 420,000 gallons per day per foot" (Hydro Logic Inc., 2009, page 2).

Numerical Ground Water Model

The November 2008 report presents a description of the construction, calibration and operation of a seven-layer, finite difference ground-water model of a region of southwestern Idaho that includes the M3 Eagle site (Hydro Logic, Inc., 2008b). The model grid and cell assignments including boundaries are shown on Figure 6 for layer 1 and Figure 7 for layers 5-7. These figures are reproductions of Figure 4-1 of the 2008 modeling report (Hydro Logic Inc., 2008b). Layers 5-7 are used to represent the Pierce Gulch Sand Aquifer. Similar figures showing cell assignments and boundaries for layers 2, 3 and 4 are not included in the 2008 modeling report.

A summary description of the model and the model results is presented below (Hydro Logic Inc., 2008b).

> "The new M3 model:
> - Covers 520 square miles,
> - Contains almost 82,000 active cells,
> - Comprises seven active layers,
> - Has cell sizes as small as 330 feet on a side,
> - Was constructed with boundary conditions far from the M3-Eagle-Star vicinity that are unaffected by simulated pumping from the M3 site, and
> - Was calibrated to three long-term (one week to one month) aquifer tests" (pages i and ii).
>
> "The M3 model was initially developed and calibrated to the Eaglefield and Lexington Hills aquifer tests, conducted near Eagle, Idaho. During the calibration process, it became apparent to the modeling team that water levels simulated by the model in the vicinity of the M3 Eagle property, were lower than those measured in the field during 2006 and 2007. As a result, two parallel models were developed: one that generally 'honored' the aquifer transmissivities calculated from 17 pumping tests in the region (the 'Tmatch' model) and one that allowed water levels to better match the field measured values (the 'Hmatch' model). Both models met calibration criteria. Both models also generated predictions of drawdowns that would be caused by pumping from the M2 Eagle property that were generally similar (generally with a few feet of each other). By

using the two parallel models for predictions, the results are presented as a range (e.g., 'Predicted drawdowns one-half mile from the M3 property boundary range from 10 to 20 ft after 50 years of pumping.')" (page ii).

"The model shows that impacts to wells completed in the shallower un-named aquifer(s) overlying the Pierce Gulch Sand Aquifer will be smaller than those predicted for wells completed in the Pierce Gulch Sand Aquifer. The initial model predicted drawdowns in the shallower aquifer that are on the order of 2/3 of those predicted for the Pierce Gulch Sand Aquifer (Pacific Groundwater Group, 2008). Because the model was not directly calibrated to the shallow aquifer, these drawdown predictions can only be considered an approximation. It is highly probable, however, that after 50 years of pumping from the Pierce Gulch Sand Aquifer, the drawdowns in the shallower aquifer will be less than those in the underlying, deeper Pierce Gulch Sand Aquifer" (page 32).

ANALYSIS OF THE HYDROGEOLOGIC CONCEPTUAL MODEL

The hydrogeologic conceptual model presented by M3 Eagle is based on two major hydrogeologic assumptions. The first assumption is that the Pierce Gulch Sand Aquifer is laterally continuous from the Boise River Valley to the Payette River Valley. The second assumption is ground water flows through this laterally continuous aquifer from recharge areas in the Boise River Valley to discharge areas in the Payette River Valley.

In most hydrogeologic studies, the lateral extent and boundaries of aquifers are delineated based on a combination of geologic information on the depositional/structural environment, often depicted on geologic maps, and on hydrogeologic data from wells. Questions relative to the information base for the delineation of the lateral continuity and boundaries of the Pierce Gulch Sand Aquifer to the north and northwest are addressed in this section of the report.

The Hydro Logic Inc. reports (2007, 2008a and 2008b) provide only limited information on the depositional environment for the Pierce Gulch Sand Aquifer. However, discussion of the environment during emplacement of the geologic units is available in supporting documents (i.e. Wood, 1994; Squires and Wood, 2001; and Wood and Clemens, 2002; Haller and Wood, 2004). The following description of the subsurface geology is taken from Squires and Wood (2001).

"Overlying the oolite-bearing section in the Western Boise foothill outcrops, is the 'Pierce Park Sand', a 150 to 250-foot thick layer of coarse sand. This thick sand represents a large 'Gilbert-type' delta system. Where the oolite section is absent, the Pierce Park Sand conformably overlies mudstone. The reason the coarse sand directly overlies mudstone is because the delta prograded basinward over muds of the deep-lake deposits" (pages 7 and 9).

"Because this is the uppermost delta in the lacustrine sequence, we correlate it to the Pierce Park sand that crops out in the upper part of the foothills section west of Crane Creek. In the foothills, this unit is mostly foreset beds of coarse sand typical of the "Gilbert-type" of delta. Some foreset bed sets are 60 feet thick, and the sand unit as a whole is up to 250 feet thick in the foothills.....We feel fairly certain that there is a "long term" hydraulic connection in the sands of the upper delta sequence ….; however, local lenses of mudstone in that section may prevent short-term detection of well-drawdown responses. It may take months to decades for large drawdowns to propagate through this seemingly continuous section of interbedded sand and thin muds" (pages 13 14).

The focus of the scientific articles has been on the area south and southeast of the M3 Eagle development. I have not been able to find any discussion of a depositional environment that would result in the Pierce Gulch Sand unit extending and being laterally continuous from the M3 Eagle property to the Payette River Valley. Similarly, I could not find any published geologic maps that show the lateral extent of the Pierce Gulch Sand in the general vicinity of the M3 Eagle property.

Various Hydro Logic Inc. documents present depictions of the lateral extent and subsurface characteristics of the Pierce Gulch Sand Aquifer based on their hydrogeologic conceptual model and geologic data from wells. The northeast boundary of the aquifer as shown on Figures 3 and 4 includes the West Boise – Eagle Fault and the edge of saturation line of the Pierce Gulch Sand Aquifer (unsaturated aquifer boundary). There appears to be little doubt that that fault has sufficient off set to form the boundary as shown on Figures 3 and 4. There is more uncertainty regarding the orientation and continuity of the unsaturated aquifer boundary. The south and west boundaries of the aquifer are not identified on Figures 3 and 4 but are generally represented in the numerical model.

The unsaturated aquifer boundary occurs where the water-level elevation is the same as the elevation of the bottom of the aquifer. Figure 2 is a hydrogeologic cross section oriented northeast to southwest. This figure shows that the boundary is located in the vicinity of well SVR #6. Figure 8 is a draft hydrogeologic cross section oriented north-northwest to south-southeast. This figure shows that the unsaturated aquifer boundary occurs in the vicinity of M3 TW #3. The location of the unsaturated aquifer boundary based on these two cross sections fits well with the east-southeast to west-northwest boundary location shown as a solid green line on Figures 1, 3 and 4.

The location and nature of the unsaturated aquifer boundary northwest of the M3 Eagle property is poorly understood. The boundary is extended in a linear fashion to the northwest on Figures 1 and 3 taken from the 2007 Hydro Logic Inc. report. Figure 4 from Squires (2008) shows that the linear, northwest trending unsaturated aquifer boundary terminates slightly west of the range line separating range 1 west from range 2 west (R1W/R2W). The boundary of the Pierce Gulch Sand Aquifer extends on Figure 4 from the R1W/R2W line in a northwesterly direction and becomes approximately parallel with the southwest edge of the valley floor of Payette River. The hydrogeologic nature portion of the northern boundary west of the R2W/R1W line, as shown on Figure 4, is not explained in any of the Hydro Logic Inc. reports prepared to date. The boundary shown may or may not represent unsaturated aquifer conditions as are present in the M3 Eagle area.

The following is my analysis of the information base for establishment of the northern boundary of the Pierce Gulch Sand Aquifer.

- Sufficient hydrogeologic data exist to support the presence of the unsaturated aquifer boundary generally trending east-southeast to west-northwest within the M3 Eagle property (as shown by the solid green line on Figures 1, 3 and 4). This means that the shoreline of the ancestral lake in which the delta deposits were placed approximately followed the green line shown on the figures.
- Extrapolation of the unsaturated aquifer boundary in a linear fashion in a west-northwest direction from the M3 Eagle site appears to be based on water level and geologic information from the Bond well located north of the mapped boundary and the Willowbrook Irrigation well located south of the mapped boundary (Figure 5). Squires (2008, Table 1) indicates that the Bond well had an August 2007 water-level elevation of about 2,358 feet, a depth of 503 feet and is completed in the Willow Creek Aquifer. According to Squires (2008), the Willowbrook Irrigation well had an August 2007 water-level elevation of 2,477 feet with the well completed in the Pierce Gulch Sand Aquifer. A well depth is not given for the Willowbrook Irrigation well in Table 1 of Squires (2008). A well driller's report was obtained from the IDWR on-line data base for an irrigation well constructed for the Willowbrook Water Corporation. This well is 400 feet deep, has screen sections in the depth interval of 250 to 340 feet and has a reported yield of 500 gpm with a drawdown of about 190 feet. It is not known if the well driller's report is for the well measured in 2007 by Hydro Logic Inc. The difference in water-level elevation between the Willowbrook Irrigation well and the Bond well plus the proximity to the M3 Eagle property appear sufficient to justify extrapolation of the unsaturated aquifer boundary from the M3 Eagle site to the vicinity of the Willowbrook Irrigation well.
- The JDH well, located about three miles west-northwest of the Willowbrook Irrigation well, is the only well identified by Squires (2008, Table 1) as completed in the Pierce Gulch Sand Aquifer in this general area (Figure 5). The JDH well has a listed depth of 421 feet. A well driller's report for the JDH well (with the same depth) was obtained from the IDWR web site. The log shows that the well obtains water from a sand zone in the depth interval of 411 to 421 feet and had test yield of 100 gpm with 250 feet of drawdown. The basis for designating that the JDH well is completed in the Pierce Gulch Sand Aquifer is not presented in any of the Hydro Logic Inc. documents. The T Johnson well, located near the JDH well, has a designation (PGSA?) which I assume means that this 272-foot well may or may not be completed in the Pierce Gulch Sand Aquifer. The water-level elevation in the T Johnson well is similar to that reported for the JDH well.
- Essentially no hydrogeologic data are presented to support the boundary of the Pierce Gulch Sand Aquifer more than about one mile northwest of the M3 Eagle site, as shown on Figure 4. No data are available to document the continuation of the unsaturated flow boundary northwestward from the vicinity of the Willowbrook Irrigation well. The apparent termination of the unsaturated flow boundary near the R1W/R2W line as shown on Figure 4 is not supported by well data. No data are provided to support the depiction of northern boundary of the aquifer northwestward from the range line. No data have been presented that

show the continuation of the Pierce Gulch Sand Aquifer to and/or under the Payette River valley.

- I conclude that there is insufficient evidence to support the assumption that the Pierce Gulch Sand Aquifer is laterally continuous from the Boise River Valley to the Payette River Valley.

ANALYSIS OF THE GROUND-WATER FLOW SYSTEM

One of the primary investigative efforts of any ground water study is the collection of water-level elevation data from wells. This effort involves locating each well and determining the elevation of the reference point used for depth-to-water measurements (typically the top of the well casing). Interpretation of the water-level elevation data is dependent on identification of both vertical and horizontal hydraulic gradients. Each well must be examined with respect to well construction and completion, stratigraphic unit penetrated and other factors that might impact the measured water level. Water-level elevation data are typically displayed in either plan-view or cross sectional figures that show contours of equal water-level elevation. Plan-view water-level maps require utilization of data taken from wells of similar depth and/or similar hydrostratigraphic completion. Cross-sectional water-level maps must be constructed along flow lined as viewed in a plan map. The construction of a water-level contour map requires interpolation between locations of measured wells. Ground-water flow typically is shown at right angle to contour lines of equal ground-water elevation. This depiction of the flow lines is dependent on assuming that the aquifer is isotropic on the scale of the study.

Water-level contour maps are presented for the M3 Eagle area in Figure 3 for 2006 data and Figure 4 for 2007 data. The locations of wells used for the construction of the maps are shown on Figure 3 for the 2006 and Figure 5 for the 2007 data. Squires (2008, pages 2-3) states the following with respect to the two maps.

> "The 2007 contours .. are more accurate than the contours developed in 2006 and presented in our Year-One Progress report … using a 'shotgun' approach with more wells and less-accurate hand-held instruments for survey positions and elevations. The new contours continue to indicate and support the general flow patterns in the greater Eagle-Star-M3 project area that we presented in 2006. Some of the perturbations shown on the 2006 contour map were apparently the result of the inherent errors associated with using all of the water level data, even from wells that completed in overlying aquifer, were pumping (or recovery from pumping0 at the time of measurement, and/or may have been inaccurately located. The 2007 contour map … shows that ground water flows from the Boise Valley toward the Payette Valley, with a generally northwest component beneath the Eagle-Star-M3 vicinity."

Based on this statement, my analysis of the ground-water flow system is the vicinity of the M3 Eagle site is based on the water-level measurements collected in 2007. Water-elevation data obtained in 2007 (rounded to the nearest foot) are shown for wells completed in the Pierce Gulch Sand Aquifer for the M3 Eagle area in Figure 9. Note that the water-level elevations given for wells SVR#7 and SVR#9 are reversed on Figure 9 from that given in Squires (2008, Table 1). Not all wells are shown for the M3 Eagle development area because of space limitations; however, the water-level elevations of those wells excluded from Figure 9 are about the same as those shown. The black contours in Figure 9 are the same as shown in Figure 4 and were constructed by Squires (2008). The red dashed contours are based on my interpolation of the westernmost three data points (2,412, 2,450 and 2,477 feet) as described below.

The following is my analysis of the water-level elevation data shown on Figure 9.

- The 2,475-foot and higher elevation water-level contours prepared by Squires (2008) are reasonably controlled by field data and show ground-water flow generally to the west-northwest.
- The JDH well (with a water-level elevation of 2,412 feet) and the Caldwell TW#19 (with a water-level elevation of 2,450 feet) are the only data points to provide control for the 2,425 and 2,450-foot contours. There are no control wells for the 2,400 foot and lower water-level contours.
- The water-level contours prepared by Squires (2008) west of the R1W/R2W range line that indicate ground-water flow to the north-northwest appear to be based on a combination of two data points (JDH well and Caldwell TW#19) and the two assumptions that underlie the M3 Eagle Analysis: 1) the Pierce Gulch Sand Aquifer is laterally continuous from the M3 Eagle area to the Payette River Valley and 2) water flows within the aquifer from the Boise River Valley to the Payette River Valley. The 2,400-foot and lower contours that show flow to the north-northwest have no control points and appear to be based on the assumptions. The 2,425 and 2,450-foot contours drawn by Squires (2008) are not direct interpretation of the field water-level data.
- The red dashed lines on Figure 9 show the 2,425 and 2,450-foot contours that I created based in a linear interpretation of the hydraulic gradient between wells with water-level data (JDH well at 2,412 feet; Caldwell TW#19 at 2,450 feet and Willowbrook Irrigation well at 2,477 feet). The red, dashed contours on Figure 9 indicate ground-water flow would be in a west-northwest direction, approximately parallel to the Payette River.
- The JDH Builders well, with a water-level elevation of 2,412 feet, is critical to the postulation that ground-water flows to the north or the north-northwest in this area. The contour map of water-level elevations would look considerably different if this well does not penetrate the Pierce Gulch Sand Aquifer.
- I conclude that the 2007 water-level data provide insufficient evidence that ground-water flow occurs from the Boise River Valley to the Payette River Valley.

ANALYSIS OF THE NUMERICAL MODEL

Conceptual Model and Flow System Issues

The numerical ground-water flow model was constructed based on the hydrogeologic conceptual model discussed in the second portion of this report and calibrated to the water-level elevation map discussed in the third section of the report.

Thus, questions posed in this report relative to the lateral continuity of the Pierce Gulch Sand Aquifer between the Boise River and the Payette River valleys are pertinent to the numerical model. The numerical model cannot provide a valid prediction of M3 Eagle pumping impacts on local well owners if the hydrogeologic conceptual is not accurately represented. In the same way, questions posed in this report relative to the validity of the postulated ground-water flow from the Boise River Valley to the Payette River Valley also are pertinent to the numerical model. The numerical model cannot provide a valid prediction of M3 Eagle pumping impacts if the steady-state calibration was conducted to match a water-level elevation contour map that does not accurately represent field data from wells completed in the Pierce Gulch Sand Aquifer.

The relative importance of the ground-water flow system from the Boise River valley into the Payette River valley in the numerical model is shown by the mass balance presented in Table 1. The Payette River seepage is 27.1% of the total inflow and is about 3.5 times larger than the Boise River seepage. The numerical model would be quite different if ground-water flow is not represented as occurring through the Pierce Gulch Sand Aquifer from the Boise River Valley to the Payette River Valley. A numerical model without ground-water flow between the river valleys would be similar to that constructed as part of the Treasure Valley Hydrologic Project (Petrich, 2004).

Table 1 Numerical Model Mass Balance (Hydro Logic Inc., 2008b, page 27)

Revised Model Results – November 14 Memo

Inflow	cfs	% of total inflow
Surficial recharge	542	52.1%
Underflow via SE Model Corner	115	11.0%
Dry Creek	4	0.4%
Lake Lowell	17	1.6%
Boise River seepage	81	7.6%
Payette River seepage	282	27.1%
TOTAL	1041	100.0%

General Modeling Issues

Two additional questions relative to the construction, calibration and operation of the M3 Eagle numerical ground-water flow model are addressed in this portion of the report. The first question pertains to the validity of constructing two versions of the model (Tmatch and Hmatch) because a single representation of the two major data sets was not attained. The second question addresses the validity of utilizing the numerical model for long-term (50 year) water-level predictions when the transient calibration was based on data from short term (30-day and 7-day) aquifer tests.

The primary question relative to any numerical ground-water flow model is to what degree it represents a "unique" solution given the array of hydrogeologic information on the area. Construction and calibration of the model must honor direct measurements of the resource (such as depth to water in wells and measured discharge from the aquifer) and also utilize indirect aquifer information (such as calculated aquifer parameters, geologic framework data and calculated water inputs and outputs). The calibration task involves using the model to test alternative representations of various model boundaries, aquifer parameter distributions and aquifer inputs/outputs. The end result typically is the creation of a single numerical model with an associated sensitivity analysis and representation of error bounds. In my opinion, the inability to have the M3 Eagle model reproduce aquifer water levels using the calculated transmissivity values indicates that problems exist in the model formulation (such as boundaries) and/or with the input data sets. I do not believe that development of two parallel numerical models is a reasonable solution to the problem. Also, I do not believe that general agreement between the "Hmatch" and "Tmatch" indicates that the numerical model is a reasonable representation of the hydrogeologic system.

Questions come to mind whenever a numerical ground-water model is used to predict impacts on a time scale that greatly exceed the data set used for transient calibration. This is defiantly the case with the M3 Eagle numerical model. The data sets used for transient calibration were short (30 and 7 days) and the stress potentially did not cause water-level changes at all aquifer boundaries. Prediction of long-term pumping effects (such as for 50 years) involves stressing a much larger portion of the model and likely a number of boundaries. This creates major uncertainty relative to reliability of the drawdown values predicted using the model.

DISCUSSION

Three questions were raised and addressed in my initial hydrogeologic analysis of the M3 Eagle site (Ralston, 2008). The purpose of this portion of the report is to revisit the questions and provide updated responses.

1. **Is there sufficient evidence to support the presumption of lateral extent and continuity of what has been called the Pierce Gulch Sand Aquifer from the presumed recharge area in the Boise River drainage to the presumed discharge area in the Payette River drainage?**
    a. I have not been able to find either geologic depositional information or geologic information from wells to support the presumption that the Pierce Gulch Sand Aquifer extends to the northwest of the M3 Eagle site beyond the Willowbrook Irrigation well. The 2007 water-level contour map shows an extension of the unsaturated aquifer boundary (green line on Figure 4) to the northwest from the M3 Eagle site. The dashed line ends near the R1W/R2W range line. I have not found any geologic information to support either the extension of the boundary west of the Willowbrook Irrigation well or the termination of the line near the range line. The location of the unsaturated aquifer boundary northwest of the M3 Eagle property depends mostly on the shoreline configuration at the time of deposition of the deltaic sand unit. No hydrogeologic data are presented to support the hypothesis that the aquifer continues from the M3 Eagle area to the Payette River valley.
2. **Assuming that the hydrogeologic conceptual model question is answered in the affirmative, is there sufficient evidence to support the presumption that ground water flows in the manner and quantity described within what has been called the Pierce Gulch Sand Aquifer from the presumed recharge area in the Boise River drainage to the presumed discharge area in the Payette River drainage?**

a. The primary evidence presented by M3 Eagle to support ground-water flow from the Boise River drainage to the Payette River drainage is the map showing 2007 ground-water elevations contours based on data from wells that are completed in the aquifer (see Figure 9). The east-west orientation of contours of equal ground-water elevation (elevation of 2,400 feet and lower) which support the concept of flow north-northwestward to the Payette River drainage are not supported by field data. The 2,413-foot reading in the JDH Builders well is the only data point that supports any significant component of flow to the northwest. I do not believe that the water-level data provided by M3 Eagle are sufficient to support the presumption of a ground-water flow system from the Boise River drainage to the Payette River drainage.

3. **Has the characterization of the target aquifer system, including a pre-development water balance, been complete enough to support an analysis of impacts from full project development?**

   a. The numerical ground-water flow model used to predict project impacts was constructed based on the presumption of lateral extent and continuity of the Pierce Gulch Sand Aquifer from the presumed recharge area in the Boise River drainage to the presumed discharge area in the Payette River drainage. In addition, steady-state calibration of the numerical ground-water flow model is based on matching the contours of equal ground-water elevation shown on Figures 4 and 9. As noted above, I do not believe that field data are sufficient to support the presumed hydrogeologic model. Also, I do not believe that the ground-water contours, particularly those below an elevation of 2,450 feet, have sufficient validity to form the basis for calibration of the model. As a result of these problems and additional issues relative to model calibration and operation, I do not believe that the current numerical model can provide a reliable prediction of water-level impacts from full project development.

CONCLUSIONS AND RECOMMENDATIONS

The hydrogeologic investigation of the M3 Eagle site has resulted in an improved knowledge of the ground-water conditions under the site. However, my concerns about development impacts from the project are focused on large scale issues rather than on-site impacts. Specifically, I believe that postulated ground-water flow through a laterally continuous sand aquifer from the Boise River valley to the Payette River valley is not supported by field data. Thus, I believe that the drawdown values predicted either by analytical methods or the numerical model have a high degree of uncertainty.

I recommend that three alternative pathways be explored to allow the M3 Eagle project to go forward. The alternatives are described below.

1. The first alternative is to formulate an administrative/legal solution. This might involve development of the project under a water right that is phased associated with incremental assessment of impacts.

2. The second alternative is to conduct the additional studies to provide the information base to support the postulated ground-water flow through a laterally continuous sand aquifer from the Boise River valley to the Payette River valley. This effort would require additional field work, perhaps including well construction, off the M3 Eagle site. The field information likely would require some modification of the existing numerical ground-water model.
3. The third alternative is to conduct an analysis of impacts from project pumping using the model boundaries and perhaps the hydraulic parameters developed as part of the Treasure Valley Hydrologic Project. Housing the M3 Eagle analysis within the results of the Treasure Valley Hydrologic Project would add considerable validity to the results. This effort possibly could be done by altering the existing numerical model.

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Wood, S.H. and D.M. Clemens, 2002, Geologic and Tectonic History of the Western Snake River Plain, Idaho and Oregon: in Bill Bonnichsen, C.M. White, and Michael McCurry, eds, Tectonic and Magmatic Evolution of the Snake River Plain Volcanic Province,: Idaho Geologic Survey Bulletin 30, pp. 69-103.

Bottom elevation based on geophysical logging conducted by Hydro Logic, Inc.

GPS locations and ground surface elevations based on TOPO®

Data contoured using Surfer® then hand contoured to remove edge contouring irregularities introduced by gridding algorithms in Surfer®

Contour of Pierce Gulch Aquifer bottom (South of Fault and Geologic Contact) (feet asl)

— 2000 —

West Boise-Eagle Fault (inferred location)

Geologic Contact between Pierce Gulch Sand Aquifer and underlying mudstone facies of the Terteling Springs Formation (approximate location)

△ Pierce Gulch Sand Aquifer Well With Geophysical Log

● Well in Willow Creek Aquifer

North ↑

Scale: 1 Mile =

April 30, 2007

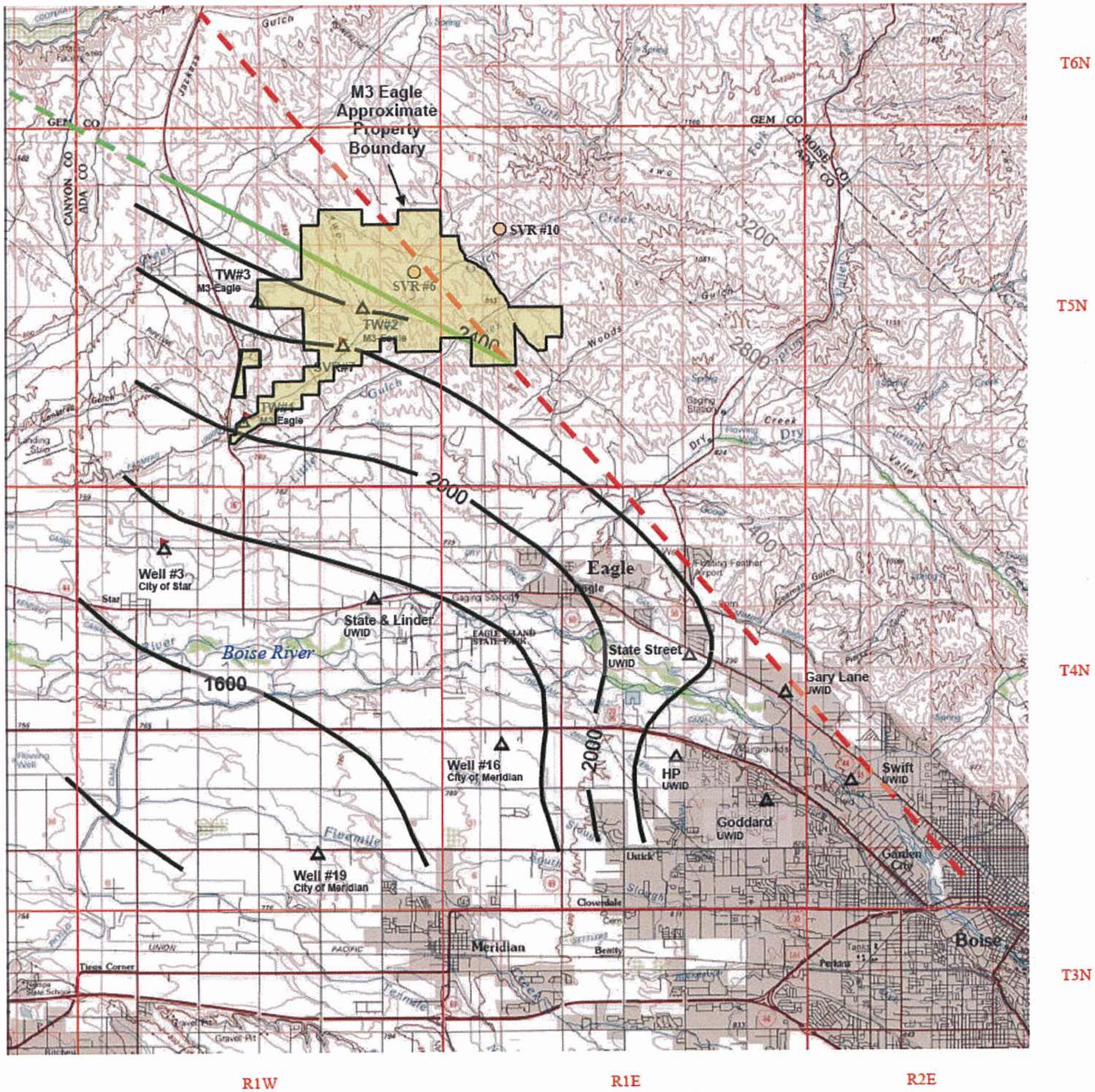

Figure 1 Plan View Map (Figure 3 of Hydro Logic Inc, 2007)

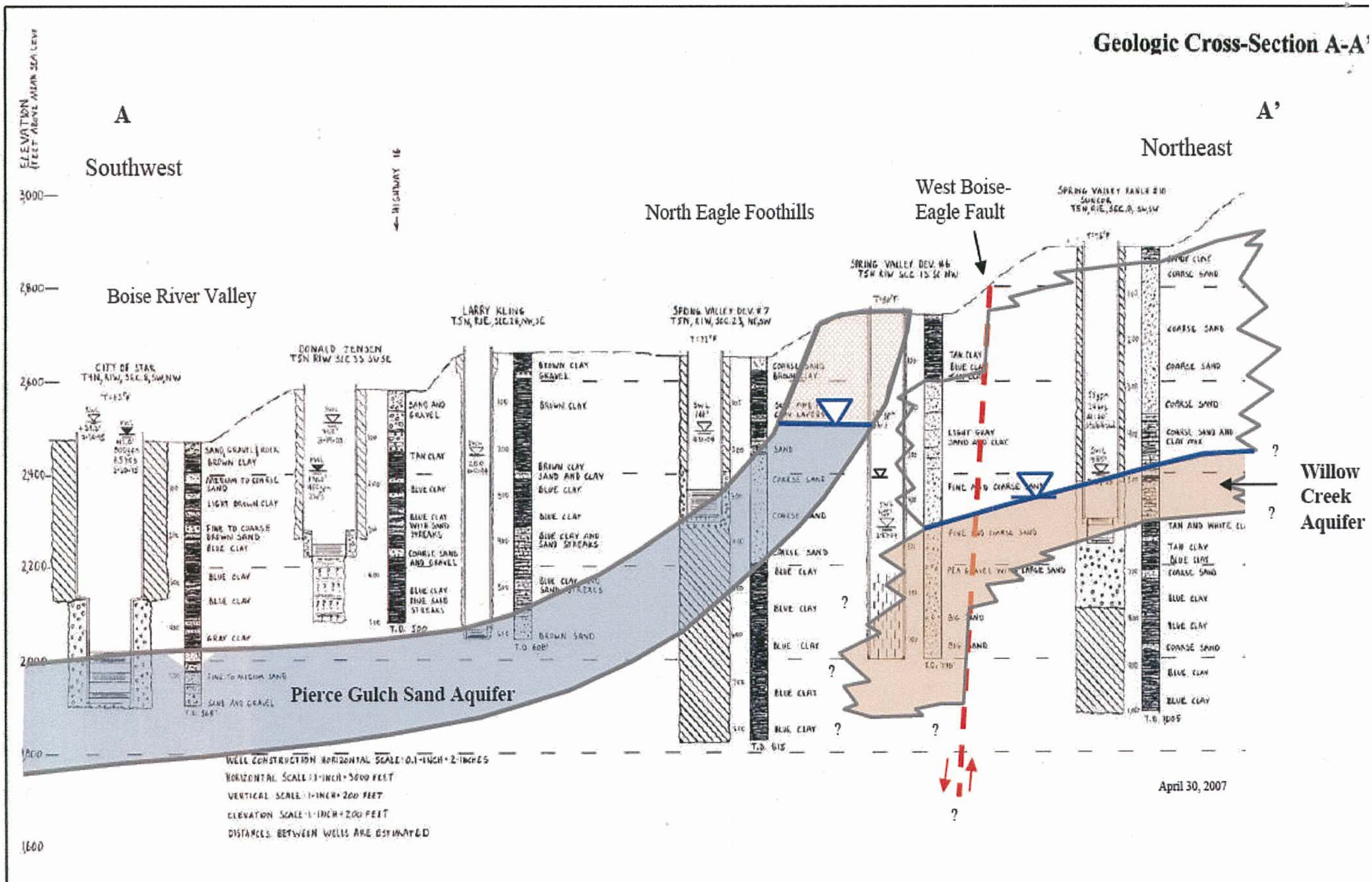

Figure 2 Northeast to Southwest Hydrogeologic Cross Section
(Figure 5 of Hydro Logic Inc, 2007)

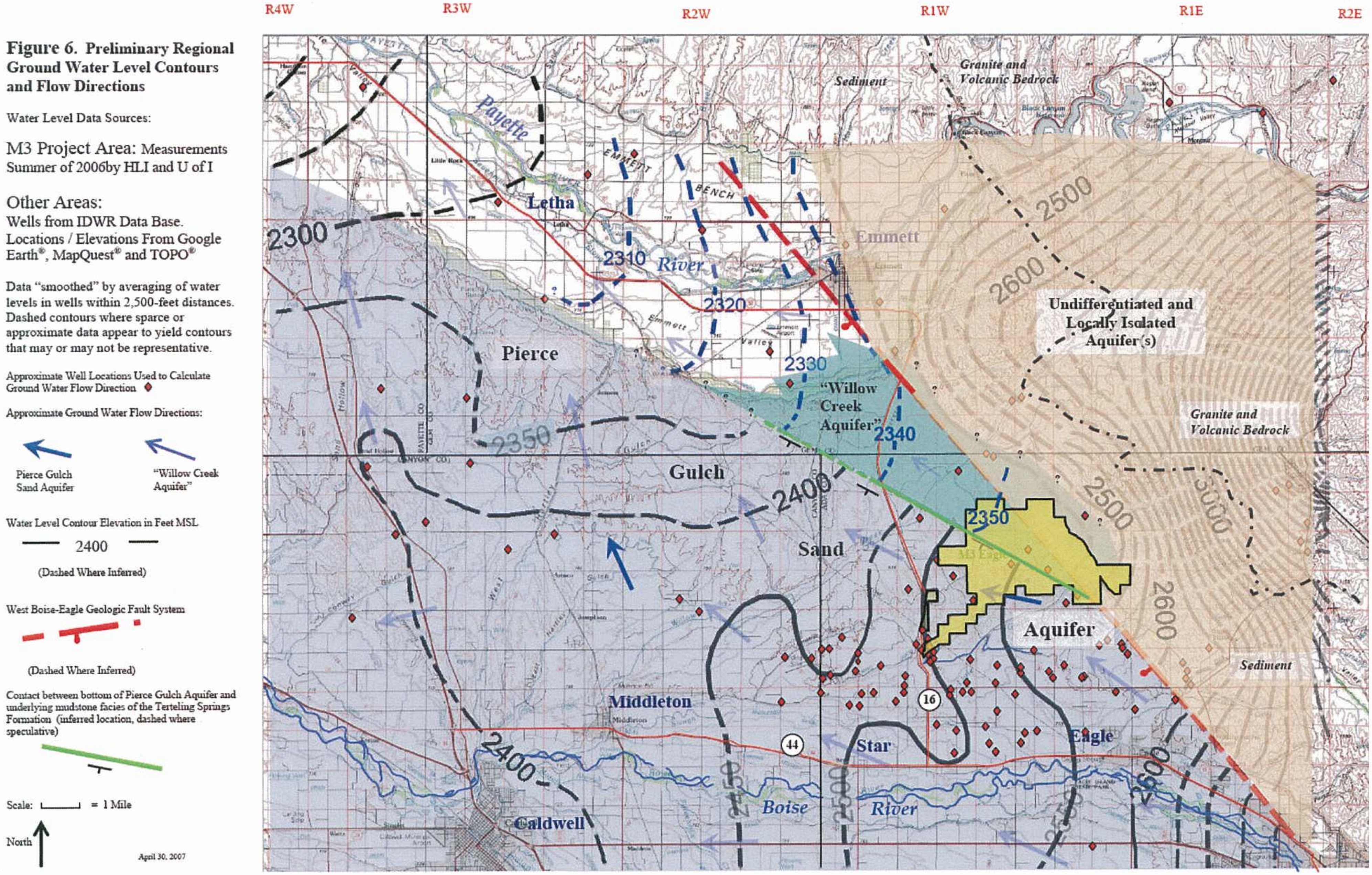

Figure 3 2006 Water-Level Contour Map (Figure 6 of Hydro Logic Inc., 2007)

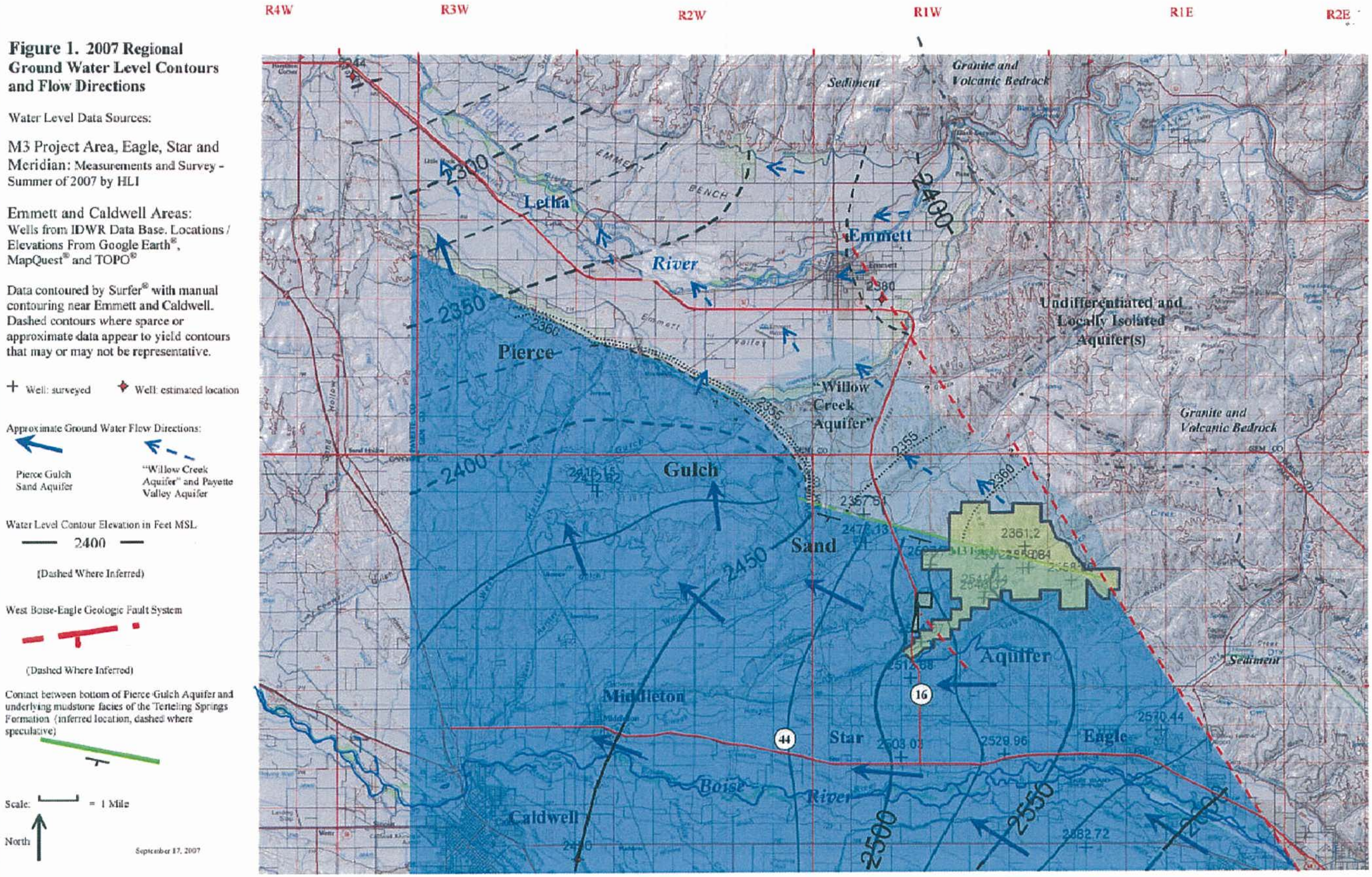

Figure 4 2007 Water-Level Contour Map (Figure 1 of Squires, 2008)

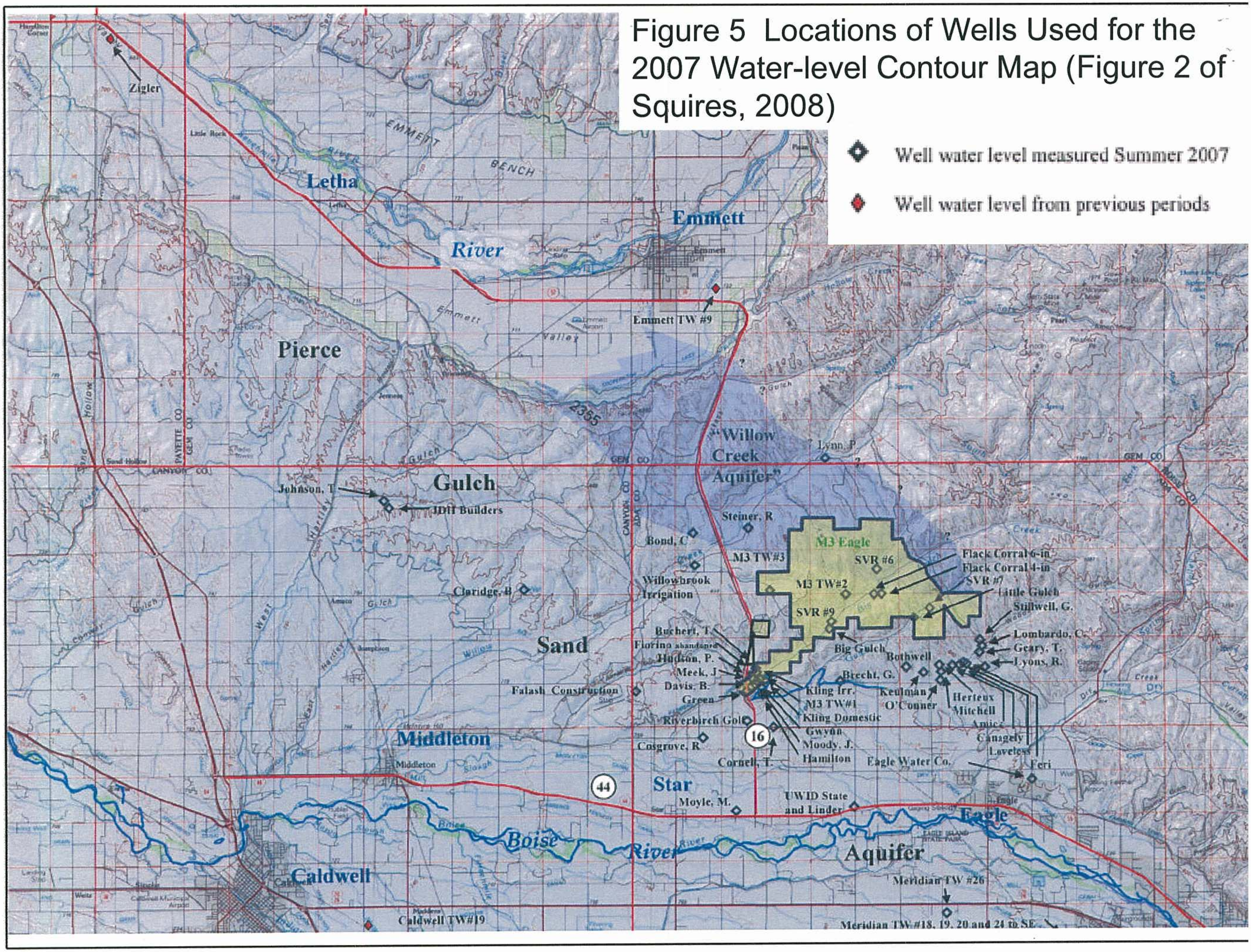

Figure 5 Locations of Wells Used for the 2007 Water-level Contour Map (Figure 2 of Squires, 2008)

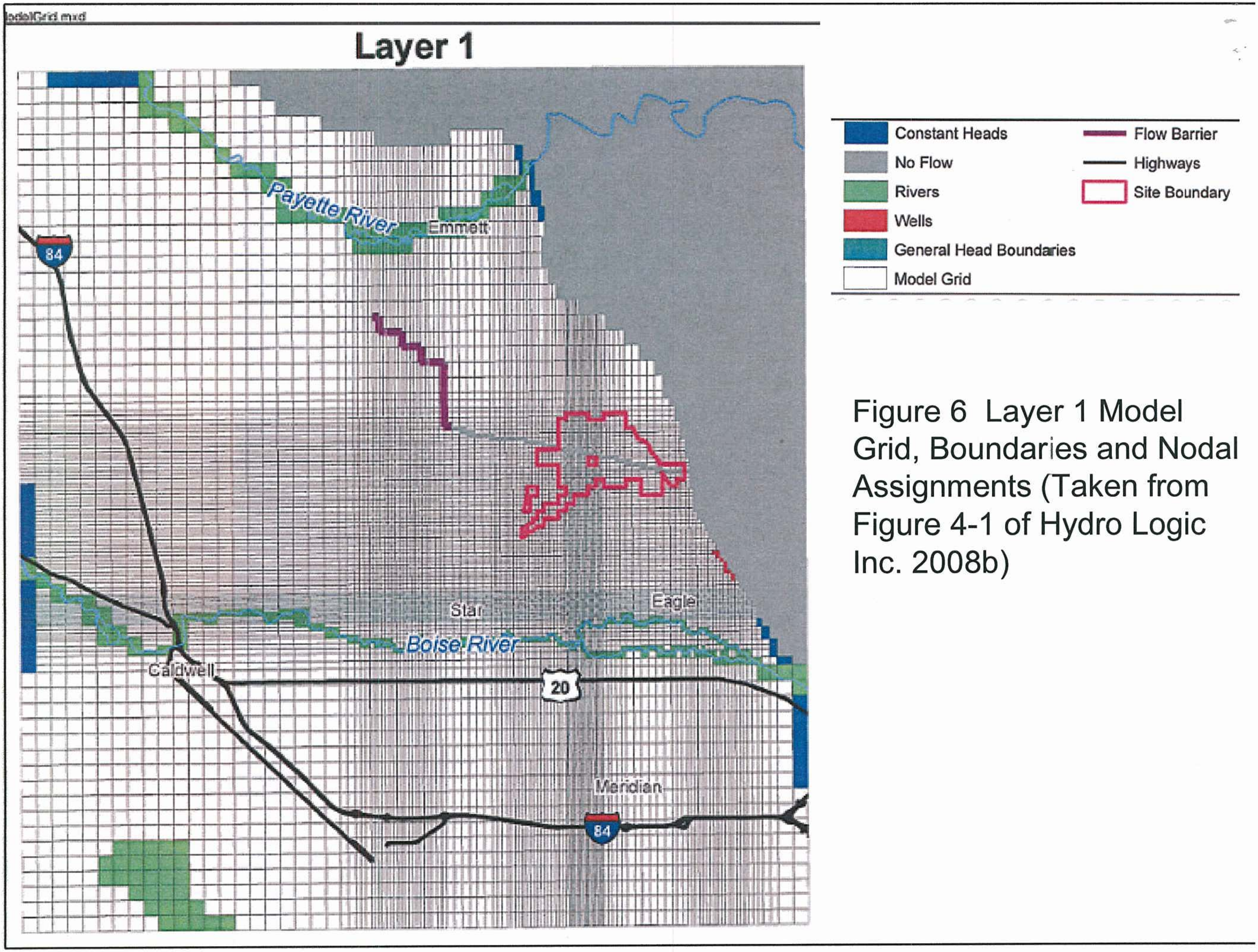

Figure 6 Layer 1 Model Grid, Boundaries and Nodal Assignments (Taken from Figure 4-1 of Hydro Logic Inc. 2008b)

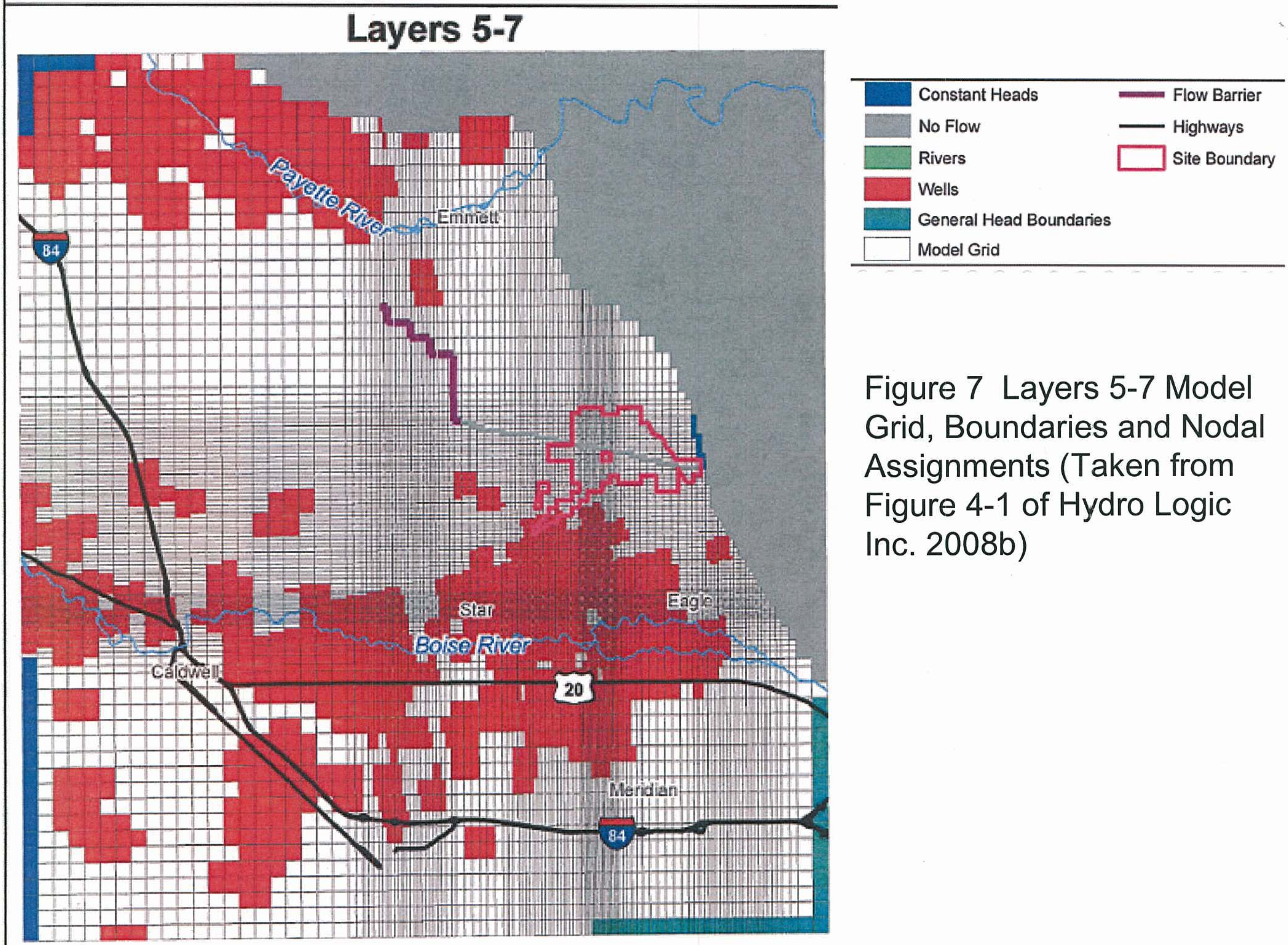

Figure 7 Layers 5-7 Model Grid, Boundaries and Nodal Assignments (Taken from Figure 4-1 of Hydro Logic Inc. 2008b)

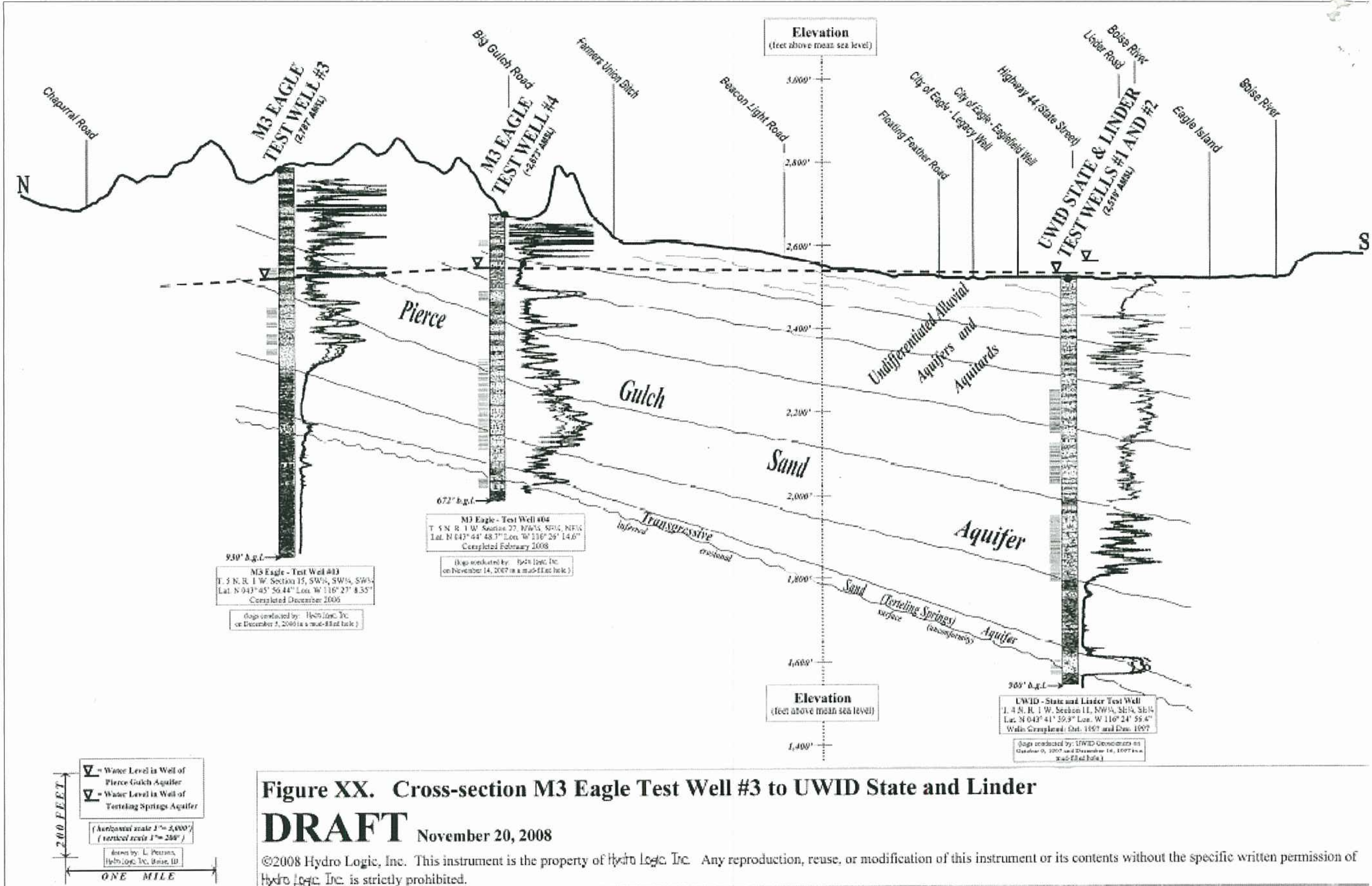

Figure 8 North-Northwest to South-Southeast Hydrogeologic Cross Section (Taken from file #26, M3 Eagle's Technical Reports and Supporting Documentation as of November 26, 2008; reproduced from IDWR FTP site)

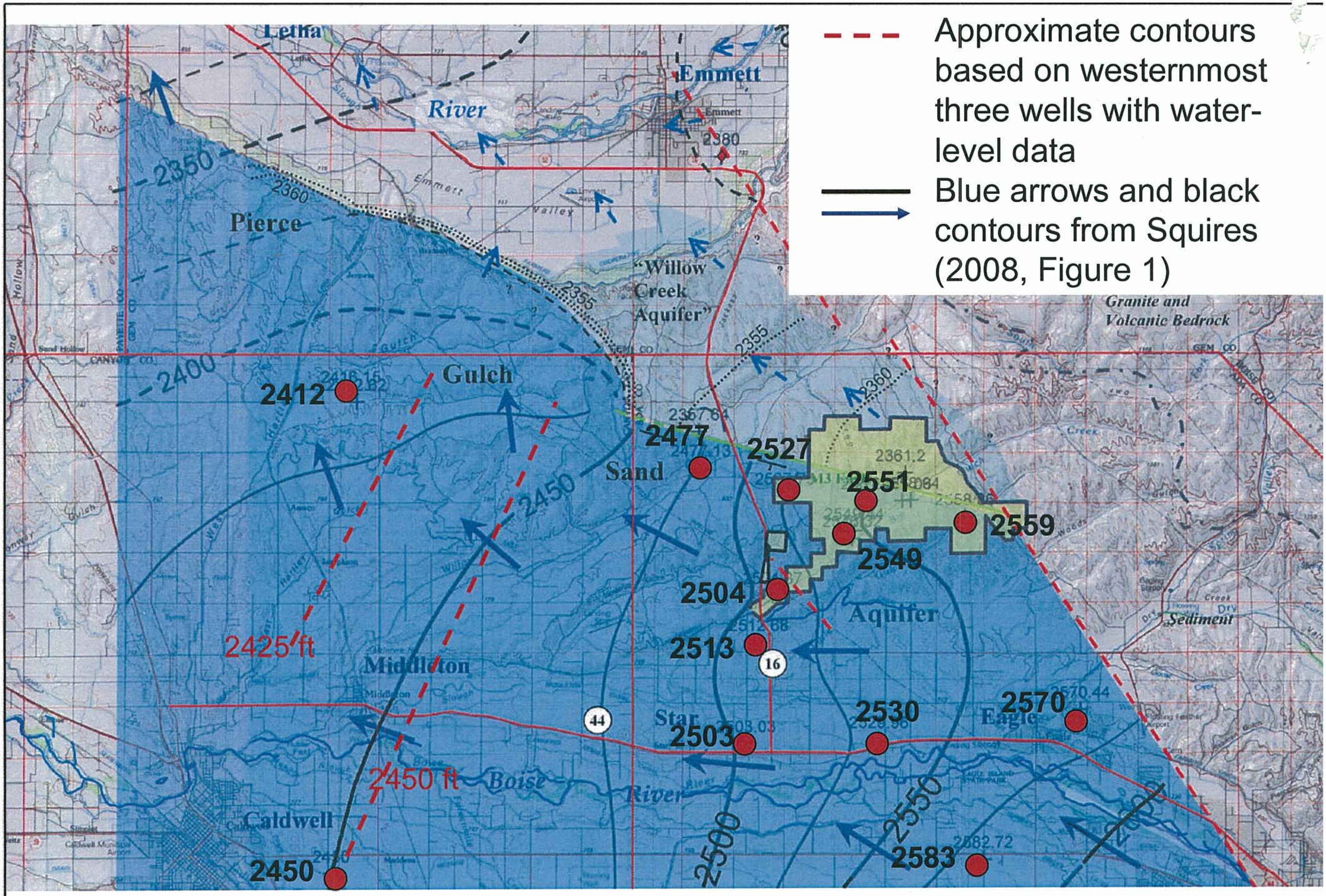

Figure 9 2007 Measurements of Water-Level Elevation Placed on the Contour Map from Squires (2008, Figure 1)

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HYDROGEOLOGIC ANALYSIS OF THE M3 EAGLE SITE:

SUPPLEMENT #1
COMMENTS FROM REVIEW OF GEOCHEMISTRY REPORT

Expert Report Prepared for the
North Ada County
Groundwater Users Association

January 2009

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INTRODUCTION

This report serves as supplement #1 to the expert report entitled **"Hydrogeologic Analysis of the M3 Eagle Site"** that was prepared in January 2009 for the North Ada County Groundwater Users Association (Ralston Hydrologic Services, Inc., 2009). The purpose of this supplement is to provide review comments relative to the technical memorandum entitled **"Ground Water Geochemistry of Wells in the North Ada County Area of Idaho"**, prepared by Glanzman and Squires and dated January 20, 2009. The focus of my review is to determine if the information provided in the Glanzman and Squires (2009) memorandum necessitates altering the conclusions reached in the above noted expert report.

SUMMARY OF GEOCHEMISTRY INFORMATION

The following quotes provide the essence of the information provided in the Glanzman and Squires (2009) memorandum.

> "Historical and newly acquired ground water chemistry was evaluated to determine the aqueous geochemistry of the ground water from wells completed in North Ada County, Idaho. Specifically, the study focused on the area encompassing NE Boise, the Cities of Eagle and Star, and the North Eagle foothills of the Boise Front...The completion intervals of the sampled wells and well locations were grouped into the Pierce Gulch Aquifer, Willow Creek Aquifer, Terteling Springs Aquifer, Spring Valley Ranch wells and the City of Emmett wells.....This geochemical evaluation is primarily based on major ion chemistry but includes selective trace elements, specifically arsenic, to determine the aqueous geochemistry of each designated well group focused on the potential for ground water exchange between aquifers" (page 1).

> "It is possible to compare individual major ion concentrations from one well location to another and then describe how differences in each of these major ions indicate associations or lack of association between well locations... Hydraulically connected ground waters plotted on a trilinear diagram can show major ion relationships between the water chemistry from its source though surface water and ground water flow paths to individual sampling locations" (page 2).

> "The tight clustering of PGSA (Pierce Gulch Sand Aquifer) ground water shown on Figures 4 and 5 (of Glanzman and Squires 2009), adjacent to and including the average Boise River water chemistry, indicates that the PGSA ground water originated almost exclusively from ancestral Boise River surface water" (page 4).

> "In summary, the aqueous geochemistry analytical results indicate that the PGSA is a distinct regional aquifer containing ground water originating from the geologically ancestral Boise River" (page 5).

> "In summary, the TSF (Terteling Springs Formation) forms a second discrete aquifer that is not hydraulically connected to the PGSA" (page 6).

> "In summary, ground water from WCA (Willow Creek Aquifer) has a very dilute TDS and other characteristics that indicate that local precipitation is the dominant

source of recharge.... It is clearly not hydraulically connected to the PGSA but there is a potential for hydraulic connection with the TSF" (page 7).

"In summary, ground water chemistry from the SVRW (Spring Valley Ranch Wells) indicates a broad spectra of mineralogies and resembles characteristics of both the WCA and TSF ground water chemistries. Recharge to the SVRW is from precipitation. The water chemistry types suggest limited lateral and vertical hydraulic connections between wells. The SVRW ground water is not hydraulically connected to the ground water in the WCA, PGSA or TSF" (page 9).

"In summary, the ground water chemistry in the Emmett area, from these two wells, indicates recharge from precipitation (probably Payette River) and no hydraulic connection to the PGSA ground water. The major ion chemistry suggests that the sediments in which the wells are completed resemble those of the TSF which is consistent with the prevailing conceptual model for this basin ..." (page 9).

DISCUSSION

Three questions are raised and addressed in my hydrogeologic analysis of the M3 Eagle site (Ralston Hydrologic Services Inc., 2009). The purpose of this portion of the report is to revisit the questions and provide updated responses based on information from the geochemistry report prepared by Glanzman and Squires (2009).

1. **Is there sufficient evidence to support the presumption of lateral extent and continuity of what has been called the Pierce Gulch Sand Aquifer from the presumed recharge area in the Boise River drainage to the presumed discharge area in the Payette River drainage?**
    a. Glanzman and Squires (2009) provide good geochemical evidence that ground water within the Pierce Gulch Sand Aquifer originates from the Boise River. They do not differentiate between water recharged directly from the Boise River and water recharged from irrigation using water from the Boise River.
    b. Glanzman and Squires (2009) include six wells located northwest of the M3 Eagle site in their analysis (Figure 1). Four of the wells (C Lynn, Lynn Irrigation, W Lynn and Perin) appear to be located within the Willow Creek Aquifer. The remaining two wells (Emmett #9 and Emmett #10) are located on the floor of the Payette River valley. Glanzman and Squires specifically indicate that, based on water chemistry, the two Emmett wells have no hydraulic connection to the PGSA.
    c. I conclude that the geochemical analysis adds no additional information relative to the hypothesis that the PGSA aquifer continues from the M3 Eagle area to the Payette River valley.
2. **Assuming that the hydrogeologic conceptual model question is answered in the affirmative, is there sufficient evidence to support the presumption that ground water flows in the manner and quantity described within what has**

been called the Pierce Gulch Sand Aquifer from the presumed recharge area in the Boise River drainage to the presumed discharge area in the Payette River drainage?

a. I conclude that the geochemical analysis adds no additional information to support the presumption of a ground-water flow system from the Boise River drainage to the Payette River drainage.

3. **Has the characterization of the target aquifer system, including a pre-development water balance, been complete enough to support an analysis of impacts from full project development?**

a. I conclude that the geochemical analysis adds no additional information to support an analysis of impacts from full project development.

CONCLUSIONS

The geochemical investigation of the general M3 Eagle site has resulted in an improved knowledge of the ground-water conditions in the area. However, the Glanzman and Squires (2009) report does not include information that addresses the major hydrogeologic questions raised in my expert report (Ralston Hydrologic Services Inc., 2009).

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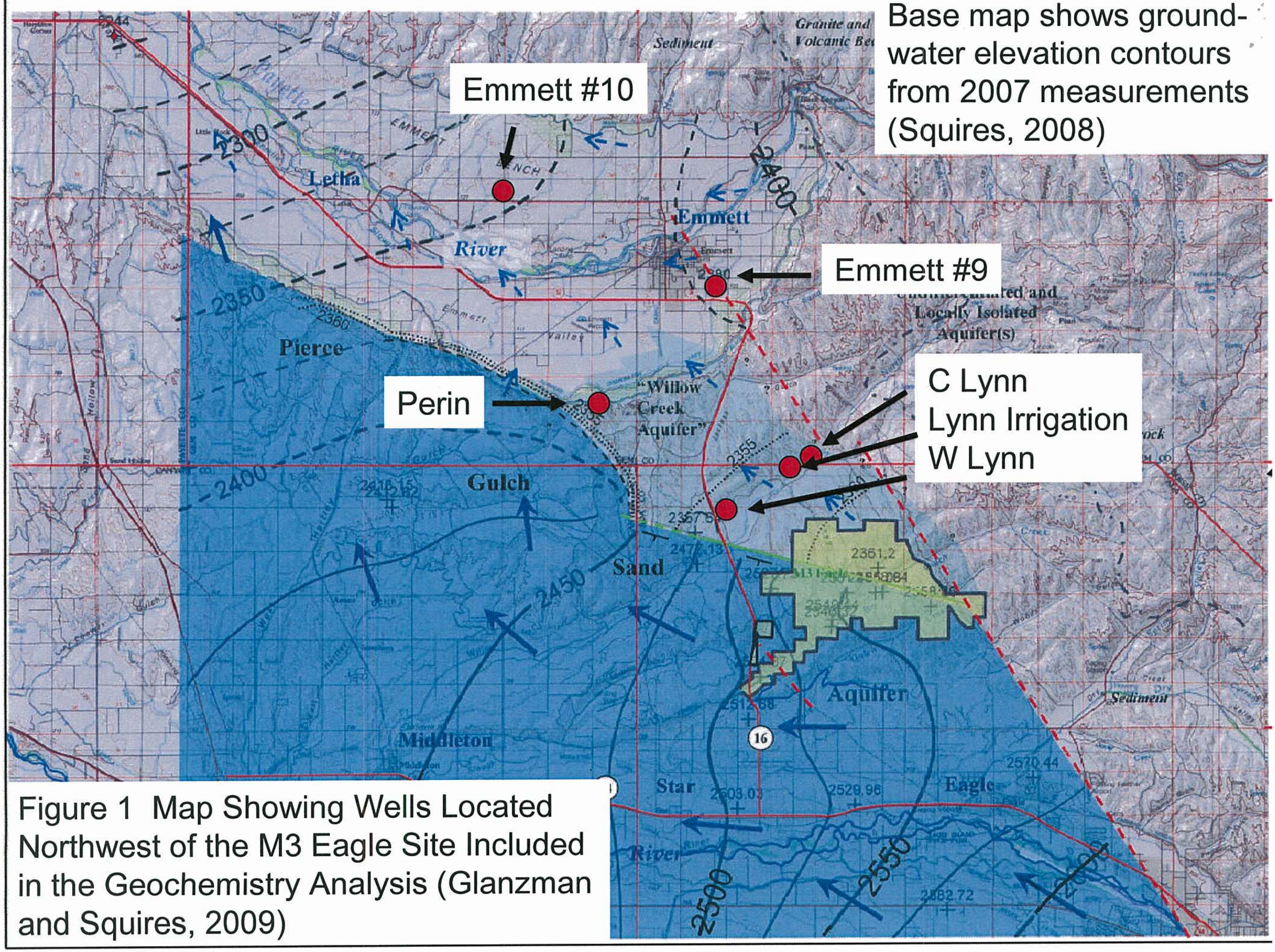

Figure 1 Map Showing Wells Located Northwest of the M3 Eagle Site Included in the Geochemistry Analysis (Glanzman and Squires, 2009)