Idaho Department of Water Resources
Technical Report

East Ada County Comprehensive Hydrologic Investigation

by

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Introduction

The East Ada County Hydrologic Project was initiated to help provide a scientific foundation for the management of aquifers underlying the Treasure Valley in southwestern Idaho. In 2008, the Idaho legislature approved House Bills 428 and 644 establishing the Statewide Comprehensive Aquifer Planning and Management Program (42-1779) and the Aquifer Planning and Management Fund (42-1780). This legislation authorized the Idaho Water Resource Board to begin Comprehensive Aquifer Management Planning (CAMP) in the Treasure Valley. Technical studies were undertaken in East Ada County to assist with Treasure Valley CAMP efforts.

The Aquifer Planning and Management Program is designed to provide the Idaho Water Resource Board and the Idaho Department of Water Resources (IDWR) with the necessary information to develop plans for managing groundwater and surface water resources. The program has two phases:

1) A technical component to characterize the surface water and groundwater resources of each basin.

2) A planning component that will integrate the technical knowledge with an assessment of current and projected future water uses and constraints.

This program will culminate with the development of long-range plans for conjunctively managing the water resources of each basin, integrating hydrologic realities with social needs. The management plans will be designed to address water supply and demand issues looking 50 years into the future. The program is intended to investigate strategies and develop plans which will lead to sustainable water supplies and optimum use of water resources. Also key to the CAMP process is identification of data gaps and additional tool development required for effective future aquifer management.

The East Ada County Hydrologic Project was initiated in 2008 as part of the Treasure Valley CAMP program. A water budget was developed in 2012 (Tesch, 2012), and data related to recharge mechanisms, groundwater flow, discharge rates, geology, and aquifer characteristics were evaluated and compiled for this comprehensive report.

The East Ada Project was also initiated because of proposed residential developments along the Interstate 84 (I-84) corridor from Boise to Mountain Home and the associated water right applications. One of the goals of the CAMP program is to avoid conflicts similar to those experienced in the Eastern Snake River Plain. Proposals for large-scale development along the Ada/Elmore county line have created concerns about the availability of groundwater resources in the area and the potential impacts to existing water users.

On October 9, 2008, there were 11 pending water right applications (Tesch, 2009) for planned communities along the I-84 corridor with a total combined appropriation of 172 ft^3/sec (cfs). As of this report, there are now six pending water right applications and two

transfers for planned communities and irrigation projects along the I-84 corridor near the Ada County/Elmore County line (Figure 1). The total combined maximum appropriation rate is 84.76 cfs, 67.84 cfs in applications and 16.92 cfs in transfers. The reduction is due to rejected, voided, and withdrawn applications since 2009. This is in addition to a combined maximum rate of 14.02 cfs for two permits already issued but not yet fully developed. Groundwater is the water source for the applications, and the anticipated depths of the production zones for the proposed wells are 800 to 1,200 feet below ground level (ft-bgl).

The area of proposed large-scale residential and irrigation development is bisected by the administrative boundary that separates Basins 61 and 63. In addition, many of the proposed developments lie along the northwest boundary of the Mountain Home Ground Water Management Area (GWMA) and are approximately five miles northwest of the Cinder Cone Butte Critical Ground Water Area (CGWA), and 10 miles south-southeast of the Southeast Boise GWMA (Figure 1). Significant water level declines resulted in the establishment of the Cinder Cone Butte CGWA on May 7, 1981 and the Mountain Home GWMA on November 9, 1982.

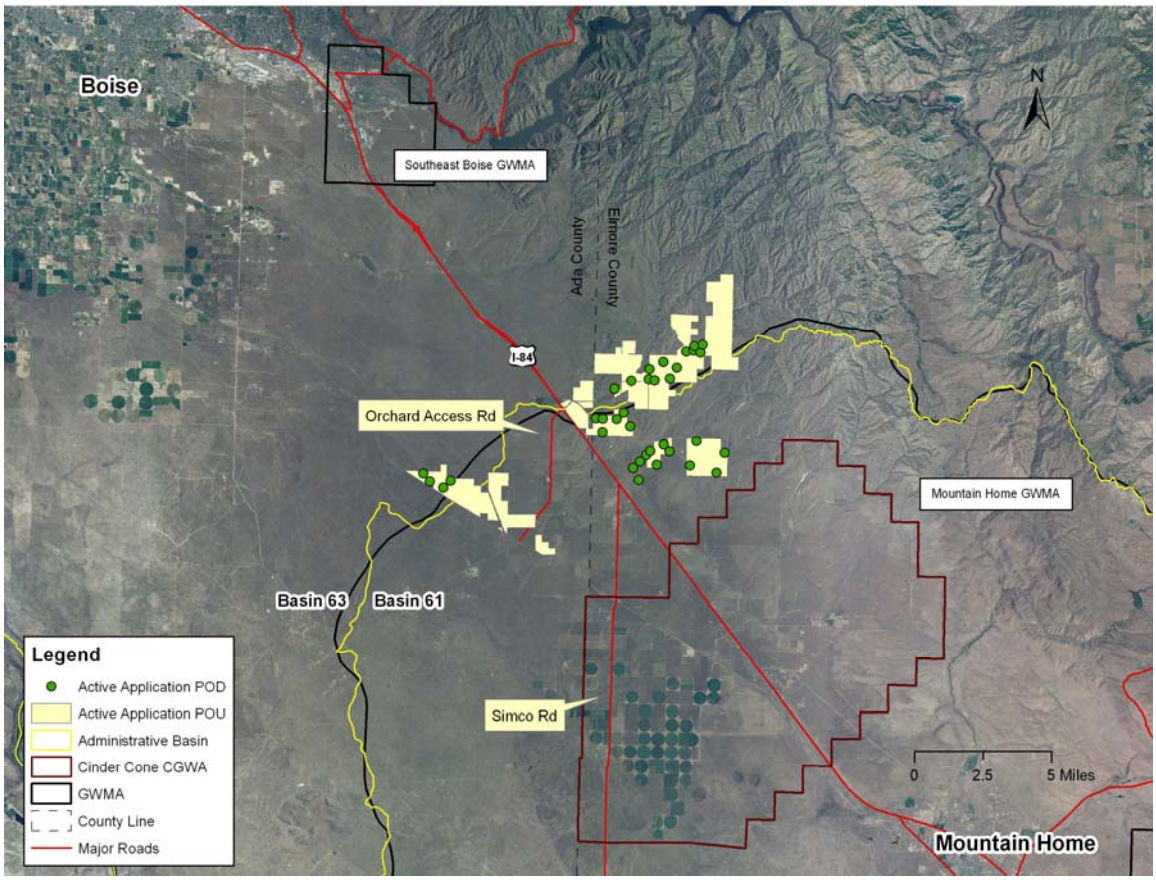

Figure 1. Place of use (POU) and point of diversion (POD) locations for proposed developments in the East Ada project area.

Regional and Local Hydrogeology

The western Snake River Plain (WSRP) is a deep structural depression that is filled with sedimentary and volcanic rocks of Tertiary and Quaternary age that is bounded by northwest-southeast trending faults (Newton, 1991). Mountains composed of granitic and volcanic rocks surround the plain on the northeast and southwest (Figure 2). The regional aquifer targeted by the recent water right applications is found primarily in the Bruneau Formation, a unit in the Idaho Group that consists of fluvial-lake deposits, layers of ash, and basaltic lava flows (Ralston, 1968). Two northwest trending faults have been mapped from Boise to Mountain Home, one along I-84 and the other along the Boise Front (Bond, 1978). Perched aquifers exist beneath the Mountain Home Plateau east of the proposed developments (Young, 1977), and are hosted in alluvial sand and gravel units on the flanks of the Boise Front (Bendixsen, 1994). The general groundwater flow direction in the regional aquifer is to the southwest towards the Snake River (Figure 3). Recharge to the regional aquifer is from downward flow from the perched aquifers, precipitation from the uplands to the north, and underflow from the north (Harrington and Bendixsen, 1999).

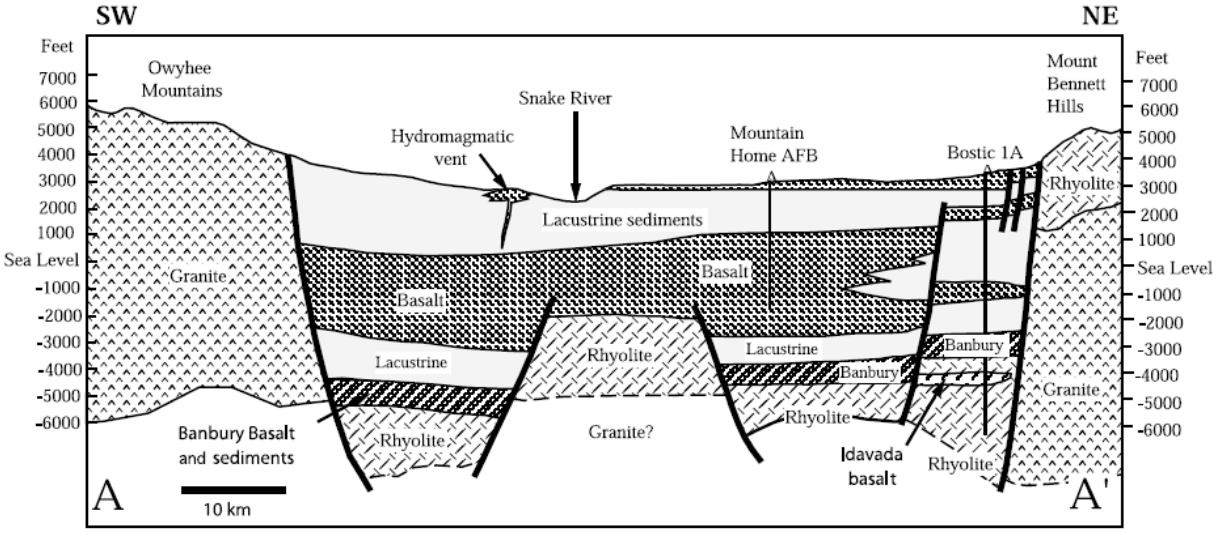

Figure 2. Geologic cross-section through the WSRP (Shervais, 2002).

The East Ada/West Elmore groundwater system (Figure 4), in the vicinity of the proposed developments, is recharged by three sources: (i) infiltration of seasonally warmed surface water into shallow aquifers near local streams, (ii) meteoric recharge into both the perched and deep aquifers derived from local watersheds, and (iii) a deep source of geothermally heated water rising along faults of the Boise Front (Welhan, 2012). The geothermal component may account for more than 20% of total recharge according to Welhan (2012).

Recent geologic mapping by the Idaho Geological Survey (Figure 5, Phillips et al., 2012) and geophysical work by Boise State University (Liberty, 2012) have provided a better understanding of the hydrogeology in the East Ada area. Additionally, geologic cross-sections based on information compiled from well driller's reports are presented in Appendix A. Quaternary basalts, gravel, and terrace deposits appear on the surface immediately south of the Cretaceous granites of the Idaho Batholith. Seismic reflectors show depth to bedrock ranges from 1,000 feet below ground surface at Indian Creek Road near Mayfield to 5,000 deep at Indian Creek Road near the Ada/Elmore County line. In the study area, basalts are primarily found northwest of Indian Creek Road as units of the Slaters Flat shield volcano (~900,000 years old). Older basalt flows that originated from vents near the WSRP central rift zone are exposed on the surface southwest of the study area, and interfinger with deeper sediments to the north, as seen in the Nevid and Mayfield wells. These buried, interfingering basalts are also identified with seismic and magnetic data (Liberty, 2012).

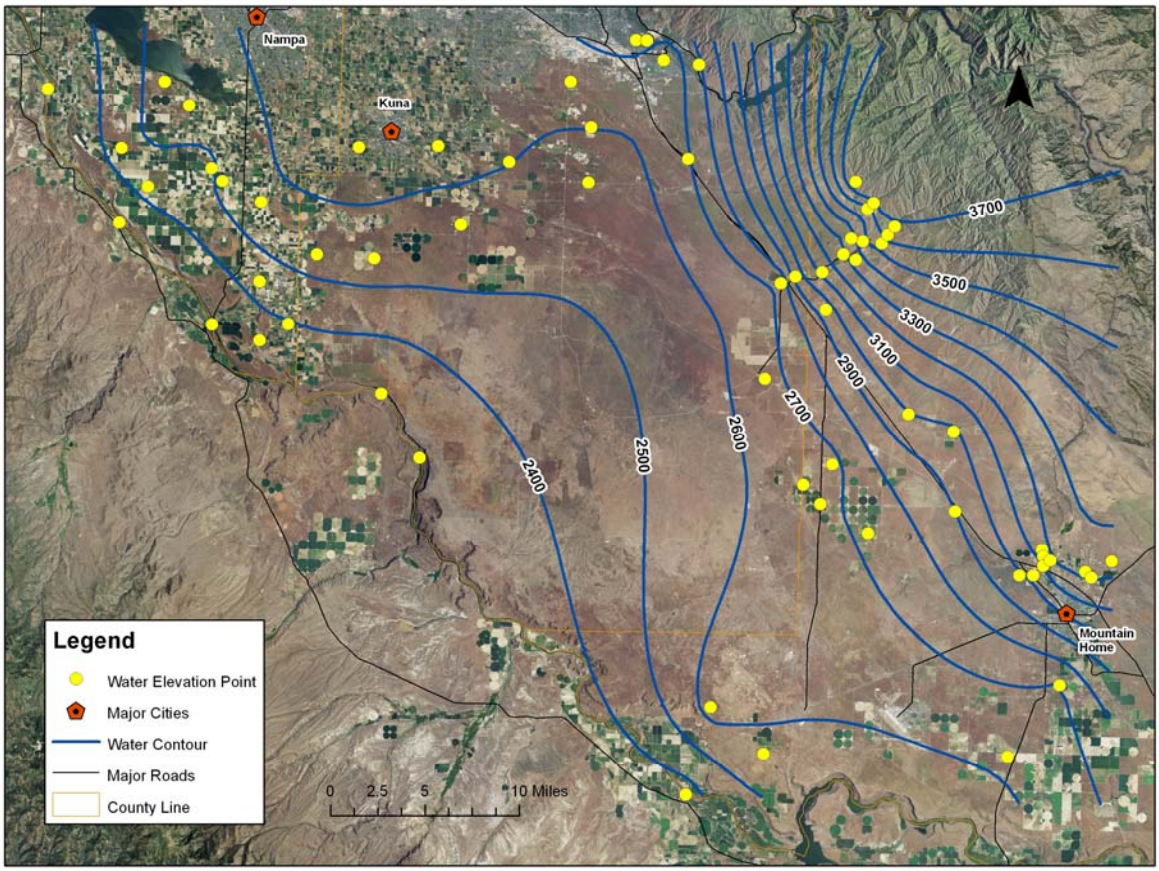

Figure 3. Water level contours (100-foot interval) for the central portion of the western Snake River Plain.

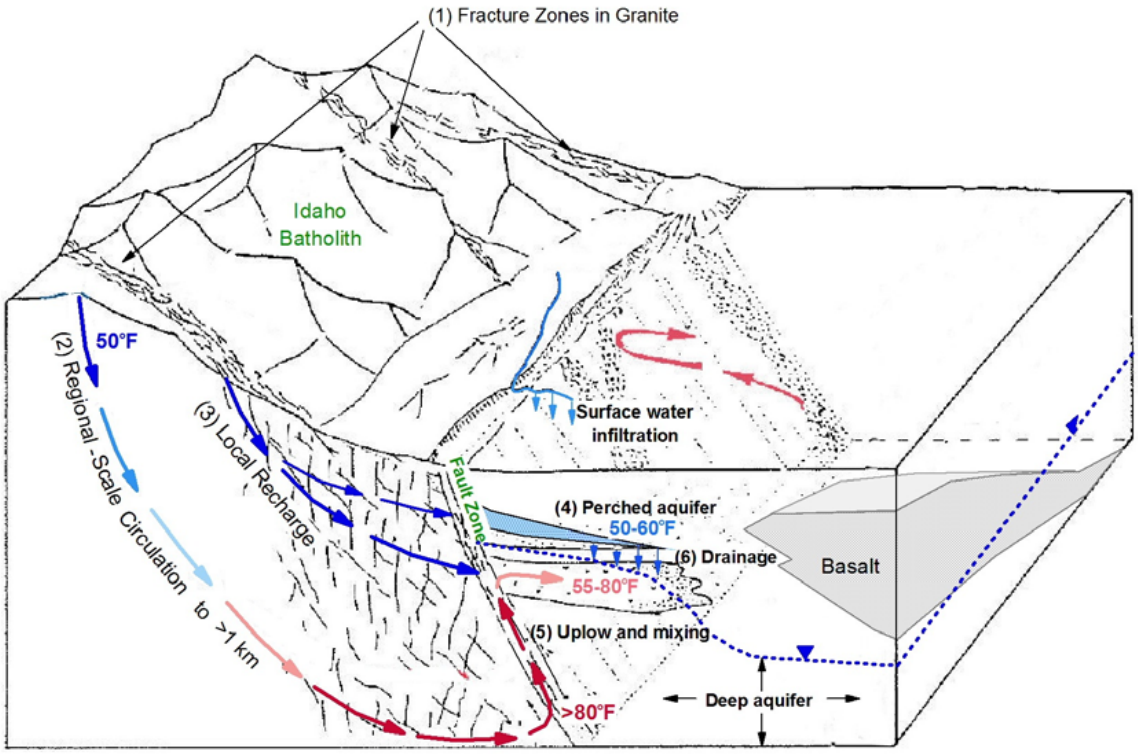

Figure 4. "Regional-scale conceptual model of the East Ada study area showing the principal elements of the flow system: (1) permeable fracture zones in the Idaho Batholith and in the Boise Front fault system; (2) regional-scale recharge via deep circulation through the Idaho Batholith that leads to a characteristic geochemical signature of these thermal waters; (3) meteoric recharge in the headwaters of the Upper Indian Creek, Sand Hollow Creek and Bowns Creek catchments (non-thermal source); (4) a shallow, perched aquifer (blue hachured) that is recharged by a combination of meteoric recharge and infiltration from local streams flowing out onto the alluvial fans; (5) upflow of thermal recharge along the range front fault and mixing between thermal and non-thermal recharge components in the East Ada deep aquifer (dotted blue line); and (6) vertical drainage of the perched aquifer to the deep aquifer. Adapted from a figure by Waag and Wood (1987) depicting the hydrogeologic elements of the Boise geothermal system." (Welhan, 2012)

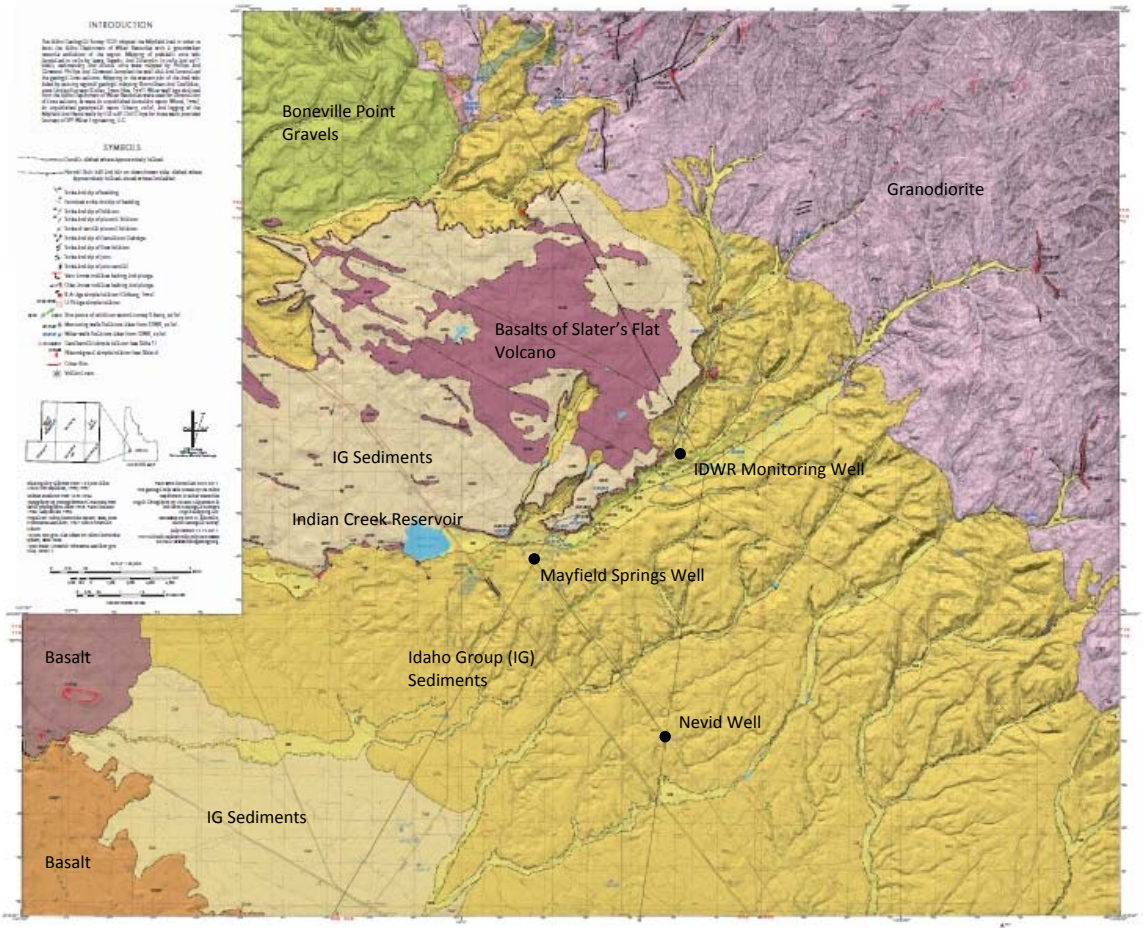

Figure 5. Geologic map of the Mayfield area, Ada and Elmore Counties, Idaho (figure altered from Phillips, 2012)

A majority of sediments in the East Ada study area that host the deep aquifer are fine sand most likely associated with lacustrine sediments of the Idaho Group. These sediments presumably interfinger with, and underlie, gravels to the northwest. Overlying the fine sand is a relatively thin granule sand unit with minor gravel representing mostly decomposed granite that has been transported from the range front (Welhan, 2012). Geophysical data corroborate this lithologic sequence with East Ada seismic profiles showing Idaho Group sands dominating the subsurface and increasing in thickness to the south (Figure 6). Increased water table depths correlate with increasing basin depths and possibly normal faults related to basin extension (Liberty, 2012).

Drill cuttings from the 1,000-foot deep Mayfield Springs and Nevid development wells (Figure 5) are consistent with cross-section A-A'" of Phillips (2012). The water table in these wells is approximately 400 ± 50 ft-bgl with the principal water-bearing zone between 700 to 800 ft-bgl in fine and medium-grained sands. The driller's report for the Nevid well indicates a specific capacity of 3.5 gpm/ft, based on 8 hours of pumping (Welhan, 2012). An IDWR monitoring well (Figure 5 and Appendix B) drilled in November 2011 near the junction of Indian Creek and Slater Creek roads (450 foot total

depth, 185 foot static water level) is also consistent with cross-section A-A'" of Phillips (2012). The IDWR well had a specific capacity of 3.4 gpm/ft, based on 8 hours of pumping. The average of all specific capacities in Welhan (2012, Table 1) is 4.1 gpm/ft.

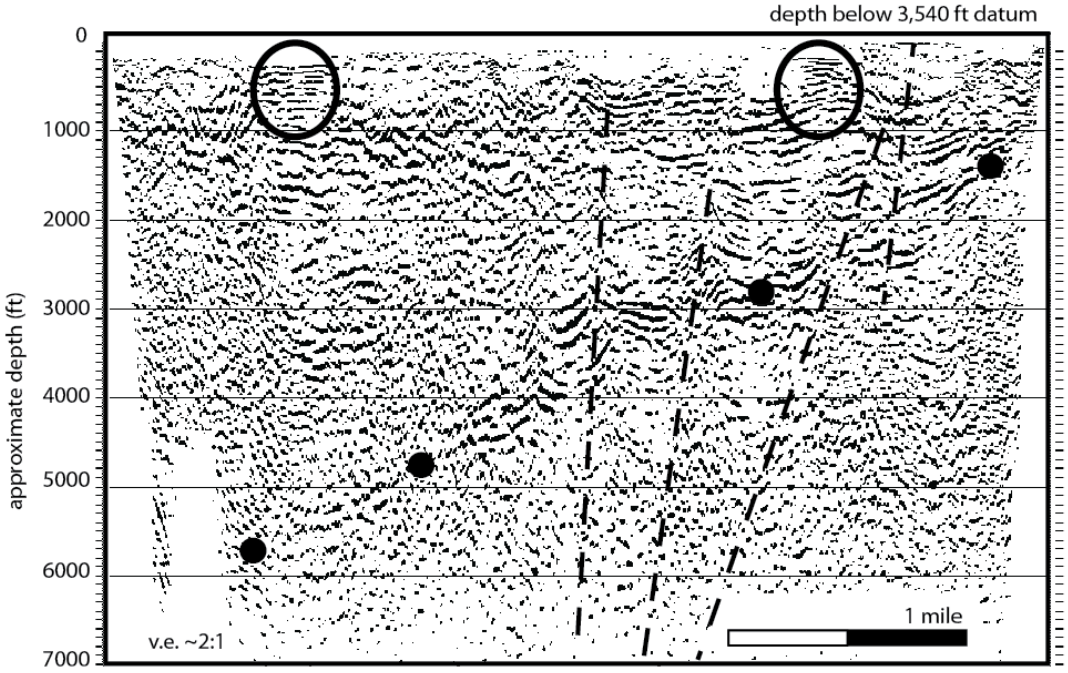

Figure 6. Indian Creek seismic profile (Liberty, 2012) showing basalt (open circles), basement rock (dark circles), Idaho Group sediments (anything above basement that's not basalt), and inferred faults (dashed lines).

The hydraulic gradient of the deep sedimentary aquifer in the East Ada area is much steeper than the regional basalt-dominated aquifer into which it drains (Figures 3 and 7). Nearest the range front, the hydraulic gradient (I_1=0.011) reflects the recharge flux derived from local catchments. Farther from the range front, the gradient steepens markedly (I_2=0.027), reflecting either (i) a systematic decrease in transmissivity away from the range front or (ii) localized additional recharge. Possible sources of localized recharge are geothermal fluids that enter the aquifer along buried faults or water that drains from the overlying perched aquifer(s), either or both of which would lead to a mounding of the deep aquifer's water table (Welhan, 2012). This change in slope of the water table is near I-84 at the location of a subsurface fault mapped by Liberty (2012) and near a surface fault mapped by Bond (1978). The location of the change in water table slope in relation to mapped faults suggests faults may contribute to water table geometries. Other transmissivity changes (e.g. buried basalts, systematic facies changes) or changing aquifer thickness may be responsible for, or work in conjunction with, faulting to influence local groundwater flow.

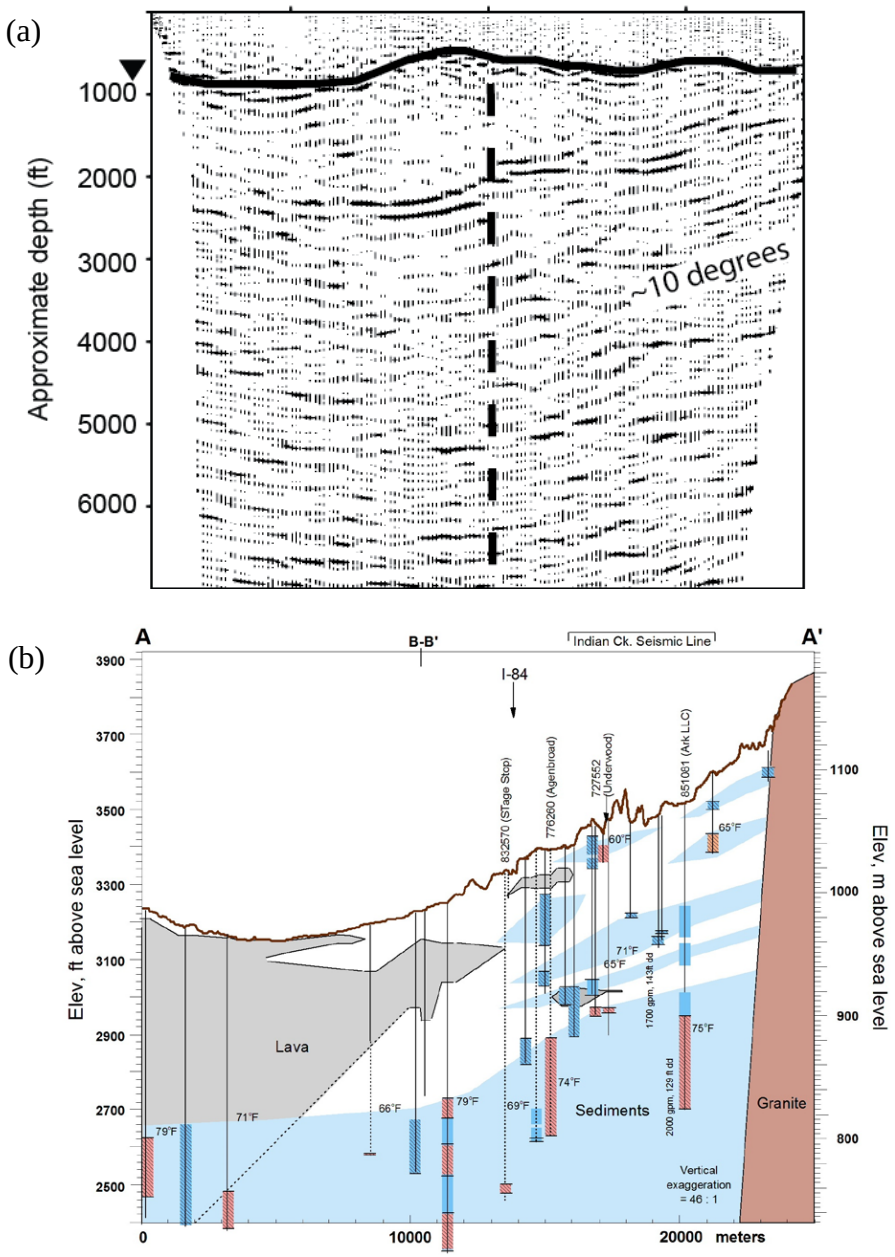

Figure 7. Representation of the change in slope of the water table from the range front to the deep basalt system in (a) a seismic profile from Liberty (2012) and (b) an interpretation of aquifer geometry from Welhan (2012).

Faulting plays an important role in the hydrogeology of the East Ada aquifer system (Welhan, 2012). One or more northwest-trending normal faults distributed over a several mile-wide zone along the range front comprise the Boise Front fault system, although no direct surface evidence has been identified yet (Welhan, 2012; Phillips et al., 2012). Liberty (2012) identified several linear features northwest of Indian Creek that suggest these faults have been obscured by surficial processes. Liberty (2012) interpreted a series of seismic reflection profiles collected in the East Ada study area to include several

normal faults offsetting basement rocks (Figure 6); two of the faults are mapped by Phillips (2012) in cross-section A-A'" two and three miles southwest of the range front. Additionally, northeast-trending faults may control local drainages in the area such as Blacks Creek, Indian Creek, and the East Fork of Slater Creek (Welhan, 2012).

In 2011, IDWR conducted a technical review of Orchard Ranch LLC application #63-32703 (Tesch, 2011). The proposed POU for the application is in the southwestern portion of the study area, southwest of I-84, and near the the older exposed basalt flows that originated from the WSRP central rift zone. Orchard Ranch retained SPF Water Engineering to develop the hydrologic information packet in support of their application. A large number of well drilling reports from the area were used to describe a sequence of shallow sediments, volcanic materials, and additional sediments at depth.

SPF (2007) summarizes water levels and aquifer zones in the area as follows:

> "The target aquifers underlying the proposed Orchard Ranch Planned Community include a series of saturated sand layers (with minor amounts of gravel) at depths ranging from 600 feet to over 800 feet. Wells penetrating these zones will likely extend to depths ranging from 700 to 900 feet or more. Volcanic materials in some portions of the property may extend to these depths, in which case target aquifers will include broken basalt or cinder zones." (p. i)
>
> "Static water levels listed on the driller's reports ranged from approximately 450 to 550 *(sic)*. Water levels in most of the deeper wells rise above the zone in which ground water was encountered, indicating confined or partially confined conditions." (p. 6)
>
> "Aquifer zones were noted at depths ranging from about 450 to over 700 feet. One well (the 800-foot deep Well No. 48) did not extend beyond volcanic rocks; primary water producing zones were noted between about 450 and 800 feet." (p. 8)
>
> "Aquifer capacity in the Orchard Ranch area will likely be moderate, with potential discharge rates ranging from about 500 to 1,000 gpm. One of the M.A.T.E.S. wells in the area was initially tested at a flow of 815 gpm." (p. 16)

A review of geologic logs for wells near the proposed development supports the SPF descriptions above; however, it is important to note that local variability can exist. For example, a deep well at the Boise Stage Stop, approximately three miles to the northeast in T01N R04E Section 32, penetrated 884 feet of sediments from land surface to the completed depth with no volcanics present. Alternatively, geologic logs for several shallow wells at the Boise Stage Stop with static water levels less than 120 ft-bgl indicate the presence of volcanics. Data deficiencies related to geology, groundwater elevations, and aquifer extent exist in this portion of the WSRP and are the focus of ongoing studies by IDWR.

Groundwater Monitoring

The IDWR East Ada monitoring network began in 2009 and consists of 30 wells with water levels measured quarterly (Appendix C). Thirteen of the wells are equipped with data loggers that collect readings every six hours. Down Right Drilling was contracted by IDWR to drill three of the wells that are currently monitored (Appendix B); JUB Engineering completed geophysical surveys in two of these wells. There is currently not enough data to determine long-term water level trends in the East Ada network, with the exception of two USGS monitoring wells in the southern portion of the study area (#01S04E-10DAD1 and #01S04E-30AAC1, Appendix C). From 2002 to 2011, Well #01S04E-10DAD1 (north of I-84) exhibited an increasing trend of 0.14 feet per year (ft/yr), which is statistically significant at the 90% confidence level. From 2001 to 2011, Well #01S04E-30AAC1 (south of I-84) has exhibited a decreasing trend of -0.20 ft/yr, which is also significant at the 90% confidence level.

IDWR has also maintained and monitored a regional groundwater level monitoring network on the Mountain Home Plateau since 1960. The Mountain Home monitoring network overlaps a portion of the East Ada network, and includes wells within the Mountain Home GWMA and the Cinder Cone Butte CGWA (Appendices C and D). Significant water level declines measured in wells in this network resulted in the establishment of the Cinder Cone Butte CGWA (May 7, 1981) and the Mountain Home GWMA (November 9, 1982).

Water level data from Mountain Home network wells collected during the fall between the years 1981 and 1991, 1991 and 2001, 2001 and 2011, and 1981 and 2011 were recently analyzed to determine water level changes over time (Figure 8). Water levels in eight of the 12 wells (67%) were lower in the Fall of 2011 than water levels measured in the Fall of 1981. These eight wells showed water level decreases ranging from 3.5 to 130.7 feet. Declines greater than 50 feet were observed in four wells located in the southwest portion of the Cinder Cone Butte CGWA.

Water levels in four of the 12 wells (33%) were higher in the Fall of 2011 than water levels measured in the Fall of 1981. These four wells showed water level increases ranging from 0.3 to 44.7 feet and are located primarily northeast of I-84. One well south of I-84 (#01S04E-30AAC1) showed an overall water level increase over the whole record from 1981 to 2011; however, it has exhibited a water level decline over the last decade (Appendix C). This change may indicate growth of the cone of depression from the Cinder Cone Butte CGWA to Well #01S04E-30AAC1, only 2.5 miles away. Well #01S04E-30AAC1 is also less than one mile southeast of the proposed Orchard Ranch POU. Causes for differing water level trends in the area are poorly understood due to lack of hydrologic data.

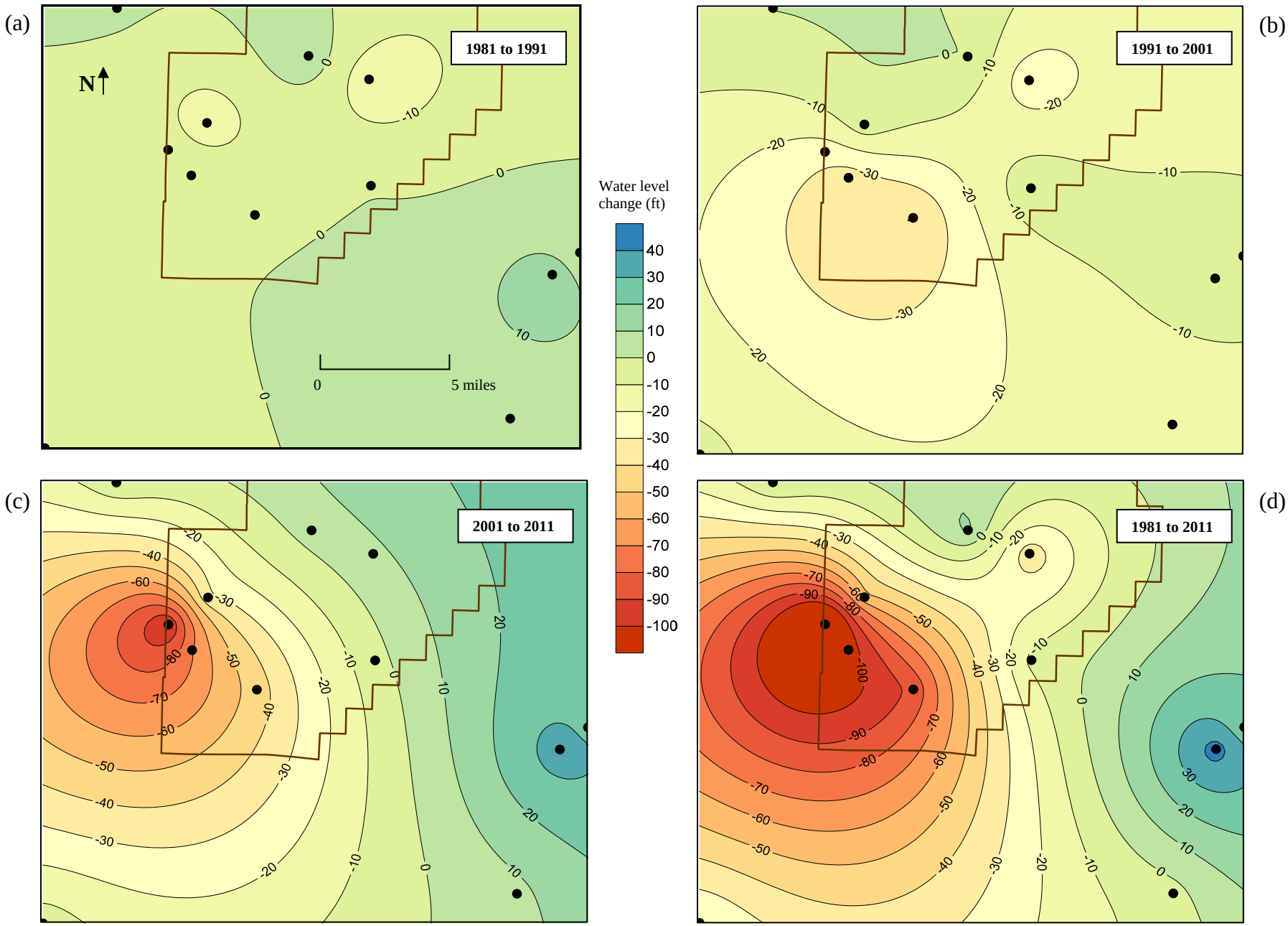

Figure 8. Groundwater level change maps for twelve wells (black dots) in the vicinity of the Cinder Cone Butte CGWA (solid brown line, established May 1981) for the fall season between the year (a) 1981 and 1991, (b) 1991 and 2001, (c) 2001 and 2011, and (d) 1981 and 2011.

Geochemistry

The USGS collected groundwater samples in 2011 and 2012 from 14 wells in the study area (Figure 9). The samples were analyzed for a suite of inorganic constituents, carbon-14, and chlorofluorocarbons (CFCs). Age dating was performed along a known groundwater flow path to help determine the relative timing of recharge to area aquifers. Geochemical modeling by the USGS identified areas receiving recharge, interpreted groundwater mixing, and provided corrected age dates. A final report was completed by the USGS in May 2013.

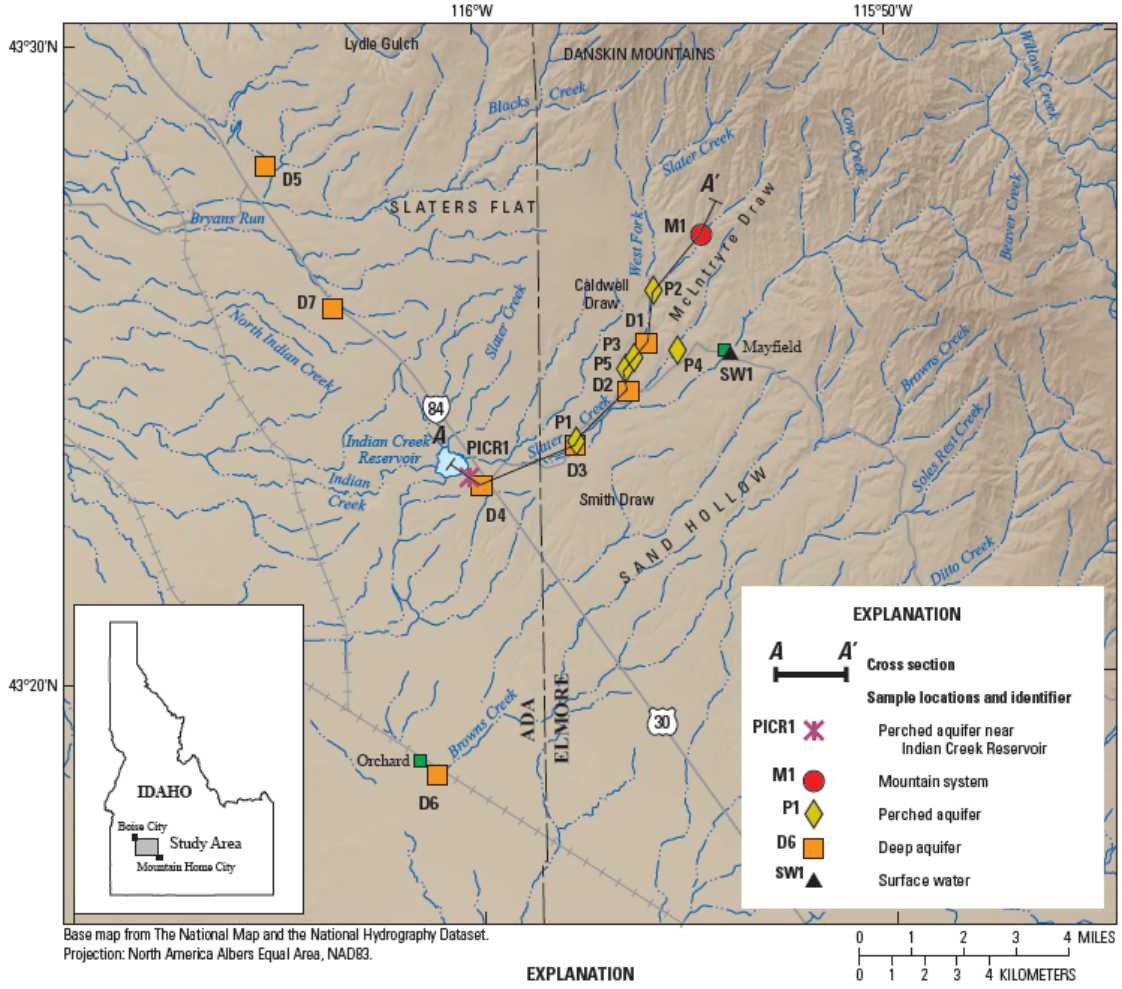

Figure 9. USGS geochemical sample locations (altered from Hopkins, 2013).

The USGS noted that geochemical differences between the perched and deep aquifers suggest different sources of recharge or a mixture of sources. Carbon-14 age dating (corrected using an open system carbon-13 mixing model) indicated that water varied in age between zero to 1,400 years in the perched system, and 2,700 to 10,000 years in the deep system (Table 1). CFCs, which indicate a component of young recharge since the

1950s, were detected in all water samples. Conflicting recharge dates between carbon-14 and CFC testing suggest a mixture of young and old water in the deep system.

Table 1. Corrected carbon-14 (C14) age dates for groundwater in the East Ada study area determined by the USGS (Hopkins, 2013).

USGS Unique Station ID	Well Depth (ft below land surface)	Depth to Water at Sampling Time (ft below land surface)	Corrected C14 Age (Years)
Perched aquifer near Indian Creek Reservoir			
PICR1	92	N/A	Modern[1]
Mountain System			
M1	170	17.3	Modern[1]
Perched Aquifer			
P1	75	N/A	Modern[1]
P2	95	44.2	1,400
P3	100	60.7	710
P4	147	70.5	Modern[1]
P5	200	93.8	390
Deep Aquifer			
D1	330	260	2,700
D2	450	N/A	2,900
D3	480	N/A	3,100
D4	711	N/A	10,000
D5	861	710	6,700
D6	960	N/A	9,400
D7	1,000	N/A	6,800

[1]Water recharged since the 1950s.

The USGS concluded that modern recharge to aquifers in the Mayfield area originates from 1) meteoric precipitation in and upgradient of the study area, 2) infiltration of surface water from streams, and 3) upwelling of geothermal water. Water temperature data, geochemical results, and mixing models suggest that the deep aquifer may receive recharge from a geothermal source (Hopkins, 2013).

Age differences also suggest that wells sampled in the perched system may not lie along a continuous flow path. Transmissivity changes (e.g. lithologic and facies changes, faults, fractures) may influence local groundwater flow and be the cause for discontinuity. Samples collected from the most upgradient deep wells (D1, D2, and D3) have a maximum age of only 3,100 years suggesting that some younger water is percolating from the perched zones to the deeper aquifer.

Surface Water Data

The headwaters for several ephemeral streams exist in the upland recharge areas for the East Ada and Cinder Cone Butte areas (Figure 10). These streams are generally intermittent, and flow is derived from precipitation and runoff events. The permeable soils in this area cause most streamflow to infiltrate into the subsurface near the range front, recharging the groundwater system.

Relatively recent gage data are available for several of the streams in the area (Table 2 and Appendix E). The USGS established new gages as part of the project on Indian Creek, Bowns Creek, Blacks Creek, and Indian Creek Reservoir and monitored them in 2011 and 2012. IDWR assumed responsibility for data collection and maintenance at the new sites in 2012. The streams and gage locations are identified in Figure 10.

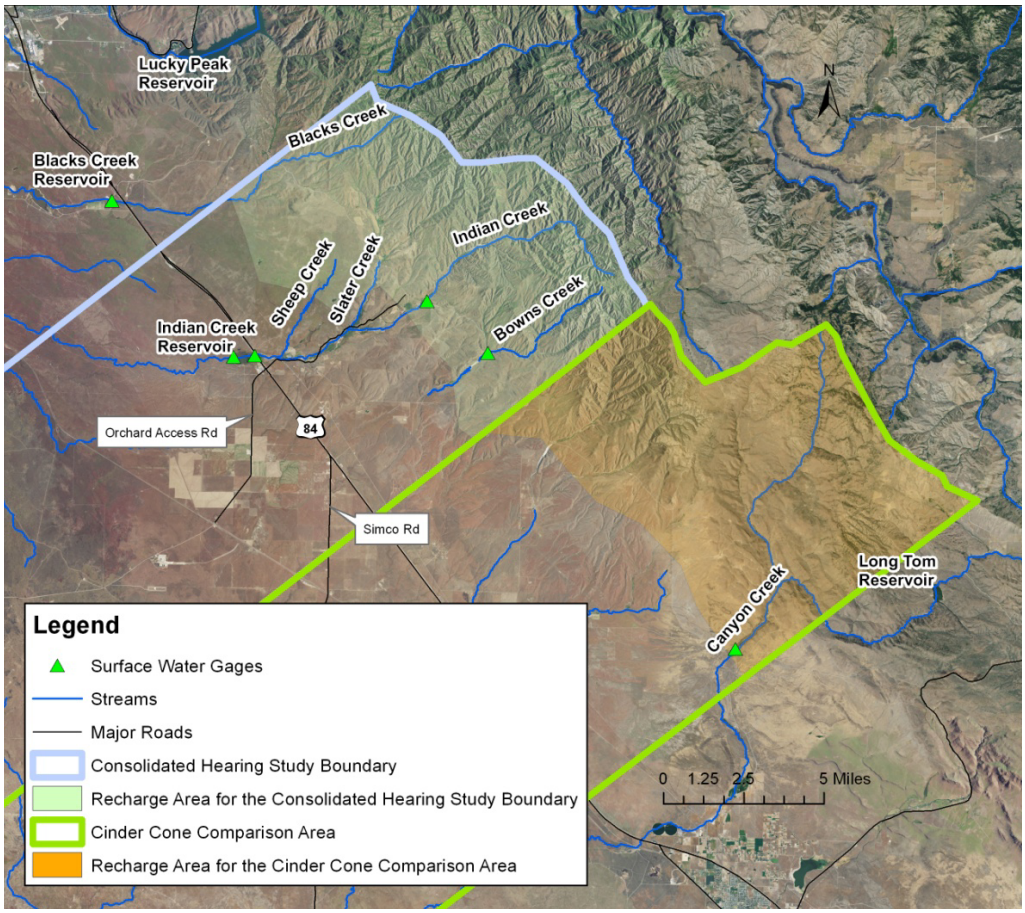

Figure 10. Surface water bodies and gages in the East Ada study area (Tesch, 2012).

Because of the longer period of record, flow data for Cottonwood Creek (USGS gage #13204640) are also presented in the Appendix. The Cottonwood Creek gage was chosen because it is approximately 18.5 miles west of, and at a similar elevation to (3,780 ft-msl), the Indian Creek gage (USGS gage #13211100) near Mayfield (3,620 ft-msl). Inspection of the hydrograph for the Cottonwood Creek gage (Appendix E) reveals that 2006 and 2011 were unusually high water years, with annual runoff volumes that were 214% and 193% percent of the average for the 11-year period of record.

Table 2. Runoff volumes for creeks in the East Ada and Cinder Cone recharge areas.

Creek	Method	Date Range	Total Runoff [1] (acre-ft)
Blacks Creek	Transducer – Mean daily discharge	1/1/11 – 6/20/11	2,309
Bowns Creek	Transducer – Mean daily discharge	10/10/10 – 7/27/11	640
Canyon Creek	Staff gage	1985-2012	24,658[2]
Cottonwood Creek (USGS #13204640)	Water stage recorder	2001 – 2011	1,183
Indian Creek (Mayfield)	Eight Flow Tracker measurements	3/12/08 – 6/13/08	2,065
Indian Creek near Mayfield (USGS # 13211100)	Transducer – Mean daily discharge	10/19/10 – 7/23/11	2,431
Indian Creek (Above Reservoir)	Transducer – Mean daily discharge	1/16/11 – 6/24/11	696

[1] Runoff volume for each creek was calculated by summing the daily mean discharge.

[2] Annual average runoff volume, which includes imported water from the South Fork of the Boise River.

Indian Creek Reservoir is the primary reservoir in the East Ada project area. Water that flows into the reservoir typically is derived from the local watershed of Sheep Creek, although some of the flow within Indian Creek reaches the reservoir during extremely high run-off conditions.

The USGS conducted a water balance and seepage study of the reservoir in 2013 (Williams, 2013). Results from the study indicate that there is some water loss from the reservoir to groundwater. However, Williams (2013) concludes "seepage losses may be due to rewetting of unsaturated near-shore soils, possible replenishment of a perched aquifer, or both, rather than through percolation to the local aquifer that lies 130 feet below the reservoir. A lithologic log from an adjacent well indicates the existence of a clay lithology that is well correlated to the original reservoir's base elevation. If the clay lithologic unit extends beneath the reservoir basin underlying the fine-grain reservoir bed sediments, the clay layer should act as an effective barrier to reservoir seepage to the local aquifer which would explain the low seepage loss estimates calculated in this study".

Additionally, estimates indicate that evaporation from the reservoir exceeds average annual precipitation. In 2011, the estimated evaporation from the reservoir was 50.2

inches, while the average annual precipitation for Boise and Mountain Home are 11.8 and 10.0 inches, respectively. Surface water and groundwater contributions are essential to maintain observed water levels in the reservoir throughout the year.

Groundwater Model Review

An important component of the Treasure Valley CAMP process is an evaluation of existing water management tools, particularly water budgets and groundwater models. Donna Cosgrove of Western Water Consulting performed an assessment of existing tools in the western Snake Plain for IDWR (Cosgrove, 2010). The Cosgrove study allowed IDWR to determine future modeling needs, additional tool development, and data gaps.

Cosgrove (2010) reviewed seven existing groundwater models in the Treasure Valley including:

- Lindgren Treasure Valley Model (1982)
- USGS western Snake Plain Model (1991)
- Treasure Valley Hydrologic Project (2004)
- University of Idaho M3 Eagle Area Model (2007)
- Pacific Groundwater Group M3 Eagle Area Model (2008)
- Bureau of Reclamation Purdam Drain Model (2008)
- Bureau of Reclamation New York Canal Linked Ground-water/Economic Model (2009)

The report provides a comparison of the design and capabilities of the models and an assessment of each model's suitability to meet the following needs of the CAMP process:

- Water administration and management alternatives to meet projected water demand for the next 50 years
- Evaluation of impacts of new water right applications, transfers, and land use changes on current water users and area groundwater resources
- Evaluation of conceptual mitigation solutions for new water diversions
- Evaluation of the potential impacts from climate change

Cosgrove (2010) concluded that a groundwater model is the best tool available for answering these critical water supply questions, and can be the foundation for water quality modeling. Cosgrove (2010) also concluded that the Treasure Valley Hydrologic Project (TVHP) model is the best-developed model of the seven reviewed; however, it could be improved by: 1) extending some model boundaries, 2) re-evaluating model boundary conditions, and c) calibrating it as a transient model.

Based on the Cosgrove (2010) recommendations, IDWR assisted the United States Bureau of Reclamation (USBR) with expanding the TVHP model boundaries and calibrating it to a transient state. A first attempt at re-calibration began in 2011 by the

USBR, after which IDWR continued updating the model for Treasure Valley CAMP needs. A technical advisory committee was formed by IDWR in November 2012 to obtain shareholder input and continue work on the model. Committee members include IDWR staff, other state and federal experts, private consultants, and university researchers.

Water Budget

A water budget was developed for the East Ada and Cinder Cone Butte areas to determine the sufficiency of water supply for existing and future uses. While the water budget was initially developed for an administrative hearing (Tesch, 2012), the original intent was to create one for this comprehensive report. Therefore, the budget used in the administrative hearing memo has been transferred to this comprehensive report, including boundary development and data presentation.

As mentioned earlier, there are six pending water right applications and two transfers for planned communities and irrigation projects along the I-84 corridor near the Ada County/Elmore County line (Figure 11), with a total combined appropriation rate of 84.76 cfs. The suggested consolidated hearing study boundary is an 11-mile wide swath oriented parallel to the southwesterly direction of regional groundwater flow (Figure 11).

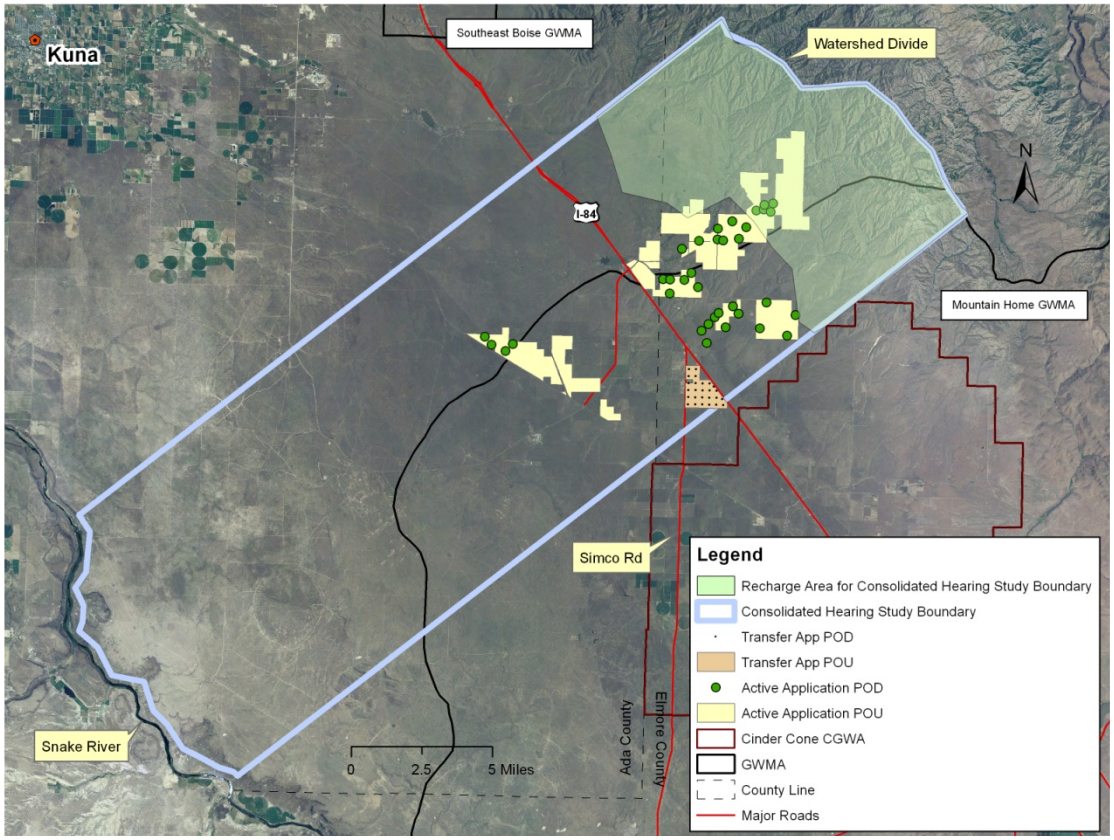

Figure 11. Consolidated hearing study area boundary.

The study boundary extends from the granitic uplands to the northeast, across the Mountain Home Plateau to the rim of the Snake River Canyon. For comparison, an adjacent swath of similar geometry and hydrogeologic setting was created which encompasses the Cinder Cone Butte CGWA (Figure 12). Comparing information from the study area to information from a nearby area that has had significant groundwater development for several decades provides context for assessing the potential hydrologic impacts of the proposed applications.

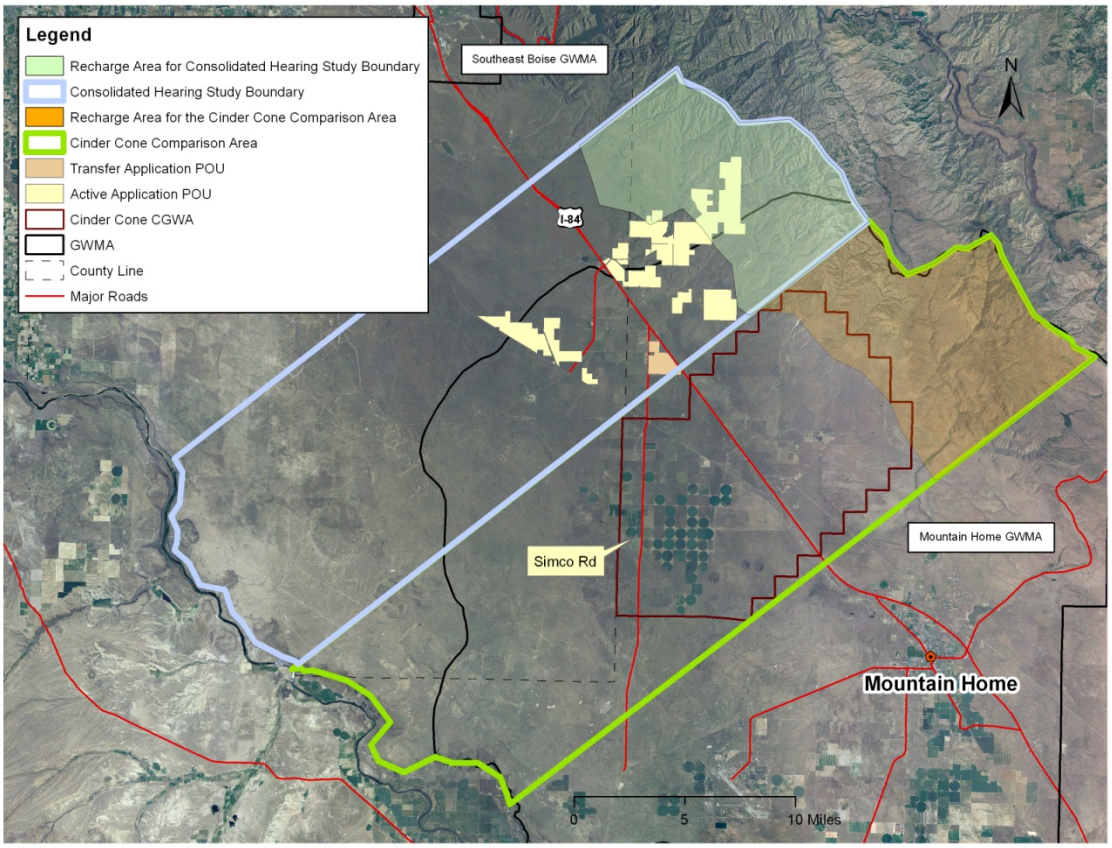

Figure 12. Consolidated hearing study area boundary (blue line) and adjacent Cinder Cone Butte comparison area boundary (green line).

Study area boundaries are as follows:

- The southwestern boundary is the rim of the Snake River Canyon.
- The southeastern boundary is a NE-SW line that runs along the northwestern boundary of Cinder Cone Butte CGWA study area.
- The northwestern boundary parallels the southeastern boundary and is generally perpendicular to groundwater flow contours (Figure 13).
- The northeastern boundary is the watershed divide between the South Fork of the Boise River and the western Snake River Plain.

The following are justifications for the study area:

- The boundary encompasses all proposed POUs and PODs.
- The study area includes the hydrogeologic system from the recharge area to the discharge area.
- The study area is large enough to encompass all of the applications, but does not include areas influenced by surface water diversions from the Boise River.
- The study area does not include the Cinder Cone Butte CGWA; however, recharge areas and overall boundary dimensions were based on consideration of the Cinder Cone Butte CGWA study (IDWR, 1981) because it also involved an assessment of the impacts of groundwater development in a similar hydrogeologic setting.

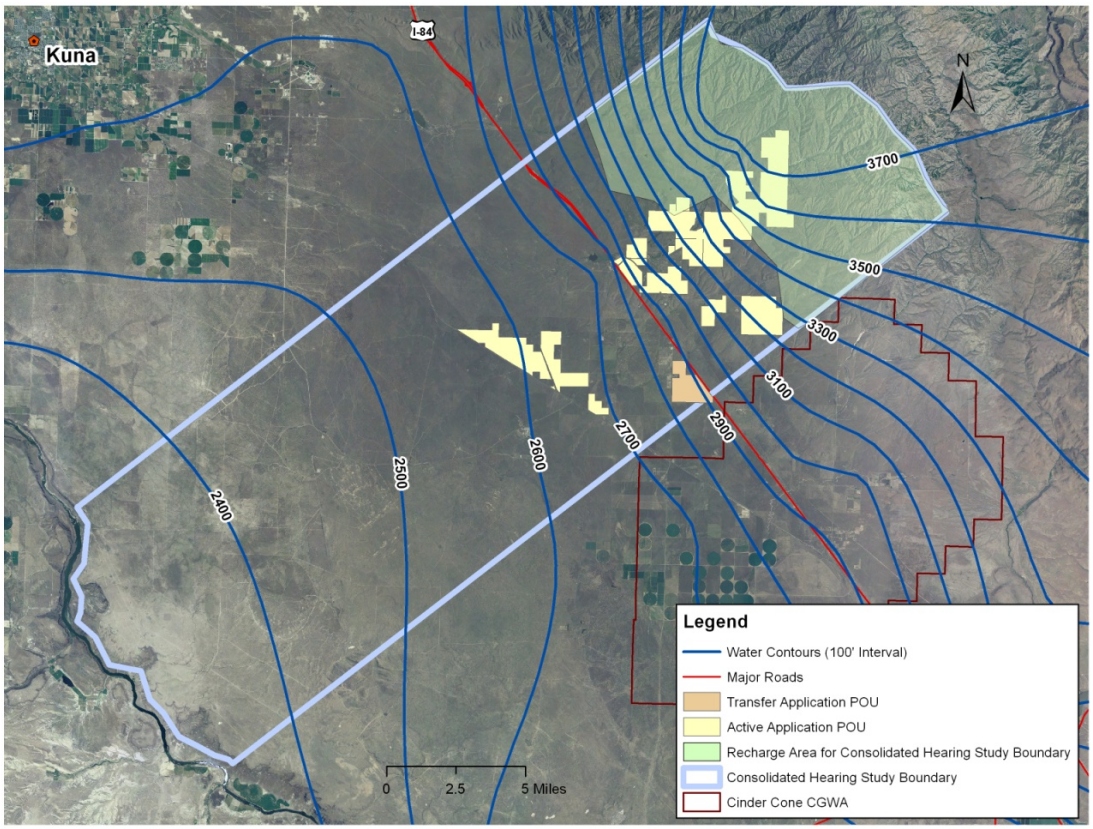

Figure 13. Water table contour map for October 2011 using water levels from the IDWR East Ada monitoring network.

The northeastern portions of the Cinder Cone Butte comparison area and the consolidated hearing study area comprise the primary recharge areas (Figure 12). Each recharge area includes all land above an elevation of 3,600 ft, which roughly corresponds to the transition between the foothills and the plateau.

Assignment of the recharge areas based on elevation is the same approach that was taken in the development of a water budget for a previous study of the Cinder Cone Butte area

(IDWR, 1981). The premise of the approach is that precipitation significantly exceeds the rate of evapotranspiration (ET) only at higher elevations. At lower elevations on the plateau, evapotranspiration on non-irrigated lands consumes almost all of the precipitation during most months of the year, resulting in limited recharge from precipitation (Newton, 1991). Some of the water that falls as precipitation in the highlands recharges the aquifer system outside the recharge areas via losing stream reaches on the plateau.

To address the sufficiency of water supply issue, water budgets were developed for the consolidated hearing study area and for the adjacent Cinder Cone Butte comparison area. Water budget development involved determining precipitation and evapotranspiration in the recharge areas and precipitation, crop irrigation requirements, and non-irrigation consumptive uses in the non-recharge areas. Details regarding each of the water budget components are presented in the following sections.

Precipitation in Recharge Areas

As previously mentioned, the primary recharge source for the study area is precipitation that falls on the uplands in the northeast portion of the study area. Precipitation in the recharge area may be consumed by evapotranspiration, leave the study area as surficial streamflow, evaporate from surface water bodies, or infiltrate either directly into the regional aquifer or through perched aquifers prior to entering the regional aquifer.

The average annual precipitation in the two recharge areas was quantified using PRISM precipitation data (PRISM, 2012). For the period 1971-2000, the average precipitation in the recharge area for the consolidated hearing study area was 1.66 ft/yr, or 75,420 acre-feet per annum (AFA). In the Cinder Cone Butte comparison area, the average precipitation was 1.70 ft/yr, or 88,989 AFA over the recharge area (Table 3). Precipitation data are also available from the Arrowrock and Anderson Ranch Dam National Weather Service (NWS) stations (Allen and Robison, 2009). The annual precipitation at the two stations is 1.58 ft/yr and 1.74 ft/yr, respectively. Weather station locations are identified on Figure 14.

Evapotranspiration in Recharge Areas

To determine the net potential recharge volume from precipitation, the evapotranspiration (ET) rates of vegetation in the recharge areas were quantified. The acreage of specific vegetation types was based on data from the 2011 National Agricultural Statistics Service Cropland Data Layer (USDA, 2012). ET estimates were based on average values for vegetation types obtained from ET Idaho (Allen and Robison, 2009) from the Arrowrock and Anderson Dam stations. Since the average precipitation in each of the recharge areas (1.66 and 1.70 ft/yr) is between the annual precipitation at the Anderson Dam and Arrowrock Dam NWS stations (1.58 and 1.74 ft/yr, respectively), it is reasonable to use ET Idaho values from these stations to calculate ET for the recharge areas. Based on these two data sources, the average evapotranspiration in the recharge area for the consolidated hearing study area is 66,147 AFA and 76,240 AFA in the recharge area for the Cinder Cone Butte comparison area.

Table 3. Water budgets for the consolidated hearing study area and the Cinder Cone Butte comparison area.

Item	Component	Consolidated Hearing Study Area	Cinder Cone Butte Comparison Area
1	Acres within Recharge Area	45,490	52,492
2	Precipitation (AFA) within Recharge Area	75,420	88,989
3	Actual Evapotranspiration (AFA) within Recharge Area	66,147	76,240
4	Acres within Non-recharge Area	177,447	181,307
5	Precipitation within Non-recharge Area (AFA)	175,662	162,111
6	Recharge from Precipitation in Non-recharge Area (AFA)	2,656	2,025
7	Irrigated Lands CIR (AFA) * Non-recharge Area	884	13,131
8	Surface Discharge Out of Area (AFA) 8a) Blacks Creek 8b) Indian Creek Reservoir Evaporation 8c) Canyon Creek Total Surface Discharge Out of Area (AFA)	 506 360 866	 9,877 9,877
9	DCMI Consumptive Use Breakdown Recharge + Non-recharge Areas (AFA): 9a) GW Rights 9b) Springs 9c) Surface Water 9d) Permit Volume Total DCMI Consumptive Use (AFA)	 317 6 170 2,566 3,059	 797 136 99 132 1,165
10	**Recharge (AFA) [Item#2-#3+#6-#8]**	11,063	4,897
11	**Recharge (cfs)**	15.27	6.76
12	**Net Recharge (AFA) [Item#10-#7-#9]**	7,120	-9,399
13	**Net Recharge (cfs)**	9.83	-12.97

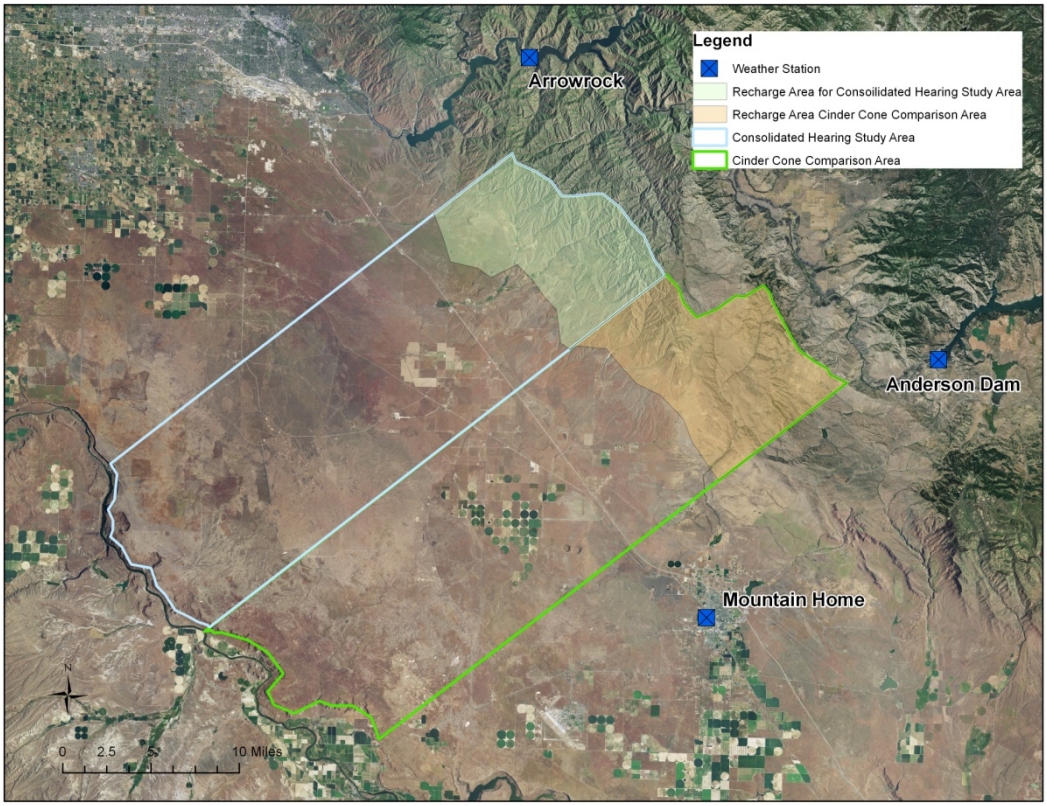

Figure 14. Weather stations in the vicinity of the study area.

Precipitation, ET, and Recharge in Non-Recharge Areas

PRISM data were also used to derive estimates of precipitation in the non-recharge areas to the southwest of the study area and the comparison area. The average precipitation for the period 1971-2000 is 175,662 AFA (0.99 ft/yr) in the study area and 162,111 AFA (0.89 ft/yr) in the Cinder Cone Butte comparison area. The precipitation at Mountain Home is slightly less at 0.91 ft/yr from ET Idaho or 0.86 ft/yr from PRISM. Using ET Idaho values from the Mountain Home station for sagebrush and range grasses in the study area likely results in underestimation because actual ET is limited by the amount of precipitation. Due to a lack of site-specific ET monitoring, estimates of non-irrigated lands recharge for each of the non-recharge areas were developed based on previous estimates that were included in the water budget for a groundwater flow model of the western Snake River Plain (Newton, 1991). Note that non-irrigated lands recharge on the Mountain Home Plateau was assumed negligible for a previous assessment of groundwater resources in the Cinder Cone Butte area (IDWR, 1981).

For non-recharge areas of the study area and the Cinder Cone Butte comparison area, Newton (1991) estimated that recharge ranges from 0.3% to 3.0% of annual precipitation. Using area-weighted recharge percentages from the model (Newton, 1991), recharge in the study area is 2,656 AFA (1.51% of the average annual precipitation), and 2,025 AFA (1.25%) in the Cinder Cone Butte comparison area.

Adjustments for Surface Water Outflows

Blacks Creek and Canyon Creek have a portion of their headwaters in the recharge areas, and transmit water southwest into and out of the study and comparison areas. The volume of water derived from precipitation within the recharge areas that flows out of the study and comparison areas was deducted from the water budget. The Blacks Creek gage station indicated 2,309 acre-ft flowed out of the study area between January 2011 and June 2011; approximately 977 acre-ft of that flow originated from precipitation in the study recharge area. To account for the abnormally high runoff conditions in 2011, the quantity of water that would leave the study area in an average season was computed. Considering the 2011 runoff season flows were 193% of normal, the 977 acre-ft was divided by a factor of 1.93, resulting in 506 acre-ft of surface water leaving the study area in Blacks Creek. The Canyon Creek gage station indicated an annual average volume of 24,658 acre-ft flowed out of the comparison area between 1985 and 2012; approximately 9,877 acre-ft of that flow originated from precipitation in the comparison recharge area.

Indian Creek Reservoir is the primary reservoir in the area. Water that flows into the reservoir typically is derived from the Sheep Creek watershed, although some Indian Creek flow reaches the reservoir during extremely high run-off conditions. A gage was established to monitor the flow into Indian Creek Reservoir in January 2011. The inflow during 2011 was approximately 696 acre-ft. Average inflow was also estimated by adjusting this value by a factor of 1.93, resulting in 360 acre-ft. It is assumed that the water that flows into Indian Creek Reservoir evaporates rather than infiltrating into the aquifer based on preliminary findings of a reservoir water balance study that is being conducted by the USGS. A report documenting the study findings is scheduled for publication by the USGS in November 2012.

Crop Irrigation Requirements

Crop irrigation requirement (CIR) values were taken from ET Idaho and multiplied by irrigated acres within the non-recharge areas for the study area and Cinder Cone Butte comparison area. The acreage of specific vegetation types was based on data from the 2011 National Agricultural Statistics Service (USDA, 2012). CIR for the non-recharge areas are 884 AFA for the study area and 13,131 AFA for the Cinder Cone Butte comparison area.

Other Consumptive Uses

Domestic and stockwater consumptive use was estimated by reviewing the IDWR water rights database files. Consumptive use for domestic households was assigned 0.8 AFA based on a family of four (Cook, et. al, 2001). In accordance with IDWR guidelines for water use, consumptive use for stockwater was determined by assigning 0.0022 AFA per sheep (2 gal/day), 0.0392 AFA per dairy cow (35 gal/day), and 0.0134 AFA per non-dairy cow (12 gal/day). Estimated total consumptive domestic and stockwater use is 493 AFA in the study area, and 866 AFA in the Cinder Cone Butte comparison area.

Diversion volume limits were used to provide conservative estimates of consumptive use for permitted, undeveloped, municipal and commercial uses. Consumptive use will likely be less than diversion volume limits by some amount depending on water use and reuse practices. Permit volume limits amount to 2,566 AFA in the hearing study area and 132 AFA in the Cinder Cone Butte comparison area.

Verification of IDWR recharge estimate

Welhan (2012) applied Darcy's law (see, e.g., Freeze and Cherry, 1979) to develop recharge estimates for the regional aquifer system in the vicinity of the proposed water right POUs as part of a hydrogeologic assessment conducted for the Treasure Valley CAMP program. Separate estimates for two hydrogeologic conceptual models were developed to explain a steepening of the hydraulic gradient that occurs in the vicinity of I-84. One conceptual model incorporated recharge from precipitation in the highlands with an additional influx of geothermal and/or perched water. The second model incorporated a zone of decreased aquifer transmissivity near I-84.

Using available aquifer transmissivity values, Welhan (2012) estimated that recharge to the regional aquifer along a 6.21 mile-wide cross-section oriented approximately perpendicular to the southwesterly groundwater flow direction (Figure 15) is 7,000 AFA for the conceptual model involving an additional influx of water and 12,600 AFA for the conceptual model involving decreased aquifer transmissivity. Proportionally scaling up the estimates from Welhan (2012) to the width of the study area (11 miles) results in a range of 12,400 AFA to 22,320 AFA.

Current consumptive uses reflected in the Welhan (2012) recharge estimate that are not in the IDWR study area estimate (item 10 in Table 3) include CIR in the non-recharge area (item #7 in Table 3) and existing DCMI consumptive uses (items 9a, 9b, and 9c in Table 3). Adding the sum of these four components (1,377 AFA) to the width-adjusted estimates, results in estimates of 13,777 AFA to 23,697 AFA. The low end of this range is somewhat higher than the recharge estimate of 11,063 AFA in Table 3. The estimates compare well given the uncertainty inherent in the estimation of recharge, especially when using Darcy's law.

Sufficiency of the Water Supply

In this section, the water budget information developed in Table 3 is used to assess the sufficiency of the water supply. Comparisons are made between the computed net recharge rate for the consolidated hearing study area to the computed net recharge rate for the Cinder Cone Butte comparison area and to the total appropriation amount for the study area. The validity of the former is enhanced by the fact that the method of calculation is the same for the two areas.

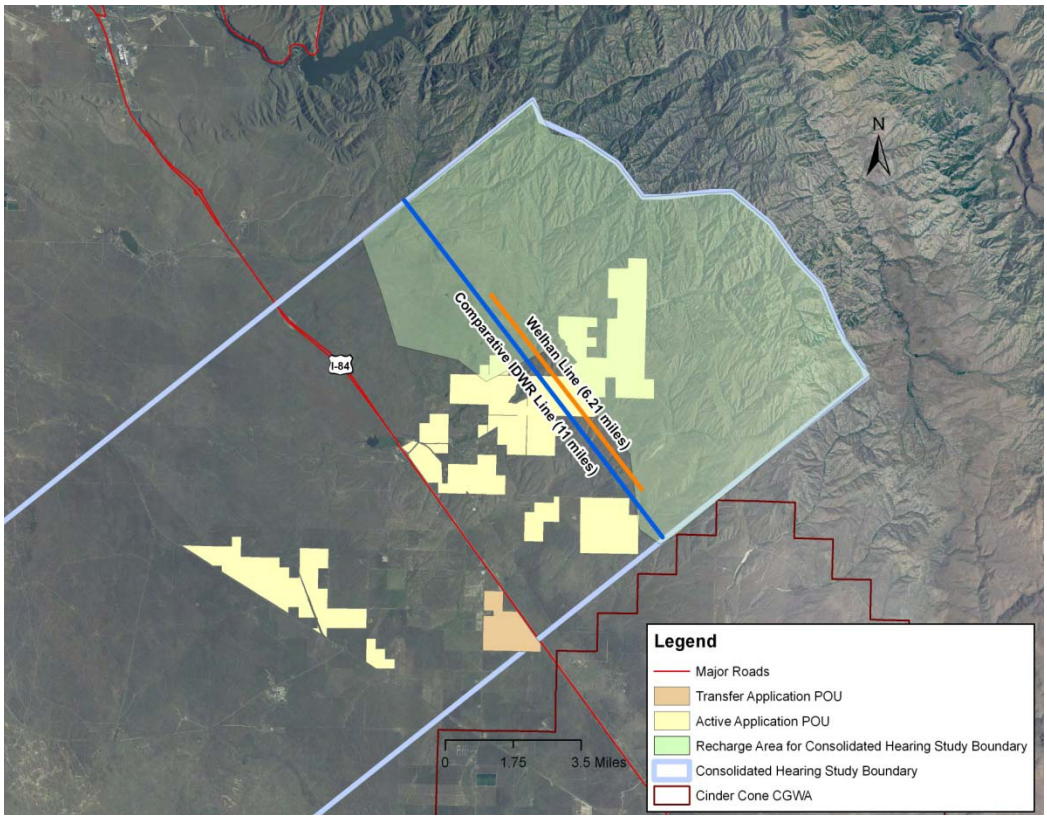

Figure 15. Darcy's law cross-section used by Welhan (2012) to develop recharge estimates.

The net recharge rate for the study area (7,120 AFA) is positive, indicating that existing consumptive uses, including those for water rights that are not yet fully developed, are less than the rate of recharge. The net recharge rate is 16,519 AFA higher than the net recharge for the Cinder Cone Butte comparison area (-9,399 AFA). Additional consumptive uses approaching the amount of the difference would be expected to result in water level declines similar to those observed in the Cinder Cone Butte CGWA and, assuming hydrologic continuity, exacerbate water level declines in the Cinder Cone Butte CGWA.

Idaho Code stipulates that, with only a couple of exceptions, "*water in a well shall not be deemed available to fill a water right therein if withdrawal therefrom of the amount called for by such right would affect, contrary to the declared policy of this act, the present or future use of any surface or ground water right or result in the withdrawing of the groundwater supply at a rate beyond the reasonably anticipated rate of future natural recharge*" (Idaho Code §42-237a.g.). According to IDAPA 37.03.11, the "*reasonably anticipated rate of future natural recharge*" includes recharge from precipitation, underflow from tributary sources, stream losses, and incidental recharge of water used for irrigation and other purposes. Thus, based on the water budget presented herein, and assuming similar hydrologic conditions in future years, the reasonably anticipated rate of future natural recharge is 11,063 AFA and the maximum additional consumptive use that

could be authorized within the study area is 7,120 AFA. On a continuous basis, this latter amount is equivalent to 9.8 cfs, which is considerably less than the maximum total appropriation amount of 84.76 cfs. Note, however, that the fraction of the maximum total appropriation that would be consumptively used depends, not on the rate limits, but rather on water use and reuse practices and the amounts withdrawn, all of which are information lacking for this analysis.

Inherent in the assumption that the future natural recharge rate would be roughly equivalent to the average based on precipitation data for the time period 1971-2000 is the assumption that the rate of inflow to the aquifer system would be unchanged by additional groundwater withdrawals that are the subject of the consolidated hearing. Induced underflow from tributary sources, for example, is assumed negligible because the recharge area extends all the way to the surface water divide and the granitic rocks that underlie the surface water divide are relatively impermeable. Similarly, induced inflow from the aquifer system adjacent to the study area is assumed to be negligible and/or off limits for appropriation because of the existence of the Cinder Cone Butte CGWA. In other words, lowering of the water table in the study area would not substantively increase the amount of water available for appropriation.

Additional groundwater extraction would, however, decrease aquifer storage, particularly in the short term, and eventually decrease aquifer discharge to the Snake River. If inflow to the study area is unchanged, mass balance requires that increased withdrawals will decrease outflow to the Snake River by an equivalent amount at steady state. This applies to both the consolidated study area and the Cinder Cone Butte comparison area. An indication of the expected transient groundwater response is provided by hydrographs for wells in the Cinder Cone Butte CGWA monitoring network (Appendix B). Despite the fact that there has been a moratorium on new irrigation appropriations for more than 30 years, water level monitoring indicates that aquifer storage continues to decline in the Cinder Cone Butte CGWA.

The table in Figure 16 shows that the current cumulative volume limit for licensed water rights in the study area is less than five percent of the cumulative volume limit for licensed water rights in the Cinder Cone Butte comparison area. In combination with the maximum rate for recently approved water right permits (14.02 cfs), the proposed additional maximum appropriation rate of 84.76 cfs represents a 1,102% increase in the permissible, instantaneous withdrawal rate in the study area.

Figure 17 relates the growth of the cumulative licensed water right volume limit for the Cinder Cone Butte comparison area to water levels in two monitoring wells in the Cinder Cone Butte CGWA. Since the study area and the Cinder Cone Butte comparison area are within a similar hydrogeologic setting, the relationship between the growth of the cumulative volume limit and the water level trends provides an indication of the potential hydrologic impacts of rapid groundwater development in the study area. The data suggest an inverse relationship between the amount of groundwater development and the water levels in the regional aquifer.

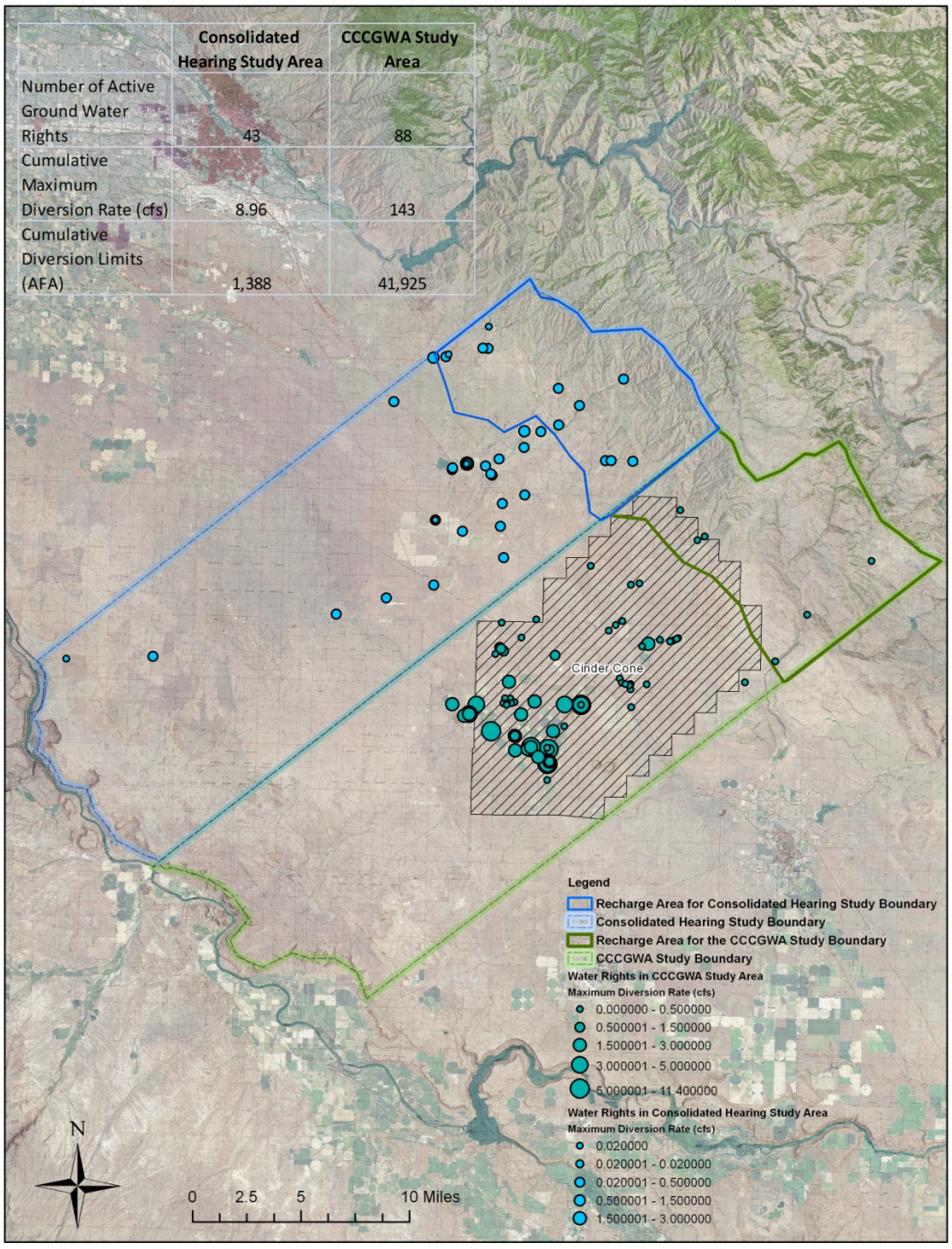

Figure 16. Licensed water rights and maximum diversion rates in the study area and in the Cinder Cone Butte comparison area.

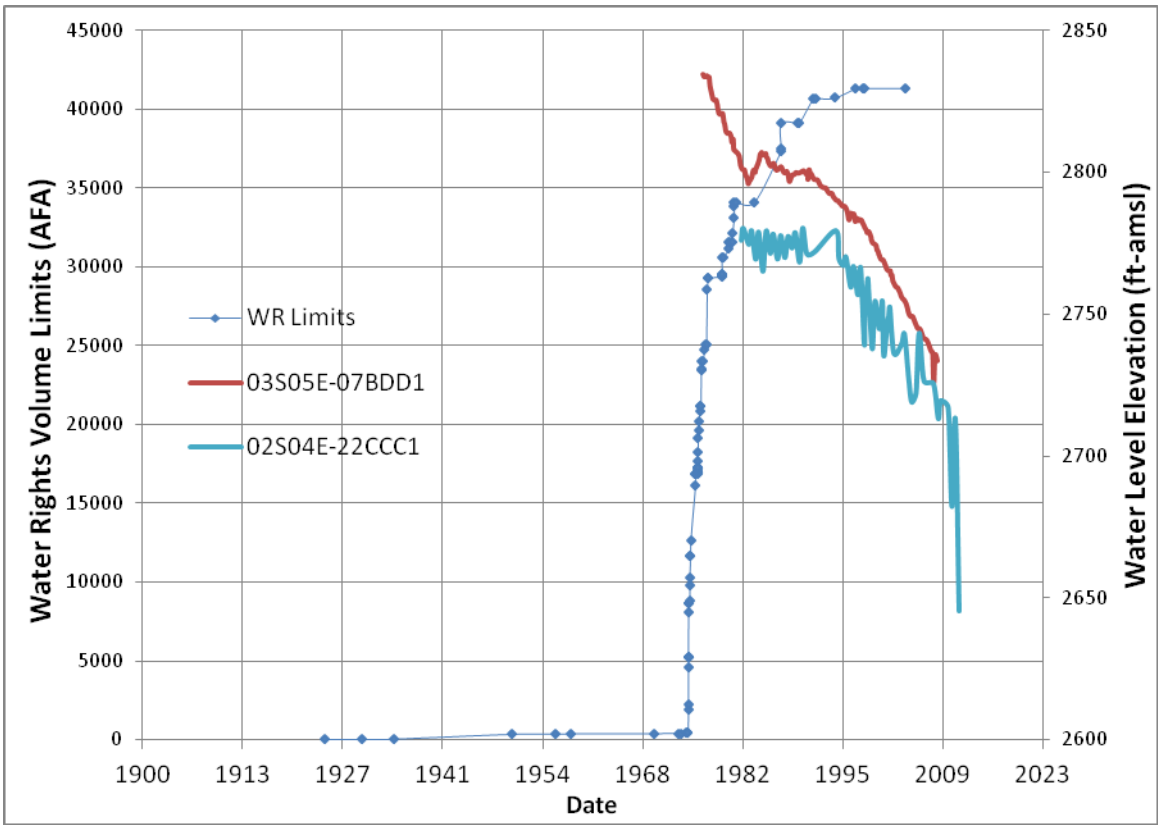

Figure 17. Cumulative water right volume limit in the Cinder Cone Butte comparison area and water levels in Well #03S05E-07BDD1 and Well #02S04E-22CCC1.

Water Budget Summary

The preceding analysis attempts to quantify the maximum amount of water that is available for appropriation in the study area. The validity of the analysis depends on the validity of the assumptions. While there is uncertainty in estimates of individual water budget components, use of the same assumptions and methodology for the Cinder Cone Butte comparison area provides context for interpreting the results.

Specific conclusions are as follows:

1. Assuming future hydrologic conditions similar to those during the recent past, the reasonably anticipated rate of future natural recharge is 11,063 AFA.

2. The estimated net recharge rate for the study area is 7,120 AFA. The estimate is positive, indicating that existing consumptive uses, including those for water rights that are not yet fully developed, are less than the rate of recharge.

3. The net recharge rate (7,120 AFA) is an estimate of the maximum additional consumptive use that could be authorized within the study area. On a continuous

basis, this amount is equivalent to 9.8 cfs, which is approximately an order of magnitude less than the maximum total appropriation amount being sought as part of the consolidated hearing (84.76 cfs).

4. In combination with the combined maximum appropriation rate for recently approved but not yet developed water rights (14.02 cfs), the proposed additional maximum appropriation rate of 84.76 cfs represents a 1,102% increase in the permissible, instantaneous withdrawal rate in the study area.

5. The magnitude of the recharge estimate for the study area is generally confirmed by extrapolation of results from an analysis that involved the application of Darcy's law.

6. Given uncertainties in aquifer properties and hydrologic boundary conditions, no attempt has been made to quantify hydrologic impacts of the proposed groundwater development. Instead, data from the Cinder Cone Butte CGWA provide an indication of potential impacts. The data suggest an inverse relationship between the amount of groundwater development and water levels in the regional aquifer.

7. Ongoing water level declines more than 30 years after establishment of the Cinder Cone Butte CGWA indicate that the groundwater supply on the Mountain Home Plateau is limited and support the conclusion that consumptive use within the Cinder Cone Butte comparison area exceeds the rate of recharge.

8. Unless inflow to the aquifer system in the study area is increased, mass balance requires that increased withdrawals will decrease outflow to the Snake River by an equivalent amount at steady state.

9. Assuming hydrologic continuity, groundwater development in the study area would eventually exacerbate declining water level conditions in the Cinder Cone Butte CGWA.

Summary and Conclusions

The East Ada County Hydrologic Project was initiated in 2008 as part of the Treasure Valley CAMP. A water budget was developed in 2012, and data related to recharge mechanisms, groundwater flow, discharge rates, geology, and aquifer characteristics were evaluated and compiled for this comprehensive report.

Recent mapping by the Idaho Geological Survey and geophysical work by Boise State University have provided information constraining the hydrogeologic picture in the East Ada area. Quaternary basalts, gravel, and terrace deposits appear on the surface immediately south of the Cretaceous granites of the Idaho Batholith. A majority of sediments in the East Ada study area that host the deep aquifer are fine sands most likely

associated with lacustrine sediments of the Idaho Group. Faulting also plays an important role in the hydrogeology of the East Ada aquifer system.

The general groundwater flow direction in the regional aquifer is to the southwest towards the Snake River. The East Ada/West Elmore groundwater system is recharged by three sources: (1) infiltration of seasonally warmed surface water into shallow aquifers near local streams, (2) meteoric recharge into both the perched and deep aquifers derived from local watersheds, and (3) a deep source of geothermal water rising along faults of the Boise Front.

IDWR began monitoring the shallow and deep East Ada groundwater systems in 2009. Water levels are measured quarterly in a network of 30 wells. Thirteen of the wells are equipped with data loggers that collect readings every six hours. Although monitoring began in 2009, there is currently not enough data to determine long-term trends. However, significant water level declines approximately five miles southeast of the East Ada study area resulted in the establishment of the Cinder Cone Butte CGWA in 1981.

The USGS collected groundwater samples in 2011 and 2012 from 14 wells in the East Ada area. Corrected carbon-14 water ages range from zero to 1,400 years in the perched system and from 2,700 to 10,000 years in the deep system. CFCs, which indicate a component of young recharge since the 1950s, were detected in all water samples. Conflicting recharge dates between carbon-14 and CFC testing suggest a mixture of young and old water in the deep system.

The USGS established surface water gages on Indian Creek, Bowns Creek, Blacks Creek, and Indian Creek Reservoir and monitored them in 2011 and 2012. IDWR took over data collection and maintenance at the sites in 2012. The USGS recently conducted a water balance and seepage study of Indian Creek Reservoir. Results from the USGS indicate that there is some water loss from the reservoir to groundwater, and that evaporation from the reservoir exceeds average annual precipitation.

Donna Cosgrove of Western Water Consulting performed an assessment of existing tools in the western Snake Plain and reviewed seven existing groundwater models in the Treasure Valley. Cosgrove (2010) concluded that the TVHP model is the best-developed model of the seven reviewed. IDWR assisted the USBR on expanding the TVHP model boundaries and calibrating it to a transient state. A technical advisory committee was also formed by IDWR in November 2012 to obtain shareholder input and continue work on the model.

A water budget was developed for the East Ada and Cinder Cone Butte areas to determine the sufficiency of water supply for existing and future uses. The water budget was developed for an administrative hearing and then transferred to this comprehensive report, including boundary development and data presentation. There are six pending water right applications and two transfers for planned communities and irrigation projects along the I-84 corridor near the Ada County/Elmore County line, with a total combined appropriation rate of 84.76 cfs. The suggested consolidated hearing study area is an 11-

mile wide swath oriented parallel to the southwesterly direction of regional groundwater flow.

The estimated net recharge rate for the study area is 7,120 AFA. The estimate is positive, indicating that existing consumptive uses, including those for water rights that are not yet fully developed, are less than the rate of recharge. The net recharge rate is an estimate of the maximum additional consumptive use that could normally be authorized within the study area. On a continuous basis, this amount is equivalent to 9.8 cfs, which is approximately an order of magnitude less than the maximum total appropriation amount being sought as part of the consolidated hearing (84.76 cfs).

Water level declines have occurred for more than 30 years after establishment of the Cinder Cone Butte CGWA, which indicates that the groundwater supply on the Mountain Home Plateau is limited and supports the conclusion that consumptive use within the Cinder Cone Butte comparison area exceeds the rate of recharge. Assuming hydrologic continuity, groundwater development in the East Ada study area would eventually exacerbate declining water level conditions in the Cinder Cone Butte CGWA and decrease outflow to the Snake River.

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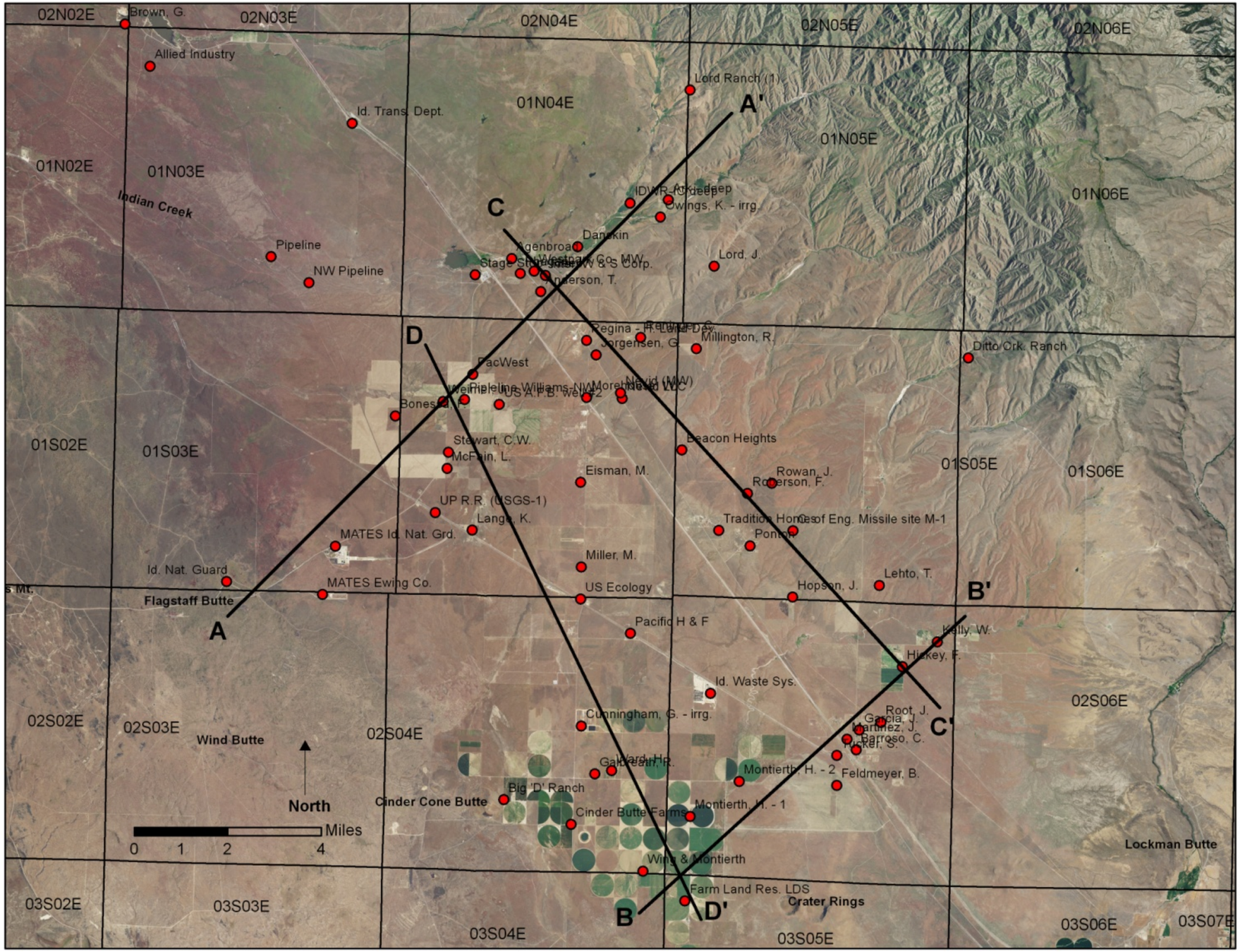
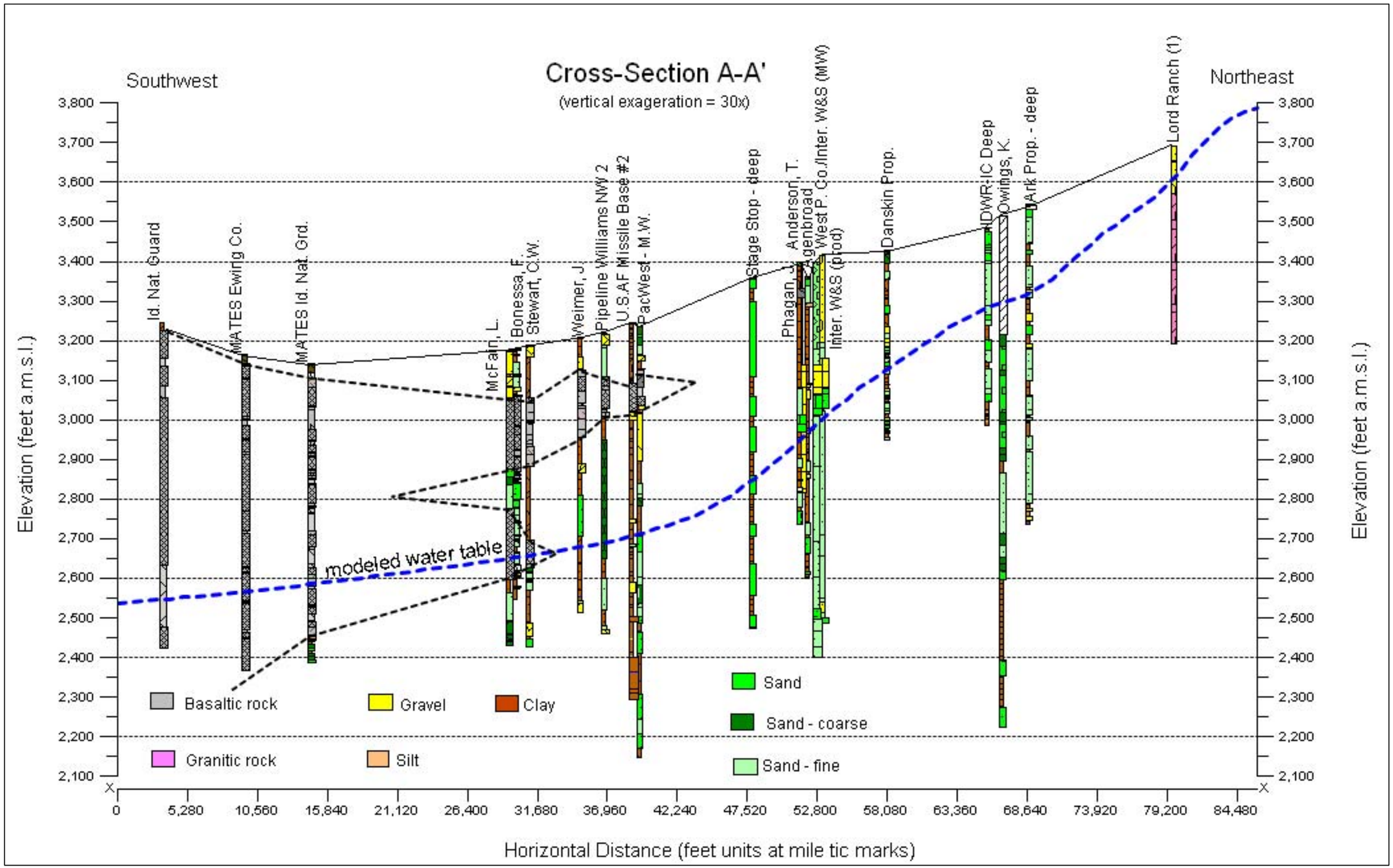
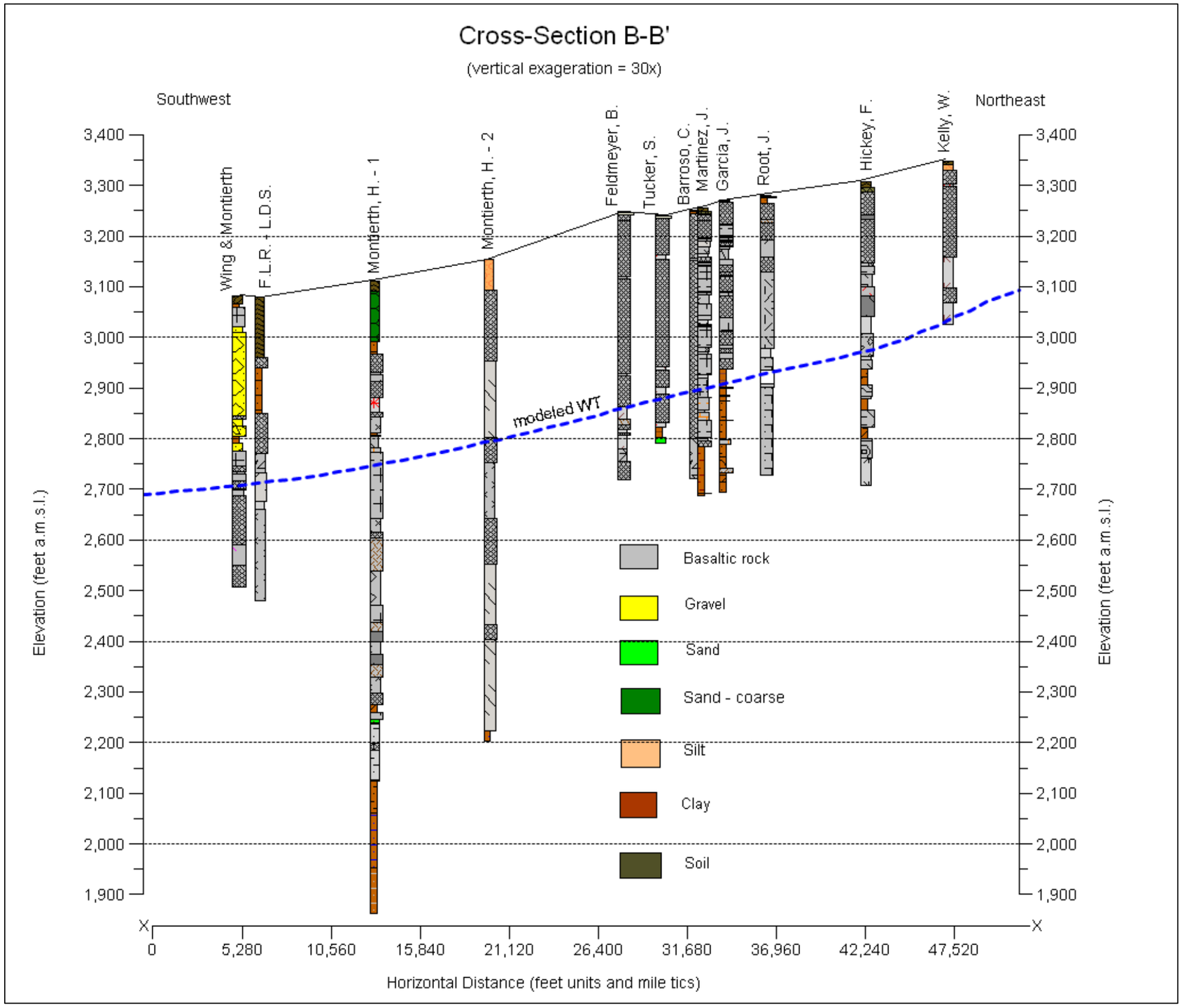
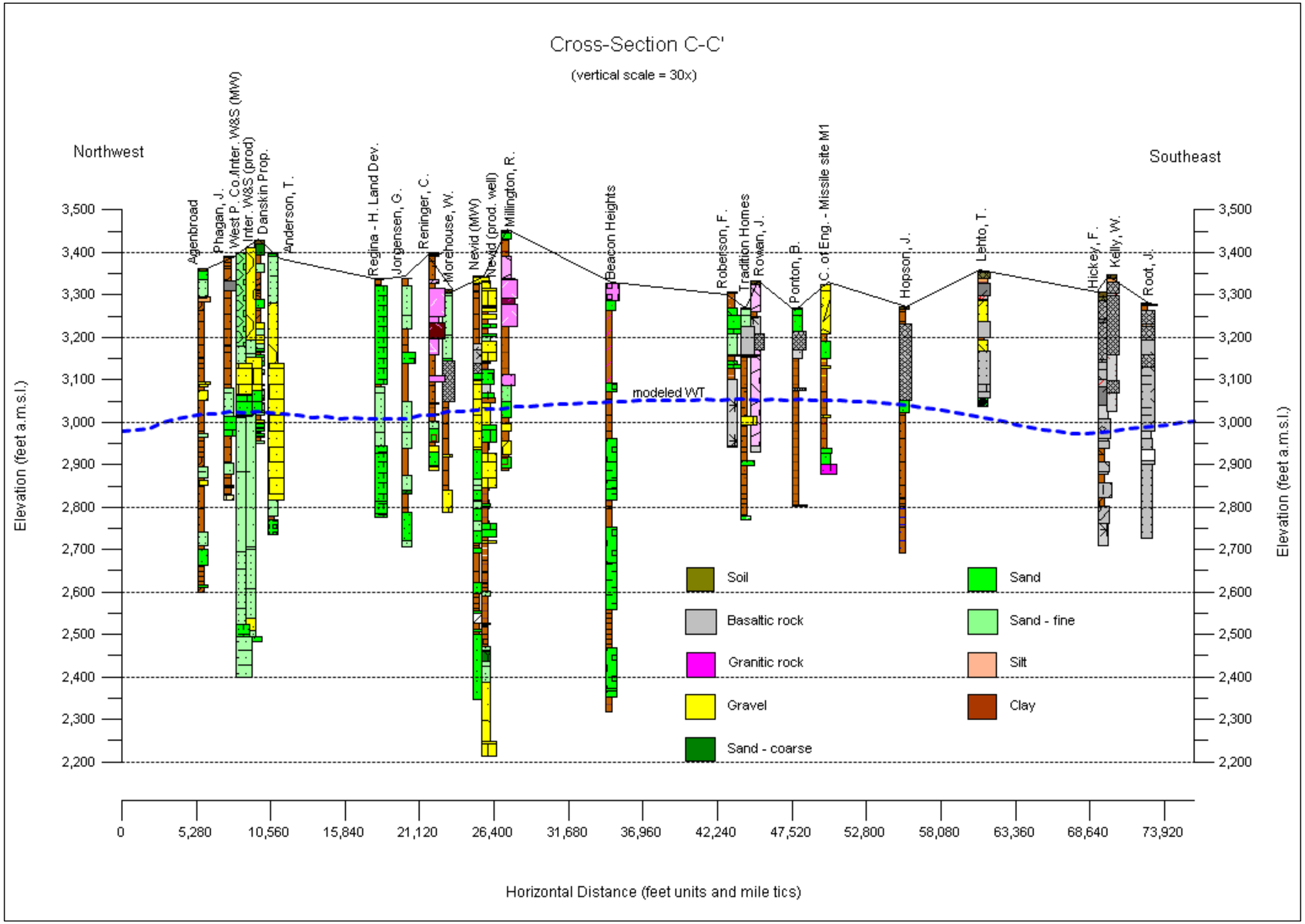
APPENDIX A

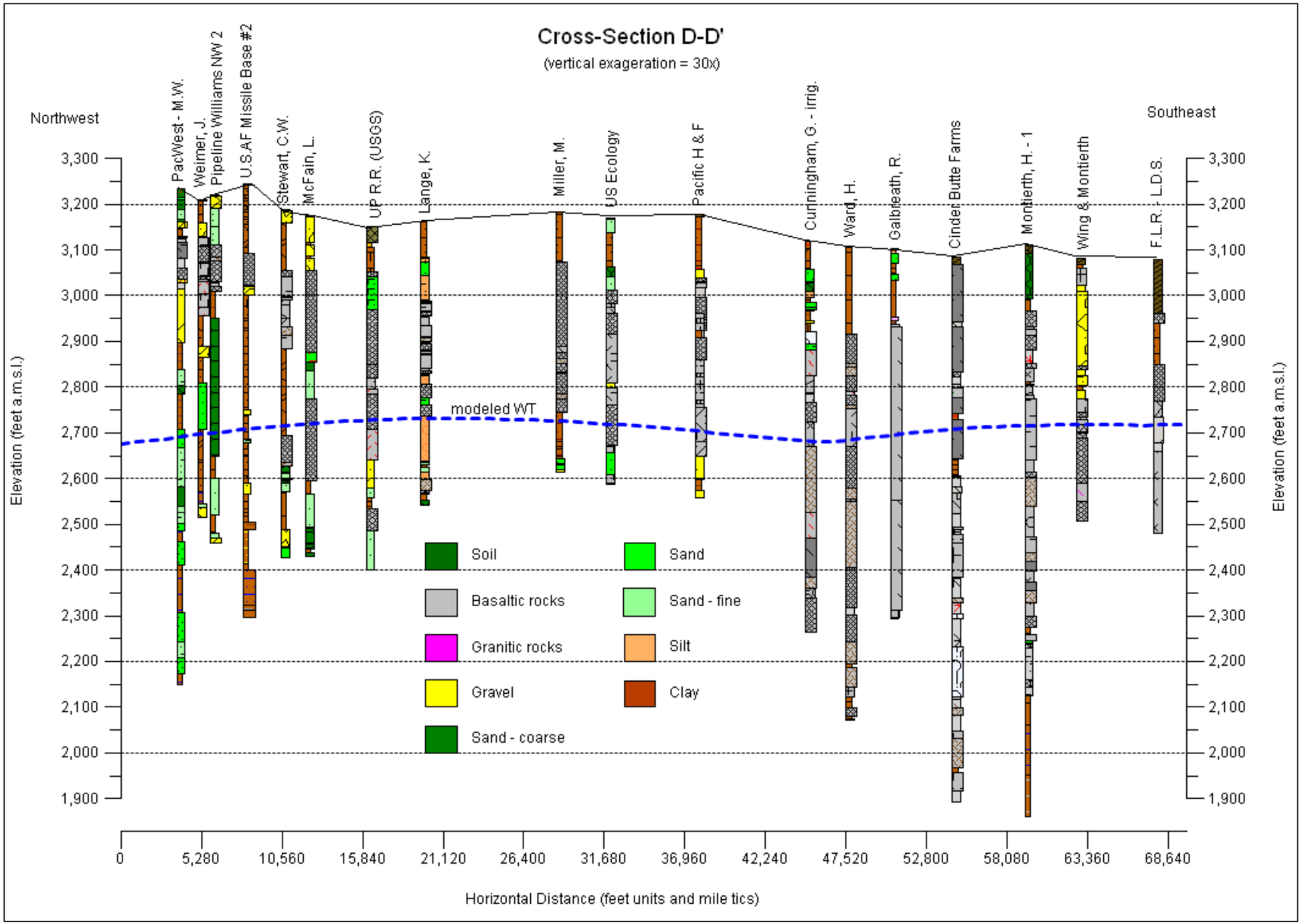
Geologic Cross Sections


02N02E
02N03E
02N04E
02N05E
02N06E
01N02E
01N03E
01N04E
01N05E
01N06E
01S02E
01S03E
01S05E
01S06E
02S02E
02S03E
02S04E
02S06E
03S02E
03S03E
03S04E
03S05E
03S06E
03S07E
Brown, G.
Allied Industry
Id. Trans. Dept.
Lord Ranch (1)
Indian Creek
Pipeline
NW Pipeline
Danskin
Lord, J.
Anderson, T.
Millington, R.
Ditto Crk. Ranch
PacWest
Jorgensen, G.
Bonestell, P.
Stewart, C.W.
McFinn, L.
Eisman, M.
UP R.R. (USGS-1)
Langa, K.
MATES Id. Nat. Grd.
Miller, M.
Id. Nat. Guard
MATES Ewing Co.
US Ecology
Flagstaff Butte
Wind Butte
Cinder Cone Butte
Big 'D' Ranch
Cinder Butte Farms
Montierth, H. - 1
Montierth, H. - 2
Feldmeyer, B.
Cunningham, G. - irrg.
Id. Waste Sys.
Pacific H & F
Beacon Heights
Rowan, J.
Roberson, F.
Tradition Homes
Eng. Missile site M-1
Hopson, J.
Lehto, T.
Hickey, F.
Root, J.
Garcia, J.
Barroso, C.
Lockman Butte
Crater Rings
Farm Land Res. LDS
A
A'
B
B'
C
C'
D
D'
North
Miles
0
1
2
4


Cross-Section A-A'
(vertical exageration = 30x)
Southwest
Northeast
Elevation (feet a.m.s.l.)
Horizontal Distance (feet units at mile tic marks)
modeled water table
Id. Nat. Guard
MATES Ewing Co.
MATES Id. Nat. Grd.
McFann, L.
Bonessa, F.
Stewart, C.W.
Weimer, J
Pipeline Williams NW 2
U.S.AF Missile Base #2
PacWest - M.W.
Stage Stop - deep
Phagan, J.
Andersen, T.
Hagenbroad
West P. Co./Inter. W&S (MW)
Inter. W&S (prod)
Danskin Prop.
IDWR:IC Deep
Owings, K.
Ark Prop. - deep
Lord Ranch (1)
Basaltic rock
Gravel
Clay
Granitic rock
Silt
Sand
Sand - coarse
Sand - fine
3,800
3,700
3,600
3,500
3,400
3,300
3,200
3,100
3,000
2,900
2,800
2,700
2,600
2,500
2,400
2,300
2,200
2,100
0
5,280
10,560
15,840
21,120
26,400
31,680
36,960
42,240
47,520
52,800
58,080
63,360
68,640
73,920
79,200
84,480


Cross-Section B-B'
(vertical exageration = 30x)
Southwest
Northeast
Wing &Montierth
F.L.R. + L.D.S.
Montierth, H. - 1
Montierth, H. - 2
Feldmeyer, B.
Tucker, S.
Barroso, C.
Martinez, J.
Garcia, J.
Root, J.
Hickey, F.
Kelly, W.
modeled WT
Basaltic rock
Gravel
Sand
Sand - coarse
Silt
Clay
Soil
Elevation (feet a.m.s.l.)
3,400
3,300
3,200
3,100
3,000
2,900
2,800
2,700
2,600
2,500
2,400
2,300
2,200
2,100
2,000
1,900
0
5,280
10,560
15,840
21,120
26,400
31,680
36,960
42,240
47,520
Horizontal Distance (feet units and mile tics)

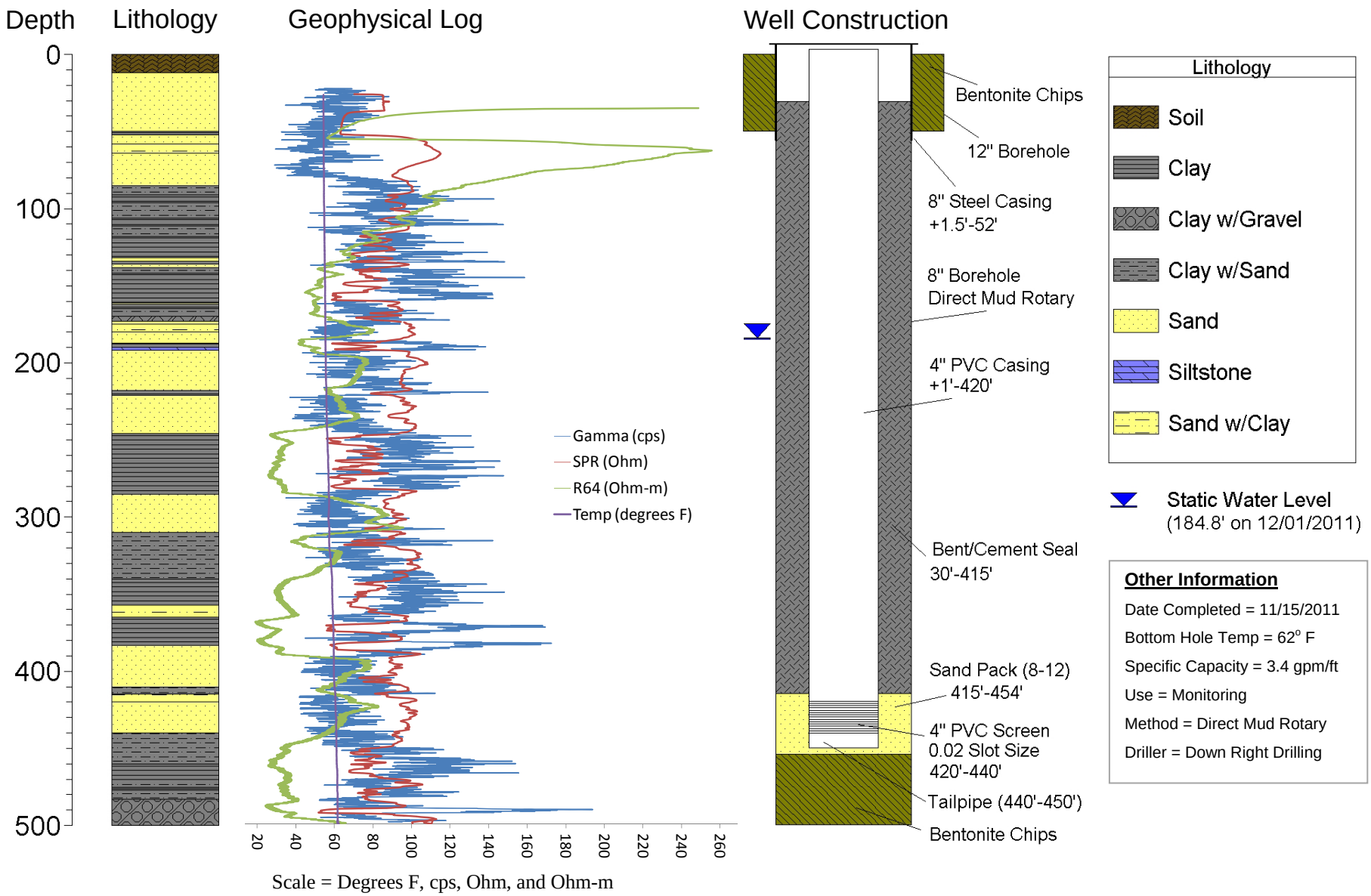

Cross-Section C-C'
(vertical scale = 30x)
Northwest
Southeast
Elevation (feet a.m.s.l.)
3,500
3,400
3,300
3,200
3,100
3,000
2,900
2,800
2,700
2,600
2,500
2,400
2,300
2,200
Agenbroad
Phagan, J.
West P. Co./Inter. W&S (MW)
Inter. W&S (prod)
Damskin Prop.
Anderson, T.
Regina - H. Land Dev.
Jorgensen, G.
Reninger, C.
Morehouse, W.
Nevid (MW)
Nevid (prod. well)
Millington, R.
Beacon Heights
Roberson, F.
Tradition Homes
Rowan, J.
Ponton, B.
C. of Eng. - Missile site M1
Hopson, J.
Lehto, T.
Hickey, F.
Kelly, W.
Root, J.
modeled WT
Soil
Basaltic rock
Granitic rock
Gravel
Sand - coarse
Sand
Sand - fine
Silt
Clay
0
5,280
10,560
15,840
21,120
26,400
31,680
36,960
42,240
47,520
52,800
58,080
63,360
68,640
73,920
Horizontal Distance (feet units and mile tics)


Cross-Section D-D'
(vertical exageration = 30x)
Northwest
Southeast
PacWest - M.W.
Weimer, J.
Pipeline Williams NW 2
U.S.AF Missile Base #2
Stewart, C.W.
McFain, L.
UP R.R. (USGS)
Lange, K.
Miller, M.
US Ecology
Pacific H & F
Cunningham, G. - irrig.
Ward, H.
Galbreath, R.
Cinder Butte Farms
Monteith, H. - 1
Wing & Monteith
F.L.R. - L.D.S.
modeled WT
Soil
Basaltic rocks
Granitic rocks
Gravel
Sand - coarse
Sand
Sand - fine
Silt
Clay
Elevation (feet a.m.s.l.)
3,300
3,200
3,100
3,000
2,900
2,800
2,700
2,600
2,500
2,400
2,300
2,200
2,100
2,000
1,900
0
5,280
10,560
15,840
21,120
26,400
31,680
36,960
42,240
47,520
52,800
58,080
63,360
68,640
Horizontal Distance (feet units and mile tics)

Appendix B

IDWR Well #01N04E-23ADC1 Construction Diagram And Well Logs For The Three Newly Drilled Wells In the East Ada Network

IDWR Well #01N04E-23ADC1



Scale = Degrees F, cps, Ohm, and Ohm-m

IDWR Well #01N04E-23ADC1
"Indian Creek Deep"

REVISED

Form 238-7
6/07

IDAHO DEPARTMENT OF WATER RESOURCES
WELL DRILLER'S REPORT

1. WELL TAG NO. D D0060212
Drilling Permit No.
Water right or injection well #

2. OWNER
Name IDWR
Address 322 East Front Street
City Boise State ID Zip 83720

3. WELL LOCATION:
Twp. 1 North ☒ or South ☐ Rge. 4 East ☒ or West ☐
Sec. 23 SW 1/4 (10 acres) SE 1/4 (40 acres) NE 1/4 (160 acres)
Gov't Lot County Elmore
Lat. 43 ° 24.498 (Deg. and Decimal minutes)
Long. 115 ° 56.334 (Deg. and Decimal minutes)
Farm field approx. 1/4mi NE of Indian Cr. Rd. &
Address of Well Site Slater Cr. Rd.
City Mayfield
(Give at least name of road • Distance to Road or Landmark)
Lot. Blk. Sub. Name

4. USE:
☐ Domestic ☐ Municipal ☒ Monitor ☐ Irrigation ☐ Thermal ☐ Injection
☐ Other

5. TYPE OF WORK check all that apply (Replacement etc.)
☒ New Well ☐ Replacement well ☐ Modify existing well
☐ Abandonment ☐ Other

6. DRILL METHOD:
☐ Air Rotary ☒ Mud Rotary ☐ Cable ☐ Other

7. SEALING PROCEDURES

Seal material	From (ft)	To (ft)	Quantity (lbs or ft³)	Placement method/procedure
3/8bentchps	0'	50'	1850 lbs	poured & tagged
DFGrt/Cmnt	30'	415'	120 cu.ft.	tremie

8. CASING/LINER:

Diameter (nominal)	From (ft)	To (ft)	Gauge/ Schedule	Material	Casing	Liner	Threaded	Welded
8"	+1.5'	52	.250	steel	☒	☐	☐	☒
4"	+1'	420	sc80	PVC	☒	☐	☒	☐
4"	440'	450'	sc80	PVC	☒	☐	☒	☐

Was drive shoe used? ☒ Y ☐ N Shoe Depth(s) 52

9. PERFORATIONS/SCREENS:
Perforations ☐ Y ☐ N Method
Manufactured screen ☒ Y ☐ N Type PVC factory slotted
Method of installation set in

From (ft)	To (ft)	Slot size	Number/ft	Diameter (nominal)	Material	Gauge or Schedule
420'	440'	.020		4"	PVC	Sch80

Length of Headpipe Length of Tailpipe 10'
Packer ☐ Y ☒ N Type

10. FILTER PACK:

Filter Material	From (ft)	To (ft)	Quantity (lbs or ft³)	Placement method
8-12 sand	415'	454'	1250 lbs.	poured & tagged
medbentchip	454'	500'	850 lbs.	poured-backfill

11. FLOWING ARTESIAN:
Flowing Artesian? ☐ Y ☒ N Artesian Pressure (PSIG)
Describe control device

12. STATIC WATER LEVEL and WELL TESTS:
Depth first water encountered (ft) 15 Static water level (ft) 183
Water temp. (°F) Bottom hole temp. (°F)
Describe access port

Well test: Test method:

Drawdown (feet)	Discharge or yield (gpm)	Test duration (minutes)	Pump	Bailer	Air	Flowing artesian
5	17	480	☒	☐	☐	☐

Water Quality test or comments:

13. LITHOLOGIC LOG and/or repairs or abandonment:

Bore Dia. (in)	From (ft)	To (ft)	Remarks, lithology or description of repairs or abandonment, water temp.	Water Y	Water N
12"	0'	2'	brown top soil		X
12"	2'	12'	brown sandy clay		x
12"	12'	43'	light grey sand	X	
12"	43'	50'	light brown sand		X
8"	50'	52'	tan clay		X
8"	52'	58'	grey sand		X
8"	58'	64'	tan sand & clay strips		X
8"	64'	85'	brown sand	X	
8"	85'	138'	light brown sand & clay strips		X
8"	138'	222'	brown sand & clay strips		X
8"	222'	235'	white/grey sand	X	
8"	235'	246'	brown sand & clay strips		X
8"	246'	285'	light brown clay		X
8"	285'	310'	grey sand	X	
8"	310'	340'	brown sand & clay strips		X
8"	340'	352'	brown clay		X
8"	352'	357'	grey clay		X
8"	357'	375'	grey sand & clay strips		X
8"	375'	420'	grey & brown sand & clay strips		X
8"	420'	440'	grey sand	X	
8"	440'	460'	tan sandy clay		X
8"	460'	470'	grey clay		X
8"	470'	475'	tan & grey sandy clay		X
8"	475'	477'	grey clay		X
8"	477'	483'	grey sandy clay		X
8"	483'	500'	grey clay		X
			Med. chips 0'-30' 500 lbs. btwn 8" & 4"		

RECEIVED
SEP 28 2012
WATER RESOURCES

Completed Depth (feet) 450
Date: Started 11-10-2011 Completed 11-15-2011

14. DRILLER'S CERTIFICATION
I/We certify that all minimum well construction standards were complied with at the time the rig was removed.
Company Name Down Right Drilling & Pump,Inc Co. No. 637
*Principal Driller Date 3-9-12
*Driller Date
*Operator II Date
Operator I Date
* Signature of Principal Driller and rig operator are required.

Form provided by Forms On-A-Disk · (214) 340-9429 · www.FormsOnADisk.com

IDWR Well #01N04E-23ADC2
"Indian Creek Shallow"

W3 862552

Form 238-7
6/07

IDAHO DEPARTMENT OF WATER RESOURCES
WELL DRILLER'S REPORT

1. WELL TAG NO. D 0060214
Drilling Permit No. 913924-862552
Water right or injection well # —

2. OWNER
Name IDWR
Address 322 East Front Street
City Boise State ID Zip 83720

3. WELL LOCATION:
Twp. 1 North ☒ or South ☐ Rge. 4 East ☒ or West ☐
Sec. 23 SW (10 acres) 1/4 SE (40 acres) 1/4 NE (160 acres) 1/4
Gov't Lot County Elmore
Lat. 43 ° 24.496 (Deg. and Decimal minutes)
Long. 115 ° 56.332 (Deg. and Decimal minutes)
Farm field approx 1/4mi NE if Indian Cr. Rd. &
Address of Well Site Slater Cr Rd
City Mayfield
(Give at least name of road • Distance to Road or Landmark)
Lot. Blk. Sub. Name

4. USE:
☐ Domestic ☐ Municipal ☒ Monitor ☐ Irrigation ☐ Thermal ☐ Injection ☐ Other

5. TYPE OF WORK check all that apply (Replacement etc.)
☒ New Well ☐ Replacement well ☐ Modify existing well ☐ Abandonment ☐ Other

6. DRILL METHOD:
☐ Air Rotary ☒ Mud Rotary ☐ Cable ☐ Other

7. SEALING PROCEDURES

Seal material	From (ft)	To (ft)	Quantity (lbs or ft³)	Placement method/procedure
3/8 bentchips	0'	18'	450 lbs.	poured
3/8 bentchips	80'	100'	250 lbs.	poured

8. CASING/LINER:

Diameter (nominal)	From (ft)	To (ft)	Gauge/ Schedule	Material	Casing	Liner	Threaded	Welded
6"	+2'	18'	.250	steel	☒	☐	☐	☒
2"	+2'	55'	sc40	PVC	☒	☐	☒	☐
2"	65'	75	sc40	PVC	☒	☐	☒	☐

Was drive shoe used? ☒ Y ☐ N Shoe Depth(s) 18

9. PERFORATIONS/SCREENS:
Perforations ☐ Y ☐ N Method
Manufactured screen ☒ Y ☐ N Type 2" 4" PVC Factory
Method of installation casing string

From (ft)	To (ft)	Slot size	Number/ft	Diameter (nominal)	Material	Gauge or Schedule
55'	65'	.020		2"	PVC	sch 40

Length of Headpipe Length of Tailpipe 10'
Packer ☐ Y ☒ N Type

10. FILTER PACK:

Filter Material	From (ft)	To (ft)	Quantity (lbs or ft³)	Placement method
8-12 sand	54'	80'	550 lbs.	poured

11. FLOWING ARTESIAN:
Flowing Artesian? ☐ Y ☒ N Artesian Pressure (PSIG)
Describe control device

12. STATIC WATER LEVEL and WELL TESTS:
Depth first water encountered (ft) 15 Static water level (ft) 62
Water temp. (°F) Bottom hole temp. (°F)
Describe access port

Well test: **Test method:**

Drawdown (feet)	Discharge or yield (gpm)	Test duration (minutes)	Pump	Bailer	Air	Flowing artesian
	No Test		☐	☐	☐	☐

Water Quality test or comments:

13. LITHOLOGIC LOG and/or repairs or abandonment:

Bore Dia. (in)	From (ft)	To (ft)	Remarks, lithology or description of repairs or abandonment, water temp.	Water Y	Water N
10"	0'	2'	brown top soil		X
10"	2'	10'	brown sandy clay		X
10"	10'	18'	brown clay		X
6"	18'	36'	grey sand	X	
6"	36'	41'	brown sandy clay		X
6"	41'	52'	brown gravel & sand	X	
6"	52'	54'	tan clay		X
6"	54'	62'	light brown sand		X
6"	62'	65'	light brown sand	X	
6"	65'	75'	tan sand & clay		X
6"	75'	80'	brown clay		X
6"	80'	85'	light brown clay w/sand strips		X
6"	85'	100'	light brown sandy clay		X

RECEIVED
DEC 19 2011
WATER RESOURCES
WESTERN REGION
SCANNED
DEC 19 2011

Completed Depth (Measurable) 82
Date: Started 11-17-2011 Completed 11-17-2011

14. DRILLER'S CERTIFICATION
I/We certify that all minimum well construction standards were complied with at the time the rig was removed.
Company Name DownRight Drilling & Pump,Inc Co. No. 637
*Principal Driller Date
*Driller Tony Daubert Date
*Operator II Date
Operator I Date
* Signature of Principal Driller and rig operator are required.

Form provided by Forms On-A-Disk · (214) 340-9429 · www.FormsOnADisk.com

IDWR Well #02N03E-34ACC1
"Blacks Creek Well"

03

Form 238-7
6/07

8626116

IDAHO DEPARTMENT OF WATER RESOURCES
WELL DRILLER'S REPORT

1. WELL TAG NO. D 0060211
Drilling Permit No. 913987-8626116
Water right or injection well #

2. OWNER
Name Idaho Dept. of Water Resources
Address 322 East Front Street
City Boise State ID Zip 83720

3. WELL LOCATION:
Twp. 2 North ☒ or South ☐ Rge. 3 East ☒ or West ☐
Sec. 34 NW (10 acres) 1/4 SW (40 acres) 1/4 NE (160 acres) 1/4
Gov't Lot County Ada
Lat. 43 ° 28.078 (Deg. and Decimal minutes)
Long. 116 ° 05.075 (Deg. and Decimal minutes)
Address of Well Site Idaho Trans land approx. 1/2 mi north of I-84 on Blacks Creek Road City Boise
(Give at least name of road + Distance to Road or Landmark)
Lot. Blk. Sub. Name

4. USE:
☐ Domestic ☐ Municipal ☒ Monitor ☐ Irrigation ☐ Thermal ☐ Injection ☐ Other

5. TYPE OF WORK check all that apply (Replacement etc.)
☒ New Well ☐ Replacement well ☐ Modify existing well ☐ Abandonment ☐ Other

6. DRILL METHOD:
☐ Air Rotary ☒ Mud Rotary ☐ Cable ☐ Other

7. SEALING PROCEDURES

Seal material	From (ft)	To (ft)	Quantity (lbs or ft³)	Placement method/procedure
3/8bentchips	0'	40'	3500 lbs	poured
grt-bent/cemt	240'	720'	193 cu/ft	tremie,pump

8. CASING/LINER:

Diameter (nominal)	From (ft)	To (ft)	Gauge/ Schedule	Material	Casing	Liner	Threaded	Welded
12"	0'	342'	.375	steel	☒	☐	☐	☒
8"	+1'	277'	.250	steel	☒	☐	☐	☒
8"	277'	720'	.322	steel	☒	☐	☐	☒

Was drive shoe used? ☒ Y ☐ N Shoe Depth(s) 342'/720'

9. PERFORATIONS/SCREENS:
Perforations ☐ Y ☒ N Method
Manufactured screen ☒ Y ☐ N Type telescoping SS
Method of installation set in, puiled back

From (ft)	To (ft)	Slot size	Number/ft	Diameter (nominal)	Material	Gauge or Schedule
795'	836'	.018		5"	St. St.	W 60
836'	856'	.020		5"	St. St.	W 60

Length of Headpipe 18' Length of Tailpipe 5'
Packer ☒ Y ☐ N Type 2 ea. K Packer

10. FILTER PACK:

Filter Material	From (ft)	To (ft)	Quantity (lbs or ft³)	Placement method

11. FLOWING ARTESIAN:
Flowing Artesian? ☐ Y ☒ N Artesian Pressure (PSIG)
Describe control device

12. STATIC WATER LEVEL and WELL TESTS:
Depth first water encountered (ft) 240 Static water level (ft) 710
Water temp. (°F) 65.3 Bottom hole temp. (°F) 72.5
Describe access port

Well test: **Test method:**

Drawdown (feet)	Discharge or yield (gpm)	Test duration (minutes)	Pump	Bailer	Air	Flowing artesian
30.5	30	1380	☒	☐	☐	☐

Water Quality test or comments:

13. LITHOLOGIC LOG and/or repairs or abandonment:

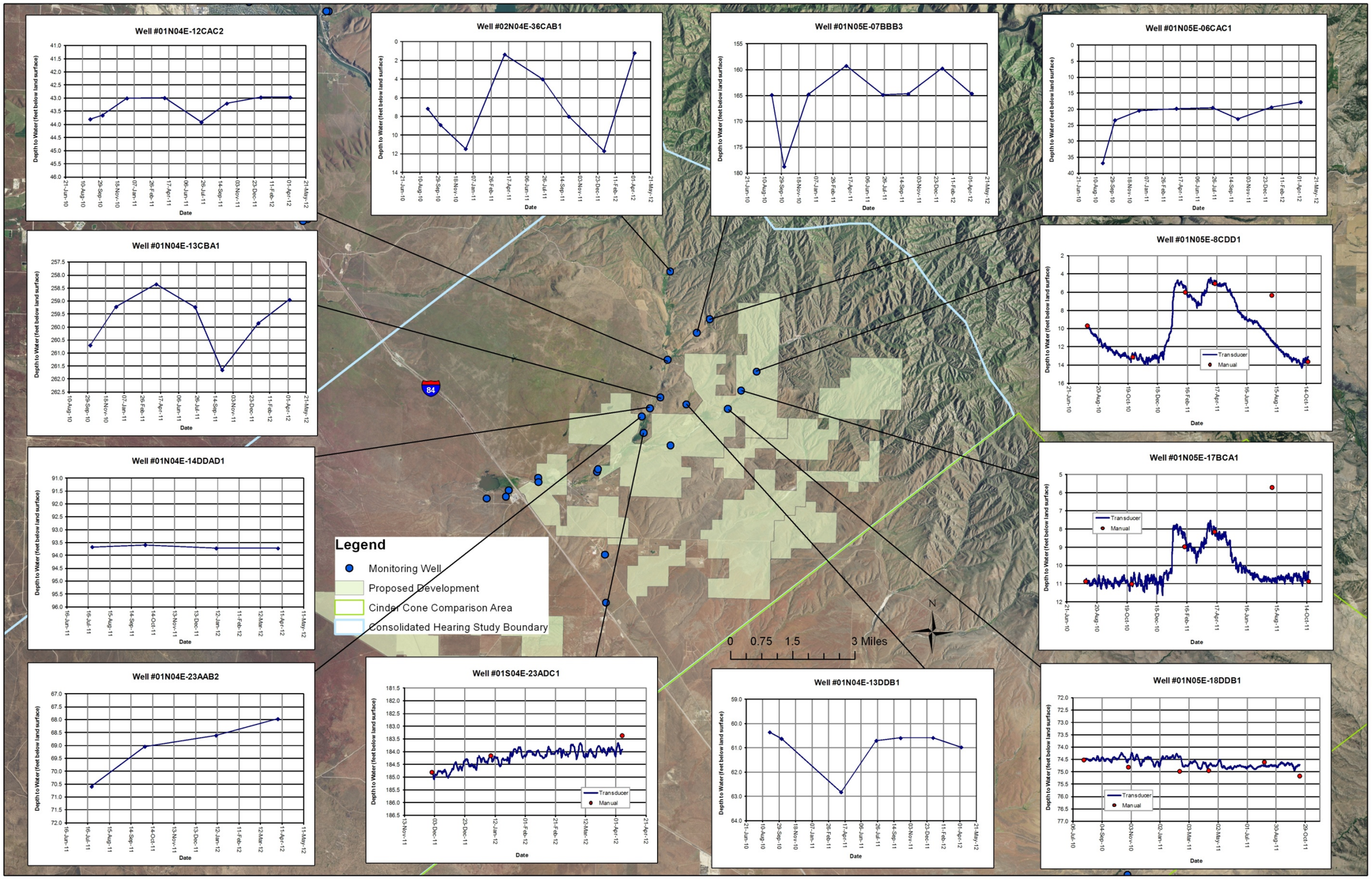
Bore Dia. (in)	From (ft)	To (ft)	Remarks, lithology or description of repairs or abandonment, water temp.	Water Y	Water N
20"	0'	5'	top soil, brown clay		X
20"	5'	13'	hardpan, brown clay		X
20"	13'	40'	sand & gravel		X
13"	40'	240'	sand & gravel		X
13"	240'	245'	sand & gravel	X	
13"	245'	280'	clay & gravel		X
13"	280'	285'	sand & gravel		X
13"	285'	295'	brown sandy clay with gravel		X
13"	295'	343'	brown sand & gravel		X
12"	343'	385'	brown sand & gravel		X
12"	385'	470'	strips of brown clay, sand & gravel		X
12"	470'	490'	granite boulder		X
12"	490'	590'	strips of sandy clay, sand & gravel		X
12"	590'	615'	brown clay		X
12"	615'	620'	granite boulder		X
12"	620'	720'	brown sandy clay strips w/some gravel		X
8"	720'	725'	brown silt		X
8"	725'	735'	brown sand	X	
8"	735'	825'	brown sand with some gravel	X	
8"	825'	830'	brown sandy clay		X
8"	830'	855'	brown sand & gravel		X
8"	855'	861'	brown silty sand & gravel		X
	8)	cont.	+3' to 787.5' 6" casing steel		
			777' to 795' 5" hdppe/packer .258 steel		
			856' to 861' 5" tailpipe .258 steel		
			Rcvd 7/24/12 MP		

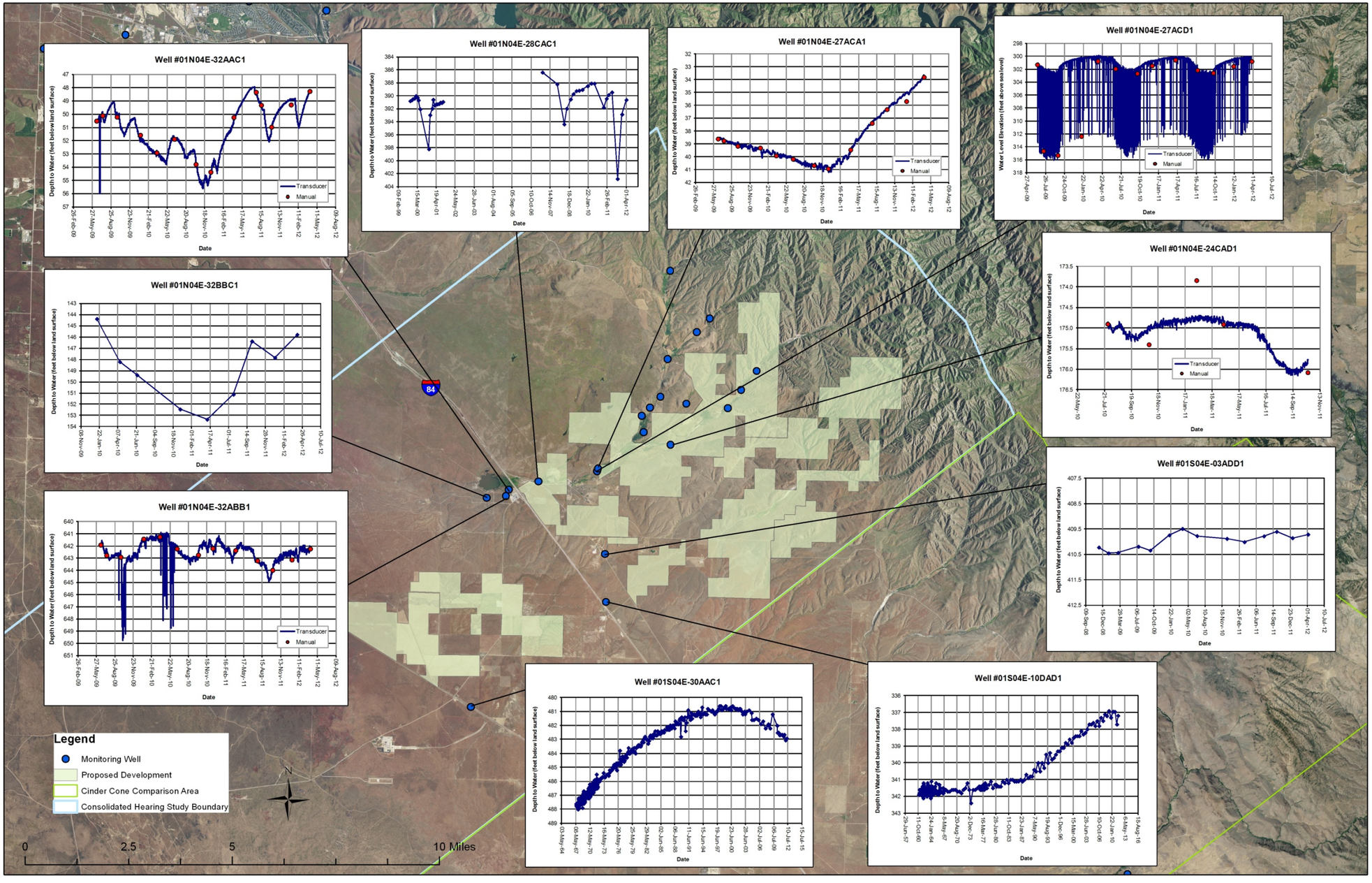
Completed Depth (Measurable) 864
Date: Started 1-3-12 Completed 3-28-12

14. DRILLER'S CERTIFICATION
I/We certify that all minimum well construction standards were complied with at the time the rig was removed.
Company Name Down right drilling & Pump,Inc Co. No. 637
*Principal Driller [signature] Date 03-28-12
*Driller Date
*Operator II Date
Operator I Date
* Signature of Principal Driller and rig operator are required.

APPENDIX C

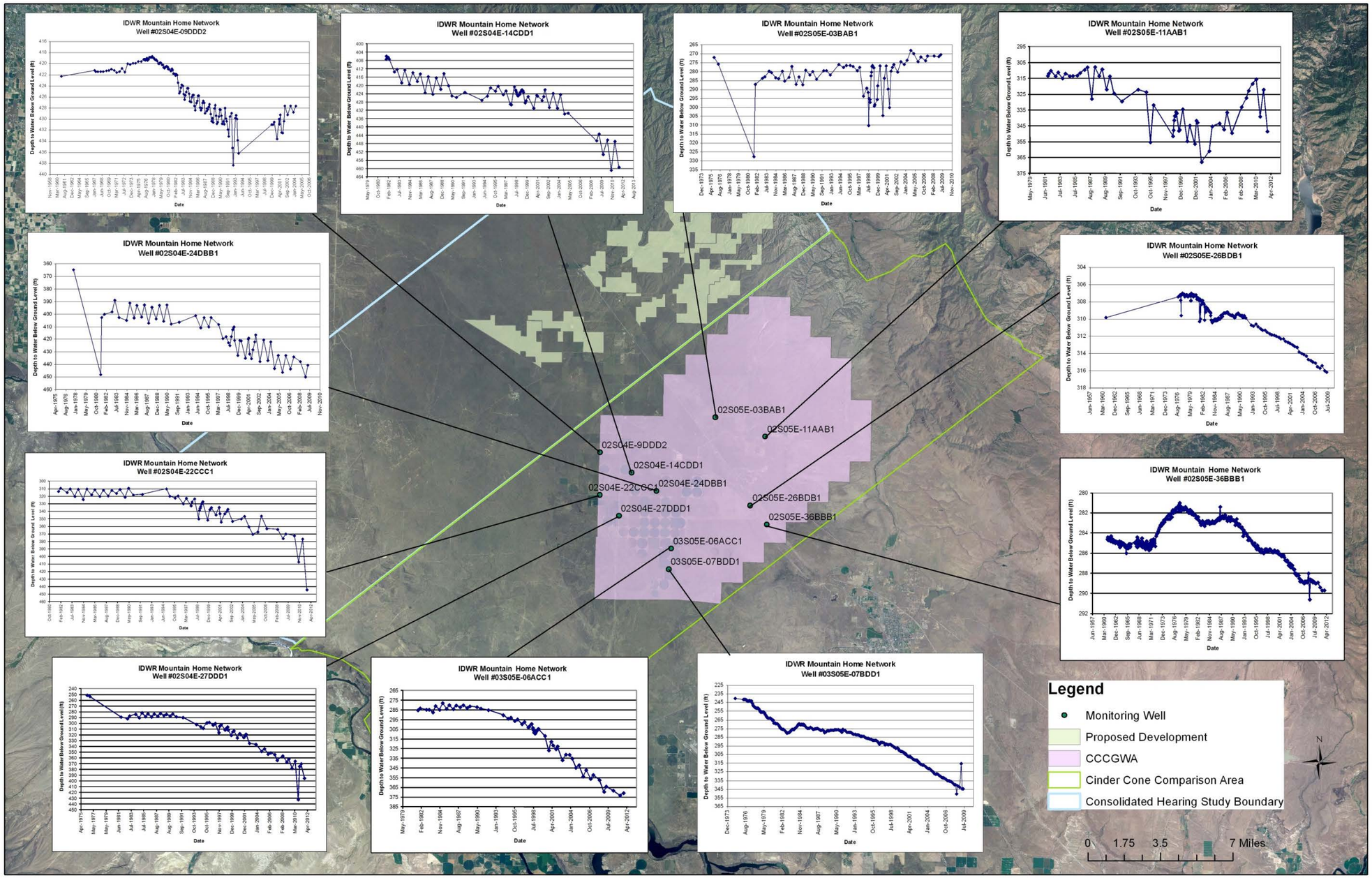
East Ada Study Area Well Hydrographs


Well #01N04E-12CAC2
Well #02N04E-36CAB1
Well #01N05E-07BBB3
Well #01N05E-06CAC1
Well #01N04E-13CBA1
Well #01N05E-8CDD1
Well #01N04E-14DDAD1
Well #01N05E-17BCA1
Well #01N04E-23AAB2
Well #01S04E-23ADC1
Well #01N04E-13DDB1
Well #01N05E-18DDB1
Depth to Water (feet below land surface)
Date
Transducer
Manual
84
Legend
Monitoring Well
Proposed Development
Cinder Cone Comparison Area
Consolidated Hearing Study Boundary
N
0 0.75 1.5 3 Miles


Well #01N04E-32AAC1
Depth to Water (feet below land surface)
Date
Transducer
Manual
Well #01N04E-28CAC1
Depth to Water (feet below land surface)
Date
Well #01N04E-27ACA1
Depth to Water (feet below land surface)
Date
Transducer
Manual
Well #01N04E-27ACD1
Water Level Elevation (feet above sea level)
Date
Transducer
Manual
Well #01N04E-24CAD1
Depth to Water (feet below land surface)
Date
Transducer
Manual
Well #01N04E-32BBC1
Depth to Water (feet below land surface)
Date
Well #01N04E-32ABB1
Depth to Water (feet below land surface)
Date
Transducer
Manual
Well #01S04E-03ADD1
Depth to Water (feet below land surface)
Date
Well #01S04E-30AAC1
Depth to Water (feet below land surface)
Date
Well #01S04E-10DAD1
Depth to Water (feet below land surface)
Date
84
Legend
Monitoring Well
Proposed Development
Cinder Cone Comparison Area
Consolidated Hearing Study Boundary
N
0
2.5
5
10 Miles

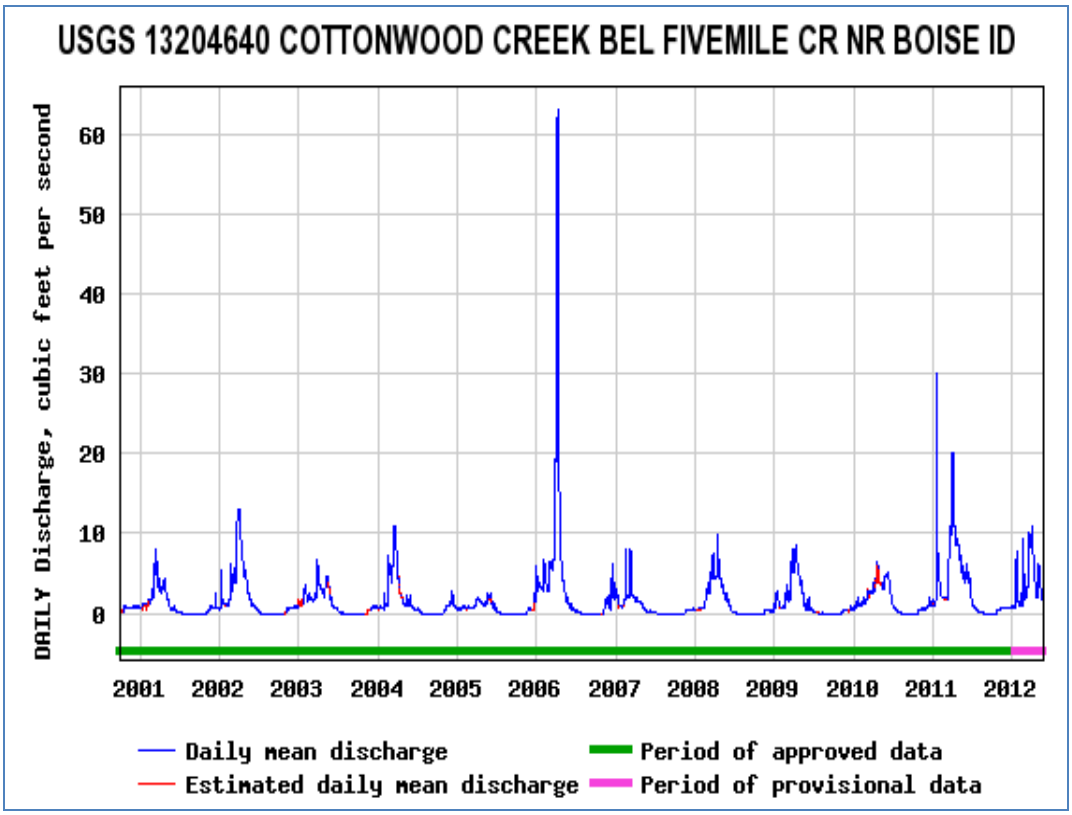
APPENDIX D

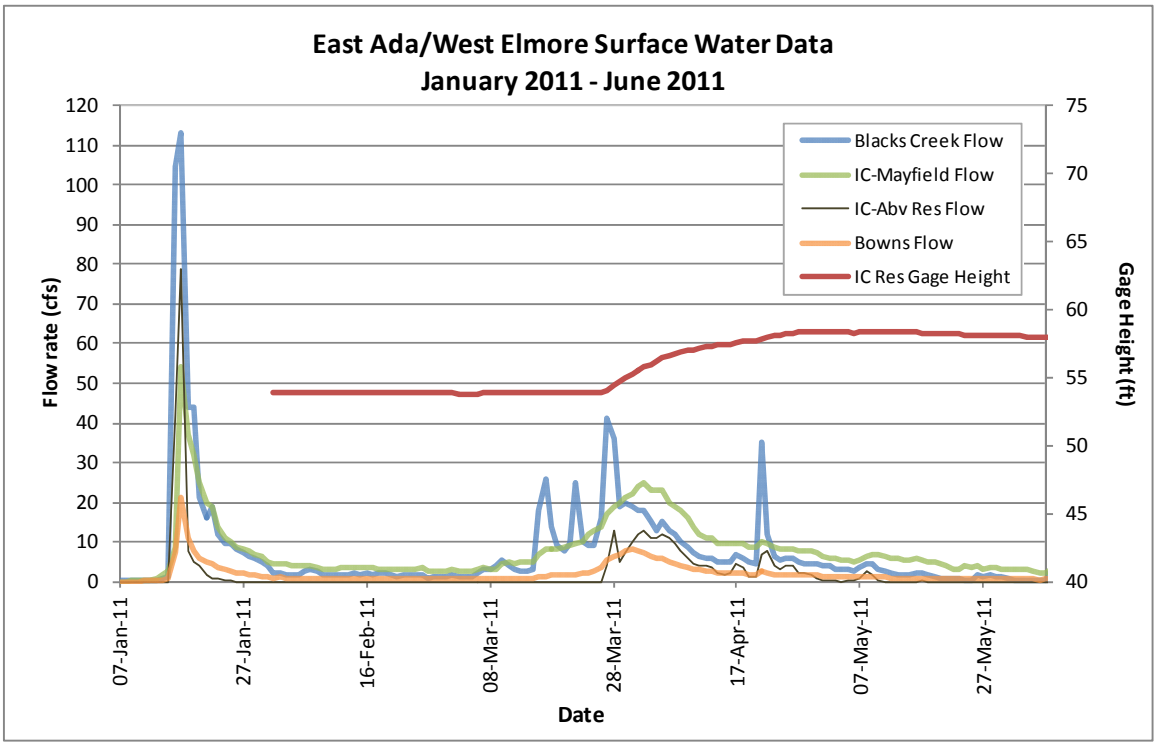
Cinder Cone Butte CGWA Well Hydrographs


IDWR Mountain Home Network
Well #02S04E-09DDD2
IDWR Mountain Home Network
Well #02S04E-14CDD1
IDWR Mountain Home Network
Well #02S05E-03BAB1
IDWR Mountain Home Network
Well #02S05E-11AAB1
IDWR Mountain Home Network
Well #02S04E-24DBB1
IDWR Mountain Home Network
Well #02S05E-26BDB1
IDWR Mountain Home Network
Well #02S04E-22CCC1
IDWR Mountain Home Network
Well #02S05E-36BBB1
IDWR Mountain Home Network
Well #02S04E-27DDD1
IDWR Mountain Home Network
Well #03S05E-06ACC1
IDWR Mountain Home Network
Well #03S05E-07BDD1
Depth to Water Below Ground Level (ft)
Date
02S05E-03BAB1
02S05E-11AAB1
02S04E-9DDD2
02S04E-14CDD1
02S04E-24DBB1
02S04E-22CCC1
02S05E-26BDB1
02S04E-27DDD1
02S05E-36BBB1
03S05E-06ACC1
03S05E-07BDD1
Legend
Monitoring Well
Proposed Development
CCCGWA
Cinder Cone Comparison Area
Consolidated Hearing Study Boundary
N
0 1.75 3.5 7 Miles

APPENDIX E

Surface Water Hydrographs


USGS 13204640 COTTONWOOD CREEK BEL FIVEMILE CR NR BOISE ID
DAILY Discharge, cubic feet per second
60
50
40
30
20
10
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Daily mean discharge
Estimated daily mean discharge
Period of approved data
Period of provisional data


East Ada/West Elmore Surface Water Data
January 2011 - June 2011
Flow rate (cfs)
Gage Height (ft)
Date
Blacks Creek Flow
IC-Mayfield Flow
IC-Abv Res Flow
Bowns Flow
IC Res Gage Height
120
110
100
90
80
70
60
50
40
30
20
10
0
75
70
65
60
55
50
45
40
07-Jan-11
27-Jan-11
16-Feb-11
08-Mar-11
28-Mar-11
17-Apr-11
07-May-11
27-May-11