Hydro Logic, Inc.
1002 W. Franklin Street, Boise, ID 83702 (208) 342-8369, (Fax) 342-3100, hydrologic@qwest.net

TECHNICAL MEMORANDUM

TO: Gerry Robbins / M3 Eagle, LLC / Eagle, Idaho

FROM: Dick Glanzman / Glanzman Geochemical LLC / Denver, Colorado
Ed Squires / Hydro Logic, Inc. / Boise, Idaho

DATE: January 20, 2009

SUBJECT: Ground Water Geochemistry of Wells In the North Ada County Area of Idaho

INTRODUCTION

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 Cites of Eagle and Star, and the North Eagle foothills of the Boise Front (Figure 1). A total of 84 chemical analyses of ground water collected between 1991 and 2008 were available for this evaluation. The analytical results evaluated by this report have been compiled from a variety of sources representing a 17-year period (Table 1). In addition to these ground water analyses, chemical analyses for average precipitation in southern Idaho and the average Boise River between 1960 and 1982 were available from Wood and Low (1988). We gratefully acknowledge M3 Eagle, LLC, SunCor, United Water Idaho, Inc. for their gracious permissions to access and use the data presented.

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. The physical characteristics of these units have been described most recently in Squires and others (2007) and previously in a number of publications by Wood, Squires, and others (listed in the REFERENCES section of this report).

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. The following sections present the ground water geochemistry of each of these designated well groups using trilinear (Piper) diagrams to visually indicate the relationships between the major ions and the ground water chemistry types.

GROUND WATER GEOCHEMISTRY

Seven major ions plus silica generally comprise almost all of the total dissolved solids (TDS) in ground water chemistry. These seven major ions include calcium, magnesium, sodium, potassium, bicarbonate, sulfate and chloride. The dissolved concentrations of each of the major ions reflect the geochemical characteristics of the aquifer mineralogy through which the water has moved. Ground water geochemistry begins with the chemistry of the sources of recharge to the aquifer and "evolves" with the chemical reactions that occur along the ground water flow path to each well and spring sampling location. Ground water geochemistry can also be altered by ground water exchange between aquifers as part of the ground water flow path to each well (sampling) location (Figure 2). The recharge water chemistry is the initial end member for understanding of the ground water geochemistry of each well location.

Recharge

Precipitation (rain and snow) is the independent source of both surface water and infiltration water to the ground water system and its TDS is very low. The calculated average TDS sum of precipitation in southern Idaho of 5.4 milligrams per liter (mg/l) means that its water chemistry is easily changed by chemical reactions in the soils and sediments of the alluvial materials that comprise the geologic section and serve as aquifers (including the rocks the ground water moves through on its way to an aquifer). The Boise River surface water, with an averaged TDS sum of only 52 mg/l, is almost an order of magnitude higher TDS than precipitation. This difference indicates how easily precipitation chemistry can change. The increase in the TDS concentration indicates that the water has dissolved minerals along its flow path to a sampling location while the major ion chemistry indicates what mineralogy has been dissolved and/or potentially mixed with other ground water up gradient of the sampling location. In other words, major ion chemistry can give indication of where the resultant ground water has been.

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. It is also elucidating to have a single illustration that shows major ion relationships for each well location compared to many other well locations. The trilinear diagram was designed to do this (Hem, 1985). Hydraulically connected ground waters plotted on a trilinear diagram can show major ion relationships between the water chemistry from its source through surface water and ground water flow paths to individual sampling locations.

Trilinear Diagram

Figure 3 is a trilinear diagram that includes the major ion chemistry for each of the sampling locations of this study for which all the major ion concentrations are available. Each plotted point is designated by a symbol defined by the physical source of the water chemistry. The spread of points within the diagram indicates that the aqueous geochemistry of the North Ada County area is not a single aquifer of commingled ground water. Rather, the plot depicts a somewhat complex ground water system of several parts. The major ion chemistry of each of the designated aquifer/area group is looked at individually to better understand their individual geochemistry characteristics but it is important to first understand how the points are plotted on the diagram.

The trilinear diagram has three segments. The lower left triangle includes the percentages of the positively charged major ions; calcium, magnesium, sodium and potassium (cations) for each water analysis that is plotted as a point within the triangle. Sodium and potassium are combined on the graph because they have similar geochemical characteristics. Percentages are developed by calculating their concentrations in milliequivalents per liter (meq/l) to give each ion an equivalent equal weight (meq/l). The cations concentrations in meq/l are summed, their respective percentages calculated and are then plotted within the triangle. Changes within the cation part of the diagram generally indicate chemical reactions occurring within the aquifer along with degree and type of cation exchange along the ground water flow path within each group.

The lower right triangle makes the same calculations for the negatively charged major ions (anions). The percentage of bicarbonate, sulfate and chloride for each water analysis are plotted as a point within the triangle. The anion part of the diagram complements the cation part of the diagram by indicating the changes in anions resulting from chemical reactions along the flow path.

Each cation and anion percentage point is projected into the central diamond part of the diagram to sum the seven major ion relationships into a single point. Because each point now represents a single water analysis, the major ion chemistry of each water analysis can be compared with all the other water analyses thereby permitting an understanding of the geochemical characteristics of the overall ground water chemistry.

Points that group together into a dense cluster in the central diamond part of the trilinear diagram indicate water from a single aquifer with very simple nearly non-reactive mineralogy and with no mixing with water from other sources unless these sources have essentially the same non-reactive mineralogy. Plotted points that form a linear trend on any of the three parts of the trilinear diagram suggest a single chemical reaction or mixing of two water chemistry sources is causing the linear change in major ion chemistry. Ion exchange, for example between calcium and sodium ions, typically show a significant change in the cations lower left triangle of the diagram but basically little to no change in the anion percentages in the lower right triangle. Chemical reactions are indicated by changes in both the cations and anions. All of these geochemical characteristics are shown together on Figure 3 but it is necessary to look at each of the individual groups, as indicated by the symbols, to understand, both, their individual geochemical characteristics and potential hydraulic associations between the groups.

PIERCE GULCH SAND AQUIFER (PGSA)

Figure 4 is a trilinear diagram showing ground water chemistry from water wells completed in the Pierce Gulch Sand Aquifer (PGSA) compared with the average chemistries of precipitation and the Boise River. Figure 5 is the same trilinear plot of PGSA wells with as many of the individual points labeled as possible within the space of the diagram while maintaining clarity. The points plotted on the trilinear further subdivide the ground waters from PGSA wells completed across total thickness of the PGSA compared to those wells completed in only the upper or lower parts of the PGSA. This separation was done to see if the upper part of the PGSA may be receiving recharge from infiltrating precipitation and if the lower part of the PGSA may be chemically reacting with clays and mudstones similar to, and possibly derived from, those in the underlying Terteling Springs Formation. Recharge from infiltrating precipitation is not indicated by the aqueous geochemistry of the Upper PGSA but it is for the Lower PGSA and a few of the deeper Lower PGSA ground waters do suggest that clays similar to the underlying Terteling Springs Formation affect the ground water chemistry at a few well locations.

Ground water from all wells completed in the PGSA is a calcium-bicarbonate water chemistry type (Figure 4). PGSA ground water has the highest average calcium and magnesium percentage of the designated aquifer/area groups at 52 and 16 percent, respectively (Table 2). Furthermore, except for three Lower PGSA ground waters, the PGSA ground water forms a tight cluster to the right of, and enveloping, the average Boise River in the diamond portion of the trilinear diagram. Two of these three Lower PGSA ground waters contain a higher sulfate percentage than those in the cluster trending slightly toward precipitation. These two ground waters came from Zone 1 in M3 Eagle Test Well #2 and M3 Eagle SVR Test Well #9 (Figure 5) that occur near the eastern edge of the PGSA aquifer approaching the Willow Creek Aquifer (Figures 1 and 6). The trend toward precipitation suggests that the PGSA ground water at these two well locations may be receiving a small percentage of precipitation as recharge. Lower PGSA ground water from the UWID Lexington Hills #1 plots on the other side of the cluster suggesting that clays similar to the Terteling Springs Formation may be incorporated into the Lower PGSA at this well location.

The tight clustering of PGSA ground water shown on Figures 4 and 5, 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. Furthermore, this tight clustering of almost all of the PGSA ground waters on the trilinear indicates that the PGSA ground water is from a distinct regional aquifer. The calcium-bicarbonate water chemistry type of the ground waters plotting in this cluster has an average TDS of 191 mg/l (Table 2) but ranges from 82 to 404 mg/l. This clustering indicates that almost all of the aquifer mineralogy is very simple because it does not change chemical type. This is unusual for ground waters from wells completed in a regional aquifer with as much as 12 to 13 miles separating the well locations and particularly so when compared with the other designated aquifer/area groups where the geochemistry changes dramatically over short distances (Figure 1). The three Lower PGSA ground water samples cited as exceptions probably reflect localized changes produced by precipitation, poorly sealed well construction, sampling and/or analytical errors and, more likely aquifer sediments that include clays and mudstones similar to those that comprise the underlying Terteling Springs Formation. The higher sodium percentage is probably a result of ion exchange on these clayey materials while the increased sulfate percentage is probably a result of a small amount of iron sulfide oxidizing in clay lenses of the Lower PGSA.

As listed in Table 2, PGSA ground water has a near neutral pH (7.19) and is oxidized with an average Eh of plus 258 millivolts (mV). The average Eh of the Upper PGSA is 334 mV while that of the Lower PGSA is 246 mV indicating a slightly lower Eh in the Lower PGSA. The Lower PGSA has the highest average total iron concentration (1.52 mg/l) of all the groups confirming the probability of trace amounts of iron sulfide in the clays of the Lower PGSA. The trace amount of sulfide is confirmed by the highest sulfate of 44 mg/l in PGSA ground water occurring in the Lower PGSA. Trace iron sulfide is supported by the average dissolved iron in the Lower PGSA that is slightly higher at 0.22 mg/l compared to the dissolved iron in the Upper PGSA at 0.11 mg/l. The dissolved manganese is very similar at 0.24 and 0.19 mg/l, respectively. The average arsenic concentration in PGSA ground water is a low 0.004 mg/l. Other metals are either near or less than their respective detection limits.

The average dissolved concentration of total organic carbon (TOC) in the PGSA ground water is 0.8 mg/l. The average nitrate nitrogen concentration is a similarly low 0.42 mg/l, ammonia nitrogen only 0.08 mg/l and Total Kjeldahl Nitrogen (TKN) of only 0.19 mg/l. Subtracting the ammonia nitrogen from the TKN gives a average organic nitrogen of 0.11 mg/l. Since the amount of organic nitrogen is proportional to microbial activity, microbial activity in the PGSA within this area is present only at very low levels. As would be expected with a calcium-bicarbonate water chemistry type, the average total phosphorus is only 0.14 mg/l and orthophosphate only 0.16 mg/l.

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. It is a calcium-bicarbonate water chemistry type. PGSA ground water has the highest calcium and magnesium percentage of all the designated well groups. Clustering of the major ion chemistry of this ground water from wide-spaced well locations clearly separate this ground water from ground water from other designated aquifer/area groups. The average arsenic is a low 0.004 mg/l. The Lower PGSA most likely contains some minor clay lenses similar in composition to, and/or derived from, the clays and mudstones of the underlying Terteling Springs Formation (Figure 6).

TERTELING SRINGS FORMATION (TSF)

Figure 7 and Figure 8 are trilinear diagrams showing the major ion relationships of ground waters from the Terteling Springs Formation (TSF) that underlies the PGSA. Ground water from wells completed in the TSF form a nearly linear trend of calcium-bicarbonate to dominantly sodium-bicarbonate ground water. The change in water chemistry type is probably caused by cation exchange of dissolved calcium in the water exchanging with sodium ions on the clay/mudstone to produce the sodium bicarbonate ground water. The plots on the trilinear diagrams trend toward the Boise River indicating that, similar to the PGSA, ground water in the TSF originates from the geologically ancestral Boise River. Even though both ground waters share a common recharge source, TSF ground water is clearly hydraulically separated from the PGSA ground water under the current hydrologic conditions.

TSF ground water has an average TDS of 206 mg/l (Table 2) but ranges from 148 to 351 mg/l. The average pH is 7.53 but ranges from 6.70 to 8.07. This ground water has the highest average pH of the designated ground water groups. It also carries the highest temperature of 69.2 degrees Fahrenheit (20.6 degrees Celsius) because wells completed in the TSF also have the deepest screened intervals. The low average fluoride concentration of 0.43 indicates that this ground water is not associated with the geothermal system in other parts of the Boise Valley. This elevated temperature and higher pH is responsible for the highest average silica concentration of the various groupings at 43.8 mg/l.

There are no available DO or ORP data but given the low average sulfate concentration of 5.3 mg/l, non-detect nitrate and an elevated average ammonia nitrogen concentration of 3.34 mg/l, it is likely that this ground water is under low oxidizing and probably reducing conditions. The average dissolved iron of 0.10 mg/l, dissolved manganese of 0.10 and arsenic of 0.004 mg/l document that all are present at low concentrations.

In summary, the TSF forms a second discrete aquifer that is not hydraulically connected to the PGSA.

WILLOW CREEK AQUIFER (WCA)

As described in the previous geologic and hydrologic reports (Squires and others, 2007) and (SPF 2004), the Willow Creek Aquifer (WCA) is the up gradient sand facies of the TSF. However, as shown on Figure 9 and Figure 10, the ground water chemistry has a very different distribution than either the PGSA or the TSF. WCA ground water from both the Spring Valley Ranch Test Well #10 and the W. Lynn well plot within the TSF trend but other WCA ground waters have a significantly higher sulfate percentages than the TSF ground waters. Furthermore the crude trend is toward precipitation rather than the Boise River as a recharge source. Ground water from both of the two wells that follow the TSF trend indicate that either the aquifer mineralogy has essentially the same composition as that of the sands in the TSF or/and they are hydraulically connected to TSF. However, it is clear that the WCA is not hydraulically connected to the PGSA.

The above relationships are supported by the other water chemistry characteristics. WCA ground water is a calcium-bicarbonate to a dominantly sodium-bicarbonate water chemistry type with the lowest TDS of all the designated well groups. WCA ground water has an average dilute TDS of only 119 mg/l but ranges from 70 to 154 mg/l. This relationship indicates that precipitation is the primary source of recharge to the WCA.

In addition to the major ion chemistry, TDS clearly shows that there is no hydraulic connection between ground water in the WCA and ground water in the PGSA. The TDS of ground water in the PGSA on Big Gulch starting at M3 Eagle Test Well 4 through Big Gulch Stock Well to M3 Eagle Test Well 2 there is a slight increase in TDS from the low to the middle 200 mg/l as the boundary with the WCA is approached. The TDS of ground water in the WCA wells SVR Test Well #6 and SVR Test Well #10 both have TDS concentrations of less than 100 mg/l. The significantly higher TDS in the PGSA ground water is also shown by the 253 mg/l TDS concentration in ground water from Little Gulch Stock Well and 238 mg/l in ground water from SVR Test Well #9. Similar to the conclusion from the major ion chemistry, the TDS clearly indicates that there is no hydraulic connection between the WCA and PGSA.

As listed in Table 2, the average pH of 7.60 is similar to that of the average pH of TSF ground water (7.8) but the average total iron of 0.12 mg/l is lower (0.28 mg/l) and the average total manganese of 0.07 mg/l is slightly lower (0.1 mg/l). Conversely, the average nitrate nitrogen of 1.56 mg/l in WCA ground water is significantly higher than that of the TSF (0.05 mg/l) further supporting the conclusion that infiltration of surface precipitation is a primary source of recharge to the WCA.

It is the arsenic and fluoride concentrations that definitively set WCA ground water apart from the other designated well groups. The average arsenic concentration in the WCA is 0.025 mg/l, two and a half times the current drinking water standard for arsenic of 0.010 mg/l, in this dilute TDS ground water. Ground water from four of the five wells completed in the WCA exceeds the arsenic drinking water standard. Although not exceeding the fluoride drinking water standard, the average fluoride concentration is 1.56 mg/l, almost 3.5 times the average fluoride concentration in the TSF ground water (0.43 mg/l). These relationships coupled with an elevated silica concentration of 38 mg/l suggest that the sands of the WCA may contain a volcanic ash component that may also be present in the Spring Valley Ranch Wells ground water but not apparent in the other designated aquifer/area groups.

In summary, ground water from the WCA has a very dilute TDS and other characteristics that indicate that local precipitation is the dominant source of recharge. Even though this ground water is the most dilute of the designated well groups, it has the highest nitrate, arsenic and fluoride concentrations. The currently available historical data from the five sampled wells suggest that this ground water contains sediments with a similar mineralogy to that of the TSF as well as a volcanic ash component. It is clearly not hydraulically connected to the PGSA but there is a potential for hydraulic connection with the TSF.

SPRING VALLEY RANCH WELLS (SVRW)

Ground water from seven Spring Valley Ranch wells (SVRW) that include one spring are plotted on the trilinear diagrams of Figures 11 and 12. This grouping of wells forms an almost north-south line about five miles northeast of WCA well SVR Test Well #10 (Figures 1 and 6). In sharp contrast to PGSA and TSF major ion chemistry, the major ion chemistry of this relatively closely spaced well field plots over most of the diamond portion of the trilinear diagram. Magnesium and calcium percentages decrease as the sodium percentage increases and bicarbonate decreases as sulfate increases. The major ion trend suggests that recharge is from precipitation while the aquifer mineralogy appears to be similar to that of both the WCA and TSF. The major ion chemistry suggests that the sediments in which the SVRW are completed appear to be Terteling Springs Formation.

It is unusual for such a closely spaced grouping of wells to have such a broad suite of major ion chemistry. Ground water from this small areal distribution of wells includes calcium-bicarbonate, calcium-sodium-bicarbonate, calcium-sulfate, calcium-sodium-sulfate and sodium-bicarbonate water chemistry types. These widely different water chemistry types in a relatively small area suggest laterally and vertically variable aquifer mineralogy with the probability of localized recharge sources and limited hydraulic connection between wells.

Ground water from the SVRW also has the highest average sulfate percentage of 28 percent and average potassium percentage of 5 percent (Table 2). This average sulfate is about two to seven times that of other designated aquifer/area groups while the average potassium is about two to three times the average concentration of the other groups. The significantly higher potassium concentration in this ground water could reflect a higher proportion of potash feldspar from the Idaho Batholith in the aquifer mineralogy of these wells than those farther to the southwest.

Ground water from the SVRW has an average TDS of 274 mg/l and ranges from 116 to 570 mg/l. There is little association of TDS with water chemistry type except that the highest TDS of 570 mg/l is a calcium-sulfate water chemistry type. The average pH of 7.42 approaches that of the TSF but ranges from about 7.39 to 7.49 for the four available pH measurements. There are no available DO or Eh measurements for ground water from these wells. Similarly there are no dissolved iron or manganese analyses available. However, the average total iron concentration is an elevated 0.81 mg/l ranging from non-detect to 4.33 mg/l. The average total manganese concentration of 0.53 mg/l is the highest for all designated well groups. The total manganese concentration ranges from non-detect to 2.29 mg/l.

The average arsenic concentration of 0.0137 mg/l exceeds the current drinking water standard of 0.010 mg/l. Three of the eight sampled locations had arsenic concentrations that exceed the current drinking water standard: SVR Test Well #2 (0.016 mg/l), Spring 1 (0.021 mg/l) and SVR Test Well #3 (0.038 mg/l). There is no apparent relationship between the arsenic concentrations and other parameters. The ground water with the highest arsenic is a calcium-sodium-bicarbonate water chemistry type while the other two samples with exceedances are associated with the calcium-bicarbonate and calcium-sulfate water chemistry types. The higher concentrations of total iron and sulfate in the SVRW ground water suggests that pyrite may be present in the finer-grained sediments and could provide a source of arsenic to this ground water. However, because the higher arsenic concentrations in the SVRW ground water are in widely different water chemistry types, the arsenic may likely be associated with volcanic materials similar to that apparently present in the WCA sediments and potentially responsible for the elevated arsenic in that aquifer.

Ground waters from this northern-most well field in the study area appear to be both spatially and hydraulically isolated. While the major ion chemistry is similar to that of the WCA the TDS would preclude hydraulic connection to the WCA ground water. In other words it is likely that the mineralogy of the sediments is probably similar but with more soluble (finer-grained) minerals than those present in the WCA. Given these relationships with the WCA, the ground water from the SVRW area cannot be hydraulically connected to the PGSA based on the previous conclusion that the WCA and the PGSA are not hydraulically interconnected.

In summary, ground water chemistry from the SVRW 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.

EMMETT WELLS

Major ion chemistry relationships for ground water from two well locations in the Emmett area are shown on Figures 13 and 14. Ground water chemistry from these two wells is included to test the possibility that the ground water from the PGSA was potentially moving into the Emmett area.

The major ion trend for ground water from these two well locations indicates that it is recharged from rainfall, both, in the diamond part of the trilinears and in the anions (lower right triangle). The trend is from precipitation to the area of TSF ground water suggesting that the sediments in which the wells are completed are the TSF. There is no trend toward the PGSA ground water cluster as evident by comparing Figures 4 and 5 with Figures 13 and 14. Therefore, based on this ground water chemistry, wells in this part of the Emmett area are not hydraulically connected to the PGSA.

Ground water from the two Emmett wells range between calcium-bicarbonate-sulfate type and sodium bicarbonate type. TDS ranges between 203 and 340 mg/l and pH ranges from near neutral 7.08 to an alkaline 7.96. There are no DO or Eh measurements. Dissolved iron ranges from non-detect to 0.44 mg/l and dissolved manganese from 0.06 to 0.6 mg/l. Nitrate nitrogen is non-detected but ammonia nitrogen ranges 0.12 to 0.64 mg/l. Fluoride ranges from 0.3 to 2.66 mg/l. Arsenic is less than 0.0025 mg/l.

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 (SH. Wood, personal communication, 2009).

SUMMARY

Ground water from the PGSA represents a discrete regional aquifer that is not hydraulically connected to any of the other designated aquifer/area groups of this area. The ancestral Boise River is the recharge source for both the PGSA and the TSF. Based on ground water chemistry of the TSF and WCA, TSF may have an as yet undefined hydraulic connection with the WCA. However, the current ground water from the TSF was recharged by the ancestral Boise River and the WCA from precipitation. Their similarity in major ion chemistry may be related to both having a similar aquifer mineralogy. Ground water from the SVRW is both spatially and hydraulically separated from all the other designated aquifer/area groups. In fact, individual well locations within the cluster of SVRW appear to be hydraulically separated from one another. Ground waters in the WCA, SVRW and Emmett area wells are recharged by precipitation. Ground water from the Emmett area wells has major ion characteristics that suggest an aquifer mineralogy similar to that of the TSF. Ground waters from the two wells in the Emmett area indicate those ground waters are not hydraulically connected to the PGSA ground water.

Arsenic exceeds drinking water standards in ground water from four of the five WCA well locations and three of the eight SVRW sampled ground waters. The very dilute ground water in the WCA suggests that the arsenic may originate in sediments from a volcanic source. Arsenic concentrations in the ground water in the SVRW may also originate in sediments from a volcanic source but this source may also include arsenic originating from oxidizing iron sulfide.

REFERENCES

Glanzman, R., Squires, E., 2005. *Boise Valley Groundwater Geochemistry – Origin, Infiltration Rate, and Transport Characteristics*, In: 15th Annual V.M. Goldschmidt Conference, 50th Anniversary of the Geochemical Society.

Hem, J.D., 1985, Study and Interpretation of the Chemical Characteristics of Natural Water: U.S. Geological Survey Water-Supply Paper 2254, Washington DC, 263p.

Squires, E., Utting, M., and Pearson, L.H., 2007. M3 Eagle Regional Hydrogeologic Characterization, North Ada, Canyon and Gem Counties, Idaho One-Year Progress Report. Consultant's report issued May 4.

Squires, E., Liberty, Lee, M., and Wood, S.H., 2003. Hydrostratigraphic Characterization and Quaternary History of Boise and Meridian, Western Snake River Plain, Idaho Using Drill-Cuttings Analysis, Borehole Geophysical Logs, and High Resolution Seismic Images

Squires, E. and Wood, S.H, 2001. *Stratigraphic Studies of the Boise (Idaho) Aquifer System using Borehole Geophysical Logs With Emphasis on Facies Identification of Sand Aquifers*, prepared for the Treasure valley Hydrologic Project, Idaho Department of Water Resources.

Squires, E., Wood, S.H., and Osiensky, 1992. *Hydrogeologic Framework of the Boise Aquifer System, Ada County, Idaho*. Research Technical Completion Report, Idaho Water Resources Research Institute, 114 p.

SPF Water Engineering, LLC, 2004, Well Construction and Aquifer Testing in the Big Gulch and Little Gulch Areas of Spring Valley Ranch. Consultant's report issued October 13.

Utting, M. and Squires, E., 2008. Re-analysis of 16 Aquifer Tests in the Greater Eagle-Star Area of North Ada County, Idaho. Consultant's report issued July 4.

Wood, S.H., 2004. Geology across and under the western Snake River Plain, Idaho: Owyhee Mountains to the Boise foothills. Chapter 7 *in* K.M. Haller and S.H. Wood (eds). Geological Field Trips in southern Idaho, eastern Oregon, and northern Nevada. U. S. Geological Survey Open-File Report 2004, p. 94-107. internet site: (http://pubs.usgs.gov/of/2004/1222/).

Wood, S.H., and Clemens, D.L., 2002, Geologic and tectonic history of the western Snake River Plain, Idaho and Oregon, *in* Bonnichsen, B., White, C.M., and McCurry, M., eds., Tectonic and magmatic evolution of the Snake River Plain Volcanic Province: Idaho Geological Survey Bulletin 30, p. 69–103.

Wood, S.H., Liberty, L., and Squires, E., 2000. Geophysical signatures of lacustrine facies: Experience from Hydrostratigraphic Studies of temperate Neogene Lake Idaho sediments and aquifers, U.S.A., Abstract of the General symposium, 3-1 Lacustrine Sedimentation, 31st International Geological congress, Rio de Janeiro, Brazil, August 6-11, 2000.

Wood, S. H., and J. E. Anderson, 1981, Geology, in J. C. Mitchell, ed., Geothermal investigations in Idaho, part 11, geological, hydrological, geochemical, and geophysical investigations of the Nampa-Caldwell and adjacent areas, southwestern Idaho: Idaho Department of Water Resources Water Information Bulletin 30, p. 9–31.

Wood, W.W. and Low, W.H., 1988, Solute Geochemistry of the Snake River Plain Regional Aquifer System, Idaho and Eastern Oregon: U.S. Geological Survey Professional Paper 1408-D, 79 p.

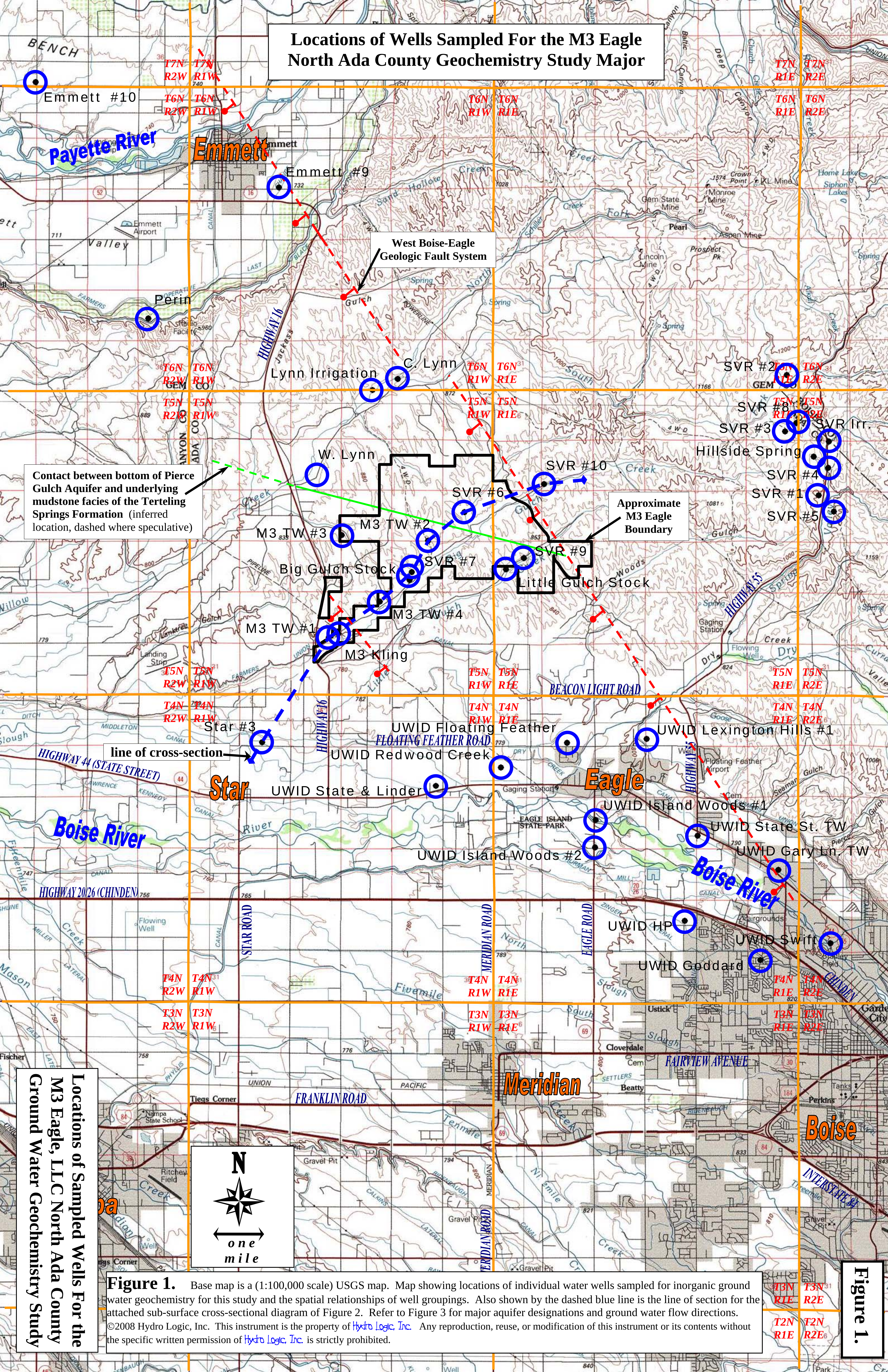

Figure 1. Base map is a (1:100,000 scale) USGS map. Map showing locations of individual water wells sampled for inorganic ground water geochemistry for this study and the spatial relationships of well groupings. Also shown by the dashed blue line is the line of section for the attached sub-surface cross-sectional diagram of Figure 2. Refer to Figure 3 for major aquifer designations and ground water flow directions.

Figure 2. **2007 Regional Ground Water Level Contours and Ground Water Flow Directions of Major Aquifers**

Water Level Data Sources:
M3 Project Area, Eagle, Star and Meridian: Measurements and Survey - Summer of 2007 by HLI

Emmett and Caldwell Areas:
Wells from IDWR Data Base. Locations / Elevations From Google Earth®, MapQuest® and TOPO®

Data contoured by Surfer® with manual contouring near Emmett and Caldwell. Dashed contours where sparce or approximate data appear to yield contours that may or may not be representative.

\+ Well: surveyed
Well: estimated location
● Wells in the M3 Area, Emmett Area, Eagle Area, Star Area, and Spring Valley Ranch Area (SVRW)

Approximate Ground Water Flow Directions:

Pierce Gulch Sand Aquifer
"Willow Creek Aquifer" and Payette Valley Aquifer

Water Level Contour Elevation in Feet MSL
2400
(Dashed Where Inferred)

West Boise-Eagle Geologic Fault System
(Dashed Where Inferred)

Contact between bottom of Pierce Gulch Aquifer and underlying mudstone facies of the Terteling Springs Formation (inferred location, dashed where speculative)

Scale: = 1 Mile

North

jJanuary 20, 2009

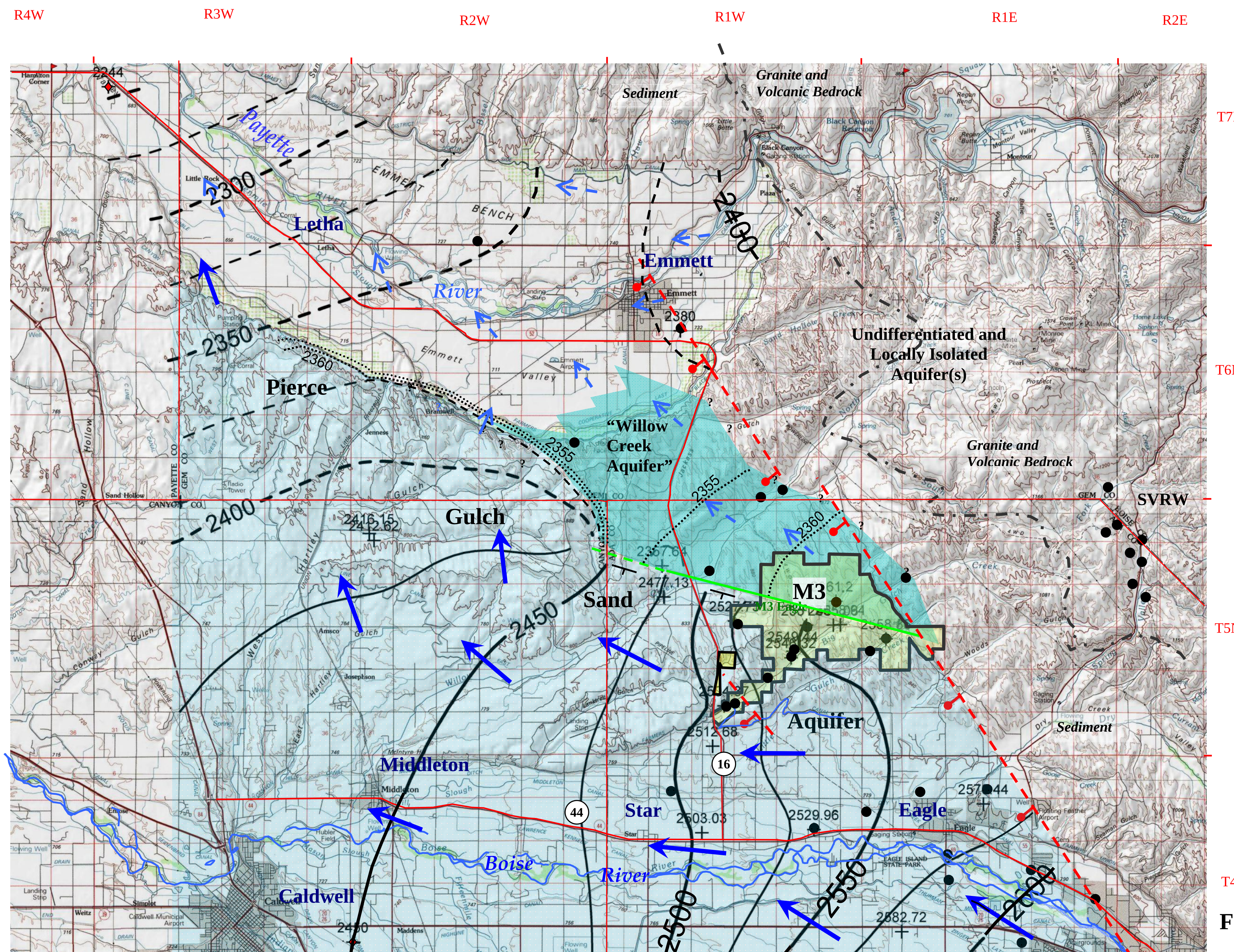

Figure 2.

The black-colored, 50-foot water level contours inside blue shading indicate the northwesterly movement of ground water from the Boise Basin to the Payette Basin north of the Cities of Star, Eagle, and Middleton through the Pierce Gulch Sand Aquifer. The dotted 5-foot water-level contours inside the turquoise area illustrate the relatively flat ground water gradient within the recharge-limited informally named "Willow Creek Aquifer" isolated between low-permeability sediments of the uplands lying to the east of the M3 site and by stratigraphic layering (a day-lighting clay stratum) on the southwest (green solid and dashed line). The boundaries of this aquifer have not been defined as indicated by the "?" symbol.

Hydro Logic, Inc
Boise, Idaho

Major Ion Chemistry of Groundwater from Wells Completed in the North Ada County Area

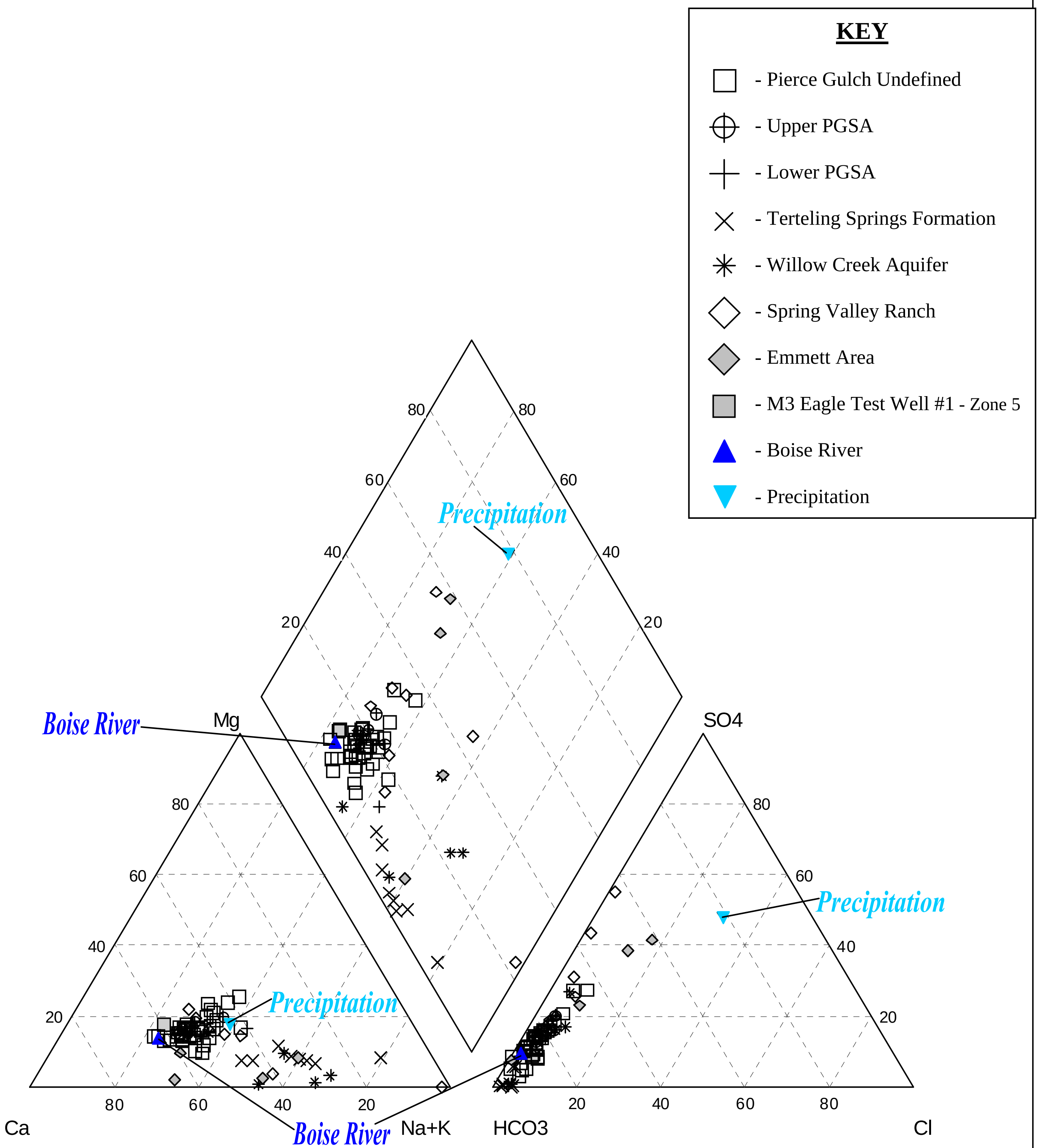

Figure 3. Trilinear diagram showing the major ion relationships of groundwater from all sampled locations in the M3 Area compared to that of precipitation and Boise River water.

Figure 3.

Major Ion Chemistry of Groundwater from Wells Completed in the Pierce Gulch Sand Aquifer (PGSA)

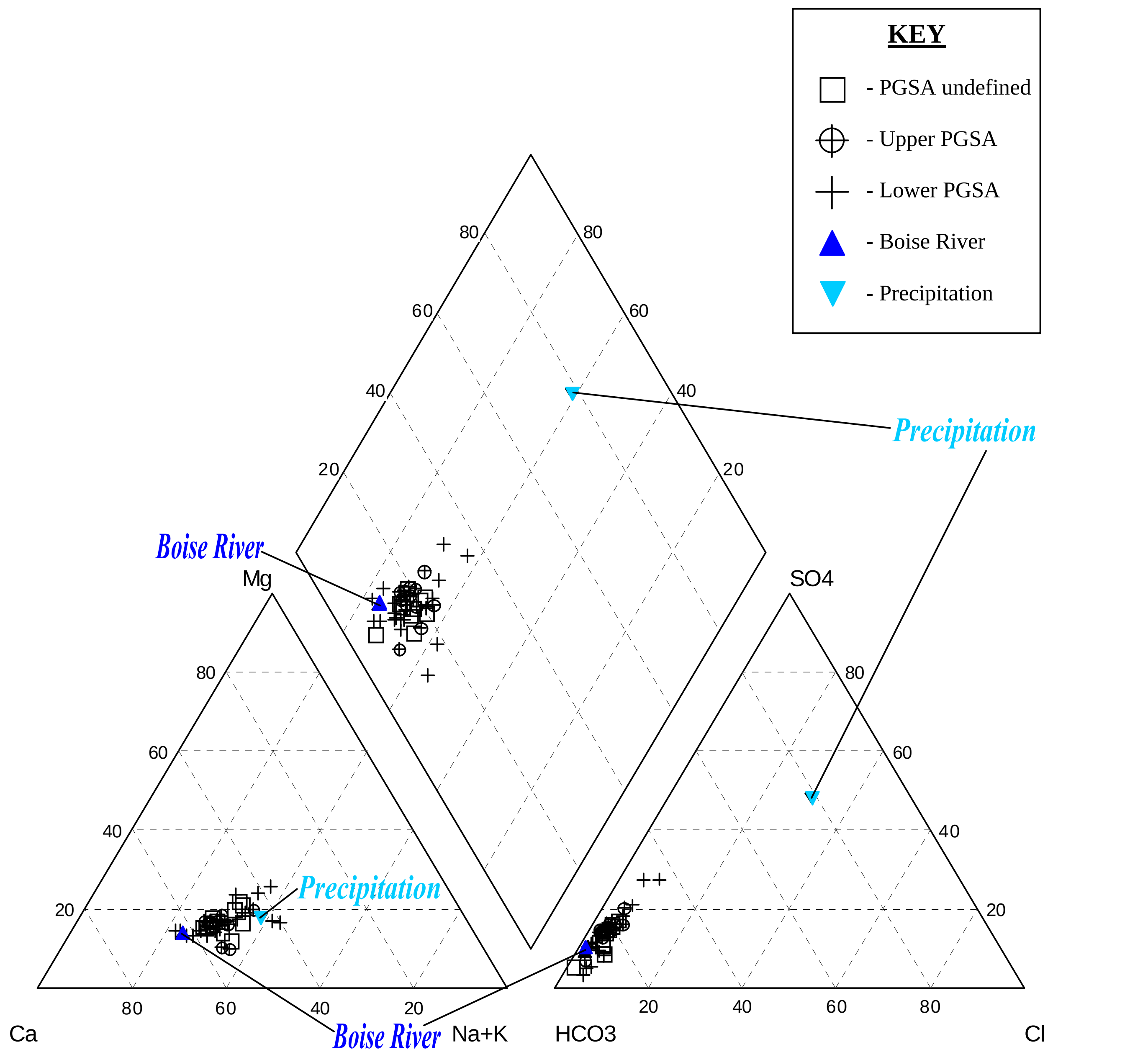

Figure 4. Trilinear diagram showing the major ion relationships of groundwater from the Pierce Gulch Sand Aquifer (PGSA) in the M3 Area compared to that of precipitation and Boise River water.

Figure 4.

Major Ion Chemistry of Groundwater from Wells Completed in the Pierce Gulch Sand Aquifer (PGSA)

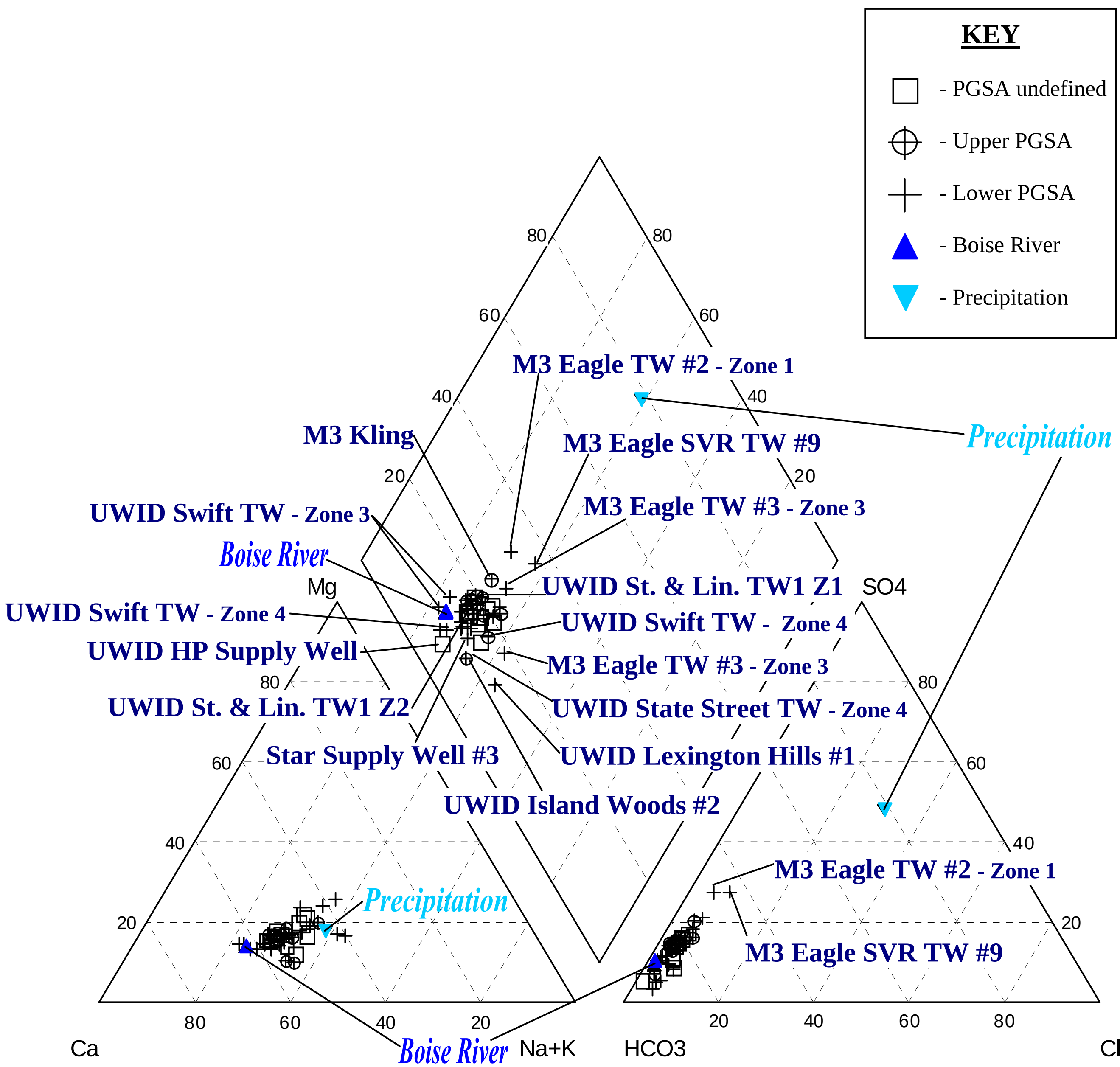

Figure 5. Trilinear diagram showing the major ion relationships of groundwater from the Pierce Gulch Sand Aquifer (PGSA) in the M3 Area compared to that of precipitation and Boise River water with labeling.

Figure 5.

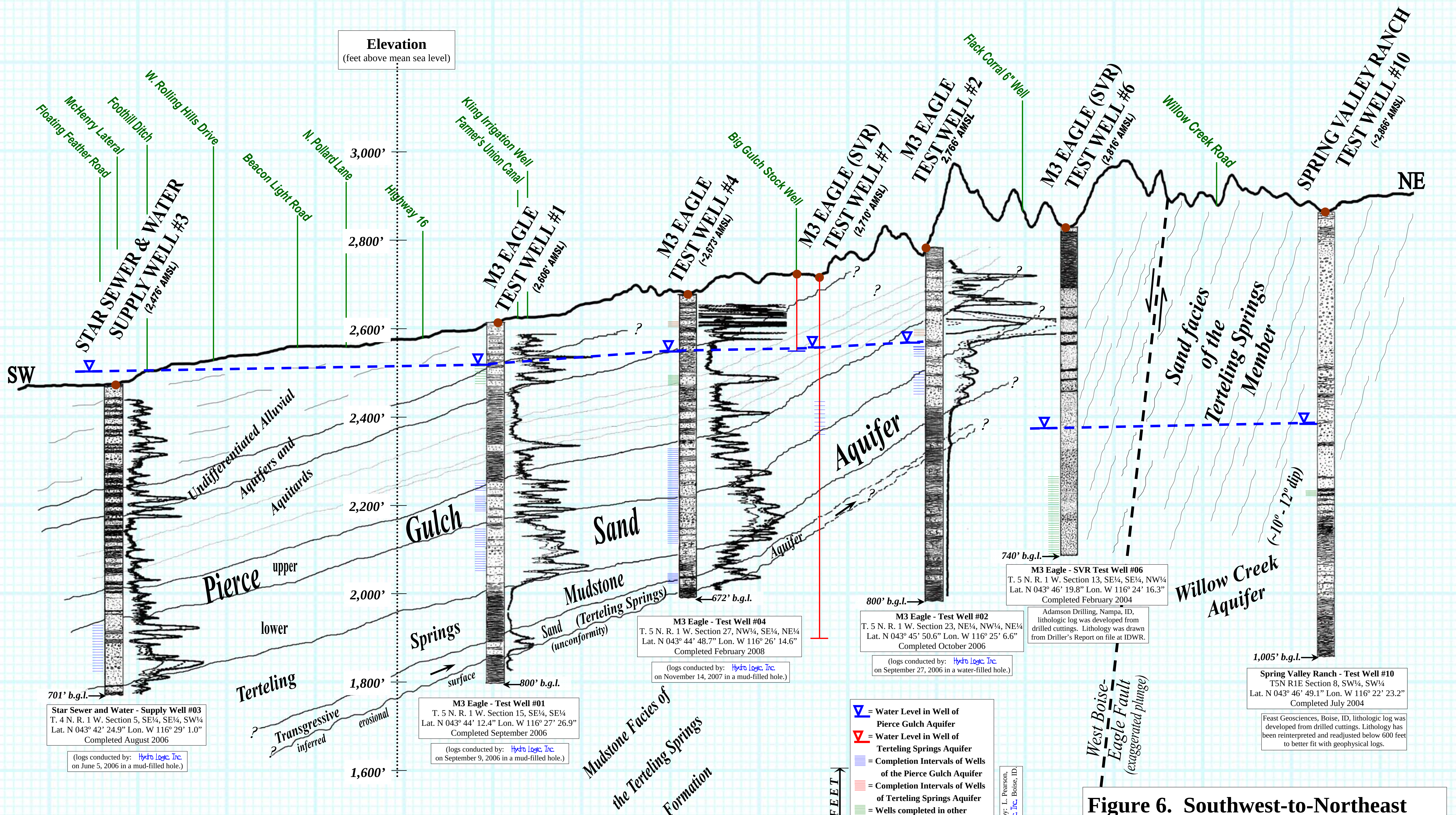

Figure 6. Sub-surface cross-sectional diagram depicting the major hydro-stratigraphic units underlying the Big Gulch-to-Star area in North Ada County, Idaho (refer to Figure 1 for line of section). The aquifer stratigraphy is interpreted from lithologic logs and borehole geophysical logs of some of the supply and test wells used for sampling ground water geochemistry for this study.

Figure 6. Southwest-to-Northeast Cross-Sectional Sub-Surface Sketch of Major Hydro-Stratigraphic Units Underlying the Big Gulch-to-Star Areas in North Ada County, Idaho

Major Ion Chemistry of Groundwater from Wells Completed in the Terteling Springs Formation

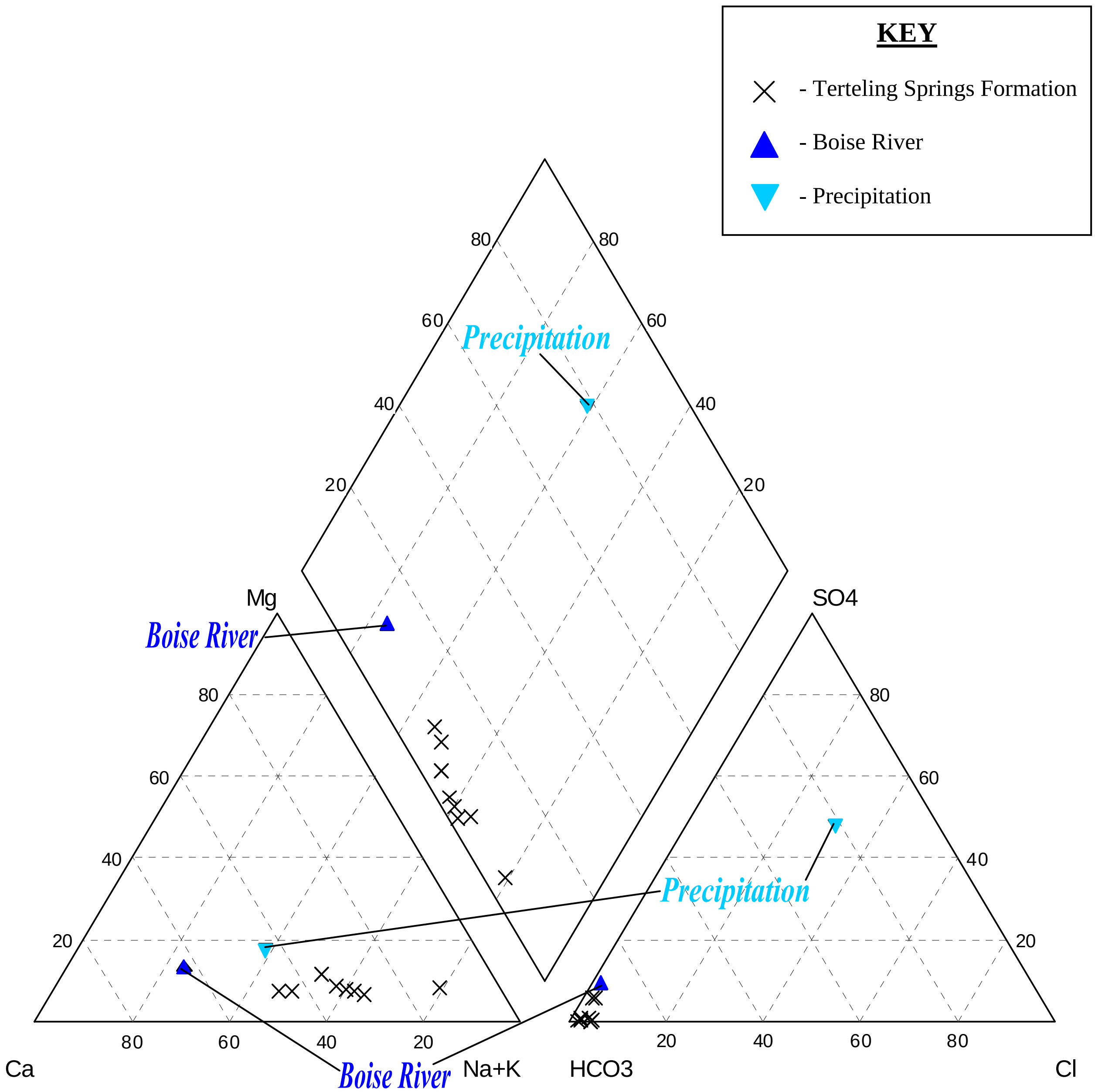

Figure 7. Trilinear diagram showing the major ion relationships of groundwater from the Terteling Springs Formation (TSF) in the M3 Area compared to that of precipitation and Boise River water.

Figure 7.

Major Ion Chemistry of Groundwater from Wells Completed in the Terteling Springs Formation

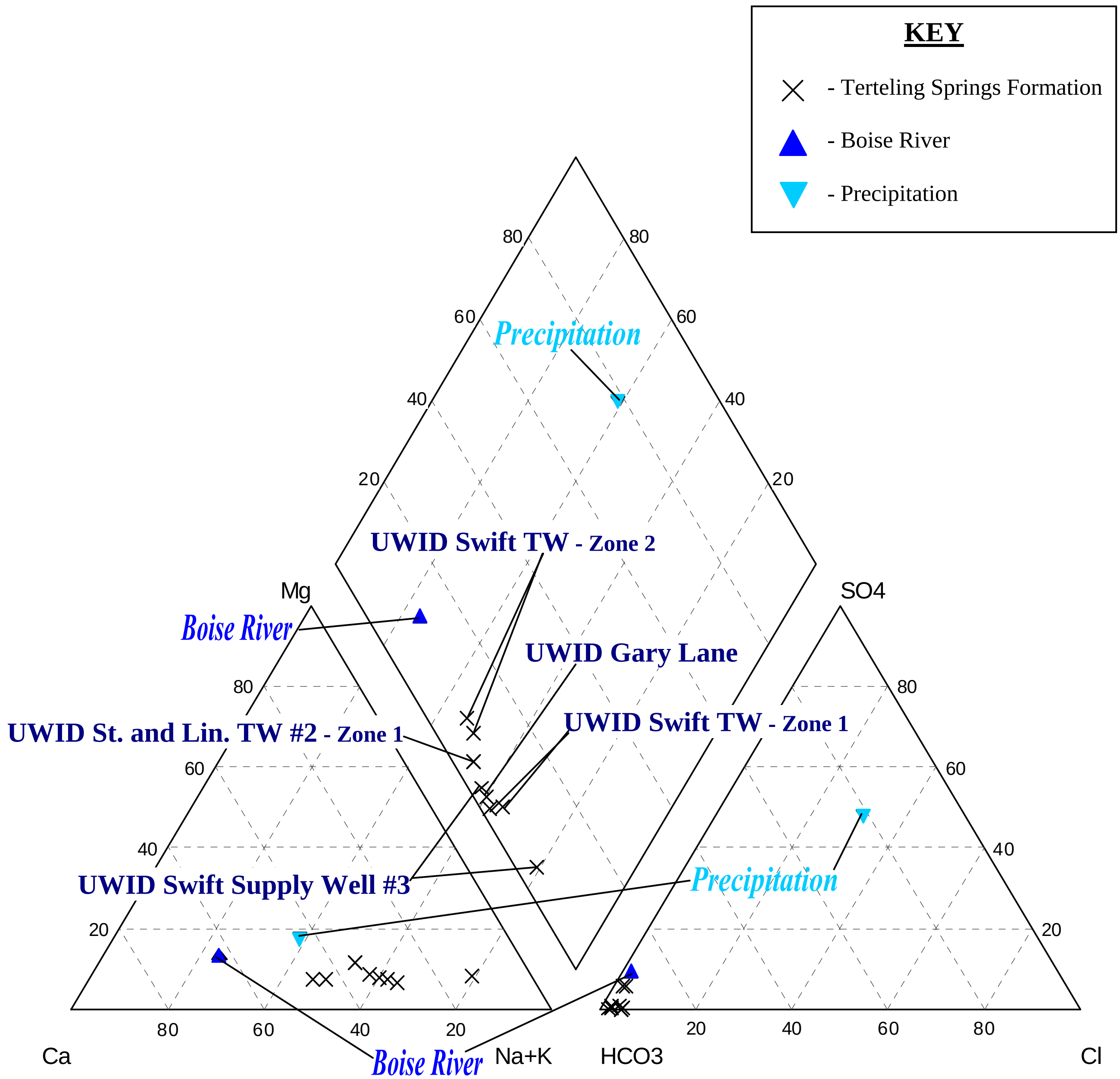

Figure 8. Trilinear diagram showing the major ion relationships of groundwater from the Terteling Springs Formation (TSF) in the M3 Area compared to that of precipitation and Boise River water with labeling.

Figure 8.

Major Ion Chemistry of Groundwater from Wells Completed in the "Willow Creek Aquifer" (WCA)

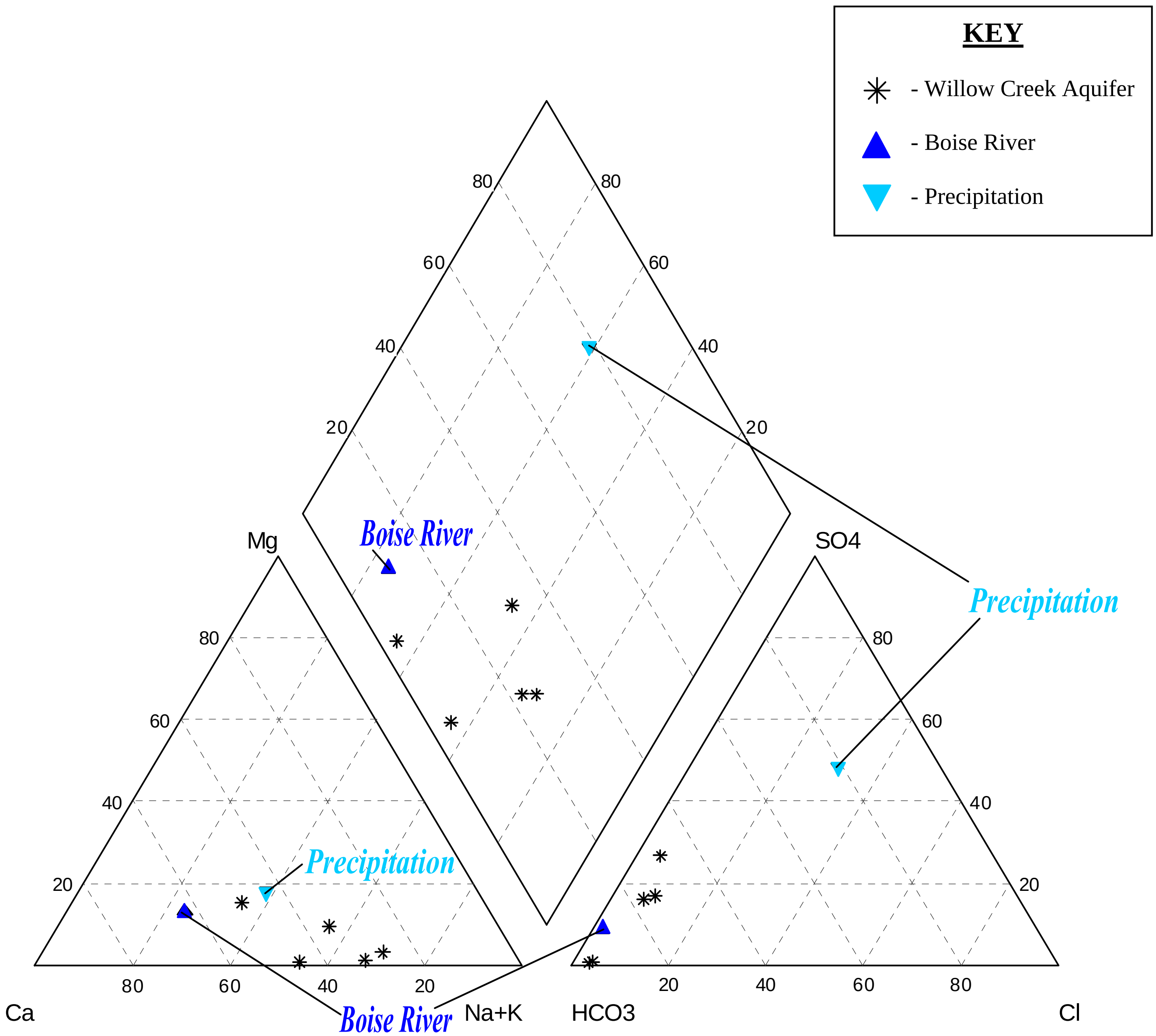

Figure 9. Trilinear diagram showing the major ion relationships of groundwater from the Willow Creek Aquifer (WCA) in the M3 Area compared to that of precipitation and Boise River water.

Figure 9.

Major Ion Chemistry of Groundwater from Wells Completed in the "Willow Creek Aquifer" (WCA)

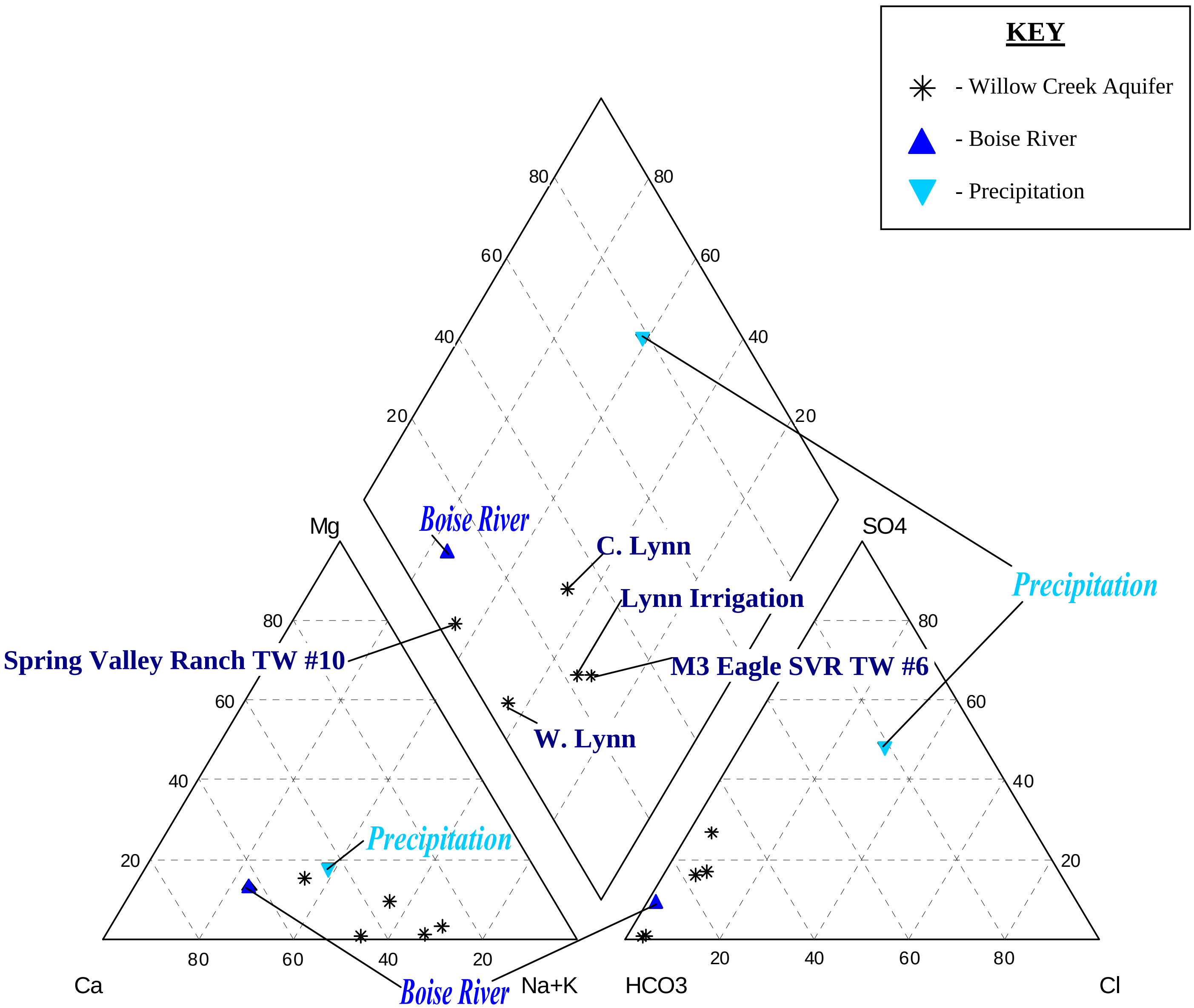

Figure 10. Trilinear diagram showing the major ion relationships of groundwater from the Willow Creek Aquifer (WCA) in the M3 Area compared to that of precipitation and Boise River water with labeling.

Figure 10.

Major Ion Chemistry of Groundwater from Wells Completed on Spring Valley Ranch (SVR)

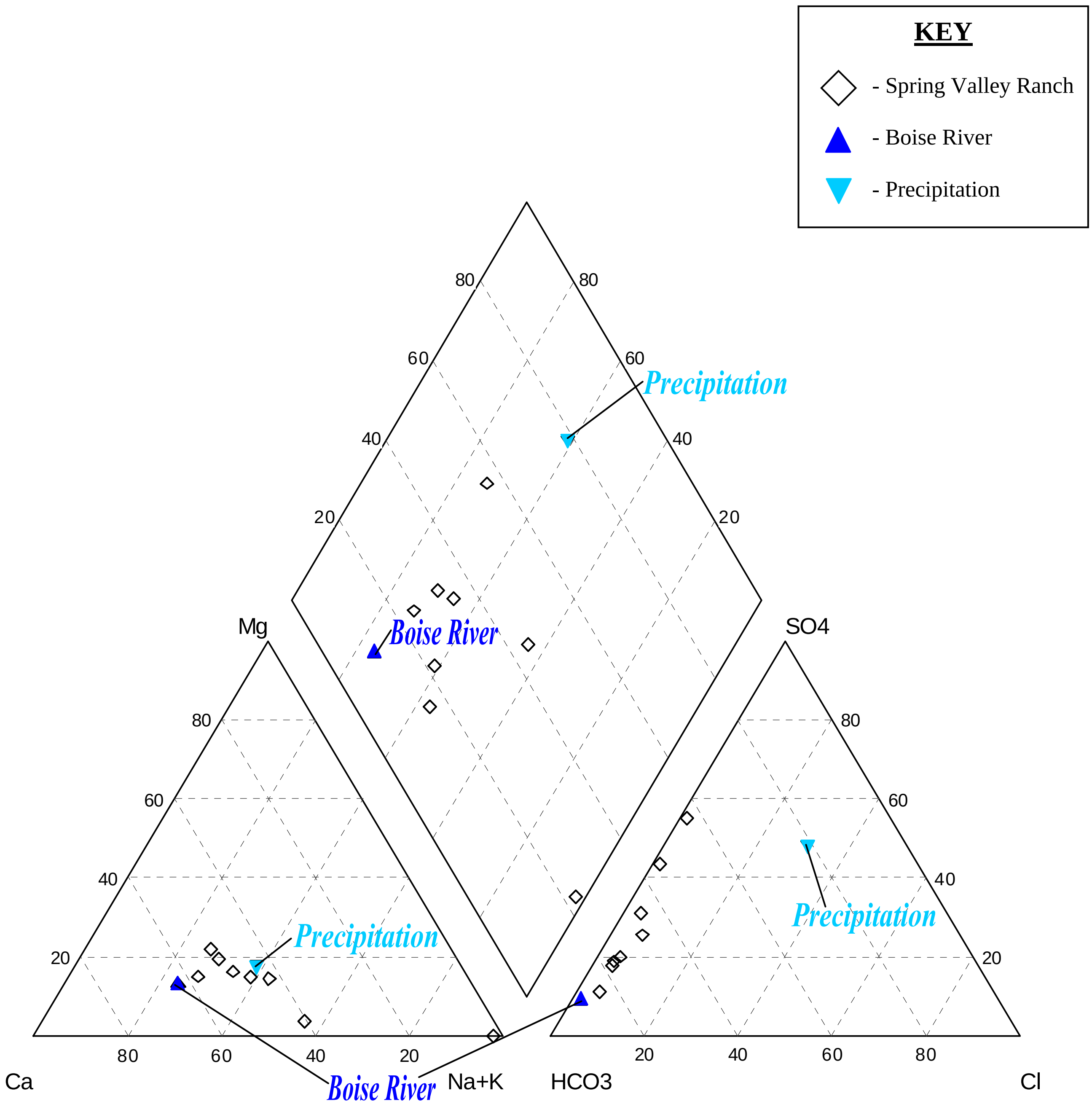

Figure 11. Trilinear diagram showing the major ion relationships of groundwater from the Spring Valley Ranch Wells (SVRW) in the M3 Area compared to that of precipitation and Boise River water.

Figure 11.

Major Ion Chemistry of Groundwater from Wells Completed on Spring Valley Ranch (SVR)

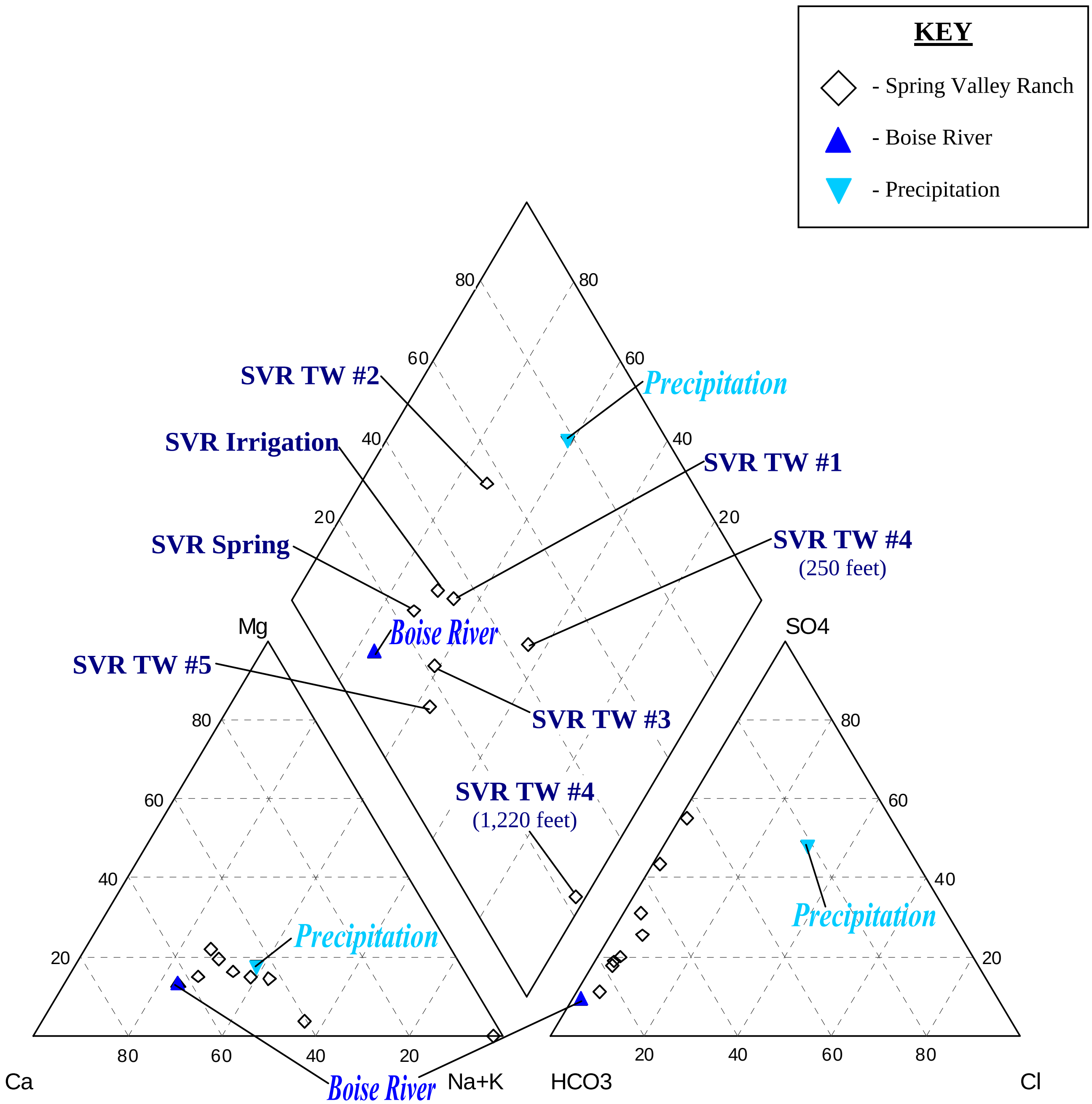

Figure 12. Trilinear diagram showing the major ion relationships of groundwater from the Spring Valley Ranch Wells (SVRW) in the M3 Area compared to that of precipitation and Boise River water with labeling.

Figure 12.

Major Ion Chemistry of Groundwater from Wells Completed in Emmett

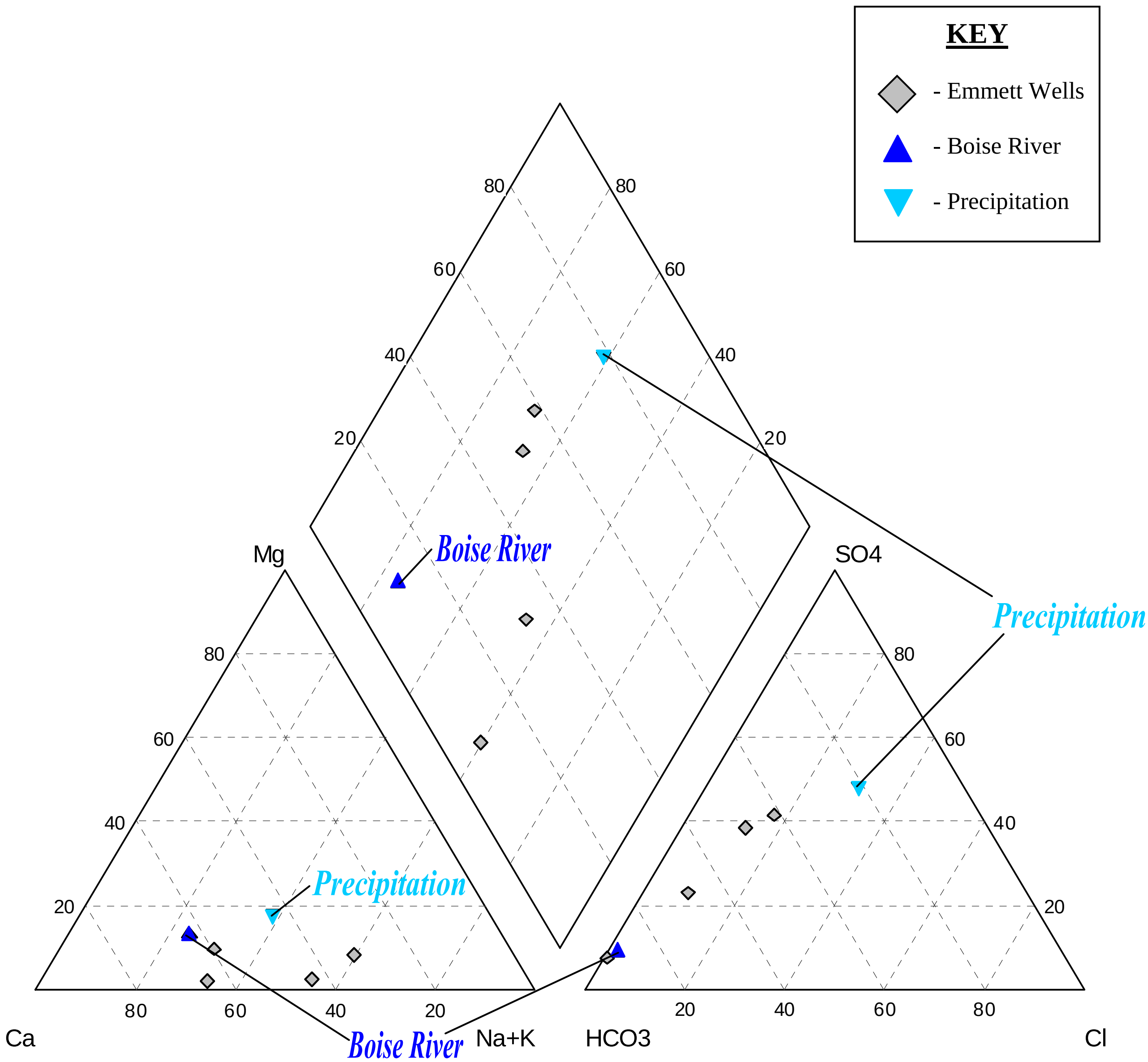

Figure 13. Trilinear diagram showing the major ion relationships of groundwater from the Emmett area wells in the M3 Area compared to that of precipitation and Boise River water.

Figure 13.

Major Ion Chemistry of Groundwater from Wells Completed in Emmett

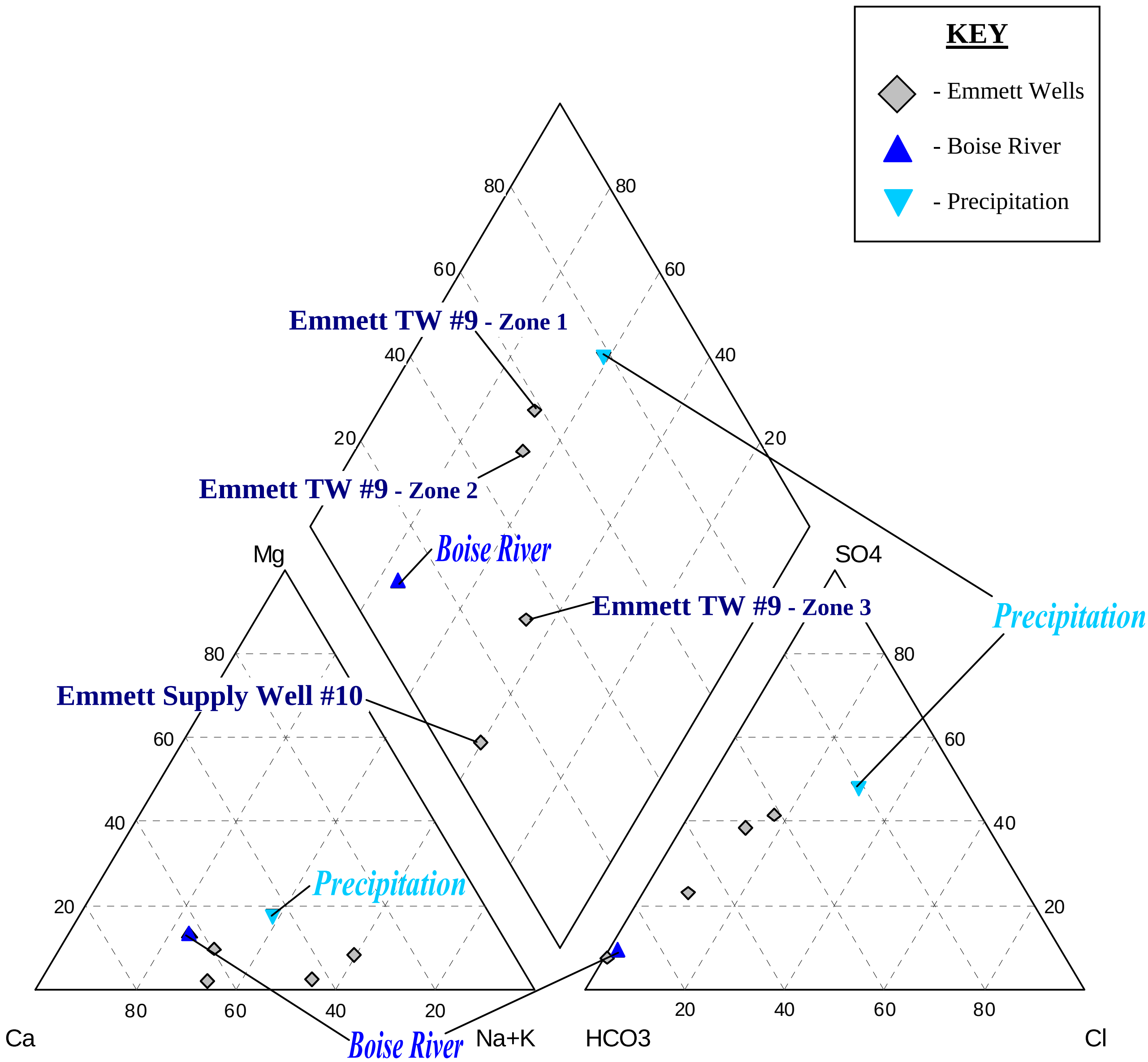

Figure 14. Trilinear diagram showing the major ion relationships of groundwater from the Spring Valley Ranch Wells (SVRW) in the M3 Area compared to that of precipitation and Boise River water with labeling.

Figure 14.

Table 1. Summary of Water Chemistry Data for M3 Eagle and Select Regional Water Supply and Test Wells

Tabulation of Available Data

Well Number	Screened Interval (feet bgl)	Date(s) Sampled	Laboratory	Alkalinity	Aluminum	Aluminum (dissolved)	Ammonia as N	Antimony	Arsenic	Barium	Beryllium	Bicarbonate	Cadmium	Calcium as CaCO3	Chloride	Chromium	Color (apparent)	Conductivity (umhos/cm)	Corrosivity (Langlier)	Fluoride	Hardness	Hydrogen Sulfide	Iron
City of Star #3	510-643	08-30-06	Alchem	82.0	<0.01		0.06		0.0050					50.2	1.60			184.0	-0.65	0.55	66.7		0.20
Gary Lane UWID	685-837	03-21-96	Alchem	198.0										62.0	3.36			386.0		0.39	74.0		
M3 Test #1 - Zone 1	444-561	10-09-06	Alchem	133.0			0.37		<0.003					84.4	3.42		1	302.0	-0.40	0.69	111.0	ND	0.25
M3 Test #1 - Zone 2	444-561	10-09-06	Alchem	125.0			0.06		<0.003					85.5	3.22		1	297.0	-0.44	0.60	109.0	ND	0.03
M3 Test #1 - Zone 3	305-428	10-09-06	Alchem	119.0			0.04		<0.003					77.7	3.57		1	282.0	-0.50	0.60	102.0	ND	0.01
M3 Test #1 - Zone 4	305-428	11-27-06	Alchem	114.0			<0.01		0.0049					81.3	3.54		<1	285.0	-0.61	0.50	105.0	*	<0.01
M3 Test #1 - Zone 5	67-144	11-27-06	Alchem	119.0			<0.01		0.0081					85.9	4.36		<1	281.0	-1.16	0.24	111.0	*	<0.01
M3 Test #2 - Zone 1	270-320	07-24-07	Alchem	101.0			0.40		0.0240					63.9	25.40		3	275.0	-0.50	0.36	97.0	*	0.79
M3 Test #2 - Zone 1	259-334	07-24-07	Alchem	101.0			0.40		0.0240					63.9	25.40		3	275.0	-0.50	0.36	97.0	*	0.79
M3 Test #2 - Zone 1	259-334	03-06-08	Alchem	91.4			0.33		0.0184					52.8	4.59		2	246.0	-0.92	0.27	83.5	*	0.65
M3 Test #3 - Zone 1	391-446	01-30-07	Alchem	136.0			0.28		0.0080					69.8	5.39		<1	316.0	-0.14	0.51	98.4	*	0.37
M3 Test #3 - Zone 2	391-446	01-30-07	Alchem	123.0			0.14		0.0050					74.8	5.31		<1	305.0	-0.46	0.52	106.0	*	0.24
M3 Test #3 - Zone 3	360-381	01-30-07	Alchem	117.0			0.05		0.0090					86.5	7.02		<1	321.0	-0.30	0.52	118.0	*	0.05
M3 Test #4 - Zone 1	617-655	04-03-08	Alchem	128.0			0.11		0.0029					83.9	4.13		<1	307.0	-0.45	0.48	118.0	*	0.31
M3 Test #4 - Zone 2	298-564	04-03-08	Alchem	122.0			<0.01		0.0066					81.0	4.57		<1	300.0	-0.46	0.43	109.0		0.02
M3 Test #4 - Zone 3	166-211																						
M3-Kling Irrigation	102-415	01-11-07	Alchem	112.0			<0.01		<0.003					83.2	4.90			295.0	-0.86	0.51	110.0	ND	0.04
Spring Valley Ranch #1	open 100-400	11-08-02	Analytical				0.18	<0.005	0.0080	<0.05	<0.0005			27.3	4.00	<0.002				0.44	99.5		0.06
Spring Valley Ranch #2	open 300-846	11-27-02	Analytical				0.23	<0.005	0.0160	0.06	<0.0005			85.6	5.00	<0.002				0.34	319.0		0.95
Spring Valley Ranch #3	150-240+	12-18-02	Analytical				<0.04	<0.005	0.0380	<0.05	<0.0005	50.4000		12.9	2.00	<0.002				0.27	41.8		0.06
Spring Valley Ranch #4 (deep)	1,035-1,220	02-25-03	Analytical				0.04	<0.005	0.0040	<0.05	<0.0005	136.0000		1.6	5.00	<0.002				0.97	5.0		0.24
Spring Valley Ranch #4 (250)	240-320	03-06-03					0.46	<0.005	<0.003	<0.05	<0.0005	155.0000		45.6	3.00	<0.002				0.17	19.0		0.73
Spring Valley Ranch #5	open 38-(147?)	02-05-04	Analytical				0.12	<0.005	0.0080	0.05	<0.0005	71.3000	<0.0005	15.8	3.00	<0.002				0.42	48.4	<0.05	0.86
Spring Valley Ranch #6	455-740	03-16-04	Anlytical	58.8			0.13	ND	0.0670	ND	ND			9.7	5.00	ND				0.95	ND	ND	0.09
Spring Valley Ranch #7	240-380	04-21-04	Analytical				<0.04	<0.005	<0.005	<0.05	<0.0005		<0.0005	29.1	5.00	<0.002				0.44	110.0	<0.05	0.11
Spring Valley Ranch #7	240-380	03-14-08	Alchem	120.0			0.02		0.0037					77.8	4.42		<1	305.0	-0.35	0.43	115.0		0.11
Spring Valley Ranch #9	215-265	06-23-04	Analytical				0.10	<0.005	<0.005	0.10	<0.0005		<0.0005	24.9	10.00	<0.002				0.45	102.0	<0.05	0.60
Spring Valley Ranch #10	600-770	08-19-04	Analytical				<0.04	<0.005	0.0120	<0.05	<0.0005	53.5	<0.0005	17.1	2.00	0.002				0.24	51.8	<0.05	0.36
Spring Valley Ranch Spring #1		12-18-02	Analytical				<0.04	<0.005	0.0210	<0.05	<0.0005			22.2	3.00	<0.002				0.33	67.7	<0.05	<0.05
Spring Valley Ranch Spring #1		03-19-02					0.07	<0.005	0.0210	<0.05	<0.0005			24.4	3.00	<0.002				0.38	69.2	<0.05	<0.05
Spring Valley Ranch Irrigation		03-06-03	Analytical				0.75	<0.005	0.0060	0.22	<0.0005			50.0	12.00	<0.002				0.79	125.0	<0.05	4.33
Big Gulch #1		02-14-03	Analytical				<0..04	<0.005	0.0050	0.05	<0.0005			30.8	5.00	<0.002				0.60	107.0		<0.05
Little Gulch #1		02-14-03	Analytical				<0.04	<0.005	0.0060	<0.05	<0.0005			23.9	6.00	<0.002				0.59	89.7		<0.05
State/Linder Test #1 Zone 1	230-545	10-27-97	Analytical	99.7			<0.04							28.3	4.00			234.0	-1.20	0.52	86.9		<0.05
		10-27-97	Alchem	97.5										27.3	2.52			231.0		0.34	89.2		<0.01
		08-28-00	Analytical						0.0030														<0.05
State/Linder Test #1 Zone 2	230-545	10-27-97	Analytical	93.3			<0.04							25.6	3.00			214.0	-1.20	0.52	78.9		<0.05
		10-27-97	Alchem	89.7										25.2	3.13			213.0		0.38	81.8		<0.01
		08-28-00	Analytical						<0.003														<0.05
State/Linder Test #2 Zone 1	880-980	02-16-98	Alchem	100.0										24.7	2.47			231.0	-0.84	0.48	82.2		2.04
		02-16-98	Analytical	105.0	0.54		7.02							24.5	3.00			220.0	-1.50	0.48	83.5		0.86
		08-28-00	Analytical						0.0050														0.23
State/Linder Test #2 Zone 2	569-730	02-16-98	Alchem	179.0										24.0	5.73			365.0	-0.25	0.29	79.7		0.18
		02-16-98	Analytical	191.0	0.18		6.05							23.6	6.00			343.0	-0.40	0.31	78.5		0.14
		08-28-00	Analytical						0.0040														28.60

Well Number	Iron (dissolved)	Magnesium	Manganese	Manganese (dissolved)	Mercury	Nickel	Nitrate as N (10.0)	Nitrite as N (1.0)	Odor	Orthophosphate	Phosphate P (total)	Phosphorus (total)	Potassium	pH (Lab)	Selenium	Silica	Silicon	Sodium	Sulfate	Sulfide	Thallium	Total Coliform	Total Dissolved Solids	Total Kjeldahl Nitrogen	Total Organic Carbon	Zinc	Field Temperature (degrees F)	Field pH (S.U.)	Field Conductivity (uS)	Field Dissolved Oxygen	Field Oxidation-Reduction Potential (mV)
City of Star #3	0.20	4.03		0.03			<0.10		<1				1.36	7.64		30.60		13.60	9.03	<0.05			123.0	0.15	<1.0		66.5	7.51	212	0.35	-
Gary Lane UWID	0.23	3.76		0.14			<0.1	<0.01			0.130		5.90	7.45		47.70		50.30					351.0				82.4	7.32			
M3 Test #1 - Zone 1	0.23	6.50		0.10			<0.1	<0.01	<1	0.021			2.26	7.47		31.80		22.10	17.20	<0.05		present	173.0	0.39	<1.0		67.1	7.19	305	1.70	-54
M3 Test #1 - Zone 2	<0.01	5.73		0.02			<0.1	<0.01	<1	0.016			2.21	7.48		30.70		21.70	20.70	<0.05		present	188.0	0.13	<1.0		66.0	7.19	295	2.60	53
M3 Test #1 - Zone 3	<0.01	5.83		<0.01			0.30	<0.01	<1	0.028			2.07	7.51		29.50		21.10	21.40	<0.05		present	185.0	<0.1	<1.0		64.7	7.27	274	4.90	84
M3 Test #1 - Zone 4	<0.01	5.85		<0.01			0.33	<0.01	<1	0.170			2.10	7.40		28.70		17.90	22.30	<0.05		absent	203.0	<0.1	<1.0		63.8	7.27	268	2.63	143
M3 Test #1 - Zone 5	<0.01	6.22		<0.01			2.30	<0.01	<1	0.420			2.74	6.91		38.00		13.60	12.00	<0.05		present	208.0	<0.1	<1.0		57.4	6.72	265	9.51	166
M3 Test #2 - Zone 1	0.73	8.05		0.22			<0.10	<0.01	<1	0.182			2.10	7.60		38.30		18.10	66.40	<0.05		absent	180.0	0.04	<1.0		68.6	7.23	322	0.56	94
M3 Test #2 - Zone 1	0.73	8.05		0.22			<0.10	<0.01	<1	0.182			2.10	7.60		38.30		18.10	66.40	<0.05		absent	180.0	0.44	<1.0		68.6	7.23	322	0.56	94
M3 Test #2 - Zone 1	0.65	7.46		0.18			<0.10	<0.01	<1	0.131			2.08	7.32		28.10		19.20	20.70	<0.05		absent	178.0	0.33	<1.0		67.8	7.26	280	0.07	-130
M3 Test #3 - Zone 1	0.16	6.94		0.07			0.13	<0.01	<1	0.477			2.90	7.90		43.50		30.40	22.70	<0.05		absent	253.0	0.35	1.34		64.2	7.62	310	6.64	106
M3 Test #3 - Zone 2	0.09	7.48		0.09			0.13	<0.01	<1	0.270			2.54	7.59		41.20		24.30	23.90	<0.05		absent	235.0	0.23	<1.0		63.2	7.22	307	4.89	6
M3 Test #3 - Zone 3	0.03	7.47		0.05			0.12	<0.01	<1	0.276			2.53	7.72		35.80		26.20	32.30	<0.05		absent	238.0	0.18	<1.0		62.2	7.46	321	4.87	110
M3 Test #4 - Zone 1	0.27	8.33		0.07			<0.10	<0.01	<1	0.104			2.52	7.45		37.20		24.00	21.20	<0.05		absent	225.0	0.11	<1.0		68.9	7.64	333	0.09	-122
M3 Test #4 - Zone 2	0.01	6.81		0.01			0.39	<0.01	<1	0.133			2.28	7.52		32.50		25.80	23.00	<0.05		absent	223.0	<0.10	1.00		64.6	7.70	334	2.26	116
M3 Test #4 - Zone 3																															
M3-Kling Irrigation	0.02	6.42		<0.01			0.54	0.01					2.28	7.18		32.20		19.70	29.10	<0.05		absent	225.0	0.14	<1.0						
Spring Valley Ranch #1		5.47	0.18		<0.0002	<0.02	0.26	<0.01					6.50					17.80	43.00	<0.05	<0.002		210.0				60.3	7.39	282		
Spring Valley Ranch #2		22.20	1.64		<0.0002	<0.02	<0.20	<0.01					12.90					43.70	229.00	<0.05	<0.002		570.0				66.7		815		
Spring Valley Ranch #3		2.54	<0.05		<0.0002	<0.02	0.63	<0.01					4.40					9.72	11.00	<0.05	<0.002		116.0				56.8		142		
Spring Valley Ranch #4 (deep)		<0.10	<0.05		<0.0002	<0.02	<0.20	0.01					0.70					83.50	32.00	<0.05	<0.002		214.0				56.0	7.40	590		
Spring Valley Ranch #4 (250)		2.58	0.26		<0.0002	<0.02	<0.2	<0.01					6.50					68.70	117.00	<0.05	<0.002		404.0				66.0	7.40	546		
Spring Valley Ranch #5		3.26	0.31		<0.0002	<0.02	<0.2	<0.01					4.90					15.30	9.00	<0.05	<0.002		176.0				57.9	6.46	184		
Spring Valley Ranch #6		0.69	ND		ND	ND	1.09	0.02					1.50		ND			27.80	13.00				98.0								
Spring Valley Ranch #7		8.19	<0.05		<0.0002	<0.02	0.31	<0.01										22.90	24.00				212.0								
Spring Valley Ranch #7	0.11	8.91		0.02			0.34	<0.01	<1				2.60	7.63		38.90		23.20	23.50	<0.05		absent	235.0	<0.10	3.36		67.0	7.40	382	1.37	55
Spring Valley Ranch #9		10.40	0.12		<0.0002	<0.02	<0.2	<0.01					2.00	2.50	<0.005			26.90	44.00				216.0								
Spring Valley Ranch #10		3.20	<0.05		<0.0002	<0.02	5.20	<0.01					2.40		<0.005			12.30	<1.0	<0.05	<0.002		70.0				75.9	7.64	160		
Spring Valley Ranch Spring #1		3.53	<0.05		<0.0002	<0.02	1.59	<0.01					4.40					9.52	17.00		<0.002		120.0								
Spring Valley Ranch Spring #1		3.63	<0.05		<0.0002	<0.02							4.10					9.67			<0.002										
Spring Valley Ranch Irrigation		11.60	2.29		<0.0002	<0.02	<0.2	0.02					10.40					27.50	61.00		<0.002		378.0				55.9	7.49	514		
Big Gulch #1		6.65	<0.05		<0.0002	<0.02	0.30	<0.01					2.10					19.20	24.00	<0.05	<0.002		206.0				64.9	7.38	269		
Little Gulch #1		6.55	<0.05		<0.0002	<0.02	0.59	<0.01					1.70					21.20	21.00	<0.05	<0.002		192.0				68.2	7.30	253		
State/Linder Test #1 Zone 1	<0.05	4.97	<0.05	<0.05			0.18					0.070	1.67	6.90		14.70		16.60	17.00				94.0				60.0	6.80	255		
	<0.01	5.10	<0.01	<0.01			0.12					0.050	1.74	7.00		42.20		15.00	16.60				98.0				60.0	6.80	255		
			<0.05																	<0.05											
State/Linder Test #1 Zone 2	<0.05	4.32	<0.05	<0.05			0.12					<0.05	1.56	7.00		14.40		15.00	14.00				82.0				59.5	6.92	224		
	<0.01	4.60	<0.01	<0.01			<0.10					0.040	1.47	7.05		42.60		13.60	14.90				128.0								
			<0.05																	<0.05											
State/Linder Test #2 Zone 1	0.38	4.99	0.05	0.02			<0.10					0.140	1.70	7.35		33.40		15.50	15.10				148.0				72.4	7.60	345		
	0.32	5.20	<0.05	<0.05			0.11					0.050	1.67	7.60		30.90		15.80	16.00				144.0				72.4	7.60	345		
			0.10																	<0.05											
State/Linder Test #2 Zone 2	0.17	4.82	0.11	0.11			<0.10					0.130	4.83	7.60		67.80		38.80	<0.50				235.0				62.0	6.70	242		
	0.14	4.79	0.10	0.10			<0.10					0.140	4.06	8.00		59.50		35.50	<1				204.0				62.0	6.70	242		
			0.26																	<0.05											

Table 1. Summary of Water Chemistry Data for M3 Eagle and Select Regional Water Supply and Test Wells

Tabulation of Available Data

Well Number	Screened Interval (feet bgl)	Date(s) Sampled	Laboratory	Alkalinity	Aluminum	Aluminum (dissolved)	Ammonia as N	Antimony	Arsenic	Barium	Beryllium	Bicarbonate	Cadmium	Calcium as CaCO3	Chloride	Chromium	Color (apparent)	Conductivity (umhos/cm)
State Street UWID Zone 1	260-357	12-13-96	Alchem	112.0										28.9	2.05			260.0
State Street UWID Zone 1	260-358	12-14-96	Analytical	114.0										29.2	2.00			255.0
State Street UWID Zone 2	260-357	12-14-96	Alchem	101.0										28.1	1.73			224.0
State Street UWID Zone 2	260-358	12-15-96	Analytical	103.0										25.8	2.00			237.0
State Street UWID Zone 3	191-249	12-15-96	Alchem	132.0										39.6	2.63			313.0
State Street UWID Zone 3	191-250	12-16-96	Analytical	138.0										35.1	3.00			305.0
State Street UWID Zone 4	105-177	12-16-96	Alchem	139.0										37.5	3.20			299.0
State Street UWID Zone 4	105-178	12-17-96	Analytical	143.0										33.3	3.00			294.0
Swift #1 Supply UWID	162-215	08-04-95	Analytical	110.0										32.0	6.00			247.0
Swift #1 Supply UWID	162-215	2007 ?		101.0	0.00	0.00			0.0000					22.4	5.00			272.0
Swift #3 Supply UWID	526-686	08-15-97	Alchem	121.0										13.3				243.0
Swift #3 Supply UWID	526-686	05-15-97	Analytical	138.0										17.0	2.00			263.0
Swift Test Well Zone 1	485-720	11-19-96	Alchem	142.0										14.8	1.67			241.0
Swift Test Well Zone 1	485-720	11-19-96	Analytical	122.0										15.8	4.00			236.0
Swift Test Well Zone 2	485-720	11-19-96	Alchem	98.9										18.2	1.55			206.0
Swift Test Well Zone 2	485-720	11-19-96	Analytical	98.7										19.3	2.00			204.0
Swift Test Well Zone 3	85-280	11-21-97	Alchem	130.0		0.22								39.2	5.27			291.0
Swift Test Well Zone 3	85-280	11-21-97	Analytical			134.00								41.7	5.00			297.0
Swift Test Well Zone 4	85-280	11-21-97	Alchem	113.0		0.27								31.1	4.05			239.0
Swift Test Well Zone 4	85-280	11-21-97	Analytical	116.0		<.1								32.6	4.00			251.0
Floating Feather	171-346			124.0			0.00		0.0030									
Floating Feather	171-346	2007 ?		130.0	0.27				4.0000					36.5	5.00			308.0
Goddard #2 UWID	451-551	2001 ?		192.0			0.00		<3ppb									
Goddard #2 UWID	451-551	2007 ?		198.0	0.20		0.17		0.0000					51.8	8.00			450.0
Goddard #1 UWID	760-960	06-24-92	Analytical	126.0										35.5	8.00			327.0
HP UWID	575-700	05-17-91	Analytical	54.0					<0.005					14.0	<1.0		<1.0	97.0
Island Woods #1	225-345	2001 ?		57.0			0.00		<0.003									
Island Woods #1	225-345	2007 ?		57.0	0.00		0.00		0.0000					15.8	2.00			132.0
Island Woods #2	230-355	2001 ?		54.0			0.00		<0.003									
Island Woods #2	230-355	2007 ?		54.0	0.00		0.00		0.0000					13.1	0.00			116.0
Redwood Creek	265-415			136.0			0.00		<0.003									
Redwood Creek	265-415	2007 ?		136.0	0.00		0.00		3ppb					39.4	5.00			313.0
Lexington Hills #1	215-385			243.0			0.00		0.0060									
Lexington Hills #1	215-385	2007 ?		244.0	0.11		0.00		5ppb					50.2	4.00			547.0
Wade Lynn Well	?	06-07-04	Analytical				0.58		<0.005					17.2	3.00			
Corbett Lynn well	540-580	06-07-04	Analytical				0.05		0.0270					20.9	4.00			
Lynn Old Irrigation well	?	06-07-04	Analytical				<0.04		0.0140					17.1	6.00			
Perin	375-385	09-01-00	Alchem	73.1			0.35							19.6	2.74			
Emmett #9 Test Zone 1	425-487	05-19-99	Alchem	114.0			0.18		<0.005					157.0	33.30			547.0
Emmett #9 Test Zone 2	360-400	05-19-99	Alchem	100.0			0.20		<0.005					130.0	19.00			416.0
Emmett #9 Test Zone 3	195-248	05-19-99	Alchem	102.0			0.12		<0.005					62.7	9.70			309.0
Emmett #10 Test	300-374	08-17-99	Alchem	219.0			0.64		<0.005					27.3	1.16			440.0

Well Number	Corrosivity (Langlier)	Fluoride	Hardness	Hydrogen Sulfide	Iron	Iron (dissolved)	Magnesium	Manganese	Manganese (dissolved)	Mercury	Nickel	Nitrate as N (10.0)	Nitrite as N (1.0)	Odor	Orthophosphate	Phosphate P (total)	Phosphorus (total)	Potassium	pH (Lab)
State Street UWID Zone 1	-0.87	0.34	90.9		0.06	0.02	4.54	0.03	0.03			0.13					0.040	2.00	7.30
State Street UWID Zone 1	-1.10	0.57	99.9		<0.05	<0.05	4.58	<0.05	<0.05			0.16				0.070		1.58	7.60
State Street UWID Zone 2	-0.54	0.36	86.4		0.05	0.01	3.94	0.04	0.04			<0.10					0.030	2.07	7.70
State Street UWID Zone 2	-0.80	0.66	93.7		<0.05	<0.05	3.70	<0.05	<0.05			<0.10				0.070		1.63	8.10
State Street UWID Zone 3	-0.35	0.37	129.0		0.63	0.57	7.22	0.06	0.05			<0.1					0.040	2.55	7.65
State Street UWID Zone 3	-0.80	0.78	125.0		0.50	0.50	6.55	0.05	0.05			<0.1				0.060		2.06	7.90
State Street UWID Zone 4	-0.33	0.33	111.0		0.03	0.01	4.16	0.01	0.01			<0.10					0.050	2.17	7.70
State Street UWID Zone 4	-0.70	0.75	108.0		<0.05	<0.050	3.62	<0.05	<0.05			<0.10				0.080		1.64	8.00
Swift #1 Supply UWID	-1.36	0.42	97.5		<0.05		4.87	0.91									0.900	3.32	
Swift #1 Supply UWID	-1.50	0.36	70.0		0.00		3.10	0.08				0.50						1.50	6.50
Swift #3 Supply UWID	-0.69	0.49	42.2		0.03	0.03	2.19	0.12	0.12			<0.10					0.090		7.60
Swift #3 Supply UWID	-0.46	0.48	56.0		0.06		2.64	0.15	0.14			<0.1					0.080	3.31	
Swift Test Well Zone 1	-0.37	0.48	46.1		0.01	<0.01	2.23	0.11	0.11			<0.1					0.120	3.84	7.80
Swift Test Well Zone 1	-0.70		49.6		<0.05	<0.05	2.22	0.10	0.10			<0.1					0.090	2.85	8.10
Swift Test Well Zone 2	-0.28	0.41	53.1		0.01	0.01	1.87	0.09	0.09			<0.10					0.080	2.30	8.02
Swift Test Well Zone 2	-0.20		54.4		<0.05	<0.05	1.85	0.09	0.09			<0.1					0.700	1.61	8.20
Swift Test Well Zone 3	-0.71	0.24	120.0		0.68	0.65	5.40	0.08	0.08									2.11	7.25
Swift Test Well Zone 3	-0.90	0.26	116.0		0.59	0.63	5.90	0.07	0.07			<0.10					0.070	2.00	7.00
Swift Test Well Zone 4	-0.64	0.49	94.5		0.06	0.06	4.07	1.37	1.59									2.12	7.45
Swift Test Well Zone 4	-0.76	0.38	93.2		<0.05	<0.05	4.39	1.24	1.43			<0.1					0.100	2.05	7.30
Floating Feather	-1.16	0.35	114.0		ND			ND				1.80							
Floating Feather	-1.02	0.31	102.0		0.00		7.30	0.00				2.40						0.90	7.10
Goddard #2 UWID	-0.86	0.25	162.0									1.51							
Goddard #2 UWID	-0.91	0.25	168.0		0.00		10.00	0.00				1.40						2.00	6.80
Goddard #1 UWID		0.21	128.0		<0.05		8.00	<0.05		<0.0005	<0.02	0.14							7.20
HP UWID	-1.90	0.32	40.0		<0.05		2.30	<0.05		<0.0005	<0.02	0.15	<0.01					0.97	6.70
Island Woods #1	-2.61	0.35	50.0		ND			ND				0.22							
Island Woods #1	-2.61	0.35	50.0		0.06		2.50	0.00				0.30						0.32	6.10
Island Woods #2	-2.61	0.37	50.0		ND			ND				ND							
Island Woods #2	-2.61	0.37	41.0		0.00		2.20	0.00				0.02						1.07	6.10
Redwood Creek	-1.10	0.41	135.0		0.15			ND				1.30							
Redwood Creek	-1.40	0.44	131.0		0.00		6.50	0.00				1.00						1.40	6.50
Lexington Hills #1	-0.60	0.39	160.0		ND			ND				1.19							
Lexington Hills #1	-1.67	0.34	177.0		0.00		12.60	0.00				2.20						2.20	7.00
Wade Lynn Well		0.30	55.4		0.08		2.84	0.19				<0.2						2.00	7.30
Corbett Lynn well		1.71	54.4		0.05		0.24	<0.05				<0.2						1.30	7.60
Lynn Old Irrigation well		4.09	45.6		<0.05		0.45	<0.05				1.30						1.00	7.90
Perin			22.0		0.23	<0.01			0.02			<0.1	<0.01						
Emmett #9 Test Zone 1	-0.19	0.74	183.0	<0.05	0.86	0.44	6.22	0.63	0.60			<0.1					0.062	2.00	7.61
Emmett #9 Test Zone 2	0.09	0.92	134.0	<0.05	<0.01	<0.01	1.08	0.07	0.07			<0.1					0.020	1.67	7.98
Emmett #9 Test Zone 3	-0.07	2.66	66.4	<0.05	0.02	<0.01	0.88	0.06	0.06			<0.1					0.033	1.42	8.08
Emmett #10 Test	-0.07	0.30	85.6	*	0.11	0.11	4.25	0.12	0.13			<0.1					0.030	0.77	7.86

Well Number	Selenium	Silica	Silicon	Sodium	Sulfate	Sulfide	Thallium	Total Coliform	Total Dissolved Solids	Total Kjeldahl Nitrogen	Total Organic Carbon	Zinc	Field Temperature (degrees F)	Field pH (S.U.)	Field Conductivity (uS)	Field Dissolved Oxygen	Field Oxidation-Reduction Potential (mV)
State Street UWID Zone 1		32.50		17.30	14.40	<0.05			218.0					7.03			
State Street UWID Zone 1			14.6	15.80	14.00	0.07			182.0					7.03			
State Street UWID Zone 2		33.60		15.20	11.40	<0.05			188.0					7.42			
State Street UWID Zone 2			15.7	14.20	12.00	0.23			164.0					7.42			
State Street UWID Zone 3		31.50		20.30	22.50	<0.05			173.0					7.18			
State Street UWID Zone 3			15.4	19.40	22.00	0.16			200.0					7.18			
State Street UWID Zone 4		28.70		24.90	10.20	<0.05			248.0					7.36			
State Street UWID Zone 4			14.3	24.20	24.20				188.0					7.36			
Swift #1 Supply UWID		24.20		15.40	10.00				180.0				59.9	6.74			
Swift #1 Supply UWID				16.10	10.00				142.0				59.9				
Swift #3 Supply UWID		56.10		36.80	1.23								73.5	7.15	256		
Swift #3 Supply UWID		46.00		31.70	1.00									7.55			
Swift Test Well Zone 1		44.70		32.30	<0.50	0.13			168.0				71.2	7.48	177		
Swift Test Well Zone 1		48.60		39.10	<1				170.0				71.2	7.48	177		
Swift Test Well Zone 2		45.80		22.50	5.88				148.0				68.2	8.00	173		
Swift Test Well Zone 2		51.10		21.30	6.00				160.0				68.2	8.00	173		
Swift Test Well Zone 3		35.10		14.30					193.0				59.0		282		
Swift Test Well Zone 3		38.80		16.50	13.00				188.0				59.0		282		
Swift Test Well Zone 4		24.00		13.20					153.0				59.0		232		
Swift Test Well Zone 4		28.40		15.20	6.00				156.0				59.0		232		
Floating Feather				17.30	16.00				202.0				59.9	6.86			
Floating Feather				21.20	16.00				222.0				54.3				
Goddard #2 UWID				25.40	26.00				262.0								
Goddard #2 UWID				31.70	25.00				270.0				60.6				
Goddard #1 UWID		65.00		15.20	30.00	0.14							68.0				
HP UWID		30.40		7.10	3.00	<0.01						<0.005					
Island Woods #1				8.60	8.00				122.0				57.6	6.05			
Island Woods #1				10.70	8.00				88.0				57.6				
Island Woods #2				8.30	5.00				88.0				59.9	6.12			
Island Woods #2				10.00	5.00				122.0				59.9				
Redwood Creek				19.60	16.00				404.0				61.3	6.88			
Redwood Creek				21.50	24.00				208.0				61.7				
Lexington Hills #1				49.20	21.00				350.0				63.5	6.96			
Lexington Hills #1				60.80	28.00				262.0				63.0				
Wade Lynn Well		37.40		30.30	1.00				154.0								
Corbett Lynn well		40.30		27.80	29.00				120.0								
Lynn Old Irrigation well		36.40		40.90	19.00				154.0								
Perin					10.80			absent					79.9	8.60	180		
Emmett #9 Test Zone 1		31.00		36.30	110.00			absent	385.0				60.5	7.08	574		
Emmett #9 Test Zone 2		22.30		29.90	76.30			absent	283.0				64.0	7.89	459		
Emmett #9 Test Zone 3		22.00		35.10	33.10			absent	203.0				66.0	7.96	335		
Emmett #10 Test		20.40		57.60	17.50	<0.05			340.0				56.5	8.07	337		

*=initial pump testing sampling suite

Table 1. - Comments

Well Number	Screened Interval (feet bgl)	Date(s) Sampled	Comments
City of Star #3	510-643	08-30-06	no comments
Gary Lane UWID	685-837	03-21-96	no comments
M3 Test #1 - Zone 1	444-561	10-09-06	no comments
M3 Test #1 - Zone 2	444-561	10-09-06	no comments
M3 Test #1 - Zone 3	305-428	10-09-06	no comments
M3 Test #1 - Zone 4	305-428	11-27-06	* = no H2S data
M3 Test #1 - Zone 5	67-144	11-27-06	* = no H2S data
M3 Test #2 - Zone 1	270-320	07-24-07	* = no H2S data
M3 Test #2 - Zone 1	259-334	07-24-07	Taste high in iron, moderate H2S smell, no sand, no yellowing, minor degassing after 20 min. (tiny bubbles), Water possibly contaminated with drillers water.
M3 Test #2 - Zone 1	259-334	03-06-08	Clear water, moderate H2S smell,
M3 Test #3 - Zone 1	391-446	01-30-07	* = no H2S data
M3 Test #3 - Zone 2	391-446	01-30-07	* = no H2S data
M3 Test #3 - Zone 3	360-381	01-30-07	* = no H2S data
M3 Test #4 - Zone 1	617-655	04-03-08	Water started clear, mild H2S smell, slight irony taste, rapid degassing at the surface, mildly foamy
M3 Test #4 - Zone 2	298-564	04-03-08	chlorine demand = 0.25 mg/l, water started slightly cloudy and cleared up in 5 minutes, moderate degassing with medium sized bubbles, no odor, smooth clean taste, no sand, no yellowing.
M3 Test #4 - Zone 3	166-211		Water contaminated by cement, will sample after more development
M3-Kling Irrigation	102-415	01-11-07	no comments
Spring Valley Ranch #1	open 100-400	11-08-02	data obtained from "Groundwater Exploration Drilling in the Spring Valley Ranch Vicinity of Gem, Ada, and Boise Counties, Idaho' Scanlan Eng, April 2003
Spring Valley Ranch #2	open 300-846	11-27-02	data obtained from "Groundwater Exploration Drilling in the Spring Valley Ranch Vicinity of Gem, Ada, and Boise Counties, Idaho' Scanlan Eng, April 2003
Spring Valley Ranch #3	150-240+	12-18-02	data obtained from "Groundwater Exploration Drilling in the Spring Valley Ranch Vicinity of Gem, Ada, and Boise Counties, Idaho' Scanlan Eng, April 2003
Spring Valley Ranch #4 (deep)	1,035-1,220	02-25-03	data obtained from "Groundwater Exploration Drilling in the Spring Valley Ranch Vicinity of Gem, Ada, and Boise Counties, Idaho' Scanlan Eng, April 2003
Spring Valley Ranch #4 (250)	240-320	03-06-03	data obtained from "Groundwater Exploration Drilling in the Spring Valley Ranch Vicinity of Gem, Ada, and Boise Counties, Idaho' Scanlan Eng, April 2003
Spring Valley Ranch #5	open 38-(147?)	02-05-04	no comments
Spring Valley Ranch #6	455-740	03-16-04	data obtained from "Well Construction and Aquifer Testing in the Big Gulch and Little Gulch Areas of Spring Valley Ranch. 10/13/2004
Spring Valley Ranch #7	240-380	04-21-04	data obtained from "Well Construction and Aquifer Testing in the Big Gulch and Little Gulch Areas of Spring Valley Ranch. 10/13/2004
Spring Valley Ranch #7	240-380	03-14-08	Water is clear, minor H2S smell, small trace of degassing, chlorine demand = 0.33 mg/l
Spring Valley Ranch #9	215-265	06-23-04	data obtained from "Well Construction and Aquifer Testing in the Big Gulch and Little Gulch Areas of Spring Valley Ranch. 10/13/2004
Spring Valley Ranch #10	600-770	08-19-04	data obtained from "Well Construction and Aquifer Testing in the Big Gulch and Little Gulch Areas of Spring Valley Ranch. 10/13/2004
Spring Valley Ranch Spring #1		12-18-02	data obtained from "Groundwater Exploration Drilling in the Spring Valley Ranch Vicinity of Gem, Ada, and Boise Counties, Idaho' Scanlan Eng, April 2003
Spring Valley Ranch Spring #1		03-19-02	data obtained from "Groundwater Exploration Drilling in the Spring Valley Ranch Vicinity of Gem, Ada, and Boise Counties, Idaho' Scanlan Eng, April 2003
Spring Valley Ranch Irrigation		03-06-03	data obtained from "Groundwater Exploration Drilling in the Spring Valley Ranch Vicinity of Gem, Ada, and Boise Counties, Idaho' Scanlan Eng, April 2003
Big Gulch Stock		02-14-03	data obtained from "Groundwater Exploration Drilling in the Spring Valley Ranch Vicinity of Gem, Ada, and Boise Counties, Idaho' Scanlan Eng, April 2003
Little Gulch Stock		02-14-03	data obtained from "Groundwater Exploration Drilling in the Spring Valley Ranch Vicinity of Gem, Ada, and Boise Counties, Idaho' Scanlan Eng, April 2003
State/Linder Test #1 Zone 1	230-545	10-27-97	
		10-27-97	same sample, different labs
		08-28-00	sulfide analysis by Alchem
State/Linder Test #1 Zone 2	230-545	10-27-97	
		10-27-97	same sample, different labs
		08-28-00	sulfide analysis by Alchem
State/Linder Test #2 Zone 1	880-980	02-16-98	no comments
		02-16-98	no comments
		08-28-00	sulfide analysis by Alchem
State/Linder Test #2 Zone 2	569-730	02-16-98	no comments
		02-16-98	no comments
		08-28-00	sulfide analysis by Alchem
State Street UWID Zone 1	260-357	12-13-96	no comments
State Street UWID Zone 1	260-358	12-14-96	no comments

Table 1. - Comments

Well Number	Screened Interval (feet bgl)	Date(s) Sampled	Comments
State Street UWID Zone 2	260-357	12-14-96	no comments
State Street UWID Zone 2	260-358	12-15-96	no comments
State Street UWID Zone 3	191-249	12-15-96	no comments
State Street UWID Zone 3	191-250	12-16-96	no comments
State Street UWID Zone 4	105-177	12-16-96	no comments
State Street UWID Zone 4	105-178	12-17-96	no comments
Swift #1 Supply UWID	162-215	08-04-95	no comments
Swift #1 Supply UWID	162-215	2007 ?	data obtained from 2007 UWID WQ Fact Sheet
Swift #3 Supply UWID	526-686	08-15-97	no comments
Swift #3 Supply UWID	526-686	05-15-97	no comments
Swift Test Well Zone 1	485-720	11-19-96	no comments
Swift Test Well Zone 1	485-720	11-19-96	no comments
Swift Test Well Zone 2	485-720	11-19-96	no comments
Swift Test Well Zone 2	485-720	11-19-96	no comments
Swift Test Well Zone 3	85-280	11-21-97	no comments
Swift Test Well Zone 3	85-280	11-21-97	no comments
Swift Test Well Zone 4	85-280	11-21-97	no comments
Swift Test Well Zone 4	85-280	11-21-97	no comments
Floating Feather	171-346		data obtained from 2001 UWID WQ Fact Sheet
Floating Feather	171-346	2007 ?	data obtained from 2007 UWID WQ Fact Sheet
Goddard #2 UWID	451-551	2001 ?	Off of 2001 UWID WQ Fact sheet, unkown field measurements, and unknown sample date
Goddard #2 UWID	451-551	2007 ?	no comments
Goddard #1 UWID	760-960	06-24-92	no comments
HP UWID	575-700	05-17-91	no comments
Island Woods #1	225-345	2001 ?	data obtained from 2001 UWID WQ Fact
Island Woods #1	225-345	2007 ?	data obtained from 2007 UWID WQ Fact Sheet
Island Woods #2	230-355	2001 ?	data obtained from 2001 UWID WQ Fact Sheet
Island Woods #2	230-355	2007 ?	data obtained from 2007 UWID WQ Fact Sheet
Redwood Creek	265-415		data obtained from 2001 UWID WQ Fact Sheet
Redwood Creek	265-415	2007 ?	data obtained from 2007 UWID WQ Fact Sheet
Lexington Hills #1	215-385		data obtained from 2001 UWID WQ Fact Sheet
Lexington Hills #1	215-385	2007 ?	data obtained from 2007 UWID WQ Fact Sheet
Wade Lynn Well	?	06-07-04	data obtained from "Well Construction and Aquifer Testing in the Big Gulch and Little Gulch Areas of Spring Valley Ranch. 10/13/2004
Corbett Lynn well	540-580	06-07-04	data obtained from "Well Construction and Aquifer Testing in the Big Gulch and Little Gulch Areas of Spring Valley Ranch. 10/13/2005
Lynn Old Irrigation well	?	06-07-04	data obtained from "Well Construction and Aquifer Testing in the Big Gulch and Little Gulch Areas of Spring Valley Ranch. 10/13/2006
Perin	375-385	09-01-00	no comments
Emmett #9 Test Zone 1	425-487	05-19-99	no comments
Emmett #9 Test Zone 2	360-400	05-19-99	no comments
Emmett #9 Test Zone 3	195-248	05-19-99	no comments
Emmett #10 Test	300-374	08-17-99	no comments

Table 2. Averages for physical and chemical characteristics of groundwater from wells in the M3 Eagle area used in this report.

	Aquifers											
Parameter (all values in milligrams per liter unless otherwise specified)	**All Pierce Gulch Sand Aquifer (PGSA)**		**Upper Pierce Gulch Sand Aquifer (PGSA)**		**Lower Pierce Gulch Sand Aquifer (PGSA)**		**Spring Valley Ranch Wells (SVRW)**		**Terteling Springs Formation (TSF)**		**Willow Creek Aquifer (WCA)**	
	N	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**
Mean Screen Depth (feet)	52	341	13	311	23	341	6	284	10	658	3	581
Field Parameters												
Temperature (°F)	35	62.7	6	63.4	17	63.5	6	60.3	8	69.2	0	
Temperature (°C)	35	17	6	17.4	17	17.5	6	15.7	8	20.6	0	
Field pH	30	7.19	8	7.29	15	7.25	4	7.42	9	7.53	0	
Laboratory pH	40	7.18	11	7.39	20	7.2	0		8	7.8	3	7.6
Field Conductivity (µS/cm)	22	286	6	252	13	287	6	482	7	219		
Laboratory Conductivity (µS/cm)	40	276	11	270	20	287	0		9	272	0	
Dissolved Oxygen	13	2.53	2	3.76	8	2.71	0		0		0	
Eh (mv)	12	258	2	334	7	246	0		0		0	
Laboratory Analyses												
Silica	33	34.2	11	32.8	18	35	0		9	43.8	3	38
Total Iron	48	0.74	15	0.09	22	1.52	9	0.81	9	0.28	5	0.12
Dissoved Iron	31	0.17	11	0.11	17	0.22	0		8	0.1	0	
Total Manganese	33	0.14	12	0.025	14	0.31	9	0.53	9	0.1	4	0.07
Dissolved Manganese	31	0.14	11	0.019	17	0.24	0		9	0.1	0	
Calcium	44	30.4	13	31	21	31.3	9	31.7	9	18.6	5	16.4
Magnesium	44	5.9	13	5.5	21	6	9	6.1	9	2.9	5	1.5
Sodium	50	20.6	13	19.1	22	22.9	9	31.7	9	34.1	5	27.8
Potassium	44	2.01	13	1.93	21	2.26	9	6.09	9	2.91	5	1.64
Bicarbonate	50	146	13	141	22	155	8	142	9	168	5	101
Sulfate	50	17.7	13	19.9	22	17.3	8	64.9	9	5.3	5	12.5
Chloride	44	4.1	13	3.7	21	4.4	9	4.4	9	2.4	5	4
Fluoride	50	0.44	13	0.52	22	0.44	9	0.46	9	0.43	5	1.46
Nitrate as Nitrogen	46	0.42	13	0.21	19	0.27	8	0.37	9	0.05	5	1.56
Total Kjeldahl Nitrogen	14	0.19	3	0.08	8	0.28	0		0		0	
Ammonia as Nitrogen	29	0.08	5	0.018	11	0.16	9	0.21	1	0.64	5	0.16
Organic Nitrogen	14	0.06	3	0.06	8	0.06	0		0		0	
Total Organic Carbon	14	0.8	3	0.5	8	0.6	0		0		0	
Total Phosphorus	10	0.14	4	0.04	6	0.21	0		8	0.17	0	
Orthophosphate	11	0.16	2	0.1	7	0.2	0		0		0	
Sulfide	27	0.04	10	0.039	13	0.04	5	0.025	3	0.06	0	
Arsenic	32	0.004	7	0.003	12	0.007	9	0.0137	2	0.0037	5	0.03
Barium	4	0.05	2	0.038	1	0.001	9	0.053	0		1	
Langlier Corrosivity Index	42	-0.97	8	-0.67	20	-0.76	0		7	-0.4	0	
Hardness	50	102	13	102	22	103	9	88.3	9	60	4	52
Total Dissolved Solids	50	192	13	171	22	200	8	274	9	206	0	
Total Dissolved Solids Sum	33	183	11	184	18	184	0		9	194	5	119
Percentages and Mass Balance												
Percent Calcium	44	52	13	54	21	51	9	44	9	35	5	38
Percent Magnesium	44	16	13	16	21	16	9	13	9	8.8	5	6
Percent Sodium	44	30	13	29	21	30	9	37	9	54	5	54
Percent Potassium	44	1.8	13	1.7	21	2	9	5	9	2.8	5	2.1
Percent Bicarbonate	44	83	13	82	21	84	8	68	9	94	5	82
Percent Sulfate	43	13	13	15	21	12	8	28	9	3.9	5	12
Percent Chloride	43	4	13	3.7	21	4.3	8	4	9	2.5	5	5.6
Cation Sum	44	2.95	13	2.88	21	3.01	9	3.62	9	2.72	5	2.19
Anion Sum	43	2.88	13	2.83	21	2.92	8	3.81	9	2.93	5	2.02
Mass Balance Error	43	3.4	13	2.1	21	2.5	8	2.5	9	-6.8	5	7.9