USDA Forest Service
Tonto National Forest
Arizona

October 11, 2018

Process Memorandum to File

Summary and Analysis of Groundwater-Dependent Ecosystems

Prepared by:
Chris Garrett
Project Manager
SWCA Environmental Consultants

Purpose of Process Memorandum

Analysis of potential impacts due to groundwater drawdown focuses on two primary receptors: groundwater-dependent ecosystems (GDEs) and water supply wells. The purpose of this process memorandum is to:

1) provide a potential list of GDEs to be included in the groundwater analysis,
2) provide a comprehensive summary of available information for each individual GDE,
3) describe analysis undertaken to validate the likely water sources that support each GDE, and
4) present the conclusions drawn from that analysis.

The purpose of this memorandum is solely to identify a list of potential GDEs and their characteristics. Analysis of predicted impacts to GDEs is the focus of the full efforts of the Groundwater Modeling Workgroup and is described separately in the project record.

Available Data Sources

1. Montgomery & Associates, 2017. Surface Water Baseline Addendum: Upper Queen Creek, Devils Canyon, and Mineral Creek Watersheds, January 26, 2017 (Project Record #0001272)
2. Montgomery & Associates, 2016. Hydrochemistry Addendum, Groundwater and Surface Water, Upper Queen Creek/Devils Canyon Study Area, August 11, 2016 (Project Record #0001002)
3. Montgomery & Associates, 2017. Spring and Seep Catalog, Resolution Copper Project Area, Upper Queen Creek and Devils Canyon Watersheds, Version 1.0, October 3, 2017 (Project Record #0002102); Note that this version was superseded by Version 2.0, June 15, 2018 (Project Record #0002677)
4. Riparian gallery locations based on aerial photographs and survey areas for western yellow-billed cuckoo (WestLand Resources, 2015. 2015 Yellow-Billed Cuckoo Survey, Whitlow Ranch Dam, Devils Canyon, and Mineral Creek, Pinal County, Arizona, November 23, 2015) (Project Record #0000098)
5. WestLand Resources, 2017. 2017 Southwestern Willow Flycatcher Survey for the Resolution Copper Project, December 19, 2017 (Project Record #0002203)
6. Audubon Arizona. Western yellow-billed cuckoo (*Coccyzus americanus occidentalis*) 2015 yellow-billed cuckoo surveys on Queen and Arnett Creeks Audubon Arizona (Project Record #0000101)
7. JE Fuller. Surface Water Data Assessment. January 31, 2017 (Project Record #0001274)
8. Montgomery & Associates, 2018. Summary Table of Groundwater Dependent Ecosystems (GDEs), Resolution Project Study Area, April 16, 2018 (Project Record #0002505)
9. Montgomery & Associates, 2018. Revised Summary Table of Groundwater Dependent Ecosystems (GDEs), Resolution Project Study Area, August 21, 2018 (Project Record #0002932)

10. Montgomery & Associates, 2018. Personal correspondence between C. Garrett and T. Keay, September 4, 2018 (Project Record #0110537)
11. Comprehensive springs inventory GIS layer, developed and maintained by SWCA Environmental Consultants (2016–present)
12. Incorporated by reference are all meetings of and materials developed by the Groundwater Modeling Workgroup (September 2017–September 2018)

Comprehensive List of Potential GDEs

The list of potential GDEs has been developed by the Groundwater Modeling Workgroup from a variety of sources. The inclusion of potential GDEs has been informed by field monitoring and surveys conducted and reported by Resolution Copper Mining, LLC (Resolution Copper), personal knowledge from workgroup members based on experience and field visits in the area, inventories based on review of literature and publicly available maps and databases, and potential locations identified during tribal consultation.

GDEs are categorized as either springs or stream segments. Any aquatic habitat and riparian vegetation that may be present at these locations is assumed to be an integral part of the GDE. Two streams (Devil's Canyon, Queen Creek) have been subdivided into smaller reaches, based primarily on physical features, geography, and hydrology.

Potential GDEs are listed in table 1, including a summary of available information used to assess likely primary sources of water. The table also includes a summary column titled "Method of Analysis for DEIS." This column reflects the conclusions reached in this process memorandum. Three potential answers are included:

- GW Model. This indicates that the GDE will be analyzed based on drawdown impacts from the regional groundwater flow model. Evidence suggests that the GDE is supported by the Apache Leap Tuff or other deeper units expected to be impacted by pumping or block-caving, or insufficient evidence exists to identify the primary source of water (in these cases, to be conservative, a connection to the regional aquifer is assumed to exist).

  The full analysis of the limitations of the groundwater flow model and the outcomes and conclusions of the Groundwater Modeling Workgroup are found elsewhere in the project record. However, the following caveat needs to be noted regarding the use of the groundwater model: *Predictions of drawdown are approximations of a complex physical system, inherently limited by the quality of input data and structural constraints imposed by the model grid and modeling approach. The groundwater model does not predict changes to flow magnitude and timing at a given GDE. By extension, drawdown hydrographs and drawdown contours do not represent the aerial extent of anticipated impacts to GDEs. These materials form part of the disclosure of impacts in the EIS, but more importantly the hydrographs and contours will be used to inform more site-specific impact monitoring and mitigation.*

- SW Model. This indicates that the GDE may potentially be impacted by reductions in surface flow and will be analyzed using the surface water model. Some GDEs may be analyzed with both the surface water model and groundwater model; these impacts are not mutually exclusive, but rather are assumed to be cumulative.
- No analysis. The following conditions must be met for no hydrologic analysis to be conducted for a GDE:

  1. Insufficient evidence exists that a potential GDE has the characteristics of being groundwater-dependent, regardless of source. For instance, a spring location that is persistently dry over a sufficiently long monitoring period, or a spring location that cannot even be located in the field, may not meet the definition of a GDE.

  or,

  2a. Sufficient evidence exists that indicates the GDE has a local water source such as shallow alluvium, colluvium, or shallow fracture networks, and has no substantial tie to the Apache Leap Tuff or deeper units, and

  2b. There is no anticipated surface disturbance, either to the upstream watershed or to nearby shallow geology, that may be feeding the GDE.

Table 1. Summary of Potential GDEs and Available Data to Assess Water Sources

Stream Segment or Watershed	Specific Locations with Monitoring Conducted	Spring or Stream?	Hydrochemistry Available?	Number of Spring or Flow Observations	Vegetation Observations Available?	Surface Base Flow Calculations Available?	No Data Available to Assess Water Source	Method of Analysis for DEIS
Upper Queen Creek—Above Superior [from Magma Avenue bridge (km 21.7) to Pump Station Spring (km 30.7)]	Pump Station Spring (QC30.7C)	Spring	YES	31	YES	-	-	No analysis; evidence for local water source
	Upper Queen Creek (QC27.3C)	Stream	YES	15	-	-	-	No analysis; evidence for local water source; no disturbance of watershed
	Upper Carbonate (QC23.9C)	Stream	YES	9	-	4 years	-	SW Model
	Boulder Hole (QC23.6C)	Spring	YES	22	-	-	-	SW Model
	Karst Spring (QC22.6E)	Spring	YES	19	YES	-	-	SW Model
	Magma Avenue (QC21.7C)	Stream	YES	14	-	-	-	SW Model
Queen Creek—Below Superior [from Magma Avenue Bridge (km 21.7) downstream to Whitlow Ranch Dam (km 0)]	QC19.7C	Stream	YES	8	-	-	-	SW Model
	Flowing reach from km 17.39 to km 15.55	Stream	-	-	-	-	No Data Available	GW Model SW Model
	Whitlow Ranch Dam Outlet	Stream	YES	-	-	-	-	GW Model SW Model
Upper Devil's Canyon [from above Hwy 60 bridge down canyon to km 9.3]	DC15.5C	Stream	YES	13	-	-	-	No analysis; evidence for local water source; no disturbance of watershed
	DC15.2C	Stream	YES	6	-	-	-	No analysis; evidence for local water source; no disturbance of watershed
	DC14.7C	Stream	YES	8	-	-	-	No analysis; evidence for local water source; no disturbance of watershed
	DC13.5C	Stream	YES	25	-	7 years	-	No analysis; evidence for local water source; no disturbance of watershed
	DC10.9C	Stream	YES	16	-	9 years	-	No analysis; evidence for local water source; no disturbance of watershed
Middle Devil's Canyon [from km 9.3 to km 6.1]	DC8.8C	Stream	YES	17	-	4 years	-	GW ModelSW Model
	DC8.2W	Spring	YES	36	YES	-	-	GW Model
	DC8.1C	Stream	YES	14	-	2 years	-	GW Model SW Model
	DC7.1C	Stream	YES	15	-	-	-	GW Model SW Model
	DC6.6W	Spring	YES	25	YES	-	-	GW Model
	DC6.14C	Stream	YES	12	-	-	-	GW Model SW Model
	DC6.1E	Spring	YES	20	YES	-	-	GW Model
Lower Devil's Canyon [from km 6.1 to confluence with Mineral Creek (km 0)]	DC5.5C	Stream	YES	18	-	6 years	-	GW Model SW Model
	DC4.1E	Spring	YES	13	YES	-	-	GW Model
Mineral Creek [from Government Springs (km 8.7) to confluence with Devil's Canyon (km 0)]	Government Springs	Spring	YES	5	-	-	-	GW Model
	MC8.4C	Spring	YES	17	-	-	-	GW Model
	Upper Mineral Creek (UMC; 6.8C)	Stream	YES	8	-	3 years	-	GW Model
	MC5.2C	Stream	YES	10	-	-	-	GW Model
	MC3.4W (Wet Leg Spring)	Spring	YES	15	-	-	-	GW Model
	Lower Mineral Creek (LMC; MC3.3C)	Stream	YES	18	-	2 years	-	GW Model
Arnett Creek	Arnett Creek (AC4.5C)	Stream	YES	-	-	-	-	GW Model
	Blue Spring	Spring	YES	-	-	-	-	GW Model
Telegraph Canyon	Telegraph Canyon (TC0.5C)	Stream	YES	-	-	-	-	GW Model
Tributaries to Devil's Canyon	Iron Canyon (IC1.0C)	Stream	YES	11	-	-	-	No analysis; evidence for local water source; no disturbance of watershed
	Hackberry Canyon (H0.1C)	Stream	YES	14	-	-	-	SW Model
	Rancho Rio Canyon (RR1.5C)	Stream	YES	5	-	-	-	SW Model
Tributaries to Queen Creek	Number 9 Wash	Stream	YES	15	-	-	-	SW Model
	Oak Flat Wash	Stream	YES	12	-	-	-	SW Model
Mineral Creek Basin (Springs)	Lyons Fork (LF0.2C)	Spring	YES	15	-	-	-	No analysis; evidence for local water source
	Patterson Spring	Spring	YES	-	-	-	-	No analysis; lies beyond boundaries of model

Stream Segment or Watershed	Specific Locations with Monitoring Conducted	Spring or Stream?	Hydrochemistry Available?	Number of Spring or Flow Observations	Vegetation Observations Available?	Surface Base Flow Calculations Available?	No Data Available to Assess Water Source	Method of Analysis for DEIS
Queen Creek Basin (Springs)	#5 Spring	Spring	-	-	-	-	No Data Available	No analysis; evidence for local water source
	Benson Spring	Spring	Yes	19	YES	-	-	No analysis; evidence for local water source
	Bear Tank Canyon Spring	Spring	YES	22	YES	-	-	No analysis; evidence for local water source
	Bitter Spring	Spring		10	YES	-	-	GW Model
	Bored Spring	Spring	YES	23	YES	-	-	GW Model
	Conley Spring	Spring	-	Marginal (2)	YES	-	-	No analysis; evidence for local water source
	Cross Canyon Spring	Spring	-	-	-	-	-	No analysis; evidence for local water source
	Fig Spring	Spring	-	-	-	-	No Data Available	No analysis; field attempts failed to locate spring.
	Happy Camp Spring	Spring	YES	18	YES	-	-	No analysis; evidence for local water source
	Hidden Spring	Spring	YES	33	YES	-	-	GW Model
	Iberri Spring	Spring	-	Marginal (1)	YES	-	-	GW Model
	Kane Spring	Spring	YES	30	YES	-	-	GW Model
	Lower Railroad Spring	Spring	-	-	-	-	No Data Available	No analysis; field attempts failed to locate spring.
	McGinnel Mine Spring	Spring	-	-	-	-	No Data Available	GW Model
	McGinnel Spring	Spring	-	-	-	-	No Data Available	GW Model
	No Name Spring	Spring	-	Marginal (2)	YES	-	-	GW Model
	Perlite Spring	Spring	YES	12	YES	-	-	No analysis; evidence for local water source
	Rock Horizontal Spring	Spring	-	-	-	-	No Data Available	GW Model
	Queen Seeps	Spring	-	4	YES	-	-	No analysis; evidence for local water source
	Silverado Ridge Spring	Spring	-	-	-	-	No Data Available	No analysis; actually a mine adit with no spring features.
	SK18-02 Spring	Spring	-	-	-	-	No Data Available	No analysis; evidence for local water source
	SK18-03 Spring	Spring	-	-	-	-	No Data Available	No analysis; evidence for local water source
	SK18-04 Spring	Spring	-	-	-	-	No Data Available	No analysis; preliminarily identified as a spring but later dropped for lack of spring characteristics.
	Tunnel Spring	Spring	-	-	-	-	No Data Available	No analysis; field attempts failed to locate spring.
	Walker Spring	Spring	-	Marginal (2)	YES	-	-	GW Model
Devil's Canyon Basin (Springs)	Gibson Well Spring	Spring	-	9	YES	-	-	No analysis; evidence for local water source
	The Grotto	Spring	-	10	YES	-	-	No analysis; evidence for local water source
	Rancho Rio Spring	Spring	-	29	YES	-	-	No analysis; evidence for local water source

Assessment of Likely Primary Sources of Water (Internal GDE Validation Analysis)

Purpose of Internal Validation Analysis

Three general sources of groundwater are present in the project area:

- Shallow alluvial or perched groundwater. This largely refers to precipitation or runoff that is seasonally stored in shallow alluvial materials along drainages, in colluvium or sediment, or in near-surface fracture systems. This water source is more variable and seasonal than regional aquifers, but in some areas still does supply substantial and sustained flow to stream systems.
- Apache Leap Tuff aquifer. The Apache Leap Tuff forms a regionally extensive aquifer throughout the Oak Flat area. In the Oak Flat area it is underlain by the Whitetail Conglomerate, which generally acts as an aquitard and prevents any significant hydraulic connection with deeper groundwater systems. The effect of the aquitard has been demonstrated empirically since 2009; the deeper groundwater system has been pumped to dewater mine infrastructure, but substantial changes in aquifer water levels are seen only in the deeper groundwater system, not in the overlying Apache Leap Tuff wells.
- Deep groundwater system. This groundwater system aquifer is formed by a number of deeper units that lie below the Whitetail Conglomerate. This groundwater system is currently being actively dewatered. This groundwater system designation also incorporates any hydraulically connected geologic formations that extend west of the Apache Leap in the Superior Basin.

Once mining begins, the aquitard formed by the Whitetail Conglomerate will fracture, subside, and essentially disappear in the area of block caving. The Apache Leap Tuff aquifer is therefore expected to dewater to some extent as it becomes hydraulically connected to the deep groundwater system, which will continue to be actively dewatered during mining. In contrast, shallow alluvial or perched groundwater should be largely independent of any hydrologic changes caused by block caving except in the immediate vicinity of the surface subsidence zone. Therefore, a critical step in analysis of impacts is determining whether a GDE is primarily supported by shallow alluvial or perched groundwater or by the Apache Leap Tuff aquifer or deeper units.

Resolution Copper and their contractors have surveyed and monitored water features in the project area for more than a decade. During their investigations they have drawn conclusions about the likely sources of water supporting springs, perennial streams, aquatic habitat, and riparian vegetation. These conclusions have helped guide discussions of the Groundwater Modeling Workgroup. However, given the importance of the water source to the impact analysis, the NEPA team also internally validated the Resolution Copper conclusions, as described in this process memorandum.

Guiding Principles for Internal Validation Analysis

It is important to note that the conclusions drawn by Resolution Copper and their contractors about likely water sources for GDEs were conducted by professional hydrologists and for the most part have been found to be reasonable, and substantial supporting analysis, data, and documentation have been provided in reports that have been submitted to the U.S. Forest Service. The goal of the internal validation analysis is to reproduce these results in an objective and consistent manner in order to identify any inconsistencies requiring further investigation.

The guiding principles for the validation analysis are:

- Identify potentially useful lines of evidence for evaluating the persistence of flow at a GDE.
- Identify potentially useful lines of evidence for distinguishing between a shallow alluvial/perched groundwater source and an Apache Leap Tuff or deeper groundwater source.
- Apply consistent criteria to all GDEs (subject to data availability), preferably in a quantitative manner.
- Identify more holistic considerations including: geologic framework, depth to the regional water table, and other less-quantitative monitoring (such as seasonal photographic evidence collected on Oak Flat).
- Consistently present conclusions from all lines of evidence, even if contradictory.

Logistically, the analysis was conducted in three parts.

1. First, preliminary work was done to identify those lines of evidence that might be useful, and consistent criteria were established for assessing those lines of evidence.
2. Second, data for each GDE were mechanically processed against those criteria (in practice, this was done using a large spreadsheet).
3. Third, the compiled conclusions were considered in their entirety, for each GDE and for complexes of GDEs along stream segments, and professional opinions were drawn as to whether: a) the analysis should assume the stream reach or spring is disconnected from the regional aquifer, or b) the analysis should assume the stream reach or spring is at least partially connected with the regional aquifer.

It is recognized that in reality most GDEs probably have some mix of water sources. The intent of this analysis is to identify the primary water source, if possible. <u>Where evidence is either so contradictory that a professional opinion about the primary water source cannot be reasonably drawn, or insufficient evidence exists in the first place, the policy is to assume a connection with the regional aquifer and therefore that the potential for impact from drawdown exists</u>.

Useful Lines of Evidence and Evaluation Criteria – Persistence of Water

The first step in the validation analysis was to identify the persistence of water at a GDE. Three lines of evidence were examined. Ultimately, while these lines of evidence speak to the persistence of water at a potential GDE, these lines of evidence were found to be inconsistent and insufficient to <u>disprove</u> that a location belongs on the list. <u>Therefore, these lines of evidence are considered to be informational only. No potential GDEs were removed from the analysis list based on these lines of evidence.</u>

Riparian Vegetation Present

During various field investigations, vegetation species present at potential GDEs have been noted. These species were consistently identified in the data validation spreadsheet and then were categorized as either obligate wetland species (OBL) or facultative wetland species (FACW) based on the U.S. Department of Agriculture PLANTS database wetland indicator status.[1] The presence of any OBL or FACW vegetation species resulted in the conclusion: "Vegetation consistent with persistent water source."

The fundamental limitation of this line of evidence is that vegetation species have not been consistently noted for all potential GDEs, and the observations themselves were self-selecting as the surveys were intended primarily to note wetland species. If no wetland species were identified, it could mean that no surveys were conducted, no vegetation was present, or vegetation was present but not considered to be wetland species.

Manual Flow Observations

Manual observations about the flow or presence of water at the location of potential GDEs have been made for years as part of field monitoring efforts. The number of observations made were noted in the spreadsheet, along with the number of observations where either flow was present (streams) or at least water was present (springs). This was then converted into a percentage and reported as: "Flow present XX% of time."

The fundamental limitation of this line of evidence is that it also appears to be self-selecting, with observations primarily being made when water is present. This is evident in those locations where continuous, automated monitoring has taken place in addition to manual measurements (see next line of evidence: "Baseflow Calculations from Automated Flow Monitoring"). For example, consider the stream monitoring location DC-13.5C, located in Upper Devil's Canyon. Based on 7 years of continuous monitoring, the median baseflow (calculated in a variety of ways) is zero, or dry. In contrast, 97 percent of manual observations show the presence of flow or water. This indicates that relying on the manual flow observations would likely overestimate the persistence of water.

Baseflow Calculations from Automated Flow Monitoring

Starting as early as 2003, data sondes have been installed by Resolution Copper at up to 14 locations in the project area, and continuous water levels have been recorded using that equipment. Resolution Copper has analyzed available records with various techniques to determine the amount of baseflow present.[2] There is substantial variability in baseflow over time, so the median values were selected for use in the spreadsheet.

---

[1] https://plants.usda.gov/core/wetlandSearch

[2] Montgomery & Associates. "Surface Water Baseline Addendum: Upper Queen Creek, Devils Canyon, and Mineral Creek Watersheds". January 26, 2017.

For example, location DC-13.5C has 7 years of record for which baseflow values were calculated:[3]

- Dry (2005)
- Dry (2009)
- 0.063 cfs (2010)
- Dry (2011)
- Dry (2012)
- Dry (2013)
- 0.045 cfs (2014)

The median of these seven values is zero or dry; therefore, a median of "0" was used in the spreadsheet to define DC-13.5C.

The fundamental limitation of this line of evidence is that this data source is restricted to very few locations overall, and therefore is difficult to apply consistently to all potential GDEs.

Useful Lines of Evidence and Evaluation Criteria – Water Quality

Initial Screening of All Water Quality Constituents

The water quality database for the project includes a large number of groundwater wells that have been monitored throughout the project area. Based on screened intervals and known geology, these wells have been categorized by Resolution Copper as representing one of three aquifers. Confirmation of these designations is included in Attachment 7 to this process memorandum:

- Shallow alluvial/perched groundwater (3 wells: JI Ranch Corral, JI Ranch Middle, Hackberry Windmill)
- Groundwater from the Apache Leap Tuff (19 wells: HRES-01, HRES-02, HRES-03d, HRES-04 through HRES-15, HRES-17, A-06, CT, MJ-11)
- Deep groundwater (7 wells: DHRES-01, DHRES-02, DHRES-06, DHRES-09, DHRES-11, DHRES-13, DHRES-15)

Summary statistics were calculated using the total body of water quality results for each of these three groundwater types (see attachment 1), and these statistics were reviewed and plotted (see attachment 2). The goal in doing this was to identify any water quality constituents that show distinct differences between water types, specifically based on the range comprised of the mean concentration +/- one standard deviation.

[3] The values shown in the example are based on one of the techniques used by Resolution Copper to define baseflow: the median daily streamflow. The other technique used to define baseflow used in the spreadsheet is minimum of the November 7-day average streamflow.

Ultimately 11 constituents were used in the validation analysis. These were divided into two categories. "Diagnostic" constituents are those constituents for which there are clear distinctions between groundwater types, or at least between shallow alluvial/perched and Apache Leap groundwater types, with no overlap. Thus, if the concentration from a GDE falls within the range of one of those groundwater types, it is diagnostic of only that groundwater type. Two of these constituents were identified (carbon-14 and tritium), but a third diagnostic tool was also developed by plotting overall inorganic water quality (Piper diagrams). Nine other constituents were considered "weight-of-evidence" constituents. These also show some difference between groundwater types, but with substantial overlap. Thus, the concentration from a GDE may fall within multiple groundwater types and these constituents are not truly diagnostic of a single groundwater type.

Diagnostic Constituents

- Carbon-14. Shows a clear difference between shallow alluvial/perched, Apache Leap, and deep groundwater with no overlap. Carbon-14 was sampled by Resolution Copper because it is used in radiometric dating. It is important to note that the internal validation analysis focused solely on differences in concentration between groundwater types, not on radiometric dating. However, the pattern matches what would be expected with dating, with shallow alluvial/perched groundwater having higher concentrations (younger water having experienced less radioactive decay) and deep groundwater having lower concentrations (older water having experienced more radioactive decay).
- Tritium. Tritium was also sampled by Resolution Copper for its use in radiometric dating, primarily associated with tritium produced during post-World War II atomic testing. As with carbon-14, the internal validation analysis focused solely on differences in concentration between groundwater types and not radiometric dating. However, the pattern with tritium also matches what would be expected with dating, with shallow alluvial/perched groundwater having greater tritium concentrations and Apache Leap or deep groundwater having lower tritium concentrations.
- Basic Inorganic Water Type (Piper Diagram). There are numerous ways to plot inorganic water quality. Piper diagrams (see attachment 3) were chosen for this analysis because they had already been plotted by groundwater type as part of Resolution Copper's investigations, and distinct areas on the Piper diagrams are associated with shallow alluvial/perched groundwater and Apache Leap Tuff groundwater.[4]

Weight-of-Evidence Constituents

- Delta Carbon-13 (of Dissolved Inorganic Carbon). Shows clear differences between shallow alluvial/perched, Apache Leap, and deep groundwater, but with overlap between all groundwater types.
- Delta Deuterium. Shows clear differences between shallow alluvial/perched, Apache Leap, and deep groundwater, but with overlap between all groundwater types.

[4] Montgomery & Associates. "Hydrochemistry Addendum Groundwater and Surface Water Upper Queen Creek/Devils Canyon Study Area", August 11, 2016.

- Delta Oxygen-18. Shows clear differences between shallow alluvial/perched, Apache Leap, and deep groundwater, but with overlap between all groundwater types. Deuterium and oxygen-18 are often used to assess water sources by comparison of these ratios to the meteoric water line. The internal validation analysis focused solely on differences in concentration between groundwater types, not on interpretation of isotopic ratios.
- Delta Sulfur-34. Shows clear differences between shallow alluvial/perched, Apache Leap, and deep groundwater, but with overlap between all groundwater types. Sulfur-34 is used in comparison with other constituents (sulfur/chloride ratio).
- Bicarbonate Alkalinity (as $CaCO_3$). Shows clear differences between shallow alluvial/perched, Apache Leap, and deep groundwater, but with overlap between shallow/Apache Leap, and Apache Leap/deep. Deeper groundwater has higher bicarbonate alkalinity values.
- Chloride. Shows relatively narrow ranges for Apache Leap and deep groundwater, but the range for shallow alluvial/perched groundwater is quite wide, and there is overlap between all three groundwater types.
- Fluoride. Shows relatively narrow ranges for shallow alluvial/perched and Apache Leap groundwater, but the range for deep groundwater is quite wide, and there is overlap between all three groundwater types.
- Silica. Shows relatively narrow ranges for shallow alluvial/perched and Apache Leap groundwater, but the range for deep groundwater is quite wide, and there is overlap between shallow/deep and Apache Leap/deep.
- U-238. Shallow alluvial/perched groundwater essentially contains no U-238, and Apache Leap and deep groundwater have wide ranges, with overlap between shallow/Apache Leap and Apache Leap/deep.

Useful Lines of Evidence and Evaluation Criteria – Hydrogeologic Environment

In addition to water quality constituents, the hydrogeologic environment was taken into account as well. This primarily included plotting the elevation of GDEs versus the nearest known Apache Leap or deeper groundwater system water level. Where GDEs lie many hundreds of feet above the regional aquifer, it is most likely those GDEs are hydrologically disconnected.

Two characteristics were evaluated using professional judgment when considering the hydrogeologic environment.

- First, for those GDEs with elevations higher than regional aquifer water levels, the difference had to be substantial.
- Second, available aquifer water levels had to be within a reasonable distance of the GDE.

Both of these characteristics had to be considered in conjunction with each other, therefore no strict rules were applied. However, in general only differences in water levels greater than about 200 feet were considered strong enough to demonstrate that a GDE is hydrologically disconnected from the regional aquifer, and wells beyond about 2 miles away were considered too distant to be useful.

Additional information was also available for some water features in the Oak Flat area, which were subject to video and other monitoring in order to determine changes in hydrology by season.[5]

Results of Internal Validation Analysis and Final Conclusions

The final conclusions are shown in table 2 for each GDE. In order to weigh the contradictory evidence, the following considerations were applied:

- The most weight was given to a diagnostic line of evidence: carbon-14, tritium, or the inorganic water plot (Piper diagram).
- It was found that the "weight-of-evidence" approach for other constituents (nine constituents in all) was often misleading. As initially envisioned, whichever groundwater type(s) had the most constituents match was considered to be the most likely source. However, it became clear that in some cases this conclusion might be the result of only one or two constituents matching a groundwater type, which represents a very weak link. Therefore, an informal terminology system was developed, as shown below. Little weight was given to weak or very weak results.
  - 1–2 constituents match = Very Weak
  - 3–4 constituents match = Weak
  - 5–6 constituents match = Moderately Strong
  - 7–8 constituents match = Strong
  - 9 constituents match = Very Strong
- For stream reaches, it was useful to consider all sample locations together as well as individually. For example, consider Upper Devil's Canyon, which had five locations analyzed (DC-15.5C, DC-15.2C, DC-14.7C, DC-13.5C, and DC-10.9C). Locations DC-15.5C and DC-15.2C either had inconclusive results or mixed results, but the remaining three locations had consistent results strongly pointing to shallow alluvial/perched groundwater as a primary water source. When considered as a whole, the conclusion was that the entire reach was disconnected from the regional aquifer, including locations DC-15.5C and DC-15.2C.

  A similar example with an opposite conclusion exists in Middle Devil's Canyon, which had seven locations analyzed. Of these, two locations were inconclusive, one location suggested a shallow alluvial/perched groundwater source, and four locations strongly suggested an Apache Leap Tuff groundwater source. In this case, when considered as a whole, the conclusion was that the entire reach was at least partially connected with the regional aquifer.

Devil's Canyon

The upper reach of Devil's Canyon, from above the Highway 60 bridge to approximately location DC-9.3, includes a reach of perennial flow from approximately DC-11.0 to DC-10.6. Montgomery & Associates' conclusion is typified as: "Together, the hydrochemistry data, occurrence surveys, and

[5] Montgomery & Associates, 2017. 2017 Oak Flat Surface Water Monitoring Program, Pinal County, Arizona. November 13, 2017.

base flow analyses suggest that base flow at DC 10.9 C is supported by snowmelt and/or floodwaters that have entered streambank storage before slowly draining into the main channel." <u>The professional opinion drawn from the validation analysis concurs: Upper Devil's Canyon is disconnected from the regional aquifer.</u>

Middle and Lower Devil's Canyon support perennial flow, aquatic habitat, and riparian galleries. Montgomery & Associates' conclusion is typified as: "…base flow at DC 8.8 is supported predominantly by regional groundwater discharge, but is supplemented seasonally by delayed release of water held locally in bank storage back into the stream channel." <u>The professional opinion drawn from the validation analysis concurs: Middle and Lower Devil's Canyon are at least partially connected with the regional aquifer.</u>

Queen Creek

Montgomery & Associates' conclusion about Upper Queen Creek (above Superior) is typified as: "The ephemeral nature and timing of streamflow at this station suggests that regional groundwater discharge is insignificant as a component of winter base flow. Instead, winter base flow at UC is interpreted to derive from local accumulation and storage of water in streambank alluvium which slowly seeps into the main channel." Queen Creek (below Superior) has been characterized as ephemeral with only artificial sources supporting perennial flow reaches. <u>The professional opinion drawn from the validation analysis concurs: Queen Creek both above and below Superior is disconnected from the regional aquifer.</u>

An exception for Queen Creek is a perennially flowing reach between kilometers 17.39 and 15.55. Originally this flowing reach had been discounted because it receives effluent discharge from the Superior Wastewater Treatment Plant. However, discussions within the Groundwater Modeling Workgroup suggested that—based on historical maps and the geologic framework—it was feasible that a component of baseflow supported by regional aquifer discharge may exist in this reach as well. Therefore, this reach was included as a potential GDE.

Members of the Groundwater Modeling Workgroup including Montgomery & Associates and Arizona Game and Fish Department also had direct knowledge of another source of flow entering in this reach from a tributary to the south, of apparently good-quality water. Flow in this tributary reportedly derives from discharges from a small open-pit perlite mining operation owned by Imerys.

Montgomery & Associates contacted the mine managers and obtained further information on this discharge.[6]

- The dewatering is permitted by the Arizona Department of Water Resources (permit 59-586176) for up to 200 acre-feet per year. The discharge point is registered as a well (55-588114) but is actually the pit sump. Some early descriptions of this flow had suggested that there may be artesian wells or springs. There does not appear to be a separate artesian well or spring, but rather groundwater directly entering the mine pit.

[6] Email communication with T. Keay, Montgomery & Associates, September 19, 2018

- There are two main pits on the property. Water is pumped from the deeper of the two pits and discharged to a drainage north of the quarry that then flows to Queen Creek, entering downstream from the Superior wastewater treatment plant outfall.
- There is no evidence of any separate spring in the drainage north of the quarry. The riparian vegetation that is evident there has developed in response to the routine surface discharge of water from the mine dewatering, which has taken place for the past 20 years or more.
- Imerys reports that they pump 12 hours a day, 5 days a week. The total is roughly 4–5 million gallons per month, or about 170–180 acre-feet/year. Some is used for dust control but most reports to Queen Creek.
- The depth of the pit lake is 100–150 feet below land surface. There is no evidence of the pre-pit water level, but based on known geology this depth would represent discharge from the uppermost hydrologic units.

The exact percent contribution of each water source (direct groundwater discharge to channel, effluent discharge, and Imerys discharge) is unknown. Effluent discharge from the Superior wastewater treatment plant has been estimated (for purposes of the groundwater modeling) as 170 acre-feet per year, approximately equivalent to the Imerys discharge of 170–180 acre-feet per year. Observations made by Arizona Game and Fish Department staff suggest that relatively little effluent reaches Queen Creek, and the main flow sustaining this reach is from the Imerys mine.

Other members of the Groundwater Modeling Workgroup noted that while Arnett Creek (a side tributary entering Queen Creek just past Boyce Thompson Arboretum) does not actually provide flow at the confluence with Queen Creek, perennial flow does occur farther upstream in both Arnett Creek and Telegraph Canyon, a tributary to Arnett Creek (see descriptions below). Groundwater from this side tributary could be moving in the subsurface and providing substantial inflow to the Queen Creek alluvium, which eventually feeds surface flows at Whitlow Ranch Dam.

Mineral Creek

Montgomery & Associates' conclusion about Mineral Creek is typified as: "Surface water in Mineral Creek is derived from a mixture of groundwater from the upper Mineral Creek watershed, groundwater from the ALT aquifer, and precipitation-driven surface water runoff. Groundwater from the Mineral Creek drainage discharges at Government Springs and along the main stem of Mineral Creek and contributes to perennial/intermittent flow for the majority of the reach between Government Springs and the confluence with Devils Canyon." <u>The professional opinion drawn from the validation analysis concurs: Mineral Creek is at least partially connected with the regional aquifer.</u>

Arnett Creek

No strong conclusions had previously been drawn regarding Arnett Creek and its potential connection with the regional aquifer. However, the water quality evidence was found to be conclusive both for samples collected from Blue Spring (located in the channel of Arnett Creek above Telegraph Canyon) and in the downstream portions of Arnett Creek (immediately downstream from Telegraph Canyon).

Both locations showed strong and consistent evidence for contribution from the Apache Leap Tuff (or similar groundwater). The professional opinion drawn from the validation analysis is that Arnett Creek is at least partially connected with the regional aquifer.

Telegraph Canyon

No strong conclusions had previously been drawn regarding Telegraph Canyon and its potential connection with the regional aquifer. The evidence reviewed was limited and showed weak results, and ultimately was not sufficient to demonstrate any particular source of water. Therefore, Telegraph Canyon was conservatively assumed to be at least partially connected with the regional aquifer.

Tributaries to Queen Creek and Devil's Canyon

A number of tributaries were evaluated originating in the Oak Flat area and feeding either Queen Creek or Devil's Canyon. These include Number 9 Wash and Oak Flat Wash (Queen Creek watershed) and Iron Canyon, Hackberry Canyon, and Rancho Rio Canyon (Devil's Canyon watershed). Sufficient evidence existed for all of these tributaries to demonstrate that they most likely have local water sources. The professional opinion drawn from the validation analysis is that these five tributaries are hydrologically disconnected from the Apache Leap Tuff or deeper groundwater systems, and most likely have local water sources derived from precipitation (shallow alluvium, colluvium, shallow fracture networks).

Springs

Springs vary quite widely in their conclusions; refer to tables 1 and 2 for details on specific GDEs. In general, many springs on the list of potential GDEs have little evidence except for consideration of the hydrogeologic framework. This evidence was sufficient to describe a number of springs as most likely hydrologically disconnected from the regional aquifers; for others, known aquifer water levels were simply too distant to draw strong conclusions and these springs are assumed to have a connection with the regional aquifer.

Patterson Spring was included in the original list of potential GDEs because water quality samples had been collected there by Resolution Copper. However, it turns out this spring lies well beyond the boundaries of the groundwater flow model and in different geologic conditions. Patterson Spring was dropped from the list of potential GDEs for these reasons.

Three other springs were included in the original list of potential GDEs because there was some indication on drawn maps that they might exist. Multiple field efforts by Resolution Copper ultimately failed to locate and substantiate the existence of these springs. Fig Spring, Lower Railroad Spring, and Tunnel Spring were dropped from the list of potential GDEs for this reason. One additional spring, Silverado Ridge Spring, was determined to actually be an old mine adit lacking any riparian vegetation or characteristics of a natural spring, and was dropped from the list of potential GDEs for this reason.

Table 2. Summary of Validation Analysis and Conclusions for each Sampling Point

Potential GDE	Persistence of Flow			Diagnostic Lines of Evidence			Consistency with Water Source, based on Key Water Quality Constituents (Number of Constituents Shown)			Physical Constraints	Assessment of Connectivity to Regional Aquifer based on All Lines of Evidence	Decision for DEIS Analysis
	Vegetation	Median Flow Statistics	Field Observations	Carbon-14	Tritium	Piper Diagram	Shallow	Apache Leap Tuff	Deep			
UPPER QUEEN CREEK												
Pump Station Spring (QC30.7C) (Spring)	Vegetation consistent with persistent water source	-	Flow present 74% of time	Shallow	Shallow	No match	Weak (4)	Moderately Strong (5)	Moderately Strong (5)	Spring elevation = 4,390 feet above mean sea level (amsl); WL in nearest Tal well (HRES-12) = 4,090 feet amsl (~6,000 feet away). Suggests hydrologic disconnect.	Mixed evidence. Water quality suggesting constituency with Apache Leap or deep groundwater is moderately strong (5 of 9 constituents). Two strong lines of evidence are carbon-14 and tritium, both of which suggest a shallow groundwater source. Physical constraints suggest a disconnect with Apache Leap groundwater.	Assume Upper Queen Creek reach is disconnected from regional aquifer. Diagnostic lines of evidence consistently point to shallow alluvial or perched source for all springs and stream samples from km 30.7 to km 21.7.
Upper Queen Creek (QC27.3C)	-	-	Flow present 80% of time	Shallow	No match	No match, but more consistent with Shallow	Very weak (2)	Weak (4)	Weak (4)	Stream elevation = 3,950 feet amsl; WL in nearest Tal well (HRES-12) = 4,090 feet amsl (~4,000 feet away). Does not preclude hydrologic connection.	Mixed evidence. Water quality suggesting consistency with Apache Leap or deep groundwater is weak (4 of 9 constituents). Piper diagram more closely resembles shallow groundwater than Apache Leap but did not meet consistent match criteria. Strongest line of evidence is carbon-14, which suggests a shallow groundwater source.	Assume Upper Queen Creek reach is disconnected from regional aquifer. Diagnostic lines of evidence consistently point to shallow alluvial or perched source for all springs and stream samples from km 30.7 to km 21.7.
Upper Carbonate (QC23.9C)	-	Baseflow indicates dry conditions	Flow present 100% of time	-	-	-	Very weak (2)	Very weak (2)	Very weak (2)	Stream elevation = 3,175 feet amsl; WL in nearest Tal well (HRES-01) = 3,300 feet amsl (~4,000 feet away). Does not preclude hydrologic connection.	Inadequate evidence to draw conclusion about water source.	Assume Upper Queen Creek reach is disconnected from regional aquifer. Diagnostic lines of evidence consistently point to shallow alluvial or perched source for all springs and stream samples from km 30.7 to km 21.7.
Boulder Hole (QC23.6C) (Spring)	-	-	Flow present 91% of time	No match	Shallow	No match	Moderately Strong (5)	Weak (3)	Moderately Strong (6)	Spring elevation = 3,060 feet amsl; WL in nearest Tal well (HRES-01) = 3,300 feet amsl (~5,000 feet away). Does not preclude hydrologic connection.	Mixed evidence. Water quality suggesting consistency with deep groundwater is moderately strong (6 of 9 constituents). Strongest line of evidence is tritium, which suggests a shallow groundwater source.	Assume Upper Queen Creek reach is disconnected from regional aquifer. Diagnostic lines of evidence consistently point to shallow alluvial or perched source for all springs and stream samples from km 30.7 to km 21.7.

Potential GDE	Persistence of Flow			Diagnostic Lines of Evidence			Consistency with Water Source, based on Key Water Quality Constituents (Number of Constituents Shown)			Physical Constraints	Assessment of Connectivity to Regional Aquifer based on All Lines of Evidence	Decision for DEIS Analysis
	Vegetation	**Median Flow Statistics**	**Field Observations**	**Carbon-14**	**Tritium**	**Piper Diagram**	**Shallow**	**Apache Leap Tuff**	**Deep**			
Karst Spring (QC22.6E) (Spring)	Vegetation consistent with persistent water source	-	Flow present 47% of time	-	Shallow	Shallow	Weak (3)	Very Weak (2)	Moderately Strong (5)	Spring elevation = 2,940 feet amsl; WL in nearest Tal well (HRES-01) = 3,300 feet amsl (~6,500 feet away). Does not preclude hydrologic connection.	Mixed evidence. Water quality suggesting consistency with deep groundwater is moderately strong (5 of 6 constituents). Two strong lines of evidence are tritium and Piper diagram, which both suggest a shallow groundwater source.	Assume Upper Queen Creek reach is disconnected from regional aquifer. Diagnostic lines of evidence consistently point to shallow alluvial or perched source for all springs and stream samples from km 30.7 to km 21.7.
Magma Avenue (QC21.7C)	-	-	Flow present 71% of time	Shallow	No match	-	Very weak (2)	Weak (3)	Weak (4)	Stream elevation = 2,844 feet amsl; WL in nearest Tal well (HRES-01) = 3,300 feet amsl (~9,000 feet away). Does not preclude hydrologic connection.	Mixed evidence. Water quality suggesting consistency deep groundwater is weak (4 of 9 constituents). Strongest line of evidence is carbon-14, which suggests a shallow groundwater source.	Assume Upper Queen Creek reach is disconnected from regional aquifer. Diagnostic lines of evidence consistently point to shallow alluvial or perched source for all springs and stream samples from km 30.7 to km 21.7.
LOWER QUEEN CREEK												
QC19.7C	-	-	Flow present 63% of time	-	Shallow	No match, but more consistent with Shallow	Very weak (1)	Weak (3)	Very weak (2)	Stream elevation = 2,680 feet amsl; WL in nearest deep well (DHRES-16) = 2,620 feet amsl (~2,300 feet away). Does not preclude hydrologic connection.	Mixed evidence. Water quality suggesting consistency with Apache Leap groundwater is weak (3 of 9 constituents). Piper diagram more closely resembles shallow groundwater than Apache Leap but did not meet consistent match criteria. Strongest line of evidence is tritium, which suggests a shallow groundwater source.	Assume stream reach is disconnected from regional aquifer, on strength of tritium and Piper evidence.
Flowing reach from 17.39 to 15.55 km	-	-	-	-	-	-	-	-	-	-	No evidence to review. This section receives flow from effluent and from the nearby Imerys perlite mine, but in addition some historic evidence suggests additional groundwater flow may exist.	Assume stream reach is at least partially connected with regional aquifer, due to insufficient evidence to determine otherwise.
Whitlow Ranch Dam Outlet	-	-	-	Shallow	Shallow	-	Moderately Strong (5)	Very weak (2)	Weak (4)	-	Consistent evidence. Water quality suggesting consistency with shallow groundwater is moderately strong (5 of 9 constituents). Two strong lines of evidence are carbon-14 and tritium, which both suggest a shallow groundwater source.	Assume stream reach is disconnected from regional aquifer, on strength of all lines of evidence.

Potential GDE	Persistence of Flow			Diagnostic Lines of Evidence			Consistency with Water Source, based on Key Water Quality Constituents (Number of Constituents Shown)			Physical Constraints	Assessment of Connectivity to Regional Aquifer based on All Lines of Evidence	Decision for DEIS Analysis
	Vegetation	Median Flow Statistics	Field Observations	Carbon-14	Tritium	Piper Diagram	Shallow	Apache Leap Tuff	Deep			
UPPER DEVIL'S CANYON												
DC15.5C	-	-	Flow present 100% of time	-	No match	-	No match (0)	Very weak (2)	Very weak (2)	Stream elevation = 4,081 feet amsl; WL in nearest Tal well (HRES-14) = 3,680 feet amsl (~2,100 feet away). Suggests hydrologic disconnect.	Water quality suggesting consistency with Apache Leap and deep groundwater is very weak (2 of 9 constituents). Physical constraints suggest hydrologic disconnect.	Assume stream reach is disconnected from regional aquifer, based on physical constraints.
DC15.2C	-	-	Flow present 50% of time	-	-	Shallow	Very weak (1)	No match (0)	Weak (3)	Stream elevation = 4,039 feet amsl; WL in nearest Tal well (HRES-14) = 3,680 feet amsl (~1,800 feet away). Suggests hydrologic disconnect.	Water quality suggesting consistency with deep groundwater is weak (3 of 9 constituents). Strongest line of evidence is Piper diagram, which suggests a shallow groundwater source, which is consistent with physical constraints that suggest hydrologic disconnect.	Assume stream reach is disconnected from regional aquifer, based on Piper diagram and physical constraints.
DC14.7C	-	-	Flow present 63% of time	-	Shallow	Shallow	No match (0)	Very weak (2)	Very weak (2)	Stream elevation = 3,999 feet amsl; WL in nearest Tal well (HRES-14) = 3,680 feet amsl (~2,100 feet away). Suggests hydrologic disconnect.	Water quality suggesting consistency with Apache Leap and deep groundwater is very weak (2 of 9 constituents). Two strong lines of evidence are tritium and Piper diagram, which suggest a shallow groundwater source, which is consistent	Assume stream reach is disconnected from regional aquifer, based on tritium, Piper, and physical constraints.
DC13.5C	-	Baseflow indicates dry conditions	Flow present 97% of time	Shallow	Shallow	Shallow	Moderately Strong (5)	Weak (3)	Weak (4)	Stream elevation = 3,901 feet amsl; WL in nearest Tal wells (HRES-15; HRES-20) = 3,670 feet amsl (~2,900 feet away); WL in second nearest Tal wells (HRES-3S,3D) = 3,790 feet amsl (~3,200 feet away). Suggests hydrologic disconnect.	Consistent evidence. Water quality suggesting consistency with shallow groundwater is moderately strong (5 of 9 constituents). Three strong lines of evidence are carbon-14, tritium, and Piper diagram, which all suggest a shallow groundwater source, which is consistent with physical constraints that suggest hydrologic disconnect.	Assume stream reach is disconnected from regional aquifer, based on all lines of evidence.
DC10.9C	-	Baseflow indicates persistent water	Flow present 100% of time	Shallow	Shallow	Shallow	Moderately Strong (5)	Very weak (2)	Very weak (2)	Stream elevation = 3,730 feet amsl; WL in nearest Tal well (A-06) = 3,645 feet amsl (~1,800 feet away). Does not preclude hydrologic connection.	Consistent evidence. Water quality suggesting consistency with shallow groundwater is moderately strong (5 of 9 constituents). Three strong lines of evidence are carbon-14, tritium, and Piper diagram, which all suggest a shallow groundwater source.	Assume stream reach is disconnected from regional aquifer, based on all water quality lines of evidence.

Potential GDE	Persistence of Flow			Diagnostic Lines of Evidence			Consistency with Water Source, based on Key Water Quality Constituents (Number of Constituents Shown)			Physical Constraints	Assessment of Connectivity to Regional Aquifer based on All Lines of Evidence	Decision for DEIS Analysis
	Vegetation	Median Flow Statistics	Field Observations	Carbon-14	Tritium	Piper Diagram	Shallow	Apache Leap Tuff	Deep			
MIDDLE DEVIL'S CANYON												
DC8.8C	-	Baseflow indicates persistent water	Flow present 76% of time	No match	Shallow	Tal	Weak (4)	Weak (4)	Very weak (2)	Stream elevation = 3,580 feet amsl; WL in nearest Tal well (HRES-07) = 3,635 feet amsl (~2,100 feet away). Does not preclude hydrologic connection.	Mixed evidence. Water quality suggesting consistency with shallow and Apache Leap groundwater is weak (4 of 9 constituents). Two strong lines of evidence are tritium and Piper diagram, but point to different sources. Inadequate evidence to draw conclusion about water source, or a mixed source.	Assume stream reach is at least partially connected with regional aquifer, due to contrary or insufficient evidence to determine otherwise.
DC8.2W (Spring)	Vegetation consistent with persistent water source	-	Flow present 86% of time	Tal	Tal	Tal	Moderately Strong (5)	Very Strong (9)	Very weak (2)	Spring elevation = 3,540 feet amsl; WL in nearest Tal well (MJ-11) = 3,615 feet amsl (~2,900 feet away); WL in second nearest Tal well (HRES-07) = 3,635 feet amsl (~3,500 feet away). Does not preclude hydrologic connection.	Consistent evidence. Water quality suggesting consistency with Apache Leap groundwater is very strong (9 of 9 constituents). All three strong lines of evidence (carbon-14, tritium, Piper diagram) suggest Apache Leap groundwater source.	Assume stream reach is at least partially connected with regional aquifer, based on all water quality lines of evidence.
DC8.1C	-	Baseflow indicates persistent water	Flow present 100% of time	No match	Tal	-	Moderately Strong (5)	Moderately Strong (6)	Weak (4)	Stream elevation = 3,520 feet amsl; WL in nearest Tal well (MJ-11) = 3,615 feet amsl (~2,900 feet away); WL in second nearest Tal well (HRES-07) = 3,635 feet amsl (~3,500 feet away). Does not preclude hydrologic connection.	Consistent evidence. Water quality suggesting consistency with Apache Leap groundwater is moderately strong (6 of 9 constituents). Strongest line of evidence is tritium, which suggests Apache Leap groundwater source.	Assume stream reach is at least partially connected with regional aquifer, based on tritium and other constituent lines of evidence.
DC7.1C	-	-	Flow present 100% of time	Shallow	No match	Tal	Weak (4)	Weak (3)	Weak (4)	Stream elevation = 3,389 feet amsl; WL in nearest Tal well (MJ-11) = 3,615 feet amsl (~4,700 feet away); WL in second nearest Tal well (HRES-07) = 3,635 feet amsl (~6,500 feet away). Does not preclude hydrologic connection.	Mixed evidence. Water quality suggesting consistency with shallow and deep groundwater is weak (4 of 9 constituents). Two strong lines of evidence are carbon-14 and Piper diagram, but point to different sources. Inadequate evidence to draw conclusions about water source, or a mixed source.	Assume stream reach is at least partially connected with regional aquifer, due to contrary or insufficient evidence to determine otherwise.

Potential GDE	Persistence of Flow			Diagnostic Lines of Evidence			Consistency with Water Source, based on Key Water Quality Constituents (Number of Constituents Shown)			Physical Constraints	Assessment of Connectivity to Regional Aquifer based on All Lines of Evidence	Decision for DEIS Analysis
	Vegetation	**Median Flow Statistics**	**Field Observations**	**Carbon-14**	**Tritium**	**Piper Diagram**	**Shallow**	**Apache Leap Tuff**	**Deep**			
DC6.6W (Spring)	Vegetation consistent with persistent water source	-	Flow present 100% of time	Shallow	Tal	Tal	Weak (4)	Strong (7)	Moderately Strong (5)	Spring elevation = 3,520 feet amsl; WL in nearest Tal well (HRES-08) = 3,860 feet amsl (~6,500 feet away). Does not preclude hydrologic connection.	Mixed evidence, but conclusive. Water quality suggesting consistency with Apache Leap groundwater is strong (7 of 9 constituents). Two strong lines of evidence (tritium and Piper diagram) suggest Apache Leap groundwater source, although the third strong line of evidence suggests a shallow source. Overall, most likely to be an Apache Leap groundwater source.	Assume stream reach is at least partially connected with regional aquifer, based on overall weight of evidence, though mixed.
DC6.14C	-	-	Flow present 100% of time	Shallow	Shallow	-	Moderately Strong (5)	Moderately Strong (5)	Weak (4)	Stream elevation = 3,281 feet amsl; WL in nearest Tal well (HRES-11) = 2,830 feet amsl (~6,500 feet away); WL in second nearest Tal well (HRES-08) = 3,860 feet amsl (~7,000 feet away). Mixed results; does not preclude hydrologic connection.	Mixed evidence. Water quality suggesting consistency with shallow and Apache Leap groundwater is moderately strong (5 of 9 constituents). Two strong lines of evidence are carbon-14 and tritium and suggest a shallow groundwater source.	Assume stream reach is at least partially connected with regional aquifer, due to contrary or insufficient evidence to determine otherwise.
DC6.1E (Spring)	Vegetation consistent with persistent water source	-	Flow present 73% of time	-	Tal	Tal	Very weak (2)	Strong (7)	Weak (4)	Spring elevation = 3,159 feet amsl; WL in nearest Tal well (HRES-11) = 2,830 feet amsl (~6,500 feet away); WL in second nearest Tal well (HRES-08) = 3,860 feet amsl (~7,000 feet away). Mixed results; does not preclude hydrologic connection.	Consistent evidence. Water quality suggesting consistency with Apache Leap groundwater is strong (7 of 9 constituents). Two strong lines of evidence are tritium and Piper diagram which both suggest Apache Leap groundwater source.	Assume stream reach is at least partially connected with regional aquifer, based on water quality lines of evidence.
LOWER DEVIL'S CANYON												
DC5.5C	-	Baseflow indicates persistent water	Flow present 100% of time	-	-	Tal	Very weak (1)	Very weak (2)	Weak (3)	Stream elevation = 2,959 feet amsl; WL in nearest Tal well (HRES-11) = 2,830 feet amsl (~6,500 feet away). Does not preclude hydrologic connection.	Water quality suggesting consistency with deep groundwater is weak (3 of 9 constituents). Strongest line of evidence is Piper diagram which suggests Apache Leap groundwater source.	Assume stream reach is at least partially connected with regional aquifer, based on Piper diagram line of evidence.
DC4.1E (Spring)	Vegetation consistent with persistent water source		Flow present 100% of time	-	-	Tal	Very weak (2)	Weak (3)	Very weak (1)	Spring elevation = 2,720 feet amsl; WL in nearest Tal well (HRES-11) = 2,830 feet amsl (~4,400 feet away). Does not preclude hydrologic connection.	Water quality suggesting consistency with Apache Leap groundwater is weak (3 of 9 constituents). Strongest line of evidence is Piper diagram which suggests Apache Leap groundwater source.	Assume stream reach is at least partially connected with regional aquifer, based on Piper diagram line of evidence.

Potential GDE	Persistence of Flow			Diagnostic Lines of Evidence			Consistency with Water Source, based on Key Water Quality Constituents (Number of Constituents Shown)			Physical Constraints	Assessment of Connectivity to Regional Aquifer based on All Lines of Evidence	Decision for DEIS Analysis
	Vegetation	Median Flow Statistics	Field Observations	Carbon-14	Tritium	Piper Diagram	Shallow	Apache Leap Tuff	Deep			
MINERAL CREEK												
Government Springs (Spring)	-	-	Flow present 100% of time	Shallow	Tal	-	Weak (4)	Moderately Strong (5)	Weak (4)	Spring elevation = 2,972 feet amsl; WL in nearest Tal well (HRES-10) = 2,880 feet amsl (~9,700 feet away). Does not preclude hydrologic connection.	Mixed evidence. Water quality suggesting consistency with deep groundwater is moderately strong (5 of 9 constituents). Strong lines of evidence are mixed, with carbon-14 pointing towards shallow and tritium pointing towards Apache Leap groundwater source. Inadequate evidence to draw conclusions about water source, or a mixed source.	Assume stream reach is at least partially connected with regional aquifer, due to contrary or insufficient evidence to determine otherwise.
MC8.4C (Spring)	-	-	Flow present 76% of time	Shallow	Tal	-	Moderately Strong (5)	Moderately Strong (5)	Weak (4)	Spring elevation = 2,881 feet amsl; WL in nearest Tal well (HRES-10) = 2,880 feet amsl (~7,600 feet away). Does not preclude hydrologic connection.	Mixed evidence. Water quality suggesting consistency with shallow and Apache Leap groundwater is moderately strong (5 of 9 constituents). Strong lines of evidence are mixed, with carbon-14 pointing towards shallow and tritium pointing towards Apache Leap groundwater source. Inadequate evidence to draw conclusions about water source, or a mixed source.	Assume stream reach is at least partially connected with regional aquifer, due to contrary or insufficient evidence to determine otherwise.
Upper Mineral Creek (UMC; MC6.8C)	-	Baseflow indicates persistent water	Flow present 100% of time	-	Tal	-	Weak (3)	No match (0)	Weak (4)	Stream elevation = 2,790 feet amsl; WL in nearest Tal well (HRES-10) = 2,880 feet amsl (~7,000 feet away). Does not preclude hydrologic connection.	Water quality suggesting consistency with deep groundwater is weak (4 of 9 constituents). Strongest line of evidence is tritium which suggests Apache Leap groundwater source.	Assume stream reach is at least partially connected with regional aquifer, based on tritium line of evidence.
MC5.2C	-	-	Flow present 100% of time	Shallow	Tal	Shallow	Weak (4)	Moderately Strong (5)	Moderately Strong (6)	Stream elevation = 2,648 feet amsl; WL in nearest Tal well (HRES-11) = 2,830 feet amsl (~1 mile away). Does not preclude hydrologic connection.	Mixed evidence. Water quality suggesting consistency with deep groundwater is moderately strong (6 of 9 constituents. Strong lines of evidence are mixed, with carbon-14 and Piper pointing towards shallow, and tritium pointing towards Apache Leap groundwater source. Inadequate evidence to draw conclusions about water source, or a mixed source.	Assume stream reach is at least partially connected with regional aquifer, due to contrary or insufficient evidence to determine otherwise.
MC3.4W (Wet Leg Spring) (Spring)	-	-	Flow present 100% of time	Tal	Tal	Tal	Weak (3)	Strong (8)	Moderately Strong (5)	Spring elevation = 2,579 feet amsl; WL in nearest Tal well (HRES-11) = 2,830 feet amsl (~7,000 feet away). Does not preclude hydrologic connection.	Consistent evidence. Water quality suggesting consistency with Apache Leap groundwater is strong (8 of 9 constituents). All three strong lines of evidence (carbon-14, tritium, Piper) suggest Apache Leap groundwater source.	Assume stream reach is at least partially connected with regional aquifer, based on all water quality lines of evidence.
Lower Mineral Creek (LMC; MC3.3C)	-	Baseflow indicates persistent water	Flow present 100% of time	Shallow	Tal	-	Moderately Strong (5)	Weak (4)	Moderately Strong (5)	Stream elevation = 2,513 feet amsl; WL in nearest Tal well (HRES-11) = 2,830 feet amsl (~7,000 feet away). Does not preclude hydrologic connection.	Mixed evidence. Water quality suggesting consistency with shallow and deep groundwater is moderately strong (5 of 9 constituents). Strong lines of evidence are mixed, with carbon-14 pointing towards shallow and tritium pointing towards Apache Leap groundwater source. Inadequate evidence to draw conclusions about water source, or a mixed source.	Assume stream reach is at least partially connected with regional aquifer, due to contrary or insufficient evidence to determine otherwise.

Potential GDE	Persistence of Flow			Diagnostic Lines of Evidence			Consistency with Water Source, based on Key Water Quality Constituents (Number of Constituents Shown)			Physical Constraints	Assessment of Connectivity to Regional Aquifer based on All Lines of Evidence	Decision for DEIS Analysis
	Vegetation	**Median Flow Statistics**	**Field Observations**	**Carbon-14**	**Tritium**	**Piper Diagram**	**Shallow**	**Apache Leap Tuff**	**Deep**			
OTHER STREAMS AND WASHES												
Arnett Creek (AC4.5C)	-	-	-	Tal	Tal	Tal	Weak (4)	Weak (3)	Weak (4)	Stream elevation = 2,559 feet amsl (from USGS DEM); WL in nearest deep well (DHRES-16) = 2,610 feet amsl (~2 miles away); WL in second nearest deep well (DHRES-13) = 2,700 feet amsl (~3 miles away). Does not preclude hydrologic connection.	Mixed evidence, but conclusive. Water quality suggesting consistency with shallow and deep groundwater is weak (4 of 9 constituents). All three strong lines of evidence (carbon-14, tritium, Piper) suggest Apache Leap groundwater source.	Assume stream reach is at least partially connected with regional aquifer.
Iron Canyon (IC1.0C)	-	-	Flow present 64% of time	-	Shallow	-	Weak (4)	Very weak (1)	Very weak (1)	Stream elevation = 4,199 feet amsl; WL in nearest Tal well (HRES-14) = 3,680 feet amsl (~2,900 feet away). Suggests hydrologic disconnect.	Consistent evidence. Water quality suggesting consistency with shallow groundwater is weak (4 of 9 constituents). Strongest line of evidence is tritium, which points towards shallow groundwater source, which is consistent with physical constraints that suggest hydrologic disconnect.	Assume stream reach is disconnected from regional aquifer, based on tritium line of evidence and physical constraints.
Hackberry Canyon (H0.1C)			Flow present 100% of time	Shallow	Shallow	Shallow	Very weak (2)	Weak (3)	Very weak (2)	Stream elevation = 3,594 feet amsl; WL in nearest Tal wells (MJ-11, HRES-07) = 3,615-3,635 feet amsl (~2,900 feet away). Does not preclude hydrologic connection.	Water quality suggesting consistency with Apache Leap is weak (3 of 9 constituents). All three strong lines of evidence (carbon-14, tritium, Piper diagram) suggest shallow groundwater source.	Assume stream reach is disconnected from regional aquifer, based on three consistent water quality lines of evidence.
Number 9 Wash	Vegetation consistent with persistent water source	-	Flow present 100% of time	Shallow	No match	-	Very weak (2)	Very weak (2)	Very weak (2)	Stream elevation = 3,760 feet amsl; WL in nearest Tal well (HRES-01) = 3,300 feet amsl (~2,900 feet away). Suggests hydrologic disconnect.	Water quality suggesting consistency with shallow, Apache Leap, and deep groundwater is very week (2 of 9 constituents). Strongest line of evidence is carbon-14, which suggests shallow groundwater source, which is consistent with physical constraints that suggest hydrologic disconnect. Additional evidence available in Oak Flat monitoring report, consistent with hydrologic disconnect.	Assume stream reach is disconnected from regional aquifer, based on carbon-14 line of evidence and physical constraints.
Oak Flat Wash	-	-	Flow present 75% of time	-	No match	-	Very weak (2)	Weak (3)	Very weak (2)	Stream elevation = 3,845 feet amsl; WL in nearest Tal well (HRES-01) = 3,300 feet amsl (~4,100 feet away). Suggests hydrologic disconnect.	Water quality suggesting constituency with Apache Leap groundwater is weak (3 of 9 constituents). Inadequate evidence to draw conclusions about water source, however physical constraints suggest hydrologic disconnect.	Assume stream reach is disconnected from regional aquifer, based on physical constraints.

Potential GDE	Persistence of Flow			Diagnostic Lines of Evidence			Consistency with Water Source, based on Key Water Quality Constituents (Number of Constituents Shown)			Physical Constraints	Assessment of Connectivity to Regional Aquifer based on All Lines of Evidence	Decision for DEIS Analysis
	Vegetation	Median Flow Statistics	Field Observations	Carbon-14	Tritium	Piper Diagram	Shallow	Apache Leap Tuff	Deep			
Rancho Rio Canyon (RR1.5C)	-	-	Flow present 100% of time	Shallow	Shallow	-	Weak (4)	Weak (3)	Weak (3)	Stream elevation = 3,881 feet amsl; WL in nearest Tal wells (MJ-11, HRES-07) = 3,615-3,635 feet amsl (~2,100 feet away). Suggests hydrologic disconnect.	Consistent evidence. Water quality suggesting consistency with shallow groundwater is weak (4 of 9 constituents). Two strong lines of evidence (carbon-14, tritium) point to shallow groundwater source, which is consistent with physical constraints that suggest hydrologic disconnect. Additional evidence available in Oak Flat monitoring report, consistent with hydrologic disconnect.	Assume stream reach is disconnected from regional aquifer, based on consistent water quality lines of evidence and physical constraints.
Telegraph Canyon (TC0.5C)	-	-	-	-	-	-	Very weak (1)	Very weak (1)	Weak (3)	Stream elevation = 2,622 feet amsl (from USGS DEM); WL in nearest deep well (DHRES-16) = 2,610 feet amsl (~2 miles away); WL in second nearest deep well (DHRES-13) = 2,700 feet amsl (~3 miles away). Does not preclude hydrologic connection.	Water quality suggesting consistency with deep groundwater system is weak (3 of 9 constituents). Inadequate evidence to draw conclusions about water source.	Assume stream reach is at least partially connected with regional aquifer, due to contrary or insufficient evidence to determine otherwise.
SPRINGS												
#5 Spring	-	-	-	-	-	-	-	-	-	Spring elevation = 3,070 feet amsl; WL in nearest well (DS16-09) = 2,626 feet amsl (~1 mile away). Suggests hydrologic disconnect.	Sole line of evidence is physical constraints, which suggests hydrologic disconnect.	Assume spring is disconnected from regional aquifer, based on physical constraints.
Benson Spring	Vegetation consistent with persistent water source	-	Flow present 53% of time	Shallow	Shallow	-	Very weak (2)	Very weak (1)	Very weak (2)	Spring elevation = 2,300 feet amsl; WL in nearest wells (DH17-32, DH16-01) = 2,212 – 2,364 feet amsl (~4,000 feet away). Does not preclude hydrologic connection.	Water quality suggesting consistency with shallow and deep groundwater system is very weak (2 of 9 constituents). Two strong lines of evidence (carbon-14, tritium) point to shallow groundwater source.	Assume spring is disconnected from regional aquifer, based on two consistent lines of evidence.
Bear Tank Canyon Spring	Vegetation consistent with persistent water source	-	Flow present 95% of time	Shallow	No match	-	Weak (3)	Weak (3)	Weak (4)	Spring elevation = 2,390 feet amsl; WL in nearest well (DH16-04) = 2,435 feet amsl (~1,600 feet away). Does not preclude hydrologic connection.	Water quality suggesting consistency with deep groundwater system is weak (4 of 9 constituents). Strongest line of evidence is carbon-14 suggesting shallow groundwater source.	Assume spring is disconnected from regional aquifer, based on carbon-14 line of evidence.

Potential GDE	Persistence of Flow			Diagnostic Lines of Evidence			Consistency with Water Source, based on Key Water Quality Constituents (Number of Constituents Shown)			Physical Constraints	Assessment of Connectivity to Regional Aquifer based on All Lines of Evidence	Decision for DEIS Analysis
	Vegetation	**Median Flow Statistics**	**Field Observations**	**Carbon-14**	**Tritium**	**Piper Diagram**	**Shallow**	**Apache Leap Tuff**	**Deep**			
Bitter Spring	Vegetation consistent with persistent water source	-	Flow present 100% of time	No match	Tal	-	Moderately Strong (5)	Very weak (1)	Very weak (2)	Spring elevation = 3,890 feet amsl; WL in nearest deep well (DHRES-09) = 2,950 feet amsl (~2.7 miles away). Does not preclude hydrologic connection (WL too distant).	Mixed evidence. Water quality suggesting consistency with shallow groundwater is moderately strong (5 of 9 constituents). Strongest line of evidence is tritium, suggesting Apache Leap groundwater source.	Assume spring is at least partially connected with regional aquifer, due to contrary or insufficient evidence to determine otherwise.
Blue Spring	-	-	-	Tal	Tal	Tal	Moderately Strong (5)	Strong (7)	Moderately Strong (6)	Spring elevation = 2,949 feet amsl; WL in nearest deep well (DHRES-13) = 2,700 feet amsl (~3.9 miles away); WL in second nearest deep well (DHRES-16) = 2,610 feet amsl (~4 miles away). Does not preclude hydrologic connection (WLs too distant).	Consistent evidence. Water quality suggesting consistency with Apache Leap groundwater is strong (7 of 9 constituents). All three strong lines of evidence (carbon-14, tritium, Piper) also point to Apache Leap groundwater source.	Assume spring is at least partially connected with regional aquifer, based on all water quality lines of evidence.
Bored Spring	Vegetation consistent with persistent water source	-	Flow present 78% of time	Tal	No match	-	Weak (3)	No match (0)	Moderately Strong (5)	Spring elevation = 2,881 feet amsl; WL in nearest deep well (DHRES-13) = 2,700 feet amsl (~1.2 miles away); WL in second nearest deep well (DHRES-16) = 2,610 feet amsl (~1.6 miles away). Does not preclude hydrologic connection (WLs too distant).	Mixed evidence. Water quality suggesting consistency with deep groundwater is moderately strong (5 of 9 constituents). Strongest line of evidence is carbon-14, suggesting Apache Leap groundwater source.	Assume spring is at least partially connected with regional aquifer, based on carbon-14 line of evidence.
Conley Spring	Vegetation consistent with persistent water source	-	Flow present 50% of time	-	-	-	-	-	-	Spring elevation = 3,640 feet amsl; WL in nearest deep well (DHRES-09) = 2,950 feet amsl (~1.5 miles away). Suggests hydrologic disconnect.	Sole line of evidence is physical constraints, which suggests hydrologic disconnect.	Assume spring is disconnected from regional aquifer, based on physical constraints.

Potential GDE	Persistence of Flow			Diagnostic Lines of Evidence			Consistency with Water Source, based on Key Water Quality Constituents (Number of Constituents Shown)			Physical Constraints	Assessment of Connectivity to Regional Aquifer based on All Lines of Evidence	Decision for DEIS Analysis
	Vegetation	**Median Flow Statistics**	**Field Observations**	**Carbon-14**	**Tritium**	**Piper Diagram**	**Shallow**	**Apache Leap Tuff**	**Deep**			
Cross Canyon Spring	-	-	-	-	-	-	-	-	-	Spring elevation = 3,100 feet amsl; WL in nearest deep well (DHRES-13) = 2,700 feet amsl (~1,300 feet away). Suggests hydrologic disconnect.	Sole line of evidence is physical constraints, which suggests hydrologic disconnect. Also, no evidence of modern flow at spring location (travertine only).	Assume spring is disconnected from regional aquifer, based on physical constraints.
Fig Spring	-	-	-	-	-	-	-	-	-	Spring elevation = 3,720 feet amsl; WL in nearest deep well (DHRES-09) = 2,950 feet amsl (~2.7 miles away). Does not preclude hydrologic connection (WL too distant).	Inadequate evidence to draw conclusion about water source. Repeated efforts to locate this spring failed; spring is assumed to not exist.	Do not include in analysis.
Gibson Well Spring	Vegetation consistent with persistent water source	-	Flow present 67% of time	-	-	-	-	-	-	Spring elevation = 3,836 feet amsl; WL in nearest Tal well (HRES-01) = 3,300 feet amsl (~2,600 feet away). Suggests hydrologic disconnect.	Sole line of evidence is physical constraints, which suggests hydrologic disconnect. Additional evidence available in Oak Flat monitoring report, consistent with hydrologic disconnect.	Assume spring is disconnected from regional aquifer, based on physical constraints.
The Grotto	Vegetation consistent with persistent water source	-	Flow present 50% of time	-	-	-	-	-	-	Spring elevation = 3,936 feet amsl; WL in nearest Tal well (HRES-02) = 3,685 feet amsl (~2,600 feet away). Suggests hydrologic disconnect.	Sole line of evidence is physical constraints, which suggests hydrologic disconnect. Additional evidence available in Oak Flat monitoring report, consistent with hydrologic disconnect.	Assume spring is disconnected from regional aquifer, based on physical constraints.
Happy Camp Spring	Vegetation consistent with persistent water source	-	Flow present 100% of time	Shallow	No match	-	Moderately Strong (5)	Very weak (2)	Very weak (2)	Spring elevation = 2,680 feet amsl; WL in nearest well (DH17-33) = 2,674 feet amsl (~1,000 feet away). Does not preclude hydrologic connection.	Consistent evidence. Water quality suggesting consistency with shallow groundwater is moderately strong (5 of 9 constituents). Strongest line of evidence is carbon-14 suggesting shallow groundwater source.	Assume spring is disconnected from regional aquifer, based on two consistent lines of evidence.

Potential GDE	Persistence of Flow			Diagnostic Lines of Evidence			Consistency with Water Source, based on Key Water Quality Constituents (Number of Constituents Shown)			Physical Constraints	Assessment of Connectivity to Regional Aquifer based on All Lines of Evidence	Decision for DEIS Analysis
	Vegetation	**Median Flow Statistics**	**Field Observations**	**Carbon-14**	**Tritium**	**Piper Diagram**	**Shallow**	**Apache Leap Tuff**	**Deep**			
Hidden Spring	Vegetation consistent with persistent water source	-	Flow present 79% of time	Shallow	Shallow	No match	Weak (4)	Moderately Strong (5)	Moderately Strong (5)	Spring elevation = 3,041 feet amsl; WL in nearest deep well (DHRES-13) = 2,700 feet amsl (~2 miles away); WL in second nearest deep well (DHRES-16) = 2,610 feet amsl (~2.2 miles away). Does not preclude hydrologic connection (WLs too distant).	Mixed evidence. Water quality suggesting consistency with deep and Apache Leap groundwater is moderately strong (5 of 9 constituents). Two strong lines of evidence (carbon-14, tritium) suggest shallow groundwater source.	Assume spring is at least partially connected with regional aquifer, due to contrary or insufficient evidence to determine otherwise.
Iberri Spring	Vegetation consistent with persistent water source	-	Flow present 100% of time	-	-	-	-	-	-	Spring elevation = 3,610 feet amsl; WL in nearest deep well (DHRES-09) = 2,950 feet amsl (~2.7 miles away). Does not preclude hydrologic connection (WL too distant).	Inadequate evidence to draw conclusion about water source.	Assume spring is at least partially connected with regional aquifer, due to contrary or insufficient evidence to determine otherwise.
Kane Spring	Vegetation consistent with persistent water source	-	Flow present 87% of time	Tal	Tal	No match	Weak (4)	Moderately Strong (5)	Moderately Strong (6)	Spring elevation = 3,159 feet amsl; WL in nearest deep well (DHRES-13) = 2,700 feet amsl (~2.7 miles away); WL in second nearest deep well (DHRES-16) = 2,610 feet amsl (~3.5 miles away). Does not preclude hydrologic connection (WLs too distant).	Mixed evidence. Water quality suggesting consistency with deep groundwater is moderately strong (6 of 9 constituents). Two strong lines of evidence (carbon-14, tritium) suggest Apache Leap groundwater source.	Assume spring is at least partially connected with regional aquifer, based on two consistent lines of evidence.
Lower Railroad Spring	-	-	-	-	-	-	-	-	-	Spring elevation = 2,470 feet amsl; WL in nearest well (DS17-16) = 2,392 feet amsl (~1,000 feet away). Does not preclude hydrologic connection.	Inadequate evidence to draw conclusion about water source. Repeated efforts to locate this spring failed; spring is assumed to not exist.	Do not include in analysis.

Potential GDE	Persistence of Flow			Diagnostic Lines of Evidence			Consistency with Water Source, based on Key Water Quality Constituents (Number of Constituents Shown)			Physical Constraints	Assessment of Connectivity to Regional Aquifer based on All Lines of Evidence	Decision for DEIS Analysis
	Vegetation	**Median Flow Statistics**	**Field Observations**	**Carbon-14**	**Tritium**	**Piper Diagram**	**Shallow**	**Apache Leap Tuff**	**Deep**			
Lyons Fork (LF0.2C)	-	-	Flow present 100% of time	Shallow	Shallow	-	Moderately Strong (5)	Weak (3)	Weak (4)	Spring elevation = 2,818 feet amsl; WL in nearest Tal well (HRES-10) = 2,880 feet amsl (~1.1 miles away). Does not preclude hydrologic connection.	Consistent evidence. Water quality suggesting consistency with shallow groundwater is moderately strong (5 of 9 constituents). Two strong lines of evidence (carbon-14, tritium) suggest shallow groundwater source.	Assume spring is disconnected from regional aquifer, based on three consistent lines of evidence.
McGinnel Mine Spring	-	-	-	-	-	-	-	-	-	Spring elevation = 3,880 feet amsl; WL in nearest deep well (DHRES-09) = 2,950 feet amsl (~2.5 miles away). Does not preclude hydrologic connection (WL too distant).	Inadequate evidence to draw conclusion about water source.	Assume spring is at least partially connected with regional aquifer, due to contrary or insufficient evidence to determine otherwise.
McGinnel Spring	-	-	-	-	-	-	-	-	-	Spring elevation = 3,240 feet amsl; WL in nearest deep well (DHRES-09) = 2,950 feet amsl (~2.5 miles away). Does not preclude hydrologic connection (WL too distant).	Inadequate evidence to draw conclusion about water source.	Assume spring is at least partially connected with regional aquifer, due to contrary or insufficient evidence to determine otherwise.
No Name Spring	Vegetation consistent with persistent water source	-	Flow present 100% of time	-	-	-	-	-	-	Spring elevation = 2,600 feet amsl; WL in nearest well (MCC-1) = 2,807 feet amsl (~2.5 miles away). Does not preclude hydrologic connection.	Inadequate evidence to draw conclusion about water source.	Assume spring is at least partially connected with regional aquifer, due to contrary or insufficient evidence to determine otherwise.
Patterson Spring	-	-	-	-	-	-	Very weak (1)	Very weak (2)	Very weak (2)	Spring elevation = 4,544 feet amsl; WL in nearest well (HRES-17) = 3,650 feet amsl (~4 miles away). Does not preclude hydrologic connection (WL too distant), but spring sits well beyond the basin boundary as per GW model.	Water quality suggesting consistency with Apache Leap and deep groundwater is very weak (2 of 9 constituents). Water levels are inconclusive, but spring is well beyond the basin boundary and was only included as a potential GDE because water quality samples existed. Not appropriate to include.	Do not include in analysis.

Potential GDE	Persistence of Flow			Diagnostic Lines of Evidence			Consistency with Water Source, based on Key Water Quality Constituents (Number of Constituents Shown)			Physical Constraints	Assessment of Connectivity to Regional Aquifer based on All Lines of Evidence	Decision for DEIS Analysis
	Vegetation	Median Flow Statistics	Field Observations	Carbon-14	Tritium	Piper Diagram	Shallow	Apache Leap Tuff	Deep			
Perlite Spring	Vegetation consistent with persistent water source	-	Flow present 92% of time	-	-	-	Very weak (2)	Very weak (2)	Very weak (2)	Spring elevation = 2,620 feet amsl; WL in nearest well (DH16-09) = 2,468 feet amsl (~1,000 feet away). Suggests hydrologic disconnect.	Water quality suggesting consistency with shallow, Apache Leap, and deep groundwater is very weak (2 of 9 constituents). Physical constraints suggest hydrologic disconnect.	Assume spring is disconnected from regional aquifer, based on physical constraints.
Rancho Rio Spring	Vegetation consistent with persistent water source	-	Flow present 72% of time	-	-	-	-	-	-	Spring elevation = 3,920 feet amsl; WL in nearest Tal well (HRES-21) = 3,670 feet amsl (~1,000 feet away). Suggest hydrologic disconnect.	Sole line of evidence is physical constraints, which suggests hydrologic disconnect.	Assume spring is disconnected from regional aquifer, based on physical constraints.
Rock Horizontal Spring	-	-	-	-	-	-	-	-	-	Spring elevation = 3,060 feet amsl; WL in nearest well (DH17-31) = 2,780 feet amsl (~3 miles away). Does not preclude hydrologic connection (WL too distant).	Inadequate evidence to draw conclusion about water source.	Assume spring is at least partially connected with regional aquifer, due to contrary or insufficient evidence to determine otherwise.
Queen Seeps	Vegetation consistent with persistent water source	-	Flow present 0% of time	-	-	-	-	-	-	Spring elevation = 3,800 feet amsl; WL in nearest Tal well (HRES-01) = 3,300 feet amsl (~2,600 feet away). Suggests hydrologic disconnect.	Sole line of evidence is physical constraints, which suggests hydrologic disconnect.	Assume spring is disconnected from regional aquifer, based on physical constraints.
Silverado Ridge Spring	-	-	-	-	-	-	-	-	-	Spring elevation = 4,090 feet amsl; WL in nearest deep well (DHRES-11) = 3,650 feet amsl (~1.5 miles away). Suggests hydrologic disconnect.	Sole line of evidence is physical constraints, which suggests hydrologic disconnect. However, further clarification received from Montgomery & Associates that spring is actually a mine adit with no characteristics of a natural spring, indications of riparian vegetation, or water use.	Do not include in analysis.
SK18-02 Spring	-	-	-	-	-	-	-	-	-	Spring elevation = 4,270 feet amsl; WL in nearest deep well (DHRES-11) = 3,650 feet amsl (~1.5 miles away). Suggests hydrologic disconnect.	Sole line of evidence is physical constraints, which suggests hydrologic disconnect.	Assume spring is disconnected from regional aquifer, based on physical constraints.

Potential GDE	Persistence of Flow			Diagnostic Lines of Evidence			Consistency with Water Source, based on Key Water Quality Constituents (Number of Constituents Shown)			Physical Constraints	Assessment of Connectivity to Regional Aquifer based on All Lines of Evidence	Decision for DEIS Analysis
	Vegetation	Median Flow Statistics	Field Observations	Carbon-14	Tritium	Piper Diagram	Shallow	Apache Leap Tuff	Deep			
SK18-03 Spring	-	-	-	-	-	-	-	-	-	Spring elevation = 4,360 feet amsl; WL in nearest deep well (DHRES-11) = 3,650 feet amsl (~1.5 miles away). Suggests hydrologic disconnect.	Sole line of evidence is physical constraints, which suggests hydrologic disconnect.	Assume spring is disconnected from regional aquifer, based on physical constraints.
SK18-04 Spring	-	-	-	-	-	-	-	-	-	Spring elevation = 4,360 feet amsl; WL in nearest deep well (DHRES-11) = 3,650 feet amsl (~1.5 miles away). Suggests hydrologic disconnect.	Sole line of evidence is physical constraints, which suggests hydrologic disconnect. However, further clarification received from Montgomery & Associates that while a possible spring location was noted in preliminary surveys, it was later dropped as there were no characteristics of a natural spring, indications of riparian vegetation, or water use.	Do not include in analysis.
Tunnel Spring	-	-	-	-	-	-	-	-	-	Spring elevation = 3,820 feet amsl; WL in nearest deep well (DHRES-09) = 2,950 feet amsl (~2.7 miles away). Does not preclude hydrologic connection (WL too distant).	Inadequate evidence to draw conclusion about water source. Repeated efforts to locate this spring failed; spring is assumed to not exist.	Do not include in analysis.
Walker Spring	Vegetation consistent with persistent water source	-	Flow present 100% of time	-	-	-	-	-	-	Spring elevation = 2,565 feet amsl; WL in nearest well (DS16-14) = 2,599 feet amsl (~2,400 feet away). Does not preclude hydrologic connection.	Inadequate evidence to draw conclusion about water source.	Assume spring is at least partially connected with regional aquifer, due to contrary or insufficient evidence to determine otherwise.

Notes: Green shading indicates evidence for shallow source of water disconnected from the regional aquifer. A dash (-) indicates that no data exist for this particular line of evidence

GDE Portfolios for Stream Segments

In order to consolidate all available information, the Groundwater Modeling Workgroup developed portfolios for Devil's Canyon, Queen Creek, and Mineral Creek. The intent of these portfolios was to describe the information available for each reach and consolidate the conclusions in the available literature regarding these segments.

These portfolios are included as Attachment 4 (Devil's Canyon), Attachment 5 (Queen Creek), and Attachment 6 (Mineral Creek).

ATTACHMENT 1

Summary Statistics All Water Quality Constituents by Groundwater Type

	Shallow Groundwater (Alluvium or shallow bedrock)										Tal Aquifer										Deep Groundwater System									
	N	Minimum	Maximum	Range	Mean	Geometric Mean	Std. Deviation	Std. Error of Mean	Variance	Median	N	Minimum	Maximum	Range	Mean	Geometric Mean	Std. Deviation	Std. Error of Mean	Variance	Median	N	Minimum	Maximum	Range	Mean	Geometric Mean	Std. Deviation	Std. Error of Mean	Variance	Median
Electrical Conductivity (Field)	5.00	208.80	880.00	671.20	543.76	457.43	324.45	145.10	105268.19	525.00	5.00	479.40	931.00	451.60	648.76	624.70	203.71	91.10	41499.51	560.00	2.00	513.40	536.10	22.70	524.75	524.63	16.05	11.35	257.65	524.75
Flow Rate	1.00	5.80	5.80	0.00	5.80	5.80	.	.	.	5.80	1.00	0.45	0.45	0.00	0.45	0.45	.	.	.	0.45										
Oxidation-Reduction Potential (Field)																					2.00	65.00	115.00	50.00	90.00	86.46	35.36	25.00	1250.00	90.00
pH (Field)	27.00	5.49	8.21	2.72	6.41	6.38	0.59	0.11	0.35	6.43	105.00	6.51	10.17	3.66	7.34	7.32	0.52	0.05	0.27	7.27	27.00	6.59	9.75	3.16	7.39	7.37	0.62	0.12	0.38	7.30
Specific Conductance (Field)	22.00	199.00	1020.00	821.00	493.54	438.26	253.30	54.00	64160.36	399.00	100.00	232.00	736.20	504.20	322.84	310.00	105.87	10.59	11209.45	274.80	25.00	285.10	4196.00	3910.90	1671.32	1258.95	1129.93	225.99	1276752.09	1922.00
Temperature (Field)	27.00	11.11	22.17	11.06	17.28	17.11	2.42	0.47	5.88	17.10	106.00	15.00	28.40	13.40	24.07	23.90	2.75	0.27	7.56	24.20	27.00	28.80	68.70	39.90	43.92	42.71	10.75	2.07	115.64	42.70
Turbidity (Field)											1.00	4.82	4.82	0.00	4.82	4.82	.	.	.	4.82										
Carbon 14	15.00	85.70	108.50	22.80	98.89	98.61	7.61	1.97	57.94	97.00	76.00	55.30	106.29	50.99	71.16	70.02	13.57	1.56	184.23	67.10	20.00	0.60	82.45	81.85	28.12	16.47	23.66	5.29	559.82	24.50
Delta Carbon-13 of DIC	15.00	-20.90	-6.30	14.60	-16.75	.[a]	4.15	1.07	17.18	-18.80	76.00	-20.10	-7.70	12.40	-15.87	.[a]	1.94	0.22	3.75	-15.80	20.00	-19.30	-7.30	12.00	-13.23	.[a]	3.37	0.75	11.33	-13.40
Delta Deuterium	25.00	-73.00	-43.00	30.00	-60.68	.[a]	8.49	1.70	72.07	-63.00	92.00	-79.00	-55.20	23.80	-68.80	.[a]	3.52	0.37	12.36	-69.85	20.00	-86.00	-67.60	18.40	-79.41	.[a]	6.48	1.45	41.98	-83.05
Delta Oxygen-18 of Sulfate	19.00	-0.70	32.30	33.00	8.12	.[a]	8.68	1.99	75.35	5.60	70.00	-5.90	23.80	29.70	6.24	.[a]	5.71	0.68	32.64	6.40	16.00	-1.00	7.60	8.60	3.71	.[a]	3.01	0.75	9.04	3.35
Delta Oxygen-18	25.00	-10.50	-4.61	5.89	-8.56	.[a]	1.58	0.32	2.51	-9.30	92.00	-11.40	-8.44	2.96	-9.92	.[a]	0.52	0.05	0.27	-9.95	20.00	-11.96	-9.17	2.79	-11.03	.[a]	0.89	0.20	0.79	-11.51
Delta Sulfur-34	20.00	-5.40	4.60	10.00	-0.56	.[a]	3.00	0.67	9.02	-1.10	70.00	-3.60	10.00	13.60	4.79	.[a]	2.65	0.32	7.01	4.90	17.00	-1.20	14.80	16.00	5.74	.[a]	4.35	1.05	18.88	7.70
Strontium 87/86	15.00	0.71	0.72	0.01	0.71	0.71	0.00	0.00	0.00	0.71	69.00	0.71	0.73	0.02	0.71	0.71	0.01	0.00	0.00	0.71	19.00	0.71	0.72	0.01	0.71	0.71	0.00	0.00	0.00	0.71
Tritium	22.00	1.22	6.20	4.98	3.50	3.28	1.25	0.27	1.56	3.25	81.00	0.30	3.40	3.10	1.13	0.99	0.68	0.08	0.46	1.00	19.00	1.00	1.50	0.50	1.05	1.04	0.16	0.04	0.02	1.00
Alkalinity (as CaCO3)	26.00	11.00	289.00	278.00	81.57	62.24	65.20	12.79	4251.33	66.00	107.00	73.00	299.00	226.00	146.92	141.87	41.84	4.05	1750.83	140.00	20.00	110.00	337.00	227.00	225.85	216.61	63.50	14.20	4031.82	245.00
Alkalinity, Phenolphthalein	3.00	6.00	6.00	0.00	6.00	6.00	0.00	0.00	0.00	6.00	44.00	6.00	6.00	0.00	6.00	6.00	0.00	0.00	0.00	6.00	18.00	6.00	33.00	27.00	7.50	6.60	6.36	1.50	40.50	6.00
Anions (Laboratory)											8.00	2.82	3.76	0.94	3.16	3.15	0.33	0.12	0.11	3.04	1.00	11.46	11.46	0.00	11.46	11.46	.	.	.	11.46
Bicarbonate (Calculated by M&A)	26.00	13.00	353.00	340.00	99.40	75.70	79.64	15.62	6342.72	80.50	107.00	73.80	365.00	291.20	177.44	170.60	52.78	5.10	2785.87	170.00	20.00	59.00	411.00	352.00	271.10	252.66	86.73	19.39	7522.09	299.00
Bicarbonate Alkalinity (as CaCO3)	26.00	11.00	289.00	278.00	81.57	62.24	65.20	12.79	4251.33	66.00	107.00	60.50	299.00	238.50	145.42	139.82	43.25	4.18	1870.31	139.00	20.00	48.00	337.00	289.00	222.25	207.05	71.22	15.93	5072.20	245.00
Bicarbonate Ion	1.00	117.00	117.00	0.00	117.00	117.00	.	.	.	117.00																				
Carbonate (Calculated by M&A)	26.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	107.00	0.00	36.50	36.50	0.87	0.00	4.73	0.46	22.33	0.00	20.00	0.00	39.00	39.00	2.17	0.00	8.72	1.95	76.09	0.00
Carbonate Alkalinity (as CaCO3)	26.00	1.00	6.00	5.00	5.04	4.34	1.93	0.38	3.72	6.00	107.00	1.00	60.90	59.90	6.60	5.24	7.12	0.69	50.63	6.00	20.00	1.00	65.00	64.00	8.76	6.23	13.29	2.97	176.60	6.00
Cations (Laboratory)											8.00	2.49	3.76	1.27	3.01	2.99	0.37	0.13	0.14	2.98	1.00	11.52	11.52	0.00	11.52	11.52	.	.	.	11.52
Chloride	27.00	3.52	66.70	63.18	28.39	21.46	18.79	3.62	353.23	27.00	107.00	4.20	39.90	35.70	7.63	6.82	4.86	0.47	23.65	5.90	20.00	5.80	27.00	21.20	15.62	13.64	7.44	1.66	55.38	17.00
Dissolved oxygen	4.00	1.12	10.61	9.49	5.53	3.93	4.45	2.23	19.82	5.20	4.00	1.00	4.60	3.60	2.89	2.52	1.47	0.74	2.17	2.97										
Fluoride	27.00	0.09	0.48	0.38	0.37	0.35	0.10	0.02	0.01	0.40	107.00	0.22	1.05	0.83	0.44	0.43	0.13	0.01	0.02	0.40	20.00	0.40	6.26	5.86	1.91	1.19	1.83	0.41	3.36	0.81
Hardness (as CaCO3)	17.00	76.50	431.00	354.50	203.15	180.34	102.82	24.94	10572.68	170.00	81.00	63.00	444.00	381.00	125.99	114.03	67.50	7.50	4556.06	92.00	20.00	6.00	700.00	694.00	335.10	241.79	217.87	48.72	47468.52	255.00
Hydroxide Alkalinity (as CaCO3)	21.00	2.00	6.00	4.00	5.81	5.69	0.87	0.19	0.76	6.00	87.00	2.00	6.00	4.00	5.82	5.70	0.84	0.09	0.71	6.00	19.00	6.00	6.00	0.00	6.00	6.00	0.00	0.00	0.00	6.00
Ion Balance (Laboratory)											8.00	-6.21	0.00	6.21	-2.58	0.00	2.13	0.75	4.55	-2.12	1.00	0.26	0.26	0.00	0.26	0.26	.	.	.	0.26
Nitrate as N	22.00	0.20	16.00	15.80	2.04	0.49	4.63	0.99	21.48	0.20	65.00	0.20	1.60	1.40	0.52	0.47	0.26	0.03	0.07	0.51	10.00	0.20	1.40	1.20	0.53	0.39	0.46	0.14	0.21	0.28
Nitrate+Nitrite as N (calculated by M&A)	22.00	0.00	16.00	16.00	1.93	0.00	4.68	1.00	21.91	0.00	65.00	0.00	1.60	1.60	0.52	0.00	0.26	0.03	0.07	0.51	10.00	0.00	1.40	1.40	0.43	0.00	0.54	0.17	0.29	0.18
Nitrate+Nitrite as N	9.00	0.03	3.63	3.61	0.59	0.19	1.15	0.38	1.32	0.30	53.00	0.02	3.46	3.44	1.37	1.04	0.79	0.11	0.62	2.00	12.00	0.02	2.00	1.98	1.29	0.77	0.88	0.26	0.78	2.00
Nitrite as N	22.00	0.10	0.20	0.10	0.16	0.16	0.05	0.01	0.00	0.20	64.00	0.10	0.20	0.10	0.17	0.17	0.04	0.01	0.00	0.20	10.00	0.03	0.20	0.17	0.16	0.13	0.07	0.02	0.01	0.20
Ortho-Phosphate																					1.00	0.12	0.12	0.00	0.12	0.12	.	.	.	0.12
pH (Laboratory)	24.00	5.54	8.20	2.66	6.82	6.79	0.65	0.13	0.42	6.86	98.00	7.01	9.79	2.78	7.74	7.73	0.43	0.04	0.19	7.65	19.00	7.00	9.38	2.38	7.63	7.61	0.62	0.14	0.39	7.39
Silica	25.00	30.00	52.60	22.60	37.19	36.94	4.59	0.92	21.06	37.00	106.00	6.98	88.00	81.02	59.34	57.54	11.83	1.15	140.00	62.50	20.00	5.80	87.00	81.20	33.31	28.61	19.40	4.34	376.44	25.00
Specific Conductance (Laboratory)	24.00	218.00	1170.00	952.00	519.21	454.78	282.80	57.73	79978.00	440.00	98.00	220.00	933.00	713.00	332.51	314.92	130.45	13.18	17018.01	275.00	19.00	260.00	1800.00	1540.00	882.63	732.98	566.98	130.07	321464.91	570.00
Sulfate	27.00	10.90	547.00	536.10	141.63	81.60	144.37	27.78	20842.84	100.00	107.00	1.40	228.00	226.60	18.07	6.89	39.33	3.80	1546.96	4.70	20.00	2.00	840.00	838.00	252.28	60.23	340.21	76.07	115740.57	28.50
Sulfide	26.00	0.04	0.41	0.37	0.11	0.07	0.13	0.03	0.02	0.04	96.00	0.04	0.73	0.69	0.08	0.06	0.12	0.01	0.01	0.05	20.00	0.02	12.00	11.98	0.73	0.09	2.66	0.60	7.09	0.05
Temperature (Laboratory)	20.00	17.80	22.20	4.40	19.73	19.70	1.13	0.25	1.27	19.55	86.00	17.70	23.00	5.30	19.55	19.52	1.03	0.11	1.05	19.50	19.00	17.30	24.10	6.80	19.89	19.83	1.65	0.38	2.72	19.70
Total Dissolved Solids (Calc by Lab)											8.00	154.00	275.00	121.00	225.25	222.74	33.81	11.95	1142.79	226.50	1.00	760.00	760.00	0.00	760.00	760.00	.	.	.	760.00
Total Dissolved Solids (Laboratory)	27.00	135.00	823.00	688.00	364.52	313.49	209.12	40.24	43729.72	290.00	107.00	140.00	663.00	523.00	247.97	236.42	89.19	8.62	7954.25	217.00	20.00	92.00	1400.00	1308.00	637.55	487.61	464.30	103.82	215576.05	410.00
Total Suspended Solids	3.00	10.00	18.00	8.00	12.67	12.16	4.62	2.67	21.33	10.00	7.00	10.00	12.00	2.00	10.29	10.26	0.76	0.29	0.57	10.00	3.00	5.00	10.00	5.00	8.33	7.94	2.89	1.67	8.33	10.00
Aluminum	26.00	0.04	1.01	0.97	0.21	0.18	0.17	0.03	0.03	0.20	107.00	0.02	0.50	0.48	0.21	0.18	0.10	0.01	0.01	0.20	20.00	0.03	4.50	4.47	0.40	0.17	0.97	0.22	0.94	0.20
Antimony	26.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	107.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	20.00	0.00	0.06	0.06	0.01	0.00	0.01	0.00	0.00	0.00

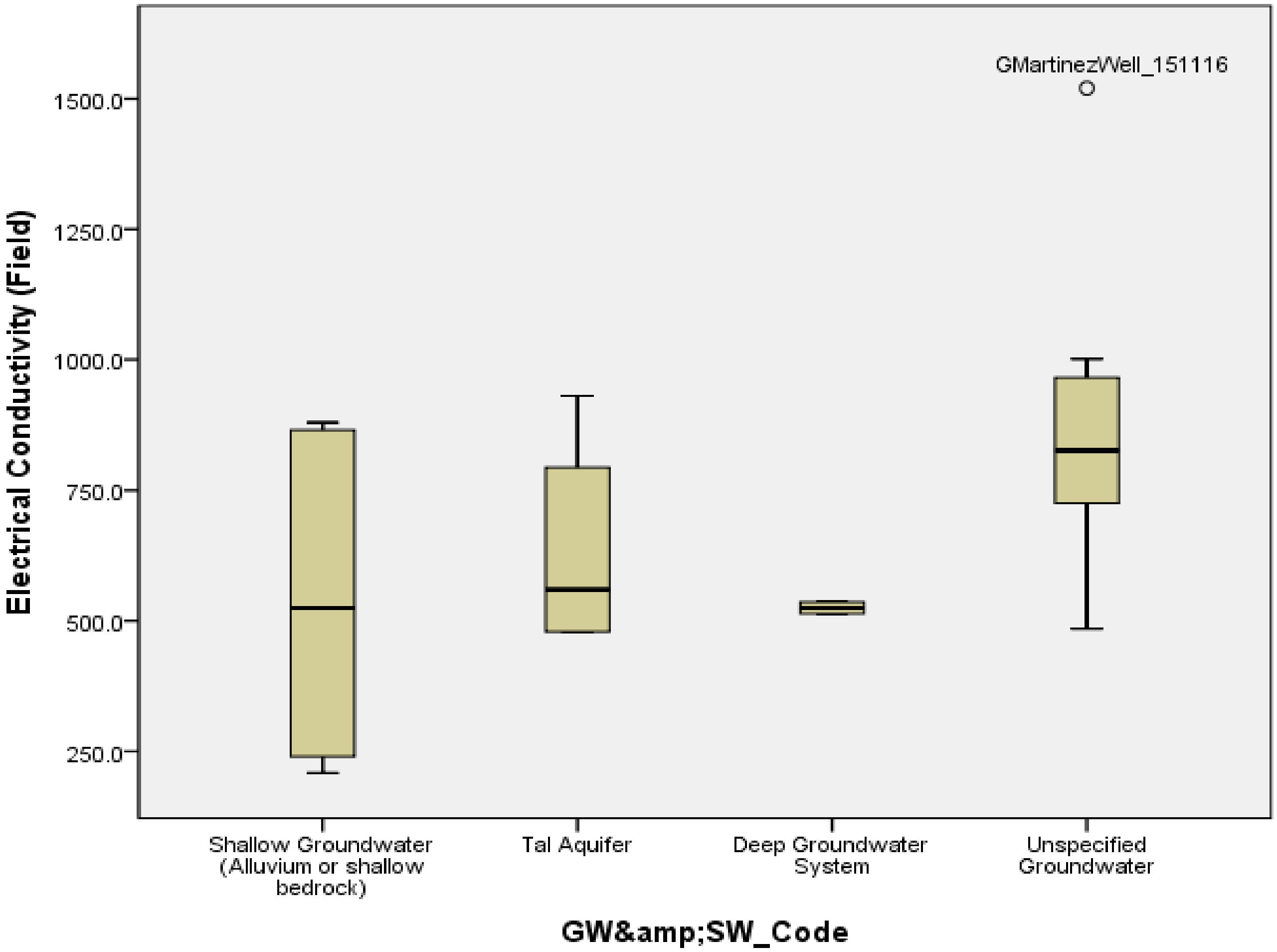
	Shallow Groundwater (Alluvium or shallow bedrock)										Tal Aquifer										Deep Groundwater System									
	N	Minimum	Maximum	Range	Mean	Geometric Mean	Std. Deviation	Std. Error of Mean	Variance	Median	N	Minimum	Maximum	Range	Mean	Geometric Mean	Std. Deviation	Std. Error of Mean	Variance	Median	N	Minimum	Maximum	Range	Mean	Geometric Mean	Std. Deviation	Std. Error of Mean	Variance	Median
Arsenic	26.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	107.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	20.00	0.00	0.13	0.13	0.01	0.00	0.03	0.01	0.00	0.01
Barium	26.00	0.01	0.22	0.21	0.08	0.07	0.05	0.01	0.00	0.09	107.00	0.00	0.06	0.06	0.02	0.02	0.01	0.00	0.00	0.02	20.00	0.01	0.48	0.47	0.08	0.04	0.12	0.03	0.01	0.03
Beryllium	26.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	107.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Boron	23.00	0.04	0.20	0.17	0.17	0.15	0.06	0.01	0.00	0.20	100.00	0.03	0.50	0.47	0.20	0.17	0.09	0.01	0.01	0.20	19.00	0.07	1.50	1.43	0.26	0.19	0.31	0.07	0.10	0.20
Bromide	26.00	0.05	0.91	0.86	0.48	0.44	0.15	0.03	0.02	0.50	97.00	0.07	1.00	0.94	0.49	0.47	0.09	0.01	0.01	0.50	20.00	0.07	0.50	0.43	0.42	0.35	0.17	0.04	0.03	0.50
Cadmium	26.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	107.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Calcium	27.00	22.10	130.00	107.90	58.33	51.20	31.39	6.04	985.55	43.00	107.00	1.16	130.00	128.84	35.22	30.40	18.49	1.79	341.80	28.00	20.00	2.00	270.00	268.00	103.16	65.60	91.00	20.35	8280.44	58.00
Chromium	26.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	107.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	20.00	0.00	0.61	0.61	0.03	0.00	0.14	0.03	0.02	0.00
Cobalt	23.00	0.00	0.04	0.04	0.01	0.00	0.01	0.00	0.00	0.00	100.00	0.00	0.05	0.05	0.00	0.00	0.01	0.00	0.00	0.00	19.00	0.00	0.06	0.06	0.00	0.00	0.01	0.00	0.00	0.00
Copper	26.00	0.00	0.19	0.19	0.02	0.01	0.04	0.01	0.00	0.01	107.00	0.00	0.06	0.06	0.01	0.00	0.01	0.00	0.00	0.00	20.00	0.00	1.80	1.80	0.10	0.00	0.40	0.09	0.16	0.00
Cyanide, Amenable	22.00	0.02	0.05	0.03	0.03	0.02	0.01	0.00	0.00	0.03	91.00	0.01	0.05	0.05	0.03	0.03	0.02	0.00	0.00	0.03	11.00	0.01	0.05	0.05	0.02	0.02	0.02	0.01	0.00	0.01
Cyanide, Free																					1.00	0.10	0.10	0.00	0.10	0.10	.	.	.	0.10
Cyanide, Total	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	8.00	0.00	0.05	0.05	0.02	0.01	0.02	0.01	0.00	0.01
Cyanide, weak acid dissociable																					1.00	0.01	0.01	0.00	0.01	0.01	.	.	.	0.01
Iron	26.00	0.05	30.00	29.95	4.53	0.66	6.94	1.36	48.21	0.39	107.00	0.02	10.00	9.98	0.65	0.19	1.51	0.15	2.27	0.13	20.00	0.05	1100.00	1099.95	59.07	2.07	245.06	54.80	60053.86	2.05
Lead	26.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	107.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	20.00	0.00	0.43	0.43	0.02	0.00	0.10	0.02	0.01	0.00
Lithium																					1.00	0.10	0.10	0.00	0.10	0.10	.	.	.	0.10
Magnesium	27.00	2.60	38.10	35.50	11.88	9.97	7.83	1.51	61.26	9.90	107.00	0.04	28.80	28.76	6.39	5.00	4.60	0.45	21.21	4.70	20.00	0.25	43.00	42.75	19.33	13.10	13.00	2.91	169.12	20.00
Manganese	23.00	0.00	2.06	2.06	0.42	0.16	0.50	0.10	0.25	0.30	100.00	0.00	1.30	1.30	0.11	0.04	0.20	0.02	0.04	0.03	20.00	0.01	15.00	14.99	0.94	0.15	3.31	0.74	10.98	0.16
Mercury	25.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	105.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Molybdenum	26.00	0.00	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.01	107.00	0.00	0.05	0.05	0.01	0.00	0.01	0.00	0.00	0.00	20.00	0.00	0.27	0.27	0.03	0.02	0.06	0.01	0.00	0.02
Nickel	26.00	0.00	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.01	107.00	0.00	0.14	0.14	0.01	0.00	0.02	0.00	0.00	0.00	20.00	0.00	0.22	0.22	0.02	0.00	0.05	0.01	0.00	0.00
Potassium	27.00	0.76	4.37	3.61	2.34	2.24	0.70	0.13	0.48	2.00	107.00	0.95	5.80	4.85	1.97	1.88	0.67	0.06	0.45	2.00	20.00	2.00	39.00	37.00	14.36	9.00	14.44	3.23	208.44	6.10
Selenium	26.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	107.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	20.00	0.00	0.04	0.04	0.00	0.00	0.01	0.00	0.00	0.00
Silicon	1.00	40.00	40.00	0.00	40.00	40.00	.	.	.	40.00	1.00	59.00	59.00	0.00	59.00	59.00	.	.	.	59.00										
Silver	26.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	107.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Sodium	27.00	7.00	131.00	124.00	29.73	22.96	25.29	4.87	639.76	22.00	107.00	16.00	69.30	53.30	28.29	26.88	10.31	1.00	106.37	25.00	20.00	13.00	160.00	147.00	72.10	49.28	59.76	13.36	3571.36	33.00
Strontium (by isotope dilution)	15.00	0.17	1.25	1.08	0.44	0.37	0.32	0.08	0.10	0.29	69.00	0.09	0.52	0.43	0.18	0.16	0.08	0.01	0.01	0.15	19.00	0.03	41.83	41.80	5.16	0.86	12.14	2.79	147.48	0.61
Strontium																					1.00	0.76	0.76	0.00	0.76	0.76	.	.	.	0.76
Thallium	26.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	107.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	20.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Uranium	12.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	62.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	20.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Zinc	26.00	0.01	1.04	1.03	0.15	0.08	0.22	0.04	0.05	0.06	107.00	0.01	1.97	1.97	0.26	0.10	0.38	0.04	0.15	0.08	20.00	0.01	1.70	1.69	0.16	0.05	0.40	0.09	0.16	0.05
Gross Alpha, Adjusted											34.00	-10.70	7.00	17.70	-0.55	0.00	3.37	0.58	11.37	-0.11	17.00	-13.70	49.00	62.70	5.24	. [a]	15.78	3.83	248.88	0.01
Gross Alpha	14.00	1.00	18.00	17.00	4.58	2.87	5.29	1.41	27.99	2.10	64.00	1.00	10.00	9.00	2.66	2.30	1.75	0.22	3.05	2.00	20.00	1.80	49.00	47.20	13.73	7.16	14.82	3.31	219.68	3.20
Gross Beta	14.00	2.00	14.00	12.00	4.62	3.82	3.57	0.95	12.71	2.80	64.00	2.00	9.70	7.70	3.68	3.46	1.46	0.18	2.13	3.80	20.00	2.60	56.00	53.40	20.17	12.99	19.17	4.29	367.59	9.40
Radium 226 + Radium 228	14.00	0.00	3.39	3.39	1.03	0.00	1.21	0.32	1.47	0.45	64.00	0.00	2.70	2.70	0.44	0.00	0.76	0.10	0.58	0.00	20.00	0.00	16.00	16.00	4.56	0.00	5.87	1.31	34.41	1.07
Radium 226	14.00	0.10	0.60	0.50	0.28	0.24	0.17	0.05	0.03	0.23	64.00	0.08	0.69	0.61	0.22	0.20	0.12	0.01	0.01	0.19	20.00	0.20	11.00	10.80	3.53	1.16	4.60	1.03	21.19	0.65
Radium 228	14.00	0.85	2.80	1.95	1.53	1.43	0.62	0.17	0.39	1.20	64.00	0.54	2.70	2.16	1.33	1.26	0.44	0.05	0.19	1.20	20.00	0.57	5.30	4.73	1.57	1.26	1.26	0.28	1.58	1.00
Radon 222											5.00	130.00	530.00	400.00	360.00	309.85	189.21	84.62	35800.00	470.00	4.00	24.00	2400.00	2376.00	1781.00	750.91	1172.28	586.14	1374244.00	2350.00
U-234/U-238											28.00	0.40	8.70	8.30	2.73	2.16	1.99	0.38	3.97	2.25	5.00	0.60	14.00	13.40	6.26	3.08	6.67	2.98	44.52	2.80
Uranium 234	12.00	0.20	0.20	0.00	0.20	0.20	0.00	0.00	0.00	0.20	63.00	0.20	7.30	7.10	1.62	1.26	1.23	0.15	1.50	1.20	19.00	0.20	46.00	45.80	6.41	1.91	13.13	3.01	172.35	1.10
Uranium 235	12.00	0.20	0.20	0.00	0.20	0.20	0.00	0.00	0.00	0.20	63.00	0.10	1.30	1.20	0.67	0.49	0.45	0.06	0.20	0.97	19.00	0.10	5.00	4.90	1.22	0.94	1.05	0.24	1.10	0.99
Uranium 238	12.00	0.20	0.20	0.00	0.20	0.20	0.00	0.00	0.00	0.20	63.00	0.20	5.32	5.12	1.04	0.68	1.00	0.13	0.99	1.00	19.00	0.10	6.29	6.19	1.76	1.23	1.52	0.35	2.30	1.10
Uranium Activity (Calc 200_8)											2.00	0.20	6.10	5.90	3.15	1.10	4.17	2.95	17.41	3.15										
Uranium Activity (Calc 907_0)	12.00	0.20	0.20	0.00	0.20	0.20	0.00	0.00	0.00	0.20	29.00	0.20	6.40	6.20	1.50	1.06	1.31	0.24	1.71	1.10	2.00	0.20	0.30	0.10	0.25	0.24	0.07	0.05	0.01	0.25

[a] The data contains negative values.

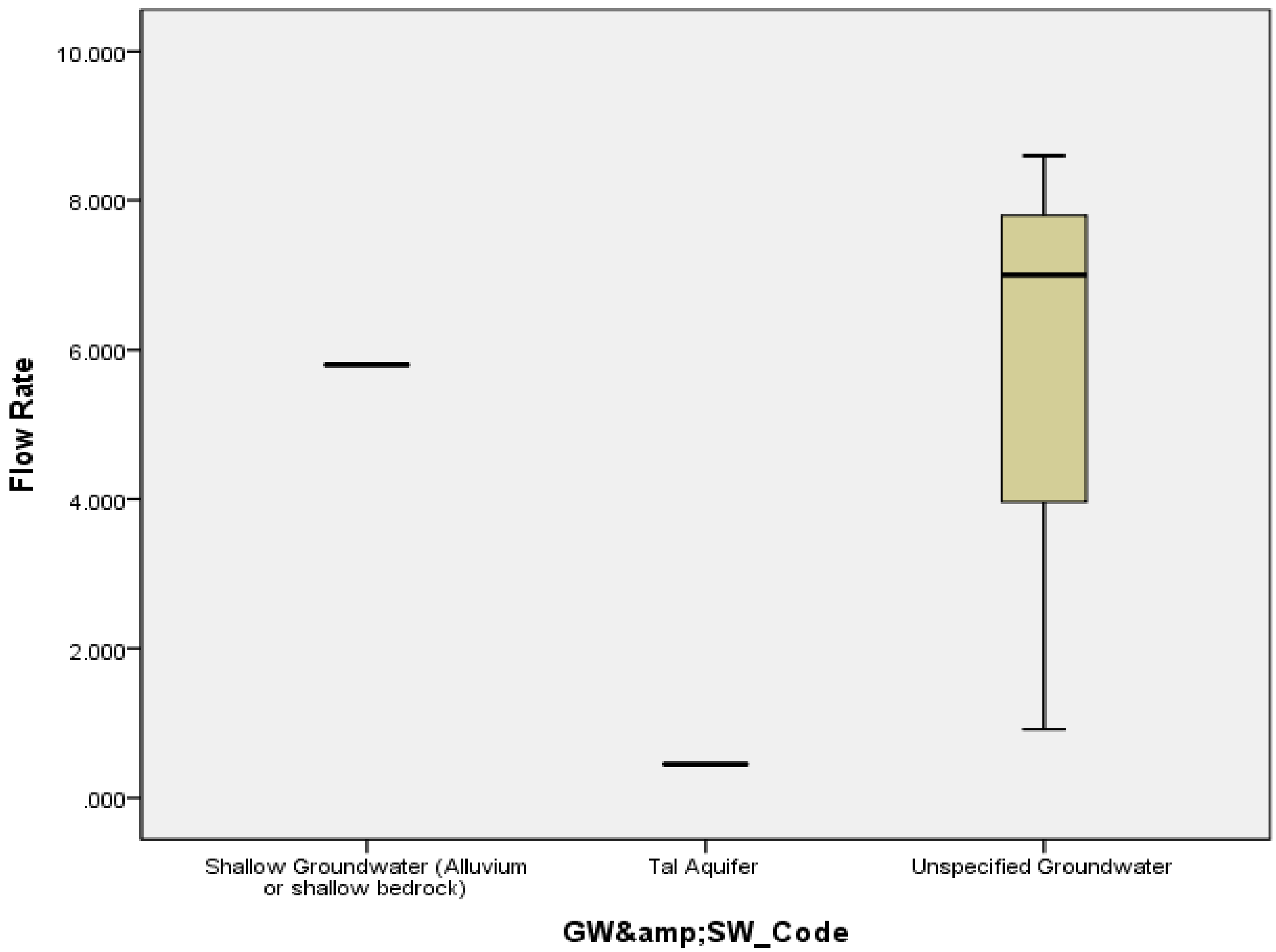
ATTACHMENT 2

Box Plots for All Water Quality Constituents by Groundwater Type

Electrical Conductivity (Field)

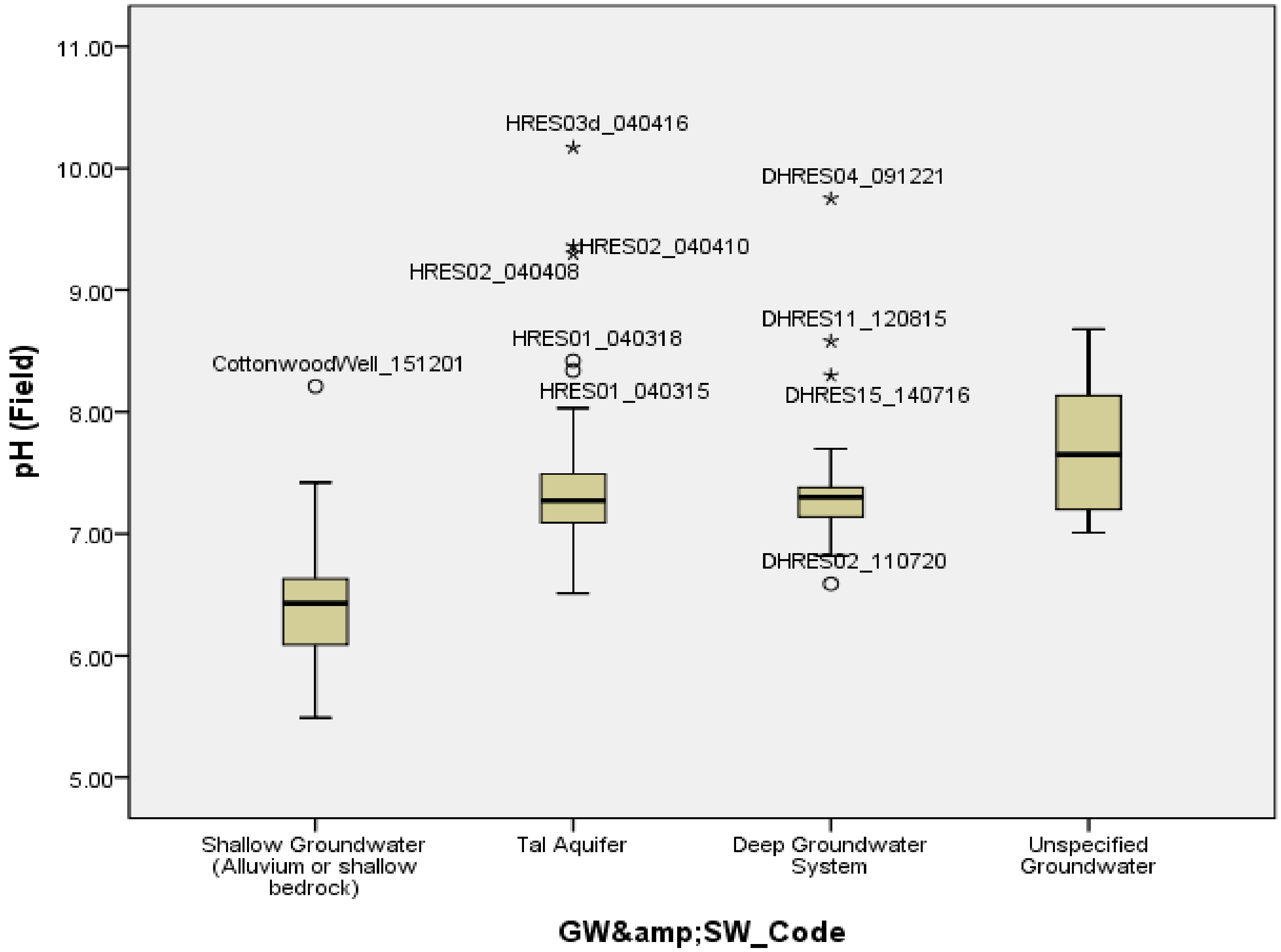


Flow Rate


10.000
8.000
6.000
4.000
2.000
.000
Flow Rate
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Unspecified Groundwater
GW&SW_Code

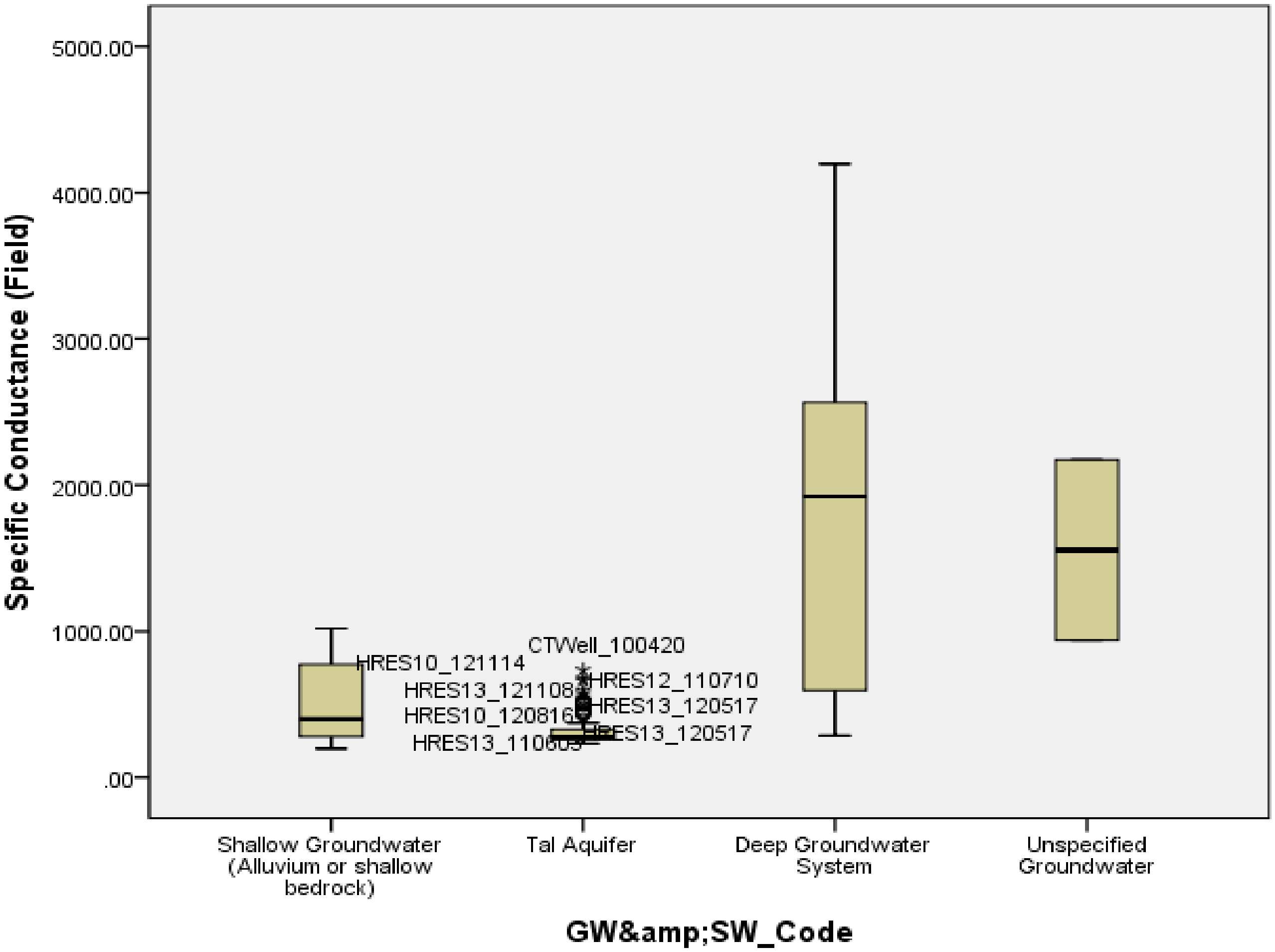
Oxidation-Reduction Potential (Field)

pH (Field)

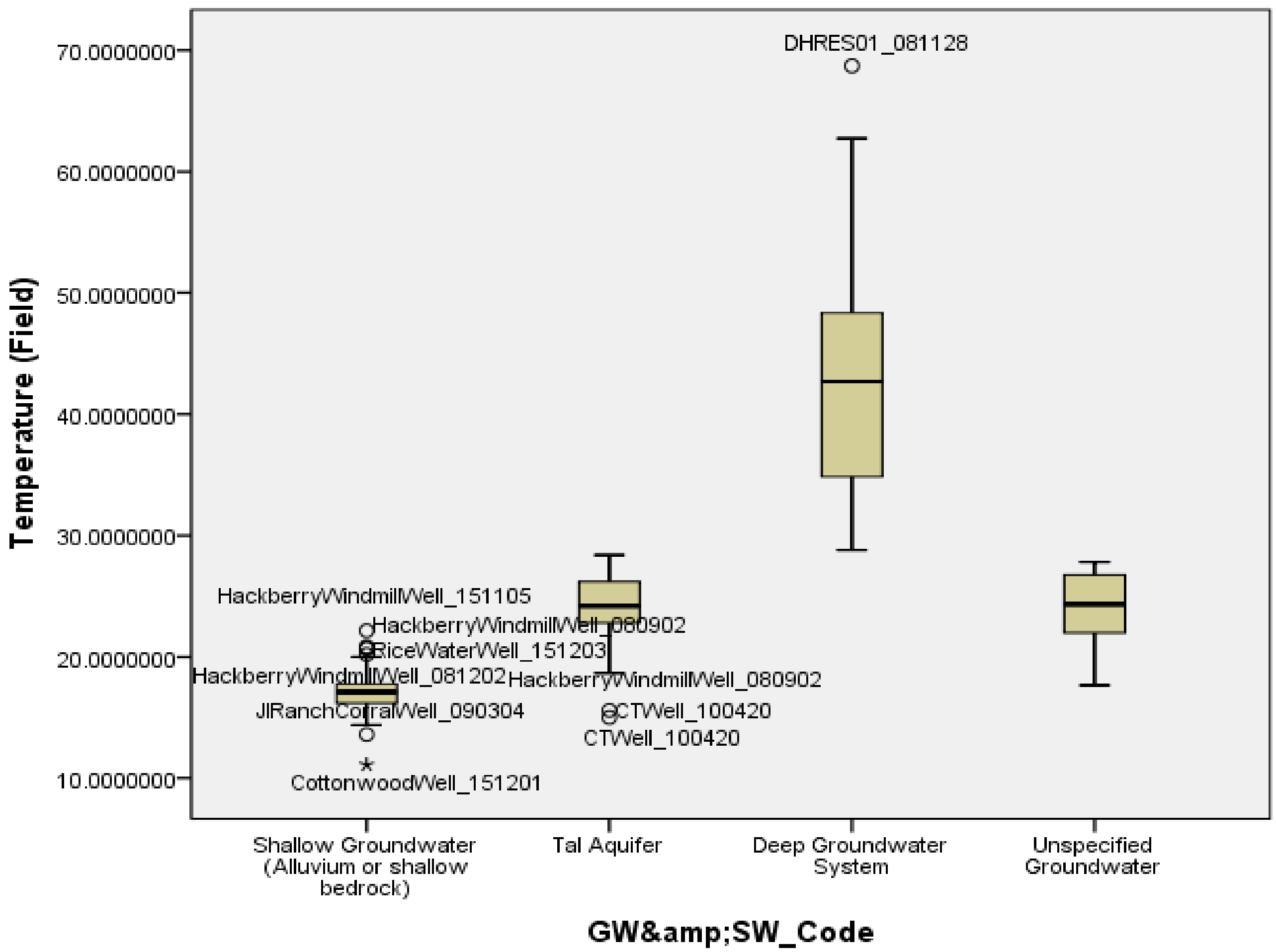


11.00
10.00
9.00
8.00
7.00
6.00
5.00
pH (Field)
HRES03d_040416
DHRES04_091221
HRES02_040410
HRES02_040408
DHRES11_120815
HRES01_040318
CottonwoodWell_151201
HRES01_040315
DHRES15_140716
DHRES02_110720
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

Specific Conductance (Field)

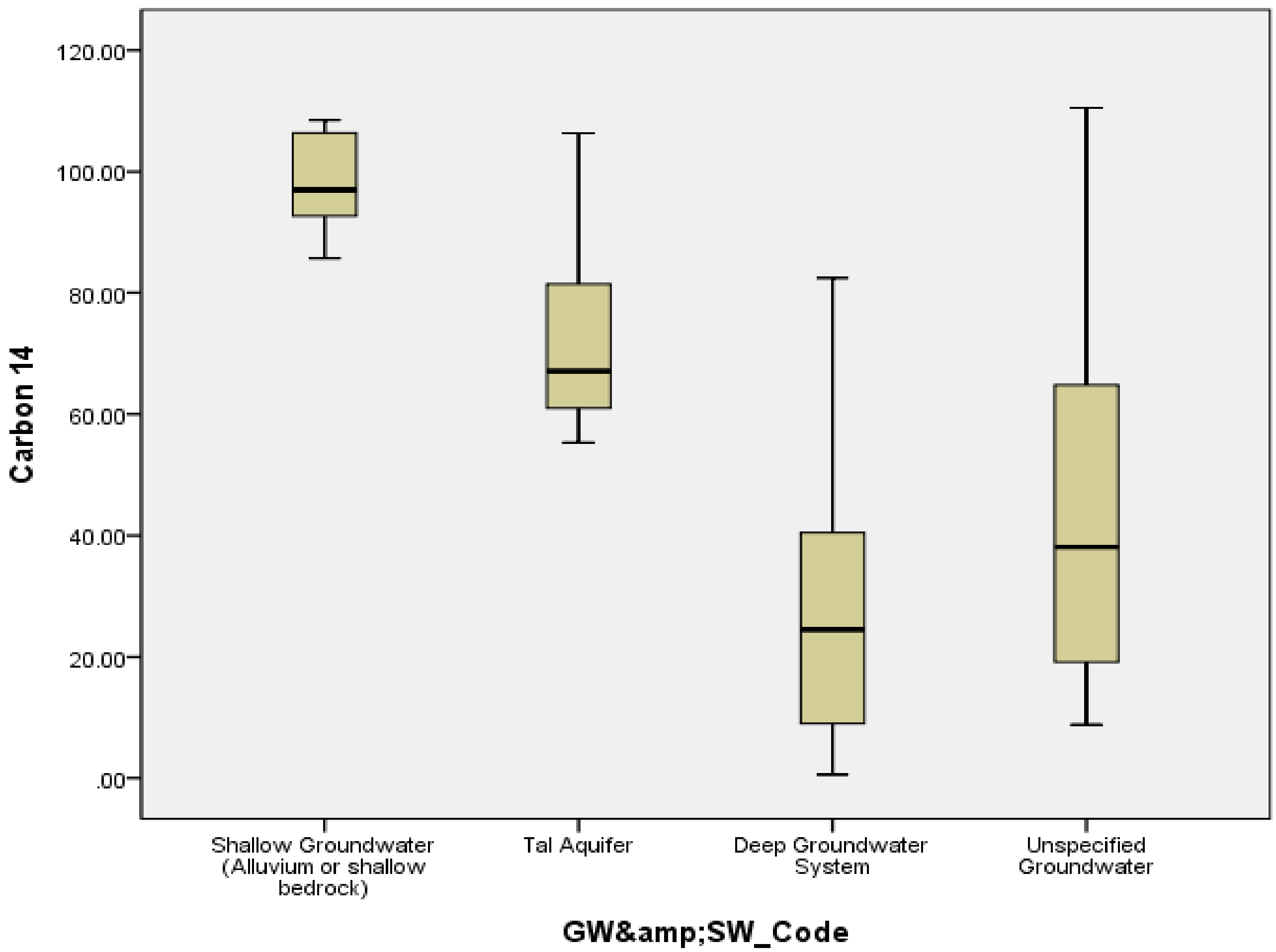


Temperature (Field)

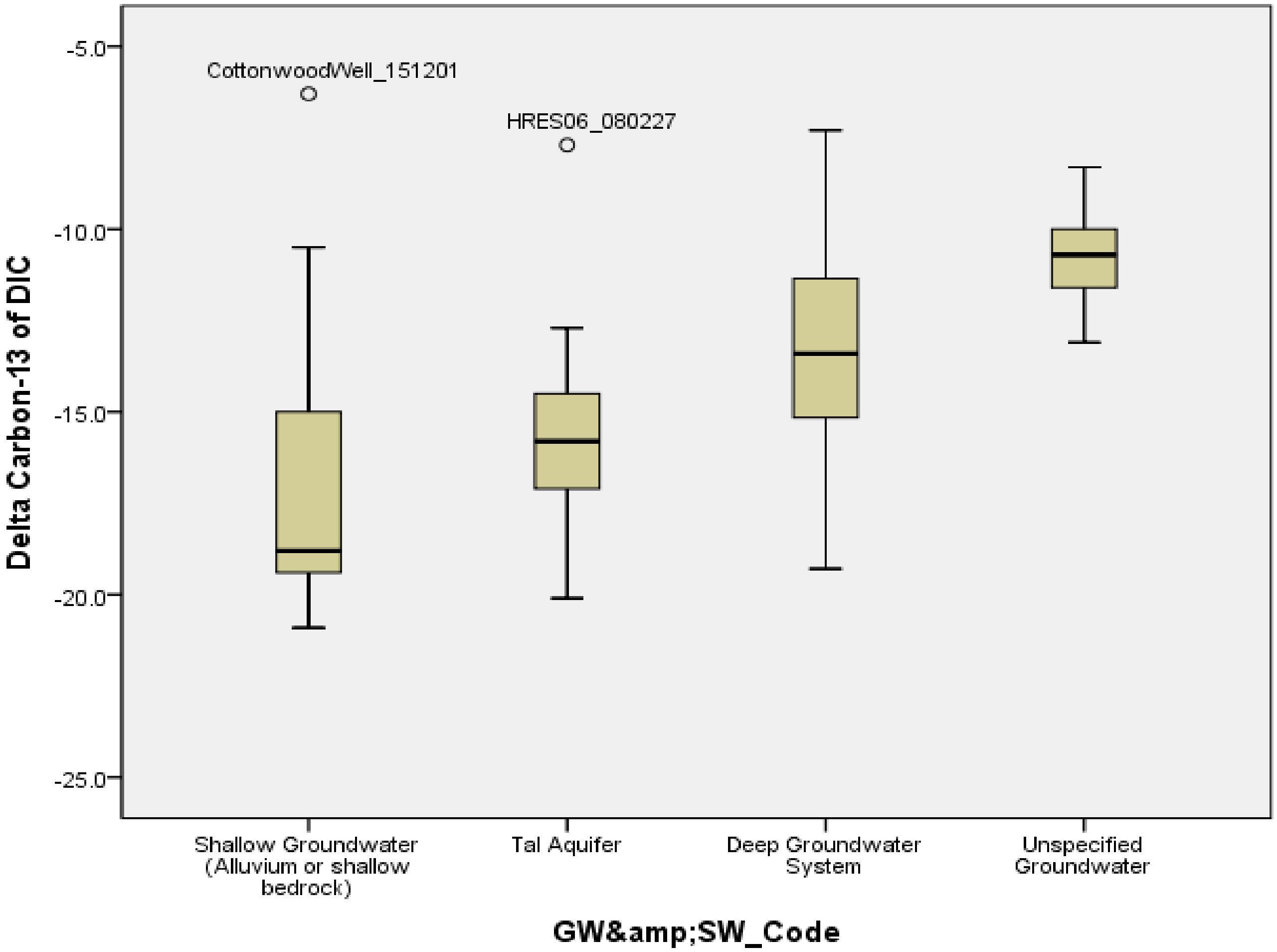


Turbidity (Field)

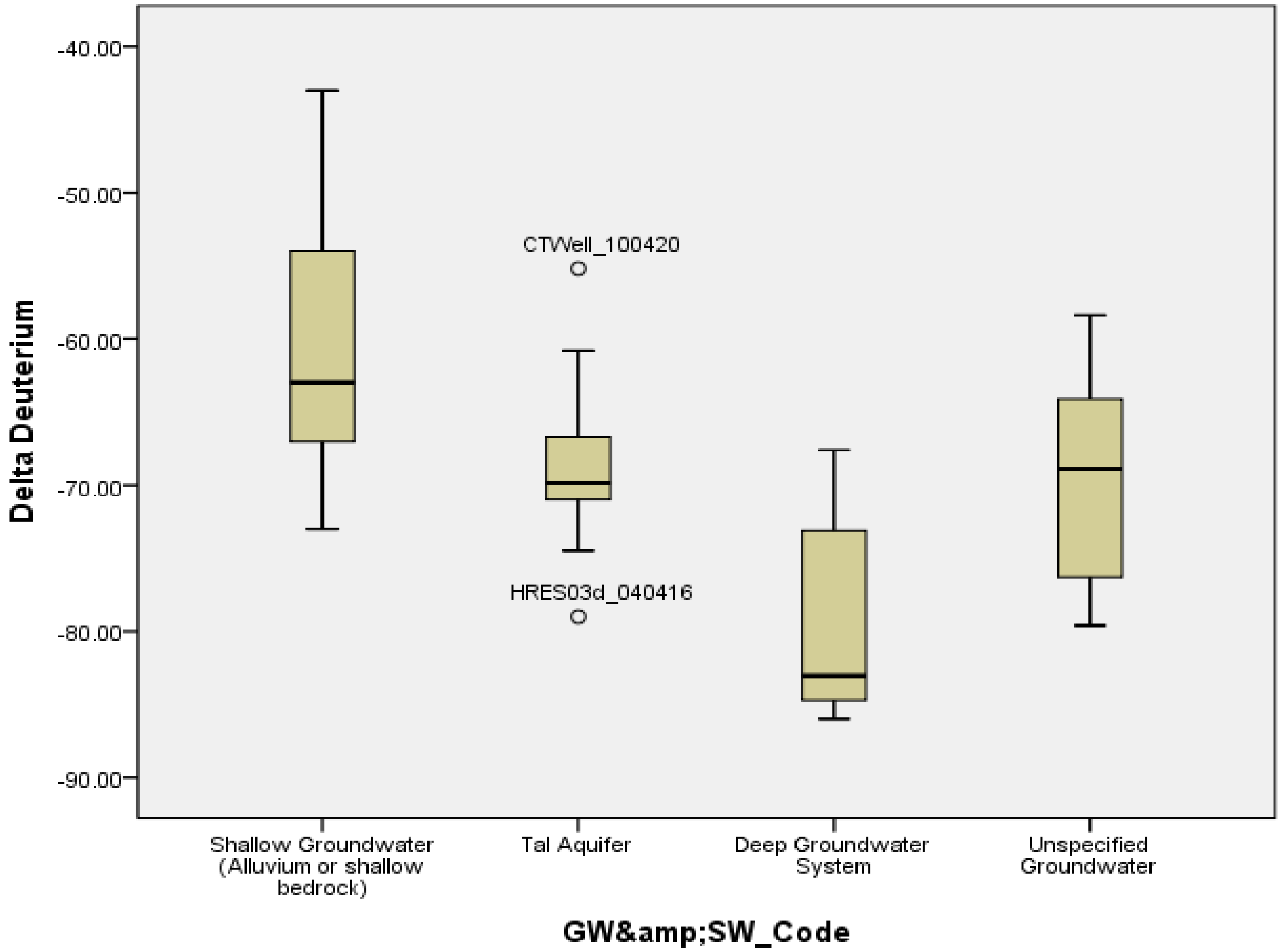
Carbon 14


Carbon 14
120.00
100.00
80.00
60.00
40.00
20.00
.00
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

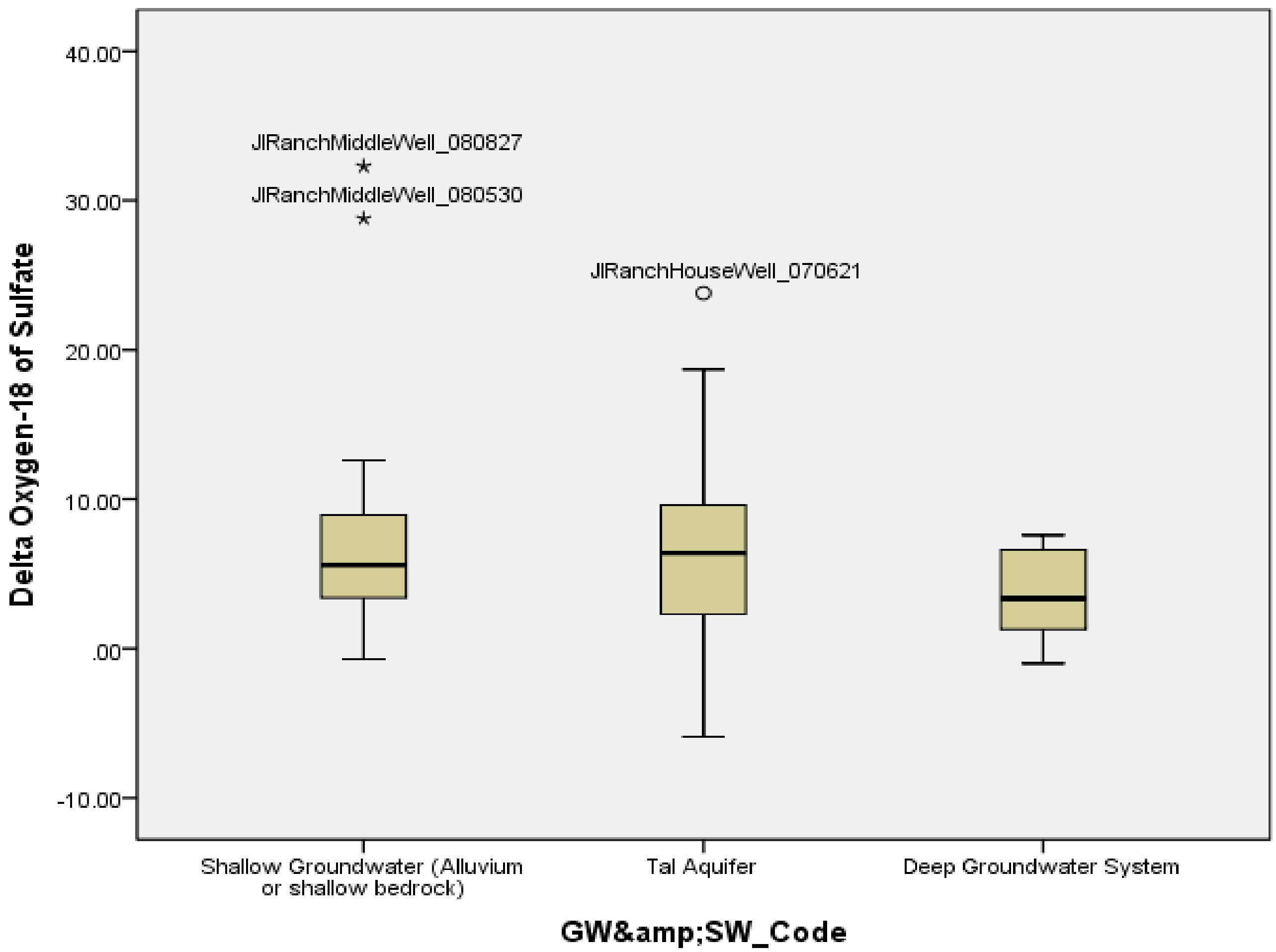
Delta Carbon-13 of DIC



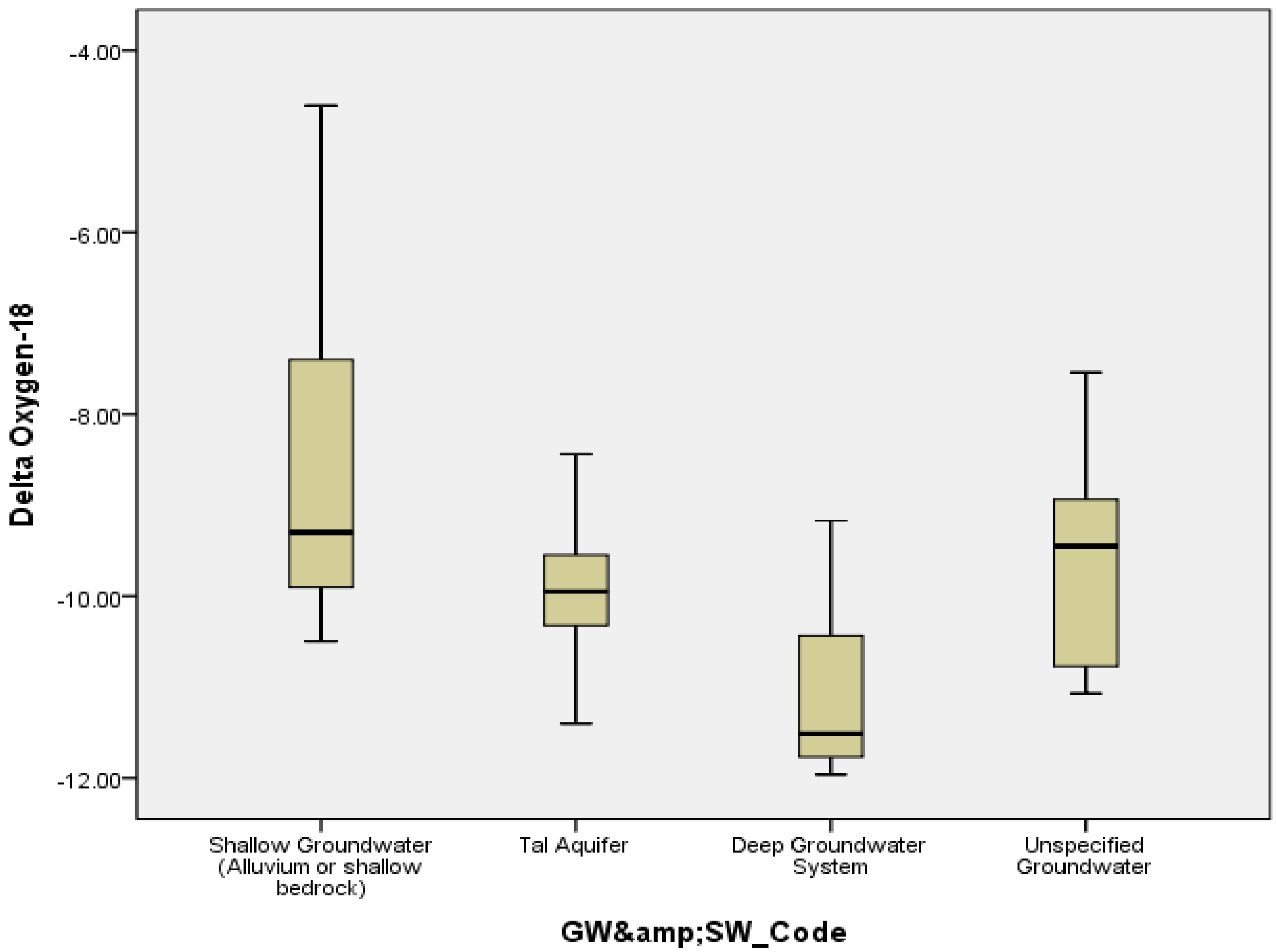
Delta Deuterium



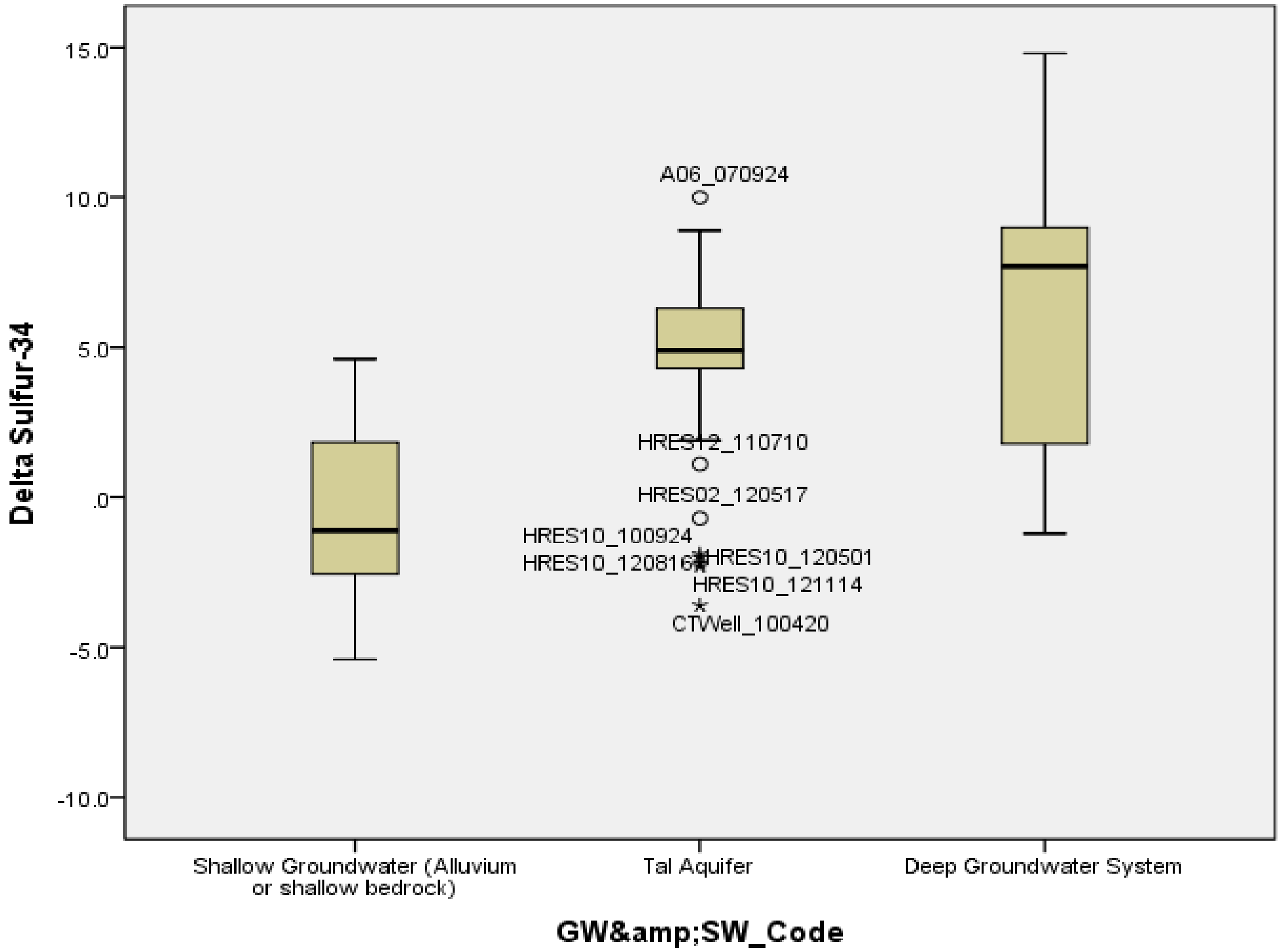
Delta Oxygen-18 of Sulfate



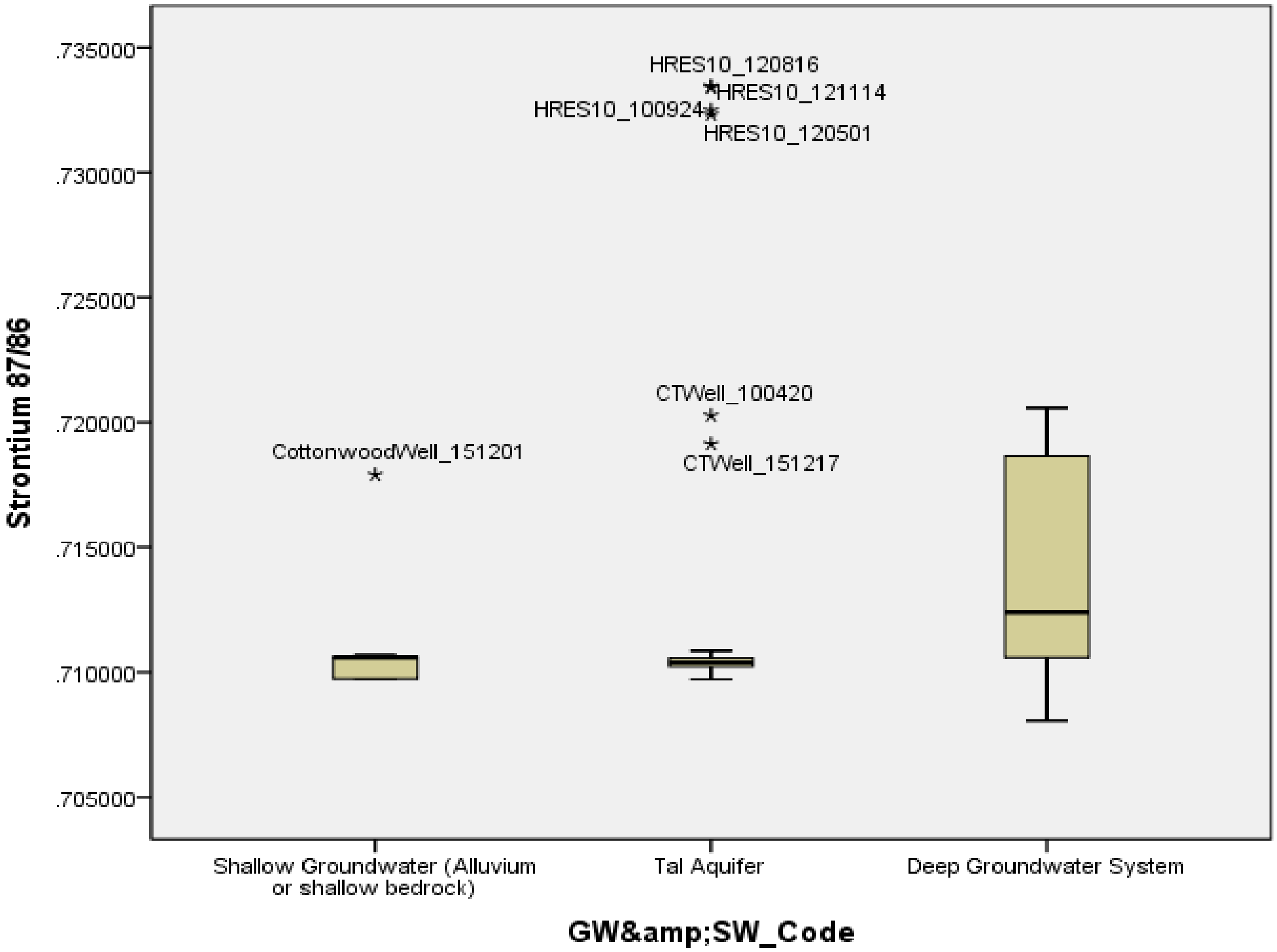
Delta Oxygen-18



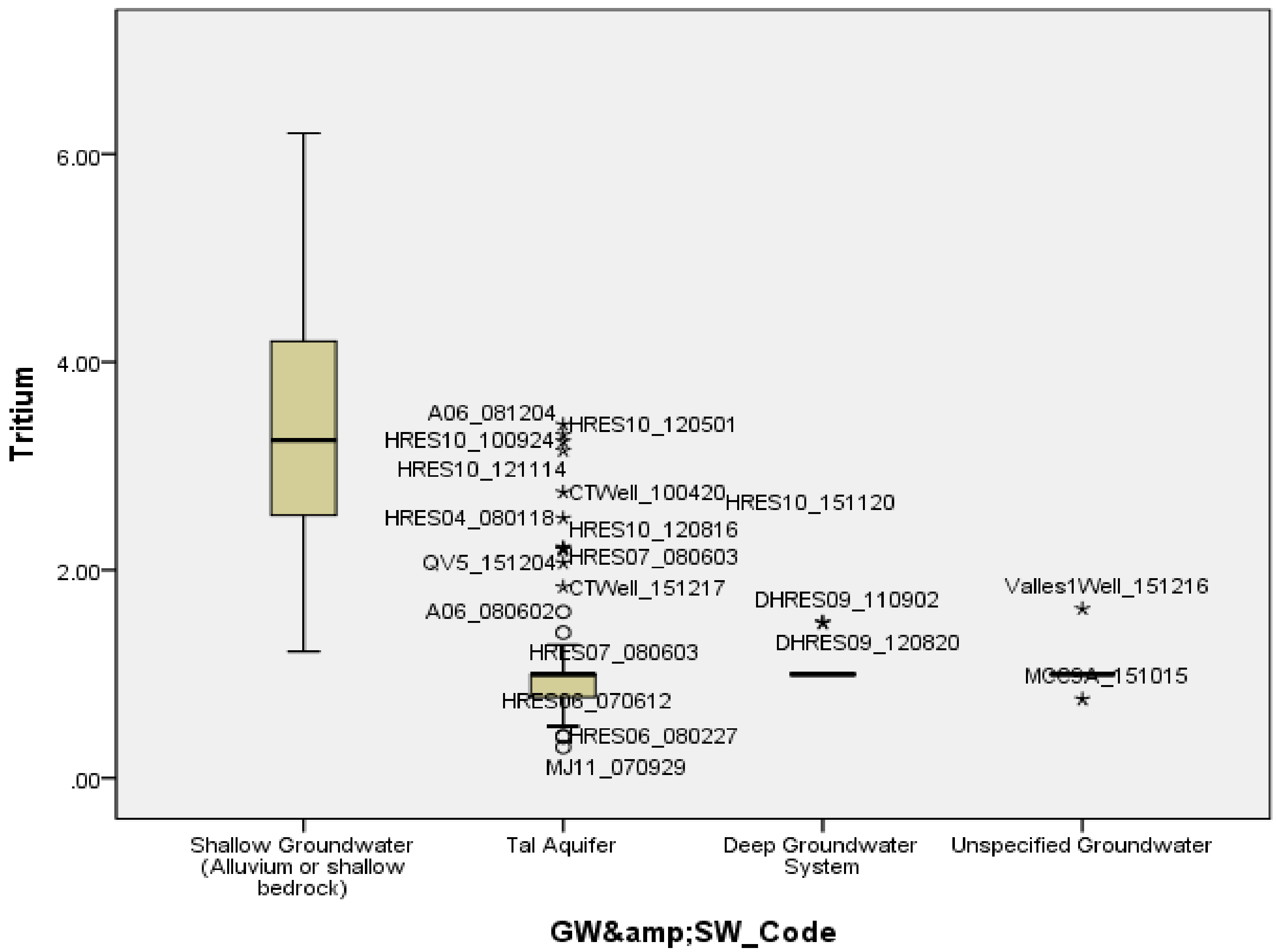
Delta Sulfur-34



Strontium 87/86

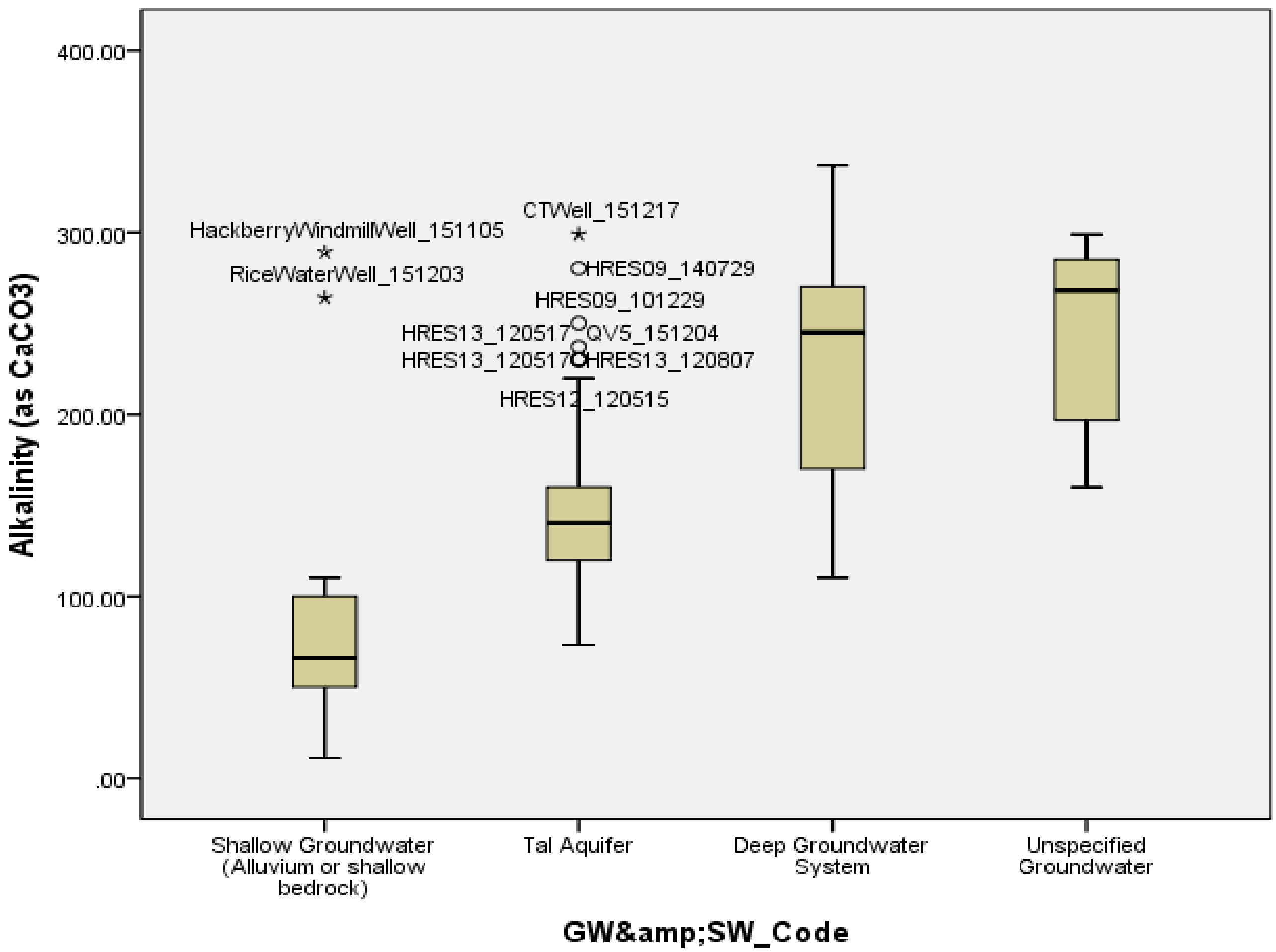


Tritium

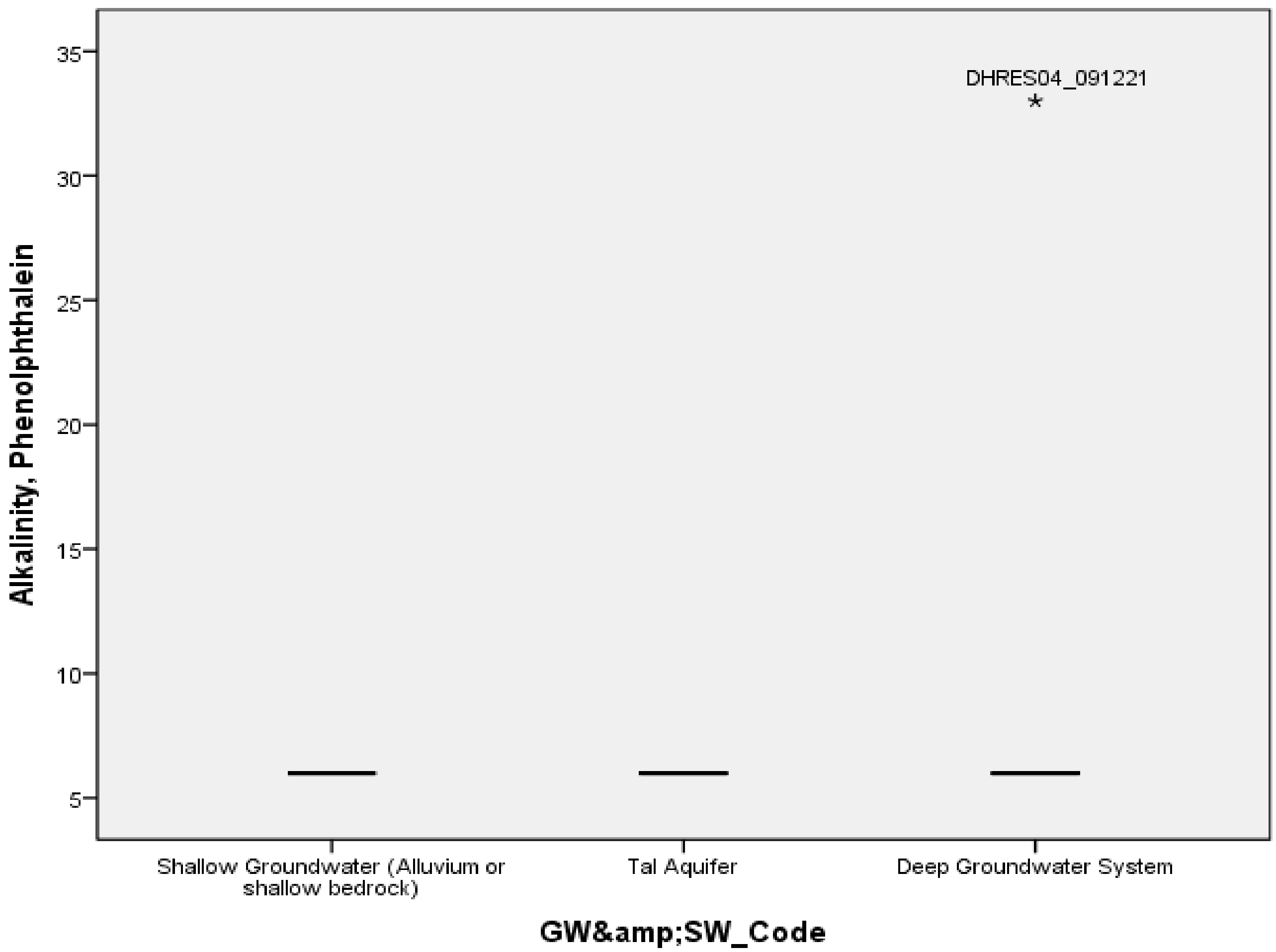


Tritium
6.00
4.00
2.00
.00
A06_081204
HRES10_120501
HRES10_100924
HRES10_121114
CTWell_100420
HRES10_151120
HRES04_080118
HRES10_120816
QV5_151204
HRES07_080603
CTWell_151217
A06_080602
DHRES09_110902
DHRES09_120820
Valles1Well_151216
HRES07_080603
HRES06_070612
MCC9A_151015
HRES06_080227
MJ11_070929
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

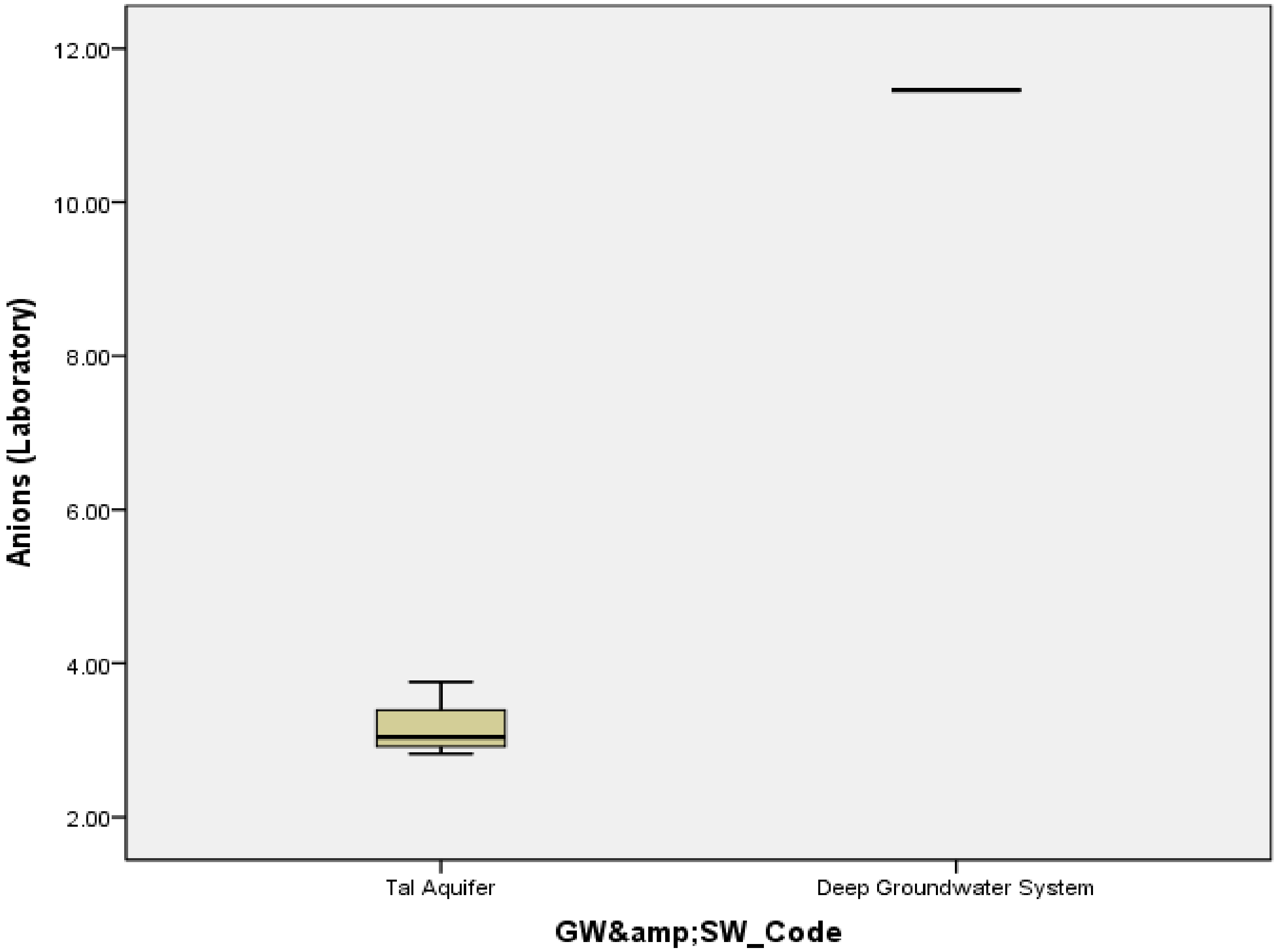
Alkalinity (as CaCO3)



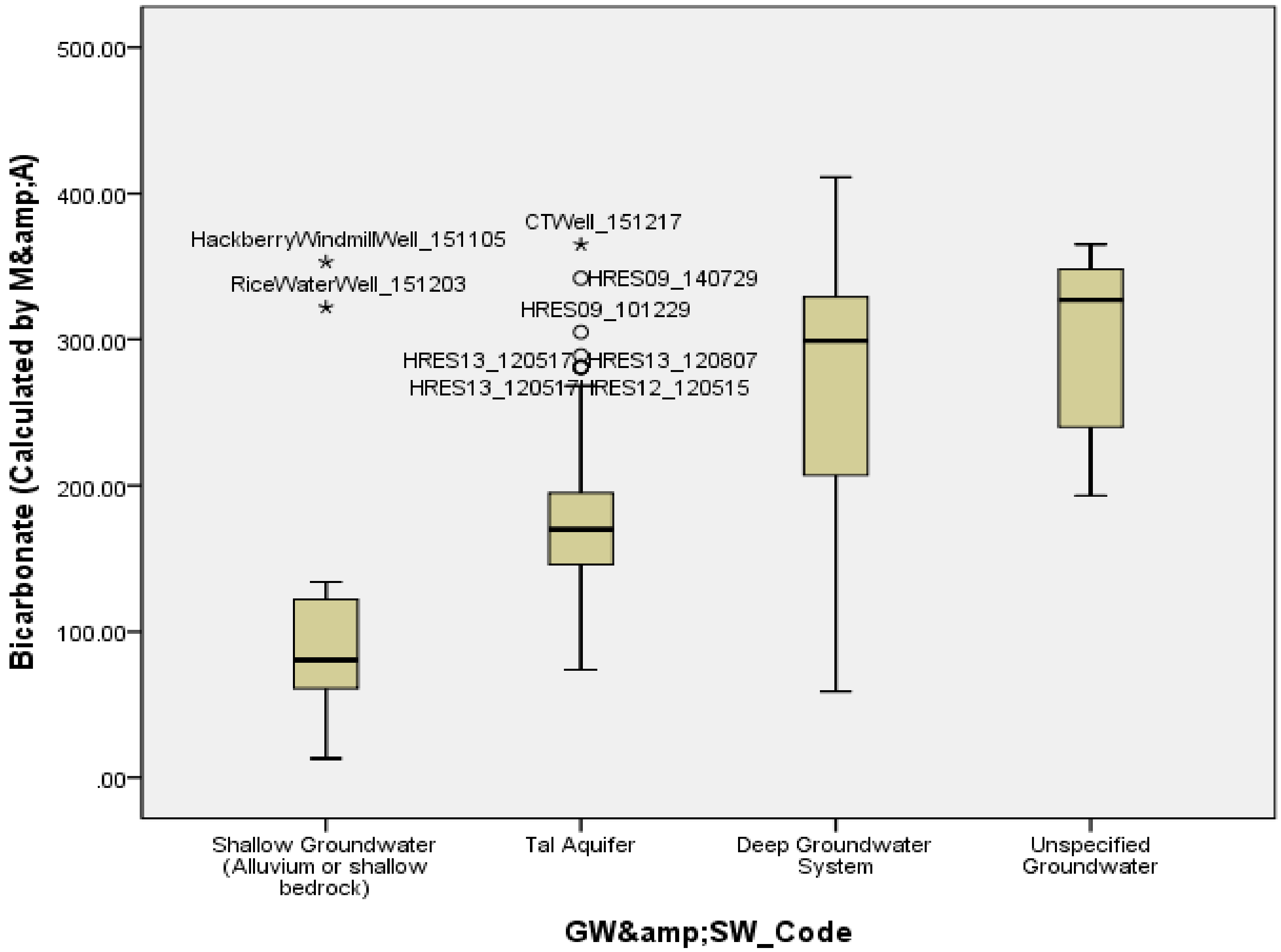
Alkalinity, Phenolphthalein



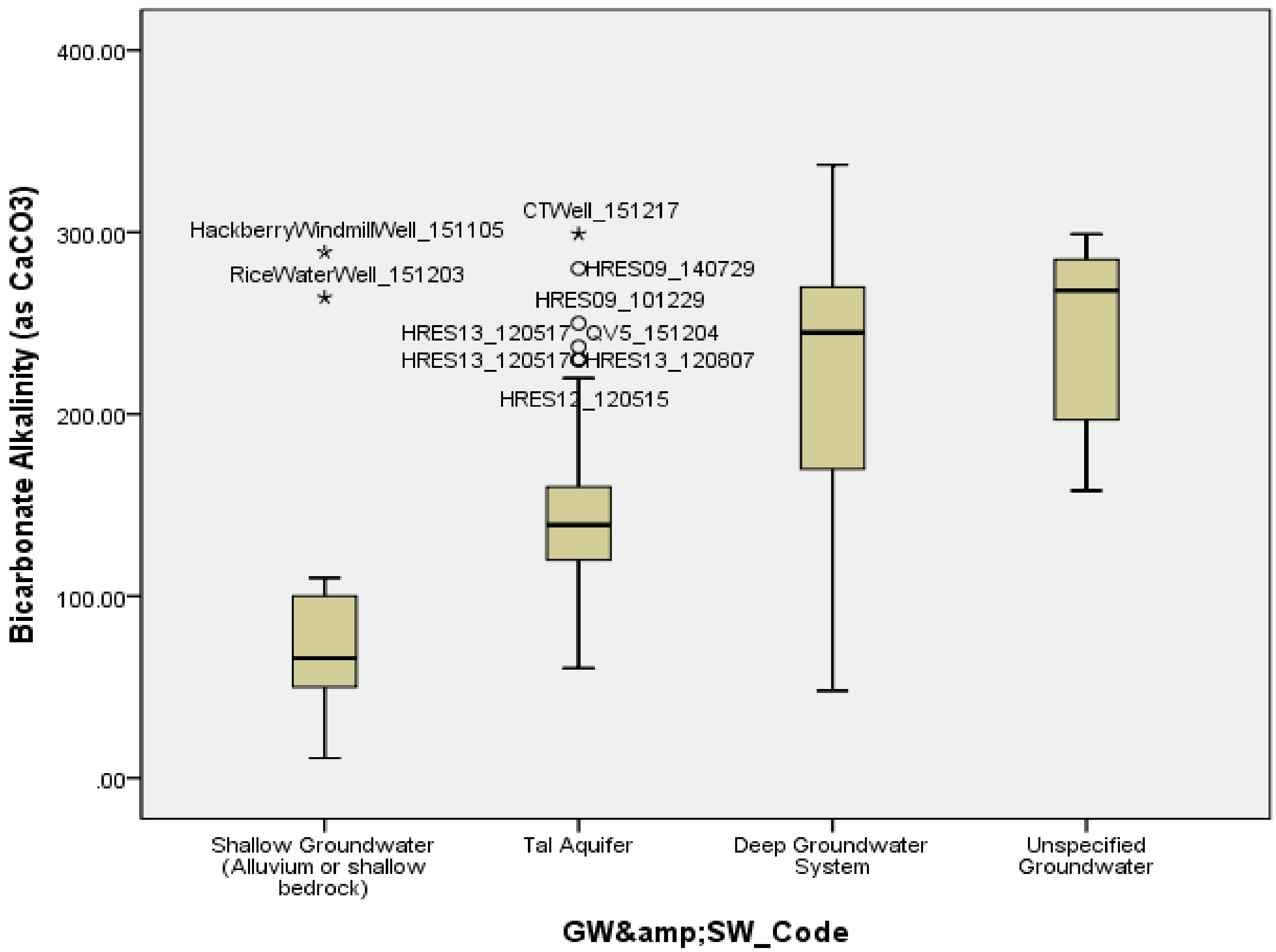
Anions (Laboratory)



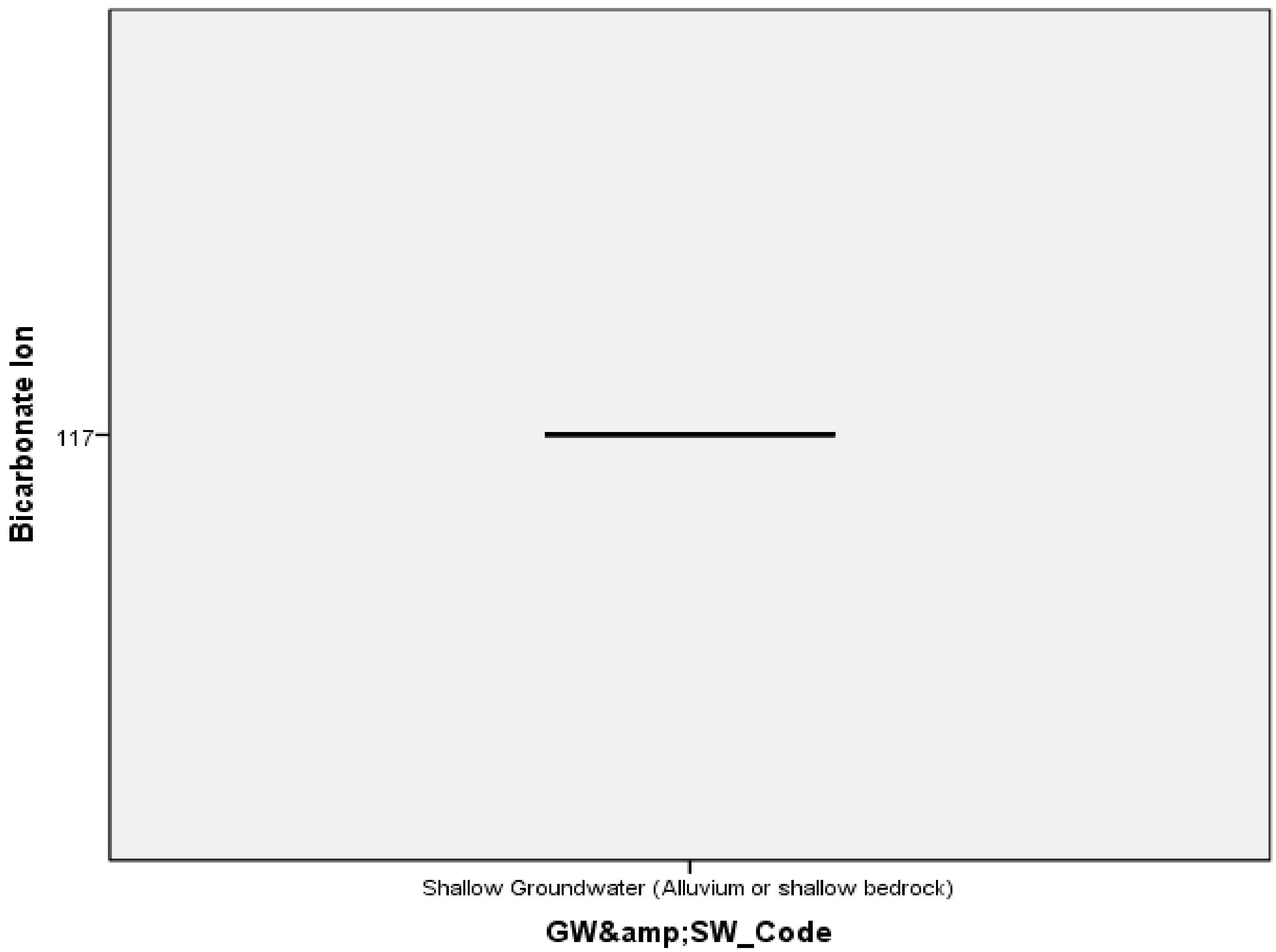
Bicarbonate (Calculated by M&A)



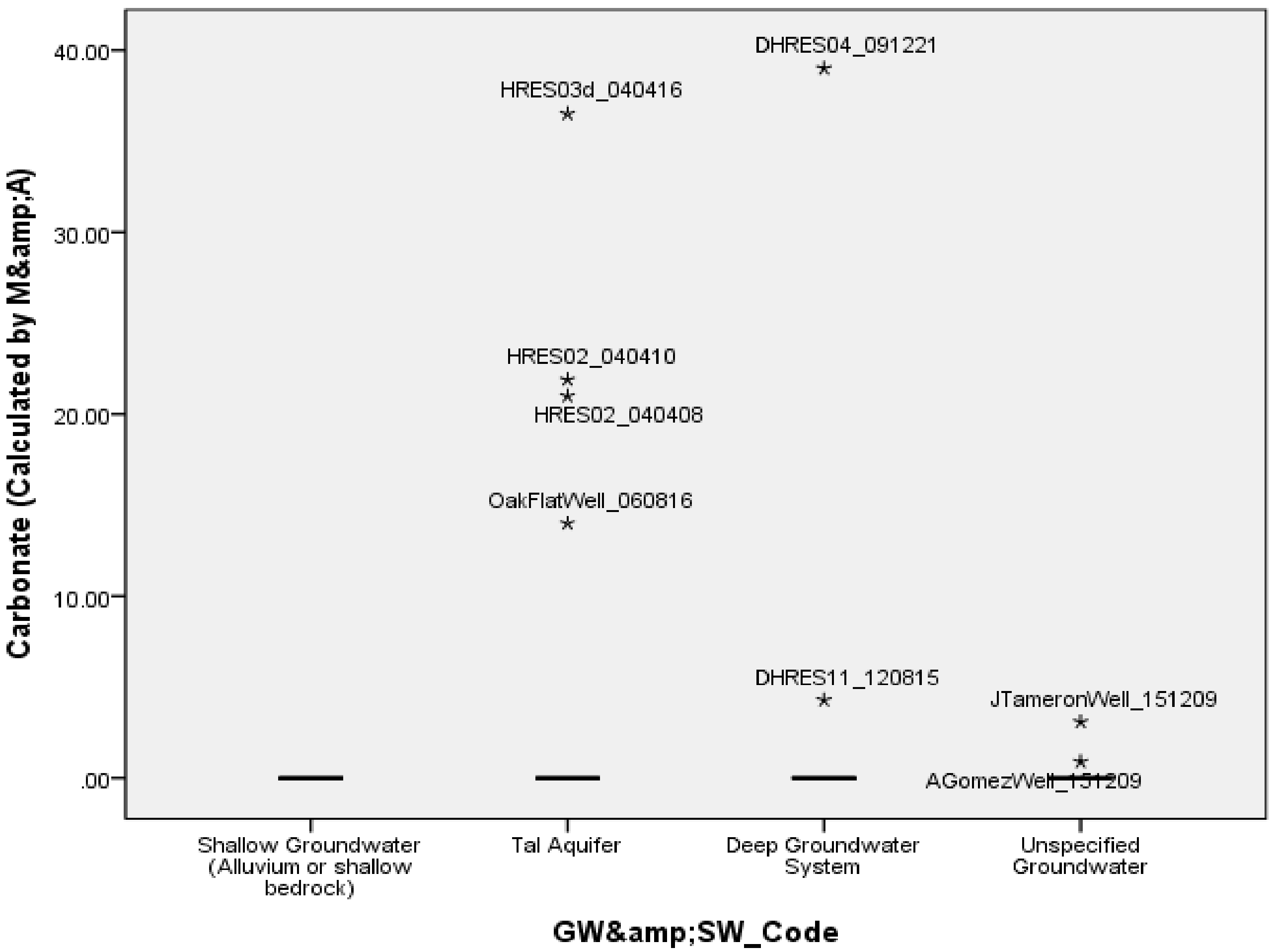
Bicarbonate Alkalinity (as CaCO3)



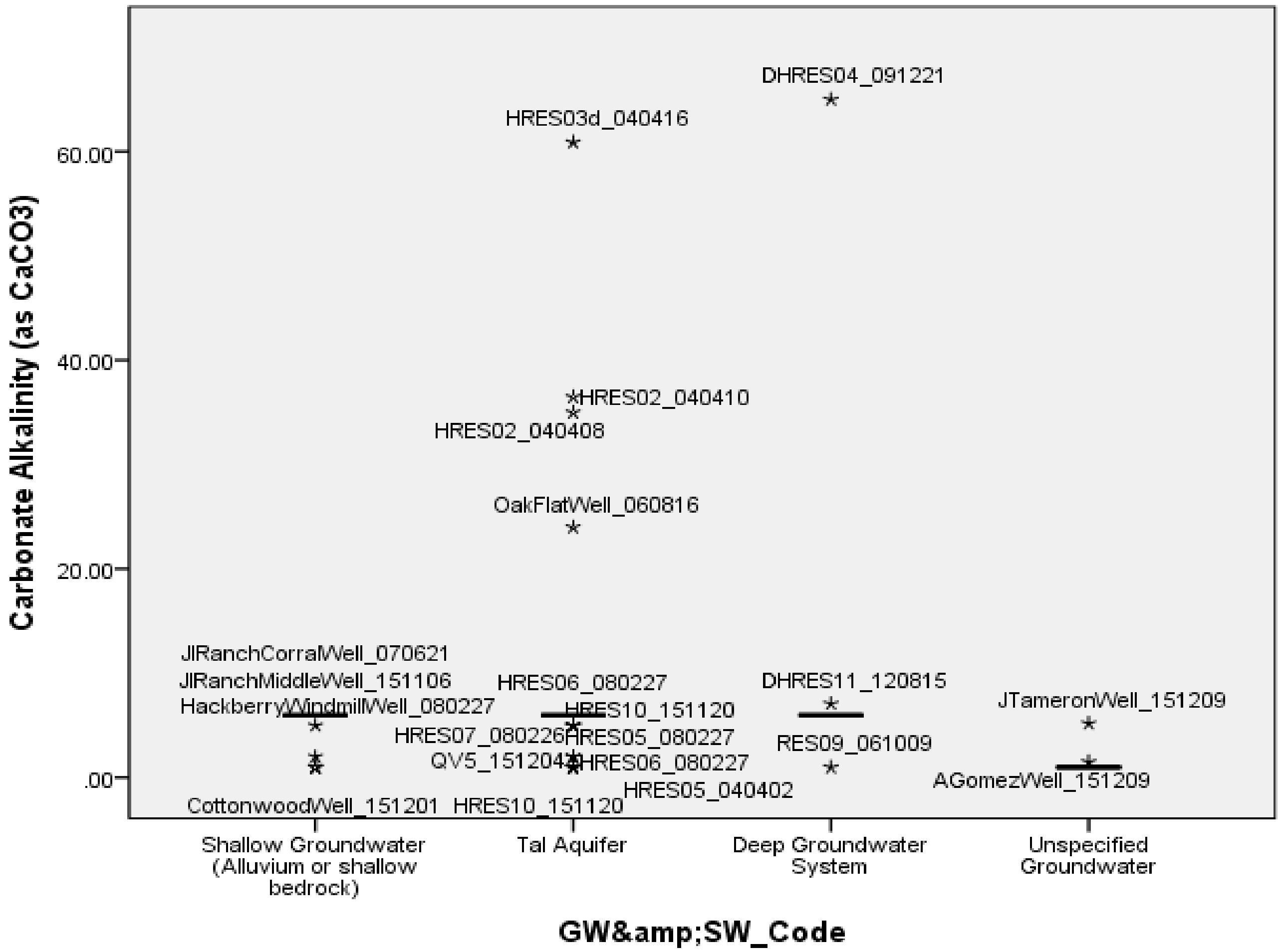
Bicarbonate Ion



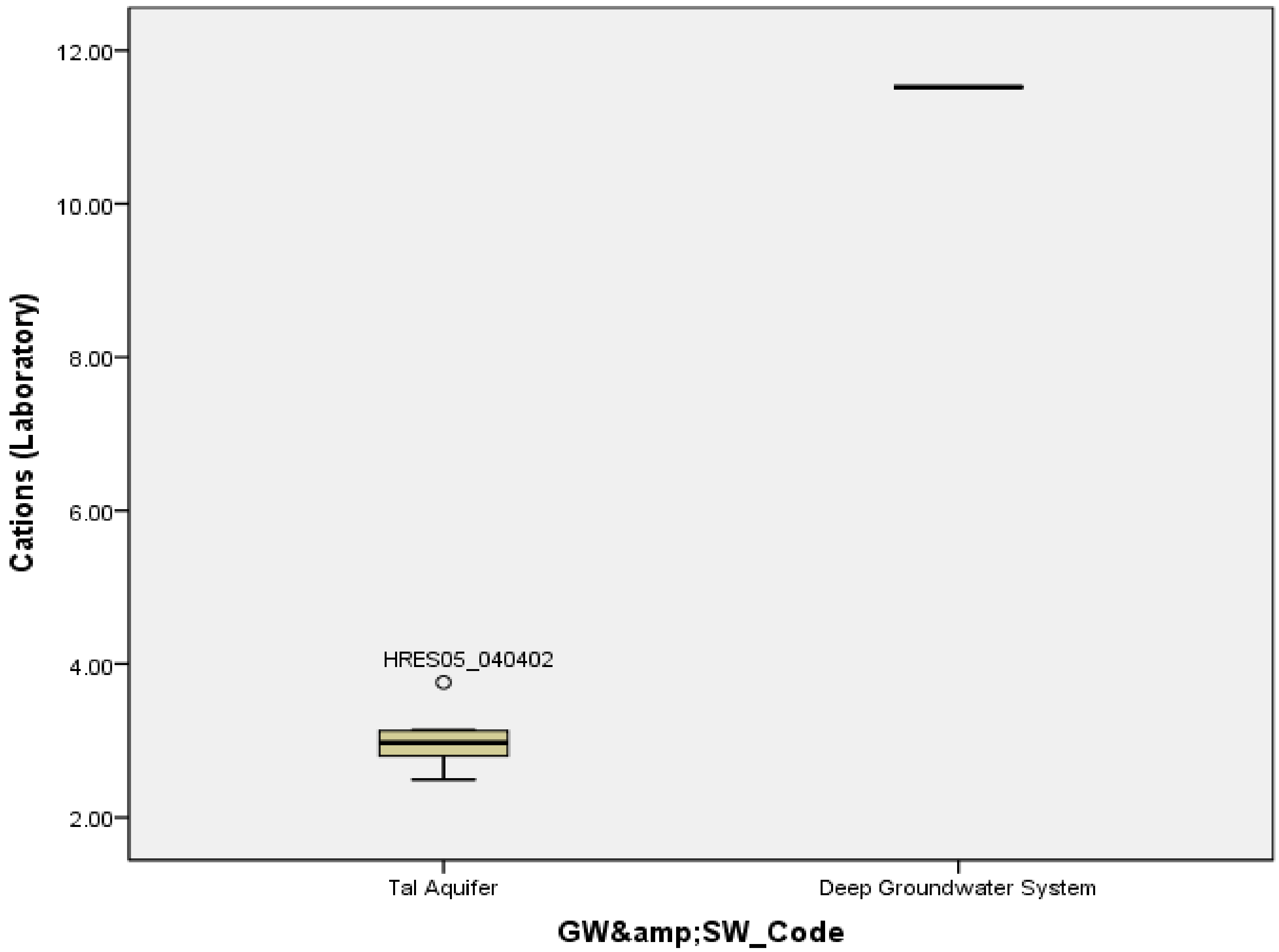
Carbonate (Calculated by M&A)



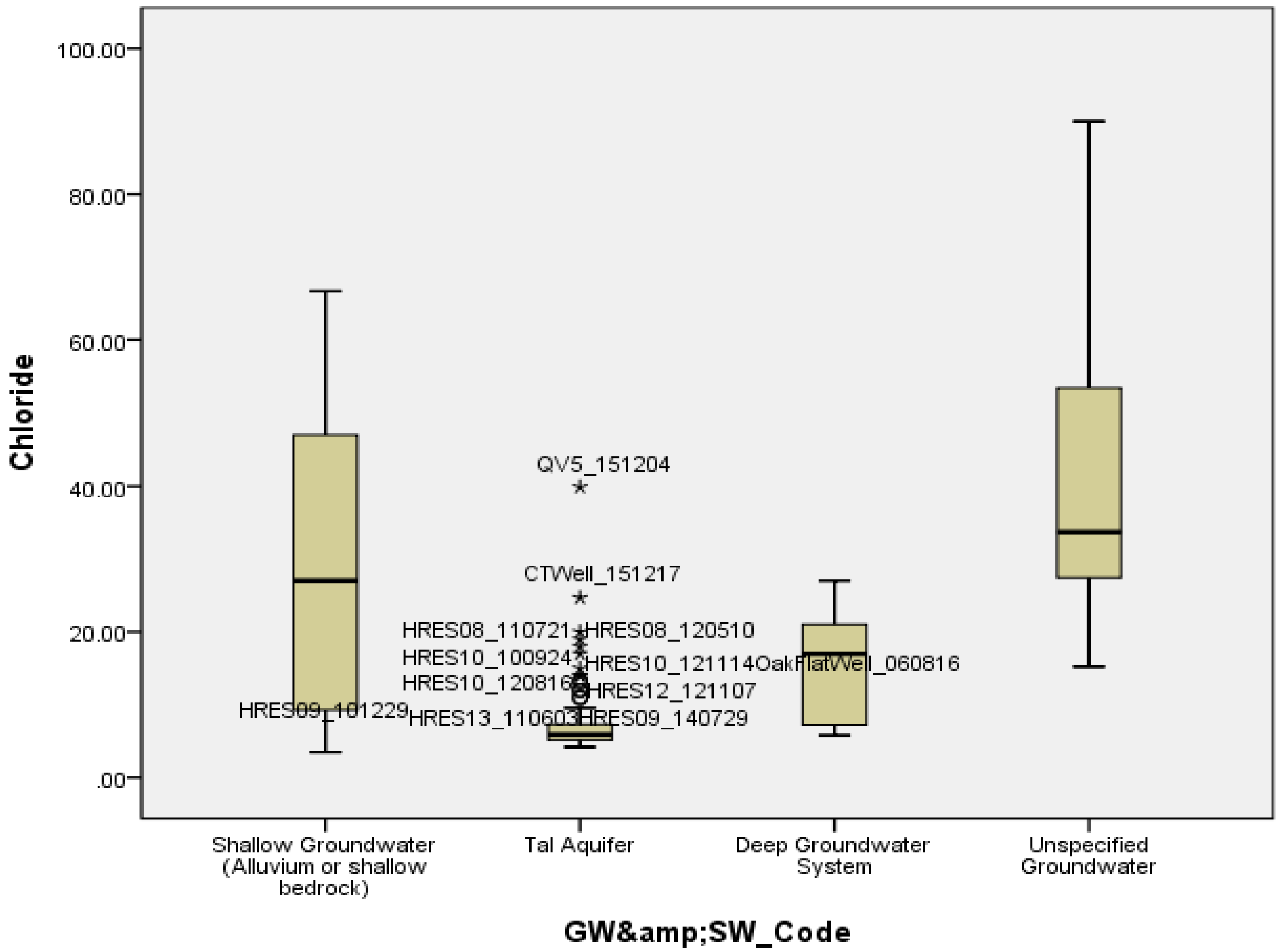
Carbonate Alkalinity (as CaCO3)



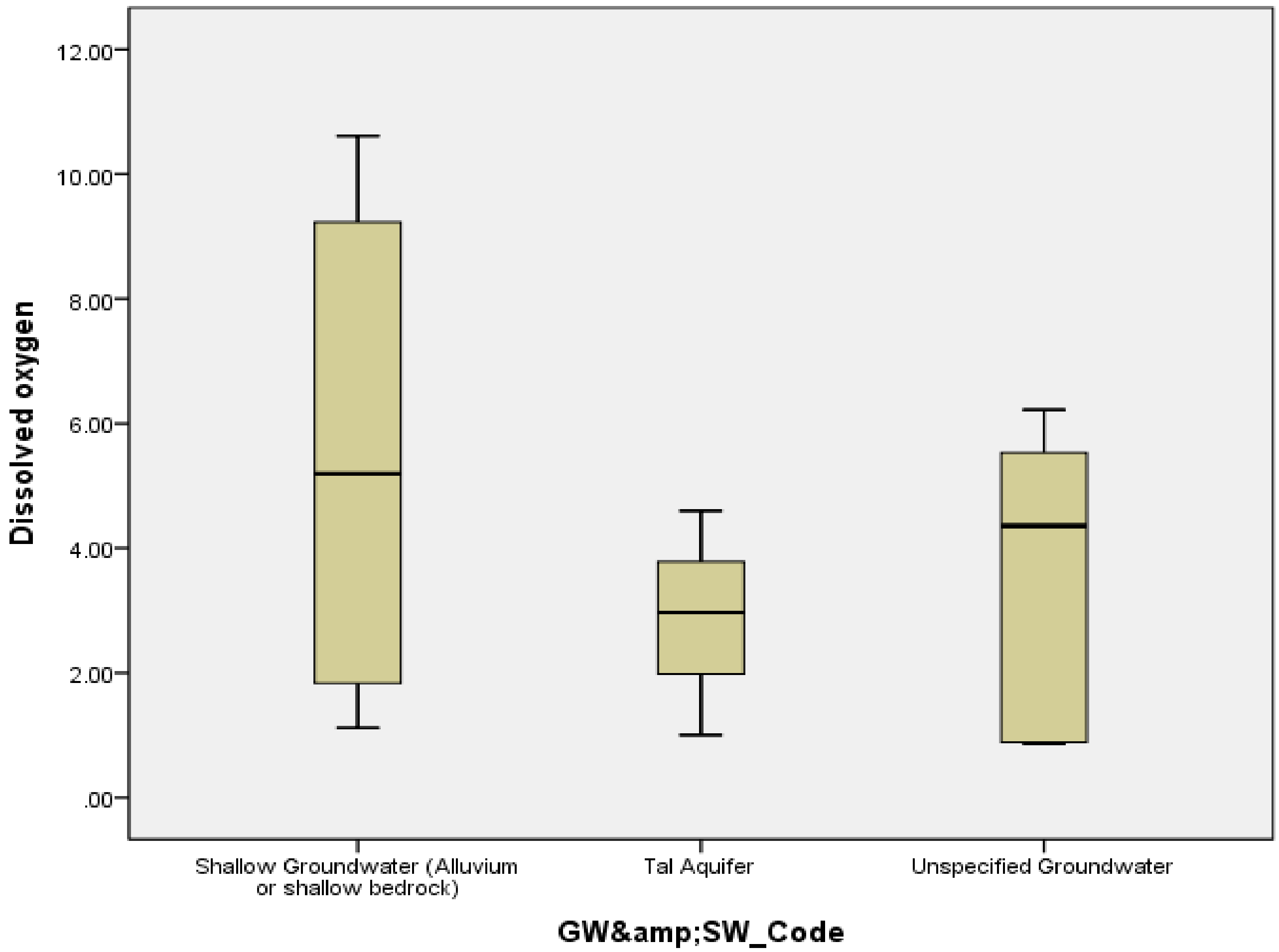
Cations (Laboratory)



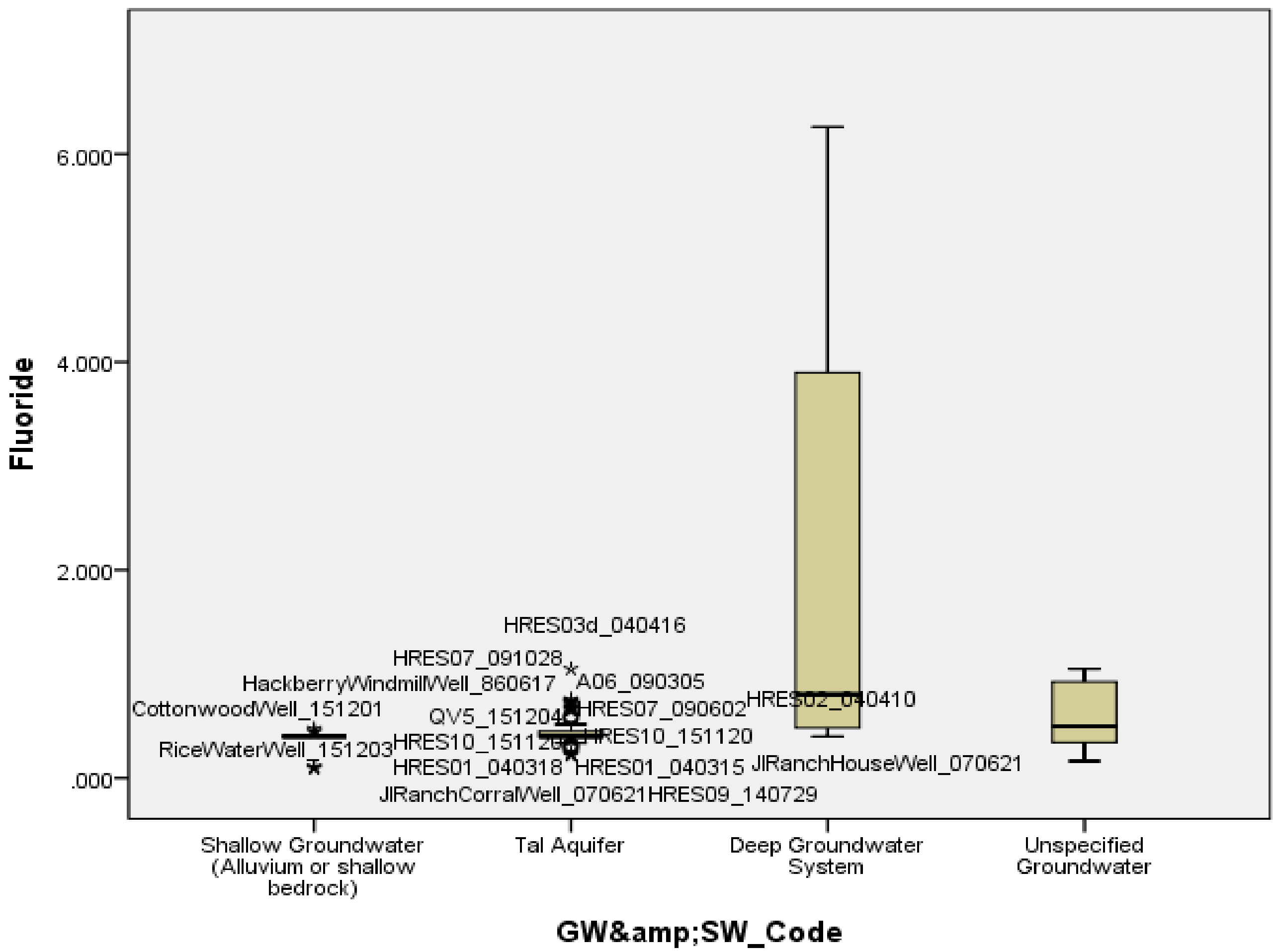
Chloride


Chloride
100.00
80.00
60.00
40.00
20.00
.00
QV5_151204
CTWell_151217
HRES08_110721
HRES08_120510
HRES10_100924
HRES10_121114
OakFlatWell_060816
HRES10_120816
HRES12_121107
HRES09_101229
HRES13_110603
HRES09_140729
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

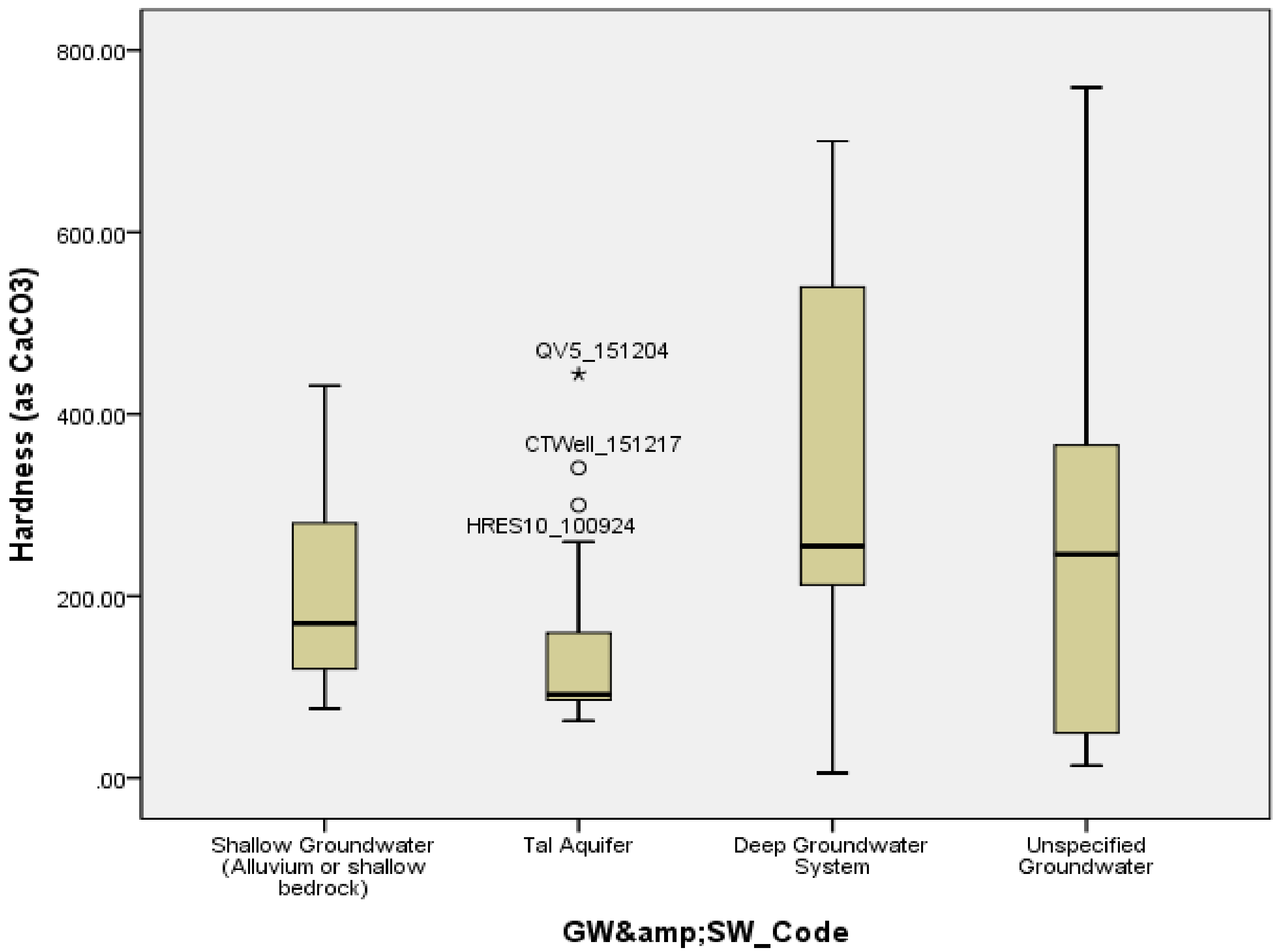
Dissolved oxygen



Fluoride

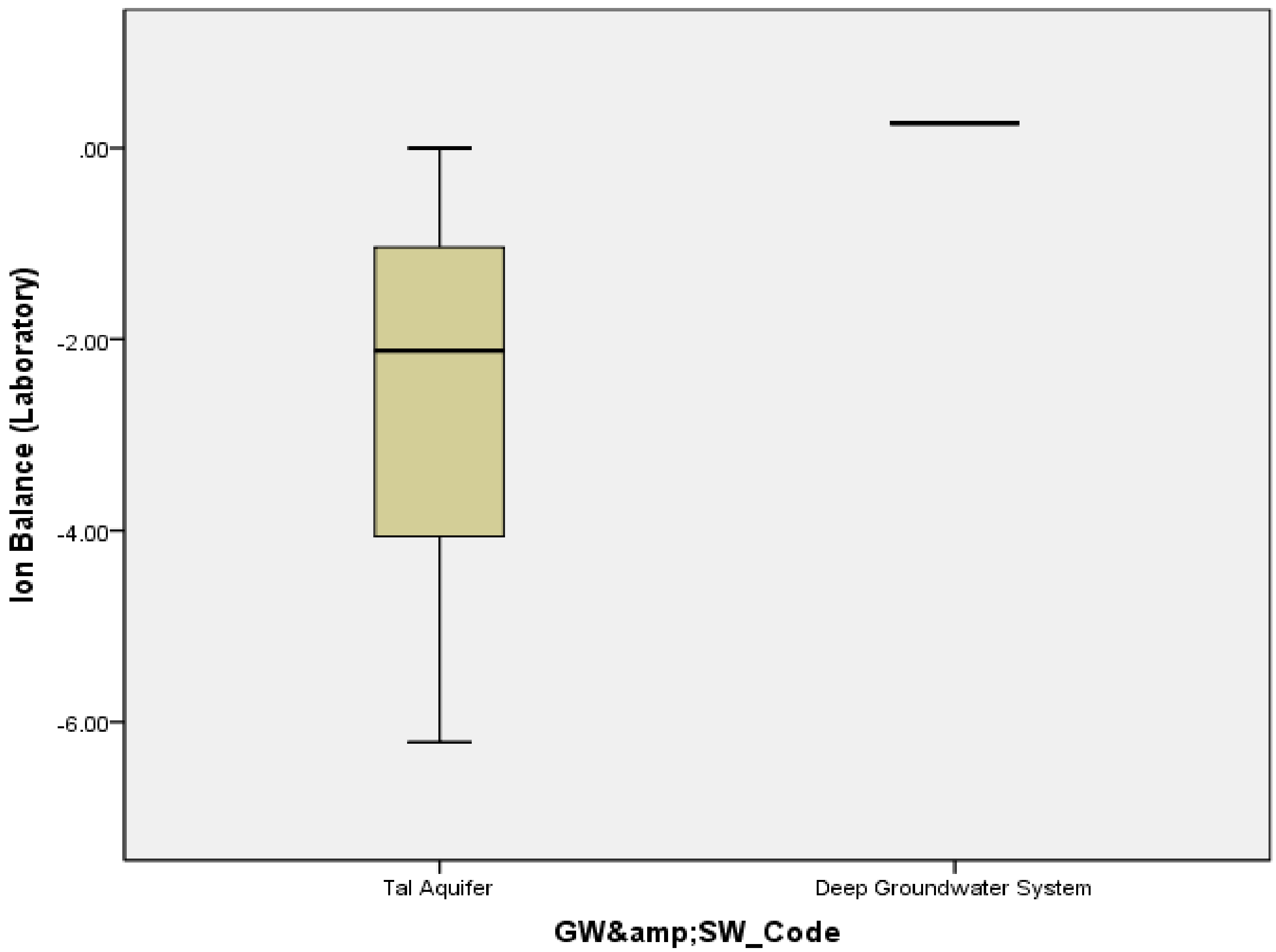

Fluoride
6.000
4.000
2.000
.000
HRES03d_040416
HRES07_091028
HackberryWindmillWell_860617
A06_090305
CottonwoodWell_151201
HRES07_090602
HRES02_040410
QV5_151204
RiceWaterWell_151203
HRES10_151120
HRES10_151120
HRES01_040318
HRES01_040315
JlRanchHouseWell_070621
JlRanchCorralWell_070621
HRES09_140729
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

Hardness (as CaCO3)

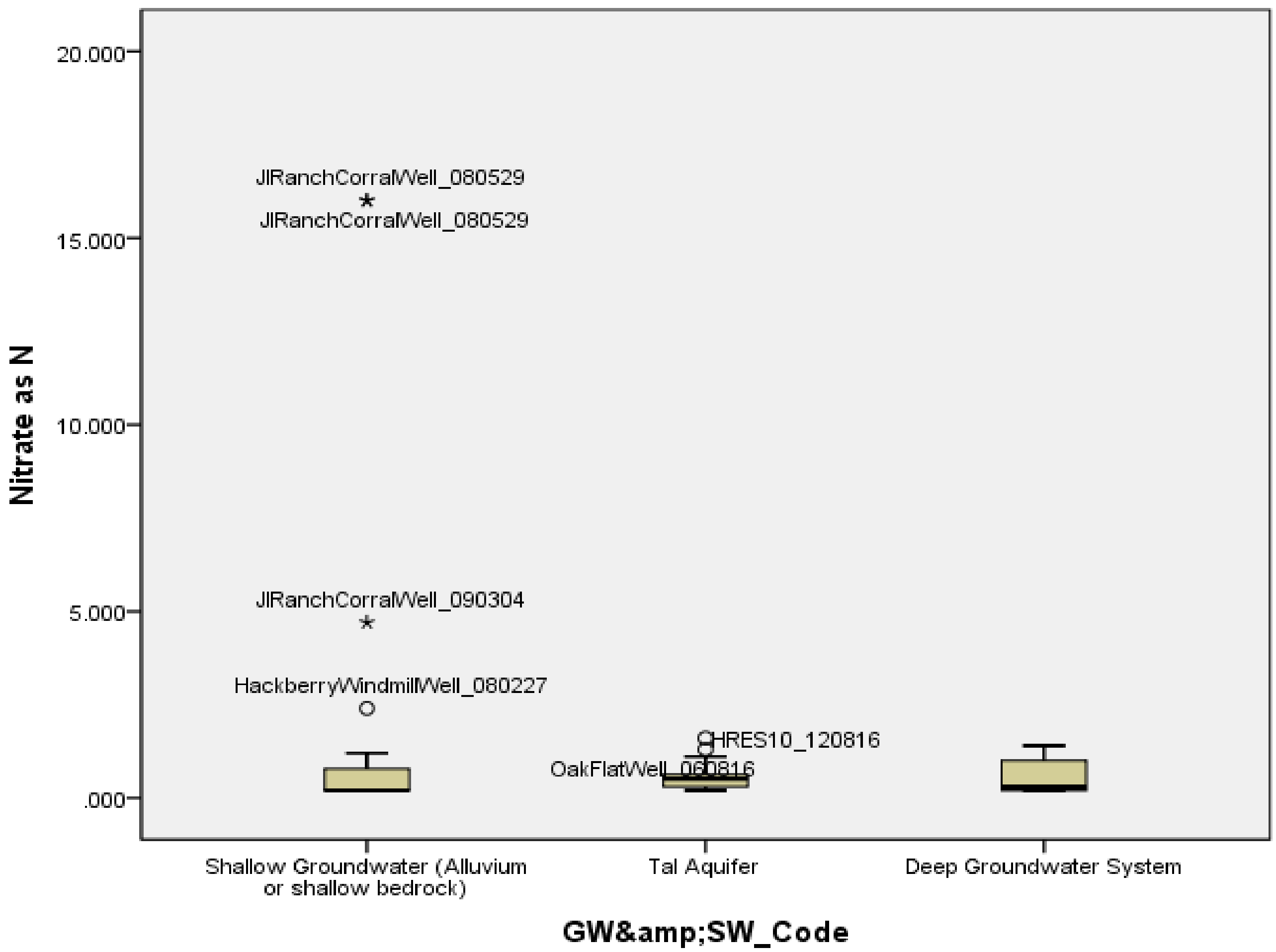


Hydroxide Alkalinity (as CaCO3)

Ion Balance (Laboratory)

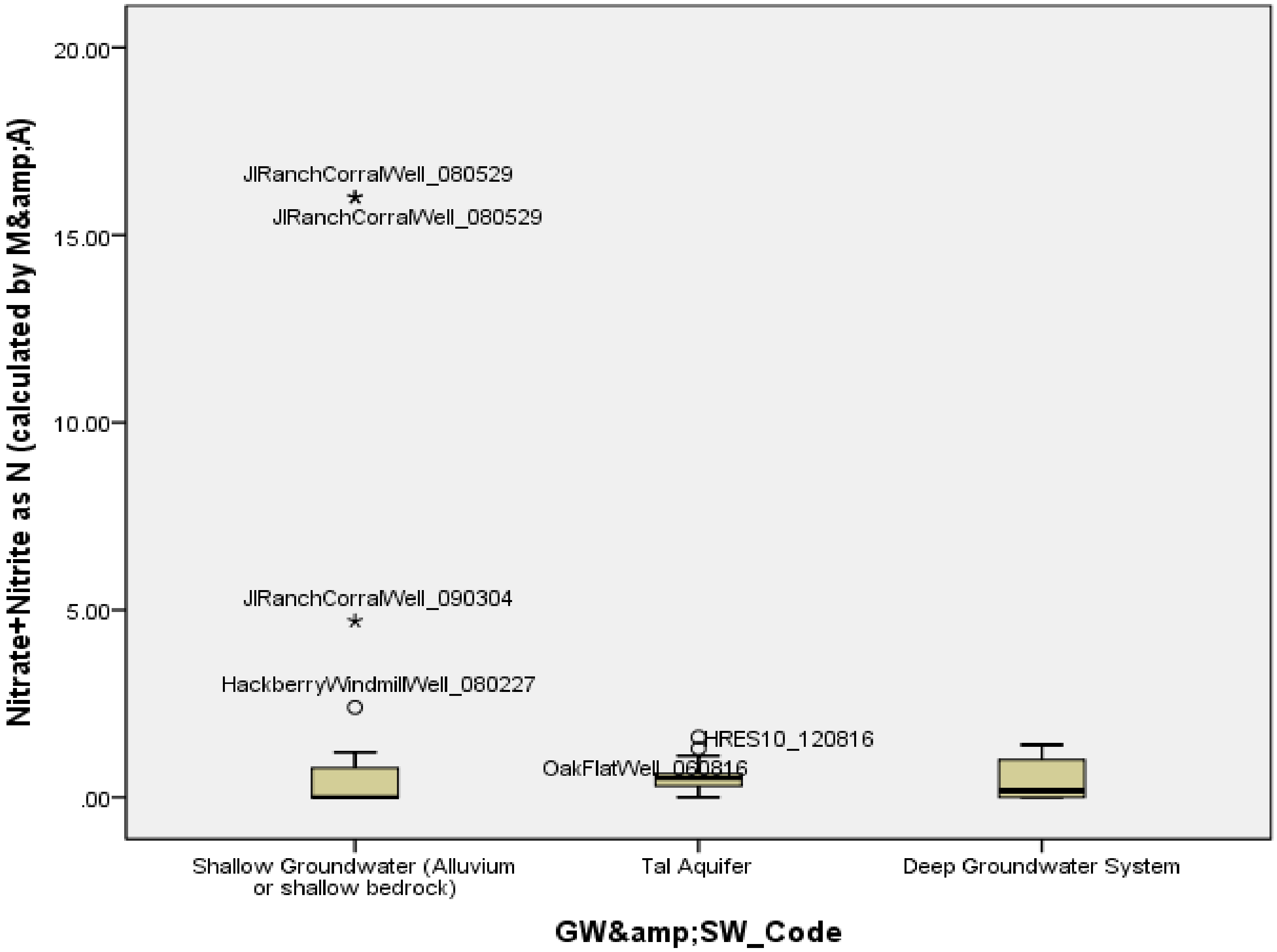


Nitrate as N

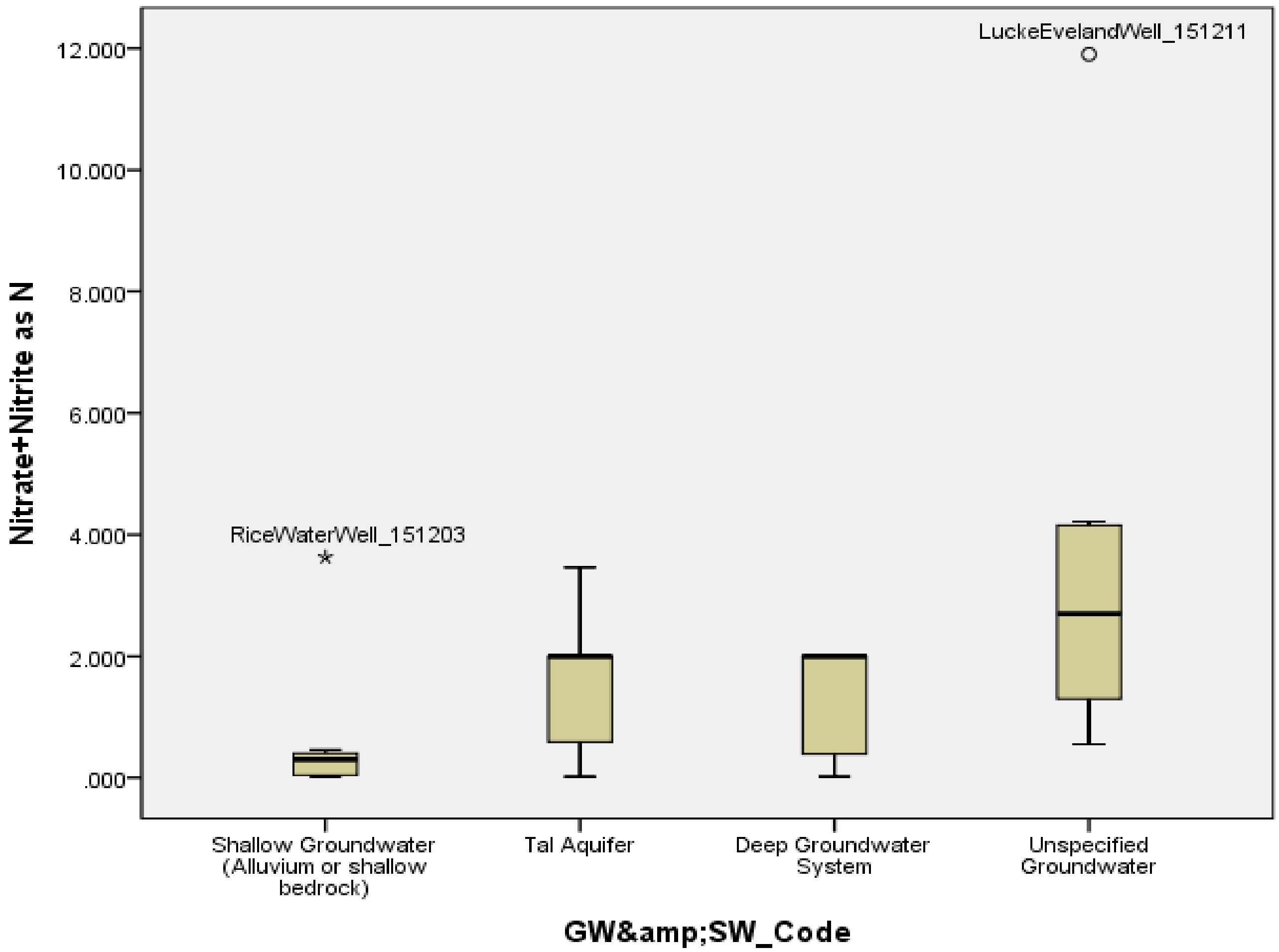


20.000
15.000
10.000
5.000
.000
Nitrate as N
JlRanchCorralWell_080529
JlRanchCorralWell_080529
JlRanchCorralWell_090304
HackberryWindmillWell_080227
CHRES10_120816
OakFlatWell_060816
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
GW&SW_Code

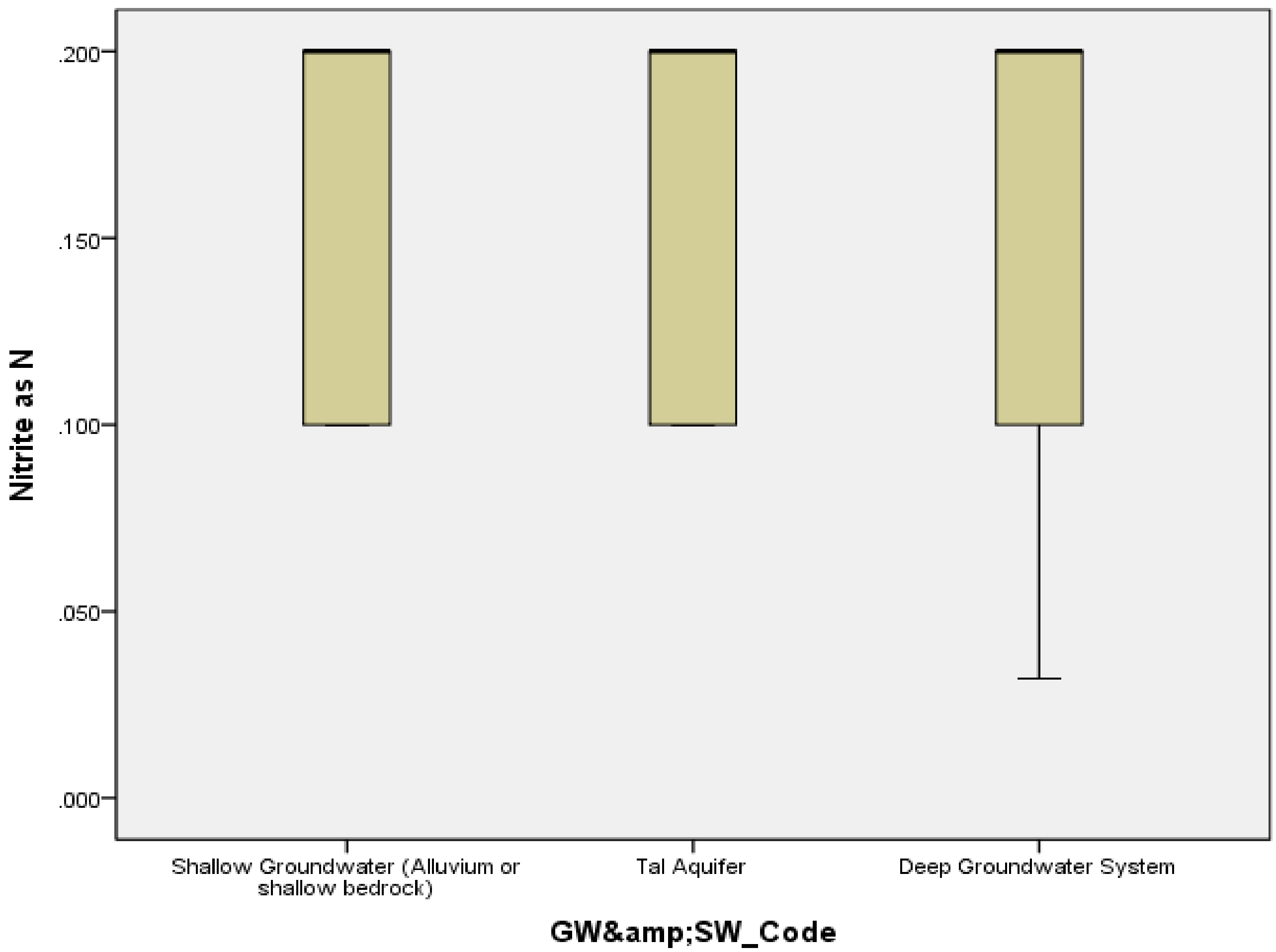
Nitrate+Nitrite as N (calculated by M&A)



Nitrate+Nitrite as N

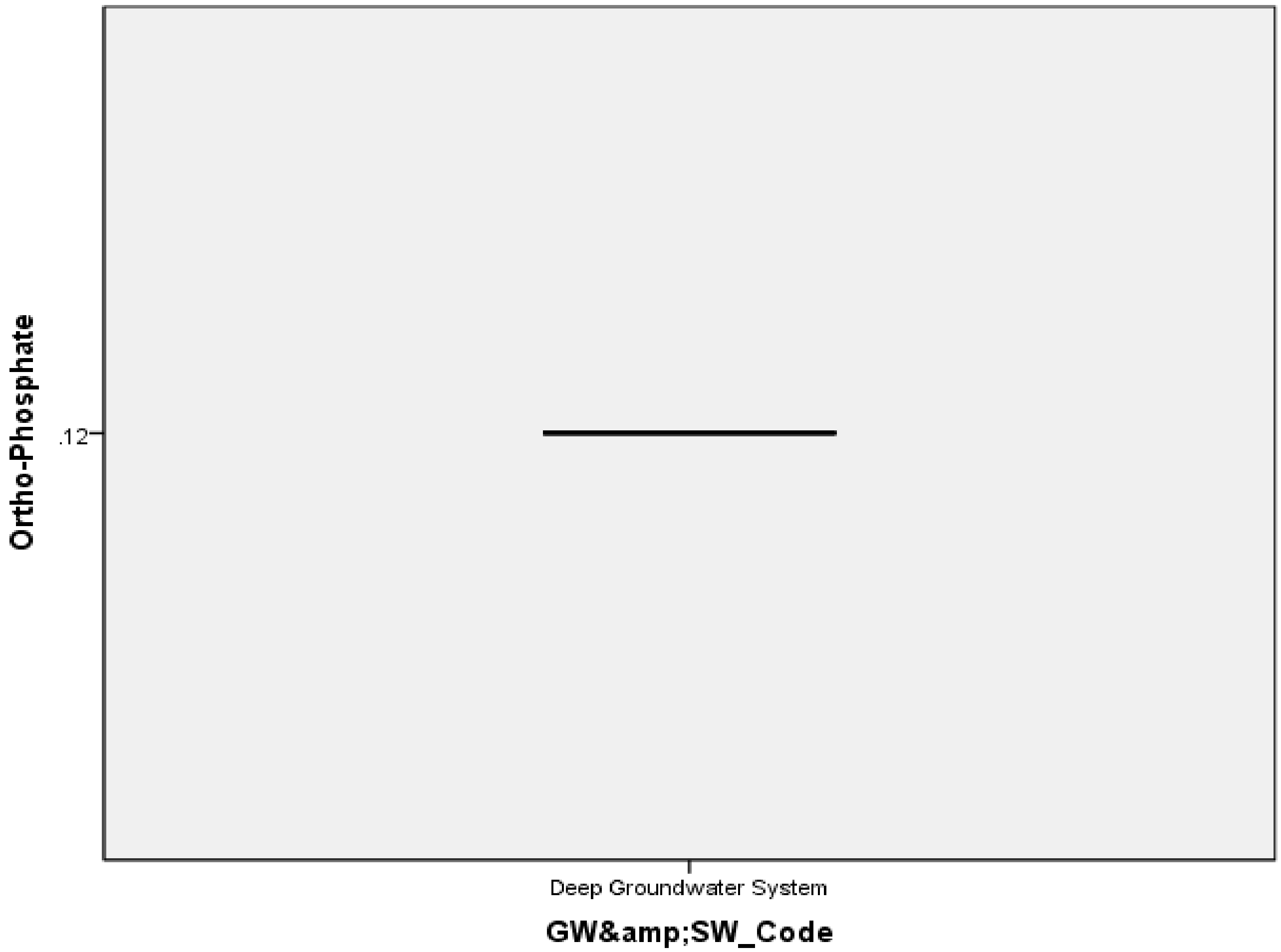


Nitrite as N

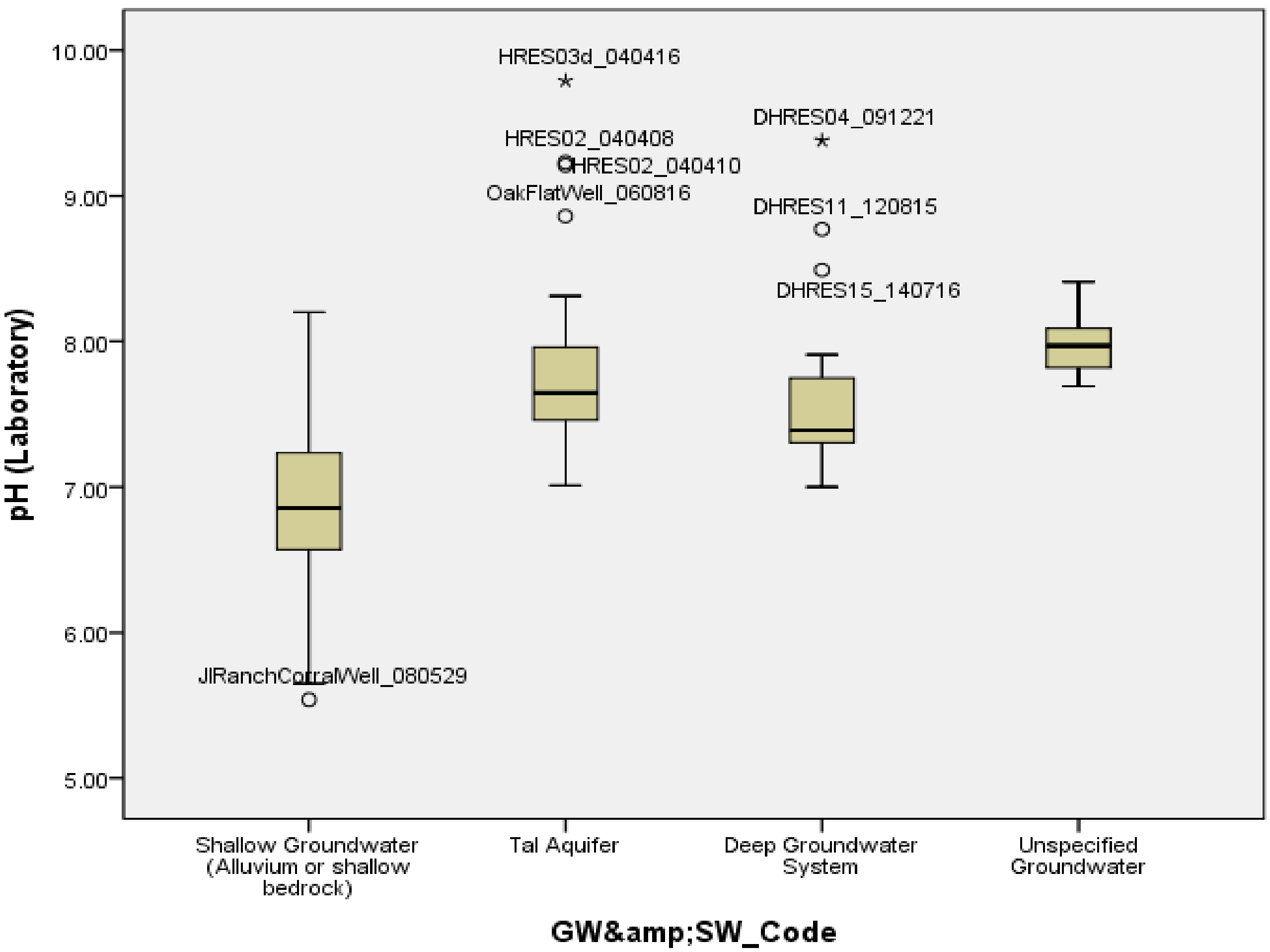


Nitrite as N
.200
.150
.100
.050
.000
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
GW&SW_Code

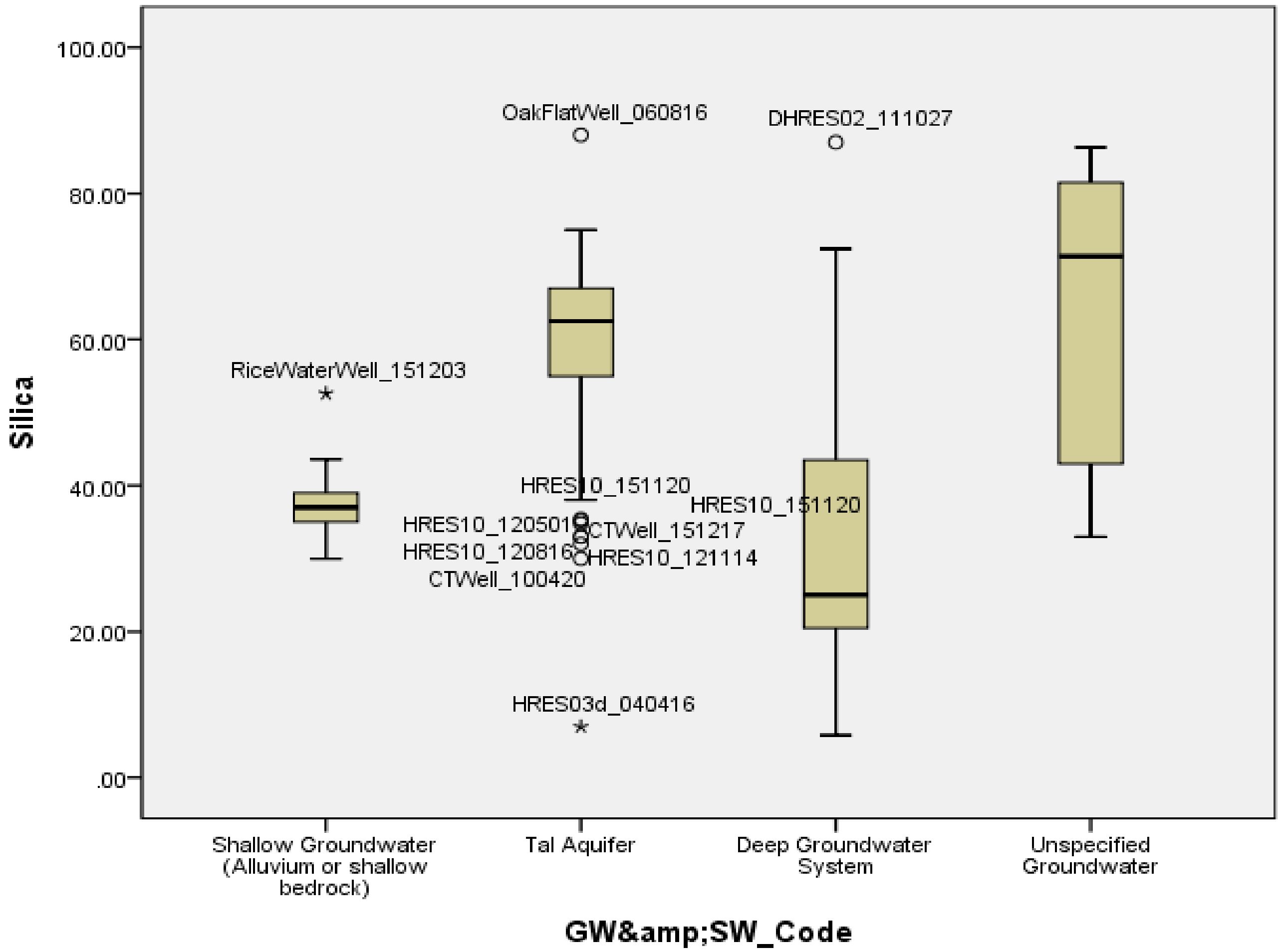
Ortho-Phosphate



pH (Laboratory)

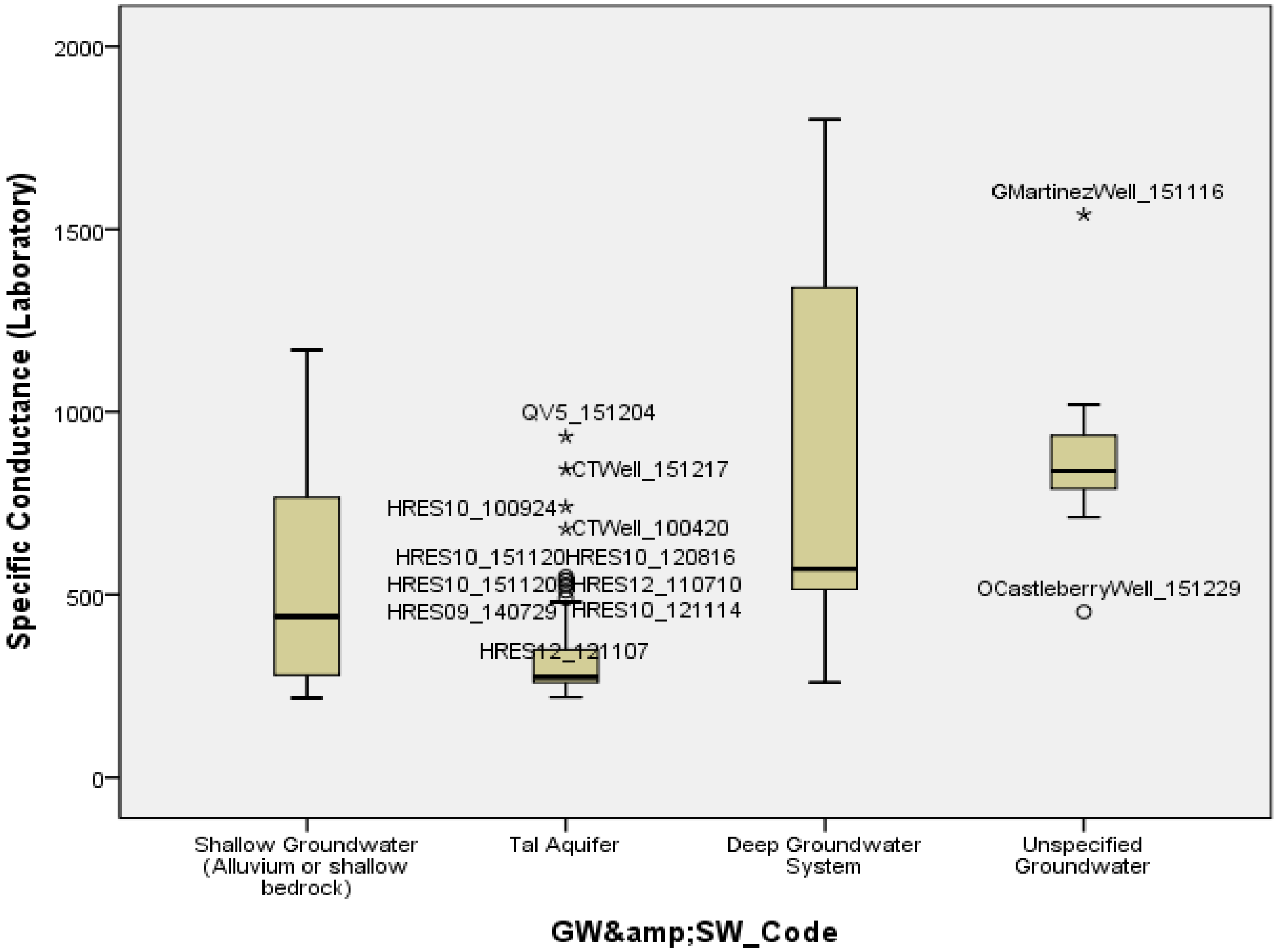


Silica

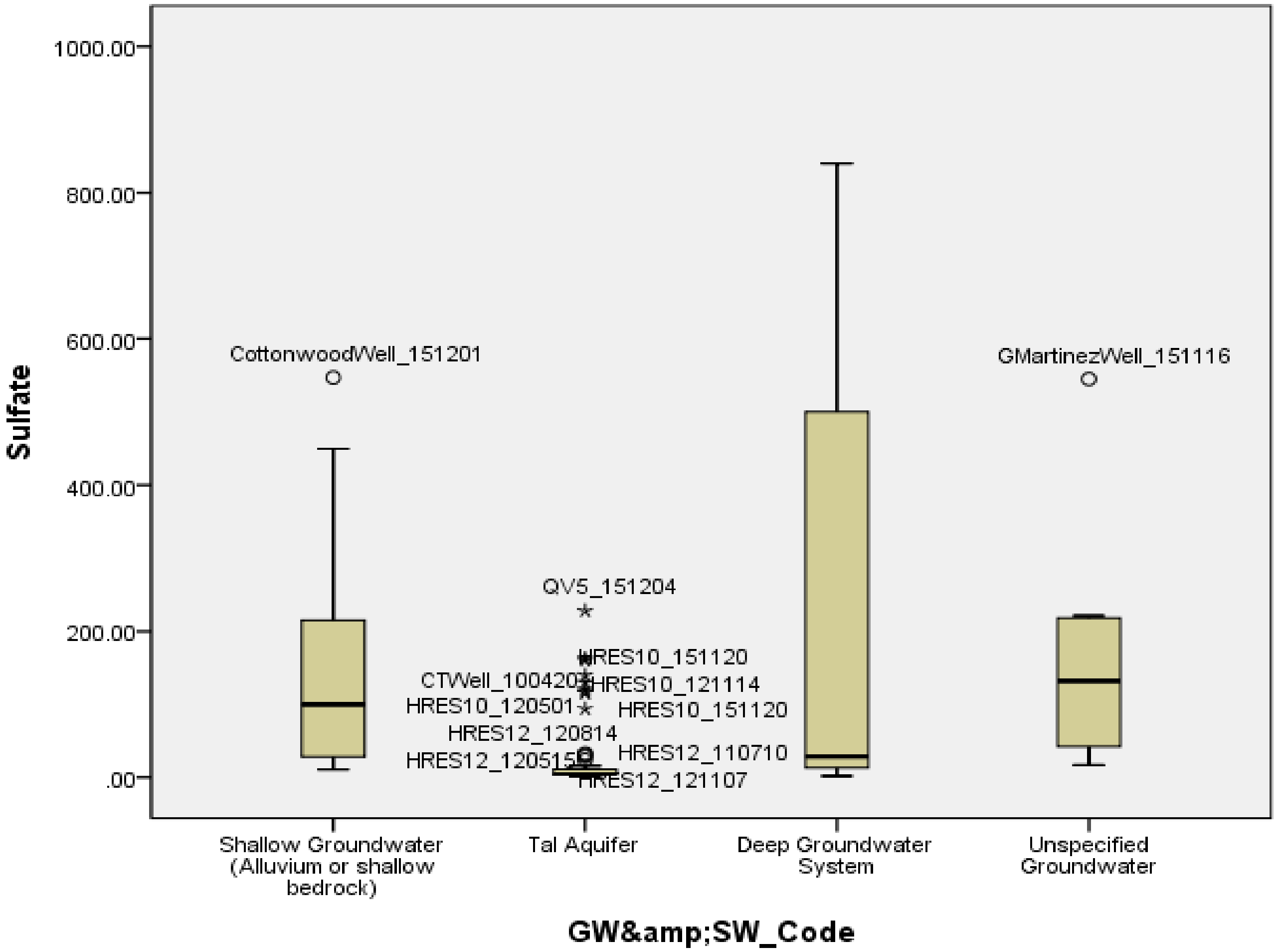


Silica
100.00
80.00
60.00
40.00
20.00
.00
OakFlatWell_060816
DHRES02_111027
RiceWaterWell_151203
HRES10_151120
HRES10_151120
HRES10_120501
CTWell_151217
HRES10_120816
HRES10_121114
CTWell_100420
HRES03d_040416
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

Specific Conductance (Laboratory)

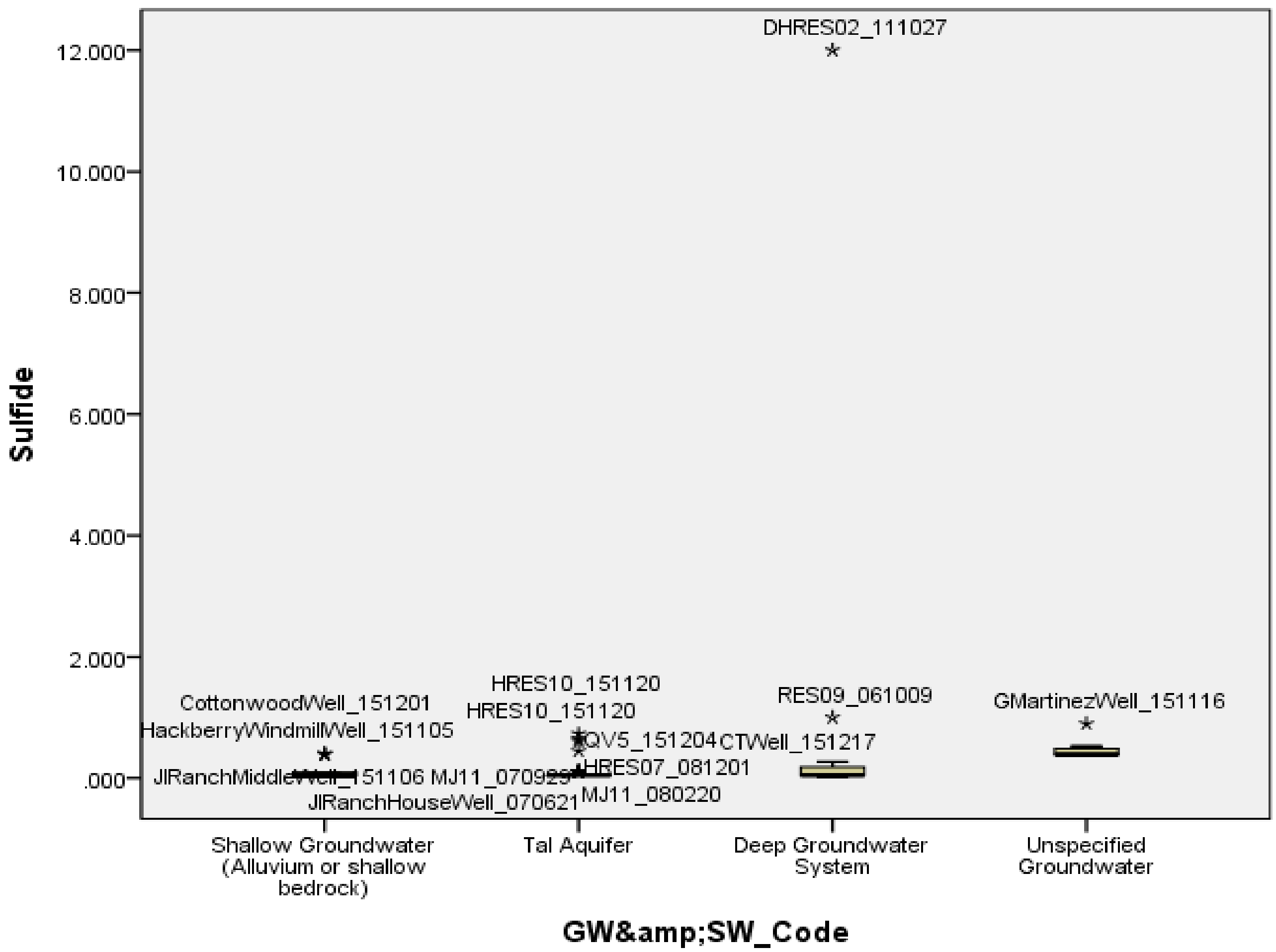


Sulfate



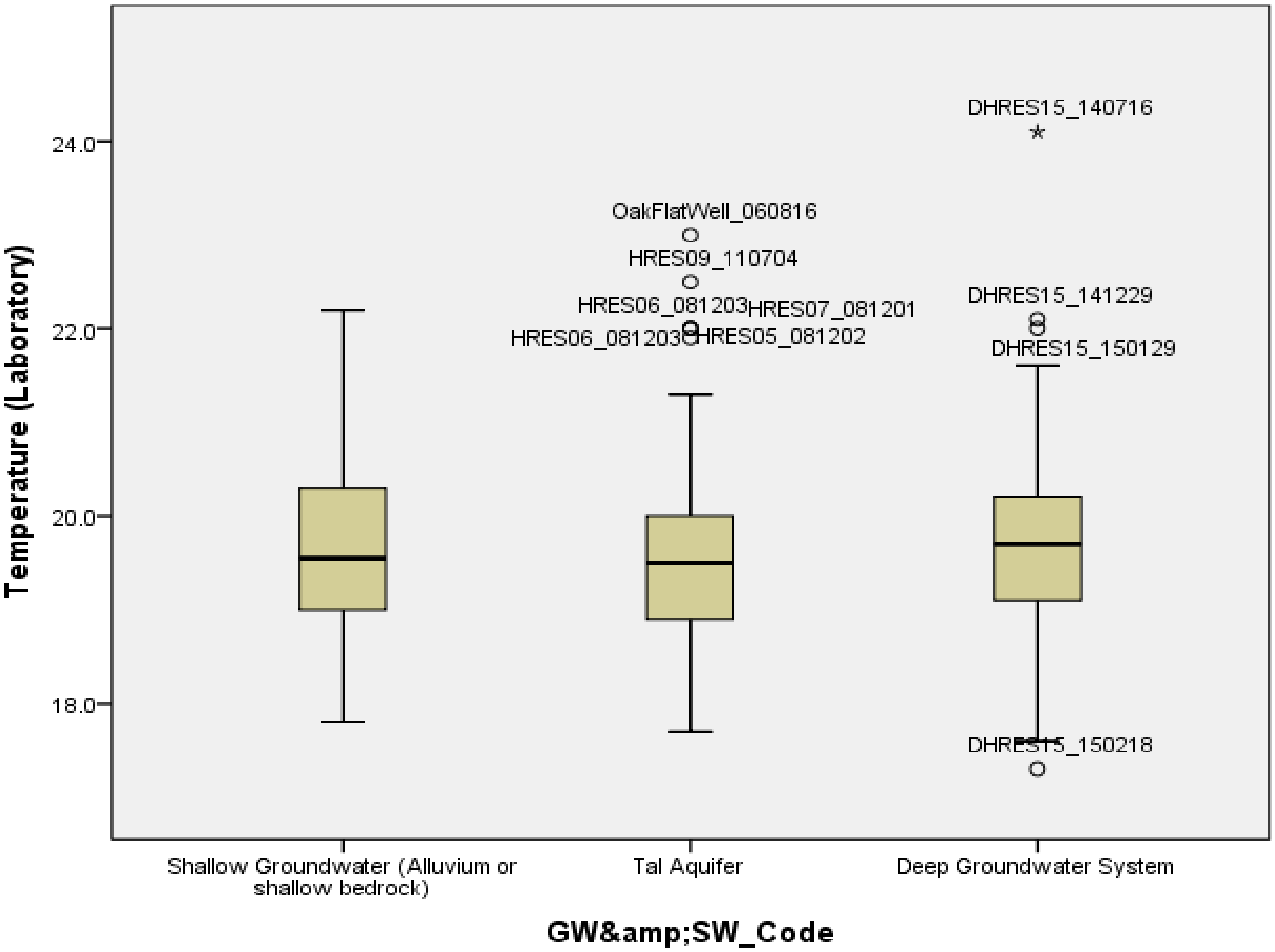
Sulfate
1000.00
800.00
600.00
400.00
200.00
.00
CottonwoodWell_151201
GMartinezWell_151116
QV5_151204
HRES10_151120
CTWell_100420
HRES10_121114
HRES10_120501
HRES10_151120
HRES12_120814
HRES12_110710
HRES12_120515
HRES12_121107
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

Sulfide

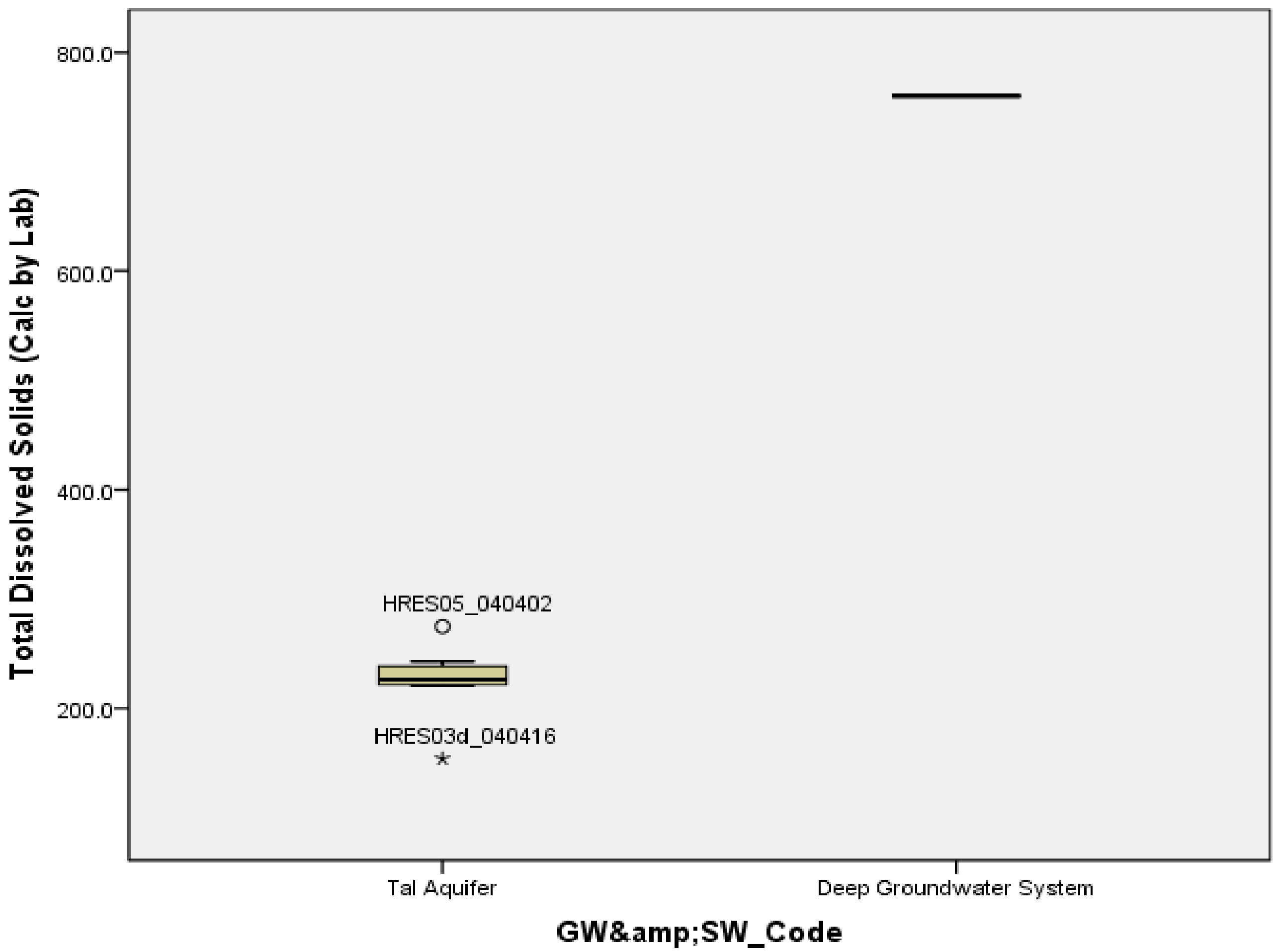


12.000
10.000
8.000
6.000
4.000
2.000
.000
Sulfide
DHRES02_111027
CottonwoodWell_151201
HackberryWindmillWell_151105
JlRanchMiddleWell_151106
JlRanchHouseWell_070621
HRES10_151120
HRES10_151120
QV5_151204
MJ11_070925
HRES07_081201
MJ11_080220
RES09_061009
CTWell_151217
GMartinezWell_151116
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

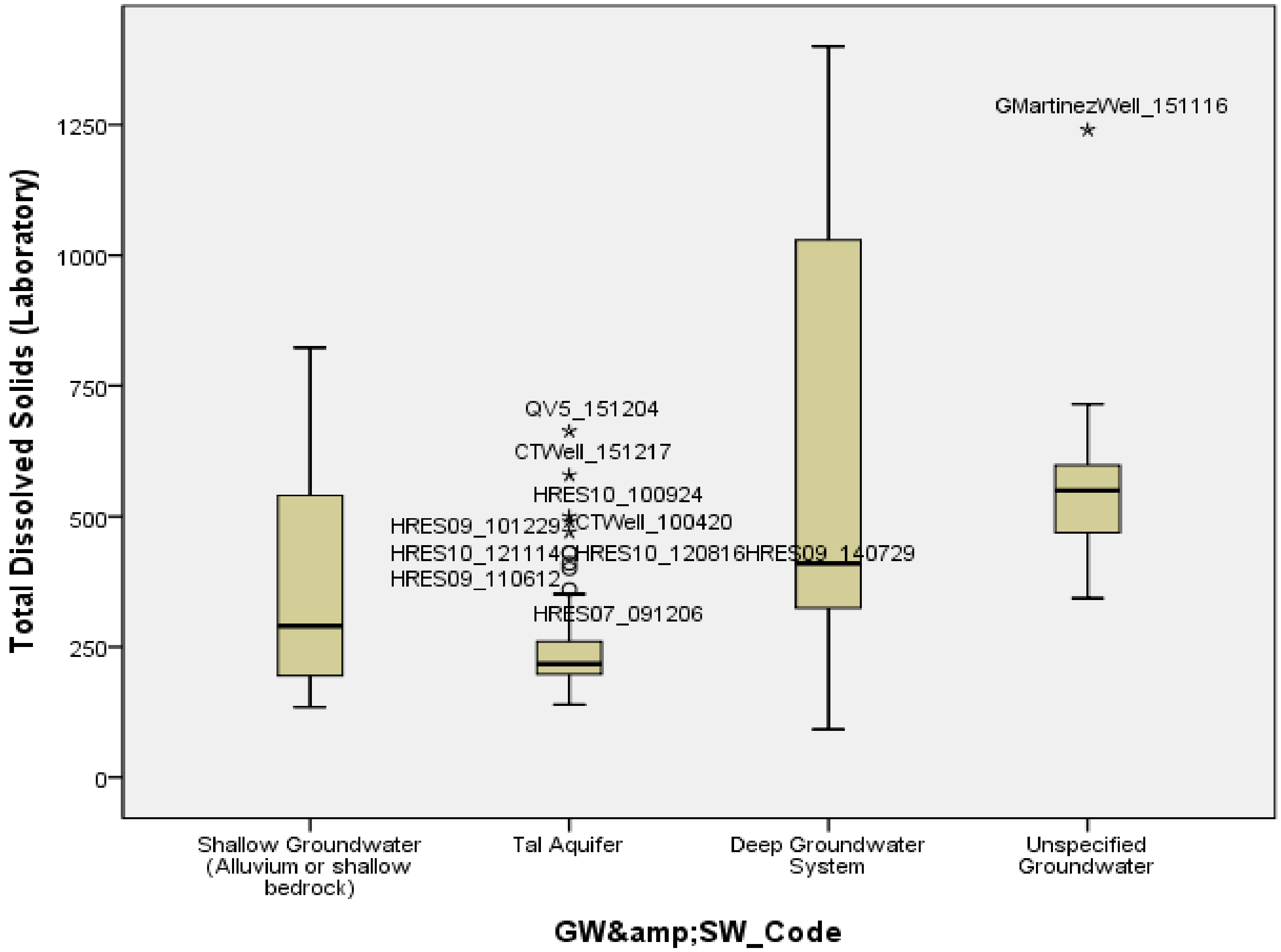
Temperature (Laboratory)



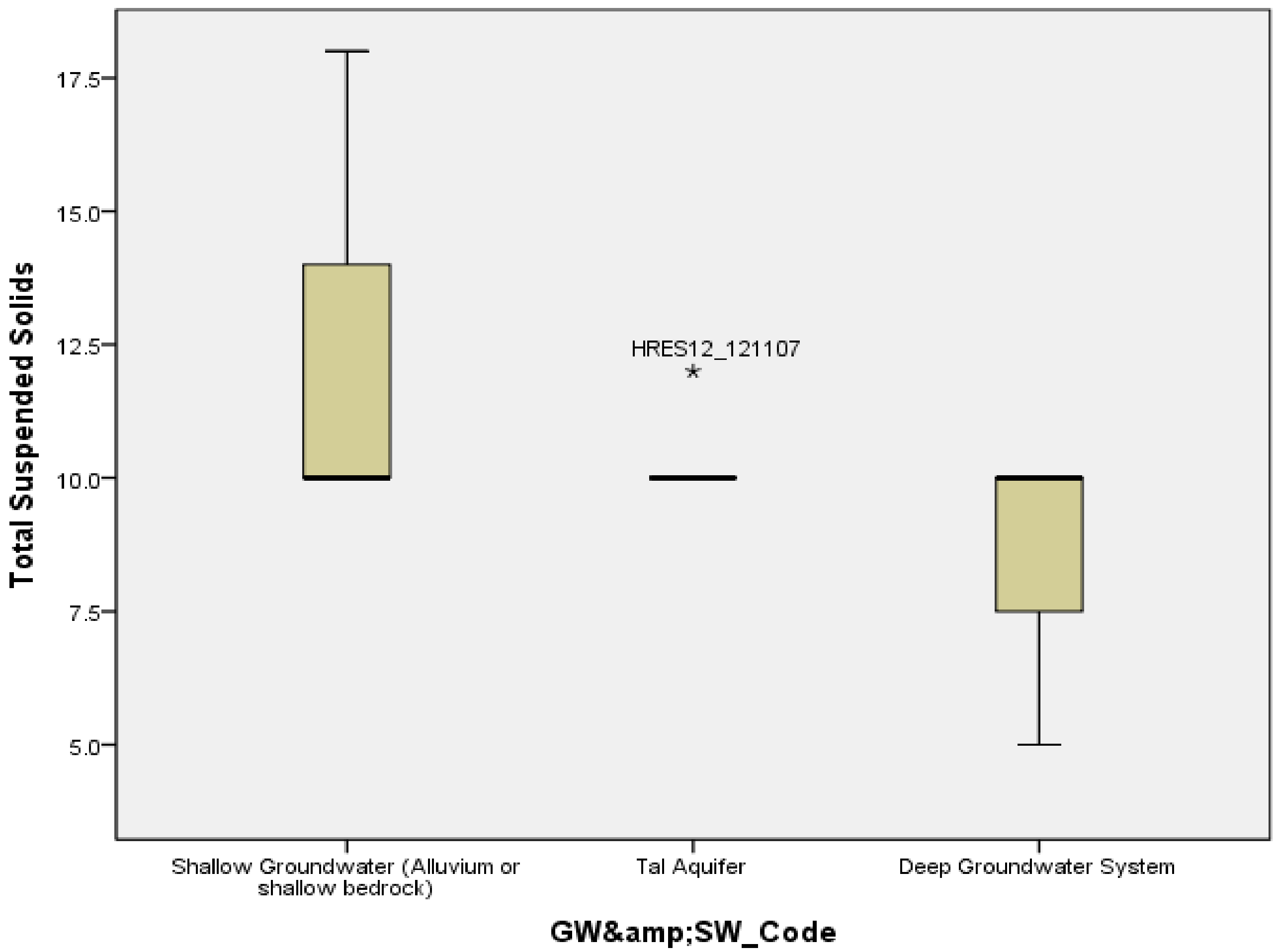
Total Dissolved Solids (Calc by Lab)



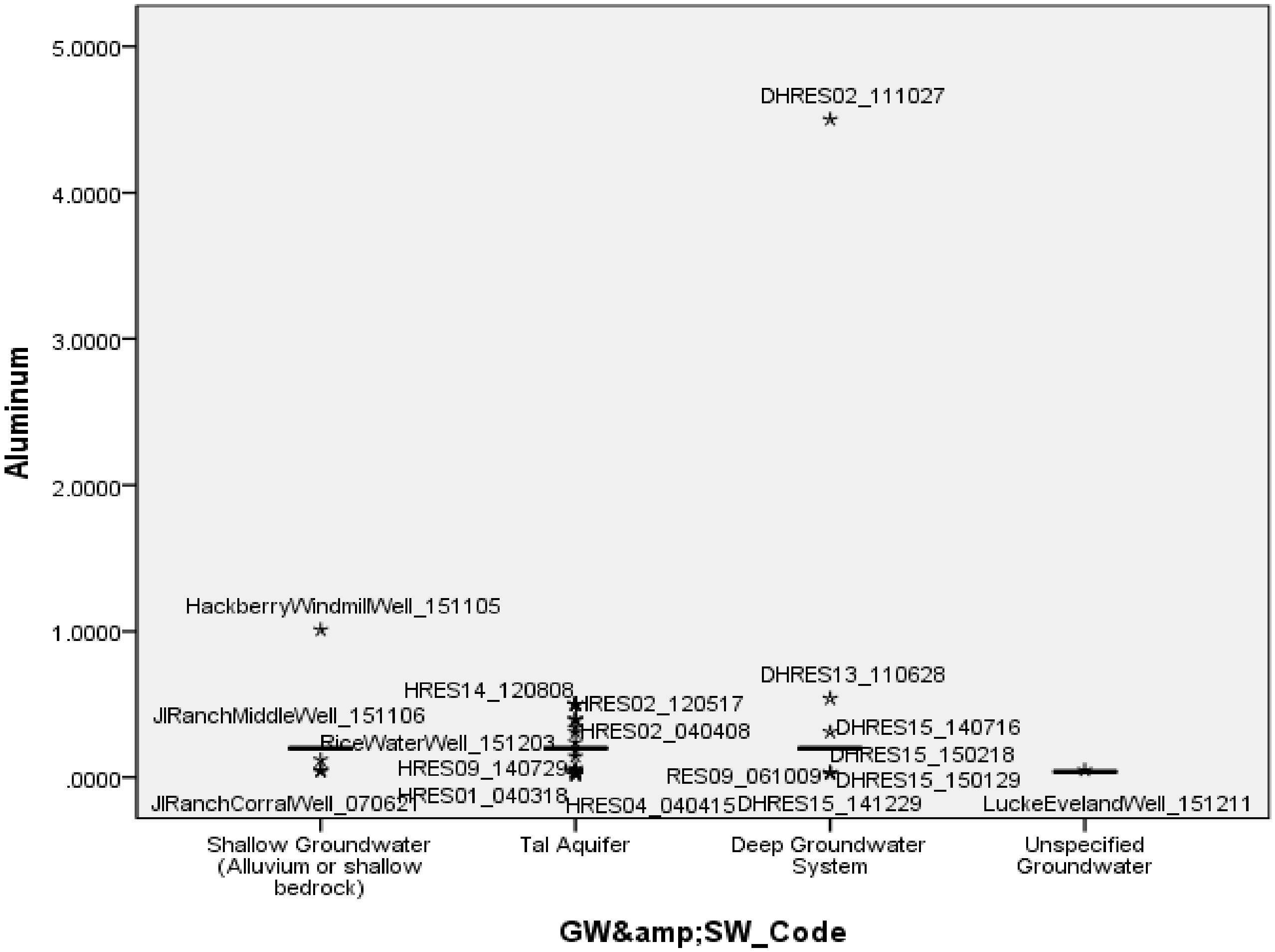
Total Dissolved Solids (Laboratory)



Total Suspended Solids

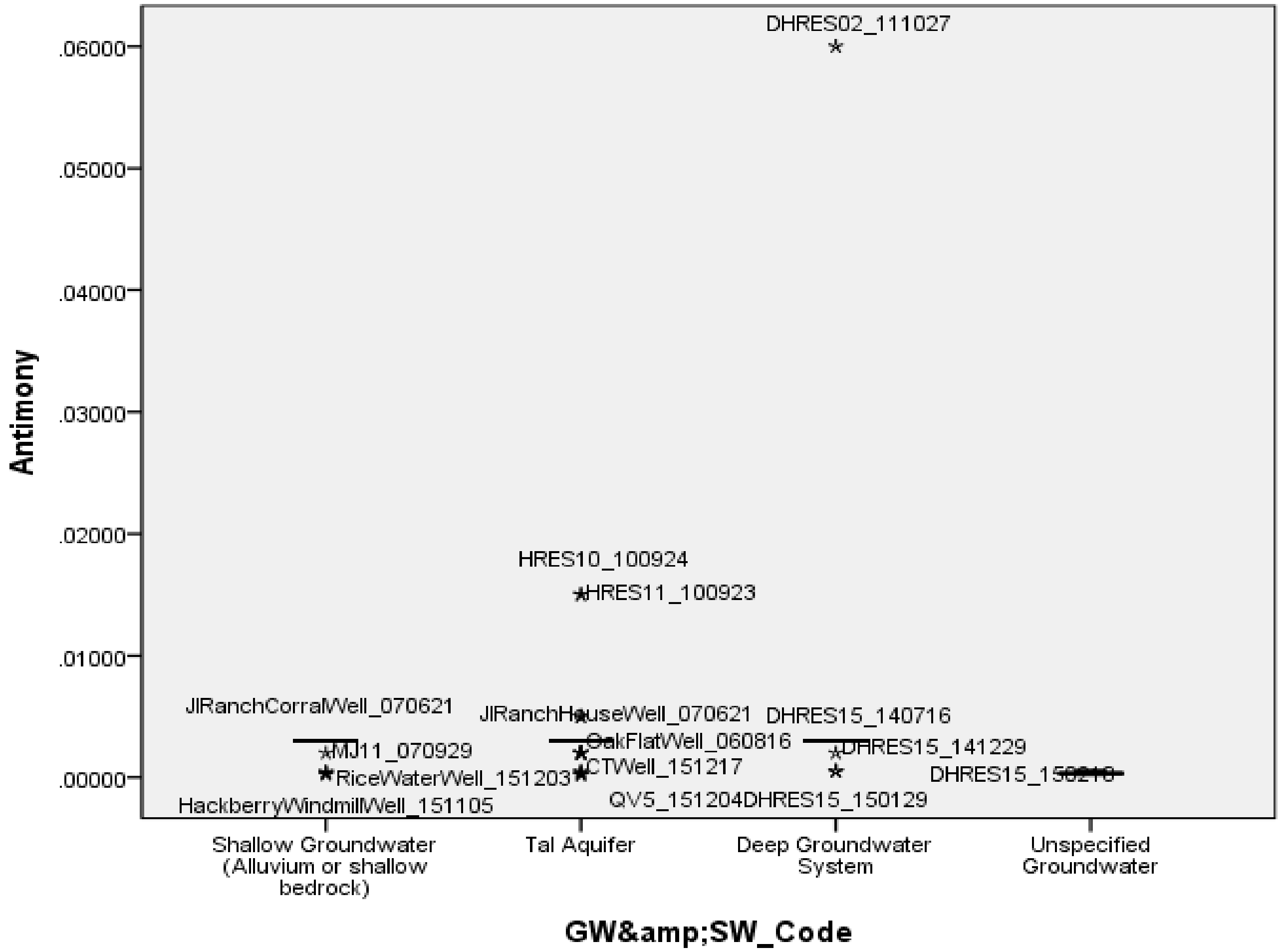


Aluminum



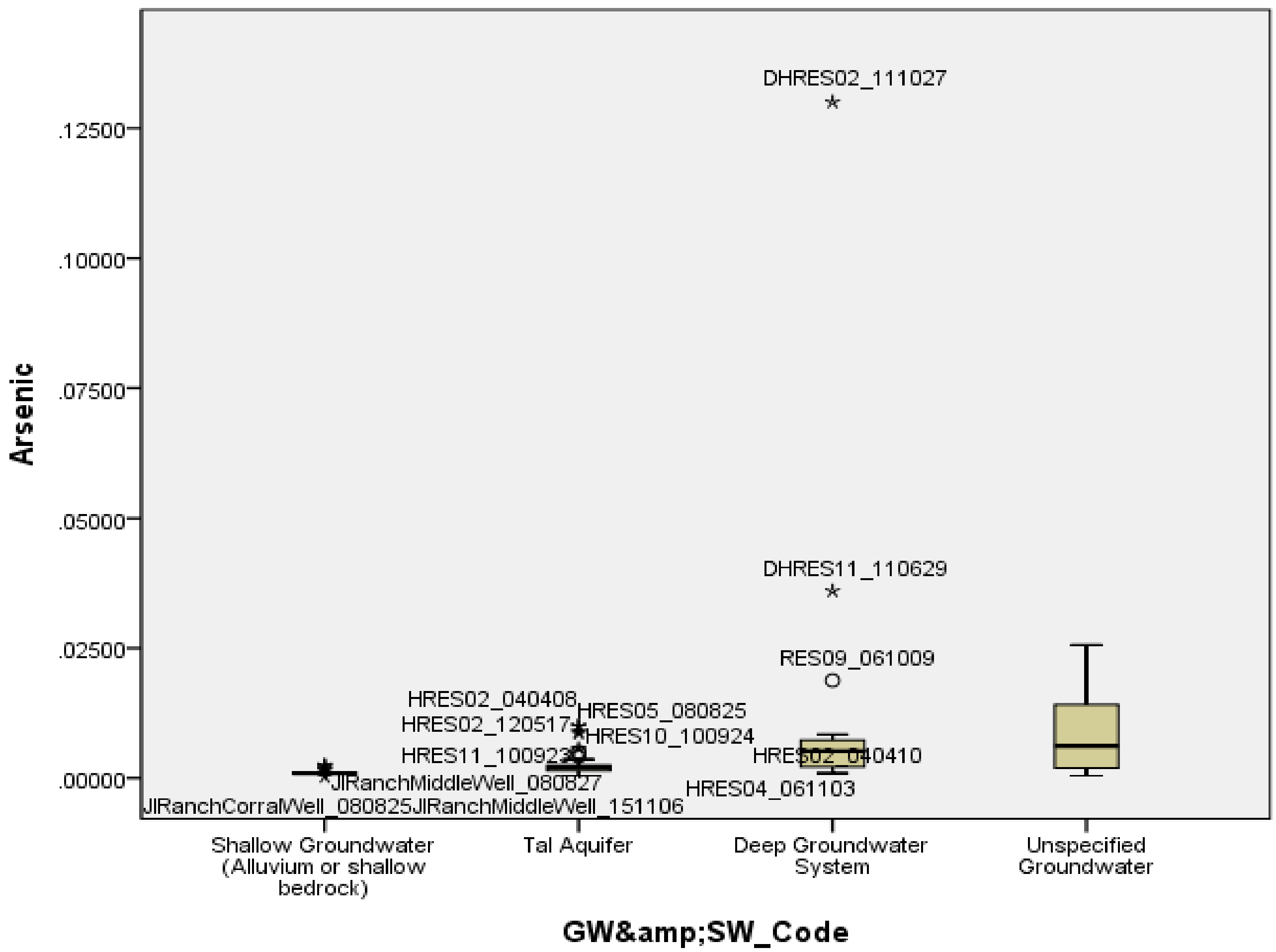
5.0000
4.0000
3.0000
2.0000
1.0000
.0000
Aluminum
DHRES02_111027
HackberryWindmillWell_151105
DHRES13_110628
HRES14_120808
HRES02_120517
JlRanchMiddleWell_151106
HRES02_040408
DHRES15_140716
RiceWaterWell_151203
DHRES15_150218
HRES09_140729
RES09_061009
DHRES15_150129
HRES01_040318
JlRanchCorralWell_070621
HRES04_040415
DHRES15_141229
LuckeEvelandWell_151211
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

Antimony



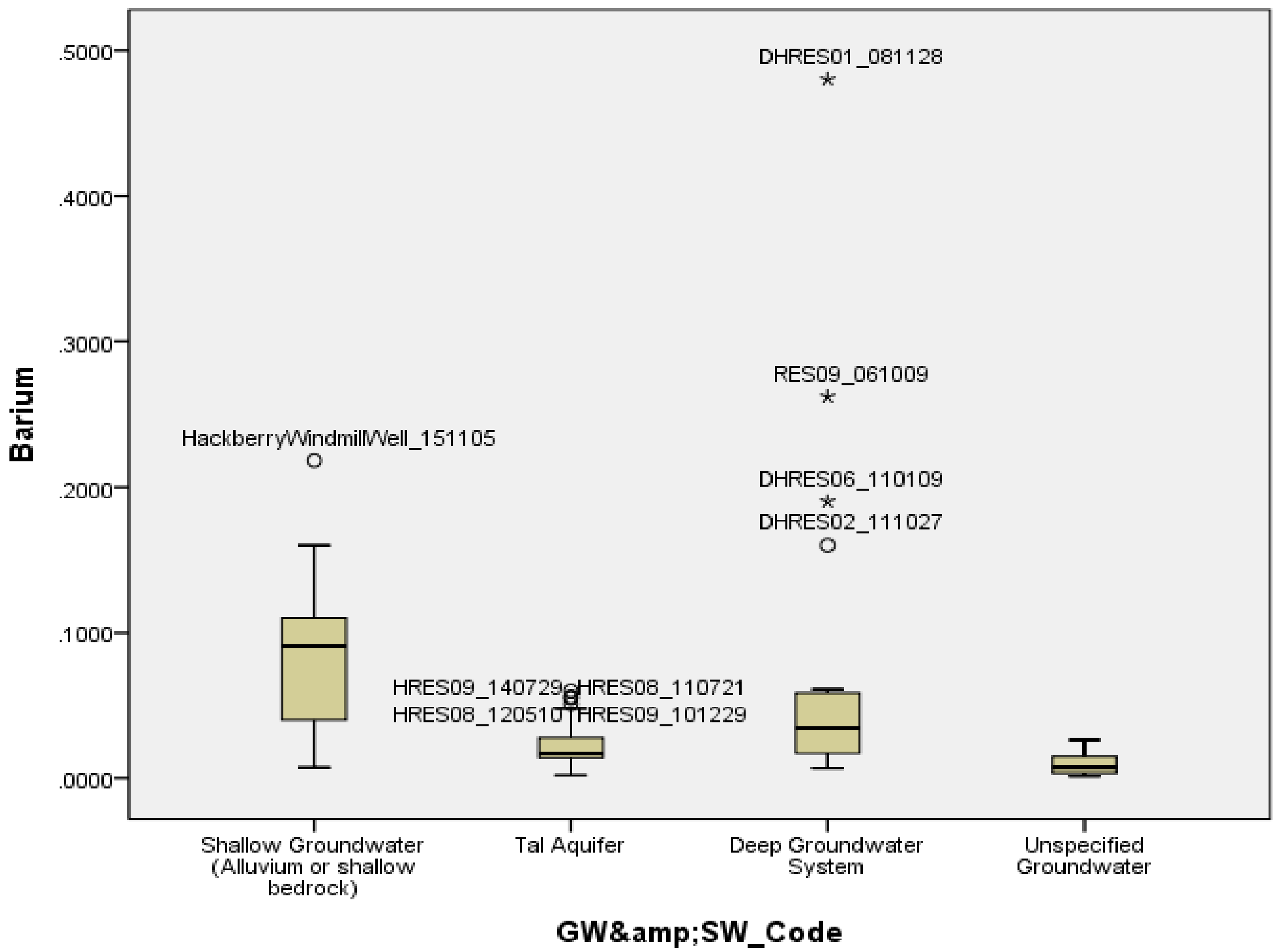
DHRES02_111027
HRES10_100924
HRES11_100923
JlRanchCorralWell_070621
JlRanchHouseWell_070621
DHRES15_140716
MJ11_070929
OakFlatWell_060816
DHRES15_141229
RiceWaterWell_151203
CTWell_151217
HackberryWindmillWell_151105
QV5_151204
DHRES15_150129
.06000
.05000
.04000
.03000
.02000
.01000
.00000
Antimony
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

Arsenic



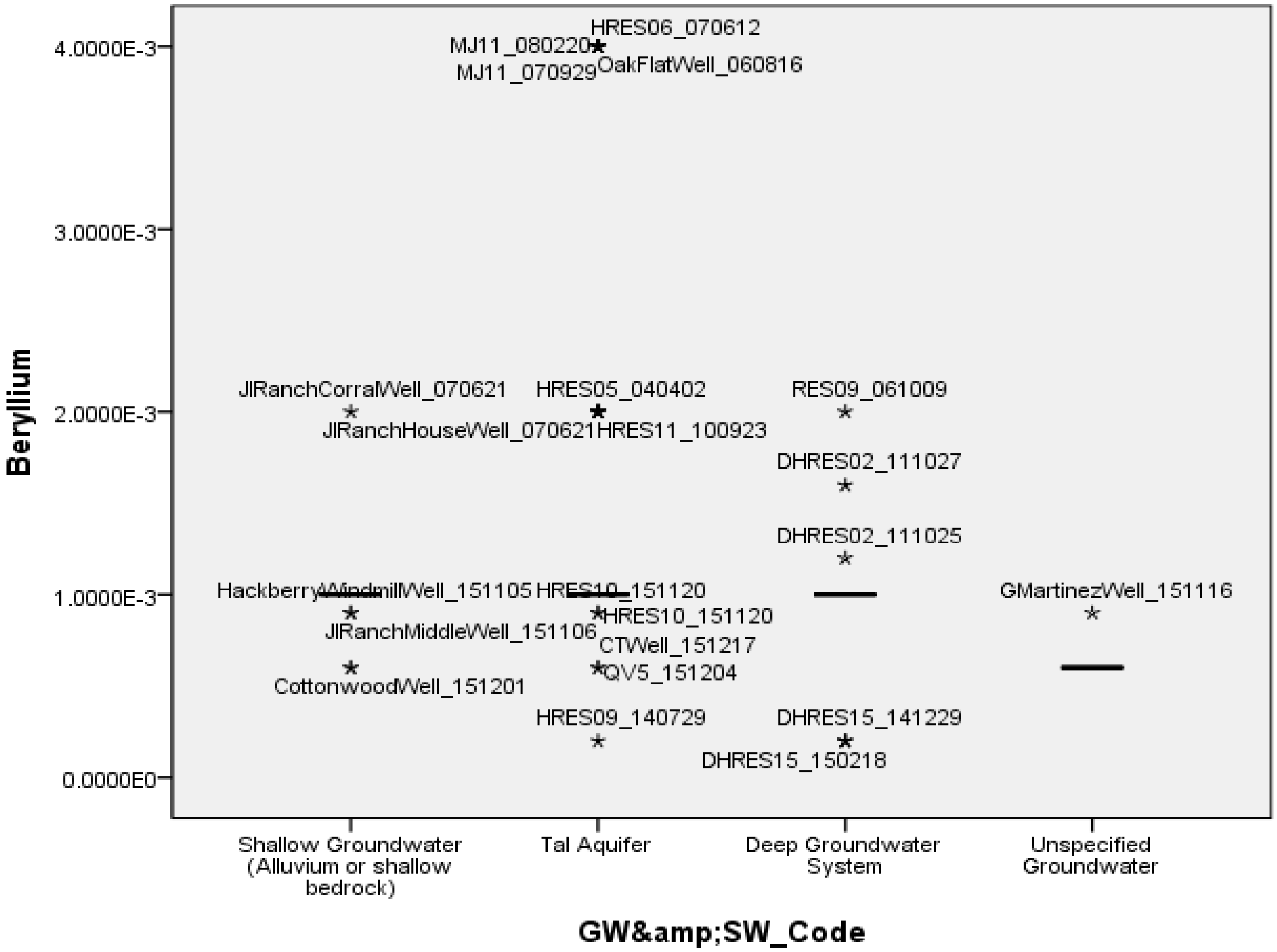
Arsenic
.12500
.10000
.07500
.05000
.02500
.00000
DHRES02_111027
DHRES11_110629
RES09_061009
HRES02_040408
HRES05_080825
HRES02_120517
HRES10_100924
HRES11_100923
HRES02_040410
JIRanchMiddleWell_080827
HRES04_061103
JIRanchCorralWell_080825
JIRanchMiddleWell_151106
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

Barium



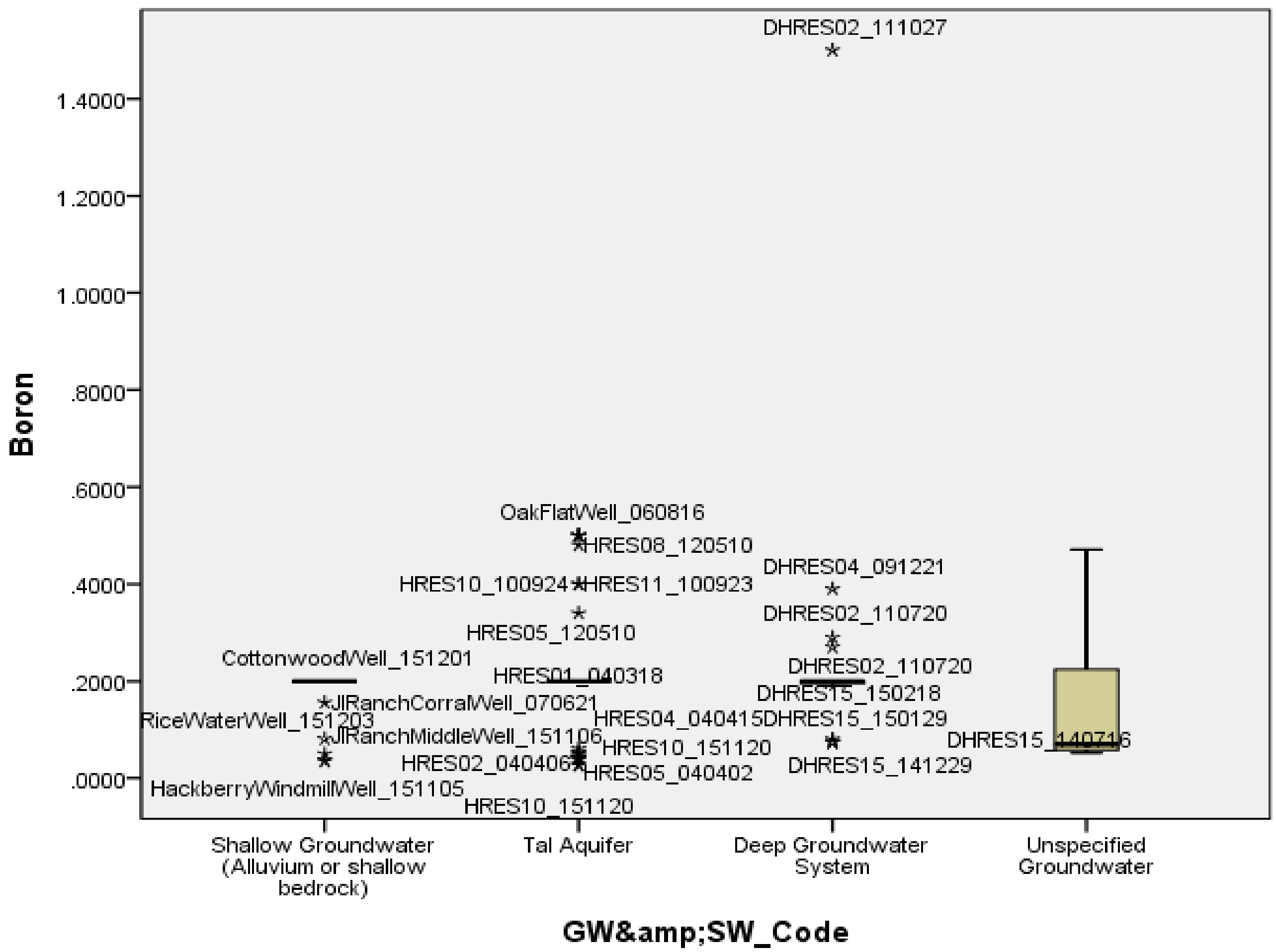
DHRES01_081128
RES09_061009
HackberryWindmillWell_151105
DHRES06_110109
DHRES02_111027
HRES09_140729
HRES08_110721
HRES08_120510
HRES09_101229
.5000
.4000
.3000
.2000
.1000
.0000
Barium
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

Beryllium



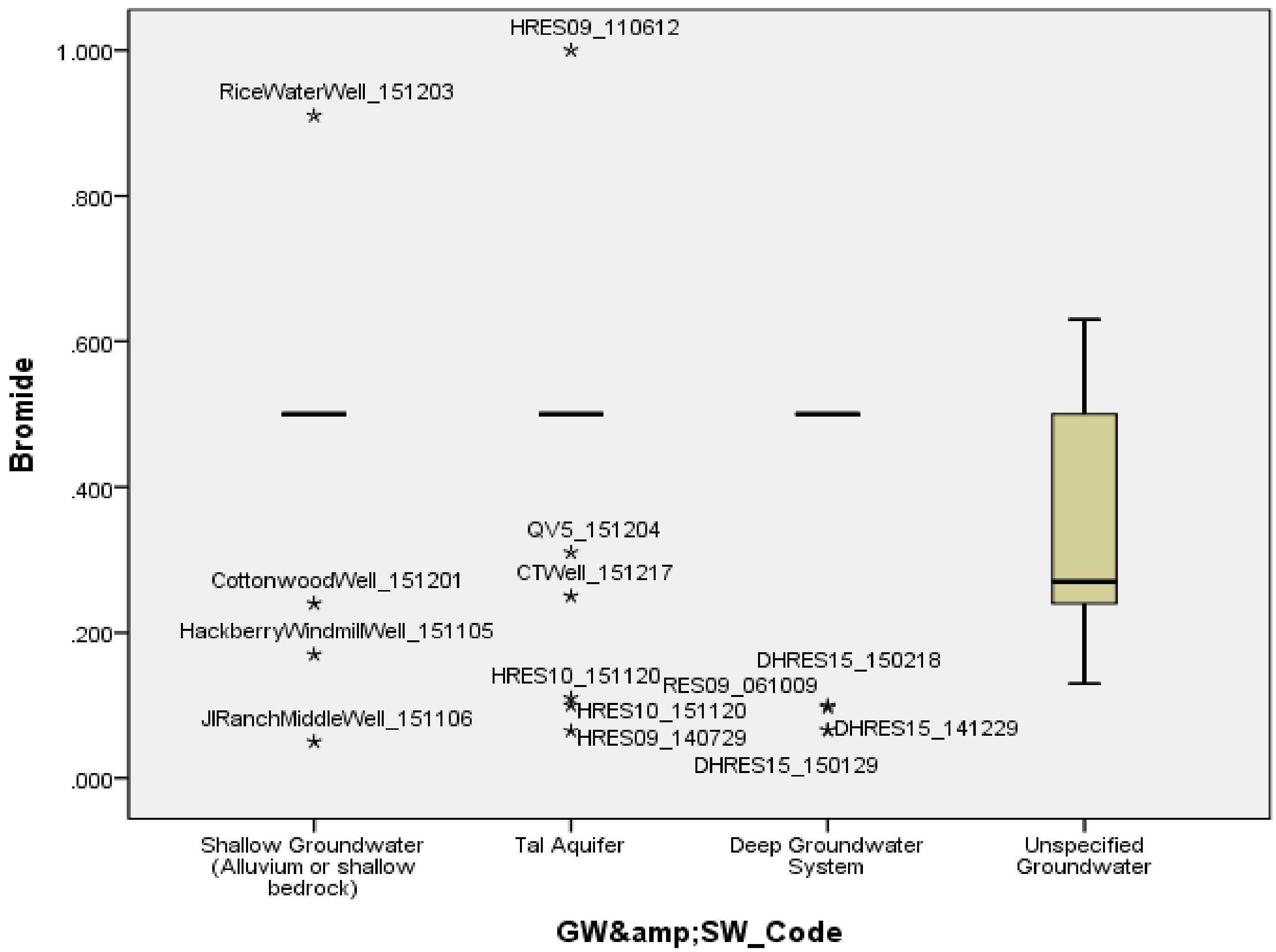
Beryllium
4.0000E-3
3.0000E-3
2.0000E-3
1.0000E-3
0.0000E0
HRES06_070612
MJ11_080220
MJ11_070929
OakFlatWell_060816
JlRanchCorralWell_070621
HRES05_040402
RES09_061009
JlRanchHouseWell_070621
HRES11_100923
DHRES02_111027
DHRES02_111025
HackberryWindmillWell_151105
HRES10_151120
GMartinezWell_151116
HRES10_151120
JlRanchMiddleWell_151106
CTWell_151217
QV5_151204
CottonwoodWell_151201
HRES09_140729
DHRES15_141229
DHRES15_150218
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

Boron



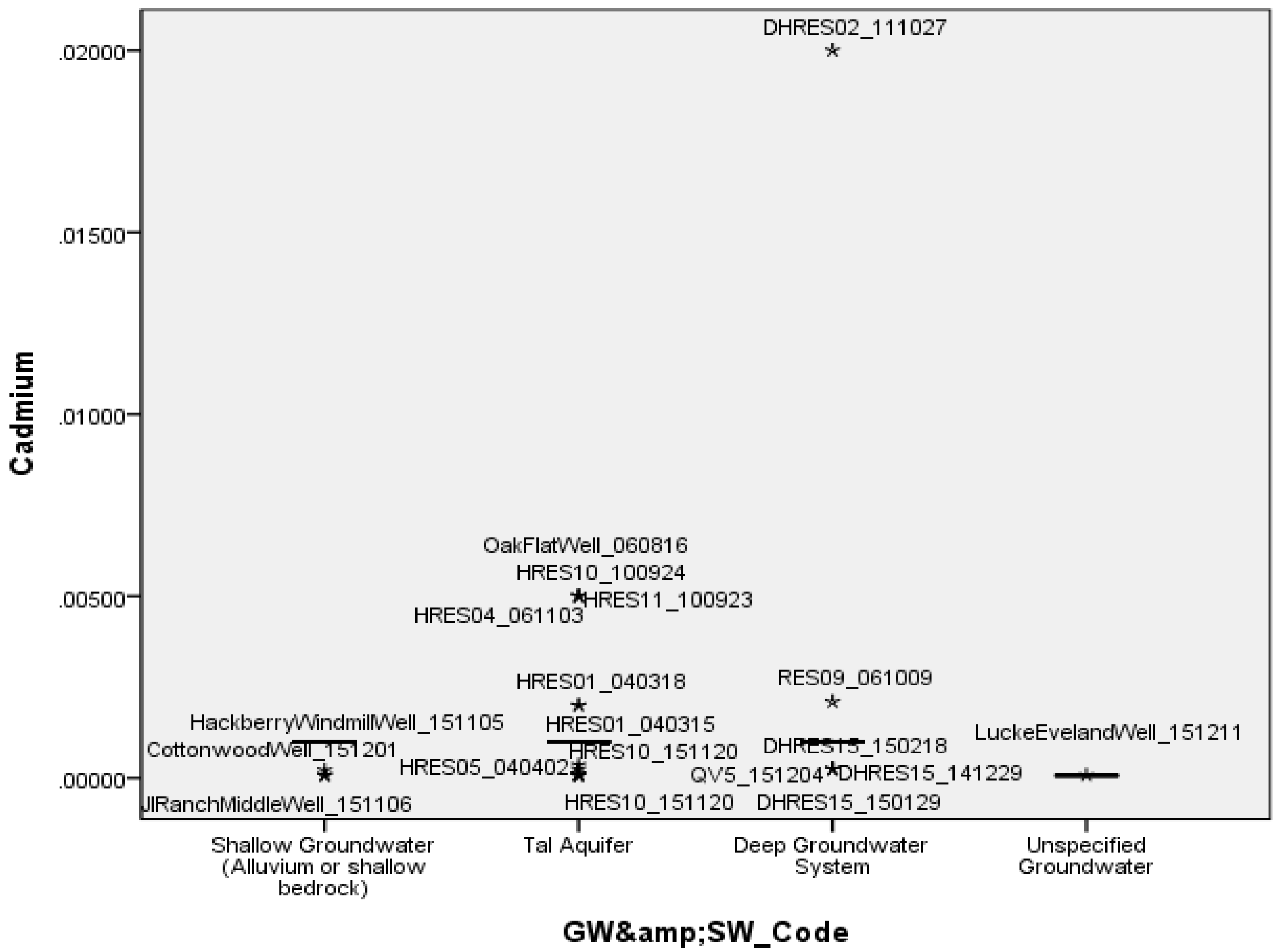
DHRES02_111027
1.4000
1.2000
1.0000
.8000
.6000
.4000
.2000
.0000
Boron
OakFlatWell_060816
HRES08_120510
HRES10_100924
HRES11_100923
DHRES04_091221
DHRES02_110720
HRES05_120510
CottonwoodWell_151201
HRES01_040318
DHRES02_110720
DHRES15_150218
JlRanchCorralWell_070621
RiceWaterWell_151203
HRES04_040415
DHRES15_150129
JlRanchMiddleWell_151106
HRES10_151120
DHRES15_140716
HRES02_040406
HRES05_040402
DHRES15_141229
HackberryWindmillWell_151105
HRES10_151120
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

Bromide



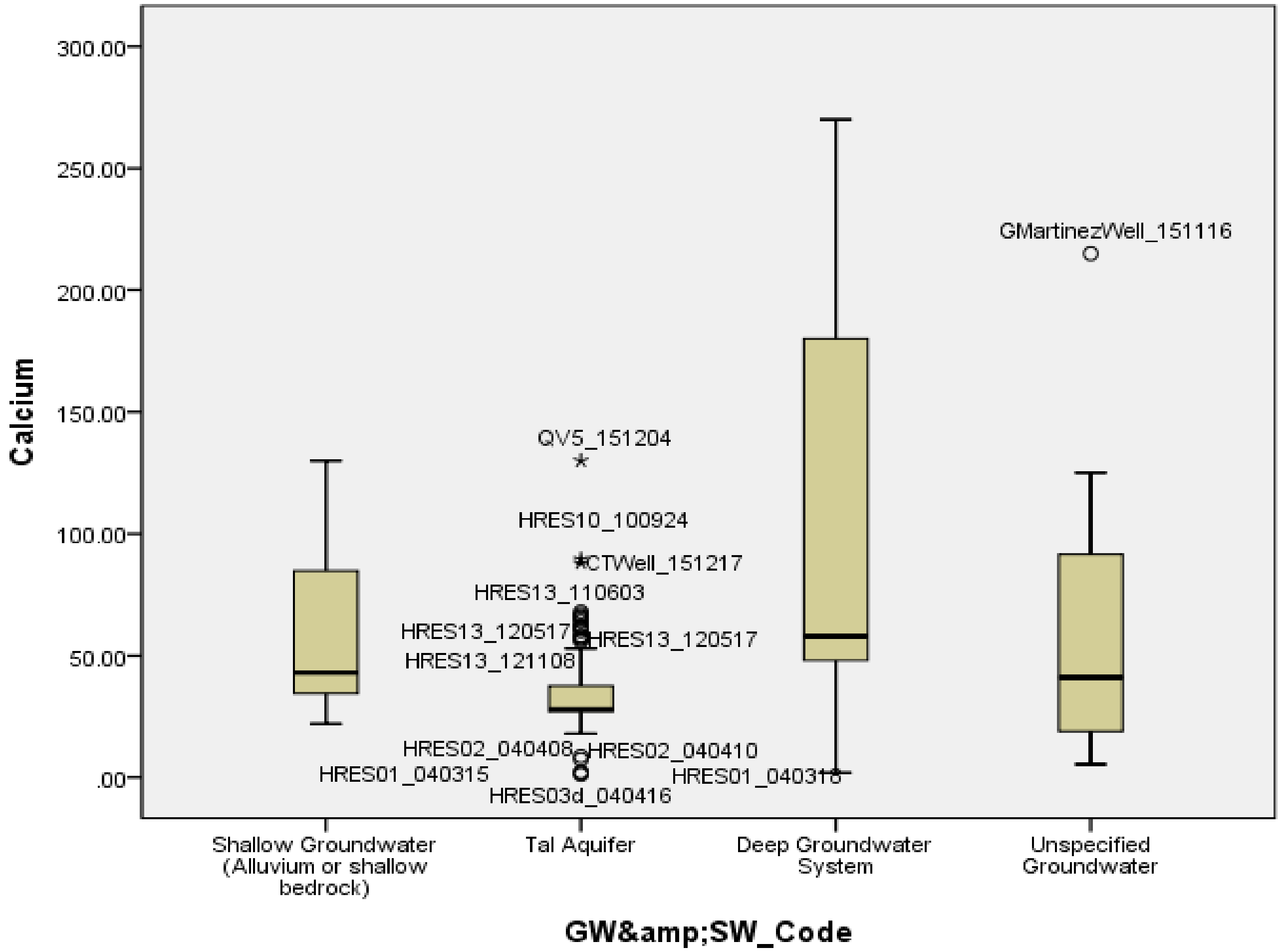
Bromide
1.000
.800
.600
.400
.200
.000
HRES09_110612
RiceWaterWell_151203
QV5_151204
CTWell_151217
CottonwoodWell_151201
HackberryWindmillWell_151105
HRES10_151120
RES09_061009
DHRES15_150218
HRES10_151120
HRES09_140729
JIRanchMiddleWell_151106
DHRES15_141229
DHRES15_150129
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

Cadmium



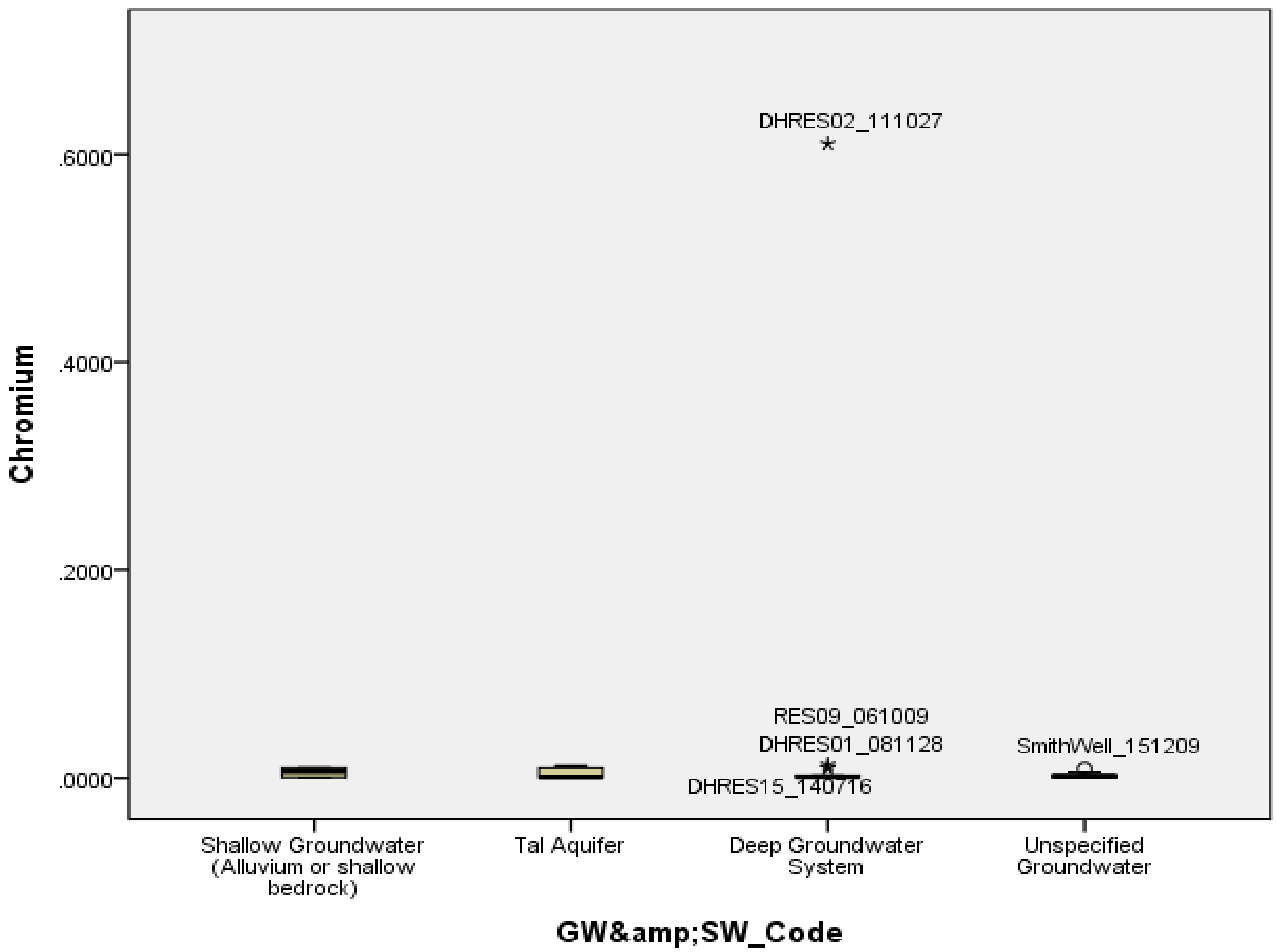
Cadmium
.02000
.01500
.01000
.00500
.00000
DHRES02_111027
OakFlatWell_060816
HRES10_100924
HRES11_100923
HRES04_061103
HRES01_040318
RES09_061009
HackberryWindmillWell_151105
HRES01_040315
CottonwoodWell_151201
HRES10_151120
DHRES15_150218
LuckeEvelandWell_151211
HRES05_040402
QV5_151204
DHRES15_141229
JIRanchMiddleWell_151106
HRES10_151120
DHRES15_150129
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

Calcium

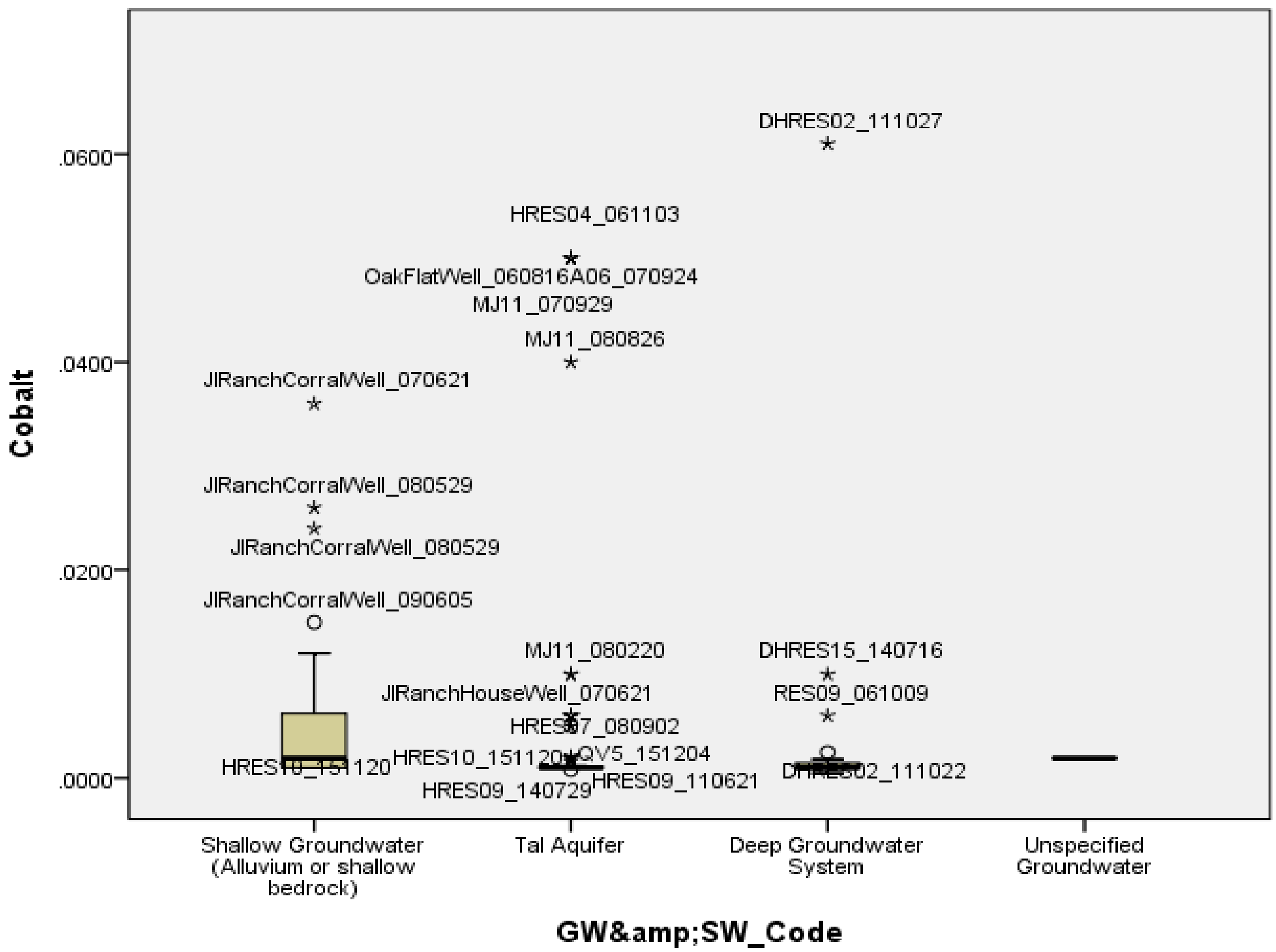


300.00
250.00
200.00
150.00
100.00
50.00
.00
Calcium
QV5_151204
HRES10_100924
CTWell_151217
HRES13_110603
HRES13_120517
HRES13_120517
HRES13_121108
HRES02_040408
HRES02_040410
HRES01_040315
HRES01_040316
HRES03d_040416
GMartinezWell_151116
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

Chromium

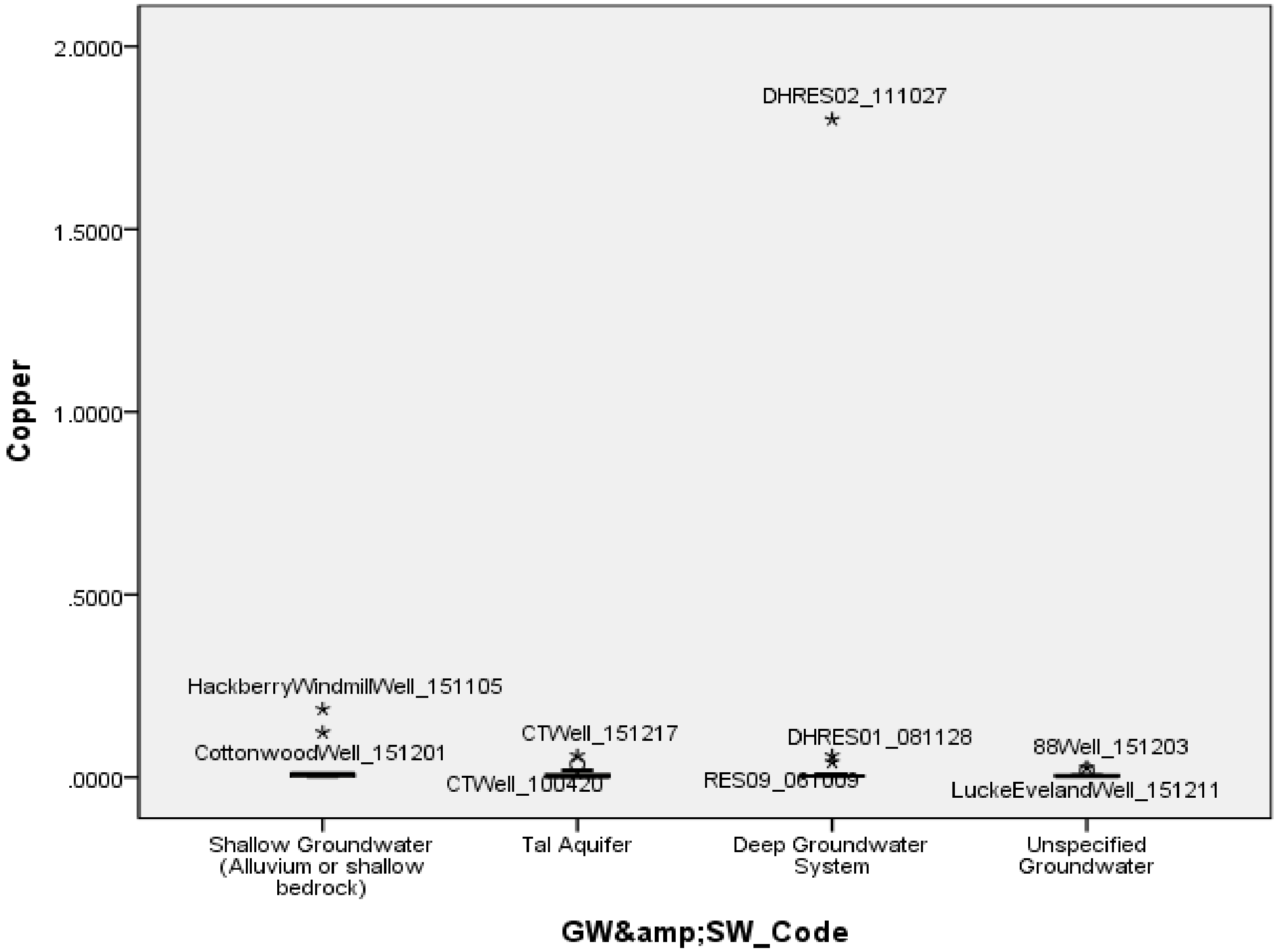

DHRES02_111027
.6000
.4000
.2000
.0000
Chromium
RES09_061009
DHRES01_081128
DHRES15_140716
SmithWell_151209
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

Cobalt



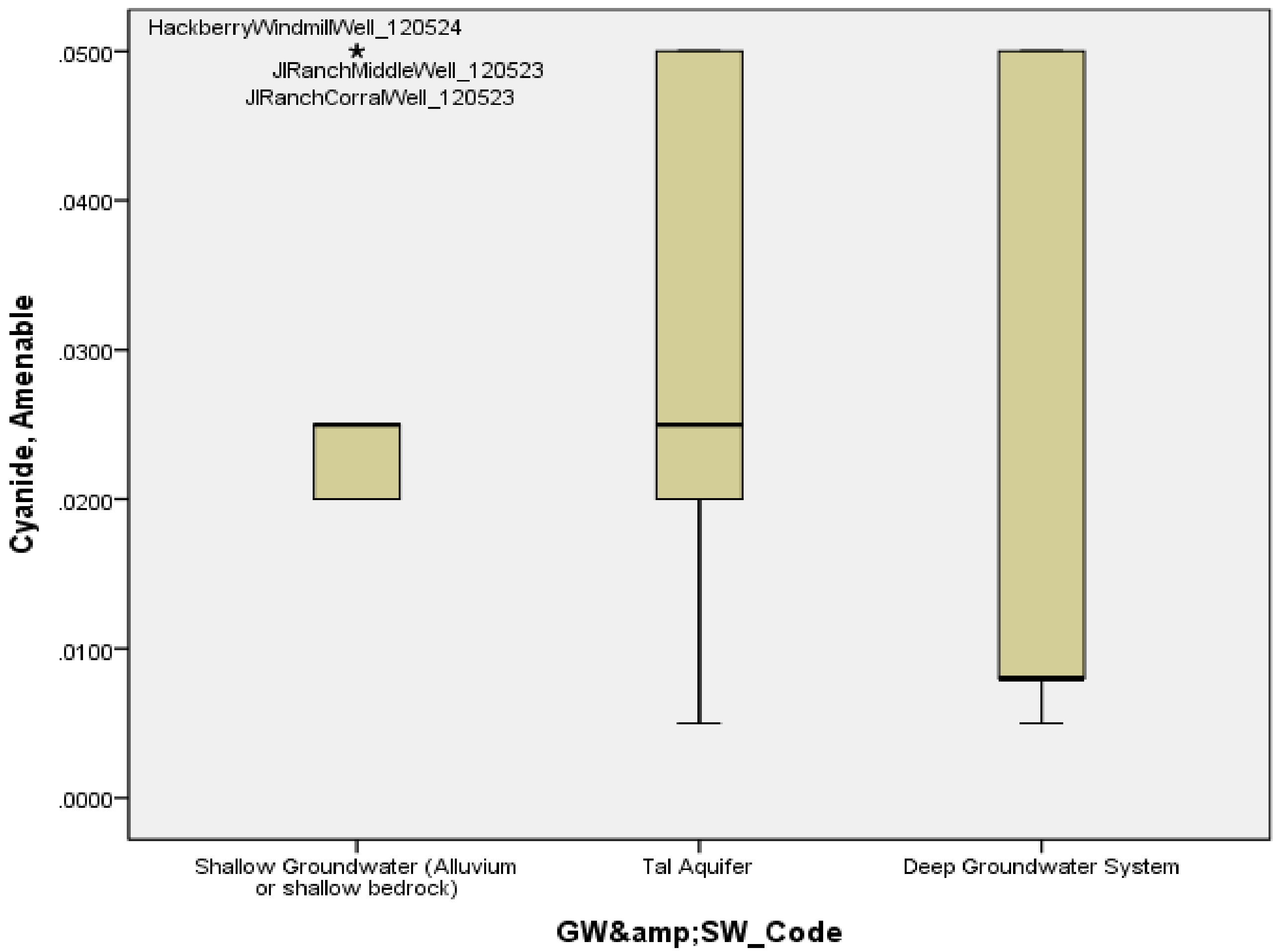
Cobalt
.0600
.0400
.0200
.0000
DHRES02_111027
HRES04_061103
OakFlatWell_060816A06_070924
MJ11_070929
MJ11_080826
JlRanchCorralWell_070621
JlRanchCorralWell_080529
JlRanchCorralWell_080529
JlRanchCorralWell_090605
MJ11_080220
DHRES15_140716
JlRanchHouseWell_070621
RES09_061009
HRES07_080902
HRES10_151120
QV5_151204
HRES09_110621
HRES09_140729
DHRES02_111022
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

Copper

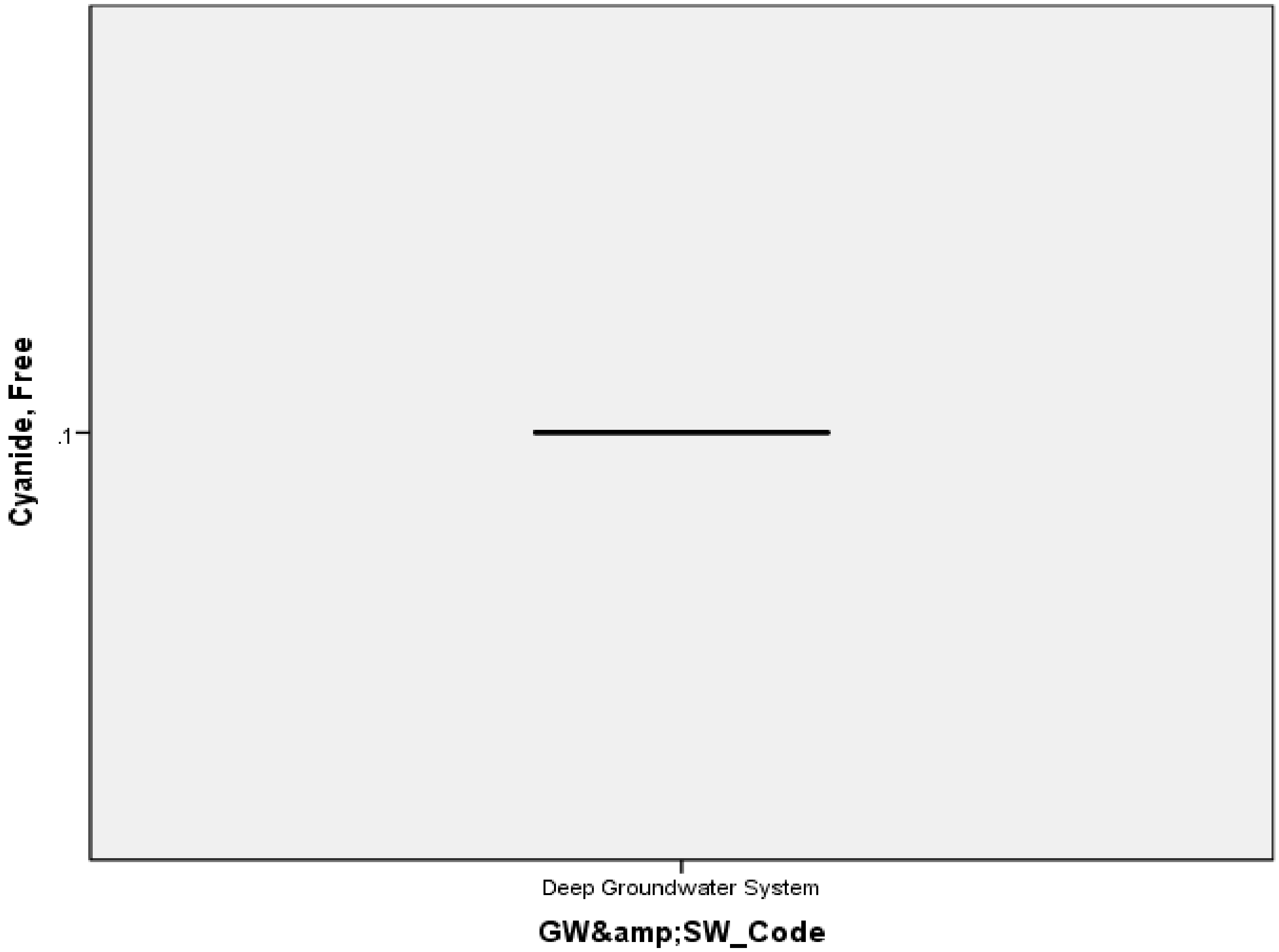


Copper
2.0000
1.5000
1.0000
.5000
.0000
DHRES02_111027
HackberryWindmillWell_151105
CottonwoodWell_151201
CTWell_151217
CTWell_100420
DHRES01_081128
RES09_081009
88Well_151203
LuckeEvelandWell_151211
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

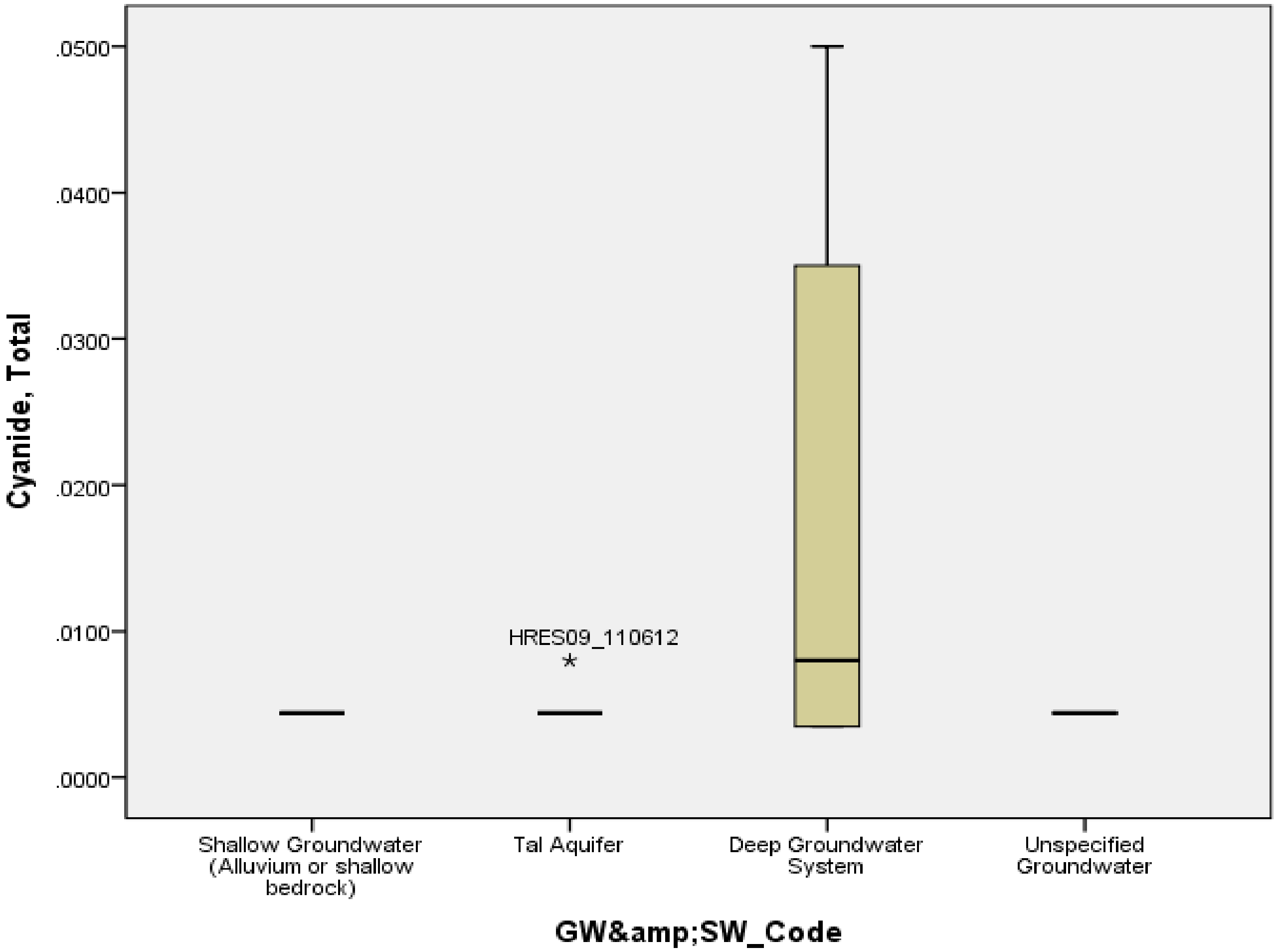
Cyanide, Amenable



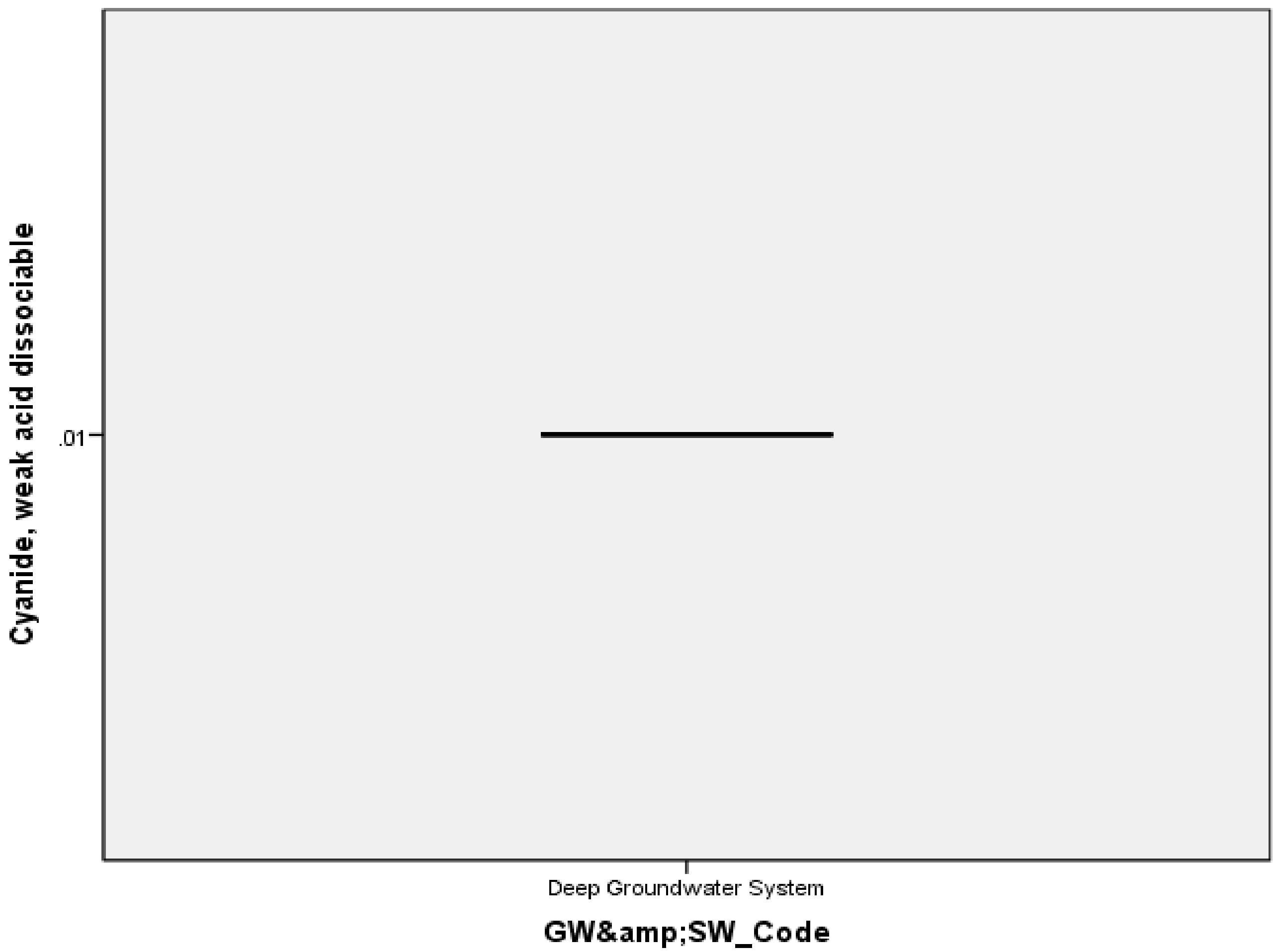
Cyanide, Free



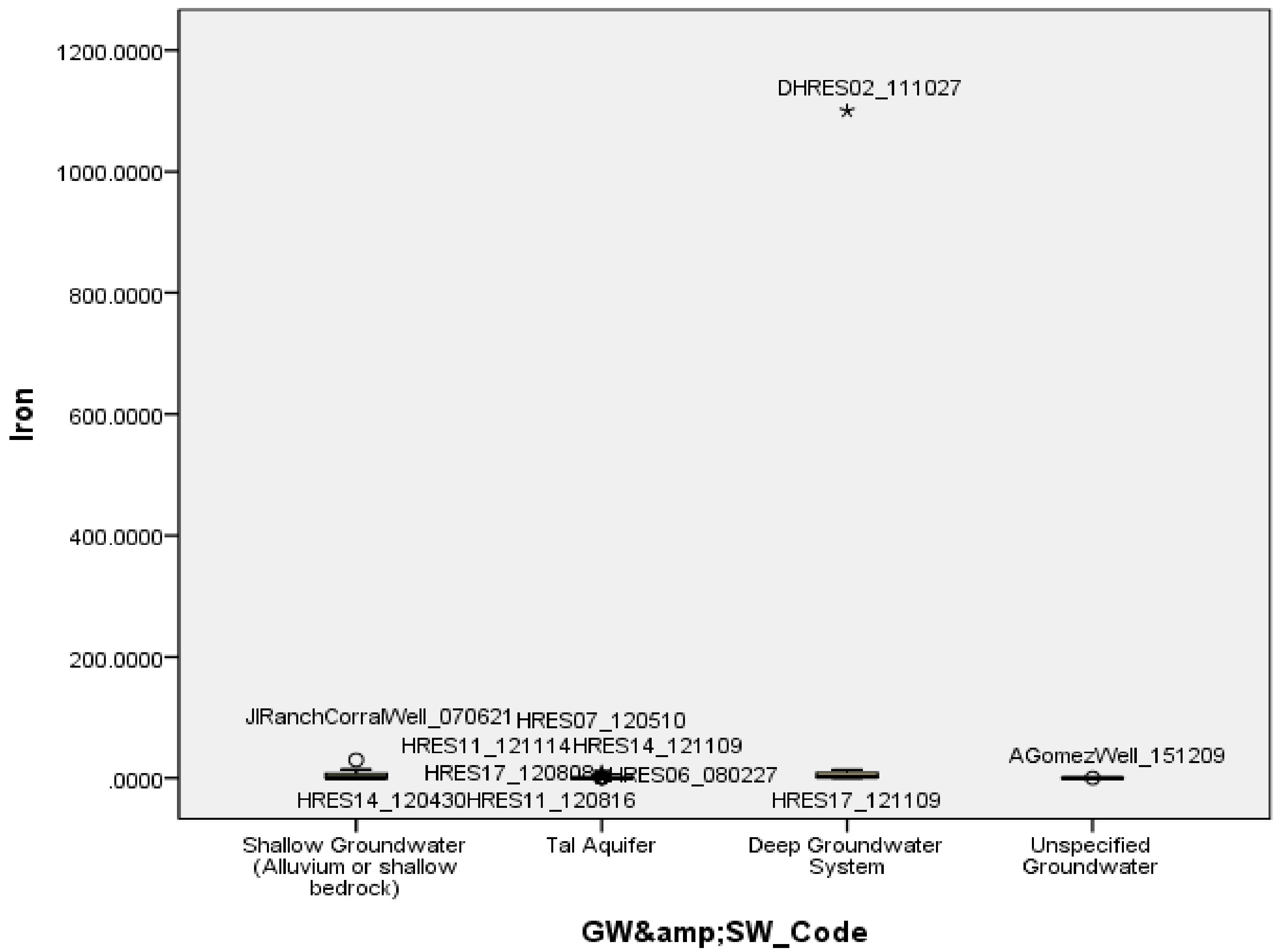
Cyanide, Total



Cyanide, weak acid dissociable

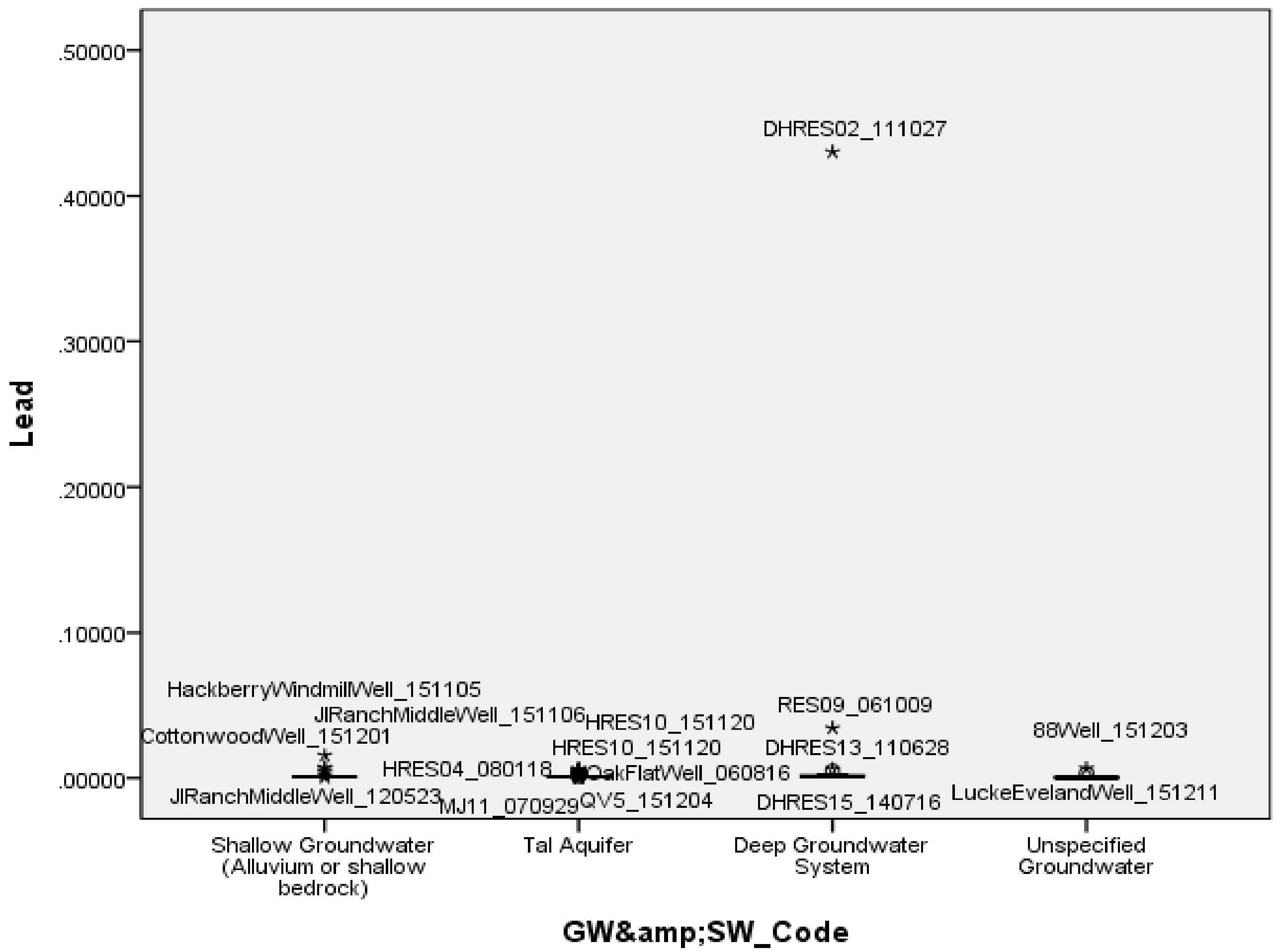


Iron



Iron
1200.0000
1000.0000
800.0000
600.0000
400.0000
200.0000
.0000
DHRES02_111027
JIRanchCorralWell_070621
HRES07_120510
HRES11_121114
HRES14_121109
HRES17_120808
HRES06_080227
HRES14_120430
HRES11_120816
HRES17_121109
AGomezWell_151209
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

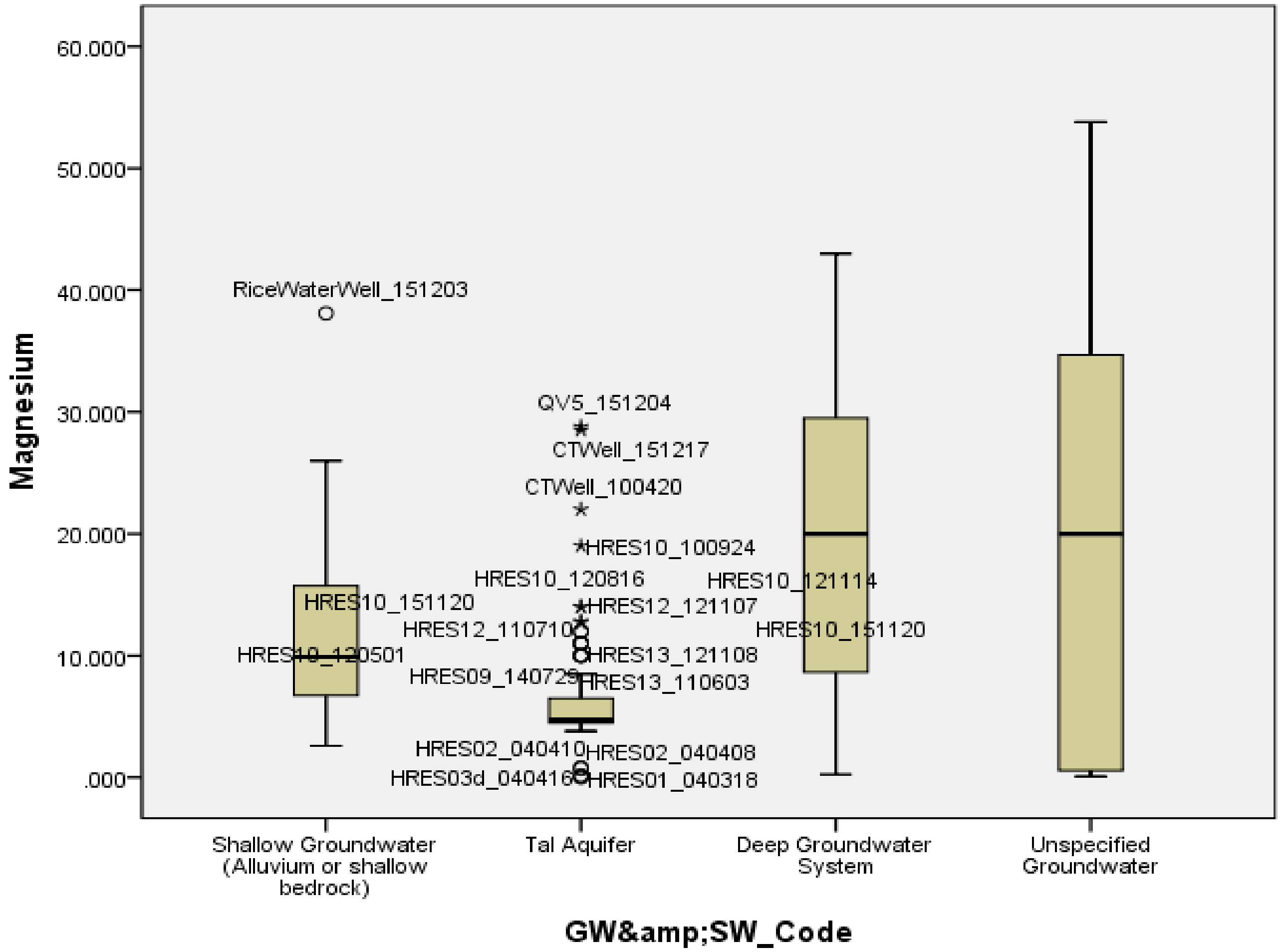
Lead



.50000
.40000
.30000
.20000
.10000
.00000
Lead
DHRES02_111027
HackberryWindmillWell_151105
JlRanchMiddleWell_151106
CottonwoodWell_151201
HRES04_080118
JlRanchMiddleWell_120523
HRES10_151120
HRES10_151120
OakFlatWell_060816
MJ11_070929
QV5_151204
RES09_061009
DHRES13_110628
DHRES15_140716
88Well_151203
LuckeEvelandWell_151211
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

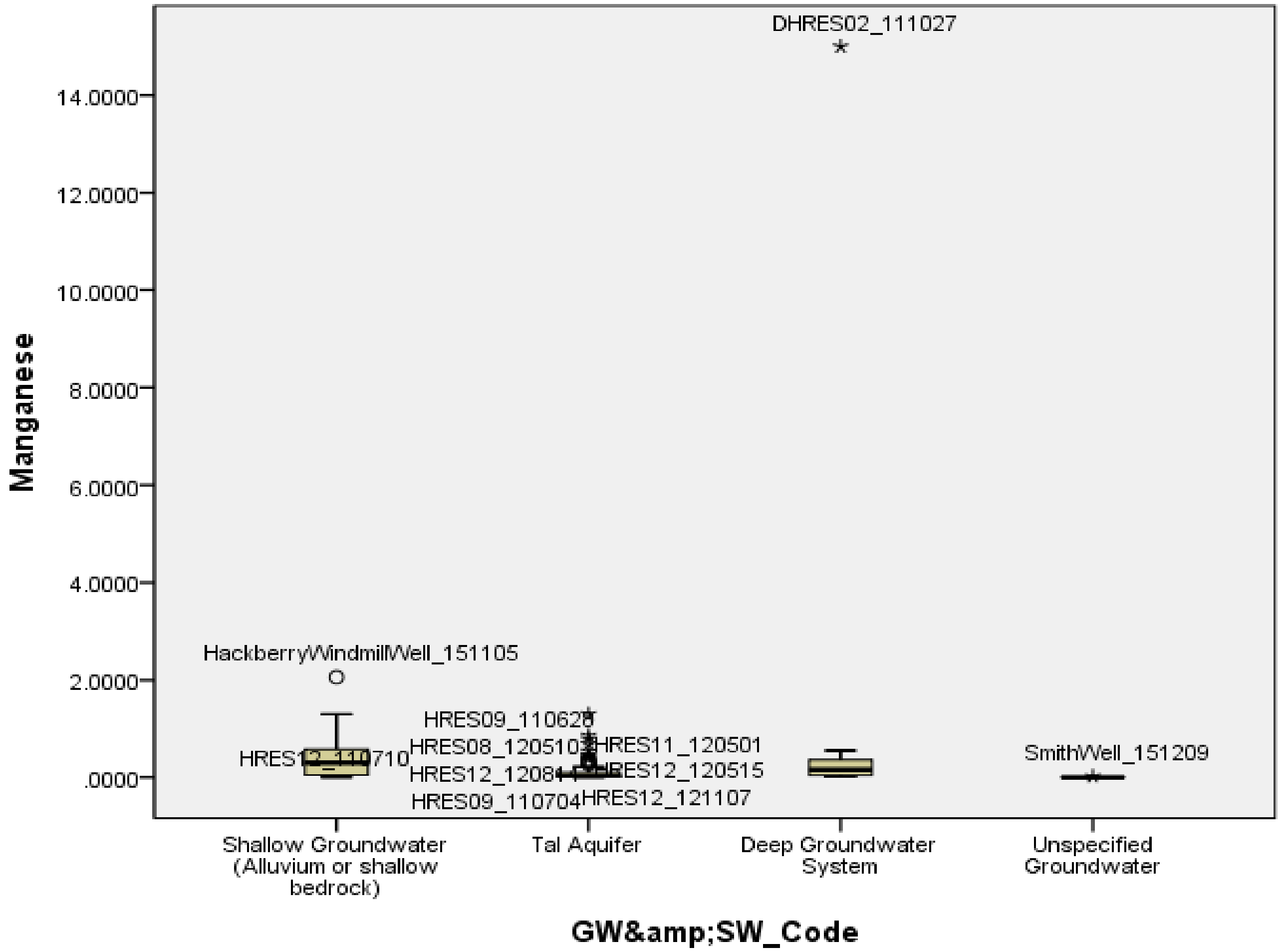
Lithium

Magnesium



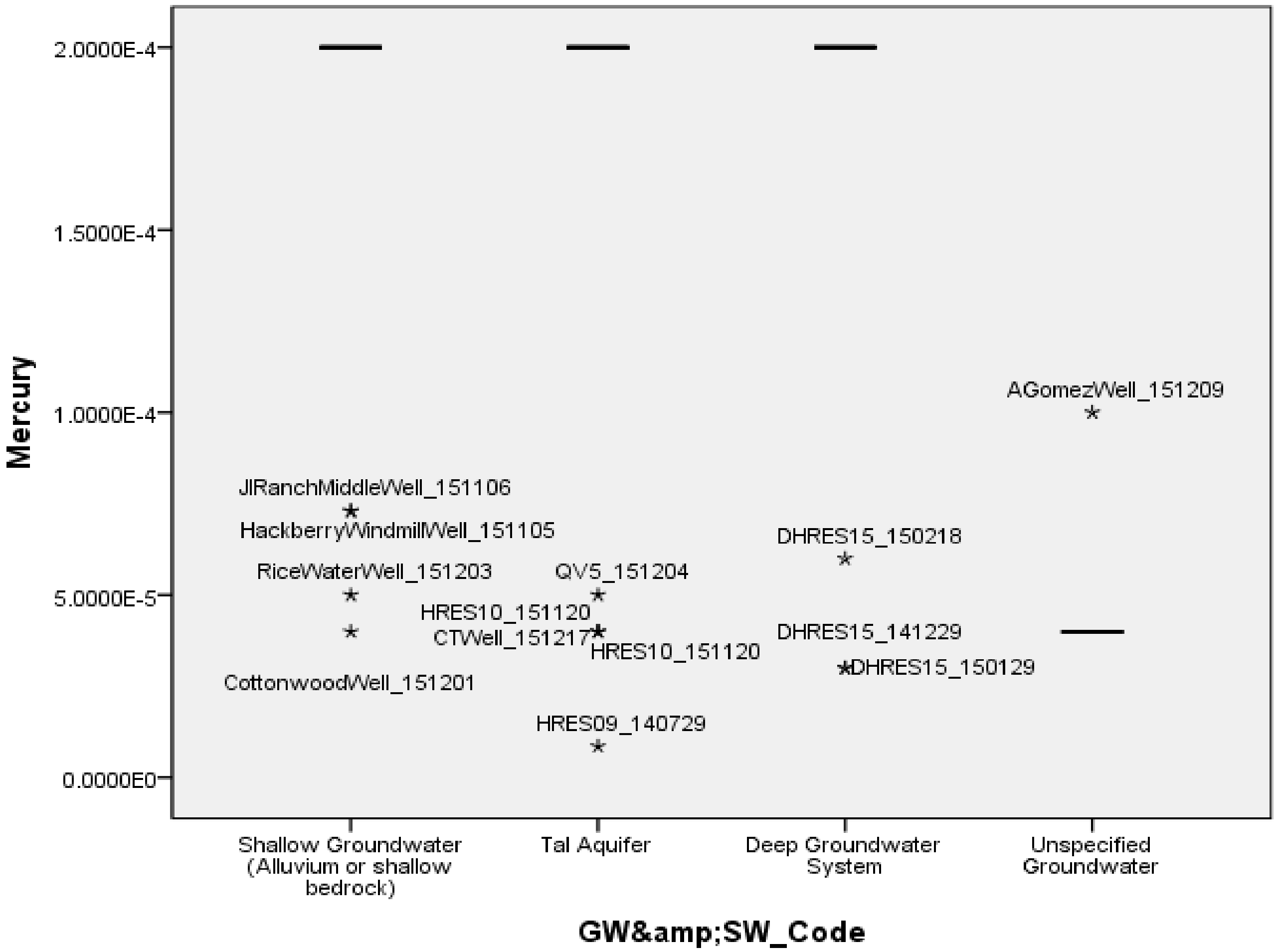
Magnesium
60.000
50.000
40.000
30.000
20.000
10.000
.000
RiceWaterWell_151203
QV5_151204
CTWell_151217
CTWell_100420
HRES10_100924
HRES10_120816
HRES10_121114
HRES10_151120
HRES12_121107
HRES12_110710
HRES10_151120
HRES10_120501
HRES13_121108
HRES09_140729
HRES13_110603
HRES02_040410
HRES02_040408
HRES03d_040416
HRES01_040318
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

Manganese



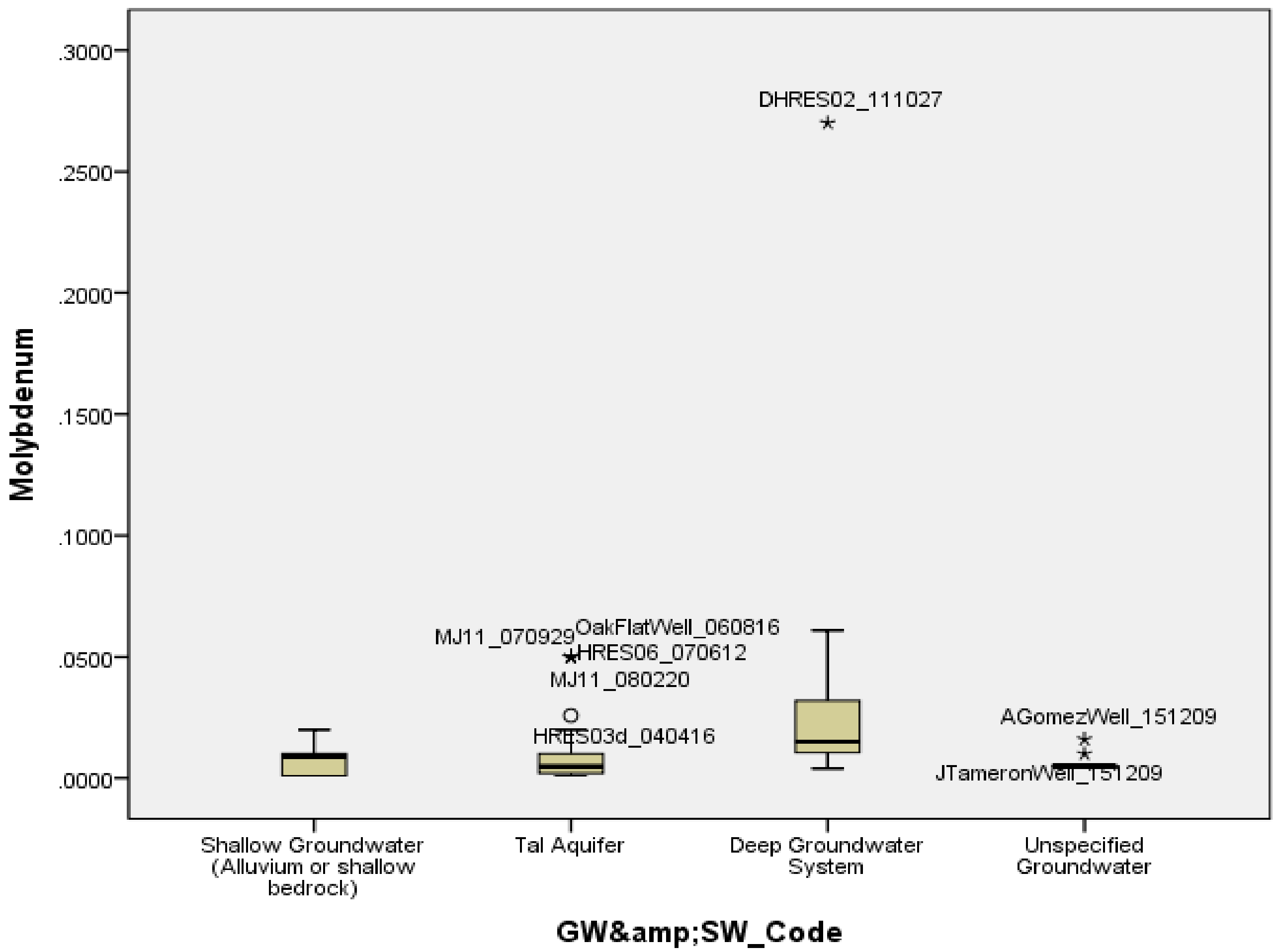
DHRES02_111027
14.0000
12.0000
10.0000
8.0000
6.0000
4.0000
2.0000
.0000
Manganese
HackberryWindmillWell_151105
HRES12_110710
HRES09_110628
HRES08_120510
HRES12_120814
HRES09_110704
HRES11_120501
HRES12_120515
HRES12_121107
SmithWell_151209
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

Mercury



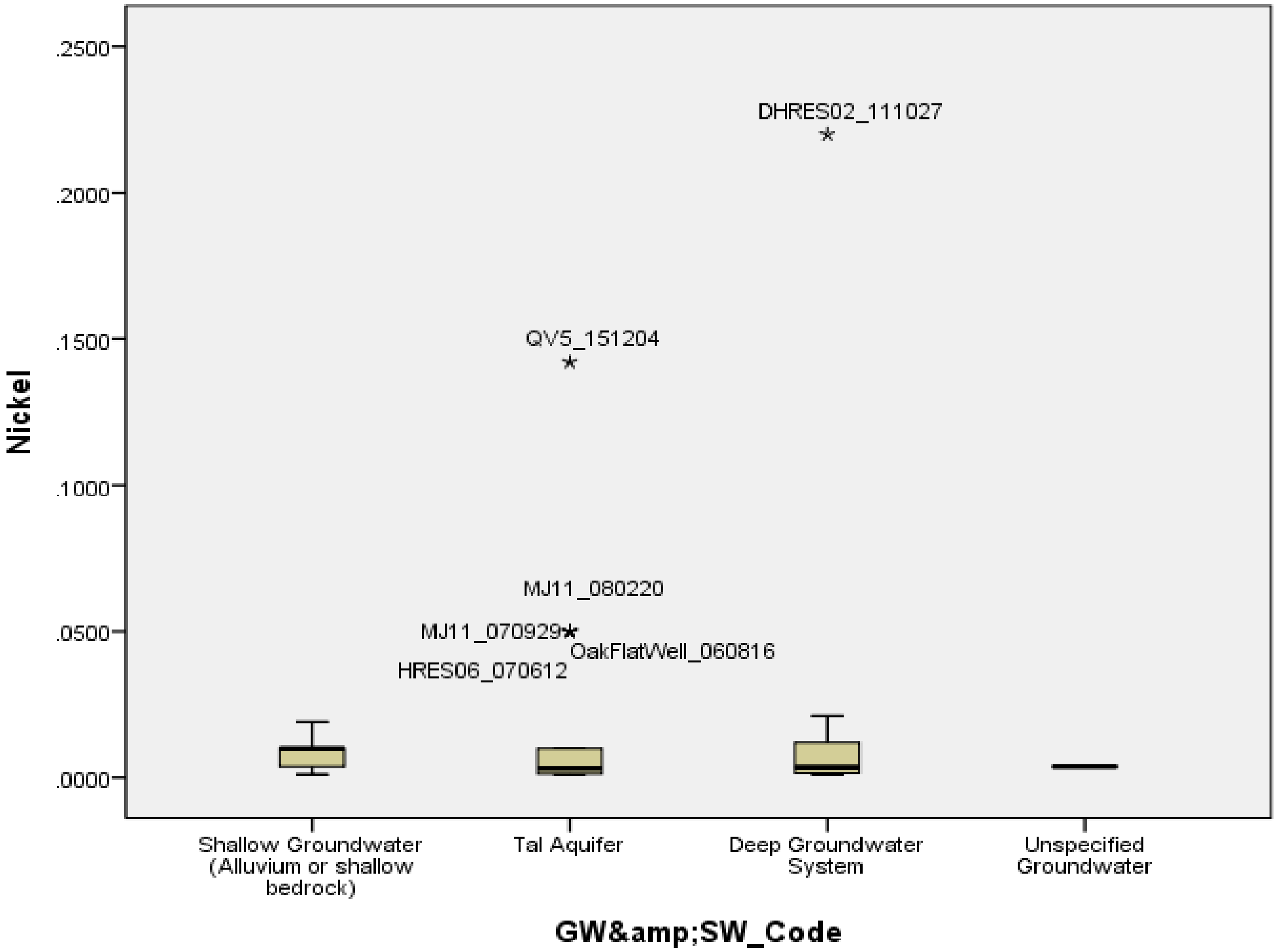
2.0000E-4
1.5000E-4
1.0000E-4
5.0000E-5
0.0000E0
Mercury
AGomezWell_151209
JlRanchMiddleWell_151106
HackberryWindmillWell_151105
DHRES15_150218
RiceWaterWell_151203
QV5_151204
HRES10_151120
CTWell_151217
HRES10_151120
DHRES15_141229
DHRES15_150129
CottonwoodWell_151201
HRES09_140729
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

Molybdenum



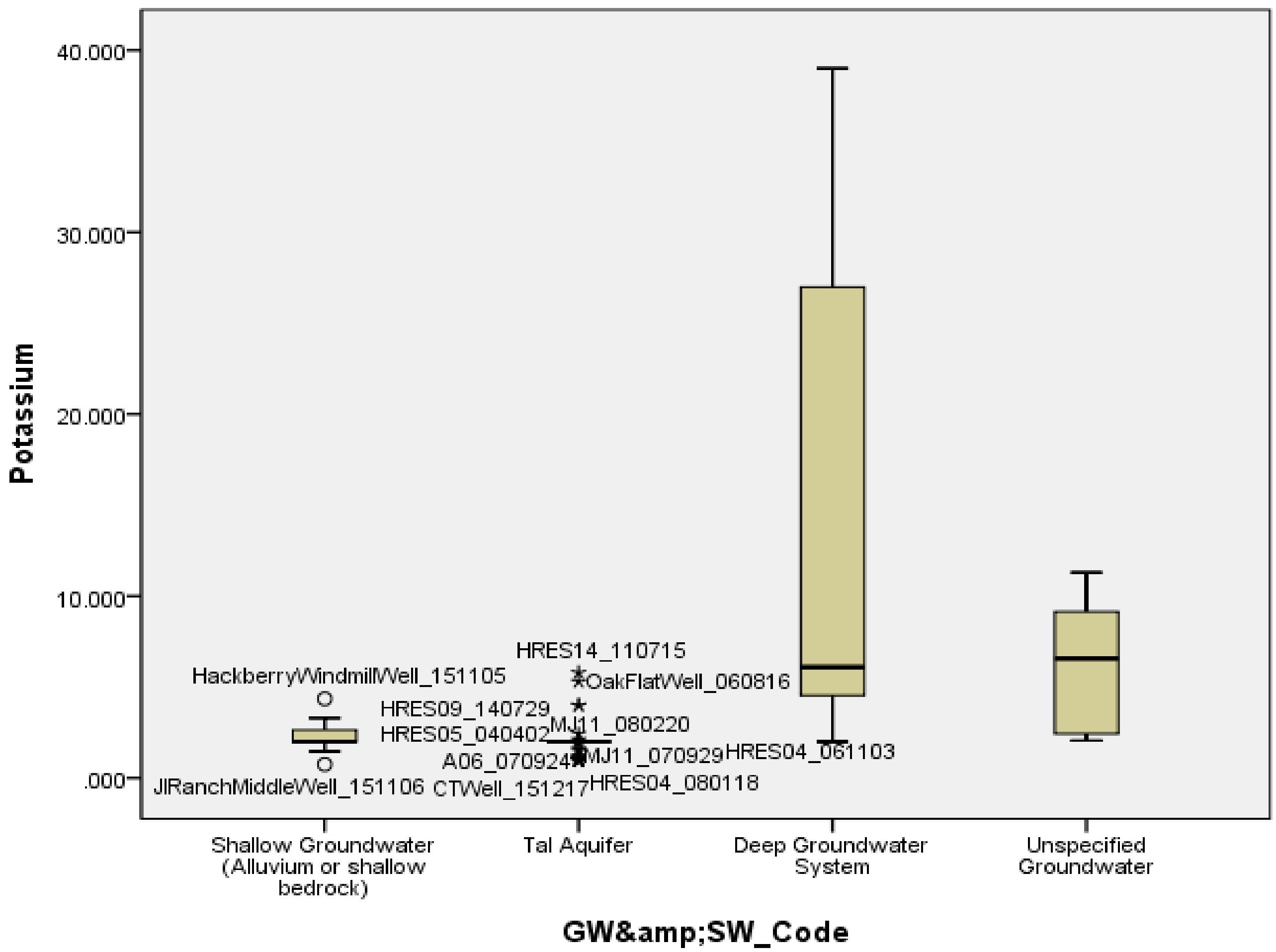
Molybdenum
.3000
.2500
.2000
.1500
.1000
.0500
.0000
DHRES02_111027
MJ11_070929
OakFlatWell_060816
HRES06_070612
MJ11_080220
HRES03d_040416
AGomezWell_151209
JTameronWell_151209
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

Nickel

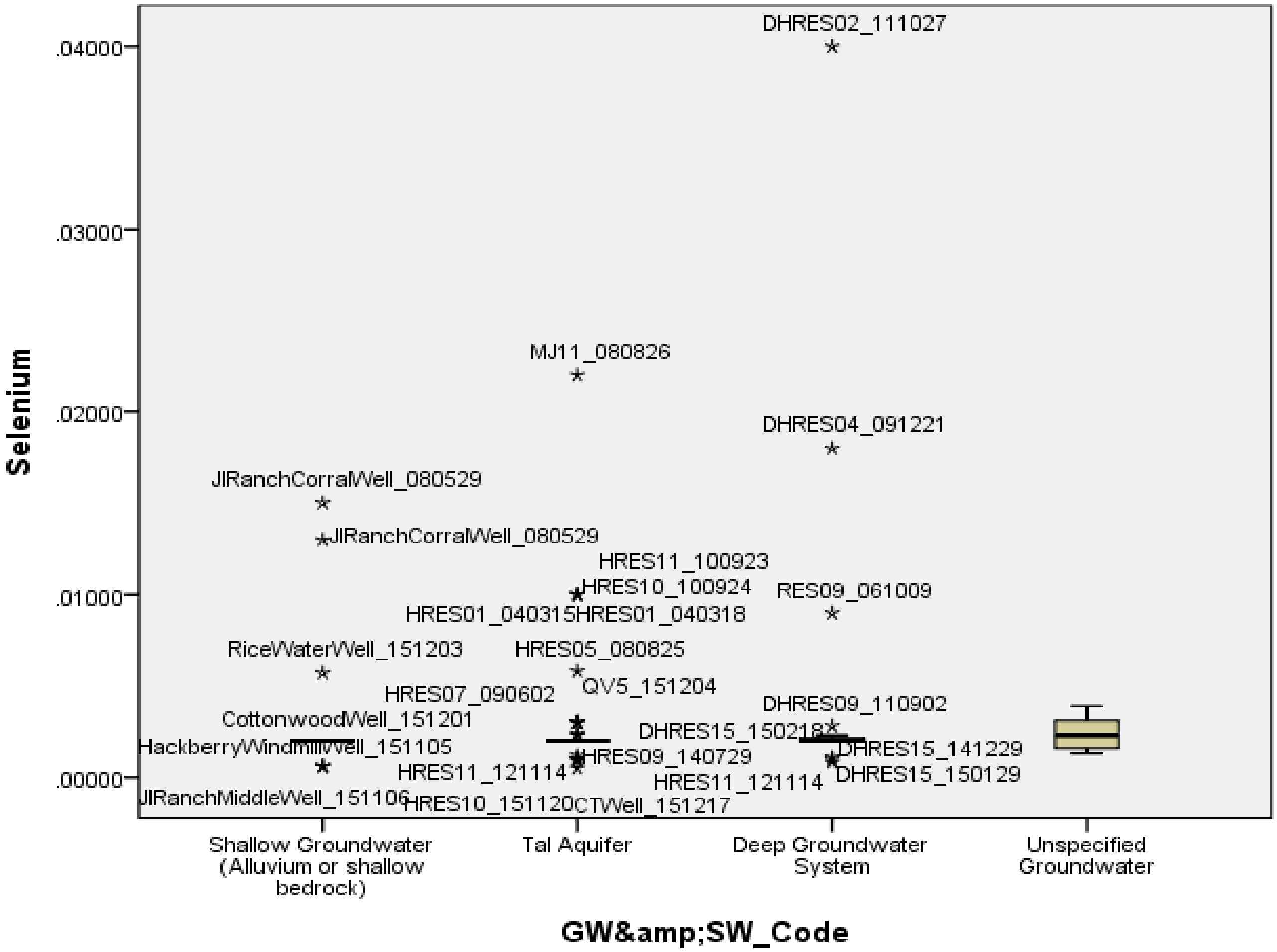


Nickel
.2500
.2000
.1500
.1000
.0500
.0000
DHRES02_111027
QV5_151204
MJ11_080220
MJ11_070929
OakFlatWell_060816
HRES06_070612
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

Potassium

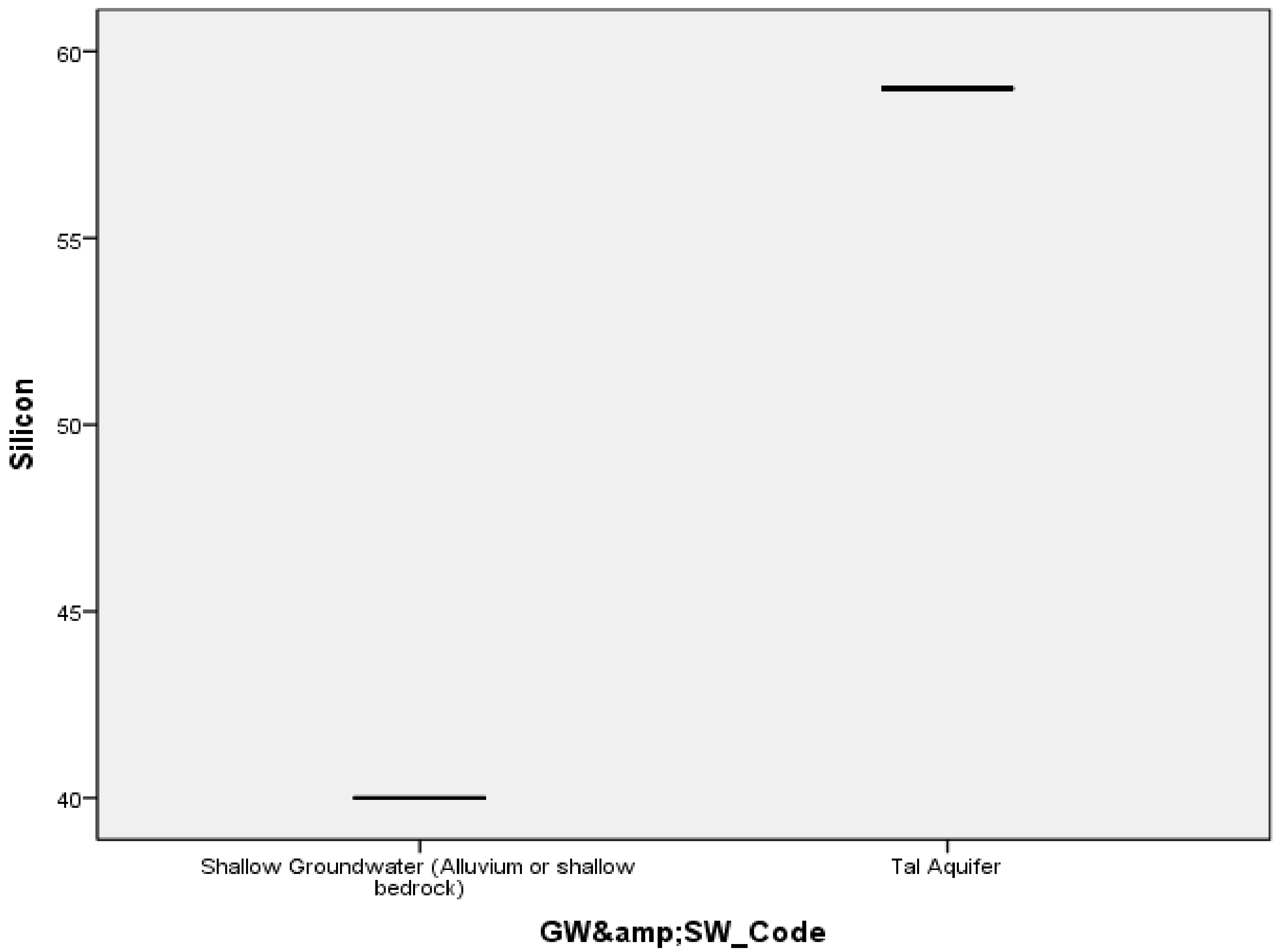

40.000
30.000
20.000
10.000
.000
Potassium
HackberryWindmillWell_151105
JlRanchMiddleWell_151106
HRES14_110715
OakFlatWell_060816
HRES09_140729
HRES05_040402
MJ11_080220
A06_070924
MJ11_070929
HRES04_061103
CTWell_151217
HRES04_080118
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

Selenium

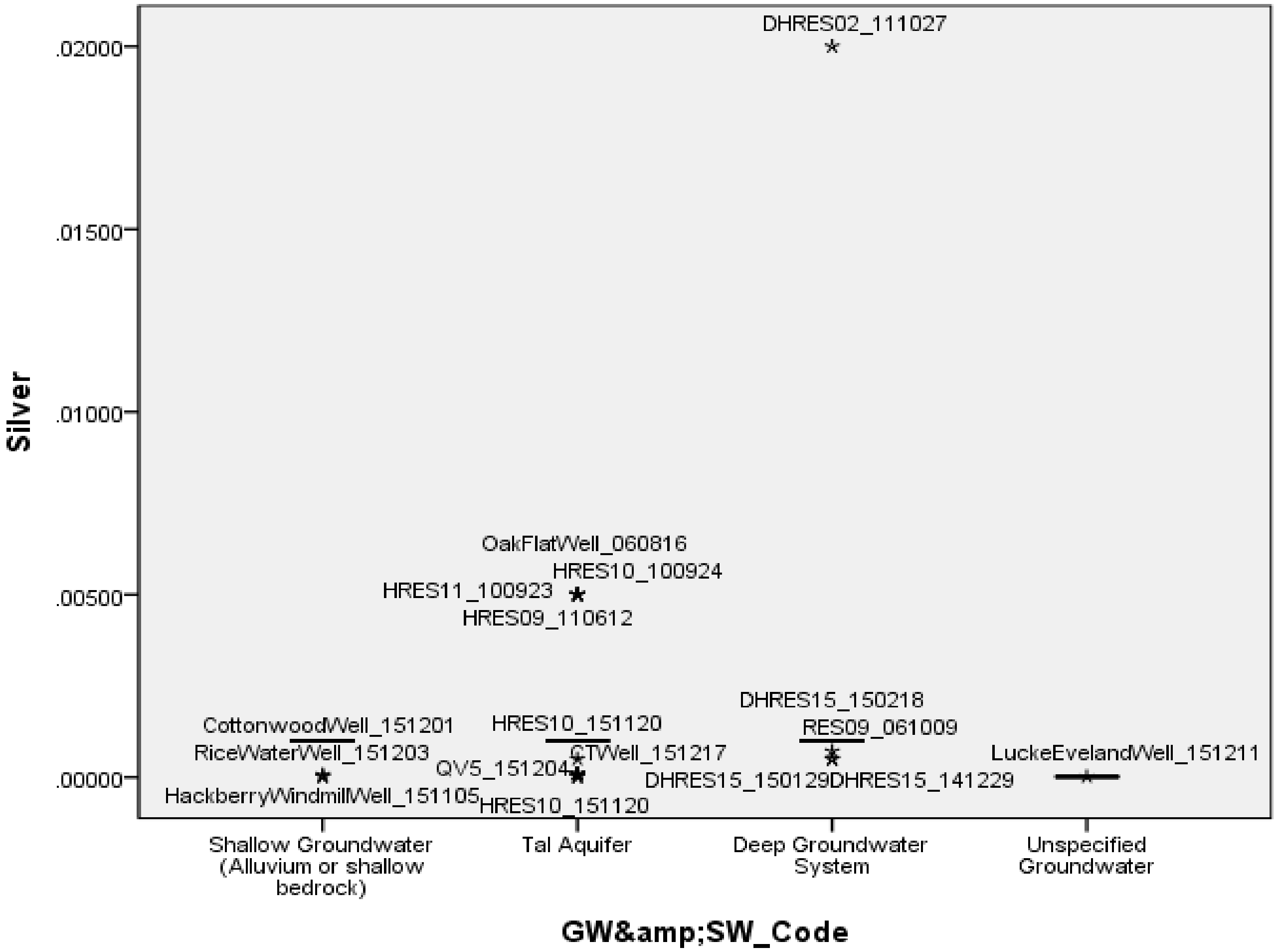


DHRES02_111027
MJ11_080826
DHRES04_091221
JlRanchCorralWell_080529
JlRanchCorralWell_080529
HRES11_100923
HRES10_100924
RES09_061009
HRES01_040315HRES01_040318
RiceWaterWell_151203
HRES05_080825
QV5_151204
HRES07_090602
DHRES09_110902
CottonwoodWell_151201
DHRES15_150218
HackberryWindmillWell_151105
DHRES15_141229
HRES09_140729
HRES11_121114
DHRES15_150129
HRES11_121114
JlRanchMiddleWell_151106
HRES10_151120
CTWell_151217
.04000
.03000
.02000
.01000
.00000
Selenium
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

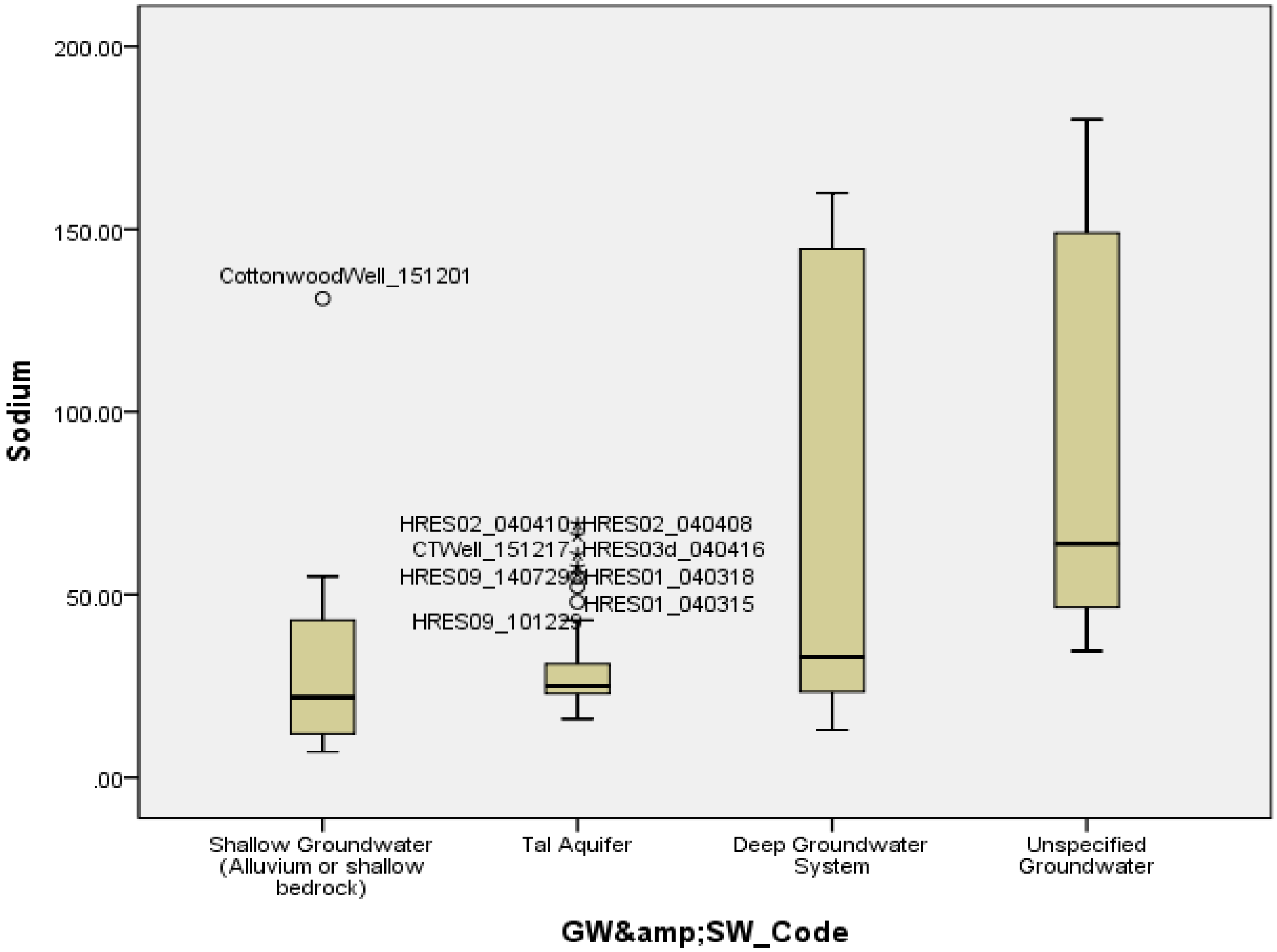
Silicon


60
55
50
45
40
Silicon
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
GW&SW_Code

Silver

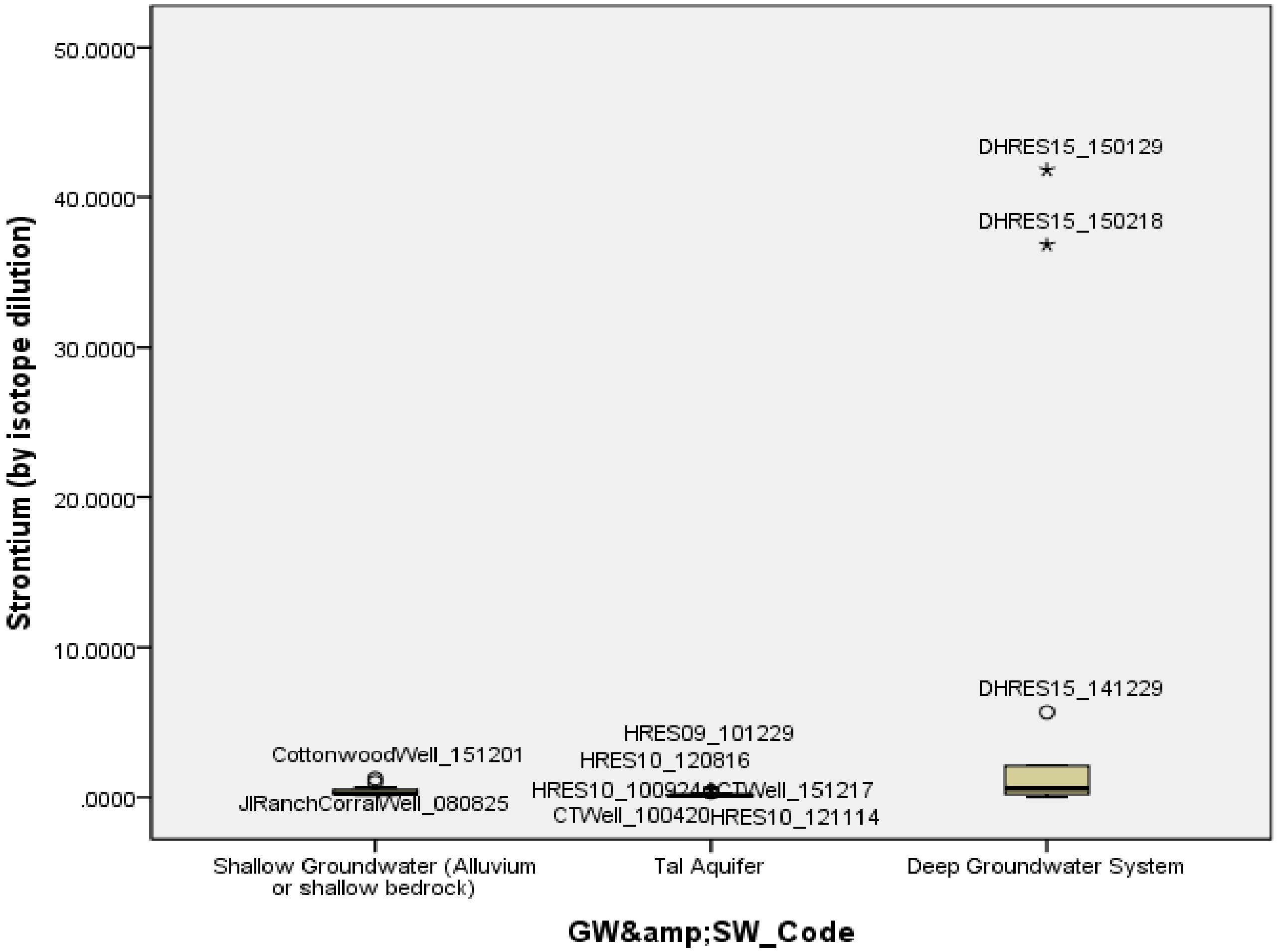

Silver
.02000
.01500
.01000
.00500
.00000
DHRES02_111027
OakFlatWell_060816
HRES10_100924
HRES11_100923
HRES09_110612
DHRES15_150218
CottonwoodWell_151201
HRES10_151120
RES09_061009
RiceWaterWell_151203
CTWell_151217
LuckeEvelandWell_151211
QV5_151204
DHRES15_150129
DHRES15_141229
HackberryWindmillWell_151105
HRES10_151120
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

Sodium

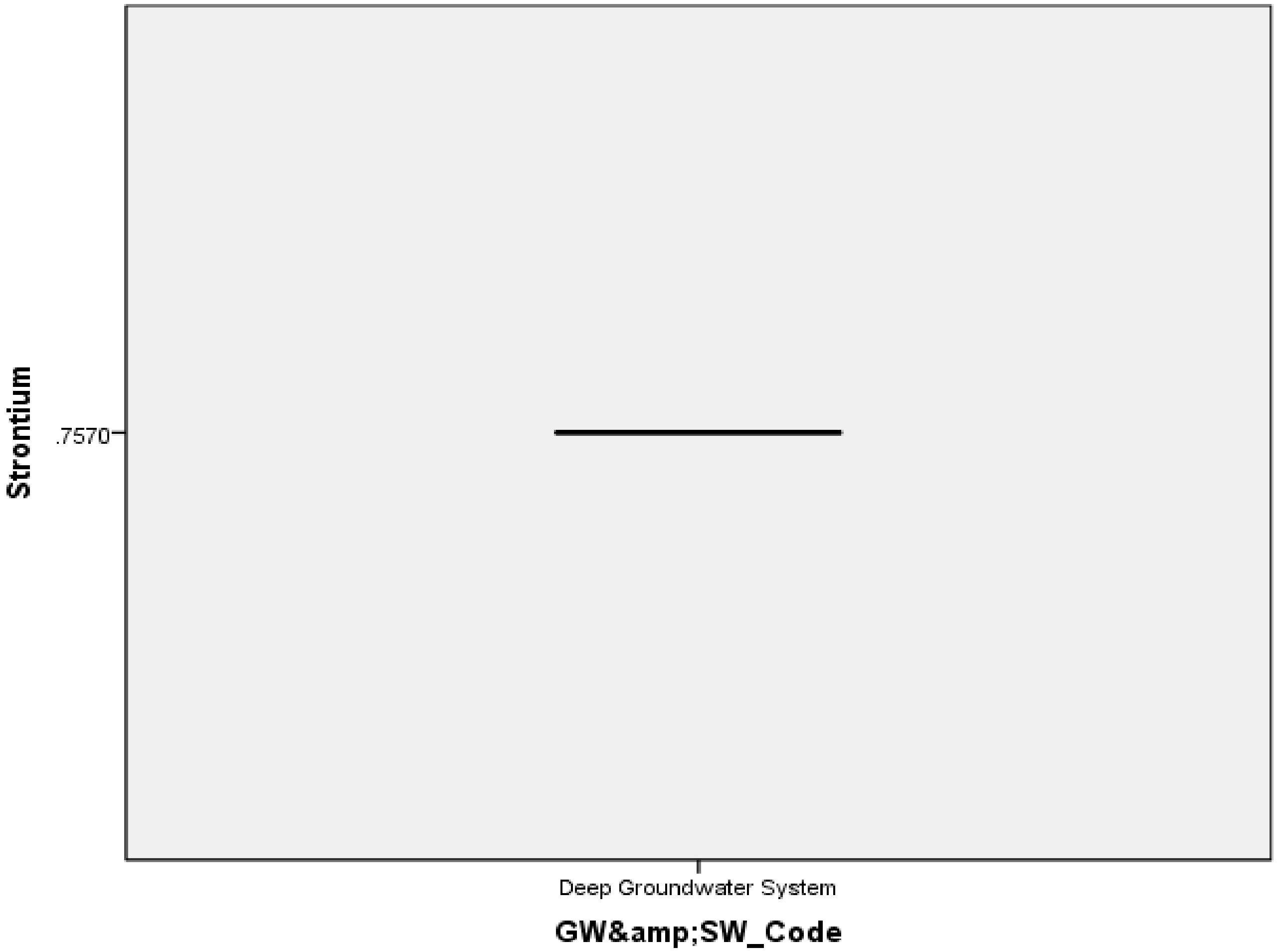


200.00
150.00
100.00
50.00
.00
Sodium
CottonwoodWell_151201
HRES02_040410
HRES02_040408
CTWell_151217
HRES03d_040416
HRES09_140729
HRES01_040318
HRES01_040315
HRES09_101229
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

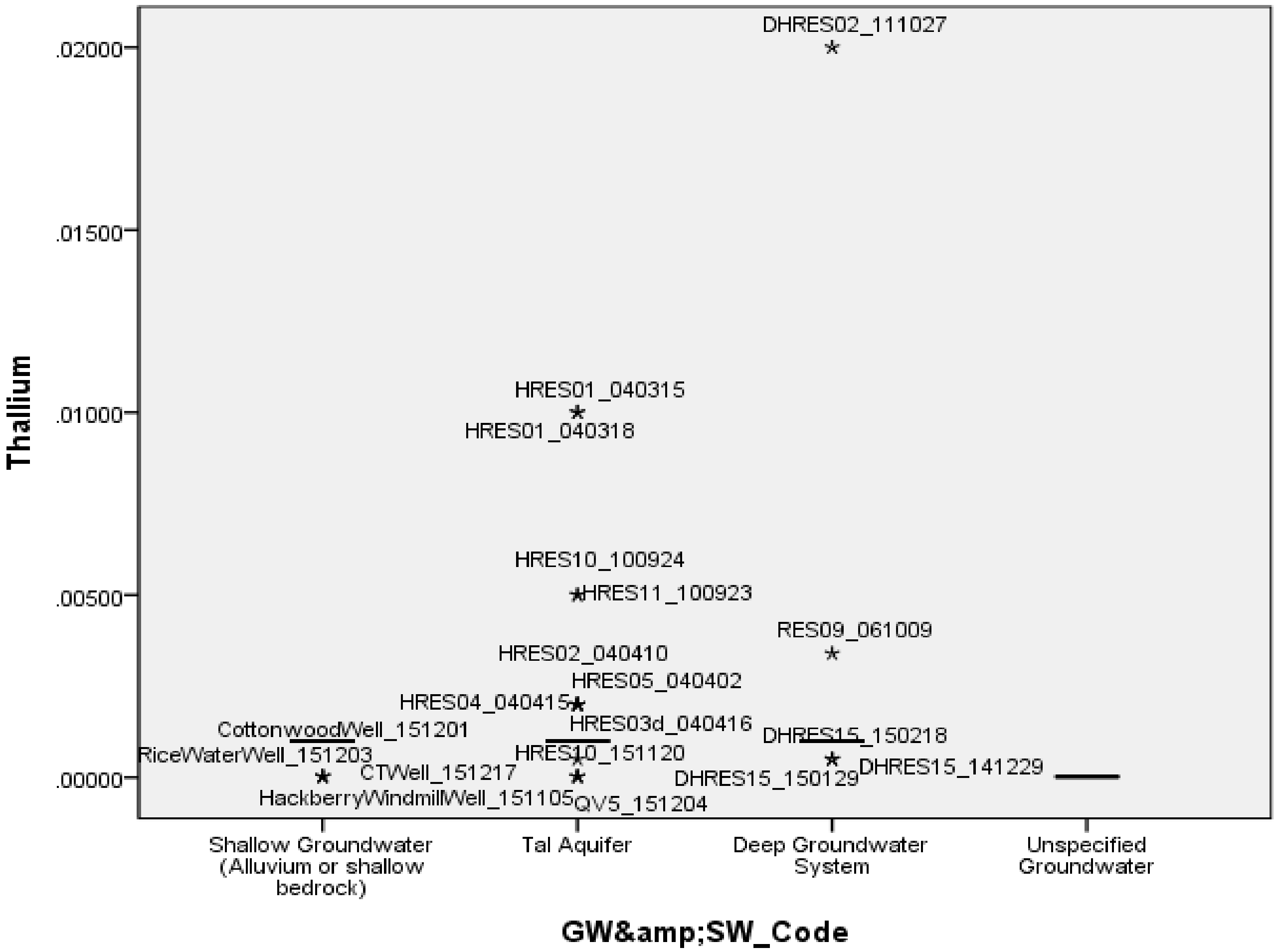
Strontium (by isotope dilution)



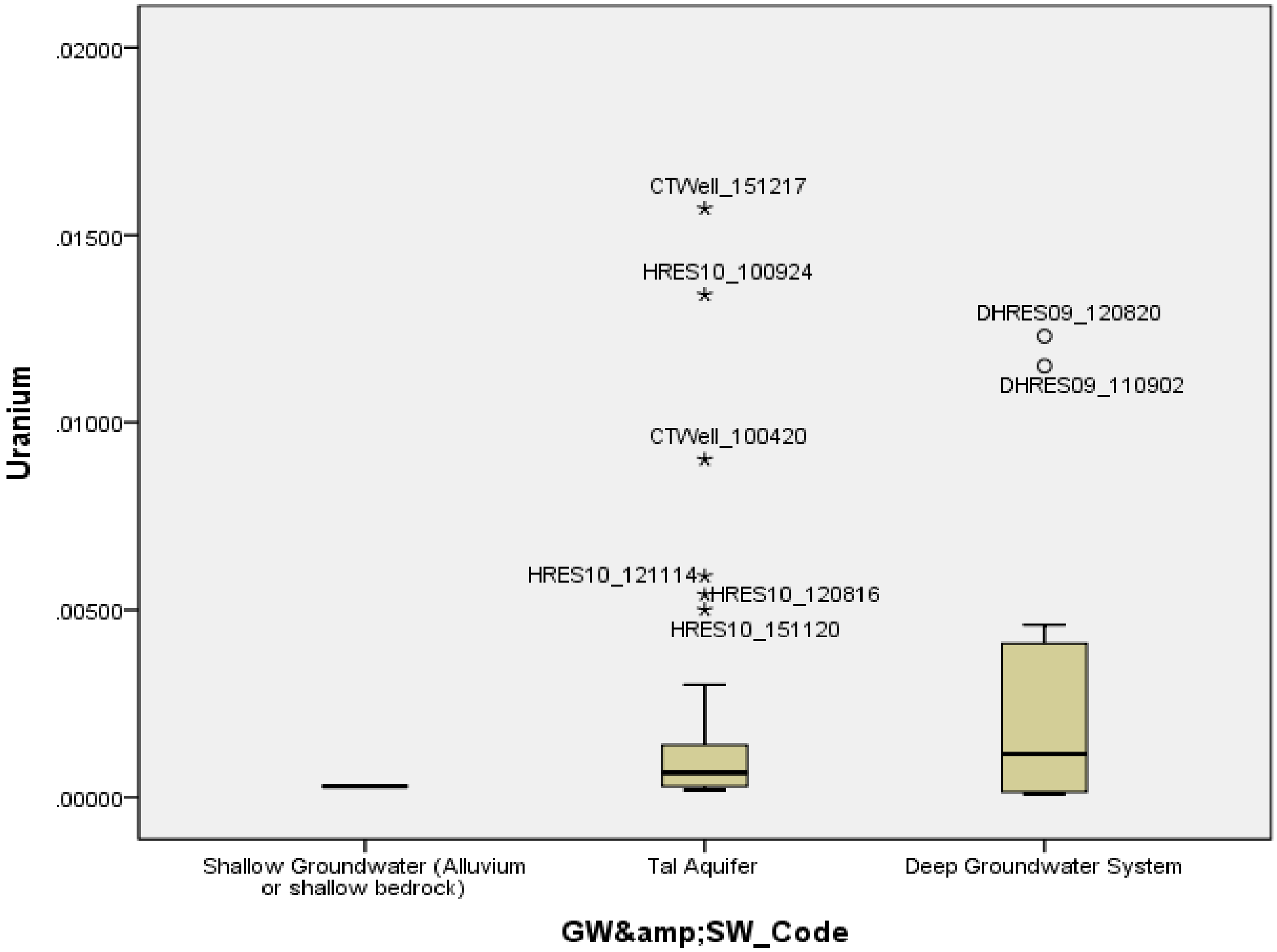
Strontium



Thallium

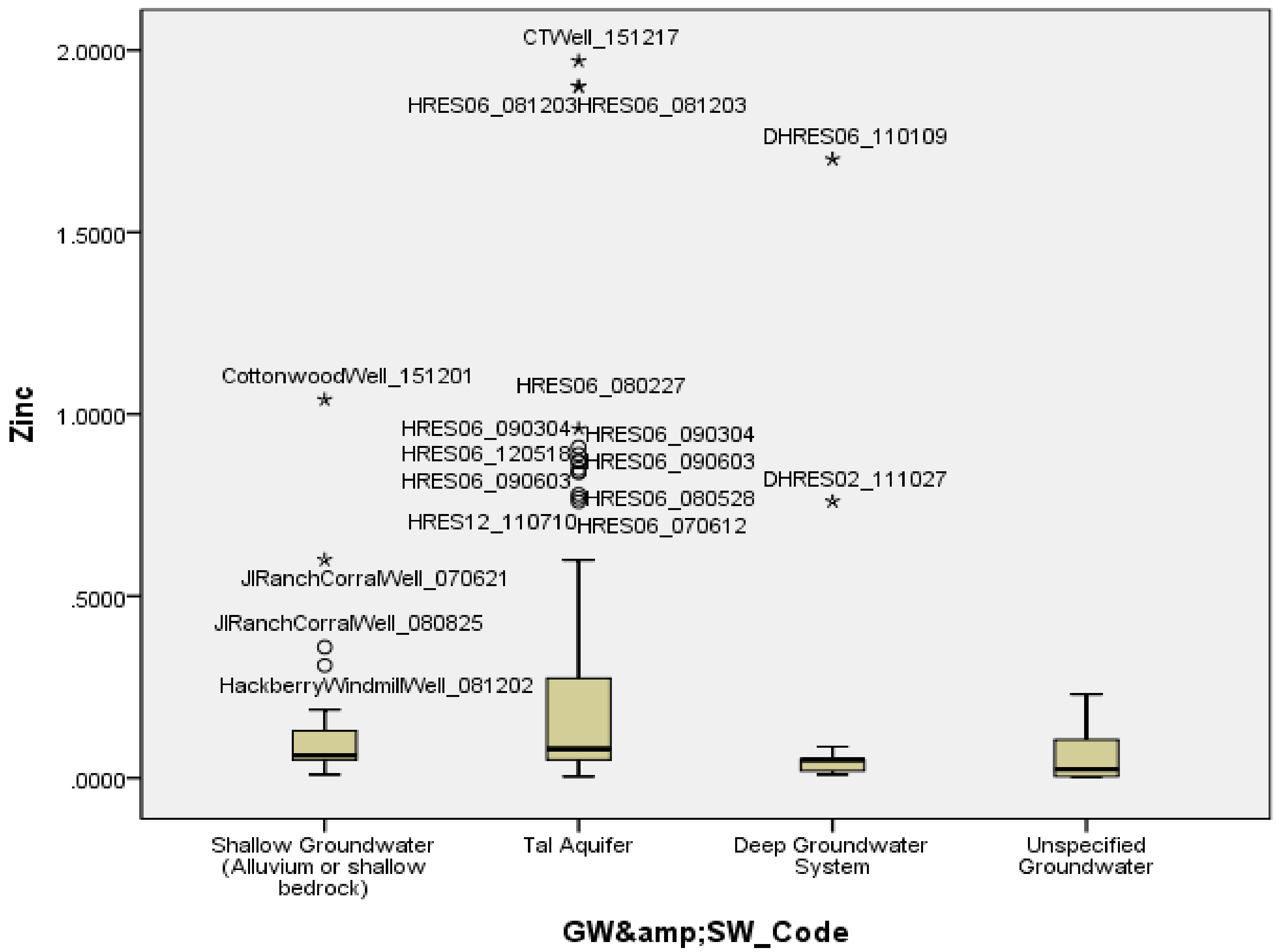

Thallium
.02000
.01500
.01000
.00500
.00000
DHRES02_111027
HRES01_040315
HRES01_040318
HRES10_100924
HRES11_100923
RES09_061009
HRES02_040410
HRES05_040402
HRES04_040415
CottonwoodWell_151201
HRES03d_040416
DHRES15_150218
RiceWaterWell_151203
HRES10_151120
CTWell_151217
DHRES15_141229
DHRES15_150129
HackberryWindmillWell_151105
QV5_151204
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

Uranium



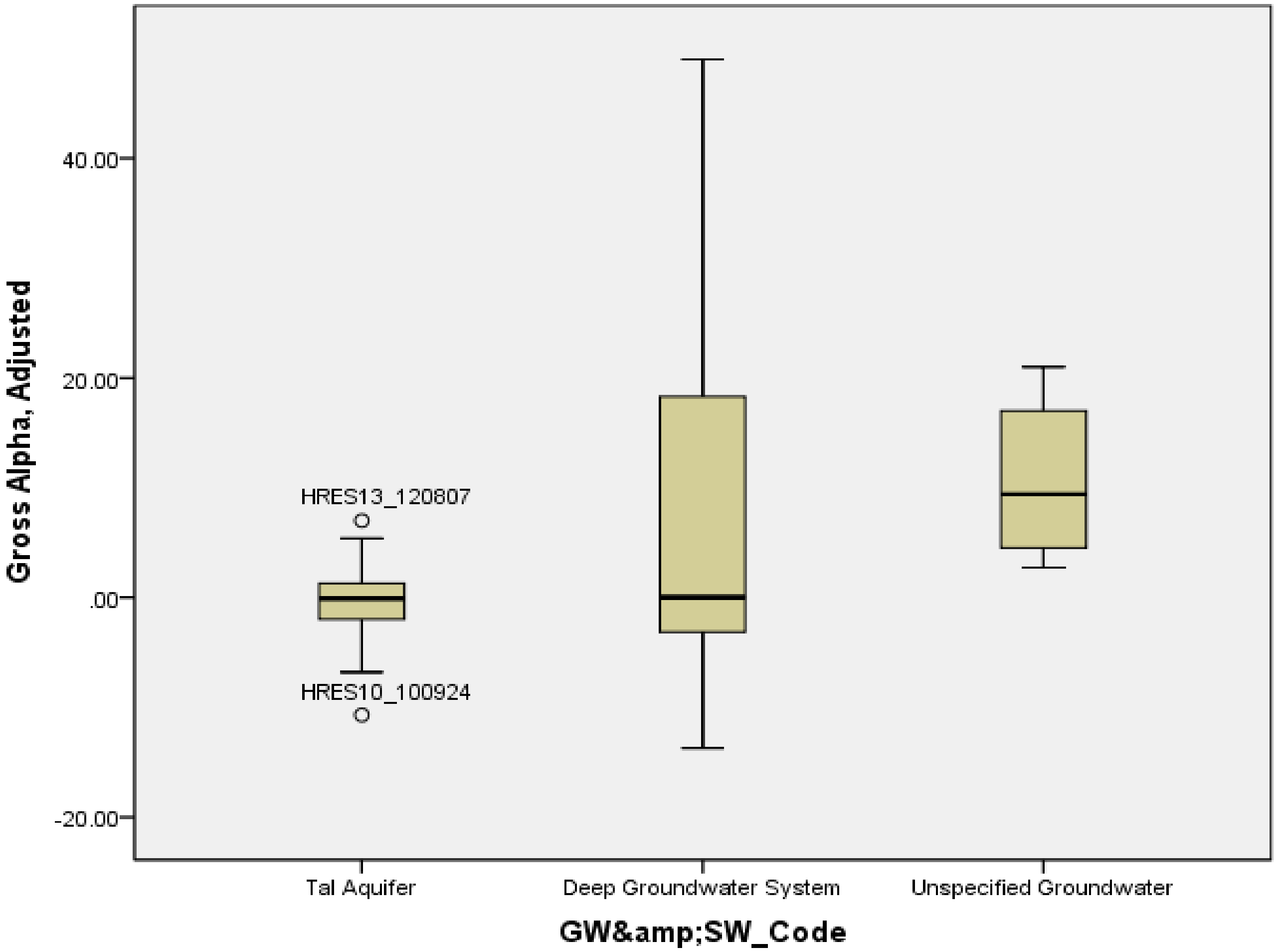
Uranium
.02000
.01500
.01000
.00500
.00000
CTWell_151217
HRES10_100924
DHRES09_120820
DHRES09_110902
CTWell_100420
HRES10_121114
HRES10_120816
HRES10_151120
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
GW&SW_Code

Zinc

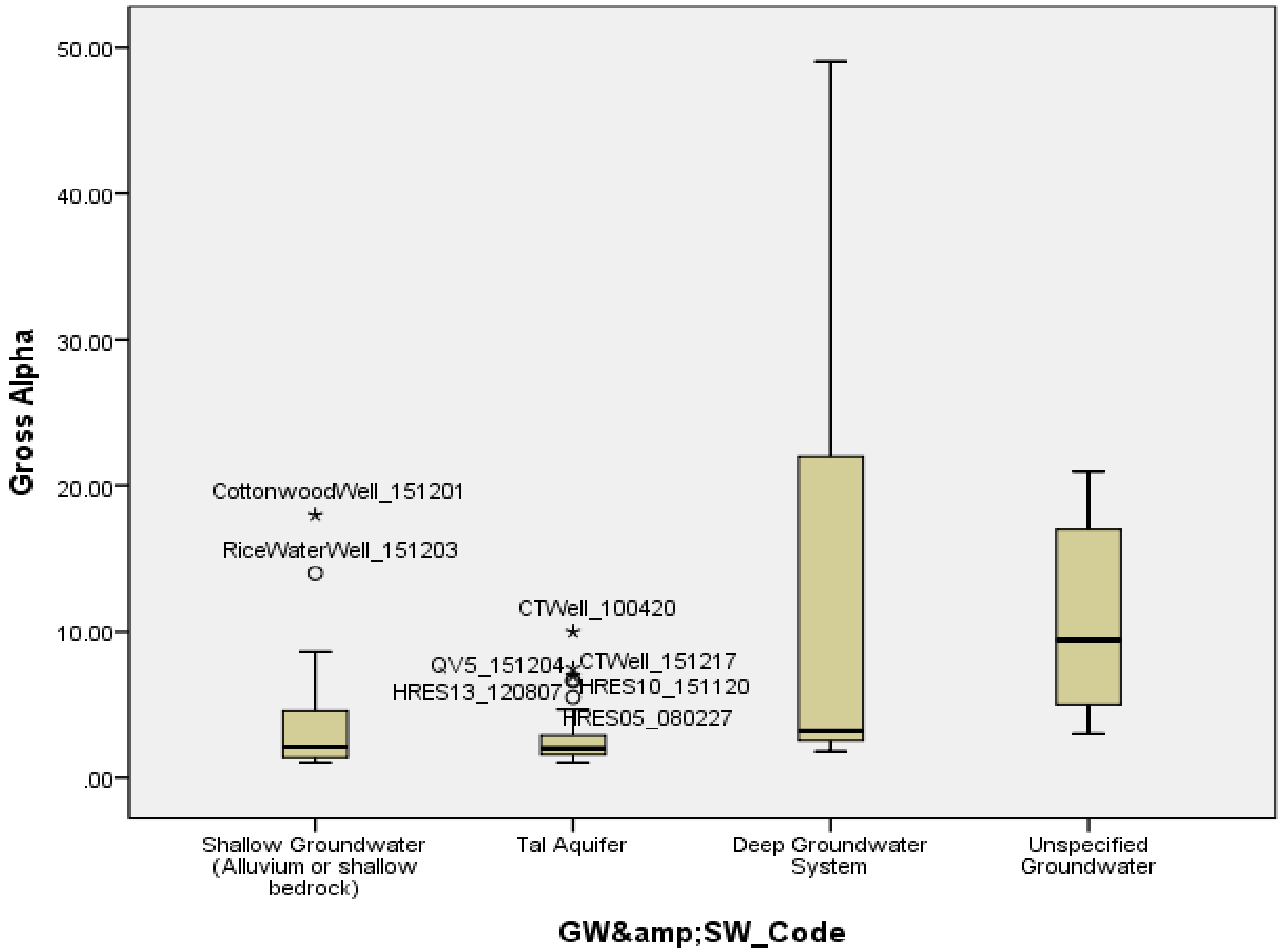


CTWell_151217
HRES06_081203
HRES06_081203
DHRES06_110109
CottonwoodWell_151201
HRES06_080227
HRES06_090304
HRES06_090304
HRES06_120518
HRES06_090603
HRES06_090603
DHRES02_111027
HRES06_080528
HRES12_110710
HRES06_070612
JlRanchCorralWell_070621
JlRanchCorralWell_080825
HackberryWindmillWell_081202
2.0000
1.5000
1.0000
.5000
.0000
Zinc
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

Gross Alpha, Adjusted

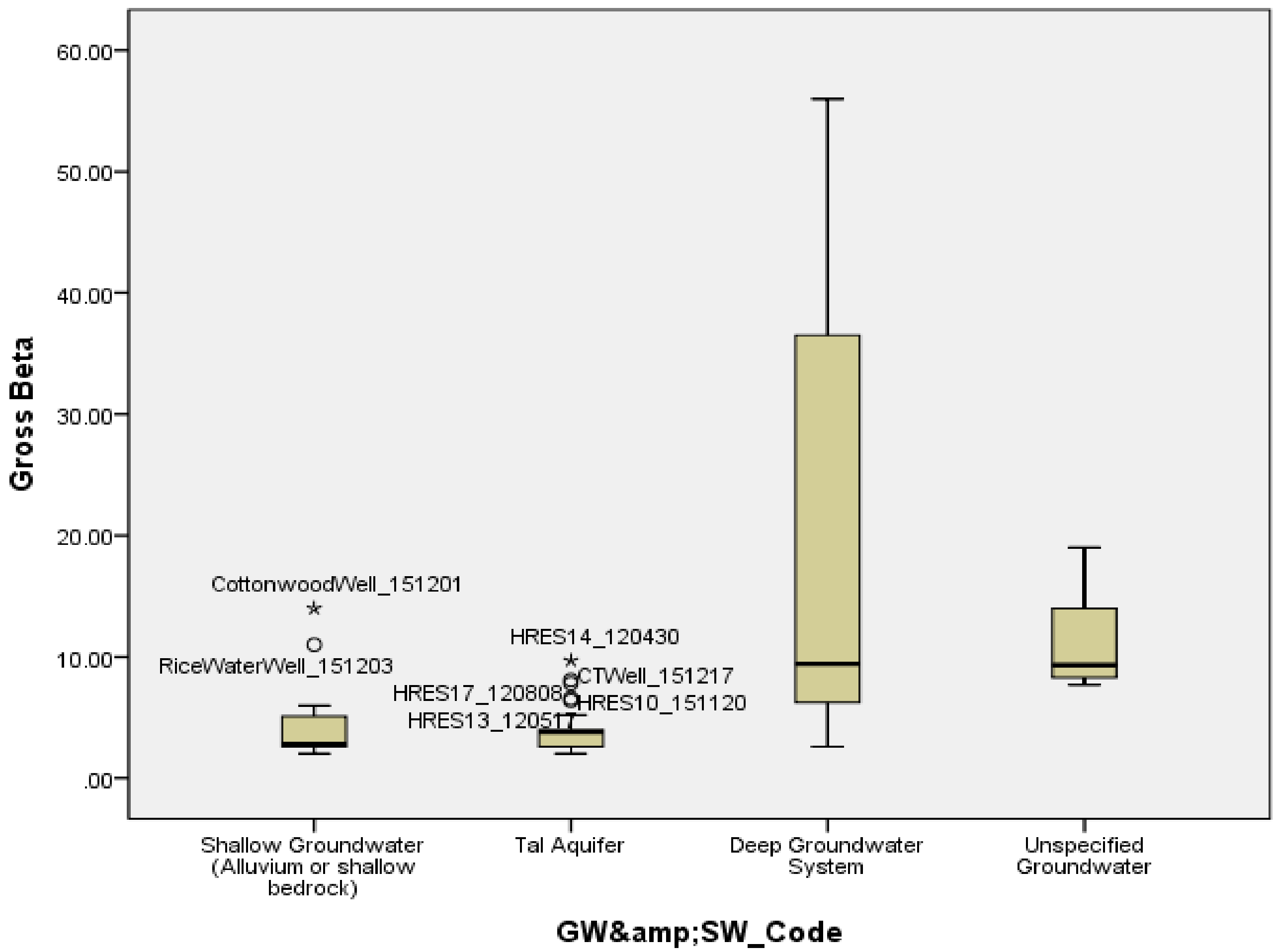


Gross Alpha



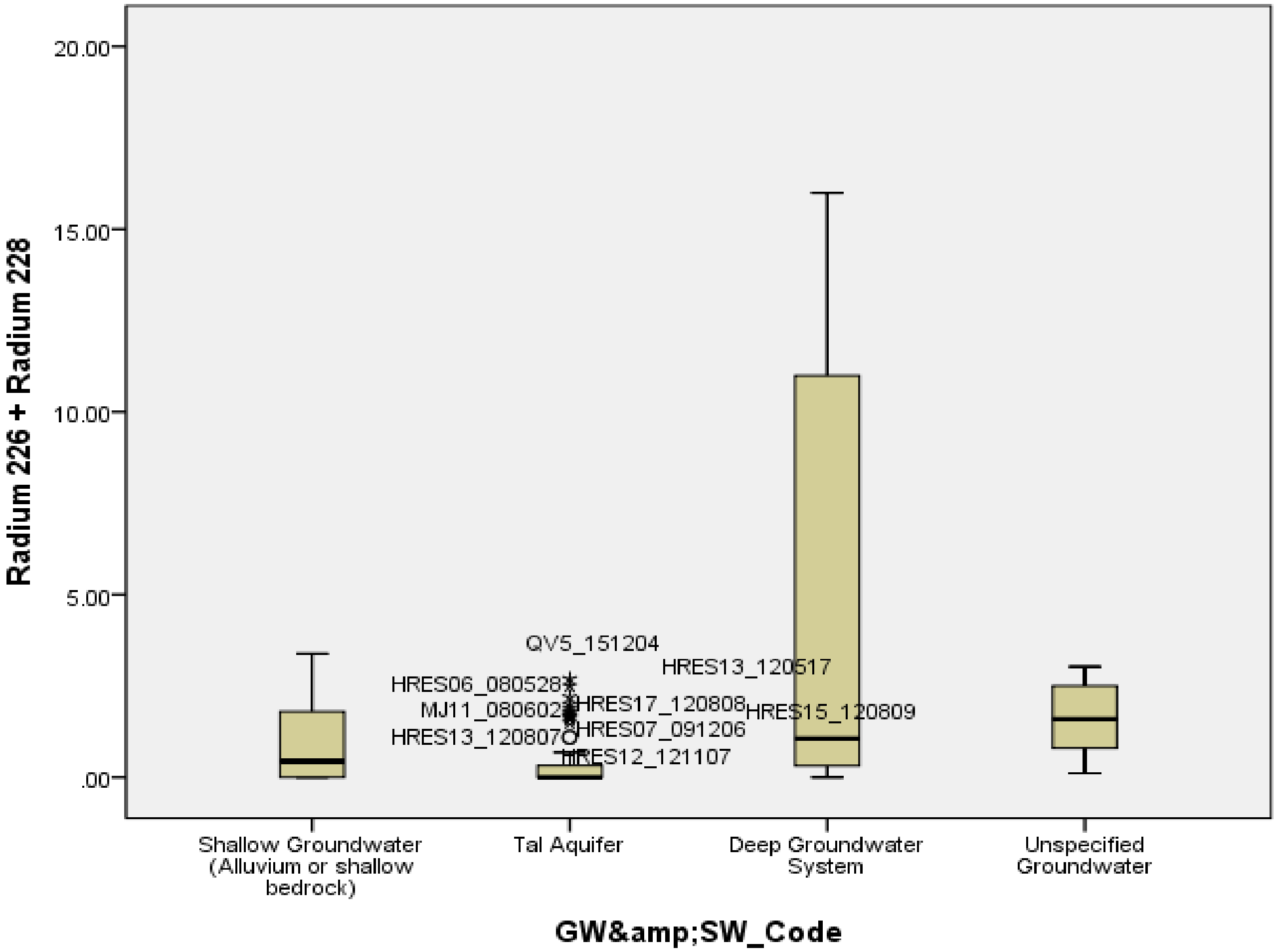
50.00
40.00
30.00
20.00
10.00
.00
Gross Alpha
CottonwoodWell_151201
RiceWaterWell_151203
CTWell_100420
QV5_151204
CTWell_151217
HRES13_120807
HRES10_151120
HRES05_080227
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

Gross Beta

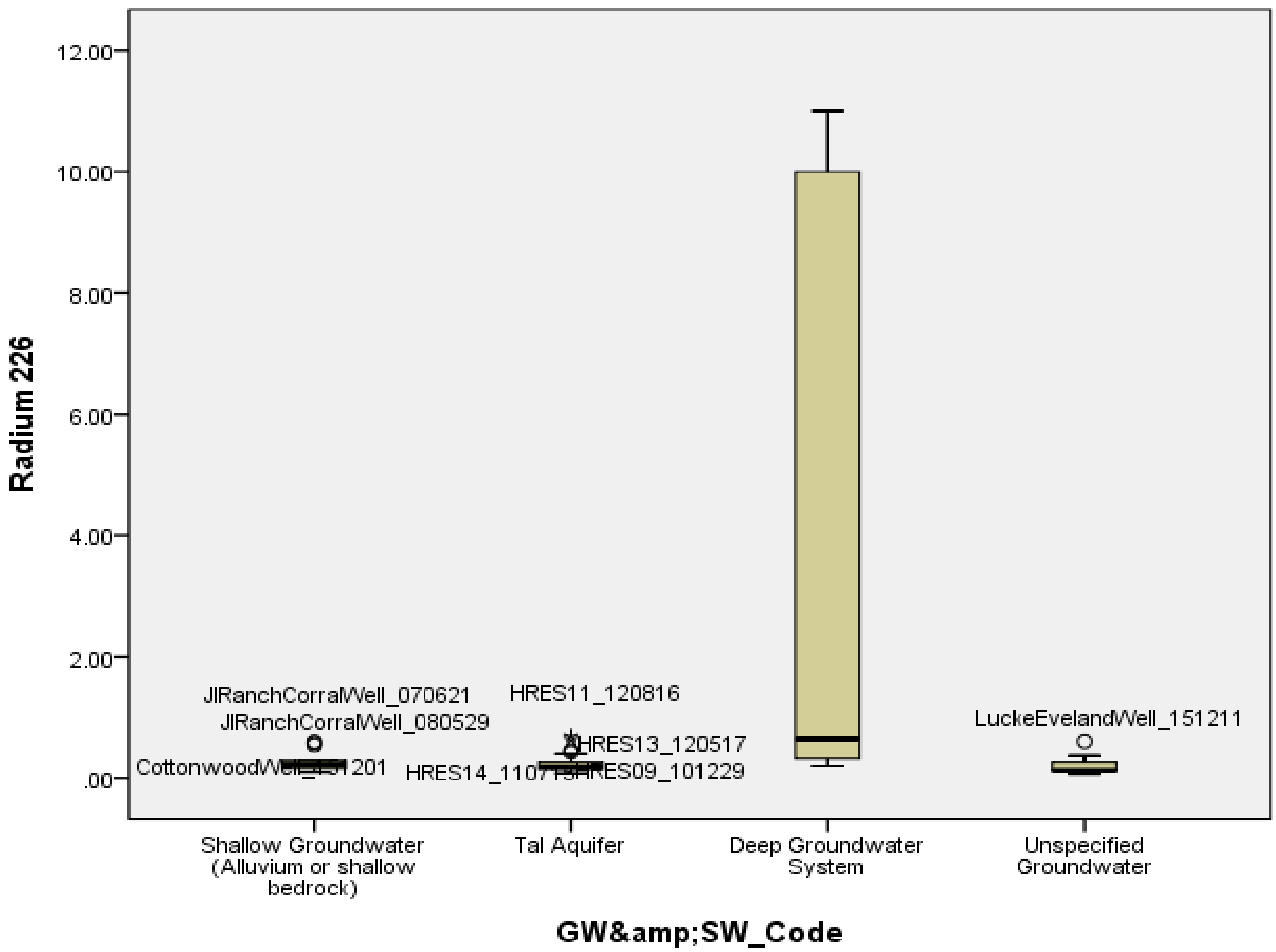


Gross Beta
60.00
50.00
40.00
30.00
20.00
10.00
.00
CottonwoodWell_151201
RiceWaterWell_151203
HRES14_120430
CTWell_151217
HRES17_120808
HRES10_151120
HRES13_120517
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

Radium 226 + Radium 228

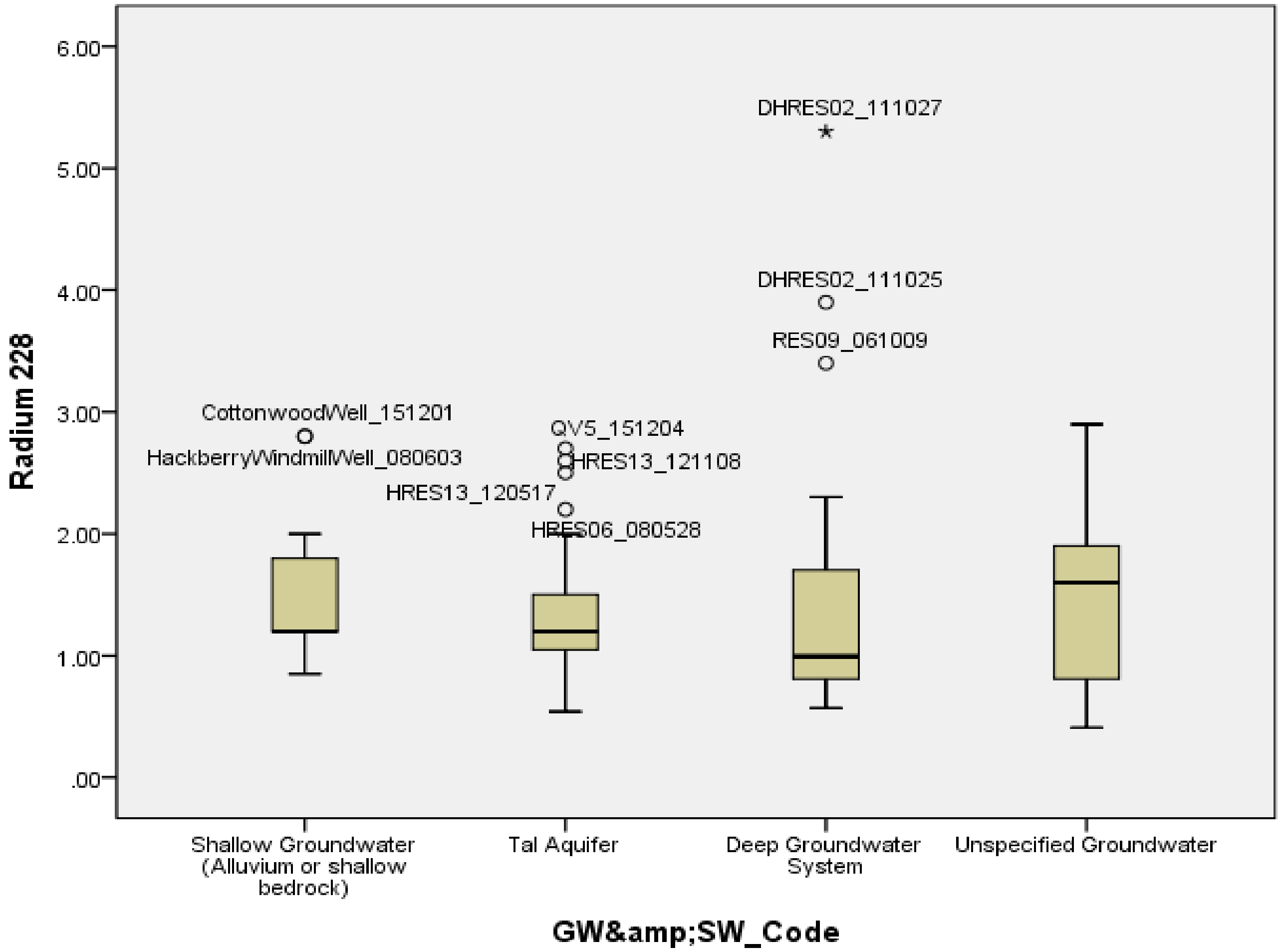


Radium 226



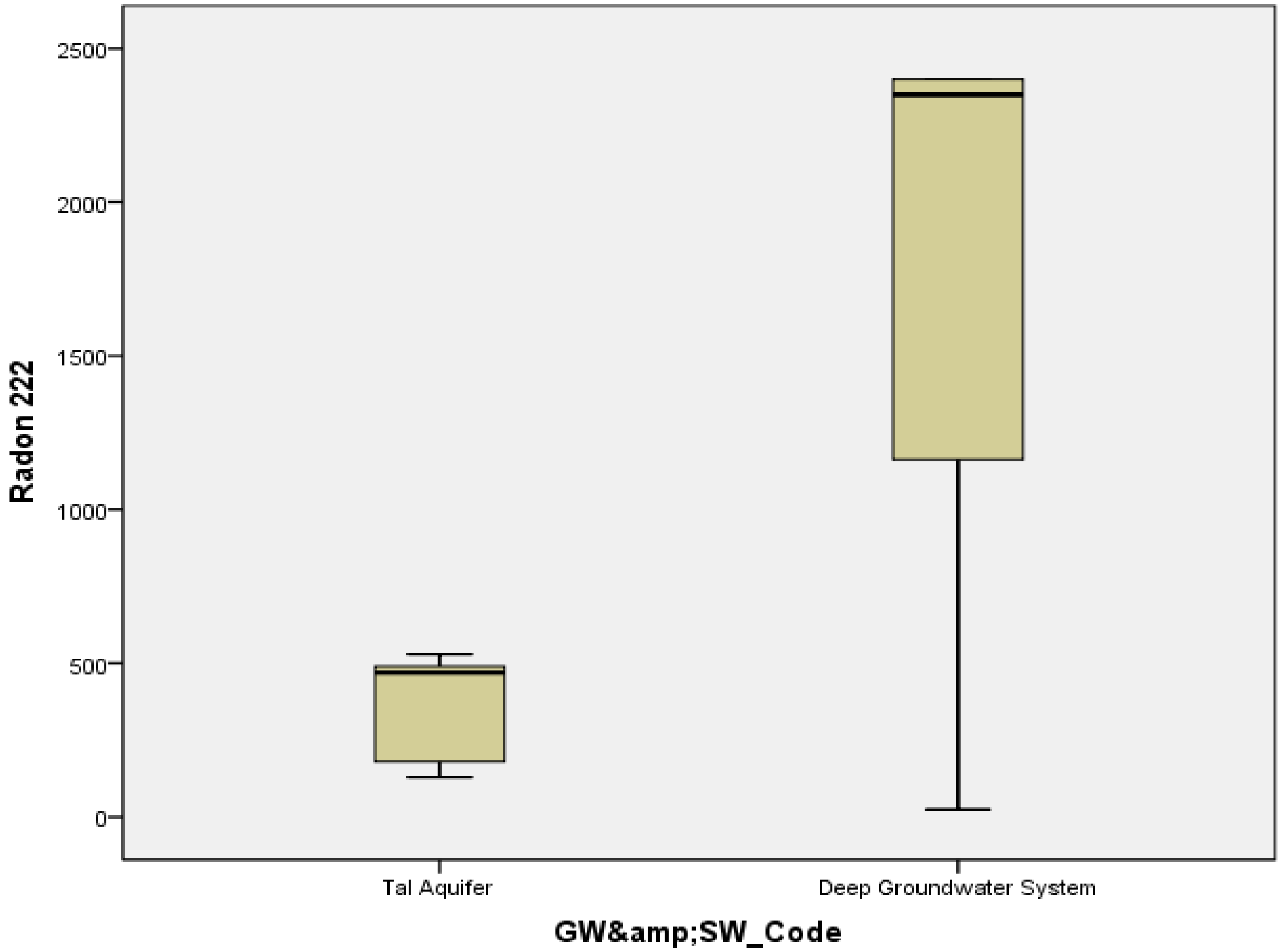
12.00
10.00
8.00
6.00
4.00
2.00
.00
Radium 226
JlRanchCorralWell_070621
JlRanchCorralWell_080529
CottonwoodWell_151201
HRES11_120816
HRES13_120517
HRES14_110715
HRES09_101229
LuckeEvelandWell_151211
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

Radium 228

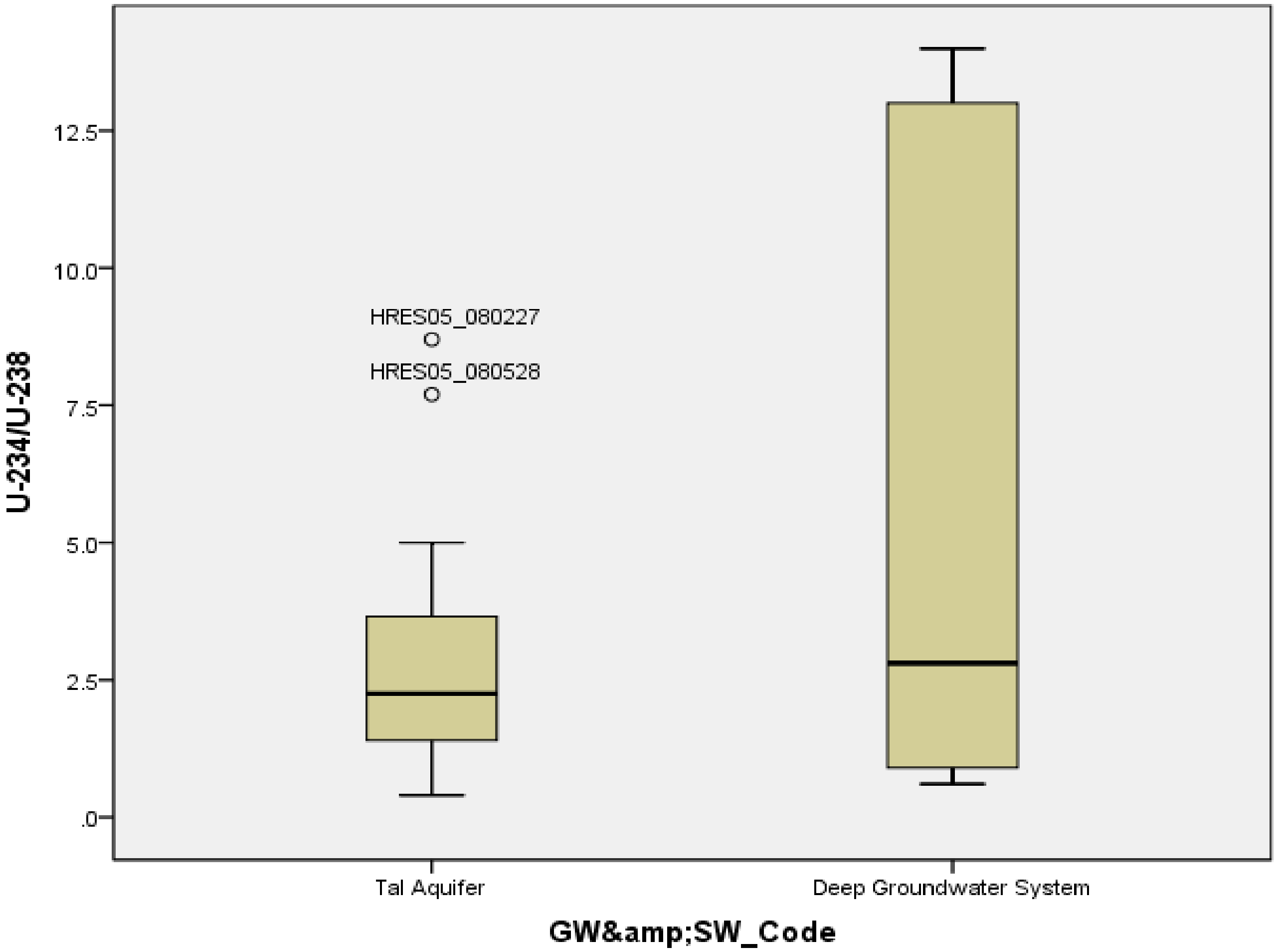


6.00
5.00
4.00
3.00
2.00
1.00
.00
Radium 228
DHRES02_111027
DHRES02_111025
RES09_061009
CottonwoodWell_151201
HackberryWindmillWell_080603
QV5_151204
HRES13_121108
HRES13_120517
HRES06_080528
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
Unspecified Groundwater
GW&SW_Code

Radon 222

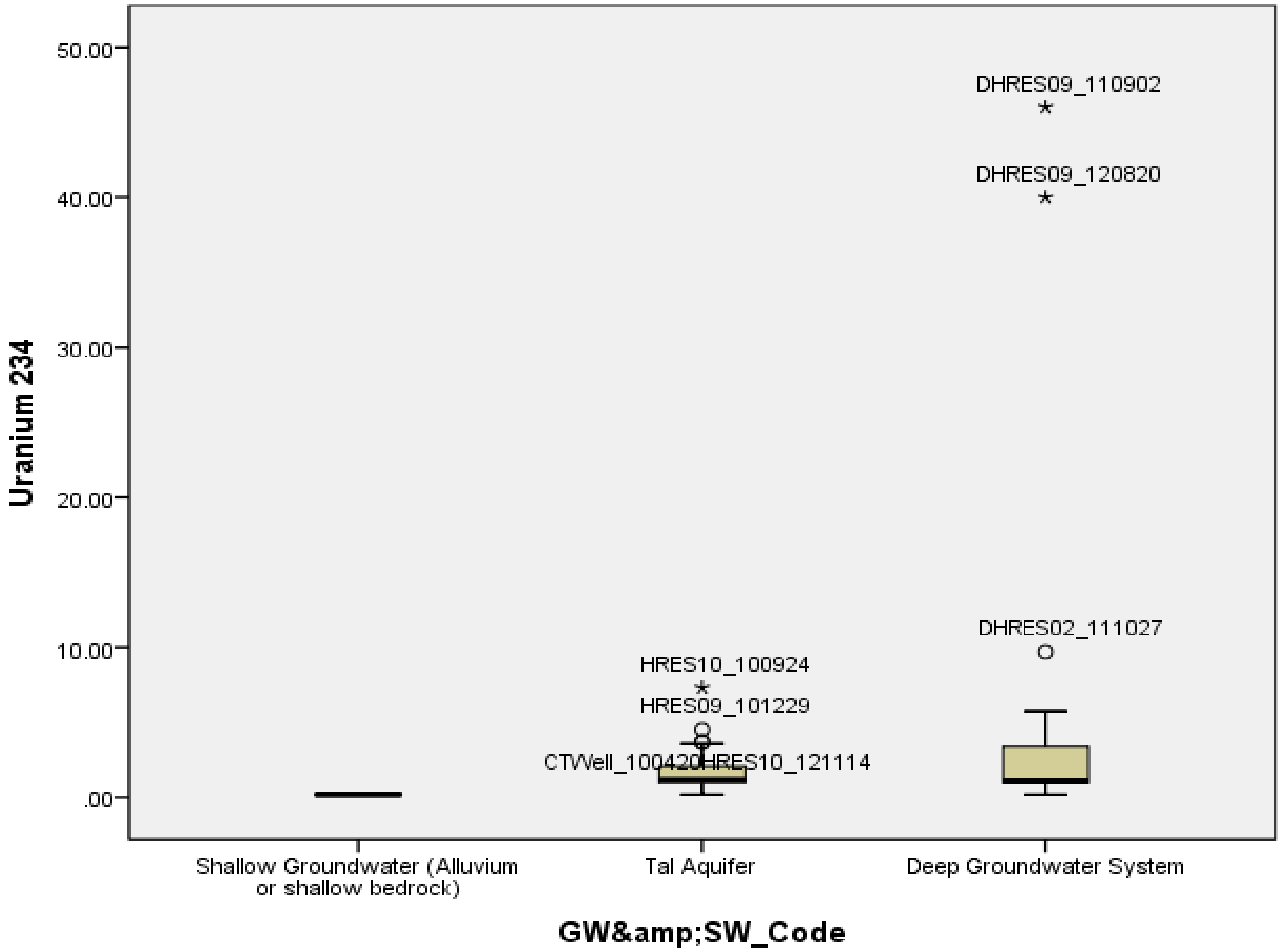

2500
2000
1500
1000
500
0
Radon 222
Tal Aquifer
Deep Groundwater System
GW&SW_Code

U-234/U-238



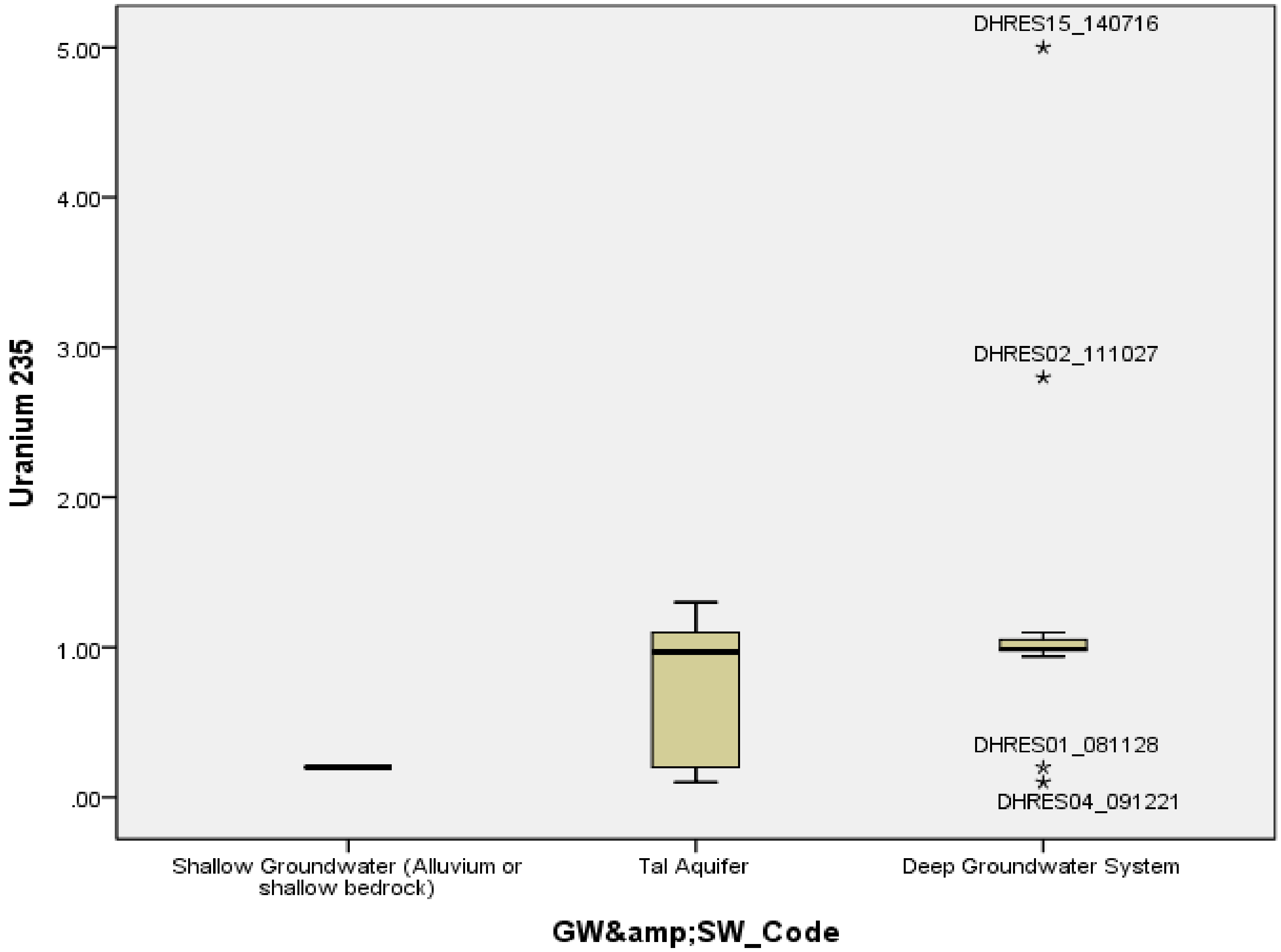
U-234/U-238
12.5
10.0
7.5
5.0
2.5
.0
HRES05_080227
HRES05_080528
Tal Aquifer
Deep Groundwater System
GW&SW_Code

Uranium 234



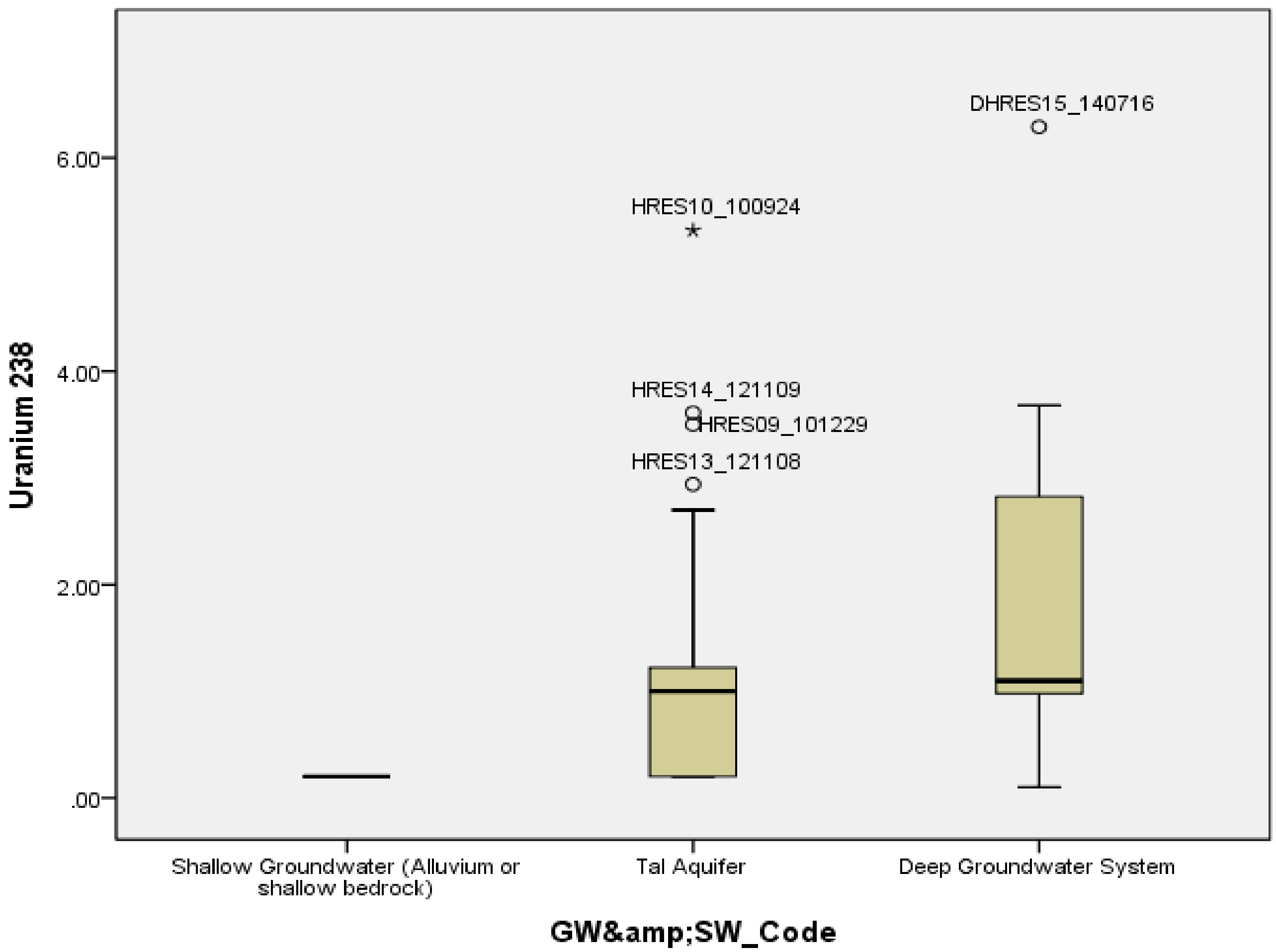
Uranium 234
50.00
40.00
30.00
20.00
10.00
.00
DHRES09_110902
DHRES09_120820
DHRES02_111027
HRES10_100924
HRES09_101229
CTWell_100420
HRES10_121114
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
GW&SW_Code

Uranium 235

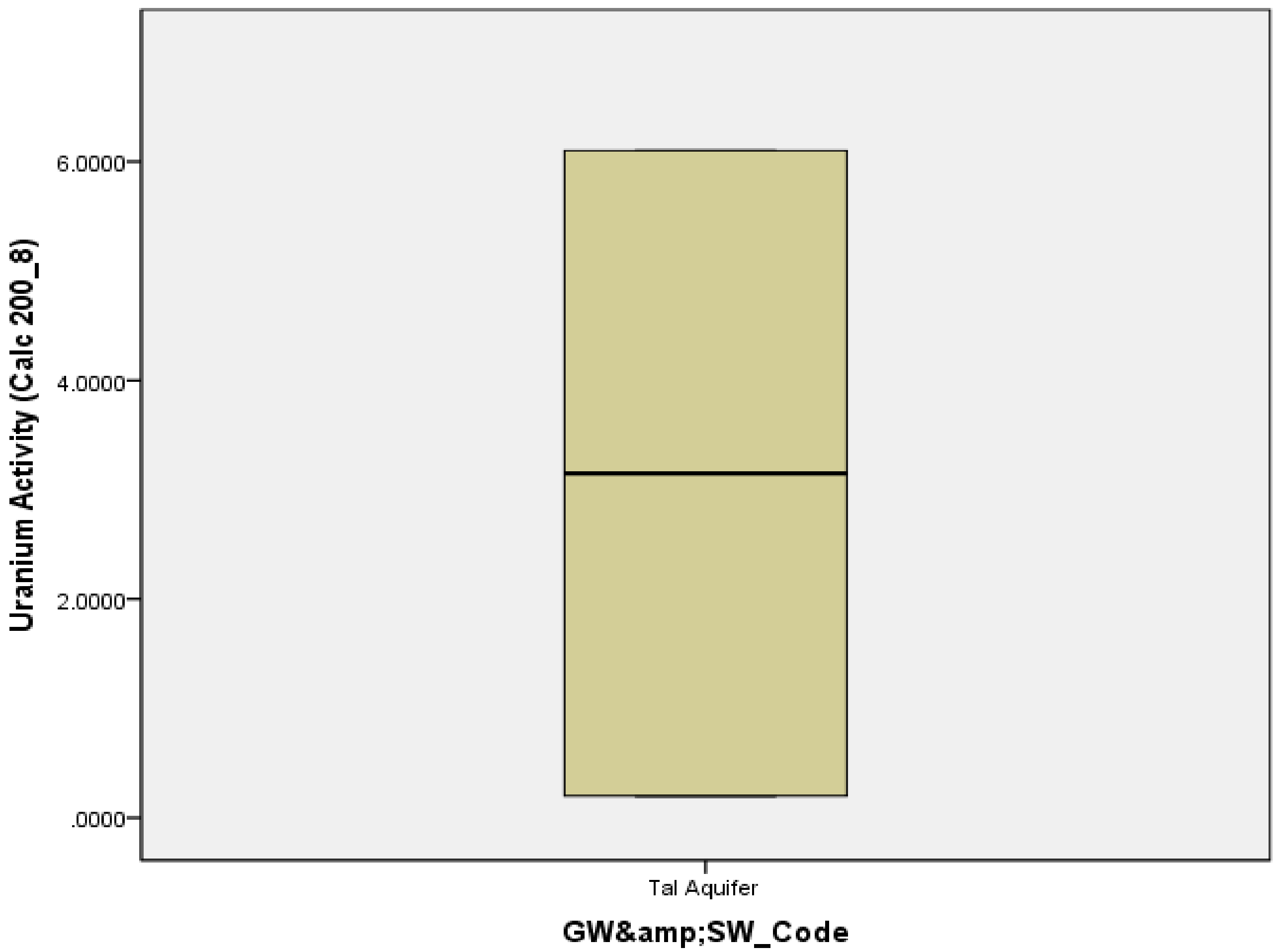


5.00
4.00
3.00
2.00
1.00
.00
Uranium 235
DHRES15_140716
DHRES02_111027
DHRES01_081128
DHRES04_091221
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
GW&SW_Code

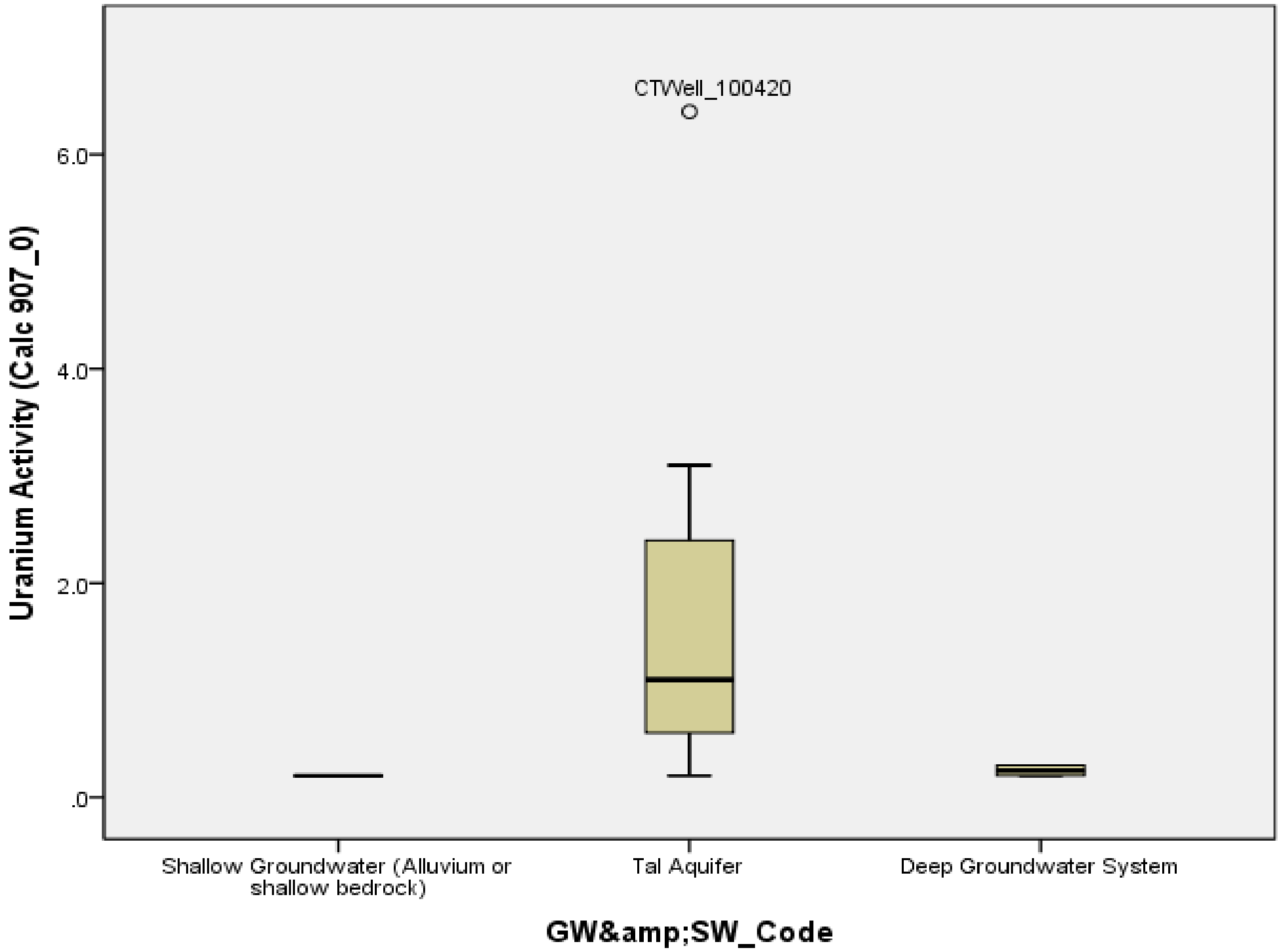
Uranium 238


Uranium 238
6.00
4.00
2.00
.00
DHRES15_140716
HRES10_100924
HRES14_121109
HRES09_101229
HRES13_121108
Shallow Groundwater (Alluvium or shallow bedrock)
Tal Aquifer
Deep Groundwater System
GW&SW_Code

Uranium Activity (Calc 200_8)



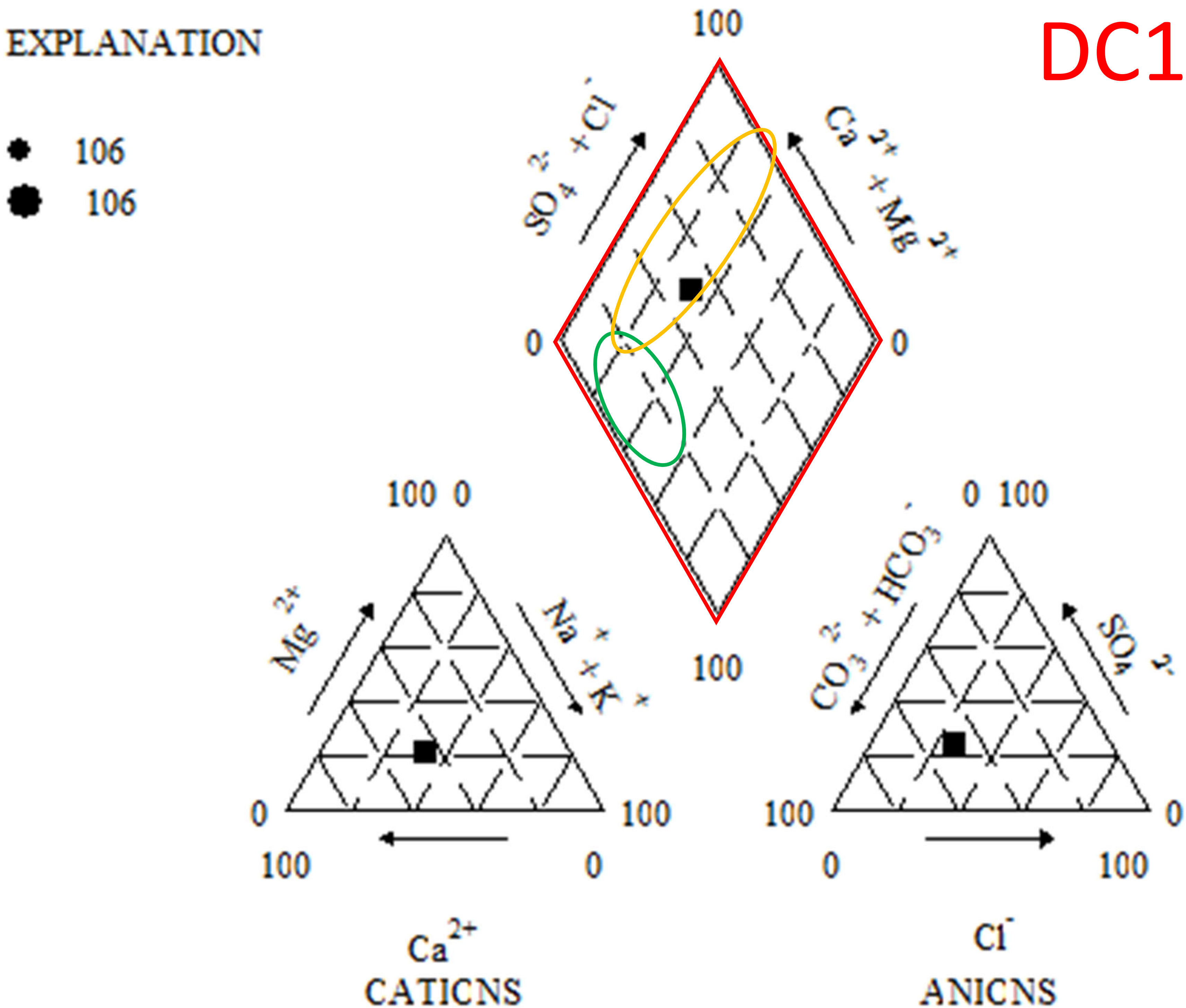
Uranium Activity (Calc 907_0)



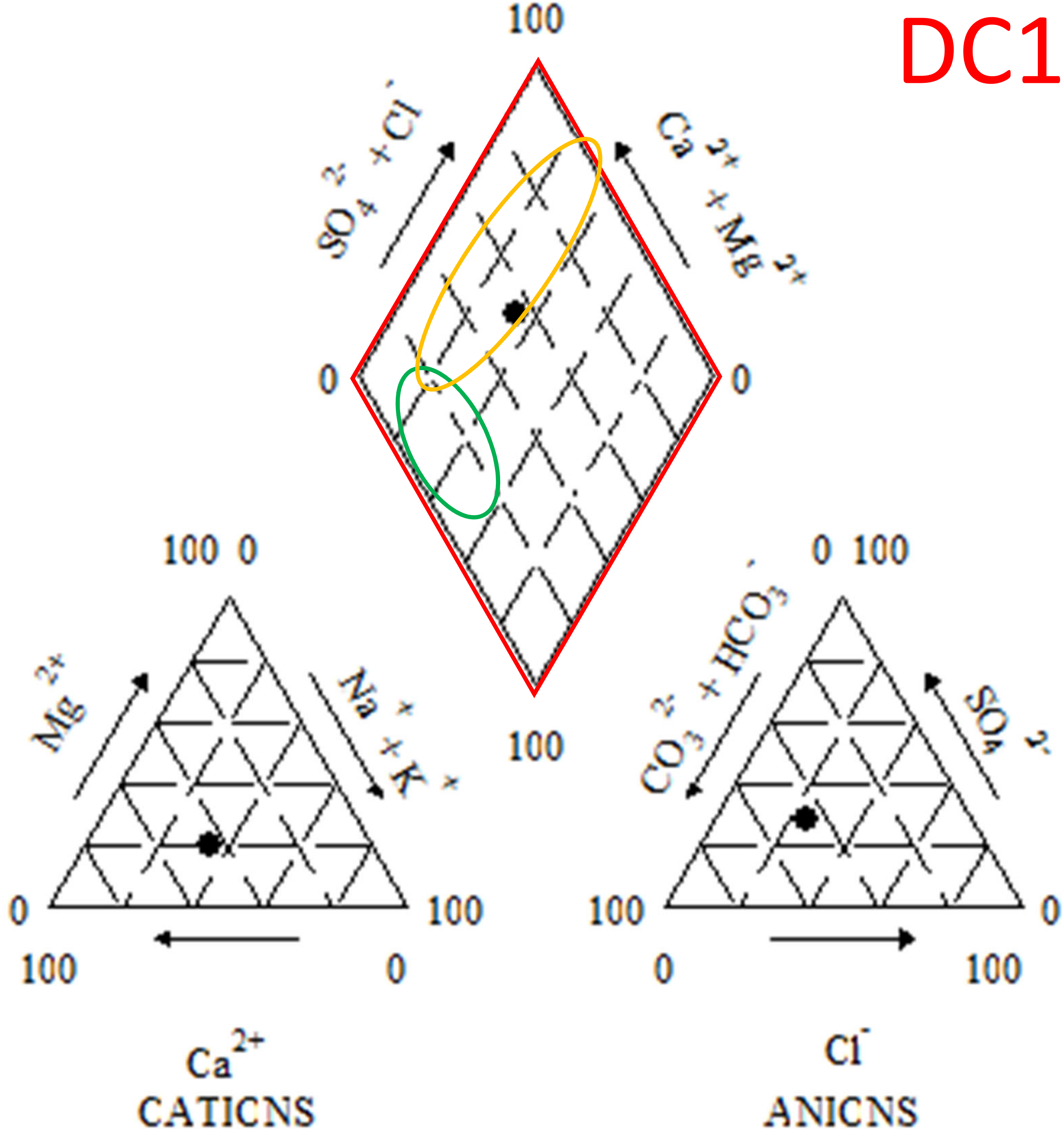
ATTACHMENT 3

Piper Diagrams

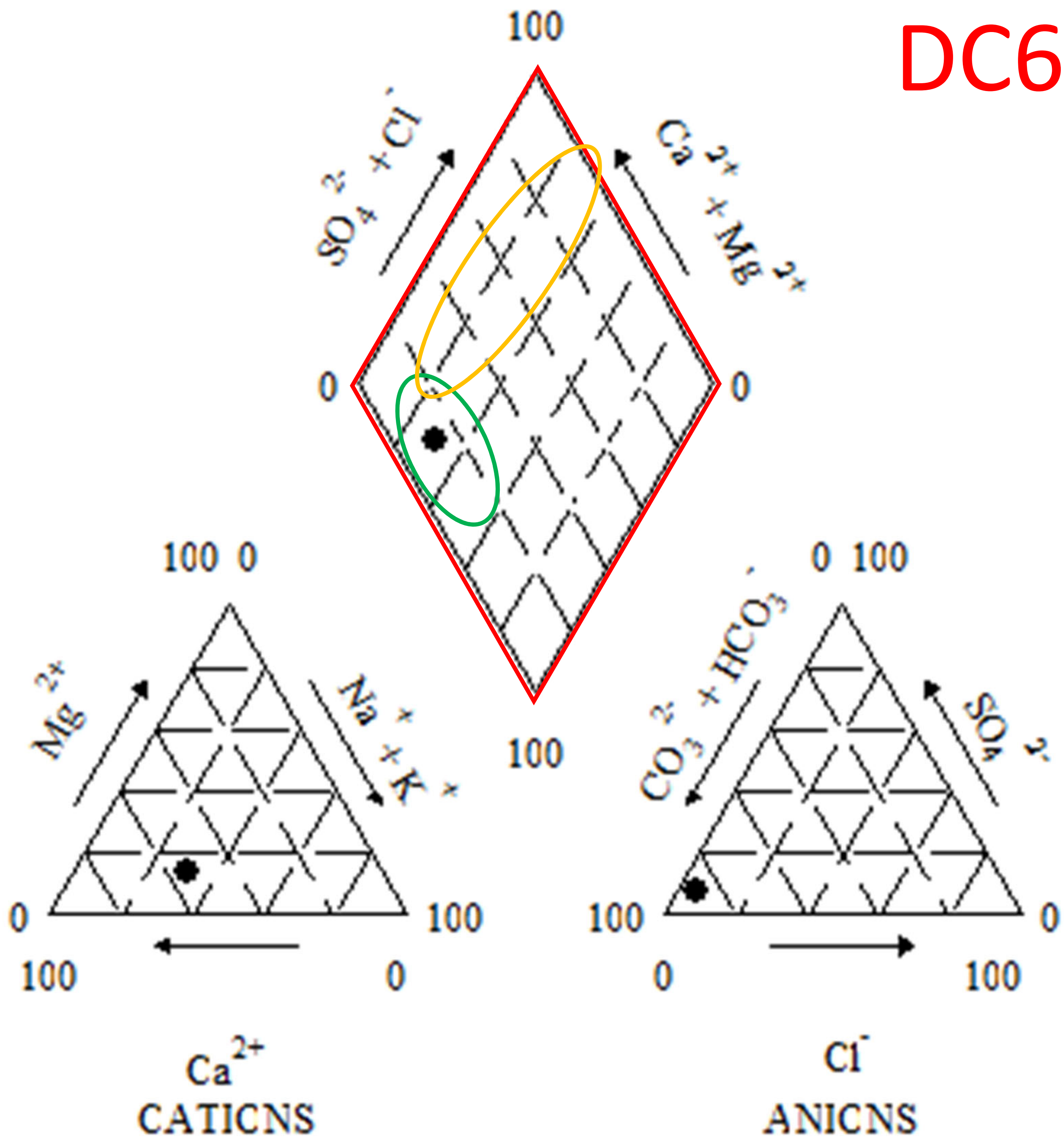
DC13.5C


EXPLANATION
106
106
100
0
0
100
SO_4^{2-} + Cl^-
Ca^{2+} + Mg^{2+}
100 0
0 100
Mg^{2+}
Na^+ + K^+
CO_3^{2-} + HCO_3^-
SO_4^{2-}
0
100
100
0
100
0
0
100
Ca^{2+}
CATICNS
Cl^-
ANICNS

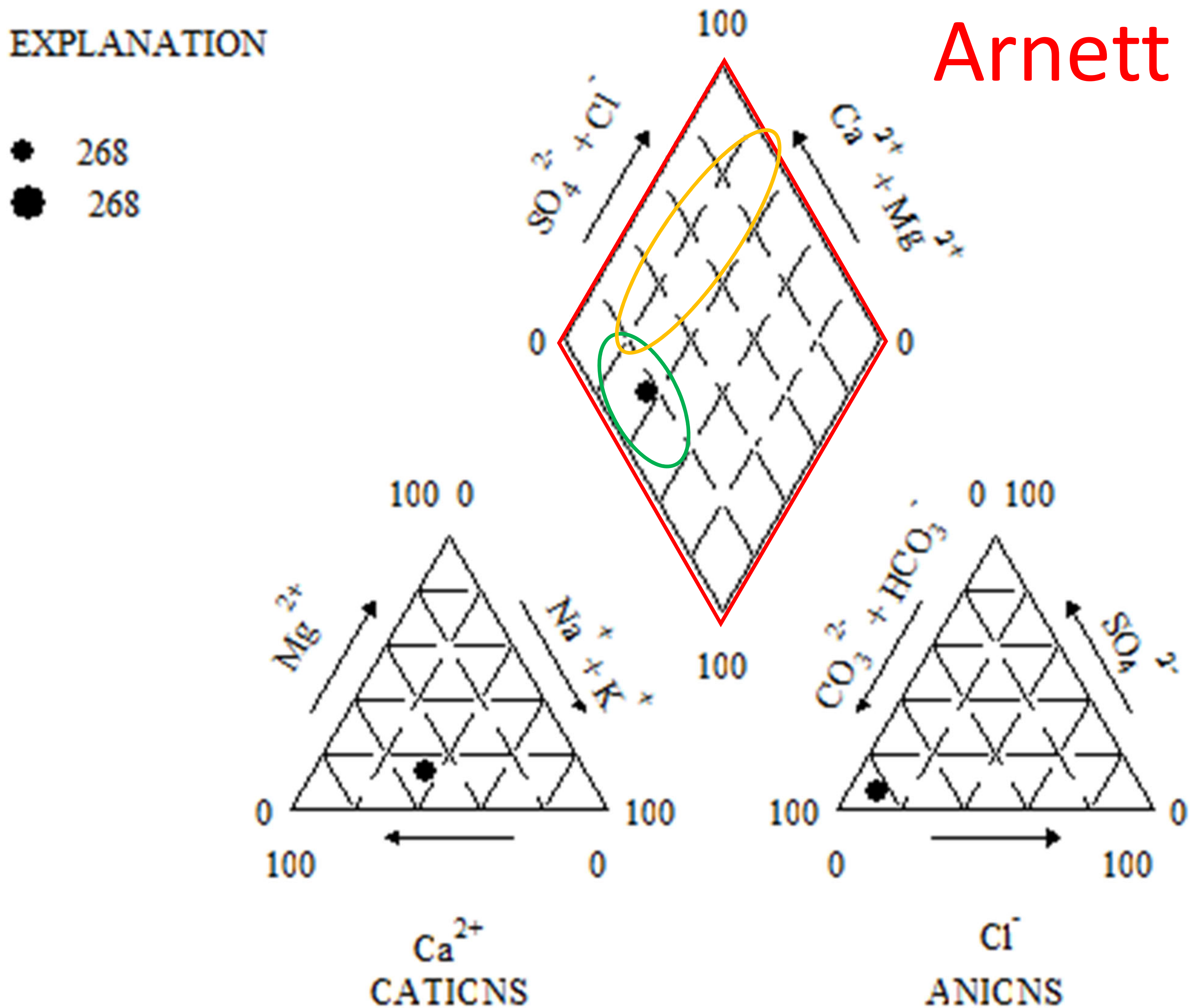
DC10.9C


100
$SO_4^{2-} + Cl^-$
$Ca^{2+} + Mg^{2+}$
0
0
100
100 0
Mg^{2+}
$Na^+ + K^+$
0
100
100
0
Ca^{2+}
CATICNS
0 100
$CO_3^{2-} + HCO_3^-$
SO_4^{2-}
100
0
0
100
Cl^-
ANICNS

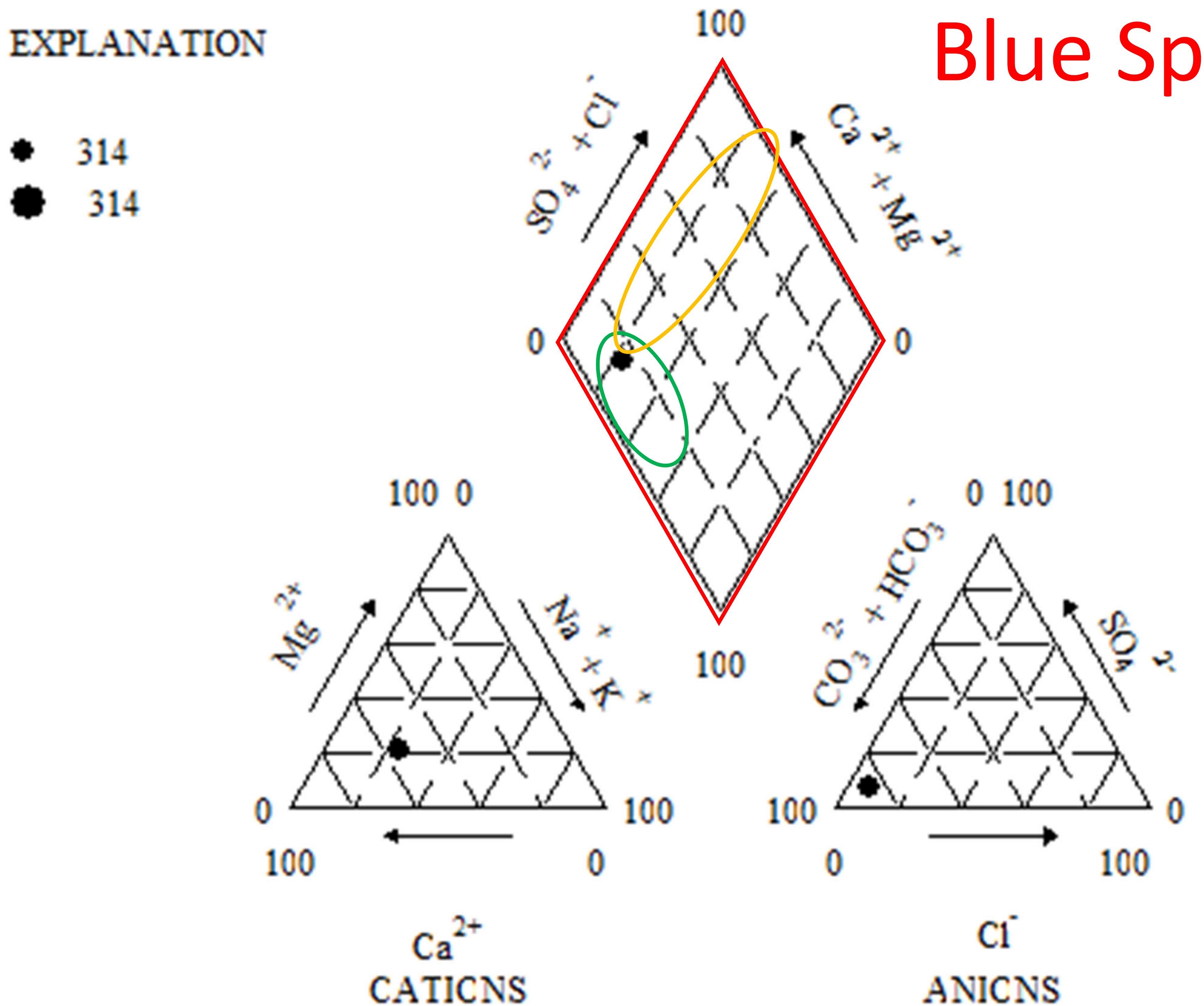
DC6.1E

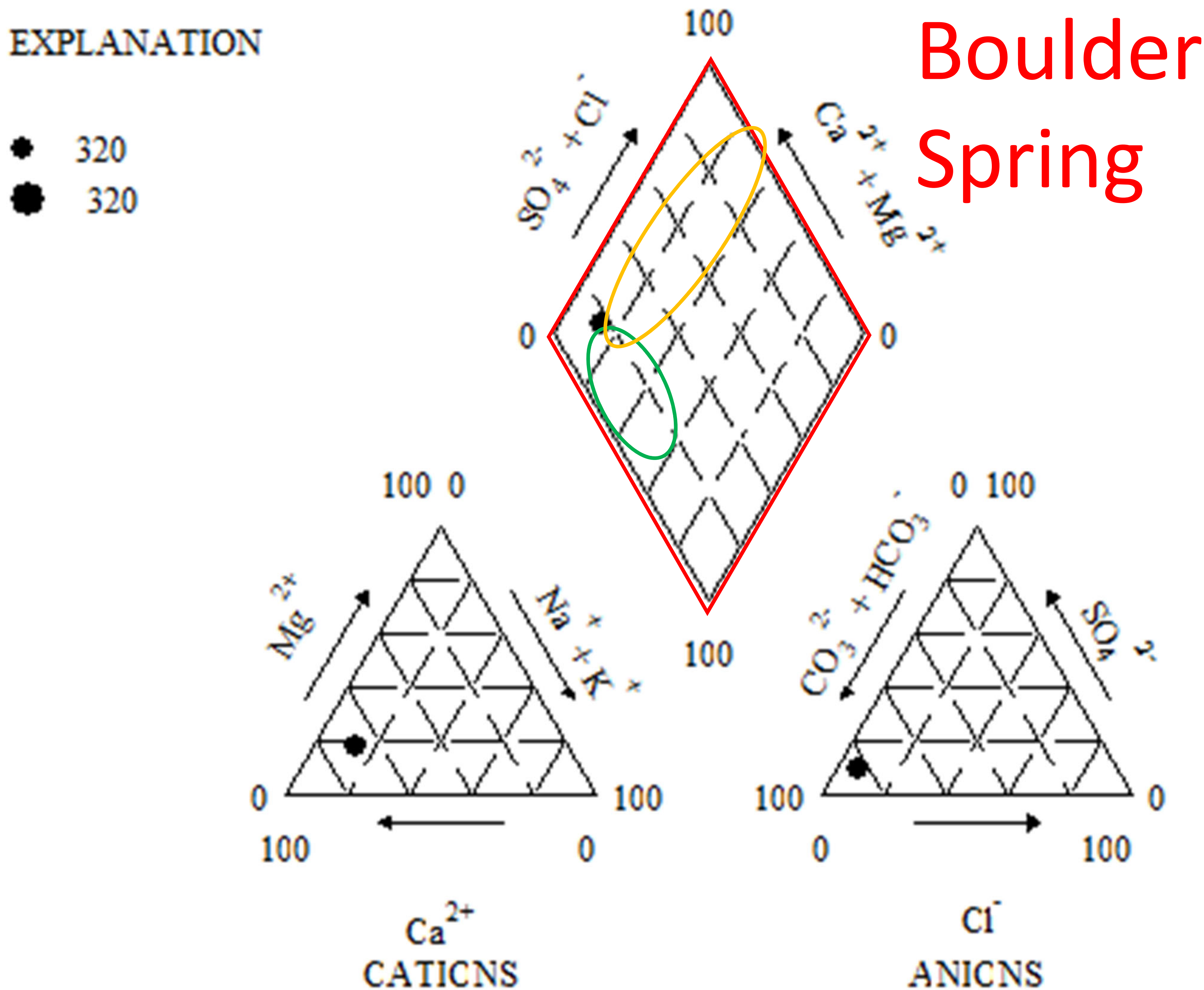

100
$SO_4^{2-} + Cl^-$
$Ca^{2+} + Mg^{2+}$
0
0
100
100 0
Mg^{2+}
$Na^+ + K^+$
0
100
100
0
Ca^{2+}
CATICNS
0 100
$CO_3^{2-} + HCO_3^-$
SO_4^{2-}
100
0
0
100
Cl^-
ANICNS

Arnett Creek



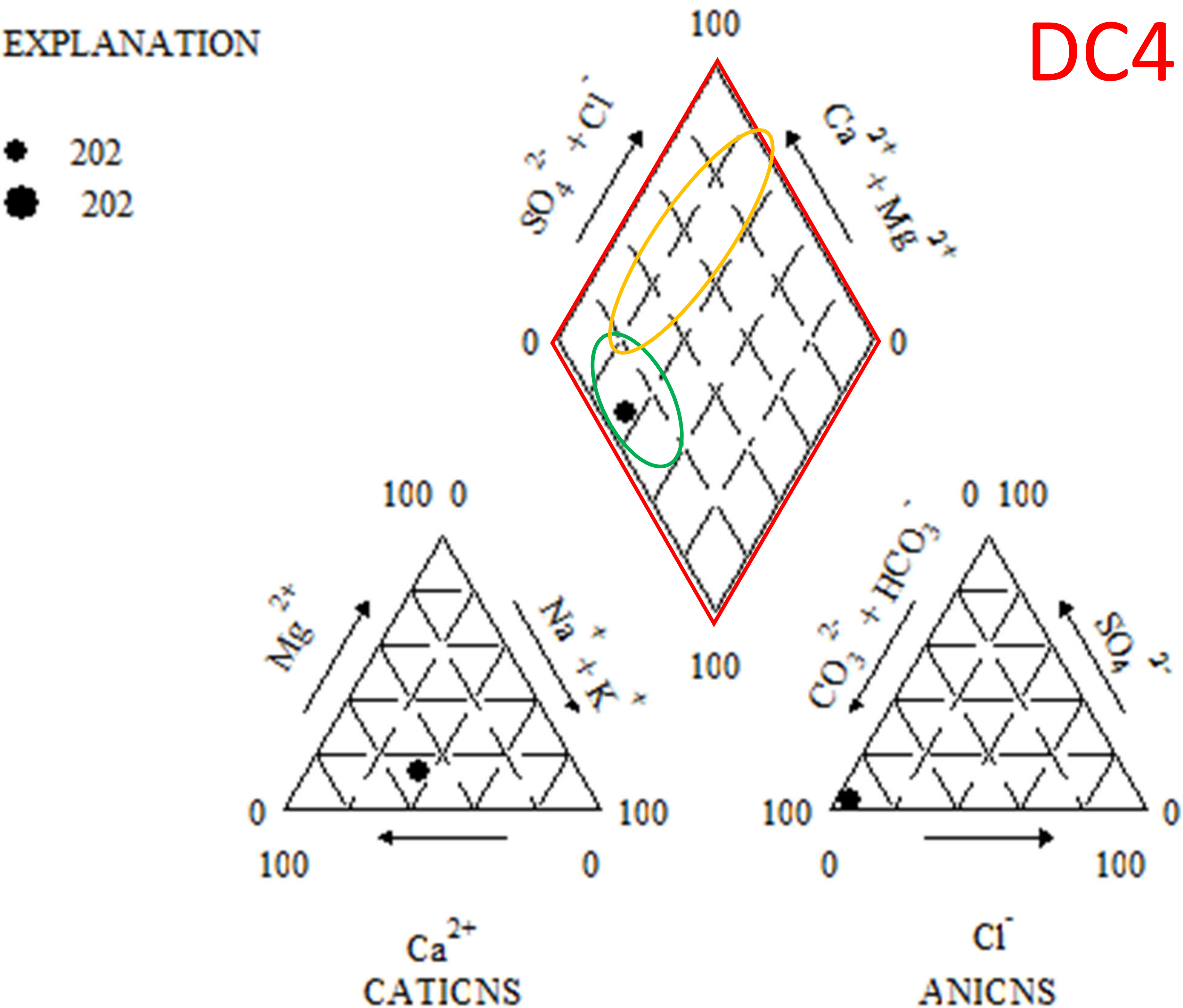
Blue Spring


EXPLANATION
314
314
100
0
0
100
$SO_4^{2-} + Cl^-$
$Ca^{2+} + Mg^{2+}$
100 0
0 100
Mg^{2+}
$Na^+ + K^+$
$CO_3^{2-} + HCO_3^-$
SO_4^{2-}
0
100
100
0
100
0
0
100
Ca^{2+}
CATICNS
Cl^-
ANICNS

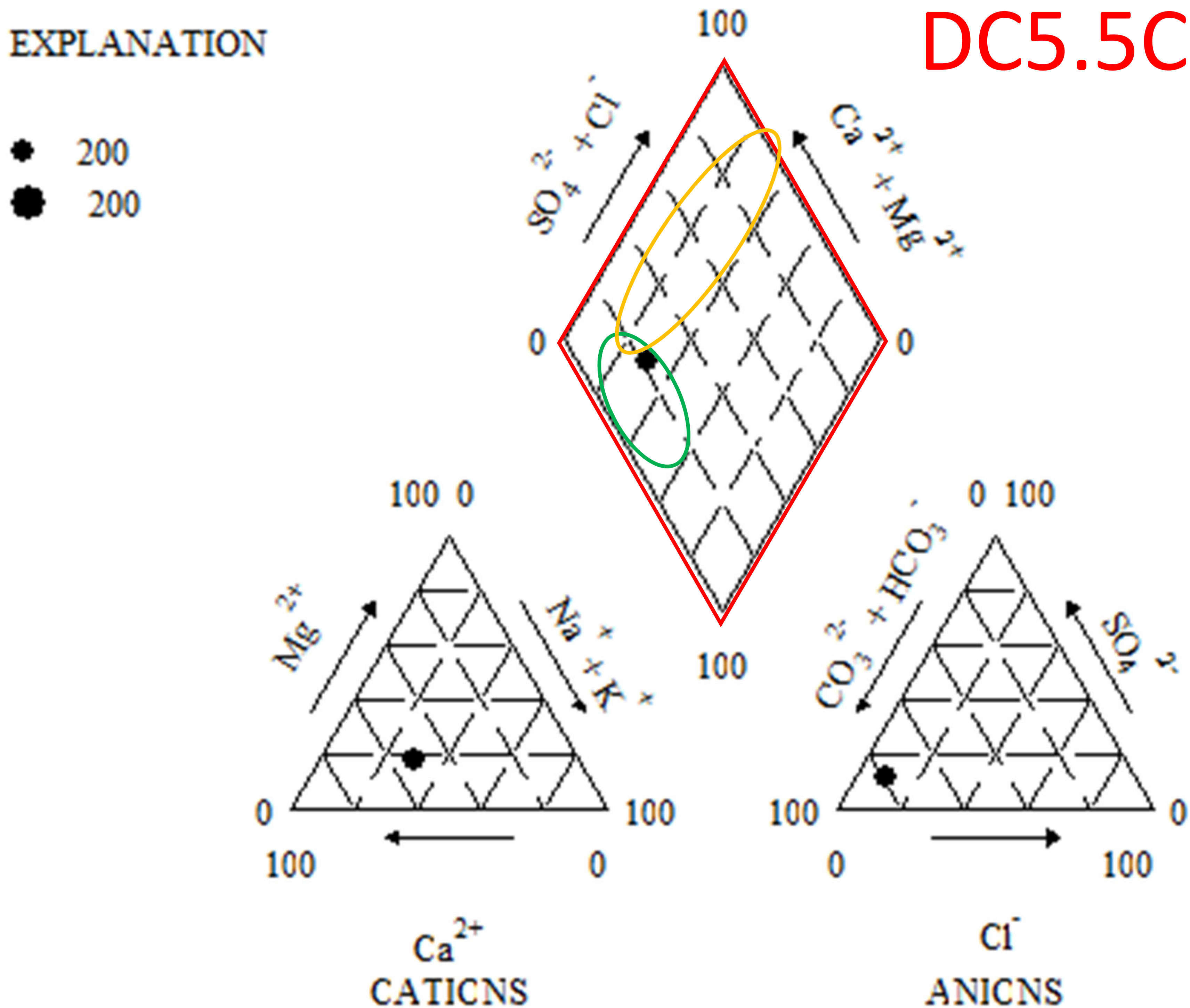


EXPLANATION
320
320
Boulder
Spring
100
$SO_4^{2-} + Cl^-$
$Ca^{2+} + Mg^{2+}$
0
0
100
100 0
0 100
Mg^{2+}
$Na^+ + K^+$
$CO_3^{2-} + HCO_3^-$
SO_4^{2-}
0
100
100
0
100
0
0
100
Ca^{2+}
CATICNS
Cl^-
ANICNS

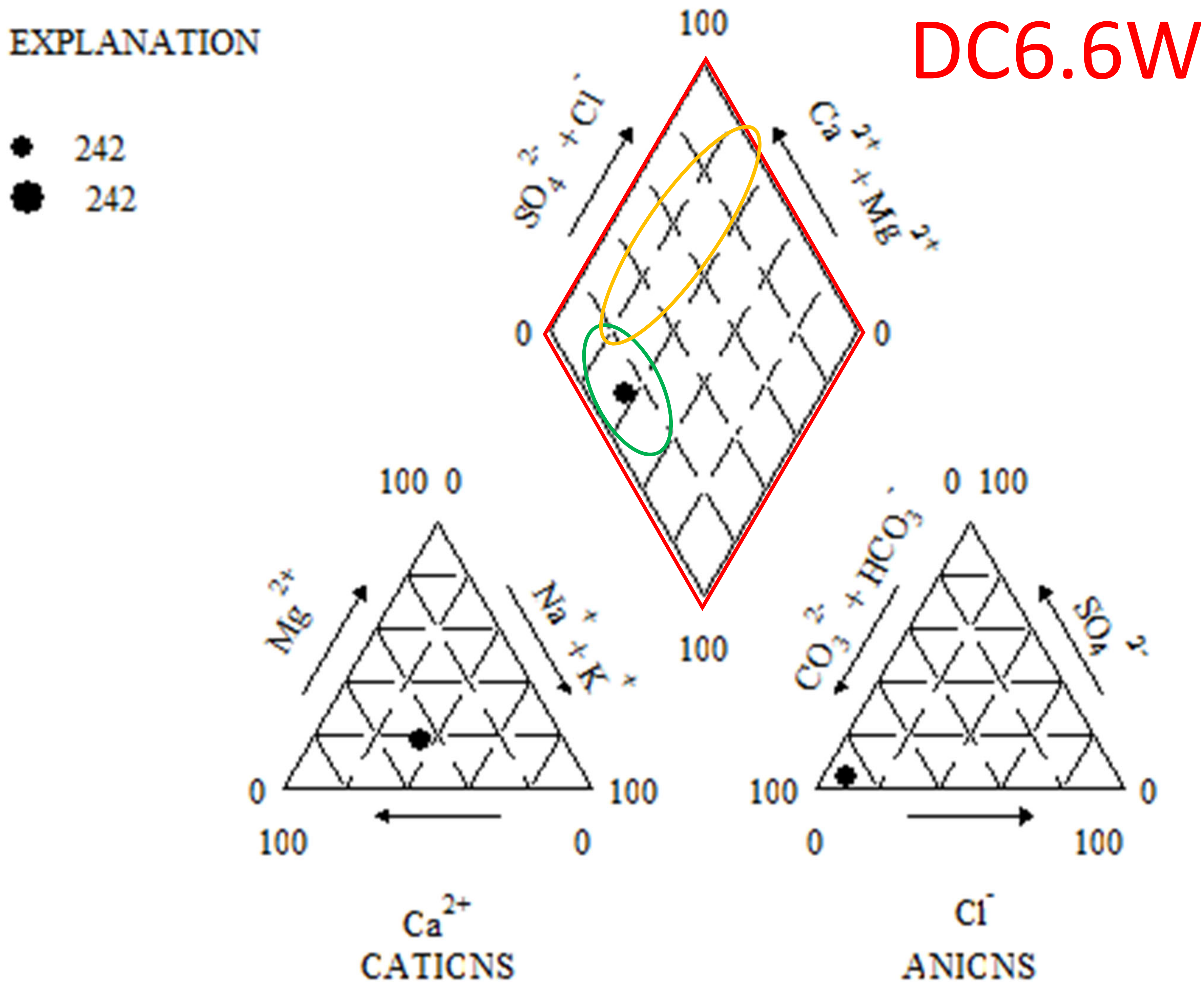
DC4.1E



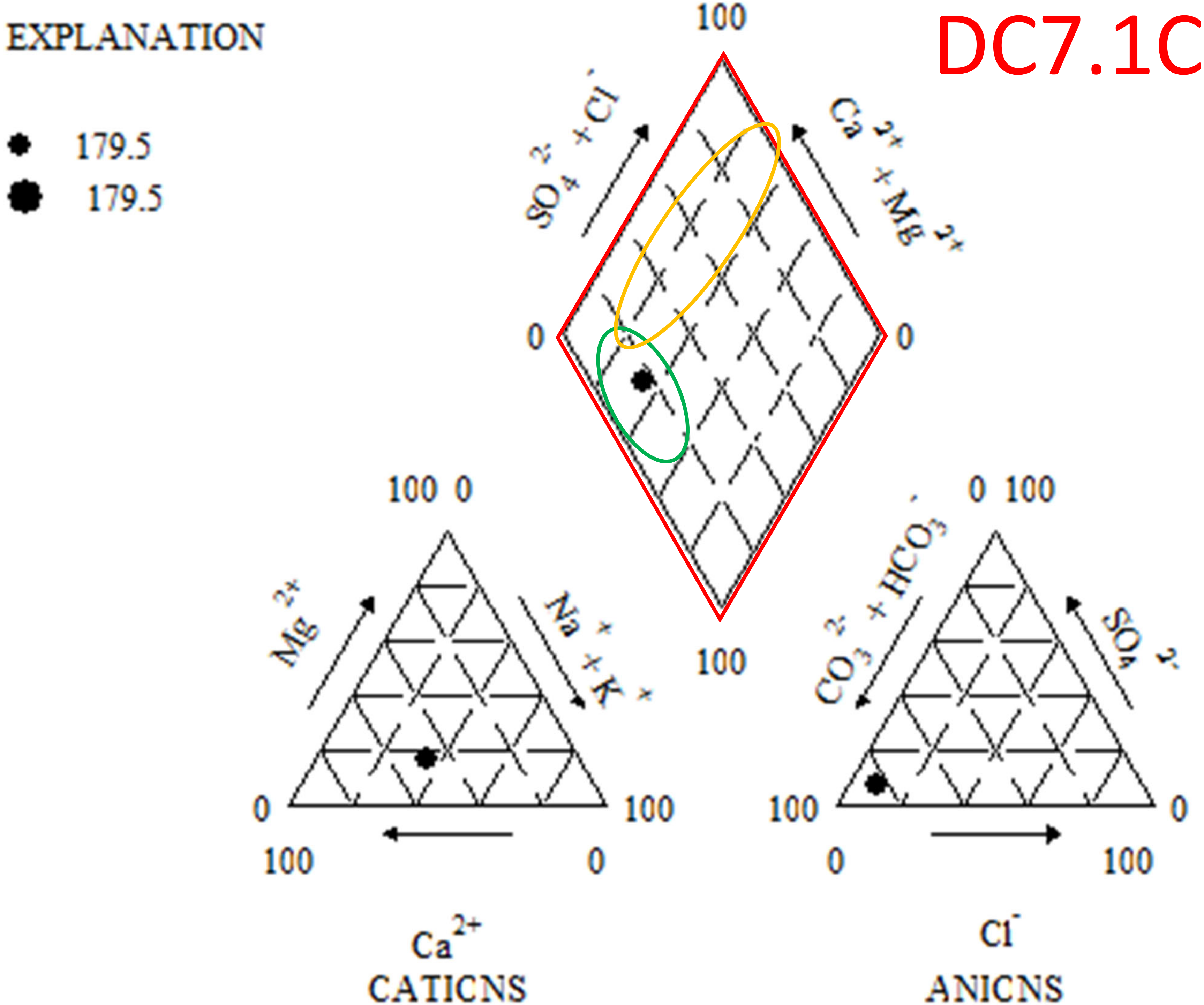
EXPLANATION
202
202
100
$SO_4^{2-} + Cl^-$
$Ca^{2+} + Mg^{2+}$
0
0
100
100 0
0 100
Mg^{2+}
$Na^+ + K^+$
$CO_3^{2-} + HCO_3^-$
SO_4^{2-}
0
100
100
0
100
0
0
100
Ca^{2+}
CATICNS
Cl^-
ANICNS

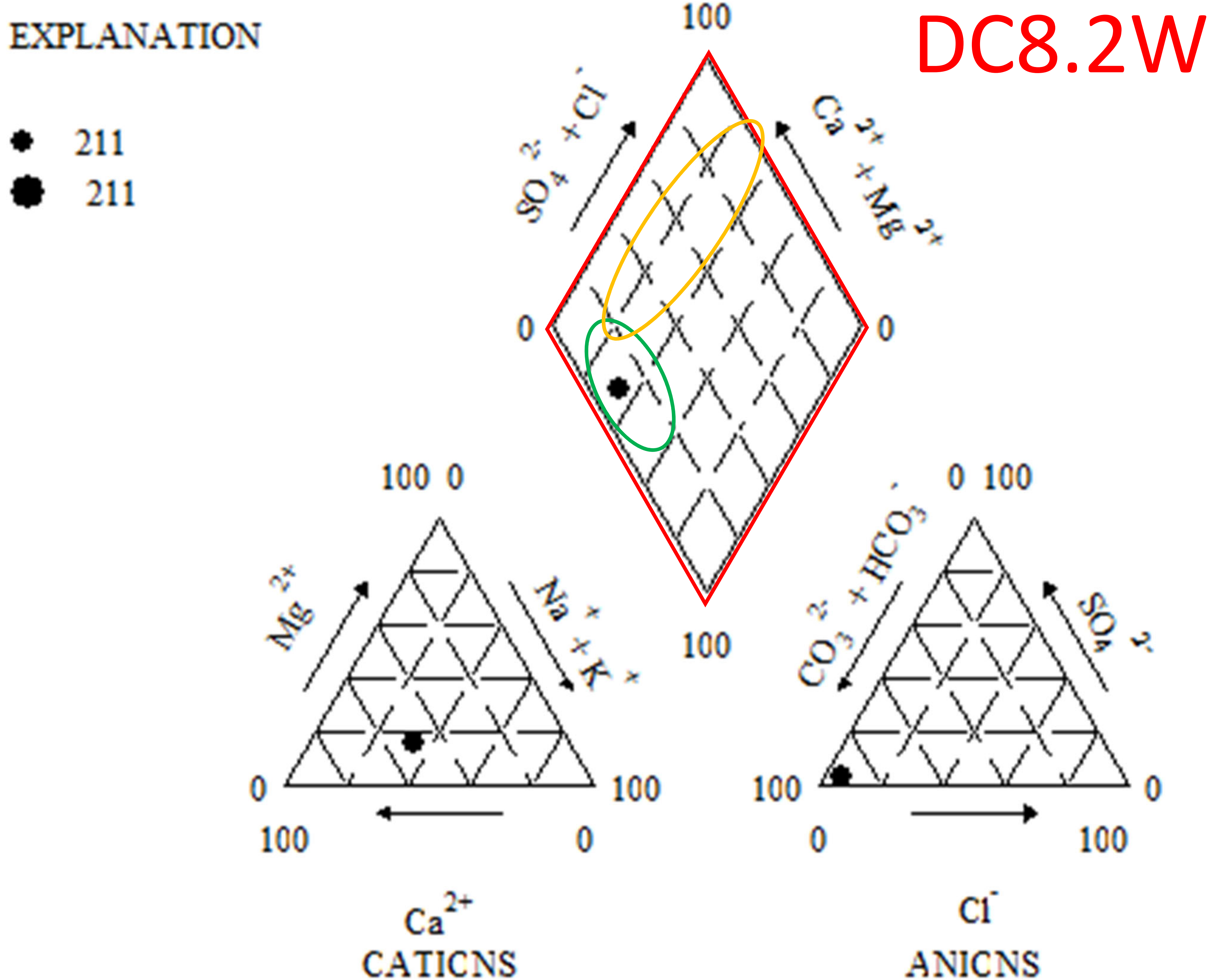


DC5.5C
EXPLANATION
200
200
100
$SO_4^{2-} + Cl^-$
$Ca^{2+} + Mg^{2+}$
0
0
100
100 0
0 100
Mg^{2+}
$Na^+ + K^+$
$CO_3^{2-} + HCO_3^-$
SO_4^{2-}
0
100
100
0
100
0
0
100
Ca^{2+}
CATICNS
Cl^-
ANICNS

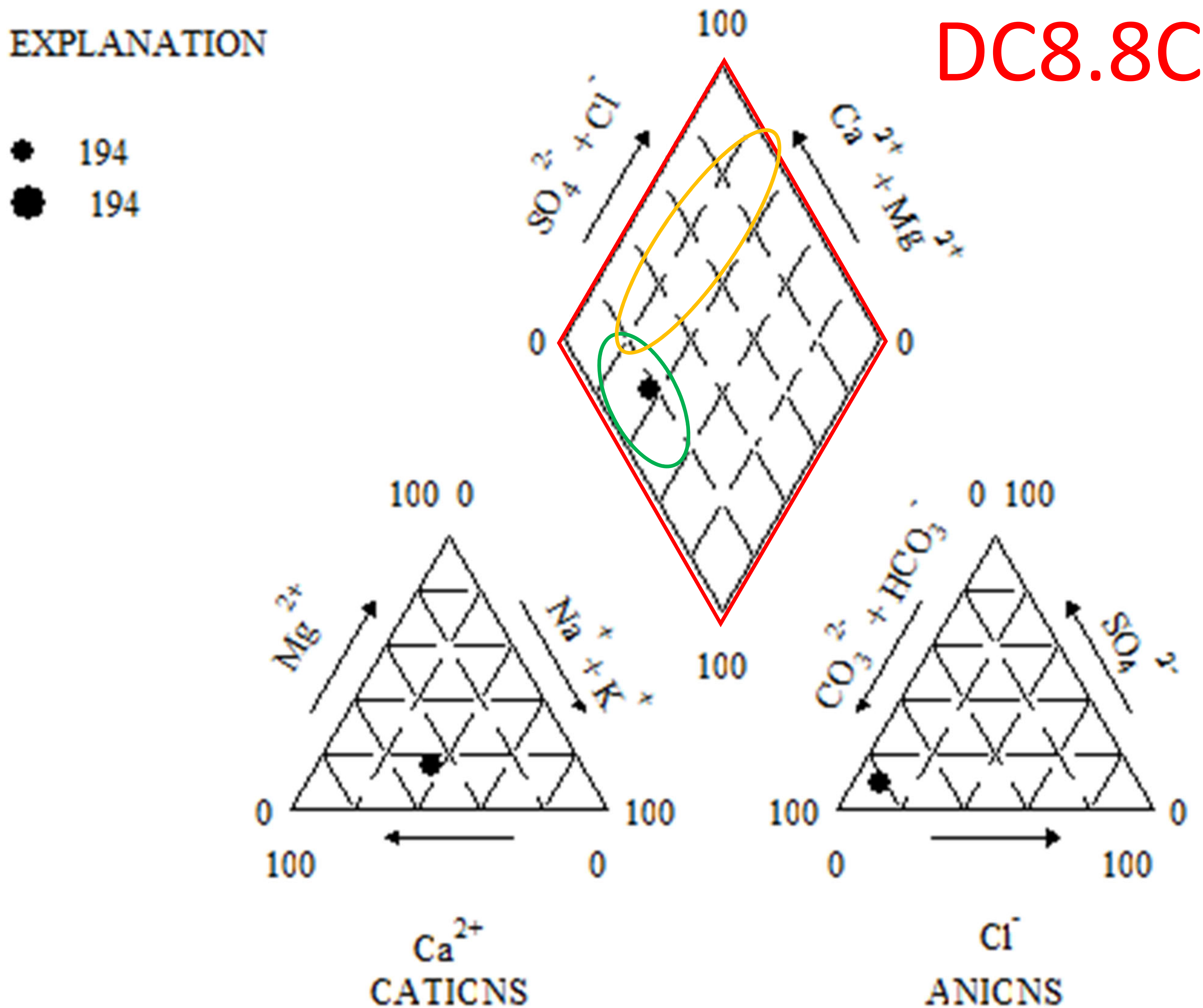

EXPLANATION
242
242
DC6.6W
100
0
0
100
$SO_4^{2-} + Cl^-$
$Ca^{2+} + Mg^{2+}$
100 0
Mg^{2+}
$Na^+ + K^+$
0
100
100
0
Ca^{2+}
CATICNS
0 100
$CO_3^{2-} + HCO_3^-$
SO_4^{2-}
100
0
0
100
Cl^-
ANICNS

DC7.1C


EXPLANATION
179.5
179.5
100
SO_4^{2-} + Cl^-
Ca^{2+} + Mg^{2+}
0
0
100
100 0
Mg^{2+}
Na^+ + K^+
0 100
CO_3^{2-} + HCO_3^-
SO_4^{2-}
0
100
100
0
100
0
0
100
Ca^{2+}
CATICNS
Cl^-
ANICNS

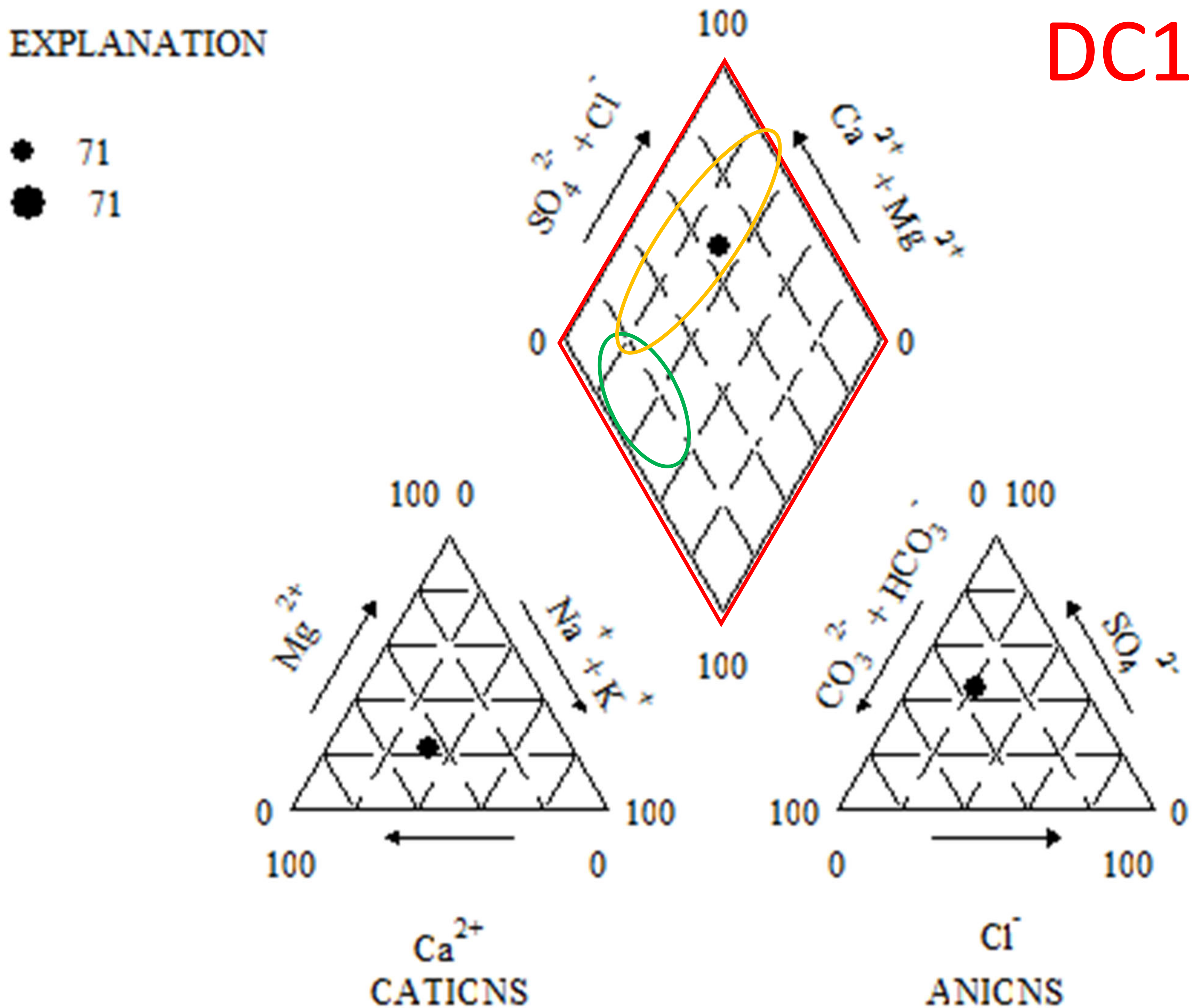


DC8.2W
EXPLANATION
211
211
100
0
0
100
$SO_4^{2-} + Cl^-$
$Ca^{2+} + Mg^{2+}$
100 0
0 100
Mg^{2+}
$Na^+ + K^+$
$CO_3^{2-} + HCO_3^-$
SO_4^{2-}
0
100
100
0
100
0
0
100
Ca^{2+}
CATICNS
Cl^-
ANICNS



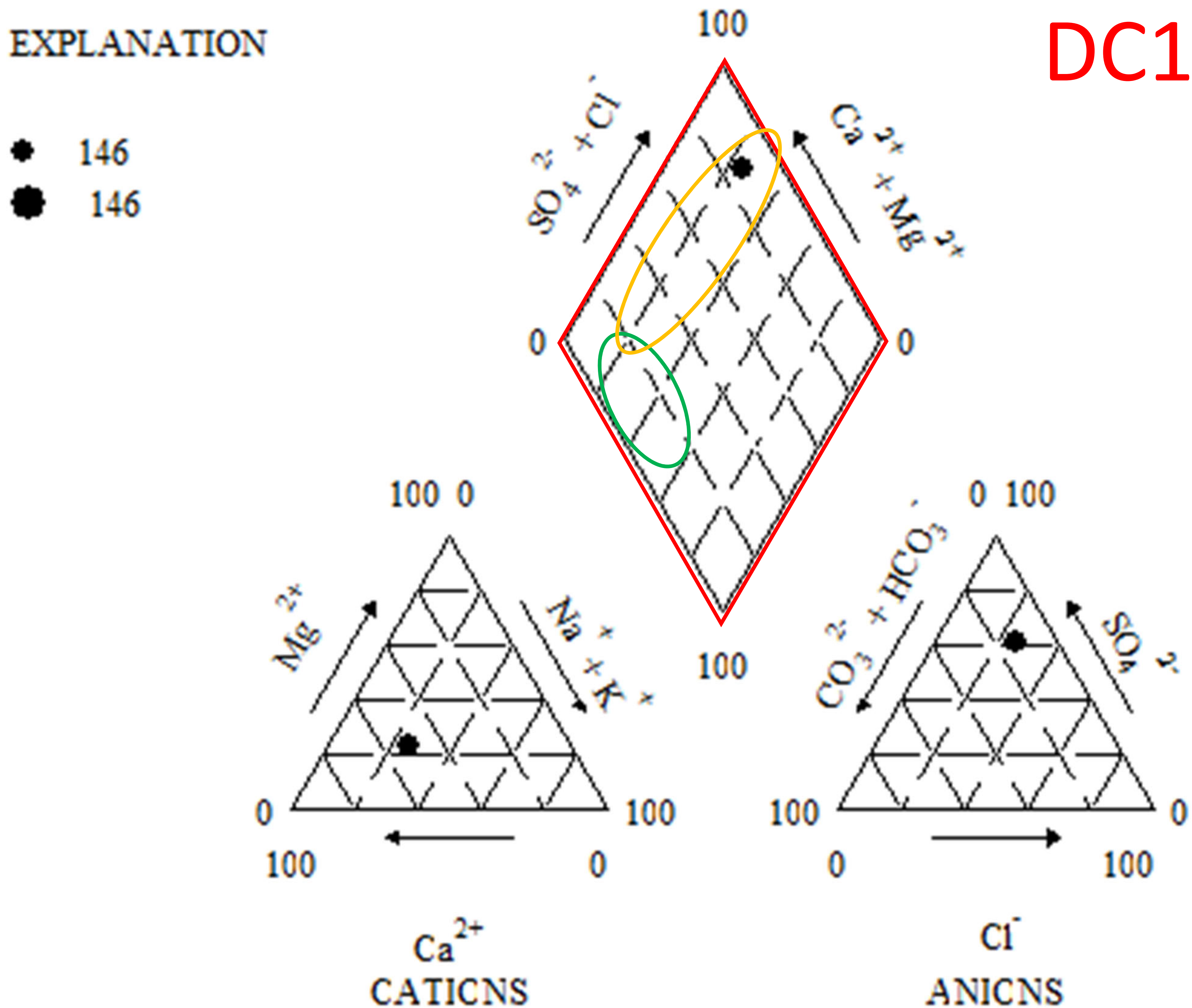
EXPLANATION
194
194
DC8.8C
100
$SO_4^{2-} + Cl^-$
$Ca^{2+} + Mg^{2+}$
0
0
100
100 0
Mg^{2+}
$Na^+ + K^+$
0
100
100
0
Ca^{2+}
CATICNS
0 100
$CO_3^{2-} + HCO_3^-$
SO_4^{2-}
100
0
0
100
Cl^-
ANICNS

DC14.7C



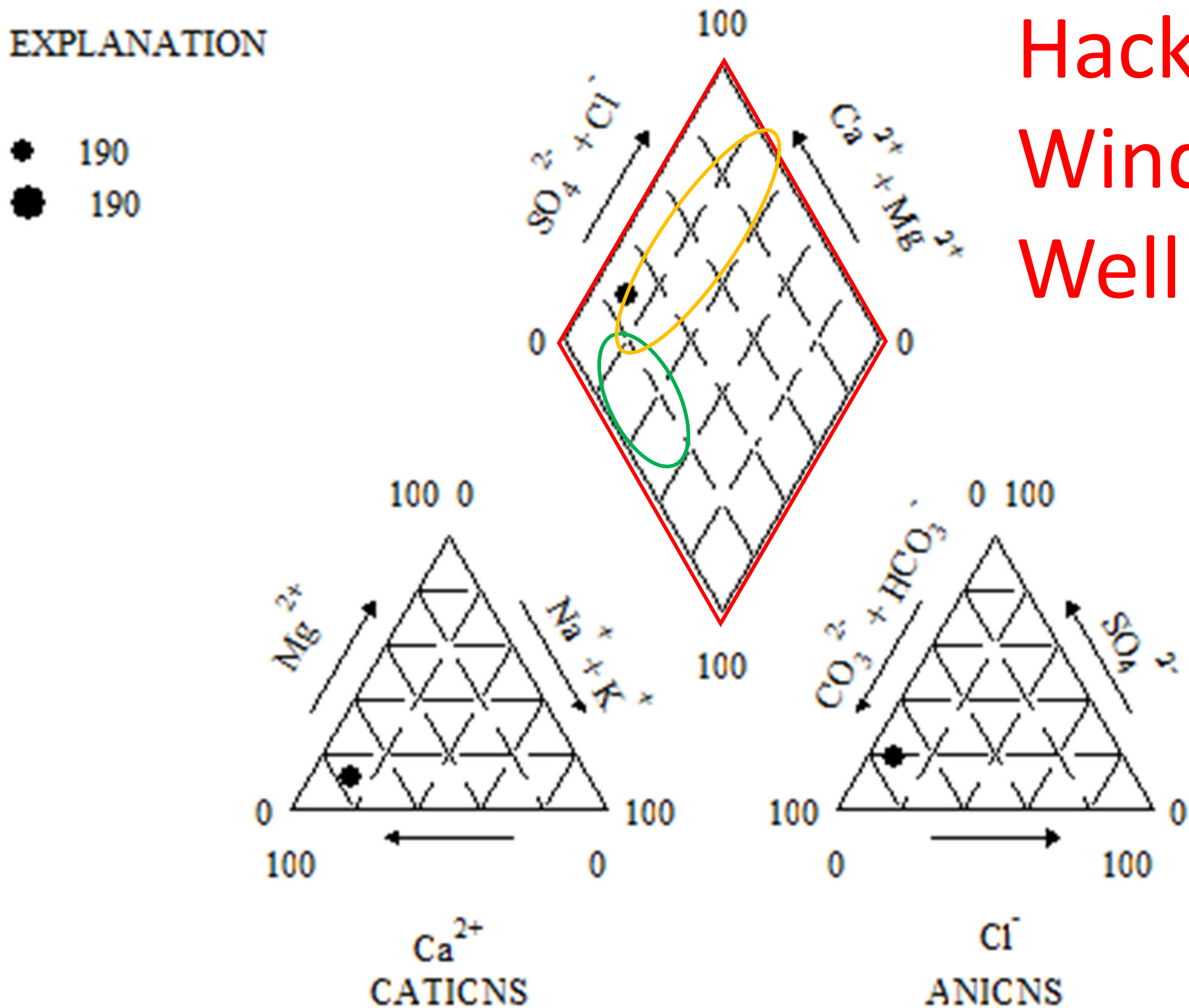
EXPLANATION
71
71
100
SO4 2- + Cl -
Ca 2+ + Mg 2+
0
0
100
100 0
Mg 2+
Na + + K +
0
100
100
0
Ca 2+
CATICNS
0 100
CO3 2- + HCO3 -
SO4 2-
100
0
0
100
Cl -
ANICNS

DC15.2C

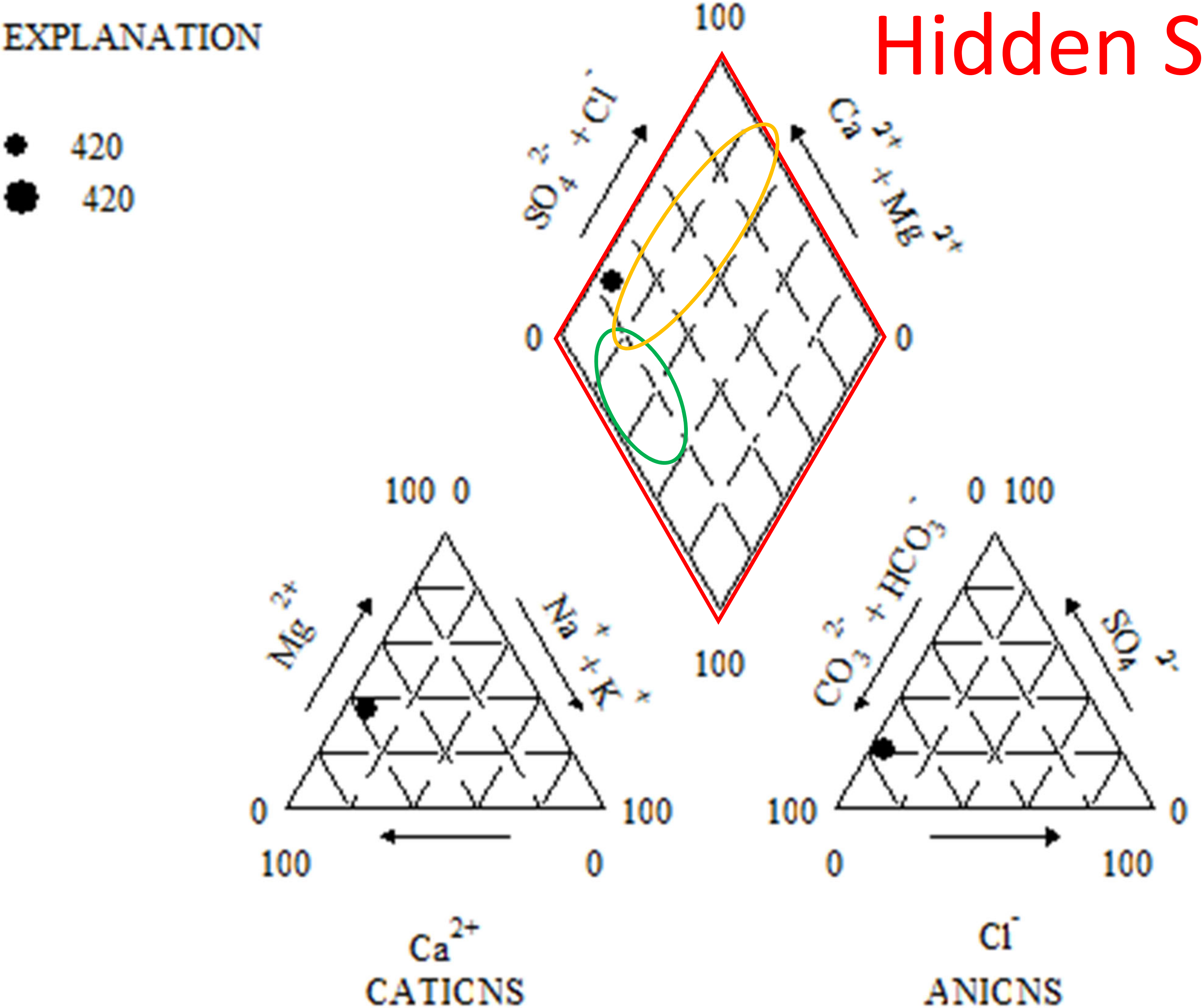


EXPLANATION
146
146
100
$SO_4^{2-} + Cl^-$
$Ca^{2+} + Mg^{2+}$
0
0
100
100 0
Mg^{2+}
$Na^+ + K^+$
0
100
100
0
Ca^{2+}
CATICNS
0 100
$CO_3^{2-} + HCO_3^-$
SO_4^{2-}
100
0
0
100
Cl^-
ANICNS

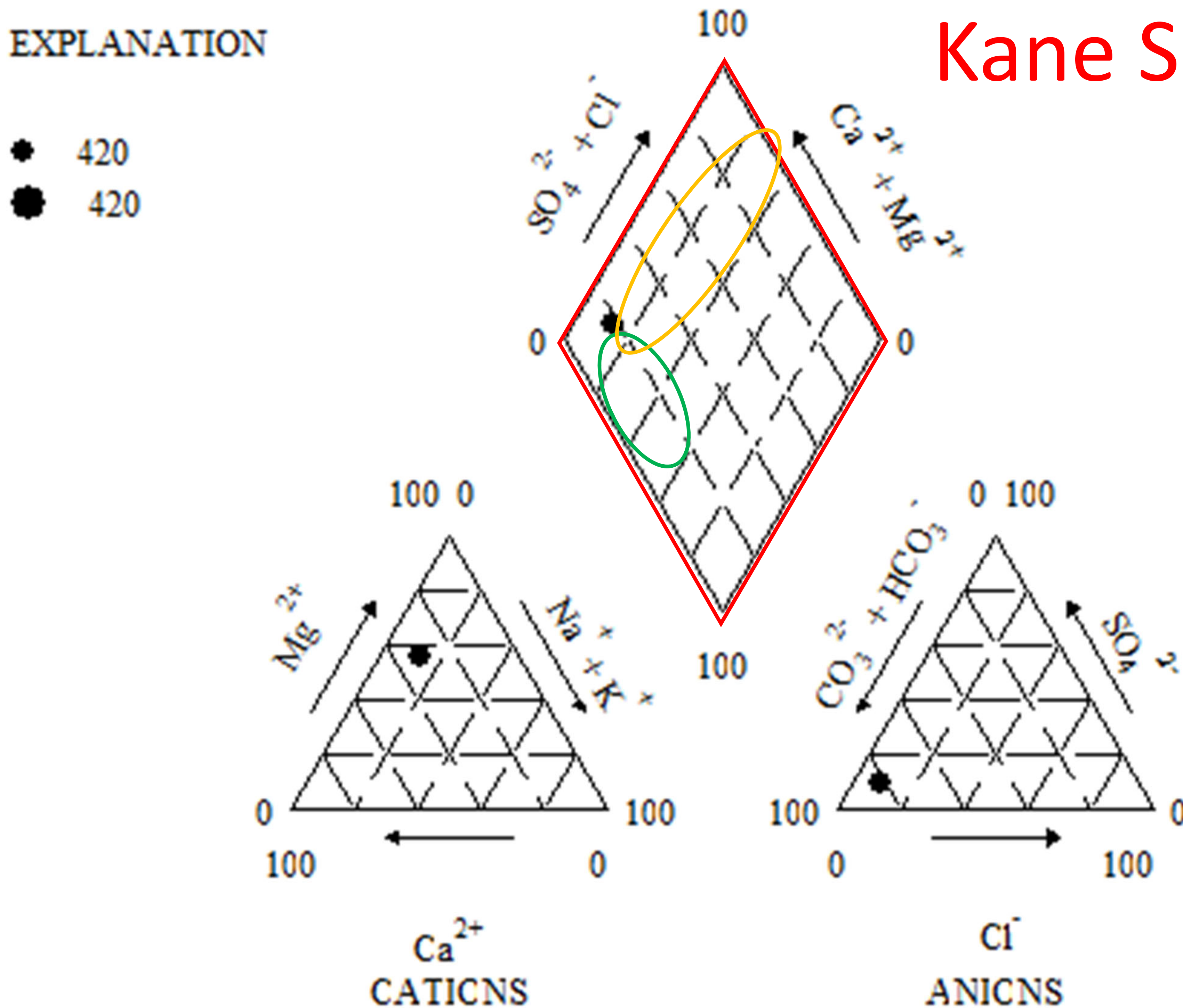
Hackberry Windmill Well



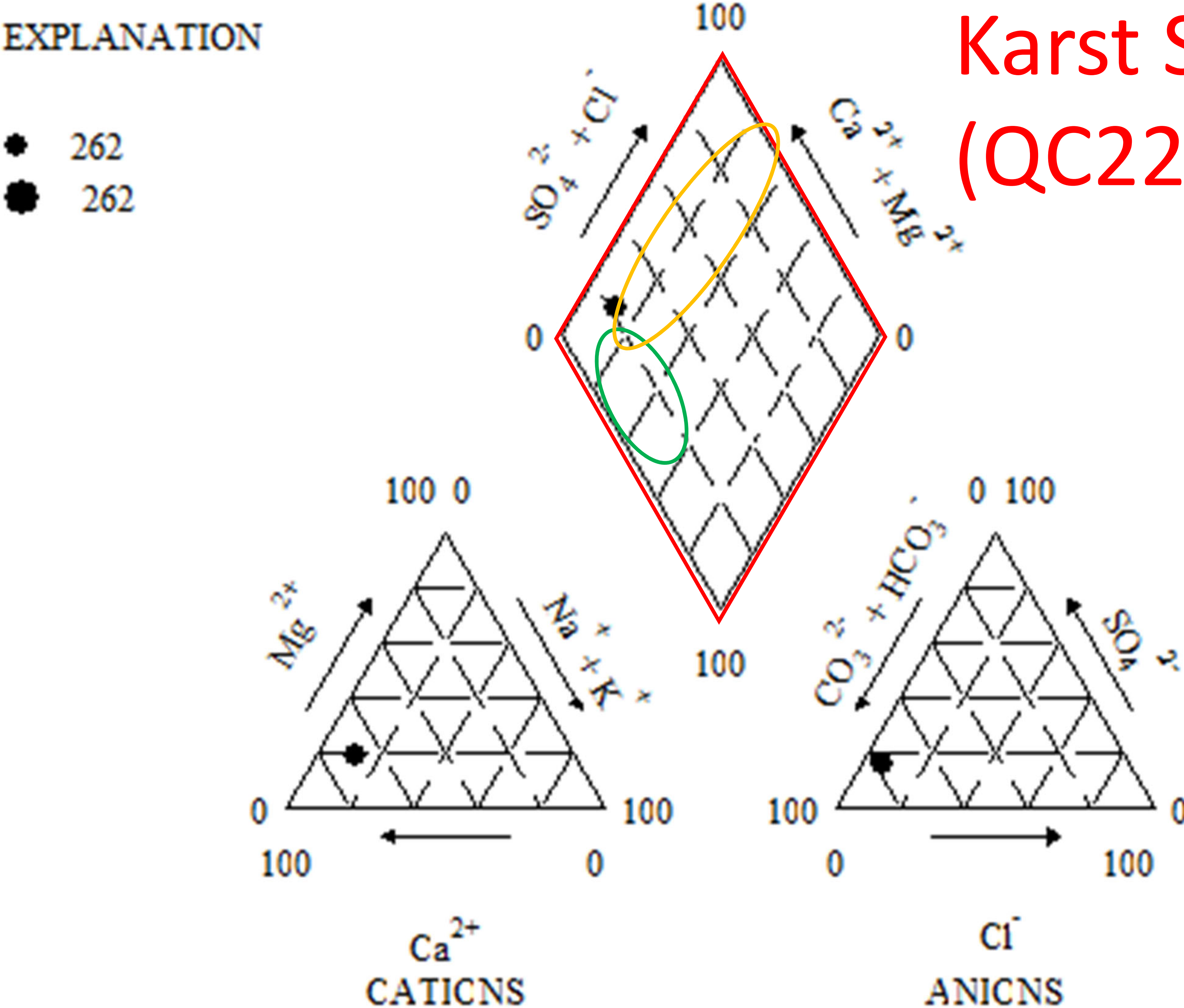
Hidden Spring

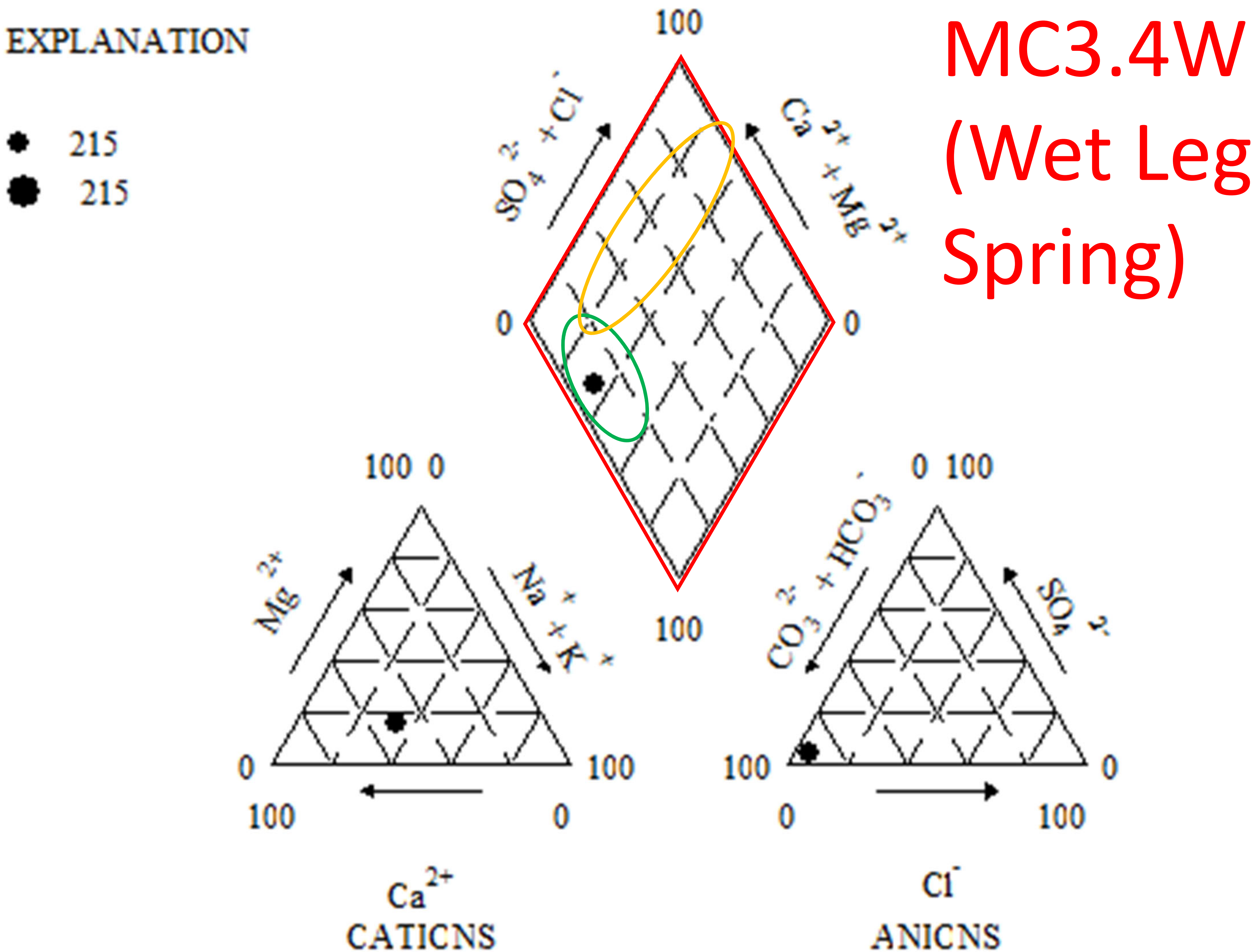


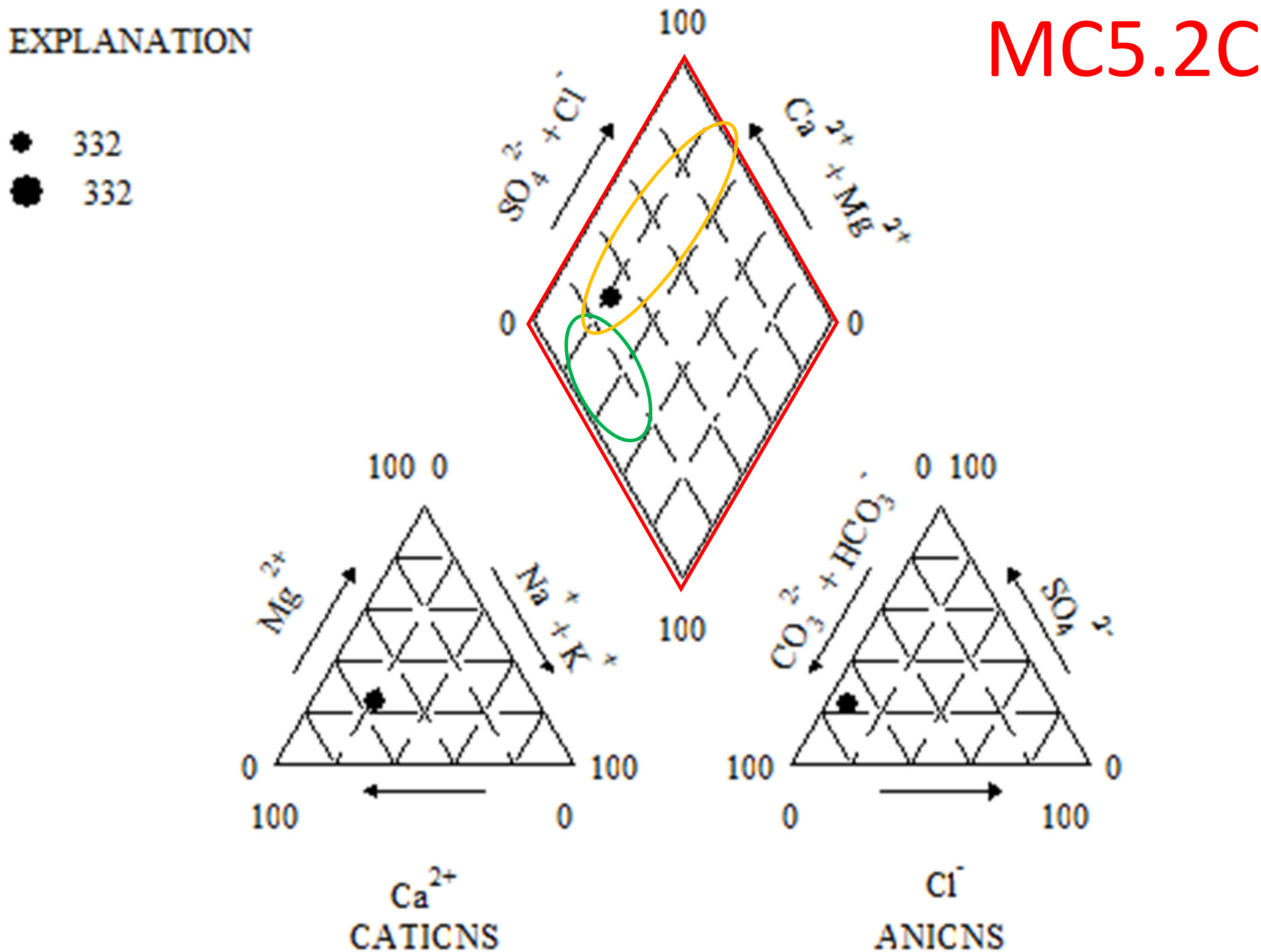
Kane Spring


EXPLANATION
420
420
100
$SO_4^{2-} + Cl^-$
$Ca^{2+} + Mg^{2+}$
0
0
100
100 0
Mg^{2+}
$Na^+ + K^+$
0
100
100
0
Ca^{2+}
CATICNS
0 100
$CO_3^{2-} + HCO_3^-$
SO_4^{2-}
100
0
0
100
Cl^-
ANICNS

Karst Spring (QC22.6E)

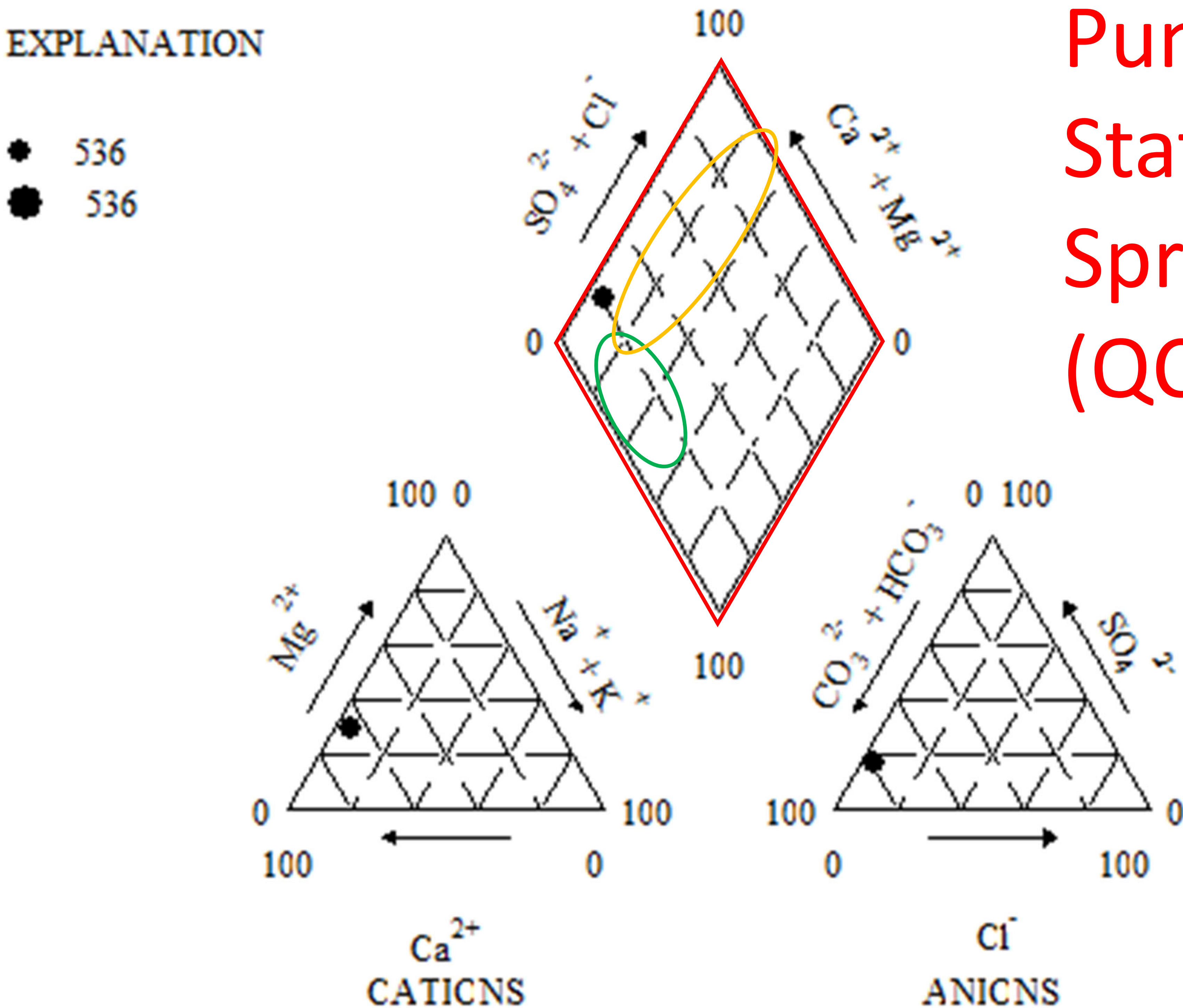



MC3.4W
(Wet Leg
Spring)
EXPLANATION
215
215
100
0
0
100
$SO_4^{2-} + Cl^-$
$Ca^{2+} + Mg^{2+}$
100 0
0 100
Mg^{2+}
$Na^+ + K^+$
$CO_3^{2-} + HCO_3^-$
SO_4^{2-}
0
100
100
0
100
0
0
100
Ca^{2+}
CATICNS
Cl^-
ANICNS

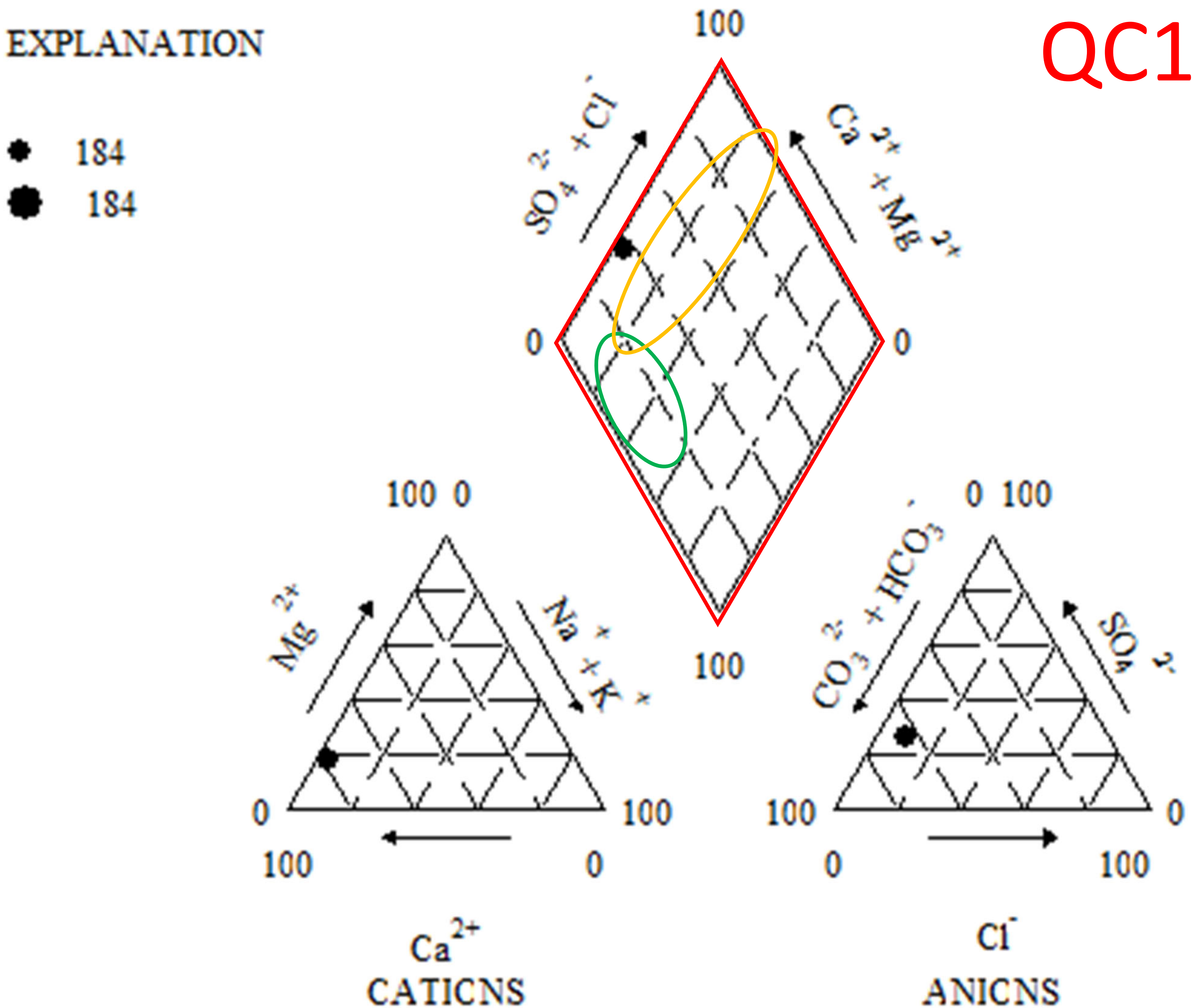


EXPLANATION
332
332
MC5.2C
100
0
0
100
$SO_4^{2-} + Cl^-$
$Ca^{2+} + Mg^{2+}$
100 0
0 100
Mg^{2+}
$Na^+ + K^+$
$CO_3^{2-} + HCO_3^-$
SO_4^{2-}
0
100
100
0
100
0
0
100
Ca^{2+}
CATICNS
Cl^-
ANICNS

Pump Station Spring (QC30.7C)

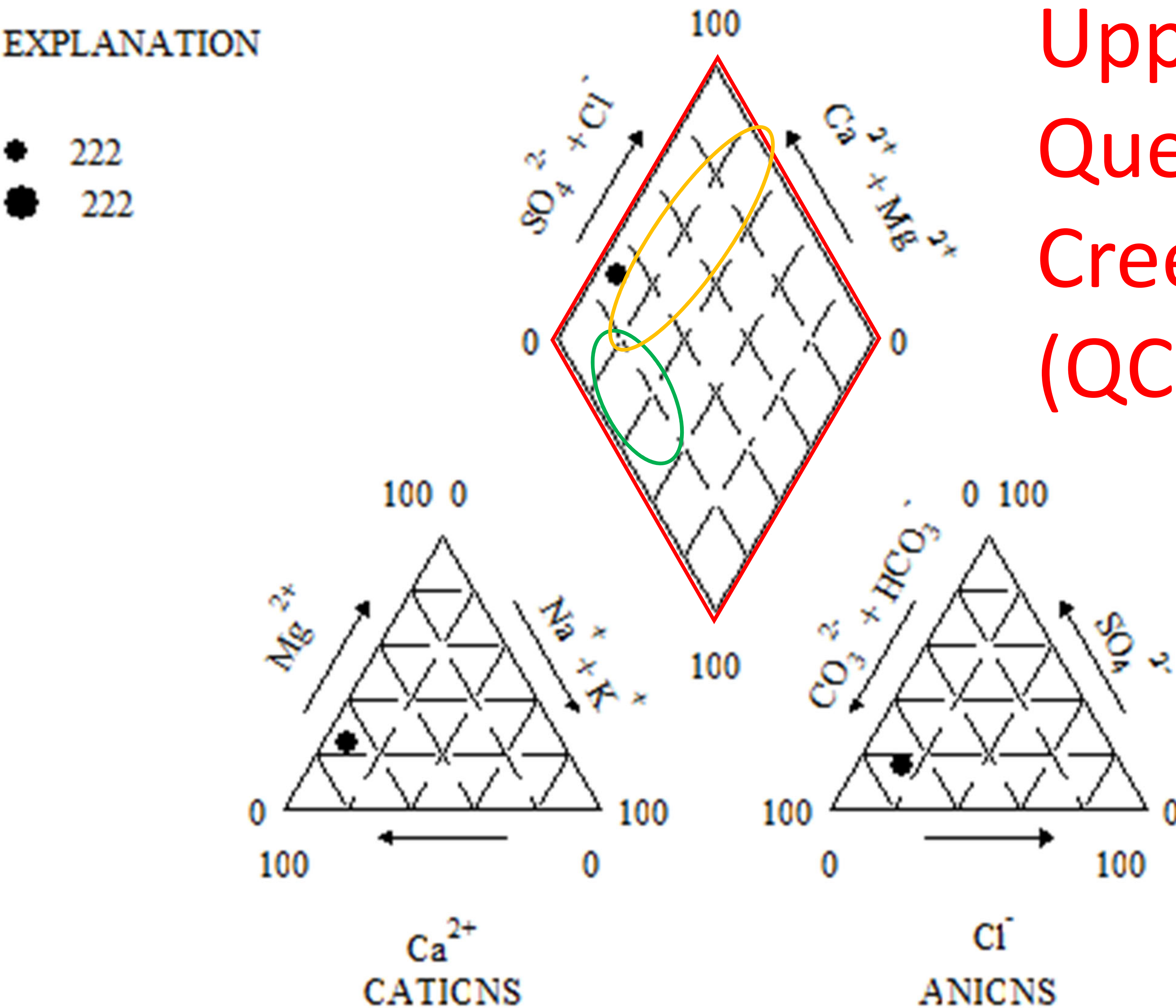


QC19.7C



EXPLANATION
184
184
100
SO_4^{2-} + Cl^-
Ca^{2+} + Mg^{2+}
0
0
100
100 0
0 100
Mg^{2+}
Na^+ + K^+
CO_3^{2-} + HCO_3^-
SO_4^{2-}
0
100
100
0
100
0
0
100
Ca^{2+}
CATICNS
Cl^-
ANICNS

Upper Queen Creek (QC27.3C)



ATTACHMENT 4

GDE Portfolio for Devil's Canyon (Three Reaches)

GDE PORTFOLIO FOR DEVIL'S CANYON

For the purposes of NEPA analysis, Devil's Canyon has been separated into three reaches: Upper, Middle, and Lower. The attached maps show the location of each reach, continuously saturated portions of the stream, springs, surface water monitoring locations, and locations of riparian galleries.

<table>
<tr><th>Reach</th><th>Upper Devil's Canyon</th></tr>
<tr><td>Overview of Reach</td><td>

From Hwy 60 bridge down canyon to km 9.3
No riparian gallery
0.25-mile long continuously saturated reach from km 10.9 to 10.5 [A-Fig4]

</td></tr>
<tr><td>Springs Present</td><td>

Contains no named springs

</td></tr>
<tr><td>Surface Water Monitoring</td><td>

DC-SW1
Ephemeral (2013-present) [A]

DC-13.5C
Ephemeral (2003-present) [A]
Baseflow estimates: [A]
<table>
<tr><td>Min. of Nov 7-day average daily streamflow (cfs)</td><td>Annual median daily streamflow (cfs)</td><td>Annual median daily baseflow from delta-filter method (cfs)</td><td>Winter median daily baseflow from delta-filter method (cfs)</td><td>Summer median daily baseflow from delta-filter method (cfs)</td></tr>
<tr><td>Dry (7 yrs)
0.001-0.035 (3 yrs)</td><td>Dry (5 yrs)
0.045-0.063 (2 yrs)</td><td>0.065</td><td>0.082</td><td>0.008</td></tr>
</table>

DC-10.9C
Intermittent (2003-present) [A]
Baseflow estimates: [A]
<table>
<tr><td>Min. of Nov 7-day average daily streamflow (cfs)</td><td>Annual median daily streamflow (cfs)</td><td>Annual median daily baseflow from delta-filter method (cfs)</td><td>Winter median daily baseflow from delta-filter method (cfs)</td><td>Summer median daily baseflow from delta-filter method (cfs)</td></tr>
<tr><td>Dry (4 yrs)
0.007-0.214 (9 yrs)</td><td>Dry (1 yr)
0.006-0.105 (8 yrs)</td><td>0.037</td><td>0.033</td><td>0.034</td></tr>
</table>

</td></tr>
<tr><td>Water Quality Monitoring</td><td>

DC-15.5C (2008-2012; 13 samples)
DC-15.2C (2005; 3 samples)
DC-14.7C (2004-2014; 4 samples)
DC-13.5C (2003-2012; 16 samples)
DC-10.9C (2003-2015; 13 samples)

</td></tr>
</table>

<table>
<tr><td>Riparian Vegetation Present</td><td>No riparian vegetation present</td></tr>
<tr><th>Reach</th><th>Middle Devil's Canyon</th></tr>
<tr><td>Overview of Reach</td><td>From km 9.3 to km 6.1
1.1-mile/26-acre riparian gallery from km 9.3 to 7.6 [D]
1-mile long continuously saturated reach from km 9.0 to 7.4 [A-Fig4]</td></tr>
<tr><td>Springs Present</td><td>DC-8.2W [A][C]
Spring complex emanates from the west bank of Devils Canyon between Hackberry and Oak Canyons
Largest single spring complex noted in the canyon.
Two springs approximately 20 meters apart, with flow connection to main channel.
Spring emerges from under a large boulder and pools in several places as flow continues down to the main channel.
Measured flow from 0.1 to 15 gpm (2002-present)
Median = 5.0 gpm
DC-6.6W [A][C]
Located in an unnamed tributary to the west of Devils Canyon, about 200 meters above main stem.
Water is present in a series of small pools and seeps that emanate through the loamy substrate.
Canyon bottom along contact between Apache Leap Tuff and Whitetail Conglomerate.
Measured flow from 0 to 32.5 gpm (2002-present)
Median flow = 0.5 gpm</td></tr>
<tr><td>Surface Water Monitoring</td><td>DC-8.8C
Perennial (2003-present) [A]
Baseflow estimates: [A]
<table>
<tr><td>Min. of Nov 7-day average daily streamflow (cfs)</td><td>Annual median daily streamflow (cfs)</td><td>Annual median daily baseflow from delta-filter method (cfs)</td><td>Winter median daily baseflow from delta-filter method (cfs)</td><td>Summer median daily baseflow from delta-filter method (cfs)</td></tr>
<tr><td>0.024-0.688 (7 yrs)</td><td>0.044-0.647 (4 yrs)</td><td>0.264</td><td>0.462</td><td>0.082</td></tr>
</table>
DC-8.1C
Intermittent (2011-present)[A]
Baseflow estimates: [A]</td></tr>
</table>

<table>
<tr>
<td></td>
<td>
<table>
<tr><th>Min. of Nov 7-day average daily streamflow (cfs)</th><th>Annual median daily streamflow (cfs)</th><th>Annual median daily baseflow from delta-filter method (cfs)</th><th>Winter median daily baseflow from delta-filter method (cfs)</th><th>Summer median daily baseflow from delta-filter method (cfs)</th></tr>
<tr><td>0.002-0.051 (5 yrs)</td><td>0.026-0.054 (2 yrs)</td><td>0.004</td><td>0.145</td><td>0.008</td></tr>
</table>

➢ DC-7.1C
o Intermittent (2003-present)[A]
</td>
</tr>
<tr>
<td>Water Quality Monitoring</td>
<td>
➢ DC-8.8C (2003-2015; 12 samples)
➢ DC-8.2W (2003-2015; 21 samples)
➢ DC-8.1C (2008-2015; 11 samples)
➢ DC-7.1C (2003-2015; 12 samples)
➢ DC-6.6W (2003-2015; 13 samples)
➢ DC-6.14C (2008-2015; 11 samples)
</td>
</tr>
<tr>
<td>Riparian Vegetation Present</td>
<td>
Riparian vegetation lines the canyon bottom, ranging from approximately 70-280 ft in width, with small extensions up several side canyons. The canopy closure is fairly consistent with few small areas of open canopy.

Dominant riparian species include:

➢ Arizona alder (Alnus oblongifolia)
➢ Velvet ash (Fraxinus velutina)
➢ Arizona sycamore (Platanus wrightii)
➢ Buttonbush (Cephalanthus occidentalis)

Also present:

➢ Goodding’s willow
➢ Fremont’s cottonwood
➢ Netleaf hackberry (Celtis reticulata)
➢ Baccharis
➢ Poison ivy (Toxicodendron spp.)

Wetland species present at spring
</td>
</tr>
</table>

<table>
<tr><th>Reach</th><th>Lower Devil’s Canyon</th></tr>
<tr><td>Overview of Reach</td><td>

From km 6.1 to confluence with Mineral Creek (km 0)
2.1-mile/50-acre riparian gallery from km 6.1 to 2.7 [D]
0.5-mile long continuously saturated reach from km 6.1 to 5.3, includes several large perennial pools [A-Fig4]

</td></tr>
<tr><td>Springs Present</td><td>

DC-6.1E [A][C]

At head of continuously flowing reach and riparian gallery
Discharges from the Apache Leap Tuff on the east wall of Devils Canyon.
Water seeps from megaspherulite zone above vitrophyre below the bottom pool of the Crater Tanks; boulder field at base of falls.
Water from the springs flows down the exposed bedrock walls to the canyon floor and infiltrates unconsolidated subsurface materials, but reemerges near the end of the spring complex.
Measured flow from 0 to 80 gpm (2002-present)
Median = 1.5 gpm

DC-4.1E [A][C]

Discharges from the Apache Leap Tuff on the east wall of Devils Canyon. Vertical fins in cliff face suggest fracture control on spring discharge.
Spring drains to small pools at base.
Part of a 200-meter long complex of springs emerging from 10-m high walls above canyon floor, quickly infiltrates unconsolidated materials.
Measured flow from 0.1 to 3 gpm
Median = 1.25 gpm

</td></tr>
<tr><td>Surface Water Monitoring</td><td>

DC-5.5C

Intermittent (2003-present)
Baseflow estimates: [A]

<table>
<tr><td>Min. of Nov 7-day average daily streamflow (cfs)</td><td>Annual median daily streamflow (cfs)</td><td>Annual median daily baseflow from delta-filter method (cfs)</td><td>Winter median daily baseflow from delta-filter method (cfs)</td><td>Summer median daily baseflow from delta-filter method (cfs)</td></tr>
<tr><td>0.002-0.204 (10 yrs)
Dry (1 yr)</td><td>0.056-0.329 (5 yrs)
Dry (1 yr)</td><td>0.088</td><td>0.287</td><td>0.003</td></tr>
</table>
</td></tr>
<tr><td>Water Quality Monitoring</td><td>

DC-6.1E (2003-2015; 17 samples)
DC-5.5C (2003-2015; 11 samples)
DC-4.1E (2003-2015; 7 samples)

</td></tr>
<tr><td>Riparian Vegetation Present</td><td>Riparian vegetation in this portion of the canyon is much less dense than upstream. The band of riparian vegetation in this stretch ranges from approximately 40-300 ft (12-91 m) in width. The canopy closure is much more fragmented in this stretch than in Middle Devil’s Canyon.</td></tr>
</table>

	Dominant riparian species include: ➢ Arizona sycamore ➢ Fremont's cottonwood ➢ Velvet ash ➢ Buttonbush ➢ Baccharis Also present: ➢ Goodding's willow ➢ Arizona alder ➢ Arizona walnut (Juglans major) Wetland species present at springs

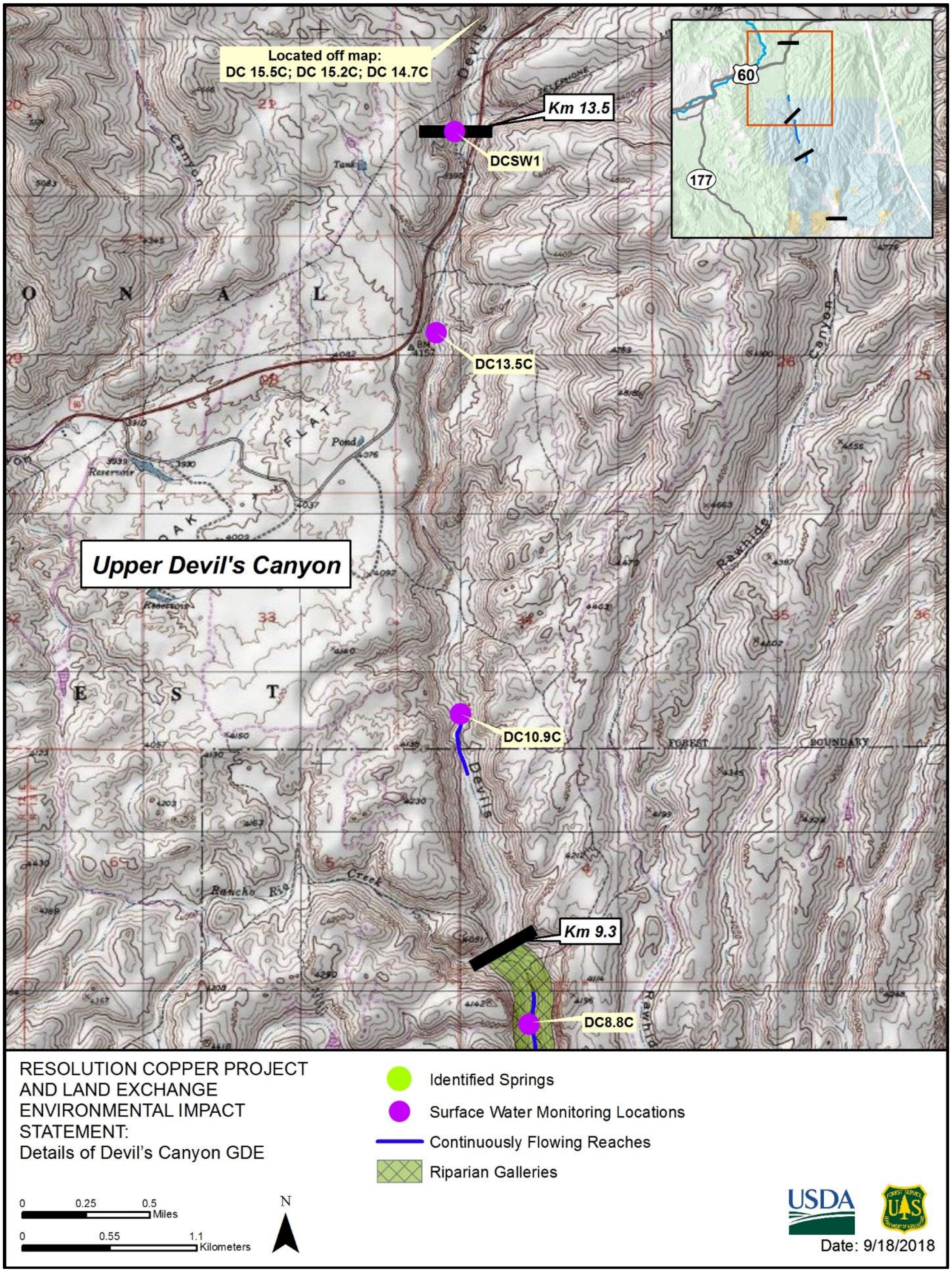
References

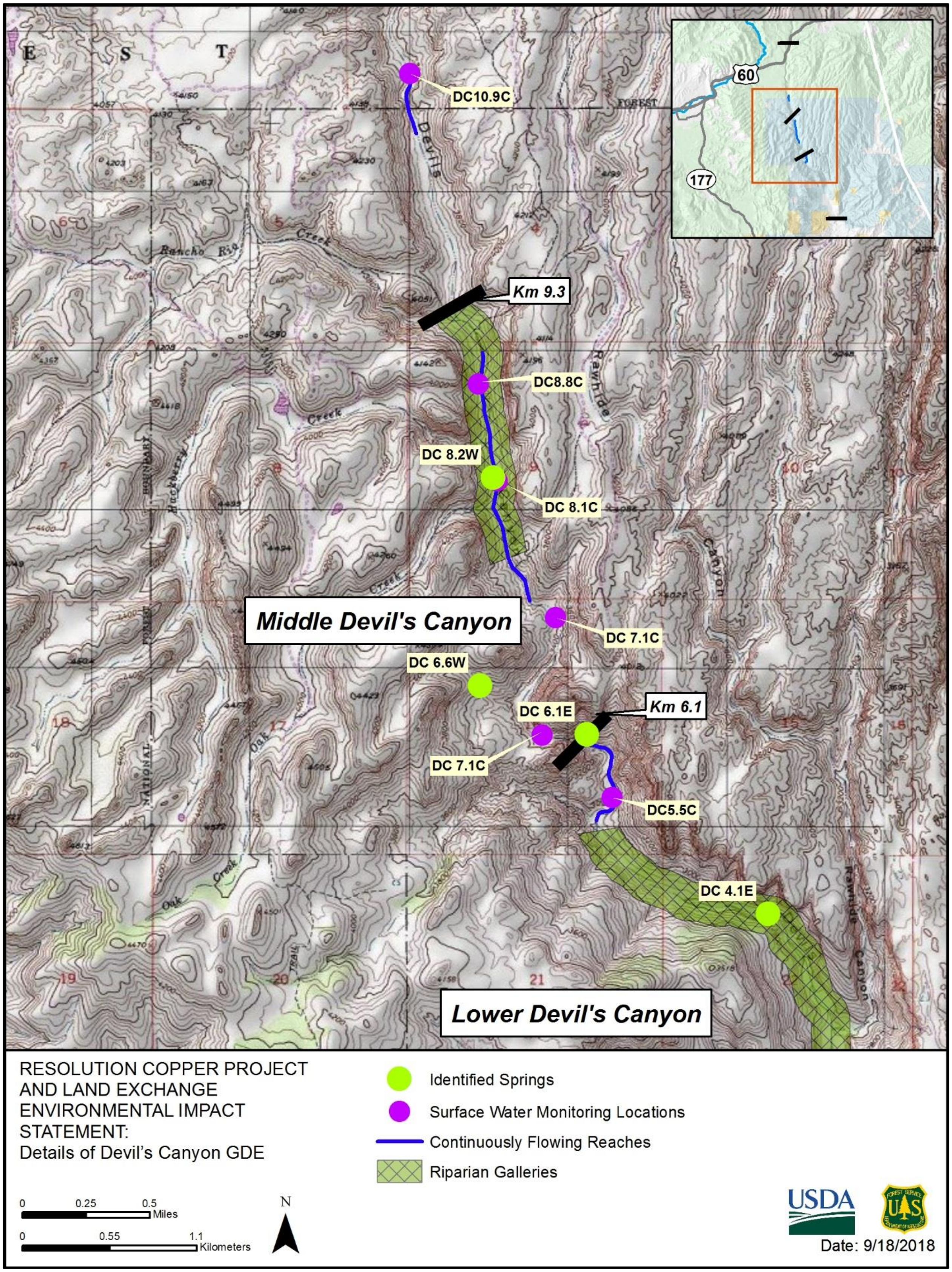
[A] Montgomery & Associates, 2017. Surface Water Baseline Addendum: Upper Queen Creek, Devils Canyon, and Mineral Creek Watersheds", January 26, 2017 (Project Record #0001272)

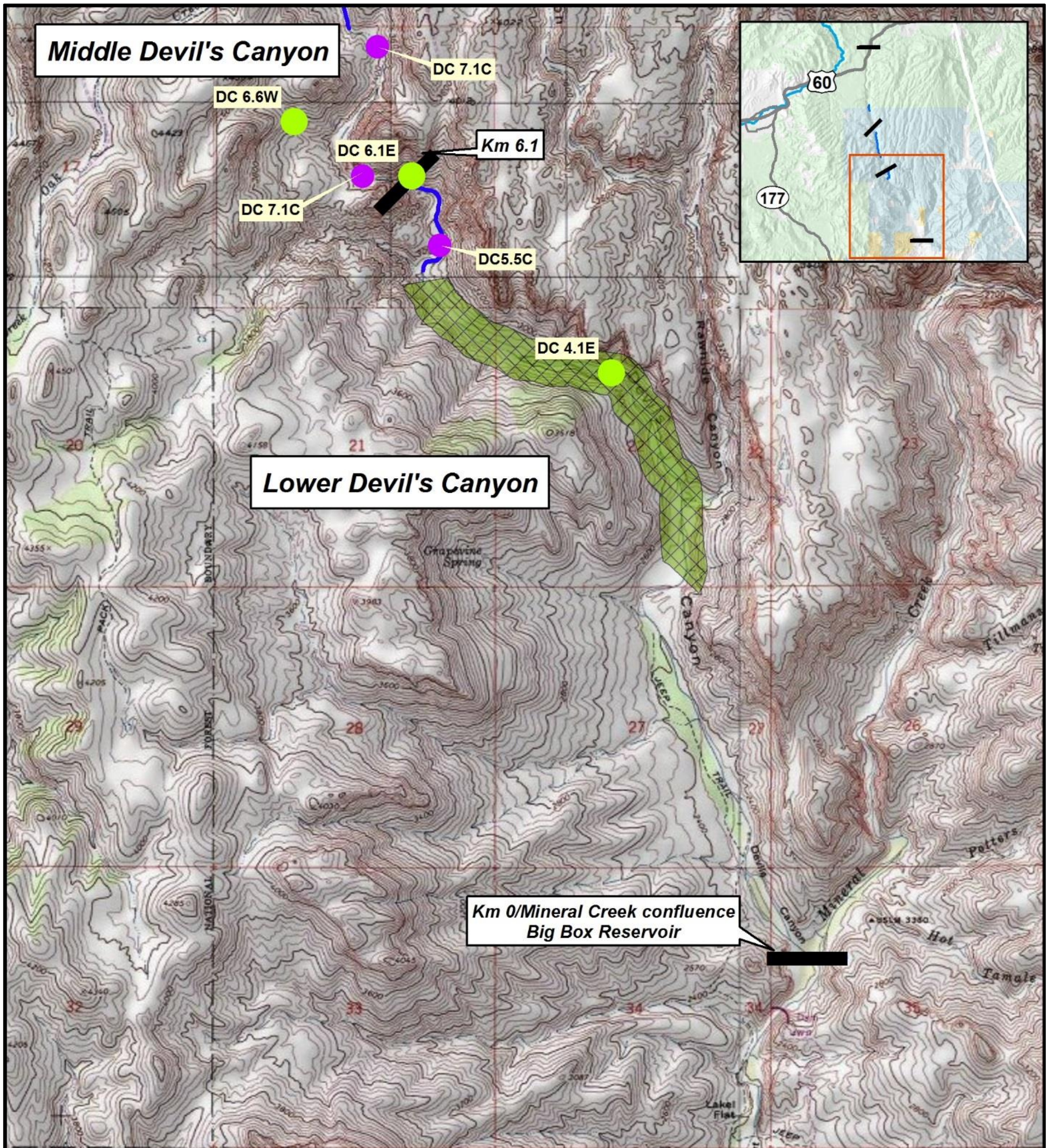
[B] Montgomery & Associates, 2016. Hydrochemistry Addendum, Groundwater and Surface Water, Upper Queen Creek/Devils Canyon Study Area", August 11, 2016 (Project Record #0001002)

[C] Montgomery & Associates, 2017. Spring and Seep Catalog, Resolution Copper Project Area, Upper Queen Creek and Devils Canyon Watersheds", October 3, 2017 (Project Record #0002102)

[D] Riparian gallery locations based on aerial photos and survey areas for western yellow-billed cuckoo (WestLand Resources, 2015. 2015 Yellow-Billed Cuckoo Survey, Whitlow Ranch Dam, Devils Canyon, and Mineral Creek, Pinal County, Arizona", November 23, 2015) (Project Record #0000098)


Located off map:
DC 15.5C; DC 15.2C; DC 14.7C
Km 13.5
DCSW1
DC13.5C
Upper Devil's Canyon
DC10.9C
Km 9.3
DC8.8C
60
177
RESOLUTION COPPER PROJECT
AND LAND EXCHANGE
ENVIRONMENTAL IMPACT
STATEMENT:
Details of Devil's Canyon GDE
Identified Springs
Surface Water Monitoring Locations
Continuously Flowing Reaches
Riparian Galleries
0 0.25 0.5 Miles
0 0.55 1.1 Kilometers
N
USDA
Date: 9/18/2018


DC10.9C
Devils
Rancho Rio Creek
Km 9.3
DC8.8C
Rawhide
DC 8.2W
DC 8.1C
Canyon
Middle Devil's Canyon
DC 7.1C
DC 6.6W
DC 6.1E
Km 6.1
DC 7.1C
DC5.5C
DC 4.1E
Lower Devil's Canyon
60
177
RESOLUTION COPPER PROJECT AND LAND EXCHANGE ENVIRONMENTAL IMPACT STATEMENT:
Details of Devil's Canyon GDE
Identified Springs
Surface Water Monitoring Locations
Continuously Flowing Reaches
Riparian Galleries
0 0.25 0.5 Miles
0 0.55 1.1 Kilometers
N
USDA
Date: 9/18/2018



RESOLUTION COPPER PROJECT
AND LAND EXCHANGE
ENVIRONMENTAL IMPACT
STATEMENT:
Details of Devil's Canyon GDE

Identified Springs
Surface Water Monitoring Locations
Continuously Flowing Reaches
Riparian Galleries

0 0.25 0.5 Miles
0 0.55 1.1 Kilometers
N

USDA

Date: 9/18/2018

ATTACHMENT 5

GDE Portfolio for Queen Creek (Two Reaches)

GDE PORTFOLIO FOR QUEEN CREEK

For the purposes of NEPA analysis, Queen Creek has been separated into two reaches: Queen Creek above Superior, and Queen Creek below Superior. The attached maps show the location of each reach, continuously saturated portions of the stream, springs, surface water monitoring locations, and locations of riparian galleries.

<table>
<tr><th>Reach</th><th>Queen Creek above Superior</th></tr>
<tr><td>Overview of Reach</td><td>From Magma Avenue bridge (km 21.7) to Pump Station Spring (km 30.7)
Sustained seasonal flow is often observed in the spring when slow release of surface water runoff and snowmelt is captured in shallow alluvial deposits and veneers, colluvium, and extensive shallow joint sets in the Tal outcrop belt drains into Queen Creek after the winter rainy season.</td></tr>
<tr><td>Springs Present</td><td>Pump Station Spring (QC-30.7C) [A][C]
Located in Queen Creek channel at the downstream extent of a large deposit of alluvium resting on Tertiary rhyolite and Apache Leap Tuff.
The most upstream water is the first of a string of five small pools along the stream channel. The most downstream surface water is a one by 10-meter rock tinaja.
Located downstream of the OMYA marble quarry. The spring discharges from shallow alluvial deposits that cover an area of more than 20 acres. Shallow groundwater stored in these alluvial deposits is the principal source of water to this spring.
It has been reported that pumped water from dewatering of the OMYA quarry during runoff events is occasionally discharged to the Queen Creek channel above Pump Station Spring where it is available to recharge shallow groundwater hosted in the alluvial deposits.
Measured flow from 0 to 46 gpm (2002-2017)
Median = 0.625 gpm
Boulder Hole (QC-23.6C) [A]
Located in boulder alluvium in the channel of Queen Creek below the Apache Leap Tuff outcrop belt.
It is generally a stagnant pool (i.e. no visible flow exiting the pool) although subflow in the boulder alluvium may occur.
Boulder Hole has never been reported to be dry, and estimates of stored water volumes range widely.
Although the source of water at Boulder Hole is not well understood, it may reflect local storage and release of seasonal runoff from the upper part of Queen Creek canyon. Storage could be inthe boulder alluvium where it rests on the poorly permeable Whitetail Conglomerate and Naco Limestone.
The interpretation that water at Boulder Hole derives from seasonal runoff is supported by observed variability in TDS, with the lowest levels of TDS occurring during January-March when there is much runoff
Karst Spring (QC-22.6E) [C]
Solution void in limestone on east bank of Queen Creek (about 3 meters from channel); immediately upstream from old US60 highway bridge;
Only flows during wet periods</td></tr>
</table>

<table>
<tr>
<td></td>
<td>

Density of wetland species, yellow monkeyflower, around cave entrance suggests increased moisture is present.
Measured flow from 0 to 52.0 gpm (2005-2017)
Median = 0.1 gpm

➢ Queen Seeps [C]

Complex of seeps along south side of Queen Creek canyon below No.9 shaft
Abundant riparian vegetation for ~300 meter reach. Majority of vegetation is within 50 meters of channel;
No standing water observed; some flow observed on occasion
No measurable center; soil on the hillslope is moist.

➢ Gibson Well Springs [C]

Spring located in Oak Flat Wash immediately upstream of confluence with Queen Creek, just south of old hand-dug well.
Streambed with damp banks supports high density of herbaceous hydrophytic vegetation, suggesting shallow sub-surface water table.
Measured flow from 0 to 25 gpm (2017)
Median = 0 gpm

</td>
</tr>
<tr>
<td>Surface Water Monitoring</td>
<td>
➢ Upper Carbonate (QC-23.9C)

Ephemeral (2010-present) [A]
Baseflow estimates: [A]

<table>
<tr><th>Min. of Nov 7-day average daily streamflow (cfs)</th><th>Annual median daily streamflow (cfs)</th><th>Annual median daily baseflow from delta-filter method (cfs)</th><th>Winter median daily baseflow from delta-filter method (cfs)</th><th>Summer median daily baseflow from delta-filter method (cfs)</th></tr>
<tr><td>0.002 (1 yr)
Dry (3 yrs)</td><td>Dry (4 yrs)</td><td>0.019</td><td>0.025</td><td>0.006</td></tr>
</table>

➢ Lower Carbonate

➢ Magma Avenue Bridge (QC-21.7C)
</td>
</tr>
<tr>
<td>Water Quality Monitoring</td>
<td>
➢ Pump Station Spring (QC-30.7C) (2003-2012; 23 samples)
➢ Upper Queen Creek (QC-27.3C) (2005-2012; 11 samples)
➢ Upper Carbonate (QC-23.9C) (2015; 1 sample)
➢ Boulder Hole (QC-23.6C) (2003-2012; 19 samples)
➢ Karst Spring (QC-22.6C) (2005-2013; 8 samples)
➢ Magma Avenue Bridge (QC-21.7C) (2008-2012; 10 samples)
</td>
</tr>
<tr>
<td>Riparian Vegetation Present</td>
<td>
The primary channel is generally devoid of vegetation and the canyon bottom substrate is dominated by large boulders, cobbles, and bedrock…Adjacent to the channel, Queen Creek supports mixed broadleaf vegetation characteristic of Interior Riparian Deciduous Forest where it is represented by [E]:
➢ Arizona sycamore,
➢ Fremont cottonwood,
</td>
</tr>
</table>

	➢ velvet ash, ➢ Arizona walnut, ➢ Goodding's willow, ➢ bigtooth maple (Acer grandidentatum) ➢ soapberry (Sapindus sp.) Also present along the drainage and on adjacent terraces: ➢ Emory oak (Quercus emoryi), ➢ shrub live oak (Q. turbinella), ➢ netleaf hackberry (Celtis reticulata), ➢ mesquite, ➢ desert broom ➢ manzanita (Arctostaphylos pungens)

Reach	Queen Creek below Superior
Overview of Reach	➢ From Magma Avenue Bridge (km 21.7) downstream to Whitlow Ranch Dam (km 0) ➢ 1.1-mile continuously saturated reach starts at the Superior Waste Water Treatment Plant and the Harborlite perlite mine. Discharges from these two facilities maintain perennial flow in Queen Creek from km 17.4 to 15.6, but there may be additional groundwater inflow into the channel. [A]
Springs Present	➢ No observed springs
Surface Water Monitoring	➢ None
Water Quality Monitoring	➢ QC-19.7C (2008-2014; 10 samples) ➢ Whitlow Ranch Dam (2015; 4 samples)
Riparian Vegetation Present	"Of the areas surveyed, the most promising sections were the eastern most portion of the Arnett Creek transect at the mouth of the canyon, the eastern portion of the Upper Queen Creek transect through the area referred to by Superior locals as "the Jungle" and the western portion of the Upper Queen Creek transect after exiting the canyon and entering Boyce Thompson Arboretum. The eastern ends of both canyons contain significant stands of native broad-leaf trees and are wide enough to potentially support adjacent mesquite bosque. The western end of the Lower Queen Creek transect is adjacent to Boyce Thompson Arboretum which contains many large non-native broadleaf trees that could potentially support cuckoos. However, it is more likely that the birds would utilize the irrigated Arboretum rather than the creek itself." [F] Approximately 45 acres of riparian vegetation present at Whitlow Ranch Dam "Riparian vegetation typical of the Sonoran Riparian Scrubland community…Exotic saltcedar is the dominant overstory species, though Goodding's willow and Fremont's cottonwood are also present, particularly along the Queen Creek channel, along with many large, dead willows and cottonwoods. The understory, often dense, includes species such as baccharis (Baccharis spp.), lupine (Lupinus spp.), and unidentified grasses. Trees charred in the June, 2012 Comet Fire are still prevalent, the majority of which are saltcedar, many of them regenerating." [D]

References

[A] Montgomery & Associates, 2017. Surface Water Baseline Addendum: Upper Queen Creek, Devils Canyon, and Mineral Creek Watersheds, January 26, 2017 (Project Record #0001272)

[B] Montgomery & Associates, 2016. Hydrochemistry Addendum, Groundwater and Surface Water, Upper Queen Creek/Devils Canyon Study Area, August 11, 2016 (Project Record #0001002)

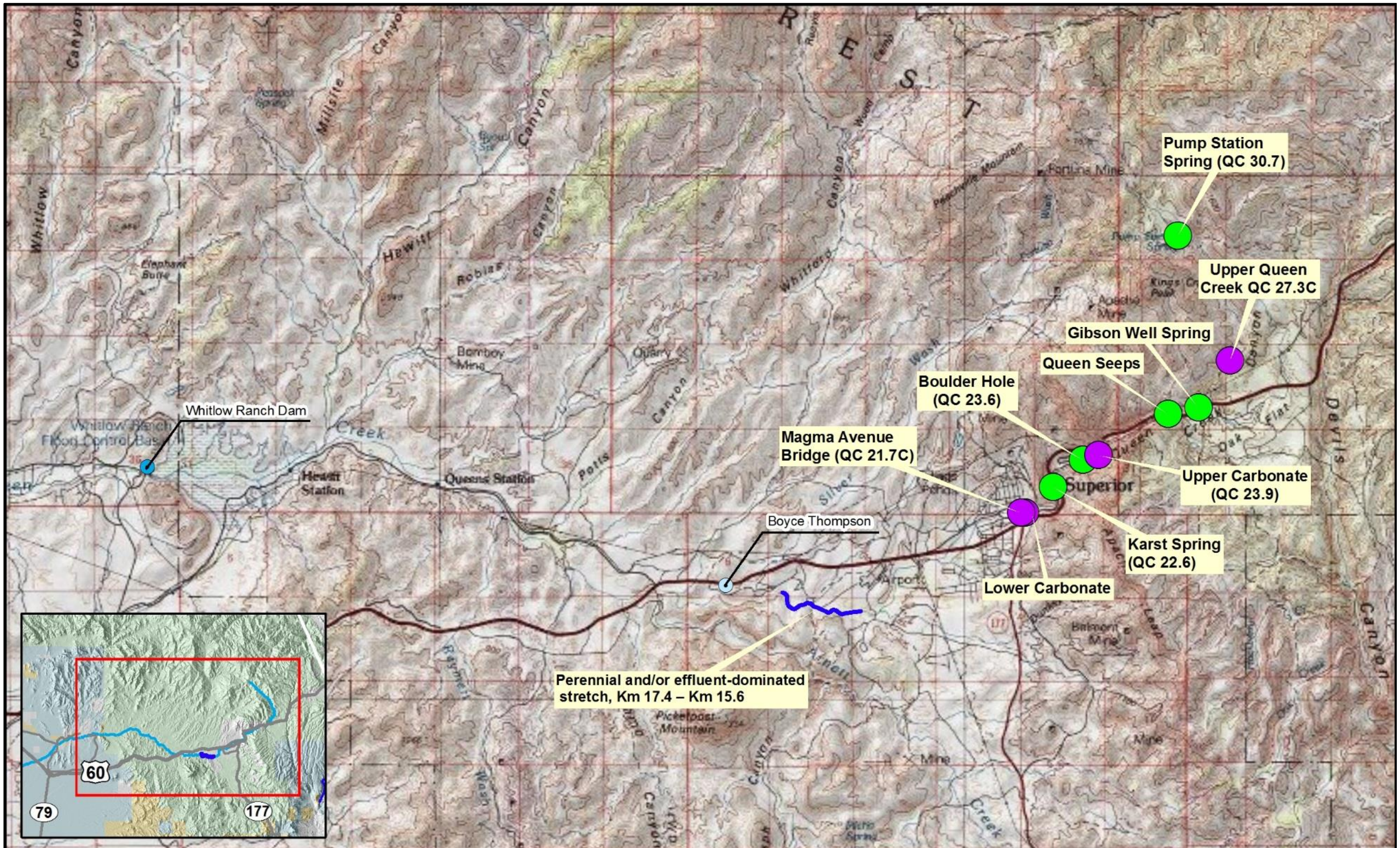
[C] Montgomery & Associates, 2017. Spring and Seep Catalog, Resolution Copper Project Area, Upper Queen Creek and Devils Canyon Watersheds, October 3, 2017 (Project Record #0002102)

[D] Riparian gallery locations based on aerial photos and survey areas for western yellow-billed cuckoo (WestLand Resources, 2015. 2015 Yellow-Billed Cuckoo Survey, Whitlow Ranch Dam, Devils Canyon, and Mineral Creek, Pinal County, Arizona, November 23, 2015) (Project Record #0000098)

[E] WestLand Resources, 2017. 2017 Southwestern Willow Flycatcher Survey for the Resolution Copper Project, December 19, 2017 (Project Record #0002203)

[F] Audubon Arizona. Western yellow-billed cuckoo (Coccyzus americanus occidentalis) 2015 yellow-billed cuckoo surveys on Queen and Arnett Creeks Audubon Arizona. (Project Record #0000101)

[G] JE Fuller. Surface Water Data Assessment. January 31, 2017 (Project Record #0001274)



RESOLUTION COPPER PROJECT AND LAND EXCHANGE ENVIRONMENTAL IMPACT STATEMENT:
Details of Queen Creek GDE

Surface Water Monitoring Locations

Identified Springs

Continuously Flowing Reaches

0 3,500 7,000 Feet

0 870 1,740 Meters

N

USDA

Date: 9/18/2018

ATTACHMENT 6

GDE Portfolio for Mineral Creek

GDE PORTFOLIO FOR MINERAL CREEK

Reach	**Mineral Creek**

Overview of Reach	➢ From Government Springs (km 8.7) to confluence with Devil's Canyon (km 0)
	➢ Roughly three riparian galleries (from aerial photos):
	    o 0.25-mile/10-acre riparian gallery from km 0 to 0.4
	    o 2.6-mile/60-acre riparian gallery from km 1.5 to 5.7
	    o 0.4-mile/10-acre riparian gallery from km 6.0 to 6.6
	➢ 2.9-mile long continuously saturated reach from km 1.7 to 6.4 [A]

Springs Present	➢ Government Springs [A]
	    o Discharges from concrete vault behind ranch house
	    o Discharges from a brecciated zone of the Apache Leap Tuff
	    o Measured flow from 0 to 3 gpm (2010-2014)
	    o Median = 0 gpm
	➢ MC-8.4C [A]
	➢ MC-3.4W (Wet Leg Spring) [A]
	    o Discharges from shallow colluvium overlying Apache Leap Tuff
	    o Measured flow from <1 to 135 gpm (2008-2014)
	    o Median = 2 gpm

<table>
<tr><td>Surface Water Monitoring</td><td>
UMC (Upper Mineral Creek, MC-6.8C)
Intermittent (2011-2014)
Baseflow estimates: [A]
<table>
<tr><th>Min. of Nov 7-day average daily streamflow (cfs)</th><th>Annual median daily streamflow (cfs)</th><th>Annual median daily baseflow from delta-filter method (cfs)</th><th>Winter median daily baseflow from delta-filter method (cfs)</th><th>Summer median daily baseflow from delta-filter method (cfs)</th></tr>
<tr><td>0.002-0.020 (3 yrs)
Dry (1 yr)</td><td>0.059-0.128 (3 yrs)</td><td>0.061</td><td>0.148</td><td>0.028</td></tr>
</table>

LMC (Lower Mineral Creek, MC-3.3C)
Perennial (2008-2014)
Baseflow estimates: [A]
<table>
<tr><th>Min. of Nov 7-day average daily streamflow (cfs)</th><th>Annual median daily streamflow (cfs)</th><th>Annual median daily baseflow from delta-filter method (cfs)</th><th>Winter median daily baseflow from delta-filter method (cfs)</th><th>Summer median daily baseflow from delta-filter method (cfs)</th></tr>
<tr><td>0.05-4.01 (5 yrs)</td><td>0.71-4.00 (2 yrs)</td><td>1.327</td><td>1.659</td><td>0.457</td></tr>
</table>

</td></tr>
<tr><td>Water Quality Monitoring</td><td>

Government Springs (2009-2015; 13 samples)
MC-8.4C (2008-2012; 17 samples)
UMC (Upper Mineral Creek, MC-6.8C) (2015; 1 sample)
MC-5.2C (2011-2015; 11 samples)
Wet Leg Spring (MC-3.4C) (2008-2015; 13 samples)
LMC (Lower Mineral Creek , MC-3.3C) (2008-2015; 13 samples)

</td></tr>
<tr><td>Riparian Vegetation Present</td><td>
Relatively dense riparian vegetation is present, with widths up to 240 ft, except in areas where the creek is constricted by steep canyon walls, where it can be as narrow as 30 ft. [D]

Dominant riparian species include:

Velvet ash
Goodding’s willow
Fremont’s cottonwood
Arizona sycamore

Also present:

Velvet mesquite

</td></tr>
</table>

	➢ Arizona walnut ➢ Baccharis ➢ Arizona alder

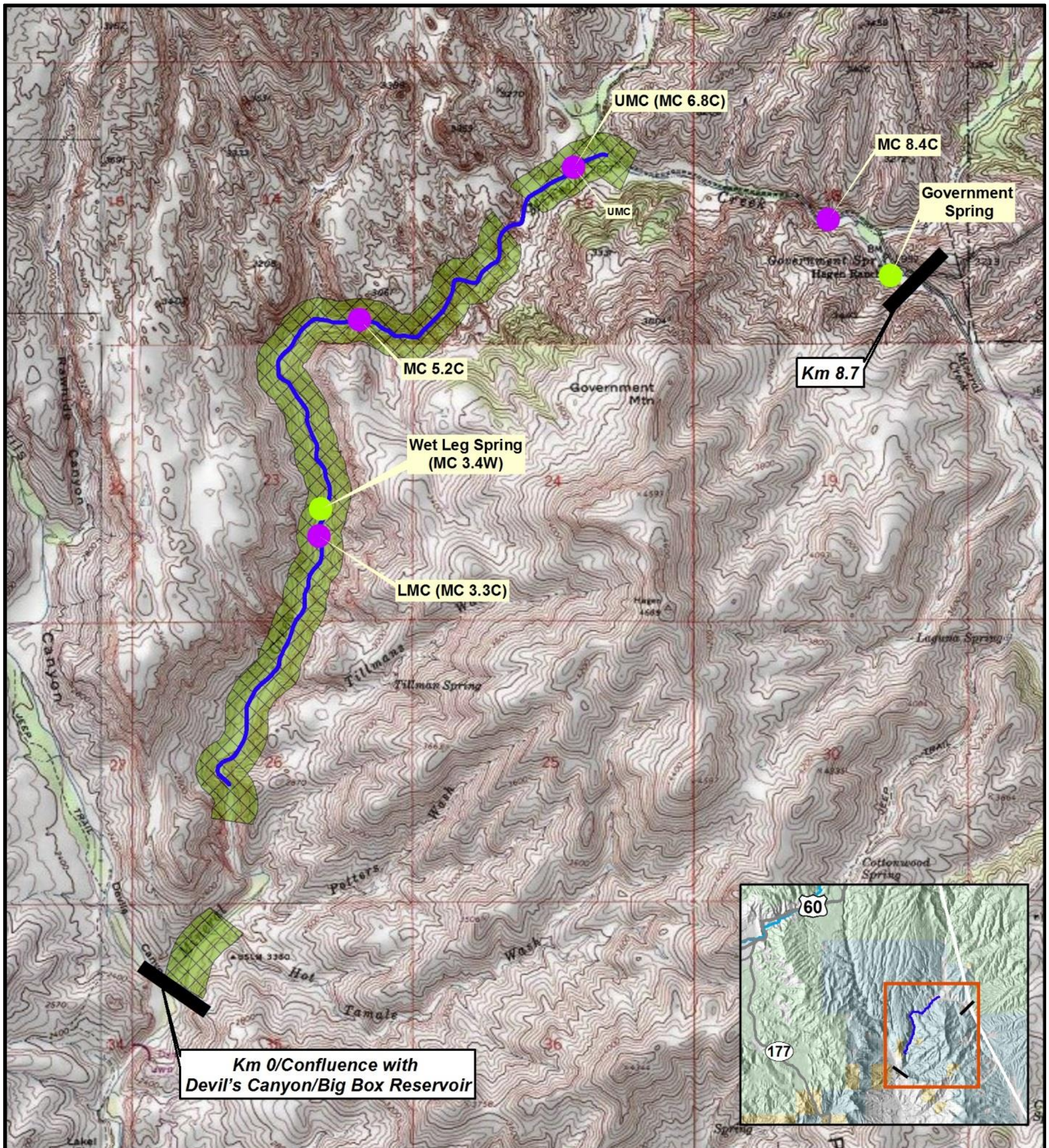
References

[A] Montgomery & Associates, 2017. Surface Water Baseline Addendum: Upper Queen Creek, Devils Canyon, and Mineral Creek Watersheds, January 26, 2017 (Project Record #0001272)

[B] Montgomery & Associates, 2016. Hydrochemistry Addendum, Groundwater and Surface Water, Upper Queen Creek/Devils Canyon Study Area, August 11, 2016 (Project Record #0001002)

[C] Montgomery & Associates, 2017. Spring and Seep Catalog, Resolution Copper Project Area, Upper Queen Creek and Devils Canyon Watersheds, October 3, 2017 (Project Record #0002102)

[D] Riparian gallery locations based on aerial photos and survey areas for western yellow-billed cuckoo (WestLand Resources, 2015. 2015 Yellow-Billed Cuckoo Survey, Whitlow Ranch Dam, Devils Canyon, and Mineral Creek, Pinal County, Arizona, November 23, 2015) (Project Record #0000098)



RESOLUTION COPPER PROJECT
AND LAND EXCHANGE
ENVIRONMENTAL IMPACT
STATEMENT:
Details of Mineral Creek GDE

Identified Springs
Surface Water Monitoring Locations
Continuously Flowing Reaches
Riparian Galleries

0 0.25 0.5 Miles
0 0.55 1.1 Kilometers
N

USDA

Date: 9/18/2018

ATTACHMENT 7

Well Construction Details and Confirmation of Designation of Groundwater Types

Well	Aquifer Designation by RCM	Total Depth of Well[1] (ft bls)	Open Intervals (ft bls)	Lithology Interpretation from Borehole[2] (ft bls)	Confirmation of Aquifer Designation
JI Ranch Corral	Shallow alluvial/perched	83	10 - 83	Alluvium: 0 - ? Apache Leap Tuff: ? - 83	Open interval through alluvium and upper Apache Leap Tuff; source of groundwater to well is alluvium[3]
JI Ranch Middle	Shallow alluvial/perched	53	1 - 53	Alluvium: 0 - ? Apache Leap Tuff: ? - 53	Open interval through alluvium and upper Apache Leap Tuff; source of groundwater to well is alluvium
Hackberry Windmill	Shallow alluvial/perched	46	All open	Alluvium: 0 - ? Apache Leap Tuff: ? - 46	Open interval through alluvium and upper Apache Leap Tuff; source of groundwater to well is alluvium
HRES-01	Apache Leap Tuff	1597.5	1055 - 1077 1360 - 1403 1577.5 - 1597.5	Apache Leap Tuff: 0 – 1676 Whitetail Conglomerate: 1676 – 1885	Open intervals all within Apache Leap Tuff

[1] Well construction details as summarized from Montgomery & Associates, 2016. Hydrochemistry Addendum, Groundwater and Surface Water, Upper Queen Creek/Devils Canyon Study Area. August 11, 2016. (Table 1) [Project Record #0001002]

[2] Lithology interpretations summarized from Montgomery & Associates, 2016. Hydrograph Set for Current Hydrogeologic Monitoring Network. July 11, 2016. [Project Record #0000926]

[3] Physical evidence that the source of water is the alluvium includes:

a) Water levels in nearby Apache Leap Tuff wells are substantially deeper than these three shallow wells. In the case of the two JI Ranch Wells, HRES-06 (an Apache Leap Tuff well) has a water level of 390 feet below ground surface, compared to about 20 feet in the JI Ranch Wells. In the case of the Hackberry Windmill well, HRES-05 and HRES-07 (two Apache Leap Tuff wells) have water levels of roughly 320-380 feet below ground surface, compared to 5 feet in the Hackberry well.

b) Water level hydrographs in these wells show occasional abrupt declines during the dry season, interpreted as the alluvium drying up until it can be replenished by infiltration of storm flows.

Well	Aquifer Designation by RCM	Total Depth of Well[1] (ft bls)	Open Intervals (ft bls)	Lithology Interpretation from Borehole[2] (ft bls)	Confirmation of Aquifer Designation
HRES-02	Apache Leap Tuff	1587	655.9 - 677.7 1026.1 - 1047.9 1265.7 - 1310	Apache Leap Tuff: 0 – 1496 Whitetail Conglomerate: 1496 – 1587	Open intervals all within Apache Leap Tuff
HRES-03d	Apache Leap Tuff	1500	1456.5 - 1500	Apache Leap Tuff: 0 – 2008 Whitetail Conglomerate: 2008 – 2116	Open intervals all within Apache Leap Tuff
HRES-04	Apache Leap Tuff	1440	584.4 - 624.4 724.4 - 764.4 1284.3 - 1304.3 1419.3 - 1440	Apache Leap Tuff: 0 – 1683 Whitetail Conglomerate: 1683 – 1747	Open intervals all within Apache Leap Tuff
HRES-05	Apache Leap Tuff	1055	385 - 425 585 - 605 1015 – 1035 [Plugged at 440 feet as of 2011]	Apache Leap Tuff: 0 – 1063 Whitetail Conglomerate: 1063 - 1147	Open intervals all within Apache Leap Tuff
HRES-06	Apache Leap Tuff	800	340 - 800	Apache Leap Tuff: 0 – 1129 Whitetail Conglomerate: 1129 - 1500	Open intervals all within Apache Leap Tuff
HRES-07	Apache Leap Tuff	1041	335 - 749 812 - 1019	Apache Leap Tuff: 0 – 1029 Whitetail Conglomerate: 1029 - 1068	Open intervals all within Apache Leap Tuff
HRES-08	Apache Leap Tuff	1022	194 - 297 793 – 1000 [Plugged at 320 feet as of 2011]	Apache Leap Tuff: 0 – 271 Whitetail Conglomerate: 271 – 1230 Naco Limestone: 1230 - 1455	Open intervals primarily within Apache Leap Tuff (77 feet), with some overlap into Whitetail Conglomerate (26 feet)
HRES-09	Apache Leap Tuff	1122	271 - 1078	Apache Leap Tuff: 0 – 1096 Whitetail Conglomerate: 1096 - 1125	Open intervals all within Apache Leap Tuff
HRES-10	Apache Leap Tuff	1119	158 - 398 698 – 1099 [Plugged at 460 feet as of 2011]	Gila Conglomerate: 0 - 65 Apache Leap Tuff: 65 - 1357 Whitetail Conglomerate: 1357 - 1546	Open intervals all within Apache Leap Tuff

Well	Aquifer Designation by RCM	Total Depth of Well[1] (ft bls)	Open Intervals (ft bls)	Lithology Interpretation from Borehole[2] (ft bls)	Confirmation of Aquifer Designation
HRES-11	Apache Leap Tuff	1078	598 - 1078	Apache Leap Tuff: 0 – 1075 Whitetail Conglomerate: 1075 – 1111	Open intervals primarily within Apache Leap Tuff (477 feet), with negligible overlap into Whitetail Conglomerate (3 feet)
HRES-12	Apache Leap Tuff	1988	1767 - 1967	Apache Leap Tuff: 0 – 2010 Tertiary Early Volcanics and Sediments: 2010-2140	Open intervals all within Apache Leap Tuff
HRES-13	Apache Leap Tuff	900	423 - 860	Apache Leap Tuff: 0 – 875 Whitetail Conglomerate: 875 - 915	Open intervals all within Apache Leap Tuff
HRES-14	Apache Leap Tuff	1460	962 - 1440	Apache Leap Tuff: 0 – 1480 Tertiary Early Volcanics: 1480 - 1643	Open intervals all within Apache Leap Tuff
HRES-15	Apache Leap Tuff	1977	679 - 1530 1750 - 1958	Apache Leap Tuff: 0 – 1759 Tertiary Early Volcanics and Sediments: 1759 – 1964 Whitetail Conglomerate: 1968 - 2018	Open intervals within Apache Leap Tuff (851 feet), as well as Tertiary units (208 feet), all still above Whitetail Conglomerate
HRES-17	Apache Leap Tuff	1345	726 - 1330	Apache Leap Tuff: 0 – 1405 Whitetail Conglomerate: 1405 - 1455	Open intervals all within Apache Leap Tuff
A-06	Apache Leap Tuff	1665	10 - 1665	Apache Leap Tuff: 0 – 1475 Whitetail Conglomerate: 1475 – 1665	Open intervals primarily within Apache Leap Tuff (1465 feet), with some overlap into Whitetail Conglomerate (190 feet)
CT	Apache Leap Tuff	100	Unknown	From nearby well HRES-10: Gila Conglomerate 0 – 65 Apache Leap Tuff: 65-100	Uncertain; likely open to both Gila Conglomerate and upper Apache Leap Tuff
MJ-11	Apache Leap Tuff	786	10.2 - 786	Alluvium: 0 - ? Apache Leap Tuff: ? - 786	Open intervals all within Apache Leap Tuff

Well	Aquifer Designation by RCM	Total Depth of Well[1] (ft bls)	Open Intervals (ft bls)	Lithology Interpretation from Borehole[2] (ft bls)	Confirmation of Aquifer Designation
DHRES-01	Deep	6018	4793 - 4978 5304 - 5489 5594 - 5618 5814 - 5938	Apache Leap Tuff: 0 – 1685 Whitetail Conglomerate: 1685 – 4537 Cretaceous Volcanoclastics: 4537 - 6018	Open intervals all within units below Whitetail Conglomerate
DHRES-02	Deep	6555	3506 - 3732 5904 - 6007 6430 - 6533	Apache Leap Tuff: 0 – 1616 Whitetail Conglomerate: 1616 – 3435 Cretaceous Volcanoclastics: 3435 – 6060 Younger Precambrian: 6060 – 6713	Open intervals all within units below Whitetail Conglomerate
DHRES-06	Deep	2690	1636 - 2649	Apache Leap Tuff: 0 – 269 Whitetail Conglomerate: 269 – 1220 Paleozoic Sedimentary: 1220 – 2570 Younger Precambrian: 2570 - 2891	Open intervals all within units below Whitetail Conglomerate
DHRES-09	Deep	2130	431 - 911 1611 - 1671 1971 - 2071	Younger Precambrian: 0 – 2071 Older Precambrian: 2071 - 2175	Open intervals all within units below Whitetail Conglomerate
DHRES-11	Deep	6700	4910 - 6679	Apache Leap Tuff: 0 – 2031 Tertiary Early Volcanics and Sediments: 2031 – 2480 Whitetail Conglomerate: 2480 – 3375 Paleozoic Sedimentary: 3375 – 5221 Younger Precambrian: 5221 - 6724	Open intervals all within units below Whitetail Conglomerate
DHRES-13	Deep	3550	1768 - 2296 2457 - 3530	Paleozoic Sedimentary: 0 – 262 Younger Precambrian: 262 – 2901 Older Precambrian: 2901 – 3265 Younger Precambrian: 3265 – 3464 Pinal Schist: 3464 – 3495	Open intervals all within units below Whitetail Conglomerate

Well	Aquifer Designation by RCM	Total Depth of Well[1] (ft bls)	Open Intervals (ft bls)	Lithology Interpretation from Borehole[2] (ft bls)	Confirmation of Aquifer Designation
				Younger Precambrian: 3495 - 3571	
DHRES-15	Deep	3633	2875 - 3633	Apache Leap Tuff: 0 – 1050 Whitetail Conglomerate: 1050 – 2330 Paleozoic Sedimentary: 2330 – 3610 Younger Precambrian: 3610 - 3920	Open intervals all within units below Whitetail Conglomerate