**Supplemental Report of Steve Nelson**
**Responses to DWQ Reply on Sunnyside Cogeneration Associates Draft Groundwater Discharge Permit, with Emphasis on Conclusions and Inferences Drawn from Previously Unavailable Data**

## Introduction

I have examined the content of the response of the DWQ to comments on the Draft SCA Groundwater Discharge Permit, which were forwarded to me on Dec. 6, 2013. Included in this report are: a) specific commentary on DWQ responses, and b) new insights which have come to light from documents obtained via GRAMA request (but unavailable to me for my previous report), as well as documents posted to the DWQ website[1]. As for items under b), they are directly relevant to DWQs' responses.

## Specific Reactions

*Overview & Comment 1.* According to DWQ, construction and groundwater permits were first issued in 1992. However, the earliest monitoring data available to me are from 1998 for MW-7. This represents a 6-year gap where no information on absolute values and trends can be assessed. DWQ states: *"However, since the original permit is over 20 years old, there are data records that are only available in paper files and others that have been archived and may no longer be available."* This is a disturbing admission by an agency that is charged with protecting the health and safety of the citizens of Utah, as well as its water resources. The importance of recordkeeping must have been understood in 1992. DWQ should scour whatever paper records still may exist, scan them, and make them available. DWQ should also not issue a permit based upon an incomplete record.

*Comment 2. "SCA landfills are completed as a dry facility. Also, as noted by Mr. Nelson, the Blue Gate Member of the Mancos Shale is highly impermeable. Any and all shallow groundwater is restricted to the alluvium immediately beneath the landfill and as such can be easily monitored via down gradient monitoring wells."*

There is evidence that however "dry" these landfills are intended to be, there appears to be contaminated water leaving the SCA#1 facility, as will be detailed below. I agree that groundwater is largely restricted to alluvium beneath the facility and existing streams. However, there are no monitoring wells that are down gradient of SCA#1. The most westerly, MW-7 is not even adjacent to the west end of existing piles. If there are additional monitoring wells further west along Icelander Creek, I am not aware of them. If there are, have they been monitored? If there are not, there should be a well located there and monitored and this should be a condition of the permit. Otherwise, the statement by DWQ is factually incorrect.

*Comment 4 and Elsewhere.* DWQ's response puts quotation marks around a reference to a "proposed location," as if I had used those words. I did not. DWQ should not attribute words to me and then use them to justify their response. My contention was, and still is,

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[1] In most instances, data were summarized by SCA in tables attached to their letter reports of monitoring results. However, in some instances SCA seems to have simply attached analytical sheets and some of these may have been omitted in my compilation owing to the lack of time available to compile and analyze data. I have also made a good faith effort to accurately transcribe monitoring data.

that the landfill is in an improper location. The fact that the landfill has been in use for 20 years does not support an argument that it should continue to be used. Previous engineering reviews may have concluded that the location is appropriate, but building it into the side of a cliff on or adjacent to an active wetland system makes the conclusions of engineering reports questionable, especially in the light of releases from the pile. No amount of engineering studies can alter this.

*Other DWQ Commentary.*
<u>Surface Hydrology—Stream capture.</u> DWQ ignores much my comment in its response, and that which it does not ignore is incomplete. For example, what happens if the railroad bed is removed, undercut through culverts, or simply fails?

I specifically addressed stream capture east of point A. There is no discussion of topographic barriers to Grass Trail Creek between point A and the mouth of the canyon east of town. SCA#2's 100 year storm water pond is not protective with respect to SCA#1 because it may not provide any protection of the existing landfill now, nor when it is built.

I certainly cannot change the regulations for storm water control for landfills, but I find it a little ironic that zoning and insurance decisions are made on the basis of 100 year events, and hazardous material *(sensu lato)* on 25 year floods.

<u>Underflow.</u> *DWQ states: Again, this statement hinges on the concept of stream capture that has been addressed above. Existing seepage that occurs naturally and seasonally under SCA # I is captured via a French drain that was installed prior to construction of Phase III. The system conveys seepage water out from under the landfill to reduce the potential for water build up to occur and thus reduces any potential contact of water with the ash.*

I agree that in the absence of stream capture, which was inadequately addressed by DWQ, only the existing seepage is of concern. Yet, as alluded to above, there is evidence of releases of material from SCA#1. This seems like a good point to evaluate the contention regarding seepage that *"occurs naturally."*

Figure 1 illustrates the rise in TDS (total dissolved solids) and other solutes as groundwater flows from a hypothetical recharge point to and past the pile. It contains a set of conservative assumptions, where "conservative" equates to conditions favorable to SCA.

First, I assume that groundwater recharges the aquifer by infiltration from surface flow at the mouth of the canyon just east of Sunnyside, flows beneath Grass Trail Creek and is partially diverted to Icelander Creek through Whitmore Springs. This clearly a major flowpath as indicated by phreatophytes in aerial photography and observed on the ground. Much of the water may enter the aquifer much further east within the Book Cliffs proper. However, assuming a recharge point closer to SCA#1 will generate a more rapid apparent rise in solute load before reaching the pile as compared to the rise as waters flow past the pile.

Second, I assume that the water, at the time and point of recharge, is reasonably dilute (300 mg/L) and contains solutes in the same proportion as they exist in Whitmore Springs. This is a reasonable assumption as the water is interacting with similar aquifer materials. However, this assumption has no real consequence to the conclusions of the analysis. It is merely a convenient starting point.

Whatever one assumes about the time, place, and composition of recharge of this system, it is very hard to believe that the precipitous rise in solute content of the waters in monitoring wells along the pile is natural (Fig. 1). In the dimension of less than 1000 m horizontal distance the TDS suddenly rise by nearly a factor of 5. In my opinion, this is strong evidence that the coal ash landfill is leaking pollutants into groundwater. The similar trends in sulfate, and chloride reinforce this view (Fig. 1). In the case of chloride, there is no sink for this ion (i.e., it is a conservative tracer) and it will travel at the same rate as the seepage velocity of water. There is little doubt that some source or process spatially associated with the pile is greatly affecting water quality in a negative sense.

SCA contends in their 1998 permit application (among other locations) that the rise in solutes is natural. In fact, they cite as evidence a 1997 GSA (Geological Society of America) abstract. Having participated in many such meetings, a GSA abstract is poor evidence at best[2]. Disturbingly, one of the co-authors, Mark Novak, is listed as being affiliated with DWQ, which brings into question the independence of the agency and whether there is a history of institutional bias in favor of SCA.

As for water quality/aquifer designation, DWQ says in the statement of basis: *"Based on available data, ground water at the SCA #1 Ash Landfill site is Class II. SCA #1 Phase II MW-7 is established under Class III, based upon TDS. Groundwater at the SCA #2 Ash Landfill is Class III based upon TDS and Selenium."* To restate, MW-7 is Class III and all of the other monitoring wells sample Class II waters near the existing landfill.

It appears that SCA is in **chronic** violation of the Class II designation at MW-1, and has exceeded this designation at MW-2. I have calculated a mean TDS of this well of 4500±2850 mg/L (1 s.d.), clearly in excess of the 500-3000 mg/L Class II range. The large standard deviation is instructive. It is due in part to several spikes in TDS and other parameters. In particular, six reported samples exceed a TDS 8000 mg/L, or nearly 3 times the Class II limit (Table 1). In all, 13 of 30 reported values are above the Class II threshold.

The July 23, 2013 draft permit (Table 3 therein) sets the protection level for MW-1 and MW-2 at 3018 mg/L. A summary from our current compilation of data (Table 1) indicates that the 13 exceedances of Class II aquifer in MW-1, and 2 in MW-2 represent

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[2] GSA abstracts are not peer reviewed in the traditional sense. The data and details of the analysis presented are not included. The reader has no sense of the quality of data and analysis. Such an abstract is essentially meaningless as technical support. For example, Geological Society of America *Abstracts with Programs*, Vol. 37, No. 7, p. 382 includes an abstract on ""L" SHAPED ROD, ENERGY WAVES, MAGNETISM, AND CHEMISTRY" also known as water dousing.

clear and **chronic** violations of the protection limit.

The situation in the monitoring wells is far worse than represented by the Statement of Basis, which concluded that MW-2 had exceeded TDS compliance once (it has exceeded it twice). MW-1 was not mentioned as being out of compliance at any time.

In my opinion, these exceedances are not the result of natural events. For example, what natural process in MW-1 would generate a rise from 2120 ppm in Dec. 2009 to 8770 ppm in June 2010 followed by a decline to 2490 ppm in Nov. 2010? It would be difficult to attribute evapotranspiration to these observations, as there is a spike to 9180 ppm in the winter of 2012 (Jan.). MW-2 also exhibits elevated concentrations (i.e., exceedances) during cold weather sampling events[3]. Cold weather produces low evapotranspiration rates because plant metabolism is reduced or inactive and water naturally evaporates much more slowly in cold weather. This contradicts DWQ's hypothesis that the rise in pollution is "natural."

Analysis of four TDS spikes in well MW-1 is illustrated in Figure 2. Using the first five analyses of MW-1 as a "baseline"(mean) composition, the individual groundwater parameters were divided by their respective baseline values. The high, normalized values for certain parameters indicate the addition of an $SO_4$-rich and perhaps Na- and Cl-rich fluid to this well. SCA's leachate analysis of Feb. 17, 2011 is consistent with very, very high sulfate concentrations. Evaporative concentration, on the other hand, would elevate all parameters equally, unless some process occurred to cause certain constituents to behave in a non-conservative fashion. The several spikes in TDS in MW-1 almost certainly represent transient leakage events of $SO_4$-rich fluids from the pile near this well[4].

The Statement of Basis attributes out of compliance conditions due to *"six years of drought,"* which was particularly responsible for the rise in sulfate concentrations. Whitmore Springs does in fact show rising solute loads over the period of record available to us. For example, TDS increases from about 1100 to 1400 mg/L over a 13-year period. Similarly, Cl and $SO_4$ also rise from about 28-44 and 400-600 mg/L respectively. The question then becomes whether or not releases can be detected in the face of climate change. It is clear that they are.

First, the increase in mean TDS, Cl, and $SO_4$ down gradient past SCA#1 is based on data collected over the same time interval (Fig. 1). Thus, as discussed above, invoking drought for this magnitude of rise over a 1000 m flow path is not credible as all wells would be affected by dry conditions in a systematic manner. However, additional clear evidence of releases is discussed below.

Conservative and relatively conservative tracers, like chloride and sulfate, should maintain constant ratios, rising only by concentration through evaporation and transpiration if drought were driving exceedances[5]. The water quality data themselves indicate this is not the case as indicated in Table 2.

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[3] Evapotranspiration is well understood to reach minimum values in cold weather months. See Fetter, CW, 2001, Applied Hydrogeology, Prentice Hall, Upper Saddle River NJ, 598 p.

[4] I have examined the neutralization potential of elevated pH leachate as high pH solutions are known to be reactive with silicate materials (this is why liquid drain cleaner is not sold in glass bottles). PHREEQCi calculations (Parkhurst DL, Appelo CAJ, 1999, User's guide to PHREEQC v. 2: a computer program for speciation, batch-reaction, one-dimensional transport, and inverse geochemical calculations. US Geol Surv Water Resour Invest Rep 99-4259, 310 pp.) for water at pH 12 set to equilibrium with Ca-montmorillonite and illite, the mineralogy of the Mancos Shale (see Nadeau & Reynolds, 1981, Clays and Clay Mineralogy, v. 29, p. 249-259), plus $CO_2$, reach equilibrium pH values of <6. Thus, field values of pH between 7 and 8 in monitoring wells are not surprising.

[5] Conservative solutes do not interact with aquifer materials or otherwise react or decay. See Fetter, CW, 2008, Contaminant Hydrogeology, Waveland Press, Long Grove IL, 500 p.

As expected, Whitmore Springs shows relatively little variability in the $SO_4$/Cl ratio as it is up gradient from and therefore unaffected by SCA#1 (Table 2). Evapotranspiration should elevate absolute abundances of Cl and $SO_4$ without affecting the ratio between them in the monitoring wells. Instead the $SO_4$/Cl ratio varies by more than a factor of 2, decreasing down gradient. This is indicative of the ever-increasing release of a $SO_4$-rich fluid from SCA#1. All of the monitoring wells have higher variability than Whitmore Springs, especially MW-7,[6] which is indicative of temporally variable seepage rates from the landfill.

I have examined the prospect for gypsum and anhydrite precipitation affecting $SO_4$/Cl ratios, thereby producing the high, observed variability in MW-7 and other wells. Using the mean composition for this well at average field temperature and pH values, both minerals are distinctly undersaturated[7]. In fact the mean values of all monitoring wells and Whitmore Springs are undersaturated in gypsum and anhydrite, whereas calcite, aragonite, and dolomite are all supersaturated. Thus, $SO_4$ should behave in a generally conservative manner.

In MW-7, chloride and sulfate do not maintain proportions that are approximately equal. The ratio increases with by a factor of nearly 7 with time. My compilation shows that the $SO_4$/Cl ratio exhibits this increase over a ~15 year time span with a high $R^2$ (square of the correlation coefficient) value of 0.52 (n=38 observations). Rather than indicating a natural solute increases due to drought, the data consistently indicate increasing releases of a sulfate-rich fluid from the pile. The upward trend in the $SO_4$/Cl ratios also strongly confirms speciation calculations indicating sulfate mineral precipitation is not confounding interpretations as gypsum and anhydrite precipitation would drive down $SO_4$ contents. Thus, it is very difficult for SCA and DWQ to explain the variability in $SO_4$ and Cl in terms of climate, and it is virtually certain that the variation in MW-7 cannot be due to the last 6 years of drought. Release from the landfill is strongly implicated as the cause.

As a final comment on major solutes, 26% of the reported analyses do not charge balance to within 5% error. Charge balance is a typical measure of the quality of the work product of reporting laboratories, and the high percentage of samples out of balance reflects poorly on the overall quality of monitoring data.

Selenium. It is also important to consider reported selenium (Se) values as this parameter is often out of compliance. For wells MW-1, -2, -3, and -4, the protection value is 0.0125 mg/L. As expected, Whitmore Springs never exceeds this value[8], even in the face of drought. In fact, Se concentrations are essentially unchanged in this well over the entire record. The slope of Se values as a function of time is near zero and there is essentially no correlation with time ($R^2$=0.02). By contrast, as seen in Table 3, up to 41% of reported Se concentrations in monitoring wells are out of compliance with the protection limit.

Violations of the protection limit are far too frequent to casually and causally attribute to releases from the Mancos Shale or climate variation. This is especially true in the context

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[6] The large variability for MW-2 is due to an anomalously low Cl concentration of 18 mg/L reported from the Dec. 14, 2004 sample. This value is almost certainly an analytical or reporting error. Admitting this, however, casts suspicions on data quality.
[7] I employed PHREEQCi for speciation and solubility calculations.
[8] The cover letter dated Feb. 8, 2003 in file DWQ_2003_001282.pdf states *"Also, natural background conditions could be contributing to slightly higher selenium concentrations. The upgradient water source, Whitmore Spring, has had selenium concentrations well above permit protection limits on several occasions in the past."* In my compilation I have never encountered Se in Whitmore Springs that exceeds the protection limit of 0.0125 mg/L. Either those data are not available to me or I have not seen them in the limited time available to me to compile and examine existing records.

of the major solute data discussed above. If this were the case, Whitmore Spring Se concentrations should be positively correlated with time (last 6 years of drought). With the exception of MW-4, the mean Se concentration of Whitmore Springs is a fraction of the remaining 4 monitoring wells (Table 3), yet this feature discharges from the same aquifer materials. To suggest that the systematically higher Se values down gradient are due to climate or water-rock interactions requires special pleading.

Monitoring Well MW-8. DWQ states in its response: *"MW-8 is an ideal location for monitoring SCA#2 and is in accordance with the rule requirements of R317-6-6(6.9)(A) "The distance to the compliance monitoring points must be must be as close as practicable to the point of discharge." MW-8 is located immediately down gradient of the proposed toe of SCA #2, the monitoring well is therefore adequate to determine compliance with permit requirements."*

Is DWQ aware that its response here conflicts with a host of engineering and regulatory documents regarding SCA facilities? Is DWQ certain of the location of MW-8? The following documents (for example) place MW-8 at the north end of the SCA#1 landfill and nowhere near the planned location of SCA#2:

- Water Quality Sampling and Analysis Plan & Ash Leachate Analysis Plan dated Feb. 2, 2009.
- Monitoring reports posted on the DWQ website:
    - DWQ_2000_001083.pdf
    - DWQ_2000_001084.pdf
    - DWQ_2001_001164.pdf
    - DWQ_2002_001181.pdf

There are likely more examples, but these suffice to make the point.

Length of Monitoring. DWQ states in its response. *"In the case of SCA, the ash landfill areas are dry. A 10 year monitoring period is adequate for these landfills. SCA #1 Phase 1 landfill has been monitored for 20 years now and has been closed for more than 10 years. Monitoring has shown that an effective landfill construction and closure program occurred. Documentation regarding this success has been submitted as required by the Permit and is available for public review in the files at DWQ."*

In light of the lengthy analysis provided above, this statement is clearly not true. In fact, it seems likely that lengthy monitoring and corrective action are needed.

Well Locations. Now that although DWQ has provided well locations ***after*** the closure of the comment period on the discharge permit, it has not provided the associated datum. Not knowing the datum (NAD83, NAD27, etc.) can result in tens of meters of uncertainty.

**Main Conclusions**
In summary, the following major conclusions are drawn from the available data.

- Monitoring data are inadequately archived. There is a 6-year gap between the start of available records and the first permit application, limiting the ability of interested parties to assess the performance of SCA's landfills.

- Some responses by DWQ are factually incorrect.
    - For example, there are no wells down gradient of landfill SCA#1.
    - Also, DWQ is also confused as to the location of MW-8. Multiple engineering drawings, including monitoring data reports, show MW-8 as near MW-3 at the east end of SCA#1. This does not even remotely agree with the position given in the response, nor in well locations posted on line.
- DWQ inadequately addresses the issue of stream capture.
- The rise in TDS, Cl, and $SO_4$ down gradient is associated spatially with SCA#1, indicating seepage from the landfill.
- Co-authorship of a published abstract by a DWQ employee concluding that elevated solute contents were natural suggest bias at the agency.
- Transient release events of $SO_4$-rich leachate is apparent at MW-1
- Mean water quality at MW-1 suggest that the aquifer at this location has become degraded to Class III, and that repeated violations of the protection limit have occurred but remain unacknowledged by DWQ.
- $SO_4$/Cl ratios further indicate seepage from SCA#1 to the adjacent aquifer and strongly suggest that recent dry climate cannot explain the variations.
- Analytical data, at least for major solutes, often appear to be of substandard quality.
- Se concentrations commonly exceed protection values at a number of monitoring wells. These exceedances cannot be explained by climate or releases from the underlying Mancos Shale. Mean Se concentrations suggest that wells MW-2 and MW-1, at a minimum, have been degraded to Class III conditions.
- The strong evidence of releases from SCA#1 that have not been recognized and addressed by DWQ is disturbing.

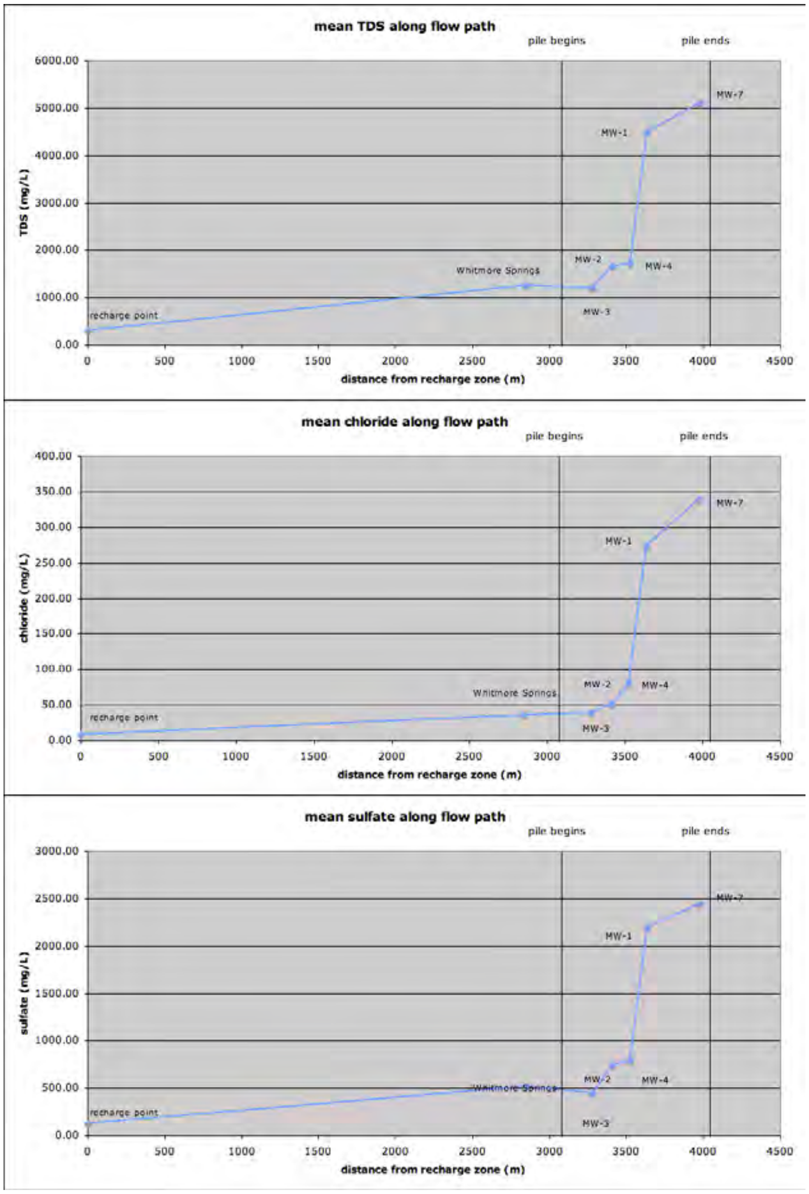


*Figure 1. Increase in TDS, Cl, and $SO_4$ along groundwater flow paths up gradient from and adjacent to the SCA#1 landfill. See text for discussion.*

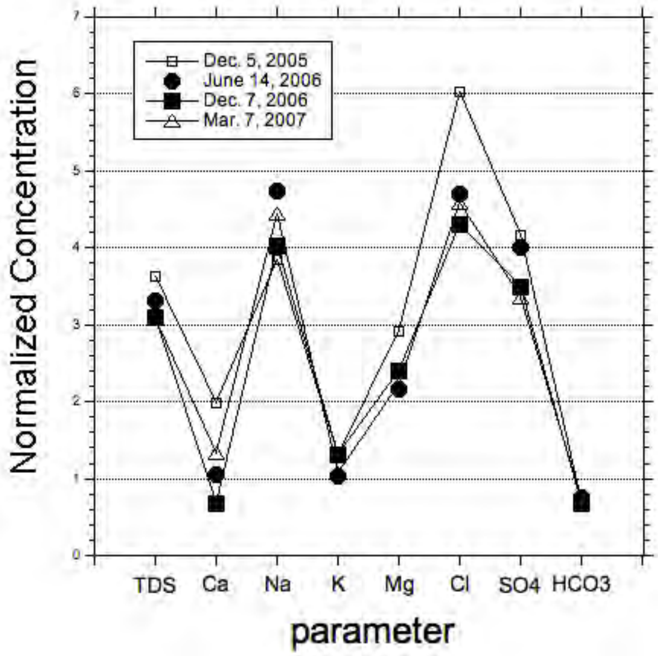


*Figure 2. Normalized concentrations of major solutes in well MW-1. See text for discussion.*

*Table 1. Exceedances of protection limits and Class II aquifer status at well MW-1*

| Well | Sample Date | TDS mg/L |
|---|---|---|
| MW-1 | 6/15/05 | 3930 |
| MW-1 | 12/5/05 | 9600 |
| MW-1 | 6/14/06 | 8730 |
| MW-1 | 12/7/06 | 8170 |
| MW-1 | 3/7/07 | 8116 |
| MW-1 | 6/19/07 | 3610 |
| MW-1 | 6/9/10 | 8770 |
| MW-1 | 7/8/10 | 8410 |
| MW-1 | 6/6/11 | 8590 |
| MW-1 | 6/21/11 | 8280 |
| MW-1 | 1/31/12 | 9180 |
| MW-1 | 5/31/12 | 5100 |
| MW-1 | 6/25/12 | 4430 |
| MW-2 | 12/4/04 | 3090 |
| MW-2 | 12/5/05 | 4890 |

*Table 2. Variation of chloride and sulfate ions in Whitmore Springs and monitoring wells.*

| Well or Spring | Mean $Cl/SO_4$ | Max. $Cl/SO_4$ | Min. $Cl/SO_4$ | Max./Min. |
|---|---|---|---|---|
| Whitmore Springs | 14.6 | 18.4 | 10.47 | 1.75 |
| MW-3 | 12.2 | 17.1 | 7.6 | 2.27 |
| MW-2 | 17.4 | 88.9 | 10.3 | 8.64 |
| MW-4 | 10.1 | 13.8 | 8.0 | 1.72 |
| MW-1 | 9.9 | 15.11 | 6.1 | 2.5 |
| MW-7 | 7.7 | 15.9 | 2.5 | 6.26 |

*Table 3. Summary of Se monitoring data near the SCA#1 landfill.*

| **Well/Spring** | **Mean Se concentration (mg/L)** | **# Se values above detection limit** | **#Se values above protection limit** | **% of values out of compliance** |
|---|---|---|---|---|
| Whitmore Springs | 0.0038±0.0022 | 22 | 0 | 0 |
| MW-3 | 0.0073±.0050 | 27 | 5 | 18 |
| MW-2 | 0.0152±0.0325 | 25 | 10 | 40 |
| MW-4 | 0.0034±0.0021 | 20 | 0 | 0 |
| MW-1 | 0.0297±0.0407 | 27 | 11 | 41 |
| MW-7 | 0.0112±0.0081 | 30 | 2 | 7 |