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From: Steven Gorelick, PhD, NAE

Subject: Review of Proposed Basin Plan Amendment for Groundwater Beneficial Uses at the Royal Mountain King Mine Site, Calaveras County ("Proposed Amendment")

This letter is in response to the requested review of the science-based elements of the "Proposed Amendment." The review is centered on the Regional Water Quality Control Board, Central Valley Region Draft Staff Report (October 2012) and consideration of the reference materials and the groundwater quality data spreadsheet provided by your office on November 19, 2012 (run on that date). Any opinions expressed here are solely my own and do not represent those of Stanford University. This review does not address the legality or regulatory authorities that are proposed as the basis for the Proposed Amendment. Attached are a summary table of TDS concentrations at actively monitored locations compiled from the monitoring data provided and a figure illustrating sub-regions discussed in this review. The sub-region boundaries are approximate and are for general location and discussion purposes only. They do not represent suggested or recommended delineations. The graphic uses Figure 4 from the Draft Staff Report (2012) as a convenient base map.

The Central Valley Water Board staff sought scientific peer review and comment on two specific topics:

1. Are the proposed boundaries for de-designating the MUN beneficial use of groundwater ("MUN de-designation") in the western part of the Royal Mountain King Mine (RMKM) Site ("Site") and for de-designating the AGR beneficial use ("AGR de-designation") in the southwestern part of the Site scientifically reasonable and defensible interpretations of the geological and hydrological conditions?

2. Is the proposed site-specific objective of 5,000 mg/L for TDS (total dissolved solids) that will continue to support livestock watering in the northwestern part of the RMKM Site reasonable?

In addition, the scope of the review allowed comment on a) whether there are any additional scientific issues related to the scientific basis of the proposed de-designation rules, and b) taken as a whole, whether the scientific part of the proposed rule is based upon sound scientific knowledge, methods, and practices.

This review addresses the above questions by focusing on groundwater TDS.

MUN de-designation

The first matter is MUN de-designation of the western part of the Site. State Water Resources Board Resolution No. 88-63 states that the MUN beneficial use exception can be granted if "The total dissolved solids (TDS) exceed 3,000 mg/L (5,000 uS/cm, electrical conductivity) and it is not reasonably expected by Regional Boards to supply a public water system...". The MUN de-designation area includes most of the Site and encompasses the Phyllite zone, the Fault zone, and a roughly north-south "buffer" swath of the Greenstone zone on the east side of the Littlejohns Fault. The basis for identifying this region is the purported high TDS groundwater in the Fault zone and Phyllite zone. To determine the scientific validity of the MUN de-designation boundary, the TDS concentration data must be inspected in each zone (CVRWQCB, 2003). Please refer to the attached summary table of groundwater monitoring TDS data extracted from the spreadsheet provided by CVRWQCB.

The initial area to consider is the Fault zone region of the MUN de-designation area. Based on the most recent sampling data, of the 21 actively monitored locations for which TDS values are reported and locations plotted on Figure 4 of the Draft Staff Report (2012), TDS concentrations exceeding 3,000 mg/L only occur in 3 currently monitored wells. Data are also available for three additional active monitoring locations not included on the Draft Staff Report map (GK-1, GK-2, and GK-3); these wells are clustered near the southern sub-region in the Fault zone, close to the 960-foot hydraulic head contour. Samples from GK-1 and GK-2 show TDS concentrations slightly in excess of 10,000 and 8,900 mg/L, respectively, while samples from GK-3 had concentrations ranging from 720 to 1,500 mg/L. The remaining 18 current monitoring locations identified in the Draft Staff Report (Figure 4) have a mean TDS concentration of 1,094 mg/L and a median TDS concentration of 590 mg/L (based on the most recent measurements reported in the spreadsheet provided). All 18 locations, which are spread throughout the Fault zone region, have TDS values that have remained below 3,000 mg/L since 2008, and all but one have never exceeded 3,000 mg/L since monitoring began. The exception is GWM-30 (listed as GWM-18/30 before 2006), which showed elevated TDS before early 1999 in 7 of over 85 sampling events; since early 1999, TDS has remained below 3,000 mg/L. The five locations where elevated TDS concentrations currently occur are FPZ-1B, GWM-12, GWM-21, GK-1, and GK-2. These locations are not randomly distributed. Rather they occur in two identifiable sub-regions shown as "A" and "D" on the attached Figure as discussed below.

First consider sub-region "A" on the attached Figure. In the northern part of the Fault zone, FPZ-1B, showing TDS of 6,490 mg/L, lies on the trace of the Littlejohns Fault on the southern side of the floatation tailings reservoir. High TDS likely occurs to the north as far as inactive monitoring location FPZ-2, also on the fault trace (at the northern part of the flotation tailings reservoir). This well showed TDS concentrations in excess of 10,000 mg/L in 2008-2009 but has been indicated as "dry" since then (and is therefore not included in the attached summary table showing groundwater TDS of active

monitoring sites). At FPZ-4, which is ~1,500 feet upgradient to the north of FPZ-2, TDS has averaged 611 mg/L since 2008, suggesting that the high TDS sub-region does not extend to this location. The existence of a preferential flow path along the fault is supported by TDS measurements to the south along the fault trace. Considering the measurement locations along the fault in this area, there is a declining trend of TDS concentrations with distance from the tailings reservoir going from FPZ-2 to FPZ-1B, GWM-30, GM36A/B, and PZ-4. TDS values at the latter three locations average about 2,450 mg/L. Because TDS values at GWM-30 and southward to the other two monitoring locations are all below 3,000 mg/L, the TDS sub-region for MUN de-designation is delimited to the south. The attached Figure shows sub-region "A," which includes FPZ-2 and FPZ-1, a narrow, high-TDS area along the fault. The fault appears to serve as a preferential flow path and perhaps provides a connection to the tailings reservoir that squarely overlies the fault.

Monitoring data suggest that the higher salinity area (sub-region "A") does not extend westward. First, there is no indication of elevated TDS at FPZ-3 (TDS < 500 mg/L), located about 1,500 feet to the west of FPZ-1, or farther west to GWM-16, at the western margin of the Fault zone (average TDS ~700 mg/L). Second, groundwater flow is toward the southeast in this area, transporting lower TDS groundwater toward the fault. No other areas in the northern part of the Fault zone region show TDS concentrations meeting the MUN de-designation criterion. Therefore, inclusion of the entire northern area of the Fault zone in the MUN de-designation is not scientifically justified based on the existing TDS data, the direction of groundwater flow, and consideration of the hydrogeologic system.

Next, consider MUN de-designation in the northwestern sub-region of the Site; this area, indicated by "B" on the attached Figure, includes the northern part of the Fault zone and coincides with the area proposed for a site-specific TDS objective of 5,000 mg/L to support livestock watering. This sub-region appears to include FPZ-1, already discussed, which shows high TDS on the Littlejohns Fault. FPZ-1B (but not FPZ-1A 17 feet deeper) is the only currently monitored well in this sub-region with TDS exceeding 3,000 mg/L; samples from the other eight wells in the sub-region (GWM-3, GWM-4, GWM-5, GWM-6, GWM-24, GWM-25, FPZ-3, FPZ-4) do not indicate that the MUN de-designation criterion is met (see attached data summary table). Measured TDS in these eight wells averages ~700 mg/L, with five wells showing TDS of 600 mg/L or less. Since 2008, TDS concentrations at all eight locations have not exceeded 1,600 mg/L. The average of the maximum TDS values is 991 mg/L. Data suggest that this northwestern sub-region of the Site (Fault zone) does not meet the TDS threshold of 3,000 mg/L necessary for MUN de-designation, with the exception of the vicinity of FPZ-1, which appears to indicate a local area of contamination along the Littlejohns Fault as discussed above.

No groundwater monitoring data for TDS are available for the central area directly to the south of the northwestern sub-region "B" (downgradient of FPZ-3 and upgradient of Skyrocket Pit) in the northern part of the area indicated by "C" on the attached Figure. However, this area, apart from a narrow region along the Littlejohns Fault, likely does not meet the 3,000 mg/L MUN de-designation criterion for the following reasons:

- The TDS measurements are below 3,000 mg/L at GWM-15 and GWM-16 (on the west boundary of the Fault zone), GWM-30 (on the east boundary of the Fault zone, as discussed above), FPZ-3 (about 1,500 feet west of FPZ-1), and at downgradient well GWM-37 (near the southern part of Skyrocket Pit). North Pit surface water in sub-region "C" is shown to have a TDS value of 1,700 mg/L (SES, 2012, Figure 2). North Pit is described as a groundwater sink (CVRWQCB, 2008, p. 24). Due to evaporative concentration of solutes it contains, the measured value might indicate an upper bound on groundwater TDS in the northwestern part of sub-region "C."

- The groundwater flow direction is to the southeast; groundwater entering this sub-region "C" from sub-region "B" has maximum TDS observed values ranging from 360 mg/L to 1,600 mg/L – below the 3,000 mg/L MUN de-designation criterion.

Should additional monitoring show TDS concentrations above 3,000 mg/L, this area ("C") or part of it could be reconsidered for MUN de-designation. Given current information about water quality and groundwater flow, there is an inadequate scientific basis for MUN de-designation of this sub-region of the Site.

In the southern part of the MUN de-designation area (shown as sub-region "D" on the attached Figure), neighboring monitoring wells GWM-12 and GWM-21 show TDS values substantially and consistently in excess of 3,000 mg/L. Elevated TDS values at GK-1 and GK-2, just south of GWM-12 and GWM-21, support the existence of a high-salinity zone in this southern sub-region of the Fault zone area. Sub-region "D" can be delineated with existing monitoring data. Monitoring well GWM-37 directly to the north of and near GWM-12 shows TDS of less than 650 mg/L, and wells GWM-34 and PZ-1 to the south in the Fault zone sub-region show TDS less than 500 mg/L (area "E" on the attached Figure). The significantly lower TDS values at these locations suggests that the very high TDS sub-region in the southern Fault zone area is likely contained between monitoring wells GWM-37 to the north and GWM-34 to the south. The highly saline groundwater in this southern sub-region would be expected to migrate to the southwest, where TDS values of ~9,000 mg/L occur at GWM-31 in the Phyllite zone. A southern high TDS sub-region in the Fault zone meeting the MUN de-designation criterion would be scientifically justified.

MUN de-designation in the Fault zone: Based on monitoring data and groundwater flow directions, most of the Fault zone area of the MUN de-designation region does not appear to have, nor has it ever had, measured TDS concentrations in excess of 3,000 mg/L. There is thus no sound scientific basis for including the entire Fault zone or most of it in the MUN de-designation region, as proposed in the Draft Staff Report (2012). The Draft Staff Report (2012) states,

> "*Under this alternative, the Board would de-designate the MUN beneficial use only within the western portion of the RMKM Site, where TDS levels have been detected at levels up to, and over, 10,000 mg/L."*

High TDS groundwater conditions are known to exist in just two areas of the Fault zone:

1) In the vicinity of FPZ-1B, along a (narrow) portion of the Littlejohns Fault, subregion "A" (see attached Figure): The contaminated area does not appear to extend as far south as MW-30, where TDS concentrations have not exceeded 3,000 mg/L (based on data since 2008) or as far west as FPZ-3, where concentrations have been less than 400 mg/L for ~4 years. The narrow zone likely extends north under the flotation tailings reservoir along the fault.

2) In the highly saline southern sub-region "D" downgradient of GWM-37 but north of sub-region "E" (see attached Figure).

MUN de-designation in the Phyllite zone: Of the seven monitoring wells in this region, four show elevated TDS concentrations in excess of 3,000 mg/L (area shown as "F" in the attached Figure). The average TDS concentration exceeds 9,000 mg/L. GWM-19 shows a TDS of 2,190 mg/L in the most recent sample, but samples from 2009, 2010, and 2011 have exceeded 3,000 mg/L. Although GWM-9 has not shown TDS exceeding 3,000 mg/L since 2008, values above this threshold were observed in 2000 and before. GMW-32 to the far west is anomalous in this zone, with TDS of ~400 mg/L, indicating local low-salinity conditions; it is possible that the low TDS could reflect interactions with nearby Clover Creek and/or better water quality associated with the local area of green chlorite schist (SES, 2006, Figure 2.1). Because there are no monitoring wells upgradient of GWM-19 (region "G" in attachment Figure 1) within the Phyllite zone, it remains uncertain whether the entire Phyllite zone meets the MUN de-designation criterion. However, based on the hydrogeochemistry of this geologic unit, it is possible that high TDS values exist over much of the Phyllite zone (CVRWQCB, 2003). With the exception of too few monitoring wells to define the measured upgradient extent of the region having TDS exceeding 3,000 mg/L in the Phyllite zone and the region to the southwest where TDS is low, there is a reasonable scientific basis for its inclusion (at least in part) in the MUN de-designation.

Extension of the MUN de-designation into the Greenstone zone: All of the monitoring locations in the Greenstone zone have TDS values below 3,000 mg/L; concentrations average 550 mg/L, with all samples less than 1,800 mg/L since 2008. All of the wells (FPZ-5, FPZ-6, GWM-2, GWM-11, GWM-26, GWM-33, and GWM-35) are in (or nearly in) the proposed Greenstone buffer zone, which is indicated by "H" in the attached Figure. Since monitoring began, none of these wells have shown concentrations above 3,000 mg/L with one exception: GWM-33 has an average TDS of 230 mg/L in 68 consistent measurements with the exception one value listed as 8,900 mg/L in 2001, which appears to be in error. Based on the TDS data, the Greenstone buffer zone does not meet the MUN de-designation criterion, and it is not evident from State Water Resources Board Resolution No. 88-63 that discretionary inclusion of a known low-TDS region is permitted.

If the prescription of the MUN de-designation region is extended to the east to create a buffer zone, then this part of the Greenstone region would, in principle, be permitted to become contaminated in excess of the unamended MUN Beneficial Use limits that exist in the remainder of the Greenstone region. Whether or not this is acceptable from a

regulatory standpoint, the buffer extension appears to be unnecessary because in this area the general direction of groundwater flow is west-southwestward. Thus, flow is generally from the proposed buffer zone toward the Fault zone region of the Site. Even in fractured rock regions, groundwater flows down the hydraulic gradient in the absence of other significant counter-gradients (e.g., temperature, concentration, etc.).

Section 1.2.4 of the Draft Staff Report (2012) recommends the Greenstone buffer zone to accommodate uncertainty and unknown features, but the rationale presented is not supported by existing water quality data. These data suggest stable TDS values (since 2008 and over a decade) much below 3,000 mg/L. Monitoring coverage is better in the proposed buffer zone than in much of rest of the Site. Had the structural geologic reasons cited in section 1.2.4 been cause for concern, monitoring data should have indicated degradation of Greenstone zone groundwater. To the contrary, GWM-2, with TDS of 860 mg/L in the buffer zone, appears to have been unaffected by high TDS groundwater (6,490 mg/L) at FPZ-1B, located nearby on the Littlejohns Fault and ~600 feet from GWM-2 (based on Figure 4 in the Draft Staff Report, 2012). Addition of the Greenstone zone buffer region as part of the MUN de-designation region lacks sufficient scientific justification based on the guiding regulation and given the actual TDS monitoring data (history). Note: If the buffer zone were MUN de-designated, additional monitoring wells might be considered to obtain compliance data in the remainder of the Greenstone area not subject to de-designation.

AGR de-designation

The second matter for consideration is de-designating the AGR beneficial use in the southwestern part of the Site. The criterion for AGR de-designation is that groundwater TDS would not support stock watering (essentially TDS in excess of 5,000 mg/L). This southwest region includes the Phyllite zone, Fault zone, and buffer zone in the Greenstone zone to the east of the Littlejohns Fault. The proposed reasons for defining the AGR de-designation region are the high TDS values in some wells and further justification that cites the hydrogeochemistry of the Phyllite and Fault zones.

The Phyllite zone contains high TDS groundwater, and AGR de-designation in the Phyllite zone has a reasonable scientific basis, with the caveat that TDS in the northern / northwestern part of it is unknown due primarily to the lack of monitoring wells, and there is an area of known low TDS.

In the Fault zone, as noted above, TDS concentrations do not exceed 3,000 mg/L over much of the zone, and MUN de-designation is not scientifically justified throughout. As such, AGR de-designation is also unjustified in the same region. AGR de-designation is justified in the high TDS sub-regions in the vicinity of FPZ-1B (area “A” on the attached Figure) and downgradient of GWM-37 (area “D” on the attached Figure).

Like the case for MUN de-designation, monitoring data indicate that in much of the Fault zone TDS does not render the groundwater for de-designation or unusable for most livestock watering. TDS concentrations are acceptable relative to stock-watering

requirements in upgradient monitoring wells in the Fault zone, and southeasterly migration of this groundwater is expected to feed groundwater of acceptable AGR stock-watering quality. It is noteworthy that even limited groundwater use from FPZ-1A (just 17 feet deeper than FPZ-1B) would meet stock water TDS requirements. Should additional monitoring wells show conclusively that TDS values in the unmonitored areas of the Fault zone proposed for AGR de-designation exceed stock watering limitations (e.g., over 5,000 mg/L TDS), the above inference should be reconsidered. In the absence of such additional information, the AGR de-designation region, as delineated, is not scientifically justified based on existing data.

Finally, there is insufficient scientific justification for inclusion of the buffer zone to the east of the Littlejohns Fault as part of the AGR de-designation. As noted above, TDS in the buffer zone is and has been of sufficient quality to maintain the unamended MUN designation, and therefore it would similarly maintain the unamended AGR beneficial use designation in the buffer zone. AGR de-designation would be a concern in the buffer zone, as the high AGR TDS limit would permit potentially severe TDS contamination of the otherwise valid unamended MUN beneficial use in the Greenstone zone.

Southern boundary

The Draft Staff Report (2012) does not address issues related to the southern site boundary (e.g., in the vicinity of the 940-foot hydraulic head contour shown on Figure 4, particularly near the center of the boundary). Groundwater flow along the southern boundary is toward the south/southwest/southeast. Although few TDS values may indeed exist beyond the southern Site boundary, it is evident that groundwater flow will not stop at the boundary under existing conditions. Elevated groundwater TDS concentrations on the Site would be expected to exit across this southern boundary. Furthermore, as a consequence of groundwater pumped in offsite localities, areas downgradient of the southern boundary and elsewhere along other Site boundaries can induce offsite groundwater flow and contamination. The proposed MUN and AGR de-designations of the southern boundary area, in the absence of groundwater hydraulic gradient control or other protective measures, implies that induced and/or expected natural offsite long-term migration of contaminated groundwater to the south either is acceptable or will not occur. The downgradient ramifications of Site de-designations that permit higher TDS deserves further consideration and scientific justification regarding boundary delineation, with discussion of the science-based effects of companion regulatory and remedial actions.

Site-specific objective for agricultural supply use

In the northwest sub-region of the site, the Proposed Amendment would establish a site-specific objective for agricultural supply beneficial uses of groundwater. As noted previously, existing groundwater TDS in this region is low enough to disqualify it from MUN de-designation, with the exception of sub-region “A” along the Littlejohns fault. Measured TDS in this region averages about 700 mg/L and has not exceeded 1,600 mg/L.

The Draft Staff Report (2012, section 3.2, p. 18) states,

"Groundwater within the northwestern portion of the RMKM Site has TDS levels that can locally exceed 3,000 mg/L and range up to 5,000 mg/L—a level that supports livestock watering for cattle, sheep, swine and horses."

This statement is not supported by the TDS data, which show values that are not in excess of 1,600 mg/L, with most values substantially lower (recently and historically). Most of the currently monitored wells in the region have never shown TDS values in excess of 3,000 mg/L. The exception is FPZ-1B indicating high TDS along a portion of the Littlejohns Fault as discussed previously. Apart from sub-region "A," assuming the rest of sub-region "B" has continued unamended MUN status, there is inadequate scientific justification to support establishing an AGR site-specific objective of 5,000 mg/L, as this could render the groundwater unusable for MUN beneficial purposes. It is noteworthy that the 5,000 mg/L objective value is more than three times the maximum observed TDS value in this sub-region (excepting FPZ-1B far to the east). Finally, it is unclear what the basis is for delineation of the site-specific AGR zone. Most of the downgradient region directly to the south-southeast has similar TDS values. The southern boundary of the proposed AGR zone excludes the adjacent area containing GWM-15 and GWM-16 (to the south), both of which show TDS values averaging less than 700 mg/L since 2008 even though these monitoring wells are next to the high TDS Phyllite zone.

Industrial Service Supply (IND) and Industrial Process Supply (PRO)

Under the Proposed Amendment, the Board would "adopt a variance that would require regulatory actions affecting the RMKM Site to protect the IND and PRO beneficial uses" for certain constituents in the western part of the Site. This approach "would maintain the current level of groundwater protection (in accordance with the Anti-Degradation Policy) at the RMKM Site, but would not require improvement over background concentrations." It is assumed that this proposed regulatory action (the permitted concentrations) would be consistent with the subject MUN or AGR de-designations (or designations). Since the background concentrations of the targeted constituents were historically variable over the Site, permitting a site-wide, uniform variance value for each of them is potentially problematic. In addition, it is possible that the variance could affect offsite groundwater and consequent surface water quality. The hydrogeologic issue is the potential impact of contaminated groundwater migrating offsite and then being used for a multitude of municipal, agricultural, or industrial purposes, as well as contaminating surface waters fed by groundwater. Whether or not this is a concern depends on the spatial and temporal averaging approach adopted to determine the variance concentrations permitted for each constituent, and whether they are applied site-wide or over specified zones.

Other issues

1) MUN and AGR de-designations of the site have the potential to affect the discharge of contaminated groundwater to surface waters. Scientifically, groundwater de-designations should not be viewed in isolation, given groundwater interactions with surface waters. Should the de-designations proceed, what are the impacts of these de-designations on

offsite groundwater discharge and subsequent discharge of groundwater to surface waters? What is the anticipated impact of highly saline groundwater migrating offsite and potentially contaminating local wells and surface waters in the future? As noted in SES (2006, p. 18), "Off-site and downgradient groundwater is used by residents in the Diamond XX subdivision for various purposes including drinking water and landscape irrigation, and surface water (Flowers Reservoir) may be used for recreation including swimming, canoeing, fishing, and to store water for downstream use in stock watering and pasture irrigation." It is important to note that since 2008, arsenic concentrations have greatly exceeded the California and US EPA drinking water arsenic standard (MCL) of 0.010 mg/L: concentrations have averaged 0.838 mg/L in GWM-12, 0.017 mg/L in GWM-37, 0.153 mg/L in GWM-38, and 0.22 mg/L in GK-1. Furthermore, two of the concentration values listed above indicate the presence of unsafe arsenic levels (>0.2 mg/L) for livestock watering (SES, 2012, p. 8).

2) It is suggested that the groundwater contour map(s) be constructed to reflect convergent flow along the Littlejohns Fault and other major faults. Groundwater contours around preferential flow paths, such as major faults, often show more angularity reflecting convergent flow toward the fault. Smoothing out contours near such preferential flow paths can give a distorted view of flow directions. Consideration of monitored TDS values can provide some guidance with respect to flow directions and consequently the placement of hydraulic head contours.

3) As a general comment, the Proposed Amendment contained numerous supporting references, but did not contain groundwater monitoring well concentration data, nor were maps presented showing all of the monitored wells or any posted TDS concentrations. The raw monitored well data were provided upon request and served as a substantial basis for this review. Any scientific evaluation of, or justification for, the Proposed Amendment must rely heavily on those data. Therefore, it is recommended that such data should be cited, discussed, and provided as part of the Staff Report.

Conclusions

- Central to the Proposed Amendment is the determination of the boundaries for proposed MUN and AGR de-designation areas and the AGR site-specific objective region. To be scientifically defensible, the establishment of these boundaries must be based primarily on water quality (i.e., TDS) historical data, sound interpretation of groundwater flow directions, and hydrogeologic as well as zonal hydrogeochemical characteristics. The following points refer to sub-regions "A" through "H" whose locations, but not precise boundaries, are shown on the attached Figure.

- The data provided do not support the notion that TDS levels over 3,000 mg/L are ubiquitous in the Fault zone. Therefore, the large delineated Fault zone area does not meet the MUN de-designation criterion and is not scientifically sound.

- Based solely on the TDS criterion of 3,000 mg/L, MUN de-designation is potentially supported in small, narrow sub-region "A" along the Littlejohns Fault in the

northeastern part of the Site and in southern sub-region "D."

- MUN de-designation is not scientifically justified in the remainder of the Fault zone area as none of the monitoring wells have shown TDS values (including recent, average, or maximum values) meeting the 3,000 mg/L criterion (see attached summary table).

- MUN de-designation is scientifically supported in Phyllite zone sub-region "F" based on monitored TDS values exceeding 3,000 mg/L with the caveat that the northwestern sub-region "G" of the zone has not been monitored, and one area is known to have low TDS. Hydrogeochemistry of the region suggests that much of the Phyllite zone has high TDS values.

- MUN de-designation in the Greenstone buffer zone is not supported scientifically for three reasons: a) This region has relatively low groundwater TDS; no measurements have indicated that TDS exceeds 3,000 mg/L and monitoring coverage is reasonable. b) It is not evident that discretionary inclusion of this region of relatively low (<3,000 mg/L) groundwater TDS is permitted under State Water Resources Board Resolution No. 88-63. c). There is no evidence that a buffer zone based on structural geologic uncertainty is appropriate when groundwater flow direction and TDS data near the Fault zone boundary suggest that the buffer zone is not necessary.

- The AGR de-designation criterion is not met over the area proposed. With the exception of sub-regions "A" and "D" in the Fault zone, and "F" and perhaps "G" in the Phyllite zone, TDS measurements do not indicate values are above 5,000 mg/L.

- Data do not support the northwestern sub-region "B" target for an AGR site-specific TDS objective of 5,000 mg/L. With the exception of sub-region "A" along the Littlejohns Fault, TDS concentrations average ~700 mg/L in sub-region "B" and maximum concentrations range from 360 to 1,600 mg/L. (MUN de-designation, which is more restrictive, also is not scientifically sound in this area.)

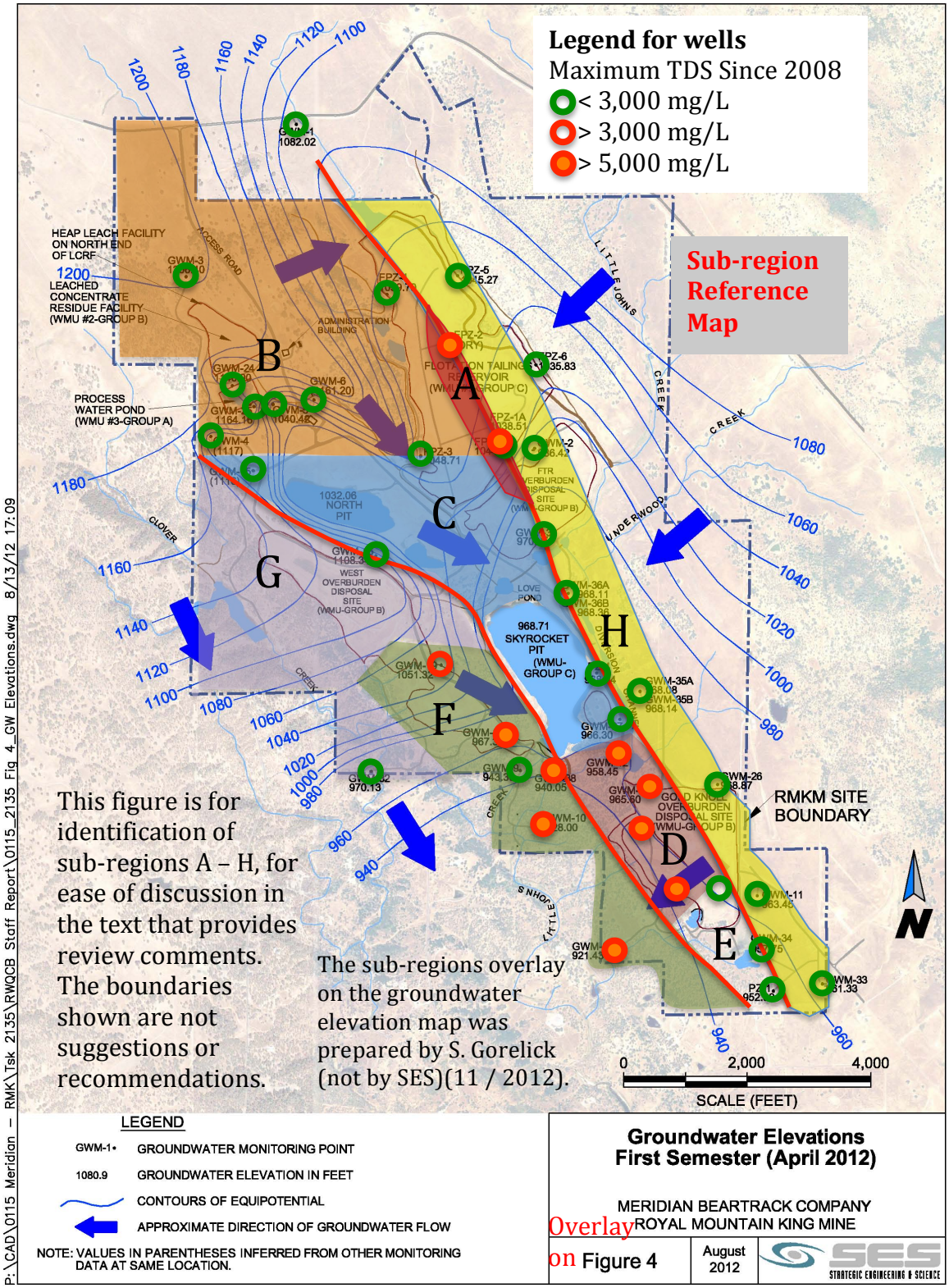
- The Proposed Amendment does not appear to consider the consequences of de-designation on downgradient, offsite groundwater and surface waters fed by contaminated groundwater, with attention to elevated arsenic concentrations as well as TDS.

- Finally, the Proposed Amendment regarding Industrial Service Supply (IND) and Industrial Process Supply (PRO) recommends a variance that would protect such beneficial uses but not require improvement of water quality over background for the targeted constituents. The hydrogeologic issue is the potential impact on offsite groundwater and groundwater-fed surface waters once those targeted constituents migrate across the Site boundaries. This potential concern depends on how the permitted variance values are determined given the spatial and temporal variability of the targeted constituent background concentrations, and whether the permitted values are applied site-wide or zonally.

Fault Zone TDS Concentrations				
Location	AVERAGE SINCE 2008	MOST RECENT	MAX SINCE 2008	Notes
GWM-3	284	240	360	NW sub-region
GWM-4	330	310	410	NW sub-region
GWM-5	830	1,100	1,100	NW sub-region
GWM-6	600	600	650	NW sub-region
GWM-24	1,065	1,090	1,210	NW sub-region
GWM-25	1,519	1,520	1,600	NW sub-region
FPZ-3	465	390	1,450	NW sub-region
FPZ-4	611	370	1,150	NW sub-region
GWM-15	576	580	740	
GWM-16	693	150	1,230	
GWM-37	641	570	700	
GWM-34	342	400	420	
PZ-1	488	480	540	
GWM-30	2,665	2,800	2,910	LJ Fault trace
GWM-36A	1,685	2,070	2,070	LJ Fault trace
GWM-36B	2,435	2,620	2,700	LJ Fault trace
PZ-4	1,711	2,350	2,350	LJ Fault trace
FPZ-1A	2,013	2,050	2,150	LJ Fault trace
FPZ-1B	4,860	6,490	6,690	LJ Fault trace
GWM-12	5,159	5,450	5,510	South sub-region
GWM-21	4,742	5,110	5,110	South sub-region
GZ-1	9,910	10,100	10,100	South sub-region
GZ-2	8,873	8,970	8,970	South sub-region
GZ-3	997	770	1,500	South sub-region

Phyllite Zone TDS Concentrations				
	AVERAGE SINCE 2008	MOST RECENT	MAX SINCE 2008	
GWM-9	2,242	2,350	2,390	
GWM-10	9,533	9,840	9,970	
GWM-19	2,862	2,190	4,230	
GWM-20	13,167	13,500	13,700	
GWM-31	8,755	8,870	9,520	
GWM-32	389	390	450	
GWM-38	27,614	26,800	31,100	

Buffer Zone TDS Concentrations				
	AVERAGE SINCE 2008	MOST RECENT	MAX SINCE 2008	
FPZ-5	269	270	290	
FPZ-6	395	460	470	
GWM-2	875	860	1,100	
GWM-35A	259	280	380	
GWM-26	340	330	370	
GWM-11	1,428	1,450	1,800	
GWM-33	289	200	1,050	


Legend for wells
Maximum TDS Since 2008
< 3,000 mg/L
> 3,000 mg/L
> 5,000 mg/L
Sub-region Reference Map
HEAP LEACH FACILITY ON NORTH END OF LCRF
LEACHED CONCENTRATE RESIDUE FACILITY (WMU #2-GROUP B)
PROCESS WATER POND (WMU #3-GROUP A)
ADMINISTRATION BUILDING
ACCESS ROAD
FLOTATION TAILINGS RESERVOIR (WMU-GROUP C)
FTR OVERBURDEN DISPOSAL SITE (WMU-GROUP B)
1032.06 NORTH PIT
WEST OVERBURDEN DISPOSAL SITE (WMU-GROUP B)
968.71 SKYROCKET PIT (WMU-GROUP C)
LOVE POND
GOLD KNOLL OVERBURDEN DISPOSAL SITE (WMU-GROUP B)
RMKM SITE BOUNDARY
LITTLE JOHNS CREEK
UNDERWOOD CREEK
CLOVER CREEK
A
B
C
D
E
F
G
H
This figure is for identification of sub-regions A – H, for ease of discussion in the text that provides review comments. The boundaries shown are not suggestions or recommendations.
The sub-regions overlay on the groundwater elevation map was prepared by S. Gorelick (not by SES)(11 / 2012).
0
2,000
4,000
SCALE (FEET)
N
LEGEND
GWM-1• GROUNDWATER MONITORING POINT
1080.9 GROUNDWATER ELEVATION IN FEET
CONTOURS OF EQUIPOTENTIAL
APPROXIMATE DIRECTION OF GROUNDWATER FLOW
NOTE: VALUES IN PARENTHESES INFERRED FROM OTHER MONITORING DATA AT SAME LOCATION.
Groundwater Elevations
First Semester (April 2012)
MERIDIAN BEARTRACK COMPANY
ROYAL MOUNTAIN KING MINE
Overlay on Figure 4
August 2012
SES STRATEGIC ENGINEERING & SCIENCE
P:\CAD\0115 Meridian – RMK\Tsk 2135\RWQCB Staff Report\0115_2135 Fig 4_GW Elevations.dwg 8/13/12 17:09