HOMESTAKE

Grants Reclamation Project

Alan D. Cox
Project Manager

May 7, 2010

Ms. Kathleen Yager
U.S. Environmental Protection Agency
Technology Innovation and Field Services Division
11 Technology Drive (ECA/OEME)
North Chelmsford, MA 01863

RE: **Grants Reclamation Project** – Cibola County, NM
Homestake Comments on "Focused Review of Specific Remediation Issues - An Addendum to the Remediation System Evaluation for the Homestake Mining Company (Grants) Superfund Site, New Mexico" – February 2010

Dear Ms. Yager,

Enclosed please find a copy of the above referenced comments from Homestake Mining Company of California (HMC) with respect to the draft Remediation System Evaluation (RSE) addendum report issued in February 2010 by USEPA and U.S. Army Corps of Engineers (ACOE).

We trust that our comments will be given full and careful consideration during the editing process involved with finalization of the report.

If you have any questions at this time regarding our comments and recommendations, please contact me at your convenience. I can be reached in our Grants, NM office at (505) 287-4456 ext. 25, or via cell phone at (505) 400-2794.

Sincerely yours,

Homestake Mining Company of California
Alan D. Cox
Project Manager

Cc: S. Appaji – USEPA, Region VI Dallas (electronic copy)
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Homestake Mining Company's Response to Recommendations Contained in the U.S. Army Corps of Engineers' Focused Review of Specific Remediation Issues:

An Addendum to the Remediation System Evaluation for the Homestake Mining Company (Grants) Superfund Site, New Mexico (Draft Report, February 2010)

May 7, 2010

Homestake Mining Company (HMC) has prepared the enclosed responses to the recommendations contained in the U.S. Army Corps of Engineers' (ACOE) evaluation of the remediation system at the Grants, New Mexico Superfund Site. Several recommendations are provided relative to the extraction and injection system, groundwater characterization, monitoring program, and water treatment. A summary of the recommendations is presented in the Executive Summary of the ACOE Draft Focused Review of Specific Remediation Issues, An Addendum to the Remediation System Evaluation (RSE) Report, and each recommendation is presented below followed by HMC's response to the recommendation. Our responses focus on the recommendations made by the ACOE and we have not attempted to address every issue. HMC has identified inconsistencies or incorrect statements in our review of the Draft RSE Report and each is discussed at the end of this document in Attachment A.

The Grants site is recognized as a complex site with multiple regulatory agency oversight. Prior reviews note that "[t]he Site is well maintained and remedial actions performed at the Site have reduced contaminant levels on-site as well as plume size reduction and containment."[1] Further, that "[t]he groundwater collection and injection system appears to contain the contaminated groundwater and has been effective in reducing groundwater contaminant concentrations within the impacted aquifers."[2]

As previously determined in the December 2008 Draft RSE Report, there is no indication that HMC's overall remediation strategy and the current regulatory agencies is deficient in protecting human health and the environment. This fact is further substantiated by the Agency for Toxic Substances and Disease Registry's Health Consultation report, which "categorized the groundwater in the private wells not connected to the Milan water supply as a no apparent public

[1] Second Five-Year Review Report for Homestake Mining Company Superfund Site, Cibola County, New Mexico, AVM Environmental Services, Inc. and U.S. Army Corps of Engineers, Albuquerque District, August 2006.

[2] *Id*.

health hazard."[3] Further, the December 2008 Draft RSE Report acknowledged the groundwater flow regime is understood and containment of the contaminant plume has been achieved through implementation of a hydraulic barrier downgradient of the Grants site tailings piles, and there is no contribution of contaminants from the tailings piles to offsite groundwater. The current Draft RSE Report also notes that "the current remediation systems have been making significant progress in improving groundwater quality at the site. . . ."

With this background in mind, HMC submits that the current evaluation fails in its mission to provide concrete recommendations to enhance the remediation system at the Grants site. HMC understood the purpose of this review was to suggest other approaches or technology initiatives that could be incorporated in conjunction with HMC's current remediation system to increase efficiency in achieving site closure goals at the site. The ACOE evaluation does not accomplish this purpose. HMC is actively and aggressively remediating the site with "significant progress." The ACOE evaluation offers little in the way of aggressive remediation, and in fact suggests less active approaches (*i.e.*, less flushing of the large tailings pile). The recommendations contained in the evaluation are often inconsistent and reflect a misunderstanding of the site's closure goals.

HMC's comments and suggestions to the ACOE evaluation outline some of the areas where HMC does find agreement with recommendations in the Draft RSE Report and in those cases it presents our plan for addressing those recommendations.

HMC has identified a number of areas where disagreement exists in the conclusions and recommendations; wherever possible, we have provided a rationale for our disagreement and have included salient information that supports our position or perspective on the particular issue. In a number of areas, HMC finds that a thorough technical understanding of the issue leads to a different conclusion or recommendation than what is outlined in the Draft RSE Report. As a paramount example, the recommendation that flushing of the large tailings pile should be "discontinued" or "curtailed", at a minimum, is reflective of a lack of understanding of the hydraulics and geotechnical and geochemical mechanisms that are in play within the tailings pile. As established by the geochemical modeling, the soluble portion of the uranium in the tailings pile has been or will be collected, while the insoluble portion of the uranium will remain immobile. As such, we strongly disagree with the conclusions and recommendations, particularly in light of the fact that the flushing program is advancing to the latter stages of that program activity (and is demonstrating success) as part of the overall remediation strategy at the Grants site.

Another example of significant disagreement, and there are others that are detailed in the following text of HMC's comments, is the suggestion that ion exchange is an effective

[3] Agency for Toxic Substances and Disease Registry, "Health Consultation, Homestake Mining Company Mill Site, Milan, Cibola County, New Mexico," June 26, 2009.

alternative to treat collected groundwater being applied in those areas where HMC is currently using land application/crop irrigation. HMC stresses that the need to move significant volumes of water is absolutely necessary to advance restoration efforts. The option suggested by ACOE has been evaluated, and the conclusion has been that a prohibitive degree of pre-treatment is necessary to deal with the inherent water chemistry that is evident in much of the groundwater in the area of the Grants site — irrespective of whether the groundwater has been impacted by the existence of the Grants tailings piles since the 1950s. Addressing this issue, and operation of the ion exchange system itself, carries with it the need to manage waste streams from the process. Recent experience has shown that management of remediation process waste streams in storage ponds (or expansion thereof) at the Grants site is problematic at best.

The ACOE evaluation is overreaching in reviewing areas that do not pose any risk at the site. The evaluation fails to consider the U.S Environmental Protection Agency's (EPA) prior findings that the operating HMC mill and tailings embankments "are not contributing significantly to off-site subdivision radon concentrations."[4] It is difficult to understand why ACOE is raising radon issues when the site is no longer operating, when these issues were found to pose no risk during operations and before partial cover of the tailings pile was put in place. Further, events such as the New Mexico Environment Department's approval of HMC's DP-725 discharge permit has addressed issues concerning the site's evaporation pond system emissions and are no longer at issue.

The ACOE evaluation also raises issues in areas in which HMC is operating beyond its license and permit requirements. Concerns over HMC's current level of monitoring are misplaced. Approximately 80 wells are required to be monitored under current license and permits, yet HMC voluntarily monitors a significant number of other wells to access performance of the remediation system and to continually characterize the extent of on-site and off-site impacts to groundwater. HMC's efforts are incorrectly characterized as redundant and not clearly tied to objectives. Like several areas of the ACOE evaluation, HMC fails to understand how such recommendations will enhance the remediation of the Grants site.

The Scope of Work (SOW) for the "second phase" of the RSE that was to govern the task elements of the report draft under current consideration was finalized in August 2009. This was after several months of effort and review by members of the RSE Advisory Group. HMC's observations have been that, while the SOW was followed in general terms, it was not in others. Several of these areas have been commented on in depth in the body of our comments and will not be repeated here. One of the significant objects of the evaluation was to "[e]valuate the adequacy of plume capture, horizontally and vertically, of the groundwater plumes in the alluvial and Chinle aquifers, using the recent EPA guidance. . . ." As part of that objective it was stated

[4] Record of Decision, Homestake Mining Company, Radon Operable Unit, Cibola County, New Mexico. EPA Region 6, Dallas, Texas, 1989.

that a conceptual model would be evaluated and refined and further that a "limited" assessment of the approach to groundwater modeling conducted by HMC would be performed. This objective was not accomplished. To the contrary, the entire report reflects a lack of understanding of the groundwater system, as well as the fate and transport modeling for the site. The hydrologic setting of the Grants site is admittedly complex; nevertheless, it has to be understood in order to draw any inferences or conclusions regarding opportunities, if any, to improve upon the current remedial systems that are in operation currently at the site.

Another stated objective in the SOW was to assess potential modification to the reverse osmosis (RO) units and related treatment components to achieve full capacity operations of the treatment plant. HMC does not see in the Draft RSE Report any suggested changes or additions in this area.

Another SOW objective was that there would be an attempt to "evaluate the projected evaporation rates for the new and existing ponds." The conclusions in this area are problematic. It is understood that a correction has been made in some of the calculations for that effort since issuance of the Draft RSE Report. Because the present conclusions are not based on the best possible numbers, we will reserve our comment until that work has been completed. It should also be noted that, after three years of permitting effort, the third evaporation pond for the project has been approved and permitted by the State of New Mexico since the issuance of the Draft RSE Report. This will allow for expanded operation of the present RO treatment system, irrespective of the debate over needed or necessary storative and evaporative capacity that the Grants site may need in the future while groundwater remediation efforts advance.

HMC believes the ACOE evaluation was inconsistent and speculative in numerous instances. The evaluation's recommendations are often contradictory to the report's findings. Many of the issues raised in the evaluation are based on unsubstantiated stakeholder concerns. HMC believes the evaluation should be a technical document, limited to factual issues. HMC requests that ACOE seriously review HMC's responses and comments and revise and/or remove many of the unsubstantiated and inconsistent recommendations from the final RSE report.

Recommendation No. 1 - The flushing of the tailings pile should be curtailed.

HMC Response:

The ACOE report recommends, in the Executive Summary, that flushing of the tailings pile should be <u>curtailed</u>; Section 9.2 recommends that the flushing of the tailings pile be <u>discontinued</u>. HMC disagrees with this recommendation, irrespective of the inconsistency of the two statements, and it should be removed from the final RSE report. The ACOE recommendation is based on the following points:

1) Flushing is unlikely to be fully successful at removing most of the original pore fluids.

2) Flushing is unlikely to remediate the source mass in the pile due to heterogeneity.

3) There is a potential for rebounding in contaminants concentrations following cessation of flushing.

4) The addition of water to the tailings complicates capture of water from the alluvial aquifer.

HMC has evaluated the success of the flushing program in removal of source mass. HMC's response to Recommendation No. 2 (presented later) discusses the mass removed, and Figure 5 of that response shows that the mass is being consistently removed through the flushing program. As noted by the ACOE, there is a large amount of heterogeneity in the hydraulic conductivities within the pile due to the presence of low-permeability zones, principally composed of tailings slimes. However, the flushing program works to overcome this heterogeneity and provide the driving force for the movement of soluble uranium out of these low-permeability zones. Figure 1 provides a conceptual illustration of the performance of the flushing program.

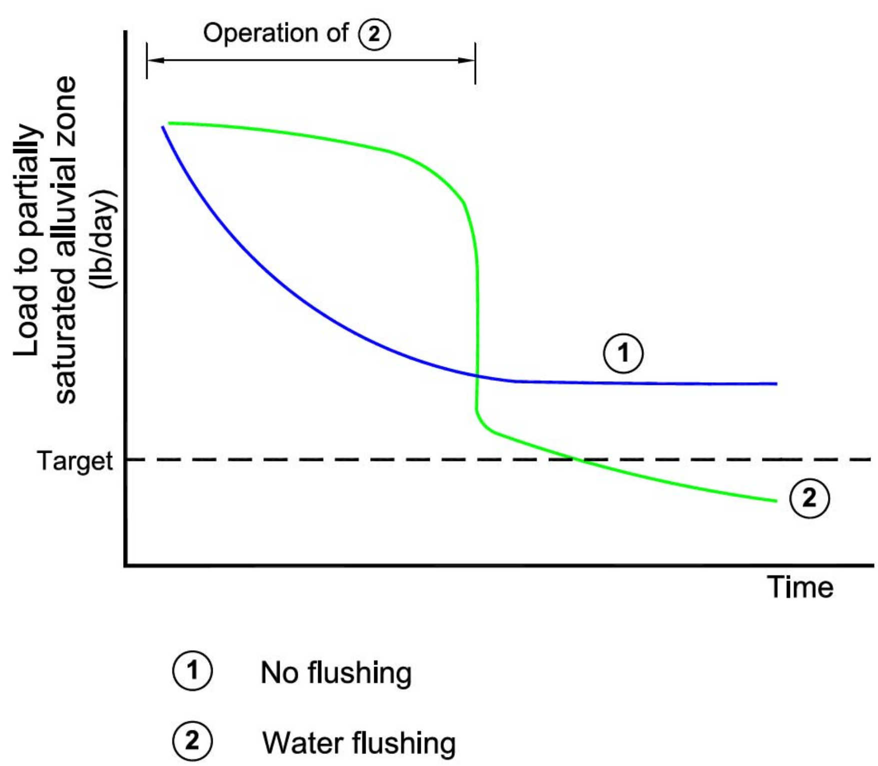

Figure 1. Conceptual performance of the large tailings pile with and without flushing.

Figure 1 depicts that, although uranium concentrations in the partially saturated alluvial zone beneath the tailings pile remain elevated for a period of time during flushing (line labeled “2” in Figure 1), the load to the partially saturated alluvial zone beneath the tailings is much more effectively controlled. Flushing provides a means to achieve concentrations well below the target corresponding to a concentration of 2 milligrams per liter (mg/L) underneath the tailings. Without flushing, uranium load drops off gradually, but concentrations remain high and, due to continual draindown of pore water with elevated concentrations of uranium, the target is never achieved (line labeled “1” in Figure 1). The Executive Summary of the ACOE report states as one of the conclusions that the seepage modeling likely overestimates the efficiency of flushing of the tailing; however, this is not the case. The model has been able to represent performance of the flushing program. There is currently a slight lag between actual and predicted performance because of the inability to flush at full capacity due to the lack of adequate evaporative capacity; however, this is not a function of model predictability and reliability. The flushing program can now proceed as planned in light of the recent approval of DP-725 and construction of Evaporation Pond 3 (EP-3).

With respect to rebound in contaminants following cessation of flushing, this is unlikely given the following factors:

1) Geochemical conditions in the tailings pore water, and the resultant chemical form of uranium, that serve to minimize the adsorption or precipitation of uranium in the tailings

2) The aggressive nature of the milling process, in terms of its efficiency at creating soluble uranium

3) The recalcitrant nature of any uranium that remains in the solid portion of the tailings

These factors are addressed here in detail.

1) The majority of the uranium in the tailings is present in the soluble form due to the presence of elevated pH and high alkalinity. This is a consequence of the milling process; the alkaline leach process was very efficient at keeping uranium in solution and is discussed below. In order to evaluate the chemical form of uranium in the tailings, HMC has performed geochemical modeling using the software Geochemist’s Workbench (Rockware, Golden, CO) and the Lawrence Livermore National Laboratory thermodynamic database (Delaney and Lundeen 1989) edited to include the most recent thermodynamic constants for uranium based upon the Nuclear Energy Agency (NEA) database (NEA 2010) and work by Bernhard et al. 2001 (for the soluble calcium uranium carbonate complexes). The values provided by NEA have undergone rigorous review and consideration (by examining the experimental methods and calculations used to derive them) and were formally accepted only after they withstood critical scientific review. The

tailings pore water chemistry for well EH-11, screened within the tailings impoundment, is provided in Table 1. The results of geochemical modeling to predict uranium chemical speciation, based on the tailings pore water chemistry, are provided in Figure 2.

Table 1. Tailings Pore Water Chemistry, Well EH-11 (pH 10).

Constituent	mg/L	g/mol	mM	log M
UO_2^{2+}	12.8	238	0.05	-4.27
Ca^{2+}	3	40	0.08	-4.127
Mg^{2+}	0.9	24	0.04	-4.43
Na^{+}	3730	23	162	-0.79
K^{+}	13.9	39	0.36	-3.45
Cl^{-}	379	35	10.8	-1.97
SO_4^{2-}	3410	96	35.5	-1.45
HCO_3^{-}	1460	61	23.9	-1.62
Se^{6+}	0.072	79	0.001	-6.04
Mo^{6+}	47.5	95.9	0.50	-3.30

Note: Nitrate and vanadium were not detected in pore water.

Geochemical modeling indicates that, at the pH of the pore water (pH 10), uranium is present as the soluble calcium uranium carbonate complex ($Ca_2UO_2(CO_3)_3$) in the tailings pore water. The soluble forms of uranium are dominant in the tailings pore water due to the excess of bicarbonate relative to uranium (Table 1), and similar concentration of calcium. Under these conditions, it is highly unlikely that any solid phase uranium can persist beyond the completion of flushing and remain available for re-dissolution. Studies have shown that uranium present as uranyl carbonate or calcium uranium carbonate is very poorly sorbed by solid mineral phases (Zheng et al. 2003), and this further supports the conceptual model based on soluble uranium resident in tailings pore water. Uranium solid phases are under-saturated (prone to dissolution), and are not expected to form at the uranium concentration and pH conditions in the pore water (solid phase forms of uranium are depicted in Figure 2 as yellow areas; soluble uranium is shown as blue areas).

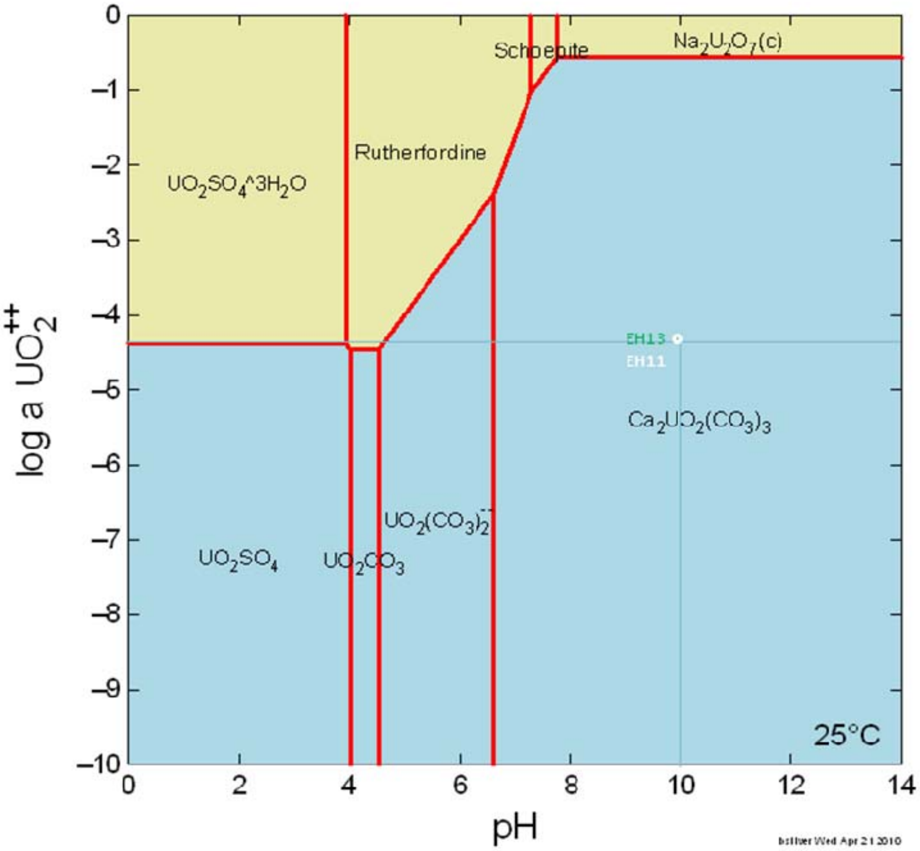

Figure 2. Results of geochemical modeling of uranium chemical speciation as a function of uranium concentration and pH. Note that the wells screened in the tailings, EH-11 and EH-13, are shown on the figure, with uranium present as the calcium uranium carbonate soluble complex in these wells. Note that the y-axis shows the log of the activity of uranium (uranium concentration).

2) A re-examination of the milling process also leads to the conclusion that very little uranium persists in solid form. The milling process was aggressive in terms of physical alteration of the ore and chemical leaching (Skiff and Turner 1981). The result of the milling process is that it dissolved the majority of uranium present in the ore that could be released under alkaline leach conditions. In addition, the uranium that remained in the solids was locked up in recalcitrant, non-leachable forms. Two basic types of ore were handled at the mill: Sandstone (80 to 85 percent of mill feed) and Limestone (15 to 20 percent of mill feed). The ore consisted of uranium minerals coffinite $[U(SiO_4)_{1-x}(OH)_{4x}]$, uraninite $[UO_2]$, tyuyamunite $[Ca(UO_2)_2(VO_4)_2 \cdot 5\text{-}8\ H_2O]$ and carnotite $[K_2(UO_2)_2(VO_4)_2 \cdot 3H_2O]$. The ore was found as an impregnation, a pore filling, or a

cementation between sand grains. The ore was crushed to an initial particle size of 2 millimeters (mm); the sandstone was ball milled so that 10 percent was greater than 0.3 mm and 35 percent was less than 0.07 mm. The limestone feed was milled twice so that 5 percent was greater than 0.2 mm and 50 percent was less than 0.07 mm. The thickened slurry was leached in two stages, with the first consisting of a pressure and temperature leach (at 60 pounds per square inch and 200° F) for 4.5 hours. The second stage consisted of an air-agitated atmospheric leach at 170° F for 12 hours for the sandstone and 24 hours for the limestone. The leached slurries were then processed through 3 filtrates stages and repulped with recycled tailings pond solution and slurried for tailings disposal. Tailings solution was recovered through decant towers and returned to the mill for soluble uranium removal (to less than 10 parts per million [ppm]).

3) The ACOE suggests that the large tailings pile contained an estimated 2.6 million pounds of uranium, present in the tailings at the end of the operation of the mill. This is based on information provided in EPA-402-R-8-005, Table 3-13; this table acknowledges that uranium present in tailings after alkaline leaching was present at a much lower concentration than from tailings after acidic leaching, and may be as low as 0.004 percent. Based upon the details provided in (1) and (2) above, the majority of the uranium deposited in the tailings pile was soluble and dissolved during the milling process but not recovered during filtration (i.e., dissolved in water that could not be recovered from the thickened slurry), and a portion present in recalcitrant mineral phases and as insoluble crystalline forms of uranium. The flushing process focuses on the soluble uranium; the insoluble forms will not be soluble in the tailings pore water under current or future geochemical conditions due to their highly insoluble nature. Any uranium present as secondary mineral precipitates (i.e., not part of the original minerals in the ore, but re-precipitated in the tailings) will also be insignificant relative to the dissolved uranium due to the conditions described in (1) above. A portion of the estimated 2.6 million pounds will, therefore, always be permanently fixed in the tailings, and flushing has removed an estimated 520,000 pounds of uranium (see Response No. 2 below) with the remaining soluble uranium, the only form of uranium of concern for groundwater, to be addressed through continuation of the flushing program.

With respect to ACOE's evaluation of an in-situ immobilization approach, continuation of the flushing program will provide the ability to transition to an approach to stabilize uranium leaching to the partially saturated zone through an augmentation program if determined appropriate. The augmentation program may be implemented at the appropriate time when it can be most effective, after flushing has been completed. Figure 3 illustrates the potential benefit of an augmentation approach.

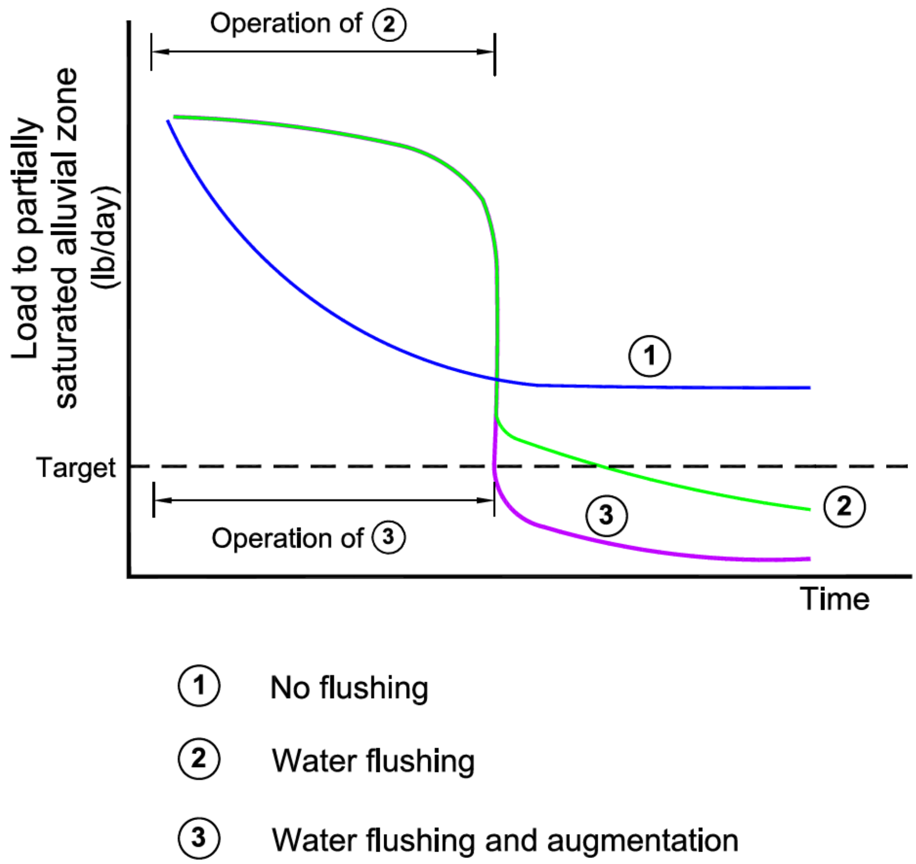

Figure 3. Conceptual remedial performance of the large tailings pile with and without flushing, and with flushing and an augmentation approach.

Because of the known occurrence and relatively low permeability of fine-grained materials (slimes) in the large tailings pile, and the presence of dissolved uranium in the slimes, an option is to create insoluble forms of uranium through the addition of a phosphate amendment. A preliminary geochemical modeling evaluation has been performed for the current uranium chemistry prevalent in the large tailings pile. The aqueous geochemistry data for wells EH-11 and EH-13 indicate that the prevalent forms of uranium in the tailings are soluble uranyl carbonates (Figure 2). A phosphate amendment (HPO_4^{3-}) was simulated and the minerals and aqueous species with a phosphate treatment solution were found to be stable over most of the pH range. This was simulated through a geochemical modeling evaluation of the addition of phosphate to the tailings (Figure 4). These initial conclusions suggest that the flushing of the tailings should be continued to remove the soluble uranium present in the slimes, then the remaining low levels of uranium could be fixed by introduction of a phosphate amendment to form insoluble uranium phosphate minerals, or another amendment that is proven to assist in remediation. The modeling results, therefore, validate that an in-situ immobilization approach using sodium tripolyphosphate (reviewed by the ACOE in Section 4.4.3) is feasible; this will be

further evaluated for application to the partially saturated alluvial zone underneath the tailings, and for groundwater where the geochemical conditions are also suitable for its application.

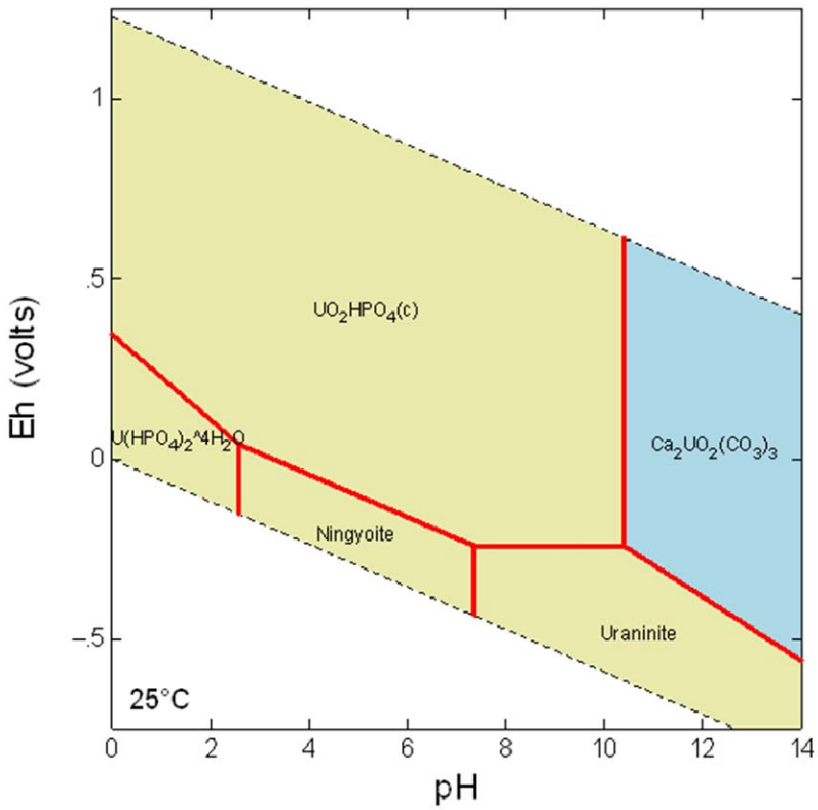

Figure 4. Evaluation of the addition of 1 mM (30 mg/L) of phosphate to the tailings pore water (water chemistry provided in Table 1). The result of the phosphate addition is precipitation of uranium as $UO_2HPO_{4(c)}$, an insoluble uranium phosphate mineral phase (yellow shaded region on the figure shows the stability field of solid forms of uranium; the blue shaded area shows the stability field of soluble uranium). Note that the y-axis shows Eh, or a measure of the oxidation-reduction potential (redox).

In summary, HMC does not believe that the recommendation that tailings flushing be curtailed, or discontinued, will lead to a better strategy for uranium source reduction in the large tailing pile. The current source reduction strategy is based on the understanding that the majority of uranium in the tailings resides as soluble uranium in the pore water, and must be hydraulically forced out of low permeability zones to effect capture and removal. The flushing program has shown significant progress (as detailed in our response to Recommendation No. 2, below) and should continue in order to meet remedial targets. It is highly unlikely that a significant amount of uranium will be present in a form capable of dissolution upon conclusion of the flushing program, due to the tailings pore water chemistry that favors soluble uranium, and that prevents sorption and retention by solids. In addition, an aggressive milling process mobilized the soluble

uranium in the ore, and any remaining insoluble uranium will not be mobile. HMC, therefore, strongly disagrees with the ACOE recommendation and believes that flushing is the most proactive source reduction option available and to achieve the remediation targets in a timely manner. We request that Recommendation No. 1 be removed from the final RSE report.

Recommendation No. 2 - Simplification of the extraction and injection system is necessary to better focus on capture of the flux from under the piles and to significantly reduce dilution as a component of the remedy.

HMC Response:

HMC believes that the current flushing and extraction system at the large tailings pile has been effective in removing a substantial amount of uranium and other constituents from the tailings that would otherwise be available to enter the alluvial aquifer. The ACOE's recommendation to simplify and better capture the flux under the pile has some merit and HMC plans to re-evaluate the existing system to possibly achieve more efficient mass removal of the constituents. The success of the existing system should not be underestimated, however. The hydraulic head created by the flushing forces uranium in otherwise immobile pore spaces to move out into the zones where it can be mobilized. Without flushing, this driving force would not exist. The following briefly discusses the effectiveness of the tailings pile flushing and extraction system over the last 16 to 18 years and evaluations that HMC may undertake to assess mass recovery.

The effectiveness of the combined flushing and extraction system can be measured by the mass of uranium removed from the tailings. A graph of the total mass of uranium removed by the toe drains along the perimeter of the tailings pile and extraction wells in the tailings since 1992 is provided as Figure 3. The toe drains began in 1992, whereas the extraction wells began operation in 1995. The cumulative mass of uranium removed from the tailings reached approximately 170,000 pounds by the end of 2009, and the removal rate has been relatively steady through time, indicating that the system continually removes a substantial amount of uranium in addition to other constituents such as sulfate, molybdenum, and selenium that also have similar and steady removal rates. This amount of uranium is no longer available to leach and migrate into the alluvial aquifer.

Added to the uranium removed by the tailings extraction wells and toe drains, a considerable amount of uranium has been flushed from the tailings and partially saturated alluvial zone beneath the tailings pile. This flushing through the partially saturated zone is vital to the success of mass removal; this mass flux beneath the pile is, or will be, ultimately removed by collection wells south and west of the pile. The amount of uranium is approximated by multiplying the average flushing rate through the partially saturated alluvial zone of approximately 150 gallons per minute (gpm) by the average uranium concentration in the tailings of 30 mg/L and summing

this over the 1992 through 2009 period. The resulting mass of uranium flushed from the alluvial zone is approximately 350,000 pounds. In total, approximately 520,000 pounds of uranium is estimated to have been removed from the tailings pile.

The effectiveness of the system is also measured in the overall reduction in uranium concentration within the tailings pile. The annual average uranium concentrations in the extraction wells and toe drains are shown on Figure 5. Uranium concentrations from the extraction wells have decreased from around 40 to 14 mg/L, or an approximate 65 percent reduction since 1995. The decrease in concentrations from extraction wells is steady. A regression trend line was fitted to the extraction well concentration data with a coefficient of determination (R^2) value of 0.85. The coefficient of determination provides a measure of how well future outcomes are likely to be predicted by the model, and in this case the linear regression line. A value near 1.0 indicates that the regression line perfectly fits the data, and the 0.85 value indicates a good fit. The uranium concentration in the toe drains has decreased from 53 to 30 mg/L, or an approximate 34 percent reduction since 1992. The uranium concentration has fluctuated through time but it has an overall decreasing trend, as depicted by the linear regression line that has an R^2 of 0.61. It is important to point out that the toe drains primarily remove tailings water from the permeable sand dikes, and this has not been the focus of flushing remediation to date. Instead, the focus has been on flushing the tailings slimes through the injection and extractions wells, which addresses the low-mobile mass that is difficult to remove. After the mass is removed from the slimes, the system can then focus on the mobile mass in the tailings sands and this is expected to occur relatively quickly. Overall, the system continues to remove uranium and other constituent mass, and concentrations are steadily decreasing.

The ACOE's recommendation states that "dilution" is a significant component of the current remedy. HMC believes that a minor degree of dilution may be occurring, but dilution is not as significant as implied by the ACOE. This is evidenced in the mass of uranium removed and concentrations presented on Figure 5. If dilution was a significant component of the remedy, the mass removed would not have a steady cumulative rate as it has had since 1992; instead, the mass removal would taper off or flatten. Therefore, the fact that mass continues to be removed at a relatively constant rate combined with concentrations that are decreasing is evidence that dilution is a minor component.

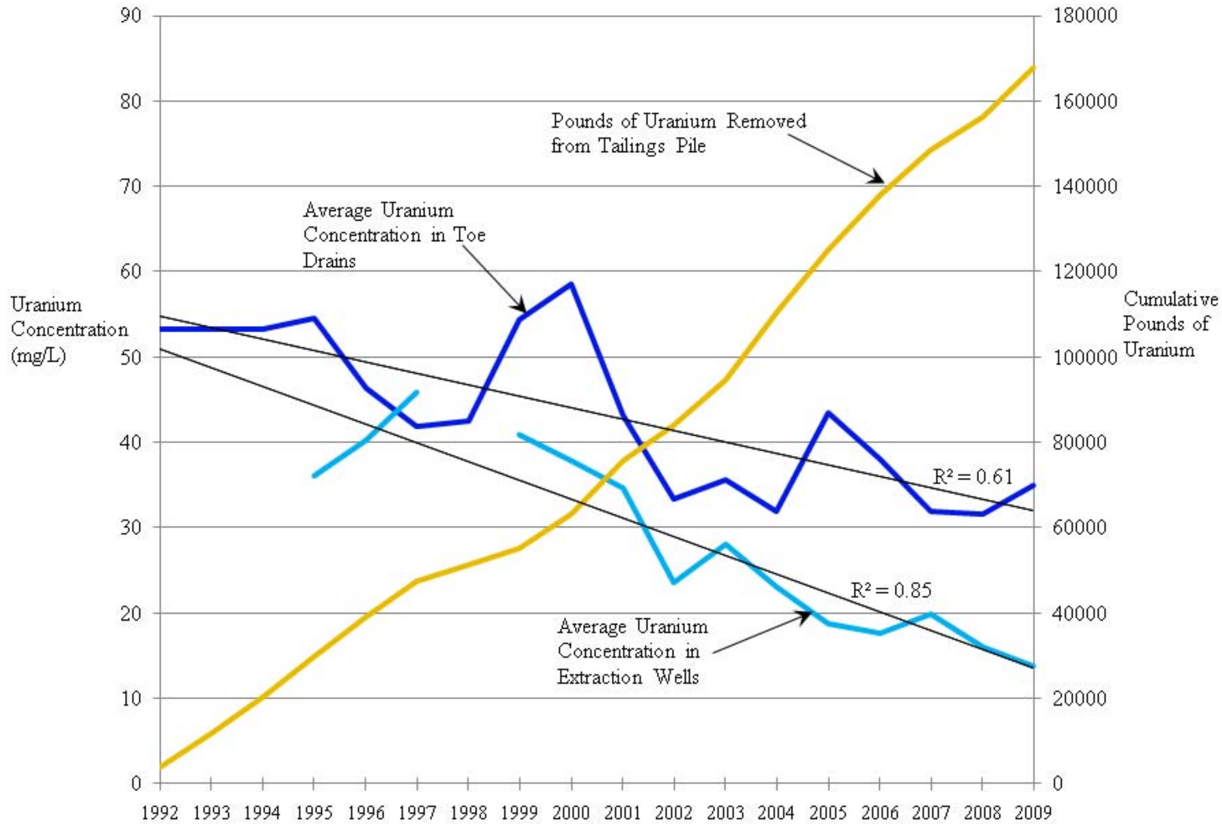

Figure 5. Mass of uranium removed by the large tailing pile extraction wells and toe drains and decreasing uranium concentrations.

To address the ACOE's recommendation regarding simplification of the system, HMC plans to evaluate the system and how it is managed and operated. The evaluation may include recommendations for future modifications to the system operation, should they be found to increase the effectiveness of the system to reduce constituent concentrations and capture of tailing seepage. The following describes evaluations that HMC may perform.

Water Balance - HMC plans to use available data to prepare annual water balances for the large tailings pile since the late 1990s. Data for the volume of rinse water, extracted water, and toe drain water will be used to approximate the amount of water that may flow out of the tailings pile into the alluvial aquifer. This type of a water balance evaluation has been done in the past, and it will be re-examined and expanded to create a historical perspective on the tailings pile water balance. The water balances provide information on how much water is flushed through the partially saturated alluvial zone beneath the tailings pile. It is important to realize, however, that a certain amount of water is needed to flush the partially saturated zone beneath the tailings pile

to flush mass from this zone into the alluvial aquifer, where it can be extracted by collection wells around the perimeter of the tailings pile. This can only be achieved by allowing some of the flushing water to flow through the partially saturated zone beneath the tailings pile.

Mass-Flux Evaluation - Building on the water balance evaluation above, HMC plans to perform a mass-flux evaluation of the large tailings pile. Flux-informed evaluations are useful in characterization and aid in remedial decision making. The first component of the evaluation is to estimate the mass of constituents stored in the fine-grained tailings (slimes) and in the coarse-grained tailings. This provides an understanding of the "mobile" mass that can be remediated using the current flushing and extraction system. The mass stored in the fine-grained tailings is less mobile, and the evaluation may find that flushing of the fine-grained tailings could be curtailed or eliminated because of its very low mass flux. The hydraulic flux (pumping) at each injection well and mass flux (concentration x pumping rate) at each extraction well will be estimated to provide information on where the highest flushing rates occur and the relationship to where the greatest mass removal occurs. The goal of the mass-flux evaluation is to optimize the mass removal rate. Results of the mass-flux evaluation may identify wells or certain areas of the tailings pile where flushing could be curtailed.

Recommendation No. 3 - Further evaluate capture of contaminants west of the northwestern corner of the large tailings pile.

HMC Response:

The saturated thickness of the alluvial aquifer northwest of the large tailings pile is limited, and the zero saturation line is less than approximately 1,000 feet northwest of the pile. Previous testing in this area indicated that well yields of greater than 1 gpm could not be sustained, which prohibits effective extraction. Therefore, several fresh water injection wells and injection lines were installed west of the pile to create a hydraulic barrier and limit the westerly migration from the large tailings pile. The injection also increases the saturated thickness of the alluvial aquifer in the area. The hydraulic barrier is illustrated on Figure 4.2-1 of the 2008 Annual Monitoring Report (HMC and Hydro-Engineering, LLC. 2009) where the water in the area of injection is approximately 10 feet higher than at the western toe of the tailings pile. The other remedial component in this area includes collection wells between the toe of the tailings pile and the injection wells/lines. The injection combined with collection near the toe of the tailings pile has been effective at remediating the alluvial aquifer west of the large tailings pile. Without the injection the collection wells alone would have limited effectiveness.

The ACOE's recommendation to further investigate capture of constituents west and northwest of the large tailings pile may have value. However, HMC must point out that this is a relatively

small portion of the site that has minimal potential exposure to residents or workers. HMC plans to assess the available injection/collection data, water levels, and chemical data in these areas and re-evaluate the effectiveness of capture system. The increased saturated thickness due to fresh water injection could have altered local groundwater flow directions resulting in some bypass of tailing seepage around the hydraulic barrier created by the injection. Because the zero saturation line for the alluvial aquifer is a relatively short distance northwest of the tailings pile, the focus of the re-evaluation should be the area west of the tailings pile. Adjustments to the existing injection/collection system may be considered to achieve more effective capture.

Recommendation No. 4 - If not previously assessed, consider investigating the potential for contaminant mass loading on the ground water in the vicinity of the former mill site.

HMC Response:

HMC is uncertain of the basis for this recommendation because demolition of the mill and cover of former mill area is well-documented. The former mill and associated structures were decommissioned between 1993 and 1995, which was approved by the U.S. Nuclear Regulatory Commission (NRC). Beginning in 1993, the major mill structures were demolished and the debris was buried on site in a total of eight pits. Five of the eight pits were in the mill area between the large tailings pile and State Road 605, and the remaining three pits were between the large tailings pile and evaporation ponds #1 and #2. Demolition debris primarily consisted of metal and wood from buildings, milling equipment including thickeners, roasters, and dryers, and concrete foundations. Pits were typically 20 feet deep and debris was placed into the pits in 5-foot lifts. After each lift was in place, a slurry grout was pumped into the pit to fill voids around the debris and solidify the debris. Once filled, a soil cover was place over the pits and surrounding areas and graded for positive drainage. The soil cover was approximately 2 feet thick over the mill area, but the cover was thicker (4 to 5 feet) over some of the pits. A diversion levee north of the mill area was also constructed to divert runoff from flowing over the mill area. A gamma survey was performed after the cover was in place to measure the effectiveness of the cover to restrict radionuclide emissions. As-built and completion documents are contained in Completion Report – Mill Decommissioning, Homestake Mining Company, Grants Uranium Mill, February 29, 1996. Quality control of earthwork and cover construction is documented in a Construction and Quality Control Report by Knight Piesold, May 17, 1996.

The slurry grout that was used to solidify the mill debris in the burial pits is believed to have effectively entombed the debris and prevented its contact with the surrounding environment. This solidification, combined with the engineered cover and storm water controls that limit percolation of water through the pits, significantly restricts potential leaching of uranium and radionuclides from the debris. The depth to water in the alluvial aquifer at the former mill is approximately 35 feet on average and deeper at approximately 50 feet between the large tailings

pile and the evaporation ponds, where pits #4 and #5 are located. Considering that the pits were typically 20 feet deep, the bottoms of the pits are 15 to 30 feet above the water table. Potential leaching of the solidified debris in the pits would have to first migrate through this unsaturated zone before reaching the water table. Given the low precipitation in the area and storm water run-on and run-off controls, it is highly unlikely that leaching of the stabilized debris is a source of contaminants to the alluvial aquifer.

A cluster of alluvial monitoring wells is located southeast of the former mill and south of several of the pits at the former mill site. Uranium concentrations in this area are variable over short distances. This is in an area where an *in situ* biological test is situated with associated water injection, which may be the source of some of the variability. The source of the elevated uranium is believed to be residual tailings seepage from the large tailings pile. However, injection south of this area has created a groundwater "high" and the groundwater flow direction in the alluvial aquifer is to the west. Collection wells in the area west of the mill also facilitate this westerly groundwater flow. Therefore, alluvial groundwater in the former mill area should flow toward the collection wells between the large tailings pile and evaporation pond #1. Burial pits #4 and #5, which are between the large tailings pile and the evaporation ponds, are also in this area of groundwater collection.

Evidence for this westerly flow direction is from concentration observations in alluvial well 1M, which is south of the mill between evaporation pond #1 and State Road 605. The 2008 uranium concentration in the well was 0.013 mg/L, and other constituents including molybdenum and selenium, were not detected. If there was a southerly flow direction from the mill and burial pit at the mill site, concentrations would be much higher in well 1M, but this has not been observed.

There are numerous monitoring wells in the former mill area and the injection and extraction system is controlling the migration of any site-related constituents. In the unlikely event that the stabilized mill debris in the pits produces leachate, the leachate would be collected in extraction wells west of the mill. For these reasons, HMC does not believe that additional investigations of the mill area are necessary and the ACOE's recommendation should be removed from the final RSE report.

Recommendation No. 5 - Further investigate the extent of contaminants, particularly uranium, in the Upper and Middle Chinle aquifers and resolve questions regarding dramatically different water levels among wells in the Middle Chinle.

HMC Response:

The ACOE's recommendation to further investigate uranium concentrations in the Upper and Chinle aquifer is inconsistent with its interpretations stated the Draft RSE Report. Section 3.5, Page 16 states: "*Performance for the extraction system in the Upper Chinle aquifer appears to*

be adequate." It is unclear why the ACOE recommends further investigation of the Upper Chinle aquifer when it interprets the performance of remediation in the Upper Chinle aquifer to be adequate. The performance is presumably based on an adequate level of monitoring in the area, yet there is a recommendation for further monitoring. HMC agrees that the collection and fresh water injection system in the Upper Chinle aquifer is performing well, as documented in the 2008 Annual Monitoring Report (HMC and Hydro-Engineering, LLC. 2009). As depicted on the water level elevation map on Figure 5.2-1 of the report, the collection wells in the Upper Chinle aquifer immediately south of the large tailings pile effectively create a hydraulic capture zone that collects groundwater with elevated uranium and other constituents. This collection system, combined with the fresh water injection further to the south between the collection wells and Broadview Acres, controls the off-site migration as shown on the uranium iso-concentration contour map, Figure 5.3-11 of the report.

A number of Upper Chinle aquifer wells are strategically positioned on site to monitor potential migration from the large tailings pile, evaporation pond #1 and #2, and the small tailings pile. Monitoring wells are also located downgradient and off site in Broadview Acres and Felice Acres. Areas that exceed the site uranium standard in the Upper Chinle aquifer are limited to the large tailings pile south to the collection pond and #2 evaporation pond, and localized areas in Broadview Acres and Felice Acres. However, an adequate number of wells surround each of these areas and, when combined with an understanding of the groundwater flow direction that is depicted on Figure 5.2-1 of the Annual Monitoring Report, the extent of uranium is defined.

As discussed below, ACOE's recommendation to resolve the difference in water levels among wells completed in the Middle Chinle aquifer is not warranted and further investigation of the extent of uranium is also not needed as discussed below.

First, the variable water levels in the Middle Chinle aquifer are adequately explained in Section 6.2 of the 2008 Annual Monitoring Report (HMC and Hydro-Engineering, LLC. 2009) and are summarized below. As illustrated on the water level map of the Middle Chinle aquifer in the report (Figure 6.2-1), steep gradients occur along the alluvial subcrop south of Felice Acres, which are due to recharge of water from the alluvial aquifer. Collection of water from CW-1 and CW-2 immediately north of the large tailings piles lowers water levels by 20 to 30 feet and creates a zone of hydraulic capture near the pile. Another area of large differences in water levels is north of Broadview Acres and southwest of Felice Acres where the injection of fresh water into wells CW14 and CW30 has created localized groundwater mounds in the areas of these wells that are approximately 50 to 70 feet higher than water levels that are farther away from the injection. The west and east faults that bound the site influence water levels by restricting flow, which results in lower water levels between the two faults. Groundwater does not readily flow across the faults. The 2008 Annual Monitoring Report contains water level hydrographs of

select wells (Figures 6.2-3 and 6.2-4), and the variable water levels shown on the graphs may be the source of the ACOE's comment on the alleged "dramatically" different water levels. However, the variable water levels in collection wells are explained by measurements taken during times of pumping and non-pumping when water levels have recovered. Some of the variation in water levels is also explained by variable pumping rates in some of the collection wells. There is a noticeable difference in water levels in wells west of the west fault that are 80 to 100 feet higher than water levels between the west and east faults. These differences are explained by the west fault restricting flow across the fault. A closer review by the ACOE of the site's hydrogeology and operation of the injection and collection system in the Middle Chinle aquifer would have found that the differences in water levels can be explained.

The second recommendation by the ACOE is to further investigate the extent of uranium in the Middle Chinle aquifer. As shown on Figure 6.3-11 of the 2008 Annual Monitoring Report, uranium concentrations greater than the site standard are limited to an area west of the west fault, in Broadview Acres and south of Felice Acres, and immediately north of the large tailings pile, although this area is minimally above the site standard. The area west of the west fault has wells surrounding the location of elevated uranium in CW-17, and the area is physically bounded on the west by the zero saturation restriction and the west fault. The elevated uranium concentrations at Broadview Acres and Felice Acres is bounded by wells to the east, fresh water injection on the west, and the subcrop extent of the Middle Chinle formation on the south. The localized area of elevated uranium immediately north of the large tailings pile is in an area of hydraulic control due to groundwater collection.

Overall, the large differences in water levels that are pointed out by the ACOE can be explained by the site's complex hydrogeology, geologic structure, and operation of the injection and extraction system. HMC believes that the existing monitoring of the Upper and Middle Chinle aquifers is adequate from a site-wide perspective and for areas where constituent concentrations are greater than site standards.

Recommendation No. 6 - Consider geophysical techniques, such as electrical resistivity tomography to assess leakage under the evaporation ponds.

HMC Response:

The ACOE states in Section 4.3 that there is no obvious evidence of leaks in the evaporation ponds, and evaluated this by comparing water levels in the ponds and in nearby wells. Except for the error noted in the top of casing elevation for some of the C series wells (this was a database error that has been corrected), the water levels did not indicate any leakage. While Evaporation Pond 1 (EP-1) does not have a leak detection system, Evaporation Pond 2 (EP-2) does possess a

leak detection system and is double-lined. However, there is an active collection system of wells that would collect any water that might seep away from EP-1 in the event of a leak.

Two-dimensional (2D) resistivity might be able to ascertain the integrity of the evaporation ponds by placing multiple 2D lines tangential to the margin of the evaporation ponds to allow imaging along these margins. Fluid migrating out of the ponds would have very high total dissolved solids and are, therefore, highly conductive. However, the geophysical survey would not be able to provide any information on leakage rates and would therefore not provide useful information. Given that the technique could not provide information on the magnitude of the leakage (e.g., flow rates), the results would not be actionable relative to altering the current strategy. Additionally, water flowing into, within, and around the ponds create self potentials (electric field induced naturally by the water) which would induce electrical noise into the geophysical measurement and significantly reduce the accuracy of the survey. Two-dimensional resistivity would not provide information on the area directly beneath the ponds due to the inability to run lines directly across them. Any vertical fluid loss would not be detected.

A better approach is to examine water levels in the pond and adjacent wells; this was evaluated by ACOE and, as discussed above, did not show any evidence of leakage. Currently, the flow at the margins of the evaporation ponds is to the wells to the northwest; therefore, any potential leakage would be collected and contained in the current collection well system south of the large tailings pile.

Recommendation No. 7 - Assure decommissioning of any potentially compromised wells screened in the San Andres Formation is completed as soon as possible.

HMC Response:

The ACOE's recommendation to decommission any San Andres Aquifer well that has a compromised screen is a good point to ensure the continued protection of the aquifer. There are 23 wells in the site vicinity that are completed in the San Andres Aquifer. About half of these wells are included in the site's monitoring program. 2008 concentration data from aquifer wells are similar to historical values; the consistent concentrations through time indicate that the aquifer is not impacted by constituents typically found in tailings seepage. This also suggests that, in the unlikely event that there is a compromised well screen, it has not resulted in cross-contamination into the deep aquifer. The ACOE apparently has this same interpretation, as mentioned in Section 3.6 Page 16 of their Draft RSE Report, which states: "*A review of water quality data and water levels for the relatively few wells screened in the San Andres Formation was conducted. Though few data were available, there was no evidence of contaminant impacts to these wells. Water levels were reasonably consistent and indicated a ground water flow direction in the San Andres toward the northeast*." The following outlines HMC's approach to evaluating potential compromised monitoring wells and supply wells.

HMC plans to review available borehole logs for San Andres Aquifer monitoring wells and identify those which have screens or gravel packs that extend up into the overlying Chinle Formation that could potentially allow from possible cross-contamination. Available water levels will also be reviewed to determine if a particular well's water level is consistent with other San Andres Aquifer wells. The aquifer is confined, and the potentiometric surface is lower than water levels in the overlying Chinle Formation and alluvial aquifer; therefore, a water level that is similar to water levels in the overlying aquifers could indicate that the well screen has hydraulically connected aquifers. HMC may also employ down-hole video to evaluate the integrity of suspect well screens. If a well is suspected of cross-contaminating the San Andres Aquifer, the well may be pumped to determine the extent of contamination. HMC has already done this at private well 986 east of Valle Verde and found that the low concentration of uranium decreased to values typical of the San Andres Aquifer (0.01 mg/L or less) after a short period of pumping. Therefore, the suspected leakage from the alluvial aquifer or Lower Chinle aquifer may be enough to slightly increase the uranium concentration in the well casing, but it is not affecting the San Andres Aquifer water quality. Monitoring wells that are proven to contaminate the San Andres Aquifer by compromised well screens will be properly abandoned in accordance with New Mexico regulations in New Mexico Administrative Code 19.27.4.31, Part K, Plugging Requirements for artesian wells. It is important to point out that some of the San Andres Aquifer wells are on private property. If found to have compromised well screens or if well screens hydraulically connect shallow and deep aquifers, abandonment of these private wells would be the responsibility of the owners, not HMC.

HMC operates two San Andres wells (#1 Deep and #2 Deep) that are used to supply the fresh-water injection systems within the collection area. Also, San Andres well 951 is used as the fresh-water injection supply for the injection system in Sections 28 and 29, and San Andres well 943 is used as the fresh-water injection supply for the injection system in Sections 3 and 35 and Felice Acres. HMC will not abandon these supply wells because they are vital to the injection system. The supply wells are heavily pumped and potential migration of constituents from shallow aquifer to the deeper is unlikely because of the pumping. Review of the water chemistry from these supply wells indicates that they are not impacted by site-related constituents such as uranium and sulfate. HMC will continue to evaluate the supply wells and, if found to have a compromised well screen that results in cross-contamination of the San Andres Aquifer, HMC may consider modifying the well screens or otherwise address the issue for that particular well.

The Draft RSE Report specifically identified well 0806 to be decommissioned because it was replaced by well 0806R. Well 0806 is located at the northern part of Murray Acres and has an opening in the casing near the water level in the Chinle shale interval. The alluvial and Lower Chinle aquifers in this area have very low uranium concentrations; thus, it is unlikely that the

opening in well 0806 is affecting the San Andres Aquifer water quality. The 2008 uranium concentration in 0806R, which is about 60 feet away, was low at 0.018 mg/L and typical of other San Andres Aquifer wells. HMC is in ongoing discussions with the Office of the State Engineer to abandon well 0806.

Recommendation No. 8 - Consider construction of a slurry wall or PRB around the site to control contaminant migration from the tailings piles. The decision for implementing such an alternative would depend on the economics of the situation.

HMC Response:

Under the alternative strategies evaluated by the ACOE, construction of a slurry wall around the entire tailings pile and a permeable reactive barrier (PRB) downgradient of about half of the tailings pile are two remedial technologies recommended for additional study as alternatives to the current extraction/injection strategy. HMC has evaluated slurry walls and PRBs as possible remedial options and found them to be difficult to construct and ineffective given the site conditions and they could result in incomplete isolation and capture of tailing seepage migration. The following elaborates on slurry walls and PRBs and their applicability as alternative remedial strategies.

Construction of a slurry wall would require trenching or excavation through the entire thickness of the alluvium, which is known to reach depths of approximately 120 feet based on the available borehole information and depth to the base of the alluvium. The actual depth of a potential slurry wall would be greater than this near the southwest corner of the large tailings pile because the Upper Chinle aquifer is in direct contact with the alluvium and the wall would have to extend to the base of the Upper Chinle, which would be another 20 feet, making the overall depth of the wall closer to 140 feet. Well CE7 is in this area and it is screened in the upper Chinle aquifer from 100 to140 feet. At another site, the U. S Department of Energy (DOE) has rejected similar trenching proposals in the immediate vicinity of the pile as a permanent remedial solution.

The success or failure of a slurry wall depends on continuous placement of the low-permeability slurry through the alluvium so that it is keyed into the underlying bedrock (Chinle shale) to cut off potential groundwater flow along the contact between alluvium and shale. This would require additional excavation into the shale of at least 5 feet, resulting in a maximum depth of at least 145 feet. It is important to note that Chinle shale may have thin layers of sandstone, and the depth could be even greater to reach low-permeability competent shale.

Although trenching technologies may be feasible at such depths, it is difficult to ensure continuity of a slurry wall. During construction, the trench would be inspected for width, depth, key penetration, verticality, continuity, stability, and bottom cleaning. The EPA guidance on

subsurface engineered barriers recognizes these important factors for successful slurry walls, stating that below about 100 feet the verticality and thus the continuity of grout barriers are difficult to control or confirm (EPA 1998). Another difficulty associated with slurry walls is excavating a key into the underlying bedrock. Depending on the hardness of the shale, blasting may be required. In addition to the fact that the depth of the slurry wall could reach 145 feet, the length of the slurry wall that would be required to isolate the tailings migration is estimated to be 13,000 feet or 2.5 miles. HMC knows of no slurry walls of this length and depth that have been constructed, much less successfully operated. Given that the continuity of a slurry wall is difficult to confirm at such great depths and the tremendous length of the wall, it is likely that complete continuity of the wall could not be achieved or maintained.

The ACOE cites two projects where slurry walls have been used: the 9th Avenue Dump in Gary, Indiana and Lipari Landfill in Glassboro, New Jersey. The 9th Avenue Dump is located in a marsh area with a shallow water table and the slurry wall was about 30 feet deep. The Lipari Landfill is in a similar setting and the slurry wall was also about 30 feet deep. These two sites are significantly different from the Grants site, where the depth of a slurry wall would be nearly five times greater. Therefore, these two sites are not appropriate references for the Grants site, where the slurry wall could be more than 145 feet deep in certain places.

A PRB would suffer the same difficulties and uncertainties as a slurry wall. The trench for the PRB would have to be excavated to depths of up to 145 feet and also keyed into the underlying Chinle shale. The PRB that ACOE evaluated was a funnel and gate barrier, where two slurry walls would be used to direct groundwater to an 800-foot long gate or PRB where the water would be treated *in situ*. Installing a PRB to depths of 145 feet would be technically challenging with a high potential for failure. Unlike a slurry wall, where the slurry is used to keep the excavation open, the continuity of the reactive material forming the PRB would likely be compromised by sloughing of excavation when the reactive material is put in place. Furthermore, PRBs are prone to clogging as constituents, in this case uranium and other dissolve inorganics, would precipitate within the PRB. This would lead to reduced permeability of the reactive barrier, as the ACOE correctly mentions (citing information from a PRB installed at the Denver Federal Center in Lakewood, Colorado) and over time, the PRB may have to be replaced. Replacement costs were not factored into the ACOE cost estimate of $19,000,000. The PRB at the Denver Federal Center has also experienced other problems of reduced permeability that occurred during trench excavation. The trenching equipment created a smear zone along the sides of the trench that reduced the permeability such that groundwater mounded behind the PRB. This smearing, in all likelihood, would also occur at the Grants site, and it would be difficult to monitor and prevent at a depth of 145 feet. As mentioned by the ACOE, a PRB would need future maintenance or replacement, which is contrary to DOE’s desire to have no long-term legacy remediation maintenance requirements. Such proposals are in direct opposition to DOE’s

preference for passive remediation systems at uranium mill tailings sites (see 40 CFR Part 190, Appendix A, Criterion 12).

The ACOE cites a PRB at the Fry Canyon site in Utah that was installed to remove uranium from groundwater. The PRB used three reactive materials: zero-valent iron, ferric iron, and phosphate, with the zero-valent iron having the highest uranium removal percentage. A funnel and gate method was used where the PRBs, or gates, were 3 feet thick, 7 feet wide, and about 4 feet deep. Although the PRBs had high uranium removal rates, the shallow depth of only 4 feet made the PRBs a very viable and constructible remedial option, whereas the depth of a PRB at the Grants site would be up to 145 feet, or potentially deeper. In fact, the Fry Canyon study cited by the ACOE (EPA and U.S. Geological Survey [USGS] 2000) states that PRBs have been installed at depths of no more than 45 feet. This acknowledgement by EPA and the USGS substantiates the difficulty and impracticability of installing deep PRBs.

The ACOE notes that there is a potential for migration of contaminants through the Upper Chinle aquifer that subcrops under the large tailings pile. This potential would still exist if a slurry wall or PRB is constructed and may require continued extraction and treatment of groundwater.

HMC has evaluated the economics and implementability of a slurry wall and PRB and found them to be impractical and cost-prohibitive remedial options given the difficulty of construction and likelihood of incomplete isolation or collection of the alluvial groundwater because of the excessive depth of excavations. As noted by the ACOE, there would still remain a potential for migration into the Upper Chinle Formation that would require continued extraction of groundwater. Therefore, HMC believes that the current extraction and injection remediation strategy is the most cost-effective alternative, and the difficulties associated with constructing an effective slurry wall or PRB limits these technologies from further consideration. The ACOE's recommendation for further evaluation of slurry walls and PRBs should be removed from the final RSE report.

Recommendation No. 9 - Relocation of the tailings should not be considered further given the risks to the community and workers and the greenhouse gas emissions that would be generated during such work.

HMC Response:

HMC agrees that relocation of the tailings should not be considered further. HMC also believes that it is important to re-emphasize that this "Alternative Strategy" would create a significant risk to human health. The ACOE's analysis reveals that at least three fatalities may be caused due to transport of tailings on public roadways; it is likely that the loss of life would be even greater due to the use of heavy trucks and limited maneuverability of these trucks under heavy load. While

the concern over carbon dioxide emission is also stated, and placed as a consideration of paramount importance in recommending against this alternative, it is clear that the very real potential for loss of multiple human lives should be first and foremost, and enough to discount this alternative.

Recommendation No. 10 - If geotechnical considerations allow, consider expansion of the evaporation pond on the small tailings pile as means to enhance evaporative capacity.

HMC Response:

The recommendations provided with respect to the expansion of evaporative capacity or reduction in discharge to the ponds are clearly based on an understanding by the ACOE that additional evaporative capacity is needed for optimal functioning of the remedial system. This has also been recognized by the State of New Mexico, with the recent approval of DP-725 for the construction of EP-3. In light of this, the recommendation to expand the evaporation pond on the small tailings is not appropriate. In addition, expansion would be difficult due to geotechnical considerations. The expanded pond would need to be tied into EP-1; this would pose a geotechnical challenge and would possibly compromise the liner system of EP-1.

Recommendation No. 11 - Consider either the pretreatment of high concentration wastes in the collection ponds as is currently being pilot tested, or adding RO capacity to increase treatment plant throughput and reduce discharge to the ponds.

HMC Response:

This recommendation is based on an evaluation by ACOE of the reverse osmosis (RO) treatment plant, and is provided as a means to enhance the operation of the remedial system so that the plant can operate at full capacity. As with Recommendation No. 10 above, the ACOE recognizes the need for enhanced evaporative capacity and pond storage. The RO treatment plant will be able to operate at its full potential, with the recent approval of DP-725, and additional RO capacity is therefore not needed in order to increase plant throughput. HMC continues to evaluate the pre-treatment of water in the collection pond through the addition of extracted tailings water, with elevated concentrations of bicarbonate, and groundwater containing elevated concentrations of calcium. The purpose of the pre-treatment is to facilitate the precipitation of calcium carbonate and to limit the need for this treatment at the RO plant.

Recommendation No. 12 - Develop a comprehensive, regular, and objectives-based monitoring program. Quantitative long-term monitoring optimization techniques are highly recommended.

HMC Response:

HMC agrees that the monitoring program for the Grants site should be comprehensive and based on specific objectives for particular areas of the site, as well as for the entire site. Currently, HMC performs substantially more monitoring than what is required under existing permits. Approximately 80 monitoring wells are required to be sampled, but as needed, HMC voluntarily samples several hundred additional wells to assess the performance of the injection/collection systems and extent of impacted groundwater. This demonstrates HMC's commitment to the remediation of the Grants site.

The ACOE's recommendation to optimize the monitoring program has potential benefit in the long term to determine if the monitoring well network can be streamlined while still meeting the future needs of the project. HMC plans to evaluate the site groundwater monitoring program, which includes identifying and categorizing wells and their intended purpose, followed by evaluating each monitoring well and determining its inclusion or exclusion in the monitoring program. HMC plans to perform this procedure for those monitoring wells that are required under state permits or federal license as detailed below.

Define Monitoring and Develop Objectives - The first step includes identify monitoring wells at the site and pertinent information associated with each well; including date drilled, depth, casing size, screened interval and formation, location, and any possible issues with the well. Additional information, such as period of chemical and water level data and frequency of sampling, will be summarized for each well. The original and current objective of each monitoring well will be identified or formulated if the purpose of the well is uncertain. The relative location of a particular well to a source area, such as the large tailings pile, will be used to assist in developing the monitoring objectives. The outcome of this first step is a comprehensive tabulation of monitoring well information and objectives of the monitoring.

Monitoring Optimization - The second step in the planned process consists of analyzing historical data using simple statistical methods and a rule-based decision process to determine if continued or additional sampling of the existing monitoring wells will provide data relevant to characterization of known impacts. The planned analysis compares historical data collected from monitoring wells to the most recent round of sampling. Recent and long-term data will be evaluated using a simple rule-based decision process to determine an adequate sampling frequency based on intrawell concentrations of the selected constituents. HMC plans to use simple and widely accepted statistical tests that have been applied successfully on numerous

contaminated groundwater sites. Several lines of evidence may be evaluated to determine if monitoring well sampling parameters and frequency are suitable. These include:

- Number of samples collected since the installation remediation started,
- Frequency of detection in recent sampling events,
- Maximum detected concentrations,
- Concentration-time profiles for the full and recent datasets,
- Magnitude of the annual concentration change with respect to important health protection, levels (i.e., site standard), and
- Predictability/variability of the concentrations over time.

Each well is then subjected to a decision process, and Figure 6 is an example of a commonly used systematic approach for evaluation and optimizing a monitoring program. Data sets are first evaluated to determine that sufficient samples have been collected. Historical and recent trends are evaluated to identify both long-term and short-term concentration trends, and the direction and magnitude of the trend can be evaluated using the relatively simple statistical tests. If no statistically significant trend is detected, the well and constituent is proposed for continued sampling at the current frequency. If a statistically significant trend is identified, the magnitude of change is evaluated with respect to the site standard. In this way, rapidly changing concentrations can indicate an important change in conditions of the plume. Wells with rapidly changing concentrations would be proposed for continued monitoring at the current frequency. Wells with negligible annual change, including those above the site standard, do not benefit from more frequent sampling and are, therefore, proposed for a lower frequency. Moreover, wells with recent trends that are similar to the overall long-term trends can be reduced to annual sampling. Because concentrations are predictable and more frequent sampling does not yield additional information. Final recommendations are subjected to scientific and engineering review to ensure that the proposed sampling program would continue to meet program needs and related permit requirements.

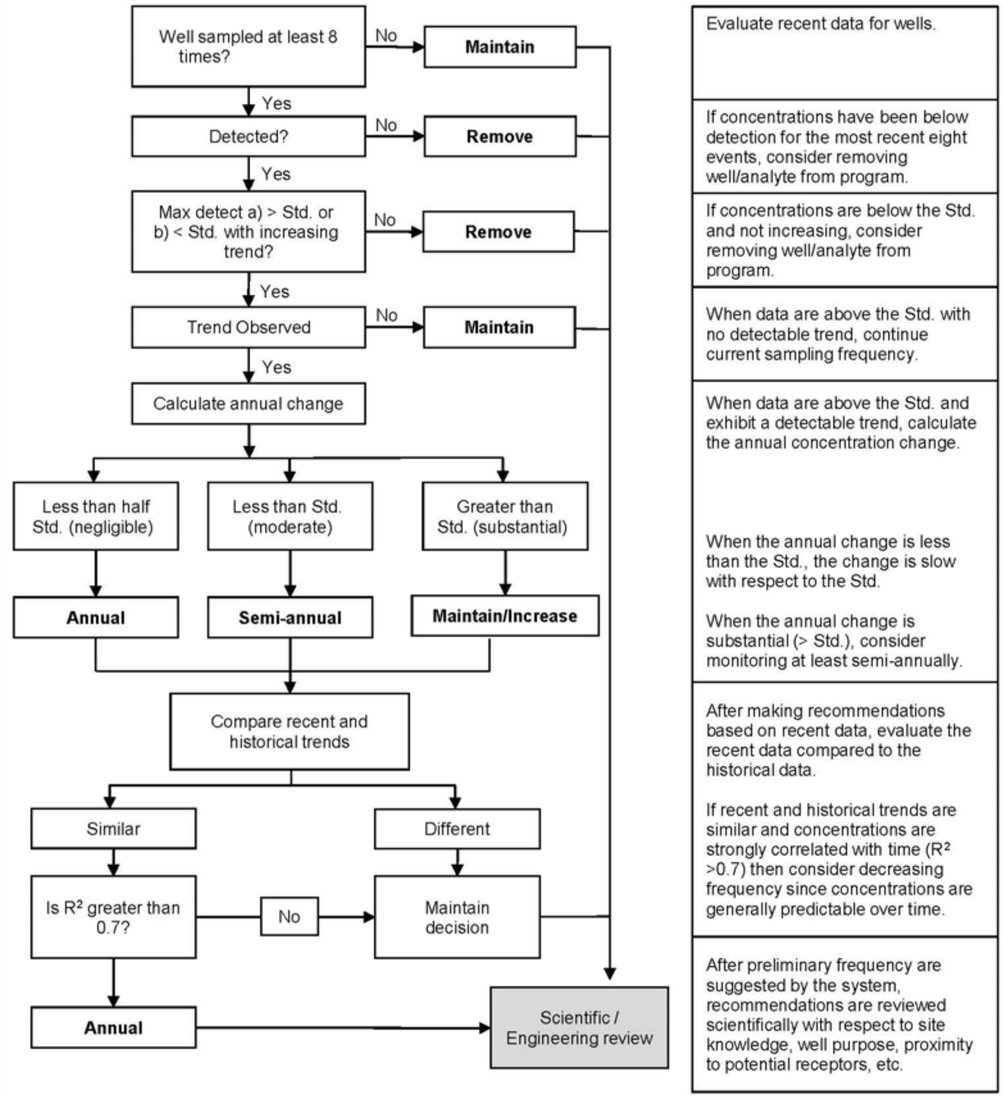

Figure 6. Decision support process for sampling optimization

Recommendation No. 13 - Adjust Air Monitoring Program to perform sampling of radon decay products to confirm equilibrium assumption, consider use of multiple radon background locations to better represent the distribution of potential concentrations and assess the radon gas potentially released from the evaporation ponds, especially during active spraying.

HMC Response:

The ACOE summary review of the monitoring program concludes that the program meets the requirements of the Nuclear Regulatory Commission Regulatory Guide 4.14 (Radiological Effluent and Environmental Monitoring at Uranium Mills). Reports detailing the monitoring

results are submitted to the NRC annually. HMC does not believe that any adjustment to the air monitoring program is required with respect to the radon decay products as well as the evaporation ponds. HMC is evaluating the location of the radon background monitor, and will work with NRC on this evaluation.

The ACOE requests that wind direction data be obtained during each monitoring period; this information is collected and maintained by HMC. Attachment B provides a wind rose summarizing data collected for some of the monitoring period during 2008.

Estimate of Radon Daughters – Radon, which is released during low wind conditions, moves primarily toward the HMC #4 and HMC #5 monitoring stations. The attached wind rose data show that this occurs approximately 20 percent of the time (blue in wind rose chart). During higher wind conditions, the radon is transported primarily in other directions and is quickly dispersed. As radon ages, the concentration of radon daughters increases relative to the radon concentration (higher equilibrium). Therefore, under high wind conditions, the concentration in air of radon daughters accumulated from radon released from the site is very small, and may be higher under low wind conditions. In order to calculate a dose to the nearest neighbors, HMC selected a radon daughter equilibrium factor of 20 percent. Details of the basis for this selection are discussed here.

ACOE incorrectly suggests that the NRC Reg. Guide 8.30 specified method is appropriate for measuring the equilibrium ratio at the site. The suggested Modified Kusnetz method is a grab sample technique that would be inappropriate for use outdoors under variable wind and other atmospheric conditions. It would be difficult to interpret grab sample results because radon progeny concentrations are reduced by attaching to dust particles or scrubbed from the air by moisture. In addition, it would be nearly impossible to quantify the contribution of radon progeny from natural background radon to the measured working levels at any point near the site.

The selection of 20 percent equilibrium is a conservative estimate. If radon is released and the radon and decay products travel together toward the site perimeter, calculations show that the percent equilibrium starts at zero upon release and reaches 20 percent equilibrium after 32 minutes. In the wind rose chart for the HMC site (Attachment B), the winds represented by the "blue color" are low speed, directed toward the southwest, and thus are dominant for radon transport. They represent winds in the range of 0.5 to 2.1 meters/second. After 32 minutes, these winds would have swept the radon and daughters downwind to a distance ranging from 960 to 4,032 meters, or 3,150 to 13,200 feet. The two monitoring stations HMC#4 and HMC#5 are at approximately 2,500 feet and 3,500 feet from the large tailings pile. Therefore, the equilibrium at the farthest station (3,500 ft) would be expected to be approximately 20 percent for the 0.5 meters/second winds but less than 20 percent for the higher winds. Naturally, it is unlikely that

the radon daughter equilibrium at the monitoring station at 2,500 feet would reach 20 percent for winds in this speed range. Therefore, this calculation shows that the assumption of 20 percent equilibrium is very conservative for the two monitoring stations located near the site perimeter and nearby population.

Calm winds may allow radon to reach 100 percent equilibrium if the calm persists for periods of a few hours. This air could then be driven toward the monitoring stations or in any other direction, depending on the wind direction at the time. The wind rose data indicate calm winds occur only 0.02 percent of the time and the wind rose data indicate that there would be only a 20 percent chance that the winds would sweep the stale air toward the monitoring stations (and population) to the southwest. It is therefore justified to ignore the effect of the small periods of calm winds.

The radon daughter equilibrium will be higher farther from the site, but because of dilution of radon and daughters with distance, the levels decrease significantly with distance and very quickly become indistinguishable from background concentrations.

Radon Background Locations - The ACOE suggests that the HMC consider the use of multiple radon background locations to better represent the distribution of potential radon concentrations. HMC does not agree that multiple locations are necessary or appropriate to define the background at HMC#4 and HMC#5, which are representative of the radon exposure to the nearest neighbors. The distance between HMC#4 and HMC#5 in the east-west direction is not far compared to the width of the air drainage path from the north-to-northeast direction. Thus, more than one background location is difficult to justify based on our current understanding of the air flows under calm conditions.

HMC has, however, recently questioned whether HMC#16 is representative of the true background for the site and has taken the initiative to establish additional radon monitoring stations. Air movement toward the site was modeled using an air model that considers topographic features. Point sources were input into the model were placed at selected locations and the direction of air flow during calm conditions were assessed. The result is that there are three principal drainages toward the site in which radon would be transported. The effort suggests that a more appropriate location would be in the San Mateo drainage closer to the site, where the confluence of all three drainages occurs under calm wind conditions. The new monitoring stations are located to capture all or portions of these drainages and should provide information on which to base an assessment.

It should be noted that HMC's radioactive material license specifies that HMC#16 should be used as the radon background location for the site. HMC will have to perform this assessment and present it to the NRC for review, and approval should the assessment justify a change.

Radon Emissions from Evaporation Ponds - During hearings for the renewal of DP-725, Mr. Gerard Shoeppner of the Mining Compliance Section within the Groundwater Quality Bureau of the New Mexico Environment Department testified that the majority of radon at the site originates from the tailings piles and not from the ponds. HMC has recently assessed the radon emissions from the site, including the evaporation ponds. The major sources of radon releases are primarily based on measurements, but where measurements are not available, conservative calculations were made. NRC requires radon flux measurements to be made on the large and small tailings piles annually following EPA Method 115 procedures. The averaged measured fluxes and the known areas of the piles were used to estimate the annual releases. The flux from the evaporation ponds was estimated from a model based on the assumption that the radon was in secular equilibrium with the dissolved radium-226. In order to validate the model, floating activated charcoal radon flux canisters were deployed on one of the ponds for 24 hours using EPA Method 115 analytical procedures. There was good agreement between the modeled results and measured results (to be published). For releases from the spray system, the annual HMC reported evaporation rate of 182 gpm (from Ponds 1 and 2 combined) as a result of the spray systems was used. It was assumed that radon-222 was in secular equilibrium with the measured radium-226 in the ponds, and that all of the radon in the sprayed water was released to the atmosphere. The only other radon source that was evaluated was the radon released within the RO building. In that case, the release was calculated by using the measured radon concentrations within the building and an assumed air exchange rate of 2 per hour. As can be seen from Table 2, the evaporation spray system is the least significant source of radon released from the site. Therefore, HMC believes that we have already addressed the recommendation to assess the releases from the evaporation ponds.

Table 2. Individual radon sources and annual contribution to total radon source.

Radon Source	Percent Contribution
RO Building	0.08
Surface Flux (Evaporation Ponds EP-1 and EP-2)	2.1
Spray System (Evaporation Ponds EP-1 and EP-2)	0.01
Small Tailings Pile	14.0
Large Tailings Pile	83.7

Recommendation No. 14 - Though risks appear minimal with the current irrigation practice, consider treatment of contaminated irrigation water via ion exchange prior to application as a means to remove contaminant mass from the environment.

HMC Response:

The irrigation system is an important component of the remedial systems at the Grants site. It provides an effective means of management of water that is extracted in order to control and contain the uranium plume, and enables continued progress toward meeting the groundwater remediation targets. Annual irrigation reports are published and provided to all stakeholders at the Grants site. These reports detail all aspects of the irrigation program.

HMC has previously evaluated the use of the irrigated areas based on the assumption that the HMC would make the irrigated areas immediately available to a resident farmer and that the currently used irrigation water would not be available to the resident farmer. This scenario is evaluated in the 2009 HMC Irrigation Report. Currently, the water applied to the irrigation areas is piped into the area rather than taken from beneath the irrigation areas. Therefore, only non-impacted irrigation water would be applied by the resident farmer.

Currently, the maximum uranium retention in the upper soil surface layers occurs in the Section 34 Flood Irrigation Area, where a buildup of uranium-238 of 0.69 pCi/g has occurred after approximately 10 years of irrigation. The HMC analysis using RESRAD indicates that the dose to the resident farmer is less than 0.3 millirems/year, which is insignificant.

ACOE RESRAD analysis - ACOE assumed a resident farmer scenario where uranium-238 accumulated in the top layers of soil was 10 pCi/g. A buildup of 10 pCi/g would only occur, based on historical data, after approximately 140 years of irrigation at the present rate using water similar to that which was used over the last 10 years. ACOE's analysis shows that the aquifer beneath the irrigated area would not be impacted from soils contaminated with uranium-238 at10 pCi/g. The ACOE calculated a water independent dose of 3.82 millirems, which agrees with HMC's analysis, if the doses are assumed to scale with the uranium-238 concentration.

The next part of the scenario is highly unlikely because HMC currently owns this property. ACOE assumed that this resident farmer uses contaminated water to irrigate his crops. The total uranium concentration is assumed to equal the NRC effluent limit of 0.44 mg/L. Naturally, the dose from garden vegetables grown under these conditions is relatively high with most of the dose arising from applying water directly to the garden plants. They estimate that the resident farmer would incur a dose of 18.2 millirem/year under these unlikely conditions, resulting in an estimated risk that is slightly above the EPA's desired cancer risk range for reclaimed CERCLA sites of 10^{-6} to 10^{-4} excess cancer risk.

HMC's primary concern with ACOE's analysis is with their scenario. First, HMC would not release this land for use by a resident farmer until the off-site groundwater restoration was considered complete. This is expected, however, to occur long before the approximate 140 years during which the projected uranium buildup in soil would reach 10 pCi/g of uranium-238. Second, the assumed uranium concentration of 0.44 mg/L is higher than the currently measured values in the monitoring wells in the area and thus, is unrealistically high. Most of the monitoring wells within the irrigated areas indicate that the water is below or near the uranium site standard of 0.16 mg/L.

HMC requests that Table 5 and Table 6 be removed from Section 8.1.1 of the report because they were generated based on the irrelevant and misleading irrigation scenario as described above.

Ion Exchange Pre-Treatment - Even though the conclusions of the very conservative RESRAD modeling indicate that concentrations of uranium (30 mg/kg) accumulated in the soil (under a conservative scenario) are not a risk, the ACOE recommends that ion exchange technology be used for the pre-treatment of water used for irrigation in order to remove the uranium. HMC does not believe this would improve the current irrigation system, and would be technically infeasible to implement due to the following reasons:

1) Ion exchange technology has been tested and was unsuccessful in the removal of uranium using an anion-exchange resin due to the presence of high concentrations of sulfate (~600 mg/L) and fouling of the resins due to calcite precipitation. In addition, the chemical speciation is non-ideal due to the presence of large molar excess of calcium and bicarbonate compared to uranium (see point 2, below).

2) The ion exchange technology suggested by ACOE involves products provided by REMCO Engineering (http://www.remco.com/ixidx.htm). This technology requires that uranium be present in groundwater in a form suitable for removal on an ion exchange resin (e.g., uranium must be present as the charged forms: cationic (UO_2^{2+}) or anionic ($UO_2(CO_3)_2^{2-}$). Geochemical modeling of the uranium speciation using the average concentration of species in the Grants site untreated irrigation water (Table 7 of the Draft RSE Report) as the input file (reproduced here as Table 3), shows that the uranium in the groundwater is dominated by a neutral form ($Ca_2UO_2(CO_3)_3$)(Figure 7). The neutral form of uranium would not be amenable to ion exchange, as verified by work conducted by the U.S. Department of Energy (Dong and Brooks 2006), that showed that uranium sorption onto anion-exchange resins is inhibited by the formation of the neutral $Ca_2UO_2(CO_3)_3$ species. Pre-treatment to create acidic conditions (to form UO_2^{2+}) would not be efficient due to the poor selectivity of cation exchange resins and the relatively high concentration of cations (e.g., Ca^{2+}, Na^{2+}, Mg^{2+}) in the groundwater compared to uranium. Use of a

cation exchange resin would require frequent backwashing to strip the groundwater cations and rejuvenate the resin.

Table 3. Average concentration of species in untreated irrigation water.

Constituent	mg/L	g/ mol	mM	log M
UO_2^{2+}	0.28	238	0.001	-5.92
Ca^{2+}	242	40	6.05	-2.22
Mg^{2+}	65	24	2.71	-2.57
Na^{+}	285	23	12.4	-1.91
K^{+}	8	39	0.21	-3.69
Cl^{-}	180	35	5.14	-2.29
SO_4^{2-}	840	96	8.75	-2.06
NO_3^{-}	3.5	62	0.06	-4.25
HCO_3^{-}	460	61	7.54	-2.12
Se^{6+}	0.06	79	0.001	-6.12

3) Even if uranium treatment were feasible, pre-treatment of groundwater prior to ion exchange treatment would be required to remove sulfate and to remove calcium. At least two separate pre-treatment resin beds would be required for this, in addition to the resin required to remove uranium. Regeneration would require 2 to 3 percent of the total influent volume, using regeneration brines. This would frequently create thousands of gallons of brine requiring management and disposal. If treatment occurred at a point near the irrigation, this would require the construction of a treatment plant in order to handle the resin and to accommodate the stripping operation required once the resin becomes expended. The concentrated waste material would create a significant management challenge relative to safety and human health.

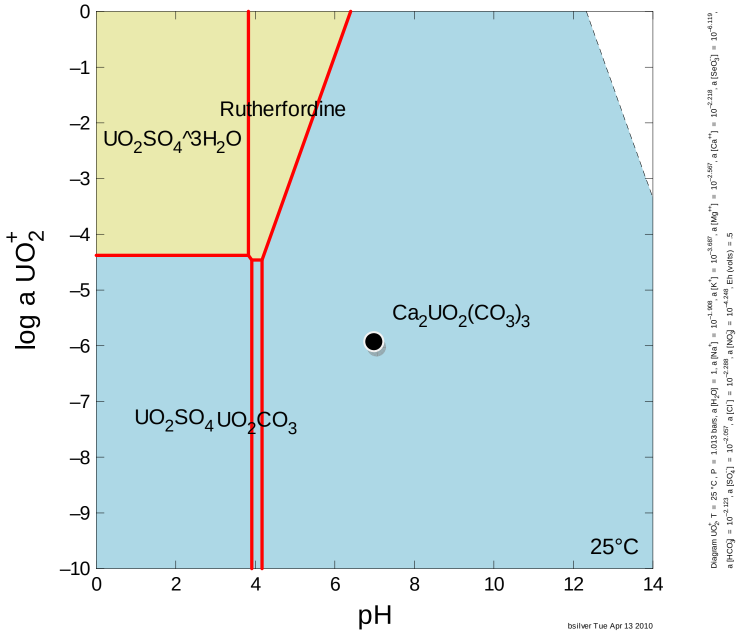

Figure 7. Predicted speciation of uranium based on the groundwater chemistry provided in Table 3. The symbol (•) on the figure shows the pH and uranium concentration relevant to the irrigation water; note that the predominant form of uranium is the neutral $Ca_2UO_2(CO_3)_3$ aqueous species. Note that the y-axis shows the uranium concentration.

Summary

The HMC Grants site has experienced significant remediation progress. HMC has aggressively worked to address the unique remedial issues at the site created by the size of the tailings pile and the number of aquifers to be addressed. In this connection, HMC has developed creative solutions to facilitate completion of remedial goals in the shortest possible time. While remediation has been ongoing for many years, the time involved is not extraordinary compared to what other complex uranium processing facilities have experienced. HMC's foregoing comments reflect a concern that the ACOE's evaluation does not reflect a full appreciation of the complexity of the Grants site, nor does the evaluation provide any innovative or positive suggestions to enhance the current remedial program. HMC is considering additional remedial techniques to accelerate remediation at the site and plans to continue its aggressive approach to finalize site reclamation.

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ATTACHMENT A

Inconsistencies and/or Incorrect Statements Identified in the ACOE Draft RSE Report (February 2010)

Executive Summary; page ii. A conclusion is made that there may have been widespread impacts on the general water quality (e.g., ions such as sulfate) of the alluvial aquifer since mill operations began, but the limited amount of historical data precludes certainty in this conclusion. HMC believes that this conclusion is speculation, and the Grants site does not contribute to widespread impacts. The ACOE fails to recognize that there are several alluvial systems in the Grants vicinity. The San Mateo alluvial system underlies the site with contributing water-quality effects from the Rio San Jose alluvium to the west and the Lobo alluvium to the east. It is, therefore, the combination of water quality from each of these alluvial systems that may represent any potential widespread impact, and the Rio San Jose alluvium is known to have elevated sulfate.

Executive Summary, page ii. A conclusion is made that the seepage modeling likely overestimates the efficiency of flushing of the tailings. HMC disagrees with this conclusion. Our review of the model predictions shows that the model reasonably matches observed conditions with a lag effect. This lag effect is due to reductions in extraction within the large tailings pile in recent years that was not envisioned nor included in the modeling effort.

Section 1.1, page 1. A statement is made that leaching from the mill site has contaminated groundwater. HMC is unaware of any supporting documentation that the mill site has contaminated groundwater.

Section 1.4, Condensed Overview of Site; page 3. The previous RSE report is mentioned. HMC would like to point out that this previous report was flawed and had errors in its interpretations.

Section 1.4.3, Contaminants; page 4. A statement is made that **"***Data for samples collected in the 1950s from a couple of alluvial aquifer wells approximate 2.5 miles west of the site (well numbers 0935 and 0936) suggest significant increases in sulfate concentrations have occurred*." These wells are in the Rio San Jose alluvium west of and unimpacted by the site. The inference in this section, however, is that the increasing sulfate in the wells may be due to the Grants site and it is not. Any observed increase in sulfate would be due to activities further west and upgradient of the wells.

Section 1.4.4, Extraction and Injection Systems; page 4. The extraction and injection system is stated to be not well documented. HMC disagrees with this statement. The system is sufficiently described in the annual groundwater monitoring report, which contains the volumes of water removed and injected, constituent concentrations of these waters, and maps showing the locations of system components.

Section 1.4.5, Treatment System; page 5. The RO treatment capacity is stated as 600 gpm and practical limitations are less than that. This is incorrect. The RO plant can be run at higher rates and, with the additional capacity provided by the third evaporation pond, can be operated at the 600 gpm rate or higher. The limitation is not in the clarifier section.

Section 1.4.6, Evaporation Ponds; page 5. A discussion of the evaporation ponds is presented, but is not complete. The ACOE does not mention that pond #2 has a double liner and pond #1 has a single liner. A third evaporation pond that has been approved by the NRC has just received approval from NMED.

Section 2.1.1, Conditions in the Tailings Piles; page 6. A statement is made that it is possible the uranium is not as accessible for dissolution, but it may slowly mobilize over time. The ACOE provided no basis for this statement, and our evaluations do not support it either (See HMC's response to Recommendation No. 1). This statement should be removed from the final RSE report.

Section 2.1.3, Evaporation Ponds; page 6. The ponds are stated as being a possible secondary source of contaminants affecting air, soil, and groundwater if the liners under the ponds were to leak. This statement is speculative and should be removed from the final RSE report.

Section 2.1.4, Irrigated Acreage; page 6. Irrigation with site water is stated as possibly affecting groundwater through leaching. This is contrary to the ACOE's finding in the draft RSE report that irrigation has not impacted groundwater. This statement should be removed from the final RSE report.

Section 2.2.1, Air; page 7. . It is stated that the air monitoring program at the Grants site attempts to quantify the radon in air pathway. HMC has actually gone to great lengths to "quantify" this pathway and has found that the measured radon at the site boundary primarily is from natural background sources, with only a small component originating from the site.. In fact, the EPA issued a "no action" on Radon in the Record of Decision for Grants at a point in time when the tailings piles were open and the mill was still operating. This decision was based on a comprehensive study where radon concentrations were measured in nearby homes by an

independent competent scientist. The tailings piles are now covered and the mill has been decommissioned so the on-site source has been greatly reduced

Section 2.3 and Figure 2, Receptors; page 7. The text incorrectly refers to Figure 1 as the conceptual site model. The conceptual site is shown on Figure 2. HMC believes that the conceptual site model is flawed. As discussed in our response for Recommendation No. 4, HMC does not believe that the former mill area is a "Primary Source," as depicted on the conceptual site model. Additionally, several of the exposure pathways that are indicated as complete are actually not complete. An example of this is the incomplete groundwater drinking pathway for a trespasser, resident, or worker, currently and in the future. We suggest that the ACOE re-examine this conceptual site model before issuing the final RSE report.

Section 3.2, Concentration Trends; page 13. The ACOE cites well 0882, located south of the wells used for irrigation in the northern plume, as providing evidence for incomplete capture because uranium concentrations have increased. However, the increase is only on the order of 0.02 mg/L and within typical variability of uranium concentrations in the alluvial aquifer in this area. The uranium concentration is below the site standard and below the maximum contaminant level, and the slight increase is not an indicator of incomplete capture.

Section 3.2, Concentration Trends; page 15. Well DD is discussed and the uranium concentration in the well is speculated to be a result of migration from the tailings pile. Well DD is an approved background well and the 95 percent confidence limit of uranium concentrations in the well were used to set the site standard for the alluvial aquifer. It is highly unlikely that groundwater is flowing to the north because the water level in well DD is several feet higher than at the tailings pile. Furthermore, the uranium concentration has consistently been near the 0.16 mg/L site standard level since 1995, indicating a steady source of uranium from upgradient areas, whereas the uranium concentration at the tailings pile has been decreasing over this period. If the tailings pile was the source of uranium in well DD, one would expect the uranium concentration to decrease to some degree because of the decreasing concentrations at the tailings pile, but this has not occurred.

Section 3.4, Ground-Water Modeling; page 15. It is stated that the model likely over-predicts the performance of tailings flushing. A similar statement is made in the Executive Summary. HMC's review of the model predictions shows that the model reasonably matches observed conditions; however, there is a lag effect. This lag effect is due to reductions in extraction within the large tailings pile in recent years that was not envisioned nor included in the modeling effort.

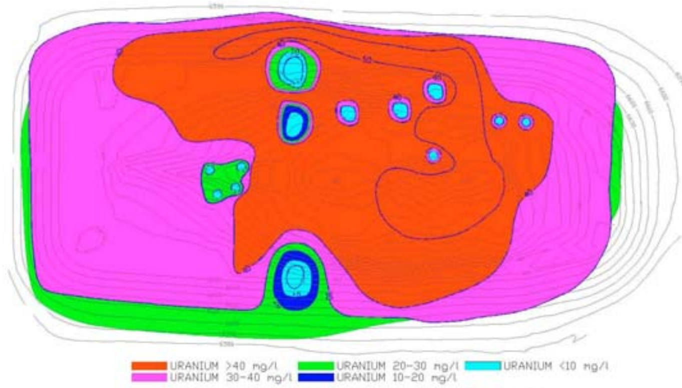
Section 3.6, Impacts to the San Andres Aquifer; page 16. It is stated that the flow direction in the San Andres aquifer is to the northeast. However, the flow direction is toward the east and

slightly southeast, as shown on Figure 8.0-1 of the 2008 Annual Monitoring Report (HMC and Hydro-Engineering, LLC. 2009).

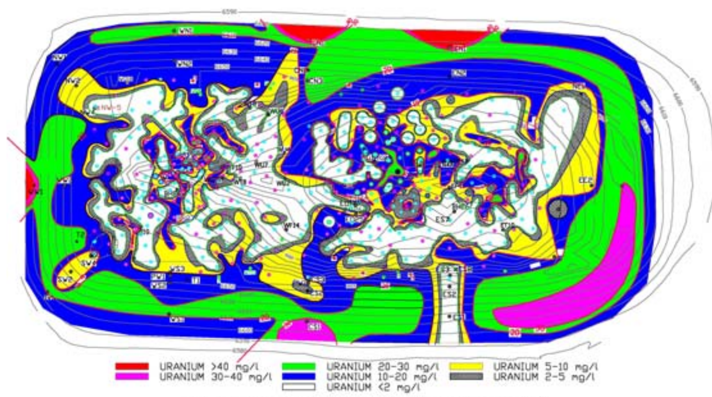
Section 4, Overall Remedial Strategy; page 17. The ACOE states that "According to Homestake, flushing of the tailings pile will be completed by 2012, with the remaining groundwater contamination completed by 2017." The last part of the sentence is worded in an awkward manner; it should read "…with remediation of the remaining groundwater contamination completed by 2017."

Section 4, Overall Remediation Strategy; page 17. The ACOEs states that "…potentially applicable replacement technologies are discussed…." Two of the possible strategies, slurry wall and PRBs are discussed. Each of these technologies is technically impracticable (see HMC's response to Recommendation No. 8). The ACOE actually provides no replacement technologies that have not already been considered.

Section 4.1 and Figure 14, Flushing of Large Tailings Pile; page 17. The flushing of the large tailings pile is discussed and Figure 14 is used to show the 2008 uranium concentrations in the tailings. Although the ACOE uses this figure to show the variability of uranium in the pile and illustrate their belief that the flushing has not been effective, HMC believes that the flushing has been effective at removing uranium mass. This is demonstrated by comparing the 2000 and 2009 maps for uranium in the tailings pile, which shows that a significant amount of uranium has been removed. See also HMC's response to Recommendation No. 2 for additional evidence of the effectiveness of the flushing and extraction program. Below is the 2000 uranium concentration map for the tailings pile showing uranium concentrations exceeding 30 mg/L in much of the pile. Also below is a map of the 2009 uranium concentrations in the pile, which illustrates the significant reduction in concentrations resulting from the flushing and extraction program. For 2009, approximately 67.5 percent of the west side slime area has uranium concentrations less than 5.0 mg/L, and 45.5 percent of the same area has concentrations lower than 2.0 mg/L.



TAILINGS URANIUM (mg/l)
2000



TAILINGS URANIUM (mg/l)
2009

Section 4.1, Flushing of Large Tailings Pile, first paragraph; Page 19. The ACOE presents a calculation of the volume of water within the tailings and bases the volume on a total porosity of 30 percent, which is not substantiated or appropriate. The mobile porosity (i.e., effective porosity) of the tailings should have been used. The slimes may have a total porosity of around 30 percent, but the effective porosity is more on the order of 8 percent and 14 percent for the tailing sands. The result of this is that the ACOE has most likely overestimated the volume of water in the tailings, which correspondingly underestimates the success of the flushing and extraction system. HMC estimates that approximately one pore volume has been flushed from the tailings.

Section 4.1, Flushing of Large Tailings Pile, second paragraph; Page 19. A calculation is made of the natural groundwater flow in the alluvial aquifer beneath the large tailings pile, which is substantially overestimated. Based on site data, the hydraulic conductivity of the alluvium used in the calculation should be about 20 feet/day, not 80 feet/day. The gradient of 0.008 is high

and should be lower near approximately 0.003. HMC's estimate of the natural flow in the alluvial aquifer is in the range of 60 to 80 gpm, not 450 gpm as estimated by the ACOE. Consequently, the amount of alluvial groundwater that needs to be captured beneath or surrounding the large tailings pile is considerably less than what is estimated by the ACOE.

Section 4.2, Downgradient Extraction and Injection, first paragraph; Pages 19-20. The ACOE states that injection of relatively clean water from other aquifers into the alluvial aquifer may do more to dilute the plume than treat it. However, injection of water has demonstrated to be an effective technology for plume control, and in addition to controlling the plumes, injection is often necessary to sustain a sufficient saturated thickness in the alluvial aquifer to enable extraction to occur; otherwise the aquifer would be dry. An example of this is at Felice Acres, where injection into the alluvial aquifer occurs. Initial extraction wells in this area yielded very little water and wells commonly became dry when pumped. With injection, a sufficient saturated thickness is maintained that enables uranium and other constituents to be collected. Without injection little or no constituent mass would be extracted.

The ACOE also states that extraction from the Upper Chinle draws water downward from the more contaminated alluvial aquifer. The only area where this could possibly occur is in the collection pond area where there is an approximate 500-foot wide zone of saturated alluvium overlying the Upper Chinle Aquifer, and extraction in the Upper Chinle Aquifer occurs in this area. However, HMC does not believe that pumping from the Upper Chinle Aquifer in this limited area is drawing contaminants downward as the following explains. The two most important parameters that control the movement from one aquifer to another are the head in the driving aquifer and the vertical hydraulic conductivity of the materials that the water has to move through between the two aquifers. In the collection pond area, the head in the alluvial aquifer would have to be substantially higher than the head in the Upper Chinle Aquifer and the materials would have to be highly permeable. Review of the 2008 water levels in the two aquifers in this area reveals that there is minimal head difference. As shown on the water level elevation map for the alluvial aquifer (Figure 4.2-1, HMC and Hydro-Engineering, LLC. 2009), the elevation near the collection pond is typically in the range of 6,525 to 6,530 feet. Water elevation in Upper Chinle Aquifer (Figure 5.2-1, HMC and Hydro-Engineering, LLC. 2009) is also interpreted to be in the same elevation range. Water levels in the two aquifers near the collection pond have not significantly changed since the increased pumping in the Upper Chinle aquifer started in 2006, which is further evidence that the pumping has not induced downward flow from the alluvial aquifer.

Section 4.4.3, In-Situ Immobilization; page 27. The ACOE suggests that a relatively new immobilization technology, still in lab development, be examined. The reference given is to "Frysell et al., 2005." This citation is incorrect; it should be Fryxell et al., 2005 (as noted correctly in Section 10, References). The referenced work involves the use of self-assembled

monolayers on mesoporous supports (SAMMS), and as indicated by the ACOE, this is experimental and currently confined to the laboratory bench.

Section 5.3, Alternatives to Current Treatment Operation; page 30. The ACOE states that ion exchange resin cannot reliably remove the cation form of selenium, selenite. Selenium will not be present as a cation in the groundwater. Selenium typically is found as selenate (SeO_4^{2-}; with selenium in the +6 oxidation state) or selinite ($HSeO_3^{-}$ or SeO_3^{2-}; with selenium in the +4 oxidation state) depending upon pH. All of these forms of selenium are anionic.

Section 6.2, Effect of Salinity; page 32. An evaporation rate reduction of 50 percent in the ponds is cited. However, HMC's research has found that the reduction rate is lower at approximately 10 percent (Salhotra et al. 1985) for the salinity present in the evaporation ponds.

Section **7.2.4, Sampling Methodology and Analytical Suite; page 38**. The ACOE provides details of improvements to the presentation of data in the air particulate laboratory reports. HMC has followed the standard reporting format required by NRC for the laboratory reports.

Section 9.3, Approach to Implementation of Recommendations, second paragraph; page 47. The ACOE provides a list of six recommendations that should proceed independent of any other recommendations. HMC's view on each of these recommendations and how to proceed are discussed in our responses as identified below:

1) the evaluation of the potential escape of contaminants at the northwestern portion of the site (see Response to Recommendation No. 3)
2) the evaluation of the former mill site as a potential source of groundwater contamination (see Response to Recommendation No. 4)
3) further characterization of the extent and migration of the Chinle plumes (see Response to Recommendation No. 5)
4) complete decommissioning of potentially compromised San Andres wells (see Response to Recommendation No. 7)
5) development of a comprehensive optimized monitoring program (see Response to Recommendation No. 12)
6) implement treatment of contaminated irrigation water to remove contaminant mass from the environment (see Response to Recommendation No. 14)

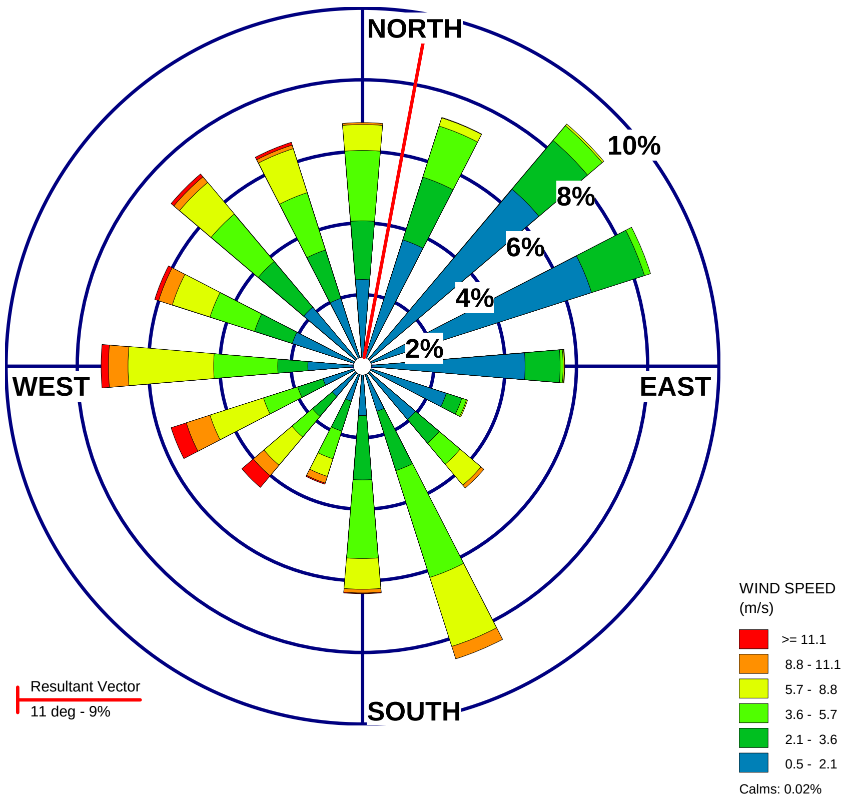
ATTACHMENT B – Wind Rose

WIND ROSE PLOT:

Homestake Meterology Station
Wind Rose

DISPLAY:

Presented in a circular format, the wind rose shows the frequency of winds blowing from particular directions over a period of time. The length of each "spoke" around the circle is related to the frequency that the wind blows from a particular direction per unit time. Each concentric represents a different frequency, emanation from 0% at the center and increasing to 10% at the outer circle.



COMMENTS:

DATA PERIOD:

00:00 September 1, 2008 to 23:00 August 31, 2009

COMPANY NAME:

MODELER:

CALM WINDS:

0.02%

TOTAL COUNT:

8765 hrs.

AVG. WIND SPEED:

3.49 m/s

DATE:

9/29/2009

PROJECT NO.:

WRPLOT View - Lakes Environmental Software