Utah DEQ Comments on

November, 2004 U.S. Department of Energy
Remediation of the Moab Uranium Mill Tailings, Grand and San Juan Counties, Utah
Draft Environmental Impact Statement

February 18, 2005

The Utah Department of Environmental Quality (DEQ) presents the following comments for DOE consideration regarding the proposed action.

Comments on DEIS Summary

1. Groundwater Remediation Costs / Timeframes (p. S-9) – should the pile be stabilized in place, the 75 – 80 year timeframe estimated by DOE for groundwater cleanup could be greatly under-exaggerated. The magnitude of this under-estimation could be great relative to the total on-site cleanup cost. Details about the factors behind this under-estimation are discussed below. Despite these problems, relocation of the tailings pile would eliminate the above-ground contaminant source term. Therefore, the shallow aquifer would passively clean itself over a period of time. As a result, any expense made now to relocate the pile could prevent dramatic long-term costs in the future.

2. Duration of Groundwater Remediation and Implications for Total Cleanup Costs (p. S-11) – we take exception to the DOE statement that "… duration of the action would likely be essentially the same regardless of whether the pile was remediated in place or relocated". Any truth in this statement is due only to DOE's arbitrary use of the acute ammonia-nitrogen standard (3.0 mg/l) as a groundwater cleanup goal. Should the lower chronic ammonia-nitrogen standard (0.6 mg/l) be required as a groundwater cleanup goal, the on-site option would require active ground water remediation for a much longer timeframe, perhaps more than 200 years (DEIS, Figure 2-43). This extended operation would greatly increase the total cost of the on-site stabilization option, in that 120 extra years of operation would cost on the order of $108,000,000. This would increase the total life-time cost of the on-site option from $248.8 Million to $356.8 Million.

   Even longer periods of active groundwater remediation may also be required. Unfortunately, the DOE contaminant transport model used to evaluate this need was limited to a 200 year simulation (DEIS Fig. 2-43). However, other DOE information indicates that the leaching effects of an ammonia salt layer found in the upper reaches of the tailings pile, will not be observed at the underlying water table for about 1,100 years. This same DOE information also suggests that after arrival of the second pulse of ammonia, it would take another 440 years for infiltration from the on-site cover system to eliminate it from the tailings pile (SOWP, p. 6-11 and 12). To date, DOE has not simulated this anticipated long-term ammonia transport (1,500 years). If these simulations were conducted it may show that over 640 years of active groundwater remediation would be required to adequately contain and control the ammonia discharge to the backwater habitats. If this were the case, the projected groundwater remediation costs could be as high as $576 Million (640 years x $900,000/year). This would increase the total cost of the project to well over $749 Million ($248.8 Million (DEIS Table 2-35) - $75.3 Million + $576 Million). In this case, an off-site remediation option would be more viable economically.

However, removal of the tailings pile would eliminate this possible complication and financial risk to the public.

3. Effects of River Migration on Floodplain and Wetlands (p. S-14) – we agree that the 100 and 500-year flood events could partially inundate the tailings pile, should it be stabilized in place. However, recent river velocity and shear force modeling performed by the USGS shows that erosion could easily occur on the right riverbank under both of these flow regimes (Kenney, Fig. 47 and 48, see Attachment 1, below). This same modeling shows how water velocities and shear forces under the 100-year flood event will be high enough inside the river's channel, across the entire length of the river in Moab Valley, to transport medium-sized (1.45-2.91 inch diameter) gravel (ibid., Fig. 47). Even larger particle sizes can be transported by higher river flow rates (ibid., Figs.48 and 49) , or under conditions where the river has scoured its channel near the West Portal (ibid., Figs. 50, 53, and 56).

   Given these recent USGS findings, it is easy to see how a 100-year flood event could easily erode the much finer silts and sands found in the riverbank near the tailings pile. It is also easy to conceive how under these conditions, the river could easily avulse its channel and rapidly undercut and destabilize part of the tailings pile. This de-stabilization could contaminate the floodplain and other downstream areas with residual radioactive material.

4. Long Term Effects on Aquatic Ecology (p. S-15) – based on the uncertainties involved in groundwater remediation costs, and the need to apply the chronic ammonia-nitrogen standard as the groundwater cleanup goal, the DOE statement at the top of this page that the adverse effects on aquatic ecology would be eliminated for 200 to 1,000 years would consequently dictate that the active groundwater remediation system be operated for at least 200 years (see discussion above). Under this scenario, the cost to the general public would be much larger than estimated by DOE. This adverse financial risk to the project must be considered in DOE's determination of a permanent solution for the site.

   Even larger periods of time may be required for active groundwater remediation under the on-site option. DOE has already mentioned concern for the effects that leaching of the ammonia salt layer found in the upper reaches of the tailings pile, would have on the underlying groundwater quality. As discussed above, DOE failed to evaluate this secondary pulse of ammonia that would arrive at the underlying water table at about 1,100 years after on-site cover construction. Because it may take about 440 years to eliminate this pulse of leachate from the tailings system, the DOE contaminant transport models should have been run for at least 1,500 years. Should this secondary pulse of ammonia cause the groundwater to exceed the chronic cleanup goal (0.6 mg/l), it may be necessary to actively treat groundwater under the on-site option for 640 years or more. This would result in a tremendous increase in the on-site groundwater remediation costs, from about $75.3 Million (DEIS, Table 2-35) to $576 Million, and thereby increase the total on-site cleanup cost from $248.8 Million to $749.5 Million ($248.8 Million – $75.3 Million + $576 Million).

5. Waste Management: Evaporation Residue from Groundwater Remediation (p. S-20) – we take exception with the statement that this residue would only need to be managed for 75-80 years. As discussed above, the time it takes to cleanup the local groundwater could be as high as 200 years or more. Any such increase in the required time would bring with it additional costs for residue disposal. However, removal of the pile would eliminate this risk in the estimated cleanup costs.

6. Consequences of Uncertainty: Omission of River Migration Effects (p. S-34) – the description in this section omits the most significant category of uncertainty for the project; that being pile de-stabilization by river migration. These consequences must clearly be described in the DEIS. DEQ's concerns with river migration are discussed in detail below.

7. Consequences of Uncertainty: Groundwater Model Calibration (p. S-35) – the need to calibrate and refine the groundwater model to predict future ground and surface water concentrations is largely academic if the pile is relocated. Existing DOE contaminant transport models show how removal of the pile will allow the nearby groundwater to regain the chronic ammonia-nitrogen standard (0.6 mg/l) under passive groundwater flow conditions within 90 years (DEIS, Figs. 2-43 and 4-7).

8. Table S-1: Consequences of Uncertainty (pp. 3-36 thru 45) – we have many concerns with DOE statements made in this table, as follows:

   A. Ground Water and Site Conceptual Model Assumptions: Omission of Dispute Over Groundwater Cleanup Goal (p. S-36) – the discussion in this paragraph omits any mention of the dispute with Utah DEQ over the applicable groundwater quality cleanup goal for ammonia nitrogen or any other tailings contaminant. In the case of ammonia, DEQ has stated on more than one occasion that the cleanup goal should be the chronic standard, 0.6 mg/l, and not the acute criteria (3.0 mg/l). Detailed rationale for this State determination is provided below. Should the 0.6 mg/l standard be applied, the existing DOE contaminant transport model shows that it would take over 200 years for groundwater near the pile to reach this value (DEIS, Figs. 2-43 and 4-1). As mentioned elsewhere in this document, this case would represent at least 120 extra years of groundwater remediation costs, over and above those predicted by DOE. At an annual operation cost of about $900,000, this represents an increase in the total project cost of more than $108,000,000. In comparison this amount is 65% of the total on-site reclamation cost estimated by DOE ($166,000,000), and certainly needs to be factored into the DEIS decision. On the other hand removal of the pile would forego these possible expenditures for the public.

   B. Surface Water Compliance Standards – Need to Apply Chronic Ammonia Standard (p. S-37) – there is no doubt that DOE's position is in error. The acute ammonia standard (3.0 mg/l) does not apply to the backwater habitat in questions for several reasons, including (for additional details see discussion below regarding DEIS Section 2.3.1.2):

      1) Mixing Zone Premise: Lack of Turbulent Flow – acute standards are applied to surface water quality problems under the assumption that 1) open channel turbulence will provide for a mixing zone to dilute or otherwise reduce the contaminant concentrations from a point source discharge, and 2) the mixing zone will be limited in its dimensions relative to the river's channel, i.e., less wide than the river channel and limited in longitudinal length (see Utah Water Quality Rules, UAC R317-2-5). However, the backwater areas in question only access the river channel at the habitat's downstream end. Hence, there is no open channel turbulence inside the backwater area. Instead, the backwater areas are recharged by infiltrating groundwater from the bank, or by river water infiltrating thru the barrier sand bar. Both of these sources of recharge constitute laminar flow and not turbulent conditions. Hence the acute standard is not applicable to an environment where water flow is largely laminar.

2) Avoidance Behavior Assumption – another critical assumption in the application of acute standards to surface water quality problems is that adult fish can avoid the toxicity of the mixing zone by swimming around it (avoidance behavior). However in the case of the backwater areas in questions, larval fish that will be deposited there by the currents do not have the capability to resist moving water. Consequently, they cannot exhibit any avoidance behavior. Given these circumstances only the chronic standard is appropriate, 0.6 mg/l.

3) Exposure Time – the acute standards are designed for a 1-hour exposure to the fish (see Utah Water Quality Rules, UAC R317-6-2, Table 2.14.2). In contrast the chronic standard is designed for a 4-hour exposure period (ibid.). In the case of the backwater areas, the habitat will serve as a nursery for the larval fish in question. Consequently, they will reside there for weeks if not months. As a result, only the chronic standard , 0.6 mg/l, is applicable.

For these reasons, the chronic ammonia-nitrogen standard must be applied to the backwater habitats in question.

We understand that water quality monitoring of these backwater areas is challenging, largely due to their transient nature; and that therefore it is preferred to monitor groundwater quality as a means of verifying compliance. We have also concluded that DOE evaluation of the transfer mechanism between groundwater and the backwater areas is incomplete. Errors have also been found in DOE's claim for a 10-fold groundwater to surface water dilution factor. These errors are discussed in detail below.

Until these errors are resolved, and without confirmation on how dilution, dispersion, retardation, or biologic decay will reduce the ammonia concentrations during this groundwater to surface water transition, it is conservative and protective of the environment to apply the chronic (0.6 mg/l) standard as a groundwater cleanup goal.

The application of the chronic ammonia-nitrogen standard, 0.6mg/l, as a groundwater cleanup criteria significantly increases the cost of the total project remediation by $108,000,000 (120 years x $900,000/yr). This additional cost needs to be factored into the total price for the onsite stabilization option. However, these costs could be eliminated from consideration if the pile were moved to another location away from the river.

C. River Migration - Need to Move the Tailings (p. S-41) – we strongly contend with the DOE statement in this section that "…river migration toward the pile would not occur as a catastrophic event but rather gradually in small increments." River channel avulsion is a time dynamic process that can occur very rapidly. History across the world shows river avulsion can be rapid and dramatic. Recent events on the Santa Clara River drainage in southwest Utah also reinforce this conclusion, where over 25 homes were destroyed in a matter of a few hours during a 100+ year flood event.

We also strongly disagree with DOE's preliminary evaluation of costs for the riprap wall planned for construction somewhere between the pile and right river bank, in that it was based on outdated 1-dimensional water velocity and shear force model (1994 Mussetter Engineering Report). More robust 2-dimensional river velocity and shear force modeling has been conducted recently by the USGS, which shows (see Kenney, Figs. 47-49, in Attachment 1, below):

1) Significantly higher river velocities and shear forces will exist in the river's channel and on the right river bank during 100-year and larger flood events, than previously predicted,

2) That these newly predicted forces are large enough to erode medium-sized (1.45-2.91 inch diameter) gravel materials, which are significantly coarser than the fine sands and silts found on the riverbank and adjacent to and under the tailings pile today,

3) Even larger particle sizes can be transported by the river, should the channel be scoured near the West Portal area during a flood event (ibid., Figs. 50, 53, and 56),

4) The physical extent of the erosion prone zones on the right riverbank extend for thousands of feet between the east and west portals to Moab valley; resulting in the need for any riprap wall to be tremendously long and costly both in terms of construction, and long term maintenance.

A copy of this USGS report is included herewith as a formal part of the DEQ comments (see Attachment 1, below).

It is also important to note that the USGS hydrologic modeling is also consistent with geologic evidence found downstream of Moab Valley near Kings Bottom (about 2 miles downstream of the West Portal) where coarse deposits of river terrace gravels are found (Doelling, et.al., p.11 and Plate 1). These geologic deposits attest to fact that the river has experienced extreme velocities in the past that are certainly capable of eroding the fine soils adjacent to and under the tailings pile. Such de-stabilization is a critical failure scenario that must be examined and resolved.

D. Shallow Ground Water Discharge/Matheson Wetlands Preserve (p. S-42) – we agree that at the upper limit of uncertainty that perpetual groundwater remediation may be required for the on-site disposal option. Based on the above discussion, this section should revised to reflect the 120 extra years of active groundwater treatment that the chronic ammonia-nitrogen standard will require. This would result in an increase of more than $108,000,000 in the groundwater management costs for the on-site option.

E. Other Contaminants of Concern (p. S-43) – we also agree that this uncertainty could result in extremely long timeframes to complete groundwater remediation under the on-site stabilization option. To frame the financial impact of this uncertainty the DOE should provide a range of costs that could occur in the event this problem occurs. Certainly, these costs could be compounded on top of the $108,000,000 mentioned above. Even greater costs could accumulate for the on-site option in terms of active groundwater remediation if it is shown that the secondary ammonia pulse, described above, also has to be contained and treated for an additional 440 years.

F. Limited-use Aquifer (p. S-44) – we agree that groundwater cleanup at this site should focus on protection of the nearby backwater habitat in the Colorado River. However, we take exception to the DOE statement that "Active ground water cleanup beyond what is currently projected is not likely to be required for the protection of aquatic species." Based on above DEQ comments, it is premature to reach this conclusion in that: 1) the chronic ammonia-nitrogen standard (0.6 mg/l) is applicable to the backwater habitat and not the acute standard (3.0 mg/l), and 2) DOE's arguments about the assumed 10-fold groundwater to surface water dilution factor have been found to contain errors. Lacking this evidence to demonstrate how a higher groundwater concentration would allow the backwater to meet the chronic standard (0.6 mg/l), DOE must apply the chronic standard as the groundwater cleanup goal.

G. Salt Layer Migration – Need to Remodel Contaminant Transport (p. S-45) – the discussion here fails to describe the implications for the ammonia salt layer in the tailings on the DOE contaminant transport model, which was used to justify the 75-80 year groundwater cleanup estimates. Review of the DOE SOWP (pp. 6-11 and 12, and 7-23) show that DOE's contaminant transport model assumed a constant tailings pore fluid ammonia concentration (1,100 mg/l). However, by DOE's own estimates, an ammonia salt layer near the top of the tailings pile will solubilize and be transferred to the water table by infiltration seepage thru the on-site cover system. In turn, this seepage will then cause a 16-fold increase in the ammonia concentrations that arrive at the water table (dissolved ammonia-nitrogen = 18,000 mg/l). Unfortunately, this step function increase in the source term concentration was not simulated in the DOE contaminant transport model (DOE SOWP, p. 7-23). Hence, the model did not represent actual field conditions anticipated.

Using DOE's estimates, this step increase in the ammonia source term concentration would arrive at the water table about 1,094 years after cover construction (SOWP, pp. 6-11 and 12 and Fig. 6-3). This means that the ammonia break-thru curve in the DEIS (Fig. 2-43), does not represent the long-term performance of the on-site option, in that the ammonia loading on the water table will increase at about year 1,094, and shortly thereafter could cause a spike increase in the predicted groundwater and backwater habitat concentrations. Further, these same DOE estimates also show it would take about 440 years for the cover system infiltration to leach out the ammonia salt layer (DOE SOWP, p. 6-11). As a result, the DOE model should have simulated tailings pile infiltration and contaminant transport for a minimum of at least 1,500 years. Instead, the DOE model only simulated 200 years of system performance (DEIS, Fig. 2-43 and SOWP, p. 7-30 and Fig. 7-17).

As a result of these findings it is clear that DOE's contaminant transport predictions are prejudiced and biased; leaving DOE's claim unsupported, i.e., that only 75-80 years of active groundwater remediation are required. In reality, additional contaminant transport modeling is required to evaluate actual field performance of the on-site remediation option thru a time span of at least 1,500 years. Given these circumstances, it is reasonable to expect that new contaminant transport modeling would show that the on-site option would allow groundwater to:

1) Achieve the 0.6 mg/l chronic ammonia-nitrogen standard during the first 200 years, only to be exceeded again at about 1,100 years when the ammonia salt layer pulse reaches the water table, and

2) Thereafter it could take as long as 440 years for this ammonia pulse to be dissipated from the groundwater system, as the ammonia salt layer in the tailings pile was leached out.

Under this scenario, active groundwater remediation would be required not for 80 years, or 200 years, but for possibly 640 years. As a consequence, the total cost for active groundwater remediation would be $576 Million (640 years x $900,000/yr), and total remediation cost for the entire on-site stabilization project would then be $749.5 Million [$248.8 Million (see DOE DEIS Table 2-35) – $75.3 Million (80 years of active groundwater cleanup) + $576 Million (640 years of active groundwater remediation)]. Under these circumstances relocation would be a much more attractive option.

Some may argue that evaluation of a 1,500 year timeframe is excessively long, given that the EPA regulations for Title I projects only require a 200 – 1,000 year evaluation (40 CFR 192.02). However, the National Academy of Science (NAS) already ruled on this issue, as follows (6/11/02 National Academy of Science, Board on Radioactive Waste Management Report to DOE, p. 3):

> "*II DOE's decision-making process should recognize the connections and potential tradeoffs between short- and long-term actions.*
>
> *The committee suggests that the ultimate objective at the Moab Site should be to implement remediation and management measures that have the best reasonably achievable probability of being protective of human health and the environment* ***for the duration of the hazard****, taking into account relevant economic and societal factors. Federal regulations (40 CFR 192) adopt 1000 years as the design objective for the maintenance of human isolation of mill tailings from the environment. The regulations require that this objective be met "to the extent reasonably achievable," and set a lower bound for control of "at least" 200 years. These are ambitious goals, even though they fall far short of the full duration of the hazard.*
>
> *Lower levels of remediation in the near term typically leave greater residual long-term hazards, which may increase the need for, the importance of, and the costs of long-term actions.* ***The committee recommends that DOE assess each alternative for disposition of the Moab pile on the basis of its entire life-cycle****, including the demands for long-term institutional management (LTIM) actions, where LTIM comprises the total system of protection, including contaminant reduction, contaminant isolation, and long-term stewardship. Thus, such an assessment would specifically include consideration of the residual risk when the near-term remediation actions at the site are complete, the LTIM measures required, the likely duration of these measures, the consequences of the failures of such measures, and the total social costs expended. DOE should consider all of these factors in establishing the balance between near-term cleanup and long-term measures, as well as in designing the LTIM measures, themselves.* ***Long-term considerations*** *do not necessarily outweigh short-term concerns (e.g., cost and remediation risk), but they* ***should be identified, evaluated, and any tradeoffs explicitly identified*** *and considered as part of the decision."* (emphasis added)

Based on this NAS guidance, DOE should have completed the contaminant transport analysis for a period of at least 1,500 years. Since this was not done, the DOE contaminant transport analysis failed to evaluate the problem for the "… full duration of the hazard." Further, the DOE evaluation also failed to fully assess the "… long-term considerations … and any tradeoffs explicitly identified … as a part of the decision."

However, should DOE decide to move the tailings to a new disposal site away from the river, this issue would be mute.

9. <u>Major Conclusions: Comparable Groundwater Remediation Costs (p. S-47)</u> - we strongly disagree with the DOE conclusion that the groundwater remediation duration and costs would be identical regardless the tailings cleanup option selected. As discussed above the

apparent comparability is an artifact of the arbitrary groundwater cleanup standard selected by DOE (3.0 mg/l acute ammonia nitrogen). Application of the more appropriate chronic ammonia-nitrogen standard, 0.6.mg/l, as a groundwater cleanup criteria could result in an increase of 120 years of additional groundwater treatment, with an associated cost of about $108,000,000. Further, contaminant transport evaluation of the secondary ammonia pulse from leaching of the ammonia salt layer in the upper reaches of the tailings pile could also dramatically increase the costs for active groundwater remediation for the on-site option, by as much as $576 Million more. These two factors combined would dramatically alter DOE's conclusion, and the on-site stabilization option would become significantly more expensive than any of the off-site alternatives.

10. Areas of Controversy (p. S-48) – more that one concern exists regarding DOE statements made here, including:

    A. Ground Water Remediation Standard Applied – here the DOE states that "USFWS agrees with DOE that the target goals that DOE has selected would be protective of aquatic species in the Colorado River". However, what was not said, is that this agreement is conditioned upon unsubstantiated affirmations from DOE that the proposed groundwater cleanup goal (3.0 mg/l ammonia-nitrogen) will allow backwater habitat water quality conditions to meet the 0.6 mg/l chronic ammonia nitrogen standard. The fact that DOE's contaminant transport model failed to analyze the secondary ammonia pulse that will result from leaching of the ammonia salt layer in the upper portion of the tailings pile further detracts from any confidence in the DOE's claims that the backwater areas will achieve the 0.6 mg/l chronic ammonia standard.

       Further, DOE has not completed any technical studies to confirm if its dilution factor claim can actually be met in the backwater habitat. Additional discussion follows below that explains why DOE's assumptions on this issue are weak and without merit.

       Recently we have become aware that the USFWS will stipulate conditions in its upcoming Biologic Opinion to require DOE to positively demonstrate that the groundwater remediation system will allow water quality conditions in the backwater area to meet the 0.6 mg/l chronic ammonia-nitrogen standard (personal communication, Henry Maddux, USFWS, SLC).

       Until a verifiable technical demonstration is made, uncertainty exists that DOE can successfully meet the required water quality conditions and prevent takings of endangered fish with the on-site stabilization option. Should DOE be unable to successfully complete this demonstration, the possibility exists that the time required for groundwater remediation will increase by more than 120 years. Under these circumstances a dramatic difference will exist between the on and off-site remediation options, and it could take more than 200 years of active groundwater remediation to cleanup the habitat, should the pile remain where it is. This would result in an increased cost to the total remediation project of more than $108,000,000. Comparatively, this value is more than 65% of the total cost for the on-site stabilization option, and therefore deserves significant evaluation and study.

       However, this issue is mute should DOE select eliminate the contaminant source term by relocating the tailings pile.

    B. River Migration – this controversy is more than a professional difference of opinion. The NAS has already established how critical this issue is to the fate of this site and protection of nearby natural resources, as follows (6/11/02 National Academy of Science, Board on Radioactive Waste Management Report to DOE, pp.3-4):

> *"III. DOE should critically examine important assumptions and conclusions in its analyses of the two primary alternatives, examine the likelihood that they might be invalid over the relevant time frames, and reassess the risks in this new light.*
>
> *The future risks from the stabilize-in-place alternative will depend on the long-term stability of the pile, the durability of the cover system, the longevity of society's memory regarding hazards at the site, the distribution and extent of contamination in the subsurface, the ability of engineered barriers to protect against movement of the course of the Colorado River toward the pile, and the persistence of organizational capabilities to respond to failures in the pile's integrity. In the current analysis, these issues are addressed by generally assuming that all engineered and natural systems will work as expected and that institutional memory will endure. The potential for these assumptions to be wrong, and the consequences if they are, need to be considered in more detail. These matters are discussed in Section V of the body of the committee's report.*
>
> *An example of an important assumption that should be reviewed at the Moab Site is DOE's acceptance of the U.S. NRC's finding that the risks that the Colorado River will intercept and carry away a portion of the mill-tailings pile are small and that this eventuality can be addressed by engineered measures.* ***In contrast, it is the committee's view that it cannot be assumed that the course of the Colorado River will remain in its current position over the next 1000 (or more) years****. While one cannot predict the timing of river migration (over the coming millennia or in the next several decades),* ***the committee sees it as a near certainty that the river's course will run across the Moab Site at some time in the future, unless engineered barriers prevent it from doing so****. In addition to appropriate consideration of the probability that the river will change course, the consequences if such an event were to occur have been examined only superficially. Accordingly, DOE should assess the risks—both probabilities and consequences—associated with river-pile interactions over time. If the stabilize-in-place option is selected, explicit consideration of this failure scenario is necessary, and the risks may warrant a plan for dealing with such failures."* (emphasis added)

After review of these NAS guidelines it is apparent that DOE made no effort to critically examine the previous Atlas and NRC position that river migration was of no consequence to the project. To this end, Utah DEQ and the Environmental Protection Agency (EPA) commissioned the USGS to conduct new river water velocity and shear force modeling to better assess the erosive forces that could interact with the tailings pile. This new study also provided an opportunity for a more robust, 2 and quasi-3-dimensional analysis of erosion potential; which represents a dramatic improvement over the simplistic and antiquated 1-dimensional model used previously by Atlas (1994 Mussetter Engineering Report).

In light of the NAS charge above, the need for an independent evaluation is clear in that the simplistic 1-dimensional model was performed for a client who had a conflict of interest to see the pile remain in place. Certainly due diligence and professional responsibility would indicate that an independent evaluation of the former model (1994 Mussetter Engineering Report) is in order. To do otherwise would be irresponsible.

The need for this new evaluation was obvious, in that channel avulsion and river migration is a time dynamic process that can be rapid and dramatic, especially for a large river system like the Colorado River. Recent flooding on the Santa Clara River branch of the Colorado River drainage is direct evidence of this possibility, where more than 25 homes were destroyed in a few hours. DOE's claims to the contrary – that river migration is a slow and passive process - are in direct contradiction with the knowledge and experience of common citizens who live near large rivers. Common sense tells us that periodic, long term monitoring and mitigation cannot guarantee that a catastrophic flood event won't erode and destabilize the pile in the future.

The new USGS hydrologic modeling has independently verified the river's potential to erode the right river bank. This new work is based on local topographic information provided in part by DOE, detailed site specific measurements of river channel bathymetry, and robust 2-dimensional river water velocity and shear stress simulations under 100 year and higher river flow rates (Kenney, Figs. 47-49, see Attachment 1, below). This new USGS modeling shows how the river can transport medium-sized (1.45-2.91 inch diameter) gravel at water velocities and shear forces found in the river's channel during 100-year flood conditions (Kenney, Fig. 47). Even larger sized sediment can be carried under higher river flow conditions (ibid., Figs. 48-49), or if channel scouring were to occur near the West Portal (ibid., Figs 50, 53, and 56). Certainly it is clear that if the Colorado River can transport sediments of this size, it could easily erode the fine silts and sands found on the riverbank and under the tailings pile. A copy of the USGS modeling report is included herewith as a part of DEQ's comments on the DEIS, see Attachment 1, below.

Furthermore, the recent USGS modeling is consistent with nearby geologic evidence. Large deposits of river terrace gravels are found near Kings Bottom, about 2 miles downstream of the West Portal. These deposits are geologic evidence that the Colorado River has experienced high water velocity, shear force, and erosive power in the geologic past (Doelling, et.al., p. 11 and Plate 1). Therefore, it is evident that the river's potential to erode the riverbank and undermine the tailings pile is real, and must be accounted for and resolved in DOE's decision-making process for determination of the pile's ultimate fate.

Comments on DEIS Volume 1

Chapter 1: Introduction

11. Section 1.4.1: On-Site Disposal Alternative (p. 1-7) – based on recent USGS river velocity and shear force modeling, flood protection will be required not only at the base of the tailings pile, but along extensive segments of the right river bank in Moab Valley. This same modeling shows significant erosive conditions will exist during a 100-year flood event across long areas adjacent to the mill site (Kenney, Fig. 47). As a result, should the DOE stabilize the pile in place, these vulnerable river bank areas will require extensive riprap protection to prevent the existing channel from migrating and undermining the tailings embankment. This will likely require a riprap wall that is 1,000's of feet long. Long-term maintenance of such a long erosion barrier would also be significant project cost. However, relocation of the tailings would eliminate the need for such costly erosion protection.

12. Section 1.4.3: Groundwater Remediation (pp. 1-9 and 10) – the Utah DEQ has several concerns with this section of the Draft Environmental Impact Statement (DEIS), as follows:

    A. Failure to Recognize State Jurisdiction for Groundwater – we agree with DOE's previous statements that Residual Radioactive Material (RRM) at Title I facilities is not defined as a contaminant under the Federal Clean Water Act or the EPA National Pollutant Discharge Elimination System (NPDES program), and is therefore not subject to this jurisdiction (3/17/04 DOE Responses, Chapter 2, Comment 40). However, this federal law and regulation apply only to navigable waters of the United States. Conversely, groundwater appropriations and quality issues are the jurisdiction of the States. Consequently, the State of Utah has authority over sources of groundwater pollution. Using this State authority, the Utah Department of Environmental Quality (DEQ) has classified the shallow aquifer at the Moab Tailings site as a Class IC aquifer, that needs protection in order to sustain a nearby wildlife habitat, that being the backwater area which is fed by groundwater on the nearby banks of the Colorado River. The DOE needs to recognize the State's authority and partner with DEQ to find a solution to protect the nearby water resources. Cooperation to find a solution to this problem, will avoid the need for escalated State action.

    B. High Uncertainty for Cost Estimates for Remediation – the time span estimated for cleanup of the polluted groundwater on the Moab Tailings site is highly uncertain. The DOE's conceptual model for the groundwater has only focused on shallow contamination. Little is known about the local groundwater – surface water interaction. Further, the DOE presentation does not acknowledge deep groundwater contamination created by high driving heads during historic operation of the tailings pile. Research on freshwater equivalent head done by the University of Utah has shown that it is possible for this deep contamination from the tailings pile to travel under the river (Gardner and Solomon, pp.14-15 and Fig. 7). The ultimate fate of this deep contamination is not known, nor have the potential receptors of this deep pollution been identified.

       Geochemical evidence regarding Oxygen-18 / Oxygen-16 ratios ($\delta^{18}O$) in groundwater on both sides of the river has also been presented to DOE by the University of Utah (Gardner and Solomon, pp. 18-20, Table 5 and Figs. 15 and 16). This evidence also shows how certain wells found in the Matheson Preserve have a $\delta^{18}O$ signature that is indicative of the lower elevation recharge from the Glen Canyon Group found in DOE wells near the tailings pile. As a result of these University findings it is clear that the Colorado River does not form the hydraulic barrier that it was once thought to be, and that deep groundwater from the DOE site can travel under the river and affect the Matheson Preserve. To date, DOE has refused to recognize these important data. Such uncertainty in the local groundwater – surface water relationship suggests the site is complex and not yet well defined hydrologically. Lacking a complete characterization of the local hydraulics, one can only conclude that the total cost and time span estimated by DOE for groundwater remediation are highly speculative, and deserve further study and determination.

Chapter 2: Description of Proposed Alternate Actions

13. Section 2.0: Groundwater Remediation paragraph (p. 2-4) – we agree that interception of the contaminated groundwater is essential to prevention of it polluting nearby surface water. However, the current remediation system discharges its contaminants back to the top of the

tailings pile. Thereby simply relocating the contaminant source term to an upstream location where it can be leached again and returned to the aquifer for renewed or repeated groundwater contamination. This "closed loop" system would appear to have the potential to exacerbate the ammonia salt layer problem and the secondary ammonia leachate pulse described above. Any long term remediation solution must break this "closed" loop approach and remove and prevent the contamination from being re-introduced into the shallow aquifer.

14. Section 2.1.1.2: Contaminated Soil, Vegetation, and Debris (p. 2-11) – prior to actual cleanup of site soils, please coordinate determination of background radium-226 concentrations with DEQ.

15. Section 2.1.1.4: Site Reclamation – Need for Longer Riprap Wall (p. 2-14) – as discussed above, the recent USGS river velocity and shear force modeling indicates a 100-year flood will cause widespread erosion of the riverbank in Moab Valley (Kenney, Fig. 47). Higher river flows and/or channel scour near the West Portal will only increase the potential for this erosion (ibid., Figs. 48-49, and 50, 53, and 56, respectively). Consequently, the riprap wall proposed in Fig. 2-3 will have to be greatly increased in length and rock diameter to protect the tailings pile from future erosion. This would add significantly to the project cost. However, relocation of the pile would make mute the need for more robust riprap protection.

16. Section 2.1.3.1: Borrow Material Standards and Requirements (pp.2-19 thru 22) – recent river velocity and shear force modeling by the USGS shows that under the possible maximum flood conditions (Q_{pmf}) that the tailings pile would be inundated to a depth of 25 feet above the toe of the pile (Kenney, Figs. 16 and 19). This same modeling also illustrated how the southeast corner of the pile would provide a restriction to river flow that would significantly increase water velocity and generate back-eddies next to the pile and across the mill site (ibid., Figs. 32 and 33). Consequently, if the pile is left in place, significant quantities of very large diameter riprap will be required along vast areas of the east and south facing sideslopes. Further, this protective blanket will need to extend vertically more than 25 feet above the toe of the tailings pile. The size of the riprap required and the quantity of the available borrow sources needs to be carefully evaluated in light of these performance requirements. However, should the pile be moved away from the Colorado River, this cover design specification need not be as rigorous, and would be much less costly to construct.

17. Section 2.1.4: Monitoring and Maintenance (p. 2-24) – with regards to riprap protection, we take exception with the statement that "… if an erosion problem were observed, the eroded area would be remedied by re-filling the area." The erosive power of the Colorado River is significant. As demonstrated by the USGS river velocity and shear force modeling, large areas of the right riverbank are vulnerable even during 100-year flood events (Kenney, Fig. 47). Several events of this magnitude should be expected in the DOE design analysis, which is required to consider a 200 – 1,000 year period. Larger flood events and channel scour near the West Portal would only exacerbate the erosive power of the river (ibid., Figs. 48-49, and 50, 53, and 56, respectively).

    In addition, DOE has overlooked how river channel avulsion is a rapid and catastrophic process that can drastically change channel location and geometry during acute runoff. Under these circumstances it may not be feasible or possible to re-fill these areas in a timely manner to control acute erosion. However, this issue becomes mute if the pile was relocated.

18. Section 2.2.5.1: Reference Disposal Cell (p. 2-77) – DOE should ensure the design of the topslope soil / rock admixture and the sideslope riprap layers are easily constructible. Following NRC guidance, the thickness of such layers should be at least 2-times the average particle diameter (D_{50}).

19. Section 2.2.5.2: White Mesa Mill Disposal Cell and Figures 2-36 and 37 (pp. 2-78 thru 81) – several issues need to be addressed for this option, including:

    A. State Regulatory Position: Groundwater Protection – Utah DEQ is an Agreement State under the U.S. Nuclear Regulatory Commission (NRC) 11e.(2) program for regulating uranium mills. Utah's uranium mill regulations, found in UAC R313-24-4(1)(b) require the mills to comply with the State Ground Water Protection Rules (UAC R317-6). By this means, uranium mill operators are required to comply with State requirements for groundwater quality protection.

    B. BAT Design Standards, Dry and Wet Cells - it is presumptive that only a clay liner would be necessary under the "dry" tailings disposal cell at the International Uranium Corporation (IUC) at White Mesa. Under the Utah Ground Water Quality Protection Regulations (UAC R317-6-1.25) this new disposal cell would be an new facility, and thus subject to the requirements of Best Available Technology (BAT) under these State rules [UAC R317-6-6.4(A)]. This would likely require double flexible membrane liners (FML) and leak detection, and thus greatly increase the cost of the project. Because the proposed cover design is integrated with other upgradient disposal cells, the "dry" cell cover system would also have to be carefully examined in this permitting process to ensure it met the performance standards already established in the facility's Ground Water Quality Discharge permit.

       The same is also true of the "wet" cell proposed, in that a single FML also fails to meet the BAT design requirement for liner systems. Again, because a FML is used in the under-liner system, a FML will also be required in the cover system to meet State BAT design requirements. These changes will increase the cost of the White Mesa disposal option.

    C. Radioactive Materials License Amendment Required - because Utah is now an Agreement State under the NRC Title II program, IUC would also have to amend its Radioactive Materials License to accommodate this disposal option at White Mesa. Said action would be in addition to the issuance of a State Construction Permit and modification of the existing Ground Water Quality Discharge Permit for the facility.

    D. Complication for Proposed Dry Cell Location – the currently proposed design locates the "dry" cell in an area where elevated uranium concentrations are known to exist in the shallow aquifer that exceed the State Ground Water Quality Standards (GWQS). These exceedances are found in three wells immediately adjacent to and downgradient of existing Tailings Cell 4A, and have exhibited a steadily increasing concentration trend for many years (DRC Statement of Basis, pp. 6 and 7). As a result, the exceedances are the subject of further study in an upcoming report required by the State Ground Water Quality Discharge Permit (ibid.). If these exceedances were to be determined to be the result of leakage from the IUC facility, groundwater remediation would be required in this area. That would be very difficult to do should the "dry" cell be constructed where it is proposed. Discrete groundwater monitoring of the new "dry" cell would also be complicated by the presence of such a plume. Therefore, the exact location of the "dry" cell should not be selected until completion of the referenced report, and a determination by DEQ as to the cause of the anomalous uranium concentrations.

20. Section 2.3.1.1: EPA Ground Water Standards – Omission of State Authority for Groundwater Protection – previously we have raised the issue of State authority for water quality protection (2/3/04 DEQ comments on Preliminary DEIS, Chp. 2, Comment 40). In response to this issue DOE took the position that Residual Radioactive Material (RRM) was not defined as a "pollutant" under the Clean Water Act (3/18/04 DOE response), and therefore the State had no jurisdiction over surface water quality issues at the Moab Tailings site. Further, DOE argued that the Moab Tailings pile was not a point source discharge, and therefore did not require a permit under the EPA National Pollutant Discharge Elimination System program, of which Utah is a Primacy State. We agree with DOE's arguments about the definition of "pollutant" and a point source. However, we remind DOE that the Clean Water Act is applicable only to navigable waters of the United States. As a result, federal law has left regulation of groundwater resources to the jurisdiction of the States. Under this premise, Utah has developed it own regulations for groundwater quality protection (UAC R317-6). These rules do apply to the Moab Tailings site.

    This said, we agree in concept with DOE's goal that the groundwater cleanup must be designed to protect the nearby backwater habitat. To this end, we have determined that the shallow aquifer below the Moab Tailings site is a Class IC aquifer, that must be protected as a source of water for wildlife habitat (UAC R317-6-4.4). Discussion found below elaborates our position regarding what groundwater cleanup standard is applicable to this end. DOE's cooperation with State authority in the matter will eliminate the need for escalated action.

21. Section 2.3.1.2: Contaminants of Potential Concern (p. 2-92) – we have several concerns with DOE statements in this section, as follows:

    A. Contaminant K_d Assumption - we agree that ammonia-nitrogen [NH_3(N)] is a significant contaminant at the Moab Tailings site. However, DOE's focus on only NH_3(N) in its planning of the groundwater remediation system assumes that all other contaminants of concern have the same soil-water partitioning coefficient (K_d) as NH_3(N). We understand that this was done to facilitate scoping-level decisions. However, should this geochemical assumption be found in error, the cost for groundwater remediation and surface water protection could escalate greatly.

    B. DOE Errors in Surface Water Point of Compliance Concepts and Policy – several errors were made in this DOE discussion regarding State policy and requirements for surface water quality compliance, contaminant mixing zones, and determination of an appropriate groundwater cleanup criteria for ammonia-nitrogen [NH_3(N)] in the backwater habitat, as outlined below:

        1) Acute Mixing Zone – the DOE is in error in its statement regarding the Utah Water Quality Regulations that "…no mixing zones are permitted for compliance with acute criteria." In contrast, the State rules depend on mixing zones to dilute or otherwise reduce point source discharges in rivers and streams (see Utah Administrative Code (UAC) R317-2-5). Beyond the acute mixing zone boundary, the acute standard must be met in the river's channel. Further, State rules also mandate that acute mixing zones must NOT (ibid.):

- Occlude or Obstruct the River Channel - instead, the width of the acute mixing zone cannot exceed 50% of the stream's width. This is done so as to allow adult fish the opportunity to swim around the acute mixing zone to avoid its toxicity (toxicity avoidance behavior).
- Have a Residency Time Greater than 15 Minutes –in other words, the acute mixing zone may not be longer than a distance equivalent to 15 minutes of in-stream travel time from the point source discharge. This length requirement is imposed in order to protect the downstream beneficial uses of the river.

Conceptually the acute mixing zone allows open channel turbulence to dilute the point source discharge to meet the acute standard. In practice, the mixing zone width and length criteria combine to control the maximum dimensions of an acute mixing zone. For a given point source discharge rate, these maximum dimensions may change with river stage. When river flow and velocity is high, the acute mixing zone may be narrow, and occupy a smaller relative cross-sectional area. Under lower flow conditions, the acute mixing zone may have a wider cross-sectional area. However, under all circumstances, the dimensions of the acute mixing zone must allow toxicity avoidance behavior of adult fish.

2) Applicability of Chronic Standards to Backwaters – from the above discussion it is clear that the chronic standard is applicable to the backwater habitats in question, for the following reasons:

- Lack of Point Source Discharge – discharge of contaminated groundwater to the backwater areas is not a point source discharge scenario. Therefore, the higher contaminant concentrations afforded by the acute standard, with its attendant mixing zone concept are NOT applicable to backwater habitat.
- Lack of Open Channel Turbulence – no open channel turbulence is found in backwater habitats, largely because they are open to the river's main channel only at their downstream end. Exchange of river water with the backwater habitat is only significant during rising river stage when water from the main channel enters at the downstream terminus. During this time river flow into the habitat is in a counter-current direction, and therefore little turbulence is expected. Without any open-channel turbulence no mixing zone can develop; and consequently, the acute standard is not applicable.
- Backwater Habitat: Largely Passive Flow - when backwater areas exist at the riverbank, they are fed primarily by groundwater baseflow, especially after peak runoff when river stage wanes, and when groundwater head is higher and dominates recharge to the backwater area. Because the Colorado River drainage is primarily an arid watershed, the river's flow for majority of the water year is derived principally from groundwater baseflow.

  Under rising river stage conditions, the exchange of river water into the habitat is rapid and transient. However, during these short periods, some horizontal seepage may also recharge the backwater by flowing thru the barrier sandbar. This source of recharge to the backwater will be a laminar flow, and not of a turbulent nature. Because rising river stage represents so little of the water year, it appears that the passive groundwater baseflow conditions are a much greater factor in life of a backwater area and its water recharge / quality conditions.

- Lack of Opportunity for Avoidance Behavior – the life stage of the fish we are trying to protect is the larval or fry stage that cannot resist the current of the river's main channel. Because these young cannot practice toxicity avoidance behavior, the chronic standard should apply in the backwater areas.
- Long Residence Time – by definition the chronic standard is based on a minimum exposure time of 4 days (UAC R317-6-2, Table 2.14.2). The backwater areas in question form a nursery for the endangered fish, who may reside in the habitat for weeks or months. In contrast, the acute standard is designed for a 1-hour exposure (ibid.). Consequently, the chronic standard applies to the backwater areas.
- Utah Narrative Standards – in addition to all these considerations, the Utah Water Quality Rules also include a Narrative Standard (UAC R317-2-7.2) for the protection of fish. Such narrative prohibits "…concentrations or combinations of substances which produce undesirable physiological responses in desirable resident fish." Certainly it is clear that to prevent mortality of the endangered fish, the chronic NH_3(N) standard is directly applicable to the backwater habitat.

C. Incomplete DOE Evaluation: Ammonia Transfer During Groundwater to Surface Water Interactions (p. 2-92) – the DOE states it has determined that NH_3(N) contamination is reduced by a factor of 10 when the contaminated groundwater transitions from the shallow aquifer to the backwater habitat. This conclusion is based on crude and flawed DOE calculations of groundwater to surface water "dilution factors", as based on data originally collected by Fairchild, et.al. (see DOE Site Observational Work Plan (SOWP), p. 5-116 and Table 5-32). Review of these DOE calculations show several discrepancies exist that need to be resolved before any credit for a groundwater "dilution factor" can be determined, as follows (ibid., Table 5-32):

1) Lack of Evaluation: Data Time Dependence and Water Flow Field – based on the discussion above, it is clear that groundwater – surface water interactions are highly time dependent, in that discharge from the shallow aquifer to the backwater habitat, or visa versa, is highly time dynamic and significantly effected by river stage. As a result, it is necessary to understand this dynamic and establish if the river was losing or gaining water at each sampling station, before any calculation of a "dilution factor" is made. To do otherwise, could greatly over-estimate the "dilution factor" in that a low concentration observed in the pore fluids under the river channel may be the product of river water infiltration caused higher river stage, and not dilution. As a result, the data and interpretation presented in the DOE SOWP (Table 5-32) are crude and biased.
2) Need for Time Intensive Sampling – the time dependence and water flow field factors outlined above make it clear that time intensive sampling is required in order to adequately establish both the flow field and water quality conditions at each sampling site, which in turn allow accurate determination of "dilution factors". The grab samples collected by the USGS and used in Table 5-32 of the DOE SOWP were likely collected with a different purpose in mind. To establish and defend any calculation of "dilution factor", DOE needs to complete an aggressive sampling program designed specifically for this robust, time dynamic problem.
3) Missing Quality Assurance Evaluation – no evaluation was made in the DOE SOWP regarding important quality assurance issues, which is needed to verify context under

which the data were collected. No information was provided on the use of any field filtering of either the river water or pore water samples collected. Nor was any description provided on where in the water column the surface water samples were taken (water surface, mid-column, base of channel, etc), or how (e.g., discrete grab samples, composite samples, etc.). No information was provided about where any of these samples lie with respect to its position within the groundwater contaminant plume. Without such information it is difficult to put the data in context and interpret what it means. All this needs to be done before calculation of any "dilution factor".

4) Lack of Statistical Power in DOE Calculations: Problem of Standard Deviation – if one ignores the above factors of time dependence, water flow directions, and quality assurance concerns, and simply calculates the standard deviation of the data presented in Table 5-32 of the DOE SOWP, it is easy to see that there is little statistical power in the DOE presentation. We have repeated DOE's calculations and agree that the mean "dilution factor" is 73.65, based on the 55 values they provided in the table. However, we have found that the standard deviation of this same data is almost 3-times greater, 195.91. This extreme variability indicates that the data are not normally distributed, and are likely unrelated to one another. This finding casts further doubt on DOE's conclusions regarding a "dilution factor" for the site. Further evaluation, sampling, and analysis is necessary in order for DOE to arrive at a defensible ammonia "dilution factor" for the backwater habitat in question.

5) Need Apply Chronic Standard to Groundwater – as a result of all these considerations, it is clear that DOE needs to collect additional data. Until DOE is able to provide a scientifically defensible evaluation of this contaminant transfer phenomenon between the local groundwater and the backwater habitat, the chronic ammonia standard, 0.6 mg/l, must be applied as a compliance strategy to the local groundwater.

From the above discussion it is clear why the acute $NH_3(N)$ standard has no application to the backwater habitat in question. It is also clear that only the chronic $NH_3(N)$ standard, 0.6 mg/l, is applicable to this critical habitat. Lacking the requisite studies to adequately determine the geochemical behavior of $NH_3(N)$ during its transfer from the contaminated groundwater to the backwater areas, DOE must take the conservative posture and apply the chronic standard as an interim groundwater cleanup criteria. To do neither the required studies, or apply the chronic standard as a cleanup goal will result in a takings of endangered fish, and is not protective of the environment upon which they depend.

22. Section 2.3.2: Proposed Ground Water Action (p. 2-98) – statements made by DOE that the duration required for active groundwater remediation is similar regardless of the selection of an on or off-site disposal option is an artifact of the artificial groundwater cleanup standard selected for ammonia-nitrogen, 3.0 mg/l. As already mentioned above, if the chronic standard, 0.6 mg/l ammonia-nitrogen, were selected, the duration would increase to 200 years or more (see DOE DEIS, Fig. 2-43).

23. Section 2.3.2.1: Groundwater Remediation Options (p. 2-101) – in the discussion regarding deep well injection disposal in the Paradox Formation of contaminated wastewater generated by groundwater remediation, the DOE may want to consider the higher chance of success for such disposal in the deeper Mississippian-age Leadville Dolomite Formation, which is known regionally as oil-producing horizon.

24. Section 2.3.2.4: Active Remediation Operations (pp. 2-106 and 107) – DOE has grossly underestimated the time and costs required for active groundwater remediation for the on-site option, based on the following two findings:

   A. DOE Cleanup Time Predictions are Artificial - the DOE statement that active groundwater remediation would only be needed for 75-80 years is an artificial construct built on the assumption that a groundwater cleanup goal of 3.0 mg/l (surface water acute ammonia-nitrogen standard) is appropriate for the Moab site. For reasons discussed above, this goal is not protective of the endangered fish in the backwater habitat areas. When the chronic ammonia-nitrogen standard, 0.6 mg/l, is used for this purpose, a striking difference arises in the comparative time required and related costs for on and off-site remediation of the tailings pile. Under this conditions, the time required for active groundwater remediation increases from 80 to 200 years (see DOE DEIS Fig. 2-43). This 120 year increase in the time the groundwater remediation system needs to be operated, equates to an incremental increase in total project cost of about $108,000,000 (see discussion above).

   B. DOE Contaminant Transport Model is Not Representative – Omission of Long-term Effects of Ammonia Salt Layer and Source Term Spike Concentration (Fig. 2-43) – the DOE statement that groundwater cleanup can be achieved in 75-80 years fails to include the effects of the ammonia salt layer in the tailings on the DOE contaminant transport model. Review of the DOE SOWP (pp. 6-11 and 12, and 7-23) show that DOE's contaminant transport model assumed a constant tailings pore fluid ammonia concentration source term (1,100 mg/l). However, by DOE's own estimates, this ammonia salt layer near the top of the tailings pile will solubilize and be transferred to the water table by infiltration seepage thru the on-site cover system. In turn, this seepage will then cause a 16-fold increase in the ammonia contamination applied at the water table (dissolved ammonia-nitrogen = 18,000 mg/l). Using DOE's estimates, this spike-like increase in ammonia would begin to arrive at the water table about 1,094 years after cover construction (SOWP, pp. 6-11 and 12 and Fig. 6-3). This means that the existing DOE ammonia break-thru curves (DEIS Fig. 2-43), are not fully representative, in that they are limited to the first 200 years of system performance, and that the asymptotic relationship shown for the on-site option will not hold true after year 1,094. At that point in time, the ammonia source term concentration applied to the water table will increase, and a subsequent spike increase in the predicted groundwater and backwater habitat concentrations will follow. DOE has estimated that the duration of this spike in ammonia concentration would be about 440 years (DEIS, p. 4-7 and SOWP, p. 6-11). Consequently, DOE's predictions that only 75-80 years of active groundwater remediation are required, ignore this delayed spike or pulse in the ammonia source term, and are therefore suspect. This also means that DOE has failed to fully evaluate the ammonia hazard to groundwater and the backwater areas for the entire life cycle or duration of the hazard, as instructed by the NAS (see discussion above). However, the long-term effects of this ammonia salt layer inside the tailings pile become mute, if the tailings are relocated.

25. Section 2.3.3: Uncertainties - Sensitivity and Omission of Key Transport Parameters and Need for Conservative Approach (pp. 2-108 and 109) – we have several concerns with the DOE statements made regarding uncertainty. We agree with the DOE statement that the outcome of contaminant transport modeling is commonly sensitive to the input values used. This is common knowledge by many who conduct contaminant transport modeling. Some of

these sensitive parameters include: soil/water partitioning (K_d) coefficients, contaminant source term, contaminant half-life, aquifer dispersion coefficients, etc. This is the underlying reason why DEQ is concerned about DOE's use of a surface water standard for the backwater habitat as a groundwater compliance and cleanup criteria for the project.

Unfortunately, DOE has simply assumed a 10-fold dilution will happen during transfer of the ammonia contamination from groundwater to surface water. This assumption is based on a crude evaluation of limited water quality data collected by others researchers who had another mission in mind. DOE's evaluation of this data is significantly flawed, and hence DOE's calculated "dilution factor" carries little weight or efficacy for the project. For additional details see DEQ discussion above. Despite these shortcomings, DOE has plowed ahead and made certain assumptions about its ability to control the contamination and protect backwater water quality habitat. At the nexus of this hubris is the risk that more than 120 extra years of active groundwater remediation could be required to cleanup this site, and the risk that the total project cost could be greater by at least $108,000,000. A matter with this weighty of a price tag deserves the expenditure of some resources to examine and resolve it.

This problem and the need for additional geochemical studies to examine these critical contaminant transport modeling assumptions were brought to DOE's attention during a July 9, 2003 conference call with DEQ staff, DOE, its contractors, and the U.S. Fish and Wildlife Service. At that time, DOE said it did not have time to fully explore and resolve this issue. Certainly the cost to resolve this issue will not decrease in the future. If DOE is unwilling or unable to study and resolve these concerns, it must then take a conservative posture and apply the same chronic ammonia-nitrogen surface water standard, 0.6 mg/l, as a groundwater cleanup criteria. To do otherwise is to take a huge gamble with a large amount of public money ($108,000,000).

26. Table 2-32: Summary and Comparison of Impacts – we have several concerns with statements made in this table, as follows:

    A. Surface Water (p. 2-140) – we take exception to the statement in this table that the on-site disposal option would result in only 80 years of active groundwater remediation. Based on the discussion above, 200 years or more may be required. It is important to consider the related price tag for this 120 or more years of extra groundwater cleanup, which equates to more than $108,000,000.

    B. Floodplains and Wetlands (p. 2-141) – no mention is made here about the adverse impact to the floodplain should river migration undercut the tailings pile and distribute contamination downstream. Based on the discussion above, this risk needs to be accounted for and the consequences discussed in this table.

    C. Accident Conditions, Disposal Cell Failure – Omission of River Migration Issue (p. 2-163) – DOE has flagrantly omitted any mention of adverse impacts to downstream users should the river migrate and undercut the tailings pile at some time in the future. Such destabilization would distribute contaminated tailings along beaches and sandbars across long stretches of the Colorado River. This contamination would have a significant impact to the local tourist economy. Costs to the public to cleanup such a spill would be extremely high and the task very difficult given the lack of access, the remote locations, and logistics of river travel thru the canyonlands.

27. Section 2.6.3: Consequences of Uncertainty – Omission of Sensitive River Migration Issue (p. 2-165) – we take strong exception to the statement that groundwater modeling is the only

aspect of uncertainty that has the potential to significantly effect the reclamation decision. As discussed above, DOE has acted in a biased and prejudicial manner in its downplay of the river migration issue for this site. Recent USGS hydrologic modeling has clearly demonstrated that this stretch of the Colorado River has the potential to undercut and de-stabilize the tailings pile under 100-year flood flow conditions. Even greater erosion potential is evident under higher flow conditions, and/or in combination with any river channel scour that may develop near the West Portal. Further, nearby river terrace gravel deposits found also provide sound geologic evidence of the river's erosive power in the past. Clearly the National Academy of Science identified this issue as critical to the project reclamation decision. To leave the pile in place and then have the river undercut and destabilize it during a future flood event would have dramatic negative impacts to tourism and recreational uses of the river between Moab and Lake Powell. Contamination left on beaches and sandbars along this stretch or the river would be extremely difficult and costly to cleanup. These impacts must be discussed in this section regarding the consequences of uncertainty. The costs that would follow such a failure also need to be clearly spelled out for all to see.

28. Table 2-33: Consequences of Uncertainty (pp. 2-166 thru 175) – this table is a recapitulation of the same discussion in Table S-1 of the DEIS Summary. Therefore all the State comments above for Table S-1 apply to this section also (see discussion beginning on page 2, above).

29. Section 2.7.1: Areas of Controversy – FWS Position (p. 2-165) – we take strong exception with the implication that the US Fish and Wildlife Service (FWS) agrees with DOE on the application of target goals for groundwater cleanup. As stated previously, DEQ discussions have found that both DEQ and FWS agree that the chronic ammonia-nitrogen standard must be met in the backwater habitat in order to protect endangered fish. However, the DOE statement that "The USF&WS agrees with DOE that the target goals that DOE has selected would be protective of aquatic species in the Colorado River" is misleading. What was not said, is that this FWS agreement is conditioned upon unsubstantiated DOE affirmations that the proposed groundwater cleanup goal (acute 3.0 mg/l ammonia-nitrogen standard) will allow water quality conditions in the backwater habitat to meet the 0.6 mg/l chronic ammonia nitrogen standard (personal communication, Henry Maddux, FWS – Salt Lake City).

    To date, DOE has not completed any technical studies to confirm if its claim can actually be met. Further, DOE's assumptions on the groundwater to surface water dilution factor are weak and without merit, as discussed above. In addition, DEQ has little confidence in DOE's contaminant transport predictions, in that it failed to incorporate the effects of the secondary ammonia pulse that would result long-term from leaching of the ammonia salt layer found in the upper portion of the tailings pile.

    Further, it is important to note that the FWS will stipulate conditions in the upcoming Biologic Opinion to require DOE to positively demonstrate that the groundwater remediation system will allow water quality conditions in the backwater area to meet the 0.6 mg/l chronic ammonia-nitrogen standard (personal communication, Henry Maddux, USFWS, SLC).

    Until this demonstration is made, it is uncertain if DOE can successfully meet the required water quality conditions and prevent takings of endangered fish with the on-site stabilization option. Should DOE be unable to successfully complete this demonstration, it is possible that the time required for groundwater remediation will increase by more than 120 years (from 80 to 200 years total). This would result in an increase in the total on-site remediation cost of at least $108,000,000. Such a large amount of public resources deserves additional evaluation to determine if the proper geochemical conditions exist to support DOE's groundwater dilution assumptions. Lacking such an evaluation, the DOE should conservatively assume at least a 200 year timeframe for active groundwater remediation under the on-site option, and include these related costs in the total project cost.

Should DOE be unsuccessful in making this demonstration, a dramatic difference will exist between the on and off-site remediation options in that the on-site option would take 200 years instead of 80 to cleanup the groundwater. This would result in an increased cost to the total on-site remediation project of $108,000,000, which is about 65% of the total cost for this option. Under these circumstances there would be a significant difference in the costs for the on-site versus off-site solutions (contrary to DOE's statements). This information must be provided to the policymakers.

30. Section 2.7.1: Areas of Controversy – Comparability of Groundwater Remediation Costs (p. 2-176) – the DOE statement that "Groundwater remediation would occur under any of the action alternatives" must be clarified. As discussed above, leaving the pile in place will perpetuate the contaminant source term, and likely require 200 years or more of active groundwater remediation in order to meet the 0.6 mg/l chronic ammonia-nitrogen standard. For this reason, there is a dramatic difference in groundwater remediation costs for the on-site versus the off-site options.

31. Section 2.7.3: Costs – Need to Revise Reflect Omitted Issues (p. 2-178 and Table 2-35) – discussion in this section has omitted 2 critical issues that have significant bearing on the costs involved, as follows:

    A. On-Site Implications for River Migration – recent USGS river water velocity and shear force modeling has demonstrated that the river has the potential to move particle sizes in the range of medium sized (1.45-2.91 inch) gravels under the 100-year flow condition, see Attachment 1, below (Kenney, Fig. 47). Larger particle sizes can be moved under higher flow rates (ibid, Figs 48 and 49), or if scouring of the river bed occurs at the West Portal (ibid., Figs. 50, 51, or 52, etc). Clearly if the river channel can transport material this size it can easily erode silts and fine sands found on the riverbank and under the tailings pile. Consequently, if the on-site option is selected, the right riverbank will need to be armored to protect the tailings pile from erosion.

       We also strongly disagree with DOE that river migration will be a slow process that can be managed from year to year. On the contrary river avulsion can be rapid and catastrophic, especially under flood conditions found in the arid southwestern United States. This was recently reaffirmed in Utah when the Santa Clara river jumped its banks and destroyed more than 25 homes in a matter of hours.

       As a result, the riprap protection required to protect the tailings pile will need to be extensive and run for 1,000's of feet along the mill site and adjacent to the tailings pile (ibid., Fig. 47). This material will need to be significantly larger in diameter than what the river can transport, and of high quality to resist these erosional forces. The costs associated with this construction need to be added to the on-site option in Table 2-35.

    B. On-Site Implications for Chronic Ammonia-Nitrogen Standard for Groundwater Cleanup - the statement that the on-site option will require only 80 years of active groundwater remediation is an artificial construct based on an substantiated DOE assumptions regarding the applicable groundwater cleanup standard and "dilution" factors. As discussed above, this figure could be greatly larger should the 0.6 mg/l chronic ammonia-nitrogen standard be applied to the groundwater cleanup. Further, DOE's groundwater to surface water "dilution" factor is suspect. As a result, more than $108,000,000 is riding on these DOE assumptions. Should DOE be wrong on either of these, more than 200 years of active groundwater would be required, which would result in an increased project cost of at least $108,000,000 (120 extra years @ $900,000/year). Certainly this problem deserves additional study and evaluation. However, if DOE is unable to complete this pre-requisite work, the conservative assumption should be made and the on-site stabilization option increased to reflect this additional cost. Please modify Table 2-35 to reflect at least a $108,000,000 increase in the on-site stabilization cost.

32. Section 2.7.3.1: On-Site Versus Off-Site Disposal Alternative Comparison (p. 2-179) – the percentages listed need to be revised. The cost figures in Table 2-35 need to be adjusted to reflect at least 120 more years of additional active groundwater remediation that will be needed for the on-site stabilization option, as a result of the chronic ammonia-nitrogen (0.6 mg/l) standard for groundwater cleanup and the failure to evaluate the secondary ammonia pulse. At a minimum, the total project costs should be changed as shown in the table below. With these new figures, the Klondike Flat option is only 14% more than the on-site stabilization alternative, while the Crescent Junction is only 15% more.

    Given the risk of river migration that the on-site option poses, the related design engineering/construction costs to control the river, and the long term maintenance costs that might be involved, this 14% differential is an inexpensive insurance policy.

	Stabilize in Place	Klondike Flats			Crescent Junction			White Mesa	
		Truck	Rail	Pipeline	Truck	Rail	Pipeline	Truck	Rail
Previous DOE Grand Total (Table 2-35)	$248.8 M	$407.2 M	$468.7 M	$472.1 M	$410.8 M	$472.3 M	$479.0 M	$497.1 M	$542.7 M
120 years of Extra Groundwater Remediation	$108 M	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Extra Riprap Protection	TBD	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
New Grand Total	$356.8 M	$407.2 M	$468.7 M	$472.1 M	$410.8 M	$472.3 M	$479.0 M	$497.1 M	$542.7 M
Ratio of Offsite to Onsite Costs	1.00	1.14	1.31	1.32	1.15	1.32	1.34	1.39	1.52

None of these figures include the 440 years of active groundwater remediation that will be needed at year 1,110 to control the secondary ammonia pulse from leaching of the ammonia salt layer found in the upper reaches of the pile. If we use the $900,000/year cost estimate for this active groundwater remediation, the cost for future control of this ammonia salt layer alone would represent more than $395 Million. Under these circumstances, the Klondike option would be even less costly than the on-site alternative.

Chapter 3: Affected Environment

33. Section 3.1.1.1: Moab Site Stratigraphy – Need to Define Age of Quaternary Deposits (p. 3.6) – previously we suggested that DOE needs to determine the age of nearby Quaternary deposits in order to establish if the river has a potential to migrate and undercut the pile (2/3/04 DEQ Comments on Preliminary DEIS, Chp. 3, Comment 1). DOE responded that the 11/03 DOE River Migration Report adequately addressed this concern. We disagree. Recent USGS modeling has established that the Colorado River can easily transport medium sized (1.45-2.91 inch) gravel materials under 100-year flood conditions (see Attachment 1 below, Fig. 47). Even larger particle sized can be transported by the river under higher flow rates and/or if the river scours its channel near the West Portal (ibid., Figs. 48-49 and 50, 53, and 56, respectively). Certainly the fine silts and sands found on the riverbank and under the tailings pile are much more prone to erosion. As a result, the need for this age dating is more important than before, should DOE select the on-site stabilization option.

34. Section 3.1.1.4: Geologic Hazards – Omission of River Migration – no mention is made in this section regarding horizontal river migration, channel avulsion, or possible undercutting of the tailings pile by the river. Clearly, the river has significant potential to migrate horizontally and undercut the pile, as demonstrated by recent USGS river velocity and shear force modeling where it was demonstrated that a 100-year flood event could easily move medium diameter (1.45-2.91 inch) gravel in the river's channel (see Kenney, Fig. 47 in Attachment 1, below). Certainly the finer grained silts and sands in the riverbank near the tailings pile would be even more prone to erosion under these conditions. Furthermore, higher river flow rates in a 500-year or larger flood, could move even larger particle sizes (ibid., Figs. 48 and 49). The same is true if the river scours its channel near the West Portal (ibid., Figs 50, 53, and 56). Recent experience with 100+ year floods on the Santa Clara River system have shown that horizontal migration of the river's channel can be swift and dramatic. DOE must thoroughly evaluate this geologic hazard in this section.

35. Section 3.1.3.1: Millsite Contamination (p.3-9) – in addition to the focus on Radium-226 concentrations, DOE should also evaluate the mill site soils to determine the concentrations of other key contaminants. This evaluation should be done in order to ensure that all mill site soil contaminants are properly controlled and do not form source terms for future leaching and groundwater contamination. Emphasis needs to be put on heavy metals, ammonia-nitrogen, and other non-radiologic contaminants.

36. Section 3.1.6.2: Moab Site Groundwater Occurrence (pp. 3-19 and 20, Fig. 3-8) – the description of the conceptual groundwater model on page 3-19 should include 2 important concepts, as follows:

    A. Vertical Extent of Legacy Groundwater Contamination – groundwater contamination from historic site operations have caused tailings related contaminants to be found below the freshwater-saltwater boundary (~35,000 mg/l TDS). We agree with your discussion on page 3-26 of how site operations generated a dense wastewater (TDS of 50,000 –

150,000 mg/l) that penetrated the 35,000 mg/l saltwater boundary, thereby contaminating the deep brine layer.

B. Ongoing Contamination Effects of Diffusion from Contaminated Saltwater Layer – contaminants are transferred from the deep saltwater layer to the freshwater layer thru diffusion. As a result, historic groundwater contamination found below the freshwater-saltwater interface will continue to contribute contaminants to the freshwater system and backwater areas for an extensive period of time. This diffusion will prolong the time it takes for the legacy plume to be eliminated from the freshwater system under both passive flow conditions or active groundwater remediation.

37. Section 3.1.6.3: Moab Site Groundwater Quality – we have several concerns with DOE statements made in this section, as follows:

A. Need to Better Define Groundwater – Surface Water Interactions (Fig. 3-9) – Figure 3-9 of the DEIS shows the freshwater - saltwater interface (35,000 mg/l TDS contact) as converging on the Colorado River. However, no nested piezometer data is available to confirm this relationship at the river's edge. Consequently, it is possible that this basal boundary to the freshwater system does not intercept the river at this location, but at some other location. To define this relationship, DOE should install nested piezometers at the river's edge and carefully monitor river stage and groundwater head in a very time dynamic way. Until this relationship is well defined, we won't know for certain how many receptors may be exposed to tailings contamination.

The lack of shallow groundwater convergence on the river is also evident in groundwater data collected by the University of Utah, where oxygen-18 to oxygen-16 ratios ($\delta^{18}O$) indicate that groundwater in the freshwater system on the DOE side of the river has traveled under the river and is found in certain areas of the water table under Matheson Preserve. This groundwater underflow beneath the river is evident where groundwater under the Matheson Preserve has a similar $\delta^{18}O$ signature as groundwater found near the tailings pile, i.e., with $\delta^{18}O$ values between –13 and –12, which is indicative of Glen Canyon Group recharge from a lower elevation [see Gardner and Solomon, pp. 18-20, Figs. 15 and 16, and Table 5, wells BL-1 (D), BL-2 (S, M, and D) N8 (10 and 14m) N11 (4 and 7m) , M11 (12 and 14m), BL-3 (S, M, and D)]. In contrast, other wells on the Matheson Preserve side of the river exhibited even smaller $\delta^{18}O$ values, in the range of –15 to –14, which is indicative of a higher elevation precipitation and groundwater recharge on the nearby La Sal mountains [ibid., Fig. 2, Table 5, and wells N3 (4 and 8m), N4 (6 and 12m), N5 (7, 10, and 14m), N6 (6 and 9m), N7 (7 and 10m), and W1 (4 and 7m)]. For comparison, a river water sample collected by the University in April, 2003 during spring runoff at site CR1 showed a $\delta^{18}O$ value of –15.4, which is also indicative of high elevation precipitation (ibid., Table 5). If the Colorado River was a hydraulic barrier, as claimed by DOE, then all the wells on the Matheson Preserve side should show small $\delta^{18}O$ values, on the order of –15 to –14.

Since this is not the case, the University of Utah geochemical evidence indicates the groundwater / surface water relationship is complex near the Moab Tailings site. This relationship needs to be well understood so as to define the fate of the groundwater contamination and adequately design a remediation system to control it. This information was brought to DOE's attention previously during comments on the Preliminary DEIS (2/3/04 DEQ Comments, Chp. 3, Comment 8). However, DOE chose to ignore it.

B. Need to Explain and Justify Background Groundwater Concentrations (pp. 3-21 thru 24 and Table3-7) – review of Table 3-7 has found that the "background" concentrations were derived from the DOE SOWP, Table 5-11. In turn, these data were based on 2 groups of monitoring well data that need revision, as follows:

1) Fresh Qal Facies – as based on wells RW-01, AMM-1 and MOA-456 (DOE SOWP, p. 5-51). However, no explanation is provided in the DOE SOWP on why these 3 wells represent background groundwater conditions. Further, well AMM-1 appears to be located downgradient of the former Atlas ore-storage area (compare SOWP, Fig 5-19 with DEIS, Fig. 3-7). Consequently, groundwater at this location may have been affected by historic site operations, and this well should be omitted from consideration in determining background ground water quality.

   In addition, the average TDS in each of these wells varies by more than 10-times, e.g., 708 mg/l in well RW-01, 5,530 mg/l in well MOA-456, and 7,113 mg/ in well AMM-1 (DOE SOWP, Table 5-8). Such high variability in groundwater quality could be a product of natural conditions. However, given the long history of this site and the possibility that well AMM-1 could be located downgradient of the former ore storage area, this well should be eliminated from any determination of background groundwater quality.

   Previously, DEQ recommended that DOE consider use of groundwater quality data from the nearby water supply well at the Arches National Park Headquarters, to represent background groundwater quality for this facies (2/3/04 DEQ Preliminary DEIS Comments, Chp. 3, Comment 11). Clearly, this geologic formation recharges the shallow alluvium found near the site, and this well is located at a sufficient distance from the tailings site, that it is unlikely to have been influenced by past tailings disposal activities. Unfortunately, DOE ignored this suggestion, and instead included the tainted well AMM-1 in its background determination.

2) Brine Qal Facies – was based on several wells apparently located in the Matheson Preserve, including: M11-14, N7-10, N7-11, W1-4.3, W1-7, and W1-10 (DOE SOWP, p. 5-54 and Table 5-9). The DOE SOWP also mentions that two other wells were used in this analysis, M9 and M10, from a 1994 Cooper and Severn Study. However, no information is provided in the SOWP to locate these last two wells (SOWP, Fig. 5-23) or to provide any groundwater quality data from them (SOWP, Table 5-9). Furthermore, no explanation is provided in the SOWP on why any of these wells represent background groundwater conditions in the Brine Qal facies.

   As discussed above, well M11-14 should not be considered used in this background evaluation, in that it has a $\delta^{18}O$ signature that does not reflect the high elevation recharge of other wells in the Matheson Preserve, but instead has a signature similar to that seen on the opposite side of the river near the Moab Tailings (Gardner and Solomon, Table 5). This $\delta^{18}O$ signature indicates that groundwater found in well M11-14 may originated from Glen Canyon Group recharge from the DOE side of the river, and therefore may have been influenced by historic site operations and tailings seepage. This possibility needs to be thoroughly examined and eliminated before inclusion of this data into the background groundwater quality data set.

In summary, any determination of background groundwater quality for either of these facies must include a careful and detailed examination and justification of hydrogeologic and geochemical considerations, to ensure that the data so used represents natural groundwater quality conditions that have not been influenced or altered by man's activities.

C. Missing State Groundwater Quality Standards (Table 3-7) – no consultation was made with DEQ to determine State Ground Water Quality Standards that may be applicable to the site cleanup. These parameters and corresponding concentrations need to be added to Table 3-7 of the DEIS.

D. Unsubstantiated Ammonia Dilution Factor (p. 3-26) – we disagree that sufficient data is available to justify a 10-fold dilution factor for the ammonia-nitrogen transfer from shallow contaminated groundwater to the backwater habitat. Details comments regarding the problems with DOE's assumptions are discussed above.

E. Need to Resolve Fate of Tailings Contamination in Deep Saline System (p. 3-26) – we agree that:

1) There is a shallow freshwater system of groundwater that overlies or floats on a heavier saline groundwater system at the site,

2) That historic tailings pile seepage has traveled downward to a depth greater than the saltwater interface (35,000 mg/l TDS) which forms the base of the freshwater system shown on Figures 3-8 and 9, and

3) That this historic pollution has created a deep "reservoir" of ammonia contamination that will continue to contaminate the shallow freshwater system thru diffusive processes.

However, no mention is made in the DEIS about advective transport of this deep contamination, or its fate in the environment. Instead the DOE DEIS focuses only on the shallow freshwater system at the site.

Previous work by the University of Utah has shown that the deep saline groundwater below the 35,000 mg/l TDS interface travels horizontally beneath the Colorado River and under the Matheson Wetlands (Gardner and Solomon, p. 15 and Figure 7). Other lines of geochemical evidence, such as groundwater $\delta^{18}O$ values, also support this conclusion (ibid., pp. 18-20 and Figures 15 and 16). This information conflicts with that shown on DOE DEIS Figure 3-9, which suggests the deep saline system discharges directly to the river. DOE needs to define local groundwater – surface water interaction, including the interaction of the river with the deep saline system, so as to determine the fate of this deep seated pollution and its possible future effects on the environment. This issue was brought to DOE attention previously in DEQ comments on the Preliminary DEIS (2/3/04 DEQ Comments, Chp. 3, Comment 8). To date, DOE has failed to resolve this issue in its groundwater cleanup efforts.

38. Section 3.4.5.3: White Mesa Site Groundwater Quality – Still Under Investigation (p. 3-142) - the claim made that 20 years of monitoring shows the existing tailings cells have not effected local groundwater quality in the shallow aquifer is still a matter of investigation. Anomalous uranium concentrations have been detected downgradient of existing Tailings Cell 4A that IUC is required to examine and explain as a mandate of their State Ground Water Quality Discharge Permit (12/1/04 Utah Division of Radiation Control Statement of Basis, pp. 6-7). With regards to the on-going chloroform contaminant investigation, the company has not yet completed its Groundwater Contaminant Investigation Report required by an August 23, 1999 Utah Division of Water Quality Ground Water Corrective Action

Order. Therefore, it is premature to conclude how many sources of chloroform actually contributed to the contaminant plume found along the eastern margin of the site.

Chapter 4: Environmental Consequences

39. Section 4.1.1.1: Construction and Operations Impacts at Moab Site, Geology – Omission of River Migration – horizontal river migration has been omitted from this section. No mention is made regarding channel avulsion, or possible undercutting of the tailings pile by the river. Clearly, the river has significant potential to migrate horizontally and undercut the pile, as demonstrated by recent USGS river velocity and shear force modeling where it was demonstrated that a 100-year flood event could easily move medium sized (1.45-2.91 inch) gravel in the river's channel (see Kenney, Fig. 47 in Attachment 1, below). Certainly the finer grained silts and sands in the riverbank near the tailings pile would be even more prone to erosion under these conditions. Furthermore, higher river flow rates in a 500-year or larger flood, could move even larger particle sizes (ibid., Figs. 48 and 49). Also the presence of any channel scouring near the West Portal could also increase the rivers erosive power (ibid., Figs. 50, 53, and 56). Recent experience with 100+ year floods on the Santa Clara River system have shown that horizontal migration of the river's channel can be swift and dramatic. DOE must evaluate this geologic hazard in this section.

    Also, the recent USGS river velocity modeling shows that the river channel areas prone to this erosion in a 100-year flood event are extensive, being 1,000's of feet long, and are found both near the pile and adjacent to the mill site area (Kenney, , Fig. 47, see Attachment 1, below). As a result the small riprap diversion wall proposed in Fig. 2-3 is insufficient in both length and particle size to protect the tailings pile from river migration.

40. Section 4.1.3.1: Construction and Operations Impacts at Moab Site, Groundwater (pp. 4-6 thru 10) – several concerns are apparent from DOE statements made in this section, as follows:

    A. Failure to Describe Long-Term Impact of Ammonia Salt Layer on Groundwater Cleanup Project (p. 4-8 and Figure 4-1) – the contaminant breakthrough curve shown in Figure 4-1 was based on a constant ammonia contaminant source term of 1,100 mg/l (DOE SOWP, pp. 6-11 and 12, and 7-23). However, by DOE's own estimates, the ammonia salt layer near the top of the tailings pile will be dissolved and transferred to the water table by infiltration seepage thru the on-site cover system. In turn, this seepage will then cause a 16-fold increase in the ammonia source term contamination applied at the water table (dissolved ammonia-nitrogen = 18,000 mg/l). Using DOE's estimates, this ammonia pulse would arrive at the water table about 1,094 years after cover construction (SOWP, pp. 6-11 and 12 and Fig. 6-3) and continue for about 440 more years or until the ammonia salt layer was depleted (DEIS, p. 4-7).

       The impact of this ammonia pulse indicates that the 200-year break-thru curves found in the DEIS (Figs. 2-43 and 4-1), are not representative of the anticipated leaching of the ammonia salt layer leaching from the tailings pile, in that a second ammonia pulse will arrive at the water table after year 1,094. Because this pulse will then increase the ammonia contaminant source term by a factor of about 16-times, higher groundwater and backwater habitat concentrations should be expected, than those predicted by the DOE model. As a result, the DOE contaminant transport modeling (DEIS Figures 2-43 and 4-

1) does not represent the anticipated long-term ammonia concentrations in the groundwater system. Consequently, DOE's predictions that only 75-80 years of active groundwater remediation are needed are biased and un-defensible. It also means that even if only 200 years of active groundwater remediation were required, that sometime after year 1,100, the delayed ammonia pulse could cause the need for a second phase of active remediation might need to be sustained for another 440 years in order protect the backwater habitat. During this second pulse of ammonia contamination, the groundwater cleanup costs could be as high as $396 Million (440 years time $900,000/yr). If this were the case, the price tag for the on-site option could easily be double that currently estimated by DOE.

However, the long-term effects of this ammonia salt layer inside the tailings pile become mute, if the tailings pile is relocated.

B. Applicable Groundwater Cleanup Standard (p. 4-9) – as discussed above the groundwater cleanup goal for ammonia-nitrogen needs to be the chronic standard (0.6 mg/l) and not the acute standard (3.0 mg/l). Use of this lower cleanup goal would necessitate DOE actively groundwater remediation for at least 120 more years, which in turn would significantly increase the total remediation cost for the project.

41. Section 4.1.4.1: Construction and Operations Impacts at Moab Site, Surface Water (p. 4-12) – we disagree that the on-site stabilization option will only require 80 years of active groundwater remediation. For reasons discussed above this figure is at least 200 years, and may be as long 640 years after consideration of the ammonia salt layer that will be leached from the tailings pile at sometime in the future.

42. Section 4.1.5.1: Construction and Operations Impacts at Moab Site, Floodplains and Wetlands (p.4-13) – we disagree that the buried riprap wall shown in Figure 2-3 will be sufficient to protect soil in the floodplain and the tailings pile from the effects of river migration. Recent USGS modeling shows that the in-channel water velocity and shear forces are high enough during a 100-year flood event to erode particles as large as medium sized (1.45 – 2.91 inch) gravel (Kenney, Fig. 47, see Attachment 1, below). Even larger particl sizes can be transported by the river under higher flow events, or should the river scour its channel near the West Portal (ibid., Figs 48-49, and 50, 53, and 56, respectively). Certainly the finer silts and sands found on the riverbank and under the tailings pile are much more prone to erosion. In light of this recent USGS modeling, it is clear that any riprap wall design sufficient to protect the tailings pile would have to be 1,000's of feet long, extend across both the toe of the pile and the mill site area, and consist of very large diameter riprap in order to resist the projected erosive forces (ibid.). Design, construction and long-term maintenance costs for such a long riprap wall would be significant, and need to be factored into the total costs for the on-site option. Without such a robust erosion protection design, DOE should expect river migration and related erosion will adversely impact floodplain soils and the tailings pile.

43. Section 4.1.6.1: Construction and Operations Impacts at Moab Site, Aquatic Ecology – Chemical Impacts (p. 4-16 and 17) – we strongly disagree with DOE's proposed groundwater cleanup goal for ammonia-nitrogen of 3.0 mg/l. As discussed in our comments on Chapter 2, above; only the chronic ammonia-nitrogen standard, 0.6 mg/l, is applicable to the backwater habitat. Also, DOE's assumption of a 10-fold dilution of ammonia at the groundwater to surface water transition is unsubstantiated. Until DOE can confirm this assumption thru time

dynamic and representative field studies, the 0.6 mg/l ammonia-nitrogen standard must be applied as a groundwater cleanup goal.

44. Section 4.1.17: Disposal Cell Failure from Natural Phenomena (p.4-50 thru 56) – we disagree with several DOE statements made in this section, as follows:

    A. Error in Slow, Passive River Migration Assumption (p. 4-50) – the DOE has simply understated the forces that control and govern river migration. Channel avulsion is a highly time dynamic process that can occur catastrophically over very short periods of time. Recent loss of more than 25 homes on the Santa Clara River in Utah over the course of just a few hours is a clear reminder of how swift and immense these forces can be. DOE's claim that river migration will always be a slow and easily controlled phenomenon is a tremendous show of hubris. Consequently, river migration must be considered as a part of a catastrophic upset of the tailings pile.

    B. Need to Remediate Downstream Beaches (p. 4-54) – the DOE statements made on page 4-54 downplay the risk of radium-226 tailings contamination to nearby sandbars and beaches, and the impact of this pollution on the local tourism economy. From DOE calculations presented in Table 4-18 and the maximum sediment exposure level for camping provided in Table 4-19 (1,700 pCi/gm radium-226 in sediments), it would appear that only about 36% of the pile would need to be washed into the Colorado River before sand bar and beach sediments near the Moab site would meet this maximum camping exposure criteria for radium-226 [(1,700 pCi/gm / 944 pCi/gm)* 20%]. This is not a far-fetched scenario when you consider that the river has the ability to transport medium sized (1.45 – 2.91 inch) gravel under a 100-year flood event (see USGS modeling in Kenney, Fig. 47), and that large expanses of the local riverbank appear to be composed of sediments that are much finer (silts and sands). This possibility is also reasonable after you consider that: 1) larger river flows can transport even larger sediment sizes (Kenney, Figs. 48 and 49), and 2) the river's capacity to erode its riverbank and undermine the tailings pile is increased further, should the river scour its channel at the West Portal (see Kenney, Figs, 50, 53, and 56).

       For sand bar and beach sediments below the Green River confluence, it would appear that only 66% of the tailings pile would need to be washed away in order for this same camping exposure criteria to be met [(1,700 pCi/gm / 515 pCi/gm)* 20%].

       From this information it is clear that the loss of control of the tailings due to river migration would be a catastrophic failure scenario and would create an unacceptable exposure to downstream river recreation users and campers. It is also clear that such losses would require significant expenditure of public funds to capture and regain control of this contamination. Given the remote locations and difficult access to the impacted areas, the cost to cleanup the contaminated sandbars and beaches would be astronomical. Such loss would pose a lengthy and significant adverse impact on the local tourism economy. For all these reasons, it would be prudent to prevent the problem in the first place and relocate the tailings to a more stable location away from the Colorado River.

    C. Error in Assumed Direction of River Migration (p. 4-55) – we strongly disagree with DOE's statement that the river can only migrate away from the tailings pile. Errors have been found in DOE's November, 2003 River Migration Report that prove that the Colorado River has migrated both towards and away from the tailings pile in the last several decades. For details regarding these errors we refer the DOE to comments provided by Dr. John Dohrenwend. Again, DOE's claim that the river can only migrate away from the tailings pile is a blatant insult of common sense.

D. Problem with Riprap Diversion Wall (pp. 4-55 and 56) – after review of the recent USGS river velocity and shear force modeling, it is clear that an extensive length of the river is prone to erosion under a 100-year flood event, and given the presence of fine grained silts and sands in the local riverbank and under the tailings pile (Kenney, Fig. 47, see Attachment 1, below). This same USGS modeling also showed that even larger sediment can be transported by the river, and even longer stretches of the river are prone to erosion, should higher flow events occur, or should the river scour its channel near the West Portal. This same modeling also demonstrated how the pile will impede river flow and create significant water velocity and shear forces near its southeast corner (ibid., Figs.32 and 33). Significant velocities and shear forces will also be generated in large areas across the mill site and in the floodplain near the tailings pile (ibid., Figs. 47, 48, and 49). All of these findings reinforce the conclusion that the small and limited riprap diversion wall shown in DOE Figure 2-is insufficient to control river migration. Instead, any riprap diversion wall that has any hope of controlling river erosion will need to be 1,000's of feet long and extend both along the toe of the pile and across the entire mill site area. Because the depth of the river will be great under the possible maximum flood (25 feet, Kenney, Fig. 19), the vertical extent of this riprap will also need to be great. The added costs for these erosion protection measures need to be incorporated into the on-site cost option. However, the need for such structures and erosion protection would be eliminated should DOE move the tailings pile.

Chapter 7: Regulatory Requirements

45. Section 7.1.2 Uranium Mill Tailings Radiation Control Act, 42U.S.C.§§ 7901 et. seq, as amended – as mentioned previously in comment 19A, Utah is now an Agreement State for regulation of uranium mill tailings under Title II of UMTRCA that includes the White Mesa Mill. Standards relating to the protection of groundwater at this alternative in the DEIS are found in Utah Water Quality rule, R317-6. As part of the amended Agreement, the Nuclear Regulatory Commission approved an "alternative groundwater standard" and the State of Utah uses its own groundwater protection rules in lieu of 40 CFR 192. Since Utah is an Agrement State, the White Mesa Mill must amend its current Radioactive Materials License to accommodate this disposal option as well as modify the facility's Ground Water Discharge permit. The EIS should be modified to reflect this state authority under Section 7.3

46. Section 7.3 State Regulatory Requirements – previously as stated in comment 12A, DOE has not recognized state groundwater authority under Utah Water Quality rule, R317-6. Under this state authority, DEQ has classified the shallow aquiferat the Moab Tailings Site as a Class 1C aquifer that needs protection in order to sustaain a nearby wildlife habitat, that being the backwater area that is being fed by groundwater on the nearby banks of the Colorado River. There should be recognition of the state groundwater program in Section 7.3 because of the demonstrated authority in comment 20 even if DOE disagrees with the assertion of groundwater authority at the Moab Millsite.

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ATTACHMENT 1

U.S. Geological Survey
Scientific Investigations Report No. 2005-5022

Initial-Phase Investigation of Multi-Dimensional Streamflow Simulations in the Colorado River, Moab Valley, Grand County, Utah, 2004

by
Terry A. Kenney

February 11, 2005

ATTACHMENT 2

Investigation of the Hydrologic Connection Between the Moab Mill Tailings and the Matheson Wetland Preserve

by
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December 11, 2005