PATHFINDER

November 14, 2003

Mr. Gary Janosko, Chief
Fuel Cycle Facilities Branch
Division of Fuel Cycle Safety and Safeguards
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
11545 Rockville Pike
Rockville, Maryland 20852

Ref: Docket No. 40-6622, Source Material License No. SUA-442
September 15, 2003 Request for Additional Information – ACL Application

Dear Mr. Janosko:

The following responses are submitted regarding the referenced correspondence:

ITEM 1. ASSESSMENT OF SPRING CREEK IMPACTS AND EVALUATION OF ALLUVIUM

Pathfinder's consultant, Intermountain Resources, has completed a qualitative biotic survey of Spring Creek. The evaluation of collected field data and report preparation are ongoing. We anticipate availability of the report before year end.

A search of historical drilling data yielded two drill holes proximate to Spring Creek that are relevant to an evaluation of any potential alluvium along the creek downgradient of the POE. The lithologies for both holes were of sufficient detail to be useful for the evaluation. A hollow stem auger drill rig was used on November 12, 2003 to drill three additional holes in the creek area downgradient of the proposed POE. The additional drill hole lithologies will permit the development of two geologic cross-sections running across the creek, one just below the POE, and the other further downstream. The cross-sections will allow us to evaluate the nature and extent of any alluvium along Spring Creek below the POE. The preliminary results support Pathfinder's previous contention that there is no viable alluvium in the area due to the artificial nature of the Spring Creek diversion excavation.

The response to item 1 will be submitted to the NRC as soon as the reports are available from our consultants.

NMSS01

PATHFINDER Mines Corporation
935 Pendell Blvd., P.O. Box 730, Mills, WY 82644 · Tel.: (307) 234-5019 · Fax: (307) 473-7306

A

ITEM 2. ADDITIONAL TECHNICAL ALTERNATIVES

The evaluation of alternative technologies for the reduction of ACL constituent concentrations at the POE involves several considerations of both a qualitative and quantitative nature. Two of the most significant constraints on technologies to reduce seepage impacts are that no significant post-reclamation maintenance is allowed, and that the technology allows timely completion of those tailings reclamation activities that reduce further seepage impacts to the ground-water system. Specifically, construction of the radon/infiltration barrier will reduce infiltration into the tailings and ultimately reduce future seepage impacts. Completion of the barrier will also reduce radon flux from the site. This limits the utility of any system that requires ongoing collection and disposal of either Surficial aquifer water or tailings water for an indefinite period, and also limits the feasibility of systems which may require replacement or rejuvenation of a component such as a reactive medium after the reclamation has been completed. Eventual transfer of the property to the DOE is contingent upon establishing a system where maintenance requirements are limited to site access concerns and the DOE approved monitoring programs.

POTENTIAL BENEFITS

The potential benefit of alternative technologies is the reduction in concentration of ACL constituents in Spring Creek. The present predictions of concentrations of ACL constituents in the ACL application have been made even more conservative by the continued operation of the CAP for more than two years beyond the modeled operation of the system. The predicted peak concentrations occur over a relatively short period of time because there is a finite quantity of water remaining in the tailings and this quantity will be reduced until there is pseudo-equilibrium with the minute quantity of water penetrating the radon/infiltration barrier. The cyclical nature of flows within Spring Creek also leads to a cycling of constituent concentrations within Spring Creek, which in turn affects the analysis of the level of potential benefit from an alternative technology. Table C.1-1 of the ACL application provides both the peak concentration and the time-weighted average concentration which incorporates the annual cycling of flow rate in Spring Creek for the period when concentrations are greatest.

Surface Water

The magnitude of potential benefits from alternative technologies can be measured as a further reduction in constituent concentration over the current predictions provided in the ACL application. The magnitude of potential benefits can also be measured as a reduction of a constituent concentration below an applicable regulatory standard. Table C.1-1 of the ACL application is replicated herein to allow direct comparison with the included tabulation of updated analyses of background water quality for Spring Creek as measured at upgradient site SW1A.

A

Table C.1-1 Constituents of Concern at the POE

Constituent	Predicted Maximum Concentration at POE	Time-Weighted Average Concentration in Spring Creek	Average Background Concentration Up-gradient of Site	Water Standards
Uranium (mg/l)	0.15	0.065	0.026	0.03[b] 0.03-1.4[f] 0.02[l]
Th-230 (pCi/l)	0.3	0.15	<0.2	
Ra-226 + Ra-228 (pCi/l)	1.5	1.14	1	5[b,c,d,e]
Selenium (mg/l)	0.0056	0.0024	0.001	0.005[a,J] 0.02[d,i] 0.01[c,l] 0.05[b,e,f,g] 9[h]
Chloride (mg/l)	118	39	5.3	860[a.1] 230[a,j] 250[b,c] 100[d] 2000[e]
Total Dissolved Solids (mg/l)	649	384	270	500[b,c] 2,000[d] 5,000[e]
Sulfate (mg/l)	183*	73*	25.2	250 [b,c] 200[d] 3,000[e] 500[l]

* Scaled from total dissolved measurements
a National Recommended Water Quality Criteria (EPA, 1998)
b. EPA Primary Drinking Water Standards
c Wyoming Groundwater Standards-Domestic
d. Wyoming Groundwater Standards-Agriculture
e. Wyoming Groundwater Standards-Livestock
f. Wyoming Groundwater Standards-Fish/Aquatic Life
g. Wyoming Surface Water Standards-Human Health Value, Fish and Drinking Water
h. Wyoming Surface Water Standards-Human Health Value, Fish
i. Wyoming Surface Water Standards-Aquatic Life, acute
j. Wyoming Surface Water Standards-Aquatic Life, chronic
k Wyoming Surface Water Standards-Human Health Class 2C waters
l. Canadian Drinking Water Guidelines

Background Water Quality for Spring Creek Site SW1A

Constituent	Percentage Non-detects	Mean	Standard Deviation	Median	Minimum	Maximum	Non-parametric 95th Percentile
Uranium	0	0.0387	0.0451	0.0216	0.0146	0.203	0.092
Th230	93.8	0.1563	0.1548	<.2	<.2	0.6	0.525
Ra226+Ra228	100.0				<1.2	<1.4	
Selenium	14.3	0.0018	0.0009	0.002	<0.001	0.003	0.0028
Chloride	5.9	10.8	13.8	2.77	<1	40.1	34.4
TDS	0	284.5	101.3	249	196	525	493.8
Sulfate	0	31.7	27.2	18.5	13.2	92	91.2

Note: Concentrations in mg/l except Th230 and Ra226+Ra228 which are in pCi/l.

Table C.1-1 lists a series of water standards for the constituents for the purposes of comparison although many of the standards are not applicable given the background water quality and the current and future uses of the Spring Creek water. Of particular note is the fact that, with the exception of uranium, the time-weighted average concentration for constituents is less than all the listed standards. In addition, the predicted maximum concentration at the POE for constituents Th-230, Ra-226 + Ra-228, and sulfate is less than all of the listed standards. The predicted maximum concentration of selenium, chloride, and TDS is only slightly greater than the most restrictive standard in Table C.1-1. The predicted maximum concentration is a temporary worst-case scenario in that it will only occur during late season base flow if the period of the critical combination of ground-water discharge to Spring Creek coincides with a moderate to severe drought cycle. The prediction of maximum concentration of all constituents is also conservative from the standpoint that no attenuation was considered in the modeling.

The predicted maximum selenium concentration at the POE is 0.0056 mg/l, which only slightly exceeds the standard of 0.005 mg/l for Aquatic Life – chronic exposure from the Wyoming Surface Water Standards. Given that the chronic standard is not applicable for a short duration peak concentration, and that the predicted peak concentration will only occur with a specific combination of environmental factors, the minor potential exceedance of this standard is not significant. A parallel situation occurs for TDS where the predicted maximum concentration of 649 mg/l only slightly exceeds the EPA drinking water standard of 500 mg/l. Water from Spring Creek is not used for human consumption and the background uranium concentration routinely exceeds the corresponding uranium drinking water standard. Add to this the potential bacterial hazards associated with untreated surface waters, and it is obvious that a drinking water standard is not appropriate for Spring Creek at the POE. The predicted peak chloride concentration of 118 mg/l slightly exceeds the Agriculture standard of 100 mg/l from the Wyoming Groundwater Standards. The Groundwater Standard is not directly applicable to the surface water and the agricultural standard pertains primarily to the use of the water for irrigation, and the current irrigation uses of Spring Creek water are far downstream of the confluence of Spring Creek and much larger drainage systems. Also, irrigation uses of water in Wyoming typically exploit the

A

larger flows that occur during spring runoff, and late season flows supply only a small fraction of irrigation water. Even if Spring Creek water was diverted to an irrigation use immediately downstream of the site, only a small fraction of the annual irrigation usage could potentially be supplied by late season base flows for the period when peak chloride concentrations occurred.

The discussion of the ACL constituents other than uranium indicates that the current and future use of the surface water in Spring Creek is not diminished by the modest and temporary increases in concentration. The predicted time-weighted average concentration of Th-230, Ra-226 + Ra-228, selenium, chloride, TDS and sulfate does not exceed any of the listed water quality standards. There is no significant degradation of the water resource with respect to these ACL constituents, so there is essentially no benefit that can be derived from alternate approaches to corrective action for these ACL constituents.

The predicted time-weighted average concentration of uranium at the POE in Spring Creek is 0.065 mg/l while the predicted peak concentration is 0.15 mg/l. There is presently no Wyoming Surface Water standard for uranium. The range of measured background uranium concentration in Spring Creek (as measured at upgradient site SW1A and presented in a preceding table) is from 0.0146 mg/l to 0.203 mg/l. The upper 95^{th} non-parametric background concentration is 0.092 mg/l. Within the last 10 years, the peak predicted uranium concentration of 0.15 mg/l at the POE has been exceeded in a site SW1A sample (0.203 mg/l) and another sample had a uranium concentration of 0.146 mg/l. The predicted time-weighted average uranium concentration of 0.065 mg/l is well below the upper bound of naturally occurring concentrations. As discussed in Appendices A, B, and C of the ACL application, the predicted peak concentrations resulting from seepage impacts to Spring Creek are below levels that are protective of human health and the environment.

The contaminant transport modeling presented in the ACL application indicates that gradual seepage of residual water within the tailings will result in a modest increase in uranium concentrations in Spring Creek over a period of several years. The predicted peak impacts will occur for a relatively short period of time and only if the critical combination of ground-water discharge coincides with a late season base flow during a period when natural flows are reduced due to drought conditions. In light of the limited increase in uranium concentration due to seepage impacts, and the inclusion of seepage impacts within the natural range of uranium concentration at the POE, the potential benefit of alternate corrective actions is somewhat limited. Alternate corrective actions may reduce the uranium concentration at the POE, but they will not change the current and future uses of the Spring Creek water. Therefore, the maximum potential benefit of alternate corrective actions with respect to uranium is limited to a qualitative assessment of the 'improvement' in water quality. There will be no change in the acceptable uses of the water and no demonstrable reduction in risk to human health or the environment.

A

Ground Water

There is very limited potential benefit to the Surficial aquifer ground-water resource that may be provided by the alternative technologies. The Surficial aquifer is a locally-supported aquifer in the affected area and the potential yield of the ground-water system is severely limited. The post-reclamation discharge of Surficial aquifer ground water to Spring Creek is predicted to be 20 gpm to 25 gpm along a reach of nearly 10,000 feet. Therefore, the potential long-term production of a single well withdrawing only from Surficial aquifer may range up to a few gallons per minute but will more likely be less than a gallon per minute. In light of the access to nearby surface water resources and much greater potential production from deeper aquifers that are accessible from outside of the proposed Long Term Care (LTC) boundary, there is very little or no potential benefit to a small reduction in the area of restricted access. In the event that a proposed alternative technology would allow a portion of the area between the tailings and Spring Creek to be removed from the LTC area, the alternative technology would further reduce the viability of the water production from the Surficial aquifer in the area. The reason for this is detailed in the discussion of each alternative technology.

The following listing provides some discussion of alternative technologies and the potential pitfalls and benefits of these alternatives.

I. Continued Operation of the CAP and Dewatering Systems

The ACL application documented three scenarios of short to long-term CAP operation and the incremental benefit of extending collection and injection. The justification for the selected alternative was included within the ACL application. The cost for an incremental reduction in seepage impacts continues to increase as the effectiveness of the dewatering system decreases dramatically. It should be noted that the system has been operated approximately two years beyond the planned termination date of the CAP described in the ACL application.

The operation of the collection system consisting of Surficial aquifer collection wells located between the tailings area and Spring Creek has served to intercept seepage-impacted ground water and prevent downgradient migration. In this respect, it serves precisely the same function as the suggested alternate corrective action of the interceptor trench. Fresh-water injection has been used to increase gradients towards the collection system and accelerate the restoration process. The system in its current configuration has been very effective and the successful performance of this approach in intercepting and containing seepage-impacted ground water has been documented over nearly two decades of operation. Although replacement of the existing collection system with an interceptor trench is possible, there is no legitimate reason to replace a functioning and effective system with a more costly system that serves the same purpose.

The continued operation of the collection system produces a stream of seepage-impacted water requiring disposal. At present, much of the Surficial aquifer collection water is diverted to the Area 2/8 reservoir and this could potentially continue. However, the continued maintenance of the pumping, fresh-water injection, and power systems will delay physical reclamation of the tailings and surrounding areas. Other disposal options include diversion to evaporation ponds on the tailings surface. The maintenance of evaporation ponds on the tailings surface is undesirable because, in addition to requiring attendant pumping operations, there will be some additional recharge to the tailings which extends the impacts of seepage. Until the radon/infiltration barrier is constructed, the level of natural recharge to the tailings from precipitation is expected to be a few gallons per minute. This is sufficient to offset the current expected rate of seepage from the tailings. The imminent cessation of the dewatering program will leave a finite volume of water within the tailings, and unless the physical reclamation of the tailings proceeds (i.e. the radon/infiltration barrier is constructed), the volume of residual water within the tailings will not change dramatically. In essence, the volume of the contaminant source will remain relatively constant for all options where completion of the physical reclamation is delayed. Although infiltration of meteoric water into the tailings may provide a modest dilution effect for the residual tailings solution when it reaches the water table, the general oxidized state of the vadose zone within the tailings and the limited pH buffering potential of the tailings may result in significant mobilization of uranium. Ultimately, the water quality of the seepage source is not expected to change, and with no significant change in the volume of the source the seepage impacts will remain relatively steady.

The collection system intercepts ground water that has been impacted by the seepage from the tailings. The rate of seepage from the tailings is diminishing due to a reduction in the volume of water within the tailings with the ongoing dewatering program. The production of the tailings dewatering system has declined due to the lowering of water levels within the tailings and the reduction of recharge to the tailings. The rate of decline in production has been roughly 40% per year over the last few years. The limited dewatering system production has resulted in an ongoing paring of the number of pumping wells as individual wells cease to be viable pumping wells. The diminishing effectiveness of tailings dewatering will likely result in discontinuation of pumping from nearly all of the tailings dewatering wells within a year.

The imminent discontinuation of tailings dewatering will leave a finite volume of water in the tailings. At this point, the seepage from the tailings will continue for many years at a gradually diminishing rate, provided the radon/infiltration barrier is installed to limit recharge to the tailings. This has implications for the continuation of the collection program or the installation of an interceptor trench because the extension of collection for a few years results in less incremental benefit after the accelerated removal of water from the tailings is terminated. The decline in seepage rate from the tailings is gradual enough (after dewatering is terminated and the radon/infiltration barrier constructed) that a modestly extended capture of the seepage-affected water with a collection system delays

A

the appearance of seepage at the POE, but does not dramatically reduce the proportion of seepage in the ground-water discharge to Spring Creek.

If construction of the radon/infiltration barrier is delayed, the seepage rate will not decline significantly and the seepage impacts at Spring Creek may be delayed, but are not expected to be appreciably attenuated.

Extending the operation of the collection/injection system for several years has the potential benefit of a modest reduction in the peak and time-weighted average concentrations of the ACL constituents in Spring Creek. As discussed previously, a reduction in the concentration of Th-230, Ra-226 + Ra-228, selenium, chloride, TDS and sulfate does not result in a quantifiable benefit because the predicted maximum seepage-related concentration of these constituents is below levels of concern. There will be no change in the current and future use of the surface water that results from this alternate corrective action. An extension of the operation of the collection system will not have any significant benefit to the ground-water resource. The LTC area will not be adjusted if the collection system operation is continued for several years, and there is still access to more productive aquifers.

The potential benefit of a modestly reduced uranium concentration in Spring Creek if the operation of the collection/injection system is extended for several years is a matter of perception. The predicted peak and time-weighted average concentrations of uranium at the POE do not exceed any directly applicable standards and are consistent with the range of measured natural concentrations in Spring Creek. The ACL application lists a predicted reduction in the ratio of seepage rate to ground-water recharge of 46% over the selected corrective action with a 3 ½ year extension of operation of certain components of the CAP. This would theoretically translate to a similar reduction in predicted uranium concentration at the POE. At present, the system has been operated well beyond the planned corrective action presented in the ACL application and is approaching the extended operation scenario. A further extension (additional 7 years) of the dewatering system produced a reduction in the ratio of seepage rate to ground-water recharge of 54% over the selected corrective action. This clearly illustrates that the incremental benefit with several years of additional operation is very small. With consideration of the additional time that the CAP has been operated, and the conservative assumptions included in the modeling, much of the perceived benefit in reduction of uranium concentration has already been realized.

II. Interceptor Trench

An interceptor trench would perform essentially the same function of the existing Surficial aquifer collection system, and thus it is questionable whether this approach warrants detailed investigation. The capital cost of installing an interceptor trench will be very large in comparison to the operational cost of continuing the existing collection/injection program. An interceptor trench would have the operational

A

advantage of consolidating the collection to a single point, but would still be subject to the same ongoing pumping, water disposal, and delayed tailings reclamation concerns.

An interceptor trench could be installed along the rough alignment of the primary collection well system. The minimum required depth of the trench at the lowest topographic point where it crosses the Mine Creek channel is approximately 22 feet in order to effectively eliminate the gradient to Spring Creek. However, it would be prudent to extend the trench to a depth of 32 feet at this location to reduce the potential for incomplete capture within the stratified Surficial aquifer. Because the surrounding topography is higher to the north and to the south of the Mine Creek channel, a typical interceptor trench depth of 40 feet is more appropriate for conceptual design purposes.

The length of the interceptor trench to capture the seepage-impacted ground water currently intercepted by the collection well system is approximately 2500 feet. Because the depth of the trench is so large, the only means of construction is a major excavation to a depth that is approaching the final trench depth. It may be possible to trench for a portion of the total depth at the base of the excavation, so a generic excavation depth of 34 feet is used for computation purposes. The total volume of excavation to install the interceptor trench in this configuration is 250,000 cu.yd. A rough estimate of the cost to install the collector trench system is $840,000 and this reflects the anticipated difficulties in installing a trench system to an elevation far below the current water table. Operational costs will be similar to those of the existing collection system with the exception that initial pumping rates will be very high as the unconfined Surficial aquifer system is dewatered.

During the period when the interceptor trench is operating and for many years following cessation of operation, the Surficial aquifer between the trench and Spring Creek will not be a viable aquifer system. The interception of a significant portion of the Surficial ground water with the trench will lower water levels to the point where pumping or even sampling of the ground water is not possible. Recovery of the system with the limited recharge in the Shirley Basin area will be slow. The only input to this area of the Surficial aquifer will be direct vertical recharge and possibly some water that is drawn from the adjacent reach of Spring Creek.

Like the continued operation of the existing collection system, the incremental benefit of extending operation of the interceptor trench beyond termination of the dewatering program becomes progressively smaller. The seepage rate will be proportional to the quantity of water left in the tailings, and with the reduced production from tailings dewatering and the impending termination of the tailings dewatering, the rate of change in quantity of water left in the tailings will be very small.

III. Permeable Reactive Barrier

Permeable Reactive Barriers (PRB's) utilizing Zero-Valent Iron (ZVI) have been used at a few sites for reduction of uranium and other metals concentrations in ground water.

A

Unfortunately, this approach is not well suited to the Shirley Basin site because the maximum depth of the required barrier could approach 70 feet in order to completely penetrate the Surficial aquifer.

The length of the PRB or an impermeable barrier wall in a funnel and gate arrangement would also be extremely long at approximately 5000 feet. The scale of an impermeable barrier is larger than an interceptor trench because the barrier must completely penetrate the aquifer and must extend much farther in a lateral direction in order to prevent circumvention of the barrier as the piezometric surface is raised upgradient of the barrier. It is likely that a funnel-and-gate arrangement would be the lower cost PRB configuration for this site. Given the required length of the barrier, a multiple gate system would likely be necessary, although the sizing of individual gates could be scaled according to the transmitting capacity of the Surficial aquifer in the area Sources in the literature indicate that PRB's have been successful in reduction of uranium and metals concentrations, but there is also some mention of the need to rejuvenate or otherwise extend the life of the PRB. This leads to obvious questions on the actual unattended life of a PRB and the long-term disposition of a PRB.

The cost of such a barrier is also very large. The installation cost of a much smaller PRB at the Monticello, Utah site is listed by one source as approximately $1,200,000. The cross-sectional area of the Shirley Basin barrier wall would likely be more than 30 times that of the Monticello barrier. Even with extensive economization in terms of barrier length, depth and materials, the barrier cost would likely be well in excess $20,000,000. The combination of large capital costs, extension of reclamation/restoration schedule for construction, and open questions about PRB longevity make this option extremely unattractive.

A recent study of the long-term performance of PRB's (Wilkin et al., 2003) notes that there is a measurable reduction in porosity in two PRB's after four years of operation. Although both PRB's were still functioning effectively at the time of the study, this does bring to light the potential for long-term plugging of the ZVI reactive media. According to Wilkin et al. (2003), the ZVI media acts as a long-term sink for carbon, sulfur, calcium, magnesium, nitrogen, and manganese. The range of natural sulfate concentrations at the Shirley Basin site, and the potential increase in sulfate concentrations due to seepage impacts makes the potential for long-term accumulation of sulfur within a ZVI media a serious concern.

Although a PRB may effectively reduce concentrations of uranium in the ground water over a period of many years after installation, eventually the effectiveness or the porosity of the ZVI media will decline to the point where the media requires replacement/rejuvenation or removal and disposal. If the porosity of the media in the gate is reduced, the funnel-and-gate arrangement becomes a 'dam' within the ground-water system. In order to prevent eventual surface expression of the ground water upstream of the PRB, it will be necessary to reestablish adequate flow through the gate or provide some other mechanism of release through or around the impermeable barrier.

A

The major potential pitfall of a PRB is that there is a strong likelihood that a portion of the system will require significant maintenance at some point in the future. A PRB may function long enough to significantly reduce uranium concentration at the POE. However, the ZVI media acts as a sink for uranium and other constituents, and eventually this material will have to be addressed. As discussed above, the material may become plugged and will have to be removed, or the material may be viewed as a possible source of the constituents in the event of a change in geochemistry. Regardless of the period of demonstrated performance, there will be a question of the future maintenance requirements of this artificial component in the ground-water system. This open question would undoubtedly affect the process of transferring the site to the DOE.

The potential benefit of a PRB would be a further reduction in the seepage impacts in the uranium concentrations in Spring Creek. As stated previously, the benefit of a reduction in uranium concentrations that do not exceed applicable standards and are within the measured range of natural concentrations is a matter of perception. There is no quantifiable change in the current and future uses of the affected Spring Creek water, and there is no quantifiable change in the risk to human health and the environment. There is no significant benefit to the ground-water resource with this technical alternative because the funnel-and-gate arrangement will restrict the viable production zones of the Surficial aquifer to those immediately downgradient of the gate. Ultimately, the LTC area would be unchanged to preclude extraction of ground water downgradient of the gate(s).

IV. Bioremediation

Bioremediation for the reduction of concentrations of uranium and other metals has been successful at some sites for both ground water and surface water. Unfortunately, the level of control for biological activity is much less precise than chemical reactions, so the magnitude of reduction in concentration is very difficult to predict and bioremediation would require extensive testing prior to full scale operation. For the Shirley Basin site, the approach to bioremediation would likely entail a series of injection wells for a nutrient source and possibly inoculation with bacteria, and associated collection wells to increase gradients and further distribute the nutrients within the ground water. Unfortunately, the injection/collection scenario for bioremediation would only be effective in 'fixing' significant quantities of uranium if the injection/collection occurs in the Surficial aquifer beneath the tailings. The operation of this system within the boundaries of the tailings will delay the physical reclamation of the tailings. Also, bioremediation using injection/collection directly beneath the tailings is not considered viable because collection and injection rates for wells in the immediate tailings area are not adequate to effectively distribute the required nutrients and biological agents.

The ground-water quality in the area between the tailings and Spring Creek has been largely restored and bioremediation in this area would rely on a system that was operated while the seepage-impacted water migrates from underneath the tailings towards Spring

A

Creek and for some time after the first appearance of the seepage impacts. In effect, the bioremediation would be done in an area in anticipation of the future arrival of the seepage and would have to be continued for some time in order to provide demonstrable benefit.

It would be counter-productive to alter the existing Surficial aquifer collection/injection system, which is currently functioning as an effective seepage containment system, in order to allow ongoing seepage migration with an uncertain potential for some future biological reduction in concentration. Restoration of an aquifer is a time dependent process requiring ongoing modification and adjustment to accommodate heterogeneities of the aquifer. Like the restoration process under the current CAP, some areas of the aquifer would require years of bioremediation to achieve a reasonable distribution of nutrients and biological activity. Extension of the nutrient injection process well beyond this point would also be required to insure that bioremediation continues with the ongoing seepage.

Implementing a bioremediation program would include installation of a number of additional wells to distribute the nutrients and any introduced bacteria. A simultaneous injection/collection system would be necessary to get a reasonable distribution of the biological activity, and this would require maintenance of water disposal systems for the collection water. A minimum operational time for such a system would likely be 3 years or more with attendant operation of the equipment in introduce the nutrients into the injection stream. A rough cost estimate for this system with 3 years of operation and maintenance is $680,000. This includes a series of new wells to distribute nutrients and operation of the necessary water supply, water disposal, and nutrient injection equipment.

Additionally, an anaerobic environment will likely be necessary to significantly reduce uranium concentrations with bioremediation. Even with introduction of a reductant in the injection stream, the shallow unconfined Surficial aquifer will likely receive sufficient oxygen from the precipitation recharge to revert to an oxidized state during or after the injection. The costs of maintaining this type of system are substantially greater than the existing CAP, and additional wells or recharge lines would undoubtedly have to be installed to enhance the distribution. Therefore, there is simply not enough potential benefit to bioremediation to justify further consideration of this unproven approach for the Shirley Basin site.

V. Injection of Reductant

A reductant could reduce the mobility of uranium and selenium within the Surficial aquifer. Unfortunately, this alternative has many of the same limitations as the bioremediation. The distribution of the reductant within the aquifer would be time dependent and would likely require additional injection points within the immediate tailings area. It is critical that the placement of the reductant occur directly beneath the tailings in order to fix the uranium prior to migration to the east of the tailings. With recharge from the surface, the maintenance of a reduced environment in the ground water

A

outside of the tailings is unlikely, and thus injection of a reductant in the area between the tailings and Spring Creek will have little or no long-term benefit.

The projected costs of implementing a reductant injection program would be very similar to those of the bioremediation program. The same distribution system with additional collection/injection wells would be required and similar water supply and water disposal systems would be necessary. With the same minimum operational time of 3 years, the rough cost estimate of $680,000 for bioremediation is considered appropriate for the reductant injection program.

It would be possible to inject a reductant directly into the tailings, but the declining production of the tailings dewatering wells makes the success of this approach very unlikely. In order to produce even a temporary reducing environment in the tailings that effectively lessens source concentrations in the residual solution, the reductant would have to be thoroughly distributed below the current water table. The very limited extraction rates from the slime tailings will also translate to very limited intrusion of a reductant into the remaining saturated zones of the tailings. A tailings injection program would first introduce the reductant into the more permeable tailings that have already been dewatered, and intrusion into the saturated slime tailings would be a very slow process. Ultimately, the increased saturation in the tailings with a heterogeneous distribution of reductant could increase vertical gradients and increase short-term seepage rates thereby negating any benefits of the reducing environment.

VI. Tailings Flushing

Injection of freshwater into the tailings to flush the tailings is a technique that has been employed at Homestake's Grants site. This approach can dramatically reduce constituent concentrations in the resident tailings water and the seepage from the tailings. However, extraction and disposal of tailings water has been an ongoing problem at the Shirley Basin site, and the concept of deliberate injection into the tailings conflicts with the ongoing and very aggressive dewatering effort. Also, the Homestake site utilized an alkali leach process while the Shirley Basin site used acid leach. Thus the success at the Homestake site may not translate to the acid leach tailings. A tailings flushing program could possibly reduce concentrations within the tailings water which in turn could result in a reduction in seepage concentrations. This system could reduce, but not eliminate seepage impacts. However, the implications to the dewatering status and consolidation process make this very unpalatable.

The injection of freshwater into the tailings also has the same distribution problems that were described in the alternate technology of injection of reductant into the tailings. The water that remains in the tailings is much more difficult to extract as reflected by the declining dewatering rates. Injected water will first enter the more permeable tailings that have already been dewatered, and will only intrude into or drive the residual solution after long-term maintenance of injection head. The resaturation of tailings would likely mobilize some constituents, and the eventual benefits of this program could be very limited.

ITEM 3. ASSESSMENT OF ALARA

The discussion of alternative technologies in the preceding section contains much of the information that is relevant to assessment of ALARA conditions. In the case of the ACL constituents other than uranium, the attainment of ALARA concentrations is revealed in the fact that further reduction in concentrations will not produce quantifiable benefit, regardless of the feasibility of the alternative which produces the reduced concentrations. Under the proposed alternative as presented in the ACL application, the time-weighted average concentrations of all constituents are within the range of natural background concentrations or are less than all regulatory standards listed in Table C.1-1.

In the case of uranium, the potential benefit that can be obtained is limited to a minor reduction in a short-term maximum concentration to levels that are within the natural range of background concentrations. The current and future use of the water in Spring Creek is not impaired by the proposed ACL Point of Exposure (POE) concentrations, and even a complete elimination of seepage impacts with respect to uranium would not alter the usage of the water according to relevant regulatory standards. Hence, the quantification of benefit for uranium concentration reduction is highly subjective. According to NUREG-1620, Section 4.3.3.3(4), three appreciably different levels of target concentration must be considered. The three levels must be below the limit that is protective of human health and the environment. Appendices A, B and C of the ACL application describe how the proposed ACL limits are protective of human health and the environment. However, given that the predicted maximum short-term uranium concentration in the ACL application is only slightly above the natural range of background, the establishment of two additional lower target levels that are appreciably different is problematic. The time-weighted average uranium concentration is less than the non-parametric upper 95th percentile of background concentration. Therefore, the only realistic additional target level for ALARA concentration is the reduction of the maximum short-term uranium concentration at the POE to a level that is indistinguishable from background concentrations.

The non-parametric 95th percentile uranium concentration for Spring Creek as calculated from site SW1A data is 0.092 mg/l. The conservative prediction of maximum uranium concentration at the POE during late season base flow is 0.15 mg/l. As discussed previously, this prediction has been made dramatically more conservative by continued operation of the CAP beyond the modeled sequence of operations. Of particular significance is the removal of substantially more tailings water than considered in the modeling, despite the fact that dewatering rates have diminished more than anticipated. No retardation of uranium transport was considered in the modeling which also adds a significant measure of conservatism.

A

I. ALARA Evaluation for Continued CAP Operation

Continued operation of the CAP with continued collection from the Surficial aquifer within the tailings area will prevent completion of the physical reclamation of the tailings. The maintenance of evaporation ponds to dispose of collection water on the tailings will also prevent reclamation of at least a portion of the tailings area. With the recognition that the rate of recharge to the unreclaimed tailings offsets the expected seepage rate, the only significant reduction in the seepage source volume results from continued operation of the dewatering program. The dewatering rates are quickly reaching levels where it is not practical to maintain a pumping system and the dewatering program will likely be discontinued in the near future, regardless of the disposition of the remainder of the CAP. With discontinuation of dewatering, the CAP must be adjusted to a configuration that will allow construction of the radon/infiltration barrier over most of the tailings in order to reduce recharge to the tailings.

Once the recharge to the tailings is reduced to levels below the current seepage rate from the tailings, there will be a gradual reduction in the source volume retained in the tailings. This will in turn result in a gradual reduction in the rate of seepage which translates to a proportionate reduction in seepage impacts to Spring Creek. This represents the potential benefit to extended operation of certain components of the existing CAP. The disadvantages to this approach are that continued collection will require maintenance of the attendant power, pumping, piping and water disposal systems, as well as the cost of maintaining these systems. These activities will also restrict completion of the reclamation until final decommissioning of the CAP.

The magnitude of the benefit of continued operation of the CAP can be estimated by estimating the reduction in the rate of seepage. The volume of drainable water left in the tailings is estimated at 70 to 90 million gallons. If the net discharge from the tailings is approximately 2 gpm, the volume of drainable water left in the tailings will be reduced by approximately 1.3% per year. With the assumption that the seepage rate is proportional to the volume of water left in the tailings, the reduction in seepage rate after 5 additional years of CAP operation would be less than 7%. This would translate to a proportional reduction in seepage impacts to Spring Creek. From this rough calculation, it is obvious that the potential benefit to a 5 year extension of the CAP is very small. The estimates of net discharge and remaining drainable water are based on estimates within the ACL application and known rates of extraction. The conclusion drawn from this is that operation of the CAP to date represents ALARA conditions, and that further extension of the CAP does not produce significant benefit. The previously established criterion that the alternative approach results in an appreciably smaller concentration at the POE is not met. The cost of extension of the CAP will be substantial, and there is a significant detriment with the delays in completion of the tailings reclamation that are imposed by the extension of the CAP.

A

II. ALARA Evaluation for Interceptor Trench

As described in the discussion of alternative technologies, the interceptor trench serves the same function as the Surficial collection/injection components of the existing CAP. The preceding evaluation of the continued operation of the existing CAP can be extended to the interceptor trench approach with a very similar range of potential benefits in terms of reduced concentrations at the POE. The same disadvantages of delayed completion of reclamation and the required

maintenance of water disposal systems apply. The volume of the contaminant source will diminish very gradually after dewatering is discontinued, and the resulting reduction in predicted concentration at the POE will not meet the criterion of being appreciably smaller than that predicted for the proposed alternative. Therefore, the operation of the CAP to date represents ALARA conditions, and construction and operation of an interceptor trench does not offer significant additional benefit.

III. ALARA Evaluation for Permeable Reactive Barrier

The construction and operation of a PRB has the potential to reduce uranium concentrations at the POE to levels that do not exceed the upper levels of the natural background range. However, the cost of a PRB is enormous (estimated to exceed $20,000,000), and the disadvantages include potential future maintenance requirements that could extend for decades. The effectiveness of a PRB is not guaranteed, and the presence of a PRB could delay final closure and transfer of the site indefinitely. The current and future uses of the Spring Creek water will not be changed by the installation of a PRB, and there is no quantifiable reduction in the risk to public health or the environment. Given the cost and significant disadvantages of a PRB, there is not sufficient potential benefit to consider this a 'reasonable' approach for ALARA evaluation.

IV. ALARA Evaluation for Bioremediation

The potential for a successful bioremediation program at this juncture is very limited given the hydrologic conditions at the Shirley Basin site. For this reason, bioremediation is not considered a reasonable alternative technology.

V. ALARA Evaluation for Injection of Reductant

The use a reductant to immobilize uranium within the Surficial aquifer is not considered feasible because, in the area beneath the tailings where the reductant would be injected, it is unlikely that an adequate distribution of reductant can be achieved within a reasonable time frame. The maintenance of an injection program within the tailings area will prevent physical reclamation of the tailings and will allow continued recharge to the tailings. The disadvantages of this technology far outweigh the limited potential benefits.

A

VI. ALARA Evaluation for Tailings Flushing

The injection of freshwater into the tailings could potentially reduce the concentrations in the composite seepage from the tailings. However, the flushing of tailings would occur largely in the areas and strata that have already been dewatered. The extraction of the remaining drainable water from low permeability tailings has become very inefficient, and the introduction and exchange of freshwater in the low permeability slimes will be equally as difficult. At best, a tailings flushing program would add a minor dilution effect by increasing the rate of seepage with the resaturation of areas of the tailings. The mass rate of contaminant discharge from the tailings would likely increase due to mobilization of constituents within the tailings. This option is not considered a reasonable alternative to the proposed action.

ITEM 4. STANDARDS FOR CHLORIDE, SULFATE AND TDS

The ACL application included prediction of maximum concentrations of chloride, sulfate and TDS at the POC wells and at the POE. These concentrations are proposed as alternate concentration limits for the respective constituents. The following table presents the POC and POE concentrations for the ACL constituents of chloride, TDS and sulfate.

TABLE 5.1-1. MAJOR CONSTITUENT POC CONCENTRATIONS

CONSTITUENT	POC WELLS		
	RPI –19B	NP01	POE
Chloride	3712	3275	118
TDS	12641	11529	649
Sulfate	5056*	4612*	183*

NOTE: Concentrations are in mg/l. Sulfate concentrations are determined by scaling as 40% of TDS concentration and compositing at the POE in the same manner as the other constituents.

ITEM 5. INSTITUTIONAL CONTROLS OF ACCESS TO SUBSURFACE CONTAMINATION

The mineral potential of the tailings area and surrounding area is negligible. Uranium exploration in the area delineated the ore trend and the only occurrence of economic ore

A

near the tailings was purchased by Pathfinder and mined out. Those portions of the tailings area that were patented, were done so on the basis of non-mineralized millsites.

There are no federal oil and gas leases, the last one terminating in 1987. There are no mining claims except for Pathfinder's unpatented millsites. There are no coal deposits.

The tailings area is primarily comprised of public domain that will be segregated to prevent mineral leasing or claimstaking. A portion of the tailings area is patented millsite claims owned by Pathfinder which will be transferred to federal ownership. A 156.8 acre tract adjoining the tailings area to the northeast is owned by Pathfinder as to the surface and the Nall family as to the mineral estate. Pathfinder proposes to acquire this mineral estate by purchase or trade, as well as both surface and minerals of 65 acres along Spring Creek. These acquisitions will preclude any access for intrusion into subsurface contamination.

ITEM 6. SLOPE STABILITY IN PIT #3.

The location of the minor slope instability in the reclaimed Area 3 Pit is so far distant from the tailings area that there are no plausible implications to the proposed ACL application. The slopes adjacent to the upstream end of the Spring Creek diversion are much flatter than those in the area of the minor instability (see attached figure) and there is no evidence of instability of the slopes in this area. With a distance of nearly a mile between the Spring Creek/Mine Creek confluence and the central area of the minor slope instability, the slope stability in the Area 3 Pit is not relevant to the ACL application.

Sincerely,

Donald L. Wichers for:

T. W. Hardgrove
Manager, Reclamation Operations

Cc: C. Cain, U.S. NRC, Region IV
D. L. Wichers

Reference: Wilken, R.T., R.W. Puls, and G.W. Sewell, 2003. Long-term performance of permeable reactive barriers using zero-valent iron: Geochemical and microbiological effects. Ground Water 41, no. 4: 493-503.

A