HIGH COUNTRY CONSERVATION ADVOCATES
RED LADY COALITION

July 25, 2014

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Submitted electronically

Re: U.S. Energy Corp. June 2, 2014 VCUP Submittals

Dear Ms. Sheets, Mr. Jamison, and Mr. Apostolopoulos:

Please accept the following letter on behalf of High Country Conservation Advocates and Red Lady Coalition. We thank CDPHE for the continued opportunity to remain engaged in the proposed U.S. Energy Corp. Voluntary Clean-up Plan (VCUP) Application process. We believe it is critical community groups are informed and included in this process due to the proposed clean-up site's close proximity to vital drinking water sources, the Town of Crested Butte, and numerous surrounding residences. Furthermore, the entire area above and below the proposed project site is an integral part of the local amenity economy, which is vital to the community's well-being. Everything in our community—human health, environmental health, and the economy—depends on clean water.

Given the proposed VCUP site's importance for human health, the environment, and local economy, we are pleased that CDPHE in its March 21, 2014 letter requested that U.S. Energy Corp. provide additional information to supplement the proposed Amended Voluntary Cleanup. We are concerned, however, that the information U.S. Energy has provided to date is not as comprehensive and rigorous as necessary to ensure protection of human health and the environment.

To assist with our analysis of the proposed project, we hired Integral Consulting, Inc. to conduct a thorough evaluation of U.S. Energy's amended VCUP and Supplemental Materials for the Historic Keystone Mine (HKM) site. Integral is a national science and engineering firm that provides multidisciplinary services in the fields of health, environment, technology, and sustainability. Integral's review and analysis provides comments on the proposed monitoring plan, contingency plan, and bulkhead engineering, as well as comments outlining additional concerns that have not been raised yet in this process. We request CDPHE to address the issues raised in this letter and the attachments, and review our previously submitted comments, as the concerns we raised earlier still remain.

After our own review and expert review (hereinafter "Integral Report") of the amended materials and June 2, 2014 Supplemental Materials, we believe CDPHE still has not been provided with the information requested in the March 21 letter. Moreover, U.S. Energy has not provided additional necessary information to determine whether the proposal would be safe and effective. Our experts noted, "[t]he current amended VCUP documentation fails to provide the necessary components of a monitoring plan, contingency plan, and detailed engineering design to ensure a *safe and effective* HKM treatment program for underground formation water." Integral Report at iv (emphasis added); *see also* at 1-1 and 6-1.

As the proposal currently stands, there is a risk of changing what is currently a one point-source discharge and compliance point into multiple-point source discharges in unidentified areas within the Coal Creek watershed, and potentially in neighboring watersheds, such as the Slate River watershed. *See id.* at 2-1; 2-3. As there is no conclusive data regarding the site's hydrogeology, we are greatly concerned by the potential for new seeps and springs to result once the bulkhead-sealed adits fill with water.

Moreover, there has been no analysis, nor discussion, of the potential for a failure of the catastrophic bulkhead seal(s) or the surrounding rock and the attendant consequences. Such analysis is necessary and must evaluate the impacts on Coal Creek and the town of Crested Butte should there be an instantaneous release of underground formation water stored behind the bulkhead(s). *Id.* at 1-2. This analysis should include, but not be limited to, the potential for loss of life, property damage, and environmental impacts. *Id.* It is of the upmost importance that a proposed plan has no significant risk of negatively impacting water quality in the Upper Gunnison River Valley without appropriate contingency and mitigation plans. As the proposal currently stands, we do not believe this is the case. Given the history of bulkhead failures in the State of Colorado, we are concerned that there is potential for such failures with this proposed plan as well. This history makes it all the more important for worst-case scenario analysis and sufficient measures to be in place should such a failure result. Accordingly, we ask CDPHE that should the VCUP proposal move forward, that such risks be accounted for and mitigated.

In addition, we would like to point out that U.S. Energy continues to actively pursue what appear to be contradictory activities on Mt. Emmons. Indeed, CDPHE noted as much when it asked U.S. Energy to withdraw its two Notice of Intents regarding a potential mine on Mt Emmons filed with the Colorado Division of Reclamation, Mine and Safety. Yet, U.S. Energy still has not satisfied the request and continues to take actions that appear to be inconsistent with a proposed cleanup. It recently came to our attention that U.S. Energy submitted a mine Plan of Operations to the U.S. Forest Service to conduct environmental data collection as a precursor to a NEPA process. Although we do not have details of this proposal yet, the two proposals are inconsistent. A proposed mine would compromise a safe and effective cleanup. We urge CDPHE to ensure its VCUP review considers all facts, context, and interconnectedness of activities related to a potential mine within close proximity to the proposed cleanup site.

The following provides a summary of additional concerns regarding the topics CDPHE requested additional information on in March. We also provide non-exhaustive lists of missing information (Attachment B) that we believe are necessary to ensure the protection of human health and the environment should the proposed project move forward. For additional information on the issues raised below, please refer to Attachment A, *Comments on the Historic Keystone Mine Amended Voluntary Cleanup Plan Application*, Integral Consulting Inc. (July 14, 2014). We welcome the opportunity to discuss these matters in person with CDPHE should that be useful. Furthermore, we invite CDPHE to visit Crested Butte and request that U.S. Energy provide them access to the proposed site so CDPHE can conduct a complete and thorough site inspection. We believe this is a fundamental aspect to achieving a comprehensive and rigorous review of the proposed project.

I. Monitoring Plan

In general, the Application relies too heavily on regional citations and provides only a minuscule amount of site-specific data to support the proposed project or to analyze potential impacts. Integral at 2-1. It is essential that quantitative data is collected at and surrounding the proposed site and that such data is used to inform the proposed project as well as *all* steps of implementation, completion, and post-completion monitoring. Independent, certified specialists should execute technical monitoring and inspections to ensure these activities are properly conducted. As the proposed structures (bulkheads and manganese beds) would be permanent fixtures, monitoring must be conducted in perpetuity to ensure any necessary maintenance and replacement would be properly conducted.

The importance of a proper and sufficient monitoring regime is critical to the protection of human health and the environment. As you are aware, segment 12 of Coal Creek (from just below the Town's water intake to its confluence with the Slate River) was given a Water Supply use classification by the Water Quality Control Commission in September 2012 based on the presence of alluvial wells near the mouth of Coal Creek. The wells at issue have been identified as sources of domestic water supply for Gunnison County citizens. In addition, the community of Riverbend draws water from alluvial wells on the Slate River, just two miles south of its confluence with Coal Creek. Other downstream communities whose drinking water supplies may be impacted include Riverland, Crested Butte South, Almont, and Gunnison. While the Town's water supply is drawn from segment 11, above the current discharge point for the wastewater treatment plant, U.S. Energy cannot guarantee that its current plan will not cause acid mine drainage to enter that segment through alteration of the hydrology and groundwater pathways on Mt. Emmons.

II. Contingency Plan

The proposed contingency plan is insufficient. It appears to be lacking in specificity with respect to events, mitigants/remedial action, and timing of response. Given the amount of necessary information missing to develop a proper monitoring plan and that the suggested plan is meager, the proposed contingency plan cannot achieve its stated purpose. We request that CDPHE ensure that the Contingency Plan, should the proposal move forward, is sufficient to protect human health, and the environment.

III. Detailed Bulkhead Design

The Integral Report noted that "[t]he minimum bulkhead design approach submitted by the application is insufficient to meet its intended purpose." *Id.* at 4-1. Should this proposal move forward, we strongly encourage that, at a minimum, the measures the Integral Report suggested are used to cure deficiencies in the detailed bulkhead design. This requires a complete site investigation specific to each adit that assesses the geotechnical and hydrogeologic characteristics that would impact the feasibility of installing bulkheads within the adits. Such investigation and assessment should take place *prior* to VCUP approval.

We are also concerned that the adit bulkhead range of pressures was based off pressures found at a bulkhead deeper in the mine workings. These ranges may not be accurate due to differences in rock structure, water flow rate, and other site-specific factors that have not been provided. We strongly encourage ranges to be determined as a result of site-specific information gathered at each adit and specific for that adit's proposed bulkhead, rather than an extrapolation from other arguably similar structures.

IV. Additional Concerns

The following concerns are also listed specifically in the Integral Report. *Id.* at 5-1. We wish to include them here as we believe they are significant issues that CDPHE should address.

1. There has not been any bench- or pilot-scale testing;
2. No water balance has been provided;
3. The hydrogeologic system has not been modeled;
4. The geochemical model does not consider the effects of acidic, sulfate-bearing mineral dissolution in the historic mine workings;
5. The geochemical model ignores effects of mixing with infiltrating meteoric water;
6. At a minimum, a complete process flow diagram, providing anticipated flow rates, water levels, water pressures should be included.

In conclusion, we do not find that CDPHE has been provided with the supplemental information it requested in March and find that additional necessary information is also missing. As stated in the Integral Report, "the existing VCUP lacks the baseline characterization, proof of concept testing, and hydrogeologic and geochemical predictive modeling that is the best standard of practice in the treatment of mining-influenced water." *Id.* at 5-1. As the Application currently stands, we are concerned that there is an unacceptable risk to our water, community, and economy.

We request that CDPHE ensures, should this proposed project move forward, that data, investigations, studies, and other measures are taken to cure information, assessment, and analysis gaps so elements of chance and risk to the Upper Gunnison River Basin's water, community, and economy are removed to the greatest extent possible. We thank CDPHE again for the continued opportunity to participate in this process and look forward to remaining involved.

Sincerely,

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<u>Attachment A</u>

High Country Conservation Advocates and Red Lady Coalition
Re: U.S. Energy Corp. June 2, 2014 VCUP Submittals
Comments on the Historic Keystone Mine
Amended Voluntary Cleanup Plan Application
Integral Consulting Inc.

COMMENTS ON THE HISTORIC KEYSTONE MINE AMENDED VOLUNTARY CLEANUP PLAN APPLICATION

Prepared for
High Country Conservation Advocates
and
Red Lady Coalition

Prepared by

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285 Century Place
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Louisville, CO 80027

July 14, 2014

CONTENTS

ACRONYMS AND ABBREVIATIONS

CDPHE	Colorado Department of Public Health and Environment
EPA	U.S. Environmental Protection Agency
HCCA	High Country Conservation Advocates
HKM	Historic Keystone Mine
psi	pounds per square inch
UFW	underground formation water
VCUP	Voluntary Cleanup Plan
WQCC	Colorado Water Quality Control Commission

EXECUTIVE SUMMARY

At the request of the High Country Conservation Advocates and the Red Lady Coalition, Integral Consulting Inc. (Integral) has completed an initial review of the amended Voluntary Cleanup Plan (VCUP) application for the Historic Keystone Mine (HKM) site. This report provides a summary of Integral's review and analysis of the amended VCUP, including subsequent Colorado Department of Public Health and Environment (CDPHE) comments and applicant (U.S. Energy Corp.) responses. Based on this analysis, our comments are similar to those presented by the CDPHE (in its letter dated March 21, 2014) and also address issues and concerns not previously raised.

It is Integral's opinion that the current amended VCUP documentation fails to provide the necessary components of a monitoring plan, contingency plan, and detailed engineering design to ensure a safe and effective HKM treatment program for underground formation water. The applicant's May 30, 2014, response to CDPHE comments does not adequately address the concerns raised by CDPHE. In addition, it is Integral's opinion that an analysis of the catastrophic failure of the bulkhead seals or surrounding rock should be conducted. This analysis should include an evaluation of the impacts on Coal Creek and the town of Crested Butte in the event of an instantaneous release from bulkheads, including but not limited to the potential for loss of life, property damage, and environmental impacts.

1 INTRODUCTION

This report provides a review and analysis of the amended Voluntary Cleanup Plan (VCUP) for the Historic Keystone Mine (HKM) site (MES et al. 2014a), at the request of the High Country Conservation Advocates (HCCA) and the Red Lady Coalition. While Integral Consulting Inc.'s (Integral's) comments are similar to those provided by the Colorado Department of Public Health and Environment (CDPHE) in its letter dated March 21, 2014 (CDPHE 2014), we also present issues and concerns not previously raised. We believe that some of the responses submitted on May 30, 2014 (MES et al. 2014b), on behalf of U.S. Energy Corp. (the applicant), fail to address CDPHE's requests. After this brief introduction, our comments on the amended VCUP monitoring plan, contingency plan, and bulkhead engineering are presented with reference to the March 21 CDPHE letter, followed by comments regarding our additional concerns.

The conceptual strategy described in the amended VCUP is to disrupt acid generation in the mine workings by flooding them with limestone-buffered water. Four bulkheads are to be installed at multiple levels prior to beginning recirculation with underground formation water (UFW) emanating from the HKM workings. Powdered limestone is to be added to recirculating UFW, adding alkalinity and thereby buffering the inundated workings. Waters that seep through the bulkhead at levels 2160 and 2000 will receive secondary polishing to remove manganese in passive reactor beds.

It is Integral's opinion that the amended VCUP fails to provide the necessary components of a monitoring plan, contingency plan, and detailed engineering design to enable the safe and effective treatment of UFW. The existing plan lacks the baseline characterization, proof of concept testing, and hydrogeologic and geochemical predictive modeling that is the best standard of practice in developing a strategy for treating mining-influenced water (Gusek and Figueroa 2009).

Bulkheads are used to control mining-influenced water; however, they are not necessarily a walkaway solution. Examples of situations where blockage of mining-influenced water in one tunnel has resulted in poor-quality discharge elsewhere include:

- Dinero Tunnel—The Dinero Tunnel bulkhead was installed in 2009 by the U.S. Bureau of Land Management to mitigate the influence of low pH, high zinc, mining-influenced water on Lake Fork Creek in the Arkansas River drainage. Five years later, negative water quality impacts and increased flow in locations adjacent to the tunnel are evident (Walton-Day et al. 2013; BLM 2013).
- American Mine Tunnel—The American Tunnel bulkhead was installed in 1996 by Sunnyside Gold as part of an effort to ameliorate Cement Creek water quality and

allowing Sunnyside to turn off its Gladstone water treatment facility in the upper Animas River drainage near Silverton, Colorado. Following bulkhead installation Cement Creek water quality improved until the static water increased to a level for water to flow out of the Red and Bonita Mine. Bulkhead feasibility studies are currently underway for Red and Bonita Mine (ARSG 2014).

- Leadville Mine drainage tunnel—A collapse within the tunnel caused 500 million to 1 billion gallons of mining-influenced water to back up into the mountain, creating the potential for a sudden release. Acidic, metalliferous water began to seep at California Gulch. The U.S. Environmental Protection Agency (EPA) is pumping the Gaw Shaft, downgradient of the tunnel, to reduce seepage at California Gulch (USEPA 2008).

The lack of understanding with respect to connectivity between the HKM workings and groundwater and surface water was noted by the Colorado Water Quality Control Commission (WQCC) as a part of the temporary modifications granted to Regulation 35; therefore, the applicant put forward a plan to evaluate sources of metal loading in the vicinity of the HKM (WQCC 2012a, 2012b). In the December 3, 2012, Temporary Modifications Rulemaking Hearing document (WQCC 2012b), the WQCC stated:

"The sampling plan includes efforts to evaluate the extent to which metals concentrations in groundwater within and immediately downgradient of the flooded mine workings are being affected by historic mining activity. If such effects are identified, or if preliminary results are inconclusive as to the effects of the flooded mine workings, U.S. Energy will develop plans for further investigation and characterization of metals loading to Segment 12 from the mine area."

While no conclusive data regarding the site hydrogeology was presented, the information gained from that proposed study would be valuable with respect to evaluating the potential impacts of the amended VCUP.

More importantly, it is Integral's opinion that an analysis of the catastrophic failure of the bulkhead seals should be conducted. This analysis should include an evaluation of the impacts on Coal Creek and the town of Crested Butte in the event of an instantaneous release of UFW stored behind the bulkhead, including but not limited to the potential for loss of life, property damage, and environmental impacts.

2 MONITORING PLAN

In its letter dated March 21, 2014, the CDPHE requested:

"***A comprehensive Monitoring Plan** encompassing the historic Keystone Mine workings, segments 11 and 12 of the Upper Gunnison River Basin (Coal Creek), and any other areas that might be impacted by the work proposed in the plan. The purpose of the monitoring plan is to characterize baseline surface and groundwater conditions and develop a network of monitoring locations to evaluate potential changes in local hydrology and hydrogeology. Data collected under the monitoring plan will be used to evaluate potential changes to groundwater and surface water quality, changes in groundwater elevations, identify and quantify potential new discharges and any other hydrologic changes that might result from bulkhead installation and associated changes in groundwater elevation and quality."*

It is Integral's opinion that the monitoring plan as presented by the applicant is insufficient to achieve the purpose described by CDPHE. The proposed plan relies on assumptions and hypothetical conditions related to groundwater elevation and water quality. There is an overreliance on regional citations, with little site-specific data presented to support the project or analyze its potential impacts. The level of hydrogeochemical information achieved by the current baseline work and proposed monitoring plan is inconsistent with other recent bulkhead installations in the state of Colorado. Based on the limited monitoring network, short monitoring duration, and brief list of monitored parameters, Integral believes that the monitoring program will not adequately characterize current conditions and will not capture the resulting changes in the hydrogeochemical system.

2.1 LIMITED MONITORING NETWORK

As a result of the lack of baseline hydrogeological and climatic data, there is not enough data to perform a water balance in support of assertions of achieving saturation behind the bulkhead. In addition, little is known about the interconnections of mine workings with adjacent fracture systems that may carry UFW away from portions of the flooded mine to groundwater and surface water outside the VCUP property. Meteoric water infiltration into the workings and infiltration to groundwater from the workings have not been quantified. Because the proposed remedy relies on saturating the workings, obtaining quantitative data regarding the hydrogeologic system is the key to the success of the proposed VCUP. However, the VCUP is based on assumptions about the hydrogeologic system, rather than data collected at and surrounding the HKM. A water balance, which is necessary to evaluate both the assertions of the remedy and its operational efficacy, cannot be achieved with the monitoring network that is proposed. At minimum, an adequate water balance would include basic water input and output fluxes related to the following:

- Infiltration of meteoric water

- Storativity and transmissivity
- Groundwater flux to surface water
- Pumping rates
- Precipitation and evaporation rates.

2.1.1 Groundwater

The VCUP documents make frequent reference to returning the area to pre-mining hydrologic conditions. However, no relevant data are presented. Furthermore, no data are provided with respect to current hydrogeologic conditions and groundwater quality. Current water levels and subsurface preferred flow paths are not known. It is suggested in the VCUP that a cone of depression exists in groundwater surrounding the HKM workings as a result of water flowing out of the workings. However, no evidence is presented as to whether or not the area is saturated or unsaturated beyond the surmised cone of depression, nor are any data provided to indicate the lateral extent of a cone of depression. Additionally, no data are presented by which to evaluate groundwater fluctuations resulting from seasonal or long-term climatic effects. All of these issues will affect the ability to saturate the HKM workings and the viability of the proposed VCUP remedy.

Monitoring and baseline characterization of groundwater elevations and quality cannot be performed with the proposed groundwater monitoring network. The proposed network consists of two wells that are collocated at a location below the KHM workings. One well is shallow and monitors groundwater in the overburden; the second well is deep and monitors groundwater in the bedrock.

The first step in the design of any groundwater monitoring network is to develop a good conceptual model. The second step is to install at least three wells in each formation of interest so that there are three points of groundwater elevation (in each formation), in order to develop a preliminary understanding of the hydraulic gradient and the direction of groundwater flow. To prevent unnecessary cost, the conceptual model is used to attempt to place at least one monitoring well in the anticipated location upgradient of a potential source of groundwater contamination, and two wells downgradient of a suspected source of groundwater contamination. The upgradient well can also be used to quantify background groundwater quality and the downgradient wells provide an indication of impacts from a suspected source of groundwater impairment such as the HKM. Typically, after the first group of three wells is installed, additional wells would be added to refine the data related to hydraulic gradient and insure proper placement of wells downgradient of any suspected groundwater quality impairment. If impacts to groundwater quality are identified, then additional groundwater monitoring wells would need to be installed to define the lateral and vertical limits of the impacts to groundwater quality. This process has been described in numerous publications during the past 30 years (Driscoll 1986; Scalf 1981; USEPA 1977, 1986), and is considered the industry practice for areas where groundwater impacts are suspected.

Therefore, at minimum, three overburden monitoring wells and three bedrock monitoring wells, situated over an area extending from upgradient to downgradient of the mine, should be used to a) establish groundwater elevations and hydraulic gradient, b) monitor changes to groundwater elevations after construction of the bulkhead, and c) monitor groundwater quality upgradient and downgradient of the mine (Sara 1991). It is likely that additional monitoring wells will be required to ascertain the lateral and vertical extent of the existing cone of depression and changes to it following remediation. Groundwater elevation and quality in all monitoring wells will need to be monitored in perpetuity.

2.1.2 Seeps, Springs, and Surface Water

The applicant's response (MES et al. 2014b) to the request for a comprehensive monitoring plan fails to identify which existing seeps and springs will be monitored, and it fails to identify how new discharges, in the form of seeps, springs, and discharge to Coal Creek, will be identified. Furthermore, comparison of adjacent seeps and springs with water that has seeped through the bulkhead is not appropriate; the cement in the bulkhead will add substantial alkalinity to the water that seeps through it. Water from within the HKM workings should be sampled through a sampling port or monitoring well placed into the workings.

2.2 INSUFFICIENT MONITORING DURATION

According to the amended VCUP application and subsequent correspondence, monitoring of seeps, springs, and monitoring wells will begin one month before initiation of the recirculation system. At a sampling rate of once a month, only one sample will be collected before the system is potentially impacting water quality. Groundwater quality and elevation fluctuate seasonally; minimally, therefore, quarterly groundwater measurements should be made for one year prior to VCUP implementation, in order to establish baseline conditions. Similarly, water quality and flow rates from all potentially influenced springs and seeps should be monitored quarterly for at least one year prior to VCUP implementation.

The VCUP proposes monitoring for only one year after recirculation has stopped. However, water quality is likely to change in the workings over time, in response to natural fluctuations in water level and the mixing of infiltrating meteoric water. As water levels fluctuate, pyrite oxidation may recommence, causing the UFW to become acidic again. This acidic water may affect the integrity of the bulkhead seals and may create additional metals and acidity load to streams and groundwater as it percolates downward. It is Integral's opinion that long-term (decades-long) water quality monitoring is necessary. Additionally, the bulkheads and passive manganese treatment beds will need to be regularly inspected (in perpetuity) to determine if and when they need maintenance or replacement.

2.3 INSUFFICIENT MONITORING PARAMETER LIST

The applicant's list of monitoring parameters with respect to potential environmental impacts is sparse and overly qualitative, relying upon visual observations instead of quantitative measures at key steps in the active and steady-state periods of the remedy. Baseline characterization, which should include monitoring for one year, captures seasonal variation (Section 2.2) and should include metals, pH, and major ions (calcium, magnesium, sodium, potassium, alkalinity, chloride, and sulfate) in order to evaluate changes in water quality. The currently proposed monitoring parameters for wells, seeps, and springs do not include all of the analytes necessary to be protective of waters of the state nor would they provide strong evidence of provenance for Coal Creek impacts. While acidic pH may be ameliorated and overall metal concentrations may go down if the UFW is successfully buffered, there are metals such as arsenic, molybdenum, and selenium that are mobile under oxidizing conditions and are circumneutral to alkaline pH (Drever 1997). A complete geochemical model, utilizing a viable water balance and incorporating mixing, dissolution of existing sulfate salts, the recirculation of buffered UFW, and the baseline water quality on-site, should be performed to evaluate the potential for exceedance of all total maximum daily loads in Coal Creek Segment 12. Reductions to the monitoring list at seeps and springs should be based on constituents not detected in the workings as the treatment system is put in place and monitored over a longer term.

The current monitoring plan is focused on bulkhead water pressure but provides insufficient monitoring of HKM workings water chemistry. Monitoring should include all metals, pH, and major ions sampled from within the workings, not as bulkhead seepage. Bulkheads should be inspected at least quarterly by a certified engineer. Likewise, the plan is focused on the effectiveness of treatment within the mine workings rather than on long-term groundwater and surface water impacts in the vicinity of the mine.

2.3.1 Groundwater and Surface Water Constituents

Monitoring wells, springs, and seeps should be monitored for pH, alkalinity, standard dissolved metal suites, and all major ions so that standard hydrogeochemical plotting practices (e.g., Piper and Stiff diagrams) can be employed in monitoring and diagnostic activities. Adding sulfate, sodium, potassium, and chloride to the monitoring list would provide an opportunity to evaluate water quality impacts during the long term, without adding a specific tracer. While the monitoring plan suggests using only calcium and magnesium as tracers in the system, these constituents are not conservative; they readily dissolve and precipitate, altering their concentrations in water. Using the proposed remedy, post-recirculation UFW within the HKM workings will be higher in some major ions than pre-remedy UFW, because salts will concentrate through recirculation and the dissolution of existing secondary mineral phases in the workings. The saltier water can be traced in the hydrogeologic system using standard plotting tools.

2.3.2 Bulkhead Monitored Constituents

Water seeping through the bulkheads will have reacted with the bulkhead and surrounding rock; therefore, pH monitoring at that point is not necessarily reflective of HKM workings water quality. Water from within the HKM workings should be monitored for a complete analytical suite for several years following the cessation of recirculation. Constituents not seen in HKM workings water could then be removed from the overall monitoring program (Section 2.3.1.) with the exception of major ions, which should be monitored for the long term.

The amended VCUP proposes that the bulkheads be monitored for stain color, static pressure, and seepage rates. A full monitoring program and inspection checklist, similar to that required for retention bulkheads in underground coal mines, should be implemented (Harteis et al. 2008). Actions to be taken when deviations from planned conditions occur should be presented as well. In addition to the aforementioned parameters, a full inspection of the structural integrity of the bulkhead and surrounding rock that could affect the integrity of the bulkhead system should be included in the monitoring plan. These parameters (stain color, static pressure, seepage rates, and structural integrity of both the bulkhead and surrounding rock) should be monitored frequently (at least weekly) during the first year of operation or until the workings have been fully saturated, whichever is longer. Specifically, seepage rates should be closely monitored, as an increase may indicate a failure in the surrounding rock. Monitoring frequency can decrease over the life of the bulkhead, as conditions are better understood; however, since bulkheads are intended to be permanent structures, monitoring should be continued in perpetuity on at least a quarterly basis.

3 CONTINGENCY PLAN

In its letter dated March 21, 2014, the CDPHE requested:

"A ***comprehensive Contingency Plan*** *addressing the Keystone Mine, the workings, the bulkhead, and any springs or leaks from the site. The contingency plan will define potential adverse water conditions and rely on the monitoring plan to determine if any adverse water condition has occurred. The contingency plan should outline a process that defines how to address any adverse water condition. Methods to address adverse water conditions could range from additional monitoring to collection and treatment of contaminated water. Notification and reporting requirements for adverse water conditions should also be outlined in the contingency plan."*

Integral believes that a lack of sufficient baseline hydrogeochemical data and inadequate continued monitoring (Section 2) minimize the ability of the applicant's contingency plan to achieve its stated objectives. In addition, the response descriptions for adverse conditions, when they occur, are poorly defined and vague. Specific contingencies should be in place for unintended impacts to groundwater, surface water, and the sudden release of water resulting from bulkhead or rock failure.

3.1 GROUNDWATER AND SURFACE WATER IMPACTS

The contingency plan presented in the applicant's response to comments does not address what will happen if the HKM UFW flows to adjacent groundwater or surface water with deleterious effects. Potential appropriate contingencies could include:

- Dewatering, as the EPA was called in to do at the Leadville Mine drainage tunnel following collapses that led to an increase in discharge at nearby mine sites (USEPA 2012).
- Pump and treat, reintroducing the treated buffered water to the HKM workings to maintain buffering and saturation.
- Collection and treatment of impacted surface water prior to discharge.

3.2 BULKHEAD

The contingency plan presented in the applicant's response to comments suggests that bulkhead pressures should fall within the following ranges at each of the adit bulkheads:

- Adit 1370 bulkhead – 0 to 10 pounds per square inch (psi)
- Adit 1670 bulkhead – 0 to 56 psi

- Adit 1920 bulkhead – 0 to 160 psi
- Adit 2000 bulkhead – 0 to 190 psi
- Adit 2160 bulkhead – 0 to 280 psi.

The contingency plan from the applicant's response to comments for these bulkhead pressure ranges is *"No Action; differential pressures readings should agree with other readings at other bulkheads, if not check gauges or other potential reasons"* (MES et al. 2014b). After installation, the pressure behind the bulkheads should slowly increase as the workings fill with water. Once the workings behind the bulkheads begin to fill with water, a bulkhead pressure of zero is no longer acceptable, as it would indicate failure or discharge. However, once the workings are full, a narrow range of pressures behind the bulkhead should be expected based on groundwater levels. This anticipated range of bulkhead pressures, once the workings are filled, should be included in the contingency plan, as well as actions to be taken if bulkhead pressures fall outside the specified range.

The contingency should include an evaluation of water balance (Section 2.1) throughout operations, because if more water is being introduced to the workings through infiltration of meteoric water and recirculation than is being withdrawn or seeping out (Section 2.3.2), without the expected pressure increase, then the water is discharging elsewhere. Additionally, a decrease in pressure that is not correlated to known operational activity is an indication of an unintended discharge that should be located and evaluated.

Finally, contingency measures have not been established based on the possible structural failure of the bulkheads and surrounding rock. There is no discussion of the volume of water that would be released as the result of a catastrophic failure. These volumes would be key to water balance, and need to be known in order to formulate an adequate contingency plan for an instantaneous release. An instantaneous release, which may be more likely during high runoff, may pose significant environmental hazards and cause flooding, the latter of which could result in property damage or loss of life.

4 DETAILED BULKHEAD DESIGN

In its letter dated March 21, 2014, the CDPHE requested:

*"**A detailed preliminary bulkhead design** for the various mine openings/portal called or in the plan."*

The minimum bulkhead design approach submitted by the applicant is insufficient to meet its intended purpose. Integral believes that the response lacks sufficient detail to provide for an adequate review of the VCUP application. As stated in Appendix 3 of the response to comments, the provided design *"represents the minimum design, final design will be based on actual site conditions and adit dimensions once bulkhead locations have been finalized"* (MES et al. 2014b). Integral recommends that a complete site investigation be carried out to assess the geotechnical and hydrogeological characteristics that will impact the feasibility of installing bulkheads within the adits prior to VCUP approval.

4.1 EXAMPLE DESIGN CALCULATIONS

Example design calculations were provided in the May 30 response to comments (MES et al. 2014b); however, as stated in a letter from L-7 Services LLC, dated March 21, 2014, these are "sample" calculations and represent the minimum design (L-7 2014). The L-7 letter stated that final design will be based on actual site conditions and adit dimensions once the bulkhead locations have been finalized. While this level of design is adequate for the initial planning phases, the minimum design does not provide adequate information to allow for a one-time interaction with the CDPHE as outlined in the VCUP guidelines (CDPHE 2008). Specifically of concern are the assumptions made for the hydrostatic pressure that must be contained by the bulkhead seals and the minimum shear strength of the rock formation surrounding the bulkhead seals.

Design hydrostatic head (753 ft) appears to be based on pressures measured at the existing 2000-level bulkhead (593 ft), taking into consideration the elevation difference between the 2000-level adit and the 2160-level adit. Depending on the duration and frequency of monitoring the 2000-level bulkhead, this pressure may not take into consideration groundwater fluctuations resulting from seasonal or long-term climatic effects. A more thorough study of the hydrogeologic conditions at the site, including a water balance to understand groundwater levels and potential pressures behind the bulkheads, should be conducted to verify the design hydrostatic head.

The surrounding rock shear strength is an important factor to consider in the design of a bulkhead (Chekan 1985; Lang 1999; Harteis et al. 2008). Because an investigation of potential bulkhead locations has not been conducted, minimum rock shear strength in the preliminary design was assumed to be for competent, intact rock (200 psi). This is approaching the recommended design shear strength for a very good rock: massive, hard, and widely jointed (Lang 1999, Table 2). Additional testing, such as uniaxial compressive strength (ASTM 2004), or inspection and evaluation should be used to determine the surrounding rock shear strength.

4.2 SITE INVESTIGATION / FEASIBILITY STUDY

To fully evaluate the feasibility of installing bulkheads to seal the adits, a site investigation/feasibility study should be conducted and included as part of the VCUP. Conducting a feasibility study of bulkheads is a standard of practice prior to bulkhead design, as indicated by the number of mine sites conducting such feasibility studies (DRMS 2013). Such studies include the Red and Bonita Mine investigation, Carbonero Mine bulkhead feasibility study/implementation, Pennsylvania Mine project, Gamble Gulch-Perigo bulkhead feasibility investigation, and the Chalk Creek/Mary Murphy Mine.

The site investigation/feasibility study should include the following steps:

- Inspection of the workings and proposed bulkhead locations by a qualified, licensed professional.
- Complete mapping of the underground workings to the extent possible (the VCUP only includes a single cross section of the workings).
- Geologic mapping of the proposed bulkhead locations.
- Evaluation of rock mass classification and estimation of rock mass strength.

The feasibility study should be thorough enough to address the following (Lang 1999):

- Are there any major continuous faults or shears that would affect the plug stability or result in excessive seepage at the proposed bulkhead location?
- What is the shear strength of the rock mass?
- What is the hydraulic conductivity of the rock mass and how does it change with distance from the tunnel?
- Is there sufficient confining stress? (The site investigation should include geologic mapping to determine overburden unit weight.)
- How tight are the joints and what kind of grout can be used to grout the rock mass?
- Is the rock or joint filling soluble or erodible?
- How much water is flowing in the tunnel and how will this be handled during construction?
- What is the anticipated design life of the structure?

Similar investigations prior to construction have been recommended for control of water in underground coal mines (Chekan 1985; Harteis et al. 2008). In addition, Integral recommends assessing the maximum hydrostatic pressure that can be restrained by the structure, by evaluating water elevations at the site and modeling the maximum elevation that water may reach within the workings. This would include assessing seasonal and long-term climatic effects on water levels (Section 2.1).

Materials of construction of the bulkhead seals are only discussed in generalities (e.g., a very-high-specification, "self-consolidating" concrete) in the VCUP application. To ensure that construction materials will be compatible with UFW, a series of bench- and/or pilot-scale tests should be conducted to determine the spectrum of water qualities that the bulkhead must be resistant against, from highly acidic waters at the beginning of operations through highly buffered, alkaline waters anticipated for long-term, steady-state conditions.

5 ADDITIONAL CONCERNS

In addition to sharing the concerns raised by the State regarding the monitoring plan, contingency plan, and bulkhead design, Integral has the following concerns regarding the implementation of the HKM site remedy.

- There has been no bench- or pilot-scale testing.
- There has been no modeling of the hydrogeologic system.
- The geochemical model fails to consider the effects of acidic, sulfate-bearing mineral dissolution in the HKM workings.
- The geochemical model ignores the effects of mixing with infiltrating meteoric water.
- At a minimum, a complete process flow diagram, providing anticipated flow rates and water levels/pressures, should be included in the amended VCUP.

In short, the existing VCUP lacks the baseline characterization, proof of concept testing, and hydrogeologic and geochemical predictive modeling that is the best standard of practice in the treatment of mining-influenced water (Gusek and Figueroa 2009).

6 CONCLUSIONS

It is Integral's opinion that the current, amended VCUP documentation fails to provide the necessary components of a monitoring plan, contingency plan, and detailed engineering design to ensure a safe and effective HKM UFW treatment program. The applicant's response (MES et al. 2014b) to CDPHE comments (CDPHE 2014) does not adequately address the concerns raised by CDPHE. In addition, it is Integral's opinion that an analysis of the catastrophic failure of the bulkhead seals or surrounding rock should be conducted. This analysis should include an evaluation of the impacts on Coal Creek and the town of Crested Butte in the event of an instantaneous release from bulkheads, including but not limited to the potential for loss of life, property damage, and environmental impacts.

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<u>Attachment B</u>

High Country Conservation Advocates and Red Lady Coalition
Re: U.S. Energy Corp. June 2, 2014 VCUP Submittals
List of Issues Derived from Integral Report

The following lists are suggestions we ask CDPHE to incorporate into a proposed Voluntary Clean-up Plan (VCUP) for the Historic Keystone Mine (HKM) site.

I. Monitoring Plan

Specific factors regarding the monitoring plan we strongly encourage CDPHE to require regarding the proposed Monitoring Plan include:

1. Quantitative baseline hydrogeochemical data for groundwater (wells, seeps, and springs) and surface water monitoring that includes pH, alkalinity, standards dissolved metal suites, and all major ions as is standard for hydrogeochemical plotting practices;
2. Quantitative data on current water levels and subsurface preferred flow paths;
3. Quantitative data for evaluating groundwater fluctuations relating to seasonal and long-term climatic effects on groundwater fluctuations;
4. Additional information on the cone of depression as stated in the Integral Report at 2-2;
5. A minimum of three bedrock monitoring wells and three overburden wells located over the proposed site from upgradient to downgradient of the mine to:
    a. Establish groundwater elevations and hydraulic gradient;
    b. Monitor changes to groundwater elevations after construction of the bulkhead; and
    c. Monitor groundwater quality upgradient and downgradient of the mine.
6. Identify existing seeps and springs that would be monitored;
7. Identify how new discharges, such as seeps, springs, and discharges into Coal Creek would be identified;
8. A minimum of at least one-year of quarterly groundwater measurements (quality and flow rate)at all monitoring stations, including wells, prior to proposed project implementation so a baseline could be established;
9. A minimum of at least one-year quarterly monitoring (water quality and flow rates) of all potentially impacted seeps and springs prior to proposed project implementation to establish a baseline;
10. Monitoring parameters based on quantitative information (not simply visual observations);
11. Regular (in perpetuity) water quality monitoring post-implementation;
12. Regular (in perpetuity) inspections and monitoring of bulkheads and passive manganese treatment beds to determine if and when they need maintenance or replacement;
13. Monitoring water in the HKM workings directly through sampling port or monitoring well, not monitoring such water only after it has seeped through the bulkhead(s);
14. Complete analytical suite monitoring of the workings for at least several years after recirculation has ceased; and
15. Treatment effectiveness focused on long-term groundwater and surface water impacts in the mine vicinity, not on impacts within the mine workings.

II. Contingency Plan

The following list includes additional factors that, at a minimum, should be addressed to move the proposal towards a plan that would protect human health and the environment:

1. Analysis of what would happen should the underground formation water in the historic mine workings flow to adjacent groundwater or surface water and cause negative impacts;
2. A reasonable range for bulkhead psi (*see* Integral Report at 3-2);

3. Water balance evaluation throughout the proposed operations;
4. Contingency measures that account for structural failure of bulkheads and surrounding rock;
5. Analysis of water amount that would be released in a catastrophic failure; and
6. Potential impacts as well as mitigation and remedial measures that would take place should a catastrophic failure result.

III. <u>Detailed Bulkhead Design</u>

The following list is necessary, yet missing, information for the detailed bulkhead design:

1. As is initial standard practice, conduct a site-specific investigation and feasibility study for each adit to determine the feasibility of installing and proposed locations of bulkheads to seal each adit;[1]
2. Quantitative, site-specific analysis for each adit that is used to determine the hydrostatic pressure bulkhead seals would have to contain;
3. Quantitative, site-specific analysis for each adit to determine minimum shear rock strength of the rock formation surrounding the proposed bulkheads;
4. Quantitative, site-specific analysis for each adit that accounts for seasonal or long-term climatic groundwater fluctuations;
5. Verify hydrostatic head design for each adit through study of hydrogeologic conditions at the site (including water balance to understand groundwater levels and potential pressures); and
6. Conduct a series of bench- and pilot-scale tests to determine the spectrum of water qualities that the bulkhead would need to be resistant against, such as highly acidic waters at the beginning of operations through highly buffered alkaline waters anticipated for long-term, steady-state conditions.

[1] *See* Integral Report (Attachment A) at 4-2 for list of specific questions the feasibility study should at a minimum be thorough enough to address.