United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Washington, D.C. 20240
http://www.blm.gov

March 31, 2020

In Reply Refer To:
1278-FOIA (640)
FOIA# 2019-00938
1:19-CV-01857

Austin R. Evers
American Oversight
1030 15th Street NW, Suite B255
Washington, DC 20005

Dear Mr. Evers:

This letter is an interim response to your Freedom of Information Act (FOIA) requests, dated March 5, 2019 and April 23, 2019 and assigned tracking numbers 2019-00938 and 2019-00952. In your letter, you asked for the following:

All records reflecting communications (including email messages, email attachments, calendar invitations or entries, and any handwritten or typed notes from meetings) between the custodians listed below and the following individuals and entities:

a. Any employee or representative of Antofagasta PLC, including anyone with an email address ending in antofagasta.co.uk;
b. Andronico Luksic, and anyone acting on his behalf such as a chief of staff, scheduler, or assistant;
c. Ivan Arriagada, and anyone acting on his behalf such as a chief of staff, scheduler, or assistant;
d. Any employee or representative of Twin Metals Minnesota (TMM), including anyone with an email address ending in twin-metals.com;
e. Robert Lehman (including but not limited to the email address rob.lehman@wilmerhale.com); and/or
f. Timothy Martin (including but not limited to the email address timothy.martin@wilmerhale.com).

All communications (including email messages, email attachments, calendar invitations or entries, and any handwritten or typed notes from meetings) between the custodians listed below and the following individuals and entities, regarding the mining leases of Twin Metals in Minnesota:

a. Representative Tom Emmer, and anyone acting on his behalf or serving on his

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staff, including but not limited to Christopher Maneval (Christopher.Maneval@mail.house.gov), David Fitzsimmons (David.fitzsimmons@mail.house.gov), Alyssa Anderson (alyssa.anderson@mail.house.gov), Landon Zinda (landon.zinda@mail.house.gov), and Catherine Lenz (Catherine.lenz@mail.house.gov).

b. Representative Paul Gosar, and anyone acting on his behalf or serving on his staff, including but not limited to Thomas Van Flein (tom.vanflein@mail.house.gov), Leslie Foti (leslie.foti@mail.house.gov), Rory Burke (rory.burke@mail.house.gov), and Jeff Small (jeff.small@mail.house.gov).

While we are still reviewing documents for responsiveness, we reviewed 13,604 pages and out of these, 485 pages were found to be responsive. We are providing via email a PDF file consisting of 485 pages, which is being released in full.

Keiosha Alexander, Bureau of Land Management (BLM) FOIA Officer, is responsible for this release.

If you have any questions regarding this request, please contact Sheriff Oladepo, BLM WO FOIA Specialist, at (202) 912-7650 or via email at BLM_WO_FOIA@blm.gov.

Sincerely,

KEIOSHA ALEXANDER

Digitally signed by KEIOSHA ALEXANDER
Date: 2020.03.31 10:47:11 -04'00'

For Ryan Witt, Acting Chief
Division of Intergovernmental and External Affairs

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From:	Bob McFarlin
To:	kbenedetto@blm.gov
Subject:	TMM Comment Letter to USFS
Date:	Thursday, March 1, 2018 11:16:04 PM
Attachments:	Twin Metals Comment Letter Final 022718.pdf TMM Comment Letter Attachments 2-27-18.pdf

Hi Kathy,

FYI - Attached is the latest Twin Metals comment letter to the US Forest Service on the withdrawal issue.

Bob McFarlin
Government Affairs Advisor
Twin Metals Minnesota
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TWIN METALS MINNESOTA

August 11, 2017

Karen Mouritsen
State Director
Bureau of Land Management, Eastern States Office
20 M Street SE, Suite 950
Washington, DC 20003

Connie Cummins
Forest Supervisor
Superior National Forest
8901 Grand Avenue Place
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Dominica VanKoten
Deputy State Director, Geospatial Services
Bureau of Land Management, Eastern States Office
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Re: Department of Agriculture, United States Forest Service Application for Withdrawal in the Superior National Forest

Dear USFS and BLM:

On January 13, 2017, the United States Forest Service ("USFS") published in the Federal Register public notice ("Notice") of a USFS application ("Application") to the Secretary of Interior. This Notice and Application propose, for a 20-year term, to withdraw, approximately 234,328 acres of National Forest System lands within the Rainy River Watershed ("Watershed") in the Superior National Forest ("SNF") from disposition under United States mineral and geothermal leasing laws, subject to valid existing rights (both the Notice and the Application are collectively referred to as, "Withdrawal Proposal"). The Withdrawal Proposal states that the USFS intends to amend the Superior National Forest Land and Resource Management Plan ("SNF Forest Plan") to preclude mineral development in the same lands. The stated purpose of the Withdrawal Proposal is to protect natural resources and waters located on national forest lands from potential adverse environmental impacts from the exploration and development of federal minerals within the Watershed. The Withdrawal Proposal invites public comments on scoping for the environmental review required to implement the Withdrawal Proposal and

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the amendments to the SNF Forest Plan. Twin Metals Minnesota LLC ("Twin Metals") has significant property rights in the Watershed through its mineral leases, prospecting permits, and other mineral tenure rights. Twin Metals, thus, has significant concerns regarding the Withdrawal Proposal.

The Withdrawal Proposal is contrary to law and long-standing public policy. It also does not take into consideration currently available science and decades of environmental review, agency decision making, and past practice, which demonstrate that mineral development is a desired condition within the SNF. For these reasons, Twin Metals requests that the United States Department of Agriculture ("USDA") cancel the Withdrawal Proposal pursuant to its authority under 43 C.F.R. § 2310.1-4(a) and rescind the proposed amendments to the SNF Forest Plan.

In the event that the Withdrawal Proposal is not canceled and the amendment process for the SNF Forest Plan continues, Twin Metals herein provides comments to the USFS and Bureau of Land Management ("BLM"). In Twin Metals' comments, Twin Metals shows that withdrawals under the Federal Land Policy and Management Act, 43 U.S.C. § 1714 ("FLPMA") are inapplicable to mineral leasing in the SNF as well as to Twin Metals' valid existing rights. Twin Metals also explains why the facts and science do not support the Withdrawal Proposal. Finally, Twin Metals demonstrates why the Withdrawal Proposal contravenes Congressional, agency, and state policy. These issues are discussed in the enclosed memorandum from counsel, Dorsey & Whitney, ("Dorsey Memo"), a memorandum from Golder Associates Inc. ("Golder Memo"), attached as Exhibit A to the Dorsey Memo, and a memorandum from Foth Infrastructure & Environment, LLC ("Foth Memo") attached as Exhibit B to the Dorsey Memo. The following is a brief summary of the conclusions these memoranda make.

Leasable Minerals are Not Subject to Withdrawal. The Withdrawal Proposal is submitted under FLPMA. However, FLPMA only authorizes the withdrawal of locatable minerals subject to the General Mining Law of 1872, not leasable minerals. All the minerals in the subject area of the SNF are leasable minerals, and therefore cannot be withdrawn under FLPMA. The USFS and BLM do not have the legal authority to withdraw the subject federal minerals under the statutory provisions outlined in the Withdrawal Proposal.

The Withdrawal Proposal Contravenes Long-Held Congressional Policies. Even if the Withdrawal Proposal were legally sustainable under FLMPA (which it is not), it runs counter to decades of carefully considered Congressional policies for the SNF. In particular, establishment of the Boundary Waters Canoe Area Wilderness ("BWCAW") arose out of a long federal process that balanced environmental protection objectives and economic development.

Through the 1920s and 1930s, the USDA and Congress took progressively greater steps to protect lands in what would later become the BWCAW. *See generally Nat'l Assoc. of Prop. Owners v. United States*, 499 F. Supp. 1223, 1254-55 (D. Minn. 1980). In the 1940s and 1950s, Congress began promoting the acceleration of mineral development in the broader SNF. During none of this time did Congress or USDA state that these two

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aims were incompatible. To the contrary, Congress continued its efforts to balance conservation and development into the 1960s and 1970s. After Congress designated the BWCAW as a wilderness area in the Wilderness Act of 1964, debate swirled around what types of development activity would be permitted in the BWCAW. *See* Wilderness Act of 1964, Pub. L. No. 88-577 § 4(d)(5), 78 Stat. 890 (1964). To resolve these disputes, in 1978, Congress enacted the Boundary Waters Canoe Area Wilderness Act ("BWCAW Act"), Pub. L. No. 95-495, 92 Stat. 1649 (1978). The BWCAW Act is Congress's latest and most authoritative statement regarding management of the BWCAW and the 1.9-million acres of SNF lands outside the 1.1-million-acre BWCAW. Although the BWCAW Act prohibited mineral development in the BWCAW, it permitted mining in the SNF—including the non-wilderness lands targeted by the Withdrawal Proposal. *See id.* § 11(b)(1). To ensure that mineral development would not harm the BWCAW, Congress established a 220,000-acre buffer area bordering the wilderness that it called the "***Mining Protection Area***." *See id.* §§ 9-10, 92 Stat. at 1655.

Congress's creation of the *Mining Protection Area* speaks volumes about Congress's intent regarding how minerals would be managed outside the BWCAW. It is important to note that Congress did not create an *industrial protection area* or a *timber protection area* in the BWCAW Act; Congress created the *Mining Protection Area* because Congress knew the SNF was mineral rich. Inherent in Congress's designation of the *Mining Protection Area* is its acknowledgement that mining would take place outside the boundaries of the BWCAW and the *Mining Protection Area*. Congress clearly was aware of the significance and importance of buffers. If Congress had intended for there to be no mining in the 1.9-million-acre SNF outside the boundaries of the BWCAW, it would have expanded the area encompassed by the *Mining Protection Area* to cover the entire SNF—but it did not. As discussed in the Dorsey Memo, USFS may not do what Congress intentionally did not do.

The Withdrawal Proposal Violates the Agencies' Own Policies. USFS and BLM policy also favors mining outside wilderness areas and discourages the creation of de facto administrative buffer zones around wilderness areas. Several years after Congress established the BWCAW, BLM established its wilderness management policy. Wilderness Management Policy, 46 Fed. Reg. 47,180 (Sept. 24, 1981).

In this guidance, BLM states:

> *Buffer Zones and Adjacent Lands.* ***No buffer zones will be created around wilderness areas to protect them from the influence of activities on adjacent land.*** The fact that nonwilderness activities or uses can be seen or heard from areas within the wilderness shall not, of itself, preclude such activities or uses up to the boundary of the wilderness area.
>
> When activities on adjacent lands are proposed, the specific impacts on those activities upon the wilderness resource and upon public use of the wilderness area will be addressed in environmental assessments or environmental impact statements, as appropriate. ***Mitigation of impacts***

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> ***from outside wilderness will not be so restrictive as to preclude or seriously impede such activities.***

Id.; *see also* U.S. Bureau of Land Management, BLM Manual 6340 § 1.6(D)(2) ("BLM does not prohibit uses outside a wilderness on public lands solely to protect the wilderness character of the designated lands.").

USFS guidance is even more direct. USFS policy states, "***Do not maintain buffer strips of undeveloped wildland to provide an informal extension of wilderness.***" U.S. Forest Serv., Forest Serv. Manual 2320.3. Numerous other examples of similar agency guidance are discussed in the Dorsey Memo. The obvious purpose of these proscriptions is to prevent wilderness areas from becoming ever expanding. As courts have recognized, "[A]t some point, the wilderness stops and civilization begins." *Izaak Walton League of Am., Inc. v. Kimbell*, 516 F. Supp. 2d 982, 989 (D. Minn. 2007).

The Withdrawal Proposal abandons these management directives in favor of unsupported decision making.

The Agencies Should Address Their Concerns on a Project-Specific Basis. A project-specific environmental review would serve the public interest better than an EIS on the entire Watershed. The USFS already generated extensive environmental analysis when it released the 1986 and 2004 Forest Plans, both of which concluded that mining was a "desired condition" in the SNF outside the BWCAW. The appropriate time to conduct additional environmental review is in response to a mine plan of operation ("MPO"). Absent an MPO, the USFS lacks a concrete, detailed project proposal and therefore does not have sufficient information for a credible environmental analysis. A project-specific review will be significantly more valuable than the withdrawal EIS. Nothing in the 60-year history of hardrock mineral regulation in the SNF suggests the USFS lacks adequate tools to protect surface resources on a project-by-project basis. In fact, the National Academy of Sciences, the USFS, and the BLM have all stated that over the past 30 years hardrock mining regulations and federal and state environmental laws successfully protect the environment.

The Withdrawal Cannot be Supported on the Science. The sole stated objective of the Withdrawal Proposal is to protect the BWCAW from the "potential" that mineral exploration and mining could result in acid rock drainage ("ARD") from sulfide-bearing ores, tailings, and other waste rock, and that it is reasonable to assume that such releases will migrate downstream and directly impact the waters of the BWCAW. To the contrary, these concerns are refuted by reports attached to the Dorsey Memo, "Twin Metals Minnesota Acid Rock Drainage White Paper," prepared by Golder Associates ("Golder ARD Report"), Exhibit A, and "Lack of Hydrologic Basis for BLM and USFS Decision to Reject Renewal of TMM Mineral Leases and Potentially Withdraw Federal Minerals in the Watershed," prepared by Foth Infrastructure & Environment, LLC ("Foth Hydrology Report"), Exhibit B. These reports show that an underground mine in the Watershed can be managed in a manner that essentially removes the risks USFS identifies in the Withdrawal Proposal.

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The Golder ARD Report explains that TMM will design and operate an underground mine that will extract Cu-Ni-PGM sulfide mineral ore body located in the Duluth Complex. The Duluth Complex rock units located above the ore body that TMM will need to pass through to get to the orebody (i.e., development rock) and the orebody itself have been chemically tested in the laboratory to assess their acid-generating potential. Most of the development rock and ore samples (approximately 90%) tested to date are classified as non-acid generating, with the remaining 10% classified as having a low potential for acid generation. Furthermore, test work to date indicates that the tailings produced during beneficiation of the ore have very low sulfur content and can be classified as non-acid generating. Golder explains that this test work is consistent with the test work conducted by the Minnesota Department of Natural Resources and the United States Geological Association over the past few decades and that the Duluth Complex is one of the most studied and tested rock complexes in the world.

These reports confirm what Twin Metals has long known: that mineral exploration, development, and closure can be managed in the Watershed in a manner that will not present a risk to the BWCAW or the SNF. In particular:

- the Cu-Ni-PGM ore body in the Duluth Complex can be extracted by underground mining – and not open pit;
- the underground mines can be designed so there are no permanent waste storage facilities in the Watershed or the SNF;
- without permanent waste storage facilities within the Watershed, developers need not rely on long-term mitigation measures, containment facilities, or other remediation to protect the BWCAW;
- the ore beneficiation process that separates the economic Cu-Ni-PGM sulfide minerals in the ore body (producing valuable copper and nickel concentrates) from the uneconomic silicate minerals (producing waste tailings), can be designed to produce tailings that have no potential to generate ARD; and
- the tailings storage facilities can be located outside the Watershed and therefore pose no risk to the BWCAW.

In short, current data support that hardrock mineral development in the SNF can take place in an environmentally safe manner. The USFS and BLM possess ample regulatory tools to analyze the impacts of mining and protect the environment. The detailed history and policies associated with mineral development in the SNF, as well as the current set of regulatory tools to ensure that mining occurs responsibly, are discussed in the attached Dorsey Memo.

The Withdrawal Upends Developers' Legitimate Investment-Backed Expectations. Twin Metals and other companies have invested hundreds of millions of dollars in validating that the SNF contains some of the most valuable copper-nickel reserves in the world, sufficient to secure critical long term strategic and economic interests of the

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United States and Minnesota for decades to come. An estimated 4 billion tons of ore containing recoverable minerals lie in the area representing significant value to private, state, and federal interests. Additionally, the United States is presently over dependent on overseas supplies.

In this context, it is surprising that the agencies first denied lease renewals to Twin Metals in late 2016 and then proposed the Withdrawal Proposal. Law and science does not support these actions. The Withdrawal Proposal effectively destroys mineral rights in the SNF, denying the state of Minnesota the jobs and economic benefits of continued mineral development, and depriving the United States access to a domestic mineral supply critical for its sustainable growth and national defense. Twin Metals respectfully requests that the USFS and BLM rely on reason, sound science, and good policy to cancel the Withdrawal Proposal.

Sincerely:

Kevin L. Baker
Vice President, Legal Affairs

Cc:

The Honorable Thomas L. Tidwell
Chief, U.S. Forest Service
Sidney R. Yates Federal Building
1400 Independence Ave., SW
Washington, DC 20250-1111

The Honorable Michael D. Nedd
Acting Director, Bureau of Land Management
1849 C Street, NW, Rm. 5665
Washington, DC 20240

Enclosure

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DORSEY
always ahead

MEMORANDUM

VIA ELECTRONIC MAIL AND POSTAL SERVICE

TO: TWIN METALS MINNESOTA LLC

FROM: Ilsley Daniel Colton
Mark Kaster
Michael Drysdale
Brian B. Bell

DATE: August 11, 2017

RE: Comments to USFS Withdrawal Proposal, Dated January 13, 2017

On January 13, 2017, the United States Forest Service ("USFS") published in the Federal Register a public notice that it had submitted an application to the Secretary of the Interior ("Secretary") proposing the withdrawal under the Federal Land Policy and Management Act ("FLPMA") of approximately **234,328 acres** of National Forest System lands within the Rainy River Watershed ("Watershed") of the Superior National Forest ("SNF") from disposition under United States mineral leasing laws ("Withdrawal Proposal"). Twin Metals Minnesota LLC ("TMM") is the largest holder of federal copper-nickel-platinum group ("Cu-Ni-PGM") mineral interests located within the area of the Withdrawal Proposal. As a result, TMM's interests in the Withdrawal Proposal cannot be overstated.

As explained in detail herein, the Withdrawal Proposal is contrary to law, because the subject federal minerals in the SNF are "leasable" rather than "locatable" minerals under federal mineral law, and FLPMA withdrawals are only authorized for locatable minerals. Moreover, SNF mineral development is expressly authorized by Congress in 16 U.S.C. § 508b ("Statute 508b"), and this specific authorization for the SNF overrides the general withdrawal authority granted the federal agencies under FLPMA. Finally, the Withdrawal Proposal is an attempt to modify the boundaries of a prior statutory withdrawal made by Congress in the Boundary Waters Canoe Area Wilderness Act ("BWCAW Act"), and as such falls outside the Secretary's authority. Consequently, the Withdrawal Proposal is illegal and cannot lawfully be granted.

In addition to falling outside the scope of FLPMA withdrawals, the Withdrawal Proposal is contrary to Congressional intent, and both USFS and Bureau of Land Management ("BLM") policy and guidance. All of these statutory and regulatory authorities expressly recognize that mineral development is an important and desired objective on federal lands, generally, and specifically within the SNF. Agencies have already completed extensive environmental analysis supporting the conclusion that mining is a "desired condition" in the area of the Withdrawal Proposal. As a policy matter, additional environmental analysis would be most appropriate and most effective after a project-specific mine plan of operation ("MPO") is submitted. The Withdrawal Proposal constitutes an unsupported reversal of longstanding law and public policy.

This significant change in policy is not supported by available science. As shown below and in analyses by Golder Associates Inc. and Foth Infrastructure & Environment, LLC, the USFS has not shown that the Withdrawal Proposal is justified. The stated purpose of the

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Withdrawal Proposal is the protection of the BWCAW and its natural resources and waters located in the SNF from "potential" adverse environmental impacts, most notably acid mine drainage, allegedly caused by the exploration and development of federal minerals within the Watershed. Scientific data does not support the Withdrawal Proposal, and all existing data actually contradicts the USFS's concerns. Moreover, the voluminous mineral leasing rules and regulations that the BLM and the USFS have promulgated over the past 50 years, and apply to mineral development in the SNF, have and will continue to protect the environment and local values on a project-specific basis while allowing valuable and strategic minerals to be extracted; which development adds to the economic prosperity and wealth of the region and the Nation. Additionally, current and future mining in the Watershed is subject to the full panoply of environmental laws enacted in the last 50 years, including the National Environmental Policy Act ("NEPA"), the Clean Water Act, the Clean Air Act, and the Resource Conservation and Recovery Act. The Withdrawal Proposal thus violates longstanding federal mineral policy, without any factual or scientific justification.

For all these reasons, the USFS should *cancel* the Withdrawal Proposal pursuant to 43 C.F.R. § 2310.1-4(a), or failing that, the BLM should *deny* the Withdrawal Proposal pursuant to 43 C.F.R. § 2310.1-4(b) or 43 C.F.R. § 2310.3-3. Detailed comments on the Withdrawal Proposal are set forth below.

I. THE WITHDRAWAL PROPOSAL IS CONTRARY TO LAW

The Withdrawal Proposal is brought pursuant to the Secretary's withdrawal authority in FLPMA, 43 U.S.C. § 1714. As applied to the minerals in the SNF, the Withdrawal Proposal is legally defective in three respects. First, FLPMA withdrawal authority extends only to locatable minerals under the General Mining Law of 1872 ("GML"), not leasable minerals under other authorities. Second, even if the FLPMA general withdrawal authority extends to leasable minerals, it is superseded by the specific provisions of Statute 508b, governing disposition of minerals in the SNF, and which was enacted to negate a prior executive withdrawal. Third, even if FLPMA withdrawal authority can be reconciled with Statute 508b, the Secretary's withdrawal authority does not include proposals to modify the boundaries of prior withdrawals established by Congress. The Withdrawal Proposal constitutes an impermissible attempt to expand the Mining Protection Area established by Congress in the BWCAW Act.

A. Locatable v. Leasable Minerals

As a threshold matter, it is crucial to recognize the differences between "locatable" minerals under the General Mining Law of 1872, 30 U.S.C. Ch. 2 and "leasable" minerals under the various mineral leasing laws. *See generally Andrus v. Shell Oil Co.*, 446 U.S. 657, 658 (1980). All minerals in the SNF are leasable minerals. While there are many important and legally significant similarities between the rights afforded to prospectors for the basis and type of mineral tenure that is granted to prospectors under the GML and the various leasing laws, there are distinctions in the authority of the agencies as it pertains to their ability to wholly remove or withdraw from the public domain access to and development of federal minerals within these regulatory systems. The distinctions between these forms of mineral disposition—and the different level of discretion afforded to the USFS and BLM to limit development under the GML as compared to the various leasing laws—explain why FLPMA withdrawals are allowable for locatable minerals, but not for minerals subject to leasing.

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The GML incentivizes private, entrepreneurial prospectors to "locate" mineral deposits on federal lands. For the most part, there are very few geographical limitations on which federals lands are available for such exploration under the GML. In exchange for "locating" mineral deposits on federal land, the government rewards a prospector's successful efforts with ownership to the land and the right to mine those minerals, upon a showing that a valuable mineral deposit has been found. 30 U.S.C. § 29. With respect to mineral development under the GML, the USFS and BLM have limited regulatory authority to control the timing, duration, and area where prospectors can and cannot locate mineral claims on federal lands, short of closing the entire area to mineral location through a withdrawal under FLPMA. *See id.* § 22. Under the GML, prospectors may also potentially acquire fee title to the subject lands (i.e., full ownership of the prospected land transfers from the U.S. Government to the prospector). Minerals subject to the GML are known as "locatable minerals." *See, e.g.*, *Sierra Club v. Watt*, 566 F. Supp. 380, 382 (D. Utah 1983). As a result, the blunt, all-or-nothing instrument of mineral withdrawal for locatable minerals is one of the few regulatory tools available to the BLM and USFS to manage locatable mineral development under the GML and to take into consideration site-specific concerns.

In the early 20th Century, Congress created an alternative mineral disposition and management system. *See* Mineral Leasing Act of 1920, Pub. L. No. 66-146, 41 Stat. 437. This newly created system authorized the permitting, exploration, and leasing of certain high value chemical and energy minerals. *Id.* Over the course of the 20th Century, Congress extended the mineral leasing system to hardrock minerals in specific geographic areas, including the SNF. *See* 43 C.F.R. § 3503.13. In many respects, the mineral leasing system is identical to the GML's mineral location system. Under the GML, the discovery of a valuable mineral deposit is the genesis and basis for the passing of mineral interests, rights, and title to the prospector. Likewise, under the mineral leasing laws, and those applicable to the minerals in the SNF, the discovery of a valuable mineral deposit entitles the prospector to mineral interests, title, and rights in the discovered minerals. Under both systems, Congress recognizes the need to reward prospectors for undertaking the financial risk of exploring for unknown federal mineral deposits for the benefit of the U.S. government. *Compare Nat. Res. Def. Council, Inc. v. Berklund*, 609 F.2d 553, 557 (D.C. Cir. 1979); *with United States v. Locke*, 471 U.S. 84, 86 (1985). Neither the Secretary of the Department of the Interior ("DOI") or the USFS have the discretion to deny a lease once a valuable mineral deposit is discovered on public domain lands. While the mineral rights and interests granted to a prospector under a mineral leasing system are not fee title interests to the mineral and the surface property, the prospectors are nonetheless granted leasehold interests and use of the mineral estate and respective surface estate until the minerals are extracted. These mineral interests and rights are legally recognized property rights. In other words the prospector retains the same or similar mineral tenure rights and duration for the use of those rights to develop the minerals under a leasing scheme as compared to the minerals granted under the GML: all of which is underpinned by the discovery of a valuable mineral deposit. *See Nat. Res. Def. Council, Inc. v. Berklund*, 609 F.2d 553, 555 (D.C. Cir. 1979); *Peterson v. Dep't of Interior*, 510 F. Supp. 777, 779 (D. Utah 1981).

One important difference between mineral leasing and mineral location is the process of a prospector's acting on its desire to explore federal land in a specific geographic area of the mineral leasing program. Unlike under the GML, in mineral leasing programs, the BLM and USFS have the initial discretion to prevent a prospector from exploring on specific federal lands by denying the explorer a prospecting permit. For example, if either BLM or USFS are concerned about protecting a sensitive ecosystem or natural resource, they have the authority

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to deny requests for prospecting permits to explore such lands and thereby preclude any and all mineral exploration and development in the area of concern (which is not the case for locatable minerals). But, as with mineral location, once the USFS and BLM issue a prospecting permit (knowing the prospector will now risk millions of dollars prospecting on unexplored federal land), the prospector is legally entitled to a mineral lease if he through his authorized exploration discovers a valuable mineral deposit on the permit lands. *Nat. Res. Def. Council, Inc. v. Berklund*, 609 F.2d 553, 555 (D.C. Cir. 1979). This agency consent right at the issuance of initial prospecting permit is a powerful regulatory tool for agencies, that is not available under the GML, to analyze whether mineral exploration should occur in the proposed area. It allows the agencies to analyze and review concerns for the specific permit areas and determine whether that activity is appropriate in accordance with the forest and other management plans. That the agencies are subsequently prevented from denying a mineral lease to a prospector once a valuable discovery occurs is a function of the reward and entitlement that Congress intended to incentivize exploration and development of strategic and important public minerals.

In his work *The Mining Law*, John D. Leshy, the Department of the Interior's Solicitor during the Clinton Administration, aptly summarizes the benefits of mineral leasing as compared to mineral location:

> [T]he genius of the Mineral Leasing Act has been its flexibility; its ability to adapt mineral development to changes in the industry and in cultural values without mandating an all-or nothing result—all-out development versus no activity at all, as in a withdrawal. The lease-no lease decision provides the opportunity to balance mineral development against nonmineral concerns at the threshold. Most important, the terms and conditions included in the lease provide ample opportunity to tailor mineral development in such a way as to protect other resource values. Where the most readily available protective tool under the Mining Law—withdrawal—is amputation, less drastic remedial accommodations are possible under the Mineral Leasing Act.

John D. Leshy, The Mining Law: A Study in Perpetual Motion 330 (2016). The greater authority and flexibility under a leasing system at the initial prospecting stage explains why Congress did not extend FLPMA withdrawals to mineral leasing because the government can protect sensitive natural resources through ad-hoc permitting and leasing decisions. It also explains the agencies' aversion in their policy and planning documents and guidelines to any mineral withdrawal for areas where a mineral leasing system exists.

Leshy explained that mineral leasing made "it easier to ***revoke*** existing withdrawals from the [GML]." *Id.* at 332 (emphasis added). And the more surgical approach of mineral leasing "allows exploration and development to proceed even in relatively sensitive areas." *Id.* at 331-32.

Because of the regulatory authority provided under a mineral leasing program, that is not applicable in a mineral location program, sufficient regulations and protections are in place so that all public uses of federal public domain lands, including mining, are appropriately and adequately considered. Thus, withdrawal is unnecessary and inconsistent with the purpose for mineral leasing programs.

Statute 508b is a model example. In Statute 508b, Congress authorized DOI to apply a mineral leasing program to the SNF to revoke the existing withdrawal for these minerals,

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allowing exploration and development to proceed. This action also provided a framework for the agencies to regulate exploration and development of these minerals in a manner that is consistent with the special nature of the resources in the SNF (i.e., the BWCAW). Since that time, the USFS and the BLM have vindicated that decision, utilizing a rigorous regulatory process for leasable minerals within the SNF to grant prospecting permits, to evaluate preference right lease applications, to grant indeterminate leasehold interests, and to monitor and regulate all mineral development activity within the SNF. The regulatory process has been undertaken and conducted by the USFS and BLM in a manner that comports with the current Forest Plan and has protected the BWCAW. In other words, there is a long history of USFS and BLM decision making and practice in the SNF, supported by the full array of protections to land, water, and air afforded by NEPA environmental review and the federal/state environmental permitting process, to demonstrate that the regulatory process in the SNF is indeed working and more than sufficient to protect the BWCAW and other valuable assets of the United States.

B. FLPMA's Definition of "Withdrawal" Does Not Permit Withdrawal of Minerals from Leasing

FLPMA does not permit withdrawal of leasable minerals. FLPMA defines "withdrawal" as "withholding an area of Federal lands from settlement, sale, location, or entry, under some or all of the general land laws." 43 U.S.C. § 1702(j). The combination and sequence of terms has a very specific meaning, and the United States Supreme Court as well as the DOI have held that "settlement, location, sale, or entry" does *not* include mineral leasing. *See, e.g.*, *Udall v. Tallman*, 380 U.S. 1, 5, 19 (1965); *Noel Teuscher*, A-27099, A-27104, A-27192, 62 I.D. 210, 211, 214 (May 31, 1955) (concluding that an executive order withdrawing land from "settlement, sale, location, or entry" did not apply to leasable minerals).[1]

In *Udall*, the Supreme Court explained that "'[s]ettlement,' 'location,' 'sale' and 'entry' are all terms contemplating *transfer of title to the lands* in question," *id.* at 19 (emphasis added), as under the GML, *see* 30 U.S.C. § 29. As in *Udall*, FLPMA also defines "withdrawal" using the identical terms, "settlement, sale, location, or entry." 43 U.S.C. § 1702(j). Therefore, like in *Udall*, FLPMA's definition of withdrawal only applies to laws in which title to land transfers. *Udall*, 380 U.S. at 19. Because the fee title to the land is not transferred to the lessee under mineral leasing schemes, *Berklund*, 609 F.2d at 555, mineral leasing does not fall within FLPMA's definition of withdrawal.

[1] There are non-precedential federal district court cases suggesting that FLPMA withdrawals may extend to leasable minerals. *See Pacific Legal Foundation v. Watt*, 529 F. Supp. 982 (D. Mont. 1981) and *Mountain States Legal Foundation v. Hodel*, 668 F. Supp. 1466 (D. Wyo. 1987). *Watt* is distinguishable because, unlike the Withdrawal Proposal, it involved an emergency withdrawal. 529 F. Supp. 982. This distinction was of critical importance to the court, which stated that "[i]t would be unreasonable to hold that the ***emergency withdrawal*** . . . was not intended to give the congressional committees and the Secretary the power to preserve [natural resource] values by withdrawing the land from disposition under the mineral leasing laws." *Id.* at 997. *Watt*, and by extension *Hodel* (which relied heavily on *Watt*), were also wrongly decided. In *Watt*, the court held that FLPMA withdrawals applied to mineral leasing because withdrawal provisions in other statutes and executive withdrawals applied to mineral leasing. 529 F. Supp. at 996-97. Unlike FLPMA, however, those other statutes and executive withdrawals expressly referred to mineral "leases" or "leasing" in connection with the withdrawal. *Compare id.*, *with* 43 U.S.C. § 1714(j).

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In addition, the broad phrase "under some or all of the general land laws" does not incorporate mineral leasing into FLPMA's definition of "withdrawal." In *Udall*, the Court rejected an argument that the definition extends to leasing. *Udall*, 380 U.S. at 19-20 ("[T]he term 'public-land laws' is used to refer to statutes governing the alienation of public land, and generally is distinguished from . . . 'mineral leasing laws.' "). Moreover, statutory references in FLPMA's definition of withdrawal state that the general land laws are codified *only* in Title 43 of the United States Code. 43 U.S.C. § 1702 References in text (2006) ("The 'general land laws,' referred to in subsec. (j), are generally classified to [title 43]."). Statute 508b and the other mineral leasing laws are not found in Title 43. *See* 16 U.S.C. § 508b; 30 U.S.C. §§ 181-287. Unlike the GML, Statute 508b is specific to and applies only to the two national forests in the state of Minnesota and has no general or universal application to other public lands in the U.S. Thus, Statute 508b is not among the "general land laws."[2]

The legislative and regulatory history of FLPMA also confirms that FLPMA withdrawals are limited to locatable minerals. The House Report states that in FLPMA " '[w]ithdrawal' is defined to preserve its traditional meaning." H.R. Rep. No. 94-1163, at 5, *reprinted in* 1976 U.S.C.C.A.N. 6175, 6179. The House Report further explained that the "traditional meaning" of withdrawal "contemplate[s] cessation of actions ***conveying or leading to the conveyance of the title of the United States***." *Id.* at 44 (citing *Udall*, 380 U.S. at 19) (emphasis added). This is a logical extension, since the Supreme Court's decision in *Udall* was decided prior to FLPMA and *Udall* was and still is the definitive interpretation of the term "withdrawal." Mineral leasing, as occurs under Statute 508b and the Reorganization Plan No. 3 of 1946, § 402, 5 U.S.C. app., does not "lead [] to the conveyance of the title of the United States." For this reason, mineral leasing does not fall within the "traditional meaning" of "withdrawal" employed in FLPMA.

The preamble to the BLM withdrawal regulations reinforces that FLPMA excludes mineral leasing from FLPMA's withdrawal provisions. In the preamble, BLM noted that a few commenters on the proposed rule "were concerned about the emphasis placed on withdrawing lands from the ***general mining laws***." Federal Land Withdrawals; Amendment to Withdrawal Procedures, 46 Fed. Reg. 5794, 5795 (Jan. 19, 1981) (emphasis added). BLM made no changes based on these comments, explaining:

> Withdrawal from the general mining laws is specifically mentioned in the rulemaking because withdrawal is the only method the Secretary of the Interior has to close Federal lands, on a long term basis, to location and disposal under the general mining laws. This is true because the 1872 Mining Law is a nondiscretionary land law which grants anyone the right to enter those public lands not closed to its operation for the purpose of exploring for and extracting

[2] It is also worth noting that Congress enacted FLPMA after the *Udall* decision. Since FLPMA used the identical language as the withdrawal language in *Udall*, Congress clearly incorporated the interpretation in *Udall*. *See Bragdon v. Abbott*, 524 U.S. 624, 645 (1998) ("When administrative and judicial interpretations have settled the meaning of an existing statutory provision, repetition of the same language in a new statute indicates, as a general matter, the intent to incorporate its administrative and judicial interpretation as well."). That DOI had already interpreted "settlement, location, sale, or entry" as excluding mineral leasing, *see Noel Teuscher*, 62 I.D. at 214, further demonstrates that Congress understood that the definition of "withdrawal" did not include mineral leasing. *Bragdon*, 524 U.S. at 645; *FDIC v. Phil. Gear Corp.*, 476 U.S. 426, 437 (1986) (interpreting "deposit" consistent with "the longstanding [agency] interpretation" of "deposit").

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> hard rock minerals. The Mineral Leasing Act of 1920, as amended, on the other hand, gives the Secretary the discretion to preclude leasing of the minerals on the public lands that are covered by that Act, so the Secretary can, when necessary, prevent mining activity involving these minerals.

Id.

BLM's statement confirms the agency's position that FLPMA withdrawals do not extend to leasable minerals, and thus the Withdrawal Proposal proposed by the prior Administration is a violation of agency policy and law, and exceeds both the USFS's and BLM's authority under FLPMA.

C. The Withdrawal Proposal Violates FLPMA's Prescription Against Executive Modifications of Existing Withdrawals

Besides falling outside of FLPMA's definition of "withdrawal," the Withdrawal Proposal, violates FLPMA's prohibition against withdrawals that modify existing Congressional withdrawals. FLPMA provides that BLM "shall not make, *modify*, or revoke any withdrawal created by Act of Congress." 43 U.S.C. § 1714(j) (emphasis added). The Boundary Waters Canoe Area Wilderness ("BWCAW") and the Mining Protection Area are both withdrawals "created by Act of Congress." BWCAW Act, Pub. L. No. 95-495 §§ 3, 9, 11, 92 Stat. 1649, 1650, 1655 (1978). As established by Congress, these withdrawals total 1,297,500 acres of land. BWCAW Act, Pub. L. No. 95-495 §§ 3, 9, 11, 92 Stat. 1649, 1650, 1655 (1978). Now, through the Withdrawal Proposal, the agencies seek to modify these Congressional withdrawals by expanding them to include an additional 234,328 acres, treating these lands as if they were wilderness. Thus, the Withdrawal Proposal seeks to "expand the wilderness boundaries beyond the area established by Congress" and fails to recognize that "at some point, the wilderness stops and civilization begins." *Izaak Walton League of Am., Inc. v. Kimbell*, 516 F. Supp. 2d 982, 989-90 (D. Minn. 2007); *see also Sierra Club Northstar Chapter v. Kimbell*, Case No. 07-3160 ADM/RLE, 2008 U.S. Dist. LEXIS 107239, at *22-23 (D. Minn. Sept. 15, 2008). Consequently, the Withdrawal Proposal conflicts with FLPMA's admonition that neither the BLM nor the Secretary of the Interior may "make, *modify*, or revoke any withdrawal created by Act of Congress. *See* 43 U.S.C. § 1714(j) (emphasis added).[3]

D. Statute 508b Is Outside of FLPMA's Withdrawal Authority

Even if one ignored the plain language of FLPMA, and FLPMA withdrawals were assumed to apply to mineral leasing generally (which they do not), Statute 508b does not fall within BLM's withdrawal authority. Applying FLPMA to Statute 508b would setup a conflict between FLPMA and Statute 508b. On the one hand, FLPMA allows BLM to prohibit various

[3] To the extent that the USFS or Secretary contends that expanding the boundaries of the Mining Protection Area is authorized because the Secretary has defined "modify" as excluding the addition of lands to an existing withdrawal or partial revocation of a withdrawal, *see* 43 C.F.R. § 2300.0-5(o), the contention fails as a matter of law as applied to a Congressional withdrawal. Changing the boundaries of a withdrawal is a quintessential "modification" within the plain meaning of the term, and Congress did not supply any different definition in FLPMA. The Secretary may not revise FLPMA, and, if applied to Congressional withdrawals, the definition of "modify" at 43 C.F.R. § 2300.0-5(o) would largely eliminate Congress' express limitation of the Secretary's withdrawal authority in 43 U.S.C. § 1714(j).

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land uses, including mining, on public lands. Statute 508b, on the other hand, expressly permits mineral development in public domain lands in Minnesota's national forests. An accepted rule of statutory construction provides that when a general and specific statute conflict in this manner, the specific statute supersedes the general statute. *See Radzanower v. Touche Ross & Co.*, 426 U.S. 148, 153 (1976) ("[A] statute dealing with a narrow, precise, and specific subject is not submerged by a later enacted statute covering a more generalized spectrum."). Here, Statute 508b is not a general mining law of the United States; rather, it is a specific mining law dealing with "a narrow, precise, and specific subject"—mineral development in the public domain lands of Minnesota's national forests. Although the GML and the MLA apply universally in the United States, Statute 508b applies only to the two national forests in Minnesota (the Chippewa and Superior national forests). FLPMA "cover[s] a more generalized spectrum" of conduct—withdrawal of any federal land from numerous uses. *See Radzanower*, 426 U.S. at 153. Because Statute 508b is not a "general" mining law, rather it is a specific statute, its provisions, authorizing mineral development in the SNF, supersede FLPMA's general withdrawal provisions.[4]

Another rule of statutory construction provides that an interpretation of a statute that furthers, rather than frustrates, a statute's purpose should be adopted. *The Emily & The Caroline*, 22 U.S. (9 Wheat.) 381, 388 (1824). The purpose of Statute 508b was to reverse a previous executive withdrawal similar to the Withdrawal Proposal.[5] When Theodore Roosevelt created the SNF, he prohibited all mineral development within the SNF. Proclamation No. 848, 35 Stat. 2223 (Feb. 13, 1909). To undo this executive withdrawal, Congress needed to enact special legislation to permit mineral development in the SNF. Therefore, Congress enacted Statute 508b, which states in part as follows:

> Where, ***through withdrawal or reservation*** or by statutory limitation or otherwise, *all or any part of the mineral resources* in *public-domain lands* . . . ***situated within the exterior boundaries of the national forests in Minnesota***, are not subject to development or utilization under the mining laws of the United States or the mineral leasing laws, and for the development and utilization of which no other statutory authority exists, the ***Secretary of the Interior is authorized, under general regulations to be prescribed by him*** and upon such terms and for specified periods or otherwise as he may deem to be for the best interests of the United States, to permit the prospecting for and the development and utilization of such mineral resources . . . .

(Emphasis added). Allowing a subsequent executive withdrawal, like the Withdrawal Proposal, to counteract Statute 508b would undermine Congress' justification for enacting it (i.e., to overturn a comparable executive withdrawal). Because such a result frustrates the purpose of the statute, this interpretation should be rejected.

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[4] FLPMA's enactment after Statute 508b does not change this analysis. *See Morton v. Mancari*, 417 U.S. 535, 550-51 (1974) ("[A] a specific statute will not be controlled or nullified by a general one, ***regardless of the priority of enactment***.").

[5] Note that prior to 1950 the public domain minerals in the Withdrawal Proposal had been withdrawn through executive action. With the implementation of Statute 508b and the subsequent regulations, these minerals became leasable minerals.

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Finally, the legislative history demonstrates that the aim of Statute 508b was to promote, not prohibit, mineral development, a goal the Withdrawal Proposal would prevent. In supporting, Statute 508b, the House Committee on Public Lands reported that the purpose of Statute 508b is to "permit the development of mineral resources in the Superior National Forest." H.R. Rep. 81-795, at 1 (1949). Similarly, the Senate Committee on Interior and Insular Affairs described the purpose of Statute 508b as "permit[ing] the development of mineral resources in the national forests in Minnesota." S. Rep. No. 81-1778, at 2 (1950). Applying FLPMA to Statute 508b would prevent Statute 508b from meeting its purpose "to permit the development of mineral resources in the Superior National Forest." H.R. Rep. 81-795, at 1. Moreover, before the House Committee on Public Lands "[r]epresentatives of the Departments of Agriculture and Interior [had] testified . . . that it is *highly desirable* to permit the prospecting, development, mining, removal, and utilization of the mineral resources with the Superior National Forest." H.R. Rep. 81-795, at 1; S. Rep. No. 81-1778, at 2 (1950) (emphasis added). Having persuaded Congress to enact Statute 508b, the agencies may not, through unilateral executive withdrawal, effectively repeal Statute 508b.

II. THE WITHDRAWAL PROPOSAL IS CONTRARY TO FEDERAL AND STATE POLICIES

A. The Proposal Is Contrary to Congressional Policy

In addition to violating FLPMA and Statute 508b, the Withdrawal Proposal undermines Congressional policy. The Government has been aware of the BWCAW's value for nearly a century and has been working carefully to balance conservation and development interests. *See generally Nat'l Assoc. of Prop. Owners v. United States*, 499 F. Supp. 1223, 1254-55 (D. Minn. 1980). Throughout that time, Congressional policy has consistently favored mineral development outside the BWCAW.

1. Pre-1978 Efforts to Balance Conservation and Development in the SNF and BWCAW

In 1922, the Department of Agriculture ("USDA") took the first in a series of steps that would culminate in the enactment of the BWCAW Act in 1978. USDA commissioned the Carhart report, which recommended that one-million acres of the SNF be set aside to be administered "to protect and enhance its Lakeland quality, avoiding urban type, man-made developments such as roads and residential units which would detract from the area." *Id.* at 1254. In accordance with this recommendation, several years later, the Secretary of Agriculture adopted a policy to set aside no fewer than 1,000-square miles of the SNF to be kept as wilderness recreation areas. *Id.* The land was to be managed to retain as much of its wilderness character as possible. *Id.* To that end, the Secretary of Agriculture prohibited roads and commercial recreational developments in the area. *Id.* A few years later, Congress took notice of the value of the SNF and withdrew select areas of the forest from entry and appropriation under the public land laws. Shipstead-Nolan Act, Pub. L. No. 71-539, 46 Stat. 1020 (1930). Then, in 1939, the USFS took the first step in defining a wilderness area with

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boundaries similar to today's BWCAW. *Nat'l Assoc. of Prop. Owners*, 499 F. Supp. 1223 at 1254. Specifically, the Secretary established the Superior Roadless Primitive Area. *Id.*[6]

In parallel with these conservation efforts, and without suggesting that its actions were at odds with such conservation efforts, Congress *expanded* mineral development in the remainder of the SNF. In 1946, Congress turned management of mineral development in acquired SNF lands (and acquired forest lands nationwide) over to the more development-minded DOI. Reorganization Plan No. 3 of 1946 § 402, 3 C.F.R. 193 (1946 Supp.), *reprinted in* 5 U.S.C. app. at 604, *and in* 60 Stat. 1097 (1946). Several years later, Congress enacted Statute 508b, which opened public domain lands in the SNF to mineral development. Act of June 30, 1950, Pub. L. No. 81-594, 64 Stat. 311 (June 30, 1950) (codified at 16 U.S.C. § 508b).

Part of Congress's motivation in passing Statute 508b was to protect private companies that were incurring financial harm as a result of the USDA's failure to renew existing mineral permits and leases. Previously, mining permits in the SNF had been granted under a ruling from the Solicitor of the USDA providing that mineral development was permissible in the SNF. S. Rep. No. 81-1778, at 2 (1950); H.R. Rep. No. 81-795, at 2 (1949). That ruling, however, was later reversed, putting permittees' investments at risk. S. Rep. No. 81-1778, at 2; H.R. Rep. No. 81- 795, at 2. Congress's concern with the "investment losses resulting from cancellation of [these] mining permits" caused Congress to act. S. Rep. No. 81-1778, at 2; *see also* H.R. Rep. No. 81-792, at 2 ("It is the opinion of the committee, and [the DOI and USDA] agree, that those . . . who have made investments for the mining and removal of the mineral substances from the described lands should be given the privilege of renewing or retaining their permits or leases."). Thus, while the USDA and Congress took steps to preserve the BWCAW, they also accelerated mineral development in the SNF.

In 1964, as environmental concerns began to appear on the public consciousness, Congress enacted the Wilderness Act of 1964 ("Wilderness Act"), "establish[ing] a National Wilderness Preservation System to be composed of federally owned areas designated by Congress as 'wilderness areas.' " Wilderness Act of 1964, Pub. L. No. 88-577 § 2(a), 78 Stat. 890 (1964). The Wilderness Act gave a 20 year period from 1964 to 1984 for individuals to explore for and perfect valid existing rights. As a result, development activities, as well as future mining were legally permissible as valid existing rights in wilderness areas after the Act's creation. The BWCAW became part of the National Wilderness Preservation System established by the Wilderness Act. Pub. L. No. 88-577 § 4(d)(5), 78 Stat. at 895. The Wilderness Act said little about how the BWCAW would be managed. *Id.* The Wilderness Act left such management decisions to the USFS. *Id.* Consequently, debate about industrial activity within the BWCAW continued. *See, e.g.*, *Izaak Walton League v. St. Clair*, 353 F. Supp. 698, 706 (D. Minn. 1973). Controversy arose relating to various types of industrial activity, including mineral exploration and development, which led to additional legislative protections for the BWCAW.

[6] In 1958, USFS changed the name of the Superior Roadless Primitive Area to the Boundary Waters Canoe Area. *Id.*

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2. The BWCAW Act and the Mining Protection Area

In 1978, Congress sought to end this controversy, as it pertained to the SNF, through passage of the BWCAW Act, Pub. L. No. 95-495, 92 Stat. 1649 (1978). Superseding the 1964 wilderness designation of the BWCAW, the BWCAW Act represents Congress's latest and most authoritative statement regarding how the BWCAW and the surrounding area should be managed. The BWCAW Act confirmed the designation of the 1.1-million-acre BWCAW, an area located along the northern border of the three-million-acre SNF. The product of intense public debate, that designation reflected a compromise that balanced preservation interests with the need for access to important mineral resources—and respect for vested valid existing mineral rights—in the SNF.

In particular, although Congress prohibited mineral development within the BWCAW, it permitted and encouraged mining in 1.7-million acres of the SNF—including the non-wilderness lands targeted by the Withdrawal Proposal. See Pub. L. No. 95-495 § 11(b)(1), 92 Stat. at 1655-56. To ensure that mineral development would not harm the wilderness, Congress established the 220,000-acre "Mining Protection Area" bordering the wilderness. *See id.* §§ 9-10, 92 Stat. at 1655.

Congress's creation of the Mining Protection Area demonstrates Congress's intent regarding how minerals would be managed outside the BWCAW. Importantly, Congress did not create an industrial protection area or a timber protection area; it created a *Mining* Protection Area because Congress knew the SNF was mineral-rich. Inherent in Congress's designation of the Mining Protection Area is the understanding that mining would continue outside both the BWCAW and Mining Protection Area. After all, the Mining Protection Area is necessary only if Congress believes that mining is likely to occur outside the BWCAW. Therefore, Congress's latest enactment on its management priorities outside the BWCAW clearly shows that Congress intended mineral development to occur outside the BWCAW.

B. The Proposal Violates Decades of Federal Administrative Policy

As discussed above, federal minerals may not be withdrawn from mineral leasing programs under FLPMA. The Withdrawal Proposal fails to recognize this limitation. Even if FLPMA withdrawals were available for mineral leasing, the Withdrawal Proposal violates agency guidance, which prohibits withdrawals under the circumstances of the Withdrawal Proposal.

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1. The Secretary of Agriculture and USFS Guidance Encourage Responsible Development and Limit Mineral Leasing Withdrawals—Especially Outside of Wilderness Areas

(a) USFS Policy Generally Favors Mineral Development

USFS guidance has historically acknowledged that "[t]he administration of . . . the mineral leasing acts is *primarily the responsibility of the Department of the Interior*." U.S. Forest Serv., Forest Serv. Manual ("FSM") 2800.01 (emphasis added). Even when the USFS has a role in minerals management, USFS's policy is not to interfere with development, but "to *encourage*, *facilitate*, and administer the orderly exploration, development, and production of mineral . . . resources on National Forest System lands to help meet the present and future needs of the Nation." FSM 2800, preamble. This general policy statement explains why the USFS is generally averse to mineral leasing withdrawals, and particularly so for withdrawals outside wilderness areas.

(b) Department of Agriculture and USFS Guidance Disfavor Mining Prohibitions Outside Wilderness Areas, including the BWCAW

As stated, before the BWCAW Act, the Wilderness Act designated the BWCAW as a wilderness area. Wilderness Act of 1964, Pub. L. 88-577, § 4(d)(5), 78 Stat. 890. The Wilderness Act largely left the management of the BWCAW to the Secretary of Agriculture. *Id.* Before issuing rules to regulate the area, the Secretary of Agriculture Orville Freeman (a former Minnesota Governor) appointed a committee to make recommendations regarding the BWCAW's management. *Izaak Walton League v. St. Clair*, 353 F. Supp. 698, 706 (D. Minn. 1973) *overruled on other grounds by* 497 F.2d 849 (8th Cir. 1974). The committee recommended that "[f]ull mineral development should be continued on the portion of the Superior National Forest outside the BWCA." *Id.* Secretary Freeman agreed, stating "mineral development should proceed outside of the Canoe Area." *Id.*

After Congress enacted the BWCAW Act, the USFS continued to believe mineral development would take place outside the BWCAW. In the Environmental Impact Statement for the 1986 Superior National Forest, Forest Plan ("1986 SNF EIS"), the USFS stated that the SNF's "nickel deposits are the largest in the Country and a large scale mining operation is possible, . . . [and] Large scale mineral developments such as taconite or copper-nickel mining, may entail the use of a large number of surface resources." 1986 SNF EIS at 2-11, 4-16. The 2004 revisions to the forest plan went a step further, endorsing mineral development in the SNF. The 2004 Superior National Forest, Forest Plan, states that "[e]xploration and development of mineral and mineral material resources" is a "*desired condition*" and is explicitly permitted on Forest land outside the BWCAW and Mining Protection Area. U.S. Forest Serv., Forest Plan, Ch. 2 at 2-9 (2004) (emphasis added).

The USFS's promotion of mineral development outside of wilderness areas extends nationwide. USFS guidance states that "***withdrawals may not be requested merely to protect the existing wilderness character within a wilderness or primitive area***." FSM 2822.21 (emphasis added). USFS guidance specific to wilderness areas is even more brusque: "***Do not maintain buffer strips*** of undeveloped wildland to provide an informal extension of wilderness." FSM 2320.3 (emphasis added). The purpose of these proscriptions is plain: to prevent the expansion of wilderness areas beyond their Congressionally defined boundaries.

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As USFS's guidance suggests, if areas outside a wilderness are withdrawn from mineral development solely because they may affect the wilderness character within an adjacent wilderness, wilderness areas become ever-expanding.

(c) The USFS Should Address Its Concerns in a Project-Specific EIS on a Mine Plan of Operation

As a policy matter, a project-specific environmental review would serve the public interest better than an EIS in connection with the Withdrawal Proposal. First, there is already extensive environmental analysis supporting the conclusion that mining is a "desired condition" in the Watershed. Both the 1986 and 2004 Forest Plans, each supported with a full NEPA process and EIS, concluded that mineral development is a "desired condition" in the SNF outside the BWCAW and the Mine Protection Area. These determinations occurred at the same time as the USFS's agreement to continue TMM's two federal leases without recommending additional stipulations to protect surface resources.

Second, the appropriate time to conduct additional environmental review is after an actual mine plan of operation ("MPO") is proposed—which hasn't happened yet. Without an actual MPO, the USFS lacks an adequate scientific and factual basis to assess environmental impacts, and any attempt to do so will necessarily be based on hypotheticals and speculation. Accordingly, it would be an inefficient use of government resources to complete such a review at this stage. The process would come at significant cost to the government (both in terms of monetary resources and agency staff time) and would provide minimal—if any—return.

Only once TMM submits a detailed MPO will federal agencies have sufficient information for a credible environmental analysis. The MPO (which is required before any mining can commence) must undergo a full-scale EIS—the most rigorous form of NEPA analysis available.

This review will be significantly more robust and valuable than the currently contemplated withdrawal EIS, because it will be based on a concrete, detailed project proposal, supported by scientific analysis and reports. And there is no indication that USFS has insufficient authority at the MPO stage to address their concerns. To the contrary, over the last 60 years, the USFS has done an excellent job permitting exploration and development in the SNF. Throughout this period—including when it twice consented to continuing TMM's leases without any readjustment to the lease terms—the USFS has given every indication it has sufficient tools to protect the environment.

2. BLM Guidance Prohibits Withdrawals Like the Withdrawal Proposal

Similar to USFS, BLM looks with disfavor upon mineral withdrawals, especially those outside wilderness areas. Several years after Congress established the BWCAW, BLM established its wilderness-management policy. Wilderness Management Policy, 46 Fed. Reg. 47,180 (Sept. 24, 1981). In this guidance, BLM stated:

> *Buffer Zones and Adjacent Lands.* ***No buffer zones will be created around wilderness areas to protect them from the influence of activities on adjacent land***. The fact that nonwilderness activities or uses can be seen or heard from areas within the wilderness shall not, of itself, preclude such activities or uses up to the boundary of the wilderness area.

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> When activities on adjacent lands are proposed, the specific impacts on those activities upon the wilderness resource and upon public use of the wilderness area will be addressed in environmental assessments or environmental impact statements, as appropriate. ***Mitigation of impacts from outside wilderness will not be so restrictive as to preclude or seriously impede such activities***.

Id. More recently, BLM stated, "BLM does not prohibit uses outside a wilderness on public lands solely to protect the wilderness character of the designated lands." BLM Manual 6340 § 1.6(D)(2). Like USFS, BLM recognizes that buffer zones allowing wilderness areas to justify their own expansion disregard the wilderness boundaries set by Congress.

During the last 60 years, BLM has supported responsible mineral development in the SNF by issuing prospecting permits in accordance with the Forest Plan and appropriately granting indeterminate mineral rights upon the discovery of a valuable mineral deposit. Additionally, in 1989 and again in 2004, the BLM renewed TMM's two mineral leases on the same terms and conditions as the 1966 federal leases (i.e. the BLM understood that the terms and conditions of those leases were in fact sufficient to protect the SNF and the resources of the United States). Therefore, nothing in BLM's past practice suggests that the conditions in the SNF make mineral development inherently incompatible with environmental protection.

C. The Withdrawal Proposal also Contradicts State Expectations and Policy

The State of Minnesota has long shared Congress's and federal agencies' policy goal of facilitating mineral development outside the BWCAW. Around the time Congress passed the BWCAW Act, the Minnesota Environmental Quality Board ("EQB") conducted a five-year, $4.3-million study of copper-nickel mining in Northern Minnesota. Minn. Envtl. Quality Bd., Regional Copper-Nickel Study (1979) *available at* https://www.leg.state.mn.us/edocs/edocs?oclcnumber=05579755. The goal was to evaluate the possible region-wide environmental, social, and economic effects of copper-nickel mining and to collect baseline data from which to measure the effects of mining development. After this extensive study, the EQB found that copper-nickel mining in the region could meet environment standards if *then-available technology* (circa 1979) was used wisely.[7] *Id.*

The State of Minnesota's creation of the BWCAW Minerals Management Corridor ("Corridor") also reflects the State's expectation that mineral development can—and should—take place outside of the BWCAW. Dep't of Nat. Res., BWCAW Mineral Management Corridor (2015).[8] The Corridor prohibits mining on state land within a quarter mile of the BWCAW unless the mine entrance is located outside the Corridor and mining within the Corridor is entirely underground. Implicit in creating the Corridor was the understanding that mineral development would take place outside the BWCAW. Otherwise, there would have been no need for the Corridor.

[7] The EQB study does not reflect over 35 years of additional technological and scientific improvements in mining and environmental controls.

[8] http://files.dnr.state.mn.us/lands_minerals/min_data/bwcaw_mineral_management_corridor_20150215.pdf.

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The USFS justifies the Withdrawal Proposal based on the value of the BWCAW and its pristine nature. Yet the character of the BWCAW was well known to Congress, the federal agencies, and the State when they established their policies. The agencies have identified no new facts or policy interests that could override the carefully considered judgments of Congress and the federal agencies regarding what mining should be allowed where in the SNF. The Withdrawal Proposal thus undermines the careful balance struck between the need to preserve the environment and permit mineral development as reflected in the BWCAW Act, agency guidance, and state practice.

III. THE WITHDRAWAL PROPOSAL SHOULD BE SUMMARILY DENIED AS NOT COST-JUSTIFIED

In light of the clear Congressional, administrative, and state policy disfavoring the Withdrawal Proposal, BLM should deny the Withdrawal Proposal as not even worth the cost of further study.

DOI regulations place the burden on the applicant (in this case USFS) to prepare the information, studies, analyses, and reports to support the Withdrawal Proposal. 43 C.F.R. § 2310.3-2(a). In addition, the Secretary may summarily deny a withdrawal application if:

> the costs (as defined in section 304(b) of the Act (43 U.S.C. 1734(b)) estimated to be incurred by the Department of the Interior would, in the judgment of the Secretary, be excessive in relation to available funds appropriated for processing applications requesting a discretionary withdrawal, or a modification or extension of a withdrawal.

43 C.F.R. § 2310.1-4(b). It is apparent even at this stage that processing the Withdrawal Proposal will not be cost-justified. The Withdrawal Proposal contains no facts or science to justify the request. The USFS and DOI must engage in a more rigorous examination of the facts and science to support any determination to withdraw under 43 C.F.R. § 2310.3-3, in addition to the extensive additional documentation requirements. This will impose a significant resource burden on both the USFS and DOI, none of which can be justified in light of the existing alternatives to the Withdrawal Proposal.

In addition, the costs of processing the Withdrawal Proposal will be borne entirely by the Federal Government and the taxpayers of the United States, since the applicant is an agency of the United States Government. In contrast, much of the costs of processing individual exploration and lease applications, and permitting an MPO, including related NEPA compliance, are borne by the private applicant. The Withdrawal Proposal thus would substitute taxpayer expense for investment-backed lease applicant expenses, an inherently poor deal for taxpayers. This concern is exacerbated by the fact USFS and DOI budgets for the processing of withdrawal requests will likely be substantially decreasing. Indeed, the Administration's proposed budget calls for an approximately 12% cut for DOI and 21% cut for the USDA. Office of Mgmt. & Budget, Exec. Office of the President, America First: A Budget Blueprint to Make America Great Again, Fiscal Year 2018 11, 27 (2017). In that budget environment and with the Administration's priorities there is no justification for engaging in a multi-year, multimillion dollar field study and analysis over whether it is reasonable to withdraw many billions of dollars of national mineral wealth from responsible development. Consequently, the Withdrawal Proposal should be rejected as not cost-justified under 43 C.F.R. § 2310.3-2(b).

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IV. THE WITHDRAWAL PROPOSAL WOULD HAVE SIGNIFICANT SOCIOECONOMIC AND NATIONAL SECURITY EFFECTS TO NO MATERIAL ENVIRONMENTAL BENEFIT

A. The Withdrawal Proposal Would Impair Valuable State and Private Minerals

The withdrawal of the SNF lands from mining and exploration, or from any other authorized use, is not only inconsistent with federal and state laws, but inconsistent with national and local interests that are crucial to our economy and security, today and for generations to come. USFS guidance requires the USFS to consider these values before withdrawing lands within national forests from development. "[B]efore withdrawing [National Forest System] lands from mineral entry," USFS must "[c]onsider strategic and critical minerals, the value of the mineral resources that may be foregone, and the value of the resource or improvement being protected." FSM 2803. It is difficult to overstate the adverse consequences of the Withdrawal Proposal to the Nation and the State of Minnesota, none of which are acknowledged in the Withdrawal Proposal. As a threshold matter, the Withdrawal Proposal would also substantially stigmatize another 190,000 acres of minerals on state and private lands in the Watershed, with devastating effects on Minnesota public schools and the regional economy. Although these minerals cannot be formally withdrawn because they lie on state and private land, and the USFS cannot flatly prohibit access, the minerals cannot be accessed without crossing lands in the proposed withdrawal area. As such, the USFS would need to authorize access roads, bridges, and other support uses and infrastructure, and it is difficult to see how USFS would not tightly constrain such authorizations if the Withdrawal Proposal is granted. The logic of the Withdrawal Proposal is that mining in the Watershed is *per se* incompatible with protection of the BWCAW, and there is no basis to conclude that mining on state and private lands in the watershed would have materially different effects from mining on federal lands. By its own reasoning, the USFS would not appear to have any non-arbitrary reason to consent to the use and occupancy of the surface of SNF lands to facilitate mining on state and private lands in the Watershed. Consequently, as a practical matter, granting the Withdrawal Proposal would greatly inhibit development of state and private minerals as well.

B. The Withdrawal Proposal Would Forfeit Tens of Thousands of Jobs and Billions of Dollars of Economic Activity

In 2012, the University of Minnesota-Duluth Labovitz School of Business and Economics' research bureau, the Bureau of Business and Economic Research ("BBER"), prepared a study on the direct, indirect, and induced economic impacts of construction and operations activities of ferrous and non-ferrous mining in Northeast Minnesota, measured in employment, output, and value added. Univ. of Minn.-Duluth, Labovitz School of Business and Economics, *The Economic Impact of Ferrous and Non-Ferrous Mining on the State of Minnesota* (March 2012). Using the 2010 base year model (operations in the year 2010), the Value Added total impact shows that copper, nickel, lead, and zinc mining contributed more than $319 million in wages, rents, and profits to Minnesota's economy.

The direct, indirect, and induced employment is estimated at over 27,300 new jobs for the Minnesota mining industry as a whole. *Id.* at viii. These employment opportunities expand opportunities, enhance image and career promotion, attract talent pools to the region, enhance education and training opportunities, and create and sustain a stable and growing work force, including opportunities for representation of women in the mining and exploration industry.

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The economic impact analysis is not just window-dressing. There will be fundamental changes reflected and multiplied through the economy. It is well recognized that an increase in spending on goods and services generates the need for additional goods and services. The direct impacts include substantial growth in expenditures and operating revenues of mines (including for example, construction, operations, capital expenditures, transportation costs, exploration and development expenditures, expenditures for environmental controls, and mine output). The direct economic impacts are supported by indirect impacts, which arise from suppliers to the mining industry. Finally there are induced impacts, which reflect spending on goods and services as a result of changes and increases in employment where wages and salaries are spent on consumption of items outside the mining industry. There is also a corresponding increase in government tax revenue from all of the economic impacts. The base-line analysis identified huge benefits to the regional and national economy.

The University of Minnesota-Duluth study estimated that development of the non-ferrous resources of the Duluth Complex have the potential to generate $2.8 billion in annual economic production in a mining-focused area of the State experiencing a long-term slowdown of iron mining activity. *Id.* at xi. In addition, minerals on 95,000 acres of the subject state lands would qualify as state school trust fund resources. Over the long term, new mining projects have the potential to generate nearly $3 billion in royalty revenue (from the area proposed for withdrawal) for the State of Minnesota's Permanent School Trust Fund, sufficient to educate nearly 900,000 K-12 students statewide. Overall, credible geologic and economic analysis estimates that the Duluth Complex may contain $2 trillion in mineral value, of which approximately half lies within the Watershed. It is remarkable that the Withdrawal Proposal fails to acknowledge, much less evaluate, this value.

Cu-Ni-PGM minerals also have special value to the Nation, because they are strategic minerals of particular value to military, industrial, and high-technology applications. The United States is presently a net importer of every one of these minerals, placing the country at unique economic and political risk if overseas supplies are threatened. Withdrawal would thus unilaterally expose the United States to unnecessary geo-political risks.

Additionally, iron mining has long been a central driver of long-term development and prosperity in Northern Minnesota. There appears to be no material controversy that iron mining in the region can be conducted responsibly and safely and generates substantial value. The USFS and BLM have apparently decided that this is not the case with respect to the non-ferrous Cu-Ni-PGM mineral-rich deposits of the Duluth Complex. This decision will have far reaching economic ramifications, directly and immediately impacting the employment opportunities and economies of Northern Minnesota that are and always have been heavily dependent on the natural resource industries, and over the long term will compromise the welfare and security of the United States.

V. THERE IS NO FACTUAL OR SCIENTIFIC SUPPORT FOR THE WITHDRAWAL PROPOSAL

As discussed above, statutes, regulations, and case law all prohibit the Withdrawal Proposal; the agencies' own guidance confirms this. Even if the law and agency guidance is not considered or disregarded, there is no scientific case showing that mining Cu-Ni-PGM minerals in the Duluth Complex presents an unacceptably high risk of adverse environmental impact to the BWCAW. To the contrary, the available science indicates that mineral exploration and development can proceed in the Watershed without harming the SNF or BWCAW.

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A. There Is No SNF-Specific Data to Justify the Concerns Raised Regarding Hardrock Mining in the SNF

The Withdrawal Proposal justifies the Withdrawal Proposal at a high level of abstraction stating that withdrawal is necessary to protect the BWCAW. The USFS identifies three aspects of "sulfide" mining operations that it believes threaten the BWCAW and justify the withdrawal:

- ***permanent*** waste storage facilities with the potential to generate and release to the environment acid rock drainage ("ARD");

- waste storage facilities with high potential for ARD that will require ***perpetual treatment*** of water discharge emanating from such facilities; and

- mitigation measures, containment facilities, or remediation efforts that are ***prone to failure***, causing ARD to have irreversible impacts to the BWCAW.

The unifying thread through all these concerns is the belief that ARD will impact the BWCAW. The Withdrawal Proposal provides no data or other information to support that ARD concerns cannot be allayed except through taking the draconian step of withdrawing federal minerals. The fact is, ARD can be eliminated through mine design and configuration that incorporate industry standards and operating practice as well as readily available and proven technologies. Instead, the Withdrawal Proposal assumes that unpermitted releases of ARD, regardless of their probability, location, duration, volume, or physico-chemical character, will with certainty occur and present unacceptable ARD risks to the BWCAW. There is no reasonable, scientific basis to support these concerns—and there never will be.

TMM is still designing and developing its mine and does not yet have an MPO to submit to agencies to review. Nevertheless, TMM's current design strategy is to develop an underground mine, to have no permanent storage facilities in the Watershed, and to locate its tailings (which are currently classified as non-acid generating) outside the Watershed.

This section will show that an underground mine can be designed, operated, and closed in the Superior National Forest (outside the BWCAW and the statutory federal and state buffer zone) in a way that effectively eliminates the three concerns listed above and, by extension, the ARD threats that USFS uses as justification for the Withdrawal Proposal. In particular:

- mines can be designed without ***permanent*** waste storage facilities of any kind within the ***Watershed*** or the SNF;

- with no ***permanent*** waste storage facilities located within the Watershed, there is no need to rely on mitigation measures, containment facilities, or other remediation efforts to protect the BWCAW from permanent waste storage facilities;

- the ore beneficiation process that separates the economic Cu-Ni-PGM sulfide minerals (producing valuable copper and nickel concentrates) from the uneconomic silicate minerals (producing waste tailings), can be designed to produce tailings that have no potential to generate ARD; and

- Tailings Storage Facilities can be located outside the Watershed and the SNF eliminating any concern that the tailings threaten the waters of the SNF or BWCAW.

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This section will explain why USFS concerns relating to permanent waste rock storage and related ARD impacts to the BWCA are incorrect based on the established science of ARD, the well-known physico-chemical nature of the Duluth Complex rocks, and implementation of accepted industry standards relating to mine design, operation, and closure.

B. Science Compels Rejection of the Withdrawal Proposal

1. Fifty-years of Scientific Study of Acid Rock Drainage in the Duluth Complex Addresses the USFS's Concerns Regarding Acid Rock Drainage

In public documents the USFS states that the run-off and drainage of water from the exposed ore body, waste/development rock stockpiles, and tailings basins associated with mining operations in the SNF will be highly acidic, resulting in direct, negative impacts to the BWCAW.

This section of the memorandum will show these concerns to be unwarranted and inaccurate with respect to the underground mining of the Duluth Complex ore body that companies like TMM seek to develop.

The following three subsections, a-c, are a high-level summary of the relevant facts and expert scientific opinions set forth in the attached report entitled, "Twin Metals Minnesota Project - Acid Rock Drainage White Paper," dated August 9, 2017, prepared by Mark Bergeon, Cheryl Ross and Rens Verburg, of Golder Associates ("Golder ARD Report"). **Exhibit A.** The Golder ARD Report was prepared at the direction and on behalf of TMM.

(a) Acid Rock Drainage Overview: A Well Recognized, Understood, and Manageable Environmental Issue

ARD is an important environmental issue facing the global hard-rock metal mining industry. Given its commonality, the industry has conducted research into the process of ARD formation, and methods to minimize its generation and impacts, over the last 50 years. Consequently, the ARD issue is a very well understood phenomenon.

ARD is formed by the oxidation of sulfide minerals when exposed to air and water. The process of sulfide oxidation and formation of ARD is very complex and involves several chemical and biological processes that can vary depending on environmental, geological, and climate conditions. Sulfide oxidation requires three basic ingredients: sulfide mineral, oxygen, and water. Absence of any one of these ingredients eliminates the generation of ARD; the presence of all three of these ingredients does not guarantee ARD. To restate this point, even when a rock contains sulfide minerals, a source of oxygen is present, and water is available, ARD may not be produced. Before one can state that a rock is a source of ARD, one needs to consider many factors, including the quantity, character, and composition of all minerals within the rock. One must not focus just on the iron, copper, and nickel sulfide minerals, like pyrite pyrrhotite, pentlandite, chalcopyrite, but also on a rock's silicate minerals with acid-neutralizing potential, such as plagioclases, pyroxenes, olivines, and biotites. Through more than 50-years of laboratory, field, and commercial trials and observations, academia and industry have developed a set of trusted and proven methods of characterizing the ARD potential of rocks. Furthermore, even when ARD potential can conclusively be shown to exist, mine design and

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engineering controls can successfully be used to eliminate, or minimize and manage, the production of ARD.

The International Network for Acid Prevention ("INAP") has produced a Global Acid Rock Drainage Guide ("GARD Guide") that is up-to-date and global in scope. The GARD Guide was developed in partnership with the Global Alliance, whose member organizations collectively represent significant technical expertise on ARD prevention, mitigation and mine waste management.[9] The prolific use of the GARD Guide indicates its integrity. For example, the United States Environmental Protection Agency appended the Executive Summary of the GARD Guide to a document prepared by the Central American Free Trade Act on Environmental Impact Assessment technical review guidelines for mining.

The Guide summarizes the best management practices with the objective of creating a body of work with high industry and external stakeholder credibility and provides a structured and standardized system to identify and catalogue proven techniques for characterization, prediction, monitoring, treatment, prevention, and management of ARD.

(b) Acid Rock Drainage – Duluth Complex – One Of The Most Well-Studied Ore Bodies in the World

The industry's ability to accurately and reliably predict the ARD potential of the different types of rock encountered during a mining project depends on two aspects of testing programs: 1) the scale of ARD testing programs (i.e. laboratory as opposed to field studies) and 2) the duration of so-called long-term testing programs (e.g., kinetic testing). As briefly outlined below and detailed in the Golder ARD Report, the data set available for the Duluth Complex is extremely robust both in terms of scale and duration, which leads to a very high level of confidence in the prediction and successful management of ARD potential.

The Minnesota Department of Natural Resources ("MDNR"), the United States Geologic Survey ("USGS"), PolyMet Mining Corporation ("PolyMet"), and TMM have extensively studied the environmental behavior of Duluth Complex rocks in both the laboratory and field, making it one of the most well studied districts in the world. Over the past 50 years, these laboratory and field scale studies of the potential ARD generation from Duluth Complex rock have included kinetic testing programs, some of which have operated for over a decade. MDNR's Duluth Complex ARD data set is one of the most well developed and well understood datasets in the world. Such a robust dataset leads to a very high level of confidence in the understanding of the ARD potential of the different types of rock in the Duluth Complex.

As indicated above, the MDNR studies have included kinetic testing programs that have operated for years, sometimes longer than a decade, and represent the longest laboratory testing programs executed by anyone in the industry. Key scientific findings, developed primarily from government studies, regarding the behavior of Duluth Complex rocks include:

[9] Global Alliance member organizations include the Sustainable Minerals Institute–Knowledge Transfer (SMIKTR - Australia), the Mine Environmental Neutral Drainage Program (MEND - Canada), the Chinese Network for Acid and Metalliferous Drainage (CNAMD), the Partnership for Acid Drainage Remediation in Europe (PADRE), the Indonesian Network for Acid Drainage (INAD), the Water Research Commission (WRC - South Africa), the South American Network for Acid Prevention (SANAP), and the Acid Drainage Technology Initiative (ADTI - United States of America).

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Government Finding 1: Sulfur content of the rock or mine material (e.g., tailings) is the controlling factor for the rate and severity of ARD generation from Duluth Complex rocks.

Government Finding 2: The silicate mineral neutralization potential present in Duluth Complex rocks and mine material is available and sufficient to maintain circum-neutral pH conditions for extended periods (i.e. decades) for rock with low total sulfur content. For higher total sulfur content rock, silicate NP is responsible for a delay in the development of ARD, thereby allowing time for implementation of appropriate engineering controls.

Government Finding 3: Relative sulfide mineral reactivity (e.g., pyrrhotite > pentlandite > pyrite > chalcopyrite) is consistent with literature rates reported by others.

TMM is currently developing but has not finalized or submitted its MPO. However, these three key findings have been integrated into TMM's material management strategy.

(c) Acid Rock Drainage – Twin Metals – Eliminating ARD at the Source

(i) The South Kawishiwi Intrusion

The proposed TMM Project is an underground mine that targets the Maturi deposit (i.e., the BMZ), located within the South Kawishiwi Intrusion ("SK"I) of the Duluth Complex. The SKI is categorized as a layered mafic intrusion. Figure 1 shows an example cross-section through the SKI.

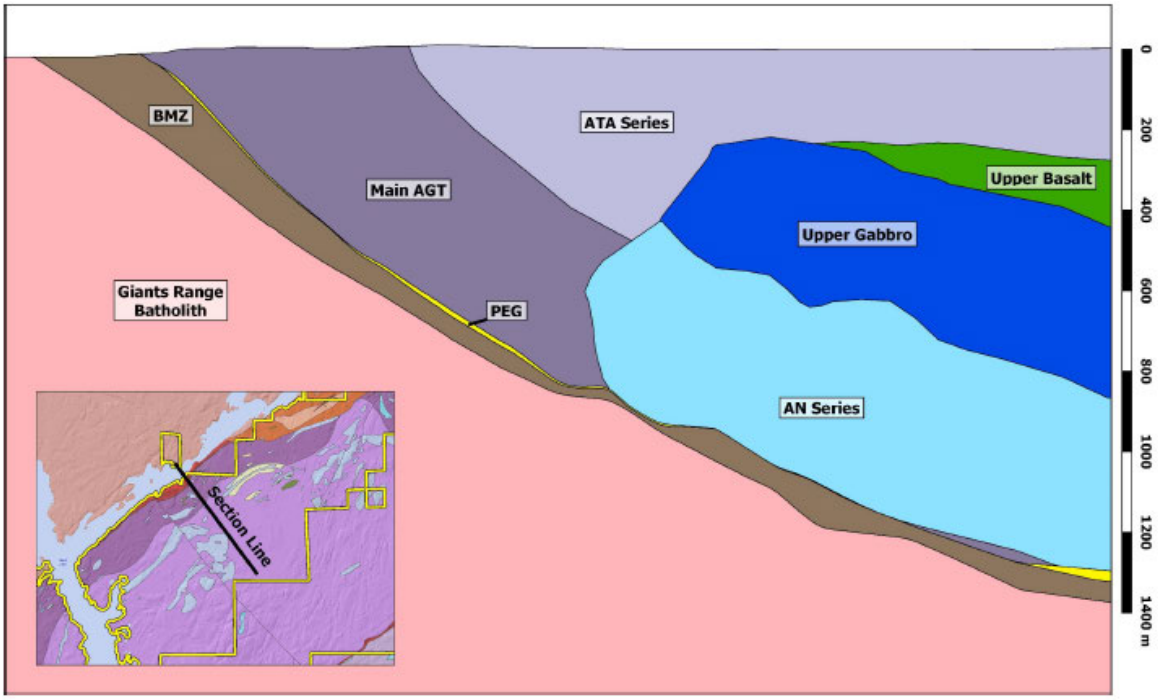


Figure 1 – Rock Units of South Kawishiwi Intrusion of Duluth Complex

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The eight major units defined in the project geologic model (listed below in order from top to bottom as they occur in a typical geologic cross-section) are as follows:

1. ATA or ATA Series - anorthositic troctolitic to troctolite, NO/LOW ARD POTENTIAL
2. AGT or Main AGT - augite-bearing troctolite, NO/LOW ARD POTENTIAL
3. UPB or Upper Basalt - basaltic hornfels, NO/LOW ARD POTENTIAL
4. UPG of Upper Gabbro - anorthositic gabbro to gabbro, NO/LOW ARD POTENTIAL
5. ANS or AN Series - anorthositic series, NO/LOW ARD POTENTIAL
6. PEG - pegmatoidal unit, NO/LOW ARD POTENTIAL
7. BMZ – basal mineralized zone, ARD POTENTIAL – TMM's Ore
8. GRB or Giants Range Batholith - porphyritic quartz monzonite, UNCERTAIN ARD POTENTIAL; additional study is required[10]

Note that within this list of rocks that TMM will encounter during the construction and operation of its underground mine, it is only the BMZ rock (i.e., the Cu-Ni-PGM mineral orebody) that is listed as having any substantial ARD potential. The hanging wall rock units (i.e., units 1-6 in the SKI) do not display significant ARD-generating potential due to the low sulfur content and/or the presence of available neutralization potential within the rock type. The footwall rock (i.e., the GRB in Figure 1) has an uncertain ARD potential due to variable sulfur content related to the proximity to the BMZ. ARD potential waste produced from the GRB would be appropriately handled in the same way as ARD potential BMZ waste; namely placed in exhausted stopes and permanently interred by low sulfur tailings backfill.

The sulfur in the BMZ rock is intimately associated with the economically valuable minerals in the BMZ, i.e., the Cu-Ni-PGM minerals. The importance of this fact cannot be overstated from a mine design and rock and mine materials ARD management standpoint: when TMM recovers the Cu-Ni-PGM minerals from the BMZ rock as part of its mineral processing (beneficiation) step, the sulfur in the BMZ rock is recovered from the BMZ as well. **This results in tailings (which are the one waste product generated during the mineral processing of the BMZ rock) that are very low in sulfur and therefore display no potential for ARD.** The information presented in this paragraph is backed up by defensible and repeatable scientific studies, which TMM continues to undertake in order to create a project-specific database which is accurate and reliable for purposes of mine design and configuration planning.

TMM's commitment to comprehensive characterization of the geochemical behavior of the BMZ began during exploration drilling. Key findings of TMM's scientific studies to date include:

TMM Finding 1: Copper sulfides are the dominant sulfide minerals in the BMZ (i.e., the Maturi ore deposit). From an environmental perspective, this is beneficial as these sulfides have lower

[10] The GRB as a rock type does is not expected to have significant ARD potential; however, GRB in close association with the BMZ may be influenced by the mineralogy of the BMZ and some BMZ material has an ARD potential; additional testing is required to develop a full understanding of the GRB ARD potential

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reactivity and acid-generation potential compared to iron sulfides (i.e. pyrite and pyrrhotite). See Government Finding #3 above.

TMM Finding 2: Most of the development rock and ore samples (approximately 90%) tested to date are classified as non-acid generating (NPAG), with the remaining 10% classified as low potential for generating ARD.

TMM Finding 3: Test work to date indicates no ARD potential for the tailings due to their low sulfur content. This conclusion is consistent with studies by MDNR and USGS (Lapakko et al. 2013b; Schulte et al. 2016).

These three TMM project-specific ARD findings are backed up by defensible and repeatable scientific studies, which TMM continues to undertake in order to create a robust database that is accurate and reliable for purpose of mine design and configuration planning.

The Golder ARD Report shows that the Withdrawal Proposal does not recognize the wealth of information the USGS and MDNR have developed with respect to the Duluth Complex and its potential, or lack thereof, to generate ARD.

The Golder ARD Report also shows that not all "sulfide" mining is alike. As discussed above, given the characteristics of the SKI in the Duluth Complex, the BMZ, and tailings produced during the mineral processing of the BMZ, the analyses for any specific project within the Watershed should be conducted on a stand-alone basis based upon the characteristics and applicable designs for that project in accordance with industry standards and the law.

(ii) TMM's Strategic Approach to Mine Design

As outlined in the GARD Guide, the principal approach to the prevention and mitigation of ARD is to apply methods during the mine design and planning phase of the mine development project (which planning phase occurs contemporaneously with environment baseline study field work and rock characterization work) that minimize the supply of the primary reactants for sulfide oxidation, e.g., excavate as little non-economic, ARD generating rock from the ground as possible. Three management strategies that TMM has developed in coordination with MNDNR are of particular relevance in this regard:

Underground Mining: the choice of underground mining rather than open pit mining is a critical step in reducing overall land disturbance and waste generation. Underground mining is a means to target the rock that contains the economically valuable minerals that are desired, and completely avoids the production of the non-economic, sulfide bearing 'waste rock' that must be permanently stored on surface and could become a source of ARD. ***TMM's strategic decision to commit to an underground mine has eliminated the risk of ARD from waste rock piles because there will be NO permanent potentially acid generating waste rock piles***.

Underground Mine Backfill: mine backfilling is an operational process in which tailings, residual development rock, and cement are placed within the workings of the underground mine after mining in that area is complete. The use of mine backfill has several environmental advantages, including the reduction or elimination of ARD potential from the underground mine

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workings by reducing the permeability of the underground mine and by reducing sulfide mineral oxidation of minerals found on the surface of the ceilings, walls, and floor of the mine, by exclusion of air and/or water.

Non-Acid Generating Tailings: the TMM mineral recovery process (i.e., beneficiation of the BMZ) produces very low sulfur tailings, which has been tested and proven to be non-acid generating. The TMM mineral recovery process eliminates the risk of ARD from tailings because the tailings are non-acid generating. ***As an additional environmental protection strategy, the non-ARD producing tailings will be placed in an engineered, lined facility located outside of the Watershed, further eliminating any risk of ARD impacts to the BWCAW***.

TMM's strategic approach to the management of rock and mine material successfully focuses on elimination of the ARD risk:

1. There will be no permanent rock or mine material piles in the Watershed; thus a primary ARD source that is of major concern to the USFS will be eliminated through TMM's mine design and configuration strategy. With all potential sources of ARD non-existent, there is no risk to the BWCAW.

2. As a result of TMM investing many millions of dollars in the optimization of its ore beneficiation process, TMM tailings are low sulfur and tested to be non-acid generating, all together eliminating the risk of ARD; furthermore, TMM plans to transport the tailings to its Tailings Storage Facility located outside both the Rainy River Watershed and the Superior National Forest. The Tailings Storage Facility and the contained tailings will therefore pose no risk to the BWCA.

Sulfur-bearing waste rock piles and tailings are potential sources of ARD for a typical mining project, and therefore engineering controls are typically required to manage those potential ARD sources. In the case of the TMM project, these sources have been ***completely eliminated***. The TMM project does not rely on new or novel technology to control and treat potential pollution – TMM is committed to eliminating the source of potential pollution by eliminating permanent waste rock piles and by producing low sulfur tailings.

2. Discharges of Effluent to Surface Waters are Unlikely to Ever Impact Waters Within the BWCAW

Public documents released by the USFS suggest that any ARD discharged to surface water near or directly into the Kawishiwi River (which is a river adjacent to TMM's project area) will present significant and unacceptable threats to waters within the BWCAW. For example, the USFS states there is a "direct flow" of water from TMM's leases to the BWCAW through the Kawishiwi River and Birch Lake. The USFS also states that given TMM's leases' proximity to the BWCAW and the "direct transport route of surface water" it is "reasonable to expect" mining will have direct effects on the BWCAW.

There is no data or other information to support these concerns. Additionally, the USFS assumes a non-permitted release into the Watershed, but has provided no parameters to define what size, scope, or magnitude of such assumed release would actually have an impact on the Watershed. The USFS must show that the potential for any assumed non-permitted release is within the realm of possibility—which it has not done. The most appropriate mechanism for

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defining site specific concerns such as these is a project based environmental review where specific designs, impacts, concerns and risks can be appropriately evaluated.

TMM's strategy is to have an underground mine and to store no sulfide-bearing rock in the Watershed. This strategy effectively eliminates the threat to surface waters in the Watershed. Second, even if there were a non-permitted release, it would not be of such a scope, scale, and magnitude that there is realistic possibility that Birch Lake, much less the Kawishiwi River and the greater BWCAW, would be at risk.

3. Existing Hydrogeological Data Indicate that Bedrock Groundwater, Emanating from Underground Mine Workings Is Unlikely to Be a Pathway for Transport to the BWCAW

In public documents USFS has taken the position that groundwater emanating from underground mine workings will present risks to the BWCAW. The existing hydrologic data contradict this concern. The remainder of this subsection on hydrology is a high-level summary of the relevant facts and expert scientific opinions set forth in the attached report entitled, "Lack of Hydrologic Basis for BLM and USFS Decision to Reject Renewal of Twin Metals Minnesota's Mineral Leases and Potentially Withdraw Federal Minerals in the Rainy River Watershed," dated August 9, 2017, prepared by David Donohue and Steve Donohue of Foth ("Foth Hydrology Report"). **Exhibit B.** The Foth Hydrologic Report was prepared at the direction and on behalf of TMM and its attorneys.

As discussed in the Foth Hydrologic Report, there is no technical basis upon which to conclude the BWCAW is at risk from mining without site-specific data, and modeling developed in accordance with standards agencies typically require in the NEPA process. Furthermore, USFS does not acknowledge data collected during TMM's early stage characterization activities that overwhelmingly indicate the absence of any pathway for groundwater at the underground mine level to transport pollutants from the mine either during operations, of after closure. Instead, the data the USFS relies on are outdated and unsupported assessments of mining impacts from historical mining activity not relevant to the minerals in the Watershed, and reports prepared by special-interest groups that lack the technical integrity to serve as a policy-making or decision-making tool.

As part of early site characterization, TMM has installed environmental monitoring wells and piezometers, conducted geologic logging of environmental and exploration borings, mapped geologic units, and tested the hydrology of bedrock to estimate hydraulic conductivity. TMM has also conducted geophysical surveys and potentiometric monitoring. According to Foth, these data show that bedrock in the vicinity of the BMZ ore body is predominantly characterized by very low hydraulic conductivities. Additionally, vertical profile potentiometric data collected from nested pressure transducers show downward hydraulic gradients, indicating it would be highly unlikely, if not physically impossible, for pollutants to migrate to surface waters.

Foth also points out that regulatory agencies routinely require and rely upon the development of hydrologic models to guide their assessments of proposed decisions, and that these hydrologic models are required to conform to scientific and industry-accepted standards guiding data collection and hydrologic model development and use. Foth discusses in detail the standard of care for hydrogeologic models, and points out that data collection under that standard of care routinely includes:

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- Installation of numerous borings to define hydrostratigraphic units
- Installation of numerous monitoring wells (and subsequent potentiometric and water quality monitoring programs) to map groundwater flow paths, delineate hydrostratigraphic units, and establish baseline groundwater quality
- Installation of surface water monitoring stations to quantify baseline seasonal flow conditions and surface water quality
- Analysis and delineation of groundwater and surface water interactions
- Water budget studies to estimate site-specific recharge, evaporation, and base flow, and
- Characterization of hydraulic conductivity and storage characteristics of the various hydrostratigraphic units through pumping tests, slug tests, single and multi-borehole packer and pump tests, etc.

As further discussed in the Foth Hydrologic Report, accepted practice for hydrologic models used for agency decision making should follow fundamental steps for model construction, calibration, sensitivity analysis predictions, and uncertainty analysis. Also, models are expected to reflect the location and construction details of proposed facilities being evaluated.

In summary, the accepted protocol for regulatory agencies making decisions with respect to natural resource development projects, such as mining projects, includes:

- Reliance on use of defensible standards that withstand legal challenge.
- Reliance on extensive site-specific data.
- Following established protocol for model construction, calibration, sensitivity analysis, predictions, and uncertainty analysis.
- Incorporation of project-specific engineering controls, monitoring, and contingency plans.
- Incorporation of project-specific geochemical assessments of waste materials.

USFS suggests there is ample science available with respect to hydrogeologic models that can be used to assess “sulfide mining” and the impacts it has on the watershed. The fact is, however, there is no available science of the standard acceptable for agency decision making within the Watershed. As stated in the Foth Hydrologic Report, the only publicly available analysis purporting to address the potential impacts of mining in the Watershed is a groundwater modeling study published in the Journal of Hydrology (JoH) in 2016 (Myers, 2016). As Foth points out, the Myers model fails to meet the acceptable standard of care for agency decision making, as it lacks any site-specific data, is inappropriately constructed, does not incorporate a real mine plan, and is inadequately documented. Furthermore, the Myers model assumes worst-case conditions and outcomes because it models a completely unrealistic

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situation with complete absence of any modern environmental protection practices and/or complete failure of standard engineering controls. As a result, Foth concludes, the model provides no meaningful representation of mining impacts.

At this time, there is no information or data that supports the conclusion that groundwater constitutes a pathway from TMM underground mine workings to the BWCAW. Furthermore, as discussed above, if the tailings that are placed back underground are not themselves a source of ARD, regardless of whether there is a groundwater pathway (which current data suggests there is not), there is no risk to the BWCAW.

C. The Regulation and Permitting of Hardrock Mines Today Effectively Prevent Unacceptable Risk to the Environment

In public documents the USFS takes the position that the regulation and permitting of a hardrock mine in the SNF today will be ineffective and insufficient to protect the BWCAW. In documents it has released to the public, the USFS has stated that, starting in 2004, USFS knowledge about the threat "sulfide" mining poses to the environment has grown and shows that such mines are a substantial contributor to contaminated lands and streams across the country. The impression the USFS creates is that regardless of the date a hardrock mine was designed, permitted and began operation, it necessarily poses an unacceptable risk to the environment because they all have a substantial likelihood of leaking ARD due to the ARD producing nature of all the rock they handle and the inevitable uncontrolled and unfixable failures in containment structures and remediation systems.

In support of this concern, the USFS has stated:

> FS data indicates between 20,000 and 50,000 mines currently generate acid on lands managed by the agency. Negative impacts from these mines affect 8,000 to 16,000 km of streams.

Although the USFS does not indicate the source of this information, Foth determined that the source of this claim is a report that the USFS produced themselves in 1993, entitled, "*Acid Drainage from Mines on National Forests, A Management Crisis;"* U.S. Department of Agriculture, Forest Service, In Cooperation with the U.S. Department of Interior's Bureau of Land Management, Program Aid 1505, March 1993 ("USFS 1993 ARD Report")

Page 3 of the USFS 1993 ARD Report states:

> Currently, reliable data on the total number of mines producing acid drainage and on the number of miles of streams affected by acid and metal drainage are not available for the Western United States. However, various estimates have placed the number of these mines in the range of 20,000-50,000, seriously affecting 5,000-10,000 miles of streams. The cumulative effect of these mines, whatever their actual number, is significant." (emphasis added)

As Foth observes, no data or source information is cited in support of this USFS claim. Foth also notes that not only does the USFS 1993 ARD Report have significant inconsistencies with respect to the report's estimation as to the extent of mining impacts, but more importantly

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that it is clearly focused on legacy (pre-1990) mining operations and conditions, and not conditions associated with modern mining practices and regulations.

USFS should not rely on this 1993 estimate to conclude that all 21st Century mining operations pose a substantial risk to the environment. As shown below, hardrock mines designed and permitted after 1990 simply do not pose the risk to the environment the USFS asserts.

With the arrival of federal and state environmental laws and regulations in the early 1970s (over 50 years ago), hardrock mine regulators with new regulatory tools at their disposal, including, to its credit, the USFS, have had an impressive track record of protecting the environment from the impact of hardrock mines. Today's hardrock mining laws and regulations have been in place for nearly 30-years, dating back to about 1990. During this time period, the Environmental Protection Agency ("EPA") has never designated a hardrock mine site as a "top priority among known response targets" for potential inclusion on the federal National Priorities List ("NPL"). Stated differently, EPA has not included any hardrock mine permitted since 1990 on the NPL.

Murkowski Inquiry. The USFS has acknowledged this impressive track record. By letter dated, March 8, 2011, U.S. Senator Lisa Murkowski (R-AK) asked the USFS and the BLM how many MPOs the agencies had approved since 1990 and asked how many of those approved MPO facilities subsequently were listed by EPA on the NPL. The USFS responded to Senator Murkowski by stating that they had approved 2,685 MPOs since 1990 and stated that none of these required EPA to place them on the NPL. The BLM responded to Senator Murkowski by stating that they had approved 659 MPOs after 1990 and stated that none of these required EPA to place them on the NPL. **Exhibit B, Attachment 2.**

The USFS response to Senator Murkowski's inquiry via USDA Secretary Thomas Vilsack also states the following with respect to USFS reviewing of proposed MPOs:

> The Forest Service works with proponents at the project stage to develop any changes or additions deemed necessary to comply with our regulatory requirements for environmental protection and to mitigate adverse environmental effects. Additionally, we incorporate appropriate monitoring and inspection into plan approvals to ensure mitigation is achieving the intended result and/or provide information to develop an adaptive management strategy

National Academy of Sciences Position on Hardrock Regulations. The USFS position in public documents is also at odds with a National Academy of Sciences National Research Council 1999 report completed close to 20-years ago on this subject. In 1999, the NAS NRC produced a comprehensive report entitled "Hardrock Mining on Federal Lands" regarding then-current hardrock mine regulation on lands managed by the USFS and BLM. **Exhibit C.** Among other conclusions made in the NAS NRC report, it states:

> The overall structure of the federal and state laws and regulations that provide mining-related environmental protection is complicated but generally effective.
> …

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> Simple "one-size-fits-all" solutions are impractical because mining confronts too great an assortment of site-specific technical, environmental, and social conditions. Each proposed mining operation should be examined on its own merits.

The NAS NRC report then makes the following recommendation: BLM and the USFS should continue to base their permitting decisions on the site-specific evaluation process provided by NEPA.

USFS 2005 Position on Protective Nature of Hardrock Regulations. USFS itself has recognized the efficacy of the modern hardrock mine regulatory framework in ensuring environmental protections compared to the past. In a 2005 report about historical abandoned mines, entitled "*Wild Land Water*," Issue 4, Winter 2005, FS-812. **Exhibit D.** USFS arrived at the following conclusions:

> Vigorous oversight and enforcement of mine operating plans, including bonding and reclamation provisions, will prevent ongoing mining operations from becoming future threats to human health and the environment.
> …
> Times have changed since earliest mine practices. Contemporary environmental laws, public attitudes, and reclamation requirements leave no room for the antiquated practices of the past. Current Forest Service regulations that require approval of a plan of operations, mitigation measures to lessen the adverse impacts to other resources, and reclamation performance bonds are extremely helpful in preventing environmental harm after an active mining operation ceases.

USFS/BLM 2007 Joint Position on Protective Nature of Hardrock Regulations. Finally, a similar joint USFS-BLM 2007 report, entitled "*Abandoned Mine Lands: A Decade of Progress Reclaiming Hardrock Mines*," 2007, FS-891, BLM-WO-GI-07-013-3720 **Exhibit E**, concludes:

> Sustainable mining practices and environmentally protective mine closure planning guarantee against abandonment and public cleanup burdens. Through optimal permitting requirements and financial assurances, land management agencies are encouraging mining companies to operate under a sustainable business model that follows a mine's life from startup to clean closure
> …
> The prosperity that mining brings will ensure that the BLM and Forest Service landscape will be safe and environmentally healthy for everyone who lives nearby or benefits from public lands

As shown above, current hardrock mining regulations are protective of the environment. Metal mines, including those containing sulfide minerals, operate safely throughout the U.S. under today's regulatory framework and oversight, without devastating downstream recreation or the environment. The USFS has presented no technically reportable information to support its position that hardrock mines in the SNF are sure to negatively impact the BWCAW.

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In summary, the science and technology do not support the USFS's position:

- TMM's tailings have no ARD generating potential, not high;
- Except for the BMZ, the rocks of the South Kawishiwi Intrusion have no to low ARD generating potential, not high;
- The BMZ ARD potential is associated with the Cu-Ni-PGM minerals that are recovered as part of the beneficiation process that produces a copper concentrate, nickel concentrate, and non-acid generating tailings waste;
- The silicate neutralization potential present in Duluth Complex rocks is available and sufficient to maintain circum-neutral pH conditions for extended periods (i.e. decades) for rock with low total sulfur content.
- The surface water pathway to BWCAW is indirect, not direct and immediate;
- The is no evidence of a groundwater pathway, not strong evidence;
- High AMD discharges at other mines are not relevant, instead of highly relevant;
- Modern mines (i.e., permitted after 1990) pose no demonstrated threat, instead of a significant threat;
- There are well-established means to remove tailings and sulfide-bearing mine material (if any) from the Watershed, not zero means; and
- Stockpiles will be temporary and be fully reclaimed, instead of posing an infinitely long threat to the environment.

Based on these facts the Withdrawal Proposal is misplaced. The reality is that the BLM cannot legally grant the Withdrawal Proposal or amend the SNF Forest Plan based on the current state of the science, and, as shown, the USFS cannot fill in those gaps because the science supports that hardrock mining can be accomplished in the SNF in an environmentally protective manner. The Withdrawal Proposal must therefore be canceled or denied, and the SNF Forest Plan should not be amended. The best and logical means for evaluating mining within the Watershed is a project-specific environmental review that takes into consideration all the project specific issues and more fully analyzes project designs and potential risks.

D. Mining Reclamation and Closure Methods Effectively Protect the Environment

Modern mine reclamation methods effectively protect the environment when applied at both historical and recent mining operations. Today's mines are designed, built and operated to integrate long-term environmental closure and reclamation as a primary design standard, and this is required by current law.

Even BLM recognizes that mines containing sulfide minerals can be closed safely and sustainably. Since 2003 BLM has managed a Sustainable Mineral Development awards

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program in which the Hardrock Mineral Environmental Award "acknowledges operators with exceptional track records of meeting or exceeding Federal, State, or local reclamation requirements." Since the inception of the program, 15 mines have received the award, seven of which have sulfide mineralization. Most of those mines are located in relatively "water-rich" states of Montana, Idaho, South Carolina, and Wyoming, and a single recipient in Arizona, the Clarkdale Tailing Project, is located adjacent to the Verde River. Cleary, BLM recognizes that mining and mine reclamation - even of mines predating modern design standards and operational practices, and in wet environments - can be accomplished in an environmentally sound manner.

F. The Withdrawal Proposal Relies on Impermissible Worst-Case Analysis at the Expense of the Northern Minnesota Economy

Administrative agencies are required to make decisions based on relevant and project-specific data, good science, and objective analysis, free of bias and political pressure. *Brower v. Evans*, 257 F.3d 1058, 1070 (9th Cir. 2001). Decisions must be based on "scientific opinion rather than the framework of a conjectural 'worst case analysis.' " *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 355 (1989) (quoting National Environmental Policy Act Regulations, 50 Fed. Reg. 32,234, 32,237 (May 1, 1989)); *see also* 40 C.F.R. § 1502.22.[11] Agencies must focus on reasonably foreseeable impacts, "rather than distorting the decision making process by overemphasizing highly speculative harms" – e.g., acid mine drainage. *Robertson*, 490 U.S. at 356. In making its Withdrawal Proposal, USFS cannot forsake science-based decision-making out of fear of the unknown or for political reasons. *Cf. Earth Island Inst. v. Evans*, No. C 03-0007 TEH, 2004 U.S. Dist. LEXIS 15729, at *90 (N.D. Cal. Aug. 9, 2004) ("[T]he intense pressures to secure larger policy objectives led to a decision driven more by politics than science."). An agency action will be set aside if it is motivated by political pressures. *D.C. Fed'n of Civic Ass'ns v. Volpe*, 459 F.2d 1231, 1246 (D.C. Cir. 1972); *Aera Energy LLC v. Salazar*, 691 F. Supp.2d 25, 33 (D.D.C. 2010). "The test is whether 'extraneous factors intruded into the calculus of consideration' of the individual decision-maker." *Peter Kiewit Sons' Co. v. U.S. Army Corps of Eng'rs*, 714 F.2d 163, 170 (D.C. Cir. 1983) (quoting *Volpe*, 459 F.2d at 1246). In other words, decisions must be "based strictly on the merits and

[11] When the Council on Environmental Quality ("CEQ") first promulgated NEPA regulations, it directed that, if an agency was faced with uncertainty regarding the environmental effects of a proposal, the agency was required to include a "worst case analysis and an indication of the probability or improbability of its occurrence." 40 C.F.R. § 1502.22 (1985). Issues began to arise regarding the interpretation of the requirement. National Environmental Policy Act Regulations; Incomplete or Unavailable Information, 51 Fed. Reg. 15,618 (Apr. 25, 1986). Consequently, CEQ solicited comments regarding this requirement. National Environmental Policy Act Regulations; Incomplete or Unavailable Information, 49 Fed. Reg. 50,744 (1984); Memorandum for Federal Agency NEPA Liaisons, 48 Fed. Reg. 36486 (Aug. 11, 1983). Based on these comments, CEQ decided to abandon the worst-case-analysis requirement. National Environmental Policy Act Regulations; Incomplete or Unavailable Information, 51 Fed. Reg. 15,618 (Apr. 25, 1986). In rescinding the requirement, CEQ stated the amendment was needed because the analysis was "unproductive and ineffective" and "breed endless hypothesis and speculation." *Id.* Several years later, the Supreme Court upheld CEQ's decision to rescind the rule. *Robertson*, 490 U.S. 332. The Court noted CEQ's statement that the previous regulation had led to "a frame work of a conjectural 'worst case analysis.' " *Id.* at 355 (National Environmental Policy Act Regulations, 50 Fed. Reg. 32,234, 32,237 (Aug. 9, 1985)).

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[made] completely without regard to any considerations not made relevant by Congress in the applicable statutes." *Volpe*, 459 F.2d at 1246.

The USFS uses worst case analyses to support the Withdrawal Proposal and other agency decisions relating to minerals in the Watershed. This practice is incorrect as it is not supported. The USFS should utilize projections that properly reflect site conditions, realistic impacts, and project-specific designs in its regulation of minerals in the Watershed. This an incorrect approach to agency decision making especially as it pertains to minerals in the Watershed.

VI. SCOPING COMMENTS ON NEPA PROCEEDINGS

The foregoing discussion demonstrates that the Withdrawal Proposal is illegal and ill-considered and should be canceled or denied based on threshold defects that do not require the thorough analysis required under NEPA and 43 C.F.R. § 2310.3-3. Nevertheless, the Withdrawal Proposal calls for comments on the scoping of the NEPA analysis necessary to implement amendments to the SNF Forest Plan and the requested withdrawal, and should the USFS and Secretary elect to move forward with NEPA, there are numerous additional alternatives to be considered, as well as environmental effects and mitigation that are entirely ignored in the Withdrawal Proposal.

Because both USFS and DOI regulations and guidance stress that withdrawal is a last resort, all potential updates and revisions to the SNF Forest Plan should be analyzed before withdrawal is considered. The drastic step of withdrawal is only legally available, if at all, if there are adverse effects of mining that cannot be reasonably addressed through revisions to the Forest Plan and the traditional case-specific tools of lease stipulations and terms and conditions to a proposed MPO.

A. Scoping for Potential Amendments to the SNF Forest Plan

As a threshold matter, the USFS proposes to amend the SNF Forest Plan only to address concerns related to mining in the Watershed portion of the SNF. The USFS is not seeking comments on updating the many other aspects of the SNF Forest Plan that regulate non-mining uses and uses outside the Watershed. This is an odd omission, since many other uses of the SNF can affect the "wilderness character" of the BWCAW as much or more than regulated mining, including logging, roadbuilding/road maintenance, winter and summer off-road vehicle use, other road and trail-based recreation, camping and canoeing, telecommunications uses, and water level and supply management.

It is correct that mineral development (as distinct from exploration) is the primary activity to handle and generate material quantities of Duluth Complex ores and mining wastes, and therefore is the primary activity to raise the hypothetical concern of ARD.[12] However, many of the other alleged concerns addressed in the Withdrawal Proposal and other public documents,

[12] The Minnesota Highway 1/169 Eagles Nest Lake Area project is encountering some sulphide bearing rock, which is being managed. It is worth noting that the Environmental Assessment for the Eagles Nest project concluded that "by . . . incorporating appropriate best management practices to avoid, minimize and mitigate potential impacts into the project, there is not a potential for significant impacts related to ARD."

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such as habitat fragmentation, wildlife disruption, wetland impacts, discharges of water quality-affecting materials, noise, and visual effects, are posed as much or more by other allowed uses in the SNF. Mining in the Watershed should not be singled out as the sole activity potentially affecting the BWCAW.

Regardless, any NEPA conducted for amending the SNF Forest Plan to address mining in the Watershed must contain at least four components: (1) adequate site-specific characterization of surface and hydrogeological resources and connectivity; (2) alternatives; (3) a thorough discussion of all the reasonably foreseeable effects of imposing new restrictions on mineral exploration and mining; and (4) available mitigation.

1. Characterization of Surface Water and Hydrogeological Resources in the Watershed

Any update to the SNF Forest Plan must contain an adequate description of the resources affected sufficient to allow a reasoned choice among alternatives. This is particularly important in that the current SNF Forest Plan states that mining is a "desired condition" and can be effectively regulated using existing tools. The USFS claims that "new information" suggests these findings are no longer correct, and that mining in fact poses an existential threat to the BWCAW.[13] The USFS bases its reversal on claims about the vulnerability of the BWCAW and connectivity between mining activities in the Watershed and effects to the BWCAW. Validating (or refuting) these claims will require a very significant updating of information on surface and groundwater flows, volumes, and connectivity (e.g., surface and/or groundwater pathways) from the Watershed to the BWCAW. Impacts to the BWCAW from any ARD from mining ("effluent") are fundamentally a function of several variables, including:

- The acid and metals-generating capacity of Duluth Complex ores and mining wastes;
- The method of handling sulfide minerals during mineral processing;
- The ability to control effluent generated, if any, from ongoing activities or accidents from leaving the source of origin or mine sites;
- The physical connectivity of groundwater to surface water;
- Groundwater flow rates and direction;
- The environmental fate of the released effluent, e.g., how the released effluent is diluted, absorbed, neutralized, altered, or physically or chemically trapped in the environment; and
- How surface and groundwater quality in the BWCAW is changed, if at all.

[13] The public has a right to know what exactly this "new information" is, because it is contradicted by the record. For example, in a letter dated July 20, 2011, Secretary of the Agriculture, Thomas J. Vilsack, informed Senator Murkowski (R-AK) that since 1990 the USFS has approved 2,685 hard rock MPOs and none of them have resulted in EPA placing them on the NPL.

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In the Withdrawal Proposal and other documents released by the USFS, it does not address these variables. Much of these data and information would be generated/collected in the normal course by a proposed mining applicant as relevant to a specific site; to the extent USFS proposes to impose blanket restrictions on exploration and mining in the Watershed, the information must be collected and analyzed by the USFS. *See* 40 C.F.R. § 1502.22.

Indeed, in the area of resource characterization, it is essential to any reasoned choice among alternatives that the USFS collect baseline ore, waste rock, surface water, and groundwater data. Even if the agencies decide to select the No Action Alternative, they will need to understand the impacts of the action alternatives by comparing them to baseline data. As shown in Section V, all existing data confirm that except for the BMZ, the rocks of the Duluth Complex have low to no ARD generating potential Analogies to release risks and experiences from historic operations in other locations are, therefore, of little value. Equally important, the USFS fairly notes that there is limited carbonaceous material of certain types in the Watershed, but the USFS ignores that the acid-neutralizing capacity of the silicates in the Duluth Complex rock is high and eliminate or slow the development of any ARD. The USFS also does not consider the fate and transport of ARD through the Watershed.

The EISs supporting the 1986 and 2004 SNF Forest Plans necessarily supported designating mining as a desired condition. Before prohibiting mining in the Watershed, USFS will need to complete new hydrologic studies that support the Withdrawal Proposal. These studies will need to comply with industry standards with respect to the design, implementation, and analysis of hydrogeologic groundwater studies. But the USFS will not have the benefit of TMM's work since TMM was not given an opportunity to complete it.

At a minimum, the USFS has an affirmative duty to collect the best available existing data, and any new data that can be compiled at less than exorbitant cost, to support such claims.

2. Alternatives to be Considered

In this instance, the first alternative to be considered is the No Action Alternative, which would allow mining to continue under a wide variety of regulatory controls and oversight. The USFS has considerable authority to reasonably regulate mineral exploration and mining through provisions in the SNF Forest Plan, as well as standard form and case-by-case lease stipulations. Once the USFS has updated and modernized its understanding of the ore and water resources in the Watershed, and their relation to water quality in the BWCAW, alternatives that must be considered in a NEPA analysis for an SNF Forest Plan Update thus include such controls as:

- Informed and judicious exercise of existing USFS consent authority, resulting in the withholding of consent for mining in especially sensitive areas;
- Forest Plan activity and zoning provisions, potentially including but not limited to such measures as:
    - Prohibiting surface mining in the Watershed;
    - Requiring that tailings storage facilities be located outside the Watershed;

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- Leaching and runoff controls on temporary and lined ore stockpiles in the Watershed to prevent off-site drainage of waters above prescribed thresholds of pH and metals;

- Removal and reclamation of stockpiles and any other acid-generating materials at the end of operations;

- The production of low-sulfide tailings, as is presently feasible using existing technology;

- Footprint designs of surface facilities in the Watershed;

- Setbacks for surface facilities from rivers and streams;

- Visual, noise, and other aesthetic location standards for surface facilities; and

- Updates to standard-form-lease stipulations to impose prudent controls.

While there is obviously a broad array of specific alternative combinations that can result from this analysis, at least two broad alternatives might emerge, in addition to the No Action Alternative, which specifically address the USFS concerns and purpose and need.

No Action Alternative – First, USFS will obviously need to consider the No Action Alternative in the EIS. Importantly, the No Action Alternative should not be framed as unregulated mining in the SNF. And the No Action Alternative should not assume wanton disregard for federal and state environmental laws. The No Action Alternative must take into account that project-specific environmental review and permitting will occur for all projects in the Watershed. If the EIS properly analyzes the project-specific tools it has, USFS will see that all of their concerns can be better addressed on a project-by-project basis. For instance, in publicly available materials the USFS has stated that the "[t]he magnitude and setting of a failure would drive the significance of the environmental risk and its potential environmental impact." USFS cannot assess this risk in the abstract; it must be considered on a project-level basis. For example, if USFS completes a project-specific EIS once TMM submits its MPO, USFS will be able to take into account that no tailings will be stored in the Watershed, that the SKI Duluth Complex rock has no or low potential to generate ARD, and that TMM's project will have no permanent waste-rock stockpiles. These are factors that influence the "magnitude and setting" of any failure that must be considered at a project-specific level. In short, all of the Action Alternatives should be secondary to ad-hoc leasing and permitting decisions, including the following.

Aggressive Monitoring and Response Alternative – In accordance with TMM Findings 1-3 in Section V.B.1.c above, test work to date shows that TMM tailings have very low sulfur content and therefore no ARD potential. Testing also shows that if the Duluth Complex rock, which is classified as having low potential to generate ARD, were to actually generate ARD, it would do so only slowly and in small amounts - giving ample time for TMM to respond to and control at the source any Duluth Complex rock that potentially gets spilled. This means that potential spills of the crushed ore or other mine rock material can be timely addressed without negative impacts to the environment by following industry standards of practice consistent with the risk posed by these solid materials; e.g., requiring, as appropriate, containment, surface and

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groundwater monitoring systems, emergency response measures, and financial assurance. It shouldn't be forgotten that the SKI rock is naturally occurring rock and that the BMZ orebody actually crops out along the bed and shore of the Kawishiwi River without adverse effect. With these understandings, the USFS might simply update the Forest Plan to require lease stipulations that ensure aggressive use of risk-appropriate containment systems, leachate collection systems, leak detection, spill detection, and emergency response provisions for any mining project in the Watershed. Because the inherent risk is low, a well-designed mitigation-spill prevention plan would be all that is necessary to provide additional and adequate protection to the BWCAW. Furthermore, with TMM's tailings exhibiting no potential to generate ARD, and the requirement for TMM to propose and eventually implement a robust reclamation plan, further testing may demonstrate there is no need for "***perpetual***" water treatment at the Tailing Storage Facility (which will be located outside the Watershed).

Sulfide Segregation Alternative – Although it would appear to be unnecessary based on the science, an aggressively risk-averse approach would be to simply isolate sulfides from exposure to the Watershed. Fears of ARD and metals releases are fully addressed if sulfides do not come in significant contact with the waters of the Watershed. This approach would have up to four primary components: (1) a prohibition on surface mining in the Watershed, eliminating most points of contact between the watershed and the ore; (2) monitored and controlled collection of any precipitation coming in contact with stockpiles containing material known to generate low pH ARD; (3) a prohibition on tailings disposal in the Watershed, negating any risk of tailings releases to the BWCAW, and (4) a prohibition of permanent stockpiles of acid-generating materials in the watershed post-mine closure. Collectively these measures would result in permanent, comprehensive protection of the Watershed, and address all the stated justifications for the SNF Forest Plan Amendment and Withdrawal Proposal. (With regard to these alternatives, as stated in Section V.B.1, TMM satisfies each of these alternatives, which results in a mine that will have no ARD impact to the environment and BWCAW.)

3. Effects to Be Considered

The entirety of the Withdrawal Proposal and most of these comments have been focused on understanding and addressing hypothetical ARD released during exploration and mining in the Watershed. In addition, the USFS will of course need to examine the effects of surface facilities on the surrounding environment. But there are other key effects of mining and other uses in the SNF that are critical to a reasoned analysis of the need for and scope of any changes to the SNF Forest Plan. For example, a NEPA analysis must also examine the direct, indirect, and cumulative effects of all other ongoing and reasonably foreseeable uses of the SNF, and fairly compare these effects to those of mineral exploration and mining. The USFS must have non-arbitrary, principled reasons for any new restrictions on mining, as opposed to concurrent regulation of other uses that cause the same, similar, or greater effects, especially given the USFS multiple-use mandate and Congressional mineral development directives for the SNF.

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Foremost among other effects to be considered are the socioeconomic effects of SNF Forest Plan restrictions on mining. As discussed, there could easily be a trillion dollars of in situ mineral wealth in the Watershed. That should only be restricted after a compelling showing that the restrictions are justified by the reasonably foreseeable environmental benefits. Consequently, a NEPA analysis of SNF Forest Plan tradeoffs must carefully examine:

- the reasonably foreseeable mineral wealth in the Watershed;
- the value of additional exploration to better characterize and define that wealth;
- the regional direct and indirect employment and economic activity effects of mining in the Watershed, independently and in conjunction with the potential future of the regional taconite industry;
- the tax, school funding, and royalty implications of mining in the Watershed;
- the national economic value of a major and reliable domestic supply of Cu-Ni-PGM minerals;
- the national security and advanced industry value of a major and reliable domestic supply of Cu-Ni-PGM minerals; and
- parallel and comparable effects on state and private minerals that can only be accessed across SNF lands.

Although NEPA does not require a formal cost-benefit analysis, some quantitative and qualitative assessment of these socioeconomic effects is essential to an understanding of the effects, risks, and rewards of mineral development in the Watershed.

4. Mitigation

The purpose of mitigation is to counteract and reduce any unavoidable adverse effects of a proposed action. Mitigation protocols for the physical surface impacts of mining facilities and support infrastructure, such as wetlands impacts, are well-established and routine. There appears to be little need for additional mitigation provisions for such surface impacts in the SNF Forest Plan itself; these can be handled in mine permitting on a case-by-case basis using established frameworks. This leaves the unique concern over hypothetical low pH ARD and metals release to the BWCAW. As shown, there is no present basis to believe that the BWCAW will be impacted by mining in the Watershed, and therefore there is no need for mitigation. To the extent there are residual risks, they are speculative and founded upon worst-case scenarios about system failures, none of which are typical candidates for mitigation.

B. Scoping for the Proposed Withdrawal

The *ending* point for any NEPA analysis of a mining-focused update to the SNF Forest Plan is the *starting* point for NEPA on the Withdrawal Proposal. That is, under both USFS and BLM regulations and guidance, withdrawal cannot even be *considered* until all other measures for addressing the risks of concern have been exhausted. As shown, all the risks identified by the USFS can be fully addressed through the SNF Forest Plan, lease stipulations, and permit terms. In particular, even though it is likely itself excessive, the *Sulfide Segregation Alternative*

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for an updated SNF Forest Plan would appear to fully address *all* the concerns of the USFS, leaving no space or justification for any withdrawal anywhere in the Watershed. As a technical NEPA matter, these other tools all fall within the "No Action Alternative" for withdrawal, because they can all be implemented without a withdrawal. For this reason, TMM expects that there will be no need to analyze any alternatives to the proposed withdrawal other than the No Action Alternative. Nevertheless, there are a few additional observations related to alternatives to the Withdrawal Proposal that bear mention.

1. Additional Alternatives to Be Considered

The USFS Withdrawal Proposal assumes that nothing less than the withdrawal of mineral use of the *entire* acreage of the Watershed for the *maximum* allowable term of FLPMA can achieve the USFS purpose and need, and therefore no alternatives other than the Withdrawal Proposal and No Action Alternative need be considered. Even if one accepts the USFS' rationale, the Withdrawal Proposal is overbroad. First, the USFS has not articulated any basis to withdraw minerals other than sulfide-bearing Cu-Ni-PGM ores, yet the Withdrawal Proposal inexplicably requests withdrawal of *all* mineral and geothermal resources. Second, neither the USFS nor anyone else has suggested that Cu-Ni-PGM minerals are distributed throughout the entire Watershed portion of the SNF. Consequently, there is no rational basis to withdraw the entire Watershed. Third, exploration does not pose any of the USFS' cited risks, because negligible quantities of ore are extracted, and even these amounts are transported out of the Watershed for analysis. Consequently, alternatives that examine reduced mineral scope, reduced acreage, and exclusion of exploration are all obvious alternatives the Secretary must consider to the extent the Secretary ever reaches the prospect of withdrawal.

2. Resource Characterization and Effects that Must Be Analyzed

TMM has described the key resource characterization and direct, indirect, and cumulative effects that must be analyzed in the context of NEPA for an SNF Forest Plan update, and these are all equally applicable to NEPA analysis for a proposed withdrawal. Indeed, the need for quality data and comprehensive analysis is even more pressing, because withdrawal is a much more drastic and preclusive action than simply updating the Forest Plan. Because withdrawal definitively forecloses mineral development in the withdrawal area for the duration of the withdrawal, it is critical that a decision to withdraw be based on sound science.

Moreover, withdrawal in the SNF has political and economic consequences that extend far beyond those of mere regulation of mining. The mining industry expects and welcomes reasonable regulation. This is a foundation of mine design and an obligation of the industry as responsible citizens and stewards of the land. Indeed, although mining regulation in the United States is viewed as complicated, costly, and strict in comparison to most international venues, the United States remains an attractive location for mining projects because of the belief that the United States is governed by the rule of law. If the Withdrawal Proposal is implemented, it will be a severe shock to that belief, because the Withdrawal Proposal reflects an abrupt abandonment of Congressional priorities and existing policy decades in the making. Consequently, implementing the Withdrawal Proposal will not simply inhibit mining in the SNF in Minnesota, but will degrade confidence in the United States as a whole as a location for mining projects. This socio-economic dimension is unique to the Withdrawal Proposal, and must be carefully assessed and addressed in any NEPA analysis for the Proposal.

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VII. TMM HAS VALID EXISTING RIGHTS WITHIN THE WATERSHED

The Withdrawal Proposal is expressly made subject to valid existing rights ("VERs"). To the extent that any withdrawal is made, it should be noted that TMM possesses VERs of four types: (1) existing leases MNES-1352 and MNES-1353, (2) two pending Preference Right Lease Applications ("PRLAs"), (3) prospecting permits effectuated through prospecting permit applications, and (4) prospecting permit applications filed prior to the Withdrawal Proposal.

A. Leases MNES-1352 and MNES-1353

TMM has VERs in its two Federal Leases MNES-1352 and MNES-1353. Despite having renewed TMM's Federal Leases without issue on two previous occasions, BLM denied renewal of TMM's two Federal Leases in December 2016. TMM is challenging BLM's right to deny renewal in federal court. If TMM prevails, as it is likely to, TMM has *valid existing rights* to renewal of its Federal Leases. *See Peterson v. Dep't of Interior*, 510 F. Supp. 777, 779 (D. Utah 1981) (concluding a permittee had a *valid existing right* in the extension of a prospecting permit based on criteria imposed before the Federal Coal Leasing Amendments Act).

B. PRLAs

TMM's two PRLAs constitute VERs that are not subject to the withdrawal action. Under the leasing system applicable to Statute 508b, mineral tenure vests through a two-step process. *See generally Nat. Res. Def. Council, Inc. v. Berklund*, 609 F.2d 553, 555-58 (D.C. Cir. 1979). First, after receiving USFS consent, BLM issues a prospecting permit to a permittee to explore lands with no known mineral deposit. 43 C.F.R. § 3501.10(a), subpt. 3505. Second, if the developer discovers a valuable deposit, BLM rewards the developer for the risk it undertook to explore lands of unknown mineral character with a preference right lease. 43 C.F.R. § 3507.11; Leasing of Solid Minerals Other Than Coal and Oil Shale, 64 Fed. Reg. at 53,533 (Oct. 1, 1999). A preference right lease grants the lessee the exclusive right to develop the minerals covered by the lease. 43 C.F.R. § 3501.16.

Since a prospecting permittee is entitled to a preference right lease upon the discovery of a valuable deposit, it is considered a property interest in the fullest sense. *Berklund*, 609 F.2d at 559. And "[c]ourts have held that an application for a preference right lease . . . give[s] the applicant a 'valid existing right' when the requisite discovery is shown." *Peterson v. Dep't of Interior*, 510 F. Supp. 777, 779 (D. Utah 1981) (citing *Nat. Res. Def. Council, Inc. v. Berklund*, 458 F. Supp. 925, 933-35 (D.D.C.1978) and *Utah Int'l, Inc. v. Andrus*, 488 F. Supp. 962, 966 (D. Utah 1979)).

TMM submitted two PRLAs for lands totaling over 1,000 acres in the Watershed. BLM verbally informed TMM in 2014 that BLM had completed its "preliminary" economic analysis concluding that TMM had established the existence of a valuable mineral deposit. Consistent with the agencies' withdrawal notices, the Withdrawal Proposal will not affect TMM's valid existing rights in the PRLA.

C. Prospecting Permits and Prospecting Permit Applications

TMM has valid existing rights in its existing prospecting permits and prospecting permit applications. In *Peterson v. Department of Interior*, the court concluded that a permittee had an entitlement right to a prospecting permit extension and an entitlement right to a lease if it

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discovered a valuable deposit. 510 F. Supp at 120; *see also Peabody*, 477 F. Supp. at 124. Under this case law, TMM has valid existing rights to explore for valuable minerals during the term of its prospecting permits and entitlement rights to leases on those lands in which it discovers valuable deposits during the term of the prospecting permits. With respect to BLM's pending decision on TMM's request for extension of its existing prospecting permits, TMM has explored the lands with reasonable diligence, *see* 43 C.F.R. § 3505.62, and, therefore, BLM must grant TMM's extension requests. Because TMM's extension requests preceded the USFS Withdrawal Proposal, BLM has no grounds to deny the extension request on the basis of the Withdrawal Proposal because TMM has valid existing rights to continue to explore the lands.

Similarly, TMM has several federal prospecting permit applications that preceded the USFS Withdrawal Proposal. The BLM may not use the Withdrawal Proposal as a reason for denying TMM's prospecting permit applications. In its materials regarding the Withdrawal Proposal the agencies have said as much. In materials released as a part of the Withdrawal Proposal USFS acknowledged that "[o]ther uses will continue uninterrupted in the proposed withdrawal area . . . , including . . . [p]ending federal . . . prospecting permit applications."

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Exhibit A

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TWIN METALS MINNESOTA PROJECT - ACID ROCK DRAINAGE WHITE PAPER

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August 9, 2017 **Project No. 113-93664-12**

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EXECUTIVE SUMMARY

This paper presents an overview of potential geochemical environmental issues associated with a potential underground mine for copper (Cu), nickel (Ni) and platinum group elements (PGEs). The proposed Twin Metals Minnesota Project (Project) targets the Maturi deposit in the Duluth Complex near Ely, Minnesota. The potential geochemical environmental issue of most concern is the generation of acid rock drainage (ARD) and associated metal leaching (ML), commonly combined using the acronym ARD/ML. The process of ARD generation is very well understood, as are the engineering options available to prevent, minimize, and mitigate ARD formation.

In general, the ARD risk associated with an ore deposit is proportional to the amount of sulfides present and inversely proportional to the amount of neutralization potential available. For the same deposit type, sulfide concentrations, and thus ARD potential, can be highly variable and, therefore, it is important to assess, design and plan projects on a site-by-site basis.

Due to a combination of the geochemical characteristics of the Project's mine materials and the engineering controls proposed by Twin Metals Minnesota, the ARD potential of the Project is characterized as low. The key characteristics of the project which support this classification are listed below.

- Considerable information is available regarding the environmental behavior of magmatic sulfide deposits in general and those of the Duluth Complex specifically.
- Extensive testing of Duluth Complex materials indicates that the sulfur content is the controlling factor for the rate and severity of ARD generation:
  - Unlike many other ore types, elevated sulfur contents in the Maturi deposit occur almost exclusively in association with the ore, which will be removed and processed during mining.
  - The sulfur content of the tailings is very low as virtually all sulfur reports to the concentrates. As such, the tailings are classified as having a low to non-existent potential to generate ARD.
  - Lag times to acid generation are inversely proportional to the sulfur content.
  - Copper sulfides are the primary sulfide minerals in the Maturi deposit. Compared to iron sulfides, which are the most common cause of ARD, copper sulfide minerals oxidize at a slower rate and may not generate acid.
- Twin Metals Minnesota will execute a comprehensive and thorough mine material's characterization program, the results of which are expected to support the current understanding of the environmental behavior of Duluth Complex rocks.
- The proposed engineered environment contains the following features:
  - Surface:
    - The tailings will be stored under a water cover in a fully lined facility (impoundment and embankment) with seepage collection.
    - There will be minimal and temporary storage of development rock on the surface in a lined facility with seepage collection (approximately half a million tonnes for less than five years). This duration is less than the anticipated lag time to acid

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generation for most development rock that is generated during the early years of operation.

- Underground:
  - Sulfide mineralization will be exposed underground. However, the period of exposure will be brief, with the stopes to be backfilled within a 6 to 18 month timeframe, i.e. well before the onset of acid generation.
  - During operation, underground water will be collected and used in the process.
  - Flooding of the underground mine following cessation of mining activities will virtually eliminate sulfide oxidation.
  - Virtually all development rock (i.e. all rock with the exception of the first six months of mining) and a portion of the tailings (40%) will be used for underground backfill. Cement slag binder will be added for geotechnical purposes, but will also represent a source of additional alkalinity and buffering.
- The modern regulatory environment requires dozens of local, state and federal environmental permits to plan, construct, operate, and close the proposed underground mine. This high level of scrutiny ensures the use of proven, state-of-the-art practices.

The project-specific details presented in this paper are preliminary and consist of project information that has been developed as part of overall project evaluation and engineering. Final project details will be presented in the future formal submission of a Mine Plan of Operations.

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1.0 INTRODUCTION

This paper presents and discusses potential geochemical environmental issues associated with the proposed Twin Metals Minnesota Project (Project), a world-class underground Copper-Nickel-Platinum Group Elements (Cu-Ni-PGE) mine near Ely, Minnesota. The potential underground Cu-Ni-PGE mine targets the Maturi deposit of the Duluth Complex. The project-specific details presented in this paper are preliminary and consist of project information that has been developed as part of overall project evaluation and engineering. Final project details will be presented in a future formal submission of a Mine Plan of Operations.

Twin Metals Minnesota is a wholly owned subsidiary of Antofagasta plc of Santiago, Chile, one of the top 10 copper producers in the world. The potential geochemical environmental issue of most concern is the generation of acid rock drainage (ARD) and associated metal leaching (ML), commonly combined using the acronym ARD/ML. This concern is not unique to the Twin Metals Minnesota Project; ARD/ML is the number one environmental issue facing the global hard rock metal mining industry (e.g., INAP 2012). Because of the industry-wide nature of the issue, research into the process of ARD formation and methods to minimize its impacts has been conducted for over 50 years.

ARD is formed by the natural oxidation of sulfide minerals when exposed to air and water. Activities that involve the excavation of rock with sulfide minerals, such as metal mining, accelerate the process. ARD results from a series of reactions and stages that typically proceed from near neutral to more acidic pH conditions. When sufficient base minerals are present to neutralize the ARD, neutral mine drainage or saline drainage may result from the oxidation process. Neutral mine drainage (NMD) is characterized by elevated metals in solution at approximately neutral pH, while saline drainage (SD) contains high levels of sulfate at neutral pH without significant dissolved metal concentrations.

The process of sulfide oxidation and formation of ARD is very complex and involves several chemical and biological processes that can vary depending on environmental, geological, and climate conditions (Nordstrom and Alpers 1999). Sulfide oxidation requires three basic ingredients: sulfide mineral, oxygen, and water. The most common sulfide mineral is pyrite [FeS_2]; however, other sulfides commonly found in ore deposits may also generate ARD. Sulfide oxidation reactions can occur either abiotically or biotically (i.e. mediated through micro-organisms). In the latter case, the oxidation reaction rates can be accelerated by many orders of magnitude relative to abiotic rates (Nordstrom 2003). Under the majority of circumstances, atmospheric oxygen acts as the oxidant. However, aqueous ferric iron (Fe^{3+}) can oxidize pyrite (and other sulfides) as well. Pyrite oxidation by ferric iron is considerably faster (two to three orders of magnitude) than the reaction with oxygen, and generates substantially (eight times) more acidity per mole of pyrite oxidized. However, this reaction is limited to conditions in which significant amounts of dissolved ferric iron occur (i.e. acidic conditions: pH 4.5 and lower).

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As previously indicated, research into the process of ARD formation and methods to minimize its impact has been conducted for over 50 years. Much progress has been made in the last 20 years through a number of research organizations and consortiums. The International Network for Acid Prevention (INAP), of which Antofagasta is an active member, has consolidated the available information and produced a Global Acid Rock Drainage Guide (GARD Guide) that is up-to-date and global in scope (INAP 2012).

INAP's goal was to produce a guide that would be a key reference for the mining industry, regulators, non-governmental organizations (NGO's) and the public on the subject. To this end, the GARD Guide summarizes the best technical and management practices with the objective of creating a body of work with high industry and external stakeholder credibility. The guide assists the industry in providing high levels of environmental protection, assists governments in the assessment and regulation of affairs under their jurisdiction, and enables the public to have a higher degree of confidence in and understanding of acid prevention plans and practices. Overall, the GARD Guide provides a structured and standardized system to identify and catalogue proven techniques for characterization, prediction, monitoring, treatment, prevention and management of ARD (as well as NMD and SD).

The GARD Guide represents a collaborative effort by many experts in the field of ARD. The guide was funded by INAP and the Mining Association of Canada (MAC). It was developed in partnership with the Global Alliance, whose member organizations collectively represent significant technical expertise on ARD/ML prevention, mitigation and mine waste management. Global Alliance member organizations include the Sustainable Minerals Institute–Knowledge Transfer (SMIKTR - Australia), the Mine Environmental Neutral Drainage Program (MEND - Canada), the Chinese Network for Acid and Metalliferous Drainage (CNAMD), the Partnership for Acid Drainage Remediation in Europe (PADRE), the Indonesian Network for Acid Drainage (INAD), the Water Research Commission (WRC - South Africa), the South American Network for Acid Prevention (SANAP), and the Acid Drainage Technology Initiative (ADTI - United States of America). Specific contributors and advisors to the GARD Guide included representatives from the mining industry, academia, private consulting, and government agencies (e.g., the United States Bureau of Land Management) from around the world. Use and reference of the guide is an indication of its acceptance and credibility. For example, the United States Environmental Protection Agency (USEPA) appended the Executive Summary of the GARD Guide to a document prepared by the Central American Free Trade Act (CAFTA) on Environmental Impact Assessment (EIA) technical review guidelines for mining (CAFTA DR and US Country EIA and Mining Experts 2011 and Chatwin 2015). The International Finance Corporation (IFC) has plans to reference the GARD Guide in future guidance documents (Chatwin 2015).

As demonstrated in the GARD Guide, proper characterization of mine materials, drainage-quality prediction, and mine-waste management can prevent ARD formation in most cases and minimize ARD formation in all cases. Activities to prevent, minimize and / or manage ARD must commence at exploration and continue

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throughout the mine life cycle. Ongoing ARD planning and management are critical to the successful prevention of ARD.

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2.0 TWIN METALS MINNESOTA PROJECT OVERVIEW

The polymetallic deposits of the Duluth Complex, including the Twin Metals Minnesota Project are so-called magmatic sulfide deposits, formed by the segregation and crystallization of sulfide- and metal-rich immiscible liquids from crystallizing mafic magmas (Plumlee et al. 1999). Once formed, the droplets of sulfide liquid settle through less dense magma. The sulfide liquid acts as a "collector" for copper, nickel, cobalt and PGEs because these elements prefer the sulfide liquid to the magma by a factor of 10 to 100,000 times. Unlike many other types of ore deposits, the sulfide mineralization of these deposits is therefore directly associated with the ore, thereby limiting the potential for the generation of potentially acid generating (PAG) waste materials.

The proposed Project is an underground mine that targets the Maturi mineral deposit, located approximately nine miles southeast of the city of Ely, Minnesota (MN). Twin Metals Minnesota has conducted numerous studies (many ongoing) to characterize both the deposit and the surrounding environment to inform decisions on the development of this resource with environmental stewardship.

Twin Metals Minnesota will adopt modern mining methods to appropriately manage mine materials (i.e. tailings, development rock and ore) focusing on prevention of ARD generation and the release of metals and/or sulfate to the environment. From what is already known about the ARD/ML potential of mine materials, based on research by others and Twin Metals Minnesota, ARD/ML potential has already been considered in mine design and material management. Final design will be guided by additional site-specific studies.

Key aspects of the mine material management strategy related to environmental performance include:

- Resource development by underground mining to minimize overall disturbance
- Comprehensive ARD/ML source control (or elimination), including:
  - No long-term development rock storage on surface
  - Storage of non-acid generating (low sulfur) tailings in an engineered facility
  - Placement of development rock and almost half the tailings underground as cemented backfill

The US is a world-leader in the implementation and enforcement of legislation to protect the environment. Dozens of local, state and federal environmental permits will be required to plan, construct and operate the proposed underground mine. Twin Metals Minnesota's license to operate is, therefore, dependent on development of the resource in an environmentally-responsible manner.

2.1 Deposit Geology

Magmatic sulfide deposits are formed by the segregation and crystallization of sulfide- and metal-rich immiscible liquids from crystallizing mafic magmas (Plumlee et al. 1999). Once formed, the droplets of

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sulfide liquid settle through less dense magma. The sulfide liquid acts as a "collector" for copper, nickel, cobalt and PGEs because these elements prefer the sulfide liquid to the magma by a factor of 10 to 100,000 times. These deposits are characterized by lenses or bodies of sulfides.

The South Kawishiwi Intrusion (SKI) of the Duluth Complex, which hosts the Maturi deposit, is categorized as a layered mafic intrusion. Figure 1 shows an example cross-section through the Maturi deposit. The eight major units defined in the Project geologic model (listed below in order from top to bottom as they occur in a typical geologic cross-section) are as follows:

- **ATA or ATA Series** - anorthositic troctolitic to troctolite
- **AGT or Main AGT** - augite-bearing troctolite
- **UPB or Upper Basalt** - basaltic hornfels
- **UPG of Upper Gabbro** - anorthositic gabbro to gabbro
- **ANS or AN Series** - anorthositic series
- **PEG** - pegmatoidal unit
- **BMZ** – basal mineralized zone
- **GRB or Giants Range Batholith** - porphyritic quartz monzonite

These units are described in more detail in Table 1.

The basal mineralized zone (BMZ) is the unit which hosts the mineralization (lowermost unit of SKI); however, some mineralization does extend into the Giants Range Batholith (GRB). The thickness of the BMZ ranges from approximately 1.5 meters to more than 260 meters, averaging 65 meters (Twin Metals Minnesota 2017). The BMZ mineralization includes both base metals (Cu and Ni) and precious metals (palladium [Pd], platinum [Pt], gold [Au] and silver [Ag]). The top of the Maturi ore zone outcrops at the surface in certain areas and extends to depths of approximately 1,500 meters (4,900 feet).

The BMZ has been subdivided into four stratigraphic units: Upper Heterogeneous (UH); Stage 1 (S1); Stage 2 (S2); and, Stage 3 (S3). These units represent an apparent time sequence and were named, in part, for their inferred time of intrusion. The late-stage units (i.e. S3 and S2) are more mineralized than the early-stage units (i.e. UH and S1).

The hanging wall and footwall refer to the geologic units immediately above and below the ore zone, respectively. The hanging wall rock to the BMZ includes the pegmatoidal unit (PEG), augite-bearing troctolite (Main AGT or AGT), and the anorthositic series (AN-Series or ANS), with PEG being the most prevalent hanging wall unit. The GRB is the footwall of the deposit. The underground mine will be accessed via a decline constructed through the hanging wall. Much of the underground mine infrastructure will be constructed in the footwall.

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With the exception of the GRB, the non-mineralized units of the Project have similar and consistent chemical and mineralogical compositions. The principal compositional variation is in the proportions of plagioclase, olivine and clinopyroxene, indicating a very comparable environmental behavior when extracted during mining.

2.2 Twin Metals Minnesota Project

The Twin Metals Minnesota Project is a proposed underground mine. Some project details are listed below:

- **Ore**: Ore will be crushed underground and transported to surface for temporary storage in an engineered, covered and lined facility prior to milling. The total sulfur content of the ore is expected to range from approximately 1 to 5 wt.%.
- **Processing**: Processing will produce copper, nickel and PGE concentrates. Virtually all of the sulfur present in the ore will report to the concentrates.
- **Tailings**: Processing will also produce low-sulfur (≤0.2 wt.%)[1], non-acid generating (NPAG) tailings. Tailings will be thickened to 73% solids in a conventional thickener and stored in two fashions.
  - **Surface Storage**: A modern, fully-lined, tailings storage facility (TSF) will be constructed southwest of Babbitt, MN. Tailings will be retained under a water cover behind a center-line dam with a low-permeability core. Any tailings seepage will be collected and returned to the mine site. During the first six months, all tailings will report to the TSF. Following commissioning of the backfill plant, approximately 60% of the tailings will be delivered to the TSF.
  - **Underground Storage**: The backfill system will deliver the remaining approximately 40% of the tailings to the underground mine. Tailings will be taken from the tailings thickener at 73% solids, blended with a small amount (1 – 2 wt.%) of cemented-slag backfill binder, and placed underground.
- **Development Rock**: Most (75%) development rock generated during excavation of decline will be used in construction (geochemical testing is planned to confirm suitability for use in construction). There will be no long-term storage of development rock on the surface. The first half million tonnes of potentially sulfide-bearing development rock will be placed on the surface in an engineered facility (i.e. lined stockpile with contact water collection) for up to five years. This rock will be processed through the mill or placed underground as backfill. Following the early stages of mining (approximately 6 months) all development rock will remain underground as backfill.
- **Water Management**: The mine water management system will be designed to prevent the discharge of contact water to the environment. Contact water will be used in the process water circuit as follows:
  - Water reclaimed from the TSF will be returned to the mine site.
  - Underground mine groundwater inflow will be collected and delivered to the mine site contact water ponds for use in processing.
  - Precipitation onto the mine site and TSF (i.e. contact water) will be collected and used in the process water circuit.
  - As practical, surface water will be diverted around the mine site and the TSF (i.e. non-contact water).

[1] Material characterization to date indicates that the total sulfur content of the tailings will be less than or equal to 0.2 wt.%.

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3.0 GEOCHEMICAL CHARACTERIZATION

An understanding of environmental geochemistry is a critical component of modern mining. Awareness of the impacts that historical and active mining can have on the environment and the implementation of regulations meant to guard against these impacts have resulted in increased focus on pre-mining characterization. For modern mines, geochemical characterization starts during the planning stage and continues through active mining, to inform water and waste management practices, and culminates in mine closure (Seal and Nordstrom 2015).

Considerable information is available regarding the environmental behavior of magmatic sulfide deposits in general and the Duluth Complex specifically. The polymetallic deposits of the Duluth Complex have been studied extensively. Although the stratigraphic sequence of individual deposits may vary, lithologic units over the Duluth Complex show remarkable consistency in terms of their geochemical, and therefore environmental, characteristics.

Two limitations frequently cited in the industry's ability to accurately predict ARD potential for a future mine include: 1) the scale of testing programs (i.e. laboratory as opposed to field) and 2) the limited duration of so-called long-term testing programs (e.g., kinetic testing). Both of these limitations have been or will be addressed for the Project. As discussed in Section 3.1, the Duluth Complex is unique in that long-duration kinetic testing has been conducted. To address the scale of testing, the behavior of the Project materials will be confirmed by the Project's Mine Material Characterization Program discussed in Section 3.2.

Kinetic tests are routinely used as a tool in understanding the long-term weathering behavior of a material, including the lag time to the generation of ARD for a PAG material. Studies of the potential for ARD generation from Duluth Complex rocks have been conducted at the laboratory and field scale by US government research organizations (i.e. Minnesota Department of Natural Resources [MDNR] and the United States Geological Survey [USGS]) and private industry. These studies have included kinetic testing programs that have operated for years, sometimes longer than a decade, and to the author's knowledge, represent the longest laboratory testing programs executed by anyone in the industry. The information available from these studies provides a fundamental understanding of the expected environmental behavior of the materials originating from the Project. Key findings regarding the environmental behavior of Duluth Complex rocks include:

- Sulfur content is the controlling factor for the rate and severity of ARD generation from Duluth Complex rocks.
- The silicate neutralization potential (NP) present in Duluth Complex rocks is available and sufficient to maintain circum-neutral pH conditions for extended periods (i.e. decades) for rock with low total sulfur content. For higher total sulfur content rock, silicate NP is responsible for a delay in the development of ARD, thereby allowing time for implementation of appropriate engineering controls.

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- Relative sulfide mineral reactivity (pyrrhotite > pentlandite > pyrite > chalcopyrite) is consistent with literature rates reported by others (e.g., Jambor 2005).

3.1 Duluth Complex Geochemical Characterization

The environmental behavior of Duluth Complex rocks has been studied by MDNR, the USGS and PolyMet Mining Corporation (PolyMet 2015), a privately-held company proposing to develop another Cu-Ni-PGE project in the Duluth Complex. Research by these organizations is summarized in the following sections.

3.1.1 MDNR Research

Since the late 1970s, MDNR has studied the potential for ARD generation from Duluth Complex rocks at both the laboratory and field scale. The extensive duration of their testing programs represents a data set that is unique in the mining industry.

MDNR has studied the weathering behavior of development rock (i.e. waste rock), tailings and low-grade ore. Details of selected MDNR studies are summarized in Table 2.

3.1.1.1 Laboratory Kinetic Testing Methodologies

Kinetic testing is conducted to assess the rate of sulfide mineral weathering and release of mass from a solid material sample. Laboratory tests are designed to accelerate the rate of weathering relative to field conditions. MDNR kinetic testing has included two methodologies: the industry-standard humidity cell test (HCT) (ASTM 1996 and 2007) and the MDNR reactor.

The standard HCT test is performed in a cylindrical cell. Within the cell, a 1-kilogram sample of solid material crushed to minus ¼ inch (waste rock or ore) is leached with a fixed-volume aqueous leach. No particle size reduction is necessary for tailings. The test procedure consists of weekly cycles, wherein for three days the cell is provided a steady flow of dry air (less than 10% oxygen), and for three days the cell is supplied with a steady flow of water saturated air (95% relative humidity). The cell is leached with a fixed volume of water on Day 7. The composition of the leachate is then determined by chemical analysis.

A comparison of the HCT and MDNR reactor tests is shown in Table 3. The MDNR reactor test procedure also involves weekly leaching of a solid material. Between leaches, the sample is exposed to air under ambient conditions. In comparison to the HCT procedure, the sample mass is lower (i.e. 75 grams versus 1 kilogram) and the particle size reduction is much greater (i.e. the MDNR reactor sample is finer than the HCT sample). The MDNR reactor weekly solution to solid ratio is higher than the HCT test (Table 3).

3.1.1.2 Results from the Development Rock and Low-Grade Ore Study

The principal finding of decades of research is that the sulfur content of the Duluth complex rocks is the controlling factor for the rate and severity of ARD generation. At low total sulfur contents, silicate NP is sufficient to neutralize acidity and maintain neutral pH conditions.

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Minimum leachate pH versus sulfur total content for the MDNR waste rock and low-grade ore samples from Studies 1 to 4 (Table 3) is shown in Figure 2. Results from the PolyMet testing program (discussed in Section 3.1.2) are included for comparison. Figure 2 includes data from numerous studies with variable test durations (months to years), test methodologies (HCT, MDNR reactor and stockpile) and scales (laboratory and field). Despite these differences, this figure shows a systematic relationship between minimum leachate pH and total sulfur content. This relationship can be used to define a threshold for ARD-generating material (approximately 0.2 wt.%). Below this threshold, the test results indicate that the neutralization potential, primarily from silicate minerals, is sufficient to neutralize acidity. This finding has important ramifications in terms of mine material management, for instance allowing the segregation of non-PAG (NPAG) versus PAG material based on the total sulfur content.

Additional observations from the MDNR studies are summarized as follows:

- **Test Duration**: The MDNR studies provide insight into the duration of kinetic testing required to inform material management decisions for Duluth Complex rock. Study 2 (Kellogg et al. 2014) in Table 2 provided an update to the test work presented in Study 1 (Lapakko and Antonson 1992). Studies 1 and 2 presented MDNR reactor results for 16 samples at the conclusion of 150 weeks and up to 24 years of testing, respectively. These studies grouped samples by sulfur content based on consistency in minimum leachate pH measured during testing. As shown in Table 4, the sulfur groupings for the two studies were similar with the only significant change being a reclassification of the 0.4 wt.% sulfur from Group 1 to Group 2. Although slight decreases in pH were observed following a longer period of testing, the pH minimums reached over the longer period of testing in Study 2 are unlikely to result in a change in the approach to material management. Toward the conclusion of Study 2 testing, an increasing pH trend was observed for most Group II and III samples. Based on drainage pH alone, Study 2 concluded that Group I development rock would probably require no rigorous reclamation, acknowledging that sulfate and metal leaching may still need to be addressed. The same conclusion could have been reached at the termination of Study 1.
- **Relative Sulfide Reactivity**: Study 2 (Kellogg et al. 2014) noted significant depletion in sulfide minerals over the period of testing. A 50 percent decrease in pyrrhotite was measured without any significant decrease in chalcopyrite. Study results were consistent with the relative rates of sulfide oxidation reported by Jambor (2005) (i.e. pyrrhotite > pentlandite > pyrite > chalcopyrite).
- **Particle Size Effect on Sulfide Reactivity**: Study 3 (Lapakko et al. 2013a) noted an increase in the rate of sulfide oxidation as particle size decreased and surface area increased. This observation is consistent with general geochemical principles.

3.1.1.3 Results from the Tailings Study

MDNR conducted a 10-year laboratory study on weathering of Duluth Complex tailings (Lapakko et al. 2013b). The geochemical characteristics of the tailings sample are shown in Table 5. The total sulfur content of the tailings was 0.2 wt.% and the primary sulfide mineral was pyrrhotite. The NP data indicated that carbonates represented only a small fraction of the total NP, as expected for Duluth Complex rocks.

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The testing program included six MDNR reactors and two humidity cells, operated in accordance with ASTM D5744-96 (ASTM 1996). Circum-neutral pH conditions were maintained in all tests over the 10-year period. HCT pH values generally declined over the period of testing from near 8 to 6.8. Neutralization was attributed to dissolution of trace calcite (early stages of testing) and silicate mineral dissolution, specifically labradorite (=plagioclase), augite (=pyroxene), olivine and biotite. The results from this investigation were consistent with those from the MDNR development rock and low-grade ore studies in terms of the relationship between ARD potential and total sulfur content.

3.1.2 PolyMet Research

PolyMet proposes to develop the NorthMet Deposit, a Cu-Ni-Co-Pt-Pd-Ag deposit within the Duluth Complex. The deposit occurs over a length of approximately 2.5 kilometers and is covered by a thin layer of glacial till (PolyMet 2015). PolyMet plans to develop the deposit by open pit mining. Disseminated copper-nickel-iron sulfides (i.e. chalcopyrite, cubanite, pentlandite, and pyrrhotite) and associated PGE mineralization will be extracted from several igneous stratigraphic horizons (SRK 2007).

PolyMet has performed a comprehensive mine materials characterization program. At the time of submittal of their draft Environmental Impact Statement (EIS), kinetic testing results from 85 HCTs operated for 168 weeks were available (SRK 2009). Final leachate pH versus total sulfur content for the 85 humidity cells is shown in Figure 3 (this figure includes three ore samples). The test results are summarized as follows:

- During the period of kinetic testing, acidic conditions (defined as pH < 4.5) were established in eight cells. The total sulfur contents of these eight samples ranged from 0.86 to 5.7 wt.%.
- All samples with total sulfur contents less than 0.1 wt.% reported circum-neutral final leachate pH values (between approximately 6.5 and 7.5).
- Acidic conditions were not reached before 60 weeks of testing in any of the samples with a total sulfur content less than 3.0 wt.%. The observed lag time to ARD was attributed to buffering by silicate minerals (i.e. plagioclase and olivine).

Results of the geochemical testing program were used to classify waste rock in the final EIS (MDNR et al. 2015). Four waste rock classes were defined on the basis of total sulfur concentration (Table 6). Greater than 90% of the waste rock that will be generated by the PolyMet mine is designated as having low to medium potential to generate ARD. PolyMet also predicts that the lag time to the onset of ARD for Class II and III waste rock will be greater than five years (PolyMet 2015) (Figure 4).

Other key findings from the PolyMet program include (SRK 2007):

- **Rate of Sulfide Oxidation** – The rate of sulfide oxidation is proportional to the total sulfur content, while the sulfide mineralogy plays a role as well. Other variables (e.g., rock type, position in intrusive stratigraphy) do not appear to be important.

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- **Metal Leaching** – Solution pH is the primary control on metal leaching. In particular, nickel leaching increases as pH levels decline below 7.0.

The results from this investigation were consistent with those from the MDNR programs in terms of the relationship between ARD potential and total sulfur content.

3.1.3 USGS Study

3.1.3.1 Determination of Neutralization Potential

The ARD potential is determined by the balance between the acid generation potential of a material (i.e. sulfide concentration) and the neutralization potential (NP). NP is a measurement of the amount of alkaline or basic material in a rock or soil. There are many minerals capable of acid neutralization; however, their reaction mechanisms and rates vary widely. Effective NP is defined as "*the acid neutralization that can neutralize internal and external acidity inputs sufficiently to maintain near-neutral pH drainage*" (MEND 2009). For many mine materials, effective NP includes only the contribution from carbonate minerals calcite and dolomite. For the Duluth Complex rocks, NP is associated with the dissolution of silicate minerals.

The static analytical testing methods used to estimate the NP of a material broadly fall in two categories:

- **Bulk NP** – Standard analytical methods for the determination of bulk NP measure a contribution from both carbonate and non-carbonate minerals with buffering capacity. The NP of a material is typically estimated by acid digestion followed by back-titration to determine the quantity of acid consumed by the sample.
- **Carbonate NP** – Standard methods to determine the NP of a material based on its carbonate content involve either direct (i.e. mineralogical analysis) or indirect (i.e. measurement of total inorganic carbon (TIC) or total carbon (TC) assumed to be present as calcite) measurement of the carbonate content of a sample.

For Duluth Complex rocks, carbonate NP is low or non-existent and therefore determination of carbonate NP is not informative. However, mineralogical analysis, which can be used to estimate carbonate NP, can also be used to estimate silicate mineral NP. Bulk NP analyses conducted on monomineralic and near-monomineralic samples provide data on mineral contributions to NP (e.g., Jambor et al. 2000, 2002, 2003, and 2006). This information, in association with mineralogical analysis results, can be used to estimate non-carbonate mineral NP.

3.1.3.2 Results

Schulte et al. (2016) evaluated the NP associated with the silicate minerals present in Duluth Complex rock. Two of the silicate minerals that have the highest NP values are present in these rocks (i.e. olivine and calcic plagioclase). Schulte calculated the NP contribution from silicate minerals for Duluth Complex drill core samples based on the NP values for the individual minerals presented in Table 7. The study included nine samples form the Maturi deposit.

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Results of this study are shown in Figure 5 (reproduced from Schulte et al. [2016]). Samples from the Maturi deposit are identified by the designation DU-14. For most Maturi samples, NP was greater than AP (Figure 5-A). Assuming virtually all (e.g., 90%) of the sulfide in ore samples reports to the concentrate during processing, NP is greater than AP for all samples (Figure 5-B). The authors concluded that the NP in these cores may be sufficient to neutralize the acid generated by sulfides.

3.2 Twin Metals Minnesota Geochemical Characterization

Although the research performed by others (Section 3.1) provides a fundamental understanding of the expected environmental behavior of the materials originating from the Project, the behavior of the Project materials will be confirmed by the Project's Mine Material Characterization Program described in this section. This characterization program is a comprehensive and thorough effort that will stand on its own merits.

Twin Metal Minnesota's commitment to comprehensive characterization of the geochemical behavior of the Maturi deposit began during exploration drilling. In cooperation with MDNR, they have developed and started implementation of a broad laboratory-based material characterization program.

Key findings of the studies to date include:

- Copper sulfides are the dominant sulfide minerals in the Maturi deposit. From an environmental perspective, this is beneficial as these sulfides have lower reactivity and acid generation potential compared to iron sulfides (i.e. pyrite and pyrrhotite).
- Most of the development rock and ore samples (approximately 90%) tested to date are classified as non-acid generating (NPAG) based on the results of static testing. This observation will be verified through kinetic testing.
- Test work to date indicates no ARD potential for the tailings due to their low sulfur content. This conclusion is consistent with studies by MDNR and USGS (Lapakko et al. 2013b; Schulte et al. 2016).

3.2.1 Sulfide Type and Occurrence

Geochemical characterization of Duluth Complex rocks has indicated that total sulfur content and sulfide mineralogy are the most important factors in the assessment of environmental behavior. The sulfide minerals identified in the Maturi deposit include (in general order of importance):

- chalcopyrite [$CuFeS_2$]
- cubanite [$CuFe_2S_3$]
- pentlandite [$(Ni,Fe)_9S_8$]
- talnakhite [$Cu_9(Fe,Ni)_8S_{16}$]
- pyrrhotite [$Fe_{1-x}S$]
- bornite [Cu_5FeS_4]

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Sulfide distribution throughout the deposit is as follows (Twin Metals Minnesota 2017):

- **BMZ (Ore)**: The mineralized zone immediately above the footwall contact with the SKI (i.e. lower BMZ) consists of 1 to 5% disseminated chalcopyrite, cubanite, pentlandite, pyrrhotite, and talnakhite (Twin Metals Minnesota 2017). The characteristic sulfide mineral distribution of subunits S2 and S3 is shown in Figure 6. Copper sulfides are the dominant sulfide minerals. Subunit S2 contains a higher proportion of pyrrhotite than S3.
- **Hanging Wall**: Magmatic sulfide mineralization in the SKI is restricted to the BMZ and rarely occurs in the hanging wall.

  Total sulfur results for four Maturi holes that underwent comprehensive assay over their entire depth are shown in Figure 7. The number of samples for each hole ranges from 360 to 441. In each total sulfur profile, the extent of the ore zone (based on a copper cut-off of 0.3 wt.%) is identified in yellow.

  These figures show that elevated sulfur concentrations (> 0.5 wt.%) generally occur within the immediate vicinity of the ore zone. The average and median sulfur concentrations for samples located outside the ore zone are 0.07 wt.% and 0.04 wt.%, respectively (1,490 determinations).
- **Foot Wall**: Magmatic sulfide mineralization is commonly present in the upper 30 feet of the footwall GRB. The sulfide mineral assemblage in the footwall is dominated by chalcopyrite, pentlandite and pyrrhotite with lesser cubanite, bornite and talnakhite.

The sulfide minerals in the Maturi deposit and their relative potential for acid generation are listed in Table 8. From an environmental perspective, pyrrhotite is the sulfide of most interest. This is because it is one of the most reactive sulfide minerals and generates acid upon oxidation. The other sulfide minerals identified will oxidize as well, but do so at a slower rate and may not generate acid, unless ferric iron is the oxidant. When acidic conditions are reached, and ferric iron becomes the oxidant, acid is generated through the oxidation of chalcopyrite, cubanite, pentlandite, and talnakhite (Plumlee 1999). These conditions (i.e. pH <3.5) are only reached for material with total sulfur greater than approximately 1% (Figure 2), which is a small proportion of overall Project material and virtually all ore (Figure 7).

3.2.2 Mine Materials Characterization Program

In consultation with MDNR, Twin Metals Minnesota developed a robust geochemical characterization program (Golder 2013a). This program comprehensively evaluates the environmental geochemistry of the Project, and addresses the following matters:

- Acid-rock drainage (ARD)
- Metal leaching (ML) under acidic, neutral or alkaline conditions
- Potential for discharges of sulfate and other non-metallic constituents
- Potential for labile mercury
- Potential for labile (asbestiform) fibers
- Potential for radon generation in the underground

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The components of the analytical testing program are shown in Table 9. This industry-standard analytical program is consistent with the requirements specified in Minnesota Rule 6132.1000 Subparts 1 and 2 (Office of Revisor of Statutes - State of Minnesota 2008).

Implementation of the testing program follows a phased approach and includes both static (short-term) and kinetic (long-term) testing. The objective of static testing is to describe the bulk chemical characteristics of a material. These tests are designed to evaluate the potential of a particular rock type to leach metals or generate acid. Static testing is typically the first phase of geochemical characterization, and routinely is a precursor to kinetic testing. Although the results of static testing may initially indicate a potential for ARD/ML, kinetic testing is required to verify whether the various ARD/ML potentials identified will indeed be realized.

Twin Metals Minnesota's testing program is ongoing. To date, static testing of 216 development rock and ore samples and static and preliminary kinetic testing of tailings samples generated during pilot testing in March 2013 has been completed. MDNR has been engaged though all stages of design and implementation of the program. As testing results become available, results and interpretation are communicated to MDNR who have provided ongoing feedback. Ongoing engagement throughout the entire process is a key component in ensuring a robust and defensible data set that is sufficient to inform decisions on appropriate material management strategies during operations and closure.

3.2.2.1 Development Rock and Ore

Samples representative of development rock and ore were obtained from drill core from the Maturi deposit (Golder 2015). Sample collection targeted representation of all the units in the project block model.

The chemical composition and ARD potential of these samples has been determined. Characterization of a material's chemical composition is fundamental to understanding its environmental behavior. The results from solid-phase chemical analysis can be used to infer which elements are of potential environmental concern, although a high concentration of a particular element does not necessarily imply that this element will indeed be mobilized in concentrations that may lead to environmental impacts. Acid base accounting (ABA) is conducted to predict the acid generation characteristics of a material and is based on the relative difference between the material's net acid generation potential and net acid neutralization potential.

The specific tests that have been conducted to characterize chemical composition and ARD potential are summarized below:

- **Chemical Composition**: Characterization of the trace metal composition of a sample is typically a two-step process that includes an acid digestion to release elements into the solution phase followed by analysis of the elements in the resulting digestate. Methods of trace metals analysis for the Project include:

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- Four acid digestion followed by inductively coupled plasma mass spectrometry (ICP-MS) and ICP optical emission spectrometry (ICP-OES) analyses (most elements)
- Three acid digestion followed by ICP-MS analysis (As, Sb and Se)
- Aqua regia digestion followed by cold-vapor atomic adsorption analysis (Hg)

The major rock forming elements have been determined by x-ray fluorescence (XRF)

- **ARD Potential**: ARD potential is commonly determined using ABA, which involves measurement of sulfur species and neutralization potential (NP). An accurate and meaningful measurement of NP is typically premised on the fact that the majority of the NP is provided by carbonate minerals. In the case of the Project, carbonates are largely absent, while any NP is instead contributed by silicate minerals such as olivines and plagioclase. Therefore, estimates for acid potential (AP) and NP from ABA will be refined as needed using mineralogical information.

  ABA analysis has included determination of the following:

  - Sulfur species (total, sulfate, sulfide)
  - Bulk NP (modified Sobek)
  - Total inorganic carbon (TIC)
  - Paste pH

  In addition to standard ABA analysis, the testing program includes net acid generation (NAG) testing. In combination with ABA results, the NAG test provides a powerful tool for prediction of ARD generation. The NAG procedure uses a strong oxidant (hydrogen peroxide) to rapidly oxidize sulfide minerals in a crushed rock sample (AMIRA 2002). The NP of the sample then can be directly challenged by the acidity generated by rapidly oxidizing sulfides. If the sample has sufficient available NP, the alkalinity of the whole rock will not be entirely depleted, and the system is expected to have the capacity to remain circum-neutral. If there is inadequate available NP, then the pH of the test solution will fall below 4.5 and there will be net acidity rather than net alkalinity. In this case, a sample shows potential for acid generation.

  The ABA and NAG tests are both designed to evaluate ARD potential. The use of two methods allows an independent evaluation of ARD potential is intended to result in a more robust characterization program.

A number of criteria exist to characterize a sample as potentially acid generating (PAG) and non-potentially acid generating (NPAG) using ABA and/or NAG results. The most common approaches are those based on the use of the net potential ratio (NPR = NP/AP) and the net neutralization potential (NNP = NP – AP). For several reasons, no single NPR ratio or NNP value has been identified as having universal applicability in terms of predicting acid generation. The actual threshold values for a particular solid are material-specific, and depend on many factors, including the amounts and types of acid generating and neutralizing minerals, their morphology, their grain size, their crystallinity, their chemical composition, their paragenesis, the material's texture, and the site-specific exposure conditions.

Guidelines for evaluating acid generation potential of mine materials presented by MEND (2009) are summarized in Table 10. These guidelines, in association with NAG pH values are applied in evaluating Project ABA results. A NAG pH of 4.5 is generally accepted as the threshold between PAG and NPAG material (AMIRA 2002).

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Based on the results of testing to date (i.e. neutralization potential ratio [NPR] and NAG pH), less than 10% of samples are preliminarily classified as having an ARD potential (defined as an NPR value less than one and a NAG pH value of less than 4.5). NPR values have been calculated using bulk NP and AP calculated from total sulfur (i.e. assuming all sulfur is present as pyrite, which is a conservative approach) (Figures 8 and 9). Approximately one third of the PAG samples are from the BMZ (i.e. ore samples) and almost half of the samples are from the GRB. Additional characterization of the environmental behavior of the GRB, which has not been studied as extensively as the hanging wall units, is an important component of the testing program.

Planned future testing includes kinetic testing (i.e. HCT testing) and mineralogical analysis. Kinetic testing is required to confirm that the bulk NP, assumed to be present as reactive silicate minerals in the mafic/ultramafic units (SRK 2007), is indeed available. Kinetic testing is also required to evaluate NP mineral reactivity in the GRB samples. Mineralogical analysis will also greatly enhance the interpretive value of the ABA and NAG results obtained to date.

3.2.2.2 Tailings

Twin Metals Minnesota has conducted both static and preliminary kinetic testing on a tailings samples generated during pilot testing in March 2013. The ore sample for this testing was sourced from drill core from the western portion of the Maturi deposit.

Static testing (including ABA analysis) was conducted on three occasions. All total sulfur contents of the tailings included in the analytical programs were less than or equal to 0.2 wt.%.

The total sulfur concentration of the tailings is low as most sulfur reports to the concentrates. As shown in Figure 10, the total sulfur concentrations in the mill feed and tailings were approximately 1.3 wt.% and ≤ 0.2 wt.%, respectively.

Mineralogical analysis by XRD indicates the dominant tailing minerals are andesine (=plagioclase) (> 50 wt.%), forsterite (=olivine) (~20 to 30 wt.%) and diopside (= pyroxene) (<10 wt.%). The XRD analysis did not identify any sulfide minerals due to the low total sulfur concentration. As mentioned previously, silicate minerals, such as olivines and plagioclase, are a source of NP.

Preliminary kinetic testing of tailings samples has been completed (i.e. a 20-week test) (Golder 2013b). Kinetic testing results indicate a low to non-existent potential for ARD. The leachate pH over the 20-week testing period ranged from approximately 7 to 8.

Magnesium leachate data were used to estimate the rate of silicate NP depletion. Assuming that all the magnesium present in cell leachates is from the dissolution of forsterite, the time to magnesium depletion is estimated to far exceed the time to sulfide depletion, based on the relative rates of sulfate and magnesium

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release observed at the end of testing. The kinetic testing results therefore support an ARD potential classification of low to non-existent.

3.3 Geo-Environmental Model

Geo-environmental models are a compilation of geologic, geochemical, geophysical, hydrologic, and engineering information pertaining to the environmental behavior of geologically similar mineral deposits pre- and post-mining and mineral processing. Such models are often used to provide *a priori* information about expected water qualities originating from a particular deposit type, including compositional variability associated with its mining effluents, wastes, and mineral processing facilities (Plumlee et al. 1999).

Mine drainage from magmatic sulfide deposits can range from acidic to alkaline depending on the degree of interaction between acid waters, generated by sulfide oxidation, and the reactive mafic and ultramafic minerals such as olivine, pyroxenes, and plagioclase. Metals enriched in these mine waters typically include copper, nickel and zinc (Plumlee et al. 1999).

Based on the work conducted by MDNR and PolyMet, the ARD/ML potential of lithologic units present in the Project (with the exception of the GRB), is very well understood. In terms of ARD potential, a strong correlation has been identified between total sulfur content and rate of sulfide oxidation. In terms of metal leaching, an increase in nickel and cobalt leachate concentrations was observed for the PolyMet samples as leachate pH values declined below 7. When pH values dropped below 5, coincident increases in sulfate, nickel, cobalt and copper concentrations occurred. These relationships are consistent with geochemical principles and observations from other magmatic sulfide deposits around the globe (Plumlee et al. 1999).

Ficklin diagrams are a tool used in geo-environmental assessments. The traditional Ficklin plot is a scattergram in which the sum of the base metals zinc (Zn), copper (Cu), lead (Pb), cadmium (Cd), cobalt (Co), and nickel (Ni) is plotted against pH. Figure 11 (reproduced from Plumlee et al. 1999) is a Ficklin plot presenting observed water qualities for magmatic sulfide deposits. This figure presents data from the Duluth Complex and the Stillwater Complex in Montana. The range in mine water qualities from circum-neutral with low metal concentrations to acidic with elevated metal concentrations is attributed to a range in total sulfur concentrations. The Stillwater Mine is the only operating PGE mine in the USA. This site was included in a study comparing actual and predicted mine water qualities (Kuipers et al. 2006). The mine has been in operation since 1986. As stated in Kuipers et al. (2006), in 2003, a comprehensive water quality review of pre and post-mining water quality concluded that "*over the approximately 18 years of mine life no noticeable impacts (compliance with Montana non-degradation water quality standards) to water quality in the Stillwater River have occurred due to the operation of the Stillwater Mine. There were no discernable impacts with the exception of increased nitrogen concentrations, which are from mining operations*."

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A Ficklin diagram using water quality data from the Twin Metals Minnesota project is shown in Figure 12. Leachate results from kinetic testing of the tailings (Section 3.2.2.2) show low metals concentrations in association with circum-neutral pH conditions.

3.4 Use of Existing Studies

Twin Metals Minnesota will use the research conducted by others to supplement the extensive Project-specific characterization program that has already been initiated. Use of the research by others to characterize the potential for ARD/ML will consider the following with regards to the applicability of earlier studies to the Project:

- **Sulfide Occurrence**: Pyrrhotite was the dominant sulfide in the MDNR studies (Lapakko and Antonson 1992; Kellogg et al. 2014); chalcopyrite is the dominant sulfide in the Maturi deposit. Pyrrhotite is much more reactive than chalcopyrite. For a given total sulfur concentration, the lag time to ARD for the Project materials is therefore expected to be longer than the lag time to ARD for the MDNR samples.
- **Lag Time to ARD**: There is widespread acceptance in the industry that laboratory studies accelerate the rate of weathering compared to field conditions; however, due to the many factors that influence laboratory versus field behavior, there is no universal approach to the application of laboratory results to predict field behavior. The original ASTM HCT method stated that "*this laboratory test method has accelerated metal-mine waste-rock weathering rates by at least an order of magnitude greater than observed field rates*" (ASTM 1996). This statement has been removed from the most recent revision of the testing procedure. ASTM (2013) instead cites examples of accelerated weathering in the laboratory compared to the field, including an example for Duluth Complex rock "*rates observed in laboratory tests of metal-mine rock have been reported to be 3 to 8[2] times those for small-scale field test piles of Duluth Complex rock*" (Lapakko 1994).

  Accelerated weathering in the laboratory versus the field is in part due to particle size reduction (i.e. consistent with the geochemical principle that mineral reactivity increases with a decrease in particle size due to an increase in surface area). MDNR observed higher rates of sulfide oxidation using the MDNR reactor methodology compared to standard HCT testing (Lapakko et al. 2013a). It is notable that just as sulfide reactivity increases as particle size decreases, so does available NP reactivity. Application of laboratory testing data to the Project, in particular MDNR reactor data, to predict the behavior of blasted wall faces in the underground will take into account the effects of particle size.

[2] The source document (Lapakko 1994) indicates 3 to 10 times.

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4.0 TWIN METALS MINNESOTA PROJECT ARD/ML POTENTIAL CONCEPTUAL MODEL AND MATERIAL MANAGEMENT

Prior to mining, the ARD/ML potential of Project materials will be well understood. When an ARD and/or ML risk is identified, state-of-the-art engineering controls will be implemented to mitigate any potential environmental impacts. The management of ARD/ML continues to undergo improvements, in part in response to increased regulatory oversight, as referenced in the literature:

- *"Best practices in AML [abandoned mine land] reclamation are continuously being tested and **proven** by the BLM, other Federal agencies. States, contractors, and mining companies."* (BLM and USFS 2007).
- *"Experience gained by the Forest Service and others during the past few decades has demonstrated that there are no quick and easy solutions to abandoned mine lands and water protection. However, modern mining regulations and progress made using collaborative partnerships and a watershed approach point positively to the potential for solid success."* (USDA Forest Service 2005)
- *"The rapid evolution of modern mining technologies and best management practices has also reduced both the "degree and duration of risk" for the release of hazardous substances to **de minimus levels**. Since the 1990s, both the Bureau of Land Management and the U.S. Forest Service have reported that thousands of mine plan operations have received approval, and not one has been added to the National Priorities (Superfund) List (NPL), demonstrating the success of existing, comprehensive regulatory programs."* (Sanderson 2017).

Twin Metals Minnesota's strategy to mine material management focuses first on **elimination** of ARD/ML risk, with engineering controls as a secondary or complementary action. Key aspects of their ARD management plan include:

- **Development Rock**: Minimize storage of development rock on surface both in terms of tonnage and duration. Use of a lined facility with contact water controls for any short-term storage (< 5 years) of development rock on surface.
- **Tailings**: Storage of low-sulfur non-acid generating tailings in an engineered facility (i.e. tailings stored in fully lined facility under a water cover with contact water management) and placement of tailings underground as cemented backfill.
- **Underground**: Minimize the duration of open stopes to limit sulfide exposure. Use of development rock and tailings (with a 1 to 2% cement slag binder) as underground mine backfill.

4.1 ARD/ML Conceptual Model

As discussed previously, extensive research by others has indicated that sulfur content is the controlling factor for the rate and severity of ARD generation from Duluth Complex rocks. The project-specific testing that will be performed by Twin Metals Minnesota has confirmed, and is expected to continue to confirm, this observation. The silicate mineral NP present in Duluth Complex rocks is available and sufficient to maintain circum-neutral pH conditions for extended periods (i.e. decades) for rock with low total sulfur content. For material with higher total sulfur contents, silicate NP is responsible for a delay in the

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development of ARD, thereby allowing time for implementation of appropriate engineering controls. The lag time to ARD is also related to sulfur content (i.e. lag time decreases as sulfur content increases).

Studies by MDNR and PolyMet provide an initial indication on the expected lag time to ARD for high sulfur content rock. However, it is likely that these studies overpredict the rate of sulfide oxidation (i.e. under predict lag time to ARD) relative to Project materials due to 1) differences in sulfide mineralogy between these studies and the Project (i.e. relative concentrations of copper sulfides and iron sulfides), and 2) the methodology used in kinetic testing (i.e. enhanced particle size reduction and increased mineral reactivity due to the use of the MDNR reactor). Project-specific kinetic testing will be performed to determine Project-specific lag times to ARD development.

The current conceptual model for the ARD/ML potential of Project materials prior to implementation of engineering controls is as follows:

- **Tailings**: Non-acid generating due to low sulfur content (≤ 0.2 wt.%).
- **Hanging Wall Development Rock and Wall Rock:** No to low ARD potential due to low sulfur content and the presence of silicate minerals with available neutralization potential.
- **Footwall Development Rock and Wall Rock:** Uncertain ARD potential due to variability in total sulfur concentration (i.e. mineralization present in some parts of the footwall) and uncertainty in the available NP of the GRB. Where sulfides are present, lag time to ARD will be related to total sulfur content. Where mineralization (i.e. sulfide minerals) are absent, the ARD potential of the GRB is characterized as low. The presence of sulfide mineralization in the GRB is associated with the BMZ.
- **Ore:** Likely ARD potential due to the presence of sulfides at percent levels. Project-specific testing will determine the lag time to ARD.

All materials have the potential for low-level metal and sulfate leaching under circum-neutral pH conditions. Establishment of acidic conditions would result in an increase in metal and sulfate concentrations.

4.1.1 Comparison to Other Deposits

In this paper, the importance of sulfur content in ARD generation has been mentioned repeatedly. In general, the ARD risk associated with an ore deposit is proportional to the amount of sulfides present and inversely proportional to the amount of NP available. However, for the same deposit type, sulfide concentrations, and thus ARD potential, can be highly variable. For this reason, Seal (2014) cautions against the blanket use of the term “sulfide mining”.

Seal et al. (2014) contrasts Cu-Ni-PGM ores in the Lake Superior Region by comparing the Eagle Mine in Michigan to the ore bodies of the Duluth Complex. Although both sets of deposits are considered sulfidic deposits and, therefore, represent “sulfide mining”, the sulfur content of the Duluth Complex ore bodies is up to a few percent total sulfur while the sulfur content of the Eagle deposit is tens of percent (i.e. 13 to 36 wt.%). Another fundamental difference in the ARD potential of these projects relates to the fate of the sulfur

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during mineral processing. For the Project, virtually all sulfur will report to the concentrates, whereas most of the sulfur at the Eagle Mine is retained in the tailings. For these two reasons, the sulfur content, and therefore ARD potential, of the Eagle Mine waste rock and tailings is significantly greater than that of the proposed Project.

Consistent with the Project's conceptual model, Seal notes that even when ARD potential is low, the potential for risks to human health and the environment from trace metals mobility at neutral pH must be considered (e.g., Ni and Cu).

4.2 Mine Material Management

As outlined in the GARD Guide, the principal approach to the prevention and mitigation of ARD/ML is to apply methods that minimize the supply of the primary reactants for sulfide oxidation, and/or maximize the amount and availability of acid neutralizing reactants. The methods listed in the GARD Guide and how they have been incorporated into Twin Metals Minnesota's mine material management strategy are listed in Table 11. Two management strategies proposed by Twin Metals Minnesota are of particular relevance in this regard: underground mining vs. open pit mining and the use of underground backfill of development rock and tailings.

4.2.1 Underground vs. Open Pit Mining

Development of the resource by underground mining, as opposed to open pit mining, is a key component of the Project's mine material management. Environmental benefits of underground mining, as compared to an open pit, include reduced land disturbance and waste generation (tailings and development rock) (Environment Canada 2009).

Comparison of the Twin Metals Minnesota Project to the proposed PolyMet project (MDNR et al. 2015) allows for a direct assessment of the disturbance from an underground versus an open pit operation. The PolyMet project over a 20-year mine life will generate approximately 308 million tons of waste rock. Waste rock will be stored either permanently (Class 1 from Table 6; "NPAG") or temporarily (Classes 2, 3 and 4; "PAG") on surface. In comparison, only the first half a million tons of development rock will be temporarily (less than five years) stored on the surface for the Twin Metals Minnesota Project while all other development rock will remain permanently underground. At the cessation of mining (i.e. after 20 years), Class 2, 3 and 4 waste rock from the PolyMet project will be relocated to the East Pit. After rebound of the groundwater table and flooding of the pit, the resulting subaqueous disposal of waste rock in the East Pit will essentially halt any sulfide oxidation reactions. It should be noted that post-closure flooding of the underground Twin Metals Minnesota mine, containing essentially all development rock in the form of backfill, will also essentially halt sulfide oxidation. As such, the ultimate ARD controls for the two projects for all or a portion of the development rock are identical.

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The Buckhorn Gold Mine in Republic, Washington provides another comparison of the relative disturbance and waste rock management from an underground versus open pit operation. The Buckhorn Mine, which entered closure this year, operated from 2008 to 2017. The underground mine was permitted in 2008 following an unsuccessful effort to permit an open pit mine in the late 1990s. At that time, the project's water rights were denied by the state Pollution Control Hearings Board because of concerns regarding the availability of water and impacts of the mine on local water resources (Banton 2008). The original EIS for the project evaluated development of the resource by both open pit and underground mining methods (USDA Forest Service and Washington State Department of Ecology 1995). The area of disturbance for the underground mine was estimated at 440 acres compared to between 766 and 927 for the open pit alternatives (4 open pit alternatives were evaluated). Similar to the Twin Metals Minnesota Project, the Buckhorn Mine will have no surface storage of development rock at the end of operation. All development rock is placed underground as backfill, with cement added depending on the ARD potential of the rock. The mine site is currently being reclaimed such that there will be minimal visible effects of the mining operation. This is much different from an open pit mine that leaves a large mine pit and rock stockpiles at the conclusion of mining.

4.2.1.1 Benefits of Thickened Tailings Backfill

Research on the management of tailings through underground placement was summarized in a 2006 MEND report (Mehling Environmental Management Inc. 2006). This study acknowledged that data on groundwater quality impacts from backfill are limited; however, despite this data gap, use of backfill has generally been considered beneficial in reducing overall environmental impacts. Benefits of this technology include:

- Reduction in tailings requiring surface disposal (i.e. decreased footprint)
- Reduction in potential for sulfide oxidation and metal leaching from thickened tailings due to:
  - Reduction in leachate generation due to reduction in free water
  - Lower permeability relative to development rock (i.e. preferential flow of groundwater around instead of through the tailings)
- Addition of cement increases NP and reduces permeability
- Flooding at closure reduces potential for sulfide oxidation

Schafer (2016) notes that adding binders to thickened tailings increases strength, reduces the permeability of the tailings mass and the contact between water/tailings (i.e. monolithic behavior), thereby reducing the chemical mobility constituents such as metals. Twin Metals Minnesota will add 1 – 2% slag cement binder to the tailings prior to underground placement, with the tailings backfill accounting for approximately 40% of the total tailings volume generated over the life of mine.

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5.0 CLOSING

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TABLES

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Table 1: Geologic Model Units

		Unit and Description	Acronym
	South Kawishiwi Intrusion (SKI)	**Anorthositic troctolite to troctolite (ATA Series)**: Medium to coarse-grained, homogenous, well-foliated and locally layered troctolitic anorthosite to troctolite, and ophitic troctolitic rocks.	ATA
Hanging Wall		**Augite-bearing troctolite (Main AGT):** Homogeneous, coarse-grained subophitic to ophitic, poorly-foliated augite troctolite characterized by scattered augite-rich pegmatitic clots and patches.	AGT
Hanging Wall		**Pegmatoidal Unit (PEG):** Upper portion of the BMZ. Characterized by its larger grain size relative to the remainder of the BMZ. Although genetically related to the BMZ, this unit is almost always barren.	PEG
Ore Zone		**Sulfide-bearing troctolite (BMZ - basal mineralized zone):** Heterogeneous, sulfide-bearing, vari-textured melatroctolite, troctolite, augite troctolite, anorthositic troctolite, and olivine gabbro with 0.5 - 5 wt.% disseminated sulfides. The lower portion of the SKI and subdivided into four units: Upper Heterogenous Zone (UH); Stage 3 Melatroctolite (S3); Stage 2 Troctolite (S2); and, Stage 1 Troctolite/Anorthosite/Gabbro (S1).	BMZ
Hanging Wall	Xenoliths in the SKI	**Anorthositic Series (AN Series):** A mega-inclusion present in the eastern portion of the Maturi deposit. Composed of well-foliated anorthosite, troctolitic anorthosite, poikilitic troctolitic anorthosite, gabbroic anorthosite, and rarely gabbro and troctolite.	ANS
		Basaltic hornfels (Upper Basalt): Fine-grained, granoblastic to poikiloblastic basaltic hornfels, containing variable amounts of plagioclase, augite, olivine, hypersthenes, and pigeonite. Commonly associated with Anorthosite xenoliths.	UPB
		Anorthositic gabbro to gabbro (Upper Gabbro): A mixed group of Anorthositic Series rocks that occur in the central portion of the Project and include well-foliated anorthositic gabbro, gabbro, anorthosite, hornfelsed basalt, and augite troctolite.	UPG
Footwall		**Porphyritic quartz monzonite (GRB - Giants Range Batholith):** Pink, coarse-grained, hornblende-phyric, quartz monzonite to diorite commonly with large orthoclase phenocrysts. It is strongly recrystallized and partially melted locally along the contact with the SKI. Locally mineralized and subdivided into three units: nickel-rich (G_N); disseminated (G_M); and, barren (G_B).	GRB

Note:
SKI - South Kawishiwi Intrusion

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Table 2: MDNR Research Summary

Parameter	Study 1	Study 2	Study 3	Study 4	Study 5
Reference	Lapakko and Antonson (1992)	Kellogg et al (2014)	Lapakko et al. (2013a)	Lapakko (1994)	Lapakko et al. (2013b)
Scale	Laboratory	Laboratory	Laboratory	Field	Laboratory
Material Type	Waste Rock	Waste Rock	Waste Rock	Low-grade ore	Tailings
Test Type	MDNR Reactor	MDNR Reactor	MDNR Reactor and Humidity Cell (ASTM 2007)	Stockpile	MDNR Reactor and Humidity Cell (ASTM 1996)
No. Samples	16	15	17	6	8
Sulfur Content	0.18 to 3.12%	0.18 to 1.64%	0.07 - 1.36%	0.63 - 1.41%	0.20 wt.% (>90% present as sulfide)
Test Duration	150 weeks	78 to 1,252 weeks (24 years)	8 years	12 to 14 years	10 years
Bulk NP	-	12 - 21 kg $CaCO_3$/t	-	-	14 - 19 kg $CaCO_3$/t
Carbonate NP	-	0.7 - 2.5 kg $CaCO_3$/t	1.6 - 4.8 kg $CaCO_3$/t	-	<1.1 kg $CaCO_3$/t
Sample Source	Blast holes at the Dunka mine (South Kawishiwi Intrusion)	Blast holes at the Dunka mine (South Kawishiwi Intrusion)	Babbitt and Dunka Road prospects of Partridge River intrusion	AMAX test stockpiles	Babbitt prospect of Partridge River intrusion
Sulfide Occurrence	Pyrrhotite dominant sulfide mineral in the samples	Pyrrhotite > chalcopyrite > cubanite > pentlandite (lesser amounts of Co and Zn sulfides)	-	Pyrrhotite > chalcopyrite / cubanite > pentlandite (Pile #1 sample)	pyrrhotite (65%) chalcopyrite (25%) pentlandite (10%),
Notes		Continuation of 1992 study			Only chalcopyrite identified during micropobe analysis

Note:
"-" Not applicable or not provided in paper.

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Table 3: Comparison of Standard HCT and MDNR Reactor

Parameter	HCT	MDNR Reactor
Sample Mass	1 kilogram	75 grams
Particle Size	< $^1/_4$ inch (6.35 mm)	0.053 to 0.149 mm diameter
Leach Volume	500 or 1,000 mL	200 mL
Leach Cycle Duration	weekly	weekly
Solution to Solid Ratio	0.5 : 1 or 1 : 1	2.7 : 1

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Table 4: MDNR Long-Term Study Details

	Study 1			Study 2		
	Sulfur (wt.%)	**Minimum pH**	**Test Duration (weeks)**	**Sulfur (wt.%)**	**Minimum pH**	**Test Duration (weeks)**
Group I	0.18 – 0.40	6.1 – 6.4	150	0.18 ≤ %S ≤ 0.22	5.7 – 5.9	1252
Group II	0.41 – 0.71	4.8 – 5.3	150	0.40 ≤ %S ≤ 0.70	3.8 – 4.1	441 - 909
Group III	1.12 – 1.64	4.3 – 4.9	69	0.70 < %S ≤ 1.64	3.0 – 3.5	360 - 724
Group IV	2.06 – 3.12	3.5 – 4.2	78	N/A	N/A	N/A

Notes:
Study 1: Lapakko and Antonson (1992)
Study 2: Kellogg et al. (2014)
N/A - Not applicable

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Table 5: Tailings Characteristics (10-year MDNR Study)

Parameter	Value
Total Sulfur	0.2 wt.%
Sulfide Distribution	pyrrhotite (65%) chalcopyrite (25%) pentlandite (10%)
Sulfide Liberation	87%
Bulk Neutralization Potential (NP) (Sobek et al. 1978)	14 - 19 kg $CaCO_3$/t
Carbonate NP	1.1 kg $CaCO_3$/t
Paste pH	8.29

Note:
Source: Lapakko et al. (2013b)

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Table 6: PolyMet EIS Waste Rock Classification

Category / Class	Sulfur Content (wt.%)	% Waste Rock Mass	ARD Potential
1	≤0.12	70%	Low
2	0.12 < %S ≤0.31	24%	Low to Medium
3	0.31 < %S ≤0.6	3%	Medium
4	> 0.6 %S (Duluth Complex)	3%	High
	0.4 ≤ %S ≤ 5.0 (Virginia Formation)[(a)]		

Note:
[(a)] Virginia formation not applicable to the Maturi deposit as it does not occur there.

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Table 7: Silicate Mineral Neutralization Potential Values

Mineral	Neutralization Potential (NP) (kg $CaCO_3$/t)	Note
Olivine	38	
Plagioclase Feldspar	<1 - 14	Dependant on the amount of anorthite (calcium end-member - $CaAl_2Si_2O_8$)
Pyroxene	4.6	

Note:
Data source: Jambor et al. 2007

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Table 8: Sulfide Mineral Reactivity

Mineral	Formula	Acid Generation Potential (Plumlee 1999)	
		Acid Generating	Resistance to Oxidation
Bornite	Cu_5FeS_4	(a)	Medium to High
Chalcopyrite	$CuFeS_2$	(b)	Medium to High
Cubanite	$CuFe_2S_3$	(c)	
Pentlandite	$(Ni,Fe)_9S_8$	(b)	
Pyrrhotite	$Fe_{1-x}S$	(a)	Low
Talnakhite	$Cu_9(Fe,Ni)_8S_{16}$	(c)	

Notes:

[a] Known to generate acid with oxygen as the oxidant (Plumlee 1999).

[b] May generate acid with ferric iron as the oxidant (Plumlee 1999).

[c] Inferred as unlikely to generate acid with oxygen as the oxidant based on metal/sulfur ratio ≥ 1.

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Table 9: Mine Materials Characterization Testing Program Components

Analysis	Test Method	Literature Reference
Static Testing		
Chemical Analysis		
Whole Rock	XRF (Borate Fusion)	-
Trace Metal	4-Acid Digest (most metals) 3-Acid Digest (As, Sb, Se) Aqua Regia Digest (Hg)	Rudolf 1979 USEPA 3052 (USEPA 1996) USEPA 7471B (USEPA 2007)
Mineralogical Analysis		
Bulk [(a)]	quantitative XRD Rietveld Method	-
Mineral Fibres	Transmission electron microscopy (TEM)	MDH 851 (MDH 1991) MDH 852 (MDH Year Unknown)
ARD Potential		
Acid Base Accounting (ABA)	Modified Sobek	Sobek et. al. 1978 (sulfur) MEND 1991 (NP) ASTM 2009 (carbon)
Net Acid Generation (NAG) Testing	EGi Method	AMIRA 2002
Short-Term Leach Testing		
Synthetic Precipitation Leaching Procedure (SPLP)	USEPA Method 1312	USEPA 1994
Toxicity Characteristic Leaching Procedure (TCLP)	USEPA Method 1311	USEPA 1992
NAG Leachate	EGi Method	AMIRA 2002
Kinetic Testing		
Humidity Cell	ASTM D 5744-07	ASTM 2007
Sequential Leach	USEPA Method 1312 - modified	USEPA 1994
Flooded Column	Project specific	none

Note:
[(a)] Detailed mineralogical examination (e.g., optical microscopy, electron microprobe (EMP) or scanning electron microscopy (SEM) will be conducted on some samples.

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Table 10: ARD Screening Guidelines for Mine Materials

Sample Potential	Criteria	Comments
PAG	NPR<1	Potentially acid generating material, unless sulfide minerals are non-reactive, or NP is preferentially exposed on surfaces.
Uncertain	1<NPR<2	Possibly PAG if NP is insufficiently reactive or is depleted at a faster rate than sulfides.
NPAG	NPR>2	Non-potentially acid generating material, unless NP is insufficiently reactive, extremely reactive sulfides are present, or preferential exposure of sulfides is found in the material.

Notes:

Source: MEND 2009

PAG = potentially acid generating

NPAG = non-potentially acid generating

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Table 11: Twin Metals Minnesota ARD Prevention and Mitigation Measures

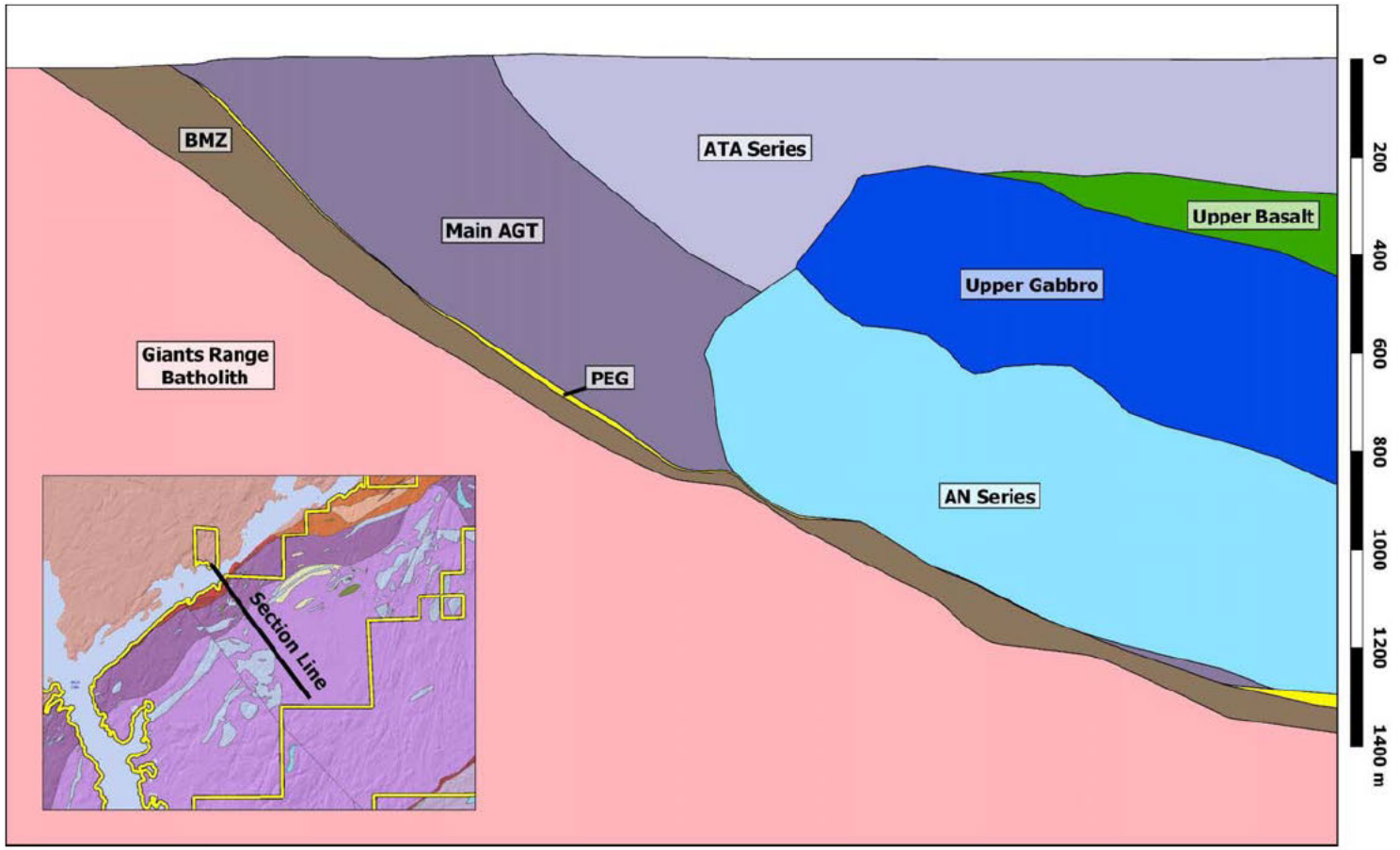
ARD Prevention / Mitigation Measure (INAP 2012)	Material Type / Location		
	Tailings	Potentially Acid Generating (PAG) Development Rock Surface Stockpile	Underground (Sulfide Mineral Exposures)
Minimize oxygen supply	Water cover	Short-term (< 5 years) storage on surface	Underground mining (as opposed to open pit) Placement of backfill during mining Flooding of underground workings at closure
Minimize water infiltration and leaching (water acts as both a reactant and a transport mechanism)	Lined facility	Lined facility	Operations - capture and manage contact water Closure - Little to no groundwater movement after flooding
Minimize, remove, or isolate sulfide minerals	Virtually all sulfur reports to concentrate	PAG development rock stored temporarily on surface will be milled	
Control pore water solution pH			Use of cemented backfill
Maximize availability of acid neutralizing minerals and pore water alkalinity	Neutralization potential (NP) available due to grain size reduction		Placement of cemented tailings backfill (amendments may provide some, albeit typically limited, NP)

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FIGURES

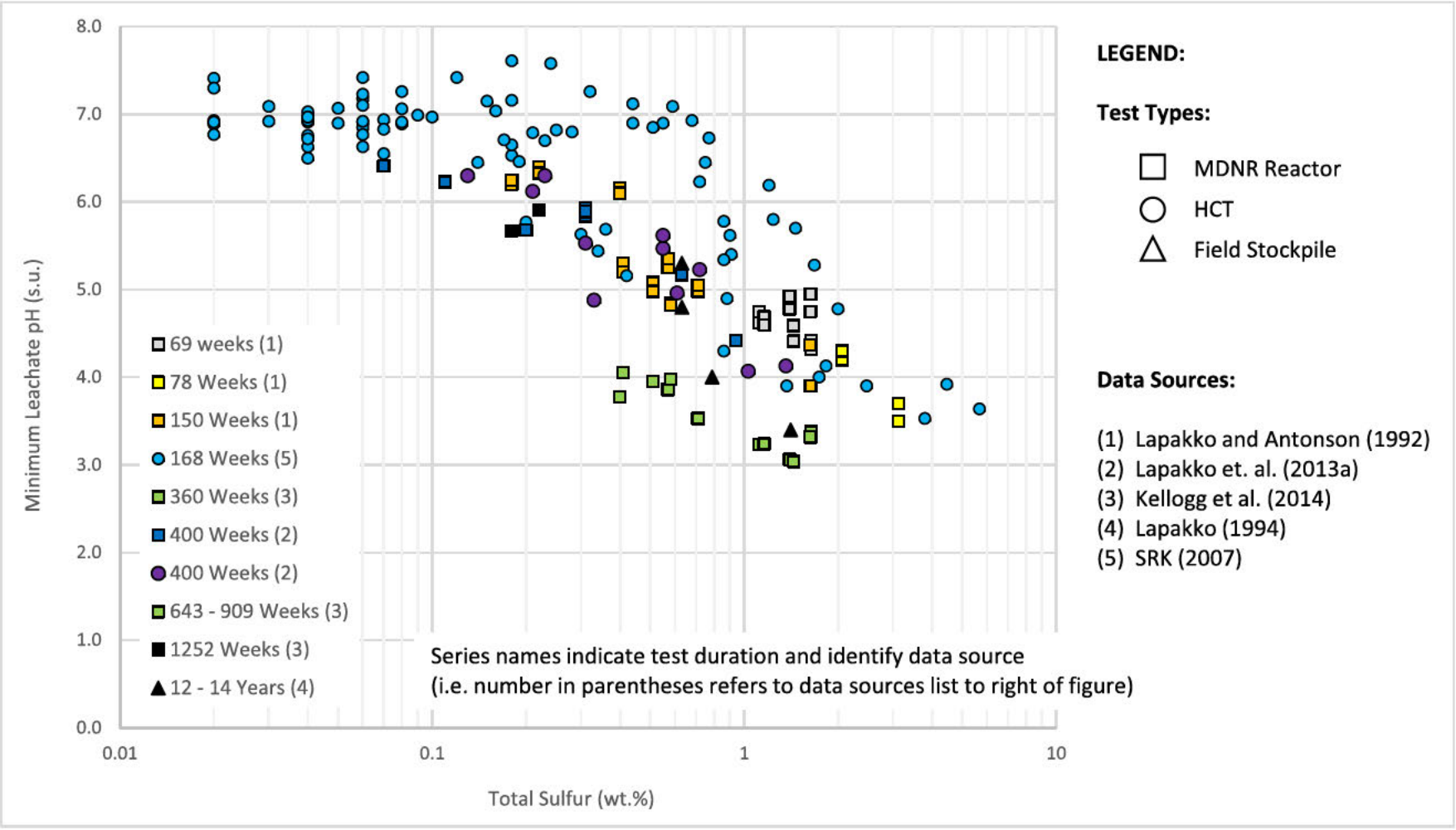
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Golder Associates	Title: Maturi Deposit Example Cross Section		
	Project Name: Twin Metals Minnesota White Paper	Project No.: 113-93664-12	
	Client Name: Twin Metals Minnesota, LLC	Date: August 2017	FIGURE 1

11393664-12-F-White Paper Figures-Rev1-2017-08-08.xlsx

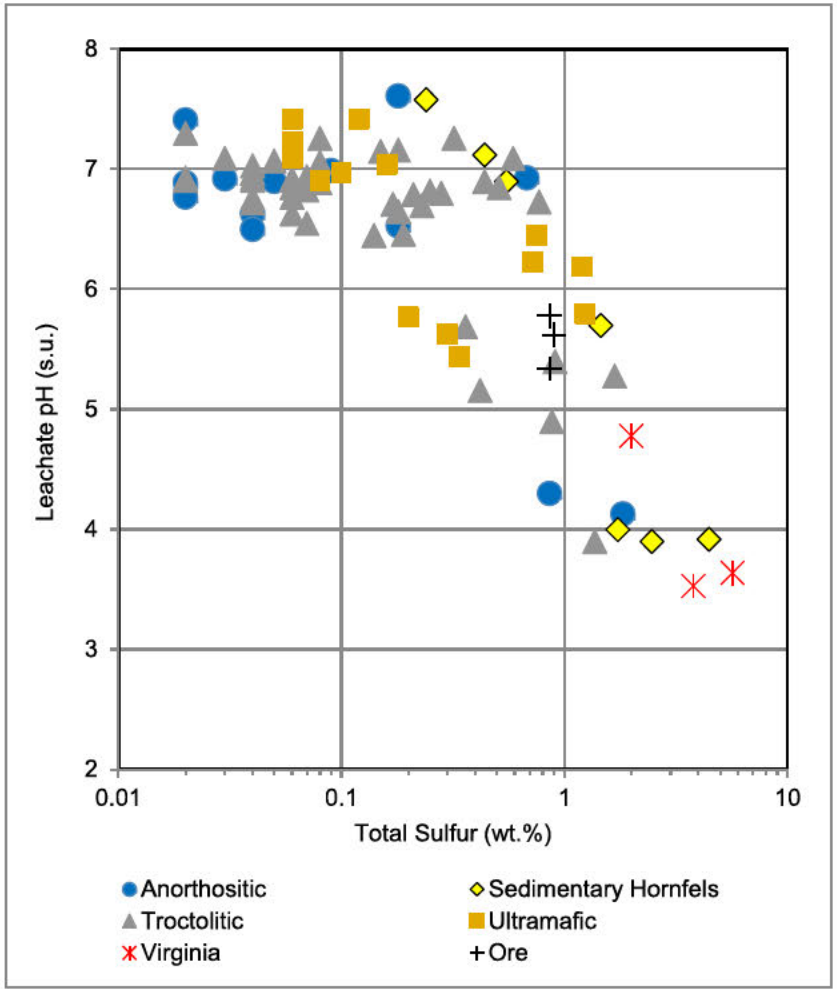
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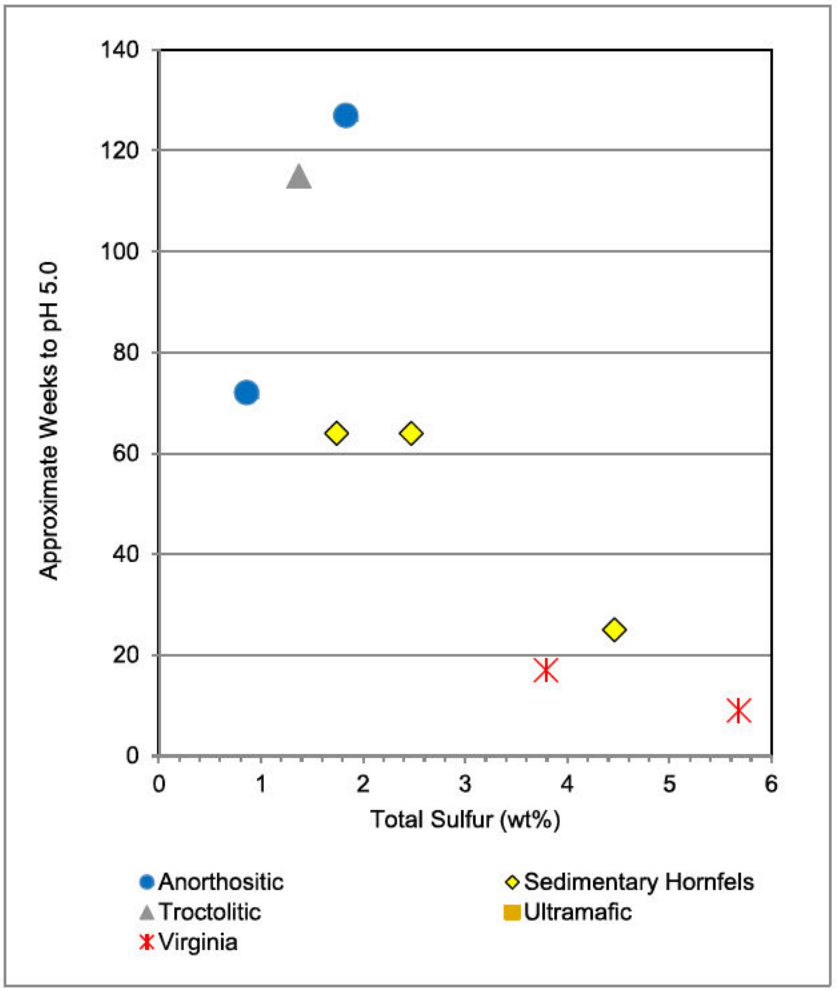


Golder Associates	Title: MDNR Duluth Complex Kinetic Testing Results		
	Project Name: Twin Metals Minnesota White Paper	Project No.: 113-93664-12	
	Client Name: Twin Metals Minnesota, LLC	Date: August 2017	FIGURE 2

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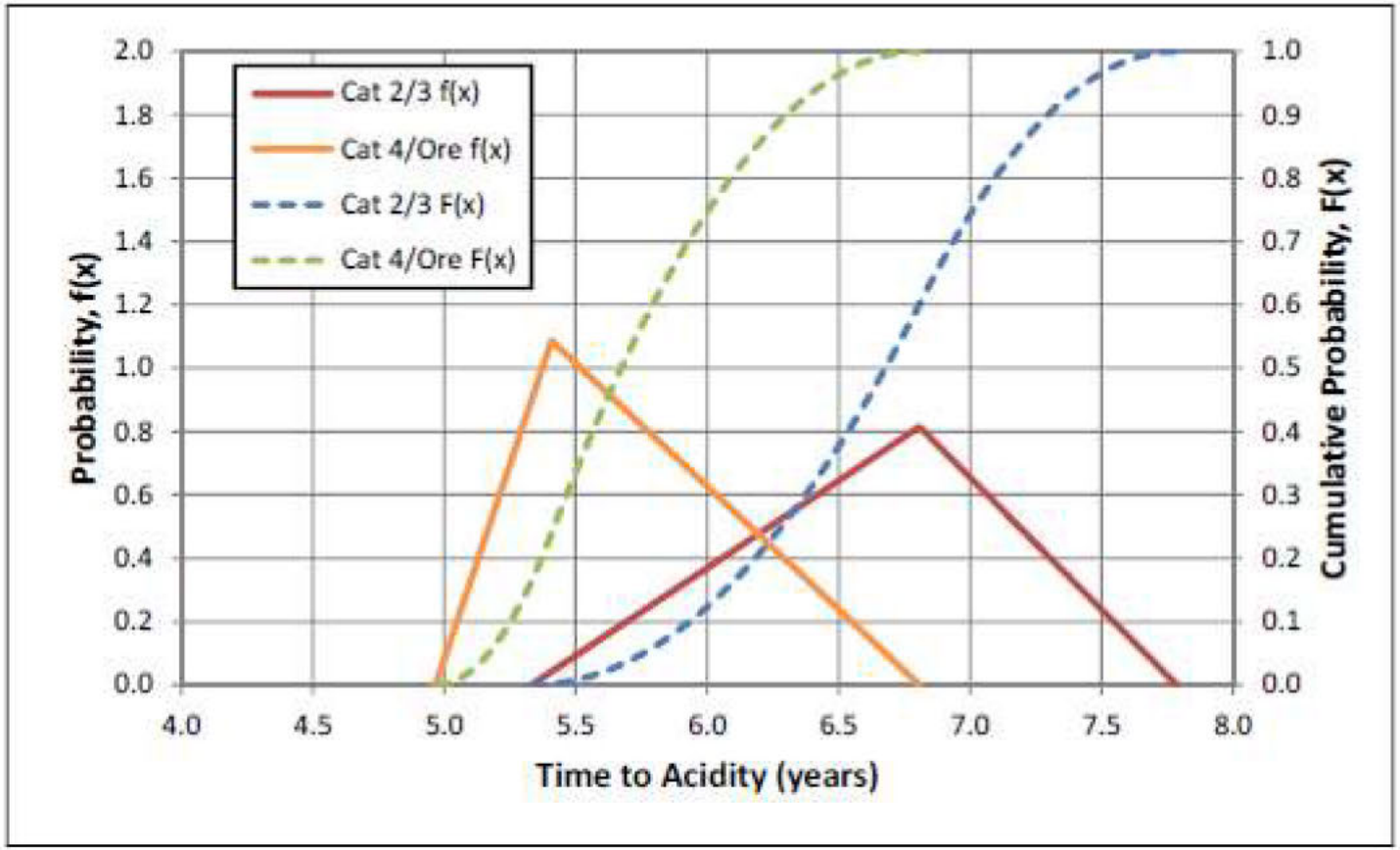


Data Source: SRK 2007

Golder Associates	Title: PolyMet NorthMet Deposit - Kinetic Testing Results		
	Project Name: Twin Metals Minnesota White Paper	Project No.: 113-93664-12	
	Client Name: Twin Metals Minnesota, LLC	Date: August 2017	FIGURE 3

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Predicted distributions for the onset to acidity (Figure 8-13 in source document)

Reproduced from PolyMet 2015

Golder Associates	Title: PolyMet Lag Time to ARD		
	Project Name: Twin Metals Minnesota White Paper	Project No.: 113-93664-12	
	Client Name: Twin Metals Minnesota, LLC	Date: August 2017	FIGURE 4

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Figure 1. Acid-neutralizing potential (NP) contributions from pyroxene, plagioclase, olivine, and carbonate for cores from the Duluth Complex.

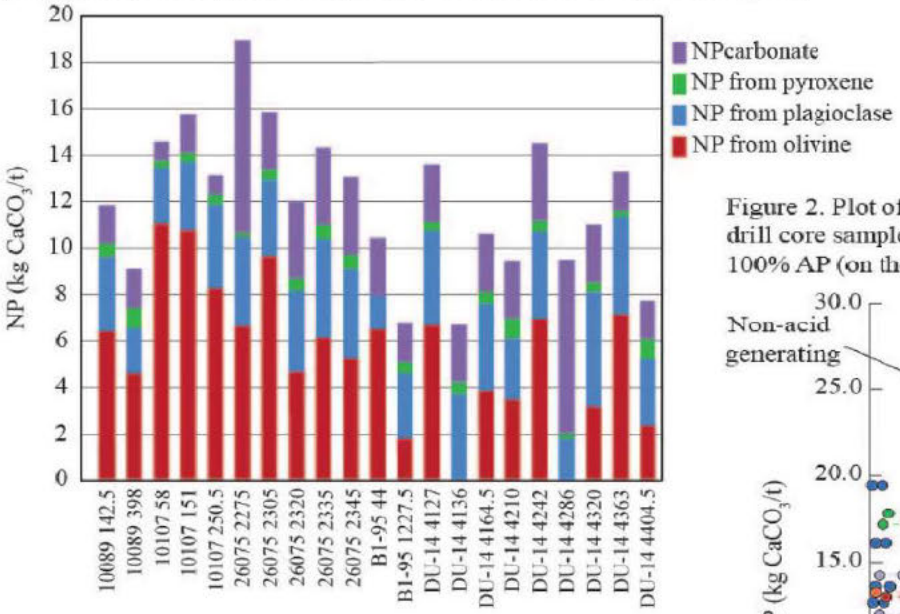
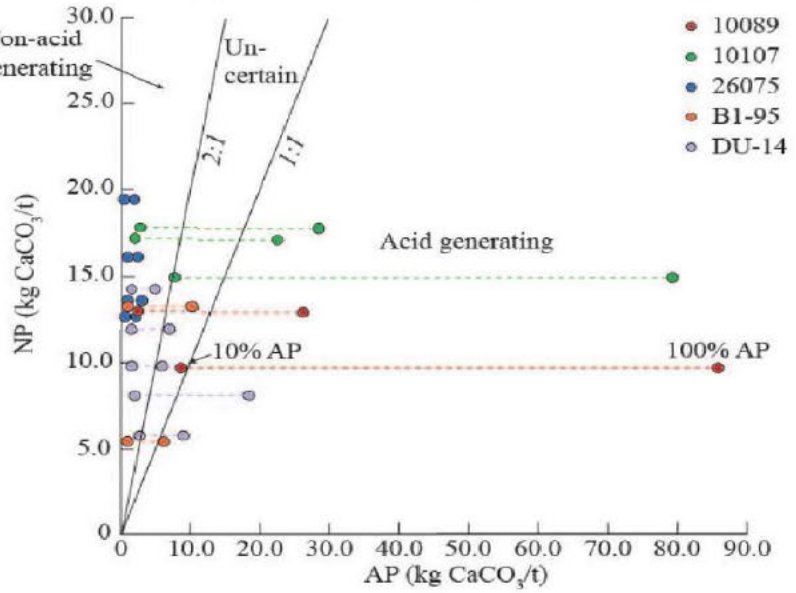


Figure 5A

Figure 2. Plot of acid-generating potential (AP) versus neutralizing potential (NP) for drill core samples from the Duluth Complex. Dashed lines represent the difference in 100% AP (on the right) and 10% AP (on the left) for the same sample.



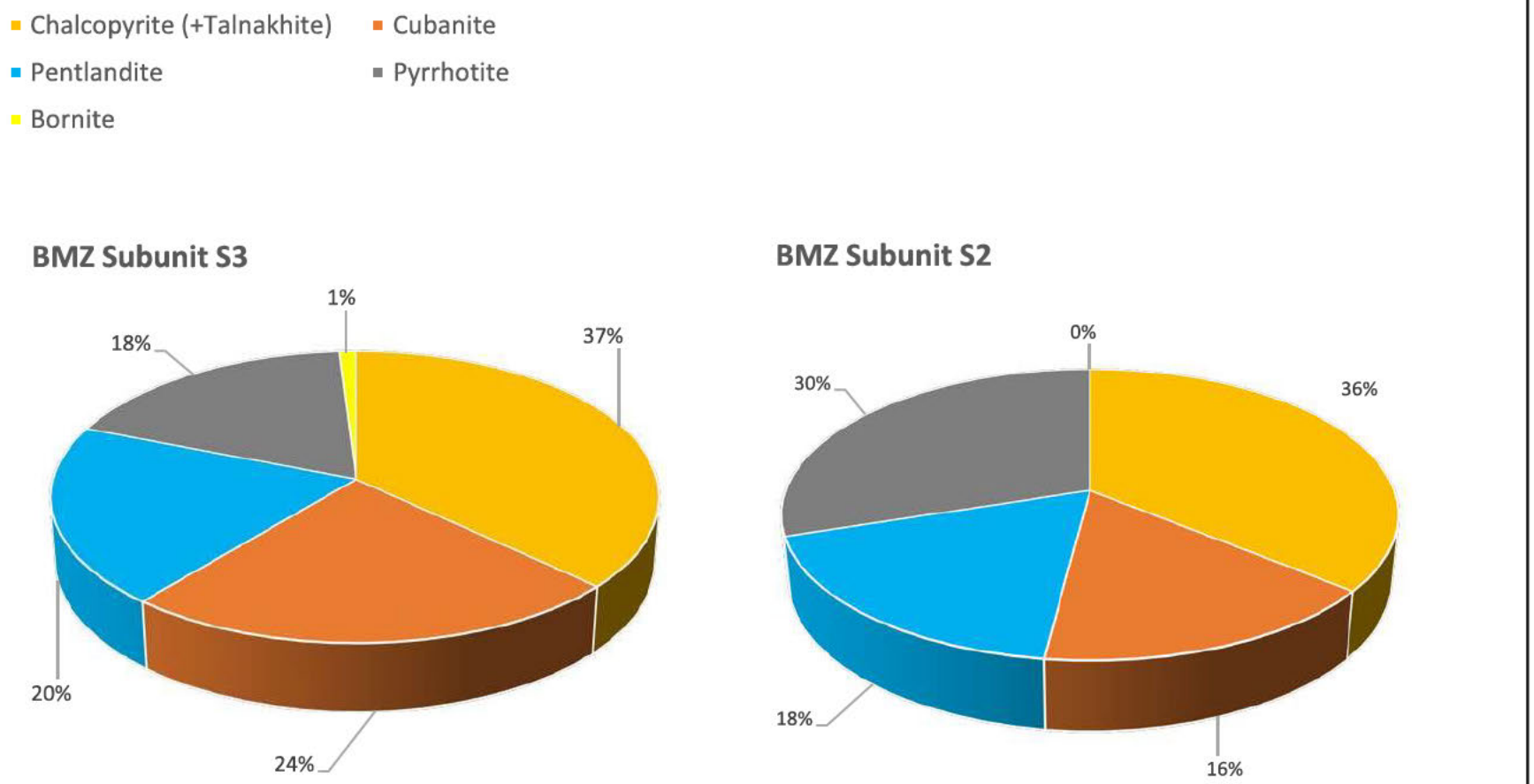
Reproduced from Schulte et al. 2016

Figure 5B

Golder Associates	Title: Silicate NP (Schulte et al. 2016)		
	Project Name: Twin Metals Minnesota White Paper	Project No.: 113-93664-12	
	Client Name: Twin Metals Minnesota, LLC	Date: August 2017	FIGURE 5

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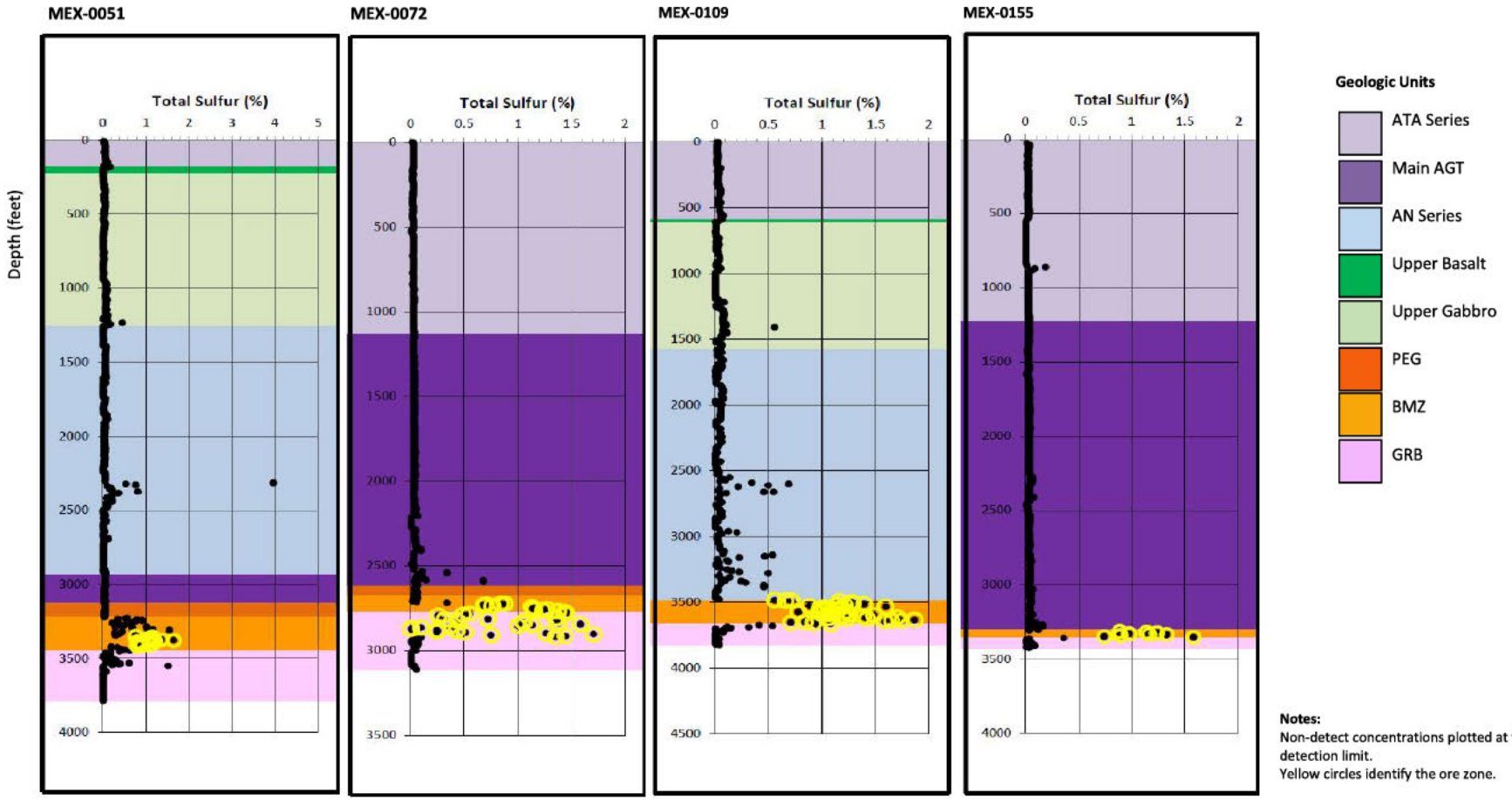


Data Source: Twin Metals Minnesota (2017)

Golder Associates	Title: S3 and S2 Characteristic Sulfide Mineral Distribution		
	Project Name: Twin Metals Minnesota White Paper	Project No.: 113-93664-12	
	Client Name: Twin Metals Minnesota, LLC	Date: August 2017	FIGURE 6

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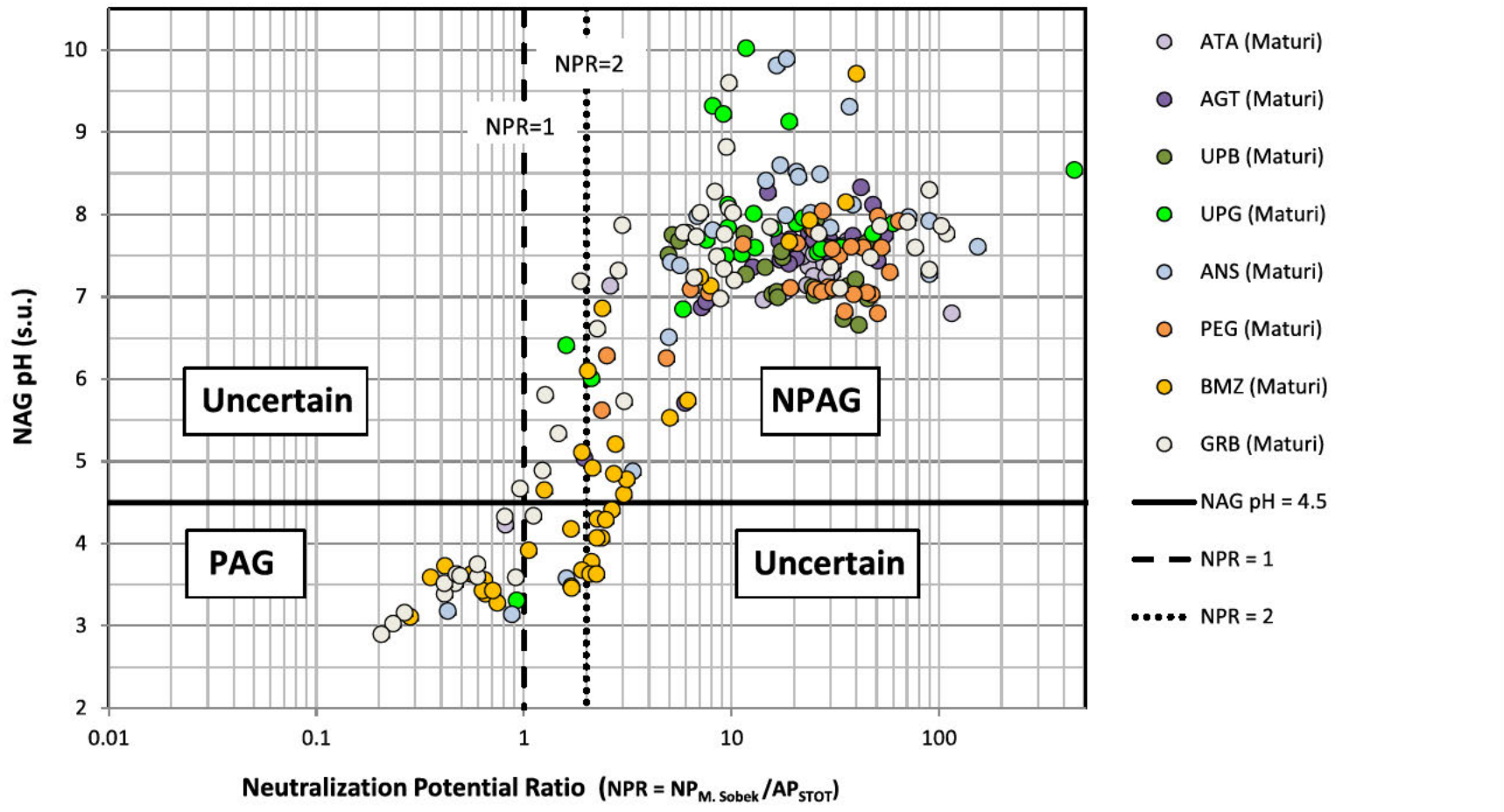


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Title	Maturi Drill Core Total Sulfur Data		
Project Name	Twin Metals Minnesota White Paper	Project No.	113-93664-12
Client Name	Twin Metals Minnesota, LLC	Date	August 2017
		FIGURE	7

11393664-12-F-White Paper Figures-Rev1-2017-08-08.xlsx

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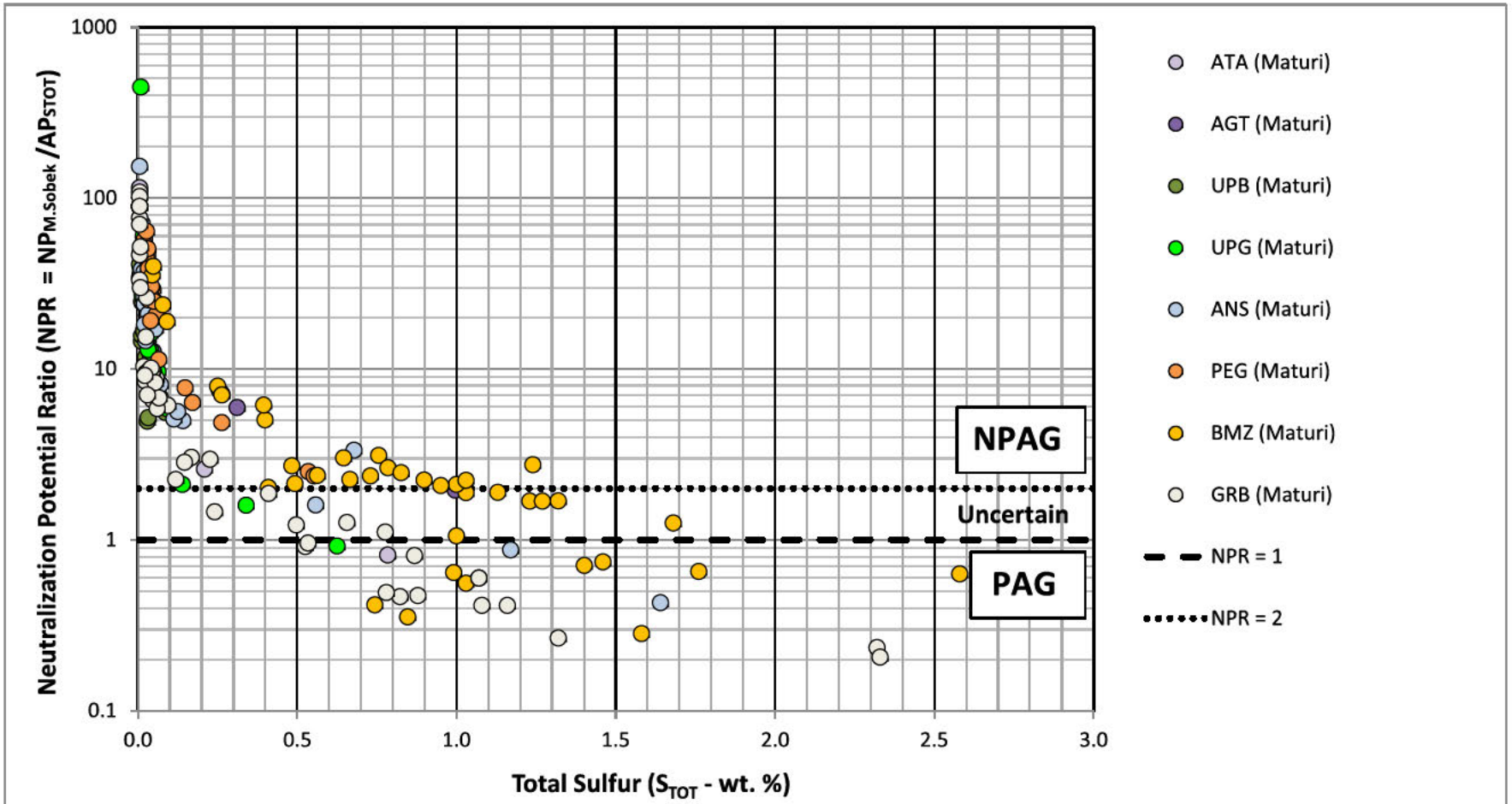


Note:
ARD Potential Classification: PAG - potentially acid generating; Uncertain; and, NPAG - non-potentially acid generating

Golder Associates	Title: Phase I ABA - Neutralization Potential Ratio vs. NAG pH		
	Project Name: Twin Metals Minnesota White Paper	Project No.: 113-93664-12	
	Client Name: Twin Metals Minnesota LLC	Date: August 2017	FIGURE 8

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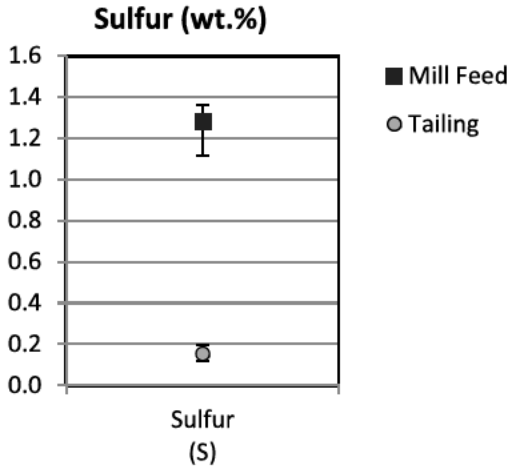


Notes:
Non-detect concentrations shown at the reporting limit.
ARD Potential Classification: PAG - potentially acid generating; Uncertain; and, NPAG - non-potentially acid generating

Golder Associates	Title: Phase I ABA - Total Sulfur vs. Neutralization Potential Ratio		
	Project Name: Twin Metals Minnesota White Paper	Project No.: 113-93664-12	
	Client Name: Twin Metals Minnesota LLC	Date: August 2017	FIGURE 9

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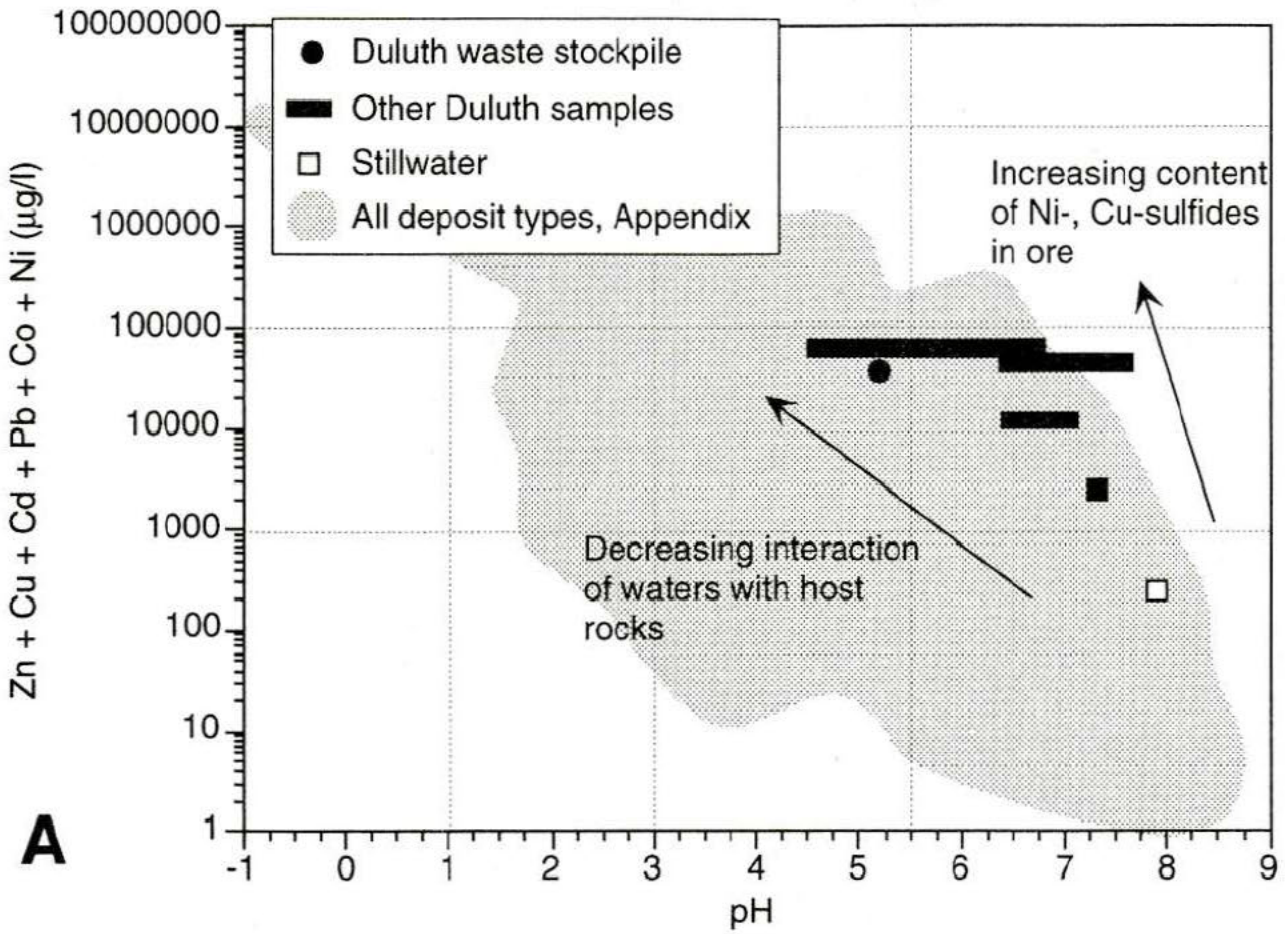
DOI-19-0291-I, 19-0538-J-000102



Average measured concentration shown.
Error bars show maximum and minimum concentrations.

Golder Associates	Title: Mill Feed and Tailings Sulfur Concentrations		
	Project Name: Twin Metals Minnesota White Paper	Project No.: 113-93664-12	
	Client Name: Twin Metals Minnesota, LLC	Date: August 2017	FIGURE 10

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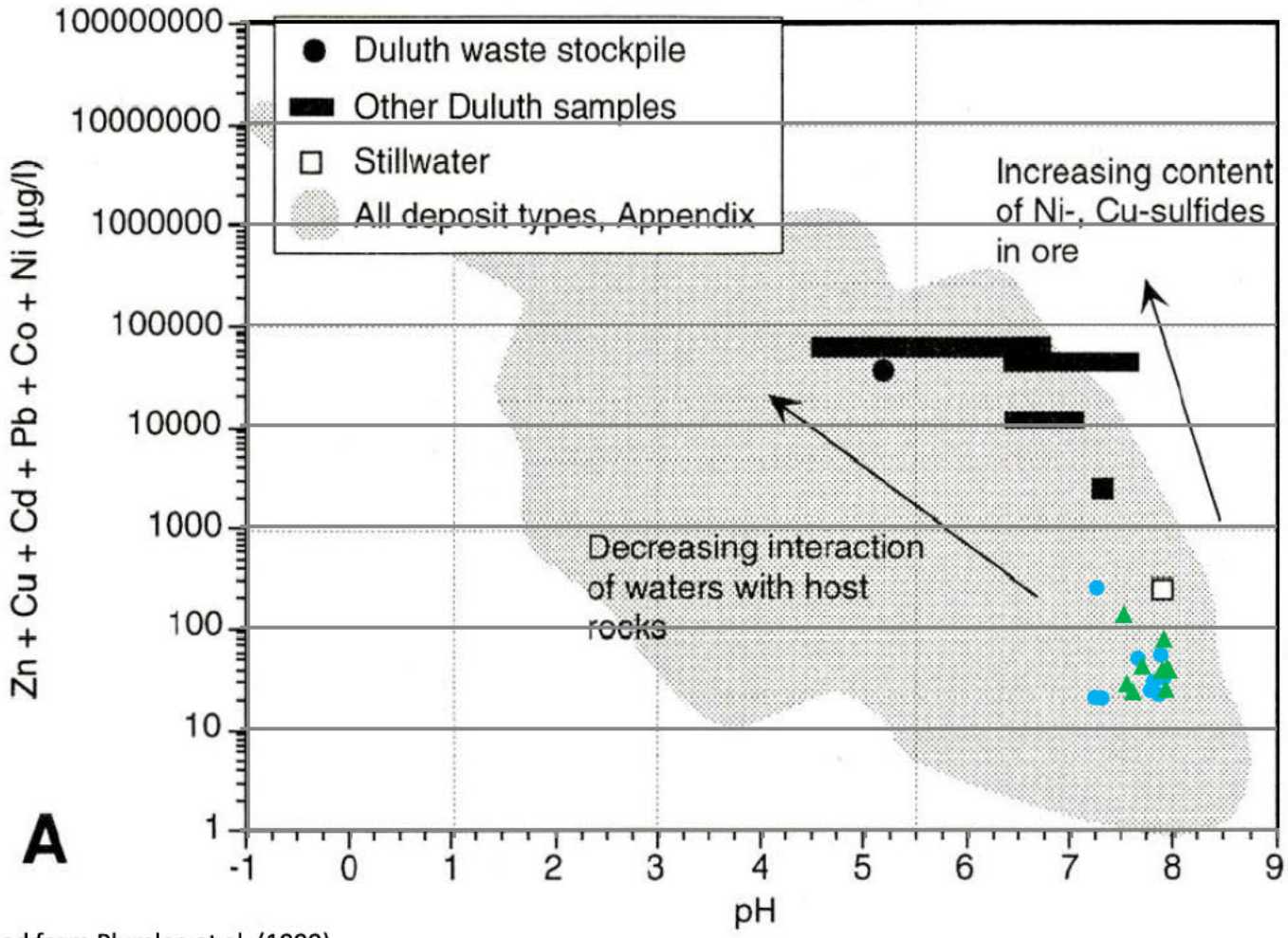


Reproduced from Plumlee et al. (1999)

Golder Associates	Title: Ficklin Diagram		
	Project Name: Twin Metals Minnesota White Paper	Project No.: 113-93664-12	
	Client Name: Twin Metals Minnesota, LLC	Date: August 2017	FIGURE 11

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Reproduced from Plumlee et al. (1999)

Golder Associates	Title: Site-Specific Ficklin Diagram		
	Project Name: Twin Metals Minnesota White Paper	Project No.: 113-93664-12	
	Client Name: Twin Metals Minnesota, LLC	Date: August 2017	FIGURE 12

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Exhibit B

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Memorandum

Foth Infrastructure & Environment, LLC

2121 Innovation Court, Suite 300
P.O. Box 5126 • De Pere, WI 54115-5126
(920) 497-2500 • Fax: (920) 497-8516
www.foth.com

August 9, 2017

TO: Kevin Baker, Twin Metals Minnesota

CC: Anne Williamson, Twin Metals Minnesota

FR: David Donohue, Foth Infrastructure & Environment, LLC
Steve Donohue, Foth Infrastructure & Environment, LLC

RE: Lack of Hydrologic Basis for BLM and USFS Decision to Reject Renewal of Twin Metals Minnesota's Mineral Leases and Potentially Withdraw Federal Minerals in the Rainy River Watershed

Summary and Key Findings

This document reviews the Bureau of Land Management (BLM) and United States Forest Service (USFS) decision to propose withdrawal of federal minerals from within the Rainy River Watershed. The BLM/USFS decision rests on an assumption that there is a hydrologic pathway for constituent migration from the TMM leases to the Rainy River Watershed and Boundary Waters Canoe Area (BWCA Wilderness). The key findings included in this document are as follows:

- The BLM/USFS decision does not rely on any site-specific data for hydrologic characterization that meets scientific, industry, or regulatory standards for site characterization.

- The BLM/USFS decision does not rely on any site-specific hydrologic model analysis that meets scientific, industry, or regulatory standards for model construction, calibration, sensitivity analysis or predictive analysis as is routinely required by regulatory agencies.

- The BLM/USFS decision disregards what resources will be mined, how they will be mined, where important facilities will be located, how those facilities will be engineered, how those facilities will be monitored and maintained, and how the operation will be closed.

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- The only published hydrologic analysis of potential impacts from the TMM leases is from the Journal of Hydrology (Myers, 2016) and does not meet scientific, industry, or regulatory standards. To the degree that this paper influenced BLM/USFS thinking, the work product rests on no site-specific data, does not meet standards for model construction and analysis, does not reflect an engineered mine plan and engineering controls, assumes development of multiple mineral resources, and fails to consider important locational features.

- TMMs hydrologic data collection program is currently underway and the data has been submitted to the BLM. This data indicates that there is no or minimal potential for a hydrologic pathway from the mine to surface waters in the Rainy River Watershed.

- Based on the above, the BLM/USFS decision is deficient in that it ignores TMM's data and is not based on a demonstrable hydrologic pathway for impacting water quality in the Rainy River Watershed.

- The USFS citation of the number of mines impacting waterways on USFS managed land refers to legacy mining operations prior to the advent of modern mining and regulatory programs. Furthermore, the citation that 8,000 to 16,000 kilometers (km) of streams are impaired from these operations is not substantiated. Moreover, both the BLM and USFS ignore the fact that they have permitted, since 1990, over 3,000 new hardrock mines and none of them have been placed on the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) National Priorities List.

- In the absence of site-specific hydrologic characterization data, a hydrologic model developed in accordance with accepted industry standards and the incorporation of an actual mine plan, it is not possible to conclude that there is or is not a pathway for migration of constituents of concern into the BWCA Wilderness and impairment of those waters. Absent these industry-standard and agency-required practices and information, no scientifically defensible conclusions of can be drawn about any aspect of Project impacts, to water resources or any other component of the natural environment or human and socio-economic concerns.

Background

On December 15, 2016, BLM and USFS announced the initiation of steps to withdraw mineral leases in the Rainy River watershed. The announcement referenced concerns presented in the USFS letter denying consent to renewal of the TMM leases. The USFS letter cited "grave concerns" that development of copper sulfide-ore in the Rainy River Watershed risks seriously impairing the water quality and ecosystem of the BWCA Wilderness.

In their December 14, 2016 letter to the BLM, the USFS cited a number of concerns with respect to renewal of the mineral leases. These concerns include acid mine drainage (AMD), leaching of metals, and hydrologic migration of liberated constituents of concern into water resources that flow into the BWCA. In essence, the USFS's concern is that the mining of

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sulfide ores will lead to the migration of metals and acid into water resources that flow into the BWCA Wilderness. Specific claims made by the USFS to substantiate their concern include:

- Oxidation of sulfide minerals creating sulfuric acid and leaching of metals.
- Citation of the number of mines that exhibit AMD on lands managed by the USFS and waterways that have been impacted.
- Water from the mine could potentially enter streams and lakes through wastewater treatment plant discharges, uncollected runoff and leakage, spills, accidents, tailings dam failures, water collection and treatment operation failures, and post-closure failures.
- A direct flow of water from lands subject to TMM's leases to the BWCA Wilderness.
- USFS belief that TMM's plan will involve development of four delineated ore bodies, all of which drain into the BWCA Wilderness.
- USFS belief that all of the waste rock and tailings to be managed at the surface will be located in the Rainy River Watershed and that all the materials will exhibit AMD and metal leaching thus creating a source and pathway for constituents of concern to enter the waters flowing into the BWCA Wilderness.

Nowhere in the December 14, 2016 letter to the BLM does the USFS cite specific data or analysis that: 1) demonstrates AMD will occur with the materials that could be mined by TMM, or 2) demonstrates a pathway for migration of metals and constituents of concern from TMM facilities to waters flowing into the BWCA Wilderness. The BLM/USFS decision to propose withdrawal of federal minerals is premised, in part, on assumptions with respect to AMD and migration pathways to waters that flow into the BWCA Wilderness, and on assumptions regarding locations of Project facilities that are not consistent with current Project concepts. This document establishes that with respect to potential migration pathways to waters flowing into the BWCA Wilderness, that the BLM/USFS opinion does not meet standards normally applied by regulatory agencies to affirm their decisions. Typically, regulatory agencies require rigorous hydrologic investigations, analyses, and models to assess important policy decisions associated with the potential for Project impacts. These hydrologic investigations, analyses, and models that properly incorporate potential mining features are not cited by the BLM/USFS and to our knowledge have not been developed. Specifically, this document presents a summary of the following:

- Standard of Care for Hydrologic Investigations, Analyses, and Application/Development of Hydrologic Models to Assess Migration Pathways.
- Use of Hydrologic Models in Support of Regulatory Decision Making in Regard to Migration Pathways and Assessing Risks to Potential Receptors.
- Journal of Hydrology research paper Assessment of Migration Pathways and BLM/USFS Decision on Nonrenewal.

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- Failure to Establish Basis for Hydrologic Pathway to Contaminate Waterways.
- Failure to Consider Other Information Related to BLM and USFS Administered Mining Operations.
- Minimal Potential for Water Quality Impacts in Area of Concern.

Standard of Care for Application/Development of Hydrologic Models to Assess Migration Pathways

In the course of carrying out their administrative functions, regulatory agencies tasked with administering the development of natural resources and protecting the environment routinely require and rely upon the development of hydrologic (groundwater and surface water) models to guide their assessments of proposed decisions. This applies to both federal and state agencies, and based on experience, applies to any regulatory decision-related mining. These hydrologic models are required to conform to scientific and industry accepted standards guiding data collection and hydrologic model development and use.

Need for Site-Specific Baseline Hydrologic Data

The development of a hydrologic model begins with the collection of baseline and site-specific data. This data collection process is typically costly, time consuming, and broad based. The norm for hydrologic data collection involves a progression of multiple stages of investigation, analysis, and data collection that conform to accepted standards. A partial list of potentially applicable standards under which hydrologic characterization and data collection are conducted includes:

- ASTM D4043 Guide for Selection of Aquifer Test Method in Determining Hydraulic Properties by Well Techniques.
- ASTM D4044 Test Method for (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers.
- ASTM D4050 Test Method for (Field Procedure) for Withdrawal and Injection Well Tests for Determining Hydraulic Properties of Aquifer Systems.
- ASTM D4106 Test Method for (Analytical Procedure) Determining Transmissivity and Storage Coefficient of Nonleaky Confined Aquifers by the Theis Nonequilibrium Method.
- ASTM D5912 Test Method for (Analytical Procedure) Determining Hydraulic Conductivity of an Unconfined Aquifer by Overdamped Well Response to Instantaneous Change in Head (Slug).
- ASTM D5920 Test Method (Analytical Procedure) for Tests of Anisotropic Unconfined Aquifers by Neuman Method.

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- ASTM D4448 Standard Guide for Sampling Ground-Water Monitoring Wells.
- ASTM D6452 Standard Guide for Purging Methods for Wells Used for Groundwater Quality Investigations.
- ASTM D6089 Standard Guide for Documenting a Groundwater Sampling Event.
- ASTM D5903 Guide for Planning and Preparing for a Groundwater Sampling Event.
- ASTM D6911 Guide for Packaging and Shipping Environmental Samples for Laboratory Analysis.
- SW-846 6020 Inductively Coupled Plasma-Mass Spectrometry for the analysis of metals.
- EPA 200.8 Determination of Trace Elements in Waters and Wastes by ICP-MS.
- ASTM D516 Standard Test Method for Sulfate Ion in Water.
- EPA 300.0 Inorganic Anions (e.g., sulfate) by Ion Chromatography.

Accepted standard of care data collection routinely includes:

- Installation of numerous borings to define hydrostratigraphic units.
- Installation of numerous monitoring wells (and subsequent potentiometric and water quality monitoring programs) to map groundwater flow paths, delineate hydrostratigraphic units, and establish baseline groundwater quality.
- Installation of surface water monitoring stations to quantify baseline seasonal flow conditions and surface water quality.
- Analysis and delineation of groundwater and surface water interactions.
- Water budget studies to estimate site-specific recharge, evaporation, and baseflow.
- Characterization of hydraulic conductivity and storage characteristics of the various hydrostratigraphic units through pumping tests, slug tests, single and multi-borehole packer and pumping tests, etc.

Standards for Model Construction

Construction of a hydrologic model to assess potential migration pathways is based on the data derived from the site characterization program. Per accepted practice and standards, model construction progresses through a number of fundamental steps including:

- Selection of the numerical model (modeling code) that will adequately simulate the documented hydrologic conditions at the site.

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- Definition and selection of the modeling domain (the area that is going to be modeled).

- Selection of hydrologically defensible boundary conditions to represent the boundaries of the modeled area and important surface water features.

- Horizontal discretization of the model.

- Vertical discretization of the model to appropriately represent hydrostratigraphic features and operational features that could affect migration pathways.

Standards to which model construction should adhere include the following:

- ASTM D6170 Guide for Selecting a Ground-Water Modeling Code.

- ASTM D5447 Guide for Application of a Ground-Water Flow Model to a Site-Specific Problem.

- ASTM D5880 Guide for Subsurface Flow and Transport Modeling.

- ASTM D5609 Guide for Defining Boundary Conditions in Ground-Water Flow Modeling.

- ASTM D5610 Guide for Defining Initial Conditions in Ground-Water Flow Modeling.

Hydrologic Model Calibration

After construction of the numerical model, the next step in model development is model calibration using site-specific data in conformance to accepted industry standards (ASTM D5981 Guide for Calibrating a Ground-Water Flow Model Application, and Anderson, et al., 2015). This generally involves calibrating the model to observed groundwater elevations and surface water flows. Typically, model calibration is carried out so that the model matches average or "steady state" groundwater level and flow conditions based on field measurements that capture seasonal variability. To improve model reliability, practitioners will also calibrate to transient conditions that result from natural or test-induced stresses to the hydrologic system. This can involve calibration to large scale pumping tests or to natural system stresses such as droughts or seasonal baseflow/stage fluctuations involving surface water bodies. The goal is to rigorously calibrate the model to natural conditions so as to gain confidence in the model's ability to adequately assess system behavior under proposed conditions. Standards (ASTM D5981 Guide for Calibrating a Ground-Water Flow Model Application, ASTM D5490 Guide for Comparing Ground-Water Flow Model Simulations to Site-Specific Information, Anderson, et al., 2015) have been developed to define what constitutes acceptable calibration based on comparison of modeled data vs. site-specific data, modeled mass balance errors and other numerical checks and statistical analyses of the modeled output.

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The standard of care for groundwater modeling associated with mine planning and permitting commonly includes calibration to site-specific groundwater elevations (potentiometric head elevations). When available and appropriate, calibration using fluxes to/from surface water bodies as calibration targets is also common. At present, the only site-specific data suitable for calibration target use that has been collected and made publically available is stream/lake discharge and stage data gathered in the Project vicinity by the state of Minnesota and the U.S. Geological Survey. The Project has begun collection of groundwater elevation data, however, no groundwater elevation data set suitable for use as a calibration target set is publically available. As such, no meaningful project-specific model development or assessment of groundwater pathways is possible by any non-project entity at this time.

Hydrologic Model Sensitivity Analysis

Upon completion of the calibration, the next step in the development of a hydrologic model is sensitivity analysis. In this phase of model development, the practitioner varies calibrated model parameters such as hydraulic conductivity values, storage coefficients, recharge, and boundary condition values to test the sensitivity of the model to various changes in model inputs. This process is completed in conformance to accepted standards (ASTM D5611 Guide for Conducting Sensitivity Analysis for a Ground-Water Flow Model Application, and Anderson et. al., 2015). In performing this step, the practitioner identifies the model parameters most influential on modeling results. This information informs conclusions and decisions associated with uncertainty in model input parameters and the implications of that uncertainty on model projections. Sensitivity analysis is also used as a basis for guiding subsequent field investigations aimed at reducing model uncertainty and improving the reliability of modeling projections.

Model Predictions and Uncertainty Analysis

After completion of model sensitivity analysis, the model is then used to assess/predict future conditions based on a proposed development scenario. As was the case with the previous steps, model predictions and uncertainty analysis are carried out according to accepted standards (ASTM D5447 Guide for Application of a Ground-Water Flow Model to a Site-Specific Problem, and ASTM D5880 Guide for Subsurface Flow and Transport Modeling). In the case of a mining operation, questions that are typically addressed include:

- How much groundwater will flow into the mine?
- Will mine dewatering negatively affect groundwater levels, stream flows, spring flows, water levels in lakes and other surface water bodies?
- Will mine dewatering adversely impact existing water supply wells?
- Will constituents associated with the ore body, ore processing, or mine waste be released into groundwater or surface water, and if so, at what levels?
- What are the migration pathways, travel times, and receptor impacts associated with constituents that may be released or mobilized as a result of mine operations?

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During the predictive phase of modeling, model parameters are typically varied over ranges defined through model sensitivity analysis to evaluate the effect of uncertainty on predicted impacts. This is sometimes carried out through the incorporation of probabilistic models used to derive a statistically-based level of confidence in the range of potential outcomes, or a probability based assessment that the site will or will not meet established water quality criteria.

It is through this process of rigorous field investigations, data collection/analysis, and model development in conformance with accepted standards that hydrologic models are developed to assess important questions related to potential impacts to water quantity and quality from proposed natural resource development projects.

Use of Hydrologic Models in Support of Regulatory Decision Making in Regard to Migration Pathways and Assessing Risks to Potential Receptors

In using hydrologic characterization and modeling to assess mining projects, regulatory agencies not only require that hydrologic characterization and model development/ application be conducted in accordance with established standards as described above; the agencies also require that data collection, testing, and modeling incorporate pertinent features of the proposed Project to provide a quantitative basis for evaluating their potential impact on water resources (groundwater and surface water quantity and quality). Project-specific features for which agencies require detailed hydrologic impact assessment via a synthesis of site characterization, data analysis, model development, and engineering alternatives analysis include:

- A model-based representation of the mine that is being proposed (open pit or underground workings) including a temporal treatment of the pit or workings as a function of time.

- A model-based impact analysis incorporating engineering design properties for major Project facilities, including:
  - Waste rock storage facilities.
  - Tailings storage facilities.
  - Water retention basins.
  - Water treatment and discharge.
  - Project reclamation plans including closure of the mine and tailings storage facilities.

- Geochemical analysis and modeling of the mined materials applied to water resources impact assessments associated with waste products, wall rock in pits or workings, and pits and workings following reclamation and closure.

In assessing potential Project impacts, the hydrologic and related models are expected or required by agencies to reflect the actual locations of the facilities and the engineering designs that reflect actual construction plans. Typical engineering plans that are incorporated into the assessment include plans and designs of lined facilities for storage of tailings and Project wastewaters, mine reclamation plans, including pit or workings backfill if proposed, and post-closure operation and maintenance plans. Other Project features that are typically

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incorporated into hydrologic models for proposed mining projects include site monitoring and contingency plans.

In summary, when regulatory agencies administer their obligations with respect to natural resource development projects such as mining projects, they follow a defensible protocol for guiding their decision making which includes:

- Reliance on use of defensible standards that withstand legal challenge.
- Reliance on extensive site-specific data.
- Adherence to established protocol for model construction, calibration, sensitivity analysis, predictions, and uncertainty analysis.
- Incorporation of project-specific engineering controls, monitoring, and contingency plans.
- Incorporation of project-specific geochemical assessments of waste materials.

Regional mine development projects provide an example of regulatory agencies adhering to the standard hydrological modeling process to assess proposed mining projects and, in particular, to assess potential migration pathways for constituents of concern. Over the last 25-plus years there have been approximately six base metal mining projects in the Great Lakes Region that have advanced through the regulatory process. All of these projects have broadly conformed to accepted industry standards with regard to the application of hydrologic models. These projects include:

- The Eagle Mine in Marquette County, Michigan (F&VD, 2006).
- The Humboldt Mill in Marquette County, Michigan (Foth, 2008).
- The PolyMet North Met Project in Hoyt Lakes, Minnesota (MDNR et al., 2015).
- The Flambeau Mine in Ladysmith, Wisconsin (WDNR, 1990).
- The Back Forty Project in Menominee County, Michigan (Foth, 2015).
- The Copperwood Project in Gogebic County, Michigan (Orvana, 2011).

These examples from the region demonstrate that in the normal course of carrying out their regulatory obligations with respect to their decision making authority, both state and federal agencies require the use of scientifically defensible models to assess potential contaminant migration pathways and potential impacts.

Journal of Hydrology Research Paper-Assessment of Migration Pathways and BLM/USFS Decision on Nonrenewal

As noted elsewhere in this memorandum, the BLM/USFS decision to pursue withdrawal does not explicitly cite any site characterization, data analysis, mine planning or engineering, or modeling as a basis for arguing that leases must be withdrawn lest irreparable impacts occur to waters within the BWCA Wilderness and Rainy River Watershed. The lease denial decision does not rest on any such analysis because none has been performed.

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However, a groundwater modeling study purporting to address the potential for groundwater and subsequent surface water impacts has been published in the Journal of Hydrology (JoH) in 2016 (Myers, 2016). To our knowledge, this is the only publically available analysis purporting to address the potential impacts associated with a mining operation in the Twin Metals Project area, and as such, this study may have formed a partial basis of perceived support for the BLM/USFS lease denial decision. Therefore, this modeling study is evaluated here.

In the final paragraphs of the introduction, the author states:

"The objective of this study was to use watershed-scale groundwater flow and transport modeling to ***predict which mine sites in a sulfide-rich watershed would be more likely to cause downstream AMD [acid mine drainage] problems if engineering controls fail****. It demonstrates how watershed-scale modeling prior to the actual development of mines can improve mine planning to facilitate future remediation when engineer failures occur…"* (**emphasis added**)

The author continues:

"The model could help to ***optimize mining and waste disposal locations*** *or to decide whether the risks of mining are too high as well as providing information on where more information is needed for decision making."* (**emphasis added**)

The first of the bold portions of the quoted text indicate that the author is seeking to establish a benign objective for the modeling study; namely, to use the model as a screening tool to consider a broad suite of sites and identify locations where a mine, or mine waste management facilities could be located and not pose a threat to water resources in the event of a failure of engineering controls. However, the author does not apply the model to a variety of potential mining sites, but rather develops the model specifically for the location of the Twin Metals ore body south of the Kawishiwi River.

Furthermore, the author states that the analysis will evaluate potential problems that may occur if "engineering controls fail." Later in the paper, the author assigns source terms to the model consisting of 10,000 milligrams per liter (mg/L) sulfate in recharge and in injection water delivered to subsurface bedrock zones. These high contaminant loading rates do not represent an engineering failure of a modern waste management system. Rather, they represent a complete absence of any modern waste management practices combined with extremely reactive mine wastes and the most extreme and unfavorable environmental conditions, as well as an absence of natural attenuation capabilities found in many natural systems. Additionally, the engineering controls failure incorporated in the model does not represent a realistic failure of a liner or overtopping of a storage pond; rather it represents something akin to the complete dissolution of a liner combined with enormous localized increases in bedrock recharge that are not physically realistic. These elements of the model indicate a lack of objectivity needed for a meaningful analysis and a predetermined agenda under which the model was developed with the intent to show a worst possible case result.

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Development of a model to identify locations where such careless mining practices could be applied without negatively impacting the environment is a pointless exercise as there are no locations in the U.S. or on the planet where such practices would be deemed acceptable. A complete failure, or, more consistent with the modeled conditions in the paper, a complete absence of engineering controls will cause unacceptable impacts to water resources no matter where the mine or mining facilities are located. The author notes as much in the second paragraph of the paper:

"Mining-caused contamination is a global problem and few sites are isolated or sufficiently under-used that potential contamination can be ignored."

Furthermore, while the author states that the objective of the study is to "*…predict which mine sites in a sulfide-rich watershed would be more likely to cause downstream AMD [acid mine drainage] problems if engineering controls fail,"* the results presented in the paper do not attempt to identify mine leases that are prone to causing environmental problems and those that are not prone to such damage. Rather, the paper considers a single site only–the Twin Metals site. Nor does the paper determine zones suitable for waste management as distinguished from those that are not. Instead, the paper steers from the beginning to a blanket conclusion that the Twin Metals site is not safe from environmental damage if poor mine practices are accompanied by a complete failure of engineering controls or a complete absence of engineering controls. The same can be said of virtually any location in the U.S. or in the world, which renders the findings of the paper of little practical value.

The nature of the study, in which complete failure of engineering controls, or an absence of such controls, and the subsequent assessment of environmental impacts under the worst possible combination of conditions attempts to impose a standard on mine planning that does not exist and is not embodied in any state or federal regulations. There are no locations in the U.S. where a mining operation could be shown to have acceptably limited water resources impact under conditions of complete failure or absence of engineering best management practices. The imposition of the standard implied in the paper would preclude all mining at any and all locations worldwide.

The value of the study in assessing potential environmental impacts is further limited by several broad features of the modeling effort. These include:

- The modeling effort included no site-specific data. Rather, it relied upon limited data published in regional studies. The ability of such a modeling effort to account for actual conditions in the study area is, therefore, severely limited or nonexistent and completely departs from standards cited previously which are expected to be adhered to by agencies when applying models for use in mine planning, permitting, and environmental review. The complete lack of site-specific data renders the result of the JoH modeling useless for inferring any future impacts associated with Twin Metals Project.

- The modeling effort does not incorporate any aspects of any mine plan. Locations of mine workings within the Duluth Complex, locations of mine operations and waste management facilities, mining methods, waste management methods and schedules, and other important variables that affect locations, environmental exposure, and

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reactivity of mined materials, are completely excluded from the study. This may be have been a necessity since final mine plans were/are not yet developed. However, this limitation severely constrains the utility of this modeling study for assessing environmental impacts prior to development of Project plans.

- The discussion and presentation of the modeling methods and results is brief, with limited text and tables, and a limited number of figures that are small in scale and not suitable to a careful evaluation of complex modeling methodologies and results. These constraints mean that many aspects of the modeling methodology and results are not presented and cannot be evaluated. As such, the ability to interpret the validity of the study and the results is, at best, limited. In this regard, the JoH paper does not conform to the standards established in ASTM D5718 (Guide for Documenting a Ground-Water Flow Model Application) for the presentation of modeling results.

The three broad constraints noted above severely limit the usefulness of the model and the paper for assessing environmental impacts. A modeling study and report similarly constrained would be considered unacceptable as a basis for water resources impact evaluation under any element of the environmental review process (such as the Environmental Impact Statement or Permit to Mine Application) through which a mining project must proceed.

In addition to these general and broad limitations on the utility of the study as a decision-making tool, there are several specific aspects of the paper and study that render it unsuitable for use as a policy-making or decision-making tool:

- The labeling of sub-units of the Duluth Complex (Pma and Pmt) on Figure 2 is such that one cannot distinguish one unit from the other. Because these sub-units are associated with parameterization of the model (hydraulic conductivity, porosity, etc.), one is unable to interpret or evaluate this important aspect of the model construction.

- The paper notes that well water levels were used as calibration targets. Figures in the paper indicate all well calibration targets are highly clustered in a few locations within the model domain and limited to data obtained from a state of Minnesota database. No information is provided regarding the types of wells included as calibration targets, manner in which the data was collected, the time at which the measurements were made, the geologic units represented, or other important details. No contour map of groundwater potentiometric surfaces is presented. These omissions preclude development of a conceptual understanding of groundwater flow and prevent an evaluation of the quality and applicability of the water level data used to calibrate the model.

- On page 283, the author states that sulfate transport was assumed to be conservative (no attenuation) "…*to estimate the sources which could have the most significant impacts without relying on estimates of reactivity to attenuate the risk*." Treating sulfate as conservative does not aid in determining which sources present more risk than others because this approach effectively treats all sources, all geologic units, and any/all source control practices the same, assuming worst case conditions for all.

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Treating sulfate as a conservative constituent simply produces conservative or worst-case projections of impact as opposed to projections that properly reflect site conditions and Project-specific practices associated with potentially reactive mined materials.

- Layer 1 for the numerical model is defined to represent overburden/glacial till that overlies bedrock in the study area. The model assigns a constant and uniform thickness of 15 meters (m) to this unit. Fifteen meters is substantially thicker than actual Quaternary deposits in much of the study area. Outcrops are common in the study area, as are zones with unconsolidated deposits of 1 to 2 m thickness. The actual limited thickness and the variability in thickness of Quaternary deposits in the area will exert a significant influence on groundwater flow paths and rates. In much of the study area, there is no aquifer or groundwater flow system in which to transport any constituent. These components of flow system variability are excluded from the model and limit the usefulness of the results as a basis for predictions.

- The second layer of the model was defined as having a thickness of 125 m. This layer is defined in the paper as that which represents the upper weathered or fractured portion of the bedrock. No data is presented to document that the upper portion of the bedrock is more fractured or weathered than deeper rock. No data is presented to document the depth or thickness of this more weathered or fractured zone. Hydraulic conductivity data collected by the Project to date via depth-specific packer testing indicates the vertical reach of bedrock that may exhibit higher hydraulic conductivity is limited to the upper 75 m. As such, the layer thickness/parameterization for the uppermost bedrock in the JoH study departs substantively from actual site conditions.

- The use of a uniform thickness for Layer 1 representing unconsolidated deposits precludes representing the actual topography of the bedrock surface. Because of the high contrast in hydraulic conductivity of the unconsolidated Quaternary deposits relative to the bedrock, the bedrock topography exerts strong controls on groundwater flow paths and rates within the Quaternary deposits. Excluding this information from the model limits the model's ability to accurately account for these processes. The transport simulation of the Quaternary groundwater system is therefore severely constrained as well.

- Calibrated hydraulic conductivities for the Duluth Complex presented in Table 1 are extremely large in comparison to literature values, preliminary results from hydraulic tests performed within the Duluth Complex, and the author's own qualitative description of this formation. For example, the author assigns a value of 0.12 for the specific yield of some zones of the Duluth Complex. Much of the Duluth Complex rocks have specific yields or porosities that are essentially zero. Hydraulic conductivity is commonly the most influential parameter in terms of flow directions and rates obtained from a flow model. The multiple-order of magnitude over-estimation of this parameter in the JoH study render the results unrepresentative of the actual hydrogeologic system and of no value for drawing conclusions regarding potential Project impacts.

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- The calibration of the model includes multiple zones for estimation of hydraulic conductivity and related parameters for each hydrogeologic unit. Yet there is no discussion of the rationale for distinguishing different zones within these units. This suggests that the zones were determined not on the basis of observed features of these units and formations, but rather were selected merely to allow some degree of calibration success. This is not consistent with common modeling practice. And the absence of a discussion of the rationale behind the zonation makes it impossible to assess the success or lack thereof of the calibration.

- The presentation of the calibration results is very limited, with only a single calibration statistic discussed and no presentation of graphical calibration results or spatial distribution of calibration statistics. This presentation departs widely from standard practice as documented in ASTM D5718 (Guide for Documenting a Ground-Water Flow Model Application). Again, this limitation precludes drawing any conclusions regarding the degree to which the model represents actual hydrogeologic conditions in the study area.

- No mass balance results are presented for the model as a whole or for individual model layers. This precludes evaluating the internal consistency of the numerical solution. The model mass balance (for the overall model and for individual model layers and units) is one of the most fundamental and important measures used in the assessment of a model's performance. Without knowledge of these model mass balance results, the validity of the model is completely unsubstantiated.

- River and lake boundary conditions are incorporated in the model using the drain feature of MODFLOW. This is not a common practice. Rather, the river package in MODFLOW is normally used to model rivers and lakes. Furthermore, the head value assigned to the drain boundary conditions was defined as an elevation 5 m below ground level. This is substantially different than actual physical conditions within the study area and will substantially increase hydraulic gradients above actual values. The effect of such an increase or distortion in hydraulic gradients is to overestimate groundwater velocities and underestimate constituent travel times. Rivers and lakes are assumed to be gaining water from the groundwater system at all times, a condition that the author acknowledges is not consistent with actual system behavior. These features of the JoH modeling study constitute serious errors in the models fidelity to the actual physical system it purports to represent.

- To represent constituent release from underground workings, the author modeled injection wells delivering 10,000 mg/L sulfate water to Layers 2 and 3 of the model. The author injected such water for a one year duration and noted that total sulfate load per model cell under this configuration was approximately 3,000 tons per year. Such a loading is considered extreme, if not impossible to achieve, even if it was one's objective. Furthermore, the use of an injection well to create a source term in the model causes an over-representation of hydraulic gradients (presumably an enormous overestimate; actual gradients associated with these predictive simulations are not reported) that does not reflect conditions that would naturally exist in the presence of underground workings or backfilling of mine waste. Again, the

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overestimation of hydraulic gradients results in overestimation of constituent transport rates and subsequent impacts.

The above represents a partial summary of the limitations and problems associated with the modeling study, the presentation of the work, and the use of both as a basis for making meaningful decisions regarding environmental impacts. They indicate that the JoH modeling study provides a poor representation of the hydrologic system at the Twin Metals site, that it does not conform to standard practice, and that it provides no meaningful representation of Project impacts.

Project Investigations Indicate No Substantive Groundwater Flow Pathway from Ore Body to Surface Waters

Although site characterization activities and analysis of hydrologic systems are yet to be completed, data collected to date overwhelmingly indicates an absence of a groundwater migration pathway from the ore body where mining will take place to surface waters. In the absence of such a pathway, there is no route for constituents released from the ore body, either during operations or following reclamation and closure, to reach surface water features and flow into the BWCA Wilderness lakes or rivers.

Early site characterization activities have included the geologic logging of exploration, monitoring well, and piezometer borings, mapping of geologic units, hydraulic testing of bedrock to estimate hydraulic conductivity, geophysical surveys and testing, and installation of and potentiometric monitoring in wells and piezometers.

Geologic logging of exploration borings, core collection and analysis, and geophysical surveys indicate that Duluth Complex rocks (and footwall rocks of the Giants Range Batholith) are predominantly composed of highly indurated, competent, unfractured rock (commonly referred to as "stick rock" or "gun-barrel core" due to the nature of the core which resembles a steel rod in general appearance) of near zero porosity. Fractures are present in the rock but are infrequent and display minimal or zero aperture. Porosity approaches zero. Such rocks have minimal capacity to transmit groundwater.

Hydraulic testing of exploration borings has included numerous packer tests at discrete intervals as well as full-length slug and pumping tests. Analysis of test data obtained shows that rocks in the vicinity of the ore body are predominantly characterized by very low hydraulic conductivities. Hydraulic conductivity values for rocks deeper than 200 feet are generally between 10^{-8} and 10^{-11} centimeters per second (cm/s). Conductivities in this range correspond to published ranges for unfractured igneous rocks which represent some of the lowest permeability rock formations on the planet. A small number of higher conductivity test results (maximum of 10^{-4} cm/s) were observed, but even these higher estimates are considered "low conductivity" and unconducive to groundwater flow. Additionally, the higher conductivity test results are predominantly isolated to shallow bedrock where weathering has occurred and which will not be exposed to underground workings, meaning they offer no pathway for groundwater migration from the proposed mine to surface waters.

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Another set of important data that has been collected is vertical profile potentiometric data which quantify groundwater elevation or hydraulic head as a function of depth. This data, collected via nested piezometers and monitoring wells, reveals that hydraulic gradients within the bedrock above the ore body are generally directed downward. Downward hydraulic gradients mean that groundwater is moving within the bedrock in a downward direction under natural conditions. Downward flow rates are very low due to the low hydraulic conductivities of the rocks in and surrounding the ore body described in the preceding paragraph. Mine operations which will involve dewatering of the underground workings will maintain downward gradients, with mine inflow rates projected to be low as a result of the low porosity and permeability of ore and host rocks. Upon mine reclamation and closure, vertical gradients will generally return to their natural state, maintaining a downward flow direction within the bedrock. Under these conditions, it would be physically impossible for constituents to migrate from the ore zone to surface water, whether it be under pre-mining conditions, operating conditions, or closure conditions. As such, contamination of BWCA Wilderness surface waters from underground operations or closure is of minimal likelihood.

Comparison of groundwater elevations in shallow unconsolidated deposits with those in deeper bedrock zones indicates groundwater levels are generally higher in the unconsolidated deposits than in bedrock. Additionally, groundwater elevations in shallow unconsolidated deposits display relatively rapid response to precipitation and snowmelt events, whereas bedrock water levels display little or no response to the same events. These observations suggest that bedrock is recharged by near-surface hydrologic features (shallow groundwater and surface water) and that this recharge is slow and involves minimal flux rates. They also suggest a poor hydraulic connection between near-surface features that would limit or minimize impacts to near-surface hydrologic systems (such as induced seepage from shallow groundwater, lakes, streams, or wetlands) in response to development of underground workings. Such conditions will further mitigate against substantive movement of constituents from workings in the ore zone to shallow groundwater or surface water both during operations and following reclamation and closure.

Failure to Establish Basis for Hydrologic Pathway to Contaminate Waterways

The BLM/USFS decision to pursue withdrawal fails to meet the standards that agencies apply to mine operators when seeking to permit a project in numerous important regards:

- The decision presents no characterization of hydrologic or hydrogeologic conditions in the Project area. Site-specific data is completely absent in the BLM/USFS denials of renewal for the subject mineral leases.

- The decision is not supported by any quantitative or even qualitative analysis of hydrologic systems in the Project area.

- The decision implicitly assumes that groundwater in the vicinity of the planned ore body and underground workings is hydrologically connected to and flowing to surface water bodies. This assumption is presented with no scientific or engineering data to support it. This assumption is also contrary to data collected by the Project to

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date which overwhelmingly indicates an absence of any substantive hydrologic pathway moving water from the ore body to surface water features.

- Development of a TMM mine plan is in progress but no final plan has been completed or published. Given the absence of a final plan, the BLM/USFS assumed, in promulgating their lease termination decisions, that all Project features are located in the Rainy River Watershed. This assumption appears, in part, to have been based on an outdated Pre-feasibility Study (prepared for Duluth Metals in 2014) that does not reflect current Project conceptual planning. While the final Project plan is still undergoing development, several important Project components have been established and are summarized on the Project web page: http://www.twin-metals.com/about-the-project/project-facts/. Important Project elements summarized here and relevant to the lease withdrawal include:
  - Storage of waste rock in underground workings.
  - Storage of approximately half of the generated tailings in underground workings using cemented backfill process.
  - Storage of remaining tailings in engineered and lined tailings impoundment near Babbitt (outside of the Rainy River Watershed).

  These Project features alone eliminate or dramatically reduce the potential for surface waste storage facilities contributing to degradation of surface waters in the Rainy River Watershed. The storage of waste rock in underground workings and the use of low-permeability cemented backfill disposal of tailings in the workings will isolate these underground storage facilities in bedrock of very low permeability. Field data collected to date indicate minimal or very poor hydraulic connectivity between these waste disposal zones and both shallow groundwater and surface water. Failure to consider these Project features in the lease denial decision indicates that the decision was based on perceived or assumed Project features and risks that will not exist.

- As with any modern infrastructure project, the Twin Metals Mining operation will be designed and constructed using modern, state of the practice technologies; both for the design of engineering controls, the selection of products used in the construction of designed controls, and the monitoring of the performance of these systems. These designs, product selections, and monitoring/maintenance practices have not yet been designed. In lieu of knowledge and analysis of these Project features, the BLM/USFS decision implicitly assumed that all systems would be designed and constructed using practices and materials equivalent to those used over the last century. The single published study purporting to evaluate impacts of the Twin Metals Project goes further and assumes that all waste management will be mismanaged to such an extent that mine waters equal or exceed the worst levels observed at any historic mining site, that all engineering controls will fail completely. These assumptions are equivalent to making decisions about the current utility and merit of solar-generated electricity based on photo cell technology from 1950 or earlier.

- Any attempt to permit a mine with the lack of site characterization, data analysis, modeling, quantitative analysis of engineered systems, and similar, conventional, state-of-the practice analysis would be summarily rejected without review by agencies responsible for such permitting.

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In the absence of site-specific hydrologic characterization data, a hydrologic model developed in accordance with accepted industry standards, and the incorporation of an actual mine plan, it is not possible to conclude that there is or is not a pathway for migration of constituents of concern into the BWCA Wilderness and impairment of those waters. Absent these industry-standard and agency-required practices and information, no scientifically defensible conclusions of can be drawn about any aspect of Project impacts, to water resources or any other component of the natural environment or human and socio-economic concerns.

Failure to Consider Other Information Related to BLM and USFS Administered Mining Operations

In the USFS letter to the BLM denying USFS consent to renew the Twin Metals leases that the agencies cite as a basis for pursuing withdrawal, the USFS states on page 11: *"FS data indicates between 20,000 and 50,000 mines currently generate acid on lands managed by the agency. Negative impacts from these mines affect 8,000 to 16,000 km of streams."* Note that 8,000 and 16,000 km correspond to 4,971 and 9,942 miles, respectively.

Although the USFS fails to cite a source for the purported claims noted in the preceding paragraph, the source of these claims is easily identified as a report that the USFS produced themselves in 1993. An internet search for any of the number combinations in the preceding paragraph quickly reveals dozens to hundreds of instances wherein these numbers are cited to characterize the extent of mining impacts on waters of the U.S. All such instances that cite a source for the estimates refer to a 1993 report prepared by the USFS itself. The report is:

Acid Drainage from Mines on National Forests, A Management Crisis. U.S. Department of Agriculture, Forest Service, In Cooperation with the U.S. Department of Interior's Bureau of Land Management, Program Aid 1505, March 1993.

Page 3 of the report (USFS, 1993) states:

*"**Currently, reliable data on the total number of mines producing acid drainage and on the number of miles of streams affected by acid and metal drainage are not available for the Western United States**. However, various estimates have placed the number these mines in the range of 20,000-50,000, seriously affecting 5,000-10,000 miles of streams. The cumulative effect of these mines, whatever their actual number, is significant."* (**emphasis added**)

No data or source is cited in support of this claim, even in the original report (USFS, 1993).

Although the USFS letter presents these estimates of AMD-generating mines and impacted stream lengths as facts supported by data, the original USFS report from which the numbers are taken (USFS, 1993) plainly states that no reliable data exist, which suggests that the estimates are mere conjecture. Furthermore, while the USFS letter states that 20,000 to 50,000 acid generating mines are leaking into 8,000 to 16,000 km of streams on *"…lands managed by the agency…,"* the original report makes no statement regarding the ownership, stewardship, or status of the lands on which these impacts are supposedly located. This

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indicates another distortion embodied in the USFS claims on page 11 of the lease denial decision.

The original USFS report (USFS, 1993) contradicts these numbers on the exact same page which presents the language quoted above. Namely, paragraph 2 on page 3 reads:

"Over 1,500 western mining sites with significant acid drainage problems have been identified on National Forest System lands."

This begs the questions: "Which is it—1,500 impacted mine sites or 50,000? The discrepancy constitutes an error of 3300%." And, "Are the impacted mine sites on USFS-administered lands or not?"

Given the date of the report (1993) upon which the USFS relies for its claims of dramatic impacts associated with mining operations, USFS (1993) is clearly focused on legacy (pre-1990) mining operations and conditions, and not conditions associated with modern mining practices and regulations. The importance of this distinction is made clear in a letter written by the U.S. Department of Agriculture to Senator Lisa Murkowski in response to inquiries made by Senator Murkowski regarding financial assurance requirements imposed on mining operations. This letter is included herein as Attachment 1. A similar letter on the same topic from the BLM to Senator Murkowski is included as Attachment 2.

Page 3 of the USFS response to Senator Murkowski presents the Senators 7th question and the USFS response:

Senator's Question:
7. How many hardrock mining and beneficiation plans of operation has your agency approved since 1990?

a. *How many of those sites are, or have been, placed on the CERCLA NPL?*
b. *How many of those sites placed on the CERCLA NPL involved (a) a responsible party that pays (paid) for the cost of short-term removals or long-term remediation, either in part or in whole?...*

USFS Response:
The total number of hardrock mines permitted since 1990 is 2,685; no sites have been placed on the CERCLA NPL list.

In summary, the USFS states in USFS (1993) that pre-1990 mining operations have resulted in 1,500 mine sites with environmental impairment. And in their response to Senator Murkowski, they state that since 1990, 2,685 mine operations have been permitted on federally administrated lands and not a single site has resulted in contamination problems resulting in CERCLA listing.

This demonstrates that the BLM/USFS decision to pursue withdrawal is based on selective use of unsupported conjecture surrounding mining practices no longer in use while simultaneously ignoring information indicating a record of safe, modern mining practices.

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Attachment 1

USDA Letter to U.S. Senator Lisa Murkowski
July 20, 2011
(See Response to Question 7)

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DOI-19-0291-I, 19-0538-J-000128

United States Department of Agriculture

Office of the Secretary
Washington, D.C. 20250

JUL 20 2011

The Honorable Lisa Murkowski
Committee on Energy and Natural Resources
United States Senate
304 Dirksen Senate Office Building
Washington, D.C. 20510

Dear Senator Murkowski:

Thank you for your letter of March 8, 2011, regarding actions being taken by the United States Environmental Protection Agency (EPA) related to financial assurance requirements, including bonds, for hardrock mines in the United States. I apologize for the delayed response.

On July 28, 2009, EPA published a priority notice identifying classes of facilities in the hard rock mining industry as those for which EPA would first develop financial responsibility requirements under section 108(b) of CERCLA (*see* 74 Federal Register 37,213 (July 28, 2009)). This notice followed a February 25, 2009, U.S. District Court order (later amended) to identify and publish the notice (*see Sierra Club v. Johnson*, No. C 08-01409 WHA, 2009 U.S. Dist. LEXIS 14819 (N.D. Cal. February 25, 2009)).

USDA's Forest Service has existing requirements that provide for financial assurances on hardrock mining operations on National Forest System lands. The EPA has been working with the Forest Service as it develops the rule in order to ensure that both agencies appropriately implement their statutory authorities. This includes protecting the public interest in ensuring that taxpayers do not bear the cost of addressing releases of hazardous substances and that the Federal government provides a streamlined set of requirements for those developing hardrock mineral resources. The Forest Service is continuing to work with the EPA towards this end.

To the extent several of your questions are directed at the content of deliberative interagency communications in an ongoing rulemaking, they raise important confidentiality concerns for the Executive Branch. Enclosed are answers to your questions as they pertain to the Forest Service. I defer further questions on the timing and content of the rule to the EPA.

Again, thank you for writing.

Sincerely,

Thomas J. Vilsack
Secretary

Enclosure

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DOI-19-0291-I, 19-0538-J-000129

Enclosure

Responses to Questions regarding Actions being taken by the Environmental Protection Agency (EPA) related to financial assurance requirements, including bonds, for hardrock mines in the United States.

1. **Has your agency received any information from EPA indicating that it intends to pursue a "one-size-fits-all" approach under CERCLA Sec. 108(b) for hardrock mining? If so, what information has been provided and has your agency expressed any concerns with this approach?**

The Forest Service understands that the EPA is working to develop regulatory requirements under CERCLA § 108(b). The Forest Service and EPA have discussed approaches to establishing financial assurances during meetings and follow-up teleconferences. The Forest Service has provided expertise based on its experience regulating hardrock mining operations on the public lands. The Forest Service has also provided EPA with information associated with the current Forest Service regulations.

2. **Has your agency received any information from EPA regarding how legacy (pre-1990) hardrock mining (or processing) sites listed on the CERCLA National Priorities List (NPL) impacted their identification of the industry as posing a high risk under CERCLA Sec. 108(b)? If so, what information has been provided and has your agency expressed any concerns with this approach?**

EPA's priority notice of action published in the Federal Register on July 28, 2009, 74 Fed. Reg. 37,213 (July 28, 2009), described eight factors it considered in identifying hardrock mining under CERCLA § 108(b). One of the eight factors considered by EPA was the number of mine sites on the CERCLA site inventory (including both National Priority List (NPL) sites as well as non-NPL sites). The Forest Service has provided EPA with information on the way mining and reclamation practices have evolved from past practices.

3. **Has your agency received any information from EPA indicating that it intends to link the cost of remediating legacy (pre-1990) hardrock mining (or processing) sites to the calculation of future financial assurance requirements that may be imposed under CERCLA Sec. 108(b)? If so, what information has been provided and has your agency expressed any concerns with this approach?**

The EPA has indicated that it has not yet determined the methodology by which the proposed rule will identify the amount of financial assurance required. The Forest Service has provided EPA with information regarding modern mining practices and Forest Service methodology for establishing financial assurances.

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DOI-19-0291-I, 19-0538-J-000130

4. **Please provide a description of how your agency currently calculates financial assurance requirements applicable to hardrock mines on federal lands.**

The Forest Service process for calculating financial assurance for hardrock mines is described in its Training Guide for Reclamation Bond Estimation and Administration For Mineral Plans of Operation authorized and administered under 36 CFR 228A; USDA – Forest Service, April 2004. The aforementioned Training Guide emphasizes the following for financial assurance estimation:

- Estimates should be made by experienced personnel;
- Estimates should assume that all equipment, supplies and work will be provided under federal contract;
- Unit costs for labor, equipment or materials should be made or verified on a site by site basis;
- Estimates should include direct and indirect costs;
- Direct costs should include interim operation and maintenance, hazmat testing and removal, water treatment, demolition and disposal of facilities, earthwork, erosion control, revegetation, cost of required mitigation, and long-term operation, maintenance and monitoring;
- Indirect costs should include redesign, mobilization/demobilization, contractor costs, agency project management, contingencies and inflation; and
- Estimates should be reviewed periodically to ensure they are adequate.

5. **Can your agency approve a plan of operations that poses a high risk of unnecessary or undue degradation of public lands? How would your agency typically respond to a plan of operations that it believed posed a high risk of unnecessary or undue degradation of public lands?**

The term "unnecessary and undue degradation" of public lands is derived from the Federal Land Policy and Management Act. The term "unnecessary and undue degradation" is also defined in the Bureau of Land Management's (BLM) hardrock regulations and, therefore, only applicable to BLM-managed lands. Regulations at 36 CFR 228A direct the Forest Service to require and approve plans of operation (Plans) for activities that may result in "significant disturbance of surface resources" in order to "minimize adverse environmental impacts" and reclaim surface disturbance.

The Forest Service works with proponents at the project design stage to develop any changes or additions deemed necessary to comply with our regulatory requirements for environmental protection and to mitigate adverse environmental effects. Additionally, we incorporate appropriate monitoring and inspection into plan approvals to ensure mitigation is achieving the intended result and/or provide information to develop an adaptive management strategy.

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6. **Does your agency have the authority to impose financial assurance requirements for post-mining, long-term monitoring, maintenance and treatment operations?**

Although not explicitly stated in our hardrock bonding regulation at 36 CFR 228.13, the Forest Service interprets our role as having the authority to impose financial assurance requirements for post-mining long-term monitoring, maintenance and treatment operations. We are working to clarify our internal guidance to apply an appropriate discount to long-term/perpetual financial assurance calculations; the consideration of uncertainty and risk in both water modeling and financial assurance calculations; and the types of financial instruments the Forest Service may accept for long-term reclamation obligations.

7. **How many hardrock mining and beneficiation plans of operation has your agency approved since 1990?**
    a. **How many of those sites are, or have been, placed on the CERCLA NPL?**
    b. **How many of those sites placed on the CERCLA NPL involve(d) a responsible party that pays (paid) for the cost of short-term removals or long-term remediation, either in part or in whole? What is the aggregate dollar amount spent by these responsible parties? What is the aggregate dollar amount spent by the federal (or state) government?**

The total number of hardrock mines permitted since 1990 is 2,685; no sites have been placed on the CERCLA NPL list.

8. **Does your agency coordinate – or has it coordinated in the past – with states to develop financial assurance requirements for hardrock mines on non-federal lands? If so, please describe this coordination.**

The Forest Service has and continues to coordinate with States to develop financial assurance requirements when dealing with individual sites involving both National Forest System lands and non-federal lands expressly for the purpose of avoiding duplicate bonding of operators. This coordination typically takes the form of agreements describing how financial assurance will be estimated, what financial assurance (bond) instruments are acceptable, who holds the instruments, and how the penal sum of these instruments are to be allocated in the event of operator default.

9. **Please provide all documents, records, papers, reports, agreements, notes, correspondence, presentation, analyses, comments, and any other materials generated by your agency as part of an inter- or intra-agency process associated with the EPA's CERCLA Sec. 108(b) rulemaking.**

This request for documents prepared as part of an ongoing rulemaking process for which no draft rule has yet been proposed implicates important confidentiality interests for the Executive Branch. We are happy to provide a briefing or additional material on the Forest Service's program as well as to participate in a multi-agency briefing with the EPA and the BLM if that is preferred.

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Attachment 2

BLM Letter to U.S. Senator Lisa Murkowski
June 21, 2011
(See Response to Question 7)

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United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Washington, D.C. 20240
http://www.blm.gov

JUN 21 2011

The Honorable Lisa Murkowski
Ranking Member, Committee on
Energy and Natural Resources
United States Senate
Washington, DC 20510

Dear Senator Murkowski:

Thank you for your letter of March 8, 2011, and your interest in the important issue of financial assurance requirements for hardrock mines in the United States.

As you point out, the Bureau of Land Management (BLM) has statutory responsibilities and existing regulatory requirements that provide for financial assurances on hardrock mining operations on public lands. The BLM promulgated regulations in 2001 that broadened bonding protections by requiring full reclamation bonding for all mining activity above casual use. These changes, coupled with changes in mining practices, have alleviated the problems related to remediation that occurred under earlier authorities and requirements for mining activity subject to BLM's bonding requirements.

On July 28, 2009, the Environmental Protection Agency (EPA) published a priority notice identifying classes of facilities in the hard rock mining industry as those for which EPA would first develop financial responsibility requirements under section 108(b) of CERCLA (*see* 74 Fed. Reg. 37,213 (July 28, 2009)). This notice followed a February 25, 2009 U.S. District Court order (later amended) to identify and publish the notice (*see Sierra Club v. Johnson*, No. C 08-01409 WHA, 2009 U.S. Dist. LEXIS 14819 (N.D. Cal. Feb. 25, 2009). The EPA has been coordinating with the BLM as it develops the rule in order to ensure that both agencies appropriately implement their statutory authorities while demonstrating good government. This includes protecting the public interest in ensuring that taxpayers do not bear the cost of addressing releases of hazardous substances and that the Federal government provides a streamlined set of requirements for those developing hardrock mineral resources. We are continuing to work with the EPA toward this end.

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To the extent several of your questions are directed at the content of deliberative interagency communications in an ongoing rulemaking, they raise important confidentiality concerns for the Executive Branch. Enclosed are answers to your questions as they pertain to the BLM. We defer further questions on the timing and content of the rule to the EPA.

Please do not hesitate to share any thoughts you have on this issue with me.

Sincerely,

Robert V. Abbey
Director

Enclosure

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Responses to Questions:

1. **Has your agency received any information from EPA indicating that it intends to pursue a 'one size-fits-all' approach under CERCLA Sec. 108(b) for hardrock mining? If so, what information has been provided and has your agency expressed any concerns with this approach?**

   The BLM understands that the EPA is working to develop regulatory requirements under section 108(b) of CERCLA. The BLM and the EPA have discussed approaches to establishing financial assurances during meetings and follow-up teleconferences.

   The BLM has provided expertise based on its experience over the past 30 years regulating hardrock mining operations on the public lands. The BLM has also provided EPA with information associated with the current BLM regulations.

2. **Has your agency received any information from EPA regarding how legacy (pre-1990) hardrock mining (or processing) sites listed on the CERCLA National Priorities List (NPL) impacted their identification of the industry as posing a high risk under CERCLA Sec.108(b)? If so, what information has been provided and has your agency expressed any concerns with this approach?**

   EPA's priority notice of action published in the Federal Register on July 28, 2009, 74 Fed. Reg. 37,213 (July 28, 2009), described eight factors it considered in identifying hardrock mining under section 108(b) of CERCLA. One of the eight factors considered by EPA was the number of mine sites on the CERCLA site inventory (including both National Priority List sites as well as non-NPL sites). The BLM has provided EPA with information on the way mining and reclamation practices have evolved from past practices.

3. **Has your agency received any information from EPA indicating that it intends to link the cost of remediating legacy (pre-1990) hardrock mining (or processing) sites to the calculation of future financial assurance requirements that may be imposed under CERCLA Sec.108(b)? If so, what information has been provided and has your agency expressed any concerns with this approach?**

   The EPA has indicated that it has not yet determined the methodology by which the proposed rule will identify the amount of financial assurance required. The BLM has provided EPA with information regarding modern mining practices.

4. **Please provide a description of how your agency currently calculates financial assurance requirements applicable to hardrock mines on federal lands.**

   In 2001, the BLM made substantial changes to its surface management regulations that strengthened bonding requirements. Currently, the BLM requires financial assurances for all surface disturbance above casual use in an amount sufficient to cover the costs of hiring a third-party contractor to fully reclaim the disturbance authorized under the Notice or Plan of Operations. Operators are not allowed to begin any surface disturbance guaranteed by the financial guarantee until the BLM has accepted and obligated the bond.

   The BLM reviews reclamation cost estimates every three years (every year if the operation is bonded incrementally) and requires the operator to increase bond coverage, if necessary.

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The BLM holds $1.7 billion in financial assurances.

The BLM considers the following costs when calculating the amount of the required financial assurance:

- All costs of complying with the reclamation performance standards in 43 C.F.R. § 3809.420, including compliance with Federal and State environmental protection laws, and any additional reclamation and closure requirements identified in the accepted Notice or approved Plan of Operations;
- All relevant operation, maintenance, and administrative costs for reclamation;
- Costs associated with using offsite equipment as if the project area was vacated, as well as associated mobilization and demobilization costs;
- When applicable, all interim maintenance costs required to keep the area of operation in compliance with applicable safety and environmental requirements while reclamation contracts are developed and executed;
- Construction and maintenance costs of any long-term treatment facilities or post-closure structures and/or activities required;
- Labor costs, based on federal regulations; and
- Costs of complying with all other performance standards in 43 CFR §3809.420.

5. Can your agency approve a plan of operations that poses a high risk of unnecessary or undue degradation of public lands? How would your agency typically respond to a plan of operations that it believed posed a high risk of unnecessary or undue degradation of public lands?

The Federal Land Policy and Management Act requires the BLM to prevent unnecessary or undue degradation (UUD) of the public lands. 43 U.S.C. § 1732(b). Under the BLM's surface management regulations, the BLM will disapprove a Plan of Operations if the proposed operations would result in UUD. 43 C.F.R. § §3809.411(d)(3)(iii). If the BLM receives a proposed Plan of Operations that would likely result in UUD, then BLM would require the operator to modify its proposed plan. Should the operator fail to make the required modifications, the BLM would not approve the plan.

6. Does your agency have the authority to impose financial assurance requirements for post-mining, long-term monitoring, maintenance and treatment operations?

The regulations at 43 C.F.R. § 3809.552(c) allow BLM to require an operator to establish a trust fund or other funding mechanism to ensure the continuation of any long-term, post-mining treatment or maintenance requirements. When the BLM District or Field Manager determines a need for a long-term funding mechanism, based on specific long-term corrective actions, the operator must establish an acceptable trust fund or other funding mechanism that is adequate to provide for construction, long-term operation, maintenance, or replacement of any treatment facilities and infrastructure, for as long as the treatment and facilities are projected to be needed

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after mine closure. As with other financial guarantees, the long-term trust fund assures the performance of the operator's obligations, and is only used if the operator defaults.

7. **How many hardrock mining and beneficiation plans of operation has your agency approved since 1990?**

   There have been 659 plans of operations authorized by BLM's Mining Law Administration Program since 1990.

   a. **How many of those sites are, or have been, placed on the CERCLA NPL?**

   There have been no sites on which a mining plan of operations was approved since 1990 that have been placed on the CERCLA NPL.

   b. **How many of those sites placed on the CERCLA NPL involve(d) a responsible party that pays (paid) for the cost of short-term removals or long-term remediation, either in part or in whole? What is the aggregate dollar amount spent by these responsible parties? What is the aggregate dollar amount spent by the federal (or state) government?**

   There are no such sites.

8. **Does your agency coordinate – or has it coordinated in the past – with states to develop financial assurance requirements for hardrock mines on non-federal lands? If so, please describe this coordination.**

   Requiring financial assurances for hardrock mines on non-federal lands is generally outside of the BLM's authority. Exceptions to this general rule include: operations on certain split-estate lands where the surface estate is patented, but the locatable mineral estate remains under Federal ownership (such as lands patented under the Stock Raising Homestead Act), and lands that remain subject to Federal regulation even after patenting (such as lands patented in the California Desert Conservation Area).

   In these instances, as with the regulation of hardrock mining on Federal lands, the BLM has authority to enter into agreements with states to allow for joint Federal and State administration and enforcement of mining operations, including financial guarantees. 43 C.F.R. § 3809.200. Alternatively, the Federal-State agreement may provide for deferral of BLM's surface management responsibilities to the State, rather than administering the operation jointly.

   If the Federal-State agreement covers financial guarantees, an operator may use a single financial instrument to meet both Federal and State financial guarantee requirements. The BLM and the State must concur on the amount of the financial guarantee, which must be

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calculated based on completion of all applicable Federal and State reclamation requirements for the entire operation. To be held as a single financial guarantee, any financial instrument(s) used for the financial guarantee must be acceptable to the BLM under 43 C.F.R. § 3809.555 or § 3809.571.

9. **Please provide all documents, records, papers, reports, agreements, notes, correspondence, presentations, analyses, comments, and any other materials generated by your agency as part of an inter- or intra-agency process associated with the EPA's CERCLA Sec.108(b) rulemaking.**

   This request for documents prepared as part of an ongoing rulemaking process for which no draft rule has yet been proposed implicates important confidentiality interests for the Executive Branch. In order to provide information, we have attached a copy of Instruction Memorandum 2006-135, detailing the BLM's latest requirements for the review and acceptance of reclamation cost estimates. We are happy to provide a briefing or additional material on the BLM's program as well as to participate in a multi-agency briefing with the EPA and the Forest Service if that is preferred.

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Index of documents responsive to the March 8, 2011, request from Senator Murkowski for documents related to the actions being taken by the Environmental Protection Agency related to financial assurance requirements, including bonds, for hardrock mines in the United States

Volume: 00026366_Murkowski_001

	Document Name	Pages	Document Date	Document Type	Document Title
1	BLM-WDC-B03-00001-000001	14	20060410	OTH	Instruction Memorandum (IM) 2006-135, Reclamation Cost Estimates for Notices and Plans of Operations
	Total Pages:	**14**			

DOI-19-0291-I, 19-0538-J-000140

United States Department of the Interior

OFFICE OF THE SECRETARY
Washington, D.C. 20240

June 17, 2011

Technical Instructions/Information

This production CD is labeled "00026366_Murkowski_001" and contains 1 document consisting of 14 pages.

All images on the CD are in a multi-page PDF format. PDF files can be opened with Adobe Reader.

On the CD-ROM there is a copy of the index for the volume. The following fields are included on the index: document name, page count, document date, document type, document title, and request number.

The format of the date field is the four-digit year, two-digit month and two-digit date (YYYYMMDD). If any part of the date is illegible or unknown, there is an X as a placeholder for the digit.

The index lists the abbreviations for the document types. A list of the abbreviations is as follows:

AGN = Agenda
ANL = Analysis
APR = Appraisal
ART = Article - News
AUD = Audit
BRF = Briefing Paper
CAL = Calendar
CON = Contract
COO = Court Decision/Opinion/Order
COR = Correspondence (Memo)
DEC = Declaration
EML = E-mail
GRT = Grant
LEA = Lease
MAP = Map
MOU = Memorandum of Understanding
MTG = Meeting/Minutes
NTE = Notes
NTI = Notice
OTH = Other
PRO = Proposal
REC = Receipt
REG = Regulation
RPT = Report
STA = Statue
STM = Statement
SUB = Subpoena
TES = Testimony
TRA = Transcript
TVO = Travel Voucher/Order

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UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
Washington, D. C. 20240
http://www.blm.gov

April 10, 2006

In Reply Refer To:
3809 (320) P

EMS TRANSMISSION 04/20/2006
Instruction Memorandum No. 2006-135
Expires: 09/30/2007

To: All Field Officials

From: Assistant Director, Minerals, Realty and Resource Protection

Subject: Reclamation Cost Estimates for Notices and Plans of Operations

Program Area: Mining Law Administration, Surface Management

Purpose: The purpose of this Instruction Memorandum (IM) is to provide policy guidance for the review and acceptance of reclamation cost estimates for Notices and Plans of Operations under the 43 CFR 3809, Surface Management Regulations.

Policy/Action: The operator must provide the responsible Field Office with an acceptable estimate of the reclamation costs for all proposed Notices and Plans of Operations. The operator's estimate of the cost to reclaim the operations must meet the requirements of 43 CFR 3809.552(a) and 3809.554(a), and must be acceptable to BLM as required by 43 CFR 3809.554(b). When the Field Manager requires a trust fund or other funding mechanism under 43 CFR 3809.552(c) to guarantee post-mining obligations, the operator must also provide the Field Office with a cost estimate for the monitoring, construction, operation, maintenance, replacement and other activities for the required facilities, treatment or other needs documented in the Plan of Operations.

Based on a review of the reclamation cost estimate, the Field Manager must provide the operator with a written decision as to the amount of the required financial guarantee. Operations may not commence until the operator has received written notification that BLM accepted and obligated the operator's financial guarantee, and the complete Notice is accepted or Plan of Operations approved by the Field Manager.

Specific policy and procedural guidance for reviewing and accepting an operator's reclamation cost estimate are given in Attachment 1 - *Guidelines for Reviewing Reclamation Cost Estimates* attached hereto.

Time Frame: This IM is effective immediately and will be in effect unless formally modified.

Budget Impacts: There will be a budget impact, but there is no estimate at this time.

Background: The revised Surface Management Regulations became effective on January 20, 2001, with subsequent amendments that took effect through December 31, 2001. The final regulations require all Notices and Plans of Operations to post full-cost financial guarantees in an amount sufficient to allow BLM to contract with a third party to reclaim the operations according to 43 CFR 3809.552(a). The final regulations also require an operator to establish a trust fund or other funding mechanism available to the BLM to ensure the continuation of any long-term, post-reclamation treatment or maintenance requirements identified in the decision document for the operation.

Manual/Handbook Sections Impacted: Bureau Manual Section 3809 - This guidance will be included in the 3809 Surface Management Manual and Handbook that are now being prepared.

Coordination: The policies and procedures found in this IM were developed with input from the Office of the Solicitor, and BLM State and Field Offices.

Contact: If you have any questions concerning this IM, please contact T. Scott Murrellwright at 202-785-6568 or Paul McNutt at 775-861-6604.

Signed by:
Thomas P. Lonnie
Assistant Director
Minerals, Realty and Resource Protection

Authenticated by:
Robert M. Williams
Division of IRM Governance, WO-560

1 Attachment
1 - *Guidelines for Reviewing Reclamation Cost Estimates* (13 pp)

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0002636 DOI-M19-02901-1, 19-0538-U-000142

Guidelines for Reviewing Reclamation Cost Estimates

BLM's Review Responsibilities

New or Modified Operation - When submitting a new Notice or Plan of Operations the operator must provide BLM with a reclamation cost estimate that meets the requirements of 43 CFR 3809.552(a) and 3809.554(a), and must be acceptable to BLM as required by 43 CFR 3809.554(b). Where an existing Notice or Plan of Operations is proposed to be modified, the operator must provide the Field Office with an estimate of the reclamation costs for all components of the existing and proposed operation that will be effected by the modification.

BLM will review the operator's reclamation cost estimate to determine if the operator has identified and incorporated all applicable reclamation and administrative costs (identified below). In performing the review of the operator's reclamation cost estimate, the responsible Field Office will notify the operator, in writing, of any deficiencies or additional information needed in order for BLM to complete the review. It is not BLM's responsibility to calculate the reclamation cost for an operator, but the Field Office, at the Field Manager's discretion, may assist the operator in identifying costs to be included in the estimate and in developing the cost estimate.

Reclamation Cost Estimate for Part of an Operation - Where the Field Manager authorizes an operator to provide BLM with a financial guarantee under 43 CFR 3809.553 that covers a part of the operation ("phased financial guarantee") the operator must prepare a reclamation cost estimate for the part of the operation to be covered by the partial financial guarantee. The reclamation cost estimate for part of the operation must conform to the same standards as the reclamation cost estimate for the entire operation. In addition to the reclamation cost estimate for a part of the operation, the operator must also prepare a separate reclamation cost estimate for all operations proposed in the Plan of Operations on public lands. The Field Manager's decision on the amount of the required financial guarantee will identify both the total and partial cost estimates. The amount of the required financial guarantee will be based on the reclamation cost estimate for the part of the operation where the authorized incremental operations are to occur.

Long-Term Funding Mechanisms - When a trust fund or other funding mechanism is required under 43 CFR 3809.552(c), the operator must provide the Field Office with a cost estimate for the monitoring, construction, operation, maintenance, replacement and other activities for the required facilities, treatment or other needs documented in the Plan of Operations. The operator's estimate must project when the cost obligations will occur. For reoccurring costs, such as maintenance of a water treatment facility, the frequency, timing and duration of the obligation should be estimated for each cost component. The operator's cost estimate prepared for long-term obligations to be covered under 43 CFR 3809.552(c) should be documented separate from the reclamation cost estimate [43 CFR 3809.554(a)]. The cost estimates for the long-term post-reclamation obligations must be reviewed by the Field Manager in the same manner and with the same degree of care that is used in estimating traditional financial guarantees for reclamation obligations.

ATTACHMENT 1-1

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Periodic Review - It is BLM's responsibility to conduct a periodic review of the reclamation cost estimate. As required by 43 CFR 3809.552(b) and 3809.553(b), BLM must ensure the amount of the required financial guarantee for ongoing operations continues to meet the requirements of the regulations and all reclamation requirements in the accepted Notice or approved Plan of Operations. Unless the operator is proposing a modification to the Notice or Plan, the existing reclamation cost estimate does not reflect authorized operations, or additional information is needed, BLM's review will consist of a complete evaluation and update of the operator's reclamation cost estimate on file. Where additional information is necessary to complete the review or a revised reclamation cost estimate is required, the Field Manager will direct the operator to provide that information.

Reclamation Cost Estimate Assumptions and Conditions

The reclamation cost estimate must be based on the following assumptions and conditions:

- The estimate must cover all relevant operation, maintenance and administrative costs for all reclamation identified in the filed Notice or approved Plan of Operations [43 CFR 3809.301(b), 3809.401(d) and 3809.552(a)].

- Costs must be estimated as if BLM were hiring a third party contractor to perform all required reclamation [43 CFR 3809.552(a)].

- Costs must include the use of off-site equipment as if the project area was vacated, and the estimate must include all associated mobilization and demobilization costs [43 CFR 3809.554(a)].

- The estimate must include, when applicable, all interim maintenance required to keep the area of operation in compliance with applicable safety and environmental requirements while reclamation contracts are developed and executed [43 CFR 3809.552(a)].

- The estimate must cover costs to construct and maintain any long-term treatment facilities or post-closure structures required by the filed Notice or approved Plan of Operations [43 CFR 3809.552(a)].

- Where applicable, labor costs must be based on federally mandated labor rates, as required by the Davis-Bacon Act and the Federal Acquisition Regulations (FAR) for contracts over $2,000. If the reclamation and cost estimate is solely for the dismantling, demolition, or removal of improvements, then contracting is under the Service Contract Act and Davis-Bacon wage rates do not apply. If construction, alteration or repair of the improvements is contemplated, even if it is under a separate contract, then the Davis-Bacon wages apply. (www.access.gpo.gov\davisbacon).

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Maximum Reclamation Cost - The reclamation cost estimate must reflect the maximum cost of reclamation for the proposed disturbance to be covered by the financial guarantee. The point of maximum reclamation costs is often when there is the greatest area of disturbance, greatest volume of materials needing special handling, or some other factor or combination of factors escalating the cost to reclaim. The maximum cost of reclamation is generally not at the end of the project life.

Unless the Field Manager authorizes a phased financial guarantee under 43 CFR 3809.553, the financial guarantee is for the entire life of the mine. In reviewing the operator's estimate, the BLM must make sure the reclamation cost estimate for a life-of-mine financial guarantee reflects the maximum reclamation obligation.

Inflation - Inflation can, over time, become a significant factor in the amount of the required financial guarantee. This is an especially important concern where the potential exists for a substantial time interval between the BLM's review of the reclamation cost estimate and the potential collection and use of a forfeited financial guarantee. To minimize the potential impact inflation can have on the amount of the financial guarantee needed to cover the current reclamation cost the Field Office must review on a periodic basis the reclamation cost estimates for all ongoing operations as addressed in this IM. The maximum allowable time period between reviews is discussed below (Periodic Review).

Reclamation, Closure, Mitigation and Monitoring

The reclamation operating and maintenance (O&M) costs reflect the direct current costs of reclamation based on the reclamation and closure measures in the Notice or approved Plan of Operations. Reclamation and closure tasks typically fall into the following categories:

- Interim Operation and Maintenance – If an operator abruptly ceases operations, immediate site operation and maintenance may be required by a third party to maintain the area of operation in compliance with applicable safety and environmental requirements. There is no preset time period for the care and maintenance of a site prior to the start of reclamation; much depends on BLM's ability to access the financial guarantee, especially in bankruptcy cases. It is a good rule-of-thumb to allow for a minimum of six months of interim O&M by a contractor. Large operations or project areas with limited seasonal access may warrant a longer time period.

- Hazardous Materials – This may include the cost of decontaminating, neutralizing, disposing, treating or isolating hazardous materials used, produced, or stored on the site. The estimated cost for handling hazardous materials should assume, unless otherwise documented, that the material is properly stored and labeled.

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If upon site inspection, it is determined the operator is using, producing or storing material on site that could be hazardous, e.g. unlabeled barrels, and the BLM is unsuccessful in getting the operator to properly manage those materials (operator has failed to comply with a noncompliance order), the reclamation cost estimate must be updated to reflect the higher cost of disposing of such material. This distinction is important as the disposal of properly managed hazardous materials may be a fraction of the disposal cost for materials that are not properly stored and identified.

- Water Treatment – All necessary construction and maintenance water treatment costs needed to ensure that mine discharge or drainage will meet relevant standards must be identified in the reclamation cost estimate. The cost of long term, post-reclamation operation, maintenance, and replacement requirements may be addressed in a trust fund established under 43 CFR 3809.552(c).

- Mine Facilities – The demolition, removal and disposal of all mine facilities, immobile equipment and material from the project area must be accounted for in the reclamation cost estimate. Disposal costs for those facilities which have been approved in writing by the BLM for post-reclamation BLM use may be excluded from the reclamation cost estimate. No salvage value for structures, equipment or materials is allowed in the reclamation cost estimate.

  Operable mobile equipment, e.g. trucks, dozers, etc., may be excluded from the cost estimate. If upon site inspection, it is determined the mobile equipment is inoperable and the BLM is unsuccessful in getting the operator to repair or remove the inoperable equipment from the project area (operator has failed to comply with a noncompliance order), the cost of removing and disposing of that equipment must be included in the reclamation cost estimate.

- Earthwork – Earthwork includes, but is not limited to, the cost of hauling, placement, regrading and backfilling to reclaim mine disturbances, including roads that have not been specifically identified and approved to remain open.

- Drill Hole Plugging – The cost of plugging, capping, and isolation of drill holes, including exploration, production and monitoring holes, must be addressed in the reclamation cost estimate. Specifically, care needs to be taken in determining plugging costs based upon whether drill holes encounter water, water under artesian pressure, or dry holes. Proposed plugging must meet all applicable Federal and State requirements.

  Where the operator is proposing drilling, the reclamation cost estimate must include, at a minimum, the estimated cost of plugging the maximum number of drill holes that may be open at one time, or the number of drill holes at a particular phase of the exploration program. The reclamation cost estimate must never be less than the cost of plugging one drill hole for each drill rig that will be working in the project area.

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Where the submitted Notice or approved Plan of Operations calls for drill holes to be plugged, but doesn't specifically require the drill holes be plugged before the drill rig has been moved from the drill pad, the reclamation cost estimate must include the plugging cost for all drill holes identified in the Notice or Plan of Operations. For all drill holes, and water, monitoring and piezometer wells scheduled to be left open, the estimated plugging cost must be included in the reclamation cost estimate. Where the approved Plan of Operations proposes mining through an area where drilling is to occur and the cost of the post-mining reclamation is included in the reclamation cost estimate, the cost estimate for plugging those drill holes is not needed.

If the State Director determines the State's plugging and financial guarantee requirements related to drill hole plugging accomplishes the same level of protection as this policy, the Field Manager may base the estimated plugging costs on the State requirements.

- Revegetation – The reclamation cost estimate must include the cost of obtaining the seed mix specified in the reclamation plan and the cost of soil preparation, such as ripping or harrowing; soil amendments, such as mulching or fertilizer; application of the seed mix; noxious weed control; and placement of tree and shrub seedlings, if required. The cost for hauling and placement of growth medium, if not addressed under earthwork, must be included.

- Mitigation – Mitigation may include avoiding, minimizing, rectifying and reducing or eliminating the impact, or compensating for the impact. The cost of any deferred mitigation the Field Office is requiring the operator to perform must be included in the reclamation cost estimate. For example, if the operator is required to develop five acres of wetlands to compensate for disturbance elsewhere on the project area, until that wetland development is completed the reclamation cost estimate must include the cost of that mitigation.

- Post-Reclamation Costs – The cost of meeting any long-term construction, operation, maintenance, or replacement of any treatment facilities and infrastructure, which are not addressed in a trust fund established by 43 CFR 3809.552(c), must be included in the reclamation cost estimate.

In estimating the cost to perform these reclamation, closure, mitigation and monitoring tasks, the operator's estimate must identify the current O&M costs relating to reclamation including:

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- Equipment rental or acquisition costs,
- Equipment operation costs,
- Equipment maintenance costs,
- Cost of operating supplies,
- Labor costs for operations, maintenance and supervision,
- Site maintenance including roads, infrastructure, power lines, fences and monitoring facilities,
- Reclamation materials acquisition costs, and
- Mobilization and demobilization costs.

All line items contained in an acceptable reclamation cost estimate are not to be considered spending constraints should a financial guarantee be forfeited. The line items listed are solely for the purpose of arriving at a total financial guarantee amount. This total amount may be spent however the BLM deems necessary to implement the reclamation plan. Care should be exercised so that decisions on the amount of the financial guarantee correctly reflect this policy.

Information sources that may be useful in conducting a cost analysis include: applicable parts of the Office of Surface Mining's Handbook for Calculation of Reclamation Bond Amounts (http://www.wrcc.osmre.gov/), BLM's Solid Minerals Reclamation Handbook H-3042-1, the Caterpillar Performance Handbook, Western Mine Engineering, Inc. (use for operator estimates only-does not consider third party contract estimates), R.S. Means Site Work Cost Data, Dataquest (equipment operating and owning costs), Rental Rate Blue Book for Construction Equipment, and Skills & Knowledge of Cost Engineering. The user of these references needs to be cognizant of how the data may be applied. The reclamation cost estimate must reflect BLM's cost to contract to have the work performed; owner/operator cost data does not reflect BLM's contracting cost.

BLM Administrative Costs

The Field Office must ensure the cost of reclamation is estimated as if BLM were hiring a contractor to perform all required reclamation. This will include costs that the operator does not normally encounter. The BLM reviewer needs to pay particular attention to costing standards that are based, in part, on the Federal Acquisition Regulations. The responsible BLM specialist should coordinate with their State Office procurement analyst concerning current labor wages, contracting requirements, and advice on various types of contracts, contract language, and administration.

This guidance contains suggested percentages for some of these administrative costs. Unless otherwise noted, these percentages should be treated as rules-of-thumb and not as precise amounts specified by regulation or law. Figures or percentages, other than those listed below, should be included in a calculation if they are explicitly addressed in a Federal-State agreement regarding the financial guarantee and/or are required by Federal or State law.

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Unless otherwise noted, the administrative cost categories identified below should be included in the reclamation cost estimate.

- Engineering, Design and Construction (ED&C) Plan - An ED&C plan provides the details needed for contracting the reclamation construction work. Where appropriate, the reclamation cost estimate should reflect the costs to prepare such a plan. Should the operator fail to reclaim, the BLM may need to undertake a number of tasks including:
    - Preparation of maps and plans to show the extent of required reclamation.
    - Survey of topsoil and growth medium stockpiles to determine amount of material available.
    - Sampling and analysis of waste rock, tails, heap material, surface and ground water, etc.
    - Sampling and analysis of topsoil, growth medium and waste piles to determine whether special handling or treatment is necessary.
    - Evaluation of structures to determine requirements for demolition and removal.
    - Evaluation of storm water facilities and process solutions or water impoundments to determine if treatment, clean out, or other improvements are necessary.
    - Preparation of a supplemental environmental analysis or site studies before reclamation may commence.

  Reported costs for preparation of this data collection, analysis and planning have ranged from 2 to 20 percent of the estimated reclamation O&M costs. The actual cost will depend to a great extent on the specifics, including reclamation complexities, of the proposed operation. The amount or percentage you apply should be based on available data within your State. Absent specific local or State data, we recommend the ED&C costs be estimated as 4 to 8 percent of the estimated reclamation O&M costs.

  Inclusion of a line item for the development of an ED&C plan may not, however, be necessary for all operations. Specifically, small operations, such as notice-level operations, may not require the inclusion of funds to collect, analyze and develop the detailed engineering information; reclamation contracting and construction may be able to proceed without developing an ED&C plan.

- Contingency – Contingency allowance is for cost overruns that regularly occur but cannot be ascertained when an operation is being reviewed. Contingency costs generally reflect the level of detail and completeness of the cost estimate, as well as the level of uncertainty in the assumptions used for the reclamation cost estimate. With the development of an ED&C plan many of the unforeseen circumstances and costs are identified. Contingency costs do not, however, include changes in the scope or unforeseeable or unanticipated events such as earthquakes, labor strikes or floods.

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Federal and State agencies that routinely prepare construction cost estimates apply contingencies, ranging from 3 to 45 percent of the O&M costs. The amount or percentage required should be based on available reclamation or construction contract information within your State. Absent reliable local or State information, we recommend the inclusion of a contingency of 4 to 10 percent of the estimated reclamation O&M costs. Where State law specifies an amount, use that figure.

Where the proposed operation involves a relatively small, uncomplicated reclamation effort, and development of an ED&C plan is not anticipated, there may not be a need to include a contingency line item. It is advisable to ensure a contingency is included for operations with estimated reclamation O&M costs over $100,000. As with an ED&C plan, reclamation cost estimates for notice-level operations may not require the inclusion of a contingency allowance.

- Contractor Profit – Government contracts generally include a contractor profit over and above the estimated reclamation O&M costs. Reported prime contractor's profits and overheads on existing contracts cover a wide range of values (10 to 35 percent). For financial guarantees we recommend 10 percent of the estimated O&M costs. Where State or local contract information suggests a different amount or where State law specifies an amount, use that figure. Inclusion of a line item for prime contractor's profit may not be required if the operator incorporates the prime contractor's profit into the O&M estimate. In such cases, the operator's reclamation O&M estimate must document the inclusion of the prime contractor's profit.

- Liability Insurance - The contractor's liability insurance premium must be included in the reclamation cost estimate. If the liability insurance is included in the reclamation O&M estimate, this needs to be documented. The contractor's liability insurance premium should be estimated as 1.5 percent of the estimated labor costs for the project and included in the reclamation cost estimate.

- Payment and Performance Bonds - Payment of premiums for both a performance bond and a payment bond as required by the Miller Act, with estimated contract costs over $100,000, must be included in the reclamation cost estimate. A set amount equal to 3 percent of the estimated O&M costs should be used to calculate the payment of premiums for both a performance bond and a payment bond.

- BLM Contract Administration - BLM's labor and operations costs for the Field and State Offices to administer the contract must be included in the financial guarantee. Reported contract administration costs range from 2 to 25 percent. We estimate BLM's contract administration and inspection cost for reclamation contracts as 6 to 10 percent of the estimated O&M costs, depending on the size and complexity of the proposed operation. The actual cost will depend to a great extent on the specifics of the proposed operation, including reclamation complexities.

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Where data is available, the State or Field Office should review their records to determine appropriate costs. Generally the larger the amount of the financial guarantee the lower the percentage needed for contract administration.

- BLM Indirect Costs - BLM's indirect costs for contract administration must be included in the amount of the required financial guarantee. The indirect cost rate is a fixed 21 percent of the estimated BLM contract administration cost; therefore the indirect costs may range from 1.26 to 2.1 percent of O&M costs (21% of the 6 - 10% contract administration costs).

  If BLM is required to administer a reclamation contract under a forfeited financial guarantee, these indirect cost funds are to remain within the State where the reclamation work will be done. The funds will be available to pay for within-State indirect costs (building rental, telephone, etc.) associated with the project and any project support needed from other offices such as the Denver Service Center contract officers or inspectors.

In reviewing the operator's reclamation cost estimate, the Field Office may need to determine what administrative costs the operator has included with their reclamation O&M costs. For example, operator's labor cost estimates may include base pay, payroll loading, overhead and profit. A typical dozer operator rate in Idaho, in 2002, was $37.59 to $40.25 per hour. This rate included the base pay plus 14.6 percent payroll loading, 10 percent overhead, and 6 percent profit. To avoid overlooking or double counting any of the identified administrative costs, e.g. contractor profit, the operator must document what administrative costs are included in their labor costs or other O&M costs. This may be done by itemizing the cost estimates or by providing BLM with a signed statement that identifies the specific administrative costs that are included in their estimated O&M costs.

Reclamation Cost Estimating Tools

Individual BLM State Offices or Field Offices may develop there own tools to support the reclamation cost estimating process. Summary sheets, checklists, and cost models maybe available to assist the operator in developing the reclamation cost estimate.

Standardized reclamation cost estimating processes, that include standardized unit costs, schedules, spreadsheets and models, are useful tools that provide simplified, efficient, defensible and consistent means of estimating reclamation costs for both Notices and Plans of Operations. Where appropriate, BLM State and Field Offices are encouraged to develop processes based on standardized unit costs to facilitate the review and approval of the operator's reclamation cost estimate. A process that uses standardized costs may be developed, based on local and/or regional costs, to reclaim typical activities, features and facilities (roads, drill pads, drill-holes, trenches, pits, structures, site stabilization, revegetation, etc.) for specific kinds of terrain (topography).

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Where a standardized reclamation cost estimating process is used, the amount of a financial guarantee must be sufficient to meet the requirements of 43 CFR 3809.552(a) and 3809.554(a). The assumptions used in developing the cost inputs must be consistent with both State and Federal regulations and laws. Determining consistency with State and Federal regulations and laws goes beyond the applicable environmental requirements. The assumptions used must also be consistent with applicable contracting requirements, such as Federal Acquisition Regulations. For example, under Federal contracting we cannot require an operator to work double shifts. As such, the reclamation cost estimate should not be based on the assumption that the reclamation contractor will conduct the work using a double shift.

Periodic Review

The BLM Field Office must provide a periodic review of reclamation cost estimates for ongoing operations and issue a determination as to the amount of the required financial guarantee. Based on a complete evaluation and update of the reclamation cost estimate, the periodic review must ensure the current amount of the financial guarantee continues to meet the requirements of 43 CFR 3809.552(a), 3809.552(c) and 3809.554(a).

The following establishes the maximum time the BLM may allow to elapse between reviews. The BLM has the authority to require a more frequent review of the reclamation cost estimate at the discretion of the Field Manager.

- Reclamation cost estimates for Notice operations must be reviewed every 2 years at time of the Notice extension under 43 CFR 3809.333.

- Reclamation cost estimates for Plans of Operations must be reviewed at least every 3 years.

- Where the BLM has an agreement under 43 CFR 3809.200 with the State that requires a review more frequent than every 2 years for Notices or every 3 years for Plans of Operations, reviews must be conducted in conformance with that agreement.

- Where the Notice or Plan of Operations is modified, a review must be conducted at the time of modification. The reclamation cost estimate review must focus on how the modification affects the existing cost estimate on file. Unless the proposed modification necessitates a complete review, the entire current reclamation cost estimate does not need to be reviewed. However, a review that covers a portion of the reclamation cost estimate on file for the modified Notice or Plan does not substitute for the required 2-year review for a Notice or 3-year review for a Plan of Operations.

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- Where the financial guarantee is for a part of the operation, as provided under 43 CFR 3809.553, BLM must review the reclamation cost estimate annually [43 CFR 3809.553(b)]. The Field Office will evaluate and update the reclamation cost estimate for each increment of the operations. In addition to the annual review requirement for the phased financial guarantee coverage, the Field Office must also review the reclamation cost estimate for the entire Notice every 2 years or entire Plan of Operations every 3 years as required above.

- The Field Office must conduct, at least every 3 years, a thorough review of the cost estimates and other assumptions used in determining the amount of funds needed in the long-term funding mechanism required under 43 CFR 3809.552(c). The Field Office must also monitor the growth of all trust funds. At least once a year the responsible Field Office must review the financial statements to ensure growth of the fund is keeping pace with the assumptions used to determine the amount needed in the fund.

Review Results and Decisions

The Field Manager must issue a decision that establishes the amount of the required financial guarantee. The decision must be provided to the operator following the completion of the review of the reclamation cost estimate with a copy provided to the BLM office responsible for adjudication of the financial guarantee.

Acceptable Review Results - When the Field Office has received an estimate that is acceptable, the Field Manager must provide the operator with a written decision as to the amount of the required financial guarantee. The decision must state: 1) the amount of the financial guarantee to be provided ($0.50 or more rounded up to the nearest whole dollar and less than $0.50 rounded down to the nearest whole dollar), and 2) the types of financial instruments that are acceptable to the BLM. The Field Manager's decision must also state that an operator may not begin operations under a new or modified Notice or Plan of Operations without first providing BLM with an acceptable financial guarantee that meets the requirements of 43 CFR 3809.551 thru 3809.572; no activity greater than casual use is authorized until the BLM has accepted and obligated the operator's financial guarantee.

Following the periodic review for an ongoing operation, the Field Manager will make a determination as to the amount of the required financial guarantee. If there is a change in the required amount of the financial guarantee or the review was conducted at the request of the operator, the Field Manager must issue a decision as to the amount of the required financial guarantee. For ongoing operations under an existing Notice and Plan, the decision must state: 1) the amount of the required financial guarantee, 2) any change (increase or decrease) in the amount of the required financial guarantee, 3) that the operator has 60 days from receipt of the decision to submit an acceptable financial guarantee if the amount has increased, and 4) that failure to provide an acceptable financial guarantee within the specified timeframe will result in an enforcement action against the operator for failure to maintain an acceptable financial guarantee.

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For a Notice extension under 43 CFR 3809.333, where the amount of the required financial guarantee has increased, the decision must also state: 1) that the Notice is conditionally extended subject to meeting the financial guarantee requirements, 2) that failure to provide an acceptable financial guarantee within 60 days will result in the Notice expiring immediately upon conclusion of the timeframe, and 3) that upon expiration of the Notice, all activities, other than reclamation, are unauthorized and must cease.

Unacceptable Review Results - If the Field Office finds the operator has incorrectly calculated operating and maintenance costs, or finds that the estimate is based on out-of-date cost data that does not reflect the actual cost of reclamation, then the estimate will not be accepted. When an estimate is not acceptable, the Field Manager must notify the operator, in writing, of its unacceptability, and identify the deficiencies or errors that led to that conclusion. The BLM must advise the operator to incorporate the administrative costs outlined above if they are not included in the estimate.

Where the reclamation cost estimate for a new Notice is not acceptable to the BLM, the Notice will not be considered complete as required under 43 CFR 3809.301.

Additional Information - For ongoing operations, where the Field Office lacks the information necessary to determine the adequacy of the existing reclamation cost estimate, the Field Manager must notify the operator of the deficiencies or errors and include a due date when the information or revised reclamation cost estimate must be submitted. Failure to provide the required information within the specified timeframe will result in an enforcement action against the operator for failure to maintain an acceptable financial guarantee.

For Notices to be extended under 43 CFR 3809.333, where the Field Office lacks the information necessary to determine the adequacy of the existing reclamation cost estimate, the Field Manager must issue a decision giving the operator 30 days from receipt to provide all of the requested information. The Notice will be conditionally extended pending Field Office receipt of the required information. Failure to provide the required information within the 30-day period will result in the Notice expiring.

Appeal of Review Decisions - Decisions relating to the acceptability or unacceptability of a financial guarantee are subject to appeal under the provisions of 43 CFR 3809.800. Any adversely affected party may elect to seek a State Director Review (SDR) under 43 CFR 3809.800(a) or appeal directly to the Office of Hearings and Appeals (OHA) under 43 CFR 3809.801.

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Appeal to OHA of a Field Manager's decision must be filed in the office that issued the decision. The Field Office then forwards the Notice of Appeal to OHA. Appeals must be filed by the appellant with the office that issued the decision within 30 days of receipt of the decision. Request for an SDR are filed with the office of the State Director within 30 days of the Field Manager's decision. If the review and evaluation of the financial guarantee and/or financial instrument was conducted by the State Office, a request for State Director review under 43 CFR 3809.806 may not be accepted.

Decrease the Amount - Where the existing amount of the financial guarantee exceeds the Field Manager's determination as to the amount of the required financial guarantee, the operator may request BLM decrease the amount of the required financial guarantee. Any request by the operator for a reduction in the amount of the financial guarantee must be made to the BLM office responsible for adjudicating the financial guarantee.

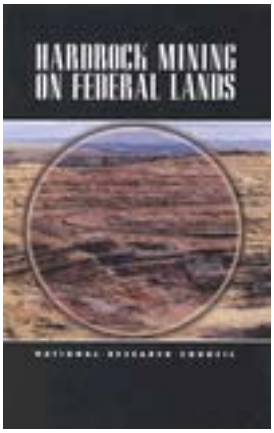
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Exhibit C

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Hardrock Mining on Federal Lands

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HARDROCK MINING ON FEDERAL LANDS

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This report has been reviewed by individuals chosen for their diverse perspectives and technical expertise in accordance with procedures approved by the NRC's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the authors and the NRC in making their published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The content of the review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their participation in the review of this report:

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Executive Summary

This report responds to a request by Congress that the National Research Council assess the adequacy of the regulatory framework for hardrock mining on federal lands. The regulatory framework applies to hardrock (locatable) minerals—such as gold, silver, copper, and uranium—on over 350 million acres of federal lands in the western United States. To conduct the study, the National Research Council appointed the Committee on Hardrock Mining on Federal Lands in January 1999.

The charge to the Committee had three major components. First, the Committee was asked to identify federal and state statutes and regulations applicable to environmental protection of federal lands in connection with mining activities. Second, the Committee was charged with considering the adequacy of statutes and regulations to prevent unnecessary or undue degradation of the federal lands. Third, the Committee was asked for its recommendations for the coordination of federal and state regulations to ensure environmental protection, increase efficiency, avoid duplication and delay, and identify the most cost-effective manner for implementation.

The report deals with hardrock mining on federal lands managed by two agencies—the Bureau of Land Management (BLM) in the Department of the Interior, and the Forest Service in the Department of Agriculture. The area of federal land available to hardrock mining in the western states is enormous, but the surface area actually physically disturbed by active mining is small in comparison. However, impacts on water quality, vegetation, and aquatic biota often extend beyond the immediate area of the mine site. The BLM is responsible for 260 million acres of land in the western states, including Alaska, of which roughly 90% are open to hardrock mining. Approximately 0.06% of BLM lands are affected by active mining and mineral exploration operations. The Forest Service manages 163 million acres in the western states, of which roughly 80% are open to hardrock mining. Together, the two land management agencies are responsible for 38% of the total area of the western states. These lands are important for their potential mineral wealth and

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timber, for grazing purposes, as a source of clean water, as a location for recreational activities, as wildlife habitats and scenic areas, and for other purposes.

Mining inevitably affects these resources. The significance of potential negative impacts depends on the extent to which they can be avoided or mitigated. This, to some extent, depends on compliance with regulations. Mining, its impacts on other resources and uses, and the regulatory structure are related matters that require balance and reason when dealing with the potentially competing issues of protection of the environment, production of minerals and metals and employment for society, and associated federal and state statutory responsibilities.

This report is particularly timely in that the BLM has proposed to revise its regulations for hardrock mineral exploration and development conducted under the authority of the General Mining Law of 1872. Because the Committee's charge stated that the baseline for the study was the existing regulatory framework rather than proposed changes to that framework, the Committee did not focus on the BLM proposal to revise its regulations. The Committee was told that the Forest Service was also internally considering revisions in its regulations for hardrock mining in national forests, but the Committee has not reviewed any of the changes being considered.

The Committee's conclusions and recommendations are based on information obtained in a series of presentations and open public forums at Committee meetings in Washington, D.C., Denver, Reno, and Spokane. Committee members also made visits to a variety of mining operations in Colorado, California, Nevada, Washington, and Alaska. The Committee also was helped in its work by a large volume of reports, submissions to the Committee, and copies of submissions to the BLM in connection with the proposed revision of its hardrock mining regulations. The Committee itself represented a wide spectrum of skills and experience relevant to mining on federal lands.

HARDROCK MINING AND THE ENVIRONMENT

Hardrock mining occurs where minerals are concentrated in economically viable deposits. Ore deposits form as variants of such geologic processes as volcanism, weathering, and sedimentation operating with an extraordinary intensity. Ore deposits typically are parts of large-scale (several miles across and perhaps just as deep) ore-forming systems in which many elements, not just those of economic interest, have been enriched. Only a very small portion of Earth's continental crust (less than 0.01%) contains economically viable

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mineral deposits. Thus, mines can only be located in those few places where economically viable deposits were formed and discovered.

Many hardrock commodities are associated with magmatic and hydrothermal processes, which in turn, are associated with modern or ancient mountain belts. The abundant igneous rocks and associated hydrothermal systems and the mountainous or sparsely vegetated terrain make the West the location of most hardrock mines in the United States. Some of these same areas are also valued for aesthetic and cultural reasons, which creates potential for conflict among uses of the land. While society requires a healthy environment, it also requires sources of materials, many of which can be supplied only by mining.

The mining process consists of exploration, mine development, mining (extraction), mineral processing (beneficiation), and reclamation (including post-closure). The hardrock mining process is described in Chapter 1 and Appendix A. Each step from exploration through post-closure has the potential to cause environment impacts. In addition to the obvious disturbance of the land surface, mining may affect, to varying degrees, groundwater, surface water, aquatic biota, aquatic and terrestrial vegetation, wildlife, soils, air, and cultural resources. Actions based on environmental regulations may avoid, limit, control, or offset many of these potential impacts, but mining will, to some degree, always alter landscapes and environmental resources. Regulations intended to control and manage these alterations of the landscape and the environment in an acceptable way are generally in place and are updated as new technologies are developed to improve mineral extraction, to reclaim mined lands, and to limit environmental impacts. Therefore, the committee emphasizes that these potential impacts will not necessarily occur, and when they do, they will not occur with the same intensity in all cases. The potential environmental impacts of hardrock mining are discussed in Chapter 1 and Appendix B.

EXISTING REGULATORY FRAMEWORK

Hardrock mining operations in the United States are regulated by a complex set of federal and state laws and regulations intended to protect the environment (see Chapter 2). The scope and degree of regulation depends on the type and size of the mining operation; the kinds of land, water, and biological resources affected; the state in which the operation is located; the organization of the state and local permitting agencies; and the ways federal and state agencies implement relevant statutes and regulations. The basic statute for hardrock mining on federal lands is the General Mining Law of 1872. Land management direction is provided in the Federal Land Policy and

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Management Act of 1976 (FLPMA) for the BLM and in the 1897 Organic Act and the 1976 National Forest Management Act for the Forest Service. These statutory authorities find further expression in the regulations adopted by the respective agencies.

Proposed mining activities on federal lands trigger the application of BLM's Part 3809 regulations (43 CFR Part 3809) and the Forest Service's Part 228 regulations (36 CFR Part 228). BLM's Part 3809 regulations establish guidelines intended to assure compliance with the FLPMA prohibition of "unnecessary or undue degradation of public lands." The Forest Service's Part 228 regulations establish guidelines intended to assure compliance with the Forest Service regulatory requirement to "minimize adverse environmental impacts on national forest surface resources," based on the Organic Act.

The National Environmental Policy Act (NEPA) serves to integrate BLM and Forest Service decision making on particular mining proposals with evaluation of other environmental concerns, as well as with other state and federal permitting requirements (see Chapter 2). For operations on federal lands that are expected to have significant impacts on the environment, the environmental impact statement (EIS) under NEPA serves as the "spine" of the federal land manager's decision-making process. The EIS process includes requirements for publicly "scoping" the issues and identifying alternatives to be evaluated, and results in a record of decision that determines the content of the plan of operations and mitigation requirements. For smaller operations on federal lands, an environmental assessment (EA) often is produced instead of an EIS. The EA is intended to assist the federal land management agency in deciding whether environmental impacts will be significant.

Various state and federal laws establish environmental requirements applicable to mining operations on federal lands. These include state reclamation laws, state and federal water pollution laws, state groundwater quality laws, state water rights laws, state and federal fish and wildlife laws, state and federal air quality laws, wetlands laws, and other laws. Memoranda of understanding (MOUs) among the federal agencies and state agencies establish the links between state environmental requirements and federal land managers' decisions.

Conclusions and recommendations are presented below related to the coordination of federal and state regulations to ensure environmental protection, increase efficiency, avoid duplication and delay, and identify the most cost-effective manner for implementation. Each conclusion is followed by a recommendation. Conclusions and recommendations are discussed in more detail, including justifications and discussion, in Chapter 4.

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GENERAL CONCLUSIONS AND RECOMMENDATIONS

Existing regulations are generally well coordinated, although some changes are necessary. The overall structure of the federal and state laws and regulations that provide mining-related environmental protection is complicated but generally effective. The structure reflects regulatory responses to geographical differences in mineral distribution among the states, as well as the diversity of site-specific environmental conditions. It also reflects the unique and overlapping federal and state responsibilities.

Conclusion: Federal land management agencies' regulatory standards for mining should continue to focus on the clear statement of management goals rather than on defining inflexible, technically prescriptive standards. Simple "one-size-fits-all" solutions are impractical because mining confronts too great an assortment of site-specific technical, environmental, and social conditions. Each proposed mining operation should be examined on its own merits. For example, if backfilling of mines is to be considered, it should be determined on a case-by-case basis, as was concluded by the Committee on Surface Mining and Reclamation (COSMAR) report (NRC, 1979). **Recommendation: BLM and the Forest Service should continue to base their permitting decisions on the site-specific evaluation process provided by NEPA. The two land management agencies should continue to use comprehensive performance-based standards rather than using rigid, technically prescriptive standards. The agencies should regularly update technical and policy guidance documents to clarify how statutes and regulations should be interpreted and enforced.**

Although the overall regulatory structure for hardrock mining on federal lands is effective, the Committee has identified a number of areas where the implementation of existing laws and regulations could be improved (see "Improvements in Implementation" below). The Committee also has identified specific issues or "gaps" in the existing regulations intended to protect the environment (see "Regulatory Gaps" below). In addition, the Committee recommends that research be conducted to improve scientific understanding of issues related to environmental impacts of hardrock mining (see "Research Needs" below).

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IMPROVEMENTS IN IMPLEMENTATION

Improvements in the implementation of existing regulations present the greatest opportunity for improving environmental protection and the efficiency of the regulatory process. Federal land management agencies already have at their disposal an array of statutes and regulations that for the most part assure environmentally responsible resource development, but these tools are unevenly and sometimes inexpertly applied. The committee has identified the following issues where the implementation of existing regulations could be improved through enhanced information management, greater understanding of existing laws and regulations by federal land management staff, and improved efficiency:

Conclusion: The Committee was consistently frustrated by the lack of reliable information on mining on federal lands. The lack of thorough information extends from that needed to characterize the lands available for mineral development to that needed to track mining and compliance with regulations. Without more and better information, it is difficult to manage federal lands properly and assure the public that its interests are protected. **Recommendation: BLM and the Forest Service should maintain a management information system that effectively tracks compliance with operating plans and environmental permits, and communicates this information to agency managers, the interested public, and other stakeholders.**

Conclusion: Better information on federal lands is needed to make wise land use decisions. The land use planning process required for BLM and Forest Service lands by the Federal Lands Policy and Management Act and the National Forest Management Act, respectively, provide for identification of land and resources deserving special environmental concern. **Recommendation: BLM and the Forest Service should identify, regularly update, and make available to the public, information identifying those parts of federal lands that will require special consideration in land use decisions because of natural and cultural resources or special environmental sensitivities.**

Conclusion: The NEPA process is the key to establishing an effective balance between mineral development and environmental protection. The effectiveness of NEPA depends on the full participation of all stakeholders throughout the NEPA process. Unfortunately this rarely happens in a timely fashion. **Recommendation: From the earliest stages of the NEPA process, all agencies with jurisdiction over mining operations or affected resources**

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should be required to cooperate effectively in the scoping, preparation, and review of environmental impact assessments for new mines. Tribes and nongovernmental organizations should be encouraged to participate and should participate from the earliest stages.

Conclusion: Inefficiencies and time delays in the completion of environmental review under NEPA, issuance of permits, and conduct of other administrative actions unnecessarily consume the resources and time of many stakeholders. **Recommendation: BLM and the Forest Service should plan for and implement a more timely permitting process, while still protecting the environment.**

Conclusion: Misunderstandings of the term "unnecessary or undue degradation" (FLPMA, 1976 [43 U.S.C. §§7401 et seq.]) leave some BLM field staff uncertain whether the agency has the authority to protect valuable resources, such as riparian habitats, that may not be specifically protected by other laws. **Recommendation: BLM should prepare guidance manuals and conduct staff training to communicate the agency's authority to protect valuable resources that may not be protected by other laws.**

Conclusion: Forest Service permitting procedures for mineral exploration projects with limited environmental impact commonly take significantly longer than necessary. **Recommendation: Forest Service regulations should allow exploration disturbing less than 5 acres to be approved or denied expeditiously, similar to notice-level exploration activities on BLM lands.**

Conclusion: Deficiencies in both staff size and training were observed by the Committee in some offices of land management agencies. Increases in staffing and improved training should result in improved environmental protection and program efficiency. **Recommendation: BLM and the Forest Service should carefully review the adequacy of staff and other resources devoted to regulating mining operations on federal lands and, to the extent required, expand and/or reallocate existing staff, provide training to improve staff capabilities, secure supplemental technical support from inside and outside the agencies, and provide other support as necessary.**

REGULATORY GAPS

Although improvements in implementation present the greatest opportunities for improving environmental protection and the efficiency of the regulatory

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process, the committee also has identified the following specific issues or "gaps" in the existing regulations:

Conclusion: Financial risks to the public and environmental risks to the land exist whenever secure financial assurances are lacking. **Recommendation: Financial assurance should be required for reclamation of disturbances to the environment caused by all mining activities beyond those classified as casual use, even if the area disturbed is less than 5 acres.**

Conclusion: Some small mining and milling operations present environmental risks and potential financial liabilities for the public. These exposures are small by comparison to large operations, but as currently regulated they constitute a disproportionate share of the problems for the land management agencies. **Recommendation: Plans of operations should be required for mining and milling operations, other than those classified as casual use or exploration activities, even if the area disturbed is less than 5 acres.**

Conclusion: Current regulations do not provide land management agencies with straightforward procedures for modification of plans of operations even with compelling environmental justification. **Recommendation: BLM and the Forest Service should revise their regulations to provide more effective criteria for modifications to plans of operations, where necessary, to protect the federal lands.**

Conclusion: Federal criteria do not distinguish between temporarily idle mines and abandoned operations. This distinction is important because mines that become temporarily idle in response to cyclical metal prices and other factors need to be stabilized but not reclaimed, whereas mines that are permanently idle need to be reclaimed. **Recommendation: BLM and the Forest Service should adopt consistent regulations that a) define the conditions under which mines will be considered to be temporarily closed; b) require that interim management plans be submitted for such periods; and c) define the conditions under which temporary closure becomes permanent and all reclamation and closure requirements must be completed.**

Conclusion: Current regulations discourage reclamation of abandoned mine sites by new mine operators. New mineral deposits are commonly found at the sites of earlier mines. Even though the operator of a new mine might volunteer to clean up previous degradation, the long-term liability acquired under current regulations can be significant. As a result, non-taxpayer supported reclamation opportunities are missed and undisturbed lands may be preferentially disturbed

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for new mining sites. **Recommendation: Existing environmental laws and regulations should be modified to allow and promote the cleanup of abandoned mine sites in or adjacent to new mine areas without causing mine operators to incur additional environmental liabilities.**

Conclusion: Post-mining land use and environmental protection are inadequately addressed by both agencies and applicants. The regulations and plans of operation generally specify what actions will be taken to protect water quality and what surface reclamation is to be performed for closure. However, there is inadequate consideration of protection of the reclaimed land from future adverse uses; of very long-term or perpetual site maintenance; or of rare, but inevitable, natural emergencies. **Recommendation: BLM and the Forest Service should plan for and assure the long-term post-closure management of mine sites on federal lands.**

Conclusion: Federal land management agency representatives are inconsistent in their understanding of their enforcement authority and tools. This results from uncertain interpretations of the statutes and regulations, inadequate staff training, and deficiencies in the tools themselves. **Recommendation: Federal land managers in BLM and the Forest Service should have both (1) authority to issue administrative penalties for violations of their regulatory requirements, subject to appropriate due process, and (2) clear procedures for referring activities to other federal and state agencies for enforcement.**

RESEARCH NEEDS

Successful environmental protection is based on sound science. Improvements are needed in the development of more accurate predictive models and tools and of more reliable prevention, protection, reclamation, and monitoring strategies at mine sites. The science base is far from complete, and environmental protection requires that improvements continue to be devised. Some of the most important environmental concerns at hardrock mining sites are those related to long-term water quality and water quantity, which affect riparian, aquatic biological, groundwater, and surface water resources. A broadly coordinated, national research effort is needed to guide future development and to create improved methods for predicting, measuring, and mitigating environmental impacts related to hardrock mining. **Recommendation: Congress should fund an aggressive and coordinated research program related to the environmental impacts of hardrock mining.**

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CONCLUDING PERSPECTIVES

Conditions are changing for regulations and mining. Technology, social values, the economy, and scientific understanding change continually. Thus, environmental regulations applicable to mining will be most effective if they use these changes to improve environmental protection. Similarly, the mining industry should benefit through lower operating cost and greater environmental protection. Therefore, a regulatory system that is adaptive to change will serve the public, the environment, and industry best.

Portions of the public and the mining industry have little confidence in the propriety or fairness of the regulatory and permitting system. Some members of the public perceive that regulators work too closely with the companies and permit operations without sufficient environmental safeguards. Conversely, some mining operators experience delays that they perceive to be caused, in part, by members of the public who seek to forestall mining through the permitting and regulatory processes. Lack of confidence in the regulatory and permitting system can lead to delays and higher costs for industry, regulatory agencies, and the public, and can also limit opportunities for improving environmental protection.

The Bureau of Land Management and the Forest Service need not have identical regulations, but some changes are warranted. The two agencies have broadly similar land management mandates. There are, however, some differences in the kinds of lands they manage, in their specific responsibilities, and in their organization. Whereas some of the Committee's recommendations would make the agencies' approaches to regulating hardrock mining more similar, the Committee is not suggesting that uniformity in all aspects is necessary.

All of the Committee's conclusions and recommendations, taken together, summarize the Committee's views of the actions needed to coordinate federal and state mine reclamation, operations, and permitting requirements and programs. Some of the recommendations will require congressional action and some will require changes in federal regulations. Still others will require changes in the implementation of existing regulations and programs. Adopting these recommendations will improve environmental protection and reclamation of hardrock mining on federal lands, as well as the efficiency of the permitting process.

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1

Introduction

In late 1998 Congress asked the National Research Council (NRC) to conduct a study of the regulatory framework that applies to hardrock mining on federal lands. The study is particularly timely in that the Bureau of Land Management (BLM) has proposed to revise its regulations for mineral exploration and development conducted under the authority of the General Mining Law of 1872 (30 U.S.C. §22 et seq.). The BLM regulations apply to hardrock minerals—such as those bearing gold, silver, copper, and uranium—on 260 million acres of federal lands managed by BLM throughout the western United States. The Forest Service manages the national forests on which mineral exploration and mining occur and implements its own regulations for managing these activities.

As specified by Congress,[1] "the study shall identify and consider:

(A) the operating, reclamation and permitting requirements for locatable minerals mining and exploration operations on federal lands by federal and state air, water, solid waste, reclamation and other environmental statutes, including surface management regulations promulgated by federal land management agencies and state primacy programs under applicable federal statutes and state laws and the time requirements applicable to project environmental review and permitting;

(B) the adequacy of federal and state environmental, reclamation and permitting statutes and regulations applicable in any state or states where mining or exploration of locatable minerals on federal lands is occurring, to prevent unnecessary or undue degradation; and

(C) recommendations and conclusions regarding how federal and state environmental, reclamation and permitting requirements and programs can be coordinated to ensure environmental protection,

[1] Department of the Interior and Related Agencies Appropriations Act, 1999 P.L. 105–277, Division A, Title I, Sec. 120, enacted October 21, 1998

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increase efficiency, avoid duplication and delay, and identify the most cost-effective manner for implementation."

To conduct the study the NRC established the Committee on Hardrock Mining on Federal Lands in January 1999. The Committee conducted an evidence-based analysis, taking account of scientific and technical knowledge. It was not asked to address the issue of comprehensive reform of the General Mining Law of 1872 or general problems related to abandoned mine lands. Because the Committee's charge indicated that the baseline for the study was the existing regulatory framework rather than proposed revisions to that framework, the Committee did not focus on the BLM proposal to revise its regulations governing hardrock mining; the Committee did, however, receive briefings on that proposed rule making.

The Committee concentrated on the intersection of three elements that form the context of hardrock mining on federal lands:

(1) minerals development and the factors that drive it; (Introduction and Appendix A)
(2) the natural environment and how it can be affected by hardrock mining (Introduction and Appendix B); and
(3) federal and state laws and regulations (Chapter 2 and Appendix C).

This federal lands context is governed by the General Mining Law of 1872 (30 U.S.C. §22 et seq.). The law defines the system of open access to hardrock minerals on federal lands of the western United States that are not withdrawn from mineral entry. The law allows any person to stake a claim on these lands and thereby to obtain the exclusive right to extract the minerals thereon without payment of royalty to the United States and without acquiring title to the land itself. The regulation of hardrock mining and exploration operations on these "unpatented" mining claims, where title to the land remains with the United States, is the focus of this study.

A mining claimant may also obtain title to (patent) the lands by proving the location of a valuable mineral deposit on the mining claim, among other requirements, and paying the United States the statutory price ($5.00 per acre for lode claims and $2.50 per acre for placer claims). The result of over a century of mineral patenting and other conveyances of federal lands is, in many parts of the West, a patchwork of intermingled privately owned lands; state-owned lands; and federally owned lands, including unpatented mining claims. A large mine may occupy a mixture of these land ownerships, each subject to different regulatory and land management requirements.

For the purposes of this study, we use the term "hardrock minerals" as a synonym for "locatable minerals," which is a legal term not widely used in the

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technical literature. Sidebar 1–1 provides a definition of locatable minerals and distinguishes locatable minerals from leasable and saleable minerals, which are also legal terms that are not widely used in the technical literature. Examples of the three groups of minerals are provided in Sidebar 1–1. Some minerals are either locatable or saleable, depending on whether they are common or uncommon varieties as defined by the Common Varieties Act of 1955 (30 U.S.C. §601 et seq.) (Sidebar 1–2). For the purposes of this report, the phrase "federal land management agencies" refers to BLM and the Forest Service.

POLICY CONTEXT

The BLM first implemented its hardrock mining surface management regulations in 1981 (codified at 43 CFR 3809; the "3809 regulations"). The preamble to the 1981 regulations stipulates that the regulations would be reviewed for possible revisions in three years. The review was postponed and was not addressed until 1989, when the BLM established a task force to address significant hardrock mining issues. In 1991 the BLM formed another review task force, but in 1993 it decided to put the review on hold because of anticipated congressional amendments to the Mining Law of 1872.

The House of Representatives and the Senate passed differing bills to reform the Mining Law of 1872 during the 103rd Congress in 1993–94. The congressional conference committee convened to reconcile the House and Senate bills, but failed to reach agreement before Congress adjourned in the fall of 1994.[2]

In January 1997 the Secretary of the Interior directed the BLM to restart the process for revising its hardrock mining regulations. Because of the time that had passed since the 1991 effort, the BLM started a new public participation process in early 1997. An agency task force with expertise in the program was created to coordinate public involvement, develop regulation options, and oversee changes in the regulations. In early 1997 BLM revised the 3809 regulations for reclamation bonding. The new bonding regulation was challenged in court. In May 1998 the District Court ruled against BLM and the 1997 bonding regulation is no longer in effect.[3]

[2] The Mining Law of 1872 has been the topic of intermittent debates in Congress since its passage. One history of the legal aspects of mineral development says, "The history of public mining law in this country has yet to record a plateau of comparative quietude" (Swenson,1968; see also Leshy, 1987).

[3] *Northwest Mining Association v. Babbitt,* No. 97–1013, D.D.C., May 13, 1998.

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SIDEBAR 1–1 LOCATABLE, LEASABLE, AND SALEABLE MINERALS

Locatable Minerals

A legal term that, for federal lands in the United States, defines a mineral or mineral commodity that is acquired through the General Mining Law of 1872, as amended (30 USC 22–54, 161, 162, 661–615). These are the base and precious metal ores, ferrous metal ores, and certain classes of industrial minerals. Acquisition is by staking a mining claim (location) over the deposit and then acquiring the necessary permits to explore or mine. Examples of locatable minerals include, but are not limited to, gold, silver, platinum, copper, lead, zinc, magnesium, nickel, tungsten, bentonite, barite, feldspar, fluorspar, uranium, and uncommon varieties of sand, gravel, and dimension stone.

Leasable Minerals

A legal term that, for federal lands or a federally retained mineral interest in lands in the United States, defines a mineral or mineral commodity acquired through the Mineral Land Leasing Act of 1920, as amended, the Geothermal Steam Act of 1970, as amended, or the Acquired Lands Act of 1947, as amended. These Acts are found in Title 30 of the United States Code—Mineral Lands and Mining. Acquistion is by application for a government lease and permits to mine or explore after lease issuance. Examples of leasable minerals include oil, gas, coal, oil shale, sodium, potash, phosphate, and all minerals within acquired lands.

Saleable Minerals

A legal term that, for federal lands, defines mineral commodities sold by sales contract from the federal government. The applicable statute is the Mineral Materials Sale Act of 1947, as amended (30 USC 602–604, 611– 615). Saleable minerals are generally common varieties of construction materials and aggregates, such as sand, gravel, cinders, roadbed, and ballast material.

Source: *Dictionary of Mining, Mineral, and Related Terms,* 2nd edition, American Geological Institute, 1997.

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SIDEBAR 1–2 COMMON AND UNCOMMON VARIETY MINERALS

Common Variety Minerals

Stone, gravel, pumice, pumicite, and cinders that, though possibly having value for trade, manufacture, the sciences, or the mechanical or ornamental arts, do not have a distinct, special value for such use beyond normal uses. On federal lands such minerals are considered saleable and are disposed of by sales or by special permits to local governments.

Uncommon Variety Minerals

On the federal lands stone, gravel, pumice, pumicite, and cinder deposits that have distinct and special properties making them commercially valuable for use in a manufacturing, industrial, or processing operation. Such minerals are locatable under the Mining Law of 1872, as amended. In determining a deposit's commercial value, the following factors may be considered: quality and quantity of the deposit, geographic location, accessibility to transportation, and proximity to market or point of use.

Source: Draft Environmental Impact Statement, Surface Management Regulations for Locatable Minerals Operations, U.S. Department of the Interior, BLM, February, 1999, p. G-5, G-26.

In late October 1998 Congress asked the NRC to conduct an independent study on mining of hardrock minerals on federal lands, including consideration of the adequacy of existing environmental and reclamation requirements to prevent "unnecessary or undue degradation" and the time requirements applicable to project environmental review and permitting. Congress instructed that the study was to be completed by July 31, 1999. The legislation also prohibited the Secretary of the Interior from promulgating final regulations to change the BLM regulations found at 43 CFR 3809 prior to September 30, 1999.

In February 1999 the BLM published its proposed revisions to the 3809 regulations and a draft environmental impact statement (EIS). The BLM held public meetings on the proposed regulations and draft EIS in 13 cities in March and April 1999. The deadline for providing comments to BLM on these documents was May 10, 1999.

In May 1999 Congress passed legislation requiring the Secretary of the Interior to provide a period of not less than 120 days for accepting public comment on the BLM's proposed rule after the Committee on Hardrock

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Mining on Federal Lands submits its report to the appropriate federal agencies, the Congress, and the governors of the affected states.

Although the Committee was aware of the proposed changes to BLM's regulations, it has focused its review on the existing regulatory framework. The Committee was informed that the Forest Service also was considering revisions to its regulations (36 CFR 228) for hardrock mining on western national forest lands; however, the Committee considered only the existing Forest Service regulatory framework.

APPROACH TO THE STUDY

The Committee on Hardrock Mining on Federal Lands consists of 13 members with a broad range of expertise and experience (Appendix H). The Committee operates under the Committee on Earth Resources, which is under the aegis of the Board on Earth Sciences and Resources within the NRC's Commission on Geosciences, Environment, and Resources.

The study was conducted on a fast-track schedule, as requested by Congress. The Committee conducted 5 meetings, three field trips, and three public participation forums in 5 months (Appendixes F and G). The committee meetings were held in Washington, D.C. (two meetings), Denver, Reno, and Spokane. The committee meetings featured 60 speakers from federal and state agencies, environmental organizations, industry, and other institutions. The public participation forums included presentations from 37 individuals (Appendixes F and G).[4]

The Committee conducted field trips to large mines, small mines, and exploration sites on lands administered or formerly administered by BLM and the Forest Service: Cripple Creek and Victor Mine (Colorado), Sleeper Mine (Nevada), Gold Quarry Mine (Nevada), Flatrock Claims (Washington), and exploration sites on Forest Service lands in the Sullivan Ranger District (Washington). Subsets of the Committee visited other mines and exploration sites in Alaska, California, and Nevada.

To supplement its analysis of the existing panoply of federal and state statutes and regulations, the Committee sought assistance from 12 western states. The Committee sent letters to state regulatory agencies requesting information about violations of state environmental regulations applicable to hardrock mining activities on federal lands during the last 5 years. Information supplied by the state agencies ranged from minimal to comprehensive. A

[4] Copies of approximately 250 documents reviewed by the Committee can be requested from the Public Access Records Office of the NRC's library (through the National Academies World Wide Web site at www4.national-academies.org/cp.nsf).

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limited number of examples of recent environmental impacts at hardrock mine sites are presented in Appendix B. One of the Committee's recommendations addresses the importance of creating a comprehensive management information system that tracks compliance and communicates this information to all stakeholders.

The study of hardrock mining on federal lands builds upon previous NRC reports on mining issues. It has been almost 20 years since the NRC's Committee on Surface Mining and Reclamation (COSMAR) published its report on *Surface Mining of Non-Coal Minerals* (NRC, 1979) pursuant to a congressional directive in the Surface Mining Control and Reclamation Act of 1977. In the two decades since the issuance of that report there have been significant advances in mining technology. Moreover, in the intervening years, many states have enacted and implemented extensive regulatory programs to address the environmental impact of hardrock mining.

More recently, the NRC issued a report entitled *Competitiveness of the U.S. Minerals and Metals Industry* (NRC, 1990). That report addresses the U.S. minerals and metals industry in a changing global context and discusses trends in U.S. production and consumption of metals. It finds that the United States is among the world's largest consumers of nearly every metal, much of which is imported. Moreover, it observes that, although the U.S. share of the world market for most major metals has slipped, the United States is among the world's largest producers of many important metals and still has substantial reserves. According to recent mine production data compiled by the U.S. Geological Survey (1999), the United States is the world's largest producer of molybdenum and second largest producer of gold, silver, and copper.

FEDERAL LANDS AND HARDROCK MINING

Federal lands have been an important source of minerals since the early part of the nineteenth century. Although most of what were once federal lands between the Appalachian and Rocky mountains are now under non-federal ownership, the remaining federal lands in the western states, including Alaska, continue to provide a large share of the metals and hardrock minerals produced in this country. The federal lands generally available for exploration for hardrock minerals are part of the original federal public domain and are now under the management of the BLM, an agency of the Department of the Interior, and the Forest Service, an agency of the Department of Agriculture.

Lands administered by the BLM and Forest Service comprise 38% of the combined land area of the 12 western states (Table 1–1). The combined

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Table 1–1 Public Lands Administered by BLM and the Forest Service

	BLM Lands (1)		Forest Service Lands (2) (3)		Sum of BLM and Forest Service Lands		Federal Total		Total State Acreage (4)
State	Acres	% of state acreage	Acres	% of state acreage	Acres	% of state acreage	Acres	% of state acreage	
Alaska	86,908,060	23.8	21,969,321	6.0	108,877,381	29.8	171,787,844	47.0	365,481,600
Arizona	14,220,457	19.6	11,251,701	15.5	25,472,158	35.0	31,336,526	43.1	72,699,000
California	14,556,074	14.5	20,647,142	20.6	35,203,216	35.1	44,757,474	44.7	100,206,720
Colorado	8,260,306	12.4	14,508,108	21.8	22,768,414	34.2	24,128,982	36.3	66,485,760
Idaho	11,775,052	22.2	20,460,774	38.7	32,235,826	60.9	32,991,905	62.3	52,933,120
Montana	6,259,211	6.7	16,877,005	18.1	23,136,216	24.8	25,485,347	27.3	93,271,040
Nevada	47,841,264	68.1	5,823,676	8.3	53,664,940	76.4	56,081,559	79.8	70,264,320
New Mexico	12,541,069	16.1	9,326,935	12.0	21,868,004	28.1	26,217,230	33.7	77,766,400
Oregon	16,145,615	26.2	15,656,351	25.4	31,801,966	51.6	31,809,283	51.6	61,598,720
Utah	22,832,630	43.3	8,112,730	15.4	30,945,360	58.7	33,898,255	64.3	52,696,960
Washington	370,110	0.9	9,177,071	21.5	9,547,181	22.4	11,938,958	28.0	42,693,760
Wyoming	18,373,492	29.5	9,247,742	14.8	27,621,234	44.3	30,878,166	49.5	62,343,040
Sub Total	260,364,677	22.3	165,082,211	14.1	425,446,888	36.4	563,080,110	48.2	1,167,797,880
U.S. Total	261,614,888	11.5	191,785,560	8.4	453,400,448	20.0			2,271,343,360
12 Western States as a % of U.S. total		99.5		86.1		93.8		51.4	

NOTES: (1) BLM, 1999a, p. 78. These data exclude Land Utilization Project lands, to which the 3809 regulations do not apply. Land Utilization Project lands comprise 2.3 million in 9 western states, including 1.8 million acres in Montana. BLM's 3809 regulations also apply to Stockraising Homestead Act Acreage, which include 67.1 million acres in the 12 western states, including 18.1 million acres in Wyoming and 15.6 million acres in New Mexico (2) Forest Service, 1998, pp. 14–35. (3) GAO, 1996, p. 11. (4) BLM, 1999a, p. 78.

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acreage of BLM and Forest Service lands range from about 76% of Nevada to about 23% of Washington (BLM, 1999b). In addition to the BLM and Forest Service lands, sometimes called the "multiple use" lands because they serve many uses, the federal government also has large land holdings in the West devoted to specific uses. These include the national parks and national wildlife refuges, which are managed by the National Park Service and Fish and Wildlife Service in the Department of the Interior, military lands managed by Department of Defense agencies, and lands managed by the Department of Energy.

The 12 western states contain 99% of the lands administered by BLM and 85% of the lands administered by the Forest Service. BLM lands in these 12 states total about 260 million acres and Forest Service lands about 163 million acres (Table 1–1). These vast areas compare with an estimated 15,000 acres of currently active notice-level mining operations (less than 5 acres each) and 134,000 acres in currently active plan-level mining operations on BLM lands (BLM, 1999a, p. 86–87). Based on these data, approximately 0.06% of BLM lands are affected by currently active plan-level and notice-level mining activities (see Sidebar 1–3 for a discussion of categories of mining activities on BLM lands). However, impacts to water quality, vegetation, and aquatic biota from both active and historic mining often extend beyond the immediate area of the mine site. In addition, there are over 200,000 inactive and abandoned mines, many of which are on federal lands (EPA, 1997b). Not all BLM and Forest Service lands are available for mineral prospecting and mining. Various categories of these lands have been withdrawn from mineral entry to meet a variety of public purposes. Chief among these are congressionally designated wilderness areas. Other lands have been withdrawn administratively to protect relatively large areas being considered for possible designation as wilderness, areas used for military facilities, and smaller areas for recreation and for other facilities. The Committee requested information about the acreage of BLM and Forest Service lands that are withdrawn from mineral entry, but these data were not readily available.

It is difficult to obtain accurate information about the level of mining activities on federal lands, because neither BLM nor the Forest Service systematically collect data on the value of hardrock minerals produced on their lands. The BLM reports the number of plans and notices of mining operations filed with the agency on an annual basis. Time series data are provided in Figures 1–1 and 1–2. These data indicate that the number of plans of operations filed with the BLM has decreased roughly by 50% since 1992 (Figure 1–1). The number of notices has fallen by a greater percentage, apparently due in large part to the imposition of a $100 holding fee per mining claim per year instead of the previous requirement that claim holders conduct $100 of assessment work per year (Figure 1–2). Declining levels of exploration and lower metals prices may also account in part for recent declines in filings of plans of operations.

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SIDEBAR 1–3 CATEGORIES OF MINING ACTIVITIES ON BLM LANDS

Casual Use

Mining activities that only negligibly disturb federal lands and resources. Casual use does not include the use of mechanized earth moving equipment or explosives or the use of motorized equipment in areas closed to off-road vehicles. Under casual use, operators do not have to notify BLM, and operations do not need to be approved. But operations are subject to monitoring by BLM to ensure that federal lands do not undergo unnecessary or undue degradation. Casual use operations must be reclaimed.

Notice-level Operation

A mining or exploration operation involving more than casual use but requiring that the operator submit only a notice rather than a plan of operations. A notice is the notification a mining operator must submit to BLM of the intention to begin an operation that will disturb 5 acres or less in a year in a mining claim or project area. The intent of a notice is to permit operations with limited geographic disturbance to begin after a quick review for potential resource conflicts and to eliminate the need for federal action. A notice requires no special forms, but an operator must submit specific information. BLM must complete its review of the notice within 15 calender days of its receipt unless more information is required to determine whether the operation would cause unnecessary or undue degradation.

Plan of Operations

A plan for mining exploration and development that an operation must submit to BLM for approval when more than 5 acres a year will be disturbed or when an operator plans to work in an area of critical environmental concern or a wilderness area. A plan of operations must document in detail all actions that the operator plans to take from exploration through reclamation.

Source: Draft Environmental Impact Statement, Surface Management Regulations for Locatable Minerals Operations, U.S. Department of the Interior, BLM, February, 1999, p. G-4, G-16, G-18.

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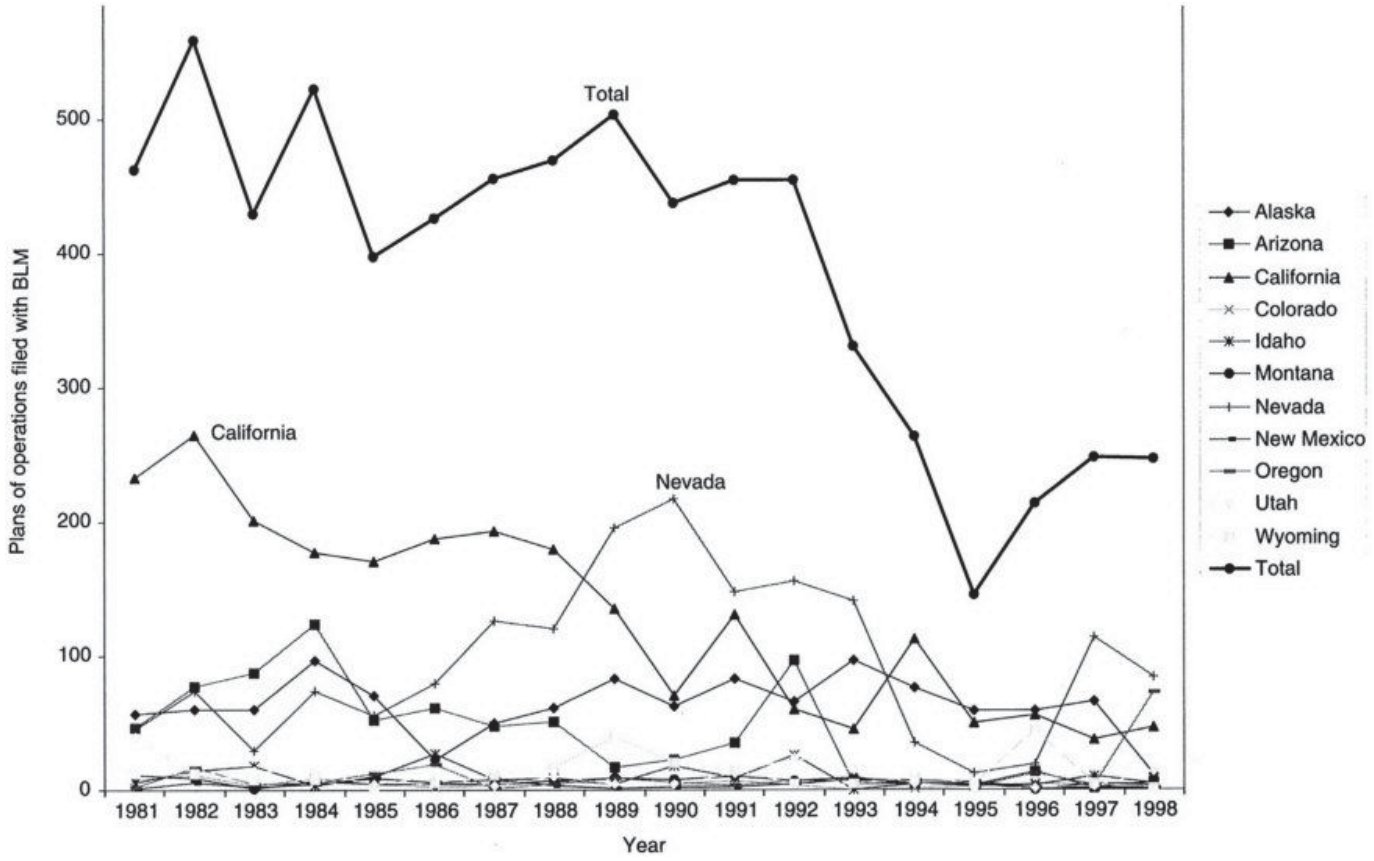


FIGURE 1–1 Plans of operations filed with BLM for mining or exploration activities on BLM lands. Source: BLM, 1992, 1994, 1999b.

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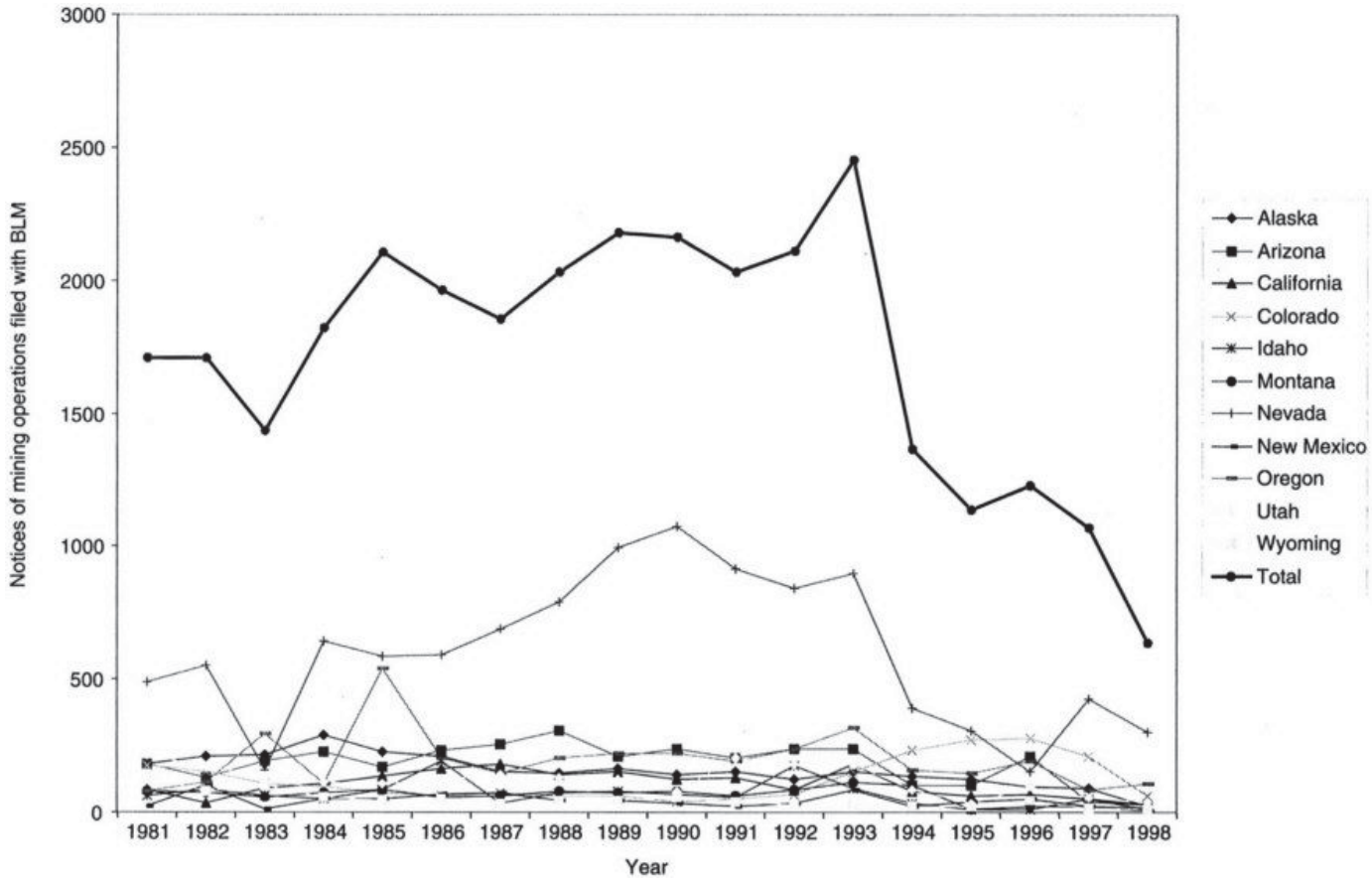


FIGURE 1–2 Notices of intent filed with BLM for exploration or mining activities on BLM lands. Source: BLM, 1992, 1994, 1999b.

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HARDROCK MINING

Hardrock mining occurs where minerals are concentrated in economically viable deposits. Ore deposits form as variants of such geologic processes as volcanism, weathering, and sedimentation operating with an extraordinary intensity. Ore deposits typically are parts of large-scale (several miles across and perhaps just as deep) ore-forming systems in which many elements, not just those of economic interest, have been enriched. Known ores constitute less than 0.01 % of the metal content of the upper 1 km of continental crust. Thus, mines can only be located in those few places where economically viable deposits have been formed and discovered (see Sidebar 1–4).

Many hardrock commodities are associated with magmatic and hydrothermal processes (Guilbert and Park, 1986). These processes, in turn, are associated with modern or ancient mountain belts. The abundant igneous rocks and associated hydrothermal systems and the mountainous or sparsely vegetated terrain make the West the location of most hardrock mines in the United States. Some of these same areas also are valued for aesthetic and cultural reasons, which creates potential for conflict among uses of the land. While society requires a healthy environment, it also requires sources of materials, many of which can be supplied only by mining.

The mining process consists of exploration, mine development, mining (extraction), mineral processing (beneficiation), and reclamation (for closure), which are discussed briefly in the following section. A more detailed discussion of the mining process can be found in Appendix A.

Exploration

The primary objective of exploration is to find an economic mineral deposit. The initial step in exploration is prospecting, which is the search for indications of a mineral deposit of potential significance. The objective is to define a target that suggests the occurrence of a mineral deposit worthy of subsequent testing. Target identification may result from relatively unobtrusive approaches, such as detailed surface geologic mapping, sampling of outcrops, and observation of alteration patterns, or from more technical methods, including various types of geochemical sampling, geophysical techniques, satellite remote sensing, and other sophisticated methods for identifying the often subtle expressions of deeply buried mineral deposits.

The second phase of exploration involves target testing. The techniques vary, but they usually focus on confirming the presence of a deposit and delineating its size, shape, and composition. In most cases, the exploration tool is drilling. Drilling into the subsurface is done to determine both the lateral

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and vertical extent of the deposit and other important deposit characteristics, such as continuity of mineralization, grade and associated trends, mineralogical relationships and characteristics, rock types, and hydrologic information.

SIDEBAR 1–4 HOW HARD IS IT TO FIND A MINERAL DEPOSIT?

The art and science of finding new mineral deposits is much better than pure luck, but it is still far from perfect. Moreover, the search for new mineral deposits is costly, time consuming, and without guarantee of success. For example, Roscoe (1971) showed that the number of mineral indications in Canada that had to be investigated to discover a significant mineral deposit was about 100 in 1951 and rose to about 1000 in 1969. There is no reason to expect that this trend has changed. Similarly, in a probabilistic analysis of exploration experience in the United States by Homestake Mining Company, Anderson (1982) concluded that from an initial sample of 1,000 reconnaissance examinations (more or less equivalent to casual use activities), 100 drillable exploration targets (roughly equivalent to notice-level activities) would emerge in which there would be a 75% chance of finding one deposit with 3 million ounces of gold. The statistics may not be quite as grim as they first appear, because there are many cases of someone with a better concept, more persistence, or luck finding an economic deposit in a prospect or worked-out mine that several companies have deemed worthless. Successful projects can be spectacularly profitable, but overall, mining has one of the lowest returns on investment of major industries (Dobra, 1997).

In general, the environmental impact of prospecting is minimal. Surface disturbance resulting from other exploration activities increases as these activities progress from preliminary to detailed. Most surface disturbance results from the construction of access roads and drill sites. Surface disturbance also may result from trenching activities across zones of mineralization or from the collection of bulk samples for metallurgical testing. The subsurface environment also may be affected by drilling, although the effects are usually minor due to the use of practices such as sealing drill holes and the proper disposal of drill cuttings. A more significant subsurface impact is often that associated with the collection of bulk samples of ore for metallurgical testing.

When exploration on federal lands indicates a valuable deposit, the prospector acquires rights, if not previously completed, to develop it by

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staking claims and recording them with appropriate agencies. The area required for a large mine and its facilities (e.g., waste dumps, tailings ponds) is frequently a few thousand acres. Because of intermixed ownerships, this often involves a combination of federal and private lands for a single mine.

Mine Development

When a deposit identified and defined from the exploration program has been judged economic and the required permits have been obtained, the next activity is mine development to prepare the deposit for extraction or mining. At this stage in the mining process the nature of the environmental impacts is different and their magnitude greater than those associated with exploration activities. The footprint of the mining operation is essentially defined at this point. Infrastructure (e.g., power, roads, and water) is put in place throughout the site, and planning and construction of support facilities (e.g., offices, maintenance shops, fuel bays, and materials handling systems) and the mineral processing facility is completed. Surface locations are delineated and prepared for placing waste or overburden material, heap leach piles (the chemical leaching of low-grade ores), stockpiles, and tailings impoundments.

Near-surface deposits in open-pit mines are prepared initially for production by removing the overlying waste material or overburden, which is then moved to waste dumps on the surface. Deeper deposits to be mined underground are developed initially by gaining access to the mineralization through vertical or inclined shafts or horizontal adits. Underground drifts, crosscuts, raises, and ramps are excavated to provide the access needed to mine the ore.

Mining (Extraction)

As mine development nears completion, there is a transition to the mining component, which refers to extraction of the mineralized material (and associated waste rock) as the mine becomes deeper and grows laterally. Although every ore deposit is different, most mines (both surface and underground) use the same basic operations: drilling, blasting, mucking (loading), and transporting (hauling).

Placer mining, in which gold or other minerals are extracted from stream or beach sediments by gravity separation using water, is different from typical hardrock mining and mineral processing in several respects. Most current placer mining in the United States involves mining with mechanized earth-moving equipment or suction dredging in streams. Placer mining with

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mechanized earth-moving equipment typically involves relocating a short (on the order of 2,000 feet) stretch of a stream, removal of the vegetative mat or soil, mining of gravels, removal of gold with sluices that separate dense from light minerals, and reclamation by replacing gravel and the vegetative mat or soil. Suction dredging pumps sediment from the stream bottom and processes it in a floating sluice, and can be as small as a "recreational" one-person operation.

Mineral Processing (Beneficiation)

Mineral processing, or beneficiation, consists of upgrading or concentrating the ore before the concentrate is transported to a smelter or refinery. It begins with crushing and grinding the ore into fine particles, thereby disaggregating ore grains and waste mineral grains. These particles are then subjected to physical and chemical processes using various chemicals and reagents to separate and concentrate the valuable minerals from the unwanted waste and other substances in the ore. Especially with copper ores, metals can be extracted on site directly through treatment of the ores by a process called solvent extraction/electrowinning. Otherwise, concentrates are reduced to metals by smelting.

Heap leaching is an increasingly common practice for the extraction of concentrated metals from ore, using cyanide solutions for gold ore and ferric sulfate/sulfuric acid solutions for low-grade copper ore. In heap leaching, ore can be leached without crushing, or it can be crushed only fine enough to allow the lixiviant (leaching solution) access to most of the mineral grains. The solution percolates through the piled ore, and the resulting metal-containing solutions are pumped to a processing facility for extraction. The fluids are then treated and recycled.

The waste or unwanted minerals (tailings) separated from the valuable minerals are routinely disposed of in a tailings pond near the mine site. The associated water is typically recycled, treated, and used in subsequent mining or processing. Tailings generally contain small amounts of the valuable mineral(s) not completely recovered during beneficiation, some unwanted or undesirable deleterious minerals, waste rock minerals, and some fluids with chemicals and metals from the separation process. Tailings from underground mines may be used to backfill underground voids. Tailings dams and ponds and leach pads are designed to high standards, but some do fail, and the release or discharge of tailings, leached rock, or pregnant leach solutions can have negative environmental impacts.

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Reclamation

Reclamation minimizes the potential for future environmental damage and prepares the mining and processing site for beneficial use after mining. Common reclamation practices include reducing the slopes on the edges of waste rock dumps and heaps to minimize erosion; capping these piles and tailings piles with soil; planting grasses or other plants that will benefit wildlife or grazing stock and help prevent erosion; directing water flow with French drains and other means to minimize the contact of meteoric water with potentially acid-generating sulfides in the dumps, heaps, and tailings piles; removing buildings; and eliminating roads to minimize unnecessary future entry by vehicles. A mine is not closed until reclamation is complete, but as discussed in this report, in some circumstances reclamation may never be accomplished fully, and long-term monitoring will be necessary.

POTENTIAL ENVIRONMENTAL IMPACTS OF HARDROCK MINING

From exploration through post-closure, hardrock mining has the potential to cause environmental impacts. In addition to the obvious disturbance of the land surface, mining may affect, to varying degrees, groundwater, surface water, aquatic biota, aquatic and terrestrial vegetation, wildlife, soils, air, and cultural resources. Actions based on environmental regulations may avoid, limit, control, or offset many of these potential impacts, but mining will, to some degree, always alter landscapes and environmental resources. Regulations intended to control and manage these alterations of the landscape and the environment in an acceptable way are generally in place and are updated as new technologies are developed to improve mineral extraction, to reclaim mined lands, and to limit environmental impacts. Therefore, the committee emphasizes that these potential impacts will not necessarily occur, and when they do, they will not occur with the same intensity in all cases. Many of the impacts discussed in this section of the report would violate current regulatory requirements and standards and would be subject to enforcement actions. Nevertheless, an understanding of the potential for mining to cause environmental impacts is essential to assessing and improving the regulation of hardrock mining on federal lands. A more detailed discussion with documentation of potential environmental impacts of hardrock mining can be found in Appendix B. In this section the Committee provides a brief overview of some of these potential impacts.

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Potential Impacts on Water Quality

If not mitigated through regulation and prevention strategies, hardrock mining can cause a number of significant long-term impacts to surface water and groundwater quality. Hardrock mining of metalliferous deposits can release to the environment metals, metalloids, sulfate, cyanide, nitrate, suspended solids, and other chemicals. Acid drainage has been considered one of the most significant potential environmental impacts at hardrock mine sites (University of California, 1988; EPA, 1997b). Increased awareness of this potential problem has improved methods that prevent and treat acid drainage at the source, thus minimizing impacts to water quality, aquatic biota, and other resources. Pit lakes that develop when surface mines fill with water can cause alterations of pre-mining water quality and quantity. In addition, the discharge of groundwater withdrawn to dewater pits can cause a variety of environmental problems because these waters sometimes contain higher levels of total dissolved salts, metals, and other chemicals than the streams into which they are discharged.

Potential Impacts on Aquatic Ecosystems

If the water quality problems discussed above occur at a hardrock mining site, they can have significant impacts on aquatic biota. Most metals and cyanide, even at low concentrations, are toxic to aquatic life. In addition to their toxic effects, low concentrations of some metals (even below the chronic criteria) may cause fish to avoid certain waters and impair their growth. This can be an issue for anadromous (migrating from fresh to salt water) fishes such as certain threatened and endangered salmonids, which may avoid streams contaminated with metals (even at low concentrations), resulting in the elimination of that species from the watershed.

Mechanized placer mining in active streams and suction dredge mining disturb to some degree streambed sediments, which provide habitat for macroinvertebrates and spawning habitat for salmonids. A streambed disturbed in this way may nearly return to its original characteristics after springtime high flows. During low-precipitation years, however, the streambed may remain unsuitable for aquatic life habitat until high flows return it more to its original characteristics.

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Potential Impacts on Water Quantity

Changes in surface water and groundwater quantity that result from hardrock mining activities can have significant environmental impacts if not mitigated. For example, under certain conditions, surplus water accumulated from mine dewatering that is discharged into nearby streams can disrupt riparian ecosystems, erode or straighten stream channels, or dislodge aquatic biota. Groundwater withdrawal for mineral processing and to prevent filling of open pits and underground mines can affect local and regional groundwater quantities and levels. The presence of pit lakes can affect regional aquifers if they act as a permanent evaporative sink.

Lowering of alluvial aquifers because of extensive groundwater withdrawals can directly affect riparian vegetation that depends on this water source, even some distance from a mine. Wetlands, like riparian ecosystems, are dependent on a continuous supply of water, and therefore any change in regional hydrology may affect wetlands, especially in the arid West. Many arid region wetlands develop at springs, and such wetlands and spring pools often support threatened or endangered species (e.g., pupfish). These spring wetlands may be very sensitive to changes in the hydrologic head of the regional or local aquifer resulting from groundwater withdrawal by mines or other uses (e.g., agriculture or municipal uses).

Potential Impacts on the Landscape and Terrestrial Ecosystems

In addition to those potential environmental impacts related to water quality and quantity, mining activities can have direct impacts on the landscape and terrestrial ecosystems. Of special concern are impacts on relatively pristine ecosystems in remote mountainous terrains where human activity has caused little disruption. Early exploratory surveying by qualified geologists has no more impact on these remote areas than geological mapping or casual recreation, but exploration activities designed to validate a mineral deposit are potentially disruptive. For example, exploration roads, and even tracks from soft-tire vehicles, may impede migration of small mammals and change behavioral patterns of larger animals. Permanent long-distance haul roads or railroads for mining purposes have the same potential impact on animal behavior as do roads and railroads used for other purposes. That is, they may alter migration patterns by creating barriers and fragmenting animal territories. Terrestrial ecosystems also can be disrupted by the introduction of non-native plant species during reclamation activities or by dispersal of seeds by vehicular traffic.

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The use of valleys for placing waste rock, leach pads, or tailings impoundments has the potential to disrupt riparian ecosystems that depend on stream flows and shallow groundwater. Although there is greater awareness today of the ecological impacts of using valleys in this way, valleys are still used in some cases for the placement of mining facilities. Valley fills destroy vegetation found within the valley and the riparian vegetation cannot be restored.

Terrestrial wildlife, waterfowl, and migratory birds may be affected by hardrock mining through bioconcentration. Plants growing in contaminated sediments accumulate metals in tissues. Aquatic plants, macroinvertebrates, and fish can develop elevated levels of metals and other contaminants in their tissue. Consumption of these organisms by wildlife and birds continues the bioconcentration process, potentially creating toxic levels of metals and other chemicals in organisms that are high on the food chain.

Some environments created by mining activities have the potential to benefit wildlife. For example, abandoned mine tunnels may be used by bat communities. Reclamation of waste rock sites and other surface disturbances may create extensive areas of forage that attract some species.

Other Potential Environmental Impacts

If not mitigated, hardrock mining activities can lead to other potential environmental impacts, including pollution of air and soils with metals and sulfur dioxide from smelter emissions; generation of fugitive dust; alteration of soils, including increased erosion; and generation of noise, which can disrupt wildlife and modify human behavior.

Cumulative Effects

Although a single mining operation may create its own set and degree of environmental impacts, a regional concentration of mines may pose problems of cumulative impacts. For example, groundwater withdrawal at a single mine has the potential to create a deep cone of depression in the local aquifer. As the cone expands over time, it may join those created by neighboring mines and lower the regional water table, which in turn may decrease or terminate flow in streams and springs some distance from the mines. Similarly, contaminated drainage or leachate from waste rock dumps, heap leach pads, or tailings ponds at a number of mines may cause environmental problems even when a single mine would not be sufficient to lower stream water quality below acceptable concentration levels. Other issues involving cumulative

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impacts include the potential for contamination of groundwater aquifers, fugitive dust and air pollution from tailings and road surfaces, smelter emissions, and landscape degradation from large mine operations in the same general area. Although most of the possible environmental effects of mining discussed in the previous sections are in the context of individual mine operations, the potential for cumulative impacts also should be considered.

Long-Term Monitoring

Monitoring of environmental conditions and responses to human activities is needed to measure changes in the environment, and to determine the effectiveness of mitigation procedures. Monitoring is applicable to the various stages of mining from exploration, through development and extraction, to closure, reclamation, and post-closure. Baseline monitoring is essential to establish conditions prior to any mining activity and to provide the conditions against which future monitoring data can be compared. Monitoring during mining should address the implementation and effectiveness of environmental controls and compliance with regulations. Long-term monitoring can be used to address the effectiveness of mine closure activities, to validate predictive models, and to follow long-term responses to post-closure conditions. Long-term monitoring also may capture unexpected events that could alter environmental conditions. Long-term monitoring must be properly designed to measure those attributes that offer useful data on changes and/or sustainability of resources affected by mining activity and post-closure conditions.

CHANGING CONTEXTS

Federal and state agencies have been active in developing the existing regulatory framework, which is focused on managing the types of mining activities common during the last two decades. However, mining is not a static activity. Substantial changes are occurring in mining and environmental technologies. Market conditions for many minerals vary significantly over time, and changes in the regulatory environment are themselves affecting the nature of new mining proposals. Socio-economic changes in U.S. mining regions and the nation as a whole may have a profound impact on future mining. Regulatory and land management agencies will need to attend to these issues if the agencies are to be sufficiently flexible, technically proficient, and able to adapt and respond to changes.

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Changes in Technology

All phases of mining have undergone substantial technological change over the last few decades. Exploration uses remote-sensing techniques, improved conceptual models, new geochemical and geophysical instrumentation, statistical analyses and visualization of large data sets, and global positioning system capabilities, many of which were unknown two decades ago. Larger excavation equipment has allowed ore to be extracted from larger and deeper pits and has made open-pit mining feasible in areas where it would not have been possible previously. Cyanide-leaching technologies have largely replaced traditional beneficiation and some types of gold ore milling now make it economical to process ores of much lower grade.

Similar changes can be expected in the future. With the depletion of large-scale, low-grade surface ore deposits, increased consideration is being given to developing underground mines. For example, in the United States the extraction of uranium has shifted from a traditional mining and beneficiation process to an *in situ* process that depends on injecting a solution into the ground to leach the uranium from the ore without excavating the ore deposits. The leachate is collected through a system of wells, and the mineral is extracted with little surface disturbance; the technique creates a new threat to groundwater supplies, however, and care must be taken to avoid contamination of groundwater. Such *in situ* processes have been used for years for sulfur and potash, and may become commercially viable for certain other types of ore deposits (including hardrock minerals) as well. Additional technological advances may make it possible to mine deposits that, for a variety of geological, geochemical, and environmental reasons, are considered infeasible today. In many cases technological changes in the mining industry, as in other industries, will respond to increased concern about environmental degradation.

Each change in technology presents new regulatory questions and challenges, one of which is to be able to predict the long-term effects of a new technology. The regulatory agencies will need to have the expertise to respond effectively to such changes and encourage the continued development of more environmentally friendly technologies.

Changing Market Conditions

Changes in market conditions can be even more dramatic and occur over a much shorter period than changes in technology. For example, the rising price of gold during the 1980s was a major stimulus to the rapid increase in gold mining on federal lands, but more recently (since 1992) gold prices in general

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have fallen as additional mines are developed in the United States and abroad and as central banks reduce their gold holdings.

Other minerals have seen similar variations in recent prices as a result of such disparate events as the discovery and development of new ore deposits; changes in the political and economic situation in producing countries; technological changes in the mineral-consuming industries that can substantially change the demand for a mineral; world economic conditions; and speculation.

Regulation in the United States has been trying to catch up with such market-driven trends as the rapid increase in gold mining during the 1980s. These up and down trends have occurred in the recent past for uranium, copper, and silver; similar trends probably will occur for the same or other minerals in the future. In one sense, rising prices present a relatively favorable economic environment for imposing new regulations, because the mining companies are eager to extract the mineral while prices are high and while they can afford the cost of increased environmental protection. With falling prices these permitting negotiations may become much more difficult, and some existing mines and mining companies may become unprofitable. One predictable result is temporary closure of existing mines until prices recover. If prices do not rebound, or if other unfavorable events transpire, temporary closures may become permanent. This means that regulatory approaches must address the challenge of falling prices to assure that resources are available to pay for site reclamation and post-closure costs.

Changes in the Regulatory Environment

The substantial changes that have taken place in the U.S. regulatory environment over the last two decades have also had a significant impact on the characteristics of the mining industry. While formerly high mineral prices may have attracted operations with insufficient capital and staying power, it is only the larger, more established firms that can afford to make the investment in time, extensive data collection, complex analyses, and expensive environmental protection measures that the state and federal regulations currently require.

This is likely to be a positive trend for the environment, for these companies have a strong ongoing interest in seeing the process work smoothly. Because they are involved for the long haul, they will go to great lengths to avoid creating problems that may cause regulators to be reluctant to approve modifications to their existing plans or proposals for new operations. They also have a strong interest in ensuring that other companies behave properly as

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well, because they are aware of how environmental failures can have a negative impact on their ability to operate.

On the other hand, under conditions of lower metal prices, existing operations with insufficient capital may not be able to afford the continued cost of environmental protection and may abandon their operations prior to full reclamation. If financial assurances are insufficient, the public will be responsible for reclamation and post-closure costs. Regulatory systems must be able to protect the environment under both higher and lower metal price conditions by requiring adequate financial assurances and including flexible, performance-based standards that do not stifle innovation.

The Committee received testimony from senior officers of mining companies as well as other evidence that delays and uncertainties associated with the U.S. regulatory environment are causing mining companies to replace domestic operations with overseas projects, a trend that is already strongly demonstrated in exploration. There are, of course, many other factors that affect such decisions, such as the availability of rich, easily mined deposits. This trend could be reversed by changes in the regulatory or political environment in foreign countries. Such changes, combined with the adoption of more efficient regulatory systems in the United States, could encourage companies to pursue mineral exploration opportunities in the United States more aggressively. Like mining technologies, regulatory programs evolve. A clear demonstration of this evolution is the growth of new state reclamation and mining waste statutes and regulations over the last two decades.

Socio-economic Changes

The population of many of the western mining states is increasing rapidly, often with people who come from regions where hardrock mining has not been a common activity. Consequently, new residents may have values and interests that differ substantially from those of other residents who depend on mining for jobs and other economic opportunities. In addition, the U.S. population today generally expects more from its federal lands—more recreational opportunities, more wildlife and habitat protection, more watershed protection, more timber and forage production, more historic and cultural preservation, more sensitivity to tribal concerns, as well as more mineral activities. It is likely to become increasingly difficult to find sites that will not stimulate some opposition from groups with competing values and interests in the same lands.

This array of changes in technology, mineral prices, regulatory practice, and in socio-economic factors poses a profound challenge for federal land managers.

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ORGANIZATION OF THE REPORT

The Committee has organized this report to respond to the three points of the statement of task. Chapter 1 provides an introduction to the report. Chapter 2 addresses the first point regarding the current regulatory requirements for mining on federal lands and time requirements for environmental review and permitting. Chapter 3 covers the second point regarding the adequacy of current regulatory requirements to prevent unnecessary or undue degradation of federal lands. Chapter 4 speaks to the third point regarding recommendations and conclusions about how federal and state regulatory requirements and programs can be coordinated to ensure environmental protection, increase efficiency, avoid duplication and delay, and identify the most cost-effective manner for implementation.

Appendix A provides an introduction to mining, its purposes, and its potential environmental impact. Appendix B discusses in some detail the potential environmental impacts of mining. Appendix C contains compilations of federal and state permitting, operating, and reclamation requirements and supplements the presentation of regulatory requirements in Chapter 2. Appendix D addresses research needs and supplements the discussion of this topic in Chapters 3 and 4. Appendix E discusses financial assurance for mining operations. Appendixes F and G list those persons who supplied input to the Committee. Appendix H provides biographical sketches of the Committee members. Technical terms and acronyms are defined, respectively, in the glossary and list of acronyms at the end of the report.

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2

Existing Regulatory Framework

The study shall identify and consider…the operating, reclamation, and permitting requirements for locatable minerals mining and exploration operations on federal lands by federal and state air, water, solid waste, reclamation and other environmental statutes, including surface management regulations promulgated by federal land management agencies and state primacy programs under applicable federal statutes and state laws and the time requirements applicable to project environmental review and permitting.

This chapter summarizes the federal land management standards and operating, reclamation, and permitting requirements for locatable (hardrock) minerals mining and exploration on federal lands.

STATUTORY POLICIES FOR MANAGEMENT

To assess the adequacy of regulatory requirements, the Committee examined the objectives set forth by Congress for federal land managers to apply to hardrock mining activities on federal lands.

The Federal Land Policy and Management Act of 1976 (43 U.S.C. §1701–1784) provides the Bureau of Land Management (BLM) with management standards for hardrock mining activities on public lands. Section 1701(a) states:

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> The Congress declares that it is the policy of the United States that— (7) goals and objectives be established by law as guidelines for public land-use planning, and the management be on the basis of multiple use and sustained yield unless otherwise specified by law.[1]
>
> (8) the public lands will be managed in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archeological values; that, where appropriate, will preserve and protect certain public lands in their natural condition; that will provide food and habitat for fish and wildlife and domestic animals; and that will provide for outdoor recreation and human occupancy and use.
>
> (12) the public lands be managed in a manner which recognizes the Nation's need for domestic sources of mineral, food, timber, and fiber from the public lands, including implementation of the Mining and Minerals Policy Act of 1970 as it pertains to the public lands.[2]

[1] 43 U.S.C. §1702(c) defines multiple use as "a combination of balanced and diverse resource uses that takes into account the long-term needs of future generations for renewable and nonrenewable resources, including, but not limited to, recreation, range, timber, minerals, watershed, wildlife and fish, and natural scenic, scientific, and historical values; and harmonious and coordinated management of the various resources without permanent impairment of the productivity of the land and the quality of the environment with consideration being given to the relative values of the resources and not necessarily to the combination of uses that will give the greatest economic return or the greatest unit output."

[2] The Mining and Minerals Policy Act of 1970 states: "The Congress declares that it is the continuing policy of the Federal Government in the national interest to foster and encourage private enterprise in (1) the development of economically sound and stable domestic mining, minerals, metal and mineral reclamation industries, (2) the orderly and economic development of domestic mineral resources, reserves, and reclamation of metals and minerals to help assure satisfaction of industrial, security, and environmental needs, (3) mining, mineral and metallurgical research, including the use and recycling of scrap to promote the wise and efficient use of our natural and reclaimable mineral resources, and (4) the study and development of methods for the disposal, control, and reclamation of mineral waste products, and the reclamation of mined land, so as to lessen any adverse impact of mineral extraction and processing upon the physical environment that may result from mining or mineral activities." 30 U.S.C. 21a.

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And Congress provided in section 1732(b):

> In managing the public lands the Secretary shall, by regulation or otherwise, take any action necessary to prevent unnecessary or undue degradation of the lands.

The Forest Service manages mining and its impacts under the standard of the 1897 Organic Act, which grants the Secretary of Agriculture general power to promulgate rules to regulate "occupancy and use and to preserve the forests thereon from destruction."[3] The Forest Services also operates under the National Forest Management Act (16 U.S.C. 1600–1640).

Both agencies also have management authority under the Surface Resources Act, which applies to mining claims located after 1955: "Rights under any mining claim hereafter located under the mining laws of the United States shall be subject…to the right of the United States to manage and dispose of the vegetative surface resources thereof and to manage other surface resources thereof."[4]

These statutory authorities find further expression in the regulations adopted by the respective agencies (43 CFR 3809 and 36 CFR 228) but the regulations do not exhaust the authority of the agencies. The statutory standards, coupled with the agencies' obligations under the National Environmental Policy Act (NEPA) to "interpret and administer" their laws in accordance with the policies set forth in NEPA,[5] make it clear that the BLM

[3] 16 U.S.C. §551. United States v. Weiss, 642 F.2d 296 (9th Cir. 1981) (upholding Forest Service Part 228 regulations under the Organic Act); United States v. Doremus, 888 F.2d 630 (9th Cir. 1989) (upholding Forest Service Part 228 regulations under Surface Resources Act).

[4] 30 U.S.C. §612.

[5] NEPA §102(1), 42 U.S.C. §4332(1), provides that "The Congress authorizes and directs that, to the fullest extent possible: (1) the policies, regulations, and public laws of the United States shall be interpreted and administered in accordance with the policies set forth in the Act." Section 105 of NEPA, 42 U.S.C. §4335, further provides that "the policies and goals set forth in this Act are supplementary to those set forth in existing authorization of Federal agencies." The policies are the six set out in §101(b), 42 U.S.C. §§4331(b): to "(1) fulfill the responsibilities of each generation as trustee of the environment for succeeding generations; (2) assure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings; (3) attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences; (4) preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity and variety of individual choice; (5) achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities; and (6) enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources."

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and Forest Service have public responsibilities that go beyond those of the state regulatory agencies seeking to protect specific environmental media. The federal agencies as land managers on the public's behalf stand in a different relationship to the land and its resources than simply as regulators of impacts. The federal land managers have a mandate for long-term productivity of the land, protection of an array of uses and potential future uses, and management of the federal estate for diverse objectives.

This relationship means that the term "regulator" does not fully describe BLM and Forest Service responsibilities when dealing with mining activities on federal lands. It also means that these agencies are not merely landholders. They are both landholders and regulators, with a set of statutory management standards. Further, they must serve a constituency almost always described in national terms—"the nation's needs," "all Americans," "future generations."

These factors explain in part why federal officials told the Committee that even in those states where working relationships and regulatory coordination were almost uniformly described as positive and productive, they were concerned about their ability to rely entirely on state regulators to address both short-term and long-term land use implications of mining operations on federal lands. Concerns surfaced in such areas as the ability to track and respond quickly to expansions in disturbed areas at small mines and to address post-mining conditions at larger mines.

ENVIRONMENTAL REGULATION

This section describes the regulatory framework governing hardrock mining on federal lands. The description is not intended to summarize every regulatory program potentially applicable to any mining operation but rather to identify the roles currently played by the major statutory and regulatory programs. It should be noted that for a major hardrock mining operation, 30 or more federal, state, and local regulatory programs may apply. (Appendix C lists the permits required for many recent large-scale mining operations on federal lands in various states.) Small-scale exploration or mining operations may be subject to a more limited array of regulations and programs.

The precise scope of regulation depends on the type of operation; the size of the operation; the types of land, water, and biological resources affected; the state in which the operation is located; the existence of state air and water

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pollution control programs operating with federal approval; and the organization of state and local permitting agencies.

Federal Land Management Agency Responsibilities

Federal land management planning requirements. BLM land use plans under the Federal Land Policy and Management Act (FLPMA)[6] and Forest Service plans prepared under the National Forest Management Act[7] establish the parameters within which surface-disturbing activities may occur on BLM or Forest Service lands subject to the interests created by the General Mining Law. These planning processes are not linked to specific mining proposals, but are intended to guide broad agency management decisions about the use of federal lands and the management of resources on the land. These land management plans do not override the interests acquired by the mining claimant under the General Mining Law, but provide a framework for agency consideration and protection of other resources. Preparation of these land management plans must comply with NEPA,[8] which includes requirements for consideration of alternatives, as well as provisions for public scoping, review, and comment.

BLM and Forest Service regulations. Proposed mining activities on federal lands trigger the application of BLM's 43 CFR Part 3809 regulations (promulgated in 1980) or the Forest Service's 36 CFR Part 228 regulations (promulgated in 1974). The regulations themselves prescribe the review procedures requiring the submission of either notices or plans of operations. The BLM regulations require no notice or other submission for "casual use" operations involving "negligible" surface disturbance; whereas reclamation is required, no standards are set forth and no financial assurance guaranteeing reclamation is required. The BLM regulations require submission of a notice for other operations disturbing 5 or fewer acres, but the BLM does not approve the notice or specify particular operating methods. Reclamation of these "notice-level" operations is required, but no financial assurance is required. Operations disturbing more than 5 acres must submit a "plan of operations" for review and approval by BLM and must post financial assurance in an amount determined by BLM to guarantee reclamation.

The Forest Service requires operations of any size to submit a notice and to submit a plan of operations if the Forest Service determines there will be

[6] 43 U.S.C. §§1701–1784.
[7] 16 U.S.C. §§1600–1687.
[8] 42 U.S.C. §4321 et seq.

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any "significant" disturbance of the surface. The Forest Service generally requires plans of operations for all mechanized mining or exploration operations on Forest Service lands regardless of acreage. Posting of financial assurance in an amount determined by the Forest Service is required. The Part 3809 and Part 228 regulations establish performance standards intended to assure compliance with, respectively, the FLPMA prohibition of "unnecessary or undue degradation of public lands" and the Forest Service regulatory requirement to "minimize adverse environmental impacts on national forest surface resources," based on the 1897 Organic Act.

The National Environmental Policy Act. NEPA serves to integrate BLM and Forest Service decision making on particular mining proposals with evaluation of other environmental concerns, as well as with other state and federal permitting requirements. The relevant land management agency (BLM or Forest Service) prepares the NEPA documents that inform the manager's decision on the proposed mining operation. Where more than one agency is involved, they reach agreement as to which will be the lead agency or share the lead. Other agencies may become "cooperating agencies" or may elect simply to comment on draft documents in the same manner as the public. The Council on Environmental Quality's regulations encourage federal, state, and tribal agencies that have decision-making responsibilities with respect to a proposed operation—including permitting responsibilities—to become cooperating agencies in preparing the NEPA documents and in performing the required analysis.[9]

For large-scale mining operations on federal lands, the environmental impact statement (EIS) required under NEPA serves as the "spine" of the federal land manager's decision-making process. The EIS process includes requirements for publicly "scoping" the issues and identifying alternatives to be evaluated. It provides for preparation of a draft EIS evaluating alternatives and identifying impacts. The draft is subject to public comment and to review and comment by other agencies. A final EIS must respond to all substantive public and agency comments and serve to inform the decision maker. The final decision is made by a record of decision (ROD), which determines the content of the plan of operations and mitigation requirements.

Smaller mines often trigger only an environmental assessment (EA), a NEPA document intended to assist the federal land management agency in deciding whether environmental impacts are significant. If the EA shows that

[9] 40 CFR §1501.6. "Cooperating agency means any Federal agency other than a lead agency which has jurisdiction by law or special expertise with respect to any environmental impact involved in a proposal… A State or local agency of similar qualifications or, when the effects are on a reservation, an Indian Tribe, may by agreement with the lead agency become a cooperating agency." 40 CFR §1508.5.

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they are, an EIS must be prepared. If not, the agency prepares a finding of no significant impact (FONSI). Unlike EISs, EA/FONSIs are not necessarily subject to public review and comment, although Council on Environmental Quality regulations state that such review is to be afforded in cases where the proposed action "is, or is closely similar to, one which normally requires the preparation of an environmental impact statement" or if the action is "one without precedent."[10] Certain routine activities, such as minor modifications to approved plans of operations, are categorically excluded from NEPA review by BLM or Forest Service procedures. BLM also has a practice of accepting notices for mining operations disturbing less than 5 acres without conducting any environmental review under NEPA.[11] In contrast, the Forest Service prepares EAs in connection with plans of operations for such small operations.

Three public land states have their own "state NEPA" laws that require state agencies to prepare EAs or EISs in connection with activities such as mining. California, Montana, and Washington usually integrate these state processes with the federal NEPA process to avoid duplication of effort. These states have effectively accepted "cooperating agency" or co-lead agency status for NEPA implementation with respect to the review of mining operations. States without "state NEPA" laws must make decisions about their level of reliance on the federal EIS and about becoming a cooperating agency under NEPA on a case-by-case, agency-by-agency basis.

Endangered species, historic preservation, Indian trust responsibilities, and other laws. Other federal laws create consultation and other substantive obligations. The Endangered Species Act (ESA) requires the federal land management agency to consult with the U.S. Fish and Wildlife Service or the National Marine Fisheries Service or both when threatened or endangered species may be adversely affected by a proposed operation.[12] ESA and NEPA processes are often integrated; indeed, the presence or potential presence of listed species may lead an agency to prepare an EIS rather than an EA. The National Historic Preservation Act[13] and the American Indian Religious Freedom Act,[14] also require BLM and the Forest Service to consult with other agencies and with tribes and to consider and mitigate impacts on protected

[10] 40 CFR §1501.4(e)(2).

[11] This practice was upheld by the U.S. Court of Appeals for the Ninth Circuit, which held that "BLM does not sufficiently involve itself in the approval process to render notice [level] mine review a major federal action requiring NEPA compliance." Sierra Club v. Penfold, 857 F.2d 1307 (9th Cir. 1988).

[12] 16 U.S.C. §1536.

[13] 16 U.S.C. §470 et seq.

[14] 42 U.S.C. §1996.

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resources or interests. The consultation processes are usually integrated with NEPA review. The federal government's trust responsibility to Indian tribes also applies to federal decision making concerning the occurrence of hardrock mining. The trust responsibility stems from a variety of sources, including treaties and statutes. Its applicability is not limited solely to mining operations that occur on Indian lands; it applies also to off-reservation activities on the public lands that affect Indian treaty rights, cultural resources, or other interests.

Coordination with state decision makers. Whereas the decision making outlined above is under the jurisdiction of the land management agencies, memoranda of understanding (MOUs) between the BLM and state agencies and the Forest Service and state agencies establish the links between state environmental regulatory requirements and federal land manager decisions under 3809 and 228 regulations. The Committee reviewed a broad array of these MOUs, which varied significantly in vintage, detail, and specificity. Of the western states, only Arizona lacks a formal interagency agreement related to hardrock mining on federal lands.

Some MOUs involve a state and a single federal land management agency; others are signed by representatives of the state, BLM, and the Forest Service. Some MOUs address only a single issue, whereas others deal with a broad range of management considerations. MOUs frequently indicate whether the federal agency will defer to state decisions, make independent decisions, or share decision-making authority, as well as define how inspection and enforcement, monitoring, and financial assurance will be handled. The MOUs are important, as they seek to avoid duplication while recognizing the sometimes divergent interests of federal and state regulators.

Effect of patenting. For the purposes of regulation, patented lands (or lands acquired by mining operations from the government through exchanges) are treated like any other privately owned lands. They are regulated under the state and federal environmental permitting programs discussed below, but are not specifically covered by the federal requirements discussed above. Specifically, the plan of operations requirements and NEPA compliance associated with approval of plans of operations do not apply to private lands. Nor does the "consultation" requirement under the Endangered Species Act apply to mining on patented lands (unless triggered by some other federal action such as issuance of a permit to fill wetlands); although the prohibition on "taking" of listed species applies whether an operation is on privately owned or publicly owned lands.

Nevertheless, if patented lands are intermingled with unpatented federal lands, the plan of operations and associated NEPA and ESA requirements will apply to the operation. For this reason, some mining operations that include only a small area of unpatented mining claims seek to exchange other lands for

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these lands, or to obtain patents, in order to simplify the review process and eliminate federal land management oversight.

Environmental Permitting Requirements

In addition to the 3809 and 228 regulations, various other state and federal laws establish environmental requirements applicable to mining operations on federal lands.[15] State environmental regulations of general applicability apply on federal lands and are not preempted by the General Mining Law or other federal laws.[16] The following description highlights the most significant of these environmental laws as they relate to surface management issues.

State reclamation laws. Laws requiring reclamation of hardrock mine sites now exist in all western public land states, although permitting of all operations under these laws has not been entirely completed in Arizona and New Mexico, among the more recent states to adopt such laws.[17] These reclamation laws often establish:

- thresholds for the regulation of exploration operations, small mining operations, large mining operations, and "special" or "designated" mining operations using certain chemical beneficiation techniques;
- application content, review and approval procedures, public participation requirements;
- requirements relating to the characterization of overburden and ores, prediction of acid drainage, and management of acid-generating materials;
- requirements relating to the management of introduced substances related to beneficiation of ores (cyanides, lixiviants);
- requirements for stabilization and reclamation of the site;
- requirements for closure of tailings disposal areas, spent ore areas;
- requirements for revegetation;
- financial assurance requirements, including what the assurance must cover, any minimum or maximum amounts required, forms of

[15] See Table C-1, Appendix C, for a list of compilations of state regulatory permitting references consulted by the Committee to assist its primary research on statutory and regulatory requirements.

[16] California Coastal Comm'n v. Granite Rock Co., 480 U.S. 572 (1987).

[17] Ariz. Rev. Stat. §37–932 provides that for mines on federal lands "an approved federal reclamation plan and a financial assurance mechanism…consistent with" the state's reclamation law "supersede" state requirements.

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acceptable assurance (bonds, letters of credit, corporate guarantee), procedures to establish or revise required amounts, and procedures for release;
- reporting requirements; and
- monitoring requirements.

Small mining operations often have fewer obligations and requirements under these laws (see Table 2–1).

State reclamation laws resemble one another in broad terms, but differ in specificity, approach (technically prescriptive standards versus performance-based standards), and financial assurance requirements. They are generally administered by agencies at the state level organized to regulate mining. In California, however, reclamation is regulated at the county level, subject to oversight by the State Mining and Geology Board.

Surface water quality protection laws. These laws, in general, correspond to the federal Clean Water Act permitting programs. Section 402 of the Clean Water Act requires permits for all discharges from "point sources" to the waters of the United States.[18] A state may operate the permitting program in place of the Environmental Protection Agency (EPA) if the EPA has approved the state's regulatory program. All the western federal land states except Alaska, Arizona, Idaho, and New Mexico operate permitting programs pursuant to EPA delegations. EPA is responsible for surface water discharge permitting in these four states. The permit limits are a combination of technology-based effluent limits and water quality-based limits (where the technology-based limits are not sufficient to meet water quality standards in the receiving waters). Such limits may face further tightening in the future as states conduct assessment of their impaired waters under section 303(d) of the Clean Water Act. Under this section, the states must identify water bodies that do not meet water quality standards with current permit limits, and must establish total maximum daily loads (TMDLs) in order to meet those standards. TMDLs allocate pollutant loads among the sources of discharge.

Section 402 permits typically include numerical standards for the active mining phase and may include different or best professional judgment standards for post-mining discharges. Some states require a "zero discharge" permit for mine facilities designed not to discharge, where there may be adverse effects if discharge occurs. A number of states rely on their water

[18] 33 U.S.C. §1342.

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TABLE 2–1 Reclamation and Financial Assurance Requirements for Small Mining and Exploration Operations

Federal Requirements	
BLM	No notice and no financial assurance is required if "casual use"; operator must prevent unnecessary or undue degradation. Filing of notice is required for all other operations under 5 acres; reclamation is required but no financial assurance.
Forest Service	Plan of operations is required if there is significant disturbance of surface resources; reclamation and financial assurance are required.
State Requirements	
Alaska	Under 5 acres requires annual application, letter of intent, annual reclamation statement; no financial assurance.
Arizona	Exploration and mining less than 5 acres are not regulated under reclamation law; no financial assurance. Notice to Department of Water Resources required for drill holes 100 ft. or more deep. Aquifer protection permit can apply to small operations, and requires demonstration of financial capacity; exempts overburden returned to excavation area and materials not chemically leached or that will not otherwise leach concentrations violating aquifer standards.
California	Not regulated under reclamation law if under 1 acre and overburden disturbed is less than 1,000 cu. yd.; no financial assurance. Waste discharge regulations (chemical processes, waste units design and closure requirements) have no size threshold and financial assurance is required.
Colorado	Prospecting not regulated if disturbed area is less than 1,600 sq. ft. and not exceeding two such disturbances per acre, or 5 acres statewide in 24-month period; no financial assurance. Larger prospecting operations require notice of intent and financial assurance of $2,000/acre. Limited impact mining

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	operations affecting less than 10 acres and less than 70,000 tons of material have simpler permitting requirements than larger operations except for designated mining operations; financial assurance is required.
Idaho	Hardrock exploration operations must file a notice and reclaim; financial assurance is not required if less than 5 acres. Mines of any size must have reclamation plan and financial assurance. Placer exploration operations must file a notice and reclaim, but financial assurance is not required if less than 2 acres. Placer mines more than 2 acres require reclamation plan and financial assurance limited to $1,800/acre.
Montana	Exploration requires statewide license; license requires bonding of $200–$2,500/acre. Small miners exclusion statement allows an operator to disturb up to 5 acres without a permit; two such sites if at least 1 mile apart. Hardrock small miners are not required to reclaim or post bond; placer small miners must reclaim and post bond not to exceed $10,000. Small operators using cyanide are required to obtain a permit and post bond for that portion of the operation.
Nevada	No reclamation permit is required for exploration or mining operation disturbing and not reclaiming areas of less than 5 acres within 1 mile radius in any calendar year (and not processing more than 36,500 tons annually). No financial assurance is required. Exploration boreholes must be plugged in accordance with regulations of state engineer. Water pollution discharge program applies with no size threshold.
New Mexico	Operations eligible for a general reclamation permit are wet operations (2–100 cu. yd. of material moved per year) or dry operations (up to 200 cu. yd. per year); no financial assurance required. Minimal impact exploration operations (less than 5 acres and no significant impact on water or groundwater or certain other factors) require a permit but no financial assurance. Minimal impact mining operations (less

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	than 10 acres and not otherwise excluded) require a permit, but do not require financial assurance if 2 acres or less.
Oregon	No reclamation permit for mining operations disturbing less than 1 acre of land, or that move less than 50 cu. yd. in streambeds or less than 5,000 cu. yd. otherwise; and no financial assurance required. A special permit is required for exploration that disturbs more than 1 cumulative acre or requires drilling of holes 50 feet or more in depth. Blanket bonding is authorized for exploration.
South Dakota	Exploration is conducted under a notice of intent. A notice is not required for activities that cause "very little or no surface disturbance." Reclamation of exploration operations conducted under notice is mandatory; financial assurance must be posted either based on site-specific conditions or a $20,000 surety for statewide exploration. Small-scale mining operations, defined as affecting less than 10 acres exclusive of access roads and extracting less than 25,000 tons of ore or overburden per calendar year and not using cyanide or other chemical or biological leaching processes; financial assurance not exceeding $2,500 total.
Utah	Notice of intent for exploration and mining operations of less than 5 acres; no financial assurance required; reclamation required in accordance with rules.
Washington	Reclamation law does not regulate mining operations disturbing and not reclaiming less than 3 acres, and exploration operations disturbing less than 1 acre in an 8-acre area; no financial assurance is required for operations below these thresholds. Metal mining and milling act does not have a size threshold.
Wyoming	Requires a notice for exploration by drilling and a license to explore by dozing; the license cannot cover more than 40 acres of disturbance in 4 contiguous 1/16th sections. Both the notice and license require a minimum financial assurance of $10,000. A letter of authorization with no financial assurance

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is given for small disturbances, such as less than 3-inch suction dredging. A small mine permit and financial assurance are required for operations moving 10,000 cu. yd. or less and 10 or fewer acres disturbed in any year.

NOTE: This table addresses primarily reclamation and financial assurance requirements and does not represent all regulation of small operations. For example, small mine operations may require water pollution discharge permits, air pollution permits, wildlife agency approvals, endangered species and cultural resources reviews, or other permits.

pollution control permitting programs to regulate hardrock mining facilities and processes that introduce cyanides, acids, or other substances to the mine site. For example, Nevada's water pollution control permitting process is the primary regulatory framework for control of beneficiation and process units.

In addition to regular section 402 permits for point source discharges from mining operations, the Clean Water Act also requires control of industrial stormwater discharges that enter surface waters, including seepage from leach heaps and waste rock dumps. These are generally regulated pursuant to a general permit or permit-by-rule.[19] General permits under section 402 are also used to regulate water quality concerns associated with placer mining in Alaska.

State groundwater quality laws. Many states have laws designed to protect the quality of groundwaters from discharges from mining and other operations. These laws range from the detailed permitting program in Arizona (requiring aquifer protection permits based on detailed prescriptive standards) to the California mining waste requirements under the Porter-Cologne Act (establishing waste characterization standards and presumptive design standards for management units) to Colorado's groundwater law (which requires each regulatory agency to integrate groundwater protection into its permitting and regulatory decisions).

State water rights laws. State laws in the West subject the withdrawal and use of surface water and groundwater to regulation by the state engineer's office or its equivalent agency. Such review is generally intended to protect beneficial users and assure the integrity of water rights. Thus, mining processes that result in consumptive uses of water or dewatering of aquifers

[19] 33 U.S.C. §1342(p).

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and surface waters must obtain permits from the state engineer. Water quantity laws also can have some impact on mining practices and approaches, including effects on the post-mining hydrology that must be achieved.

Fish and wildlife laws. Many states have enforceable requirements that relate to fish and wildlife. These may include provisions requiring stream diversion permits (as in California), netting of process ponds to prevent death or injury to migratory birds and terrestrial animals (as with Nevada's industrial pond permitting program), limitations on the timing and location of suction dredging in streams used by anadromous fish (as in Washington), as well as requirements related to definition of post-mining land use objectives and revegetation standards.

Air quality permitting. Air pollution permits are required for most hardrock mining operations beyond the smallest operations. Generally, this is state permitting pursuant to the federal Clean Air Act; it may include controls for fugitive dust, particulates, sulfur dioxide emissions, certain metals, and volatile organic compounds.[20]

Clean Water Act section 404 permitting. A federal permit from the U.S. Army Corps of Engineers is required when a mining activity will result in filling waters of the United States, including wetlands.[21] In some cases, a "general permit" may be available for activities disturbing small areas that are believed to cause minimal impacts. The 404 program requires avoidance of wetlands, minimization of unavoidable impacts, and mitigation of impacts (including compensatory mitigation). Section 404 permitting also triggers a requirement under section 401 that the state in which the activity occurs must certify that the activity will not impair water quality below state standards; states may impose conditions or requirements in connection with their grant of certification.[22]

Other regulation. Other types of regulation typical at hardrock mines on federal lands include Resource Conservation and Recovery Act (RCRA) regulation of certain hazardous wastes and laboratory chemicals as well as certain processing wastes not exempted by RCRA or state laws more stringent than RCRA. Wastes from the extraction and benefication of mineral ores are exempt from hazardous waste regulation under RCRA, as are specified mineral processing wastes, but states may apply more stringent definitions. State solid waste regulations also apply to various wastes, including garbage, construction debris, and other wastes not exempt under state law. Other regulatory programs include the Safe Drinking Water Act regulation of underground injection and protection of source waters; protection of cultural resources and

[20] 42 U.S.C. §§7401 et seq.
[21] 33 U.S.C. §1344.
[22] 33 U.S.C. §1341.

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archaeological permitting; reporting requirements under the Emergency Planning and Community Right-to-Know Act; spill reporting obligations under the Comprehensive Environmental Response, Compensation, and Liability Act, and liability under that Act for releases of hazardous substances to the environment (including liability for natural resource damages); Uranium Mill Tailings Radiation Control Act regulation of uranium tailings disposal sites; local regulation, zoning, and occupancy requirements; transportation regulation (including road closures, relocations, crossings); and other requirements.

Section 313 of the Emergency Planning and Community Right-to-Know Act requires certain types of operations annually to report any releases to the environment, accidental or planned, of the 650 listed chemicals (including metals and other substances identified as hazardous), as well as amounts of chemicals involved in certain other types of activities, such as recycling or destruction. Originally implemented in 1987, the Toxic Release Inventory regulations under this section were revised in 1997 to require hardrock mining operations to complete this reporting. The first report from hardrock mines was due on July 1, 1999, for 1998 calendar year releases.

Regulation of uranium industry. The regulatory structure that governs the uranium industry is unique because of the role of the Nuclear Regulatory Commission, which regulates all aspects of the uranium industry that involve processing of uranium, including the *in situ* solution mining of uranium. The EPA, or a state with a delegated program, also regulates the *in situ* solution mining of uranium because the injection wells are considered to be Class 3 wells under the Underground Injection Control Program (40 CFR 140–143). State groundwater protection and water rights laws also apply. Traditional mining of uranium is regulated in the usual fashion by other federal and state agencies. A more detailed discussion of the uranium industry is in Appendix A.

RELATIONSHIPS AMONG STATE AND FEDERAL ENVIRONMENTAL REGULATIONS

Crosscutting issues under all the federal, state, and local programs include permitting, monitoring and reporting requirements, inspection and enforcement, reclamation, surety, bond release, and public participation opportunities. Some of these relationships are defined by MOUs, while others are worked out more informally. The current array of MOUs differ significantly in their specificity.

Given the variation in topography, climate, and area of federal lands open to hardrock mining in any state, differences in state laws, and local differences in public attitudes toward mining, consistency among state MOUs may not be necessary or even desirable. Testimony provided by federal and state officials

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at meetings of the Committee indicated that the MOUs generally serve their stated purposes. However, of more relevance is whether federal and state laws each need to cover all topics of concern, or whether coordination of the respective laws can adequately address hardrock mining impacts. For example, apparent gaps in federal regulatory authority (e.g., groundwater quality) may be filled by state authority. On the other hand, federal reclamation bonding requirements, such as for small operations on Forest Service lands, sometimes fill a state regulatory vacuum. Unless there is strong coordination, gaps or duplication of effort may occur.

How do these varying programs relate to one another? Federal agencies that manage lands open to mineral exploration and development regulate hardrock mining and exploration by managing the land and regulating the land's uses. Congress, mostly acting through laws administered by the EPA, has assigned permitting and regulation of water quality and air quality to the states (except where states have elected not to seek authorization and have left permitting to EPA). Most states have taken on these responsibilities. Water quantity has historically been subject to state regulation. Groundwater quality (in the absence of federal legislation) has also been largely a matter of state regulation.

Protection of cultural resources on lands open to mineral extraction is of concern to federal agencies through the National Historic Preservation Act, to states through their state historic preservation offices, and to Indian tribes and others with cultural heritage in the mining areas, such as residents of historic mining towns. This dispersion of management and concerns for environmental and cultural protection among federal, state, tribal, and local entities raises the issue of which entity has, or should have, the leading role in managing and regulating activities that may create environmental degradation.

Virtually all areas of concern about environmental degradation or protection of cultural resources are addressed in some fashion by regulation and permitting procedures; however, there are times when higher levels of environmental or cultural protection may be desired for site-specific reasons. These resource protection issues can often be addressed through federal resource management planning processes, which allow input from all interested parties.

In general, the state and federal environmental permitting agencies are the first-line enforcers. The BLM and Forest Service may also take enforcement action under their respective 3809 and 228 regulations when the activity results in violation of those regulations or violates the terms of the plan of operations or the notice requirements.

State regulatory agencies, the EPA, the U.S. Army Corps of Engineers, or the U.S. Fish and Wildlife Service will ordinarily take the lead in enforcement when a regulatory standard has been contravened—such as

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violation of an effluent guideline, failure to report a release, or causing the death of migratory birds or harm to endangered species. Federal land managers may act independently (even where a regulatory agency has also acted) to assure that land management objectives not necessarily reflected in an abatement order issued by another agency are satisfied.

In general, the existence of multiple regulatory programs helps to assure that at least large-scale mining on federal lands is subject to substantial scrutiny. At the same time, however, the complexity of the various programs can make the system difficult to understand, approach, and implement efficiently. As a result, mining regulation, permitting, monitoring, reclamation, closure, and post-closure becomes a series of negotiations carried on against a background of regulatory requirements and programs. This means that governmental regulators at all levels need a significant degree of sophistication and training in order to make these programs efficient and effective. The programs do not—and cannot—operate in cookbook fashion. Thus, many of the findings and conclusions of this report involve mixed issues of regulatory adequacy and implementation.

TIME REQUIREMENTS FOR ENVIRONMENTAL REVIEW AND PERMITTING

Examination of timing provisions and requirements in state and federal laws and regulations reveals a variety of approaches by the agencies. The amount of time required for project review and permitting is influenced as much by implementation practices of state and federal agencies as by statutory and regulatory requirements. For example, while NEPA comment and review requirements under the Council on Environmental Quality's regulations[23] could in theory allow a project to proceed from notice of intent to prepare an EIS to a record of decision in approximately six months, the committee found that large-scale mines on federal lands require between 18 months and 8 years to complete both the EIS review and all the permitting and other approvals by state and federal agencies with jurisdiction over the mining operations. NEPA regulations do provide some opportunities to address timing issues. The regulations expressly encourage federal agencies to set time limits appropriate to individual actions. They also provide that an agency "shall set time limits if an applicant for the proposed action requests them."[24]

[23] 40 CFR §1500.
[24] 40 CFR §1501.8(a).

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Some laws have explicit timing requirements. For example, Colorado law provides that a decision must be made on the state reclamation permit within 120 days after receipt of the application, unless the operation is particularly complex or other circumstances require more time. The law provides for an additional 60-day review period under such circumstances. To afford sufficient time for review, Nevada's water pollution regulations state that applications must be submitted at least 165 days before the intended commencement of operations; the regulations also require a pre-application meeting with the regulatory agency to identify data needs and avoid unnecessary delays in determining that permit applications are complete. Nevada's reclamation regulations tie the timing of the reclamation permit issuance to completion of the federal EIS process. Some states, such as California, have adopted time requirements for their “state NEPA” processes. However, even where state laws impose time limits, operators noted that there can be implicit pressure to agree to extensions of time beyond these limits in order to avoid risking a denial based on lack of information desired by an agency.

The time required for environmental review and permit issuance is also related to the completeness and technical adequacy of the permit information provided by the operator. It can take a significant time for the applicant to acquire an adequate data base. Timing of environmental review and permitting is affected by agencies' ability to coordinate with one another, as well as by the availability of sufficient agency staff and technical resources. Where coordination among state and federal regulatory agencies is high, environmental review and permitting appears to be faster—at least in areas that are not highly controversial due to publicly competing interests and values. Where separate agencies engage in serial permitting, rather than coordinating their review efforts, the process—including data gathering—can take longer. These implementation relationships are explored further in Chapter 3.

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3

Adequacy of Environmental Protection

As specified by Congress, the study shall identify and consider…the adequacy of federal and state environmental, reclamation, and permitting statutes and regulations applicable in any state or states where mining or exploration of locatable minerals on federal lands is occurring, to prevent unnecessary or undue degradation.

This chapter responds to Congress's second request to the Committee, and includes assessment of statutes and regulations, implementation of the regulations, and related matters to protect the environment. The Committee's assessments are presented as a series of issues related to the adequacy of environmental protection and regulatory efficiency related to mining. Apart from the issues that are identified, the Committee noted the significant improvements in mining-related environmental protection in recent decades. The Committee also noted that the staffs of federal land management agencies and the federal and the state regulatory agencies are generally dedicated to their tasks. Finally, all stakeholders the Committee encountered appeared to be concerned about environmental protection, even though they may disagree about the means and extent of that protection.

An evaluation of the adequacy of environmental protection related to mining on federal lands should include an analysis of the statutes to determine if they are protective of the environment or if they contain gaps or duplications. A regulatory program, however, is more than a collection of statutes. Laws can differ in their implementation, and their interpretation can be modified by court decisions. Laws are amplified and clarified through regulations. The regulations in turn are supplemented by published guidelines,

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policy statements, and administrative interpretations, which may not be consistent over time or among offices. The Committee has reviewed several recent compilations of regulatory requirements (see Appendix C).

The implementation of regulations through permits depends on such factors as the training and experience of the permit writers, their workload and staffing levels, their specific knowledge of the proposed operations, and their interpretation of rules and policies. Similar factors may affect the quality and effectiveness of the site inspections and monitoring that determine if mining activities are in compliance with operating permits. Finally, the implementing authorities must have and be willing to use enforcement tools when noncompliance occurs. Ultimately, the adequacy of state and federal regulatory programs for protecting the environment must be measured by what happens on the ground.

In this Chapter the Committee first presents a brief discussion of the essential elements of a regulatory program. The Committee then discussed a number of issues related to the adequacy of environmental protection of hardrock mine sites. The following issues are discussed and assessed: regulatory issues; regulatory implementation issues; scientific issues; the need for early stakeholder consultation; reclamation, closure, and post-closure management; regulatory efficiency issues; and public involvement issues. The issues presented herein lead to the recommendations presented in Chapter 4.

ELEMENTS OF A REGULATORY PROGRAM

The Committee identified the following 11 elements of an effective regulatory program:

(1) *Information* to describe pre-mining conditions, potential changes to the environment resulting from a project, and proposed post-mining/reclamation land use conditions;
(2) *Models and tools* to project and assess the consequences of these changes;
(3) *Standards and criteria* to determine if the changes comply with permit requirements, or are otherwise acceptable;
(4) *Monitoring* to demonstrate that standards and criteria are met.
(5) *Reporting and analysis* of the monitoring results to assess compliance with standards and criteria and trigger appropriate response to noncompliance;
(6) *Appropriate responses* to correct noncompliance and assure it will not reoccur;

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(7) *Enforcement* actions to assure adequate responses to non-compliance;
(8) *Financial guarantees* to protect the environment if the operator fails;
(9) *Personnel and resources,* properly trained and supported, to adequately implement and administer the regulatory program;
(10) *A management information system* to track the effectiveness of the regulatory program; and
(11) *Stakeholder communications* to assure that the entire process is open to appropriate public scrutiny.

Some of the elements are procedural (e.g., reporting and enforcement), and others describe the resources needed to make the procedures effective (e.g., models and tools, monitoring, and the management information system). Recognizing in advance the need to satisfy these eleven elements will add to the timeliness and adequacy of the regulatory program. These essential elements are discussed below and were used to identify the issues discussed later in this chapter.

Information

Information needed to describe environmental changes that result from a mining project can be divided into two categories: (1) environmental data and other information describing the site's existing, and, if available, pre-mine conditions; and (2) proposed plans of operations, reclamation plans, post-closure management plans, and other information required to identify the physical activities proposed for the site, and whether mining conditions can support the post-mining land use. Both sets of information must be adequate to determine the type and extent of impacts.

Models and Tools

The models and tools needed to project and assess the consequences of changes in baseline conditions resulting from the activities proposed for the site include air quality emission factors and models, acid-generation prediction models, pit lake water quality models, and hydrological models, among others. Current models and tools have varying degrees of uncertainty and have been subjected to varying degrees of calibration and verification (see Appendix D).

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Standards and Criteria

Standards and criteria are required to determine if the physical activities proposed for the site are in compliance with permit requirements. These standards and criteria are derived from the authorities applicable to the regulation of mining. They range from specific numerical standards, such as those included in federal and state Clean Water and Clean Air Act requirements, to the more qualitative requirements, such as those typically contained in state reclamation laws.

Monitoring

Appropriate environmental monitoring is essential to establish the effectiveness of containment measures, demonstrate compliance with standards and criteria, and direct responses to non-compliance (see Appendix B for discussion of long-term monitoring). Care should be taken to assure that monitoring requirements are adequately comprehensive and include the necessary quality control measures and documentation to be credible to the public. To the extent feasible, monitoring programs should include "early warning" elements to detect potential non-compliance far enough in advance to allow a suitable response that will prevent violation of standards and criteria.

Reporting and Analysis

Adequate reporting of monitoring results is required to assess compliance with standards and criteria and to trigger appropriate responses to incidents of non-compliance or, in the case of early warning monitoring, incidents of potential non-compliance. Reports should include tabulations, analyses, interpretations, and summaries that will allow the public to understand the results, will clearly support the conclusions, and will target actions to correct non-compliance.

Corrective Actions

Mine operators should quickly respond to correct actual or potential environmental problems identified through inspection and monitoring activities. These responses should be designed and engineered by qualified professionals, and if non-compliance has occurred, should be reviewed and

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approved by the agencies with jurisdiction. Implementation should be monitored and documented with the same care given to original construction.

Enforcement

Enforcement tools are required to assure adequate responses to violations and to assure that all of the required program elements are implemented. However, enforcement tools are preferably a seldom used component of an effective regulatory program. It is important to distinguish between circumstances presenting imminent danger to human health or the environment and other occurrences of non-compliance. Any enforcement mechanism should include appropriate due process for the violator and should emphasize compliance rather than operator penalty.

Financial Guarantees

Reclamation financial guarantees have long been an element of both state and federal programs, and are needed to assure that mines are reclaimed, even when the operator fails or is financially unable to undertake reclamation. These costs should not become a public burden. More recently, financial assurances are being required for predicted or actual environmental impacts during or after mining if the operator fails to appropriately correct identified problems or does not respond to pollution releases. In addition, most jurisdictions are now examining the need to assure post-closure management of reclaimed mine sites. The various financial mechanisms should be secure and sufficiently liquid to allow responses to near-term needs.

Personnel and Resources

Adequately trained personnel and supporting resources are the key to effective implementation of a regulatory program. Adequate training is needed to maintain skills in the face of changing technology and to maintain an understanding of mining and environmental requirements. Acquiring and maintaining the necessary skills requires adequate funding and other technical resources. To complete inspections in remote areas, the federal land management agencies should consider the use of helicopters. Although costly, this option may be especially useful when notices of intent are filed in remote areas and BLM has only 15 days to respond.

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Management Information System

A management information system (MIS) is essential to regulatory programs. Such a system tracks the effectiveness of the regulatory effort and allocates the necessary personnel and resources to maintain adequate environmental protection and to continuously improve overall program effectiveness. An MIS can provide the basis for effective stakeholder communications, as well as the number and types of mines; summaries of monitoring, inspection, and enforcement information; and the status of reclamation, financial assurances, and outstanding violations.

Stakeholder Communications

Effective, two-way stakeholder communications are essential to assure that the entire regulatory program is appropriately open to public scrutiny. An open and well-communicated regulatory program is essential in building public confidence that effectiveness has been achieved and that federal lands are being adequately protected.

REGULATORY ISSUES

The Committee did not have sufficient information to evaluate fully the environmental impacts of modern hardrock mining. Regulation of mining will limit and control many of these impacts, but mining will still alter landscapes and environmental resources because regulations generally are not designed to prevent all impacts, because some impacts are not addressed by regulations, and because it is unreasonable to expect there will not be violations or failures of the regulations.

While most of the current environmental impacts from hardrock mining are related to the over 200,000 inactive and abandoned mines (EPA, 1997b), some ongoing mining operations also affect environmental resources. (Appendix B contains a summary of the kinds of potential environmental impacts that can occur at hardrock mines on federal lands.) Nearly 20% of the mining sites inspected by EPA and the states between August 1990 and August 1995 were subject to enforcement actions. Nearly all the violations involved either the Clean Water Act, the Clean Air Act, or the Resource Conservation and Recovery Act (EPA, 1997b). This suggests that some hardrock mining operations cause environmental impacts, even under current regulatory conditions, and that these impacts are subject to regulatory enforcement

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actions. The Committee has no information regarding the effectiveness of these enforcement actions.

The Committee reviewed several assessments of the substance and adequacy of federal and state laws and regulations pertaining to hardrock mining throughout the western United States. The Committee heard testimony from speakers who contended that a compelling case had not been made to revise the BLM regulations and from other speakers who contended that the regulations do not adequately protect the environment. The Committee identified issues or gaps that reflect inadequacies in the statutes and regulations related to environmental protection and regulatory efficiency. In spite of these issues or gaps, and based on numerous discussions and meetings with federal and state regulators, mining industry representatives, and the public, the Committee finds that the existing regulations are generally well coordinated and effective. These issues or gaps related to regulation are discussed below.

Role Conflicts in Land Management Agencies

The Committee found that federal land management agencies have potentially conflicting roles. First, they manage the land for the multiple, and often conflicting, uses provided for by laws and regulations. In a sense, they are hosts for miners, lumbermen, and recreation visitors. Second, they are regulators responsible for ensuring that all activities conform to laws and regulations and that the environment is protected. Third, they are responsible for implementing the Mining Law of 1872, which appears to assign a priority to hardrock mining on the lands they manage. This leads to the following questions: Can they fairly and evenly discharge their historic role as host to land users and accommodate their growing role as regulators? Can they balance the interests of miners and the general public by issuing timely permits that reasonably protect the environment? Can they effectively implement the regulatory authorities that statutes provide?

Other agencies face similar conflicts. For instance, the Environmental Protection Agency (EPA) is responsible for evaluating the adequacy of environmental impact statements (EISs). Yet, the EPA should be a cooperating agency in the NEPA process for preparation of EISs. In some instances, when conflicts between management and regulation apparently became too serious, Congress assigned different roles to different agencies, sometimes by dividing the original agency into independent parts. One partial solution to this problem is to provide easy public access to agency information and activities so the public could perform an oversight function. Recommendations 10, 11, and 13 address the issue of interagency cooperation and public participation. The

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Committee believes the federal lands can be managed efficiently and effectively despite these potential conflicts.

Regulatory Standards

There are two types of regulatory standards used to limit environmental effects of mining: performance-based standards and technically prescriptive standards. Performance-based standards, sometimes referred to as outcome-based standards, specify the desired result or outcome rather than a method, process, or technology. The BLM's standard to avoid "unnecessary or undue degradation" and the Forest Service's standard to "minimize adverse environmental impacts" are both performance-based standards. These general standards articulate the agencies' overall management objectives, and can be used as the foundations or goals on which more specific standards are established. Technically prescriptive standards sometimes referred to as design standards, prescribe the specific techniques to be used to achieve adequate environmental protection. Standards that specify the type and thickness of liners below waste dumps and tailings piles are examples of technically prescriptive standards.

A strength of performance-based standards is that they allow maximum consideration of the particular site-specific conditions and technology options in deciding how to achieve environmental goals. They also encourage the development of new and more cost-effective approaches to achieving these goals. Some disadvantages are that they may require regulators to have a greater degree of technical sophistication to assess the ability of proposed methods to meet the standards. Also, mine operators may have less initial certainty as to the methods that agencies will deem acceptable in meeting performance standards; the public may be confused by the approval of different methods to meet the standards from site to site. These disadvantages may, however, be addressed through training and development of clear guidance manuals and procedures. Examples of Canadian guidance materials that are used routinely by mine operators in Canada and the United States include Price and Errington (1998) and Price (1997). Manuals such as these that provide technical guidelines but acknowledge site-specific variability could be created for issues related to environmental protection at mine sites.

A strength of technically prescriptive standards is that they minimize ambiguity and uncertainty about requirements of the regulated facility. Technically prescriptive standards also have disadvantages. For example, they typically assume that a national or statewide standard is appropriate for all locations and conditions and do not allow for site-specific conditions that may warrant special considerations. They also are insensitive to technological

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change and may inhibit improvements. Recommendation 9 in Chapter 4 reflects the Committee preference that BLM and the Forest Service rely predominantly on performance-based standards.

Financial Assurance

The requirement for financial assurance for mining activities on federal lands has been inconsistent, depending in part on the type and size of the activity and the state where it occurs. For example, the Committee observed instances of recently abandoned but unreclaimed exploration and mining sites that had not been covered by any financial assurance. Financial assurance for such disturbances beyond casual use could discourage unreclaimed abandonment and provide funds for reclamation.

The Committee also found that long-term water treatment and monitoring at mine sites generally does not carry financial assurance at either the state or federal level. A few states have adopted regulatory programs that authorize agencies to require financial assurance for long-term water quality protection. The BLM and the Forest Service have negotiated such financial assurances, but on a case-by-case basis for some mines on federal lands.

Under current federal land management regulations all mines with operating plans are required to have some type of financial assurance for reclamation. Notice-level operations under the BLM regulations do not have to provide financial assurance. Notice-level activities can include exploration, mining, and processing operations, provided they disturb less than 5 acres. Casual use activities pose insufficient environmental risk to warrant financial assurance.

Appendix E summarizes the types of available financial assurance. Based on the Committee's findings, inadequate protection of the public and the environment caused by current financial assurance procedures is a gap in the regulatory programs. Recommendations 1 and 14 in Chapter 4 address financial assurance for mining activities.

Modification of Plans of Operations

Several commentors, including federal agency personnel, expressed concern to the Committee that BLM and the Forest Service lack sufficient authority to require prompt modifications of plans of operations when the potential for degradation is identified. Examples warranting revisions could include unexpected acid drainage, problems with water balance, potential inadequacy of containment structures, and discovery of water quantity impacts

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on wells and springs (see Appendix B). The authority to require operators to make modifications for cause is necessary to prevent unnecessary or undue degradation of federal lands. BLM regulations state that "at any time during operations under an approved plan, the operator on his/her own initiative may modify the plan or the authorized [BLM] officer may request the operator to do so." (43 CFR 3809.1–7). A "significant" modification must be reviewed and approved by BLM "in the same manner as the initial plan," that is, with appropriate NEPA review, among other requirements. If an operator fails to submit a modification requested by the authorized BLM officer "within a reasonable time, usually 30 days," the officer may recommend to the BLM state director that the operator be required to submit a modification.

In deciding whether to require a modification, the state director must determine whether "all reasonable measures" were taken by the authorized officer "at the time the plan was approved to ensure that the proposed operations would not cause unnecessary or undue degradation"; that the disturbance now resulting from operations under the approved plan or from unforeseen circumstances "is or may become of such significance" that modification is "essential" to prevent unnecessary or undue degradation; and that the disturbance can now be minimized using "reasonable means." Operations continue under the prior approved plan until a modified plan has been submitted and approved. However, if the operations are actually causing unnecessary or undue degradation, the state director must advise the operator of "reasonable measures" to be taken pending review and approval of the modifications. The operator must immediately take all necessary steps to implement those measures within a "reasonable period" established by the state director.

Forest Service regulations provide that "at any time during operations under an approved plan of operations, the authorized officer may ask the operator to furnish a proposed modification of the plan detailing the means of minimizing unforeseen significant disturbance of surface resources." If the operator does not furnish a proposed modification within a time deemed reasonable by the authorized officer, the authorized officer may "recommend to his immediate superior that the operator be required to submit a proposed modification of the plan" (36 CFR 228.4[e]). The supervisor must find that all reasonable measures were taken to predict the impacts in reviewing the original plan of operations, that the unforeseen disturbance is significant, and that it can be minimized using reasonable means. "Lacking such determination that unforeseen significant disturbance of surface resources is occurring or probable and that the disturbance can be minimized using reasonable means, no operator shall be required to submit a proposed modification of an approved plan of operations" (36 CFR 228.4[e][3]). As with BLM regulations, the Forest Service regulations provide that operations may continue under the

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previously approved plan of operations pending approval of a modified plan unless the supervisor determines that measures are needed to prevent unnecessary or unreasonable injury to surface resources.

Disputes have arisen over the ability of the BLM and Forest Service to require modifications in various settings based on the language of the regulations. Such disputes include (1) whether issues of concern were identified in the review of the original plan, or whose fault it was that they were not addressed and (2) issues of the "reasonable means" that may be considered in a modification proceeding. The lack of clarity in these standards and the backward-looking nature of the findings required by the regulations have created uncertainties and inefficiencies in addressing impacts promptly. Recommendation 4 in Chapter 4 addresses the issue of modifying plans of operations to protect public lands.

Different Regulatory Approaches for Exploration, Mining, Extraction, and Mineral Processing

Exploration, mining, and processing present different levels of environmental risks (see Appendixes A and B). Similarly, different types of exploration and different types of mining and processing present different levels of environmental risk. The Committee found that regulatory efficiency does not necessarily reflect the level of environmental risk (e.g., exploration projects creating little potential environmental impact may take an extraordinarily long time to permit).

It appears that the Forest Service and BLM do not adequately tailor regulations and permitting to match a project's potential for environmental damage. The Forest Service requires that financial assurances be provided and environmental assessments and plans of operations be prepared for any activity beyond "casual use." The Forest Service requirement for plans of operations seems restrictive for small exploration projects that have little environmental impact. The BLM, on the other hand, requires neither financial assurance nor plans for activities disturbing less than 5 acres, requiring only that a 15-day review period precede any operations. The BLM approach seems more appropriate for exploration projects, except for the lack of financial assurances for activities on less than 5 acres.

Information developed as exploration proceeds is used in decisions on steps that follow. At each stage of exploration, new findings help the operator decide whether to abandon the project, modify work in the already disturbed area, or extend the program in a particular direction on the ground. Extensions must be approved promptly if work is to continue and particularly if there is a limited exploration season. The Committee heard suggestions that this

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permitting process should consider the past environmental performance of the operator and a maximum of 5 unreclaimed acres as bases for extending the exploration area.

On the other hand, other mining activities, such as mine development, extraction, and mineral processing, can generate significant environmental impacts, and BLM's policy of requiring neither financial assurances nor plans of operations for such activities that disturb less than 5 acres may not be sufficiently protective of the environment or the government's fiduciary obligations.

The Committee emphasizes the need for regulatory efficiency (e.g., short permit time and permit restrictions that match the potential for environmental damage). Recommendations 2 and 3 in Chapter 4 offer approaches to minimize the inconsistencies in the different regulatory approaches for mining disturbances.

Protecting Valuable Resources and Sensitive Areas

The agencies have at least 5 mechanisms for protecting valuable resources and sensitive areas from mining. The first is to formally withdraw federal land from mining and mineral development in recognition of extraordinary natural, scenic, or cultural values that are of such significance that other competing resource uses must be excluded. The withdrawal authority is also used to protect administrative and other public facilities.

The second mechanism is to prepare land management plans that identify natural and cultural resources and allocate competing uses accordingly. These plans specify limitations and mitigation that apply in particular locations and to particular uses, such as mining. These plans are intended to be based on thorough resource inventories and to be developed with broad public input so that they balance the needs of all constituencies. For BLM lands FLPMA also specifies that land use plans give priority to the designation and protection of areas of critical environmental concern (FLPMA, Sec. 202[c][3]). These are areas recognized as needing special management “to protect and prevent irreparable damage to important historic, cultural, or scenic values, fish and wildlife resources or other natural systems or processes, or to protect life and safety from natural hazards” (FLPMA, Sec. 103). Designated areas of critical environmental concerns (ACEC) are usually withdrawn from hardrock mining.

The third mechanism for protecting valuable resources and sensitive areas is the use of advisory guidelines that identify categories of resources or lands that deserve special consideration. Use of such guidelines is consistent with the principle that regulatory decisions should be based on site-specific evaluations and conditions. For instance, in many areas of the western United States,

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healthy riparian habitat is scarce and has high value for wildlife or as a buffer to protect stream quality. In these cases, the flexible regulatory framework would suggest that riparian areas should be valued and be provided reasonable protection in site-specific decisions.

A fourth mechanism is through use of BLM's Visual Resource Management System (VRMS) which recognizes that public lands have a variety of visual values (BLM, 1986; BLM/EPA, 1998). The BLM uses the VRMS to evaluate the potential effects of an action on existing visual resources. A VRMS classification is part of BLM's land use planning process. It is important to note that the VRMS classification applies to all activities on BLM lands, not just mining-related activities. The system is also used as a guide to help ensure that every attempt is made to minimize potential visual impacts of a proposed action. The basic philosophy and uses of the system are described in the *Visual Resource Contrast Rating Handbook* (BLM, 1986).

A fifth important mechanism by which BLM and the Forest Service routinely protect environmental resources that are not governed by specific laws is the adoption of site-specific mitigation measures imposed on a plan of operations after the environmental assessment or EIS process. This is the most common way for the federal land management agencies to protect cultural values, riparian habitat, springs, seeps, and ephemeral streams that are not otherwise protected by specific laws.

The Forest Service appears to have ample authority to provide protection. BLM's interpretation of unnecessary or undue degradation, however, does not explicitly state that the BLM has the ability to provide such reasonable protection. It only indicates that the BLM can require reasonable mitigation for damage that does occur. In practice, however, the BLM has protected some resources that are not protected under other statutes. In most of these cases the applicant has either not formally protested the BLM's proposed protection or the Department of the Interior's Board of Land Appeals (IBLA) has upheld the BLM decision.

The right to mine on federal lands under the Mining Law of 1872 is conditioned on validation of discovery, which depends in part on the expected total costs of production, including those for environmental compliance and mitigation. The IBLA has stated this principle as: “First of all, the mere filing of a plan of operations by a holder of a mining claim invests no rights in the claimant to have any plan of operations approved… If the costs of compliance render the mineral development of a claim uneconomic, the claim itself is invalid and any plan of operations therefor is properly rejected” (IBLA 97–307, 97–506, 97–510: Great Basin Mine Watch et al. decided November 9, 1998). Recommendation 15 addresses the agencies' authorities to protect valuable resources that are not protected by other laws.

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Protecting Cultural Resources and Tribal Interests

Several presentations to the Committee emphasized the difficulty of identifying cultural resources and tribal issues, and the time and cost that can be involved in locating and dealing with these issues. Government agencies have not expended as much effort in identifying, cataloguing, and protecting these resources as they have on behalf of the natural environment.

Cultural resources may include any works of mankind, be it American Indian or immigrant, pre-historic or of the current era. They may also include natural landscape features that are specially significant for cultural reasons. Proposed mining activities commonly will occur in previously mined areas because that is where new mineral deposits are likely to be found. New mining could put at risk historic ghost towns, railroads, bridges and other mining-related relics. These features are part of the settlement of the West and the industrial history of this country, and they often are afforded cultural preservation consideration.

Tribal interests may include, in addition to easily recognized cultural resources such as burial sites, less obvious features or locations such as seasonal campsites, or water sources such as springs. Federal land management agencies have limited capability to identify such areas unless they are assisted by tribal members. Some tribes have only recently begun to identify and protect their cultural and historic interests. Tribes may be reluctant to identify important areas or resources in order to protect their sanctity or prevent intrusion and plunder by others. This reluctance makes it difficult to fully consider tribal interests in a NEPA review and permitting process that relies on full participation of stakeholders and full disclosure and discussion of relevant information.

The Committee learned that efforts to identify cultural and tribal resources can significantly delay the completion of environmental impact studies. Tribes, for instance, may fail to respond or respond late in the NEPA process. In some cases this may be a result of a tribe having limited resources to deal with such issues. However, such delays can disrupt the efforts of other stakeholders to conduct an efficient process. In other cases, all tribes with potential interests in a land use proposal are not contacted, or are not contacted in a timely manner. Similar problems may arise with other types of cultural resources, even though most states have agencies that are responsible for cultural resources.

Federal agencies and many states now employ specialists in cultural and tribal resources. The Committee was told that better notification of land use proposals is now generally given to potentially interested stakeholders. Some tribes enter into confidential disclosure agreements with land management agencies. The Committee is not clear about the extent to which existing laws and regulations, such as the National Historic Preservation Act, the American

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Indian Religious Freedom Act, and various state laws, adequately protect cultural resources and tribal interests. It also is not clear if cultural resources and tribal concerns are protected by either the Forest Service regulations providing the agency with authority to "minimize adverse environmental impacts on National Forest resources" or by BLM's authority to avoid "unnecessary or undue degradation." Providing adequate protection to these resources and concerns without unreasonably delaying the permitting process requires a delicate balancing of interests. This can best be achieved by the early participation of all potentially affected interests in the NEPA and permitting process, which is the focus of Recommendation 10 in Chapter 4.

Issues of Small Mining Operations

Several individuals, including both small and large operators, stated that small miners or small operators play an important part in the mining industry, especially in the discovery of new mineral deposits. Although the environmental risk may be small compared to large operations, small operations are sometimes abandoned without adequate reclamation, requiring considerable agency time and imposing financial liabilities on the land management agency.

Recognizing the special circumstances of small operators, BLM regulations exempt operators disturbing less than 5 acres from the requirements of an operating plan or financial assurance (see Chapter 2). The small operations need only submit a "notice" to BLM indicating what they intend to do. BLM must respond to the notice within 15 days if it chooses to restrict or modify the proposed operations. Such notice-level activities require much less effort and time to obtain permission to begin operations. Nevertheless, such operations, particularly if they involve mine development, extraction, or mineral processing activities, should be reviewed, and questions should be raised if the regulatory program is inadequate.

The Forest Service provides no such exemption for small operations, although most small operators need submit no more than a short environmental assessment and operating plan with their applications. Nevertheless, agency staff restrictions often delay the preparation of EAs for several months, thus delaying the decision on the application.

The Committee visited notice-level sites on BLM lands and received testimony from BLM, the Forest Service, state regulatory officials, and industry and concerned citizens regarding the adequacy of current regulations. Degradation on notice level sites included open trenches and unreclaimed roads, abandoned mining and processing equipment, and unreclaimed stockpiles of ore and waste rocks. This is a burden to the agencies, and to the

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taxpayers, who will pay for cleanup. Regulatory agencies find it difficult to implement procedures that protect and promote the beneficial activities of small mining operations without allowing significant environmental impacts or imposing financial liabilities on the public. Issues related to small mining operations are addressed in Recommendations 1, 2, and 3 in Chapter 4.

Mining Reclamation of Abandoned Mine Sites

During presentations to the Committee, representatives of mining companies and regulatory agencies expressed frustration with current laws that discourage new mining operations from disturbing or reclaiming abandoned mine sites. Although the charge to the Committee did not include consideration of abandoned mines on federal lands, the affect of these historic features on future mining, and their related impacts, requires some mention.

New mines commonly develop at or near the sites of abandoned mines. New mining activities have the potential to reclaim damage from earlier mining activities. However, some federal environmental laws, such as the Clean Water Act, the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and potentially the Resource Conservation and Recovery Act (RCRA), discourage these opportunities and encourage companies to design their operations to avoid redisturbing previously disturbed areas. Similarly, operators are discouraged from reclaiming previously mined areas in the vicinity of new mining operations, even though the work would be beneficial and voluntary on the part of the miner. Reclamation of some abandoned mines has been integrated into current operations, and nearby historic waste disposal sites have been reclaimed in connection with ongoing mining activities. This is done, however, at the miners' risk. As a result of existing statutes, mine operators conducting work at an abandoned mine site could incur liabilities. Some states have environmental laws that may pose additional barriers to voluntary clean up. Therefore, operators avoid redisturbance of abandoned mine discharges and arrange their own discharges so that the pre-existing discharge is not affected. This is not in the best interests of environmental protection; opportunities for remediation are missed and new operations are, in effect, encouraged to disturb undisturbed lands. Recommendation 7 in Chapter 4 addresses the reclamation of abandoned mine sites.

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Temporary Mine Closures

Changes in commodity prices and other factors can influence the economics of mining and can result in an operator temporarily closing a facility. The duration of the closure is generally not known in advance, hence steps to protect the environment under these interim conditions may not be taken. In some cases concern was expressed that operators were using this temporary status to delay or avoid proper closure and cleanup of the facility. Lacking regulations that cover these situations, regulatory agencies have difficulty protecting the environment.

Agencies cannot make business decisions, such as when to open or close a mine, for the operators. However, several states, such as California, have adopted regulations covering temporary closures. California's regulations require the operator, after an operation becomes idle, to submit an interim management plan that must specify how the site will be maintained during the idle period. The interim plan may be effective for not more than 5 years, after which the lead agency must either grant a renewal of the plan or require commencement of reclamation. Unless an interim management plan has been submitted, an operation idle for over one year must commence reclamation. Neither the Forest Service nor BLM have yet adopted regulations dealing with temporary closure. Current low metal prices suggest this can be a serious regulatory issue. Recommendation 5 in Chapter 4 addresses issues related to temporary mine closures.

REGULATORY IMPLEMENTATION ISSUES

When poorly implemented, statutes and regulations are of limited benefit to the environment, the public, and mining operators. The Committee was told of instances in which regulatory agencies, particularly the federal land management agencies, did not implement their statutes and regulations efficiently. Shortcomings included failure to use existing statutory authority to meet environmental protection goals; inadequate information systems to track mining operations and inform the public; unreasonable time delays for NEPA reviews and permits; and inadequate staffing in terms of work loads, skills, and training.

Adequacy of Staff and Other Resources

The Committee found that BLM offices are often unable to meet their field site inspection goals. Some notice-level activities are rarely inspected,

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and intervals between inspections of operating mines are longer than seems warranted. Oversight of critical mine development projects (e.g., the construction of liners under leach pads or liquor ponds) requires greater staff allocations than some agencies and offices are apparently capable of making. Still, the Committee was impressed by the competence, dedication, and effort expended by many of the agency personnel interviewed.

Staff shortages are likely to be at least partially responsible for the excessive delays experienced in NEPA reviews and issuance of permits that the Committee repeatedly heard described. Actions through the Department of the Interior's Board of Land Appeals are reportedly also unreasonably long. The availability of competent staff was another concern raised during the Committee's study.

Oversight of mining activities is a technologically demanding activity. It often requires hydrogeochemical analysis of proposed tailings ponds, waste ponds, and heap leach pads the hydrologic effects of proposed dewatering schemes; and the long-term impacts of pit waters on surrounding water quality and quantity (see Appendix B). The needed levels of expertise are not always readily available to regulatory agencies. Staff sharing among agencies or between agency offices and use of outside experts is of some, but apparently insufficient, help.

The current use of consultants raises questions about potential conflicts of interest, for in many cases the consultants, although retained by the agency, are paid by the applicant and the applicant therefore retains at least a perceived role in directing the consultant. For instance, most environmental impact statements prepared to support decisions to permit new mining operations or substantial modifications of existing operations are prepared by third parties selected by the agency and the applicant, and paid for by the applicant. Similarly, the agencies have apparently been able to receive technical assistance in spite of budgetary restrictions because the mining companies have offered to pay for the required consultants. The Committee heard of no instance in which this system created a problem, and it does allow the agencies to have access to expertise and resources that would be unavailable to them otherwise. The agencies also have the authority to reject advice and require changes to in draft reports, and have exercised this authority. However, the relationship does create the appearance, if not the fact, of a potential conflict of interest.

The Committee also received evidence that staff training is inadequate, for example, in the interpretation of the agency's regulatory authority and enforcement options. Issues of staff numbers and competence will more seriously affect environmental protection and regulatory efficiency if agencies are required to further reduce the resources devoted to regulating mining activities or if the regulatory burden is increased.

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In addition to staffing issues, some administrative and operating procedures of the agencies appear to be out of date and inefficient. Opportunities for more efficient and effective monitoring and enforcement through remote-sensing techniques and air surveillance are worthy of further consideration. Recommendation 12 in Chapter 4 addresses issues related to adequacy of staff and other resources.

Agency Data and Information Systems

The Committee was consistently frustrated by the inability of federal land management agencies to provide timely, accurate information regarding how they manage their lands and the status of mining projects under their jurisdiction. The agencies could provide only approximate information regarding protected lands under their jurisdiction, the area of land currently subject to mining claims, the area covered by land use plans, and other basic land use statistics.

Information about current mining activities was even scarcer. The lack of information appeared to be greatest among highly placed officials who have the greatest need to know. Consequently, those responsible for regulatory management and change, and for keeping the public and Congress adequately informed, appear to be severely limited in their ability to do so.

More specifically, the Committee found it difficult to obtain comprehensive information on agency failures to prevent unnecessary or undue degradation on federal lands. Some compilations of non-compliance were obtained from the BLM, but there was no analysis or interpretation of the data to identify gaps or weaknesses in the regulatory system. The Committee considers this type of information essential for developing any proposals for regulatory change. Federal land management agencies have a responsibility to track the compliance of mines under their jurisdiction and to communicate this information to the public and other stakeholders. Although the Committee got the impression from field-level personnel that such tracking was generally accomplished, the Committee found no systematic, easily available compilation and analysis of the information for public and other stakeholder use.

Regulation of mining on federal lands requires that the federal land management agencies coordinate with a multitude of other regulatory agencies. It was not clear, however, if the federal land management agencies were systematically tracking operator compliance with the commitments made in permits and effectively communicating these findings to the various federal and state regulatory agencies, and to interested stakeholders. Examples of information that could be usefully tracked, compiled, and reported include:

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- an up-to-date accounting of the number, commodity, type (e.g., openpit, underground), status (e.g., active, post-closure), land ownership status, and approximate production of all hardrock mines;
- inspection reports of federal land managers and of other federal, state, and local agencies;
- summaries and analysis of monitoring data and reports that characterize the degree of compliance with standards and criteria at the mine site and highlight incidences of noncompliance;
- appropriate responses taken to return sites to compliance;
- enforcement actions required to assure implementation of required corrective response;
- status of reclamation at the sites;
- status of financial assurances;
- any financial assurance forfeitures required; and
- any outstanding incidents of noncompliance requiring further action.

Reports on the status of NEPA reviews and permit actions, including lapsed time and estimated completion dates, would also be appropriate. Compiled information should be summarized periodically and reported upward in the federal land management agencies. This same information should be readily accessible to the public either as published reports or postings on the Internet. Periodic public reporting of NEPA and permitting status and the compliance status of individual mines, as well as aggregated district, state, and national compliance information, would help the public to determine whether the environment is being adequately protected and whether the regulations are being managed efficiently. This reporting would also focus public and agency attention on those circumstances requiring improvement. Recommendation 11 in Chapter 4 addresses the creation and management of a management information system.

Enforcement Authority

The Committee heard from staff in BLM and Forest Service field offices regarding the adequacy and availability of their enforcement tools for violations of plans of operations (see 43 CFR 3809.3–2 and 36 CFR 228.7[b]). Committee members were struck by the differences in understanding that agency staff members expressed concerning their authority. Staff members in some Forest Service and BLM districts lamented their inability to use enforcement tools effectively, whereas staff members in another district of the same agency expressed confidence that they could use them.

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For example, federal land managers can issue a notice of non-compliance to an operator, but must rely on a court injunction to compel an operator to respond. Whereas some districts of the BLM and Forest Service have found the notice relatively useful, others regard it as ineffective. Part of the difference appears to be the ease with which an office can obtain assistance from the U.S. attorney. This depends, in turn, on such factors as location of the federal district court, attorney and agency workloads, agency staff experience, and prosecutor priorities. The agencies have no authority to impose administrative penalties or other sanctions for failures to comply promptly with a notice of noncompliance under current regulations. There is, moreover, some debate about whether the general provisions for regulations under FLPMA or the Forest Service Organic Act authorize the federal agencies to adopt administrative civil penalties in the absence of express statutory provisions for such penalties.

Forest Service staff members advised the Committee that they commonly resort to regulations at 36 CFR part 261 to enforce the terms of operating plans, rather than seeking civil injunctive relief. These regulations contain a general provision that makes violation of a Forest Service-approved operating plan a petty offense punishable by a fine of not more than $500 or six months imprisonment (36 CFR 261.10[1], 261.1b). A $500 fine provides only a limited inducement for operators to correct problems in cases where compliance costs can be several orders of magnitude higher. Access to a U.S. magistrate, assisted by Forest Service law enforcement personnel, apparently is a stronger tool to achieve compliance from operators that are in violation of their plans of operations. Some Forest Service staff members also noted that their use of the 261 authority rather than the mining-specific 228 authority was in part due to poor wording of 228.7(b). That section currently provides that a notice of noncompliance will be issued when an operator is failing to comply with regulations or the plan of operations, and the noncompliance is unnecessarily or unreasonably causing injury, loss, or damage to surface resources. The apparent requirement that actual harm be occurring in addition to a violation has led to concern about the efficacy of the notice of noncompliance in preventing harm to land resources, rather than just correcting damages after the fact.

States retain much of the enforcement responsibility related to mining activities on federal lands. State regulatory programs contain enforcement provisions that provide for issuing notices of non-compliance and assessing penalties when the notices are not resolved. Typically, state agency personnel can issue the notices, and in some cases also the penalties. In other cases, an independent board or panel decides violations and assesses penalties. The state processes for dealing with noncompliance and an operator's failure to respond,

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which vary widely, may be more timely than the federal processes, which depend on the involvement of a U.S. magistrate.

In addition to these federal and state enforcement authorities, there are enforcement authorities for other federal regulatory programs, such as those of the Army Corps of Engineers and the EPA. These programs may provide a more expedited path for dealing with operator noncompliance than the federal land management agency process. However, the Committee found that federal agency procedures for deciding when to refer apparent violations to state environmental permitting agencies, EPA, or the Army Corps of Engineers are not consistent or readily accessible. Memoranda of understanding (MOUs) address this issue in some states. MOUs do not always address enforcement coordination with federal agencies in those states where EPA (rather than the state) has permitting authority.

While enforcement actions taken by BLM or the Forest Service are generally limited to violations of plans of operations, a plan is likely to include areas that state permitting agencies consider their responsibility. The regulation of water quantity through water rights issued by a state engineer is one such area. Initiation of an enforcement action by BLM or the Forest Service without prior consultation with, and agreement by, a state water resources agency undoubtedly would result in dispute.

In summary, enforcement of mining-related compliance on federal lands is inconsistent and unnecessarily difficult. Recommendations 6 and 15 in Chapter 4 address the enforcement authority of the land management agencies.

SCIENTIFIC ISSUES

Regulatory programs are based on scientific understanding and analyses, and the adequacy of any regulatory program is substantially determined by the adequacy of its scientific underpinnings. The Committee identified several environmental issues whose solutions require more scientific information and understanding than is now available (see Appendix D). Science has contributed greatly to the amelioration of environmental problems associated with mining, and it has the potential to do much more. It serves as the foundation on which to base effective regulations, provides baselines and mileposts for performance expectations, and promises an ever improving ability to forecast and control future environmental impacts. Scientific research and observations have provided the basis for the development of models that predict the concentration of metals and other constituents in leachate and pit lakes over time; for predictions of the impacts of discharge waters on aquatic and terrestrial biota; and for improvements in the effectiveness and environmental protection of exploration and development techniques. A coordinated research effort is

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needed to properly calibrate and improve the methods and models, and to adequately address such issues as the long-term cumulative effects of mining. Expanded discussions of some of these issues and others related to the environmental impacts of hardrock mining are found in Appendixes A, B, and D.

Water

Among the various environmental concerns related to hardrock mining, those involving the quantity, quality, and distribution of water are dominant. Water quality issues at mine sites may include metals, cyanide, acid drainage, pit lake water quality, placer mining, and mine water discharge to streams, all such conditions being site specific. Water quantity issues include mine water discharge to streams, groundwater withdrawal, and pit lake water quantity. Water quality and quantity issues affect riparian resources and aquatic biota. The potential environmental impacts of mining related to water are discussed in Appendix B. Some of the technological approaches to minimize impacts to water from mining are discussed in Appendix A.

Sidebar 3–1 describes the origin of metal-bearing acid drainage whose prediction and mitigation are critical to planning an environmentally acceptable mining operation. Appendix B includes a discussion of predictive and empirical tests for acid-generating potential. Appendix D addresses some of the uncertainties associated with the accurate prediction of acid mine drainage.

Pit lakes have recently been recognized as major long-term environmental concerns (see Appendixes B and D), and the Committee was able to visit several mines in Nevada that do or will contain pit lakes. The ability to accurately model the future hydrology and chemistry of these lakes and to forecast their roles as social and ecological assets or liabilities is a significant challenge deserving a large and diverse research effort (see Appendix D). The challenge is made even greater by the states that have not classified or designated a status for pit lakes, either individually or collectively. Recommendation 8 in Chapter 4 proposes the funding of a research program for the environmental impacts of mining.

Baselines and Backgrounds

Mine exploration and development occur in remote places where the environment has been relatively undisturbed or in areas that have been disturbed by prior mining or other development. In both cases, data must be collected to establish baseline conditions for tracking the effects of mining on

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environmental conditions and to help guide reclamation decisions. Baseline measurements are needed on parameters such as rainfall and its variability, infiltration and stream discharge rates, vegetational communities, and the character and dynamics of terrestrial wildlife and aquatic biota over a sufficiently long period to establish meaningful baseline conditions. In previously disturbed areas, such features as the original drainage patterns and soil and water chemistry may be indecipherable. Determining the sufficiency of data is important and difficult for both administration and science, but it is an action that deserves both a practical resolution and continued investigation. The importance of monitoring is discussed in Chapter 1 and Appendix B.

SIDEBAR 3–1 WHERE DOES ACID MINE DRAINAGE COME FROM?

One major environmental concern at many hardrock mine sites is metal-rich acid drainage, often referred to as acid mine drainage. A common feature of most ores is the presence of large quantities of sulfur, usually as pyrite or marcasite (both FeS_2) or pyrrhotite ($Fe_{1-x}S$). These minerals often occur with copper, zinc, lead, silver, arsenic, and other sulfides that constitute the economic part of the mineralization in sulfide ore bodies. Disseminated pyrite, in particular, commonly occurs in areas well beyond the zone of economic mineralization and as a component of waste rock. In such sulfur-rich deposits sulfur is released by the slow natural processes of oxidation, weathering, and erosion. The mountain ranges of the West are populated by areas stained red by the weathering of pyrite to earthy iron oxides, or “rust.” The sulfuric acid concurrently produced had been diluted and dispersed, crating local, and generally minor, natural degradation, although some natural acid springs do exist. Nature has created this natural oxidation at a leisurely pace. Mining exposes sulfur-rich material to the atmosphere at a much faster pace, which leads to more rapid oxidation. In the process, mining may create environmental problems with acidic runoff if this sulfuric acid is released to the environment. The acidity of the water and its proximity to metals in the ore may generate waters of low pH that are high in copper, iron, zinc, aluminum, arsenic, selenium, and other elements

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THE NEED FOR EARLY STAKEHOLDER CONSULTATION

The Committee heard from many individuals and organizations that early consultation among all stakeholders is essential for regulatory efficiency. Many individuals who addressed the Committee on this issue emphasized that the NEPA and permitting processes could be expedited if all stakeholders were to participate in the earliest scoping and pre-application meetings. Agreement might not be reached among all of the stakeholders. However, the issues would be better understood by the public and defined to the benefit of the public, the agencies, and the applicant if early consultation occurred under the NEPA and permitting processes. Early consultation should include all stakeholders, including the relevant federal, state, and county agencies, tribes, citizens groups, and the applicant. The Arizona Aquifer Protection Permits Application Guidance Manual provides an example of procedures for pre-application meetings and coordination, in this case between the Arizona Department of Environmental Quality and the applicant.

The Committee heard that some federal agencies had declined to be involved in the scoping and pre-permitting meetings, but subsequently had imposed additional information gathering and other requirements on the applicant. This approach is particularly disruptive and likely has the effect of prolonging both the NEPA and permitting processes. The EPA was repeatedly criticized at the Committee's public meetings, as well as in various reports, for declining to be a cooperating agency in the preparation of mining EISs (EPA, 1997a,b).

The federal land management agencies appear to be attempting to promote early consultation among the agencies most involved in the approval of the proposed mining operations. They testified that they, as a matter of course, encourage many of these agencies to cooperate in the preparation of the EIS. In some cases, however, they have not been sufficiently aggressive in identifying and inviting nongovernment organizations to cooperate in the EIS process. These organizations must have the opportunity to identify their concerns during the scoping process. Otherwise, they may raise their concerns late in the process or in appeals of the final EIS to federal courts, which disrupts the permitting process and makes it difficult to collect the appropriate baseline data.

The land management agencies can invite, encourage, and facilitate the early participation of other federal, state, and local government agencies, but they cannot require it. Recommendation 10 in Chapter 4 addresses the need for early stakeholder involvement in EIS scoping, preparation, and review.

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RECLAMATION, CLOSURE, AND POST-CLOSURE MANAGEMENT

The Committee learned of concerns about reclamation, closure, and post-closure management of mining sites and also inspected examples of reclamation at active and inactive mining sites. This section addresses the principal issues related to these topics. Although most of these issues do not lead to specific recommendations, long-term post-closure management of mine sites is addressed in Recommendation 14 in Chapter 4.

Backfilling

The matter of requiring backfilling at open-pit mine sites was addressed in 1979 by a National Research Council report by the Committee on Surface Mining and Reclamation (COSMAR) as follows (NRC, 1979, p. xxviii):

> The [Surface Mining Control and Reclamation] Act requires that [coal-mined] land be restored to approximately its original contours. This provision is generally not technically feasible for non-coal minerals, or has limited value because it is impractical, inappropriate, or economically unsound…
>
> Further, to restore the original contour where massive ore bodies have been mined by the open-pit method could incur costs roughly equal to the original costs of mining. Although technically possible, such backfilling of a large open pit would be of uncertain environmental and social benefit, and it would be economically impractical to mine some deposits under the current cost structures.

The appropriateness of backfilling open-pit mines continues to be a matter of public debate. The Committee has no strong basis to contradict the COSMAR conclusion on backfilling, which was based on an analysis of estimated costs. Although the Committee believes partial or complete backfilling can be environmentally and economically desirable in some circumstances, it was unable to find a basis to establish a general presumption either for or against backfilling in all cases. The NEPA process is appropriate for considering and weighing the costs and benefits of backfilling in a site-specific context.

Federal land management agencies can assist that process with guidance documents that address the following factors:

- the impact of backfilling on the potential availability of mineral

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resources that may become economically recoverable in the future;

- the site-specific environmental benefits that complete or partial backfilling may provide, such as reducing acid rock drainage, avoiding the development of poor water quality in a pit lake, or protecting surrounding groundwater resources;
- the negative environmental impacts that backfilling may cause, such as delayed reclamation and habitat development; and
- the degradation of groundwater quality if the backfill material is leached or chemically transformed as a result of geochemical conditions in the backfilled pit or underground workings.

The circumstances under which backfilling is most likely to be viable include the following:

- mining areas where multiple ore bodies allow mining and backfilling to proceed without double handling of the backfill material;
- locations where backfilling may eliminate negative environmental impacts, such as acid drainage; and
- sites where backfilling provides an economically viable means of achieving reclamation goals or protecting other, specified resource values.

Reclamation Planning for Possible Future Uses

Some presenters to the Committee pointed out that mining operations may create features that are positive contributions to the surrounding area. For example, historic mining features may be of significant economic and cultural value to adjacent communities, either as tourist attractions or as part of the cultural heritage of the communities. Historic mining towns such as Cripple Creek and Leadville, Colorado, are important parts of America's cultural legacy, as well as continued centers of economic activity from tourism. Similarly, modern mines, if appropriately designed and reclaimed, could become important historic or cultural resources in the future. It was also pointed out that portions of a mine, such as waste rock dumps, tailings impoundments, pit lakes and highwalls, and underground mine openings may be attractive to wildlife if appropriately reclaimed. Pit lakes can provide aquatic resources for wildlife in otherwise arid regions of the country. The highwalls of the former open pits offer habitat for raptors. Waste rock dumps and exposed mineral deposits also provide recreational opportunities for hobbyists. And, as the number of operating mines declines, the opportunity for

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"hands on" training of earth science students increasingly rests with historic mines. Finally, the Committee was told of the responsibility of the United States, as the largest consumer of minerals in the world, to retain opportunities for mining on public lands. Experience has indicated that the most likely locations for future development and extraction of additional mineral resources will probably be in existing mining regions. Based on these arguments, reclamation decisions should carefully consider possible future uses of mine sites. Protection of the environment and consideration of safety are paramount, but those goals may still be met while considering other potential future values and uses for the mine sites.

Post-Closure Issues

One of the most common concerns expressed to the Committee was the post-closure condition and use of past mining sites. It was pointed out that many reclaimed sites will require some degree of monitoring and maintenance by the landowner over the long term. In the case of unpatented mining claims on federal lands, the long-term landowner will be BLM or the Forest Service. Unless other provisions have been made through financial assurance, the costs of continuing care will be paid by the public.

An important part of long-term management will be monitoring, inspection, and low-level maintenance of reclamation features, such as soil covers, vegetation, closed impoundments, waste rock piles, and water diversion structures. In some cases the quality of surface water or groundwater must also be monitored.

It is also important for the federal land management agencies to plan for post-closure uses of the land. Pit lakes, for example, may provide an opportunity for boating and other water sports. Leach and wasterock piles may attract off-road vehicle enthusiasts, and open-pit highwalls may attract weekend rock climbers.

Some of these post-closure uses, however, may violate the integrity of the reclamation features. Extensive off-road vehicle use, for example, could cause significant damage to soil and vegetative covers on leach and waste rock piles. If this occurs, the entry of water and air may exceed the design objectives, possibly leading to unexpected seepage and changes in water quality. Some unintended uses may also conflict with the intended uses of the site. Some recreational activities, for instance, could conflict with intended grazing or wildlife use. Post-closure land use conflicts have the potential for creating significant environmental and safety problems. Dealing with these problems and attempting to manage the unplanned or unforeseen uses may impose

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additional costs and staffing requirements on the federal land management agencies.

Post-closure problems could also arise from unusual climatic or hydrological events. Climate variations, especially in a desert environment, could lead to flooding or drought, either of which could damage the reclaimed site and result in increased costs to maintain the integrity of the reclamation design and structures. Although the likelihood of extreme events occurring at any one site may be low, the probability that they will occur at some site at some time is high.

Long-term monitoring to detect potential problems and trends must be a part of post-closure plans. The responsibility and costs for monitoring and responding to unexpected uses and events will ultimately remain with the property owner. Ideally, such monitoring consists of nothing more than periodic inspections of the site by the owners or appropriate agency personnel or both. Some sites, however, will require a more extensive and sophisticated post-closure monitoring program.

Monitoring is used for at least the following three purposes:

(1) determine if certain management actions were properly fulfilled;
(2) test predicted outcomes of closure plans; and
(3) identify and characterize trends or changes in site or regional attributes.

Many types of monitoring are important in post-closure issues. The most obvious is monitoring for geotechnical, hydrologic, and geochemical stability. A variety of tools exist for monitoring in each of these areas, and the tools must be selected and used appropriately. Guidance documents and manuals should be developed by the federal land management agencies, and appropriate training should be provided to responsible personnel. Monitoring results should be used by land managers to verify that the outcomes of closure designs are those that were predicted. If monitoring results deviate from the expected outcomes, monitoring should be increased to verify the deviations, and appropriate responses to correct noncompliance should be taken in a timely fashion. Accurate evaluation and interpretation of monitoring data are not trivial tasks, and agencies should be certain that the personnel who are assigned those tasks are well qualified and trained. In some cases, it might be appropriate to employ non-agency professionals to assist in the evaluation and interpretation of the monitoring results (see Appendix B).

Information presented to the Committee suggests that issues of reclamation, closure, and post-closure management have not been adequately addressed by the federal land management agencies. Without changes in planning, the agencies will not be prepared to handle these significant use and

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environmental challenges, and the public may be faced with major financial liabilities.

REGULATORY EFFICIENCY ISSUES

The charge to the Committee includes provisions to review time requirements, efficiency, duplication, and delay. Specifically, the Committee was asked to address the time requirements applicable to project environmental review and permitting; and to make recommendations and conclusions regarding how permitting requirements and programs can be coordinated to increase efficiency, avoid duplication and delay, and identify the most cost-effective manner for implementation.

Concerns about timing and delays were raised by many who communicated with the Committee. Such delays are an indication of regulatory inefficiency, whether the delay results from inadequate resources or from inefficient use of the resources available.

The Committee did not conduct a management audit of the efficiency of the federal land management agencies, considering that to be beyond the scope of this study. However, comments regarding timeliness and delays are within the Committee's charge. The most serious matter is the excessive time required to complete a NEPA review, followed by the often lengthy time required to issue operating permits.

The laws and regulations applicable to a proposed mining operation and the associated administrative procedures ensure that approval of a new mine is a very deliberate process. In many cases, two years of baseline data are needed before a plan of operations can be submitted. If the data are not available from an existing source, then the applicant may need to wait two years while the data are collected. However, this process has become much slower and more costly than was originally intended or than it needs to be. The process can now take many years. It commonly imposes data collection and analysis requirements on the applicant and the regulatory agency that are poorly coordinated, excessively expensive, and of uneven value in protecting the environment. Mining operators are entitled to a NEPA and permitting process that is as timely and cost effective as possible while still achieving compliance with all statutes and regulations. The federal land management agencies are responsible for making certain this happens by managing the NEPA and permitting process efficiently. The public is entitled to confidence that the foregoing has occurred. Based on presentations to the Committee, improvements in efficiency of the process are needed.

Issues discussed earlier in this chapter affect regulatory efficiency. For example, the early involvement of all key agencies and other cooperating

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entities in the NEPA process could speed the permitting and make agency resources available for other regulatory work. Freeing staff from the distractions of financially unprotected notice-level activities and small mines and mills without plans of operations, along with providing an adequate management information system, should improve service to clients and make the operations more efficient. Recommendation 16 in Chapter 4 addresses the need for a more timely permitting process that still protects the environment.

PUBLIC INVOLVEMENT ISSUES

The Committee heard evidence of public distrust of the management of mining on federal lands. Local residents near a mine spoke of being excluded from mining decisions that affected the health and quality of life in their community. Others alleged that agencies collaborated with mining operators to advance mine plans regardless of contrary information and views. People spoke of repeatedly being excluded from crucial decisions. Commonly, this was because the decisions were considered to be "technical amendments" to the operating plan or because the proposal was considered to be of such limited significance that it could be addressed through the administrative process, categorical exclusion, or environmental assessment, all of which involve reduced public review and comment.

As addressed earlier, the Committee was frustrated in its attempt to find publicly accessible information regarding mining on federal lands. Such experiences produce distrust in the fairness and propriety of the management and regulatory system. At the same time, the Committee saw evidence of stakeholders developing communication and participation among all interested constituencies. Discussions with federal and state agency employees at state and field office levels generally demonstrated personal and agency commitments to public participation. The committee visited one mining operation where the company took extra steps to keep the public informed by establishing a citizens advisory committee and issuing periodic newsletters about mine activities. These initiatives appear to have raised public involvement and public trust. The NEPA process is designed to promote public participation in decisions regarding federal lands, and it appears to be achieving many of its objectives.

Mining on public lands is controversial and many people hold strongly opposing views. Some people value mining for what it contributes to the national economy and to war efforts. Others are more concerned with pollution and environmental issues than with mineral production. Both sets of values are important and are needed in the debate, but a shift toward more environmental concern is causing difficulties for federal land management agencies as they try to adjust to these changes in public values.

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Federal land management agencies historically have given support to such public land uses as mining, logging, and grazing. Now they are giving as much attention to such issues as watershed protection and clean water for public use, wildlife habitat, wilderness, ecosystem preservation, and endangered species. Because these are public lands, they must support the full range of public values. To fulfill this responsibility they must provide information on all aspects of the public lands and encourage the public to use that information in expressing its interests and concerns.

The public is entitled to confidence that public lands are environmentally protected during exploration and mining activities. Federal and state laws, regulations, policies, and procedures go far in assuring this protection, but they are not sufficient. Changes in public values, environmental understanding, mining and reclamation technology, and the federal land management and regulatory agencies demand an extraordinary effort to promote public education, involvement, scrutiny, and trust in the coordination of environmental protection and management of mining on federal lands. The foregoing cannot be achieved solely through public relations programs. Public confidence also cannot be achieved with the currently inadequate management information systems, as discussed in earlier sections. The NEPA process is well suited to help achieve the objectives, but its effectiveness suffers from inadequate participation by many agencies and constituencies. Public confidence in the land management agencies is compromised if the public lacks the ability to track compliance with land use decisions.

The Committee believes that the recommendations in this report, if adopted, will significantly benefit public education and participation, and contribute to a healthy balance between mining and the environment. Recommendations 11 and 13 in the next chapter address issues related to public participation and availability of information about mining operations.

SUMMARY

The analysis of hardrock mining-related issues in this chapter leads to the Committee's conclusions and recommendations presented in Chapter 4, which are based on the elements needed for an effective regulatory program as outlined in the introduction of this chapter. The analysis shows a need for correcting some gaps and inadequacies in the regulations themselves, for improving implementation of the regulations, and for increasing the availability and quality of scientific information. Ignoring these needs for corrections and improvements in the face of rapidly changing technology, economics, and environmental concerns puts the environment, the public, and the mining industry at risk.

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4

Conclusions and Recommendations

> *The study shall identify and consider…recommendations and conclusion regarding how federal and state environmental, reclamation and permitting requirements and programs can be coordinated to ensure environmental protection, increase efficiency, avoid duplication and delay, and identify the most cost-effective manner for implementation.*

The charge to the Committee has three major components. First, the Committee was asked to identify federal and state statutes and regulations applicable to environmental protection of public lands in connection with mining activities. Second, the Committee was charged with considering the adequacy of statutes and regulations to prevent unnecessary or undue degradation of the public lands. These were discussed in Chapters 2 and 3 respectively. In this chapter, the Committee addresses the third part of its charge and presents its conclusions and recommendations for the coordination of federal and state regulations to ensure environmental protection, increase efficiency, avoid duplication and delay, and identify the most cost-effective manner for implementation.

Each recommendation is followed by supporting text that provides the justification for the recommendation, discusses its implications, and explains the Committee's view of how it can be implemented.

CONCLUSIONS

Existing regulations are generally well coordinated, although some changes are necessary. The overall structure of the federal and state laws and regulations that provide mining-related environmental protection is compli

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cated, but generally effective. The structure reflects regulatory responses to geographical differences in mineral distribution among the states, as well as the diversity of site-specific environmental conditions. It also reflects the unique and overlapping federal and state responsibilities. Conclusions that address overall environmental protection and program efficiency related to technical issues, regulations, or guidance include:

(a) Federal land management agencies' regulatory standards for mining should continue to focus on the clear statement of management goals rather than on defining inflexible, technically prescriptive standards. Simple "one-size-fits-all" solutions are impractical because mining confronts too great an assortment of site-specific technical, environmental, and social conditions. Each proposed mining operation should be examined on its own merits.

(b) If backfilling of mines is to be considered, it should be determined on a case-by-case basis, as was concluded by the Committee on Surface Mining and Reclamation (COSMAR) report (NRC, 1979). Site-specific conditions are too variable for prescriptive regulation.

(c) The Bureau of Land Management (BLM) and the Forest Service need not have identical regulations, but some changes are warranted. The two agencies have broadly similar land management mandates. There are, however, some differences in the kinds of lands they manage, in their specific responsibilities, and in their organization. Whereas some of the Committee's recommendations would make the agencies' approaches to regulating hardrock mining more similar, the Committee is not suggesting that uniformity in all aspects is necessary.

(d) Some small mining and milling operations present environmental risks and potential financial liabilities for the public. These exposures are small by comparison to large operations, but as currently regulated they constitute a disproportionate share of the problems for the land management agencies.

(e) Current regulations do not provide land management agencies with straightforward procedures for modification of plans of operations even with compelling environmental justification.

(f) Federal criteria do not distinguish between temporarily idle mines and abandoned operations. This distinction is important because mines that become temporarily idle in response to cyclical metal prices and other factors need to be stabilized but not reclaimed, whereas mines that are permanently idle need to be reclaimed.

(g) Financial risks to the public and environmental risks to the land exist whenever secure financial assurances are lacking.

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(h) Current regulations discourage reclamation of abandoned mine sites by new mine operators. New mineral deposits are commonly found at the sites of earlier mines. Even though the operator of a new mine may volunteer to clean up previous degradation, the long-term liability acquired under current regulations can be significant. As a result, non-taxpayer supported reclamation opportunities are missed and undisturbed lands may be preferentially disturbed for new mining sites.

(i) Post-mining land use and environmental protection are inadequately addressed by both agencies and applicants. The regulations and plans of operation generally specify what actions will be taken to protect water quality and what surface reclamation is to be performed for closure. However, there is inadequate consideration of protection of the reclaimed land from future adverse uses; of very long-term or perpetual site maintenance; or of rare, but inevitable, natural emergencies.

Improvements in the implementation of existing regulations present the greatest opportunity for improving environmental protection and the efficiency of the regulatory process. Federal land management agencies already have at their disposal an array of statutes and regulations that for the most part assure environmentally responsible resource development, but these tools are unevenly and sometimes inexpertly applied. Specific conclusions regarding implementation are as follows.

(a) The National Environmental Policy Act (NEPA) process is the key to establishing an effective balance between mineral development and environmental protection. The effectiveness of NEPA depends on full participation of all stakeholders throughout the NEPA process. Unfortunately this rarely happens in a timely fashion.

(b) The Committee was consistently frustrated by the lack of reliable information on mining on federal lands. The lack of thorough information extends from that needed to characterize the lands available for mineral development to that needed to track mining and compliance with regulations. Without more and better information, it is difficult to manage federal lands properly and assure the public that its interests are protected.

(c) Deficiencies in both staff size and training were observed by the Committee in some offices of land management agencies. Increases in

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staffing and improved training should result in improved environmental protection and program efficiency.

(d) Forest Service permitting procedures for mineral exploration projects with limited environmental impact commonly take significantly longer than is necessary.

(e) Misunderstandings of the term "unnecessary or undue degradation" (FLPMA, 1976 [43 U.S.C. §§7401 et seq.]) leave some BLM field staff uncertain whether the agency has the authority to protect valuable resources, such as riparian habitats, that may not be specifically protected by other laws.

(f) Federal land management agency representatives are inconsistent in their understanding of their enforcement authority and tools. This results from uncertain interpretations of the statutes and regulations, inadequate staff training, and deficiencies in the tools themselves.

(g) Inefficiencies and time delays in the completion of environmental review under NEPA, issuance of permits, and conduct of other administrative actions unnecessarily consume the resources and time of many stakeholders.

(h) Better information on federal lands is needed to make wise land use decisions. The land use planning process required for BLM and Forest Service lands by the Federal Lands Policy and Management Act and the National Forest Management Act, respectively, provide for identification of land and resources deserving special environmental concern.

Successful environmental protection is based on sound science. Improvements are needed in the development of more accurate predictive models and tools and of more reliable prevention, protection, reclamation, and monitoring strategies at mine sites. The science base is far from complete and environmental protection requires that improvements continue to be devised. Some of the most important environmental concerns at hardrock mining sites are those related to long-term water quality and water quantity, which affect riparian, aquatic biological, groundwater, and surface water resources. A broadly coordinated, national research effort is needed to guide future development and to create improved methods for predicting, measuring, and mitigating environmental impacts related to hardrock mining.

Portions of the public and the mining industry have little confidence in the propriety or fairness of the regulatory and permitting system. Some members of the public perceive that regulators work too closely with the companies and permit operations without sufficient environmental safeguards. Conversely, some mining operators experience delays that they perceive to be

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caused, in part, by members of the public who seek to forestall mining through the permitting and regulatory processes. Lack of confidence in the regulatory and permitting system can lead to delays and higher costs for industry, regulatory agencies, and the public and can also limit opportunities for improving environmental protection.

Conditions are changing for regulations and mining. Technology, social values, the economy, and scientific understanding change continually. Thus, environmental regulations applicable to mining will be most effective if they can use these changes to improve environmental protection. Similarly, the mining industry should benefit through lower operating cost and greater environmental protection. Therefore, a regulatory system that is adaptive to change will serve the public, the environment, and industry best.

RECOMMENDATIONS

Recommendation 1: Financial assurance should be required for reclamation of disturbances to the environment caused by all mining activities beyond those classified as casual use, even if the area disturbed is less than 5 acres.

Justification

The Committee observed unreclaimed exploration and mining sites that currently fall under BLM's category of notice-level activities, where the land disturbance amounts to less than 5 acres. Some of these sites are examples of unnecessary or undue degradation. The Committee believes that the inability to require a bond or other financial assurance for reclamation of these sites represents a gap in existing regulations. This recommendation proposes a major change in the way BLM regulates notice-level activities, which currently do not require financial assurances.

According to data reported by BLM, there are 181 currently outstanding notices of noncompliance for 14,989 currently active notice-level activities (BLM, 1999a, Tables 3–2 and 3–6); that is, less than 2% of the currently active notice-level operations have outstanding notices of noncompliance. Approximately 72% of the outstanding notices of noncompliance for notice-level activities are for “failure to reclaim” (BLM, 1999a, Table 3–6). Although the percentage of notice-level activities cited for noncompliance is small, and even fewer sites are left without some form of reclamation, BLM staff spend

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significant time locating operators of these sites and achieving compliance with reclamation requirements.

Disturbance of surface resources beyond those defined as casual use (see Sidebar 1–3) are considered significant. If bonds or other acceptable types of financial assurances were posted for reclamation of all such disturbances, regulatory agencies could use these funds to reclaim sites that have been abandoned or for which the operator is unwilling to reclaim the land. The requirement of financial assurance would protect taxpayers, who might otherwise be shouldered with the responsibility of reclamation. Furthermore, the bond itself provides an incentive for operators to reclaim the land in a timely manner.

Discussion

The objective of this recommendation is to guarantee financial assurance for all significant disturbances, while continuing to allow activities with negligible impact to be conducted without permits. In this context significant disturbance for the purpose of requiring financial assurances generally occurs when motorized equipment is taken off existing roads onto a site. Examples include the use of bulldozers (for building new roads and drill pads) and backhoes (for digging exploration trenches).

The Forest Service currently uses a standard of "significant disturbance" in determining the threshold beyond which a plan of operations is needed (26 CFR 228.4). On BLM lands, neither a notice nor a plan of operations is required if the activity is classified as "casual use," which is an activity ordinarily resulting in only negligible disturbance of the land and its resources (see Sidebar 1–3). BLM generally considers as casual use those activities that do not involve mechanized earth-moving equipment or explosives or do not involve motorized vehicles in areas designated as closed to off-road vehicles (43 CFR 3809.0–5).

Implementation

Standard bond amounts for certain types of activities on specific kinds of terrain should be established by the regulatory agencies. It should be recognized that certain types of activities are less costly to reclaim than others. A set of activity- and terrain-dependent standard bond amounts (by state, BLM district, or forest) should be established for typical activities, especially those of prospectors, small exploration companies, and small miners, so that adequate bonds are posted for activities under 5 acres and so that the permitting process is expedited. Standard bond amounts (a certain number of dollars per acre of land disturbed for a particular type of activity) should be

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used in lieu of detailed calculations of bond amounts based on the engineering design of a mine or mill. In addition, the Committee encourages the use of bond pools to lessen the financial burden on small miners.

Recommendation 2: Plans of operations should be required for mining and milling operations, other than those classified as casual use or exploration activities, even if the area disturbed is less than 5 acres.

Justification

The Committee observed examples of unnecessary or undue degradation on a few notice-level mining operations, which are not now required by BLM to have plans of operations. The Committee considers this to be a gap in the current regulations. This recommendation proposes a major change in the way notice-level operations are treated.

Mine development, extraction, and mineral processing activities generally disturb the land more significantly than exploration activities (see Appendix A, which describes the overall mining process, Appendix B, which discusses impacts, and Recommendation 3, which addresses notice-level exploration activities). As such, mine development, extraction, and mineral processing require considerable engineering design and construction activities, whereas, apart from the design of roads to minimize erosion and impact on sensitive areas, exploration requires little, if any, engineering and construction. A plan of operations should be subjected to regulatory approval to assess and help minimize environmental disturbance from mine development, extraction, and mineral processing activities. (Recommendation 3 addresses expedited procedures for exploration.)

Discussion

This recommendation seeks to ensure that potential environmental impacts of mine development, extraction, and mineral processing operations are adequately considered and that the land will be reclaimed after mines and mills close.

The Committee favors retaining the BLM distinction for casual use operations and the Forest Service's similar recognition of activities with no significant impact.

The Committee discussed two examples in an effort to determine which kinds of mining-related activities should have approved operating plans. In the first example, small suction dredges used to recover placer gold from

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sediments in streams generally are allowed under various state laws to be in the streams only during certain times of the year, preventing disturbance of fish at critical stages in their life cycles. The Committee believes that BLM and the Forest Service are appropriately regulating these small suction dredging operations under current regulations as casual use or as causing no significant impact, respectively.

In the second example, the Committee debated whether bulk sampling for metallurgical testing, an activity that could be considered advanced exploration rather than mining, should require a plan of operations or be considered a notice-level activity. Bulk sampling commonly involves excavation, from a shallow open pit or small underground openings, of 10 to 1,000 tons or more of presumed ore. The rock is tested, typically off site at an operating mill or at a metallurgical laboratory, to determine whether the contained metals can be extracted efficiently and profitably. Because an exploration project must advance to a considerable degree before bulk sampling is done and because bulk sampling can require the excavation of considerable amounts of overburden and waste rock, the Committee believes a plan of operation should generally be required for activities involving bulk sampling.

Thus, the Committee believes that, in association with a quick review of the operating plans, these same types of operations would benefit from a NEPA review that uses existing and readily available information. Some of this information may be available through the documentation developed by the land management agency for the land use planning process. The NEPA process will commonly require an environmental assessment rather than an environmental impact statement; in either case, the land management agency is responsible for timely completion of the appropriate NEPA documents. The requirement for a plan of operation for all mine development, extraction, and mineral processing operations should not be viewed as an opportunity to slow the process through extended review, but rather as an opportunity to develop the information needed for improved operations and for better monitoring and enforcement.

Implementation

The Committee recognizes the valuable role that small miners play in the development of the nation's mineral wealth. Because of scale, small mines generally have less potential environmental impact than major mines. The Committee therefore believes that, with adequate bonding for reclamation, small miners should receive expedited schedules and services in permitting. For example, regulators should provide small miners with examples of generic permit applications that clearly explain the miner's responsibilities. The Committee believes that certain types of mineral extraction processes should be

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treated differently than others in terms of the speed with which plans of operations are reviewed and approved. Some could have rapid, check-off-the-boxes approaches to permit applications. For example, mining for mineral specimens for collectors could be reviewed and permitted rapidly if no potentially harmful chemicals are used on site for beneficiation and if less than 5 acres of land is disturbed. Most specimen mining occurs in established mining districts, where adequate surface access exists. In addition, the land management agencies could assist small miners and mill operators by assigning more personnel to help complete permit applications, educate the operators in the permitting process, and develop standardized, easy-to-understand forms.

Recommendation 3: Forest Service regulations should allow exploration disturbing less than 5 acres to be approved or denied expeditiously, similar to notice-level exploration activities on BLM lands.

Justification

The ability to obtain access to land in a timely manner is vital to exploration (see Appendix A). The Committee found that the time it takes industry to obtain permission to explore on federal lands varies considerably by agency, even when disturbance to the land is likely to be minimal. This recommendation calls for a major change in the way the Forest Service approves exploration activities for disturbances of less than 5 acres. Along with Recommendation 1, which would require financial assurances for such exploration activity on BLM lands, this recommendation would make the requirements for exploration on Forest Service and BLM lands similar.

Under the current system for notice-level exploration activities affecting 5 acres of land or less, BLM has 15 days to respond and notify the operator if extraordinary measures are needed for the planned activities. In contrast, Forest Service officials reported that essentially identical exploration activities on Forest Service lands often require eight months lead time and sometimes as long as two years to obtain approval, although some approvals for exploration are obtained more quickly. Before plans of operations for exploration are approved, Forest Service officials generally inspect the sites, carefully review the plans, and prepare environmental assessments. The length of time can vary depending on whether the operator has the financial resources to provide for a third party to prepare an environmental assessment or must wait for the Forest Service to prepare the document.

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Exploration typically progresses from one place to another depending on the results of the previous tests. For example, the results of one drill hole will often dictate the optimal location of the next drill hole. Anticipating the location of all drill holes on a particular piece of land is difficult. Therefore, exploration companies, when planning their exploration programs, tend to add to the estimated number of drill hole locations that are necessary.

Exploration companies informed the Committee that companies typically attempt to limit disturbance to less than 5 acres at a time on BLM lands because of the quick review from BLM for notice-level disturbances. Because such a provision does not exist in Forest Service regulations, there is less incentive to limit disturbance on these lands. In fact, because the review time is so lengthy, companies are likely to submit proposals for far larger exploration programs on Forest Service land than on BLM land in order to avoid further delays that would be caused in obtaining additional approvals. The only incentive for limiting disturbance on Forest Service lands appears to be the cost of reclamation.

Discussion

The objective of this recommendation is to allow exploration activities to be conducted quickly when minimal degradation is likely to occur. The Committee believes that, with reclamation bonds or other financial assurances in hand for land disturbance (see Recommendation 1), exploration should be able to proceed expeditiously. That is, the current BLM 3809 regulation with a 15-day response time for notice-level exploration activities should be maintained, and a similar procedure should be adopted by the Forest Service.

Increased use of geographic information systems to check locations for such features as riparian areas, steep terrain, cultural resources, and known habitats and locations of threatened or endangered species should facilitate the necessary evaluations by land managers. Quick response time improves exploration efficiency because it gives operators the necessary flexibility to modify plans based on initial results, and because it provides an incentive for operators to design exploration activities that minimize the disturbed acreage.

Implementation

Although the Committee recognizes that Forest Service lands often are in steeper terrain with more springs and creeks than BLM lands, the Committee believes that, with financial assurances in place, exploration disturbing less than 5 acres should be able to proceed on Forest Service lands as rapidly as on BLM lands. That is, the Forest Service should modify its 228 regulations to allow for rapid approval of exploration activities disturbing less than 5 acres.

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The Committee does not intend that the requirement of bonding for exploration activities (Recommendation 1) result in a federal action that would automatically trigger an environmental assessment or environmental impact statement. BLM does not currently require companies to supply an environmental assessment for notice-level activities. The Committee believes that not requiring environmental assessments for exploration with less than 5 acres of disturbance is appropriate for both BLM and Forest Service lands.

The Committee debated whether the 5-acre threshold for BLM notice-level activities, above which full plans of operations with environmental assessments or environmental impact statements are required, is appropriate. Five acres appears to be a reasonable threshold, if reclamation bonds or other financial assurances are required, because environmental impacts from exploration at this level are likely to be minimal and because the cost (generally $5,000 to $25,000 for a full 5 acres of expected disturbance) is likely to be sufficiently high to provide an incentive for operators to reclaim the land quickly.

Recommendation 4: BLM and the Forest Service should revise their regulations to provide more effective criteria for modifications to plans of operations, where necessary, to protect the federal lands.

Justification

Concern was expressed to the Committee about the ability of BLM and the Forest Service to require modifications of plans of operations in light of new circumstances or information, such as unexpected acid drainage, problems with water balance, adequacy of approved containment structures, or discovery of impacts on wells and springs. The ability to require operators to make necessary modifications is essential to the agencies' ability to prevent unnecessary or undue degradation of federal lands.

A BLM state director or Forest Service supervisor now may require modifications only after making a set of findings that include determinations on the foreseeability of the issue when the original plan was approved, and if the agency took all reasonable measures to forestall the issue at that time. However, arguments over what should have been “foreseen” or whether a BLM or Forest Service officer took “all reasonable measures” in approving the original plan makes the modification process dependent on looking backward. Instead, the process should focus on what may be needed in the future to correct problems that have resulted in harm or threatened harm. Protection of the lands should not depend entirely on an after-the-fact assessment of how good a job was

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done at the time the original plan was approved. It is more important to address what can be done now to avoid unnecessary or undue impacts. Modification procedures should look forward, rather than backward, and reflect advances in predictive capacity, technical capacity, and mining technology.

Discussion

Disputes have arisen over the ability of the BLM and Forest Service to require modifications under particular circumstances, for example, Island Mountain Protectors, IBLA 97–76R et al. (Nov. 20, 1998) (dispute over whether revised closure plan is or is not a "proposed modification" of the plan of operations); and Creole Corp., 146 IBLA 107 (1998) (dispute over authority to require modification where detailed factual findings were not made on adequacy of 17-year old plan of operations where active operations had never commenced).

In part, this look backward is intended to prevent unfairly reopening issues that were, or should have been, anticipated at the outset. In practice, these requirements can complicate attempts to address current effects that became apparent only after some period of operation. See, for example, Red Thunder, Inc., 129 IBLA 219, 101 I.D. 52 (1994) (recounting dispute over legal status of letter "revisions" to plan of operations when acid drainage had been considered in the original plan of operations, but mining of sulfide ores had not been anticipated).

Various offices of BLM and the Forest Service have resorted to different strategies to preserve flexibility to respond to environmental harm or threatened harm despite the limitations of the current regulations. For example, some BLM offices routinely include reopener provisions in approved plans of operations, explicitly providing for submission of modifications where monitoring or other operating experience shows results different from those that were anticipated. The Forest Service often issues plans of operations that are valid only for a defined period—thus requiring the operator to submit a new plan of operations periodically, giving the Forest Service an opportunity to require modifications in the new plan. Some larger operators have agreed to include periodic review and update requirements in their plans to give the land management agency some ability to make necessary changes. While these approaches do not entirely conform to current regulations, they have helped protect the environment. Staff comments and documents reviewed by the Committee suggest that the regulations should be modified to improve criteria for modifications, require periodic reviews, and/or specify expiration dates for approved plans of operations to assure the opportunity to adjust practices where needed.

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Implementation

Provisions for periodic review of plans of operations, and the ability to require modifications, are important to deal with adverse effects on public lands. BLM and Forest Service regulations should not require the agencies to make retrospective findings on "foreseeability" or whether "all reasonable measures" were applied in approving the existing plan. Modifications should be based on the results of monitoring or other data that demonstrate the occurrence or likely occurrence of unnecessary or undue degradation if the plan is not modified.

One of the implications of requiring modifications is the need for NEPA review. Where such modifications are needed to prevent unnecessary or undue degradation, such review should be expeditious and tied to the NEPA document approving the initial plan of operations. In addition, revised agency procedures should contain safeguards to assure that modifications are imposed only after serious consideration and following a procedure that protects the interests of the mining company in continuing to conduct operations, consistent with the avoidance of unnecessary or undue degradation.

The Committee did not determine if plans of operations should be reviewed or reopened at predetermined intervals. The evolutionary nature of mining at individual sites—particularly at mines using newer technologies and dealing with disseminated mineral deposits—requires changes in the limitations on plan modifications in the original BLM and Forest Service regulations. Updating of financial assurance instruments should also take place as conditions change that might affect the levels of bonding or other forms of financial assurance. Practices now vary among the states and federal agencies.

Recommendation 5: BLM and the Forest Service should adopt consistent regulations that a) define the conditions under which mines will be considered to be temporarily closed; b) require that interim management plans be submitted for such periods; and c) define the conditions under which temporary closure becomes permanent and all reclamation and closure requirements must be completed.

Justification

Temporary closures as a result of low mineral prices may cause environmental problems if appropriate management measures are not undertaken. Federal land management agencies should have regulations to

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address such events. The land management agencies need to have the authority to require an operator to properly close a mine rather than allow it to remain in limbo if poor market conditions persist. The situation today is quite different from that over the last two decades when gold and other mineral prices were high and relatively stable.

Discussion

Under some state regulations, temporary closures (defined as substantial reductions in output) exceeding a specific period of time trigger a requirement for permanent closure. Some companies have used "temporary" status to delay or avoid taking appropriate final actions to clean up and otherwise close their facilities. Agencies should have a clearly stated process and criteria to be used in responding to temporary closures. Several states already have adopted regulations addressing this issue for mining operations.

Implementation

The Forest Service and BLM should develop a common approach to addressing temporary closures and should delineate when temporary closures become permanent. This should be implemented through a rule-making process. They should also enter into understandings, and if necessary formal agreements, with the states that have already adopted such regulations concerning how the agencies will coordinate their efforts and which agency will take the lead in addressing temporary closures.

Recommendation 6: Federal land managers in BLM and the Forest Service should have both (1) authority to issue administrative penalties for violations of their regulatory requirements, subject to appropriate due process, and (2) clear procedures for referring activities to other federal and state agencies for enforcement.

Justification

Field-level BLM and Forest Service personnel told the Committee that they have experienced difficulty, in some cases, in enforcing compliance with regulations and the requirements of notices and plans of operations. The Committee is not able to assess the relative levels of on-the-ground compliance and noncompliance resulting from the limitations of the existing enforcement procedures. However, the Committee is persuaded that more consistent and accessible procedures for deciding when to refer apparent violations to other

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agencies and the ability to issue reasonable administrative penalties, subject to appropriate due process, would improve the efficiency of agency operations and enhance the protection of the environment.

Discussion

Currently, federal land managers must seek a court injunction to compel an operator to respond to a "notice of noncompliance," which directs the operator to return to compliance (43 CFR 3809.3–2; 36 CFR 228.7[b]). While some districts of BLM and the Forest Service have found such notices sufficient, others regard them as ineffective. The difference appears to be the ease or difficulty with which these offices can obtain the assistance of a U.S. attorney to seek injunctive relief.

Forest Service staff members also advised the Committee that they resort to regulations containing a general provision that makes violation of any Forest Service "approved operating plan" a petty offense punishable by a fine of not more than $500 or six months imprisonment (36 CFR 261.10[1], 261.1b). Access to a U.S. magistrate, assisted by Forest Service law enforcement personnel, apparently gets the early attention of operators that are in violation of their plans of operations.

Some Forest Service staff members also reported the use of the 261 authority, rather than the mining-specific 228 authority, because of poor wording of the "notice of noncompliance" section of 228.7(b). This section currently provides that a notice of noncompliance will be issued when an operator is failing to comply with regulations or the plan of operations, and the noncompliance "is unnecessarily or unreasonably causing injury, loss, or damage to surface resources." The apparent requirement that actual harm be occurring in addition to a violation leads to concern about the efficacy of the notice of noncompliance in preventing harm to forest land resources.

Currently, the consequence for failing to comply with a notice of noncompliance from BLM or the Forest Service is the possibility that an operator may be ordered to comply by a federal court at some later date, with no sanction or disincentive for not responding at the outset. In the case of the Forest Service, petty criminal prosecution is also an option. The Committee finds that an administrative penalty authority should be added to the array of enforcement tools in order to make the notice of noncompliance a credible and expeditious means to secure compliance.

In addition to their own enforcement authorities, federal land management agencies need to acknowledge and to rely on the enforcement authorities of other federal, state, and local agencies as much as possible. The provision of

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this additional enforcement authority for federal land management agencies makes it imperative that formal understandings be developed between those agencies and the state and federal permitting authorities to prevent duplication of effort and to promote efficiency.

Implementation

BLM and the Forest Service should establish more consistent and accessible procedures for deciding when to refer apparent violations to other agencies that have direct interests in, and responsibilities for, operator activities that adversely affect the environment. Using memoranda of understanding (MOUs) or other means, the procedures should allow for the expeditious involvement of other agencies, except in cases where the land management agency needs to act immediately to protect public lands and resources, or in cases where the other agency is unable or unwilling to act with appropriate speed. In these cases clear procedures and standards are needed to guide the use of existing enforcement authority when violations have occurred or are imminent.

In addition, BLM and the Forest Service should seek authority from Congress, if statutory authorization is necessary, or otherwise revise and expand the existing enforcement provisions in the 3809 and 228 regulations to include administrative penalty authority for violations of their regulations and operating plans or notice-level requirements. Such penalty authority should be subject to appropriate due process, including the opportunity for the operator to rectify the circumstance of noncompliance, to undertake an administrative appeal, and to seek recourse to the courts.

Recommendation 7: Existing environmental laws and regulations should be modified to allow and promote the cleanup of abandoned mine sites in or adjacent to new mine areas without causing mine operators to incur additional environmental liabilities.

Justification

Representatives of several mining companies indicated to the Committee that they would consider partial or full voluntary cleanup of some abandoned sites in or adjacent to their ongoing operations. They were, however, concerned about liabilities they might incur in doing work on abandoned sites. Under the Clean Water Act, CERCLA, and potentially under RCRA, mine operators doing any work at an abandoned site could incur liabilities.

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In most cases, some cleanup would improve environmental quality and is better than no cleanup. In addition to federal impediments to voluntary clean up, some states have environmental laws that may pose additional barriers, laws that may be more stringent than their federal counterparts. The Committee did not address the general problem of abandoned hardrock mines on federal lands, but it believes barriers to reclaiming abandoned mines sites in connection with new operations should be removed.

Discussion

The goal of environmental regulations is to protect and improve the environment. There are opportunities for correcting environmental problems caused by abandoned mines, in some cases where new mining is being done in old mining districts. Concern over legal liabilities or the ability to meet regulatory standards leads mine operators to design around older mined areas and pre-existing discharges. In many cases, however, reclamation of previously mined areas would be a reasonable approach for combining construction of the new mine with improvement of environmental problems caused by earlier mining. For example, existing pits might be appropriate places for waste rock disposal; construction of tailings facilities might present opportunities to stabilize or reclaim previous disposal sites; or replacement wetlands sites might be located to provide some treatment for existing poor-quality discharges. Incentives might be needed to assure that appropriate opportunities for reclamation and improvement of environmental impacts are not missed. Similarly, in previously mined areas adjacent to new mining operations, but not necessary for operation of the new mine, there may be opportunities for voluntary activities that could benefit the public. The added cost of full or partial cleanup of these sites could be considerably less than later cleanup under CERCLA rules. For example, use of equipment that is already on site would be less costly for the company or the government than the standalone costs if the cleanup were to be accomplished by bringing in the equipment at another time. By working with stakeholders and agencies responsible for overseeing the Clean Water Act, CERCLA, and other potentially inhibiting regulations, federal land management agencies could affect some degree of environmental improvement at old mining sites.

The Committee does not propose these changes to allow cleanup of abandoned mines without any liability for performance of the work. Regulatory agencies must be able to review and approve a work plan, to oversee the work, and to use appropriate mechanisms of control if the actions taken are not improving the environment. The objective of changes in laws and regulations

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would be to recognize that environmental improvement is worth pursuing at abandoned sites and to limit the liability incurred by the cleanup entity. The Committee also recognizes that if a responsible party can be identified for the site, the site may not be considered truly abandoned and other cleanup approaches can be pursued.

Some states (e.g., Colorado and Montana) have voluntary cleanup regulations for all types of industrial sites. State regulators and the entities that have used those regulations for abandoned mine-site cleanup indicate that these regulations appear to be working well in promoting cleanup of abandoned sites or sites grandfathered from reclamation requirements. However, their application is limited to those sites where the Clean Water Act or CERCLA liability is not a concern. In addition, the ability of regulators to regulate site cleanup varies with each program.

Implementation

To promote voluntary cleanup programs at abandoned mine sites, Congress needs to approve changes to the Clean Water Act and the CERCLA legislation to minimize company liabilities. The federal land management agencies, in cooperation with the EPA, and other state or federal agencies with potential regulatory authority, should propose to Congress changes in regulatory authority that would promote voluntary cleanup. Input should be solicited from other stakeholders, such as mining companies, tribes, and environmental organizations.

Recommendation 8: Congress should fund an aggressive and coordinated research program related to environmental impacts of hardrock mining.

Justification

Regulatory agencies and the mining industry are not adequately addressing research needs related to the environmental aspects of hardrock mining and reclamation, including the uncertainty associated with predictive modeling. The Committee recommends that Congress provide funds to support this important research. The mining industry, environmental groups, and other stakeholders should participate in defining needed research. Some of these needs are identified in Appendix D, including those related to water quality and quantity and to biological and ecological impacts. Research that looks at cumulative impacts, either from multiple mines or multiple uses should be supported to sort out the significance of the impacts of each use. That applies,

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for example, to cumulative impacts of groundwater withdrawal on regional aquifers and regional water balances.

The potential for long-lasting environmental impacts from mining is high, but research on these issues is inadequate. Ideally, prioritization of and participation in funding for research on these issues should come from a combination of governmental, environmental, and industrial entities.

Discussion

Unlike many other kinds of industrial point-source emissions, releases from mining operations may take years to develop (e.g., acid drainage) and may continue for many years after a mining operation has closed. So far, the success of modeling long-term water quality and quantity impacts has been fragmented, and the concordance of predicted and actual outcomes has not been adequately reviewed. Sampling, testing, and monitoring can provide data to help test, refine, and calibrate long-term predictive models.

The biological aspects of mining are even more neglected and deserve research support. Success in improving environmental controls has shifted some of the most severe remaining impacts of hardrock mining from humans to aquatic and terrestrial biota. Species that may be affected include some threatened or endangered species. Most research on pollution prevention has been focused on manufacturing wastes, but the potential for reducing process waste in mining may exceed that in other industries because of the large scale of mining. Advanced mining technologies, such as bioleaching and *in situ* solution mining, have the potential to reduce pollution and minimize surface disturbance, but the long-term environmental consequences of these methods have not been adequately investigated.

Implementation

Research on the long-term environmental effects of hardrock mining should involve federal agencies (USGS, BLM, USFWS, USFS, EPA, NSF, DOE/National Laboratories), state mining and environmental regulatory agencies, state geologic surveys, universities, environmental groups, and the hardrock mining industry. The capabilities and cooperation of all these groups are needed. Lacking at the present time are adequate funding, a broad commitment to a coordinated research effort, and a focus for coordinating research and disseminating the results. The land management agencies should participate, along with federal and state regulatory agencies, by identifying their priorities for research related to their land management responsibilities.

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No single agency or organization can take on full responsibility for the variety of research needs. In addition to the range of government research organizations, each with topical and disciplinary research strengths, some large mining companies have research facilities that could contribute to a focused program. A research program on environmental effects also should have a strong competitive grants program to stimulate relevant academic research. In addition, the EPA and the U.S. Fish and Wildlife Service have research programs that could contribute to a better understanding of the environmental impacts of mining. A listing and discussion of significant research topics is given in Appendix D. The environmental issues are serious enough to warrant immediate congressional funding of research in this area.

Recommendation 9: BLM and the Forest Service should continue to base their permitting decisions on the site-specific evaluation process provided by NEPA. The two land management agencies should continue to use comprehensive performance-based standards rather than using rigid, technically prescriptive standards. The agencies should regularly update technical and policy guidance documents to clarify how statutes and regulations should be interpreted and enforced.

Justification

The intent of this recommendation is to retain the advantages of the current decision-making approach, which bases environmental protection and reclamation requirements on site-specific evaluations conducted pursuant to NEPA, while encouraging the agencies to provide clear public information about their interpretations of and intentions for implementing their regulatory requirements. Several individuals recommended to the Committee that the land management agencies develop regulations incorporating specific numeric standards to control many aspects of the operation and reclamation of hardrock mines. Such an approach would have the advantage of providing explicit quantitative requirements that would be clear to all stakeholders. It would have the disadvantage of reducing the ability of the operating plan and reclamation requirements to be sensitive to site-specific conditions and considerations.

Discussion

The Committee believes that the NEPA process and its various state equivalents provide the most useful and efficient framework for evaluating proposed mining activities for three reasons.

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First, the NEPA process provides the most comprehensive and integrated framework for undertaking these evaluations. The NEPA environmental assessment process includes the full range of environmental concerns, whether or not they are specifically addressed by some other regulatory program, as well as cultural and other concerns. It allows for clear identification of tradeoffs between different and sometimes competing values, and promotes a better understanding by all stakeholders of the implications of the many decisions involved in the preparation and approval of a mine's operating plan. It also provides a framework for coordinating the diverse information requirements, concerns, and permitting decisions of the many regulatory agencies and other stakeholders. No other regulatory program provides such a comprehensive, integrated mechanism for decision making.

Second, the NEPA process ensures that the decisions are based on careful analyses of site-specific conditions. For example, ore deposits occur in every conceivable type of geographic and geologic location from arid deserts to tropical rain forests to high mountains. The values and sensitivities associated with diverse types of environmental and cultural resources can vary at least as widely. An operating plan for mining activities must adapt and respond to these specific conditions and sensitivities. The NEPA process allows this responsiveness; regulatory programs relying on inflexible, technically prescriptive standards often do not.

Setting objectives for pit lake water quality is a good example of the advantages of the site-specific NEPA process. Requirements for the long-term quality of pit lake waters vary widely among the states and even in the same state. Water quality standards applied to pit lakes vary from those appropriate to industrial ponds to those required to protect waters of the United States. Pit lake settings are highly variable, and include circumstances where pit waters discharge to downstream watersheds, where pit lake waters mix with surrounding groundwater, and/or where pit lakes are closed basins subject to high evaporation. The Committee concluded that pit lake water quality should be subject to regulation and not simply left to chance. However, the Committee had difficulty identifying a universal approach suitable for the classification of all pit lakes.

In the Committee's view, the site-specific, long-term consequences of pit lakes should be fully considered in the NEPA process. Project approvals should clearly establish acceptable post-closure water quality conditions appropriate to the long-term use of the site and those that provide adequate protection for affected ground and surface waters, as well as wildlife and water fowl.

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Third, mining technology for a site can vary substantially, depending on the type of ore, the nature and extent of the ore deposit, and many other site-specific conditions. Mining technologies also have changed, and will continue to change. The NEPA process allows the agencies to be responsive to such technological differences. Less flexible regulatory approaches do not allow this flexibility and, as a result, can cause technologies to be "frozen," often with adverse impacts for both the mining operators and the environment.

For all these reasons, the Committee believes that the agencies should continue to rely to the maximum extent possible on the flexible, comprehensive NEPA evaluation process for making permitting decisions. However, the Committee also recognizes that the NEPA process is not perfect. The process is complex and time consuming and can be implemented inefficiently (see discussions under Recommendations 10 and 16). In addition, although the process recognizes environmental impacts of alternative actions, its objective is to minimize (not necessarily prevent) impacts through mitigation. Therefore some unrestorable impacts may occur even with agreed mitigation measures.

The Committee also believes it is in everyone's best interest if the agencies clearly set forth their policies, interpretations, intentions, and environmental goals in guidance documents and policy papers and make them available to all stakeholders. Discussions with agency personnel demonstrated that many differences in interpretation and perception about existing authorities and policies currently exist in an agency. Such confusion in the agencies can only confuse other stakeholders about the agency's policies. By clearly setting forth these interpretations and policies the agencies can reduce confusion and increase the efficiency of the decision-making process for everyone. By using guidance documents and policy papers rather than regulations for this purpose, the agencies can retain the flexibility that the Committee believes is so important.

Implementation

Continued reliance on the NEPA process requires no modifications to current agency procedures except as identified under other recommendations. The agencies already have the authority to issue guidance documents and policy papers. The challenge is to implement a process for developing, issuing, and updating such documents that allows them to be informed by stakeholder comments (including public comments, where appropriate), while avoiding the inflexibility and costs of the traditional regulatory process. In order to be useful and effective, the advisories also must be easy for mining claimants to obtain. Examples of such guidence documents created by the British Columbia Ministry of Energy and Mines include Price and Errington (1998) and Price (1997).

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Recommendation 10: From the earliest stages of the NEPA process, all agencies with jurisdiction over mining operations or affected resources should be required to cooperate effectively in the scoping, preparation, and review of environmental impact assessments for new mines. Tribes and nongovernmental organizations should be encouraged to participate and should participate from the earliest stages.

Justification

The lack of early, consistent cooperation and participation by all the federal, state, and local agencies involved in the NEPA process results in excessive costs, delays, and inefficiencies in the permitting of mining on federal lands. Delayed and inconsistent involvement by nongovernmental organizations exacerbates these problems. In some cases, the agency representatives who do participate in the NEPA process are not those who will be responsible for issuing the ultimate permits, resulting in the raising of new information collection and analytical requirements during the final permitting phases. The objective of this recommendation is to promote efficient, fair, and timely consideration of mining proposals by streamlining the NEPA compliance process and eliminating permitting delay.

Discussion

The Committee received testimony about the frequency of this problem and the substantial costs and delays that it can cause. Examples of problems include:

- failure to achieve early consensus on the appropriate scope and methodologies for collecting baseline environmental data (this failure may result in the need to repeat studies);
- introduction of new issues not included in the initial scoping by parties, including agencies that failed to participate in early consultation;
- late requirements to analyze additional alternatives not included in the original scope;
- intra-agency disconnect between personnel responsible for NEPA compliance and those responsible for permit decisions, resulting in late requests for additional information that should have been included in the original NEPA document; and

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- multiple draft documents and revisions requiring additional public review.

The EPA was frequently singled out as an agency that often creates such problems because of its unwillingness to participate early in the NEPA process.[1] Other nongovernmental and tribal organizations were also cited for failing to participate early in the process, partly because the land management agency did not invite or encourage these organizations to participate.

On the other hand, several examples of effective collaboration among agencies were also presented to the Committee. Cooperation appeared to work particularly well when the state also had an environmental impact assessment requirement. The earlier the joint efforts begin the more effective and efficient the decision-making process is for everyone concerned. In many cases, for instance, the land management agency should begin organizing the process even during exploration, when it becomes evident that the mineral resources appear sufficient to support mining.

Implementation

The land management agencies can promote the early consultation process by undertaking an aggressive, critical review of their current NEPA implementation practices and identifying sources of delay and inefficiency. Examples of effective and timely permitting also should be examined and used as models to improve and streamline the permitting of mining projects elsewhere.

In addition, it is crucial that the land management agencies adopt policies that will ensure that they secure high-level commitments to participate fully in the NEPA process from each potentially concerned federal, state, and local agency, and that will identify and include as cooperators the appropriate tribal and other nongovernment organizations. This must include full participation in the scoping process so that new issues are not introduced too late, and it must include concurrence on the appropriate work programs for baseline studies and other report components before the work is undertaken. Implementation of this recommendation also may require other federal agencies involved in decision making to adopt and implement guidance of their own to assure that the collaboration is early, effective, and sufficient. In this regard, the EPA Hardrock Mining Framework, if implemented, provides an example of such an agency commitment.[2]

[1] EPA, 1997a
[2] See draft EPA policy (EPA, 1997b).

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The National Interagency Coordinating Committee formed in 1995 by interagency agreement among EPA, BLM, the Forest Service, and the National Park Service represents an approach to coordination among senior managers on a policy level that might also support implementation of this recommendation. However, the agreement will expire in 2000 unless it is extended, and its effectiveness depends on continued attention by senior managers.

Recommendation 11: BLM and the Forest Service should maintain a management information system that effectively tracks compliance with operating plans and environmental permits, and communicates this information to agency managers, the interested public, and other stakeholders.

Justification

The Committee was consistently frustrated by the inability of federal land management agencies to provide timely, accurate information regarding the status of mining projects under their jurisdiction. The lack of information appeared to be greatest among highly placed officials who have the greatest need to know. Consequently, those responsible for regulatory management and change, and for keeping the public and Congress adequately informed, appear to be severely limited in their ability to do so. Public testimony expressing concern that mining on federal lands is or is not adequately regulated was based mainly on anecdotal data and generally lacked systematic support.

Discussion

As stewards of the federal lands, federal land management agencies have a responsibility to track systematically the performance of mining projects under their jurisdiction and to communicate this information effectively to stakeholders. Although the Committee was told by field-level personnel that such tracking was generally accomplished, the systematic compilation of the information necessary to document this conclusion was found only in field office files.

This recommendation addresses two of the essential elements of a regulatory program (see Sidebar 3–1), a management information system and stakeholder communications. The objective is to improve the federal land management agencies' management capabilities and to increase the confidence

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of stakeholders that the agencies are adequately fulfilling their obligation to protect the environment at mining projects on federal lands.

Mining regulation depends on the application of a multitude of statutes and regulations by numerous agencies, which the Committee found, in the aggregate, to be generally effective in protecting the environment from the potential impacts of mining on federal lands. The Committee also was told that mine operators are comprehensively implementing permit requirements, conducting required monitoring, and appropriately reporting results.

It was not clear, however, that the federal land management agencies are systematically tracking operator compliance with the commitments made in permits, reviewing and evaluating monitoring results, and effectively communicating this information to agency officials and interested stakeholders. Information that could be usefully tracked, compiled, and reported includes:

- inspection reports of federal land managers and of other federal, state, and local agencies;
- summaries of monitoring data and reports that, in particular, characterize the degree of compliance with standards and criteria at mines and that highlight incidents of noncompliance;
- corrective actions taken to return sites to compliance;
- enforcement actions required to assure implementation of required corrective actions;
- status of reclamation at mine sites;
- status of financial assurances;
- financial assurance forfeitures required; and
- outstanding incidents of noncompliance requiring farther action.

Compiled information should be summarized periodically and reported upward in the federal land management agencies. This same information should be readily accessible to the public, either as published reports or postings on the Internet.

Implementation

The federal land management agencies should review and compile compliance data from the management information systems used by cooperating federal, state, and local agencies to track and report compliance with their permits and environmental requirements. The agencies should not duplicate efforts. Other federal, state, and local agencies also have an obligation to maintain their own management information systems and to provide appropriate information to the land management agencies. Care in the

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design and implementation of an appropriate management information system can avoid excessive paperwork and diversion of personnel from field inspection duties.

Periodic public reporting is needed on the compliance status of individual mines, as well as aggregated district, state, and national compliance information. This would help allay public concerns that federal land management agencies are not adequately protecting the environment at mining operations on federal lands.

Recommendation 12: BLM and the Forest Service should carefully review the adequacy of the staff and other resources devoted to regulating mining operations on federal lands and, to the extent required, expand and/or reallocate existing staff, provide training to improve staff capabilities, secure supplemental technical support from inside and outside the agencies, and provide other support as necessary.

Justification

Some land management offices report that they have too few people to conduct inspections, review proposed operating plans, process appeals, and conduct other required activities. This concern extends beyond the simple numbers of people assigned to these functions. The responsibilities of the land management agencies involve many different scientific disciplines and can be technically very complex. Offices responsible for regulating mining projects may not always have access to the trained and experienced personnel required.

Discussion

The objective of this recommendation is to improve and supplement the technical capabilities of the land management agencies to increase efficiency and ensure environmental protection. Opportunities available to supplement the existing capabilities of land management agencies are various and include the following:

- expanding and/or reallocating existing staff;
- providing intra and inter-agency training to improve staff capabilities, including not only briefings and seminars but also rotational temporary assignments, field visits, and other means of exposing less-experienced staff to the accumulated knowledge of veteran personnel;

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- securing supplemental technical support from within the agencies (e.g., the BLM Technical Services Center's support of hydrological analyses in Nevada) and from other public agencies (e.g., the U.S. Geological Survey's Humboldt River Basin study provides important technical support to a land management agency by assisting in the evaluation and management of cumulative hydrological impacts);
- developing and using centers of excellence where individuals with the appropriate training and experience are available to support a number of different field offices;
- providing field offices with sufficient contracting funds to retain outside experts as necessary;
- expanding the role of private sector registered professionals (e.g., in addition to designing engineered mine facilities such as tailings dams, leach pads, diversion structures, and waste dumps; specifying the monitoring necessary to determine whether the facility is operating appropriately; reviewing the resulting data periodically; and certifying that the facility is operating within its design parameters, and if necessary, specifying corrective actions);
- using tools that will increase staff productivity, such as conducting more frequent inspections of exploration and mining activities and using computer models to estimate reclamation costs, conduct viability analyses, and support other tasks; and
- providing necessary supplies.

Implementation

Several of these opportunities warrant early attention by the federal land management agencies. Staff training should be provided to improve staff capabilities. BLM should explore opportunities to expand the role of its Technical Services Center to assist in scoping and preparing environmental documents, specifying appropriate environmental monitoring, reviewing environmental monitoring data, and assisting on other technical matters. The Forest Service research stations may be able to provide similar assistance. BLM and the Forest Service should seek additional technical resources from the USGS and other appropriate agencies such as NSF, DOE/National Laboratories, EPA, and the Fish and Wildlife Service. In addition, the academic community could become better engaged in support of the land management agencies. The agencies also could expand the role of registered professionals from the private sector and increase the use of tools to enhance staff productivity.

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Recommendation 13: BLM and the Forest Service should identify, regularly update, and make available to the public, information identifying those parts of federal lands that will require special consideration in land use decisions because of natural and cultural resources or special environmental sensitivities.

Justification

Lacking information on the important natural and cultural resources and environmental sensitivities of federal lands, miners are at risk of investing in exploration and then being denied a permit or being permitted under unfavorable terms. From the public's viewpoint, lack of prior environmental information may cause a mining project to advance to the point where environmental sensitivities are recognized too late and cannot be adequately accommodated. The best opportunity to avoid these unfortunate outcomes is through the prior identification of special environmental and resource situations. The public availability of this information will permit all stakeholders to make informed decisions regarding the use of federal lands.

Discussion

Riparian zones, cultural and religious sites, unique ecosystems, and other settings on federal lands are now generally recognized as deserving special consideration in determining the appropriateness and management of mining. In reserving selected areas of federal lands for special purposes, such as national parks or wilderness areas, Congress typically withdraws the land from competing uses, including mining. The Forest Service and BLM use administrative withdrawals within legislatively prescribed limits to preclude hardrock mining on federal lands for such facilities as offices and campgrounds and for protecting areas used for scientific studies, municipal watersheds, and similar public purposes. The Committee notes, however, that using withdrawal orders is a relatively inflexible tool for reflecting environmental sensitivities during permitting in site-specific situations.

The land use planning processes required for federal lands by the Federal Land Policy and Management Act (FLPMA) for BLM and the National Forest Management Act (NFMA) for the Forest Service provide for identification of land and resources deserving special environmental concern. FLPMA, for example, provides for the designation of “areas of critical environmental concern” (ACECs) on BLM lands where special management is needed “to

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protect and prevent irreparable damage to important historic, cultural, or scenic values, fish and wildlife resources or other natural systems or processes, or to protect life and safety from natural hazards" (FLPMA, Sec. 103). Areas defined in land use plans as requiring special protection can be withdrawn from mineral entry within legislatively prescribed limits.

The agencies' land use planning processes provide for public input and review. However, the time needed to prepare and revise plans limits their usefulness in providing timely information. In addition to the information on environmentally sensitive resources and conditions provided in the land use plans, additional information should be provided in advisories that identify the types of resources and areas that the agencies consider sensitive. This additional information could serve as an early signal for miners and others about conditions that are likely to require additional attention during the permitting process.

Implementation

BLM and the Forest Service should identify natural or cultural resources or environmental sensitivities on federal lands that require special consideration in land use planning, including that related to hardrock mining. The agencies should use their land use planning processes to (1) identify these lands that should be withdrawn from hardrock mining or may require special considerations in permitting, (2) give specific consideration to hardrock mining as a potential land use, and (3) establish guidelines for reclamation and mitigation that apply to mining. This can be accomplished through the land use plans for federal lands required by FLPMA and NFMA.

Adopting this recommendation should help to assure appropriate consideration of all surface resources and efficient use of resources and environmental information in mining decisions. When land use planning identifies lands that should be protected from all mining, existing withdrawal authority should be sufficient.

Recommendation 14: BLM and the Forest Service should plan for and assure the long-term post-closure management of mine sites on federal lands.

Justification

The Committee found that current regulatory programs primarily address the exploration, permitting, operation, reclamation, and closure of mines and

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have only recently focused on the post-closure management needs of mine sites on federal lands. Because hardrock mining on unpatented mining claims is a temporary use of the land and because the federal land management agencies resume direct responsibility for management of mine sites after reclamation and closure are complete and reclamation bonds are released, consideration should be given to the long-term needs and responsibilities for managing these sites.

Discussion

Federal land management agencies should consider the land uses that are appropriate for a closed and reclaimed mine site, and perhaps more importantly, whether any uses should be controlled or precluded. In addition, the following management requirements should be addressed and assured for each site:

- measures needed to preserve future mineral access;
- residual public safety hazards and the need for fences, signs, and other features that must be periodically checked and maintained;
- measures needed to assure the integrity of closed waste units including the monitoring of tailings pond caps and waste rock and leach pad covers and their possible repair because of erosion or other failure, and the checking of adit plugs for continued effectiveness;
- long-term environmental monitoring required to assure that the site remains stable and does not become a source of off-site contamination and the implementation of appropriate corrective measures;
- the operation and maintenance of any water treatment facilities required to maintain water quality compliance of the site over the long term; and
- financial assurance to ensure implementation of these post-closure management requirements.

These matters are more relevant to large sites than small, but should be considered on a site-specific basis for any operation subject to a plan of operations. Site-specific post-closure management plans should be prepared and approved, and to the extent that costs can be reasonably identified, appropriate post-closure financial assurances should be established for mine sites on public lands.

The need for appropriate consideration of sites reasonably anticipated to require long-term operation of water treatment facilities is of particular importance because of the substantial costs of operating and maintaining these

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facilities. Many questions remain about maintenance of treatment facilities for long periods of time and the types of financial assurances that might be appropriate to cover such costs. Questions also remain about the predictive tools currently available, their ability to accurately predict the need for long-term water treatment (see Appendixes B and D), and how and when to apply the results of such predictions to the need for financial assurances.

The Committee did not examine the long-term treatment and associated financial assurances in great detail. However, information was received indicating concern by the public and regulatory personnel about long-term treatment and the ability to require financial assurances. The Committee found that, with some exceptions, most states, the BLM, and the Forest Service do not require bonding for long-term or perpetual treatment of water at mine sites. The need for treatment of acid drainage and pit waters may extend long beyond typical post-closure periods (generally 30 years or less). If these costs are not assured, the public will eventually incur the costs of long-term water treatment at such sites if they become necessary. The Committee agreed that long-term water treatment and associated financial assurances will be necessary at some sites, and that the appropriate application of the predictive models and the appropriate long-term financial assurance instruments are areas that need further study.

The Committee reached no conclusion regarding the appropriateness of either requiring financial assurances for unanticipated, potentially environmentally damaging, extremely low-risk post-closure occurrences (such as the failure of drainage control systems or tailings embankments in a storm that is greater than the design storm event).

Implementation

The federal land management agencies should develop procedures that will enable them to identify, in the review and approval process for plans of operations, the kinds of post-mining requirements that are likely to arise and to incorporate these into the approved plan of operations. In addition, provisions should be made to amend or clarify, as necessary, applicable land use plans to reflect the post-closure requirements of the site and to consider institutional, management, staffing, and other needs of the post-closure mine site. Appropriate types of financial assurance should be investigated for long-term water treatment.

Recommendation 15: BLM should prepare guidance manuals and conduct staff training to communicate the agency's authority to protect valuable resources that may not be protected by other laws.

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Justification

Although mining operations are regulated under a variety of environmental protection laws implemented by a number of different federal and state agencies, the Committee was concerned that these laws may not adequately protect all the valuable environmental resources that might exist at a particular location proposed for mining development. Examples of resources that may not be adequately protected include springs, seeps, riparian habitat, ephemeral streams, and certain types of wildlife. In such cases, the BLM must rely on its general authority under FLPMA and the 3809 regulations to prevent "unnecessary or undue degradation." Because the regulatory definition of "unnecessary or undue" at 3809.0–5(k) does not explicitly provide authority to protect such valuable resources, some of the BLM staff appear to be uncertain whether they can require such protection in plans of operations and permits. Some resources may deserve to be protected from all impacts, while other resources may withstand some impacts with associated mitigation. BLM should clarify for its staff the extent of its present authority to protect resources not protected by specific laws, such as the Endangered Species Act.

Discussion

As discussed in Chapter 3, BLM and the Forest Service have a variety of mechanisms available for withdrawing from mining or protecting particularly valuable or sensitive areas or resources in advance of any proposed development. To the extent that they can make use of these mechanisms, they will provide protection to such resources or areas at the same time that they provide advanced notice to potential mining operations about which areas and resources ought to be avoided or protected in the planning and design of these operations. However, it may not be possible to identify all such areas or resources in advance. In this case, the agencies will have to rely on their general authorities, implemented through the NEPA process, to provide such protection on a site-specific basis.

Representatives from the Forest Service seemed clear in their authority to provide such protection, but some BLM representatives expressed ambiguity about this issue. The ambiguity results from the definition of "unnecessary or undue" in the agency's regulations pertaining to hardrock mining. These regulations emphasize such factors as "reasonable mitigation measures," "prevention of a nuisance," and compliance with other explicit environmental protection statutes. They do not, however, provide explicit authority to protect valuable or sensitive resources that are not adequately protected by these other

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environmental protection statutes. Nevertheless, BLM has required such protection in some operating plans, and the Department of the Interior's Board on Land Appeals has upheld these requirements.

However, there is no clear guidance for agency personnel in the regulations or in the guidance documents on the extent of the agency's authority or on how these issues should be handled in the development and approval of operating plans for proposed mining operations.

Implementation

BLM should prepare guidance manuals to clarify its existing authority to protect resources and train staff accordingly. During the NEPA process for mine operating plans, BLM should consider unnecessary or undue degradation of those resources that are not protected by other laws, determine what authority it has to act, and take appropriate actions to provide the appropriate level of protection.

Recommendation 16: BLM and the Forest Service should plan for and implement a more timely permitting process, while still protecting the environment.

Justification

The permitting process is cumbersome, complex, and unpredictable because it requires cooperation among many stakeholders and compliance with dozens of regulations for a single mine. As a result, there is a tendency for the process to drag on for years, even a decade or more. This drains and diverts the resources of land management agencies that should be managing their full range of responsibilities. It is also burdensome to operators and does not provide the best environmental protection. The public, the land management agencies, and the permit applicants would all benefit if the permitting process were conducted more efficiently.

Discussion

NEPA reviews and permitting are complex and time consuming because of the wide range of environmental and other issues and the numerous stakeholders with diverse priorities. The collection of some baseline environmental data requires at least a full cycle of seasons, and sometimes longer. All deserve thorough consideration. At the same time, the review and permitting processes should be completed as soon as the work can be done properly,

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eliminating delays due to inadequate stakeholder cooperation, insufficient planning, or insufficient agency staffing. An efficient process will require full disclosure of information related to a proposed operation, full public access to and participation in the process, and full cooperation of all stakeholders and agencies interested or involved in the proposed operation.

The efficiency of NEPA review and permitting is in large part a management matter. The land management agency with lead responsibility should set and achieve deadlines and have sufficient qualified staff to do so. More timely permitting will free the agency staff to better address all their other environmental responsibilities. Recommendations in this report that support more efficient reviews and permitting include Recommendations 1, 2, 6, 10, 11, and 12.

Implementation

Several of the other recommendations in this report, when implemented, will help achieve the objectives of this recommendation. Information on the time involved in recent reviews and permitting need to be compiled and analyzed to identify and correct causes of any unnecessary delays. With these actions land management agencies can set and manage to achieve reasonable goals for completion of reviews and permits while continuing to protect the environment.

SUMMARY

The above conclusions and recommendations, taken together, summarize the Committee's views of the actions needed to coordinate federal and state mine reclamation, operations, and permitting requirements and programs. Some of these will require congressional action and some will require changes in federal regulations. Still others will require changes in the implementation of existing regulations and programs. Adopting these recommendations will improve environmental protection and reclamation of hardrock mining on federal lands, as well as the efficiency of the permitting process.

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APPENDIXES

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Appendix A

The Nature of Mining

The purpose of this Appendix is to provide an introduction and basic understanding of the nature of ore deposits and various mining activities. Some environmental issues are mentioned, but a detailed discussion of potential environmental impacts of mining activities is presented in Appendix B. Appendix D includes a discussion of the directions that mining will likely take in the future, along with identification of research needs for the industry, particularly regarding environmental issues.

DESCRIPTION OF ORE DEPOSITS

Ore deposits form as variants of such geologic processes as volcanism, weathering, and sedimentation operating with an extraordinary intensity. Ore deposits typically are parts of large-scale (several miles across and perhaps just as deep) ore-forming systems in which many elements, not just those of economic interest, have been enriched. For example, arsenic, antimony, thallium, and mercury are commonly enriched in or near Carlin-type gold deposits. Explorationists continually seek to discern trace chemical haloes or geophysical patterns to combine with geological observations and concepts to recognize faint clues to the location of the ore deposit. Known ores constitute less than 1 part in 10,000 of the metal endowment of the upper 1 km of continental crust; thus, by far the largest portion of metals resides in ordinary rocks as a low-level background geochemical signature in amounts too meager for economic mining. Most ore deposits that cropped out in the lower 48 states have been discovered; new discoveries come from unrecognized extensions of known deposits or from “blind” ore bodies buried under alluvium or sedimentary or volcanic rocks. The Twin Creeks deposit near Getchell, Nevada is a good example of such an ore body. Many discoveries of ore deposits are made in or near old mining districts, in part because the same hydrothermal system that formed the high-grade, easy-to-find deposits that were previously mined commonly formed other deposits nearby (either

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laterally or deeper). The Round Mountain deposit mentioned later is an excellent example.

Many hardrock commodities are associated with magmatic and hydrothermal processes (Guilbert and Park, 1986). These processes, in turn, are associated with modern or ancient mountain belts. Mountainous or sparsely vegetated terrains, such as those in the western states, expose possibly productive rocks much more fully than do, for example, the mid-continent prairies. In addition, the West is blessed with geologic conditions, including abundant igneous rocks and associated hydrothermal systems, that have led to the formation of ore deposits. Thus, the prime prospecting ground is in land that many people regard as valuable for aesthetic reasons, which creates potential for conflict among uses of the land. Nonetheless, society requires both a healthy environment and sources of materials, many of which can be supplied only by mining.

One of the common features of most ores and the reason underlying much environmental concern is the presence of large quantities of sulfur, usually as the mineral pyrite (FeS_2), which creates the potential for environmental problems caused by acid runoff (see Sidebar 3–1 and Appendix B). A few mineral types (e.g., chromium or aluminum and placer deposits of gold, titanium, or tin) contain little sulfur and constitute minimal geochemical environmental problems. Many sulfide-bearing deposits contain abundant carbonate minerals, which buffer acid produced from the oxidation of sulfides, and many sulfide deposits that have been thoroughly oxidized by natural weathering no longer pose an acid mine drainage threat.

Many hydrothermal ore deposits have haloes of low-grade mineralization surrounding the ore. With better technologies (or higher prices) low-grade waste rock can become ore. A good example is the Round Mountain mine in Nevada (Figure A-1), where early production (350,000 ounces of gold from 1906 to 1969) was from high-grade veins mostly mined underground. From 1977 through 1997 about 4 million additional ounces were produced from a large open pit exploiting relatively low-grade disseminated mineralization in the rock surrounding the high-grade veins mined long ago; the projected eventual output will be more than 11 million ounces of gold (Tingley and Bonham, 1998), worth close to $3 billion at the current price of approximately $250/ounce.

Heap leaching has made possible the economic recovery of gold from low-grade ores. In some of today's major mining operations, grades can be lower than 0.01 ounce of gold per short ton of ore (0.3 gram of gold per metric ton of ore). Typical grades for open-pit gold mines in Nevada are about 0.07 ounce of gold per short ton of ore; underground mining is more costly and requires ores of about 0.3 ounce of gold per short ton to be profitable (Tingley and Bonham, 1998).

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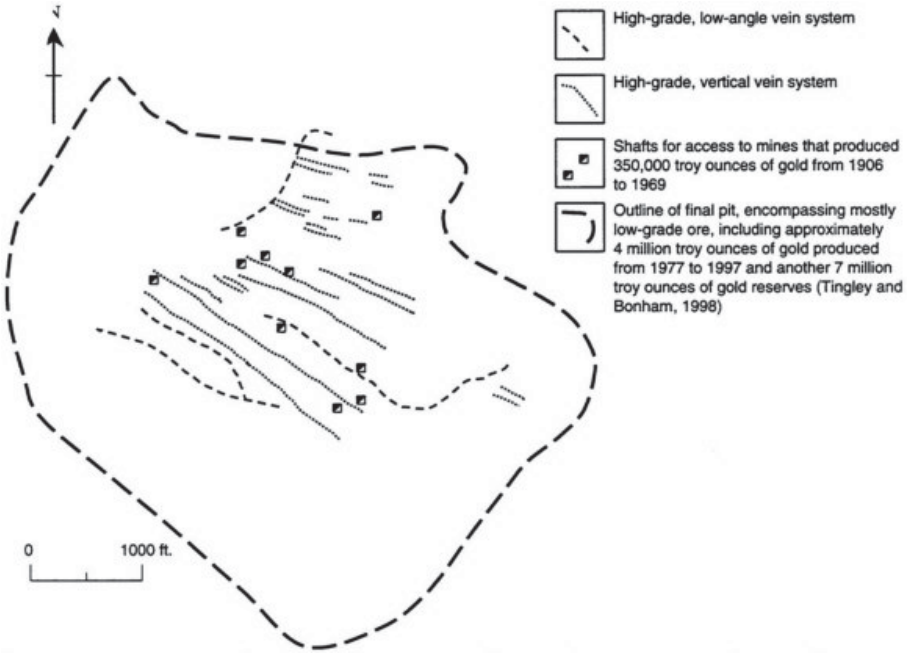


FIGURE A-1 Map view of the Round Mountain gold Mine. SOURCE: Tingley and Berger. 1985. Round Mountain Gold Corporation. 1994.

Some minerals seldom occur in sufficient quantities to be mined just for themselves. Instead they are recovered as by-products or co-products with other commodities. Examples of by-products are cadmium, indium, gallium, germanium, and thallium with lead-zinc ores and rhenium with copper-molybdenum ores. Coproducts (e.g., gold and copper in many porphyry copper deposits, lead and zinc in many deposits hosted in limestones, and silver and gold in many epithermal vein deposits) augment the value of each other and make deposits economic that might be unmineable for only one of them.

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Most metallic mineral deposits that formed by magmatic or hydrothermal processes have complex geometries that influence the selection of mining method; in contrast, most economically viable coal deposits are relatively flat-lying sedimentary rocks. Some examples are illustrated in Figure A-2. As a result, metallic mineral deposits are typically mined in a downward or vertical fashion, while coal deposits are normally mined horizontally. As stated in the COSMAR report (NRC, 1979), backfilling of large open pits for hardrock mines is generally impractical, because the irregular lateral and vertical extents of the metallic deposits normally preclude them from being strip mined as simply as coal deposits, wherein overburden and waste rock can be recycled as backfill while mining proceeds from one area to the next.

THE MINING PROCESS

The mining process consists of exploration, mine development, mining (extraction), mineral processing (beneficiation), and reclamation (for closure). The first three steps in the mining process are characterized by dramatically increasing costs.

Exploration

The primary objective of exploration is to find an economic mineral deposit. The initial step in exploration is prospecting, which is the search for indications of a mineral deposit of potential significance. The objective is to define a target that suggests the occurrence of a mineral deposit worthy of subsequent testing with one or more exploration methods. These targets frequently result from the compilation and analysis of data germane to the type of mineral occurrence sought.

Target identification may result from relatively unobtrusive and proven approaches, such as detailed surface geologic mapping, sampling of outcrops, and observation of alteration patterns. More typically, modern prospecting embraces various types of geochemical sampling, geophysical techniques, satellite remote sensing, and other sophisticated methods for identifying the often subtle expressions of deeply buried mineral deposits.

In general, the environmental impact of prospecting is minimal. Surface access to or near the prospect is the primary requirement. When exploration on federal lands indicates a valuable deposit, the prospector acquires rights, if not previously completed, to develop it by staking claims and recording them with appropriate agencies. The area required for a large mine and its facilities

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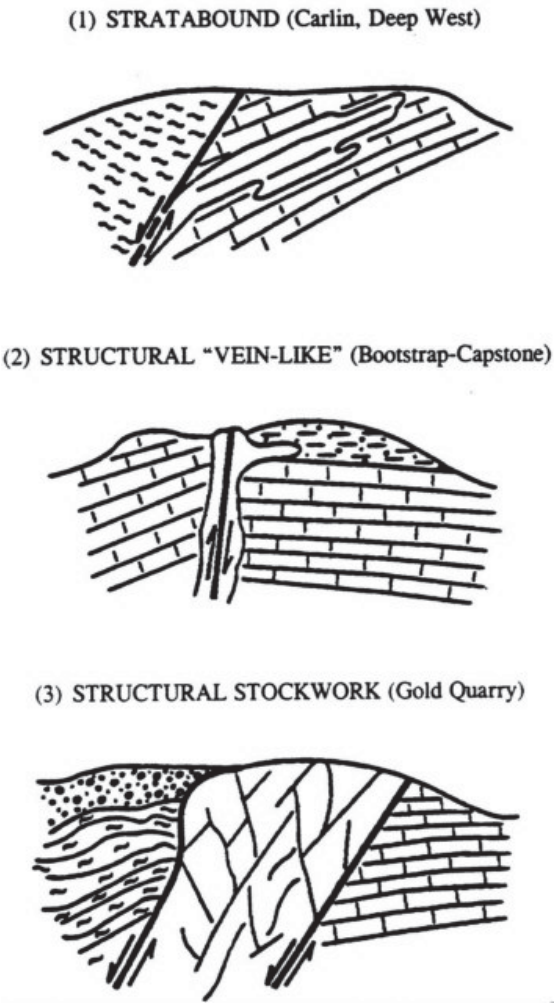


FIGURE A-2 Styles of mineralization of Carlin trend gold deposits. (Coope. 1991. p. 14).

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(e.g., waste dumps, tailings ponds) is frequently a few thousand acres. Because of intermixed ownerships, this often involves a combination of federal and private lands for a single mine.

Exploration continues with target testing. Target exploration techniques vary; however, they usually focus on confirming the presence of a deposit and delineating its size, shape, and composition. In nearly every case, the primary exploration tool is drilling. Drilling into the subsurface is performed to determine both the lateral and vertical extent of the deposit, as well as other important deposit characteristics (e.g., continuity of mineralization, grade and associated trends, mineralogical relationships and characteristics, rock types, and local hydrologic information).

Surface disturbance resulting from exploration activities increases as these programs progress from preliminary to detailed. Most surface disturbance results from the construction of access roads and drill sites. The spacing or distance between drill sites is site-specific, but may be 100 feet or less in some geologic situations. Wider drill spacings may be acceptable for predicting mineral continuity and for deposits that are reasonably well understood and exhibit predictable results over greater intervals. Closer drill spacing is required for other types of deposits containing more variable or erratic mineralization. Surface disturbance also may result from trenching activities across zones of mineralization or from the collection of a larger bulk sample for metallurgical testing.

The subsurface environment also may be affected by the drilling program, although the effects are usually minor due to the use of practices such as sealing holes and the proper disposal of drill cuttings. A more significant subsurface impact is often that associated with the collection of a large bulk sample at depth for metallurgical testing.

In contrast with most other industries, hardrock mining has few alternatives relative to location, because economic occurrences of minerals are geologically and geographically scarce. Only a very small portion of Earth's continental areas, certainly less than .01%, contains the economic portion of its non-fuel mineral endowment. Thus, one cannot arbitrarily decide to build a mine here or there, but rather one must discover and mine those few places where nature has hidden its minerals (see Sidebar 1–4).

Over the last century and a half the western lands owned or formerly owned by the federal government have yielded metals worth hundreds of billions of dollars at today's prices. These lands continue to be major producers of gold (Figure A-3) and many other mineral resources. The U.S. Geological Survey estimates that many new deposits remain to be discovered (U.S. Geological Survey, 1999), but they will be deeper and more costly to find and extract.

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Mine Development

When a deposit identified and defined from the exploration program has been judged economic and the required permits have been obtained, the next activity is mine development to prepare the deposit for extraction or mining. Infrastructure (e.g., power, roads, and water) is put in place throughout the mine and physical facilities. Planning and construction of support facilities (e.g., offices, maintenance shops, fuel bays, and materials handling systems) and the mineral processing facility is completed. Surface locations are delineated and prepared for waste or overburden material placement, heap leach piles (the chemical leaching of low-grade ores), stockpiles, tailings impoundments, and so on.

Near-surface deposits in open-pit mines are prepared initially for production by removing the overlying waste material or overburden for placement at surface waste dumps. These dumps are engineered structures that continue to grow both laterally and vertically until mining ceases; occasionally it may be possible to return waste to exhausted portions of the pit as mining progresses. Deeper deposits designed for underground mining are developed initially by gaining access to the mineralization through vertical or inclined shafts or horizontal adits. Underground drifts, crosscuts, raises, and ramps are excavated to provide the access needed to mine the ore.

At this stage in the mining process the nature of the environmental impacts is different and their magnitude is greater than those associated with exploration activities. The footprint of the mining operation is essentially defined at this point.

Mining (Extraction)

As mine development nears completion, there is a transition to the mining component, which refers to extraction of the in-place mineralized material, as well as associated waste rock as the mine becomes deeper and grows laterally.

Even though every ore deposit is different, generalizations can be made about the basic functioning of mining. Whether an ore deposit is mined by surface (open pit) or underground, most mines use the same basic operations:

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Hardrock Mining on Federal Lands
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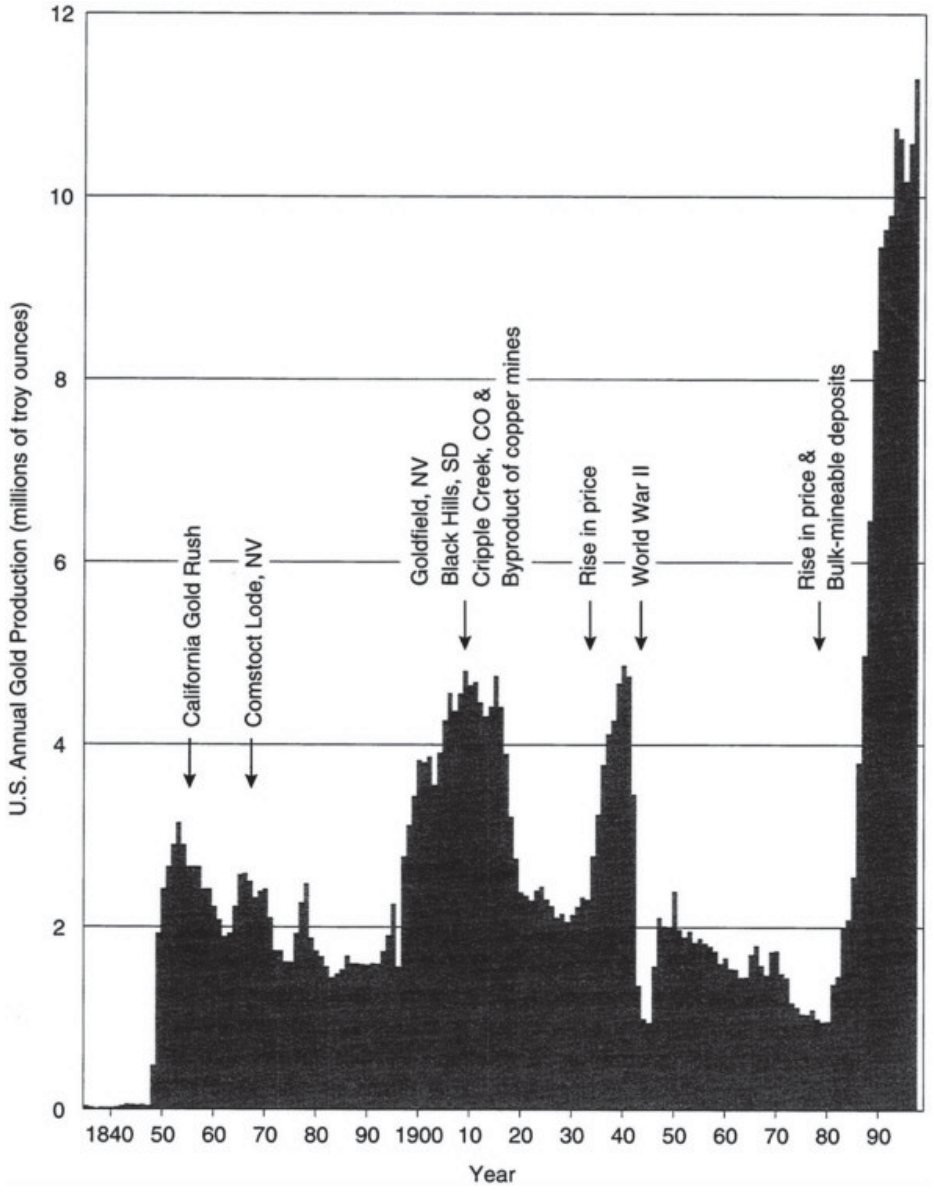


FIGURE A-3 Historic gold production in the United States Modified from Dobra, 1999.

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drilling, blasting, mucking (loading), and transporting (hauling). At times a fifth operation of extending services, supplies, and ground control is needed.

Drilling and blasting refer to the drilling of holes for placement of explosive materials and detonation of the explosives contained in the drill holes. After blasting, the fragmented rock (muck) is typically loaded into some form of transportation system, in which it begins its journey to the mineral processing facility.

As mining progresses, open pits are excavated on the surface or a maze of underground openings or voids are created where the in-place ore was removed. In some cases, these relatively large underground voids (slopes) in the deposits may be backfilled with waste material, either for convenience or to enhance structural support, provide safety, or improve ore recovery.

Continued mining activities necessarily result in larger mines, along with growing waste dumps, heap leach piles, tailings ponds, etc. Many of the environmental impacts become obvious as one scans the surface; other impacts (i.e., impacts on the associated hydrologic regime) are more subtle and perhaps not so apparent.

Placer mining, in which gold is extracted from stream or beach sediments by gravity separation, is different from typical hardrock mining and mineral processing in several respects. Two types of placer mining are common on federal lands: (1) mining with mechanized earth-moving equipment and (2) suction dredging in streams. Placer mining with mechanized earth-moving equipment typically involves relocating a short (on the order of 2,000 feet) stretch of a stream, removal of the vegetative mat or soil, mining of gravels, removal of gold with sluices that separate dense from light minerals, and reclamation by replacement of gravel and the vegetative mat or soil.

Suction dredging is a technique that uses a pump to suction sediment from the stream bottom and process it in a floating sluice. Suction dredges can be small enough to be “recreational” one-person operations. States regulate mechanized placer mining both with suction dredges and with earth-moving equipment. The practice of hydraulic mining, wherein massive jets of water erode mineral-bearing gravels and wash them through an extraction facility, is practiced in a few places in the United States today, and these operations must comply with state and federal water quality discharge requirements.

Mineral Processing (Beneficiation)

Mineral processing, or beneficiation, consists of upgrading or concentrating the ore material before the concentrate is transported to a smelter or refinery. It begins by crushing and grinding the ore into small particles, thereby releasing interlocked ore grains from each other and from waste mineral

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grains. These particles are then subjected to various physical or chemical processes to separate and concentrate the valuable minerals from the unwanted waste and deleterious substances in the ore. Separation is designed specifically to take advantage of the unique physical or chemical properties of the valuable mineral(s). In many instances, various chemicals and reagents are used in the separation process.

Most notably with certain copper ores, metal can be produced on site directly through treatment of the ores by a process called solvent extraction/electrowinning. This process avoids the need to produce a concentrate prior to smelting.

The waste or unwanted minerals (tailings) separated from the valuable minerals, now in concentrated form, are routinely disposed of in a tailings pond near the mine site; the associated water is typically recycled, treated, and used in subsequent mining or processing activities. Tailings generally contain small amounts of the valuable mineral(s) not completely recovered during beneficiation; some unwanted or undesirable deleterious minerals; waste rock minerals; and some of the chemicals that may have been used in the course of the separation process. Underground mines may use these tailings to backfill mining-created underground voids.

Leaching is an increasingly common alternative extraction practice, almost universally applied (as cyanide solution) to the ore mined from some gold mines and (as ferric sulfate/sulfuric acid solution) to low-grade copper ore. In heap leaching, run-of-mine ore can be leached without crushing, or it is crushed only fine enough to allow the lixiviant (leaching solution) access to most of the mineral grains. The solution percolates through the piled ore, and the pregnant solutions are pumped to a processing facility for extraction. Then the fluids are treated and recycled. In some cases, uranium ores are leached *in situ* without mineralized material being removed or mined in a conventional manner (see following section on the uranium industry). While tailings dams and ponds and leach pads are carefully designed to high standards, the potential impacts resulting from release or discharge of tailings, leached rock, or pregnant leach solutions can be substantial.

Reclamation

Reclamation returns the mining and processing site to beneficial use after mining. A mine should not be closed until reclamation is complete, but as discussed extensively in this report, in some circumstances reclamation may never be fully accomplished, and long-term monitoring will be necessary.

Some common reclamation practices include lessening the slopes on the edges of waste rock dumps and heaps (to minimize erosion); capping these

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piles and tailings piles with soil; planting grasses or other plants that will benefit wildlife or grazing stock and help prevent erosion; directing water flow with French drains and other means to minimize the contact of meteoric water with potentially acid-generating sulfides in the waste rock dumps, heaps, and tailings piles; removing buildings; and eliminating roads to minimize unnecessary future entry by vehicles.

THE URANIUM INDUSTRY

The General Mining Law of 1872 classifies uranium as a hardrock mineral. Because special provisions apply to uranium, a brief discussion of regulatory issues related to uranium mining is given in this appendix. During the uranium "rush" of the 1950s and 1960s, a large number of mining claims were staked, and many uranium mines were developed on federal lands in Utah, Colorado, Wyoming, and other western states. However, because of the low price of uranium in the late 1990s, few uranium mines remain operating in the United States, primarily on BLM, private, and Indian lands. The need for uranium, principally as a fuel for commercial power plants that generate approximately 20% of U.S. electric power, is increasingly being met by imports. Uranium is also recovered as a by-product of other mineral mining activities, such as the production of phosphoric acid (from phosphate rock). In the United States uranium is also recovered from a variety of low-grade uranium-bearing rocks, from the mineral wastes of various processing facilities, and from groundwater that issues from an abandoned underground mine in New Mexico.

According to the EPA (1993), approximately 4 billion tons of mine-related wastes have been generated from surface and underground uranium mines. From the 1970s through the early 1990s open-pit mining produced almost 90% of that waste. According to the EPA, of the more than 1,300 open-pit uranium mines that have operated in the United States, most have been small, with only about 300 having a total ore production of more than 900 metric tons.

The Nuclear Regulatory Commission regulates uranium processing on public and private lands. It does not regulate uranium mining by traditional mechanical methods, but it does regulate *in situ* solution mining, because that extraction method is considered a form of processing. Traditional uranium ore mining is regulated by the usual federal and state agencies. Uranium mill tailings are regulated under the Uranium Mill Tailings Radiation Control Act (UMTRCA), which mandates special closure designs for uranium mill tailings ponds to prevent unacceptable release of radon gas to the environment.

Currently, there are only a few small underground uranium mines, and no active open-pit mines, operating in Colorado and Utah. Since the mid-1970s, *in situ* solution mining has been a commercially viable method for extracting

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uranium from subsurface ore bodies in porous sandstone. *In situ* uranium mining involves the injection through a borehole of an alkaline, oxidizing leaching agent (lixiviant) into the uranium-bearing sandstone at depth. The uranium is recovered, through production wells adjacent to the injection wells, from the pregnant lixiviant by passing the solution through ion-exchange columns; afterwards, the solution is chemically reconstituted and re-injected into the subsurface. The lixiviant consists of an aqueous solution of sodium carbonate-bicarbonate and/or carbon dioxide, and oxygen.

In situ mining occurs in Wyoming, Texas, and Nebraska. As mentioned earlier, the Nuclear Regulatory Commission is involved in the permitting and regulation of *in situ* uranium mines because the leaching of the ore is considered a form of chemical processing. The injection wells are considered by the EPA to be Class 3 underground injection wells, subject to regulation in the Underground Injection Control Program (40 CFR 143–147). Industry personnel report a significant degree of overlap between the regulatory requirements of the Nuclear Regulatory Commission and the EPA for injection wells. Several states have primacy over the Nuclear Regulatory Commission and the EPA for regulating radiation issues and underground injection.

The primary risk associated with *in situ* uranium mining is the potential for contamination of adjacent groundwater. If the system of injection and production wells is not properly designed and constructed, the pregnant lixiviant may escape into the sandstone aquifer, carrying with it dissolved uranium and radium. Small amounts of several trace metals are also present in the lixiviant, including lead, selenium, molybdenum, and arsenic. The requirements of the Underground Injection Control Program include restoration of the aquifer after completion of *in situ* mining. *In situ* mining also has been applied to other metals, especially copper, but not to the extent it has been used for uranium extraction.

Reclamation of uranium mines includes the typical steps considered at most other mine sites. Waste rock piles are regraded and revegetated, with the major objectives usually being control of erosion, physical stability, and restoration of the land for such uses as grazing and wildlife habitat. Open pits are evaluated relative to the physical stability of high walls and land use objectives, including pit lake water quality. Depending on the situation, the reclamation of a uranium mine may also include radiation-specific objectives. For example, reclamation of the large Jackpile mine in New Mexico used objectives for radiation control similar to the mill tailings program. At the Jackpile mine, a cover was constructed to limit the radiation exposure from the waste rock piles. Overburden enriched in uranium was placed in the bottom of the mine pit prior to backfilling. This selective burial of higher-grade overburden is consistent with reclamation practices used elsewhere, as in the

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Wyoming and Texas abandoned mines reclamation programs (under the Wyoming Environmental Quality Act of 1973 and the Texas Surface Mining Act of 1975).

Most western states have regulations requiring the submission of a reclamation plan and bond prior to the issuance of a mining permit. Although these programs are not designed to mitigate potential radiological risks, such measures do reduce potential exposure to direct radiation, radon gas, fugitive dust emissions, and the possibility that waste materials will be removed and put to other uses, such as construction.

Many mines developed prior to implementation of regulations requiring reclamation are not yet reclaimed. Finally, there are examples of uranium mine reclamation in Superfund environments that follow the very stringent guidelines for reclamation specified in the UMTRCA.

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Appendix B

Potential Environmental Impacts of Hardrock Mining

INTRODUCTION

From exploration through post-closure, hardrock mining has the potential to cause environmental impacts. In addition to the obvious disturbance of the land surface, mining may affect, to varying degrees, groundwater, surface water, aquatic and terrestrial vegetation, wildlife, soils, air, and cultural resources. Actions based on environmental regulations may avoid, limit, control, or offset many of these potential impacts, but mining will, to some degree, always alter landscapes and environmental resources. Regulations intended to control and manage these alterations of the landscape in an acceptable way are in place and are continually updated as new technologies are developed to improve mineral extraction, to reclaim mined lands, and to limit environmental impacts.

Some past mining practices have undeniably led to many of the potential impacts discussed in this appendix, and specific references are provided to describe the impacts in more detail where available. Although the committee was not successful in obtaining much information on recent environmental impacts at hardrock mine sites, the following three examples were obtained from a variety of sources, as listed below.

- Cyanide from a mine in Idaho was found to be contaminating a salmon stream in early 1999 (Idaho Division of Environmental Quality, May 21, 1999 News Release). The mine in question is currently in temporary shut down because the ore reserves were lower than expected. Cyanide was detected in routine quarterly monitoring conducted by company personnel, and the source of contamination is believed to be a lined tailings impoundment (personal communication, Nick Ceto, EPA Region 10).
- The Colorado Department of Public Health and Environment (CDPHE), Water Quality Control Division issued a notice of violation and cease and desist order for a gold mine that operated from 1989 until 1996 and is now in closure (notice of violation dated August 20, 1999, CDPHE).

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The cause of the issuance was the discharge of manganese and sulfate that are leaching from backfill materials to a nearby creek through groundwater flow.

- The South Dakota Department of Environment and Natural Resources (DENR) issued a notice of violation and order for compliance to a gold mine for violation of the South Dakota Water Pollution Control Act (notice of violation, dated September 5, 1998, South Dakota DENR). The mine was found to be discharging effluent into streams in excess of permit levels for cadmium, copper, zinc, and total suspended solids, and its discharge failed a portion of the acute whole effluent toxicity test. Permit levels were exceeded once in 1996, twice in 1997, and nine times in 1998. In addition, the company failed to conduct daily monitoring of its effluent after the June 1998 violations and failed to promptly send samples for analysis, resulting in exceedance of holding times, both of which also constituted violations of its permit.

As discussed above, these examples are not necessarily representative of environmental impacts at all modem mines, but they do indicate that environmental impacts from some hardrock mining operations continue to exist under current regulatory conditions. However, the full extent of environmental problems at modern mine sites will not be known until better information on hardrock mine sites is collected and analyzed, as discussed in Chapter 3.

The Committee addresses the issue of mining-related impacts by presenting a discussion of the environmental impacts that have occurred, and that may still occur in some cases, even with regulations in place. It must be emphasized that these potential impacts will not necessarily occur, and when they do, they will not occur with the same intensity in all cases. Many of the impacts discussed in this appendix would violate current regulatory requirements and standards and would be subject to enforcement actions. Nevertheless, because some impacts continue, an understanding of the potential for mining to cause environmental impacts is essential to assessing and improving the regulation of hardrock mining on Federal lands.

CUMULATIVE EFFECTS

The environmental impacts of a single mining operation are broadly proportional to the size of the mine, although these vary depending on:

- the character of the mineral body and surrounding rock;
- the character of the environment directly and indirectly affected by mining;

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- the character of the surrounding human environment;
- the nature of the mining operation; and
- the extent and effectiveness of actions to ameliorate the environmental impacts of mining.

Although a single mining operation creates its own set and degree of environmental impacts, a regional concentration of mines poses problems of cumulative impacts. For example, the number of gold mines along the Carlin Trend in Nevada and copper mines in the Miami and Globe area of Arizona poses environmental issues that can be addressed only if adequate consideration is given to their combined effects, along with those of other activities such as agriculture and timbering.

For example, groundwater withdrawal at a single mine has the potential to create a deep cone of depression in the local aquifer. As this cone expands over time, it may join those created by neighboring mines and lower the regional water table, which in turn may decrease or terminate flow in streams and springs some distance from the mines. Other regional uses of groundwater, such as agriculture and urbanization, contribute to the cumulative effects on the water table, but no one activity is fully responsible for this impact.

Similarly, potentially contaminated drainage or leachate from waste rock dumps, heap leach pads, or tailings ponds at a single mine may not be sufficient to lower stream water quality below acceptable concentration levels. But, when combined with discharges from neighboring mines and other contaminant sources, such as urban runoff and agriculture, the cumulative effects, especially in the semi-arid conditions of much of the West, has the potential to produce unacceptably high mass loadings.

In the Carlin Trend in Nevada, the Humboldt River receives discharged groundwater from the dewatering activites of several mines. Because the river ends in a closed-basin playa (Humboldt sink), the cumulative impacts of these discharges, along with highly contaminated irrigation return flows, have the potential to affect biota and water quality in this evaporative system. In addition, sediments and periphyton in the Humboldt River can concentrate constituents such as metals and metalloids over time and adversely affect macroinvertebrates. The USGS, the Forest Service, and other agencies are currently studying some of the cumulative impacts in the Humboldt River system.

Another example of cumulative impacts involves placer mining and suction dredging operations, which disturb streambeds and produce suspended sediments. The disturbed sediment usually settles out a short distance downstream if the activity is properly timed and controlled. However, there has been little evaluation of the cumulative impacts of sequential sediment dredges or placer mines.

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Other issues involving cumulative impacts include the potential for contamination of groundwater aquifers, fugitive dust and air pollution from tailings and road surfaces, smelter emissions, and landscape degradation from large mine operations in the same general area. While most of the possible environmental effects of mining discussed in the following sections are in the context of individual mine operations, the potential for cumulative impacts also should be considered.

LONG-TERM MONITORING

Monitoring of environmental conditions and responses to human activities is needed to measure changes in the environment and to determine the effectiveness of mitigation procedures. There are different types of, or reasons for, monitoring (MacDonald et al., 1994):

- trend monitoring to measure changes in environmental parameters of interest (e.g., water quality components);
- baseline monitoring to characterize conditions prior to any action;
- implementation monitoring to assess whether an action was carried out as planned;
- effectiveness monitoring to determine whether a planned activity had the desired effect;
- project monitoring to assess the impact of an activity on an environmental component of concern (e.g., mining on water quality or stream biota);
- validation monitoring to validate particular predictive models used for planning (e.g., pit lake models); and
- compliance monitoring, to determine whether certain environmental criteria are being met (e.g., metal or pH standards in water).

Each of these types of monitoring may be applicable to the various stages of mining from exploration, through development and extraction, to closure, reclamation and post-closure. Baseline monitoring is essential to establish conditions prior to any mining activity and to provide the conditions against which future monitoring data can be compared. Monitoring during mining should address the implementation and effectiveness of environmental controls and compliance with regulations. Of equal concern is long-term monitoring to evaluate environmental protection during post-closure conditions and to validate predictive models.

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Monitoring to address the effectiveness of mine closure activities and to validate predictive models related to closure must be long term for several reasons. First, conditions created during active mining operations might not lead to environmental impacts until after closure. This is especially true for water quality conditions, such as acid generation and migration of leachate from mine wastes to groundwater or surface water. Second, although design of post-closure conditions may have been based on best available information and technologies, unexpected events can alter future environmental conditions. The best available technologies may not have been sufficient to address, for example, long-term (decadal) changes in climatic patterns that may alter amounts and timing of precipitation events that influence the effectiveness of soil covers placed on heap leach pads and waste rock piles. In addition, post-closure use of these surfaces by recreationists, cattle, or other disturbances may be greater than expected, resulting in unanticipated erosion and releases from these closed areas. Third, predictive models used to design or plan closure procedures must be tested through monitoring to determine their accuracy. For example, the lack of robustness of pit lake models may lead to uncertainty about future conditions of surface and groundwater quality and quantity. Fourth, models designed to predict long-term responses of local and regional environmental parameters to post-closure conditions may be site specific and ignore the cumulative effects of other activities in the area, as discussed above.

Finally, monitoring to test predictions, calibrate models, and follow long-term trends of resources, such as groundwater levels and stream flows and chemistry, will produce information that is useful to researchers developing long-term predictive models. For this reason, long-term monitoring must be properly designed to measure those attributes that offer useful data on changes and/or sustainability of resources affected by mining activity and post-closure conditions.

WATER QUALITY

If not mitigated through regulation and prevention strategies, hardrock mining can have long-term impacts on water quality, which are defined in the Clean Water Act to include not only chemical but also biological and physical attributes. The water quality issues discussed below include metals and cyanide, acid drainage, pit lakes, and placer mining. Each of these issues also can have long-term impacts on water chemistry, aquatic biota, and aquatic habitat.

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Metals and Cyanide

Hardrock mining of metalliferous deposits has the potential to release to the environment metals, metalloids (e.g., arsenic, antimony, selenium), sulfate, acid drainage, cyanide, nitrate, suspended solids, and other chemicals used in mining processes. These constituents are often present in waste rock, tailings, other mine waste materials, pit walls, and pregnant and barren solution ponds. Once the waste materials come in contact with water, the contaminants can be chemically leached and/or physically mobilized from the waste sources and transported downgradient to groundwater and surface water. Sediments and down-gradient soils may become contaminated and act as a secondary source of contamination to surface water and groundwater. Unless the waste materials are removed or effectively isolated from the environment by capping and/or lining, releases of contaminants, especially metals, can continue for long periods of time.

Some of these contaminants, such as cyanide in surface water and surface impoundments, nitrate, and sulfate, can be broken down or transformed into relatively innocuous constituents through microbial activity or photolytic reactions. The fate of cyanide and metal-cyanide complexes in groundwater is less well understood. The impact of metals and metalloids to down-gradient or downstream waters may be minimized by adsorption onto soils and sediment, precipitation of solid compounds, or dilution by groundwater or surface water. However, unlike many organic compounds, metals cannot be transformed to other compounds. Metals and metalloids can be transformed from one aqueous species to another or from one environmental medium to another, but metals are not lost through biogeochemical transformations. It is this lack of degradation that renders metals a long-term water quality concern.

Acid Drainage

Acid drainage that contains metals is another potential long-term water quality issue at some mine sites. The nature of the acid drainage reaction is such that it is difficult to stop the production of acid once it has begun. Lead mines that were operating at the time of the Roman Empire are still producing acid drainage 2,000 years later. In addition, acid drainage may take years to form or become a water quality concern. Although the factors that create acid drainage and that may minimize its impacts are well understood, there is little long-term monitoring data to use in predicting the extent of acid drainage at a given mine site. If a laboratory test shows that acid drainage will be produced, it is even more difficult to predict when it will start, how acidic it will be, or how high the metal concentrations will be. Predictability issues associated with acid drainage are

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discussed in the following section in Appendix D (see "Water Quality" in Appendix D).

Carbonate-bearing waste rock or tailings can produce drainage with an alkaline or near-neutral pH, but it will still contain elevated concentrations of components such as cadmium, zinc, manganese, arsenic, molybdenum, and selenium. Iron may or may not be elevated in circumneutral drainage water, depending on the oxidation state of the water.

Methods for prevention of acid drainage fall into two categories, those that prevent the acid generation from occurring and those that treat the acid generation at the source so that no drainage occurs. Although the latter is technically a treatment method, it stops the acid from draining and is different enough from the typical collect-and-treat methods to be considered here an acid drainage prevention method.

The most widely used methods for preventing acid generation include capping and sealing acid-generating rock to prevent air and water from reaching the rock. Such capping will require long-term maintenance to ensure that erosion, animal burrows, or other activities do not compromise the integrity of the cap. A variation on this method used in drier climates is to provide a less effective cap and a good vegetative cover, which will allow evapotranspiration of most of the water infiltrating into the pile. While not 100% effective in stopping water, such a cover may provide enough of a barrier to minimize the acid generation to levels that will not be detectable in ground or surface waters. Another variation on capping, which is practiced widely outside the United States, is burial of acid-generating materials in water to prevent the contact with air that is necessary to start the process. This is accomplished by placing the waste in a body of water, or by covering the top of a tailings pond with water once tailings deposition is completed. Some mines both in and outside the United States place potentially acid-generating materials into pits that are expected to fill with water. Once the pit lake is formed, the material no longer is exposed to air. To remain effective, water must always be over the material; this therefore requires long-term maintenance.

There are also specially developed chemical additives that, when applied to waste rock or spent ore piles prevent acid generation (for example, phosphate and surfactants.) Many of these additives are new and have not been studied for long-term effectiveness. These additives also can be expensive when used to cover a large area.

Certain types of recovery processes make it cost effective to separate the potentially acid-generating constituents in the ore from the rest of the ore. These methods concentrate the metals and sulfides, but render the majority of the ore benign and available for easy disposal. The concentrated material, which would have potentially more severe environmental impacts, can then be treated more cost effectively than the larger volume of spent ore material.

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The most common method for treating in place to prevent acid drainage is to mix the acid-generating materials with a neutralizing material such as lime. The materials can be layered with lime or physically mixed together before or after disposal. The neutralizing material must be placed in ratios high enough to counteract all the acid-generating potential of the other material. The long-term effectiveness of this type of mixing is not known, and the relative rates of exhaustion of acid generation and neutralization have not been well studied.

Pit Lakes

Pit lakes have the potential to create long-term impacts on the environment that include major surface disturbances and alterations of pre-mining water quality and quantity. If water in a pit lake is contaminated and does flow to down-gradient groundwater and possibly to surface water, the impact of pit water on down-gradient waters will be another long-term water quality issue. Even if pit water does not flow down gradient, the concentration of metals, other contaminants, and salinity in the pit through evaporation may become a long-term water quality issue, especially for migratory birds and terrestrial wildlife. For example, waters of the Berkeley pit in Butte, Montana, were lethal to migrating snow geese that used the lake as a stopover in 1995 (Hagler Bailly Consulting, Inc., 1996). Most states are just beginning to establish water quality standards or designated uses for pit lakes. Standards that are established should be protective of designated uses, such as use by wildlife and migratory birds. The scientific basis for establishment of water quality standards for protection of wildlife and migratory birds needs more research. Predictability issues associated with pit lakes are discussed in Appendix D.

Surplus Water Discharge

Groundwater withdrawn to dewater pits is often discharged into local streams and drainages. These waters have the potential to be higher in total dissolved salts, metals, and other chemicals than the streams into which they are discharged. Although the normal flow of the stream may dilute these chemicals, they may become concentrated in stream sediments and periphyton, which can adversely affect some aquatic biota. Over the long term, this problem can become more serious if the stream ends in an evaporative sink that allows the contaminants to accumulate in the water column and sediments, which provide habitat and food for waterfowl and migratory birds.

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Road Construction

Road construction during several phases of mineral exploration and extraction may disturb the soil surface sufficiently to create an excess of loose sediment that is carried off the site into local streams. Sediment may also be eroded from waste rock piles and may be carried by storm events down gradient into stream channels. The amount of sediment entering streams is a function of the quality of the road construction, the closeness of the streams, the types of hydrological events in the region that drive sediment transport, and the effectiveness of the erosion control measures employed.

Contamination from Railroads

Railroad beds constructed in mining areas may have been composed of mine wastes. This results in the placement of mine wastes over a greater area than normally anticipated in a mine operation. Railroads commonly have been located in valley bottoms where there is less topographic variability. Consequently, railroad beds historically have been placed adjacent to rivers. Storm events may leach chemicals out of the railroad beds into the streams or adjacent drainages. Occasional spills from rail cars carrying toxic materials may also contaminate surface waters.

WATER QUANTITY

Minewater Discharge to Streams

Surplus water accumulated from mine dewatering is, in some cases, discharged into nearby streams. The timing and amount of discharge has the potential to affect the down-gradient riverine ecosystem. Riparian vegetation has evolved to disperse seed, and recruit young plants on the declining limb of spring floods. If surplus water discharge occurs after this period, young plants established in the spring will be inundated and lost. Surplus flows also may erode or straighten stream channels, reducing availability of natural sandbar recruitment sites for riparian vegetation (Stromberg and Patten, 1992). Increased velocity of surplus flows also may dislodge aquatic biota such as attached macroinvertebrates, or disrupt fish habitat. For example, alteration of flows from mine water discharge could increase turbidity in streams and cause increases in embeddedness of gravels used for spawning.

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Groundwater Withdrawal

Groundwater withdrawal for mineral processing and to prevent filling of open pits and underground excavations has the potential to affect local and regional groundwater quantities and levels. In the former case, much of the water used is kept on site, while in the latter the excess water may be temporarily stored in impoundments but eventually may be discharged into local streams. In both cases, groundwater withdrawal may affect the local water table. For example, groundwater withdrawn from the Santa Cruz River Basin in southern Arizona for mineral processing at a nearby copper mine is lowering the water table by many meters, and is drying up the river. The impact on riparian vegetation is significant (Patten et al., 1994). A groundwater pump test at several hundred feet of depth for a new copper mine in Arizona was shown to alter surface flows of a small perennial stream by 75 acre ft/year (a significant reduction for the size of the stream) through lowering of the shallow alluvial water table that supported surface flows (Carlota Mine EIS). This evidence of impacts of groundwater withdrawal on surface flows can be extended to the potential of surface flow declines resulting from groundwater withdrawal for pit dewatering. Of greater concern are the potential cumulative effects of dewatering wells and groundwater wells for processing associated with several neighboring mines. The cones of depression in the deep aquifer resulting from groundwater withdrawal may coalesce and affect regional spring and stream flows that are dependent on the aquifer. Models of potential effects of groundwater withdrawal from deep aquifers in Nevada show that the decline in the shallow basin-fill aquifer and regional water table may be delayed for several decades following initiation of groundwater pumping (Schaefer and Harrill, 1995). The delay is partly due to the time taken to dewater a large regional aquifer.

Pit Lake Interception of Groundwater

While groundwater is withdrawn to prevent filling of the mineral extraction pits, abandonment of the pits may create lakes that have the potential to affect the local shallow aquifer. If the pit is excavated on sloping terrain, the shallow aquifer may be intercepted on the upper edge of the pit and its water may drain. The shallow aquifer is interrupted and little or no flow will continue into the aquifer downslope of the pit depending on the local head of the deeper aquifer. Water input to the pit lake from the shallow aquifer may eventually interact with a deeper aquifer at lower levels in the lake. The hydrological balance among these entities, the pit lake and the shallow and deeper aquifer, is not well understood (see “Pit Lake Water Quality” in Appendix D).

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Runoff from Hardened Surfaces

Construction of roads, parking lots, buildings, and the like reduces the amount of absorption surface in the mining area. Similar to an urbanized area, a mine area has the potential to produce more runoff to nearby streams than would be expected without alteration of the ground surface. The runoff may carry contaminants, for example, oils from vehicles and sediment from the roads or roadside areas, but perhaps the greatest concern is the acceleration of runoff during storms and a reduction in moisture percolating into the ground. This has the potential to affect stream hydrological functions, to change sediment transport characteristics, and to alter instream habitat for fish and other aquatic organisms.

AQUATIC BIOTA

Aquatic Biota Response to Metals and Cyanide

Most metals and cyanide are toxic to aquatic life (e.g., fish, macroinvertebrates) at low concentrations (Borgmann and Ralph, 1984; Sorenson, 1991; Marr et al., 1995a,b, 1996). Aquatic life criteria are designed to protect aquatic life from such impacts as death and reproductive and growth disorders. For example, at 100 mg/l hardness, the chronic (long-term) aquatic life criteria for dissolved cadmium and copper are 2.24 and 8.96 mg/l, respectively. At lower hardness values typical of mountain streams, the criteria are even lower. For example, at a hardness of 25 mg/l as $CaCO_3$, which is typical of a number of mountain streams, the chronic criteria for dissolved cadmium and copper are 0.18 and 2.74 mg/l, respectively (EPA, 1996). Very low concentrations of metals, even below the chronic criteria, may cause fish to avoid certain waters and impair their growth (DeLonay et al., 1995; Marr et al., 1996). This is an issue for anadromous (migrating from fresh to salt water) fishes such as certain threatened and endangered salmonids, which may avoid streams with low metal concentrations, resulting in the elimination of that species from the watershed. The presence of natural organic acid can decrease or delay the toxicity of metals to aquatic biota (Playle et al., 1993; Azenha et al., 1995; MacRae et al., in press; Marr et al., 1999). Although there are no specific aquatic life standards or criteria for aquatic sediments, macroinvertebrates, which serve as food for fish, live in sediments and eat periphyton (algae) that coat rocks in streams. Both sediments and periphyton often contain metals at concentrations many times higher than their concentration in overlying surface water. The impact of metals from mining activities on macroinvertebrates has been shown in a number of studies (Clements et al., 1988; Kiffney and Clements, 1993; Nelson and Roline, 1993; Clements, 1994; Kiffney and Clements, 1996a,b; Beltman et al., 1999). When water quality

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in streams containing acid drainage and metals from mining activity is improved, macroinvertebrate communities have been shown to recover (Nelson and Roline, 1996). Metal- or acid-rich groundwaters can also contaminate surface waters.

Aquatic Biota Response to Acid Drainage

If acid drainage enters surface water, metals in the drainage will have the same types of effects discussed above under metals and cyanide. Fresh water biota also have certain pH requirements, usually between pH 6.5 and 9 (EPA, 1985), and acid conditions can cause adverse conditions for fish (Bolis et al., 1984). Metals in acid drainage, after being diluted downstream by higher pH waters, can be precipitated out of solution and can coat streambed material with an iron-rich and heavy metal-rich cement. The cement can impair streambed habitat for fish and macroinvertebrates by physically embedding gravels. When the spaces between gravels are embedded with fine-grained sediment or floc, egg survival is threatened by a lack of oxygen. Higher hardness and alkalinity can decrease toxic responses of aquatic biota to metals (Brown et al., 1974; Howarth and Sprague, 1978; Chakoumakos et al., 1979; Lauren and MacDonald, 1986; Erickson et al., 1996). Mine drainage water may have higher hardness values than nearby surface waters because of increased leaching of silicates and other materials in the rocks, efflorescent salts, and calcium- and magnesium-containing solids, but the low pH values of acid drainage almost always result in lower alkalinity values.

Impact of Placer Mining and Suction Dredging on Aquatic Biota

Placer (mechanized) mining in active streams and suction dredge mining disturb to some degree streambed sediments, which provide habitat for macroinvertebrates and spawning habitat for salmonids (redds). Fine-grained sediment, if disturbed by placer operations, may move downstream and cause damage to spawning grounds for fish or to benthic biota. If flows are high enough, and there is sufficient sediment upstream, the streambed may return to near its original characteristics after springtime high flows. Depending on the degree of disturbance during low-precipitation years, the streambed may remain unsuitable for aquatic life habitat until high flows return it more to its original characteristics. The U.S. Geological Survey is investigating the environmental impact of suction dredge mining on turbidity and metal concentrations in an Alaskan river (Wanty et al., 1997; Gough et al., 1997). Studies on the impact of suction dredge and mechanized placer mining on macroinvertebrate and spawning habitat should also be conducted.

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LANDSCAPE OR ECOSYSTEM ALTERATIONS

While many active mines have been developed around existing or historic mining sites, new mineral discoveries may also occur in remote, roadless, mountainous country where human activity has caused little disruption of these relatively pristine ecosystems. Early exploratory surveying by qualified geologists has no more impact on these remote areas than geological mapping or casual recreation. However, exploration activities designed to evaluate a mineral deposit have the potential to disrupt these remote locations. Development of exploration roads, use of mechanized equipment such as drill rigs or soft-wheeled off-road vehicles, or use of helicopters are all invasive activities in otherwise unaltered ecosystems.

TERRESTRIAL VEGETATION

General Disturbances

Any disturbance of a terrestrial ecosystem, whether natural or anthropogenic, results in a change in vegetational composition. Some ecosystems are disturbance systems requiring some form of natural disturbance to maintain their particular structure and composition. For example, chaparral ecosystems are fire disturbance systems, while most riparian ecosystems are flood disturbance systems. As a consequence of natural disturbance processes, these ecosystems are maintained in an early successional stage, while removal of the disturbances will allow succession to proceed to a later successional, non-disturbance plant community.

Development of roads or use of off-road vehicles, whether soft- or hard-wheeled, during exploration activities has the potential to disrupt the soil and low stratus vegetation, stimulating invasion by disturbed-site plant species (e.g., members of the mustard family). This may be little different than surface disturbance by burrowing animals, but the consequences of mining activities are potentially less localized.

Small alterations of topography by exploration activities may create new habitats for hydrophytes in low areas and xerophytes on elevated terrain. These terrain changes result in localized composition changes of plant species, which may in turn alter composition of local invertebrate and other associated species. In time, most of these small changes may, through biological and physical processes, return the vegetation to a state similar to predisturbance.

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Smelter Emissions Fumigation

Plant communities adjacent to some historic mineral processing facilities have been altered by fumigation from smelter emissions (Gabriel and Patten, 1994). Uncontrolled smelters have released large amounts of sulfur dioxide (SO_2) that settled on the surrounding landscape. When combined with water in plant leaves, SO_2 is converted to sulfuric acid, which is often lethal to foliage and consequently the plant. Some plants are resistant to SO_2 fumigation, resulting in plant communities near smelters being composed of resistant plants and devoid of non-resistant plants. With increasing distance from the pollution source, the plant community composition gradually returns to normal (Wood and Nash, 1976). Where long-term smelter emissions historically affected surrounding forests and associated soils, for example near Anaconda, Montana, Coeur D'Alene, Idaho, and Salt Lake City, Utah, much of the surrounding hillsides still are devoid of trees. Apparently, present ecological conditions at these sites are such that forest recovery is either slow or prevented by changes in soils or microclimate.

Metal Toxicity

Contaminants in air pollution from mining processes have the potential to affect terrestrial vegetation. Metals from uncontrolled smelter emissions contaminate soils and then are taken up by plants, or the emissions may settle on foliage and be taken up directly into the leaves. Soils, vegetation, and wildlife habitat in areas affected by smelter emissions have been shown to contain elevated concentrations of metals, and vegetation abundance and species diversity have been severely affected (Galbraith et al., 1996; Kapustka et al., 1996; LeJeune et al., 1996). Depending on the concentration of pollutants influencing plant physiology, uptake of metals and other contaminants may or may not be lethal. For example, concentration of metals in foliage of vegetation near a smelter was reduced by 50% to 100% when the smelter was not operating, and yet total foliar necrosis occurred only immediately adjacent to the smelter (Gabriel and Patten, 1995a). Plants used as indicators of pollution near a smelter had foliage metal concentrations much greater than plants growing in a pristine unpolluted area (Gabriel and Patten, 1995b). Foliage sampled near the smelter had copper concentrations nearly 800% greater and arsenic about 500% greater than foliage sampled at a non-smelter site. Uptake of metal-contaminated water and sediments by plants also causes contaminated foliage and stems in riparian and wetland areas.

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Exotic Plant Species

Selection of plant species for reclamation is based on suitability for future uses, such as grazing, resistance to abuse by future uses (e.g., overgrazing or recreational use), and tolerance of site conditions. Plant species that fit these selection criteria may be non-native species; therefore, reclamation procedures may increase the distribution of non-native species.

Vehicular traffic on and off mining sites also may disperse non-native plant species into active mining areas. Off-road vehicles used for exploration purposes may carry propagules of non-native species into relatively pristine backcountry areas. This type of introduction is not unique to mining exploration (Kummerow, 1992), but invasion of non-native species into the backcountry is enhanced through mining exploration, which may be the first mechanical intrusion into some of these areas.

RIPARIAN VEGETATION

Valley Fill

Riparian plant communities are found in valleys where stream flows and shallow groundwater support phreatophytes. Historically, some valleys have been used as areas for placing waste rock, leach pads, or tailings impoundments. Although there is greater awareness today of the ecological impacts of using valleys for deposits, valleys may, in some cases, still be used for the placement of mining facilities. Obviously, if a valley is filled, the vegetation in the valley will be destroyed. Once filled, the riparian vegetation that requires the conditions found at the bottom of the valley cannot be restored.

Altered Hydrology

Some mining activities have the potential to consume most of the locally available water through extensive groundwater withdrawal, which in turn may affect surface flows and shallow valley fill aquifers (Patten et al., 1994). Some mines may intercept the deep water table, potentially disrupting regional aquifers and reducing stream and spring flows (Nelson et al., 1991). Groundwater withdrawal can affect riparian vegetation some distance from a mine. Reduced flows and lowering of the alluvial aquifer directly affect phreatophytic riparian vegetation, which depends on this water source. A lowered water table will stress riparian vegetation, causing either mortality or reduced vigor (Stromberg et al., 1992, 1996; Scott et al., in

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press). Lowered shallow alluvial aquifers may not maintain riparian vegetation, resulting in replacement of riparian species with upland species.

Water Contaminants

Metal-contaminated water and sediments that reach wetlands or settle along streams in the wetland or riparian zone create a contaminated substrate for plants that take up the metals and store them in foliage and stems (Sullivan, 1991). Contaminated soils and sediments from mine sites have the potential to affect bed, bank, and floodplain sediments, as well as down-gradient riparian areas and wetlands some distance from the mine.

WETLANDS: HYDROLOGICAL AND SURFACE CHANGES

Wetlands, like riparian ecosystems, are dependent on a continuous supply of water. Any change in regional hydrology may affect wetlands, especially in the arid West. Many arid region wetlands develop at spring orifices. The wetlands and the spring pools often support threatened or endangered species (e.g., pupfish). In Nevada, for example, springs occur throughout the desert, where the deep regional aquifer supplies water to the surface through the basin fill aquifer. These spring wetlands may be very sensitive to changes in the hydrologic head of the regional or local aquifer resulting from groundwater withdrawal by mines, agriculture, or municipal water use. There is sufficient evidence to show that small changes in the hydrologic head may lower the water table several meters, resulting in the drying up of springs and associated wetlands (Schaefer and Harrill, 1995).

Wetlands also occur in depressions throughout much of the mountainous West. Off-road vehicles can greatly alter the stability of these wetlands by creating ruts that drain the water. Even use of soft-tired vehicles can produce linear depressions that create pools and tend to dry up the remaining wetland.

SOIL

Surface Alterations

The Earth's surface supports a wide variety of organisms, but it is also susceptible to ambient environmental changes such as drought and wet cycles. Such human activities as road building or construction, whether a result of mining or other processes, have the potential to greatly alter soil surfaces and affect soils

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to some depth. Commonly topsoil is set aside to be replaced with a hardened, durable road surface or some other facility. Topsoil may be used eventually for reclamation of the roaded area or in reclamation of other mining activities (e.g., topping for waste rock piles). Hardened road surfaces also cause runoff to the road's edge, increasing the potential for invasion of weeds. In cold climates, roads may be salted, which causes soil contamination along the roadbed. Temporary roads may sufficiently alter soil surfaces through changes in topsoil structure and chemistry to prevent short-term recovery following reclamation.

Erosion

Disturbance of soil surfaces by mining activities may leave soils susceptible to erosion if precautionary measures are not taken. Eroded soils have the potential to contribute to sediment output into local drainages causing reduction in water quality.

Air Deposition

Chemical participates and metals from smelter emissions and blowing tailings have the potential to settle on soil surfaces near some mineral processing facilities. In such cases, contamination of soils decreases with distance from the contaminant source. In a study around a copper smelter in Arizona, several metals, including iron, manganese, and copper, were found to significantly decrease in concentration in soils with distance from the smelter (Gabriel and Patten, 1994). This was true for both surface soil and soil at 25 cm depth. Plants can accumulate contaminants found in soils and may pass these along to herbivores.

TERRESTRIAL WILDLIFE

Disruptive Activities

Exploration into relatively pristine ecosystems, although minimal in surface disturbance, has the potential to disrupt wildlife. The location of dispersed drill pads over an extended area may prevent wildlife from finding seclusion from this type of activity. Exploration roads and even tracks from soft-tire vehicles, can disrupt migration of small mammals and change behavioral patterns of larger animals. Permanent long-distance haul roads or railroads for mining purposes have the same potential impact on animal behavior as roads and railroads used for

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other purposes, that is, they may alter migration patterns by creating barriers and fragment animal territories (Simberloff and Abele, 1982). This is especially true for smaller animals.

Noise from vehicular traffic, including off-road vehicles, has the potential to disrupt wildlife (Brattstrom and Bondello, 1983), sometimes preventing normal reproductive processes because the noisy activity is located in or near a calving or whelping area for ungulates or canines, respectively. Noise from blasting also has the potential to disrupt wildlife. Although some wildlife may become accustomed to blasting noises, others will move from the area, potentially reducing the population of that species.

Consumption of Toxic Plants and Animals

Terrestrial wildlife, waterfowl, and migratory birds may consume plants and animals that have accumulated toxic materials. Plants growing in contaminated sediments accumulate metals in tissues (Sullivan, 1991). Bioconcentration in trophic dynamics of aquatic organisms in lakes and streams produces aquatic plants, macroinvertebrates, and fish with elevated levels of metals and other contaminants in their tissues. Consumption of these organisms by wildlife and birds continues the bioconcentration process, potentially creating toxic levels of metals and other chemicals in these organisms.

Wildlife Enhancement

Some environments created by mining activities have the potential to benefit wildlife. For example, abandoned mine tunnels may be used by bat communities, thus influencing closure procedures for these developments. Reclamation of waste rock sites and other surface disturbances may create extensive areas of forage that attract some species.

AIR QUALITY

Smelter Emissions

Emissions of particulates and sulfuric acid from smelters have the potential to produce extensive regional air pollution. For example, prior to the imposition of current air quality standards, several copper smelters located in central and southern Arizona had been shown to create an extended haze and potential acid deposition over much of southern Arizona under the right climatic conditions

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(Blanchard and Stromberg, 1987). Smelter emissions from the Sonora region of Mexico have been linked to wet sulfuric deposition and acidification of lakes in the Colorado Rockies (Oppenheimer and Epstein, 1985). Changes in lake acidity can cause changes in aquatic biotic composition and chemical processes.

Fugitive Dust

Unpaved roads, tailings ponds, and other disturbed areas have the potential to become sources of fugitive dust if they are not kept damp, adequately revegetated, or otherwise controlled. Mining, loading, dumping, and crushing activities are also potential sources of fugitive dust as are the surfaces of some tailings deposits.

NOISE

Noise can play an important role in human as well as animal behavior. Constant noise from heavy equipment operations at mines adjacent to residential communities may cause persons who are sensitive to noise pollution to move away or change their behavior to try to avoid the noise.

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Appendix C

Existing Regulatory Requirements

Hardrock mining and exploration on federal lands are subject to many federal and state permitting, operating, and reclamation requirements. The committee has not attempted to produce an independent catalogue of the regulatory requirements. It has, however, reviewed several recent compilations, such as those listed in Sidebar C-1.

In addition, the committee has compiled excerpts from recent environmental impact statements that list regulatory requirements for proposed mines. The EISs contain this information because the Council on Environmental Quality's (CEQ) regulations implementing NEPA require that a federal agency identify and list the federal permits or licenses required to implement the proposal being studied:

> The draft environmental impact statement shall list all federal permits, licenses, and other entitlements which must be obtained in implementing the proposal. If it is uncertain whether a Federal permit, license, or other entitlement is necessary, the draft environmental impact statement shall so indicate. (40 CFR 1502.25[b])

Although the CEQ regulation addresses only federal requirements, the Bureau of Land Management's National Environmental Policy Act Handbook (BLM, 1988) has a provision that expands the requirement to state and local permits:

> Authorizing Actions (40 CFR 1502.25[b]). Identify the actions necessary to authorize the proposed action or alternatives. Include Bureau actions to authorize applicant proposals (e.g., granting right-of-way) and actions by other Federal, State, and local entities which

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would be required for implementation (e.g., obtaining State or local permits). (BLM NEPA Handbook, Section V.C.3.e[5], at p. V-17)

Tables C-1 through C-9 include excerpts from nine recent EISs that identify permits, licenses, and other regulatory requirements for recent mines in six states:

- Table C-1, Cortez Pipeline Gold Deposit, Nevada, January 1996
- Table C-2 Zortman and Landusky Mine Extensions, Montana, March 1996
- Table C-3, Twin Creeks Mine Project, Nevada, December 1996
- Table C-4, Crown Jewel Mine, Washington, January 1997
- Table C-5, Ruby Hill Project, Nevada, January 1997
- Table C-6, Lisbon Valley Copper, Utah, February 1997
- Table C-7, Olinghouse Mine, Nevada, February 1998
- Table C-8, Yarnell Mining Project, Arizona, June 1998: Regulatory Compliance Summary
- Table C-9, Yarnell Mining Project, Arizona, June 1998: Significant Issues Raised During Scoping

SIDEBAR C-1 RECENT COMPILATIONS OF HARDROCK MINING REGULATORY REQUIREMENTS

- Barringer, S. 1999. *Mining Regulatory Programs in the Western United States: A Survey of State Laws and Regulations.* Unpublished, 87 pp.
- Bureau of Land Management. 1999a. *Surface Management Regulations for Locatable Mineral Operations: Draft Environmental Impact Statement.*
- Environmental Protection Agency. 1997b. *National Hardrock Mining Framework. Mine Waste Task Force.*
- Interstate Mining Compact Commission. 1997. *Noncoal Mineral Resource Report.*
- McElfish, J.M., T.Bernstein, S.P.Bass, and E.Sheldon. 1996. *Hard Rock Mining: State Approaches to Environmental Protection.* Washington, D.C.: Environmental Law Institute, 358 pp.
- Northwest Mining Association. 1997. *Permitting Directory for Hard Rock Mineral Exploration.* Spokane, Washington.

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TABLE C-1 Cortez Pipeline Gold Deposit, Nevada, January 1996

Agency	Permit/Approval	Facet of Project	Time Requirements	Comments
FEDERAL				
U.S. Bureau of Land Management (BLM)	(1) Approval of Plan of Operations (Requires Environmental Assessment [EA] or EIS)	All activities on unpatented mining claims or involving right-of-way on federal land	120–180 days	If EIS required, could take 365 days or longer, Public notice required.
	(2) Right-of-Way Permits	Road and Powerline access on federal land	30–180 days	Data in Plan of Operations and EA can be used for this application.
U.S. Environmental Protection Agency (EPA)	Review of State Water and Air Permits	Surface and groundwater discharge permits; Air Quality Permit	30–60 days review	Review capacity.
U.S. Army Corps of Engineers	Section 404 Permit	Any filling or dredging of wetland/riparian areas	90–180 days	If nationwide permit acceptable. Individual permit could take 365 days or longer.
STATE				
Nevada Division of Environmental Protection (NDEP)	Air Quality Permits (1) Air Quality Permit to Construct (ATC)	All aspects, including construction, that produce air contaminants, i.e., particulates, hydrocarbons, sulfur dioxide, etc.	Up to 95 days	Requires plans and specifications for air pollution control facility. Public notice/hearing required.

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Agency	Permit/Approval	Facet of Project	Time Requirements	Comments
	(2) Air Quality Permit to Operate (ATO)	All aspects, including construction, that produce air contaminants, i.e., particulates, hydrocarbons, sulfur dioxide, etc.	180 days to demonstrate compliance after start-up	No public notice required.
Water Quality Permits				
(1) Water Pollution Control Discharge Permit	Mine, tailings, heap leach operation; review discharge and seepage potential.	Minimum of 165 days	Review of geotechnical design criteria to verify zero-discharge operation; Public notice required.	
(2) National Pollution Discharge Elimination System (NPDES)	Any discharge of wastewater to surface water (i.e., sediment control facilities)	180 days	Review of geotechnical design; Public notice required.	
(3) NPDES— Stormwater	Coverage by general mining storm water permit at each site	30 days	Review of site plan; No public notice required.	
Solid Waste Disposal	Disposal of solid, non-toxic waste, i.e., garbage, construction waste, etc.	14–90 days prior to construction	Site location, design, and operation plan.	
Reclamation Permit for a Mining Operation	Any surface-disturbing aspect of the project			

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Agency	Permit/Approval	Facet of Project	Time Requirements	Comments
Nevada Division of Water Resources (NDWR)	(1) Permit to Appropriate the Public Water	Use of surface and groundwater	90–180 days; prior to construction	Requires data regarding source of water and annual consumption; public notice required.
	(2) Permit to Construct Tailings Dam	Any tailings dam over 10 feet high or impounding more than 10 acre-feet	45–120 days; prior to construction	Review of geotechnical design; no public notice required.
Nevada Division of Wildlife (NDOW)	(1) Industrial Artificial Pond Permit	All facets	To be determined	Regulate wildlife impacts and cyanide-related impacts.
	(2) Dredging Permit	Removal of material from or placing material in wetlands	10 days; prior to operation	In conjunction with Army Corps of Engineers.
Nevada Division of Health/Consumer Protection Services	(1) Sewage Disposal Plans	Sewage system plans	5–30 days; prior to construction	No public notice required.
	(2) Drinking Water Supply	Drinking water supply plans	5–30 days; prior to construction	No public notice required.
Nevada Division of Historic Preservation	Review project to determine impact on cultural resources	All surface disturbances	30–90 days; prior to operation	Submit legal description with map.
State Inspection of Mines	Notification of Opening or Closing of Mines	Mining	60–120 days	

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Agency	Permit/Approval	Facet of Project	Time Requirements	Comments
COUNTY				
Planning Commission (varies from County to County)	Special Use Permit	All surface disturbances	60–120 days	Application should include detailed plan of operations.
	Building Permit	Surface facilities	30–60 days	Must have prior approval from Nevada State Health Division.

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TABLE C-2 Zortman and Landusky Mine Extensions, Montana, March 1996

Agency	Permit, License, or Review	Authority	Purpose/Status
Montana Department of Environmental Quality	• State Operational Permit (Metal Mine Reclamation Act)	Title 82, Chapter 4, Part 3, *et seq.*, MCA; ARM §26.4.101 *et seq.*	To allow mining while adequately providing for the subsequent beneficial use of the lands to be reclaimed. Approval is documented in a Record of Decision.
	- Reclamation Bond	§82-4-338, MCA	Required of Proponent to assure sufficient reclamation funding is available at mine closure or abandonment.
	- Monitoring Plans	§82-4-335(4)m, MCA	To assure compliance with state and federal environmental resource standards and criteria;coordinate with other governmental agencies.
	• Open Cut Permit	§82-4-442 *et seq.*, MCA	For excavation of shale and clay pits; includes reclamation plan and bond.
	• Montana Pollutant Discharge Elimination System Permit (MPDES)	ARM 16.20.1301 *et seq.*	To control discharge (including stormwater runoff) to surface waters by setting water quality limitations and requiring self-monitoring. Conditions for MPDES permits for Zortman and Landusky mines are under negotiation in 1996.
	• 401 Certification	Sec. 401, Federal Clean Water Act (33 USC 1341); Montana ARM 16.20.1701 *et seq.*	Require prior to the U.S. Corps of Engineers being able to issue a 404 Permit; and is applicable to all federal activities which results in a discharge to state waters.
	• Permit for Construction and Operation of Air Contaminant Source	Montana Clean Air Act, ARM §16.8.11 *et seq.*	To control emissions of more than 25 tons per year of particulate matter.

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Agency	Permit, License, or Review	Authority	Purpose/Status
U.S. Bureau of Land Management (2)	• Approved Plan of Operations	43 CFR §3809	To allow for mineral exploration and development on U.S. lands administered by BLM. Approval incorporates management requirements to minimize or eliminate effects on other BLM resources. Approval is documented in a Record of Decision.
	- Monitoring Plans	43 CFR §3809	To assure compliance with state and federal environmental resource standards and criteria; coordinate with other governmental agencies.
	- Reclamation Plan	43 CFR §3809; BLM Solid Minerals Reclamation Handbook No. H-3042-1	In coordination with DEQ, to ensure all reclamation activities meet the guidelines in the Resource Management Plan and BLM Manual Section 3042.
	• Material Site Permit	43 CFR §3610; Mineral Material Regs.	Material sale contract to establish fair market value and reclamation procedures for limestone from proposed quarry.
U.S. Environmental Protection Agency	• Review and approve authority for various programs, including 404 permit	Section 309 of Clean Air Act; Clean Water Act; other environmental statutes	Various NEPA review, environmental enforcement and oversight authorities.
U.S. Army Corps of Engineers	• Section 404 Permit for placement of fill or dredge materials in wetlands or water of the U.S.	Section 404 of the Clean Water Act	To control discharge of dredge or fill material into waters or wetlands of the United States; including intermittent streams where a bed and bank are recognizable.

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Agency	Permit, License, or Review	Authority	Purpose/Status
U.S. Fish and Wildlife Service	• Biological Assessment	Section 7, Endangered Species Act, Migratory Bird Act	For Endangered Species Act compliance. If it is determined that adverse effects would occur to threatened or endangered species as a result of the Zortman and Landusky Mine extensions, the lead agencies would consult with USFWS to determine if measures could be developed to protect the affected species.
Montana State Historic Preservation Office	• Review of project for compliance with regulations governing protection of cultural and historic resources	Section 106 of the National Historic Preservation Act; 36 CFR Part 800	If historical, archaeological, or other cultural resources are located in the project area, the State Historic Preservation Officer would advise the lead agencies on impact mitigation of sites eligible for nomination to the National Register of Historic Places.
Montana Department of Natural Resources and Conservation	• Water Rights Permit	Montana Water Use Act, Title 85,Chapter 2, MCA	Required if the Proposed Action would use or extract, through surface water diversion or groundwater withdrawal, state water in an amount exceeding 100 gallons per minute.
Phillips County	• Floodplain Development Permit	Title 76, Chapter 6, Part 113, MCA	Required for construction of facilities within designated 100-year floodplains.
Montana Hard Rock Mining Impact Board and "Affected" Local Government Units	• Fiscal Impact Plan	Hard Rock Mining Impact Act: Title 90, Chapter 6, Parts 3-4, MCA	To mitigate fiscal impacts on local government services; (not required for ZMI extensions).
Phillips County Conservation District	• 310 Permit	Natural Streambed and Land Preservation Act, Title 87, Chapter 5, Sections 501-509, MCA	For any activity that physically alters the bed or banks of a stream. MDFWP provides recommendations and consultation.

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SOURCE: Final EIS Zortman and Landusky Mines, Reclamation Plan Modifications and Mine Life Extensions, Montana (BLM/MDEQ, 1996).

NOTE: (1) It is the responsibility of the operator to have knowledge of, and obtain, any federal, state, or local permits, licenses, approvals, or reviews required by such entities for construction, operation, or closure of these projects. This table does not present an exhaustive list; several other actions will likely be required for project permitting. Expected hazardous materials for the Zortman/Landusky sites, including provisions for spills, are detailed in Sections 3.14 and 4.14.

(2) BLM, as the lead federal agency in the mine permitting action, and the steward for the federal lands impacted by the mining activities, would be responsible for ensuring that permitted actions comply with a number of federal statutes and regulations implementing those laws, including: the American Indian Religious Freedom Act (Public Law 95-341), the Archaeological Resource Protection Act (Public Law 96-95); the National Historic Preservation Act (Public Law 89-665); the Archaeological and Historic Preservation Act (Public Law 93-291); and the Endangered Species Act (Public Law 93-205).

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TABLE C-3 Twin Creeks Mine Project, Nevada, December 1996

Permit or Approval	Regulatory Agency
Plan of Operations and Mine Reclamation Permit Approval	U.S. Department of the Interior, Bureau of Land Management; Nevada Department of Conservation and Natural Reosurces, Division of Environmental Protection
Right-of-Way Permits	U.S. Department of the Interior, Bureau of Land Management
Review of EIS and Air Permits	U.S. Environmental Protection Agency
Section 404 Permit (Predischarge Notice)	U.S. Army Corps of Engineers
Artifical Pond Permit	Nevada Department of Conservation and Natural Resources, Division of Wildlife
Air Quality Surface Disturbance Permit; Air Quality Operating Permit	Nevada Department of Conservation and Natural Resources, Division of Environmental Protection
Water Pollution Control Permit; Renewal of National Pollutant Discharge Elimination System Permit; General Stormwater Discharge Permit; and Groundwater Protection Permit	Nevada Department of Conservation and Natural Resources, Division of Environmental Protection
Permit for Dam Construction; Permit to Appropriate Public Waters	Nevada Department of Conservation and Natural Resources, Division of Water Resources
Review Project to Determine Impact on Cultural Resources	Nevada Division of Historic Preservation
Special Use Permit	Humboldt County

SOURCE: Final EIS, Twin Creeks Mine, Nevada (BLM, 1996b).

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TABLE C-4 Crown Jewel Mine, Washington, January 1997

FEDERAL GOVERNMENT	
Forest Service	• Plan of Operations • Special Use Permits (Right-of-Way, etc.)
Bureau of Land Management	• Plan of Operations • Special Use Permits (Right-of-Way, etc.)
U.S. Army Corps of Engineers	• Section 404 Permit—Federal Clean Water Act (Dredge and Fill)
Environmental Protection Agency	• Spill Prevention Control and Countermeasure (SPCC) Plan • Review of Section 404 Permit • Notification of Hazardous Waste Activity (1)
U.S. Fish and Wildlife Service	• Threatened and Endangered Species Consultation (Section 7 Consultation)
Federal Communications Commission	• Radio Authorizations
Treasury Department (Department of Alcohol, Tobacco, and Firearms)	• Explosives User Permit
Mine Safety and Health Administration	• Mine Identification Number (1) • Legal Identity Report (1) • Miner Training Plan Approval

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STATE OF WASHINGTON	
Washington Department of Ecology	• National Pollutant Discharge Elimination System (NPDES)/Construction Activities Stormwater General Permit • State Waste Discharge Permit • Water Quantity Standards Modification • Water Quality Certification (Section 401—Federal Clean Water Act) • Dam Safety Permits • Reservoir Permit • Permit to Appropriate Public Waters • Changes to Existing Water Rights • Notice of Construction Approval (Air Quality) • Air Contaminant Source Operating Permit • Prevention of Significant Deterioration (PSD)—(Air Quality) (2) • Dangerous Waste Permit (2)
Washington Department of Natural Resources	• Surface Mine Reclamation Permit • Forest Practice Application • Burning Permit (Fire Protection)
Washington Department of Fish and Wildlife	• Hydraulic Project Approval
Washington Department of Community Development, Office of Archaeology and Historic Preservation	• Historic and Archaeological Review (Section 106 National Historic Preservation Act of 1966)

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Washington Department of Health	• Sewage Disposal Permit • Public Water Supply Approval
Washington Department of Labor and Industries	• Explosive License • Safety Regulation Compliance (1)
LOCAL GOVERNMENT	
Okanogan County Planning Department	• Shoreline Substantial Development Permit • Conditional Use Permit/Zoning Requirements • Building Permits • Maximum Environmental Noise Levels (1) • Socioeconomic Impact Analysis Approval (County Commissioners) • Growth Management Critical Areas Regulations
Okanogan County Health District	• Solid Waste Handling • Septic Tanks and Drain Field Approval
Okanogan County Public Works Department	• Road Construction and/or Realignment
Okanogan Public Utility District (PUD)	• Power Service Contract

SOURCE: Final EIS, Crown Jewel Mine, Washington (Forest Service/WSDE, 1997)
NOTES: (1) Performance standard/requirement—No formal permit necessary.
(2) Potential permit—At this time, these permits are not anticipated for the Crown Jewel Project.

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TABLE C-5 Ruby Hill Project, Nevada, January 1997

Permit/Approval	Granting Agency
Approval of Plan of Operation	Bureau of Land Management
Surface Disturbance Permit (Air Quality)	Nevada Department of Conservation and Natural Resources, Division of Environmental Protection, Bureau of Air Quality
Permit to Operate (Air Quality)	Nevada Department of Conservation and Natural Resources, Division of Environmental Protection, Bureau of Air Quality
Water Pollution Control Permit	Nevada Department of Conservation and Natural Resources, Division of Environmental Protection, Bureau of Mining Regulation and Reclamation
Reclamation Permit	Nevada Department of Conservation and Natural Resources, Division of Environmental Protection, Bureau of Mining Regulation and Reclamation
Permit to Appropriate Water	Nevada Department of Conservation and Natural Resources, Division of Water Resources
Industrial Artificial Pond Permits	Nevada Department of Conservation and Natural Resources, Nevada Division of Wildlife
Approval to Operate Sanitary Landfill	Nevada Department of Conservation and Natural Resources, Division of Environmental Protection, Bureau of Solid Waste
General Discharge Permit (Stormwater)	Nevada Department of Conservation and Natural Resources, Division of Environmental Protection, Bureau of Water Pollution Control
Hazardous Materials Storage Permit	State of Nevada, Fire Marshal Division

SOURCE: Final EIS, Ruby Hill Project, Nevada (BLM, 1997a).

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TABLE C-6 Lisbon Valley Copper, Utah, February 1997

Agency	Item/Permit	Description	Submittal Data	Likely Permit Specifications/ Comments
FEDERAL				
U.S. Bureau of Land Management	POO, EIS	Environmental report including all aspects of operation, environmental and socioeconomic impacts, and mitigation.	Submittal data include air quality, areas of critical environmental concern, cultural resources, prime or unique farmlands, floodplains, Native American religious concerns, threatened or endangered species, solid and hazardous waste, water quality, wetlands and riparian zones, wild and scenic rivers, wilderness, paleontology, and other issues.	BLM as lead agency. Because of the location, and environmental sensitivity of the project, an EIS is required. A permit is not issued; approval of a selected alternative is granted in the form of Record of Decision (ROD). The BLM has a Memo of Understanding (MOU) with the Utah Division of Oil, Gas and Mining (UDOGM) concerning mine permitting and bonding.
	Right-of-Way	Right-of-Way grant required for authorization of power line.	PacifiCorp submitted Right-of-Way application specifying location and use.	Avoid cultural resource sites during construction.
U.S. Environmental Protection Agency	National Pollution Discharge Elimination System, (NPDES) - Water Quality	Must comply with surface and groundwater quality standards for discharge and non-discharging systems. State of Utah Department of Environmental Quality has EPA primacy for issuance of these permits.	Application fee and a characterization of baseline conditions, surface water, and groundwater hydrology.	To control discharge of metals and other potential effluents. Monitoring of discharge and reporting would be required.

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Agency	Item/Permit	Description	Submittal Data	Likely Permit Specifications/ Comments
	Prevention of Significant Deterioration (PSD) - Air Quality	Permit is required if the operation of the proposed facility would emit greater that 250 tons of both point source and fugitive emissions from the facility. State of Utah Department of Environmental Quality has EPA primacy for issuance of these permits.	This environment evaluation includes all climatology and air quality data and identification and evaluation of all sources of fugitive and point source emissions, and a modeling of those emissions to project air quality impacts.	A permit is issued to control emissions of hazardous air pollutants, visible emissions, particulate emissions, and sulfur emissions. Monitoring and reporting is required.
U.S. Fish and Wildlife Service	Threatened and Endangered Species	Must prepare Biological Opinion based on projected impacts to threatened and endangered species in area of project. Comply with Section 7 consultation with ESA.	Preparation of Biological Assessment by BLM precedes Formal Section 7 consultation conducted as a part of EIS.	A permit is not issued; USFWS and State wildlife agencies use EIS as resource document to demonstrate compliance.
U.S. Mine Safety and Health Administration	Safety Permit	Must address operational safety issues.	Compliance with health and safety requirements	Identification number assigned.
U.S Army Corps of Engineers	Section 404 Permits - Dredge and Fill Activities in Watercourses	Provides protection for wetlands by regulating dredged or fill disturbances.	Submit water quality and other environmental data and development data.	Required for stream diversions and wetlands disturbance; compliance with Nationwide Permit 26.

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Agency	Item/Permit	Description	Submittal Data	Likely Permit Specifications/ Comments
STATE OF UTAH				
Department of Environmental Quality				
Division of Water Quality	Groundwater Discharge Permit	This permit is required for all activities having the potential to affect groundwater. Primacy action for EPA under provisions of CWA	A permit application is required that shows all water-discharging facilities and their design, along with proposed monitoring requirements.	Compliance with all Federal, Sate and local water quality parameters or site-specific standard based upon groundwater monitoring.
	Stormwater Approval Order	To satisfy stormwater permitting requirements on the state and federal land. Primacy action for EPA under provisions of CWA.	Construction and operation permit required for stormwater discharges. Application fees required.	BMPs (Best Management Practice) would be required.
Division of Air Quality	Air Quality Approval Order	Required for the construction of any facility or activity that may emit both a point source and a fugitive emission.	Submit permit dust control plan application that describes volume of through put and the location of proposed disturbance activities.	For compliance with Federal and State air quality point source requirements for both mining operation and powerline construction.
Division of Drinking Water	Public Water Supply Permit	Required for projects with more than 25 employees.	This permit requires design and control systems for clean drinking water, septic tanks, leach fields, and a review of any proposed landfill at the project area.	Includes regular monitoring of an on-site water supply or purchase orders if drinking water is provided from an outside source.
Division of Environmental Response and Remediation	Permits for Underground Storage Tanks	Permits required if underground storage tank or tanks are proposed.	Design specification of proposed tanks along with a description of the hydrology of the project area.	Independent monitoring and leak detection would be required.

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Agency	Item/Permit	Description	Submittal Data	Likely Permit Specifications/ Comments
Division of Radiation Control	Radiation Control Permit	For the operation of equipment with radioactive material.	The specifications of the proposed equipment, the location of proposed equipment, and training and responsible party information.	Annual reporting and calibration reports.
Division of Solid and Hazard Waste	Resource Conservation and Recovery Act (RCRA) Permit	Permit to build and operate any type of solid waste disposal facility.	An analysis and characterization of all proposed waste products that would be disposed of (this may include waste dump material).	If there is hazard constituency to the proposed solid waste, there may be a requirement for lime facilities. There would be a requirement for annual reporting of volume placed in the facilities.
Department of Natural Resources				
Division of Oil, Gas, and Mining	Notice of Intent to Conduct Mining Operations Approval of Bonding	A proposed plan of mining operations, reclamation plan, and environmental impacts.	An application fee, environmental description, a mining plan, and reclamation plan.	Annual reporting requirements of production as well as reclamation activities and bonding requirements. An MOU is in place with the BLM to address bonding and other issues.
Division of State Lands and Forestry (2)	Lease	Must address all impacts on state lease lands.	Plan of Operations, reclamation plan, proposed bond to guarantee reclamation, and a schedule.	Annual fees and a report on throughput and reclamation activities.
Division of Water Rights	Water Right Permit	This permit requires an appropriation for a beneficial use, of which mining is considered to be a primary use.	A filing fee, well location, and information on surrounding appropriations.	Annual reporting requirements of volume of water used, and water level monitoring.

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Agency	Item/Permit	Description	Submittal Data	Likely Permit Specifications/ Comments
	Impoundment Permits	Approval for any impoundment (dam) or the storage of water or solution.	Impoundment design specifications.	Leak detection monthly, quarterly, and annual reports as well as water level information.
Division of Wildlife Resources	Vegetation and Wildlife Impacts	Review of mining impacts on Federal and State listed sensitive species, as well as threatened and endangered species.	Information on surface disturbances, as well as a review of the reclamation plan to ensure compliance with surrounding vegetation and wildlife utilization; as a part of the EIS.	No formal permit required. Recommendations for mitigation may be incorporated in final BLM/DOGM approvals.
Other Agencies				
Utah State Historic Preservation Office	Compliance with the NHPA	A review of project area for significant archaeological and historic sites.	A cultural resources report showing the results of literature review, field surveys, and NRHP (National Register of Historic Places) significance evaluation.	Mitigation of any potential adverse effects to Federal and State significant sites.
Local Health Department	Septic Permit	Sanitation disposal permit.	Construction details with design capacities must be reviewed and approved by regional (state) health representative.	Facility must be sized adequately to successfully treat/handle sanitary waste.

SOURCE: Final EIS, Lisbon Valley Copper Project, Utah (BLM, 1997b).

NOTES: (1) Adapted from information provided by Summo USA Corporation. This list may not be all-inclusive; the operator is responsible for securing all the necessary permits and approvals for the project. (2) Mining activities that would occur on State lease lands. Division of Oil, Gas, and Mining has primary state lead on review of mine plan, reclamation plan, and bonding.

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TABLE C-7 Olinghouse Mine, Regulatory Responsibilities

Authorizing Action/Permit/Regulatory Requirement	Regulatory Agency
Plan of Operations	U.S. Department of the Interior, Bureau of Land Management (BLM)
National Environmental Policy Act	BLM and Environmental Protection Agency (EPA)
National Historic Preservation Act	BLM and Nevada State Historic Preservation Office
Native American Graves Protection and Repatriation Act	BLM
American Indian Religious Freedom Act	BLM
Environmental Justice	BLM
Clean Water Act (Section 404)	U.S. Army Corps of Engineers (USCOE)
High Explosive License/Permit	Bureau of Alcohol, Tobacco, and Firearms
Industrial Artificial Pond Permit	Nevada Division of Wildlife (NDOW)
Water Appropriation Permits	Nevada State Engineer, Nevada Division of Water Resources
National Pollution Discharge Elimination System (NPDES) Permit	Nevada Division of Environmental Protection (NDEP)
401 Certification	NDEP
Surface Disturbance Permit (Air Quality)	Washoe County Health Department, Air Quality Division
Permit to Construct (Air Quality)	Washoe County Health Department, Air Quality Division

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Authorizing Action/Permit/Regulatory Requirement	Regulatory Agency
Permit to Operate (Air Quality)	Washoe County Health Department, Air Quality Division
Water Pollution Control Permit	NDEP
Mine Reclamation Permit	NDEP
Solid Waste Disposal Permit	NDEP
Potable Water	NDEP
Sewer System Approvals	Nevada Department of Health, NDEP
Safety Plan	Mine Safety and Health Administration (MSHA)
Threatened and Endangered Species Act	U.S. Fish and Wildlife Service (USFWS)
Hazardous Materials Permit	Nevada State Fire Marshal
Special Use Permit	Washoe County
Building Permit(s)	Washoe County
Encroachment Permit	Nevada Department of Transportation (NDOT)

SOURCE: Final EIS, Olinghouse Mine, Nevada (BLM, 1998).

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TABLE C-8 Yarnell Project, Arizona, June 1998: Regulatory Compliance Summary

Regulatory Agency	Law, Regulation, Permit, Document	Requirements
U.S. FEDERAL AGENCIES		
Bureau of Land Management	Federal Land Policy and Management Act	Approved operations conform to FLPMA requirements
Mining Plan of Operations (MPO)	Approval by the BLM and reclamation bonding	
Use and Occupancy Regulations	Concurrence with regulations	
Reclamation Plan Requirements	Development, approval of reclamation plans and financial security	
Cyanide Management Plan 1992	Compliance with operational guidelines; required inspections	
NEPA Environmental Analysis	EIS prepared by the BLM as lead agency and Record of Decision on MPO	
Authorization of water supply facilities on federal land	Approval as part of the MPO	
Endangered Species Act	Biological assessment and consultation with U.S. Fish and Wildlife Service	
Migratory Bird Treaty Act of 1918	Protection of migratory birds	
Executive Order 11990	Protection of wetlands	
National Historic Preservation Act	Evaluation and consideration of project effects on properties eligible for the National Register of Historic Places, Native American consultations	
Executive Order 12898	Environmental justice in minority and lower income populations	
Executive Order 13007	Consideration of project effects on Indian sacred sites	
Department of Interior Secretarial Order 3175	Consideration of project effects on Indian Trust Resources	

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Regulatory Agency	Law, Regulation, Permit, Document	Requirements
U.S. Environmental Protection Agency (EPA)	National Pollutant Discharge Elimination System (NPDES) Permit (Clean Water Act)	Permit required to discharge to surface water from point sources other than process areas using cyanide
	NPDES Stormwater Discharge Permit (Clean Water Act)	Permit and Stormwater Pollution Prevention Plan required for monitoring and best management practices to reduce stormwater pollution discharge
	Section 404 Permit (Clean Water Act)	Consultation and oversight responsibilities with COE
	NEPA Environmental Analysis	Cooperating agency in preparation of EIS
	40 CFR 112 Spill Prevention Control and Counter-measures (SPCC)	SPCC Plan required for inspection of petroleum storage and dispensing facilities and actions to be taken in the event of a release of oil or fuel on-site
	Clean Air Act	Review and concurrence of state issued permit
U.S. Army Corps of Engineers (COE)	Section 404 Permit	Wetland and jurisdictional waters delineation, protection, and mitigation
U.S. Fish and Wildlife Service (USFWS)	Endangered Species Act	Threatened or endangered species evaluation
	Fish and Wildlife Coordination Act	Consultation with COE on Clean Water Act Section 404 Permit
Mine Safety and Health Administration (MSHA)	Health and safety regulations	Training and compliance during operations

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Regulatory Agency	Law, Regulation, Permit, Document	Requirements
STATE OF ARIZONA AGENCIES		
Department of Environmental Quality (ADEQ)		
Air Quality Division	Air Installation Permit/Permit to Operate (Clean Air Act)	Permit related to construction and operational activities
Aquifer Protection Permit Unit	Clean Water Act	Section 401 Water Quality Certification
	Aquifer Protection Permit	Permit specifying process solution containment features and monitoring requirements for groundwater protection
		Contingency Plan required for actions to take in the event of a release of chemicals or process water from the site facilities
Department of Agriculture	Salvage or Removal Permit	Salvage or removal of protected native plants
State Historic Preservation Office (SHPO)	National Historic Preservation Act	Evaluation of project effects on cultural and historic resources
Mine Inspector's Office	Arizona Mining Code	Training and operations to conform to regulations
	Mined Land Reclamation Act	Reclamation/mine closure/bonding
Department of Transportation	Use Permit	Detailed traffic control plan to coordinate emergency services
Department of Public Safety	Notification required for state highway closure	Notification to State Patrol required to stop traffic on Highway 89 for blasting

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Regulatory Agency	Law, Regulation, Permit, Document	Requirements
STATE OF ARIZONA AGENCIES		
Department of Environmental Quality (ADEQ)		
Air Quality Division	Air Installation Permit/Permit to Operate (Clean Air Act)	Permit related to construction and operational activities
Aquifer Protection Permit Unit	Clean Water Act	Section 401 Water Quality Certification
	Aquifer Protection Permit	Permit specifying process solution containment features and monitoring requirements for groundwater protection
		Contingency Plan required for actions to take in the event of a release of chemicals or process water from the site facilities
Department of Agriculture	Salvage or Removal Permit	Salvage or removal of protected native plants
State Historic Preservation Office (SHPO)	National Historic Preservation Act	Evaluation of project effects on cultural and historic resources
Mine Inspector's Office	Arizona Mining Code	Training and operations to conform to regulations
	Mined Land Reclamation Act	Reclamation/mine closure/bonding
Department of Transportation	Use Permit	Detailed traffic control plan to coordinate emergency services
Department of Public Safety	Notification required for state highway closure	Notification to State Patrol required to stop traffic on Highway 89 for blasting

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TABLE C-9 Yarnell Mining Project, Arizona, June 1998: Sigificant Issues Raised During Scoping

Issue Category	Issues
Water Resources	• Impacts on the quality of surface waters in the watershed, both during the life of the mine and after the mine closes • Potential changes to the quantity of surface water flows as a result of groundwater pumping by the mine • Impacts on the quality of groundwater and water in wells in Glen Ilah, Yarnell and the surrounding area, both during the life of the mine and after the mine closes • Potential for depletion of the water table and wells as a result of groundwater pumping • Potential accumulation of water in the mine pit and the quality of that water during the life of the mine and after the mine closes
Air Quality	• Impacts resulting from dust, fumes, and chemical emissions • Potential for cyanide emission release • Public health issues associated with airborne transmission of disease, dust, or emissions
Blasting	• Impacts on the stability of natural features including boulders and aquifer systems • Potential for damage to residences, utility lines, and roads
Noise	• Impacts on public health and the quality of life in the nearby communities
Visual Resources	• Impacts on views from residences and Highway 89 during the life of the mine and after the mine closes • Effects of lighting on the night sky
Public Safety and Transportation	• Potential hazards created by truck traffic and the transport and storage of hazardous materials • Potential hazards to motorists from blasting • Effects of road closures on access to medical and emergency services by area residents

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Issue Category	Issues
Socioeconomic Conditions	• Impacts on property values • Impacts on employment and income • Impacts on local businesses • Impacts on tourism • Impacts on tax revenues • Impacts on crime rates • Potential for increased demand on local services from possible influx of mine employees • Disruption of quality of life from noise, visual impacts, night lighting, or other aspects of the mine operation
Closure and Reclamation	• Adequacy of bonding to ensure completion of reclamation • Effectiveness of proposed reclamation plan and monitoring measures
Biological Resources	• Impacts to wildlife and wildlife habitata • Impacts to threatened or endangered species • Potential wildlife mortality from exposure to hazardous substances • Impacts on vegetation including riparian zones along Antelope Creek
Cultural Resources	• Impacts on prehistoric or historic sites and roads
Land Use	• Impacts on livestock grazing, other land uses and access routes

SOURCE: Draft EIS, Yarnell Mining Project, Arizona (BLM/EPA 1998).

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Appendix D

Research Needs

The objective of the research discussed below is to minimize adverse environmental effects of mining on federal lands by filling gaps in knowledge about the long-term environmental impacts from hardrock mining. This appendix expands on the information provided in Chapter 3.

Research is needed in a number of areas and is summarized in this appendix according to scientific discipline. The areas of highest priority are listed below and may encompass more than one of these disciplines.

- **Pit Lakes:** A number of significant research needs are related to the long-term environmental impacts of pit lakes. Making accurate long-term projections based on short-term data is challenging, and the concordance between predicted and actual outcomes has not been evaluated. Research on the chemistry, hydrology, and biology of pit lakes and their surroundings is needed to minimize the environmental impact of those that presently exist and to improve the design of those proposed for the future.
- **Acid Drainage:** Improved methods for predicting and preventing acid drainage are also a high-priority research need. Acid drainage is the source of many of the water quality problems associated with hardrock mining. Improved methods for prediction, prevention, and long-term treatment are needed to minimize the expenses related to acid drainage and to enhance the long-term protection of the environment.
- **New Technologies:** Research on the mining approaches of the future is the next most important research area. Mining methods such as bioleaching and *in situ* mining, which are being proposed for a number of new mining operations, have the potential to prevent pollution, yet the long-term environmental consequences of these methods have not been investigated.

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Each topic area requires three types of research:

(1) modeling to accurately project the changes in environmental parameters forward in time and outward in space;
(2) monitoring to provide information on the averages, extremes, and trends of environmental indexes, and to help calibrate and verify the accuracy of the models; and
(3) sampling and testing to acquire baseline data in and around mines.

It is impossible to predict which types of research will provide answers to the needs identified here or whether the critical problems have been identified. The scientific community needs support and flexibility to innovate and respond to new opportunities, as well as to resolve the well-identified problems.

WATER QUALITY

Water represents by far the most important interface between mining and the environment, and its quality, quantity, and distribution provide some of the most effective criteria for monitoring the state of the environment. There is an array of models and laboratory techniques used to predict water quality and quantity from the leaching of mine waste and rock at mine sites. These techniques and models include tests for acid-generation potential, leach tests, pit lake models with water quality and quantity components, and waste rock and tailings discharge models with water quality and quantity components. The results from these tests and models are used to determine if pit water or leachate from mine waste will pose a threat to aquatic life, wildlife, or human health. Predictions of long-term water quality related to acid drainage, especially in pit lakes, have a high degree of uncertainty. Without reliable forecasts of long-term water quality, it is difficult to design effective mine waste management techniques to protect against future deterioration of water quality. Uncertainty about long-term water quality and quantity predictions points to a number of research needs that could help increase the accuracy or define the appropriate use of these predictive tools.

Pit Lake Water Quality

The objective of pit lake models is to accurately predict the chemistry and hydrology of pit water as the lake forms, after water levels have stabilized and taking into account any long-term impacts of evaporation or other factors that may affect water quantity. The modeling results can indicate the factors that

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control water quality and quantity and opportunities to adjust operation and closure plans so that water quality problem can be reduced. Pit lake models predict future water chemistry based on such factors as up-gradient groundwater concentrations, the amount and types of materials (including mineral phases), availability to weathering, leaching of materials, hydrological parameters, and oxidation and reduction reactions that may occur in the lake.

It is currently not known how accurately pit lake models predict concentrations of contaminants in pit lakes and surrounding groundwaters. Thus, comprehensive comparisons of predicted and actual concentrations in pit lakes and groundwaters are needed to evaluate whether existing models can predict long-term water quality. For example, a number of pit lakes at uranium mines have filled, and although pit lake models were rarely used before the lakes filled, it would be possible to model retrospectively the pit water chemistry and compare modeled results to actual concentrations. The parts of the models that needed improving would be adjusted based on results from the comparison study. Pit lakes in Nevada that are currently filling should be monitored to evaluate how the chemistry changes with time.

The use of a pit lake model without data from long-term leach tests increases the uncertainty of the predictions. Eary (in press) found that, for the toxic metals copper, cadmium, lead, and zinc, concentrations were not well represented by theoretical solubilities of known mineral phases, indicating the importance of empirical data based on adequate leach tests for predicting pit water quality. The Nevada Bureau of Mines has conducted an inventory of pit lake water quality in Nevada (Price et. al., 1995). This type of information can be used, in conjunction with knowledge of the geology and mineralization of the mines, to compare predicted and actual concentrations in pit lakes. Tempel et al. (in press) found that predicted arsenic concentrations in the North pit at the Getchell Mine in Nevada did not match actual concentrations. The lower measured concentrations in the pit water may be related to adsorption to aluminum hydroxide and clay mineral surfaces. Until more of these comparisons are conducted, the validity of pit water prediction models will remain uncertain.

The possibility that backfilling of pits will become more common raises additional research questions, because the environmental consequences of backfilling have not been adequately investigated. Partial backfilling of pits with acid-generating wastes has led to temporary increases in metal concentrations and acidity of pit waters, and geochemical models used to predict pit lake chemistry have had to take these changes into account (e.g., at the Sleeper Mine in Nevada) (Mark Logsdon, personal communication, 1999). The impact of partial or complete backfilling on down-gradient groundwater should also be investigated.

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Acid Drainage and Leaching of Mine Materials

The prediction of both acid drainage and the leaching of mine waste and pit wall rock needs improving. Like pit lake models, there has been little effort to compare predicted and actual concentrations. Predicted concentrations of acid, metals and other constituents in waste rock, heap, and tailings discharge should be compared to measured concentrations to determine and improve the accuracy of these methods.

Sample collection strategies for estimating both acid drainage and mine waste leachate need re-evaluation. Sulfide ore bodies, which generally have the greatest potential to generate acid, are known to be heterogeneous in their metal and sulfide content. Therefore, proper sampling of all geologic materials that will become exposed to the environment or become waste is essential. The recommended number of samples per rock type or waste unit varies widely, from one sample for every million tons to one sample per 20,000 tons of waste rock or 50 samples for each million tons (Schafer, 1993; Forest Service, 1992). Another approach is to allow the variability of the material itself to dictate how many samples are collected and analyzed, and then to quantify and evaluate the results using statistical methods (Runnells et al., 1997). Compositing of samples can underestimate the variability in acid-generation potential; therefore, it is important to composite materials only of similar lithology and mineralogy. Waste rock is much more heterogeneous than tailings, and compositing of samples may be more acceptable. In addition to sampling of solids, long-term monitoring strategies for leachate need to be improved. A better understanding is needed of when and how to sample effluents, especially under variable seasonal and meteorological conditions.

Acid Drainage

Acid drainage forms when oxygen and water come in contact with sulfide minerals and certain metal sulfates that form from the weathering of metal sulfides. Factors affecting acid generation include sulfide amounts and types, particle size of waste material, pH, oxygen availability and diffusion, temperature, storage (evaporative concentration of acid products), availability and type of neutralizing material, water saturation, amount of ferric iron present in the water, and the presence of iron and sulfur-oxidizing bacteria (EPA, 1994). Although many states require the use of acid-generation prediction testing as part of the permitting process, variability in one or more of the factors listed above over time and the type of testing performed can limit the reliability of the test and projection results.

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Although acid drainage at ancient mine sites has continued for millennia, the study of acid generation and associated drainage is recent. In addition, the generation process is not well enough understood to determine definitively how long it will run and how high the concentration of acid and metals will reach. Accurately predicting acid drainage potential is a very important element of accurately projecting pit lake water quality. Because of the importance of acid drainage, all aspects of the acid drainage assessment process could benefit from additional research.

Two general types of tests are used to predict acid-generation potential: static and kinetic. Static tests estimate the maximum acid-generation potential (AGP) and neutralization potential (NP) of a rock or waste material. Kinetic tests are conducted for six weeks or longer, use larger sample volumes, provide information on the acid production rate and drainage water quality, and are generally more reliable than static tests. Modified humidity cell- and column-type tests are currently the preferred kinetic tests (EPA, 1994). Special equipment is required, and the costs of the tests are higher than those of static tests. The opportunity to examine changes in pH and metal concentrations over time is available with the kinetic tests.

There are a number of instances where acid drainage has occurred even though it was not predicted or expected. Examples include the Thompson Creek mine in Idaho, the LTV Steel Mining Company in Minnesota (EPA, 1994), the Newmont Rain facility in Nevada (EPA, 1994), and the Zortmann-Landusky mine in Montana (Federal Register, August 7, 1996, [61 FR 41182]). In some cases, waste rock or pit wall material was not initially acid generating, but waste material removed later was. In other cases, static or kinetic tests results showed that acid generation would not be a problem, but actual drainage from mine waste units was acidic. In still other cases, the acid-base accounting data showed the potential for acidification, but errors in construction of the piles or errors in interpreting and reporting the data led to on-the-ground problems.

The effectiveness of the acid-generation prevention and source treatment methods is unknown. General research is needed into the effectiveness of the various treatments on various types of ores and waste. Research should focus on better understanding the acid-generation process and on the effectiveness of the prevention methods in the short and long term. Research is also necessary on comparison of modeled results, either by computer or in the laboratory, to actual field conditions at sites where the methods are in use.

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Leaching of Mine Materials

The leach tests most commonly used were developed primarily to predict contaminant concentration in leachate from solid and hazardous waste landfill. Substantially less effort has been devoted to determining their accuracy in mining situations.

Leach tests used currently include the WET test, the toxicity characteristic leaching procedure (TCLP), the synthetic precipitation leaching procedure (SPLP), and humidity cell tests (EPA, 1978). The WET, TCLP, and SPLP tests are all short-term tests; the humidity cell tests can last for six weeks or longer. The leaching reagent (acetic acid) used in the TCLP may be appropriate for municipal landfills, but is not appropriate for mining wastes. The SPLP test uses a lower pH leach solution for waste materials east of the Mississippi River, because of acid rain from the use of high sulfur coals.

The WET, TCLP, and SPLP tests all may underestimate leachate concentrations because they are conducted in time frames that do not allow equilibration of materials with the leachate solution. Alternating wetting and drying used in some humidity cell tests best approximates the conditions that are most favorable for the formation of acid drainage. In some cases, it may take months or years for stable pH and metal concentrations to be reached. If the tests are cut short before steady state concentrations are reached, predicted concentrations may underestimate actual concentrations.

Finally, the fate and transport of leached metals and other constituents in the environment need additional research. For example, although cyanide and some cyanide-metal complexes are susceptible to photolytic degradation in surface water, not much is known about how they behave in down-gradient groundwater that eventually may be discharged to surface water or be used for drinking water or irrigation.

HYDROLOGY

Like long-term water quality predictions, the modeling of water quantity and hydrologic processes also contains uncertainties. It may not be known, for example, whether some pit lakes will have closed-basin or flow-through hydrologic features, or whether and under what circumstances they may turn over. Long-term ecological, water quantity, and water quality impacts of pit dewatering and discharge of pit water to streams are beginning to be investigated, but results of these studies are not yet available. Site-specific water balances, which in part were responsible for uncontrolled discharges from the mine at Summitville, Colorado, are not sufficiently understood. The flow of water through and interaction with unsaturated waste rock and

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saturated fractured media is poorly characterized and affects the validity of models that predict the behavior of groundwater in these media. Water quantity affects water quality, and uncertainties in one area compound uncertainties in the other. The following research areas in hydrology warrant further investigation.

Pit Lake Water Quantity

The most important physical parameters for a pit lake model are evaporation, precipitation, groundwater flow, and transfer of gases into and in the lake. These processes affect lake level, whether or not the lake turns over, and the oxidation and reduction state of the pit water, all of which affect lake chemistry. There are many methods that can be used to estimate evaporation rates for the pit lake. Pan evaporation rates may overestimate or underestimate evaporation depending on the use of correction factors, the wind speed across the lake, and other factors (Bird, 1993). Wind speed, the amount of precipitation and surface runoff entering the lake, and the amount of metals and other constituents associated with run-on water will change from year to year depending on the amount of precipitation and other climatic factors. Long-term weather data may not be available to provide accurate maximum and minimum precipitation amounts. The original groundwater flow pattern around a pit may be altered by dewatering or by the presence of the lake, which presents large amounts of water for evaporation that were previously present as groundwater. Large precipitation events could cause the lake level to rise above that of the surrounding groundwater and discharge potentially contaminated pit lake water to groundwater (Macdonald et al., 1994). The long-term hydrologic status of pit lakes is affected by all the physical factors discussed above. Whether a lake is a flow-through system or a closed-basin lake with no outputs will affect the chemistry of the lake water. If evaporation is significantly greater than precipitation, the concentrations of metals and other constituents will increase over time through evapoconcentration. If, however, the lake flows through for all or part of the year, down-gradient groundwater concentrations may increase above pre-mining concentrations.

Mine Area Dewatering and Discharge of Surplus Water

Mining influences surface flows on and off site through alteration of runoff from several types of constructed surfaces (e.g., roads, waste piles, leach pads), through discharge of surplus water from pit or underground dewatering, and through use of water for processing. Groundwater

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withdrawals for processing and pit dewatering may affect local and regional aquifers. Pits can influence local hydrology through interaction with the local aquifers, interception of runoff and precipitation, and lake surface evaporation. Mines may supplement stream flow with surplus water from pit dewatering, and then, after mining operations cease, diminish stream flow as the pits and dewatered aquifers are allowed to fill.

The impacts of mine area dewatering include reduced flow in springs, which in arid areas provide habitat for terrestrial wildlife. The flow of streams may also be decreased, which can change the type of aquatic biota that can survive in that system. A decrease in streamflow can increase concentrations of contaminants in the stream, especially if mine pollution sources discharge directly or indirectly to surface water. The existence of a pit creates a permanent higher evaporation sink and can lower the water table off site, especially in arid areas such as Nevada.

Modeling of groundwater withdrawal (Schaefer and Harrill 1995) has demonstrated the effects of pumping from deep and shallow aquifers on shallow basin-fill water tables. Other studies have shown reduction in local stream flow when water is withdrawn from nearby deep aquifers. Water balance models for different hydrogeological settings should be developed that address local and regional interrelationships among surface flow, pit lake hydrology, and hydraulic head of shallow and deep aquifers. These models should enable long-term predictions of the consequences of alteration of surface waters, and interruption, use, and withdrawal of groundwater by mining activities. The models should include consideration of transient events.

Surface water discharge may alter the timing of high flow events, which may eliminate recruitment of riparian vegetation and eventually lead to senescence and death of existing vegetation. This can increase erosion of streambanks, which provide shelter and shade for fish. Long-term hydrologic, geomorphic, and water quality changes from riverine discharge of mine water should be investigated and modeled. Studies on riverine discharge of mine water to the Humboldt River in Nevada are under way at such federal agencies as the U.S. Geological Survey and the Fish and Wildlife Service, but similar studies elsewhere, and site-specific modeling, will facilitate long-term predictions of the response of riverine ecosystems to hydrological changes.

Modeling Flow in Mine Dumps and Impoundments

Waste rock dumps and tailings impoundments show strongly heterogeneous patterns of permeability, which current hydrologic models are incapable of reproducing. In the case of waste rock, end dumping from haul trucks produces inclined layering in the waste rock dump, with a pronounced

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gradation from the finest material at the top of the dump to very coarse material at the bottom. Compaction of the upper surfaces of the dumps by movement of haul trucks and other vehicles tends also to produce horizontal layers that may be less permeable than other portions of the dump and may act as barriers to fluid flow.

In the case of tailings impoundments, discharge of the tailings from spigots produces horizontal and vertical sedimentation of particles of different sizes. The coarsest materials are deposited near the points of discharge and the finest grained materials (slimes) are transported along a gentle slope down gradient from the points of discharge toward the center of the pond. As a result of this differential sedimentation, the horizontal permeabilities in a tailings impoundment tend to be much higher than the vertical permeabilities. These heterogeneities are not included in current hydrologic models and should be considered as improvements are made to these models.

The flow of water through unsaturated waste rock and saturated fractured media is also not well understood and affects the validity of models that predict groundwater flow. Improved models are needed to more accurately predict the infiltration and flow of water into waste rock dumps and tailings impoundments from rainfall and snow melt.

ECOLOGY

Modern hardrock mining is creating potential biological habitats in pit lakes. The viability of these lakes as long-term habitat and food sources for aquatic biota and wildlife has not been evaluated. In addition, the long-term sublethal effects of cyanide and metals on aquatic biota and migratory birds have not been extensively studied. The following areas need further study:

- potential development of biological communities in pit lakes and impacts on aquatic biota and wildlife;
- sublethal effects of cyanide and metals on aquatic biota and migratory birds;
- establishment of water quality standards for pit lakes and waste leachate for protection of aquatic biota and wildlife;
- integrated ecologic-hydrologic studies and modeling to determine the consequences of mine water discharge on riverine ecosystems; and
- impacts of placer mining on stream ecology and aquatic biota.

The viability of creating fish habitat in pit lakes turn in part on the long-term water quality predicted for the lakes. The hydrologic and water quality

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condition of the lake may change if it later becomes a closed-basin lake or begins to turn over. The nature of the food chain in the lake, such as the type of algae and bacteria, and its ability to bioconcentrate or accumulate contaminants has not been studied. Certain birds may feed on zooplankton in the pit lake, while others may feed on fish. Food chain effects in general in pit lakes need to be studied to determine the viability of creating long-term biological habitats in these mine features.

Sublethal (e.g., growth, reproduction, behavioral avoidance) effects of metals on salmonids and macroinvertebrates have been studied to some extent (see Appendix B, "Aquatic Biota"), but sublethal effects on wildlife, including migratory birds, have received less attention. The effects of cyanide and metal-cyanide complexes on aquatic life and wildlife have received less attention. If pit lake cyanide and metal concentrations meet chronic aquatic life criteria, aquatic biota will not die off immediately, but there may be a long-term effect for communities that live in the lake or feed on biota from the lake. Investigation into acceptable whole-body metal and cyanide burdens for consumption by migratory birds should also be investigated.

Water quality standards for pit lakes and mine waste leachate have not been designed for protection of migratory birds. Research is needed to establish the scientific bases for standards for consumption of lake water by waterfowl and migratory birds. In addition, leachate standards have only been developed for a limited number of constituents, and are based only on human health concerns. Therefore, research is needed to establish the scientific bases of leachate standards for protection of aquatic life in cases where leachate from a mine waste deposit has the potential to discharge directly or indirectly (through groundwater) to surface water.

The discharge of mine water to streams can increase loadings of contaminants, even if the concentrations are lower than those in the stream. The added influx of contaminants can be retained on stream sediments and periphyton, which serve as habitat and food sources for macroinvertebrates, which in turn are one of the main food sources for fish. In terminal basins, such as the Humboldt Sink in Nevada, discharge of mine water to streams that feed the sink will cause metals and other constituents to evapoconcentrate in the sink, which provides habitat for waterfowl and migratory birds.

Finally, the impact of placer mining on stream ecology should be investigated. Placer (mechanized) or suction dredge mining disturbs streambed sediments, which provide habitat for macroinvertebrates and spawning habitat for salmonids. The long-term impact of placer mining is unknown, especially under low-flow conditions or when springtime high flows are not able to return bed sediment to its original characteristics. As discussed in Appendix B, studies on the impact of suction dredge and mechanized placer mining on macroinvertebrate and spawning habitat should be conducted.

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CUMULATIVE IMPACTS

A mine's environmental impacts are considered during the preparation of the environmental impact statement (EIS), but multiple, diverse demands on the resources of a region (e.g., a complex ecosystem or a watershed) can create interactions and interferences that may be beyond the purview of individual impact statements. If a proposed mine is near other mines or other human activities, there is a potential for cumulative impacts that extend beyond what an isolated mine may cause. Cumulative impacts are considered during the EIS process, but methodologies for accurately predicting and assessing these impacts are not well developed. Research is needed to improve our understanding of how mining participates in cumulative effects and to predict impacts from mining under different environmental circumstances.

An example of cumulative impacts includes the impact of exploration combined with hunting, off-road vehicle use, fishing, and camping that may use access roads created for exploration. Also, groundwater withdrawal by several mines may deplete a regional aquifer that is shared by agriculture or urbanization. Each incremental withdrawal introduces potentially expanded impacts that need to be evaluated during the EIS process. In addition, the cumulative tapping of groundwater that feeds springs may affect the wildlife and riparian habitat.

Research is needed on the cumulative impacts of past and current mining activity and the development of predictive models for use in evaluating proposed actions. Long-term monitoring should be designed to measure attributes that offer useful data on changes and sustainability of resources affected by mining activity and post-closure conditions. With respect to cumulative impacts, it is particularly important to develop long-term monitoring strategies for water quality and biological analyses that correspond with critical periods in the hydrograph.

ALTERNATIVE MINING AND POLLUTION PREVENTION METHODS

The potential environmental consequences, of new mining techniques should be assessed before they come into widespread practice. Some of these techniques have pollution prevention potential, but the net environmental impact of the practices discussed below generally has not been investigated. These techniques include bioleaching, deep underground mining, *in situ* mining, and the use of alternative lixiviants.

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Alternative Mining Techniques

In the precious metals industry, especially in Nevada, the near-surface oxidized ore is being exhausted, and the industry is moving into the deeper sulfide reserves. Because of their sulfide characteristics, these reserves are not as amenable to cyanide recovery as the oxide ores. This problem is being addressed mainly by finding ways of economically oxidizing the ore so that cyanide leaching can be used, and by identifying substances (lixiviants) that can effectively leach the precious metal from the sulfidic ores.

Bioleaching is one way of oxidizing the ore. In this approach, the ore is treated with a low-pH solution into which iron- and/or sulfur-oxidizing bacteria are introduced. Typically, *Thiobacillus ferrooxidans* or *thiooxidans* (the same microbes responsible for acceleration of the acid drainage production rate) are issued and, not surprisingly, one of the by-products is sulfuric acid. After microbial oxidation, the ore is neutralized and put through the cyanidation process, either in a heap leach or a milling circuit.

Although bioleaching is similar to leaching of copper ores with sulfuric acid or the production of acid drainage, the combined environmental impacts of acidic drainage and cyanide have not been examined. For example, the kinetics of formation and the stability of metal-cyanide complexes may be different under acidic, rather than basic, pH values. In addition, the long-term acid generation potential of neutralized and cyanidized sulfidic ore has not been investigated. The long-term environmental impacts of bioleaching and other new techniques for recovering precious metals from sulfide ore bodies need to be investigated.

Much of the new mining in the United States may be deep underground mining (see Appendix A). Although there will be less surface disturbance, impacts on the quality and quantity of deep groundwater and other environmental factors have not been investigated. As with pit mining, these environmental impacts may be complicated by an increased emphasis on backfilling of the underground shafts and tunnels, which can affect the stability of the underground workings and drainage and groundwater chemistry.

In situ mining has been conducted for decades in the uranium industry, but the techniques have only recently been applied to base metal mining, especially copper mining. This process involves injecting leaching agents directly into the ground and collecting the pregnant solutions in down-gradient wells. Permitting these types of facilities has been difficult, in part because of the uncertainties associated with groundwater quality and quantity.

The use of alternative lixiviants has been investigated for years, but the long-term impacts of the alternatives on aquatic life, wildlife, and groundwater and surface water quality have not been sufficiently researched. Particular

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attention should be given to identifying alternative lixiviants that are more environmentally acceptable than cyanide to leach precious metals; they would be valuable assets to industry and comforting changes to the public.

Pollution Prevention and Treatment

Some of the new technologies have the potential to prevent the amount of pollution generated by mining activities. However, additional research is needed to discover new and improved existing methods for cost-effective long-term treatment of acid drainage, other types of mine leachate, and other types of water quality problems. Some of the techniques being developed to clean up hazardous waste sites may also be applicable to mining. Examples include the use of iron curtains to treat groundwater contaminated with acid drainage (Shokes and Moller, 1999), bioremediation techniques, and the use of constructed wetlands to remove contamination from waste waters. Both the active and passive treatment systems require long-term maintenance and can be expensive to operate.

A common method for treating in place to prevent acid drainage is to mix the acid-generating materials with a neutralizing material such as lime. The materials can be layered with lime or physically mixed either before or after disposal. The long-term effectiveness of this type of active treatment merits additional examination. Both active and passive treatment systems require long-term care (in some cases in perpetuity) and maintenance, and can be expensive to operate. The systems are difficult to standardize when each is treating a unique chemical mix of metals and salts. More research is necessary on treatment methods to determine whether there are better treatment options for contaminated water and to find improvements that can be made to help them function with less maintenance over the long term. Operators and regulators alike recognize that the most cost-effective control may be to prevent the drainage from occurring in the first place, because once drainage begins, there is very little that can be done except long-term treatment of the effluent. Environmentally acceptable alternatives, such as pre-treating incoming waters or controlling the activity of the acid-promoting biota, are worthwhile research goals.

MINING TECHNOLOGIES FOR THE FUTURE

Technologies of the modern mining industry are very different from those of the past. Mines now employ highly efficient, advanced production systems, coupled with innovative engineering designs to prevent or significantly mitigate

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environmental disturbance. Even so, the remarkable advances in mining-related technologies, the better understanding of our environment, and the application of innovative engineering designs have not eliminated all detrimental impacts of mining, nor are they likely to do so. Mining technologies of the future will continue to improve operational efficiency, productivity, and safety while minimizing pollution and maximizing control through improved designs and efficient operation. It is in these areas where additional incentives exist to develop innovative, if not revolutionary, minerals extraction technologies.

Future mine production systems will consist of people, machines, computers, sensors, and the communication links among them. New technologies will be developed that offer the potential for major discontinuous change in the way minerals and metals are discovered, mined, and processed. To extend the lives of U.S. mines and discover new mineral deposits, more and better technologies will be required as mineralized grades continue to decline, metallurgical characteristics of the ores become more complex, and environmental regulatory pressures build. Examples of new technologies are presented below (Beebe, 1995; Gentry, 1998).

Exploration

Advances in control mechanisms, mostly implemented with computers, and sensor development will enable minerals exploration to be far less intrusive to surface and subsurface environments, and include:

- satellite remote sensing techniques capable of penetrating high-density foliage, surface cover, and even short distances into the rock itself;
- advanced geophysics and geochemical techniques capable of detecting smaller and more subtle signatures of deeply buried deposits;
- borehole geophysics and other techniques to improve sampling, analysis, estimation of deposit reserves, and geotechnical assessments with a minimum of drilling into the subsurface; and
- manipulation of increasingly complex data bases for target and deposit modeling with sophisticated pattern recognition software that is both efficient and effective.

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Mining

Although surface mining is the most efficient method for mining minerals in use today, its economies of scale and labor productivity may be approaching limits. With respect to surface area disturbed, surface mines are less benign than their underground counterparts; however, underground mining is generally more expensive in terms of capital and operating costs, more labor intensive, and more dangerous. Also, some underground mines can result in land and hydrologic disturbances due to surface subsidence and groundwater withdrawals.

In the future, there will be even greater pressures to increase mining efficiencies in terms of labor costs, productivity, capital investment, safety, and environmental sensitivity. Where these objectives cannot be achieved satisfactorily, social and environmental factors will tip the balance.

New mining technologies may provide the key to achieving the above objectives (Beebe, 1995; Gentry, 1998). There will be greater use of:

- remote-controlled and autonomous robotic equipment, progressing toward "intelligent" mining systems that require minimal human intervention;
- geosensing techniques to navigate and control intelligent mining systems to obtain assay and geotechnical data in real time and to warn of potentially dangerous variations, such as faults, shear zones, or pockets of water or gas;
- improved mechanical and some form of nonexplosive rock fragmentation techniques fitted to intelligent mining machines;
- *in situ* mining of small or deeply buried deposits economically and in an environmentally safe manner; and
- more efficient, effective, and safe underground extraction systems that comply with growing environmental pressures and meet society's demand for optimal life-cycle costing.

Mineral Processing

The tailings impoundments generated by mineral processing plants can preclude certain post-mining land uses or can release toxic constituents over time. The issue is to minimize the amount of tailings produced, find a suitable storage location for them, and subsequently stabilize and revegetate to the maximum extent possible.

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It is frequently assumed that the relatively new advances in hydrometallurgical systems result in better waste minimization characteristics than the more traditional physical separations. This is true only if leaching agents can be entirely recycled or if discharge streams can be treated effectively to eliminate pollutants before discharge. Toxic leaching agents must be contained if subsequent environmental problems are to be avoided.

Future mineral processing and extractive metallurgy technologies must improve efficiencies in energy consumption, liberation and process metallurgy (including mathematical modeling for process optimization augmented by better sensors and control mechanisms), and most importantly waste reduction and stable disposal techniques. From an environmental standpoint, future technological advances in process metallurgy must address issues pertaining to methods that:

- generate less waste or create waste forms that are more stable or benign;
- establish more efficient separations that avoid discarding valuable or troublesome constituents;
- avoid dissolution of particularly troublesome metals or fix them as inert compounds;
- promote selective solution or dissolution of minerals through pressure oxidation and bioleaching technologies;
- promote more efficient, selective, and timely oxidation, and stabilization of minerals using bio-oxidation techniques and associated bioremediation techniques for environmental mitigation;
- use genetically engineered microbial approaches to oxidation, dissolution, and immobilization of metals and associated toxic elements;
- use hybrid processing flowsheets combining physical, chemical, and microbiological methods in place of repetitive stages of the same methods;
- use alternative lixiviants for *in situ* mining and processing technologies that are efficient in mineral recovery and are environmentally benign (i.e., agents that dissolve desired metals while minimizing dissolution of impurities);
- efficiently eliminate cyanide and other troublesome processing chemicals safely and rapidly;
- improve recovery of by-products or co-products, even ones considered unconventional by today's standards; and

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- use waste treatments that minimize later dependence on time or natural processes to fix or eliminate troublesome constituents (Beebe, 1995; Gentry, 1998).

These technological advances should eliminate, or at least significantly mitigate, many of the environmental concerns now associated with mining and related technologies; however, it is doubtful that these future technologies will provide utopian solutions to environmental concerns. For example, *in situ* mining will present enormous challenges relative to lixiviant selection; solution and dissolution of desired versus undesirable metals; lixiviant containment and control in the structurally complex geologic settings hosting most hardrock mineral deposits; and related impacts on the neighboring groundwater regime.

Another example is the anticipated trend toward underground mining using automated, robotic mining systems. Such systems are likely to incorporate storage of significant amounts of waste rock and tailings underground in mined-out workings, but they will not eliminate surface disturbances or concerns about impacts to groundwater systems pertaining to waste isolation, containment, leakage, and impacts on hydrologic regimes. Surface subsidence will remain and will require equally sophisticated technologic systems to monitor and control.

Mining and associated exploration and processing technologies will advance, some quite rapidly (e.g., hydrometallurgy and biotechnology). While these new technologies will resolve many environmental concerns, they no doubt will introduce other areas of concern not yet recognized or contemplated. These technologic advances will present new opportunities and challenges to all stakeholders in the domestic minerals industry.

SUMMARY

In conclusion, research related to the long-term environmental impacts of mining is needed in the areas of water chemistry, hydrology, ecology, and mine treatment and pollution prevention technology. A number of important research areas have been discussed in this appendix. Results from a well-coordinated and consistently funded research program could help improve current methods used to predict, prevent, and minimize the environmental impacts of mining and could also reduce costs associated with long-term maintenance at mine sites.

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Appendix E

Financial Assurance

Financial assurance is an important part of the regulatory framework to protect federal lands and the environment when an operator is unable or unwilling to perform reclamation and other obligations, and to address contingencies and future long-term post-closure management expenses. Financial assurance for mining operations raises four issues: (1) the activities and events the assurance covers; (2) the amount of the assurance; (3) the forms the assurance may take; and (4) conditions under which the financial assurance is to be released.

ACTIVITIES AND EVENTS COVERED

Financial assurance for reclamation of mining sites is part of mining regulatory requirements in all of the western states that have mining on federal lands. In addition, financial assurance for reclamation is required by the federal land management agencies for mining operations with approved plans of operations on federal lands. Notice-level operations under BLM regulations do not currently have to provide a financial assurance; under the regulations of some states, these small operations are also not required to post a financial assurance for reclamation.

Financial assurances required by plans of operations and state reclamation laws (and some state laws governing closure of waste management units) are monetary guarantees that provide for completion of the reclamation plan for a mining site when an operator is unable or unwilling to do it. Typically, these financial assurances also include money for monitoring the success of the reclamation program, including vegetation surveys and water quality monitoring. Several states have requirements for long-term maintenance of reclaimed units.

Several states—but not the Forest Service or BLM—have adopted regulatory programs that require or authorize the agencies to require financial

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assurance for long-term protection of water quality. Some mines on federal lands have provided such assurances negotiated on a case-by-case basis with state and federal agencies, even where explicit authority to require such assurance may not have been in the regulations.

AMOUNT OF FINANCIAL ASSURANCE

State laws, regulations, and state and federal guidance documents cover the determination of financial assurance amounts. Financial assurances for reclamation are calculated based not on the operator's cost to complete the work but on the cost to bring in a third party to complete the work with regulator agency and/or consultant oversight. The regulatory agency determines the costs, often based on information submitted by the operator. The equipment costs are determined based on equipment available for rental in the vicinity of the operation, fuel costs, and operator costs, typically an hourly rate. The equipment's efficiency at material movement and rate of progression of the work is determined from such resources as the Caterpillar Performance Handbook. Building demolition and disposal is based on standard demolition costs. Seed and revegetation costs are based on actual information available from seed distributors. Knowledge of local labor rates and typical time requirements to complete the work are also used to develop detailed costs for all aspects of the site reclamation.

Most financial assurance language allows for periodic review of the reclamation costs and the bond instruments to ensure that the financial assurance is adequate. Some regulations require that the full amount of financial assurance for the maximum disturbance be submitted prior to construction; others allow the financial assurance to be submitted for the amount to be disturbed at any one time, usually a year, plus the amounts previously disturbed and not successfully reclaimed prior to that time. Almost all financial assurances are for the life of the project, although regulatory language may allow for periodic review and for change to the amount or form of the assurance. For instance, financial assurance forms used in Colorado specify that the bond is for one year, but the bond is automatically renewable for subsequent years if no other bond is put in place prior to the expiration date. That allows the state to review the financial assurance on a yearly basis, but does not require them to do so in order to maintain the appropriate coverage.

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TYPES OF FINANCIAL ASSURANCE

Regulations for each state and for the federal land management agency dictate types of financial assurances that are acceptable. Typically, cash, certificates of deposit, letters of credit, and corporate sureties are accepted in all settings. Less common, but still accepted in some states, are deeds of trust for real estate or liens on equipment. Some states also accept a guarantee known as self-bonding or corporate bonding for all or a portion of the financial assurance. This is a guarantee by the company that it will complete the reclamation work, and there is no exchange of money to the regulatory agency. The company provides information to show that it is a going concern and will be solvent for the life of the operation. Publicly or privately held trust funds established by companies have been used to guarantee long-term water treatment and monitoring.

Most states have regulations that dictate which state agency can hold the bond for reclamation. These regulations restrict the ability of other agencies in the state to hold a financial assurance for the same purposes. Where federal, private, or state lands are involved in an operation, the states and federal land management agencies have memoranda of understanding (MOUs) specifying which agency will hold the financial assurance. In most cases, the MOUs also determine how the assurance amount will be calculated and how it will be released.

CONDITIONS FOR RELEASE

Financial assurances for reclamation are required until reclamation is complete and successful. Reclamation is typically defined as the successful physical stabilization and revegetation of the site. Most states and the federal land management agencies consider partial release of the reclamation bond as portions of the work are completed. For example, if the operator has successfully completed regrading, that portion of the bond designated for regrading can be released.

Procedures for release of financial assurances vary among states. In most cases, the process is a technical determination by agencies responsible for administering the provisions guaranteed by the assurance. Some states, such as Colorado and Montana, expressly provide for receipt of comments on decisions to release reclamation bonds.

Trust funds for long-term monitoring and maintenance, such as for long-term water treatment, can be structured so that they are not released, but are administered by the public or private trustee to provide sufficient revenue to assure continuous funding.

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Appendix F

Presentations to the Committee

SPEAKERS AT COMMITTEE MEETINGS

Stephen Alfers, Vice-Chairman for Hardrock Mining, Colorado Mining Association, Denver, Colorado

Robert Anderson, Deputy Assistant Director, Bureau of Land Management, Washington, D.C.

David Baker, Vice-President of Environmental Affairs, Newmont Mining Co., Denver, Colorado

Adele Basham, Supervisor, Water Quality Standards Branch, Nevada Environmental Protection Division, Carson City, Nevada

Douglas Bland, Director, New Mexico Mining and Minerals Division, Santa Fe, New Mexico

Steven Borell, Executive Director, Alaska Miners Association, Anchorage, Alaska

Jim Butler, Attorney, Parsons, Behle, and Latimer, National Mining Association, Salt Lake City, Utah

Cathy Carlson, Director, National Wildlife Federation, Boulder, Colorado

Nicholas Ceto, Regional Mining Coordinator, U.S. Environmental Protection Agency, Region X, Seattle, Washington

Kelly Courtright, District Mining Engineer, Bureau of Land Management, Spokane District, Spokane, Washington

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Alan Coyner, Adminstrator, Nevada Division of Minerals, Carson City, Nevada

Rusty Dersch, Mining Law and Geologic Survey, U.S. Forest Service, Lakewood, Colorado

Stephen D'Esposito, President, Mineral Policy Center, Washington, D.C.

Roy Drew, Geologist, Branch of Solid Minerals, Bureau of Land Management, Lakewood, Colorado

Leo Drozdoff, Chief, Bureau of Mining Regulations and Reclamation, Nevada Division of Environmental Protection, Carson City, Nevada

James Dunn, Mine Waste Team Leader, U.S. Environmental Protection Agency, Denver, Colorado

James Edwards, Solid Minerals Group Leader, Bureau of Land Management, Lakewood, Colorado

Russell Fields, President, Nevada Mining Association, Reno, Nevada

Roger Flynn, Executive Director, Western Mining Action Project, Boulder, Colorado

Thomas Fry, Acting Director, Bureau of Land Management, Washington, D.C.

Rich Haddock, Senior Counsel, Barrick Goldstrike Mines, Inc., Salt Lake City, Utah

John Hardaway, Cripple Creek & Victor Mines, Victor, Colorado

Chris Herald, President, Crown Resources Corporation, Denver, Colorado

David Holm, Director, Colorado Division of Water Quality Control, Denver, Colorado

Hugh Ingle, President, Nevada Miners and Prospectors Association, Yerington, Nevada

Ron James, Nevada State Historic Preservation Officer, Nevada Historic Preservation Office, Carson City, Nevada

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David Kiegman, Executive Director, Okanogan Highlands Alliance, Tonasket, Washington

James Kuipers, Consulting Mining Engineer, Center for Science in Public Participation, Boulder, Montana

Rodney Lentz, Area Mining Engineer, Okanogan National Forest, U.S. Forest Service, Okanogan, Washington

Tom Leshendok, Assistant Director for Minerals, Nevada State Office, Bureau of Land Management, Reno, Nevada

John Leshy, Solicitor, U.S. Department of the Interior, Washington, D.C.

Robert Loeffler, Director, Division of Mining of Water Management, Alaska Department of Natural Resources, Anchorage, Alaska

Michael Long, Co-Chair, Mine Waste Task Force, Western Governors' Association, Denver, Colorado

Mary Beth Marks, Geologist, Humboldt-Toiyabe National Forest, Elko, Nevada

Alan McKay, Associate Research Hydrogeologist, Desert Research Institute, University of Nevada, Reno

Mike Menge, Professional Staff Member, Senate Committee on Energy and Natural Resources, Washington, D.C.

Glenn Miller, Professor, Department of Environmental & Resource Sciences, University of Nevada, Reno, and Co-Chair, Mining Committee, Sierra Club, Toiyabe Chapter, Reno, Nevada

Robert Miscak, Chairman, Colorado Minerals, Energy, and Geology Advisory Board, Englewood, Colorado

Richard Mohr, Director, Environmental Operations, Phelps Dodge Corp., Phoenix, Arizona

John Mudge, Director, Environmental Affairs, Newmont Mining Company, Reno, Nevada

Tom Myers, Hydrologic Consultant, Center for Science in Public Participation, Reno, Nevada

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Scott Nichols, Chief, Bureau of Minerals, Idaho Department of Lands, Boise, Idaho

Dianne Nielson, Executive Director, Utah Department of Environmental Quality, Salt Lake City, Utah

David Norman, Chief Reclamation Geologist, Division of Geology, Washington Department of Natural Resources, Olympia, Washington

Russell Plume, Hydrologist, U.S. Geological Survey, Carson City, Nevada

Geoffrey Plumlee, Chief Scientist, Central Region Mineral Resource Team, U.S. Geological Survey, Denver, Colorado

Bruce Ramsey, Assistant Director, Division of Minerals and Geology, U.S. Forest Service, Washington, D.C.

Victor Ross, Project Manager, U.S. Army Corps of Engineers, Anchorage, Alaska

Nancy Rusho, Forest Geologist, Nez Perce National Forest, U.S. Forest Service, Grangeville, Idaho

Luke Russell, Director, Environmental Affairs, Coeur d'Alene Mines, Coeur d'Alene, Idaho

Stuart Sanderson, President, Colorado Mining Association, Denver, Colorado

Michael Schwartz, Group Manager, Regulatory Affairs, Bureau of Land Management, Washington, D.C.

Christopher Sewell, Consultant, Western Shoshone Defense Project, Crescent Valley, Nevada

Laura Skaer, Executive Director, Northwest Mining Association, Spokane, Washington

Debra Struhsacker, Environmental Consultant, Reno, Nevada

Michael Turnipseed, State Engineer of Nevada, Division of Water Resources, Carson City, Nevada

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Milton Ward, Chairman, President, and CEO, Cyprus Amax Minerals Company, Englewood, Colorado

Stanley Wiemeyer, Resources Contaminant Specialist, U.S. Fish and Wildlife Service, Reno, Nevada

Cy L.Wilsey, Land Manager, U.S. Homestake Mining Company, Sparks, Nevada

Shannon Work, Attorney, Givens, Funke, and Work, Coeur d'Alene, Idaho

SPEAKERS AT PUBLIC PARTICIPATION FORA

Steve Balman, Glamis Imperial Corporation, Reno, Nevada

Jim Butler, Attorney, Mining Industry, Salt Lake City, Utah

Ann Carpenter, Nevada Colca Gold, Inc., Reno, Nevada

Rob Corkran, Ph.D. candidate, Colorado State University

Barbara Filas, Principal, Environmental Consulting Firm, Reno, Nevada

David Finkenbinder, National Mining Association, Washington, D.C.

Bill Goodhard, Geological Engineer, Mining Industry, Reno, Nevada

Greg Hahn, President and CEO, Summo Minerals Corporation, Reno, Nevada

Anne Hite, East Asia Gold Corp., Spokane, Washington

Harold Hoeberg, Geologist, New Mexico

Kirby Hughes, Citizens for Victor, Victor, Colorado

Ivan Irnavitz, Northwest Mining Association, Spokane, Washington

Bob Johnson, Kennecott Exploration, Reno, Nevada

Charles Knuth, Washington State Director of Gold Prospectors and Miners Association, Spokane, Washington

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Mark Levin, Mining/Geological Engineer, Reno, Nevada
Frank Lewis, Small Miner, Reno, Nevada
Steve MacIntosh, Echo Bay Minerals, Republic, Washington
Donna Marie-Noel, Pyramid Lake Payute Tribe, Reno, Nevada
Ed Mangold, Citizens for Victor, Victor, Colorado
Gene McClelland, Atla Gold, Sparks, Nevada
Tim McCrum, Crowell & Moring, Washington, D.C.
Bob McQuivey, Bureau Chief, Nevada State Division of Wildlife, Reno, Nevada
Dan Mead, BHP Nevada Mining, Reno, Nevada
John Mudge, Director of Environmental Affairs, Newmont Gold Company, Reno, Nevada
Tom Myers, Center for Science in Public Participation, Reno, Nevada
Peter O'Conner, Independence Mining Company, Denver, Colorado
Ray Powers, President, Goose Creek Mining District, Spokane, Washington
Neil B.Prenn, Mine Development Associates, Mining Engineering Services, Reno, Nevada
Mike Rasmussen, Echo Bay Mining Company, Spokane, Washington
Otto Schumacher, President, Western Mine Engineer, Spokane, Washington
Laura Skaer, Executive Director, Northwest Mining Engineer, Spokane, Washington

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Dave Skinner, People for the USA, Denver, Colorado
Lois Sneddon, Vice President for Conservation, Sierra Club, Reno, Nevada
Bill Upton, Placer Dome, Reno, Nevada
David Watson, Kennecott Mining Company, Salt Lake City, Utah
Anna Weiland, Spokane, Washington
Jon Winter, Environmental Specialist at Crown Jewel, Battle Mountain Gold Company, Spokane, Washington

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Appendix G

Individuals Who Provided Documents to the Committee

Robert Anderson, Deputy Assistant Director, Minerals, Realty and Resource Protection, Bureau of Land Management, U.S. Department of the Interior, Washington, D.C.

Bruce Babbitt, Secretary of the Interior, Washington, D.C.

Sylvia Baca, Acting Assistant Secretary, Lands and Minerals Management, Department of the Interior, John Leshy, Solicitor, Department of the Interior, James Lyons, Under Secretary, Natural Resources and Environment, Department of Agriculture, & Charles Rawls, General Counsel, Department of Agriculture (letter to Greg Etter, Vice President and General Counsel, Battle Mountain Gold Company, March 25, 1999)

David A.Baker, Newmont Mining Corporation, Denver, Colorado

Mary Barraco, Manager of Compliance and Regulatory Affairs, Kinross Gold U.S.A., Inc., Salt Lake City, Utah

Steven G.Barringer, Singer, Brown, & Barringer, prepared for *Precious Metals Producers,* Las Vegas, Nevada

Douglas Bland, Director, New Mexico Mining and Minerals Division, Santa Fe, New Mexico

Steve Borell, Executive Director, Alaska Miners Association, Inc., Anchorage, Alaska

Gary C.Boyle, General Manager, Glamis Imperial Corporation, Winterhaven, California

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Lowell Braxton, Director, State of Utah, Department of Natural Resources, Division of Oil, Gas and Mining, Salt Lake City, Utah

Neal Brecheisen, BLM Carson City Office (letter to Kinross Gold U.S.A. Inc, Carrie Eddy, March 5, 1999)

James Bright, Mining Geologist, Reno, Nevada

Michael Burnside, Northern Region U.S. Forest Service, Missoula, Montana

Jim Butler, Attorney, Parsons, Behle and Latimer, Salt Lake City, Utah

Cathy Carlson, Executive Director, National Wildlife Federation, Boulder, Colorado

Nick Ceto, Regional Mining Coordinator, U.S. Environmental Protection Agency, Region X, Seattle, Washington

Rob Corkran, Ph.D. candidate, Colorado State University

Alan Coyner, Administrator, Nevada Division of Minerals, Carson City, Nevada

Les Darling, Director, Environmental Affairs and Land Administration, Cyprus Amax Minerals Company, Englewood, Colorado

Desert Research Institute, *Technical Review and Assessment of Ground and Surface Water Relationships in the Tuscarora Mountains,* Prepared for Barrick Goldstrike Mines, Newmont Gold Company

Stephen D'Esposito, President, Mineral Policy Center, Washington, D.C.

Doug Driesner, Director of Mining Services, State of Nevada Department of Business and Industry, Division of Minerals, Reno, Nevada

Leo Drozdoff, Chief, Bureau of Mining and Regulation and Reclamation, Nevada Division of Environmental Protection, Carson City, Nevada

James Dunn, Mine Waste Team Leader, U.S. Environmental Protection Agency, Denver, Colorado

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Timothy M.Dyhr, Manager, Environment, BHP Copper, Inc., Gila County, Arizona

Rich and Marilyn Fay, Citizens for Victor, Victor, Colorado

Russell Fields, President, Nevada Mining Association, Reno, Nevada

Tom Fry, Acting Director, Bureau of Land Management, Washington, D.C.

Glamis Imperial Corporation, Winterhaven, California (Chronology Handout)

Bill Goodhard, Director, Reclamation Environmental Affairs, Echo Bay, Englewood, Colorado

Robert Gosik, Kinross Gold U.S.A., Inc., Salt Lake City, Utah

Rich D.Haddock, Senior Counsel, Barrick Goldstrike Mines, Inc., Salt Lake City, Utah

Gregory Hahn, President & CEO, Summo Minerals Corporation, Arizona

Pat Hallinan, Water Quality Section, State of Washington Department of Ecology

Stanley Hamilton, Director, Idaho Department of Lands, Boise, Idaho

John Hardaway, Independence Mining Company, Inc., Victor, Colorado

Paul D.Hartley, President, ADGIS, Inc., Reno, Nevada

Christopher Herald, President, Crown Resources Corporation, Denver, Colorado

Karen Highley, Records Manager, Department of Environmental Quality, Environmental Management Bureau, State of Montana

Jane Dee Hull, Governor of Arizona, Phoenix

Bruce Humphries, Minerals Programs Supervisor, State of Colorado, Denver

Hugh Ingle, Jr., President, National Miners and Prospectors Association, Yerington, Nevada

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Bob Johnson, U.S. Land Manager, Kennecott Exploration Company, Reno, Nevada

David Kimball, National Mining Association, Denver, Colorado

Chuck Knuth, Small Miner & Prospector, Gold Prospectors Association of America

James Kuipers, Consulting Mining Engineer, Center for Science in Public Participation, Boulder, Montana

Frank W.Lewis, Reno, Nevada

Ken Loda, Bureau of Land Management, Winnemucca Field Office, Winnemucca, Nevada

Bob Loeffler, Director, Division of Mining and Water Management, Department of Natural Resources, State of Alaska, Anchorage

Michael B.Long, Western Governors' Association, Denver, Colorado

Mary Beth Marks, Geologist, Humboldt-Toiyabe National Forest, U.S. Forest Service, Elko, Nevada

Timorthy McCrum, Attorney, Crowell & Moring LLP, Washington, D.C.

Daniel L.Mead, BHP Nevada Mining, Reno, Nevada

Glenn Miller, Professor, University of Nevada, Reno

Robert W.Micsak, Vice President and General Counsel, Colorado Minerals, Energy & Geology, Policy Advisory Board, Englewood, Colorado

Richard Mohr, Director, Environmental Operations, Phelps Dodge Corp., Phoenix, Arizona

Dalva Moellenberg, Attorney, Gallagher & Kennedy, P.A., Phoenix, Arizona

Tom Myer, Center for Science in Public Participation, Reno, Nevada

Newmont Gold Company, Gold Quarry Operations, Carlin, Nevada

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Dianne Nielson, Executive Director, Utah Department of Environmental Quality, Salt Lake City

David Norman, Chief Reclamation Geologist, Washington State Department of Natural Resources, Spokane

Peter O'Conner, Senior Attorney, Independence Mining Company, Englewood, Colorado

Russ Plume, Hydrologist, U.S. Geological Survey, Carson City, Nevada

Geoff Plumlee, Chief Scientist, U.S. Geological Survey, Denver, Colorado

James Pompy, Manager, Reclamation Unit, Department of Conservation, State of California

Ray Powers, Moose Creek Mining District

Neil B.Prenn, Mine Development Associates, Mine Engineering Services, Reno, Nevada

James T.Price, Great Falls, Montana

Bruce Ramsey, Assistant Director, Division of Minerals and Geology, U.S. Forest Service, Washington, D.C.

Luke Russell, Director of Environmental Affairs, Coeur d'Alene Mines, Coeur d'Alene, Idaho

Stuart Sanderson, President, Colorado Mining Association, Denver, Colorado

Christopher Sewell, Consultant, Western Shoshone Defense Project, Crescent Valley, Nevada

Laura Skaer, Executive Director, Northwest Mining Association, Spokane, Washington

Lois Snedden, Vice President for Conservation, Sierra Club, Reno, Nevada

Debra W.Struhsacker, Consultant, Environmental & Government Relations, Reno, Nevada

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Bob Townsend, Administrator, Minerals and Mining, State of South Dakota

Bill Upton, Placer Dome, Beowawe, Nevada

Ivan Urnovitz, Northwest Mining Association, Spokane, Washington

Milton H.Ward, Chairman and Chief Executive Officer, Cyprus Amax Minerals Company, Englewood, Colorado

David L.Watson, Director, Technical and Health, Safety, AND Environmental Quality, Kennecott Minerals Company, Salt Lake City, Utah

Kent Watson, Thompson Creek Mining Company, Clayton, Idaho

Western Governors' Association Correspondence & Comments on the 3809 Regulations, Resolution 93–006; Western Governors' Association; June 24, 1996–January 1, 1999

Francis M.Wheat, Los Angles, California

Stanley Wiemeyer, Resource Containment Specialist, U.S. Fish and Wildlife Service, Nevada Fish and Wildlife Office, Reno, Nevada

Robert D.Williams, Field Supervisor, Nevada Fish and Wildlife Office, Reno, Nevada

Cy Wisley, U.S. Land Manager, Homestake Mining Company, Sparks, Nevada

Shannon Work, Attorney, Givens, Funke & Work, Coeur d'Alene, Idaho

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Appendix H

Biographical Sketches of Committee Members

PERRY R.HAGENSTEIN, *chair,* is an independent consultant on natural resources policy, economics, and management. Since 1982 he has also served as president of the Institute for Forest Analysis, Planning, and Policy, a national nonprofit research and education organization. He is the former president of Resource Issues, Inc., and former executive director of the New England Natural Resources Center. He has been a visiting professor at the Yale School of Forestry and Environmental Studies, University of Vermont, University of Massachusetts, and Vermont Law School. He served as Charles Bullard research fellow at the John F. Kennedy School of Government and Harvard Forest, Harvard University, and as a senior policy analyst for the U.S. Public Land Law Review Commission. He has been a member of the NRC Committee on Surface Mining and Reclamation, Committee on Abandoned Mine Lands (chair), Committee on Onshore Oil and Gas Leasing (chair), Committee on Earth Resources, Board on Earth Sciences and Resources, Committee on Environmental Issues in Pacific Northwest Forest Management, and Committee on Noneconomic and Economic Value of Biodiversity.

SAMUEL S.ADAMS, *vice-chair,* is an independent minerals consultant in Lincoln, New Hampshire. He is the past-president of the American Geological Institute, past-president of the Society of Economic Geologists, and former head and professor of the Department of Geology and Geological Engineering at the Colorado School of Mines. He has 24 years of industry experience as a mine and exploration geologist, exploration manager, chief geologist, and vice-president for geology and technology. He is a member of the Ad Hoc Advisory Committee to the supervisor of the White Mountain National Forest. He served as chair of the NRC Panel to Review the Mineral Resource Surveys Program Plan of the U.S. Geological Survey. He is a former member of the NRC Committee on Earth Resources and the Board on Earth Sciences and

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Resources. He received his B.A. and M.A. from Dartmouth College and his Ph.D. from Harvard University.

ANNE C.BALDRIGE has worked in environmental impact evaluations and regulatory compliance in the mining industry in the United States and internationally for the last 20 years. Most recently, she was vice-president for environmental and governmental affairs, Battle Mountain Gold Company, where she helped develop a mining regulatory framework for Bolivia and submitted the first environmental impact assessment for a large operation under the new regulation. Additionally, she was responsible for the initial permitting of a mine under one of the most complex permitting scenarios in the United States, which included four federal agencies, American Indian interests, more than a dozen state and local agencies, and significant opposition to the project. She previously served as an associate with Colder Associates, Inc., principal of EIC Corporation, division head of Steffen, Robertson, and Kirsten, and reclamation specialist with the State of Colorado. Ms. Baldrige was awarded a B.S. in geology from the University of Pittsburgh and a M.B.A. in finance and accounting from Regis University.

PAUL B.BARTON, JR., recently retired from the U.S. Geological Survey. His research focuses on the genesis of mineral deposits, chemical and physical nature of ore-forming fluids, phase relations between minerals, thermodynamic properties of minerals, long-range availability of resources, and geochemistry. He was president of the Mineralogical Society of America in 1986 and president of the Society of Economic Geologists in 1979. He is a member of the National Academy of Sciences, the NRC Board on Earth Sciences and Resources, and the NRC Committee on Earth Resources.

EDWIN H.CLARK II is president of Clean Sites, Inc., in Alexandria, Virginia. He is the former secretary of natural resources and environmental control for the State of Delaware, vice-president of the Conservation Foundation, and associate assistant administrator for pesticides and toxic substances in the U.S. EPA. He holds a Ph.D. in applied economics from Princeton University. He has served as a member of the NRC Board on Environmental Studies and Toxicology.

DONALD W.GENTRY is president and chief executive officer of PolyMet Mining Corporation. From 1972 to 1998, he was on the faculty of the Colorado School of Mines, where he served as professor of mining engineering, head of the Mining Engineering Department, and dean of engineering and undergraduate studies. He has served as president of the

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Society for Mining, Metallurgy, and Exploration, and president of the American Institute of Mining, Metallurgical, and Petroleum Engineers. He has been a member of the Board of Directors of Santa Fe Pacific Gold Corporation, Newmont Gold Company, and Newmont Mining Corporation. He has contributed to the restructuring of national mineral policies and related taxation issues in developing countries, including Chile, Peru, and Argentina. His expertise includes surface and underground mining and mine planning, as well as project evaluation and financing. He has published more than 100 papers. He received a B.S. from the University of Illinois, a M.S. from the University of Nevada, and a Ph.D. in mining engineering from the University of Arizona. He is a member of the National Academy of Engineering.

RAYMOND E.KRAUSS is an independent environmental planning and resource management consultant. Previously, he served as the environmental manager for the Homestake Mining Company's McLaughlin Mine. In this capacity, he managed all phases of the project from discovery and permitting through engineering, construction, operations, reclamation, and initial closure. He received the 1993 Earle A.Chiles Award for application of environmentally sound management principles to the mining and extraction of mineral resources in the intermountain West. Also, he received a Merit Award from the Soil Conservation Society for his aggressive mitigation of the environmental impact of the McLaughlin Mine. His technical skills cover the areas of pollution prevention strategies, waste rock and tailings disposal, and the prevention of acid rock drainage.

ANN S.MAEST is an aqueous geochemist whose research interests include the fate, transport, and speciation of metals and other contaminants in natural waters. She has worked as a research geochemist at the U.S. Geological Survey in Menlo Park, California; as a senior scientist at the Environmental Defense Fund in Washington, D.C.; and as a senior scientist and manager at Hagler Bailly and Hydrosphere, environmental consulting companies in Boulder, Colorado. Currently she is vice-president of Buka Environmental in Boulder. She has worked nationally and internationally on water quality and policy aspects of hardrock mining and has served on two NRC committees related to mineral resource research at federal agencies. She holds a Ph.D. in geochemistry and water resources from Princeton University, and was a NRC research associate at the U.S. Geological Survey. Her recent collaborative research efforts with fish toxicologists have focused on the effect of chemical speciation on the toxicity of metals to salmonids.

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JAMES M.MCELFISH, JR., is a senior attorney and director of the Mining Center at the Environmental Law Institute, where he also works on RCRA, biological diversity, and sustainable development issues. He is lead author of two reference works on mining in the United States—*Hard Rock Mining: State Approaches to Environmental Protection* and *Environmental Regulation of Coal Mining: SMCRA's Second Decade—a*nd has written chapters of several treatises, including "State Environmental Law" in *The Law of Environmental Protection* and "Recreation Law" in *Sustainable Environmental Law,* both updated annually. He is a 1979 graduate of Yale Law School.

DUNCAN T.PATTEN is professor emeritus of plant biology and past director of the Center for Environmental Studies at Arizona State University. He also is an adjunct research professor with the Mountain Research Center at Montana State University. His research interests include arid and mountain ecosystems, especially the understanding of ecological processes and restoration of western riparian and wetland ecosystems. He was a senior scientist of the Bureau of Reclamation's Glen Canyon Environmental Studies, overseeing the research program to evaluate the effects of Glen Canyon Dam operations on the Colorado River riverine ecosystem. He is past-president of the Society of Wetland Scientists. He has been a member of the NRC Commission on Geosciences, Environment, and Resources; the Board on Environmental Studies; and numerous NRC committees. He chaired the National Technical Advisory Committee to the National Institute for Global Environmental Change. He received an A.B. from Amherst College, a M.S. from the University of Massachusetts at Amherst, and a Ph.D. from Duke University.

JONATHAN G.PRICE is state geologist and director of the Nevada Bureau of Mines and Geology. He is president-elect, as of July 1, 1999, of the Association of American State Geologists and chair of the Research Council of the Society for Mining, Metallurgy, and Exploration, and is past-president of the American Institute of Professional Geologists. His experience includes serving as geologist with the Anaconda Company, adjunct assistant professor at Bucknell University, geologist with U.S. Steel Corporation, and research associate, research scientist, and then program director, mineral resources, at the Bureau of Economic Geology, The University of Texas at Austin. In addition, he has served as director of the Texas Mining and Mineral Resources Research Institute, lecturer in the Department of Geological Sciences at The University of Texas at Austin, and staff director for the NRC Board on Earth Sciences and Resources. His research and publications address mineral resources, geology and geochemistry of ore deposits, igneous petrology,

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tectonics and geologic mapping, environmental geochemistry, and solution mining. He is a member of the NRC Committee on Earth Resources, the Board on Earth Sciences and Resources, and has served on the Panel to Review the Mineral Resource Surveys Program Plan of the U.S. Geological Survey.

RICHARD E.REAVIS is a former deputy administrator for air, water, and mining programs in the Nevada Division of Environmental Protection. In that capacity he developed policy and guidance to provide direction for state regulatory programs. Mr. Reavis served in a number of positions with the U.S. EPA, including deputy director of the Water Division for EPA Region 9, border coordinator, chief of the Arizona Branch of the Water Division, and chief of the Nevada Branch of the Water Division. He has also been awarded the EPA's Silver Medal for superior service and the U.S. Public Health Service Meritorious Service Medal. He received his B.S. degree in civil engineering from the Missouri School of Mines and Metallurgy and his M.S. degree in civil engineering from Northwestern University.

DONALD D.RUNNELLS is senior technical advisor of Shepherd Miller, Inc., a consulting environmental and geotechnical engineering firm in Fort Collins, Colorado. Previously, he served as chair of the Department of Geological Sciences at the University of Colorado, Boulder, and is now professor emeritus. His research and teaching have been in geochemistry of mineral deposits, natural waters, low-temperature geochemistry, water pollution, geochemical exploration, and geochemistry of trace substances. He has also served as a geochemist at Shell Development Company in Texas and Florida and as assistant professor of geology at the University of California, Santa Barbara. He also has been a member of the NRC Water Science and Technology Board and has participated in the Committee on Ground Water Models: Scientific and Regulatory Applications and the Panel to Review the Mineral Resource Surveys Program Plan of the U.S. Geological Survey. He received a Ph.D. and M.A. in geology from Harvard University and a B.S. in geology from the University of Utah. In 1998 he was appointed by President Clinton to the Nuclear Waste Technical Review Board.

NRC STAFF

CRAIG M.SCHIFFRIES, *study director (through August 1999),* is associate executive director for special projects of the NRC Commission on Geosciences, Environment, and Resources. He previously served as director of

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the NRC Board on Earth Sciences and Resources. He was the first director of government affairs for the American Geological Institute, a federation of 32 national scientific and professional societies in the geosciences. He was a congressional science fellow on the staff of the U.S. Senate Judiciary Committee, where he worked on legislation to ensure that federal laws keep pace with changes in technology. As a Carnegie fellow at the Geophysical Laboratory of the Carnegie Institution of Washington, he conducted research in petrology, geochemistry, and economic geology. He holds a Ph.D. in geology from Harvard University; a B.A. in philosophy, politics, and economics from Oxford University, where he was a Marshall scholar; and a B.S. and M.S. in geology and geophysics from Yale University.

GREGORY H.SYMMES, *study director (since August, 1999),* is associate executive director of the NRC Commission on Geosciences, Environment, and Resources. Since joining the NRC staff in 1995, he has been responsible for overseeing the review and publication of reports produced under the commission. He also directed a study for the NRC Board on Radioactive Waste Management (BRWM) that led to the report, *Peer Review in Environmental Technology Development Programs: The Department of Energy's Office of Science and Technology,* and is currently directing a BRWM study that will lead to the report, *Technologies for Environmental Management: The Department of Energy's Office of Science and Technology.* Prior to joining the NRC, he served as a research assistant professor and postdoctoral associate in the Department of Earth and Space Sciences at the State University of Stony Brook. He received his Ph.D. in geology from the Johns Hopkins University, where he studied fluid-rock interaction and mineral-fluid-melt phase equilibria in the deep crust, and his B.A. summa cum laude in geology from Amherst College

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Acronyms

ACEC	Area of Critical Environmental Concern
BLM	Bureau of Land Management, an agency of the Department of the Interior
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COSMAR	Committee on Surface Mining and Reclamation, an NRC committee that in 1979 wrote *Surface Mining of Non-Coal Minerals: A Study of Mineral Mining from the Perspective of the Surface Mining Control and Reclamation Act of 1977*
DOE	Department of Energy
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FLPMA	Federal Land Policy and Management Act
FONSI	Finding of No Significant Impact (under NEPA)
FS	see USFS
FWS	see USFWS
IBLA	Interior Board of Land Appeals
MMS	Minerals Management Service, an agency of the Department of the Interior
MOU	Memorandum of Understanding
NAE	National Academy of Engineering
NAS	National Academy of Sciences
NHPA	National Historical Preservation Act
NEPA	National Environmental Policy Act
NFMA	National Forest Management Act
NRC	National Research Council, the operating arm of the NAS and the NAE

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NSF	National Science Foundation
RCRA	Resource Conservation and Recovery Act
SMCRA	Surface Mining Control and Reclamation Act
SPLP	Synthetic Precipitation Leaching Procedure
TCLP	Toxicity Characteristic Leaching Procedure
USFS	U.S. Forest Service, an agency of the Department of Agriculture
USFWS	U.S. Fish and Wildlife Service, an agency of the Department of the Interior
UMTRCA	Uranium Mill Tailings Radiation Control Act
USC	United States Code
USGS	U.S. Geological Survey, an agency of the Department of the Interior

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Glossary

ACQUIRED LANDS	Lands in federal ownership which were obtained by the government through purchase, condemnation, of gift, of by exchange. They are one category of public lands (Bureau of Land Management, 1999b).
ALLUVIUM	Natural accumulations of unconsolidated clay, silt, sand, or gravel that have been transported by water, wind, or gravity to their present position.
AQUIFER	A body of rock that contains sufficient saturated permeable material to conduct groundwater and to yield significant quantities of water to wells and springs.
BACKFILLING	The filling in again of a place from which the rock or ore has been removed.
BACKGROUND GEOCHEMISTRY	The abundance of an element in a naturally occurring material in an area where the concentration is not anomalous.
BASE METALS	Those metals usually considered to be of lesser value and of greater chemical reactivity compared to the noble (or precious) metals, most commonly copper, lead, zinc and tin.
BENEFICIATION	Improvement of the grade of ores by milling, flotation, sintering, gravity concentration, or other processes. Also termed “concentration”.
CASUAL USE	Mining activities that only negligibly disturb BLM lands and resources. Further discussion is found in Sidebar 1–3.
CLAIM	The portion of mining ground held under the Federal and local laws by one claimant or association, by virtue of one location and record. Also called a “location.”
CLOSURE	In this report the term refers to the point at which a company permanently stops activity (although it may still retain liabilities for unforeseen environmental or safety concerns).
COMMON VARIETY MINERALS	Mineral materials that do not have a special quality, quantity, character, or location that makes them of unique

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	commercial value. On public lands such minerals are considered saleable and are disposed of by sales or by special permits to local governments. See also Sidebar 1–2.
CONCENTRATION	See "beneficiation." It also refers to the amount of a material in a host (e.g., the amount of gold in a ton of ore.)
CONSTRUCTION MINERALS (OR MATERIALS)	Materials used in construction, notably sand, gravel, crushed stone, dimension stone, asbestos, clay, cement, and gypsum.
COOPERATING AGENCY	Any federal, state, or local agency or Indian tribe with jurisdiction by law or special expertise enabling it to cooperate with the lead agency preparing an environmental impact statement under NEPA.
CORPORATE BONDING	As used in this report, the use of corporate assets as part or all of the financial assurance for the successful completion of reclamation or other corporate responsibility.
CRITICAL ENVIRONMENTAL CONCERN	Describes an area under BLM management and having special attributes.
CULTURAL RESOURCES	As used in this report, natural or manmade features having cultural or historical significance, such as structures, graves, religious sites, vistas, or bodies of water.
CUMULATIVE IMPACT	As used in this report, the collective impacts of several operations involving human activities, including mining, grazing, farming, timbering, water diversion or discharge, and industrial processing, also includes future impacts not immediately observable.
DEVELOPMENT	The preparation of a mining property so that an ore body can be analyzed and its tonnage and quality estimated. Development is an intermediate stage between exploration and mining.
DISCOVERY	As used in this report, initial recognition and demonstration of the presence of valuable mineral within a claim.
DUMP	A pile of ore, coal, or waste at a mine.
EMERGENCY FUNDS	(re: for low-probability, post-closure events) As used in this report, funds provided to deal with unexpected failures of reclamation on closed mining sites.
EPHEMERAL STREAM	A stream or reach of a stream that flows briefly only in direct response to precipitation in the immediate locality and whose channel is at all times above the water table.
EXPLORATION	As used in this report, the search for valuable minerals by geological, geochemical, geophysical, or intrusive physical examination. (See also "prospecting," which in this report is considered part of exploration.)
FEDERAL LAND MANAGEMENT AGENCIES	In this report the term refers to the Bureau of Land Management and the U.S. Forest Service;

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	management agencies not discussed here might include the National Park Service, the Department of Energy, the Department of Defense, and others.
FERROUS METALS	Metals commonly occurring in alloys with iron, such as chromium, nickel, manganese, vanadium, molybdenum, cobalt, silicon, tantalum, and columbium (niobium).
FINANCIAL ASSURANCE	Funding or enforceable pledges of funding used to guarantee performance of regulatory obligations in the event of default on such obligations by the permittee.
GOOD SAMARITAN ACTION	An action taken for the benefit of part or all of the community at large rather than for that of the doer. In the context of this report, it usually refers to the correction of some prior detrimental environmental legacy as a convenience or as a public service, but without direct personal or institutional benefit.
GROUNDWATER	Underground water.
HARDROCK	Locatable minerals that are neither leasable minerals (oil, gas, coal, oil shale, phosphate, sodium, potassium, sulphur, asphalt, or gilsonite) nor saleable mineral materials (e.g., common variety sand and gravel). Hardrock minerals include, but are not limited to, copper, lead, zinc, magnesium, nickel, tungsten, gold, silver, bentonite, barite, feldspar, fluorspar, and uranium. (BLM, 1999b) Usually refers to rock types or mining environments where the rocks are hard and strong and where blasting is needed to break them for effective mining. As used in this report, the term hardrock minerals is defined synonomous with "locatable minerals."
HEAP LEACHING	As used in this report, a process for recovery of minerals from heaps of crushed ore by percolation of a solvent (such as cyanide for gold, or ferric sulfate and sulfuric acid for copper) through the heap, followed by chemical processing of the lixiviant.
LEACH PAD	The surface upon which ore is piled for heap leaching, including those facilities to collect the lixivant for mineral recovery.
LEASABLE MINERALS	A legal term that identifies a mineral or mineral commodity that is leasable by the federal government under the Mineral Leasing Act of 1920 and similar legislation. Leasable minerals include oil, gas, sodium, potash, phosphate, coal, and all minerals on acquired lands. See Sidebar 1–1.
LIXIVIANT	A liquid medium that selectively extracts the desired metal from the ore or material to be leached rapidly and completely, and from which the desired metal can be recovered in a concentrated form.
LOCATABLE MINERALS	A legal term that identifies minerals acquired through the General Mining Law of 1872, as amended. Examples are given in Table A-1. Locatable minerals are distinguished from federally owned minerals that are disposed of by leasing (see leasable minerals). In some

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	situations, the term "hardrock minerals" is applied to locatable minerals. See Sidebar 1–1.
LOCATION	See "claim." Also, the process of claiming or appropriating a parcel of mineral land.
LODE CLAIM	Synonymous with "vein claim." As used in this report, a claim based on the presumption that the valuable mineral is a part of a bed-rock lode, vein, stockwork, stratum, or intrusion and is not dominantly a physical redistribution of values by surficial processes (the latter constitutes a placer deposit).
MINE	An opening or excavation in the ground for the purpose of extracting minerals.
MINERAL	Several other common meanings, but the following is used in this report: Any natural resource extracted from the earth for human use; e.g., ores, salts, coal, or petroleum.
MINERAL DEPOSIT	A mineral occurrence of sufficient size and grade that it might, under favorable circumstances, be considered to have economic potential.
MINERAL OCCURRENCE	A concentration of mineral that is considered to be valuable or that is of technical or scientific interest.
MINERAL SPECIES	Term used in this report to distinguish specific mineralogical species from the unmodified term *"mineral"* as defined above.
MULTIPLE USE	A combination of balanced and diverse resource uses that takes into account the long-term needs of future generations for renewable and nonrenewable resources, including, but not limited to, recreation, range, timber, minerals, watershed, wildlife and fish, and natural scenic, scientific and historical values; and harmonious and coordinated management of the various resources without permanent impairment of the productivity of the land and the quality of the environment with consideration being given to the relative values of the resources and not necessarily to the combination of uses that will give the greatest economic return or the greatest unit output. [43 U.S.C. §1702 (c)].
NOTICE-LEVEL OPERATION	A mining or exploration operation on BLM land involving more than casual use but requiring that the operator submit only a Notice rather than a plan of operations. It is limited to an area of disturbance of 5 or fewer acres. See Sidebar 1–3.
OPERATIONS	As used in this report, all activities and facilities involved in management, access, exploration, extraction, beneficiation, maintenance, or reclamation.
ORE	The naturally occurring material from which a mineral or minerals of economic value can be extracted profitably or to satisfy social or political objectives.

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OVER-BURDEN	Material of any nature, consolidated or unconsolidated, that overlies a deposit of useful minerals or ores.
OXIDA-TION	As used in this report, the reaction of ores or waste with oxygen (usually above the water table); in sulfide ores this results in the release of sulfuric acid that, in the absence of neutralization, mobilizes iron, copper, zinc, and other minerals. (See also redox.)
PATENT	Concerning the ownership of a mining claim: as a noun, A document that conveys title to the ground; or the process of securing a patent.
PERFOR-MANCE -BASED STAN-DARDS	standards expressed in terms of a desired result or outcome rather than a method, process, or technology. See also "Technically prescriptive standards."
PHREATO-PHYTE	A plant that obtains its water supply from the zone of saturation or through the capillary fringe and is characterized by a deep root system.
PIT LAKE	As used in this report, a lake that forms within the open pit of a mining operation.
PLACER	A mineral deposit that has achieved its present distribution through the prior action of moving water or wind. Placers are usually in poorly consolidated materials and are the sources of much, but not all, tin, titanium, rare earths, diamonds, and zirconium, and some gold.
PLAN OF OPERA-TIONS	A plan for mining exploration or development on BLM land involving more than 5 acres or a plan for mining where the operator with preexisting, valid claims intends to mine in an area of Critical Environmental Concern or a Wilderness area. See Sidebar 1–3. Also a plan required for mining or exploration on Forest Service lands whenever the Forest Service determines that the operation will result in "significant" disturbance of the land surface.
POINT SOURCE DIS-CHARGE	Discharge of pollutant from a discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, or container.
POST-CLOSURE	As used in this report, referring to the time after a property formerly used for mining has been reclaimed.
PRECIOUS METAL	Any of several relatively scarce and valuable metals, such as gold, silver, and the platinum group metals.
PROSPECT-ING	The search for outcrops or surface exposures of mineral deposits. Searching for new deposits; also preliminary explorations to test the values of lodes or placers already known to exist. (See also "exploration".)
PUBLIC DOMAIN	Land owned, controlled, or heretofore disposed of by the U.S. government.

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Hardrock Mining on Federal Lands
http://www.nap.edu/catalog/9682.html

PUBLIC LAND	The part of the U.S. public domain to which title is still vested in the federal government and that is subject to appropriation, sale, or disposal under the general laws.
RECLAMATION	Restoration of mined land to original contour, use, or condition. But as used in this report, also describes the return of land to alternative uses that may, under certain circumstances, be different from those prior to mining.
RECORD OF DECISION	Under NEPA, a concise public record that states what an agency's decision was, identifies all alternatives considered by the agency and the factors considered by the agency, and states whether all practicable means to avoid or minimize environmental harm from the alternative selected have been adopted or if not, why not.
REDOX	Adjective identifying chemical reactions involving oxidation (and reduction).
RESERVED LANDS	Federal lands which are dedicated to or set aside for a specific purpose or program and which are, therefore, generally not subject to disposition under the operation of all of the public land laws.
RESERVE	The quantity of mineral demonstrated to be present and known to be economically producible.
SALEABLE MINERALS	A legal term that defines mineral commodities that are sold by contract from the Federal Government. These are generally construction materials and aggregates. See Sidebar 1–1.
SEDIMENTARY	A rock composed of sediments, or ores formed during a process of sedimentation.
SUCTION DREDGE	A dredge in which the material is lifted by pumping through a suction pipe.
TAILINGS	As used in this report, the waste from mineral beneficiation. They are usually regarded as liabilities, but under some circumstances they may be reprocessed to recover additional values.
TECHNICALLY PRESCRIPTIVE STANDARDS	As used in this report: standards expressed in terms of the techniques to be applied. See also “Performance-based standards.”
UNCOMMON VARIETY MINERALS	Mineral materials that have a special quality, quantity, character, or location that makes them of unique commercial value. On public lands such minerals are locatable under the Mining Law of 1872, as amended. See Sidebar 1–2.
UNNECESSARY OR UNDUE	A surface disturbance greater than what would normally result when an activity is being accomplished by a prudent operator in usual, customary, and proficient operations of similar character and taking into consideration the effects of operations on other resources and land uses, including those resources and uses outside the area of operations. Failure to initiate and complete reasonable mitigation measures,

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	including reclamation of disturbed areas or creation of a nuisance, may constitute unnecessary or undue degradation. Failure to comply with applicable environmental protection statutes and regulations thereunder will constitute unnecessary or undue degradation. Where specific statutory authority requires the attainment of a stated level of protection or reclamation, such as in the California Desert Conservation Area, Wild and Scenic Rivers, areas designated as part of the National Wilderness System administered by the Bureau of Land Management and other such areas, that level of protection shall be met.
WASTE	The part of an ore deposit that is too low grade to be of economic value at the time of mining, but which may be stored separately for possible treatment later.
WATER TABLE	As used in this report, the surface separating the zone is water-saturated from the zone containing air that is freely connected to the atmosphere.
WEATHERING	As used in this report, the process of decomposition of rocks or ores through the action of air and water.
WITHDRAWAL	Segregation of particular lands from the operation of specified public land laws, making those laws (including the mineral location and leasing laws) inapplicable to the withdrawn lands.
YEAR EVENT	The probabilistic frequency for an event of a given magnitude (e.g., a 1000-year flood).
228 AUTHORITY	U.S. Forest Service regulations found at 36 CFR Part 228.
261 AUTHORITY	U.S. Forest Service regulations found at 36 CFR Part 261.
3809 REGULATIONS	Bureau of Land Management regulations found at 43 CFR Subpart 3809.

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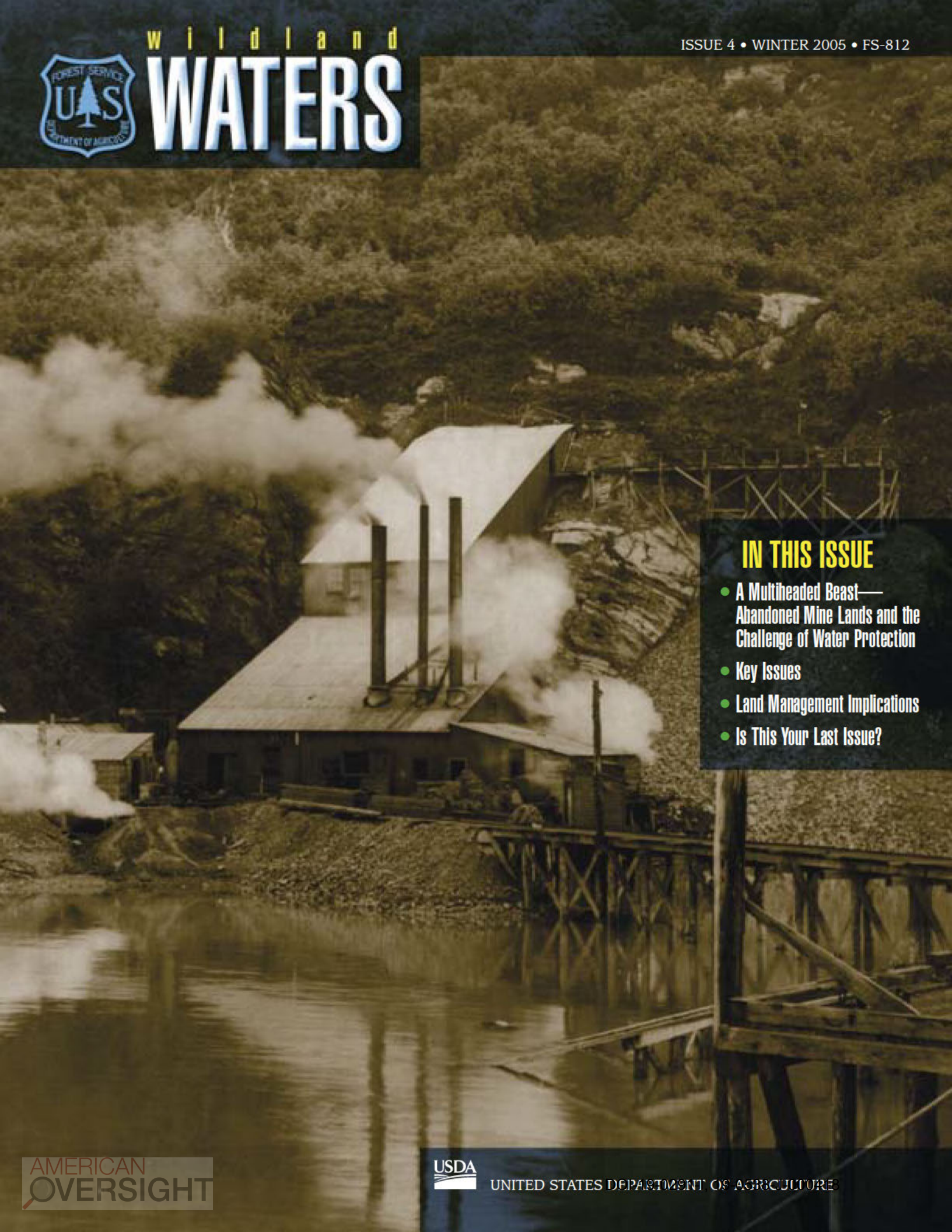
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Exhibit D

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wildland WATERS



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- Key Issues
- Land Management Implications
- Is This Your Last Issue?

USDA
UNITED STATES DEPARTMENT OF AGRICULTURE

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A Multiheaded Beast:

Abandoned Mine Lands and the Challenge of Water Protection

"The process for reclamation of abandoned mine sites is a multiheaded beast that has been difficult to master."

—Forest Service Geologist Mike Greeley

As producers of gold, silver, copper, lead, and other "hardrock minerals," the hardrock miners once held a prominent place in our 19th century social and economic fabric. Now, the deserted remains of tens of thousands of these mines are scattered across the landscape of national forests, many posing immediate or potential threats to our water and watersheds.

The movement to clean up abandoned mines on public lands has gained momentum in recent years as the U.S. Department of Agriculture (USDA) Forest Service and numerous Tribal, Federal, State, and private partners have begun to tackle mutual problems of health and safety with new authority and heightened commitment. Although complex challenges remain, substantial progress is being made toward reclaiming abandoned hardrock mine sites in priority watersheds and other sites across public and private boundaries.

In this issue, we will examine how past hardrock mining activities can affect water today and tomorrow. We'll also explore a few of the successful efforts to date that demonstrate creative solutions to complex clean up challenges, along with a sampling of the research, technology, and policy issues that may help us tackle this beast.

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Not all mining is hardrock

"Hardrock minerals" refer to "locatable" materials in rock, such as metals, uranium, and uncommon varieties of sand, stone, and gravel claimed and developed under the General Mining Law of 1872. But not all mining is hardrock. Coal, oil, gas, phosphate, potash, sodium, sulphur, and other nonmetalliferous minerals are considered "leasable" minerals. Common varieties of sand, stone, gravel, and other rocks are considered "salable" minerals. Leasable and salable minerals have their own sets of laws, regulations, and impacts.



Minerals used for heating, fuel, plastics, wiring, coins, building products, manufacturing materials, and electronics, for a few examples, all come from mines.

Ghosts from the past—old laws and old ways

One of the most significant laws regulating the use of Federal lands for mining today was passed more than a century ago. The United States Mining Law of 1872 promoted and provided for the use of several hundred million acres of public lands in the United States for the exploration, location, and development of gold, silver, copper, iron, nickel, and other hardrock minerals.

The promotion of mining for metals and mineral resources on federally administered lands helped encourage industrial growth and settlement of the West. Many of these mineral deposits were located in remote areas far from population centers. When a mine was no longer profitable, common practice was to abandon the site and, in some cases, to vacate entire mining districts.

Although many Federal lands have been withdrawn from mineral entry, approximately 65 percent of lands administered by the Forest Service are still open to hard rock mining. Mining remains one of the core industries of the U.S. economy.

Current environmental laws and permitting procedures aim to minimize and prevent impacts on human health and the environment from contemporary mining operations. But things were different in the old days when land was cheap and environmental laws were practically unheard of.

"The miners of yore were operating in different times," noted Mike Greeley, minerals program manager for the Forest Service, in a presentation to the Society for Mining, Metallurgy, and Exploration.

"Mine sites were remote, often almost inaccessible; population density was low; and prospectors and miners were not constrained generally by environmental concerns or regulations," he added. "The attention and understanding of scientists and the public to the cause and effect of environmental hazards was weak. The practices of the miners were, for the most part, the practices of society." Today, miners are well acquainted with environmental laws and use best management practices in their mining and mineral processing operations.

The most common casualty: water

Water has been called mining's "most common casualty" (Environmental Mining Council of British Columbia [EMCBC]) because the most pressing environmental problems associated with abandoned hardrock mine sites relate to water pollution.

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"Mining by its nature consumes, diverts, and can seriously pollute water resources," notes the EMCBC. "Water contamination ... can occur when streams, rainwater, and melting snow come into contact with toxic mine material...," threatening wildlife, fish, insects, soil, and vegetation.

The problem is particularly acute in the Western United States where "thousands of stream miles are impaired by drainage and runoff from such [abandoned] mines, one of the largest sources of adverse water quality impacts in several Western States," according to the Western Governors Association (WGA 2001).

"As the West's population expands," described environmental consultants Debra Struhsacker and Jeffrey Todd in a report for the National Mining Association (Struhsacker and Todd 1998), "more people are at risk of coming into contact with abandoned mines scattered throughout the region."

Abandoned mines pose a danger to water on a number of scores:

- **Earth disturbance.** To reach and extract the desired minerals, most mining operations displace massive amounts of soil and rock, either at the surface or underground.
- **Toxic processing.** Desired metals must be extracted or leached using chemicals that can be toxic if released into the environment.
- **Piles of waste.** Waste rock, spent ore, or tailings are generally disposed of in large heaps, ponds, or tailing impoundments, which can occupy a few or a hundred or more acres. If these facilities are poorly designed, improperly sealed, or abandoned, their failure can lead to contamination of streams and aquifers. Toxic powders from dried-up tailings ponds can blow away and contaminate surface and groundwater far from the original site.
- **Acid mine drainage.** Exposure of the Earth's crust to water, air, and bacteria can transform the sulfide minerals —which are frequently associated with metallic ores—into sulfuric acid and metal ions, which were once locked within rock. The toxic liquid, known as "acid mine drainage," constitutes one of the most common, serious, and long-term water pollution problem associated with mining.



Traditionally, it takes a LOT of rock to end up with a little valuable metal, let alone a finished product. The production of a single 18-karat gold ring, for example, can generate over a ton of mine waste.

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The orange-stained toxic effluent known as acid mine drainage is the most visible and pervasive effect on water from abandoned hardrock mines.



Little Bear Abandoned Mine Site, Arapaho National Forest, south of Idaho Springs, CO. Sulphide-bearing waste rock pile, discharging directly into Little Bear Creek, is stabilized and vegetated to stop sediment and heavy metal runoff. Such clean up efforts can be complicated, time-consuming, and expensive.

Just the facts: A big reach and a big job

Estimates of the numbers of abandoned hardrock mine lands and the costs to clean them up are rough because data collection has been difficult and highly variable. The following are some rough numbers indicating the size and scope of the task:

• **Abandoned hardrock mine sites in country**	**557,000**
• **Abandoned sites on or affecting National Forest System (NFS) lands**	**38,500**
• **Abandoned sites on or affecting NFS lands with identified pollution problems**	**6,000—about a third of which are high-priority for clean up because of potential releases of hazardous substances**
• **Sites on or affecting NFS lands already cleaned up**	**203 from 1998 to 2003—83 of which were Comprehensive Environmental Response, Compensation, and Liability Act (hazardous) clean ups**
• **Sites on or affecting NFS lands with the clean up underway**	**In 2004, clean up should be completed at 21 sites, work ongoing at 103 more**
• **Estimated cost to clean up identified sites on or affecting NFS lands**	**$4 billion**

Compiled from various sources including the U.S. Environmental Protection Agency and Forest Service reports.

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Substantial progress is being made toward reclaiming abandoned hardrock mine sites across public and private boundaries.

Taming the beast: a clean up challenge

Abandoned mines may require management or treatment for decades, or forever, often far downstream from the mine site itself. The challenge to clean up and stabilize these sites was likened by Mike Greeley to a massive "multiheaded beast" whose taming will require inventories to find the most dangerous sites, laws and new approaches to be effective, and a willingness to work together to overcome daunting jurisdictional disputes.

Inventory: first you have to find them

Locating the many thousands of abandoned mining operations on Federal land is the first step in the effort to clean them up. Some operations, particularly those that produced and milled ore were described and entered into databases by various State and Federal agencies, for example the Bureau of Mines and the U.S. Geological Survey. Many mine facilities, however, were never described or documented. The task for Federal land management agencies, like the Forest Service, was to use existing records to find, locate, and assess the human health and environmental hazards at these sites.

In the 1990s, the national effort to inventory abandoned mine sites became more systematic. Today, the focus is more on determining which sites in existing inventories most put human health or the environment at risk and prioritizing these for immediate action.

Laws and new approaches

Clean up responsibility of abandoned sites is often shared by both government and private entities. The goals of clean up efforts under the various laws are similar:

- Removal or modification of mining facilities for environmental or safety reasons;
- Isolation, removal, and/or treatment of toxic or hazardous materials;
- Reshaping and stabilization of disturbed lands;
- Establishment of vegetative communities; and
- Monitoring and maintenance of the site.

Federal law sampler

Several Federal laws are relevant to abandoned mine clean up, including:

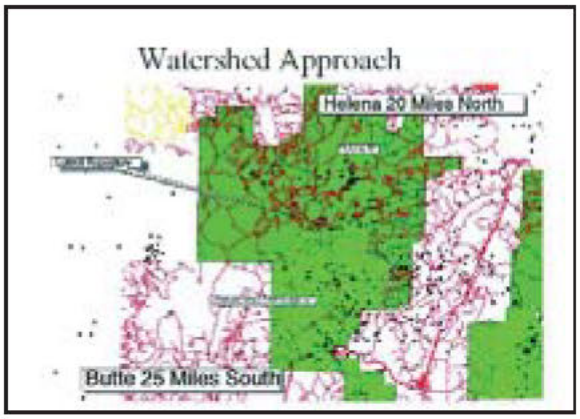
- *the Clean Water Act,*
- *the National Historic Preservation Act,*
- *the Endangered Species Act, and*
- *the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or otherwise known as Superfund). Through Executive Order 12580 (1987), the Forest Service has authority to administer CERCLA on National Forest System lands.*

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Four steps in a watershed approach

Four general components of a watershed approach include:

- *Statewide analysis and prioritization,*
- *Watershed characterization,*
- *Site characterization, and*
- *Monitoring (Nimick and von Guerard 1998).*



This map illustrates part of the logic behind a watershed approach for abandoned mine land work. Each dot represents an inventoried abandoned mine site. The centralized Luttrell Pit repository was the focal point for clean up efforts across two major watersheds in Montana.

Under the authority provided by environmental laws and agency regulations, the Forest Service completed more than 200 clean ups between 1998 and 2003 at an agency cost of more than $80 million. Responsible parties also have paid for more than $230 million worth of clean up at sites since 1998. For 2004, the agency plans to spend more than $13 million on abandoned mine land clean ups in more than 70 watersheds in 13 Western States and 1 Eastern State. In addition, the Forest Service has started multiyear clean up projects at more than 100 abandoned mine sites of varying size.

The sequence of events generally starts with agencies identifying hazardous sites and potentially responsible parties for clean up. Agencies then attempt to secure funding from responsible parties and, eventually, take clean up action themselves if no viable responsible party can be found (Smit and Broetzen 1998).

Although each individual situation requires its own solution, managers must understand what is going on throughout the watershed and identify the various sources of contamination if the clean up is to be effective. For example, in some mining districts, the geology and hydrology that produced the desirable minerals also produce water whose natural acidic levels is unrelated to mining. In a cleanup program, the manager must prioritize the watersheds, as well as abandoned mine sites within a watershed, to be the most cost effective in reducing stream pollution.

Consequently, Federal agencies today use a more holistic "watershed" approach to identify entire watersheds that are most at risk. "The concept behind this approach," Greeley pointed out, "is to unify all stakeholders in the identification, prioritization, and clean up of important drinking water supplies, fisheries, and wildlife habitat."

In a watershed approach, scientists undertake water and soil sampling, biological assessments, and engineering cost estimates across the watershed; managers then identify for remediation those sites that may pose the most serious threats.

The holistic approach also involves identifying and engaging all the relevant players—across administrative, political, and geographic boundaries. By working together, watershed-wide clean up efforts can address all significant abandoned mine problems within watersheds regardless of ownership—faster, cheaper, and more efficiently than struggling site by site.

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Impediments to progress

Even the most committed efforts to clean up abandoned mine lands are hindered by a variety of challenges and problems. The most vexing include:

- **Mixed ownership patterns**—Pockets of private mine lands within the boundaries of Federal lands can hinder access, funding, data gathering, and authority to conduct work, making clean up a complicated procedure.
- **Costs**—The huge amounts of person-power, time, and money required to address the enormous problems are hard to come by with limited budgets.
- **Concerns about liability**— Efforts by States, municipalities, citizen groups, and private parties to voluntarily clean up abandoned mine sites have been limited because of concerns over liability. Good Samaritan parties who may want to clean up the private land portions of mixed-ownership watersheds fear that pollution permit requirements might be imposed on them even though they had no previous liability for the site and might have actually reduced the amount of pollution being discharged from the site.

The Forest Service completed more than 200 clean ups from 1998 to 2003 at an agency cost of more than $80 million.

Working together: sampler of success stories

While the process has often been slow, tedious, and frustrating, there are encouraging successes as Federal, State, and private organizations have combined resources to tackle mutual, often controversial, problems. The following examples are from the Western United States, representing a cross-section of the challenges, opportunities, pitfalls, partnerships, costs, and creative solutions for protecting and restoring waters from the impacts of abandoned mine lands.

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Moon Gulch before and after



Moon Gulch before and after

Moon Creek/Moon Gulch Reclamation Project, Idaho

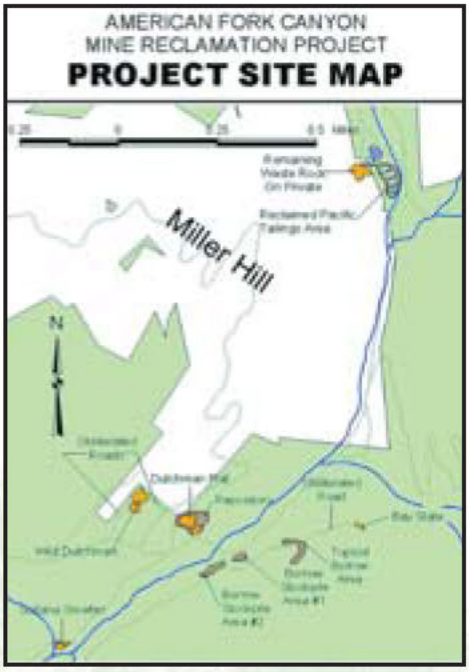
http://ecorestoration.montana.edu/mineland/histories/metal/moon_gulch/default.htm

Less than a decade ago, a 20-acre abandoned hardrock mine and mill complex on the East Fork of Moon Creek, within the Coeur d'Alene District of the Idaho Panhandle National Forest, posed an impending risk to humans, fish, and wildlife. High concentrations of lead, zinc, mercury, arsenic, and other toxic metals were draining and eroding from this early 20th century mine site, creating a treeless, lifeless moonscape. In the mid 1990s, a multiagency team of engineers, scientists, and forest managers from the Forest Service, Bureau of Mines, and a private engineering company began an extensive effort to reduce human health hazards, improve habitat for native Westslope Cutthroat trout, and restore the adjacent riparian area to premining conditions. The $1.9 million Comprehensive Environmental Response, Compensation, and Liability Act removal action, completed in 2000, diverted the stream away from the tailings impoundment, removed the road that was causing sedimentation, and revegetated the slopes and floodplain with native plants. An innovative waste containment uses a compacted gravel drain system, a hi-tech "geocell mattress," a 5-foot impervious berm armored with riprap, and a special cap designed to keep water out. "Water quality measurements show vast improvement, erosion no longer occurs, and the project's removal action goals have been achieved," explained Forest Service geologist Jeff Johnson, who added, "but we are still not finished." Plans are underway with Tribal and Federal trustees to accomplish a more complete restoration of the ecosystem than originally envisioned. "We are now looking at true restoration focused on fisheries and wildlife habitats, including better upland habitat for wintering elk," Johnson noted. "We want to be able to say, 'It's finished—human health has been addressed and we have also restored this place to pre-mining conditions for fish and wildlife.'" Construction of the next phase for Moon Creek is planned for completion during the 2005 field season.

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The excavated repository at American Fork before material placement.





American Fork Canyon Watershed Reclamation Project, Utah

http://www.fs.fed.us/r4/mine_clean up/mc_projects/american.pdf

The high, rugged alpine lakes, canyons, and ridges of the North Fork area of the American Fork River Canyon in Utah are premier recreation destinations for skiing, hunting, fishing, camping, hiking, and off-road-vehicle use. They are also popular for exploring the more than 100 abandoned mine sites that date from the 1870s through the 1950s. But the abandoned mines, mills, and smelters that once produced lead, silver, and gold—extending across both public and private lands—presented more than a recreational opportunity; they also posed serious threats to people and wildlife. "ATVs [all-terrain vehicles] kicked up lead dust at 2,000 times acceptable limits, and arsenic levels were so high that a State advisory was issued against eating local trout," noted Forest Service Regional Mine Clean up Coordinator Maggie Manderbach. Important habitats for wildlife and fish, including the sensitive Bonneville cutthroat trout, were also at risk from toxic metal mine pollution.

In partnership with State and Federal agencies, local recreation interest groups, county commissioners, and landowners, the Uinta National Forest launched a $1.2 million study and complex watershed-scale reclamation effort in 2002 to restore the six historical sites that posed the highest risks to people and the environment. A private contractor excavated and stockpiled more than 20,000 cubic yards of soil and rock from a 3-acre site designated as the permanent repository for contaminated materials. "Borrow" material was then used to backfill other sites after toxic materials were removed and placed into the repository. Temporary roads were constructed, then obliterated and revegetated. New ponds were created to help filter metals from continuing mine drainage before it enters the river. Once the repository was filled, a unique four-layer composite liner was placed over the carefully shaped area to prevent future water from reaching the stored toxics; the whole thing was covered with 2 feet of soil and revegetated. The repository design even allowed for the concrete foundations of one of the mill sites to remain as a cultural artifact.

Completed in 2003, the project benefited from an excellent on-scene coordinator and committed State support. According

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A guardrail barrier (weathering steel) was installed at the base of the American Fork repository to prevent access by motorized vehicles and disturbance to the repository cover materials and vegetation.



Cleanup of the Pennsylvania Mine on the White River National Forest. This is one of the abandoned mines in the Peru Creek Basin.

Successful clean up of abandoned mine lands on public and private lands ultimately will rely on effective public policy.

to Manderbach, "One hurdle not quite leapt was that parts of the project site are on private land, with no support from the landowners. But the good news is that Trout Unlimited has hired the recently retired on-scene coordinator to develop a plan for cleaning up the private land with grant funds. That's pretty exciting." Future challenges will be to monitor and prevent damage to the liner from motorized vehicles, moose, beavers, and acts of vandalism. Environmental monitoring will also include sampling of water quality and testing of fish and invertebrate tissues beginning in 2006; native vegetation will continue to be planted during 2004–2006.

Peru Creek Basin Site Assessment, Colorado

http://www.epa.gov/brownfields/pdf/asummit.pdf

Lingering acid contamination from numerous abandoned 19th century mine sites posed a contemporary dilemma for the nearly 25,000 people living and recreating in the Peru Creek basin in Colorado. Community attempts to fix environmental problems associated with the sites had floundered for more than a decade, in part because of an overwhelming fear of potential liability. In 2001, Summit County proposed to take the lead in conducting environmental site assessments and legal analysis of about 1,200 acres of privately held mining claims. A $200,000 U.S. Environmental Protection Agency (EPA) grant has helped the county and many partners start the long clean up process in this high-elevation area that is a prime recreational draw in peak season. This dynamic community-based environmental protection effort involves county, State, and Federal agencies along with a nonprofit land trust, academics, and community members who are conducting environmental site assessments and legal analysis of the mining claims. The hope is that with sufficient accurate information and an understanding of the liability issues, proven management techniques can be used to clean up the creek and contain the contamination.

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Workers in the foreground are preparing the Luttrell Abandoned Mine Waste Repository for 2003 remediation work. Previously placed abandoned mine wastes with temporary cover are shown in the background.

Luttrell Pit Joint Repository, Montana

A creative collaborative approach is being used to address complex technical, financial, legal, and political challenges at more than 60 abandoned mines within two major watersheds on the Beaverhead-Deerlodge National Forest in Montana. Mined since the 19th century, the sites were contaminating and degrading the Boulder and Upper Tenmile Creek watersheds, which are the sources of drinking water for the town of Basin and the capital city of Helena.

Stimulated in part by energetic community efforts, an EPA- and Forest Service-led multiagency clean up of the sites focuses on use of the Luttrell Pit within the defunct Basin Mine complex as the first regional joint mine waste repository to be implemented in the Nation. In the first year alone, numerous partners cleared the 6-acre repository, improved access roads, backfilled the floodplain with top soil, planted 5,000 native trees and shrubs to stabilize streambanks, constructed a streambed and two sediment ponds for settling out toxic chemicals, and excavated and hauled away some 40,000 cubic yards of mine wastes. The repository provides a geographically centralized and topographically stable engineered facility to safely seal more than 2 million yards of contaminated soil and mine waste in a lined and capped pit using state-of-the-art technology. The U.S. Geological Survey began monitoring the drainages prior to and during the reclamation process, and several deep wells surrounding the pits provide a way to monitor water quality over time.

"Vegetation is beginning to return to the sites, and conditions in the drainages are improving," described Bob Wintergerst of the Forest Service's Northern Regional Office. "The ultimate success will be the elimination of the human health risks associated with historical mining sites and substantial improvement to the water quality in the drainages." The project is expected to be completed in 2010.

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Exorcising the ghosts: research, technology, and public policy

Creative research collaborations

Numerous initiatives began to emerge in the 1990s to address research and remediation needs through Federal/State/private collaborative alliances. One example is the Abandoned Mine Land (AML) Initiative, launched in 1997, initially involving the National Mining Association, the Western Governors' Association, U.S. Department of Energy, Bureau of Land Management, EPA, National Park Service, Forest Service, and U.S. Geological Survey. This initiative has evolved to the point where affected Federal agencies work together on a site-by-site basis when mutual interests make regional collaboration most fruitful.

Creative research discoveries and technologies that emerged from the AML Initiative include:

- **Tracer tests:** A harmless tracer, such as a dye, is put into a stream, where its movements are measured and modeled to help identify sources of contamination.
- **Water quality and flow measurements:** The movements of contaminants are studied over time and the seasons.
- **Determination of pre-existing environmental conditions:** Natural levels of metals in streams are estimated and realistic restoration goals established.
- **Mapping:** Identification of those areas where land surfaces and stream channels have been affected by historical mining activities (U.S. Geological Survey1999).

Federal agencies today use a more holistic "watershed" approach to abandoned mine land clean up.

The huge amounts of person-power, time, and money required to address the enormous problems are hard to come by with limited budgets.

Advances in technology

Advancements in technology could make the abandoned mine land clean up efforts more efficient and affordable. Some examples include:

- **Wood-fiber water filters:** The Forest Service Forest Products Laboratory (FPL) is researching whether a new kind of water filter made from a variety of wood fibers, such as juniper, could be an effective way of removing heavy metals that drain from mine sites (Forest Service 2002). Tests at a coal mine indicate that the filters can be about 80 to 90 percent effective. Based on these successes, Forest Service Northern Region engineers and geologists are evaluating the effectiveness of this technology for hardrock mine drainage. The region is planning a pilot system that would be installed at the abandoned Charter Oak mine on the Helena National Forest.
- **Fly ash:** Fly ash is a by-product of coal-burning electrical production facilities. When mixed with water the ash forms an impermeable grout-like barrier that can effectively contain mill tailings and may also help to minimize certain chemical reactions associated with the production of acid mine drainage. One study revealed that after 4 years of monitoring a site grouted with fly ash, concentrations of most mine drainage parameters were reduced 40–90 percent (Sheetz, Silsbee, Schueck 1998).
- **Biological methods:** At the Zortman–Landusky Mine area in central Montana in 2000, a pilot bioremediation treatment system used specifically selected bacteria and microbes to dramatically reduce the concentrations of nitrates, selenium, and cyanide from a contaminated leach pad, at a cost estimated to be three to seven times lower than that of other water treatment systems. The results of the test were used to develop a full-scale water treatment system whose processes and bacteria could be tailored to other mine sites.

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Public policy implications

Successful clean up of abandoned mine lands on public and private lands ultimately will rely on effective public policy that supports, encourages, and provides incentives for the daunting task.

To alleviate the hesitancy to undertake voluntary clean ups engendered by Clean Water Act liability stipulations, parties interested in abandoned mine land clean ups have proposed legislation to amend the act to protect a Good Samaritan remediating party from becoming liable for continuing discharges from an abandoned mine site after the clean up is complete. The Good Samaritan would have to demonstrate that he or she has attempted to improve the conditions and is not otherwise a potentially responsible party for the site.

Various bills have been introduced in recent years. Some proposed Good Samaritan abandoned mine land clean up bills would fund clean up through the imposition of a fee on hardrock mining operations. Other bills simply provided for the issuance of a special abandoned mine remediation permit that would allow the implementation of best available clean up technology but would not burden a Good Samaritan with Clean Water Act discharge limits. Some would shield the remediating party from liability under the Clean Water Act, and some have proposed shielding the Good Samaritan from liability under all environmental laws.

There is consensus among interested parties that a well-crafted Good Samaritan Abandoned Mine Remediation Act could have tremendous water-quality benefits. However, there is also concern that such a law could make it easier for potentially responsible parties to avoid their clean up obligations. Another major concern has been finding a reliable source of funding for abandoned mine land clean ups that does not divert from other important programs. Discussions on these issues are continuing.

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Science and communication: up front and personal

Some environmental managers emphasize that the scientific process underlying abandoned mine land clean up needs to be at the front end of any policy decisions so that people remain knowledgeable and involved. Public involvement will depend on dependable timelines, shared data, and an open communication process that is sensitive to the problems and needs of each individual watershed and community.

"Watersheds provide a framework for using scientific information to make informed decisions," wrote Margot Smit and Gary Broetzman of the Colorado Center for Environmental Management (Smit and Broetzman 1998). However, just doing good science is not enough, they noted. "There is a need for the information to be synthesized and for it to be presented in an understandable format, using consistent terminology, so that everyone can communicate with each other. This kind of communication of the science will hopefully enable an easier marriage between the scientific community and land management practitioners."

Toward a future of clean water

Since many abandoned mine sites have been around for decades, some more than a century, clean up will be a long-term process taking substantial human and financial resources.

Experience gained by the Forest Service and others during the past few decades has demonstrated that there are no quick and easy solutions to abandoned mine lands and water protection. However, modern mining regulations and progress made using collaborative partnerships and a watershed approach point positively to the potential for solid success. As Mike Greeley noted, there is every expectation that, "as stakeholders continue to meet and work together to attempt reasonable techniques and implement balanced, equitable solutions, increased success will be gained."

Times have changed since earliest mine practices. Contemporary environmental laws, public attitudes, and reclamation requirements leave no room for the antiquated practices of the past. Current Forest Service regulations that require approval of a plan of operations, mitigation measures to lessen the adverse impacts to other resources, and reclamation performance bonds are extremely helpful in preventing environmental harm after an active mining operation ceases. As research, technology, and policy decisions continue to evolve, so will the effectiveness of the effort to exorcise the ghosts of contamination from abandoned mine lands and to minimize the need for future generations to wrestle with this multiheaded beast.

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Key Issues



- Approximately 6,000 abandoned hardrock mine sites on or affecting National Forest System lands may pose a threat to water resources across the country, especially in the West.
- About one-third, or 2,000, sites are a high clean up priority due to the threat of hazardous substance releases. Their clean up is vital to the restoration of many wetlands and watersheds.
- The main threat is water pollution from past mining processes, chemicals, or residues; management or treatment may be needed for years, often far downstream from the mine itself.
- A major goal of mine inventory and clean up is to identify and clean up those mines that put human health or the environment at risk.
- Impediments to effective clean up include mixed ownership patterns, costs, and fears of liability.
- The focus of research and technology must be on developing more efficient treatments and making them more passive and affordable. ▮

Land Management Implications



- Inventory and clean up efforts require a watershed-scale approach and effective use of partnerships.
- Adequate funding and leveraged funding from other sources for abandoned mine land clean up must be a management priority.
- Risk of liability can be reduced by Good Samaritan legislation, proactive management and policy actions.
- Vigorous oversight and enforcement of mine operating plans, including bonding and reclamation provisions, will prevent ongoing mining operations from becoming future threats to human health and the environment. ▮

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Exhibit E

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Abandoned Mine Lands:
A Decade of Progress Reclaiming Hardrock Mines





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ABANDONED MINE LANDS:
A DECADE OF PROGRESS
RECLAIMING HARDROCK MINES

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A Word From the BLM and the Forest Service

It is with great enthusiasm and appreciation that we celebrate 10 years of hardrock abandoned mine lands (AML) program success addressing the impacts of abandoned mines on public lands. Over the last decade, the U.S. Department of the Interior's (DOI) Bureau of Land Management (BLM) and U.S. Department of Agriculture's (USDA) Forest Service hardrock AML programs have grown and matured through the dedication and hard work of many people. As Federal land management agencies, our success comes through the strength of our commitment to Cooperative Conservation principles, and the transparency, accountability and innovation that occurs through the exchange of ideas and ongoing dialogue with partners.

The BLM and Forest Service hardrock AML programs operate to improve the quality of public lands placed in our care through similar missions:

- To mitigate hazards present at abandoned mine sites;
- To restore watersheds for natural resources; and
- To protect public health and safety, recreation, fish, and wildlife.

We implement a risk-based approach to encourage watershed-wide cleanups that leverage resources through collaboration with other stakeholders. We also work to mitigate hazards at AML-affected watersheds in western, arid climates where water is scarce and the need to improve water quality for human and aquatic resources use is critical. Addressing AML impacts is becoming increasingly important as more and more people choose to live near and recreate in our public lands.

We have expanded our outreach efforts to increase awareness and educate the public about the serious dangers that exist at abandoned mine sites. We improved our information and technology transfer through avenues such as our newly redesigned Web sites (see http://www.blm.gov/aml and http://www.fs.fed.us/geology/aml-index.htm) and project highlights. In addition, we continue to work with the commercial sector, such as off-highway vehicle distributors, to increase education and awareness as more remote sites are being developed and accessed for recreation.

We are committed to fostering innovation and work closely with our Federal, State, tribal, and non-governmental partners to address the highest priority sites first. Together, we coordinate lessons learned and share best practices to integrate decision-making, improve accountability, and advance cleanup technologies across agency programs.

As we look to the future we know there is still work to be done. We renew our commitment to address high-risk and high-priority abandoned mine sites to protect public health and safety. We will cultivate existing relationships and pursue additional partnerships to further reduce risks and liabilities, share information and ideas, and leverage additional funding. Furthermore, we will seek out new and innovative means to implement sustainable mining practices.

James M. Hughes
Bureau of Land Management,
Acting Director

Abigail R. Kimball
Forest Service Chief

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THE BLM AML PROGRAM MISSION

To support core BLM programs by addressing degraded water quality, hazardous materials, and other environmental impacts on or affecting lands administered by the BLM, and to mitigate physical safety hazards of abandoned mine sites on public lands.



THE FOREST SERVICE AML PROGRAM MISSION

To minimize the environmental, human health, and safety hazards at abandoned mines, while preserving the historic and wildlife habitat resources that they provide.

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INTRODUCTION



Acid mine drainage leaching from the Mozart Mine in Colorado.

Ten years ago, the Department of the Interior's (DOI) Bureau of Land Management (BLM) and the U.S. Department of Agriculture's (USDA) Forest Service embarked on mutual efforts to address the impacts of hardrock abandoned mine lands (AML). Although both DOI and USDA have coordinated with States to clean up abandoned coal mines under the Surface Mining Control and Reclamation Act (SMCRA) of 1977, the need for a national strategy to address abandoned hardrock mines was the driving force behind both agencies initiating AML programs. Since 1997, these AML programs have addressed physical and environmental hazards at thousands of abandoned hardrock mines. Through cooperative efforts, the BLM and Forest Service have learned lessons about the complexities and obstacles associated with cleaning up these sites. The purposes of this report are threefold: 1) to shed light on abandoned mining sites and their impacts on public lands; 2) to highlight the accomplishments of the BLM, the Forest Service, and project partners in addressing AML problems; and 3) to describe the outlook for future AML reclamation efforts. Examples throughout the report offer insight into the environmental, health, safety, and economic effects often associated with these sites and illustrate the lasting and positive impacts of reclamation activities on formerly mined lands.

The Impact of Abandoned Hardrock Mine Lands on America's Landscape

The historic mining of hardrock minerals such as gold, lead, copper, silver, and uranium was a powerful incentive for exploration and settlement of the American West. Mineral development often provided the economic base on which many remote communities were established. However, when ore bodies were mined out and miners left to find new deposits, they often left behind a legacy of abandoned mines, structures, safety hazards, and contaminated land and water.

Today, approximately 47,000 abandoned mine sites have been identified on more than 450 million acres of Federal land managed by the BLM and the Forest Service. An estimated 20 to 30 percent of these mines have dangerous human safety hazards such as open mine shafts and adits, deadly gas and lack of oxygen, as well as unstable explosives and toxic chemicals. As many as 10 percent may be releasing toxic heavy metals, acidity, and radioactivity into rivers, lakes, and streams from underground and open pit mines, waste rock storage, and mill tailings facilities.

Currently, more than 63 million people live in the West and this number is increasing. More than 22 million people live within 25 miles of public lands in the West. Once remote sites are becoming ever closer to new population centers. In the Eastern United States, abandoned coal mines on National Forest System lands pose similar hazards to an even greater number of people. There is a strong emphasis on the cleanup of abandoned mining sites due in part to this increased exposure.



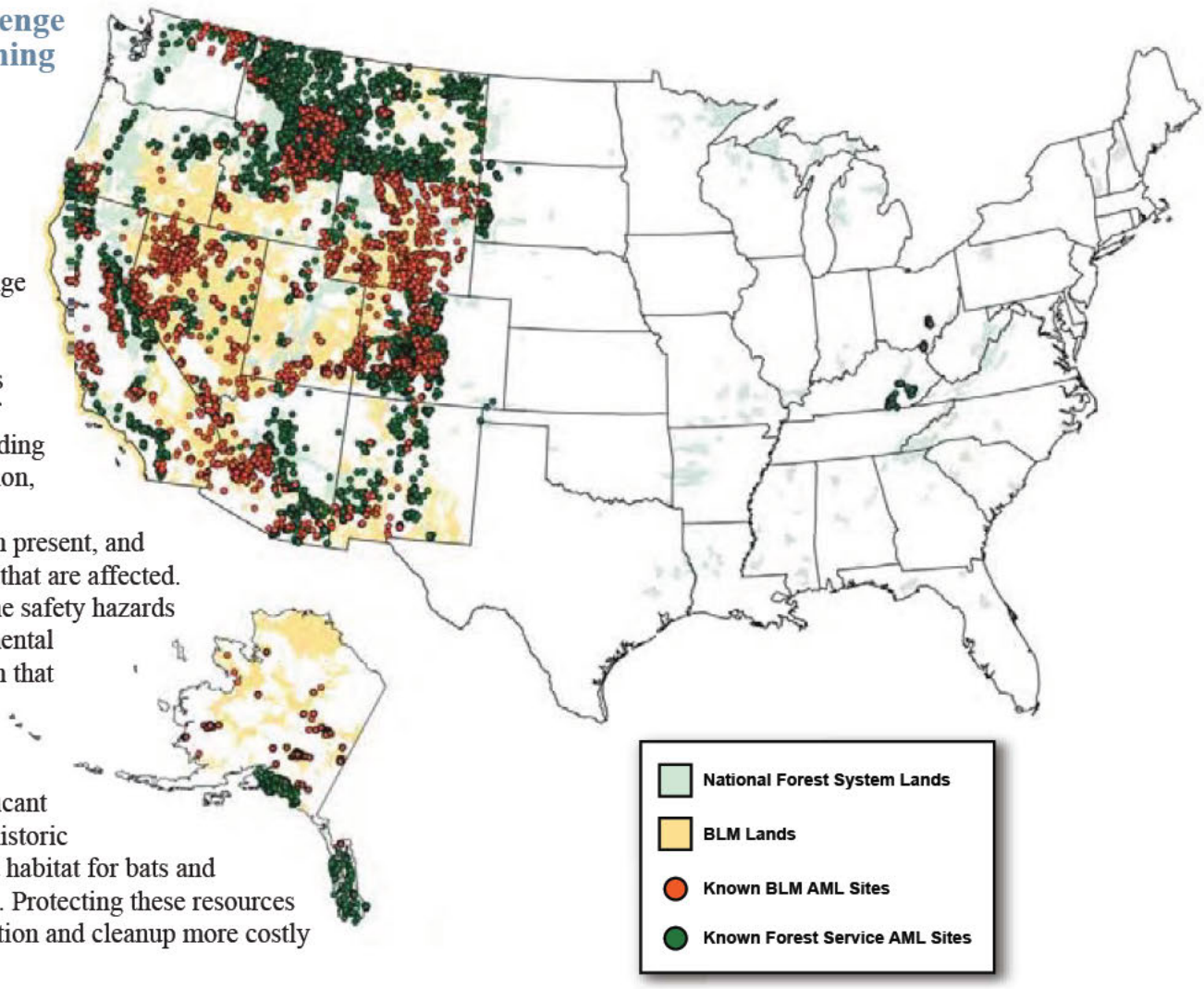
Recreational vehicles in the California Desert District.

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The Challenge of Reclaiming AMLs

The cost of reclaiming a single abandoned mine may range from tens of thousands of dollars to tens of millions of dollars depending on size, location, the nature of contamination present, and the resources that are affected. Aside from the safety hazards and environmental contamination that may exist, abandoned mines can also be significant cultural and historic resources and habitat for bats and other wildlife. Protecting these resources makes mitigation and cleanup more costly at these sites.



Currently no single source of funding, whether it be Federal, State, tribal, or private, is adequate on its own to address the magnitude of the problem that exists. To remediate a particular site, the BLM and Forest Service may work with Federal, State, and private partners who are able to apply funding from a variety of programs and authorities, including SMCRA; the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); and the Clean Water Act Grant Program.

Benefits of AML Reclamation

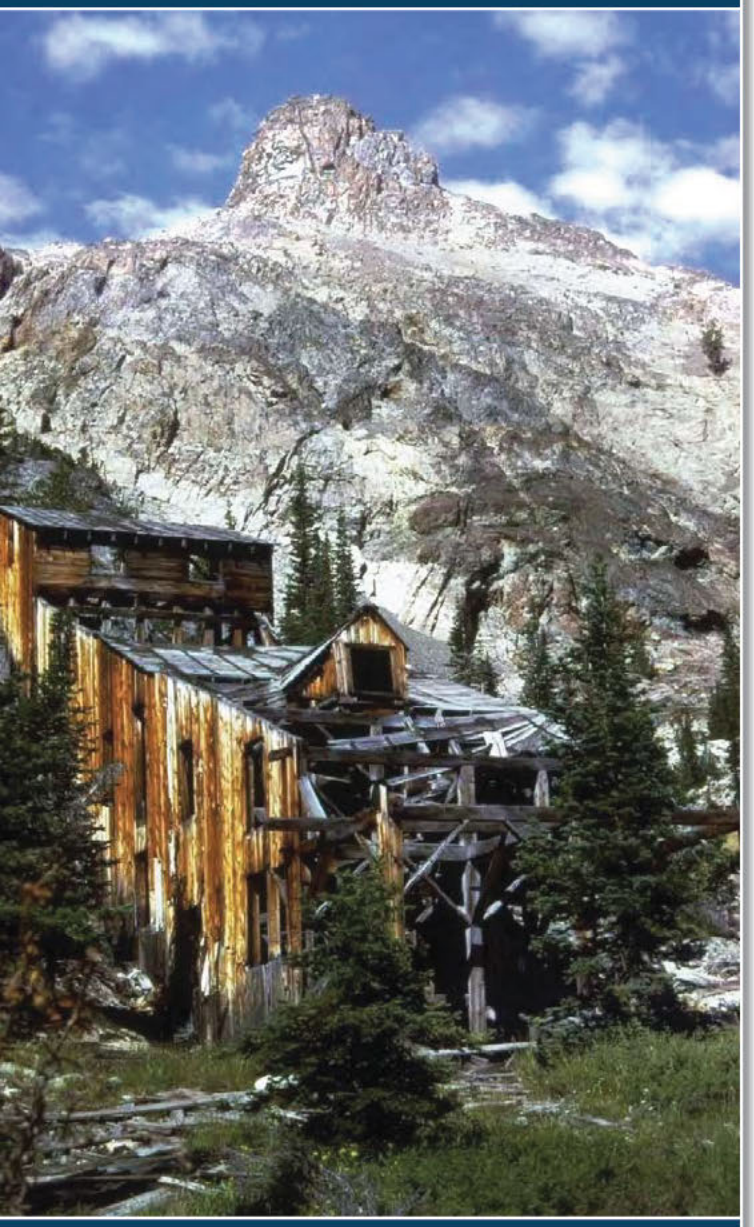
Although the work is costly and difficult, the benefits of cleaning up abandoned mine lands make the effort worthwhile. Onsite soil and water quality is often returned to premining conditions. Visitors to public lands are protected from health and safety hazards. Nearby communities enjoy cleaner water, a more diverse and healthy economy, and a better quality of life. Habitat for plants and wildlife is restored, and the aesthetics for both visitors and residents who live nearby are improved.

This report demonstrates how the BLM and the Forest Service's AML programs are achieving these and other benefits with the support and help of many stakeholders at the local, State, and Federal levels. With further support, the BLM and Forest Service will continue their abandoned mine programs that restore natural resources, protect public health and safety, and improve the quality of life for nearby communities and visitors to public lands. □

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PROGRAM HISTORY

Federal land management agencies, such as the BLM and the Forest Service, are charged with managing the public lands in their care, including those disturbed by past mineral extraction activities. Throughout the 1990s, awareness of the environmental, human health, and safety risks posed by abandoned hardrock mines was growing along with the realization that a unified Federal approach to the problem was needed.



A former mill in the Boulder Basin of Idaho's Sawtooth National Forest.

Early Efforts To Address AML Sites

In the beginning, the sheer number of abandoned mining sites in the United States was daunting, with estimates ranging from tens of thousands to hundreds of thousands. To determine the extent of the problem, the BLM and the Forest Service began to inventory abandoned mines in the early 1990s. Built on inventory data previously compiled by other Federal, State, and tribal entities, the effort focused on hardrock and noncoal abandoned mines and produced estimates of approximately 65,000 BLM sites and 39,000 Forest Service sites.

In 1994, an interagency task force was formed consisting of Federal land management agencies, including the BLM, the Forest Service, the National Park Service (NPS), and DOI science bureaus, including the U.S. Geological Survey (USGS) and the former Bureau of Mines. Known as the Interdepartmental Watershed Cleanup Initiative, this task force worked closely with the Environmental Protection Agency (EPA) to develop a "watershed approach" for the cleanup of abandoned hardrock mines on public lands. This approach focused on working within the geographic boundaries of a watershed with partners (including applicable Federal, State, private, and tribal entities) to jointly resolve problems that affect the physical, chemical, and biological quality of that watershed. The goals of the watershed approach are to foster coordination and collaboration across Federal and State agencies, facilitate solutions to address mixed ownership issues on sites within watersheds, address important problem sites first, and reduce costs through fund leveraging and avoiding duplication of efforts and conflicting actions.

In 1997, two top priority watersheds were selected as pilot projects for remediation:

- The Upper Animas River watershed in southwestern Colorado
- The Boulder River watershed in western Montana

These watersheds were chosen based on criteria that included: the interest and participation of State officials, availability of existing data on ore bodies, mining history, existing AML sites, water quality, heavy metal concentrations, geologic conditions, Federal land partners, extent of Federal lands in the watershed, and cleanup

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A contractor sealing a Cottonwood adit.

work already in progress. In consultation with the EPA, interagency preparation began to compile data and watershed information that would build on ongoing work in the Upper Animas River and complementary efforts (e.g., site inventory work) in Montana.

The BLM and the Forest Service Launch AML Programs in 1997

Riding the momentum of the interagency AML initiatives, the BLM and the Forest Service launched formal AML programs in 1997. The positive results of early AML initiative partnerships and commitment to reclamation efforts in these two pilot watersheds eventually led to Federal funds that were specifically directed at AML programs. In 1997, Congress appropriated $1 million to the BLM for work in the Animas and Boulder watersheds. In 1998, the BLM's appropriation increased to $3 million and the Forest Service was appropriated $4.6 million for the watershed initiative. This funding allowed AML programs to expand to include a third top priority pilot in 1998, the Cottonwood Wash watershed in southeastern Utah. Since then, the BLM and the Forest Service have continued to fund the cleanup of abandoned hardrock mines using a variety of approaches that are designed to meet multiple objectives, including addressing physical safety hazards, as well as hazardous substances and nonhazardous sources of pollution and contamination.

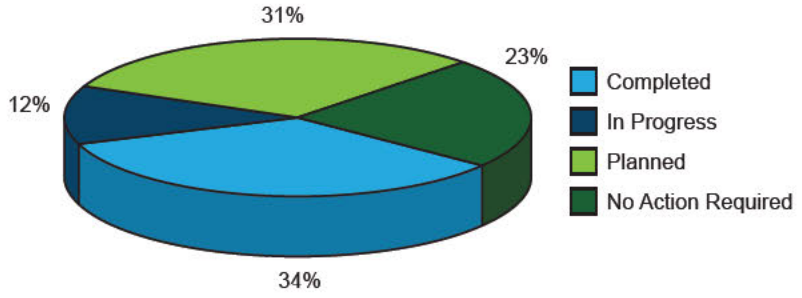
CERCLA Authorities

CERCLA provides broad Federal authority to mitigate contamination from the release of hazardous substances. CERCLA also authorizes Federal agencies to recover cleanup costs from persons responsible for the release of hazardous substances. The law authorizes removal actions to reduce pollution on an interim basis, and long-term remedial actions that are intended to result in permanent cleanups.

Between 2000 and mid year FY 2007, the BLM:

- Inventoried 5,500 sites. In addition, took mitigation actions at safety hazards at many of these sites;
- Remediated physical safety hazards at more than 3,000 sites; and
- Restored water quality at 281 sites through FY 2003 and at more than 3,000 acres since FY 2004.

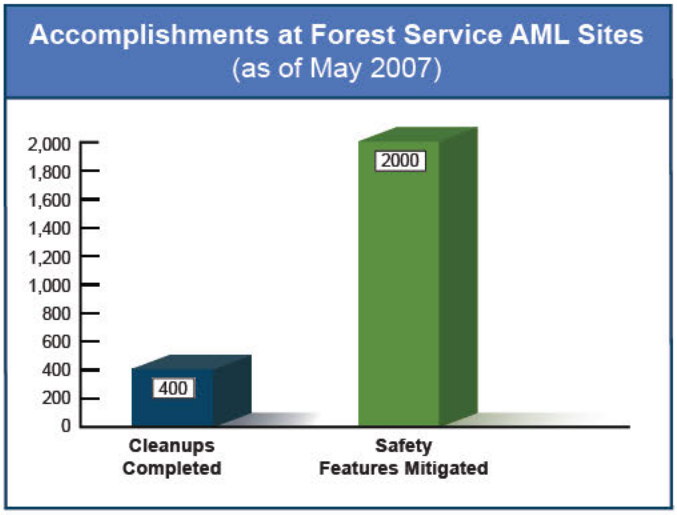
Status of Known BLM AML Sites (as of June 2007)



Since 1998, the Forest Service has:

- Inventoried 20,000 sites;
- Mitigated more than 2,000 AML safety hazards; and
- Cleaned up hazardous substances at more than 400 abandoned mines, with 150 hazardous substance cleanups in process.

Abandoned mine lands are now at the forefront of reclamation issues and more visible due to Federal abandoned mine programs and active participation of grass-roots organizations such as Trout Unlimited and the Animas River Stakeholders Group. These groups



Historical Milestones in Prioritization and Cleanup of Hardrock AML Sites in the United States

1969

PROGRAM
- Other Federal, State, and tribal entities conduct AML site inventory efforts

LEGISLATION

Enactment of:
- National Environmental Policy Act (1969)
- Federal Land Policy and Management Act (1976)
- Clean Water Act and SMCRA (1977)
- CERCLA (1980)
- Executive Order 12580 (1987)

1987

1992

PROGRAM
- BLM and Forest Service initiate inventory of AML sites

1994

INITIATIVE
- Watershed approach developed for addressing abandoned and inactive mines

1995

PARTNERSHIP
- Federal Mining Dialogue established

1996

INITIATIVE
- Interdepartmental AML Watershed Cleanup Initiative established

PARTNERSHIP
- Western Mine Restoration Partnership established

1997

PROGRAM
- Colorado and Montana pilot watersheds selected
- Congress appropriates initial BLM funding for pilot program
- BLM and Forest Service shift from pilot efforts to na ional programs

LEGISLATION
- Congress enacts Wyden Amendment authority allowing BLM and Forest Service to enter into cooperative agreements

1998

PROGRAM
- Utah pilot watershed selected
- Congress appropriates initial Forest Service funding for pilot program

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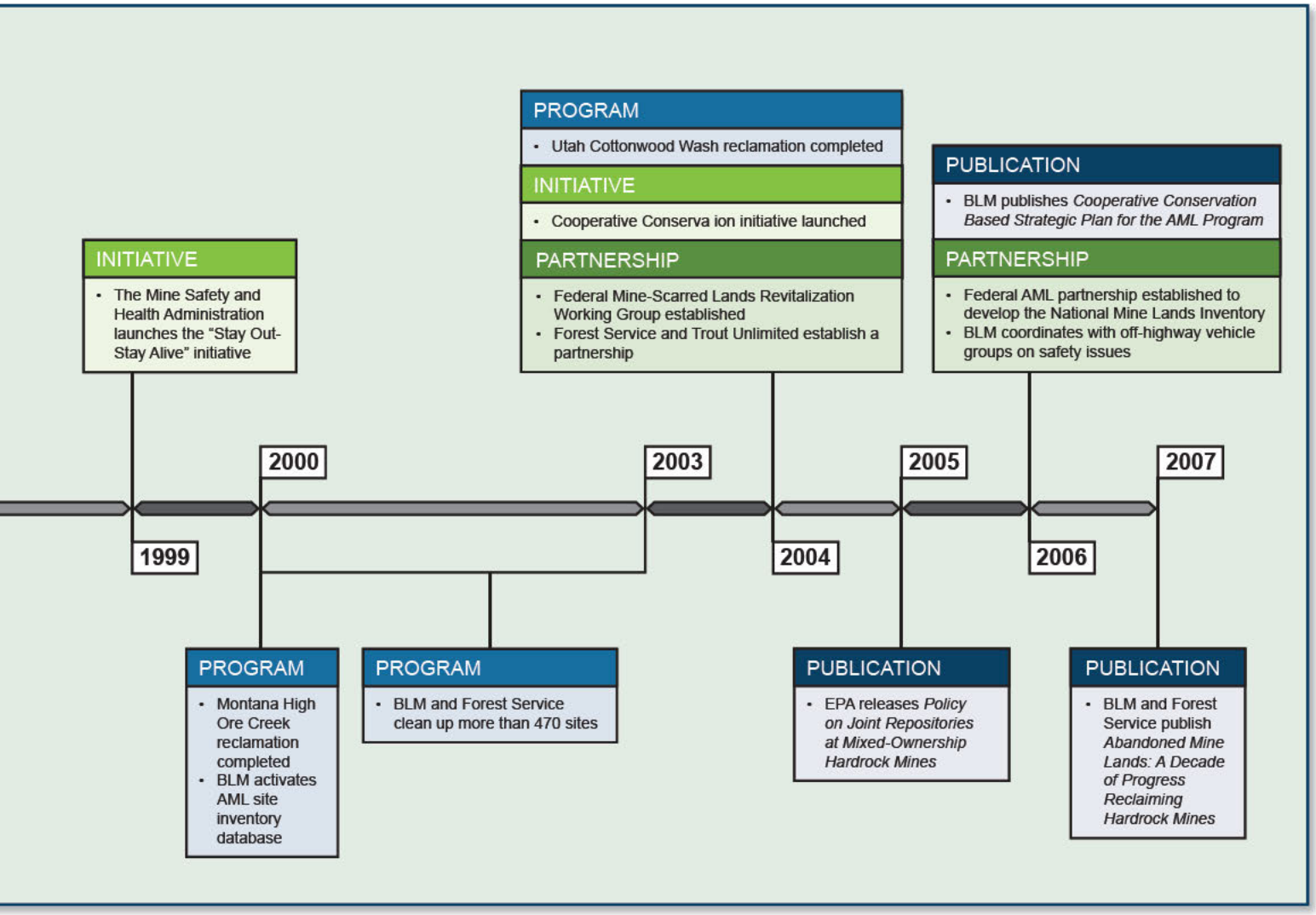
actively support watershed initiatives and provide much needed resources, including education, awareness, and volunteer labor during reclamation projects.

Land and resource management agencies are faced with evaluating risks associated with thousands of potentially harmful mine sites, and this level of effort is not always feasible for every affected watershed. The detailed work described in this report can help Federal land management agencies decide which characterization efforts would be most useful in the characterization of other affected watersheds. Although there is more to do, AML programs have demonstrated continued success through leveraged funding, strong partnerships, and innovative methods to address abandoned mine lands. □

Scientific Support from the U.S. Geological Survey

USGS science for a changing world

The U.S. Geological Survey (USGS) conducted an AML Initiative in 1997-2001 to provide technical assistance in support of Federal Land Management Agency (FLMA) actions to remediate contamination associated with abandoned hardrock mining activities. The USGS supported assessment activities at the Boulder River and Animas River watersheds by inventorying historical mines, defining geological conditions, assessing and analyzing aquatic life and indicators of physiological stress, collecting and chemically analyzing water and sediment samples, and defining hydrological regimes.



PILOT SUCCESS

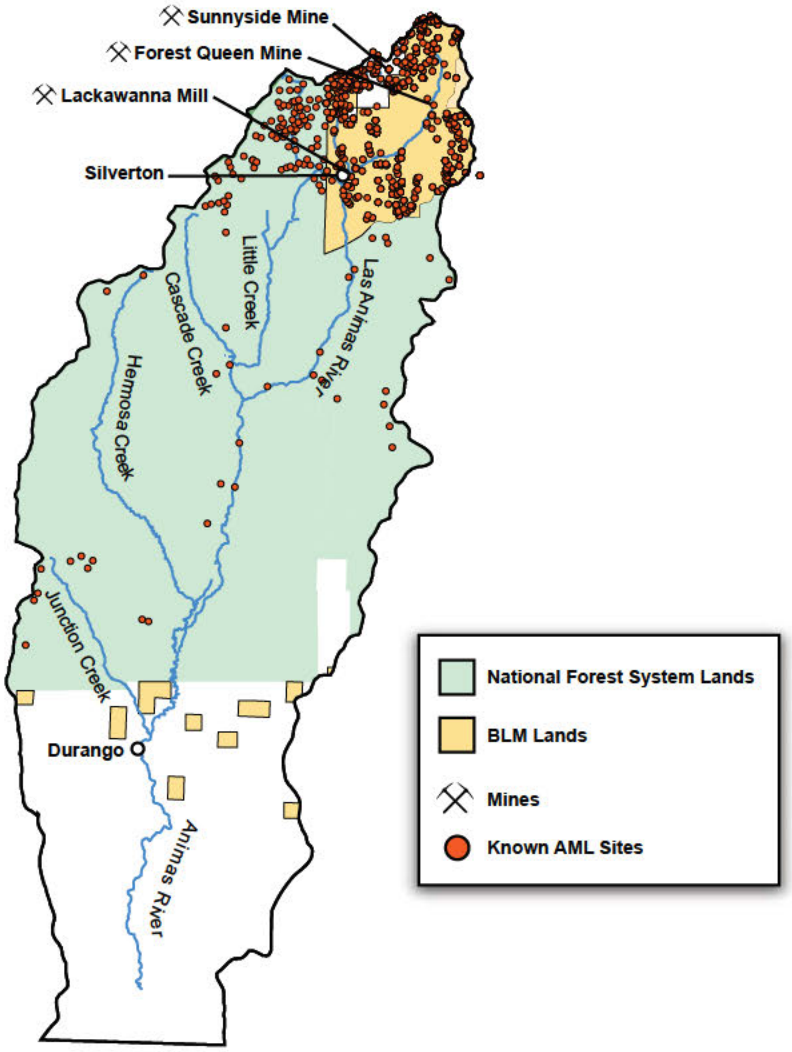
Animas River Watershed



Pilot Profile

Reaching across 186 square miles of Colorado's San Juan Mountains, the Animas River watershed is a place of rich mineral deposits, recreational opportunities, and historic interest. Communities that call the Animas home, like the town of Silverton, are transitioning from a once thriving mining industry to an economy based on tourism and recreation. The Animas River Stakeholders Group (ARSG) is assisting this transition through its efforts to address the environmental impacts of mining within this watershed, a high priority for restoration in the State of Colorado.





The Ecological Impacts of Historic Mining:

Over time, the impacts of contaminants including aluminum, cadmium, copper, iron, lead, and zinc emanating from historic mines and natural sources became environmentally and economically visible; acidity levels in the water rose to levels impairing many fisheries and leaving some streams devoid of fish. Project stakeholders faced the challenge of improving water quality not only for the benefit of local residents and aquatic life, but to ensure the well-being of the town's tourist and recreational trades.

Impediments to Local Economic Prosperity:

The area served as a mineral-rich region for metal mining as far back as the late 1800s. When the Sunnyside Mine closed in 1991, more than 300 jobs were lost. Silverton and its surrounding communities have since relied primarily on the seasonal tourism industry, with the scenic narrow-gauge railroad between Durango and Silverton serving as its anchor by attracting train, history, and outdoor enthusiasts. Yet, lingering blight and environmental problems due to the area's historic mining legacy have impeded efforts to fully capitalize on the Animas' significant opportunities for recreation, tourism, and business expansion.

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Though barriers were encountered along the way, stakeholders were able to develop successful methods to reclaim the Animas River watershed.

Formulating a New Approach to Cleanup Through Collaborative Partnerships



Recreational fishing has returned to the Animas.

While several mining-impacted communities have used the EPA Superfund designation to gain resources for complex and costly cleanup efforts, a broad group of partners—including the BLM and the Forest Service—formed the ARSG in 1994 to leverage the necessary expertise and resources for mine reclamation.

In the early 1990s, the State conducted initial studies that revealed environmental contamination in the watershed—enough that EPA considered listing the area as a Superfund site. Concerns that this designation might impact the area's transition to a tourist-based economy led to an alternative approach. The ARSG represents a volunteer collaborative effort to improve water quality and aquatic habitats in the watershed through assistance from mining companies, elected officials, local citizens, landowners, environmental groups, and State and Federal agencies. Because so many partners engaged in the project, EPA agreed not to take any formal Superfund action as long as reclamation was ongoing. The ARSG continues to demonstrate that a highly engaged, active, and patient stakeholder group can make critical progress toward cleanup and reclamation goals.

Identifying Priority Sites in a Large Watershed



A former mining structure near the Elk Tunnel Mill in Colorado.

Addressing abandoned mine lands within a watershed can be difficult due to the considerable size of the affected area. Through strategic planning, however, the ARSG partners were able to prioritize cleanup activities by characterizing the watershed to identify the most significant contamination sources.

With approximately 1,500 former mining sites in the watershed, the ARSG partners, utilizing expertise from a number of State and Federal agencies, conducted an analysis of factors such as amount of each contaminant; physical attributes; accessibility to power; and proximity to streams, wetlands, and avalanche paths. Eventually, 400 sites were identified as priorities. Further analysis revealed that 67 of these former mining sources accounted for 90 percent of the metals contamination from mining sources. This comprehensive prioritization approach proved successful and led the Colorado Department of Public Health and Environment (CDPHE) to implement 27 realistic Total Maximum Daily Load standards based on partial remediation of the priority sites.

Reclaiming Mine Sites With Mixed Ownership

Through collaboration among its Federal, State, and local partners, the ARSG overcame the types of complicated ownership issues that often prevent mining communities from reclaiming sites, such as difficulty in identifying and engaging owners.

Within the watershed, land ownership is mixed among Federal and private owners. The formation of the ARSG creates a forum for all property owners, remediation experts, and local community members to provide input into cleanup priorities and identify resources. This collaborative effort promotes an effective cleanup process by leveraging the best resources from each ARSG partner and avoiding a piecemeal approach to cleanup, which can be prohibitively expensive.

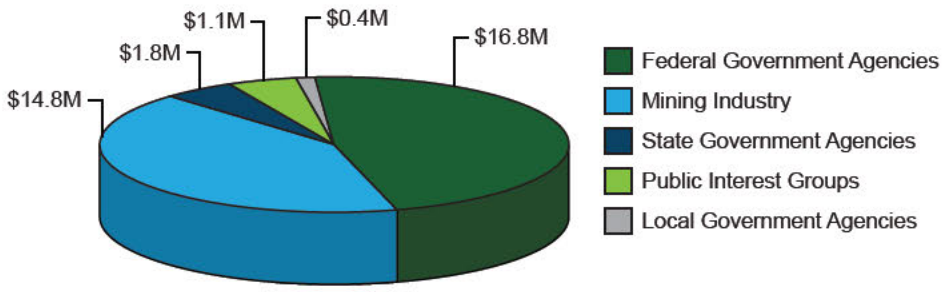
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Leveraging Funding Through Partnerships

By forming partnerships during the reclamation process, project stakeholders collectively maximize and pool resources that would not have been readily available if only one entity was involved.

The partnerships formed through the ARSG allowed for the successful leveraging of more than $35 million for remediation activities and more than $3 million worth of in-kind volunteer support. Various partners including the BLM, Forest Service, State and local agencies, public interest groups, and mining industry representatives contributed much needed financial resources to enable successful reclamation of the former mining sites in the watershed.

Animas River Watershed Pilot Leveraged Funding*



*Funding amounts (provided by BLM Colorado) are approximations as of March 2007

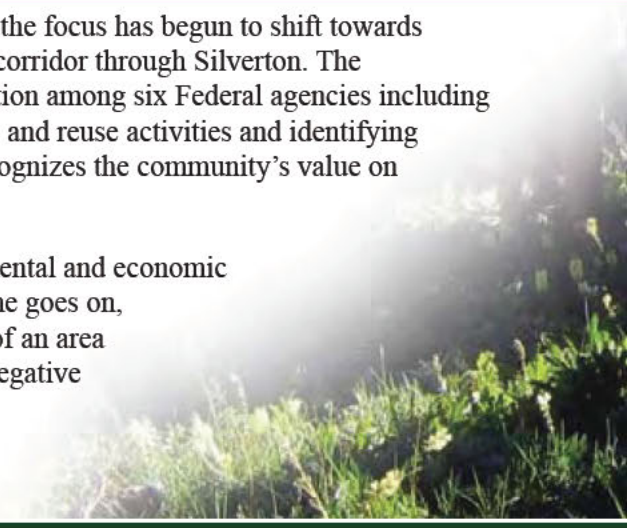
Project Results

Approximately 50 mining remediation projects, which addressed draining adit and waste site concerns, were successfully completed within the Animas River watershed. Of the completed projects, which includes the completion of remediation activities for 19 priority sites, mining companies addressed approximately one-half, Federal land management agencies addressed approximately one-quarter, and the ARSG addressed approximately one-quarter. The BLM has completed seven projects and the Forest Service has completed four. The community is reaping the benefits of these cleanup efforts, including overall increased water quality and two reproducing species of trout that did not exist before in downstream areas. This, in turn, is beginning to entice more visitors seeking recreation to the area.

Looking Forward

As the community continues to work together to address the remaining sites, the focus has begun to shift towards improving the economy by revitalizing a 2-mile stretch of the Animas River corridor through Silverton. The Brownfields Federal Partnership Mine-Scarred Lands Initiative—a collaboration among six Federal agencies including the BLM—assisted the community with outlining next steps for land cleanup and reuse activities and identifying the technical and financial resources to implement them. This partnership recognizes the community's value on tourism as it promotes aesthetic and quality-of-life improvements to the area.

Through the collaborative efforts of the ARSG partners, significant environmental and economic accomplishments have been made in the Animas River watershed. And as time goes on, more and more people will be able to appreciate the beauty and opportunity of an area whose mining legacy can now be defined in historical terms, rather than by negative environmental impacts. □



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DOI-19-0291-I, 19-0538-J-000452

Community Impact

Preserving San Juan County's Mining History

Mining served as the backbone of San Juan County's economy since the 1800s, holding a special place in residents' lives. While the ARSG has focused on cleaning up the watershed, other community groups have focused on preserving mining relics, providing an opportunity for residents and tourists to relive history. Beverly Rich of the San Juan County Historical Society described her passion for mining history by stating, "My father and husband were miners and Silverton would not be here without mining. It is a part of our heritage that is quickly disappearing and so it needs to be preserved." The BLM and Forest Service support historical preservation efforts by preserving historic elements during mine reclamation activities—for instance, helping to stabilize and preserve a facility that once housed miners working at the Old Hundred Mine.

Animas River Project Partners

Federal Partners
- Army Corps of Engineers (USACE)
- BLM
- Bureau of Reclamation
- EPA
- Forest Service
- USGS

State Partners
- CDPHE
- Colorado Division of Mining Reclamation and Safety
- Colorado Division of Wildlife
- Colorado River Watch

Local Agencies
- City of Durango
- San Juan County Commissioners
- San Juan County Historical Society
- San Juan Resource, Conservation and Development
- Southwestern Water Conservation District
- Town of Silverton

Citizen Groups
- Friends of the Animas River
- River Watch Network, Inc.
- San Juan Citizens Alliance
- Taxpayers for the Animas River
- Western Colorado Congress

Private Entities
- Alpine Environmental Services
- Durango and Silverton Narrow Gauge Railroad
- Gold King Mining Company
- Mining Remedial Recovery Company
- PanEnergy Corporation
- Root and Norton Assayers
- Salem Minerals, Inc.
- Silver Wing Co., Inc.
- Sunnyside Gold Company
- Tusco, Inc.



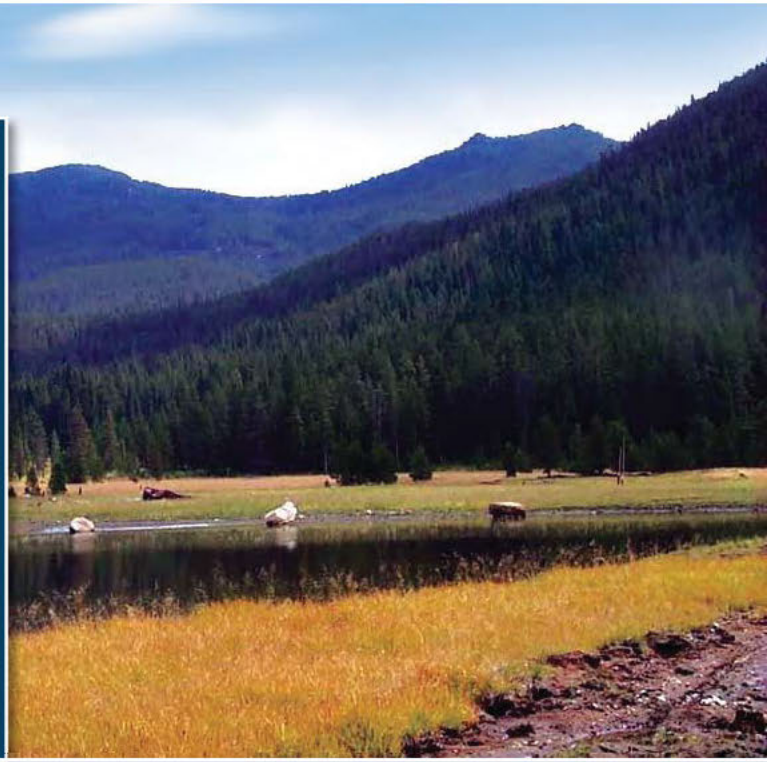
Stakeholders discussing future revitalization plans for the Animas River corridor.

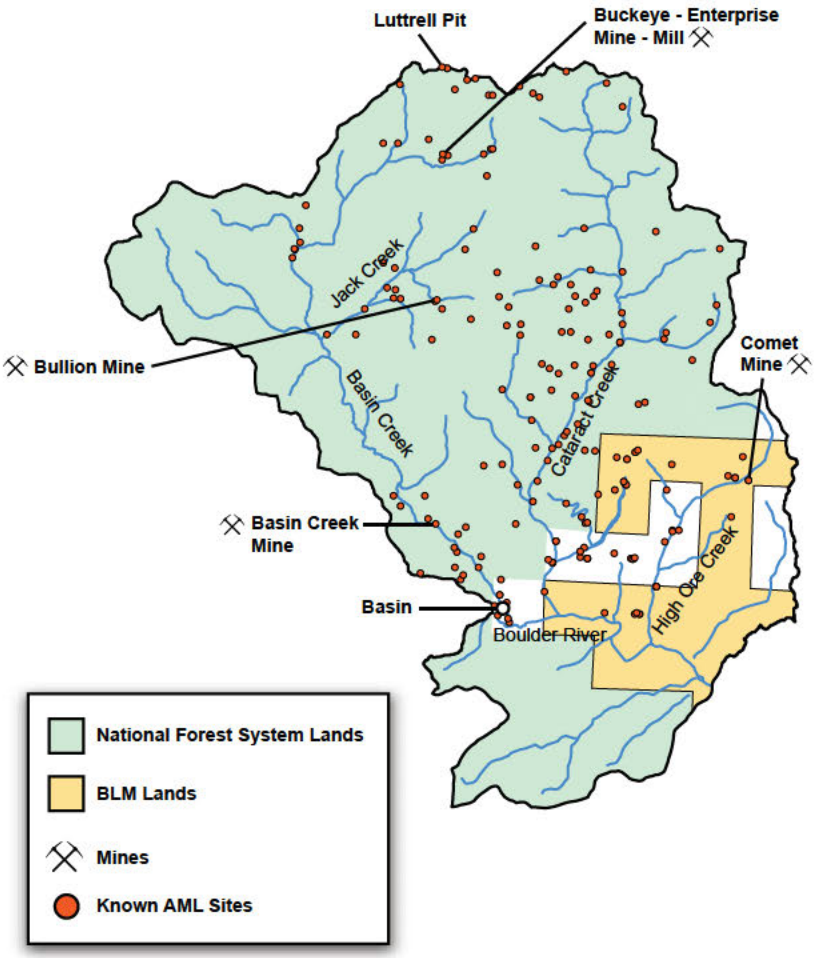
▪ Boulder River Watershed

Pilot Profile



Located in Jefferson County, Montana, the 90-square-mile Boulder River watershed is home to 22 miles of stream. As surrounding communities transitioned to an economy based on agriculture, tourism, and recreation, stakeholders needed to work together to design a cleanup approach that would not only restore recreational fishing in the area, but protect the health and safety of area residents.





The Ecological Impacts of Historic Mining:

Primarily at fishing sites and campgrounds, recreational users have considerable access to the Upper Boulder and East Boulder Rivers. More than 80 years of mining gold, silver, lead, copper, and zinc left a legacy of degraded water quality from the heavy metals in mine waste and mill tailings, contaminated water supplies in local communities, and the drastic reduction or complete elimination of fish populations as far as 55 miles downstream. Surrounding communities faced the challenge of reversing this damage to improve water quality and restore impacted fish populations.

Impediments to Local Economic Prosperity:

During times of mining prosperity, the Town of Basin's population reached as high as 8,000. Today, Basin has as few as 220 residents as a result of closing mining operations. Spurred by a transitioning economy and impacts to local drinking water supplies, area stakeholders took action to improve water quality, restore local fish populations, and improve public health and safety by addressing mining-impacted water supplies and contaminated land.

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Given the challenges associated with the watershed's location, stakeholders were able to develop solutions that increased overall project efficiency.

Implementing a More Targeted Remediation Approach

Since the effects of past mining activities can be spread across an expansive area, it is essential that the cleanup approach prioritize areas of higher contamination first. In the Boulder Creek watershed, stakeholders, including the BLM and the Forest Service, utilized state of the art information collected by the USGS and others to create a more efficient and focused remediation plan.



X-Ray Fluorescence in use.

For example, in the High Ore Creek area of the watershed, the BLM and other stakeholders utilized X-Ray Fluorescence Spectrometry, an analytical technique used to identify and determine the concentrations of elements present in solid, powdered, and liquid samples. This method greatly increased project efficiency, allowed the remediation team to work side-by-side with the contractors excavating the material, and ultimately minimized the amount of soil and sediment requiring removal. The increased efficiency was particularly important due to the geographic location of the area, which has a long winter and consequently a fairly short construction season. This approach was innovative at the time of remediation and is now a common method employed at AML sites across the country.

Collaboration as a Tool To Overcome Remediation Boundaries

When addressing contamination on abandoned mine lands, potential issues include mixed ownership and the question of where mining waste should be deposited during cleanup. In the Boulder River watershed, the BLM and the Forest Service developed a unique and efficient approach that promoted the use of partnerships.

Within the Basin Creek area of the watershed, abandoned mine land ownership is divided among the BLM, the Forest Service, EPA, and the State of Montana, all of whom planned to move the area's mining waste to individual repository areas. Through the use of collaborative partnerships, the partners drafted an agreement in 1999 that allowed them to use the Luttrell Pit, the first regional joint mine waste repository in the United States. This innovative approach reduced costs and increased safety by requiring maintenance of only one large repository instead of many throughout the watershed. This project set precedents for the storage of abandoned mine waste by multiple Federal and State land management agencies and was a successful demonstration of addressing Superfund sites in the Western United States.

Joint Repositories: A Model for Collaborative Cleanup



The Luttrell Pit.

The Luttrell Pit was the first regional joint mine waste repository to be established in the United States. This approach to disposing of mine wastes in a mixed-ownership watershed became a model for future mine reclamation projects, resulting in a multiagency agreement signed by EPA, the Forest Service, the BLM, and private and local partners for the Boulder River watershed cleanup. Individual agencies, including EPA and the BLM, subsequently developed policies to encourage partnerships with other agencies for establishing new joint waste repositories at other sites.

An Alternative to the National Priorities List



Stream side tailings impacting High Ore Creek.

CERCLA provides the BLM, Forest Service, and EPA with legal authorities and access to funds that are not otherwise available to these agencies. One aspect of the CERCLA process, listing of an AML site on the National Priorities List (NPL) by EPA, may lead to benefits or drawbacks for a cleanup depending on the situation. While NPL listing provides access to EPA-administered Superfund resources, it also requires use of CERCLA remedial cleanup procedures that can be time consuming and limit the use of certain funds.

High Ore Creek and the Comet Mine were excluded from the Basin Mining Area NPL site, allowing the BLM and the Montana Department of Environmental Quality to take the lead in cleaning up these areas using procedures and funding that allowed them to respond more quickly. The BLM used its authority under CERCLA to conduct non-time-critical removal actions at the Comet Mine to address the streamside tailings in High Ore Creek on a faster schedule than would have occurred if it had been included as part of the NPL site. To complete this project in June of 2000, the BLM spent approximately $2 million and collaborated with several State agencies on cleanup activities, including improving access roads, excavating and transporting approximately 40,000 cubic yards of mine waste, backfilling the flood plain with topsoil, stabilizing streambanks by planting 5,000 native trees and shrubs, and constructing a streambed and two sediment ponds for settling out toxic chemicals. Fish sightings have been documented in wetlands and key fishing locations where no fish were present prior to remediation.

Project Results

In addition to the BLM and State cleanup efforts in High Ore Creek, other characterization and cleanup actions have taken place in the Boulder River watershed. EPA spent approximately $4 million in cleanup activities on the Town of Basin in 2004, and approximately $3.4 million on cleanup activities at the Buckeye-Enterprise, Crystal, and Bullion Mines. The USGS completed its geochemical characterization of the drainage that was used to prioritize cleanup efforts at a cost of $3.2 million. The Forest Service spent $5 million using its CERCLA authority to conduct time-critical removal actions at the Buckeye-Enterprise, Bullion, Bullion Smelter, Hector, Lower Hector, Jack Creek, and Daly West mine and mill sites.

This unprecedented group of agencies—including the Montana Department of Environmental Quality, and local agencies and organizations—coordinated efforts to bring a watershed approach to fruition. In doing so, they enhanced the natural resources in the area and protected the residents of the Basin Creek area from exposure to contaminated water, sediment, and mine waste.



The Buckeye-Enterprise Mine.

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DOI-19-0291-I, 19-0538-J-000456

Looking Forward



Water quality monitoring activities in High Ore Creek.

As project partners continue to monitor the effects of cleanup in the Boulder River watershed, they plan to address remaining sites within the Basin Creek area that contribute to contamination. Additionally, the Forest Service plans to begin work in the Cataract drainage area in 2008, with the goal of addressing all Basin Creek area sites located on National Forest System land by fall of 2009. Over the years, Federal and State agency partners have succeeded in addressing the area's surface contamination, but they are still looking to develop a technological solution for acid mine drainage being released from underground mines. For example, in the High Ore Creek area, the waste materials and dumping grounds have been cleaned up, but contaminated water from underground mine tunnels still discharge into area streams.

Thus far, the Boulder River watershed reclamation project has successfully demonstrated the efficiency of approaches that use innovative cleanup methods and collaborative partnerships. Local communities continue to benefit from the area's environmental improvements, and the region's recreational opportunities may increase in years to come. □

Community Impact

The Return of the Westslope Cutthroat Trout

Prior to mining, the fisheries in the drainages that make up the Boulder River watershed would have been optimal. Historic mining activities created an environment that few, if any, fish were able to survive. But as a result of initial reclamation efforts, fish species like the Westslope Cutthroat Trout (Oncorhynchus clarki lewisi) have begun to return and increase in number. While it is still too early to know the extent of these recent water quality improvements on fish populations, project partners expect that eventually local species and recreational fishing may once again thrive and the watershed could become a premier fishery.

Boulder River Project Partners

Federal Partners
- USACE
- BLM
- Bureau of Reclamation
- EPA
- Forest Service
- USGS

State Partners
- Montana Bureau of Mines and Geology
- Montana Department of Environmental Quality
- Montana Department of Fish, Wildlife, and Parks

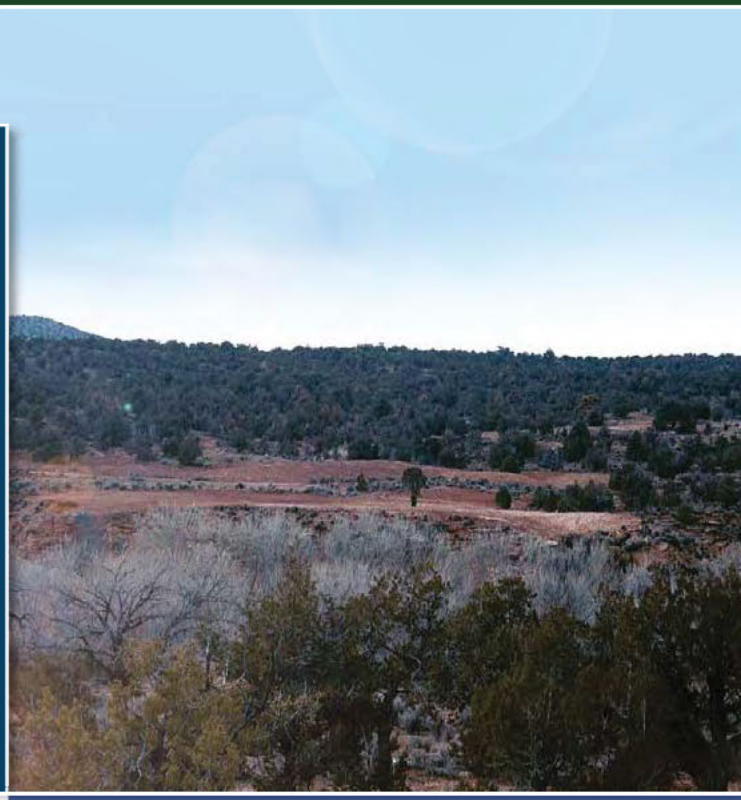
Private Entities
- Pioneer Technical Services, Inc.
- Schumaker Trucking and Excavating

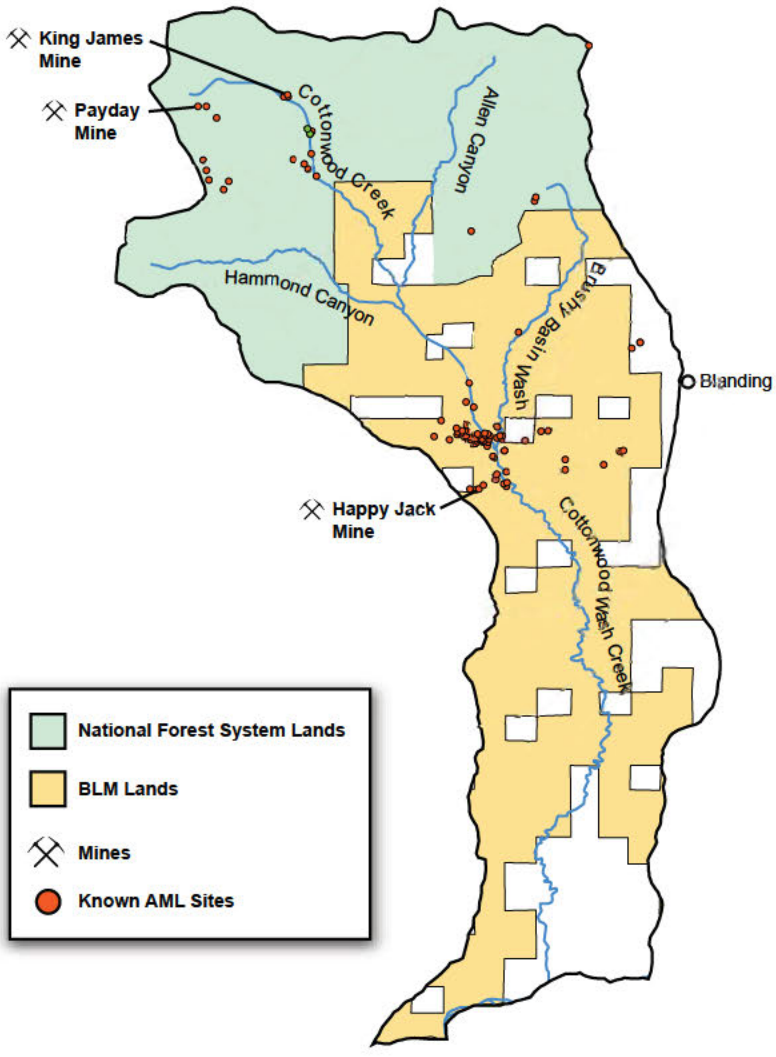
▪ Cottonwood Wash Watershed

Pilot Profile



Encompassing approximately 143,000 acres in southeastern Utah's San Juan County, the Cottonwood Wash watershed and its local community are closely intertwined with the mining history that defines them. National market demands for uranium and vanadium dictated the growth of the local economy, as well as its decline, for nearly nine decades. In an effort to improve water quality and protect the health and safety of the community, Federal and State agencies developed a collaborative reclamation strategy to address the area's former mines while preserving the lure of local mining history.





The Ecological Impacts of a Mining Past:

After decades of vanadium and uranium mining, the waters and sediments in the watershed were left with elevated levels of radiation from mine drainage and waste dumps. Project partners faced the challenge of addressing this contamination, which impacted the use of local water for drinking, recreation, aquatic life, wildlife, grazing, and agriculture.

Impediments to Local Economic Prosperity:

Nationwide economic demands ranging from steel production to national defense drove the local vanadium and uranium mining industry and dictated the growth and decline of San Juan County's economy. Although the local economy took a downturn after mining operations ceased, the community remains attached to its mining history.



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DOI-19-0291-I, 19-0538-J-000458

The Cottonwood Wash watershed area posed several challenges, but through the formation of collaborative partnerships, Federal and State agency partners were able to successfully complete remediation efforts.

Protecting the Local Community From Degraded Water Quality

The Technical Committee, comprised of Federal and State partners, focused on radioactive minerals impairing the watershed in conjunction with developing an efficient reclamation plan to address the physical safety hazards left behind as reminders of the local mining history.

Results of an inventory conducted in the late 1990s revealed dangerous levels of radon emissions in mine openings and elevated radiation levels in waterways caused by sediment, heavy metals, and uranium particles from mine waste dumps. This contamination affected drinking water, recreation, wildlife, grazing, and agriculture. The Technical Committee developed a reclamation approach that mitigated the area's physical and environmental hazards in one step: portions of uranium mine dumps located in stream channels were removed and used as backfill material for hazardous openings and face-up areas.



Upper reaches of Cottonwood Wash.

Stimulating the Local Economy Through a Reclamation Strategy

Most former mining communities are left with weakened economies once mining activities cease. The Technical Committee took a twofold approach to assisting the local community not only through cleanup efforts, but by bolstering the local economy as part of its reclamation strategy.

As the demand for local vanadium and uranium ore dwindled to near nonexistence, mining operations shut down in the area, negatively impacting the local economy. In efforts to stimulate the local economy, the BLM and the Forest Service recognized the importance of dividing project construction work—which included closing off mine openings and removing waste dumps—into seven phases over 5 years. This allowed small and local contractors to bid on projects, benefiting the local economy, increasing competition, and reducing overall project costs. Ultimately, three local companies were selected to conduct the construction work, which returned $800,000 to the local economy.



Closing one of many mine openings in the Cottonwood Wash area.

Preserving Local Mining History During Reclamation

Many former mining communities become worried about losing a part of their identity during reclamation. Partners such as the BLM and the Forest Service were sensitive to these concerns and made every attempt to include the local community in the planning process.

When reclamation discussions were initiated in the Cottonwood Wash area, the community felt protective of the mining structures they felt represented their livelihood, history, and community. By working with local residents,



Payday mine circa 1960.

Photo by Patsy Shumway

the Technical Committee found a balance between keeping the community safe from elevated radiation levels and hazardous mine openings and allowing them to hold on to their memories. A cultural survey and inventory was conducted, and included the collection of oral histories from area residents. These efforts, supported by the BLM and the Forest Service, contributed to three issues of *Blue Mountain Shadows* magazine, dedicated to the mining history and reclamation efforts in the Cottonwood Wash watershed.



Engineer McBride at the Kimmerle mill circa 1944.

Photo by David Kimmerle

Project Results

Reclamation activities included sealing 219 adits and shafts, removing 39 hazardous structures, plugging 225 drill holes, and removing more than 250 waste dumps. These activities—in addition to approximately $2 million leveraged from the BLM, Forest Service, and the State of Utah—allowed the Technical Committee to protect and benefit the local community, while acknowledging the area's mining history. The partnerships formed during this reclamation project were critical to its success and led to continued reclamation efforts in the State of Utah.

Looking Forward

Although reclamation activities are complete in the Cottonwood Wash area, additional efforts are ongoing to ensure that the mining history so treasured by the local community is not lost. An onsite informational kiosk and an educational pamphlet are being developed, both of which will explain the mining history and reclamation work completed in the watershed. Prior to sign installation, an environmental assessment must be conducted to ensure that no additional negative environmental impacts result.

By directly addressing the environmental, economic, and cultural needs of the local community, the Technical Committee has achieved success in the Cottonwood Wash watershed. And as reclamation efforts move forward in other areas of Utah, this former mining community can continue to celebrate the positive influences of the mining industry without concern for environmental impacts for years to come. □

Understanding the Historic and Prehistoric Importance of Cottonwood Wash

The Four Corners area in the southwestern United States attracts sightseers from far and wide every year to explore the ruins of early Native American civilizations. The Cottonwood Wash area, first inhabited by the people of the Puebloan Culture, is rich in artifacts; potsherds and other remnants from almost 7,000 years of human inhabitants are apparent with nearly every turn of a shovel. Historic relics of the area's mining legacy are also scattered throughout Cottonwood Wash. Notably, some of Madam Curie's early radiation experiments were possible due to the samples she reportedly collected from the area. Additionally, vanadium and uranium from Cottonwood Wash supported the Nation's steel and atomic endeavors.

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DOI-19-0291-I, 19-0538-J-000460

Community Impact

Remembering the Local Mining History

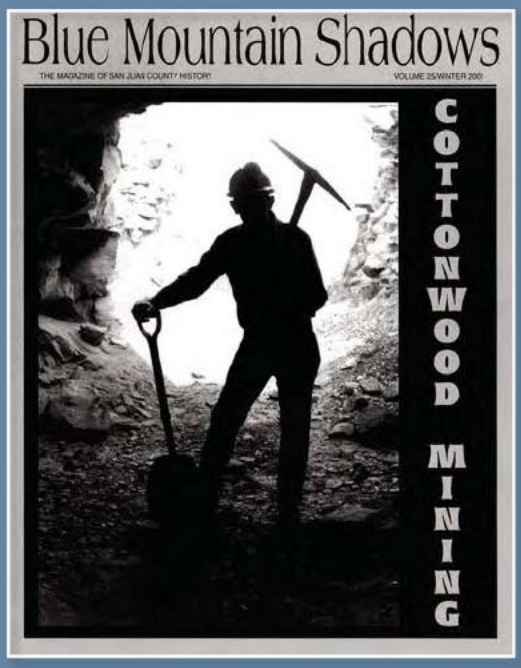


Photo by Colleen Black Hawks

Cover of the first issue of *Blue Mountain Shadows* magazine dedicated to mining in the Cottonwood Wash area.

Dating back to the early 1900s, vanadium and uranium mining was more than just a job to many locals, it was a way of life that defined who they were. Fathers and sons would work side-by-side down in the mine shafts. Young boys would run around searching for arrowheads that provided a glimpse into the area's prehistoric past. Former miner Cleal Bradford recalled, "My first experience with the Cottonwood mines was when my father was working as foreman of the Blanding mines. During the Second World War I would go with him as a youngster and be out around and about. I didn't do any mining at that time. But I did travel with him out and spend the day exploring and doing other things while he would be involved." Through an oral history collection effort supported by the BLM; the Forest Service; Utah Division of Oil, Gas, and Mining; and the San Juan County Historical Commission, the community was able to memorialize personal mining experiences like these in three issues of *Blue Mountain Shadows* magazine.

Cottonwood Wash Project Partners

Federal Partners
- BLM
- Forest Service

State Partners
- Utah Division of Oil, Gas, and Mining
- Utah Division of Water Quality

Local Agencies
- San Juan County Historical Commission

Private Entities
- Crowley Construction
- KSUE Corporation
- VCM Construction

PROGRESS THROUGH COLLABORATION

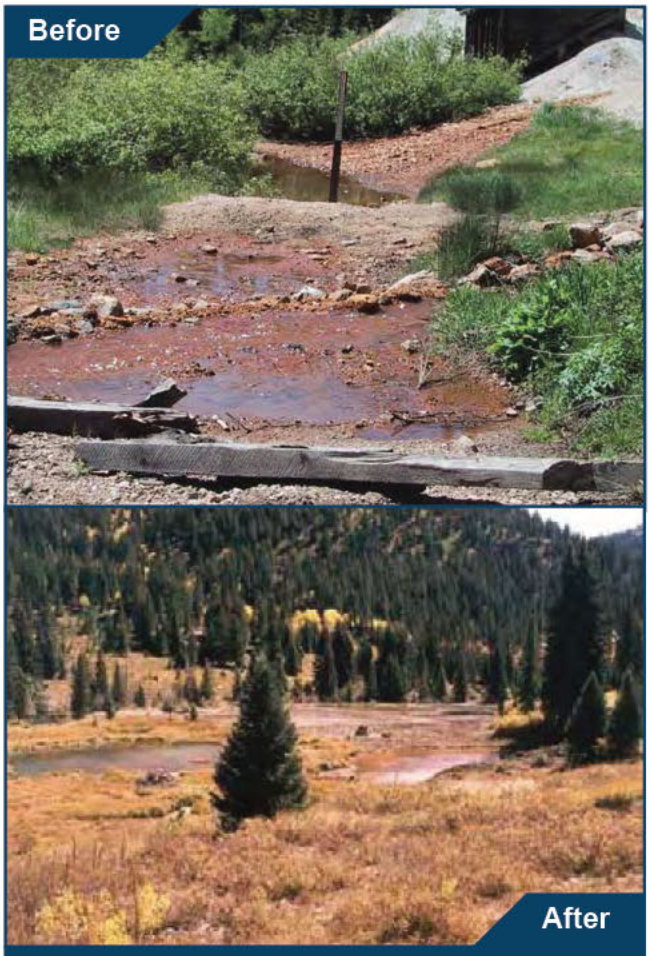
Communication and collaboration among project partners are essential to overcoming the complexities of restoring abandoned mine lands. Not only can formerly mined lands be large enough to stretch over multiple jurisdictions, but their contaminant runoff can also affect streams, watersheds, individual landowners, and communities far beyond a site's actual borders. For a single agency or organization with limited resources, it is often impossible to carry out effective restoration activities without partners.

The BLM and the Forest Service recognize that collaborative partnerships are essential to increasing efficiency and enhancing resources in AML restoration projects. As part of its ongoing policy of cooperative conservation, the BLM works with the Forest Service to apply a "Service First" approach to AML program coordination. Examples of this approach range from joint field operations on specific AML sites, technical training, and development of shared policies and strategies. The examples provided in this section demonstrate the success that results from partnerships among the BLM, the Forest Service, and other entities that complement each other's efforts, are open and communicative, and indicate a willingness to work with all stakeholders.

Forming Innovative Partnerships To Clean Up Private Lands

Addressing contamination on AMLs can be a costly process for Federal and State agencies that often have limited resources, making leveraging support a critical part of the process. In Utah's American Fork Canyon, valuable partnerships were formed with nonprofit and private entities that provided needed technical and financial support.

Migrating from the Pacific Mine Site in American Fork Canyon, water with lead concentrations 10 times higher than the Federal Clean Water Act standard was harming fish like the native Bonneville Cutthroat Trout in the American Fork watershed. After significant progress toward the cleanup of six sites within the American Fork Canyon, the Forest Service found itself at an impasse because two of the former mining sites were owned by Snowbird Ski and Summer Resort and beyond the agency's jurisdiction. Through negotiations with EPA, Trout Unlimited, a nonprofit organization dedicated to conserving and protecting fishing areas, obtained an Administrative Order of Consent that limited long-term liability and provided the legal authorization for cleanup work on private land. Diamond retailer Tiffany & Co. provided $50,000 a year through a conservation fund, and in 2006 awarded Trout Unlimited a $450,000 grant for additional watershed restoration efforts. The collaborations formed among Trout Unlimited, the Forest Service, EPA, Snowbird, and Tiffany & Co., proved integral to the cleanup of the mine tailings on privately owned land affecting the American Fork watershed. The project has since been recognized by EPA and the State of Utah for its success.



The Pacific Mine in Utah.

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DOI-19-0291-I, 19-0538-J-000462

Improving Public Safety and Water Quality by Collaborating With State Agencies

Partnering with State agencies provides Federal land management agencies with additional resources for addressing not only safety, but environmental concerns on abandoned mine lands. By working with State agencies, industry, private firms, and diverse volunteers in Nevada and Washington State, BLM has made great strides in transforming AML sites into safer and healthier environments for humans and wildlife to enjoy.



Members of the 2005 backfill team in Southern Nevada during a week of intense AML shaft backfilling.

With approximately 25 fatalities in the United States related to abandoned mines every year, these sites can pose imminent danger to humans and animals. According to the Nevada Division of Minerals estimates, the State of Nevada has more abandoned mining sites than all other Western States combined —approximately 200,000 to 300,000 sites. To remove the threats these mines pose, the BLM Nevada State Office formed a partnership with the Nevada Division of Minerals and the Nevada Mining Association in 1999 to permanently close abandoned mines. The Abandoned Mines Permanent Closure Program uses fences, warning signs, and, most effectively, seals mine openings with bat gates, expanding foam, and backfill to prevent access and exposure to associated hazards, including falls into openings, rotten timbers, bats, toxic air, and forgotten explosives. In its first year, the program closed six mines. In 2006, the program set a national BLM record of 118 abandoned mine closures. Additional volunteers have come forward to provide support for the program, including university researchers and graduate students, professional archaeologists, Eagle Scouts, Girl Scouts, and prospecting clubs. The program now serves as a model for other States looking to address their own hazardous, abandoned mining sites through closure.



Reclamation work underway at the Cleveland Mine site in Washington.

In Washington, BLM partnered with the Washington State Department of Ecology to reclaim land impacted by the Cleveland Mine and Mill site in Stevens County, Washington. Mills adjacent to Hunters Creek had discharged contaminated tailings directly into the creek or into tailings ponds constructed directly in the creek's stream channel. To address these environmental concerns, BLM worked with the Washington State Department of Ecology to restore two saturated tailings areas a quarter of a mile downstream of the site. Reclamation activities included removing most of the saturated tailings in the stream channel to repositories, armoring the channel and repositories with cabled concrete blocks to reduce erosion, restoring the stream's natural meander, capping the repositories and constructing French drains around them to divert water away, and revegetating the site with grass and trees.

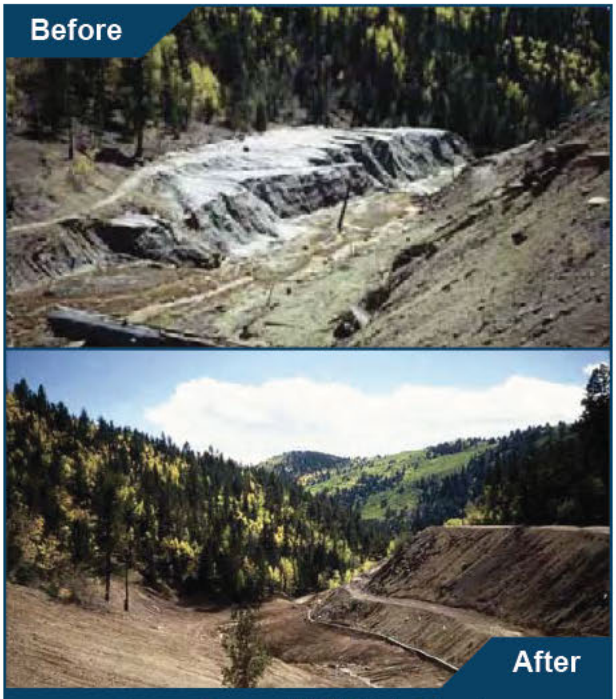
Partnering on Voluntary Cleanups

Involving parties that are potentially responsible for contamination on former mining sites can be challenging. But when these parties agree to address any remaining environmental issues, an ideal situation can result that avoids litigation for all stakeholders, which was the case in Colorado's Bonanza Mining District.

The approximately 30-square-mile Bonanza Mining District was home to intermittent mining operations between the 1890s and 1970s. This caused an 18-mile stretch of Kerber Creek to become devoid of aquatic life decades before restoration work began in 1994. In response to potential CERCLA litigation, the remaining five potentially responsible parties formed the Bonanza Group and signed an official voluntary cleanup agreement with CDPHE. This was an

innovative arrangement at the time, taking place before the State's own voluntary cleanup program emerged. CDPHE signed a memorandum of understanding with the Forest Service to jointly oversee cleanup, and EPA agreed to put any Superfund designation of the area on hold pending cleanup results.

The cleanup effort began only 16 months after the formation of the Bonanza Group, and has led to aquatic life, including fish, returning to the formerly dead section of Kerber Creek. To complement this effort, EPA provided nearly $300,000 to CDPHE to clean up orphaned mining sites just outside the Bonanza Mining area and the BLM began to address additional abandoned mining sites in the region.



Bonanza Rawley 12 Mill Site in Colorado.

Ensuring Continued Collaboration

The last 10 years of the BLM and the Forest Service's AML programs have provided countless lessons learned and confirmations about the value of partnerships and cooperation. As part of their continued efforts to collaborate with other partners, both agencies play key roles in the Federal Mining Dialogue, which provides a forum for coordinating and building upon AML-related approaches among participating Federal agencies.

The BLM entered into a Statement of Mutual Intent agreement with the National Association of Abandoned Mine Land Programs, an association of States and tribes with AML programs. Under this agreement, members agree to collaborate and communicate with each other, share abandoned mine data, and encourage efforts to establish and implement effective partnerships with other organizations to increase the awareness of abandoned mine problems nationwide. In 1998, the Forest Service established a formal partnership agreement with Trout Unlimited, which developed the institutional framework for volunteer opportunities in restoration, education, and research activities on Forest Service lands and developed 44 State-specific partnership agreements.

Partnerships like these help keep lines of communication open—not just among AML Federal partners, but among all potential State and local stakeholders. They also encourage trust between project partners and affected communities, and often produce the types of specific knowledge and expertise that can only be found at the local level. They allow Federal partners to determine the ways in which they can contribute the greatest value. They eliminate confusion by making individual goals apparent early in the process. And, they generate resources—technical as well as financial—far beyond what independent efforts can produce. □

Federal Agencies Actively Collaborate To Address AML Issues

Established in 1995, the Federal Mining Dialogue is a cooperative initiative among Federal environmental and land management agencies aimed at addressing contamination from abandoned mine sites, primarily on Federal lands. Participating agencies including DOI, EPA, USDA, the Department of Justice, and USACE, provide a "toolbox" of resources that can be adapted depending upon circumstances, such as agency jurisdiction and land management protocol for a given area. In some cases, actions are coordinated with State agencies, and State laws, regulations, and environmental standards play significant roles. In recent years, the Federal Mining Dialogue has increased its emphasis on long-term sustainability through sound land management practices.

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RESTORING THE ENVIRONMENT

Abandoned mine lands are often located in beautiful, scenic areas, such as the mountainous regions of the Western United States. In some instances, the historical quaintness of an empty mine site can create a strong tourist draw, but more often, the legacy of these former mines is the environmental contamination caused by residual mining wastes.

Former mining activities may result in the formation of acid mine drainage (AMD), production of waste rock, and sediment erosion. Mine shafts, drill holes, and other mining methods may alter natural ground water flow patterns and carry contaminants like heavy metals to surface and ground water bodies, which can poison aquatic life and area wildlife. These effects not only can inhibit reuse of the affected land for recreation and other purposes, but they can also potentially impact communities far outside a mining site's borders.

Over the past 10 years, the BLM and the Forest Service have developed different techniques for the varied mining sites that fall under their jurisdictions. The examples provided in this section illustrate the approaches undertaken by the BLM and the Forest Service and demonstrate the positive environmental impacts that result from the reclamation of former mining sites.



White King Pond in Lakeview County, Oregon.

Returning Life to Dead Lakes and Streams

Pit lakes, formed when ground water flows into an open mining pit, are a common feature at hardrock mining sites. The water quality is typically very poor at these sites, with pH values ranging near 2.0 in some lakes, a dangerous level for people and wildlife. In some areas, pit lakes are accessed by the public for recreational bathing and swimming, and the acidic water can cause skin irritation and other ailments. In addition, the acidic water can cause significant fish kills and harm other wildlife that ingests the water.

At the White King Mine located in rural Lakeview County, Oregon, the Forest Service and other partners cooperated to clean up contamination resulting from years of underground and open-pit uranium mining. To correct the high acidity of the site's pit lake, the Forest Service and other partners used an in-situ neutralization process, adding hydrated lime to stabilize the water's pH. The success of this treatment soon became apparent, as organic matter began to flourish in the formerly dead lake. The quick return of life points to a bright future for this body of water and its surrounding ecosystem.

Acid Mine Drainage: A Threat to Humans and Wildlife

The sulfide minerals contained in mine waste tailings piles react with rain, surface, or ground water to form an acidic runoff called AMD, which leaches metals like lead, copper, and mercury from the native rock. When AMD reaches rivers and streams, it can wipe out all aquatic life, impact wildlife in the area, and contaminate the sources of drinking water for entire communities. AMD is particularly hard to clean up and, if left untreated, can require centuries for water to return to its premining condition.

In the case of Blue Joe Creek, which crosses the border between northwestern Idaho and Canada, international collaboration was necessary to successfully address contaminants leaching from mine tailings that affected water and

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wildlife in both countries. A lead and copper mining operation in Idaho created a tailings-pile dam that burst in the 1940s, sending large amounts of contaminated water and sediment pouring into Blue Joe Creek. As a result of this and continued erosion of remaining tailings, the creek was devoid of fish and had low levels of invertebrates. Sampling conducted by the U.S. Fish and Wildlife Service (FWS) indicated extremely high levels of lead in wildlife around the mine site and along Blue Joe Creek. Forest Service sampling revealed highly contaminated sediments in areas of the flood plain. Surface water testing showed levels of lead in the creek at 960 times the Idaho Chronic Aquatic Standards just below the mine and 162 times the standard 7 miles downstream at the Canadian border. In order to adequately address the contamination, the Forest Service and Canadian authorities shared sampling data and established an agreement allowing the Forest Service to sample portions of Blue Joe and Boundary Creeks in Canada as part of its monitoring program.



Blue Joe Creek in Idaho.

Cleanup activities conducted from 2003 to 2006 included the EPA mitigating more than 120,000 tons of mine tailings at the site and reconstructing nearly 900 feet of Blue Joe Creek, and the Forest Service removing nearly 47,000 tons of tailings from the flood plain and reconstructing nearly 2,000 feet of the creek. A follow-up study conducted by the Idaho Department of Environmental Quality in 2006 verified that aquatic life had returned to long-dead areas of Blue Joe Creek.

Partnering to Restore Fish Habitats



As part of the "Bring Back the Natives" Program, Trout Unlimited and the BLM have funded and developed inland western native trout projects since 1993. Sponsored by the National Fish and Wildlife Foundation, the program funds large watershed restoration projects on Federal lands managed by the BLM, the Forest Service, and the FWS. Additionally, Trout Unlimited and the BLM have developed a separate cooperative agreement for native trout recovery on BLM lands, covering large-scale projects such as Lahontan Cutthroat in Nevada and Bonneville Cutthroat in Idaho, as well as for Wyoming's "Strategies for Restoring Native Trout" Initiative.

Using Innovative Cleanup Methods

Depending on the amount and type of abandoned mine land impacts, reclamation can be complex and require unique solutions. Through the use of an innovative approach, project partners were able to address mercury contamination at the former Boston Placer Mine located northeast of Sacramento, California.

The site's problems stemmed from the 400-foot sluice tunnel once used to extract gold from mined sediment, which discharged water and sediment with high levels of mercury contamination onto adjoining Forest Service administered lands. Sampling performed by USGS confirmed toxic concentrations of mercury in both the tunnel and the wetlands area. Through the removal of sediments from the sluice tunnel, plunge pool, and sluice tunnel inlet, and then separating the mercury from the sediments, the California BLM AML Team was able to recover and recycle the mercury. This innovative technique helped to preserve approximately 1 billion gallons of potential drinking water.

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Completed in 2005, this project became the first successful mercury removal, recovery, and recycling project undertaken in California. For its efforts, the AML Team received a DOI Environmental Achievement Award in 2006. A number of partners, including the Forest Service, Bureau of Reclamation, EPA, USACE, and multiple other Federal, State, local, and private entities, supported the project. By extracting mercury from sediment within the sluice tunnel and the above wetlands, the site was no longer a pollution point source, and the area became safe again for humans and wildlife.

Restoring Watersheds and Protecting Endangered Species

Past mining can affect not only nearby waterways, but also dependent ecosystems. Project partners created a collaborative cleanup approach for the Monarch Mill mining site in Atlanta, Idaho—an area prized for hiking and fishing—that restored the watershed while protecting endangered wildlife.



Volunteers conducting watershed rehabilitation work along the Boise River in Idaho.

During the mill's operation, tailings discharged directly into the Middle Fork Boise River and its tributaries released high concentrations of toxic metals. In 1990, a neighboring dam failed, washing substantial amounts of remaining mining waste into the river. Studies confirmed that area wildlife—including Bull Trout, an endangered species in Idaho, and Bald Eagles dependent on area fish—were exposed to these toxic metals. In 2006, the Forest Service signed a memorandum of agreement with EPA to clean up the former mill site. Each agency contributed $365,000, while Trout Unlimited provided hands-on support from volunteer members. Cleanup included transporting contaminated tailings to a safe repository, reshaping and reconstructing the floodplain to original free-flowing conditions, stabilizing the Middle Fork Boise River utilizing "earth burritos" and rip rap, constructing rock barbs for streambank protection, reshaping the site to control runoff, and revegetating to control erosion and stabilize remaining tailings. To further protect Bull Trout, freshwater pools were created along the river, restoring natural habitat that had been lost to flooding and erosion. In 2007, fencing the site, installing an irrigation system, enhancing vegetation, incorporating signage, and installing an informational kiosk will complete the project.

Reclamation activities stemmed the migration of toxic metals into the river. The once bleak outlook for the area's Bull Trout is now promising, as aquatic and other dependent wildlife are safe in this restored watershed. Visitors to this recreational area can enjoy unspoiled land and water for hiking and fishing in the years to come.

Continuing To Protect the Environment

Environmental impacts of mining can linger decades and even centuries after active mining has ceased. The BLM and the Forest Service are working hard to clean up mining sites to ensure continued enjoyment and use of public lands and the protection of watersheds and life within them. The BLM and the Forest Service are protecting wildlife—from the bears that hunt fish to every animal that drinks from a stream. And the communities living downstream—that may be unaware that a decades-closed mining operation located miles uphill could ever affect their drinking water—are protected by these actions. The BLM and the Forest Service are ensuring that the repercussions of exposed mining waste are safely addressed through continued efforts to identify new cleanup tools and methods. They are protecting the well-being of the environment, and of all of the creatures—human and otherwise—who depend on these lands and waters to survive. □

Bats: Protecting Endangered and Threatened Species

Abandoned mines house significant colonies of bats, many of which include threatened and endangered species. Bats are important and valued members of the environment; they can eat up to half their weight in insects each night and are instrumental in pollination and seed dispersal. Because many natural bat habitats have been disturbed or destroyed, bats have found new homes in abandoned mines. Bat Conservation International, the BLM, the Forest Service, FWS, and National Park Service have partnered to help protect vulnerable bat species in abandoned mines.



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ENSURING PUBLIC HEALTH AND SAFETY

The remnants of abandoned mining sites tell an alluring story about an adventurous time in the Nation's past. Unfortunately, they can also be the subject of distressing news about injuries and fatalities. One of the main goals of the BLM and Forest Service AML programs is to address the health and safety hazards that exist in these formerly mined areas.

While surface water contamination presents a common challenge on AML sites, addressing physical safety issues is another major priority during BLM and Forest Service reclamation work, as dozens of people every year are injured or killed in and around abandoned mine facilities. Over the years, the BLM, the Forest Service, and their partners have worked together to safeguard the lives and well-being of individuals who come into contact with these sites. The following section describes some of their successes toward that goal.

Protecting Human Uses of Water

In many abandoned mining sites with impacted waters, local residents and visitors are oftentimes unaware of the associated health hazards. In areas like Moon Creek, Idaho, reclamation partners were proactive in their efforts to protect aquatic and human life.



The Silver Crescent/Moon Gulch site in Idaho.

More than 50 years of mining left portions of Moon Creek, and 20 acres of Forest Service land around the Silver Crescent/Moon Gulch site, contaminated with high concentrations of arsenic, lead, mercury, zinc, and other toxic metals, impacting fish and wildlife habitats in the area. One and a half miles downstream from the site, inhabitants of a small residential community, unaware of the contamination, occasionally used water from the creek to irrigate their gardens. Recreational activities in the area also put visitors at risk from exposure to contaminated water, as well as from the dangers of access to decaying mine facilities. These conditions and events prompted the Forest Service to remove 130,000 cubic yards of contaminated mine tailings and waste rock from the streambed and flood plains, and to recontour and stabilize the channel using native vegetation. Plans are underway to completely restore the creek's ecosystem as part of a pilot project in Idaho, including the addition of habitat for the Westslope Cutthroat Trout, a protected species in the State.

The Forest Service improved this project's efficiency and contributed to a healthier overall watershed by coordinating cleanup efforts with EPA, which was remediating a neighboring site within the same watershed. Now, residents of the Moon Creek area can feel safe watering their backyards, and hikers and backpackers can wade through the creek's fresh, clear waters on a hot summer's day.

Making Recreation the Future of Former Mining Sites

Many former mining areas are rich in recreational opportunities for hikers, backpackers, off-road vehicle riders, and historical mine buffs alike. Reclamation of these sites makes the land safer and helps to provide a deeper appreciation for an area's mining past through its recreational future.

Blueprints for a prospective Wyoming State Park interpretive trail—with the final destination being a historic mine site with signage and kiosks—put arsenic-laden tailings at the Sturman Quartz Mill Tailings site in the trail's path.

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There was a danger that the tailings might contaminate hikers who breathed the arsenic-laden dust or got it onto their clothing. Before the State could move forward, this abandoned mill site on BLM land was reclaimed in 2005 by removing these tailings, re-contouring the topography, and re-seeding the ground. This jointly funded project by the BLM and the State ensures that any visitors who pass through the former Sturman Quartz Mill Tailings site can do so without thinking twice about their health.



The historic Sturman Quartz Mill in Wyoming.

In the Town of Lake Valley, New Mexico, several historic houses and buildings are on the New Mexico Register of Historic Places. Two of the town's structures located on BLM land have been stabilized, including a church and a schoolhouse that serves as a repository for historical artifacts. Hiking trails with historic markers have been constructed. The BLM work at this site corrected or protected against 63 safety hazards on BLM land and 21 safety hazards on private land during the summer of 2005.

Through these successful projects in Wyoming and New Mexico, recreation and history enthusiasts can safely enjoy areas that posed major threats to human health and safety.

Addressing Mine Closures

Poor air quality, unstable structures, cavernous shafts, maze-like adits and tunnels, and leftover chemicals and explosives can present significant threats to humans and wildlife at abandoned mine sites. The Forest Service, the BLM, and their partners have developed innovative methods in their endeavors to protect the lives of visitors to their great expanses of land in the West.



One of several open vertical shafts addressed at the Reef Gulch site in Colorado.

The Colorado Division of Reclamation, Mining and Safety (DRMS) joined forces with the Forest Service in 1999 to set up a 50/50-cost-share program to safely close open mines on National Forest System land in the State. Through an annual prioritization process involving the BLM and the NPS, 20 closure projects are selected to be undertaken each year. Often, sites are prioritized if an area has numerous mines that can be addressed at once, or if they are of concern to citizens nearby. This unique funding mechanism and partnership has created a cost-effective and efficient manner to address treacherous mine openings. In the fall of 2002, 26 mine openings at the Reef Gulch site were backfilled, sealed, and gated. In a matter of months spanning the summer and fall of 2006, 33 adits at the Mosquito Gulch site were secured. Both of these successes represent extraordinary undertakings in their scope, and with every mine opening properly closed, the Forest Service and Colorado DRMS decreased the chance that someone might be seriously injured or killed at an abandoned site.

In California, the formation of a Bat Gating Workshop was prompted by the existence of dangerous mine openings inhabited by bats in prominent recreation areas and the need for personnel with the knowledge and skills to address these openings. In April 2006, representatives from the BLM, the Forest Service, the California State Department of Conservation, and the NPS met for a hands-on seminar to learn techniques for constructing bat gates on open mine adits and shafts that are home to bats. The discussions between the various agencies facilitated creative measures for funding the closures of these dangerous sites. Guided by an engineering contractor, the group successfully surveyed and closed two openings using angled iron bars with gaps large enough for bats to pass

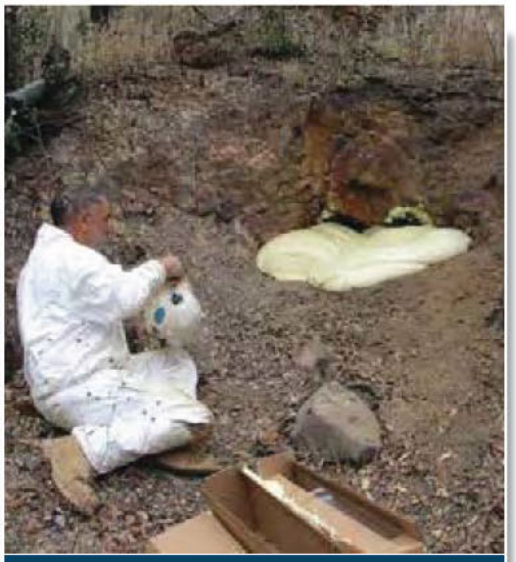


Bat Gating Workshop students on top of a successfully closed vertical shaft.

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through, but small enough to keep people out. The adits and shafts that were addressed posed major safety hazards, as they were easily accessible by road and close to motorcycle trails in the surrounding area. At the same time, these high-priority sites were home to several bat species, which are an important link in the food chain. The gates addressed both of these issues.

Encompassed by the Coronado National Forest in Arizona, the Alum Gulch watershed area is used heavily for hiking, camping, picnicking, and riding off-road vehicles. However, past mining operations left behind mining waste rock and tailings piles, open mine shafts, and leaking adits. To ensure the safe closure of all open adits and shafts at former mining sites, including the Humbolt, Chief, and World's Fair Mines, the Forest Service used innovative, polyurethane foam plugs to seal openings. These plugs are produced by mixing two liquid reagents that are then poured into adit and mine entrances; the resulting chemical reaction creates a foam that expands to fill all openings and cracks. Once this foam hardens, it is covered with dirt and rock, creating a permanent, weatherproof seal that safely prevents access by humans and wildlife. In addition, the Forest Service undertook an elaborate campaign to preserve the local bat population, by installing bat culverts and grates in the hillsides to provide new habitat once adits and mine shafts were filled. While long-term monitoring of water quality and contaminant sources will continue, the cleanup of former mining sites in the Alum Gulch watershed was completed in the spring of 2007.



Foam closure at the Humbolt Mine.

The successes of the programs in Colorado, California, and Arizona are notable achievements on the road to a safer back country. They highlight the mindful techniques used by the BLM and the Forest Service to keep their constituents—human and otherwise—safe while approaching their tasks in a cost-effective manner.

Protecting Public Health and Safety into the Future

As part of their AML program goals, the BLM and the Forest Service have saved and continue to help save countless lives and prevent innumerable injuries, all while taking into consideration the wildlife and historic landmarks that frame the landscape. As a result of efforts made over the past 10 years, many formerly impacted local communities, nature lovers, and recreational enthusiasts can fully enjoy these former mining sites without fear for their lives and safety. As their AML programs continue to grow, both agencies will continue supporting the "Stay Out-Stay Alive" campaign launched by the Mine Safety and Health Administration (MSHA). Over time, exposure to AML sites will likely increase and put more lives at risk. In response, the BLM and the Forest Service strive to minimize this exposure by conducting education and outreach activities that inform the public about the potential health and safety concerns associated with AML sites. □

STAY OUT STAY ALIVE

The ***Stay Out-Stay Alive*** campaign, launched in 1999 by MSHA, is a collaborative effort between more than 70 agencies and organizations, including the BLM and the Forest Service. "There are about 500,000 abandoned mines and another 14,000 active operations throughout the United States," said Richard E. Stickler, assistant secretary of labor for MSHA. "Many of them contain hidden hazards and, for those not trained to work in mines, the outcome can be deadly. That's why we urge hikers, bikers, rock hounds, and swimmers to 'Stay Out and Stay Alive.'"

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IMPROVING QUALITY OF LIFE



Volunteer high school students conducting stream sampling in Monday Creek in Ohio.

Mining activities were historically the backbone of surrounding communities, and in many cases towns were developed solely to house miners. When mine closures occur, a significant number of jobs are lost and communities are forced to identify a new economic livelihood, which can be complicated by their remote locations. Many communities are left with high unemployment rates and small populations, as residents are forced to leave in search of other opportunities.

By working closely with residents and providing a range of related training opportunities, Federal and State partners have increased the capacity of local communities to tackle environmental problems and create new jobs. The examples provided in this section demonstrate the positive effect the BLM and the Forest Service have had on local economies and residents' quality of life.

Increasing Community Pride Through Reclamation Efforts

It can be a daunting task for communities to revitalize their abandoned mine lands because lives revolved around mining and residents cannot imagine a different landscape. This is particularly true in the Appalachian coal belt. By taking the initiative to improve their surroundings through collaborative partnerships, residents of the Monday Creek watershed in Ohio's Wayne National Forest were able to expand their opportunities and increase community pride.

Large portions of Monday Creek and its tributaries were dead due to AMD left behind from a century of coal mining. In 1990, EPA rated it an unrecoverable stream. In 1994, local residents formed the Monday Creek Restoration Project group, which sought to restore 27 miles of the creek. While initially concerned with correcting flooding issues, the group focus has since expanded—it now coordinates the efforts of more than 20 partners, including grassroots organizations, universities, State offices, the Forest Service, EPA, USACE, OSM, and FWS. This collaboration has been critical as each partner provides unique technical expertise and resources. The Forest Service, for example, provided support for CERCLA actions, cleanup design, and geographic information system (GIS) analysis. At last report, partners had invested approximately $5 million toward creek cleanup, and the Forest Service contributed a similar amount of work and funding.

"Over the years, it has been the concern and involvement of citizens that has made the Monday Creek Restoration Project a reality. Local citizens have participated in planning meetings, volunteered for stream sampling and litter cleanups, provided management plan input, and become involved in Friends of Monday Creek events."

- **Mike Steinmaus**
Monday Creek Watershed Coordinator

Since reclamation projects began in the forest, community pride in the project has grown. Residents have been involved in activities such as conducting stream sampling, trash cleanups, and the painting of murals depicting coal mining and restoration work. The hard work of all partners has begun to pay off; the creek's water quality has improved

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substantially, people are using the area for recreation, and EPA reversed the creek's unrecoverable rating in 2004. With additional cleanup, the stream could someday be used as a warm water fishery to support recreational fishing.

Building Capacity To Further Environmental Progress

When empowered with the right skills, local community members can have a substantial impact on improving their environment and economy. In Alaska, the BLM provided funding for the Yukon River Inter-Tribal Watershed Council (YRITWC) to remediate a small abandoned mine site and build local capacity for future projects.



A YRITWC leadership meeting taking place at a bi-annual summit in Fort Yukon, Alaska.

The YRITWC was established in 1997 by a group of tribal elders concerned about cancer and other health issues caused by contamination of the Fortymile watershed, a tributary of the Yukon River that flows through an area including Alaska and Canada. The BLM provided $250,000 and partnered with the Yukon Territory Division of Indian Affairs and Northern Development, YRITWC, and others to create a 5-year cooperative agreement to remediate the watershed's Steel Creek site.

By 2006, the YRITWC reclaimed the site within budget and schedule. Through the process, more than 15 Tribes were trained in water quality monitoring and mapping, which led to a collaborative, 3-year water quality monitoring project with USGS and creation of a comprehensive contaminant database. The BLM's support also helped YRITWC leverage more than $900,000 in funding and in-kind support. These capacity-building efforts led to new jobs and job retention for tribal members; for instance, the EPA Indian General Assistance Program provides funding for two environmental jobs in each community.



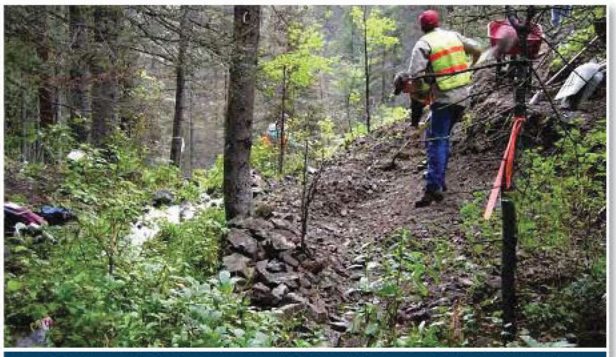
YRITWC members searching for macro-invertebrates from the Yukon River.

The support that partners provided to YRITWC enabled tribes to expand their environmental efforts to cover a wide range of issues. Some of these efforts include removing and recycling more than 3.5 million tons of wastes, developing a brownfields inventory and conducting environmental assessments, monitoring water quality, and initiating renewable energy pilot projects. YRITWC is scheduled to begin its second mining project, using an additional $150,000 from the BLM to address mining impacts on Hausa Tribal lands.

Supporting a Local Economy Through Reclamation

Although the Red River area near the town of Questa, New Mexico, has a history of gold and copper mining, it successfully transitioned to a tourism economy based on skiing and other recreational activities. The Forest Service helped promote this new economic base by ensuring the safety of Federal lands.

When visiting Questa, many visitors hike on surrounding National Forest System lands. There were four abandoned mine sites on these lands, causing safety concerns associated with exposed adits, AMD, and erosion. One of the sites identified as a cleanup priority was adjacent to a creek situated upstream of the City of Red River's water system.



Waste rock being removed from the area below a newly constructed recreational path in Red River, New Mexico.

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The Forest Service worked closely with partners such as the State, EPA, FWS, Trout Unlimited, and ski resort owners to improve the safety of the area by consolidating contamination from these sites into a single, capped repository. For example, a local ski resort owner contributed by donating the use of equipment to dry out the soil for construction of an access road. Throughout the reclamation process, the community was supportive, recognizing that the Forest Service's work was designed to improve the safety of the area and promote the local tourist industry.



Waste rock from the Buffalo Mine in New Mexico being dumped in the repository.

Helping Communities To Turn the Tide

The BLM and the Forest Service have had a positive impact on people's lives through reclamation of abandoned mine lands over the past 10 years. As part of their efforts to promote community involvement, both agencies will continue to work closely with local communities throughout the reclamation process by involving them in decision-making regarding cleanup and reuse options, providing a range of training opportunities, and involving local contractors in remediation work. Through these efforts, the BLM, the Forest Service, and their partners plan to continue to help communities and their residents transition into economies that offer brighter futures. □

Office of Surface Mining Works Together with the BLM and the Forest Service

The Office of Surface Mining's (OSM) AML program mitigates the effects of past mining by aggressively pursuing reclamation of abandoned mines. While most abandoned mines involve coal, OSM has the authority to allow AML funds to be spent to reduce threats to public health and safety from noncoal mines. BLM and the Forest Service have leveraged funding from OSM in situations where a State or tribe, particularly in the West, has certified that all abandoned coal sites have been reclaimed.



Monday Creek Watershed camp participants.

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LOOKING FORWARD

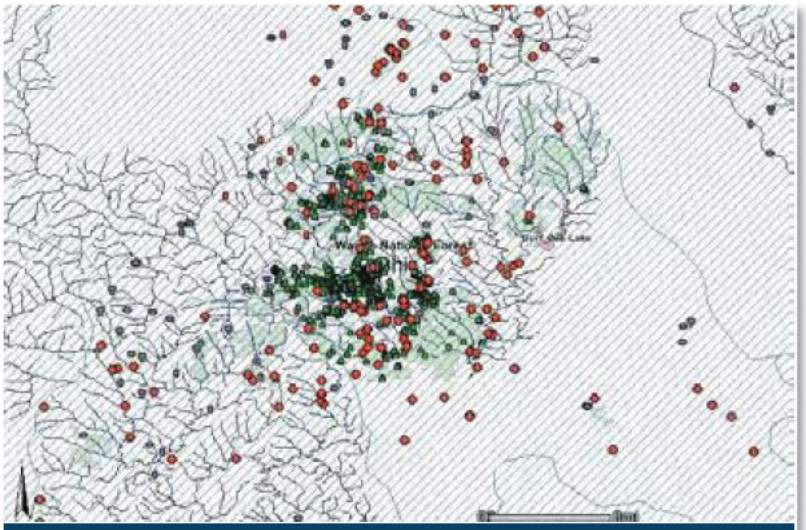


The Golden Butte Mine site in Nevada.

As this report demonstrates, much progress has been made in reclaiming AMLs and revitalizing the impacted watersheds and communities that are on or near public lands. With more than 12,000 abandoned mining sites on the BLM lands, more than 39,000 sites on National Forest System land, and hundreds of thousands of more sites yet to be identified and characterized, more progress must be made. While these AML sites may represent environmental and safety threats, these lands also present opportunities for new ecological, economic, and other assets. Through continued funding, the BLM and the Forest Service can build on 10 years of progress and support the next phases of reclaiming the AML sites on public lands. In looking forward, the BLM and the Forest Service expect to focus on several key areas.

Enhancing Site Inventories and Prioritizing Reclamation Projects

Building on their existing site inventories, the BLM and the Forest Service can enhance their AML inventories to enable more optimized program planning and prioritization of sites for reclamation. Although initial inventories provide solid baseline information, additional data collection is necessary to ensure that all sites that pose significant health and safety threats are prioritized appropriately. Furthermore, priorities have changed since initial inventories were first developed and there have been significant shifts in population centers and recreation intensity. In an effort to coordinate and consolidate AML activities, the BLM has embarked on an effort to develop a National Mine Lands Inventory that will show AML and mine site locations on all Federal lands. Providing these site locations in a GIS platform along with other data layers (e.g., recreation facilities, impaired watershed boundaries, property lines) will allow for better communication and coordination between State and Federal agencies and the public, promoting better use of scarce resources to produce the greatest positive impact from reclamation. Additionally, the Forest Service is in the process of putting its regional AML data into a national database, making it available for use for the first time for land use planning and other resource management activities.



National Mine Lands Inventory: A compilation map of mining sites for multiple land management agencies.

Leveraging Resources and Results Through Cooperation and Partnership

Past partnerships show that collaboration and coordination result in more efficient use of limited funding. Looking beyond the traditional intergovernmental partnerships to private sector, academia, and nonprofit alliances will tap

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new capabilities in technology transfer, funding sources, and knowledge management. Developing interagency training courses and technology lessons learned will help Federal partners stay apprised of emerging and innovative technological and scientific advances. Future AML site successes depend on initiating and building long-term relationships with local individuals and organizations that are in tune with the local wildlife, traditional culture, and character of the community.

Transferring Technological Innovations To Ensure Effective and Efficient AML Site Cleanups

With more than 50 years of experience cleaning up mining sites, the BLM and the Forest Service know that the greatest savings in cleanup cost savings come from technology improvements and new technologies. Best practices in AML reclamation are continuously being tested and proven by the BLM, other Federal agencies, States, contractors, and mining companies. To bring these technological advancements to bear on public lands, the BLM and the Forest Service must partner with others in training and technical assistance efforts to test their effectiveness in differing site conditions. Over the past 10 years, technologies such as X-Ray Fluorescence metals analysis and sulfate reducing bioreactors have gone from innovative to mainstream. The next 10 years will certainly bring new and cost-effective tools to AML reclamation.

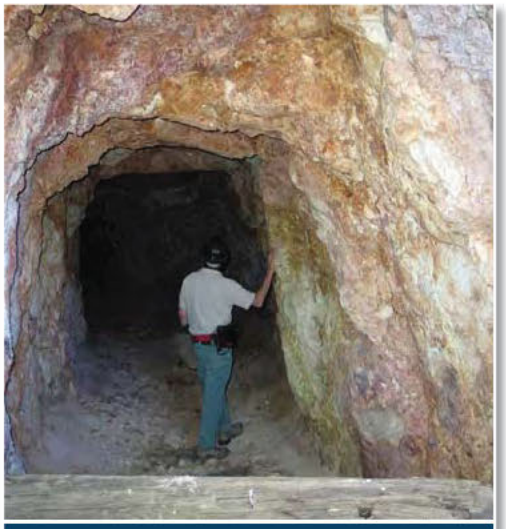


Close up view of an X-Ray Fluorescence Spectrometer.

Solving the Long-Term AML Problem Through Prevention and Sustainable Practices

With the current estimates of AML sites on public lands in the hundreds of thousands, reclamation will not be completed in the near term. However, preventing future AML sites is a crucial component of any land management agency's AML program. Sustainable mining practices and environmentally protective mine closure planning guarantee against abandonment and public cleanup burdens. Through optimal permitting requirements and financial assurances, land management agencies are encouraging mining companies to operate under a sustainable business model that follows a mine's life from startup to clean closure. These efforts ensure that the inventory of AML sites on public lands continues to shrink.

With adequate funding and other technical resources, the BLM and the Forest Service can meet these future objectives and ensure that mining remains a key component of the economy. The prosperity that mining brings will ensure that the BLM and Forest Service landscape will be safe and environmentally healthy for everyone who lives nearby or benefits from public lands. □


The Sunnyside Adit in Alum Gulch, AZ.

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DOI-19-0291-I, 19-0538-J-000478

TWIN METALS MINNESOTA

February 27,

Via Electron

Dominica Va
Deputy State
Bureau of La
Eastern State
20 M Street
Washington,

Connie Cum
Forest Supervi
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Duluth, MN

Re:

Dear Deputy

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TMM respectfully provides comments on the EA Notice in this submission. TMM's comments dated August 11, 2017 are relevant to the EA Notice and are incorporated into these comments. Overall, the Withdrawal Proposal lacks any reasonable legal foundation and is not based on any credible science.

A. The Withdrawal Proposal is Contrary to Law and Public Policy

The Withdrawal Proposal is illegal and the government has yet to explain the rationale for it. It contradicts longstanding mineral tenure policies for the SNF, which are supported by decades of environmental review concluding that mineral exploration and development may occur in an environmentally sound manner. The Withdrawal Proposal also contradicts Congress's original intent for these minerals and is outside the Agencies' regulatory authority for leasable minerals.

In 1950, Congress authorized mineral development in the SNF, and it has since twice reaffirmed its support for such mining: first when it passed the 1964 Wilderness Act, and again in enacting the 1978 Boundary Waters Canoe Area Wilderness Act (BWCAW). Both laws support rather than infringe on robust mineral development in the SNF. They represent a national compromise, balancing the preservation of important wilderness areas with the protection of mineral rights within the SNF. Agencies may not revisit that balance, both because they lack authority to second-guess Congress and because for over 60 years now, mining companies have relied on that legislative balancing to invest hundreds of millions of dollars in the SNF—outside of the wilderness area and adjacent statutory buffer zones. TMM's August 11, 2017 comments explain in detail why the Withdrawal Proposal is contrary to law and should be cancelled by USFS or denied by the Department of Interior.

Cancellation of the Withdrawal Proposal by USFS or denial of it by the Secretary would not constitute a major federal action, because either outcome maintains the status quo for leasing federal minerals in the SNF that is authorized by 16 U.S.C. § 508b ("Statute 508b") and the Reorganization Plan No. 3 of 1946, § 402, 5 U.S.C. app. ("Reorg. Plan No. 3"). Under Statute 508b and the Reorg. Plan No. 3, BLM and USFS have significant authority to appropriately regulate federal mineral development through forest planning, recommending stipulations to federal mineral leases, and conducting project-specific environmental review on a case-by-case basis. Such control ensures that mineral development on these lands is conducted in a responsible and environmentally sound manner, in harmony with management plans and best practices. As explained in TMM's August 11, 2017 comments, leasable minerals are not subject to withdrawal under the Federal Land Policy and Management Act ("FLPMA") generally, withdrawal is not authorized under Statute 508b, and it would be contrary to congressional policy and the emphasis of the Administration on jobs and growing the economy.

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Indeed, the USFS Forest Manual recognizes the ability of existing laws and procedures to protect the environment and discourages withdrawal requests, stating:

> *There should be relatively few requests for withdrawals from operation of the mineral leasing laws, because the land and surface resources ordinarily can be protected by proper stipulations, or because detrimental leasing can be prevented by recommendations or refusal to consent to applications.* FSM 2822.21.

Both the 1986 and 2004 Forest Plans, each supported with a full NEPA process and EIS, concluded that mineral development is a "desired condition" in the SNF outside the BWCAW and the Mine Protection Area. These determinations occurred at the same time as the USFS's agreement to continue TMM's two federal leases without recommending additional stipulations to protect surface resources. Additionally, the Federal Hardrock Minerals Prospecting Permits Project Record of Decision dated May 2012 concluded that federal prospecting and mineral development could be conducted in an environmentally sound manner within the Superior National Forrest.

Moreover, USFS lacks the hydrological, geological, air quality, and resource information required under 43 C.F.R. § 2310.3-2(b)(1) and (3) to make an informed decision to withdraw minerals on a blanket, area-wide basis, rather than in response to project-specific mineral development applications. Only once a Mine Plan of Operations has been proposed will the USFS have a sufficiently detailed scientific and factual basis to consider the environmental impacts of mining in the SNF. The Agencies also lack sufficient funds to properly conduct this type of review on their own. As a result, neither USFS nor BLM can presently support the determination necessary under 43 C.F.R. § 2310.1-4(b) and 43 C.F.R. § 2310.3-3 that processing the withdrawal is feasible and cost-justified. Consequently USFS should cancel the Withdrawal Proposal pursuant to 43 C.F.R. § 2310.1-4(a).

The basis for canceling the Withdrawal Proposal has only strengthened in the past year. The Trump Administration has made it clear that it prioritizes the domestic production of critical minerals, including Cu-Ni-PGM minerals. The minerals in the area covered by Withdrawal Proposal represent a large portion of the nation's identified strategic mineral reserves. Removal of these minerals from the public domain is not only unwise but against current public policy. The President has signed an Executive Order, known as the Critical Minerals EO, with the goals of "identifying new sources of critical minerals," and "increasing activity at all levels of the supply chain, including exploration, mining, concentration, separation, alloying, recycling, and reprocessing critical minerals." Exec. Order No. 13,817, 82 Fed. Reg. 60835 (December 20, 2017). The Critical Minerals EO was released in conjunction with a United States Geological Survey ("USGS") assessment of available and potential domestic resources, which concluded that the Lake Superior region has "high potential to contain undiscovered copper-nickel-PGE sulfide deposits." U.S. Geological Survey, Professional Paper 1802 at p. N34 (December 19, 2017). Given the Administration's clearly stated priorities as reflected in the Critical

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Minerals EO, there is no justification for engaging in a multi-year, multi-million dollar field study and analysis over whether it is reasonable to withdraw many hundreds of billions of dollars of national strategically important mineral wealth from responsible development. Consequently, the Withdrawal Proposal should be rejected as not cost-justified under 43 C.F.R. § 2310.3-2(b).

B. The Withdrawal Proposal Can and Should be Canceled Without NEPA Analysis

The Withdrawal Proposal can be canceled without any NEPA analysis. *Havasupai Tribe v. Provencio*, 876 F.3d 1242, 1250 (9th Cir. 2017) (citing *Upper Snake River Chapter of Trout Unlimited v. Hodel*, 921 F.2d 232, 235 (9th Cir. 1990)); *see also Comm. for Auto Responsibility v. Solomon*, 603 F.2d 992, 1002-03 (D.C. Cir. 1979). "[A]gency decisions that maintain the status quo do not constitute major federal actions." *Int'l Ctr. for Tech. Assessment v. Thompson*, 421 F. Supp. 2d 1, 8 (D.D.C. 2006). Additionally, "NEPA applies only to agency *actions* even if *in*action has environmental consequences . . . because no agency could meet its NEPA obligations if it had to prepare an environmental impact statement every time the agency had power to act but did not do so." *Id.* (emphasis added); *see also Defs. of Wildlife v. Andrus*, 627 F.2d 1238, 1245-46 (D.C. Cir. 1980) (agency inaction is not subject to NEPA). Where an agency has the power but not the duty to act, the agency's failure to do so is not considered an "action" that triggers NEPA review. *Id*. This principle has been adopted and expanded by the Eighth Circuit, which has held that even if an agency has undertaken certain practices on administered lands in the past, its decision not to repeat the action does not trigger NEPA. *See Minnesota Pesticide Information & Educ., Inc. v. Espy*, 29 F.3d 442, 443 (8th Cir. 1994) (USFS decision not to use herbicides in certain forests is not an "action" under NEPA, but rather a "decision to *not* do something" (emphasis in original)).

Even assuming for the sake of argument that the Secretary is *authorized* under FLPMA to approve withdrawal of SNF minerals (which TMM contests), he is under no *duty* to do so. 43 U.S.C. § 1714(a). Similarly, USFS can apply for withdrawals, but it is under no duty to do so—even if it has done so in other cases. Therefore, a decision not to proceed with the Withdrawal Proposal, either through cancellation under 43 C.F.R. § 2310.1-4(a) or denial under § 2310.3-3(a), is not an "action" under NEPA and therefore does not trigger any additional environmental review.[1]

C. The Agencies Must Recognize TMM's Valid Existing Rights

Regardless whether the Withdrawal Proposal is canceled, USFS and BLM must recognize TMM's VERs. USFS acknowledged the need to accommodate VERs in its

[1] BLM has canceled two withdrawal applications in the last five months pursuant to 43 C.F.R. § 2310.1-4(a) without additional NEPA review: the proposed withdrawal of National Forest and other public lands in the Sagebrush Focal Areas, 82 Fed. Reg. 47,248 (Oct. 11, 2017), and the proposed withdrawal of public lands within designated California Desert National Conservation Lands. 83 Fed. Reg. 5,459 (Feb. 7, 2018).

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original Withdrawal Proposal, but at that time it was arguing in litigation that TMM did not have VERs because BLM had terminated TMM's Leases MNES-1352 and MNES-1353 ("TMM Leases"). The BLM has since rescinded the M-Opinion that prompted termination of the TMM Leases, replacing it with M-Opinion M-37049. M-37049 determined that TMM has a nondiscretionary right of renewal in the TMM Leases, and BLM is in the process of reinstating the TMM Leases. There can be no dispute that TMM has VERs in those leases.

In addition, TMM possesses VERs in two pending Preference Right Lease Applications ("PRLAs"), and prospecting permits and their renewal applications filed prior to the Withdrawal Proposal. Regardless of how the agencies proceed on the Withdrawal Proposal, the TMM Leases, PRLAs, prospecting permits, and prospecting permit applications confer VERs – resulting from over $400 million in investment in the exploration for and the discovery of valuable mineral deposits. These rights are unequivocally exempt from any withdrawal.

D. <u>To the Extent the Agencies Contest any of TMM's VERs, the Agencies Should Consider the Negative Economic Impacts of the Proposed Withdrawal</u>

As explained in the preceding section, TMM has extensive VERs in the SNF that must be excluded from any form of withdrawal. Moreover, to the extent the Agencies contest or reserve judgment on any of TMM's VERs, the Agencies' analysis must fully recognize the devastating effects of withdrawal. The EA Notice describes the socio-economic effects of withdrawal as "controversial." In fact, withdrawal of the minerals encompassed by TMM's VERs would wreak substantial harm on northern Minnesota and indeed the Nation. TMM's August 11, 2017 comments described in detail the value and importance of TMM's mineral interests, and the effects of withdrawal would reach far beyond TMM, affecting thousands of families who live and work in northern Minnesota. This region has depended for generations on good-paying mining jobs. TMM's project will provide thousands of such jobs for decades.

Denying those jobs via withdrawal would have a draconian impact on people's lives and the viability of these communities costing the region billions of dollars in future economic growth.

Both USFS guidance and DOI regulations require USFS to analyze and report on the impacts a withdrawal will have on mineral resources and the economy before a withdrawal can be approved. 43 C.F.R. § 2310.3-2(b)(3). The Forest Service Manual states that the agency should "consider strategic and critical minerals, the value of the mineral resource that may be foregone, and the value of the resource or improvement being protected before withdrawing NFS lands from mineral entry." U.S. Forest Serv., Forest Serv. Manual ("FSM") 2803. The Cu-Ni-PGM minerals to be withdrawn in the SNF are a strategic resource of the United States, and the USGS has found that there is the potential for substantial reserves of these critical minerals in the Superior region. *See* U.S.

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Geological Survey, Professional Paper 1802 at p. N34 (December 19, 2017). USFS should carefully consider the economic and strategic value of the minerals to be withdrawn before proceeding, particularly considering the President's recent Critical Minerals EO.

As part of the required NEPA review for a withdrawal, DOI regulations require the applicant (here, USFS) to prepare "an analysis of the economic impact of the proposed uses and changes in use associated with the requested action on individuals, local communities, State and local government interests, the regional economy and the Nation as a whole." 43 C.F.R. § 2310.3-2(b)(3)(v). The regulations also require the applicant to prepare a detailed mineral resource analysis which includes "evaluation of future mineral potential and present and potential market demands." *Id.* at (iv). These studies, along with others identifying cultural resources, roadless wilderness areas, and endangered and threatened species, must be included in the NEPA document

The Withdrawal Proposal will have significant negative impacts on the regional economy and the country as a whole by barring access to critical mineral resources. These impacts, however, are poorly understood at this point and require further study by USFS as part of the environmental review process. To our knowledge, none of the reports or analyses required by 43 C.F.R. § 2310.3-2(b)(3) have been completed to date. [2]

For these reasons and those stated in TMM's previous comments, the Withdrawal Proposal should be canceled.

Sincerely:

Kevin L. Baker
V.P. of Legal Affairs

[2] For all the reasons stated herein, the Agencies can cancel or deny the Withdrawal Proposal without any additional NEPA analysis. Or, if the Agencies prepared an EA, they could select the No Action Alternative at the conclusion of it. None of those three courses of action (cancellation, denial, or no-action) would have the potential for significant environmental effects. Conversely, any decision that would prohibit or significantly limit the development of the Basal Mineralization Zone ("BMZ") deposits should be supported by an EIS. The BMZ has been clearly shown to contain valuable mineral deposits. Socioeconomic effects are cognizable under NEPA, *Friends of the Boundary Waters Wilderness v. Dombeck*, 164 F.3d 1115, 1125-1127 (8th Cir. 1999), and prohibiting or limiting the development of the BMZ would have significant such effects. It would also fundamentally change the near-future of the SNF from what is stated in the Forest Plan, thereby requiring a revision to the Forest Plan. Withdrawal of the BMZ would also alter what is achievable in the SNF through demonstrated investment and exploration results, causing a wide array of environmental effects.

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cc: without enclosures

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