# Task 3: Request for Proposals

## Bio-inspired Critical Mineral Recovery from Mining Waters

**Proposed, developed, and sponsored by Platinum Sponsor**: Freeport-McMoRan Inc.

**Task Summary:**
The recovery of critical minerals, such as nickel, lanthanum, yttrium, and copper is becoming increasingly vital to our nation's economy and supply chains. These minerals are extracted in mining operations, but many process streams still contain valuable residuals that go un-recovered because traditional source streams and extraction methods are not economically viable.

Biological materials and their derivatives are showing great promise for cost-effectively extracting these minerals from mining waters. To be feasible, the mineral recovery process must yield a marketable product whose sales offset recovery costs and ideally generate a profit.

**Problem Statement**
Demonstrate an innovative, cost-effective means of recovering target critical minerals from mining water that can be scaled up to full production at a Freeport-McMoRan[1] (FMI) copper processing facility (see Appendix). Flow rates and retention times for a full-scale system will be selected by your team.

- Focus your solution on a single non-targeted MIW mining water source, either from ARD, raffinate, or pit waters.
- Utilize any organism (living or dead), any organic derivative, or organic component to capture critical minerals from the selected MIW. Your team is urged to look beyond often-used, conventional biological recovery methods to explore a truly novel technologies.
- Consider using non-biological pre-treatments and/or substrates to improve water chemistry, if needed, to optimize critical mineral recovery. If included, their contribution to mineral recovery must be accounted for separately in your final assessment of overall system effectiveness.
- Recommend a method to extract/recover the mineral(s) from the system at the end of your process.
- Include a Techno-Economic Analysis for your full-scale system that demonstrates economic benefits of your solution. Ideally, the goal is to produce a salable product that offsets, or is more profitable than, the cost of operating your selected design.

**Background**
Critical minerals are non-fuel minerals essential to economic and national security in the United States and have been determined to have a high risk of supply chain disruption [1]. Recovery of these minerals is attracting more attention due to their importance for the green economy, potential risks to global supply chains, and national security concerns.

While the list of critical and near-critical minerals changes over time, the US Department of Energy identified a subset in its *2023 Federal Register Notice*, including copper (Cu), nickel (Ni), lanthanum (La), and Yttrium (Y) [2].

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[1] Freeport-McMoRan is pronounced "FREE-port MAC-moh-ran"

While these minerals may be found in mines specifically targeted for recovery, they are also found in lower concentrations in various mining-process waters, where they are byproducts of copper refinement, legacy mine runoff, surface and groundwater accumulating in mine pits, etc. – sources that have not historically been targeted for mineral extraction. Hence, these waters are often called "nontargeted water sources." Previously underutilized, these unconventional sources now offer the potential to strengthen national supply chains through enhanced recovery efforts.

Freeport-McMoRan is particularly interested in exploring biologically-mediated technologies that leverage the natural mineral-accumulating abilities of biological elements. These approaches have shown promise in recovering critical minerals through multiple pathways including biosorption, bioleaching, phyto-mining, bioprecipitation, and more. Using these bio-inspired means to recover critical minerals from existing mining process waters can support a circular economy by promoting environmentally sustainable and economically viable solutions.

**Biological Elements**

This task is open-ended, allowing teams to select from a wide array of bio-inspired critical mineral recovery designs. Since your solution may incorporate the use of live organisms, dead organisms, or only products of organisms, we will use the general term *biological element* to refer to any such component or product.

For your biologically mediated system, you must include one or more biological elements. These may include, but are not limited to:

- Algae
- Microorganisms
- Enzymes derived from living organisms
- Fungi
- Vascular plants
- Bryophytes
- etc.

**Recovering Critical Minerals at Mine Sites**

In the context of this design challenge, *mining-influenced waters* (MIWs) refer to any water whose chemistry has been altered by mining or mineral processing [3]. Relevant examples of MIW for this task include *acid rock drainage* (ARD); and Mineral Processing Waters, specifically *raffinate* and *pit water*.

Your team will select one of these three types of MIWs (in bold below) as the source for critical mineral recovery. Each has distinct water chemistry, which will directly influence the design of your selected mineral-recovery system.

- ***ARD*** is typically characterized by low pH and high acidity. It also typically contains elevated concentrations of dissolved metal ions, making it a potential source of critical minerals. The specific ARD chemistry for this design challenge is provided in Table 1.
    - ARD forms when sulfide-rich ore is chemically weathered at a mine site or in mine waste rock due to exposure to air and water. It results from a geochemical process that converts metal sulfides to ions, dissolved metals, sulfate, and hydrogen ions.
    - A simple, well-known example involves the mineral pyrite ($FeS_2$). When exposed to oxygen ($O_2$) and water ($H_2O$), it oxidizes to release ferrous iron ($Fe^{2+}$), sulfate ($SO_4^{2-}$), and hydrogen ions ($H^+$). The hydrogen ions increase acidity and cause leaching of additional metals from the ore into solution.

  - ARD can occur at any location where sulfide ores, air, and water come into contact, such as at mine sites, where rock has been disturbed or excavated. Crushing the rock increases its surface area, creating more sites for chemical reactions to occur.

- ***Mineral processing waters*** are waters that are recirculated in mining operations to facilitate operations such as crushing, flotation, leaching, and tailings management. Continuous recirculation reduces the need to add more fresh water to the system, and it may also provide opportunities to recover minerals from previously overlooked sources.
  - Leaching operations use chemically engineered solutions to dissolve target minerals by adding acid to the waters. For example, mining companies often use acidic leach water to dissolve copper from its ore. Once dissolved, the copper is recovered from the leach solution through chemical or hydrometallurgical processes (e.g., solvent extraction-electrowinning (SX-EW)).
    - Essentially, leaching is a controlled-environment ARD process that is intentionally used to aid copper recovery, but its water chemistry is typically more acidic than ARD waters.
    - Due to their acidity, these processing waters may carry dissolved critical minerals.
    - **Raffinate** is the liquid that remains after SX-EW removes valuable metals from ore. Raffinate is recirculated back into leaching and other operations. It still carries dissolved critical minerals, but in reduced concentrations, making it another potential source for enhanced critical mineral recovery. In this design challenge, of the three MIWs, the raffinate solution (see Table 2) has the highest acidity.
  - Non-leaching operations separate materials using physical methods such as flotation and washing. These processes typically involve less acidic chemistry than leaching operations. While leaching processes carry dissolved minerals, non-leaching operations generate water streams that may carry suspended critical minerals.
  - **Pit waters** accumulate in the bottom of open-pit mines at either leaching or non-leaching mining operations. Depending on the mine layout, the water can come from multiple sources (groundwater, rainfall, surface runoff, seepage from tailings or waste rock, or mineral processing waters. Similar to ARD, pit waters come into contact with sulfide-rich ore in the pit. Adding air and the right conditions will result in increased acidity in the pit water.
    - Pit waters may contain dissolved metals (similar to ARD)
    - Low-grade leaching may occur in lower pH pit water
    - Seasonal precipitation may result in seasonal changes in water chemistry, and therefore, affect mineral recovery

For more information on copper leach mining, see the following resources:

Copper Mining and Processing: Processing Copper Ores [4]
Copper Leaching Practices - 911Metallurgist [5]

**MIW Chemistries**

Simplified representative chemistries of each of these MIWs, provided by FMI, are shown in Tables 1, 2, and 3, respectively. Your team will use the tables as recipes for mixing your own synthetic mine water for bench-scale testing. While actual MIW chemistries are more complex, the synthetic versions used for this task focus solely on pH and mineral constituents.

Your team will select one of the three water types and re-create its chemistry in your lab. Therefore, when developing your design, refer only to the chemistry associated with your selected MIW. Be sure to identify your chosen MIW chemistry in your 30% Project Review (see below).

TABLE 1. ARD SYNTHETIC SOLUTION CHEMISTRY

| **ARD** | |
|---|---|
| pH | 2-4 |
| Metals (mg/L) | Concentration (ppm) |
| Cu | 55 |
| Fe | 80 |
| Ni | 1 |
| La | 5 |
| Y | 5 |

TABLE 2. RAFFINATE SYNTHETIC SOLUTION CHEMISTRY

| **Raffinate** | |
|---|---|
| pH | 1-2 |
| Metals (mg/L) | Concentration (ppm) |
| Cu | 90 |
| Fe | 1300 |
| Ni | 15 |
| La | 2 |
| Y | 15 |

TABLE 3. PIT WATER SYNTHETIC SOLUTION CHEMISTRY

| **Pit Water** | |
|---|---|
| pH | 2-3 |
| Metals (mg/L) | Concentration (ppm) |
| Cu | 150 |
| Fe | 300 |
| Ni | 6 |
| La | 0 |
| Y | 3 |

**Solving the WERC Challenge:**

*Mine Parameters and Locale*

In this scenario, waters targeted for critical mineral recovery are located at an open pit copper mine that produces refined (99.99%) copper cathodes using the electrowinning process (an electrochemical process that uses an electric current to extract metals from a solution).

The mine site offers sufficient space to deploy biologically-mediated critical mineral recovery technologies and has access to ARD and mineral processing waters. Water temperatures can range from 32-80° F across sites, with temperatures typically fluctuating no more than 30° F at a given site annually. All locations have ready access to reliable power sources and other utilities, as well as personnel for operation, maintenance, and monitoring.

Mining operations typically pump their water at extremely high rates (on the order of 15,000 gallons per minute, or gpm). You may assume this as the maximum flow rate for the full-scale mining application in this task. Since this rate may be too high for your bio-inspired solution, your team may assume that a diversion system is in place that reduces influent flow to a manageable flow rate and hydraulic retention time (HRT) for your system's design. Ideally, after mineral recovery, the water effluent from your treatment system will be recycled back into the mine's process waters for reuse.

*Substrates and Pre-treatments*

The design challenge allows for teams to implement pre-treatment (such as pH adjustment, filtration, chemical dosing) of the process waters before they enter your mineral-recovery system. Pre-treatment may be used to improve the effectiveness of your biologically-based recovery strategy, but the pre-treatments themselves do not need to involve biological components or their products.

The effect of these pre-treatments on water chemistry and mineral recovery must be accounted for in the mass balance for your system. Similarly, if a substrate is used in your system, it shall not contribute additional metals nor remove metals <u>unless</u> contributions are calculated and accounted for in the mass balance for the system.

There are many ways that minerals can be recovered from MIW, including the following:

- taken up in a wet biomass through biosorption or bioaccumulation using algae, fungi, or bacterial cells;
- precipitated from solution through microbial or enzymatic activity;
- absorbed and concentrated by plants that grow in metal-rich environments (phytomining);
- transformed into nanoparticles by biological processes that alter solubility or oxidation state;
- trapped and concentrated into biofilms or biocolloids;
- released and captured through microbial metabolism that is based on redox conditions.
- etc.

**Analysis: Percent Removal**

The ideal goal of this task is to design a critical mineral removal process that achieves profitability, regardless of the total quantity of critical minerals recovered. For example, a system that extracts only a small amount of critical mineral mass will still be considered successful if its operating and maintenance costs are low enough to result in a net gain or cost offset. However, the production of any salable product, even if not immediately profitable, will help demonstrate the viability of the chosen technology.

If pre-treatment(s) are applied, % removal should be calculated separately for both the pre-treatment and the mineral recovery system to clearly account for each component's contribution to overall mineral recovery. Likewise, any effects from a substrate material must also be evaluated and reported independently.

Success will be measured using percent metal removal for your selected water chemistry:

$$\%\ Removal = \left[\frac{(influent\ mineral\ concentration - effluent\ mineral\ concentration)}{influent\ mineral\ concentration}\right]\ x\ 100$$

**Primary and Secondary Metal Recovery**

The viability of your technology depends on the ability to recover the minerals in a final salable form. To achieve this, two key steps are required:

1) Primary Recovery: This step involves removing the target minerals from mine waters. Also referred to as *mineral capture* or *extraction*, it can be accomplished through various biologically mediated processes such as biosorption, bioleaching, precipitation, and others. For this task, your team's biological element(s) will perform the primary recovery.

2) Secondary Recovery: The ultimate goal of secondary recovery is to isolate or purify the minerals into a saleable form. Secondary recovery is sometimes referred to as *mineral liberation* because in this step, the captured minerals are recovered from the medium that removed them during primary recovery. For example, if minerals were initially captured on a biosorbent material, secondary recovery would involve extracting those metals from the biosorbent. If the metals precipitated out of solution, secondary recovery might involve filtering and refining the precipitate to isolate specific metals.

For this task, once the metals have been captured through primary recovery, teams will identify appropriate secondary methods to recover those metals. In some cases, such as precipitation, the recovery process is straightforward, since the metals form solids that can be physically separated. In other cases, such as a biosorption, where metals are bound to wet biomass, additional steps are required to extract the minerals from the biological elements.

A wide range of methods are available for liberating minerals from biological media, including desorption, thermal treatment, chemical extraction, incineration, or other appropriate technologies. However, some of these methods may be beyond the capabilities of the contest's bench-scale area (for example, ovens will not be available). Therefore, your team will likely address secondary recovery only in the technical report, and not during the bench-scale demonstration.

To ensure your team's thorough coverage of all stages of mineral recovery, in the technical report, include:

- Pre-treatment Methods and Substrate Materials: Account for their contribution to critical mineral recovery.
- Primary Recovery Methods: A detailed description of the biological element(s) used during primary recovery to extract the minerals from the mine water;
- Secondary Recovery Strategy: Identification and explanation of the most appropriate technologies for liberating minerals from the products of primary recovery; and
- Performance and Cost Analysis: A discussion of the expected efficiency of both the primary and secondary processes, the achievable purity levels of recovered minerals, and a cost analysis of both primary and secondary recovery steps.

**Design Requirements**

Your proposed design should provide specific details and outcomes as follows.

- Identify one or more innovative ways to employ biological elements – living, dead, or biologically derived products – to remove metals from your selected MIW.
- Design a financially viable system that uses biological element(s) to recover critical mineral(s) of your choice from your selected MIW (ARD, raffinate, or pit waters). The biologically-mediated technology should be easily implemented at bench-scale and at full-scale at a mine site.
- Outline the processes your technology will employ for primary and secondary recovery. Report the demonstrated efficiency of primary recovery and the expected efficiency of secondary recovery. For each step in the recovery process, include recovery rate and purity of the recovered metals.
- Include a Process Flow Diagram (PFD) for the selected treatment process. The PFD must clearly show mass and energy balances, including input and output streams, reactants, reaction rates, raw material inputs, and waste product removal.
- Determine the hydraulic retention time (HRT) required to recover your team's target amount of critical minerals. This calculation will help define the necessary flow rates and volume of MIW needed for a full-scale treatment system and support accurate cost estimation. Note that multiple passes through your system are permitted, but all associated costs must be factored into the operational analysis.
- Determine any inputs (such as nutrition or reinoculation) needed to support the biological element at full scale. Include the expected frequency and amounts for each input. Identify the indicators that would signal when inputs are required, and estimate the total input needs over time.
- Account for the impact of any pre-treatments or substrates used in your system. If they add or remove metals, account for their effects in the overall mass balance for the system.
- Ensure that your bench-scale demonstration operates in the same manner as your full-scale system design (e.g., if the system requires live algae, the bench-scale system should include live algae).
- Address the management of all materials involved in the system, including raw materials, recovered products, and waste streams. Consider mining-specific regulations governing material handling, as well as requirements for offsite transportation and disposal.
- Discuss potential impacts (e.g., environmental, operational) of your process on the operation of the mine and on the local region, if applicable.
- Present a Techno-Economic Analysis (a.k.a. Techno-Economic Assessment) for your full-scale system that recovers critical minerals from a one type of MIW: either ARD, raffinate, or pit water. Your selected flow rates and HRT for a full-scale operation will affect mineral recovery and must be reflected in the TEA. The analysis should include pre-treatments, primary, and secondary recovery processes and assess overall feasibility, cost, and performance.

  Include your estimate of capital costs (CAPEX), operational costs (OPEX), and key profitability markers. Include appropriate graphical representation of your cost data to support your analysis.

  - Capital expenses (CAPEX) typically include, but are not limited to, equipment, pipes, pumps, etc. needed to set up the system. Do not include costs of buildings and appurtenances to the treatment process.
  - Operating expenses (OPEX) should include, but not be limited to, materials needed, including consumables (chemicals, sacrificial components, etc.) In addition to other

operating costs your team identifies, include these: staff labor rate ($70/hour); solids disposal costs ($50/ton). In particular, include costs for:

    - acquiring, growing, and/or replenishing/re-inoculating the biological element(s)
    - adding nutrients, chemicals, or other needed support for the biological elements
    - retrieving the results of primary recovery
    - recovering the minerals during secondary recovery
    - instituting health and safety protocols
    - disposing of any waste products

  - Profitability markers, such as return on investment and break-even point, depend on system efficiency as well as CAPEX and OPEX. To evaluate financial viability:
    - Quantify mineral-removal efficiency relative to market value, maintenance costs, and recovery complexity.
    - Estimate potential income from metal recovery, after subtracting all process costs.
    - Calculate the time required for the system to break even or become profitable.
  - Visualization tools: Use tools such as sensitivity analyses, graphs, and other visuals to illustrate how key parameters impact system performance and economics.
  - Consider creating a multi-disciplinary team by inviting a business major to help draw up economic plans for full-scale implementation of your designs.

- Determine the efficacy of your strategy based on:
  - *Economic potential:* Estimate profits by assessing the quantity, purity, and marketability of recovered critical minerals; the efficiency of recovery methods; and operational and maintenance costs, using current market values. Note that purer products tend to have higher value but are more difficult to produce, while mixed or lower purity products may be easier to generate, but more difficult to price and sell.
  - *Scalability:* Consider the full-scale implementation, including the hardiness and maintenance needs of the biological element, growth (if applicable), and the residence time required for mineral accumulation.
  - *Waste management:* Outline strategies for managing waste products and potential impacts on mine operations. Assume that the water effluent from your recovery process is recycled within the mining operations stream and is not considered waste. All other waste materials must be managed in compliance with applicable mining waste regulations

- You may choose to ship a back-up sample of your biological element(s) and any related equipment or substrate to WERC. Ship early enough for it to arrive at least one week before the contest, to allow sufficient time for acclimation.

**Bench-scale Demonstration**
The Bench-scale demonstration will serve to illustrate your team's solution while addressing the design requirements outlined above. It should demonstrate a continuous process that can be scaled up to an operational copper mining and processing plant. Your team will determine appropriate flow rates for the full-scale system and ensure that the bench-scale unit is designed to scale appropriately to those rates. Ensure that your bench-scale demonstration operates in the same manner as your full-scale system design (e.g. if the system requires live algae, the bench-scale system should include algae that is alive).

As part of this demonstration, the system must show effective primary recovery by using biological element(s) to remove one or more target critical minerals from your team's selected synthetic MIW. If feasible, the bench-scale demonstration may include secondary recovery, but this is not required.

When preparing the MIW solution, take care to avoid the unintended introduction of microbial contaminants (other fungi or bacteria) in the laboratory environment. Growth of such microbes is unlikely if the storage container is autoclaved, sugars are not included in the solution, and if the solution is stored at colder temperatures, such as in a refrigerator or a cold room.

If possible, recovered minerals will be evaluated by NMSU laboratories using a rapid-approximation dilution method with ICP-OES to quantify metal-removal rates. If direct analysis is not feasible, recovery of critical minerals will be assessed indirectly through a mass balance, based on the concentration of metals your system removes from the synthetic MIW.

Prior to the contest:
*Synthetic Solution:* Teams will prepare the synthetic feed solution for bench-scale testing at their home institution.

*Transporting Biological Elements to the Contest:* Depending on the biological elements chosen, whether living or dead, multicellular or microbial, your team is responsible for ensuring they arrive at the competition in working condition. Transportation can cause some organisms to go into shock (slowed growth, partial die-off, or complete die-off), although a well-packed and quickly shipped system should not experience severe shock. If acclimation is necessary for your elements, plan the shipping date to allow at least one week for acclimation after your biological elements arrive in Las Cruces.

If you plan to ship any materials, include detailed care instructions both in your 30% Project Review and inside the shipped package. If these instructions change after submitting the 30% Review, email the updates to werc@nmsu.edu.

Ship your organism (if applicable) and any related equipment to:
WERC Environmental Design Contest
NMSU College of Engineering
1025 Stewart St. Room 121
Las Cruces, NM 88003-8001

*WERC cannot guarantee successful growth and acclimation of the organism that you ship to us.*

At the contest, teams will provide:

Teams will bring their biological element, along with all equipment needed to run the project. When you arrive at the contest, your team will determine which of the duplicate systems (the one you shipped or the one you brought) to use during the bench-scale demonstration.

In addition to the bench-scale demonstration, teams may bring video productions, computer simulations, tabletop displays, and scale or architectural models to assist in the presentation; these inclusions can be extremely beneficial to your presentation but shall not be substitutes for the bench-scale demonstration.

At the contest, WERC will provide:

- Your team's back-up system and any attached equipment you sent to us. These will be waiting for you at your booth when you arrive at the contest on Sunday.
- Up to 18 liters of your team's chosen synthetic MIW (mixed according to Table 1, 2, or 3) to work with during the bench-scale demonstration. Teams should request the specific MIW solution, and the volume desired, in their 30% Project Review and the ESP.
- Five wide-mouth 125 mL polymer bottles for sample collection. Teams are not expected to collect the full 125 mL of solution. The bottles will be autoclaved upon request in the 30% Project Review.
- WERC can provide bulky difficult-to-ship items such as kiddie wading pools as secondary containment, upon request.

Requests for additional items needed to run the bench-scale demonstration at the contest should be specified in the 30% Project Review and the ESP (see below and the 2026 Team Manual).

Analytical Testing Techniques

Your team will run the bench-scale demonstration under the supervision of our laboratory safety specialists. They will observe as you capture a sample of your influent as well as the other samples listed above.

During the operation of your bench-scale system, your team will measure the following in the presence of your judges:

- Temperature – These values help demonstrate and validate the incubation conditions for your biological process.

At the end of the treatment process at the contest, each team will submit up to five samples for analysis:

- One sample of influent (synthetic solution);
- One sample taken immediately after any pre-treatment step, if applicable;
- Two samples of the treated solution (effluent);
- One sample of the recovered minerals, if applicable.

On Tuesday afternoon, WERC will send the samples to NMSU labs for analytical testing. In your technical report, be sure to also include corresponding values obtained from testing at your home institution's laboratory.

- ICP-OES to quantify metal-removal rates. (Method SM 4500-SO4_E using a Spec 20 instrument.)
- Rapid-dilution of recovered solids with ICP-OES to quantify metal-recovery rates. (Method SM 4500-SO4_E using a Spec 20 instrument.)

**30% Project Review**

Completing the 30% Project Review – due in late January, or a date your team requests – is key to preparing for your bench-scale demonstration. It outlines your design, how it works, and how you will demonstrate and test your mineral recovery process at the contest in Las Cruces.

Your team is welcome to revise or update your design parameters after submitting this report. The 2026 Team Manual gives general guidelines for preparing the 30% Project Review. However, the items listed below are specific to this project and should be included in your submission.

Specific to this project:

- Include a complete PFD. This will be reviewed by subject-matter experts from FMI. The PFD should provide a clear outline of how materials and energy move through your system. Be sure to include all input and output streams, key reactants, reaction rates, raw materials, and how waste products are removed or managed.
- Specify which synthetic solution you need WERC to provide at the contest for your bench-scale demonstration (from either Table 1, Table 2, or Table 3), and specify the volume needed (18 L is the default amount provided).
- Report any additional chemicals you plan to use, and whether you need WERC to supply them.
- Request additional sample bottles and autoclaving of sample bottles (if needed).
- Indicate whether or not you plan to ship your back-up system prior to arriving at the contest. If so, include detailed care instructions.
- Submit a draft for your bench-scale demonstration setup. The draft should be a 3-D view, drawn to-scale, with dimensions labeled. Consider that the contest is held at a banquet facility, without typical lab resources (e.g., no fume hoods, ovens, etc.). WERC typically provides your team with an 8' folding table with access to 120V power. See the Team Manual for more bench-scale parameters.
- Outline all bench-scale needs, including the need for pressurized gas cylinders, indoor versus outdoor bench-scale demonstration area, and potential need to run the process overnight (this is approved by our Safety Officer on a case-by-case basis).

**Evaluation Criteria**

Each team is advised to read the 2026 Team Manual for a comprehensive understanding of the contest evaluation criteria for all contest events. For a copy of the Team Manual, Public Involvement Plan, and other important resources, visit the WERC website: Guidelines | werc.nmsu.edu

Judges will evaluate your team's response to the problem statement, with consideration of:

- Thoroughness and quality of the technical analysis, including a complete PFD.
- The effectiveness of your bench-scale demonstration in demonstrating your team's solution and how it integrates into FMI's mine processing needs.
- Potential for real-life implementation (ease of operation and maintenance, affordability, etc.).
- Thoroughness and quality of the economic analysis.
- Originality and innovation represented by the proposed technology.
- Task-specific considerations, such as:
    - i. Potential profitability of the system (market value of product, cost of mineral removal and recovery)
    - ii. Detailed discussion in the technical report of the potential technologies for mineral recovery from the product including recovery efficiency.
    - iii. Environmental impact of the system on mining operations.
    - iv. Thorough safety considerations for operations and maintenance of the system including necessary PPE.
- Other specific evaluation criteria that may be provided at a later date (watch the FAQs online).

**Experimental Safety Plan (ESP) and Required Short Course.**

See team manual for details. Due date is listed below.

**Dates, Deadlines, FAQs** (*dates subject to change—watch website FAQs*)

| | |
|---|---|
| Early Fall | Email us to reserve a spot for your team and get on the email list for this task. Registration is limited. |
| Weekly | Check FAQs weekly for updates:<br>• Task-specific FAQs: 2026 Tasks/Task FAQs<br>• General FAQs: 2026 General FAQs |
| November 1, 2025 - December 31, 2025 | Early Bird Registration (discount applies) |
| December 1, 2025 – January 30, 2026 | 30% Project Review Due (or as arranged with WERC). |
| December 1, 2025 – March 01,2026 | Mandatory On-demand Course: Preparing the Experimental Safety Plan. See website and Team Manual for information. |
| February 17, 2026 | Final date to register a team w/o permission. |
| March 9 -13, 2026 | Experimental Safety Plan (ESP) due to Juanita Miller. Include requests for chemicals, materials, etc. |
| April 2, 2026 | Technical Report due |
| April 12 – 15, 2026 | Contest in Las Cruces |

**References**

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[2] U.S. Department of Energy. (2025, May 29). *Critical material list; Addition of metallurgical coal used for steelmaking* (Federal Register Document No. 2025-09607). Federal Register, 90(102), 22711–22712. https://www.federalregister.gov/documents/2025/05/29/2025-09607/critical-material-list-addition-of-metallurgical-coal-used-for-steelmaking. (Accessed 7/15/2025)

[3] Wildeman, T. R., & Schmiermund, R. (2004). Mining influenced waters: Their chemistry and methods of treatment. In Proceedings of the National Meeting of the American Society of Mining and Reclamation and the 25th West Virginia Surface Mine Drainage Task Force (pp. 2001–2013). American Society of Mining and Reclamation. https://doi.org/10.21000/JASMR04012001. (Accessed 7/15/2025)

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[5] Copper Leaching Practices. 911 Metallurgist. 2021. Copper Leaching Practices - 911Metallurgist. (Accessed 7/31/2025).