



**Broad Agency Announcement**

**Environmental Microbes as a Bioengineering Resource  
(EMBER)**

**BIOLOGICAL TECHNOLOGIES OFFICE**

**HR001121S0035**

**July 13, 2021**

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## PART I: OVERVIEW INFORMATION

- **Federal Agency Name** – Defense Advanced Research Projects Agency (DARPA), Biological Technologies Office (BTO)
- **Funding Opportunity Title** – Environmental Microbes as a Bioengineering Resource (EMBER)
- **Announcement Type** – Initial Announcement
- **Funding Opportunity Number** – HR001121S0035
- **North American Industry Classification System (NAICS)** – 541714
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- **Dates**
  - Posting Date: **July 13, 2021**
  - Proposal Abstract Due Date and Time: **4:00 PM ET, August 16, 2021**
  - Full Proposal Due Date and Time: **4:00 PM ET, September 27, 2021**
  - BAA Closing Date: **September 27, 2021**
  - Proposers Day: **July 27, 2021**

<https://sam.gov/opp/6f7b9d46a7cb4e12b17440165b6f5dc8/view>
- **Concise description of the funding opportunity** – The Environmental Microbes as a BioEngineering Resource (EMBER) program aims to develop novel, bio-based technologies to overcome key challenges facing domestic supply of Rare Earth Elements (REEs) critical to the U.S. and Department of Defense (DoD). The EMBER program will leverage the diversity, specificity, and customizability of environmental microbiology to enable new biomining methods for the separation, purification, and conversion of REEs into manufacturing-ready forms. Microbes (and/or biomolecules), including those from extreme or metal-rich environments, can be biologically engineered or adapted to bind, assimilate, and manipulate individual REEs. These biological components, once developed, may be assembled into an in-line separation, purification, and recovery workflow resulting in individual, purified REEs. Scalability of EMBER’s approach will be demonstrated with proof-of-concept, pilot scale studies aligned with existing mining/waste treatment infrastructure.
- **Anticipated individual awards** – Multiple awards are anticipated.
- **Types of instruments that may be awarded** – Award instruments may include procurement contract, grant, cooperative agreement, or Other Transaction; however, only procurement contracts and Other Transactions may be used for proposers whose proposed solution includes Controlled Unclassified Information (CUI).
- **Agency contact**

The BAA Coordinator for this effort may be reached at:  
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## **PART II: FULL TEXT OF ANNOUNCEMENT**

### **1. Funding Opportunity Description**

This publication constitutes a Broad Agency Announcement (BAA) as contemplated in Federal Acquisition Regulation (FAR) 6.102(d)(2) and 35.016 and 2 CFR § 200.203. Any resultant award negotiations will follow all pertinent law and regulation, and any negotiations and/or awards for procurement contracts will use procedures under FAR 15.4, Contract Pricing, as specified in the BAA.

The Defense Advanced Research Projects Agency (DARPA) is soliciting innovative proposals to develop a cohesive, domestic Rare Earth Element (REE) separation and purification technology that uses biologically engineered microbes and/or biomolecules. Proposed research and development should investigate and exploit environmental microbial strategies for recovering and separating individual REEs from complex mixtures. To accomplish this goal, new design-build-test-learn synthetic biology paradigms that capitalize on specific metal binding, transport, and mineralization mechanisms employed by microbial and biomolecular systems are needed. Resultant bioengineering approaches will be coupled to process engineering workflows to extract and purify REEs from domestic source materials. Demonstration of viable schemes will be supported by compelling techno-economic analyses and culminate in an aggressive, proof-of-concept pilot-scale REE biomining operation.

#### **1.1. PROGRAM OVERVIEW**

The Environmental Microbes as a BioEngineering Resource (EMBER) program will develop a biotechnology-based separation and purification strategy for REEs from under-utilized domestic sources such as phosphate mine waste, acid mine drainage, and electronics recycling processes. The program aims to deliver multiple capabilities such as the separation of REE mixtures into individual elements using aqueous processes; inter-conversion of REE salts/oxides to facilitate production of manufacturing-ready forms (e.g., halides, phosphates, nitrates); and new assays for high-throughput analysis of REE-containing cells and biomolecules.

REEs, which include the 15-element lanthanide group plus yttrium and scandium, are critical ingredients in many DoD systems: e.g., in permanent magnets for electric motors, high-temperature ceramics, and lasers. REE purification is challenging – similarities between the 17 REEs require many physical and chemical extraction steps that are energy-intensive, hazardous to the environment and personnel, and often inefficient. As a group, these elements exhibit only modest differences between their Lewis acidities, molecular weights, and atomic radii; subsequently, separation of mixtures of these species into distinct concentrates of isolated elements remains technically challenging.

Biomining is an alternative approach that utilizes microbes to recover metals (e.g., copper, gold) from source materials, often using redox processes to liberate the target metal from a mineral source. Biosorbent and biofiltration approaches show promise in the extraction or removal of metals from contaminated milieu (e.g., for bioremediation) but need to be able to function with complex REE source materials and enable efficient recovery of the bound metals. Using microbes or biomolecules to separate REEs from mixtures is under study, but this approach

currently lacks the required specificity to separate all individual REEs, is slow, and is not yet viable at scale.

Advances in microbial and biomolecular engineering could help address these limitations. While synthetic biology tools are well-developed for conventional lab-adapted chassis organisms, and may be suitable for production of organic molecules at circumneutral pH and moderate temperatures ( $T^\circ$ ), these approaches are underdeveloped for environmental and extremophile microbes, including those known to tolerate and utilize heavy metals. Engineering of organisms that thrive at acidic or alkaline pH and elevated  $T^\circ$ , and those that bind, uptake, or store metals, has been impeded by cultivation and isolation challenges. Pathway design and engineering to produce organic molecules are informed by vast libraries of enzymes and regulatory parts, but a lack of annotated genomes, regulatory components, and genome integration tools has impeded advances to develop organisms that specifically utilize inorganic elements, including REEs. Lastly, current assays for precise measurement of organism-associated REEs are low-throughput, destructive, and, thus, incompatible with typical synthetic biology pipelines. Overcoming these deficiencies could enable selective, specific, and high-capacity biomining of individual REEs.

## **1.2. TECHNICAL APPROACH**

Performers for the EMBER program will develop bioengineered organism/biomolecular approaches for REE separation and purification, then translate these to practical platforms for biomining (e.g., biosorbent, biofiltration, bioleaching) modules that will be used to extract REEs from domestic REE sources. Some of the key technical challenges to be addressed by EMBER include:

- Design and engineering of chassis organisms tolerant of pH and temperature extremes, and high metal concentrations.
- Selective and specific biologically-driven extraction of individual REEs from complex mixtures.
- Development of high-throughput, sensitive, non-destructive assays for REEs associated with cells/biomolecules.
- Optimization of REE accumulation, rates, and regenerability/reuse of the bio-extraction process.
- Process engineering to integrate the chosen REE source material (e.g., mine waste, acid mine drainage, recycled electronics) with bio-based REE extraction modules to form a complete REE purification system. Demonstration of the developed technology at the pilot scale will likely require co-location at the facility that provides the REE source material.
- Techno-economic analysis of the developed bio-based approach that supports its scalability and commercial viability.

Developing these REE separation and purification solutions will require two Technical Areas (TAs) – Bioengineering for REE Utilization (TA1) and REE Biomining (TA2), which are described in Section 1.2.1 below. Proposing teams are required to address both TA1 and TA2, and must provide an integrated, multidisciplinary approach addressing each element of TA1 and TA2. Strategies for optimizing, integrating, and expanding capabilities should be elaborated throughout. Proposals should also discuss mitigation of technical challenges that may arise

within each Phase and TA. **Proposals that fail to address both technical areas will be considered non-conforming and will not be evaluated.**

Proposers are strongly encouraged to team with domestic industry partners focused on activities such as mining or reclamation, mine waste treatment, and/or electronics waste/recycling. Partners with this experience can identify procedural, regulatory, economic, and technical challenges that will need to be overcome; provide real-world REE source material for development of biological chassis for REE extraction; and maximize compatibility of the end-of-program pilot scale biomining demonstration with an industrial operation. Performer teams must describe their intended domestic REE source materials/processing sites and work within the specific parameters of those sites (e.g., pH, metal content/concentrations, halide content, REE composition, radioactive contaminants, redox potential, sulfur content) to guide bioengineering decisions. Performers may elect to pursue different strategies to extract each individual REE (e.g., multi-stage approaches that first remove other competing ions/metals/radioactive elements from their selected REE source material, separate light from heavy REEs, or “one-pot” approaches). Since diverse strategies are possible, performers are encouraged to explore multiple biomolecules/chassis. Ultimately, the selected bio-based strategies must converge to demonstrate the program goal to specifically bind and purify at least 8 different REEs. Because demonstrating the feasibility of industrial scale up and the economic viability of developed processes are critical aims of EMBER, proposers should describe how they will develop and substantiate techno-economic analyses of their approach.

Specifically excluded from this opportunity is research that: (1) results in incremental improvements to the existing state of practice or lacks a bioengineering approach; (2) focuses on coal/coal by-products as a domestic source of REEs; or, (3) utilizes intact, living terrestrial plants or macroalgae to extract the REEs. (NOTE: employment of genetic parts, pathways, biomolecules, or biopolymers obtained from these sources is permitted). **Proposals falling into these categories may be considered non-conforming and may not be evaluated.**

### 1.2.1. TA1: Bioengineering for REE Utilization

The overall goal of TA1 is to create the tools, both organismal and biomolecular, that will enable the TA2 effort to develop efficient REE biomining processes. Teams will need to establish a design-build-test-learn (DBTL) platform for engineering organisms and/or biomolecules that manipulate REEs and enable their separation and purification from complex mixtures. “Organisms” envisioned for this TA include microbes, fungi, or bacteriophage; use of photosynthetic organisms (cyanobacteria, microalgae) as chassis must include justification of the additional energy demands that these organisms require.

**Design:** Performers will explore and develop pathway and design tools that incorporate genomes, genes, biomolecules, and regulatory parts required to build organisms/biomolecules capable of selective, specific, and regenerable REE extraction and manipulation under harsh reaction conditions. This program component should focus, at a minimum, on developing the capability to **design** chassis organisms possessing the following phenotypes:

- *Survival in harsh conditions:* Chassis will need to function in hot, acidic (or basic) milieu, and overcome toxicity associated with high concentrations of REEs and other metals.

- *Ability to specifically bind/extract REEs:* Performers should consider mechanisms of cellular metal transport, binding and uptake, and possible synergistic approaches. Bioengineered strategies for removal or mitigation of radioactive contaminants may also be required if present in the selected source material.
- *Bio-conversion of REE compounds for manufacturing:* Bio-focused methods that interconvert between different REE chemical forms (e.g., oxides into halides or nitrates, halides into phosphates, etc.) are also sought. Design strategies that explore biological routes to convert REE compounds into fully reduced chemical states, with individual REE metallic elements as end products, are of great interest.

**Build:** While conventional DNA synthesis, amplification, and sequencing verification steps are expected and will be acceptable over the course of the program, codon usage and genetic pathway assembly may require adaptation to facilitate insertion into non-traditional chassis. Performers will also develop the tools necessary to cultivate, isolate (if necessary), and genetically transform selected chassis organisms, to enable expression of biological components identified in the **Design** component.

**Test:** An effective DBTL platform requires assays to measure improvements in strain performance. To this end, development of high-throughput, non-destructive assays is required:

- Assessment of survival of low and high pH, elevated temperatures, and high REE/metal concentration relative to growth in minimal media.
- Specific REE association with individual cells with sensitivity at the femtogram scale. Performers will need to advance beyond existing limits of assay capabilities in order to detect specific REE association and kinetics with biomolecules, biomass, and/or cells.

**Learn:** Identify the relationships between observed REE specificity/selectivity/accumulation levels and design factors through the use of statistical methods and machine learning, with appropriate experimental validation. Experimental and computational analysis of results with 1<sup>st</sup> generation strains will be re-iterated as needed to meet program goals for REE specificity/purity and growth in TA2-driven biomining conditions. The minimum performer objectives for TA1 are as follows:

- Selective and specific binding of  $\geq 8$  target REEs.
- Chassis organisms that function at extremes of pH and T°.
- High-throughput assays compatible with genetic screening protocols.
- Methods for REE bioconversion to aid in downstream manufacturing of REE-containing products.

### 1.2.2. TA2: REE Biomining

The overall goal for TA2 is to develop technology and processes to utilize organisms, biomolecules, or biopolymers as the key means to separate, purify, and recover individual REEs from domestic REE source materials. Recovered REE materials may be in the form of salts (e.g., halides or nitrates), phosphates, oxides/hydroxides, or reduced metals, and should be devoid of biomass and impurities. Teams will develop and test a biomining workflow to purify individual REEs from complex source mixtures, likely using a combination of geological, chemical, and/or process engineering steps. Studies will progress from the laboratory bench scale to a pilot scale

demonstration capable of generating at least 700 grams total REEs (tREE) per week. It is anticipated that the pilot scale demo will need to be co-located with the REE source material site.

*REE source material:* Many domestic sources can enable the U.S. to meet current and growing demand (e.g., phosphate deposits, acid mine drainage, recycled electronics). Due to extensive concurrent research investment from other Government agencies, coal/coal by-product sources are specifically excluded from the EMBER funding opportunity. While it is anticipated that the processes developed under this program can be generalizable to many varied REE sources, proposals must identify an intended domestic (fully contained on land of U.S. and territories and/or within the economic exclusion zone of the U.S.) REE source. To limit the focus on the separation and purification of REEs, rather than the mining process as a whole, the source material for the program should consist of downstream concentrates, which contain at least 300 parts per million (ppm) total REEs and at least 8 different REEs. Proposals should also describe researcher's access to sufficient quantities of the source material to complete the work outlined in the proposal as well as the current and projected annual production amounts.

*REE biomining workflow:* REE source material characteristics are anticipated to guide the development of modular components of biomining platforms that incorporate REE-specific organisms/biomolecules, optimize their safe and effective deployment, and integration with existing infrastructure to maximize accumulation rates and throughput. Performers should describe their strategy for incorporating organisms/biomolecules, identify the initial REE-binding organisms, biomolecules, and/or biopolymers to be used, and the performance requirements (e.g., binding profile kinetics, structural stability, scalability of production) required of the improved strains/biomolecules developed in TA1. Workflow may remove/mitigate radioactive or other toxic/hazardous contaminants (if present in source material), concentrate REEs, separate light from heavy REEs, and purify individual REEs. It is anticipated that novel processes enabled by sophisticated bioengineering accomplished in TA1 that can facilitate specific REE separation and purification may include the following:

- Expression of chelators and proteins (e.g., lanthanophores, siderophores) to sequester and/or solubilize target REEs.
- Secretion of biolixiviants, such as organic acids to solubilize metals.
- Hyperaccumulation/biomineralization by cells.
- Biosorbents/biofiltration media fabricated from living or dead/dried biomass.
- Bioengineering to facilitate recovery of REEs from biomass.

*Process engineering:* Proposers should also discuss the anticipated physical infrastructure required for their biomining workflow, from the preparation of biomining organisms/biomolecules to intake of REE source material through output of purified REEs and waste by-products. Performers are likely to consider a combination of processing steps that facilitate the extraction and separation of REEs depending on their selected REE source material and specific biomining approach. Physical infrastructure may include, but is not limited to, the following:

- Bioreactors for organism growth or biomolecule preparation, and for processing biomass to recover REEs.
- Energy requirements and sources.
- Liquid/solid handling pumps, piping, and valving.



- Aeration and/or stirring equipment.
- Columns/tanks/bioreactors for REE accumulation/separation/extraction.
- Effluent and waste discharge and disposal.
- Physical safeguards to contain living genetically engineered organisms within the workflow cycle.

*Demonstrate feasibility and economics of scale-up:* TA2 will emphasize development of regenerable and/or reusable bio-based components; will require multiple techno-economic analyses; and culminate with a pilot scale demonstration of the fully integrated system. Proposals should describe how the developed REE bioextraction steps will integrate within a complete processing pipeline and outline the ways in which the new process mitigates the central challenges to domestic purification of REEs (e.g., waste and hazard reduction, energy efficiency, cost reduction). Over the course of the program, three techno-economic analyses of the developed process, including material and energy balances, will be required (toward the end of each program Phase) in order to help inform the feasibility and viability of the performer's approach.

Performer requirements for TA2 are to demonstrate pilot scale extraction with the following minimal objectives:

- Process should be regenerable or reusable.
- Strategy to recover REE from biomass should be practical (e.g., feasible at industrial scale up).
- Alignment/integration at pilot scale on site with existing mining/waste treatment infrastructure is required.
- Safeguards against accidental release if living genetically engineered organisms are used.
- Process occurs in-line and extraction of each REE only adds one additional step.
- Techno-economic analysis supports feasibility at industrial scale.

### **1.2.3. Integration of TA1 and TA2**

Proposing teams must address both TAs to ensure a complete, integrated system tailored to specific REE source and site infrastructure by the end of Phase 3. TA1 and TA2, as described above, must converge to deliver a pilot scale REE extraction operation. Each of the TAs will remain active for all three phases as it is anticipated that iterative improvement and optimization will be required throughout the project.

Performers must plan their approach for TA1 to integrate with their strategy for TA2 to address the following program objectives:

- Developed REE-utilizing organisms and/or biomolecules need to function and grow under conditions relevant to the chosen source material (e.g., REE- and mineral-rich mixtures, extremes of pH, elevated temperatures).
- Selective, specific, and efficient binding/accumulation of multiple, individual REEs from these complex source materials.
- Recovery of the REEs from the biomass should be efficient: remove 95% REEs from source media, recover 95% REE bound to biomass; with  $\geq 95\%$  final purity for each REE.

- Purity of extracted REEs, selectivity and efficiency of separation steps must be analytically confirmed using validated materials characterization methods (e.g., Inductively coupled plasma mass spectroscopy (ICP-MS), X-ray diffraction, other spectroscopic methods, elemental analysis, electron microscopy, titration analysis).
- Removal or mitigation of radioactive or other hazardous contaminants, should the selected REE source material contain them.
- Multiple safeguards (genetic, physical) against inadvertent environmental release, should the TA2 Biomining process depend upon genetically engineered living organisms used in a manner where such accidental release is possible.

#### **1.2.4. Independent Validation and Verification**

Throughout the program, the performers will work with an Independent Verification and Validation (IV&V) team established by the Government. The IV&V team will consist of subject matter experts from the Government, Federally Funded Research and Development Centers (FFRDCs), academia and/or other relevant domains. The IV&V team will test and validate the ability of the EMBER bio-based technologies to separate and purify REEs from similar (or different) source materials. IV&V partners with expertise in chemical and materials analysis will confirm the identity, purity, and chemical composition of extracted and separated REEs. IV&V partners with expertise in process engineering and technoeconomic analysis of mining, biomining, or waste bio-treatment systems will review and comment on performer's initial and final designs for REE biomining workflows and performer-generated technoeconomic analyses.

The milestone and metrics section below describes the schedule for delivery of performer-developed strains, biomolecules, integrated systems, and protocols to the IV&V team for testing and evaluation.

To avoid potential conflicts of interest, performers for HR001121S0035 will not be allowed to compete for the IV&V contract. HR001121S0035 is not soliciting proposals for IV&V.

#### **1.2.5. Schedule**

The EMBER program spans four (4) years and consists of an 18-month Phase 1, 18-month Phase 2 Option, and 12-month Phase 3 Option. Progress towards the stated goals will be assessed throughout the program. Participation in Phase 1 does not guarantee funding in the Option Phases; the Government's unilateral determination to exercise an option will be contingent on performance in the previous phase and availability of funds.

During Phase 1, performers will focus on developing micro-organisms and biomolecules suitable for use in REE separation, assays for non-destructive monitoring of REE accumulation in or on microorganisms and biomolecules, and initial system designs. An initial techno-economic analysis utilizing acquired data will be used to inform feasibility/viability of the performer's bio-based REE extraction and purification process.

During Phase 2, performer teams will focus on improving the efficiency and scale of REE separation from actual source materials and providing a second techno-economic analysis incorporating information gained from this initial scale up phase.

In Phase 3, performer teams will integrate components from Phase 2, to execute a pilot-scale demonstration of the REE-separation technology, co-located at the facility where the selected REE source material is generated. A final techno-economic analysis, including data obtained from pilot-scale studies, will be executed.

### **1.3. PROGRAM TASKS, MILESTONES, AND DELIVERABLES**

In order for the Government to evaluate the effectiveness of a proposed solution in achieving the stated program objectives, proposers should note that the Government hereby promulgates the following program milestones that may serve as the basis for determining whether satisfactory progress is being made to warrant continued funding of the program. Continued funding for each subsequent phase is contingent upon meeting or exceeding the milestones prescribed for the current phase.

Although the following program milestones are specified, proposers should note that the Government has identified these goals with the intention of bounding the scope of effort, while affording the maximum flexibility, creativity, and innovation in proposing solutions to the stated problem, to include variations in performance. The milestones identified for this program were designed to encourage and drive innovative solutions that significantly increase the understanding of the biological, geochemical, and physical processes that will enable optimized REE Biomining systems. Only satisfaction of the milestones for both TAs will be considered as successful completion of a given phase.

#### **1.3.1. Program Tasks, Specifications, and Milestones**

The milestones are listed in tables below, separated Phase and TA, on pages 12-17.

Phase	TA	Task	Task Specifications	Milestone
Phase 1 (Months 1-18)	Technical Area 1: Bioengineering for REE Utilization	Task 1: Develop engineerable chassis organisms from different genera which function and grow under the extreme conditions relevant to REE biomining.	<ul style="list-style-type: none"> <li>• Chassis strains reliably express exogenous (reporter) genes.</li> <li>• Growth (rate or # of cells) <math>\geq 25\%</math> of that seen with minimal media (after transformants selected; @ extreme conditions).</li> <li>• Extreme conditions defined as: <math>T \geq 42^{\circ}\text{C}</math>; <math>\text{pH} \leq 2</math>, <math>\text{pH} \geq 9</math>.</li> <li>• Total REE (tREE) comprised of equimolar concentrations of 10 different REE.</li> <li>• Composition/concentrations of other metals/ions/sulfides should simulate the selected TA2 REE source material.</li> </ul>	<p>(Month 6) Assays under extreme conditions help reduce DBTL cycle time by 20% (relative to Month 2)</p> <p>(Month 6) <math>\geq 2</math> engineered chassis strains able to survive and grow in <math>500 \mu\text{M}</math> tREE.</p> <p>(Month 12) Assays under extreme conditions that reduce DBTL cycle time by 40% (relative to Month 2).</p> <p>(Month 18) <math>\geq 5</math> engineered chassis strains, with some functional at <math>\text{pH} \leq 2</math> and some at <math>\text{pH} \geq 9</math>; <math>500 \mu\text{M}</math> tREEs + other metal/ions/sulfides.</p>
		Task 2: Develop a platform to assay REE association with organisms.	Assays should be non-destructive in nature or allow recovery of sequenceable nucleic acids post-analysis, or otherwise allow for pairing of sequence data to specific organisms.	(Month 15) Detect $\geq 3$ different REEs at concentration of femtograms/cell at a rate of $10^3$ cell samples per day.
		Task 3: Demonstrate organisms (and/or identify/express biomolecules) that bind and/or modify REEs.	<ul style="list-style-type: none"> <li>• Specific binding and conversion of REEs using cells, biomolecules, or cell-free systems. Approach should be adaptable to TA2 workflow.</li> <li>• Specificity is defined as analytically verified ratio of target bound REEs to non-targeted REEs.</li> <li>• Media should simulate the components of the planned TA2 source material.</li> <li>• Specificity, purity, and yields of REEs must be demonstrated analytically.</li> </ul>	<p>(Month 12) Biologically convert 1 REE from one chemical form into another (e.g., oxide to salt, salt to elemental metal) at <math>\geq 75\%</math> yield.</p> <p>(Month 15) Specific binding of <math>\geq 3</math> individual REE with 4:1 specificity.</p>

Phase	TA	Task	Task Specifications	Milestone
Phase 2 (Months 19-36)	Technical Area 1: Bioengineering for REE Utilization	Task 4: Continue to advance engineerable chassis strains which function and grow under the extreme conditions relevant to REE biomining by increasing the extremes of conditions.	<ul style="list-style-type: none"> <li>Actual REE source material selected for TA2 will be employed.</li> <li>Chassis strains reliably express pathways for interactions with REE.</li> <li>Growth (rate or # of cells) <math>\geq 25\%</math> of that seen with minimal media (after transformants selected; @ extreme conditions).</li> <li>REEs added if needed to reach tREE concentrations indicated; equimolar concentrations of 10 different REEs.</li> </ul>	<p>(Month 24) <math>\geq 2</math> engineered chassis strains able to survive and grow at <math>\text{pH} \leq 2.0</math> or <math>T^\circ \geq 42^\circ\text{C}</math>, in actual source material with <math>\geq 500 \mu\text{M}</math> tREE.</p> <p>(Month 27) <math>\geq 2</math> engineered chassis strains that survive and grow in source material with 10 mM tREE.</p> <p>(Month 36) <math>\geq 5</math> engineered chassis strains that survive and grow in source material with 10 mM tREE at <math>T^\circ \geq 80^\circ\text{C}</math>, with multiple strains functional at <math>\text{pH} \leq 0.5</math>, and <math>\text{pH} \geq 10</math>.</p>
		Task 5: Build on the progress made in Phase 1 to expand the numbers of organisms and or biomolecules which specifically bind and/or modify REEs.	<ul style="list-style-type: none"> <li>Specific binding and conversion of REEs using cells, biomolecules, or cell-free systems.</li> <li>Specific binding approaches must be adaptable to TA2 workflow.</li> <li>Actual REE source material selected for TA2 must be employed for specific binding studies.</li> <li>Specificity is defined as analytically verified ratio of target bound REEs to non-targeted REEs.</li> <li>Purity of converted REE chemical forms (e.g., oxide to salt, salt to elemental metal) must be verified analytically.</li> </ul>	<p>(Month 30) Specific binding of <math>\geq 8</math> REE (<math>\geq 4</math> heavy REE) with specificity <math>\geq 10:1</math>. (Month 30) Biologically convert 1 light, and 1 heavy REE from one chemical form into another at <math>\geq 90\%</math> yield.</p> <p>(Month 36) 8 or more distinct organisms or biomolecules, each capable of specifically binding a different REE (<math>\geq 4</math> 'heavy' REE), with specificity <math>\geq 20:1</math>.</p>
		Task 6: Develop a platform to assay REE association with organisms.	Assays should be non-destructive in nature or allow recovery of sequenceable nucleic acids post-analysis, or otherwise allow for pairing of sequence data to specific organisms.	(Month 36) Detect $\geq 8$ REEs at concentration of femtograms/cell at a rate of $10^5$ cell samples per day.

Phase	TA	Task	Task Specifications	Milestone
Phase 3 (Months 37-48)	Technical Area 1: Bioengineering for REE Utilization	Task 7: Expand the capability to biologically interconvert and purify chemical forms of multiple, biologically extracted REEs.	<ul style="list-style-type: none"> <li>• Specific binding or conversion of REEs using cells, biomolecules, or cell-free systems.</li> <li>• Actual TA2 REE source material will be employed for specific binding studies.</li> <li>• Specificity is defined as analytically verified ratio of target bound REEs to non-targeted REEs.</li> <li>• Purity of converted REE chemical forms (e.g., oxide to salt, salt to elemental metal) must be verified analytically.</li> </ul>	<p>(Month 42) Biologically convert <math>\geq 5</math> REE (<math>\geq 2</math> heavy REE) from one chemical form into another <math>\geq 90\%</math> yield.</p> <p>(Month 48) Selective binding <math>\geq 1</math> REE with specificity of 1000:1 using a biological mechanism.</p>
		Task 8: Develop a platform to assay REE association with single cells.	Assays should be non-destructive in nature or allow recovery of sequenceable nucleic acids post-analysis, or otherwise allow for pairing of sequence data to specific organisms.	(Month 48) Ability to identify association of different REEs with single cells at a rate of $10^6$ cell samples per day.

Phase	TA	Task	Task Specifications	Milestone
Phase 1 (Months 1-18)	Technical Area 2: REE Biomining	Task 1: Design, develop, and justify a modular REE-biomining workflow capable of purifying individual REEs from complex domestic source materials.	<ul style="list-style-type: none"> <li>• Clear outline of purification pipeline compatible with current mining operations and detailed cost, energy, and scalability analyses.</li> <li>• REE source material must have a minimum tREE concentration of 300 ppm and <math>\geq 8</math> different REEs.</li> <li>• Techno-economic analysis (TEA, with Life Cycle Analysis, LCA) should project financial realities and other benefits/ bottlenecks such as energy efficiency and state-of-the-art costs (SOA) for REE.</li> </ul>	<p>(Month 3) Characterize components of REE source material to inform TA1 and TA2 activities.</p> <p>(Month 6) Provide descriptions/ schematics of initial biomining concept pipeline along with preliminary format/matrix for individual steps.</p> <p>(Month 15) Conceptual TEA.</p>
		Task 2: Develop and demonstrate biomining modules for REE separation and recovery.	<ul style="list-style-type: none"> <li>• REE separation and recovery modules capable of isolating individual REEs from simulated source material (modeled on the selected TA2 REE source material in terms of REE composition/ concentrations, pH, and other components).</li> <li>• Processes should be robust and scalable.</li> <li>• Purity of recovered REEs must be analytically confirmed.</li> </ul>	<p>(Month 12) Bind/remove <math>\geq 50\%</math> of a target REE at milligram scale from simulated source material.</p> <p>(Month 15) Separate and recover <math>\geq 3</math> individual REEs, each at mg scale, <math>\geq 75\%</math> final purity from simulated source material.</p> <p>(Month 18) Demonstrate a 2nd cycle of REE binding and recovery with 90% efficiency relative to 1<sup>st</sup> cycle.</p>

Phase	TA	Task	Task Specifications	Milestone
Phase 2 (Months 19-36)	Technical Area 2: REE Biomining	Task 3: Design, develop, and justify a modular REE-biomining workflow capable of purifying individual REEs from complex domestic source materials.	<ul style="list-style-type: none"> <li>• Refined outline of purification pipeline compatible with current mining operations.</li> <li>• Physical/genetic containment strategies for any living genetically engineered organisms must be included.</li> <li>• TEA (with LCA) should project financial realities and other benefits/bottlenecks such as energy efficiency and state-of-the-art costs (SOA) for REE.</li> <li>• TEA should be based on data acquired during the project.</li> </ul>	<p>(Month 19) Established process for transfer of REE source material to, and disposal of waste from, the processing site at quantities reflective of increased scale.</p> <p>(Month 24) Updated descriptions/drawings of biomining concept pipeline along with format/matrix for individual steps.</p> <p>(Month 33) Updated TEA.</p>
		Task 4: Develop and demonstrate biomining modules for REE separation and recovery.	<ul style="list-style-type: none"> <li>• Demonstrate pipeline of REE separation and recovery modules capable of isolating individual REEs from actual source material.</li> <li>• Processes should be robust, scalable, and operate as a unified pipeline where purification of each REE adds one (or less) additional step(s).</li> <li>• Actual source material processed through the upstream stage used as input media.</li> <li>• Purity of recovered REEs must be analytically confirmed.</li> </ul>	<p>(Month 24) Bind/remove <math>\geq</math> 80% of a target REE at milligram scale.</p> <p>(Month 30) Bind/remove <math>\geq</math> 80% of target REE at the gram scale at a rate of <math>\geq</math> 2 g total REE/day.</p> <p>(Month 36) As a full pipeline, separate and recover <math>\geq</math> 8 individual REEs, <math>\geq</math> 14 g/week total REE, recover <math>\geq</math> 80% of bound REE from biomass; <math>\geq</math> 90% final purity for each REE.</p> <p>(Month 36) For an individual 'module' demonstrate 10 cycles of REE binding and recovery with 90% efficiency (at 10<sup>th</sup> cycle) relative to 1st cycle.</p>



Phase	TA	Task	Task Specifications	Milestone
Phase III (Months 37-48)	Technical Area 2: REE Biomining	Task 5: Demonstrate pilot scale operations.	<ul style="list-style-type: none"> <li>• Pilot scale pipeline of REE separation and recovery modules must be capable of isolating individual REEs from actual source material.</li> <li>• Processes should be robust, scalable, and capable of operating in-line with operation at source site.</li> <li>• Controls for regeneration, biofouling mitigation, contaminants (e.g., radioactive elements, sulfides); biological and chemical waste disposal must be included.</li> <li>• Efficacy of physical/genetic containment strategies for any living genetically engineered organisms to prevent accidental release must meet local, state and/or Federal compliance thresholds.</li> <li>• TEA (LCA) should project financial realities and other benefits/bottlenecks such as energy efficiency and state-of-the-art costs (SOA) for REE. TEA should be refined from prior versions using data acquired from the pilot study.</li> </ul>	<p>(Month 48) Bind/remove &gt; 95% of <math>\geq 8</math> individual REEs from actual source material and recover &gt; 95% of <math>\geq 8</math> individual REEs at a scale of <math>\geq 700</math> g/week total REE, with a final purity of <math>\geq 95\%</math>.</p> <p>(Month 48) Final TEA.</p>

### 1.3.2. Deliverables

The following will be delivered by the performer teams to the IV&V team(s):

#### Phase 1 (15, 16 months)

- Biological - Performance of strains, proteins, and materials will be tested using performer provided protocols (16 mo).
- Elemental - REE materials produced with TA2 bioengineering approaches will be tested for composition and purity (16 mo).
- Analytical - Performers will provide a techno-economic analysis of their approach at bench scale (15 mo).

#### Phase 2 (33, 36 months)

- Biological - Performance of strains, proteins, materials, will be tested using performer-provided protocols (36 mo).
- Elemental - REE materials produced with TA2 bioengineering approaches will be tested for composition and purity (36 mo).

- Analytical - Performers will provide an updated techno-economic analysis of their approach reflecting scaled up experiments, and IV&V will review (33 mo).

#### Phase 3 (48 months)

- Biological - Performance of strains, proteins, and materials will be tested using performer provided protocols.
- Elemental - REE materials produced with TA2 bioengineering approaches will be tested for composition and purity.
- Analytical - Performers will provide a final techno-economic analysis of their approach as they approach the end of their pilot scale demo.

### **1.4. PERMITS, LICENSES, AND COMPLIANCE**

Performers will obtain any necessary permits, licenses or certifications required for acquisition, transportation, storage, and/or disposal of REE source materials, radioactive elements, biomass, waste by-products, and other system components. Performers will describe anticipated regulatory guidance (if any) and safety practices applicable to their planned research activities using their selected REE source material. This may include the Environmental Protection Agency (EPA), Department of the Interior, Nuclear Regulatory Commission, State or local regulators for certification, licensing, packaging, handling, transportation, research uses, and disposal of REEs, heavy metals, radioactive elements, other hazardous materials, and genetically modified living organisms (if used in the biomining workflow).

### **1.5. GENERAL REQUIREMENTS**

#### **1.5.1. Proposing Teams**

Proposer teams must address both TA1 and TA2 described above, which should run in parallel. Consequently, it is expected that the teams will include experts from the multiple disciplines related to the program challenges and goal (e.g., synthetic biology, environmental microbiology, geology, chemical engineering). Because several different technologies must ultimately work together, teams must identify one or more members as project integrators who will ensure those team members focused on a specific TA are also appropriately working towards the overall program goal. The project integrator should also address all risks specifically associated with integration.

Specific content, communications, networking, and team formation are the sole responsibility of the proposer teams. Proposer teams must submit a single, integrated proposal led by a single Principal Investigator or Prime Contractor.

#### **1.5.2. Controlled Unclassified Information (CUI)**

Because REEs are considered to be critical materials for the DoD, and their natural mineral deposits sometimes also contain radioactive elements, it is expected that certain aspects of the proposed research may be considered CUI if they reveal proprietary or other sensitive technical information, and may require safeguarding or dissemination controls pursuant to and consistent with applicable law, regulations, and government-wide policies. Proposals that anticipate the production of any such information must deliver a detailed CUI risk mitigation plan to DARPA (see Section 4.2.2.A. Volume I, Technical and Management Proposal, Section III; **Attachment 1** - CUI Guide; **Attachment 2** - CUI Management Plan Template). Performers must partition

potentially sensitive tasks from non-sensitive research efforts, and are asked to identify sensitive tasks within their Statement of Work (**Attachment 3 – Statement of Work Template**). All performers (prime contractor and subcontractors) desiring public release of project information will be required to submit a request for public release from DARPA in accordance with their contractual requirements. As such, organizations that can comply with DoD CUI requirements as described in **Attachment 1** must be part of the proposed team.

### **1.5.3. Other Requirements**

Performers are expected to attend semi-annual program reviews to provide updates to the DARPA program management team, IV&V partners, government stakeholders and other EMBER performers on progress towards their milestones and scientific goals on the EMBER program. Performers will also summarize outstanding challenges and limitations that must still be overcome to achieve the overarching goals of the program.

## **2. Award Information**

### **2.1. GENERAL AWARD INFORMATION**

Multiple awards are possible. The amount of resources made available under this BAA will depend on the quality of the proposals received and the availability of funds.

The Government reserves the right to select for negotiation all, some, one, or none of the proposals received in response to this solicitation and to make awards without discussions with proposers. The Government also reserves the right to conduct discussions if it is later determined to be necessary. If warranted, portions of resulting awards may be segregated into pre-priced options. Additionally, DARPA reserves the right to accept proposals in their entirety or to select only portions of proposals for award. In the event that DARPA desires to award only portions of a proposal, negotiations may be opened with that proposer. The Government reserves the right to fund proposals in phases with options for continued work, as applicable.

The Government reserves the right to request any additional, necessary documentation once it makes the award instrument determination. Such additional information may include but is not limited to Representations and Certifications (see Section VI.B.2., “Representations and Certifications”). The Government reserves the right to remove proposers from award consideration should the parties fail to reach an agreement on award terms, conditions, and/or cost/price within a reasonable time, and the proposer fails to timely provide requested additional information. Proposals identified for negotiation may result in a procurement contract, cooperative agreement, or Other Transaction, depending upon the nature of the work proposed, the required degree of interaction between parties, whether or not the research is classified as Fundamental Research, and other factors.

Proposers looking for innovative, commercial-like contractual arrangements are encouraged to consider requesting Other Transactions. To understand the flexibility and options associated with Other Transactions, consult <http://www.darpa.mil/work-with-us/contract-management#OtherTransactions>.

In accordance with 10 U.S.C. § 2371b(f), the Government may award a follow-on production contract or Other Transaction (OT) for any OT awarded under this solicitation if: (1) that participant in the OT, or a recognized successor in interest to the OT, successfully completed the

entire prototype project provided for in the OT, as modified; and (2) the OT provides for the award of a follow-on production contract or OT to the participant, or a recognized successor in interest to the OT.

In all cases, the Government contracting officer shall have sole discretion to select award instrument type, regardless of instrument type proposed, and to negotiate all instrument terms and conditions with selectees. DARPA will apply publication or other restrictions, as necessary, if it determines that the research resulting from the proposed effort will present a high likelihood of disclosing performance characteristics of military systems or manufacturing technologies that are unique and critical to defense. Any award resulting from such a determination will include a requirement for DARPA permission before publishing any information or results on the program. For more information on publication restrictions, see the section below on Fundamental Research.

## **2.2. FUNDAMENTAL RESEARCH**

It is DoD policy that the publication of products of fundamental research will remain unrestricted to the maximum extent possible. National Security Decision Directive (NSDD) 189 defines fundamental research as follows:

‘Fundamental research’ means basic and applied research in science and engineering, the results of which ordinarily are published and shared broadly within the scientific community, as distinguished from proprietary research and from industrial development, design, production, and product utilization, the results of which ordinarily are restricted for proprietary or national security reasons.

As of the date of publication of this solicitation, the Government expects that program goals as described herein may be met by proposed efforts for fundamental research and non-fundamental research. Some proposed research may present a high likelihood of disclosing performance characteristics of military systems or manufacturing technologies that are unique and critical to defense. Based on the anticipated type of proposer (e.g., university or industry) and the nature of the solicited work, the Government expects that some awards will include restrictions on the resultant research that will require the awardee to seek DARPA permission before publishing any information or results relative to the program.

More specifically, research conducted for TA1 Bioengineering for REE Utilization is expected to constitute fundamental research, and research conducted on REE Biomining (TA2) is expected to produce Controlled Unclassified Information (CUI). However, the overall program will require protection as CUI, thus the Government expects that all awards, to include subawardees, will include restrictions on the resultant research that will require the awardee to seek DARPA permission before publishing any information or results relative to the program.

Proposers should indicate in their proposal whether they believe the scope of the research included in their proposal is fundamental or not. While proposers should clearly explain the intended results of their research, the Government shall have sole discretion to determine whether the proposed research shall be considered fundamental and to select the award instrument type. Appropriate language will be included in resultant awards for non-fundamental research to prescribe publication requirements and other restrictions, as appropriate. This language can be found at <http://www.darpa.mil/work-with-us/additional-baa>.

For certain research projects, it may be possible that although the research to be performed by a potential awardee is non-fundamental research, its proposed subawardee's effort may be fundamental research. It is also possible that the research performed by a potential awardee is fundamental research while its proposed subawardee's effort may be non-fundamental research. In all cases, it is the potential awardee's responsibility to explain in its proposal which proposed efforts are fundamental research and why the proposed efforts should be considered fundamental research.

### **3. Eligibility Information**

#### **3.1. ELIGIBLE APPLICANTS**

All responsible sources capable of satisfying the Government's needs may submit a proposal that shall be considered by DARPA.

##### **3.1.1. Federally Funded Research and Development Centers (FFRDCs) and Government Entities**

###### **FFRDCs**

FFRDCs are subject to applicable direct competition limitations and cannot propose to this solicitation in any capacity unless they meet the following conditions. (1) FFRDCs must clearly demonstrate that the proposed work is not otherwise available from the private sector. (2) FFRDCs must provide a letter, on official letterhead from their sponsoring organization, that (a) cites the specific authority establishing their eligibility to propose to Government solicitations and compete with industry, and (b) certifies the FFRDC's compliance with the associated FFRDC sponsor agreement's terms and conditions. These conditions are a requirement for FFRDCs proposing to be awardees or subawardees.

###### **Government Entities**

Government Entities (e.g., Government/National laboratories, military educational institutions, etc.) are subject to applicable direct competition limitations. Government Entities must clearly demonstrate that the work is not otherwise available from the private sector and provide written documentation citing the specific statutory authority and contractual authority, if relevant, establishing their ability to propose to Government solicitations and compete with industry. This information is required for Government Entities proposing to be awardees or subawardees.

###### **Authority and Eligibility**

At the present time, DARPA does not consider 15 U.S.C. § 3710a to be sufficient legal authority to show eligibility. While 10 U.S.C. § 2539b may be the appropriate statutory starting point for some entities, specific supporting regulatory guidance, together with evidence of agency approval, will still be required to fully establish eligibility. DARPA will consider FFRDC and Government Entity eligibility submissions on a case-by-case basis; however, the burden to prove eligibility for all team members rests solely with the proposer.

##### **3.1.2. Non-U.S. Organizations**

Non-U.S. organizations and/or individuals may participate to the extent that such participants comply with any necessary non-disclosure agreements, security regulations, export control laws, and other governing statutes applicable under the circumstances.

### **3.2. ORGANIZATIONAL CONFLICTS OF INTEREST**

#### FAR 9.5 Requirements

In accordance with FAR 9.5, proposers are required to identify and disclose all facts relevant to potential OCIs involving the proposer's organization and *any* proposed team member (subawardee, consultant). Under this Section, the proposer is responsible for providing this disclosure with each proposal submitted to the solicitation. The disclosure must include the proposer's, and as applicable, proposed team member's OCI mitigation plan. The OCI mitigation plan must include a description of the actions the proposer has taken, or intends to take, to prevent the existence of conflicting roles that might bias the proposer's judgment and to prevent the proposer from having unfair competitive advantage. The OCI mitigation plan will specifically discuss the disclosed OCI in the context of each of the OCI limitations outlined in FAR 9.505-1 through FAR 9.505-4.

#### Agency Supplemental OCI Policy

In addition, DARPA has a supplemental OCI policy that prohibits contractors/performers from concurrently providing Scientific Engineering Technical Assistance (SETA), Advisory and Assistance Services (A&AS) or similar support services and being a technical performer. Therefore, as part of the FAR 9.5 disclosure requirement above, a proposer must affirm whether the proposer or *any* proposed team member (subawardee, consultant) is providing SETA, A&AS, or similar support to any DARPA office(s) under: (a) a current award or subaward; or (b) a past award or subaward that ended within one calendar year prior to the proposal's submission date. If SETA, A&AS, or similar support is being or was provided to any DARPA office(s), the proposal must include:

- The name of the DARPA office receiving the support;
- The prime contract number;
- Identification of proposed team member (subawardee, consultant) providing the support; and
- An OCI mitigation plan in accordance with FAR 9.5.

#### Government Procedures

In accordance with FAR 9.503, 9.504 and 9.506, the Government will evaluate OCI mitigation plans to avoid, neutralize or mitigate potential OCI issues before award and to determine whether it is in the Government's interest to grant a waiver. The Government will only evaluate OCI mitigation plans for proposals that are determined selectable under the solicitation evaluation criteria and funding availability.

The Government may require proposers to provide additional information to assist the Government in evaluating the proposer's OCI mitigation plan.

If the Government determines that a proposer failed to fully disclose an OCI; or failed to provide the affirmation of DARPA support as described above; or failed to reasonably provide additional information requested by the Government to assist in evaluating the proposer's OCI mitigation plan, the Government may reject the proposal and withdraw it from consideration for award.

### **3.3. COST SHARING/MATCHING**

Cost sharing is not required; however, it will be carefully considered where there is an applicable statutory condition relating to the selected funding instrument. Cost sharing is encouraged where there is a reasonable probability of a potential commercial application related to the proposed research and development effort.

## 4. Application and Submission Information

### 4.1. ADDRESS TO REQUEST APPLICATION PACKAGE

This announcement, any attachments, and any references to external websites herein constitute the total solicitation. If proposers cannot access the referenced material posted in the announcement found at <http://www.darpa.mil>, contact the administrative contact listed herein.

### 4.2. CONTENT AND FORM OF APPLICATION SUBMISSION

All submissions, including abstracts and proposals, must be written in English with a type no smaller than 12-point font. Smaller fonts may be used for figures, tables, and charts. The page limitation includes all figures, tables, and charts. All pages shall be formatted for printing on 8-1/2 by 11-inch paper. Margins must be 1-inch on all sides. Copies of all documents submitted must be clearly labeled with the BAA number (HR001121S0035), proposer organization, and submission title.

#### 4.2.1. Proposal Abstract Format

Proposers are **strongly** encouraged to submit an abstract in advance of a proposal to minimize effort and reduce the potential expense of preparing an out-of-scope proposal. DARPA will respond to abstracts providing feedback and indicating whether, after preliminary review, there is interest within BTO for the proposed work. DARPA will attempt to reply within **20** calendar days of receipt. Proposals may be submitted irrespective of comments or feedback received in response to the abstract. Proposals are reviewed without regard to feedback given as a result of abstract review. The time and date for submission of proposal abstracts are specified in Part I above.

The abstract is a concise version of the proposal comprising a maximum of **eight (8)** pages, including all figures, tables, and charts.

The page limit does NOT include:

- Official transmittal letter (optional);
- Cover sheet;
- Executive summary slide (**Attachment 4**);
- Curriculum Vitae; and
- Bibliography (optional).

Abstracts must include the following components:

**A. Cover Sheet (does not count towards page limit):** Include the administrative and technical points of contact (name, address, phone, fax, e-mail, lead organization). Also include the BAA number, title of the proposed project, primary subcontractors, estimated cost, duration of the project, and the label “ABSTRACT.”

**B. Executive Summary:** Clearly describe what is being proposed and what difference it will make (qualitatively and quantitatively), including brief answers to the following questions:

1. What is the proposed work attempting to accomplish or do?
2. How is it done today? What are the limitations?

3. What is innovative in your approach, and how does it compare to the current state-of-the-art (SOA)?
4. What are the key technical challenges in your approach, and how do you plan to overcome these?
5. Who will care, and what will the impact be if you are successful?
6. How much will it cost, and how long will it take?

**C. Executive Summary Slide:** The slide template is provided as **Attachment 4** to the BAA posted at <https://SAM.gov>. Use of this template is required.

**D. Technical Plan:** Outline and address all technical areas and challenges inherent in the approach and possible solutions for overcoming potential problems. Both TA1 and TA2 must be addressed. This section should provide specific objectives, metrics, and milestones at intermediate stages of the project to demonstrate a plan for accomplishment of the program goals. Propose additional appropriate qualitative and quantitative metrics specific to the approach, as needed. Outline of intermediary milestones should occur at no greater than 6-month increments.

**E. Management and Capabilities:** Provide a brief summary of expertise of the team, including subcontractors and key personnel.

A principal investigator for the project must be identified, and a description of the team's organization, including a breakdown by Technical Area (TA). All teams are strongly encouraged to identify a Project Manager/Integrator to serve as the primary point of contact to communicate with the DARPA Program Manager, IV & V partner, and Contracting Officer's Representative, coordinate the effort across co-performer, vendor, and subcontractor teams, organize regular performer meetings or discussions, facilitate data sharing, and ensure timely completion of milestones and deliverables.

Include a description of the team's organization, including roles and responsibilities. Team member/consultant descriptions should address the Technical Plan (and should include members with needed regulatory/ environmental compliance, technoeconomic analysis, and biocontainment/biosafety expertise). Describe the time and percent effort divisions for members participating across multiple TAs, and delineate individuals to avoid duplication of efforts.

Describe the organizational experience in this area, existing intellectual property required to complete the project, and any specialized facilities to be used as part of the project. List Government-furnished materials or data assumed to be available. Describe any specialized facilities to be used as part of the project, the extent of access to these facilities, and any biological containment, biosafety, and certification requirements.

**F. Cost and Schedule:** Provide a cost estimate for resources over the proposed timeline of the project, broken down by phase and major cost items (e.g., labor, materials, etc.). Include cost estimates for each potential subcontractor (it may be a rough order of magnitude).



**G. Curriculum Vitae** (do not count towards page limit): Include CVs of key team members, one of which must be from/for the Principal Investigator.

**H. Bibliography** (Optional, does not count towards page limit): If desired, include a brief bibliography with links to relevant papers and reports. The bibliography should not exceed two (2) pages.

#### 4.2.2. Full Proposal Format

All full proposals must be in the format given below. Proposals shall consist of two volumes: 1) **Volume I, Technical and Management Proposal**, and 2) **Volume II, Cost Proposal**. All submissions must be written in English with type no smaller than 12-point font. A smaller font may be used for figures, tables, and charts. The page limitation includes all figures, tables, and charts. All pages shall be formatted for printing on 8-1/2 by 11- inch paper. Margins must be 1- inch on all sides. Copies of all documents submitted must be clearly labeled with the DARPA BAA number, proposer organization, and proposal title/proposal short title. Volume I, Technical and Management Proposal, may include an attached bibliography of relevant technical papers or research notes (published and unpublished) which document the technical ideas and approach upon which the proposal is based. Copies of not more than three (3) relevant papers may be included with the submission. The submission of other supporting materials along with the proposals is strongly discouraged and will not be considered for review. **The maximum page count for Volume 1 is thirty (30) pages.** Volume I should include the following components:

**NOTE: Non-conforming submissions that do not follow the instructions herein may be rejected without further review.**

##### a. Volume I, Technical and Management Proposal

#### Section I. Administrative

##### **A. Cover Sheet (Labeled “PROPOSAL: VOLUME I”) NOT INCLUDED IN PAGE COUNT:**

1. BAA number (HR001121S0035);
2. Lead organization submitting proposal (prime contractor);
3. Type of organization, selected from among the following categories: “LARGE BUSINESS,” “SMALL DISADVANTAGED BUSINESS,” “OTHER SMALL BUSINESS,” “HBCU,” “MI,” “OTHER EDUCATIONAL,” OR “OTHER NONPROFIT”;
4. Proposer’s reference number (if any);
5. Other team members (if applicable) and type of business for each;
6. Proposal title;
7. Technical point of contact (Program Manager or Principle Investigator) to include: salutation, last name, first name, street address, city, state, zip code, telephone, fax, e-mail;

8. Administrative point of contact (Contracting Officer or Award Officer) to include: salutation, last name, first name, street address, city, state, zip code, telephone, fax, e-mail;
9. Award instrument requested: cost-plus-fixed-fee (CPFF), cost-award—no fee, cost sharing contract – no fee, or other type of procurement contract (*specify*), cooperative agreement, or Other Transaction;
10. Place(s) of performance, including all subcontractors and consultants;
11. Period of performance;
12. Total funds requested from DARPA, total funds requested per phase and the amount of any cost share (if any);
13. Proposal validity period; AND
14. Date proposal was submitted.

Information on award instruments is available at <http://www.darpa.mil/work-with-us/contract-management>.

**B. Official Transmittal Letter NOT INCLUDED IN PAGE COUNT.**

**C. Executive Summary Slides NOT INCLUDED IN PAGE COUNT:** The slide template is provided as **Attachment 5** to the BAA posted at <https://SAM.gov>. Use of this template is required.

Section II. Detailed Proposal Information

**A. Executive Summary:** Provide a synopsis of the proposed project, including answers to the following questions:

- What is the proposed work attempting to accomplish or do?
- How is it done today, and what are the limitations?
- What is innovative in your approach?
- What are the key technical challenges in your approach, and how do you plan to overcome these?
- Who or what will be affected, and what will be the impact if the work is successful?

**B. Goals and Impact:** Clearly describe what the team is trying to achieve and the difference it will make (qualitatively and quantitatively) if successful. Describe the innovative aspects of the project in the context of existing capabilities and approaches, clearly delineating the uniqueness and benefits of this project in the context of the state of the art, alternative approaches, and other projects from the past and present. Describe how the proposed project is revolutionary and how it significantly rises above the current state-of-the-art. Describe the deliverables associated with the proposed project and any plans to commercialize the technology, transition it to a customer, or further the work.

**C. Technical Plan:** Outline and address technical challenges inherent in the approach and possible solutions for overcoming potential problems. Proposal should address both TA1 and TA2 across all three Phases. This section should provide appropriate

measurable milestones (quantitative if possible) at intermediate stages of the program to demonstrate progress, plan for achieving the milestones, and must include a simple process flow diagram of their final system concept. The technical plan should demonstrate a deep understanding of the technical challenges and present a credible (even if risky) plan to achieve the program goal. Discuss mitigation of technical risks. Include description of how formal techno-economic analyses will be conducted.

- D. Management Plan:** Provide a summary of expertise of the team, including any subcontractors, and key personnel who will be doing the work. A Principal Investigator (PI) for the project must be identified, along with a description of the team organization, including the breakdown by Technical Area. All teams are strongly encouraged to identify a Project Manager/Integrator (PM/I) to serve as the primary point of contact to communicate with the DARPA Program Manager, IV&V partner, and Contracting Officer's Representative, coordinate the effort across co-performer, vendor, and subcontractor teams, organize regular performer meetings or discussions, facilitate data sharing, and ensure timely completion of milestones and deliverables.

Provide a clear description of the team's organization, including an organization chart that includes, as applicable: the programmatic relationship of team members; the unique capabilities of team members; the task responsibilities of team members, the teaming strategy among the team members; and key personnel with the amount of effort to be expended by each person during each year. Provide a detailed plan for coordination, including explicit guidelines for interaction among collaborators/subcontractors of the proposed effort. Include risk management approaches. Describe any formal teaming agreements that are required to execute this program.

- E. Capabilities:** Describe organizational experience in relevant subject area(s), development of techno-economic analyses, existing intellectual property, specialized facilities, and any Government-furnished materials or information. Describe any specialized facilities to be used as part of the project, the extent of access to these facilities, and any biological containment, biosafety, and certification requirements. Describe plans for compliance with safety and regulatory requirements for selected REE source materials, and for mitigation against accidental environmental release of living, genetically engineered living organisms (if pertinent). Discuss any work in closely related research areas and previous accomplishments.
- F. Qualifications of Key Personnel **NOT INCLUDED IN PAGE COUNT**:** Curriculum Vitae for PI, PM, and key co-Investigators (not included toward Volume 1 page count).
- G. Current and pending awards **NOT INCLUDED IN PAGE COUNT**:** Provide a list of current and pending awards related to the proposed research, including the funding source (for PI, PM/I, and key co-Investigators). Describe areas of overlap or leveraging with your EMBER proposal.

**H. Statement of Work (SOW) NOT INCLUDED IN PAGE COUNT:** The SOW should provide a detailed task breakdown, citing specific tasks for each Technical Area, and their connection to the milestones and program metrics. Each phase of the program should be separately defined. The SOW must not include proprietary information. The Government strongly encourages proposers to use the provided MS Word™ SOW Template (**Attachment 3**) in the development of their SOW proposals.

For each task/subtask, provide:

- A detailed description of the approach to be taken to accomplish each defined task/subtask.
- Identification of the primary organization responsible for task execution (prime contractor, subcontractor(s), consultant(s), by name).
- A measurable milestone, i.e., a deliverable, demonstration, or other event/activity that marks task completion. Include completion dates for all milestones. Include quantitative metrics.
- A definition of all deliverables (e.g., data, reports, software) to be provided to the Government in support of the proposed tasks/subtasks.
- For each listed task and subtask, note whether it is envisioned to deliver Fundamental Research or Non-Fundamental Research (as described in Part II, Section 2.2). Provide a short justification of each categorization and cross-reference with listed items in the CUI guide (**Attachment 1**), as appropriate.
- It is recommended that the SOW be developed so that each Technical Area and Phase of the program is separately defined.

**I. Schedule and Milestones:** Provide a detailed schedule showing tasks (task name, duration, work breakdown structure element as applicable, performing organization), milestones, and the interrelationships among tasks. The task structure must be consistent with that in the SOW. Measurable milestones should be clearly articulated and defined in time relative to the start of the project.

**J. Technology Transfer Plan:** Provide information regarding the types of partners (e.g., government, private industry) that will be pursued and submit a timeline with incremental milestones toward successful engagement. The plan should include a description of how DARPA will be included in the development of potential technology transfer relationships. If the Technology Transfer Plan includes the formation of a start-up company, a business development strategy must also be provided.

### Section III. CUI Management Plan **NOT INCLUDED IN PAGE COUNT**

Required for proposers who anticipate generating information that may be considered CUI in accordance with Section 1.5 “Controlled Unclassified Information.” Provide a detailed plan for how the organization and its subcontractors will meet CUI safeguarding requirements **following the program-specific CUI guidance stated in Attachment 1**. The plan should provide a detailed strategy to protect CUI without unnecessarily compartmentalizing information flow within or among performer teams. This plan must describe safeguard procedures for protecting any sensitive program deliverables. The

Government strongly encourages proposers to use the provided MS Word™ CUI Management Plan template (**Attachment 2**).

**Section IV. Additional Information NOT INCLUDED IN PAGE COUNT**

Provide a brief bibliography of relevant technical papers and research notes (published and unpublished), which document the technical ideas upon which the proposal is based. Copies of not more than three (3) relevant papers can be included in the submission.

**b. Volume II, Cost Management Proposal**

**Cover Sheet (LABELED “PROPOSAL: VOLUME II”):**

1. BAA Number (HR001121S0035).
2. Lead Organization Submitting proposal.
3. Type of organization, selected among the following categories: “LARGE BUSINESS,” “SMALL DISADVANTAGED BUSINESS,” “OTHER SMALL BUSINESS,” “HBCU,” “MI,” “OTHER EDUCATIONAL,” OR “OTHER NONPROFIT.”
4. Proposer’s reference number (if any).
5. Other team members (if applicable) and type of business for each.
6. Proposal title.
7. Technical point of contact (Program Manager or Principal Investigator) to include: salutation, last name, first name, street address, city, state, zip code, telephone, fax (if available), electronic mail (if available).
8. Administrative point of contact (Contracting Officer or Award Officer) to include: salutation, last name, first name, street address, city, state, zip code, telephone, fax (if available), and electronic mail (if available).
9. Award instrument requested: cost-plus-fixed-fee (CPFF), cost-contract—no fee, cost-sharing contract – no fee, or other type of procurement contract (*specify*), cooperative agreement, or Other Transaction.
10. Place(s) of performance, including all subcontractors and consultants.
11. Period of performance.
12. Total funds requested from DARPA, total funds requested per phase (as defined in Table 1), and the amount of any cost-share (if any).
13. Name, address, and telephone number of the proposer’s cognizant Defense Contract Management Agency (DCMA) administration office (*if known*).
14. Name, address, and telephone number of the proposer’s cognizant Defense Contract Audit Agency (DCAA) audit office (*if known*).
15. Date proposal was prepared.
16. Data Universal Numbering System (DUNS) number (<http://www.dnb.com/get-a-duns-number.html>).
17. Taxpayer ID number (<https://www.irs.gov/Individuals/International-Taxpayers/Taxpayer-Identification-Numbers-TIN>).
18. Commercial and Government Entity (CAGE) code (<https://cage.dla.mil/Home/UsageAgree>).
19. Proposal validity period.

**NOTE: Non-conforming submissions that do not follow the instructions herein may be rejected without further review.**

The Government requires that proposers use the provided MS Excel™ DARPA Standard Cost Proposal Spreadsheet in the development of their cost proposals. A customized cost proposal spreadsheet may be an attachment to this solicitation. If not, the spreadsheet can be found on the DARPA website at <http://www.darpa.mil/work-with-us/contract-management> (under “Resources” on the right-hand side of the webpage). All tabs and tables in the cost proposal spreadsheet should be developed in an editable format with calculation formulas intact to allow traceability of the cost proposal. This cost proposal spreadsheet should be used by the prime organization and all subcontractors. In addition to using the cost proposal spreadsheet, the cost proposal still must include all other items required in this announcement that are not covered by the editable spreadsheet. Subcontractor cost proposal spreadsheets may be submitted directly to the Government by the proposed subcontractor via e-mail to the address in Part I of this solicitation. **Using the provided cost proposal spreadsheet will assist the Government in a rapid analysis of your proposed costs and, if your proposal is selected for a potential award, speed up the negotiation and award execution process.**

- (1) Total program, per phase (Phase I (Base); Phase II (Option); and Phase III (Option)), and per task cost broken down by major cost items to include:
  - i. **Direct labor** – provide an itemized breakout of all personnel, listed by name or TBD, with labor rate (or salary), labor hours (or percent effort), and labor category. All senior personnel must be identified by name.
  - ii. **Materials and Supplies** – itemized list which includes a description of material, quantity, unit price, and total price. If a material factor is used based on historical purchases, provide data to justify the rate.
  - iii. **Equipment** – itemized list which includes a description of equipment, unit price, quantity, and total price. Any equipment item with a unit price over \$5,000 must include a vendor quote.
  - iv. **Animal Use Costs** – itemized list of all materials, animal purchases, and per diem costs, associated with proposed animal use; include documentation supporting daily rates.
  - v. **Travel** – provide an itemized list of travel costs to include purpose of trips, departure and arrival destinations, projected airfare, rental car and per GSA approved diem, number of travelers, number of days); provide screenshots from travel website for proposed airfare and rental car, as applicable; provide a screenshot or web link for conference registration fee and note if the fee includes hotel cost. Conference attendance must be justified, and explain how it is in the best interest of the project. **Plan for one (1) DARPA program review meeting per year.**
  - vi. **Other Direct Costs (e.g., computer support, clean room fees)** – Should be itemized with costs or estimated costs. Backup documentation and/or a supporting cost breakdown is required to support proposed costs with a unit price over \$5,000. An explanation of any estimating factors, including their derivation and application, must be provided. Please include a brief description of the proposers’ procurement method to be used.

- vii. **Other Direct Costs** – Consultants: provide executed Consultant Agreement that describes work scope, rate, and hours.
  - viii. **Indirect costs** including, as applicable, fringe benefits, overhead, General and Administrative (G&A) expense, and cost of money (see university vs. company-specific requirements below).
  - ix. **Indirect costs specific to a University performer:** (1) **Fringe Benefit Rate** (provide current Department of Health and Human Services (DHHS) or Office of Naval Research (ONR) negotiated rate package; if calculated by other than a rate, provide University documentation identifying fringe costs by position or HR documentation if unique to each person); (2) **F&A Indirect Overhead Rate** (provide current DHHS or ONR negotiated rate package); (3) **Tuition Remission** (provide current University documentation justifying per student amount); and (4) **Health Insurance/Fee** (provide current University documentation justifying per student amount, if priced separately from fringe benefits with calculations included in the EXCEL cost file).  
**Indirect costs specific to a Company performer:** (1) **Fee/Profit** (provide rationale for proposed fee/profit percentage using criteria found in DFARS 215.404-70); and (2) **Fringe Benefit/Labor OH/Material OH/G&A Rates** (provide current Forwarding Pricing Rate Proposal (FPRP) or DCMA/DCAA Forward Pricing Rate Recommendation or Agreement (FPRR or FPRA). If these documents are not available, provide company historical data, preferably two years, minimum of one year, to include both pool and expense costs used to generate the rates).
- (2) A summary of total program costs by phase I, II, and III and task.
  - (3) An itemization of Subcontracts. All subcontractor cost proposal documentation must be prepared at the same level of detail as that required of the prime. Subcontractor proposals should include Interdivisional Work Transfer Agreements (IWTA) or evidence of similar arrangements (an IWTA is an agreement between multiple divisions of the same organization). The prime proposer is responsible for compiling and providing all subcontractor proposals for the Procuring Contracting Officer (PCO). The proposal must show how subcontractor costs are applied to each phase and task. If consultants are to be used, proposer must provide consultant agreement or other document that verifies the proposed loaded daily/hourly rate.
  - (4) An itemization of any information technology (IT) purchase (including a letter stating why the proposer cannot provide the requested resources from its own funding), as defined in FAR Part 2.101.
  - (5) A summary of projected funding requirements by month for all phases of the project.
  - (6) A summary of tasks that have animal or human use funding.
  - (7) The source, nature, and amount of any industry cost-sharing. Where the effort consists of multiple portions that could reasonably be partitioned for purposes of funding, these should be identified as options with separate cost estimates for each.



- (8) Identification of pricing assumptions of which may require incorporation into the resulting award instrument (e.g., use of Government Furnished Property/Facilities/Information, access to Government Subject Matter Expert/s, etc.).
- (9) Any Forward Pricing Rate Agreement, DHHS rate agreement, other such approved rate information, or such documentation that may assist in expediting negotiations (if available).
- (10) Proposers with a Government acceptable accounting system who are proposing a cost-type contract must submit the DCAA document approving the cost accounting system.

Per FAR 15.403-4, certified cost or pricing data shall be required if the proposer is seeking a procurement contract award per the referenced threshold, unless the proposer requests and is granted an exception from the requirement to submit cost or pricing data. Certified “cost or pricing data” are not required if the proposer proposes an award instrument other than a procurement contract (e.g., a grant, cooperative agreement, or Other Transaction.)

### **Subawardee Proposals**

The awardee is responsible for compiling and providing all subawardee proposals for the Procuring Contracting Officer (PCO)/Grants Officer (GO)/Agreements Officer (AO), as applicable. Subawardee proposals should include Interdivisional Work Transfer Agreements (ITWA) or similar arrangements. Where the effort consists of multiple portions which could reasonably be partitioned for purposes of funding, these should be identified as options with separate cost estimates for each.

All proprietary subawardee proposal documentation, prepared at the same level of detail as that required of the awardee’s proposal and which cannot be uploaded with the proposed awardee’s proposal, shall be provided to the Government either by the awardee or by the subawardee organization when the proposal is submitted. Subawardee proposals submitted to the Government by the proposed subawardee should be submitted via e-mail to the address in Section I.

### **Other Transaction Requests**

All proposers requesting an OT must include a detailed list of milestones for each phase of the program (I, II, and III). Each milestone must include the following:

- milestone description,
- completion criteria,
- due date, and
- payment/funding schedule (to include, if cost share is proposed, awardee and Government share amounts).

It is noted that, at a minimum, milestones should relate directly to accomplishment of program technical metrics as defined in the BAA and/or the proposer’s proposal. Agreement type, expenditure or fixed-price based, will be subject to negotiation by the Agreements Officer. Do not include proprietary data.



### 4.2.3. Additional Proposal Information

#### Proprietary Markings

Proposers are responsible for clearly identifying proprietary information. Submissions containing proprietary information must have the cover page and each page containing such information clearly marked with a label such as “Proprietary” or “Company Proprietary.” NOTE: “Confidential” is a classification marking used to control the dissemination of U.S. Government National Security Information as dictated in Executive Order 13526 and should not be used to identify proprietary business information.

#### Unclassified Submissions

DARPA anticipates that submissions received under this BAA will be unclassified. However, should a proposer wish to submit classified information, an *unclassified* e-mail must be sent to the BAA mailbox requesting submission instructions from the Technical Office Program Security Officer (PSO). If a determination is made that the award instrument may result in access to classified information, a Security Classification Guide (SCG) and/or DD Form 254 will be issued by DARPA and attached as part of the award.

#### Controlled Unclassified Information (CUI)

For unclassified proposals containing CUI, applicants will ensure personnel and information systems processing CUI security requirements are in place.

If an unclassified submission contains CUI or the suspicion of such, as defined by Executive Order 13556 and 32 C.F.R. Part 2002, the information must be appropriately and conspicuously marked CUI in accordance with DoD Instruction (DoDI) 5200.48. Identification of what is CUI about this DARPA program is described in **Attachment 1** - CUI Guide.

Unclassified submissions containing CUI may be submitted via DARPA’s BAA Website (<https://baa.darpa.mil>) in accordance with Section 4.2.4 of this BAA.

Proposers submitting proposals involving the pursuit and protection of DARPA information designated as CUI must have, or be able to acquire prior to contract award, an information system authorized to process CUI information IAW NIST SP 800-171 and DoDI 8582.01.

#### Disclosure of Information and Compliance with Safeguarding Covered Defense Information Controls

The following provisions and clause apply to all solicitations and contracts; however, the definition of “controlled technical information” clearly exempts work considered fundamental research and therefore, even though included in the contract, will not apply if the work is fundamental research.

DFARS 252.204-7000, “Disclosure of Information”

DFARS 252.204-7008, “Compliance with Safeguarding Covered Defense Information Controls”

DFARS 252.204-7012, “Safeguarding Covered Defense Information and Cyber Incident Reporting”

The full text of the above solicitation provision and contract clauses can be found at

<http://www.darpa.mil/work-with-us/additional-baa#NPRPAC>.

Compliance with the above requirements includes the mandate for proposers to implement the security requirements specified by National Institute of Standards and Technology (NIST)

Special Publication (SP) 800-171, “Protecting Controlled Unclassified Information in Nonfederal Information Systems and Organizations” (see <https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-171r2.pdf>) and DoDI 8582.01 that are in effect at the time the solicitation is issued.

For awards where the work is considered fundamental research, the contractor will not have to implement the aforementioned requirements and safeguards. However, should the nature of the work change during performance of the award, work not considered fundamental research will be subject to these requirements.

### **Human Subjects Research (HSR)/Animal Use**

Proposers that anticipate involving human subjects or animals in the proposed research must comply with the approval procedures detailed at <http://www.darpa.mil/work-with-us/additional-baa>, to include providing the information specified therein as required for proposal submission.

### **Approved Cost Accounting System Documentation**

Proposers that do not have a Cost Accounting Standards (CAS) compliant accounting system considered adequate for determining accurate costs that are negotiating a cost-type procurement contract must complete an SF 1408 (Pre-award Survey of Prospective Contractor (Accounting System)). For more information on CAS compliance, see <http://www.dcaa.mil/cas.html>. To facilitate this process, proposers should complete the SF 1408 found at <http://www.gsa.gov/portal/forms/download/115778> and submit the completed form with the proposal.

### **Small Business Subcontracting Plan**

Pursuant to Section 8(d) of the Small Business Act (15 U.S.C. § 637(d)) and FAR 19.702(a)(1), each proposer who submits a contract proposal and includes subcontractors might be required to submit a subcontracting plan with their proposal. The plan format is outlined in FAR 19.704.

### **Section 508 of the Rehabilitation Act (29 U.S.C. § 749d)/FAR 39.2**

All electronic and information technology acquired or created through this BAA must satisfy the accessibility requirements of Section 508 of the Rehabilitation Act (29 U.S.C. § 749d)/FAR 39.2.

### **Grant Abstract**

Per Section 8123 of the Department of Defense Appropriations Act, 2015 (Pub. L. 113-235), all grant awards must be posted on a public website in a searchable format. To comply with this requirement, proposers requesting grant awards must submit a maximum one (1) page abstract that may be publicly posted and explains the program or project to the public. The proposer should sign the bottom of the abstract confirming the information in the abstract is approved for public release. Proposers are advised to provide both a signed PDF copy, as well as an editable (e.g., Microsoft word) copy. Abstracts contained in grant proposals that are not selected for award will not be publicly posted.

### **Intellectual Property**

All proposers must provide a good-faith representation that the proposer either owns or possesses the appropriate licensing rights to all intellectual property that will be utilized under the proposed effort.

For Procurement Contracts

Proposers responding to this BAA requesting procurement contracts will need to complete the certifications at DFARS 252.227-7017. See <http://www.darpa.mil/work-with-us/additional-baa> for further information. If no restrictions are intended, the proposer should state “none.” The table below captures the requested information:

Technical Data Computer Software To be Furnished With Restrictions	Summary of Intended Use in the Conduct of the Research	Basis for Assertion	Asserted Rights Category	Name of Person Asserting Restrictions
(LIST)	(NARRATIVE)	(LIST)	(LIST)	(LIST)

For All Non-Procurement Contracts

Proposers responding to this BAA requesting a Cooperative Agreement, Technology Investment Agreement, or Other Transaction for Prototypes shall follow the applicable rules and regulations governing these various award instruments, but, in all cases, should appropriately identify any potential restrictions on the Government’s use of any Intellectual Property contemplated under the award instrument in question. This includes both Noncommercial Items and Commercial Items. Proposers are encouraged to use a format similar to that described in the section above. If no restrictions are intended, then the proposer should state “NONE.”

**System for Award Management (SAM) and Universal Identifier Requirements**

All proposers must be registered in SAM unless exempt per FAR 4.1102. FAR 52.204-7, “System for Award Management” and FAR 52.204-13, “System for Award Management Maintenance” are incorporated into this solicitation. See <http://www.darpa.mil/work-with-us/additional-baa> for further information.

International entities can register in SAM by following the instructions in this link: [https://www.fsd.gov/sys\\_attachment.do?sys\\_id=c08b64ab1b4434109ac5ddb6bc4bcbb8](https://www.fsd.gov/sys_attachment.do?sys_id=c08b64ab1b4434109ac5ddb6bc4bcbb8).

**4.2.4. Submission Information**

DARPA will acknowledge receipt of all submissions and assign an identifying control number that should be used in all further correspondence regarding the submission. DARPA intends to use electronic mail correspondence regarding HR001121S0035. Submissions may not be sent by fax or e-mail; any so sent will be disregarded.

Submissions will not be returned. An electronic copy of each submission received will be retained at DARPA and all other non-required copies destroyed. A certification of destruction may be requested, provided the formal request is received by DARPA within five (5) business days after notification that a proposal was not selected.

For abstract and proposal submission dates, see [Part I, Overview Information](#). Submissions received after these dates and times may not be reviewed.

Abstracts and Full Proposals requesting procurement contracts or Other Transactions sent in response to HR001121S0035 may be submitted via DARPA's BAA Website (<https://baa.darpa.mil>). Visit the website to complete the two-step registration process. Submitters will need to register for an Extranet account (via the form at the URL listed above) and wait for two separate e-mails containing a username and temporary password. After accessing the Extranet, submitters may then create an account for the DARPA BAA website (via the "Register your Organization" link along the left side of the homepage), view submission instructions, and upload/finalize the abstract. Proposers using the DARPA BAA Website may encounter heavy traffic on the submission deadline date; it is highly advised that the submission process be started as early as possible.

All unclassified concepts submitted electronically through DARPA's BAA Website must be uploaded as zip files (.zip or .zipx extension). The final zip file should be no greater than 50 MB in size. Only one zip file will be accepted per submission. Classified submissions and proposals requesting or cooperative agreements should NOT be submitted through DARPA's BAA Website (<https://baa.darpa.mil>), though proposers will likely still need to visit <https://baa.darpa.mil> to register their organization (or verify an existing registration) to ensure the BAA office can verify and finalize their submission.

Technical support for BAA Website may be reached at [BAAT\\_Support@darpa.mil](mailto:BAAT_Support@darpa.mil), and is typically available during regular business hours (9:00 AM- 5:00 PM EST Monday – Friday).

Proposers using the DARPA BAA Website may encounter heavy traffic on the submission deadline date; it is highly advised that the submission process be started as early as possible.

### **For Grants and Cooperative Agreements Only:**

Proposers requesting grants or cooperative agreements must submit proposals through one of the following methods: (1) electronic upload per the instructions at <https://www.grants.gov/applicants/apply-for-grants.html> (DARPA-preferred); or (2) hard-copy mailed directly to DARPA. If proposers intend to use Grants.gov as their means of submission, then they must submit their entire proposal through Grants.gov; applications cannot be submitted in part to Grants.gov and in part as a hard-copy. Proposers using Grants.gov do not submit hard-copy proposals in addition to the Grants.gov electronic submission.

Submissions: In addition to the volumes and corresponding attachments requested elsewhere in this solicitation, proposers must also submit the three forms listed below.

*Form 1: SF 424 Research and Related (R&R) Application for Federal Assistance, available on the Grants.gov website at [https://apply07.grants.gov/apply/forms/sample/RR\\_SF424\\_2\\_0-V2.0.pdf](https://apply07.grants.gov/apply/forms/sample/RR_SF424_2_0-V2.0.pdf). This form must be completed and submitted.*

To evaluate compliance with Title IX of the Education Amendments of 1972 (20 U.S.C. § 1681 et.seq.), the Department of Defense (DoD) is collecting certain demographic and career information to be able to assess the success rates of women who are proposed for key roles in applications in science, technology, engineering or mathematics disciplines. In addition, the National Defense Authorization Act (NDAA) for FY 2019, Section 1286, directs the Secretary of

Defense to protect intellectual property, controlled information, key personnel, and information about critical technologies relevant to national security and limit undue influence, including foreign talent programs by countries that desire to exploit United States' technology within the DoD research, science and technology, and innovation enterprise. This requirement is necessary for all research and research-related educational activities. The DoD is using the two forms below to collect the necessary information to satisfy these requirements. Detailed instructions for each form are available on Grants.gov.

*Form 2: Research and Related Senior/Key Person Profile (Expanded)*, available on the Grants.gov website at [https://apply07.grants.gov/apply/forms/sample/RR\\_KeyPersonExpanded\\_2\\_0-V2.0.pdf](https://apply07.grants.gov/apply/forms/sample/RR_KeyPersonExpanded_2_0-V2.0.pdf). *This form must be completed and submitted.*

The Research and Related Senior/Key Person Profile (Expanded) form will be used to collect the following information for all senior/key personnel, including Project Director/Principal Investigator and Co-Project Director/Co-Principal Investigator, whether or not the individuals' efforts under the project are funded by the DoD:

- Degree Type and Degree Year.
- Current and Pending Support, including:
  - A list of all current projects the individual is working on, in addition to any future support the individual has applied to receive, regardless of the source.
  - Title and objectives of the other research projects.
  - The percentage per year to be devoted to the other projects.
  - The total amount of support the individual is receiving in connection to each of the other research projects or will receive if other proposals are awarded.
  - Name and address of the agencies and/or other parties supporting the other research projects
  - Period of performance for the other research projects.

Additional senior/key persons can be added by selecting the “Next Person” button at the bottom of the form. Note that, although applications without this information completed may pass Grants.gov edit checks, if DARPA receives an application without the required information, DARPA may determine that the application is incomplete and may cause your submission to be rejected and eliminated from further review and consideration under the solicitation. DARPA reserves the right to request further details from the applicant before making a final determination on funding the effort.

*Form 3: Research and Related Personal Data*, available on the Grants.gov website at [https://apply07.grants.gov/apply/forms/sample/RR\\_PersonalData\\_1\\_2-V1.2.pdf](https://apply07.grants.gov/apply/forms/sample/RR_PersonalData_1_2-V1.2.pdf). *Each applicant must complete the name field of this form, however, provision of the demographic information is*

*voluntary. Regardless of whether the demographic fields are completed or not, this form must be submitted with at least the applicant's name completed.*

Grants.gov Submissions: Grants.gov requires proposers to complete a one-time registration process before a proposal can be electronically submitted. First-time registration can take between three business days and four weeks. For more information about registering for Grants.gov, see <http://www.darpa.mil/work-with-us/additional-baa>.

**Proposal abstracts will not be accepted if submitted via Grants.gov.**

Hard-copy Submissions: Proposers electing to submit cooperative agreement proposals as hard copies must complete the SF 424 R&R form (Application for Federal Assistance,) available on the Grants.gov website ([https://apply07.grants.gov/apply/forms/sample/SF424\\_2\\_1-V2.1.pdf](https://apply07.grants.gov/apply/forms/sample/SF424_2_1-V2.1.pdf)).

Failure to comply with the submission procedures may result in the submission not being evaluated. DARPA will acknowledge receipt of complete submissions via e-mail and assign control numbers that should be used in all further correspondence regarding proposals.

**4.3. FUNDING RESTRICTIONS**

Not applicable.

**4.4. OTHER SUBMISSION INFORMATION**

DARPA will post a consolidated Frequently Asked Questions (FAQ) document. To access the posting go to <http://www.darpa.mil/work-with-us/opportunities>. A link to the FAQ will appear under the HR001121S0035 summary. Submit your question(s) via e-mail to [EMBER@darpa.mil](mailto:EMBER@darpa.mil).

**5. Application Review Information**

**5.1. EVALUATION CRITERIA**

Proposals will be evaluated using the following criteria, listed in descending order of importance: 5.1.1 Overall Scientific and Technical Merit; 5.1.2 Potential Contribution and Relevance to the DARPA Mission; 5.1.3 Cost Realism; and 5.1.4 Proposer's Capability and/or Related Experience.

**5.1.1. Overall Scientific and Technical Merit**

The proposed technical approach is innovative, feasible, achievable, and complete.

The proposed technical team has the expertise and experience to accomplish the proposed tasks. Task descriptions and associated technical elements provided are complete and in a logical sequence with all proposed deliverables clearly defined such that a final outcome that achieves the goal can be expected as a result of award. The proposal identifies major technical risks, and planned mitigation efforts are clearly defined and feasible. The timeline for achieving major milestones is aggressive but rationally supported with a clear description of the requirements and risks. The proposer's prior experience in similar efforts must clearly demonstrate an ability to

deliver products that meet the proposed technical performance within the proposed budget and schedule.

### **5.1.2. Potential Contribution and Relevance to the DARPA Mission**

The potential contributions of the proposed effort are relevant to the national technology base. Specifically, DARPA's mission is to make pivotal early technology investments that create or prevent strategic surprise for U.S. National Security.

The proposer clearly describes the potential to transition the technology to the research, industrial, and/or operational military communities in such a way as to enhance U.S. defense and reduce supply chain vulnerabilities. The evaluation will also take into consideration the extent to which the proposed intellectual property (IP) rights will potentially impact the Government's ability to transition the technology.

### **5.1.3. Cost Realism**

The proposed costs are realistic for the technical and management approach and accurately reflect the technical goals and objectives of the solicitation. The proposed costs are consistent with the proposer's Statement of Work and reflect a sufficient understanding of the costs and level of effort needed to successfully accomplish the proposed technical approach. The costs for the prime proposer and proposed subawardees are substantiated by the details provided in the proposal (e.g., the type and number of labor hours proposed per task, the types and quantities of materials, equipment and fabrication costs, travel and any other applicable costs and the basis for the estimates).

It is expected that the effort will leverage all available relevant prior research in order to obtain the maximum benefit from the available funding. For efforts with a likelihood of commercial application, appropriate direct cost sharing may be a positive factor in the evaluation. DARPA recognizes that undue emphasis on cost may motivate proposers to offer low-risk ideas with minimum uncertainty and to staff the effort with junior personnel in order to be in a more competitive posture. DARPA discourages such cost strategies.

### **5.1.4. Proposer's Capability and/or Related Experience**

The proposer's prior experience in similar efforts clearly demonstrates an ability to deliver products that meet the proposed technical performance within the proposed budget and schedule. The proposed team has the expertise to execute the proposed technical effort as well as manage the cost and schedule. Similar or related efforts completed/ongoing/pending by the proposer in this area are fully described, including identification of other Government sponsors.



## **5.2. REVIEW OF PROPOSALS**

### **Review Process**

It is the policy of DARPA to ensure impartial, equitable, comprehensive proposal evaluations based on the evaluation criteria listed in Section 5.1 and to select the source (or sources) whose offer meets the Government's technical, policy, and programmatic goals.

DARPA will conduct a scientific/technical review of each conforming proposal. Conforming proposals comply with all requirements detailed in this solicitation; proposals that fail to do so may be deemed non-conforming and may be removed from consideration. Proposals will not be evaluated against each other since they are not submitted in accordance with a common work statement. DARPA's intent is to review proposals as soon as possible after they arrive; however, proposals may be reviewed periodically for administrative reasons.

Award(s) will be made to proposers whose proposals are determined to be the most advantageous to the Government, consistent with instructions and evaluation criteria specified in the BAA herein, and availability of funding.

### **Handling of Source Selection Information**

DARPA policy is to treat all submissions as source selection information (see FAR 2.101 and 3.104) and to disclose their contents only for the purpose of evaluation. Restrictive notices notwithstanding, during the evaluation process, submissions may be handled by support contractors for administrative purposes and/or to assist with technical evaluation. All DARPA support contractors performing this role are expressly prohibited from performing DARPA-sponsored technical research and are bound by appropriate non-disclosure agreements.

Subject to the restrictions set forth in FAR 37.203(d), input on technical aspects of the proposals may be solicited by DARPA from non-Government consultants/experts who are strictly bound by the appropriate non-disclosure requirements.

### **Federal Awardee Performance and Integrity Information (FAPIIS)**

Per 41 U.S.C. § 2313, as implemented by FAR 9.103 and 2 C.F.R. § 200.205, prior to making an award above the simplified acquisition threshold, DARPA is required to review and consider any information available through the designated integrity and performance system (currently FAPIIS). Awardees have the opportunity to comment on any information about themselves entered in the database, and DARPA will consider any comments, along with other information in FAPIIS or other systems, prior to making an award.

## **6. Award Administration Information**

### **6.1. SUBMISSION STATUS NOTIFICATIONS**

Proposal Abstracts and Full Proposals submitted in response to HR001121S0035 will be evaluated as they are received. DARPA will respond as described below. These official notifications will be sent via e-mail to the Technical POC and/or Administrative POC identified on the submission coversheet.



### **6.1.1. Proposal Abstracts**

DARPA will respond to abstracts with a statement as to whether DARPA is interested in the idea. If DARPA does not recommend the proposer submit a full proposal, DARPA will provide feedback to the proposer regarding the rationale for this decision. Regardless of DARPA's response to an abstract, proposers may submit a full proposal. DARPA will review all conforming full proposals using the published evaluation criteria and without regard to any comments resulting from the review of an abstract.

### **6.1.2. Full Proposals**

As soon as the evaluation of all proposals is complete, the proposer will be notified that (1) the proposal has been selected for funding pending award negotiations, in whole or in part; or (2) the proposal has not been selected.

## **6.2. ADMINISTRATIVE AND NATIONAL POLICY REQUIREMENTS**

### **6.2.1. Meeting and Travel Requirements**

There will be a program kickoff meeting and semi-annual program-wide meetings either held virtually or in the Washington, D.C. metropolitan area, that all key participants are required to attend. Proposers shall include within the content of their proposal details and costs of any travel or meetings they deem to be necessary throughout the course of the effort. Performers should anticipate monthly meetings by teleconference, in-person program reviews, and, provided no travel restrictions, at least annual site visits by DARPA Program Manager and/or Government team.

### **6.2.1. Solicitation Provisions and Award Clauses, Terms and Conditions**

Solicitation clauses in the FAR and DFARS relevant to procurement contracts and FAR and DFARS clauses that may be included in any resultant procurement contracts are incorporated herein and can be found at <http://www.darpa.mil/work-with-us/additional-baa>.

### **6.2.2. Controlled Unclassified Information (CUI) and Controlled Technical Information (CTI) on Non-DoD Information Systems**

Further information on Controlled Unclassified Information on Non-DoD Information Systems is incorporated herein can be found at <http://www.darpa.mil/work-with-us/additional-baa>.

### **6.2.3. Representations and Certifications**

In accordance with FAR 4.1102 and 4.1201, proposers requesting a procurement contract must complete electronic annual representations and certifications at <https://www.sam.gov/>.

In addition, all proposers are required to submit for all award instrument types supplementary DARPA-specific representations and certifications at the time of proposal submission. See <http://www.darpa.mil/work-with-us/rebs-certs> for further information on required representation and certification depending on your requested award instrument.

### **6.2.4. Terms and Conditions**

For terms and conditions specific to grants and/or cooperative agreements, see the DoD General Research Terms and Conditions (latest version) at <http://www.onr.navy.mil/Contracts-Grants/submit-proposal/grants-proposal/grants-terms-conditions> and the supplemental DARPA-

specific terms and conditions at <http://www.darpa.mil/work-with-us/contract-management#GrantsCooperativeAgreements>.

### **6.3. REPORTING**

The number and types of reports will be specified in the award document, but will include as a minimum monthly financial status reports, monthly technical status reports, and quarterly technical status reports. The reports shall be prepared and submitted in accordance with the procedures contained in the award document and mutually agreed on before award. Reports and briefing material will also be required as appropriate to document progress in accomplishing program metrics. A Final Report that summarizes the project and tasks will be required at the conclusion of the performance period for the award, notwithstanding the fact that the research may be continued under a follow-on vehicle.

### **6.4. ELECTRONIC SYSTEMS**

#### **6.4.1. Wide Area Work Flow (WAWF)**

Performers will be required to submit invoices for payment directly to <https://wawf.eb.mil>, unless an exception applies. Performers must register in WAWF prior to any award under this BAA.

#### **6.4.2. I-EDISON**

The award document for each proposal selected for funding will contain a mandatory requirement for patent reports and notifications to be submitted electronically through i-Edison (<http://public.era.nih.gov/iedison>).

## **7. Agency Contacts**

Administrative, technical or contractual questions should be sent via e-mail to the mailbox listed below.

#### Points of Contact

The BAA Coordinator for this effort may be reached at:

[EMBER@darpa.mil](mailto:EMBER@darpa.mil)

DARPA/BTO

ATTN: HR001121S0035

675 North Randolph Street

Arlington, VA 22203-2114

For information concerning agency level protests see <http://www.darpa.mil/work-with-us/additional-baa#NPRPAC>.

## **8. Other Information**

The Biological Technologies Office (BTO) of the Defense Advanced Research Projects Agency (DARPA) will host a virtual Proposer's Day for the potential proposer community in support of this Broad Agency Announcement (BAA) for the EMBER (Environmental Microbes as a

BioEngineering Resource) Program on or about July 27, 2021. A link to the Special Notice announcing this Proposer's Day, as well as information relayed during the event, will be made available on the BTO section of the DARPA Opportunities page: <http://www.darpa.mil/work-with-us/opportunities>. Attendance at this event is not a requirement for submission of an abstract, proposal or selection for funding. To maximize the pool of innovative proposal concepts, DARPA strongly encourages participation by non-traditional performers (e.g., small businesses, academic and research institutions, and first-time Government contractors).

The Proposer's Day goals will include:

1. Introduce the EMBER program vision and goals to the research community;
2. Explain the mechanics of a DARPA program in general and the objectives and milestones of this program in particular; and
3. Encourage and promote teaming arrangements among organizations that have the relevant expertise, research facilities, and capabilities for executing research and development responsive to the EMBER program goals.

The Proposer's Day will include brief overview presentations by government personnel as well as an information session to respond to questions from participants. Potential performers will be able to highlight their technical capabilities through "lightning" talks such that teaming relationships can be developed. It is expected that EMBER will require strong teaming efforts to successfully innovate and integrate critical technologies necessary to meet the metrics of the program. Potential performers will be able to publish profiles of their expertise and sought-after capabilities for prospective teammates to establish partnerships.

Proposers Day Point of Contact:  
[DARPA-SN-21-32@darpa.mil](mailto:DARPA-SN-21-32@darpa.mil)  
ATTN: DARPA-SN-21-32

**9. APPENDIX 1 – List of Attachments**

**Attachment 1 – CUI Guide**

**Attachment 2 – CUI Management Plan**

**Attachment 3 – SOW Template**

**Attachment 4 – Executive Summary Slide for ABSTRACT**

**Attachment 5 – Executive Summary Slide for Full Proposal**

**Attachment 6 – MS Excel Cost Proposal Template**

## 10. APPENDIX 2 – Volume II checklist

### Volume II, Cost Proposal Checklist and Sample Templates

**The following checklist and sample templates are provided to assist the proposer in developing a complete and responsive cost volume. Full instructions appear in Section 4.2.2 of HR001121S0035. This worksheet must be included with the coversheet of the Cost Proposal.**

1. Are all items from Section 4.2.2 (Volume II, Cost Proposal) of **HR001121S0035** included on your Cost Proposal cover sheet?

**YES**       **NO**      **Appears on Page(s)** [Type text]

If reply is “No”, please explain:

2. Does your Cost Proposal include (1) a summary cost buildup by Phase, (2) a summary cost buildup by Year, and (3) a detailed cost buildup of for each Phase that breaks out each task and shows the cost per month?

**YES**       **NO**      **Appears on Page(s)** [Type text]

If reply is “No”, please explain:

3. Does your cost proposal (detailed cost buildup #3 above in item 2) show a breakdown of the major cost items listed below:

Direct Labor (Labor Categories, Hours, Rates)

**YES**       **NO**      **Appears on Page(s)** [Type text]

Indirect Costs/Rates (i.e., overhead charges, fringe benefits, G&A)

**YES**       **NO**      **Appears on Page(s)** [Type text]

Materials and/or Equipment

**YES**       **NO**      **Appears on Page(s)** [Type text]

Subcontracts/Consultants

**YES**       **NO**      **Appears on Page(s)** [Type text]

Other Direct Costs

**YES**       **NO**      **Appears on Page(s)** [Type text]

Travel

**YES**       **NO**      **Appears on Page(s)** [Type text]

If reply is “No”, please explain:

4. Have you provided documentation for proposed costs related to travel, to include purpose of trips, departure and arrival destinations and sample airfare?

- YES**       **NO**      **Appears on Page(s)** [Type text]

If reply is "No", please explain:

5. Does your cost proposal include a complete itemized list of all material and equipment items to be purchased (a priced bill-of-materials (BOM))?

- YES**       **NO**      **Appears on Page(s)** [Type text]

If reply is "No", please explain:

6. Does your cost proposal include vendor quotes or written engineering estimates (basis of estimate) for all material and equipment with a unit price exceeding \$5000?

- YES**       **NO**      **Appears on Page(s)** [Type text]

If reply is "No", please explain:

7. Does your cost proposal include a clear justification for the cost of labor (written labor basis-of-estimate (BOE)) providing rationale for the labor categories and hours proposed for each task?

- YES**       **NO**      **Appears on Page(s)** [Type text]

If reply is "No", please explain:

8. Do you have subcontractors/consultants? If YES, continue to question 9. If NO, skip to question 13.

- YES**       **NO**      **Appears on Page(s)** [Type text]

9. Does your cost proposal include copies of all subcontractor/consultant technical (to include Statement of Work) and cost proposals?

- YES**       **NO**      **Appears on Page(s)** [Type text]

If reply is "No", please explain:

10. Do all subcontract proposals include the required summary buildup, detailed cost buildup, and supporting documentation (SOW, Bill-of-Materials, Basis-of-Estimate, Vendor Quotes, etc.)?

- YES**       **NO**      **Appears on Page(s)** [Type text]

If reply is "No", please explain:

11. Does your cost proposal include copies of consultant agreements, if available?

- YES**       **NO**      **Appears on Page(s)** [Type text]

If reply is "No", please explain:

12. If requesting a FAR-based contract, does your cost proposal include a tech/cost analysis for all proposed subcontractors?

- YES**       **NO**      **Appears on Page(s)** [Type text]

If reply is "No", please explain:

13. Have all team members (prime and subcontractors) who are considered a Federally Funded Research & Development Center (FFRDC), included documentation that clearly demonstrates work is not otherwise available from the private sector AND provided a letter on letterhead from the sponsoring organization citing the specific authority establishing their eligibility to propose to government solicitations and compete with industry, and compliance with the associated FFRDC sponsor agreement and terms and conditions.

**YES**       **NO**      **Appears on Page(s)** [Type text]

If reply is “No”, please explain:

14. Does your proposal include a response regarding Organizational Conflicts of Interest?

**YES**       **NO**      **Appears on Page(s)** [Type text]

If reply is “No”, please explain:

15. Does your proposal include a completed Data Rights Assertions table/certification?

**YES**       **NO**      **Appears on Page(s)** [Type text]

If reply is “No”, please explain: