Biological and Environmental Research

Overview

The Biological and Environmental Research (BER) program's basic research portfolio is poised for rapid advancement and leadership in key scientific innovations vital to America's energy expansion and economic prosperity, fully aligned with Departmental and Administration priorities for Artificial Intelligence (AI), Quantum Information Science (QIS) and securing Critical Minerals and Materials (CMM) for the Nation. The Genesis Mission goal is to double the productivity and impact of American research within a decade, which includes pursuing pathbreaking advances in BER's science. In partnership with industry, BER will target the challenges most vital to ensure that America leads the global race in AI-enabled biotechnology. BER's earth-energy-biological systems models are becoming faster, more precise, and purpose-driven through AI methodologies. BER data systems are open, curated, and increasingly integrated and AI ready in support of the Genesis Mission. AI together with targeted laboratory and modeling research innovate new approaches to securing CMM. BER's QIS research is developing revolutionary methods to image and sense biological and material properties at unprecedented resolution and with reduced damage opening new technological advances.

BER's mission is to support transformative science and scientific user facilities to achieve a predictive understanding of complex biological and earth systems, supporting DOE's vision to advance innovative solutions for the Nation's energy, economic and national security challenges. BER's fundamental research, conducted at DOE national laboratories, research institutions and in partnership with industry, plays a unique role in ensuring national leadership in biotechnology innovation and in the ability to understand and predict the interdependencies involving energy and the environment over a wide range of conditions. Biology remains a vast, largely untapped resource of genomic potential and BER science unlocks the fundamental drivers of processes within microorganisms, plants, and microbiomes. AI assists researchers to harness the power of biology and discover, understand, design, and build new biosystems. BER is pioneering self-reinforcing AI capabilities integrated with automated experimental systems and trained on world-class datasets to dramatically accelerate biotechnology innovation. The experimental data feeds back into AI systems to progressively train the models, with the potential to gain unprecedented insight into biological function and design across species. Advanced AI methods include developing techniques to synthesize new experimental data in the context of previously published information in order pose new hypotheses for additional research. Through AI, DOE is poised to vastly expand biotechnology's potential for the Nation, including designs of novel proteins, cells, microbes, plants and microbiomes for next generation fuels, chemicals, and materials, the efficient recovery of CMM, enhancement of soils, and design of robust plants.

Earth and environmental research leverages AI and computationally advanced modeling to enhance predictability of integrated energy, biological, and earth systems. DOE's Energy Exascale Earth System Model (E3SM) is supplemented with detailed atmospheric and terrestrial observations and curated data for initialization, parameterization, and validation. AI methods enable modeling of finer spatial scales, enhance accuracy, increase simulation speeds and allow for integration of earth and energy sector models. The predictive models are increasingly skillful to provide energy stakeholders with key information to ensure resiliency to power grid vulnerabilities and to expand U.S. energy dominance.

Over the past three decades, BER's scientific impact has been transformative and world leading, beginning with the DNA sequencing revolution that evolved from the Human Genome Project in the 1990's to more recent developments in genome editing technology (CRISPR) and AI breakthroughs in computational protein design. Focused on non-biomedical microorganisms, plants, and ecosystems, BER science fills a unique niche among federal basic science agencies by addressing the most pressing energy and national security challenges. BER has also been a critical contributor to fundamental earth science, tackling grand challenges in atmospheric and

terrestrial science and developing DOE's flagship E3SM with careful coupling to energy system models targeting the needs of the energy sector.

BER's Scientific Joint Genome Institute (JGI) and the Environmental Molecular Science Laboratory (EMSL) user facilities, data, and experimental capabilities are advancing through AI innovation, using novel approaches to autonomous experimentation for genomic and molecular sciences and for rapid processing and analysis of data streams. BER supports the Genesis Mission by building an open, accessible, curated, federated AI Biodata Network vital for biotechnology advances. BER's bioimaging and quantum-science efforts in imaging and sensing, data analytics, and computational modeling are using AI to rapidly provide visual and calculated validation to experimental results. These advances may unlock the ability to not only understand but rapidly re-design biological systems. Biodesign innovations in biotechnology, biofuels, biochemicals, and bioproducts are pursued in the Bioenergy Research Centers (BRCs), expanding options for plant biomass.

Highlights of the FY 2027 Request

The BER FY 2027 Request of $396.0 million is a decrease of $458.0 million below the FY 2026 Enacted level. Aligned with the Genesis Mission, BER is integrating AI across its research portfolio and user facilities to accelerate biotechnology innovation. BER is developing AI automated experimental workflows, an AI Biodata Network, data analytics, and foundation modeling for genomics, microbial and plant biotechnology integrated with the SC-wide American Science Cloud and Modeling Consortium activities. A new Plant Transformation Capability (PTC) project starts at Lawrence Berkeley National Laboratory's (LBNL) JGI that will support the Genesis Mission as it leverages AI to rapidly automate plant gene editing. A complementary new grand challenge biotechnology initiative seeks to efficiently design and incorporate large DNA sequences into plants spurring game changing innovation and supporting America's global leadership in biotechnology. BER will prioritize efforts in QIS for bioimaging and sensing applications. BER continues biosystems design research for CMM extraction, recovery, and design of alternative forms of minerals and materials, using AI to accelerate this vital research to mitigate domestic supply chain constraints.

<u>Research</u>

- Genomic Sciences continues foundational research on microbial, plant, and microbiome systems. Reductions to the portfolio focus efforts on Administration priorities. The BRCs will focus research both individually and through shared themes, underpinning energy and biotechnology innovations and biological production of fuels, chemicals, and other products.
- Computational Biosciences efforts are consolidated as BER shifts to include a more AI -centric approach to genomic science and to develop integrated approaches to analyzing genomic and ecosystem data across platforms and user facilities. As a critical component of the Genesis Mission, and in partnership with industry, AI for biotechnology is developing the AI Biodata Network interconnected with automated laboratories together with foundation models for rapid discovery and design for proteins, microbial, and plant systems.
- Research in Biomolecular Characterization and Imaging Science will focus on QIS-enabled techniques to visualize and develop new sensing capabilities to understand biological processes while minimizing damage to samples.
- Bio-inspired CMM research will continue to support fundamental research to augment or enhance microbes and plants, using synthetic biology approaches to selectively remove or concentrate CMM from source materials and/or dilute solutions. CMM will also explore the biosynthesis of new minerals and materials capable of replacing existing CMMs to provide sustainable, lower-energy manufacturing options.
- Earth and environmental modeling is focused on developing an AI-driven hyper-resolution predictive system for integrated energy and earth systems, including the AI-enhanced E3SM model, to address key uncertainties affecting the ability to predict seasonal (weeks) and near-term (years) water availability for

energy needs. These models continue to benefit from new software and computational advances, atmospheric and terrestrial process research, curated and open data, and field work with a particular focus on regional case studies that target science, energy, or national security challenges.

Facility Operations

- JGI continues to transition towards a more AI-centric user facility by reorganizing its data resources into an AI Biodata Network, thereby facilitating AI analysis while continuing to deliver high-quality genome sequencing and innovative analysis techniques for complex plant and microbiome samples. Consolidating data analytics while integrating and standardizing data workflows will enable seamless aggregation and harmonization of genomic data, ensuring that users benefit from cutting-edge AI-powered insights and streamlined access to comprehensive analytical capabilities.
- EMSL develops integrated analyses across multiple analytical capabilities to advance biological and environmental science to uncover the biochemical pathways connecting gene functions to complex biological responses and develop predictive understanding of the mechanistic interplay of physical, environmental and biological processes. EMSL supports the Genesis Mission through use of AI workflows, data analytics, visualization, computational modeling, and AI techniques applied to phenotyping anaerobic microbes in field sites distributed across the U.S.
- The Atmospheric Radiation Measurement (ARM) user facility completes all campaigns and is closed.

Projects

- The FY 2027 Request includes $35.0 million to continue the Microbial Molecular Phenotyping Capability (M2PC) project at the Pacific Northwest National Laboratory (PNNL).

Biological and Environmental Research
Funding

(dollars in thousands)

	FY 2025 Enacted	FY 2026 Enacted	FY 2027 Request	FY 2027 Request vs FY 2026 Enacted
Biological and Environmental Research				
Genomic Science	340,900	260,404	136,142	-124,262
Biomolecular Characterization and Imaging Science	45,750	47,000	33,487	-13,513
Biological Systems Facilities & Infrastructure	95,127	97,596	101,900	+4,304
Total, Biological Systems Science	**481,777**	**405,000**	**271,529**	**-133,471**
Atmospheric System Research	28,656	39,500	–	-39,500
Environmental System Sciences	82,800	96,000	–	-96,000
Earth and Environmental Systems Modeling	109,281	118,500	28,968	-89,532
Earth and Environmental Systems Sciences Facilities and Infrastructure	148,486	176,000	60,470	-115,530
Total, Earth and Environmental Systems Sciences	**369,223**	**430,000**	**89,438**	**-340,562**
Subtotal, Biological and Environmental Research	**851,000**	**835,000**	**360,967**	**-474,033**
Construction				
24-SC-31 Microbial Molecular Phenotyping Capability (M2PC), PNNL	19,000	19,000	35,000	+16,000
Subtotal, Construction	**19,000**	**19,000**	**35,000**	**+16,000**
Total, Biological and Environmental Research	**870,000**	**854,000**	**395,967**	**-458,033**

(dollars in thousands)

	FY 2027 Request vs FY 2026 Enacted
Biological Systems Science	**-$133,471**

Within Genomic Sciences, the Request reduces lower priority efforts while focusing support on the Genesis Mission and integrating AI to accelerate biotechnology innovation and CMM recovery and supporting key quantum science research for imaging and sensing to align with Administration priorities. Foundational genomics will reduce and focus the portfolio on core elements of basic microbial and plant biosystems design research to underpin and accelerate biotechnology development. CMM will focus on key biodesign efforts to enhance microbial and plant abilities to recover, separate, and concentrate on critical elements from the environment. The BRCs focus on resolving remaining fundamental research challenges to producing fuels, chemicals, and other products from plant biomass. A new biotechnology initiative will advance the ability to design large sequences of DNA to be incorporated into plants to spur plant biotechnology for bioenergy and a broader bioeconomy. Computational Bioscience continues to integrate AI techniques across the research portfolio, within open-access AI Biodata Network and computational platforms for genomic analyses, and among BER user facilities. Environmental Genomics will reduce and prioritize plant and microbiome biotechnology. Biomolecular Characterization and Imaging Science research will reduce characterization and structural biology capabilities, de-emphasize multimodal classical bioimaging science, and focus on quantum-science enabled imaging and sensing concepts. JGI will prioritize user-initiated genome sequence production support and data infrastructure reorganization for AI. Other project costs are requested for a new PTC project at LBNL.

Earth and Environmental Systems Sciences	**-$340,562**

All BER programmatic activities involving earth and environmental systems sciences are funded under earth system modeling. The consolidation includes the environmental system sciences, atmospheric system research, earth system modeling, and data management. The Atmospheric Radiation Measurement (ARM) User Facility completes all campaigns and will close. Earth system modeling will focus on harnessing AI to accelerate, enhance and couple BER's suite of exascale class and multi-sector dynamics models and integrate atmospheric and environmental field observations to enhance weeks to years predictive skill for energy expansion. This integrated system will be applied to specific target regions where energy expansion is envisioned and are particularly sensitive to variable environmental conditions such as water availability, ice storms and within the Arctic.

	(dollars in thousands) FY 2027 Request vs FY 2026 Enacted
The EMSL User Facility will focus on biological and environmental molecular science, including further preparation of new AI-driven automated technologies for microbial molecular phenotyping. EMSL's experimental and analytic efforts support BER priorities in biotechnology and critical mineral extraction with biology, using AI analytics and laboratory automation to advance biosystems discovery.	
Construction Construction of the facility and procurement of the high-throughput phenotyping equipment will continue for the M2PC at PNNL.	**+$16,000**
Total, Biological and Environmental Research	**-$458,033**

Basic and Applied R&D Coordination

BER research underpins the needs of DOE's energy and environmental missions and is coordinated through internal DOE mechanisms, and more broadly through the National Science and Technology Council (NSTC) and other committees of the Office of Science and Technology Policy (OSTP). BER research includes biological and environmental systems investments in theoretical, experimental, predictive modeling research, and science supporting energy expansion. Basic research on genomics, microbes and plants provides fundamental knowledge that can be used to develop new biotechnology innovations in bioenergy and bioproduct production processes that enhance the economy. Coordination with other federal agencies on priority biotechnology science occurs through the Biomass Research and Development Board, a Congressionally mandated interagency group created by the Biomass Research and Development Act of 2000, as amended by the Energy Policy Act of 2005 and the Agricultural Act of 2014. BER coordinates with DOE's applied energy offices through regular joint DOE working groups, program manager meetings, the Critical Minerals Collaborative (CMC), and by participating in internal program reviews and in joint principal investigator meetings and technical workshops.

BER supports interagency projects to manage databases (such as the Protein Data Bank) through interagency awards and funding for complementary community resources (such as beamlines and cryo-electron microscopy), particularly with NIH and NSF. BER is a member of the advisory committee for DoW's BioMADE project researching synthetic biology applications. BER seeks to partner across agencies to build federated biological databases vital to Genesis and U.S. leadership in biotechnology.

Program Accomplishments

- *Dataset helps decode fungal genomes.* Researchers at the JGI have assembled a massive dataset on the diversity and functional potential of over 2000 fungi gleaned from over 200 publications. Fungi harbor unique metabolic capabilities with numerous applications in bioenergy and biomanufacturing and the new dataset will serve as a resource for deep machine learning and AI algorithms to decipher fungal genomes. The work dovetails with ongoing efforts to assemble broader AI-ready datasets at the JGI.
- *Accelerated enzyme engineering.* Using an AI-enabled approach to help guide enzyme engineering, researchers at Northwestern University combined cell-free gene expression, DNA assembly, and functional assays to design optimized enzymes for distinct chemical reactions. The new AI technique tracks changes in protein sequence that link to function to converge on an optimized enzyme activity opening design pathways to explore new-to-nature enzymes, a key focus of a rapidly expanding biotechnology sector.
- *Progress towards whole cell mechanistic models.* A major drawback to simulating metabolic processes in cells is the sparse availability of kinetic data on which to describe biochemical reactions. The Center for Bioenergy Innovation (CBI) developed a new deep learning method (CatPred) that uses protein language models and three-dimensional protein structures to predict enzyme kinetics. The new AI-based method assigns functions and kinetic parameters to genes of unknown function, a key step towards a mechanistic understanding of biology from genome principles.
- *New plant transformation method.* Plant species harbor some of the largest genomes and are a significant source of untapped genomic potential for economically important products, fuels, chemicals, and materials. Bottlenecks in plant biotechnology are a lack of efficient, cheap, and broadly applicable methods to edit the genomes. Researchers at UC Los Angeles, UC Berkeley, and LBNL overcame barriers by developing a method using a plant virus to deliver CRISPR gene editing components into the plant genome.

- *Improved predictions of elemental cycling across complex soil types.* Using data from EMSL's Molecular Observing Network (MONet), scientists applied an AI algorithm based on molecular composition of soil organic matter, resulting in dramatically improved predictions of elemental cycling in U.S. soil systems. The new science informs the dynamics and biogeochemistry governing the fate and transport of trace compounds and legacy waste.
- *Causal understanding of thunderstorm dynamics.* Using multi-year multi-instrument observational datasets, researchers applied causal discovery models to reveal how different atmospheric conditions affect the height at which storm clouds stop rising and begin to spread out. Explicitly describing the causal pathways instead of using correlation-based approaches paves the way to dramatically improved representations of processes in earth system models and next-generation machine learning frameworks.
- *Revolutionary insights into coastal atmospheric processes with AI.* The DOE TRACER experiment and coordinated campaigns (2021-2022) in southeastern Texas created an unprecedented dataset on aerosol, cloud, convection, and surface gradient interactions in a populated energy-intensive coastal environment. Outcomes included AI-driven insights into convective updrafts, identification of distinct aerosol composition regimes and frequent new and unexpected particle formation, quantification of sea breeze impacts on convection, and testing aerosol-convection invigoration theories. Results led to significantly improved predictions of environmental impacts on energy infrastructure in populated coastal regions.
- *Incorporating AI in high resolution Earth system and energy predictions.* Scientists developing DOE's Energy Exascale Earth System Model achieved a breakthrough with the release of an AI emulator that operates at 100X the speed of previous capabilities. Model simulations were conducted at the DOE NERSC computing facility to enable scientific discoveries to inform the design and deployment of the suite of emerging energy infrastructures.

Description

The Biological Systems Science subprogram supports the DOE Genesis Mission through integration of AI capabilities with advanced genomics research and user facility capabilities to greatly accelerate the ability to understand the largely undiscovered complexity and potential of biology. Science focuses on plant, microbial and microbiome systems and includes assembly of increasingly vast genomic datasets driven by increasingly capable AI capabilities to accelerate the understanding and design of biology. The activity also targets breakthrough discoveries in critical mineral and material (CMM) extraction and in quantum sensing and imaging as part of BER's Quantum Information Science (QIS) efforts. These investments focus on advancing U.S. leadership in biotechnology innovation relevant to DOE missions in energy, biomanufacturing and biosecurity.

Genomic Science

The Genomic Science activity supports basic research in Foundational Genomics, Bioenergy, Environmental Genomics, Computational Bioscience and includes CMM research and development of new AI capabilities for genomic science. This activity addresses the grand challenges necessary to efficiently design new biosystems and advance biotechnology.

Foundational Genomics supports basic research to understand the organization, regulation and expression of genes in plants and microorganisms to enable the design of biological processes tailored to specific DOE mission applications. Efforts support the Genesis Mission through development of self-reinforcing AI systems coupled to automated experimental labs to accelerate the ability to design biomolecules, metabolic pathways, cells, microbiomes and plants from genome-based, first principles. This leads to the understanding, prediction and design of biological processes to produce a range of bioproducts and bioprocesses. A new initiative supports the Genesis Mission, as it seeks efficient design of synthetic plant chromosomes, a crucial breakthrough that if realized would transform plant biotechnology. Efforts continue to design microbes and plants with enhanced capabilities to scavenge and sequester key CMMs, such as rare earth elements.

The DOE Bioenergy Research Centers (BRCs) address basic science bottlenecks impeding the ability to convert inedible lignocellulosic biomass grown on underutilized lands to biofuels, chemicals, materials, and other bioproducts. These multi-disciplinary, multi-institutional centers accelerate the scientific groundwork necessary for biomanufacturing and biotechnology innovation to ensure domestic supply chains of critical commodity products that can be produced from plant-based resources. The BRCs partner with and spawn new start-up efforts to move basic research concepts to industry.

Environmental Genomics supports research to understand functional genomics in plants and microbial communities. The research seeks to understand plant and microbial processes in the lab and the environment as a foundation on which to learn how to engineer microbial communities and plant-microbe interactions for specific industrial and/or environmental purposes relevant to bioenergy and bioproduct development.

Computational Biosciences supports on-line, open access bioinformatics and modeling capabilities within the DOE Systems Biology Knowledgebase (KBase) and the National Microbiome Data Collaborative (NMDC). These integrated resources together with new AI capabilities, support large-scale collaborative genomic science investigations of plant and microbial systems to reveal insights into biological processes and new biosystems designs. Efforts continue to integrate these data resources together with the Joint Genome Institute (JGI), the Environmental Molecular Sciences Laboratory (EMSL) and other DOE Laboratory data into an open-access, curated AI-Biodata Network to create the high-quality datasets needed to train AI models. Efforts continue on

new AI-driven automated laboratory systems to accelerate the design of biomolecules, microbes and plants. These activities directly support the Genesis Mission, including DOE's American Science Cloud (AmSc) and Model Consortium (ModCon), leading to accelerated discovery and biosystems design.

Biomolecular Characterization and Imaging Science

Biomolecular characterization and imaging science supports integrative approaches, including QIS-enabled efforts, to detect, visualize, and measure biological processes *in-situ* and gain a predictive understanding of cellular function, critical for advanced genomics research and biotechnology development. This activity will emphasize innovative QIS-enabled research on sensors and sensing capabilities that are key to observing biological systems with minimal damage.

Biological Systems Facilities and Infrastructure

The DOE JGI user facility is the only federally funded major genome sequencing center focused on genome discovery and analysis in plants and microbes for energy, biotechnology, and environmental research. This scientific user facility provides high-throughput DNA sequencing and analysis capabilities for plants, microorganisms, and microbial communities from samples obtained within the U.S. (including from Federal lands) and worldwide as a foundational source of genomic data for BER's genomic science research efforts. JGI will continue efforts coordinated with KBase, NMDC, and EMSL to organize its vast genomic data resources into an open access AI Biodata Network suitable to facilitate broader integration of AI into genomic research in support of the Genesis Mission. The new data and burgeoning AI capability will efficiently provide the vast high-quality datasets needed to train advanced AI capabilities to accelerate an unprecedented understanding of biological complexity across species with game changing implications for DOE efforts in energy, economy, and national security with far-reaching implications for health and agriculture as well. A new Plant Transformation Capability (PTC) project starts at LBNL.

Activities and Explanation of Changes

(dollars in thousands)

FY 2026 Enacted	FY 2027 Request	Explanation of Changes FY 2027 Request vs FY 2026 Enacted
Biological Systems Science **$405,000**	**$271,529**	**-$133,471**
Genomic Science $260,404	$136,142	-$124,262
Funding supports Foundational Genomics priorities in fundamental systems biology research on plants and microorganisms. Funding continues to support biotechnology innovation and accelerate biosystems design efforts. Additionally, efforts in CMM research narrow focus on key synthetic biology objectives to explore designing plants and microorganisms for extraction and recovery of critical elements.	The Request for Foundational Genomics will prioritize AI-enabled fundamental systems biology research on plants and microorganisms supporting biotechnology innovation and accelerating biosystems design efforts. Efforts in CMM research will focus on key synthetic biology designs for plants and microorganisms to extract and recover critical elements. Efforts will be initiated to explore how to construct a synthetic plant chromosome to advance plant biotechnology.	The funding will support Foundational Genomics efforts at the DOE National Laboratories and within academia to focus on the Genesis Mission including AI-enabled biosystems design and biotechnology innovation. Plant and microbial research key to the Genesis Mission and biotechnology will continue, while a new effort to explore building a synthetic plant chromosome will be initiated. Biosystem design research for CMM extraction, recovery, and synthesis efforts will continue.
Funding supports Environmental Genomics priorities in plant functional genomics and environmental microbiome science to enable efforts in plant biotechnology and engineered microbial communities.	The Request for Environmental Genomics will prioritize plant functional genomics and environmental microbiome design science to enable plant biotechnology and engineered microbial communities tailored for biotechnology applications.	The funding will support and prioritize research projects in AI-enabled biotechnology development efforts within plants and microbiomes.
BRaVE efforts are complete. Funding supports Low dose radiation research prioritizes research on experimental dataset generation to serve as training sets for AI modeling of low dose radiation effects.	The Request will prioritize AI modeling of low dose radiation effects.	The funding will support the focus on the potential to extrapolate key AI modeling outputs from available datasets to understand potential health effects of low dose radiation.
Funding supports Computational Bioscience for Genomic Science by providing bioinformatics, simulation, and modeling capabilities. Efforts	The Request will support Computational Bioscience for Genomic Science by developing a cyberinfrastructure data and AI	The funding will support Computational Biosciences research focused on developing a more comprehensive, holistic

(dollars in thousands)

FY 2026 Enacted	FY 2027 Request	Explanation of Changes FY 2027 Request vs FY 2026 Enacted
expand to integrate AI/ML infrastructure and capabilities across BER User Facilities and KBase.	framework to support an AI Biodata Network, including NMDC, BER user facilities, and other National Laboratories. These efforts will support the Genesis Mission and will develop AI capabilities to accelerate Administration priorities to advance AI more broadly into basic research.	approach that integrates AI across BER's research portfolio, computational platforms, and user facilities, building upon the advanced and federated AI Biodata Network supports the Genesis Mission, AmSC, genomic science and biotechnology innovation.
Funding supports the BRCs by sharpening their focus on critical basic science needs to accelerate plant and microbial biotechnology innovation including prioritizing the integration of AI/ML techniques into their research plans and shared research objectives.	The Request will support BRCs to focus on critical basic science needs to accelerate plant and microbial biotechnology innovation including integrating AI/ML techniques into their research plans while the teams participate in a re-competition of the BRC program.	The funding will support AI-enabled capabilities with emphasis on activities to accelerate leading edge design of plants and microorganisms to bolster U.S. biotechnology leadership for producing a range of products from plant biomass.
Funding supports EPSCoR-State/National Laboratory Partnerships.	The Request will support EPSCoR Implementation Grants.	The funding will continue to support research in EPSCoR jurisdictions.
Biomolecular Characterization and Imaging Science $47,000	$33,487	-$13,513
Funding supports imaging and characterization technologies with an emphasis on quantum-science enabled imaging and sensor development tailored to plants and microorganisms, while maintaining capabilities for structural biology.	The Request will support imaging technology prioritizing QIS-enabled imaging and sensor development tailored to plants and microorganisms.	The funding will support priority efforts in QIS related research, particularly the development of novel quantum science-informed sensor technologies, characterization techniques, and structural biology capabilities at the DOE light sources.
Biological Systems Facilities & Infrastructure $97,596	$101,900	+$4,304
Funding supports JGI sequence production capacity to meet the needs of scientific users. JGI provides users with high quality genome sequences and new analysis techniques for complex plant and microbiome	The Request will support JGI to continue to provide genome sequence production capabilities to meet the needs of scientific users. JGI will provide users with high quality genome	Funding will focus on supporting the Genesis Mission. Funding will accelerate development of the AI Biodata Network, integrating JGI's data with other BER biological data and making this enhanced data

(dollars in thousands)

FY 2026 Enacted	FY 2027 Request	Explanation of Changes FY 2027 Request vs FY 2026 Enacted
samples. Integrative activities with KBase continuing to provide new cross-platform capabilities for users. Progress on reorganizing JGI's data infrastructure environment continues as the facility prepares to become a more AI-centric facility for genomic science.	sequences and analysis techniques for complex plant and microbiome samples. Integrative activities with KBase and NMDC will continue to provide new cross-platform capabilities for users. The development of a federated AI Biodata Network will be prioritized as the facility transitions to a more AI-centric facility for genomic science.	resource available to the research community. These efforts will contribute towards JGI becoming a more AI-centric facility for AI-enabled genomic science and biotechnology innovation. Planning will begin with other project costs for a Plant Transformation Capability to rapidly automate plant gene editing.

Description

The Earth and Environmental Systems Sciences (EESS) subprogram supports fundamental research and scientific user facilities that enable enhanced predictability of dynamically variable environmental and earth systems, in support of DOE's mission involving transformative science for energy dominance and national security. Research includes radically improving predictability of variable environmental conditions that inform the design, optimization, and deployment of next generation energy technologies and infrastructures, based on experimental and modeling research on earth and energy systems. This work includes modeling, analysis, and uncertainty quantification of the interdependent atmospheric terrestrial, marine, coastal, and cryospheric systems, with energy technologies and infrastructures embedded in the earth system. This integrated portfolio extends from molecular to regional and global scales and time scales from sub-seasonal (weeks) to decadal (years) as appropriate for energy strategic planning horizons. The research uses the DOE Office of Science (SC) Environmental Molecular Sciences Laboratory (EMSL) user facility to advance basic science through its world-class, multi-modal instrumentation and scientific leadership that equips researchers to achieve a predictive understanding of complex interdependent biological and environmental systems. Modeling and facility activities leverage DOE's exascale leadership computing user facilities and harness artificial intelligence (AI) to accelerate speed and precision of models and science providing unique successes to the Genesis Mission.

Earth and Environmental Systems Modeling

EESM develops the physical, biogeochemical, and dynamical science and software capabilities underpinning the design and use of fully coupled earth system models, focusing on the most challenging predictive timescales of weeks to years that are most vital for energy expansion. DOE's flagship Energy Exascale Earth System Model (E3SM) as well as more regional and multi-sector dynamics models are continually upgraded with state-of-the-art AI tools and use of DOE's exascale computers to achieve unprecedented capabilities and accuracy. EESM brings unique modeling, simulation, and prediction capabilities in support of the Genesis Mission, with more efficient AI methodologies as part of surrogate components, multi-model optimization strategies, huge ensembles to enhance predictive skill, and new data initialization methods. EESM relies on critical observations drawn from BER's open-access, curated field research, crowd-sourced information, and AI-generated synthetic data to accelerate progress towards new predictive understanding in complex geographic domains relevant to DOE's science, energy, and national security missions.

Earth and Environmental Systems Sciences Facilities and Infrastructure

The EMSL user facility provides a unique resource to discover the basic principles of how gene and microbial processes interplay with biochemical pathways and physical conditions. EMSL is a prime contributor to the Genesis Mission by developing AI-driven laboratory automation and workflows to process, analyze, visualize, and model the data from its distributed networks of soil, microbiome, and biogeochemical field and experimental systems. EMSL's Microbial Molecular Phenotyping Capability (M2PC) project fully embraces state-of-the art AI capabilities as part of the Genesis Mission to accelerate progress in achieving a comprehensive understanding of the drivers and potential design of microbial systems. EMSL contributes to BER's AI Biodata Network together with the Joint Genome Institute and other BER data systems, providing the scientific community with curated open-access data as well as scientific expertise to facilitate cutting edge research and predictive modeling capabilities across molecular science disciplines. This information is also vital to multiple DOE challenges involving critical minerals and materials (CMM) and other energy-relevant needs involving subsurface science. The ARM User Facility will be closed in FY 2027.

Activities and Explanation of Changes

(dollars in thousands)

FY 2026 Enacted	FY 2027 Request	Explanation of Changes FY 2027 Request vs FY 2026 Enacted
Earth and Environmental Systems Sciences **$430,000**	**$89,438**	**-$340,562**
Atmospheric System Research $39,500	$ —	-$39,500
Atmospheric System Research (ASR) completes and closes out most research on clouds, aerosols, and thermodynamic processes, including those with a focus on data from the Atmospheric Radiation Measurement (ARM) facility long-term sites as well as data from the completed Cape-K (Cloud and Precipitation Experiment at Kennaook) in Tasmania and CoURAGE (Coast-Urban-Rural Atmospheric Gradient Experiment) in Baltimore, Maryland.	Most ASR research on clouds, aerosols, and thermodynamic processes, analyzing observational datasets is completed except those supporting the modeling activities aligned with administration priorities.	ASR funding will be consolidated under Earth and Environmental Systems Modeling to support the administration's highest priority research.
Environmental System Sciences $96,000	$ —	-$96,000
Environmental System Sciences (ESS) completes most research on permafrost, boreal ecology, and modeling hydrobiogeochemistry of watersheds and terrestrial-aquatic interfaces, with a focus on urban systems and on the coastal zones encompassed by the Delaware and Susquehanna watersheds and the Great Lakes, and Puget Sound.	Most ESS research on hydro-biogeochemical processes in terrestrial watershed, coastal systems and urban systems is completed except those supporting the modeling activities aligned with administration priorities.	ESS funding will be consolidated under Earth and Environmental Systems Modeling to support the administration's highest priority research.

(dollars in thousands)

FY 2026 Enacted	FY 2027 Request	Explanation of Changes FY 2027 Request vs FY 2026 Enacted
Earth and Environmental Systems Modeling $118,500	$28,968	-$89,532
Funding supports EESM to focus investments towards regionally refined modeling of earth-energy system interactions using the E3SM and other models on exascale computers, achieving hyper-resolution scales and incorporating state-of-the-art AI in support of the Genesis Mission. New science was derived from data and new process representations provided from ASR research on cloud-aerosol-precipitation interactions as well as advanced biogeochemical, watershed, and coastal research derived from ESS.	The Request for EESM expands engagement with the Genesis Mission with focused investments on foundational hybrid modeling of detailed earth-energy interactions on hyper-resolution scales, sophisticated AI methodologies and best-in-class exascale computer architectures. Science will emphasize a select set of regionally refined modeling domains, including the Arctic, that utilize critical observations to develop, test, and validate new near-term prediction capabilities.	The funding will support the integration of new observations from watershed and atmospheric field campaigns into the model development research.
Earth and Environmental Systems Sciences Facilities and Infrastructure $176,000	$60,470	-$115,530
Funding supports EMSL to proceeded with MONet solicitations for proposals from the scientific community, expanded the DigiPhen effort to derive data from fungal proteins from U.S. sites, initiated new science on phenotyping anerobic microorganisms using a test automation platform, and contributed to the Genesis Mission with new AI driven science.	The Request will allow EMSL to continue to accelerate science outputs by placing greater emphasis on the use of AI methodologies in support of the Genesis Mission applied to multi-disciplinary scientific projects that use combinations of EMSL's advanced instrumentation, data analytics, and modeling and simulation capabilities through a variety of workflows. EMSL continues to leverage a network of geographically distinct field sites to achieve a comprehensive understanding of molecular processes.	The funding will support EMSL's emphasis on AI-driven laboratory automation and other AI efforts enhances the Genesis Mission. EMSL will operate a platform that uses AI analysis and workflow techniques to phenotype anaerobic microbes and will expand the scope of solicitations for user research in alignment with its campaigns toward a U.S.-based network of molecular observations in order to develop a digital phenome and integrate modeling and data agents.

(dollars in thousands)

FY 2026 Enacted	FY 2027 Request	Explanation of Changes FY 2027 Request vs FY 2026 Enacted
The Atmospheric Radiation Measurement (ARM) SC user facility completes ARM mobile facility campaigns in Tasmania, Baltimore, and Phoenix and completes activities at fixed sites in Alaska, Oklahoma, and the Eastern North Atlantic site. ARM conducts remediation of sites and deployments.	ARM campaigns will be completed, and the facility is closed.	ARM campaigns will be completed.
The Earth and Environmental Sciences Data Management activity completes activities to support and maintain existing and new software and data archives for experimental and modeling research. Essential data archiving and storing protocols, capacity, and provenance are completed. Advanced analytical methodologies such as AI and Machine Learning were enhanced and used to improve predictability more rapidly using the combination of field observations with Earth system models.	Most Earth and Environmental Sciences Data Management activities are completed except those supporting the modeling activities aligned with administration priorities.	Earth and Environmental Sciences Data Management funding will be consolidated under Earth and Environmental Systems Modeling to support the highest priority research proposals.

Description

This subprogram supports line-item construction for the BER program. All Total Estimated Costs (TEC) are funded in this subprogram, including engineering, design, and construction. The FY 2027 Request continues the Microbial Molecular Phenotyping Capability project.

24-SC-31, Microbial Molecular Phenotyping Capability (M2PC), PNNL

The M2PC will be the world's first fully connected end to end phenotyping platform from genetic diversity creation, to culturing, functional testing, and deep analyses of produced proteins and metabolites allowing for autonomous biological experimentation when combined with AI approaches. The M2PC project will design and construct a new capability that will provide a range of 24,500–50,000 gross square feet (GSF) of instrumentation and support spaces conducive for highly autonomous operations, with a target of greater than 30,000 GSF. In addition, the M2PC design will include acquisition of analytical instrumentation and microbial culturing and characterization capabilities that will be modular and expandable, self-contained, and operate in an automated pod configuration. Capabilities will include a suite of 5 to 10 microbial culturing pods, 3 to 5 biological and functional assay pods, and 4 to 5 analytical phenotyping workflow pods. This new capability will position BER to take a global lead in answering the most pressing challenge in biology—generating molecular phenotypic data at a pace that matches the rapid developments in high throughput genome sequencing and synthesis. Applicability of this capability to BER interests in bioproducts, critical elements, nutrient cycling, and other DOE-relevant bioeconomy applications, will create a knowledge ecosystem that would provide data to amplify BER's genome engineering and biosystems design efforts, as well as mechanistic hydro-biogeochemistry modeling capabilities. In the FY 2027 Request, the TEC funding of $35,000,000 will be used to continue construction of the conventional facility, and procurement of the high throughput phenotyping equipment.

Activities and Explanation of Changes

(dollars in thousands)

FY 2026 Enacted	FY 2027 Request	Explanation of Changes FY 2027 Request vs FY 2026 Enacted
Construction **$19,000**	**$35,000**	**+$16,000**
24-SC-31, Microbial Molecular Phenotyping Capability (M2PC), PNNL $19,000	$35,000	+$16,000
Funding supports initial construction boreholes for the Facility and achievement of the final designs for both the Facility and the High-throughput Automated Phenotyping Platform (HTP-APP).	Funding will support contract awards to cover the first two years of construction of the Facility, and assembly of instrumentation for the HTP-APP.	Funding will increase to transition from 100% designs to actual construction of the Facility and assembly of HTP-APP.

Biological and Environmental Research
Capital Summary

(dollars in thousands)

	Total	Prior Years	FY 2025 Enacted	FY 2026 Enacted	FY 2027 Request	FY 2027 Request vs FY 2026 Enacted
Capital Operating Expenses						
Capital Equipment	N/A	N/A	3,000	14,071	2,071	-12,000
Total, Capital Operating Expenses	**N/A**	**N/A**	**3,000**	**14,071**	**2,071**	**-12,000**

Capital Equipment

(dollars in thousands)

	Total	Prior Years	FY 2025 Enacted	FY 2026 Enacted	FY 2027 Request	FY 2027 Request vs FY 2026 Enacted
Capital Equipment						
Major Items of Equipment						
Total, MIEs	N/A	N/A	–	–	–	–
Total, Non-MIE Capital Equipment	N/A	N/A	3,000	14,071	2,071	-12,000
Total, Capital Equipment	**N/A**	**N/A**	**3,000**	**14,071**	**2,071**	**-12,000**

Note:
- *The Capital Equipment table includes MIEs with a Total Estimated Cost (TEC) > $10M.*

Biological and Environmental Research
Construction Projects Summary

(dollars in thousands)

	Total	Prior Years	FY 2025 Enacted	FY 2026 Enacted	FY 2027 Request	FY 2027 Request vs FY 2026 Enacted
27-SC-33, Plant Transformation Capability, LBNL						
Total Estimated Cost (TEC)	112,920	-	-	-	-	-
Other Project Cost (OPC)	8,120	-	-	-	4,000	+4,000
Total Project Cost (TPC)	**121,040**	**-**	**-**	**-**	**4,000**	**+4,000**
24-SC-31, Microbial Molecular Phenotyping Capability (M2PC), PNNL						
Total Estimated Cost (TEC)	117,000	10,000	19,000	19,000	35,000	+16,000
Other Project Cost (OPC)	5,000	1,200	-	-	-	-
Total Project Cost (TPC)	**122,000**	**11,200**	**19,000**	**19,000**	**35,000**	**+16,000**
Total, Construction						
Total Estimated Cost (TEC)	**229,920**	**10,000**	**19,000**	**19,000**	**35,000**	**+16,000**
Other Project Cost (OPC)	**13,120**	**1,200**	**-**	**-**	**4,000**	**+4,000**
Total Project Cost (TPC)	**243,040**	**11,200**	**19,000**	**19,000**	**39,000**	**+20,000**

Biological and Environmental Research
Scientific User Facility Operations

The treatment of user facilities is distinguished between two types: TYPE A facilities that offer users resources dependent on a single, large-scale machine; TYPE B facilities that offer users a suite of resources that is not dependent on a single, large-scale machine.

(dollars in thousands)

	FY 2025 Enacted	FY 2025 Current	FY 2026 Enacted	FY 2027 Request	FY 2027 Request vs FY 2026 Enacted
Scientific User Facilities - Type B					
Environmental Molecular Sciences Laboratory	**57,729**	**60,411**	**70,000**	**60,470**	**-9,530**
Number of Users	753	599	859	780	-79
Joint Genome Institute	**95,127**	**96,281**	**97,596**	**97,900**	**+304**
Number of Users	2,491	2,627	2,571	2,645	+74
Atmospheric Radiation Measurement User Facility	**83,757**	**83,365**	**96,000**	**–**	**-96,000**
Number of Users	1,073	1,116	1,215	–	-1,215
Total, Facilities	**236,613**	**240,057**	**263,596**	**158,370**	**-105,226**
Number of Users	4,317	4,342	4,645	3,425	-1,220

Note:

- *Percent optimal operations defines what is achieved at this funding level. This includes staffing, up-to-date equipment and software, operations and maintenance, and appropriate investments to maintain world leadership.*

Biological and Environmental Research
Scientific Employment

	FY 2025 Enacted	FY 2026 Enacted	FY 2027 Request	FY 2027 Request vs FY 2026 Enacted
Number of Permanent Ph.Ds (FTEs)	1,740	1,708	795	-913
Number of Postdoctoral Associates (FTEs)	405	400	200	-200
Number of Graduate Students (FTEs)	630	619	305	-314
Number of Other Scientific Employment (FTEs)	405	395	205	-190
Total Scientific Employment (FTEs)	**3,180**	**3,122**	**1,505**	**-1,617**

Note:
- *Other Scientific Employment (FTEs) includes technicians, engineers, computer professionals, and other support staff.*

24-SC-31, Microbial Molecular Phenotyping Capability (M2PC), PNNL
Pacific Northwest National Laboratory, PNNL
Project is for Design and Construction

1. Summary, Significant Changes, and Schedule and Cost History

Summary

The FY 2027 Request for the Microbial Molecular Phenotyping Capability (M2PC) project is $35,000,000 of Total Estimated Cost (TEC) funding. The project will design and construct a new research capability that will be broadly available to the scientific community as part of an Office of Science User Facility. The PNNL Director, designated as the M2PC Project Management Executive (PME), approved Critical Decision (CD)-2/3 on September 2, 2025. The Total Project Cost (TPC) is set at $122,000,000 with project completion (CD-4) in 1Q FY 2032.

Significant Changes

In accordance with the DOE Memo to National Laboratory Directors regarding 413.3 Capital Asset Projects less than $300,000,000, authority for the M2PC project has been delegated to the PNNL Director. An independent review committee evaluated the project documentation and artifacts required by DOE 413.3B and recommended the approval of CD-2/3 for the M2PC project. An Independent Cost Estimate (ICE) team reviewed the documentation and performed an ICE and an independent risk analysis. The PNNL Director, designated as the M2PC PME, approved Critical Decision (CD)-2/3 on September 2, 2025. Upon receiving DOE consent to award, both the High Throughput Automated Phenotyping Platform (HTP-APP) solution and the facility construction subcontracts were awarded in October. The Total Project Cost (TPC) is set at $122,000,000, which is within the cost range approved at CD-1 ($100,000,000 to $167,000,000).

FY 2025 funding was used to prepare documentation, including preliminary designs for both the Facility and the HTP-APP, for the Independent Cost Estimate (ICE) review, and for the CD-2/3 approval meeting, with CD-2/3 approved in early September 2025. FY 2026 funding supports initial construction boreholes for the Facility and achievement of final designs for both the Facility and the HTP/APP. The FY 2027 Request will support contract awards that cover the first two years of construction of the Facility, and assembly of instrumentation for the HTP/APP. Design-Build activities for the facility construction will commence and procurement and fabrication of the initial HTP phenotyping equipment components will begin.

Critical Milestone History

Fiscal Year	CD-0	Conceptual Design Complete	CD-1	CD-2	Final Design Complete	CD-3	CD-4
FY 2027	4/28/21	6/30/22	2/15/24	9/2/2025	4Q FY 2026	9/2/2025	1Q FY 2032

CD-0 – Approve Mission Need for a construction project with a conceptual scope and cost range; **Conceptual Design Complete** – Actual date the conceptual design was completed (if applicable); **CD-1** – Approve Alternative Selection and Cost Range; **CD-2** – Approve Performance Baseline; **Final Design Complete** – Estimated/Actual date the project design will be/was complete(d); **CD-3** – Approve Start of Construction; **D&D Complete** – Completion of D&D work; **CD-4** – Approve Start of Operations or Project Closeout.

Project Cost History

(dollars in thousands)

Fiscal Year	TEC, Design	TEC, Construction	TEC, Total	OPC, Except D&D	OPC, Total	TPC
FY 2026	29,000	88,000	117,000	5,000	5,000	122,000
FY 2027	29,000	88,000	117,000	5,000	5,000	122,000

2. Project Scope and Justification

Scope

The scope of this project includes the acquisition of a fully functional HTP-APP to increase data throughput, content, quality, and reproducibility of experimental analysis to meet the Mission Need. It also includes construction of a facility that is greater than 30,000 gross square feet to house, and provide support laboratories and spaces to effectively operate, the HTP-APP. M2PC will be attached to the North side of the Environmental Molecular Sciences Laboratory (EMSL) user facility at PNNL to leverage existing related adjacent research and facility systems.

Justification

Within the Biological and Environmental Research (BER) program, basic research to gain a predictive understanding of biological systems provides the foundation for harnessing and integrating the latest biosystems design techniques with data science and multi-scale modeling approaches. This effort will advance a burgeoning bioeconomy and provide transformative science and technology solutions to enable DOE to meet its energy and environmental challenges. Toward systems-level understanding, BER-supported research has increasingly embraced the integration of multi-omics analyses together with phenotypic characterization of microbial isolates and communities to determine the function of expressed genes and pathways.

While the number of microbial isolates and chassis microbes interrogated is expanding rapidly along with advances in next generation genome sequencing and synthesis, incomplete and constrained genome annotation limits the ability to understand and model the range of activities and functions of individual microbes, engineered microbial consortia with bio-industrial potential or ecological relevance, and microbial communities from natural soil environments. Specifically, there is a significant gap in the ability of the scientific community to identify proteins and biochemical pathways of unknown function in microbes at the single-cell to microbial-community scales, in part because the phenotypes of microbes change rapidly due to environmental factors and perturbations. To address this gap, BER proposes a research capability for a M2PC that would be broadly available to the scientific community as part of a DOE Office of Science User Facility.

An emphasis on coupled high-throughput autonomous experimental and multimodal analytical capabilities would be the primary components of the instrumentation part of the M2PC. These capabilities would be integrated with, and amplify, existing BER data platforms within the DOE JGI, the NMDC, and the KBase to speed the discovery of new protein functions and metabolic pathways in microbial systems, including fungi, algae, bacteria, protists, archaea, and viruses.

This new capability will position BER to take a global lead in answering the most pressing challenge in biology—generating molecular phenotypic data at a pace that matches the rapid developments in high throughput genome sequencing and synthesis, and it will advance the DOE mission to ensure America's security and prosperity by addressing energy and environmental challenges through transformative science and

technology solutions. Applicability of this capability to BER interests in bioproducts, critical elements, nutrient cycling, and other DOE-relevant bioeconomy applications, will create a knowledge ecosystem that will provide data to amplify BER's genome engineering and biosystems design efforts, as well as to mechanistic hydro-biogeochemistry modeling capabilities.

The project is being conducted in alignment with DOE's project management requirements.

Key Performance Parameters (KPPs)

The Threshold KPPs represent the minimum acceptable performance that the project must achieve. The achievement of the Threshold KPPs will be a prerequisite for approval of CD-4, Project Completion. The Objective KPPs represent the desired project performance.

Performance Measure	Threshold	Objective
Demonstrate high-throughput (HTP) Culturing	Capacity to operate with 500 Experiments/Week	Capacity to operate with 2,000 Experiments/Week
Demonstrate HTP Microbiome Culturing	Capacity to operate with 100 Microbiome Experiments/Week*	Capacity to operate with 500 Microbiome Experiments/Week*
Demonstrate HTP Assaying and Phenotyping	Capacity to obtain 1,000,000 Multi-Modal Analytical Measurements/Month	Capacity to obtain 3,000,000 Multi-Modal Analytical Measurements/Month
Remote Capability to Access Operations	Demonstrate that remote users can run pre-defined EMSL protocols to be executed autonomously within M2PC across culturing, assaying, and analyses**	Demonstrate remote users can perform dynamic experimental intervention with help from EMSL staff by modifying an executed protocol during the experimental timeframe**
Total Building Size (GSF)	24,500 sq. ft.	50,000 sq. ft.
*A microbiome start is an experiment consisting of a mix of 2-8 microbial species cultured under a defined set of conditions. **Protocol settings will have built-in acceptable safe operating ranges for selection within established instrument specifications from vendors, EMSL protocol best-practices, and PNNL EH&S safe research operating windows.		

3. Financial Schedule

(dollars in thousands)

	Budget Authority (Appropriations)	Obligations	Costs
Total Estimated Cost (TEC)			
Design (TEC)			
Prior Years	10,000	10,000	10,000
FY 2025	19,000	19,000	19,000
Total, Design (TEC)	**29,000**	**29,000**	**29,000**
Construction (TEC)			
FY 2026	19,000	19,000	19,000
FY 2027	35,000	35,000	35,000

(dollars in thousands)

	Budget Authority (Appropriations)	Obligations	Costs
Total Estimated Cost (TEC)			
Outyears	34,000	34,000	34,000
Total, Construction (TEC)	**88,000**	**88,000**	**88,000**
Total Estimated Cost (TEC)			
Prior Years	10,000	10,000	10,000
FY 2025	19,000	19,000	19,000
FY 2026	19,000	19,000	19,000
FY 2027	35,000	35,000	35,000
Outyears	34,000	34,000	34,000
Total, Total Estimated Cost (TEC)	**117,000**	**117,000**	**117,000**

(dollars in thousands)

	Budget Authority (Appropriations)	Obligations	Costs
Other Project Cost (OPC)			
Prior Years	1,200	1,200	1,200
Outyears	3,800	3,800	3,800
Total, Other Project Cost (OPC)	**5,000**	**5,000**	**5,000**

(dollars in thousands)

	Budget Authority (Appropriations)	Obligations	Costs
Total Project Cost (TPC)			
Prior Years	11,200	11,200	11,200
FY 2025	19,000	19,000	19,000
FY 2026	19,000	19,000	19,000
FY 2027	35,000	35,000	35,000
Outyears	37,800	37,800	37,800
Total, TPC	**122,000**	**122,000**	**122,000**

4. Details of Project Cost Estimate

(dollars in thousands)

	Current Total Estimate	Previous Total Estimate	Original Validated Baseline
Total Estimated Cost (TEC)			

(dollars in thousands)

	Current Total Estimate	Previous Total Estimate	Original Validated Baseline
Design	20,500	N/A	20,500
Design - Contingency	8,500	N/A	8,500
Total, Design (TEC)	**29,000**	**N/A**	**29,000**
Construction_No_Detail	10,000	N/A	10,000
Total, Construction (TEC)	**10,000**	**N/A**	**10,000**
Total, TEC_No_Detail	**78,000**	**N/A**	78,000
Total, TEC	**117,000**	**N/A**	**117,000**
Contingency, TEC	*8,500*	***N/A***	*8,500*
Other Project Cost (OPC)			
OPC, Except D&D	5,000	N/A	5,000
Total, Except D&D (OPC)	**5,000**	**N/A**	**5,000**
Total, OPC	**5,000**	**N/A**	**5,000**
Contingency, OPC	***N/A***	*N/A*	***N/A***
Total, TPC	**122,000**	**N/A**	**122,000**
Total, Contingency (TEC+OPC)	***8,500***	***N/A***	***8,500***

5. Schedule of Appropriations Requests

(dollars in thousands)

Fiscal Year	Type	Prior Years	FY 2025	FY 2026	FY 2027	Outyears	Total
FY 2026	TEC	10,000	19,000	10,000	—	78,000	117,000
	OPC	1,200	—	—	—	3,800	5,000
	TPC	11,200	19,000	10,000	—	81,800	122,000
FY 2027	TEC	10,000	19,000	19,000	35,000	34,000	117,000
	OPC	1,200	—	—	—	3,800	5,000
	TPC	11,200	19,000	19,000	35,000	37,800	122,000

6. Related Operations and Maintenance Funding Requirements

Start of Operation or Beneficial Occupancy	1Q FY 2032
Expected Useful Life	50 years
Expected Future Start of D&D of this capital asset	1Q FY 2082

Related Funding Requirements
(dollars in thousands)

	Annual Costs		Life Cycle Costs	
	Previous Total Estimate	**Current Total Estimate**	**Previous Total Estimate**	**Current Total Estimate**
Operations	N/A	223	N/A	11,150
Utilities	N/A	145	N/A	7,250
Maintenance and Repair	N/A	331	N/A	16,550
Total, Operations and Maintenance	N/A	699	N/A	34,950

7. D&D Information

The new area being constructed is part of this project and will not be replacing any existing facilities.

	Square Feet
New area being constructed by this project at PNNL	34,500
Area of D&D in this project at PNNL	—
Area at PNNL to be transferred, sold, and/or D&D outside the project, including area previously "banked"	—
Area of D&D in this project at other sites	—
Area at other sites to be transferred, sold, and/or D&D outside the project, including area previously "banked"	—
Total area eliminated	—

8. Acquisition Approach

The two largest procurements, the HTP-APP and the facility, have been awarded and Notice to Proceed with design has been established for both contractors. The contractors are coordinating design efforts and multiple partnering meetings have been held, which include M2PC project team, the facility team, and the HTP-APP team. As of December, the project is preparing for the first on-site construction activities: scanning and bore hole drilling. SC will evaluate the M&O contractor's performance through the annual laboratory performance appraisal process.

SC and the M&O will draw from lessons learned from other SC projects and other similar facilities in planning and executing the M2PC project.