July 30, 2024

ADVISORY BOARD

Ms. Candice Robertson Senior Advisor Office of Environmental Management U.S. Department of Energy 1000 Independence Avenue, SW Washington, DC 20585

Dear Ms. Robertson:

On behalf of the Environmental Management Advisory Board (EMAB), we congratulate you on your new leadership role in the U.S. Department of Energy (DOE)'s Office of Environmental Management (EM).

In January 2024, former Senior Advisor William "Ike" White issued a charge to the EMAB. The request centered around two EM projects that provide a framework for the remediation, closure, and long-term management of DOE's complex groundwater sites, where cleanup is expected to take decades or longer.

The EMAB established three subcommittees to learn about and study key issues related to the charge. Many of the members participated in a visit to the Savannah River Site (SRS) in May to observe firsthand the research being conducted and technologies being implemented to improve both monitoring efficiency and effectiveness in support of EM's long-term remediation goals.

It is our privilege to transmit the final report, *Best Practices for Implementing EM's Groundwater Closure Strategy and Long-Term Monitoring Paradigm*, for your review and consideration.

My special thanks to the Director of the Office of Environmental Management and Intergovernmental & Stakeholder Programs, the EMAB staff, EM's Office of Subsurface Closure staff, Savannah River National Laboratory subject matter experts, and tour personnel for their assistance to EMAB. Importantly, members of EMAB, particularly the subcommittee chairs, have invested many hours of volunteer time to develop a report that we hope you will find meaningful, and which adds value to addressing the topics as outlined in the charge. We look forward to continuing engagement in this critical area of the EM mission.

Sincerely yours,

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Amy S. Fitzgerald, Ph.D. EMAB Vice-Chair

Report to the Senior Advisor Office of Environmental Management United States Department of Energy

Best Practices for Implementing EM's Groundwater Closure Strategy and Long-Term Monitoring Paradigm

Prepared by the Environmental Management Advisory Board July 2024

### Acknowledgment

This report to the Senior Advisor, Office of Environmental Management, was prepared by a subcommittee of members of the U.S. Department of Energy (DOE) Environmental Management Advisory Board (EMAB).

EMAB members participating in this charge: David Abelson, Subcommittee Co-chair Mark Barnett Bruce Bordenick, Subcommittee Co-Chair Amy Fitzgerald, EMAB Vice-Chair Celeste Greene Rich Janati Andy Kelsey, Subcommittee Co-Chair Frazer Lockhart Sheri Meghreblian Tracye McDaniel Brian Powell Jim Rispoli Michael Shapiro

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## **Introduction**

The EMAB reviewed two projects that provide a framework for the remediation, closure, and long-term management of DOE's complex groundwater sites, where cleanup is expected to take decades or longer.

The first project is the Closure Strategy Plan for DOE-EM Complex's Groundwater Plumes, NNLEMS-2024-00001, issued by SRNL in March 2024 (Appendix A). The strategy is based on identifying site needs and associated technical targets, developing an end-state vision for the complex groundwater plumes at each site (to be completed by the sites, with technical assistance from DOE national laboratory experts), and establishing overarching metrics to document and track progress in achieving the end states.

The second project, Advanced Long-Term Environmental Monitoring Systems (ALTEMIS), addresses the extended periods of institutional control that will be required at most of DOE's complex groundwater cleanup sites where attenuation-based remediation is the final stage in achieving the end-state vision. The project is led by SRNL, Lawrence Berkeley National Laboratory (LBNL), and Pacific Northwest National Laboratory (PNNL), which are developing and demonstrating a long-term monitoring (LTM) framework that incorporates advanced hardware and software technologies, such as in situ sensors, geophysics, radiation mapping, and artificial intelligence/machine learning. These technologies are intended to optimize monitoring efficiency and cost-effectiveness and to identify and track vulnerable regions of contaminated sites or treatment systems.

The charge tasks EMAB to provide comments to NNLEMS-2024-00001 and respond to four specific questions. The below heading "Overarching Charge" is the EMAB response to review of NNLEMS-2024-00001, followed by headings for response to the specific questions in the order provided in the charge.

The EMAB established three sub-committees to respond to the charge:

- Groundwater strategy sub-committee (NNLEMS-2024-00001), covering the overarching charge of the response.
- ALTEMIS sub-committee, covering questions 1 and 3 of the charge.
- Stakeholder and regulatory sub-committee, covering question 4 of the charge.

All sub-committees reviewed NNLEMS-2024-00001 and had the opportunity to provide comments regarding the document and recommendations regarding the four questions in the charge. The consolidated recommendations and commentary are below.

### <u>Overarching Charge</u>: "The EMAB is asked to review EM's groundwater closure strategy and ALTEMIS projects and to recommend best practices for complex-wide implementation and long-term success."

Observation: Use of the word "closure" in NNLEMS-2024-00001 is ambiguous.

- Is closure solely to meet requirements for transfer to DOE-Legacy Management (DOE-LM)?
- Does closure allow for monitored natural attenuation and other residual contamination scenarios?
- Figure 2 of NNLEMS-2024-00001 illustrates end state or "site closure" metrics, however, each groundwater plume is unique and most are regulated independently.
- The use of "closure" for both sites and individual management units is confusing.

**Overarching Recommendation A:** Clearly define "closure" in the context of this complex-wide groundwater strategy *OR* eliminate "closure" from the document title and context, instead issuing a "Groundwater Protection and Cleanup Strategy."

A precise definition of closure will allow for better definition of technology requirements and priorities on a complex-wide basis. A definition like transfer to DOE-LM with some groundwater technical parameters would support a complex-wide strategy. The sites generally have their own negotiated end states and cleanup objectives, usually in the form of a Federal Facility Agreement or Consent Agreement along with the relevant Record of Decision. Diving into those would likely fragment any complex-wide strategy, reducing the utility for DOE-EM.

Eliminating "closure" removes the possible misconception that DOE-EM is focused on transferring responsibility to DOE-LM and saving money, where the actual priority is protecting human health and the environment.

<u>Observation</u>: NNLEMS-2024-00001 is "a closure strategy plan" developed by SRNL with support from LBNL, PNNL and government contractors. The document is essentially a recommendation to DOE-EM Headquarters as opposed to an issued strategy.

**Overarching Recommendation B**: The efforts undertaken thus far with respect to NNLEMS-2024-00001 needs a commitment to transition the plan into a published strategy and/or plan of action that includes opportunity for public comment, regulator input and senior leadership approval, which optimally would include both headquarters and affected site leadership. This leadership commitment should also align funding with actions.

<u>Observation</u>: NNLEMS-2024-00001 general recommendations wander into project management and stakeholder engagement, which the sites have been doing for decades. It is not obvious that the three management recommendations add value to existing site operations.

• Adaptive Site Management – appears to simply rename the current approach of lifecycle management (remediation is projectized with interim and final objectives) combined with required effectiveness reviews under CERCLA (5-year reviews).

- Tiered Collaborative Regulatory Framework most if not all sites already work in tiers with their regulators. Site management works with regional regulators for FFAs, Consent Agreements, etc. while project teams of DOE, contractors, and regulator staff deal with regulatory submissions such as RODs. The middle tier in the model seems to be unnecessary and it is not obvious that most regulators could even staff it.
- Contractor Incentives the existing DOE-EM End State Contracting Model (ESCM) is designed to incentivize meeting milestones and ultimately site closure (and not mentioned in the NNLEMS report or EMAB charge). If DOE wishes to incorporate technology incentives, it can do so through ESCM. However, technology-specific incentives would be more directive than is customary. Good contracting practice requires the Government to specify what is to be accomplished, and the contractor to determine how best to accomplish the objectives. If new technology accomplishes objectives "better, faster, cheaper," there is no other incentive required other than making the sites aware of the technology.

### Overarching Recommendation C: Avoid project management strategy recommendations.

<u>Observation:</u> NNLEMS-2024-00001 has a stated purpose: "To identify applied, science-based strategies focused on site closure that can be used to develop a consistent, complex-wide management strategy to address the remaining complex groundwater plumes." The focus on site closure has the potential to frustrate stakeholders as it places the action of closure ahead of protecting the public and the environment.

### Overarching Recommendation D: Consider revising NNLEMS-2024-00001 goals to:

- 1. Protect human health and the environment.
- 2. Motivate groundwater plume monitoring, modeling, and remediation improvements with innovative solutions.
- 3. Expand regulator and stakeholder understanding of groundwater plume monitoring, modeling and remediation methods and data for decision making.
- 4. Respond nimbly to changes (e.g., climate change, unexpected alterations in plume behavior, unanticipated decreases in remediation system effectiveness, presence of emerging contaminants) as cleanup progress.

<u>Observation</u>: During a visit to SRS, EMAB members toured the Defense Waste Processing Facility (DWPF). During the brief prior to the tour, EMAB observed a wall size Gantt chart depicting the scheduled closure of all SRS high level waste tanks. The schedule was revision 24, with additional revisions likely prior to completion. The Gantt chart was one element used by facility managers to effectively rally their team to complete their mission, which is treatment of all waste and closure of all tanks. The existence of the Gantt chart has already supported beneficial interactions with regulators and cost savings \$100 million dollars, due to innovation undertaken to double stack cylinders filled with vitrified waste in storage buildings.

The high-level waste tanks have different levels of risk to human health and the environment given the chemical and radiological constituents of their contents, their method of construction, and their proximity to ground water. The Gantt chart depicting scheduled closure allows decision

making based on risk and annual funding constraints, such that highest risk tanks are completed early in the schedule and future funding can be stable and predictable. Some of the prior revisions occurred to change scheduled work to prioritize tanks and allow for maximum efficiency given that groups of tanks are interconnected.

**Overarching Recommendation E:** Developing a similar Gantt chart construct for all of the DOE-EM ground water plumes offers a similar opportunity. Because each ground water plume is unique, the opportunity exists to group plumes by similar characteristics, such as radionuclide half-lives, type of remediation, proximity to site boundary or bodies of water, and risk to human health (e.g. dose projection). Clearly plumes exist at different sites in different states across the country and local stakeholders will be less concerned about plumes outside of their direct area. However, grouping ground water plumes in this manner offers the opportunity to share lessons learned between sites, regulators and stakeholders. In this way the potential stakeholder concern that arises from such a national perspective, and potential to favor one site's plumes over another in funding decisions, can be converted to a positive benefit from the broader and more transparent sharing of lessons learned and information. The Gantt chart can be revised periodically as lessons learned are applied and progress is made to remove uncertainty with respect to regulatory requirements.

<u>Observation:</u> The Executive Summary (ES) is not aligned with the report. The ES mostly discusses work that was done but the only recommendation mentioned is TRAC.

**Overarching Recommendation F**: Focus the ES on actions and recommendations – that is what an executive wants to know.

<u>Observation</u>: Significant issues that were discussed on the SRS site visit is knowledge transfer and database development and upkeep. Thus, the ALTEMIS collaboration with contributions from three national laboratories is very positive and much-needed in view of single-laboratory initiatives in the past. Participation of three laboratories from different parts of the country and with significantly different groundwater regimes in their area should assist acceptance by sites and their local stakeholders. This broader laboratory participation is also consistent with use of a Gannt chart or other national-level plume planning to address groundwater issues.

<u>Observation: Page 14</u>: Groundwater Plume Status heading: The use of the word "status" is correct. If the end-state is known and accepted, then DOE-EM can focus on remedy definition and implementation as the phase defined in that section is more of the "tell us you are making progress" phase.

<u>Charge Question 1</u>: "What are EMAB's recommendations for ensuring that the products of late-stage technology development are incorporated by EM sites and their contractors into the groundwater strategy for site cleanup and closure, particularly for large, complex groundwater plumes?"

<u>Observation</u>: The DOE-EM Groundwater Closure Strategy should focus on the Technical Targets. Figure 1 and Tables 2 and 3 are relevant to technical strategies specific to groundwater. Continue to review the current state of the Technical Targets (Savannah River National Laboratory, 2021. Technical Targets 2021 – A Tool to Support Strategic Planning in the United Stated Department of Energy (DOE). SRNL-STI-2021-00502. Revision 0.) to identify gaps and areas where the targets are not beneficial.

**Recommendation 1A:** Focus the strategy on science and technology and regulatory/stakeholder acceptance. Develop these further in context of current technology gaps and define strategies for:

- Ensuring Environmental Stewardship
- Eliminating Contaminant Sources
- Isolating Contaminants
- Controlling Contaminant Plumes
- Enabling Cleanup Efforts

By developing strategies in these categories, DOE can better identify late-stage technologies and NNLEMS/national laboratory support that is most beneficial.

<u>Observation</u>: Discussions on the SRS site tour (particularly with Brian Looney) illustrated technical strategies that may have value across the complex. Examples include:

- Consideration of "how to turn it off" when remediating groundwater. The strategy involved both regulatory negotiation (give to get) and transition from active to passive (soil vapor extraction moving from steam to solar to barometric).
- Use of the red/green/blue plume model where red is the disturbed/source zone, green is the impact zone, and blue is the transition zone. This helps define applicable technologies and technology needs.
- Monitoring strategies to move from sampling to sensors (ALTEMIS).

**Recommendation 1B:** Build on SRS and Hanford experience with groundwater science and technology to develop the complex-wide groundwater strategies.

At Hanford, PNNL has developed advanced models of groundwater plumes in heterogeneous systems. Application of next generation computation and AI is potentially an excellent late-stage technology for DOE groundwater remediation/closure.

<u>Observation:</u> Contractors generally cannot deviate from approved remedies to apply new technology without DOE and regulatory approval

**Recommendation 1C:** DOE should take the lead in sponsoring demonstration projects for latestage technologies by providing funding and technical assistance, as discussed on Page 21 and in Table 3 of NNLEMS-2024-00001. The strategy of test beds will demonstrate to regulators and contractors the value of the new technology, encouraging deployment where beneficial to effectiveness, cost and/or schedule.

<u>Observation:</u> As discussed in the 2021 Technical Targets report, one model is DoD's Strategic Environmental Research and Development Program (SERDP) and Environmental Security Technology Certification Program (ESTCP). <u>https://serdp-estcp.mil/</u> "The Program's goal is to identify and demonstrate the most promising innovative and cost-effective technologies and methods that address DoD's high-priority environmental, resilience, and installation energy and water requirements. Projects conduct formal demonstrations at DoD facilities and sites in operational settings to document and validate improved performance and cost savings. To ensure the demonstrated technologies have a real impact, ESTCP collaborates with end users and regulators throughout the development and execution of each demonstration." SERDP Statements of Needs are user-written to focus on specific site needs, and hence more likely to result in deployment of technologies.

**Recommendation 1D:** DOE should develop a framework to move promising technologies to late stage by leveraging the new EM-3.2 Office of the Chief Technology Officer/Lab Policy Office/Chief Engineer. EM-3.2 should lead intra-site communication and sharing of technologies, solutions, and approaches to groundwater remediation and other DOE-EM technologies.

<u>Observation</u>: Ground water plumes are regulated by states or the Environmental Protection Agency. In 2004, the Environmental Protection Agency issued EPA530-R-04-030, Handbook of Groundwater Protection and Cleanup Policies for the Resource Conservation and Recovery Act (RCRA) Corrective Action. This handbook is designed to help regulators, members of the regulated community, and members of the public find and understand EPA policies on protecting and cleaning up groundwater at facilities subject to corrective action under subtitle C of RCRA. Not all DOE-EM groundwater plumes are subject to RCRA, but the content of the EPA handbook is useful regardless of which organization has regulatory authority.

**Recommendation 1E:** Because of the age of this document and the appearance that regulatory agencies are acting inconsistently, EMAB recommends DOE-EM Headquarters engage with EPA Headquarters to issue updated guidance to the regulatory community that would improve consistency of underground plume corrective actions. The ARTEMIS effort and initial success would suggest specifically addressing use of:

- Artificial Intelligence/Machine Learning to determine optimal sampling methods and locations
- Monitoring of controlling variables as a means to predict plume behavior in lieu of monitoring all constituents present in the plume (regardless of concentration).
- Realtime monitoring in lieu of periodic water sample collection and analysis.

In addition to engaging EPA to update guidance, given the age of the existing guidance and changes in personnel at both DOE-EM and regulatory agencies, EMAB recommends investing in joint developmental events such that staff understand the latest technologies available and why they are superior to previous methods. Investment in this type of shared learning is an effective change management technique.

<u>Observation</u>: The construct of ALTEMIS involves a system of sensors, data transfer hardware and software, data storage capability, records management, and data analysis software. Each of these components of the system requires a commitment (human resource and financial) for

lifecycle management. For example, data analysis software needs software engineering to keep up with security requirements and changes to operating systems.

**Recommendation 1F**: DOE-EM develop a concept of operations for ALTEMIS as the project scales from demonstration to working model, to ensure that required infrastructure is planned, resourced and maintained.

- Since the above described ALTEMIS system elements compete for scarce funding, there may be a need to prioritize. For example, if commercial off the shelf sensors are adequate but software is not, software development should be a higher priority than sensor development.
- ALTEMIS is a premium product, like a Cadillac of automobiles. It may be cost and resource prohibitive to scale ALTEMIS to multiple sites. EMAB recommends DOE-EM consider deploying individual elements of ALTEMIS, like real time monitoring, where that technology presents an opportunity to deliver improved data and analysis for regulatory decision making

<u>Observation</u>: EMAB believes that ALTEMIS is technologically superior to existing methods of sample acquisition and analysis, and underground plume modeling. However, there is no published business case analysis from which to justify future investment, nor is there a means to demonstrate to the regulatory community that the technology will benefit their responsibility to protect public health and the environment.

**Recommendation 1G**: Develop business case analyses for ALTEMIS compared to existing methods of sample acquisition and analysis, and underground plume modeling. Developing both of these analyses would support transition of ALTEMIS from demonstration/research status to the standard means of groundwater protection and cleanup.

# <u>Charge Question 2</u>: "What are recommended approaches for EM to financially incentivize EM site contractors (through new or amended contracts) to identify, demonstrate, scale, and deploy new technologies for remediating and monitoring EM's most challenging and persistent groundwater plumes?"

<u>Observation</u>: To be competitive in business, including government operations, organizations must improve processes and innovate. DOE-EM has existing capabilities to develop and implement process improvement and innovation, including the national laboratories, the technology development program, and innovation programs that exist at field sites. These innovation and process improvement capabilities are essentially an innovation system, similar to how safety is implemented via a safety system at field sites. Innovation systems have many parts, including idea generation, prototyping, use of six sigma and lean principles, pilot programs, funding mechanisms, project management and employee recognition. The charge requests EMAB recommendations regarding financial incentives, ostensibly because DOE-EM is dissatisfied with the performance of its innovation system. This dissatisfaction appears to exist both in the results generated by government employees and contractors.

**Recommendation 2A:** DOE-EM assess its innovation/process improvement system with respect to performance and desired outcomes, and make changes holistically, vice focusing specifically on financial incentives. EMAB notes that during the tour of the DWPF at SRS, there were several examples of innovation and process improvement observed or cited, which suggests that the innovation and process improvement system in the tank remediation program offers a model for the groundwater plume program to replicate.

<u>Observation:</u> Technology development is one of the most difficult areas to incentivize due to the uncertain scope and schedule inherent in technology development. Typically, the more innovative and untested a new technology is, the greater the time period for its development and 'proof' of viability. With most EM contracts limited to ten years, many with only five years guaranteed and then additional years based on option decision, technology development incentives may be outside the business time horizon for the contractor. The higher risk and uncertainty of technology development also would warrant significantly higher incentive percentages than typical to offset the development risk.

**Recommendation 2B:** Specific technology activities, such as supporting ARTEMIS at a specific level of manpower or funding, may be a way to incentivize technology development with a limited scope and time period that fits logically within the contractor's larger scope and contract period of performance.

<u>Observation</u>: Incentives work best when the specific metrics or end goals can be tied to the incentive. Such specificity is rare for new technologies that are in the concept or early development and testing phases, such as ALTEMIS. Most incentives for new technology will need to be qualitative and thus somewhat subjective for evaluation criteria. Contractors with strong quantitative incentives for project completion or cost reduction will tend to favor those over qualitative incentives that can be more difficult to demonstrate success.

**Recommendation 2C:** Frank conversation with contractors during development of incentives, discussing the nature and validity of the evaluation criteria, can help to ensure the qualitative incentives for new technology applications receive the attention desired from the contractors.

<u>Observation:</u> Government agencies may grant individual incentives up to \$10,000 without external approval, up to \$25,000 with Office of Personnel Management (OPM) approval, and in excess of \$25,000 with Presidential approval. Contractors generally do not have the same limitations, unless mandated contractually. There are existing incentive award programs for individual performance, such that additional programs within ALTEMIS or DOE are not necessary. The extended time period and typical qualitative nature of success criteria for technology development further argue against implementing individual incentives for ground water remediation and monitoring.

**Recommendation 2D:** Avoid developing additional individual incentives for ground water remediation and monitoring due to the lack of equity in employee incentive programs between contractor and DOE, and potentially between different sites.

# <u>Charge Question 3</u>: "How can EM better utilize the Tracking Restoration And Closure (TRAC) system (https://trac.pnnl.gov) for measuring progress toward site closure? Are there features that should be added to TRAC?"

The subcommittee did not offer any recommendations for this charge. It instead offers the following observation.

<u>Observation</u>: TRAC breaks down each site by management unit. For each management unit, there is a data set called "technology approaches." These approaches are focused on treatment methods. All of the information provided is with respect to treatment.

Information about monitoring and modeling could be added. However, the treatment information cited is generic and does not provide reference to actual treatment details, like equipment used, flow rates, etc. Adding monitoring information would be consistent, however, there is little likelihood that it would cause knowledge transfer and ultimate use of improved technologies.

# <u>Charge Question 4</u>: "How should EM socialize the principles of its groundwater closure strategy and LTM approaches with sites, site contractors, regulators, Tribes, local communities, and stakeholders?"

The groundwater strategy and long-term monitoring program being advanced by DOE-EM shows a positive pivot toward improved performance, lowered costs, and better communication and collaboration. It is vital that the strategies and plans are discussed at the local level to ensure understanding and true involvement. For groundwater programs the DOE-EM benefits from decades of experience, both positive and negative, with various groundwater treatment efforts. As the DOE-EM program matured the stakeholders and Tribes have been provided increased access to information on these groundwater projects. While the increasing transparency is good it provides a challenge at this point for socializing the latest groundwater strategy. For some stakeholders, and maybe even some regulators, this may look like just another plan amongst decades of previous plans and strategies. It will be important for DOE-EM to link the history into this latest strategy for discussion with stakeholders, Tribes, and regulators. DOE-EM should also be very clear in describing its goals and how those goals will satisfy the long-term, often multi-generational, concerns of the various stakeholders.

Additionally, the EMAB recommends that the report authors add additional details regarding stakeholder and regulatory engagement strategies. These details will help HQ work with site managers to ensure DOE achieves its goal of a national plan with site-specific adaptations. The following comments and recommendations are offered to help support that goal.

<u>Observation: Goals/Strategies/Tactics</u>: A challenge EM managers often face is defining its engagement goals, strategies and tactics. There are specific instances where the goals are not well defined, strategies are unknown, and the tactics are viewed as the purpose of the engagement. For example, meetings/briefings/tours etc. are not the goal; they are tactics that support a strategy. Those strategies, in turn, must directly support the identified goal.

A proposed goal for the groundwater closure strategy would be to secure clear, express stakeholder and regulatory support at each site where groundwater is a concern, recognizing that some stakeholders will raise concerns and/or dissent. Regulator dissention, in contrast, is not viable.

Proposed strategies could include securing support for the groundwater strategy from state and local elected officials, tribal leaders and other leaders (e.g., resolutions/letters from councils and commissions and tribal governments); securing positive articles and editorials from local papers; and implementing a communications plan that includes addressing (and countering as needed) misinformation about the strategy and effectiveness of groundwater controls.

Tactics could include public presentations to councils, commissions, Tribal leaders, SSAB; individual meetings with local elected officials and tribal leaders; strategy sessions with local leaders and regulatory agencies to identify avenues to meet their common interests; meetings with the state's governor and Congressional delegation; communications tools (e.g., news releases, social media, etc.); and editorial board and reporter meetings. Inherent in the tactics is the ability to negotiate when defining the vision and steps to achieve that vision, as well as a thorough vetting of site data by both EM and the lead regulatory agency. These tactics will also allow EM to adjust the strategy to secure the necessary support.

By defining its goals, strategies and tactics, EM can shift from informing the stakeholders and tribal governments of its intention to substantively engaging these parties as partners in achieving their shared goal of protecting human and aquatic ecosystems and protecting water supplies. Tribal consultation likewise necessitates this level of engagement.

This level of engagement will counter the ever-present dissention with clear and affirmative support for the final groundwater closure strategy. The process the EMAB is recommending is, by design, iterative.

<u>Observation: Page 19 & beyond, Adaptive Site Management:</u> This approach is well documented within DOE and Department of the Interior. Inclusion of this approach for RCRA sites in this report is strong.

<u>Observation: Site-Level Engagement Training</u>: Linked to clearly defining the goals, strategies and tactics is ensuring that site-level personnel area periodically trained in stakeholder engagement and communications techniques. Such training should include risk communications. EM should consult with other federal agencies, as needed, particularly the Nuclear Regulatory Commission.

<u>Observation: Technical and Policy Goals</u>: EM and regulatory agency/agencies must support the same technical and policy goals. Without that alignment it will be difficult to ensure a timely and expeditious process.

<u>Observation: The Word "Socialize" in the Charge</u>: As the subcommittee hopes these recommendations make clear, "socialize" as used in the charge is not the correct word. The EMAB is recommending clear, intentional, focused engagement with the goal of securing state,

local and tribal support for the end-state and groundwater closure strategy. Equally important, the EMAB recommends a similar approach be made, tailored to each site's stakeholder community, with all other stakeholders as well, to include community groups both organized and at large.

**Recommendation 4A**: EM needs to ensure that the end-state at each site is known, has the support of the regulatory agency/agencies, Congress, Tribal leaders, local officials and other stakeholders including organized and at- large groups specific to each site. The groundwater closure strategy, in turn, must support that end-state vision.

**Recommendation 4B**: The site-specific groundwater closure strategy must define in clear, unambiguous terms what interests are being protected (e.g., downstream water supplies, aquatics species, etc.) and how the groundwater closure strategy will protect those interests.

**Recommendation 4C**: Each DOE field manager should develop a written plan for engaging tribal leaders, state elected officials, local elected officials and other engaged stakeholders on the groundwater closure strategy. This plan can/should be tied into existing engagement plans, should written plans exist at a given site. Additionally, each manager should periodically secure an independent review of the stakeholder and regulatory engagement plan, including the groundwater closure strategy elements contained therein, and adjust it as necessary.

**Recommendation 4D**: Consistent with recommendation 4C, the groundwater closure strategy should distinguish between informing and engaging. Often the two are conflated. The former is communications; the latter is geared to securing support for DOE's policy goals, though the latter necessitates effective communications. Without such stakeholder support, EM might not have regulatory concurrence for the remedy.

**Recommendation 4E**: EM should evaluate on a case-by-case basis the need for funds for local communities near sites with complex groundwater plumes to hire a technical advisor. The advisor's primary function would be to simplify and explain complex technical information, and offer expert opinions and advice to the community on technical matters.

**Recommendation 4F:** To increase stakeholder, Tribal, and regulator confidence in and acceptance of the groundwater closure strategy, DOE-EM should:

- 1. Explain the broader and more collaborative approach to solving technology challenges. The ALTEMIS structure with participation of three national laboratories provides demonstration of this.
- 2. Strengthen the alignment with the DOE-LM to ensure messages, goals, and initiatives are consistent or at least compatible. Federal bureaucratic structures and alignments are typically difficult for the layperson to understand, so efforts at transparency for such long-term programs will be helpful. The DOE-EM to DOE-LM transition has been primarily limited to smaller sites across the DOE complex. There remains significant uncertainty about the regulatory and institutional "handoff" process at larger sites, particularly those with ongoing missions. Groundwater corrective action plans, Records of Decision (RODs) and other groundwater closure documentation must contain details regarding funding, ongoing monitoring responsibilities, and the obligations delegated to

DOE-LM for engagement with local communities, Tribes, and other stakeholders. Ongoing implementation of corrective actions and enforcement of institutional controls are essential to the long-term protection of human health and the environment.

## Appendix A

Proposed Charges to the Environmental Management Advisory Board for Soil and Groundwater Remediation: Best Practices for Implementing EM's Groundwater Closure Strategy and Long-Term Monitoring Paradigm

EM is supporting two projects that provide a framework for the remediation, closure, and longterm management of DOE's complex groundwater sites, where cleanup is expected to take decades or longer. The Environmental Management Advisory Board (EMAB) is asked to review these projects and provide advice regarding their complex-wide implementation.

Under the first project, led by EM's Office of Subsurface Closure, an EM complex-wide **groundwater management and closure strategy** is being developed (Savannah River National Laboratory (SRNL), May 2023). The strategy is based on identifying site needs and associated technical targets, developing an end-state vision for the complex groundwater plumes at each site (to be completed by the sites, with technical assistance from DOE national laboratory experts), and establishing overarching metrics to document and track progress in achieving the end states.

The second project, **Advanced Long-Term Environmental Monitoring Systems (ALTEMIS)**, addresses the extended periods of institutional control that will be required at most of DOE's complex groundwater cleanup sites where attenuation-based remediation is the final stage in achieving the end-state vision (SRNL, March 2023). This project is led by SRNL, Lawrence Berkeley National Laboratory (LBNL), and Pacific Northwest National Laboratory (PNNL), which are developing and demonstrating a long-term monitoring (LTM) framework that incorporates advanced hardware and software technologies, such as in situ sensors, geophysics, radiation mapping, and artificial intelligence/machine learning. These technologies are intended to optimize monitoring efficiency and cost-effectiveness and to identify and track vulnerable regions of contaminated sites or treatment systems.

EM believes the successful application of its groundwater closure strategy and long-term monitoring framework will help it to:

- Select and deploy site-specific, science-based solutions to challenging soil and groundwater problems in an adaptive, flexible manner during long-term remediation projects.
- Respond nimbly to changes (e.g., climate change, unexpected alterations in plume behavior, unanticipated decreases in remediation system effectiveness, presence of emerging contaminants) while ensuring continuous cleanup progress.
- Improve regulatory and stakeholder consensus-building regarding the selection and transition of remediation approaches and technologies over long time frames.

Implementing EM's groundwater closure strategy and LTM paradigms across the complex will require strong coordination between EM Headquarters (HQ), field managers, site contractors, regulators, Tribes, and stakeholders. It will particularly require efficient cooperation and

communication as multiple entities are interested and have a role in soil and groundwater remediation, regulatory compliance, technology development (TD), stakeholder engagement, and acquisition and project management. The EMAB is asked to review EM's groundwater closure strategy and ALTEMIS projects and to recommend best practices for complex-wide implementation and long-term success.

Two recent EMAB reviews, the first on regulatory reform (EMAB 2021) and the second on technology development for Hanford's tank waste mission (EMAB 2023), may help to inform the EMAB's review in terms of:

- How new technologies should be incorporated/incentivized in long-term EM mission activities.
- How progress can be measured and used to demonstrate how the new paradigms are working.
- How EM can promote regulatory acceptance of the end-state vision approach and the adaptive, flexible use of remediation and monitoring technologies.

## The following questions (in order of importance) can guide the review:

- 1. What are EMAB's recommendations for ensuring that the products of late-stage technology development are incorporated by EM sites and their contractors into the groundwater strategy for site cleanup and closure, particularly for large, complex groundwater plumes?
- 2. What are recommended approaches for EM to financially incentivize EM site contractors (through new or amended contracts) to identify, demonstrate, scale, and deploy new technologies for remediating and monitoring EM's most challenging and persistent groundwater plumes? Sources of new technologies are not limited to EM's Technology Development program (which funds ALTEMIS), but include other government, private, and academic research programs; external commercial entities; and DOE site contractors themselves. Incentivization should include defined rewards for federal employees and contractors who identify and contribute innovatively to the management of groundwater plumes; a process for contractors to propose site-based technology demonstrations or insertion points for new technologies; and a reporting mechanism that communicates results, costs, and benefits that are *specific to* the utilization of EM's groundwater closure strategy/ALTEMIS LTM paradigm.
- 3. How can EM better utilize the Tracking Restoration And Closure (TRAC) system (https://trac.pnnl.gov) for measuring progress toward site closure? Are there features that should be added to TRAC?
- 4. How should EM socialize the principles of its groundwater closure strategy and LTM approaches with sites, site contractors, regulators, Tribes, local communities, and stakeholders?

Feedback from EMAB is requested by August 2024. Please refer questions to Ms. Kelly Snyder, EMAB Designated Federal Officer, at Kelly.Snyder@em.doe.gov or (702) 918-6715.

#### References

- Savannah River National Laboratory, "Workshop Report: Innovative Strategies for Long-Term Monitoring of Complex Groundwater Plumes at DOE's Legacy Sites." Report SRNL-STI-2023-00103, prepared for the Department of Energy, March 2023.
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- EMAB, April 2021. Report to the Senior Advisor to the Undersecretary of Science United States Department of Energy: Observations and Recommendations on Regulatory Reform (https://www.energy.gov/sites/default/files/2021-04/EMAB-Regulatory-Reform-Report-April-2021.pdf)
- EMAB, May 2023. Report to the Senior Advisor Office of Environmental Management United States Department of Energy: Focused Review of the Research & Development Roadmap for Hanford Tank Waste Mission Acceleration.