Laboratory-Scale In-Situ Recovery and Restoration Demonstration Using Uranium Deposit Core Materials

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NuFuels, Inc.
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PROJECT MANAGEMENT PLAN

a. Executive Summary.

Concerns over groundwater usage and the associated disposal of wastewater hinders the cost-effectiveness of uranium in-situ recovery (ISR) operations and restoration efforts at many legacy sites associated with DOE and DOD. Any enhancement in the efficiency of groundwater usage and cost reduction related to subsurface remediation could have a large impact on the global competitiveness of the U.S. natural resource industry at restoration strategy at numerous legacy sites. The objective of the proposed research project is to demonstrate the capacity to restore groundwater geochemical conditions to background levels at uranium recovery operations through the application of restoration strategies optimized for pore-water/flow-water mixing and exchange. This will be accomplished by laboratory-scale experiments that first maximize mixing between pore-water and flow-water and then evaluate the performance of these maxing strategies in simulated post-ISR restoration approaches, including but not limited to, 1) groundwater sweeping, 2) active treatment through reverse osmosis and recirculation operations, 3) amendment injections, and 4) natural attenuation processes. The primary focus though will be on ISR restoration technologies that would result in reduced groundwater consumption during groundwater restoration activities following uranium ISR operations, though the results are likely to aid in the reduction of water usage at other uranium recovery related groundwater restoration projects such as legacy tailings operations. This study will be performed using uranium rich core collected from multiple representative locations from Nuclear Regulatory Commission (NRC) licensed ISR uranium properties owned by NuFuels, Inc. in the Grants Uranium District of New Mexico.

Specific project objectives include:
1. Construction of a representative laboratory-scale ISR testing facility that can be used to optimize pore-water/flow-water mixing and post-ISR restoration strategies.
2. Use the ISR testing facility to test new restoration strategies aimed at reducing the volume of water required to complete restoration and optimize the long-term stability of the restored subsurface.
3. Evaluate the economic impact of the new restoration strategies on domestic uranium production

The key innovations of the proposed research include:
1. Optimization of pore-scale mixing to improve the effectiveness of sweep operations and amendment deployment.
2. Examination of the effect of acoustic stimulation on pore-scale mixing.

3. Laboratory investigation of the potential impact of natural attenuation on the fate of uranium and other trace metals.

If successful, this study will have a significant impact on reducing the cost related to ISR, reducing the amount of water used in restoration efforts, and create a pathway for more sustainable uranium recovery operations in the United States. Additionally, a successful demonstration of the effectiveness of the remedial approaches developed in this research could inform regulators of how to setup robust and effective monitoring programs. Although the research developed here is geared towards the uranium industry, the techniques and strategies developed would benefit many DOE and DOD as well as legacy industrial sites that would benefit from water-efficient remedial approaches.

b. Risk Management.

Conceptual risks factors that potentially impede project progress are 1. Field Coring Risks and 2. Laboratory Risks. These are addressed below.

1. Field Coring Risks Factors
   - Access into the Church Rock property. NuFuels, Inc. has not finalized access from the State Highway into the Church Rock property. The company believes that the process will be completed before the core drilling program is scheduled to begin. If access into the Church Rock property becomes an issue it will not impede the project process because NuFuels will obtain the core material from the companies Crownpoint property where access is certain. NuFuels, Inc. would prefer to core drill at the Church Rock property because drilling costs are less at Church Rock than at Crownpoint. It should be noted that whichever property is chosen for core drilling and water sampling there would be no cost difference to the Government because all drilling costs are included in NuFuels, Inc.'s shared cost fraction of total costs.
   - Weather related problems. By its very nature, field work is outdoors and subject to weather conditions. Extensive rain or extreme cold can delay drilling activity. Fortunately, the project schedule calls for drilling in the fall which is traditionally very dry and mild in the desert south west. In the event that there is a weather related delay drilling will be put on hold until conditions improve.
   - Equipment failure. Drilling will require a drill rig and ancillary mechanical equipment. Such equipment is subject to breakage and if breakage occurs project progress would be temporarily impeded. The Church Rock and Crownpoint properties are relatively close to cities with parts and mechanics that would facilitate repairs in the event of an equipment breakdown. As such any delay would be short term.
   - Drilling and water sampling operational problems. Because the activity occurs in natural geologic conditions, coring and water sampling is subject to unexpected problems that may temporarily delay project process. For example, drilling and coring may experience hole collapse or dropped core resulting in more time and effort to retrieve the core or even having to drill a twin hole. Water sampling may experience an unknown problem such as a well that requires remediation. NuFuels, Inc. has mitigated these operational delays by using a drilling contractor with

extensive drilling and coring experience in McKinley County and having the drilling and water sampling operation supervised by a professional geologist with experience drilling and water well sampling in the region.

2. Laboratory Risks

- The pressurized columns that will be use to conduct the experiments will require custom fabrication. Additionally, other equipment such as pumps will be unique to the laboratory set-up. As such, the budgeted $100,000 cost estimate may be an insufficient amount. If so, NuFuels, Inc. has established a generous contingency in its cost share amount and the company is prepared to fund the amount that may exceed $100,000 when they procure the equipment.

c. Milestone Log.

Groundwater Restoration R&D Study With Uranium Core and Groundwater Groundwater Restoration R&D Study With Uranium Core and Groundwater Milestone Log (Assume Project Award 08/25/21)			
Task (Milestone)		Start	End
Task 1. Drilling, ore Retrieval, and Borehole Logging		8/25/2021	12/30/2021
	Contract with drillers, field support (MD)	8/25	9/17
	Mobilize equipment and begin core drilling and water sampling campaign (MD)	10/4	10/4
	Drilling and water sampling. Transport core and water to LANL (MD)	10/4	11/22
	Drill site cleanup and reclamation	11/22	12/30
Task 2. Optimize of Pore-Scale Mixing (MY)		1/22	3/22
Task 3. Construction of Laboratory-Scale ISR Testing at LANL (MY)		11/21	6/22
Task 4. Simulation of In Situ Recovery Preocess (MY)		4/22	7/22
Task 5. Optimization of Post-ISR Restoration Strategies (MY)		8/22	5/23
	Task 5.1 Reverse Osmosis Only (MY)	8/22	11/22
	Task 5.2 Reverse Osmosis with Abiotic Reduction (Dithionite) (MY)	9/22	5/23
Task 6. Natural Attenuation (MY)		12/22	5/23
Task 7. Techno-economic Assessment of Post-ISR Restoration Strategies from Tasks 4 through 6 (MY)		4/23	8/23

During project performance, the PI will report the milestone status for each Task and Subtask as part of the required quarterly Progress Report as prescribed under the Reporting Requirements Checklist. The Milestone Status will present actual performance in comparison with Milestone Log, and include:

1) the actual status and progress of the project;
2) specific progress made toward achieving the project's milestones; and
3) any proposed changes in the project's schedule required to complete milestones.

d. Funding and Costing Profile.

The Project Funding Profile below shows, by budget period, the amount of government funding going to each project team member.

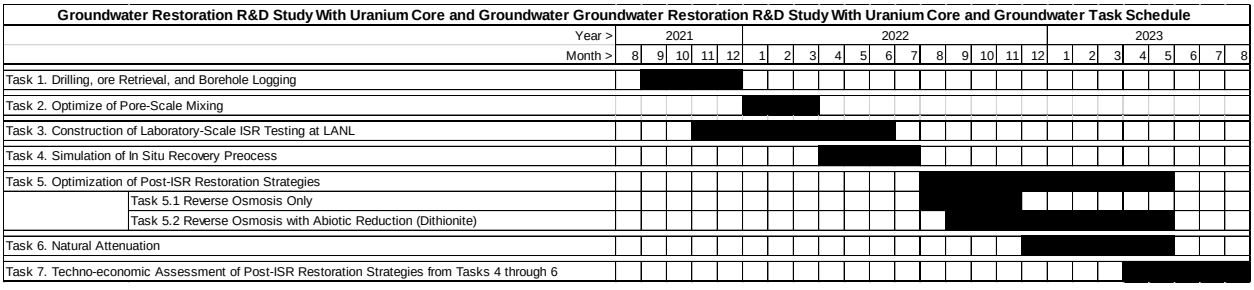
Project Funding Profile			
Budget Period	Government Funding to NuFuels, Inc.	Government Funding to LANL	Total Government Funding
Task 1	$20,000	Included in Task 1-7	$20,000
Tasks 2-7	$235,000	$785,000	1,020,000

The Project Costing Profile below shows monthly expenditure of government funds.

Project Costing Profile		
Task 1 – Core Drilling		
Nufuels, Inc.	$ 20,000	August 24-December 30, 2021
LANL	Incl. Tasks 2-7	
Tasks 2-5 Laboratory Research		
Nufuels, Inc.	$235,000	November 2021 – August 2023
LANL	$785,000	November 2021 – August 2023

e. Project Timeline.

A timeline broken down by each task and subtask, as described in the Statement of Project Objectives is shown below. The timeline includes for each task a start and end date. The timeline shows interdependencies between tasks and include the milestones that are identified in the Milestone Log (Section 4.c.).



f. Success Criteria at Decision Points:

Success criteria for each decision point in the project, and go/no-go decision points will be Task dependent and are presented in the Table below. Budget periods for the project will be Task 1 which spans from August 24-December 30, 2021 and Tasks 2-6 which spans from November 2021 – August 2023. The potential for a no-go decision is extremely small through Tasks 2-6. If a situation were to occur that would result in a no-go decision during Task 2-6, the PI would

provide information related to a no-go scenario in the immediate quarterly report and explain how government funding and the budget would be affected.

Success Criteria at Decision Points	
Task	Go/No Go Decision Analysis
1. Drilling and water sampling	If the drilling and/or water sampling activity fails then the project would terminate. The risk of coring failure is low but it is plausible because drilling and water sampling occurs in natural systems. The financial risk to the Government of a drilling or water sampling activity is minimal because most all fed funding is provided during Tasks 2-7.
2. Optimize of Pore Scale Mixing	There is no potential for a no-go decision during Task . Task 2 is performed by LANL scientists with extensive knowledge of the subject matter.
3. Construction of Laboratory-Scale ISR Testing at LANL.	There is little potential for a no-go decision during Task 3. The is the potential for delays as a result of the availability of materials but these delays would be made up over the course of the project.
4. Simulation of the ISR process.	There is no potential for a no-go decision during Task 4. Task 4-6 experiments are in a controlled laboratory setting which are routinely performed by LANL scientists.
5. Optimization of Post-ISR Restoration Strategies.	There is no potential for a no-go decision during Task 5. Task 4-6 experiments are in a controlled laboratory setting which are routinely performed by LANL scientists.
6. Natural Attenuation.	There is no potential for a no-go decision during Task 6. Task 4-6 experiments are in a controlled laboratory setting which are routinely performed by LANL scientists.
7. Techno-economic Assessment of Post-ISR Restoration Strategies from Tasks 4 and 5.	There is no potential for a no-go decision during Task 7. Task 7 is based on analysis of Tasks 4-6.