

## **REQUEST FOR PROPOSAL DIRECTOR'S REVIEW**

Pilot Program to Determine Best Techniques for Remediating Contaminates from Soil Surrounding Legacy (1951-1984) Waste Pits in North Central North Dakota (Section 9 of House Bill No. 1358 – 2015 Legislative Session)

### **Purpose**

The Industrial Commission, as recommended by the Oil and Gas Research Council, requested proposals from North Dakota research facilities to conduct a pilot program to determine the best techniques for remediating salt and any other contamination from the soil surrounding legacy (1951-1984) waste pits in North Central North Dakota reclaimed by trenching. A copy of the request for proposals (RFP) is available on the OGRP website.

### **Submitted Applications and Review Process**

Two proposals were received: submitted by the Energy and Environmental Research Center (EERC) and North Dakota State University (NDSU). One additional recipient of the RFP declined to submit a proposal noting that one growing season was not sufficient time to conduct the work outlined in the RFP.

To assist in the review of the two proposals four independent confidential technical reviewers were tasked with reviewing each proposal and choosing the best proposal in meeting the requirements outlined in the law and in the RFP.

- Identified techniques should be utilized for at least one growing season.
- Research facility should consult with the Department of Mineral Resources and Northwest Landowners on site selection.
- Final report should include a list of best practices.
- Final report should include a long term management/monitoring plan for the Department of Mineral Resources - Abandoned Oil and Gas Well Plugging and Site Reclamation Fund oversight.

The confidential reviewers represented a diverse group of professionals in the areas of reclamation management, farming and ranching in North Dakota, and soil science.

### **Results and Director's Recommendation**

The technical reviewers voted 3-1 in favor of the EERC proposal. In addition to funding the EERC proposal, I recommend additional State funding be considered for finding the best techniques for remediating contaminants from soil.

July 31, 2015

Ms. Karlene Fine  
North Dakota Industrial Commission  
ATTN: Oil and Gas Research Program  
State Capitol – 14th Floor  
600 East Boulevard Avenue, Department 405  
Bismarck, ND 58505-0840

Dear Ms. Fine:

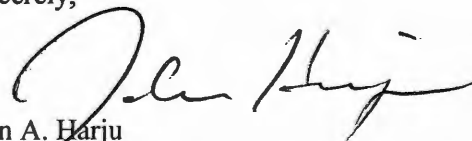
Subject: EERC Proposal No. 2016-0003 Entitled “Pilot Project to Remediate Soil Surrounding Legacy Brine Pits” in Response to the North Dakota Industrial Commission Oil and Gas Research Program Solicitation

The Energy & Environmental Research Center (EERC) is pleased to propose a research project designed to determine the best techniques for remediating salt and any other contamination from the soil surrounding waste pits reclaimed by trenching between 1951 and 1984 in the north-central portion of this state.

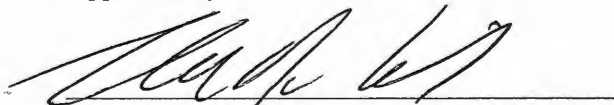
Enclosed please find an original and four copies of the subject proposal along with a check for \$100. The EERC, a research organization within the University of North Dakota, an institution of higher education within the state of North Dakota, is not a taxable entity; therefore, it has no tax liability.

This transmittal letter represents a binding commitment by the EERC to complete the project described in this proposal. If you have any questions, please contact me by telephone at (701) 777-5157, by fax at (701) 777-5181, or by e-mail at [jharju@undeerc.org](mailto:jharju@undeerc.org).

Sincerely,

  
John A. Harju  
Associate Director for Strategic Partnerships

Approved by:

  
Thomas A. Erickson, Director  
Energy & Environmental Research Center

JAH/kal

Enclosures

c/enc: Brent Brannan, Oil and Gas Research Council

## Oil and Gas Research Program

North Dakota

Industrial Commission

## Application

Project Title: Pilot Project to Remediate Soil  
Surrounding Legacy Brine Pits

Applicant: Energy & Environmental Research  
Center

Principal Investigator: Jay C. Almlie

Date of Application: July 31, 2015

Amount of Request: \$500,000

Total Amt. of Proposed Project: \$500,000

Duration of Project: 22 months

Point of Contact (POC): John A. Harju

POC Telephone: (701) 777-5157

POC E-Mail Address: jharju@undeerc.org

POC Address:

15 North 23rd Street, Stop 9018

Grand Forks, ND 58202-9018

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## **ABSTRACT**

### **Objective**

The Energy & Environmental Research Center (EERC), along with internationally recognized experts Kerry Sublette (Sublette Consulting, Inc.) and Ken Carlson (Habitat, Management, Inc.), proposes a research project with the goal of selecting, applying, and validating the best techniques for remediating salt and any other contamination from the soil surrounding legacy (1951–1984) waste pits in north-central North Dakota reclaimed by trenching. Prior to 1982, North Dakota permitted storage of high-salinity produced water resulting from oil production in evaporation ponds. The remaining soil salinity and subsequent diffusion transport left many scarred acres of land across hundreds of pit sites. This pilot project will demonstrate successful approaches to remediate these brine pit sites and will provide a blueprint for additional repeated reclamation activities by state and/or industry entities.

### **Expected Results**

The results of the proposed work will demonstrate current best practices and possible improved/advanced practices to remediate these saline-affected sites and will validate cost estimates for such remediation efforts. It is anticipated that this demonstration will provide a blueprint for remediation of other legacy brine pit sites in Renville and Bottineau Counties. The affected soils will be remediated and made conducive to native seed germination, restoring the site to fertile condition.

### **Duration**

The duration of the proposed project will be 22 months (September 1, 2015, to June 30, 2017), which includes one growing season, as specified in HB1358 Section 9.

### **Total Project Cost**

The total cost of the project is \$500,000. The amount requested from the Oil and Gas Research Council (OGRC) is \$500,000. Complementary resources of approximately \$200,000 have been made available via existing funding through the Bakken Production Optimization Program, cofunded by the North Dakota Industrial Commission (NDIC) and its industry members. This linkage stems from preexisting parallel efforts within the Bakken Production Optimization Program (BPOP). BPOP has been working toward remediation demonstrations during the past year in close cooperation with its industry sponsors.

### **Participants**

Proposed participants include the EERC; the NDIC Oil and Gas Research Program (OGRP); Sublette Consulting, Inc.; Habitat Management, Inc.; and Mr. Daryl Anderson, affected landowner. Additional financial and technical input from members of the Bakken Production Optimization Program will be utilized to leverage the demonstration effort.

## PROJECT DESCRIPTION

The Energy & Environmental Research Center (EERC) and its partners Sublette Consulting, Inc., and Habitat Management, Inc., propose to develop a pilot project and perform a demonstration with the goal of providing a framework for addressing and remediating brine impacts from legacy waste pit activities operated from 1951 through 1984.

The proposed activities will be performed at an existing legacy brine-impacted site in Bottineau County and will compare and contrast the efficacy of “best available conventional practices” against “common practices,” as well as demonstrate the potential for a novel brine remediation technology. The proposed demonstration site is unique in the sense that the brine-impacted soils are separated by an access road and well location, creating two distinct impacted areas approximately equal in size (approximately 1.5 acres each) and a third smaller area (approximately 0.5 acres) which is separated from the other two impacted areas by a reclaimed road. This separation enables the application of different remediation activities in a “test plot” approach.

The EERC intends to couple the efforts mandated by HB1358 with its existing spill remediation and land reclamation work under way within the Bakken Production Optimization Program, thereby leveraging the potential of both efforts to magnify the impact of results achieved from this legacy brine pit remediation demonstration.

**Goals and Objectives:** The primary goals of the proposed project are to a) apply a best practice, a common practice, and a novel remediation approach to a representative field site with distinct and separated areas to facilitate direct comparison of alternatives and b) validate each approach for efficacy and cost. Specific objectives supporting these goals include initial site characterization to determine areal and vertical extent of brine contamination; site remediation support system design (drain tile, sumps, wells, irrigation, deep hydraulic delivery); site preparation; extensive site irrigation at the best practice site area and hydraulic delivery of amendments at the novel technique site area; and periodic, regular soil sampling until threshold levels are met.

**Methodology:** All work will be conducted as outlined in the proposed Scope of Work and, if necessary, with clarifications and modifications directed by the Oil and Gas Research Council (OGRC).

**1. Safety Plan and Risk Assessment.** A site-specific project safety plan, a general health and safety plan, a hazard communication program, and a complete project risk assessment will be developed immediately after contract award.

**2. Study Site Selection.** A suitable study site (Study Sites N, S, and SW, collectively, as shown in Figure 1) that represents a typical legacy waste pit that has been previously reclaimed using a variety of soil mitigation and revegetation techniques and requires additional mitigation has been selected. The site's use has been negotiated prior to submittal of this proposal. The site is an oil production facility located in the Wiley Field area in Bottineau County, near the town of Renville. The Bull B1R Tank Battery is located in the eastern half of the southwest quarter of Section 23, Township 161 North, Range 82 West.

Approximately 3.5 acres are impacted by produced brine water, distributed among three distinct areas. A letter of commitment for the study site can be found in Appendix B.

**3. Preliminary Document Review and Site Assessment.** A preliminary assessment of past reclamation plans, reports, and activities for each of the selected study site areas will be completed. Well pad site maps with aerial images, topography, Natural Resources Conservation Service (NRCS) soil surveys, and initial and current brine impact areas will be developed. The preliminary assessment will

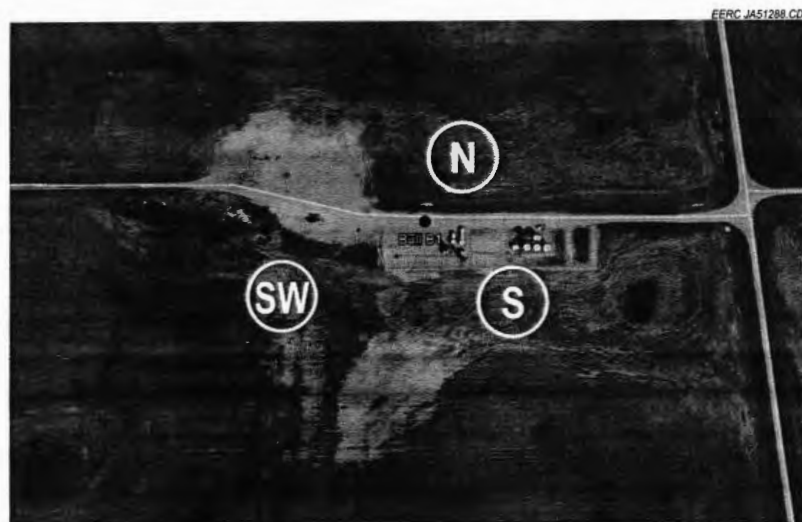


Figure 1. Selected study site – Bull B1.



involve an initial site reconnaissance visit to examine the current well pads and operating facilities and become familiar with the details of the project area, such as surface water impacts, vegetation establishment, surface soil conditions, erosion, and topographic relief. An EM (electromagnetic) survey will be conducted on-site in August 2015 to determine the electrical conductivity (EC) concentrations of the near-surface soils.

**4. Baseline Sampling Plan.** Current aerial photography, site maps, and EM survey maps along with the site inspection notes will be compiled and reviewed to develop a baseline monitoring plan for the selected site in 2015. Because of the critical time constraints to get the site mitigated and revegetated by October 2015, the baseline monitoring plan will be developed by mid-September 2015.

**5. Baseline Site Characterization.** Baseline site characterization will be conducted to effectively determine the baseline conditions of the soil, vegetation, and other site parameters resulting from previous site mitigation and revegetation activities. An EM survey will be conducted, vegetation sampling of existing cover will be conducted, soil sampling will be completed, and irrigation water will be sampled and analyzed.

**6. Soil Mitigation Plan.** This demonstration project will prescribe that one area be treated using BACT (best available conventional technology) for brine remediation, a second area be treated using common industry practices, and a third area be treated using a novel method of hydraulic delivery remediation amendments to the subsurface. The baseline soil coring data and the EM survey will be analyzed to determine the mitigation methods and amendment rates for each site area. A French drain gallery and irrigation system will be designed. The soil mitigation plan will account for the fact that previous mitigation attempts have been tried and failed to produce successful results.

#### **7. Execution of Soil Mitigation Plan**

*a. BACT at Site Area N.* Best practice for remediation of brine-impacted soil optimizes each aspect of the remediation protocol. Therefore, best practice as demonstrated in this project will include the following:

- 1) amendments of a calcium source with high surface area (such as gypsum flour) and a source of readily biodegradable organic matter,
- 2) deep ripping and tilling to incorporate amendments to maximum depth achievable with commonly available field equipment,
- 3) installation of a tile drainage system and sump to collect salty leachate for disposal,
- 4) installation of an irrigation system to supply necessary freshwater, and



5) placement of a thick mulch cover to maximize infiltration of irrigation water and rainfall. This practice will be applied to the north test area.

*b. Novel Hydraulic Delivery Remediation Amendments at Site Area SW.* The southwest test area will be treated in a similar way, with the exception of the use of a novel hydraulic delivery method for injection of remediation amendments. This method will allow the amendments (a calcium source and an injectable organic matter) to be injected at a desired rate to an injection depth determined by the depth of contamination, the depth of any low permeability zones, and salinity and sodicity profiles. This means of delivery of amendments will have the added benefits of 1) deeply fracturing the soil profile increasing permeability (and, therefore, rates of migration of salty leachate) and 2) deeply injecting large quantities of freshwater during application of the amendments. It is anticipated that the net result will be greater rates of salt removal from the site and higher reaction rates in the soil to displace sodium from clays, reducing sodicity and rebuilding soil structure. Therefore, it is anticipated that the site will more rapidly be prepared for revegetation.

Hydraulic injection of remediation amendments is labor-intensive and may be cost-prohibitive for most brine-impacted sites but may be ideal for sites that are difficult to access, such as sites with steep slopes or for sites where mobilization and collection of brine components is very time sensitive because of a threat to environmental receptors.

*c. Control or Common Practice Site S.* The results of implementation of the best practice protocol and the more novel hydraulic amendment delivery system described above will be compared to common practice. In the experience of the principal investigators, common practice typically consists of a) limited shallow cultivation of soil; b) shallow incorporation of remediation amendments, typically mine-quality (low surface area) gypsum; c) little or no irrigation; d) no subsurface drains; and e) no fencing for livestock to prevent soil compaction. This is basically the protocol employed in previous remediation attempts at this site in 2007. This general treatment approach will be repeated but will include much more extensive site characterization and subsequent site monitoring, allowing demonstration of the behavior of brine

components in the soil in common practice as compared to the two more science-based approaches outlined above.

**8. Site Monitoring and Management.** Irrigation will be initiated on-site in early May 2016. Weekly inspections of the irrigation system for coverage and leaks will be conducted. The site will also be inspected for erosion and the presence of noxious weed infestations. Vegetation and soil monitoring will be conducted in June and September 2016.

**9. Best Available Remediation Methods Report (final report).** Following the conclusion of the proposed field work, a final project report will document the results of field tests and compare outcomes of application of best available conventional remediation methods to the novel amendment and common practice application methods described above. These results will also be compared to case studies of applications of basic brine remediation principles as applied by various producers in North Dakota to the extent that adequate data can be obtained. Following the report submittal, the EERC will be available to brief state entities as needed through the end of the 2017 Legislative Session.

**Anticipated Results:** Quantitative assessment of each of three approaches will clearly demonstrate best practices for other similar legacy brine pit spill sites. This activity will result in a nearly complete return to foliage cover of the previously contaminated site. Although several additional years will be required for foliage to normalize to match surrounding natural plant biota, testing of the soils will prove that the soils are capable of supporting normal, natural, native plant growth indistinguishable from surrounding biota. This return to productive land utilization will yield public relations benefits to the state and industry partners involved in the project, possibly leading to a decrease in overall landowner fatigue with industry. The project will yield valuable insights to guide state regulators in protecting North Dakota lands.

**Facilities, Resources, and Techniques to Be Used:** The EERC possesses a number of laboratory facilities that may be employed at will by individual tasks within this project. The Applied Geology Laboratory conducts geomechanical, petrographic, geochemical, and customized core sample-related experiments designed to solve targeted problems in the oil and gas industry. The Natural Materials Analytical Research Laboratory includes x-ray diffraction, x-ray fluorescence, and scanning electron

microscopy systems. The Analytical Research Laboratory conducts wet-chemistry and advanced trace element analyses. The Water and Wastewater Treatability Laboratory offers bench- and pilot-scale testing and evaluation of a variety of processes for the treatment of wastewaters, contaminated groundwaters, and soils. The EERC's experienced staff encompasses the geology, chemistry, physics, and engineering disciplines. These laboratories have decades of experience and have been instrumental in conducting a broad range of wastewater cleanup, soil remediation, and Bakken research activities. Highly competent out-of-state soil laboratories will also be utilized.

**Environmental and Economic Impacts While Project Is under Way:** The project will likely exhibit the following environmental and economic impacts:

**Environmental**

- Increased vehicle and equipment traffic at the site.
- Disturbance of the brine-impacted surface areas to perform soil sampling, install drain tile systems, and perform remediation activities such as amendment placement and tillage.
- Disturbance of nonimpacted surface areas to install an irrigation well.
- Creation and off-site disposal of additional brine from the drain tile system(s).

**Economic**

- The project will generate additional revenue for the selected contractors installing infrastructure and executing remediation activities as well as for any outside laboratories that are contracted to perform analysis.

**Ultimate Technological and Economic Impacts:** Ultimately, it is anticipated that the results of this activity will provide a blueprint for successful remediation of multiple additional legacy brine pit sites of similar character and composition. Successful remediation of the selected site will demonstrate that hundreds of other similar legacy sites in north-central North Dakota can be remediated in a similar manner. Also, the costs of such remediation efforts will be well established, allowing industry and the state of North Dakota to address these scarred lands responsibly for improved landowner relations.

The data collected during this demonstration will also be available for use with other current and future remediation efforts across the state. Lessons from this project will be applicable throughout the state and will address a large public relations liability for both industry and the state of North Dakota. Lessons learned from this project will be disseminated via outreach efforts already under way within the Bakken Production Optimization Program, managed by the EERC.

**Why the Project Is Needed:** During the past few years of Bakken growth, landowners have become increasingly fatigued by industry efforts to negotiate cooperative use of landowners' surface rights to gain access to subsurface mineral resources. This fatigue has been exacerbated by hundreds of spills that remain unaddressed decades after the fact in north-central and northwestern North Dakota. In many cases, the entities responsible for the spills no longer exist, leaving the state no recourse to encourage industry remediation efforts or pursue punitive damages to financially support state-directed remediation efforts. In turn, this leaves landowners wary of new agreements with industry to engage in new exploration pursuits.

From industry's perspective, there has been little incentive, other than positive public relations, to address spills that were not caused by current, active industry entities. This is especially true given that these decades-old legacy spill sites are much more difficult (and, therefore, expensive) to remediate after decades of weathering action and soil diffusion. The unknowns of remediating aged, weathered, affected soils increase the liability encountered by any companies willing to step up, even if only for improved public relations. This proposed project will provide both state and industry interests a successful path forward with known costs and known outcomes, possibly encouraging a more rapid pace of reclamation of these sites.

### **STANDARDS OF SUCCESS**

Success will be achieved when the soil is returned to fertile conditions supportive of native species plant growth. This will be validated through multiple soil tests. Although the project intends to seed and germinate native plant species as part of the methodology, the short, single growing season prescribed within the scope of HB1358 will not necessarily result in final results for complete reclamation of the affected land. Plant growth will continue to reclaim the affected land for several growing seasons. However, this proposal team strongly believes that sufficient data will be obtained within the relatively short

prescribed project schedule to declare success in the absence of final normalized results. Data from soil samples before and after new plant germination will demonstrate a sustained return to normal soil salinity levels supportive of unfettered plant growth.

All results of the demonstration project will be made available via reports to the North Dakota Industrial Commission (NDIC) and via the Bakken Production Optimization Program Web site, as this work is inextricably linked to the soil remediation and land reclamation work already under way within that program and with participation from program partners. Success will also be measured by timely achievement of project objectives.

### **Deliverables**

1. Quarterly reports to the Oil and Gas Research Program (OGRP) highlighting results of ongoing remediation efforts and outlining upcoming activities.
2. Final report to OGRP summarizing project achievements and including a data package containing soil sample results, cost analysis, and before/after photographs of site reclamation.

### **BACKGROUND/QUALIFICATIONS**

**Personnel:** Resumes of key personnel are provided in Appendix A. John Harju, EERC Associate Director of Strategic Partnerships, will serve as project advisor. Jay Almlie, EERC Senior Research Manager, will serve as project manager, and Brad Stevens, P.E., Research Engineer, will serve as principal investigator and will guide technical aspects and integration of the project, including direction of contractors.

**Energy & Environmental Research Center:** The EERC is a high-tech, nonprofit branch of the University of North Dakota, exclusively conducting contract research for a multinational client base. The EERC's oil and gas experience is highlighted within the Center for Oil and Gas, a specialized technical group focusing on design and implementation of new approaches to the exploration, development, and production of oil and gas. Related ongoing projects include the Bakken Production Optimization Program, which includes tasks focused on soil remediation and land reclamation, and the North Dakota legislature-mandated Gathering Pipeline Study. Related projects conducted in the past include studies

focused on the Williston, Powder River, Denver–Julesburg, and Alberta Basins, and multiple soil and groundwater remediation efforts within the Water Management Center.

**Sublette Consulting, Inc.:** Sublette Consulting, Inc., will contract with Habitat Management to accomplish in-field work and will provide spills remediation expertise. Kerry Sublette is a nationally renowned expert in practical solutions for remediation of contaminated soils. Sublette Consulting, Inc. has completed contaminated soil remediation projects in seven states and has extensive experience with oilfield contamination, including brine spills.

**Habitat Management, Inc.:** Habitat Management, Inc., will contract with the EERC to provide in-field direction of all field efforts and soil science expertise to the project. Ken Carlson has over 33 years of soil science, environmental permitting, and operational experience in the oil and gas industry. He has technical and project managerial expertise in baseline data collection and assessments, reclamation success evaluations, reclamation liability releases, noxious weed control, construction oversight, and environmental compliance and audits. He has completed a large number of baseline soil and vegetation surveys, topsoil substitution and overburden suitability determinations, acid/alkaline soil-handling plans, saline and sodic soil mitigation plans, test plot studies, and disturbed land reclamation plans. Mr. Carlson and team members were awarded the 2012 Excellence in Reclamation Award for abandoned mine land reclamation work near Raton, New Mexico. He has completed projects in Arizona, Colorado, Kansas, Kentucky, Louisiana, Minnesota, Mississippi, Missouri, Montana, Nevada, New Mexico, Texas, Utah, and Wyoming.

## **MANAGEMENT**

The EERC manages approximately 216 contracts a year, with more than 1300 clients in 52 countries. Best practices are provided to EERC project managers and clients with regard to fund accounting, budget reporting, contract milestone tracking, and contract services. The deliverables of this proposal will be incorporated into a contract agreement ensuring timely accomplishment of milestones. Progress reports will be prepared on a quarterly basis and will serve as a means of evaluating the project with respect to budget, schedule, and technical achievement.



Jay Almlie, Senior Research Manager, will oversee the project. He will be responsible for understanding technical details, budget details, schedule details, project coordination, guidance, and supervision to ensure consistent progress. Further, he will be responsible for communicating project and task progress to NDIC OGRC on a regular basis via reports and in-person meetings with NDIC OGRC.

Brad Stevens, P.E., Research Engineer, will provide technical experience and expertise. He has a background in commercial remediation efforts and will be highly effective in coordinating the efforts of the proposed contractors. Mr. Stevens will also be responsible for interpreting and reporting results in coordination with the project manager.

### TIMETABLE

This project is proposed as a 22-month project beginning on September 1, 2015, and ending on June 30, 2017, as prescribed by HB1358. As dictated by the terms of the OGRC request for proposals, all field work will be completed in time to provide a final project report to OGRC by November 1, 2016. OGRC will be briefed upon request or at its semiannual meetings. The EERC will also be available to brief legislative committees and other state agencies as required during the course of the project. Figure 2 summarizes the project timetable.

### BUDGET

The total cost of the project and the amount requested from OGRC is \$500,000 (see Table 2 for budget breakdown). Complementary resources of approximately \$200,000 have been made available via existing

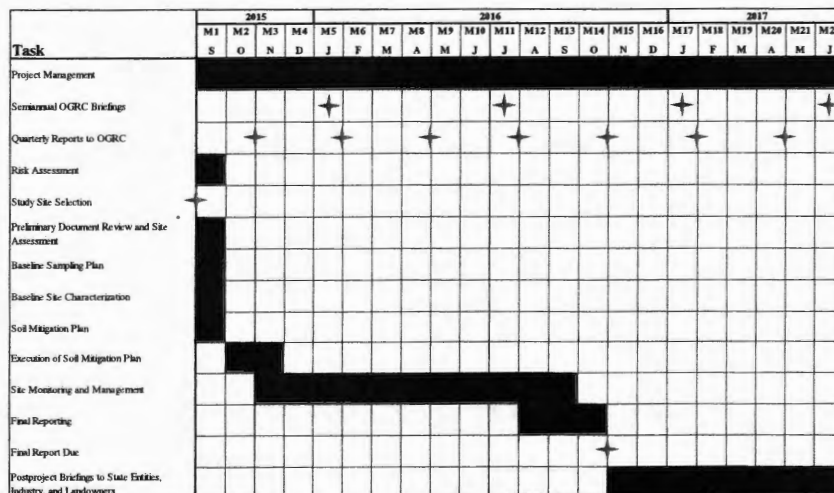


Figure 2. Preliminary project timetable.



**Table 2. Budget Breakdown**

Labor	\$53,231
Travel	\$6,377
Supplies	\$200
Subcontractor – Habitat Management, Inc.	\$387,887
Other	\$177
Laboratory Fees & Services: Graphics Service	\$6,120
Total Direct Costs	\$453,992
Facilities & Admin. Rate – % of MTDC – 50.5%	\$46,008
Total Project Costs – U.S. Dollars	\$500,000

funding through the Bakken Production Optimization Program, cofunded by NDIC and by industry members including Continental Resources, Marathon Oil, Whiting Petroleum, Oasis Petroleum, SM Energy, Hess Corporation, ConocoPhillips, XTO Energy, Nuverra Environmental Solutions, and Hitachi Data Systems. This project linkage stems from preexisting parallel efforts within the Bakken Production Optimization Program. This program has been working toward remediation demonstrations during the past year with the concurrence of the Bakken Production Optimization Program's industry membership. The EERC will contract with Habitat Management Inc. to accomplish much of the required fieldwork (a budget justification is included in Appendix C). Dr. Kerry Sublette, of Sublette Consulting, Inc., will contract with Habitat Management to accomplish in-field work and will provide spills remediation expertise.

**CONFIDENTIAL INFORMATION**

There is no confidential information included in this proposal.

**PATENTS/RIGHTS TO TECHNICAL DATA**

No patentable technologies are expected to be created during this work.

**STATUS OF ONGOING PROJECTS**

The EERC has previously been awarded OGRC funding for several different projects. Active projects include the Plains CO<sub>2</sub> Reduction Partnership; the Program to Determine the Uniqueness of the Three Forks Bench Reserves, Determine Optimal Well Density in the Bakken Pool, and Optimize Bakken Production (also known as the Bakken Production Optimization Program, or BPOP); the project known as the Oil Characterization Study; and the Produced Fluids Gathering Pipeline Study (commissioned by the 64th North Dakota Legislative Assembly). The status of those projects is presented in Appendix D.