

Establishing an Early CO₂ Storage Complex in Kemper County, Mississippi: Project ECO₂S

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Abstract

The CarbonSAFE Phase II: Storage Complex Feasibility project, entitled “*Establishing an Early CO₂ Storage Complex in Kemper County, Mississippi: Project ECO₂S*,” demonstrates that the subsurface adjacent to the Kemper County energy facility can safely and permanently store commercial-scale volumes of carbon dioxide (CO₂). Project ECO₂S is led by the Southern States Energy Board (SSEB). Mississippi Power Company (MPC) serves as the site host. The project includes technical and field implementation support from Advanced Resources International (ARI) and obtains analytical support from two national laboratories (Los Alamos and Lawrence Berkeley), a host of universities, and other key participants.

A 30,000-acre area of interest was established. Three new characterization wells were drilled to facilitate the detailed geologic analyses, characterization, and modeling of three prospective storage reservoirs. The results verify and validate that the subsurface reservoirs examined have gigatonne CO₂ storage potential. This final report documents the achievements of the project team in successfully attaining the goals and objectives set forth for the project and summarizes the results of the feasibility study.

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Experimental Methods / Approach

Project ECO₂S pursued key advances in CO₂ storage knowledge and technology, including optimizing CO₂ storage efficiency, modeling the fate of injected CO₂, and establishing residual CO₂ saturations. In addition, Project ECO₂S involved “real-life” experiences, issues, and challenges of scaling-up from its regional, pre-feasibility assessment of CO₂ storage to establishing a site-specific, commercial-scale CO₂ storage facility, including capturing the “lessons learned” in making this transition.

Project ECO₂S supported all four of DOE’s Carbon Storage R&D Program objectives by integrating flow-unit level characterization of three major saline formations with state-of-the-art reservoir modeling, Project ECO₂S further refined the project team’s understanding of CO₂ storage efficiency and containment. By rigorously modeling the areal (and vertical extent) of the prospective CO₂ plume, Project ECO₂S enhanced industry’s ability to predict (as well as optimize) CO₂ storage capacity. The project team also engaged in extensive storage site screening and characterization as well as risk analysis (using DOE/NETL developed NRAP tools). Finally, Project ECO₂S drew on geomechanical modeling by Virginia Polytechnic Institute and State University, the University of Alabama at Birmingham’s Caprock Integrity Laboratory, and the DOE/NETL Carbon Storage Program’s NRAP tools to ensure 99% storage permanence.

Results and Discussion

Schedule/Milestone Status

Task 1.0 – Project Management and Planning

Subtask 1.1 – Overall Project Management, Planning, and Communication

Upon award, SSEB issued sub-recipient contracts to Advanced Resources International, Inc. (ARI), Auburn University (AUB), Gerald R Hill PHD, Inc. (Hill dba Crescent Resource Innovation), Pashin Geoscience, LLC (Pashin), Trimeric Corporation (Trimeric), the University of Alabama at Birmingham (UAB), and the University of Wyoming (UW). ARI managed the technical and field operations and issued sub-recipient contracts to the partners that provided services in the field that were most likely to incur the Mississippi contractors’ tax, including Battelle Memorial Institute (Battelle), Geological Survey of Alabama (GSA), GHG Underground (GHGU), Loudon Technical Services, LLC (Loudon), Mississippi State University’s (MSU) Department of Geosciences, Oklahoma State University (OSU), and Virginia Polytechnic Institute and State University (VA Tech). Southern Company Services (SCS) provided management oversight on behalf of Mississippi Power Company (MPC), a subsidiary of Southern Company, as it related to the work completed on MPC property but did not receive a formal sub-recipient contract. Lawrence Berkeley National Laboratory (LBNL) and Los Alamos National Laboratory (LANL) conducted work through Field Work Proposal (FWP) agreements that were approved directly by DOE/NETL.

SSEB monitored and tracked the project’s technical and financial progress. SSEB coordinated and reviewed all deliverables from sub-recipients and submitted them to DOE/NETL. SSEB evaluated the progress of each task through frequent communication with the lead sub-recipients. SSEB provided financial management of the overall project to include issuing sub-recipient contracts, budget negotiations and tracking, and monitoring federal cost and cost share for SSEB and the project team. SSEB enforced reporting

requirements to meet DOE requests and assisted subgrant holders in compliance with the requests.

SSEB provided regular briefings to DOE/NETL and attended the Kickoff Meeting and annual program review meetings, the last of which in 2020 included a final project briefing to report project status. To support and foster knowledge sharing and interaction within the project team, SSEB hosted several conference calls and annual team meetings. Milestone 1, *Participate in Project Kickoff Meeting*, was completed on March 15, 2017. The presentation that fulfills the milestone 1 requirement is available for download at <https://www.osti.gov/biblio/1608444-establishing-early-carbon-dioxide-storage-complex-kemper-county-mississippi-project-eco2s-milestone>

Subtask 1.2 – Project Management Plan

Project ECO₂S was managed in accordance with the current and approved Project Management Plan (PMP). The PMP is a living document that outlines the project organization and structure, PMP implementation and coordination strategy, and potential risks to the project's execution. It also provides a resource loaded schedule and Gantt chart, funding and costing profiles, milestone log, success criteria and decision points.

The initial PMP that satisfied Milestone 2, *Implement Project Management Plan*, was prepared and submitted to NETL on March 31, 2017. An updated PMP was completed and submitted in March 2019 (Appendix I).

Subtask 1.3 – Data Management Plan

During the execution of Project ECO₂S, the project team collected and generated large volumes of data from the field, the laboratory, and the desktop. The Data Management Plan (DMP) sets forth the strategy for sharing such data sets publicly, as well as identifying limited rights and/or protected data (Appendix II).

A catalog of geologic materials/samples collected under the project was developed and maintained throughout the project. The following deliverables represent updates to the catalog that occurred throughout the period of performance:

- Deliverable 1.3.b.1 Catalog of Geologic Material was completed February 27, 2018 <https://www.osti.gov/servlets/purl/1617859>
- Deliverable 1.3.b.2 Catalog of Geologic Material was completed January 9, 2019 <https://www.osti.gov/servlets/purl/1617863>
- Deliverable 1.3.b.3 Catalog of Geologic Material was completed July 31, 2020 <https://www.osti.gov/servlets/purl/1735728>

Task 2.0 - Outreach

Subtask 2.1 - Community Outreach and Education

Community outreach and education related to the Storage Complex were performed primarily by Mississippi Power's landmen, corporate real estate, and cooperate communicates divisions as needed and appropriate in order to share project plans and results. These outreach efforts were documented in quarterly reports and are included in Deliverable 2.3.

Subtask 2.2 - Regulatory Outreach

The Mississippi Oil and Gas Board (MSOGB) and Department of Environmental Quality (DEQ) are the state regulatory agencies that were informed of the project shortly after award. Given that the project team has worked with these agencies and specific individuals for previous CCUS projects, there was little need for comprehensive outreach and educational meetings. As reported in Subtask 3.3, the MSOGB issued well drilling and completion permits for the three characterization and monitoring wells in March, May, and August 2017. During well drilling and periodically thereafter, SSEB and the project team maintained ongoing communications with the MSOGB and DEQ on the status of the overall project.

Subtask 2.3 - Knowledge Sharing through Conferences, Workshops, and Technical Papers

Throughout the three-year project performance period, the ECO₂S project team participated in a significant number of knowledge sharing and outreach activities (26 presentations, 19 abstracts, 25 topical reports). These activities incorporated the development and dissemination of outreach materials, presentations of project findings at scientific meetings, submissions of papers to publications, and the production of topical reports. The deliverable *Report on Knowledge Sharing and Outreach* was completed on September 18, 2020 (Appendix III).

Task 3.0 - Permitting and Site-Access Agreements

Task 3 ensured that National Environmental Policy Act (NEPA) requirements were met and that valid federal, state, and local permits were attained. The project team satisfied all local, state and federal permitting requirements, including environmental, transportation, and storage monitoring.

Subtask 3.1 - National Environmental Policy Act (NEPA) Assessment

The project team complied with the NEPA process, receiving Categorical Exclusions for all work conducted. The deliverable *Completed NEPA Questionnaire* was submitted to DOE/NETL on July 7, 2017.

Subtask 3.2 - Contractual

A site access agreement was negotiated to conduct field data collection activities on property near the Kemper County energy facility. The site access contract allowed for negotiations with the surface preparation and drilling service providers (including site construction, drilling, cementing, and geophysical logging, etc.) to formulate a timeline of field activities. All service providers met site access contractual stipulations for performing services on Mississippi Power Company's properties. The deliverable *Site Access Agreement* was completed on March 7, 2017. (Appendix IV)

Subtask 3.3 - Permitting and Site Survey

Mississippi Oil and Gas Board drilling and completion permits for the three characterization and monitoring wells were prepared and submitted. The well permits are documented as the following deliverables (Appendix V):

- Deliverable 3.3.a *Well Drilling Permits MPC Well 26-5 #1* was completed on March 7, 2017;
- Deliverable 3.3.b *Well Drilling Permits MPC Well 34-1 #1* was completed on May 1, 2017; and

- Deliverable 3.3.c *Well Drilling Permits MPC Well 10-4 #1* was completed on August 10, 2017.

Task 4.0 - Site Characterization and Modeling

Subtask 4.1 - Assessment of Existing Subsurface Data

A critical requirement for permitting the Storage Complex for CO₂ injection and storage is to identify and evaluate potential leakage risks from the proposed injection reservoir to the surface or groundwater reservoirs. Of particular importance in screening a potential storage site for carbon capture and storage (CCS) operations is understanding the natural leakage risks (fractures, faults, thinning of the confining unit) as well as those that are man-made (artificial penetrations or wellbores). In Deliverable 4.1, the project team discusses existing wellbores in and around the Storage Complex to assess the potential for leakage risks. These evaluations are important for several reasons, including demonstration of overall site integrity, project planning, injection permitting, and the design and execution of injection and monitoring operations.

Kemper and Lauderdale Counties contain approximately 60 deep oil and gas wells and approximately 180 shallow, public and private water wells. Within the 10-mile radius of the proposed injection site, there are 16 known deep well penetrations, 1 deep water well penetration, and 42 shallow water well penetrations located within 10 miles of the Project ECO₂S hypothetical injection site. Of the deep wells, none have produced oil or gas and remain as plugged and abandoned (7), dry and abandoned (5), appearing plugged and abandoned/no record (1), and expired location wells (1). Well reports suggest that they have been appropriately abandoned according to regulations and provide sufficient integrity to minimize conduits for potential CO₂ leakage.

Deliverable 4.1 *Report on Subsurface Characterization Wells* was completed on February 1, 2018. The detailed report can be accessed at <https://www.osti.gov/servlets/purl/1617869>

Subtask 4.2 - Surface Seismic Surveys

A key uncertainty identified during pre-feasibility risk assessment was the possible presence of faults over the study area interrupting the continuity of reservoir seals. The primary risk involved with the existence of faults is the potential loss of CO₂ captured and stored in the prospective formations. Vintage 2D seismic data was obtained encompassing the field area to image any large faults cross cutting the storage and confinement intervals. As an added benefit of this study, the lateral continuity of the overall reservoir (sinks and seals) could be determined within seismic resolution.

Seismic reflection lines were collected by Western Geophysical Company and Shell Western in the early to mid-1980s to facilitate deep hydrocarbon exploration in Kemper County, Mississippi. Four key seismic lines in the vicinity of the Kemper County energy facility were identified and acquired for interpretation. Building upon the pre-feasibility work completed by the project team, horizons of interest were identified and interpreted, including the previously identified geologically favorable injection intervals: two Lower Cretaceous saline sandstones (the Paluxy Formation and the Washita-Fredericksburg interval) and one Upper Cretaceous interval (Lower Tuscaloosa Massive Sand). There are laterally extensive shales within these formations that act as seals, and the overlying Tuscaloosa Marine Shale and Selma Group act as major regional confining units. Analysis and interpretation of the seismic lines confirmed that the three saline formations targeted for injection are regionally extensive and maintain considerable thickness within the study area. Additionally, the study

verifies the presence and continuity of multiple sealing layers, including the regional seals of the Tuscaloosa Marine Shale and the substantial chalk of the Selma Group.

Faults were imaged in the Paleozoic units beneath the deepest storage reservoir. However, none of the faults below the Paleozoic unconformity are seen to crosscut or disturb the shallow reservoir section with only minor faults present within the Cretaceous section. Only minor faulting present within the Cretaceous section with vertical offsets less than the thickness of the confining intervals.

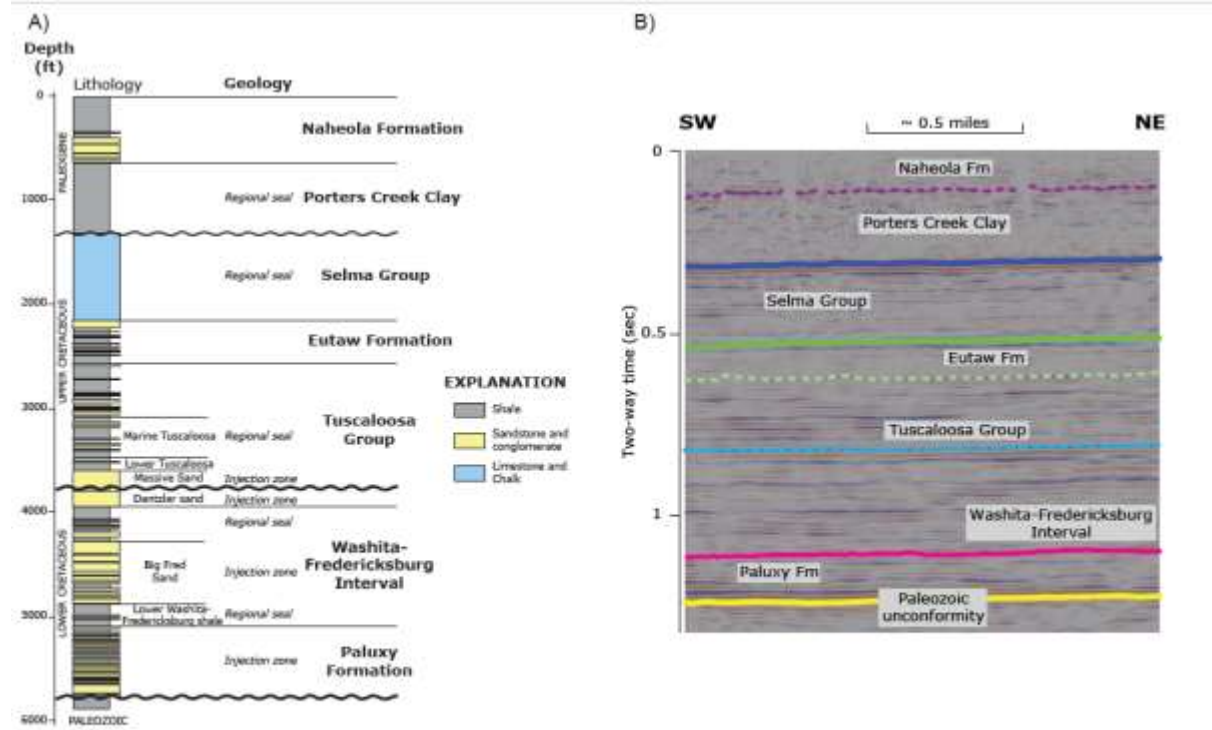


Figure 2—Stratigraphy of the Project ECO₂S study area. A) Generalized stratigraphic column of the Mesozoic-Cenozoic strata in the project area. B) Blow-up of zone of interest from one of the seismic lines, indicating stratigraphic units and contacts.

Figure 1 Stratigraphy of the Project ECO₂S study area produced by the Geologic Survey of Alabama.

Deliverable *Interpreted Seismic Survey Report* was completed on January 9, 2019. <https://www.osti.gov/servlets/purl/1635360>

Subtask 4.3 - Surface Characterization

The potential well sites were surveyed to determine their suitability for: 1) drilling characterization/monitoring wells and, later, injection wells; 2) potential delivery points for CO₂ and well services; 3) locations for surface and subsurface monitoring equipment; and 4) useable rights of way. Site visits and surface surveys were conducted to determine the existing infrastructure at the sites. Maps of the terrain and surface ownership were developed by Mississippi Power Company and were used to establish the level of effort necessary to prepare the site for characterization well drilling and the prospective injection of CO₂ in later phases of the CarbonSAFE program. Characterization well sites are discussed in Subtask 5.1, and the CO₂ injection infrastructure is discussed in Task 8.

Subtask 4.4 - Reservoir Modeling

An initial geologic model of the target formations and seals was constructed prior to the drilling of the characterization wells in 2017 (see Task 5). An initial CO₂ injection simulation was conducted to estimate the behavior and areal extent of the CO₂ plume and the pressure increase during and after CO₂ injection. The reservoir model drew on existing subsurface data from well logs taken in proximity to the injection site, from previous regional geophysical surveys, and from the results of the previous injection tests that have been conducted in the saline reservoir. The results of the initial reservoir simulation are shown in Deliverable 5.1. The model was re-calibrated once the well logs and core data were gathered and fully analyzed and is discussed in Deliverable 8.1.a.

<https://www.osti.gov/servlets/purl/1635356>

Subtask 4.5 - Risk Assessment

Areas of risk to a storage project's success include geologic uncertainties, project management and planning, outreach, permitting and site access agreements, infrastructure development, contractual and regulatory pathways, and the field development plan. Identifying and evaluating every important source of risk is of key interest to future owners/operators of such a project. In October 2017, a workshop was conducted to identify and evaluate the principal risks to the project. One hundred and two (102) unique risk scenarios were developed from the project team's input and presented at the workshop. The scenarios encompassed five specific topic groups: 1) Geologic; 2) Monitor-Model; 3) Operations; 4) Project-Program Management; and 5) Public Acceptance.

Eighteen (18) project team members and stakeholders initiated the workshop by sharing current project information, incorporating all technical disciplines and operational areas. Discussion centered on known risks as well as unknowns that could potentially impede the achievement of project goals. Strong group consensus identified five to seven program-management scenarios related to CO₂ supply as the main sources of project risk. The concept of operating the geological storage facility as a regional hub (as a backup source plan) was identified as bearing important risks related to transportation, institutional support, and legal access to surface operational area and pore space. Technical risks ranked lower, with concerns about seal (caprock) continuity ranking highest. Induced seismicity risks were ranked low. The highest monitoring-modeling risks focused on the prospect that the plume of injected CO₂ might not be confidently observable using available monitoring techniques. Following risk evaluation and ranking, the project team developed specific risk treatments for all scenarios.

In March 2019, participants in a risk update workshop generated new risks and treatments. For the storage-site component of Project ECO₂S, risk identification, evaluation, and treatment development are well advanced. However, the source and transportation components of an eventually integrated source(s)-to-sink project are currently undefined. Some of the uncertainties related to those undefined components show up as significant programmatic risks in this report. As the project progresses toward full buildout and operation, risk assessments for the new components and for the integrated project will need to be done.

Milestone 3 *Complete Initial Risk Assessment* was completed on February 23, 2018.

<https://www.osti.gov/servlets/purl/1617864>

Deliverable *Kemper Storage Complex Commercial Risk Assessment* was completed on May 11, 2020. <https://www.osti.gov/servlets/purl/1735721>

Subtask 4.6 - Risk Assessment Tools

The project team reviewed the National Risk Assessment Partnership software tools that were available on the Energy Data Exchange (EDX) for the evaluation of risk associated with carbon capture and storage. The consensus of the team was that the NRAP Tool likely to provide the simulation results of greatest value to the project was the NRAP Seal Barrier Reduced-Order Model or Natural Seal ROM (NSealR). The software, with examples set up for other projects, and the Goldsim Player needed to compile and run the simulations, were downloaded from the EDX website. Dr. Robert Dilmore, NRAP Technical Director, and Dr. Ernest Lindner, Research Leader with the Battelle / Leidos Research Support Team at NETL, developer of the NSealR Tool and author of its User's Guides, were both extremely helpful during the setup of the model, specification of the reservoir and seal layer properties for the reservoirs, and seals of greatest interest to Project ECO₂S.

Three sets of simulations were run. Unexpected reservoir behavior was exhibited in the initial simulation results using the NSealR Tool. With significant help from Dr. Lindner, the team identified and resolved the problematic features in the software which led to unexpected behavior. Dr. Lindner found that the assignment of the large value of 50m to the standard deviation of the thickness led to the inclusion of negative values for the thickness among the allowed properties and conditions. To eliminate any possibility of negative seal thicknesses in the calculations, as well as excessively large thicknesses, Dr. Lindner added to the "Seal Thickness & Reference Parameters" dashboard, on which the user specifies the properties of the seal, a requirement that the user specify maximum and minimum thicknesses for the seal.

Dr. Lindner also implemented other useful modifications to NSealR: 1) the number of Probabilistic Simulation Realizations was increased from 50 to 1000, to achieve more consistent repeatability between simulation runs; 2) Limits of 1.0 MPa on the Bubbling Pressure and Threshold Pressure (for the initial simulations, an unreasonably large value had been chosen for the bubbling pressure); and 3) Limitation of the Maximum Seal Permeability to 1000 nanodarcies.

Deliverable *Risk Assessment Tool Report* was completed on April 7, 2020. <https://www.osti.gov/servlets/purl/1617878>

Subtask 4.7 - Data Sharing

Geologic data, analyses, and samples collected from the project were provided to the DOE's Energy Data eXchange (EDX), National Carbon Sequestration Database and Geographic Information System (NATCARB) and the DOE core library, as appropriate and as outlined in the current Data Management Plan (reference Subtask 1.3).

Task 5.0 – Site Selection and Well Drilling

Subtask 5.1 - Well Site Selection

Three geologic characterization wells were drilled to test the amenability for commercial scale storage of CO₂ in the subsurface. Deliverable 5.1 outlines the steps that were taken to select appropriate sites for the three wells and includes the selected sites locations and the permits that were obtained for each site. Deliverable *Drilling Site Selection and Survey Report* was completed on December 7, 2017. <https://www.osti.gov/servlets/purl/1608455>

Site selection was conducted by ARI in coordination with MPC. Each site location was reviewed and graded based on considerations such as a diversity of locations (in order to evaluate the entire ECO₂S project area), ease of access/egress, topography, location to existing structures, available roads, and avoidance of environmentally sensitive areas. Once the appropriate sites were selected, ARI obtained bids to conduct surface work at the site, and the site surveys were drawn up for each of the three. **Figure 2** shows the locations of the three Phase II characterization/monitoring wells, the MPC 26-5 #1, MPC 34-1 #1, and MPC 10-4 #1 wells. An application for permit to drill was then submitted to the Mississippi State Oil and Gas Board. The accepted permits for each well are included in the deliverable.



Figure 2 Locations of the Three Phase II Project ECO₂S Characterization/Monitoring Wells.

Subtask 5.2 – Well Design

The three project wells, the MPC 26-5 #1, MPC 34-1 #1, and MPC 10-4 #1, were designed for characterization purposes and to comply with UIC Class VI monitoring well specifications. Per EPA's guidance¹, construction of monitoring wells is similar to the construction of injection or production wells in that all necessitate maintaining zonal isolation, employing good cementing practices, and selecting suitable well materials for the conditions with which they will come into contact. Topics that pertain to construction of monitoring wells at CO₂ storage projects include material selection, drilling techniques, well completion and zonal isolation. Key monitoring construction criteria are described below.

The surface casing should extend through the base of the lowermost underground source of drinking water (USDW) using a single or multiple casing strings and be cemented to the surface. The MSOGB designated the base of the USDW at each of the well sites at 580 ft., representing the minimum surface casing depth allowable. A conservative depth of approximately 2,500 ft. was selected for all the wells to protect USDWs and to provide multiple casing strings and cement across shallow, friable formations. The surface casing is continuously cemented from total depth (TD) to the ground surface. The long-string casing should extend to the injection zone and be cemented to the surface. Each of the three wells are fully cased to total depth and will be continuously cemented from TD to the ground surface. Monitoring well construction materials should be selected to withstand downhole conditions, including the fluids with which the materials may be expected to come into contact. The long string casing cement program was designed to be resistant to CO₂ and chrome casing (13CR-85) was run over all potential storage reservoirs starting at the marine Tuscaloosa (confining unit) to TD. The MPC 26-5 #1 well diagram is shown in **Figure 3**. Completions of the MPC 34-1 #1 and MPC 10-4 #1 wells are similar.

¹ <https://www.epa.gov/sites/production/files/2015-07/documents/epa816r13001.pdf>

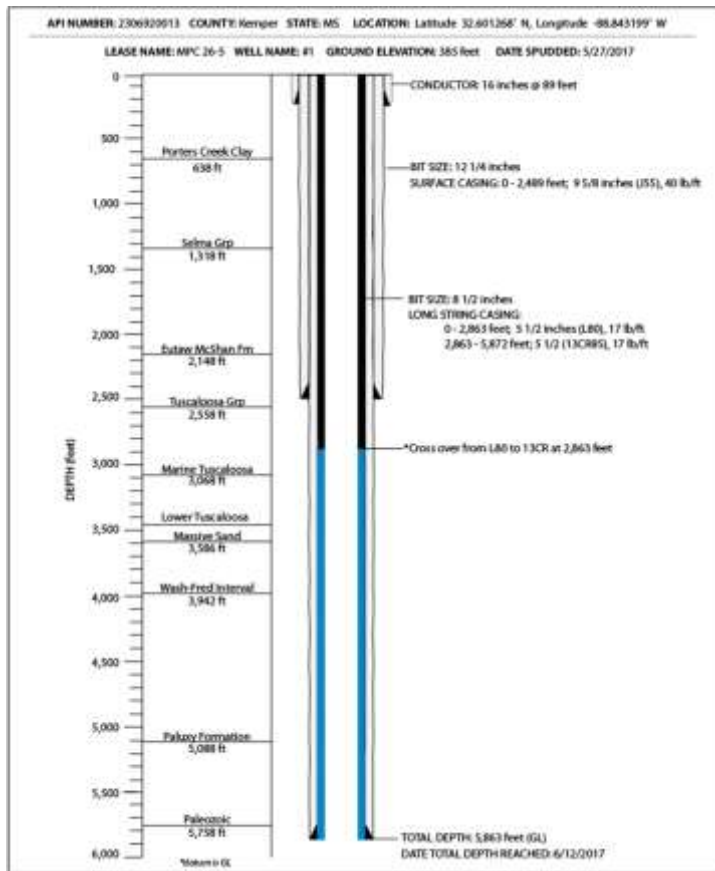


Figure 3 Well Schematic for the MPC 26-5 #1

Extensive geophysical wireline logging programs were implemented on both the open and cased holes during the construction of the three wells. These programs were used to verify lithology, determine petrophysical properties of the potential injection zones, characterize the confining units, perform cement bond evaluations, and baseline casing inspections. In addition, a lithology log was assembled using descriptions of the rock cuttings (i.e., a mud log).

Deliverable *Well Design Report* was completed on November 28, 2017.
<https://www.osti.gov/servlets/purl/1608462>

Subtask 5.3 - Well Drilling and Geologic Data Collection

Deliverable 5.3.a *Well and Security Installation Report* was completed January 16, 2018. As discussed in the previous subtask, all three wells were installed to UIC Class VI monitoring well standards. The geologic data acquired from each well is described in the Task 6 deliverables. This report provides an assessment of the well construction activities at the MPC 26-5 #1, MPC 34-1#1, and MPC 10-4 #1 locations, and includes the following for each well:

- A drilling and completion narrative;
- Catalog of open hole and cased-hole geophysical well logs gathered during well construction and completion;
- An as built description of the wells including drawings and material specifications; and

- Site security and closure.

<https://www.osti.gov/servlets/purl/1635362>

Deliverable 5.3.b *Geologic Characterization Well Report* was completed on July 5, 2018. This report includes a description of remedial work that was required on the MPC 34-1. During the cementing operations on the long casing string, much of the cement was lost to the surrounding formations (most likely the Paleozoic intervals that underlie the injection zone(s)) and had no returns to surface. Further, the cement bond log logs showed that the cement coverage was not adequate to meet the UIC Class VI monitoring well standards. Due to the poor cement coverage a remediation job including a successful perforation and cement squeeze was performed. During those operations, a reservoir fluid sample was acquired and a reservoir pumping test was conducted. This report contains a summary of the remediation, fluid sampling and well test.

<https://www.osti.gov/servlets/purl/1608464>

Task 6.0 - Geologic Data Analysis

Subtask 6.1 - Core Analysis

A geological model was developed for the Storage Complex based on data collected from the three Phase II characterization/monitoring wells. To augment understanding of the target storage reservoirs, a comprehensive study of the CO₂ injection and confining zones was completed by evaluating the petrophysical properties observed in collected core samples. These advanced core tests provide important information on the injectivity, phase trapping, displacement efficiency, aerial and vertical sweep efficiency, and formation damage of the target storage reservoirs. The results of these tests are utilized as input parameters in the simulation model.

For this work, reservoir and confining unit core samples were selected and provided to team members for investigation of the petrophysical properties of various storage zones and low permeability layers at the Storage Complex. Reservoir core plugs underwent basic core analysis including grain density, porosity, air permeability, oil saturation, water saturation, and sample fluorescence. Routine core analysis results show that the CO₂ storage reservoirs have exceptional quality, with mean reservoir porosity of 28.5% and mean reservoir permeability of 3.5 Darcy. Minimum capillary displacement pressure experiments (breakthrough pressure) for confining unit samples initially saturated with brine and pressure decay permeametry tests were conducted. Results of the pressure decay permeametry tests suggest that the confining units have very low (nanodarcy) permeability. In addition, select core samples were run in a CO₂-steady state CT core flood lab where CO₂-brine relative permeability curves were generated. Additional analysis of the core samples, including core description, reservoir petrography, thin section description, including microscopy, SEM analysis, and interpretation of depositional environment and stratigraphic analysis, also was performed.

Deliverable 6.1 *Core Analysis Report* was completed on July 8, 2020.

<https://www.osti.gov/servlets/purl/1639012>

Subtask 6.2 - Refined Geologic Model

Phase II of Project ECO₂S evaluated the viability of deep underground CO₂ storage in Kemper County, Mississippi. Deliverable 6.2.a *Final Geophysical Well Log Report* was completed on June 29, 2020 and synthesizes the various forms of geological well log data

that were compiled and gathered from subsurface wells that penetrate the storage geology at or in the vicinity of the Storage Complex. Both routine and non-routine geophysical well logs, in addition to limited core, were used to evaluate several stacked saline reservoirs and confining units from a combination of legacy oil/gas wells, a deep water production test well, and three Project ECO₂S wells drilled in 2017.

Routine geophysical well logs include industry standard logging tools such as the differential caliper, spontaneous potential, gamma ray, neutron porosity, and density porosity among other forms of subsurface data. These well logs were typically available due to the presence of older oil and gas wells that occurred in and around Kemper County. In addition, three new wells (MPC 26-5 #1, MPC 34-1 #1, and MPC 10-4 #1) were drilled in 2017 and provided new Triple Combo logs and mud logs of the storage geology immediately within the project site.

Non-routine processed geophysical well logs include well logging instruments that measure advanced petrophysical properties from the target formation. Non-routine geophysical logs utilized at the new ECO₂S wells include Combined Magnetic Resonance (CMR), Dipole Sonic, and Formation Micro-Imaging (FMI). Using a combination of core, density/neutron porosity, and CMR, the porosity and permeability of the saline storage reservoirs were estimated. Importantly, these determinations of reservoir quality were used to estimate the CO₂ storage capacity at the Storage Complex and to model the reservoir performance during future CO₂ injection. Table 1 lists the well logs acquired from each well.

Table 1 A list of geophysical well logs from the three ECO₂S Phase II Characterization/Monitoring Wells

| Well Logs | | | | | | |
|---|----------|-------------------|----------|---------------------|----------|---------------------|
| Logs | MPC 26-5 | | MPC 34-1 | | MPC 10-4 | |
| Surface Casing | | | | | | |
| Borehole Profile | x | 100 - 2,489 ft. | x | 90 - 506 ft. | x | 103 - 2,008 ft. |
| Platform Express: Compensated Neutron, Lithodensity, Array Induction, GR, SP, Caliper | x | 100 - 707 ft. | x | 91 - 506 ft. | x | 104 - 2,008 ft. |
| Cement Bond Log | x | 0 - 2,434 ft. | x | surface - 2,334 ft. | x | surface - 2,470 ft. |
| Temperature | x | 0 - 2,434 ft. | x | surface - 2,334 ft. | | surface - 2,330 ft. |
| Long String | | | | | | |
| Mudlog | x | 2,500 - 5,877 ft. | x | 2,500 - 5,750 ft. | x | 2,520 - 5,440 ft. |
| Borehole Profile | x | 2,491 - 5,869 ft. | x | 2,495 - 5,740 ft. | x | 2,520 - 5,440 ft. |
| Combinable Magnetic Resonance Tool | x | 3,000 - 5,855 ft. | x | 2,495 - 5,740 ft. | x | 2,520 - 5,440 ft. |
| Platform Express: Compensated Neutron, Lithodensity, Array Induction, GR, SP, Caliper | x | 2,491 - 5,869 ft. | x | 2,495 - 5,740 ft. | x | 2,520 - 5,440 ft. |
| Sonic Scanner | x | 2,491 - 5,877 ft. | x | 2,830 - 5,748 ft. | x | 2,520 - 5,440 ft. |
| Cement Bond Log | x | 100 - 5,740 ft. | x | 400 - 5,600 ft. | x | 100 - 5,330 ft. |
| Formation Micro Imager | x | 2,491 - 5,877 ft. | x | 2,830 - 5,748 ft. | x | 2,600 - 5,440 ft. |
| Mechanical Sidewall Coring Tool | x | 2,360 - 5,715 ft. | | | | |
| Additional Logs | | | | | | |
| Pulsed Neutron Capture | x | 2,475 - 5863 ft. | x | 2,485 - 5,500 ft. | x | 2,016 - 5,440 ft. |

Deliverable 6.2.a *Final Geophysical Well Log Report* was delivered on June 29, 2020. <https://www.osti.gov/servlets/purl/1639013>

Previous work has identified three porous high-quality reservoirs; the lower Cretaceous Paluxy Formation and Washita-Fredericksburg interval and the Upper Cretaceous Lower Tuscaloosa group Massive sand. Each reservoir contains laterally extensive shale seals and are overlain by the Marine Tuscaloosa Shale, an extensive regional seal. Additional Tertiary-age seals are also present above the Marine Tuscaloosa, including the Selma Group and the Porters Creek Clay. In 2017, three characterization wells were drilled for this work and provided valuable subsurface data for the updated geologic mapping, stratigraphic studies, and geologic modeling work that was undertaken by the project team. Subsurface characterization partners include Advanced Resources International Inc., Oklahoma State University, and Mississippi State University, among others. Milestone 4 and Deliverable 6.2.b *Geologic Framework for the Kemper Storage Complex Report* was completed on June 10, 2020, and summarizes the efforts by OSU and MSU to describe the geologic frameworks of the Storage Complex. **Figure 4** shows a composite well log and identifies the saline storage reservoirs, seals, and USDW in the Project ECO₂S area.

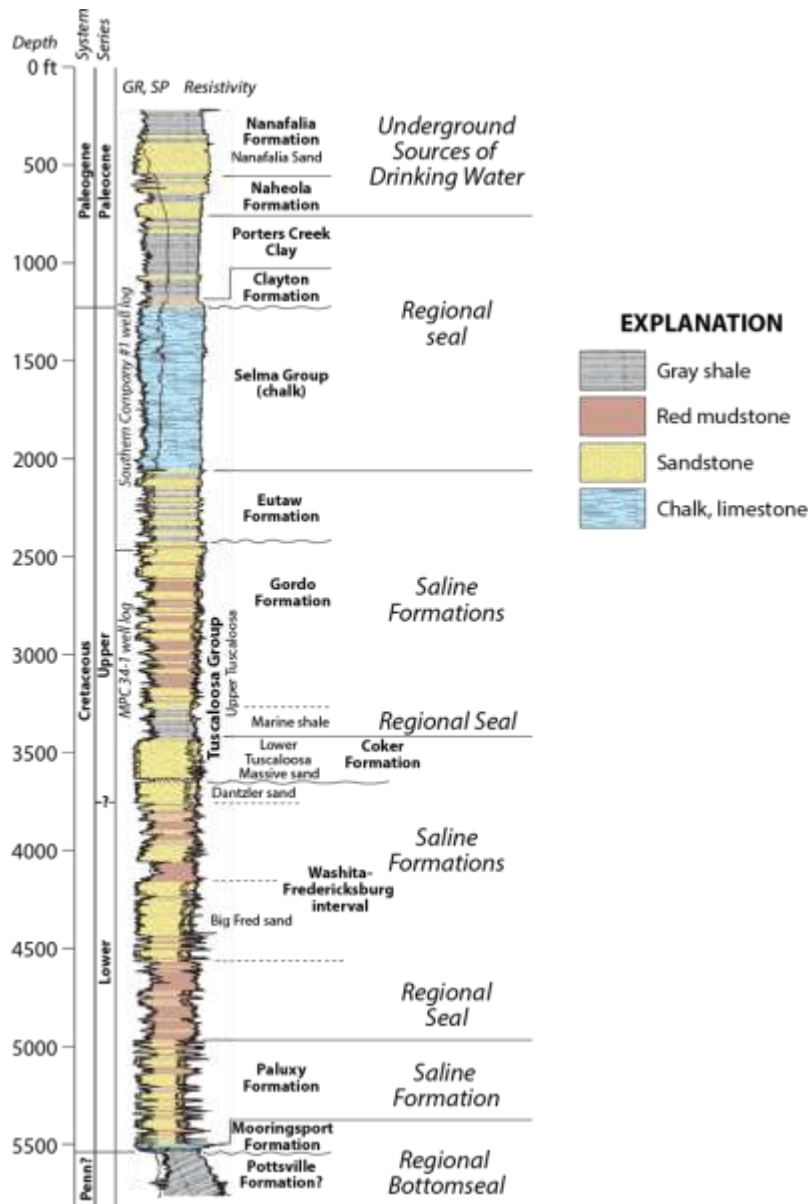


Figure 4 Composite geophysical well log showing Mesozoic-Cenozoic stratigraphic section at the Kemper County energy facility (OSU)

OSU contributed research on the basic geologic characterization, well log analysis, core analysis, and volumetric analysis of the candidate CO₂ storage reservoirs and reservoir seals. Key activities performed include stratigraphic analysis, sedimentologic analysis, petrologic analysis, petrophysical analysis, and calculation of the static storage resource of the Storage Complex using data from geophysical well logs and core. MSU provided a study on the sequence stratigraphic framework for the region beneath and around the Storage Complex. This work identified chronostratigraphic timelines within depositional environments and regional transgressive and regressive cycles. The research and analysis performed by MSU was used to further enhance the dataset for the target reservoirs, characterize petrophysical properties, and confirm regional integrity of reservoir and seal formations for geologic storage. Methods included correlation of petrophysical well logs in the study area, petrographic well log analysis, and core analyses.

Milestone 4 and Deliverable 6.2.b *Geologic Framework for the Kemper Storage Complex Report* were completed on June 10, 2020. <https://www.osti.gov/servlets/purl/1635350>

Subtask 6.3 - Reactive Transport Simulations

Auburn University leveraged the mineralogic data and geologic framework developed in Task 6.1 to conduct geochemical reactive fate and transport simulations of CO₂ injection. This work evaluated the extent of geochemical reactions in the reservoir and their effects on changes in formation porosity and permeability. Pore and continuum scale simulations were developed and focused on the potential for mineral dissolution and precipitation reactions and their potential changes to pore-throat diameters.

Samples of the Paluxy Formation were taken from well MPC-34 #1, and their mineral reactions and bulk mineralogy were examined using Scanning Electron Microscopy (SEM) and X-ray Diffraction (XRD), respectively. Overall, quartz is the dominant mineral phase in all samples with subordinate amounts of clay minerals, feldspars, and carbonates. In terms of mineral reactivity, reach transport simulations suggest that carbonates rapidly dissolve in acidic conditions following CO₂ injection while non-carbonate minerals remain stable. This leads to an overall increase in rock porosity. At longer time scales (7,300 days), the dissolution of non-carbonate minerals is apparent. The precipitation of amorphous silica prevents a dramatic increase in rock porosity.

Pore network models were constructed with pore and pore-throat size distribution and connectivity information obtained from 3D X-ray Computed Tomography (X-ray CT) images of individual samples. These models consider the range of possible permeability evolution as minerals dissolve. For example, depending on the spatial location of mineral reactions, dissolution of the Paluxy Formation may result in a permeability increase of up to 6,445 mD. Macroscopic porosity-permeability relationships provide a means of estimating changes in permeability due to mineral dissolution and precipitation. These equations reflect the evolution of porosity and permeability when reactions impact all surfaces or a fraction of randomly distribution surfaces within the matrix. Reactions that are distributed randomly between small or large pores or pore-through are predicted by existing porosity-permeability equations while those that occur exclusively in small or large pores are not. Importantly, this work provides a basis for understanding how the reservoir units of the Storage Complex will react at the micro scale during CO₂ injection.

Deliverable *Reactive Transport Analysis Report* was completed on January 9, 2020. <https://www.osti.gov/servlets/purl/1617876>

Subtask 6.4 - Thermo-Hydro-Mechanical (THM) Modeling

The Virginia Center for Coal and Energy Research (VCCER) at Virginia Tech was tasked with providing an assessment of the geomechanical integrity and induced seismicity potential associated with commercial-scale geological CO₂ storage. This investigation was conducted on a collection of whole and sidewall core samples, geophysical logs, and seismic interpretation. This data and other work produced by the project team was used to assess the risk of adverse geomechanical responses to CO₂ injection operations and provide recommendations to minimize these risks.

In this context, an adverse geomechanical response would be an irreversible process that negatively impacts the performance of the Storage Complex. The irreversibility is attributed to plastic deformation (i.e., failure) of a rock mass subjected to a load exceeding a critical

threshold, which will not return to its original configuration after the load is removed. Negative impacts on performance include the creation of unfavorable migration pathways and initiation of perceptible seismic events, which could threaten the permanence of storage.

The failure mechanisms considered in this study are tensile failure of the borehole wall, shear failure of intact rock mass, and shear failure along a preexisting plane of weakness, i.e., a joint or fault. In each case, failure may be precipitated by an increase in pore pressure due to the injection of CO₂ into geological storage units. While it is difficult to predict the severity of the outcome for these modes of failure, especially prior to testing the well in a real operating environment, it is pertinent to quantify injection pressure thresholds to minimize the likelihood of initiating rock failure and consider these constraints during testing and operation of the Storage Complex.

The maximum injection or pore pressure is quantified by the use of a failure criterion, a mathematical function which evaluates the likelihood of failure given numerical values describing the geomechanical scenario. The usefulness of a failure criterion analysis is predicated by the choice of appropriate numerical parameters, such as in-situ stress and rock strength. Because each of these parameters is subject to uncertainty, and sometimes is not known at all, a multitude of scenarios based on random sampling was generated and collated to determine the outcome in a probabilistic sense. This method, sometimes referred to as the *Monte Carlo method*, does not require judicious selection of representative parameter values, which can be a difficult and contentious issue. Each parameter may be assigned a *probability distribution* rather than a single value, which can describe a range of values or propensity to assume certain values. These distributions can be based on measured data or assumptions and are most effective when they reflect the confidence and uncertainty associated with the parameter. This is especially important in evaluating the likelihood of shear failure of intact rock and preexisting faults, as the location of rock failure may occur far from the wellbore, which is typically where all rock property measurements are taken.

Each failure analysis includes a description of the failure criterion, the data (or lack thereof) associated with each parameter in the failure criterion, the assumed distributions of each parameter, and the resulting probability spectrum of failure. Results are reported in terms of the 5% confidence interval that the anticipated conditions will result in failure. If more conservative (e.g., 1%) or more favorable (e.g., 10%) confidence intervals are required, the reader may determine those values from the probability distribution plots. These analyses were dependent on the available data, and conservative estimates were used when data was either not available or existing data lacked credibility.

Using the Schlumberger Sonic Scanner open hole logging tool, acoustic velocity data was collected for MPC-25 #2 and MPC-34 #1. These data were used to determine the properties of the rock and the in-situ geomechanical stress of the Kemper County Complex. This indirect method required verification using established correlations (e.g., horizontal stress anisotropy vs. static shear modulus). Importantly, these methods confirmed that the horizontal stress magnitudes as determined by open hole logging tools are appropriate for the qualitative geomechanical analysis of the Storage Complex.

In addition to the in-situ measurements of horizontal stress magnitudes, open hole acoustic measurements were used to determine in-situ rock strength properties, including unconfined compressive strength, cohesion, angle of internal friction, and tensile strength. Mathematical

relationships used to determine the unconfined compressive strength and tensile strength were constant throughout the wellbore despite changes in lithology, suggesting that this in-situ method is not appropriate for the determination of rock strength properties at the Storage Complex. Further, this observation suggests that conventional tests are required to determine rock strength properties of the lithologies.

For an injection well, tensile failure of the rock immediately outside of the wellbore are possible given sufficient injection pressure. Compressive or tensile failure of the rock surrounding the wellbore could impact the performance of the well and, consequently, require an appropriate level of understanding. To accomplish this, 10,000 scenarios were created by generating pseudo-random numbers based on the distributions of Young's Modulus and Poisson's Ratio values determined for MPC-25 #2 and MPC-34 #1. These parameters were determined from in-situ measurements of compressional and shear velocities of the wellbore between depths of 3,500 and 5,500 ft. This assessment determined at the 95% confidence interval that the difference between the maximum injection pressure and the corresponding pore pressure ($P_{max} - P_0$) is greater than 3,184 PSI. Ultimately, this suggests that the difference in maximum injection pressure relative to initial pore pressure should not exceed 3,184 PSI.

Unlike tensile stress, which exists only in close proximity to the wellbore, shear failure can occur anywhere within the reservoir where pore pressures are sufficient. In addition to the rock properties that govern tensile failure, coefficient of internal friction and cohesion also control shear failure. Following similar principles governing the estimation of reservoir tensile failure, the project team determined that for shear failure, the difference between the maximum permissible pore pressure relative to the initial pore pressure should not exceed 1,094 PSI. While the direct measurement of rock properties through conventional methods is preferred, this contribution illustrates that open hole logging data can be used to better constrain rock properties and inform future activities.

Deliverable *Thermo-Hydro-Mechanical Modeling Report* was completed on May 11, 2020. <https://www.osti.gov/servlets/purl/1735724>

Task 7.0 – Infrastructure Development

Task 7.1 – Site Infrastructure Development

The Project ECO₂S team, led by Trimeric, completed an initial feasibility assessment and an implementation plan for the surface infrastructure to move high pressure CO₂ from the Kemper County energy facility to a series of CO₂ injection locations.

The first section of this plan provides screening-level capital and operating cost estimates for CO₂ compression and dehydration on a nominal one million tonne per year (1 MTPY or 55 MMSCFD) basis (excluding pipelines). The next section of the report provides screening-level capital and operating cost estimates for several different cases for Plant Barry and includes a comparison of compression versus pumping for dense phase CO₂. The final section of the report provides screening-level cost estimates for CO₂ pipelines from Plant Daniel to Kemper and from Plant Miller to Kemper, as well as screening-level cost estimates for the compression and dehydration at each of the three sites. The compression and dehydration costs estimated on a per million tonne per year basis in the first part of the project were scaled to develop cost estimates for Plant Daniel, Plant Miller, and Kemper near the completion of the work. The estimated total capital investment costs are three times the purchased equipment costs. Electricity for compression is approximately 72% of the operating costs.

Deliverable *Site Infrastructure Development and Estimated Costs* was completed on June 29, 2020. <https://www.osti.gov/servlets/purl/1635352>

Task 7.2 – Regional Infrastructure Assessment

Subtask 7.2 focused on building the tools and databases needed to regionally assess CCS infrastructure in the region. The most significant investment was made in helping develop the *SimCCS* framework and the *SimCCS* sub-tools including *CostMAP* and *SCO₂T*. Tool development culminated in the *SimCCS* framework winning two R&D 100 Awards in December 2019; one award in the software and services category and a silver medal in the special recognition category of corporate social responsibility. The *SimCCS* R&D 100 Award package was supported through reference letters from ECO₂S partners including Southern Company, Advanced Resources International, and Battelle Memorial Institute.

The *SimCCS* R&D 100 Awards package and the case study software bundled with *SimCCS* focused on the ECO₂S/southeast region (**Figure 5**). This study consists of capture, transportation, and storage parameters from 20 coal-fired power plants and seven potential storage locations. The region of interest covers an area of roughly 1000 km by 625 km in southern Louisiana, Mississippi, Alabama, Georgia, and northern Florida. To demonstrate the connection (or linkage) between the site-scale processes and regional-scale modeling, LANL parameterized the *SimCCS* framework (regional scale) with outputs from modeling efforts at the site scale using coal-fired power plants from the EPA eGRID database.

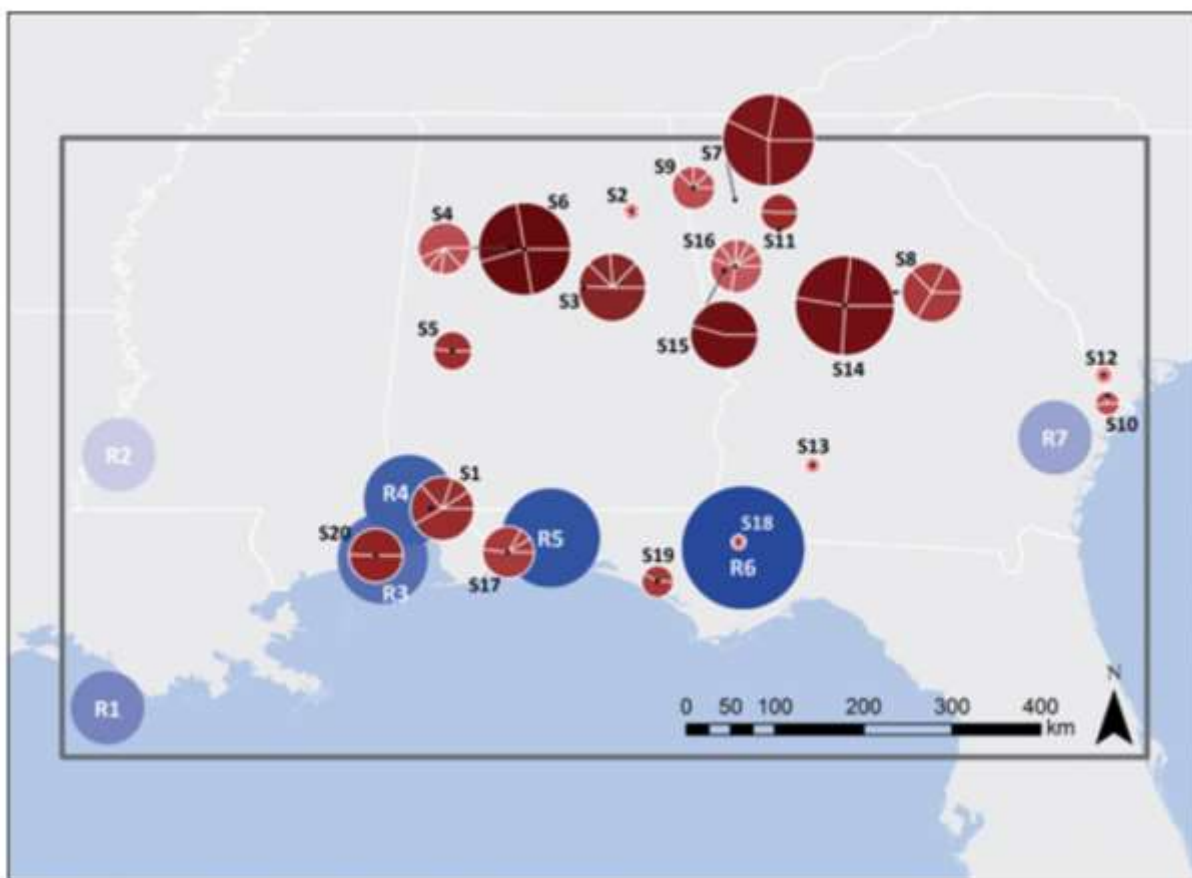


Figure 5 Overview map of the study region. Power plant (red circles) CO₂ production rates range from low (0.5 MtCO₂ yr⁻¹, smallest circle) to high (22 MtCO₂ yr⁻¹, largest red circle), and

from lowest capture cost (\$45/tCO₂, dark red) to highest capture cost (\$102/tCO₂, light red). Each power plant pie chart is divided into the number of constituent boilers, where the pie wedge is proportional to the CO₂ from each boiler. Reservoirs (blue circles) range from low capacity (360 MtCO₂ yr⁻¹, smallest circle) to high (845 MtCO₂ yr⁻¹, largest circle), and lowest cost (\$3.78/tCO₂, light blue) to highest injection/storage cost (\$8.60/tCO₂, dark blue).

The 20 coal-fired plants vary greatly in terms of their CO₂ production rates, the cost to capture the CO₂ stream, and the number of boilers. The 20 power plants in this study consist of 65 separate coal-fired boilers with 65 associated electricity generating units—each power plant has between one and seven separate boilers. Since it is the boilers that emit CO₂, regardless of whether the generating units are producing electricity, it is critical to understand the cost of infrastructure to CO₂-retrofit each boiler. The CO₂ emissions for each boiler are taken from the emissions Generation Resource Integrated Database (eGRID) produced by the EPA.¹

Each boiler in the database varies in terms of age, electricity output (not modeled in this study), and CO₂ emissions. This variation leads to a large associated variation in capture costs (**Figure 5**). The estimated costs to capture CO₂ from each boiler is derived from reports published by NETL², which provide a thorough and current engineering-economic systems analysis of constructing subcritical and supercritical Pulverized Coal (sub-PC) fired power plants. Here, the NETL plant-level assumptions are downscaled to the individual boiler-level using methodologies applied in previous work³.

The principal advantage of modeling at this level is that power plants are often composed of a set of heterogeneous boilers, where each boiler can have a separate decision to retrofit, continue to emit CO₂, or completely shut down in response to a price on CO₂ emissions. The decision to shut down one or more boilers will be based on the economics of reducing CO₂ emissions and minimizing the loss of electricity generation capacity; the current version of the *SimCCS* framework does not include electricity generation and so the “shut down” option is not available in this study. Moreover, boilers within the same plant are not necessarily co-located to the extent where grouped infrastructure is possible. Conversely, where appropriate, common capture infrastructure can save costs. For example, the overnight capital cost to retrofit the four separate Plant Hammond boilers (S9 in **Figure 5**) in this study is estimated at \$1.78B. However, in 2008, Plant Hammond installed a combined stack (CS) for their scrubber which would allow common retrofit infrastructure to be installed for the four boilers. As a result, the overnight capital cost would fall approximately one-third (does not include the CS cost), which would reduce estimated unit capture costs from \$70/tCO₂ to \$60/tCO₂.

Figure 6 illustrates *SimCCS* solutions for the above scenario for the southeastern United States dataset and a scenario consisting of a 30-year project capturing 110 MtCO₂/yr. In this Figure, red dots correspond to opened sources (with the fraction of available CO₂ captured represented by the dark red component of the pie chart), blue dots correspond to the opened reservoirs (with the fraction of available storage capacity used represented by the dark blue component of the pie chart), and green links correspond to selected pipeline routes.

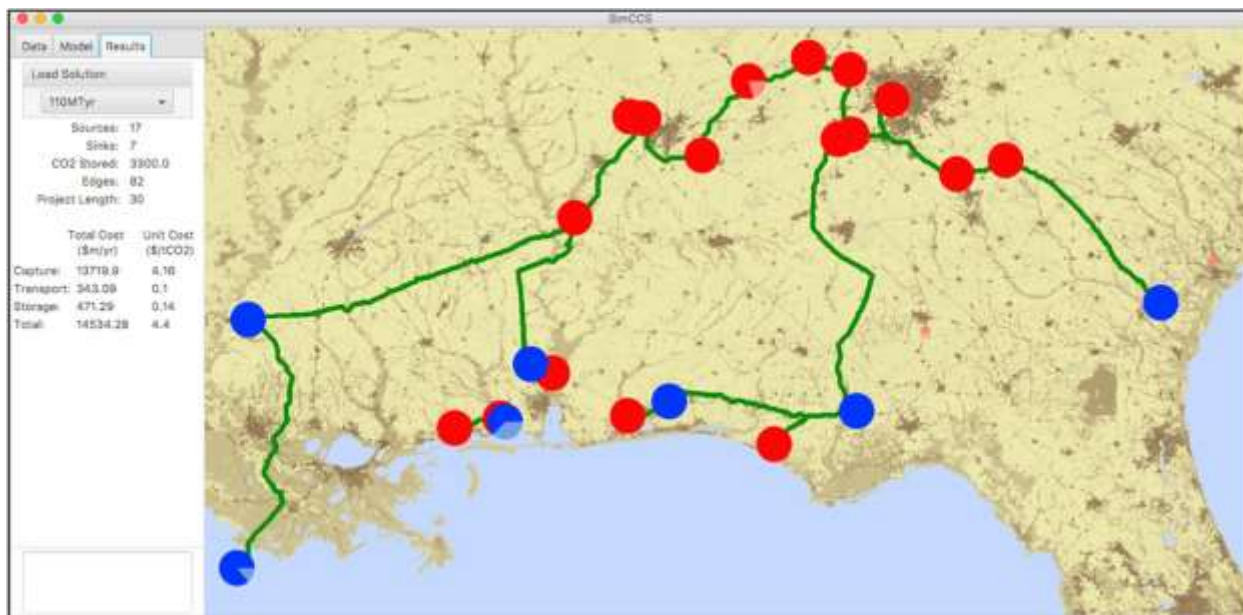


Figure 6 SimCCS infrastructure design for southeast United States case study with a target capture amount of 110 MtCO₂/yr over a 30-year project life. The data for this case study is included in the SimCCS^{2.0} software repository.

The regional scale demonstrates how CCS infrastructure might be deployed to capture CO₂ emissions on an industrial scale. In this study, we have constructed CCS management scenarios capable of storing up to 110 MtCO₂ yr⁻¹ of CO₂ emissions from Southern Company-operated coal-fired power plants. The spatial configuration of where to capture, transport, and store CO₂ will be integral to help large electric utilities like Southern Company consider the scale and cost of widespread deployment of commercial scale operations. Specifically, the analysis at the four process scales presented in this paper may support the development of CO₂-related business models and strategic plans whether operations will be vertically integrated (self-build and operate model), through a joint-venture model, or as a third party pay-at-the-gate system.

Deliverable *Regional Infrastructure Assessment* was completed on May 11, 2020.
<https://www.osti.gov/servlets/purl/1617880>

Task 8.0 – Commercial Development Plan

Subtask 8.1 – Numerical Modeling of CO₂ Flow and Storage

Three Southern Company coal- and natural gas-fired power plants have been identified that could serve as the initial sources of captured CO₂ for the Storage Complex – Plants Ratcliffe, Daniel and Miller. These three power plants together could provide 22.5 MMmt of captured CO₂ per year, equal to 675 MMmt of CO₂ captured and stored over 30 years of injection. In this task, large volume injection and storage of CO₂ in vertically stacked saline formations in the Storage Complex was studied through reservoir flow simulation. A base model was developed using the latest geologic interpretation at the Storage Complex. The simulation results from the base case show that injecting a total volume of 675 million metric tons of CO₂ over 30 years is attainable, and the CO₂ is contained within the target formations in an area of approximately 55 square miles. Due to limited data availability to determine permeability anisotropy and hysteresis trapping, sensitivity analysis was

performed to test the impact of these parameters on the plume migration and its extent. The impact of cycling produced water from down production wells to updip injection wells was also evaluated. Horizontal permeability anisotropy has the largest impact on the plume size. Lack of permeability anisotropy causes the CO₂ plume to cover about 70 square miles at the top of the Massive Sand. This is approximately 27% higher than the base case, where a 3:1 horizontal permeability anisotropy was used. During phase III of this project, special attention will be given to evaluating the horizontal permeability anisotropy ratio and the direction of the higher permeability. Additional observation wells around the storage site would provide valuable information on CO₂ movement and better estimating the permeability anisotropy through reservoir simulation and history matching.

A summary of the results from the simulation study is presented here:

- An isotropic horizontal permeability case will result in a 70 square mile plume, approximately 27% larger than the base case (3:1 horizontal permeability anisotropy).
- A change of hysteresis residual gas saturation from 5.1% to 40% (in a water-cycling scenario) results in a 5% change in the CO₂ plume size (from 17% to 22%). A water-cycling scenario with a 15% maximum residual gas saturation, or Sgr_{max}, (similar to the base case), resulted in 18% reduction in the plume size compared to the base case.
- Changing the perforation interval of the water injectors from perforating the entire target reservoir interval to only the top roughly 100 feet of the target formation results in the plume size reduction of 10% in the case of partial perforation and 18% in the case of full-interval perforation, compared to the base case
- Placing the water injection wells up-dip of the CO₂ injection site (northeast) with full-interval perforation and water extraction wells down-dip of the CO₂ injection site (southwest) results in an 18% plume reduction

Deliverable 8.1.a *Numerical Modeling Report* was completed on June 29, 2020.

<https://www.osti.gov/servlets/purl/1635356>

Deliverable 8.1.b *Identification of Wells within the AoR* provides a survey of existing wellbores in and around the potential injection area. The wells located within a 10-mile radius of the ECO₂S site were evaluated. Several abandoned wells penetrate the storage zones and overlying confining units in the proposed test site within proximity to the Kemper County energy facility, and this assessment of existing wellbores is critical for the demonstration of the site's storage integrity. If improperly sealed, the wellbores could serve as potential vertical migration conduits for CO₂ and brine from the deep saline reservoir systems through the overlying confining system into shallow USDWs.

Within the ten-mile radius of the proposed injection site, there are 16 known deep well penetrations and 42 shallow water well penetrations. 12 of the 16 deep wells are vintage deep oil and gas exploration wells which were either drilled and abandoned or plugged and abandoned per MSOGB publicly available records. Of the remaining 4 deep wells, 3 are the recently drilled and temporarily abandoned Project ECO₂S Phase II characterization/monitoring wells and one is a plugged and abandoned water production test well located at Plant Ratcliffe. Well reports suggest that they were appropriately abandoned according to existing State regulations at the time of their drilling. While they appear to have been abandoned in accordance to State oil and gas regulations at the time, the 12 abandoned exploration wells represent a moderate leakage risk and their conditions and locations will be further evaluated in Phase III of Project ECO₂S as the AoR is updated and refined.

Deliverable 8.1.b *Identification of Wells Within the AoR* was completed on June 5, 2020. <https://www.osti.gov/servlets/purl/1635357>

Subtask 8.2 - Commercial Development Plan

Milestone 5 and Deliverable *Commercial Development Plan* were completed June 10, 2020, and an update was completed on December 31, 2020, to factor in some key findings that have occurred since the June 2020 version. <https://www.osti.gov/servlets/purl/1635358>

The Task 8 report, *Commercialization Plan: Early CO₂ Storage (ECO₂S) Regional CO₂ Storage Complex*, dated June 10, 2020, established an initial commercialization plan for the integrated facility. The Commercialization Plan addresses a variety of topics essential for establishing the ECO₂S Regional CO₂ Storage Complex including: 1) defining the location of the CO₂ storage site; 2) characterizing the subsurface at the storage site; 3) establishing the CO₂ storage capacity at the site; 4) defining the sources of captured CO₂; 5) linking the sources of CO₂ to the storage site with large volume CO₂ pipelines; 6) constructing and operating the CO₂ storage facility, consistent with EPA Class VI Underground Injection Control (UIC) regulations; 7) estimating the costs of installing and operating the CO₂ storage facility; 8) defining the business case for the Storage Complex; and 9) emphasizing a series of stakeholder issues central to establishing and operating a commercial-scale CO₂ storage facility in east-central Mississippi.

The June 10, 2020, Commercialization Plan identified 16 large coal- and natural gas-fueled power plants, 13 large steel, chemical and cement plants, and a large refinery complex as potential CO₂ sources. Combined, these facilities emitted over 70 million metric tons of CO₂ in 2017. The Commercialization Plan also focuses on three Southern Company coal- and natural gas-fueled power plants that, initially, could serve as potential sources of captured CO₂ for the Storage Complex. These three power plants together would provide 22.5 MMmt of captured CO₂ per year, equal to 675 million metric tons (MMmt) of CO₂ captured and stored over 30 years of injection.

Two different approaches were utilized to analyze capture costs. The chart below focuses on the construction cost for the Plant Miller and Plant Daniel pipelines.

| Plant Miller Cost Estimates | | | | | | | | | |
|-----------------------------|------------|----------|--------------------|-----------|-----------------------|-----------|---------------------------------|----------------------------|----------------------------|
| | Flowrate | Flowrate | Length | Elevation | Preliminary | Pressure | Construction Cost Estimate (\$) | | |
| | Metric | MMSCFD | Miles | Change | Pipe Size | Drop | Low | Medium | High |
| | Tons/Year | | | Feet | Estimate | | | | |
| | | | | | Inches | | | | |
| Trimeric | 19,578,245 | 1,020 | 144 ⁽¹⁾ | 0 | 32 ^{(2) (3)} | 524 (psi) | 317,000,000 ⁽⁴⁾ | 552,000,000 ⁽⁴⁾ | 915,000,000 ⁽⁴⁾ |
| ARI | 18,800,000 | 1,000 | 150 | | 24 ⁽⁵⁾ | 3.2 (Mpa) | | 316,000,000 ⁽⁶⁾ | |

| Plant Daniel Cost Estimates | | | | | | | | | |
|-----------------------------|-----------|----------|--------------------|-----------|-----------------------|-----------|---------------------------------|----------------------------|----------------------------|
| | Flowrate | Flowrate | Length (1) | Elevation | Preliminary | Pressure | Construction Cost Estimate (\$) | | |
| | Metric | MMSCFD | Miles | Change | Pipe Size | Drop | Low | Medium | High |
| | Tons/Year | | | Feet | Estimate | PSI | | | |
| | | | | | Inches | | | | |
| Trimeric | 5,203,600 | 271 | 178 ⁽¹⁾ | 400 | 20 ^{(2) (3)} | 692 (psi) | 245,000,000 ⁽⁴⁾ | 427,000,000 ⁽⁴⁾ | 708,000,000 ⁽⁴⁾ |
| ARI | 3,000,000 | 160 | 180 ⁽⁵⁾ | | 12.75 ⁽⁵⁾ | 3.2 (Mpa) | | 200,000,000 ⁽⁶⁾ | |

(1) - Distance calculated based on straight line distance plus 20%

(2) - Estimates are for calculated flow and do not contemplate for additional CO₂ flow

(3) - Initial diameter requires no booster pumps to deliver CO₂ at injection pressure of 1,500 psig (starting psig 2,200 psig)

(4) - Values from "CO₂ Transport" of the National Petroleum Council (NPC) December 2019 report

(5) - Booster pumps are anticipated being installed and operating - 4 for Plant Miller and 5 for Plant Daniel

(6) - ARI calculated a single value for the pipeline cost and does not provide a range of costs (low - Medium - High)

Key differences in the analysis are as follows:

- CO₂ Volumes are different. ARI and Trimeric started with different volumes which would influence the size of pipe selected.
- Trimeric uses larger diameter of pipe which increases cost relative to the pipe diameter chosen for ARI. Trimeric notes the larger diameter was chosen to avoid the additional cost of booster pumps but does not provide for additional CO₂ flow.
- ARI designed each pipeline to include booster pumps
 - Pipeline of Plant Miller will need 4 booster pumps. The capital cost for the pumps is \$47,681,705
 - Pipeline for Plant Daniel will need 4 booster pumps. The capital cost for the pumps is \$9,504,495
- The long term benefit/cost of booster pumps would need to be viewed over the life of the project and will be greatly influenced by energy prices and expected maintenance. Trimeric and ARI may have additional items that would need to be considered.
- Trimeric based their costs estimates on the NPC study but data in report the is for 4"-24" diameter pipe. Trimeric used the same cost information for the 32" diameter pipe for Plant Daniel.
- ARI used an independent pipeline model to estimate costs

The ARI cost estimate is likely the more representative of the two analyses.

Conclusion

The primary objective of Project ECO₂S Phase II was to establish the foundation for a commercial-scale geologic storage site for CO₂ captured from the Kemper County energy facility and potentially other CO₂ captured from industrial and/or power plants in the region.

The scope of work was designed to achieve eight primary objectives. First, the project partners demonstrated that the subsurface at the Storage Complex can store commercial volumes of CO₂ safely and permanently within the saline reservoir system. Second, state of the art reservoir modeling, populated with the data gained from the characterization wells, was conducted to establish the areal extent of the CO₂ plume and incorporate reservoir architecture to optimize the CO₂ storage capacity of the site. Third, Core from the seals were analyzed at UAB's Caprock Integrity Laboratory and by other means to confirm the viability of each of the reservoir seals to serve as a long-term, reliable confining system for the Storage Complex. Fourth, seismic and wellbore logging were used to identify any large-scale fault systems and the regional stress vectors that would potentially lead to induced seismicity. Fifth, a suite of NETL's National Risk Assessment Partnership (NRAP) tools, as well as other DOE Carbon Storage Program tools, were used to assess the operational risks, particularly for potential induced seismicity and leakage of CO₂ from the reservoir. Sixth, a comprehensive MVA system and a quick-response contingency plan, should the monitoring system signal the onset of CO₂ leakage, was defined to assure that any injected CO₂ is securely stored. Seventh, the project team performed public outreach throughout the entire performance period to provide project information to the community, regulators, and other stakeholders and to share knowledge and lessons learned with the technical/CCUS community. Finally, the project team completed detailed plans for the Site Characterization (Phase III) of CarbonSAFE and the first draft of the Construction (Phase IV) of CarbonSAFE.

As part of the Phase II project, the project team continued its pursuit of advances in CO₂ storage knowledge and technology. This included an enhanced capability to define discrete reservoir flow units using advanced well logging integrated with core analysis and detailed characterization of fluid and rock properties to better establish time-based projections of the fate of the injected CO₂. An equally important advancement to the state-of-the-art for CO₂ storage was the major issues and challenges to be defined, addressed, and solved in transforming and scaling-up from a regional, pre-feasibility assessment of CO₂ storage to a defined, site-specific commercial-scale CO₂ storage site, including all of the "lessons learned" in making this transition.

List of Acronyms and Abbreviations

| | |
|-----------------|--|
| AAPG | American Association of Petroleum Geologists |
| AIChE | American Institute of Chemical Engineers |
| AIME | American Institute of Mining, Metallurgical, and Petroleum Engineers |
| BEG | Bureau of Economic Geology at The University of Texas at Austin |
| CCS | carbon capture and storage |
| CCUS | carbon capture, utilization and storage |
| CEU | continuing education unit |
| CO ₂ | carbon dioxide |
| DOE | U.S. Department of Energy |
| ECC | Eastern Coal Council |
| EPA | U.S. Environmental Protection Agency |
| GSA | Geological Survey of Alabama |
| HILL | GERALD R HILL PHD, Inc. |
| MVA | monitoring, verification and accounting |
| NETL | National Energy Technology Laboratory |
| PDH | professional development hour |
| PI | principal investigator |
| PMP | Project Management Plan |
| R&D | research and development |
| RCSP | Regional Carbon Sequestration Partnership |
| RECS | Research Experience in Carbon Sequestration |
| SSEB | Southern States Energy Board |
| SECARB | Southeast Regional Carbon Sequestration Partnership |
| SECARB-Ed | Southeast Regional CO ₂ Sequestration Technology Training Program |
| SIPES | Society of Independent Professional Earth Scientists |
| SME | Society for Mining, Metallurgy, and Exploration |
| SMP | Sponsorship Marketing Plan |
| SOPO | Statement of Project Objectives |
| STEP | Student Transition Engineering Program |
| VAT | Virginia Tech |
| VCCER | Virginia Center for Coal and Energy Research |

Appendices

Establishing an Early CO₂ Storage Complex in Kemper County, Mississippi: Project ECO₂S

DE-FE0029465 Final Report Appendices

- Appendix I Project Management Plan
- Appendix II Data Management Plan
- Appendix III Knowledge Sharing Report
- Appendix IV Site Access Agreement
- Appendix V Well Permits

Appendix I Project Management Plan

PROJECT MANAGEMENT PLAN
for
Establishing an Early CO₂ Storage Complex in Kemper County, Mississippi:
Project ECO₂S
March 20, 2017

COOPERATIVE AGREEMENT NUMBER

DE-FE0029465

SUBMITTED BY
Southern States Energy Board
6325 Amherst Court
Peachtree Corners, Georgia 30092

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SUBMITTED TO

U.S. Department of Energy
National Energy Technology Laboratory

A. Executive Summary

The Phase II: Storage Complex Feasibility project, entitled “*Establishing an Early CO₂ Storage Complex in Kemper County, Mississippi: Project ECO₂S*,” will establish a commercial-scale (438 million metric tons of capacity) CO₂ Storage Complex adjacent to the Kemper County energy facility. Further, it is the Project Team’s intent to establish this Storage Complex (including completing subsequent Phases III and IV) three years earlier than the proposed year 2025 target date discussed by DOE/NETL for a fully characterized, permitted, and constructed CO₂ Storage Complex able to accept commercial scale CO₂ injection. Three regionally extensive porous and permeable saline formations, with thick confining systems, have been identified at the Storage Complex. The Storage Complex will have the capacity to receive 3 million metric tons per year of CO₂, and potentially three times as much as determined by pre-feasibility models, for a period of at least 30 years.

Project ECO₂S is headed by the Southern States Energy Board (SSEB). Mississippi Power Company (MPC) will serve as the site host, as well as the primary cost share partner and the source of the CO₂. The project includes technical and field implementation support from Advanced Resources International (ARI) and will obtain analytical support from two national laboratories (Los Alamos and Lawrence Berkeley), a host of universities and other key participants.

Project ECO₂S will pursue key advances in CO₂ storage knowledge and technology, including optimizing CO₂ storage efficiency, modeling the fate of injected CO₂, and establishing residual CO₂ saturations. In addition, Project ECO₂S will involve “real-life” experiences, issues, and challenges of scaling-up from its regional, pre-feasibility assessment of CO₂ storage to establishing a site-specific, commercial-scale CO₂ storage facility, including capturing the “lessons learned” in making this transition.

Project ECO₂S supports all four of DOE’s Carbon Storage R&D Program objectives. By integrating flow-unit level characterization of three major saline formations with state-of-the-art reservoir modeling, Project ECO₂S will further refine our understanding of CO₂ storage efficiency and containment (DOE Goal #2). By rigorously modeling the areal (and vertical extent) of the CO₂ plume, Project ECO₂S will enhance industry’s ability to predict (as well as optimize) CO₂ storage capacity (DOE Goal #3). By engaging in extensive storage site screening and characterization as well as risk analysis (using DOE/NETL developed NRAP tools) and conducting early public outreach, Project ECO₂S will contribute to DOE’s Commercial-Scale Best Practices Manuals (DOE Goal #4). Finally, Project ECO₂S will draw on geomechanical modeling by Virginia Polytechnic Institute and State University, the University of Alabama at Birmingham’s Caprock Integrity Laboratory, and the DOE/NETL Carbon Storage Program’s NRAP tools to ensure 99% storage permanence (DOE Goal #1).

B. Project Organization and Structure

Organizational Charts. SSEB is the overall lead for Project ECO₂S. An organizational chart depicting the contractual flow down to sub-recipients is provided in

Figure 1, and the management organizational chart is provided as

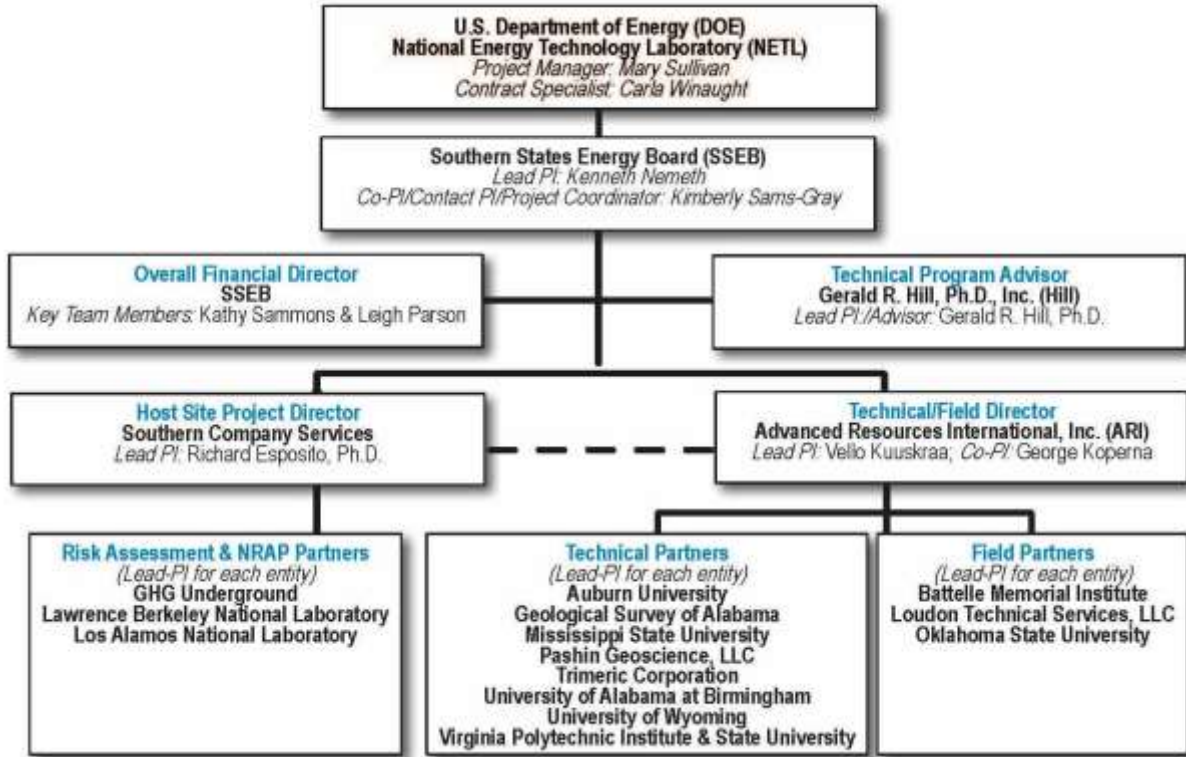


Figure 2. The need for two structures arises from a Mississippi Sales and Use Tax for construction contractors. To simplify the accounting and reporting procedure, the best contractual approach is to cluster the sub-recipients into taxable and non-taxable categories. SSEB will issue sub-recipient contracts to Advanced Resources International, Inc. (ARI), Auburn University (AUB), Gerald R Hill PHD, Inc. (Hill), Pashin Geoscience, LLC (Pashin), Trimeric Corporation (Trimeric), the University of Alabama at Birmingham (UAB), and the University of Wyoming (UW). ARI will manage the technical and field operations and will issue sub-recipient contracts to the partners that will provide services in the field that are most likely to incur the Mississippi contractors' tax, including Battelle Memorial Institute (Battelle), Geological Survey of Alabama (GSA), GHG Underground (GHGU), Loudon Technical Services, LLC (Loudon), Mississippi State University's (MSU) Department of Geosciences, Oklahoma State University (OSU), and Virginia Polytechnic Institute and State University (VA Tech). Southern Company Services (SCS) will provide management oversight on behalf of Mississippi Power Company (MPC), a subsidiary of Southern Company, as it relates to the work completed on MPC property but will not receive a formal sub-recipient contract. Lawrence Berkeley National Laboratory (LBNL) and Los Alamos National Laboratory (LANL) are project partners and will conduct work through Field Work Proposal (FWP) agreements to be approved directly by DOE/NETL. All partners have provided commitment letters offering technical support and/or financial resources to the project.

Contractual Organizational Chart

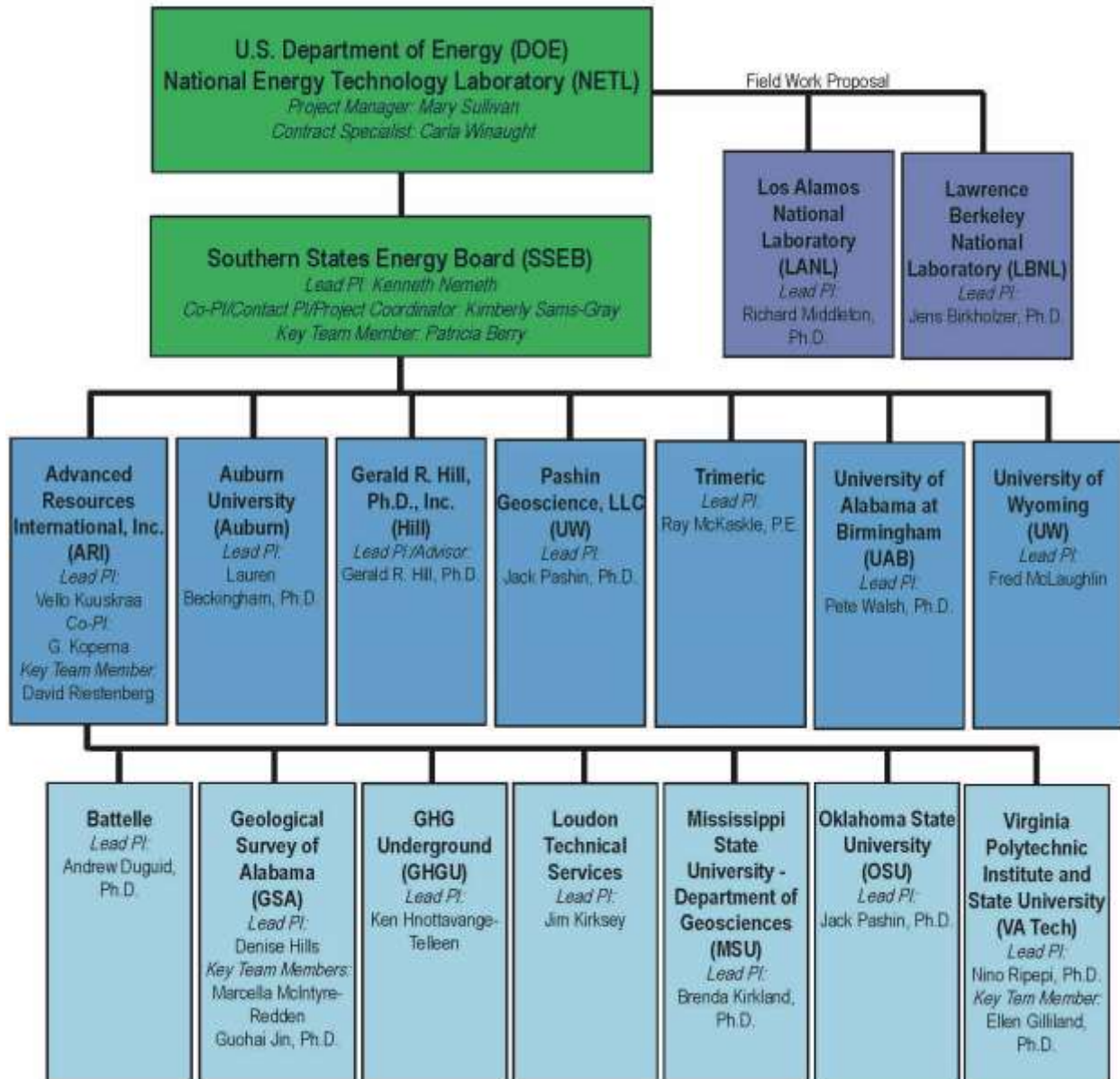


Figure 1. Project ECO₂S contractual organizational chart.

The Project Team's overall management organizational structure facilitates the performance of the tasks and achievement of the objectives described in the Statement of Project Objectives (SOPO) within the specified schedule and budget. Utilizing the successful model of the DOE Regional Carbon Sequestration Partnerships, SSEB has taken a team approach to developing the SOPO. Project ECO₂S is comprised of a partnership of eighteen entities with multiple principal investigators (PIs). **SSEB's Lead PI and Co-PI** are responsible for all aspects of project performance in accordance with the DOE/NETL Cooperative Agreement. MPC is the **Project Host** and is providing the Project Team with access to the property. MPC/SCS is not receiving federal funds for their work associated with the project. A **Host Site Project Director (SCS)** is assigned to facilitate communication between MPC and the Project Team and to lead the risk mitigation activities along with the **Risk Assessment and NRAP Partners** (GHGU, LBNL, and LANL). The

Technical/Field Director (ARI) will contract with and manage the **Technical Partners** (AU, GSA, MSU, Pashin, Trimeric, UAB, UW, and VA Tech) and **Field Partners** (Battelle, Loudon, and OSU) and will provide direct oversight for the geologic characterization, well drilling, and reservoir modeling activities. A **Technical Program Advisor** (HILL) will provide project management support and guidance as it relates to overall management strategies, CCS component integration, and risk assessment. SSEB's **Overall Financial Director** will provide daily support related to all financial and contractual management.

Roles and Responsibilities of Participants. The Project Team is a partnership comprised primarily of organizations and individuals who have collaborated and/or are currently collaborating on CCS projects. To facilitate collaboration, the partners will communicate frequently via individual calls, regularly scheduled conference calls, and web or in-person meetings and also share files and data through a web-based portal. The only necessary business arrangement needed to perform the project, the site access agreement between MPC and ARI, was fully executed in January 2017. There are no intellectual property issues associated with this project. Table 1 identifies senior and key personnel by organization, task assignment, and the roles to be performed by each partner within the context of the Task structure contained in the SOPO.

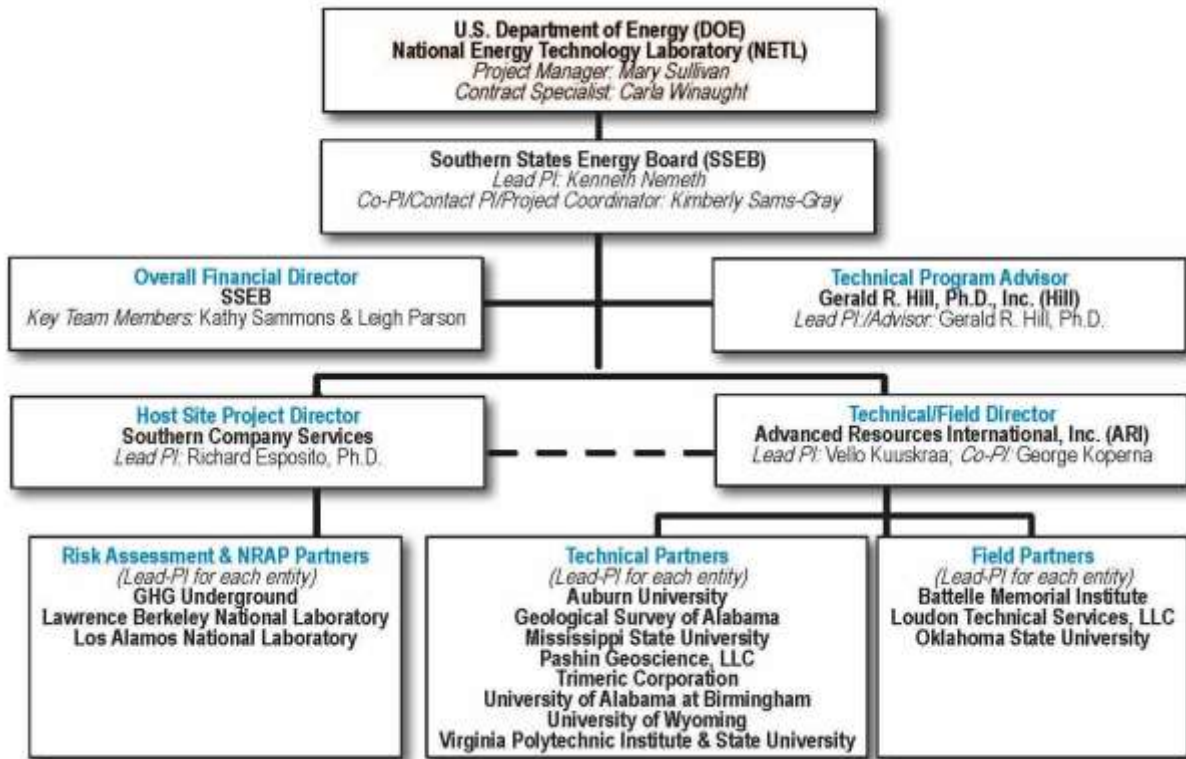


Figure 2. Project ECO₂S management organizational chart.

Table 1. Senior and key personnel by organization, task assignment, and roles to be performed by each partner.

| Project Partners | Sr. & Key Personnel | Task(s) | Role |
|------------------|--------------------------------|---------|---|
| SSEB | Nemeth, Gray, Berry | 1,2 | PI/Lead organization, project mgmt./admin., outreach, risk |
| ARI | Kuuskraa, Koperna, Riestenberg | 1-8 | Lead for technical/field operations, outreach support, risk identification, commercial development planning |
| AUB | Beckingham | 6 | Geologic data analysis support |
| Battelle | Duguid | 5 | Site selection and well drilling support, engineering design collaboration |

| | | | |
|----------|--------------------|---|--|
| GHGU | Hnottavange-Tellen | 4 | Risk assessment and mitigation |
| GSA | Hills | 4 | Site characterization and modeling, geophysics expertise |
| HILL | Hill | 1 | Advisor for project management, CCS component integration and engineering, risk analysis |
| LANL | Middleton | 7 | Infrastructure development, technoeconomic analysis of CO ₂ capture and storage, risk analysis |
| LBNL | Birkholzer | 4 | Advisor for model testing in geomechanical simulations and induced seismicity risk assessments, NRAP support |
| Loudon | Kirksey | 5 | Site selection and well drilling support, process engineering |
| MSU | Kirkland | 6 | Geologic data analysis support |
| OSU | Pashin | 6 | Geologic data analysis support |
| Pashin | Pashin | 5 | Site selection and well drilling support, geology |
| SCS-MPC | Esposito | 1 | Project/Site Host, Outreach, Communication between Project Team and MPC (no contract) |
| Trimeric | McKaskle | 7 | Infrastructure development support, surface facilities and pipelines |
| UAB | Walsh | 6 | Geologic data analysis support, caprock integrity laboratory analysis, MVA |
| UW | McLaughlin | 6 | Geologic data analysis support, advanced characterization in state of the art laboratory |
| VA Tech | Ripepi, Gilliland | 6 | Geologic data analysis support |

Technical and Managerial Capabilities. The Project ECO₂S partners possess the **necessary credentials** to execute a successful project on schedule and on budget. **SSEB - Nemeth** has over 40 years of experience providing technical and financial oversight for the board's DOE-funded projects and currently is the Lead PI/Project Director for the SECARB partnership and the SOSRA project. **Gray**, Managing Director and a geologist, has 23 years of experience managing the daily activities of DOE-funded projects and industry/academic/public partnerships. She currently serves as the SECARB Project Coordinator and the Co-PI/Contact PI/Project Coordinator for the SOSRA project. She is as a member of the U.S. Technical Advisory Group to the International Organization for Standardization's Technical Committee 265 (ISO TC-265) on CO₂ Capture, Transportation, and Geological Storage. Her expertise is in the areas of technical and field program research and development; storage capacity assessments, including offshore opportunities for CO₂ storage; MVA protocols; risk assessment and mitigation planning; program management and team coordination; and communication and outreach. **Berry** is a geologist at SSEB and currently supports SECARB and SOSRA project management, outreach, and education activities by preparing technical progress reports from multiple contributors and maintaining a current outreach program for CCS projects. **Gray and Berry** also provide project management and outreach support to the Virginia Center for Coal and Energy Research at Virginia Tech on its enhanced coalbed methane recovery and carbon storage project. **HILL - Hill** is a Project Integration Consultant and engineer with over thirty years of experience with the petroleum and electric utility industries. He spent several years as director of technology programs for SSEB and currently serves as senior technical advisor. He is the technical coordinator for the board's CCS programs. He also is a consultant to the Virginia Center for Coal and Energy Research at Virginia Tech on its CCS projects. **SCS - Esposito** will serve as the Host Site's Project Director. He provides program level management responsibilities for geoscience-related R&D and commercial development of technologies including geologic storage, CO₂-EOR, CO₂ utilization, bulk energy storage, and geothermal. He is the utility host advisor and program facility for DOE's Research Experience in Carbon Sequestration program (2011 - present), an industry advisory board member for the University of Illinois Frontier Energy Research Center for Storage of Carbon Dioxide (2015 - present), and a member of the ISO TC-265 on CCS (2014 - present). He holds a B.S. and M.S. in Geology, an M.S. in Environmental Management, and a Ph.D. in Interdisciplinary. **ARI - Kuuskraa**, President, will provide direct oversight for the geologic characterization, well drilling, and reservoir modeling activities. He performed a similar role on the SECARB/Plant Daniel reservoir characterization/CO₂ injection test and the Anthropogenic Test conducted in Citronelle, Alabama. He holds a M.B.A., Highest Distinction from The Wharton Graduate School and a B.S., Applied

Mathematics/ Economics, from the North Carolina State University. **Koperna**, Vice President and Reservoir Engineering Manager, oversees an interdisciplinary team of geologists, engineers, and economists. He has lead numerous CO₂ storage field tests for DOE's RCSPs, including those at Plant Daniel (SECARB PHII), Pump Canyon (SWP PHII), and the Anthropogenic Test (SECARB PHIII). Koperna holds M.Sc. and B.Sc. degrees in Petroleum and Natural Gas Engineering from West Virginia University. **Riesterberg**, Project Manager and geologist has planned and supervised field geologic characterization activities at the DOE's RCSP CO₂ storage field tests at Plant Daniel (SECARB PHII) and the Anthropogenic Test (SECARB PHIII). Riesterberg holds a M.Sc. degree in Geology from the University of Tennessee, Knoxville and a B.Sc. degree in Biology from the College of Mount St. Joseph, Cincinnati.

Decision-making and Communication Strategy. The management structure facilitates the performance of the tasks and achievement of the objectives described in the SOPO within the specified time frame and budget. SSEB is ultimately responsible for decision-making on the scientific/technical direction of the Project. Each organization has designated a Lead PI that has the authority/responsibility for the proper conduct of the research, intellectually and logistically, and the technical, financial, and scheduling aspects of the project. Each Lead PI has the authority to provide scientific/technical advice and a decision on behalf of his/her organization. The level of project team involvement and management necessary for decision-making will be determined on a case-by-case basis and at the discretion of the SSEB Contact PI/Project Coordinator (Gray). To arrive at a decision on scientific/technical direction Gray will consult with the SCS Lead PI. As appropriate, SCS will seek advice and input from the Lead/Co-PI of ARI who, in turn, can seek advice/input from the technical and field partners. These decisions will be shared with the Gray, and she will make a preliminary decision and obtain final approval on the decision from SSEB's Lead PI, Nemeth, before communicating the decision to DOE/NETL. SSEB's Contact PI/Project Coordinator will keep DOE/NETL informed of the decision-making process and progress as these issues arise.

C. Risk Management

The Host Site Project Director (SCS) will lead a Risk Assessment and NRAP Partners team to identify potential risks associated with the project (Task 4.0). In coordination with the entire Project Team all risks will be identified and evaluated by measuring the severity of potential consequences (relative to health and safety, environmental protection, cost, reputation, and schedule) and their likelihood of occurrence. Each risk will be assigned a responsible party to assume ownership of minimizing and mitigating the risk, along with actions that can be taken and a schedule for their implementation.

Risk Registry

| Uncertain Future Event | Risk to Project | Risk Management Method | Risk Level |
|---|---|--|----------------------------------|
| Management Issues: Reporting and Milestones | Delayed or late reports | Reporting requirements and milestones are manageable and not constrained by any single participant or event. SSEB will manage the project and assist in report preparation to regain any schedule slippage. | Low probability, Low consequence |
| Cost Share | Cost share not harmonized temporally with federal spend | Cost share requirements will be met early on in the project with immediate drilling of the first well. | Low probability, Low consequence |
| Environmental, Health, or Safety Issues | Environmental impacts to air, land, and water resources and potential impacts of waste production | The Kemper County energy facility completed the EIS process. Partners are experienced in well drilling and will follow the MPC HSE plan/protocols. Members of the team also will be on-site during well drilling to monitor the field service personnel. | Low probability, Low consequence |
| Environmental, Health, or Safety Issues | Delay in obtaining Mississippi permits | Draw upon team experience in well permitting and maintain an open dialogue with state and federal regulators. | Low probability, Low consequence |

| | | | |
|---------------------------------------|--|--|-------------------------------------|
| | | | |
| Management Issues: Staff Availability | Delays in completion due to excessive staff workload | Participants are experienced in handling multiple projects. The participating partners and entities have considerable depth in professional staff with related experience. | Low probability, Low consequence |
| Management Issues: Staff Availability | Key person replacement | Maintain work distribution to ensure that other individuals are prepared and qualified to assume responsibilities. | Low probability, Medium consequence |
| Management Issues: Staff Availability | Delays in approving Foreign Nationals access | Pre-screen potential project partners and team members and provide necessary credentials to NETL for approval. | Medium probability, Low consequence |
| Technical Difficulties | Unforeseen issues with well drilling and completion | Draw upon team experience to identify issues and secure equipment and professionals to address issues. | Low probability, Medium consequence |
| Resource Availability | Availability of drilling, workover, and well support equipment and technical field crews | Draw upon team experience to obtain early bids/commitments. | Low probability, Medium consequence |
| Site Access Issues for Field Work | Site access is necessary to perform the project | MPC will host the Project and provide reasonable site access to its property. As of the proposal date, the agreement is near final and no issues are anticipated. | Low probability, High consequence |
| Storage Reservoir | Lack of suitable storage reservoirs | The Project Team will consider geology along CO ₂ pipeline or engineered storage. | Low probability, High consequence |
| Pore Space Ownership | No CO ₂ storage complex or the need for an alternate site | The MPC Real Estate Department has successfully acquired surface and pore space rights for both the Plant and the associated lignite mine. | Low probability, Medium consequence |

D. Schedule, Labor and Cost Baselines:

Baseline Schedule/Timeline. Project ECO₂S will be conducted over a three-year (36-month) performance period divided into two 12-month budget periods. The following Gantt chart provides a schedule of the project broken down by Task and Subtask as described in the Statement of Project Objectives. The chart also indicates the start date and end date for each Task/Subtask and identifies all deliverables, milestones, and decision points as identified in Section F (Project Milestones) of the PMP. Task 1.0, Project Management and Planning, and Task 2.0, Outreach, will be active throughout the entire performance period. Task 3.0 will entail the completion and approval of all Permitting and Site Access Agreements. Task 4.0 involves all Site Characterization and Modeling activities that set the foundation for Task 5.0, Site Selection and Well Drilling. Comprehensive Geologic Data Analysis will be conducted under Task 6.0 using data collected under Tasks 4.0 and 5.0. Infrastructure development is the focus of Task 7. Task 8.0 provides for the development of a Commercial Development Plan to be based on the regional geologic framework created under Task 6.0 and findings from all aspects of the project.

| | | | 3-5 | 6-8 | 9-11 | 12-2 | 3-5 | 6-8 | 9-11 | 12-2 | 3-5 | 6-8 | 9-11 | 12-2 |
|---|-----------|------------|-----------------|-----------------|------|------|-----------------|-------------------------|------|------|-------------------------------|-----|------|------|
| | | | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 | Q11 | Q12 |
| PROJECT ECO ₂ S | KEY | Milestone | Budget Period 1 | | | | Budget Period 2 | | | | Budget Period 2 - No Cost Ext | | | |
| | | | 3/1/17-2/28/18 | | | | 3/1/18-2/28/19 | | | | 3/1/19-2/28/20 | | | |
| Task Description | Start | End | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 |
| Task 1.0: Project Management and Planning | 3/1/2017 | 2/28/2020 | | | | | | | | | | | | |
| Subtask 1.1: Overall Proj. Mgmt., Planning, Communication | 3/1/2017 | 2/28/2020 | PMP | Kickoff Meeting | | | | | | | | | | |
| Subtask 1.2: Project Management Plan | 3/1/2017 | 2/28/2020 | ◆ | | | | | | | | | | | |
| Subtask 1.3: Data Management Plan | 3/1/2017 | 2/28/2020 | | | | | | | | | | | | |
| Task 2.0: Outreach | 3/1/2017 | 2/28/2020 | | | | | | | | | | | | |
| Subtask 2.1: Community Outreach and Education | 3/1/2017 | 2/28/2020 | | | | | | | | | | | | |
| Subtask 2.2: Regulatory Outreach | 3/1/2017 | 2/28/2020 | | | | | | | | | | | | |
| Subtask 2.3: Knowledge Sharing | 3/1/2017 | 2/28/2020 | | | | | | | | | | | | |
| Task 3.0: Permitting and Site-Access Agreements | 3/1/2017 | 8/31/2017 | | | | | | | | | | | | |
| Subtask 3.1: NEPA Assessment | 3/1/2017 | 8/31/2017 | | | | | | | | | | | | |
| Subtask 3.2: Contractual | 3/1/2017 | 8/31/2017 | | | | | | | | | | | | |
| Subtask 3.3: Permitting and Site Survey | 3/1/2017 | 8/31/2017 | | | | | | | | | | | | |
| Task 4.0: Site Characterization and Modeling | 3/1/2017 | 2/28/2020 | | | | | | | | | | | | |
| Subtask 4.1: Assessment of Existing Subsurface Data | 3/1/2017 | 12/31/2017 | | | | | | | | | | | | |
| Subtask 4.2: Surface Seismic Surveys | 3/1/2017 | 5/31/2018 | | | | | | | | | | | | |
| Subtask 4.3: Surface Characterization | 3/1/2017 | 12/31/2017 | | | | | | | | | | | | |
| Subtask 4.4: Reservoir Modeling | 3/1/2017 | 8/31/2017 | | | | | | | | | | | | |
| Subtask 4.5: Risk Assessment | 3/1/2017 | 2/28/2020 | | | | | ◆ | Initial Risk Assessment | | | | | | |
| Subtask 4.6: Risk Assessment Tools | 9/1/2017 | 2/28/2020 | | | | | | | | | | | | |
| Subtask 4.7: Collaboration and Data Collection | 3/1/2017 | 2/28/2020 | | | | | | | | | | | | |
| Task 5.0: Site Selection and Well Drilling | 3/1/2017 | 8/31/2018 | | | | | | | | | | | | |
| Subtask 5.1: Well Site Selection | 3/1/2017 | 12/31/2017 | | | | | | | | | | | | |
| Subtask 5.2: Well Design | 3/1/2017 | 12/31/2017 | | | | | | | | | | | | |
| Subtask 5.3: Well Drilling and Geologic Data Collection | 11/1/2017 | 8/31/2018 | | | | | | | | | | | | |
| Task 6.0: Geologic Data Analysis | 3/1/2017 | 2/28/2020 | | | | | | | | | | | | |
| Subtask 6.1: Core Analysis | 3/1/2017 | 2/28/2020 | | | | | | | | | | | | |
| Subtask 6.2: Refined Geologic Model | 3/1/2017 | 2/28/2020 | | | | | | | | | | | | |
| Subtask 6.3: Reactive Transport Simulations | 3/1/2017 | 2/28/2020 | | | | | | | | | | | | |
| Subtask 6.4: Thermo-Hydro-Mechanical (THM) Modeling | 3/1/2017 | 2/28/2020 | | | | | | | | | | | | |
| Task 7.0: Infrastructure Development | 8/1/2017 | 2/28/2020 | | | | | | | | | | | | |
| Subtask 7.1: Site Infrastructure Development | 8/1/2017 | 2/28/2020 | | | | | | | | | | | | |
| Subtask 7.2: Regional Infrastructure Development | 8/1/2017 | 2/28/2020 | | | | | | | | | | | | |
| Task 8.0: Commercial Development Plan | 3/1/2018 | 2/28/2020 | | | | | | | | | | | | |
| Subtask 8.1: Numerical Modeling of CO ₂ Flow and Storage | 3/1/2018 | 2/28/2020 | | | | | | | | | | | | |
| Subtask 8.2: Commercial Development Plan | 12/1/2018 | 3/30/2020 | | | | | | | | | | | | |

Baseline Labor Effort by Task. The Project Team is comprised of individuals with very specialized skills and CCS project development expertise that are required to achieve the project goals. The partners represent 18 organizations with multiple PIs, Co-PIs, professors, engineers, scientists, geologists, research assistants, IT technicians, administrative personnel, and graduate and undergraduate students. The Lead PIs and the Co-PIs have the authority and responsibility for the proper conduct of the research, intellectually and logistically, and the technical and financial aspects of the project. The PIs are experienced in conducting complex Federally-funded projects, either as a PI or senior key personnel. These individuals will ensure that the project meets or exceeds all administrative, technical, and scientific, and financial objectives. The PIs will provide the required personnel, facilities, equipment, supplies, and services necessary to carry out the SOPO as delineated in the most current Cooperative Agreement/Modification by utilizing the approved PMP. Labor hour distributions for personnel are based on experience managing similar programs and historical costs related to those projects.

Baseline Labor Effort by Task

| Labor Categories | Task 1 | Task 2 | Task 3 | Task 4 | Task 5 | Task 6 | Task 7 | Task 8 | Total |
|--------------------------------------|-------------|-------------|------------|-------------|-------------|--------------|------------|-------------|--------------|
| 1. Principal Investigator/Contact PI | 1708 | 784 | 96 | 136 | 1222 | 2056 | 120 | 204 | 6326 |
| 2. Co-PI/Project Manager/Professor | 104 | 280 | 96 | 188 | 432 | 4280 | 363 | 132 | 5875 |
| 3. Engineer | 648 | 630 | | 852 | | 2071 | 112 | 260 | 4573 |
| 4. Scientist/Geologist | 2044 | 860 | 140 | 689 | 1123 | 678 | 38 | 328 | 5900 |
| 5. Research Assistant | 664 | 160 | 80 | 1012 | 1808 | 1520 | | 226 | 5470 |
| 6. IT Technician | | | | | | 960 | | | 960 |
| 7. Administrative/Financial | 1184 | 32 | 60 | 224 | 380 | 40 | | 160 | 2080 |
| 8. Grad & Undergrad Student | | | | | | 20143 | | | 20143 |
| Total Hours Per Task/Category | 6352 | 2746 | 472 | 3101 | 4965 | 31748 | 633 | 1310 | 51327 |

Baseline Project Cost by Task

| Task Breakdown | BP1-Fed Share | BP1-Cost Share | BP1-TOTAL | BP2-Fed Share | BP2-Cost Share | BP2 TOTAL | TOTAL Fed Share | Total Cost Share | Total Budget |
|--|--------------------|--------------------|---------------------|--------------------|------------------|--------------------|---------------------|--------------------|---------------------|
| Task 1.0 - Project Management and Planning | \$458,799 | \$8,985 | \$467,784 | \$353,299 | \$88,324 | \$441,623 | \$812,098 | \$97,309 | \$909,407 |
| Task 2.0 - Outreach | \$220,635 | \$0 | \$220,635 | \$216,082 | \$54,020 | \$270,102 | \$436,718 | \$54,020 | \$490,738 |
| Task 3.0 - Permitting & Site Access Agreements | \$85,821 | \$0 | \$85,821 | \$0 | \$0 | \$0 | \$85,821 | \$0 | \$85,821 |
| Task 4.0 - Site Characterization & Modeling | \$442,726 | \$16,089 | \$458,815 | \$193,368 | \$52,036 | \$245,404 | \$636,094 | \$68,125 | \$704,219 |
| Task 5.0 - Site Selection & Well Drilling | \$7,057,499 | \$3,153,054 | \$10,210,553 | \$162,212 | \$40,555 | \$202,767 | \$7,219,711 | \$3,193,609 | \$10,413,320 |
| Task 6.0 -Geologic Data Analysis | \$1,063,745 | \$102,047 | \$1,165,792 | \$656,414 | \$163,548 | \$819,962 | \$1,720,159 | \$265,595 | \$1,985,754 |
| Task 7.0 - Infrastructure Development | \$63,855 | \$0 | \$63,855 | \$80,512 | \$20,128 | \$100,640 | \$144,367 | \$20,128 | \$164,495 |
| Task 8.0 - Commercial Development Plan | \$0 | \$0 | \$0 | \$165,570 | \$41,393 | \$206,963 | \$165,570 | \$41,393 | \$206,963 |
| Total | \$9,393,080 | \$3,280,175 | \$12,673,255 | \$1,827,457 | \$460,004 | \$2,287,461 | \$11,220,537 | \$3,740,179 | \$14,960,716 |

E. Baseline Funding Profiles

Baseline Funding Profiles are provided below by Budget Period and Recipient Organization, by Funding Source and DOE Funding by FY Quarter.

Baseline Funding Profile by Budget Period and Recipient Organization

| Funding By Budget Period/Recipient Org | | | | | | | |
|---|---------------------|------------------------|--------------------|------------------------|---------------------|--------------------|---------------------|
| Recipient Organi | Budget Period 1 | | Budget Period 2 | | TOTAL | | |
| | DOE Funds | Non-Federal Cost Share | DOE Funds | Non-Federal Cost Share | DOE Funds | Non-Federal | Total Costs |
| SSEB | \$ 432,326 | \$ - | \$ 439,550 | \$ - | \$ 871,876 | \$ - | \$ 871,876 |
| Advanced Resources Int. (includes Subs) | \$ 11,268,609 | \$ 45,401 | \$ 1,314,431 | \$ 46,542 | \$ 12,583,040 | \$ 91,943 | \$ 12,674,983 |
| Auburn University | \$ 124,999 | \$ 13,889 | \$ 124,999 | \$ 13,889 | \$ 249,998 | \$ 27,778 | \$ 277,776 |
| Gerald R Hill | \$ 35,943 | \$ 8,985 | \$ 37,786 | \$ 9,446 | \$ 73,729 | \$ 18,431 | \$ 92,160 |
| Pashin Geoscience LLC | \$ 54,564 | \$ - | \$ - | \$ - | \$ 54,564 | \$ - | \$ 54,564 |
| Trimeric | \$ 13,856 | \$ - | \$ 39,644 | \$ - | \$ 53,500 | \$ - | \$ 53,500 |
| University of Alabama-Birmingham | \$ 117,752 | \$ 6,250 | \$ 62,750 | \$ 6,250 | \$ 180,502 | \$ 12,500 | \$ 193,002 |
| University of Wyoming | \$ 384,005 | \$ 52,595 | \$ 81,254 | \$ - | \$ 465,259 | \$ 52,595 | \$ 517,854 |
| Los Alamos National Lab | \$ 49,999 | \$ - | \$ 50,001 | \$ - | \$ 100,000 | \$ - | \$ 100,000 |
| Lawrence Berkeley National Lab | \$ 64,081 | \$ - | \$ 60,919 | \$ - | \$ 125,000 | \$ - | \$ 125,000 |
| MS Power Company | \$ (3,153,054) | \$ 3,153,054 | \$ (383,877) | \$ 383,877 | \$ (3,536,931) | \$3,536,931 | \$ - |
| Total | \$ 9,393,080 | \$ 3,280,174 | \$1,827,457 | \$ 460,004 | \$11,220,537 | \$3,740,178 | \$14,960,715 |

| Funding Source | Type | Budget Period 1 | Budget Period 2 | Total |
|---|--------|----------------------|---------------------|----------------------|
| DOE | Cash | \$ 9,393,080 | \$ 1,827,457 | \$ 11,220,537 |
| SSEB | | | | \$ - |
| Advanced Resources Int. (includes Subs) | Inkind | \$ 45,401 | \$ 46,542 | \$ 91,943 |
| Auburn University | Inkind | \$ 13,889 | \$ 13,889 | \$ 27,778 |
| Gerald R Hill | Inkind | \$ 8,985 | \$ 9,446 | \$ 18,431 |
| University of Alabama-Birmingham | Inkind | \$ 6,250 | \$ 6,250 | \$ 12,500 |
| University of Wyoming | Inkind | \$ 52,595 | | \$ 52,595 |
| Mississippi Power Company | Cash | \$ 3,153,054 | \$ 383,877 | \$ 3,536,931 |
| Total | | \$ 12,673,254 | \$ 2,287,461 | \$ 14,960,715 |

DOE Funding by FY Quarter

| | FY 2017 (\$) | FY 2018 (\$) |
|------------------------|--------------------|--------------------|
| CYQ1 (Jan-Mar) | \$7,712,890 | \$456,864 |
| CYQ2 (Apr-June) | \$822,368 | \$456,864 |
| CYQ3 (Jul-Sep) | \$500,000 | \$456,864 |
| CYQ4 (Oct-Dec) | \$357,822 | \$456,864 |
| Total By FFY | \$9,393,080 | \$1,827,457 |

E. Project Milestones

The following table provides a list of project milestones. The milestones are quantitative and indicate progress toward accomplishing the project goals and will be reported as part of the required progress report.

| Task | Milestone Title | Planned Completion Date (Actual Dates in Bold) | Verification Method |
|------|--|--|---|
| 1.0 | Participate in Project Kickoff Meeting | 3/15/17 | Attendance at Meeting; Presentation File |
| 1.0 | Implement Project Management Plan | 3/31/2017 | File to be provided to DOE (WP 1.2) |
| 4.0 | Complete Initial Risk Assessment | 2/23/2018 | Letter from SSEB to DOE documenting findings of initial risk assessment |
| 6.0 | Complete Geologic Framework | 2/28/2020 | File to be provided to DOE (WP 6.2.b) |
| 8.0 | Complete Commercial Development Plan | 3/30/2020 | File to be provided to DOE (WP 8.2) |

F. Decision Points and Success Criteria

The following decision points and success criteria will be encountered during the course of the project, including go/no-go decision points, and describes criteria that will be used to define “success” at each decision point.

| Decision Point | Success Criteria | Description | Criteria to Define Success & Importance |
|----------------|------------------|--|---|
| ✓ | ✓ | Negotiation/Implementation of PMP <i>Go/No-Go Decision Point 1 (Reference Deliverable 1.2)</i> | SSEB will revise the PMP by including details from the negotiation process. The PMP will be updated to incorporate any changes in project management, schedule, and/or budget. DOE/NETL’s approval of this plan and its implementation is necessary to carry out the stated goals of the project and budget objectives. |
| ✓ | ✓ | Negotiation/Implementation of Phase II Go/No-Go Decision Point 2 | A continuation application will be prepared and submitted to DOE/NETL for approval of BP2. Success will be measured by DOE/NETL’s approval of the continuation application and concurrence that the project is meeting its objectives on schedule and within budget. |

Appendix II Data Management Plan

DATA MANAGEMENT PLAN

A. Objective. The scope of work for “*Establishing an Early CO₂ Storage Complex in Kemper County, Mississippi: Project ECO₂S*” focuses on demonstrating that the subsurface in the vicinity of the Kemper County energy facility has the potential to store commercial volumes of CO₂ safely, permanently, and economically within a regionally significant saline reservoir system. To meet this objective, as part of the Phase II CO₂ Storage Complex Feasibility Study, the project team will characterize and refine their understanding of the subsurface geology through the installation of new wells, collection of reservoir and confining unit core, laboratory testing, and use of numerical models to simulate and investigate the efficacy of commercial storage operations. The Project Team also will develop robust monitoring plans specific to the site, identify the contractual and regulatory pathways necessary to develop this significant storage site, assess project risks, and continue its public outreach.

During the execution of Project ECO₂S, the Project Team will collect and generate large volumes of data from the field, the laboratory, and the desktop. The purpose of this document is to set forth the plans for sharing such data sets publically, as well as identifying restricted and/or proprietary data.

B. Data Types and Sources. Three types of data will be generated from this project; field data, laboratory data, and desktop data.

Field data is information collected from the wellsite and may include the following: (1) well completion data, such as costs, casing tallies, casing weight and grade, cement type and quantity pumped, total depth, and wellhead construction information; (2) geologic data, such as formation tops, lithologic data, rock core (unprocessed), and cuttings samples; and/or (3) pre-processed (raw) geophysical log data.

Laboratory data is information generated from experimental processes. Examples of laboratory data includes: (1) routine core analysis, covering rock type, permeability, and porosity; (2) experiments where core is processed, which covers the creating of thin sections, scanning electron microscopy results (mineralogy), rock mechanical properties, and structural analyses; (3) core flooding experimental data; and/or (4) fate and transport experimental data.

Desktop data is information that is generated as a result of processing either field or laboratory data, such as: (1) processed geophysical log data; or (2) numerical modeling input and output data.

There may be other types of data used in the execution of Project ECO₂S that entails the purchase of pre-existing seismic, existing geophysical logs, or well construction data from third party sources. In all cases, this data will need to remain undisclosed per the third party vendor requirements. These types of data will be termed undisclosed data.

C. Content and Format. All data generated from this Project will be made available to the DOE/NETL and the public at large. In all cases, data will be provided in standard formats. One such format is the .LAS file for geophysical well logs. Where standards are not present, the data will be annotated with appropriate units and the process to generate the data would be briefly described in a short text file to accompany the data set. This metadata text file would serve as a control document that references the specific data file, describes its contents, and explains the events leading to the generation of the data. It is expected that data would be provided in readily accessible excel formats, using the worksheet tabs to generate the description of the file’s contents and providing the data.

D. Sharing and Preservation. Excluding data purchased from third party vendors, the Project Team plans to release all data generated during the execution of this work. The data will be shared in two ways. First, the Project Team will develop a running list of all data generated during the project, indicating a planned release date. This information will be hosted on either a website or FTP site, whereby unique logins and passwords can be generated for interested parties, under a “free of charge” profile system. This enables routine tracking of login and downloads, generating valuable reporting statistics for the project. Second, complete datasets will be provided to DOE/NETL via

their EDX service. As appropriate, data files will be uploaded to this system for use by others, including any descriptive information.

Please recognize that data from specific individuals may not become immediately available to either the DOE/NETL or the public at large, unless those materials are presented at public meetings, conferences, workshops, or similar. University researchers are collaborating as members of the Project Team, and we are sensitive to the researchers seeking advanced degrees to be able to present their work as novel and unique. Further, it does take time to ensure data sets are complete and accurate to the best of the Project's ability.

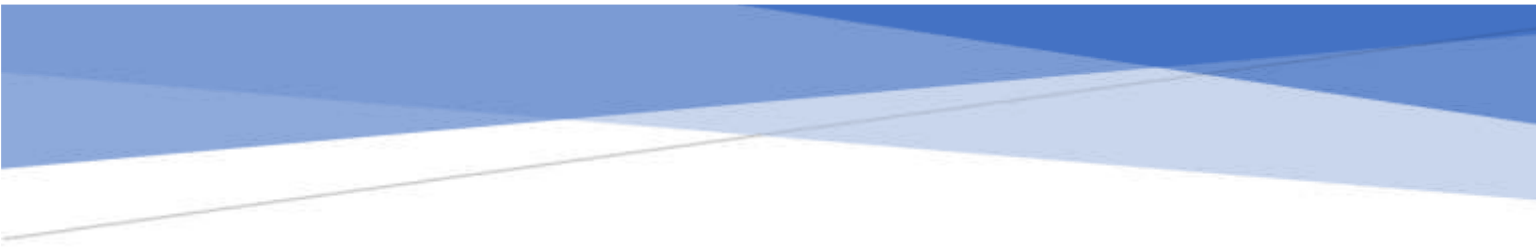
A catalog of geologic materials/samples collected under the project must be developed and maintained throughout the project. Throughout the life of the project, the Recipient must provide DOE with physical access to available materials/samples upon request ensuring this request does not impede ongoing or planned investigations. If the Recipient does not wish to retain the materials/samples, then the Recipient must offer DOE the opportunity to obtain possession of available materials/samples before the materials/samples are disposed.

E. Protection. As previously stated, there may be other types of data used in the execution of Project ECO₂S that will entail the purchase of pre-existing seismic, geophysical log, or well construction data from third party sources. In all cases, this data will remain undisclosed per the third party vendor requirements. With regard to the remaining data, Mississippi Power Company (MPC), as the operator of the Storage Complex, will have the final say in the release of all data to the public. This will serve as a system of checks and balances in ensuring no proprietary data is released.

The researcher will submit the data set(s) to ARI. ARI will review the data set(s) and, if acceptable for release, will provide the data set(s) and any explanation of the contents to MPC for approval to release. In this manner, data sets will be reviewed by multiple parties, ensuring no data is released in error.

F. Rationale. It is anticipated that the site associated with the Kemper County energy facility will become a world-class Storage Complex due to its robust geology, the co-location of the CO₂ capture facility, and the existence of CO₂ transportation infrastructure. As such, we anticipate there to be a modicum of interest in data sets generated from the site. Therefore, we want to ensure all data that is released is not only appropriate for release (not confidential or protected) but is also complete and accurate. Hence, we will employ a tiered approach to review data sets for publication and release to either a dedicated FTP/website, where the Project Team may track download statistics, or the DOE/NETL EDX.

Appendix III Knowledge Sharing Report



**Establishing an Early CO₂
Storage Complex in Kemper
County, Mississippi:
Project ECO₂S**

Report of Knowledge Sharing and Outreach
Activities

Southern States Energy Board
DE-FE0029465

Disclaimer

“This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.”

Introduction

The Southern States Energy Board (SSEB) is leading a coalition of southern universities and technical experts to establish a commercial-scale (438 million metric tons of capacity) CO₂ Storage Complex adjacent to Mississippi Power's Kemper County energy facility.

Project ECO₂S will pursue key advances in CO₂ storage knowledge and technology, including optimizing CO₂ storage efficiency, modeling the fate of injected CO₂, and establishing residual CO₂ saturation. In addition, Project ECO₂S will involve “real-life” experiences, issues, and challenges of scaling-up from its regional, pre-feasibility assessment of CO₂ storage to establishing a site-specific, commercial-scale CO₂ storage facility, including capturing the “lessons learned” in making this transition.

To perform the work, SSEB is partnering with Advanced Resources International, Inc. (ARI), Auburn University, Gerald R Hill PHD, Inc., Pashin Geoscience, LLC, Trimeric Corporation, the University of Alabama at Birmingham, and the University of Wyoming. ARI will manage the technical and field operations and has issued sub-contracts to Battelle Memorial Institute, Geological Survey of Alabama, GHG Underground, Loudon Technical Services, LLC, Mississippi State University's Department of Geosciences, Oklahoma State University, and Virginia Polytechnic Institute and State University.

Project ECO₂S supports all four of the Department of Energy's (DOE) Carbon Storage R&D Program objectives. By integrating flow-unit level characterization of three major saline formations with state-of-the-art reservoir modeling, Project ECO₂S will further refine our understanding of CO₂ storage efficiency and containment (DOE Goal #2). By rigorously modeling the areal (and vertical extent) of the CO₂ plume, Project ECO₂S will enhance industry's ability to predict (as well as optimize) CO₂ storage capacity (DOE Goal #3). By engaging in extensive storage site screening and characterization as well as risk analysis (using DOE/NETL developed NRAP tools) and conducting early public outreach, Project ECO₂S will contribute to DOE's Commercial-Scale Best Practices Manuals (DOE Goal #4). Finally, Project ECO₂S will draw on its partners' geomechanical modeling expertise and the DOE/NETL Carbon Storage Program's (NRAP) tools to ensure 99% storage permanence (DOE Goal #1).

Summary of Activities and Outcomes

Throughout the three-year project performance period the ECO₂S project team successfully completed many knowledge sharing and outreach activities (26 presentations, 19 abstracts, 25 topical reports). These activities incorporated the development and dissemination of outreach materials, presentation of project findings at scientific meetings, construction and submission of papers to publications, and production of topical reports.

Topical reports produced:

- CarbonSAFE Phase II: Project ECO₂S: Geological Data Catalog Report (Deliverable 1.3.b.1)
- CarbonSAFE Phase II: Project ECO₂S: Geological Data Catalog Report (Deliverable 1.3.b.2)
- CarbonSAFE Phase II: Project ECO₂S: Geological Data Catalog Report (Deliverable 1.3.b.3)
- Site Access and Use Agreement (Deliverable 3.2)
- Well #1 Drilling Permits: Kemper County, Mississippi (Deliverable 3.3.a)
- Well #2 Drilling Permits: Kemper County, Mississippi (Deliverable 3.3.b)
- Well #3 Drilling Permits: Kemper County, Mississippi (Deliverable 3.3.c)
- Survey of Existing Wellbores in and around Kemper County, Mississippi (Deliverable 4.1)

- Seismic Reflection Interpretation in Support of Project ECO₂S (Deliverable 4.2)
- CarbonSAFE ECO₂S Project Phase 2 Storage Complex Feasibility Study (Deliverable 4.5)
- Project ECO₂S: Risk Assessment Tool Report (Deliverable 4.6)
- CarbonSAFE Phase II: Project ECO₂S, Site Selection and Survey Report (Deliverable 5.1)
- CarbonSAFE Phase II: Project ECO₂S Well Design Report (Deliverable 5.2)
- Well and Security Installation Report (Deliverable 5.3.a)
- CarbonSAFE Phase II: Project ECO₂S, Geologic Characterization Well Report (Deliverable 5.3.b)
- Core Analysis Report (Deliverable 6.1.a)
- Geophysical Well Log Report (Deliverable 6.2.a)
- Geologic Framework for the Kemper Storage Complex (Deliverable 6.2.b)
- Evaluation of water-rock-CO₂ interactions in the Paluxy formation at the Kemper County Energy Facility (Deliverable 6.3)
- Assessment of Geomechanical Integrity and Induced Seismicity Potential in Support of Project ECO₂S (Deliverable 6.4)
- Site Infrastructure Development and Estimated Costs (Deliverable 7.1)
- Project ECO₂S: Regional Infrastructure Assessment (Deliverable 7.2)
- Numerical Modeling Report (Deliverable 8.1.a)
- Identification of Wells within the Area of Review (Deliverable 8.1.b)
- Commercial Development Plan (Deliverable 8.2)

Additionally, the project team promoted information exchange and knowledge sharing through various avenues, including the Regional Carbon Sequestration Partnerships' working groups, direct briefings and conferences, conference calls, emails, website links, electronic newsletters and press releases, and social media. Appendix I provides a visual summary of project presentations, abstracts, and meetings. Presentation PowerPoints, full text abstracts, and other materials referred to in this report are available on request. These tasks increased the visibility of the Carbon Storage Program to SSEB's carbon management industrial partners, member governors and state legislators, private industry, policymakers, regulators, and federal and state officials, emphasizing the safety and technology readiness of carbon capture and storage operations.

Appendix I Summary of ECO₂S presentations, abstracts, and meetings

The following tables provide reference to all formal presentations, abstracts, and meetings conducted during the project performance period.

Table 1 ECO₂S Presentations

| Date | Presentation Title/Subject | Meeting Title | Location (City, State) | Presenter(s) | OSTI Link |
|---------|---|---|------------------------|---|---|
| 3/8/17 | Southern Company's Carbon Management- R&D Technology Portfolio | 12th Annual SECARB Stakeholders' Briefing | Atlanta, GA | Richard Esposito | https://www.osti.gov/biblio/1608239-southern-company-carbon-management-technology-portfolio |
| 3/15/17 | Project ECO ₂ S Kickoff Meeting | Project Kickoff Meeting at the NETL Headquarters | Pittsburgh, PA | Kimberly Gray, Dave Riestenberg, George Koperna | https://www.osti.gov/biblio/1608444-establishing-early-carbon-dioxide-storage-complex-kemper-county-mississippi-project-eco2s-milestone |
| 8/3/17 | Establishing an Early CO ₂ Storage Complex in Kemper County, Mississippi: Project ECO ₂ S | NETL Mastering the Subsurface Annual Review Meeting | Pittsburgh, PA | Richard Esposito | https://www.osti.gov/biblio/1617042-establishing-early-co2-storage-complex-kemper-county-mississippi-project-eco2s |
| 9/20/17 | Establishing an Early Carbon Dioxide Storage Complex in Kemper County, Mississippi: Project ECO ₂ S | Midwest Geological Sequestration Consortium (MGSC) Annual Meeting | Champaign, IL | Gerald Hill | https://www.osti.gov/biblio/1469581-establishing-early-carbon-dioxide-storage-complex-kemper-county-mississippi-project-eco2s |
| 9/24/17 | Project ECO ₂ S Update | SSEB Executive Committee Meeting | Charleston, SC | Kimberly Gray | https://www.osti.gov/biblio/1623274-carbon-management-program-carbon-capture-storage-projects |
| 3/7/18 | Project ECO ₂ S: What have we learned about the subsurface so far? | 13th Annual SECARB Stakeholders' Briefing | Atlanta, GA | David Riestenberg | https://www.osti.gov/biblio/1617022-project-eco2s-what-have-we-learned-about-subsurface-so-far |
| 5/21/18 | Project ECO ₂ S: Characterization of a World Class Carbon Dioxide Storage Complex | AAPG Annual Meeting | Salt Lake City, Utah | David Riestenberg | https://www.osti.gov/biblio/1469584-project-eco2s-characterization-world-class-carbon-dioxide-storage-complex |
| 5/21/18 | Risk Management for a Commercial-Scale CO ₂ Storage Project (POSTER) | AAPG Annual Meeting | Salt Lake City, Utah | David Riestenberg | https://www.osti.gov/biblio/1623280-risk-management-commercial-scale-co2-storage-project |

Table 2 ECO2S Presentations (continued)

| Date | Presentation Title/Subject | Meeting Title | Location (City, State) | Presenter(s) | OSTI Link |
|-------------|---|----------------------|-------------------------------|-------------------------------|---|
| 5/21/18 | Risk Management for a Commercial-Scale CO2 Storage Project (POSTER) | AAPG Annual Meeting | Salt Lake City, Utah | David Riestenberg | https://www.osti.gov/biblio/1623280-risk-management-commercial-scale-co2-storage-project |
| 5/21/18 | The Paluxy Formation in the East-Central Gulf of Mexico Basin: Geology of a Giant Anthropogenic CO2 Sink (POSTER) | AAPG Annual Meeting | Salt Lake City, Utah | Jack Pashin | https://www.osti.gov/biblio/1469596-paluxy-formation-eastern-central-gulf-mexico-basin-geology-giant-anthropogenic-co2-sink |
| 5/21/18 | Advanced Reservoir and Seal Characterization at the Kemper Storage Site (POSTER) | AAPG Annual Meeting | Salt Lake City, Utah | Fred McLaughlin | https://www.osti.gov/biblio/1469355-advanced-reservoir-seal-characterization-kemper-storage-site |
| 5/21/18 | Seismic Reflection Data Interpretation to Support Project ECO2S, Kemper County, MS (POSTER) | AAPG Annual Meeting | Salt Lake City, Utah | Denise Hills | https://www.osti.gov/biblio/1623280-risk-management-commercial-scale-co2-storage-project |
| 5/21/18 | Evaluation of a potential geochemical reactions and change in hydrologic properties at the Kemper County CO2 Storage Complex (POSTER) | AAPG Annual Meeting | Salt Lake City, Utah | Lauren Beckingham | https://www.osti.gov/biblio/1469587-evaluation-potential-geochemical-reactions-change-hydrologic-properties-kemper-county-co2-storage-complex |
| 5/21/18 | Investigation of the Reactions between Glaucinite and Carbon Dioxide, with Implications for Carbon Sequestration (POSTER) | AAPG Annual Meeting | Salt Lake City, Utah | Ahn Nguyen, Lauren Beckingham | https://www.osti.gov/biblio/1469363-investigation-reactions-between-glaucinite-carbon-dioxide-implications-carbon-sequestration |
| 5/21/18 | Lessons Learned from Recent CCS Well Construction Projects (POSTER) | AAPG Annual Meeting | Salt Lake City, Utah | Andrew Duguid | https://www.osti.gov/biblio/1469368-lessons-learned-from-recent-ccs-well-construction-projects |

Table 3 ECO2S Presentations (continued)

| Date | Presentation Title/Subject | Meeting Title | Location (City, State) | Presenter(s) | OSTI Link |
|-------------|--|---|-------------------------------|------------------------------|---|
| 8/13/18 | CarbonSAFE: Establishing an Early CO2 Storage Complex in Kemper County Mississippi: Project ECO2S | NETL Mastering the Subsurface Annual Review Meeting | Pittsburgh, PA | David Riestenberg | https://www.osti.gov/biblio/1476351-carbonsafe-establishing-early-co2-storage-complex-kemper-county-mississippi-project-eco2s |
| 8/13/18 | Seismic Reflection Interpretation in Support of Project ECO2S, Kemper County, MS (POSTER) | NETL Mastering the Subsurface Annual Review Meeting | Pittsburgh, PA | John Koster, Denise Hills | https://www.osti.gov/biblio/1617030-seismic-reflection-interpretation-support-project-eco2s-kemper-county-ms-poster |
| 10/23/18 | Project ECO2S: Characterization of a World Class Carbon Dioxide Storage Complex | GHGT-14 | Melbourne, Australia | David Riestenberg | https://www.osti.gov/biblio/1617032-project-eco2s-characterization-world-class-carbon-dioxide-storage-complex |
| 10/24/18 | Risk Management for Development of a Regional CO2 Storage Hub (POSTER) | GHGT-14 | Melbourne, Australia | Ken Hnottavange-Telleen | https://www.osti.gov/biblio/1623276-risk-management-development-regional-co2-storage-hub |
| 12/15/18 | Impact of image resolution on quantification of mineral abundances and accessible surface areas (POSTER) | AGU 2018 | Washington D.C. | Fanqi Qin, Lauren Beckingham | https://www.osti.gov/biblio/1623277-impact-image-resolution-quantification-mineral-abundances-accessible-surface-areas |
| 12/15/18 | Seismic Reflection Interpretation in Support of Project ECO2S, Kemper County, MS (POSTER) | AGU 2018 | Washington D.C. | John Koster, Denise Hills | https://www.osti.gov/biblio/1617030-seismic-reflection-interpretation-support-project-eco2s-kemper-county-ms-poster |
| 2/11/19 | Outcomes of the ECO2S Project | GoMCarb and SECARB Offshore GoM Joint Partnership Meeting | Beaumont, TX | David Riestenberg | https://www.osti.gov/biblio/1617034-project-eco2s-characterization-world-class-co2-storage-complex |

Table 4 ECO2S Presentations (continued)

| Date | Presentation Title/Subject | Meeting Title | Location (City, State) | Presenter(s) | OSTI Link |
|-------------|--|---|-------------------------------|--|---|
| 3/28/19 | Project ECO2S: Overview | 14th Annual SECARB Stakeholders' Briefing | Atlanta, GA | David Riestenberg | https://www.osti.gov/biblio/1630135-project-eco2s-overview |
| 3/28/19 | Project ECO2S: Kemper Core Flooding Results | 14th Annual SECARB Stakeholders' Briefing | Atlanta, GA | Fred McLaughlin | https://www.osti.gov/biblio/1630137-project-eco2s-kemper-core-flooding-results |
| 3/28/19 | CO2-brine-mineral interactions in the Paluxy formation at Kemper pilot CO2 injection site | 14th Annual SECARB Stakeholders' Briefing | Atlanta, GA | Lauren Beckingham, Fanqi Qin, Ishan Anjekar, Jacob Bensinger | https://www.osti.gov/biblio/1630138-co2-brine-mineral-interactions-paluxy-formation-kemper-pilot-co2-injection-site |
| 3/28/19 | Project ECO2S: Risk Update | 14th Annual SECARB Stakeholders' Briefing | Atlanta, GA | Ken Hnottavange-Telleen | https://www.osti.gov/biblio/1630139-project-eco2s-risk-update |
| 8/28/19 | Establishing an Early CO2 Storage Complex in Kemper County, Mississippi: Project ECO2S (FE0029465) | NETL Mastering the Subsurface Annual Review Meeting | Pittsburgh, PA | David Riestenberg | https://www.osti.gov/biblio/1617036-establishing-early-co2-storage-complex-kemper-county-mississippi-project-eco2s-fe0029465 |
| 12/13/19 | Impact of Mineral Surface Area on Simulated CO2-Brine-Mineral Reactions and Reaction Rates | AGU 2019 | San Francisco, CA | Fanqi Qin, Lauren Beckingham | https://www.osti.gov/biblio/1617038-impact-mineral-surface-area-simulated-co2-brine-mineral-reactions-reaction-rates |

Table 5 ECO2S Abstracts

| Date | Abstract Title | Submitted to | Author(s) | OSTI Link |
|-------------|---|---|--|---|
| 10/31/17 | The Cost of Getting CCS Wrong: Uncertainty, Infrastructure Design, and Stranded CO ₂ | International Journal of Greenhouse Gas Control | Richard Middleton, Sean Yaw | https://www.osti.gov/biblio/1417829-cost-getting-ccs-wrong-uncertainty-infrastructure-design-stranded-co2 |
| 10/22/18 | CO ₂ well construction: Lessons learned from United States Department of Energy sponsored projects | GHGT-14 | Andrew Duguid | https://www.osti.gov/biblio/1509818-co2-well-construction-lessons-learned-from-united-states-department-energy-sponsored-projects |
| 10/22/18 | Project ECO2S: Characterization of a World Class Carbon Dioxide Storage Complex | GHGT-14 | David Riestenberg | https://www.osti.gov/biblio/1469376-project-eco2s-characterization-world-class-carbon-dioxide-storage-complex |
| 10/22/18 | Risk Management for Development of a Regional CO ₂ Storage Hub | GHGT-14 | Ken Hnottavange-Telleen | https://www.osti.gov/biblio/1469384-risk-management-development-regional-co2-storage-hub |
| 10/22/18 | Uncertainty and Infrastructure Design: Getting Commercial-scale CCS Right | GHGT-14 | Richard Middleton | https://www.osti.gov/biblio/1469577-uncertainty-infrastructure-design-getting-commercial-scale-ccs-right |
| 11/11/18 | The impact of image resolution on simulate mineral reactions and reaction rates | Chemical Geology | Fanqi Qin, Lauren Beckingham | https://www.osti.gov/biblio/1509822-impact-image-resolution-quantification-mineral-properties-simulated-mineral-reaction-rates |
| 12/11/18 | Simulation of calcite dissolution at the pore scale using OpenFOAM | AGU 2018 | Ishan Anjekar | https://www.osti.gov/biblio/1475400-simulation-calcite-dissolution-pore-scale-using-openfoam |
| 12/11/18 | Impact of image resolution on quantification of mineral distribution and accessible surface areas | AGU 2018 | Fanqi Qin | https://www.osti.gov/biblio/1476352-impact-image-resolution-quantification-mineral-distribution-accessible-surface-areas |
| 5/15/19 | Enhancement of storage capacity of CO ₂ in megaporous saline aquifers using nanoparticle-stabilized CO ₂ foam | International Journal of Greenhouse Gas Control | Feng Guo, Saman Aryana, Yuhang Want, J. Fred McLaughlin, Kipp Coddington | https://www.osti.gov/biblio/1623281-enhancement-storage-capacity-co2-megaporous-saline-aquifers-using-nanoparticle-stabilized-co2-foam |
| 6/26/19 | Use of OpenFOAM for 3D Reactive Transport Modelling at the Pore Scale | 2019 SECCUS Symposium | Ishan Anjekar | https://www.osti.gov/biblio/1509820-use-openfoam-reactive-transport-modelling-pore-scale |

Table 6 ECO2S Abstracts (continued)

| Date | Abstract Title | Submitted to | Author(s) | OSTI Link |
|-------------|---|---|---|---|
| 6/26/19 | Impact of image resolution on quantification of mineral properties and simulated mineral reaction rates | 2019 SECCUS Symposium | Fanqi Qin | https://www.osti.gov/biblio/1509822-impact-image-resolution-quantification-mineral-properties-simulated-mineral-reaction-rates |
| 9/11/19 | Reconsidering CCS in the US fossil-fuel fired electricity industry under section 45Q tax credits | GHG Science & Technology | Richard Esposito, Vello Kuuskraa | |
| 10/12/19 | SimCCS: An open-source tool for optimizing CO2 capture, transport, and storage infrastructure | Environmental Modeling and Software | Richard Middleton, Sean Yaw, Brendan Hoover, Kevin Ellett | https://www.osti.gov/biblio/1623282-simccs-open-source-tool-optimizing-co2-capture-transport-storage-infrastructure |
| 10/17/19 | CostMAP: an open-source software package for developing cost surfaces using a multi-scale search kernel | International Journal of Geographical Information Science | Brendan Hoover, Sean Yaw, Richard Middleton | https://www.osti.gov/biblio/1623283-costmap-open-source-software-package-developing-cost-surfaces-using-multi-scale-search-kernel |
| 12/13/19 | Graph Simplification for Infrastructure Network Design | Conference on Combinatorial Optimization and Applications | Sean Yaw, Richard Middleton, Brendan Hoover | https://www.osti.gov/biblio/1623284-graph-simplification-infrastructure-network-design |
| 12/17/19 | Geological Framework of an Anthropogenic Carbon Capture and Sequestration System at the Kemper County Energy Center, East-Central Mississippi | AAPG 2019 | Conn Wethington, Jack Pashin | https://www.osti.gov/biblio/1618109-geological-framework-anthropogenic-carbon-capture-sequestration-system-kemper-county-energy-center-east-central-mississippi |
| 2/1/20 | CO2 storage in the Paluxy formation at the Kemper County CO2 Storage Complex: Pore network properties and simulated reactive permeability evolution | International Journal of Greenhouse Gas Control | Jacob Bensinger, Lauren Beckingham | https://www.osti.gov/biblio/1618114-co2-storage-paluxy-formation-kemper-county-co2-storage-complex-pore-network-properties-simulated-reactive-permeability-evolution |
| 2/2/20 | Fused Filament Fabrication 3-D Printing of Reactive Porous Media | Geophysical Research Letters | Ishan Anjekar, Shelby Wales, Lauren Beckingham | https://www.osti.gov/biblio/1618113-fused-filament-fabrication-printing-reactive-porous-media |

Table 7 ECO2S Meetings

| Date | Meeting Title | Location (City, State) | Attendees |
|-------------|--|-------------------------------|--|
| 3-18-17 | 12 th Annual SECARB Stakeholders' Briefing | Atlanta, GA | Esposito, |
| 3-15-17 | Project Kickoff Meeting at NETL Headquarters | Pittsburgh, PA | Gray, Riestenberg, Koperna |
| 8-3-17 | NETL Mastering the Subsurface through Technology Innovation, Partnerships, and Collaboration Meeting | Pittsburgh, PA | Esposito |
| 9-20-17 | Midwest Geological Sequestration Consortium (MGSC) Annual Meeting | Champaign, IL | Hill |
| 9-24-17 | SSEB Executive Committee Meeting | Charleston, SC | Gray |
| 3-7-18 | 13 th Annual SECARB Stakeholders' Briefing | Atlanta, GA | Riestenberg |
| 5-21-18 | AAPG Annual Meeting | Salt Lake City, UT | Riestenberg, Pashin, McLaughlin, Hills, Beckingham, Nguyen, Duguid |
| 8-13-18 | NETL Mastering the Subsurface through Technology Innovation, Partnerships, and Collaboration Meeting | Pittsburgh, PA | Riestenberg, Koster, Hills |
| 10-23-18 | GHGT-14 | Melbourne, Australia | Riestenberg, Hnottavange-Telleen |
| 12-15-18 | AGU 2018 | Washington, D.C. | Qin, Beckingham, Koster, Hills |
| 2-11-19 | GoMCarb and SECARB Offshore GoM Joint Partnership Meeting | Beaumont, TX | Riestenberg |
| 3-28-19 | 14 th Annual SECARB Stakeholders' Briefing | Atlanta, GA | Riestenberg, McLaughlin, Beckingham, Qin, Anjekar, Besinger, Hnottavange-Telleen |
| 8-28-19 | NETL Carbon Capture, Utilization, Storage, and Oil and Gas Technologies Integrated Review Meeting | Pittsburgh, PA | Riestenberg |
| 12-13-19 | AGU 2019 | San Francisco, CA | Qin, Beckingham |

Appendix IV Site Access Agreement

SITE ACCESS AND USE AGREEMENT

This Site Access and Use Agreement (together with all exhibits and attachments, "Agreement") is entered into by and between **MISSISSIPPI POWER COMPANY**, a corporation organized under the laws of the state of Mississippi ("Company"), having its principal offices located at 2992 West Beach Boulevard, Gulfport, Mississippi 39501, and **ADVANCED RESOURCES INTERNATIONAL, INC.**, a corporation organized under the laws of the state of Delaware ("Contractor"), having its principal offices located at 4501 Fairfax Drive, Suite 910, Arlington, Virginia 22203. This Agreement will become effective on the date it is signed by the last party ("Effective Date").

INTRODUCTION

Contractor has received funding from the Southern States Energy Board ("SSEB") through an award from the U.S. Department of Energy ("DOE") to perform the "Characterization Well Drilling Portion of the Geologic CO2 Storage Assessment" at property near Company's Kemper County Integrated Gasification Combined Cycle Power Generation Facility ("Plant Ratcliffe") (the "Project").

In connection with the Project, Contractor desires to access and use Company's property described in **Exhibit B** (the "Host Site"), to perform work for the Project set forth in in **Exhibit A**, which generally consists of (i) site preparation, (ii) designing, drilling, and completing a characterization well ("Well"), (iii) gathering the geologic data from the Well, and (iv) site closure and reclamation (collectively, the "Work").

Company is willing to allow Contractor to access and use a defined location within the Host Site to perform the Work, subject to Contractor's compliance with the terms and conditions set forth in this Agreement.

TERMS AND CONDITIONS

In consideration of the representations and agreements contained herein and for other good and valuable consideration acknowledged and received by both parties, the parties hereby covenant and agree as follows:

1. The Work.

A. Subject to the terms and conditions of this Agreement, Contractor, its employees and permitted subcontractors (including all suppliers, materialmen, laborers, craft workers) (collectively, "Representatives") may access and use the Host Site to perform the Work, including the installation of the Well. In its performance of the Work, Contractor shall comply, and ensure that its Representatives comply, with the terms and conditions of this Agreement.

B. Contractor will coordinate the performance of the Work with Company so as to ensure the proper and timely performance of the Work, and to avoid interference with any other Company operations at the Host Site. To effectuate overall coordination efforts relative to this Agreement and the performance of the Work, Contractor initially designates Mr. George J. Koperna as its key contact for such coordination ("Contractor Key Contact"), and Company designates Mr. Richard Esposito as its key contact for such coordination ("Company Key Contact").

2. Term, Termination, Cancellation, Suspension.

A. The Term of this Agreement begins on the Effective Date and end upon completion of all Work, unless earlier terminated or cancelled. Either party may cancel this Agreement due to its material breach by the other party in the event that such breach remains uncured twenty (20) days after the non-breaching party provides written notice to the breaching party describing such breach.

3. Work Materials; Costs and Expenses.

A. Contractor shall be responsible for providing all materials and equipment necessary for the Work. As between Company and Contractor, Contractor shall be solely responsible for all costs, expenses, taxes, charges, duties, and fees associated with the Work and its obligations under this Agreement. Promptly upon completion of the Work, Contractor shall submit a correct, properly completed, executed final lien waiver (in the form included in Attachment 1 hereto entitled Waiver and Release Upon Final Payment) from Contractor and each subcontractor utilized by Contractor in connection with the Work.

4. Compliance with Applicable Laws.

A. In connection with its performance under this Agreement, Contractor will comply and will require all Representatives to comply, at all times, with all applicable federal, state, county, local, municipal, foreign, regulatory, and administrative, statutes, laws, rules, regulations, codes, ordinances, procedures, and common law ("Applicable Laws"). Without limiting the generality of the foregoing obligation, Contractor agrees that it will adhere to (a) all labor laws and regulations including the use of U.S. citizens or properly documented alien workers under the Immigration Act of 1990 and the Immigration and Nationality Act of 1952, as amended, (including, as applicable, the Department of Homeland Security's E-Verify requirements), (b) all safety and health standards promulgated under the Occupational Safety and Health Act of 1970 and by any state or local health or safety authority with jurisdiction over the Work performed or to be performed under this Agreement, (c) all United States import and export laws, rules, and regulations; and (d) all Mississippi laws concerning the licensing and certification of contractors and other professionals.

B. The Contractor and its subcontractors shall obtain and, maintain and pay for all permits (including building and environmental permits), approvals and licenses required for the performance of the Work and not specifically identified herein as being the Company's responsibility. The applicable permits from the Mississippi State Oil and Gas Board shall be obtained by the Company. Contractor shall be solely responsible for determining the need for any required license, and any Contractor failure to comply with all applicable licensing requirements shall be Contractor's sole responsibility and a material breach of this Agreement. Contractor shall arrange for all inspections, tests, and approvals required by codes, regulations, and local, state or federal authorities. The Contractor shall give the Company reasonable notice of the date arranged for any required inspection. The Company shall obtain and pay for all permits and licenses required to own and operate the completed Well.

5. Treatment of Protected Information; Publicity.

A. The term "Protected Information" means data and information that is owned by, controlled by, or in the possession of a party, its affiliates, and/or third parties and that contains or concerns

proprietary, non-public information, or private business, financial, operational, or strategic information that is marked as set forth below and treated as confidential, proprietary, or otherwise not subject to public disclosure. Protected Information also includes any documents, notes, or other tangible or intangible materials that contain, reflect or are generated from any Protected Information.

B. The party disclosing Protected Information ("Discloser") must identify that Protected Information by stamping or affixing a stamp, label, title, or footer of "Protected," "Confidential," or similar designation ("Mark" or "Marking"). If intangible Protected Information cannot be physically Marked, Discloser must provide the party receiving the Protected Information (the "Recipient") with a written communication before, at the time of, or within five (5) business days after, disclosure, that specifically identifies that information as Protected Information ("Written Confirmation"). Notwithstanding anything to the contrary contained herein, "Protected Information" shall not include information that is or becomes:

- (a) publicly available other than through fault or negligence of Recipient;
- (b) known by the Recipient prior to receiving such information from the Discloser and without restriction as to use or disclosure;
- (c) rightfully obtained without restriction from a third party;
- (d) released without restriction by Discloser to a third party; or
- (e) developed by or for Recipient independently of, and without use of, Discloser's Protected Information.

C. Recipient agrees that it will limit access to Discloser's Protected Information to its directors, officers, employees, agents, affiliates, and contractors (collectively, "Personnel") who have a need to know consistent with the Approved Purposes (defined below) and who are bound by some form of written confidentiality and non-disclosure obligation, unless the other party agrees otherwise in advance in writing. Recipient and its Personnel agree that any Protected Information that is disclosed to them will be used solely for the purposes of performing their obligations and exercising their rights under this Agreement, and in the case of Company also owning, operating, and maintaining the Well and complying with Applicable Laws thereto (the "Approved Uses"). Recipient and its Personnel agree to exercise reasonable efforts, consistent with or better than the efforts that Recipient exercises to protect information of its own that it regards as confidential, to keep such Protected Information in confidence and not to copy or permit others to copy the information or disclose the same to unauthorized persons.

D. The obligations of confidentiality and non-disclosure with regard to Protected Information shall last for three (3) years following completion of the Work.

E. In the event that Recipient is mandated by law, statute, rule or regulation, including any subpoena or other similar form of process, to disclose any Protected Information, Recipient must provide Discloser with written notice before making any such disclosure so as to afford Discloser with an adequate opportunity either (i) to seek a protective order or other appropriate relief and/or (ii) to waive the requirement that Recipient not disclose the Protected Information. In the event that any disclosure is required, Recipient must furnish only that portion of the Protected Information that is legally required and must exercise its best efforts to obtain a reliable assurance that confidential treatment will be accorded the Protected Information that is disclosed.

F. Each party must submit to the other party all advertising, sales promotion or other publicity matter relating to this Agreement or the Project wherein the other party's name or logo or the name or

logo any parent, affiliate, or the Kemper County Integrated Gasification Combined Cycle Power Generation Facility or Plant Ratcliffe is mentioned, and neither party will use or publish such advertising, sales promotion or publicity matter without the prior written consent (email is sufficient) of the other party.

6. General Indemnity; Property Damage.

A. Contractor hereby agrees to indemnify, defend and hold harmless Company, its parent, affiliates, the respective directors, officers, employees, representatives, agents, successors and assigns of each of them, and all persons and entities claiming through them (the "Persons Indemnified") from and against all demands, claims, suits, costs, proceedings, grievances, or actions of any kind or character (regardless of whether Contractor is a named party) brought against any person or entity of the Persons Indemnified, and all associated loss, damage, costs judgments, settlements, fines, assessments, penalties, sanctions, and liability (collectively, "Claims"), arising out of or related to any act or omission, violation of any Applicable Laws, or failure to comply with this Agreement, by Contractor or any of its Representatives, anyone directly or indirectly employed by any of them, or anyone for whose acts any one of them may be liable that is in any way associated with or connected with any obligation of Contractor, any right of Company, or any Work under this Agreement, except to the proportionate extent such Claim is caused by the Persons Indemnified.

B. Contractor will be responsible for all damage to the Host Site, and all theft, damage, or destruction of or to any equipment, facilities, fixtures, materials, tools, or other property (real or personal) at the Host Site caused by or arising from the acts or omissions of Contractor or its Representatives, or the failure of the Work to comply with the terms and conditions of this Agreement, except to the proportionate extent caused by the negligence of Company. Contractor will be responsible for its share of the reasonable costs and expenses associated with the repair, replacement, or restoration or such stolen, damaged, or destroyed property.

C. Should the Well fail or malfunction, Contractor shall not be liable to Company for the costs to repair or replace the Well; provided however, that this provision shall not modify, supersede, or replace any provision in any other agreement relating to the Project in which Contractor assumes responsibility for any such costs.

D. For clarification, Contractor's obligations under this Article 6, include all amounts payable by Company to a third party that are attributable to matters for which Contractor is required to indemnify Company, including special, incidental, consequential, or punitive damages.

8. Limitation of Liability.

A. Except as contemplated in Section 6(D), and except with regard to Contractor's defense obligations set forth in this Agreement, and except for the willful, wanton, or intentional misconduct or violation of Applicable Laws by Contractor or any of its Representatives:

1. Contractor will not be liable to Company for special, incidental, consequential, or punitive damages for any matter, including but not limited to (i) damages suffered by the Company as a result of the loss of the use of its power system or production facilities, (ii) cost of purchased or replacement power, (iii) damages suffered by customers of the Company for service interruptions, or (iv)

cost of capital, and (v) loss of anticipated profits, whether such liability is based on contract, warranty, tort (including negligence and strict liability) or otherwise; and

2. EACH PARTY’S TOTAL LIABILITY TO THE OTHER ARISING UNDER OR RELATING IN ANY WAY TO THIS AGREEMENT, REGARDLESS OF THE THEORY UNDER WHICH SUCH DAMAGES ARE CLAIMED, WHETHER IN TORT, CONTRACT, STRICT LIABILITY OR OTHERWISE, WILL NOT EXCEED \$7,000,000.

9. Insurance.

The Contractor, at its expense, shall procure and maintain in effect without interruption during the term of this Agreement with insurance companies authorized to transact insurance in the State in which the Work is performed, and rated A-/VII or better by Best’s Key Rating Guide, policies of insurance providing, at a minimum, the coverages and limits specified, and complying with the other requirements stated below:

- (A) **Worker’s Compensation.** Workers’ Compensation insurance in statutory amounts covering the legal liability of the Contractor under the applicable worker compensation and occupational disease laws of the State (or under Federal acts or statutes, including but not limited to the Longshore and Harbor Workers’ Compensation Act, when applicable) for claims for bodily injuries, including death, to the Contractor’s employees; and Employers’ Liability insurance with limits of not less than \$1,000,000.
- (B) **Commercial General Liability.** Commercial General Liability for Bodily Injury and Property Damage on a Per Occurrence Basis, subject to a General Aggregate Limit, broad form property damage, severability of interest for each insured, with the following coverages and limits:

| DESCRIPTION | OCCURRENCE | AGGREGATE |
|--|-------------|-------------|
| Bodily Injury and Property Damage | \$1,000,000 | \$1,000,000 |
| Products-Completed Operations for 2 yrs after completion | | \$1,000,000 |
| Personal & Advertising Injury | \$1,000,000 | \$1,000,000 |
| Fire Damage (any one fire) | \$50,000 | \$1,000,000 |
| Medical Expense (any one person) | \$5,000 | \$1,000,000 |

If applicable, the Commercial General Liability policy shall also include an endorsement for Explosion, Collapse and Underground (XCU) coverage.

- (C) **Commercial Automobile Liability.** Commercial Automobile Liability covering automobiles of the Contractor, including owned, hired and non-owned automobiles, for Bodily Injury and Property Damage with a combined single limit of \$1,000,000 each Occurrence combined single limit bodily injury and property damage.
- (D) **Excess Liability.** Excess (Umbrella) Liability Insurance with limits of \$4,000,000 per occurrence in excess of the limits of the underlying Commercial General Liability and Commercial Automobile Liability.

- (E) **Contractual Liability and Property Damage Liability.** The Commercial General Liability Insurance shall include Blanket Broad Form Contractual Liability and Broad Form Property Damage Liability Insurance. (The Contractor shall maintain above cited insurance coverage for at least two years after Final Completion).
- (F) **Waiver of Subrogation.** The Contractor and its subcontractors waive, and shall cause its and their insurers to waive by endorsement, all rights of subrogation against the Company and all Persons Indemnified herein with respect to any subsequent claim or loss payable or paid under each of the insurance policies set forth in A., B., C., and D. above.
- (G) **Additional Insureds.** The Contractor shall cause its insurer(s) to issue endorsements to add the Company herein as Additional Insureds on the policies set forth in B., C. and D. Coverages afforded the Additional Insureds shall be primary. If any Additional Insured has other insurance which is applicable to a loss, such other insurance shall be excess, non-contributory and contingent. The additional insured endorsement shall be in a form acceptable to Company and providing completed operations coverage.
- (H) **Primary Insurance.** Contractor's insurance shall be primary and non-contributory, but only in the event of a named insureds sole negligence.
- (J) **Pollution Coverage.** If the nature of the Work, or the nature of the Project, creates, in the judgment of the Company, a significant pollution exposure for any party, then pollution insurance shall be furnished with aggregate coverage of \$1 million.
- (K) **Insurance Certificates.** The Contractor shall promptly submit to the Purchaser a Certificate of Insurance, signed by an authorized representative of the insurance carrier, listing the policies, coverages, limits, waiver of subrogation and Additional Insureds, and certifying that the said policies provide primary coverage and shall be in effect for the time periods stated in the Certificate. Contractor, in its agreements with its subcontractors, shall require each subcontractor that performs any Work at the Host Site to obtain and maintain in effect during the term of each subcontract, insurance policies providing the coverages and limits and complying with other requirements set forth herein.
- (L) **Professional Liability Insurance.** If design or engineering services are required of the Contractor, the Contractor shall furnish Contractor's professional liability insurance, which shall include coverage for all professional services provided by the Contractor or on Contractor's behalf, be on a comprehensive basis, include contractual coverage, in such limits and with such endorsements as Purchaser may prescribe. At a minimum, the required Contractor's professional liability insurance shall be maintained for the duration of this Agreement, including any warranty period, with an insurance company authorized to do business in the jurisdiction in which the Project is located and which is reasonably satisfactory to the Company. The professional liability insurance shall provide coverage for claims arising from the negligent performance of professional design or engineering services provided by the Contractor, and with limits of not less than \$1 million per claim and in the aggregate with a deductible not to exceed \$150,000. The professional liability insurance shall contain prior acts coverage

sufficient to cover all professional services performed by the Contractor for this Project. If Project specific coverage is provided, these requirements shall be continued in effect for three years following final payment to the Contractor. The deductible shall be paid by the Contractor. Consultants retained by the Contractor to provide professional design services shall maintain professional liability insurance with a company and for such amounts as are satisfactory to the Company for claims arising from the negligent performance of their professional services, consistent with the professional liability insurance required of the Contractor. The Contractor shall furnish the Company with Certificates of Insurance evidencing the required coverages and, if requested, a copy of the professional liability policy or policies. No policy shall be canceled without thirty (30) days prior written notice to the Purchaser by Contractor and insurer, ten (10) days notice for non-payment of premium.

10. Notices.

A. All notices permitted or required to be given under this Agreement shall be in writing and shall be deemed duly given upon personal delivery (against receipt); on the fourth day following the date on which each such notice is deposited postage prepaid in the United States mail, registered or certified, return receipt requested; or on the day after being sent by nationally recognized overnight courier. All notices shall be delivered or sent to the other party at the address shown below or to any other address as the party may designate by ten (10) days prior written notice given in accordance with this provision.

If to Company: Mississippi Power Company
c/o Southern Company Services, Inc.
600 North 18th Street; 14N-8195
Birmingham, Alabama 35203
Attn: Richard A. Esposito, Consulting Engineer

with copy to: Southern Company Services, Inc.
42 Inverness Center Parkway; Bin B414
Birmingham, Alabama 35242
Attn: Dan Meeks, Sourcing Agent

with additional
copy to: Southern Company Services, Inc.
600 North 18th Street; 7N-8374
Birmingham, Alabama 35203
Attn: Griff Waters, Managing Attorney

If to Contractor: Advanced Resources International, Inc.
4501 Fairfax Drive, Suite 901
Arlington, Virginia 22203
Attn: George J. Koperna, Vice President

11. Governing Law and Jurisdiction.

A. This Agreement is governed by, subject to, and construed in all respects in accordance with the laws of the State of Mississippi, without regard to its conflict of laws provisions. In the event of any dispute or claim arising out of this Agreement, the parties hereby agree that any lawsuit or other legal claim or action must be filed in said State.

12. Independent Contractor.

A. Company does not reserve any right to control the methods or manner of performance of Contractor's performance under this Agreement. In its performance under this Agreement, Contractor and all Representatives are and will at all times act as independent contractors, and are free to perform the obligations of this Agreement by such methods and in such manner as Contractor may choose, furnishing all labor, tools, equipment and materials, and doing everything else necessary to perform their obligations properly and safely, having supervision over and responsibility for the safety, conduct and actions of themselves, and control over and responsibility for their tools, equipment and materials.

13. Assignment and Subcontracting.

A. Neither party will transfer or assign, directly or indirectly, the whole or any part of this Agreement or any of its rights or performance obligations without the prior written permission of the other party. Each party agrees to provide the other party with thirty (30) days' written notice in advance of any change in control of all or substantially all of its assets or stock, and in such event the other party will have the right to terminate this Agreement for its convenience. In the event of a change to either party's corporate name, the party making the change will provide notice to the other party in writing in advance of such change. Under any of the forgoing circumstances, the party making the change will cooperate with the other party in preparing and executing any documents that may be necessary or beneficial in connection with any such changes.

B. Contractor will not award or contract or subcontract the whole or any portion of this Agreement or any portion of the Work to any Subcontractor without first obtaining the written approval of Company. Contractor shall provide Company with the name of each proposed Subcontractor and a Contractor Compliance Background Form and Contractor Safety Qualification Questionnaire completed and signed by the proposed Subcontractor (these forms will be provided by Company upon request).

C. In the event any part of the Work is contracted or subcontracted with Company's permission, Contractor agrees to bind the Subcontractor (in writing) to the terms and conditions of this Agreement as the same are applicable to the Subcontractor's portion of the Work. Should Contractor fail to obtain each Subcontractor's written acceptance of such terms and conditions or fail to require each Subcontractor to assume toward Contractor all of the obligations and responsibilities that Contractor assumes toward Company, and should such failure cause or contribute to a loss or damage to any person or entity of the Persons Indemnified, then Contractor will indemnify and hold such person or entity harmless from any and all losses or damages, claims, or suits so incurred, including expenses and reasonable attorney fees with respect thereto. Contractor shall ensure that its Subcontractors possess and maintain all licenses and certifications required for the performance of their work.

D. Contractor will be as fully responsible to Company and the Persons Indemnified for the acts and omissions of its Subcontractors and the persons directly and indirectly employed by its Subcontractors as Contractor is for the acts and omissions of the persons directly employed. Any Subcontractor must look solely to Contractor and not to Company for the payment of any sums due to the Subcontractor

and for the performance by Contractor of all obligations required by Contractor pursuant to the terms and conditions of this Agreement. Contractor will promptly pay each Subcontractor the amount that the Subcontractor is entitled to receive. Should a lien, claim, or other encumbrance be filed or threatened on any property of Company or its affiliates, Contractor shall immediately take all steps to fully resolve and discharge such lien, claim, or encumbrance and shall indemnify, defend (if requested by Company), and hold the Persons Indemnified harmless from and against all related Claims, including without limitation attorneys' fees and court costs incurred by Company in obtaining discharge of the lien, claim, encumbrance or Claim. Contractor will, through an appropriate agreement with each Subcontractor, require each Subcontractor to make payments to their sub-subcontractors in similar manner.

E. Any purported or attempted assignment, delegation, or subcontracting in violation of this article shall be null and void and of no effect.

14. Authority.

A. Each party represents and warrants that as of the Effective Date of this Agreement: (a) it is a corporation or other business entity duly organized, validly existing and in good standing under the laws of the state of its incorporation or formation, (b) it has all requisite power and authority to enter into and perform the Work and its obligations under this Agreement, and (c) there are no actions, suits or proceedings pending, or to the best of its knowledge threatened, which may have a material adverse effect on its ability to fulfill its obligations under this Agreement or the Work.

15. Force Majeure.

A. Neither party breaches any provision of this Agreement for failures in performance, resulting from acts or events beyond the reasonable control of such party. Such acts include, but are not limited to, acts of God, civil or military authority, civil disturbance, war, strikes, fires, other catastrophes, or other "force majeure" events beyond the reasonable control of the party claiming relief under this Article. Provided, however, that this provision does not preclude Company from terminating this Agreement regardless of any "force majeure" event occurring to Contractor. Any party claiming force majeure shall promptly notify the other party of the event and expected duration of the event and shall take all commercially reasonable actions to mitigate the effects of the force majeure.

16. Compliance with Site Rules and Special Conditions.

A. Throughout the term of this Agreement, Contractor will comply, and require its Representatives to comply, with the Site Rules and Special Conditions set forth in Exhibit C.

17. Miscellaneous.

A. No provision of this Agreement is waived and no breach is excused unless such waiver or consent is in writing and signed by the party claimed to have waived or consented. No consent by either party to, or waiver of, a breach by the other, whether express or implied, constitutes a consent to, waiver of, or excuse for any different or subsequent breach. In order to be valid and enforceable, any modification to this Agreement must be both in writing and signed by a duly authorized representative for each party. If any provision of this Agreement is found to be unenforceable then, notwithstanding such unenforceability, this Agreement remains in effect and a like but enforceable provision which most

nearly effects the intention of the parties will be substituted for the unenforceable provision. If a like but enforceable provision cannot be substituted, the unenforceable provision is deemed to be deleted and the remaining provisions continue in effect, provided that the performance, rights, and obligations of the parties hereunder are not materially adversely affected by such deletion. This Agreement inures to the benefit of and is binding upon the respective successors and permitted assigns, if any, of the parties, provided that this provision does not permit any assignment which would be unauthorized or void pursuant to any other provision contained herein. The remedies set forth in this Agreement are intended to be cumulative to any other remedies provided by law or equity. This Agreement contains the entire agreement of the parties and there are no oral or written representations, understandings or agreements between the parties respecting the subject matter of this Agreement which are not fully expressed herein. The Exhibits and Attachments to this Agreement are incorporated herein by referenced and are made a part of this Agreement. This Agreement may be signed in any number of counterparts, each of which, when signed, will be deemed an original and all of which taken together will be deemed to be one and the same instrument. This Agreement may be circulated among the parties via facsimile, email, or other electronic transmission for signature, and the signatures appearing on the faxed, emailed, or electronically transmitted Contract shall be deemed originals for all purposes. The terms and conditions that by their nature, sense, or context survive the expiration, termination, or cancellation of this Agreement (including without limitation, all indemnity and confidentiality provisions) shall so survive.

IN WITNESS WHEREOF, each party acknowledges that it has read the terms and conditions contained herein, understands and agrees to the same and agree to be bound thereby, and has caused this Agreement to be signed by its duly authorized representative on the respective date entered below.

MISSISSIPPI POWER COMPANY

ADVANCED RESOURCES INTERNATIONAL, INC.



By: Steve Craig

By: Velloff

Title: General Manager Transmission

Title: President

Date: 1/20/17

Date: 1/24/2017

EXHIBIT A DESCRIPTION OF THE WORK

Background and Purpose

Mississippi Power Company's ("MPC") Kemper County Energy Facility (the "Energy Facility") is located in a lightly explored region with respect to subsurface data. The nearest geophysical logs that penetrate prospective CO₂ storage horizons are from wells located six or more miles from the Energy Facility and no core data is currently available for establishing the reservoir properties of the site. A water supply test hole drilled in 2008 confirmed the depth and saline nature of the uppermost injection target, the Lower Tuscaloosa Massive Sand. However there remains significant uncertainty about basic geologic properties essential for defining the injection capacity of CO₂ storage reservoirs as well as confining zone properties below the Energy Facility.

Because of this lack of site specific geologic data at the Energy Facility, the first step towards a geologic CO₂ storage assessment is to drill a characterization well ("Characterization Well") at the site to gather the essential well log and core information. This geologic information will be used to define the storage capacity and confining ability of the stack of subsurface formations at the site.

Statement of Work

- 1) Site Selection and Drilling Preparation** – ARI will work with MPC to choose an appropriate location for a test well. The location (approximately 4 acres) will be cleared, leveled and prepared for drilling operations. MPC will provide access and egress for well drilling and support operations.

- 2) Well Drilling and Geologic Data Collection** –The well would penetrate and take whole core from potential geologic targets, potentially including the Massive Sand, Washita–Fredericksburg and Paluxy formations and their confining zone(s). This coring effort would be augmented with detailed geophysical logging, including "triple combo", wave form sonic, magnetic resonance imaging, electrochemical spectroscopy, and possibly formation micro-imaging. After geologic data acquisition, the well will be cased from total depth to ground surface and will be cemented from total depth to ground surface. After these operations the well will be temporarily abandoned in a manner such that it could be utilized later for monitoring or permanently abandoned, depending on MPC's preference.

- 3) Schedule** –The estimated schedule for the Characterization Well drilling would entail an eight (8) month period. The progress of well drilling and any occurrence of unanticipated events will establish the final completion date including reclamation of the site. ARI shall reasonably communicate with Company as to the status of the schedule and progress of the work when requested by the Company.
- 4) Deliverables** – The primary deliverable would be a drilled, characterized and completed Characterization Well and a series of “Close Out” reports.

**EXHIBIT B
HOST SITE DESCRIPTION**

See Attached Document



EXHIBIT C
SITE RULES AND SPECIAL CONDITIONS

1. SITE RULES.

A. Contractor acknowledges that Company has site rules at its various premises and facilities with which Contractor and its Representatives must comply. Contractor covenants to use commercially reasonable efforts to ensure that all Contractor Representatives comply with any Company site rules, policies, postings, signage, and guidelines (which, if applicable, will be provided to Contractor in advance). If Company at any times finds that Contractor is not in compliance with this provision, Company has the right, in its sole discretion, to refuse Host Site entry to (or to have removed from the Host Site), Contractor or any Contractor Representative or to terminate this Agreement pursuant to the termination provisions hereof.

B. The policies and procedures in effect at said Host Sites and to which Contractor must adhere include those set forth in Agreement, this exhibit, including their attachments, and those contained on the following website: <http://www.southernco.com/about-us/suppliers/requirements-plant-access.cshhtml>, all of which are incorporated into Agreement by reference (collectively, the "Site Access Provisions"). In addition, Contractor must register with the Department of Homeland Security's E-Verify system and must use E-Verify to confirm the eligibility of its work force to the extent possible within the legal and regulatory framework and requirements of the Department's program. Contractor shall complete, execute, and submit to Company the Contractor Verification of I-9 / E-Verify Status form included in Attachment 1. Contractor's Representatives will be required to execute certain certifications acknowledging that they have read certain Host Site rules and requirements, and they may be required to attend specific orientation programs before they may be admitted to any Host Sites. Company reserves the right to refuse Host Site entry to any or all Contractor Representatives.

2. SITE OPERATIONS.

A. Contractor shall maintain a sign in sheet showing all personnel on site at all times. The sign in sheet shall be made available to Company and a copy submitted to the Company's field representative via email at the end of every shift.

B. Contractor shall be responsible for the security and control of all material and equipment used in connection with the Work. Security measures shall be employed as required by Contractor to ensure the protection of such material and equipment from theft, vandalism, fire and all other damage and loss. Contractor shall provide all equipment, rigging, dunnage, labor and supervision required to unload all materials that arrive on site. Only qualified personnel may operate lifts, hoists, cranes and other equipment.

C. All temporary construction surface material for soil stabilization, such as crushed stone, shall be the responsibility of the Contractor. Regardless of the allocation of responsibilities between the Contractor and Company for the provision of any crane which may be used during the performance of the Work, the Contractor shall be deemed the controlling entity responsible to ensure that ground preparations for any and all cranes are performed timely and in a manner necessary to meet all Applicable Laws.

D. The construction and shipping address for the Host Site is:

92 Kittrell Swamp Road
Collinsville, Mississippi 39325
Attn: Advanced Resources International, Inc.

E. Company shall not furnish office space, compressed air, service water, sanitary or other facilities for the Contractor's use. The Contractor shall provide any such services or facilities it may require in connection with the performance of the Work.

F. All materials and equipment required for the Contractor's temporary electrical installations shall be furnished by the Contractor and such materials and equipment shall comply with the National Electric Code (NFPA No. 70) in effect as of the Effective Date. In the event that in the opinion of Company's senior project representative, the requirements of Occupational Safety and Health Administration ("OSHA") Regulations Part 1926, Sub-part K – Electric exceed the requirements of the referenced National Electric Code, then the requirements of OSHA shall govern. All cable carrying voltages over two hundred twenty (220) volts shall be installed in conduit or interlocked armor cable. If any of the temporary electrical materials or equipment furnished by the Contractor become in any way defective or dangerous, Contractor shall immediately have the supply of electricity to same disconnected. There shall be no exceptions to this requirement. The supply of electricity shall remain disconnected until the dangerous condition has been remedied.

G. Contractor shall provide all labor and materials required for installation and maintenance of any of the Contractor's facilities requiring potable and non-potable water. Such facilities include, but are not limited to, office, hand washing, toilet, ice makers and craft change areas. Contractor is also responsible to provide any heat tracing, insulation or other materials required for winterizing such facilities. All piping and electrical associated with potable and non-potable water systems shall comply with all current applicable codes and standards.

H. Contractor shall provide and maintain a sufficient number of sanitary facilities. Sanitary facilities will be kept clean, free of graffiti and in good, working order and maintained in that manner. Contractor shall place sanitary facilities in Company designated areas only.

I. Contractor shall provide Contractor's office, clothes changing, tool and storage trailers. Contractor shall provide Company detailed information regarding trailer number(s), size, utility requirements and trailer plan prior to Work mobilization. Company's trailer space is limited and a multi-wide trailer is preferable to multiple single-wide trailers. Contractor's office trailer plans are subject to final approval by Company.

J. Contractor shall provide all telephone, DSL, WiFi or any other service required at any of Contractor's facilities.

K. Contractor's storage and fabrication area is limited to the designated areas. Damage to these areas due to the Contractor's activities shall be repaired by the Contractor in a timely manner prior to completion of the Work, and these areas will be returned to Company in their original condition.

L. During the performance of the Work, Contractor will keep the Host Site reasonably clear and in such condition that other work going on at the same time will not be impeded. All rubbish and trash generated by Contractor or its Representatives in the performance of the Work will be removed by Contractor from time to time and disposed of to the satisfaction of Company.

3. ENVIRONMENTAL, HEALTH AND SAFETY.

A. Contractor shall review Company's "E&CS Project EH&S Policy and Procedure Manual". These procedures can be accessed through the following link: <http://www.southerncompany.com/about-us/suppliers/ecs.cshtml> and clicking on "Environmental, Health and Safety (EH&S).

B. Contractor's environmental, health and safety program shall meet or exceed the requirements of this document and the Southern Company Generation's "E&CS Project EH&S Policy and Procedure Manual", referenced above. Contractor shall comply with Southern Company's E&CS Environmental, Health and Safety Specifications which can be accessed through the following link: www.southerncompany.com/about-us/suppliers/pdfs/EHS_Specifications_Section_1H.pdf

C. Contractor shall submit its own site specific manual for review and approval of Company prior to the commencement of Work.

D. Contractor equipment operator qualification shall include physical examinations. The Contractor is responsible for ensuring that any such physical examinations or testing complies with the Americans with Disabilities Act of 1990, as amended. This physical shall be required for all mobile equipment operators with the exception of golf carts, buggies and manlifts. All operators shall meet the requirements as outlined in the EH&S Policies and Procedures.

E. The Contractor shall designate an appropriately trained and experienced supervisor to assume the duties of the EH&S resource. Such duties may be shared with other responsibilities of the individual if less than twenty-five (25) employees are under the control of the Contractor at the Work site; otherwise, this duty shall require a fulltime safety professional. The EH&S resource shall be assigned to the jobsite upon Contractor's mobilization. Company reserves the right to review the résumés and qualifications of the proposed Environmental, Health and Safety (EH&S) resource, whether internal or from third parties. Company further reserves the right to reject any proposed EH&S resource. The EH&S resource or a designated person working under his/her direction shall be on-site during all working hours.

F. In addition to the Drug and Alcohol Policy, the following site requirements are to be implemented. After initial pre-site/pre-employment drug testing, all Contractor personnel are to be retested within the first thirty (30) days of employment and within every sixth (6th) months of continuous on site employment. Said testing is to be directed by Contractor at unannounced times during the first thirty (30) days of assignment to the Work. After this, the Contractor shall drug test a minimum of ten percent (10%) of work force randomly each subsequent month.

G. Hooks used in any material handling/lifting operations must have a nondestructive inspection test performed prior to use as outlined in the EH&S Policies and Procedures. In addition to equipment listed in the procedure, trackhoe buckets, backhoe buckets or fifty (50) Ton and larger air hoists shall also fall under this requirement. The test method is to be by magnetic-particle inspection performed by an ASNT-TC-1A Level II inspector.

H. Contractor shall be responsible for providing its Representatives with all appropriate and required safety equipment and personal protective equipment (PPE) including without limitation hard

hats, hearing protection, eye protection, hand protection, foot protection, fall protection, heat and fire protection.

I. Contractors are required to use Form SH-1N (Job Safety Analysis / Common JSA) and train their employees on how to use this form. Contractors are not required to use Form SH-1N exclusively. Contractors can still use their own company JSA forms so long as they do so in addition to Form SH-1N. Any Contractor requests to use their company JSA form exclusively must be approved by Company, per the process specified by the E&CS Project EH&S Policy and Procedure Manual. Form SH-1N, Job Safety Analysis and the associated training can be accessed through the following link: [Common JSA Form and Training\(Form SH-1N, Job Safety Analysis\)](#)

J. Contractor shall keep records of all employee safety training and make copies available to Company, upon request. Contractor shall submit the safety training information and other data required by Company to Company’s field representative via email, upon request.

4. DOCUMENTATION AND COMMUNICATION.

A. For all subcontractors that Contractor intends or desires to use to perform any Work on the Host Site, Contractor shall submit the names, qualifications and complete compliance safety questionnaires (which will be provided by Company upon request) for any proposed subcontractors. Subcontractor diversity participation is encouraged. Company reserves the right to reject any proposed subcontractors. Company’s safety criteria shall be utilized by Contractor in the subcontractor selection process to ensure that each proposed subcontractor has the ability and upper-management support to perform all Work in a safe manner.

B. Documentation Submitted Per Identified Milestone

Contractor shall submit the following information to Company’s Site Representative.

| Data Description | Data Code | Due Date |
|---|---------------------------|--|
| Contractor shall submit to Company a site specific quality plan related to the Scope of Work being performed, in accordance with CQR-1 Contractor Quality Requirements for Construction Services. | For review and acceptance | Within 5 days of Initial site mobilization and prior to any craft Work on site |
| Contractor shall submit to Company a Site Specific Health & Safety Plan for themselves as well as their Subcontractors. | For review and acceptance | Within 5 days of Initial site mobilization and prior to any craft Work on site |

| Data Description | Data Code | Due Date |
|--|---------------------------|--|
| Contractor shall submit to Company a Site Specific Hazardous Material Handling Plan related to the Scope of Work being performed, including all related handling procedures. | For review and acceptance | Within 5 days of Initial site mobilization and prior to any craft Work on site |

C. Daily Progress Reports: Throughout the course of the Work, Contractor’s supervisory staff shall be required to contact Company’s field representative by 5:00 p.m. each day via telephone to report on daily progress. The report shall include the following:

- a. Synopsis of the Work performed since the previous report, any issues encountered and the resolutions recommended or implemented, and the planned Work for the twenty-four (24) hours ahead;
- b. Actual progress versus the planned progress;
- c. Material delivery updates and status;
- d. Information and updates on first aides and/or recordables, if any; and
- e. Total number of Contractor personnel and Representatives onsite per shift

D. Bi-Monthly Progress Reports: The Contractor shall provide a written progress report to Company, describing activities begun or finished during the preceding three (3) weeks, Work in progress, expected completion of the Work, a projection of all activities to be started or finished in the upcoming two (3) weeks, the Contractor’s work force crew size and total resource hours anticipated in connection with the Work to be started or completed within the next two (2) weeks and any other information reasonably requested by Company. The weekly progress report shall be submitted via email no later than five p.m. (5:00 p.m.) local (site) time on the 15th and the last day of the month. Specifically, the report shall include the following:

- a. Written synopsis of the Work performed since the previous report date, the issues encountered and the resolutions recommended or implemented and the planned Work for the upcoming two (2) weeks;
- b. Updated schedule for performance of the Work;
- c. Copies of all drilling logs produced since the last report;
- d. Material delivery updates and status;
- e. An electronic (Microsoft Excel or other importable format) and/or marked PDF (Portable Document Format) copy of the entire fully updated schedule with all progress and logic changes highlighted;

- f. Safety statistics and measures implemented by the Contractor to address safety concerns;
- g. Contractor's weekly safety meeting minutes with the required attendance sheet;
- h. Any problems impacting the timely and efficient performance and completion of the Work. On a daily basis, the Contractor shall record any specific activities affected, the extent of the impact, the specific area(s) of the Work affected, and describe the Contractor's efforts to mitigate the impact;
- i. Project Security Rules certification forms;
- j. Drug and alcohol release forms; and
- k. Background check verification: The Contractor shall submit a letter, signed by an executive of the company, providing the listing of all supervisory personnel and/or other personnel as provided for in the Compliance Documents to have background investigations, verifying that the list of all personnel as provided for in the Agreement to have background investigations are complete and current. It is the responsibility of the Contractor, should personnel be changed for any reason, to provide notice to Company in the same manner required above to ensure compliance.

5. QUALITY ASSURANCE/QUALITY CONTROL.

A. The Contractor shall establish, document, and maintain a quality program which meets the requirements of Company's "Contractor Quality Requirements for Construction Services" (CQR-1) document. Company's CQR-1 can be accessed through the following link: [CQR-1](#). A copy of the Contractor's quality control manual shall be submitted to Company for review. Company reserves the right to hold a pre-Work meeting with the Contractor to discuss and review the expectations of the Contractor regarding quality. Contractor shall designate a QA/QC representative who is qualified to properly inspect and evaluate the Work being performed. The QA/QC representative shall be assigned to the jobsite upon Contractor's mobilization. The QA/QC representative can be an employee of the Contractor or their Subcontractor. The Quality representative shall be on-site whenever Work is being performed and shall be familiar with the Work being performed.

6. COMPLIANCE PROVISIONS.

A. Contractor agrees that it will, at all times during the term of this Agreement, maintain a safe, secure, and drug- and alcohol-free workplace. The requirements of this provision apply to the Contractor and all Representatives. Contractor agrees to adhere to the minimum standards and eligibility guidelines set forth herein concerning Contractor Representative background investigations and drug and alcohol testing ("Standards"). Contractor understands and acknowledges that the Standards may require certain Contractor Representatives to undergo a background investigation and/or drug and alcohol testing. In addition to the obligations set forth herein, Contractor Representatives who are classified by Company as Risk I must meet the additional requirements that are set out in the documents included as Attachment 1. Company shall have the exclusive right at any time

to change the requirements of the Standards. Such change shall be effective upon notice to the Contractor.

B. Contractor agrees that, upon request by Company, it will provide Company with a list of individuals and other identifying information deemed necessary by Company whom Contractor is either using or plans to use to perform services or Work in connection with this Agreement. Solely for purposes of ensuring compliance with this provision of the Agreement, Company may perform or have performed investigations and may use any appropriate investigative technique to detect violations of the Standards. Initial or pre-site, reasonable cause, post-accident, and random drug and alcohol tests and/or background investigations of Contractor Representatives may be required at Company's discretion and at any time. Failure of any Contractor Representative to submit to a required drug and alcohol test or a background investigation may result in a restriction of such individual's access to work sites of Company, The Southern Company and any or all of The Southern Company subsidiaries or in a request by Company that the individual not perform services or Work under this Agreement. If, at any time during the term of this Agreement, Company learns that Contractor or any Contractor Representative did not comply with, or fails to meet the requirements of, the Standards, Company may, in its sole discretion, exercise any and all of its legal and equitable remedies, including the rights (i) to prohibit non-compliant Contractor Representative from entering the work site, (ii) to remove non-compliant Contractor Representative from the work site, and/or (iii) to request that the non-compliant Contractor Representative not perform services or Work under this Agreement.

C. Contractor must promptly notify Company of any incident of known or suspected unlawful involvement with drugs; possession of alcoholic beverages on a work site or consumption of alcoholic beverages during work hours or on Company premises; any felony conviction, or other serious behavioral incident involving Contractor Representatives; and any potentially serious hazard to Contractor Representatives while on the work site. Contractor Representatives involved in a serious on-the-job accident and Contractor Representatives whose on-the-job behavior provides reasonable cause to suspect drug or alcohol use must be drug and alcohol tested by Contractor. Serious accidents include, but are not necessarily limited to: an accident that caused or could have caused loss of life, bodily injury occurring to any person that required medical treatment, material damage to property, equipment or operations; a vehicle accident during the course of the work in which a vehicle is towed from the scene or a citation is issued to any Contractor Representative; or a material disruption to Company's business or operations.

D. Company reserves the right to conduct audits at any time during the term of the Agreement to determine Contractor's compliance with this provision of the Agreement. This reservation of rights and the Company's discretion to exercise those rights will not relieve Contractor of any obligation to comply with the Standards nor will it constitute the exercise of control over the manner and means by which Contractor implements this provision of the Agreement. Company retains the exclusive right to waive any or all part of the requirements for drug and alcohol testing and background investigations. Unless otherwise expressly waived as provided in the foregoing sentence, no act or omission by Company will operate as a waiver of Company's rights to enforce the Standards or the Contractor's duty to comply with the Standards.

E. Contractor and its Contractor Representative must at all times conduct their business activities pursuant to this Agreement in a highly ethical manner and in compliance with Applicable Laws. Contractor agrees to advise all Contractor Representatives that the following are unacceptable

behaviors and covenants to ensure that no Contractor Representatives exhibit any of these behaviors in connection with the project Work:

- a. Contractor covenants to use commercially reasonable efforts to ensure that all Contractor Representatives comply with any Company work site rules, policies, or guidelines (which, if applicable, will be provided to Contractor in advance) and, at all times when using Company's electronic communication policies (which are available to Contractor). If Company at any times finds that Contractor is not in compliance with this provision, Company has the right, in its sole discretion, to refuse Company work site entry to (or to have removed from a Company work site), or to terminate access to Company's electronic communication systems for, Contractor or any Contractor Representative or to terminate this Agreement pursuant to the termination provisions hereof.
- b. Harassment or discrimination of any kind or character, including conduct or language that: (i) is derogatory to any individual on the basis of race, gender, color, religion, age, national origin, disability, veteran status or sexual orientation; or (ii) creates an intimidating, hostile or offensive working environment. Specific examples include jokes, pranks, epithets, written or graphic material, or hostility or aversion toward any individual or group; or
- c. Any conduct or act (e.g., threats or violence) that creates a hostile, abusive, or intimidating work environment. Examples of these inappropriate behaviors include fighting, abusive language, inappropriate signage, use or possession of firearms on a Company work site, destruction of Company property or Company employee property, or the threat of any of these behaviors; or
- d. Work practices that are unsafe or harmful to the environment; or
- e. Use of Company's computers, e-mail, telephone or voice-mail system that in any way involves material that is obscene, pornographic, sexually oriented, threatening, or otherwise derogatory or offensive to any individual on the basis of race, gender, color, religion, age, national origin, disability, veteran status, or sexual orientation; or
- f. Use of, being under the influence of, or possession of alcoholic beverages or unlawful drugs on a Company work site; or
- g. Engagement in any activity that creates a conflict of interest or appearance of the same, or that jeopardizes the integrity of Company or Contractor (including providing gifts or gratuities to Company or Company employees).

If Company in its sole discretion concludes Contractor has breached this provision, Company has the right, regardless of any other Agreement provision and in addition to legal or equitable remedies, to terminate immediately this Agreement. If any Contractor Representative observes a Company employee doing, or is asked by a Company employee to do, something the Contractor Representative considers to be unethical, illegal, or in violation of these behavior standards, Company requests Contractor immediately to notify Company management or call Company Workplace Ethics at 1-800-754-9452.

F. Contractor shall coordinate all safety and work rules and procedures with the Company and all Contractor Representatives. Contractor warrants that, before performing Work at each Work site, it will have communicated and discussed with Company the characteristics of the Work and the Work site that are related to the safety of the Work to be performed, including, as applicable to the Work, (i) the nominal voltages of lines and equipment, (ii) the maximum switching-transient voltages, (iii) the presence of hazardous induced voltages, the presence and condition of protective grounds and equipment grounding conductor, (iv) the locations of circuits and equipment, including electric supply lines and condition of poles, communication lines, and fire-protective signaling circuits, and (v) any environmental conditions relating to safety. Contractor further covenants that it will instruct its Subcontractors and Contractor Representatives of the above relevant information supplied by the Company and agrees that it shall advise and notify the Company, Subcontractors and Contractor Representatives of any unique hazardous conditions presented by the Work, including any such conditions found or identified during the Work.

G. Before performing Work, Contractor warrants that it will communicate and instruct all Representatives on all applicable safety, health, and legal requirements and job-related duties and hazards including, without limitation, (i) Applicable Laws and Occupational Safety and Health Administration (“OSHA”) requirements and regulations; (ii) Contractor’s safety program; (iii) any project-specific safety plan; (iv) any information specific to the Work performed under this Agreement; (v) any work site hazard; and (vi) obligations under this Agreement. To ensure ready communication of information at all times at any work site, if any Contractor Representative is non-English-speaking, Contractor agrees that it will ensure the availability of an English-speaking Contractor Representative who is able to communicate with, and translate for, the non-English speaking Contractor Representatives. If non-English speaking Contractor Representatives are divided into separate work groups, Contractor must make an English-speaking Contractor Representative available for each such group. Contractor agrees to continue this communication and translation program for all new Contractor Representatives and regarding the Work and to provide necessary informational updates for the Work throughout the term of this Agreement.

H. If Work is likely to involve Hazardous Substance exposure, each party must have a written Hazard Communication Program (HCP) making Hazardous Substance information available to the other’s personnel. “Hazardous Substance” shall mean any hazardous waste, hazardous substance or toxic substance or material defined, regulated, controlled, limited, or prohibited in the Comprehensive Environmental and Liability Act of 1980, 42 USC § 9601, et seq., or by any applicable state or federal law, including substances defined as pollutants, contaminants, chemicals, petroleum, urea, formaldehyde, radioactive materials, PCB’s, pesticides, herbicides, asbestos, sludge, acids, metals, solvents, waste water and sewage. The HCP describes how the party will make MSDS available to the other, how it will inform the other of precautionary measures to protect personnel (in both normal operating conditions and in emergencies), and how it labels Hazardous Substances. Contractor agrees to submit its HCP to Company at least 30 days before commencing Work and, if notified it does not comply with Legal Requirements, agrees to correct the HCP before performing Work.

I. Contractor acknowledges that it is responsible for coordinating its Work with private parties, local governments, and other utilities. If the Work involves overhead or underground utility facilities, Contractor covenants to provide notices and locate requests to the Utilities Protection Center, and to coordinate its Work with the Utilities Protection Center and with utility facility owners or operators per the applicable Utility Facility Protection Act (or its state equivalent) and the High-voltage Safety Act (or

its state equivalent) Contractor further agrees to perform any excavation Work on the Company's Property according to Company's "Excavation Practices" Memorandum.

Attachment 1
Miscellaneous Forms and Documents

See attached documents



Attachment 1.pdf

Appendix V Well Drilling Permits

State Oil and Gas Board



RECEIVED

SEP 29 2016

ENVIRONMENTAL AFFAIRS

Board Members

DAVID A. SCOTT, Jackson
Chairman

JAMES H. HEIDELBERG, Pascagoula
Vice-Chairman

OWEN B. EMERSON, Hernando
CARROLL V. HOOD, Hazlehurst
LEW YODER, Laurel

State Of Mississippi

500 Greymont Avenue, Suite E
Jackson, MS 39202
Telephone (601) 576-4900

LISA IVSHIN
Executive Director

HOWARD O. LEACH
Board Attorney

September 26, 2016

- (X) Permit to drill and approved Form 2 enclosed.
- (X) Minimum surface casing requirements 580 feet.
For all new drill wells, surface casing must be cemented to surface as stated in Statewide Rule 11.

In the appropriate casing row on the Form 3 Completion Report, the sacks of cement shall be stated with an affirmative statement that cement is to the surface either for the surface casing or first intermediate string of casing.

- () Permit issued pursuant to Docket No. N/A
Order No. N/A
- (X) Land disposal form attached.
- (X) Form 21, NORM Survey attached; a Norm Survey is required if the well is completed as a producing well or a Class II well.
- (X) Fracking requirements. A Form 2 must be submitted in accordance with Statewide Rules in order to conduct a fracture stimulation on this well.

Lisa A. Ivshin

STATE OIL AND GAS SUPERVISOR

**MISSISSIPPI STATE OIL AND GAS BOARD
APPLICATION FOR PERMIT TO DRILL, WORKOVER OR CHANGE OPERATOR**

APPLICATION TO DRILL

FORM No. 2
WORKOVER

CHANGE OF OPERATOR

| | | | | | |
|---|--|---|---|---|----------------------------------|
| NAME OF COMPANY OR OPERATOR Mississippi Power | | | | DATE 7/18/2016 | |
| ADDRESS 2992 W Beach Blvd | | CITY Gulfport | STATE MS | ZIP 39501 | TELEPHONE 228.897.4338 |
| NAME OF WELL MPC 26-5 | | WELL NO. #1 | ELEVATION (GROUND) 385 | | |
| WELL LOCATION (WHEN POSSIBLE, GIVE FOOTAGE FROM SECTION LINES) 1783' FNL, 816' FWL | | SECTION - TOWNSHIP - RANGE 26-9S-14E | | CHECK TYPE OF PROPOSED WELL <input type="checkbox"/> OIL <input type="checkbox"/> GAS OTHER (NAME) Stratigraphy | |
| FIELD & RESERVOIR (IF WILDCAT, SO STATE) Wildcat | | API No. (EXISTING WELL) | | APPROX. DATE WORK BEGINS 10.1.2016 | |
| PROPOSED DEPTH 7,000 <small>FEET</small> | PROPOSED LENGTH OF SURFACE CASING 2,500 <small>FEET</small> | NUMBER OF ACRES IN RILLING UNIT N/A <small>ACRES</small> | DISTANCE FROM PROPOSED LOCATION N/A <small>FEET</small> | DISTANCE FROM PROPOSED LOCATION TO NEAREST DRILLING, COMPLETED OR APPLIED FOR WELL 14,684* <small>FEET</small> | |
| NAME OF DRILLING CONTRACTOR H.A.D. Inc. | | | | | |
| ADDRESS 9797 Benner Road | | CITY Rittman | STATE Ohio | ZIP 44270 | |
| FOR CHANGE OF OPERATOR ONLY - SIGNATURE OF FORMER OPERATOR REQUIRED FOR TRANSFER OF WELL | | | | | |
| AUTHORIZED REPRESENTATIVE SIGNATURE | | | NAME OF FORMER OPERATOR | | |
| NOTE: AREA FIELD INSPECTOR OR FIELD DIRECTOR (JACKSON OFFICE) OF DATES OF SPUDDING AND REACHING TOTAL DEPTH. Mississippi State Oil and Gas Board, 500 Greymont Avenue, Suite E, Jackson, MS 39202 601-576-4900 | | | | | |
| REMARKS: (IF THIS IS AN APPLICATION TO WORKOVER, BRIEFLY DESCRIBE WORK TO BE DONE, GIVING PRESENT PRODUCING ZONE AND EXPECTED NEW PRODUCING ZONE) * nearest well is API 2307500016; Culpepper #1; Lauderdale County | | | | | |
| ARE THERE SEPARATELY OWNED TRACTS OR INTERESTS IN THE DRILLING UNIT FOR WHICH THIS PERMIT IS SOUGHT? (REF. MS. STATUTE 53-3-7) | YES | NO X | IF YES, HAVE THE PERSONS OWNING THE DRILLING RIGHTS IN SAID TRACTS OR INTERESTS AND THE RIGHTS TO SHARE IN THE PRODUCTION THEREFROM AGREED TO DEVELOP THEIR LANDS AS A DRILLING UNIT AND TO THE DRILLING OF THE WELL? (REF. MS. STATUTE 53-3-7) | | YES |
| EXECUTED THIS THE <u>18th</u> DAY OF <u>August</u> , 20 <u>16</u> | | STATE OF <u>Mississippi</u> | | | |
| COUNTY OF <u>Harrison</u> | | SIGNATURE OF AFFIANT <u>Charles R Berry</u> | | | |
| BEFORE ME, THE UNDERSIGNED, THIS DAY PERSONALLY APPEARED <u>Charles R Berry</u> KNOWN TO ME TO BE THE PERSON WHOSE NAME IS SUBSCRIBED TO THE ABOVE INSTRUMENT; WHO BEING BY ME DULY SWORN ON OATH, STATES THAT HE IS DULY AUTHORIZED TO MAKE THE ABOVE REPORT AND THAT HE HAS KNOWLEDGE OF THE FACTS STATED THEREIN AND THAT SAID REPORT IS TRUE AND CORRECT. | | SUBSCRIBED AND SWORN TO BEFORE ME THIS <u>18th</u> DAY OF <u>August</u> , 20 <u>16</u> | | | |
| SEAL NOTARY PUBLIC ID No. 60783 My Commission Expires November 5, 2017 HARRISON COUNTY | | SIGNATURE <u>[Signature]</u> NOTARY PUBLIC IN AND FOR <u>Mississippi</u> COUNTY <u>Harrison</u> | | | |
| PERMIT NUMBER | <u>2017-OPD-0028</u> | | | | |
| APPROVAL DATE | <u>9/22/2016</u> | | | | |
| APPROVED BY | <u>1250</u> | | | | |

| | | |
|---|----------------------|----------------------|
| MISSISSIPPI STATE OIL AND GAS BOARD FORM 2 (Rev. 5/10) A. P. I. WELL NUMBER | | |
| STATE 23 | COUNTY 069 | WELL 20013 |

NOTICE: BEFORE SENDING THIS FORM, BE SURE THAT ALL INFORMATION REQUESTED IS GIVEN. SEE INSTRUCTIONS ON REVERSE SIDE OF FORM.

**MISSISSIPPI STATE OIL & GAS BOARD
APPLICATION FOR PERMIT TO DRILL, WORKOVER OR CHANGE OPERATOR**

APPLICATION TO DRILL WORKOVER CHANGE OF OPERATOR

| | | | | | | |
|--|--|---------------------------------|--|---------------------------------|---|---------------|
| NAME OF COMPANY OR OPERATOR MISSISSIPPI POWER COMPANY | | | | DATE 9/22/2016 3:42:16 DM | | |
| ADDRESS 2992 West Beach Blvd. | | CITY GULFPORT | STATE MS | ZIP 39501 | TELEPHONE (228) 864-1211 | |
| NAME OF WELL MPC 26-5 | | WELL NO 1 | ELEVATION (GROUND) 385 | | PROPOSED WELL TYPE ST - Stratigraphic | |
| WELL LOCATION 1783' FNL & 816' FWL | | FNL/FSL FEL/FWL | SECTION 26 | TOWNSHIP 9 S | | RANGE 14 E |
| | | | LATITUDE 32.601268 | LONGITUDE (NEW) -88.843199 | | |
| FIELD NAME Wildcat | | | API No. (EXISTING WELL) 23-069-20013 | | APPROX. DATE WORK BEGINS | |
| RESERVOIR NO POOL NAMED | | | COUNTY KEMPER | | | |
| PROPOSED DEPTH (FT) 7000 | PROPOSED LENGTH OF SURFACE CASING (FT) 2500 | NO. ACRES IN DRILLING UNIT 0 | DISTANCE FROM PROPOSED LOC. TO NEAREST DRILLING LINE (FT) 0 | | DISTANCE FROM PROPOSED LOCATION TO NEAREST WELL (FT) 14684 | |
| NAME OF DRILLING CONTRACTOR | | | | | | |
| ADDRESS | | | | | | |
| CITY | | | | | | |
| STATE | | | | | | |
| ZIP | | | | | | |

For Change of Operator Only - Signature of Former Operator Required for Transfer of Well

| | |
|-------------------------------------|-------------------------|
| AUTHORIZED REPRESENTATIVE SIGNATURE | NAME OF FORMER OPERATOR |
|-------------------------------------|-------------------------|

NOTIFY AREA FIELD INSPECTOR OR FIELD DIRECTOR (JACKSON OFFICE) OF DATES OF SPUDDING AND REACHING TOTAL DEPTH.
Mississippi State Oil and Gas Board, 500 Greymont Avenue, Suite E, Jackson, MS 39202 601-354-7142

| | |
|---------|--|
| REMARKS | IF THIS IS A WORKOVER: PRESENT PRODUCING ZONE |
| | EXPECTED NEW PRODUCING ZONE |
| | |

Executed this day _____ Affiant name _____
State _____ Notary Name _____
County _____ Commission Expires _____

PERMIT NUMBER 2017-OPD-0028
APPROVAL DATE 9/22/2016

APPROVED BY _____
NOTICE: BEFORE SENDING THIS FORM, BE SURE THAT ALL INFORMATION REQUESTED IS GIVEN.

| |
|--|
| MISSISSIPPI STATE OIL & GAS BOARD APPLICATION FOR PERMIT TO DRILL, WORKOVER OR CHANGE OPERATOR FORM 2 (rev. 5/10) API WELL NUMBER 23-069-20013-0000 |
|--|

RULE 11. SURFACE CASING. The minimum amount of surface or first-intermediate casing to be set shall be determined from the following table:

| Proposed Total Depth-Feet | Minimum Casing Requirements-Feet |
|----------------------------------|---|
| 0-2500 | 200' |
| 2500-6000 | 200' + 8% of proposed depth in excess of 2500' |
| 6000-7000 | 480' + 10% of proposed depth in excess of 6000' |
| 7000-8000 | 580' + 15% of proposed depth in excess of 7000' |
| 8000-9000 | 730' + 20% of proposed depth in excess of 8000' |
| 9000-Deeper | 930' + 25% of proposed depth in excess of 9000' |

Casing shall be cemented to the surface.

Casing shall be tested at a pressure equivalent to one pound (1 lb.) per sq. inch per foot of casing set with a maximum test pressure of 1,000 lbs. per sq. inch.

Cement or cement-admix shall be allowed to stand a minimum of twelve (12) hours under pressure before initiating test or drilling plug. "Under pressure" is complied with if one (1) float valve is used, or if pressure is held otherwise.

The proposed surface casing program for any well is to be presented with the filing of Form No. 2, "Application to Drill."

Prior to the spudding of any well, exceptions may be granted to the above minimum casing requirements upon submission of proper evidence and subject to the joint approval of the Supervisor and Chief Engineer of the Board. In event this approval for an exception to the minimum casing requirements is denied, the operator may seek further relief before the Board after notice and hearing.

In case an operator decides to drill deeper after drilling to his initial proposed total depth, he may secure relief to the above minimum casing requirements just as though his original intent was to drill the well as an exception to the minimum casing requirements, provided, however, that such exception is approved by the Supervisor and Chief Engineer.

Source: MCA Section 53-1-17(3) (1972)

Approved 9-19-2012

Effective Date 11-5-2012

State Oil and Gas Board



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State Of Mississippi

500 Greymont Avenue, Suite E
Jackson, MS 39202
Telephone (601) 576-4900

LISA IVSHIN
Executive Director

HOWARD O. LEACH
Board Attorney

OPERATOR'S RESPONSIBILITY FOR LAND DISPOSAL (LANDFARMING) OF APPROVED EXPLORATION AND PRODUCTION WASTE FROM A RESERVE PIT

To be completed by person responsible for pit closure. Each required document shall reference the well name, operator, and location. Note: An employee of the MSOGB cannot sign as a witness to any required document. **This form and required attachments should be given to the field inspector prior to land farming.** (Copy of finalized form will be mailed to operator after receipt in Jackson office)

I. Field: _____ Operator: _____

Well Name & Number: _____

A.P.I. Number: 23-_____

Location: Section _____ Township _____ Range _____ County _____

II. Location of disposal site: _____

Landowner: _____

III. Requirements for approval by MSOGB, before landfarming begins:

- | | | |
|--|------------------------------|-----------------------------|
| A. Site acceptable | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| B. Land owner's approval granted** | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| C. Pit analysis acceptable** | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| D. Were hazardous materials in the waste?*** | <input type="checkbox"/> Yes | <input type="checkbox"/> No |

Rec'd? (✓)

**REQUIRED ATTACHMENTS

_____ LAND OWNER'S WITNESSED OR NOTARIZED SIGNED APPROVAL

_____ COPY OF THE PIT ANALYSIS

_____ NOTARIZED SIGN-OFF BY THE DRILLING CONTRACTOR THAT
NO HAZARDOUS MATERIALS WERE INTRODUCED TO THE WASTE.

E. Conditions for land spreading by MSOGB: _____

F. Approved by _____ (Field Inspector) DATE _____

IV. Final inspection and approval by MSOGB after landfarming is completed.

FIELD INSPECTOR _____ DATE _____

State Oil and Gas Board



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Board Attorney

SPECIAL NOTICES FOR DRILLING PERMITS

1. Drilling sites permitted after June 1, 1996, must have a NORM Survey performed in accordance with Statewide Rule No. 69, prior to the start of production operations. This survey shall be documented on Board Form No. 21 (enclosed).
2. A person issued a permit after July 1, 1998, to drill a new well is required prior to beginning operations to provide certified mailed notice to the taxpayer shown on the most recent county ad valorem tax receipt available in the office of the tax collector of the county in which the well site is located. The notice shall include a copy of the unit plat showing the proposed well location.
3. At least one electric log shall be run in each well and shall be filed with the Board within thirty (30) days of completion of the well or within 60 days after log is run, whichever is the earlier date. This will include an electrical correlation log consisting of the spontaneous potential or gamma ray and induction resistivity surveys, or equivalent, and covering that portion of the wellbore from total depth to the base of the surface casing, specifically displayed on a one inch: one hundred foot scale, a two inch: one hundred foot scale and a five inch: one hundred foot scale. **One copy of all additional open hole electrical, mechanical and radioactive logs run in the well shall be filed with the Board within said filing period**, provided, however, that logs obtained on stratigraphic tests shall be filed with the Board within six (6) months. This shall not include any interpretative, computer-analyzed or computer-interpreted logs run in the well. It shall, however, include the raw data curves from a dipmeter if run in the well. The Supervisor of the Board may, for good cause and at the discretion of the Supervisor, waive the requirement that one electric log be run from total depth to the base of the surface casing.

**Mississippi Oil & Gas Board
RADIATION SURVEY
for
Oil Field NORM**

SURVEY

Purpose: Periodic Survey (*Initial, Continuing Operations, Property/Equipment Transfer*)
 (Check One) Maintenance/Special Activities (*Description _____*)
 Unrestricted Release (*Description _____*)

Surveyed by _____ Company _____
 Survey Date _____ Telephone (____) _____ Address _____

SITE

Well Name & No. _____ Sec. _____ Twn. _____ Range _____
 API Well No. _____ Field _____ County _____
 Operator _____ Phone (____) _____
 Address _____

SURVEY INSTRUMENT(S)

Φ R Instrument Make/Model _____ Serial No. _____
 Calibrated within past year? YES NO Battery/Instrument check OK? YES NO
 Pancake GM Make/Model _____ Serial No. _____ Calibrated within
 past year? YES NO Battery/Instrument check OK? YES NO

EQUIPMENT MEASUREMENT SUMMARY

| | |
|----------------|------------------------------------|
| Location _____ | Maximum _____ Φ R/h _____ c/m |
| Location _____ | Maximum _____ Φ R/h _____ c/m |
| Location _____ | Maximum _____ Φ R/h _____ c/m |
| Location _____ | Maximum _____ Φ R/h _____ c/m |

LAND MEASUREMENT SUMMARY

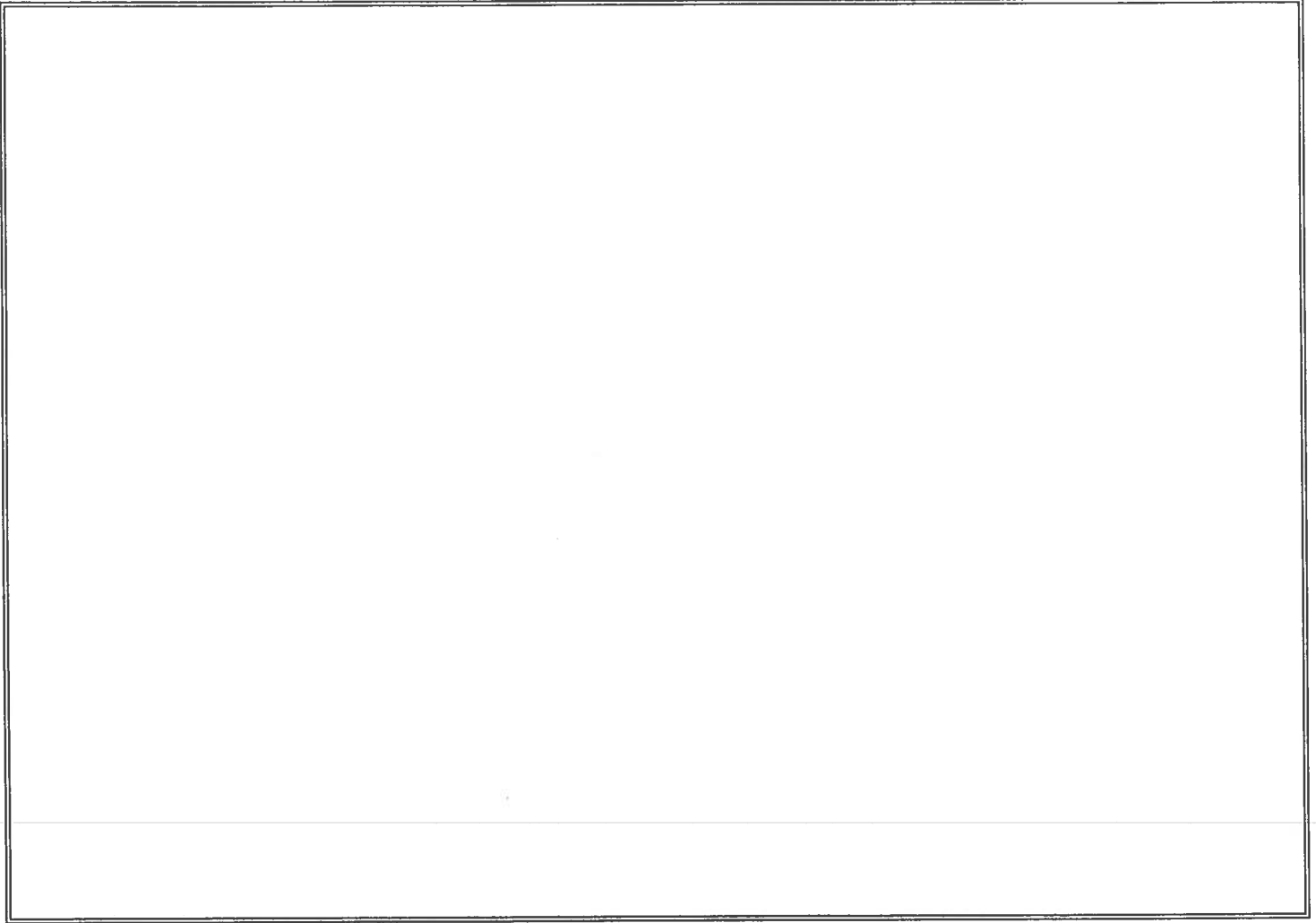
| | | |
|----------------|--------------------------|-----------------------|
| Location _____ | Average _____ Φ R/h | Max. _____ Φ R/h |
| Location _____ | Average _____ Φ R/h | Max. _____ Φ R/h |
| Location _____ | Average _____ Φ R/h | Max. _____ Φ R/h |
| Location _____ | Average _____ Φ R/h | Max. _____ Φ R/h |

MISSISSIPPI STATE OIL AND GAS BOARD
 RADIATION SURVEY
 for Oil Field NORM
 OGB Form 21

Authorized by Order No. 73-96 Effective June 1, 1996

Diagram of Site/Equipment Measurements:

- ☐ Show individual measurements and locations.
- ☐ Attach additional pages as needed.



1. Periodic radiation surveys of oilfield site and equipment NORM shall be documented on Mississippi State Oil and Gas Board (OGB) Form 21. OGB Form 21 is to be submitted to the UIC/Technical Group, 500 Greymont Avenue, Suite E, Jackson, Mississippi 39202 for review. Call (601) 354-7127 if you have any questions about completion of OGB Form 21.
2. This radiation survey shall be completed according to the practices recommended in Rule 69 of the Mississippi Oil and Gas Board, "Control of Oilfield NORM," and signed below by the person performing the survey, whose name is listed on the reverse side.
3. This survey form will be returned if not properly completed and signed.

STATE OF MISSISSIPPI

I have personally performed the radiation survey as described on this OGB Form 21 and hereby certify that it is true, correct, and representative of the site and/or equipment as intended by Rule 69 of the Mississippi State Oil and Gas Board.

(Signature)

(Date)

Rule 1.26 - Requirements for Hydraulic Fracture Stimulation –Report of Shooting or Treating

I. Definitions

For the purposes of this Rule, the following definitions shall apply:

- a. “Board” means the Mississippi State Oil and Gas Board.
- b. “Additive” means any substance or combination of substances, including proppants, having a specified purpose which is intentionally combined with the Base Fluid as hereinafter defined.
- c. “Base Fluid” means the continuous phase fluid, such as water, which is used in a particular Hydraulic Fracturing Treatment.
- d. “Chemical Abstract Service” or “CAS” means the chemical registry which is the authoritative collection of disclosed chemical substance information.
- e. “Chemical Constituent” means a discrete chemical with its own specific name or identity (such as, but not necessarily, a CAS number) which is contained in an Additive.
- f. “Chemical Family” means a group of elements in the Periodic Table or, more commonly, compounds which share certain physical and chemical characteristics and which have a common name.
- g. “Hydraulic Fracturing Fluid” means the Base Fluid and Additives utilized in a particular Hydraulic Fracturing Treatment.
- h. “Hydraulic Fracturing Treatment” means stimulating a well by the application of Hydraulic Fracturing Fluids with force in order to create artificial fractures in the formation for the purpose of improving the capacity of the well to produce hydrocarbons.
- i. “Supervisor” means the State Oil and Gas Supervisor of the Mississippi State Oil and Gas Board.

2. The provisions of this Rule shall apply to oil and gas wells which are proposed to undergo a temporary or intermittent hydraulic fracturing procedure to improve the productive capacity of such oil and gas wells utilizing Hydraulic Fracturing Treatment as hereinabove defined.

3. Before an operator shall commence the hydraulic fracturing of any oil and gas well, including the application of Hydraulic Fracturing Treatment as hereinabove defined, such operator shall file with the Mississippi State Oil and Gas Board a duly executed **FORM 2** indicating in the narrative portion of such **FORM 2** the nature of the hydraulic fracturing procedure proposed to be conducted. No such hydraulic fracturing procedure shall commence prior to the approval of such permit application. Operator shall provide the Mississippi State Oil and Gas Board Field Inspector with not less than forty-eight (48) hours notice in advance of the commencement of any Hydraulic Fracturing Treatment.
4. Operators applying for a permit to commence Hydraulic Fracturing Treatment of any oil or gas well shall state clearly such intent on the **FORM 2** submitted to the Mississippi State Oil and Gas Board in accordance with Paragraph 5 below.
5. The permit application described in the preceding paragraphs shall, at a minimum, include:
 - (A.) The following information on the existing or proposed casing program, demonstrating that the well will have steel alloy casing designed to withstand the anticipated maximum injection pressures to which the casing will be subjected in the well:
 - (1) Whether the well is or will be a vertical well, a directional well or a horizontal well; and
 - (2) The estimated true vertical and measured production casing setting depths in the well; and
 - (3) The casing grade and minimum internal yield pressure for the existing or proposed production casing used in the well; and
 - (4) The surface casing shall be set at least 100.0 feet below the Base Underground Source of Drinking Water (“**BUSDW**”) and cemented to the surface or the intermediate or production string casing shall have cement to the surface starting 100.0 feet below the **BUSDW** or the operator shall use tubing and packer to perform the Hydraulic Fracturing Treatment.
 - (B.) The following information demonstrating that the well has or will

have sufficient cement volume and integrity to prevent the movement of Base Fluids and Additives up-hole into the various casing or well bore annuli:

- (1) The existing or proposed cement minimum compressive strength; and
 - (2) The known or estimated top of cement for the production casing string.
- (C.) The anticipated surface treating pressure range for the proposed Hydraulic Fracturing Treatment. The production casing described in subparagraph 5.(A.) above shall be sufficient to contain the maximum anticipated treating pressure of the proposed Hydraulic Fracturing Treatment which shall not exceed the API minimum internal yield pressure for such production casing.
6. Within thirty (30) days following the completion of the Hydraulic Fracturing Treatment, the operator shall, for the purpose of disclosure, report the following information to the Supervisor regarding such procedure utilizing a duly executed **FORM 3 ("Completion Report")**:
- (A.) The maximum pump pressure measured at the surface during each stage of the Hydraulic Fracturing Treatment unless reasonable grounds for confidentiality exist in which event a request for confidentiality may be submitted to the Supervisor who shall be authorized to waive the disclosure of such data for a period of six (6) months and for an additional six (6) months upon written request to the Supervisor at the Supervisor's sole discretion; and
 - (B.) The types and volumes of the Base Fluids and Additives used for each stage of the Hydraulic Fracturing Treatment expressed in gallons or pounds; and
 - (C.) The calculated fracture height as designed to be achieved during the Hydraulic Fracturing Treatment and the estimated TVD to the top of the fracture; and
 - (D.) A list of all Additives used during the Hydraulic Fracturing Treatment specified by general type, such as acids, biocides, breakers, corrosion inhibitors, cross-linkers, demulsifiers, friction reducers, gels, iron controls, oxygen scavengers, pH adjusting agents, scale inhibitors, proppants and surfactants; and

- (E.) For each additive type listed under subparagraph 6.(D.) above, the specific trade name and suppliers of all the Additives utilized during the Hydraulic Fracturing Treatment; and
 - (F.) If the operator causes any Additives to be used during the Hydraulic Fracturing Treatment not otherwise disclosed by the person performing such treatment, the operator shall disclose a list of all Chemical Constituents and associated CAS numbers contained in such Additives that are subject to the requirements of 29 CFR 1910.1200(g)(2); and
 - (G.) A list of Chemical Constituents intentionally added to the Base Fluids which are subject to the requirements of 29 CFR Section 1910.1200(g)(2) and their associated CAS numbers; and
 - (H.) The maximum ingredient concentrations within the Additive expressed as a percent by mass for each chemical ingredient listed under subparagraph 6.(G.) above; and
 - (I.) The maximum concentration of each chemical ingredient listed under subparagraph 6.(G.) above expressed as a percent by mass of the total volume of Hydraulic Fracturing Fluids utilized.
7. Notwithstanding subparagraph 6.(G.) above, if the specific identity of a Chemical Constituent and the Chemical Constituent's associated CAS number are claimed to be a trade secret, or have been finally determined to be entitled to protection as a trade secret under 29 CFR Section 1910.1200(i), the entity entitled to make such a claim may withhold the specific identity of the Chemical Constituent and the Chemical Constituent's associated CAS number from the list required to be reported by subparagraph 6.(G.) above. If the entity entitled to make such a claim elects to withhold the information, the report must:
- (A.) Disclose the Chemical Family associated with the ingredient; and
 - (B.) Include a statement that a claim of trade secret protection has been made by the entity entitled to make such a claim.
8. An operator will not be responsible for reporting information that is not provided to them due to a claim of trade secret protection by the entity entitled to make such a claim.
9. Nothing contained in Paragraph 7 above shall authorize any person to withhold information which is required by state or federal law to be provided to a health

care professional, a doctor or a nurse for the purpose of diagnosis or treatment of a medical condition and it is further stated that any health care professional, a doctor or a nurse receiving such information is required to maintain it as confidential.

10. In lieu of submitting to the Supervisor on the FORM 3 (Completion Report) the information regarding the Hydraulic Fracturing Treatment prescribed in Paragraph 6 of this Rule, the operator of an oil and gas well may furnish to the Supervisor a FORM 3 containing a statement signifying that the required information has been submitted to the Ground Water Protection Council Hydraulic Fracturing Chemical Registry (<http://fracfocus.org>) or any other similar registry, in accordance with their requirements. In any event, the operator shall submit to the Supervisor on a FORM 3 a list of the chemicals used in the Hydraulic Fracturing Treatment.

Authority: MCA Section 53-1-17(3) (1972)

Approved: January 16, 2013

Effective Date: March 4, 2013

CHECK LIST OF RULE 26 DATA REQUIREMENTS FOR FORM 3 SUBMITTAL
FOR HYDRAULIC FRACTURING

26.10

Submitted to FracFocus: Yes No

If Yes, then

- In lieu of submitting to the Supervisor on the FORM 3 (Completion Report) the information regarding the Hydraulic Fracturing Treatment prescribed in Paragraph 6 of this Rule, the operator of an oil and gas well may furnish to the Supervisor a FORM 3 containing a statement signifying that the required information has been submitted to the Ground Water Protection Council Hydraulic Fracturing Chemical Registry (<http://fracfocus.org>) or any other similar registry, in accordance with their requirements. In any event, the operator shall submit to the Supervisor on a FORM 3 a list of the chemicals used in the Hydraulic Fracturing Treatment.

If NO, please provide the following information with the Form 3 Submittal:

26.6.

- Submitted within thirty (30) days following the completion of the Hydraulic Fracturing Treatment.
 - (A) The maximum pump pressure measured at the surface during each stage of the Hydraulic Fracturing Treatment.
 - (B) The types and volumes of the Base Fluids and Additives used for each stage of the Hydraulic Fracturing Treatment expressed in gallons or pounds.
 - (C) The calculated fracture height as designed to be achieved during the Hydraulic Fracturing Treatment and the estimated TVD to the top of the fracture.

- (D) A list of all Additives used during the Hydraulic Fracturing Treatment specified by general type, such as acids, biocides, breakers, corrosion inhibitors, cross-linkers, demulsifiers, friction reducers, gels, iron controls, oxygen scavengers, pH adjusting agents, scale inhibitors, proppants and surfactants.
- (E) For each additive type listed under subparagraph 6.(D.) above, the specific trade name and suppliers of all the Additives utilized during the Hydraulic Fracturing Treatment.
- (F) If the operator causes any Additives to be used during the Hydraulic Fracturing Treatment not otherwise disclosed by the person performing such treatment, the operator shall disclose a list of all Chemical Constituents and associated CAS numbers contained in such Additives that are subject to the requirements of 29 CFR 1910.1200(g)(2).
- (G) A list of Chemical Constituents intentionally added to the Base Fluids which are subject to the requirements of 29 CFR Section 1910.1200(g)(2) and their associated CAS numbers.
-
- (H) The maximum ingredient concentrations within the Additive expressed as a percent by mass for each chemical ingredient listed under subparagraph 6.(G.) above.
- (I) The maximum concentration of each chemical ingredient listed under subparagraph 6.(G.) above expressed as a percent by mass of the total volume of Hydraulic Fracturing Fluids utilized.

26.7.

Trade Secret: Yes No

If Yes, then

- (A.) Disclose the Chemical Family associated with the ingredient; and
- (B.) Include a statement that a claim of trade secret protection has been made by the entity entitled to make such a claim.

State Oil and Gas Board



State Of Mississippi

500 Greymont Avenue, Suite E
Jackson, MS 39202
Telephone (601) 576-4900

LISA IVSHIN
Executive Director

HOWARD O. LEACH
Board Attorney

Board Members
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LEW YODER, Laurel

Date: August 29, 2013
From: State Oil and Gas Supervisor
To: To All Mississippi "Operators"
Subject: Reporting of H₂S and CO₂

By order of the Mississippi State Oil and Gas Board, the operators of all oil and gas wells and Class II fluids injection and disposal wells in the State of Mississippi are directed, effective immediately, to report to this agency on a FORM 3 ["Completion Report"] any and all amounts of either hydrogen sulfide (H₂S) or carbon dioxide (CO₂) contained in any gas stream (whether being produced or injected).

This reporting requirement applies to both producing oil and/or gas wells and Class II fluids injection and disposal wells permitted by this agency.

The amount of H₂S or CO₂ contained in a well's gas stream shall be reported to the Mississippi State Oil and Gas Board on a FORM 3 utilizing the space designated in the lower right hand corner of the form.

The amount of H₂S or CO₂ being reported may be reflected by the operator either as a percentage of the total gas stream or as parts per million (ppm).

If no H₂S or CO₂ is contained in the gas stream, that fact should be clearly indicated by inserting either the word "Zero" or "None" in the designated space. Under no circumstance should this space on the FORM 3 be left blank.

Any FORM 3 submitted in the future to the Mississippi State Oil and Gas Board without this information being clearly indicated will be deemed incomplete and the FORM 3 will be returned to the operator.

Any questions regarding this matter should be directed to Allen Floyd at 601-576-4925.

MISSISSIPPI STATE OIL AND GAS BOARD

By: Lisa
Lisa A. Ivshin
State Oil and Gas Supervisor



Mississippi State
MSOGB
Oil & Gas Board



RULE 11, SURFACE CASING IN NEW WELLS

Effective 11/5/1012, all new wells drilled are required under Rule 11 to have the surface casing or the first intermediate casing string cemented to surface.

CEMENTING:

By itself, circulating cement to the surface is not adequate unless the cement remains at the surface. If cement is circulated to the surface and settling occurs, the casing must be topped off with cement.

If cement cannot be circulated to surface without cement settling the operator shall discuss with the Oil & Gas Board staff as to the method(s) they will use to get cement to the top of casing.

If a two stage cement program is necessary, cement returns from the first stage shall be circulated to the surface through DV tool to insure cement is in place from casing shoe to DV tool.

State Oil and Gas Board



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LISA IVSHIN
Executive Director

HOWARD O. LEACH
Board Attorney

May 3, 2017

- (X) Permit to drill and approved Form 2 enclosed.
- (X) Minimum surface casing requirements 580 feet.
For all new drill wells, surface casing must be cemented to surface as stated in Statewide Rule 11.

In the appropriate casing row on the Form 3 Completion Report, the sacks of cement shall be stated with an affirmative statement that cement is to the surface either for the surface casing or first intermediate string of casing

- (X) Permit issued pursuant to Docket No. N/A
Order No. N/A.
- (X) Land disposal form attached.
- (X) Form 21, NORM Survey attached.
- (X) Fracking requirements. A Form 2 must be submitted in accordance with Statewide Rules in order to conduct a fracture stimulation on this well.

Lisa A. Ivshin

STATE OIL AND GAS SUPERVISOR

**MISSISSIPPI STATE OIL AND GAS BOARD
APPLICATION FOR PERMIT TO DRILL, WORKOVER OR CHANGE OPERATOR**

APPLICATION TO DRILL

FORM No. 2
WORKOVER

CHANGE OF OPERATOR

213936

| | | | | | |
|--|--|---|---------------------------|---|---------------------------|
| NAME OF COMPANY OR OPERATOR Mississippi Power | | | DATE 4/17/2017 | | |
| ADDRESS 2992 W Beach Blvd | | CITY Gulfport | STATE MS | ZIP 39501 | TELEPHONE 228.897.6438 |
| NAME OF WELL MPC 34-1 | | WELL NO. #1 | ELEVATION (GROUND) 460 | | |
| WELL LOCATION (WHEN POSSIBLE, GIVE FOOTAGE FROM SECTION LINES) 104' FNL, 104' FEL | | SECTION - TOWNSHIP - RANGE 34-9S-14E | | CHECK TYPE OF PROPOSED WELL <input type="checkbox"/> OIL <input type="checkbox"/> GAS <input checked="" type="checkbox"/> OTHER (NAME) Stratigraphy | |
| FIELD & RESERVOIR (IF WILDCAT, SO STATE) Wildcat /TD Reservoir, Paleozoic | | API No. (EXISTING WELL) | | APPROX. DATE WORK BEGINS 6.1.2017 | |
| SECTION 34 TOWNSHIP 9N RANGE 15E | | LATITUDE - LONGITUDE (NEW WELLS) (dd.ddddd) 30.59175000 -88.74305556 | | | |

| | | | | |
|--|---|--|---|--|
| PROPOSED DEPTH 7,000 <small>FEET</small> | PROPOSED LENGTH OF SURFACE CASING 2,500 <small>FEET</small> | NUMBER OF ACRES IN RILLING UNIT N/A <small>ACRES</small> | DISTANCE FROM PROPOSED LOCATION N/A <small>FEET</small> | DISTANCE FROM PROPOSED LOCATION TO NEAREST DRILLING, COMPLETED OR APPLIED FOR WELL 6,475 <small>FEET</small> |
|--|---|--|---|--|

NAME OF DRILLING CONTRACTOR
H.A.D. Inc.

ADDRESS
9797 Benner Road

CITY
Rittman

STATE
Ohio

ZIP
44270

FOR CHANGE OF OPERATOR ONLY - SIGNATURE OF FORMER OPERATOR REQUIRED FOR TRANSFER OF WELL

| | |
|-------------------------------------|-------------------------|
| AUTHORIZED REPRESENTATIVE SIGNATURE | NAME OF FORMER OPERATOR |
|-------------------------------------|-------------------------|

NOTE: AREA FIELD INSPECTOR OR FIELD DIRECTOR (JACKSON OFFICE) OF DATES OF SPUDDING AND REACHING TOTAL DEPTH.
Mississippi State Oil and Gas Board, 500 Greymont Avenue, Suite E, Jackson, MS 39202 601-576-4900

REMARKS: (IF THIS IS AN APPLICATION TO WORKOVER, BRIEFLY DESCRIBE WORK TO BE DONE, GIVING PRESENT PRODUCING ZONE AND EXPECTED NEW PRODUCING ZONE)
* nearest well is API 230690001000; WT Caldwell; Kemper County

**NOTICE: PRIOR TO BEGINNING WORK NOTIFY OIL & GAS BD REPRESENTATIVE - RONALD WESSON
MOBILE - 662-871-4227**

| | | | | | |
|--|-----|----------------|---|-----|----|
| ARE THERE SEPARATELY OWNED TRACTS OR INTERESTS IN THE DRILLING UNIT FOR WHICH THIS PERMIT IS SOUGHT? (REF. MS. STATUTE 53-3-7) | YES | NO X | IF YES, HAVE THE PERSONS OWNING THE DRILLING RIGHTS IN SAID TRACTS OR INTERESTS AND THE RIGHTS TO SHARE IN THE PRODUCTION THEREFROM AGREED TO DEVELOP THEIR LANDS AS A DRILLING UNIT AND TO THE DRILLING OF THE WELL? (REF. MS. STATUTE 53-3-7) | YES | NO |
|--|-----|----------------|---|-----|----|

EXECUTED THIS THE 28 DAY OF April, 2017

STATE OF Mississippi

COUNTY OF Harrison

SIGNATURE OF AFFIANT [Signature]

BEFORE ME, THE UNDERSIGNED AUTHORITY, ON THIS DAY PERSONALLY APPEARED Charles E. Berry KNOWN TO ME TO BE THE PERSON WHOSE NAME IS SUBSCRIBED TO THE ABOVE INSTRUMENT, WHO BEING BY ME DULY SWORN ON OATH, STATES THAT HE IS DULY AUTHORIZED TO MAKE THE ABOVE REPORT AND THAT HE HAS KNOWLEDGE OF THE FACTS STATED THEREIN, AND THAT SAID REPORT IS TRUE AND CORRECT.

SUBSCRIBED AND SWORN TO BEFORE ME THIS 28 DAY OF April, 2017

SEAL: [Signature]
Signature

NOTARY PUBLIC IN AND FOR Mississippi
COUNTY Harrison

MY COMMISSION EXPIRES November 5, 2017

PERMIT NUMBER 2017-OPD-0110

APPROVAL DATE 5/2/2017

APPROVED BY RNT

MISSISSIPPI STATE OIL AND GAS BOARD
FORM 2 (Rev. 5/10)
A. P. I. WELL NUMBER
STATE 23-069-20014 COUNTY _____ WELL _____

RECEIVED
MAY 01 2017

STATE OIL & GAS BOARD

NOTICE: BEFORE SENDING THIS FORM, BE SURE THAT ALL INFORMATION REQUESTED IS GIVEN. SEE INSTRUCTIONS ON REVERSE SIDE OF FORM.

RULE 11. SURFACE CASING. The minimum amount of surface or first-intermediate casing to be set shall be determined from the following table:

| Proposed Total Depth-Feet | Minimum Casing Requirements-Feet |
|--------------------------------------|--|
| 0-2500 | 200' |
| 2500-6000 | 200' + 8% of proposed depth in excess of 2500' |
| 6000-7000 | 480' + 10% of proposed depth in excess of 6000' |
| 7000-8000 | 580' + 15% of proposed depth in excess of 7000' |
| 8000-9000 | 730' + 20% of proposed depth in excess of 8000' |
| 9000-Deeper | 930' + 25% of proposed depth in excess of 9000' |

Casing shall be cemented to the surface.

Casing shall be tested at a pressure equivalent to one pound (1 lb.) per sq. inch per foot of casing set with a maximum test pressure of 1,000 lbs. per sq. inch.

Cement or cement-admix shall be allowed to stand a minimum of twelve (12) hours under pressure before initiating test or drilling plug. "Under pressure" is complied with if one (1) float valve is used, or if pressure is held otherwise.

The proposed surface casing program for any well is to be presented with the filing of Form No. 2, "Application to Drill."

Prior to the spudding of any well, exceptions may be granted to the above minimum casing requirements upon submission of proper evidence and subject to the joint approval of the Supervisor and Chief Engineer of the Board. In event this approval for an exception to the minimum casing requirements is denied, the operator may seek further relief before the Board after notice and hearing.

In case an operator decides to drill deeper after drilling to his initial proposed total depth, he may secure relief to the above minimum casing requirements just as though his original intent was to drill the well as an exception to the minimum casing requirements, provided, however, that such exception is approved by the Supervisor and Chief Engineer.

Source: MCA Section 53-1-17(3) (1972)

Approved 9-19-2012

Effective Date 11-5-2012

State Oil and Gas Board



Board Members

DAVID A. SCOTT, Jackson
Chairman

JAMES H. HEIDELBERG, Pascagoula
Vice-Chairman

OWEN B. EMERSON, Hernando
CARROLL V. HOOD, Hazlehurst
LEW YODER, Laurel

State Of Mississippi

500 Greymont Avenue, Suite E
Jackson, MS 39202
Telephone (601) 576-4900

LISA IVSHIN
Executive Director

HOWARD O. LEACH
Board Attorney

OPERATOR'S RESPONSIBILITY FOR LAND DISPOSAL (LANDFARMING) OF APPROVED EXPLORATION AND PRODUCTION WASTE FROM A RESERVE PIT

To be completed by person responsible for pit closure. Each required document shall reference the well name, operator, and location. Note: An employee of the MSOGB cannot sign as a witness to any required document. **This form and required attachments should be given to the field inspector prior to land farming. (Copy of finalized form will be mailed to operator after receipt in Jackson office)**

I. Field: _____ Operator: _____

Well Name & Number: _____

A.P.I. Number: 23-_____

Location: Section _____ Township _____ Range _____ County _____

II. Location of disposal site: _____

Landowner: _____

III. Requirements for approval by MSOGB, before landfarming begins:

- | | | |
|--|------------------------------|-----------------------------|
| A. Site acceptable | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| B. Land owner's approval granted** | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| C. Pit analysis acceptable** | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| D. Were hazardous materials in the waste? ** | <input type="checkbox"/> Yes | <input type="checkbox"/> No |

Rec'd? (✓)

**REQUIRED ATTACHMENTS

_____ LAND OWNER'S WITNESSED OR NOTARIZED SIGNED APPROVAL

_____ COPY OF THE PIT ANALYSIS

_____ NOTARIZED SIGN-OFF BY THE DRILLING CONTRACTOR THAT
NO HAZARDOUS MATERIALS WERE INTRODUCED TO THE WASTE.

E. Conditions for land spreading by MSOGB: _____

F. Approved by _____ (Field Inspector) DATE _____

IV. Final inspection and approval by MSOGB after landfarming is completed.

FIELD INSPECTOR _____ DATE _____

State Oil and Gas Board



Board Members

DAVID A. SCOTT, Jackson
Chairman

JAMES H. HEIDELBERG, Pascagoula
Vice-Chairman

OWEN B. EMERSON, Hernando

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500 Greymont Avenue, Suite E
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LISA IVSHIN
Executive Director

HOWARD O. LEACH
Board Attorney

SPECIAL NOTICES FOR DRILLING PERMITS

1. Drilling sites permitted after June 1, 1996, must have a NORM Survey performed in accordance with Statewide Rule No. 69, prior to the start of production operations. This survey shall be documented on Board Form No. 21 (enclosed).
2. A person issued a permit after July 1, 1998, to drill a new well is required prior to beginning operations to provide certified mailed notice to the taxpayer shown on the most recent county ad valorem tax receipt available in the office of the tax collector of the county in which the well site is located. The notice shall include a copy of the unit plat showing the proposed well location.
3. At least one electric log shall be run in each well and shall be filed with the Board within thirty (30) days of completion of the well or within 60 days after log is run, whichever is the earlier date. This will include an electrical correlation log consisting of the spontaneous potential or gamma ray and induction resistivity surveys, or equivalent, and covering that portion of the wellbore from total depth to the base of the surface casing, specifically displayed on a one inch: one hundred foot scale, a two inch: one hundred foot scale and a five inch: one hundred foot scale. **One copy of all additional open hole electrical, mechanical and radioactive logs run in the well shall be filed with the Board within said filing period**, provided, however, that logs obtained on stratigraphic tests shall be filed with the Board within six (6) months. This shall not include any interpretative, computer-analyzed or computer-interpreted logs run in the well. It shall, however, include the raw data curves from a dipmeter if run in the well. The Supervisor of the Board may, for good cause and at the discretion of the Supervisor, waive the requirement that one electric log be run from total depth to the base of the surface casing.

Mississippi Oil & Gas Board RADIATION SURVEY for Oil Field NORM

SURVEY

Purpose: Periodic Survey (Initial, Continuing Operations, Property/Equipment Transfer)
 (Check One) Maintenance/Special Activities (Description _____)
 Unrestricted Release (Description _____)

Surveyed by _____ Company _____
 Survey Date _____ Telephone (____) _____ Address _____

SITE

Well Name & No. _____ Sec. _____ Twn. _____ Range _____
 API Well No. _____ Field _____ County _____
 Operator _____ Phone (____) _____
 Address _____

SURVEY INSTRUMENT(S)

Φ R Instrument Make/Model _____ Serial No. _____
 Calibrated within past year? YES NO Battery/Instrument check OK? YES NO
 Pancake GM Make/Model _____ Serial No. _____ Calibrated within
 past year? YES NO Battery/Instrument check OK? YES NO

EQUIPMENT MEASUREMENT SUMMARY

| | |
|----------------|------------------------------------|
| Location _____ | Maximum _____ Φ R/h _____ c/m |
| Location _____ | Maximum _____ Φ R/h _____ c/m |
| Location _____ | Maximum _____ Φ R/h _____ c/m |
| Location _____ | Maximum _____ Φ R/h _____ c/m |

LAND MEASUREMENT SUMMARY

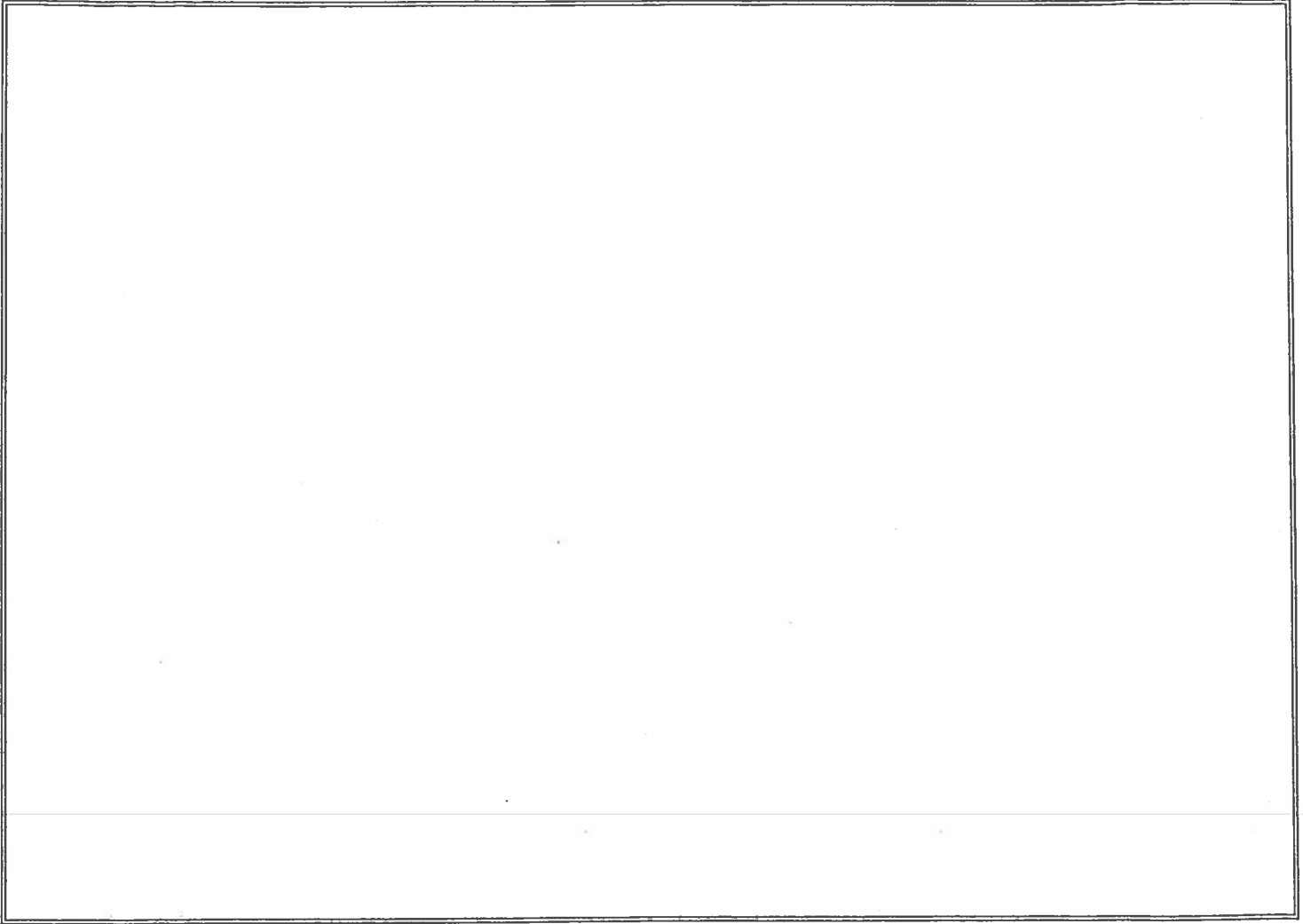
| | |
|----------------|--|
| Location _____ | Average _____ Φ R/h Max. _____ Φ R/h |
| Location _____ | Average _____ Φ R/h Max. _____ Φ R/h |
| Location _____ | Average _____ Φ R/h Max. _____ Φ R/h |
| Location _____ | Average _____ Φ R/h Max. _____ Φ R/h |

MISSISSIPPI STATE OIL AND GAS BOARD
 RADIATION SURVEY
 for Oil Field NORM
 OGB Form 21

Authorized by Order No. 73-96 Effective June 1, 1996

Diagram of Site/Equipment Measurements:

- 3 Show individual measurements and locations.
- 3 Attach additional pages as needed.



1. Periodic radiation surveys of oilfield site and equipment NORM shall be documented on Mississippi State Oil and Gas Board (OGB) Form 21. OGB Form 21 is to be submitted to the UIC/Technical Group, 500 Greymont Avenue, Suite E, Jackson, Mississippi 39202 for review. Call (601) 354-7127 if you have any questions about completion of OGB Form 21.
2. This radiation survey shall be completed according to the practices recommended in Rule 69 of the Mississippi Oil and Gas Board, "Control of Oilfield NORM," and signed below by the person performing the survey, whose name is listed on the reverse side.
3. This survey form will be returned if not properly completed and signed.

STATE OF MISSISSIPPI

I have personally performed the radiation survey as described on this OGB Form 21 and hereby certify that it is true, correct, and representative of the site and/or equipment as intended by Rule 69 of the Mississippi State Oil and Gas Board.

(Signature)

(Date)

Rule 1.26 - Requirements for Hydraulic Fracture Stimulation –Report of Shooting or Treating

1. Definitions

For the purposes of this Rule, the following definitions shall apply:

- a. "Board" means the Mississippi State Oil and Gas Board.
- b. "Additive" means any substance or combination of substances, including proppants, having a specified purpose which is intentionally combined with the Base Fluid as hereinafter defined.
- c. "Base Fluid" means the continuous phase fluid, such as water, which is used in a particular Hydraulic Fracturing Treatment.
- d. "Chemical Abstract Service" or "CAS" means the chemical registry which is the authoritative collection of disclosed chemical substance information.
- e. "Chemical Constituent" means a discrete chemical with its own specific name or identity (such as, but not necessarily, a CAS number) which is contained in an Additive.
- f. "Chemical Family" means a group of elements in the Periodic Table or, more commonly, compounds which share certain physical and chemical characteristics and which have a common name.
- g. "Hydraulic Fracturing Fluid" means the Base Fluid and Additives utilized in a particular Hydraulic Fracturing Treatment.
- h. "Hydraulic Fracturing Treatment" means stimulating a well by the application of Hydraulic Fracturing Fluids with force in order to create artificial fractures in the formation for the purpose of improving the capacity of the well to produce hydrocarbons.
- i. "Supervisor" means the State Oil and Gas Supervisor of the Mississippi State Oil and Gas Board.

2. The provisions of this Rule shall apply to oil and gas wells which are proposed to undergo a temporary or intermittent hydraulic fracturing procedure to improve the productive capacity of such oil and gas wells utilizing Hydraulic Fracturing Treatment as hereinabove defined.

3. Before an operator shall commence the hydraulic fracturing of any oil and gas well, including the application of Hydraulic Fracturing Treatment as hereinabove defined, such operator shall file with the Mississippi State Oil and Gas Board a duly executed FORM 2 indicating in the narrative portion of such FORM 2 the nature of the hydraulic fracturing procedure proposed to be conducted. No such hydraulic fracturing procedure shall commence prior to the approval of such permit application. Operator shall provide the Mississippi State Oil and Gas Board Field Inspector with not less than forty-eight (48) hours notice in advance of the commencement of any Hydraulic Fracturing Treatment.
4. Operators applying for a permit to commence Hydraulic Fracturing Treatment of any oil or gas well shall state clearly such intent on the FORM 2 submitted to the Mississippi State Oil and Gas Board in accordance with Paragraph 5 below.
5. The permit application described in the preceding paragraphs shall, at a minimum, include:
 - (A.) The following information on the existing or proposed casing program, demonstrating that the well will have steel alloy casing designed to withstand the anticipated maximum injection pressures to which the casing will be subjected in the well:
 - (1) Whether the well is or will be a vertical well, a directional well or a horizontal well; and
 - (2) The estimated true vertical and measured production casing setting depths in the well; and
 - (3) The casing grade and minimum internal yield pressure for the existing or proposed production casing used in the well; and
 - (4) The surface casing shall be set at least 100.0 feet below the Base Underground Source of Drinking Water ("BUSDW") and cemented to the surface or the intermediate or production string casing shall have cement to the surface starting 100.0 feet below the BUSDW or the operator shall use tubing and packer to perform the Hydraulic Fracturing Treatment.
 - (B.) The following information demonstrating that the well has or will

have sufficient cement volume and integrity to prevent the movement of Base Fluids and Additives up-hole into the various casing or well bore annuli:

- (1) The existing or proposed cement minimum compressive strength; and
 - (2) The known or estimated top of cement for the production casing string.
- (C.) The anticipated surface treating pressure range for the proposed Hydraulic Fracturing Treatment. The production casing described in subparagraph 5.(A.) above shall be sufficient to contain the maximum anticipated treating pressure of the proposed Hydraulic Fracturing Treatment which shall not exceed the API minimum internal yield pressure for such production casing.
6. Within thirty (30) days following the completion of the Hydraulic Fracturing Treatment, the operator shall, for the purpose of disclosure, report the following information to the Supervisor regarding such procedure utilizing a duly executed **FORM 3 ("Completion Report")**:
- (A.) The maximum pump pressure measured at the surface during each stage of the Hydraulic Fracturing Treatment unless reasonable grounds for confidentiality exist in which event a request for confidentiality may be submitted to the Supervisor who shall be authorized to waive the disclosure of such data for a period of six (6) months and for an additional six (6) months upon written request to the Supervisor at the Supervisor's sole discretion; and
 - (B.) The types and volumes of the Base Fluids and Additives used for each stage of the Hydraulic Fracturing Treatment expressed in gallons or pounds; and
 - (C.) The calculated fracture height as designed to be achieved during the Hydraulic Fracturing Treatment and the estimated TVD to the top of the fracture; and
 - (D.) A list of all Additives used during the Hydraulic Fracturing Treatment specified by general type, such as acids, biocides, breakers, corrosion inhibitors, cross-linkers, demulsifiers, friction reducers, gels, iron controls, oxygen scavengers, pH adjusting agents, scale inhibitors, proppants and surfactants; and

- (E.) For each additive type listed under subparagraph 6.(D.) above, the specific trade name and suppliers of all the Additives utilized during the Hydraulic Fracturing Treatment; and
 - (F.) If the operator causes any Additives to be used during the Hydraulic Fracturing Treatment not otherwise disclosed by the person performing such treatment, the operator shall disclose a list of all Chemical Constituents and associated CAS numbers contained in such Additives that are subject to the requirements of 29 CFR 1910.1200(g)(2); and
 - (G.) A list of Chemical Constituents intentionally added to the Base Fluids which are subject to the requirements of 29 CFR Section 1910.1200(g)(2) and their associated CAS numbers; and
 - (H.) The maximum ingredient concentrations within the Additive expressed as a percent by mass for each chemical ingredient listed under subparagraph 6.(G.) above; and
 - (I.) The maximum concentration of each chemical ingredient listed under subparagraph 6.(G.) above expressed as a percent by mass of the total volume of Hydraulic Fracturing Fluids utilized.
7. Notwithstanding subparagraph 6.(G.) above, if the specific identity of a Chemical Constituent and the Chemical Constituent's associated CAS number are claimed to be a trade secret, or have been finally determined to be entitled to protection as a trade secret under 29 CFR Section 1910.1200(i), the entity entitled to make such a claim may withhold the specific identity of the Chemical Constituent and the Chemical Constituent's associated CAS number from the list required to be reported by subparagraph 6.(G.) above. If the entity entitled to make such a claim elects to withhold the information, the report must:
- (A.) Disclose the Chemical Family associated with the ingredient; and
 - (B.) Include a statement that a claim of trade secret protection has been made by the entity entitled to make such a claim.
8. An operator will not be responsible for reporting information that is not provided to them due to a claim of trade secret protection by the entity entitled to make such a claim.
9. Nothing contained in Paragraph 7 above shall authorize any person to withhold information which is required by state or federal law to be provided to a health

care professional, a doctor or a nurse for the purpose of diagnosis or treatment of a medical condition and it is further stated that any health care professional, a doctor or a nurse receiving such information is required to maintain it as confidential.

10. In lieu of submitting to the Supervisor on the FORM 3 (Completion Report) the information regarding the Hydraulic Fracturing Treatment prescribed in Paragraph 6 of this Rule, the operator of an oil and gas well may furnish to the Supervisor a FORM 3 containing a statement signifying that the required information has been submitted to the Ground Water Protection Council Hydraulic Fracturing Chemical Registry (<http://fracfocus.org>) or any other similar registry, in accordance with their requirements. In any event, the operator shall submit to the Supervisor on a FORM 3 a list of the chemicals used in the Hydraulic Fracturing Treatment.

Authority: MCA Section 53-1-17(3) (1972)

Approved: January 16, 2013

Effective Date: March 4, 2013

CHECK LIST OF RULE 26 DATA REQUIREMENTS FOR FORM 3 SUBMITTAL
FOR HYDRAULIC FRACTURING

26.10

Submitted to FracFocus: Yes No

If Yes, then

- In lieu of submitting to the Supervisor on the FORM 3 (Completion Report) the information regarding the Hydraulic Fracturing Treatment prescribed in Paragraph 6 of this Rule, the operator of an oil and gas well may furnish to the Supervisor a FORM 3 containing a statement signifying that the required information has been submitted to the Ground Water Protection Council Hydraulic Fracturing Chemical Registry (<http://fracfocus.org>) or any other similar registry, in accordance with their requirements. In any event, the operator shall submit to the Supervisor on a FORM 3 a list of the chemicals used in the Hydraulic Fracturing Treatment.

If NO, please provide the following information with the Form 3 Submittal:

26.6.

- Submitted within thirty (30) days following the completion of the Hydraulic Fracturing Treatment.
- (A) The maximum pump pressure measured at the surface during each stage of the Hydraulic Fracturing Treatment.
- (B) The types and volumes of the Base Fluids and Additives used for each stage of the Hydraulic Fracturing Treatment expressed in gallons or pounds.
- (C) The calculated fracture height as designed to be achieved during the Hydraulic Fracturing Treatment and the estimated TVD to the top of the fracture.

- (D) A list of all Additives used during the Hydraulic Fracturing Treatment specified by general type, such as acids, biocides, breakers, corrosion inhibitors, cross-linkers, demulsifiers, friction reducers, gels, iron controls, oxygen scavengers, pH adjusting agents, scale inhibitors, proppants and surfactants.
- (E) For each additive type listed under subparagraph 6.(D.) above, the specific trade name and suppliers of all the Additives utilized during the Hydraulic Fracturing Treatment.
- (F) If the operator causes any Additives to be used during the Hydraulic Fracturing Treatment not otherwise disclosed by the person performing such treatment, the operator shall disclose a list of all Chemical Constituents and associated CAS numbers contained in such Additives that are subject to the requirements of 29 CFR 1910.1200(g)(2).
- (G) A list of Chemical Constituents intentionally added to the Base Fluids which are subject to the requirements of 29 CFR Section 1910.1200(g)(2) and their associated CAS numbers.
-
- (H) The maximum ingredient concentrations within the Additive expressed as a percent by mass for each chemical ingredient listed under subparagraph 6.(G.) above.
- (I) The maximum concentration of each chemical ingredient listed under subparagraph 6.(G.) above expressed as a percent by mass of the total volume of Hydraulic Fracturing Fluids utilized.

26.7.

Trade Secret: Yes No

If Yes, then

- (A.) Disclose the Chemical Family associated with the ingredient; and
- (B.) Include a statement that a claim of trade secret protection has been made by the entity entitled to make such a claim.

State Oil and Gas Board



State Of Mississippi

500 Greymont Avenue, Suite E
Jackson, MS 39202
Telephone (601) 576-4900

LISA IVSHIN
Executive Director

HOWARD O. LEACH
Board Attorney

Board Members
DAVID A. SCOTT, Jackson
Chairman
JAMES H. HEIDELBERG, Pascagoula
Vice-Chairman
OWEN B. EMERSON, Hernando
CARROLL V. HOOD, Hazlehurst
LEW YODER, Laurel

Date: August 29, 2013
From: State Oil and Gas Supervisor
To: To All Mississippi "Operators"
Subject: Reporting of H₂S and CO₂

By order of the Mississippi State Oil and Gas Board, the operators of all oil and gas wells and Class II fluids injection and disposal wells in the State of Mississippi are directed, effective immediately, to report to this agency on a FORM 3 ["Completion Report"] any and all amounts of either hydrogen sulfide (H₂S) or carbon dioxide (CO₂) contained in any gas stream (whether being produced or injected).

This reporting requirement applies to both producing oil and/or gas wells and Class II fluids injection and disposal wells permitted by this agency.

The amount of H₂S or CO₂ contained in a well's gas stream shall be reported to the Mississippi State Oil and Gas Board on a FORM 3 utilizing the space designated in the lower right hand corner of the form.

The amount of H₂S or CO₂ being reported may be reflected by the operator either as a percentage of the total gas stream or as parts per million (ppm).

If no H₂S or CO₂ is contained in the gas stream, that fact should be clearly indicated by inserting either the word "Zero" or "None" in the designated space. Under no circumstance should this space on the FORM 3 be left blank.

Any FORM 3 submitted in the future to the Mississippi State Oil and Gas Board without this information being clearly indicated will be deemed incomplete and the FORM 3 will be returned to the operator.

Any questions regarding this matter should be directed to Allen Floyd at 601-576-4925.

MISSISSIPPI STATE OIL AND GAS BOARD

By:



Lisa A. Ivshin
State Oil and Gas Supervisor



Mississippi State
M SOGB
Oil & Gas Board



RULE 11, SURFACE CASING IN NEW WELLS

Effective 11/5/1012, all new wells drilled are required under Rule 11 to have the surface casing or the first intermediate casing string cemented to surface.

CEMENTING:

By itself, circulating cement to the surface is not adequate unless the cement remains at the surface. If cement is circulated to the surface and settling occurs, the casing must be topped off with cement.

If cement cannot be circulated to surface without cement settling the operator shall discuss with the Oil & Gas Board staff as to the method(s) they will use to get cement to the top of casing.

If a two stage cement program is necessary, cement returns from the first stage shall be circulated to the surface through DV tool to insure cement is in place from casing shoe to DV tool.

214342

MISSISSIPPI STATE OIL AND GAS BOARD
APPLICATION FOR PERMIT TO DRILL, WORKOVER OR CHANGE OPERATOR

APPLICATION TO DRILL WORKOVER CHANGE OF OPERATOR

NAME OF COMPANY OR OPERATOR
Mississippi Power Company

ADDRESS
2992 W Beach Blvd
Gulfport

STATE MS ZIP 39501

DATE 7/14/2017

TELEPHONE 228.897.6438

WELL NO. #1

SECTION - TOWNSHIP - RANGE 10-9N-15E

ELEVATION (GROUND) 460

WELL LOCATION (WHEN POSSIBLE, GIVE FOOTAGE FROM SECTION LINES)
562 FNL, 1289 FWL

SECTION 10 TOWNSHIP 9N RANGE 15E

FIELD & RESERVOIR (IF WILDCAT, SO STATE)
Wildcat /TD Reservoir, Paleozoic

APPROX. DATE WORK BEGINS 7.31.2017

CHECK TYPE OF PROPOSED WELL
 OIL GAS OTHER (NAME) Stratigraphy

APPROX. DATE WORK BEGINS 7.31.2017

DISTANCE FROM PROPOSED LOCATION TO NEAREST DRILLING, COMPLETED OR APPLIED FOR WELL 21,088 FEET

DISTANCE FROM PROPOSED LOCATION TO NEAREST DRILLING, COMPLETED OR APPLIED FOR WELL 21,088 FEET

NAME OF DRILLING CONTRACTOR
WT Drilling 601.442.1607

CITY Natchez STATE MS ZIP 39121

FOR CHANGE OF OPERATOR ONLY - SIGNATURE OF FORMER OPERATOR REQUIRED FOR TRANSFER OF WELL

AUTHORIZED REPRESENTATIVE SIGNATURE

NOTE: AREA FIELD INSPECTOR OR FIELD DIRECTOR (JACKSON OFFICE) OF DATES OF SPLIDDING AND REACHING TOTAL DEPTH.
Mississippi State Oil and Gas Board, 500 Greymont Avenue, Suite E, Jackson, MS 39202 601-576-4900

REMARKS: IF THIS IS AN APPLICATION TO WORKOVER, BRIEFLY DESCRIBE WORK TO BE DONE, GIVING PRESENT PRODUCING ZONE AND EXPECTED NEW PRODUCING ZONE

* nearest well is API 23-069-20014; MPC 34-1; Kemper County

ARE THERE SEPARATELY OWNED TRACTS OR INTERESTS IN THE DRILLING UNIT FOR WHICH THIS PERMIT IS SOUGHT? (REF. MS. STATUTE 53-3-7)

YES NO

X

IF YES, HAVE THE PERSONS OWNING THE DRILLING RIGHTS IN SAID TRACTS OR INTERESTS AND THE RIGHTS TO SHARE IN THE PRODUCTION THEREFROM AGREED TO DEVELOP THEIR LANDS AS A DRILLING UNIT AND TO THE DRILLING OF THE WELL? (REF. MS. STATUTE 53-3-7)

YES NO

EXECUTED THIS THE 9th DAY OF August 2017

STATE OF Mississippi

COUNTY OF Harrison

SIGNATURE OF AFFIANT Charles Barry

NOTARY PUBLIC IN AND FOR Harrison County Mississippi

BEFORE ME, THE UNDERSIGNED AUTHORITY ON THIS DAY PERSONALLY APPEARED Charles Barry KNOWN TO ME TO BE THE PERSON WHOSE NAME IS SUBSCRIBED TO THE ABOVE INSTRUMENT, WHO BEING BY ME DULY SWORN ON OATH, STATES THAT HE IS DULY AUTHORIZED TO MAKE THE ABOVE REPORT AND THAT HE HAS KNOWLEDGE OF THE FACTS STATED THEREIN, AND THAT SAID REPORT IS TRUE AND CORRECT.

SUBSCRIBED AND SWORN TO BEFORE ME THIS August 9th DAY OF August 2017

SEAL

MY COMMISSION EXPIRES 2018-09-09-0010

PERMIT NUMBER 2018-099-20015

APPROVAL DATE 8/12/2017

APPROVED BY RSW

STATE 23-069-20015

COUNTY

WELL

NOTICE: BEFORE SENDING THIS FORM, BE SURE THAT ALL INFORMATION REQUESTED IS GIVEN. SEE INSTRUCTIONS ON REVERSE SIDE OF FORM.

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AUG 10 2017

STATE OIL & GAS BOARD