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## **INTRODUCTION**

Pursuant to 40 C.F.R. § 124.19(a), the Leinberger family (Andrew H. Leinberger Family Trust and DJL Farm LLC), and the Critchelow family (William and Sharon Critchelow) (collectively referred to as “Petitioners”), both of whom own property in the vicinity of the subject project, petition for review of the conditions of the Class VI Underground Injection Control Permit for Permit No. IL-137-6A-004, (“the Permit”), which was issued to FutureGen Industrial Alliance, Inc. (“Permittee” or “ FutureGen”) on August 29, 2014, by the United States Environmental Protection Agency (“USEPA”). Because USEPA has issued four separate permits for each of four UIC wells, Petitioners have submitted a Petition for Review for each Permit proceeding.

## **ISSUES PRESENTED FOR REVIEW**

Petitioners contend that certain Permit conditions are based on clearly erroneous findings of fact and conclusions of law, or an exercise of discretion or an important policy consideration that the Environmental Appeals Board (“Board” or “EAB”) should, in its discretion, review.

Specifically, Petitioners challenge the following Permit conditions:

1. Permit Condition G (Area of Review or “AoR”): Permit Condition G is based on a FutureGen model that purports to delineate the AoR, design the site monitoring network, and provide plume dimensions (and associated risk) during the lifetime of the project. Inadequacies in the FutureGen model reveal an undersized plume and USEPA’s “independent” modeling of the FutureGen project was simply a re-run of the FutureGen model with the same deficiencies.
2. Permit Condition M (Testing and Monitoring): Permit Condition M includes a site monitoring network that is not explained or justified in the record, especially given the undersized plume radius.
3. Permit Condition G (Area of Review): Permit Condition G is based on inaccurate well identification and a failure to adequately investigate well impacts.

- A. FutureGen failed to adequately identify wells in the AoR by relying solely on state databases. USEPA concedes that State well databases are inaccurate or out of date, but states that they “believe” wells would “likely” be shallow. USEPA fails to meet the strict standard set by regulation and case law to locate and identify wells.
  - B. A well on Petitioner Critchelow’s property has already been impacted by FutureGen’s drilling. USEPA responded by stating that since that no written complaint was issued, no further investigation is warranted. The Critchelows provided a sworn affidavit and USEPA’s simple denial does not overcome that burden.
4. Permit Condition H (Financial Responsibility): The Financial Protections in the final Permit are inadequate for an untested Project. The Trust Fund alone is not sufficient financial protection, the Permit fails to provide detailed cost estimates, the Permit fails to require financial assurance to be maintained for the life of the Project, and the Trust has an improper pay-in period.

### **FACTUAL AND STATUTORY BACKGROUND**

The Permit at issue in this proceeding authorizes FutureGen to construct and operate a Class VI injection well located in the State of Illinois, Morgan County, Township 16N, Range 9W, Section 26. The well is one of four that will be used for the injection of a carbon dioxide (CO<sub>2</sub>) stream generated by an oxy-combustion power plant in Meredosia, Illinois (the “Project”). The CO<sub>2</sub> stream is characterized as a liquid, supercritical fluid or gas, which will be injected into the Mount Simon and Eau Claire Formations at depths between 3785 feet and 4432 feet below ground surface. The Permit allows FutureGen to inject millions of tons of CO<sub>2</sub> into an area where persons reside and private property is located (See FutureGen Fact Sheet, p. 1, Public Comment on First Carbon Storage Draft Permits, Administrative Record, hereafter “AR”, #16). Additionally, underground drinking water sources are located in the area (See AR #511, p. 67, Comment 3.14)

Petitioners own property located within the Area of Review of the FutureGen UIC Project. The Critchelow Family’s property is approximately four acres and is located at 1760 Bluegrass

Road in Jacksonville, Illinois (“Critchelov Property”). The Critchelov Property is located directly on the edge of the CO<sub>2</sub> plume modeled by FutureGen (See Permit map Figure 12, modified to show Critchelov and Leinberger Properties and wells, attached to the Declaration of Karl Leinberger, AR #497, Ex. 4). The members and trusts of the Leinberger family own approximately 1,285 acres within the Area of Review (“Leinberger Property”). Portions of the Leinberger Property are on the edge of the CO<sub>2</sub> plume identified by FutureGen, with the remaining parcels very close to the CO<sub>2</sub> modeled plume (See Attachment A to Leinberger Declaration, AR #497, Ex. 4).

USEPA recognized the unique risks to underground sources of drinking water (“USDWs”) associated with geologic sequestration (“GS”) in its Final rule, stating, “Large CO<sub>2</sub> injection volumes associated with GS, the buoyant and mobile nature of the injectate, the potential presence of impurities in the CO<sub>2</sub> stream, and its corrosivity in the presence of water could pose risks to USDWs...recognizing that an improperly managed GS project has the potential to endanger USDWs...the properties (of CO<sub>2</sub>), as well as the large volumes that may be injected for GS result in several unique challenges for protection of USDWs in the vicinity of GS sites from endangerment” (See 75 FR 77230, Section II.A. (3), AR# 330). Moreover, there is no question that the Permit allows activity that consists of a “demonstration” and “first-of-a-kind” project (See U.S. Department of Energy Final Environmental Impact Statement (“Final EIS”), p. S-3, AR #411). The EPA stated that “[t]hese are the first Class VI permits for carbon sequestration in the United States” (See FutureGen Fact Sheet, p. 1, Public Comment on First Carbon Storage Draft Permits, AR #16). Because of the unique risks associated with the Permit, and because the Permit

will set an important precedent, strict adherence to the applicable UIC regulations, for Class VI wells is imperative.

Despite the need for strict adherence to the regulations, USEPA's actions in issuing a final Permit are based on clearly erroneous findings of fact and conclusions of law. In its Response to Comments (AR #511), USEPA effectively ignores the technical comments raised by Petitioners' expert, Dr. Gregory Schnaar, concerning the FutureGen modeling that forms the basis for key assumptions in the Permit and deficiencies in the site monitoring network. USEPA also fails to account for wells in the Area of Review and is allowing the FutureGen Project to proceed without sufficient financial protection.<sup>1</sup> This Board should remand the Permit proceeding to require the Director of the USEPA Region V Water Division ("Director") to seek additional information regarding the Project, as necessary, in order to properly assess the Permit and to strictly comply with the UIC regulations. The USEPA's failure to comply with the regulations jeopardizes enforcement of important provisions of the Safe Drinking Water Act to which the regulations pertain.

### **THRESHOLD PROCEDURAL REQUIREMENTS**

Petitioners satisfy the threshold requirements for filing a petition for review under

40 C.F.R. §124:

1. Petitioners have standing to petition for review of the Permit decision because Petitioners participated in the public comment period on the Permit. See 40 C.F.R. § 124.19(a). A copy of Petitioner's written comments appears in the Administrative Record at AR #497 and the comments are incorporated by reference.

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<sup>1</sup> USEPA's Response to Comments (AR #511) fails to include specific references to the Administrative Record, making USEPA's responses incomplete and its references to documents unclear. In this Petition, Petitioners attempt to include the AR numbers for record documents that Petitioners believe that USEPA relied upon in its Response to Comments.

2. The issues raised by Petitioners in their petition were raised during the public comment period and therefore were preserved for review (See Petitioners' Comments, AR #497).
3. Petitioners are timely filing their Petition for Review. USEPA issued its notice of issuance of the final permit decision, by mail, on August 29, 2014. When USEPA serves the notice by mail, the 30-day deadline for filing a petition for review is extended by three days (See 40 C.F.R § 124.20(d)), resulting in an October 1, 2014 due date for petitions for review.

## **ARGUMENT**

USEPA has stated that “the purpose of the AoR and the corrective action requirements of the Class VI Rule is to ensure that the areas potentially impacted by a proposed GS operation are delineated, all wells that need corrective action receive it, and that this process is updated throughout the injection project” (See EPA AoR Guidance, AR # 439, p.2). The UIC regulations must prevent contamination of drinking water and prevent the movement of fluids containing contaminants that “otherwise adversely affect human health.” *In re NE Hub Partners, L.P.*, 7 E.A.D. 561, 567 (EAB 1997) (*citing* 40 C.F.R. § 144.12(a)). Due to the deficiencies in the materials submitted by FutureGen for the draft Permit, combined with USEPA’s inadequate responses to comments addressing the FutureGen deficiencies, USEPA’s final Permit fails to ensure that the areas potentially impacted by a proposed GS operation are delineated, does not properly address area wells and is based on clearly erroneous findings of fact and conclusions of law, and/or an exercise of discretion or an important policy consideration that the EAB should, in its discretion, review.

Although this Board may defer to the decisions made by USEPA in issuing the final Permit, this Board must still determine that USEPA adequately supported and explained its decisions:

“[D]eferral does not require blind acceptance. ... the Board must ascertain whether these EPA determinations are adequately explained and supported by information in the administrative record ... [T]he Board has emphasized that a permit issuer must adequately explain[] its rationale and support[] its reasons in the record. ... The Board will not hesitate to order a remand when a Region’s decision on a technical issue is illogical or inadequately supported by the record.”

*In re: Stonehaven Energy Mgmt, LLC*, UIC Appeal No. 12-02, slip op. at 18 (EAB March 28, 2013), 15 E.A.D. \_\_\_\_; *e.g.*, *In re: Bear Lake Properties., LLC*, UIC Appeal No. 11-03, slip op. at 22 (EAB June 28, 2012), 15 E.A.D. \_\_\_\_, (remanding permit where the EPA failed to account for all drinking water wells within the area of review); *In re: ESSROC Cement Corp.*, RCRA Appeal No. 13-03, slip op. at 33 (EAB July 30, 2014), 16 E.A.D. \_\_\_\_ (remanding and stating that “the Region must articulate with reasonable clarity the reasons for [its] conclusions and the significance of the crucial facts in reaching those conclusions.” (internal quotations omitted)). For discretionary issues that are technical in nature, the Board looks “to determine whether the record demonstrates that the Region duly considered the issues raised in the comments and whether the approach ultimately adopted by the Region is rational in light of all the information in the record.” *In re MCN Oil & Gas Co.*, UIC Appeal No. 02-03, slip op. at 25-26, n.1 (EAB Sept. 4, 2002).

Here, the record is clear that USEPA did not adequately explain and support its final Permit decisions in the record. In fact, the record establishes that USEPA failed to duly consider issues raised in the comments relating to the model that forms the basis of the Permits, the scope of the monitoring well network, proper identification of wells, and adequate financial protection. While USEPA nominally responded to comments, its responses often lacked the substance needed to be “duly considered.” In many instances, USEPA sidesteps the significant flaws that Petitioners identified by stating merely that USEPA would require the Project to be monitored in the future.

This response lacks the requisite substance, and the Board's acceptance of this USEPA approach would create an exception that would swallow the rule (or here, regulations).

**I. The Plume Size is Materially Understated Due to Deficiencies in the FutureGen Model**

Permit Conditions G and M are based on a FutureGen model that delineates the AoR, provides plume dimensions (and area of associated risk), and informs design of the site monitoring network, during the lifetime of the Project. In response to Petitioners' comments that the FutureGen model was inadequate and inaccurate in many respects, USEPA repeatedly referenced their allegedly "independent" modeling of the FutureGen Project as justification for their acceptance of FutureGen's model. USEPA's model, however, was simply a re-run of the FutureGen model, using the same parameters, and thus did not address any of the specific comments or inadequacies in the FutureGen model. USEPA's decision to accept the FutureGen model is not supported by the record and the Permit decision should be remanded to require FutureGen to correct the model and to require USEPA to truly conduct an independent review, as well as to correct the resulting monitoring network and plume dimensions.

Petitioners retained Dr. Gregory Schnaar to conduct an expert review of the FutureGen model and USEPA's purported independent review of the model. Dr. Schnaar is particularly qualified to conduct the review because he specializes in geologic sequestration of carbon dioxide (CO<sub>2</sub>), was a key member of the regulatory development team for USEPA's geologic sequestration Class VI rulemaking, and was an expert technical contractor to USEPA for development of several technical guidance documents regarding geologic sequestration projects, including *UIC Program Class VI Well Area of Review Evaluation and Corrective Action Guidance* (See AR #439) and *UIC Program Class VI Well Testing and Monitoring Guidance*

(See AR #441). Dr. Schnaar submitted an expert report to support Petitioners' comments, along with his curriculum vitae (See AR # 497, Ex. 2), and conducted a subsequent review of the final Permit and USEPA's responses to comments. Dr. Schnaar's Supplemental Expert Report is attached as Exhibit 1 and incorporated by reference.

In Exhibit 1, Dr. Schnaar discusses the comments he raised to USEPA concerning the draft permit, and explains that USEPA's responses to those comments are not rational in light of the information in the record. Specifically, Dr. Schnaar comments that the plume size is understated in size and configuration, due, in part, from the following:

- USEPA's and FutureGen's model sensitivity analyses are too limited;
- FutureGen did not include 100 percent of the supercritical CO<sub>2</sub> mass in delineations of the supercritical plume, including the thin leading edge, in order to identify the complete projected horizontal extent of supercritical CO<sub>2</sub>.

(See Schnaar Supp. Report, Ex. 1, pp. 2-6, attached). Dr. Schnaar further comments that FutureGen should provide USEPA and stakeholders a reasonable prediction of the extent of the dissolved-phase carbon dioxide plume during the lifetime of the project so that the risk of the Project can be fully understood (Id. at p. 8). Petitioners were not the only commentators objecting to the materially understated plume size that is unsupported by the record. The Natural Resources Defense Council, Clean Air Task Force and Sierra Club also noted this defect in the Permit (See AR #511, p. 66, Comment 3.13).

The information in the Administrative Record consistently reveals that the plume size is larger than set forth in the Permit. FutureGen's own modeling sensitivity analysis resulted in a plume 120% larger in size than presented in the draft Permit (See Schnaar Report, AR# 497, Ex. 2, para. 1 and Figure 1). In response to Dr. Schnaar's comment on this point, USEPA states that

USEPA conducted its own “independent model” and performed a model sensitivity analysis. As Dr. Schnaar points out, however, USEPA’s model is not an independent model, but just a re-run of the FutureGen model (See Schnaar Supp. Report, Ex.1, p. 2, attached). Moreover, even USEPA’s sensitivity analysis indicates that, using conservative input parameters that are consistent with known geologic conditions, the predicted plume appears to be 125% larger than presented by FutureGen (See Schnaar Supp. Report, Ex.1, p. 5, attached). *Thus, all of the data in the record reasonably identifies the plume as larger in scope than assumed in the Permit* (See Final Permit, AR #594, Attachment B; p. 37).

Despite the contrary data in the record, USEPA simply accepts the initial FutureGen model and plume prediction. In an attempt to justify its decision, USEPA repeatedly states that FutureGen will obtain additional site information during the pre-operation phase, and revisions to the Permit will be considered (See, e.g. AR #511, pp. 59, 61, 62, 64, 76, 77, 83). When the record already establishes that the Permit is based on inaccurate model assumptions and predictions, USEPA cannot simply ignore the information by stating that it may fix the issue later. As stated by this Board in *In re: Stonehaven Energy Mgmt, LLC*, UIC Appeal No. 12-02, slip op. at 18 (EAB March 28, 2013), 15 E.A.D. \_\_\_\_\_, a Region’s decision on a technical issue will be remanded if it is illogical or inadequately supported by the record. Here, there is no question that the plume size in the Permit supporting documents is inadequately supported by the record.

Dr. Schnaar shows the impact of the larger 120% plume, and explains that the 120% size is a *minimum* size for the projected plume given the deficiencies of the model (See AR #497, Ex. 2, pp. 2-3 and Figure 1). Further, the 120% minimum projected plume size does not account for the significant differences in injection rates and well construction amongst the injection wells (Id. at p. 7). Failing to revise the plume in the final Permit is not supported by the record, including

USEPA's own review, and does not ensure that the areas potentially impacted by the proposed operation are delineated. Thus, at an absolute minimum, the Permit should be remanded and the plume should be designated as 120% larger than currently modeled.

The Permit also should be reviewed and remanded in connection with the plume configuration. As pointed out in Petitioners' comments, the injection wells are generally pointed in a southerly direction, yet the modeled plume does not reflect this (See AR #497, pp. 8 and 10). The plume size to the south is insignificantly larger than the plume size to the north where no pipes are directly pointed and where the pipes are shorter and the flow rate smaller. In light of the injection rates, pipe lengths, and pipe directions, the modeling fails to explain the quasi-symmetrical plume configuration. USEPA responds with statements relying on its "independent" modeling, but as discussed above, USEPA failed to conduct a truly independent review of FutureGen's modeling, which leaves the plume configuration highly suspect. The plume configuration is directly relevant to proper monitoring, which also impacts emergency and remedial actions.

USEPA's failure in this regard violates the regulations requiring USEPA to obtain proper assurances regarding potential effects on underground drinking water, modeling, monitoring, and emergency and remedial actions that may be needed based on plume size and location (See 40 C.F.R. §144 subpart E and 146 subpart H). Review and remand is required due to clear error, as well as the discretionary and important policy aspects for this issue.

**II. FutureGen and USEPA's Justification for the Number and Placement of Monitoring Wells is Inadequate and Inconsistent With USEPA's Regulations and Guidance**

FutureGen is required to submit a detailed description of how the number and placement of monitoring wells have been determined based on specific information about the Project (e.g.,

injection rate and volume, geology, presence of artificial penetrations, baseline geochemical data, and modeling conducted for the AoR delineation) (See 40 C.F.R. §146, AR #329). USEPA guidance states that monitoring wells should be sited based on modeling results, projected plume migration, dip direction, and presence of potential leakage pathways (See Geologic Sequestration of Carbon Dioxide: Underground Injection Control (UIC) Program Class VI Well Testing and Monitoring Guidance, AR #441 p. 56/115). Because geologic sequestration is a new technology, methods for monitoring the location of the plume are largely untested and thus should be strictly reviewed. This Permit will serve as a guide for future sequestration projects and must set a precedent that is clearly justified and satisfies the regulations.

Petitioners commented on the fact that the draft Permit failed to contain details on how the number, type, and proposed location of the two “early detection” monitoring wells, completed in the first permeable unit above the confining zone, satisfy the Class VI requirements (See AR #497, p. 9 and Ex. 2 at p. 7-9). Further, and as set forth above, FutureGen’s modeled CO<sub>2</sub> plume must be enlarged, and the extent of the monitoring in those areas must be correspondingly increased to satisfy the regulations. Additional deep and shallow monitoring wells are needed. The proposed monitoring configuration is inappropriate in light of a material change to the size and shape of the projected plume.

USEPA again responded to Petitioners’ comment by stating that “EPA considered the AoR modeling and geologic data in evaluating the special distribution and frequency of sampling at the monitoring wells,” citing, without an AR or page number, to a March 2014 EPA Evaluation report (See AR #511, p. 168, Comment 7.20; see also Evaluation of AoR Delineation and Corrective Action, AR #296, which was only available by request). A careful review of the 2014 Evaluation

report reveals *no* discussion of the sufficiency of monitoring well locations, and *no* justification for the number and placement of wells. This is contrary to the regulations (40 C.F.R. § 144 subpart E and 146 subpart H) and guidance, and fails to meet the standard set by the EAB requiring the USEPA to articulate reasons for its conclusions (See, e.g. *ESSROC Cement Corp.*, RCRA Appeal No. 13-03, slip op. at 33 (EAB July 30, 2014), 16 E.A.D. \_\_\_\_\_, remanding and stating that “the Region must articulate with reasonable clarity the reasons for [its] conclusions and the significance of the crucial facts in reaching those conclusions.” (internal quotations omitted)). Based on the foregoing, USEPA has not satisfied the SDWA regulations (40 C.F.R. §144 subpart E and 146 subpart H) and has failed to support its findings and conclusions with information in the record (*In re: Stonehaven Energy Mgmt, LLC*, UIC Appeal No. 12-02, slip op. at 18 (EAB March 28, 2013), 15 E.A.D. \_\_\_\_\_). Accordingly, there is clear error requiring review and remand. Additionally, it is a discretionary matter and an important policy consideration requiring Board review and remand for this issue.

### **III. Permit Condition G Is Based on Inaccurate Well Identification and a Failure to Adequately Investigate Reported Well Impacts**

#### **A. Failure to Identify All Wells in the AoR**

USEPA fails to meet the strict standards set by regulation and case law to locate and identify all wells in the AoR. (See, e.g. *In re Bear Lake Props., LLC*, UIC Appeal No. 11-03, slip op. at 22 (EAB June 28, 2012), 15 E.A.D. \_\_\_\_\_, remanding permit where the EPA failed to account for all drinking water wells within the area of review). In their comments, Petitioners included a detailed discussion of FutureGen’s failure to adequately identify wells in the AoR as required by the UIC regulations (See AR #497, pp. 3, 8 and Price Expert Report Ex. 1 at pp. 3-5). In its response to the comments, USEPA states that it relied upon “its own independent review” of

the State's private well records to support its conclusion to not modify the Permit (AR #511, pp. 93, 96-98, 100-101). Yet, USEPA concedes that the State's private well databases are inaccurate or out of date (See AR #511, pp. 93-94, Comment 3.49). In fact, the Illinois State Water Survey notified USEPA that the source documentation for the well records "is sparse and does not typically indicate the use or disposition of the wells." The State went on to warn USEPA "*Please be aware also that we do not have documentation of all wells.*" (See AR #514, emphasis added). Nevertheless, USEPA "believes" that the wells would "likely" be shallow, and thus summarily concludes there is no concern (AR #511, p. 94, Comment 3.49).

To be protective, particularly for a first-of-its-kind experimental injection Permit, a well search should include more than an electronic database records search, particularly when the State's own well records agency acknowledges that its records are insufficient to show all wells within the area (See Schnaar Supp. Report, Ex. 1, pp. 11-12; "Because U.S. EPA limited their well survey to a search of the same public records as FutureGen, U.S. EPA's search is subject to the same limitations and is not sufficient to identify abandoned wells that may pose a risk of endangering a USDW"). In fact, UIC Guidance states that the "*primary stages* of an abandoned well investigation within the AoR includes historical research, review of aerial and satellite imagery, and one or more geophysical surveys." (AR #439, p. 52). In regard to the review of aerial and satellite imagery, USEPA guidance states: "EPA *recommends* that historical aerial photographs and satellite imagery be used in the identification of abandoned wells" (See AR # 439, p.53-54; see also Schnaar Supp. Report Ex. 1, pp. 12-13). In regard to geophysical surveys, USEPA guidance states: "EPA *recommends* geophysical surveys throughout the regions of the AoR that may have been subject to oil and gas exploration, deep well injection, or any other activity that may result in deep well penetration" (Id.). The FutureGen AoR includes areas subject to oil and gas exploration

and deep well injection, and therefore USEPA guidance specifically recommends geophysical surveys be performed for the FutureGen Project.

USEPA responds by stating that its guidance “only *suggests* options...but these are not required or always appropriate.” (AR #511, p. 96, Comment 3.52). However, USEPA guidance actually *recommends* additional investigation and describes these activities as “primary stages” to find all abandoned wells. USEPA provides no justification in their response to explain why these steps, which are otherwise recommended, are not warranted for the FutureGen Project (See Schnaar Supp. Report, Ex. 1, p. 13). In the absence of such a justification, USEPA and FutureGen are assuming the public records search is sufficient without any clear basis and contrary to the record. Failing to conduct additional research of abandoned wells, particularly when USEPA knows and acknowledges that the historical research is incomplete, is a clear error. The EAB should grant review and remand the permit ordering USEPA to fully follow the strict regulatory standard to locate and identify all wells within the AoR.

The scope of USEPA’s error in failing to properly identify wells is underscored as it relates to wells on Petitioner Leinberger’s Property. Petitioners commented (including an uncontested affidavit) that there are two non-producing natural gas wells located on the Leinberger Property that are not reflected in the draft permit or in the ISGS database (See AR #497, Ex. 1, p. 4). In order to prepare its response to Petitioners’ comments, USEPA evaluated wells on Petitioner Leinberger’s Property (See FutureGen Corrective Action Evaluation ISGS Well Data, July 2014, AR #538). In their evaluation report, USEPA concedes:

As stated by the commenter, these wells do not appear in the ISGS dataset. *Without additional information, no determination regarding the depth of the wells can be made.*

(AR #538, p. 7, emphasis added). Despite this finding, USEPA carefully words its response and states that “there are no *known* private water wells in the AoR that are deep enough to be of concern...EPA believes there is no concern...” (AR #511, pp. 93-94, Comment 3.49, emphasis added). USEPA cannot merely rely on its *lack* of information to avoid conducting (or requiring FutureGen to conduct) any additional investigation. Instead, USEPA is duty bound to obtain additional information to determine the well depth, and not rely upon the corrective action plan to protect the USDWs<sup>2</sup> (AR #511, p. 97-98, Comment 3.52). This Board has previously rejected USEPA’s attempts to rely on a corrective action plan in lieu of identifying all of the water wells. The Board has held that corrective action provisions do not relieve the Region of its regulatory obligation to properly identify all water wells in the AoR (See *In Re Bear Lakes Properties, LLC*, UIC Appeal No. 11-03, slip op. at 22 (EAB June 28, 2012), 15 E.A.D. \_\_\_\_\_ at fn. 10). Similarly, here, USEPA cannot merely rely on the corrective action plan to remedy any eventual impacts.

The fact that USEPA cannot make assumptions about data, or simply rely on the statements of FutureGen, is evidenced by the fact that FutureGen’s information about deep wells in the AoR has already proved to be wrong. Petitioners commented that there were two deep wells located within the expanded AoR that penetrate the primary confining zone (See AR #497, p. 9). FutureGen stated in its 2013 permit application that the wells were believed to have been sufficiently plugged and recompleted (See AR #1 and 2, Figures 2.15 and 2.16, p. 2.25). Yet, in its response, USEPA states that the Criswell well was just recently plugged on June 16, 2014 (AR

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<sup>2</sup> In a similar matter, the EAB remanded a permit because the EAB found that the Region committed a clear error by failing to provide a reasoned analysis evidencing compliance with its regulatory obligation to ensure that water wells within the AoR were properly identified. In particular, the EAB stated that “the Region has *utterly failed* to clearly articulate its regulatory obligations or compile a record sufficient to assure the public that the Region relied on accurate and appropriate data in satisfying its obligations.” *In Re Bear Lakes Properties, LLC*, p. 13 (*emphasis added*).

#511, p. 96, Comment 3.51). USEPA gives no explanation in its response nor cites to any document in the record to explain why the Criswell well needed to be plugged when FutureGen asserted it was already plugged. USEPA's actions regarding the Criswell well create more questions than answers, including whether the Criswell well was ever plugged at all, whether it was deficient, or whether the ISGS documentation regarding the plugging of the well was inaccurate. Regardless, USEPA's decision to plug a well that had been believed to have already been plugged shows that the well information collected thus far is deficient, and it is a clear error for the USEPA to rely upon it. Review and remand is required where USEPA has failed to support its findings and conclusions with information in the record (See *In re: Stonehaven Energy Mgmt, LLC*, UIC Appeal No. 12-02, slip op. at 18 (EAB March 28, 2013), 15 E.A.D. \_\_\_\_). The EAB should grant review of the Permit and find that USEPA has committed a clear error to by failing to provide a reasoned analysis showing compliance with the regulatory obligations under 40 C.F.R. 146.84. Further, it is a discretionary matter and an important policy consideration requiring Board review and remand to require all wells, particularly those within a mile of the anticipated CO<sub>2</sub> plume, to be properly accounted for and analyzed for a first-of-its-kind experimental injection well that exposes underground drinking water and people to danger.

B. Failure to Investigate Impacts to the Critchelow Well

USEPA committed a clear error in failing to investigate impacts to the Critchelow well. The Critchelow Family has a water well on their property, which the family uses for drinking and washing, yet is not identified in the Permit materials.<sup>3</sup> The Critchelow Family has lived on their property and used the well water for over 25 years. Petitioners submitted detailed comments and

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<sup>3</sup> In fact, the Critchelows appear to have water two wells on their property, neither of which is identified by FutureGen. (See Leinberger Declaration, attached to AR #497 as Exhibit 4.)

a sworn (and uncontested) affidavit testifying that a well on Petitioner Critchelow's property was impacted by FutureGen's drilling (See AR #497, p.5 and Declaration of William Critchelow, Ex. 5). In response, USEPA merely stated, that "no complaints were registered" and states that its "inquiries with the State" did not result in additional information, thus no further investigation is warranted (AR #511, p. 11, Comment 2.11). Petitioners' review of the record reveals the very limited extent of USEPA's purported investigation. USEPA concluded that there was no basis for Petitioners' comment by *calling two people*, and writing a 5-line Memo to File on the day before USEPA's Response to Comments was issued (See AR #591). According to the Memo, USEPA merely asked both individuals whether they were "aware of any local water well issues when the stratigraphic well was constructed," and both replied that they were not (Id.). USEPA conducted no additional investigations nor did it require or request that FutureGen conduct any investigations. Making two phone calls to two people is not an investigation of the impacts of drilling in the area; and, two people being unaware of problems caused by drilling does not mean the problems did not occur. It is the applicant's burden to show that its activities related to injection did not allow contaminated fluid into underground sources of drinking water (See AR #497, p. 4, citing to 40 CFR 144.12(a)). Here, Petitioners presented uncontested allegations, in the form of a sworn affidavit, that FutureGen's injection activities caused the movement of contaminated fluid into the Critchelow well, which is located within and draws water from a USDW (See AR # 497, Ex. 5). USEPA's Memo describing two brief conversations, without any additional investigation, does not satisfy USEPA's burden as established by the regulations. As this Board has stated when it remanded a UIC Permit, "[t]he primary aim of the UIC program [] is to protect sources of drinking water from contamination." *In the Matter of Osage (Pawhuska, Oklahoma)*, 4 E.A.D. 395 at 403 (EAB 1992). USEPA clearly erred by failing to either conduct its own investigation or require the

applicant to conduct additional investigations of the movement of contaminated fluid into a drinking water source, per the mandates of the UIC regulations.

USEPA attempts to justify its lack of investigation by stating that it “is willing to require” that FutureGen provide advance notice to the Critchelows of well construction so the Critchelows can see if there is any damage to their well in the future, after the fact (See AR # 511, p. 29, Comment 2.11). This response is insufficient and a clear error. USEPA does not include any requirement for notification in the Permit, nor does USEPA describe how it will require FutureGen to notify the Critchelows. A statement in a response to a permit comment is devoid of any enforcement authority, and there is nothing requiring FutureGen to actually contact the Critchelows. USEPA cannot be allowed to ignore a water well contamination issue by arguing that it can be handled after the contamination has occurred. To ensure protection of drinking water from contamination, the Board should remand the Permit and order USEPA to require that FutureGen further investigate the contamination to the Critchelow well caused by the FutureGen injection activities. The Board should also remand the Permit to require that USEPA modify the Permit to insert a requirement that FutureGen monitor the Critchelow well and notify the Critchelows when well construction begins.

Based on the foregoing, USEPA has not satisfied the SDWA regulations (See 40 C.F.R. §144 subpart E and 146 subpart H). Nor has USEPA supported its findings and conclusions with information in the record (See *In re: Stonehaven Energy Mgmt, LLC*, UIC Appeal No. 12-02, slip op. at 18 (EAB March 28, 2013), 15 E.A.D. \_\_\_\_). Accordingly, there is clear error requiring review and remand. Additionally, it is a discretionary matter and an important policy consideration requiring Board review and remand to require the Critchelow well to be properly considered.

#### **IV. The Financial Protections in the Final Permit are Inadequate**

The financial assurance conditions in the Permit are based upon clearly erroneous findings of fact and conclusions of law, and are exercises of discretion and important policy considerations that the Board should review. The record fails to support USEPA's conclusion that the FutureGen trust fund ("Trust") provides sufficient funding for the many risks associated the carbon sequestration Project, which even FutureGen calls "first-of-its-kind." <http://futuregenalliance.org/futuregen-2-0-project/>. Without proper financial assurance, the SDWA goal of ensuring safe drinking water sources will be unmet when remedial action is needed. *See NE Hub Partners, L.P.*, 7 E.A.D. 561, 567 (E.A.B. 1997) ("The Agency's UIC regulations are oriented exclusively toward the statutory objective of protecting drinking water sources.") (*quoting In re Brine Disposal Well, Montmorency Cty, MI*, 4 E.A.D. 736, 742 (EAB 1993)). In particular, USEPA made a clear error in relying *exclusively* on a Trust for the emergency and remedial response ("E&RR"), instead of allowing for an insurance policy as supplemental protection. Moreover, the allocated funds for the E&RR are insufficient to cover all of the risks associated with the Project. USEPA also clearly erred in failing to include a detailed cost estimate for the financial assurance, failing to require maintenance of financial assurance for the duration of the Project, and allowing a lengthy pay-in period for the Trust. For these reasons, the EAB should grant review of the Permit and remand it to USEPA to remedy the multiple deficiencies.

##### **A. The Trust Fund is Improper for the Emergency and Remedial Response**

One of the most important Permit considerations is the vehicle through which FutureGen will provide financial assurance for the Project. In the original permit application FutureGen proposed to fund a trust for all of the required elements under 40 C.F.R. §146.85(a)(2) (AR #329), except for the E&RR, for which it proposed a \$100 million insurance policy (See AR #1, Section.

9.4.2.2 and Appen. D). USEPA rejected FutureGen’s proposal and instead decided to rely exclusively upon a Trust of only \$26.7 million to cover all of the possible risks associated with the Project. This decision to rely only on the Trust is a clear error, a discretionary decision and an important policy consideration that the EAB should review.

Petitioners commented on USEPA’s decision to rely on a Trust for the E&RR noting that USEPA failed to include any explanation for its decision. In its response to comments, USEPA stated merely that it rejected the insurance policy because the policy did not “clearly delineat[e] the liability amount dedicated to financial responsibility for Emergency and Remedial Response (E&RR)”(AR #511, p. 125, Comment 4.13). Nonetheless, only requiring a Trust is contrary to the recommendations in USEPA’s Underground Injection Control (UIC) Program Class VI Financial Responsibility Guidance (“UIC Guidance”) (AR #438). The UIC Guidance provides, “[f]or activities of uncertain frequency and cost, such as emergency and remedial responses, the trust will likely not have the right amount of funds—too little is a partial failure of the instrument and too much represents an inefficient use of funds that unnecessarily raises GS costs.” (Id. p. 21). Rather, the UIC Guidance recommends that “[i]nsurance is the ideal instrument for handling the numerous possible scenarios associated with uncertain events such as emergency and remedial response demonstrations.” (Id. at p. 22). USEPA’s failure to follow its own guidance document and, without any explanation, rely exclusively on a Trust for activities of uncertain frequency and cost, such as the E&RR, is a clear error and a discretionary decision the Board should review.

Even if the insurance coverage did not “clearly delineate” the liability amount for E&RR, (AR #511, p. 125, Comment 4.13), USEPA should accept FutureGen’s proposed insurance coverage to supplement the Trust. As USEPA explains in its response to Comment 4.13, “the proposed insurance coverage included a number of elements beyond financial assurance for the

[E&RR Plan].” (AR #511, p. 125, Comment 4.13). In other words, FutureGen’s insurance coverage was beyond that specifically required by the UIC regulations. While the regulations only require coverage for activities and emergency response related to the wells, 40 C.F.R. §146.85(a)(2) (AR #329), the regulations do not limit coverage to those elements. Without explanation in the record, USEPA unilaterally decided to squelch additional coverage for the Project when the Project is admittedly untested. The EAB should grant review of the Permit and require that USEPA accept the proposed insurance policy in conjunction with a fully funded Trust, to ensure that all possible risks associated with this large Project are accounted.<sup>4</sup>

B. The Amount of Financial Assurance Required Under the Permits Is Insufficient

The Trust amount allocated for the E&RR for all four injection wells is insufficient to cover all of the potential risks and expenses. Without sufficient funding to remedy drinking water contamination, the purpose of the SDWA is disregarded. *See In re Pennsylvania Gen’l Energy Co., LLC*, UIC Appeal Nos. 14-63, 14-64, & 14-65, slip op. at 2 (August 21, 2014), 16 E.A.D. \_\_\_\_\_. The USEPA’s decision to underfund the E&RR is a clear error, which requires EAB review.

Petitioners noted in their comments that the funds were grossly insufficient, and due to the experimental nature of the Project and the dangerous nature of CO<sub>2</sub>, should be closer to the high end estimate of USEPA’s Cost Estimate (AR #497, p. 13-14, citing to AR #320, Ex. B-2). In response, USEPA merely states that its cost estimation was based upon conservative assumptions (AR #511, p. 115 & 117) and that its cost estimate “is sufficient” to meet the financial responsibility requirements (AR #511, pp. 115, 117, 121, and 129). USEPA included little

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<sup>4</sup> The Project is even larger than estimated by the USEPA. See Section I of this Petition.

additional explanation for the approximately \$50 million difference in the estimates to treat contaminated groundwater, and characterizes its approach as “conservative” with little support or explanation. As the purpose of the UIC regulations is to protect drinking water sources and USEPA admits that movement of CO<sub>2</sub> into drinking water is the costliest event to remediate (AR #320, pp. 7-8, AR #511, p. 115), USEPA is in clear error for insufficiently funding future treatment of contaminated groundwater, without any reasonable explanation.

The EAB should remand the Permit to increase the amount of E&RR financial assurance. USEPA should be directed on remand to consider insurance in conjunction with the Trust, and/or to increase the Trust for the E&RR to \$77.9 million – the high end of the range for FutureGen’s estimate for emergency and remedial actions (AR #320, Ex. B-2). Because of the high degree of risks and the numerous unknowns for this Project, the high end of the cost estimate is required to satisfy SDWA goals of remediation and preservation of drinking water.

C. The Permit Does Not Provide Detailed Cost Estimates

The EAB should grant review of the Permit because it fails to include a detailed written estimate for the injection and post-injection emergency and remedial response funding, as required under the SDWA regulations. Under 40 C.F.R. §146.85(c) (AR #329), “The owner or operator must have a detailed written estimate, in current dollars, of the cost of performing corrective action on wells in the Area of Review, plugging the injection well(s), post-injection site care and site closure, and emergency and remedial response.” Additionally, “the cost estimate must be performed for each phase separately and must be based on the costs to the regulatory agency of hiring a third party to perform the required activities.” (40 C.F.R. §146.85(c)(1), AR #329). The SDWA regulations require a detailed cost estimate to achieve the important goal of protecting

drinking water sources. Without detailed and accurate cost estimates, the SDWA regulations and goal of preserving drinking waters sources is jeopardized.

Petitioners commented that USEPA failed to provide a detailed cost estimate for the E&RR financial assurance (See AR #497, p. 12). In particular, Petitioners commented that the Patrick Engineering estimate was outdated and had inaccurate information, and that USEPA's "Cost Estimate Tool" Estimate (AR #320) failed to include a detailed accounting for the basis of its conclusions (AR #497, pp. 12-13). In response, USEPA stated that the detailed cost estimate was provided for in the Patrick Engineering cost estimate (See AR #511, p. 122, Comment 4.12). However, the Agency rejected the Patrick Engineering cost estimate because it was too low (See AR #511, p. 114, Comment 4.8). Instead, USEPA used its own "Cost Estimate Tool," which it stated was "designed to provide an 'acceptable range of costs' for GS financial responsibility activities using information from the permit application." (AR #511, p. 114, citing AR #320). It is improper and a clear error for USEPA to rely upon the Patrick Engineering Cost Estimate to comply with 40 C.F.R. §146.85(c)(1) (AR #329), yet reject that same cost estimate for the actual estimation of the cost for the E&RR.

Moreover, USEPA's own cost estimation tool (AR #320) does not include a detailed cost estimate. USEPA states that it used detailed cost information provided by FutureGen to apply USEPA's cost estimation tool, (AR #511, p. 122, Comment 4.12), yet the Agency does not provide the actual cost information. The USEPA's Cost Estimate is devoid of any detailed information accounting for the basis for the contaminated water estimates (AR #320). The UIC regulations require a "detailed written estimate" for the financial assurance, and it is a clear error for USEPA to neglect that requirement and an important policy matter that the Board should review and remand.

D. The Permit Fails to Require Maintenance of Financial Assurance for the Duration of the Project

The Permit should be reviewed because it fails to contain a provision requiring FutureGen to maintain Financial Assurance through the duration of the Project. The Permit states that the Trust is irrevocable and “shall continue until terminated by the Grantor and Trustee, with the concurrence of USEPA Water Division Director.” (AR #594, Attachment H, Section 17). In other words, if the Director agrees, FutureGen could terminate the Trust before the completion of site closure and post-injection site care. In response to Petitioners comment, USEPA states that it will not modify the Permit to require the Trust to exist through completion of site closure and post-closing maintenance because FutureGen may seek to substitute one form of financial mechanism for (AR #511, p. 114, Comment 4.7). This response is inadequate because FutureGen cannot be allowed to terminate before site closure is completed. Under 40 C.F.R. §146.85(b)(1) (AR #329), a permittee must maintain financial responsibility and resources through the time when the Director “approves the completed post-injection site care and site closure plan” and “approves site closure.” Here, the Permit allows FutureGen to terminate the Trust before that time. Even though USEPA states that it would not agree to a termination until all regulatory conditions are met (AR #511, p. 114, Comment 4.7), its statement in a response to comments is unenforceable. Without an affirmative statement in the Permit that FutureGen must have sufficient financial assurance throughout the Project, FutureGen could terminate the financial assurance without creating another mechanism. USEPA failed to fully respond to Petitioners’ comments regarding such deficiency, and the Permit fails to follow the UIC regulatory requirements.

E. The Trust has An Improper Pay-in Period

The EAB should review the Permit because the Trust is insufficiently funded at the beginning of the Project, which is a clear error, abuse of discretion, and an important policy consideration. The Permits allow FutureGen to pay-in incrementally to the Trust for each phase of the Project and only require \$8.823 million for the entire construction phase (See AR #594, Attachment H, Schedule C). As Petitioners stated in their comments, the initial payment into the Trust is an insufficient amount to cover an E&RR event during construction and fails to comply with the UIC regulations, which require E&RR financial assurance for events that adversely affect the health of persons (40 C.F.R. § 144.12 and § 146.94, AR #329). In response to Petitioners' comments, USEPA stated that it approved a pay-in period because the UIC Guidance allows a pay-in period, the period is sufficient to protect USDWs, and a pay-in period minimizes the risk of instrument failure (See AR #511, p. 111, Comment 4.5).

While the UIC Guidance may allow a pay-in period, the UIC Guidance recommends “[a] fully funded trust fund or escrow account minimizes the risk of instrument failure.” (AR# 438 p. 23, emphasis added). Moreover, emergency or remedial actions involve a large, one-time (up front) cost, which could only be covered by a fully funded trust (Id.). Here the Agency merely requires that within 7 days of issuance of the final permits, FutureGen fund \$8.823 million of the total financial assurance required for the Project, and the remaining E&RR amount of \$20.6 million is not due until two years later (See AR #594, Attachment H, Schedule C). According to its response to the comments, in calculating the initial pay-in amount, the Agency relied upon the Patrick Engineering estimates for response to catastrophic failure of the caprock, “which was the costliest potential event identified.” (AR #511 p. 111). Yet, in a response to Comment 4.8, the Agency found that the Patrick Engineering estimate “was too low based on the range of costs

provided by USEPA’s cost estimation tool.” (AR #511, p. 114, Comment 4.8). It is inconsistent and a clear error for USEPA to depend upon the Patrick Engineering estimates to support its estimates for the pay-in period, yet find the Patrick Engineering estimates to be insufficient in evaluating the E&RR. Instead, the Agency should have relied upon its own Cost Estimation Tool to determine the appropriate initial deposit to cover “a scenario in which CO<sub>2</sub> moves into the USDW (which is generally the costliest event to remediate.)” (AR #511, p. 115, Comment 4.8).

Additionally, the EAB should review the Permit because the pay-in period is deficient as a policy matter with regard to E&RR funding. Under the Permits, FutureGen will only have \$8.823 million in E&RR funding during the drilling period, and only \$20.6 million more when it begins to inject CO<sub>2</sub> (See AR #594, Attachment H, Schedule C). As E&RR costs often are large and at one time, it is an abuse of discretion for USEPA to allow the initial deposit to be so small. The EAB should grant review of the Permit and remand it to require FutureGen to have all of its E&RR costs in the Trust before drilling begins or at the very least shorten the pay-in-period to minimize the risk of instrument failure. Nothing short of that would ensure meeting the SDWA’s goals.

### **CONCLUSION**

Because of the multiple deficiencies in the Permit, which are a clear error and an abuse of discretion, EAB should grant review of this first-of-its-kind permit. This Board should remand the Permit proceeding to require the Director to seek additional information from FutureGen regarding the Project in order to properly assess the Permit and to strictly comply with the UIC regulations. Specifically, on remand the Director should require that USEPA (whether itself or through FutureGen):

1. develop a new model correcting the deficiencies noted by Dr. Schnaar to address sensitivity analysis, provide a complete projection of the entire supercritical CO<sub>2</sub> plume, and revise the Permit to include maps of the extent of the dissolved-phase carbon dioxide plume, so that the record contains a reasonable prediction of the extent of the dissolved-phase carbon dioxide plume during the lifetime of the Project;

2. present a detailed analysis justifying the placement of monitoring wells, in consideration of the most recently updated AoR, including a search for all potential leakage pathways within the expanded AoR, and revise the Permit to provide for additional monitoring wells as necessary.

3. require a detailed analysis of area wells, not limited to state databases, and an investigation of the Critchelow well prior to issuing the final Permit;

4. increase the E&RR financial assurance in the Permit by either increasing the Trust amount and/or using insurance to supplement the trust fund;

5. provide a detailed cost estimate of the financial assurance;

6. include an affirmative statement in the Permit that the financial assurance must be maintained throughout the Project; and,

7. revise the Permit to eliminate or shorten the pay-in-period for the Trust and add an affirmative statement that the Director must approve the pay-in-period.

### **STATEMENT REQUESTING ORAL ARGUMENT**

Petitioners request that the Board hold oral argument on this appeal. Oral argument is appropriate because, as stated by USEPA, “[t]hese are the first Class VI permits for carbon sequestration in the United States” (See AR #16, p.1). As a result, there are unique risks associated

with the Permit and the Permit will set an important precedent for future sequestration projects. This Board should give full and detailed consideration to all issues presented on appeal to ensure compliance with the UIC regulations and long-term safety of the public.

**STATEMENT OF COMPLIANCE WITH WORD LIMITATION**

Pursuant to 40 C.F.R §124.19(d)(3), Petitioners state that this Petition for Review contains 8,987 words, which does not exceed the 14,000 word limit set by the Board.

**LIST OF EXHIBIT/ATTACHMENT**

Supplemental Expert Report of Gregory Schnaar, PhD., attached as Exhibit 1.

Respectfully submitted,

/s/ Jennifer T. Nijman

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# EXHIBIT 1

Dr. Schnaar's Supplemental Expert Report

**Supplemental Expert Report of  
Gregory Schnaar, Ph.D.  
Comments on FutureGen Alliance UIC Draft  
Permits for FutureGen 2.0 Morgan County  
Class VI UIC Wells 1, 2, 3, and 4**

**September 29,  
2014**



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**Gregory Schnaar**



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## **Supplemental Expert Report of Gregory Schnaar, Ph.D.**

### **1. Introduction**

I have reviewed the FutureGen Alliance permit materials for the FutureGen 2.0 site in Morgan County, Illinois ('the Site'), and I previously submitted comments to U.S. EPA on the project (DBS&A, 2014, Administrative Record "AR" #497). Subsequently, U.S. EPA has approved of the FutureGen permit and released a formal response-to-comments document (AR #511). U.S. EPA's response-to-comments document includes responses to all of my comments, and I have reviewed U.S. EPA's responses.

Several of my original comments on the FutureGen permit application material related to limitations of FutureGen's modeling of carbon dioxide (CO<sub>2</sub>) plume and pressure-front migration; modeling is used to delineate the area of review (AoR), evaluate risks to underground sources of drinking water (USDWs), design the site monitoring network, and gain a general understanding of the anticipated plume dimensions (and associated risk) during the lifetime of the project.

In their responses, U.S. EPA repeatedly refers to their own independent modeling of the FutureGen project as justification for their acceptance of FutureGen's model. I have obtained and reviewed U.S. EPA's documentation of their own modeling of the FutureGen project in order to address U.S. EPA's responses (U.S. EPA, 2014, AR # 296). As detailed below, U.S. EPA's model was simply a re-creation of FutureGen's model. As such, U.S. EPA's modeling is not properly characterized as independent, and U.S. EPA does not address my original comments.

### **2. Qualifications**

I specialize in geologic sequestration of CO<sub>2</sub>, contaminant transport evaluation, environmental chemistry, field monitoring programs, and numerical groundwater and vadose zone modeling. As a post-doctoral fellow with the U.S. EPA Underground Injection Control (UIC) program I was a key member of the regulatory development team for U.S. EPA's geologic sequestration Class VI rulemaking (U.S. EPA Final Rule, 2010, AR #330). Subsequently, I was an expert technical



contractor for development of several technical guidance documents published by U.S. EPA regarding geologic sequestration projects, including *UIC Program Class VI Well Area of Review Evaluation and Corrective Action Guidance* (U.S. EPA, 2013a; AR #439) and *UIC Program Class VI Well Testing and Monitoring Guidance* (U.S. EPA, 2013b; AR #441).

I am also the author of technical papers and presentations regarding geologic sequestration, including a review article on modeling of CO<sub>2</sub> plume and pressure migration at geologic sequestration projects (Schnaar and Digiulio, 2009). I have given numerous technical presentations and trainings on geologic sequestration and associated UIC regulations to groups including the U.S. EPA Region 8 State UIC Workshop, U.S. EPA Region 7 UIC Manager's Meeting, WESTCARB Regional Carbon Sequestration Partnership, Big Sky Regional Carbon Sequestration Partnership, American Association of Petroleum Geologists, International Energy Agency, Air and Waste Management Association, Ground Water Protection Council, Electric Power Research Institute, Edison Electric Institute, and Groundwater Resources Association of California. My complete Curriculum Vitae is included in the Administrative Record at AR #497.

### **3. Comments**

#### ***1.) U.S. EPA has not performed an independent evaluation to test FutureGen's model assumptions and projections of CO<sub>2</sub> plume migration***

In my original comments, I critiqued several aspects of FutureGen's modeling as not being sufficiently conservative and consistent with project data. In responding to my comments, U.S. EPA states repeatedly that they have accepted FutureGen's modeling only after U.S. EPA performed their own independent modeling of the FutureGen project separate from FutureGen's modeling.

However, U.S. EPA's model is simply a re-creation of FutureGen's model, was based on the same assumptions as the FutureGen model, and therefore is not an independent evaluation of key model assumptions and input parameter values.

My original criticisms of FutureGen's modeling included the following:



- Conservative input parameter values were not used to generate ‘maximum-risk’ scenario simulations to project potential risks to USDWs, inconsistent with U.S. EPA guidance (See AR #497, Ex.2, p.2, Comment 3.1);
- Model grid block sizes clearly impact model results (i.e., as shown by stair-stepping shape around the modeled plume edges including long straight sections). FutureGen’s selection of model grid block sizes is inconsistent with U.S. EPA guidance. FutureGen provides no demonstration that model gridding is not a cause of model error (See AR #497, Ex.2, p.5, Comment 3.5);
- Various model assumptions (e.g., regional hydraulic gradient, injectate fluid impurities) are not consistent with site conditions, and FutureGen has provided no analysis to demonstrate that these invalid assumptions will not impact model results (See AR #497, Ex.2, pp.5-6, Comment 3.6-8);
- Model boundaries may be set too close to the location of the project, and this may cause model error. Inconsistent with U.S. EPA guidance, FutureGen provided no analysis to demonstrate that boundary conditions are properly implemented (See AR #497, Ex.2, p.6, Comment 3.9).

In response to these comments, U.S. EPA states that they found FutureGen’s modeling to be adequate based on their own separate modeling. However, U.S. EPA did not independently develop a separate model, but rather used FutureGen’s submitted model documentation to design a model wholly identical to FutureGen’s model. EPA simply recreated FutureGen’s own model based on the same assumptions and same input parameter values, using the same model platform. Further, U.S. EPA has not performed rigorous model testing that addresses my original comments listed above.

U.S. EPA and FutureGen models are identical in the following ways:

- Both models are built in the Subsurface Transport Over Multiple Phases (STOMP) platform (U.S. EPA, 2014 p. iii; AR #296)



- An identical model grid is used in both models (U.S. EPA, 2014 p.7/40; AR # 296), including overly-coarse grid blocks that clearly impact model results.
- Identical input parameter values were used in both models, including permeability (U.S. EPA, 2014 p.8/40; AR #296), porosity (U.S. EPA, 2014 p.12/40; AR #296), bulk and grain density (U.S. EPA, 2014 p.19/40; AR #296), formation compressibility (U.S. EPA, 2014 p.14/40; AR #296), and relative permeability-saturation-capillary pressure functions (U.S. EPA, 2014 p.17/40; AR #296).
- Initial conditions are identical in both models (U.S. EPA, 2014 p.19/40; AR #296).
- Boundary conditions are identical in both models (U.S. EPA, 2014 p.20/40; AR #296)

Because U.S. EPA designed their model to be identical to FutureGen's, U.S. EPA's modeling is not an independent evaluation of model input parameters and assumptions; rather it is a test of FutureGen's model implementation. The only possible source of variability between U.S. EPA and FutureGen's models would be if typographical errors were made when entering model parameters into the STOMP platform.

My original comments on FutureGen's model are not addressed by U.S. EPA's modeling, and therefore U.S. EPA's comment response and modeling do not address my comments and opinion that FutureGen's model does not provide an adequately conservative prediction of plume and pressure-front migration to be protective of USDWs.

## ***2.) U.S. EPA and FutureGen model sensitivity analyses are too limited***

Modeling sensitivity analysis is a critically important methodology for evaluating potential model error (U.S. EPA, 2013a; AR #439). FutureGen's model sensitivity analysis was "parsimonious" by design, and does not rigorously evaluate model uncertainty resulting from data limitations (Underground Injection Control Permit Applications for FutureGen 2.0 Morgan County Class VI UIC Wells 1, 2, 3, 4 – Supporting Documentation, March 2013, Revised May 2013 in accordance with U.S. EPA Completeness Review [hereafter FutureGen, 2013 AR #1, 2], p. 3.41). In responding to my comment that the modeling sensitivity analysis should be revised (See AR #497,



Ex.2, p.3, Comment 3.2), U.S. EPA stated that U.S. EPA had performed an independent sensitivity analysis and confirmed FutureGen's results (See U.S. EPA Response, AR #511, p. 83, Comment 3.38). However, U.S. EPA's model sensitivity analysis was nearly identical to FutureGen's analysis, and therefore subject to the same limitations.

In my original comments, I stated that FutureGen should revise the model sensitivity analysis to account for all relevant parameters and incorporate reasonable "scaling factors" (i.e., scaling factors determine by how much model parameters are varied during sensitivity analysis) (See AR #497, Ex.2, p.3, Comment 3.2). For example, field estimates of permeability obtained by FutureGen for the Lower Mt. Simon varied by approximately a factor of 4.0 (i.e., 400 percent), depending on the field technique used to obtain results (i.e., wireline ELAN log testing versus field hydraulic packer tests; FutureGen, 2013, p.3.6; AR # 1, 2). However, the FutureGen 'scaling factor' for testing the sensitivity of this parameter in their model was only  $\pm 25$  percent (FutureGen, 2013, p.3.42; AR #1, 2). FutureGen's field measurements indicate that a 400% scaling factor is the minimum appropriate scaling factor that should have been used to evaluate potential model error.

U.S. EPA's scaling factors were identical to FutureGen's for porosity, permeability, and fracture gradient (U.S. EPA, 2014 p.32/40; AR #296), and therefore does not represent a more thorough analysis that incorporates reasonable scaling factors.

Further, it is my opinion that FutureGen's sensitivity analysis is inadequate because important model parameters were not tested at all, including permeability-saturation relationships, capillary pressure-saturation relationships, anisotropy of intrinsic permeability, gas entry pressure, regional hydraulic gradient, and formation dip. With one exception (residual water saturation), U.S. EPA's sensitivity analysis included the same set of parameters as FutureGen's, and U.S. EPA did not include sensitivity analyses for the key parameters I listed in my original comment.

As conveyed in my original comment letter, it is necessary to conduct a comprehensive, and not parsimonious, sensitivity analysis in order to provide the technical basis for evaluating model uncertainty resulting from data limitations and provide a conservative estimate of plume migration. Because it is nearly a replication of FutureGen's modeling, U.S. EPA's modeling does not provide the comprehensive sensitivity analysis that is necessary.



**3.) U.S. EPA's model sensitivity analysis, although limited, indicates that using conservative input parameters the predicted plume may be 125% larger than presented by FutureGen**

U.S. EPA included one additional model parameter in their sensitivity analysis: residual water saturation. Residual saturation values used in U.S. EPA's sensitivity analysis are more consistent with site conditions than those used in FutureGen's modeling, as stated by U.S. EPA:

*Residual water saturation values used in the FutureGen AoR model ranged from 0.0597 to 0.0810. However, residual water saturation values found in the literature for the Mt. Simon Sandstone range from approximately 0.2 to 0.4 (Zhou et al. 2010; Bandilla et al., 2012b; Krevor et al., 2012). Thus, EPA evaluated the sensitivity of the results to this parameter.*

(U.S. EPA, 2014, p. 31/40; AR #296). When using a site-specific value of residual water saturation (0.4), U.S. EPA's modeling indicated a final plume area of 6.96 mi<sup>2</sup>, compared to 5.56 mi<sup>2</sup> (or 125% larger) using FutureGen's assumed residual water saturation value (U.S. EPA, 2014 p.34/40; AR #296). This highlights the necessity to perform rigorous model testing and base initial modeling on conservative assumptions that are consistent with site data.

As stated in my original comments, FutureGen and U.S. EPA should update plume and pressure-front delineation maps using maximum-risk scenario simulations based on conservative parameter values determined through sensitivity analysis consistent with U.S. EPA guidance, addressing each parameter that could significantly affect plume and pressure extent. U.S. EPA should require FutureGen, as a minimum beginning point, to revise the presented plume delineation based on the more conservative and site appropriate modeling run that incorporates a residual water saturation value of 0.4.

**4.) U.S. EPA has no basis for claiming that "very low concentrations of CO<sub>2</sub>" are not worth plotting on informative maps; this is inconsistent with existing U.S. EPA guidance and the potential risks to USDWs posed by supercritical CO<sub>2</sub>**

FutureGen's CO<sub>2</sub> plume is projected to form a large 'clover-leaf' pattern around the four injection wells, with supercritical CO<sub>2</sub> plume thickness greatest at the center of the plume. Moving away from the center of the plume, the CO<sub>2</sub> thickness will decrease, and a thin 'leading edge' of CO<sub>2</sub>



will move very far away from the injection wells. The thin leading edge contains supercritical CO<sub>2</sub> subject to buoyant forces and potential leakage, and dissolved-phase CO<sub>2</sub> (discussed below), and therefore poses risks to USDWs. Although the thin leading edge may only represent a small fraction of the total injected mass (e.g., ≤1%), it is important for understanding risk because it is the portion of the plume that has moved furthest from the injection wells and away from the center of the project.

However, FutureGen has not provided U.S. EPA or stakeholders a complete projection of the entire supercritical CO<sub>2</sub> plume, including the thin leading edge. In fact, FutureGen's "VIMPA" analysis (FutureGen 2013, p.3.37; AR #1, 2) effectively removes the modeled thin leading edge of the supercritical CO<sub>2</sub> plume from all the plume delineation maps that FutureGen submitted to U.S. EPA.

In my original comments, I stated that FutureGen should include 100 percent of the supercritical CO<sub>2</sub> mass in their delineations of the supercritical plume, including the thin leading edge, so that the complete projected horizontal extent of supercritical CO<sub>2</sub> is clear (See AR #497, Ex.2, p.4, Comments 3.3, 3.4). U.S. EPA rejected this comment, stating in part:

*One hundred percent of the CO<sub>2</sub> was modeled, but the CO<sub>2</sub> plume plotted on maps is the surface expression of 99% of the CO<sub>2</sub> injected. This was done due to difficulties in representing (and the limited value of representing) very low concentrations of supercritical CO<sub>2</sub> at the margins of the modeled plume. EPA therefore believes that the existing plume depiction is a reasonable representation of the maximum extent of the supercritical CO<sub>2</sub>.*

(See U.S. EPA Response, AR #511, p. 58, Comment 3.9). Although 100 percent of the CO<sub>2</sub> may have been modeled by FutureGen, this modeling is not useful for understanding risk to USDWs if the model results are never presented. Computer graphing difficulties must be overcome to present a full depiction of model-predicted CO<sub>2</sub> plume migration. If FutureGen is technologically advanced enough to perform complex geologic sequestration computer modeling, not to mention build a state-of-the-art geologic sequestration project, it is most likely that they can overcome computer graphing difficulties to provide a full projection of their modeling results.

In addition, U.S. EPA provides no basis for stating that there is "limited value of representing" the thin leading edge of the supercritical plume. Supercritical CO<sub>2</sub> poses risks to USDWs wherever



it is present, including at the thin leading edge where the relative thickness of the plume is minor compared to the thickness at the center of the project. In fact, the thin leading edge represents a unique risk to USDWs as it will move into areas very far from the injection project that may be subject to less site characterization and identification of leakage pathways.

For these reasons, FutureGen and/or U.S. EPA should present a full depiction of modeled projections of 100 percent of the supercritical carbon dioxide plume, including the thin leading edge. This information is already generated by FutureGen and U.S. EPA's models, simply needs to be plotted on maps and provided to stakeholders for review, and be considered for overall project risk management.

***5.) U.S. EPA is ignoring potential risks from the dissolved phase plume, inconsistent with U.S. EPA-funded research projects on this subject***

In my original comments, I stated that FutureGen should provide maps of the extent of the dissolved-phase carbon dioxide plume to inform U.S. EPA and stakeholders (See AR #497, Ex.2, p.4, Comment 3.3). The presence of dissolved-phase CO<sub>2</sub> poses potential risks to groundwater, including geochemical changes and potential mobilization of drinking water contaminants such as arsenic and lead. For this reason, the extent of the projected dissolved-phase plume should be clear to U.S. EPA and stakeholders.

In rejecting my comment, U.S. EPA stated that:

*Once CO<sub>2</sub> dissolution occurs, it results in less CO<sub>2</sub> that is subject to the buoyant forces that may cause endangerment to USDWs. Although the dissolved CO<sub>2</sub> may alter the geochemistry of fluids in the injection zone, it is unlikely that these changes would increase the possibility of leakage out of the injection zone. Therefore, contrary to the commenter's indication, dissolution of CO<sub>2</sub> generally reduces potential risks to groundwater and EPA therefore did not separately require the delineation of the dissolved CO<sub>2</sub> phase. Dissolution is, in fact, a trapping mechanism, reducing the risk for endangerment to USDWs as long as the storage site is suitable for the containment of the brine with dissolved CO<sub>2</sub>.*

(See U.S. EPA Response, AR #511, p. 59, Comment 3.9). U.S. EPA appears to be ignoring the recognized potential unique risks to USDWs posed by the dissolved phase carbon dioxide plume. However, U.S. EPA itself has funded multiple research projects to specifically investigate the



potential detrimental impacts to groundwater quality as a result of contamination by dissolved-phase carbon dioxide plumes. For example, one U.S. EPA-funded research progress report posted on U.S. EPA's website states:

*While dissolved phase CO<sub>2</sub> poses less of a threat to the security of shallower drinking water supplies [compared to supercritical CO<sub>2</sub>], the risk is not zero. There are plausible mechanisms by which the CO<sub>2</sub> laden brine could be transported to a shallower depth, where the CO<sub>2</sub> would come out of solution (exsolve), forming a mobile CO<sub>2</sub> gas phase. This significant mechanism for drinking water contamination has received little attention, and there are basic science and reservoir engineering questions that need to be addressed in order to reduce risks to underground drinking water supplies.*

(Falta et al., 2013). Similarly, another U.S. EPA-funded research project out of Lawrence Berkeley National Laboratory indicates that leakage of dissolved-phase carbon dioxide into a USDW may cause mobilization and contamination by drinking water contaminants including lead and arsenic (Zheng et al., 2008).

For these reasons, FutureGen should provide U.S. EPA and stakeholders a reasonable prediction of the extent of the dissolved-phase carbon dioxide plume during the lifetime of the project. This information is already generated by FutureGen and U.S. EPA's models, simply needs to be plotted on maps and provided to stakeholders for review, and be considered for overall project risk management.

**6.) FutureGen and U.S. EPA's justification for the number and placement of monitoring wells is inadequate and inconsistent with both U.S. EPA's regulations and guidance**

Monitoring wells placed above the confining zone are critical for early detection of any fluid leakage that may endanger a USDW. In my original comments, I stated that in order to be consistent with U.S. EPA regulations and guidance, FutureGen should present a detailed justification for the number and placement of monitoring wells at the project necessary to detect potential fluid leakage above the confining zone (See AR #497, Ex.2, p.7, Comment 3.11). Based on this analysis, FutureGen may need to plan for additional monitoring wells.

In rejecting this comment, U.S. EPA's definitively states the following:



*The two monitoring wells in the Ironton Sandstone, immediately above the Eau Claire confining zone, are sufficient to detect changes in fluid chemistry, temperature and pressure that would indicate the movement of CO<sub>2</sub> beyond the injection zone formation. This is particularly true during the early years of the project where the CO<sub>2</sub> plume would typically still be relatively close to the wells and a potential problem with the confining zone (such as previously unknown faults or fractures or other permeable features) would be likely to become apparent.*

(See U.S. EPA Response, AR #511, p. 170, Comment 7.20). However, no detailed analysis is presented to justify U.S. EPA's definitive statement that these wells are sufficient. U.S. EPA's simple declarative statement that these two monitoring wells above the confining zone "are sufficient" does not make it so.

My original comment was based on the following U.S. EPA regulation that requires the permit applicant to provide a detailed analysis justifying the number and placement of monitoring wells:

*The owner or operator of a Class VI well must prepare, maintain, and comply with a testing and monitoring plan to verify that the geologic sequestration project is operating as permitted and is not endangering USDWs. The requirement to maintain and implement an approved plan is directly enforceable regardless of whether the requirement is a condition of the permit. The testing and monitoring plan must be submitted with the permit application, for Director approval, and must include a description of how the owner or operator will meet the requirements of this section, including accessing sites for all necessary monitoring and testing during the life of the project. Testing and monitoring associated with geologic sequestration projects must, at a minimum, include:*

...

*(d) Periodic monitoring of the ground water quality and geochemical changes above the confining zone(s) that may be a result of carbon dioxide movement through the confining zone(s) or additional identified zones including:*

*(1) The location and number of monitoring wells based on specific information about the geologic sequestration project, including injection rate and volume, geology, the presence of artificial penetrations, and other factors; and*

*(2) The monitoring frequency and spatial distribution of monitoring wells based on baseline geochemical data that has been collected under §146.82(a)(6) and on any modeling results in the area of review evaluation required by §146.84(c).*

(U.S. EPA Final Rule, 2010, at p. 77298, AR #330). According to these regulations, FutureGen is required to submit a detailed description of how the number and placement of monitoring wells have been determined based on specific information about the project (e.g., injection rate and



volume, geology, presence of artificial penetrations, baseline geochemical data, and modeling conducted for the AoR delineation) such that they will be sufficient to detect leakage that endangers a USDW.

U.S. EPA's Testing and Monitoring Guidance document further states:

*The number of required monitoring wells may be greater for projects with larger predicted areas of elevated pressure and/or plume movement, or in cases of more complex or heterogeneous injection/confining zone hydrogeology. If the predicted area of impact of a given project increases in size as indicated during an AoR reevaluation, additional monitoring wells may be necessary...*

*The number of monitoring wells placed above the confining zone should be determined such that any leakage through the confining zone that may endanger a USDW will be detected in sufficient time to implement remedial measures. The number of monitoring wells above the confining zone may be determined based on a modeling and/or statistical analysis, which may be documented in the Testing and Monitoring Plan. Considerations that may be included in this analysis are the regional hydraulic gradient, flow paths, transmissivity, and baseline geochemistry.*

(U.S. EPA, 2013b, p.56-57/115; AR # 441). However, FutureGen's permit application does not include any of the analyses (e.g., modeling, statistical methods, baseline geochemistry evaluation) to justify monitoring well placement as required by U.S. EPA regulations and suggested in U.S. EPA guidance to be protective of USDWs. Similarly, U.S. EPA has not provided any detailed justification for why they have accepted FutureGen's proposed monitoring network as sufficient. In the absence of any such justification, it appears that FutureGen and U.S. EPA are assuming that these two wells above the confining zone are sufficient without any clear scientific basis.

In order to be consistent with U.S. EPA regulations, FutureGen should present a detailed analysis justifying the placement of monitoring wells, in consideration of the most recently updated AoR, and including a search for all potential leakage pathways within the expanded AoR. Additional monitoring wells may be necessary.

**7.) U.S. EPA and FutureGen provide no justification for limiting their survey for artificial penetrations (e.g., abandoned wells) to a public records search**



Another comment on the FutureGen permit application submitted to U.S. EPA stated that the well survey (or search of artificial penetrations) was inadequate because it was limited to a search of local public records even though the public records are incomplete (AR # 497, Price Expert Report Ex. 1, pp. 3-5). In rejecting this comment, U.S. EPA states that they have accepted FutureGen's well survey because they performed their own search of the same public well records (See U.S. EPA Response, AR #511, p. 96, Comment 3.52). Because U.S. EPA limited their well survey to a search of the same public records as FutureGen, U.S. EPA's search is subject to the same limitations and is not sufficient to identify abandoned wells that may pose a risk of endangering a USDW.

Artificial penetrations (i.e., active and abandoned wells, mines) represent a critical potential leakage pathway from the geologic zone(s) where CO<sub>2</sub> is injected into USDWs. For this reason, the primary purpose of plume/pressure-front modeling is delineation of the AoR, the area within which the owner/operator is required to identify all artificial penetrations that may penetrate the confining zone (U.S. EPA, 2010; §146.84(c)(2), AR # 329).

Previous experience indicates that abandoned wells are often not listed in public records. Early U.S. EPA UIC program guidance on abandoned wells searches states:

*The exact location of many abandoned [wells] are often difficult to determine because records may be imprecise, incomplete, antiquated, and difficult to locate. Record searches can be time consuming and expensive, and there is always a chance that a records search will not show an abandoned well falling within the radius of review for an injection well. Other means for locating abandoned wells are needed.*

(U.S. EPA, 1985). More recently, U.S. EPA guidance for geologic sequestration projects states:

*A variety of types of abandoned wells may exist within the delineated AoR of a proposed GS project, including wells constructed prior to federal or state regulation (i.e., in the late 1800s or early 1900s) and any recently decommissioned wells. Wells constructed during early oil exploration, including cable-tool drilled wells, pose the largest risk because these wells may be relatively deep and often consist of an open (i.e., non-cased) well bore over much of their length. **These older wells may also not have been documented in state or local records.***

(U.S. EPA, 2013a, p.51/83; AR # 439, emphasis added). For this reason, U.S. EPA guidance suggests that abandoned well surveys include (1) historical research, (2) site reconnaissance, (3)



review of aerial and satellite imagery, and (4) one or more field geophysical surveys (U.S. EPA, 2013a, p.52/83; AR # 439). FutureGen and U.S. EPA have performed only the first step in this sequence (historical research) by searching local public records.

In regard to step 3 – review of aerial and satellite imagery, U.S. EPA guidance states: “EPA recommends that historical aerial photographs and satellite imagery be used in the identification of abandoned wells” (U.S. EPA, 2013a, p.53/83; AR # 439).

In regard to step 4 – geophysical surveys, U.S. EPA guidance states: “EPA recommends geophysical surveys throughout the regions of the AoR that may have been subject to oil and gas exploration, deep well injection, or any other activity that may result in deep well penetration” (U.S. EPA, 2013a, p.53-54/83, AR # 439). The FutureGen AoR includes areas subject to oil and gas exploration and deep well injection, and therefore U.S. EPA guidance recommends geophysical surveys be performed for the FutureGen project.

In responding to the original comment, U.S. EPA states that site reconnaissance, review of aerial and satellite imagery and geophysical surveys are “not required nor always appropriate” (See U.S. EPA Response, AR #511, p. 96, Comment 3.52). U.S. EPA provides no clarification in their response to specify under what conditions U.S. EPA has determined that these additional steps beyond public records search are warranted, and why these steps are not warranted for the FutureGen project inconsistent with U.S. EPA guidance as cited above. In the absence of such a justification, it appears that U.S. EPA and FutureGen are assuming the public records search is sufficient without any clear basis.

U.S. EPA’s abandoned well survey was limited to the same local public records search as FutureGen’s, and is therefore subject to the same limitations. Therefore, U.S. EPA has not addressed the original comment that additional steps are warranted to identify abandoned wells that may be a leakage pathway and pose a risk of endangering USDWs.



## References

Daniel B. Stephens & Associates, Inc. (DBS&A, 2014). Expert Report of Gregory Schnaar, Ph.D. Comments on FutureGen Alliance UIC Draft Permits for FutureGen 2.0 Morgan County Class VI UIC Wells 1, 2, 3, and 4. May 15, 2014 (AR #497, Ex. 2).

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*Daniel B. Stephens & Associates, Inc.*

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**CERTIFICATE OF SERVICE**

The undersigned, an attorney, certifies that copies of the foregoing Petition for Review in the matter of FutureGen Industrial Alliance, Inc., Permit No. IL-137-6A-004, Appeal No. \_\_\_\_\_, were served by United States First Class Mail on the following persons, this 1<sup>st</sup> day of October 2014:

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