

FutureGen Corrective Action Evaluation Illinois State Geological Survey (ISGS) Well Data

July 2014

1 Introduction

An ISGS dataset of wells in the vicinity of the proposed FutureGen geologic sequestration (GS) project was evaluated to assess the wells within the project's area of review (AoR). Specifically, the data were analyzed to:

- Determine the number of wells located within the boundary of the AoR (defined with the 60-year 10 psi pressure contour).
- Determine which of the wells in the AoR penetrate the confining zone.
- Determine which wells are located on the Leinberger or Critchelow properties, to address relevant comments on the draft FutureGen permit.

2 ISGS Dataset

The file "ISGShead.xlsx" received from ISGS contains a total of 18,219 records, organized by API number. All of the API numbers indicate a location within the eight-county area of Cass, Greene, Macoupin, Mason, Menard, Morgan, Sangamon, and Scott counties, and all but 27 entries have latitude/longitude information.¹ Based on the coordinate data, a comparatively small number of wells in the dataset appear to be located outside of the eight-county region. These wells are shown in red in the map in Figure 1.

A total of 68 wells appear to fall outside of the eight-county region (including 27

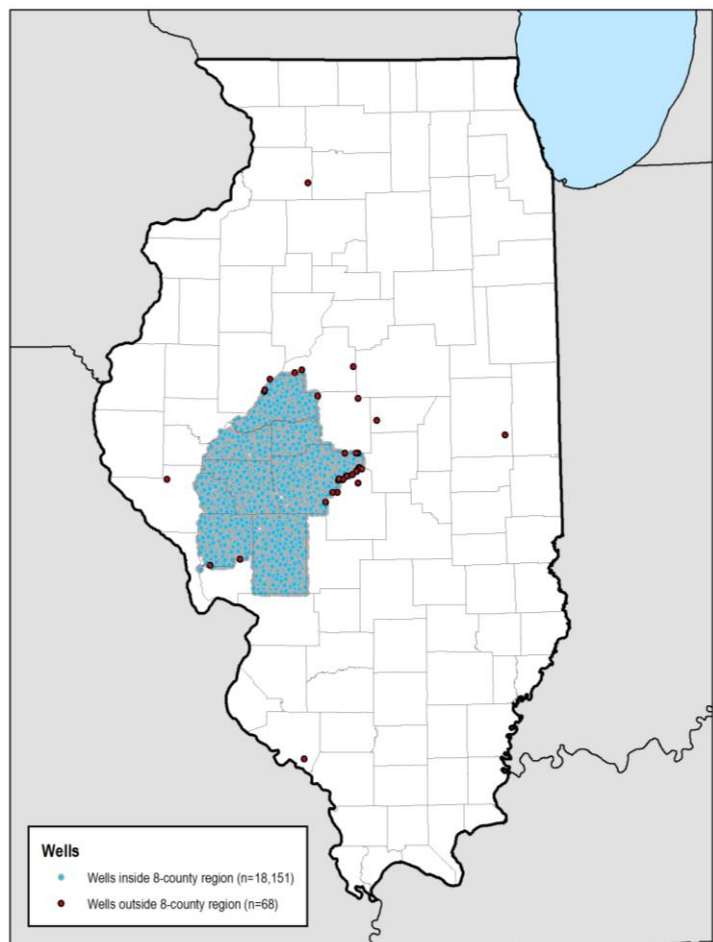


Figure 1. Wells in the ISGS dataset that fall outside the eight-county area. Of the 68 wells meeting this criterion, 44 wells have coordinate data and are shown in red on the map.

¹ In Illinois, an API number has 12 digits: the state code ("12"), a three digit county code, a five-digit unique well identifier, and a two-digit re-drill code. API numbers that are identical except for the last two digits represent the same physical borehole. As a result, there are fewer than 18,219 wells represented in this dataset.

wells that do not have coordinate data). As shown in the map, the majority of the wells that have coordinates but fall outside the eight-county region (34 wells total) are very close to the region's boundaries. Seven wells have coordinates for other parts of the state.

The Illinois Oil and Gas Resources (<http://maps.isgs.illinois.edu/iloil/>) and Illinois Water & Related Wells (<http://maps.isgs.illinois.edu/ilwater/>) online map tools were used to investigate the true locations of the wells apparently located outside the eight-county area and of the wells without coordinates. Both tools were searched for the API numbers of each of the 68 wells, with the following results:

- Of the 34 wells with coordinates that are very close to the eight-county region's boundaries, 11 were found using the ILOIL tool and 21 were found using the ILWATER tool (the remaining two API numbers were not found using either tool). Based on the well records available online, it appears that these wells may in fact be located in the counties indicated by their API numbers. It seems possible that the reported coordinates for these wells are just somewhat imprecise (potentially as a result of the conversion from township/section/range to latitude/longitude). Of these wells, 26 are less than 500 ft deep, and the remaining wells (all approximately 1,800 ft deep) reach Silurian rocks that are well above the confining zone.
- All seven of the wells with coordinates farther from the eight-county region's boundaries were found using the ILWATER tool. As with the wells above, it appears that these wells may actually be located in the counties indicated by their API numbers. It is unclear why the coordinates reported for these wells do not agree with the counties listed in the well records; further investigation of the township/section/range descriptions reported for these wells would be necessary to gather more information on the wells' true locations. The deepest of these wells is 115 ft deep.
- None of the wells without coordinates were found using the ILOIL or ILWATER tools. Of these 27 wells, 26 have depths less than 725 ft. Based on other information in the dataset, the remaining well (API number 121372149000) appears to be located in the Waverly gas storage field (see Section 4). At 1,700 ft, the depth of this well is shallower than the top of the confining zone in that area.

The results of these searches are presented in more detail in the file "ISGShead Review.xlsx" in the "FlaggedWells" sheet.

3 Wells in the AoR

Of the 18,192 wells with coordinates in the ISGS dataset, 6,110 are located within the AoR (as delineated using the 60-year 10 psi pressure contour). The locations of all the wells in relation to the AoR boundary are shown on the map in Figure 2. For comparison, the figure also shows the outline of the maximum extent of the plume, as well as structural contour lines indicating the top of the Eau Claire Formation (the confining zone) in ft below sea level.

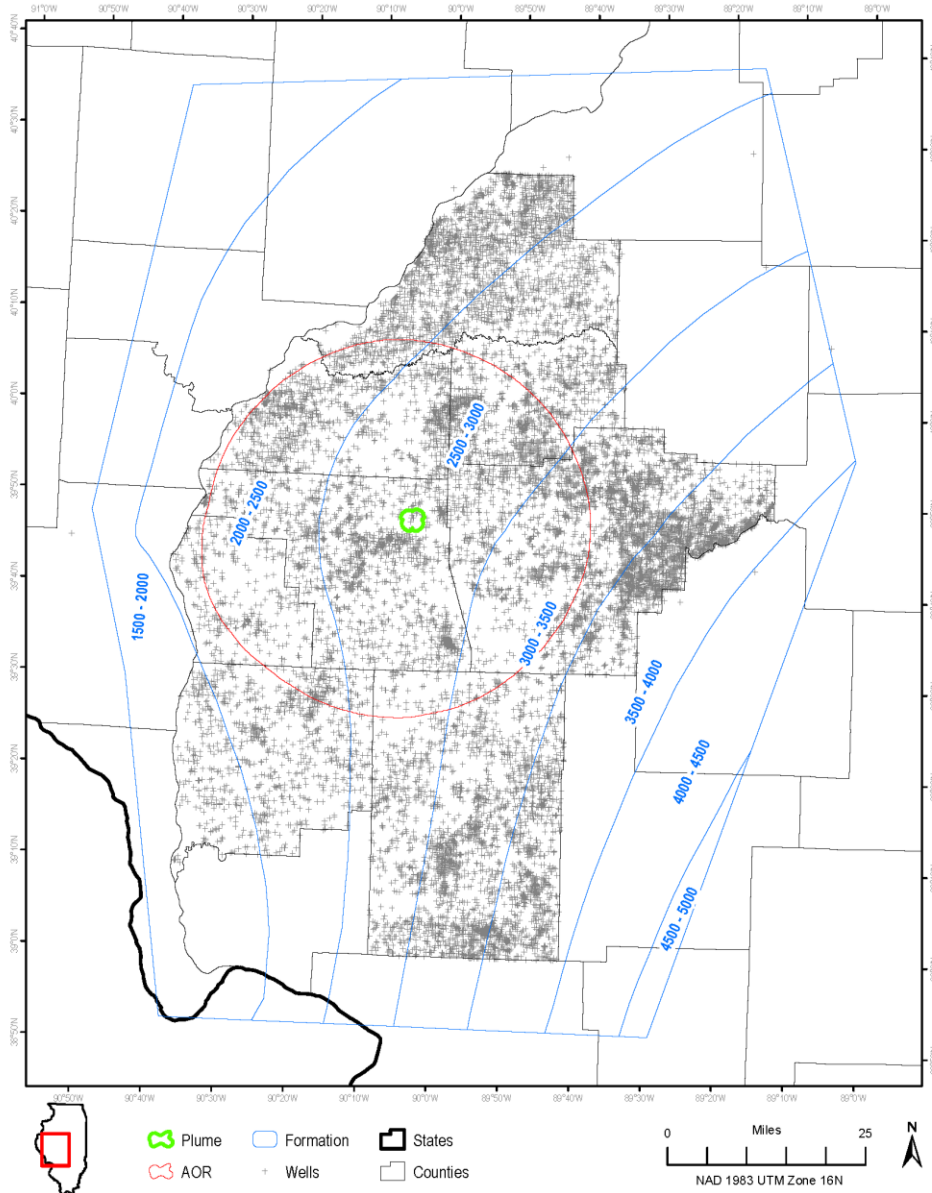


Figure 2. Wells in the ISGS dataset (in gray) compared to the maximum extent of the plume (the small green boundary) and pressure front (the large red boundary). Blue contour lines represent the top of the Eau Claire Formation in ft below sea level, as shown in Figure 2.8 of FutureGen’s permit application.

4 Wells Penetrating the Confining Zone in the AoR

FutureGen reported the following corrective action information in Section 3.2.1 of the original permit application (page 3.45):

With the exception of the stratigraphic well, the nearest wells that have penetrated through the primary confining zone (Eau Claire Formation) and into the injection zone (Mount Simon Sandstone) are more than 16 mi away in the Waverly Storage Field (Figure 3.28), south-southwest of the proposed storage site, and are not in the AoR. The two boreholes, the Criswell #1-16 (API number 121370034900) and Whitlock #7-15 (API number 121370034601), are part

of the Waverly Storage Field, which is an active natural-gas storage facility that is currently operated by Panhandle Eastern Pipeline Company. The primary storage reservoir used at the Waverly Storage Field is the St. Peter Sandstone. However, several wells were drilled into the underlying Ironton-Galesville Sandstone and two test wells were drilled into the Mount Simon Sandstone. The Ironton-Galesville Sandstone was selected as a second storage reservoir and received natural-gas exchange beginning in 1968 (Buschbach and Bond 1974).

Well construction details obtained from available records for the Criswell #1-16 and Whitlock #7-15 wells are presented in Figure 3.29 and Figure 3.30, respectively. The Criswell #1-16 well was drilled approximately 133 ft into the Mount Simon Sandstone to a total depth of 4,253 ft. A cement plug was placed in the bottom of the well and the casing was perforated within the Ironton/Galesville Sandstone, presumably for natural-gas storage. In 1978, the well was reconfigured as an observation well by isolating the original perforations with a bridge plug, and recompleting the well with additional perforations above the primary storage reservoir (St. Peter Sandstone) within the Joachim “B” horizon.

Records available for the Whitlock #7-15 well indicate that it was drilled to a total depth of 4,250 ft in 1965 and completed as a saltwater disposal well in 1966. However, the depth interval or reservoir used for saltwater disposal was not determined from available records. In 1997, the well was reconfigured as an observation well and completed below the primary (St. Peter Sandstone) storage reservoir with perforations across the Oneota Dolomite and Potosi Dolomite.

Both wells are believed to have been sufficiently plugged and recompleted, and are not considered to represent a risk of providing a preferential pathway for leakage of formation brine to surface or near-surface environments. Subsequently, no direct monitoring and/or corrective action will be performed.

Of the 6,110 wells within the AoR in the ISGS dataset, 5,660 (approximately 93%) are shallow wells less than 500 ft deep. One well (API number 120170011000) does not have a depth reported in the ISGS dataset; the well’s record in ILWATER indicates that this is a private water well and as such it is assumed that the well does not penetrate the confining zone.

To obtain a preliminary estimate of how many wells penetrate the top of the confining zone, the depth of each well in the AoR was compared to the depth of the top of the Eau Claire Formation. Contours representing the depth of the top of the Eau Claire Formation were provided by FutureGen in Figure 2.8 of the original permit application. Because the structural contour data were provided in ft below sea level, and the well depths reported in the ISGS dataset were assumed to (approximately) reference ground level, the ISGS well depths were converted to elevations above sea level for the purposes of this evaluation using a digital elevation model from ISGS.²

The preliminary comparison of well depths to the structural contour data identified 20 wells in the AoR that were deeper than the shallower bound of the relevant contour interval. (For example, a well 2,575 ft deep located within the 2,500 ft to 3,000 ft contour interval would meet this criterion.) These wells were considered to be candidates for penetrating the top of the confining zone and were selected for further evaluation of the information from the ISGS dataset, ILOIL, and/or ILWATER, with the following results:

² See metadata at http://crystal.isgs.uiuc.edu/nsdihome/outmeta/il_dem_30m.html.

- For 13 of these 20 wells, a “total depth formation” was identified in the ISGS dataset: one in the New Richmond, 10 in the Galesville, and two in the Mt. Simon. The New Richmond and the Galesville are located above the Eau Claire. The ISGS dataset confirms that the two Mt. Simon wells are the Whitlock #7-15 and Criswell #1-16 wells noted by FutureGen.
- Five wells without a reported formation appear to be located within the Waverly field, located within the AoR about 20 miles from the proposed injection site (see Figure 3):
 - Three of these wells (API numbers 121370041101, 121370060301, and 121370060401) are duplicates of wells reported to be drilled into the Galesville (API numbers 121370041100, 121370060300, and 121370060400, respectively).
 - The remaining two wells (API numbers 121370060100 and 121370060200) have scout tickets available in ILOIL suggesting that they are also drilled into the Galesville.
- The two remaining wells (API numbers 121370034600 and 121370034602) are duplicates of the Whitlock #7-15 well (API number 121370034601).

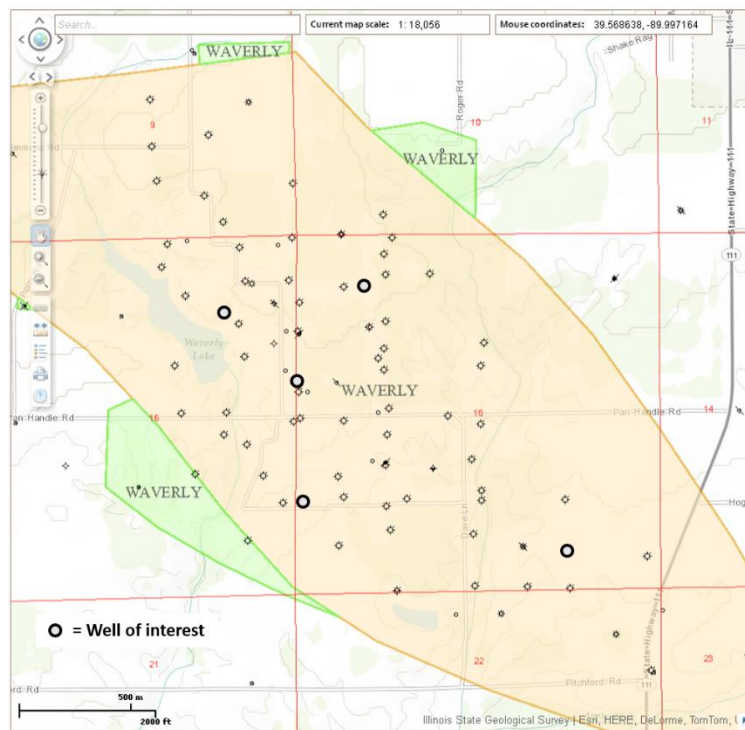


Figure 3. Approximate locations of the five wells without a reported formation located within the Waverly field. Based on documentation available online in ILOIL, these wells appear to be drilled into the Galesville.

Based on this analysis, two boreholes penetrate the top of the confining zone within the AoR: the Whitlock #7-15 well (API number 121370034601) and Criswell #1-16 well (API number

121370034900). These are the same wells identified by FutureGen, though these wells fell outside the boundary of the proposed AoR as delineated in the original permit application.

5 Wells Located on the Leinberger and Critchelow Properties

To investigate which wells in the ISGS dataset are located within the Leinberger and/or Critchelow properties, the property boundaries provided in comments #156–157 were georeferenced and plotted on the map in Figure 4. The map shows wells in the ISGS dataset that fall within the property boundaries in red, and nearby wells (within approximately 1,500 m of either property) are shown in orange.

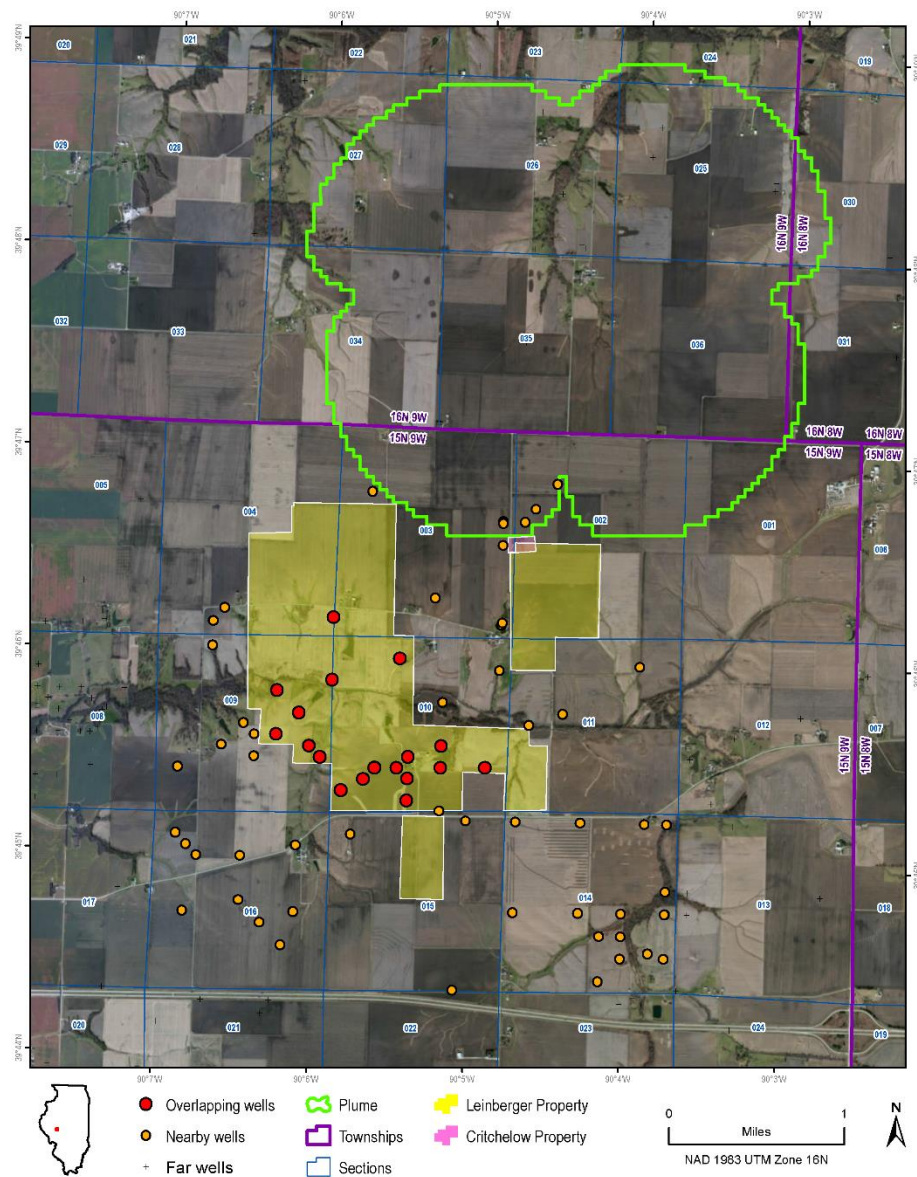


Figure 4. Wells located on the Leinberger/Critchelow properties (red dots) and nearby wells (orange dots).

Based on the coordinate data, there are 20 wells on the Leinberger property within the ISGS dataset, plus an additional 58 nearby wells. (No wells are located within the Critchelow property boundaries.) Among the 20 wells located on the Leinberger property, there are 12 dry holes, five gas wells, one water well, one coal test well, and one well that was permitted but may never have been drilled. The deepest of the wells is 390 ft; as such, none penetrate the confining zone.

In his comment on the draft FutureGen permit (Exhibit 4, comment #154), Karl Leinberger makes several statements regarding the Leinberger property wells. These statements, with notes from the ISGS dataset analysis, are given in Table 1. Additional details on the Leinberger property wells are given in the file “ISGShead Review.xlsx”

Table 1. Leinberger comments on the wells within the AoR and associated notes from the ISGS dataset analysis. Page numbers refer to the AoR and Corrective Action Plan (Appendix B to the draft permit).

Items from Comment #154	Analysis Notes
<p>6. The draft permit for FutureGen's project identifies only one oil/gas well located on Leinberger Property that is properly identified. This oil/gas well is identified as Map ID Number 118. The oil/gas wells identified as Map Id Numbers 116 and 119 appear to be located on Leinberger Property, but are misidentified in Table 9 on page B35 of the draft permit as belonging to other owners.</p>	<p>The information presented in the AoR and Corrective Action Plan for well 116 (API number 121370024600) and well 119 (API number 121370007900) is consistent with the ISGS dataset. The “Owner” column in Table 9 of the AoR and Corrective Action Plan represents the wells’ farm name, not necessarily the property owner.</p>
<p>7. There are 17 non-producing oil/gas wells located on Leinberger Property that are reflected in the Illinois State Geological Survey (“ISGS”) database, but are not reflected in FutureGen's draft permit in Table 9 or Figure 12 on pages B33-B37. Attached hereto as Exhibit B is a true and accurate printout of oil/gas wells located on Leinberger Property and vicinity that were recorded with the ISGS (http://isgs.illinois.edu/iloil), as well as a true and accurate demarcation of Leinberger Property boundaries.</p>	<p>The ISGS dataset includes 20 wells that are located on the Leinberger property. Four of these wells are included in Table 9 of the AoR and Corrective Action Plan:</p> <ul style="list-style-type: none"> • Map ID 114, API number 121372086900 • Map ID 116, API number 121370024600 • Map ID 118, API number 121372105200 • Map ID 119, API number 121370007900 <p>The remaining wells are not included in Table 9.</p>
<p>8. There are two non-producing natural gas wells located on Leinberger Property that are not reflected in the draft permit nor in the ISGS database. One old natural gas well is located within 0.3 miles of FutureGen's projected carbon dioxide plume. The second old natural gas well is approximately 0.7 miles from the projected plume. Both of these wells are identified on the map attached hereto as Exhibit B as "1" and "2".</p>	<p>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.</p>