

POST-INJECTION SITE CARE AND SITE CLOSURE PLAN  
40 CFR 146.93(a) and 16 TAC 5.203(m)

**Sugarberry CCS Hub**

**Facility Information**

Facility Name: Sugarberry CCS Hub

Facility Contact: Sugarberry CCS, LLC  
14302 FNB Parkway  
Omaha, NE 68154

RRC Organization  
Report Number: 102245

Well Locations: Projection WGS84

Well	County/State	Latitude	Longitude
SB-01	Hopkins, TX	33.202707	-95.338539
SB-02	Hopkins, TX	33.189225	-95.375952
SB-03	Hopkins, TX	33.196028	-95.405035
SB-04	Hopkins, TX	33.219565	-95.434859
SB-05	Hopkins, TX	33.207361	-95.385666

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### **List of Acronyms/Abbreviations**

AOB	Above-Zone Observation Well
AoR	Area of Review
APHA	American Public Health Association
ASTM	American Society for Testing and Materials
CCS	Carbon Capture and Sequestration
CFR	Code of Federal Regulations
CO <sub>2</sub>	Carbon Dioxide
DAS	Distributed Acoustic Sensing
DFOS	Distributed Fiber Optic Sensing
DSS	Distributed Strain Sensing
DTS	Distributed Temperature Sensing
EPA	Environmental Protection Agency
ERRP	Emergency and Remedial Response Plan
Ft-MSL	Feet Relative to Mean Sea Level
ICP	Inductively Coupled Plasma
IOB	In-Zone Observation Well
MIT	Mechanical Integrity Testing
MS	Mass Spectrometry
OES	Optical Emission Spectrometry
PISC	Post-Injection Site Care
PNC	Pulsed Neutron Capture
psi	Pounds per square inch
QASP	Quality Assurance and Surveillance Plan
RRC	Railroad Commission of Texas
sCO <sub>2</sub>	Supercritical Carbon Dioxide
TAC	Texas Administrative Code
TBD	To be Determined
TCEQ	Texas Commission on Environmental Quality
TD	Total Depth
TDS	Total Dissolved Solids
UIC	Underground Injection Control
UOB	USDW Observation Well
USDW	Underground Source of Drinking Water
VSP	Vertical Seismic Profile



## **A. Introduction**

This Post-Injection Site Care (PISC) and Site Closure plan describes the activities that Sugarberry CCS, LLC will perform to meet the requirements of 40 CFR 146.93 and 16 TAC 5.203(m). This plan is based on the results of computational modeling performed pursuant to delineation of the Area of Review (AoR). Sugarberry CCS, LLC will monitor ground water quality and track the position of the CO<sub>2</sub> plume and pressure front for the default PISC timeframe of 50 years following the end of injection (**Figure 9-1**). Sugarberry CCS, LLC will not cease post-injection monitoring until a demonstration of non-endangerment of USDWs has been approved by the UIC Program Director pursuant to 40 CFR 146.93(b)(3) and RRC Director pursuant to 16 TAC 5.203(m)(1). Sugarberry CCS, LLC will submit a Notice of Intent (NOI) for site closure to the UIC Program Director and RRC Director at least 120 days prior to initiating closure activities. Following approval for site closure, Sugarberry CCS, LLC will plug all monitoring wells, restore the site to its original condition, and submit a site closure report and associated documentation.

## **B. Pre- and Post-Injection Pressure Differential [40 CFR 146.93(a)(2)(i) and 16 TAC 5.203(m)(2)]**

As discussed in the **AoR and Corrective Action Plan (Section 2)**, the delineated AoR for the Sugarberry CCS Hub is based on the Maximum Extent of the Separate-phase Plume and/or Pressure-front methodology over the lifetime of the project, as detailed in the “UIC Program Class VI Well Area of Review Evaluation and Corrective Action Guidance” (EPA, 2013). Simulations show that in all years, pre- and post-injection, the critical pressure is not exceeded in the simulation domain (see discussion in **Section 2.D** for details). The AoR is delineated as the maximum extent of the supercritical CO<sub>2</sub> plume over the lifetime of the project. Modeled pressure differentials do not exceed the calculated critical pressure for the Sugarberry CCS Hub. **Figure 9-2** shows the pressure differentials calculated in the dynamic model over time at the five (5) proposed injection wells, both at the top of the Woodbine injection zone (base of the confining zone, Eagle Ford) and the top of the Paluxy injection zone. In both cases, the majority of the pressure buildup occurs within the first ten (10) years of injection.

The maximum predicted injection pressure differential over the life of the project within the Woodbine occurs approximately 11 years into injection at SB-05 (360 psi). Injection into the Woodbine stops at wells SB-04 and SB-05 after ten (10) years, with continued injection at SB-01 through SB-03 until 20 years. When injection into the Woodbine stops at 20 years, pressure differentials rapidly begin falling off, as seen from the concave-up pattern on **Figure 9-2**. Pressure differentials fall to about 30 psi or less at the injection wells by the end of the PISC period at 80 years model time. Pressure differentials continue to decrease after the end of the PISC period at a slower rate.

The maximum predicted injection pressure differential over the life of the project within the Paluxy occurs approximately 21 years into injection at SB-05 (828 psi). Injection into the Paluxy stops at wells SB-04 and SB-05 after 20 years, with continued injection at SB-01 through SB-03 until 30 years. Similar to the Woodbine, pressure differentials rapidly begin falling off after injection into the Paluxy stops at 30 years, as seen from the concave-up pattern on **Figure 9-2**. Pressure differentials fall to about 160 psi at the injection wells by the end of the PISC period at 80 years model time and continue to decrease after the end of the PISC period at a slower rate.

Predicted pressure differentials at the observation wells compared to the injection wells are shown on **Figures 9-3 through 9-6**. Note that the pressure differential contours terminate at the approximate location of the Mexia-Talco Fault Zone. This fault zone is encoded into the computational model as a vertical band with impermeable properties assigned and therefore does not allow pressure to migrate across the fault zone. By the end of the PISC period, pressure differentials are similar (to within 50 psi) at the injection wells and observation wells (**Figure 9-6**). Additional information on the projected post-injection pressure declines and differentials is presented in the **AoR and Corrective Action Plan (Section 2)**.

### **C. Predicted Position of the CO<sub>2</sub> Plume and Associated Pressure Front at Site Closure [40 CFR 146.93(a)(2)(ii) 16 TAC 5.203(m)(3)]**

As discussed in **Section B** of this plan and the **AoR and Corrective Action Plan (Section 2)**, the delineated AoR for the Sugarberry CCS Hub is governed by the maximum extent of the supercritical CO<sub>2</sub> plume. Simulations show that in all years, pre- and post- injection, the critical pressure is not exceeded in the simulation domain (see discussion in **Section 2.D of the AoR and Corrective Action Plan** for details). **Figure 9-7** shows the predicted maximum extent of the plume at the end of the 50-year PISC timeframe (Year 80) compared to the delineated AoR (overall maximum plume extent).

The CO<sub>2</sub> plume within the Woodbine continues to migrate northward (up-dip) after the end of the PISC period near IOB-04, IOB-02, and IOB-01, though at a slower rate. As modeled, the plume migrates less than a mile to the north towards IOB-02 and IOB-04 and about one mile to the north near IOB-1 between 80 and 200 years (**Figure 9-7**) and CO<sub>2</sub> saturations are low at the leading edges of the plume, indicating dissolution (**Figure 9-21**).

The CO<sub>2</sub> plume within the Paluxy is slightly less mobile compared to the Woodbine and migrates in the same direction. Given the slowed rate of plume migration and decrease in pressure differentials by 80 years, shown by current modeling results, and the minimal number of artificial penetrations in the path of the leading edge of the CO<sub>2</sub> plume, the default 50-year PISC timeframe and following closure will be suitable to demonstrate USDW non-endangerment.

Refer to **Section D.2 of the AoR and Corrective Action Plan** for more details on AoR stability and **Section C.2 of the AoR and Corrective Action Plan** for plume stability. **Figures 2-36 and 2-37 in Section 2.C.2 of the AoR and Corrective Action Plan** show the distribution of trapped supercritical CO<sub>2</sub> as a function of time. Throughout the project lifetime, 100% of the supercritical CO<sub>2</sub> mass is trapped. The trapping mechanisms are dissolution in the aqueous phase, immobilization by capillary forces, and immobilization by the low permeability and high capillary entry pressure of the primary regional seal. At this time, site specific data for relative permeability and capillary pressure are not available and values used in the dynamic model are therefore based on literature-based assumptions. See **Section 2.B of the AoR and Corrective Action Plan** for a discussion of these values and the accompanying references. Future site characterization efforts and pre-operational testing during the construction phase will focus on collecting site-specific data for the injection and confining zones, including cores to measure relative permeability and capillary pressure to calibrate the model and better understand plume mobility and pressure front migration. In addition, as detailed in the **Testing and Monitoring Plan (Section 7)**, monitoring before and during injection will directly measure pressure changes in the near- and far-field,

indirectly monitor the CO<sub>2</sub> plume via vertical seismic profiles (VSPs) and help understand migration rates and stability. Refer to **Section C.4 of AoR and Corrective Action Plan (Section 2)** for details on the sensitivity analyses conducted for the computational model.

#### **D. Post-Injection Monitoring Plan [40 CFR 146.93(b)(1) and 16 TAC 5.203(m)(4)]**

Performing post-injection monitoring as described in the following sections during the post-injection phase will meet the requirements of 40 CFR 146.93(b)(1) and 16 TAC 5.203(m)(4). The results of all post-injection phase testing and monitoring will be submitted annually, within 90 days of receiving analytical results, as described under **Section C.3** of this plan.

Monitoring during the post-injection phase will include a combination of:

- Groundwater quality and geochemical monitoring to capture potential vertical migration of CO<sub>2</sub> out of the reservoir after injection through loss of containment;
- Pressure front tracking to observe how elevated pressures related to injection dissipate within the reservoir and near the confining zone (Eagle Ford) over time following injection and to capture potential pressure changes in units above the confining zone; and
- CO<sub>2</sub> plume tracking to observe the direction and rate of plume migration after cessation of injection.

**Figure 9-1** shows an overview of the proposed monitoring network within the AoR. The proposed injection period for the Sugarberry CCS Hub is 30 years. Wells SB-04 and SB-05 are planned to stop injecting after 20 years, at which time they will be considered in-zone observation (IOB) wells and follow the proposed monitoring and reporting methods for IOB wells until the end of the injection period at 30 years. Injection wells SB-01, SB-02, and SB-03 will be converted to IOB wells at 30 years when the PISC phase begins. Each injection well will be used as IOB wells for five (5) years following cessation of injection to monitor pressure front dissipation. As such, the injection wells will be plugged five (5) years after cessation of injection (i.e., at Year 35). This monitoring and reporting scheme is outlined in **Appendix 9-A**.

All observation well locations, methods, and schedules are designed to assess the CO<sub>2</sub> plume, monitor the pressure front, and provide evidence for the USDW non-endangerment demonstration required for Site Closure pursuant to 40 CFR 146.93(b) and 16 TAC 5.203(m)(1). Sugarberry CCS, LLC plans to secure options for rights to surface access in the AoR for the life of the project.

Details for each post-injection monitoring method are provided in **Tables 9-1 through 9-5**. All monitoring related to injection operations will end at cessation of injection and are described in the **Testing and Monitoring Plan (Section 7)**. The monitoring technologies and methods proposed in this plan reflect those proposed in the **Testing and Monitoring Plan** with frequencies adjusted accordingly. A **Quality Assurance and Surveillance Plan (QASP)** applicable to all testing and monitoring activities is provided as **Section 7.1**.

### **D.1. Groundwater Quality and Geochemical Monitoring**

**Table 9-1** presents the monitoring methods, locations, depths and frequencies for monitoring above the confining zone. **Table 9-2** identifies the parameters to be monitored and the analytical methods Sugarberry CCS, LLC will employ. As discussed in the **Testing and Monitoring Plan**, each observation well will be installed prior to initiation of injection for baseline data collection and monitored throughout the injection period. These wells will be monitored throughout the proposed PISC timeframe as well as detailed in **Table 9-1**. The monitoring locations were chosen based on predicted pressure front migration and CO<sub>2</sub> plume migration throughout the injection and post-injection periods.

Observation wells designated AOB will directly monitor pressure changes and geochemistry within the lowermost permeable unit directly above the confining zone (above-zone), the Subclarksville Sand Member of the Eagle Ford Formation. The in-zone pressure monitoring data, coupled with above-zone pressure and geochemical monitoring data, will provide the first evidence of any vertical loss of containment.

Observation wells designated UOB will monitor potential USDWs (sands in the Taylor Group) within the AoR as an additional protective measure. Early indications of leakage to the above-zone and shallow USDWs would be manifested primarily as aquifer pressure increases and would be captured by downhole pressure gauges. Later indications of leakage may be detected by a change in the composition of formation water (e.g., lowering of pH and increased CO<sub>2</sub> concentration), which is more difficult to spatially capture compared to pressure changes. Above-zone and USDW observation wells have been located near the proposed injection wells since this is where the pressure differential will be highest within the injection zones and where caprock integrity concerns are highest.

Geochemical sampling at the above-zone and USDW observation wells will take place on an annual basis up to 45 days before the anniversary date of authorization of injection each year. Observation wells will follow this sample schedule throughout the PISC period until site closure is approved. Monitoring frequencies may be adjusted depending on calibrated model predictions following collection of additional site characterization and baseline data. For the continuous monitoring methods, refer to **Table 9-3** for the frequency of data sampling and recording. Fluid sampling and sample handling and custody will be performed as described in **Section B of the QASP**; and quality control will be ensured using the methods described in **Section B of the QASP**.

**Table 9-1. Monitoring of Ground Water Quality & Geochemical Changes Above the Confining Zone**

Target Formation	Monitoring Activity	Monitoring Location(s)	Estimated Depth (Top to Base) (ft-BGS)	Frequency
USDW: Sands that are characterized as USDWs in the shallow subsurface (Taylor Group)	Geochemical Monitoring via Direct Fluid Sampling during and after injection.	UOB-01 UOB-04	UOB-01: 782 (top) UOB-04: 713 (top)	Annually <sup>1</sup>
	Downhole P Gauges			Continuous
Above-Zone: Sands within the Upper Eagle Ford (Subclarksville Sand Member)	Geochemical Monitoring via Direct Fluid Sampling during and after injection.	AOB-01 AOB-04 AOB-05	AOB-01: 3082-3182 AOB-04: 3064-3164 AOB-05: 3102-3202	Annually <sup>1</sup>
	Downhole P Gauges			Continuous
<ol style="list-style-type: none"> <li>1. Annual sampling will occur up to 45 days before the anniversary date of authorization of injection each year.</li> <li>2. In-zone observation wells (IOB) will also contain downhole pressure gauges to directly monitor the pressure front. See <b>Section D.2</b> of this plan for pressure front monitoring details.</li> <li>3. Ft-BGS = feet below ground surface</li> </ol>				

**Table 9-2. Summary of Analytical & Field Parameters for Ground Water Samples**

Parameters	Analytical Methods
<b>All Monitored Zones</b>	
Cations: Al, Ba, Mn, As, Cd, Cr, Cu, Pb, Sb, Se, and Tl	ICP-MS, EPA Method 6020B (U.S. EPA, 2014) or EPA Method 200.8 (U.S. EPA, 1994)
Cations: Ca, Fe, K, Mg, Na, and Si	ICP-OES, EPA Method 6010D (U.S. EPA, 2014) (U.S. EPA, 2014) or EPA Method 200.7 (U.S. EPA, 1994)
Anions: Br, Cl, F, NO <sub>3</sub> , and SO <sub>4</sub>	Ion Chromatography, EPA Method 300.0 (U.S. EPA, 1993)
Isotopes*: $\delta^{13}\text{C}$ of Dissolved Inorganic Carbon	Isotope ratio mass spectrometry
Dissolved CO <sub>2</sub>	Coulometric titration, ASTM D513-16 (ASTM, 2016)
Total Dissolved Solids	Gravimetry, APHA 2540C (APHA)
Water Density	ASTM D4052
Alkalinity	APHA 2320B (APHA, 1997)

Parameters	Analytical Methods
pH (field)	EPA 150.1 (U.S. EPA, 1982)
Specific Conductance (field)	APHA 2510 (APHA, 1992)
Temperature (field)	Thermocouple

**Table 9-3. Sampling & Recording Frequencies for Continuous Monitoring**

Parameter	Device(s)	Location	Min. Sampling Frequency	Min. Recording Frequency
Downhole Pressure	Downhole P gauges	Downhole above packer	5 sec. / 4 hours	5 min. / 4 hours
Distributed temperature and acoustic (pressure) measurements	DTS/DAS fiber optic network	SB-(01-05); IOB-(01-04) outside long string casing to packer	10 min. / 10 min.	10 min. / 10 min.
<ol style="list-style-type: none"> <li><i>All downhole gauges will be placed above the packer and ported through to the respective well monitoring zone.</i></li> <li><i>In-zone observation wells will be equipped with downhole pressure gauges and DTS/DAS fiber optics for continuous monitoring according to the minimum sampling and recording frequencies specified above.</i></li> <li><i>DTS = Distributed Temperature Sensing; DAS = Distributed Acoustic Sensing</i></li> <li><i>Sampling frequency refers to how often the monitoring device obtains data from the well for a particular parameter. For example, a recording device might sample a pressure transducer monitoring injection pressure once every two seconds and save this value in memory.</i></li> <li><i>Recording frequency refers to how often the sampled information gets recorded to digital format (such as a computer hard drive). For example, the data from the injection pressure transducer might be recorded to a hard drive once every minute.</i></li> </ol>				

## **D.2. Carbon Dioxide Plume and Pressure Front Tracking [40 CFR 146.93(a)(2)(iii)]**

Sugarberry CCS, LLC will employ direct and indirect methods to track the extent of the carbon dioxide plume and the presence or absence of elevated pressure, consistent with those presented in the **Testing and Monitoring Plan (Section 7)**.

**Table 9-4** presents the indirect methods that Sugarberry CCS, LLC will use to monitor the CO<sub>2</sub> plume, including the activities, locations, and frequencies Sugarberry CCS, LLC will employ. Methods will include a combination of DTS/DAS fiber optics, PNC logging, and repeat seismic (e.g., 3D DAS VSPs) to detect the plume and potential CO<sub>2</sub> breakthrough. Refer to **Section I.2 of the Testing and Monitoring Plan (Section 7)** for additional detail presented on each of these methods.

**Table 9-4. Post-Injection Phase Plume Monitoring**

Target Formation	Monitoring Activity	Monitoring Location(s)	Spatial Coverage	Frequency <sup>3</sup>
<b>Indirect Plume Monitoring</b>				
Injection Zones	DTS/DAS	SB-(01-05) <sup>2</sup> ; IOB-(01-04)	Distributed measurements across target interval	Continuous
	PNC Logging <sup>1</sup>	SB-(01-05) <sup>2</sup> ; IOB-(01-04)	Distributed measurements across target interval	Once every 5 years (up to 45 days before the anniversary of date of authorization to inject).
	1) 3D DAS VSP; OR 2) 3D seismic survey	1) SB-(01-05) <sup>2</sup> ; IOB-(01-04); OR 2) AoR based seismic survey	1) Distributed measurements across target interval 2) Full AoR coverage focused on plume extent area	Once every 5 years (up to 45 days before the anniversary of date of authorization to inject).
<ol style="list-style-type: none"> <li>Other than the injection and in-zone wells, repeat PNC logging will only occur in above-zone and lowermost USDW wells with detected CO<sub>2</sub> breakthrough and containment loss.</li> <li>Injection wells will be used for monitoring for the first five years post-injection and will be plugged thereafter, with a final PNC log and VSP conducted prior to plugging.</li> <li>Sampling, testing, and logging frequencies may be altered based on project-specific benchmarks that will be defined from baseline and injection phase monitoring data.</li> </ol>				

**Table 9-5** presents the direct and indirect methods that Sugarberry CCS, LLC will use to monitor the pressure front, including the activities, locations, and frequencies Sugarberry CCS, LLC will employ. As detailed in the **Testing and Monitoring Plan (Section 7)**, wells designated IOB will directly monitor pressure changes within the injection intervals as in-zone observation wells. Monitoring each of these locations will allow Sugarberry CCS, LLC to monitor the far-field pressure front in comparison to modeled pressure changes and calibrate the model accordingly. As noted in **Section D** of this plan, the proposed injection period for the Sugarberry CCS Hub is 30 years. Wells SB-04 and SB-05 are planned to stop injecting after 20 years, at which time they will be considered in-zone observation (IOB) wells and follow the proposed monitoring and reporting methods for IOB wells until the end of the injection period at 30 years. Injection wells SB-01, SB-02, and SB-03 will be converted to IOB wells at 30 years when the PISC phase begins. Each injection well will be used as IOB wells for five (5) years following cessation of injection to monitor pressure front dissipation. As such, the injection wells will be plugged five (5) years after cessation of injection (i.e., at Year 35). This monitoring and reporting scheme is outlined in **Appendix 9-A**. Microseismicity via DAS will be continuously monitored at the injection wells and in-zone observation wells. Refer to **Section I.4 of the Testing and Monitoring Plan (Section 7)** for additional detail presented on each of these methods.



**Table 9-5. Post-Injection Phase Pressure-Front Monitoring**

Target Formation	Monitoring Activity	Monitoring Location(s)	Spatial Coverage	Frequency <sup>2</sup>
Direct Pressure-Front Monitoring				
Injection Zones (Woodbine and Paluxy)	Downhole P gauges	SB-(01-05) <sup>1</sup> ; IOB-(01-04)	Above the packer – ported to Injection Zones	Continuous; see Table 9-3
Above-Zone (Subclarksville Sand Member)		AOB-01, -04, -05	Above the packer – ported to Above-Zone	
USDW (Taylor Group sands)		UOB-01, -04	Above the packer – ported to USDW	
Indirect Pressure-Front Monitoring				
Injection Zones (Woodbine and Paluxy)	DAS Passive Seismicity	SB-(01-05) <sup>1</sup> ; IOB-(01-04)	Distributed measurements across target intervals	Continuous; see Table 9-3
<div>1. Injection wells will be used for monitoring for the first five years post-injection and will be plugged thereafter.</div> <div>2. Sampling, testing, and logging frequencies may be reduced based on project-specific benchmarks that will be defined from baseline and injection phase monitoring data.</div>				

Predicted CO<sub>2</sub> plume extents and saturations are presented in **Figures 9-8 through 9-21** and predicted pressure differentials late in the injection period and throughout the PISC period are presented in **Figures 9-3 through 9-6**. Quality assurance procedures for seismic monitoring methods are presented in **Sections A.3 and A.4 of the QASP (Section 7.1)**.

### **D.3. Schedule for Submitting Post-Injection Monitoring Results [40 CFR 146.93(a)(2)(iv) and 16 TAC 5.203(m)(5)]**

All post-injection site care monitoring data and monitoring results collected using the methods described above will be submitted to EPA and RRC in reports submitted on a semi-annual basis, within 90 days of receipt of analytical results. The reports will contain information and data generated during the reporting period; i.e. well-based monitoring data, sample analysis, and the results from updated site models.

### **E. Alternative Post-Injection Site Care Timeframe [40 CFR 146.93(c)]**

Following the cessation of injection operations, Sugarberry CCS, LLC will conduct post-injection monitoring for the default 50-year time frame until approval of site closure. Should future modeling results and AoR updates suggest an alternative PISC time frame is necessary, justification will be provided in this section in future revisions to this plan. Regardless of the alternative PISC timeframe, monitoring and reporting as described in the sections above will continue until Sugarberry CCS, LLC demonstrates, based on monitoring and other site-specific data, that no additional monitoring is needed to ensure that the project does not pose an endangerment to any USDWs, per the requirements at 40 CFR 146.93(b)(2) or (3) and 16 TAC 5.203(m)(1) and (7).



## **F. Non-Endangerment Demonstration Criteria**

Prior to approval of the end of the post-injection phase, Sugarberry CCS, LLC will submit a demonstration of non-endangerment of USDWs to the UIC Program Director, per 40 CFR 146.93(b)(2) and (3) and RRC Director per 16 TAC 5.203(m)(1) and (7).

Sugarberry CCS, LLC will issue a demonstration of non-endangerment of USDWs at the end of the PISC timeframe established in the permit to the UIC Program Director and RRC Director. The report will include all relevant monitoring data and interpretations upon which the non-endangerment demonstration is based, model documentation and all supporting data, and any other information necessary for the UIC Program Director and RRC Director to review the analysis. The report will include the following sections:

### **F.1. Introduction and Overview**

A summary of relevant background information will be provided, including the operational history of the injection project, the date of the non-endangerment demonstration relative to the post-injection period outlined in this PISC and Site Closure Plan, and a general overview of how monitoring and modeling results will be used together to support a demonstration of USDW non-endangerment.

Based on salinity calculations and the assessment of the Texas State Railroad Commission, the lowermost USDW is in the Taylor Formation at about -1600 to -1800 feet below ground surface (-1200 to -1400 feet below sea level). The top of the Woodbine Formation is approximately -3000 to -3200 feet below sea level or -3700 feet below ground surface. As such, the uppermost injection zone is vertically separated from USDWs at the Sugarberry CCS Hub by approximately 1,800 feet.

### **F.2. Summary of Existing Monitoring Data**

A summary of all previous monitoring data collected at the site, pursuant to the **Testing and Monitoring Plan (Section 7)** and this **PISC and Site Closure Plan (Section 9)**, including data collected during the injection and post-injection phases of the project, will be submitted to help demonstrate non-endangerment. Data submittals will be in a format acceptable to the UIC Program Director [40 CFR 146.91(e)] and RRC Director [16 TAC 5.207(b)], and will include a narrative explanation of monitoring activities, including the dates of all monitoring events, changes to the monitoring program over time, and an explanation of all monitoring infrastructure that has existed at the site. Data will be compared with baseline data collected during site characterization [40 CFR 146.82(a)(6) and 146.87(d)(3)]. The narrative will also include a summary of any emergencies that occurred during the injection and post-injection phases of the project per the **Emergency and Remedial Response Plan (Section 10)** and actions taken to resolve issues and prevent USDW endangerment.

### **F.3. Summary of Computational Modeling History**

The results of computational modeling used for AoR delineation will be compared to monitoring data collected during the operational and the PISC period. The data will include the results of time-lapse temperature and pressure monitoring, groundwater quality analyses, and geophysical surveys

(i.e., logging and seismic profiles) used to update the computational model and to monitor the site. Data generated during the PISC period will be used to verify that the computational model accurately represents the storage site and can be used as a proxy to determine the plume's properties and extent. Sugarberry CCS, LLC will demonstrate this degree of accuracy by comparing the monitoring data obtained during the PISC period against the model's predicted properties (i.e., plume location, rate of movement, and pressure decay). Statistical methods will be employed to correlate the data and confirm the model's ability to accurately represent the storage site. The specific metrics of comparison and methods for handling deviations will be established following the collection of additional site characterization data during construction, collection of baseline data, and model calibration and validation. The validation of the computational model with the large volume of available data will be a significant element to support the non-endangerment demonstration. Further, the validation of the complete model over the areas, and at the points where direct data collection has taken place, will help to ensure confidence in the model for those areas where surface infrastructure preclude geophysical data collection and where direct observation wells cannot be placed.

#### **F.4. Evaluation of Reservoir Pressure**

Sugarberry CCS, LLC will also show that, during the PISC period, the pressure within the injection zone decreases to a level that no longer poses potential endangerment of USDWs. Because the increased pressure during injection is the primary driving force for fluid movement that may endanger a USDW, the decay in the pressure differentials will provide strong justification that the injectate does not pose a risk to any USDWs. In addition to the rapid decay rate of the pressure in the injection interval, the lack of any measurable pressure increases in the unit directly above the Eagle Ford confining zone (above-zone; Subclarksville Sand Member), indicates that endangerment of USDWs is unlikely.

Sugarberry CCS, LLC will monitor the downhole reservoir pressure at various locations and intervals via downhole gauges and fiber optics as detailed in the **Testing and Monitoring Plan (Section 7)** and the Post-Injection Monitoring presented herein. The measured pressure at a specific depth interval will be compared against the pressure predicted by the computational model. Agreement between the actual and the predicted values will help validate the accuracy of the model and further demonstrate non-endangerment.

#### **F.5. Evaluation of Carbon Dioxide Plume**

Sugarberry CCS, LLC will use indirect (DTS, PNC logging, and 3D DAS VSP or 3D seismic surveys) monitoring methods to locate and track the extent of the CO<sub>2</sub> plume and understand its trapping and dissolution rates. The monitoring data will be compared to the expected pressure front and plume data generated by the model. A good correlation between the data sets will help provide evidence in validating the model's ability to represent the storage system. 3D DAS VSPs (or 3D seismic surveys) will be employed to determine the plume location at specific times. The data produced by these activities will be compared against the model using statistical methods to validate the model's ability to accurately represent the storage site.

Regarding the CO<sub>2</sub> plume, the PISC monitoring data will be used to support a demonstration of the stabilization of the CO<sub>2</sub> plume as the reservoir pressure declines toward its pre-injection levels.

## **F.6. Evaluation of Emergencies or Other Events**

This section covers the evaluation of events that would be considered emergencies per the ERRP (**Section 10**) and endanger USDWs.

### **F.6.A. Evaluation of Mobilized Fluids**

In addition to CO<sub>2</sub>, mobilized fluids from the injection zones may pose a risk to USDWs. These include native fluids that are high in total dissolved solids (TDS) or other mobilized drinking water contaminants (e.g., metals). The geochemical data collected from monitoring wells will be used to demonstrate that no mobilized fluids have moved above the confining zone and therefore after the PISC period would not pose a risk to USDWs. In order to demonstrate non-endangerment, the operator will compare the groundwater quality data collected during the injection and post-injection phases from units above the injection zone, including the above-zone and USDWs, against the pre-injection baseline samples. This comparison will support a demonstration that no significant changes in the fluid properties of the overlying formations have occurred and that no mobilized formation fluids have endangered USDWs through vertical migration.

### **F.6.B. Evaluation of Potential Conduits for Fluid Movement**

As detailed in the AoR and Corrective Action Plan, wells that may require corrective action will be reviewed and assessed prior to initiating injection. Artificial penetrations within the AoR and corrective action area are shown on each of the attached figures. Each penetration will be assessed prior to injection for proper construction materials and proper plugging and abandonment procedures. Any warranted corrective action will be conducted based on predicted pressure front and CO<sub>2</sub> plume migration.

## **G. Site Closure Plan**

Sugarberry CCS, LLC will conduct site closure activities to meet the requirements of 40 CFR 146.93(e) at the end of the approved PISC timeframe as described below. These activities will include the decommissioning of surface facilities and equipment, plugging monitoring wells, restoration of the site to pre-operational conditions, and preparing and submitting all documentation necessary to demonstrate that site closure has been completed.

A Notice of Intent for Site Closure is required prior to site closure activities (40 CFR 146.93(d); 16 TAC 5.206(k)(4)). Sugarberry CCS, LLC shall notify the UIC Program Director and RRC Director in writing at least 120 days in advance of commencing site closure activities. Any revisions to the **Post-Injection Site Care and Site Closure Plan** shall be submitted with this notice. If revision of the plan is not necessary, Sugarberry CCS, LLC shall demonstrate this through monitoring data and modeling results (40 CFR 146.93(a)(3)). Site closure activities shall not commence until authorization is received from the UIC Program Director.

### **G.1. Equipment Decommissioning and Site Restoration**

Surface equipment decommissioning is planned to occur in two phases: the first phase will occur after the active injection phase ends, and the second phase will take place at the end of the PISC period. Monitoring of the plume will continue at the end of the active injection phase, but there will no longer be a need for the pumping and other control equipment on location. All unnecessary equipment and temporary facilities, if applicable, will be broken down and removed. This works toward clearing space on location as well as enabling surface site reclamation processes that can begin in areas that are no longer impacted by continuing operations.

### **G.2. Plugging Monitoring Wells**

The well plugging program is designed to prevent communication between the injection reservoir and overlying USDWs. The injection and in-zone observation wells will have a direct connection between the injection interval and ground surface. Because of this, they will be plugged and abandoned using industry best practices to prevent any upward migration of CO<sub>2</sub> or other formation fluids to USDWs upon site closure.

CO<sub>2</sub>-resistant cement will be used to plug access across the injection interval, with the well then being filled with Class A, or equivalent, cement in staged increments, to prevent fugitive movement of CO<sub>2</sub> through the wellbore.

Internal and external integrity of the wells will be confirmed through the utilization of cement-bond, temperature, and/or noise logs prior to them being plugged. Additionally, a pressure test will be conducted above the perforated intervals, where present, to confirm well integrity. The results of the logging and testing will be approved before well plugging operations are to commence.

Details of injection well plugging are provided in the **Injection Well Plugging Plan (Section 8)**. Plugging for the in-zone observation (IOB) wells will follow the procedures outlined for the injection wells in the **Injection Well Plugging Plan (Section 8)**. Above-zone (AOB) and USDW (UOB) observation wells will be plugged in accordance with the procedures outlined in the Texas Commission on Environmental Quality (TCEQ) Landowner's Guide to Plugging Abandoned Water Wells (2021).

Sugarberry CCS, LLC will notify the UIC Program Director and RRC Director at least 60 days before plugging wells. Upon completion of plugging activities, a plugging and abandonment report will be submitted to the UIC Program Director within 60 days fully describing the methods used and tests performed on the monitoring wells during plugging [40 CFR 146.92(d)]. Additionally, plugging and abandonment forms will be submitted to the Texas Water Development Board within 30 days of completion of the plugging activities for each injection and observation well [16 TAC 5.203(k)(4)].

### **G.3. Site Restoration**

At the end of the active injection phase, all acreage that has been disturbed because of operations will be reclaimed and returned to its pre-development condition. Any gravel pads, access roads,

and surface facilities will be removed, and the land will be reclaimed for agricultural or other pre-development utilization unless the landowner requests that rock or fencing are to remain.

#### **G.4. Site Closure Report**

Sugarberry CCS Hub will prepare and submit a site closure report within 90 days following site closure. Contents of the report include [40 CFR 146.93(f); 16 TAC 5.206(k)(6)]:

- Documentation of injection and monitoring well plugging as specified in 40 CFR 146.92 and 16 TAC 5.206(k)(6) including pre-plugging activities, plugging procedures and the confirmation plugging requirements have been met;
- A survey plat indicating the location of the sealed injection wells relative to permanently surveyed benchmarks shall be submitted to the UIC Program Director and RRC Director. Sugarberry CCS, LLC, will submit a copy of the survey plat to the Regional Administrator of the EPA Region 6 office within 90 days of site closure;
- Notifications to state and local authorities as required at 40 CFR 146.93(f)(2);
- Documentation of appropriate notification to RRC reflecting the nature, composition, and volume of the CO<sub>2</sub> stream and any other geochemical analysis conducted at the site if necessary; and
- Post-injection monitoring records.

Additionally, Sugarberry CCS, LLC shall record a notation on the deed to the facility property that includes the following information:

- The land has been used to sequester CO<sub>2</sub>;
- The name and address of the agencies to which a plat of survey with injection well location was submitted; and
- The volume of fluid injected, injection zones into which the fluid was injected, and the period over which the injection occurred (40 CFR 146.93(f)(1)).

The site closure report will be submitted to the permitting agency and maintained by Sugarberry CCS, LLC for a period of 10 years following site closure. Additionally, Sugarberry CCS, LLC will maintain the records collected during the post-injection period for a period of 10 years after which these records will be delivered to the UIC Program Director.

##### **G.4.A. Site Closure Cost**

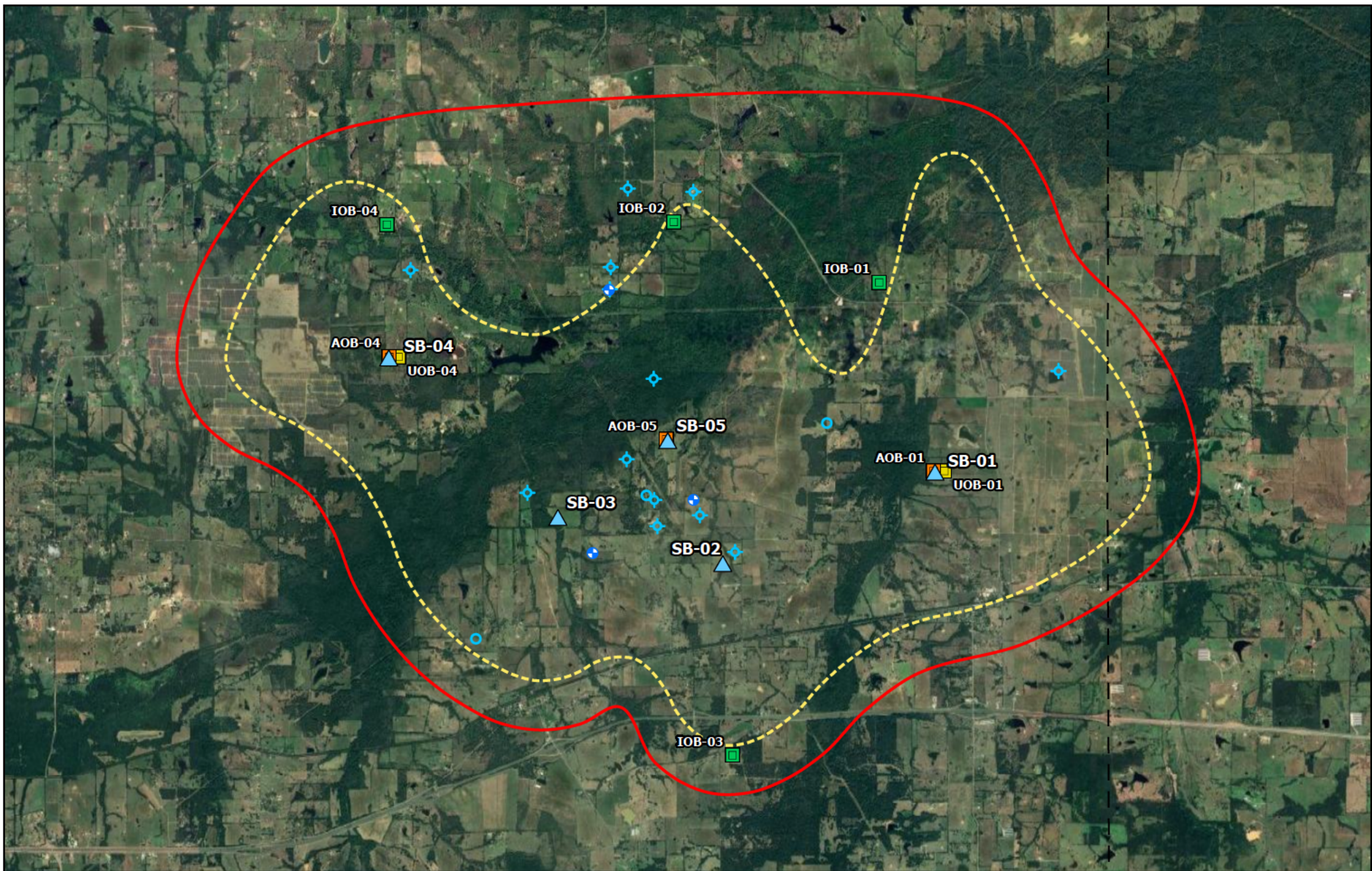
The estimated total cost of site closure is \$9,377,000, reported in adherence with Texas requirements [16 TAC 5.203(m)(6)]. This cost includes plugging of injection and monitoring wells, site restoration and site closure reporting. A detailed estimate is provided within the **Financial Responsibility Demonstration (Section 3)**.

## **References**

- EPA (2013). Geologic Sequestration of Carbon Dioxide: Underground Injection Control (UIC) Program Class VI Well Site Characterization Guidance. EPA 816-R-13-004. Prepared by the Office of Water (4605M), May 2013. [www.epa.gov/safewater](http://www.epa.gov/safewater).
- TCEQ (2021). Landowner's Guide to Plugging Abandoned Water Wells. RG-347. Prepared by the Texas Groundwater Protection Committee, Revised April 2021.  
<https://www.tceq.texas.gov/downloads/groundwater/publications/landowners-guide-to-plugging-abandoned-water-wells-rg-347.pdf>.

## FIGURES





## Legend

- |                             |                            |
|-----------------------------|----------------------------|
| Injection Wells             | Artificial Penetrations    |
| Above-zone Observation Well | Permitted Location         |
| In-zone Observation Well    | Dry Hole                   |
| USDW Monitoring Well        | BRACS Database Water Wells |
| Area of Review              | County Line                |
| Area of Corrective Action   |                            |

**FIGURE 9-1**  
**OVERVIEW OF THE PROPOSED MONITORING NETWORK WITHIN THE AOR**  
 SUGARBERRY CCS HUB  
 SUGARBERRY CCS, LLC  
 HOPKINS COUNTY, TEXAS

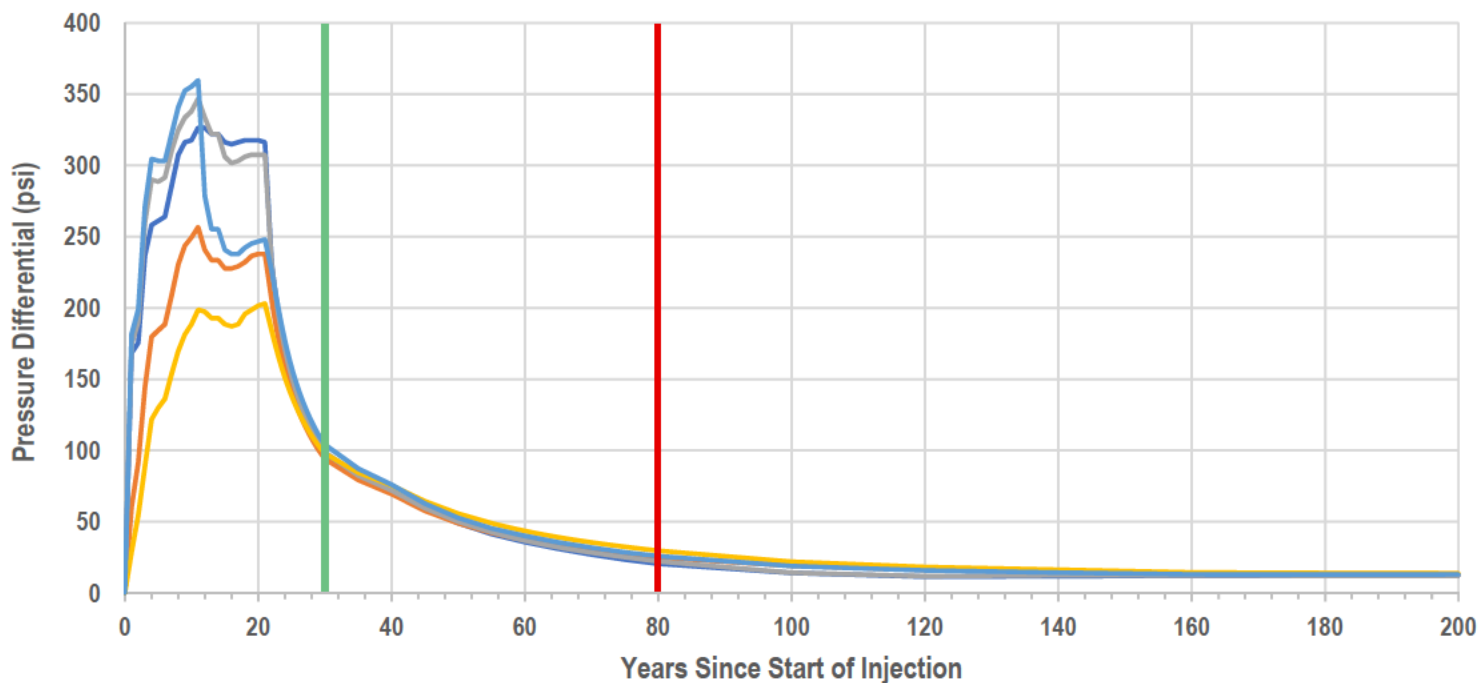
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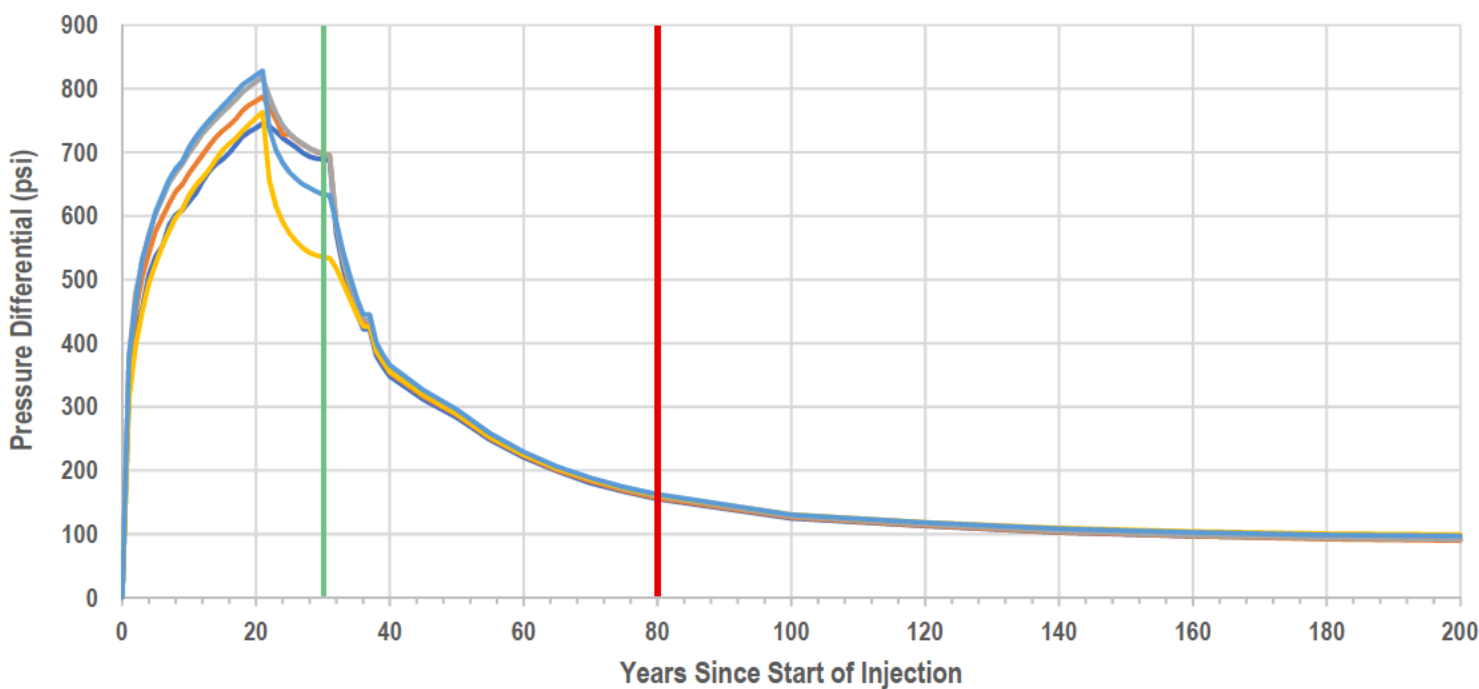
April 2025

0 1 2 Miles





Top of the Woodbine/Base of Eagle Ford Confining Zone



Top of Paluxy/Base of Fredricksburg Group

### Legend

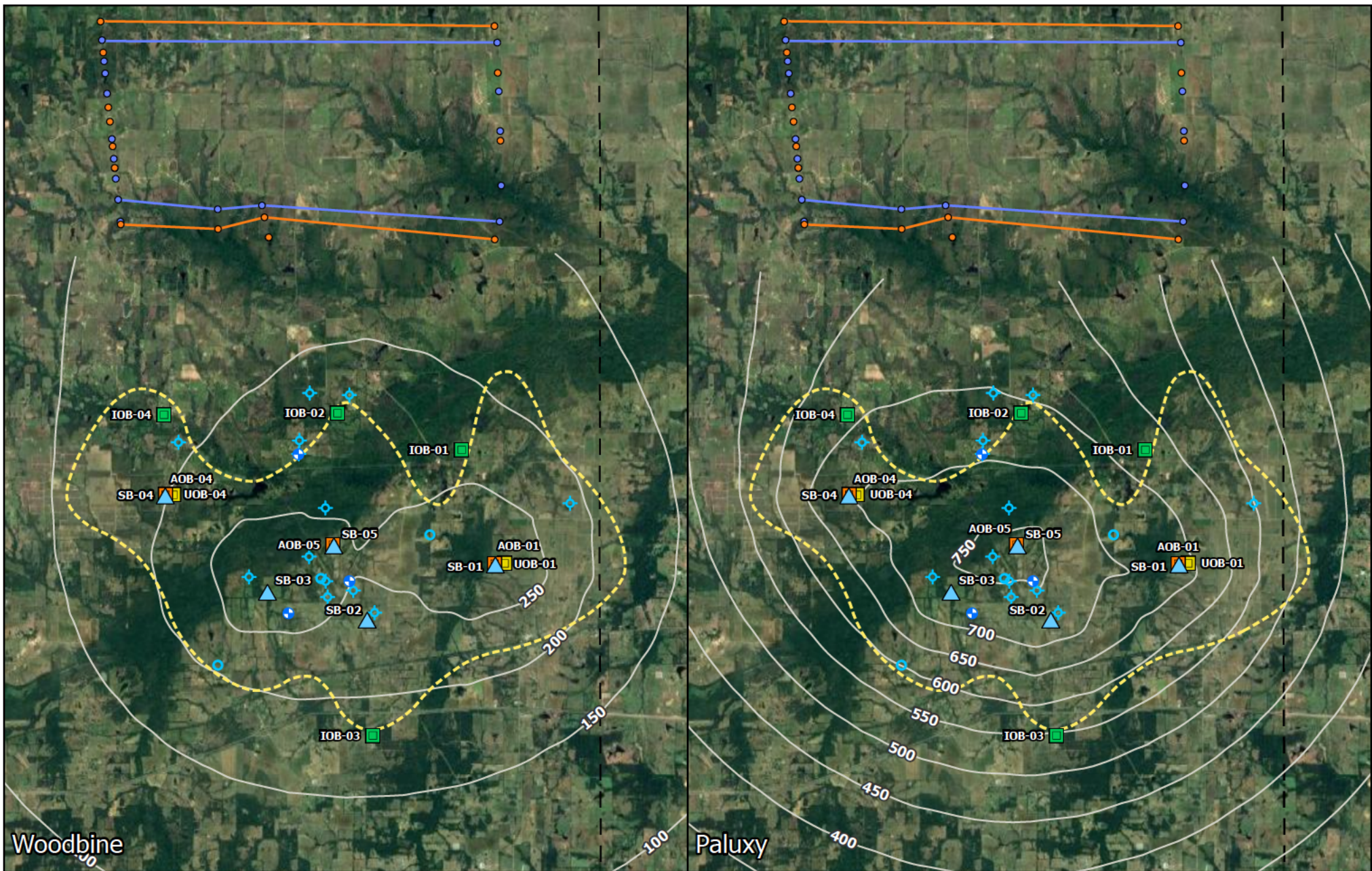
SB-01	Start of PISC Period
SB-02	End of PISC Period
SB-03	
SB-04	
SB-05	

**FIGURE 9-2**  
**PRESSURE DIFFERENTIAL GRAPHS – INJECTION WELLS**  
 SUGARBERRY CCS HUB  
 SUGARBERRY CCS, LLC  
 HOPKINS COUNTY, TEXAS

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## Legend

- |                             |                            |                                     |
|-----------------------------|----------------------------|-------------------------------------|
| Injection Wells             | Artificial Penetrations    | Pressure Contour Intervals (50 psi) |
| Above-zone Observation Well | Permitted Location         | Eagle Ford Fault Intersects         |
| In-zone Observation Well    | Dry Hole                   | Eagle Ford Fault                    |
| USDW Monitoring Well        | BRACS Database Water Wells | Fredericksburg Fault Intersects     |
| Area of Review              | County Line                | Fredericksburg Fault Lines          |

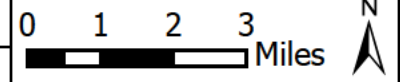
Note:  
Year 20 is the last year of injection into the Woodbine.

**FIGURE 9-3**  
**DELTA PRESSURE – YEAR 20**  
SUGARBERRY CCS HUB  
SUGARBERRY CCS, LLC  
HOPKINS COUNTY, TEXAS

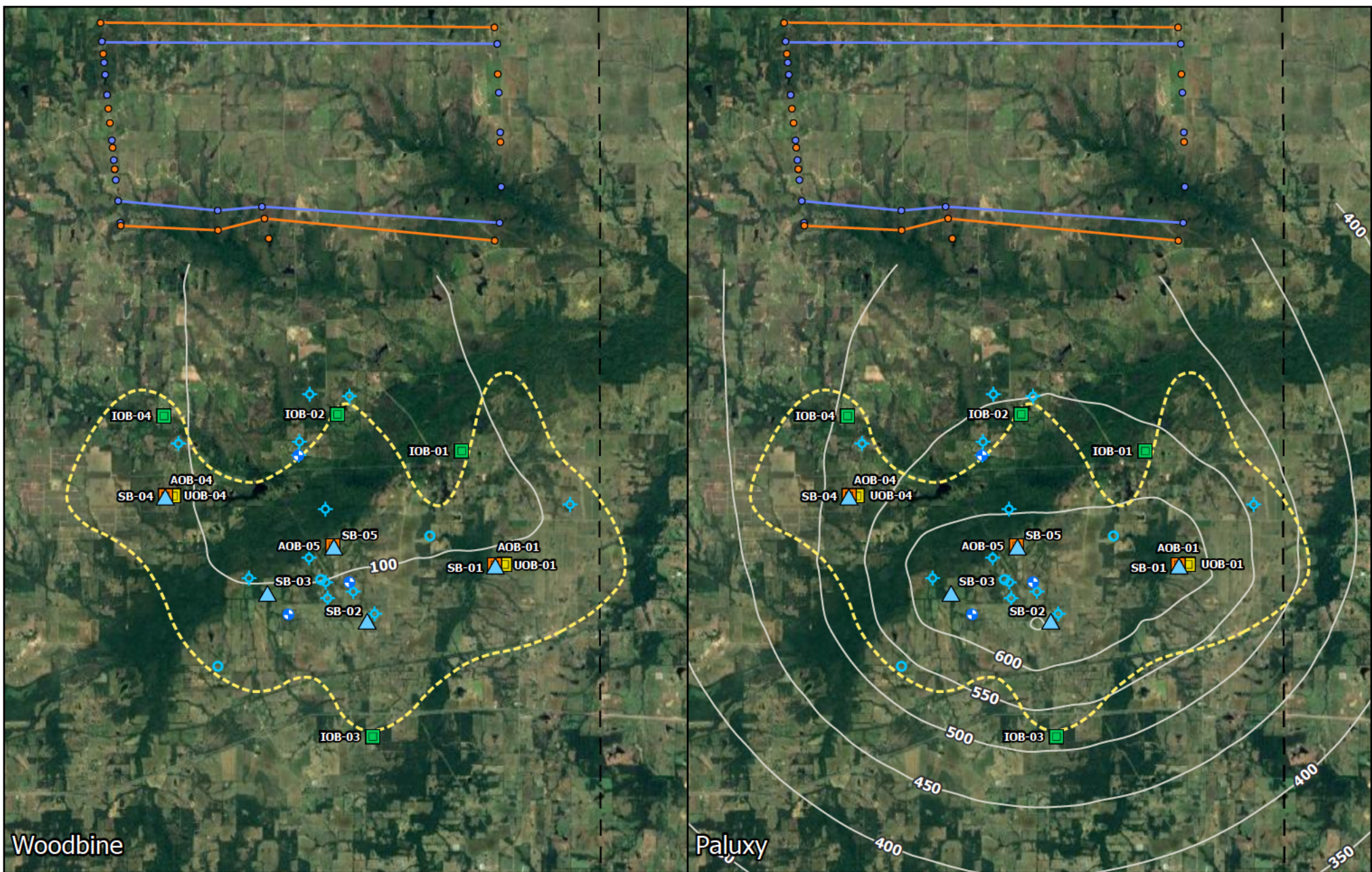
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April 2025







## Legend

- |                             |                            |                                     |
|-----------------------------|----------------------------|-------------------------------------|
| Injection Wells             | Artificial Penetrations    | Pressure Contour Intervals (50 psi) |
| Above-zone Observation Well | Permitted Location         | Eagle Ford Fault Intersects         |
| In-zone Observation Well    | Dry Hole                   | Eagle Ford Fault                    |
| USDW Monitoring Well        | BRACS Database Water Wells | Fredericksburg Fault Intersects     |
| Area of Review              | County Line                | Fredericksburg Fault Lines          |

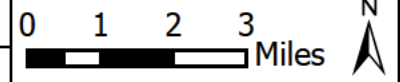
Note:  
Year 30 is 10 years after injection ends in the Woodbine, the last year of injection in the Paluxy, and the start of the PISC period.

**FIGURE 9-4**  
**DELTA PRESSURE – YEAR 30**  
SUGARBERRY CCS HUB  
SUGARBERRY CCS, LLC  
HOPKINS COUNTY, TEXAS

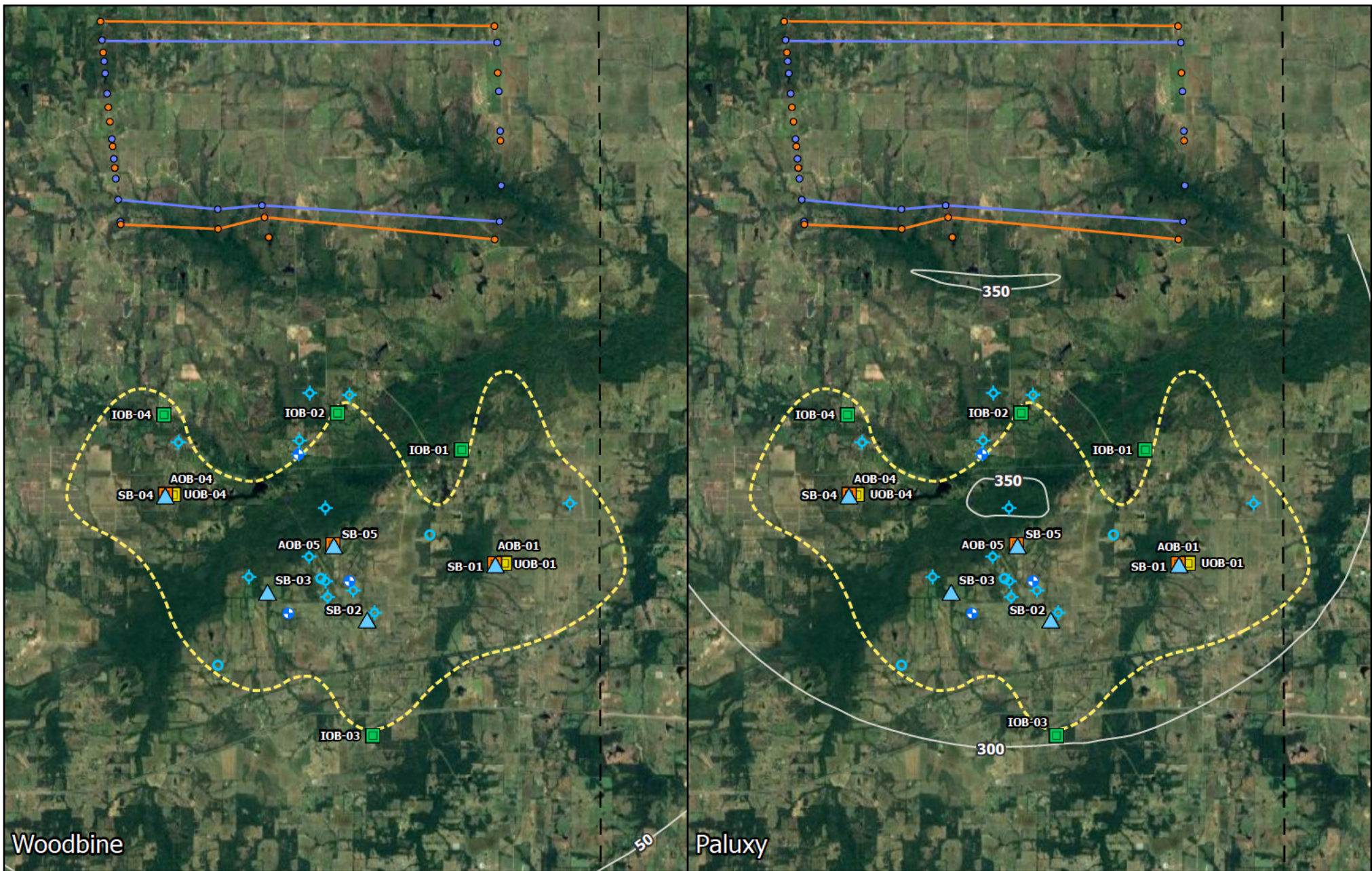
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April 2025





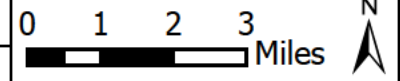


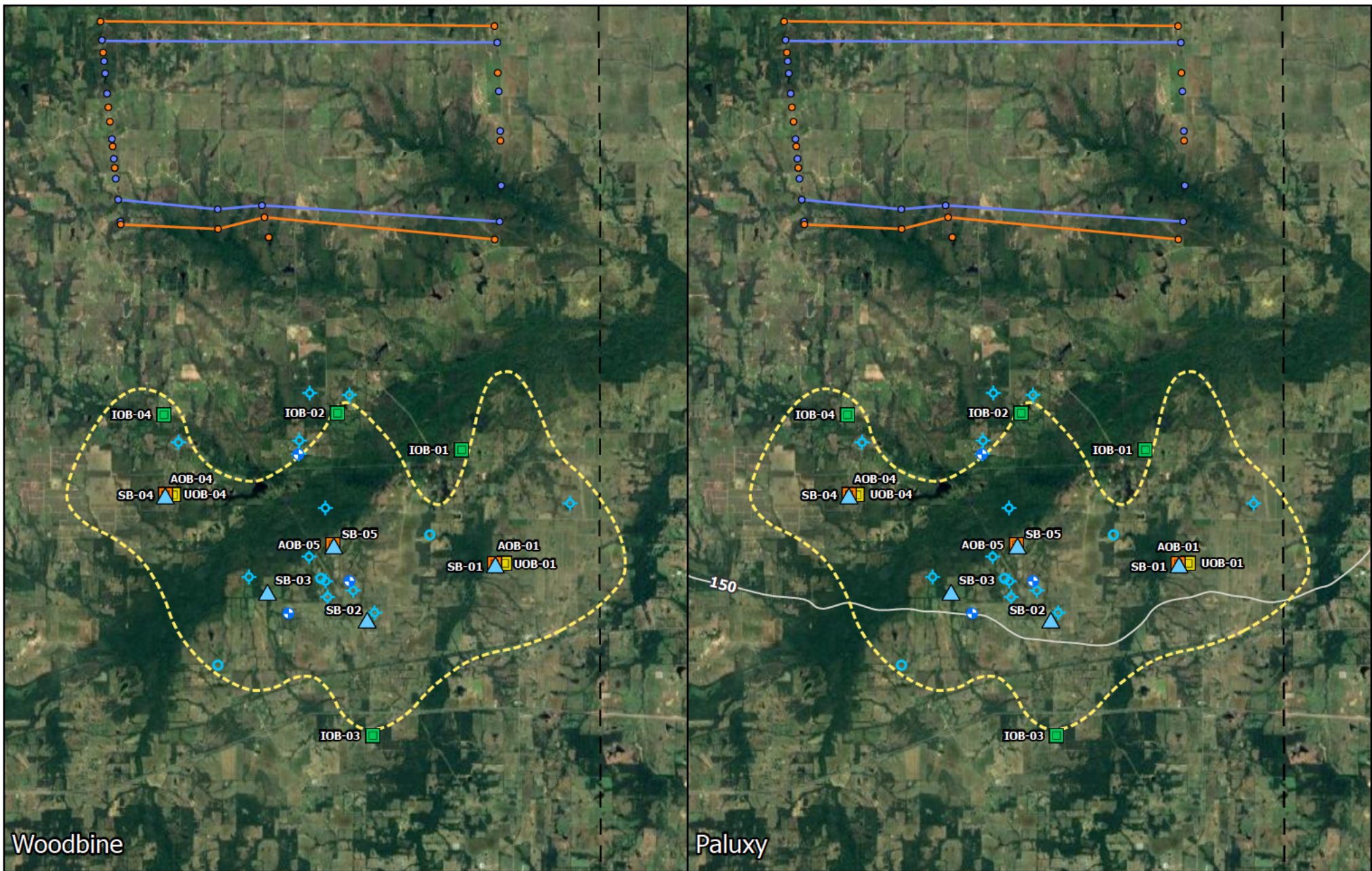
**FIGURE 9-5**  
**DELTA PRESSURE – YEAR 40**  
 SUGARBERRY CCS HUB  
 SUGARBERRY CCS, LLC  
 HOPKINS COUNTY, TEXAS

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April 2025





## Legend

- |                             |                            |                                     |
|-----------------------------|----------------------------|-------------------------------------|
| Injection Wells             | Artificial Penetrations    | Pressure Contour Intervals (50 psi) |
| Above-zone Observation Well | Permitted Location         | Eagle Ford Fault Intersects         |
| In-zone Observation Well    | Dry Hole                   | Eagle Ford Fault                    |
| USDW Monitoring Well        | BRACS Database Water Wells | Fredricksburg Fault Intersects      |
| Area of Review              | Fredricksburg Fault Lines  |                                     |
| County Line                 |                            |                                     |

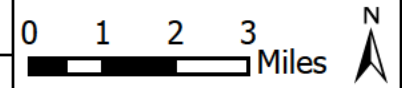
Notes:  
Max pressure in the Woodbine is 31.21 psi. Year 80 is the end of the PISC period. Pressure in the Paluxy is lower to the south of the 150 psi contour.

**FIGURE 9-6**  
**DELTA PRESSURE – YEAR 80**  
SUGARBERRY CCS HUB  
SUGARBERRY CCS, LLC  
HOPKINS COUNTY, TEXAS

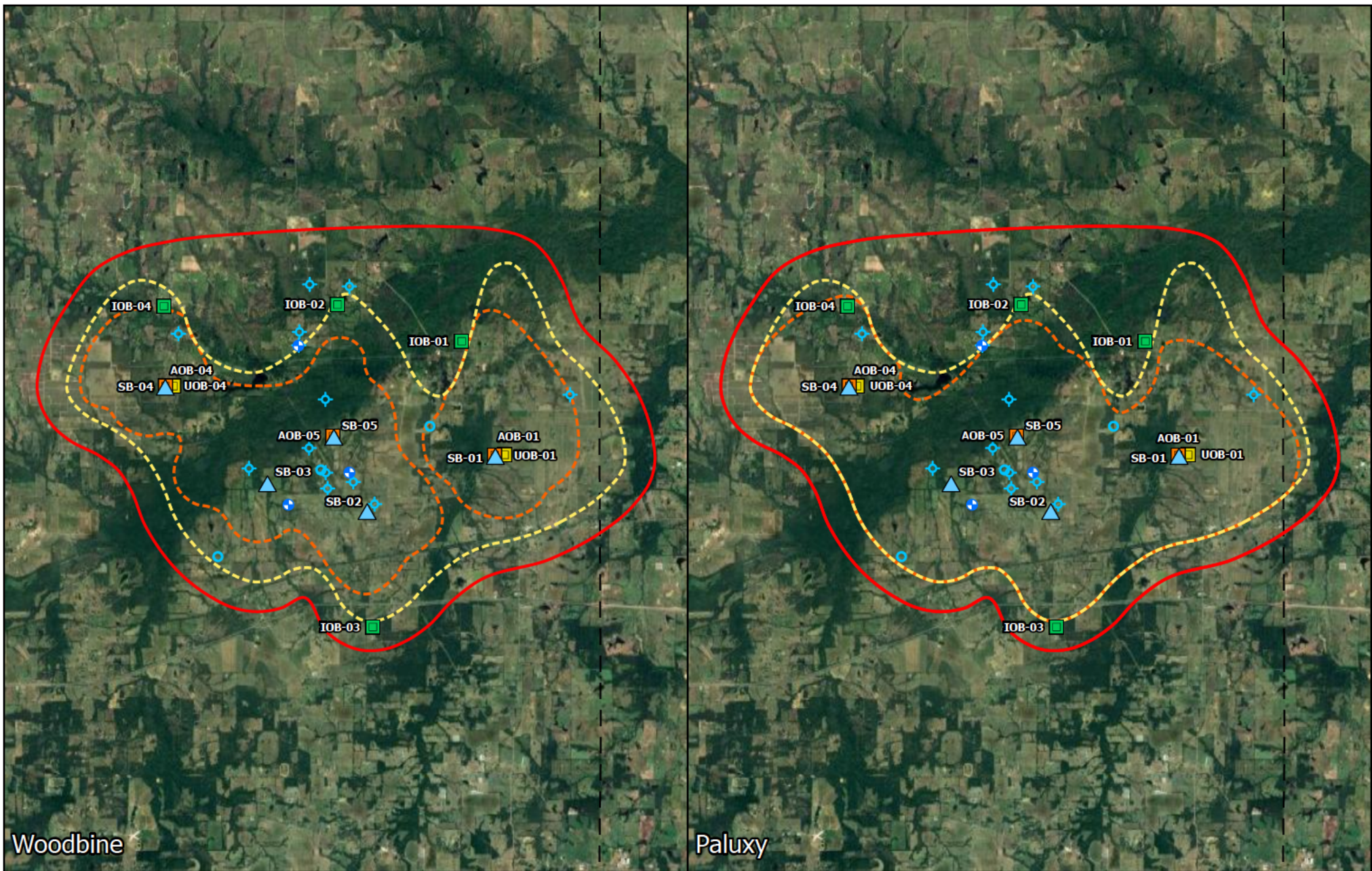
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April 2025







Woodbine

Paluxy

### Legend

- ▲ Injection Wells
- ▬ Area of Review at End of PISC Timeframe (Year 80)
- ▬ Overall Project Delineated Area of Review
- ▬ Overall Project Area of Corrective Action
- Above-zone Observation Well
- In-zone Observation Well
- USDW Monitoring Well
- Artificial Penetrations
- ⬠ Permitted Location
- ⬠ Dry Hole
- ⊕ Water Wells
- County Line

Note:  
Year 80 is the end of the PISC period.

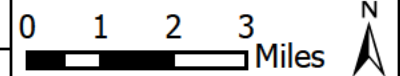
**FIGURE 9-7**  
**DELINEATED AREA OF REVIEW AT THE END OF THE PISC TIMEFRAME**

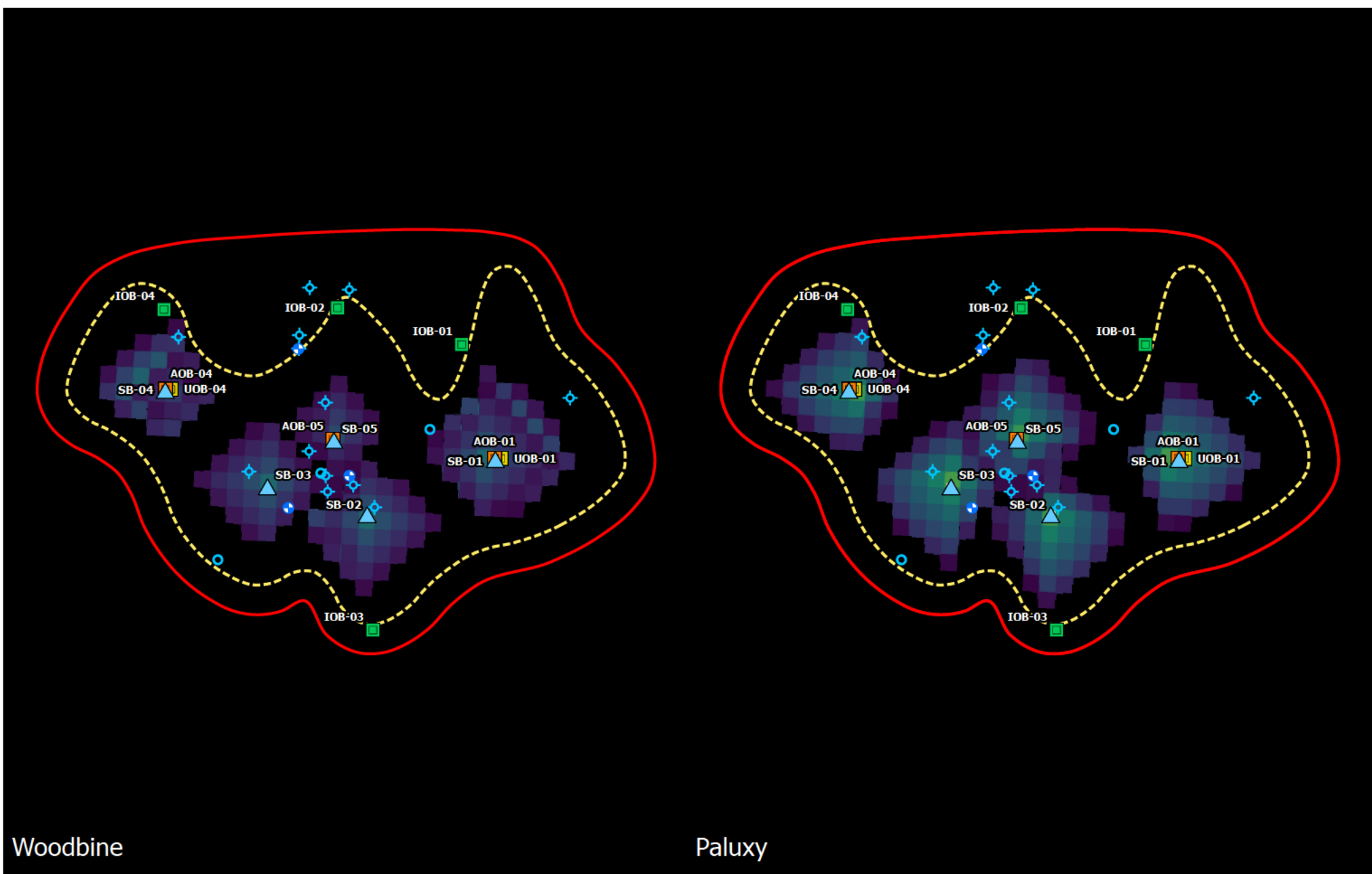
SUGARBERRY CCS HUB  
SUGARBERRY CCS, LLC  
HOPKINS COUNTY, TEXAS

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April 2025





Woodbine

Paluxy

### Legend

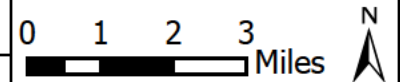
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| <ul style="list-style-type: none"> <li> Injection Wells</li> <li> Above-zone Observation Well</li> <li> In-zone Observation Well</li> <li> USDW Monitoring Well</li> <li> Area of Review</li> <li> Area of Corrective Action</li> </ul> | <ul style="list-style-type: none"> <li> Artificial Penetrations</li> <li> Permitted Location</li> <li> Dry Hole</li> <li> BRACS Database Water Wells</li> <li> County Line</li> </ul> | <p>CO<sub>2</sub> Saturation (Decimal fractions)</p> <p>0.5 0.45 0.4 0.35 0.3 0.25 0.2 0.15 0.1 0.05 0.0</p> |
|---|---|--|

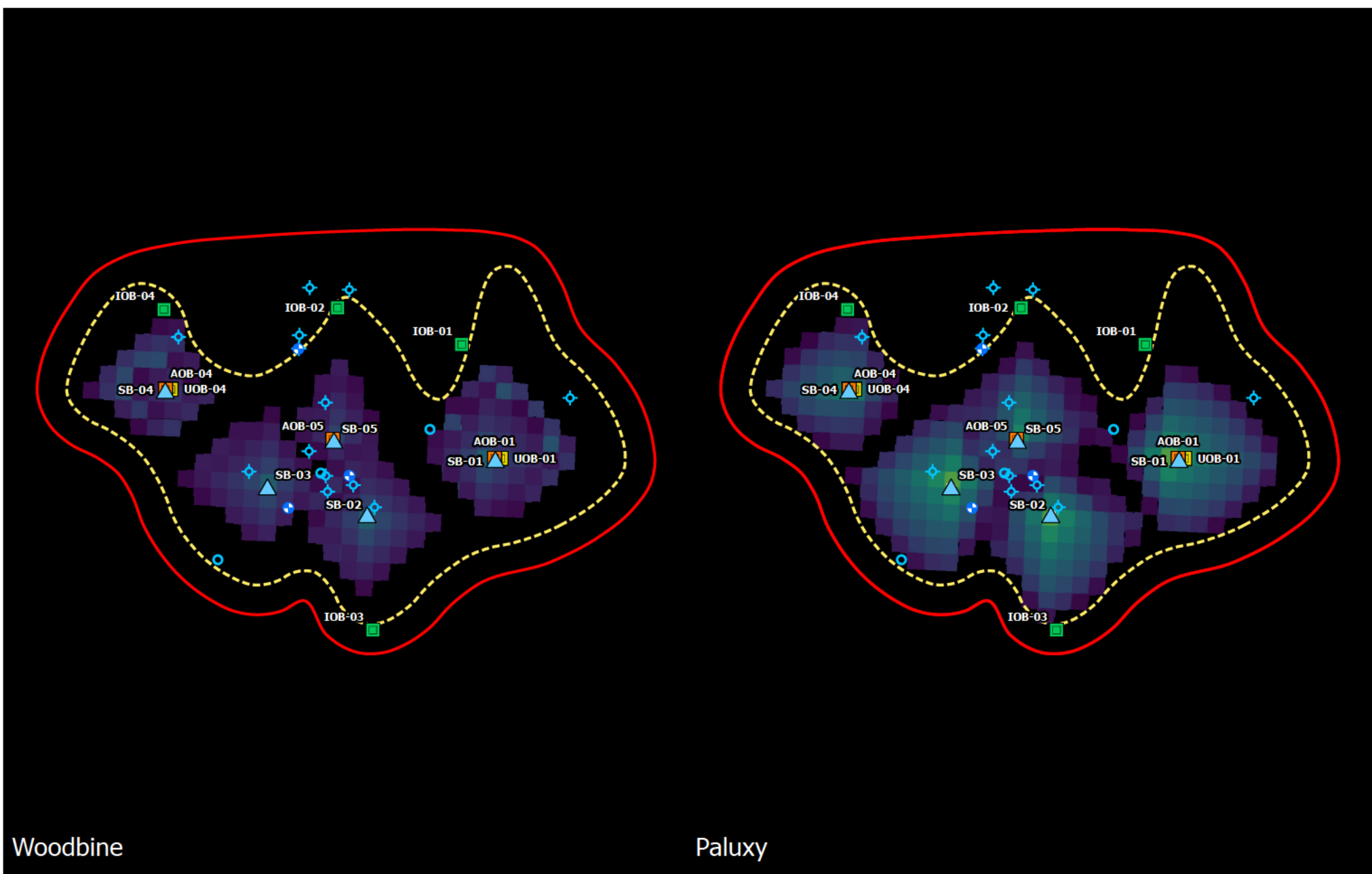
**FIGURE 9-8**  
**PREDICTED CO<sub>2</sub> PLUME EXTENT – YEAR 20**  
 SUGARBERRY CCS HUB  
 SUGARBERRY CCS, LLC  
 HOPKINS COUNTY, TEXAS

**SCS ENGINEERS**

Wichita, KS

April 2025





Woodbine

Paluxy

### Legend

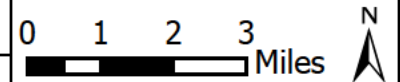
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| <ul style="list-style-type: none"> <li> Injection Wells</li> <li> Above-zone Observation Well</li> <li> In-zone Observation Well</li> <li> USDW Monitoring Well</li> <li> Area of Review</li> <li> Area of Corrective Action</li> </ul> | <ul style="list-style-type: none"> <li> Artificial Penetrations</li> <li> Permitted Location</li> <li> Dry Hole</li> <li> BRACS Database Water Wells</li> <li> County Line</li> </ul> | <p>CO<sub>2</sub> Saturation (Decimal fractions)</p> <p>0.5 0.45 0.4 0.35 0.3 0.25 0.2 0.15 0.1 0.05 0.0</p> |
|---|---|--|

**FIGURE 9-9**  
**PREDICTED CO<sub>2</sub> PLUME EXTENT – YEAR 30**  
 SUGARBERRY CCS HUB  
 SUGARBERRY CCS, LLC  
 HOPKINS COUNTY, TEXAS

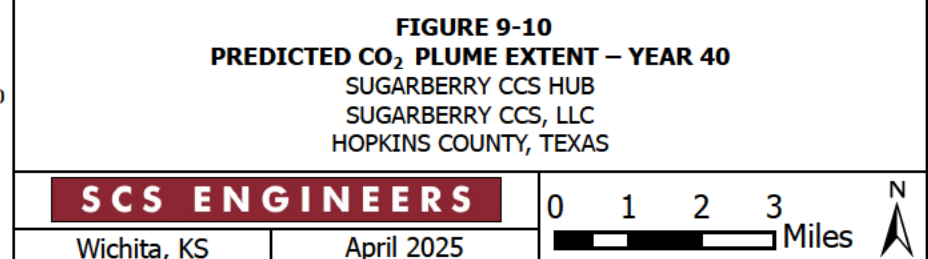
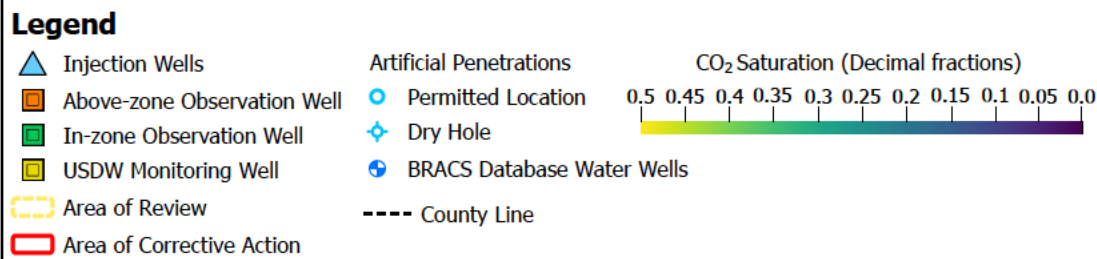
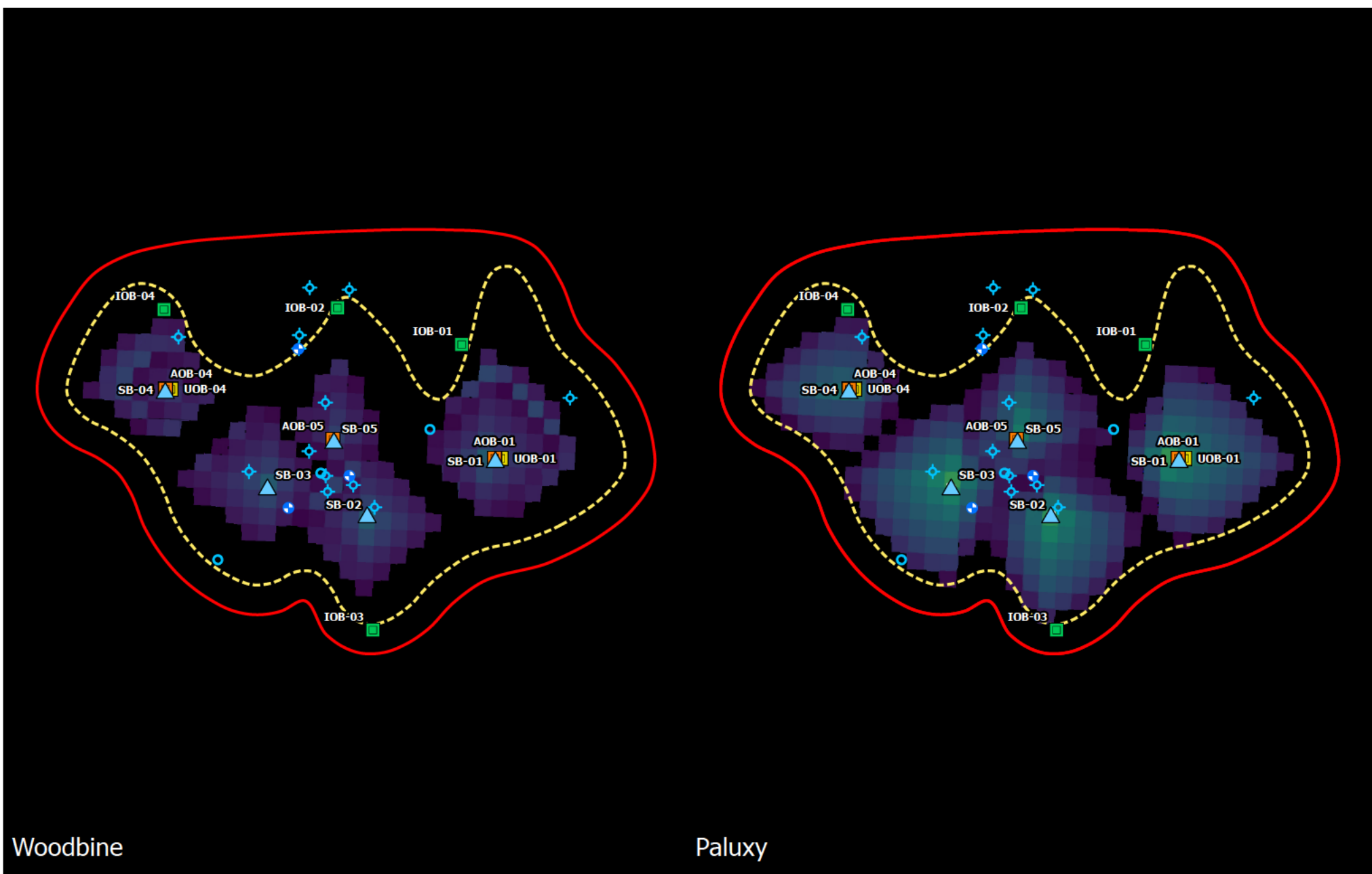
**SCS ENGINEERS**

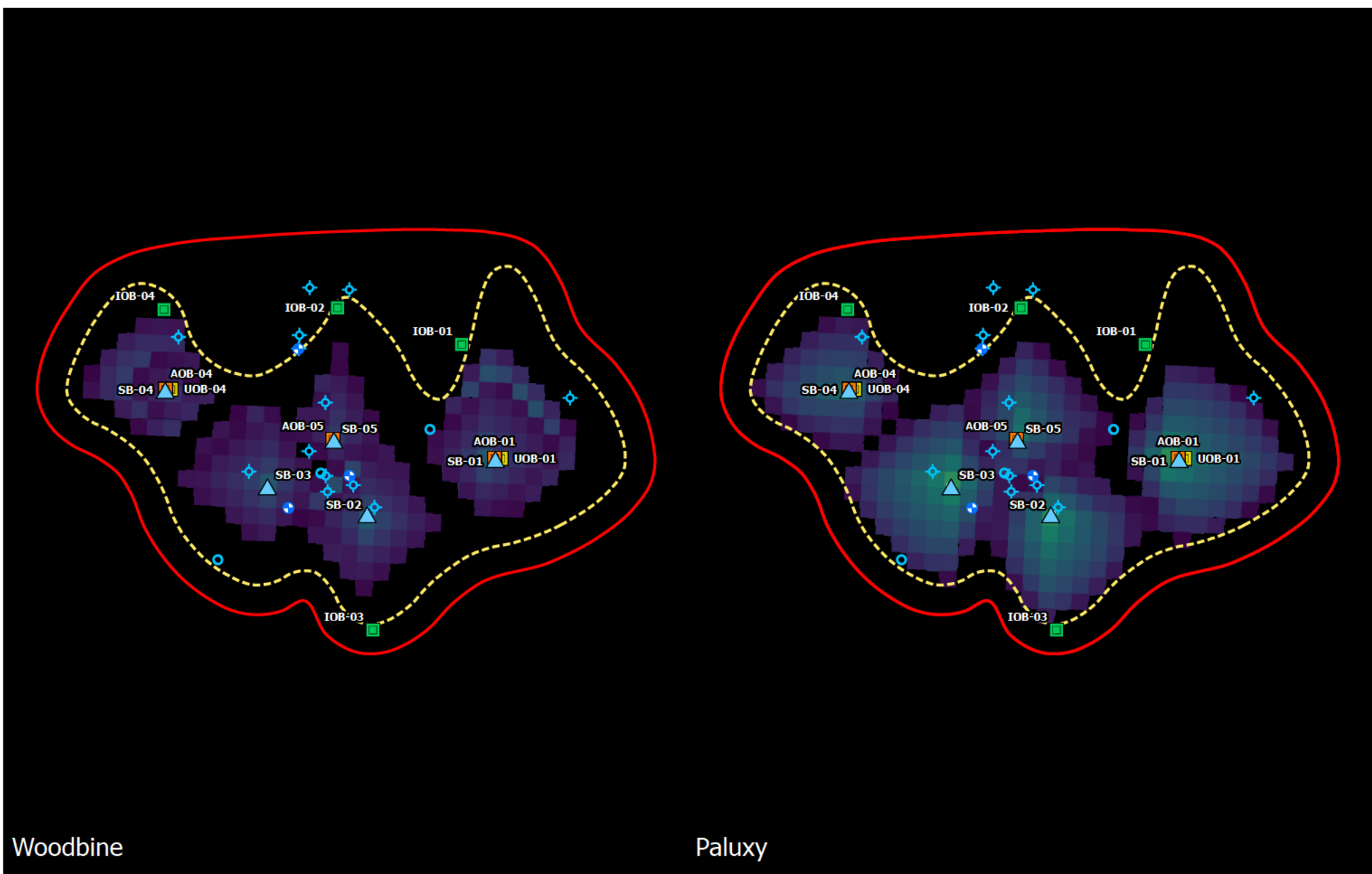
Wichita, KS

April 2025









Woodbine

Paluxy

### Legend

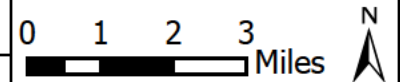
- |                             |                            |  |
|-----------------------------|----------------------------|--|
| Injection Wells             | Artificial Penetrations    |  |
| Above-zone Observation Well | Permitted Location         |  |
| In-zone Observation Well    | Dry Hole                   |  |
| USDW Monitoring Well        | BRACS Database Water Wells |  |
| Area of Review              | County Line                |  |
| Area of Corrective Action   |                            |  |

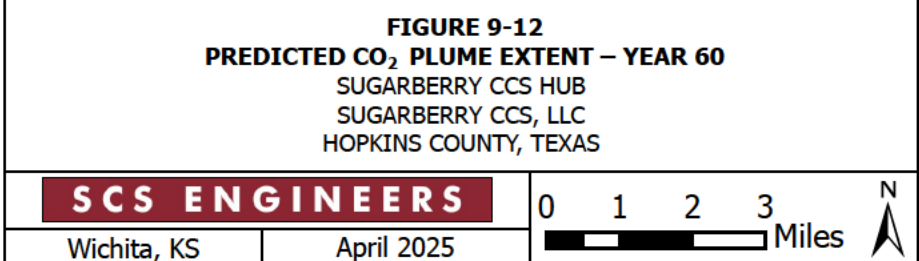
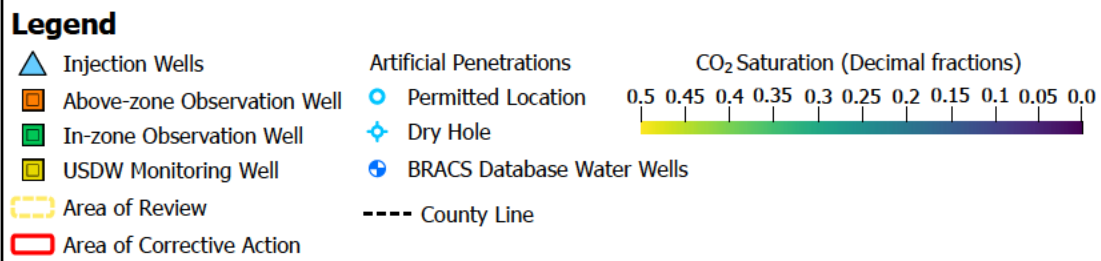
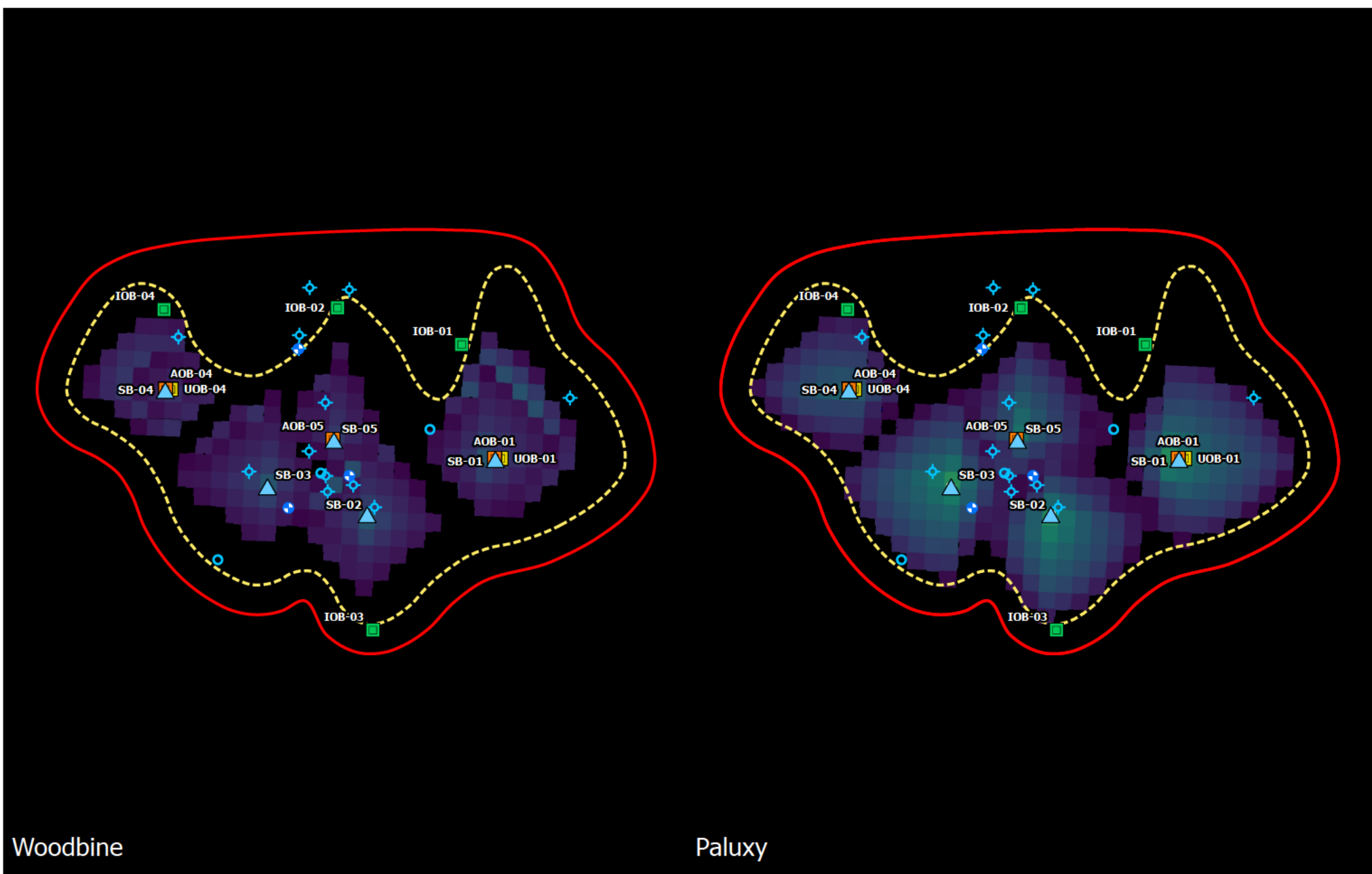
**FIGURE 9-11**  
**PREDICTED CO<sub>2</sub> PLUME EXTENT – YEAR 50**  
 SUGARBERRY CCS HUB  
 SUGARBERRY CCS, LLC  
 HOPKINS COUNTY, TEXAS

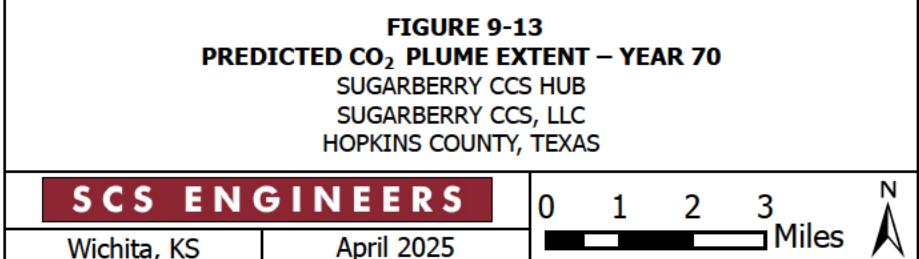
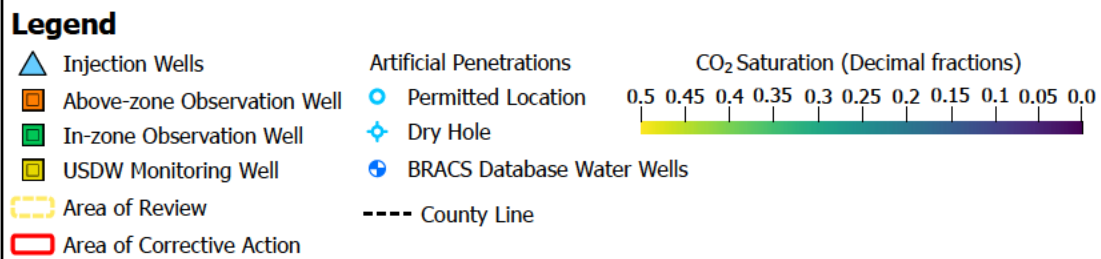
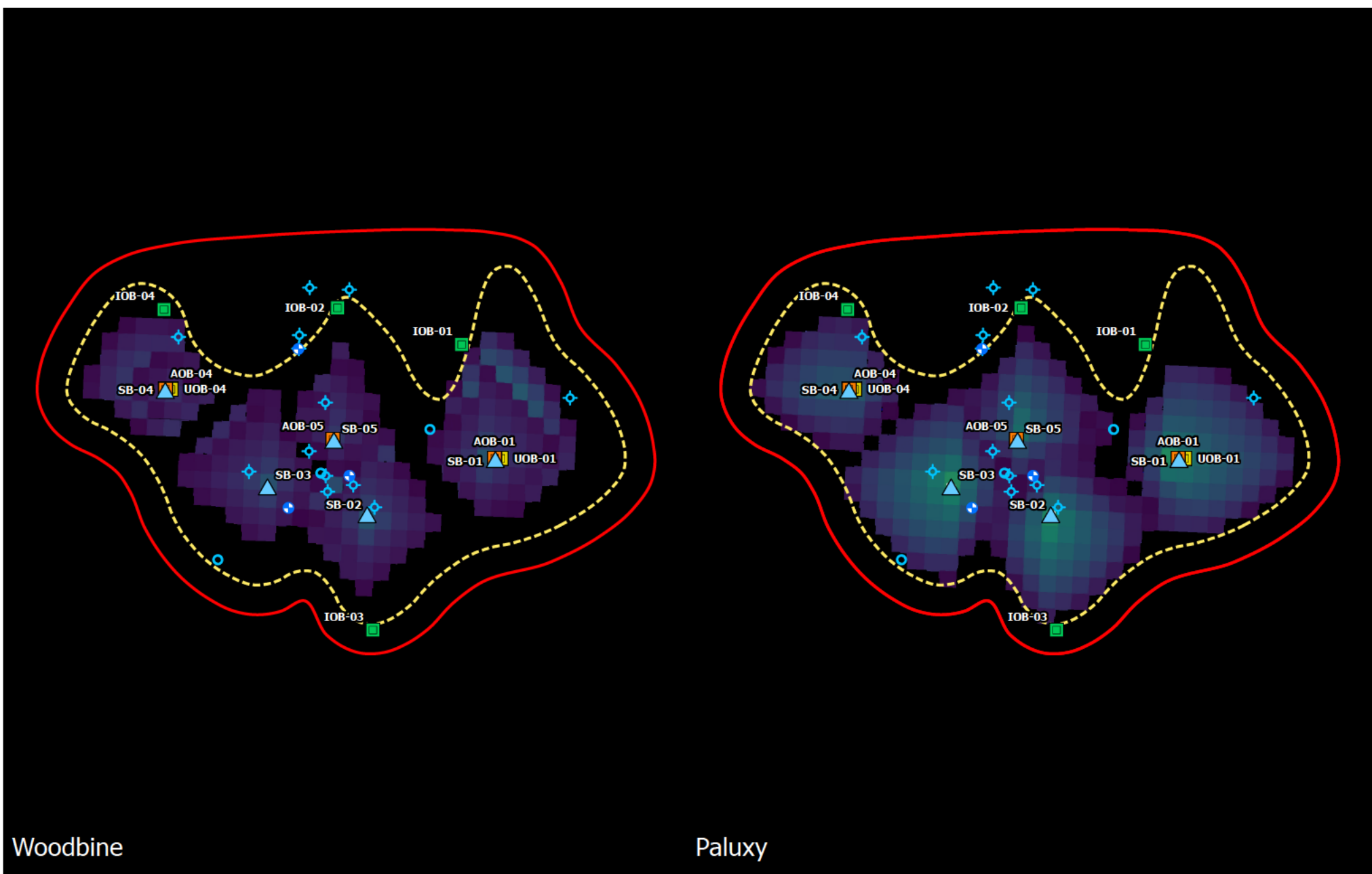
**SCS ENGINEERS**

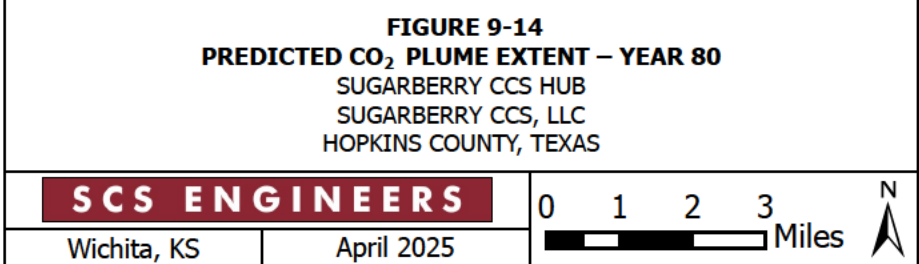
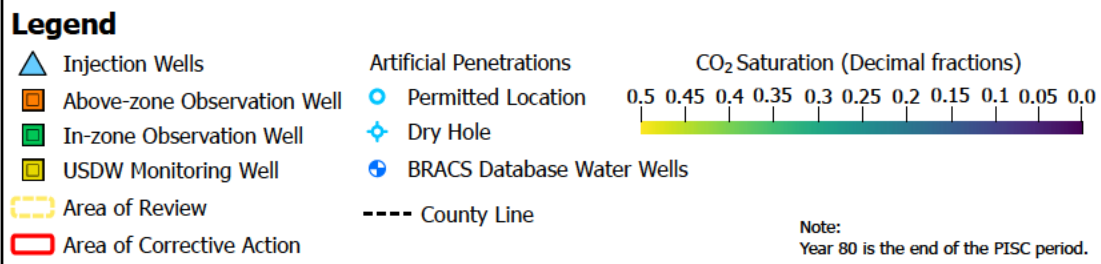
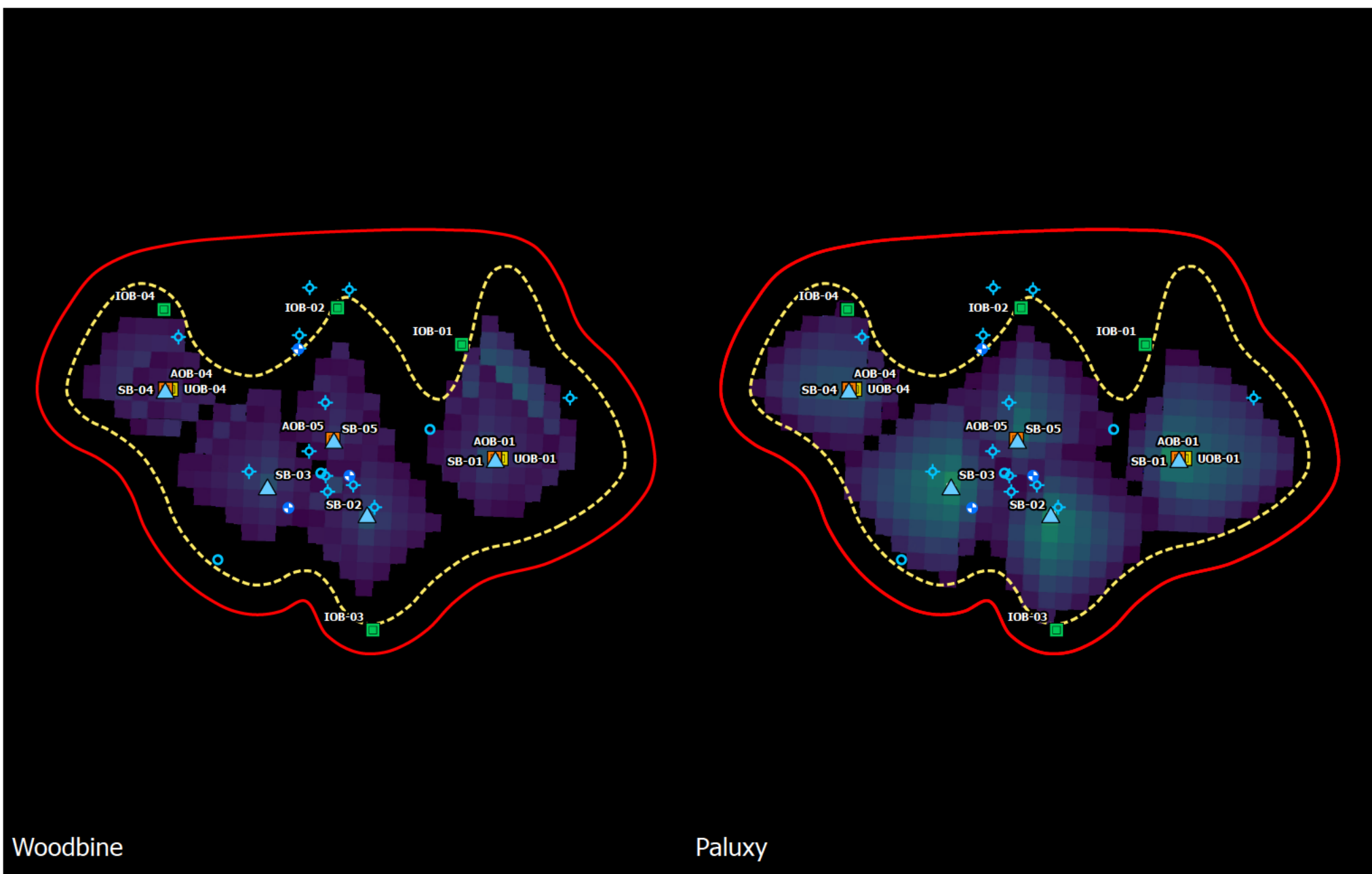
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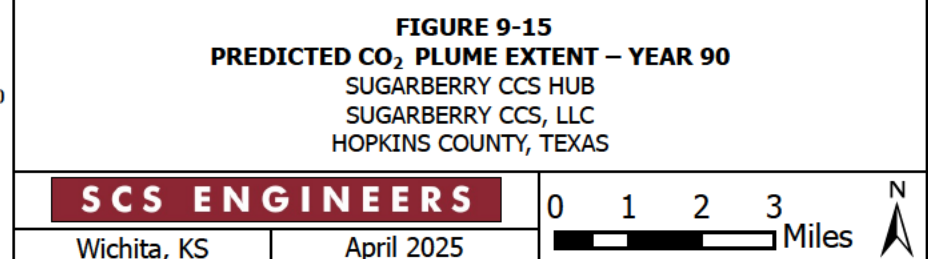
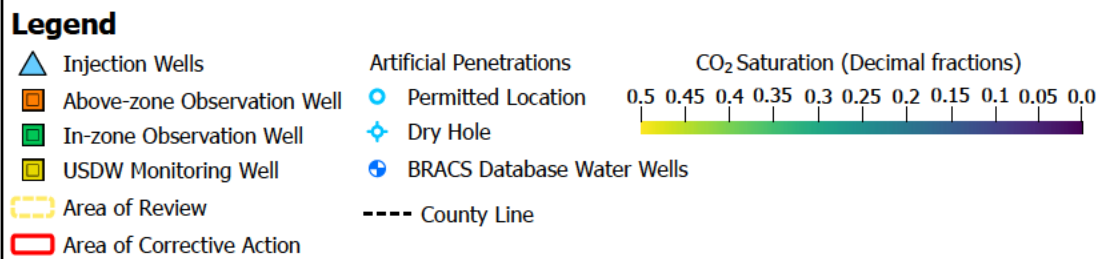
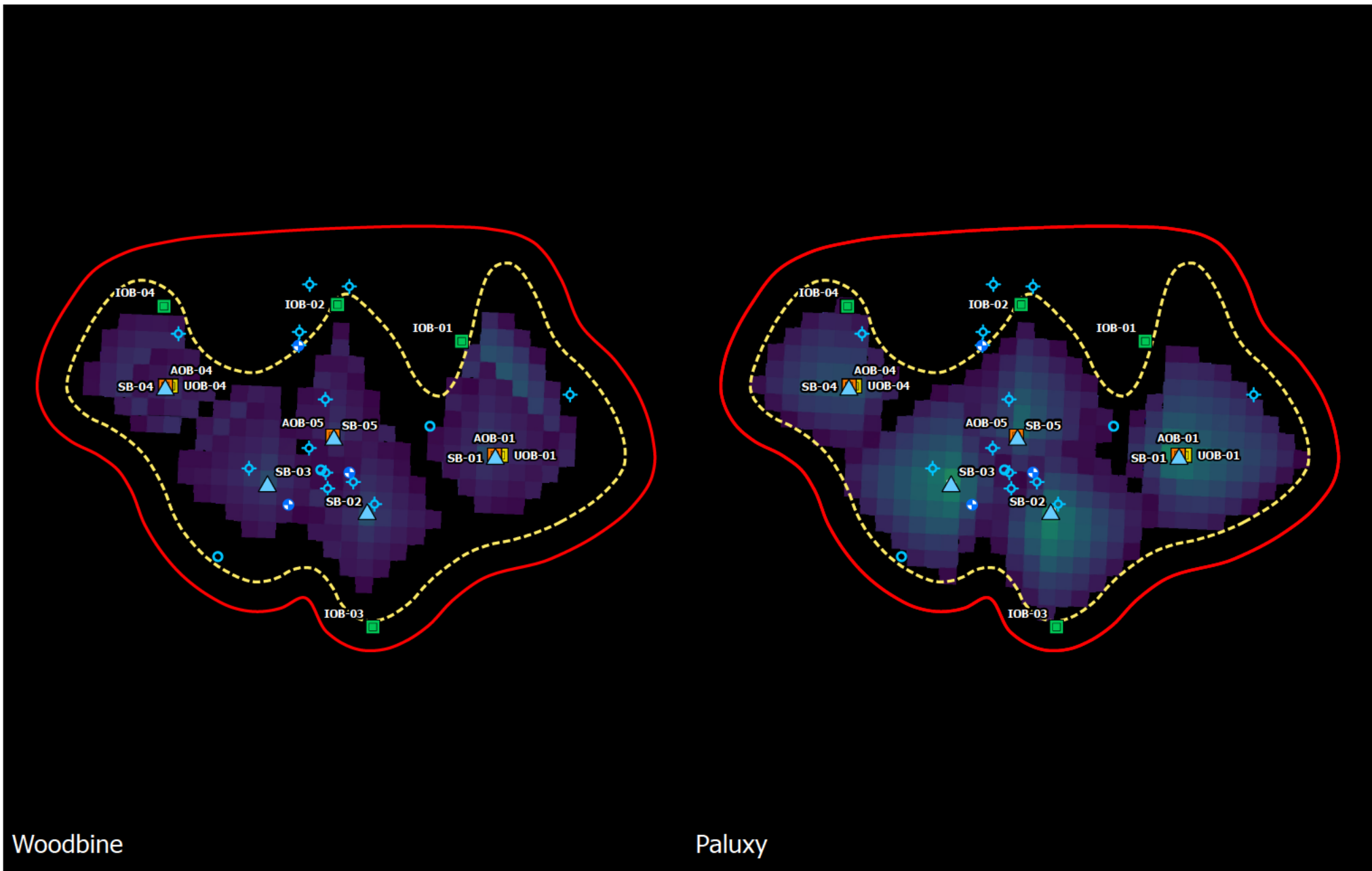
April 2025

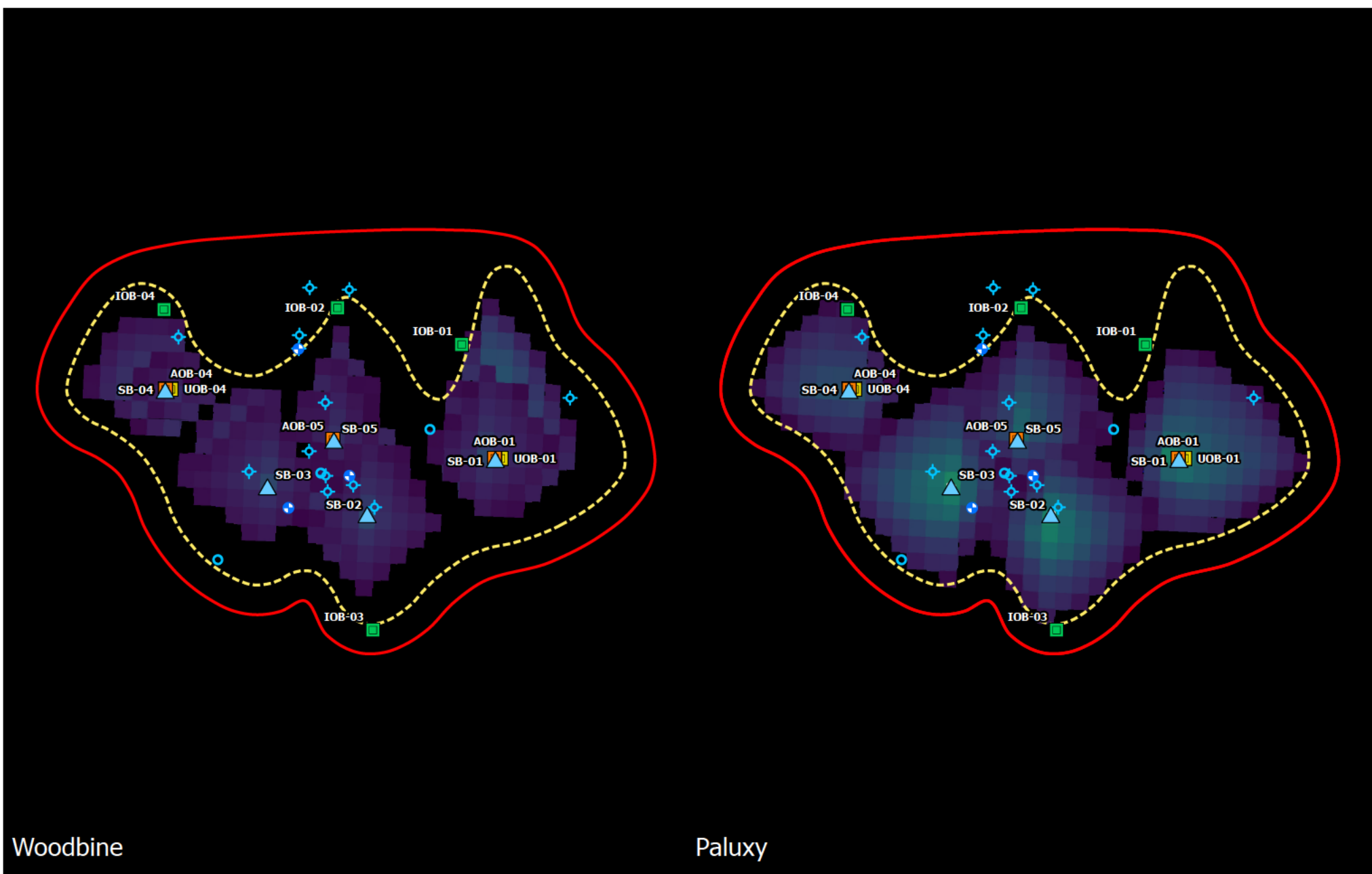












Woodbine

Paluxy

### Legend

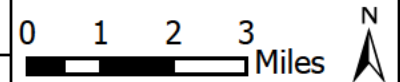
- |                             |                            |  |
|-----------------------------|----------------------------|--|
| Injection Wells             | Artificial Penetrations    | <p>CO<sub>2</sub> Saturation (Decimal fractions)</p> <p>0.5 0.45 0.4 0.35 0.3 0.25 0.2 0.15 0.1 0.05 0.0</p> |
| Above-zone Observation Well | Permitted Location         |  |
| In-zone Observation Well    | Dry Hole                   |  |
| USDW Monitoring Well        | BRACS Database Water Wells |  |
| Area of Review              | County Line                |  |
| Area of Corrective Action   |                            |  |

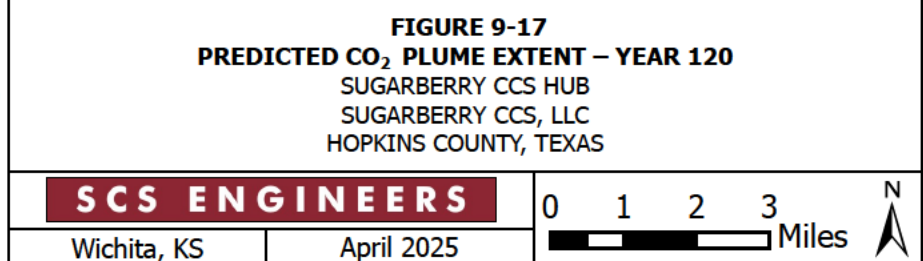
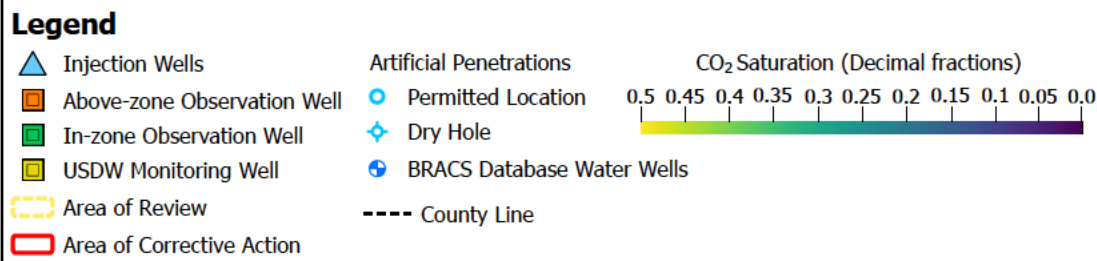
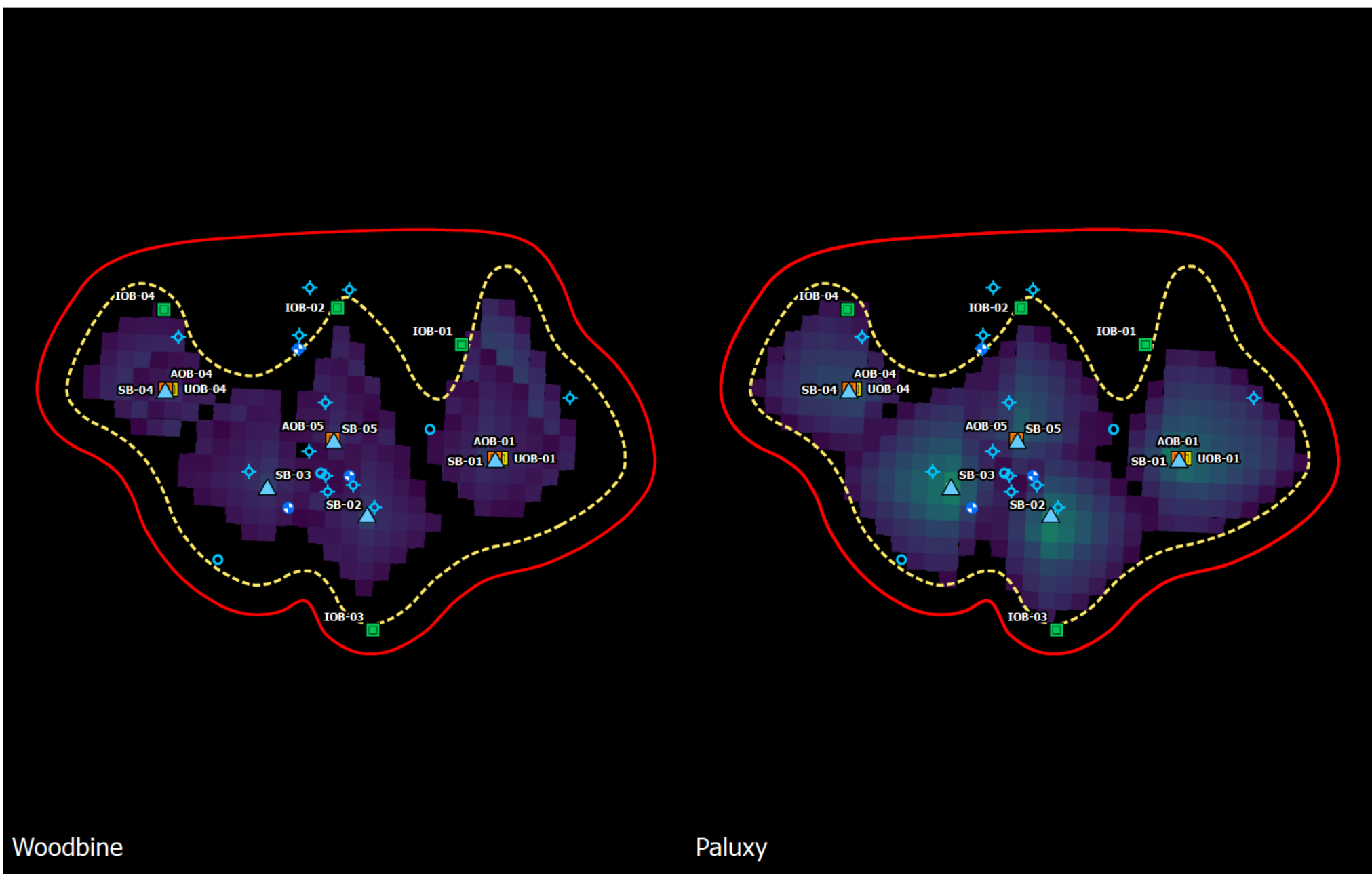
**FIGURE 9-16**  
**PREDICTED CO<sub>2</sub> PLUME EXTENT – YEAR 100**  
 SUGARBERRY CCS HUB  
 SUGARBERRY CCS, LLC  
 HOPKINS COUNTY, TEXAS

**SCS ENGINEERS**

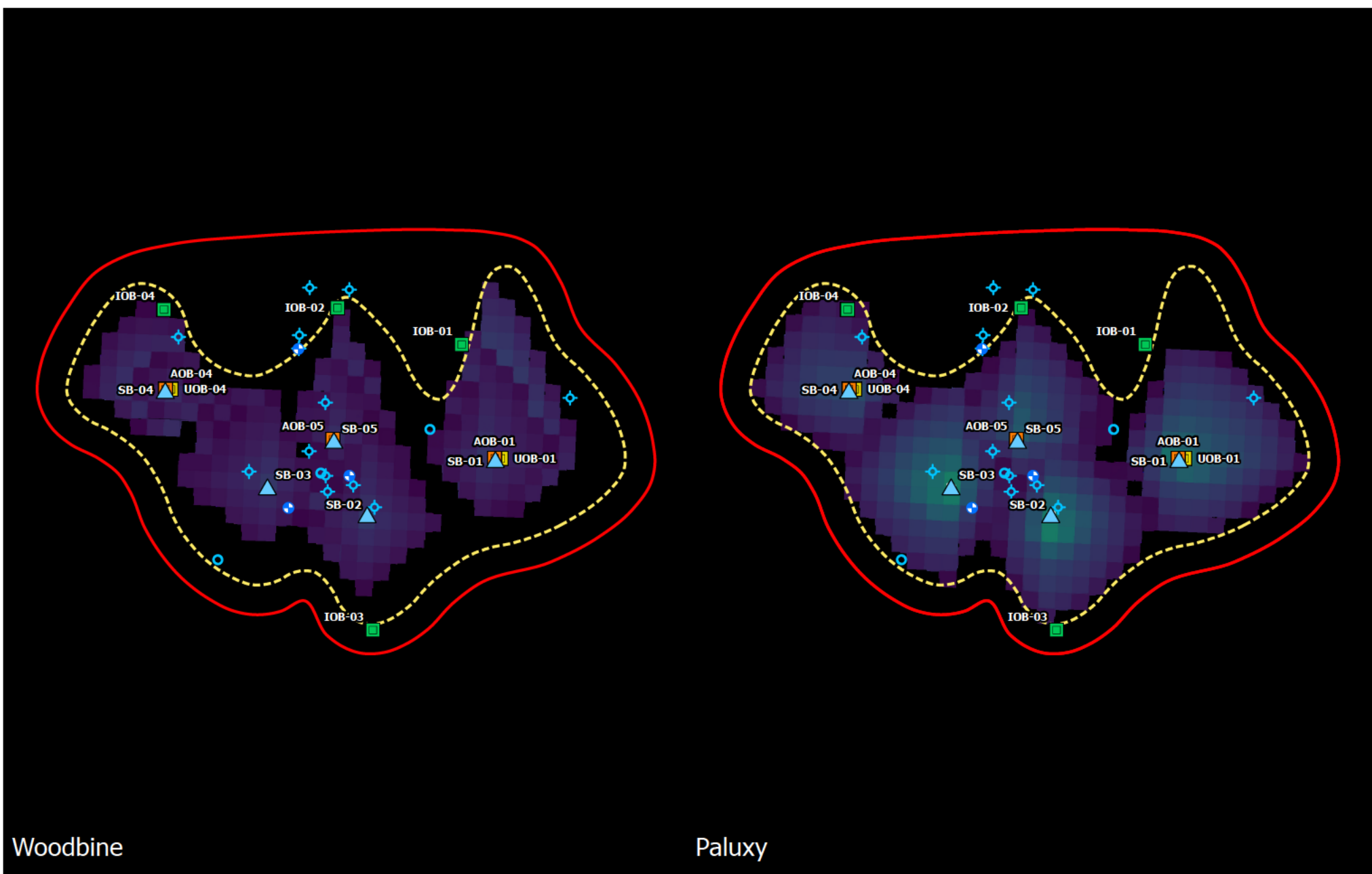
Wichita, KS

April 2025









Woodbine

Paluxy

### Legend

- |                             |                            |  |
|-----------------------------|----------------------------|--|
| Injection Wells             | Artificial Penetrations    | <br>CO <sub>2</sub> Saturation (Decimal fractions) |
| Above-zone Observation Well | Permitted Location         |  |
| In-zone Observation Well    | Dry Hole                   |  |
| USDW Monitoring Well        | BRACS Database Water Wells |  |
| Area of Review              | County Line                |  |
| Area of Corrective Action   |                            |  |

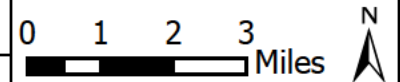
**FIGURE 9-18**  
**PREDICTED CO<sub>2</sub> PLUME EXTENT – YEAR 140**

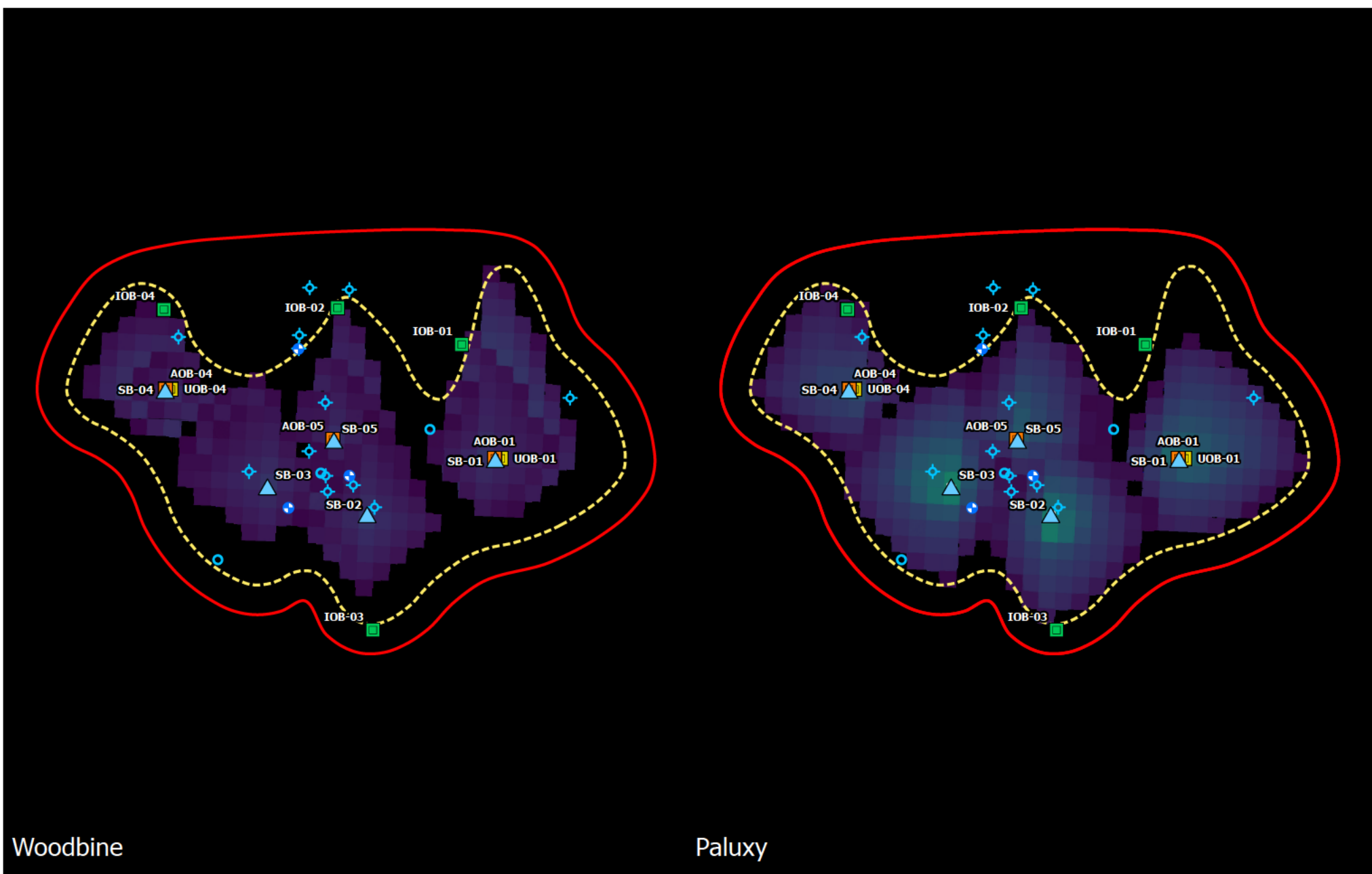
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SUGARBERRY CCS, LLC  
HOPKINS COUNTY, TEXAS

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Wichita, KS

April 2025





Woodbine

Paluxy

### Legend

- |                             |                            |  |
|-----------------------------|----------------------------|--|
| Injection Wells             | Artificial Penetrations    | <p>CO<sub>2</sub> Saturation (Decimal fractions)</p> |
| Above-zone Observation Well | Permitted Location         |  |
| In-zone Observation Well    | Dry Hole                   |  |
| USDW Monitoring Well        | BRACS Database Water Wells |  |
| Area of Review              | County Line                |  |
| Area of Corrective Action   |                            |  |

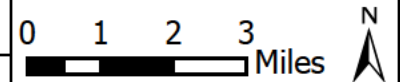
**FIGURE 9-19**  
**PREDICTED CO<sub>2</sub> PLUME EXTENT – YEAR 160**

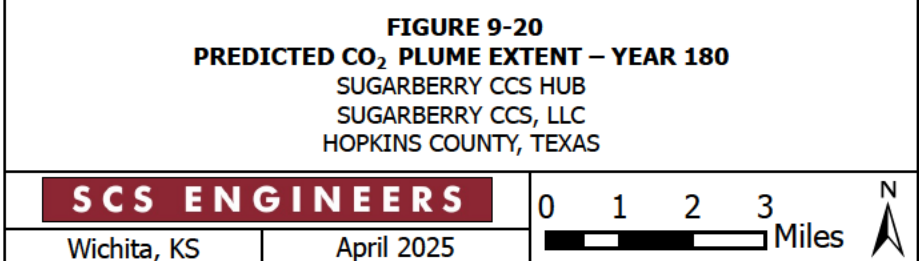
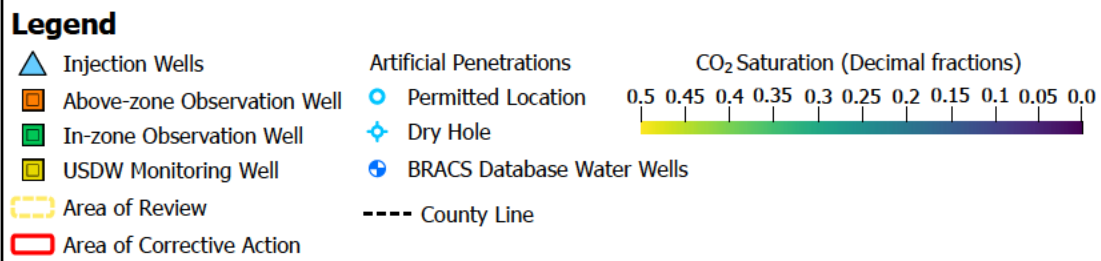
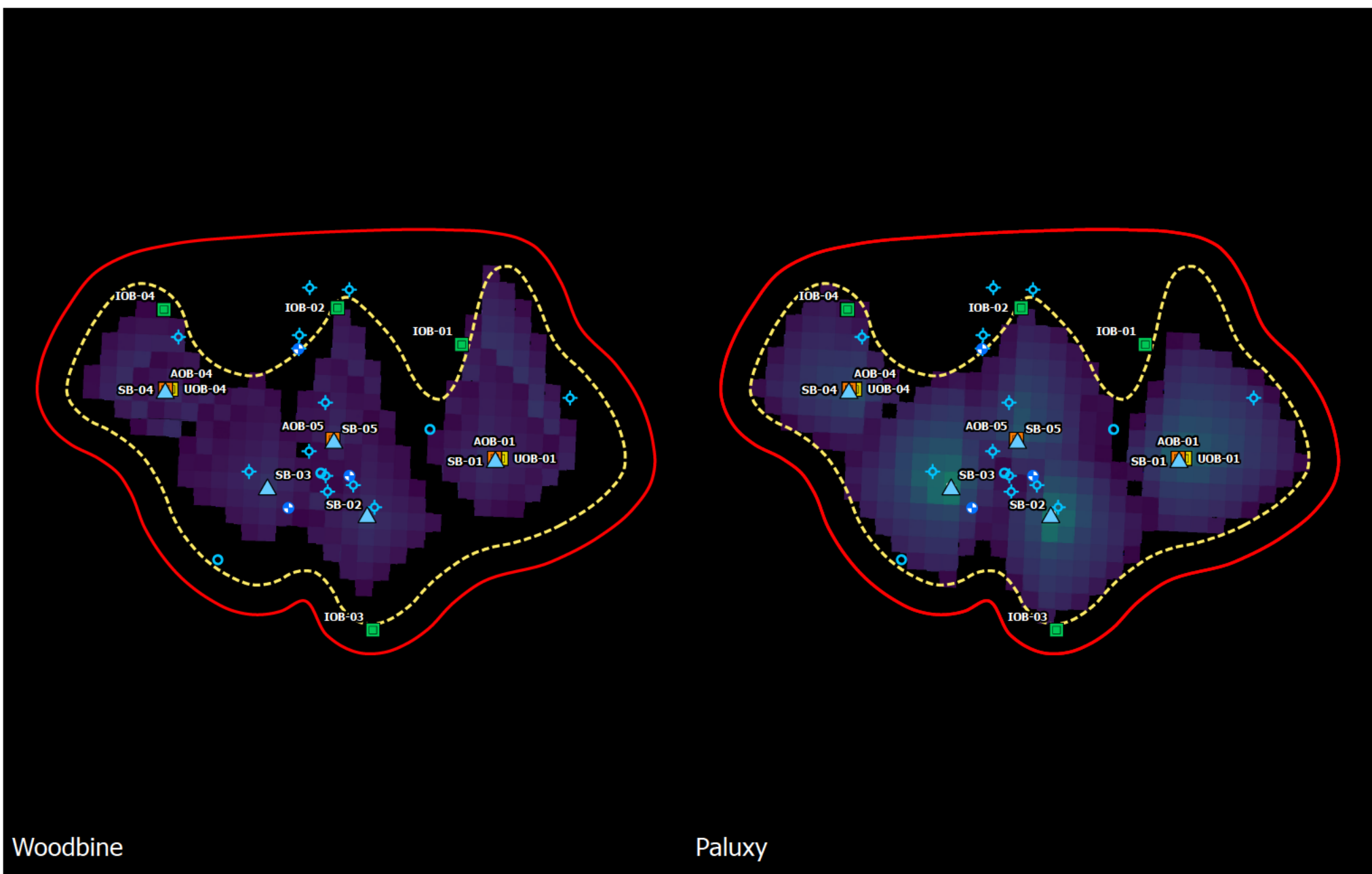
SUGARBERRY CCS HUB  
SUGARBERRY CCS, LLC  
HOPKINS COUNTY, TEXAS

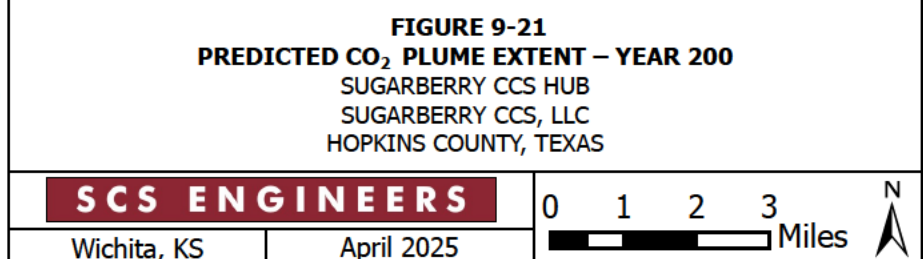
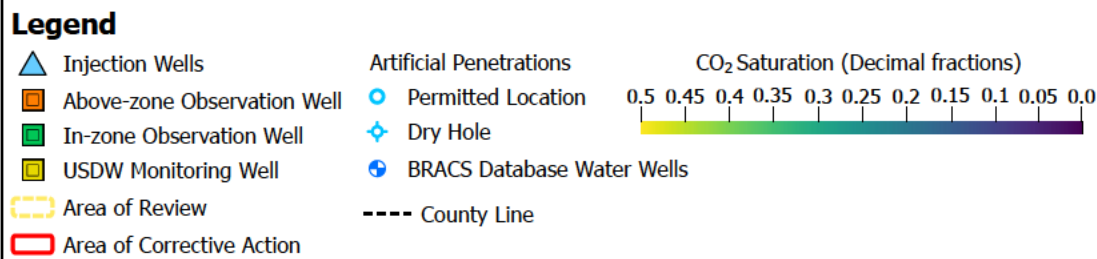
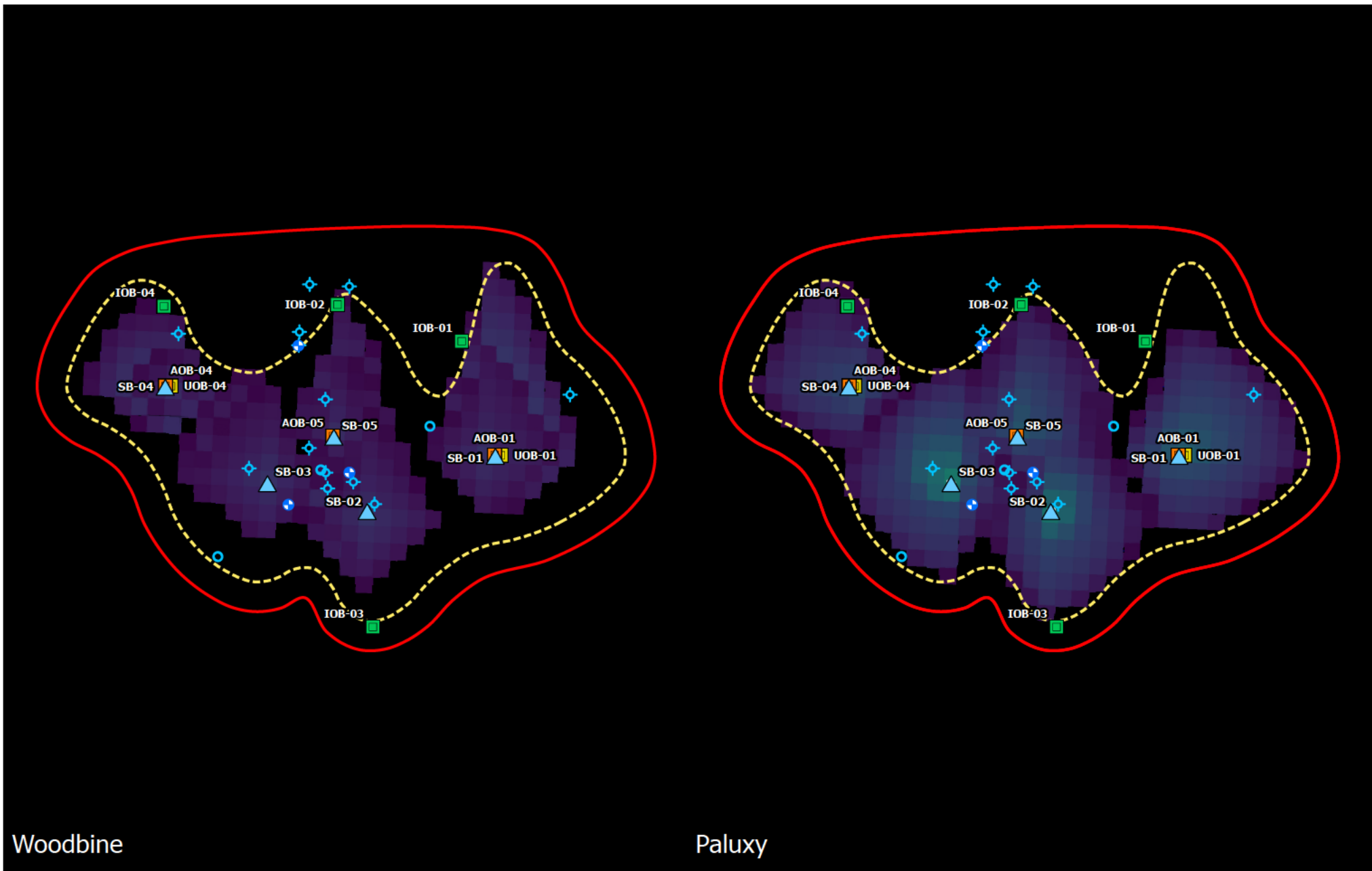
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## APPENDIX

Reporting Schema	Year								
	0	10	20	30	40	50	60	70	80
SB-01	Injection Well Reporting				IOB Well Reporting				
SB-02	Injection Well Reporting				IOB Well Reporting				
SB-03	Injection Well Reporting				IOB Well Reporting				
SB-04	Injection Well Reporting			IOB Well Reporting					
SB-05	Injection Well Reporting			IOB Well Reporting					

**Legend**

- Testing & Monitoring Plan
- PISC Plan

**REPORTING SCHEMA FOR INJECTION WELLS  
RELATIVE TO PROJECT PHASE**  
SUGARBERRY CCS HUB  
SUGARBERRY CCS, LLC  
HOPKINS COUNTY, TEXAS

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