Orchard Storage Company LLC

# Underground Injection Control – Class VI Permit Application for

Orchard No. 1 to No. 7

# Section 7 – Post-Injection Site Care and Site Closure Plan

## Gaines County, Texas

Prepared for *Orchard Storage Company LLC*
*Houston, Texas*

By
*Lonquist Sequestration, LLC*
Austin, TX

Revised August 2024

LONQUIST SEQUESTRATION LLC

# SECTION 7 – POST-INJECTION SITE CARE AND SITE CLOSURE PLAN

**TABLE OF CONTENTS**



**Figures**

**Tables**

## 7.1. Overview

This Post-Injection Site Care (PISC) and Site Closure Plan is prepared to meet the requirements of 16 Texas Administrative Code (TAC) **§5.206(k)** [Title 40, U.S. Code of Federal Regulations (40 CFR) **§146.93**]. This section provides a comprehensive overview of (1) the anticipated plumes and pressure front behavior at the end of the injection phase, (2) post-injection monitoring plans, (3) a discussion demonstrating non-endangerment to the Underground Source of Drinking Water (USDW), and (4) site closure plans. This plan provides the activities that Orchard Storage Company LLC (Orchard Storage) will perform once injection has ceased. The program will conclude with the site closure activities, once it is demonstrated that no additional monitoring is needed to ensure that this project does not endanger the USDW. This plan will be maintained during the life of the project and reevaluated every 5 years and submitted to the Underground Injection Control (UIC) Director.

## 7.2. Post-Injection Pressure Differentials

To meet the requirements of 16 TAC **§5.203(m)(2)** [40 CFR **§146.93(a)(2)**], Figures 7-1 through 7-7 show the expected pressure differentials for Orchard No. 1 through No. 7, respectively, in the injection zone from start of injection through 50 years post injection, as determined by the plume model described in *Section 2 – Plume Model*. Table 7-1 then shows the same for all seven injection wells at 50 years post-injection.

The expected pressure differential relative to pre-injection pressures for each of the Orchard injection wells is presented in Figures 7-1 through 7-7, respectively. The differential pressure, calculated for each grid block in the simulation model, is a snapshot of the difference between the pressure prior to the start of injection and the pressure at a given time post-injection. The data plotted on the graph represent the maximum for that differential pressure for all simulator grid blocks penetrated by each of the Orchard injectors.

Figures 7-1 through 7-7 also present the maximum differential pressure ($\Delta$p) vs. time, plotted as circles, for each injector. The horizontal axis represents time in years, relative to the start of injection. The vertical axis represents the maximum $\Delta$p value in psi. The dashed horizontal line shows the value of the critical pressure differential calculated at 213 psi, and a vertical dashed line flags the time at which injection ceases for this project.

The maximum $\Delta$p values increase with time until injection ends after 12 years. After injection ceases, the $\Delta$p values drop sharply for the first 5 years after injection ends then continues to drop over the remaining PISC period.

Critical pressure is the pressure differential required to lift formation fluids up to the base of the lowest USDW. The assumptions used to calculate critical pressure are discussed in more detail in Section 2.4.1. The pressure front ($P_{i,f}$) calculations for the injection zone are:

(Eq. 1) $$P_{i,f} = P_u + \rho_i g \cdot (z_u - z_i)$$

Where $P_u$ is the initial fluid pressure in the USDW, $\rho_i$ is the injection-zone fluid density, g is the acceleration due to gravity, $z_u$ is the representative elevation of the USDW, and $z_i$ is the representative elevation of the injection zone.

The critical pressure rise ($\Delta P_{i,f}$) is then calculated:

(Eq. 2) $$\Delta P_{i,f} = P_u + \rho_i g \cdot (z_u - z_i) - P_i$$
$$\Delta P_{i,f} = 880.4 + 0.448 \cdot [1{,}105 - (-1{,}880.8)] - 2{,}005.0$$
$$\Delta P_{i,f} = 213 \text{ psi}$$

The pressure differential in the injection zone drops below the critical pressure within 10 years after injection ceases.

Figure 7-1 – Maximum Pressure Differential Over Time for Orchard No. 1

Figure 7-2 – Maximum Pressure Differential Over Time for Orchard No. 2

Figure 7-3 – Maximum Pressure Differential Over Time for Orchard No. 3

Figure 7-4 – Maximum Pressure Differential Over Time for Orchard No. 4

Figure 7-5 – Maximum Pressure Differential Over Time for Orchard No. 5

Figure 7-6 – Maximum Pressure Differential Over Time for Orchard No. 6

Figure 7-7 – Maximum Pressure Differential Over Time for Orchard No. 7

Table 7-1 – Maximum Pressure Differential by Year, Post-Injection (50 Years) for Orchard No. 1–No. 7

| Year | Maximum Pressure Differential (psi) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Orchard No. 1 | Orchard No. 2 | Orchard No. 3 | Orchard No. 4 | Orchard No. 5 | Orchard No. 6 | Orchard No. 7 |
| [redacted] | | | | | | | |

## 7.3. $CO_2$ Plume Position and Pressure Front at End of Injection and at Closure

To meet the requirements of 16 TAC **§5.203(m)(3)** [40 CFR **§146.93(a)(2)**], Figure 7-8 shows the predicted maximum, stabilized position of the combined carbon dioxide plumes and associated pressure front at the time of site closure. These plumes, as discussed in Section 2 – Plume Model, are delineated based on a 2% gas saturation cutoff and includes 50 years after the end of injection. The color codes on the plumes show the modeled gas saturation at a given point from the respective injection well. Figures 7-9 and 7-10 present the east-west and north-south cross-sectional views of the stabilized plume at the end of injection and at the time of site closure (50 years post-injection) for Orchard No. 1. Figures 7-11 through 7-22 then show the same for Orchard No. 2 through No. 7, respectively.

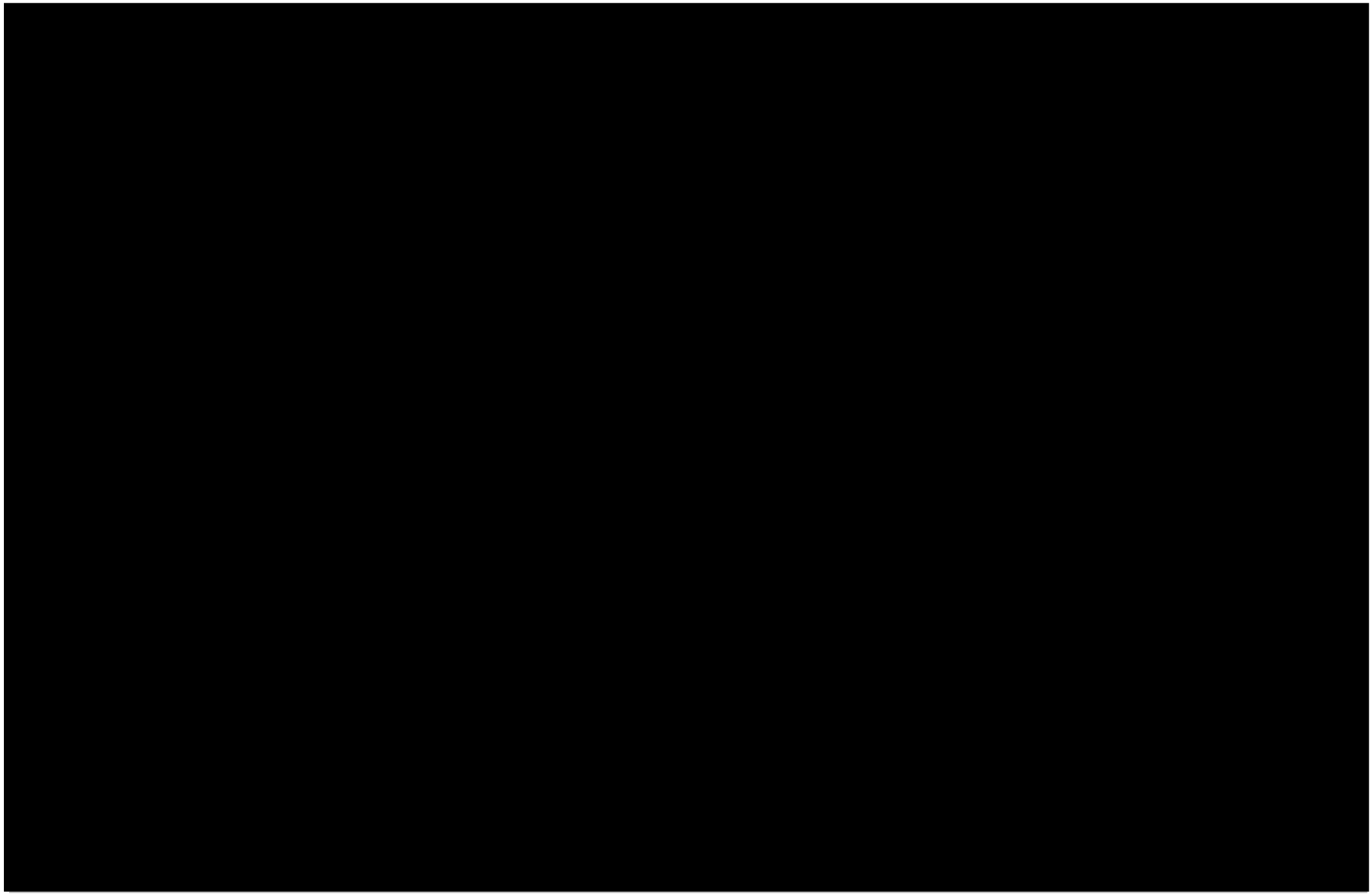

Figure 7-8 – Stabilized Combined $CO_2$ Plumes and Pressure Front Extent

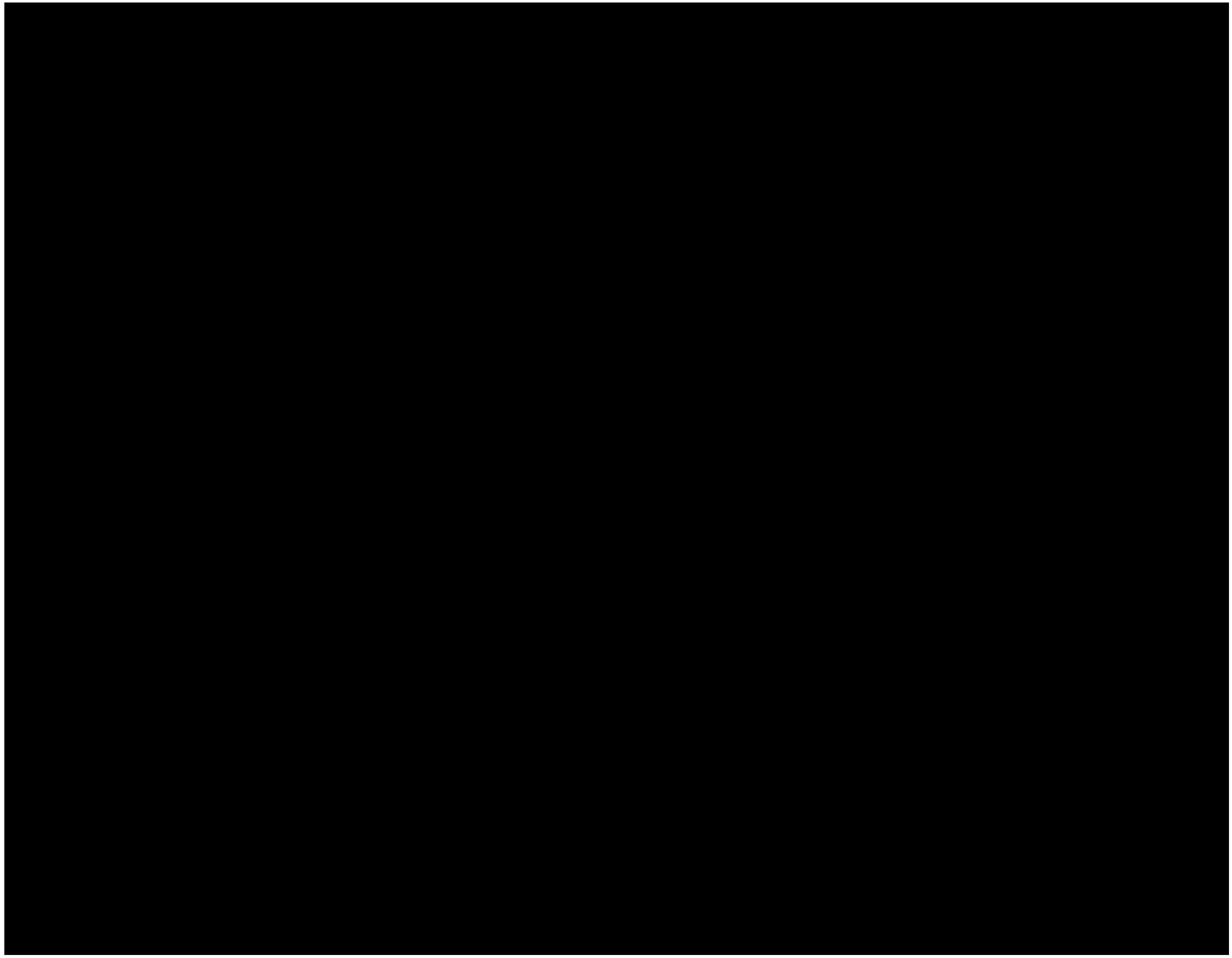

Figure 7-9 – East-West Cross-Sectional Views of $CO_2$ Saturation, Years 0 and 50 for Orchard No. 1

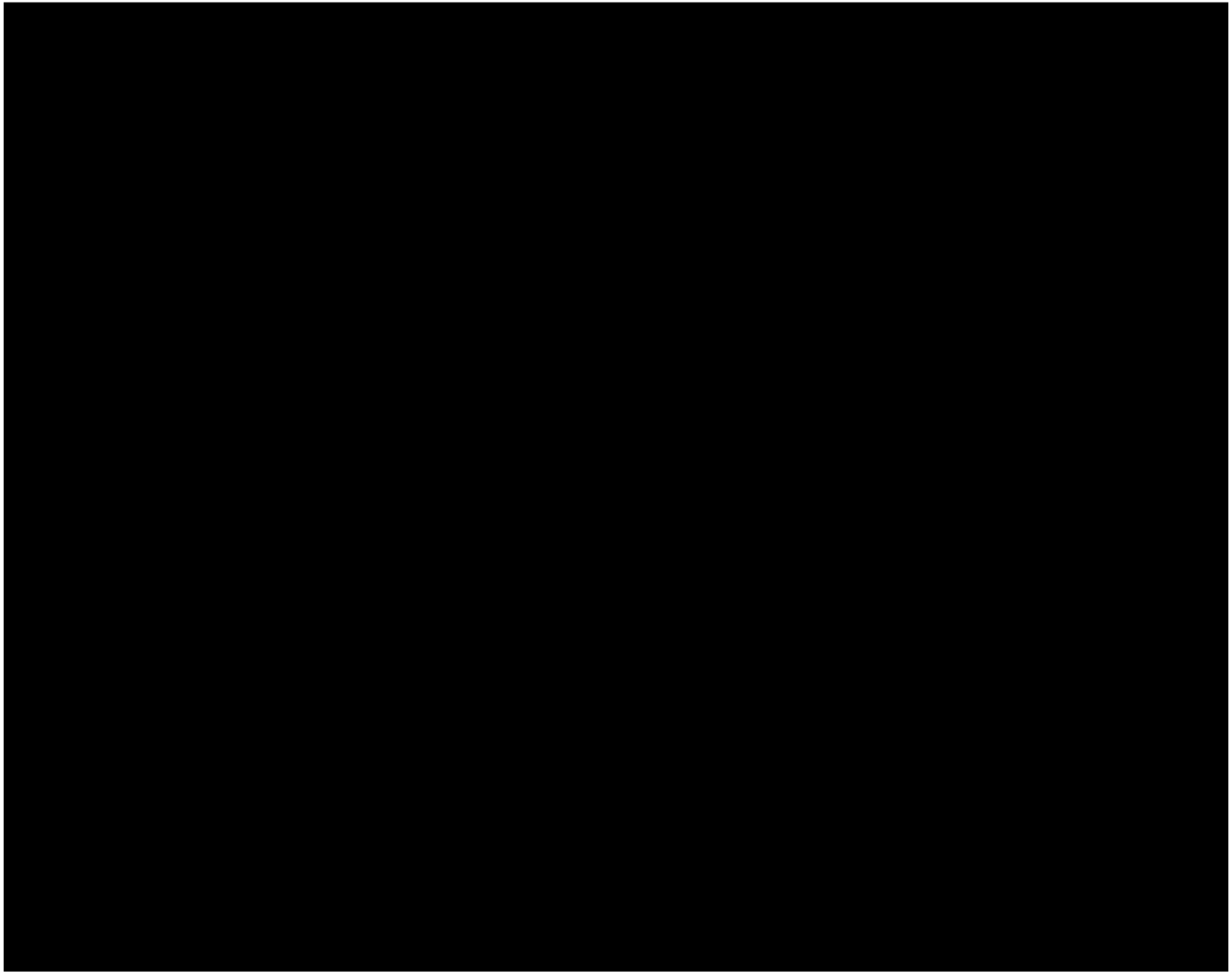

Figure 7-10 – North-South Cross-Sectional View of $CO_2$ Saturation, Years 0 and 50 for Orchard No. 1

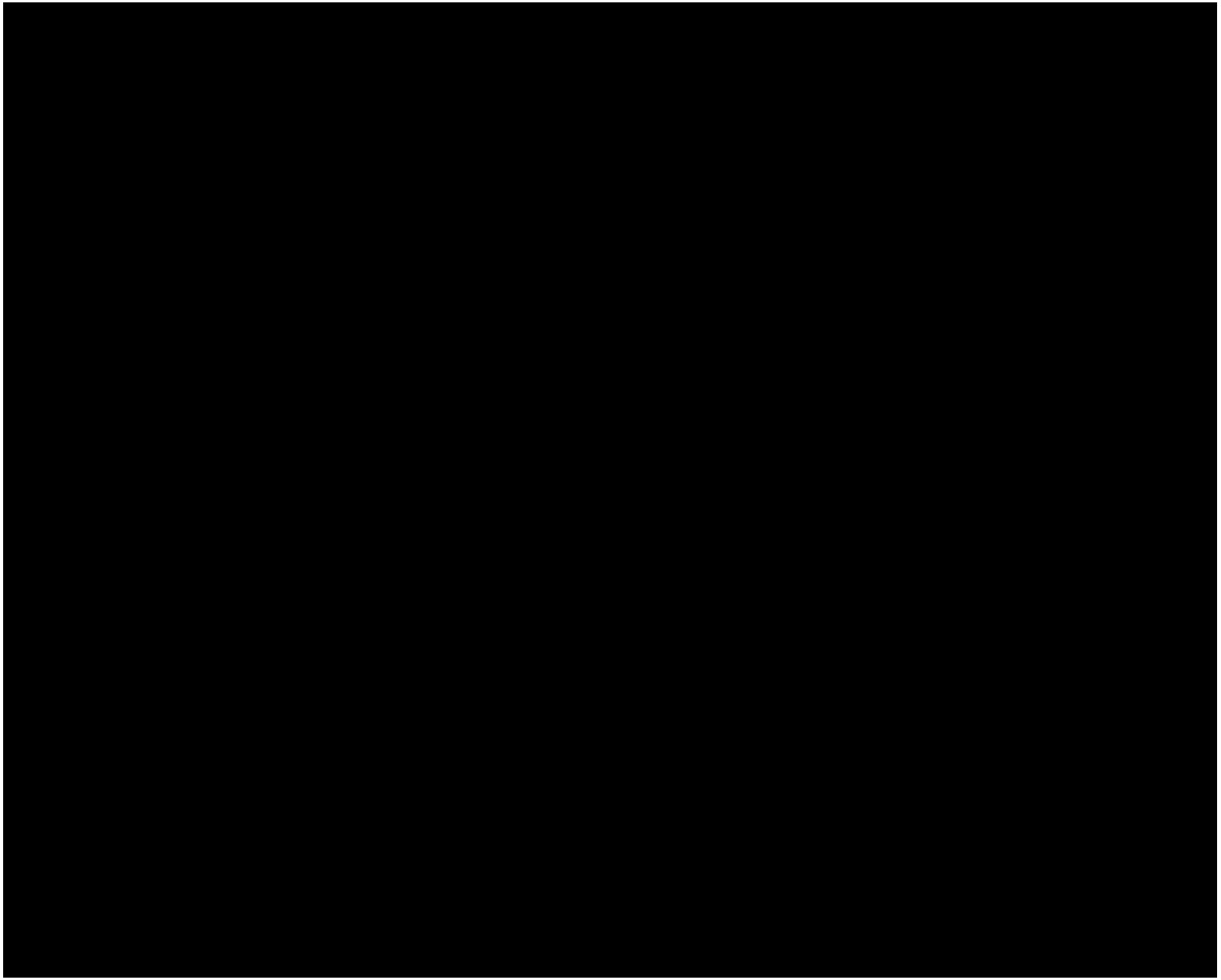

Figure 7-11 – East-West Cross-Sectional Views of $CO_2$ Saturation, Years 0 and 50 for Orchard No. 2

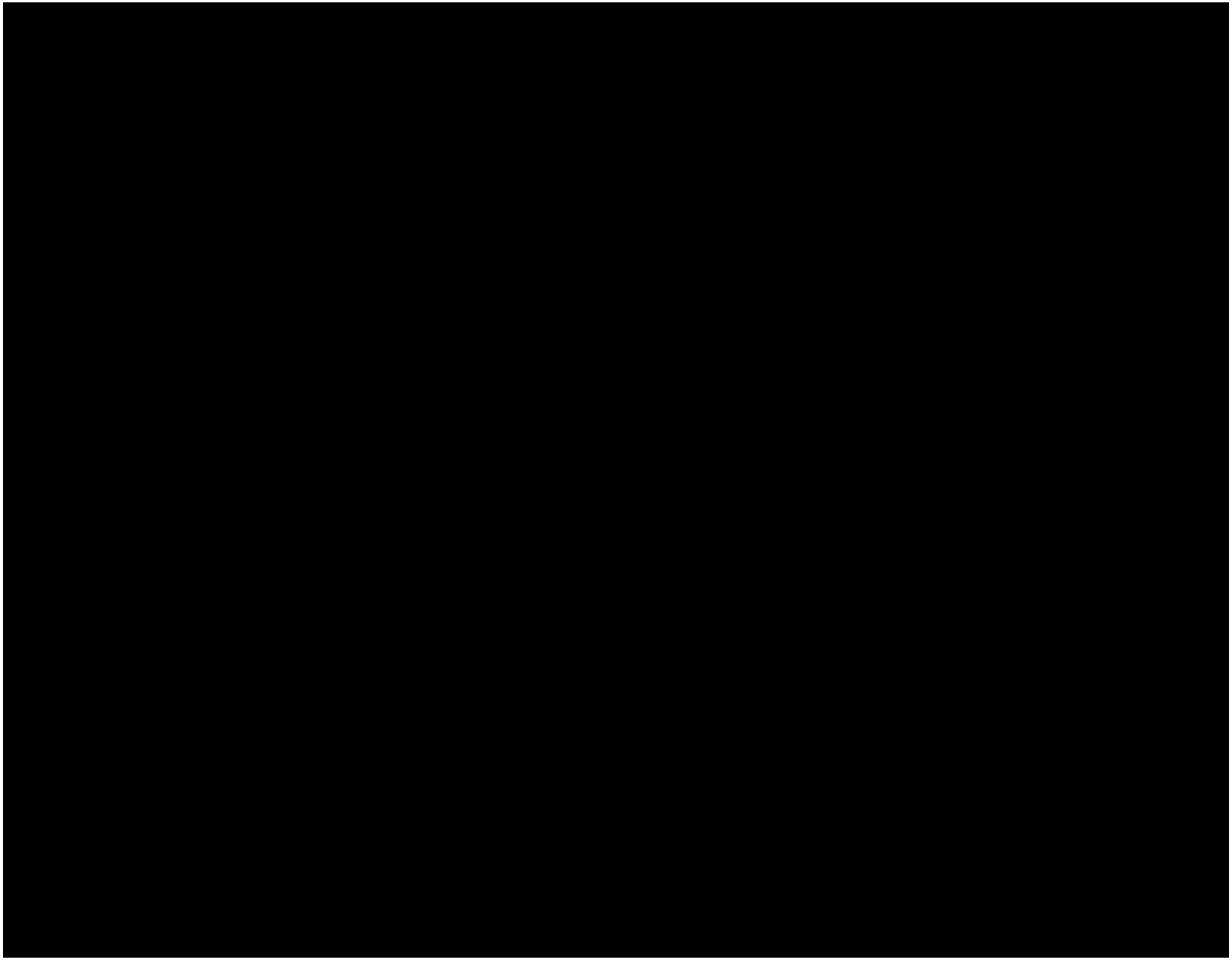

Figure 7-12 – North-South Cross-Sectional View of $CO_2$ Saturation, Years 0 and 50 for Orchard No. 2

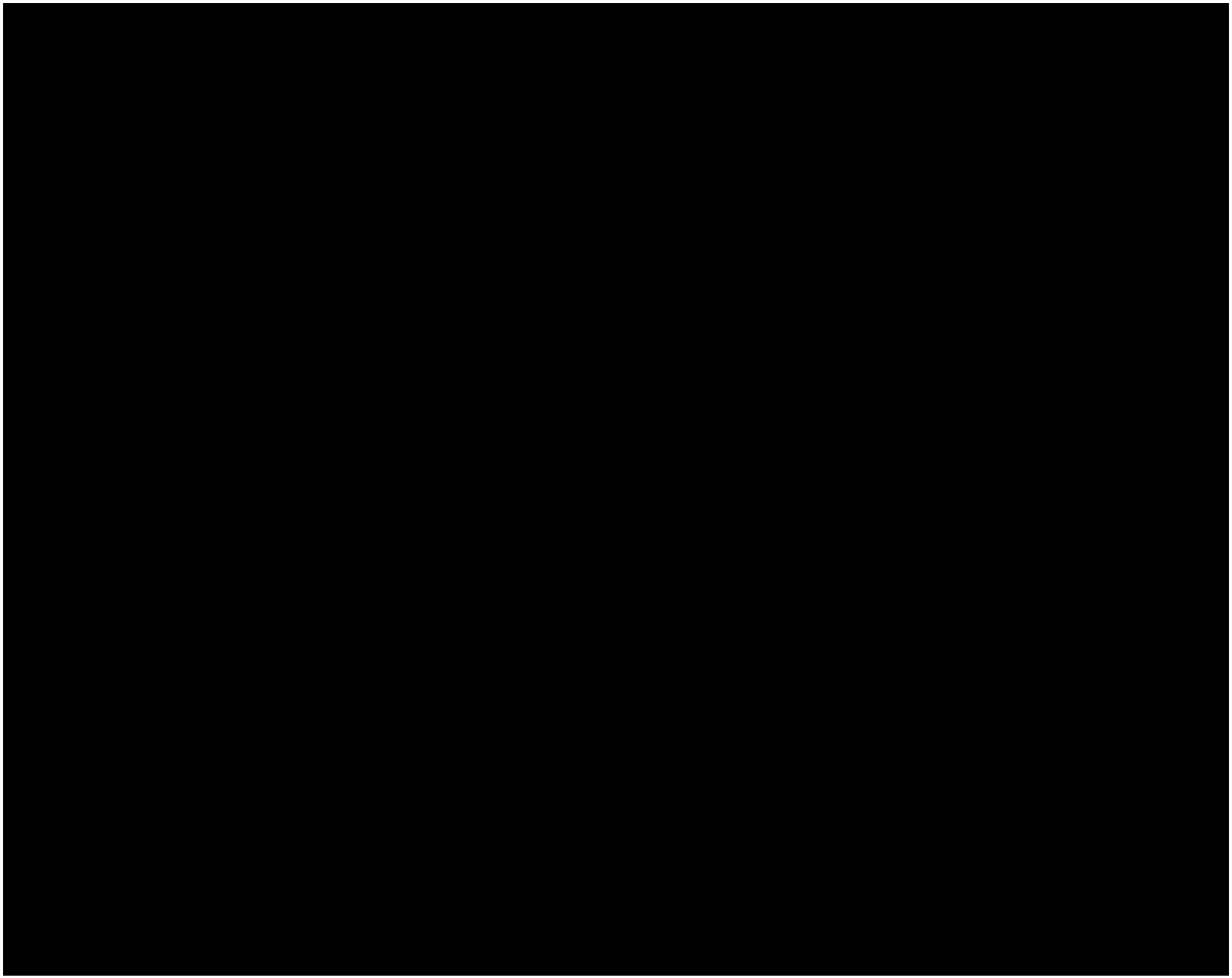

Figure 7-13 – East-West Cross-Sectional Views of $CO_2$ Saturation, Years 0 and 50 for Orchard No. 3

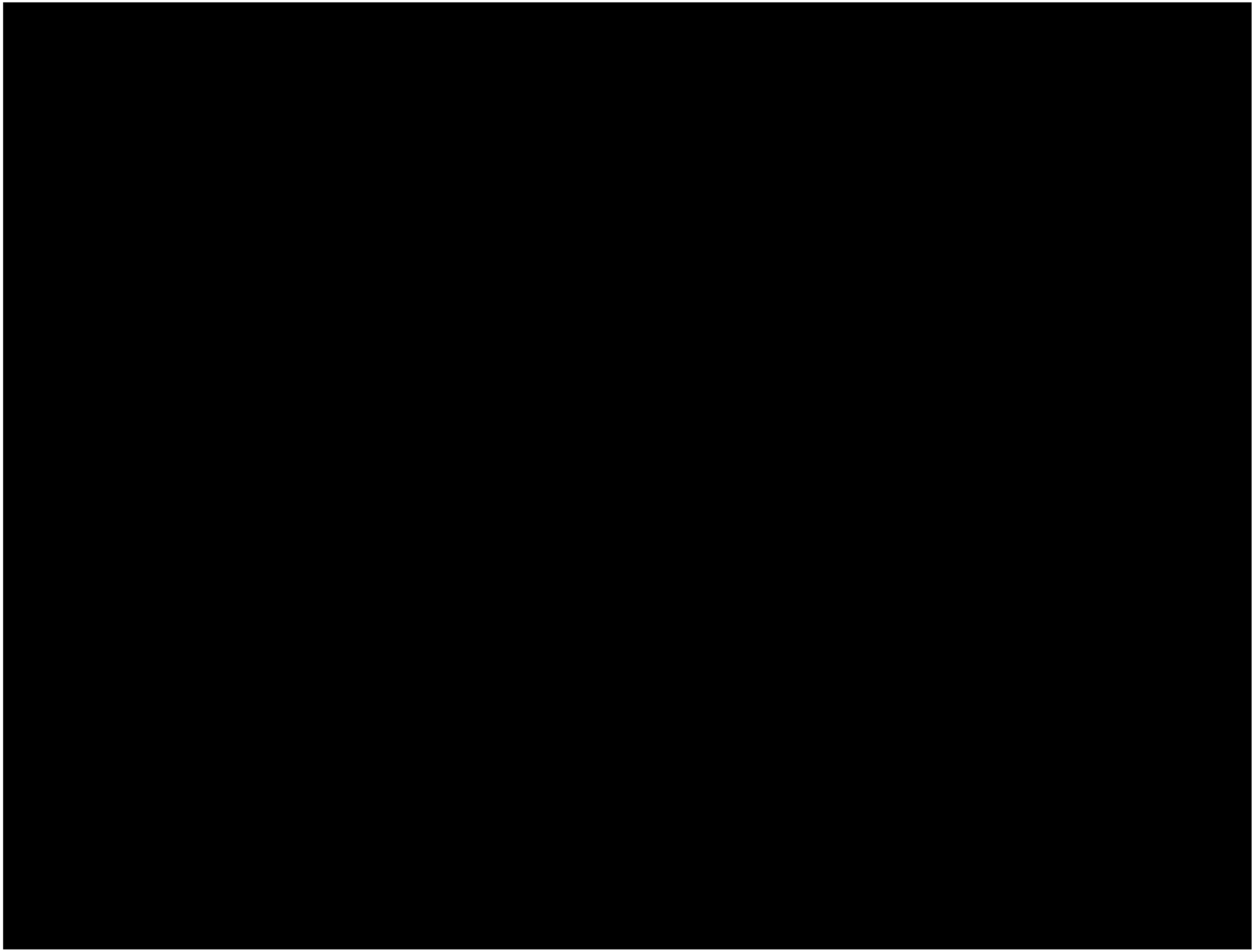

Figure 7-14 – North-South Cross-Sectional View of $CO_2$ Saturation, Years 0 and 50 for Orchard No. 3

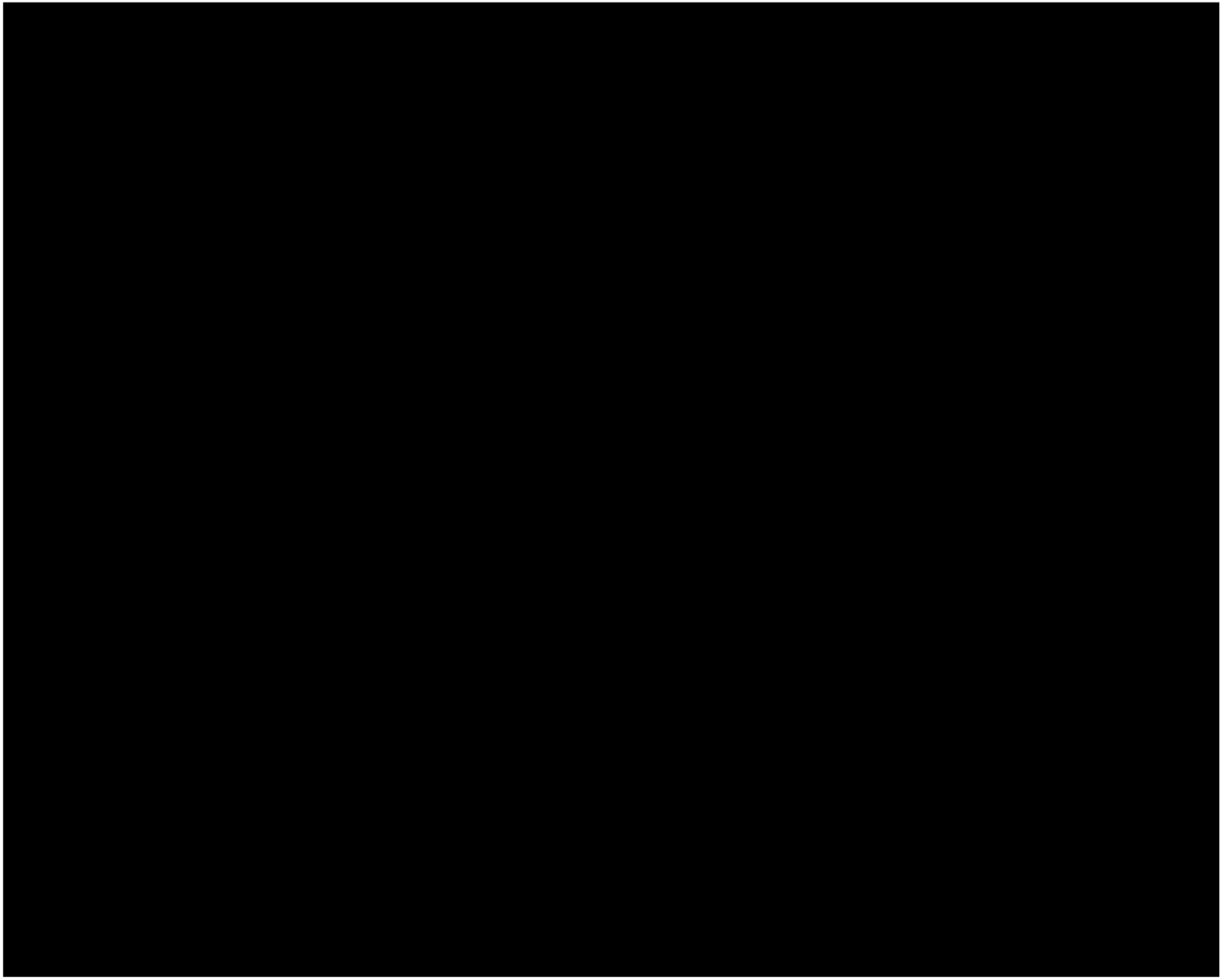

Figure 7-15 – East-West Cross-Sectional Views of $CO_2$ Saturation, Years 0 and 50 for Orchard No. 4

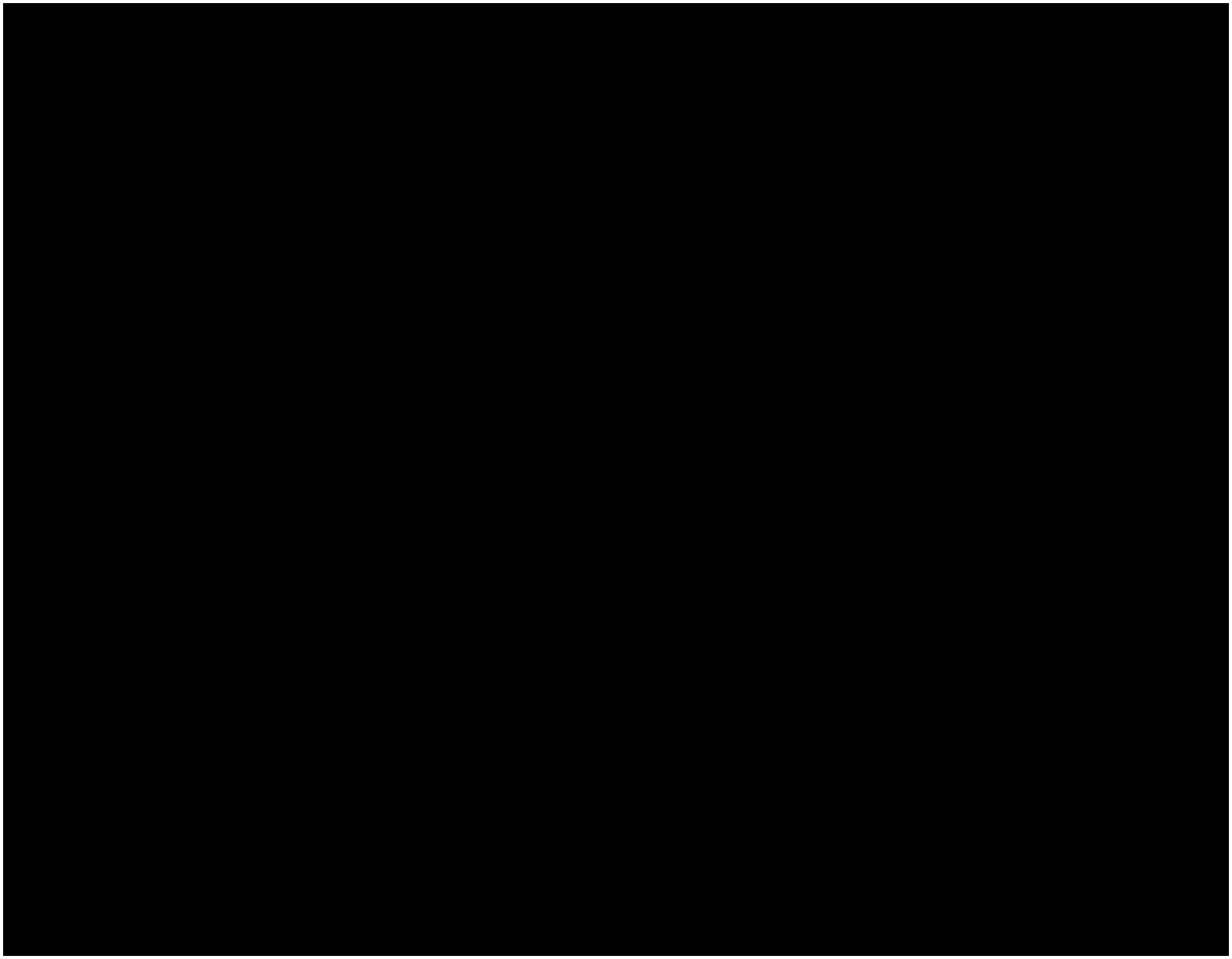

Figure 7-16 – North-South Cross-Sectional View of $CO_2$ Saturation, Years 0 and 50 for Orchard No. 4

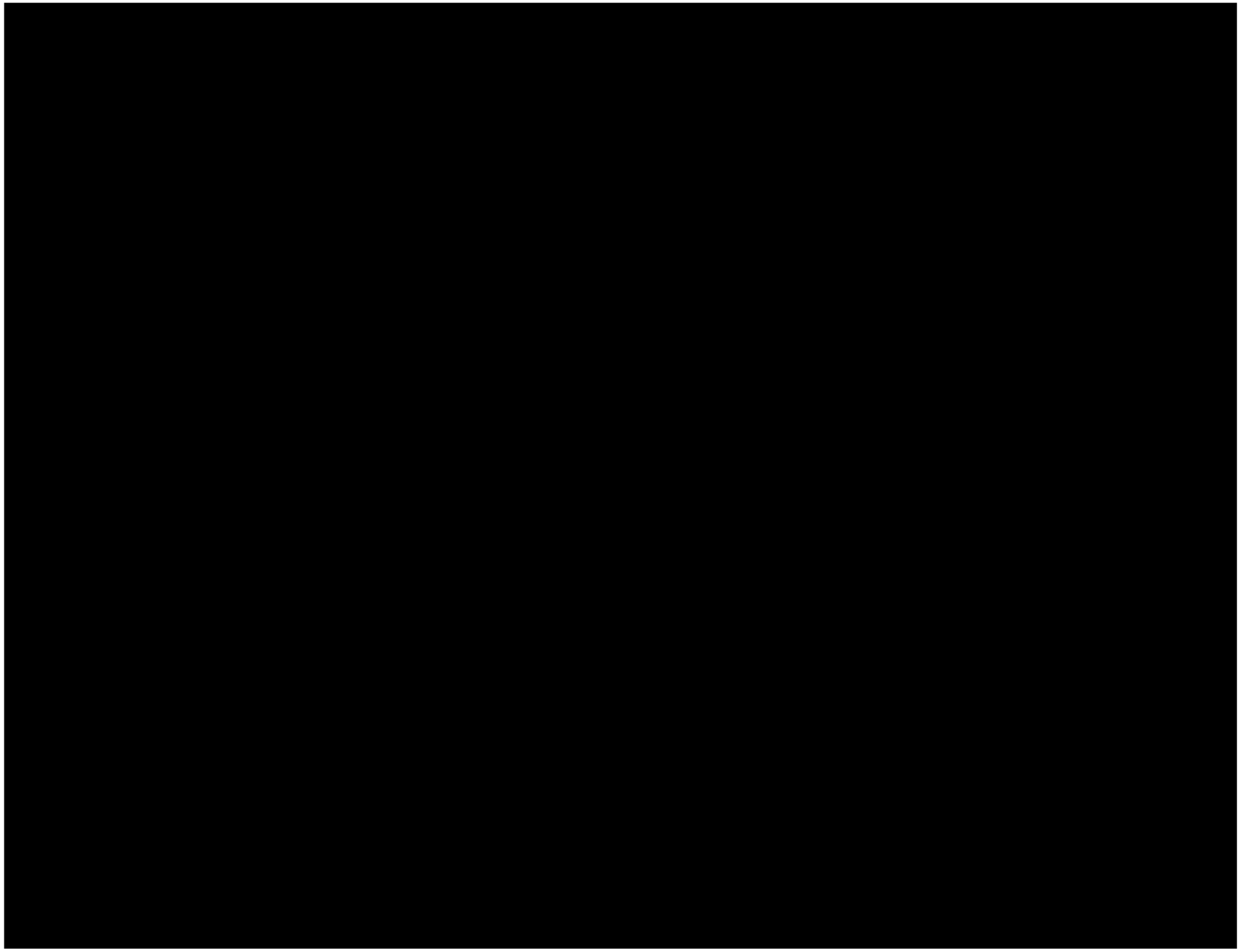

Figure 7-17 – East-West Cross-Sectional Views of $CO_2$ Saturation, Years 0 and 50 for Orchard No. 5

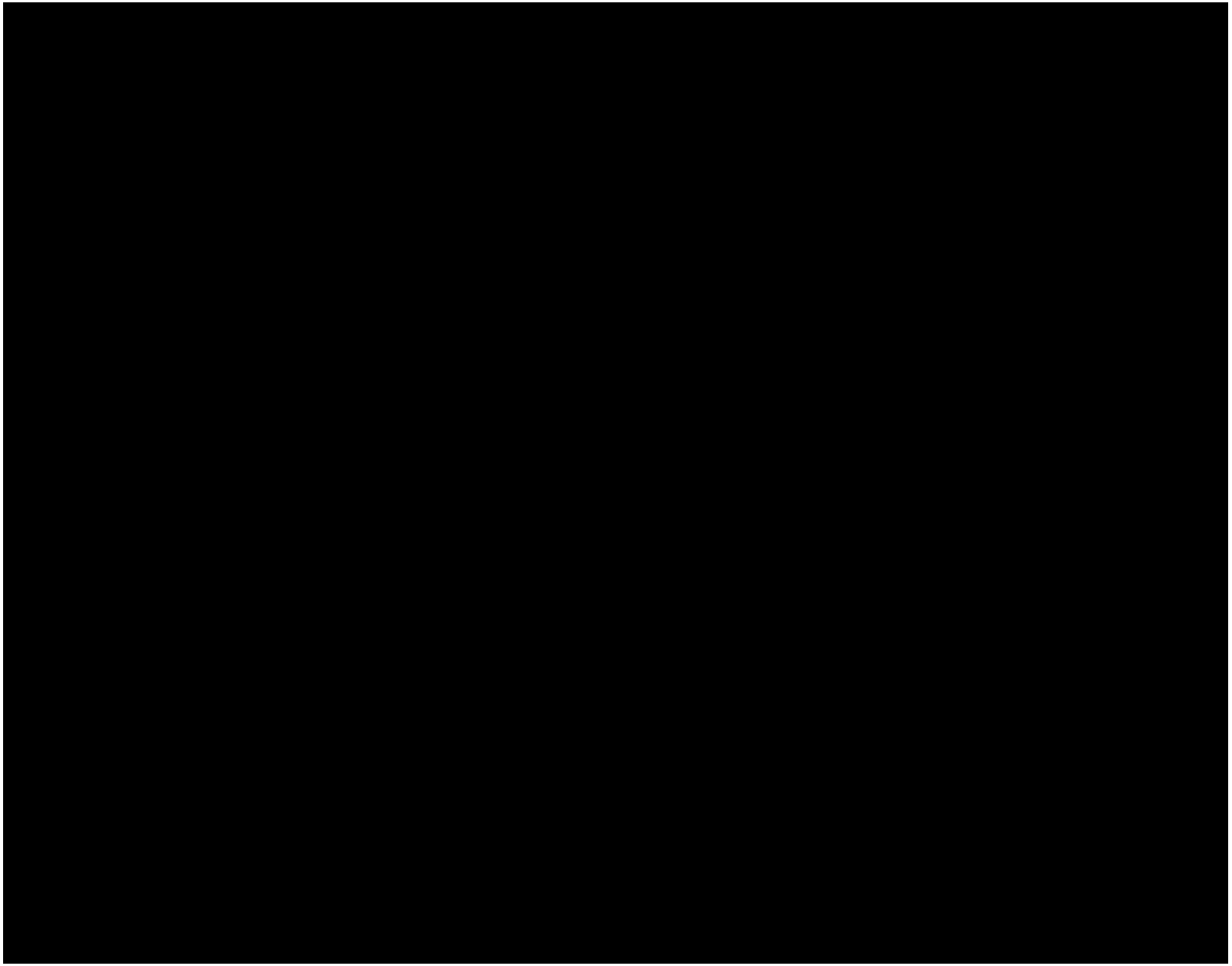

Figure 7-18 – East-West Cross-Sectional View of $CO_2$ Saturation, Years 0 and 50 for Orchard No. 5

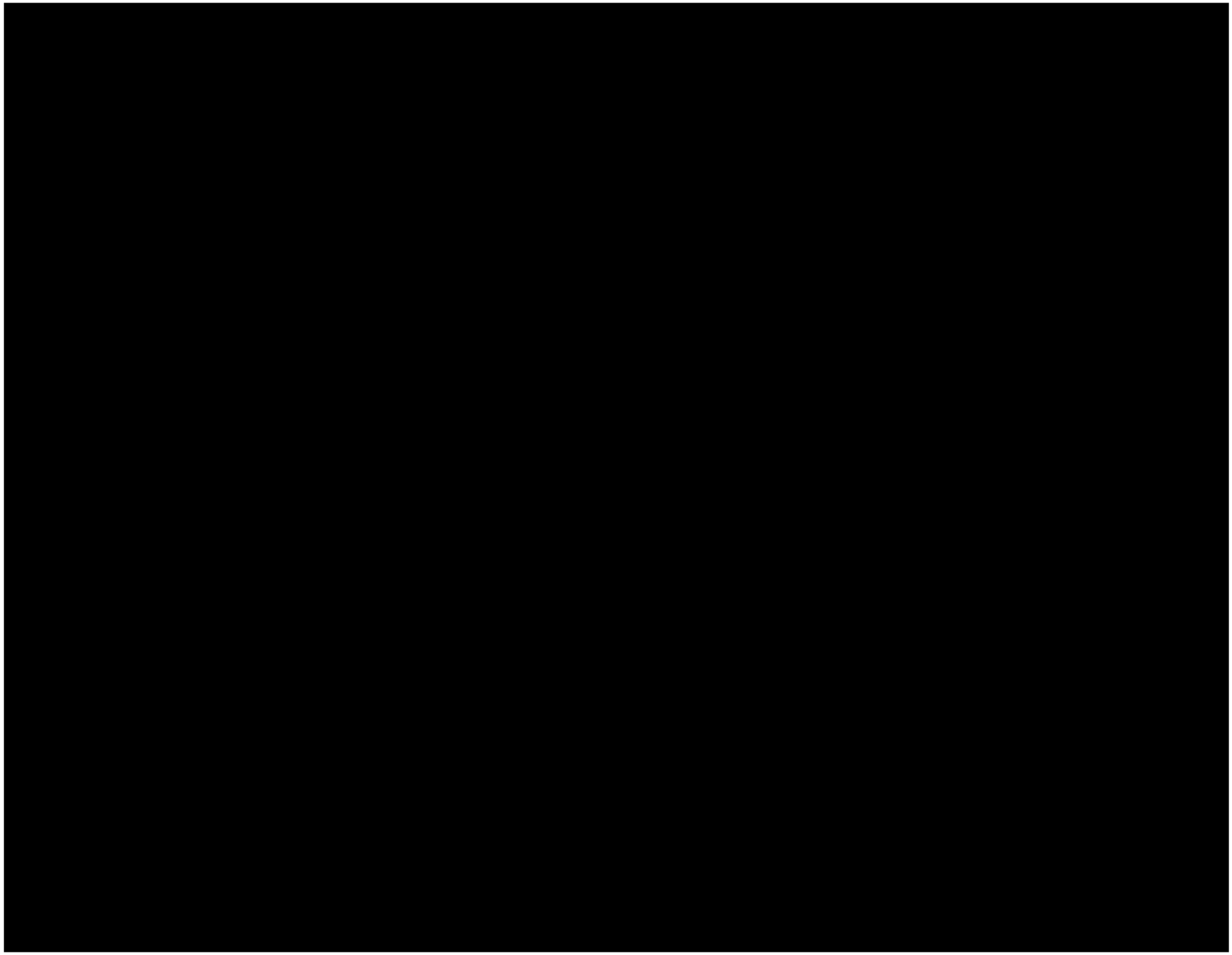

Figure 7-19 – East-West Cross-Sectional Views of $CO_2$ Saturation, Years 0 and 50 for Orchard No. 6

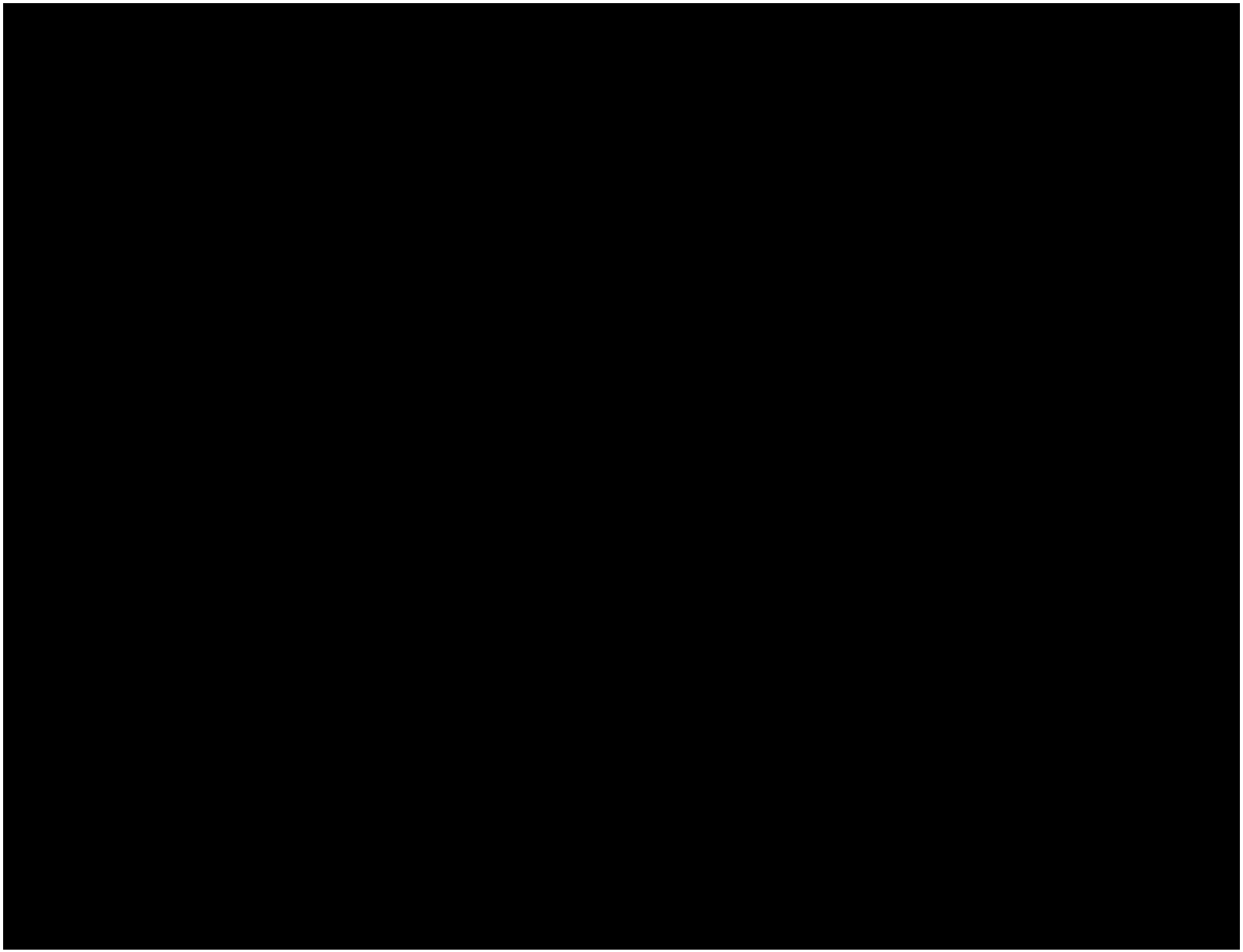

Figure 7-20 – East-West Cross-Sectional View of $CO_2$ Saturation, Years 0 and 50 for Orchard No. 6

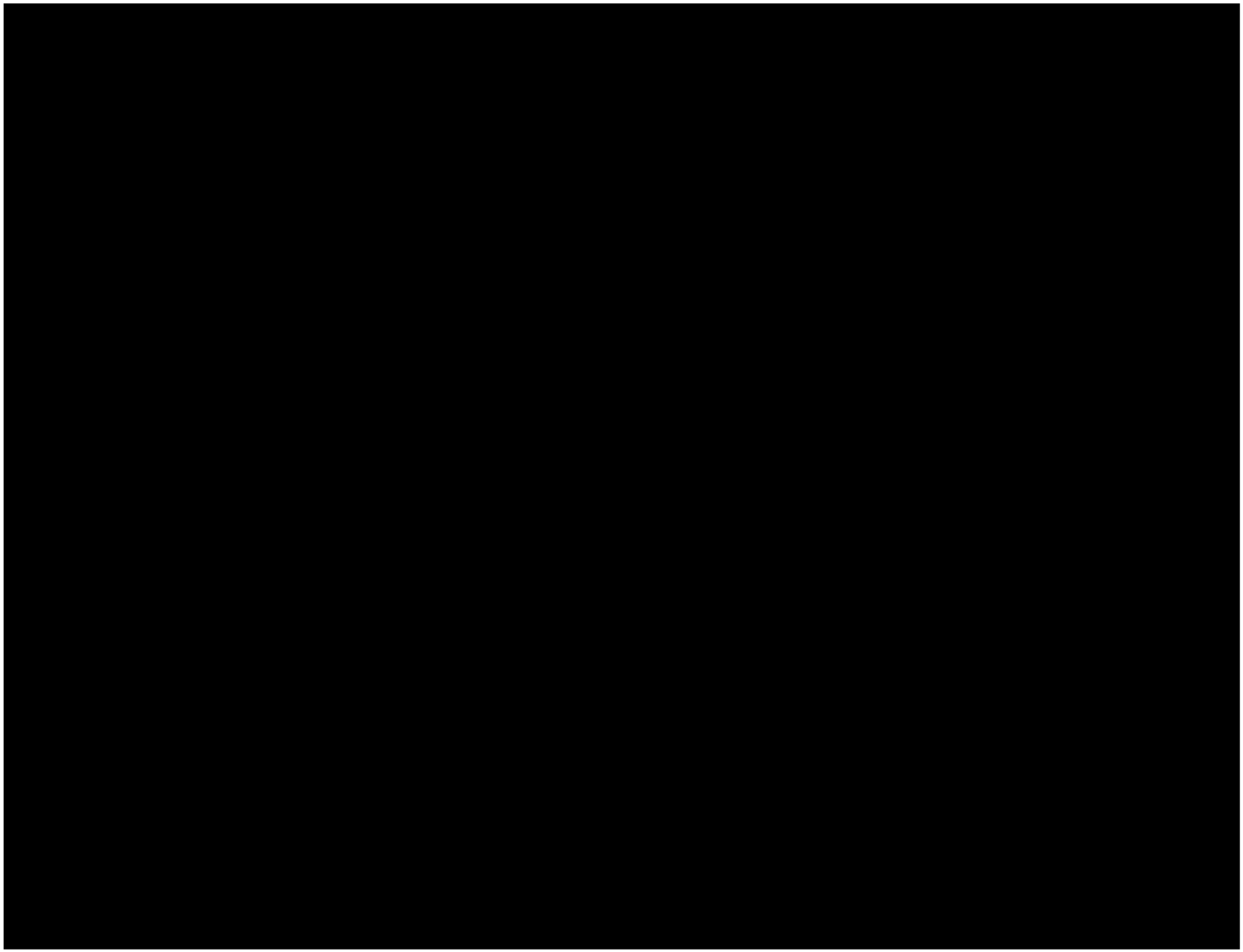

Figure 7-21 – East-West Cross-Sectional Views of $CO_2$ Saturation, Years 0 and 50 for Orchard No. 7

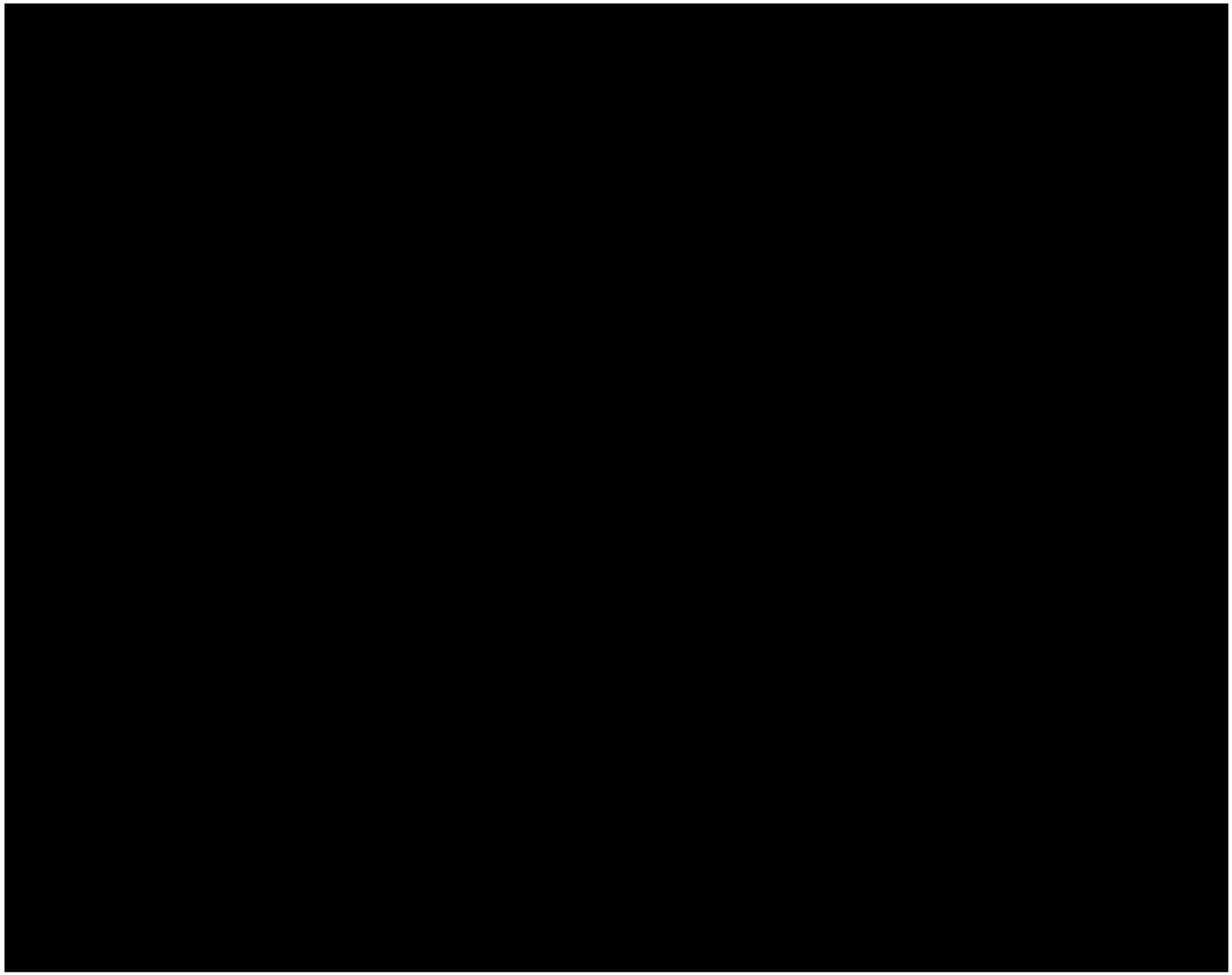

Figure 7-22 – East-West Cross-Sectional View of $CO_2$ Saturation, Years 0 and 50 for Orchard No. 7

## 7.4. Post-Injection Monitoring Plan

As required by 16 TAC **§5.206(k)(2)** [40 CFR **§146.93(b)**], Orchard Storage will continue to monitor the site until the project no longer poses an endangerment to USDWs via the fiber optic cable with sDAS/DTS installed and cemented in the annulus behind the long-string casing of each injector, the five groundwater monitoring wells, and the three above-zone monitoring wells across the Orchard Project area. These wells will be placed across the anticipated pressure front to measure any change from baseline parameters that would indicate the migration of $CO_2$ into the USDW (Figure 7-23).

Details about the monitoring plan for the injector wells can be found in Section 5.5.7, while details about the monitoring plan for the five groundwater monitoring wells can be found in Section 5.5.4, and details about the monitoring plan for the three above-zone monitoring wells can be found in Section 5.5.5.

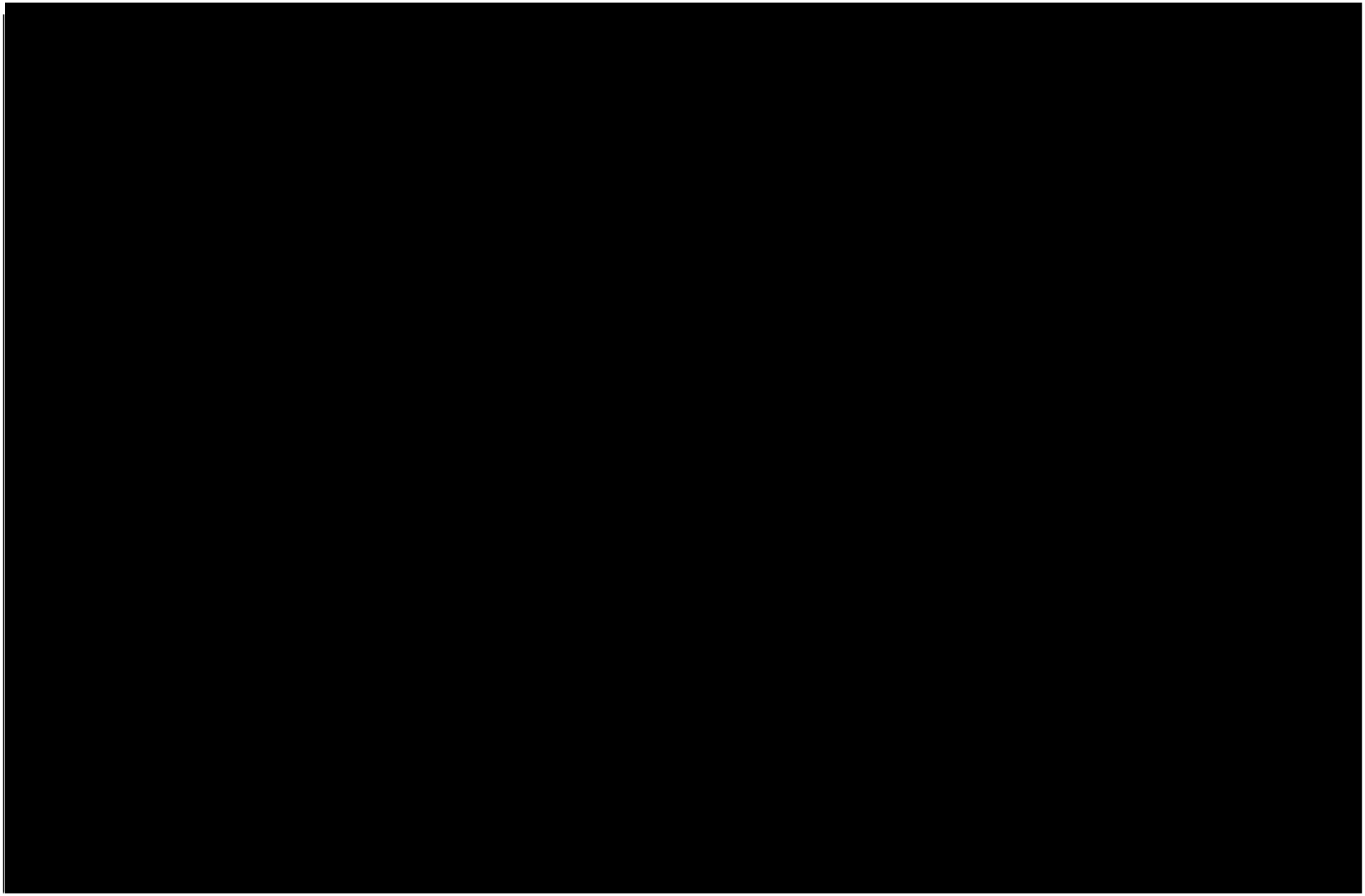

Figure 7-23 – Location of Groundwater, In-Zone and Above-Zone Monitoring Wells

### 7.4.1. Post-Injection Monitoring Activities

Post-injection monitoring will be utilized to track the movement of the plume and pressure front per 16 TAC **§5.206 (k)(2)** [40 CFR **§146.93(b)**]. The Testing and Monitoring Plan will be extended and used to confirm not only that the injection project is continuing to conform to the permit conditions, but also that any unexpected USDW endangerment is identified and mitigated. Testing and monitoring activities, as described in *Section 5 – Testing and Monitoring Plan*, will be performed and reported to the UIC director at the frequency shown in Table 7-2.

Table 7-2 – Post-Injection Monitoring and Reporting Frequency

| Testing/Monitoring Activity | Frequency | Reporting Schedule |
|---|---|---|
| Groundwater Monitoring Well Geochemical Analysis | Every 5 years | Within 30 days after data collection and analysis |
| Soil Gas Monitoring | Annually | Within 30 days after data collection and analysis |
| Seismic Monitoring | Continuously | Annually |
| Pressure and Temperature Monitoring (Injection and Monitor Wells) | Continuously | Annually |
| Indirect Plume and Pressure Front Monitoring (Vertical Seismic Profile (VSP)) | Every 5 years | Within 30 days after data collection and analysis |
| Direct Plume Calculations Based on Pressure and Temperature Data | Annually | Annually |

All testing and monitoring activities listed will be performed and analyzed as discussed in *Section 5*, including quality assurance/quality control measures.

### 7.4.2. Demonstration of Non-Endangerment of USDW

Before the approval of the site closure authorization, Orchard Storage will provide documentation that the USDW is not at risk of endangerment from the $CO_2$ plume, future plume migration, or any induced pressure within the pressure front capable of lifting fluids to the USDW as required by 16 TAC **§5.206(k)(3)** [40 CFR **§146.93(c)**]. The monitoring strategy for doing so is outlined in Section 5.5.7. Orchard Storage will submit a report to the UIC Director demonstrating the non-endangerment of the USDW, including site-specific conditions, updated plume model, predicted pressure decline within the injection zone, and any updates to the underlying geological assumptions used in the original model.

## 7.5. Site Closure Plan

Orchard Storage will perform site closure activities to meet the requirements of 16 TAC **§5.203(m)(3)** [40 CFR **§146.93(e)**]. These activities include removing surface equipment, plugging all wells, site restoration, and submission of final site-closure reports.

### 7.5.1. Pre-closure

Notice of intent to close the site will be submitted to the UIC Director at least 120 days before closing operations, per 16 TAC **§5.206(k)(4)** [40 CFR **§146.93(d)**]. Orchard will submit an amended post-injection site care and site closure plan or demonstrate to the Director through monitoring data and modeling results that no amendment to the plan is needed. Relevant notifications and applications, such as plugging requests, must be submitted to and approved by the Texas Railroad Commission (TRRC)/EPA before commencing such activities. No facility closure activities will be executed until the UIC Director has authorized closure.

### 7.5.2. Plugging Activities

The Orchard No. 1 through No. 7 injection wells and related monitoring wells will be plugged as discussed in *Section 6 – Injection Well Plugging Plan*. The plugging and abandonment procedures are designed to prevent the migration of $CO_2$ or formation fluids from the injection interval to the USDW. Before the wells are plugged, their mechanical integrity will be determined by an annulus pressure test, casing inspection log, and temperature log as described in *Section 5 – Testing and Monitoring Plan*. Plugging schematics and procedures are provided in *Appendix G.*

### 7.5.3. Site Restoration

Once the injection and monitoring wells are plugged and capped below grade, all surface equipment will be decommissioned and removed from the site. The sites will be restored as agreed with the surface owners.

### 7.5.4. Documentation of Site Closure

Within 90 days of site closure, a final report must be submitted to the UIC Director, per 16 TAC **§5.206 (k)(6)** [40 CFR **§146.93(f)**], and include the following:

- Documentation of appropriate injection and monitoring well plugging, including a copy of the survey plats which shall indicate the location of the injection wells relative to permanently surveyed benchmarks
- Documentation of well-plugging report
- Documentation of notification and information to appropriate authorities that have authority over drilling activities to impose appropriate conditions on subsequent drilling activities that may penetrate the injection and confining zone
- Records of the nature, composition, and volume of the $CO_2$ stream over the injection period

A record of notation in the facility property deed will be added to provide, in perpetuity, any potential purchaser of the property with

- a complete legal description of the affected party;
- the fact that the land was used to sequester $CO_2$;
- confirmation that the survey plat has been filed with the TRRC/Environmental Protection Agency (EPA);
- the address of the office of the EPA, to which the operator sent a copy of the survey plat; and
- the total volume of fluid injected, the injection zones into which it was injected, and the period over which the injection occurred.

Orchard Storage will retain all records collected during the PISC period for 10 years following site closure. At the end of the retention period, Orchard Storage will deliver all records to the UIC Director, which will thereafter be retained at a location designated by the director for that purpose.