

## **2 AREA OF REVIEW AND CORRECTIVE ACTION PLAN**

### **40 CFR 146.84(b)**

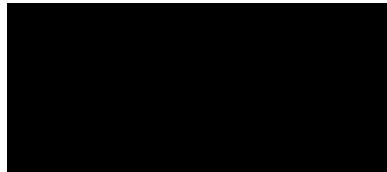
#### **TULARE COUNTY CARBON STORAGE PROJECT (TCCSP)**

##### **Facility Information**

Facility (site) Name: Tulare County Carbon Storage Project (TCCSP)

Facility Operator: TCCSP, LLC.

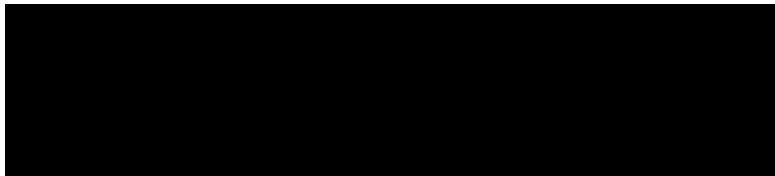
Facility Contact:



Project Location:



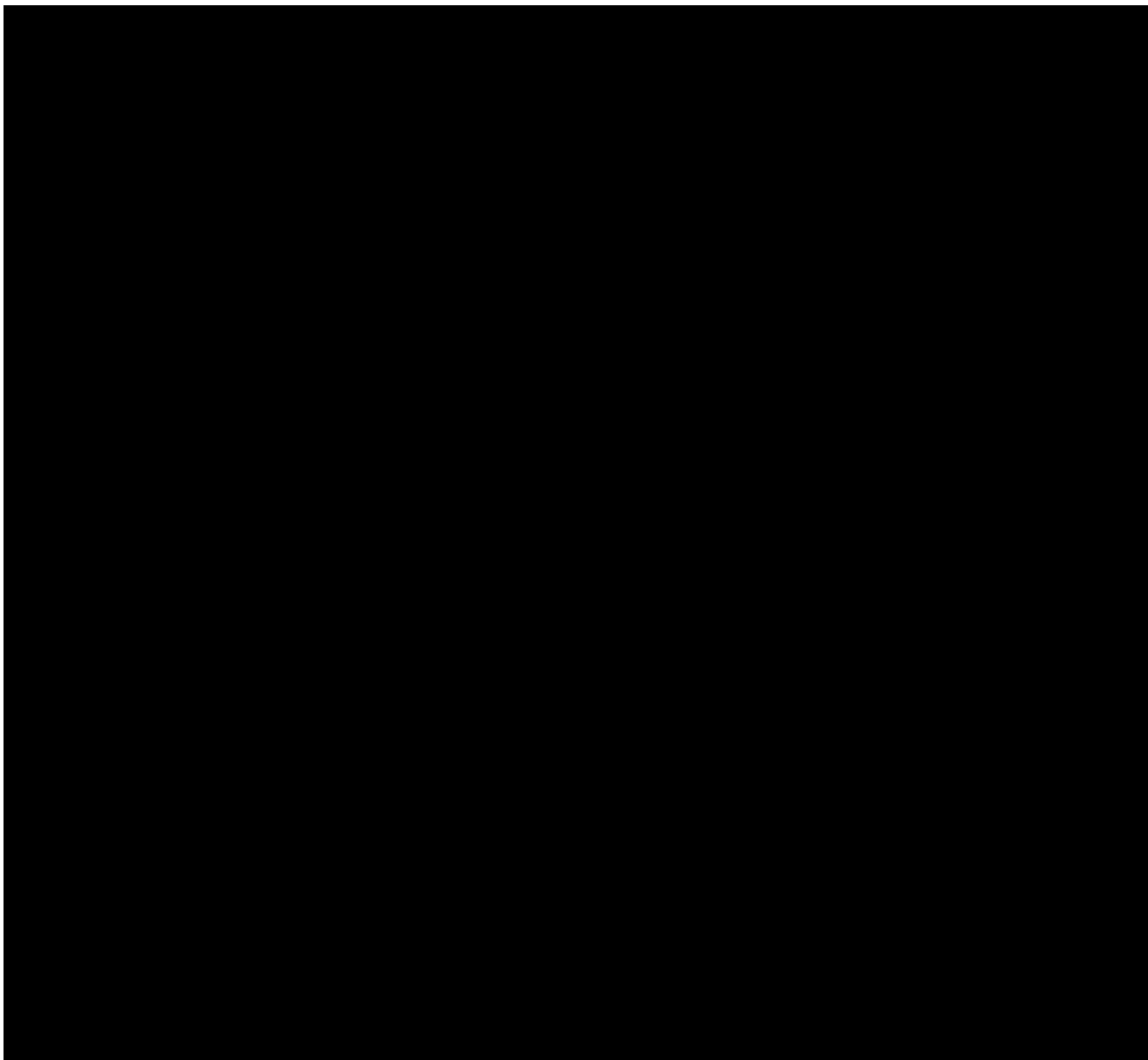
Injection Well Name and Coordinates:



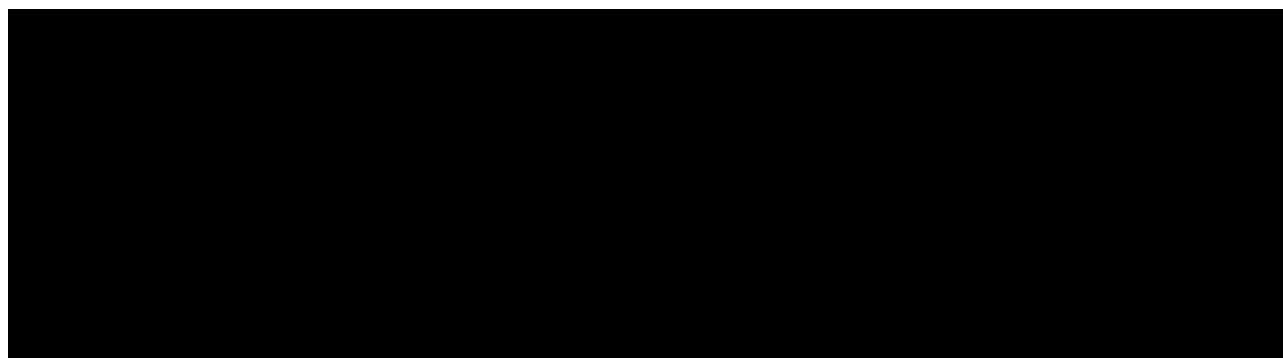
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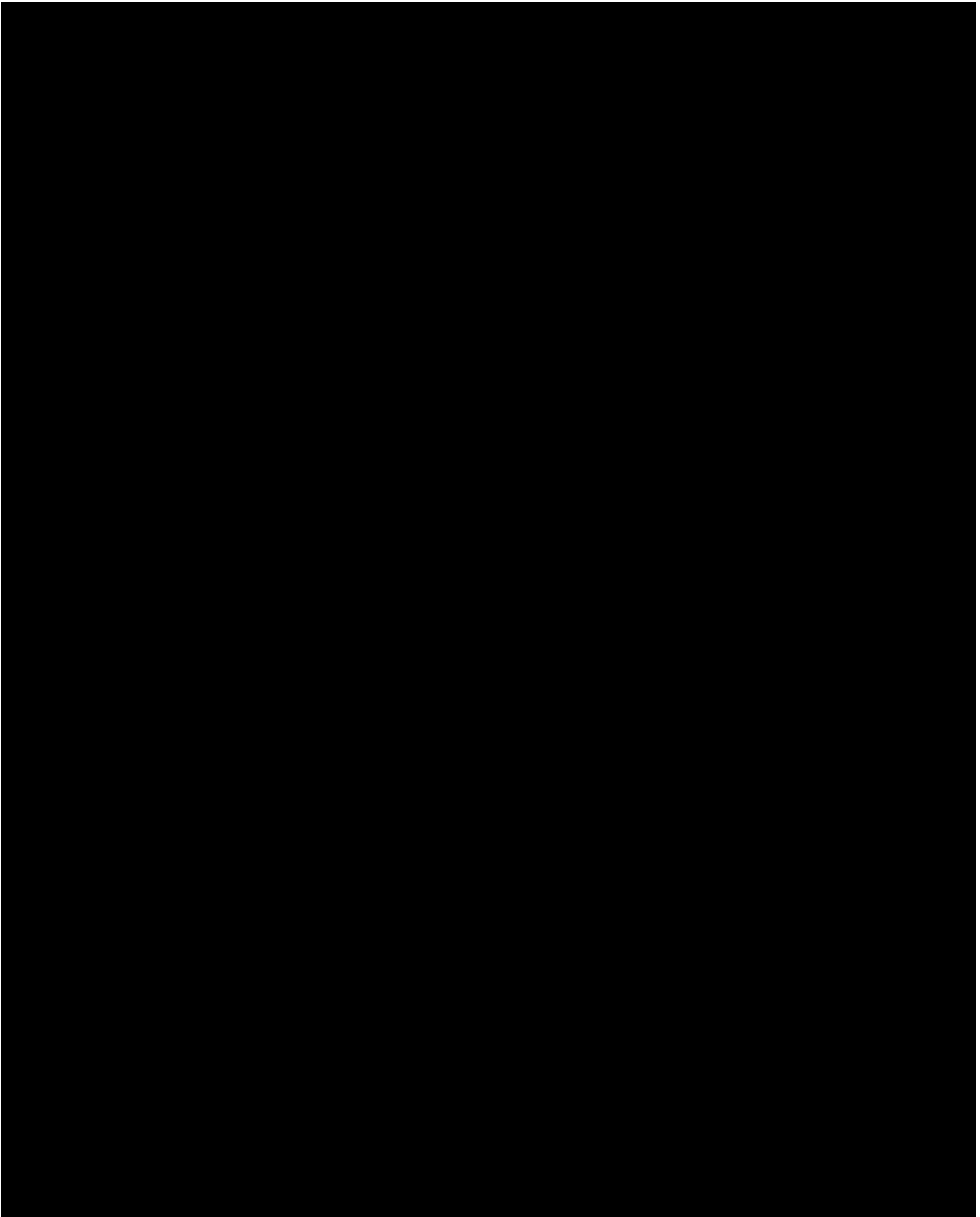
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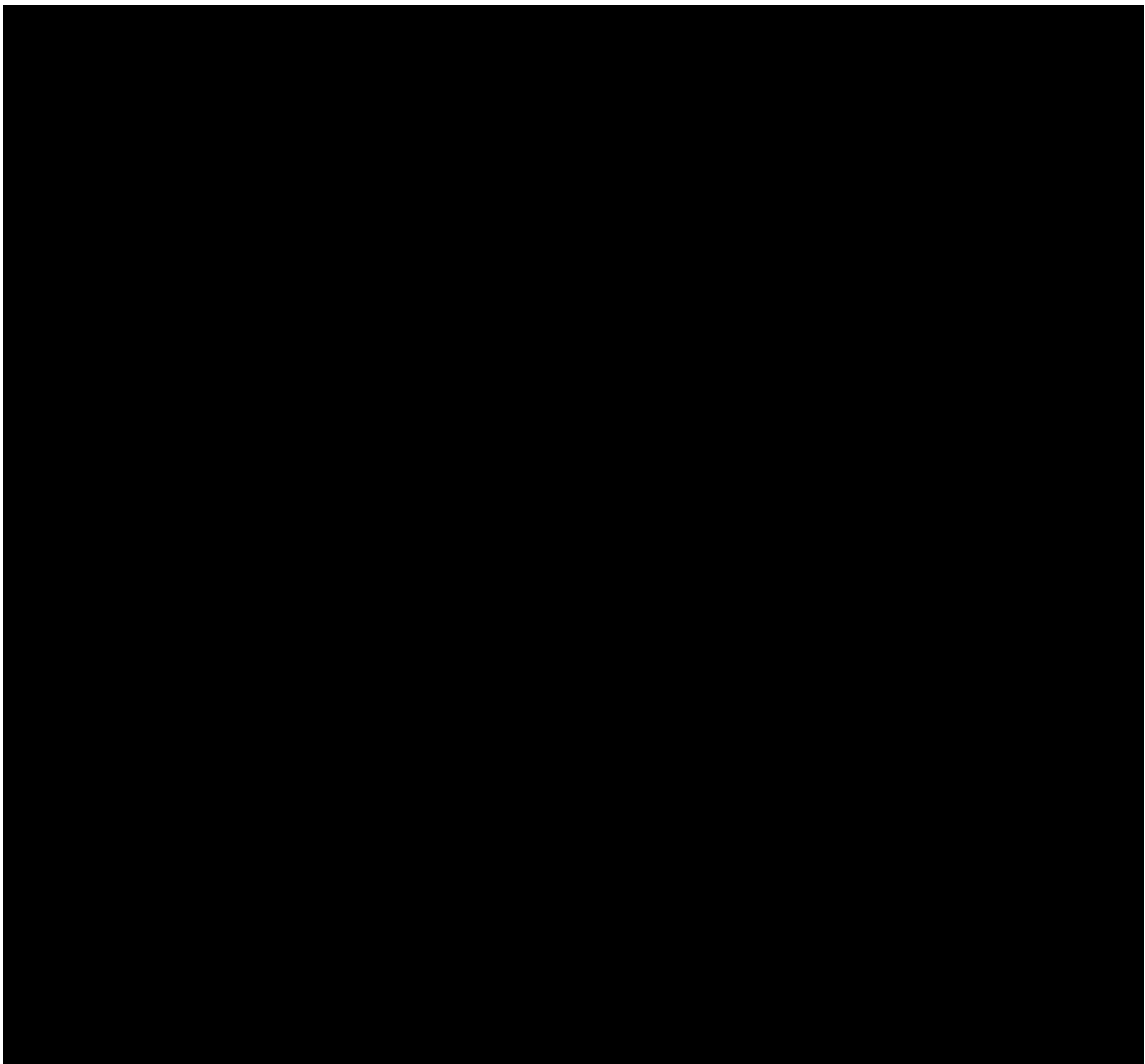
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### **Abbreviations and Acronyms**

2D	2-Dimensional
3D	3-Dimensional
AoR	Area of Review
bbbl/d	Barrels per day
BHP	Bottom Hole Pressure
CCS	Carbon capture, and storage
CO <sub>2</sub>	Carbon dioxide
CMG	Computer Modelling Group
D <sub>H</sub>	Hydraulic Diameter
DRM	Dynamic Reservoir Model

EoS	Equation of State
EPA	Environmental Protection Agency
$f_D$	Darcy's Friction Factor
ft.	Feet
g	Acceleration due to Gravity
GEM	General Equation of State
KB	Kelly Bushing
$k_{r,CO_2}$	CO <sub>2</sub> Relative Permeability
kh	Permeability-Thickness Product
$k_h$	Absolute Horizontal Permeability
$k_v$	Absolute Vertical Permeability
$k_{r,w}$	Water Relative Permeability
LWM	Leaky Well Model
mg/L	Milligrams per liter
MIP	Mercury Intrusion Porosimetry
MMt	Millions of Metric tons
MMtpa	Millions of Metric tons per annum
$\Delta P$	Pressure Difference
$\Delta P_{TH}$	Threshold Pressure
PISC	Post-Injection Site Care
$P_{grid}$	Grid Block Pressure
pH	Potential Hydrogen
ppm	Parts per Million
psi	Pounds per square inch
psia	Pounds per square inch, absolute
$\rho$	Fluid Density
$\rho_i$	Injection Zone Fluid Density
$\rho_u$	Underground Source for Drinking Water Fluid
RCA	Routine Core Analysis
$Re$	Reynolds Number
SCA	Specialized Core Analysis
SEM	Static Earth Model
$S_{grmax}$	Maximum Residual Gas Saturation
SS	Subsea
$S_{wconn}$	Connate Water Saturation
$S_{wirr}$	Irreducible Water Saturation
$T_{grid}$	Grid Block Temperature
TVD	True Vertical Depth
UIC	Underground Injection Control
USDW	Underground Source of Drinking Water
U.S.	United States Department of Energy
U.S.	United States Environmental Protection Agency
v	Fluid Velocity
$z_i$	Injection Zone Top Depth

Z<sub>u</sub>      Underground Source for Drinking Water Bottom

## **2.1 Executive Summary**

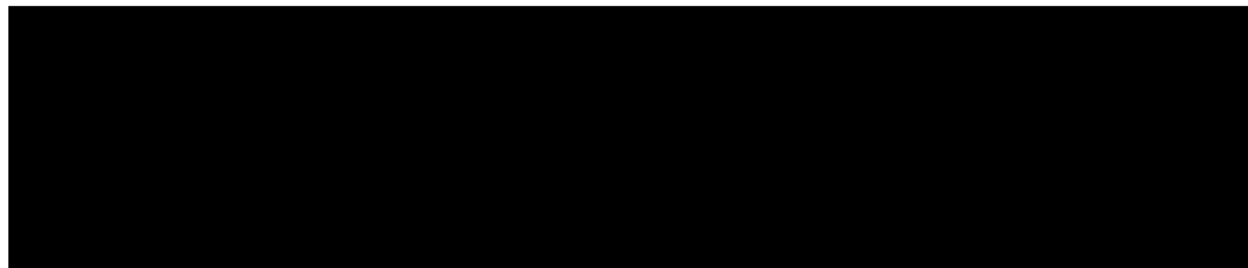
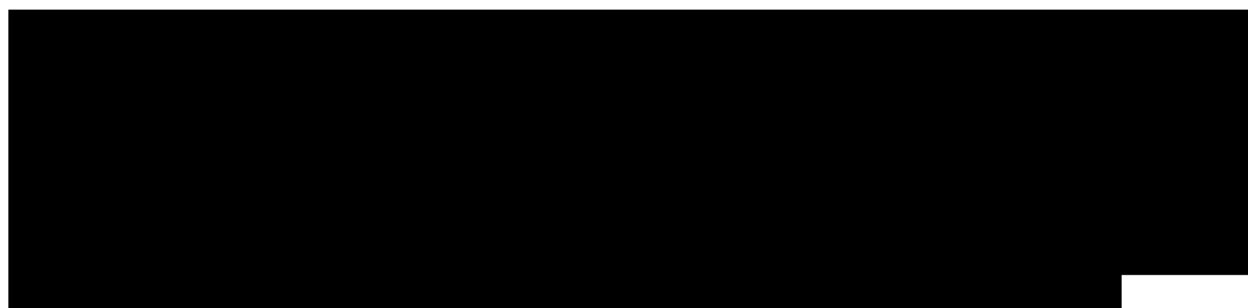
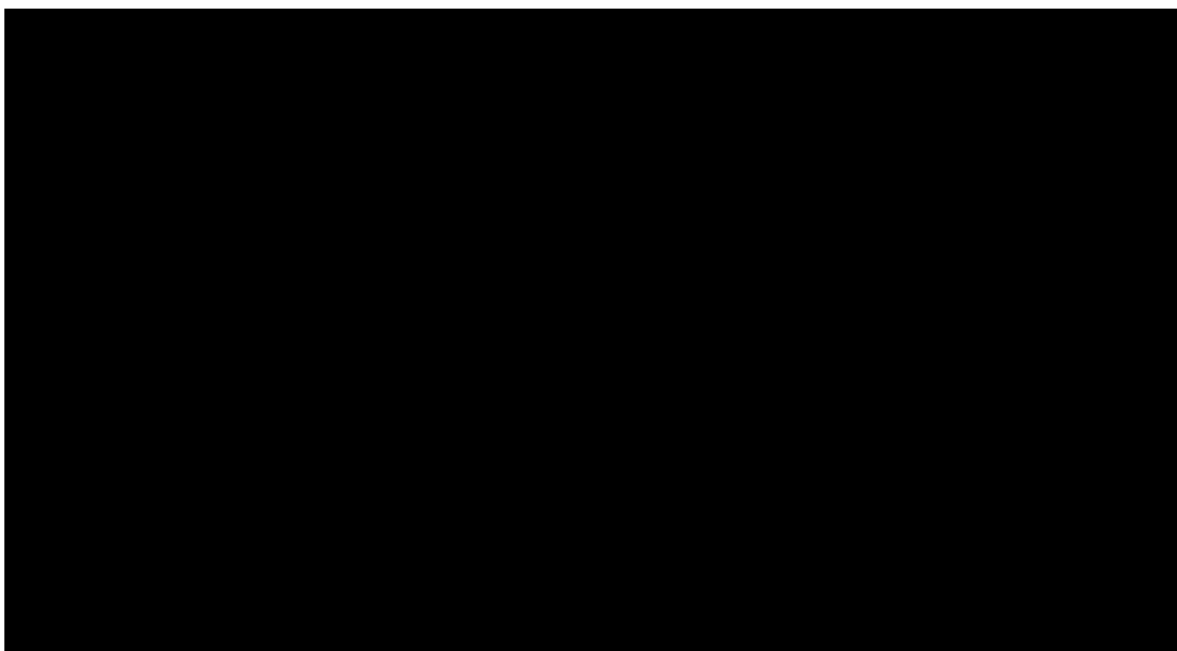
This section of the Class VI application details the methods adopted to delineate the TCCSP Area of Review (AoR). The details of the computational modeling details adopted both for static earth model (SEM) and dynamic reservoir model (DRM) are presented in section **2.2. Computational Modeling Approach**. The system behavior in the form of spatial and temporal variations of the free phase CO<sub>2</sub> plume and pressure buildup in the reservoirs are presented in section **2.3. Computational Modeling Results**. The geological settings at TCCSP required a risk-based AoR delineation approach, as threshold pressure calculations methods recommended by the U.S. EPA do not apply. The details of the risk-based methodology adopted to delineate the AoR are summarized in section **2.4. AoR Delineation**. The artificial penetrations through the caprock and corresponding corrective actions are summarized in section **2.5. Corrective Action**, followed by AoR reevaluation strategy in section **2.6. Reevaluation Schedule and Criteria**.

## **2.2 Computational Modeling Approach**

### **2.2.1 *Model Background***



**Table 2-1. Key fluid behavior models implemented in CMG-GEM for TCCSP.**



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### ***2.2.2 Site Geology and Hydrology***

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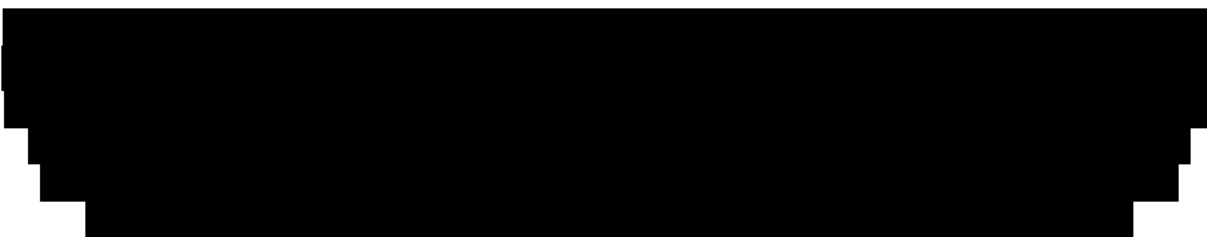
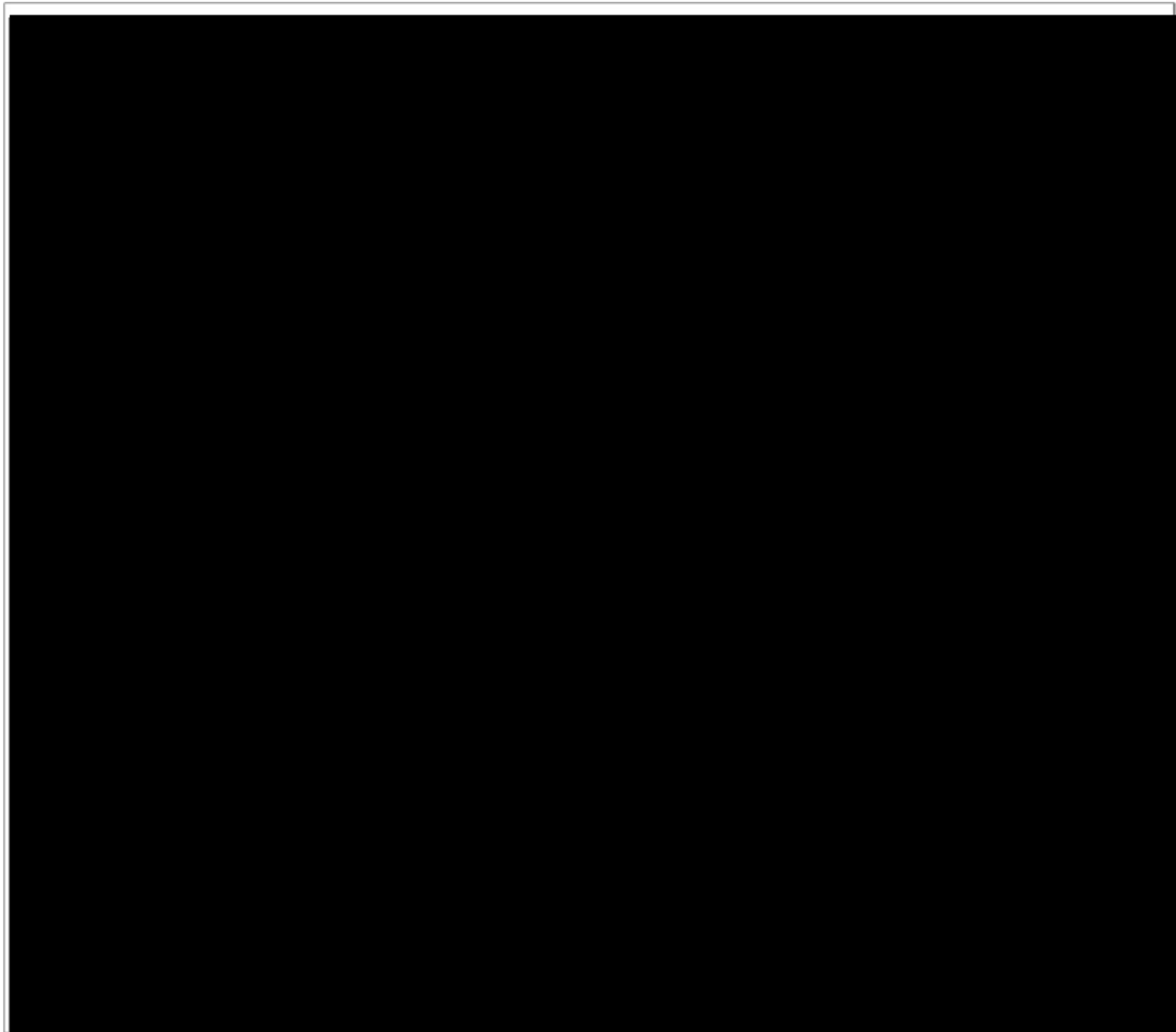
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### ***2.2.3 Static Earth Modeling Details***

The Static Earth Model (SEM) for the TCCSP was generated in SLB's Petrel. The purpose of the

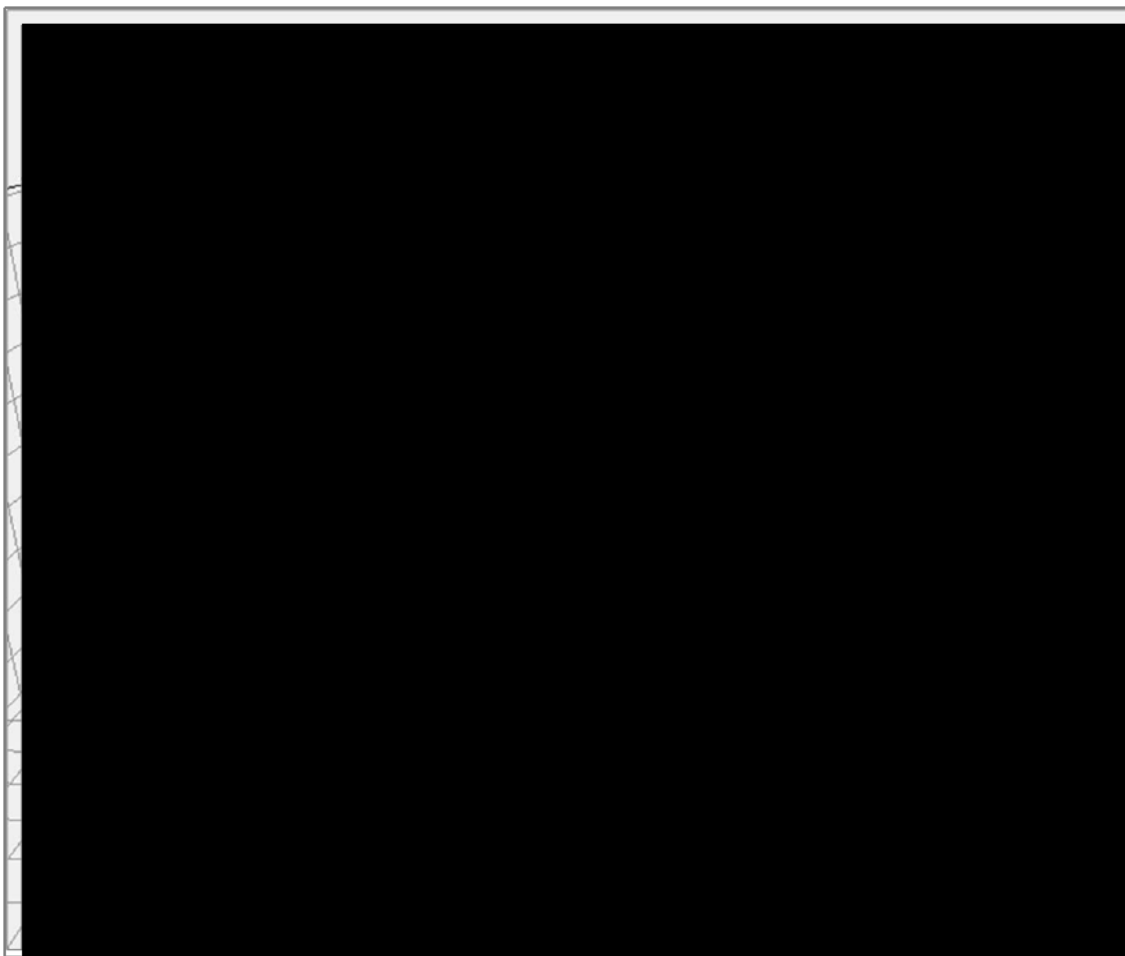
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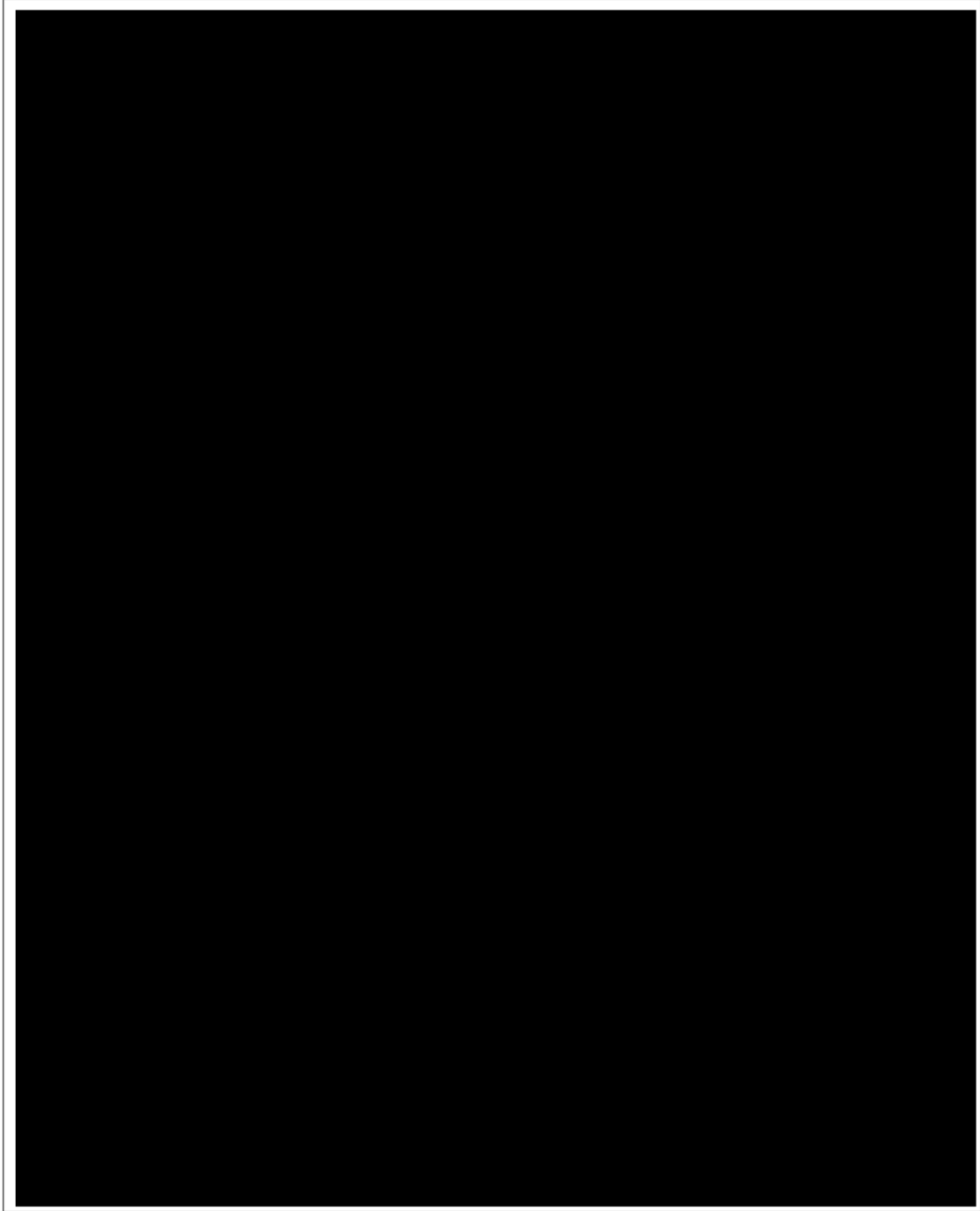
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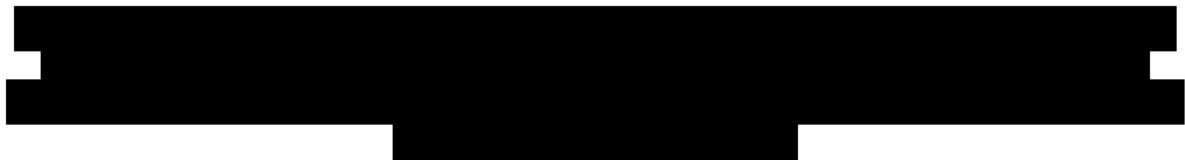
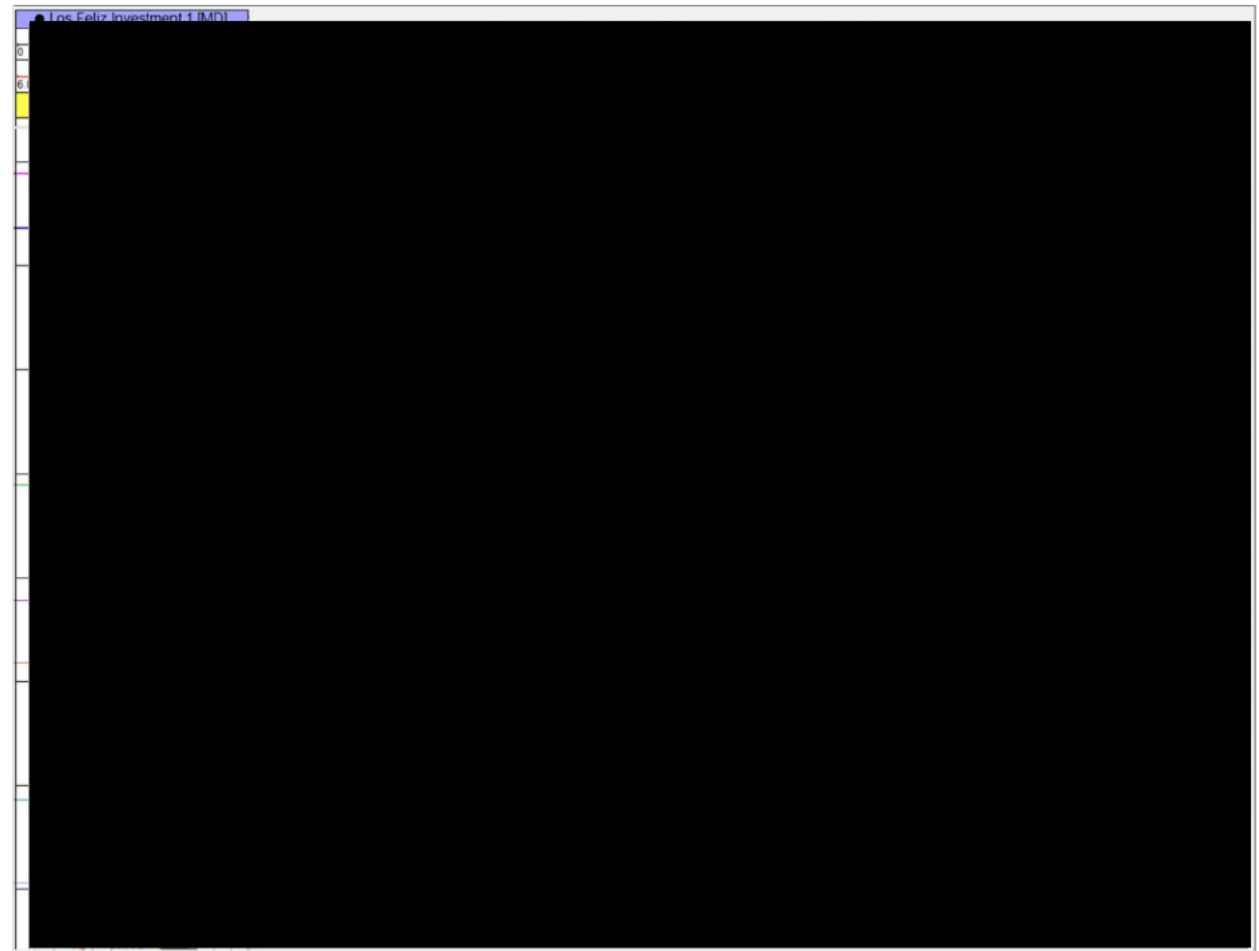
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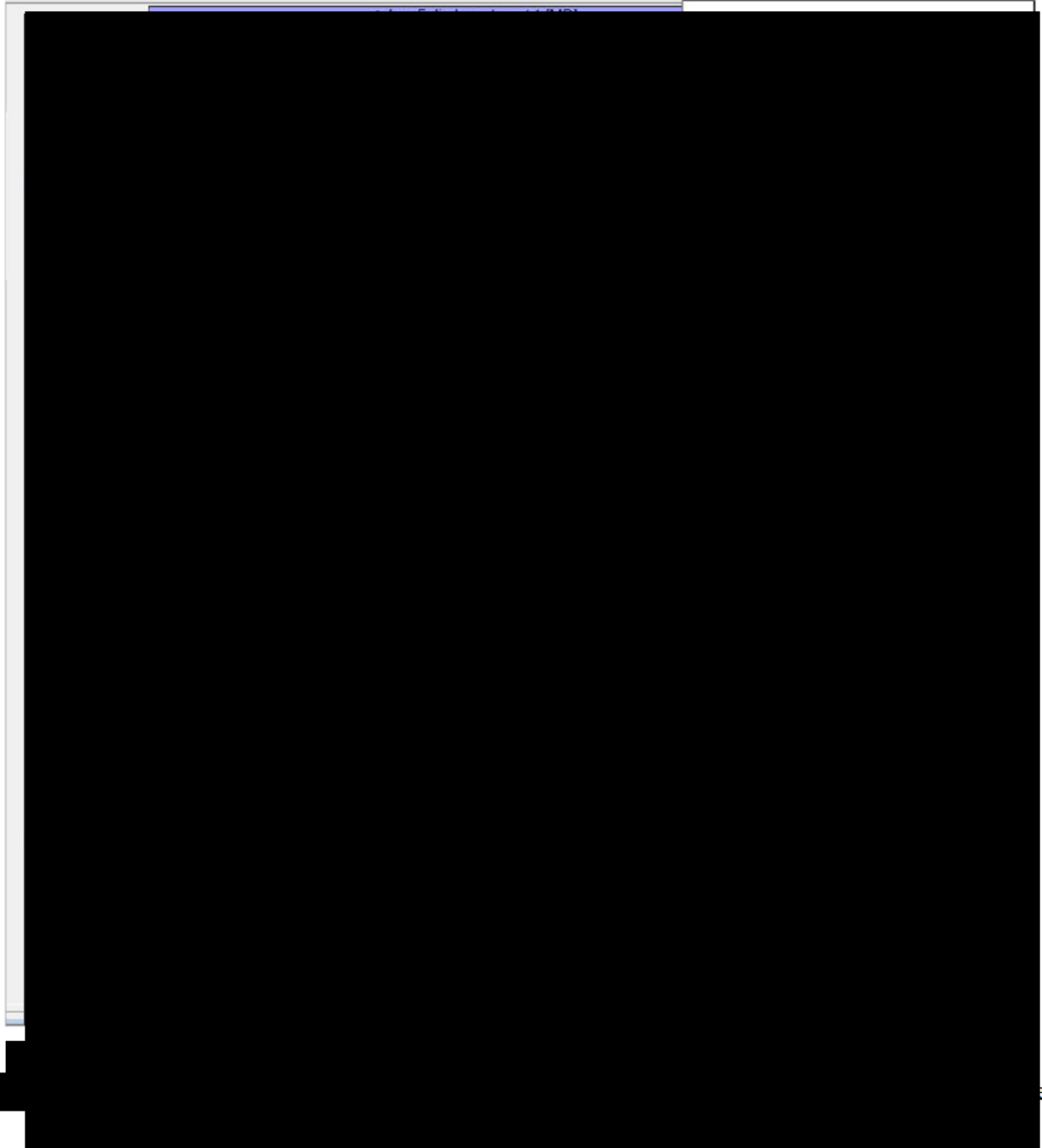


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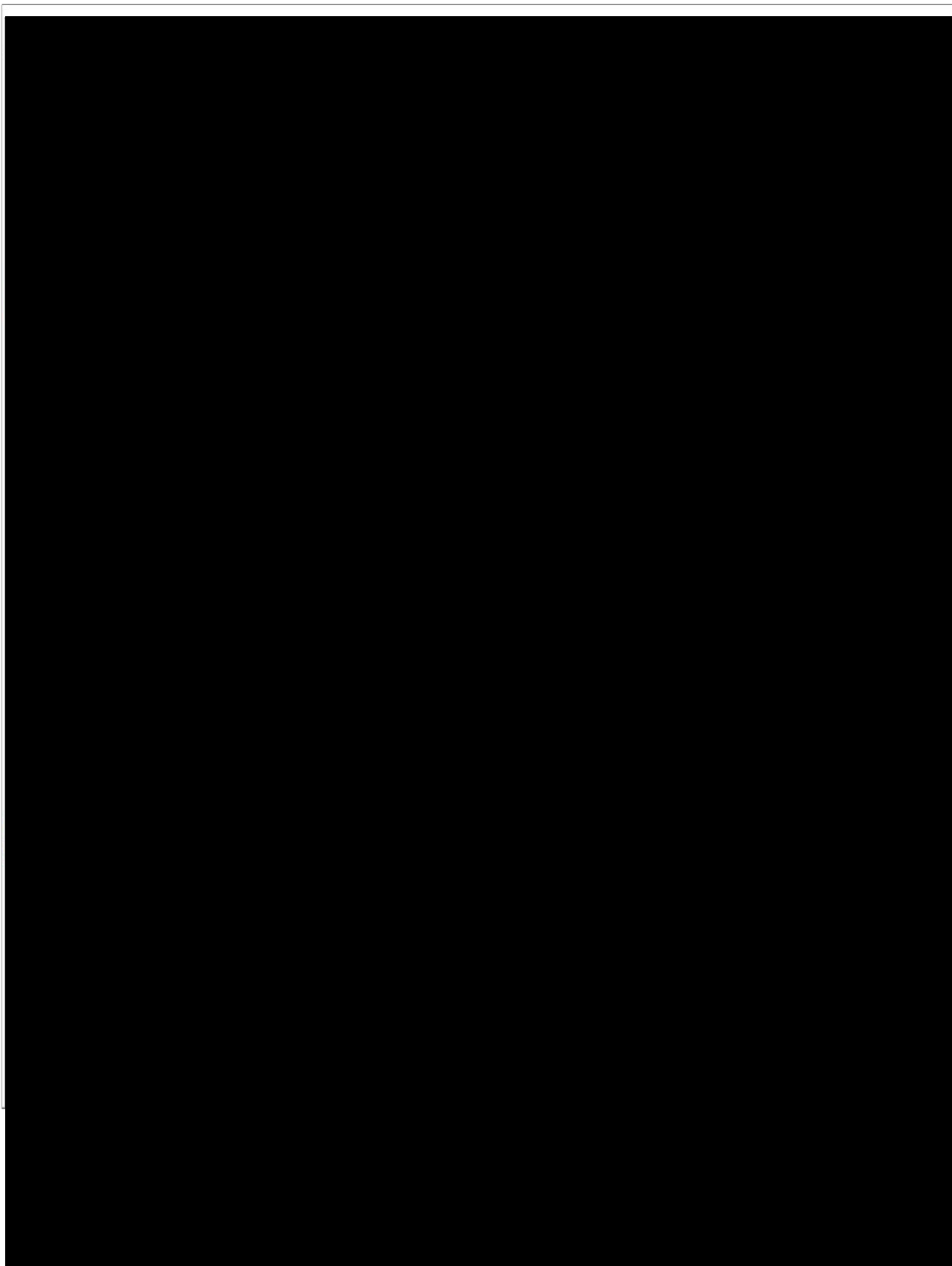


#### **2.2.4 Model Domain**



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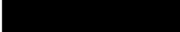



















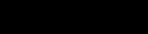

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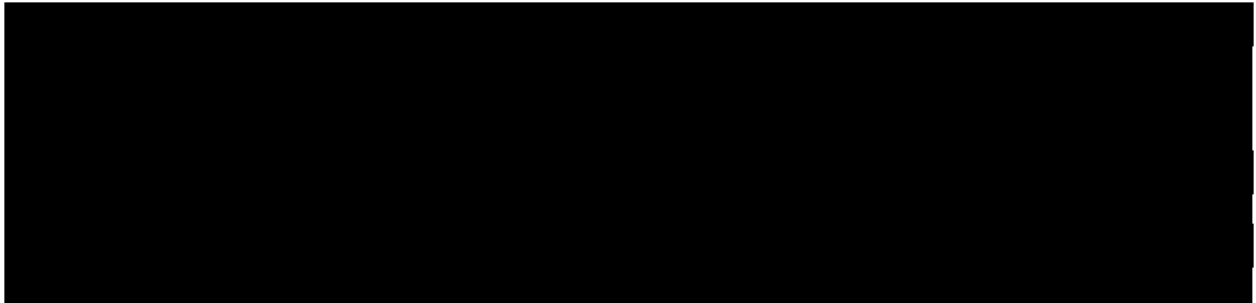
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#### **2.2.7 *Boundary Conditions***

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#### ***2.2.8 Initial Conditions***

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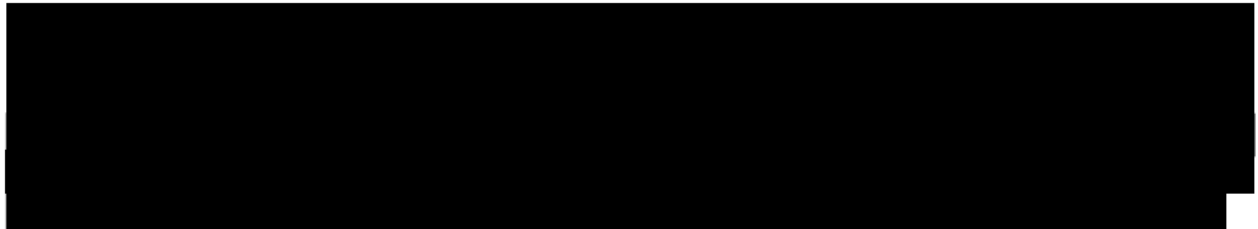
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**2.2.9 Operational Information**



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The diagram consists of a large grid with a complex pattern of black, white, and gray cells. A vertical column of small squares is located on the far left. The grid is divided into several horizontal sections by black bars. The top section has a gray bar at the top. The middle section has a gray bar in the center. The bottom section has a gray bar at the bottom. The grid is composed of 10 columns and 10 rows. The cells are colored black, white, or gray. The vertical column of small squares is on the far left, with 10 squares in total. The grid is divided into several horizontal sections by black bars. The top section has a gray bar at the top. The middle section has a gray bar in the center. The bottom section has a gray bar at the bottom. The grid is composed of 10 columns and 10 rows. The cells are colored black, white, or gray.

### 2.2.10 Fracture Pressure and Fracture Gradient

[REDACTED]

[REDACTED]

\_\_\_\_\_

[illegible]

## **2.3 Computational Modeling Results**

### **2.3.1 *Predictions of System Behavior***

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[REDACTED]

[REDACTED]

[REDACTED]

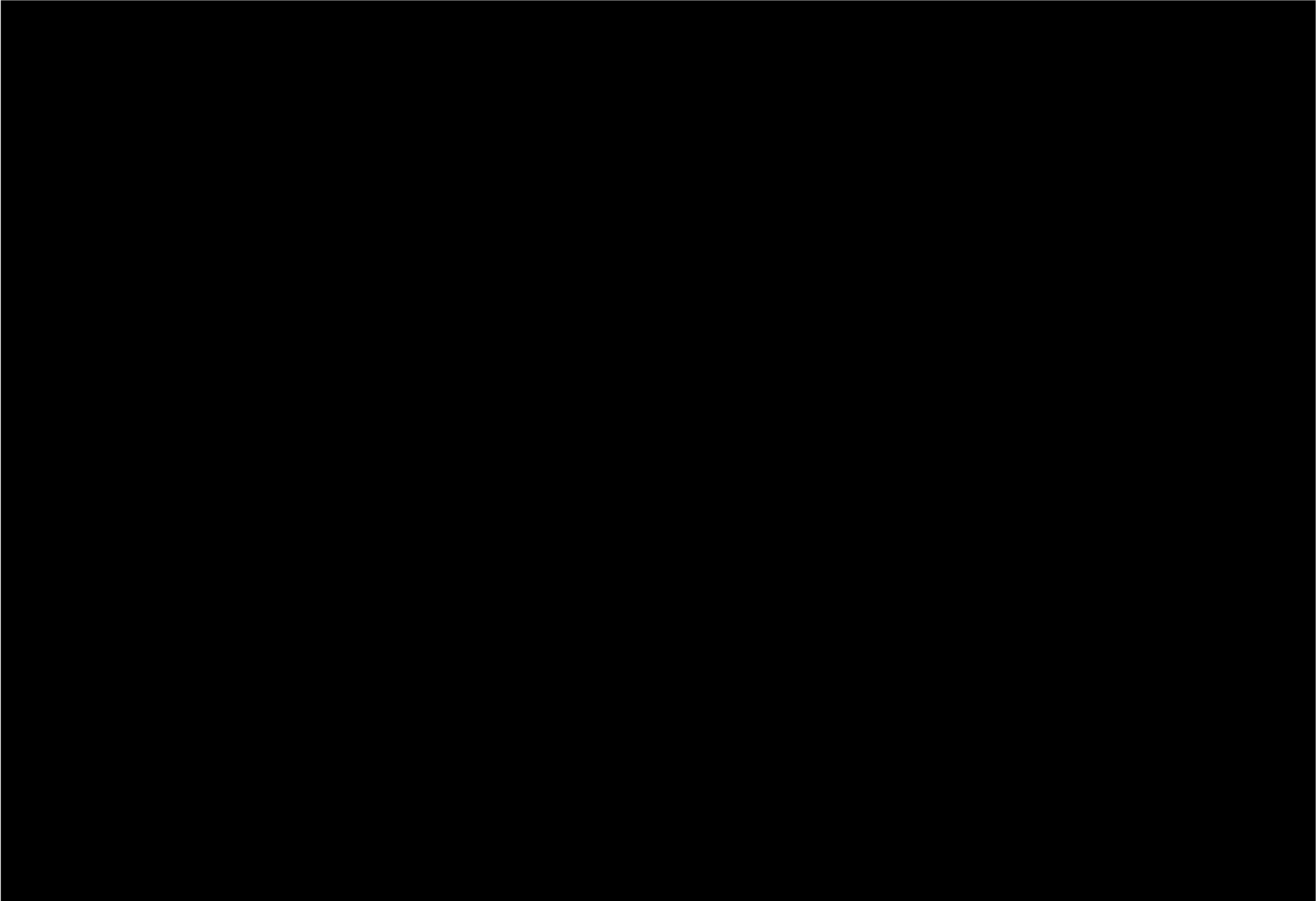


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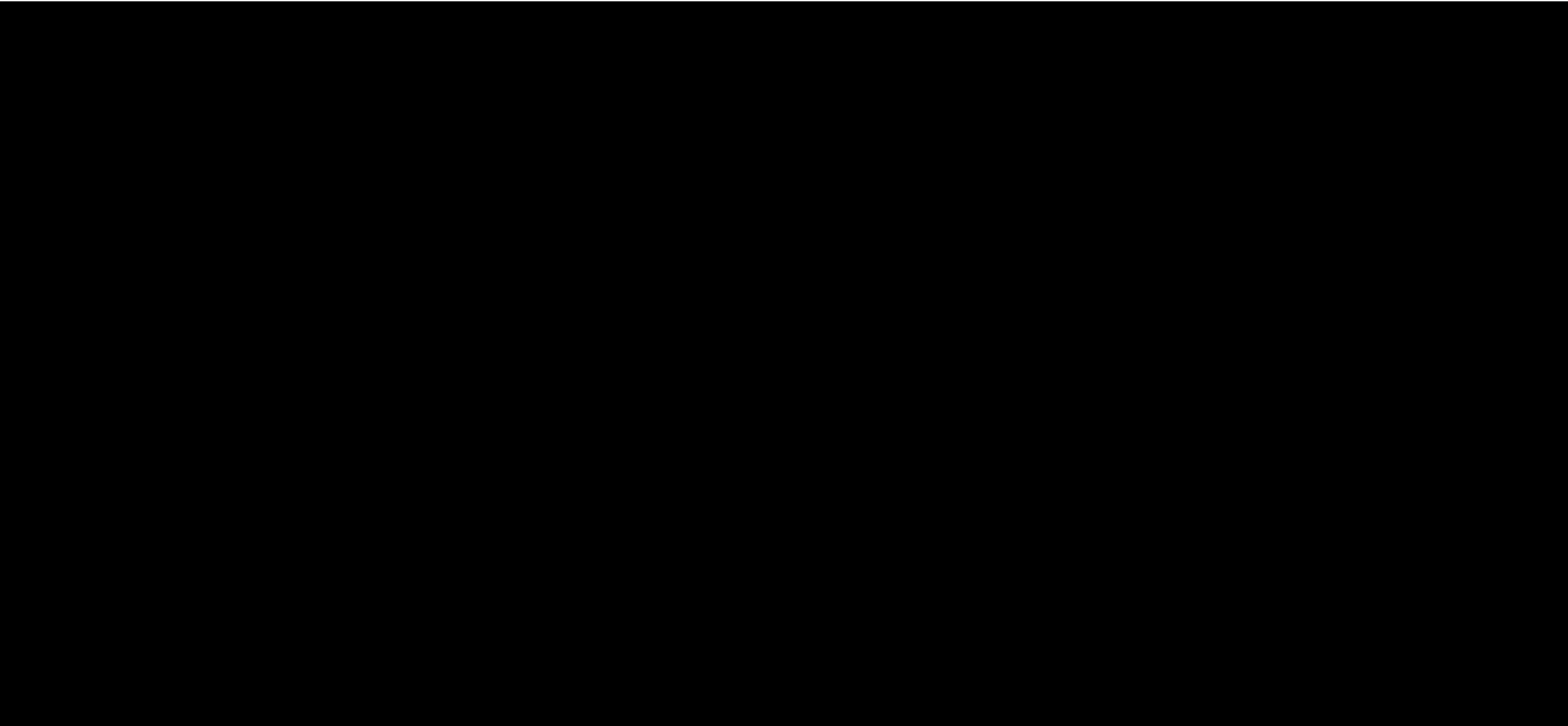
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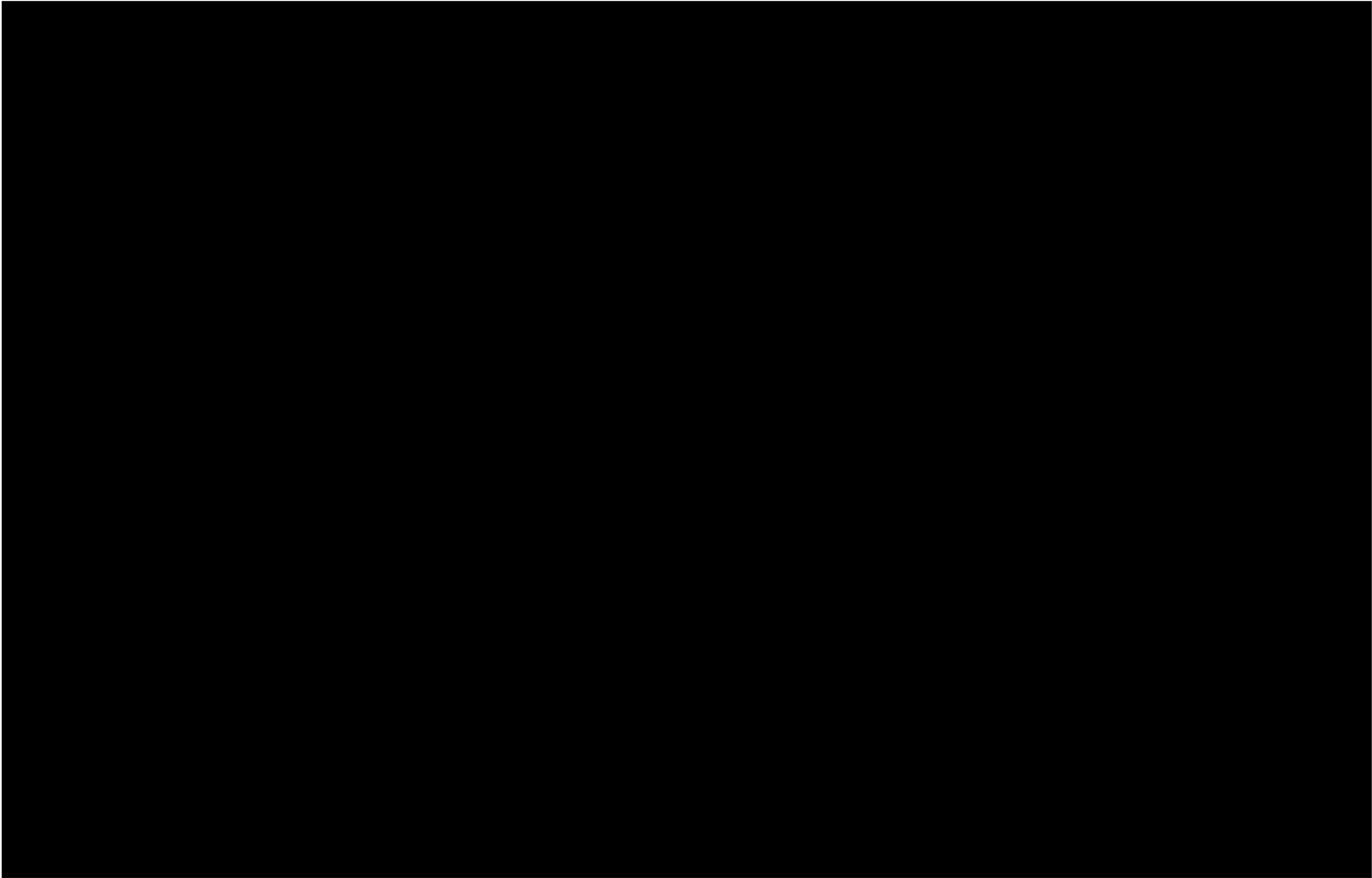




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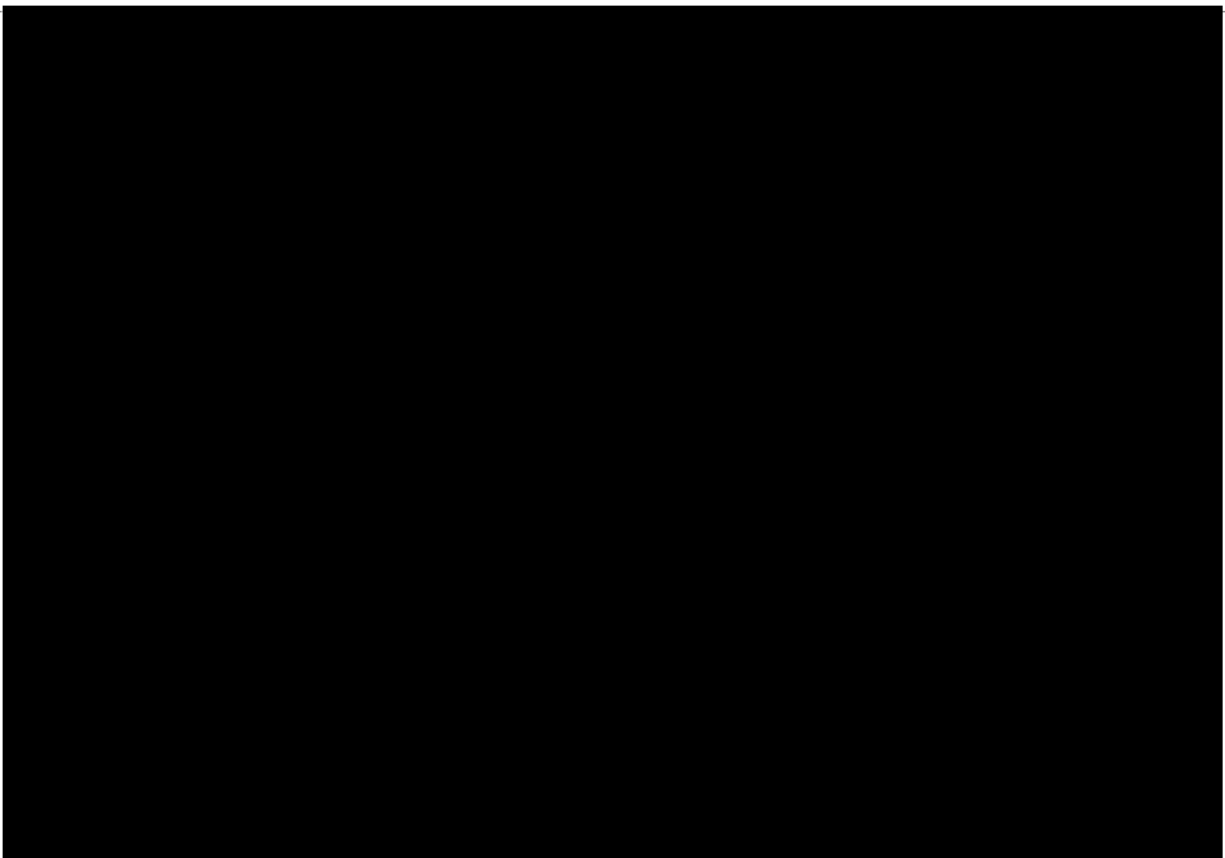


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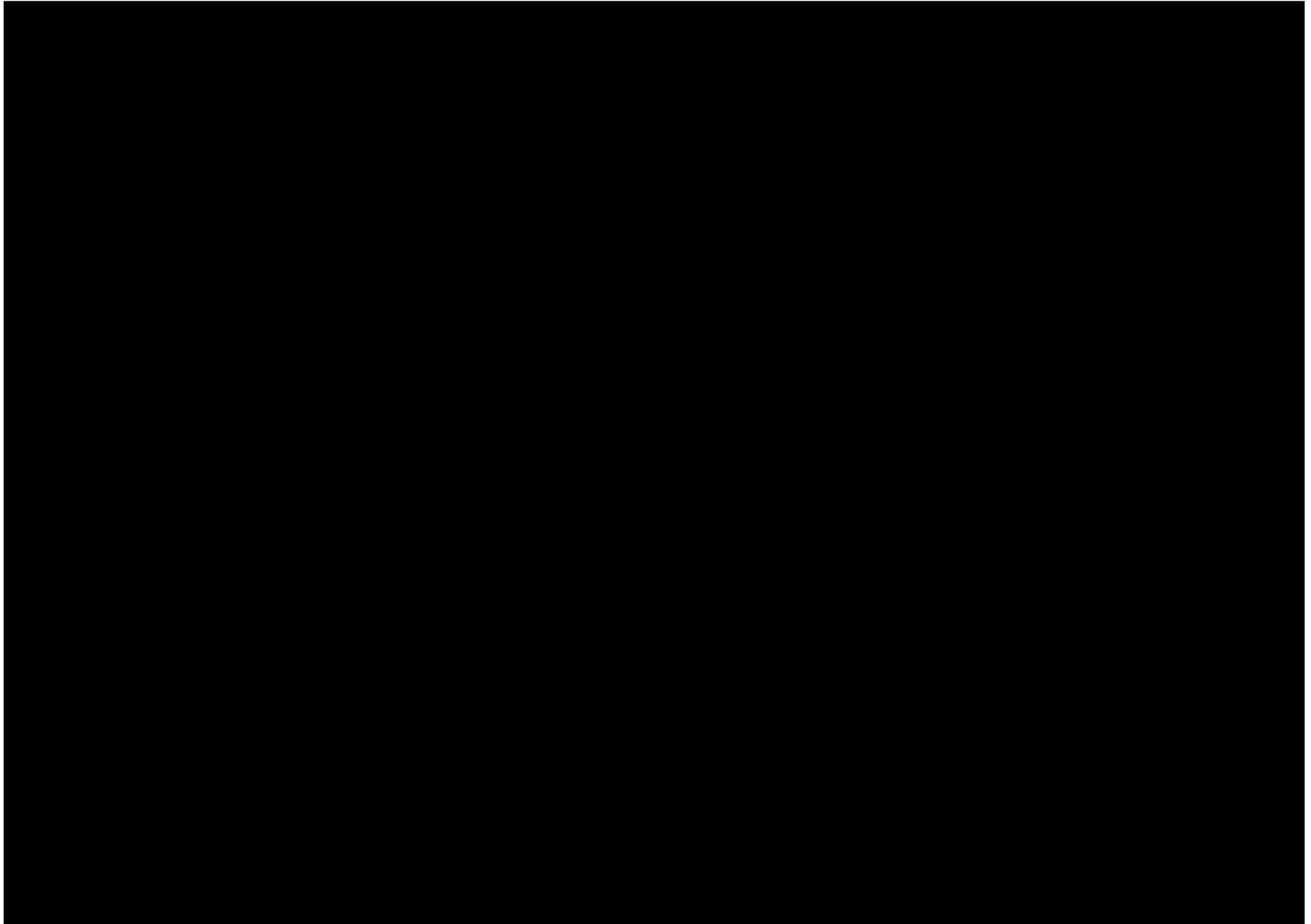
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Document: TCCSP Class VI AoR and CA Plan



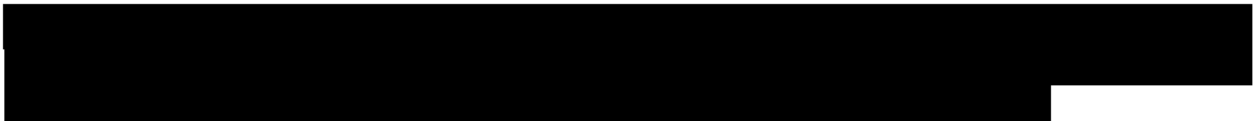




### ***2.3.2 Model Calibration and Validation***



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## 2.4 AoR Delineation

### 2.4.1 *Threshold Pressure Calculations*

[REDACTED]

[REDACTED]

[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]		[REDACTED]	[REDACTED]
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[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
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[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
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#### 2.4.2 AoR Delineation

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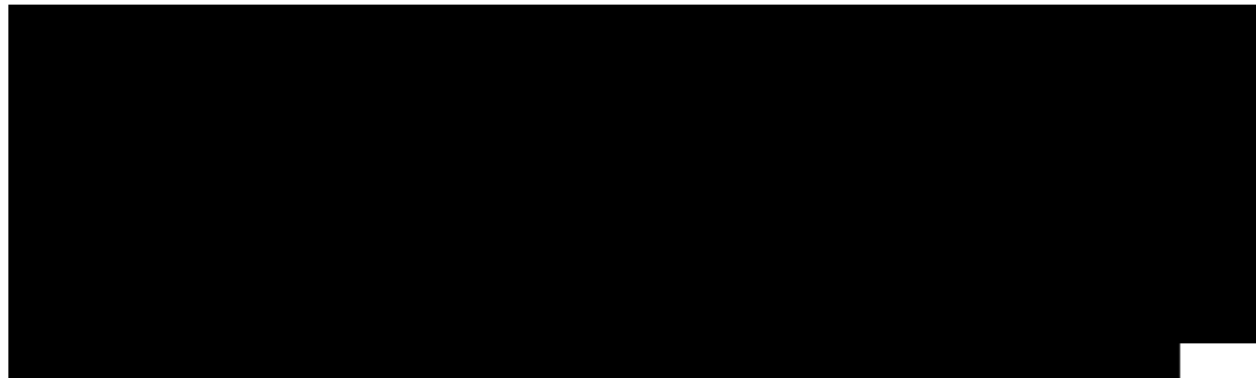
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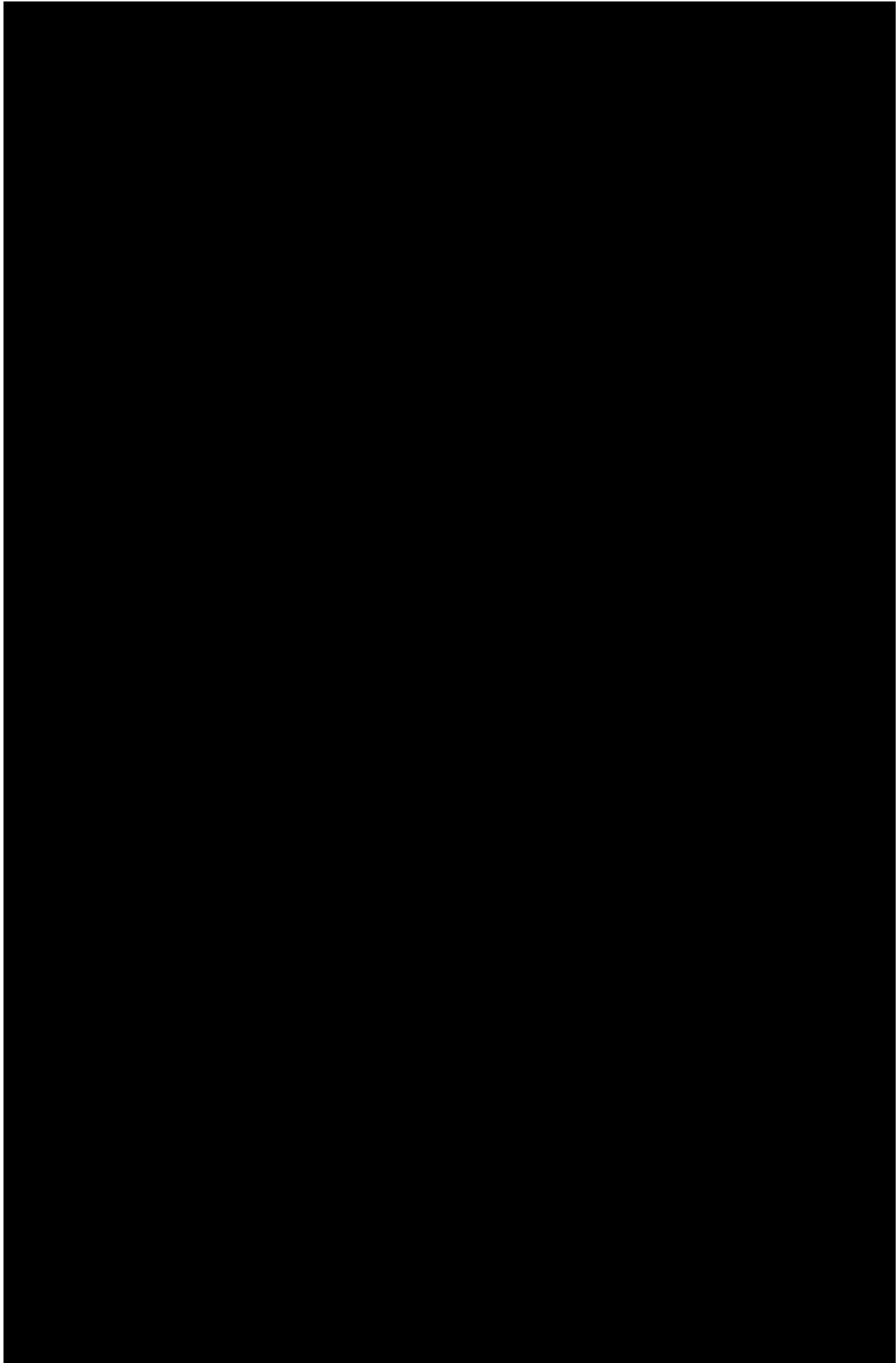
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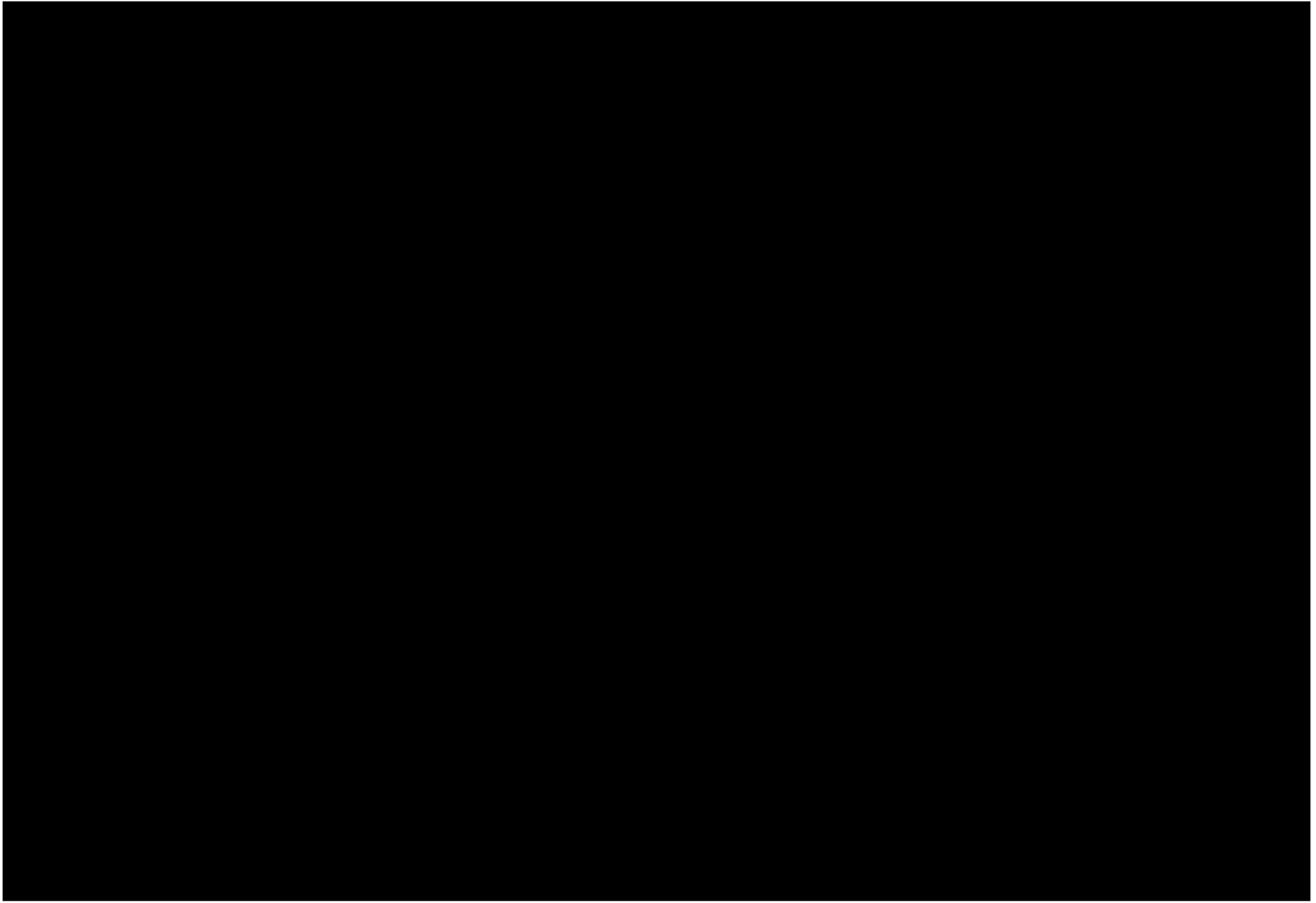
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[REDACTED]

[REDACTED]





#### *2.4.3 Sensitivity Analysis*





[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
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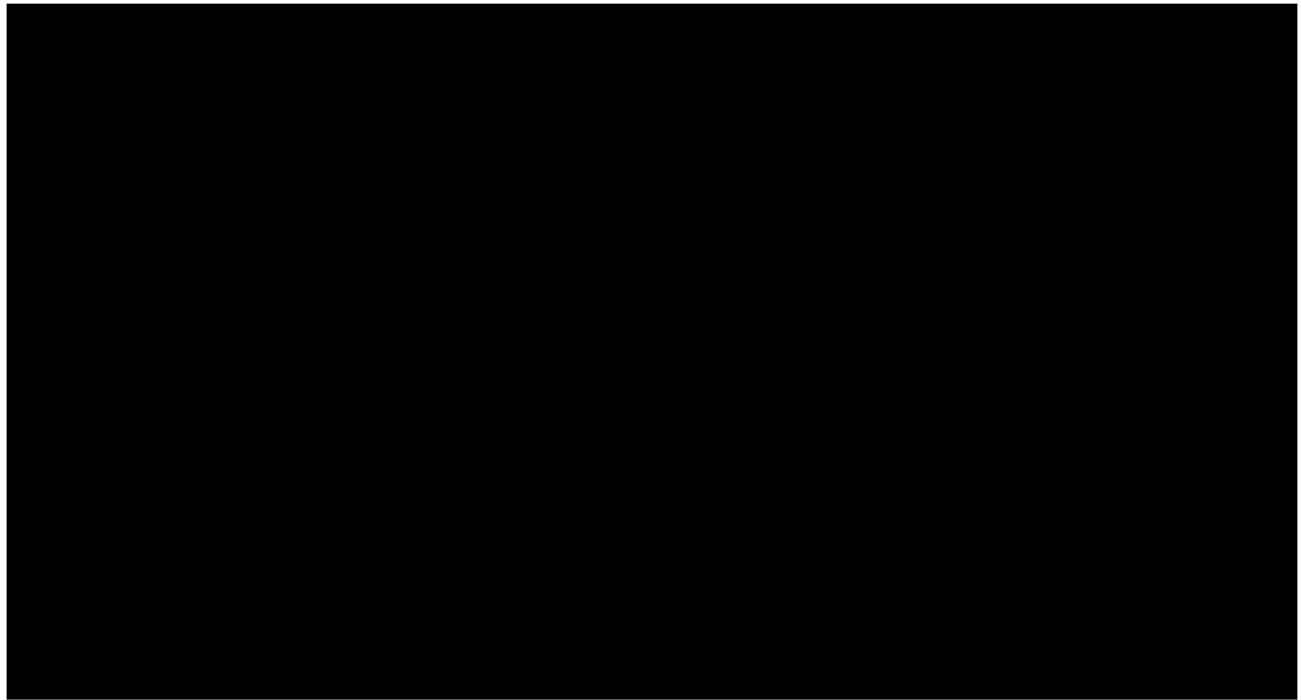
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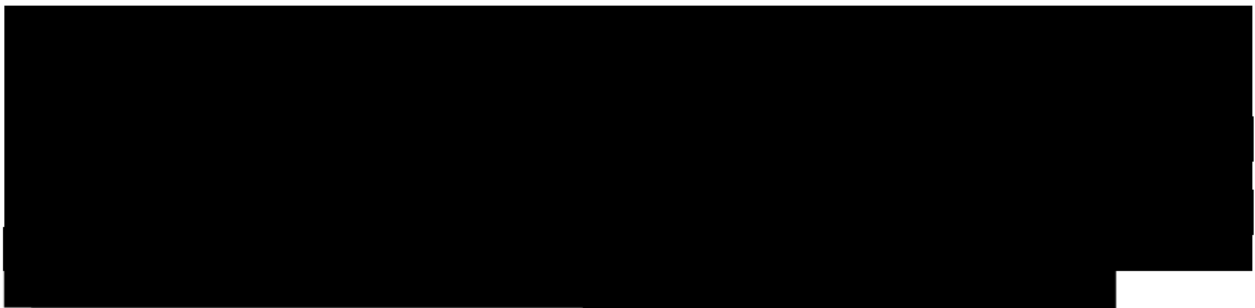
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## 2.5 Corrective Action



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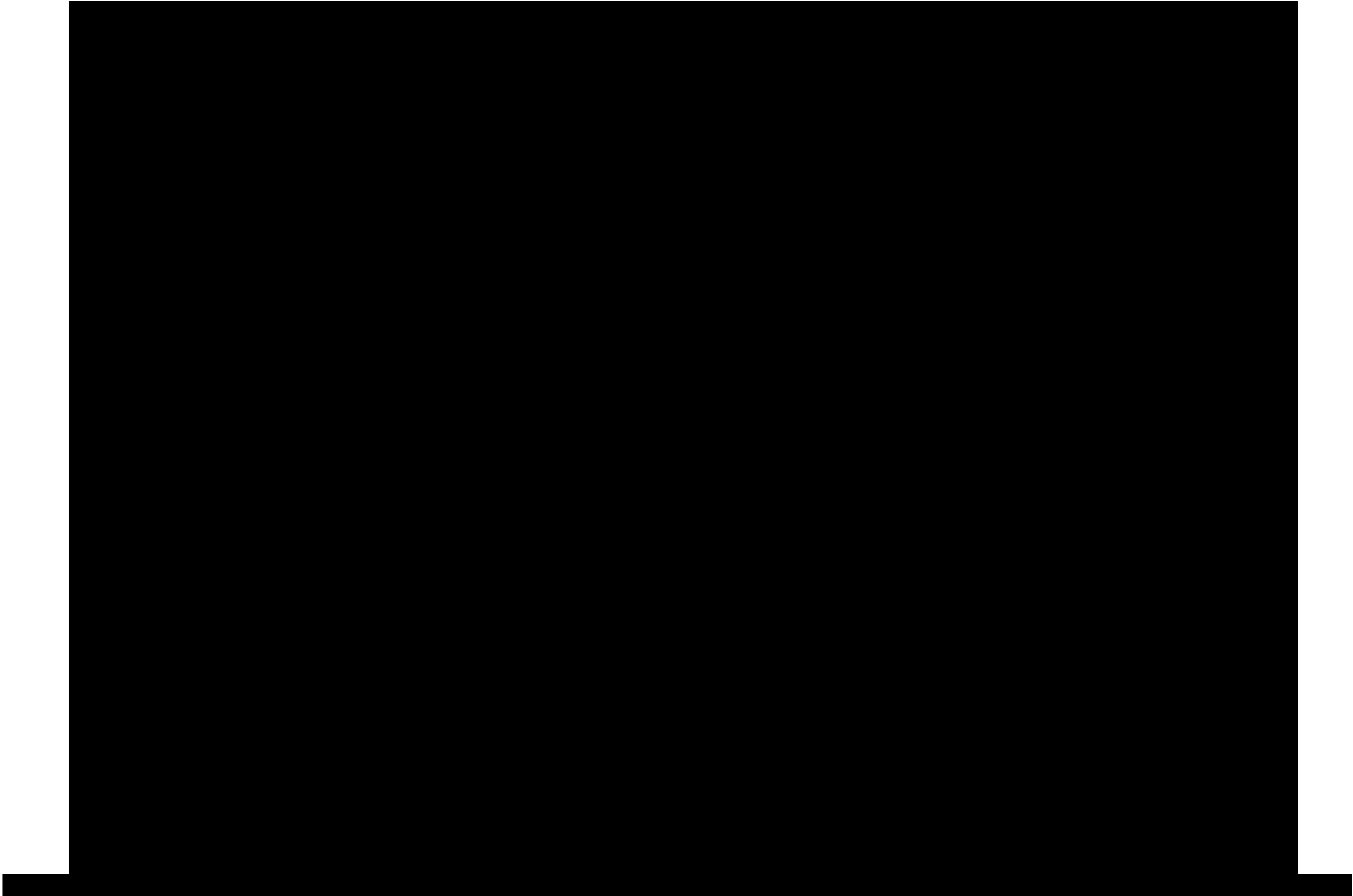
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[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]



### **2.5.2 Plan for Site Access**



### **2.5.3 Corrective Action Schedule**

According to the current site-specific data analyzed prior to this application submission, none of the wells within the AoR require corrective action. But in case needs arise for the corrective action, the following corrective action schedule will be followed for the impacted wells:

- Submit and obtain approval from California Geologic Energy Management (CalGEM).
- Rig up on well location.
- Reach to the corrective action depth
- Complete a mechanical pressure integrity test and run cement bond logs on any existing casing strings.
- Remediate any problem areas identified by the mechanical integrity tests.
- Place CO<sub>2</sub> resistant cement plug across the confining zone using balance method
- Back up hole and place plug across the bottom of any existing casing string using balance method.
- Place cement plug at the base of lowermost USDW level using balance method
- Place cement plugs at the surface extending 50 feet below surface.
- Cut off casing 3 feet below the surface and below the plow line.
- Install blanking plate with the required permit information to the top of the cutoff casing.
- Submit a plugging report to the UIC Program Director and CalGEM after plugging operations are completed.

## **2.6 Reevaluation Schedule and Criteria**

### **2.6.1 AoR Reevaluation Cycle**

Pursuant to 40 CFR 146.84 (e), TCCSP LLC will reevaluate the above described AoR at least once every 5 years during the injection and post-injection phases, unless any one of the following conditions are met, which would trigger an earlier reevaluation:

- There are significant changes in operations of the injection wells or other project wells which may include deviation of permitted injectate compositions, pressure, and flowrates, emergency leaks or spills, and major operational challenges (this does not include short-term routine workovers).
- Significant deviation of operational and monitoring data from modeled and permitted behavior of the storage site compared to its baseline conditions.
- Any additional site characterization conducted prior to the next scheduled AoR reevaluation.

AoR reevaluations will address the following:

- Changes to the monitoring and operational data prior to the scheduled 5-year reevaluation date.
- Deviations in monitoring and operational data (e.g., injection rate and pressure).
- Methods of conducting corrective action, if necessary, include: 1) what corrective action will be performed and 2) how corrective action will be adjusted if there are changes in the AoR.

If the plume or pressure front behavior are not consistent with the model predictions, TCCSP LLC will re-delineate the AoR. Triggers for AoR reevaluation are listed below. If necessary, re-delineation will include the following steps:

- Calibrating the model with new site characterization, operational, or monitoring data (pressures, fluid saturations).
- Performing a new AoR delineation with the same methods described in the Computational Modeling Section of this chapter.
- Identify any new wells that penetrate the confining zone and provide a description of each well's type, construction, date drilled, location, depth and records of plugging and/or completion.
- Performing corrective action on all new wells that penetrate the confining zone and cannot be proven to exist or be abandoned in a way that prevents the movement of CO<sub>2</sub> or other fluids that endanger any USDWs.

If the reevaluation process results in the re-delineation of the AoR, TCCSP LLC will prepare a report to be submitted to the UIC Program Director that details the decision to update the AoR delineation, the data evaluated used to make the decision, and any necessary changes to the corrective action plan.

### ***2.6.2 Triggers for AoR Reevaluations Prior to Next Schedule Reevaluation***

If monitoring data suggests that the actual extent and movement of the plume or pressure font have deviated significantly from the modeled predictions TCCSP LLC will discuss any such events with the UIC Program Director to determine if an AoR reevaluation is required. The following is a list of unexpected changes in quantitative parameters that could trigger a reevaluation of the AoR.

- Pressure: Unexpected changes in injection pressure in reservoir or above-zone formations.
- Temperature: Unexpected changes in bottom-hole temperature in the reservoirs.
- Fluid Saturations: Unexpected changes in CO<sub>2</sub> saturation that indicate the movement of CO<sub>2</sub> out of the injection formation and above the confining zone. If this change is due to well integrity, no AoR reevaluation will be triggered, and the well integrity issue will be addressed.
- Groundwater Sampling: Unexpected changes in groundwater geochemical and physical parameters that may indicate the movement of CO<sub>2</sub> and formation fluids from the injection zone and into formations above the confining zone.

Other events that may trigger an AoR reevaluation include the following:

- New site characterization data become available that significantly modifies the extent of the plume or excessive pressure buildup beyond what is predicted by the initial model. This can include the identification of a previously unknown fault or fracture in the confining or injection zones.

TCCSP, LLC. will promptly notify the UIC Program Director if an unplanned AoR reevaluation is required.

## 2.7 References

[illegible]





[REDACTED]

[REDACTED]