Barrett Solar Preliminary Hydrology Study

Revision 0A

Prepared for:

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FIGURES

TABLES

REVISION HISTORY

REVISION	DATE	DESCRIPTION
0A	09/13/2024	Draft Report for Client Review

ACRONYMS AND ABBREVIATIONS

%	percent
CN	Curve Number
CONUS	Contiguous United States
CWA	Clean Water Act
DEM	Digital Elevation Map
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
HEC-18	Hydraulic Engineering Circular No. 18
HEC-RAS	Hydraulic Engineering Center River Analysis System
HSG	Hydrologic Soil Group
LiDAR	Light Detection and Ranging
NFIP	National Flood Insurance Program
NLCD	National Land Cover Dataset
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
PFD	Precipitation Frequency Data
PV	Photo Voltaic
ROW	Right-of-way
SCS	Soil Conservations Service
SSA	Storm and Sanitary Analysis
TR-55	Technical Release No. 55
UDFCD	Urban Drainage and Flood Control District
Ulteig	Ulteig Engineers, Inc.
USACE	U.S. Army Corps of Engineers
WOUS	Waters of the United States

1. INTRODUCTION

PCL Solar Constructors USA, Inc. ("Client") has enlisted the services of Ulteig Engineering, Inc. ("Ulteig") to perform a desktop hydraulic and hydrologic analysis of the Barrett Solar Project ("Barrett Solar") in Rains County, Texas. This study includes the analysis of the 2-, 10-, 25-, 50-, 100-, and 500-year, 24-hour storm events. This report will primarily discuss the results of the 100-year, 24- hour storm event.

This report explains the hydrologic model inputs, the development of the hydraulic model, and the model results, which predict the inundation depths, flow velocities, and potential local scour depths within and adjacent to the photovoltaic system's (PV) buildable area. This study encompasses an analysis of the site in existing and proposed conditions. This report was submitted as part of the design package.

1.1 Project Location and Site Characteristics

The Barrett Solar project-leased property boundary ("property boundary") covers approximately 800 acres in Rains, Texas. The Project site is located south of US Highway 69 West approximately 0.7 miles northwest of Point, Texas. The project limits are shown in **Figure A- 1. Vicinity Map**. The latitude and longitude for Barrett Solar are 32.953° N, 95.898° W, respectively. These coordinates represent the approximate center of the project area.

Ground cover throughout the property is mostly pasture/hay. A small percentage of the area is classified as deciduous forest and woody wetlands. Soils data was obtained from the USDA SSURGO Soils Database for the project and the surrounding area. The Hydrologic Soil Group (HSG) classifications for this area are dominated by HSG type B/D and D soils.

The existing topography of the project site generally consists of mild slopes, which typically range between 0% and 3%. The topography for the site was sourced from publicly available LiDAR data and client-provided LiDAR data. Within the study area, runoff predominantly flows south toward Cedar Creek and its contributing tributaries, which convey flow south of the project site. A map of the drainage features, including wetlands provided by the Client, within and surrounding the Project is provided as **Figure A-2: Existing Drainage Map.**

A FEMA Flood Hazard Zone A area borders the southwest edge of the project boundary. The project site is located on FEMA Flood Insurance Rate Map (FIRM) panel numbers 48379C, effective 4/17/2012 and 48231C, effective 1/6/2012. The Special Flood Hazard Area (SFHA) is displayed on **Figure A- 2. FEMA Floodplain Map.** Portions of the project within or near the Zone A floodplain are subject to flooding by the 100-year flood and are therefore at higher risk of being damaged by floodwaters. Any construction activities within the SFHA are subject to federal and/or local floodplain management regulations. Local and federal jurisdictions should be consulted during preliminary design phases to determine if floodplain development permits are required for this project.

1.2 Methodology Overview

The hydraulic and hydrologic analysis of the project area was completed using a 2D HEC-RAS model.

All drainage areas contributing to the project site were modeled using a 2D rain-on-grid model. No offsite hydrology was modeled as part of the analysis.

This study incorporates an analysis of the site in existing and proposed conditions for the 2-, 10-, 25-, 50-, 100-, and 500-year, 24-hour storm events. This report focuses on the results of the 100-year, 24-hour storm event. The results of this study were included as part of the Barrett Solar design package.

1.3 Application of 2D Hydrologic/Hydraulic Model Results in Civil Design

A 2D hydrologic and hydraulic analysis provides predicted runoff velocities and inundation depths that are used to approximate local scour depths throughout the project site. Inundation depths, runoff velocities, and local scour depths are important factors in determining the locations of PVs, their pile heights, and the design of erosion control measures. Refer to Appendix C for a copy of the Erosion and Sediment Control Plan for the Barrett Solar 60% Design Submittal.

2. HYDRAULIC AND HYDOLOGIC MODEL RESULTS

2.1 Inundation Depth

The predicted 100-year, 24-hour inundation depths for the 2D model area in existing and proposed conditions are provided in **Figure B- 5** and **Figure B- 23.** Inundation depths for additional storms are shown in **Appendix B**. The project site is approximately 35% inundated during the 100-year, 24-hour storm in existing conditions, and 38% inundated in the proposed conditions, excluding all depths less than 0.1 ft. Typical inundation depths in existing and proposed conditions range from approximately 0.1 to 2 ft with small portions of the project area with depths exceeding 2 ft. The areas of highest inundation are located within the channelized areas on site. These are mostly along Cedar Creek and its tributaries.

2.2 Flow Velocity

The predicted, 100-year, 24-hour runoff velocities for the 2D model area in existing and proposed conditions are provided in **Figure B- 11** and **Figure B- 29**. Runoff velocities for additional storms are shown in **Appendix B**. Typical flow velocities range from approximately 0.5 to 2 fps across the site in existing and proposed conditions. The model results indicate that the highest velocities within the project boundary are primarily located within several channelized flow areas that convey stormwater through the project area. Velocities within these channels range from approximately 2 fps to 5.5 fps.

Areas that exhibit high runoff velocity are more prone to erosion and can cause adverse impacts to the PV block array. The structural engineer shall determine what velocities are considered excessive and/or not suitable locations for PVs.

2.3 Local Scour Depth

The potential for local scour was determined utilizing Equation 4.2 from the USDOT Federal Highway Administration's (FHWA) Hydraulic Engineering Circular 18 (HEC-18), which is titled *Bridge Scour and Stream Instability Countermeasures: Volume 1*. The predicted 100-year, 24-hour potential local scour depths for existing conditions and proposed are provided in **Figure B-** 17 and **Figure B- 35. Local** scour depths for additional storms are shown in **Appendix B.**

The potential maximum local scour depth for the solar array foundations was modeled based on the maximum inundation depths and maximum flow velocities that were obtained from the HEC-RAS 2D model. The maximum flow velocity and maximum depth may not occur at the same time within the model simulation. These scour calculations assume cohesionless soils across the site, although industry guidance has shown that the calculations are conservative in cohesive soils. All scour calculations utilizing HEC-18 are for local scour only. No general scour, bedform scour, or low-flow incisement calculations have been performed for this project.

3. HYDRAULIC AND HYDROLOGIC MODELING PROCEDURE

The two-dimensional (2D) hydrologic/hydraulic modeling was performed with the HEC-RAS v. 6.4.1 software package. Model results for the existing and proposed conditions are discussed in **Section 2.** A discussion of model parameters for existing and proposed conditions model is provided in **Section 3.**

The framework for the 2D hydraulic model is a mesh of computation cells which are associated with topographic data, an infiltration layer based on a Curve Number, and Manning's roughness values. This unsteady-state modeling approach uses the 2D Diffusion Wave equations. A 24-hour analysis was used for the HEC-RAS simulations to ensure the peak flow depths and velocities were captured.

3.1 Rainfall

Precipitation estimates were obtained from the NOAA Atlas 14 Point Precipitation Frequency Estimates: Texas. The 100-year, 24-hour rainfall estimate from NOAA Atlas 14 at the project location is 9.74 inches. A printout of the site-specific, partial-depth rainfall data from the NOAA Precipitation Frequency Data Server is provided in **Appendix C** and is also listed in **Table 1. NOAA Atlas 14 Rainfall Depths**.

Table 1. NOAA Atlas 14 Rainfall Depths

Duration	2-year Rainfall Depth (in.)	10-year Rainfall Depth (in.)	25-year Rainfall Depth (in.)	50-year Rainfall Depth (in.)	100-year Rainfall Depth (in.)	500-year Rainfall Depth (in.)
5-min	0.506	0.698	0.815	0.903	0.99	1.2
15-min	1.01	1.39	1.62	1.79	1.96	2.37
1-hr	1.85	2.55	2.98	3.3	3.62	4.44
2-hr	2.32	3.28	3.88	4.35	4.82	6.04
3-hr	2.6	3.75	4.48	5.05	5.64	7.16
6-hr	3.12	4.57	5.52	6.27	7.06	9.07
12-hr	3.68	5.41	6.55	7.45	8.41	10.9
24-hour	4.28	6.29	7.61	8.64	9.74	12.7

A synthetic, site-specific 24-hour rainfall distribution based on the NOAA Atlas 14 rainfall partial-duration depths was used for this model. Precipitation Frequency Data (PFD) was used to develop synthetic mass curves using HydroCAD Version 10.10-7c. This allowed for creation of a site-specific synthetic hyetograph using local precipitation data rather than a regional rainfall distribution such as SCS Type II or SCS Type III. The hyetograph was generated with the peak rainfall depth occurring at 12 hours (consistent with a second-quartile distribution). The development of this hyetograph follows the NRCS procedure for the construction of rainfall distributions from NOAA Atlas 14 data.

3.2 Subbasin Delineation

HUC-12 Boundaries and NHD flowlines were used to delineate a 2D model domain that encapsulates the entire project boundary shown in Figure B-1: 2D Model Domain. Since the project boundary is at a high point, runoff flows in multiple directions off the site. No offsite flows were calculated and a rain-on-grid model was utilized.

The HUC-12 watershed boundaries, 2D model domain boundary, and offsite drainage basins are provided in **Figure C- 1. Drainage Area Map**.

3.3 Infiltration and Initial Abstraction

The SCS CN Method uses land cover data and hydrologic soil group data to calculate a CN dataset used to quantify infiltration and runoff. A land cover shapefile was downloaded from the 2021 USGS National Landcover Dataset (NLCD) of the contiguous United States (CONUS) and can be viewed in **Figure C- 2. Existing Conditions Land Cover Map**.

A soils data shapefile, including soil type and Hydrologic Soil Group (HSG), was obtained from the NRCS SSURGO Web Soil Survey to encompass the study area. The HSG data can be viewed in **Figure C- 4. Existing Conditions Hydrologic Soil Group Map.** Per **Figure C- 4**, soils within the 2D model area are B/D and D soils.

The land cover and HSG datasets were merged to produce a dataset of areas that are assigned both a land cover and HSG. Each of these regions was assigned a CN based on the tables in the NRCS's Technical Release 55, *Urban Hydrology for Small Watersheds* ("TR-55"). **Table 2. NLCD Land Cover to TR-55 Cover Type Correlation** lists Ulteig's correlation between the NLCD land cover type and the land cover types listed in Chapter 2 of TR-55. For each land cover type, **Table 2** provides the CN for all HSGs. **Figure C- 5. Existing Conditions Curve Number Map** provides the CNs assigned within the 2D model area.

Table 2. NLCD Land Cover to TR-55 Cover Type Correlation

NLCD Land Cover Type	Cover Type and Condition	Curve Number for Hydrologic Soil Group			
		A	B	C	D
Barren Land	Bare soil	77	86	91	94
Cultivated Crops	Cultivated Land: With conservation treatment	67	78	85	89
Deciduous Forest	Wood or Forest Land: Good Cover	25	55	70	77
Developed High Intensity	Urban Districts - Commercial and Business	89	92	94	95
Developed Medium Intensity	Residential 1/8 acres or less	77	85	90	92
Developed Low Intensity	Residential 1/4 acre	61	75	83	87
Developed Open Space	Streets and Roads - Paved; Open Ditches (w/ ROW)	83	89	92	93
Emergent Herbaceous Wetlands	Assumed Inundated: Open Water	98	98	98	98
Evergreen Forest	Wood or Forest Land: Good Cover	25	55	70	77
Grassland/Herbaceous	Meadow: Good Condition	30	58	71	78
Mixed Forest	Wood or Forest Land: Good Cover	25	55	70	77
Open Water	Open Water	98	98	98	98
Pasture/Hay	Pasture or Rand Land: Good Condition	39	61	74	80
Shrub/Scrub	Brush - Good Condition	30	48	65	73
Woody Wetlands	Assumed Inundated: Open Water	98	98	98	98

The existing conditions land use generally consists of Pasture/Hay, with some areas of wetlands and deciduous forest. It is assumed that all fenced areas will be cleared for construction and re-vegetated post-construction. Therefore, CN's within all fenced areas were set to Grassland/Herbaceous condition for the proposed conditions analysis, according to the values presented in **Table 2**.

Additionally, it is assumed that all proposed access roads and driveways will be impermeable. All access roads and driveways were assigned a CN of 98.

A map of the proposed conditions CN's is provided in **Figure C- 6. Proposed Conditions Curve Number Map.**

An initial abstraction ratio of r = 0.2 was selected for all modeled regions in both existing and proposed conditions. The initial extraction ratio was selected to align with Equation 2-2 of TR-55[1].

[1] NRCS, Urban Hydrology for Small Watersheds. Technical Release 55 (TR-55), 2-1.

3.4 Topography

Topography data was sourced from the survey data received on March 27th, 2024 from Dudek, Inc and supplemented with U.S. Geological Survey's The National Map (1-meter resolution, 2017) data for areas outside of the project boundary. A one-meter DEM was created based on the data received from Dudek. The two digital elevation models (DEMs) were merged to a GeoTIFF format with a one-meter grid resolution. The resulting DEM was used as the topography for the existing model.

A proposed conditions topographic model was created by merging the existing conditions DEM with the proposed grading from the Barrett Solar design.

3.5 2D Mesh

The 2D computational mesh generated for 2D model uses a typical cell spacing of 40 ft x 40 ft to cover approximately 895 square miles.

For each computational cell within the HEC-RAS 2D mesh, an elevation-volume relationship, or stage-storage curve, for the cell is generated and a terrain profile along each cell face is computed. Because of this, HEC-RAS 2D models require breaklines to ensure the cell faces in the 2D mesh capture areas of localized topographic relief or controlling ground features that may not be captured by the cell faces. Breaklines are typically placed to align the computational cell faces with notable topographic features, such as elevated berms, roadway centerlines, ditches adjacent to road edges, channel centerlines, and the top of channel embankments. Breaklines also provide refinement to the mesh by reducing the typical cell size. This allows for more detailed model results and more frequent depth and velocity data at areas of interest within the 2D model. The refined cell size defined by the breaklines in the 2D model is variable and dependent on the adjacent topography.

Minor changes to the existing conditions mesh were made to create the proposed conditions mesh. It is recommended to keep the computational points generated by the 2D mesh similar to that of the existing conditions model to ensure an accurate comparison of the results. The breaklines used throughout the Barrett Solar 2D mesh were modified to capture the major changes proposed by the Barrett Solar grading surface.

3.6 Surface Roughness

Manning's roughness values, or "n" values, were based on the NLCD land cover dataset.

The HEC-RAS 2D User's Manual provides a table of typical ranges for Manning's "n" values for different types of land cover where appreciable depths of flow are present. Manning's "n" values were assigned based on the HEC-RAS 2D User's Manual typical ranges. The selected Manning's "n" values are provided in **Table 3. Existing Conditions Manning's "n" Values**. A map of the existing conditions Manning's "n" values is provided in **Figure C-7. Existing Conditions Manning' "n" Value Map**.

Table 3. Existing Conditions Manning's "n" Values

Land Cover	Existing Manning's "n"
Open Water	0.04
Developed, Open Space	0.04
Developed, Low Intensity	0.10
Developed, Medium Intensity	0.12
Developed High Intensity	0.15
Barren Land	0.03
Deciduous Forest	0.16
Evergreen Forest	0.16
Mixed Forest	0.16
Shrub Scrub	0.10
Grassland Herbaceous	0.04
Pasture Hay	0.03
Cultivated Crops	0.04
Woody Wetlands	0.12
Emergent Herbaceous Wetland	0.07

The existing conditions Manning's "n" coverage was modified to create the proposed conditions Manning's "n" coverage. The modifications included changes to land cover types within fenced areas and the addition of proposed access roads. It was assumed that all fenced areas will be cleared for construction and re-vegetated post-construction. Therefore, all fenced areas were assigned a Manning's "n" value of 0.04 which corresponds with Grassland/Herbaceous land use. All proposed access roads were assigned a Manning's "n" value of 0.023. A map of the proposed conditions Manning's "n" values is provided in **Figure C- 8. Proposed Conditions Manning' "n" Value Map**.

3.7 Hydraulic Structures

Several existing hydraulic structures, such as bridges and culverts, are present within the existing conditions model domain. In general, the LiDAR data used to create the existing conditions terrain model included bridge and culvert deck elevation data. The terrain model was modified to remove the bridge and culvert deck elevations. This modification removed obstructions to existing flow paths that would have otherwise caused pooling along drainageways that is not consistent with the existing hydraulic conditions of the 2D model domain. The existing bridges and culverts were not modeled in the 2D domain due to the limited availability of structure data at the time of this study. A map of the locations where the existing terrain was modified to remove bridge and culvert deck elevation data can be found in **Figure C- 11. Existing Hydraulic Structures** Map. Proposed culverts were designed on site but were not included within the 2D model. Refer to the Barrett Solar Hydraulic Design report for more information on proposed crossings.

3.8 Boundary Conditions

The precipitation hyetograph based on NOAA Atlas 14 precipitation data as previously discussed in **Section 2.1: Rainfall** was applied uniformly to the hydraulic model's 2D mesh as a precipitation boundary condition.

Normal depth boundary conditions were applied at locations along the perimeter of the 2D mesh where runoff leaves the hydraulic model. The friction slope used for the normal depth boundary condition at these locations was determined using the public LiDAR topographic data along the flow path of stormwater crossing the model boundary.

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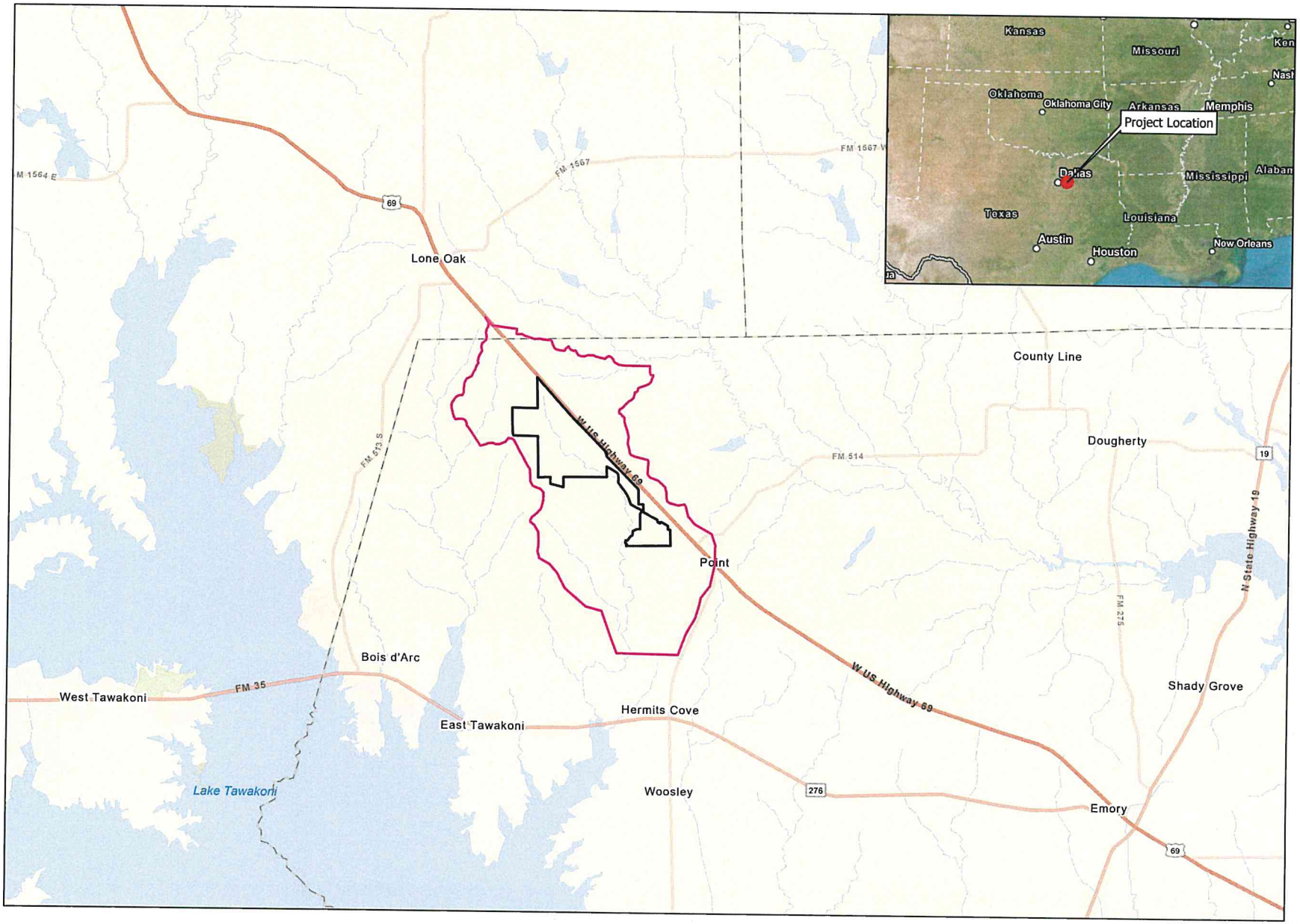
Appendix A. Project Location Maps



Barrett Solar Project

Rains County, Texas

Rev.	Date	Description	By
	09/13/2024	60% Hydrology Study	UEI

Legend

- 2D Model Domain
- Project Boundary

N

0 0.45 0.9 1.8 Miles

NAD 1983 State Plane New Mexico East FIPS 3001 (US Feet)

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Drawn By:	J. Wade
Approved By:	A. Wiles
Project Number:	24.01273

Figure A-1

VICINITY MAP

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0A

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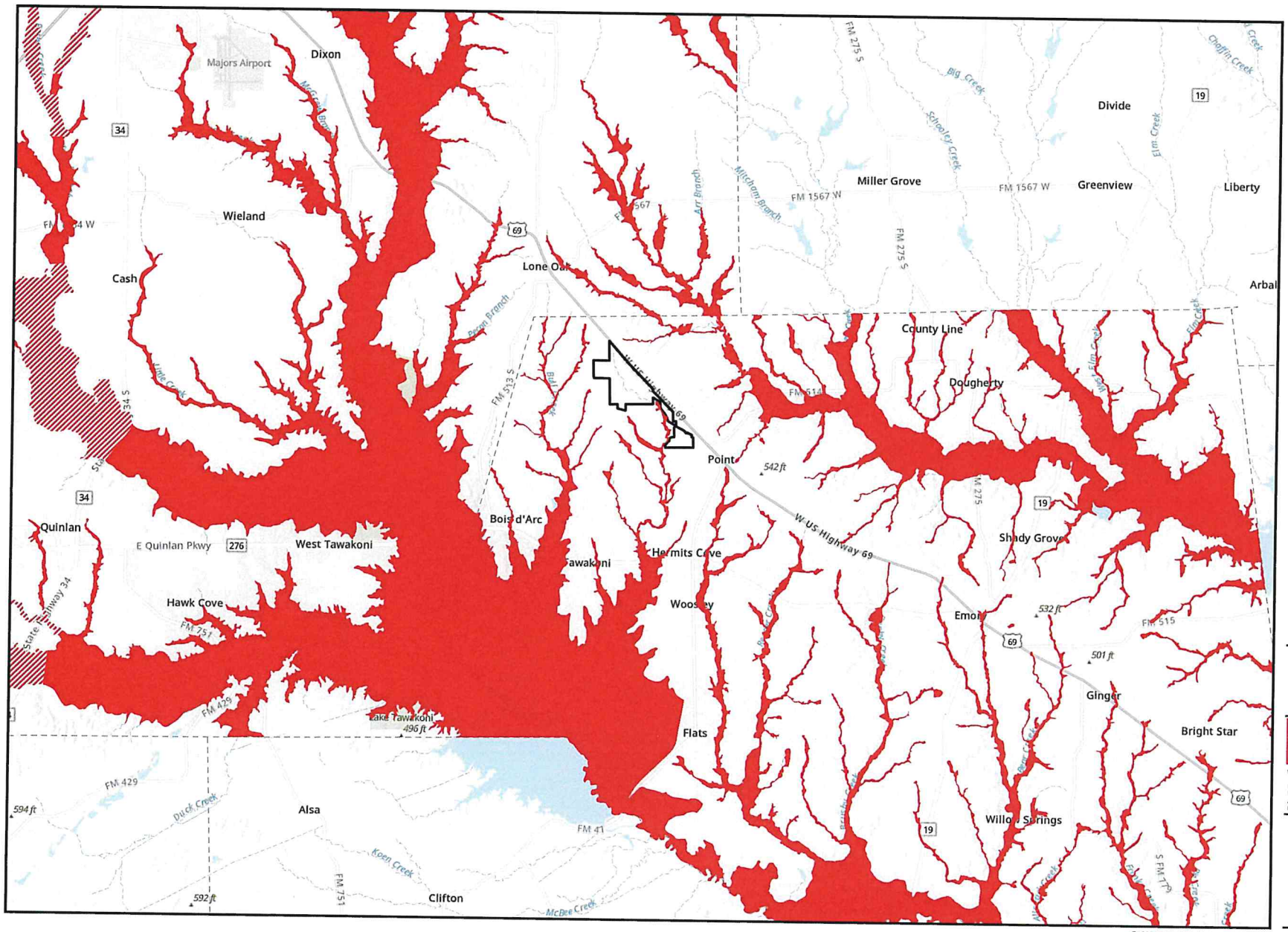

Barrett Solar Project

Rains County, Texas

Rev.	Date	Description	By
	09/13/2024	60% Hydrology Study	UEI

Legend

- Project Boundary
- FEMA Flood Hazard Zone
  - 0.1 - 0.5
  - 0.5 - 1

N

0 5,000 10,000 US Feet

NAD 1983 State Plane Texas North Central FIPS 4204 (US Feet)

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Figure A-2

FEMA Floodplain Map

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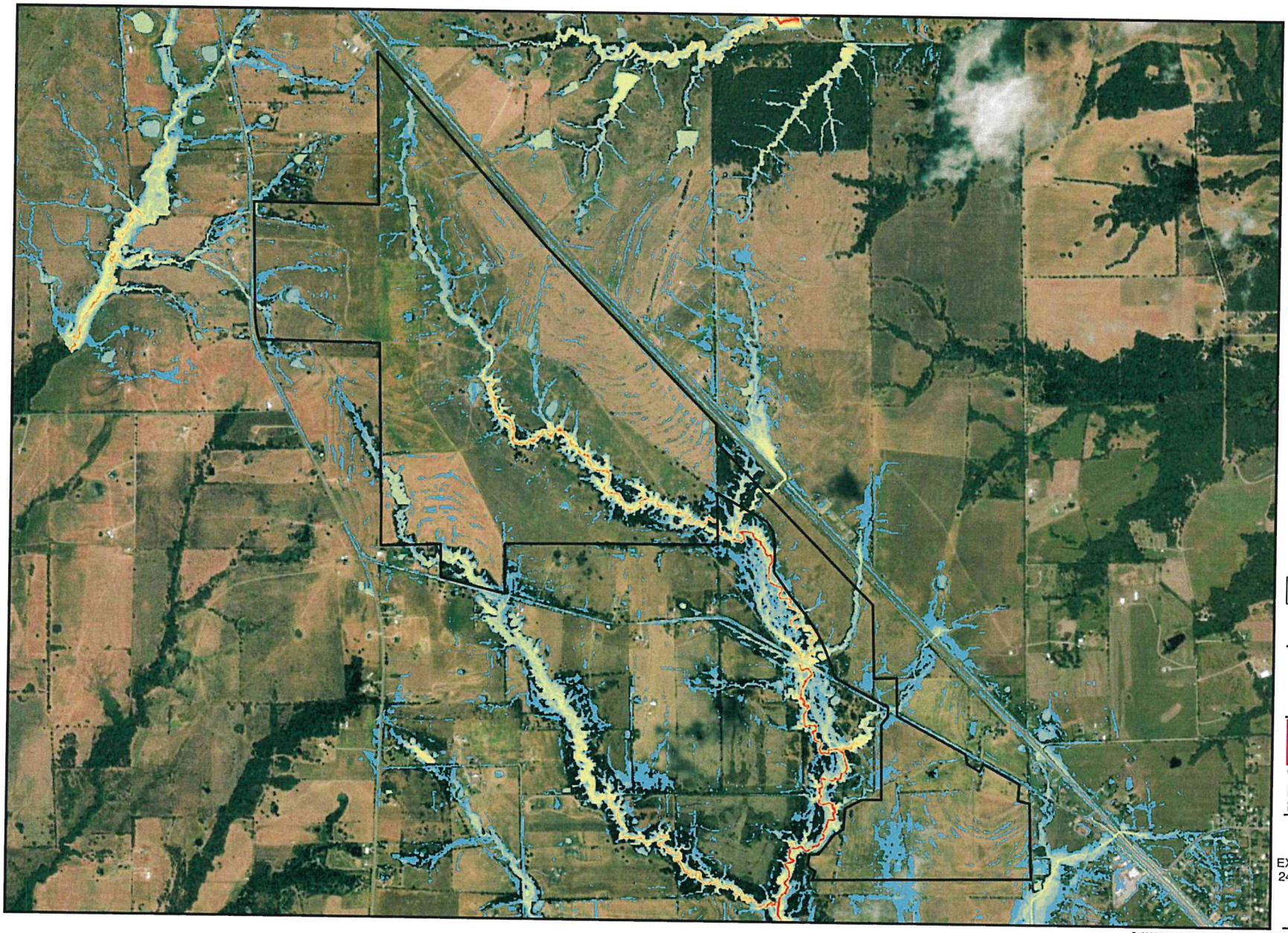
Appendix B. HEC-RAS 2D Model Results



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Legend

Project Boundary

Inundation Depths (ft)

- 0 - 0.1
- 0.1 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- < 7

N

0 1,000 2,000 US Feet

NAD 1983 State Plane Texas North Central FIPS 4204 (US Feet)

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Figure B-1

EXISTING CONDITIONS 2-YR, 24-HR INUNDATION DEPTHS

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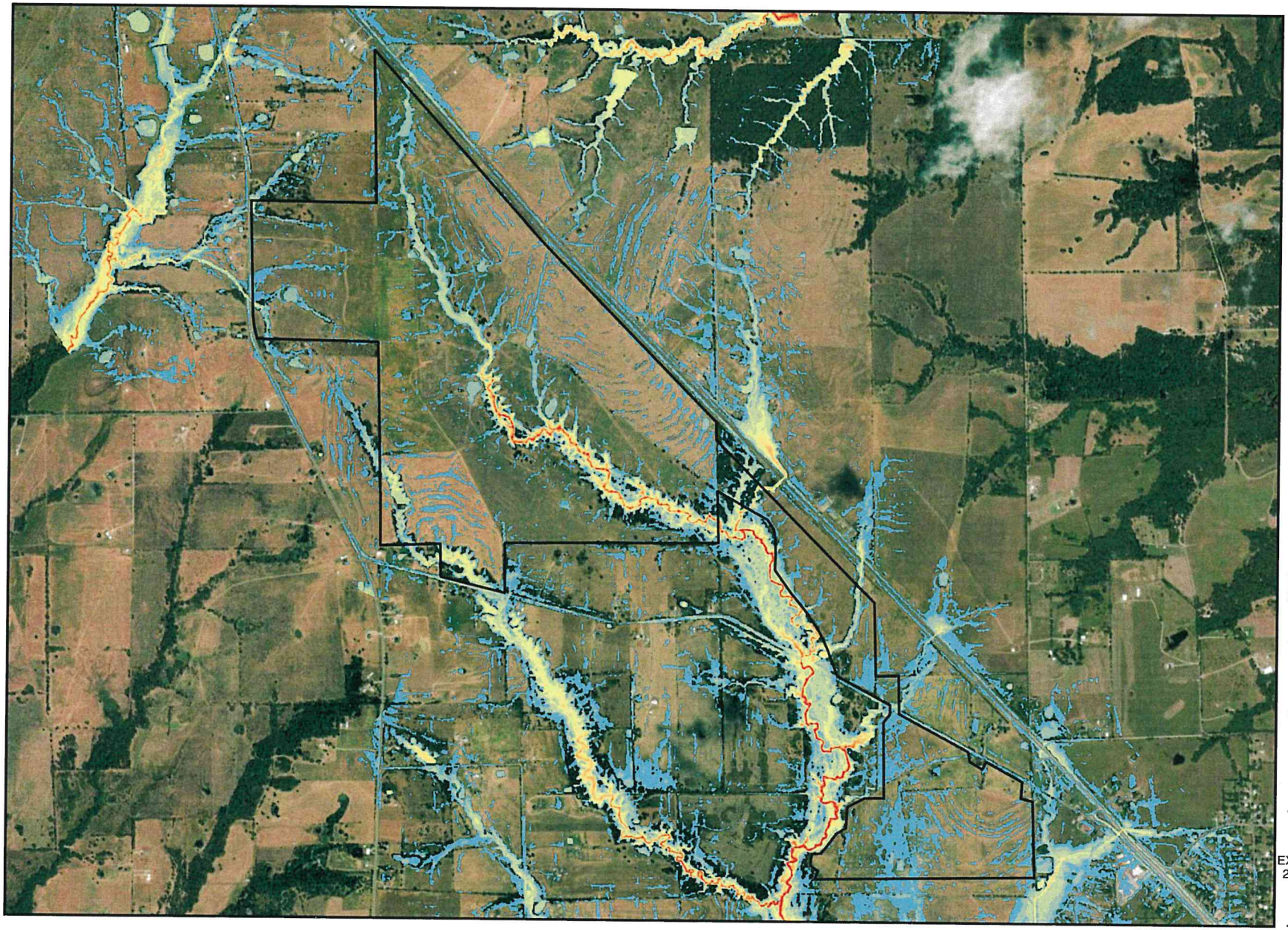

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Legend

Project Boundary

Inundation Depths (ft)

- 0 - 0.1
- 0.1 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- < 7

N

0 1,000 2,000 US Feet

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Figure B-2

EXISTING CONDITIONS 10-YR, 24-HR INUNDATION DEPTHS

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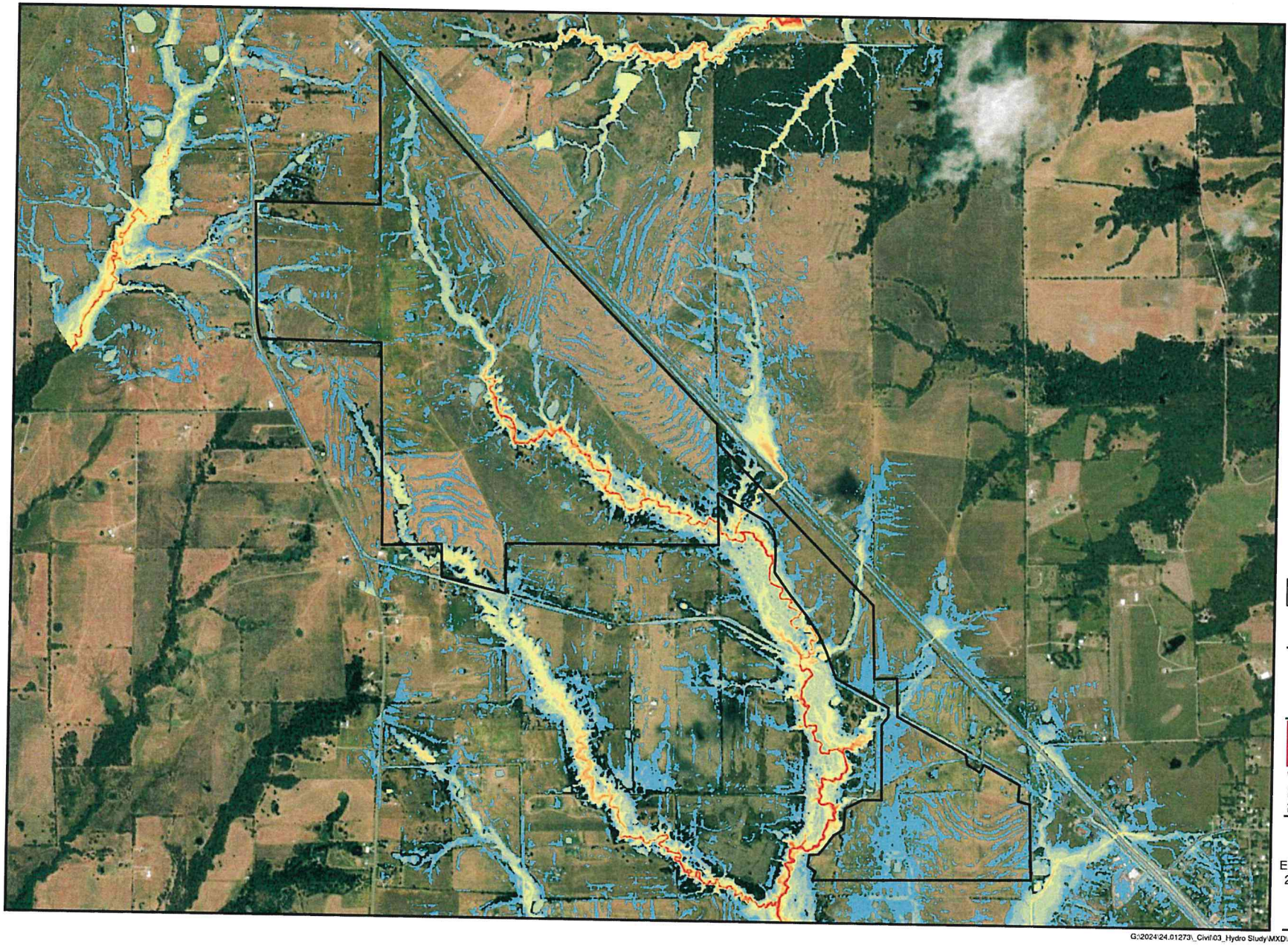

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Project Boundary

Inundation Depths (ft)

- 0 - 0.1
- 0.1 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- < 7

N

0 1,000 2,000 US Feet

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Figure B-3

EXISTING CONDITIONS 25-YR, 24-HR INUNDATION DEPTHS

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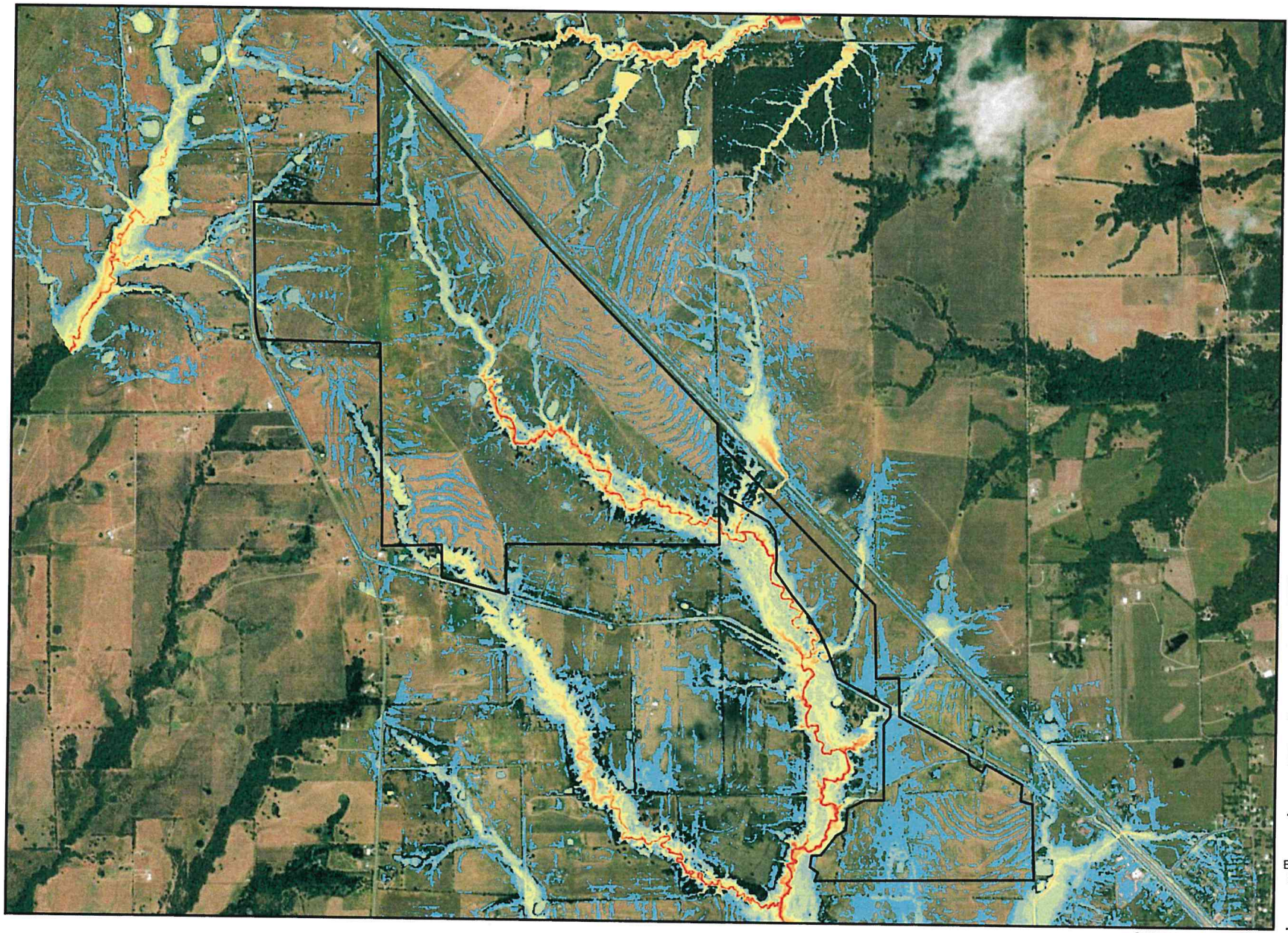

Barrett Solar Project

Rains County, Texas

Rev.	Date	Description	By
	09/13/2024	60% Hydrology Study	UEI

Legend

- Project Boundary

Inundation Depths (ft)

- 0 - 0.1
- 0.1 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- < 7

N

0 1,000 2,000 US Feet

NAD 1983 State Plane Texas North Central FIPS 4204 (US Feet)

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Figure B-4

EXISTING CONDITIONS 50-YR, 24-HR INUNDATION DEPTHS

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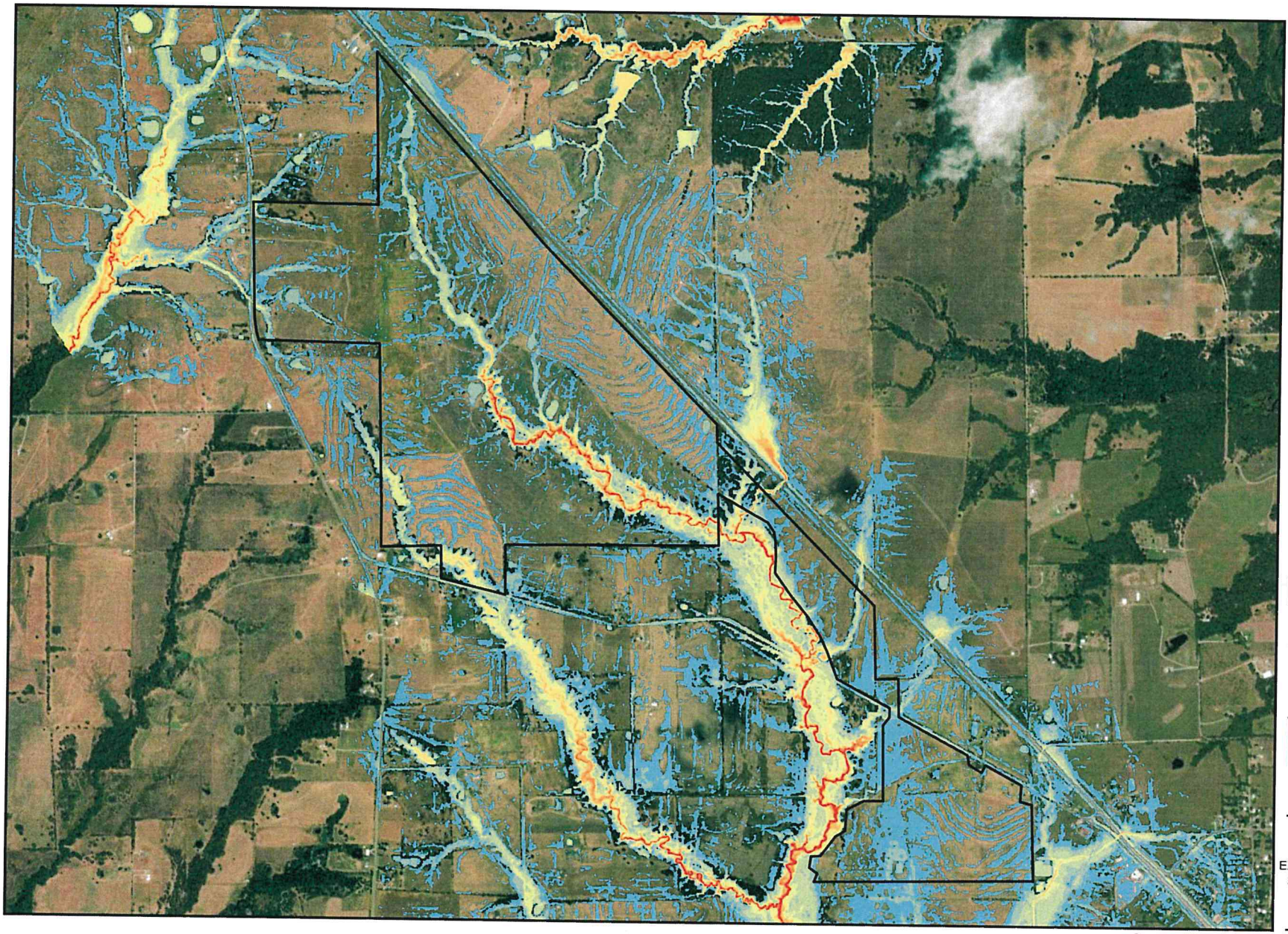

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Legend

Project Boundary

Inundation Depths (ft)

- 0 - 0.1
- 0.1 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- < 7

N

0 1,000 2,000 US Feet

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Figure B-5

EXISTING CONDITIONS 100-YR, 24-HR INUNDATION DEPTHS

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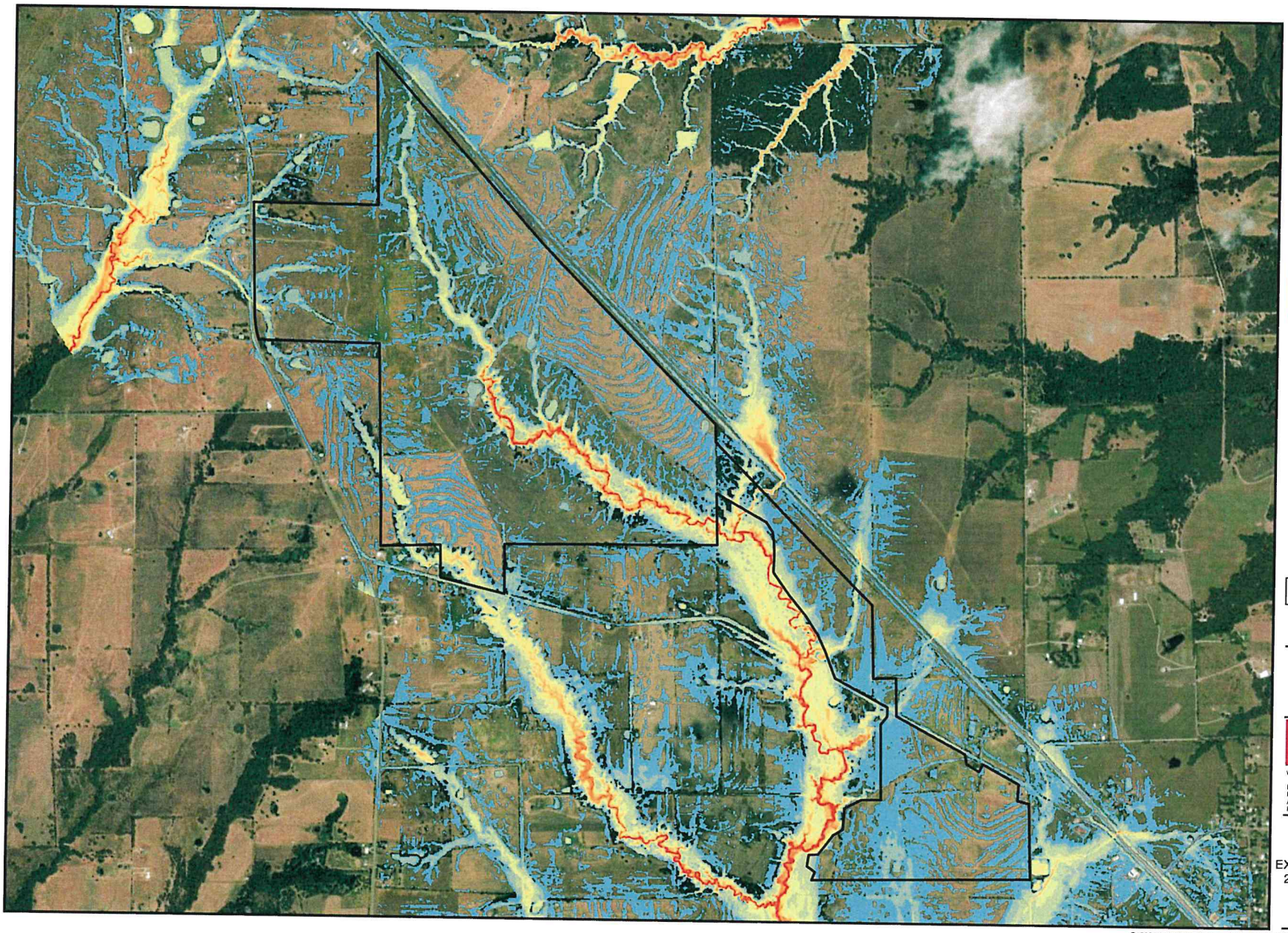

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- Project Boundary

Inundation Depths (ft)

- 0 - 0.1
- 0.1 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- < 7

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0 1,000 2,000 US Feet

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Figure B-6

EXISTING CONDITIONS 500-YR, 24-HR INUNDATION DEPTHS

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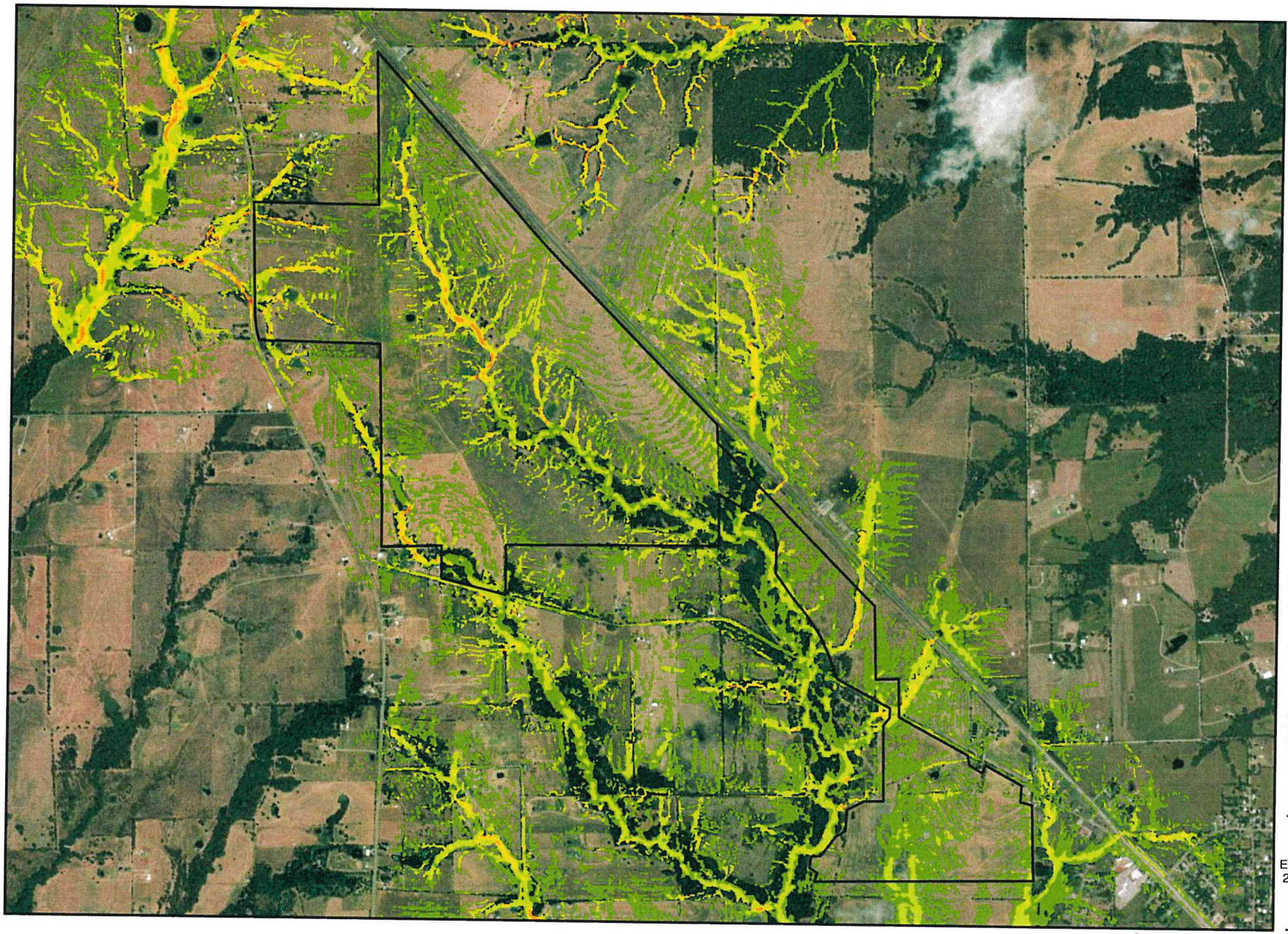

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Project Boundary

Runoff Velocities (ft/s)

- 0 - 0.5
- .5 - 1
- 1 - 2
- 2 - 3
- 3 - 5
- > 5

N

0 1,000 2,000 US Feet

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Figure B-7

EXISTING CONDITIONS 2-YR, 24-HR RUNOFF VELOCITIES

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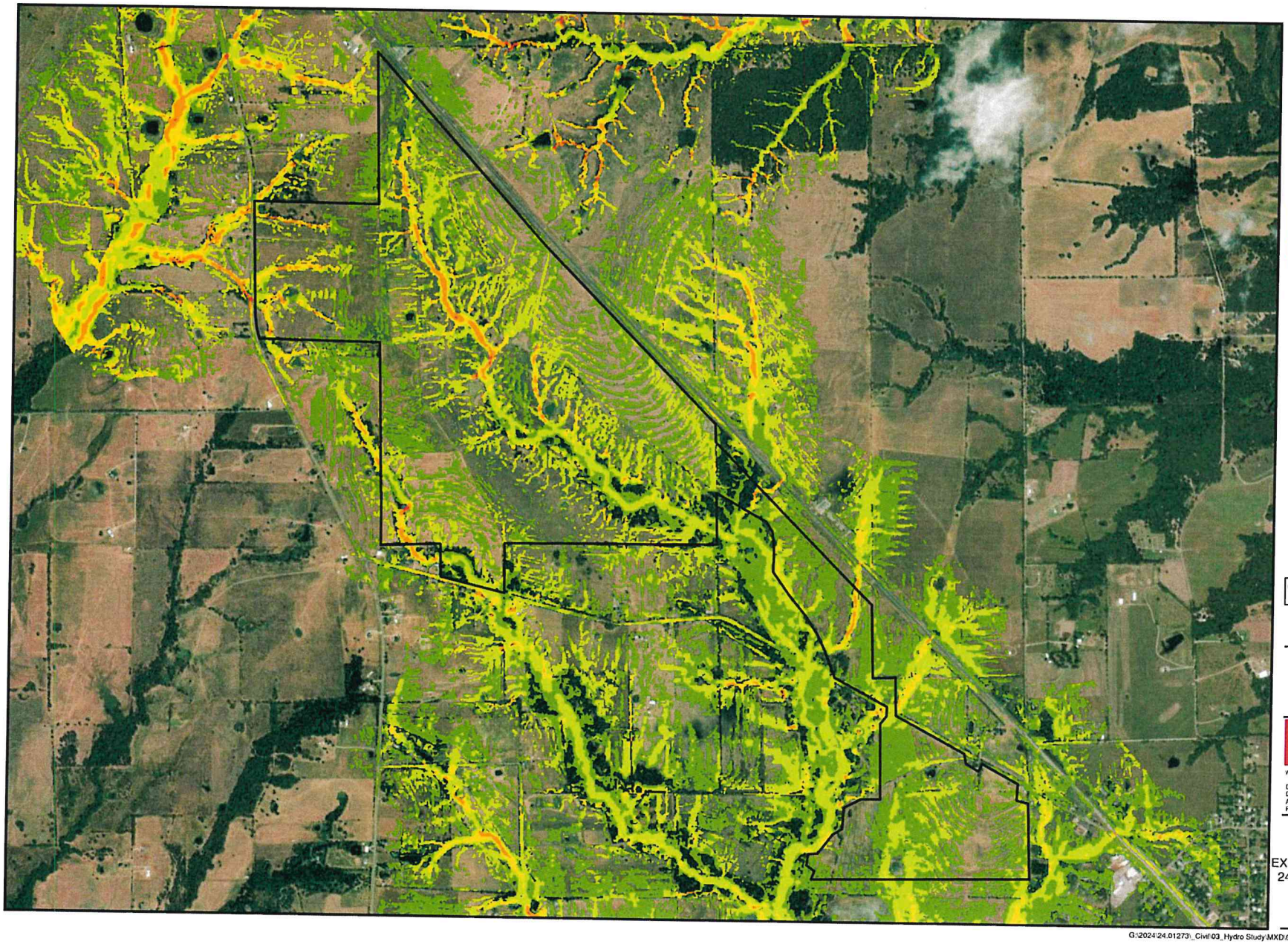

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- Project Boundary
- **Runoff Velocities (ft/s)**
  - 0 - 0.5
  - .5 - 1
  - 1 - 2
  - 2 - 3
  - 3 - 5
  - > 5

N

0 1,000 2,000 US Feet

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Figure B-8

EXISTING CONDITIONS 10-YR, 24-HR RUNOFF VELOCITIES

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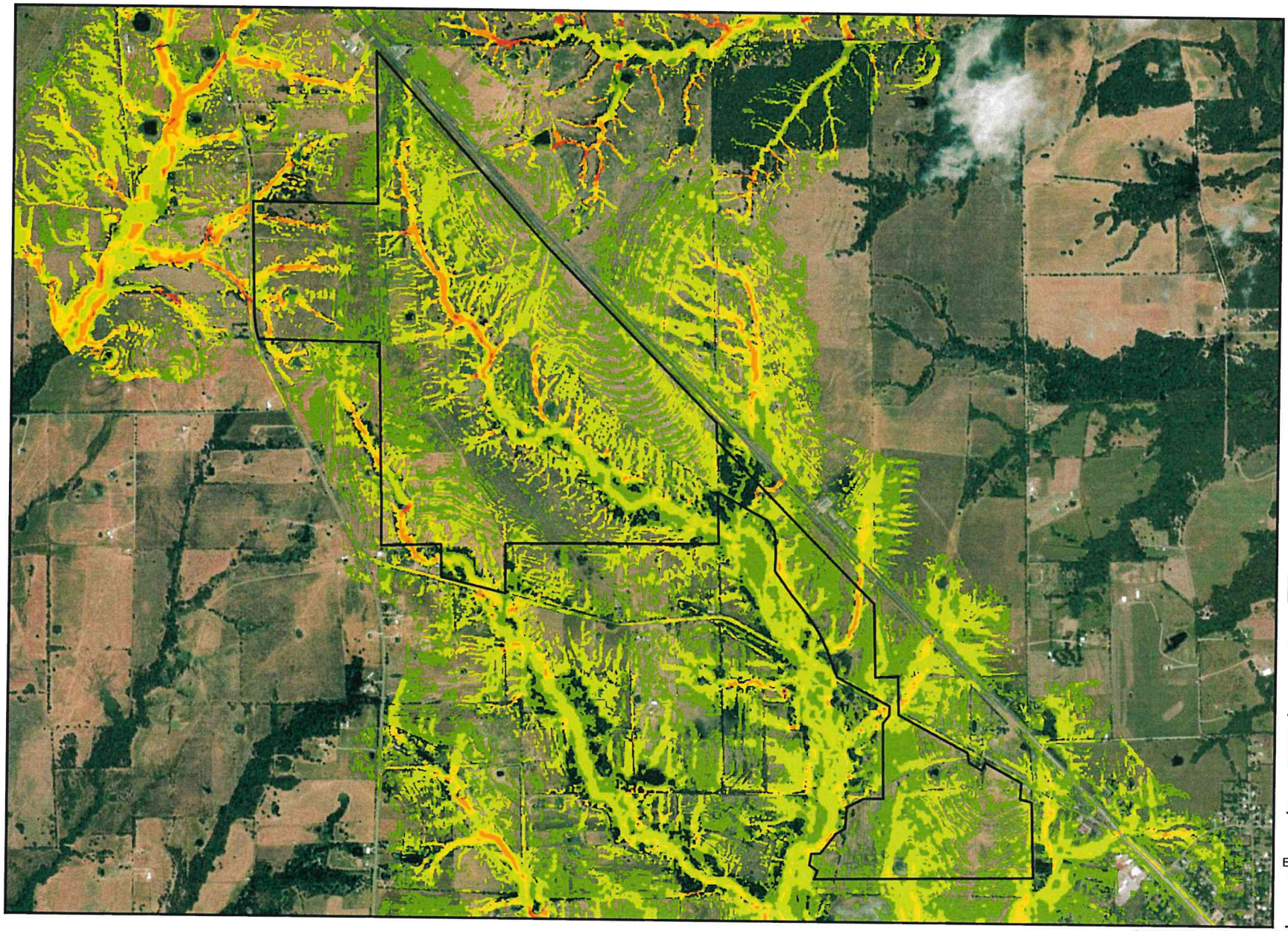

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Project Boundary

Runoff Velocities (ft/s)

- 0 - 0.5
- .5 - 1
- 1 - 2
- 2 - 3
- 3 - 5
- > 5

N

0 1,000 2,000 US Feet

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Figure B-9

EXISTING CONDITIONS 25-YR, 24-HR RUNOFF VELOCITIES

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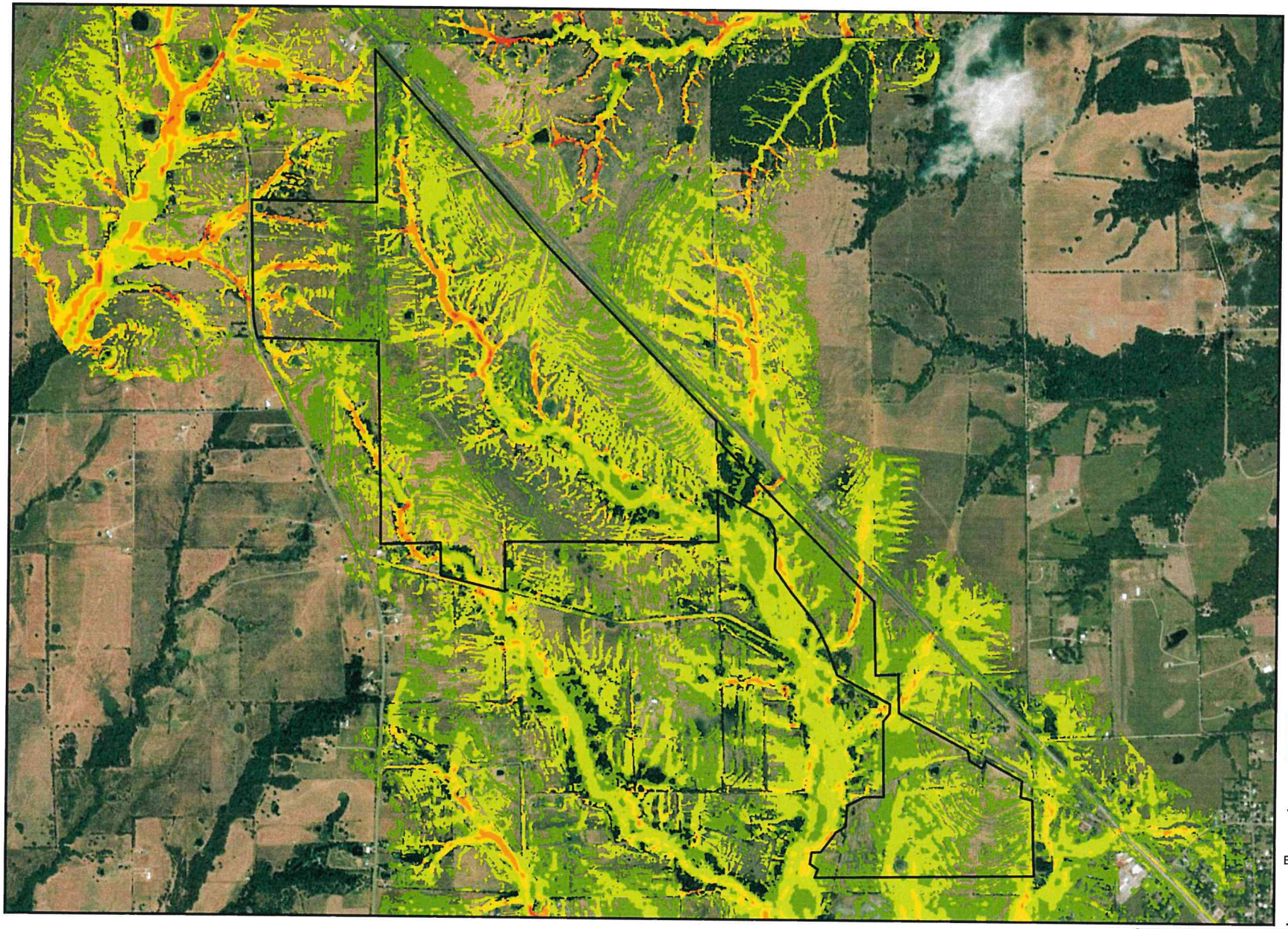

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Project Boundary

Runoff Velocities (ft/s)

- 0 - 0.5
- .5 - 1
- 1 - 2
- 2 - 3
- 3 - 5
- > 5

N

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Figure B-10

EXISTING CONDITIONS 50-YR, 24-HR RUNOFF VELOCITIES

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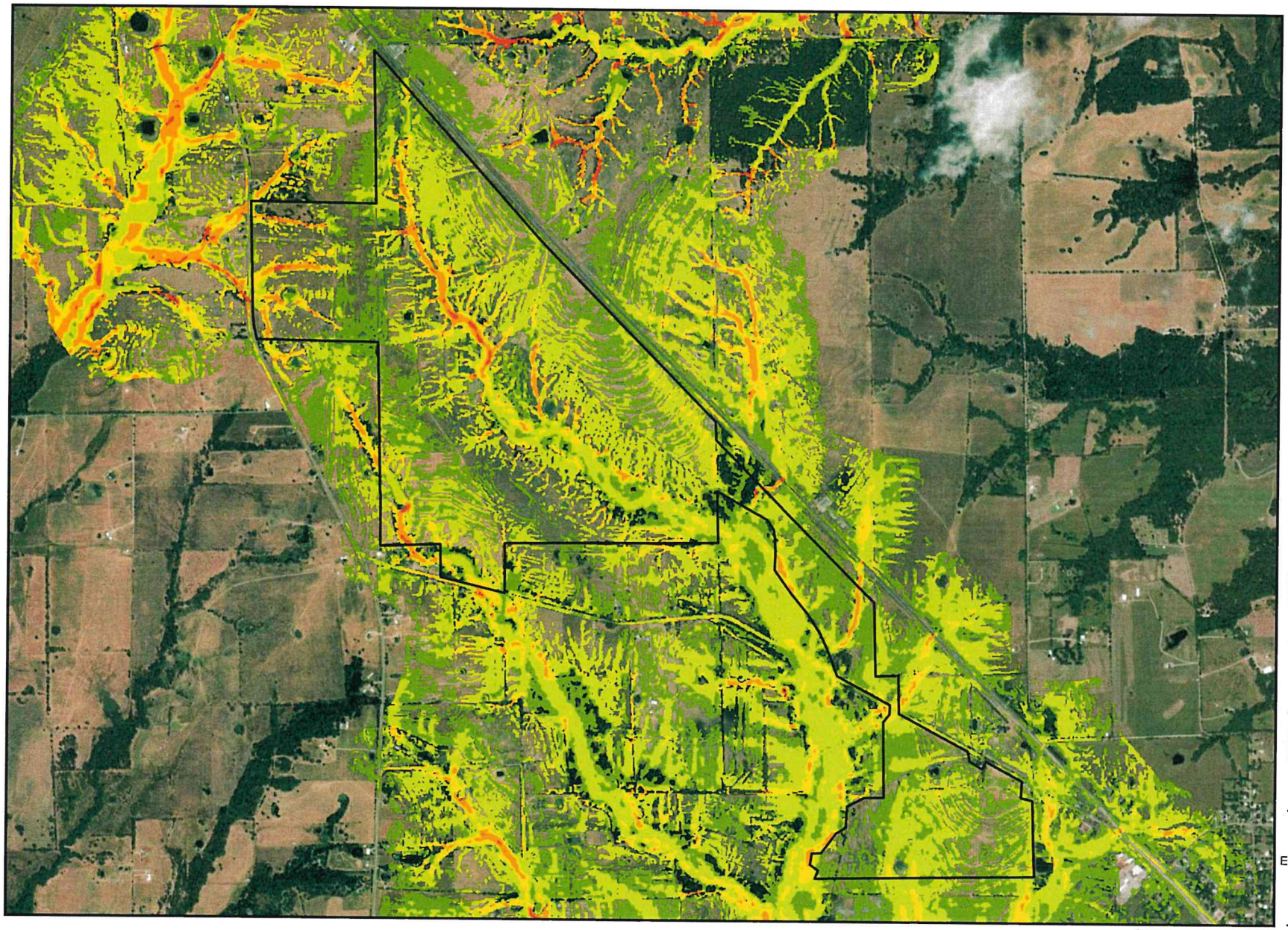

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- Project Boundary

Runoff Velocities (ft/s)

- 0 - 0.5
- .5 - 1
- 1 - 2
- 2 - 3
- 3 - 5
- > 5

N

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Figure B-11

EXISTING CONDITIONS 100-YR, 24-HR RUNOFF VELOCITIES

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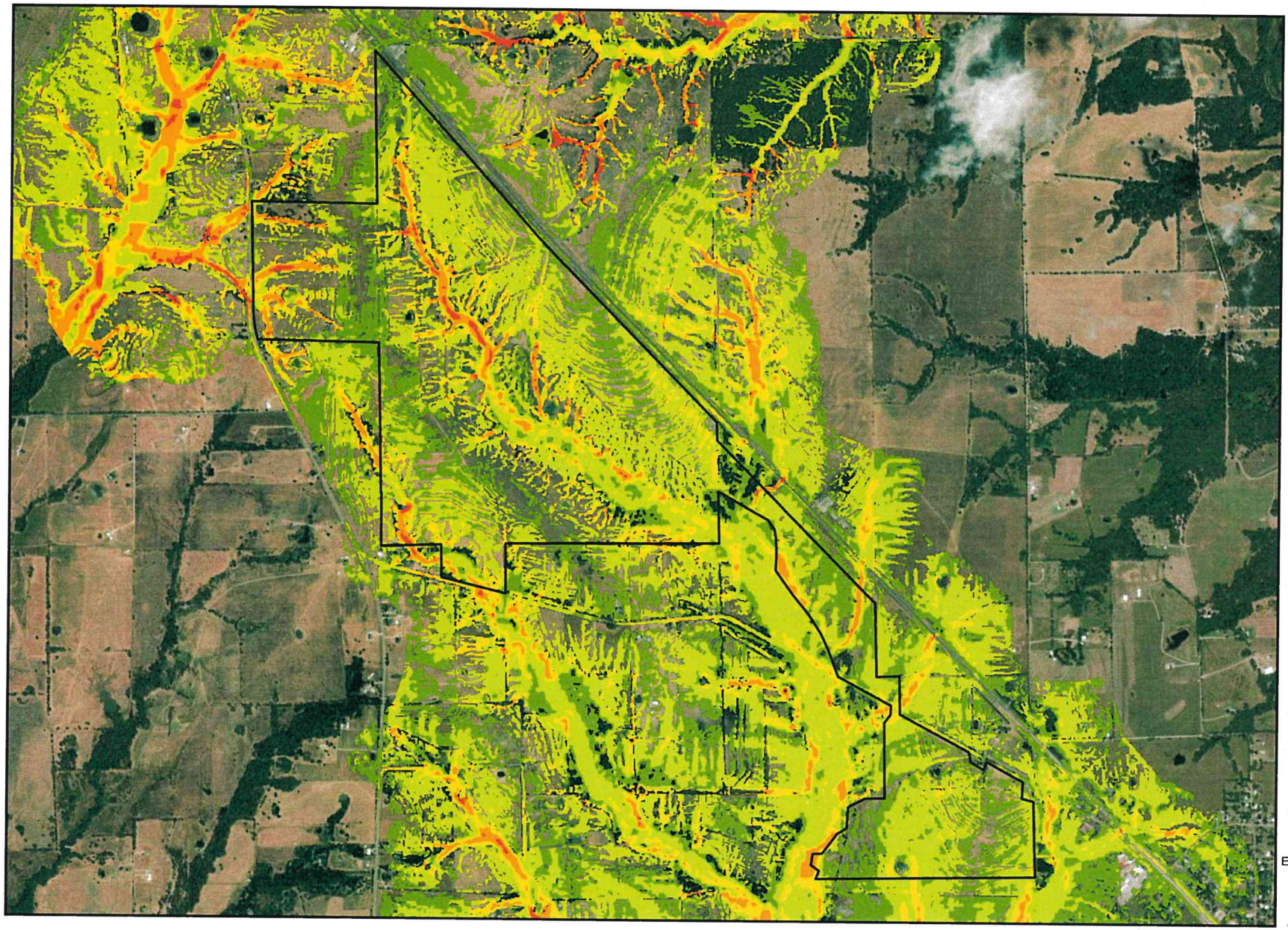

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- Project Boundary
- **Runoff Velocities (ft/s)**
  - 0 - 0.5
  - .5 - 1
  - 1 - 2
  - 2 - 3
  - 3 - 5
  - > 5

N

0 1,000 2,000 US Feet

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Figure B-12

EXISTING CONDITIONS 500-YR, 24-HR RUNOFF VELOCITIES

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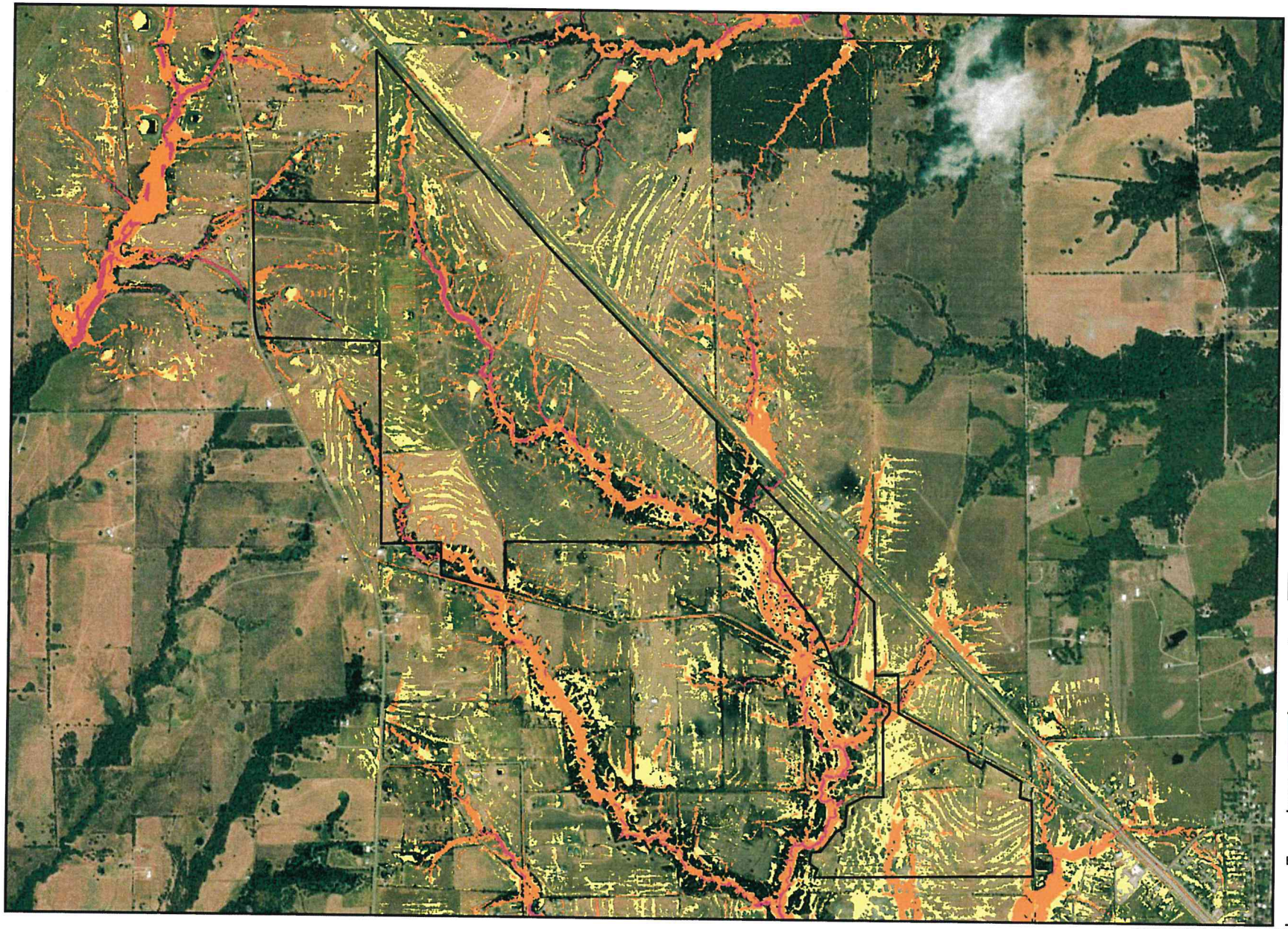

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Project Boundary

Scour Depths (ft)

- 0 - 0.25
- 0.25 - 0.5
- .5 - 1
- 1 - 1.5
- 1.5 - 2

N

0 1,000 2,000 US Feet

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Figure B-13

EXISTING CONDITIONS 2-YR, 24-HR SCOUR DEPTHS

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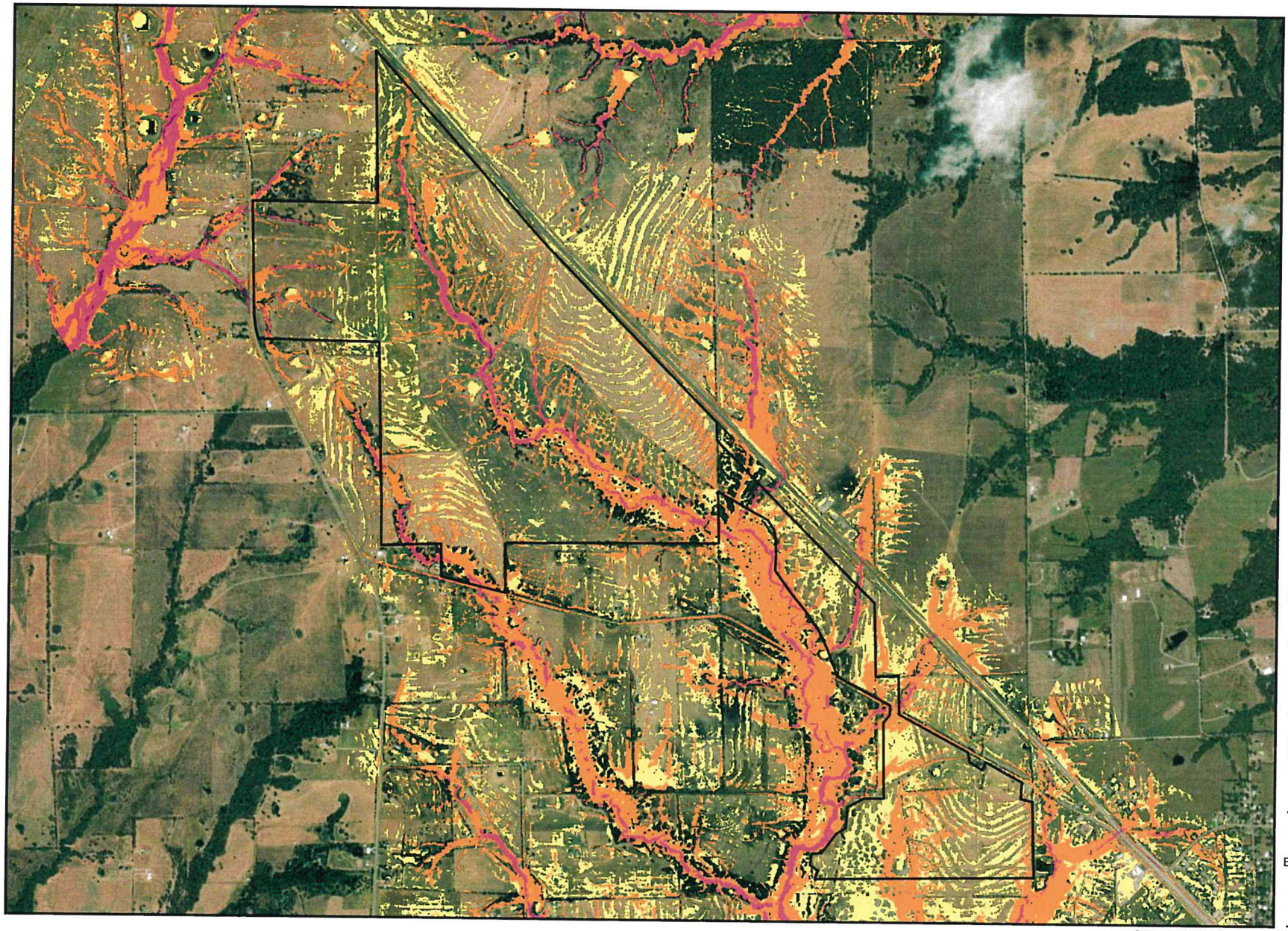

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Project Boundary

Scour Depths (ft)

- 0 - 0.25
- 0.25 - 0.5
- .5 - 1
- 1 - 1.5
- 1.5 - 2

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0 1,000 2,000 US Feet

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Figure B-14

EXISTING CONDITIONS 10-YR, 24-HR SCOUR DEPTHS

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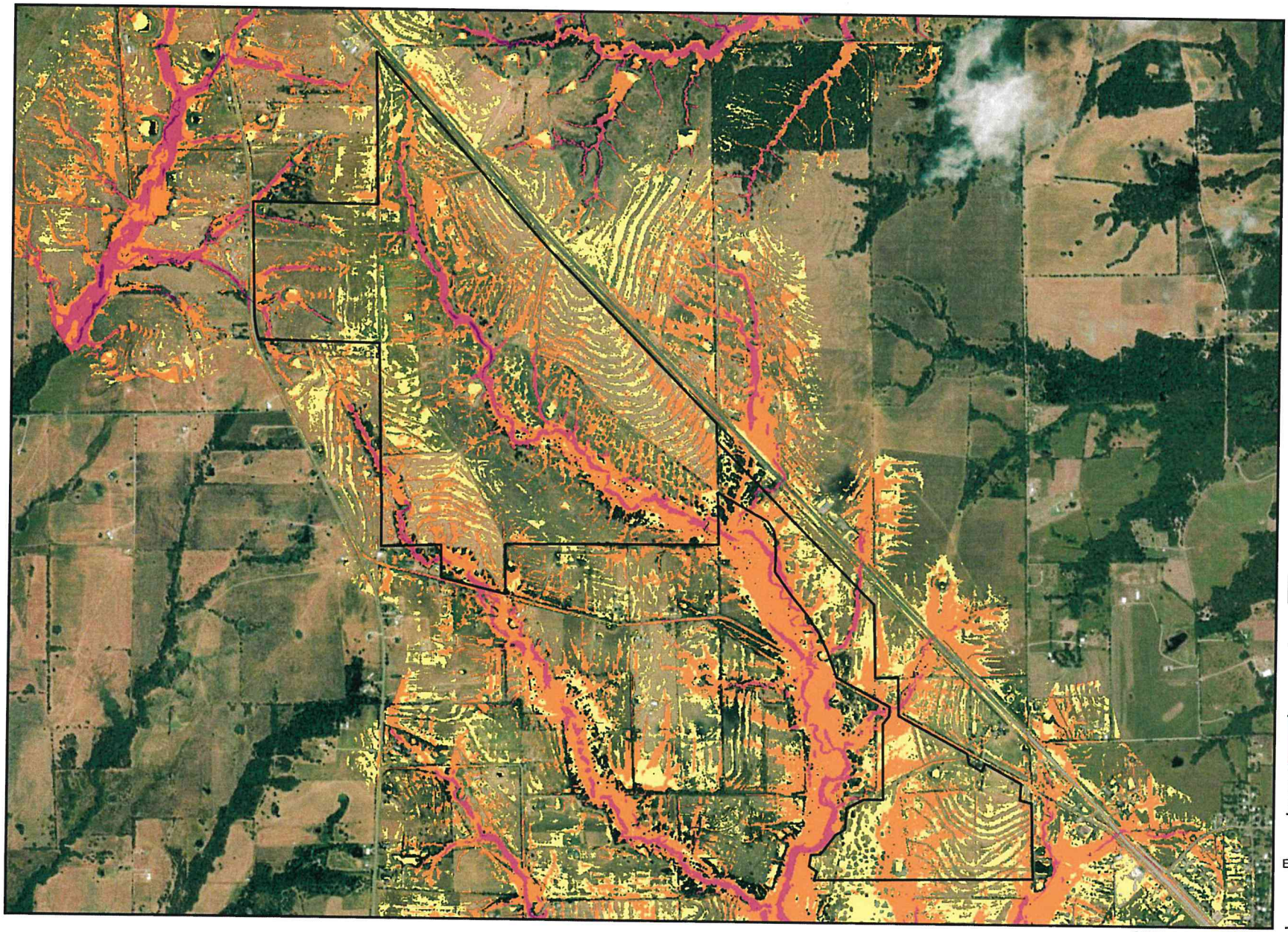

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- Project Boundary

Scour Depths (ft)

- 0 - 0.25
- 0.25 - 0.5
- .5 - 1
- 1 - 1.5
- 1.5 - 2

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Figure B-15

EXISTING CONDITIONS 25-YR, 24-HR SCOUR DEPTHS

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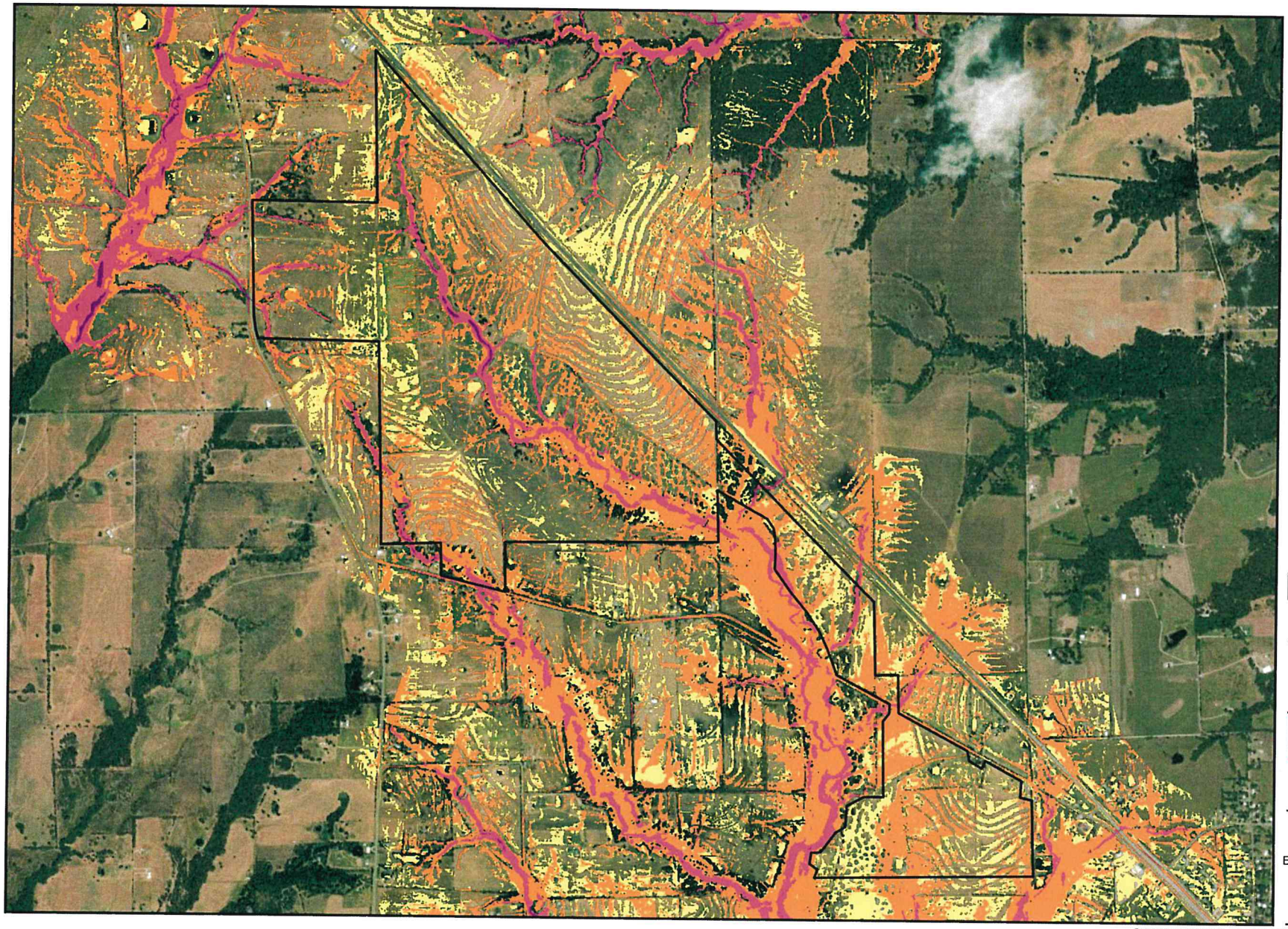

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Project Boundary

Scour Depths (ft)

- 0 - 0.25
- 0.25 - 0.5
- .5 - 1
- 1 - 1.5
- 1.5 - 2

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Figure B-16

EXISTING CONDITIONS 50-YR, 24-HR SCOUR DEPTHS

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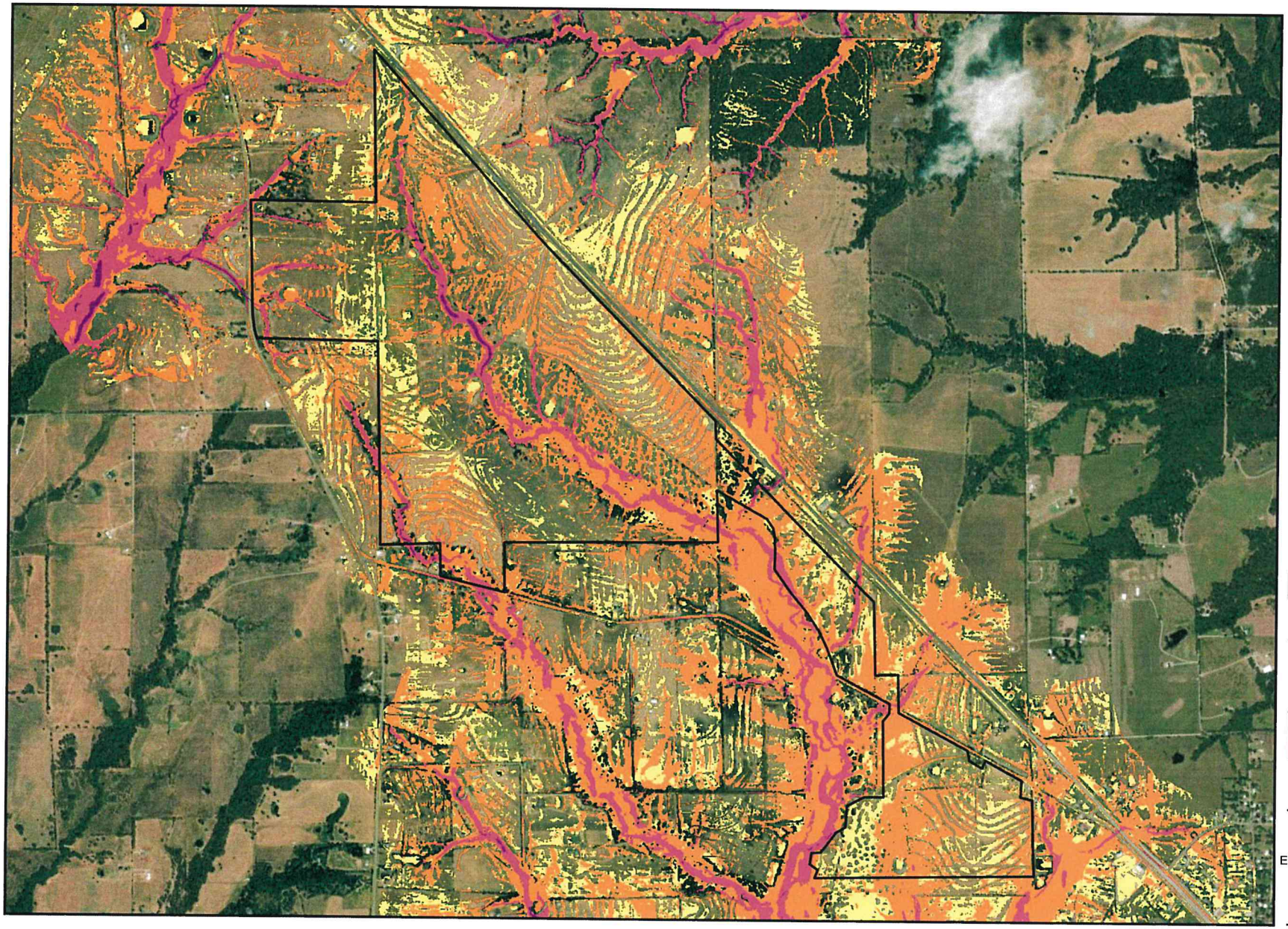

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- Project Boundary

Scour Depths (ft)

- 0 - 0.25
- 0.25 - 0.5
- .5 - 1
- 1 - 1.5
- 1.5 - 2

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Figure B-17

EXISTING CONDITIONS 100-YR, 24-HR SCOUR DEPTHS

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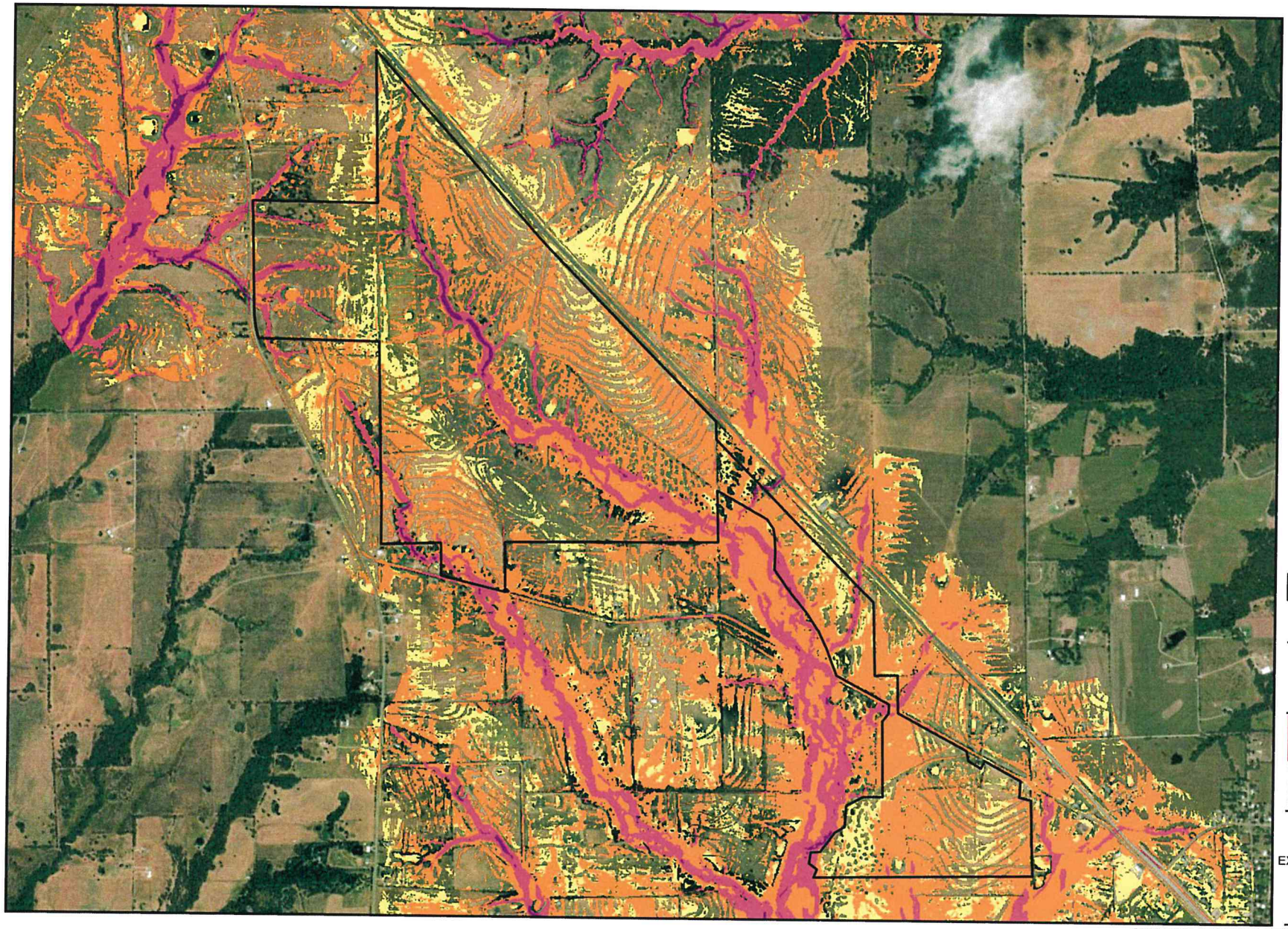

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Legend

- Project Boundary

Scour Depths (ft)

- 0 - 0.25
- 0.25 - 0.5
- .5 - 1
- 1 - 1.5
- 1.5 - 2

N

0 1,000 2,000 US Feet

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Figure B-18

EXISTING CONDITIONS 500-YR, 24-HR SCOUR DEPTHS

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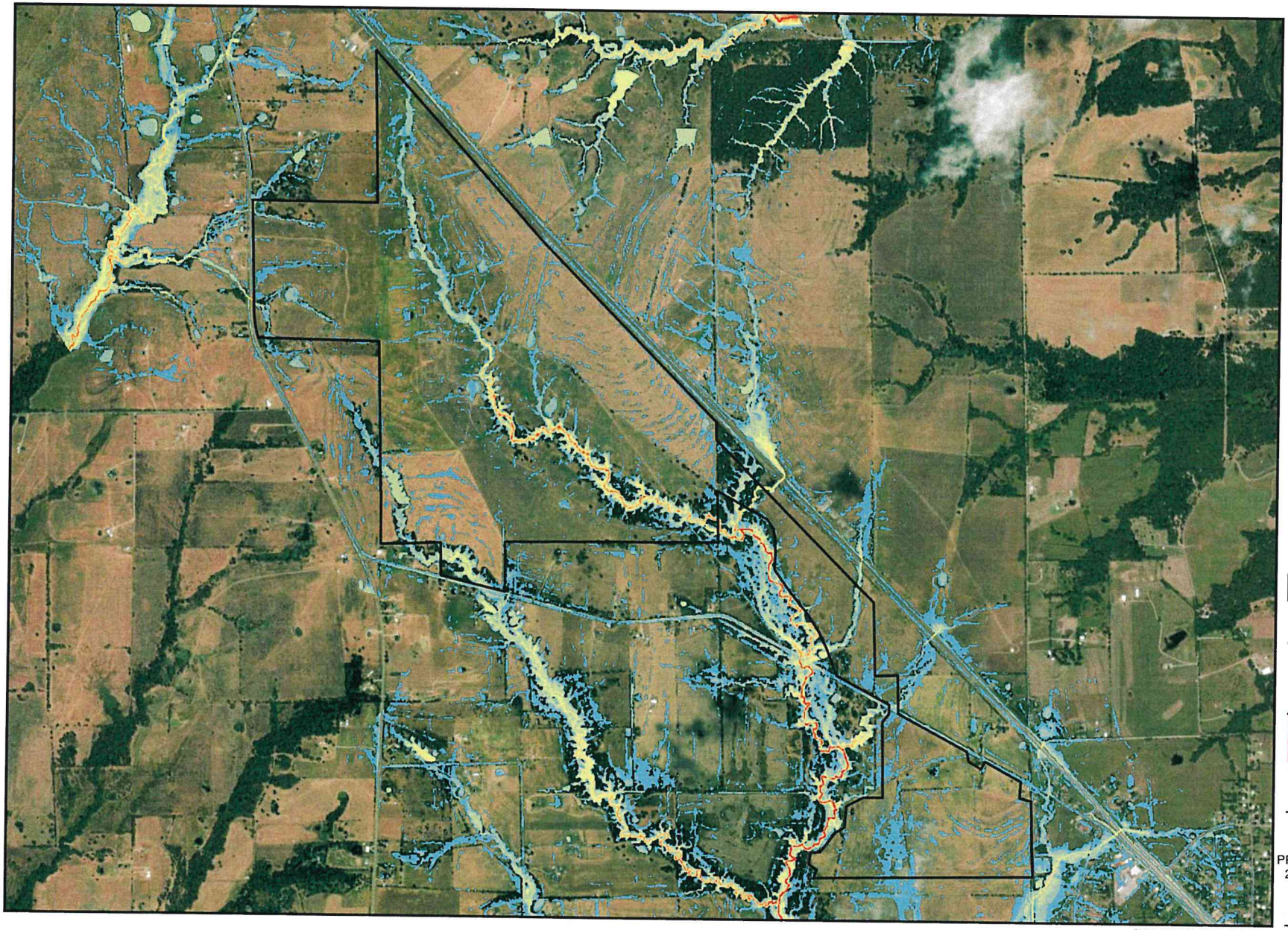

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Project Boundary

Inundation Depths (ft)

- 0 - 0.1
- 0.1 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- < 7

N

0 1,000 2,000 US Feet

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Figure B-19

PROPOSED CONDITIONS 2-YR, 24-HR INUNDATION DEPTHS

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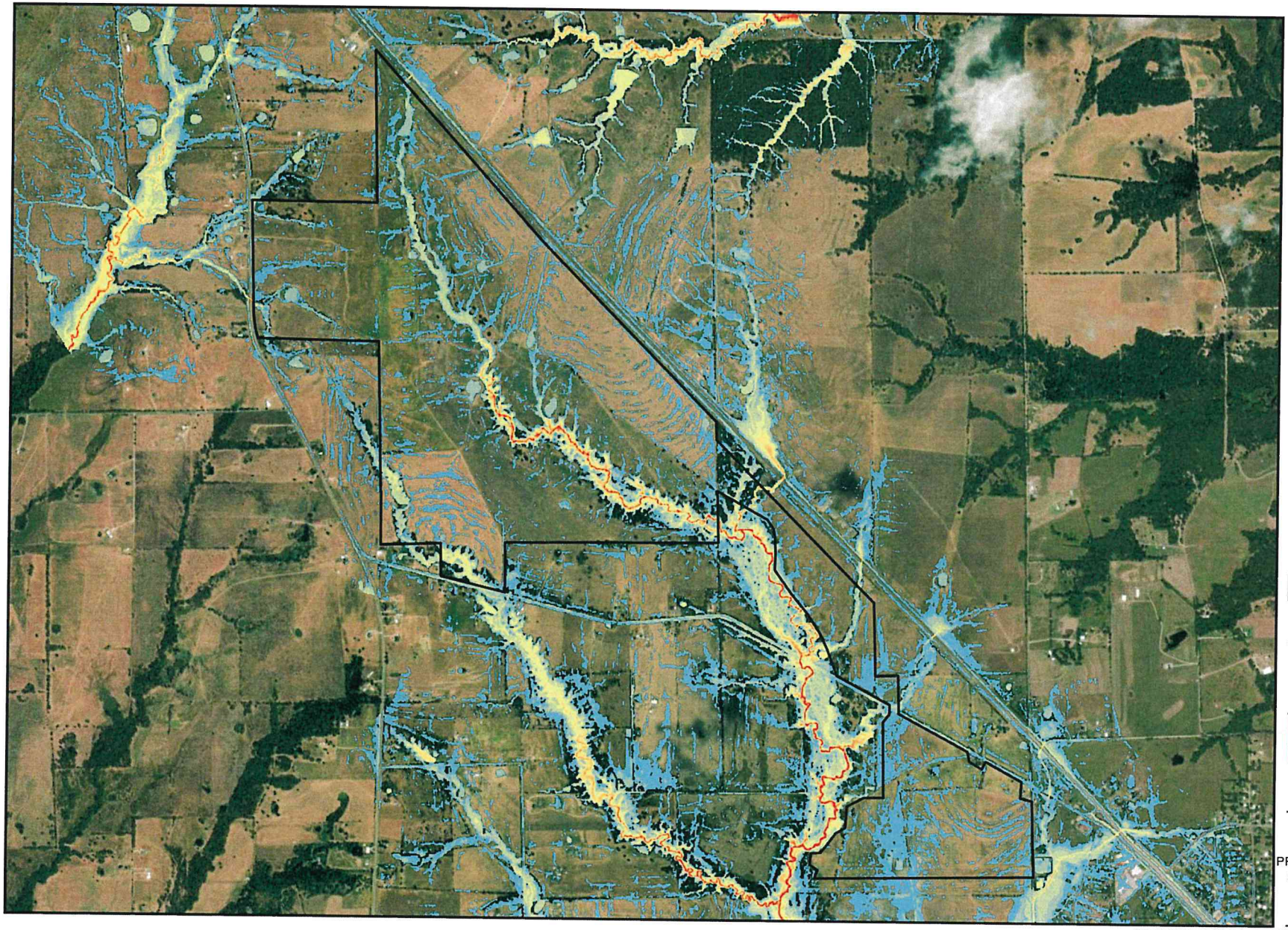

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Project Boundary

Inundation Depths (ft)

- 0 - 0.1
- 0.1 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- < 7

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0 1,000 2,000 US Feet

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Figure B-20

PROPOSED CONDITIONS 10-YR, 24-HR INUNDATION DEPTHS

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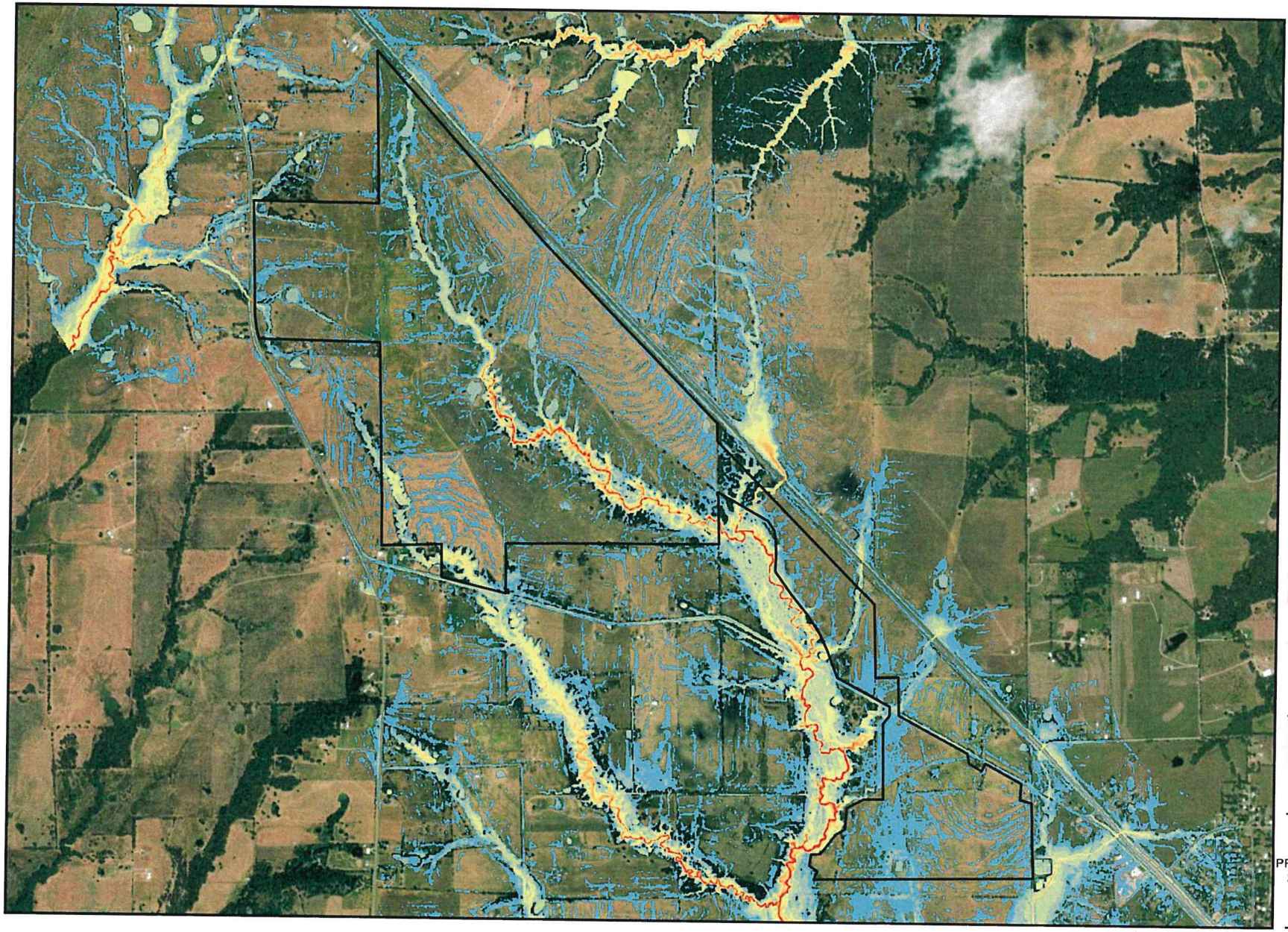

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Project Boundary

Inundation Depths (ft)

- 0 - 0.1
- 0.1 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- < 7

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Figure B-21

PROPOSED CONDITIONS 25-YR, 24-HR INUNDATION DEPTHS

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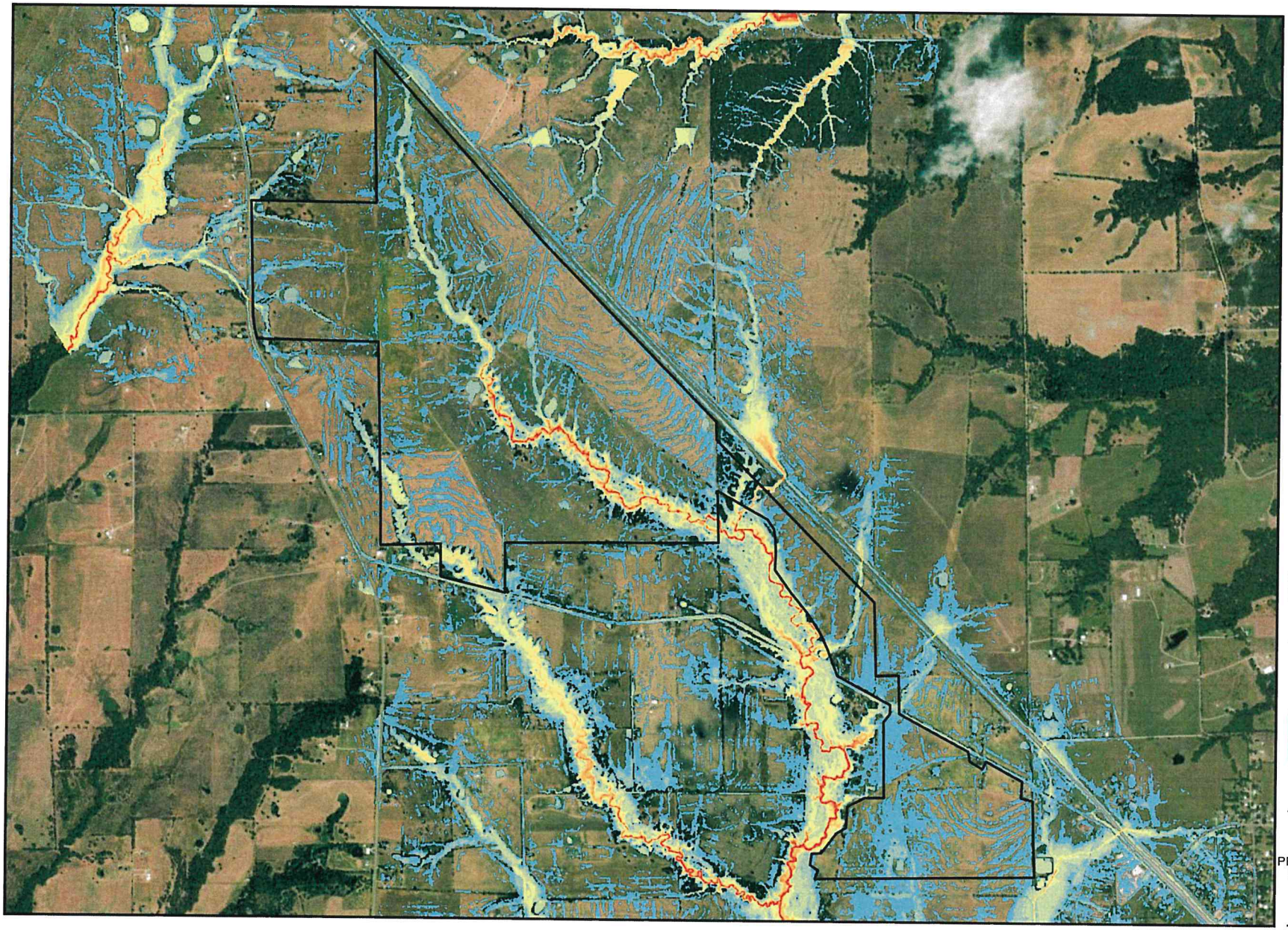

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Legend

Project Boundary

Inundation Depths (ft)

- 0 - 0.1
- 0.1 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- < 7

N

0 1,000 2,000 US Feet

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Figure B-22

PROPOSED CONDITIONS 50-YR, 24-HR INUNDATION DEPTHS

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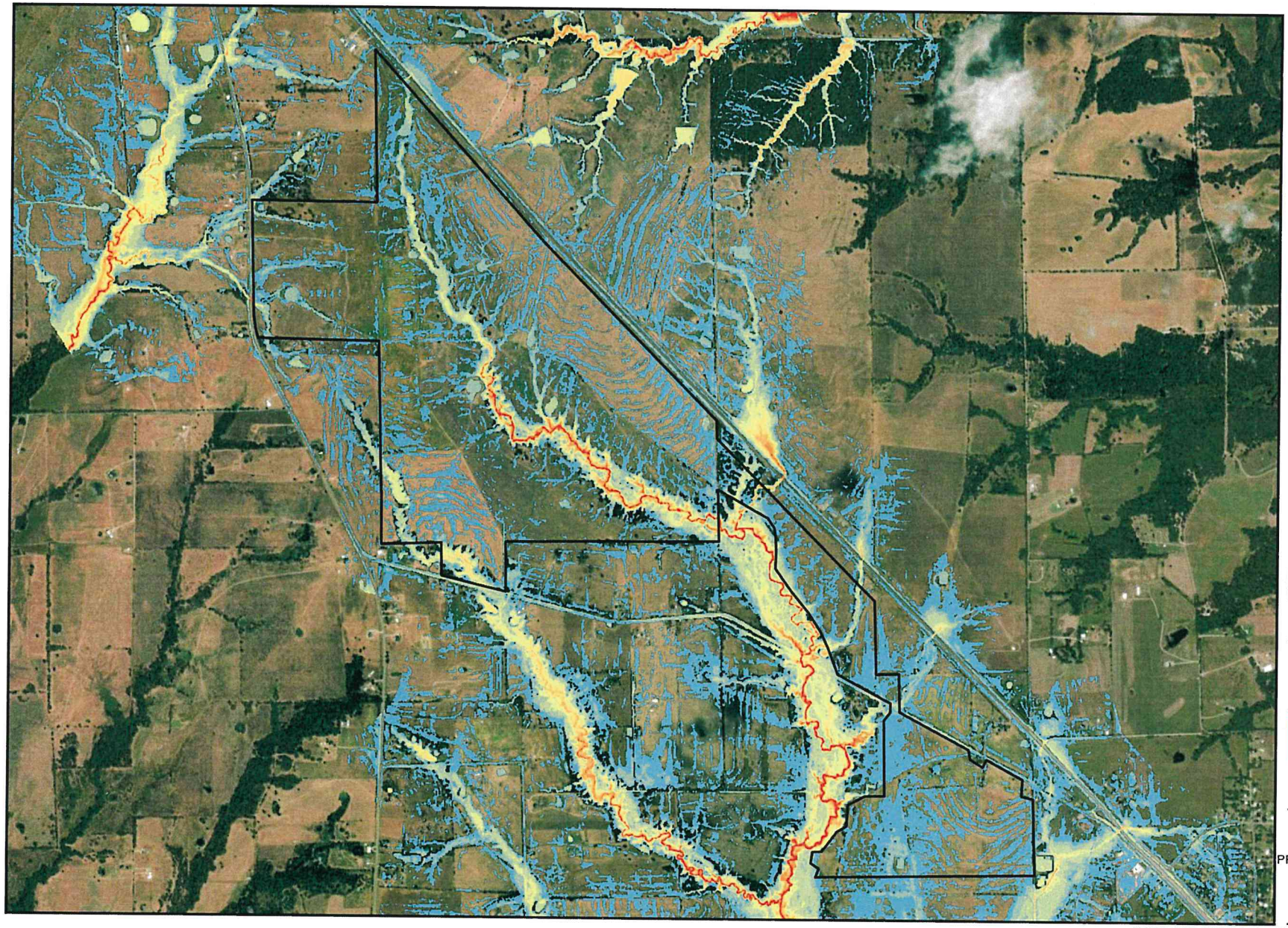

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Legend

- Project Boundary
- **Inundation Depths (ft)**
  - 0 - 0.1
  - 0.1 - 0.5
  - 0.5 - 1
  - 1 - 2
  - 2 - 3
  - 3 - 4
  - 4 - 5
  - 5 - 6
  - 6 - 7
  - < 7

N

0 1,000 2,000 US Feet

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Figure B-23

PROPOSED CONDITIONS 100-YR, 24-HR INUNDATION DEPTHS

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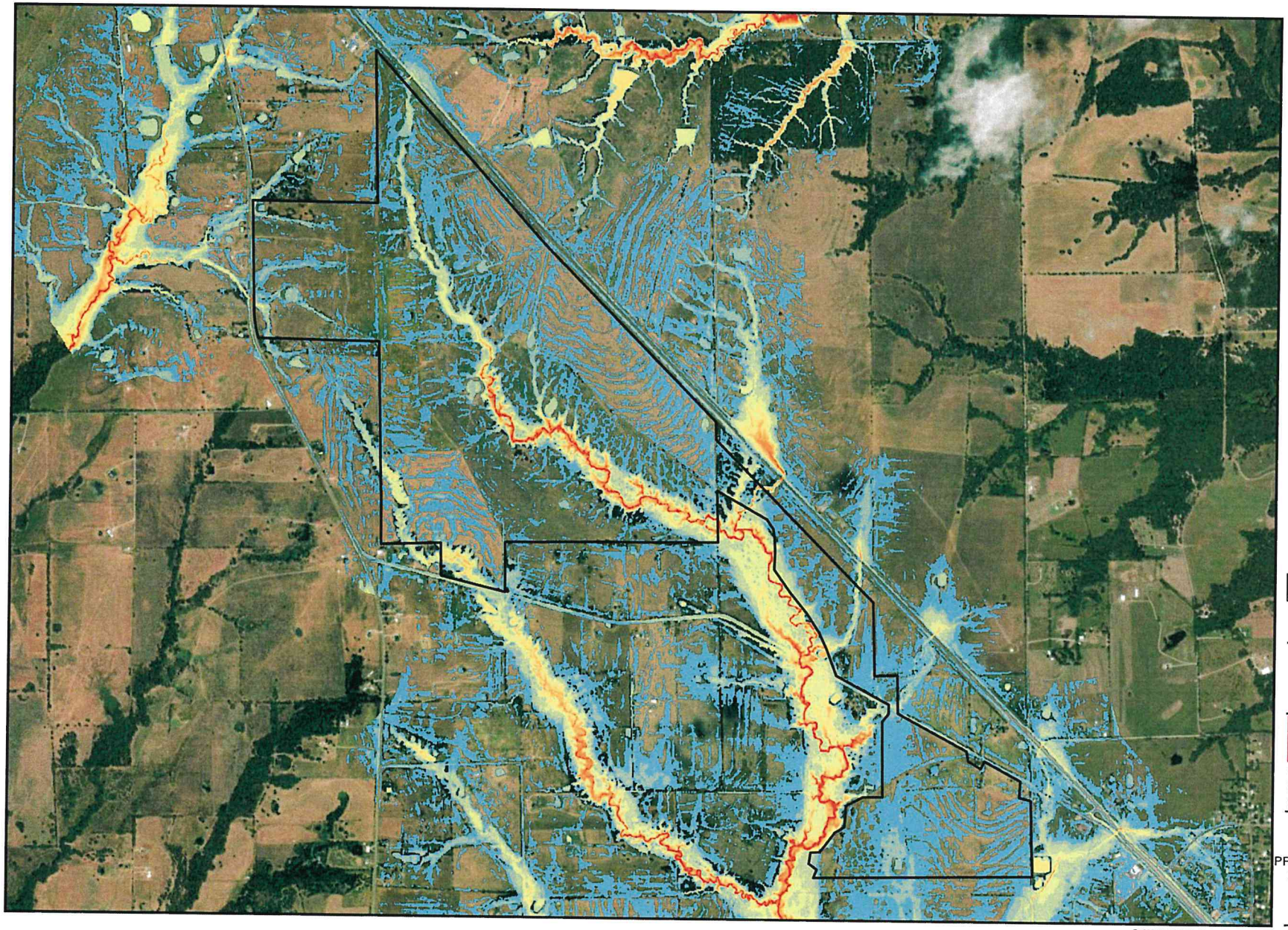

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- Project Boundary

Inundation Depths (ft)

- 0 - 0.1
- 0.1 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- < 7

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Figure B-24

PROPOSED CONDITIONS 500-YR, 24-HR INUNDATION DEPTHS

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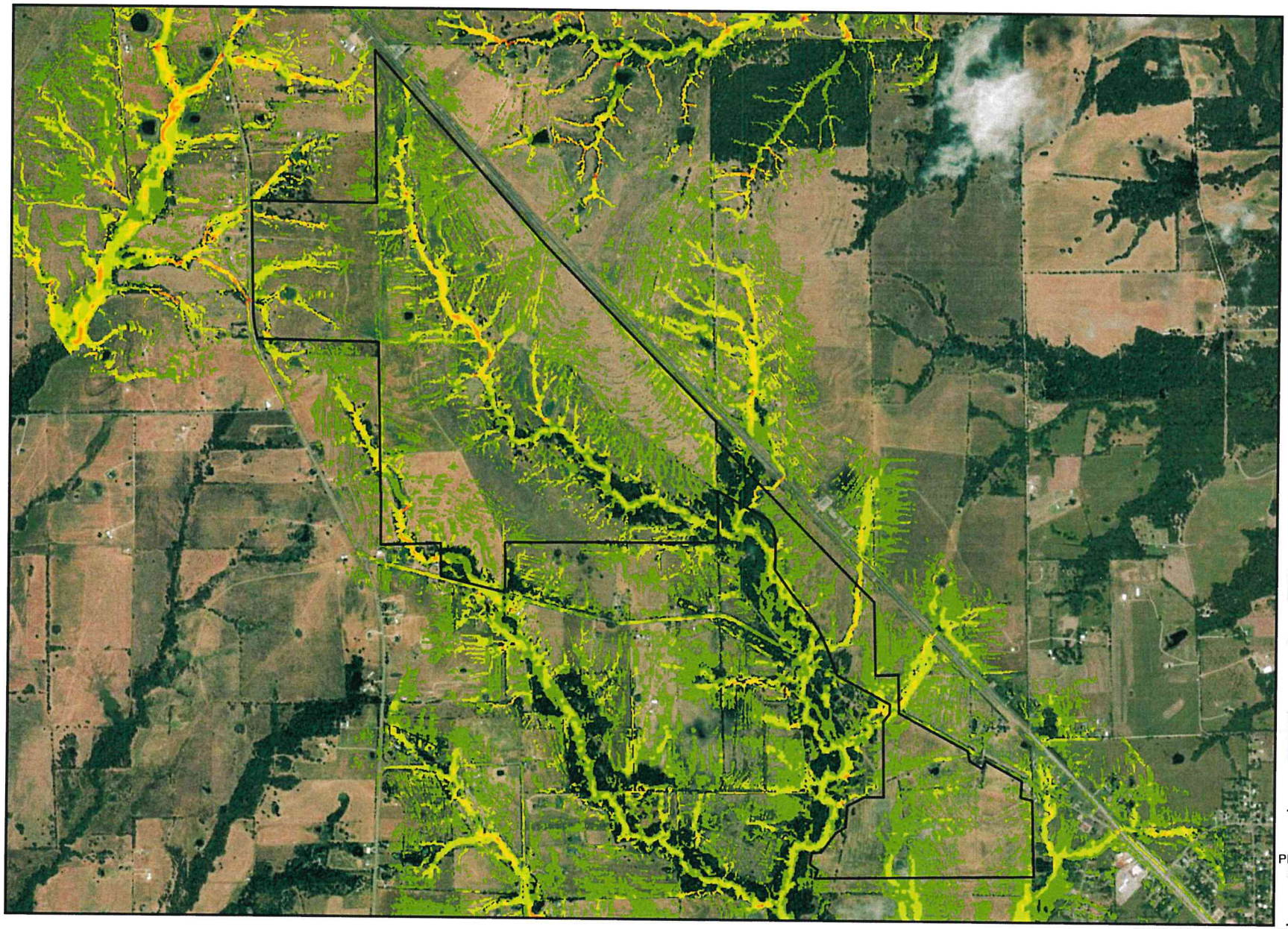

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Project Boundary

Runoff Velocities (ft/s)

- 0 - 0.5
- .5 - 1
- 1 - 2
- 2 - 3
- 3 - 5
- > 5

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Figure B-25

PROPOSED CONDITIONS 2-YR, 24-HR RUNOFF VELOCITIES

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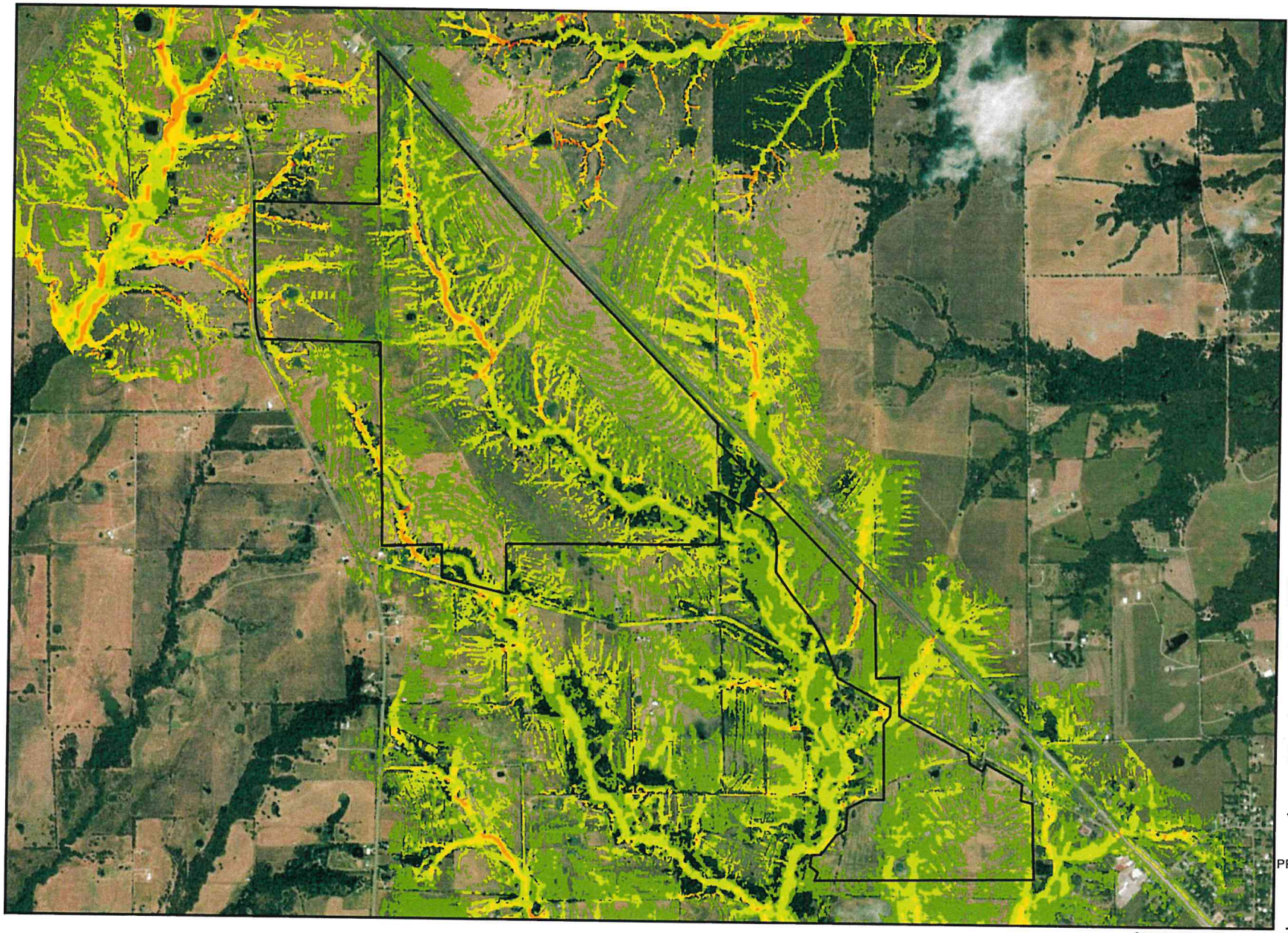

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Project Boundary

Runoff Velocities (ft/s)

- 0 - 0.5
- .5 - 1
- 1 - 2
- 2 - 3
- 3 - 5
- > 5

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Figure B-26

PROPOSED CONDITIONS 10-YR, 24-HR RUNOFF VELOCITIES

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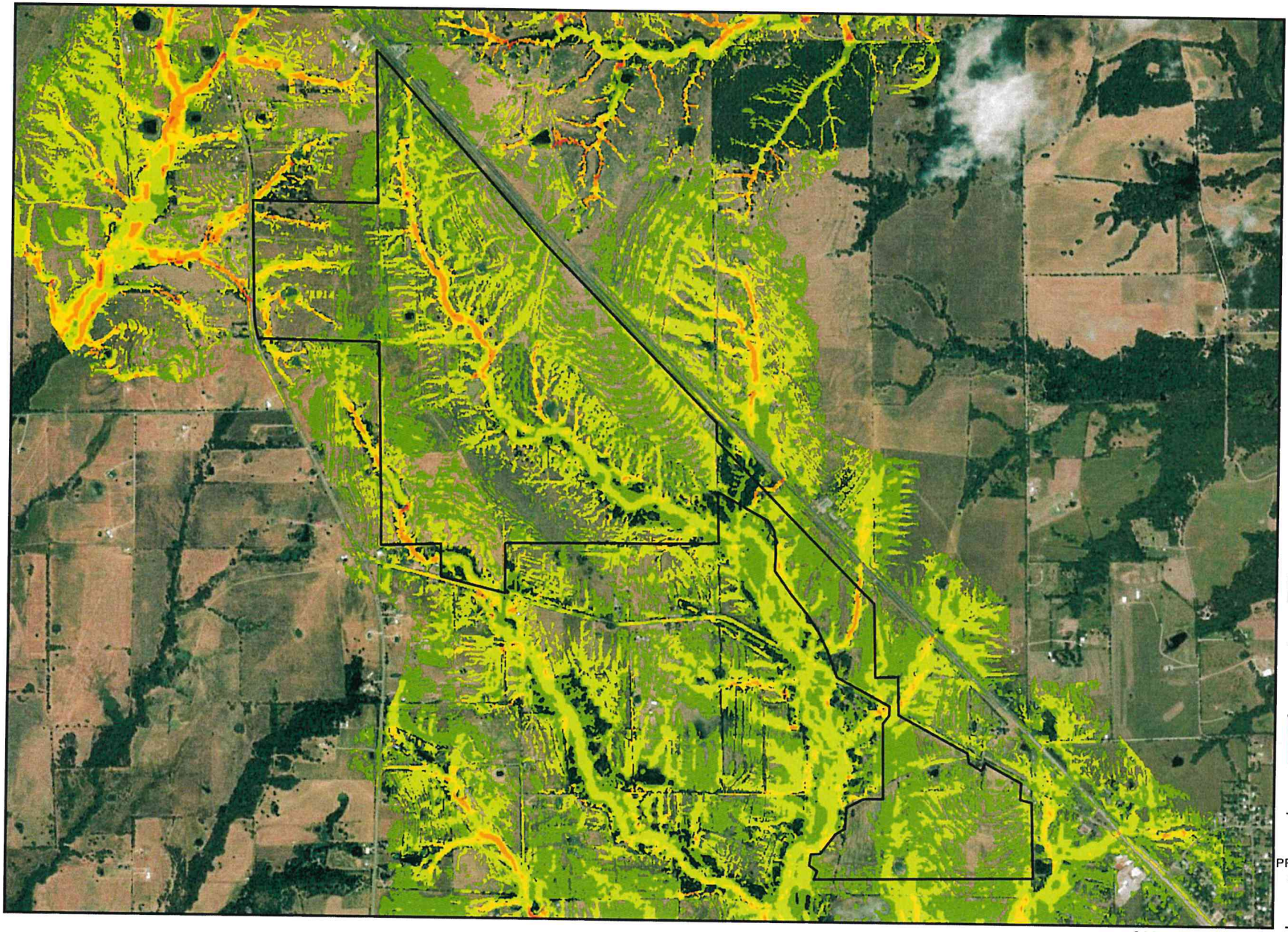

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Project Boundary

Runoff Velocities (ft/s)

- 0 - 0.5
- .5 - 1
- 1 - 2
- 2 - 3
- 3 - 5
- > 5

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Figure B-27

PROPOSED CONDITIONS 25-YR, 24-HR RUNOFF VELOCITIES

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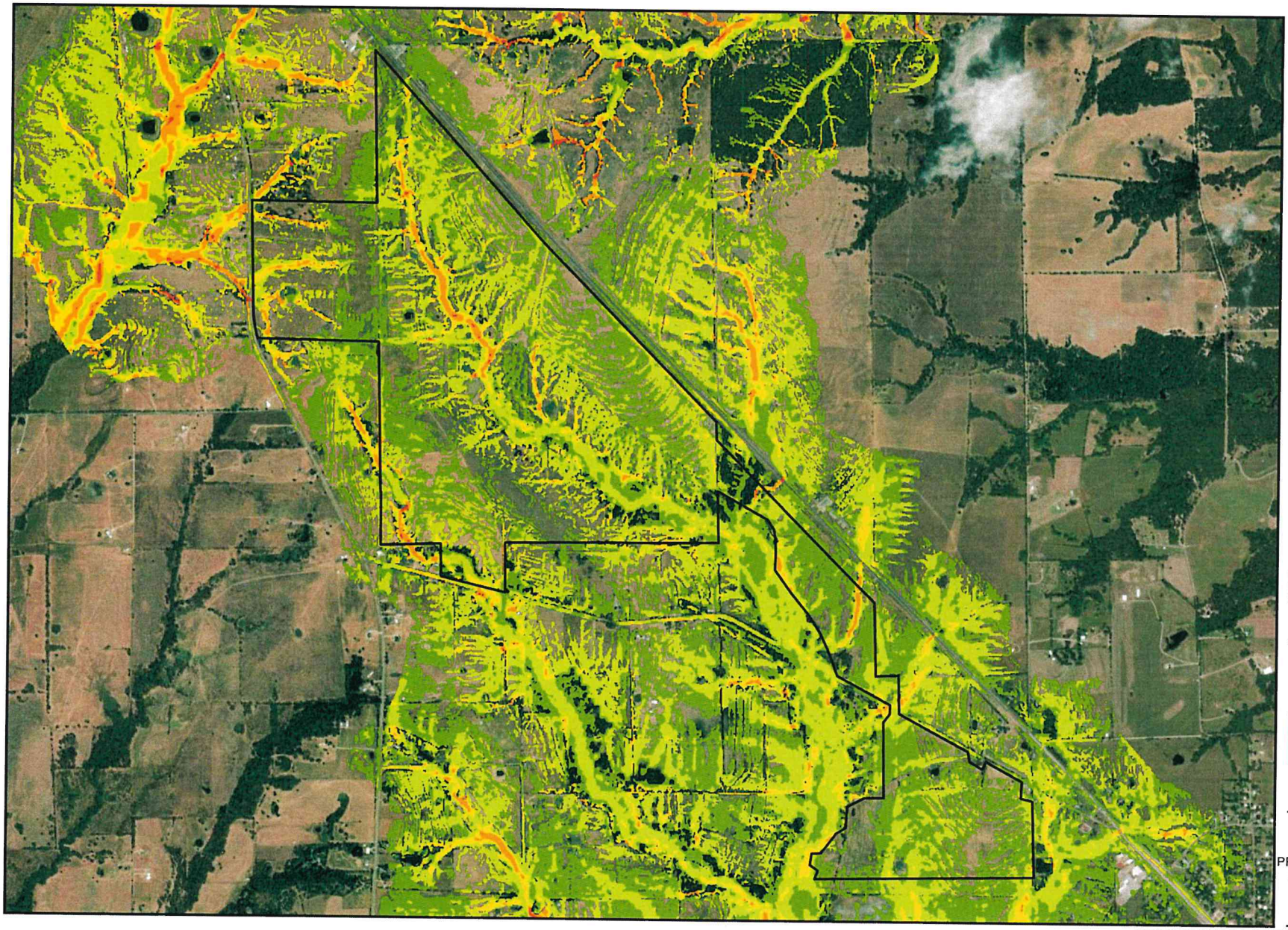

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Project Boundary

Runoff Velocities (ft/s)

- 0 - 0.5
- .5 - 1
- 1 - 2
- 2 - 3
- 3 - 5
- > 5

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Figure B-28

PROPOSED CONDITIONS 50-YR, 24-HR RUNOFF VELOCITIES

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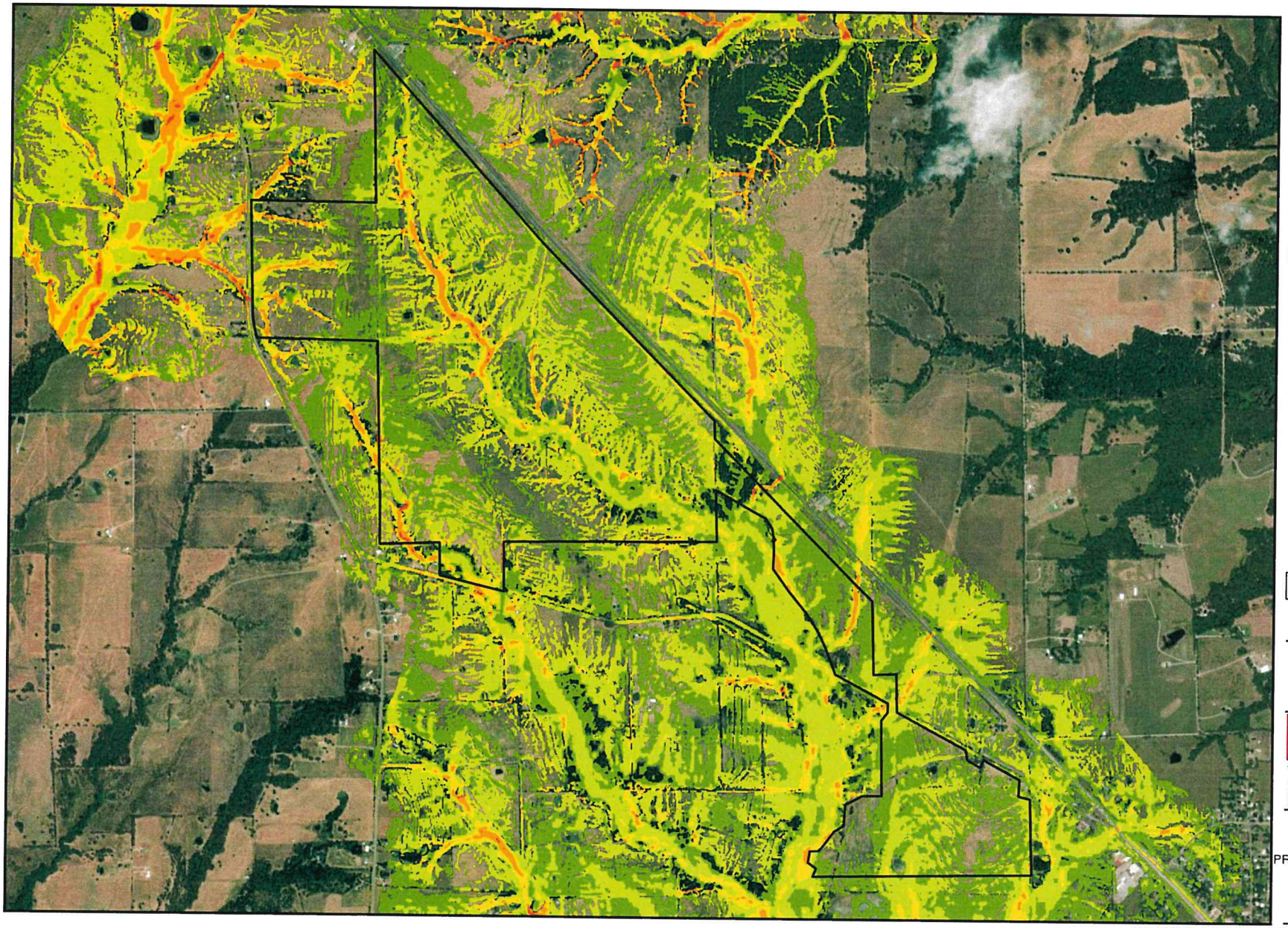

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Legend

- Project Boundary

Runoff Velocities (ft/s)

- 0 - 0.5
- .5 - 1
- 1 - 2
- 2 - 3
- 3 - 5
- > 5

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Figure B-29

PROPOSED CONDITIONS 100-YR, 24-HR RUNOFF VELOCITIES

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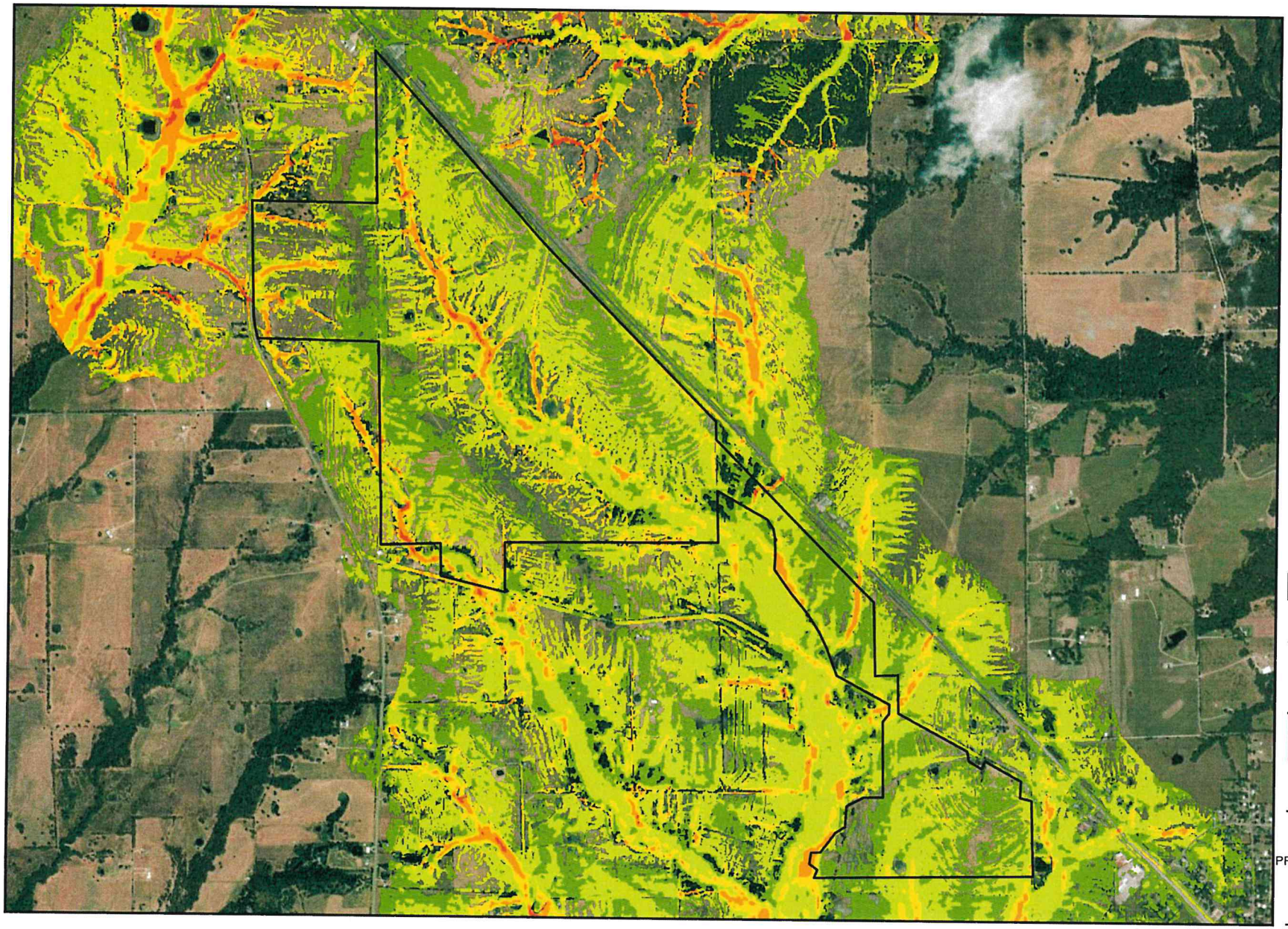

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Project Boundary

Runoff Velocities (ft/s)

- 0 - 0.5
- .5 - 1
- 1 - 2
- 2 - 3
- 3 - 5
- > 5

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Figure B-30

PROPOSED CONDITIONS 500-YR, 24-HR RUNOFF VELOCITIES

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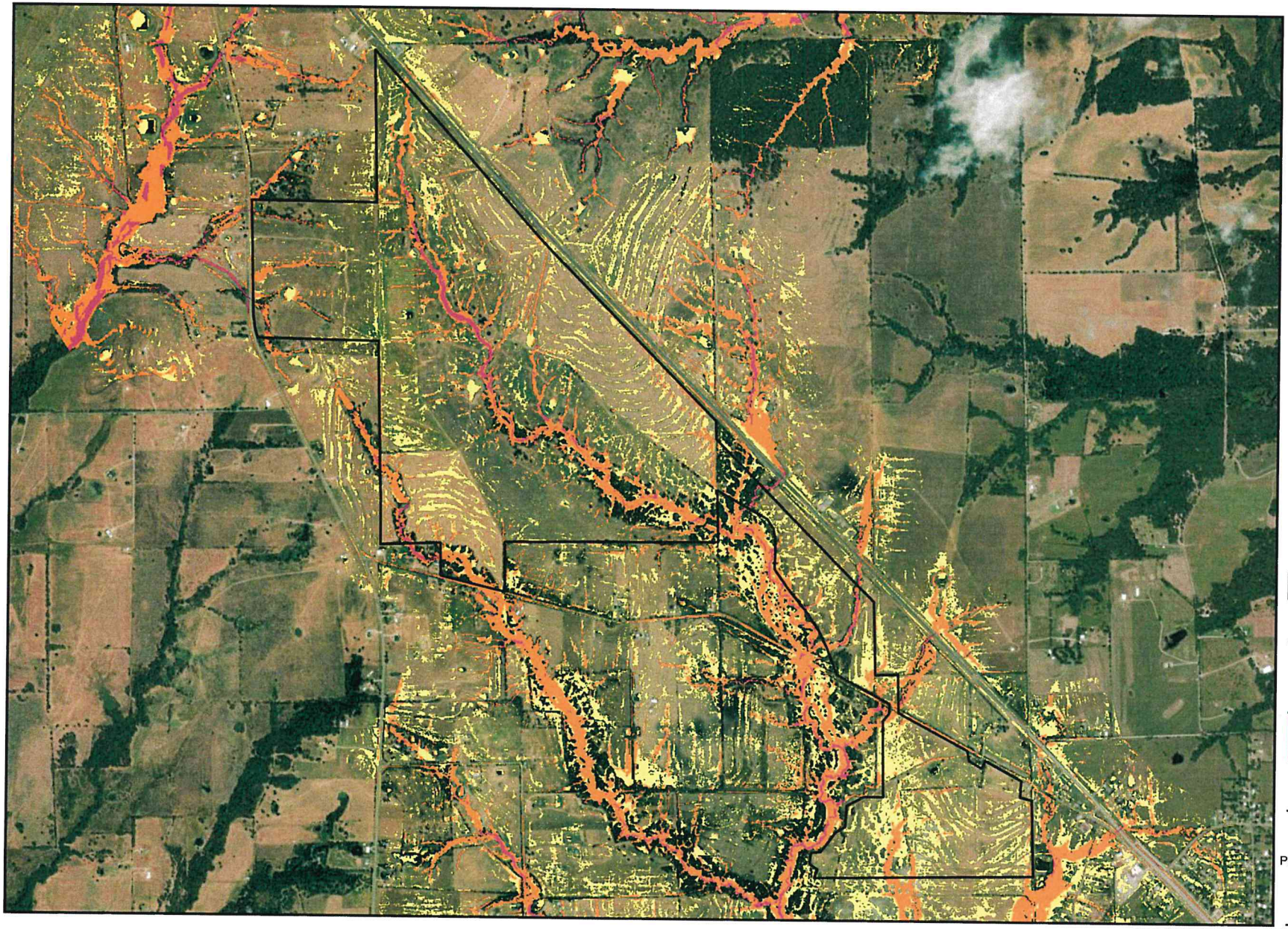

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Project Boundary

Scour Depths (ft)

- 0 - 0.25
- 0.25 - 0.5
- .5 - 1
- 1 - 1.5
- 1.5 - 2

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Figure B-31

PROPOSED CONDITIONS 2-YR, 24-HR SCOUR DEPTHS

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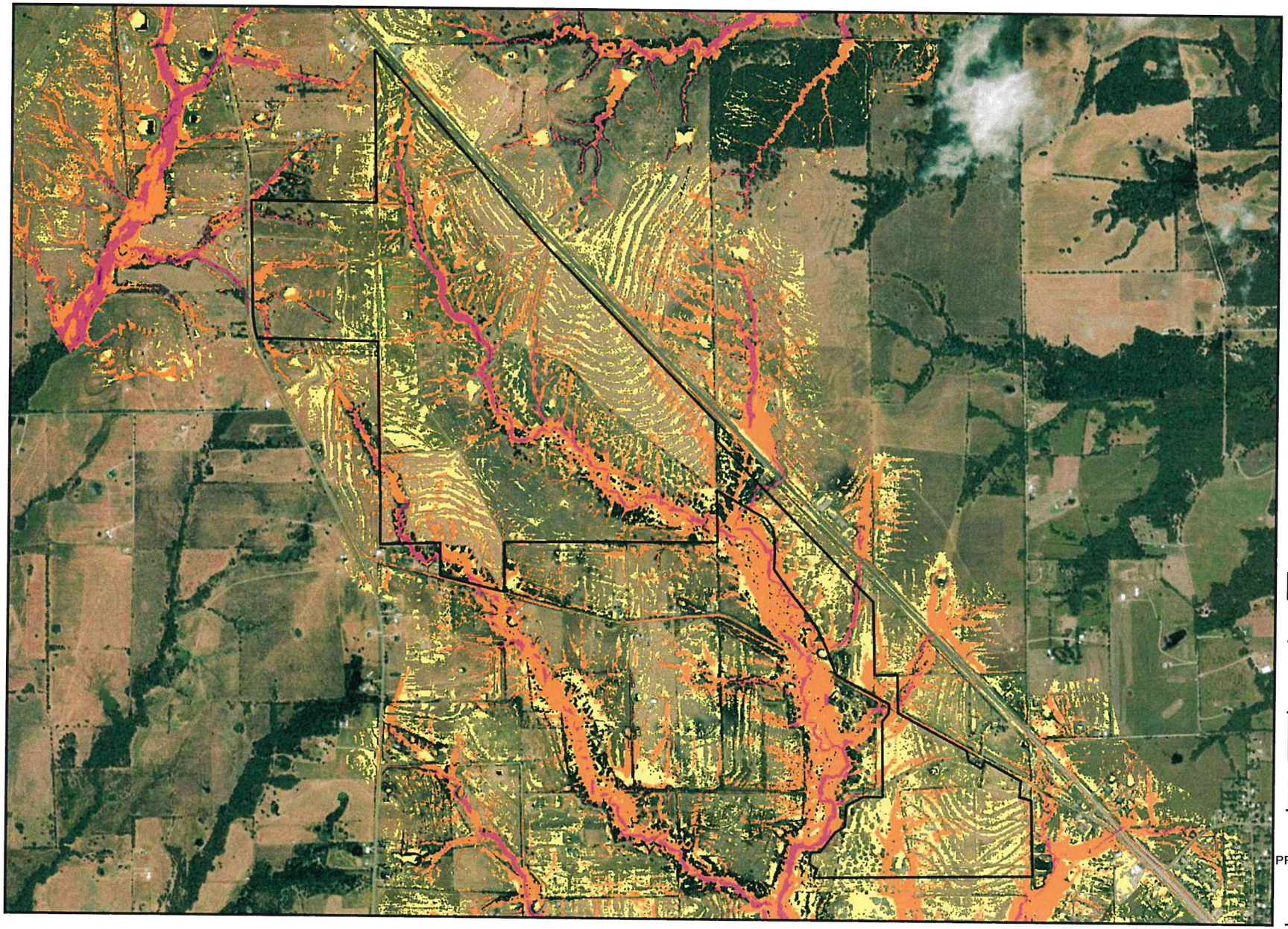

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Legend

- Project Boundary
- **Scour Depths (ft)**
  - 0 - 0.25
  - 0.25 - 0.5
  - .5 - 1
  - 1 - 1.5
  - 1.5 - 2

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Figure B-32

PROPOSED CONDITIONS 10-YR, 24-HR SCOUR DEPTHS

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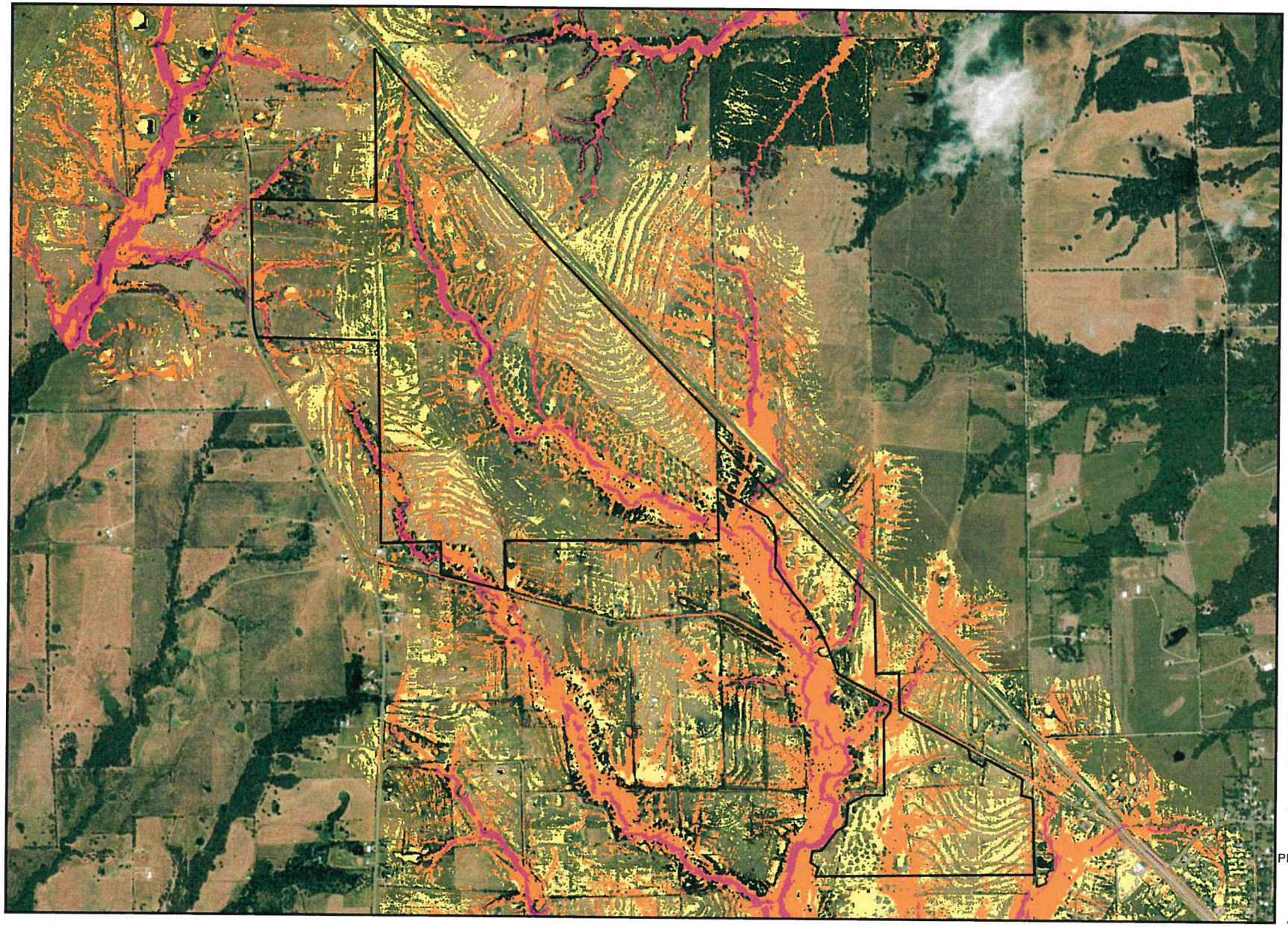

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Legend

- Project Boundary
- **Scour Depths (ft)**
  - 0 - 0.25
  - 0.25 - 0.5
  - .5 - 1
  - 1 - 1.5
  - 1.5 - 2

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Figure B-33

PROPOSED CONDITIONS 25-YR, 24-HR SCOUR DEPTHS

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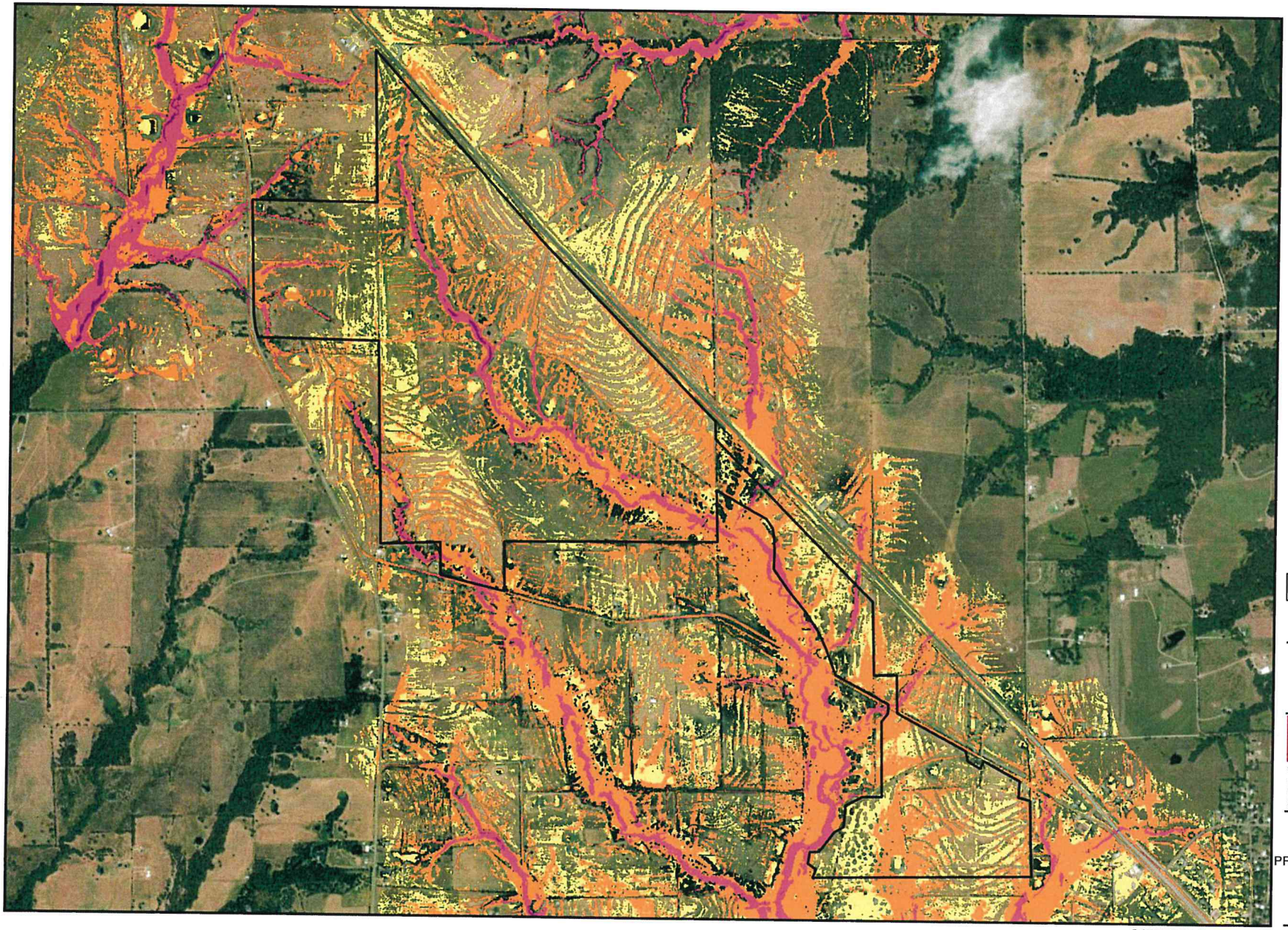

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Project Boundary

Scour Depths (ft)

- 0 - 0.25
- 0.25 - 0.5
- .5 - 1
- 1 - 1.5
- 1.5 - 2

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Figure B-34

PROPOSED CONDITIONS 50-YR, 24-HR SCOUR DEPTHS

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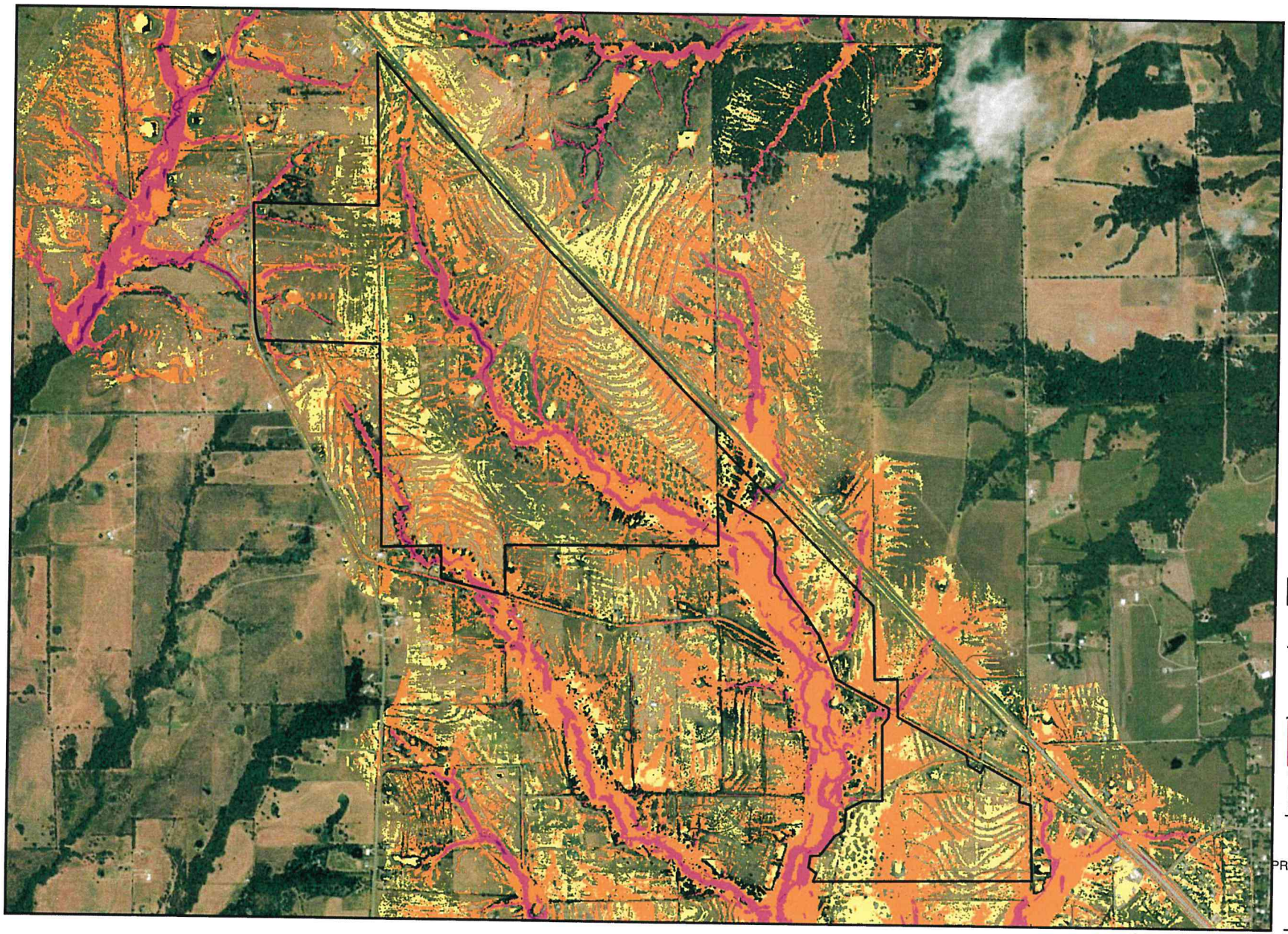

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Project Boundary

Scour Depths (ft)

- 0 - 0.25
- 0.25 - 0.5
- .5 - 1
- 1 - 1.5
- 1.5 - 2

N

0 1,000 2,000 US Feet

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Figure B-35

PROPOSED CONDITIONS 100-YR, 24-HR SCOUR DEPTHS

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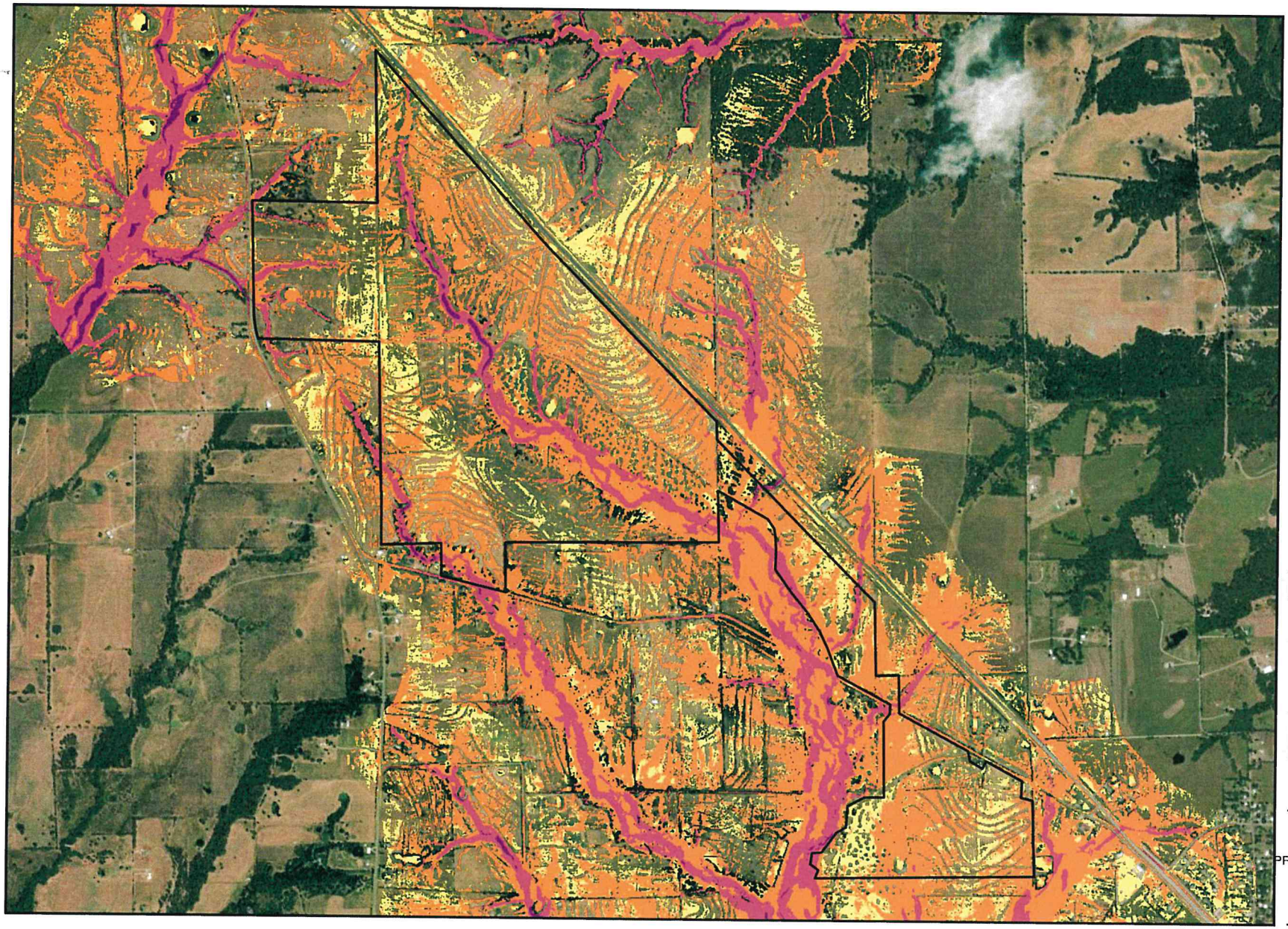

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Project Boundary

Scour Depths (ft)

- 0 - 0.25
- 0.25 - 0.5
- .5 - 1
- 1 - 1.5
- 1.5 - 2

N

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Figure B-36

PROPOSED CONDITIONS 500-YR 24-HR SCOUR DEPTHS

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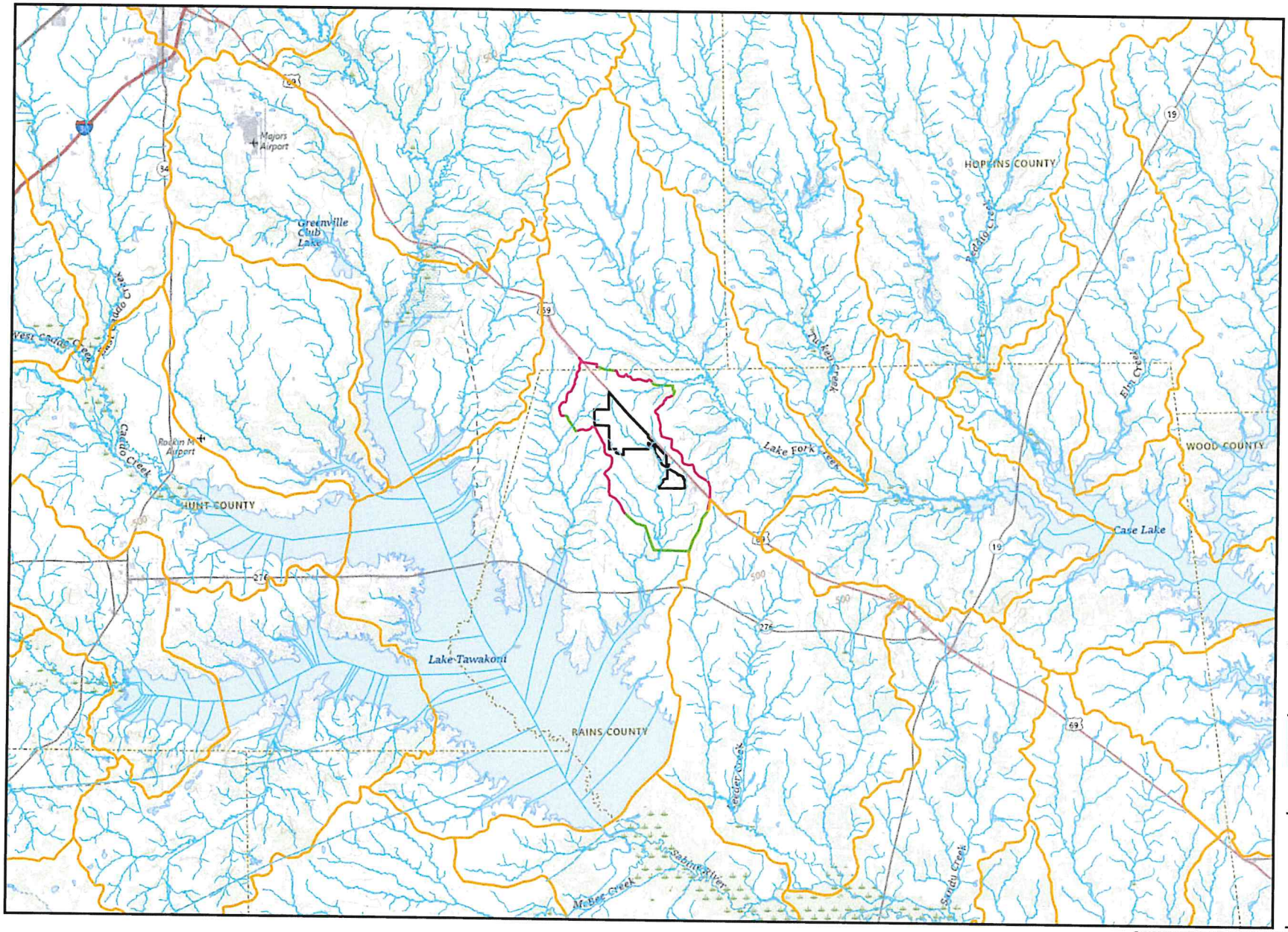
Appendix C. Hydraulic and Hydrologic Parameters

Figure C- 1. Drainage Area Map
Figure C- 2. Existing Conditions Land Cover Map
Figure C- 3. Proposed Conditions Land Cover Map
Figure C- 4. Existing Conditions Hydrologic Soil Group Map
Figure C- 5. Existing Conditions Curve Number Map
Figure C- 6. Proposed Conditions Curve Number Map
Figure C- 7. Existing Conditions Manning' "n" Value Map
Figure C- 8. Proposed Conditions Manning' "n" Value Map
Figure C- 9. Existing Topogrgaphy Data
Figure C- 10. Proposed Topography Data
Figure C- 11. Existing Hydraulic Structures Map
NOAA Atlas 14 Precipitation Frequency Data Server Printout
Barrett Solar 60% Erosion and Sediment Control Plan



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Legend

- Project Boundary
- Outflow Boundary Condition
- HUC-12 Boundaries
- 2D Model Domain
- NHD Flowline

N

0 5,000 10,000 US Feet

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Figure C-1

DRAINAGE AREA MAP

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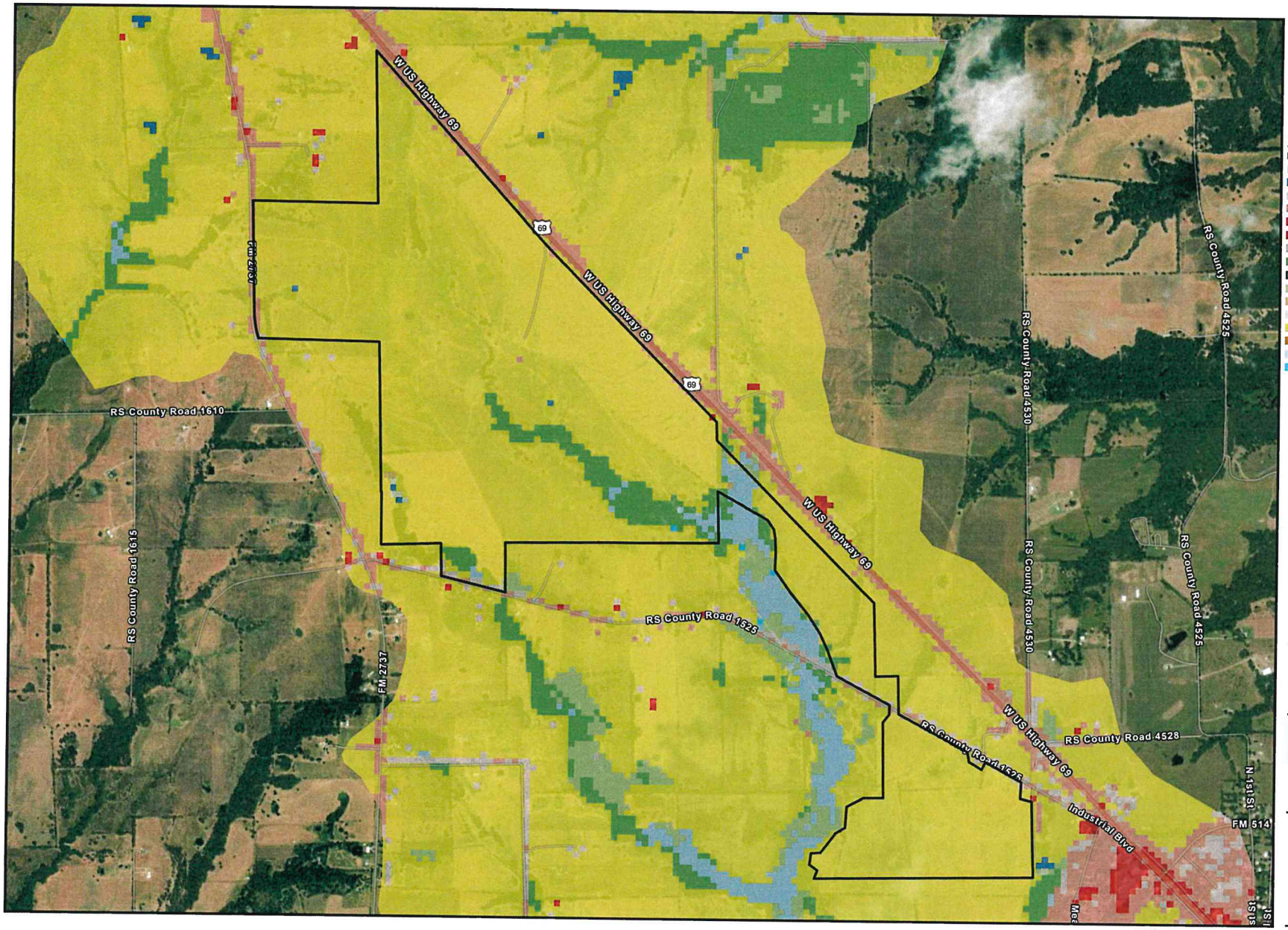

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Legend

- Project Boundary

Land Cover

- Open Water
- Developed Open Space
- Developed Low Intensity
- Developed Med. Intensity
- Developed High Intensity
- Barren Land
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands
- Emergent Herb. Wetlands

N

0 1,000 2,000 Feet

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Figure C-2

EXISTING LAND USE MAP

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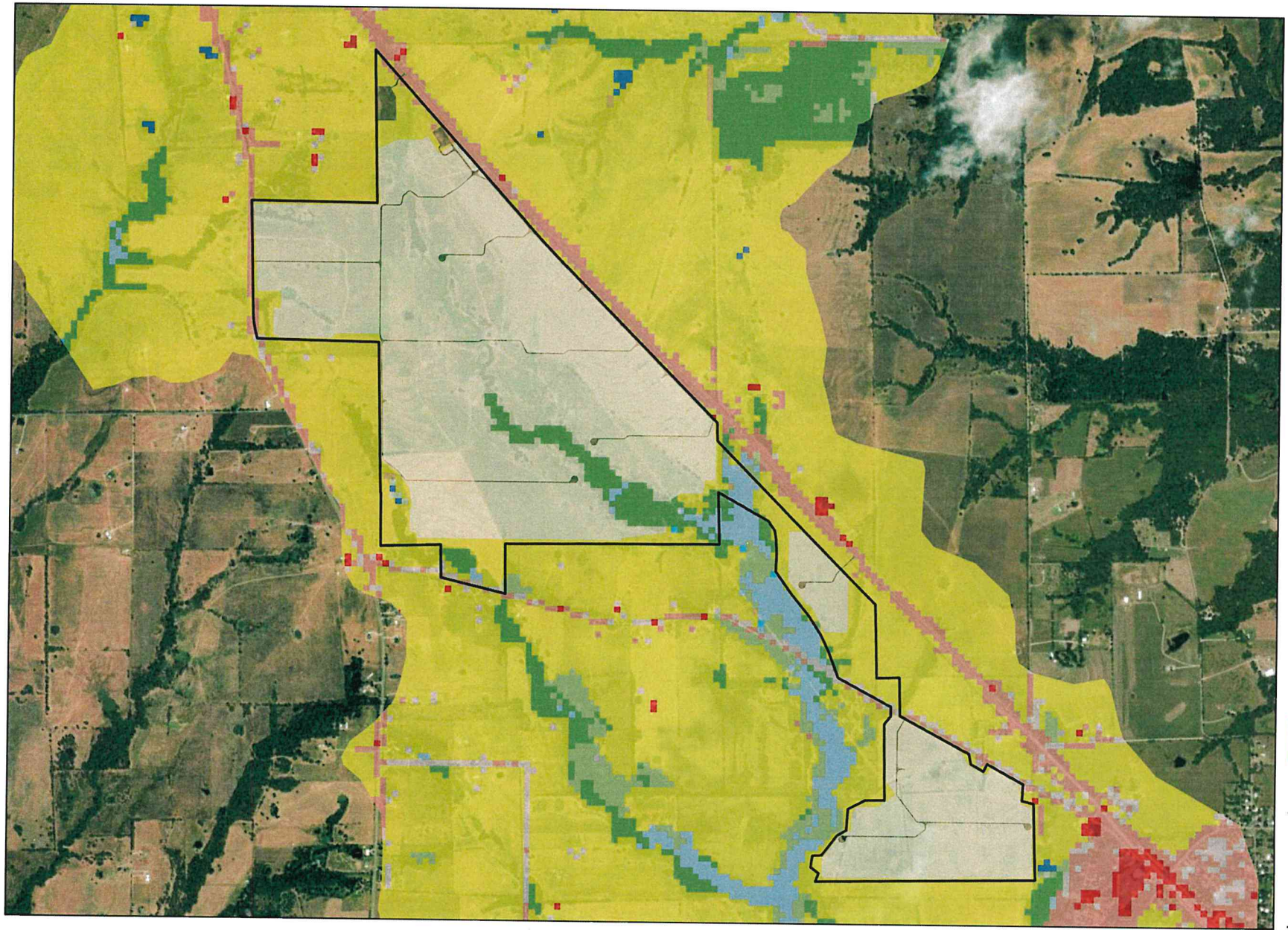

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Legend

- Project Boundary

Proposed Land Cover

- Open Water
- Developed, Open Space
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, High Intensity
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Woody Wetlands
- Emergent Herbaceous Wetlands

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0 1,000 2,000 US Feet

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Figure C-3

PROPOSED LAND USE MAP

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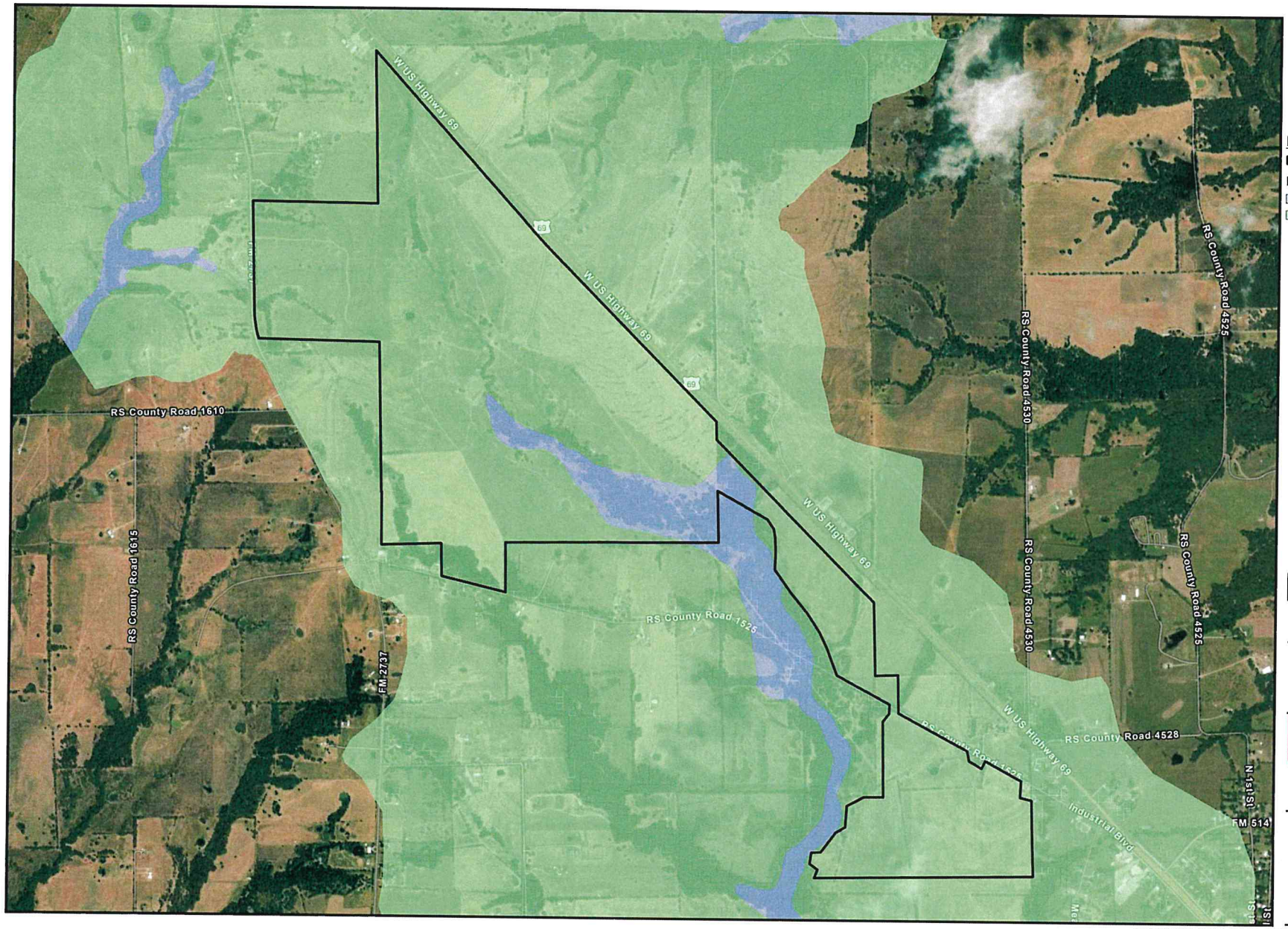

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Legend

- Project Boundary

Hydrologic Soils Group

- B/D
- D

N

0 1,000 2,000 US Feet

NAD 1983 State Plane Texas North Central FIPS 4204 (US Feet)

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Drawn By:	J. Wade
Approved By:	A. Wiles
Project Number:	24.01273

Figure C-4

HYDROLOGIC SOILS GROUPS MAP

REVISION: 0A

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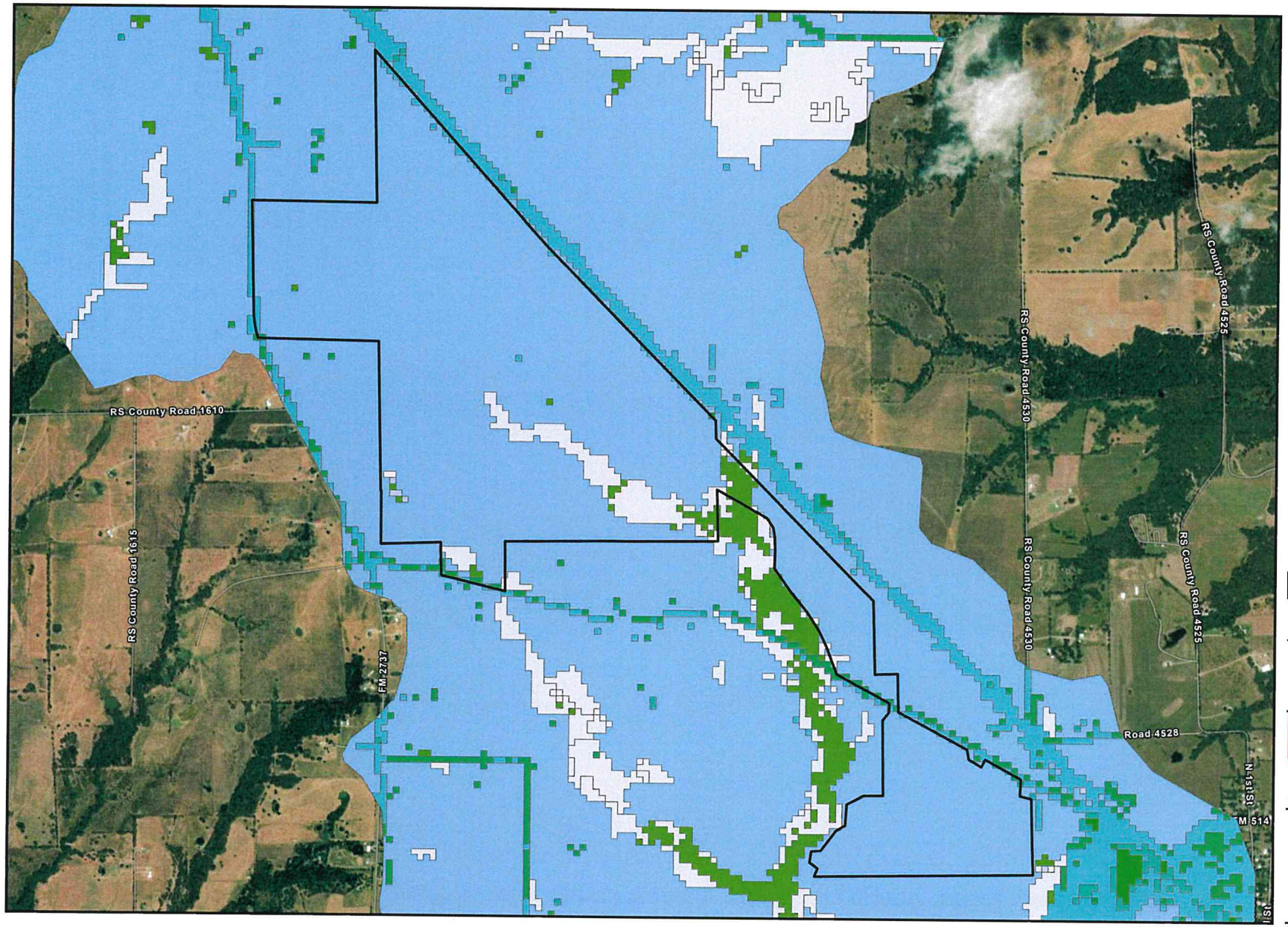

Barrett Solar Project

Rains County, Texas

Rev.	Date	Description	By
	09/13/2024	60% Hydrology Study	UEI

Legend

Project Boundary

Existing Curve Numbers

- 73
- 77
- 78
- 80
- 87
- 92
- 93
- 95
- 98

N

0 1,000 2,000 US Feet

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Figure C-5

EXISTING CURVE NUMBERS MAP

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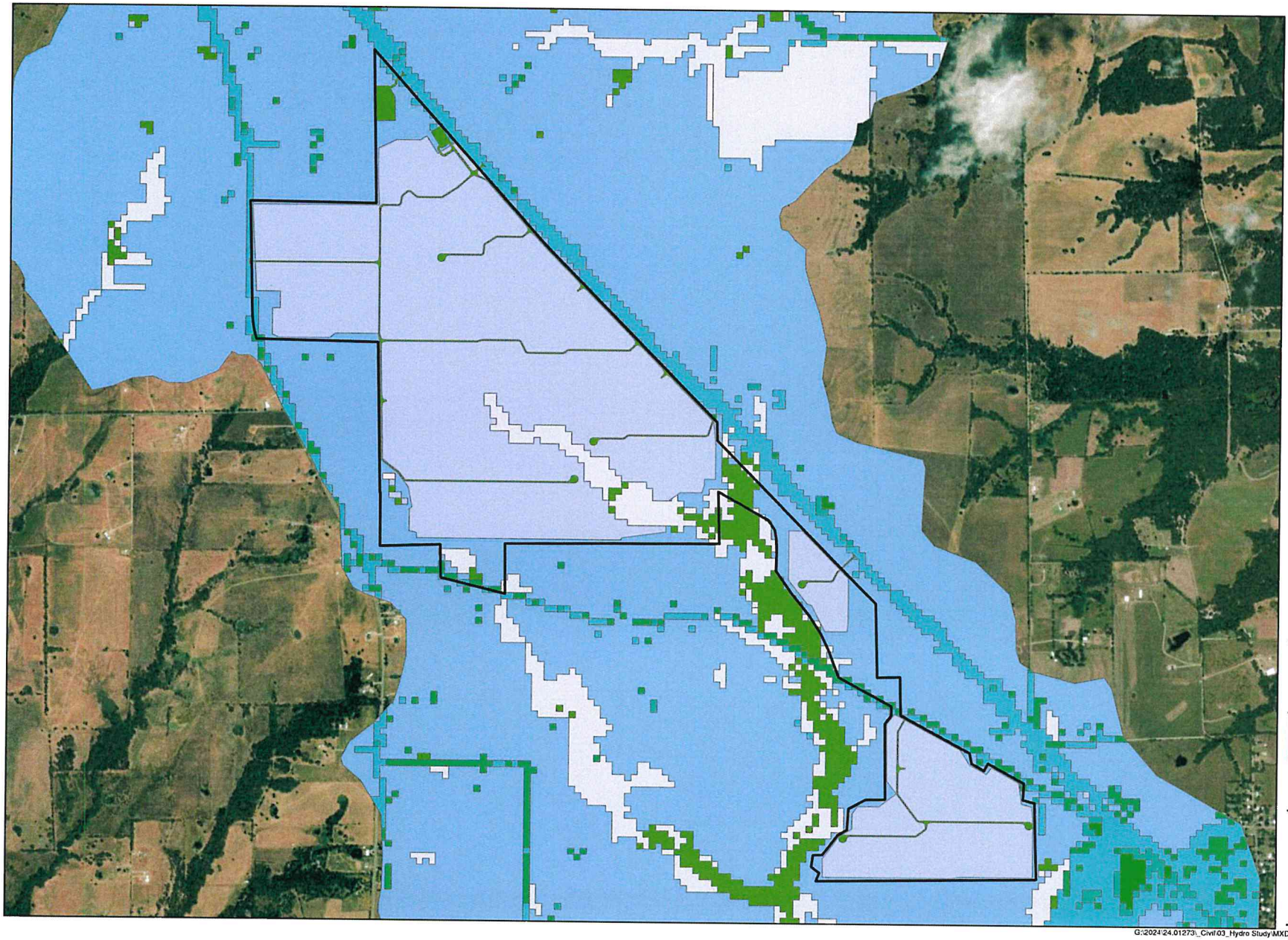

Barrett Solar Project

Rains County, Texas

Rev.	Date	Description	By
	09/13/2024	60% Hydrology Study	UEI

Legend

Project Boundary

Proposed Curve Numbers

- 73
- 77
- 78
- 80
- 87
- 92
- 93
- 95
- 98

N

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Figure C-6

PROPOSED CURVE NUMBERS MAP

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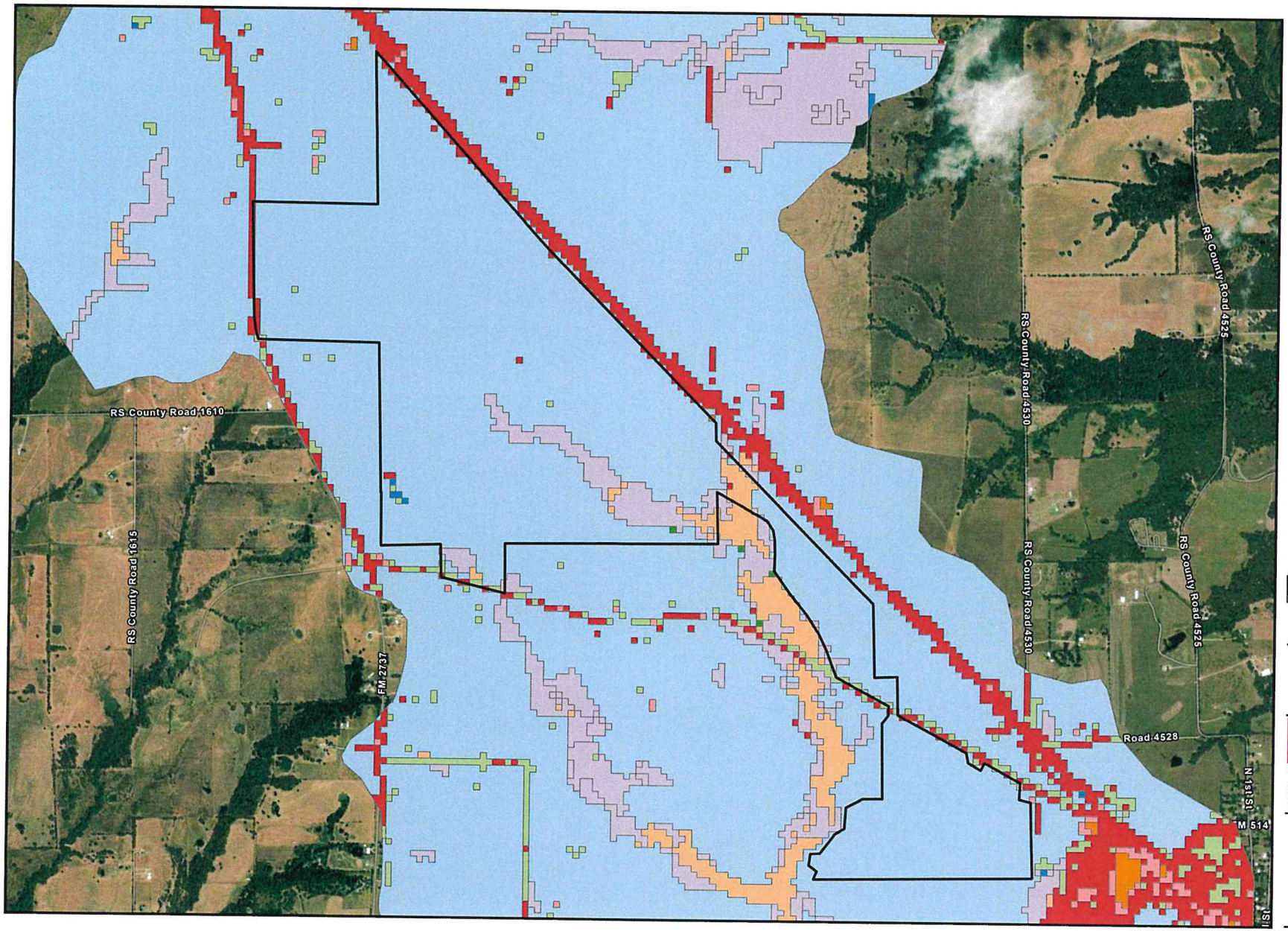

Barrett Solar Project

Rains County, Texas

Rev.	Date	Description	By
	09/13/2024	60% Hydrology Study	UEI

Legend

Project Boundary

Existing Manning's n Values

- 0.03
- 0.035
- 0.04
- 0.07
- 0.08
- 0.1
- 0.12
- 0.15
- 0.16

N

0 1,000 2,000 US Feet

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Figure C-7

EXISTING MANNING'S n VALUE MAP

REVISION: 0A

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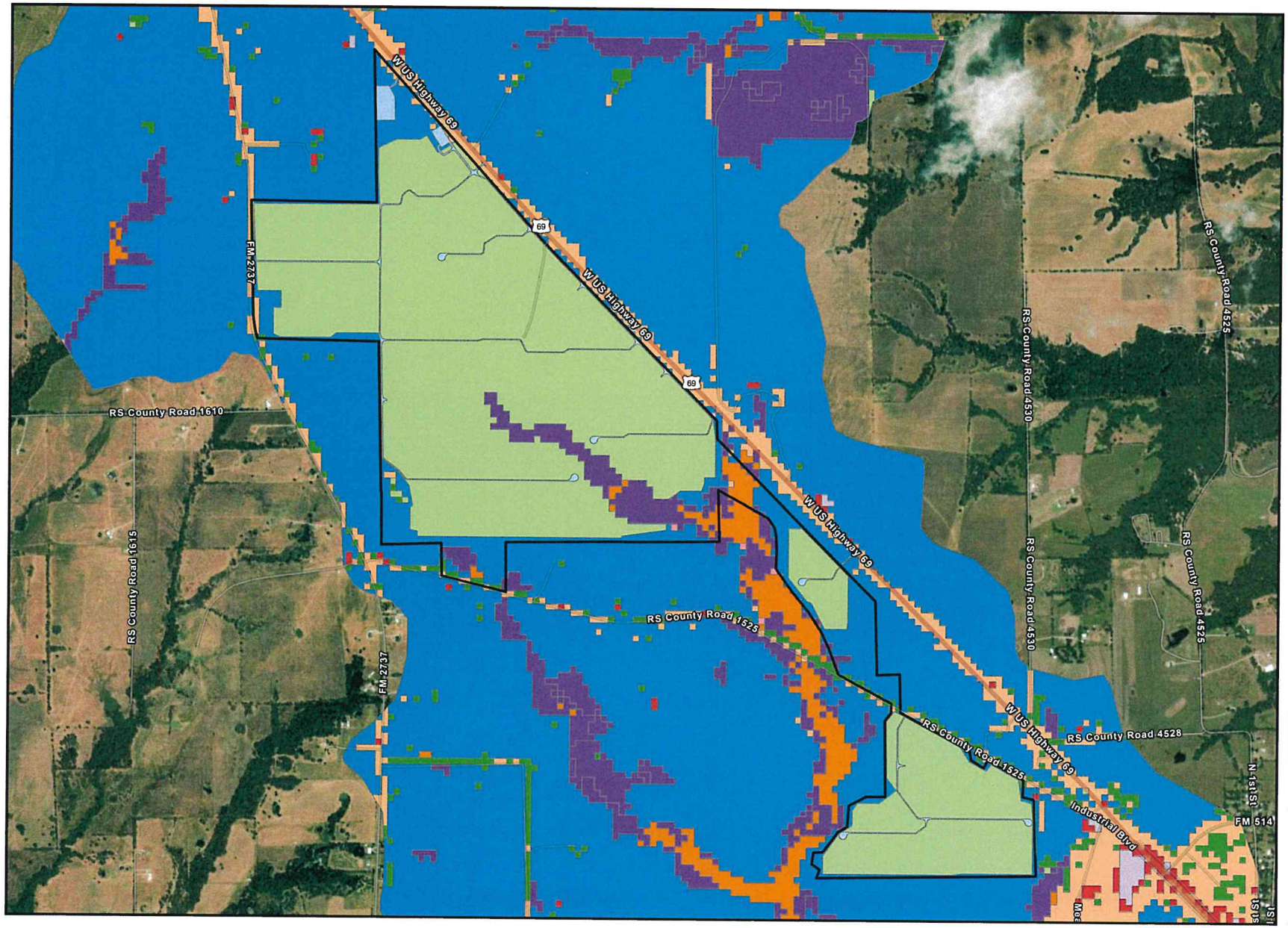

Barrett Solar Project

Rains County, Texas

Rev.	Date	Description	By
	09/13/2024	60% Hydrology Study	UEI

Legend

- Project Boundary

Proposed Manning's n Values

- 0.023
- 0.03
- 0.035
- 0.04
- 0.07
- 0.08
- 0.1
- 0.12
- 0.15
- 0.16

N

0 1,000 2,000 US Feet

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Figure C-8

PROPOSED MANNING'S n VALUE MAP

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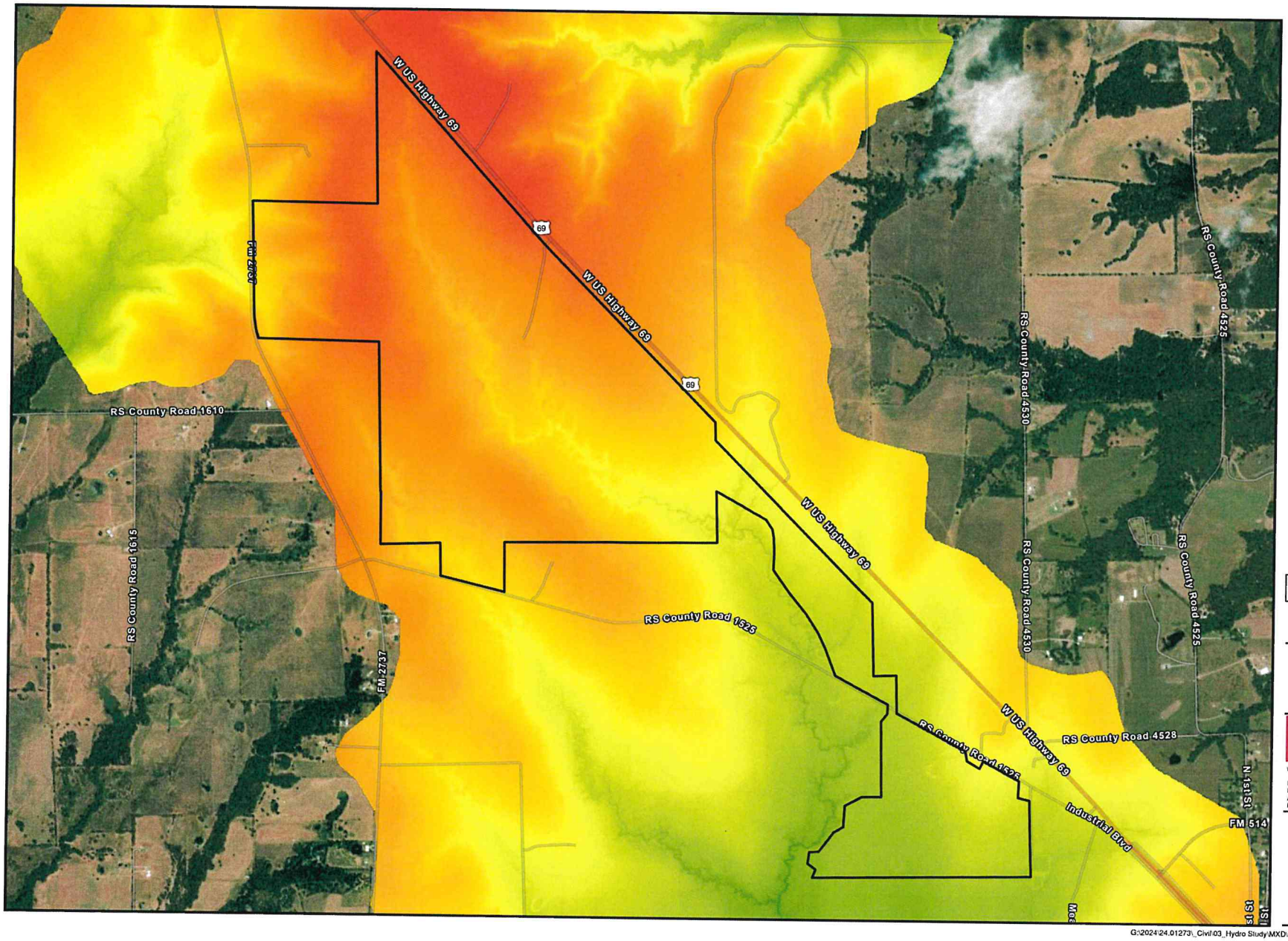

Barrett Solar Project

Rains County, Texas

Rev.	Date	Description	By
	09/13/2024	60% Hydrology Study	UEI

Legend

Project Boundary

Existing Topo (ft)

562.086

443.621

N

0 1,000 2,000 US Feet

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Figure C-9

EXISTING TOPOGRAPHY MAP

REVISION: 0A

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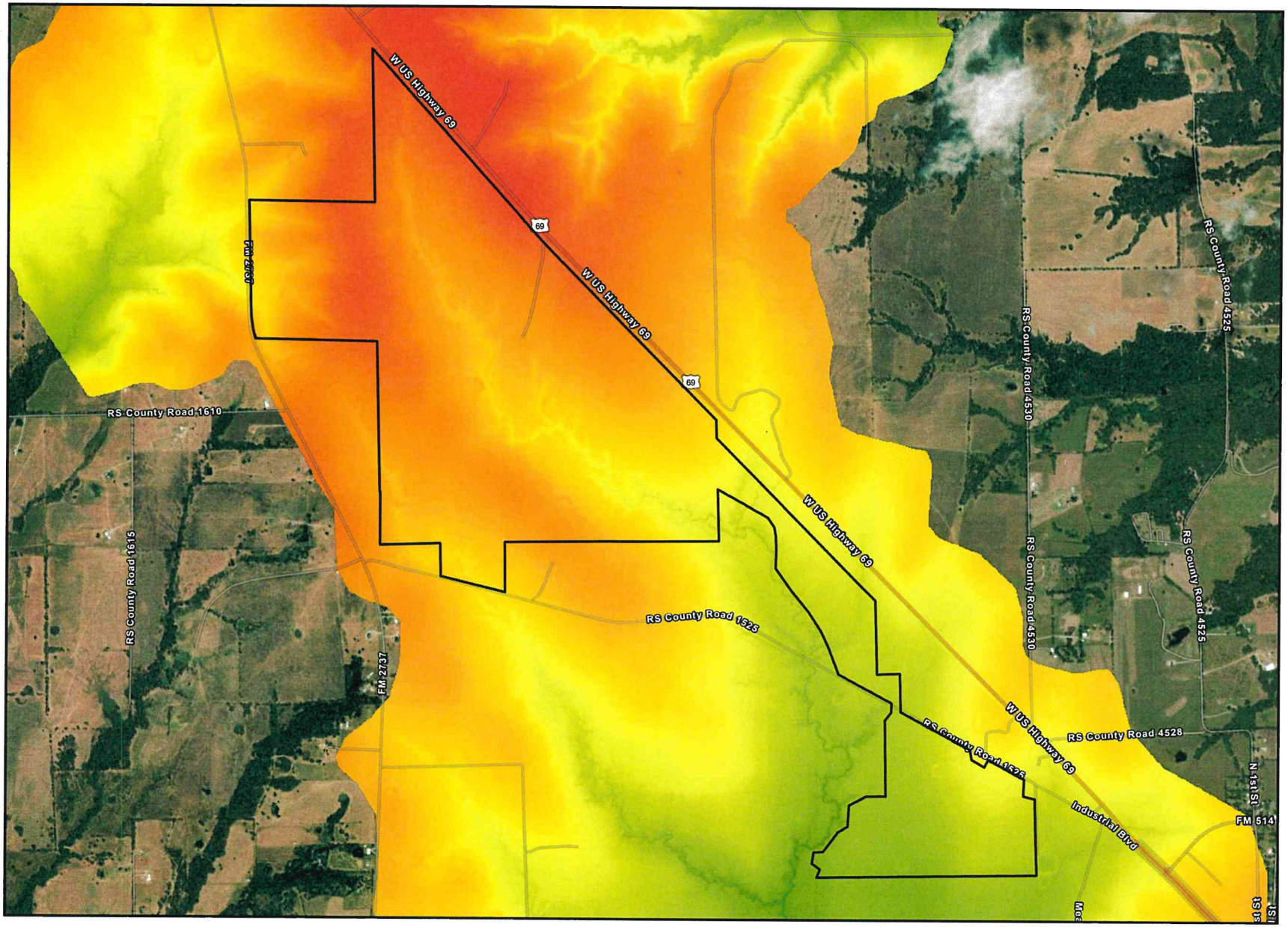

Barrett Solar Project

Rains County, Texas

Rev.	Date	Description	By
	09/13/2024	60% Hydrology Study	UET

Legend

Project Boundary

Proposed Topo (ft)

562.179

443.514

N

0 1,000 2,000 US Feet

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Figure C-10

PROPOSED TOPOGRAPHY MAP

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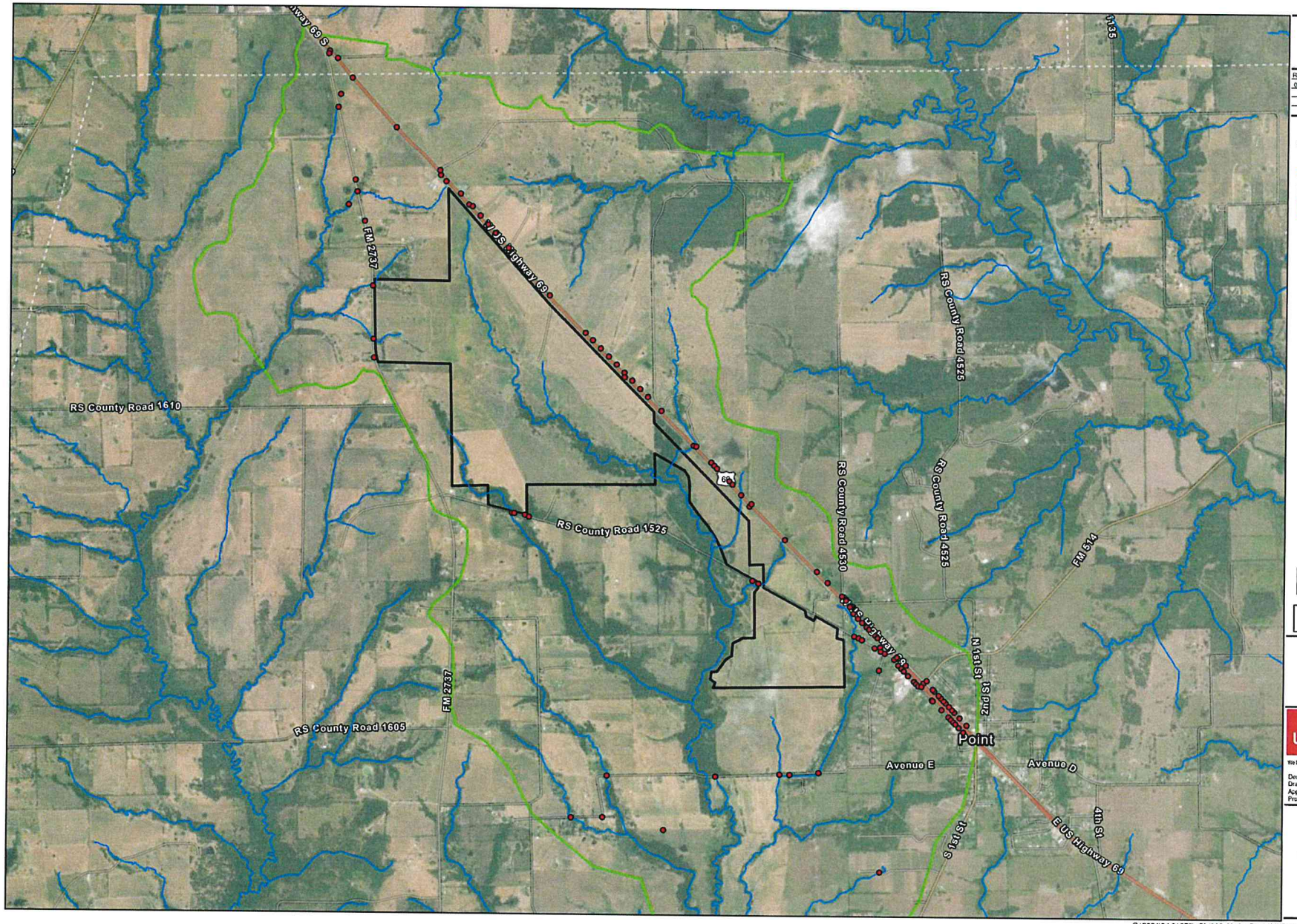

Barrett Solar Project

Rains County, Texas

Rev.	Date	Description	By
	09/13/2024	60% Hydrology Study	UEI

Legend

- Existing Hydraulic Structures
- NHDFlowline
- Project Area
- 2D Model Domain

N

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Project Number:	24.01273

Figure C-11

EXISTING HYDRAULIC STRUCTURES MAP

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NOAA Atlas 14, Volume 11, Version 2
Location name: Point, Texas, USA*
Latitude: 32.9567°, Longitude: -95.9021°
Elevation: 532 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.443 (0.336-0.585)	0.506 (0.388-0.665)	0.612 (0.467-0.805)	0.698 (0.524-0.928)	0.815 (0.592-1.11)	0.902 (0.638-1.26)	0.989 (0.682-1.41)	1.08 (0.725-1.57)	1.20 (0.778-1.80)	1.29 (0.815-1.98)
10-min	0.708 (0.536-0.934)	0.810 (0.620-1.06)	0.980 (0.747-1.29)	1.12 (0.840-1.49)	1.31 (0.950-1.78)	1.45 (1.03-2.02)	1.59 (1.10-2.26)	1.72 (1.16-2.52)	1.90 (1.24-2.86)	2.03 (1.29-3.12)
15-min	0.885 (0.671-1.17)	1.01 (0.774-1.33)	1.22 (0.930-1.60)	1.39 (1.04-1.85)	1.62 (1.18-2.20)	1.79 (1.27-2.50)	1.96 (1.35-2.80)	2.14 (1.44-3.12)	2.37 (1.54-3.56)	2.55 (1.61-3.92)
30-min	1.24 (0.938-1.63)	1.41 (1.08-1.85)	1.70 (1.30-2.23)	1.93 (1.45-2.57)	2.24 (1.63-3.05)	2.48 (1.75-3.45)	2.71 (1.87-3.87)	2.96 (1.99-4.32)	3.30 (2.14-4.96)	3.56 (2.25-5.46)
60-min	1.62 (1.23-2.14)	1.85 (1.42-2.43)	2.24 (1.71-2.94)	2.55 (1.92-3.39)	2.98 (2.16-4.05)	3.29 (2.33-4.58)	3.61 (2.49-5.16)	3.96 (2.66-5.78)	4.44 (2.88-6.68)	4.82 (3.05-7.40)
2-hr	1.99 (1.52-2.60)	2.32 (1.79-3.00)	2.84 (2.18-3.70)	3.28 (2.48-4.31)	3.88 (2.84-5.22)	4.34 (3.10-5.98)	4.82 (3.35-6.79)	5.33 (3.61-7.68)	6.03 (3.95-8.95)	6.60 (4.20-9.99)
3-hr	2.22 (1.70-2.88)	2.60 (2.02-3.34)	3.22 (2.49-4.16)	3.75 (2.86-4.90)	4.48 (3.30-5.99)	5.05 (3.62-6.91)	5.64 (3.94-7.89)	6.27 (4.26-8.97)	7.15 (4.69-10.5)	7.84 (5.01-11.8)
6-hr	2.63 (2.04-3.38)	3.12 (2.43-3.96)	3.90 (3.04-4.99)	4.57 (3.52-5.92)	5.52 (4.11-7.31)	6.26 (4.53-8.48)	7.05 (4.96-9.74)	7.89 (5.40-11.1)	9.06 (5.98-13.1)	9.99 (6.42-14.8)
12-hr	3.09 (2.42-3.93)	3.68 (2.89-4.61)	4.61 (3.63-5.83)	5.41 (4.20-6.93)	6.55 (4.92-8.58)	7.46 (5.44-9.97)	8.41 (5.96-11.5)	9.44 (6.51-13.1)	10.9 (7.24-15.6)	12.0 (7.79-17.6)
24-hr	3.60 (2.85-4.54)	4.29 (3.41-5.32)	5.37 (4.27-6.72)	6.30 (4.94-7.98)	7.62 (5.76-9.86)	8.65 (6.36-11.4)	9.75 (6.97-13.1)	11.0 (7.62-15.1)	12.7 (8.49-17.9)	14.1 (9.16-20.2)
2-day	4.19 (3.35-5.22)	4.95 (3.98-6.10)	6.18 (4.97-7.66)	7.22 (5.71-9.05)	8.67 (6.60-11.1)	9.79 (7.24-12.7)	11.0 (7.91-14.6)	12.3 (8.64-16.7)	14.3 (9.66-19.9)	16.0 (10.5-22.6)
3-day	4.57 (3.68-5.66)	5.39 (4.37-6.62)	6.72 (5.43-8.28)	7.82 (6.23-9.74)	9.37 (7.17-11.9)	10.5 (7.83-13.6)	11.8 (8.54-15.6)	13.2 (9.32-17.8)	15.4 (10.4-21.2)	17.1 (11.3-24.0)
4-day	4.85 (3.92-5.98)	5.72 (4.65-6.98)	7.12 (5.78-8.73)	8.29 (6.62-10.3)	9.92 (7.62-12.5)	11.2 (8.32-14.3)	12.5 (9.07-16.4)	14.0 (9.88-18.7)	16.2 (11.0-22.2)	18.0 (11.9-25.1)
7-day	5.45 (4.43-6.65)	6.42 (5.26-7.77)	7.99 (6.54-9.71)	9.31 (7.50-11.4)	11.2 (8.65-13.9)	12.6 (9.46-16.0)	14.1 (10.3-18.3)	15.7 (11.2-20.8)	18.1 (12.3-24.5)	20.0 (13.2-27.5)
10-day	5.97 (4.88-7.26)	7.03 (5.79-8.46)	8.73 (7.18-10.6)	10.2 (8.22-12.4)	12.1 (9.46-15.1)	13.7 (10.3-17.3)	15.3 (11.2-19.7)	17.0 (12.1-22.3)	19.4 (13.3-26.1)	21.3 (14.2-29.1)
20-day	7.89 (6.52-9.48)	9.09 (7.61-10.9)	11.1 (9.22-13.3)	12.7 (10.4-15.3)	14.9 (11.7-18.3)	16.5 (12.6-20.6)	18.2 (13.4-23.1)	19.9 (14.3-25.8)	22.3 (15.4-29.6)	24.2 (16.2-32.6)
30-day	9.52 (7.91-11.4)	10.8 (9.14-12.9)	13.0 (10.9-15.6)	14.8 (12.2-17.8)	17.2 (13.5-20.9)	18.9 (14.4-23.4)	20.5 (15.3-25.9)	22.3 (16.1-28.6)	24.7 (17.1-32.4)	26.5 (17.8-35.3)
45-day	11.7 (9.82-13.9)	13.3 (11.3-15.8)	15.9 (13.4-18.8)	17.9 (14.8-21.3)	20.6 (16.3-24.9)	22.5 (17.3-27.6)	24.3 (18.1-30.4)	26.1 (18.9-33.3)	28.6 (19.9-37.1)	30.4 (20.5-40.0)
60-day	13.7 (11.5-16.2)	15.4 (13.2-18.3)	18.4 (15.6-21.7)	20.7 (17.2-24.5)	23.7 (18.9-28.5)	25.8 (19.9-31.5)	27.7 (20.8-34.5)	29.7 (21.6-37.5)	32.2 (22.5-41.5)	33.9 (23.0-44.5)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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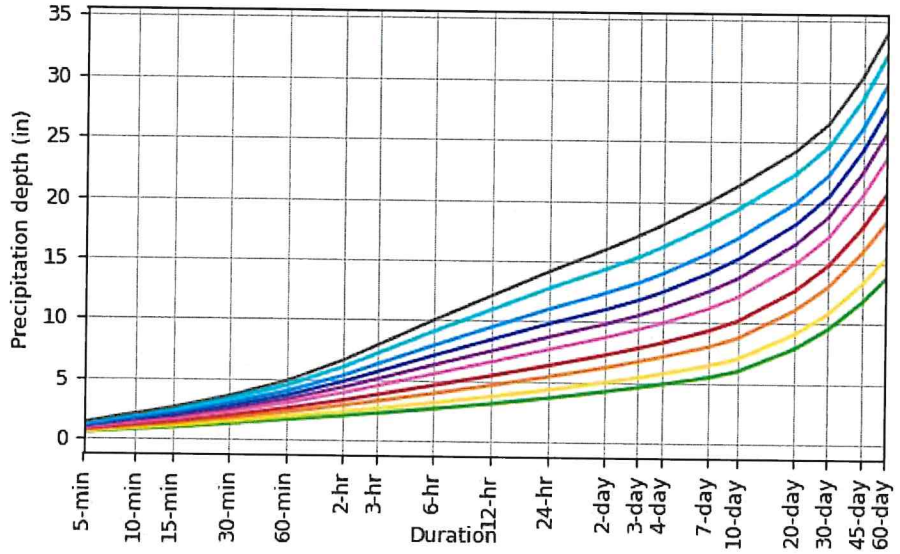
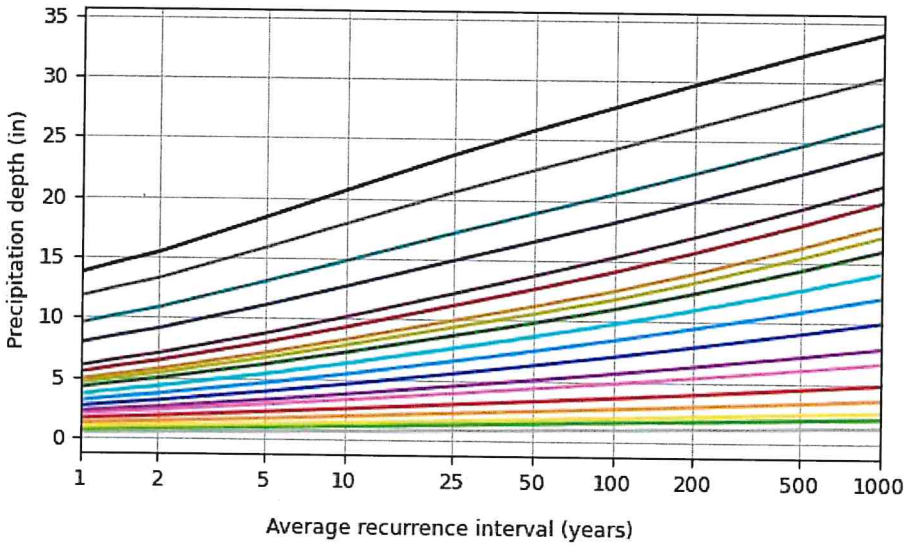
PF graphical

PDS-based depth-duration-frequency (DDF) curves
Latitude: 32.9567°, Longitude: -95.9021°





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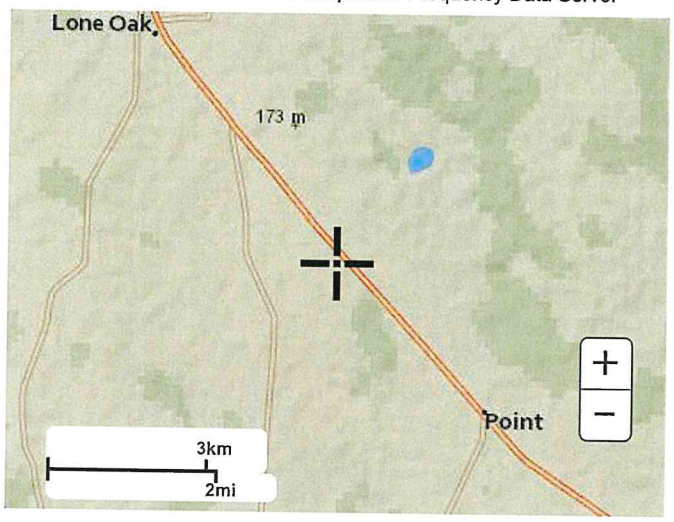
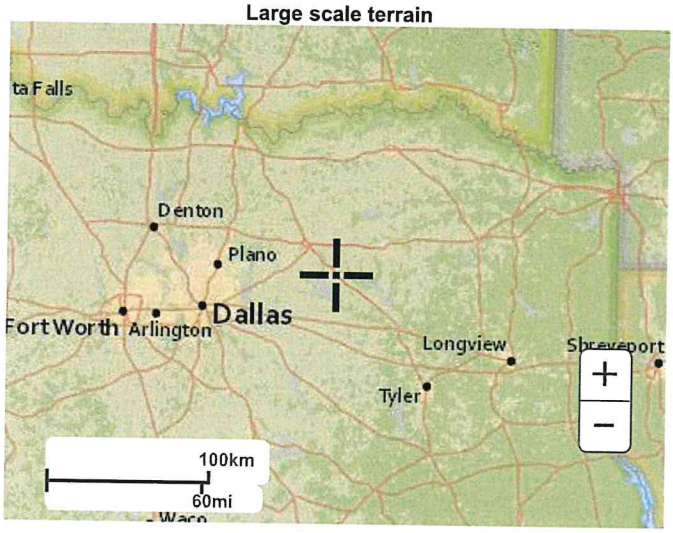
Maps & aerials

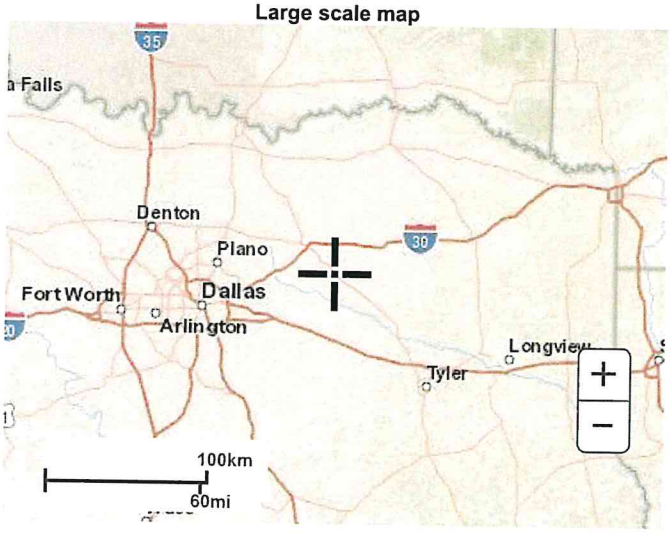
Small scale terrain



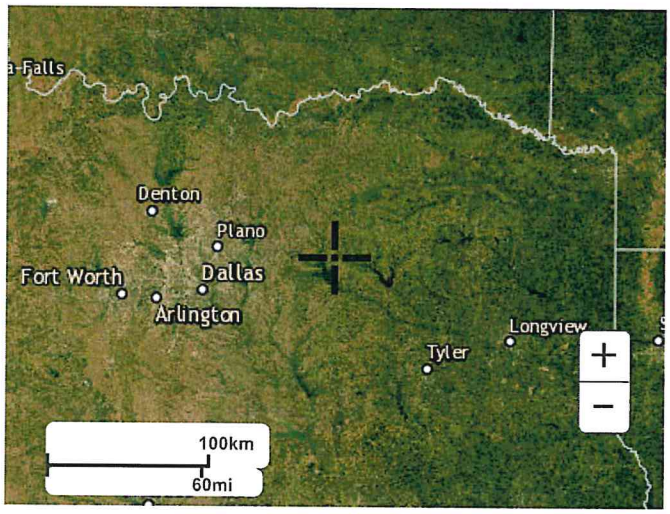
Large scale terrain



Large scale map



Large scale aerial



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National Weather Service
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Silver Spring, MD 20910
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