APPENDIX E-1 Current Drought Management Plan

Pensacola Project, FERC No. 1494
Drought Adaptive Management Plan

Background

Under its existing Federal Energy Regulatory Commission (FERC) license for the Pensacola Project No. 1494 (Project), the Grand River Dam Authority (GRDA) is required to ensure maintenance of dissolved oxygen (DO) concentrations in the tailrace area downstream of the Project. It also is required under Article 401 of its downstream Markham Ferry Project to mitigate for low DO levels to meet state water quality standards.

During periods of drought, however, strict adherence to the Project's rule curve under Article 401 can result in an inadequate supply of water to meet these water quality requirements—as well as potential water supply needs downstream. For these reasons, the amended Article 401 of the license requires GRDA to implement this Drought Adaptive Management Plan (Plan) "during any period in which the National Drought Mitigation Center's U.S. Drought Monitor has identified a severe to exceptional drought within the Grand/Neosho River basin."

This Plan provides for certain deviations from the Article 401 target elevations to allow GRDA to meet other obligations during drought conditions. It is intended to help GRDA to have sufficient water to maintain flow releases to meet downstream DO requirements at the Pensacola and Markham Ferry Projects, while maintaining lake elevations necessary for the reliable operation of its downstream Salina Pumped Storage Project. Moreover, recognizing the potential for historic properties and burial sites along the Project shoreline to be adversely affected during low levels at Grand Lake, this Plan includes measures for GRDA to consult closely with the Oklahoma State Historic Preservation Office (SHPO) and the Oklahoma Archaeological Survey (OAS) during periods in which this plan is implemented.

Description

In the event that the National Drought Mitigation Center's U.S. Drought Monitor has identified a severe to exceptional drought within the Grand/Neosho River basin, GRDA will continue to make releases at the Project to meet downstream obligations, regardless of the prevailing levels at Grand Lake O' the Cherokees (Grand Lake) and Article 401 rule curve target elevations. Such releases are limited to up to 0.06 feet of reservoir elevation per day—up to approximately 837 cubic feet per second per hour over a 24-hour period.

The daily release allowances under this Plan are designed to allow short-duration pulsed releases to simultaneously conserve water in Grand Lake while maintaining downstream DO requirements. These release allowances are expected to provide enough flow to maintain gate releases downstream at the Markham Ferry Project while maintaining an elevation of 619 feet mean sea level at Lake Hudson, which is necessary to meet general daily operations and North American Electric Reliability Corporation reliability standards associated with the Salina Pumped Storage Project.

In the unusual event that the allowances authorized under this Plan are insufficient to meet its objectives, GRDA may seek further authorization from FERC to release additional flows from Grand Lake to meet downstream requirements during a severe to exceptional drought.

Procedures

- ***Monitoring.*** GRDA will monitor drought conditions in the Grand/Neosho River basin using the U.S. Drought Monitor, available at http://droughtmonitor.unl.edu, as well as other generally accepted sources of drought information applicable to the basin.

- ***Weekly Teleconferences.*** When these sources indicate that a severe to exceptional drought is imminent in the Grand/Neosho River basin, GRDA will commence weekly teleconferences to keep federal and state resource agencies informed of prevailing conditions and GRDA's plans to begin additional releases in the event a severe to exceptional drought is declared. These weekly conference calls will continue until the threat of a severe to exceptional drought subsides. Entities invited to participate in this weekly teleconference include the U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, Oklahoma Water Resources Board, Oklahoma Department of Wildlife Conservation, SHPO, OAS, the City of Miami, and FERC staff. A listing of all entities to receive notification of GRDA's weekly conference calls is provided below, and each entity is expected to keep GRDA informed of any changes in personnel or contact information on the list.

- ***Commencement of Additional Releases.*** Upon the declaration of a severe to exceptional drought in the Grand/Neosho River basin, GRDA at its discretion and based on input received during the weekly teleconferences may commence additional releases of up to 0.06 feet of reservoir elevation per day—up to approximately 837 cubic feet per second per hour over a 24-hour period. At each weekly teleconference during the duration of a severe to exceptional drought, GRDA will address the following issues: (1) current and forecasted drought conditions and planned project operation; (2) maintenance of water levels and flows sufficient to maintain downstream DO concentrations for water quality and the prevention of fish kills; and (3) maintenance of reservoir elevations at Markham Ferry sufficient to operate the Salina Pumped Storage Project for system reliability; and (4) based on available information, when the severe to exceptional drought period is expected to end.

- ***Cessation of Additional Releases.*** Upon the end of the declared severe to exceptional drought condition in the Grand/Neosho River basin, GRDA will cease the additional releases authorized under this Plan. GRDA will notify the entities on the Contact List below of the end of the severe to exceptional drought and its cessation of additional releases.

Historic Properties and Burial Sites

To help keep the SHPO and OAS informed of prevailing conditions at the Project during severe to exceptional drought conditions, GRDA will include SHPO and OAS on the Contact List, and both SHPO and OAS will be invited to participate in weekly teleconferences described above.

In addition, in the event that SHPO concludes that any measure to implement this Plan would result in the exposure of any known or identified archaeological site or other cultural resource that is listed in or eligible for listing in the National Register of Historic Places, GRDA will consult with the SHPO and develop a site-specific plan for the adequate protection or mitigation of the historic property during the period in which this Plan is implemented. Such plans may include measures to restrict public access to sensitive areas, increase the presence of law enforcement in sensitive areas and at public access points to sensitive areas, install fences or other access barriers, install signage to educate and warn the public regarding proper treatment of archaeological resources, or other measures mutually agreed to by SHPO and GRDA designed to preserve the integrity of the site during Plan implementation.

In Oklahoma, human remains are protected under the Oklahoma Burial Desecration Law (Oklahoma Statute Title 21 [Section 1168.0-1168.6]). If GRDA staff encounter or are made aware of previously unidentified burial sites or human remains in locations of the Project area that are typically inundated during non-drought conditions, GRDA will carry out the following steps immediately:

1. Inform GRDA’s Environmental Coordinator of the discovery.
2. Notify the county coroner or sheriff.
3. Locate the site and establish a 50 meter (164 foot) radius around the suspected remains.
4. Do not allow anyone to touch, disturb, or photograph human remains.
5. Treat human remains with dignity and respect.
6. Do not leave the burial or remains unsupervised if possible.
7. Notify SHPO and OAS within 24 hours of the discovery.
8. Develop a plan that will result in consultation with federally recognized tribes within 10 business days.

CONTACT LIST

Grand River Dam Authority

Federal Energy Regulatory Commission

U.S. Army Corps of Engineers, Tulsa District

Oklahoma Secretary of Energy and Environment

Oklahoma Department of Wildlife Conservation

Oklahoma Water Resources Board

Oklahoma Office of Emergency Management

U.S. Fish and Wildlife Service

City of Miami

Ottawa County Office of the County Commissioner

Ottawa County Emergency Management

Modoc Tribe

United Keetoowah Band of Cherokees

Quapaw Tribe of Indians

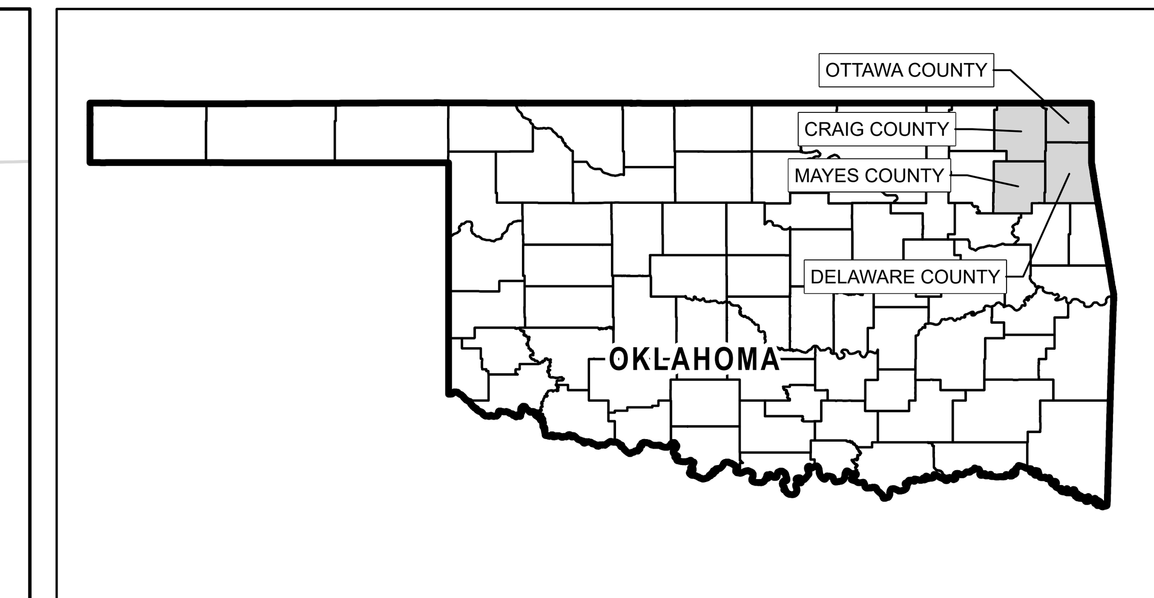
Oklahoma State Historic Preservation Office

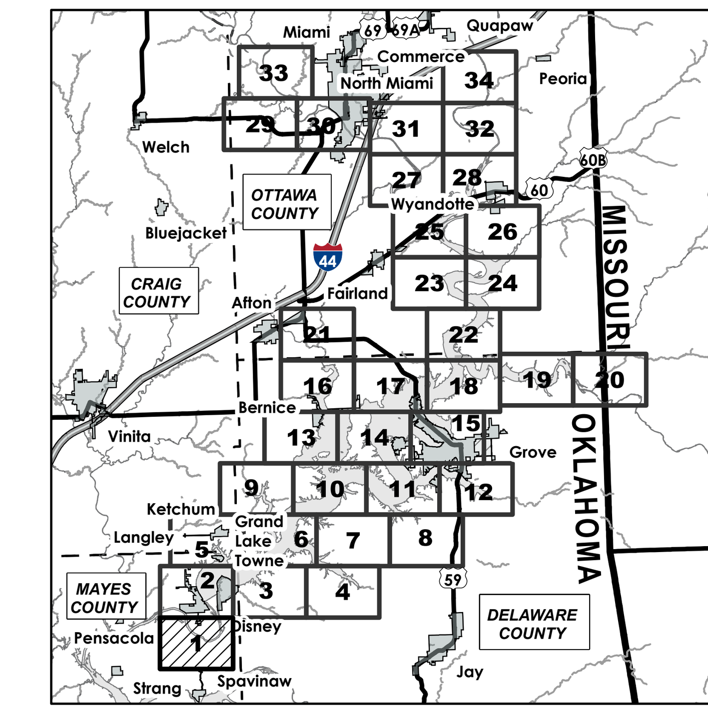
Oklahoma Archeological Survey

APPENDIX E-2 Exhibit G Explanation Maps

PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
1	2	Approved 2014 project boundary





Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.64°E

Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 1

GRAND RIVER DAM AUTHORITY LANGLEY, OKLAHOMA

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494

NEOSHO AND GRAND RIVERS
OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

DATE: MAY 2023

MAP NOTES

1. Assessor data from Mayes, Ottawa, Delaware, and Craig counties is current as of June 2022. Any inaccuracies are in the original datasets. Interpretation of ownership designations is based on descriptive data provided in the Assessors' data. No additional research was conducted to validate the accuracy of the information.
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3. When the project boundary description references a specific known location in the field, that reference shall govern over graphical location on the Exhibit G in case of conflict.
4. Public Land Survey System (PLSS) obtained from the Oklahoma Water Resources Board (https://home-owrb.opendata.arcgis.com/).
5. National Hydrography Dataset (NHD) data (streams and lakes) were obtained from the National Map Download application (TNM Download at https://viewer.nationalmap.gov/basic/#/).
6.Transportation network, county and municipal boundaries from the Oklahoma Department of Transportation GIS Open Data Portal (https://gis-okdot.opendata.arcgis.com/)
7. Federal lands shown were developed from Bureau of Indian Affairs (BIA) parcel data and Wetland Reserve Program (WRP) easements.

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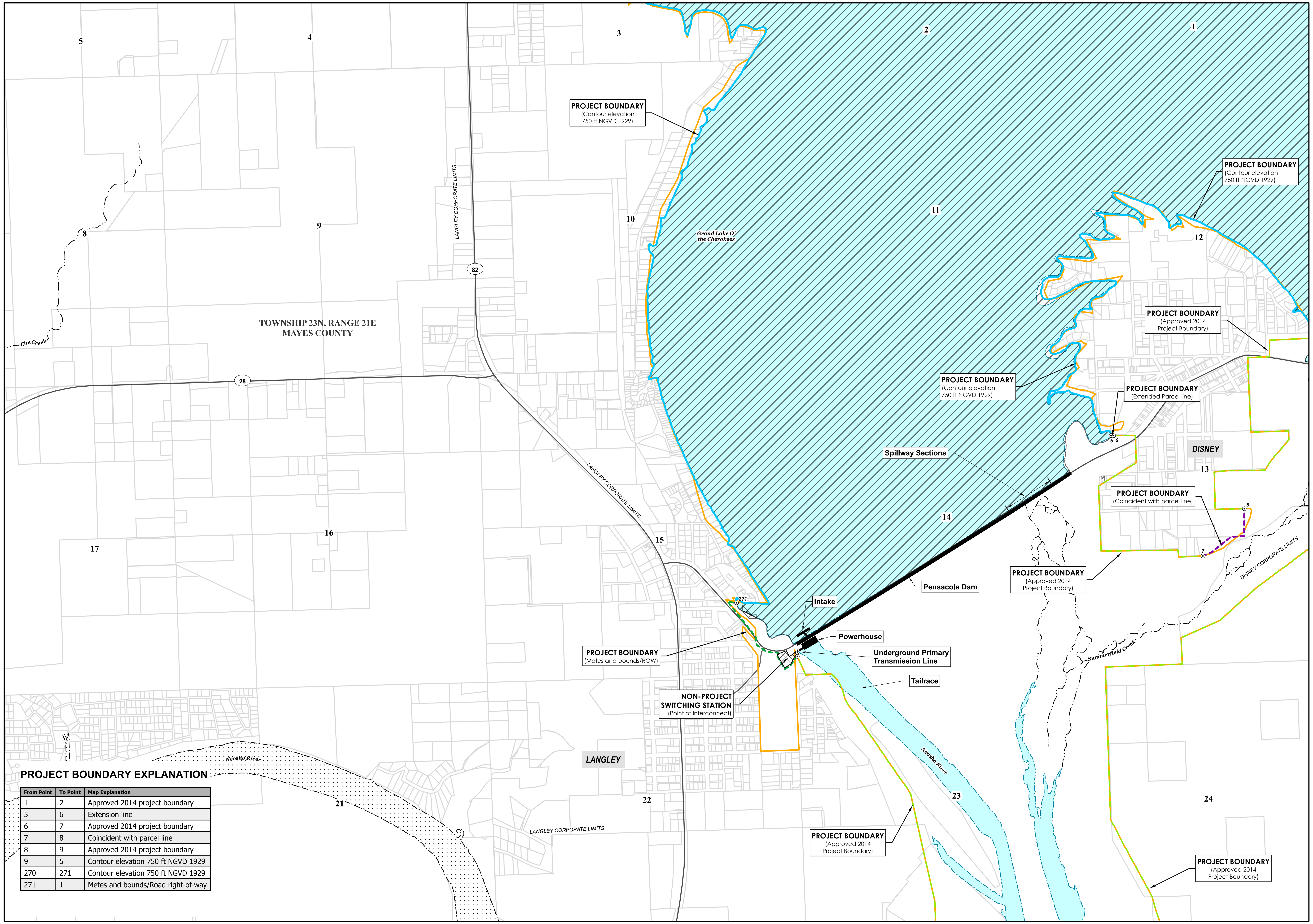
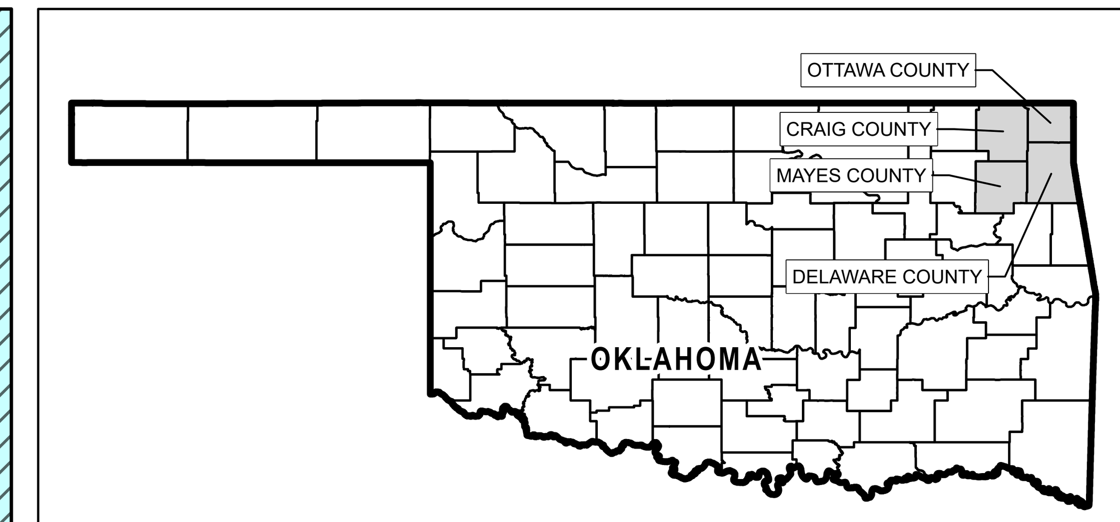
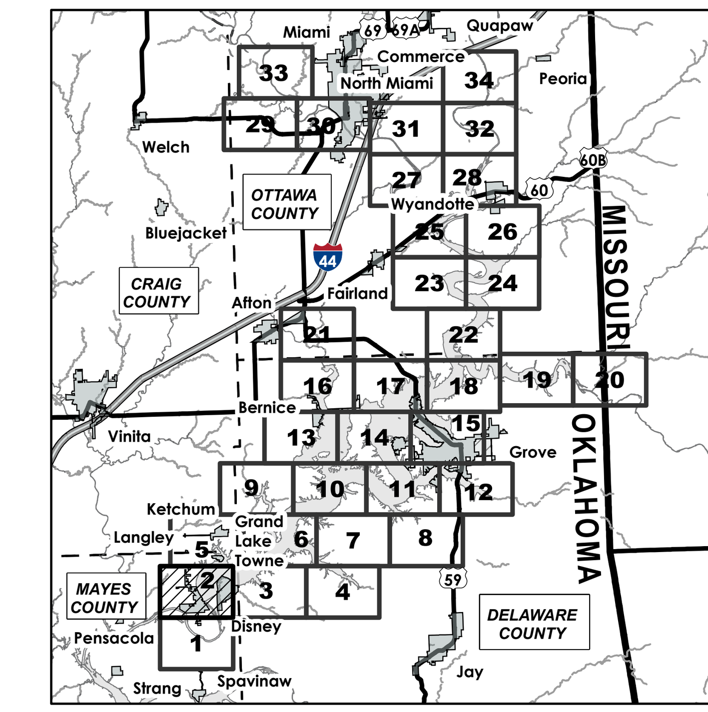


PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
1	2	Approved 2014 project boundary
5	6	Extension line
6	7	Approved 2014 project boundary
7	8	Coincident with parcel line
8	9	Approved 2014 project boundary
9	5	Contour elevation 750 ft NGVD 1929
270	271	Contour elevation 750 ft NGVD 1929
271	1	Metes and bounds/Road right-of-way





Magnetic Declination at Pensacola Dam April 2022 (Degrees): 1.63°E

Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 2

GRAND RIVER DAM AUTHORITY LANGLEY, OKLAHOMA

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494

NEOSHO AND GRAND RIVERS

OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

DATE: MAY 2023

MAP NOTES

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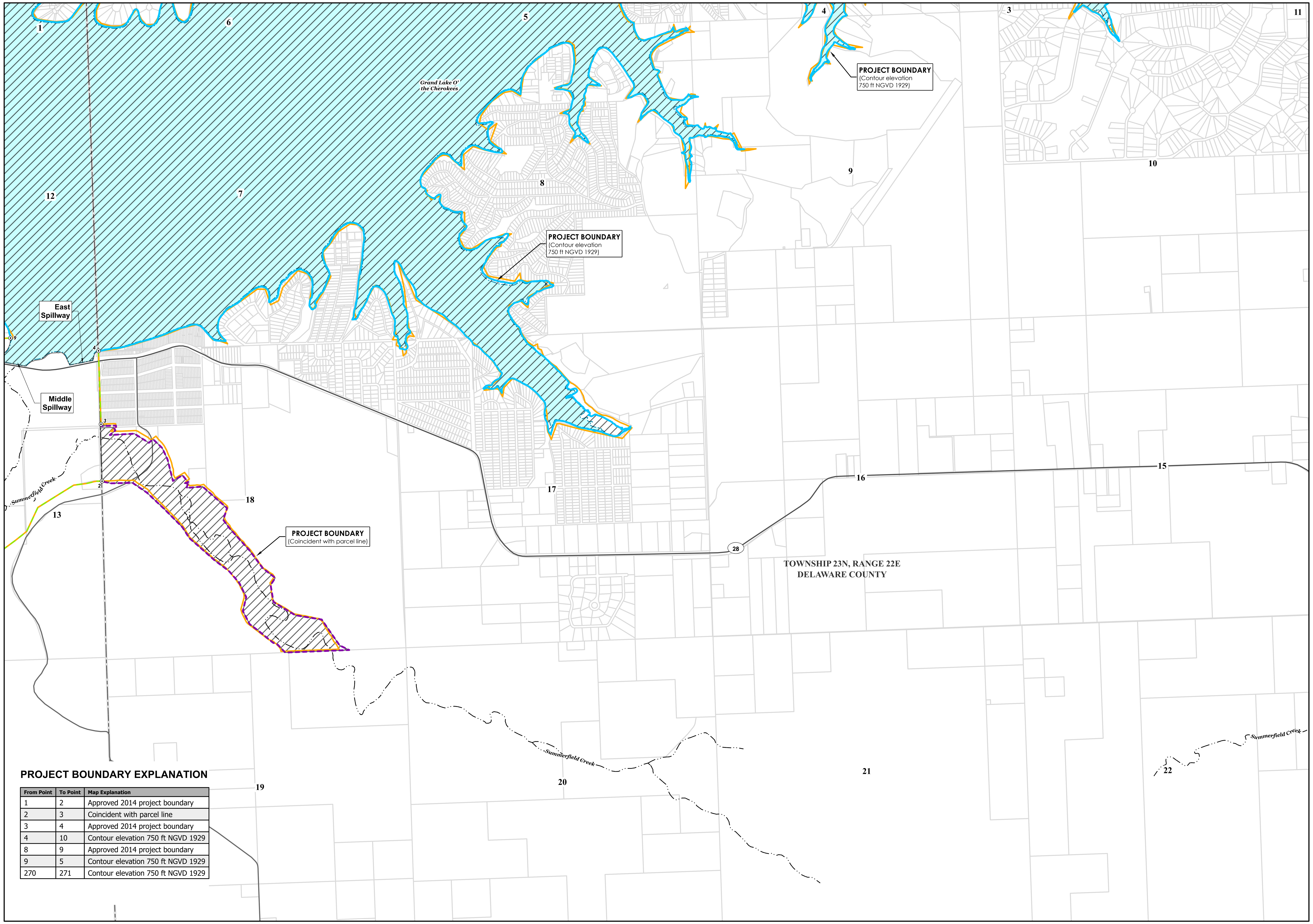
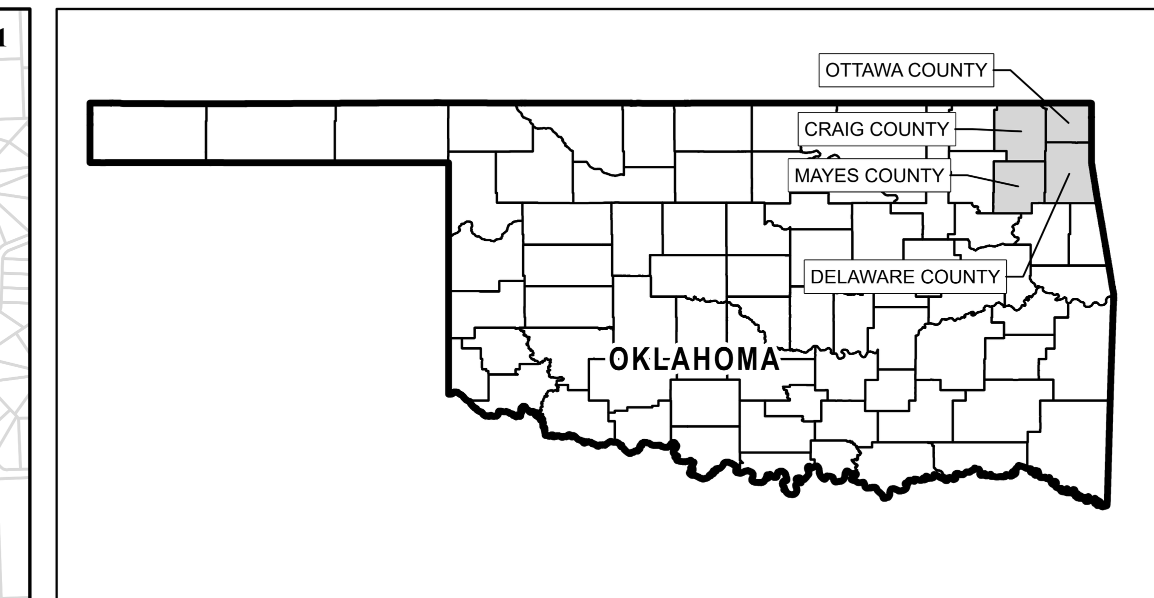
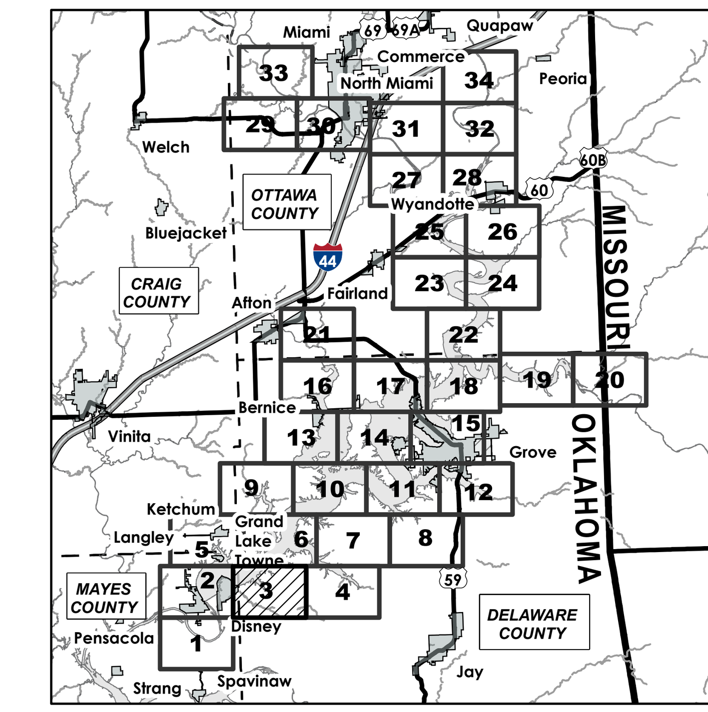


PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
1	2	Approved 2014 project boundary
2	3	Coincident with parcel line
3	4	Approved 2014 project boundary
4	10	Contour elevation 750 ft NGVD 1929
8	9	Approved 2014 project boundary
9	5	Contour elevation 750 ft NGVD 1929
270	271	Contour elevation 750 ft NGVD 1929





Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.58°E

Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
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- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 3

GRAND RIVER DAM AUTHORITY **LANGLEY, OKLAHOMA**

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494

NEOSHO AND GRAND RIVERS

OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

DATE: MAY 2023

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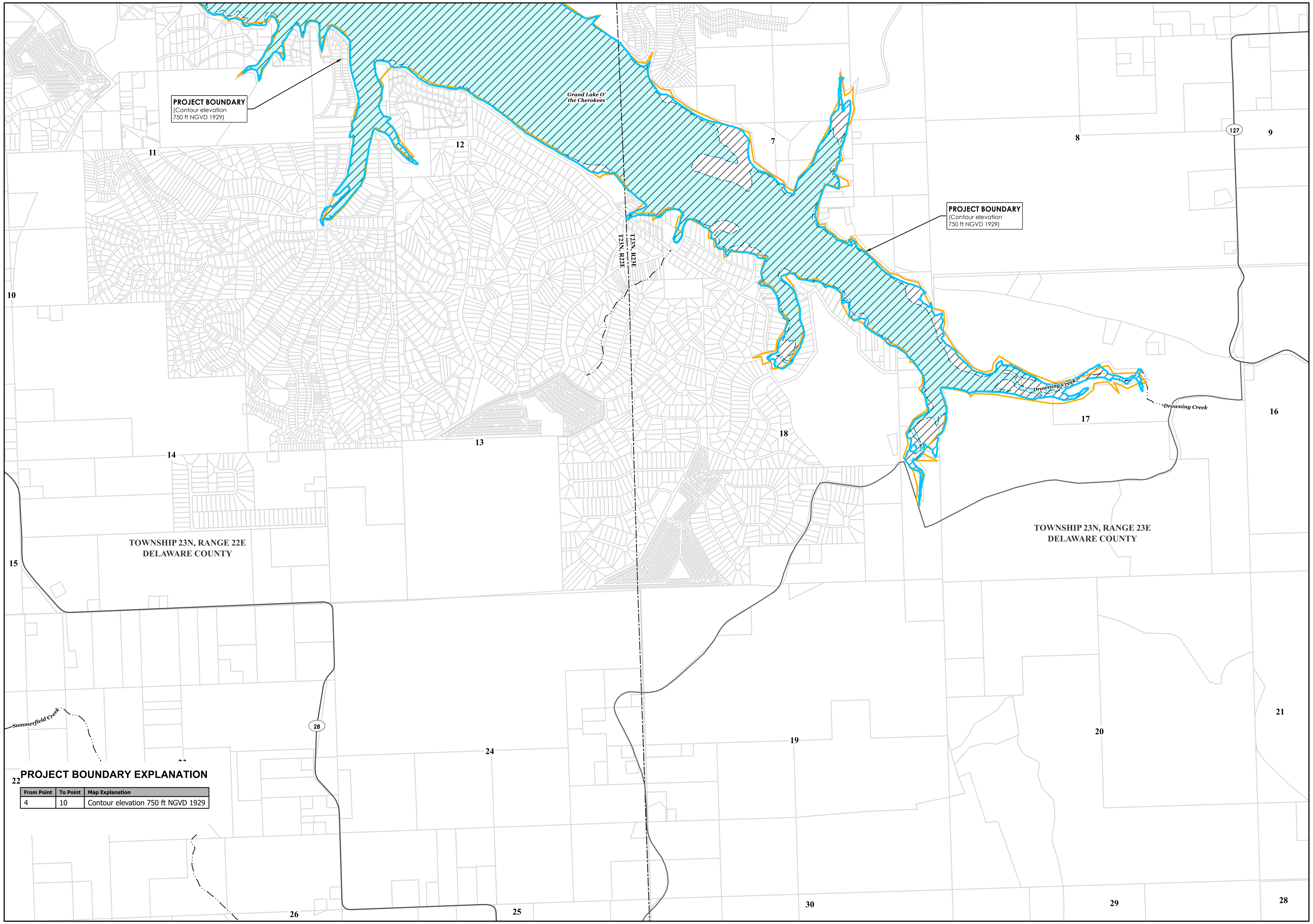
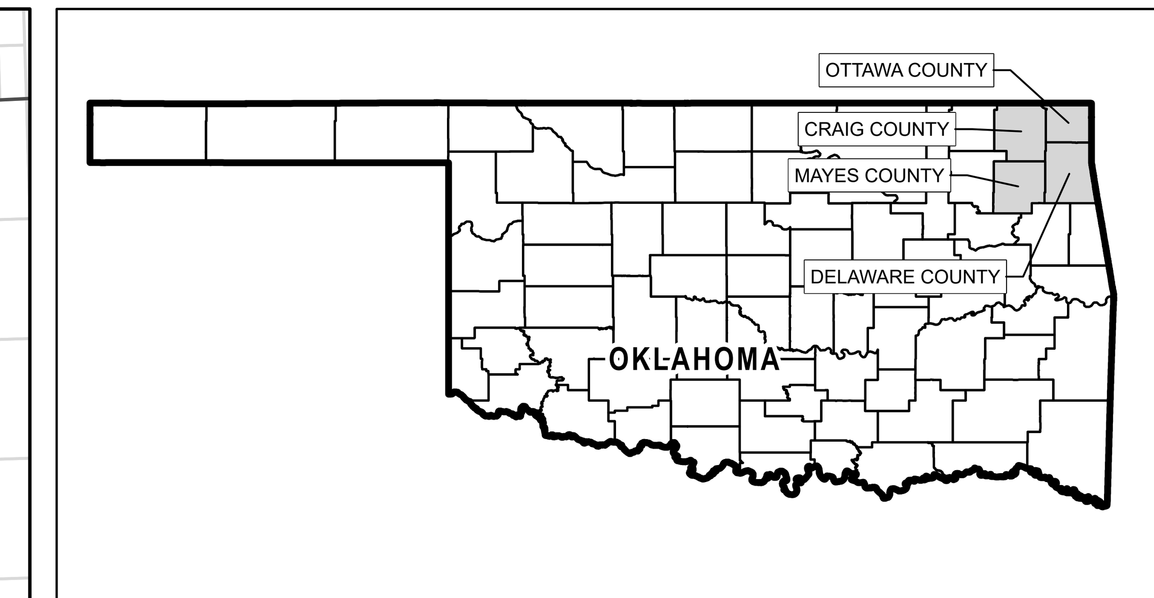
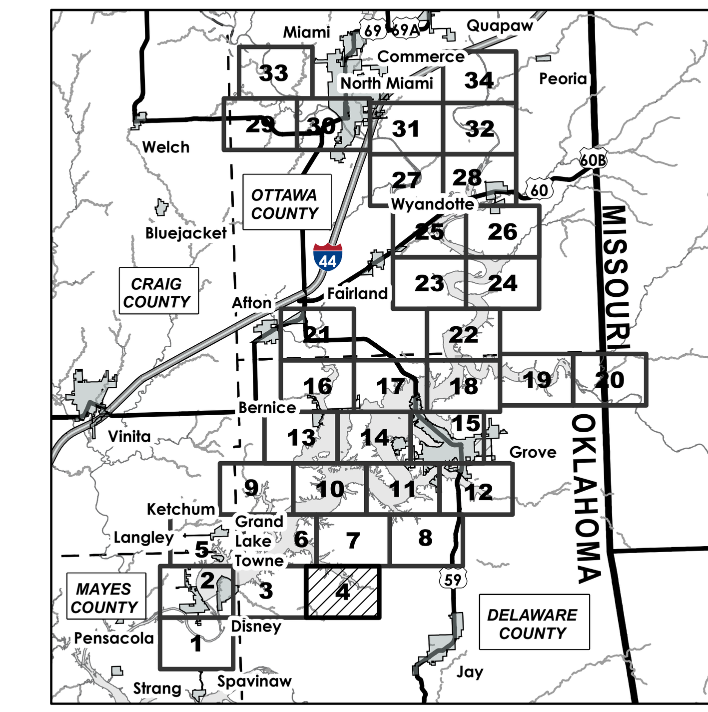


PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
4	10	Contour elevation 750 ft NGVD 1929





N

Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.53°E

Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
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- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

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900 450 0 900 1,800 2,700 3,600 Feet

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EXHIBIT 4

GRAND RIVER DAM AUTHORITY **LANGLEY, OKLAHOMA**

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494
NEOSHO AND GRAND RIVERS
OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

DATE: MAY 2023

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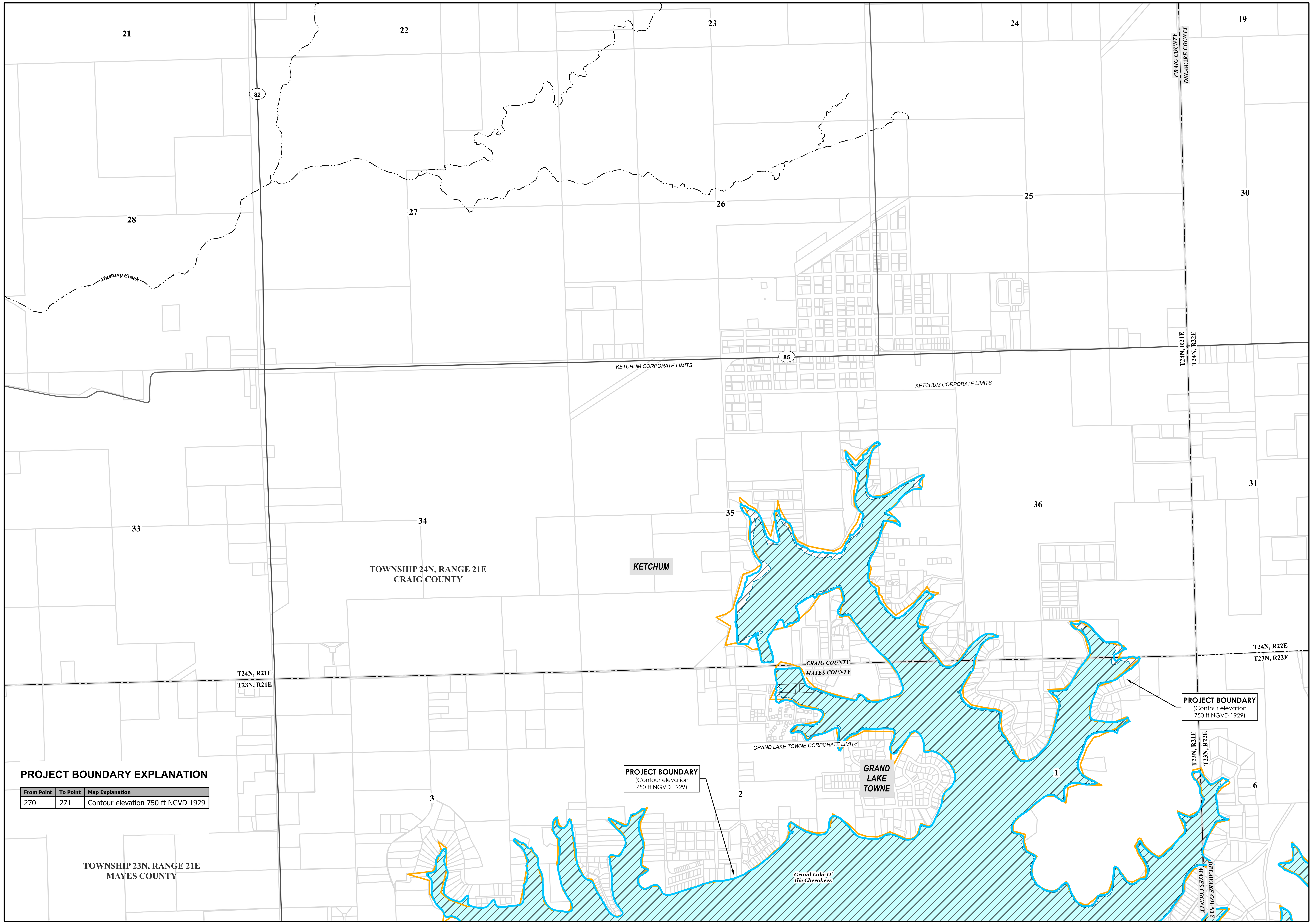
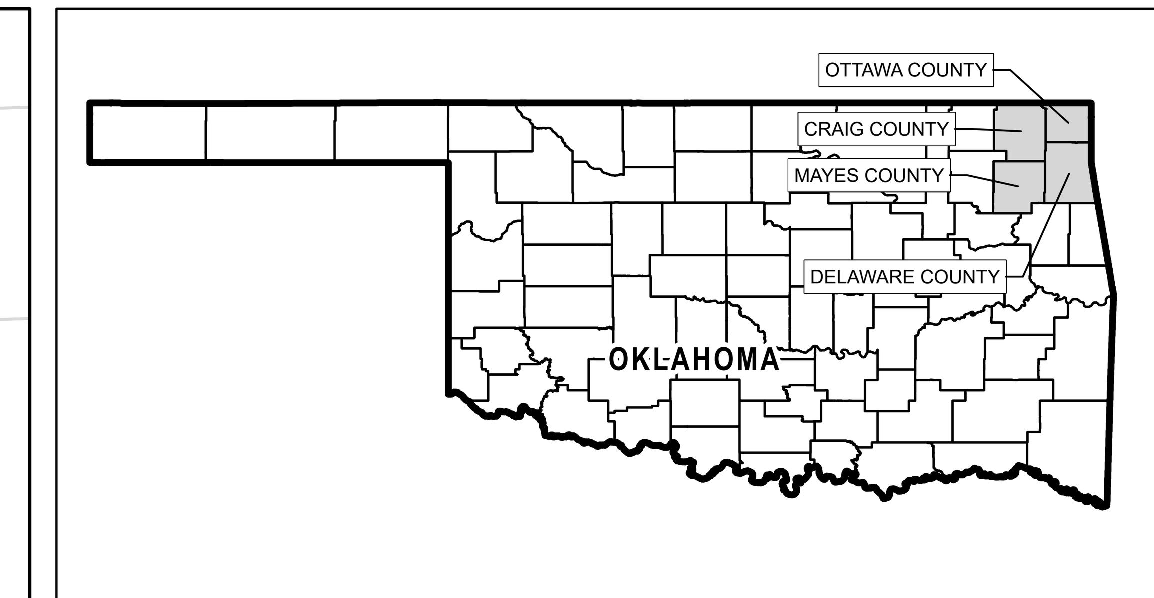
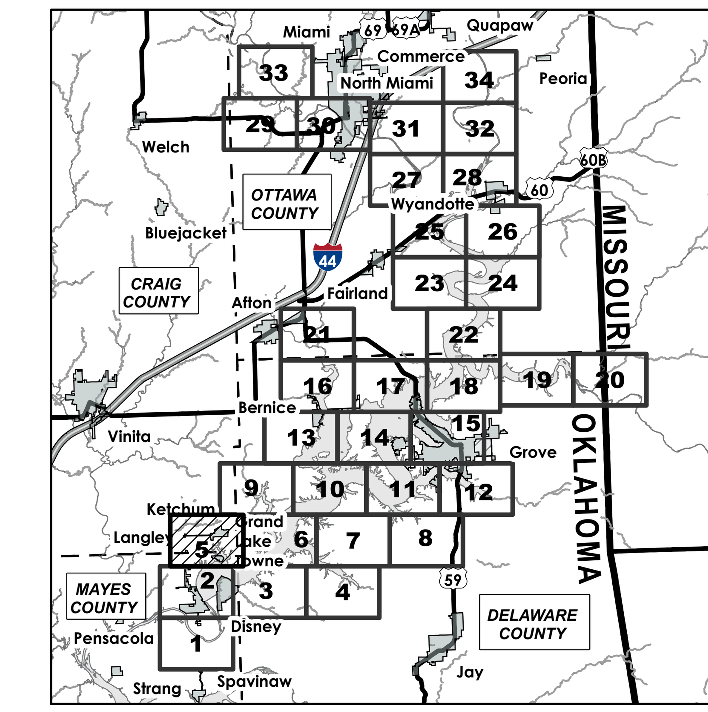


PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
270	271	Contour elevation 750 ft NGVD 1929





N

Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.62°E

Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

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900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 5

GRAND RIVER DAM AUTHORITY LANGLEY, OKLAHOMA

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494

NEOSHO AND GRAND RIVERS

OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

DATE: MAY 2023

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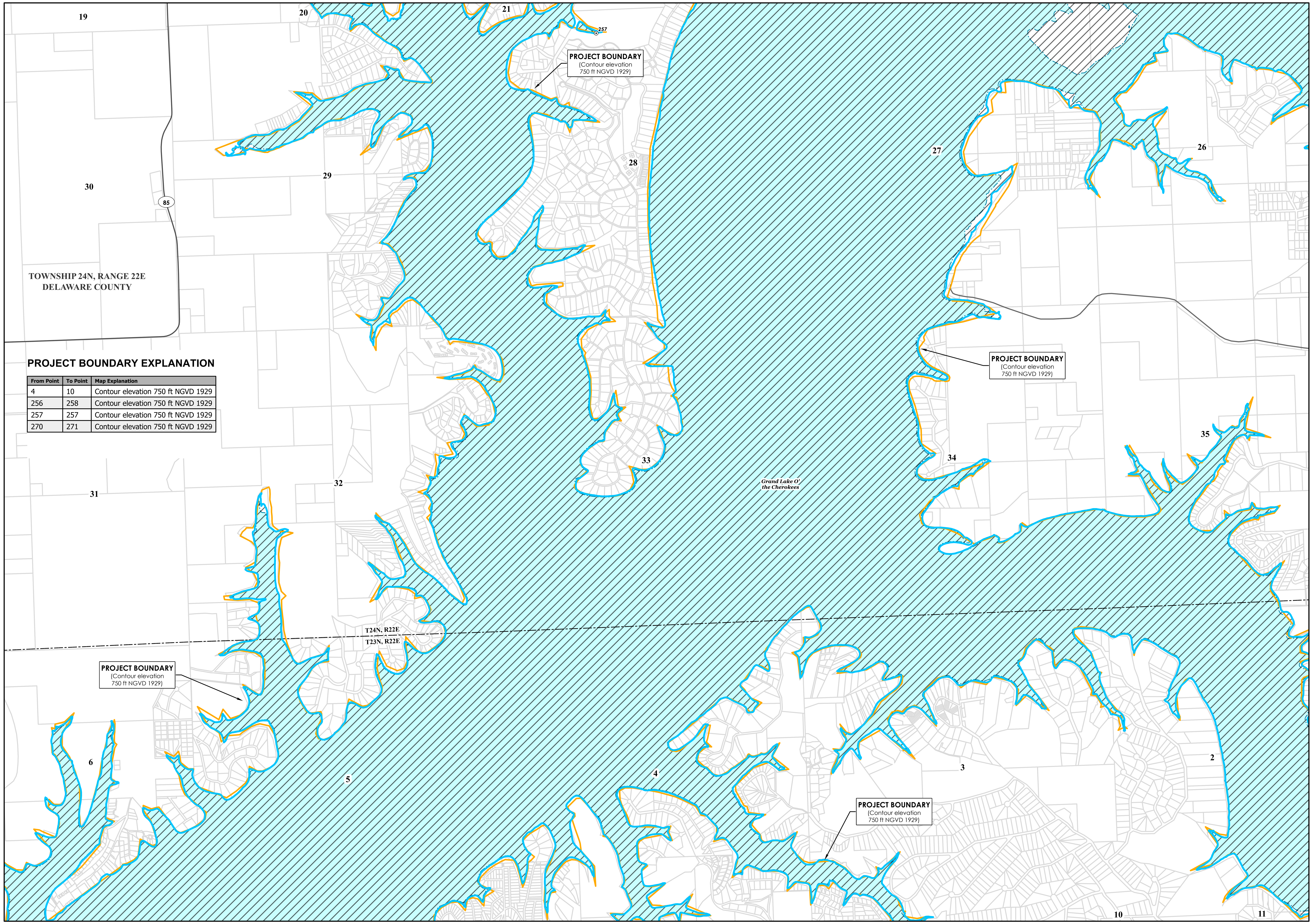
4. Public Land Survey System (PLSS) obtained from the Oklahoma Water Resources Board (https://home-owrb.opendata.arcgis.com/).
5. National Hydrography Dataset (NHD) data (streams and lakes) were obtained from the National Map Download application (TNM Download at https://viewer.nationalmap.gov/basic/#/).
6.Transportation network, county and municipal boundaries from the Oklahoma Department of Transportation GIS Open Data Portal (https://gis-okdot.opendata.arcgis.com/)
7. Federal lands shown were developed from Bureau of Indian Affairs (BIA) parcel data and Wetland Reserve Program (WRP) easements.

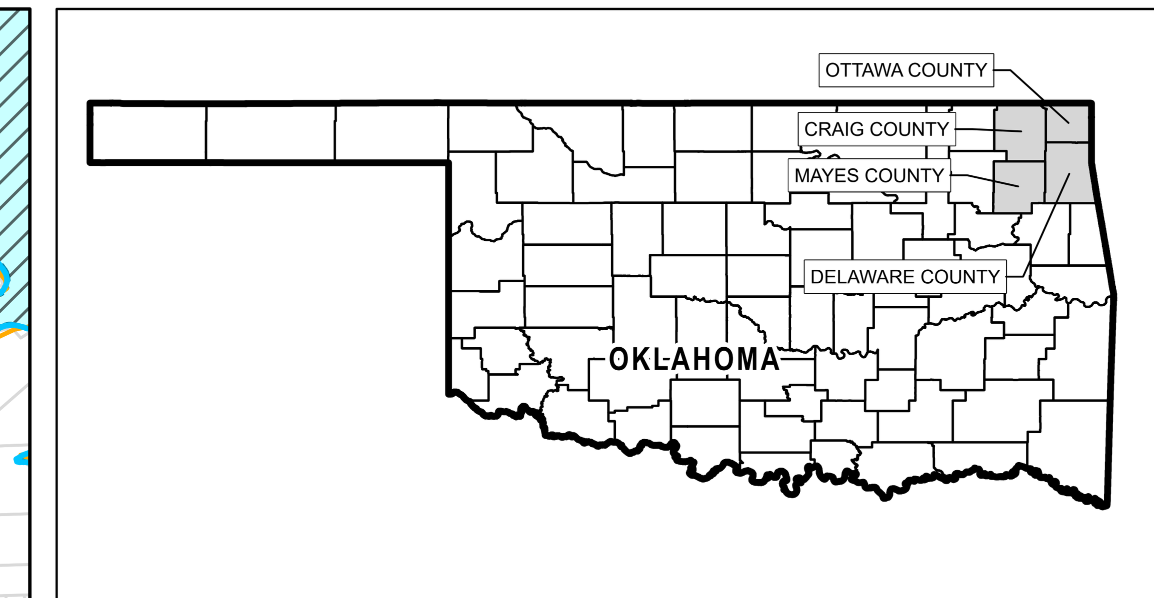
PROJECT BOUNDARY DEFINITION

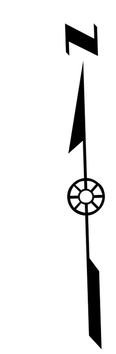
1. Portions of the anticipated project boundary labeled as "Approved 2014 Project Boundary" are based on the FERC approved project boundary last amended January 27, 2014.
2. Portions of the anticipated project boundary labeled as "Interpolation or Extension" indicate either an interpolated contour line is used to join disconnected segments of equivalent contours or a parcel line extension to connect to a defined contour.
3. Portions of the anticipated project boundary based on contour lines are labeled with the contour and datum upon which they are based.
4. Portions of the anticipated project boundary labeled as "Coincident with parcel line" are intended to follow a parcel boundary. See Map Note #1 for more information on parcel data sources.
5. Portions of the anticipated project boundary labeled as "Metes and bounds/ROW" are defined by a metes and bounds description or an existing ROW.



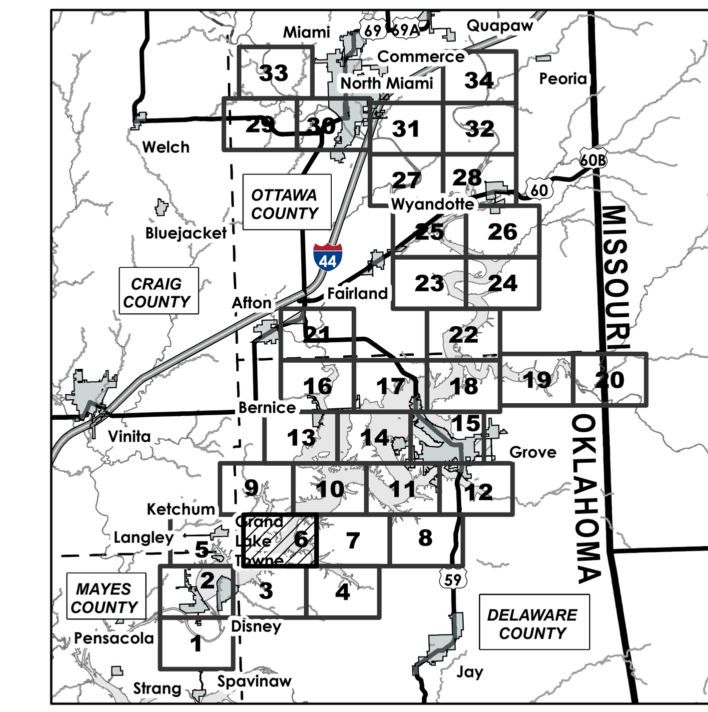
PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
4	10	Contour elevation 750 ft NGVD 1929
256	258	Contour elevation 750 ft NGVD 1929
257	257	Contour elevation 750 ft NGVD 1929
270	271	Contour elevation 750 ft NGVD 1929





Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.57°E



Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary

- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township

- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 6

GRAND RIVER DAM AUTHORITY **LANGLEY, OKLAHOMA**

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494
NEOSHO AND GRAND RIVERS
OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

DATE: MAY 2023

MAP NOTES

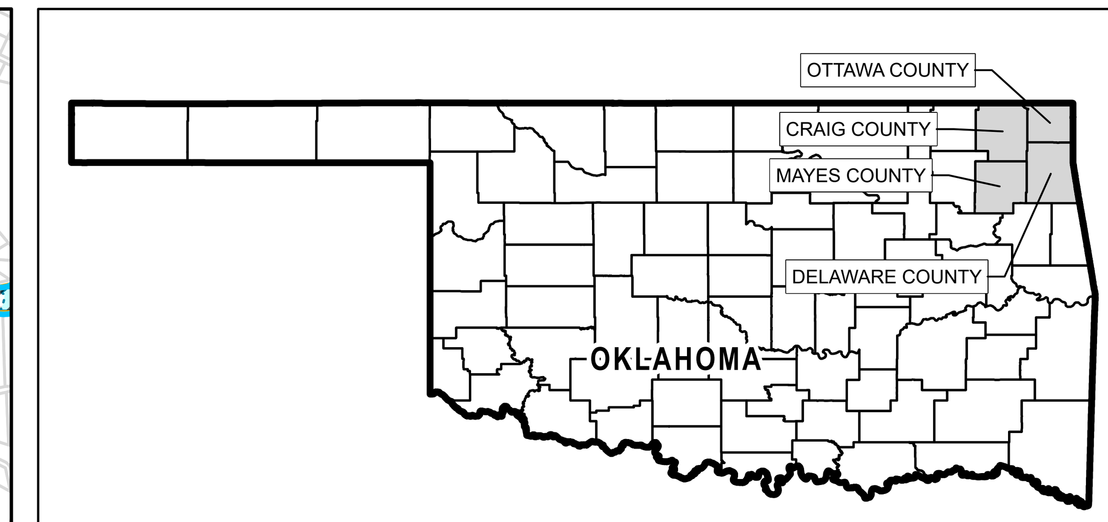
1. Assessor data from Mayes, Ottawa, Delaware, and Craig counties is current as of June 2022. Any inaccuracies are in the original datasets. Interpretation of ownership designations is based on descriptive data provided in the Assessors' data. No additional research was conducted to validate the accuracy of the information.
2. The Reservoir shown was developed from the 745 ft Pensacola Datum (PD) contour. Contours (745 ft PD and 750 ft NGVD) where used as a basis for the Project boundary were derived from the Digital Elevation Model (DEM) developed for the Upstream Hydraulic Model (UHM).
3. When the project boundary description references a specific known location in the field, that reference shall govern over graphical location on the Exhibit G in case of conflict.
4. Public Land Survey System (PLSS) obtained from the Oklahoma Water Resources Board (https://home-owrb.opendata.arcgis.com/).
5. National Hydrography Dataset (NHD) data (streams and lakes) were obtained from the National Map Download application (TNM Download at https://viewer.nationalmap.gov/basic/#/).
6.Transportation network, county and municipal boundaries from the Oklahoma Department of Transportation GIS Open Data Portal (https://gis-okdot.opendata.arcgis.com/)
7. Federal lands shown were developed from Bureau of Indian Affairs (BIA) parcel data and Wetland Reserve Program (WRP) easements.

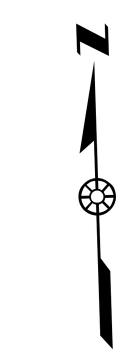
PROJECT BOUNDARY DEFINITION

1. Portions of the anticipated project boundary labeled as "Approved 2014 Project Boundary" are based on the FERC approved project boundary last amended January 27, 2014.
2. Portions of the anticipated project boundary labeled as "Interpolation or Extension" indicate either an interpolated contour line is used to join disconnected segments of equivalent contours or a parcel line extension to connect to a defined contour.
3. Portions of the anticipated project boundary based on contour lines are labeled with the contour and datum upon which they are based.
4. Portions of the anticipated project boundary labeled as "Coincident with parcel line" are intended to follow a parcel boundary. See Map Note #1 for more information on parcel data sources.
5. Portions of the anticipated project boundary labeled as "Metes and bounds/ROW" are defined by a metes and bounds description or an existing ROW.

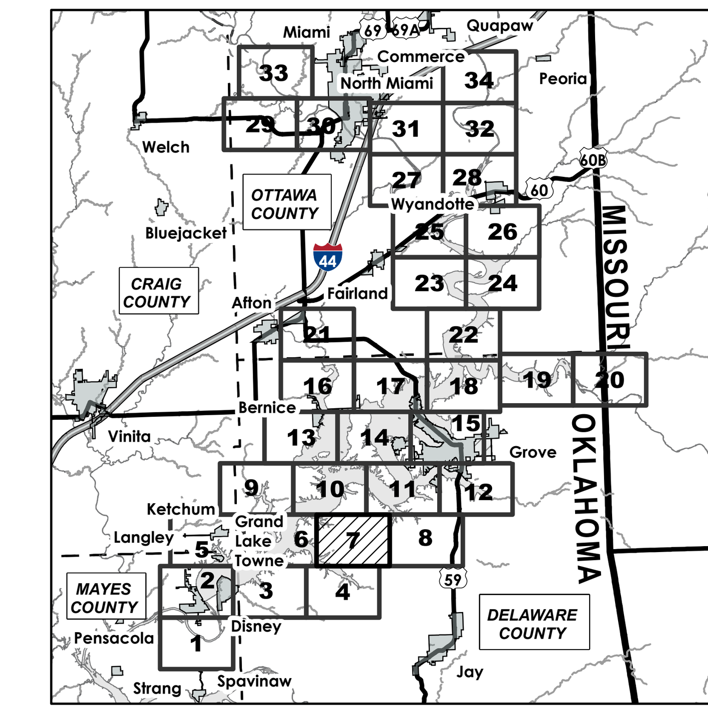
PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
4	10	Contour elevation 750 ft NGVD 1929
10	11	Extension line of right-of-way
11	12	Extension line
12	12	Contour elevation 750 ft NGVD 1929





Magnetic Declination at Pensacola Dam April 2022 (Degrees): 1.52°E



Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 7

GRAND RIVER DAM AUTHORITY LANGLEY, OKLAHOMA

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494

NEOSHO AND GRAND RIVERS

OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

DATE: MAY 2023

MAP NOTES

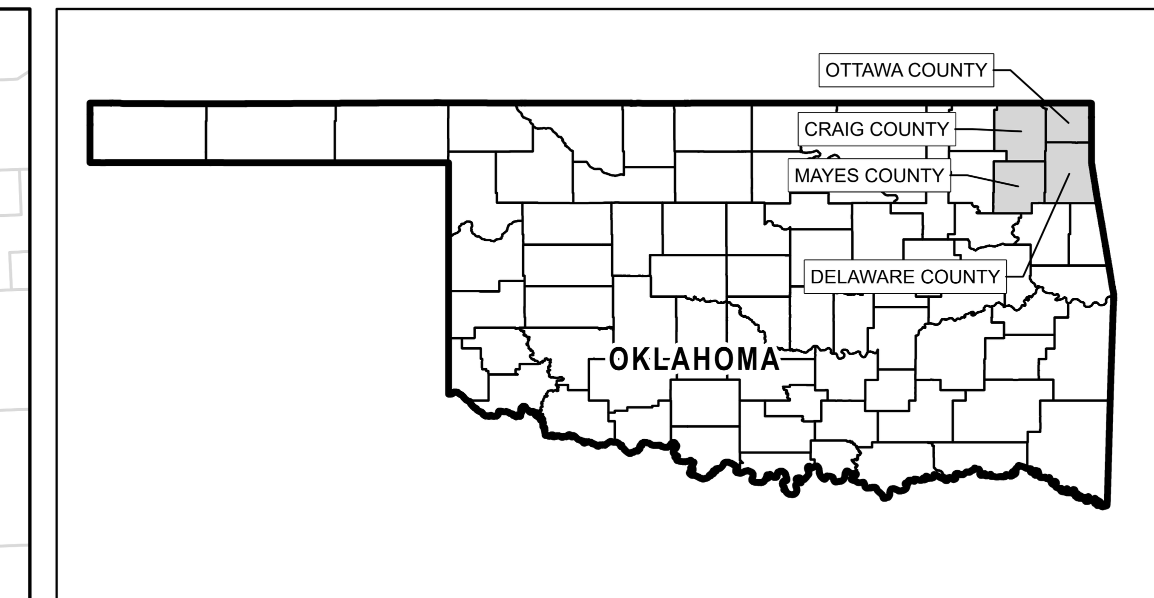
1. Assessor data from Mayes, Ottawa, Delaware, and Craig counties is current as of June 2022. Any inaccuracies are in the original datasets. Interpretation of ownership designations is based on descriptive data provided in the Assessors' data. No additional research was conducted to validate the accuracy of the information.
2. The Reservoir shown was developed from the 745 ft Pensacola Datum (PD) contour. Contours (745 ft PD and 750 ft NGVD) where used as a basis for the Project boundary were derived from the Digital Elevation Model (DEM) developed for the Upstream Hydraulic Model (UHM).
3. When the project boundary description references a specific known location in the field, that reference shall govern over graphical location on the Exhibit G in case of conflict.
4. Public Land Survey System (PLSS) obtained from the Oklahoma Water Resources Board (https://home-owrb.opendata.arcgis.com/).
5. National Hydrography Dataset (NHD) data (streams and lakes) were obtained from the National Map Download application (TNM Download at https://viewer.nationalmap.gov/basic/#/).
6.Transportation network, county and municipal boundaries from the Oklahoma Department of Transportation GIS Open Data Portal (https://gis-okdot.opendata.arcgis.com/)
7. Federal lands shown were developed from Bureau of Indian Affairs (BIA) parcel data and Wetland Reserve Program (WRP) easements.

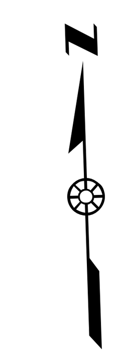
PROJECT BOUNDARY DEFINITION

1. Portions of the anticipated project boundary labeled as "Approved 2014 Project Boundary" are based on the FERC approved project boundary last amended January 27, 2014.
2. Portions of the anticipated project boundary labeled as "Interpolation or Extension" indicate either an interpolated contour line is used to join disconnected segments of equivalent contours or a parcel line extension to connect to a defined contour.
3. Portions of the anticipated project boundary based on contour lines are labeled with the contour and datum upon which they are based.
4. Portions of the anticipated project boundary labeled as "Coincident with parcel line" are intended to follow a parcel boundary. See Map Note #1 for more information on parcel data sources.
5. Portions of the anticipated project boundary labeled as "Metes and bounds/ROW" are defined by a metes and bounds description or an existing ROW.

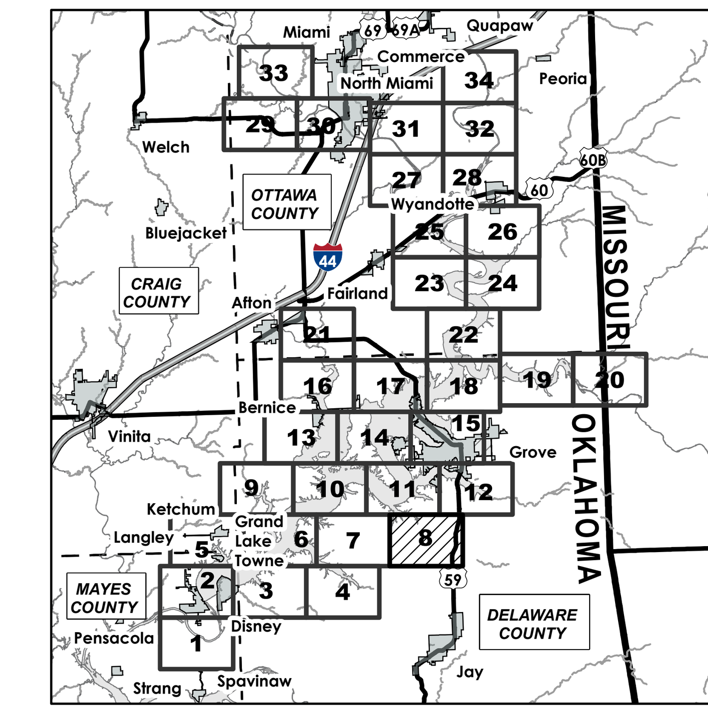
PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
11	12	Extension line
13	14	Interpolation/Extension line
14	15	Contour elevation 745 ft PD
15	16	Interpolation/Extension line
16	17	Contour elevation 750 ft NGVD 1929





Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.47°E



Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 8

GRAND RIVER DAM AUTHORITY — LANGLEY, OKLAHOMA

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494
NEOSHO AND GRAND RIVERS
OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

DATE: MAY 2023

MAP NOTES

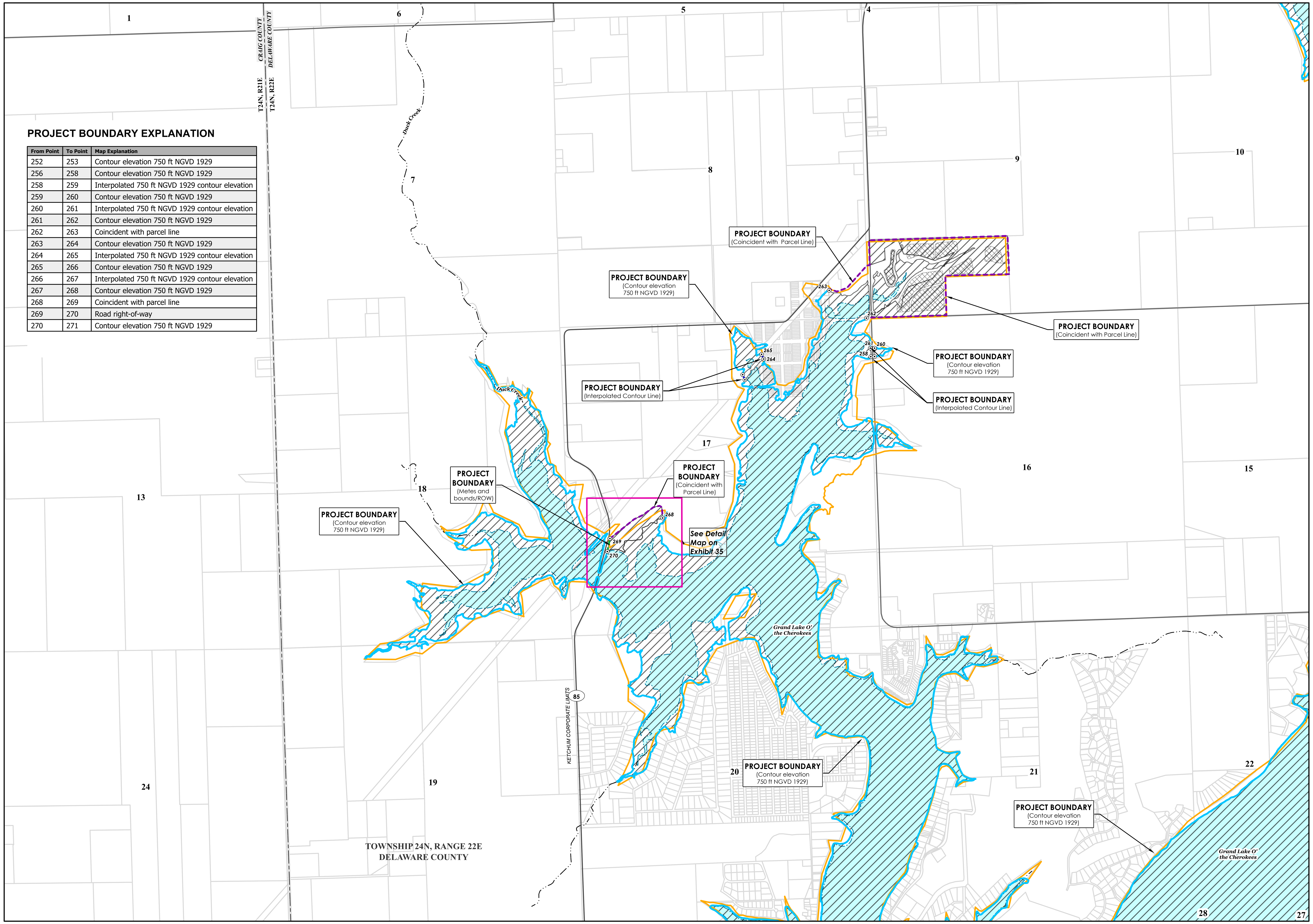
1. Assessor data from Mayes, Ottawa, Delaware, and Craig counties is current as of June 2022. Any inaccuracies are in the original datasets. Interpretation of ownership designations is based on descriptive data provided in the Assessors' data. No additional research was conducted to validate the accuracy of the information.
2. The Reservoir shown was developed from the 745 ft Pensacola Datum (PD) contour. Contours (745 ft PD and 750 ft NGVD) where used as a basis for the Project boundary were derived from the Digital Elevation Model (DEM) developed for the Upstream Hydraulic Model (UHM).
3. When the project boundary description references a specific known location in the field, that reference shall govern over graphical location on the Exhibit G in case of conflict.
4. Public Land Survey System (PLSS) obtained from the Oklahoma Water Resources Board (https://home-owrb.opendata.arcgis.com/).
5. National Hydrography Dataset (NHD) data (streams and lakes) were obtained from the National Map Download application (TNM Download at https://viewer.nationalmap.gov/basic/#/).
6.Transportation network, county and municipal boundaries from the Oklahoma Department of Transportation GIS Open Data Portal (https://gis-okdot.opendata.arcgis.com/)
7. Federal lands shown were developed from Bureau of Indian Affairs (BIA) parcel data and Wetland Reserve Program (WRP) easements.

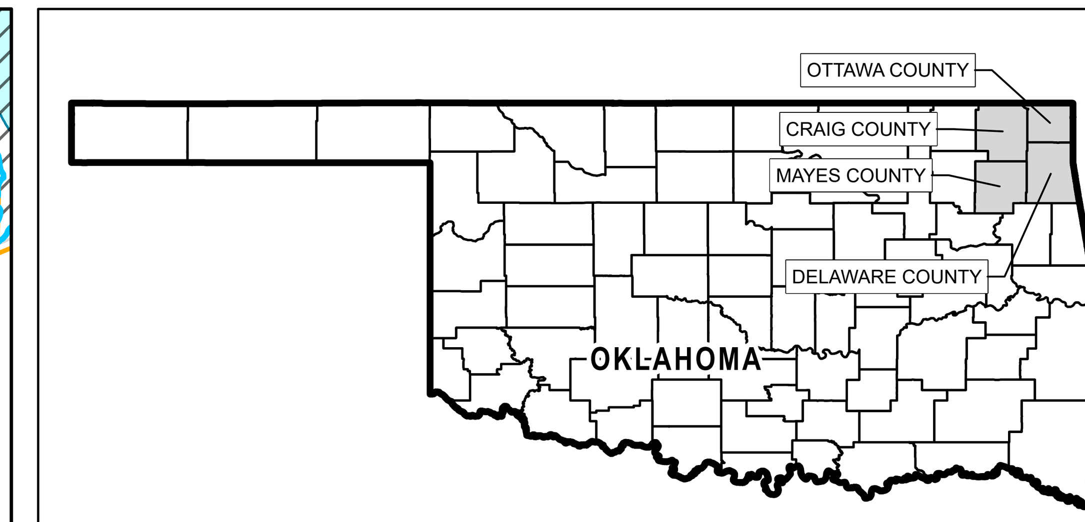
PROJECT BOUNDARY DEFINITION

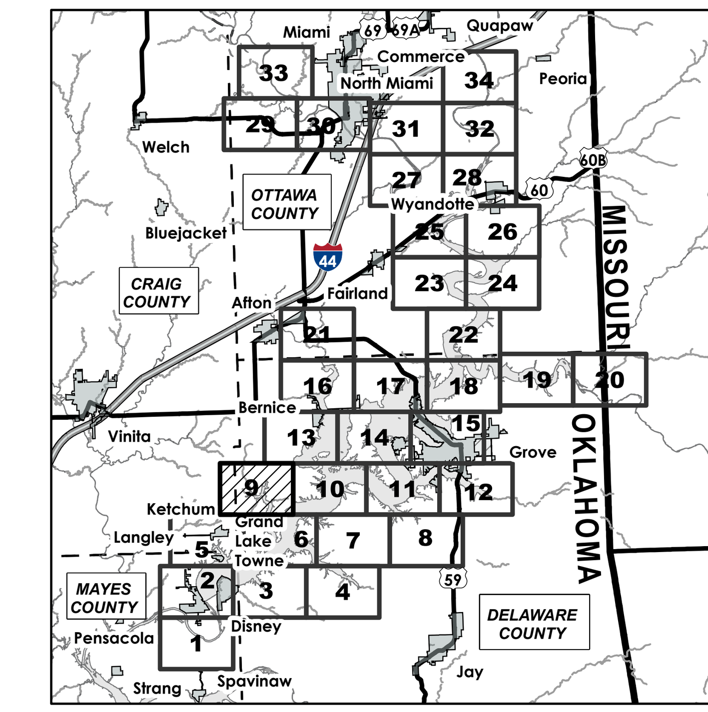
1. Portions of the anticipated project boundary labeled as "Approved 2014 Project Boundary" are based on the FERC approved project boundary last amended January 27, 2014.
2. Portions of the anticipated project boundary labeled as "Interpolation or Extension" indicate either an interpolated contour line is used to join disconnected segments of equivalent contours or a parcel line extension to connect to a defined contour.
3. Portions of the anticipated project boundary based on contour lines are labeled with the contour and datum upon which they are based.
4. Portions of the anticipated project boundary labeled as "Coincident with parcel line" are intended to follow a parcel boundary. See Map Note #1 for more information on parcel data sources.
5. Portions of the anticipated project boundary labeled as "Metes and bounds/ROW" are defined by a metes and bounds description or an existing ROW.

PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
252	253	Contour elevation 750 ft NGVD 1929
256	258	Contour elevation 750 ft NGVD 1929
258	259	Interpolated 750 ft NGVD 1929 contour elevation
259	260	Contour elevation 750 ft NGVD 1929
260	261	Interpolated 750 ft NGVD 1929 contour elevation
261	262	Contour elevation 750 ft NGVD 1929
262	263	Coincident with parcel line
263	264	Contour elevation 750 ft NGVD 1929
264	265	Interpolated 750 ft NGVD 1929 contour elevation
265	266	Contour elevation 750 ft NGVD 1929
266	267	Interpolated 750 ft NGVD 1929 contour elevation
267	268	Contour elevation 750 ft NGVD 1929
268	269	Coincident with parcel line
269	270	Road right-of-way
270	271	Contour elevation 750 ft NGVD 1929







Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.59°E

Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 9

GRAND RIVER DAM AUTHORITY — LANGLEY, OKLAHOMA

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494

NEOSHO AND GRAND RIVERS

OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

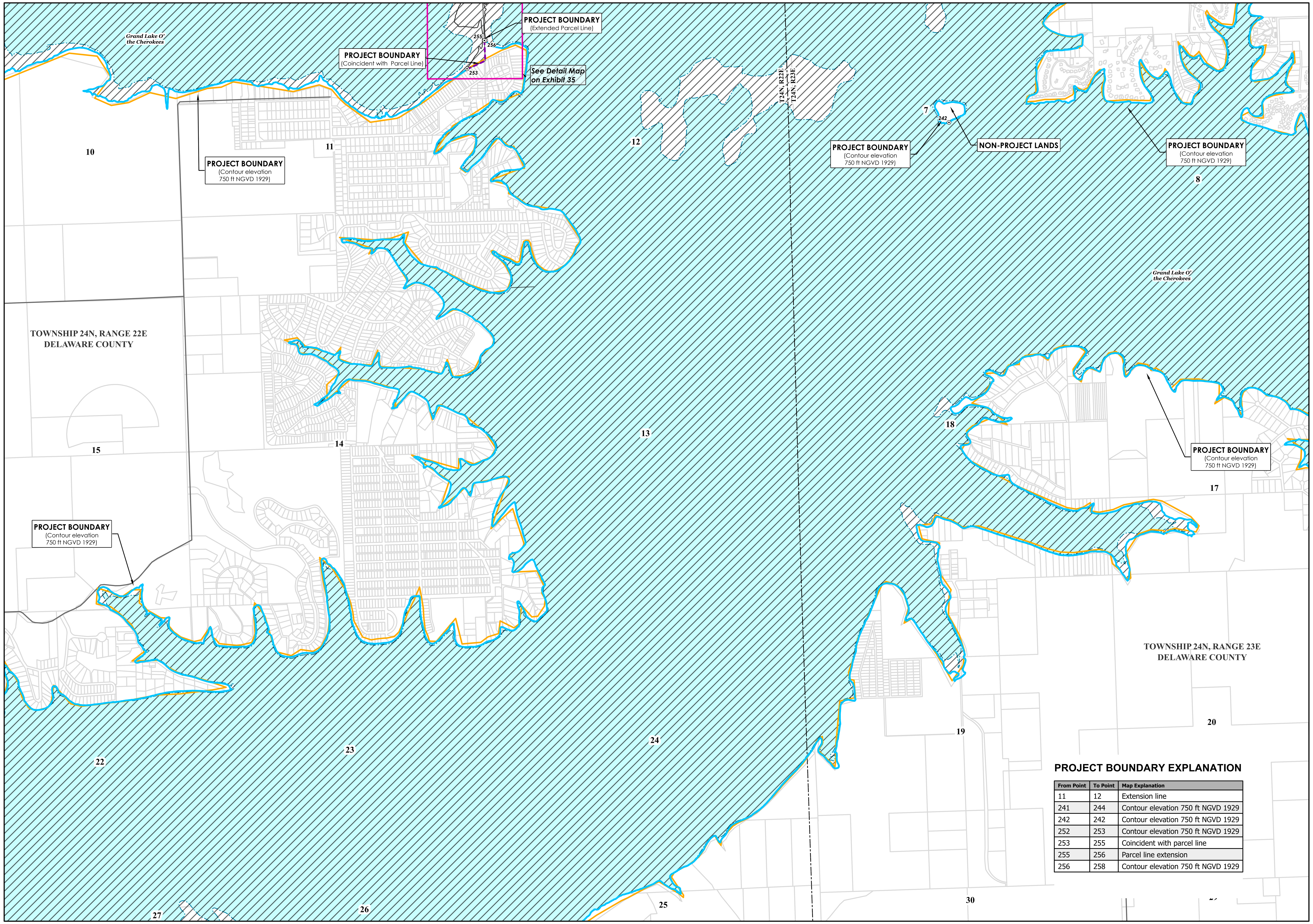
DATE: MAY 2023

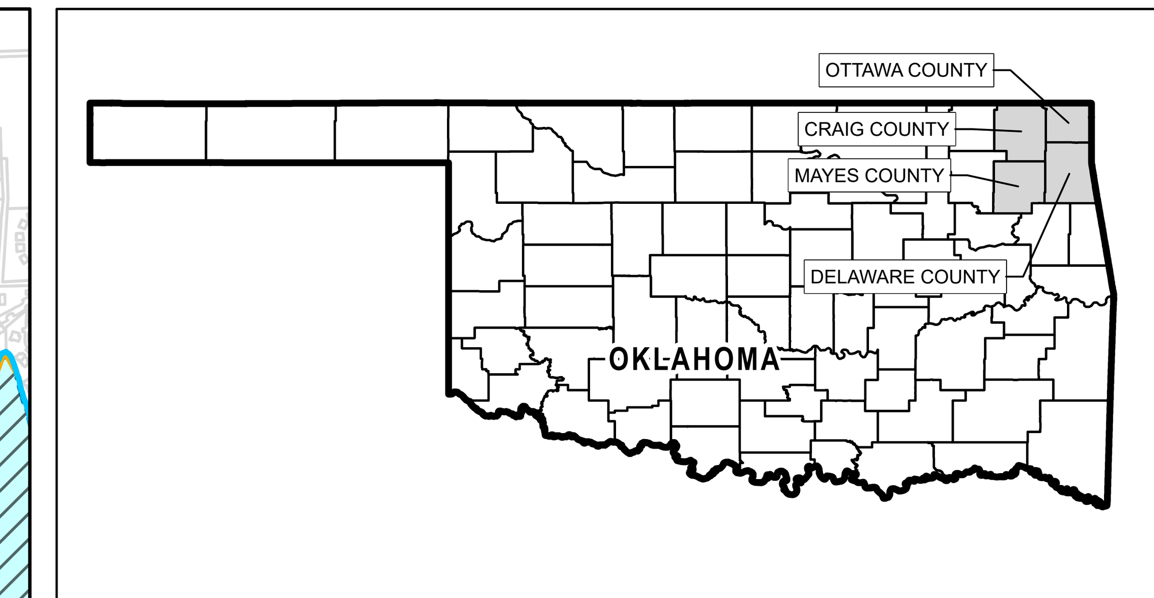
MAP NOTES

1. Assessor data from Mayes, Ottawa, Delaware, and Craig counties is current as of June 2022. Any inaccuracies are in the original datasets. Interpretation of ownership designations is based on descriptive data provided in the Assessors' data. No additional research was conducted to validate the accuracy of the information.
2. The Reservoir shown was developed from the 745 ft Pensacola Datum (PD) contour. Contours (745 ft PD and 750 ft NGVD) where used as a basis for the Project boundary were derived from the Digital Elevation Model (DEM) developed for the Upstream Hydraulic Model (UHM).
3. When the project boundary description references a specific known location in the field, that reference shall govern over graphical location on the Exhibit G in case of conflict.
4. Public Land Survey System (PLSS) obtained from the Oklahoma Water Resources Board (https://home-owrb.opendata.arcgis.com/).
5. National Hydrography Dataset (NHD) data (streams and lakes) were obtained from the National Map Download application (TNM Download at https://viewer.nationalmap.gov/basic/#/).
6.Transportation network, county and municipal boundaries from the Oklahoma Department of Transportation GIS Open Data Portal (https://gis-okdot.opendata.arcgis.com/)
7. Federal lands shown were developed from Bureau of Indian Affairs (BIA) parcel data and Wetland Reserve Program (WRP) easements.

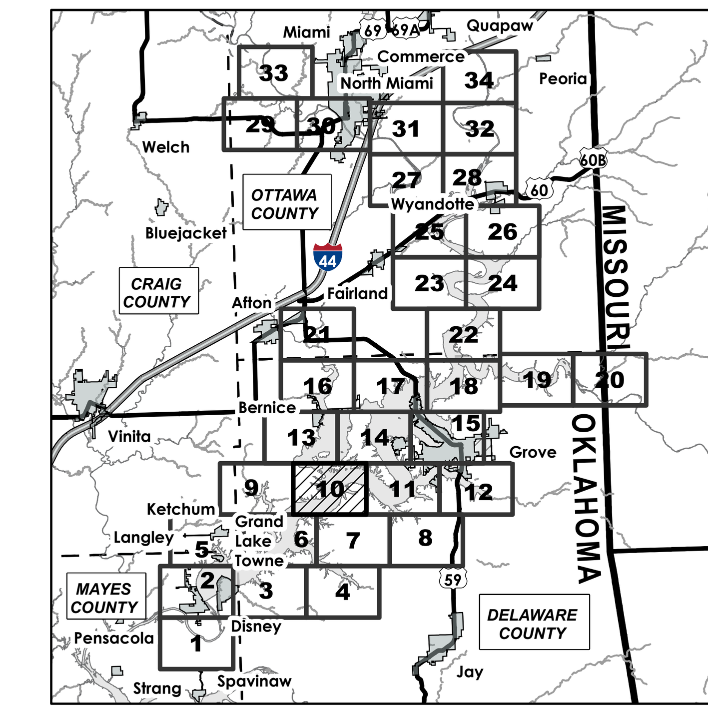
PROJECT BOUNDARY DEFINITION

1. Portions of the anticipated project boundary labeled as "Approved 2014 Project Boundary" are based on the FERC approved project boundary last amended January 27, 2014.
2. Portions of the anticipated project boundary labeled as "Interpolation or Extension" indicate either an interpolated contour line is used to join disconnected segments of equivalent contours or a parcel line extension to connect to a defined contour.
3. Portions of the anticipated project boundary based on contour lines are labeled with the contour and datum upon which they are based.
4. Portions of the anticipated project boundary labeled as "Coincident with parcel line" are intended to follow a parcel boundary. See Map Note #1 for more information on parcel data sources.
5. Portions of the anticipated project boundary labeled as "Metes and bounds/ROW" are defined by a metes and bounds description or an existing ROW.





Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.54°E



Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary

- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township

- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
11	12	Extension line
241	244	Contour elevation 750 ft NGVD 1929
242	242	Contour elevation 750 ft NGVD 1929
252	253	Contour elevation 750 ft NGVD 1929
253	255	Coincident with parcel line
255	256	Parcel line extension
256	258	Contour elevation 750 ft NGVD 1929

EXHIBIT 10

GRAND RIVER DAM AUTHORITY **LANGLEY, OKLAHOMA**

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494

NEOSHO AND GRAND RIVERS

OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

DATE: MAY 2023

MAP NOTES

1. Assessor data from Mayes, Ottawa, Delaware, and Craig counties is current as of June 2022. Any inaccuracies are in the original datasets. Interpretation of ownership designations is based on descriptive data provided in the Assessors' data. No additional research was conducted to validate the accuracy of the information.
2. The Reservoir shown was developed from the 745 ft Pensacola Datum (PD) contour. Contours (745 ft PD and 750 ft NGVD) where used as a basis for the Project boundary were derived from the Digital Elevation Model (DEM) developed for the Upstream Hydraulic Model (UHM).
3. When the project boundary description references a specific known location in the field, that reference shall govern over graphical location on the Exhibit G in case of conflict.
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5. National Hydrography Dataset (NHD) data (streams and lakes) were obtained from the National Map Download application (TNM Download at https://viewer.nationalmap.gov/basic/#/).
6.Transportation network, county and municipal boundaries from the Oklahoma Department of Transportation GIS Open Data Portal (https://gis-okdot.opendata.arcgis.com/)
7. Federal lands shown were developed from Bureau of Indian Affairs (BIA) parcel data and Wetland Reserve Program (WRP) easements.

PROJECT BOUNDARY DEFINITION

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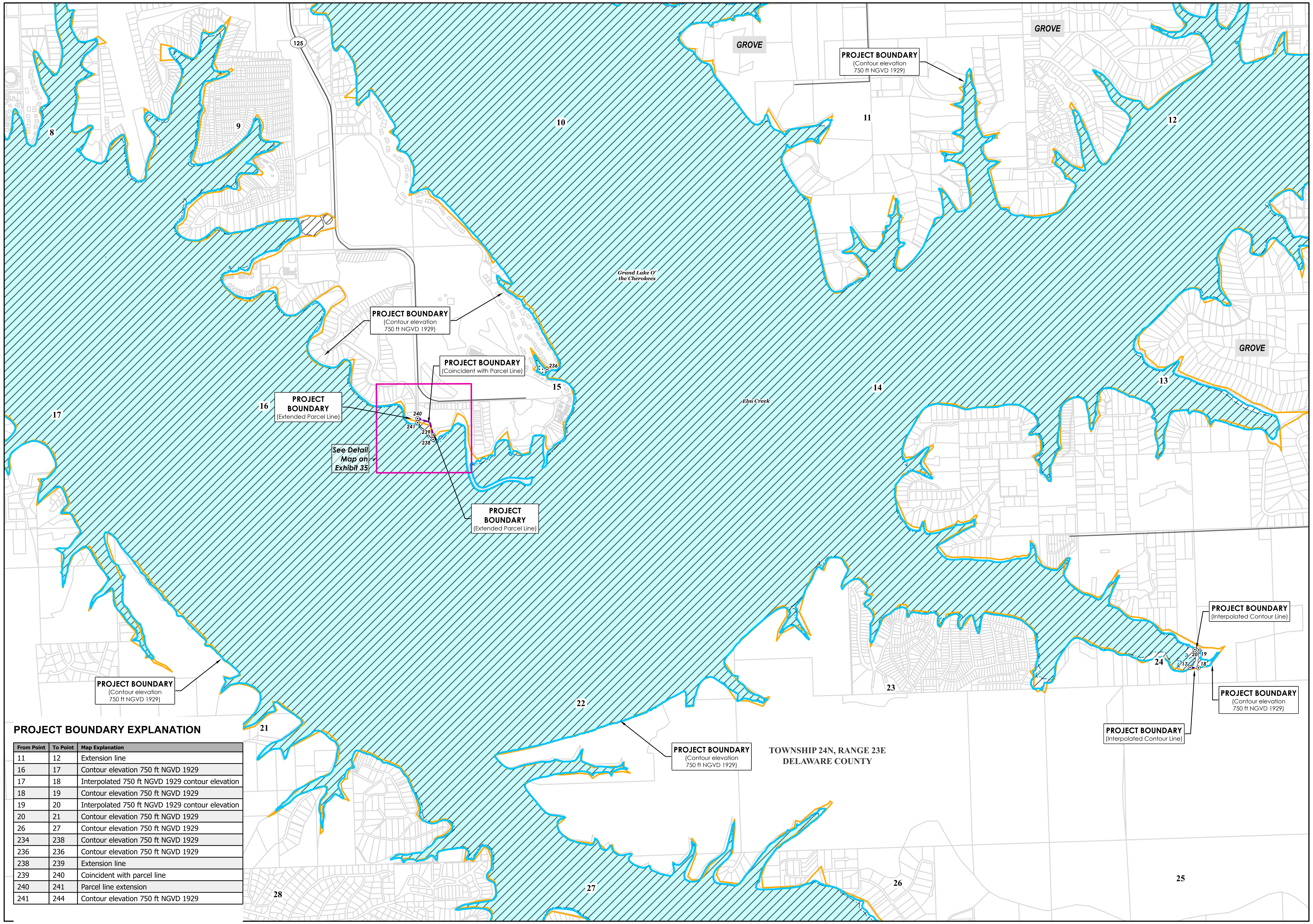
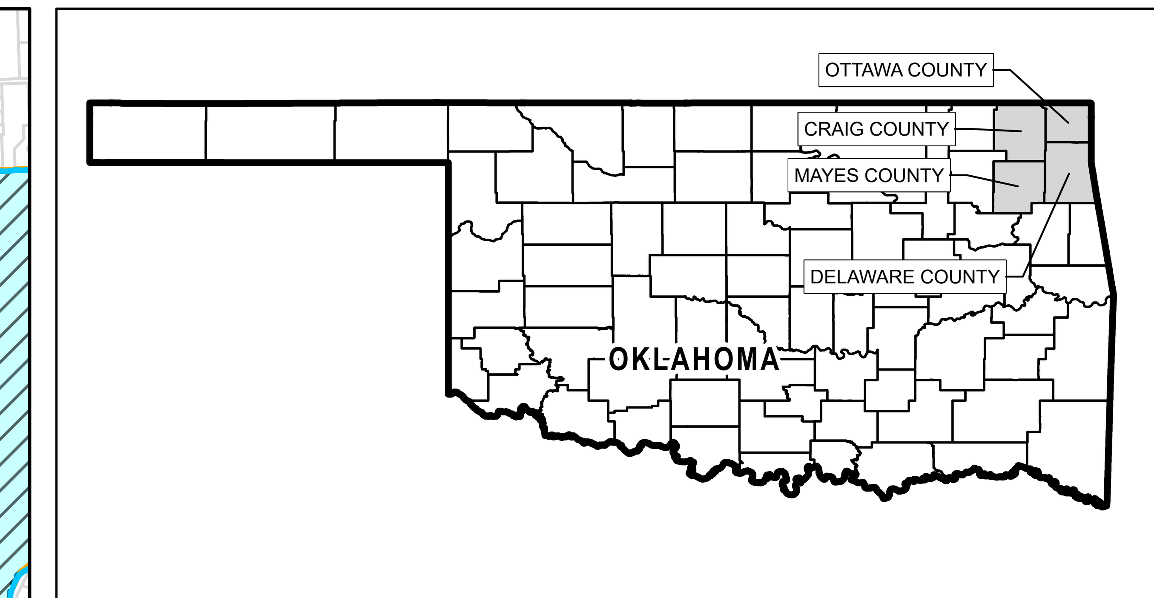
3. Portions of the anticipated project boundary based on contour lines are labeled with the contour and datum upon which they are based.
4. Portions of the anticipated project boundary labeled as "Coincident with parcel line" are intended to follow a parcel boundary. See Map Note #1 for more information on parcel data sources.
5. Portions of the anticipated project boundary labeled as "Metes and bounds/ROW" are defined by a metes and bounds description or an existing ROW.



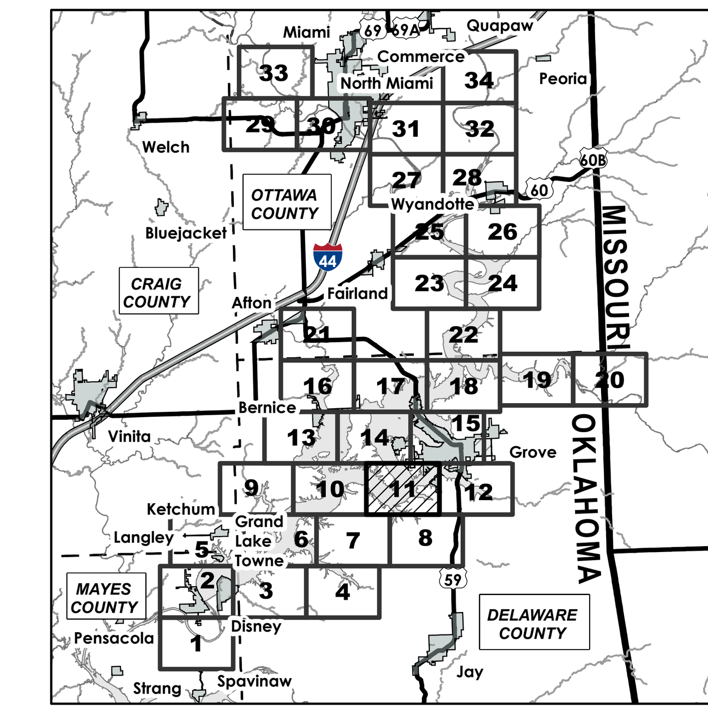
PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
11	12	Extension line
16	17	Contour elevation 750 ft NGVD 1929
17	18	Interpolated 750 ft NGVD 1929 contour elevation
18	19	Contour elevation 750 ft NGVD 1929
19	20	Interpolated 750 ft NGVD 1929 contour elevation
20	21	Contour elevation 750 ft NGVD 1929
26	27	Contour elevation 750 ft NGVD 1929
234	238	Contour elevation 750 ft NGVD 1929
236	236	Contour elevation 750 ft NGVD 1929
238	239	Extension line
239	240	Coincident with parcel line
240	241	Parcel line extension
241	244	Contour elevation 750 ft NGVD 1929



N

Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.49°E



Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 11

GRAND RIVER DAM AUTHORITY LANGLEY, OKLAHOMA

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494

NEOSHO AND GRAND RIVERS

OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

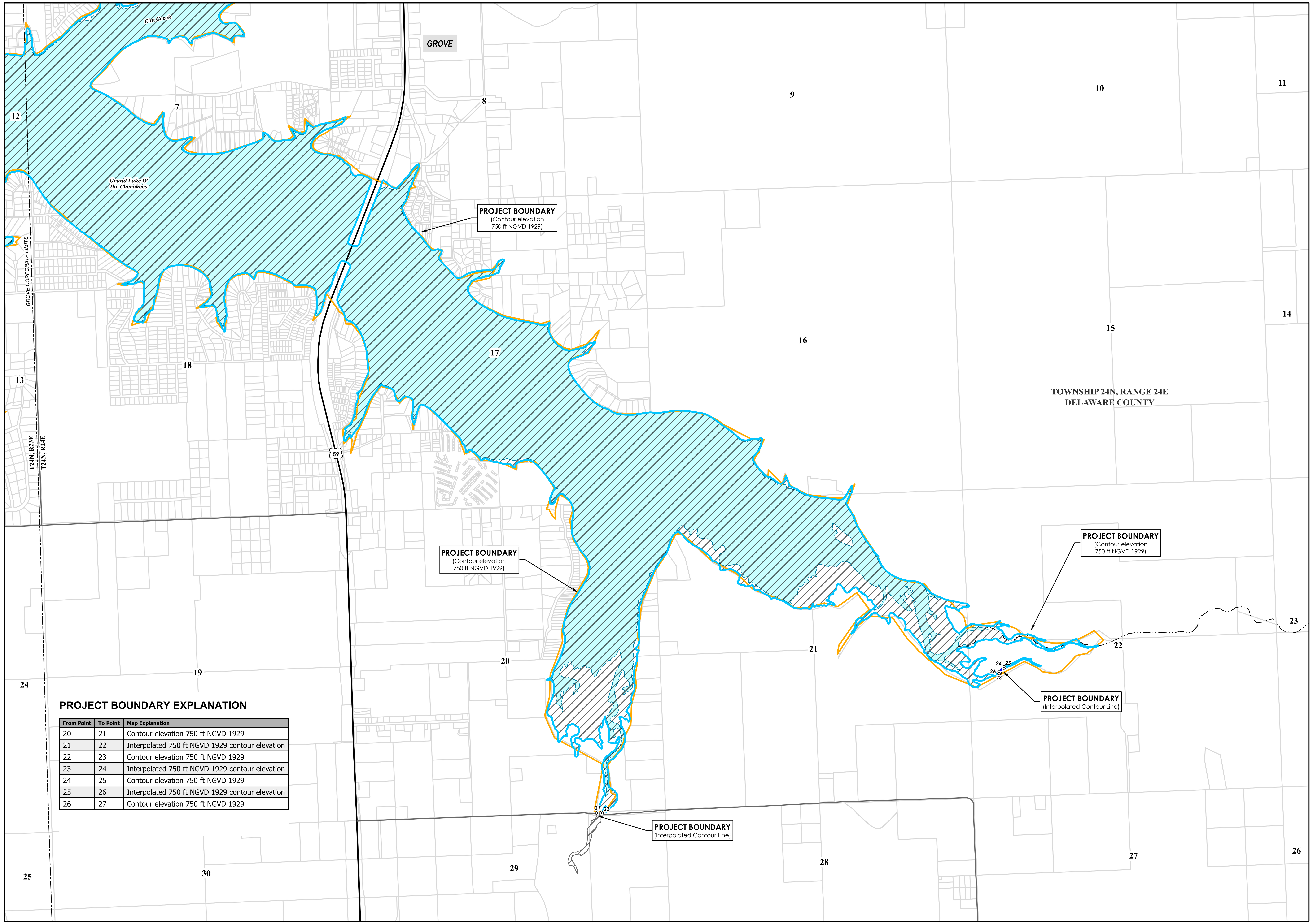
DATE: MAY 2023

MAP NOTES

1. Assessor data from Mayes, Ottawa, Delaware, and Craig counties is current as of June 2022. Any inaccuracies are in the original datasets. Interpretation of ownership designations is based on descriptive data provided in the Assessors' data. No additional research was conducted to validate the accuracy of the information.
2. The Reservoir shown was developed from the 745 ft Pensacola Datum (PD) contour. Contours (745 ft PD and 750 ft NGVD) where used as a basis for the Project boundary were derived from the Digital Elevation Model (DEM) developed for the Upstream Hydraulic Model (UHM).
3. When the project boundary description references a specific known location in the field, that reference shall govern over graphical location on the Exhibit G in case of conflict.
4. Public Land Survey System (PLSS) obtained from the Oklahoma Water Resources Board (https://home-owrb.opendata.arcgis.com/).
5. National Hydrography Dataset (NHD) data (streams and lakes) were obtained from the National Map Download application (TNM Download at https://viewer.nationalmap.gov/basic/#/).
6.Transportation network, county and municipal boundaries from the Oklahoma Department of Transportation GIS Open Data Portal (https://gis-okdot.opendata.arcgis.com/)
7. Federal lands shown were developed from Bureau of Indian Affairs (BIA) parcel data and Wetland Reserve Program (WRP) easements.

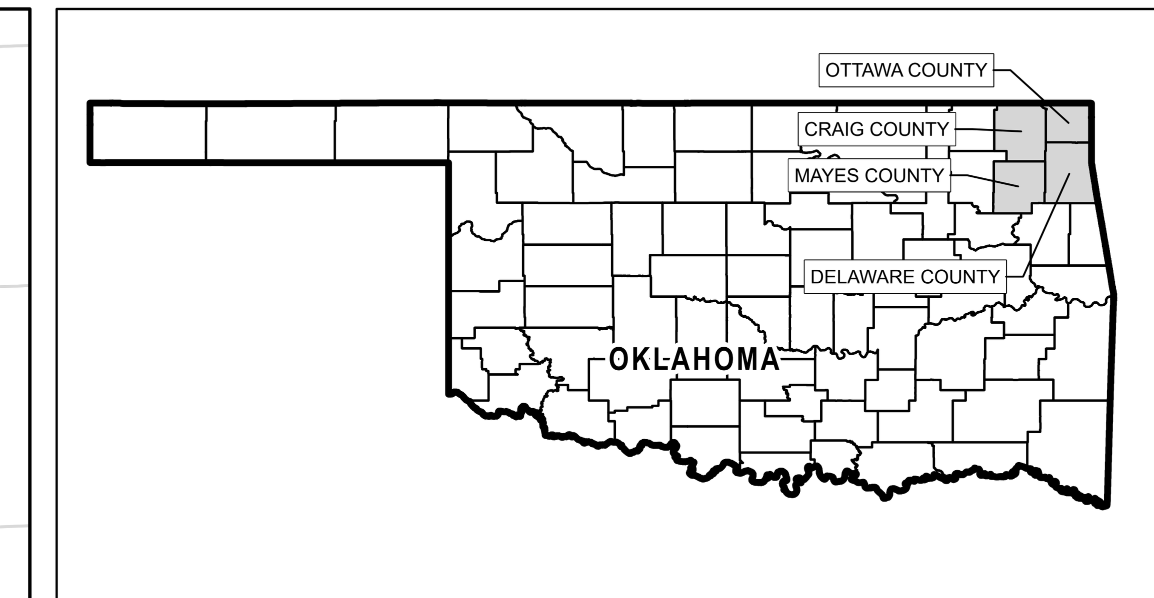
PROJECT BOUNDARY DEFINITION

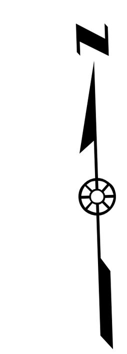
1. Portions of the anticipated project boundary labeled as "Approved 2014 Project Boundary" are based on the FERC approved project boundary last amended January 27, 2014.
2. Portions of the anticipated project boundary labeled as "Interpolation or Extension" indicate either an interpolated contour line is used to join disconnected segments of equivalent contours or a parcel line extension to connect to a defined contour.
3. Portions of the anticipated project boundary based on contour lines are labeled with the contour and datum upon which they are based.
4. Portions of the anticipated project boundary labeled as "Coincident with parcel line" are intended to follow a parcel boundary. See Map Note #1 for more information on parcel data sources.
5. Portions of the anticipated project boundary labeled as "Metes and bounds/ROW" are defined by a metes and bounds description or an existing ROW.



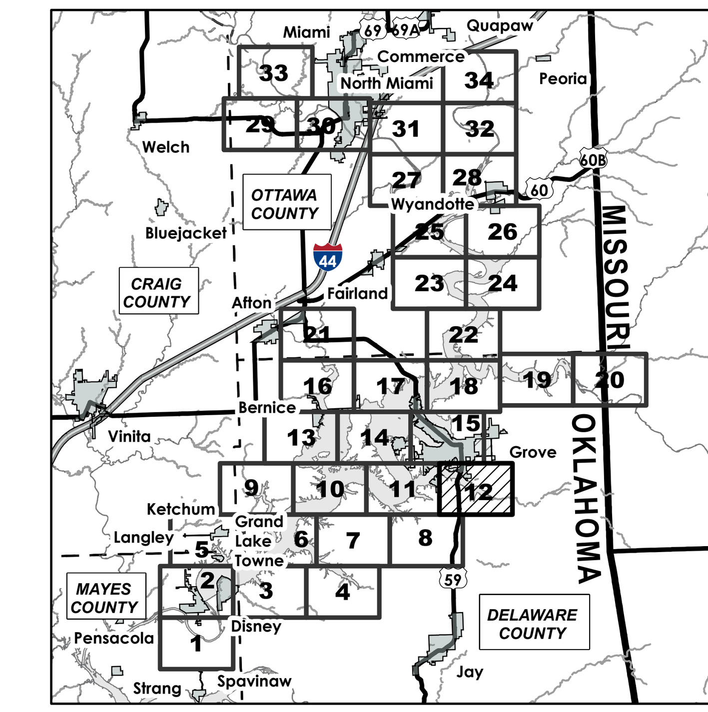
PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
20	21	Contour elevation 750 ft NGVD 1929
21	22	Interpolated 750 ft NGVD 1929 contour elevation
22	23	Contour elevation 750 ft NGVD 1929
23	24	Interpolated 750 ft NGVD 1929 contour elevation
24	25	Contour elevation 750 ft NGVD 1929
25	26	Interpolated 750 ft NGVD 1929 contour elevation
26	27	Contour elevation 750 ft NGVD 1929





Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.44°E



Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 12

GRAND RIVER DAM AUTHORITY LANGLEY, OKLAHOMA

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494
NEOSHO AND GRAND RIVERS
OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

DATE: MAY 2023

MAP NOTES

1. Assessor data from Mayes, Ottawa, Delaware, and Craig counties is current as of June 2022. Any inaccuracies are in the original datasets. Interpretation of ownership designations is based on descriptive data provided in the Assessors' data. No additional research was conducted to validate the accuracy of the information.
2. The Reservoir shown was developed from the 745 ft Pensacola Datum (PD) contour. Contours (745 ft PD and 750 ft NGVD) where used as a basis for the Project boundary were derived from the Digital Elevation Model (DEM) developed for the Upstream Hydraulic Model (UHM).
3. When the project boundary description references a specific known location in the field, that reference shall govern over graphical location on the Exhibit G in case of conflict.
4. Public Land Survey System (PLSS) obtained from the Oklahoma Water Resources Board (https://home-owrb.opendata.arcgis.com/).
5. National Hydrography Dataset (NHD) data (streams and lakes) were obtained from the National Map Download application (TNM Download at https://viewer.nationalmap.gov/basic/#/).
6.Transportation network, county and municipal boundaries from the Oklahoma Department of Transportation GIS Open Data Portal (https://gis-okdot.opendata.arcgis.com/)
7. Federal lands shown were developed from Bureau of Indian Affairs (BIA) parcel data and Wetland Reserve Program (WRP) easements.

PROJECT BOUNDARY DEFINITION

1. Portions of the anticipated project boundary labeled as "Approved 2014 Project Boundary" are based on the FERC approved project boundary last amended January 27, 2014.
2. Portions of the anticipated project boundary labeled as "Interpolation or Extension" indicate either an interpolated contour line is used to join disconnected segments of equivalent contours or a parcel line extension to connect to a defined contour.
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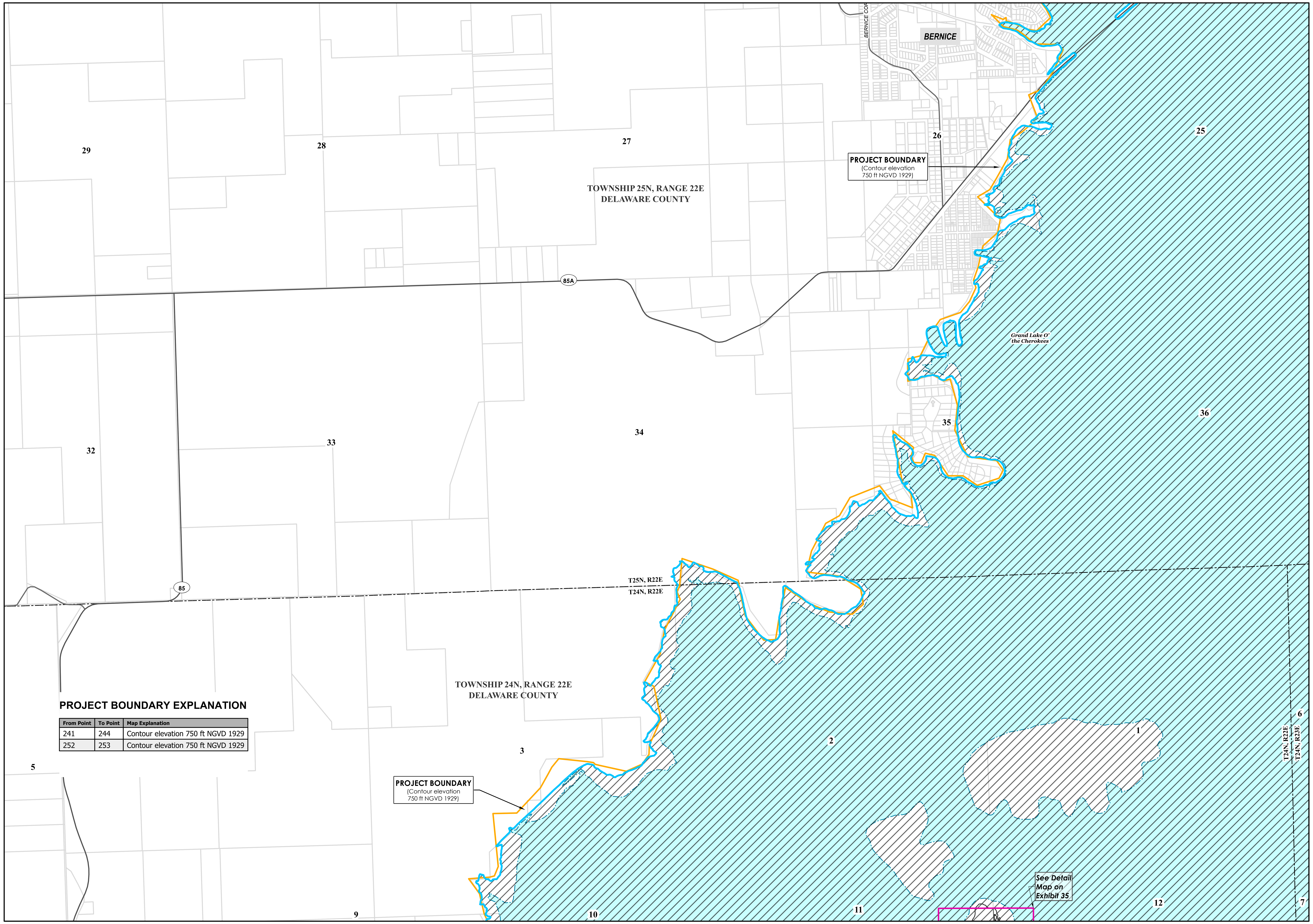
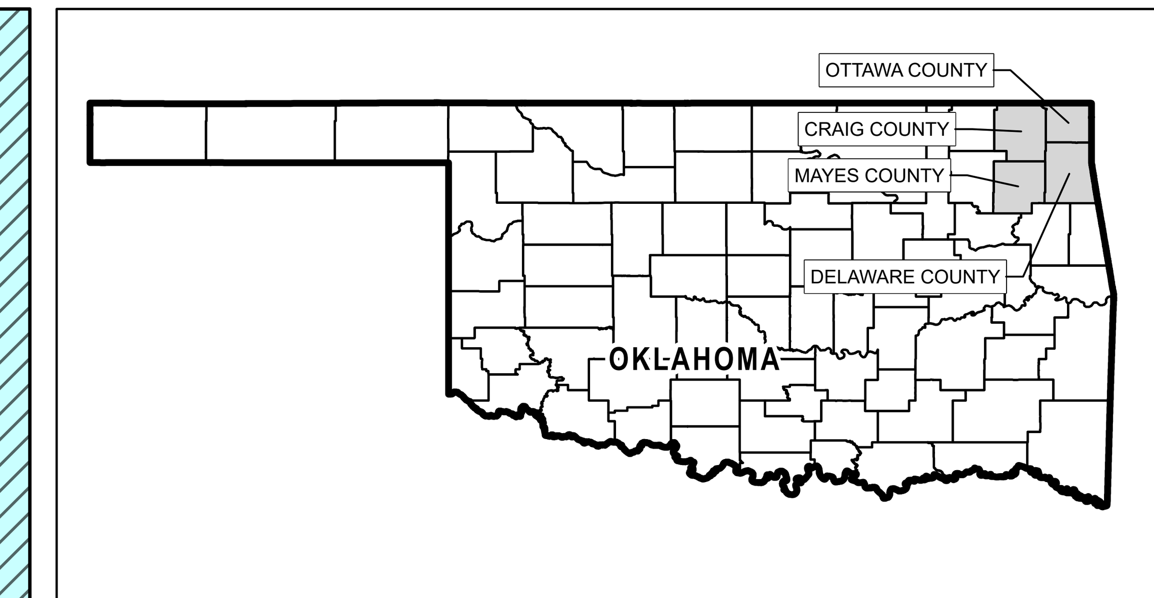
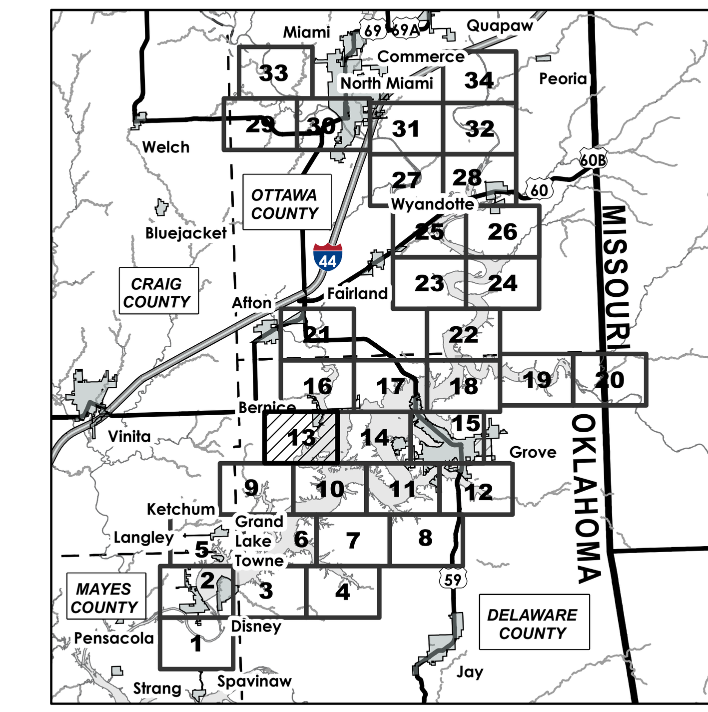


PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
241	244	Contour elevation 750 ft NGVD 1929
252	253	Contour elevation 750 ft NGVD 1929





Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.56°E

Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 13

GRAND RIVER DAM AUTHORITY LANGLEY, OKLAHOMA

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494

NEOSHO AND GRAND RIVERS

OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

DATE: MAY 2023

MAP NOTES

1. Assessor data from Mayes, Ottawa, Delaware, and Craig counties is current as of June 2022. Any inaccuracies are in the original datasets. Interpretation of ownership designations is based on descriptive data provided in the Assessors' data. No additional research was conducted to validate the accuracy of the information.
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5. National Hydrography Dataset (NHD) data (streams and lakes) were obtained from the National Map Download application (TNM Download at https://viewer.nationalmap.gov/basic/#/).
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PROJECT BOUNDARY DEFINITION

1. Portions of the anticipated project boundary labeled as "Approved 2014 Project Boundary" are based on the FERC approved project boundary last amended January 27, 2014.
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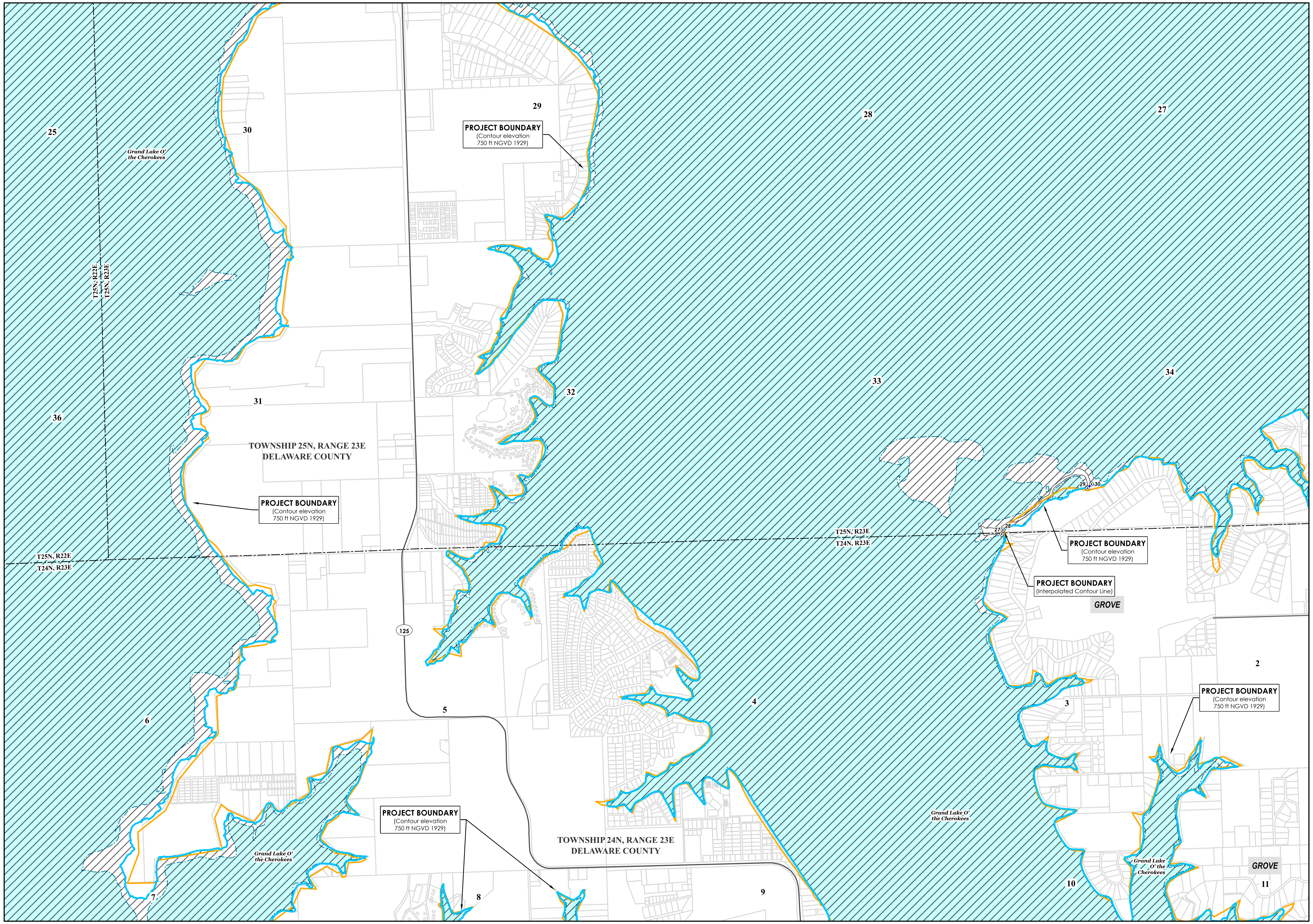
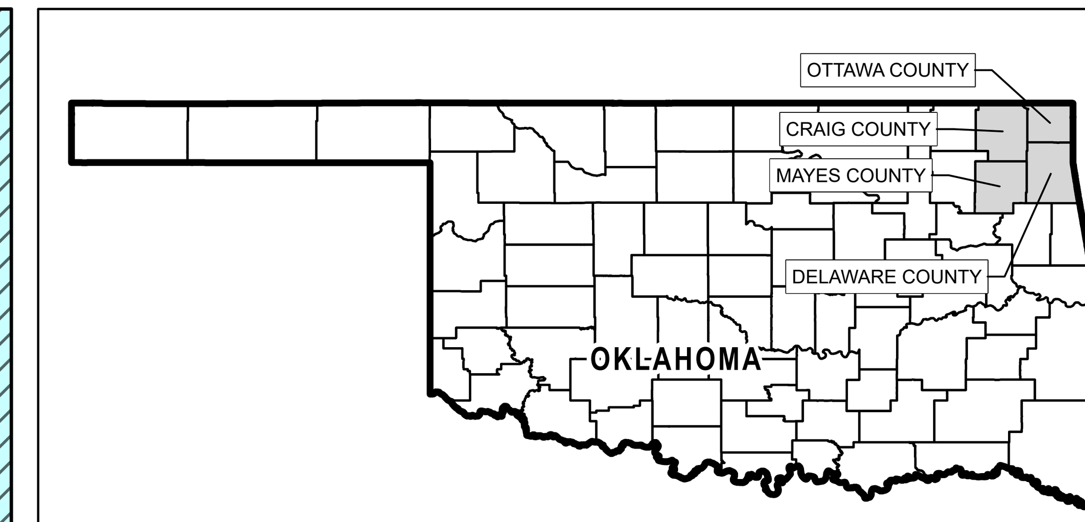
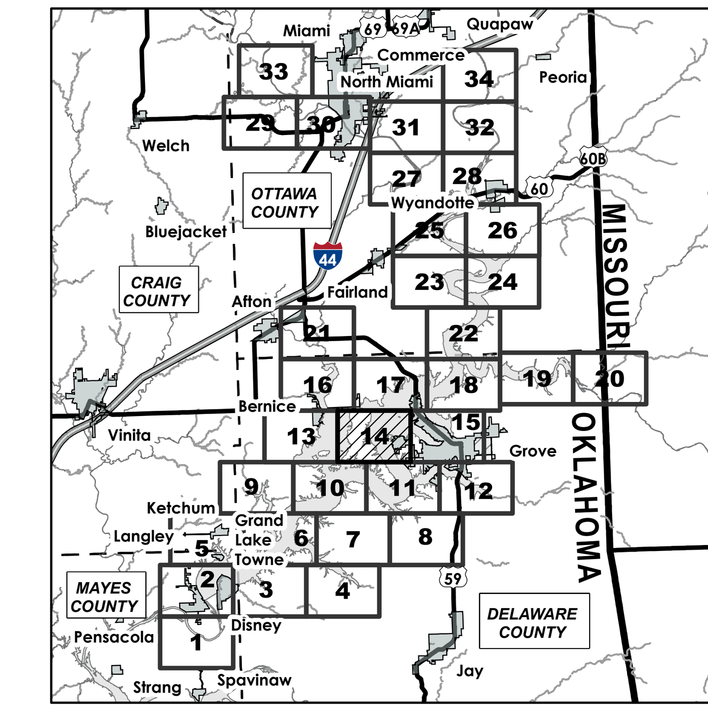




Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.5°E



Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 14

GRAND RIVER DAM AUTHORITY LANGLEY, OKLAHOMA

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494
NEOSHO AND GRAND RIVERS
OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

DATE: MAY 2023

PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
26	27	Contour elevation 750 ft NGVD 1929
27	28	Interpolated 750 ft NGVD 1929 contour elevation
28	29	Contour elevation 750 ft NGVD 1929
29	30	Interpolated 750 ft NGVD 1929 contour elevation
30	32	Contour elevation 750 ft NGVD 1929
234	238	Contour elevation 750 ft NGVD 1929
241	244	Contour elevation 750 ft NGVD 1929

MAP NOTES

1. Assessor data from Mayes, Ottawa, Delaware, and Craig counties is current as of June 2022. Any inaccuracies are in the original datasets. Interpretation of ownership designations is based on descriptive data provided in the Assessors' data. No additional research was conducted to validate the accuracy of the information.
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4. Public Land Survey System (PLSS) obtained from the Oklahoma Water Resources Board (https://home-owrb.opendata.arcgis.com/).
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PROJECT BOUNDARY DEFINITION

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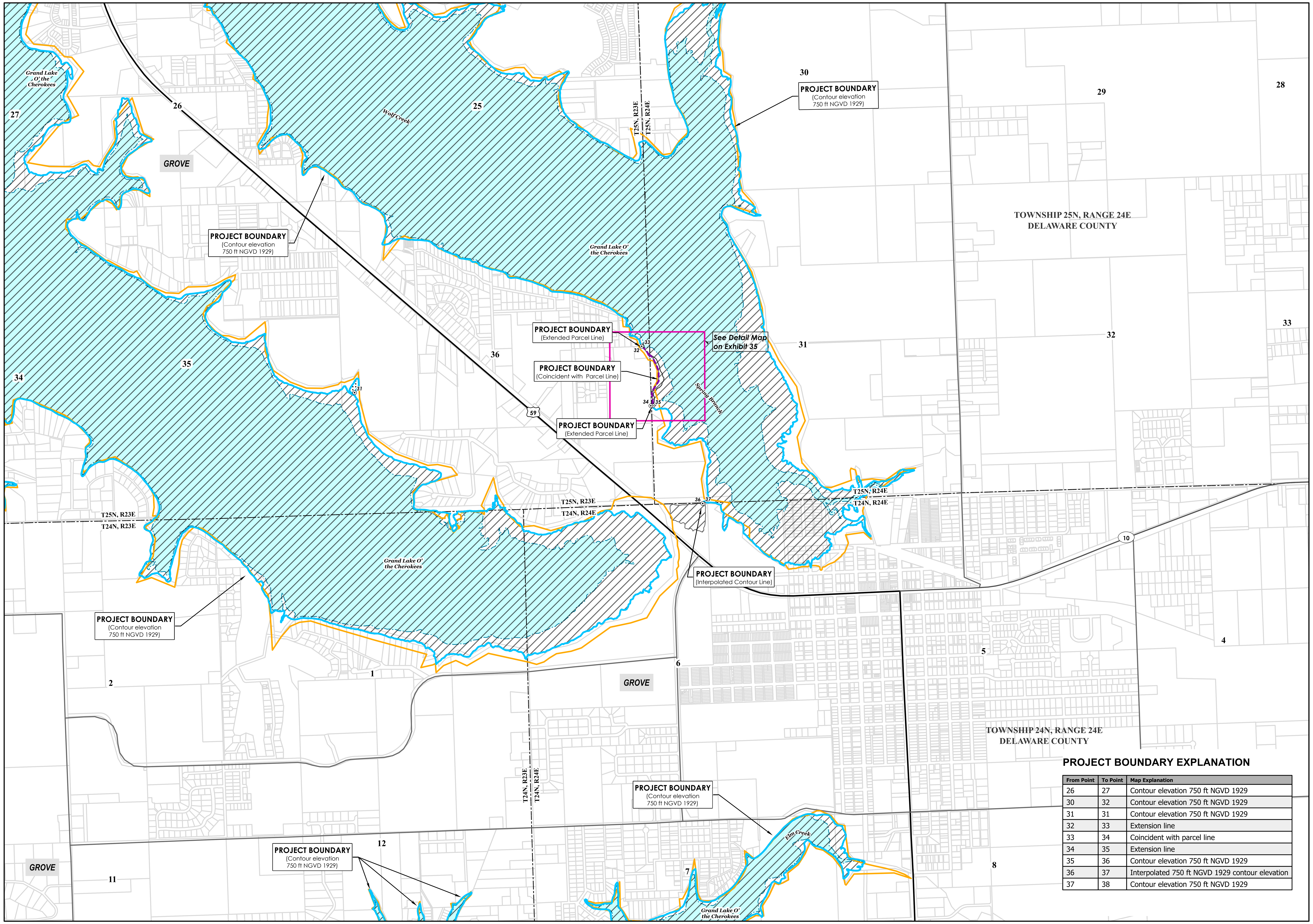
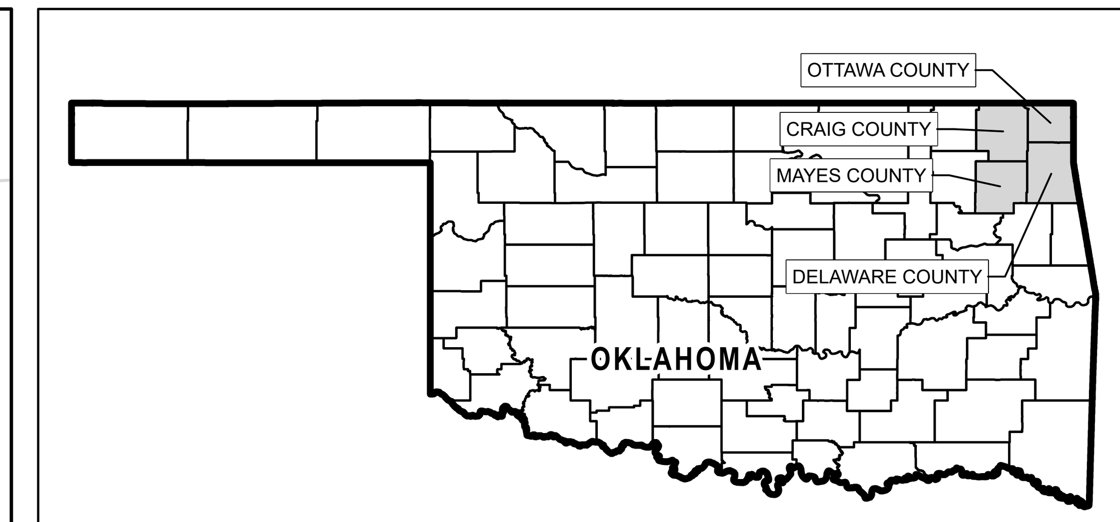
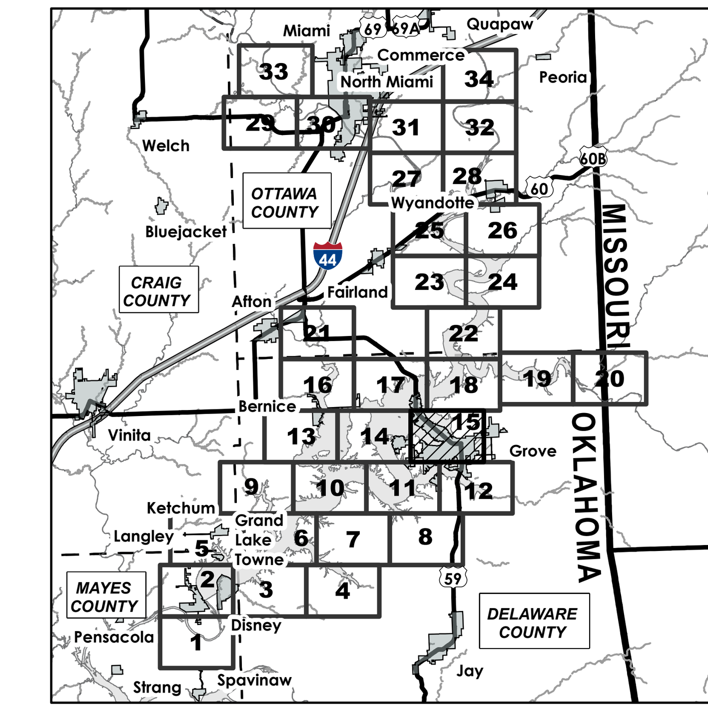


PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
26	27	Contour elevation 750 ft NGVD 1929
30	32	Contour elevation 750 ft NGVD 1929
31	31	Contour elevation 750 ft NGVD 1929
32	33	Extension line
33	34	Coincident with parcel line
34	35	Extension line
35	36	Contour elevation 750 ft NGVD 1929
36	37	Interpolated 750 ft NGVD 1929 contour elevation
37	38	Contour elevation 750 ft NGVD 1929





Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.45°E

Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 15

GRAND RIVER DAM AUTHORITY LANGLEY, OKLAHOMA

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494
NEOSHO AND GRAND RIVERS
OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

DATE: MAY 2023

MAP NOTES

1. Assessor data from Mayes, Ottawa, Delaware, and Craig counties is current as of June 2022. Any inaccuracies are in the original datasets. Interpretation of ownership designations is based on descriptive data provided in the Assessors' data. No additional research was conducted to validate the accuracy of the information.
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PROJECT BOUNDARY DEFINITION

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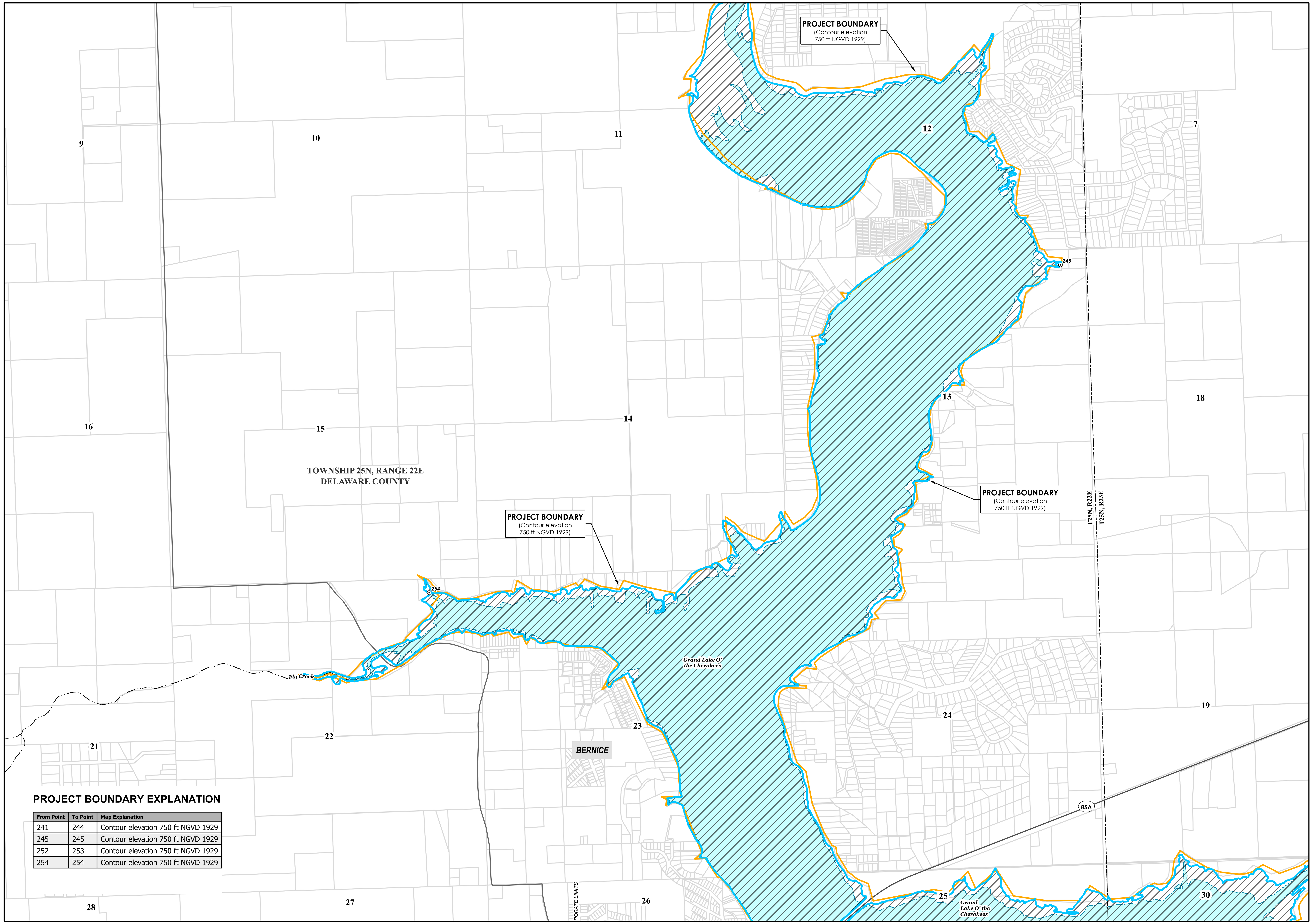
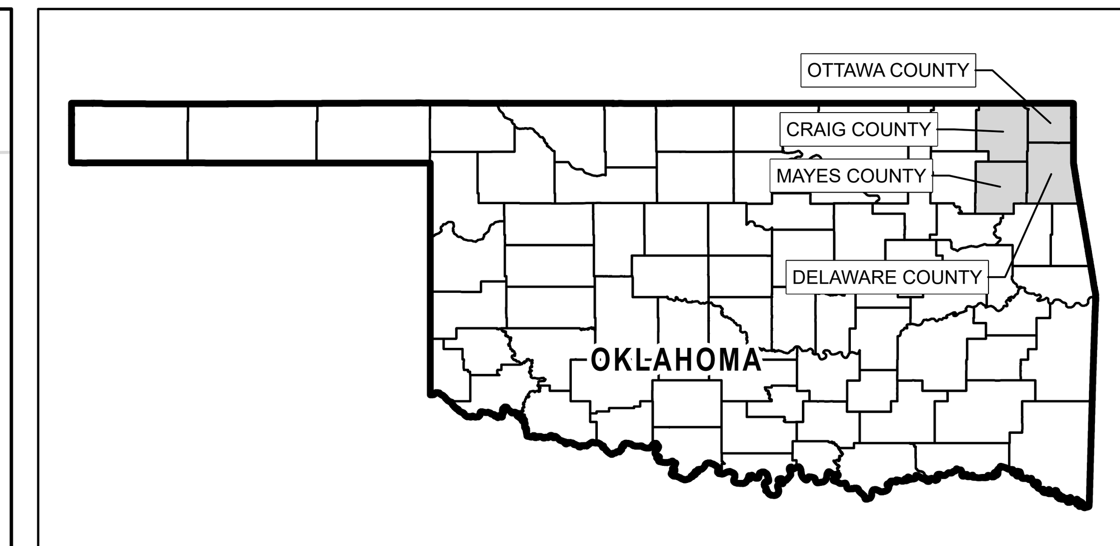
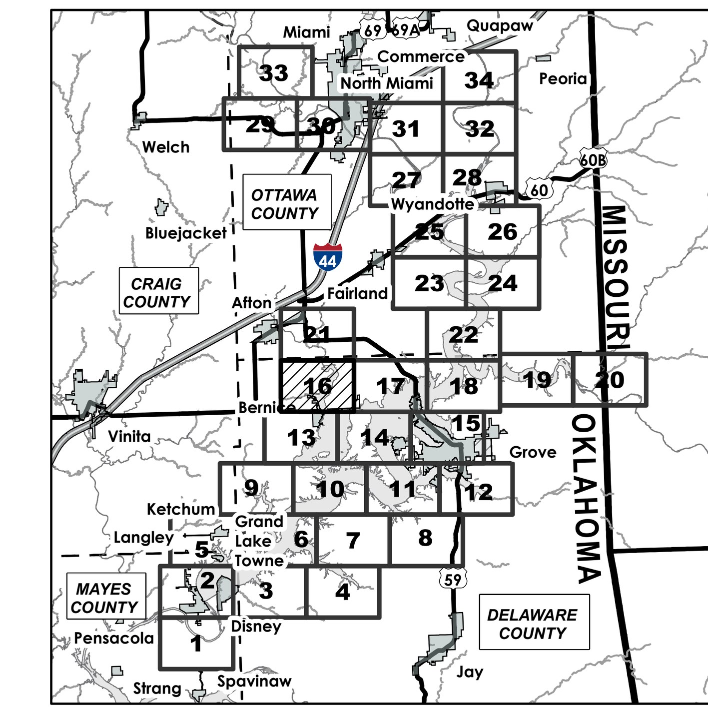


PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
241	244	Contour elevation 750 ft NGVD 1929
245	245	Contour elevation 750 ft NGVD 1929
252	253	Contour elevation 750 ft NGVD 1929
254	254	Contour elevation 750 ft NGVD 1929





N

Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.54°E

Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 16

GRAND RIVER DAM AUTHORITY **LANGLEY, OKLAHOMA**

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494

NEOSHO AND GRAND RIVERS
OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

DATE: MAY 2023

MAP NOTES

1. Assessor data from Mayes, Ottawa, Delaware, and Craig counties is current as of June 2022. Any inaccuracies are in the original datasets. Interpretation of ownership designations is based on descriptive data provided in the Assessors' data. No additional research was conducted to validate the accuracy of the information.
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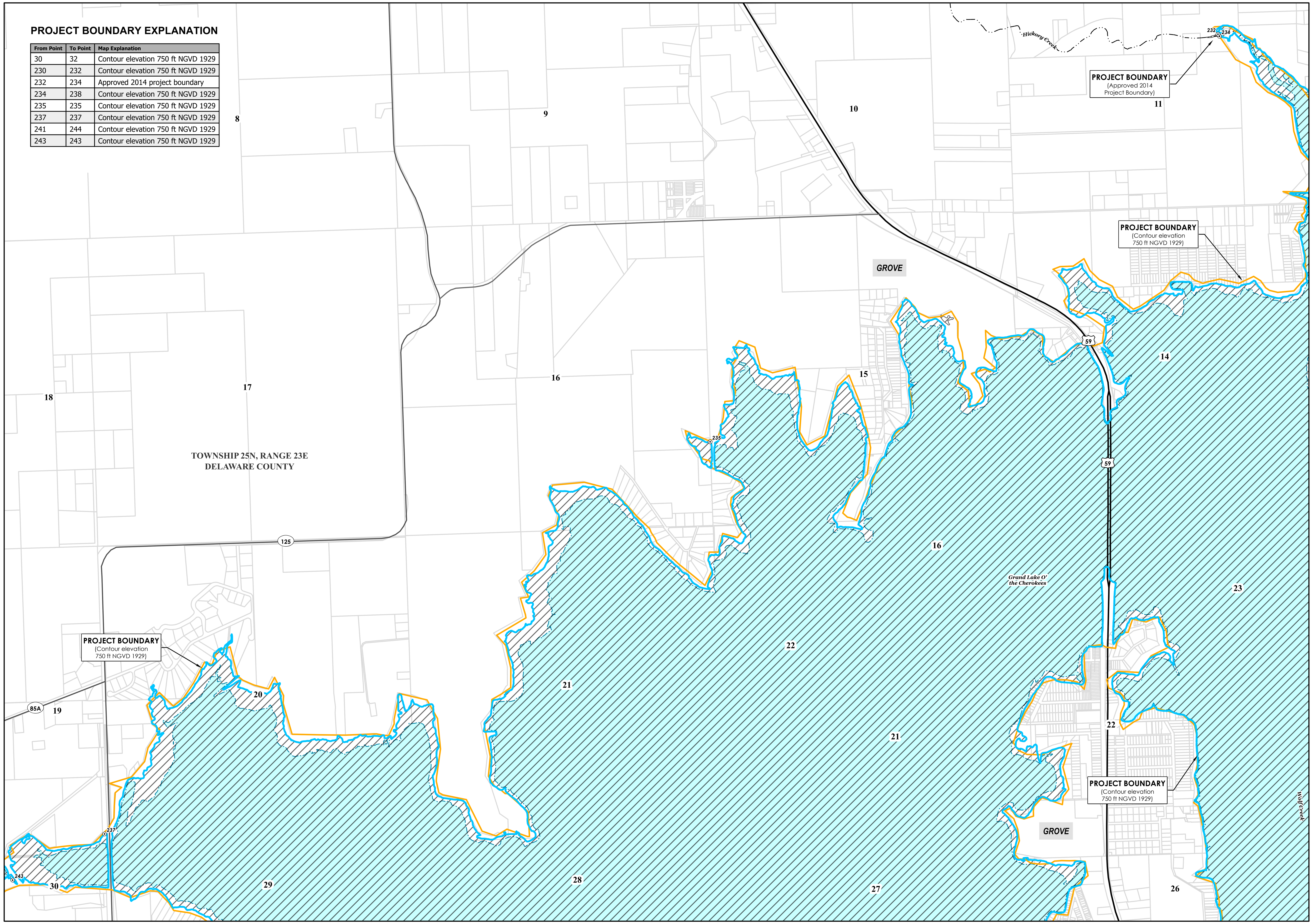
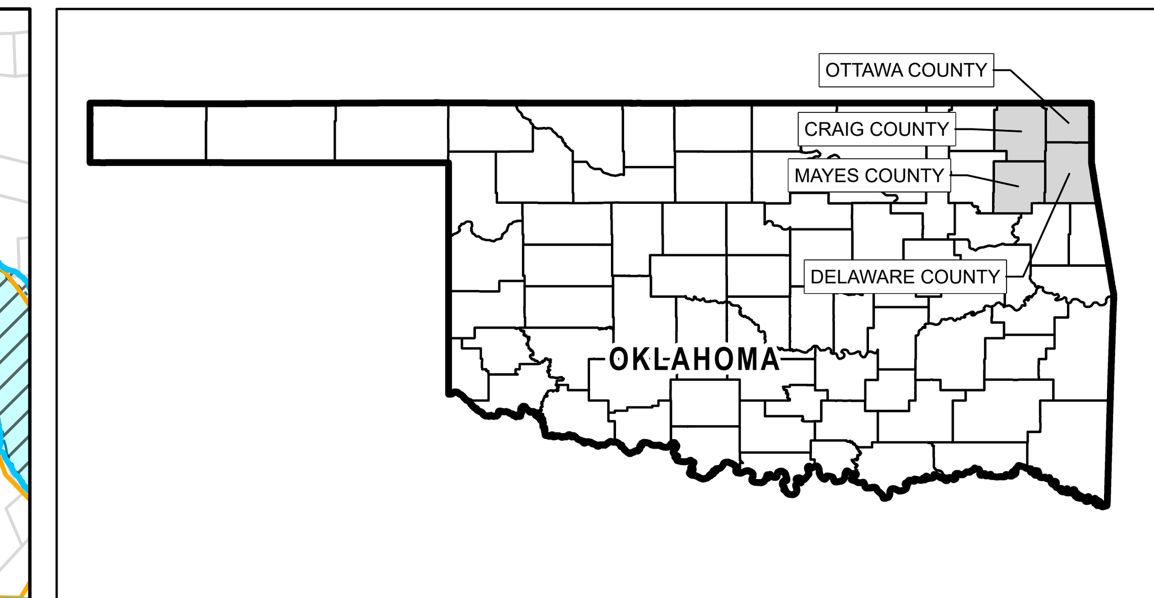
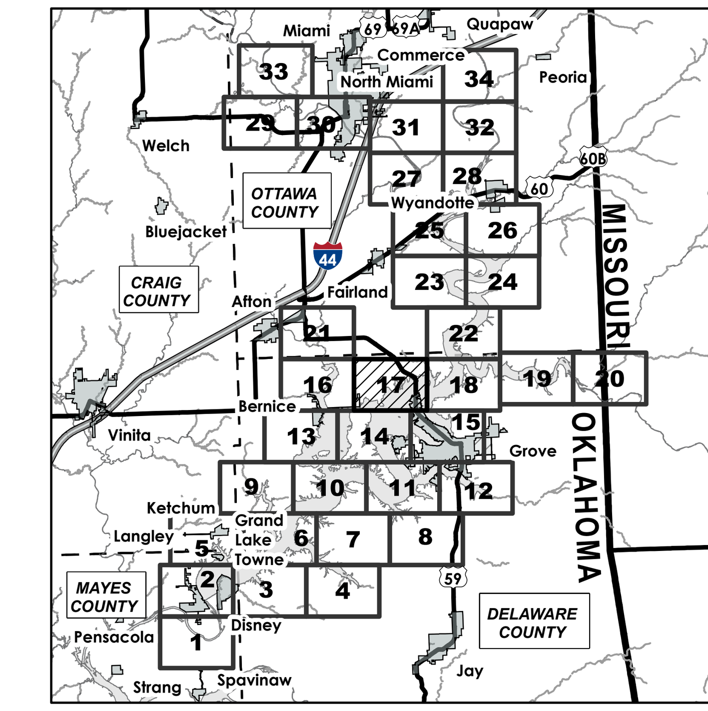
PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
30	32	Contour elevation 750 ft NGVD 1929
230	232	Contour elevation 750 ft NGVD 1929
232	234	Approved 2014 project boundary
234	238	Contour elevation 750 ft NGVD 1929
235	235	Contour elevation 750 ft NGVD 1929
237	237	Contour elevation 750 ft NGVD 1929
241	244	Contour elevation 750 ft NGVD 1929
243	243	Contour elevation 750 ft NGVD 1929







Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.49°E

Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary

- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township

- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 17

GRAND RIVER DAM AUTHORITY **LANGLEY, OKLAHOMA**

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494

NEOSHO AND GRAND RIVERS

OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

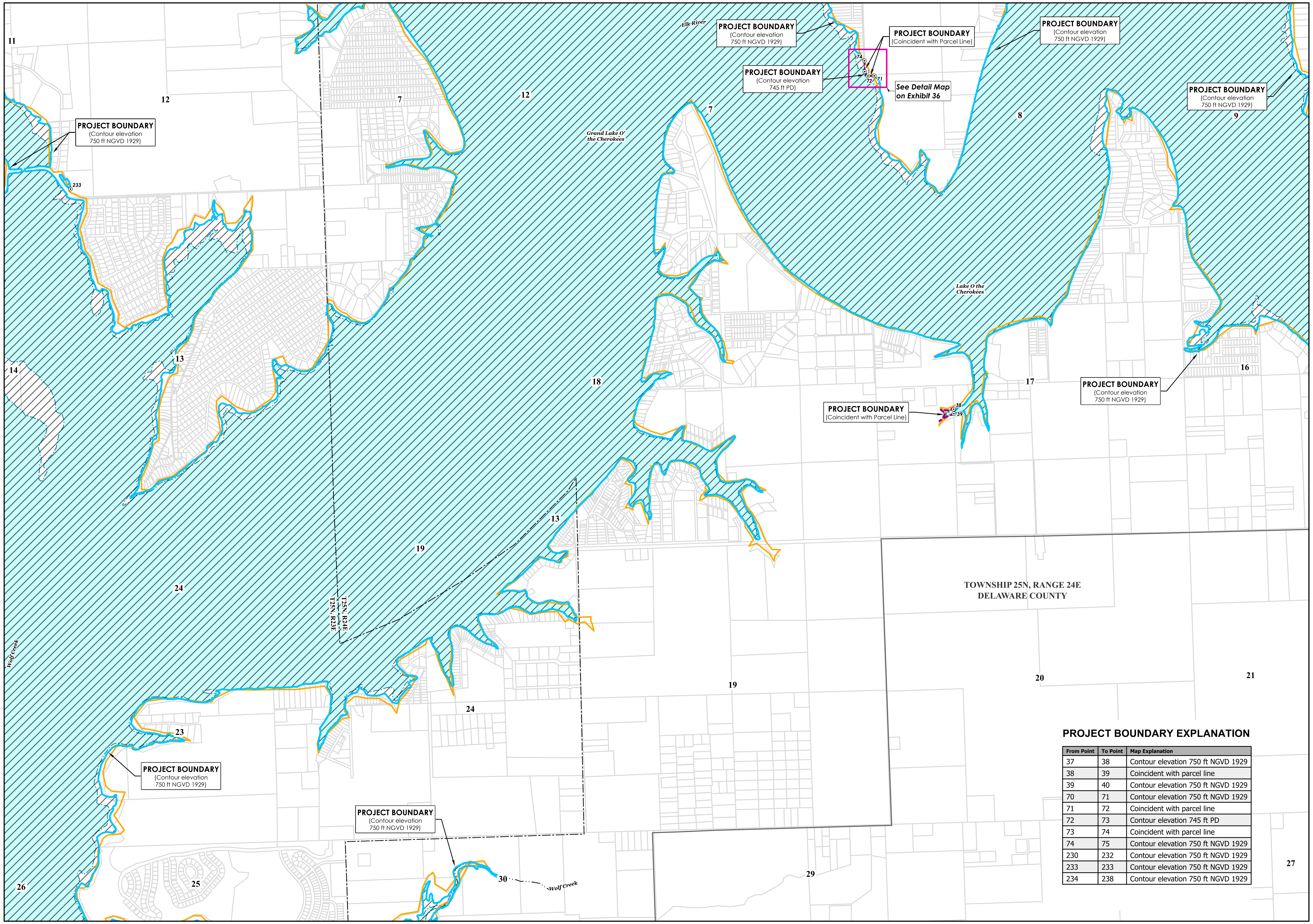
DATE: MAY 2023

MAP NOTES

1. Assessor data from Mayes, Ottawa, Delaware, and Craig counties is current as of June 2022. Any inaccuracies are in the original datasets. Interpretation of ownership designations is based on descriptive data provided in the Assessors' data. No additional research was conducted to validate the accuracy of the information.
2. The Reservoir shown was developed from the 745 ft Pensacola Datum (PD) contour. Contours (745 ft PD and 750 ft NGVD) where used as a basis for the Project boundary were derived from the Digital Elevation Model (DEM) developed for the Upstream Hydraulic Model (UHM).
3. When the project boundary description references a specific known location in the field, that reference shall govern over graphical location on the Exhibit G in case of conflict.
4. Public Land Survey System (PLSS) obtained from the Oklahoma Water Resources Board (https://home-owrb.opendata.arcgis.com/).
5. National Hydrography Dataset (NHD) data (streams and lakes) were obtained from the National Map Download application (TNM Download at https://viewer.nationalmap.gov/basic/#/).
6.Transportation network, county and municipal boundaries from the Oklahoma Department of Transportation GIS Open Data Portal (https://gis-okdot.opendata.arcgis.com/)
7. Federal lands shown were developed from Bureau of Indian Affairs (BIA) parcel data and Wetland Reserve Program (WRP) easements.

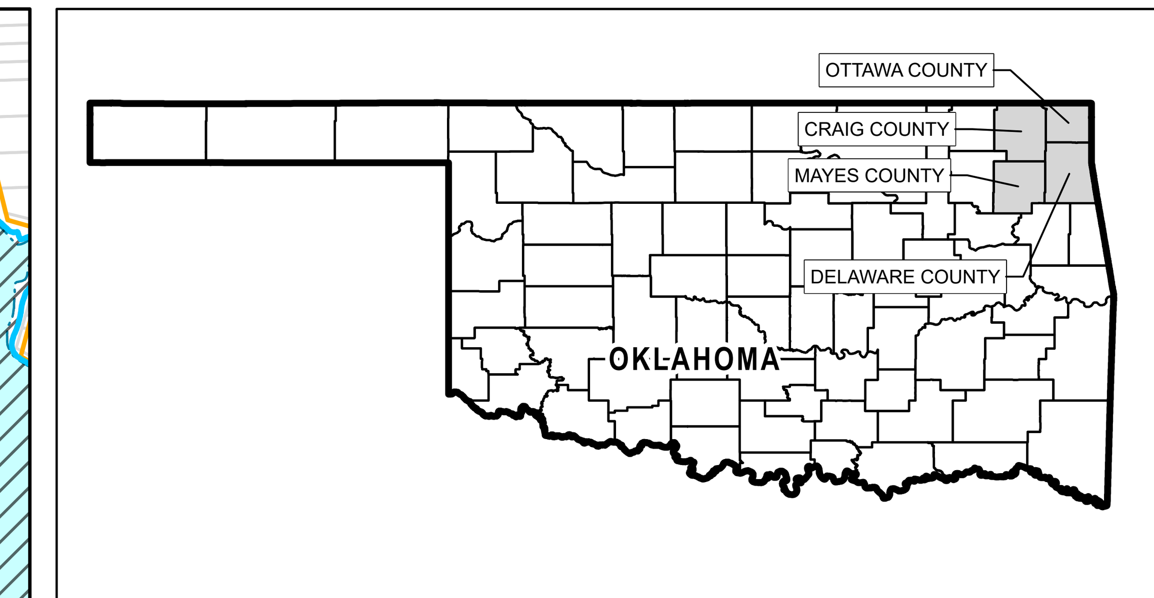
PROJECT BOUNDARY DEFINITION

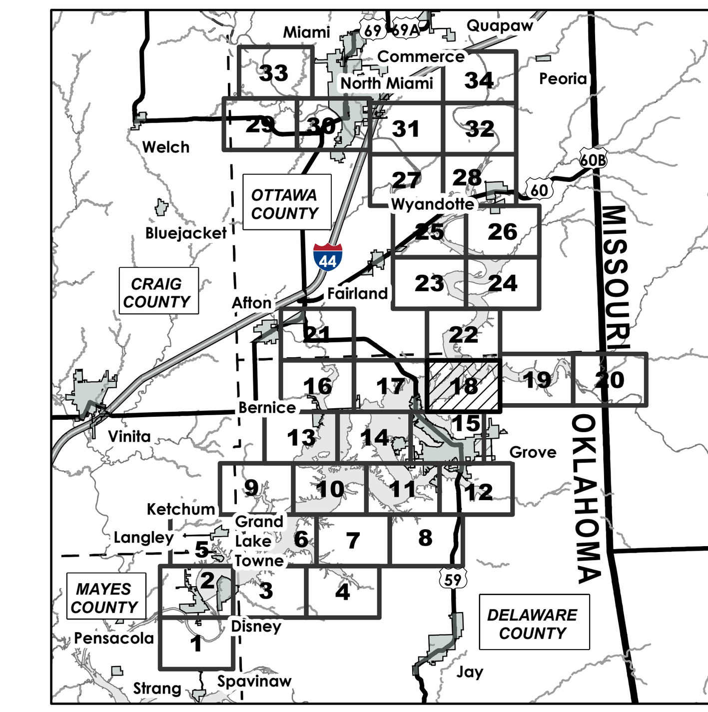
1. Portions of the anticipated project boundary labeled as "Approved 2014 Project Boundary" are based on the FERC approved project boundary last amended January 27, 2014.
2. Portions of the anticipated project boundary labeled as "Interpolation or Extension" indicate either an interpolated contour line is used to join disconnected segments of equivalent contours or a parcel line extension to connect to a defined contour.
3. Portions of the anticipated project boundary based on contour lines are labeled with the contour and datum upon which they are based.
4. Portions of the anticipated project boundary labeled as "Coincident with parcel line" are intended to follow a parcel boundary. See Map Note #1 for more information on parcel data sources.
5. Portions of the anticipated project boundary labeled as "Metes and bounds/ROW" are defined by a metes and bounds description or an existing ROW.



PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
37	38	Contour elevation 750 ft NGVD 1929
38	39	Coincident with parcel line
39	40	Contour elevation 750 ft NGVD 1929
70	71	Contour elevation 750 ft NGVD 1929
71	72	Coincident with parcel line
72	73	Contour elevation 745 ft PD
73	74	Coincident with parcel line
74	75	Contour elevation 750 ft NGVD 1929
230	232	Contour elevation 750 ft NGVD 1929
233	233	Contour elevation 750 ft NGVD 1929
234	238	Contour elevation 750 ft NGVD 1929





Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.44°E

Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 18

GRAND RIVER DAM AUTHORITY — LANGLEY, OKLAHOMA

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494

NEOSHO AND GRAND RIVERS

OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

DATE: MAY 2023

MAP NOTES

1. Assessor data from Mayes, Ottawa, Delaware, and Craig counties is current as of June 2022. Any inaccuracies are in the original datasets. Interpretation of ownership designations is based on descriptive data provided in the Assessors' data. No additional research was conducted to validate the accuracy of the information.
2. The Reservoir shown was developed from the 745 ft Pensacola Datum (PD) contour. Contours (745 ft PD and 750 ft NGVD) where used as a basis for the Project boundary were derived from the Digital Elevation Model (DEM) developed for the Upstream Hydraulic Model (UHM).
3. When the project boundary description references a specific known location in the field, that reference shall govern over graphical location on the Exhibit G in case of conflict.
4. Public Land Survey System (PLSS) obtained from the Oklahoma Water Resources Board (https://home-owrb.opendata.arcgis.com/).
5. National Hydrography Dataset (NHD) data (streams and lakes) were obtained from the National Map Download application (TNM Download at https://viewer.nationalmap.gov/basic/#/).
6.Transportation network, county and municipal boundaries from the Oklahoma Department of Transportation GIS Open Data Portal (https://gis-okdot.opendata.arcgis.com/)
7. Federal lands shown were developed from Bureau of Indian Affairs (BIA) parcel data and Wetland Reserve Program (WRP) easements.

PROJECT BOUNDARY DEFINITION

1. Portions of the anticipated project boundary labeled as "Approved 2014 Project Boundary" are based on the FERC approved project boundary last amended January 27, 2014.
2. Portions of the anticipated project boundary labeled as "Interpolation or Extension" indicate either an interpolated contour line is used to join disconnected segments of equivalent contours or a parcel line extension to connect to a defined contour.
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4. Portions of the anticipated project boundary labeled as "Coincident with parcel line" are intended to follow a parcel boundary. See Map Note #1 for more information on parcel data sources.
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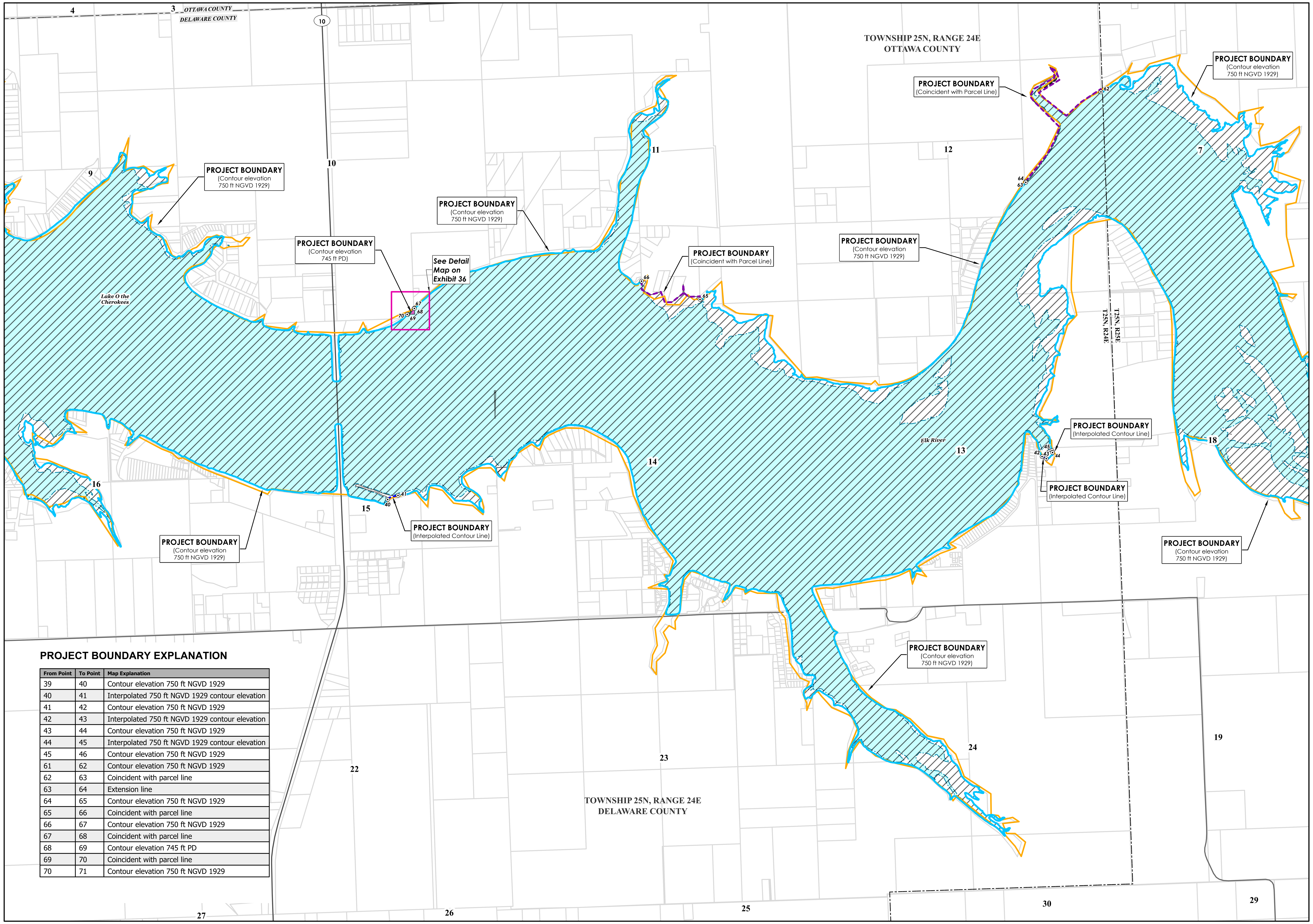
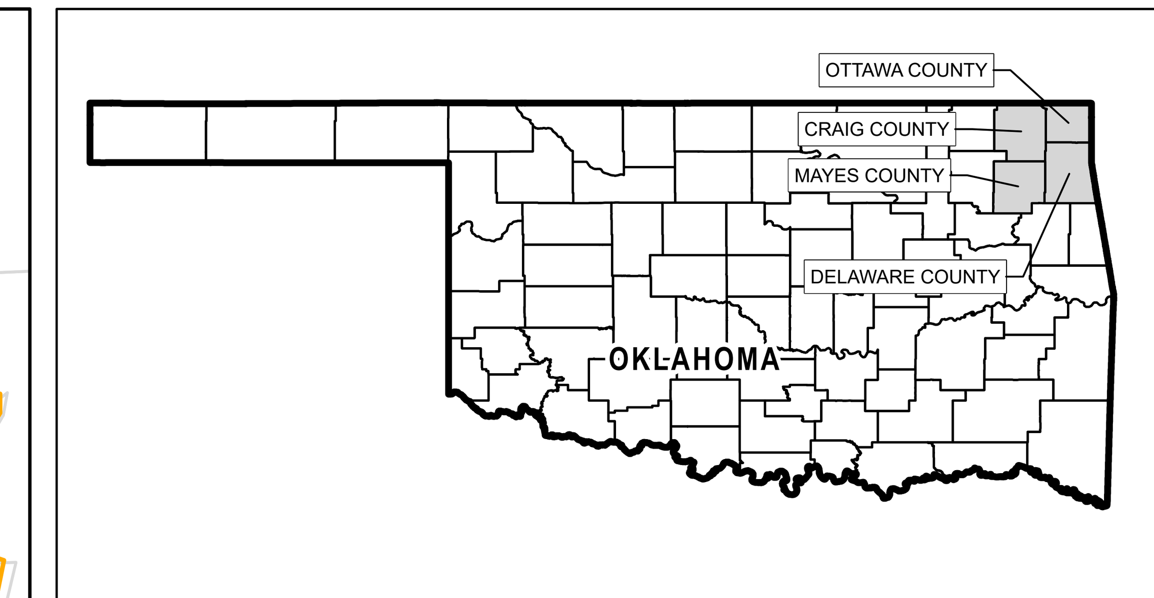
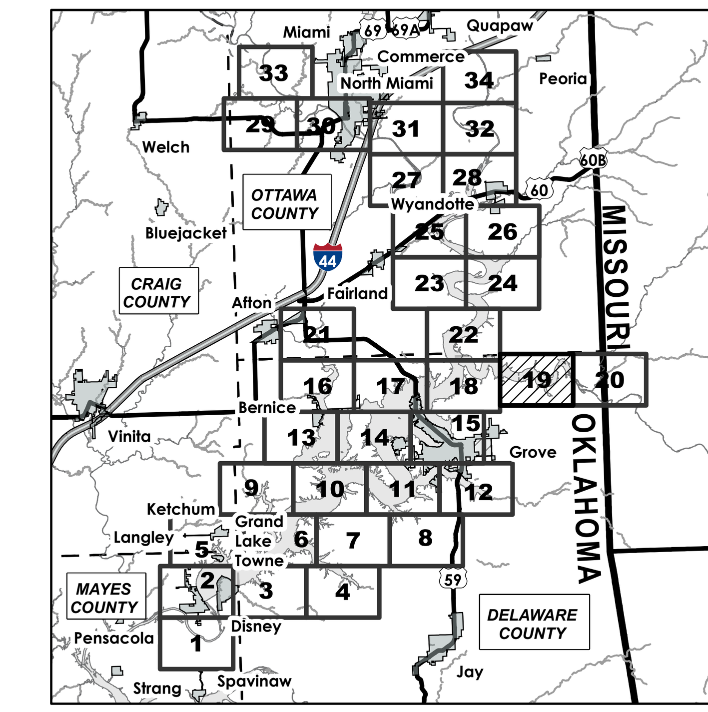


PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
39	40	Contour elevation 750 ft NGVD 1929
40	41	Interpolated 750 ft NGVD 1929 contour elevation
41	42	Contour elevation 750 ft NGVD 1929
42	43	Interpolated 750 ft NGVD 1929 contour elevation
43	44	Contour elevation 750 ft NGVD 1929
44	45	Interpolated 750 ft NGVD 1929 contour elevation
45	46	Contour elevation 750 ft NGVD 1929
61	62	Contour elevation 750 ft NGVD 1929
62	63	Coincident with parcel line
63	64	Extension line
64	65	Contour elevation 750 ft NGVD 1929
65	66	Coincident with parcel line
66	67	Contour elevation 750 ft NGVD 1929
67	68	Coincident with parcel line
68	69	Contour elevation 745 ft PD
69	70	Coincident with parcel line
70	71	Contour elevation 750 ft NGVD 1929





Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.39°E

Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 19

GRAND RIVER DAM AUTHORITY **LANGLEY, OKLAHOMA**

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494

NEOSHO AND GRAND RIVERS
OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

DATE: MAY 2023

MAP NOTES

1. Assessor data from Mayes, Ottawa, Delaware, and Craig counties is current as of June 2022. Any inaccuracies are in the original datasets. Interpretation of ownership designations is based on descriptive data provided in the Assessors' data. No additional research was conducted to validate the accuracy of the information.
2. The Reservoir shown was developed from the 745 ft Pensacola Datum (PD) contour. Contours (745 ft PD and 750 ft NGVD) where used as a basis for the Project boundary were derived from the Digital Elevation Model (DEM) developed for the Upstream Hydraulic Model (UHM).
3. When the project boundary description references a specific known location in the field, that reference shall govern over graphical location on the Exhibit G in case of conflict.
4. Public Land Survey System (PLSS) obtained from the Oklahoma Water Resources Board (https://home-owrb.opendata.arcgis.com/).
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7. Federal lands shown were developed from Bureau of Indian Affairs (BIA) parcel data and Wetland Reserve Program (WRP) easements.

PROJECT BOUNDARY DEFINITION

1. Portions of the anticipated project boundary labeled as "Approved 2014 Project Boundary" are based on the FERC approved project boundary last amended January 27, 2014.
2. Portions of the anticipated project boundary labeled as "Interpolation or Extension" indicate either an interpolated contour line is used to join disconnected segments of equivalent contours or a parcel line extension to connect to a defined contour.
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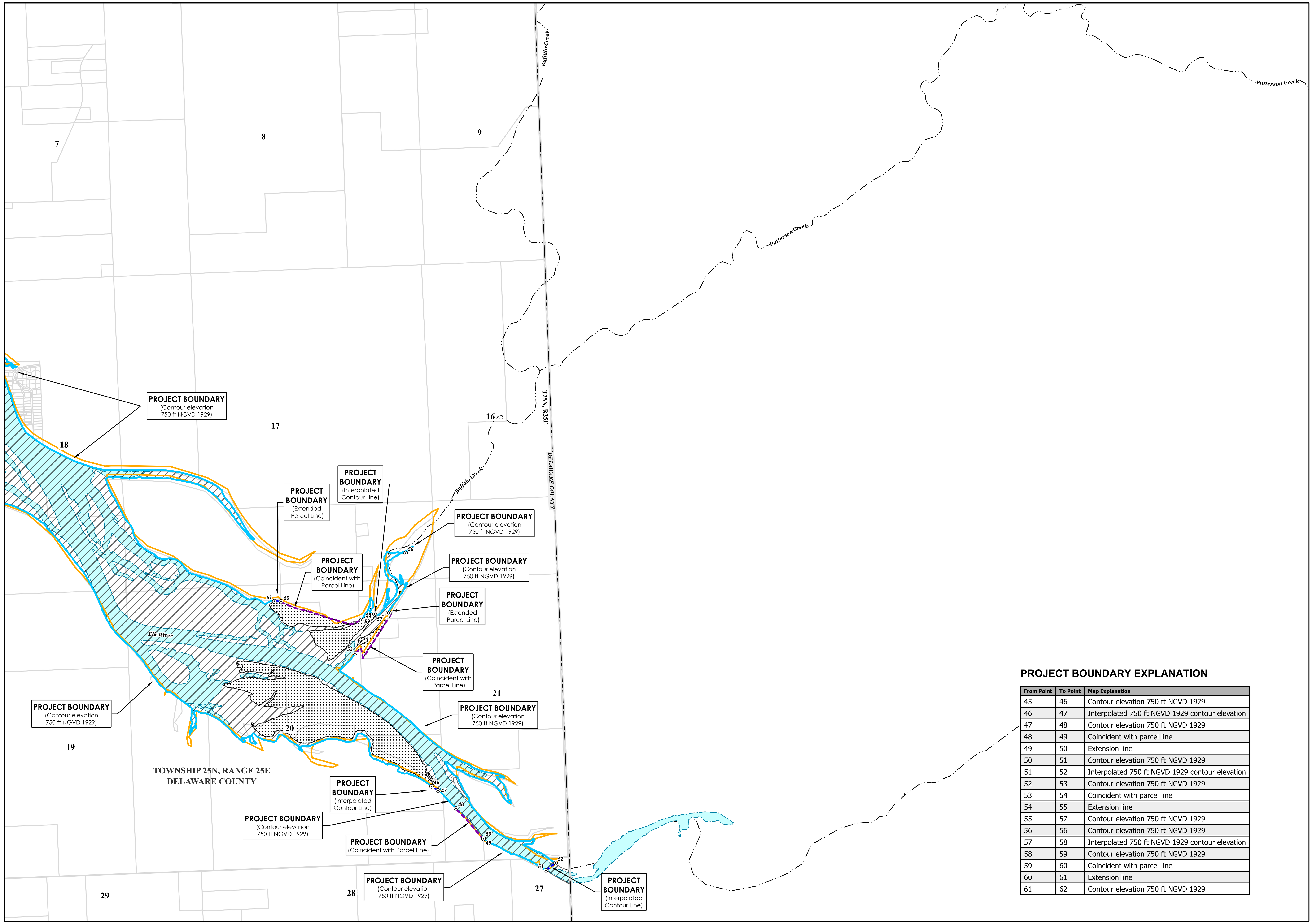
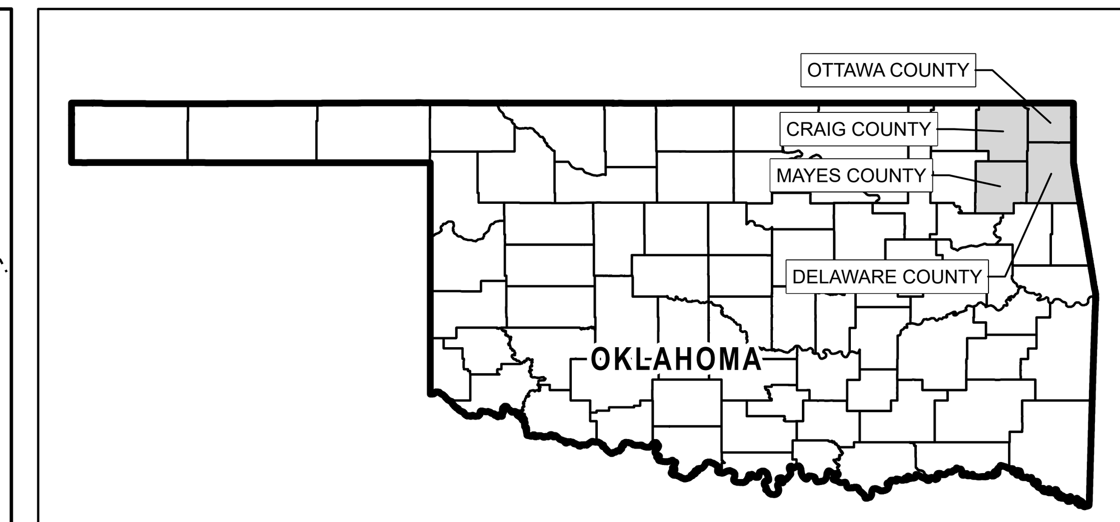
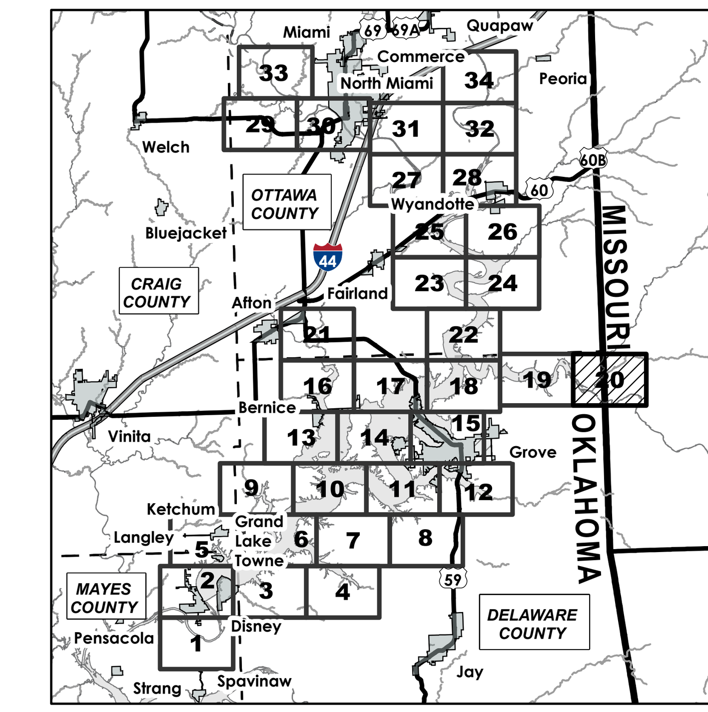


PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
45	46	Contour elevation 750 ft NGVD 1929
46	47	Interpolated 750 ft NGVD 1929 contour elevation
47	48	Contour elevation 750 ft NGVD 1929
48	49	Coincident with parcel line
49	50	Extension line
50	51	Contour elevation 750 ft NGVD 1929
51	52	Interpolated 750 ft NGVD 1929 contour elevation
52	53	Contour elevation 750 ft NGVD 1929
53	54	Coincident with parcel line
54	55	Extension line
55	57	Contour elevation 750 ft NGVD 1929
56	56	Contour elevation 750 ft NGVD 1929
57	58	Interpolated 750 ft NGVD 1929 contour elevation
58	59	Contour elevation 750 ft NGVD 1929
59	60	Coincident with parcel line
60	61	Extension line
61	62	Contour elevation 750 ft NGVD 1929





Magnetic Declination at Pensacola Dam April 2022 (Degrees): 1.34°E

Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)
- **Anticipated Project Boundary Basis**
- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 20

GRAND RIVER DAM AUTHORITY — LANGLEY, OKLAHOMA

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494
NEOSHO AND GRAND RIVERS
OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

DATE: MAY 2023

MAP NOTES

1. Assessor data from Mayes, Ottawa, Delaware, and Craig counties is current as of June 2022. Any inaccuracies are in the original datasets. Interpretation of ownership designations is based on descriptive data provided in the Assessors' data. No additional research was conducted to validate the accuracy of the information.
2. The Reservoir shown was developed from the 745 ft Pensacola Datum (PD) contour. Contours (745 ft PD and 750 ft NGVD) where used as a basis for the Project boundary were derived from the Digital Elevation Model (DEM) developed for the Upstream Hydraulic Model (UHM).
3. When the project boundary description references a specific known location in the field, that reference shall govern over graphical location on the Exhibit G in case of conflict.
4. Public Land Survey System (PLSS) obtained from the Oklahoma Water Resources Board (https://home-owrb.opendata.arcgis.com/).
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7. Federal lands shown were developed from Bureau of Indian Affairs (BIA) parcel data and Wetland Reserve Program (WRP) easements.

PROJECT BOUNDARY DEFINITION

1. Portions of the anticipated project boundary labeled as "Approved 2014 Project Boundary" are based on the FERC approved project boundary last amended January 27, 2014.
2. Portions of the anticipated project boundary labeled as "Interpolation or Extension" indicate either an interpolated contour line is used to join disconnected segments of equivalent contours or a parcel line extension to connect to a defined contour.
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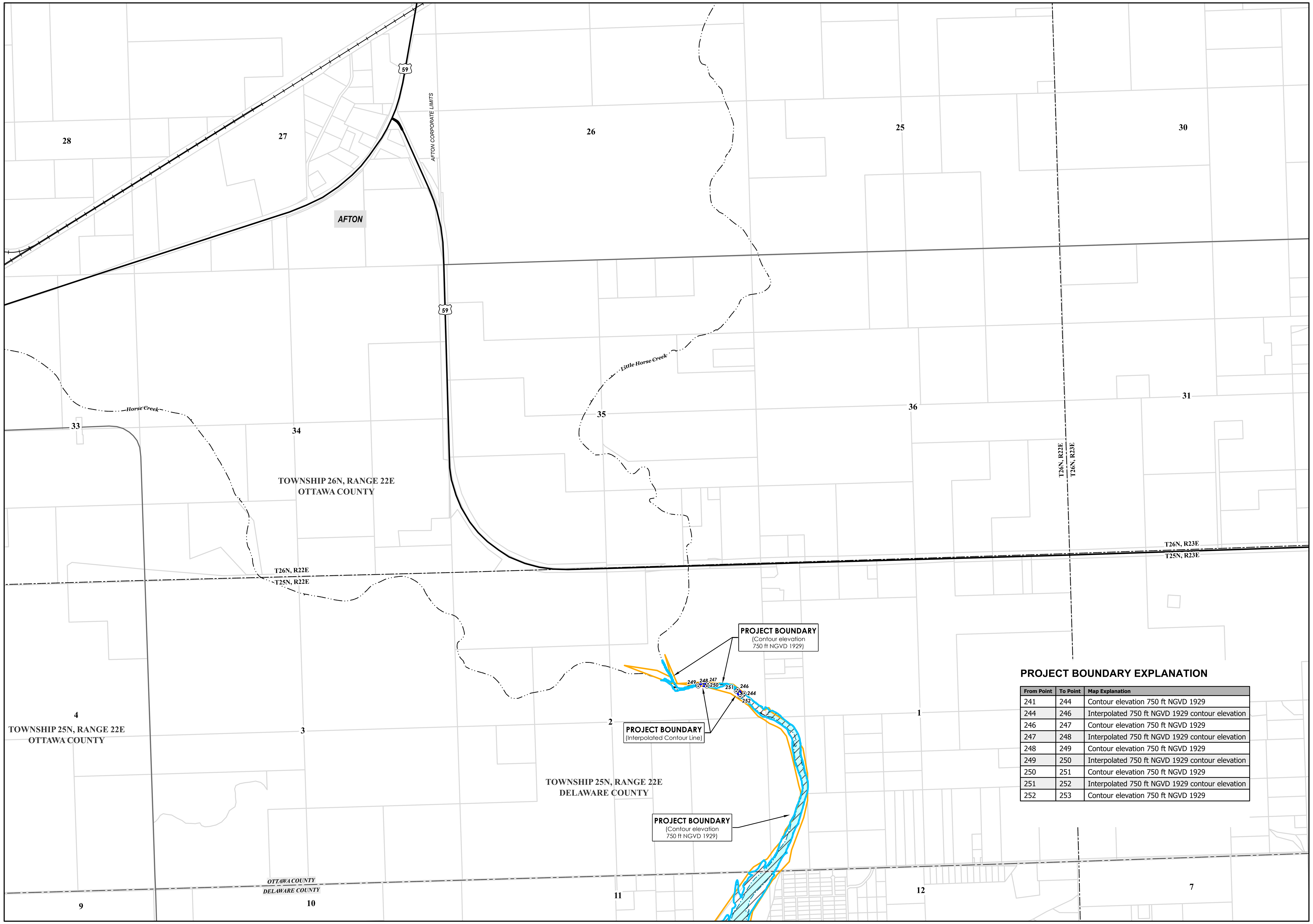
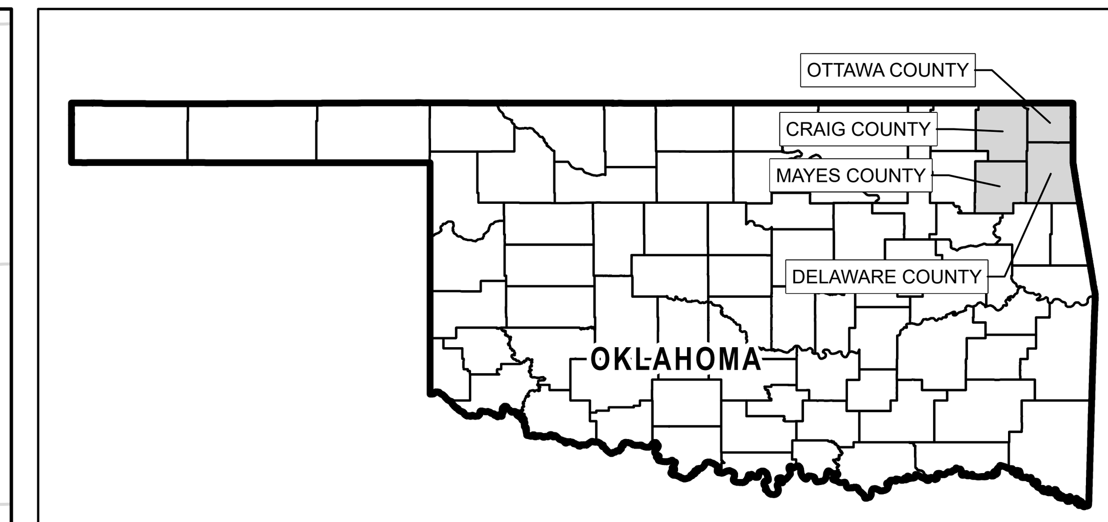
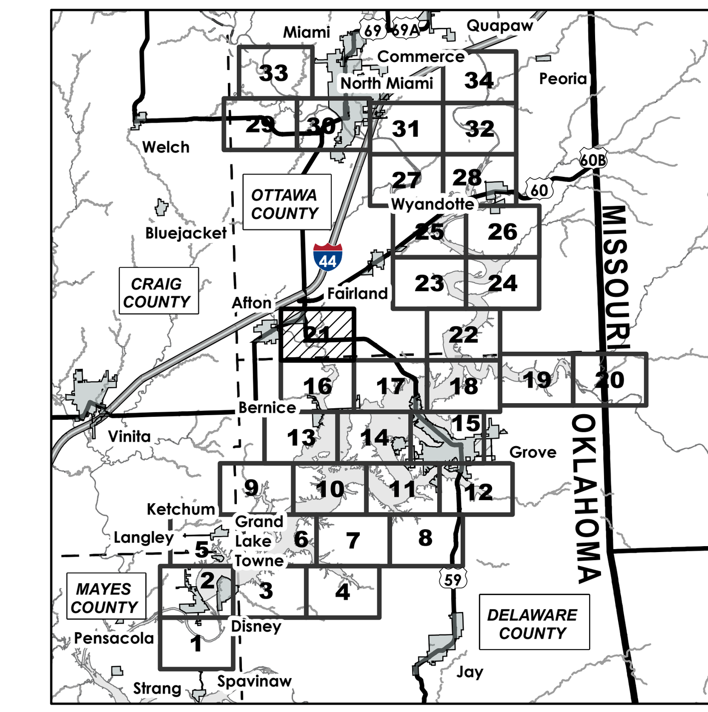


PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
241	244	Contour elevation 750 ft NGVD 1929
244	246	Interpolated 750 ft NGVD 1929 contour elevation
246	247	Contour elevation 750 ft NGVD 1929
247	248	Interpolated 750 ft NGVD 1929 contour elevation
248	249	Contour elevation 750 ft NGVD 1929
249	250	Interpolated 750 ft NGVD 1929 contour elevation
250	251	Contour elevation 750 ft NGVD 1929
251	252	Interpolated 750 ft NGVD 1929 contour elevation
252	253	Contour elevation 750 ft NGVD 1929





N

Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.54°E

Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 21

GRAND RIVER DAM AUTHORITY **LANGLEY, OKLAHOMA**

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494

NEOSHO AND GRAND RIVERS
OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

DATE: MAY 2023

MAP NOTES

1. Assessor data from Mayes, Ottawa, Delaware, and Craig counties is current as of June 2022. Any inaccuracies are in the original datasets. Interpretation of ownership designations is based on descriptive data provided in the Assessors' data. No additional research was conducted to validate the accuracy of the information.
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PROJECT BOUNDARY DEFINITION

1. Portions of the anticipated project boundary labeled as "Approved 2014 Project Boundary" are based on the FERC approved project boundary last amended January 27, 2014.
2. Portions of the anticipated project boundary labeled as "Interpolation or Extension" indicate either an interpolated contour line is used to join disconnected segments of equivalent contours or a parcel line extension to connect to a defined contour.
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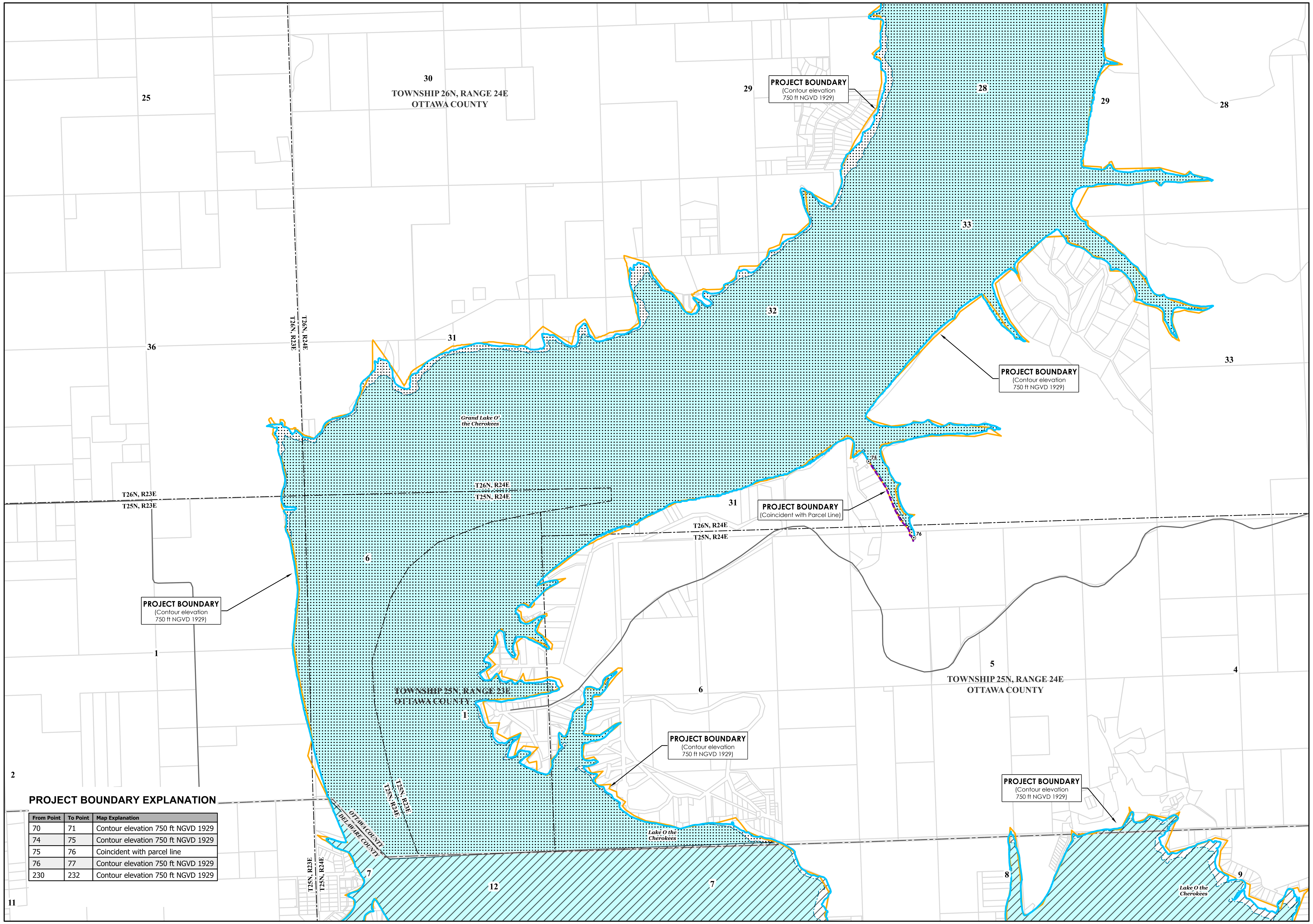
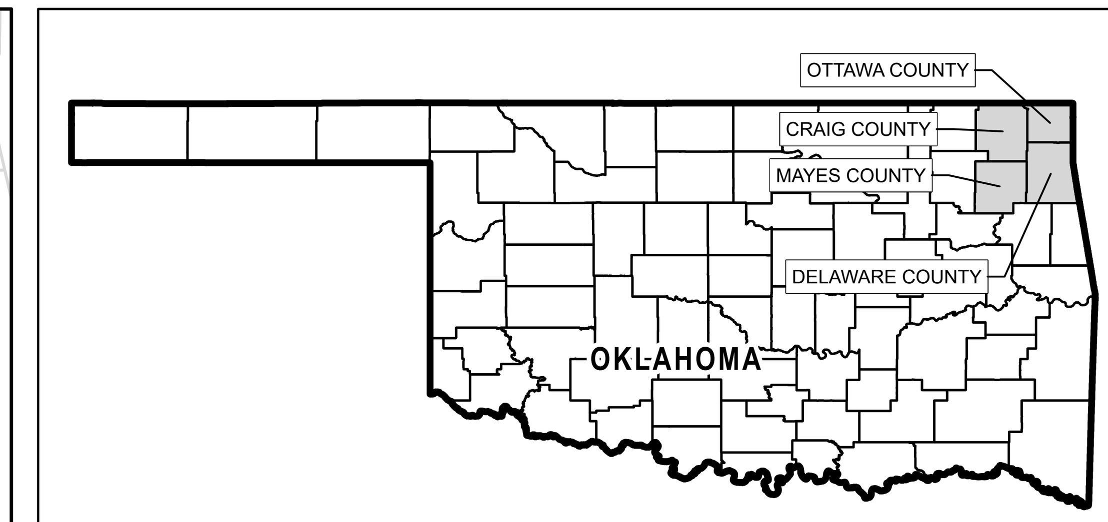
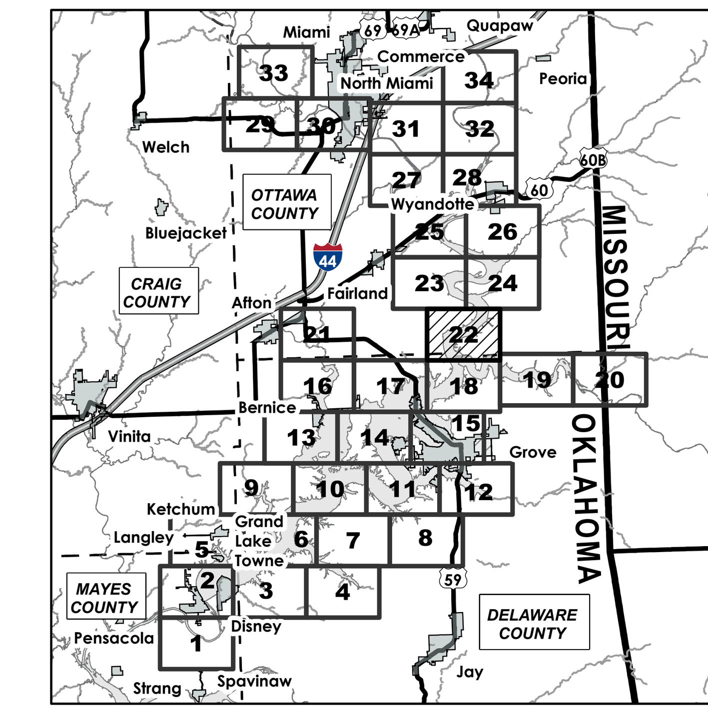


PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
70	71	Contour elevation 750 ft NGVD 1929
74	75	Contour elevation 750 ft NGVD 1929
75	76	Coincident with parcel line
76	77	Contour elevation 750 ft NGVD 1929
230	232	Contour elevation 750 ft NGVD 1929





Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.44°E

Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 22

GRAND RIVER DAM AUTHORITY — LANGLEY, OKLAHOMA

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494

NEOSHO AND GRAND RIVERS
OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

DATE: MAY 2023

MAP NOTES

1. Assessor data from Mayes, Ottawa, Delaware, and Craig counties is current as of June 2022. Any inaccuracies are in the original datasets. Interpretation of ownership designations is based on descriptive data provided in the Assessors' data. No additional research was conducted to validate the accuracy of the information.
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7. Federal lands shown were developed from Bureau of Indian Affairs (BIA) parcel data and Wetland Reserve Program (WRP) easements.

PROJECT BOUNDARY DEFINITION

1. Portions of the anticipated project boundary labeled as "Approved 2014 Project Boundary" are based on the FERC approved project boundary last amended January 27, 2014.
2. Portions of the anticipated project boundary labeled as "Interpolation or Extension" indicate either an interpolated contour line is used to join disconnected segments of equivalent contours or a parcel line extension to connect to a defined contour.
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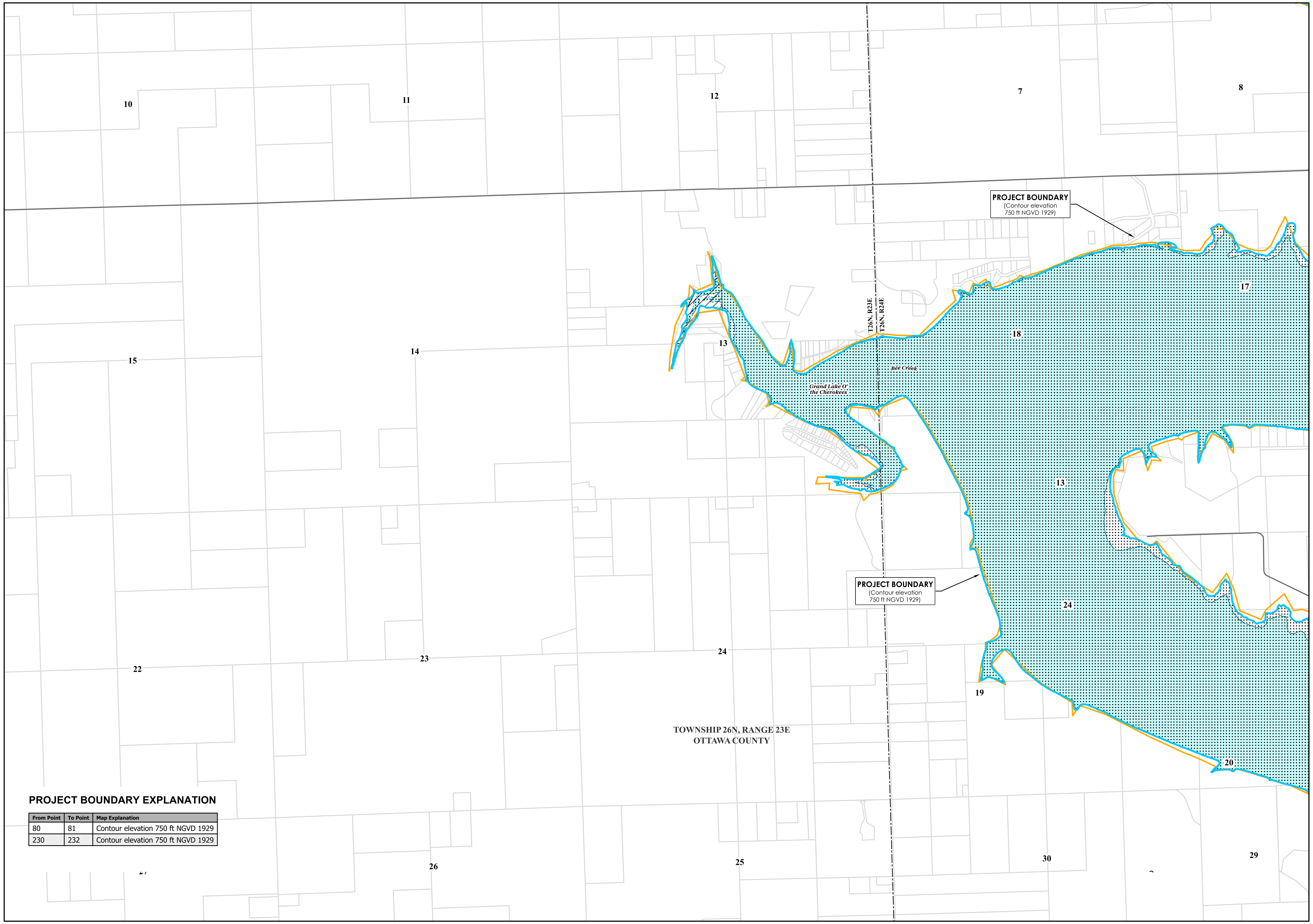
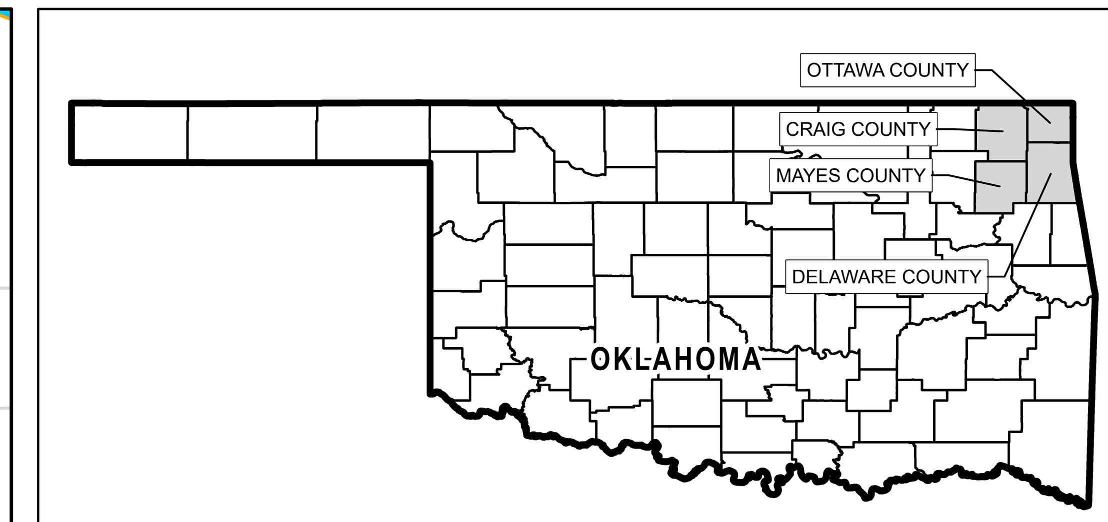
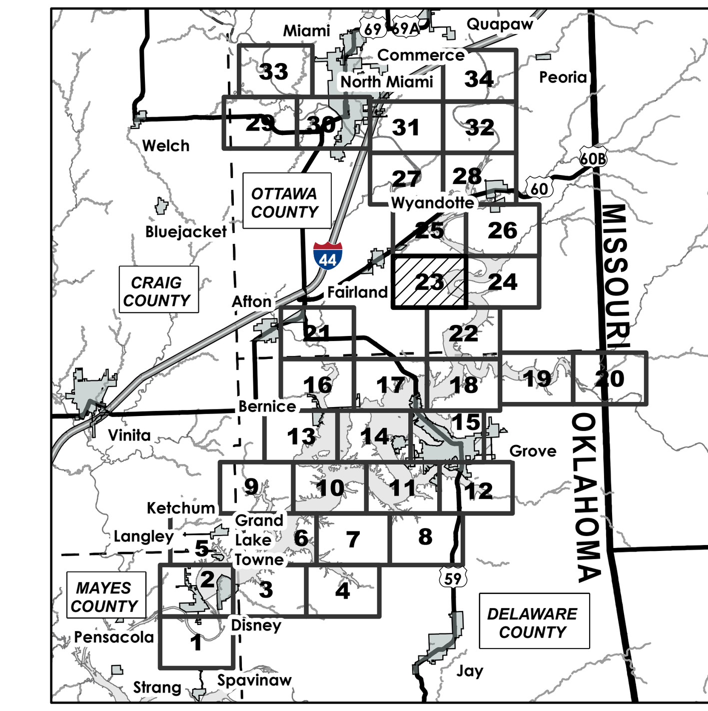
5. Portions of the anticipated project boundary labeled as "Metes and bounds/ROW" are defined by a metes and bounds description or an existing ROW.



PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
80	81	Contour elevation 750 ft NGVD 1929
230	232	Contour elevation 750 ft NGVD 1929





Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.46°E

Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 23

GRAND RIVER DAM AUTHORITY — LANGLEY, OKLAHOMA

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494
NEOSHO AND GRAND RIVERS
OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

DATE: MAY 2023

MAP NOTES

1. Assessor data from Mayes, Ottawa, Delaware, and Craig counties is current as of June 2022. Any inaccuracies are in the original datasets. Interpretation of ownership designations is based on descriptive data provided in the Assessors' data. No additional research was conducted to validate the accuracy of the information.
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PROJECT BOUNDARY DEFINITION

1. Portions of the anticipated project boundary labeled as "Approved 2014 Project Boundary" are based on the FERC approved project boundary last amended January 27, 2014.
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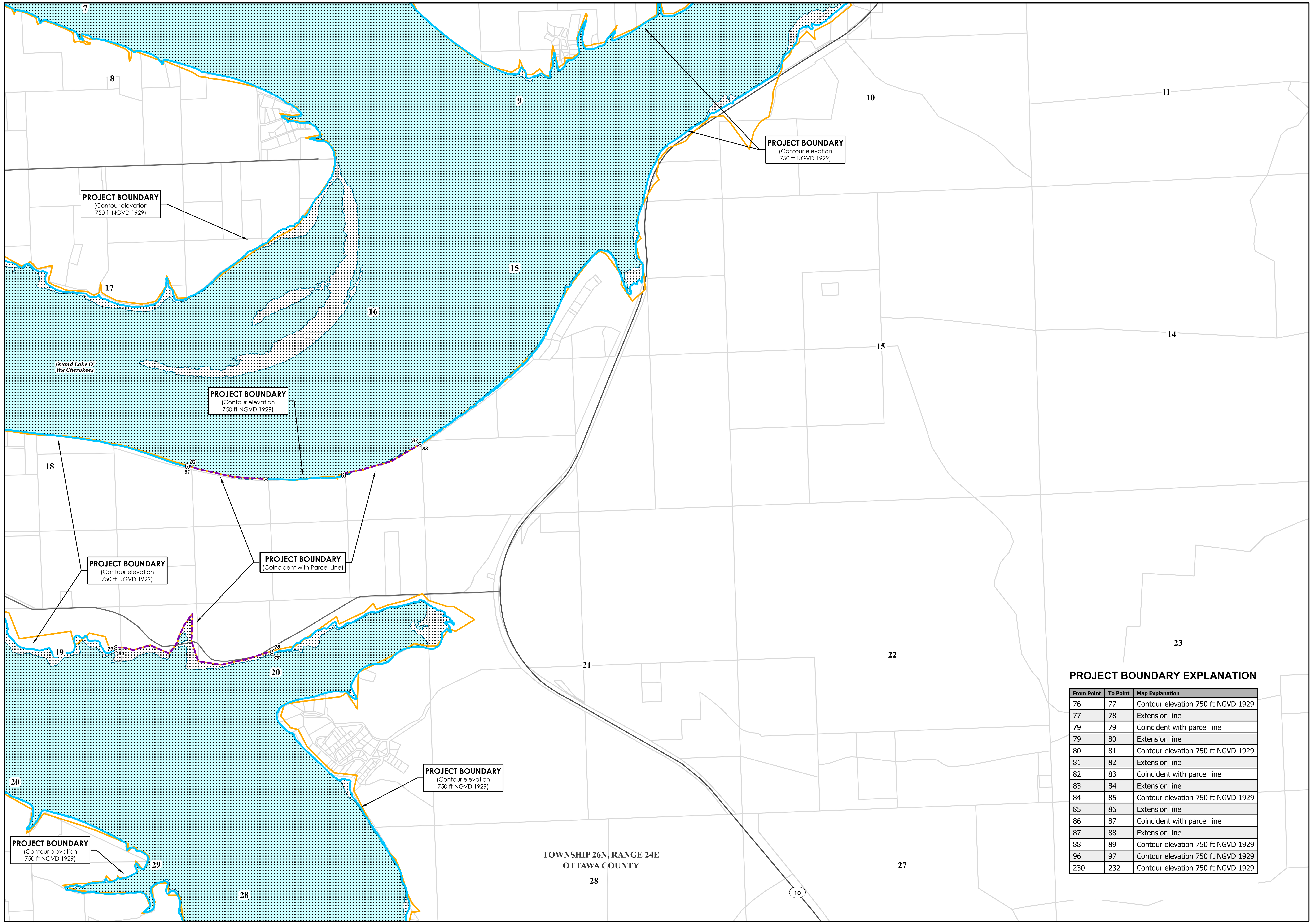
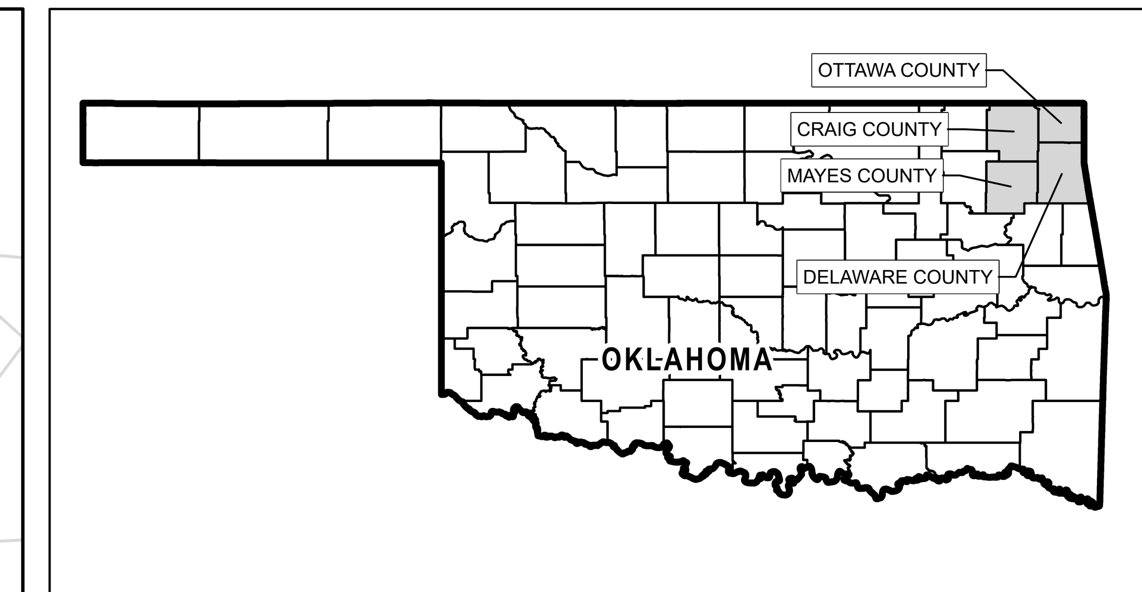
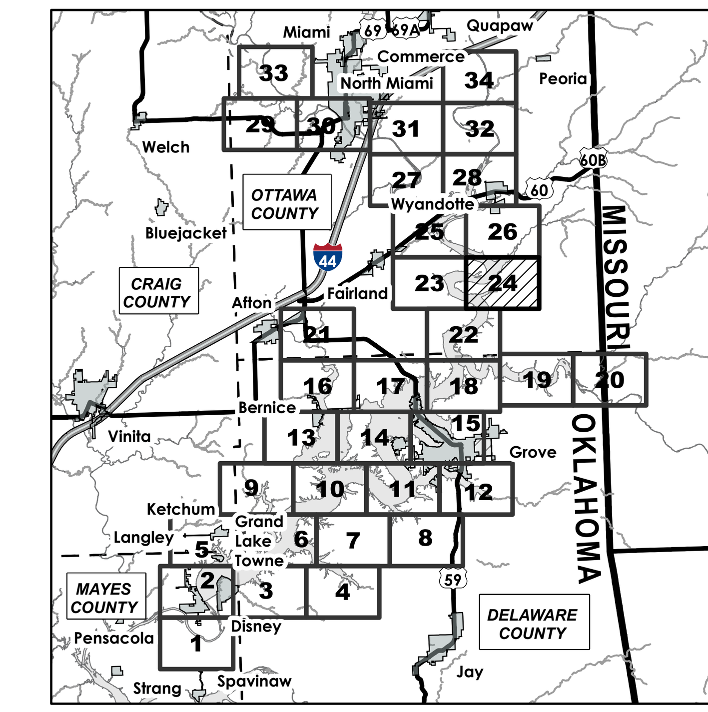


PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
76	77	Contour elevation 750 ft NGVD 1929
77	78	Extension line
79	79	Coincident with parcel line
79	80	Extension line
80	81	Contour elevation 750 ft NGVD 1929
81	82	Extension line
82	83	Coincident with parcel line
83	84	Extension line
84	85	Contour elevation 750 ft NGVD 1929
85	86	Extension line
86	87	Coincident with parcel line
87	88	Extension line
88	89	Contour elevation 750 ft NGVD 1929
96	97	Contour elevation 750 ft NGVD 1929
230	232	Contour elevation 750 ft NGVD 1929





Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.41°E

Legend

Boundary Point
Non-Project Facility
Project Facility
Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

Coincident with Parcel Line
Extension/Interpolation
Metes and bounds/ROW
Contour elevation 745 ft PD
Contour elevation 750 ft NGVD 1929
Approved 2014 Project Boundary

Open Water
Open Water - Flowage Rights
Flowage Easement
Other Open Water
Stream
Fee Simple Ownership
Parcel Boundary
Federal Lands
County Boundary
PLSS Township

Railroad
Interstate
US Highway
State Highway
Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 24

GRAND RIVER DAM AUTHORITY **LANGLEY, OKLAHOMA**

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494
NEOSHO AND GRAND RIVERS
OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

DATE: MAY 2023

MAP NOTES

1. Assessor data from Mayes, Ottawa, Delaware, and Craig counties is current as of June 2022. Any inaccuracies are in the original datasets. Interpretation of ownership designations is based on descriptive data provided in the Assessors' data. No additional research was conducted to validate the accuracy of the information.
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PROJECT BOUNDARY DEFINITION

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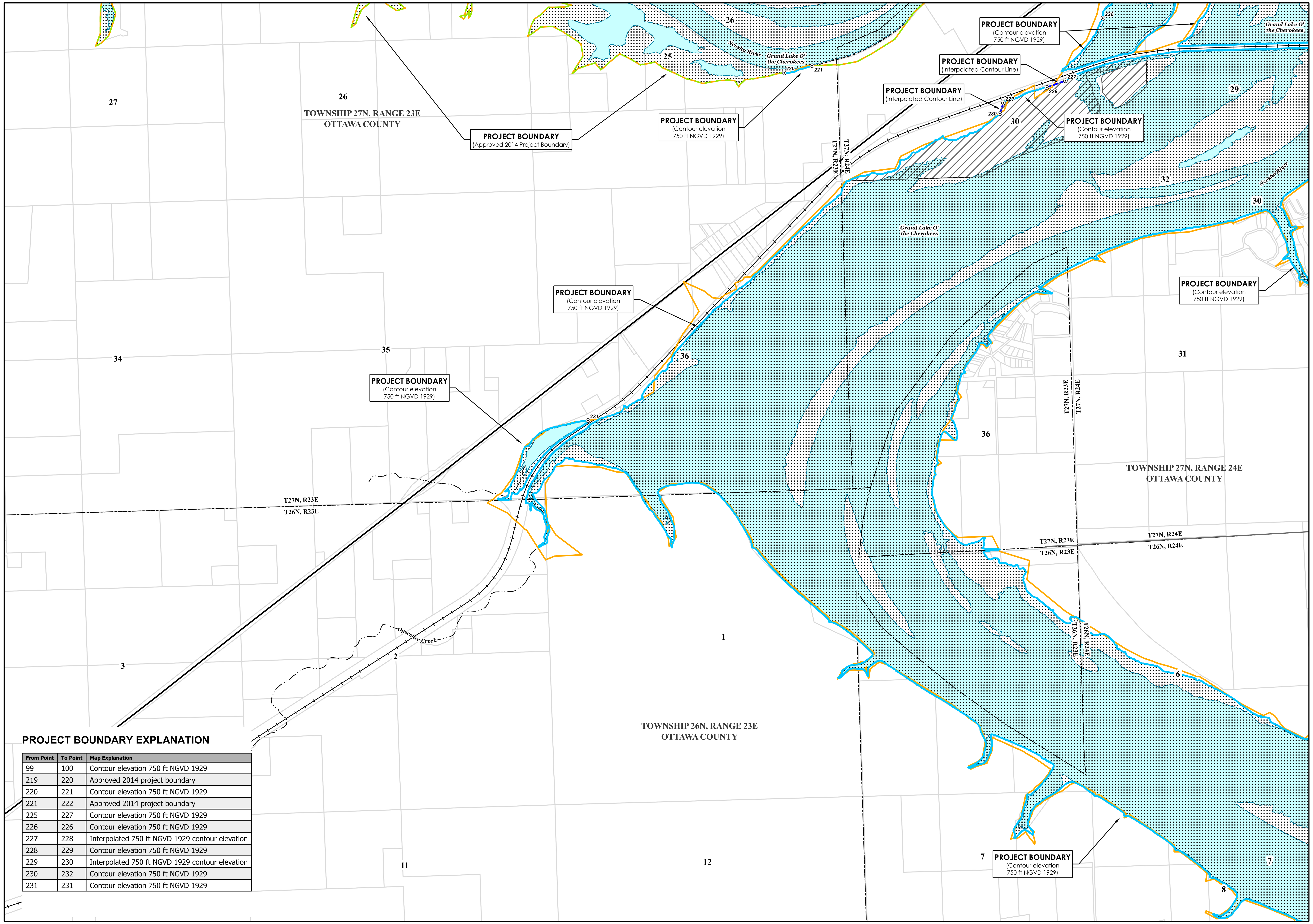
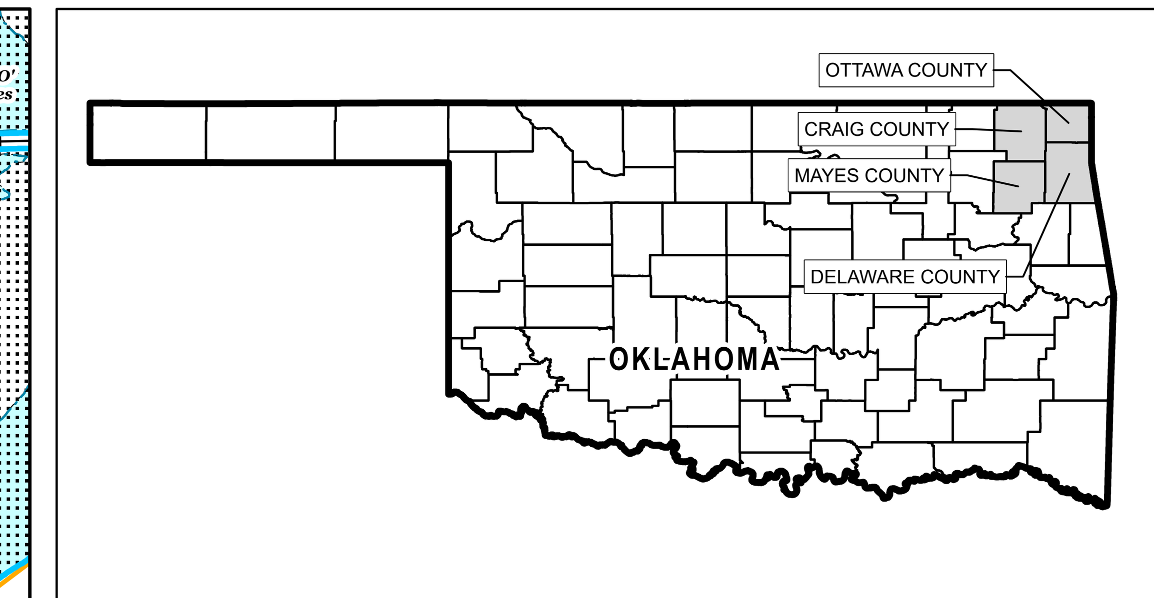
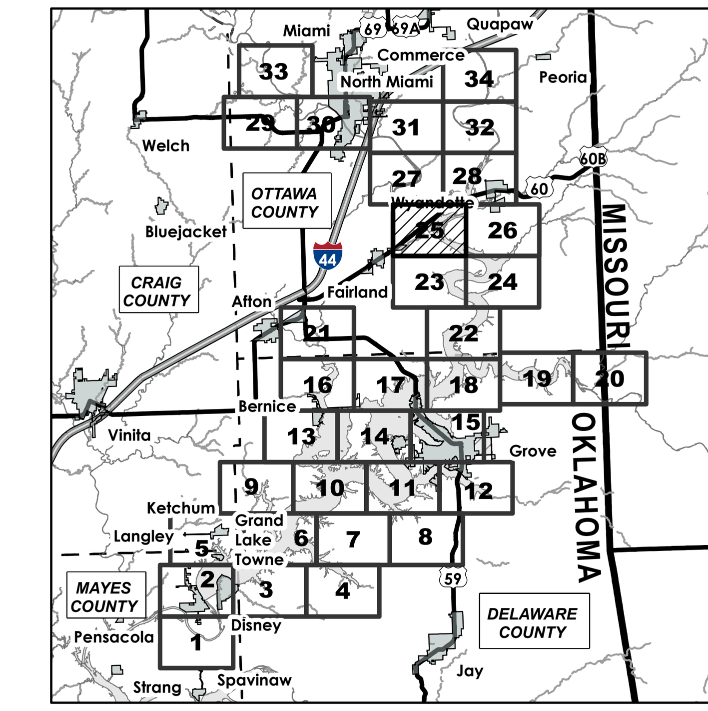


PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
99	100	Contour elevation 750 ft NGVD 1929
219	220	Approved 2014 project boundary
220	221	Contour elevation 750 ft NGVD 1929
221	222	Approved 2014 project boundary
225	227	Contour elevation 750 ft NGVD 1929
226	226	Contour elevation 750 ft NGVD 1929
227	228	Interpolated 750 ft NGVD 1929 contour elevation
228	229	Contour elevation 750 ft NGVD 1929
229	230	Interpolated 750 ft NGVD 1929 contour elevation
230	232	Contour elevation 750 ft NGVD 1929
231	231	Contour elevation 750 ft NGVD 1929





Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.46°E

Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 25

GRAND RIVER DAM AUTHORITY LANGLEY, OKLAHOMA

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494
NEOSHO AND GRAND RIVERS
OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

DATE: MAY 2023

MAP NOTES

1. Assessor data from Mayes, Ottawa, Delaware, and Craig counties is current as of June 2022. Any inaccuracies are in the original datasets. Interpretation of ownership designations is based on descriptive data provided in the Assessors' data. No additional research was conducted to validate the accuracy of the information.
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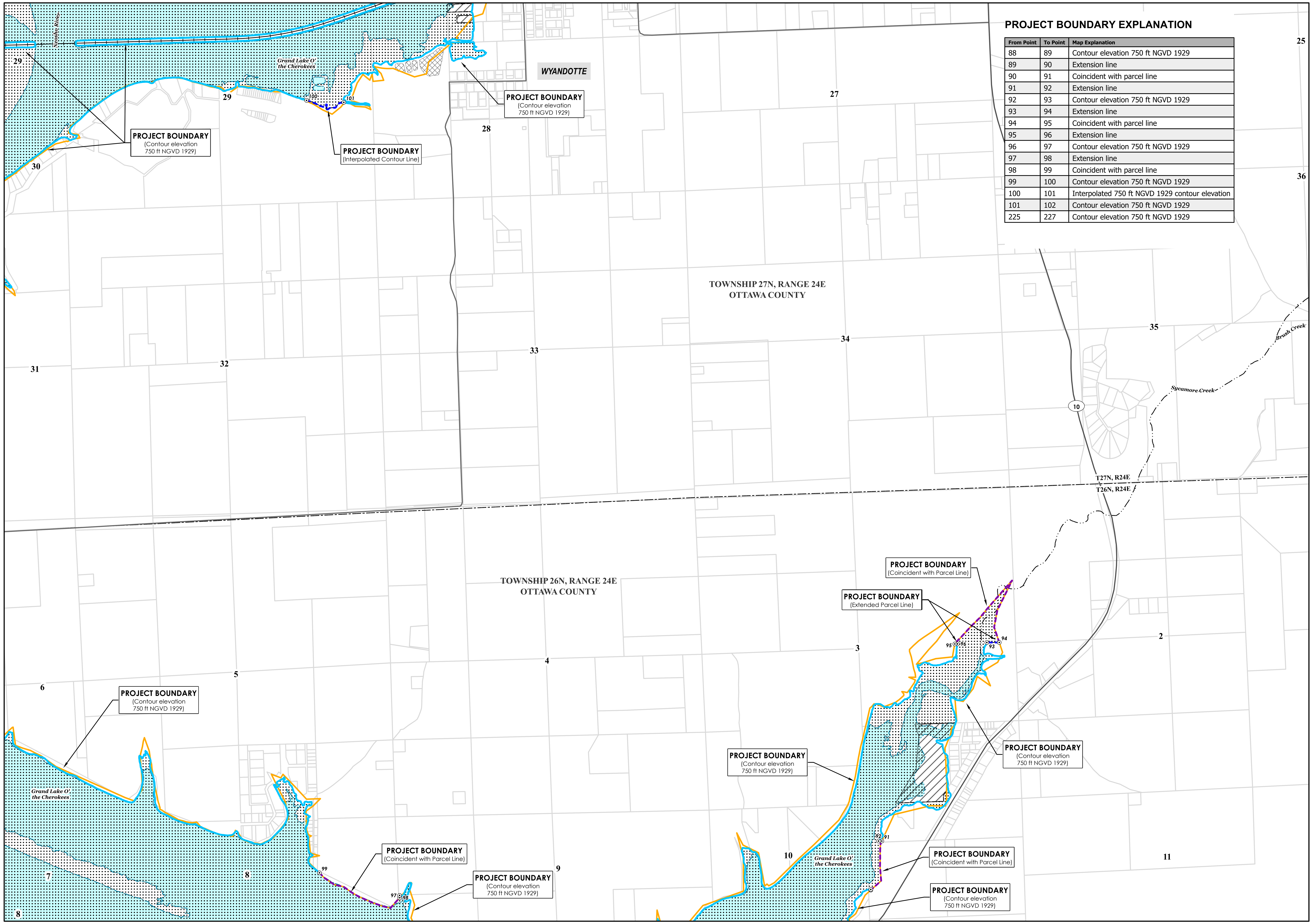
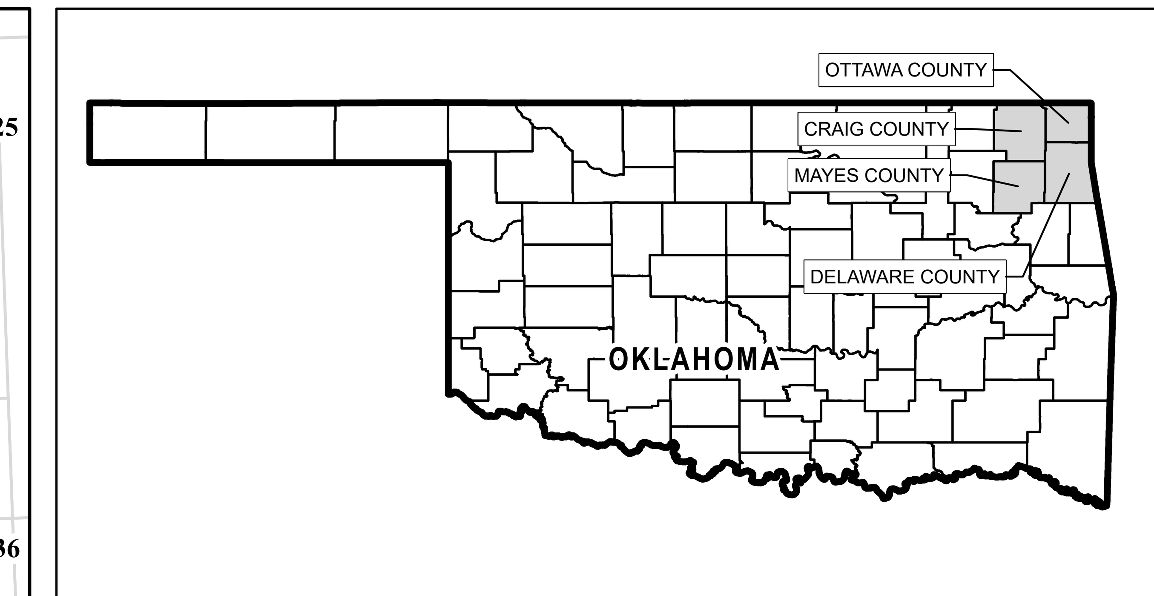
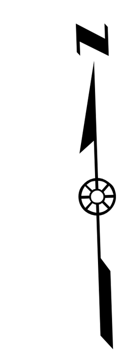


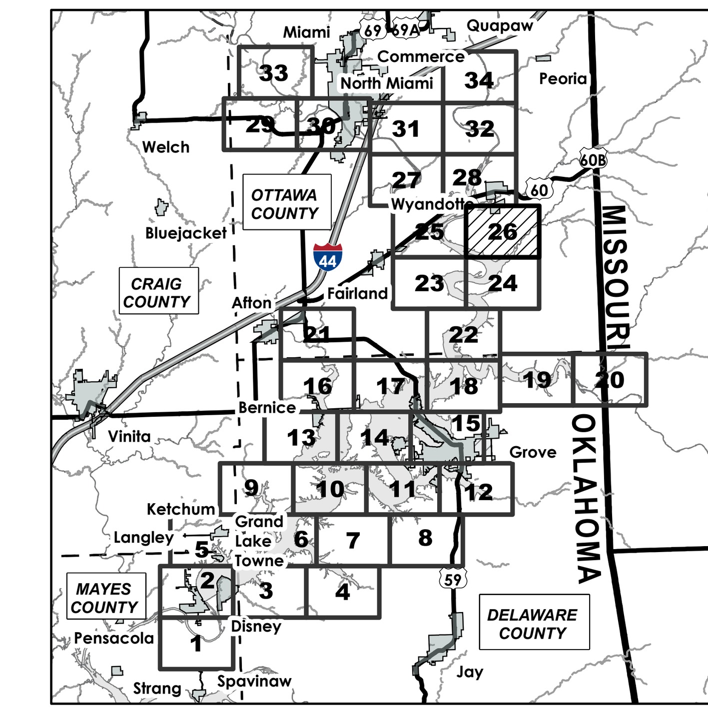
PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
88	89	Contour elevation 750 ft NGVD 1929
89	90	Extension line
90	91	Coincident with parcel line
91	92	Extension line
92	93	Contour elevation 750 ft NGVD 1929
93	94	Extension line
94	95	Coincident with parcel line
95	96	Extension line
96	97	Contour elevation 750 ft NGVD 1929
97	98	Extension line
98	99	Coincident with parcel line
99	100	Contour elevation 750 ft NGVD 1929
100	101	Interpolated 750 ft NGVD 1929 contour elevation
101	102	Contour elevation 750 ft NGVD 1929
225	227	Contour elevation 750 ft NGVD 1929





Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.41°E



Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 26

GRAND RIVER DAM AUTHORITY — **LANGLEY, OKLAHOMA**

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494

NEOSHO AND GRAND RIVERS

OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

DATE: MAY 2023

MAP NOTES

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PROJECT BOUNDARY DEFINITION

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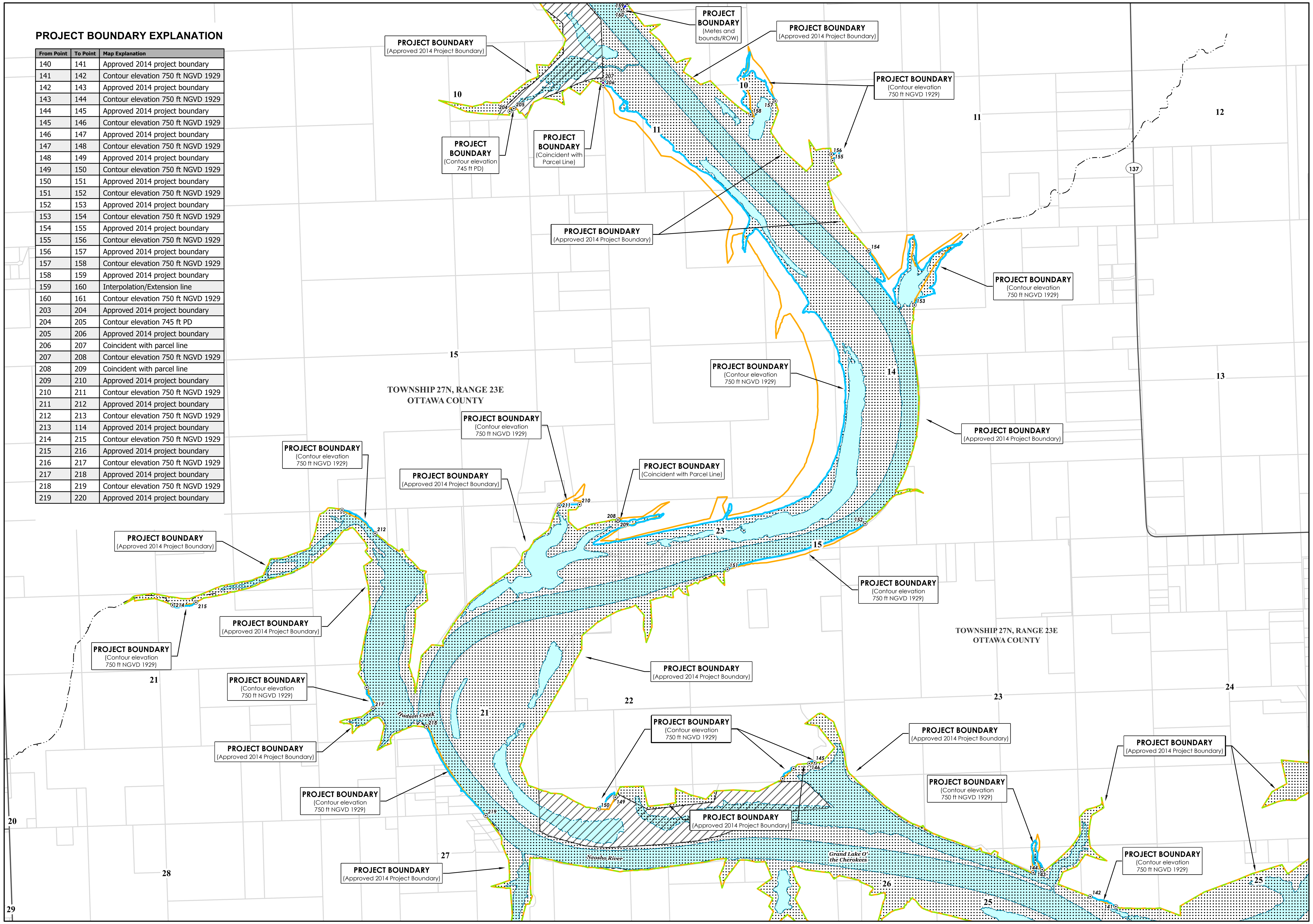
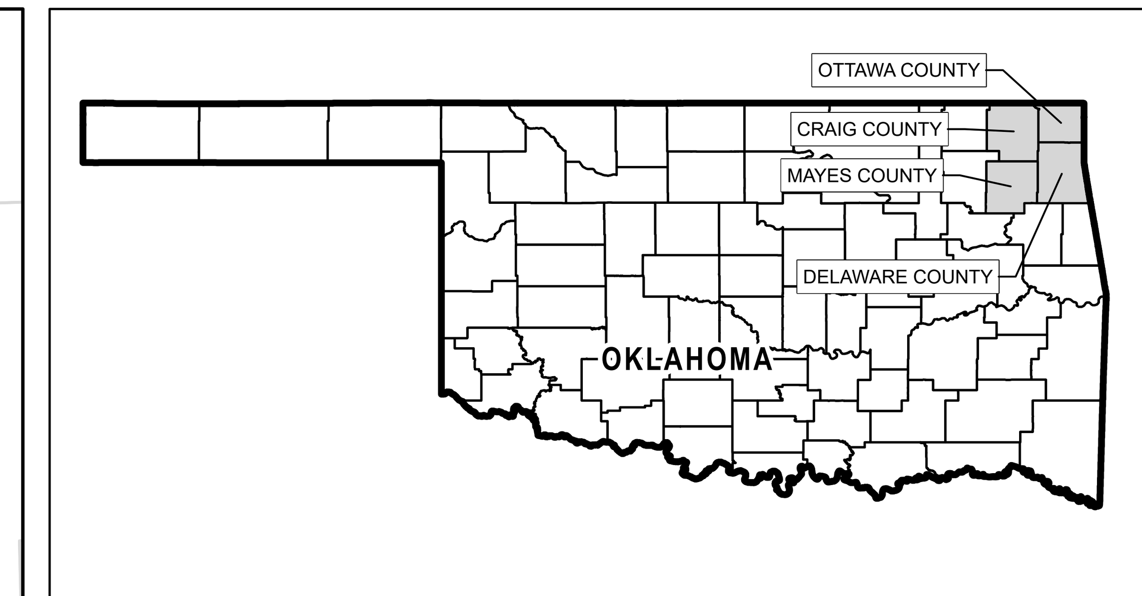
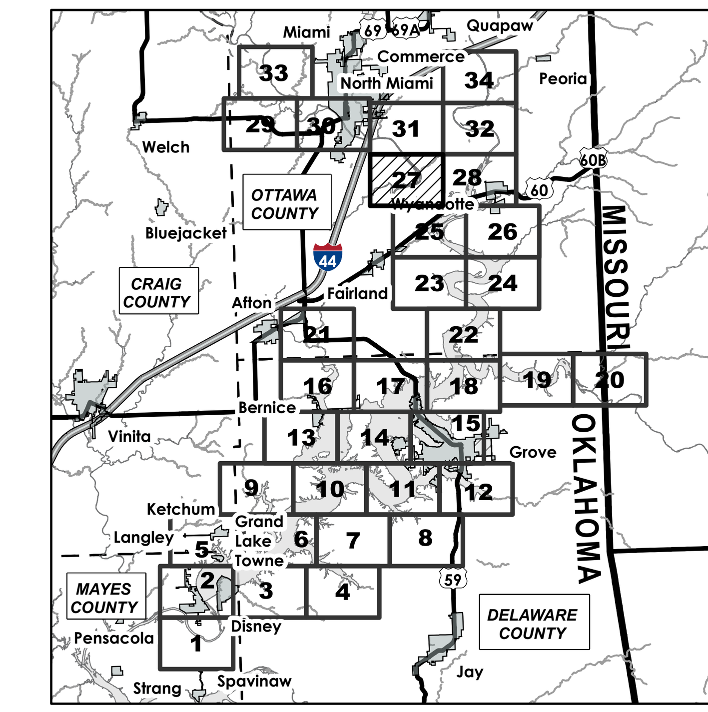
PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
140	141	Approved 2014 project boundary
141	142	Contour elevation 750 ft NGVD 1929
142	143	Approved 2014 project boundary
143	144	Contour elevation 750 ft NGVD 1929
144	145	Approved 2014 project boundary
145	146	Contour elevation 750 ft NGVD 1929
146	147	Approved 2014 project boundary
147	148	Contour elevation 750 ft NGVD 1929
148	149	Approved 2014 project boundary
149	150	Contour elevation 750 ft NGVD 1929
150	151	Approved 2014 project boundary
151	152	Contour elevation 750 ft NGVD 1929
152	153	Approved 2014 project boundary
153	154	Contour elevation 750 ft NGVD 1929
154	155	Approved 2014 project boundary
155	156	Contour elevation 750 ft NGVD 1929
156	157	Approved 2014 project boundary
157	158	Contour elevation 750 ft NGVD 1929
158	159	Approved 2014 project boundary
159	160	Interpolation/Extension line
160	161	Contour elevation 750 ft NGVD 1929
203	204	Approved 2014 project boundary
204	205	Contour elevation 745 ft PD
205	206	Approved 2014 project boundary
206	207	Coincident with parcel line
207	208	Contour elevation 750 ft NGVD 1929
208	209	Coincident with parcel line
209	210	Approved 2014 project boundary
210	211	Contour elevation 750 ft NGVD 1929
211	212	Approved 2014 project boundary
212	213	Contour elevation 750 ft NGVD 1929
213	114	Approved 2014 project boundary
214	215	Contour elevation 750 ft NGVD 1929
215	216	Approved 2014 project boundary
216	217	Contour elevation 750 ft NGVD 1929
217	218	Approved 2014 project boundary
218	219	Contour elevation 750 ft NGVD 1929
219	220	Approved 2014 project boundary







Magnetic Declination at Pensacola Dam April 2022 (Degrees): 1.47°E

Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)
- Anticipated Project Boundary Basis
- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary
- Open Water
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- Flowage Easement
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- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 27

GRAND RIVER DAM AUTHORITY — LANGLEY, OKLAHOMA

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494
NEOSHO AND GRAND RIVERS
OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

DATE: MAY 2023

MAP NOTES
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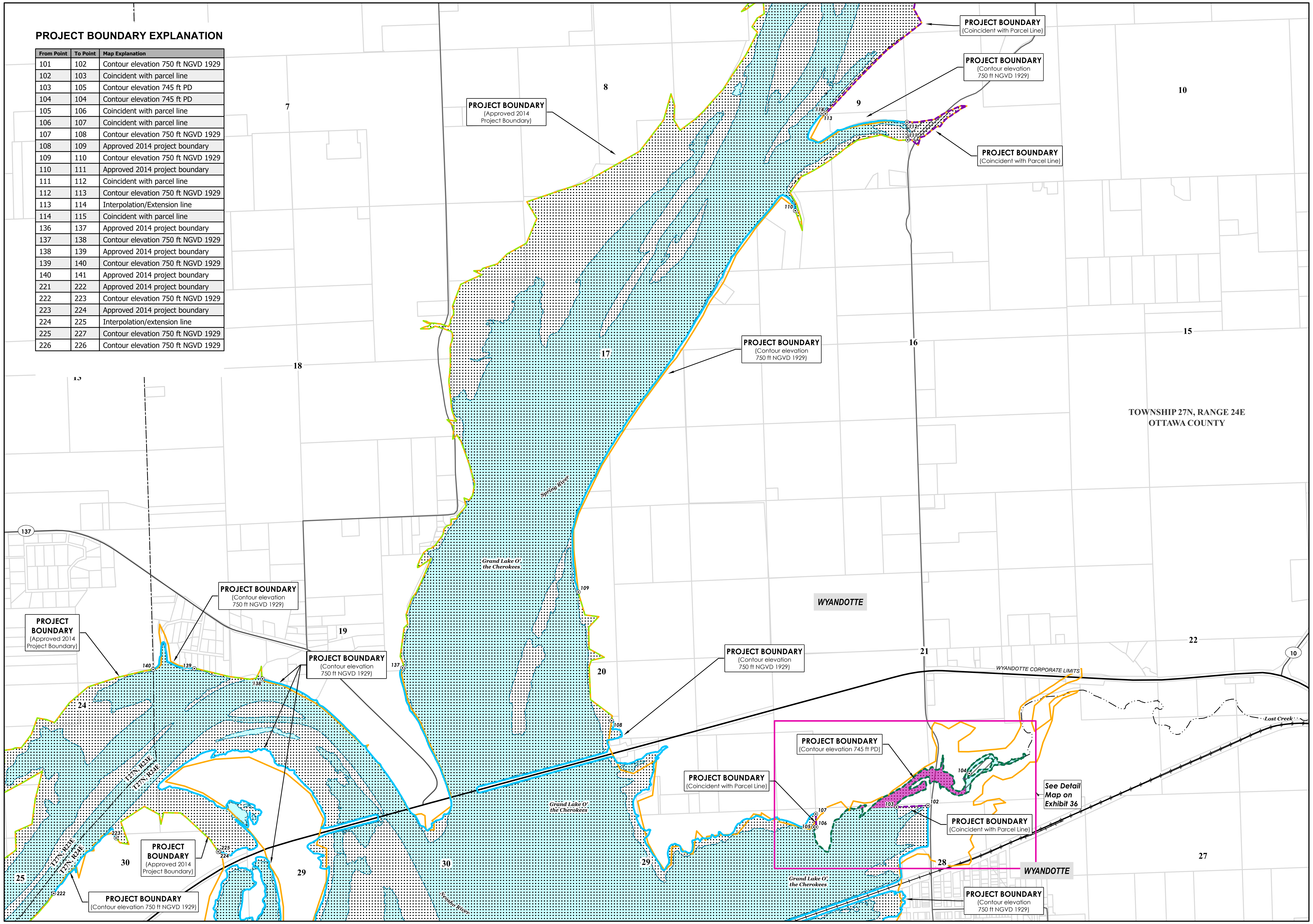
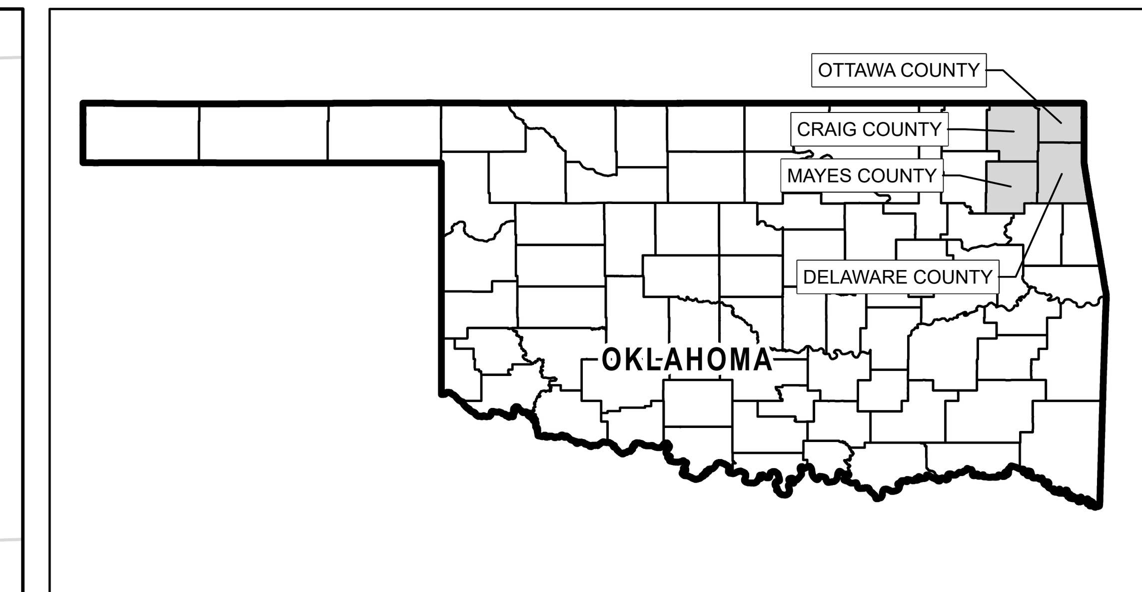
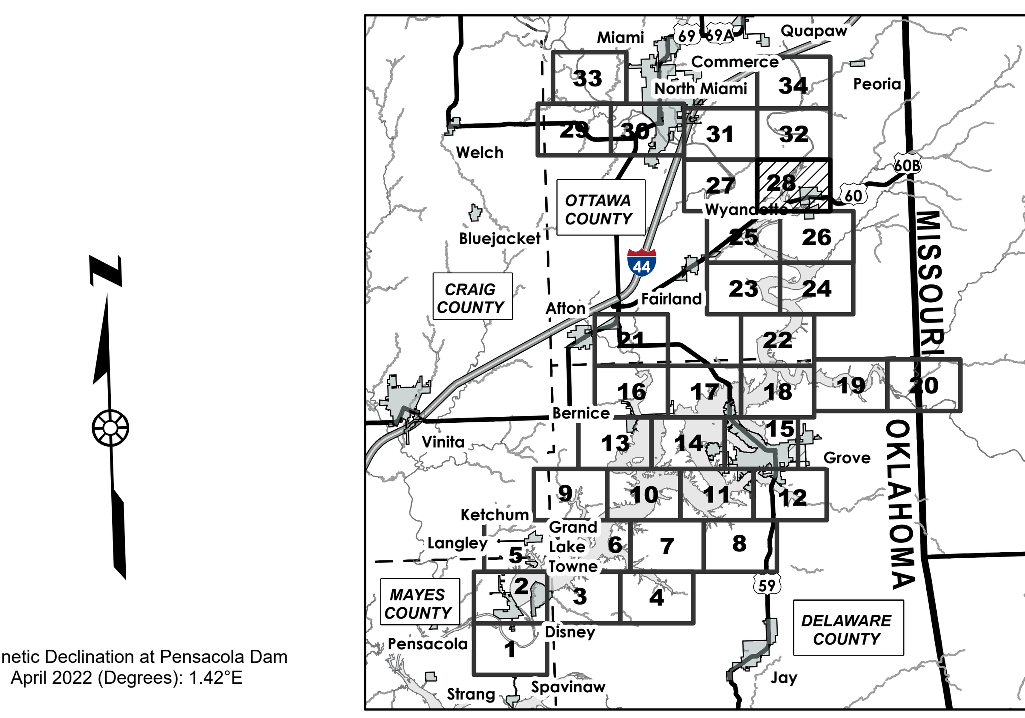
5. Portions of the anticipated project boundary labeled as "Metes and bounds/ROW" are defined by a metes and bounds description or an existing ROW.

PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
101	102	Contour elevation 750 ft NGVD 1929
102	103	Coincident with parcel line
103	105	Contour elevation 745 ft PD
104	104	Contour elevation 745 ft PD
105	106	Coincident with parcel line
106	107	Coincident with parcel line
107	108	Contour elevation 750 ft NGVD 1929
108	109	Approved 2014 project boundary
109	110	Contour elevation 750 ft NGVD 1929
110	111	Approved 2014 project boundary
111	112	Coincident with parcel line
112	113	Contour elevation 750 ft NGVD 1929
113	114	Interpolation/Extension line
114	115	Coincident with parcel line
136	137	Approved 2014 project boundary
137	138	Contour elevation 750 ft NGVD 1929
138	139	Approved 2014 project boundary
139	140	Contour elevation 750 ft NGVD 1929
140	141	Approved 2014 project boundary
221	222	Approved 2014 project boundary
222	223	Contour elevation 750 ft NGVD 1929
223	224	Approved 2014 project boundary
224	225	Interpolation/extension line
225	227	Contour elevation 750 ft NGVD 1929
226	226	Contour elevation 750 ft NGVD 1929







Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.42°E

Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 28

GRAND RIVER DAM AUTHORITY **LANGLEY, OKLAHOMA**

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494
NEOSHO AND GRAND RIVERS
OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

DATE: MAY 2023

MAP NOTES

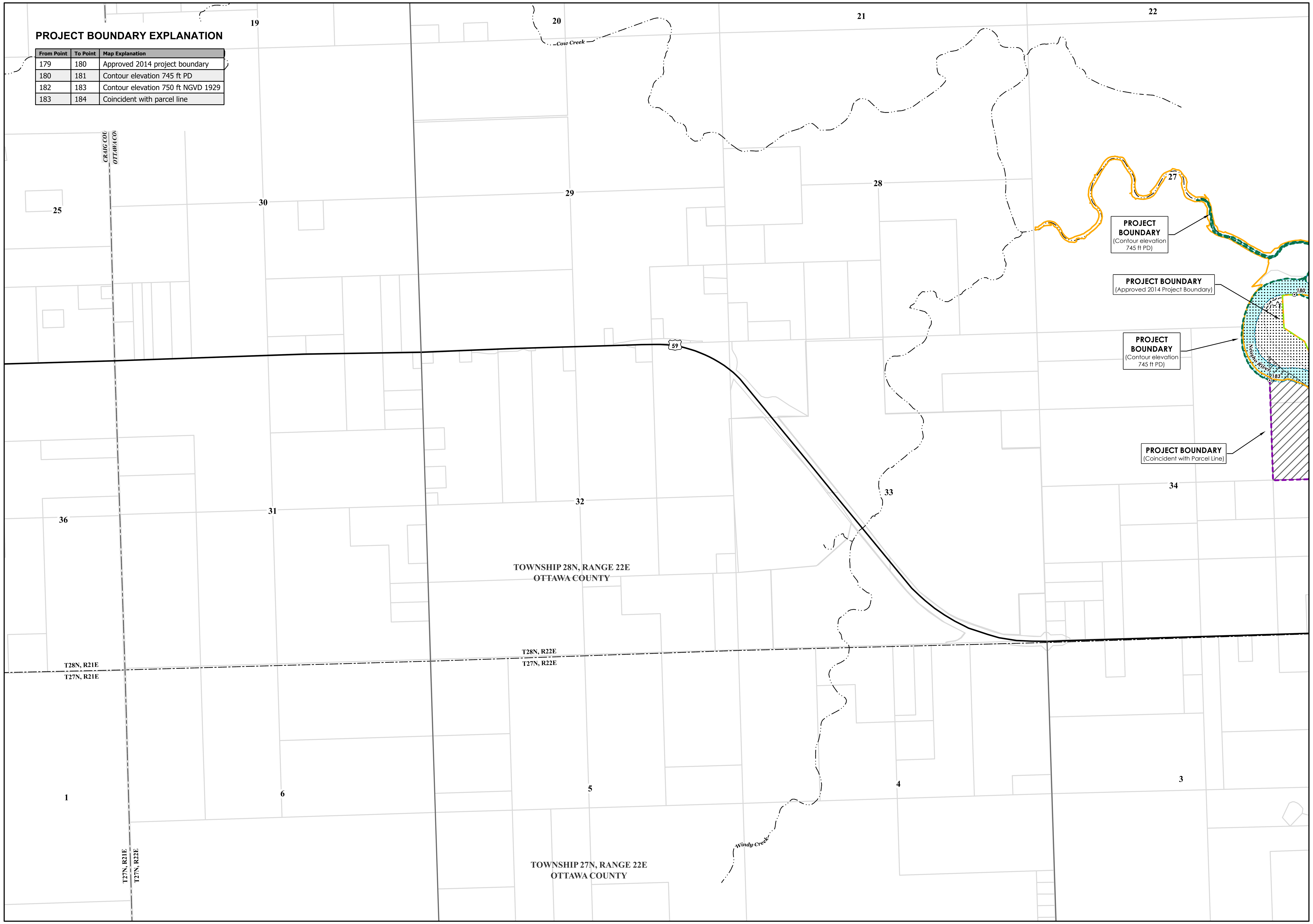
1. Assessor data from Mayes, Ottawa, Delaware, and Craig counties is current as of June 2022. Any inaccuracies are in the original datasets. Interpretation of ownership designations is based on descriptive data provided in the Assessors' data. No additional research was conducted to validate the accuracy of the information.
2. The Reservoir shown was developed from the 745 ft Pensacola Datum (PD) contour. Contours (745 ft PD and 750 ft NGVD) where used as a basis for the Project boundary were derived from the Digital Elevation Model (DEM) developed for the Upstream Hydraulic Model (UHM).
3. When the project boundary description references a specific known location in the field, that reference shall govern over graphical location on the Exhibit G in case of conflict.
4. Public Land Survey System (PLSS) obtained from the Oklahoma Water Resources Board (https://home-owrb.opendata.arcgis.com/).
5. National Hydrography Dataset (NHD) data (streams and lakes) were obtained from the National Map Download application (TNM Download at https://viewer.nationalmap.gov/basic/#/).
6.Transportation network, county and municipal boundaries from the Oklahoma Department of Transportation GIS Open Data Portal (https://gis-okdot.opendata.arcgis.com/)
7. Federal lands shown were developed from Bureau of Indian Affairs (BIA) parcel data and Wetland Reserve Program (WRP) easements.

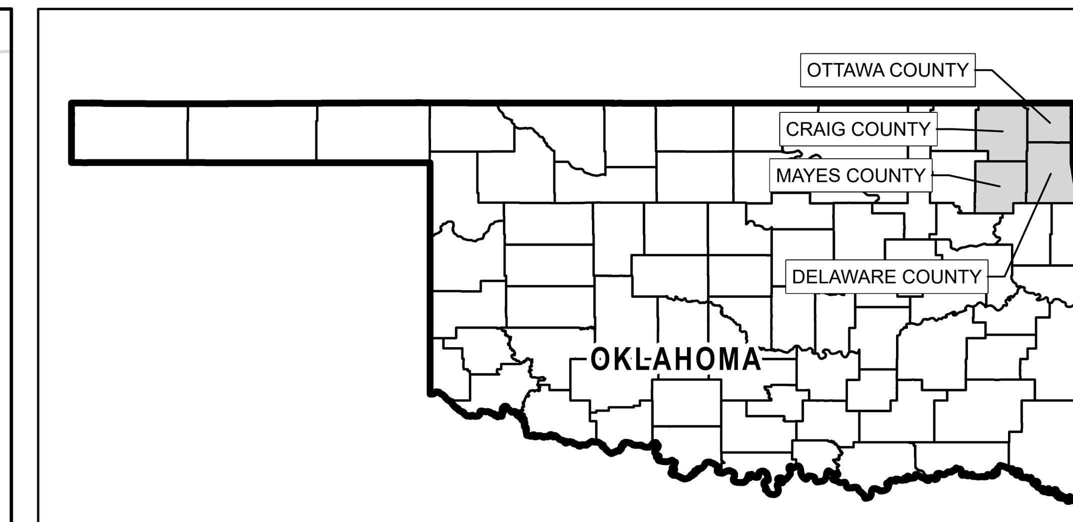
PROJECT BOUNDARY DEFINITION

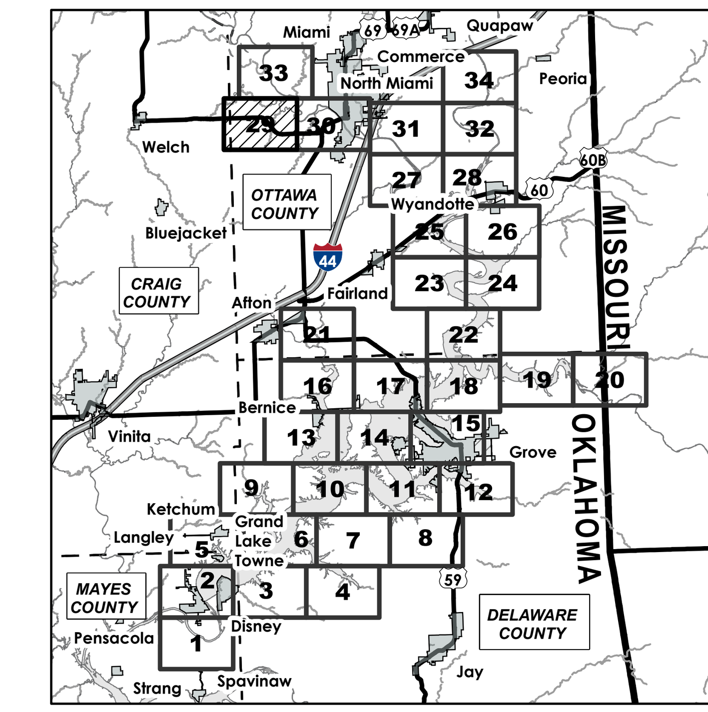
1. Portions of the anticipated project boundary labeled as "Approved 2014 Project Boundary" are based on the FERC approved project boundary last amended January 27, 2014.
2. Portions of the anticipated project boundary labeled as "Interpolation or Extension" indicate either an interpolated contour line is used to join disconnected segments of equivalent contours or a parcel line extension to connect to a defined contour.
3. Portions of the anticipated project boundary based on contour lines are labeled with the contour and datum upon which they are based.
4. Portions of the anticipated project boundary labeled as "Coincident with parcel line" are intended to follow a parcel boundary. See Map Note #1 for more information on parcel data sources.
5. Portions of the anticipated project boundary labeled as "Metes and bounds/ROW" are defined by a metes and bounds description or an existing ROW.

PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
179	180	Approved 2014 project boundary
180	181	Contour elevation 745 ft PD
182	183	Contour elevation 750 ft NGVD 1929
183	184	Coincident with parcel line







Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.57°E

Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 29

GRAND RIVER DAM AUTHORITY **LANGLEY, OKLAHOMA**

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494
NEOSHO AND GRAND RIVERS
OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

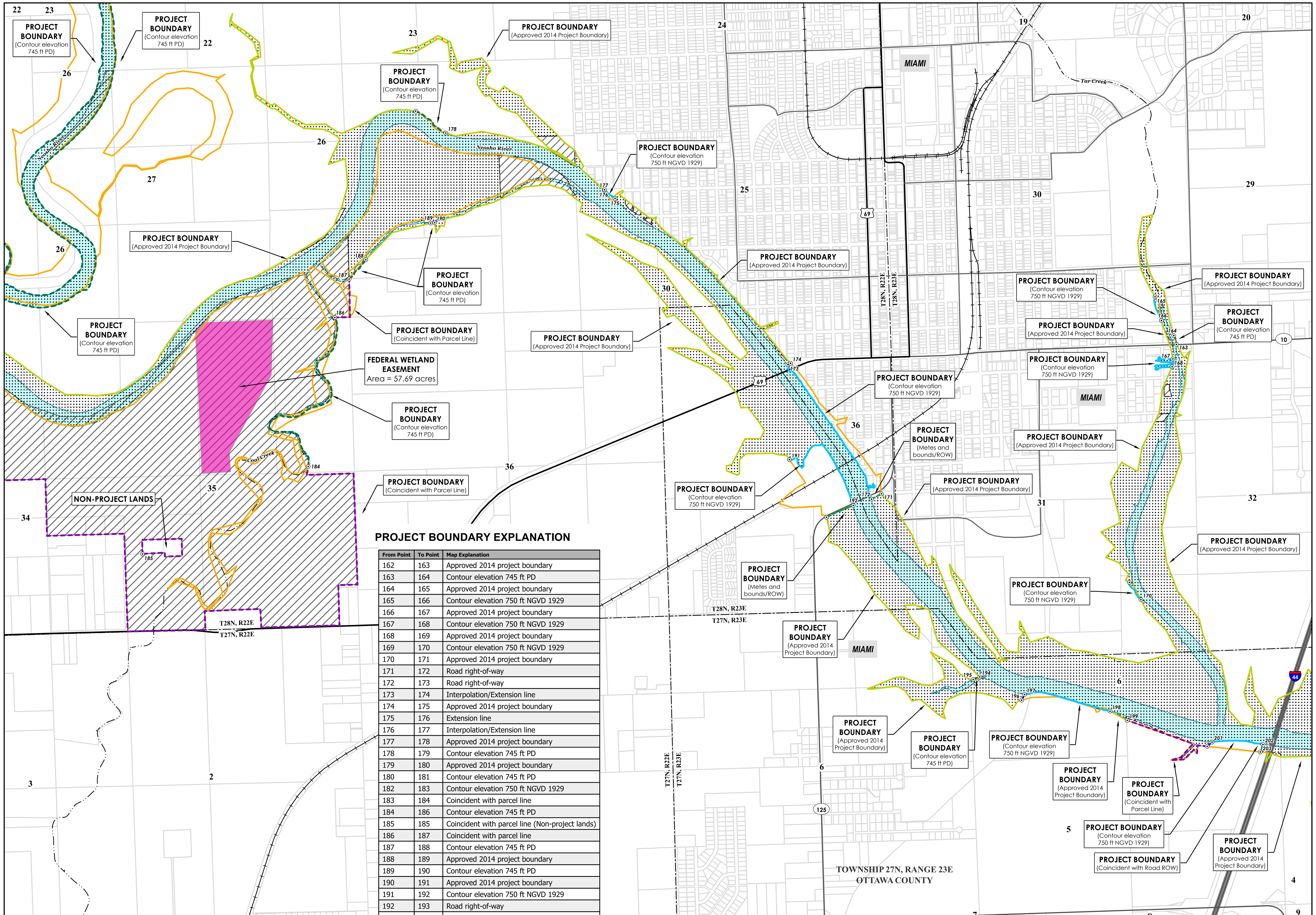
DATE: MAY 2023

MAP NOTES

1. Assessor data from Mayes, Ottawa, Delaware, and Craig counties is current as of June 2022. Any inaccuracies are in the original datasets. Interpretation of ownership designations is based on descriptive data provided in the Assessors' data. No additional research was conducted to validate the accuracy of the information.
2. The Reservoir shown was developed from the 745 ft Pensacola Datum (PD) contour. Contours (745 ft PD and 750 ft NGVD) where used as a basis for the Project boundary were derived from the Digital Elevation Model (DEM) developed for the Upstream Hydraulic Model (UHM).
3. When the project boundary description references a specific known location in the field, that reference shall govern over graphical location on the Exhibit G in case of conflict.
4. Public Land Survey System (PLSS) obtained from the Oklahoma Water Resources Board (https://home-owrb.opendata.arcgis.com/).
5. National Hydrography Dataset (NHD) data (streams and lakes) were obtained from the National Map Download application (TNM Download at https://viewer.nationalmap.gov/basic/#/).
6.Transportation network, county and municipal boundaries from the Oklahoma Department of Transportation GIS Open Data Portal (https://gis-okdot.opendata.arcgis.com/)
7. Federal lands shown were developed from Bureau of Indian Affairs (BIA) parcel data and Wetland Reserve Program (WRP) easements.

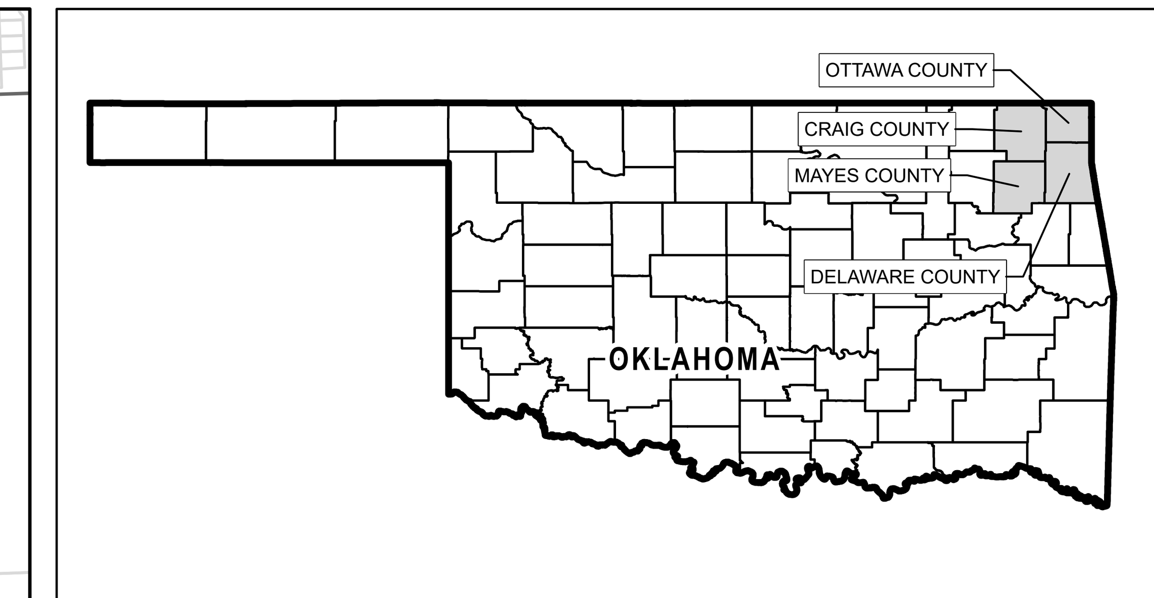
PROJECT BOUNDARY DEFINITION

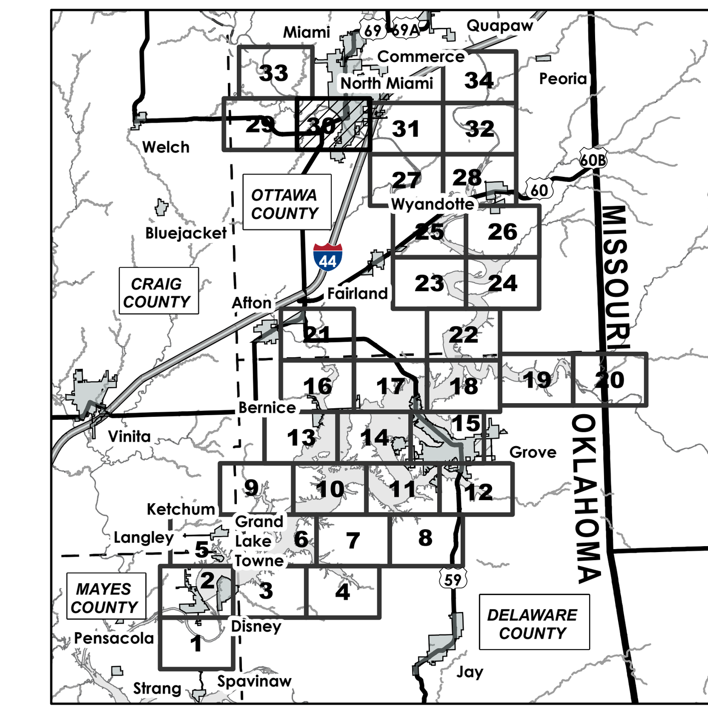
1. Portions of the anticipated project boundary labeled as "Approved 2014 Project Boundary" are based on the FERC approved project boundary last amended January 27, 2014.
2. Portions of the anticipated project boundary labeled as "Interpolation or Extension" indicate either an interpolated contour line is used to join disconnected segments of equivalent contours or a parcel line extension to connect to a defined contour.
3. Portions of the anticipated project boundary based on contour lines are labeled with the contour and datum upon which they are based.
4. Portions of the anticipated project boundary labeled as "Coincident with parcel line" are intended to follow a parcel boundary. See Map Note #1 for more information on parcel data sources.
5. Portions of the anticipated project boundary labeled as "Metes and bounds/ROW" are defined by a metes and bounds description or an existing ROW.



PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
162	163	Approved 2014 project boundary
163	164	Contour elevation 745 ft PD
164	165	Approved 2014 project boundary
165	166	Contour elevation 750 ft NGVD 1929
166	167	Approved 2014 project boundary
167	168	Contour elevation 750 ft NGVD 1929
168	169	Approved 2014 project boundary
169	170	Contour elevation 750 ft NGVD 1929
170	171	Approved 2014 project boundary
171	172	Road right-of-way
172	173	Road right-of-way
173	174	Interpolation/Extension line
174	175	Approved 2014 project boundary
175	176	Extension line
176	177	Interpolation/Extension line
177	178	Approved 2014 project boundary
178	179	Contour elevation 745 ft PD
179	180	Approved 2014 project boundary
180	181	Contour elevation 745 ft PD
182	183	Contour elevation 750 ft NGVD 1929
183	184	Coincident with parcel line
184	186	Contour elevation 745 ft PD
185	185	Coincident with parcel line (Non-project lands)
186	187	Coincident with parcel line
187	188	Contour elevation 745 ft PD
188	189	Approved 2014 project boundary
189	190	Contour elevation 745 ft PD
190	191	Approved 2014 project boundary
191	192	Contour elevation 750 ft NGVD 1929
192	193	Road right-of-way
193	194	Approved 2014 project boundary
194	195	Contour elevation 745 ft PD
195	196	Approved 2014 project boundary
196	197	Interpolation/Extension line
197	198	Contour elevation 750 ft NGVD 1929
198	199	Approved 2014 project boundary
199	200	Coincident with parcel line
200	201	Interpolation/Extension line
201	202	Contour elevation 750 ft NGVD 1929
202	203	Road right-of-way
203	204	Approved 2014 project boundary





Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.52°E

Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 30

GRAND RIVER DAM AUTHORITY **LANGLEY, OKLAHOMA**

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494
NEOSHO AND GRAND RIVERS
OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

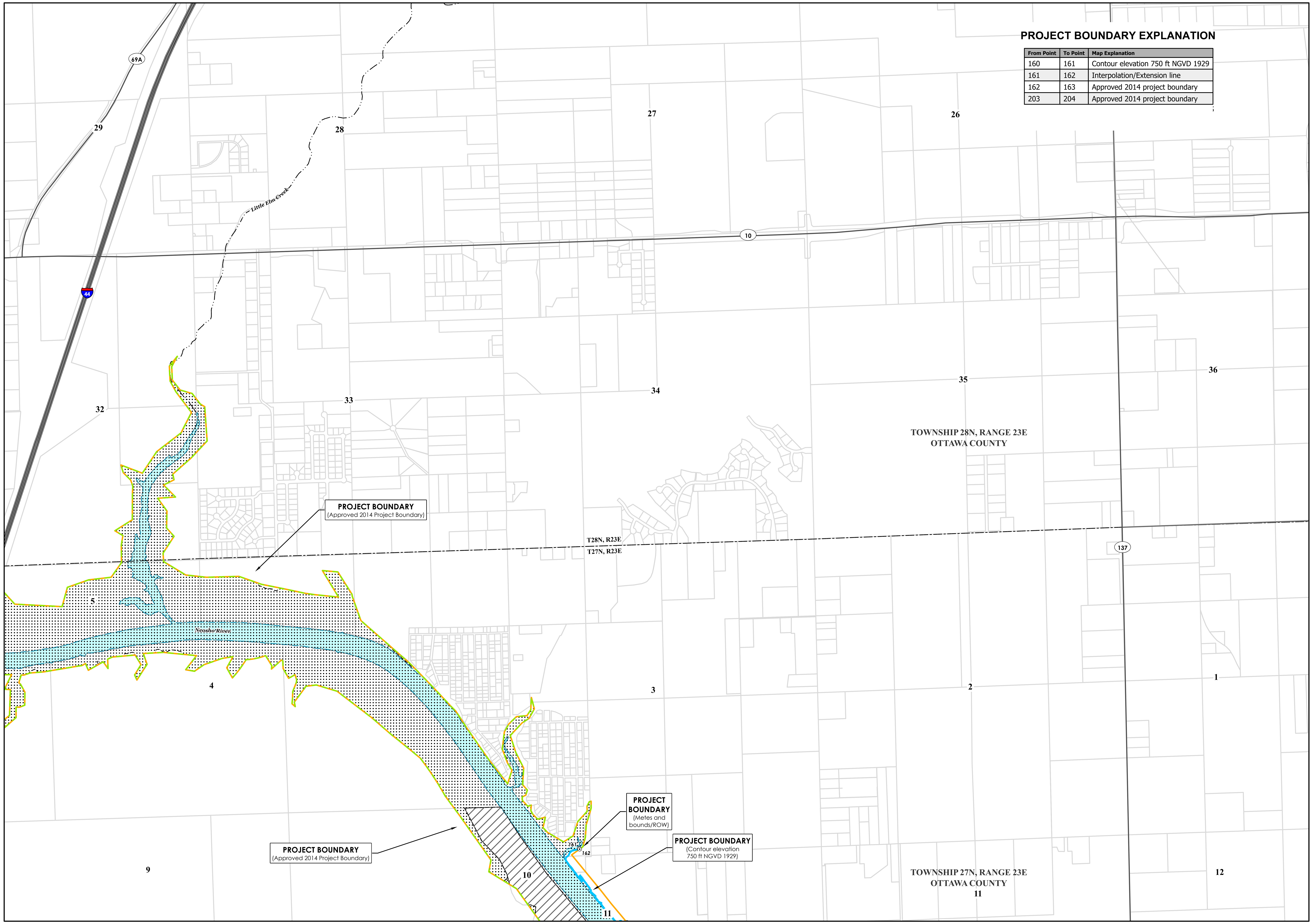
DATE: MAY 2023

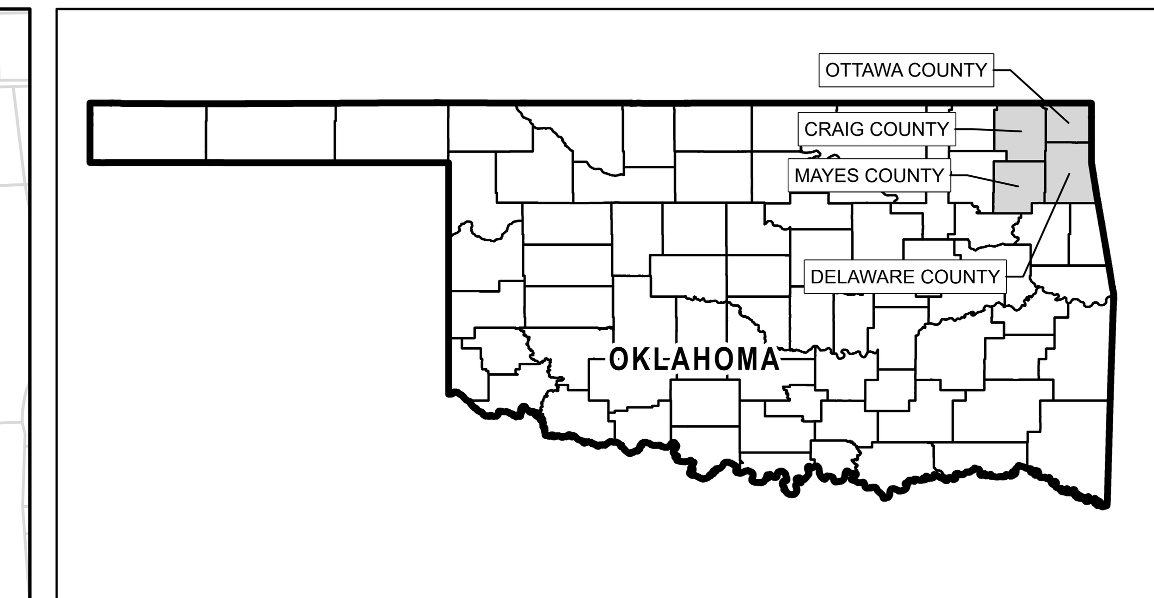
P NOTES
Assessor data from Mayes, Ottawa, Delaware, and Craig nties is current as of June 2022. Any inaccuracies are in original datasets. Interpretation of ownership signations is based on descriptive data provided in the sessors' data. No additional research was conducted to date the accuracy of the information.
The Reservoir shown was developed from the 745 ft nsacola Datum (PD) contour. Contours (745 ft PD and ft NGVD) where used as a basis for the Project undary were derived from the Digital Elevation Model EM) developed for the Upstream Hydraulic Model (UHM).
When the project boundary description references a ecific known location in the field, that reference shall vern over graphical location on the Exhibit G in case of conflict.
4. Public Land Survey System (PLSS) obtained from the Oklahoma Water Resources Board (https://home-owrb.opendata.arcgis.com/).
5. National Hydrography Dataset (NHD) data (streams and lakes) were obtained from the National Map Download application (TNM Download at https://viewer.nationalmap.gov/basic/#/).
6.Transportation network, county and municipal boundaries from the Oklahoma Department of Transportation GIS Open Data Portal (https://gis-okdot.opendata.arcgis.com/)
7. Federal lands shown were developed from Bureau of Indian Affairs (BIA) parcel data and Wetland Reserve Program (WRP) easements.

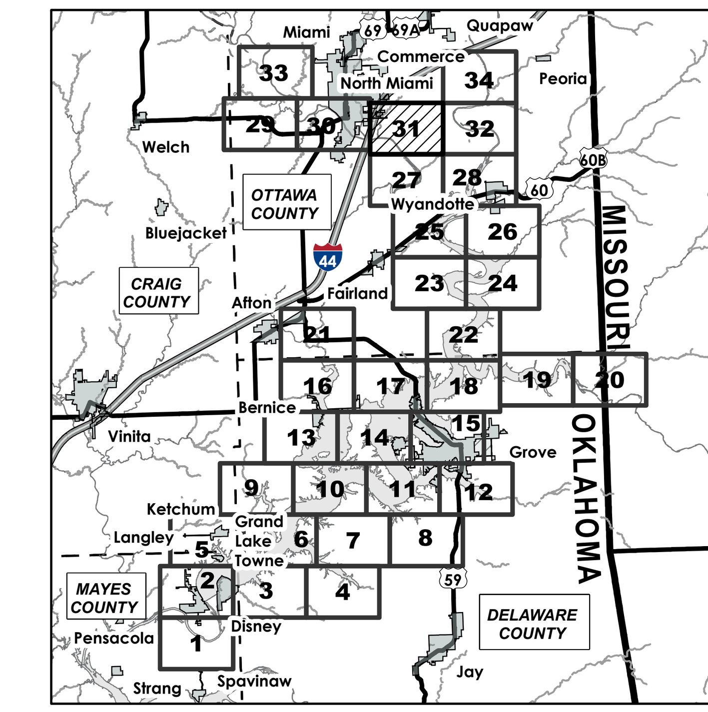
PROJECT BOUNDARY DEFINITION
1. Portions of the anticipated project boundary labeled as "Approved 2014 Project Boundary" are based on the FERC approved project boundary last amended January 27, 2014.
2. Portions of the anticipated project boundary labeled as "Interpolation or Extension" indicate either an interpolated contour line is used to join disconnected segments of equivalent contours or a parcel line extension to connect to a defined contour.
3. Portions of the anticipated project boundary based on contour lines are labeled with the contour and datum upon which they are based.
4. Portions of the anticipated project boundary labeled as "Coincident with parcel line" are intended to follow a parcel boundary. See Map Note #1 for more information on parcel data sources.
5. Portions of the anticipated project boundary labeled as "Metes and bounds/ROW" are defined by a metes and bounds description or an existing ROW.

PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
160	161	Contour elevation 750 ft NGVD 1929
161	162	Interpolation/Extension line
162	163	Approved 2014 project boundary
203	204	Approved 2014 project boundary







Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.47°E

Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 31

GRAND RIVER DAM AUTHORITY **LANGLEY, OKLAHOMA**

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494
NEOSHO AND GRAND RIVERS
OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

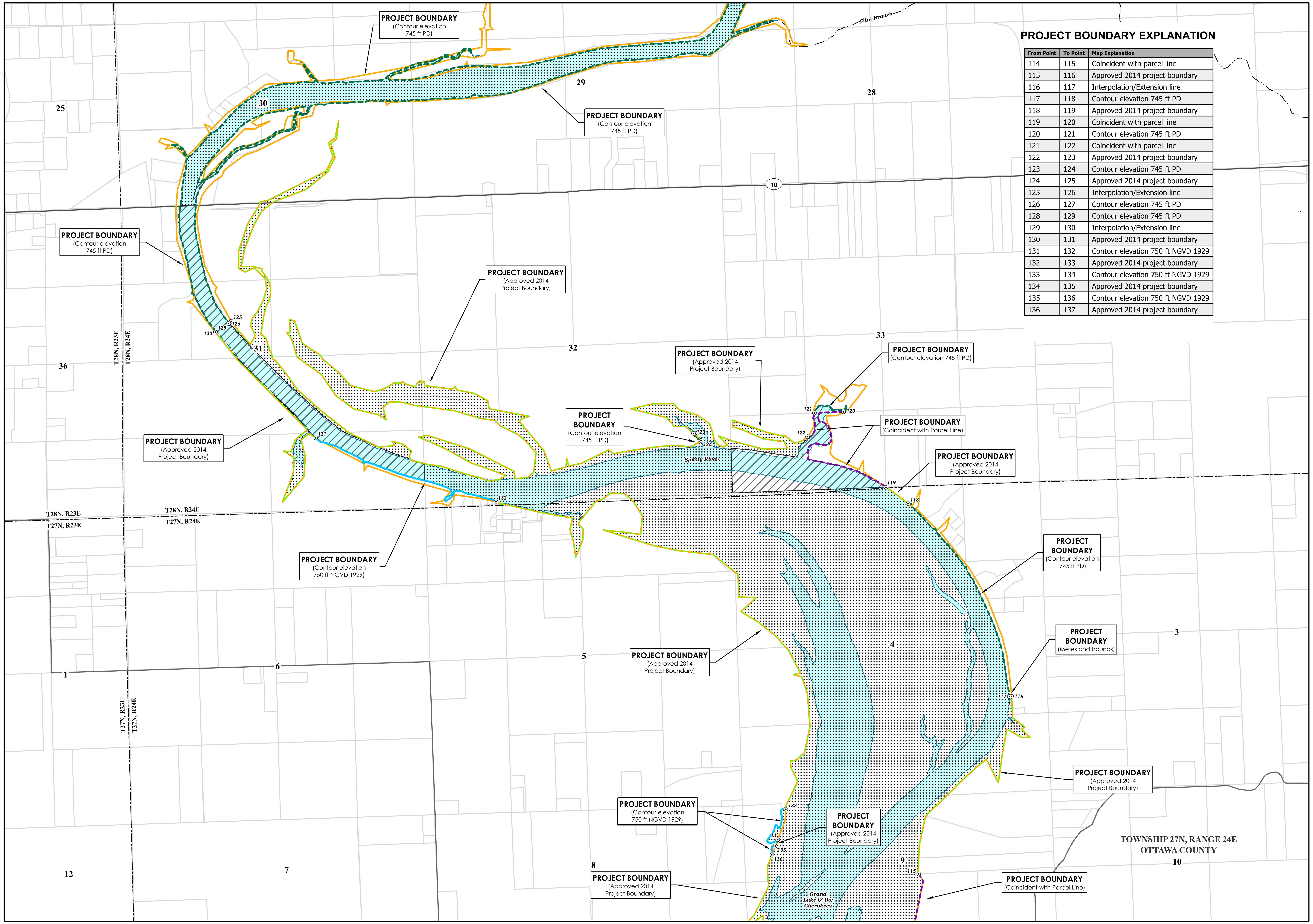
DATE: MAY 2023

MAP NOTES

1. Assessor data from Mayes, Ottawa, Delaware, and Craig counties is current as of June 2022. Any inaccuracies are in the original datasets. Interpretation of ownership designations is based on descriptive data provided in the Assessors' data. No additional research was conducted to validate the accuracy of the information.
2. The Reservoir shown was developed from the 745 ft Pensacola Datum (PD) contour. Contours (745 ft PD and 750 ft NGVD) where used as a basis for the Project boundary were derived from the Digital Elevation Model (DEM) developed for the Upstream Hydraulic Model (UHM).
3. When the project boundary description references a specific known location in the field, that reference shall govern over graphical location on the Exhibit G in case of conflict.
4. Public Land Survey System (PLSS) obtained from the Oklahoma Water Resources Board (https://home-owrb.opendata.arcgis.com/).
5. National Hydrography Dataset (NHD) data (streams and lakes) were obtained from the National Map Download application (TNM Download at https://viewer.nationalmap.gov/basic/#/).
6.Transportation network, county and municipal boundaries from the Oklahoma Department of Transportation GIS Open Data Portal (https://gis-okdot.opendata.arcgis.com/)
7. Federal lands shown were developed from Bureau of Indian Affairs (BIA) parcel data and Wetland Reserve Program (WRP) easements.

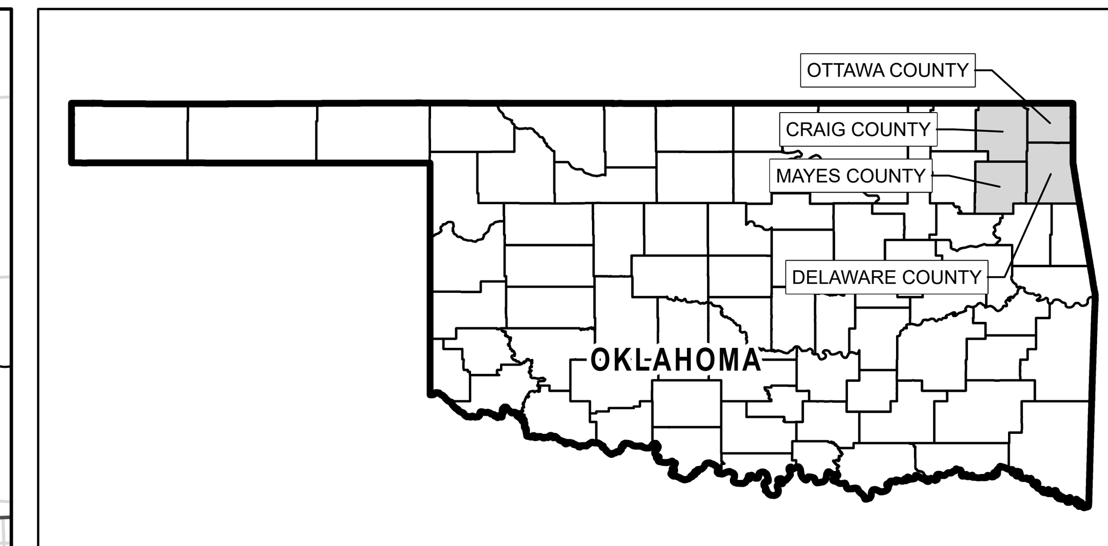
PROJECT BOUNDARY DEFINITION

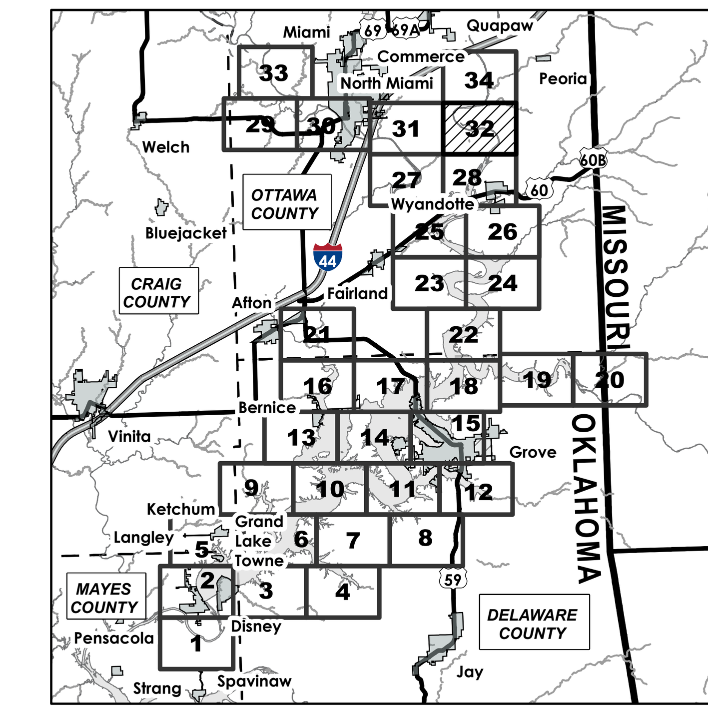
1. Portions of the anticipated project boundary labeled as "Approved 2014 Project Boundary" are based on the FERC approved project boundary last amended January 27, 2014.
2. Portions of the anticipated project boundary labeled as "Interpolation or Extension" indicate either an interpolated contour line is used to join disconnected segments of equivalent contours or a parcel line extension to connect to a defined contour.
3. Portions of the anticipated project boundary based on contour lines are labeled with the contour and datum upon which they are based.
4. Portions of the anticipated project boundary labeled as "Coincident with parcel line" are intended to follow a parcel boundary. See Map Note #1 for more information on parcel data sources.
5. Portions of the anticipated project boundary labeled as "Metes and bounds/ROW" are defined by a metes and bounds description or an existing ROW.



PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
114	115	Coincident with parcel line
115	116	Approved 2014 project boundary
116	117	Interpolation/Extension line
117	118	Contour elevation 745 ft PD
118	119	Approved 2014 project boundary
119	120	Coincident with parcel line
120	121	Contour elevation 745 ft PD
121	122	Coincident with parcel line
122	123	Approved 2014 project boundary
123	124	Contour elevation 745 ft PD
124	125	Approved 2014 project boundary
125	126	Interpolation/Extension line
126	127	Contour elevation 745 ft PD
128	129	Contour elevation 745 ft PD
129	130	Interpolation/Extension line
130	131	Approved 2014 project boundary
131	132	Contour elevation 750 ft NGVD 1929
132	133	Approved 2014 project boundary
133	134	Contour elevation 750 ft NGVD 1929
134	135	Approved 2014 project boundary
135	136	Contour elevation 750 ft NGVD 1929
136	137	Approved 2014 project boundary





N

Magnetic Declination at Pensacola Dam April 2022 (Degrees): 1.42°E

Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 32

GRAND RIVER DAM AUTHORITY LANGLEY, OKLAHOMA

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494

NEOSHO AND GRAND RIVERS

OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

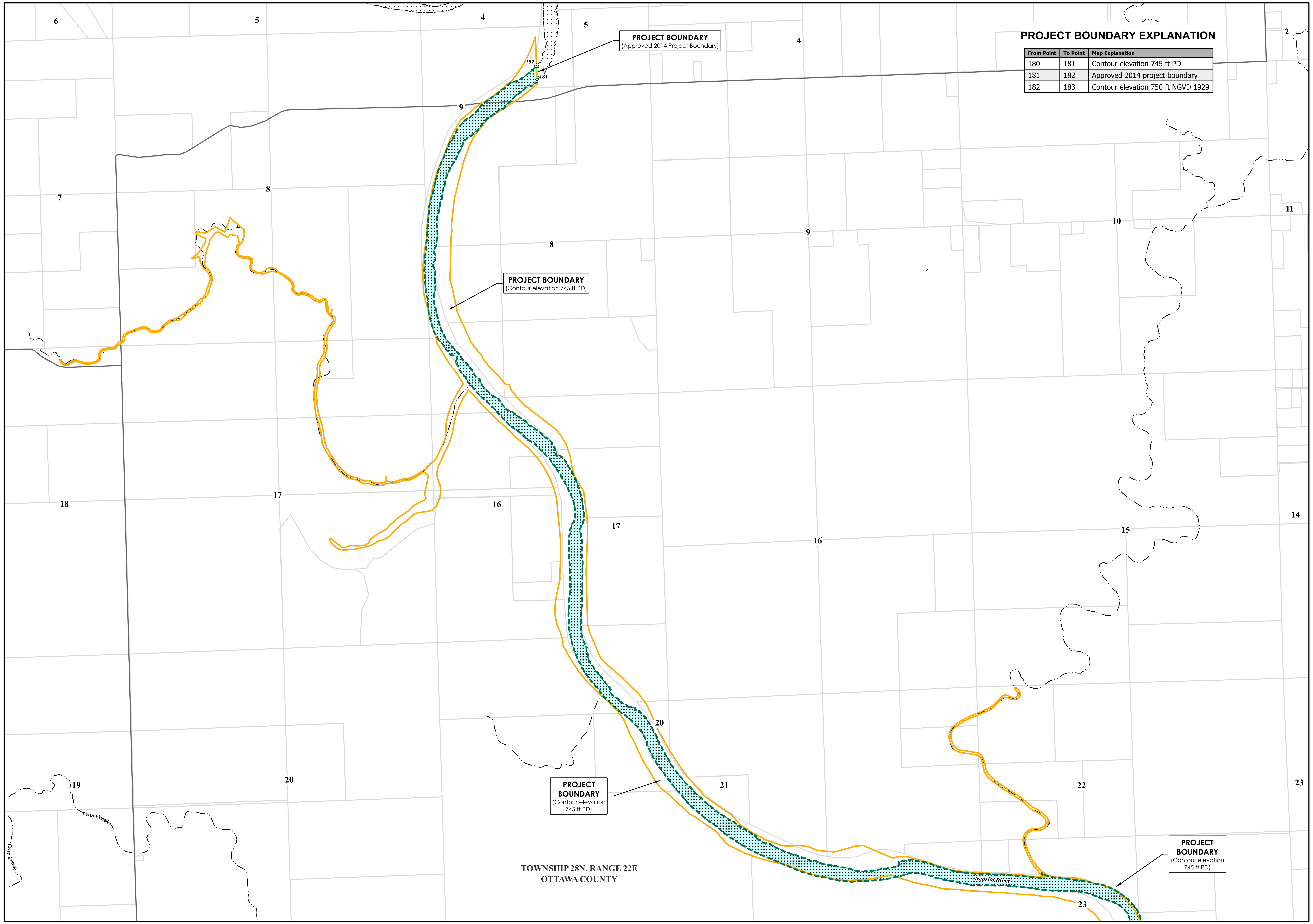
DATE: MAY 2023

MAP NOTES

1. Assessor data from Mayes, Ottawa, Delaware, and Craig counties is current as of June 2022. Any inaccuracies are in the original datasets. Interpretation of ownership designations is based on descriptive data provided in the Assessors' data. No additional research was conducted to validate the accuracy of the information.
2. The Reservoir shown was developed from the 745 ft Pensacola Datum (PD) contour. Contours (745 ft PD and 750 ft NGVD) where used as a basis for the Project boundary were derived from the Digital Elevation Model (DEM) developed for the Upstream Hydraulic Model (UHM).
3. When the project boundary description references a specific known location in the field, that reference shall govern over graphical location on the Exhibit G in case of conflict.
4. Public Land Survey System (PLSS) obtained from the Oklahoma Water Resources Board (https://home-owrb.opendata.arcgis.com/).
5. National Hydrography Dataset (NHD) data (streams and lakes) were obtained from the National Map Download application (TNM Download at https://viewer.nationalmap.gov/basic/#/).
6.Transportation network, county and municipal boundaries from the Oklahoma Department of Transportation GIS Open Data Portal (https://gis-okdot.opendata.arcgis.com/)
7. Federal lands shown were developed from Bureau of Indian Affairs (BIA) parcel data and Wetland Reserve Program (WRP) easements.

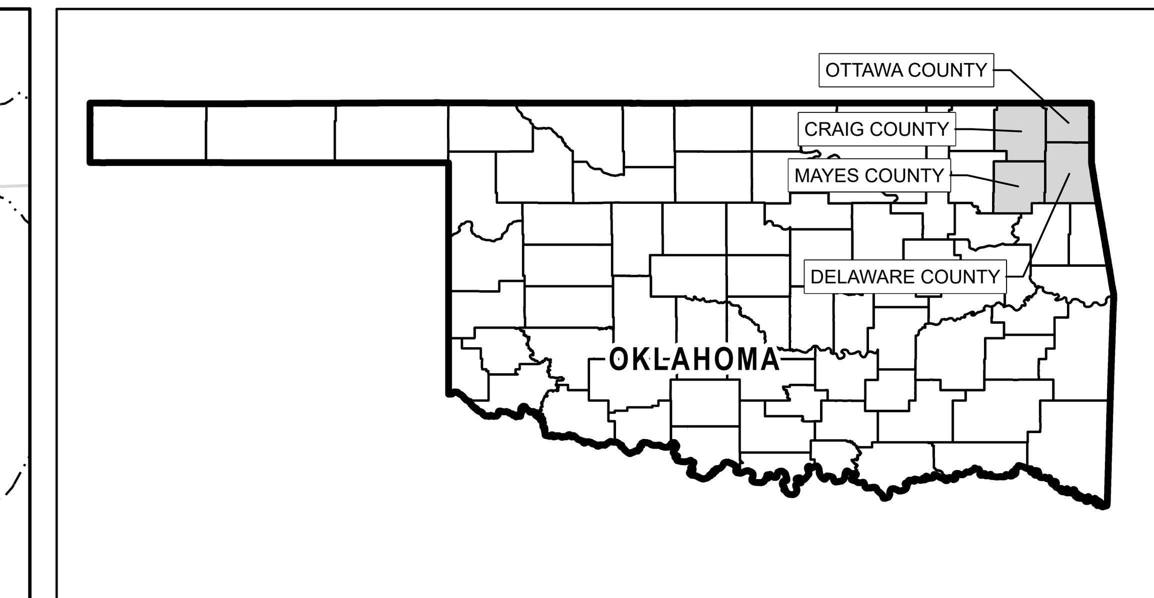
PROJECT BOUNDARY DEFINITION

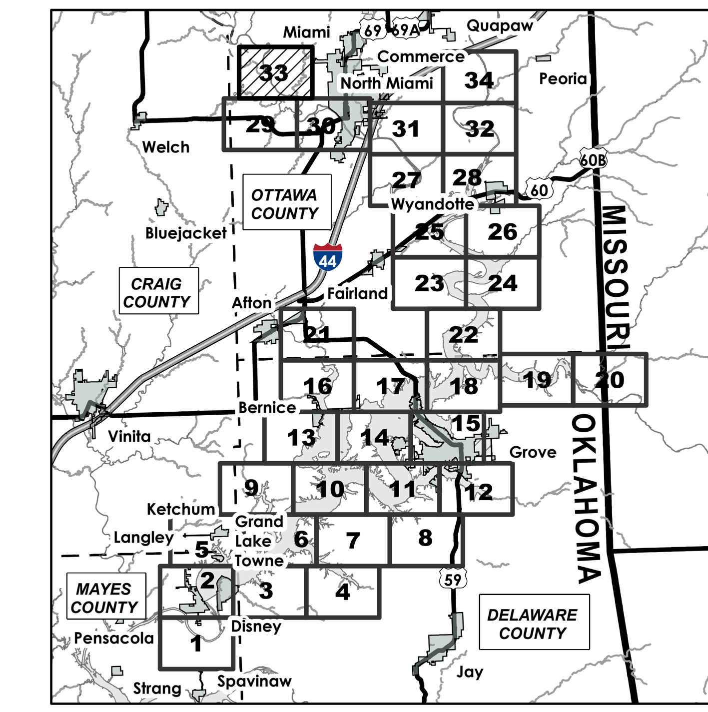
1. Portions of the anticipated project boundary labeled as "Approved 2014 Project Boundary" are based on the FERC approved project boundary last amended January 27, 2014.
2. Portions of the anticipated project boundary labeled as "Interpolation or Extension" indicate either an interpolated contour line is used to join disconnected segments of equivalent contours or a parcel line extension to connect to a defined contour.
3. Portions of the anticipated project boundary based on contour lines are labeled with the contour and datum upon which they are based.
4. Portions of the anticipated project boundary labeled as "Coincident with parcel line" are intended to follow a parcel boundary. See Map Note #1 for more information on parcel data sources.
5. Portions of the anticipated project boundary labeled as "Metes and bounds/ROW" are defined by a metes and bounds description or an existing ROW.



PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
180	181	Contour elevation 745 ft PD
181	182	Approved 2014 project boundary
182	183	Contour elevation 750 ft NGVD 1929





Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.56°E

Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

900 450 0 900 1,800 2,700 3,600 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 33

GRAND RIVER DAM AUTHORITY LANGLEY, OKLAHOMA

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494

NEOSHO AND GRAND RIVERS

OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

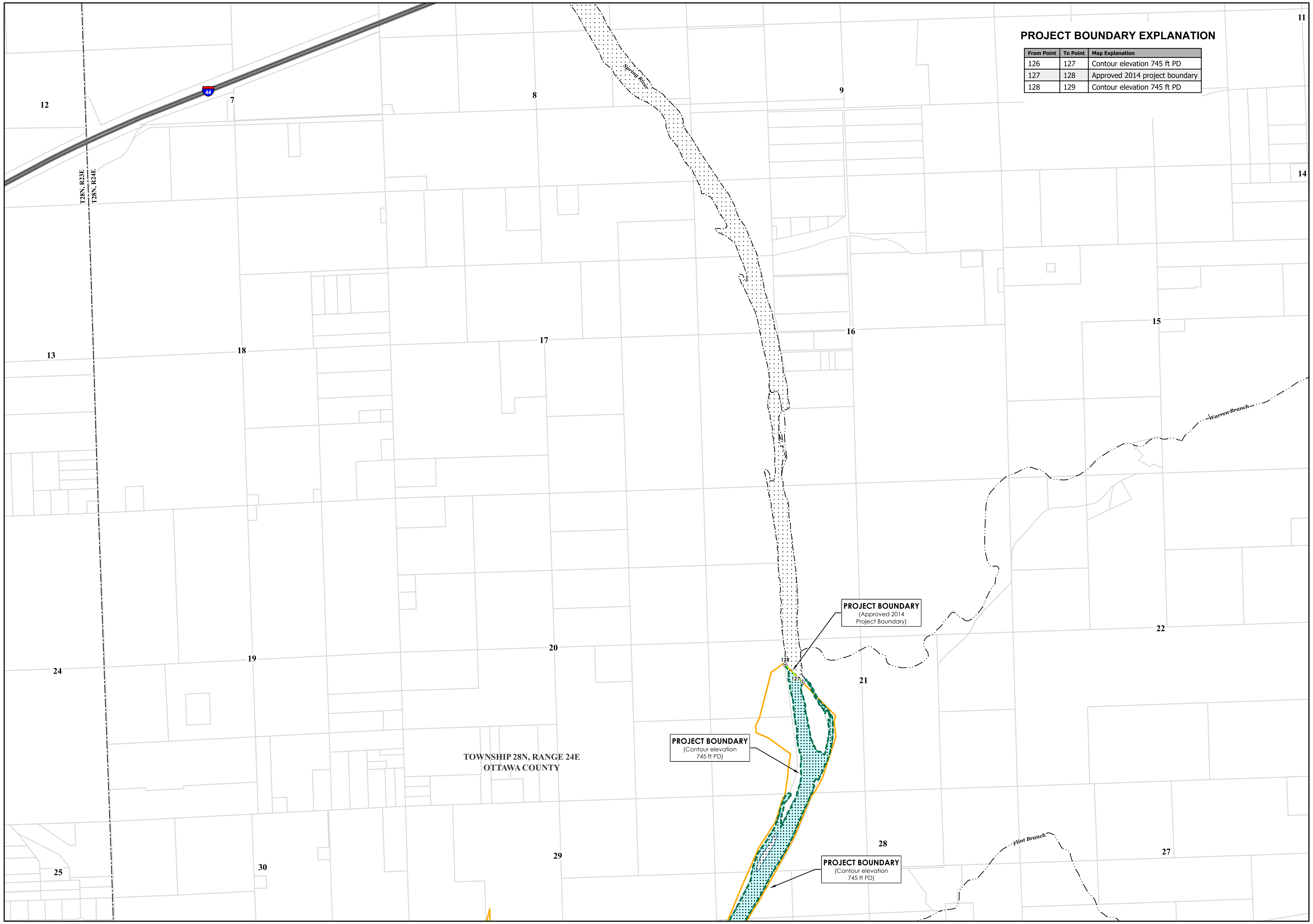
DATE: MAY 2023

MAP NOTES

1. Assessor data from Mayes, Ottawa, Delaware, and Craig counties is current as of June 2022. Any inaccuracies are in the original datasets. Interpretation of ownership designations is based on descriptive data provided in the Assessors' data. No additional research was conducted to validate the accuracy of the information.
2. The Reservoir shown was developed from the 745 ft Pensacola Datum (PD) contour. Contours (745 ft PD and 750 ft NGVD) where used as a basis for the Project boundary were derived from the Digital Elevation Model (DEM) developed for the Upstream Hydraulic Model (UHM).
3. When the project boundary description references a specific known location in the field, that reference shall govern over graphical location on the Exhibit G in case of conflict.
4. Public Land Survey System (PLSS) obtained from the Oklahoma Water Resources Board (https://home-owrb.opendata.arcgis.com/).
5. National Hydrography Dataset (NHD) data (streams and lakes) were obtained from the National Map Download application (TNM Download at https://viewer.nationalmap.gov/basic/#/).
6.Transportation network, county and municipal boundaries from the Oklahoma Department of Transportation GIS Open Data Portal (https://gis-okdot.opendata.arcgis.com/)
7. Federal lands shown were developed from Bureau of Indian Affairs (BIA) parcel data and Wetland Reserve Program (WRP) easements.

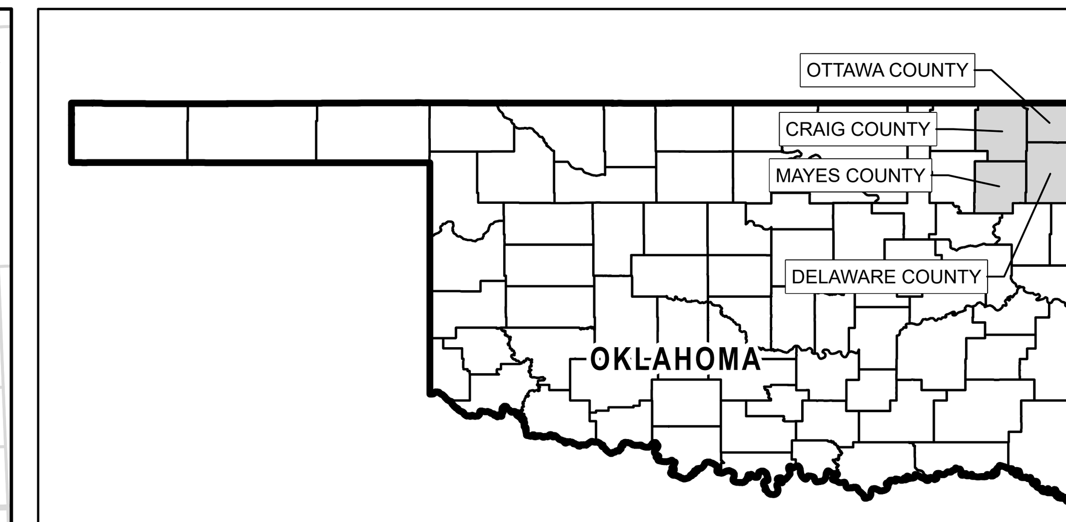
PROJECT BOUNDARY DEFINITION

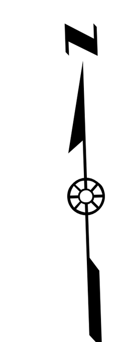
1. Portions of the anticipated project boundary labeled as "Approved 2014 Project Boundary" are based on the FERC approved project boundary last amended January 27, 2014.
2. Portions of the anticipated project boundary labeled as "Interpolation or Extension" indicate either an interpolated contour line is used to join disconnected segments of equivalent contours or a parcel line extension to connect to a defined contour.
3. Portions of the anticipated project boundary based on contour lines are labeled with the contour and datum upon which they are based.
4. Portions of the anticipated project boundary labeled as "Coincident with parcel line" are intended to follow a parcel boundary. See Map Note #1 for more information on parcel data sources.
5. Portions of the anticipated project boundary labeled as "Metes and bounds/ROW" are defined by a metes and bounds description or an existing ROW.



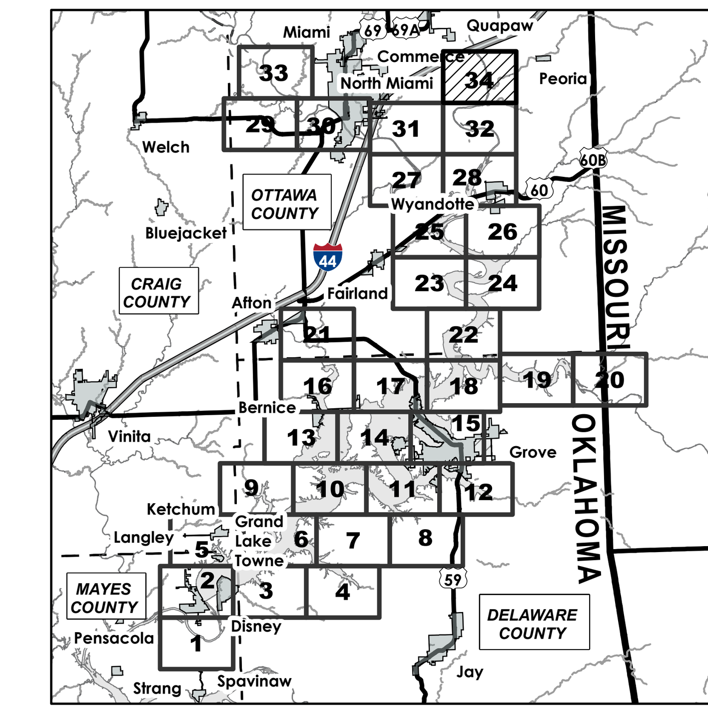
PROJECT BOUNDARY EXPLANATION

From Point	To Point	Map Explanation
126	127	Contour elevation 745 ft PD
127	128	Approved 2014 project boundary
128	129	Contour elevation 745 ft PD





Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.42°E



Legend

- Boundary Point
- Non-Project Facility
- Project Facility
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 34

GRAND RIVER DAM AUTHORITY **LANGLEY, OKLAHOMA**

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494
NEOSHO AND GRAND RIVERS
OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

DATE: MAY 2023

MAP NOTES

1. Assessor data from Mayes, Ottawa, Delaware, and Craig counties is current as of June 2022. Any inaccuracies are in the original datasets. Interpretation of ownership designations is based on descriptive data provided in the Assessors' data. No additional research was conducted to validate the accuracy of the information.
2. The Reservoir shown was developed from the 745 ft Pensacola Datum (PD) contour. Contours (745 ft PD and 750 ft NGVD) where used as a basis for the Project boundary were derived from the Digital Elevation Model (DEM) developed for the Upstream Hydraulic Model (UHM).
3. When the project boundary description references a specific known location in the field, that reference shall govern over graphical location on the Exhibit G in case of conflict.
4. Public Land Survey System (PLSS) obtained from the Oklahoma Water Resources Board (https://home-owrb.opendata.arcgis.com/).
5. National Hydrography Dataset (NHD) data (streams and lakes) were obtained from the National Map Download application (TNM Download at https://viewer.nationalmap.gov/basic/#/).
6.Transportation network, county and municipal boundaries from the Oklahoma Department of Transportation GIS Open Data Portal (https://gis-okdot.opendata.arcgis.com/)
7. Federal lands shown were developed from Bureau of Indian Affairs (BIA) parcel data and Wetland Reserve Program (WRP) easements.

PROJECT BOUNDARY DEFINITION

1. Portions of the anticipated project boundary labeled as "Approved 2014 Project Boundary" are based on the FERC approved project boundary last amended January 27, 2014.
2. Portions of the anticipated project boundary labeled as "Interpolation or Extension" indicate either an interpolated contour line is used to join disconnected segments of equivalent contours or a parcel line extension to connect to a defined contour.
3. Portions of the anticipated project boundary based on contour lines are labeled with the contour and datum upon which they are based.
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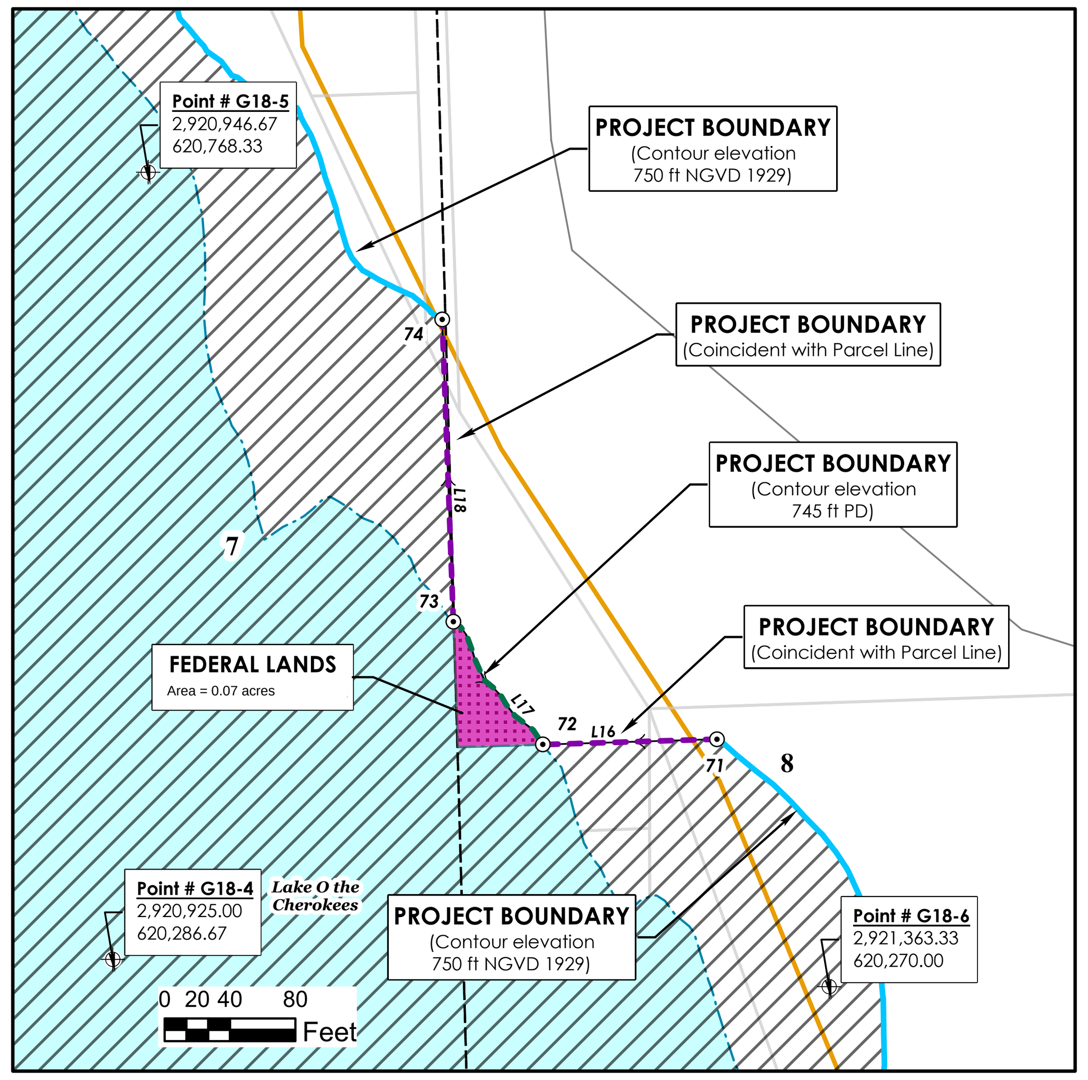
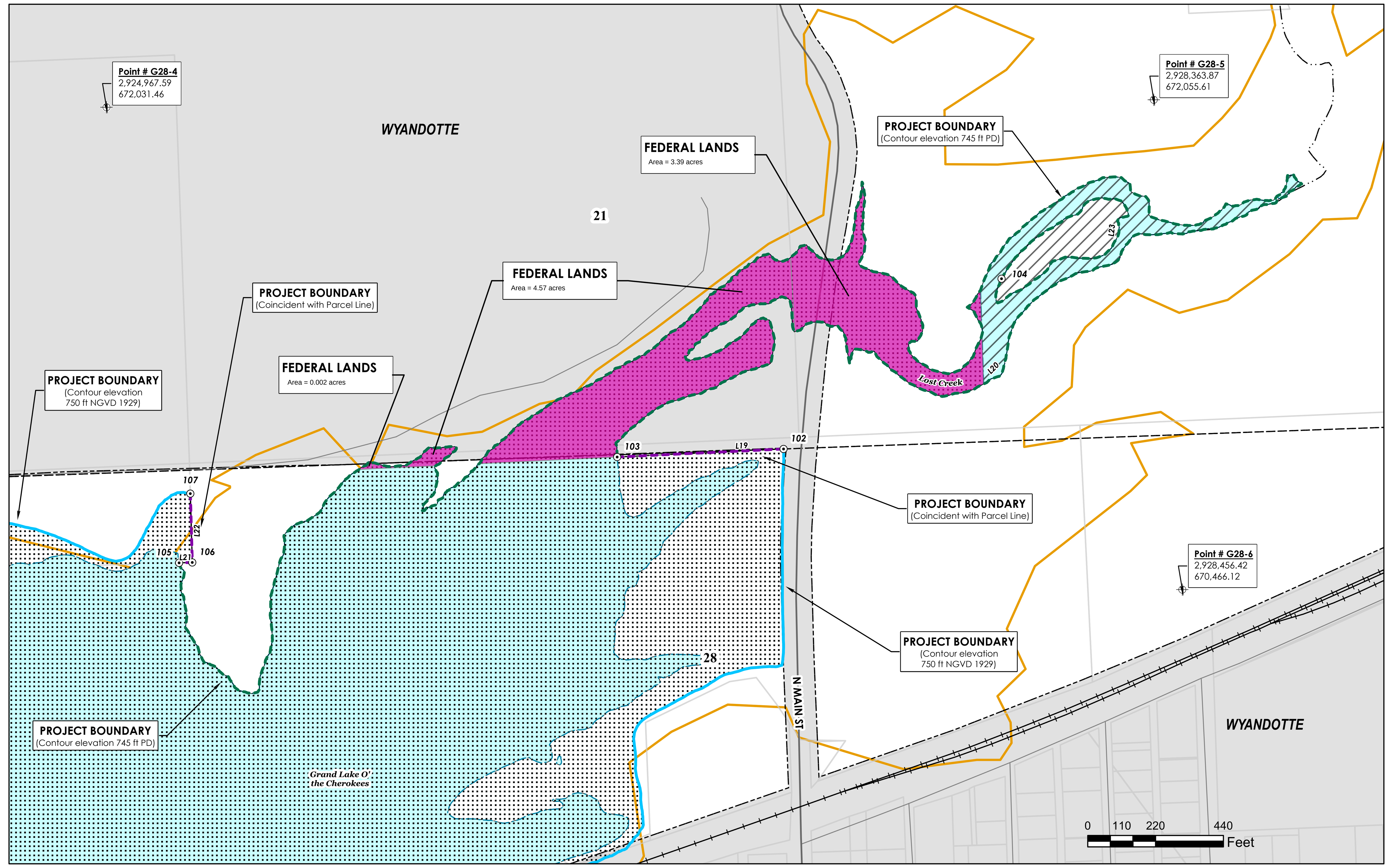
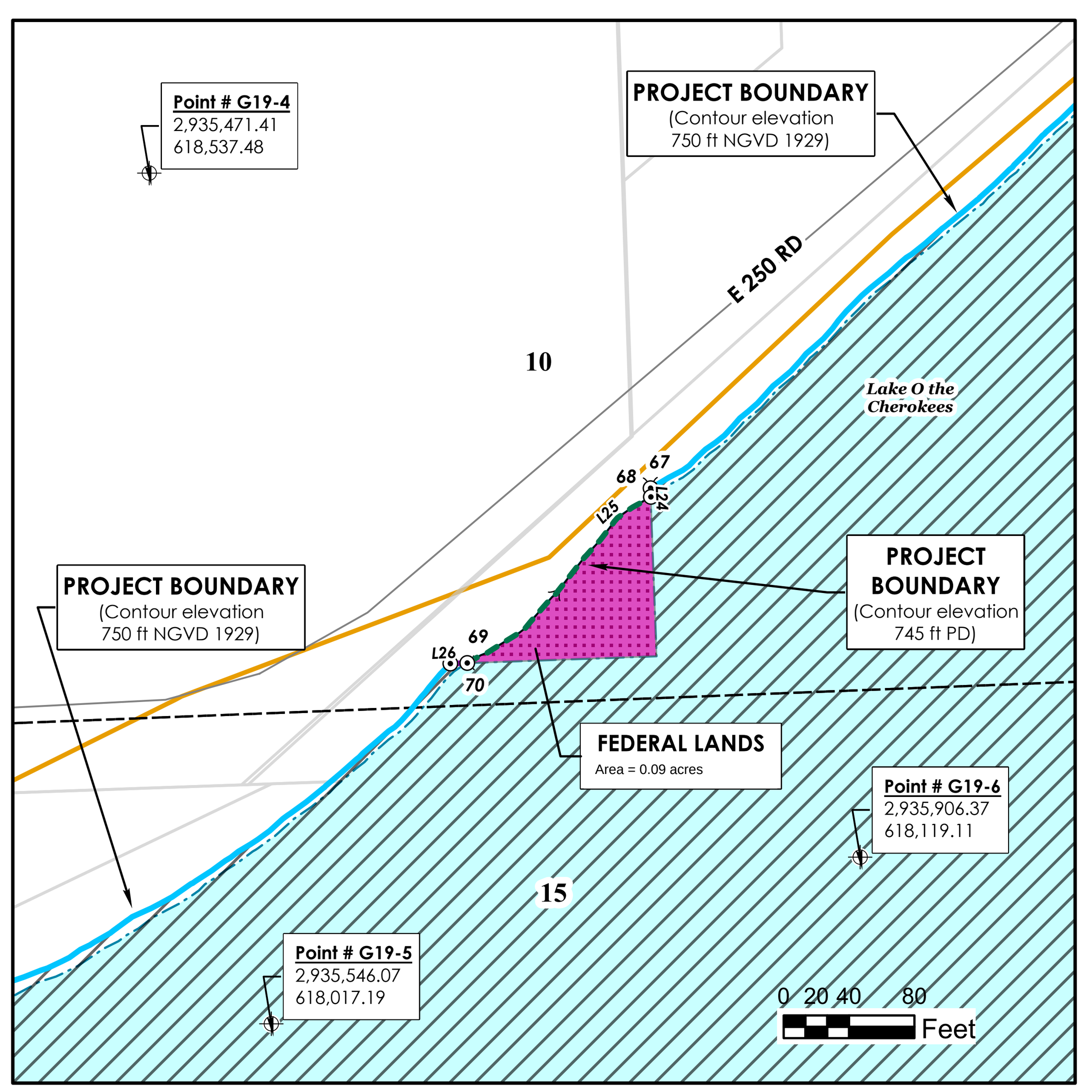
5. Portions of the anticipated project boundary labeled as "Metes and bounds/ROW" are defined by a metes and bounds description or an existing ROW.



ID	From Point	To Point	Direction	Distance	Notes
16	71	72	S88°18'59.09"W	106.59	From a point on 750 ft NGVD contour elevation along parcel line to a point on the 745 ft PD contour elevation
17	72	73		94.98	Along 745 ft PD contour elevation
18	73	74	N2°06'44.48"W	185.07	From a point on 745 ft PD contour elevation along parcel line to a point on the 750 ft NGVD 1929 contour elevation

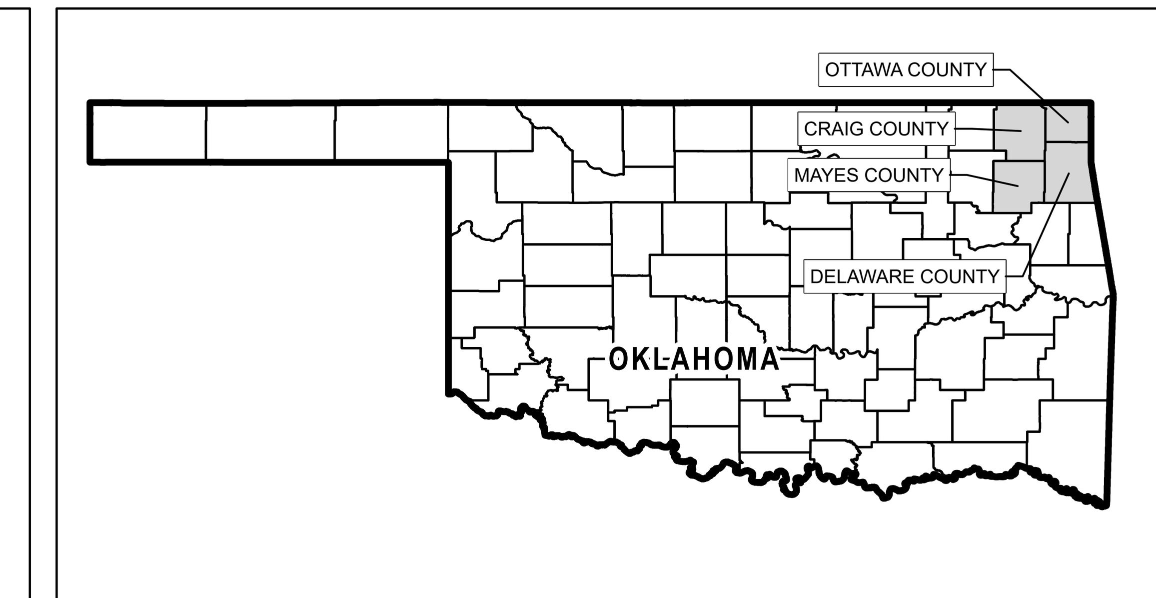


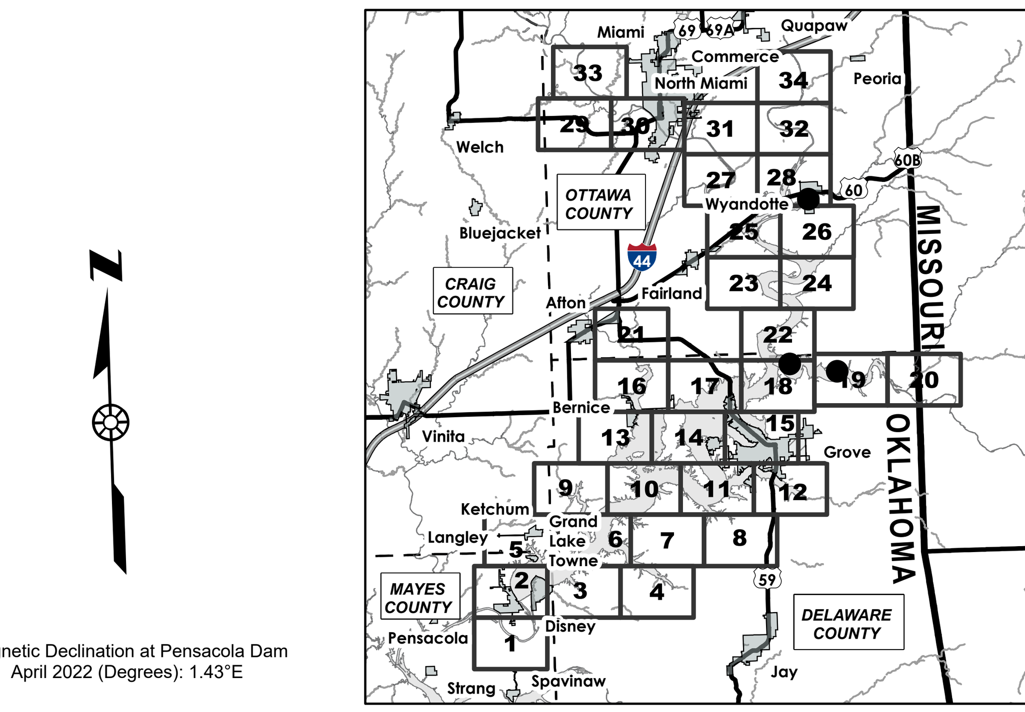
ID	From Point	To Point	Direction	Distance	Notes
19	102	103	S87°13'26.66"W	540.21	Along parcel line
20	103	105		10,457.47	Along 745 ft PD contour elevation to a point on parcel line
21	105	106	N88°15'05.86"E	42.70	Along parcel line
22	106	107	N1°37'10.76"W	223.47	Along parcel line to a point on the 750 ft NGVD 1929 contour elevation
23	104	104		1,209.96	Along 745 ft PD contour elevation



Please Note: The purpose of this map is to describe the changes to the Exhibit G drawings. The actual depiction of Tribal lands held in trust and the resulting acreage is ongoing with the Bureau of Indian Affairs. Therefore, the actual acreages depicted on this map are subject to adjustment.

ID	From Point	To Point	Direction	Distance	Notes
24	67	68	S2°03'26.08"E	5.33	From a point on the 750 ft NGVD 1929 contour elevation along parcel line to a point on the 745 ft PD contour elevation
25	68	69		153.76	Along 745 ft PD contour elevation
26	69	70	S87°58'31.64"W	10.35	From a point on the 745 ft PD contour elevation along parcel line to a point on the 750 ft NGVD 1929 contour elevation





Magnetic Declination at Pensacola Dam
April 2022 (Degrees): 1.43°E

Legend

- Reference Point Location
- Public Access Site
- Boundary Point
- Approved Project Boundary (1-27-2014)

Anticipated Project Boundary Basis

- Coincident with Parcel Line
- Extension/Interpolation
- Metes and Bounds/ROW
- Contour elevation 745 ft PD
- Contour elevation 750 ft NGVD 1929
- Approved 2014 Project Boundary
- Open Water
- Open Water - Flowage Rights
- Flowage Easement
- Other Open Water
- Stream
- Fee Simple Ownership
- Parcel Boundary
- Federal Lands
- County Boundary
- PLSS Township
- Section Line
- Municipal Boundary
- Railroad
- Interstate
- US Highway
- State Highway
- Major Collector
- Local Road

Unless noted otherwise, the Anticipated Project Boundary is based on the 750 ft NGVD 1929 contour elevation.

100 50 0 100 200 300 400 Feet

Reference coordinates are in Oklahoma Stateplane North Zone FIPS 3501, NAD83. Coordinate units are in U.S. Survey feet. Project boundary elevation contour is referenced to the National Geodetic Vertical Datum (NGVD) 1929 or Pensacola Datum (PD) (NGVD 1929=PD+1.07 ft

EXHIBIT 35

GRAND RIVER DAM AUTHORITY **LANGLEY, OKLAHOMA**

PENSACOLA DAM HYDROELECTRIC PROJECT

FERC PROJECT No. 1494
NEOSHO AND GRAND RIVERS
OTTAWA, DELAWARE, MAYES, AND CRAIG COUNTIES

PROJECT BOUNDARY EXPLANATION MAP

DATE: MAY 2023

MAP NOTES

1. Assessor data from Mayes, Ottawa, Delaware, and Craig counties is current as of June 2022. Any inaccuracies are in the original datasets. Interpretation of ownership designations is based on descriptive data provided in the Assessors' data. No additional research was conducted to validate the accuracy of the information.
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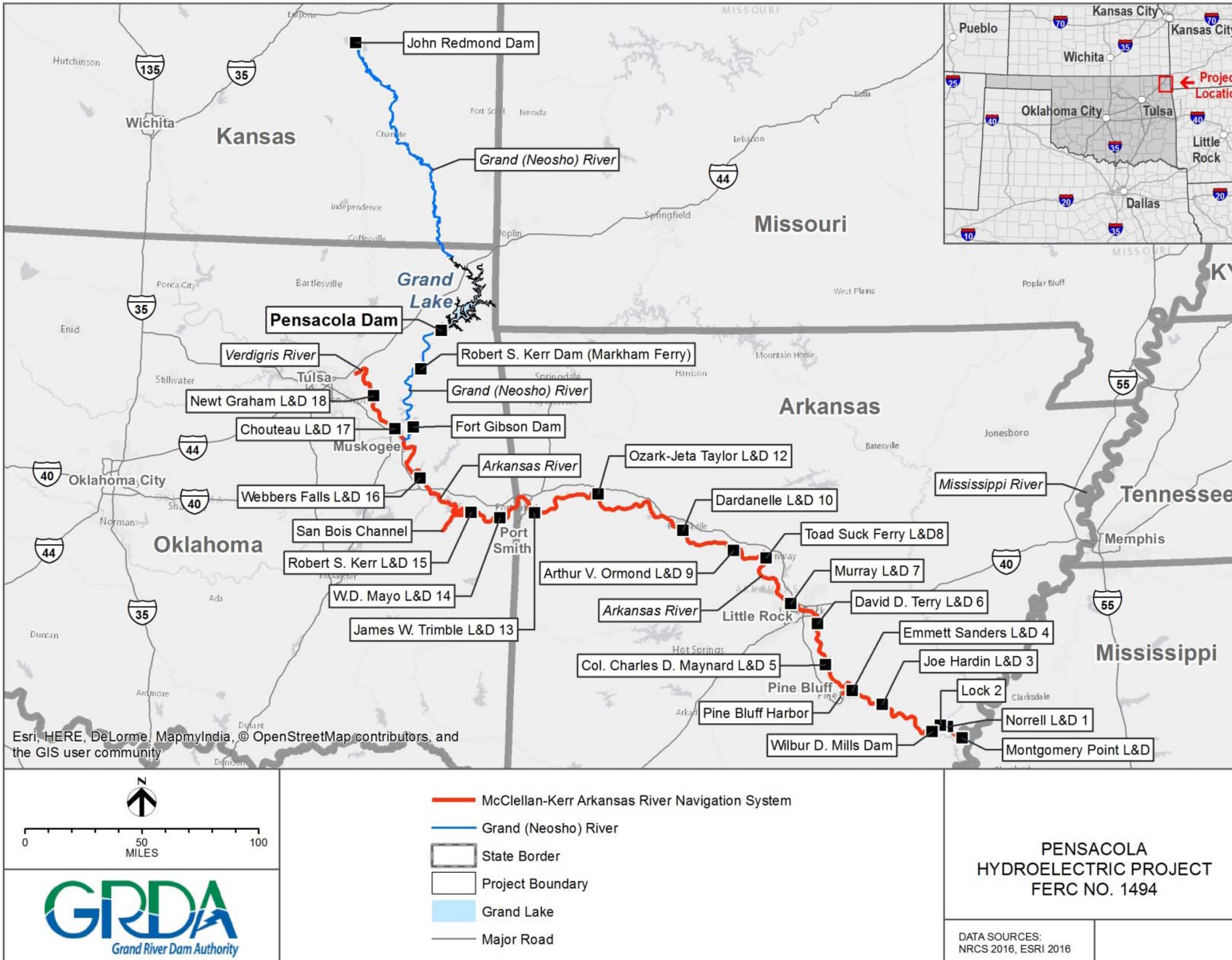
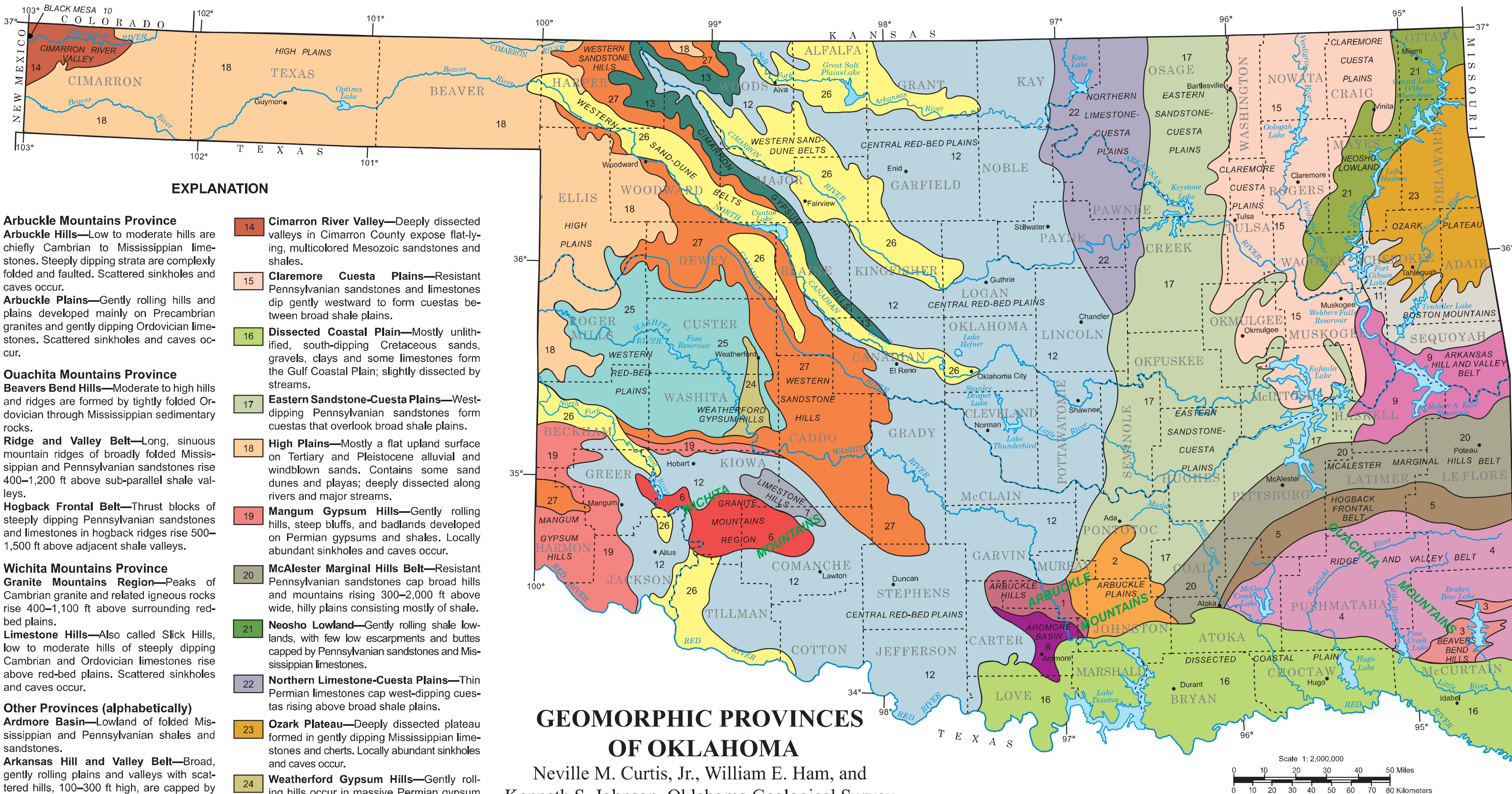
APPENDIX E-3 Dams on the Arkansas and Grand Rivers



PATH: N:\GIS2\PROJECTS\GRAND_RIVER_DAM_AUTHORITY\10027621_GRDA_PENSACOLA_RELICENSING\MAP_DOCS\FINAL\MCCLELLAN_KERR_SYSTEM_STUDY_MAP_PENSACOLA_PROJECT_20180416.MXD - USER: DSOUCIE - DATE: 4/16/2018

APPENDIX E-4 Geomorphic Provinces of Oklahoma



EXPLANATION

Arbuckle Mountains Province

1 **Arbuckle Hills**—Low to moderate hills are chiefly Cambrian to Mississippian limestones. Steeply dipping strata are complexly folded and faulted. Scattered sinkholes and caves occur.

2 **Arbuckle Plains**—Gently rolling hills and plains developed mainly on Precambrian granites and gently dipping Ordovician limestones. Scattered sinkholes and caves occur.

Ouachita Mountains Province

3 **Beavers Bend Hills**—Moderate to high hills and ridges are formed by tightly folded Ordovician through Mississippian sedimentary rocks.

4 **Ridge and Valley Belt**—Long, sinuous mountain ridges of broadly folded Mississippian and Pennsylvanian sandstones rise 400–1,200 ft above sub-parallel shale valleys.

5 **Hogback Frontal Belt**—Thrust blocks of steeply dipping Pennsylvanian sandstones and limestones in hogback ridges rise 500–1,500 ft above adjacent shale valleys.

Wichita Mountains Province

6 **Granite Mountains Region**—Peaks of Cambrian granite and related igneous rocks rise 400–1,100 ft above surrounding red-bed plains.

7 **Limestone Hills**—Also called Slick Hills, low to moderate hills of steeply dipping Cambrian and Ordovician limestones rise above red-bed plains. Scattered sinkholes and caves occur.

Other Provinces (alphabetically)

8 **Ardmore Basin**—Lowland of folded Mississippian and Pennsylvanian shales and sandstones.

9 **Arkansas Hill and Valley Belt**—Broad, gently rolling plains and valleys with scattered hills, 100–300 ft high, are capped by Pennsylvanian sandstones.

10 **Black Mesa**—Flat-topped erosional remnant of Tertiary basaltic lava flow that was extruded from a volcano in Colorado; the highest point in Oklahoma (elevation, 4,973 ft).

11 **Boston Mountains**—Deeply dissected plateau is capped by gently dipping Pennsylvanian sandstones.

12 **Central Red-Bed Plains**—Permian red shales and sandstones form gently rolling hills and broad, flat plains.

13 **Cimarron Gypsum Hills**—Escarpments and badlands developed on Permian gypsums and shales. Locally abundant sinkholes and caves occur.

14 **Cimarron River Valley**—Deeply dissected valleys in Cimarron County expose flat-lying, multicolored Mesozoic sandstones and shales.

15 **Claremore Cuesta Plains**—Resistant Pennsylvanian sandstones and limestones dip gently westward to form cuestas between broad shale plains.

16 **Dissected Coastal Plain**—Mostly unlithified, south-dipping Cretaceous sands, gravels, clays and some limestones form the Gulf Coastal Plain; slightly dissected by streams.

17 **Eastern Sandstone-Cuesta Plains**—West-dipping Pennsylvanian sandstones form cuestas that overlook broad shale plains.

18 **High Plains**—Mostly a flat upland surface on Tertiary and Pleistocene alluvial and windblown sands. Contains some sand dunes and playas; deeply dissected along rivers and major streams.

19 **Mangum Gypsum Hills**—Gently rolling hills, steep bluffs, and badlands developed on Permian gypsums and shales. Locally abundant sinkholes and caves occur.

20 **McAlester Marginal Hills Belt**—Resistant Pennsylvanian sandstones cap broad hills and mountains rising 300–2,000 ft above wide, hilly plains consisting mostly of shale.

21 **Neosho Lowland**—Gently rolling shale lowlands, with few low escarpments and buttes capped by Pennsylvanian sandstones and Mississippian limestones.

22 **Northern Limestone-Cuesta Plains**—Thin Permian limestones cap west-dipping cuestas rising above broad shale plains.

23 **Ozark Plateau**—Deeply dissected plateau formed in gently dipping Mississippian limestones and cherts. Locally abundant sinkholes and caves occur.

24 **Weatherford Gypsum Hills**—Gently rolling hills occur in massive Permian gypsum beds, 100 ft thick. Locally abundant sinkholes and caves occur.

25 **Western Red-Bed Plains**—Gently rolling hills of nearly flat-lying Permian red sandstones and shales.

26 **Western Sand-Dune Belts**—Hummocky fields of grass-covered, stabilized sand dunes and some active dunes, occur mainly on north sides of major rivers. Sand is from Quaternary alluvium and terrace deposits.

27 **Western Sandstone Hills**—Slightly lithified, nearly flat-lying Permian red sandstones form gently rolling hills cut by steep-walled canyons.

GEOMORPHIC PROVINCES OF OKLAHOMA

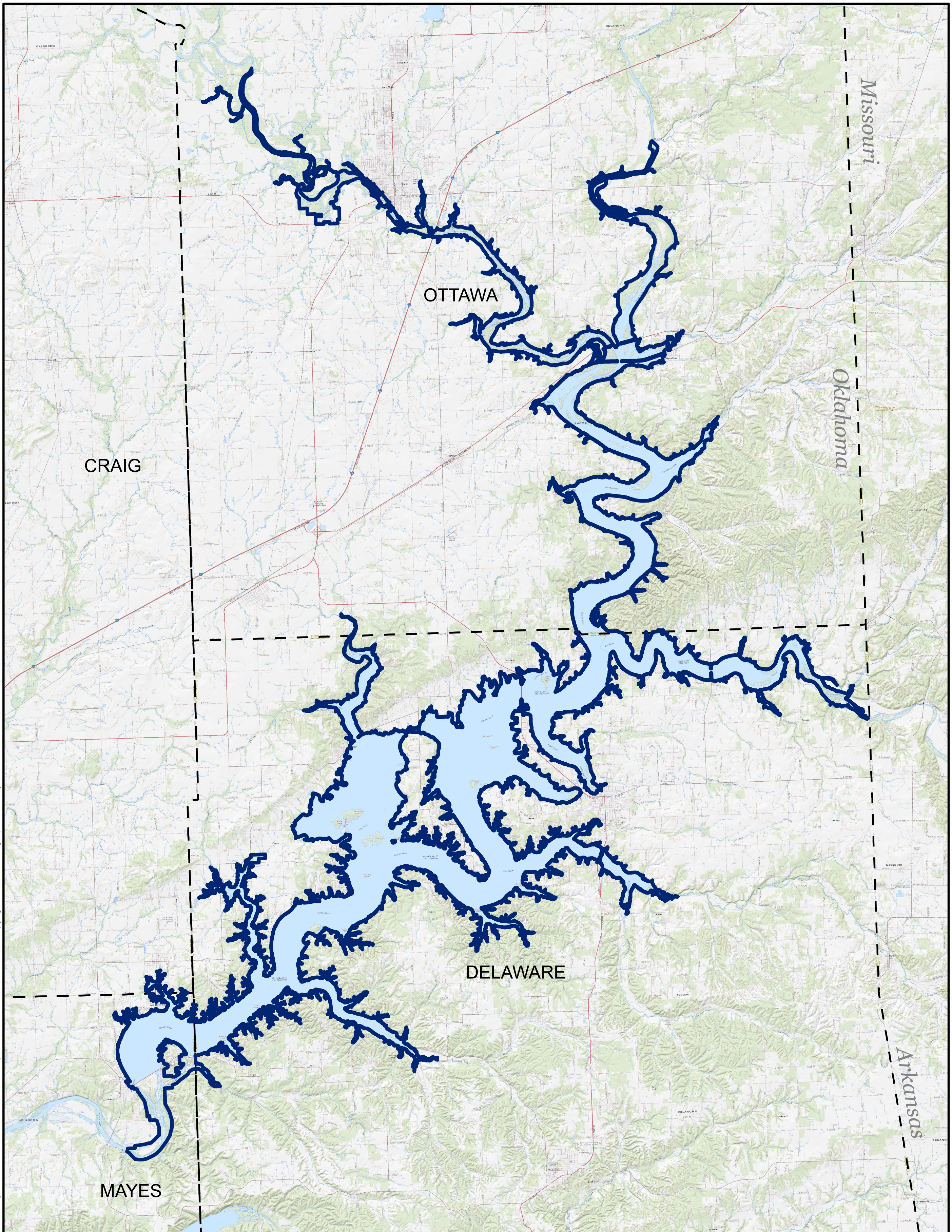
Neville M. Curtis, Jr., William E. Ham, and Kenneth S. Johnson, Oklahoma Geological Survey

A geomorphic province is part of the Earth's surface where a suite of rocks with similar geologic character and structure underwent a similar geologic history, and where the present-day character and landforms differ significantly from adjacent provinces. The term used here is the same as "physiographic province."

Most outcrops in Oklahoma consist of horizontal or gently dipping sandstones, sands, and shales of Pennsylvanian, Permian, Cretaceous, and Tertiary ages (see Geologic Map of Oklahoma on page 6). Some sandstones (mainly in eastern Oklahoma) are well indurated (cemented), but in most other parts of Oklahoma they are not so well indurated and erode easily; therefore, much of Oklahoma is gently rolling hills and broad, flat plains. Elsewhere, erosion-resistant layers of sandstone, limestone, or gypsum form protective caps on buttes, cuestas, escarpments, and high hills.

Among the more impressive geomorphic provinces are several mountain belts and uplifts in southern and northeastern Oklahoma. In the southern third of Oklahoma, well-indurated rocks were folded, faulted, and uplifted forming the Wichita, Arbuckle, and Ouachita Mountains. The mountains and high hills, the resistant rock units, and the complex geology of these three provinces contrast sharply with Oklahoma's typical rolling hills and broad plains. In hilly, wooded areas of the Ozark Plateau and Boston Mountains in northeastern Oklahoma, streams and rivers created sharp relief locally by cutting down into resistant limestones and sandstones.

**APPENDIX E-5	Topographic Map of Project Vicinity**



Service Layer Credit: USGS The National Map, Data refreshed June 2022, Copyright National Geographic Society.

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Anticipated Project Boundary

Oklahoma County Boundary

0 1 2 4 6 Miles

N

Pensacola Hydroelectric Project
Topographic Map

FERC No. 1494

APPENDIX E-6 Pensacola Soils Report

Soil Map—Delaware County, Oklahoma, and Ottawa County, Oklahoma
(Pensacola Project Soils-North Part)

Map Scale: 1:206,000 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 3000, 6000, 12000, 18000

Feet: 0, 10000, 20000, 40000, 60000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 15N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Delaware County, Oklahoma
Survey Area Data: Version 19, Sep 6, 2022

Soil Survey Area: Ottawa County, Oklahoma
Survey Area Data: Version 17, Sep 6, 2022

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 1, 1999—Dec 31, 2003

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
CkD	Clarksville very gravelly silt loam, 1 to 8 percent slopes	0.0	0.0%
ClF	Clarksville very gravelly silt loam, 20 to 50 percent slopes, stony	0.7	0.0%
W	Water	62.7	0.1%
Subtotals for Soil Survey Area		**63.4**	**0.1%**
Totals for Area of Interest		**45,359.5**	**100.0%**

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Ad	Osage-Verdigris complex, 0 to 1 percent slopes, frequently flooded	1,245.0	2.7%
BaB	Bates loam, 1 to 3 percent slopes	197.0	0.4%
BaC	Bates loam, 3 to 5 percent slopes	485.8	1.1%
BaC2	Bates loam, 3 to 5 percent slopes, eroded	45.5	0.1%
Bb	Coweta-Bates complex, 1 to 5 percent slopes	67.0	0.1%
BcB	Macedonia silt loam, 1 to 3 percent slopes	161.4	0.4%
BcC	Macedonia silt loam, 3 to 5 percent slopes	47.0	0.1%
BdB	Clarksville gravelly silt loam, 0 to 3 percent slopes	502.8	1.1%
BnD	Clarksville very gravelly silt loam, 1 to 8 percent slopes	3,896.3	8.6%
BoE	Clarksville stony silt loam, 12 to 50 percent slopes	7,050.6	15.5%
Bp	Pits, borrow	61.1	0.1%
Br	Eram-Verdigris complex, 0 to 20 percent slopes	121.8	0.3%
ChA	Choteau silt loam, 0 to 1 percent slopes	487.8	1.1%
ChB	Choteau silt loam, 1 to 3 percent slopes	1,537.0	3.4%
Co	Collinsville stony loam, 3 to 20 percent slopes	122.0	0.3%
CrB	Craig silt loam, 1 to 3 percent slopes	124.9	0.3%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
CrC	Craig silt loam, 3 to 5 percent slopes	137.7	0.3%
DnB	Dennis silt loam, 1 to 3 percent slopes	1,899.2	4.2%
DnC	Dennis silt loam, 3 to 5 percent slopes	171.3	0.4%
DnC2	Dennis silt loam, 3 to 5 percent slopes, eroded	297.3	0.7%
DUM	Dumps	4.8	0.0%
Ed	Eldorado gravelly silt loam, 1 to 8 percent slopes	605.4	1.3%
EhD	Waben gravelly silt loam, 3 to 8 percent slopes	1,271.7	2.8%
EtA	Britwater silt loam, 0 to 3 percent slopes	2,732.5	6.0%
Hg	Razort gravelly silt loam, 0 to 1 percent slopes, frequently flooded	153.8	0.3%
Hu	Healing silt loam, 0 to 1 percent slopes, occasionally flooded	1,204.1	2.7%
Ka	Wynona silty clay loam, 0 to 1 percent slopes, frequently flooded	5.4	0.0%
La	Captina silt loam, 0 to 1 percent slopes	68.7	0.2%
Ln	Lightning silt loam, 0 to 1 percent slopes, occasionally flooded	429.2	0.9%
M-W	Miscellaneous water	17.8	0.0%
Mp	Dumps, mine	1.3	0.0%
NaB	Newtonia silt loam, 1 to 3 percent slopes	516.5	1.1%
NaC	Newtonia silt loam, 3 to 5 percent slopes	2.0	0.0%
Ns	Newtonia-Shidler complex, 1 to 8 percent slopes	94.7	0.2%
Os	Osage silty clay, 0 to 1 percent slopes, occasionally flooded	5,442.6	12.0%
PaA	Parsons silt loam, 0 to 1 percent slopes	1,385.2	3.1%
PaB	Parsons silt loam, 1 to 3 percent slopes	423.8	0.9%
PaB2	Parsons silt loam, 1 to 3 percent slopes, eroded	22.5	0.0%
Prqg	Pits, gravel and quarry	54.9	0.1%
RvC	Riverton gravelly loam, 3 to 5 percent slopes	104.9	0.2%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
SuB	Apperson silty clay loam, 1 to 3 percent slopes	43.6	0.1%
TaA	Taloka silt loam, 0 to 1 percent slopes	889.8	2.0%
Vd	Verdigris silt loam, 0 to 1 percent slopes, occasionally flooded	2,402.4	5.3%
W	Water	8,465.4	18.7%
WoA	Mayes silty clay loam, 0 to 1 percent slopes	221.9	0.5%
WoB	Mayes silty clay loam, 1 to 3 percent slopes	71.1	0.2%
Subtotals for Soil Survey Area		**45,294.8**	**99.9%**
Totals for Area of Interest		**45,359.5**	**100.0%**

RUSLE2 Related Attributes

This report summarizes those soil attributes used by the Revised Universal Soil Loss Equation Version 2 (RUSLE2) for the map units in the selected area. The report includes the map unit symbol, the component name, and the percent of the component in the map unit. Soil property data for each map unit component include the hydrologic soil group, erosion factor Kf for the surface horizon, erosion factor T, and the representative percentage of sand, silt, and clay in the mineral surface horizon. Missing surface data may indicate the presence of an organic layer.

Report—RUSLE2 Related Attributes

Soil properties and interpretations for erosion runoff calculations. The surface mineral horizon properties are displayed or the first mineral horizon below an organic surface horizon. Organic horizons are not displayed.

RUSLE2 Related Attributes–Delaware County, Oklahoma								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
CkD—Clarksville very gravelly silt loam, 1 to 8 percent slopes								
Clarksville	85	174	A	.37	5	29.3	53.7	17.0
ClF—Clarksville very gravelly silt loam, 20 to 50 percent slopes, stony								
Clarksville	80	108	B	.32	3	21.2	67.5	11.3

RUSLE2 Related Attributes–Ottawa County, Oklahoma								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
Ad—Osage-Verdigris complex, 0 to 1 percent slopes, frequently flooded								
Osage	60	325	D	.20	5	26.1	28.9	45.0
Verdigris	35	325	B	.37	5	11.3	67.7	21.0
BaB—Bates loam, 1 to 3 percent slopes								
Bates	85	298	C	.28	3	42.0	37.0	21.0
BaC—Bates loam, 3 to 5 percent slopes								
Bates	90	223	C	.28	3	42.0	37.0	21.0
BaC2—Bates loam, 3 to 5 percent slopes, eroded								
Bates	85	223	C	.28	3	42.0	37.0	21.0

RUSLE2 Related Attributes–Ottawa County, Oklahoma								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
Bb—Coweta-Bates complex, 1 to 5 percent slopes								
Coweta	63	223	D	.28	2	42.0	38.0	20.0
Bates	35	223	C	.28	3	42.0	37.0	21.0
BcB—Macedonia silt loam, 1 to 3 percent slopes								
Macedonia	90	276	B	.43	4	26.5	53.5	20.0
BcC—Macedonia silt loam, 3 to 5 percent slopes								
Macedonia	90	223	B	.43	4	26.5	53.5	20.0
BdB—Clarksville gravelly silt loam, 0 to 3 percent slopes								
Clarksville	90	276	A	.37	2	26.5	53.5	20.0
BnD—Clarksville very gravelly silt loam, 1 to 8 percent slopes								
Clarksville	90	174	A	.37	5	29.3	53.7	17.0
BoE—Clarksville stony silt loam, 12 to 50 percent slopes								
Clarksville	100	108	A	.32	2	26.3	52.7	21.0
Br—Eram-Verdigris complex, 0 to 20 percent slopes								
Eram	55	108	D	.43	3	26.0	52.0	22.0
Verdigris	35	325	B	.37	5	15.0	62.0	23.0
ChA—Choteau silt loam, 0 to 1 percent slopes								
Choteau	95	325	C	.32	5	25.0	53.0	22.0
ChB—Choteau silt loam, 1 to 3 percent slopes								
Choteau	90	276	C	.32	5	25.0	53.0	22.0
Co—Collinsville stony loam, 3 to 20 percent slopes								
Collinsville	90	108	D	.43	1	45.0	42.0	13.0
CrB—Craig silt loam, 1 to 3 percent slopes								
Craig	85	276	C	.43	4	25.0	55.0	20.0
CrC—Craig silt loam, 3 to 5 percent slopes								
Craig	85	223	C	.43	4	25.0	55.0	20.0

RUSLE2 Related Attributes–Ottawa County, Oklahoma								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
DnB—Dennis silt loam, 1 to 3 percent slopes								
Dennis	82	298	C/D	.43	5	23.0	58.0	19.0
DnC—Dennis silt loam, 3 to 5 percent slopes								
Dennis	85	223	C/D	.43	5	23.0	58.0	19.0
DnC2—Dennis silt loam, 3 to 5 percent slopes, eroded								
Dennis	82	223	C/D	.43	5	23.0	58.0	19.0
Ed—Eldorado gravelly silt loam, 1 to 8 percent slopes								
Eldorado	85	174	B	.37	3	26.0	52.0	22.0
EhD—Waben gravelly silt loam, 3 to 8 percent slopes								
Waben	90	174	A	.37	5	30.9	56.6	12.5
EtA—Britwater silt loam, 0 to 3 percent slopes								
Britwater	95	298	B	.43	5	27.0	53.0	20.0
Hg—Razort gravelly silt loam, 0 to 1 percent slopes, frequently flooded								
Razort	90	325	B	.37	5	29.1	53.4	17.5
Hu—Healing silt loam, 0 to 1 percent slopes, occasionally flooded								
Healing	90	325	B	.37	4	13.6	68.9	17.5
Ka—Wynona silty clay loam, 0 to 1 percent slopes, frequently flooded								
Wynona	90	325	C	.37	5	6.9	62.1	31.0
La—Captina silt loam, 0 to 1 percent slopes								
Captina	95	98	C/D	.43	3	14.4	76.1	9.5
Ln—Lightning silt loam, 0 to 1 percent slopes, occasionally flooded								
Lightning	90	325	D	.43	5	12.0	68.0	20.0
NaB—Newtonia silt loam, 1 to 3 percent slopes								
Newtonia	90	276	B	.43	5	13.7	69.3	17.0
NaC—Newtonia silt loam, 3 to 5 percent slopes								
Newtonia	84	223	B	.43	5	13.7	69.3	17.0

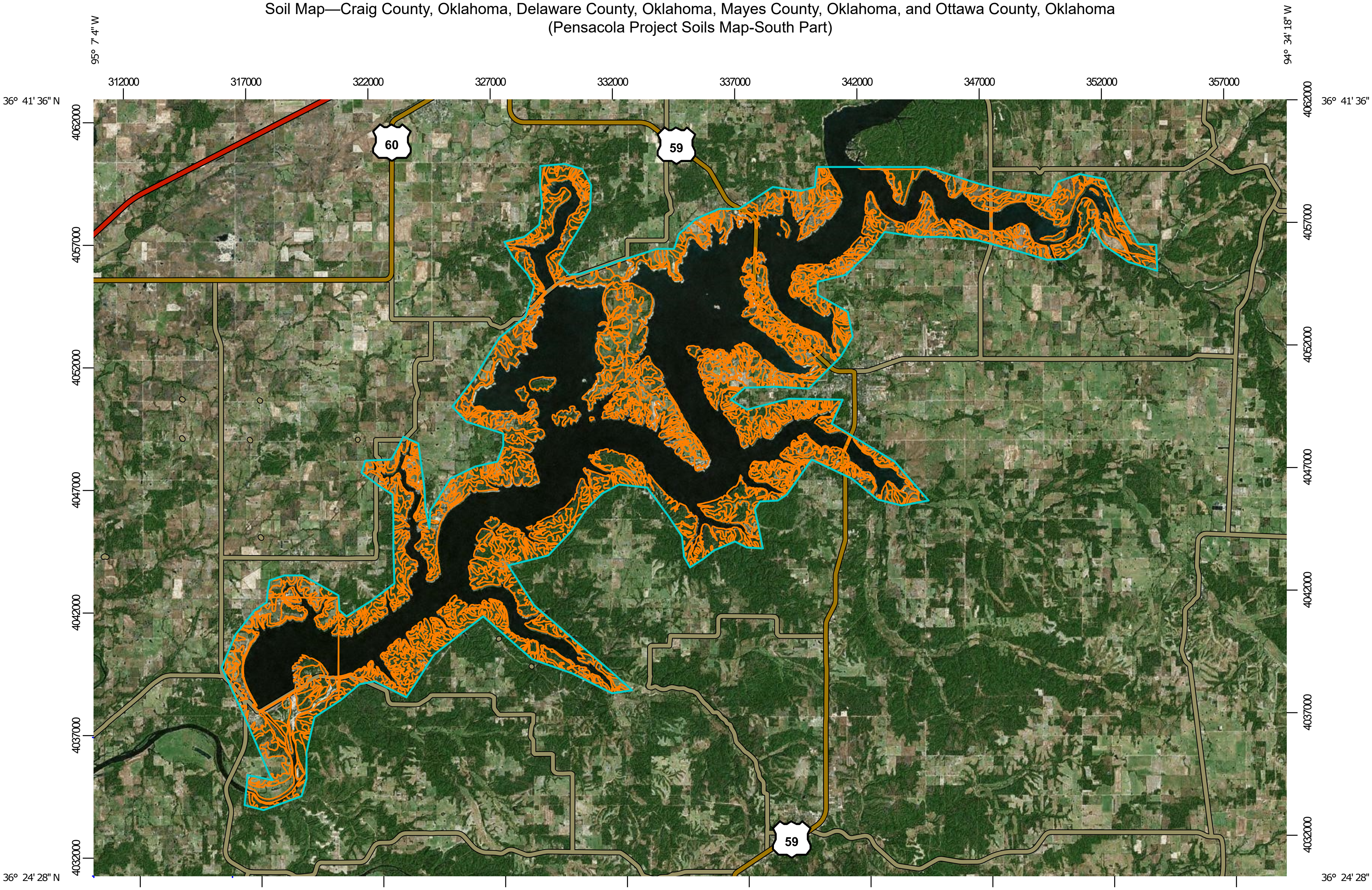
RUSLE2 Related Attributes–Ottawa County, Oklahoma								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
Ns—Newtonia-Shidler complex, 1 to 8 percent slopes								
Newtonia	46	174	B	.43	5	13.7	69.3	17.0
Shidler	45	174	D	.43	1	26.0	52.0	22.0
Os—Osage silty clay, 0 to 1 percent slopes, occasionally flooded								
Osage	86	98	D	.20	5	2.0	45.0	53.0
PaA—Parsons silt loam, 0 to 1 percent slopes								
Parsons	85	98	D	.43	3	13.0	67.0	20.0
PaB—Parsons silt loam, 1 to 3 percent slopes								
Parsons	90	298	D	.49	3	13.0	67.0	20.0
PaB2—Parsons silt loam, 1 to 3 percent slopes, eroded								
Parsons	90	298	D	.49	3	13.0	67.0	20.0
RvC—Riverton gravelly loam, 3 to 5 percent slopes								
Riverton	90	223	B	.32	4	40.0	37.0	23.0
SuB—Apperson silty clay loam, 1 to 3 percent slopes								
Apperson	90	298	D	.32	3	11.0	58.0	31.0
TaA—Taloka silt loam, 0 to 1 percent slopes								
Taloka	92	325	D	.43	4	13.0	67.0	20.0
Vd—Verdigris silt loam, 0 to 1 percent slopes, occasionally flooded								
Verdigris	82	197	B	.37	5	15.0	62.0	23.0
WoA—Mayes silty clay loam, 0 to 1 percent slopes								
Mayes	90	325	D	.37	5	20.0	49.0	31.0
WoB—Mayes silty clay loam, 1 to 3 percent slopes								
Mayes	90	276	D	.37	5	20.0	49.0	31.0

Data Source Information

Soil Survey Area: Delaware County, Oklahoma
Survey Area Data: Version 19, Sep 6, 2022

Soil Survey Area: Ottawa County, Oklahoma
Survey Area Data: Version 17, Sep 6, 2022

Soil Map—Craig County, Oklahoma, Delaware County, Oklahoma, Mayes County, Oklahoma, and Ottawa County, Oklahoma
(Pensacola Project Soils Map-South Part)



Map Scale: 1:224,000 if printed on A landscape (11" x 8.5") sheet.

Meters: 0 3000 6000 12000 18000

Feet: 0 10000 20000 40000 60000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 15N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at scales ranging from 1:20,000 to 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Craig County, Oklahoma
Survey Area Data: Version 19, Sep 2, 2022

Soil Survey Area: Delaware County, Oklahoma
Survey Area Data: Version 19, Sep 6, 2022

Soil Survey Area: Mayes County, Oklahoma
Survey Area Data: Version 16, Sep 6, 2022

Soil Survey Area: Ottawa County, Oklahoma
Survey Area Data: Version 17, Sep 6, 2022

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 1, 1999—Dec 31, 2003

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
CmE	Clarksville stony silt loam, 5 to 12 percent slopes	84.8	0.1%
CnD	Clarksville very gravelly silt loam, 1 to 8 percent slopes	110.9	0.2%
CrB	Craig silt loam, 1 to 3 percent slopes	90.6	0.1%
ElD	Eldorado stony silt loam, 1 to 8 percent slopes	11.8	0.0%
EoC	Eldorado silt loam, 3 to 5 percent slopes	103.3	0.1%
NcB	Nixa gravelly silt loam, 0 to 3 percent slopes	0.5	0.0%
W	Water	77.0	0.1%
Subtotals for Soil Survey Area		**479.0**	**0.7%**
Totals for Area of Interest		**71,392.4**	**100.0%**

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BaB	Bates loam, 1 to 3 percent slopes	250.2	0.4%
BcB	Macedonia silt loam, 1 to 3 percent slopes	688.6	1.0%
BhB	Doniphan gravelly silt loam, 1 to 3 percent slopes	389.1	0.5%
BlC	Doniphan-Tonti complex, 3 to 5 percent slopes	36.1	0.1%
CaB	Captina silt loam, 1 to 3 percent slopes	27.5	0.0%
ChA	Choteau silt loam, 0 to 1 percent slopes	133.2	0.2%
ChB	Choteau silt loam, 1 to 3 percent slopes	197.0	0.3%
CkD	Clarksville very gravelly silt loam, 1 to 8 percent slopes	4,047.4	5.7%
ClE	Clarksville very gravelly silt loam, 5 to 20 percent slopes, stony	4,367.5	6.1%
ClF	Clarksville very gravelly silt loam, 20 to 50 percent slopes, stony	7,477.3	10.5%
CoC	Coweta fine sandy loam, 3 to 5 percent slopes, very rocky	199.8	0.3%
DAM	Large dam	16.3	0.0%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
DnB	Dennis silt loam, 1 to 3 percent slopes	681.4	1.0%
EdB	Eldorado silt loam, 1 to 3 percent slopes	2,588.5	3.6%
EdC	Eldorado silt loam, 3 to 5 percent slopes	1,095.2	1.5%
ElD	Eldorado stony silt loam, 3 to 12 percent slopes	3,474.9	4.9%
Es	Elsah very gravelly loam, 0 to 3 percent slopes, frequently flooded	332.0	0.5%
LoB	Tonti gravelly silt loam, 1 to 3 percent slopes	126.4	0.2%
NaA	Newtonia silt loam, 0 to 1 percent slopes	163.2	0.2%
NaB	Newtonia silt loam, 1 to 3 percent slopes	279.1	0.4%
OeA	Okemah silt loam, 0 to 1 percent slopes	85.2	0.1%
OkA	Okemah silty clay loam, 0 to 1 percent slopes	17.9	0.0%
OkB	Okemah silty clay loam, 1 to 3 percent slopes	104.8	0.1%
PaA	Parsons silt loam, 0 to 1 percent slopes	208.1	0.3%
PIT	Pits	15.1	0.0%
SaB	Britwater silt loam, 1 to 3 percent slopes	955.8	1.3%
SgB	Britwater gravelly silt loam, 1 to 3 percent slopes	283.5	0.4%
SgD	Britwater gravelly silt loam, 3 to 8 percent slopes	1,357.8	1.9%
Sm	Healing silt loam, 0 to 1 percent slopes, occasionally flooded	362.9	0.5%
Sn	Razort gravelly loam, 0 to 3 percent slopes, occasionally flooded	544.6	0.8%
SrA	Stigler silt loam, 0 to 1 percent slopes	5.5	0.0%
TkA	Taloka silt loam, 0 to 1 percent slopes	344.4	0.5%
TrD	Shidler-Rock outcrop complex, 2 to 8 percent slopes	280.1	0.4%
Vd	Verdigris silt loam, 0 to 1 percent slopes, occasionally flooded	227.9	0.3%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Vr	Verdigris silt loam, 0 to 1 percent slopes, frequently flooded	106.0	0.1%
W	Water	32,199.0	45.1%
WoA	Mayes silt loam, 0 to 1 percent slopes	301.0	0.4%
Subtotals for Soil Survey Area		**63,970.4**	**89.6%**
Totals for Area of Interest		**71,392.4**	**100.0%**

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Bp	Pits, borrow	0.7	0.0%
Ca	Razort gravelly loam, 0 to 1 percent slopes, occasionally flooded	81.6	0.1%
ChA	Choteau silt loam, 0 to 1 percent slopes	11.5	0.0%
CkD	Clarksville gravelly silt loam, 1 to 8 percent slopes	731.7	1.0%
ClE	Clarksville very gravelly silt loam, 5 to 20 percent slopes, stony	294.4	0.4%
ClF	Clarksville very gravelly silt loam, 20 to 50 percent slopes, stony	620.2	0.9%
CrB	Craig silt loam, 1 to 3 percent slopes	179.5	0.3%
CrC	Craig silt loam, 3 to 5 percent slopes	41.6	0.1%
DAM	Large dam	15.4	0.0%
ElD	Eldorado gravelly silt loam, 1 to 8 percent slopes	67.3	0.1%
Es	Elsah gravelly loam, 0 to 1 percent slopes, frequently flooded	6.8	0.0%
NxB	Nixa gravelly silt loam, 0 to 3 percent slopes	226.5	0.3%
PaA	Parsons silt loam, 0 to 1 percent slopes	165.0	0.2%
Qu	Quarles silt loam, 0 to 1 percent slopes, occasionally flooded	20.9	0.0%
ReB	Riverton loam, 1 to 3 percent slopes	318.8	0.4%
RvC	Riverton gravelly loam, 1 to 5 percent slopes	99.7	0.1%
SaB	Britwater silt loam, 1 to 3 percent slopes	366.5	0.5%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
TaA	Taloka silt loam, 0 to 1 percent slopes	41.3	0.1%
Ve	Verdigris silty clay loam, 0 to 1 percent slopes, occasionally flooded	593.6	0.8%
Vs	Verdigris silty clay loam, 0 to 1 percent slopes, frequently flooded	298.8	0.4%
W	Water	2,693.1	3.8%
Subtotals for Soil Survey Area		**6,874.8**	**9.6%**
Totals for Area of Interest		**71,392.4**	**100.0%**

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BoE	Clarksville stony silt loam, 12 to 50 percent slopes	45.8	0.1%
EtA	Britwater silt loam, 0 to 3 percent slopes	0.1	0.0%
W	Water	21.6	0.0%
Subtotals for Soil Survey Area		**67.5**	**0.1%**
Totals for Area of Interest		**71,392.4**	**100.0%**

RUSLE2 Related Attributes

This report summarizes those soil attributes used by the Revised Universal Soil Loss Equation Version 2 (RUSLE2) for the map units in the selected area. The report includes the map unit symbol, the component name, and the percent of the component in the map unit. Soil property data for each map unit component include the hydrologic soil group, erosion factor Kf for the surface horizon, erosion factor T, and the representative percentage of sand, silt, and clay in the mineral surface horizon. Missing surface data may indicate the presence of an organic layer.

Report—RUSLE2 Related Attributes

Soil properties and interpretations for erosion runoff calculations. The surface mineral horizon properties are displayed or the first mineral horizon below an organic surface horizon. Organic horizons are not displayed.

RUSLE2 Related Attributes–Craig County, Oklahoma								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
CmE—Clarksville stony silt loam, 5 to 12 percent slopes								
Clarksville	85	108	A	.32	5	26.3	52.7	21.0
CnD—Clarksville very gravelly silt loam, 1 to 8 percent slopes								
Clarksville	90	174	A	.37	5	29.3	53.7	17.0
CrB—Craig silt loam, 1 to 3 percent slopes								
Craig	85	276	C	.43	4	25.0	55.0	20.0
ElD—Eldorado stony silt loam, 1 to 8 percent slopes								
Eldorado	90	174	B	.37	5	26.0	52.0	22.0
EoC—Eldorado silt loam, 3 to 5 percent slopes								
Eldorado	90	223	B	.37	3	26.0	52.0	22.0
NcB—Nixa gravelly silt loam, 0 to 3 percent slopes								
Nixa	95	298	D	.49	4	14.6	74.4	11.0

RUSLE2 Related Attributes–Delaware County, Oklahoma								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
BaB—Bates loam, 1 to 3 percent slopes								
Bates	85	298	C	.28	3	42.0	37.0	21.0
BcB—Macedonia silt loam, 1 to 3 percent slopes								
Macedonia	92	276	B	.43	5	26.5	53.5	20.0
BhB—Doniphan gravelly silt loam, 1 to 3 percent slopes								
Doniphan	90	276	B	.43	5	24.8	52.7	22.5
BlC—Doniphan-Tonti complex, 3 to 5 percent slopes								
Doniphan	58	223	B	.43	5	24.8	52.7	22.5
Tonti	42	223	D	.43	2	29.1	53.4	17.5
CaB—Captina silt loam, 1 to 3 percent slopes								
Captina	90	298	C/D	.43	3	14.4	76.1	9.5
ChA—Choteau silt loam, 0 to 1 percent slopes								
Choteau	95	325	C	.32	5	25.0	53.0	22.0
ChB—Choteau silt loam, 1 to 3 percent slopes								
Choteau	90	276	C	.32	5	25.0	53.0	22.0
CkD—Clarksville very gravelly silt loam, 1 to 8 percent slopes								
Clarksville	85	174	A	.37	5	29.3	53.7	17.0
ClE—Clarksville very gravelly silt loam, 5 to 20 percent slopes, stony								
Clarksville	80	108	B	.32	3	21.2	67.5	11.3
ClF—Clarksville very gravelly silt loam, 20 to 50 percent slopes, stony								
Clarksville	80	108	B	.32	3	21.2	67.5	11.3
CoC—Coweta fine sandy loam, 3 to 5 percent slopes, very rocky								
Coweta	82	223	D	.28	2	60.0	30.0	10.0
DnB—Dennis silt loam, 1 to 3 percent slopes								
Dennis	87	276	C/D	.43	5	27.1	54.4	18.5

RUSLE2 Related Attributes–Delaware County, Oklahoma								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
EdB—Eldorado silt loam, 1 to 3 percent slopes								
Eldorado	97	276	B	.37	3	26.0	52.0	22.0
EdC—Eldorado silt loam, 3 to 5 percent slopes								
Eldorado	100	223	C	.37	3	21.0	61.0	18.0
ElD—Eldorado stony silt loam, 3 to 12 percent slopes								
Eldorado	100	108	C	.37	3	21.0	61.0	18.0
Es—Elsah very gravelly loam, 0 to 3 percent slopes, frequently flooded								
Elsah	90	197	B	.32	5	45.4	41.6	13.0
LoB—Tonti gravelly silt loam, 1 to 3 percent slopes								
Tonti	85	276	D	.43	3	20.0	68.0	12.0
NaA—Newtonia silt loam, 0 to 1 percent slopes								
Newtonia	95	325	D	.43	5	13.7	69.3	17.0
NaB—Newtonia silt loam, 1 to 3 percent slopes								
Newtonia	92	298	B	.43	5	13.7	69.3	17.0
OeA—Okemah silt loam, 0 to 1 percent slopes								
Okemah	85	325	C/D	.49	5	20.0	56.0	24.0
OkA—Okemah silty clay loam, 0 to 1 percent slopes								
Okemah	93	325	C/D	.37	5	20.0	49.0	31.0
OkB—Okemah silty clay loam, 1 to 3 percent slopes								
Okemah	93	325	C/D	.37	5	20.0	49.0	31.0
PaA—Parsons silt loam, 0 to 1 percent slopes								
Parsons	95	325	D	.43	3	26.5	53.5	20.0
SaB—Britwater silt loam, 1 to 3 percent slopes								
Britwater	95	298	B	.43	5	27.0	53.0	20.0
SgB—Britwater gravelly silt loam, 1 to 3 percent slopes								
Britwater	95	298	B	.43	5	26.0	54.0	20.0

RUSLE2 Related Attributes–Delaware County, Oklahoma								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
SgD—Britwater gravelly silt loam, 3 to 8 percent slopes								
Britwater	95	157	B	.43	5	26.0	54.0	20.0
Sm—Healing silt loam, 0 to 1 percent slopes, occasionally flooded								
Healing	87	325	B	.37	5	13.6	68.9	17.5
Sn—Razort gravelly loam, 0 to 3 percent slopes, occasionally flooded								
Razort	81	325	B	.32	5	43.0	39.5	17.5
SrA—Stigler silt loam, 0 to 1 percent slopes								
Stigler	94	325	D	.43	3	30.1	54.9	15.0
TkA—Taloka silt loam, 0 to 1 percent slopes								
Taloka	89	325	D	.37	4	26.5	53.5	20.0
TrD—Shidler-Rock outcrop complex, 2 to 8 percent slopes								
Shidler	62	174	D	.37	1	20.0	49.0	31.0
Vd—Verdigris silt loam, 0 to 1 percent slopes, occasionally flooded								
Verdigris	95	325	B	.37	5	11.3	67.7	21.0
Vr—Verdigris silt loam, 0 to 1 percent slopes, frequently flooded								
Verdigris	85	197	B	.37	5	11.3	67.7	21.0
WoA—Mayes silt loam, 0 to 1 percent slopes								
Mayes	92	325	D	.49	3	27.0	54.0	19.0

RUSLE2 Related Attributes–Mayes County, Oklahoma								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
Ca—Razort gravelly loam, 0 to 1 percent slopes, occasionally flooded								
Razort	90	325	B	.32	5	43.0	39.5	17.5
ChA—Choteau silt loam, 0 to 1 percent slopes								
Choteau	95	325	C	.32	5	25.0	53.0	22.0

RUSLE2 Related Attributes–Mayes County, Oklahoma								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
CkD—Clarksville gravelly silt loam, 1 to 8 percent slopes								
Clarksville	90	174	A	.37	5	26.5	53.5	20.0
ClE—Clarksville very gravelly silt loam, 5 to 20 percent slopes, stony								
Clarksville	80	108	B	.32	3	21.2	67.5	11.3
ClF—Clarksville very gravelly silt loam, 20 to 50 percent slopes, stony								
Clarksville	80	108	B	.32	3	21.2	67.5	11.3
CrB—Craig silt loam, 1 to 3 percent slopes								
Craig	85	276	C	.43	4	25.0	55.0	20.0
CrC—Craig silt loam, 3 to 5 percent slopes								
Craig	85	223	C	.43	4	25.0	55.0	20.0
ElD—Eldorado gravelly silt loam, 1 to 8 percent slopes								
Eldorado	85	174	B	.37	3	26.0	52.0	22.0
Es—Elsah gravelly loam, 0 to 1 percent slopes, frequently flooded								
Elsah	90	325	B	.37	5	44.3	40.7	15.0
NxB—Nixa gravelly silt loam, 0 to 3 percent slopes								
Nixa	95	298	D	.49	4	14.6	74.4	11.0
PaA—Parsons silt loam, 0 to 1 percent slopes								
Parsons	85	98	D	.43	3	13.0	67.0	20.0
Qu—Quarles silt loam, 0 to 1 percent slopes, occasionally flooded								
Quarles	90	325	C/D	.37	5	24.5	52.0	23.5
ReB—Riverton loam, 1 to 3 percent slopes								
Riverton	85	276	B	.32	4	40.0	37.0	23.0
RvC—Riverton gravelly loam, 1 to 5 percent slopes								
Riverton	85	223	B	.32	5	39.8	37.7	22.5
SaB—Britwater silt loam, 1 to 3 percent slopes								
Britwater	95	298	B	.43	5	27.0	53.0	20.0

RUSLE2 Related Attributes–Mayes County, Oklahoma								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
TaA—Taloka silt loam, 0 to 1 percent slopes								
Taloka	92	325	D	.43	4	13.0	67.0	20.0
Ve—Verdigris silty clay loam, 0 to 1 percent slopes, occasionally flooded								
Verdigris	90	98	C	.32	5	7.0	62.0	31.0
Vs—Verdigris silty clay loam, 0 to 1 percent slopes, frequently flooded								
Verdigris	95	325	C	.32	5	7.0	62.0	31.0

RUSLE2 Related Attributes–Ottawa County, Oklahoma								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
BoE—Clarksville stony silt loam, 12 to 50 percent slopes								
Clarksville	100	108	A	.32	2	26.3	52.7	21.0
EtA—Britwater silt loam, 0 to 3 percent slopes								
Britwater	95	298	B	.43	5	27.0	53.0	20.0

Data Source Information

Soil Survey Area: Craig County, Oklahoma
Survey Area Data: Version 19, Sep 2, 2022

Soil Survey Area: Delaware County, Oklahoma
Survey Area Data: Version 19, Sep 6, 2022

Soil Survey Area: Mayes County, Oklahoma
Survey Area Data: Version 16, Sep 6, 2022

Soil Survey Area: Ottawa County, Oklahoma
Survey Area Data: Version 17, Sep 6, 2022

APPENDIX E-7 Updated Study Report

ECOSYSTEMS & WATERSHED MANAGEMENT
420 Hwy 28, PO Box 70
Langley, OK 74350-0070
918-256-5545. 918-256-0906 Fax

Grand River Dam Authority

September 30, 2022

Via E-Filing

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

Subject: Pensacola Hydroelectric Project (FERC Project No. 1494-438)
Updated Study Report and Request for Privileged Treatment of Cultural Resources Information

Dear Secretary Bose:

The Grand River Dam Authority (GRDA) hereby electronically files its Updated Study Report (USR) pursuant to 18 C.F.R. § 5.15(f) for the relicensing of the Pensacola Hydroelectric Project (FERC No. 1494). The purpose of this USR is to describe GRDA's overall progress during the final study season in implementing its relicensing study plan and schedule. The schedule originated in GRDA's Revised Study Plan (RSP) in September 2018 and was approved with Federal Energy Regulatory Commission (Commission) staff-recommended modifications in the Commission's November 8, 2018 study plan determination (SPD) letter.

The enclosed USR builds on the Initial Study Report (ISR), which GRDA filed with the Commission on September 30, 2021. In the ISR, GRDA recommended modifications to the Sedimentation Study and Terrestrial Species of Concern Study. In response to the ISR, relicensing participants recommended modifications to the Hydrologic and Hydraulic Modeling Study, Sedimentation Study, Aquatic Species of Concern Study, Cultural Resources Study, Socioeconomic Study, and Infrastructure Study. In addition, the Relicensing participants also recommended a Contaminated Sediment Transport Study, which Commission staff had previously rejected in its November 2018 SPD.

Commission staff resolved most of these issues in its February 24, 2022 Study Modification Determination (SMD). In the SMD, Commission staff recommended modifications to the Hydrologic and Hydraulic Modeling Study, Aquatic Species of Concern Study, and the Infrastructure Study. Staff's SMD deferred a decision on the Sedimentation Study and did not recommend any modifications to the Terrestrial Species of Concern, Cultural Resources, or Socioeconomics Study. Also in the SMD, Commission staff once again rejected the request for Contaminated Sediment Transport Studies, just as it had in its November 2018 SPD.

ECOSYSTEMS & WATERSHED
MANAGEMENT
420 Hwy 28, PO Box 70
Langley, OK 74350-0070
918-256-5545. 918-256-0906 Fax

Grand River Dam Authority

On April 27, 2022, GRDA provided the Commission with an updated Sedimentation Study Plan. On May 27, 2022, Commission staff approved the updated Sedimentation Study Plan with several staff-recommended modifications.

The enclosed USR contains a complete and exhaustive reporting of all studies undertaken since last year's ISR and is the culmination of the environmental study phase of this relicensing effort. With the filing of the USR, GRDA has now completed the Commission-approved study plan for the relicensing of the Project, including all elements of staff's November 2018 SPD, February 2022 SMD, and May 2022 determination regarding the Sedimentation Study Plan.

The USR includes reports for all Commission-approved study plans, including Hydrologic and Hydraulic Modeling, Sedimentation, Aquatic Species of Concern, Terrestrial Species of Concern, Wetlands and Riparian Habitat, Recreation, Cultural Resources, Socioeconomics, and Infrastructure.

The Bathymetric Study is considered part of the Hydrologic and Hydraulic Modeling Study because the Commission recommended it be completed in their study determination letter as part of the Hydrologic and Hydraulic Modeling Study. For completeness, this USR includes the final reports for the Recreation and Socioeconomic studies provided in last year's ISR, but these reports remain unchanged, as these studies were completed in the first study season.

GRDA greatly appreciates the engagement of Commission staff, other federal and state resource agencies, Native American tribes, local governmental entities, and all relicensing participants in the development and implementation of the Commission-approved study plan—an effort that has taken nearly four years to complete. This highly collaborative, closely scrutinized, and time-consuming effort has resulted in an administrative record that is robust, scientifically sound, and fully satisfactory of the Commission's obligations under the Federal Power Act, National Environmental Policy Act, and other applicable programs in this relicensing effort.

With the scientific record now complete, GRDA hereby notifies the Commission and relicensing participants of its intent to file a Draft License Application (DLA) in lieu of a preliminary licensing proposal. *See* 18 C.F.R. § 5.16(c). As provided in the Commission's September 9, 2019 order, GRDA plans to file the DLA by January 1, 2023. *See Grand River Dam Auth.*, 168 FERC ¶ 62,145 (2019), *reh'g denied*, 170 FERC ¶ 61,027 (2020).

Prior to preparing the DLA, GRDA looks forward to discussing the USR with Commission staff and relicensing participants. Pursuant to 18 C.F.R. § 5.15(c)(2), GRDA has scheduled the USR meetings for Wednesday, October 12, and Thursday, October 13, 2022, beginning at 9:00 a.m. CDT. The meeting will be held virtually. An informal notification of the meeting location, time, and date was provided to the relicensing participants on record on September 16, 2022. The

ECOSYSTEMS & WATERSHED
MANAGEMENT
420 Hwy 28, PO Box 70
Langley, OK 74350-0070
918-256-5545. 918-256-0906 Fax

notice and agenda have been updated to include the virtual information. The agenda is enclosed as Appendix 1 of the USR.

Finally, GRDA notes that the enclosed cultural resources studies contain sensitive, non-public information related to the location and character of cultural resources; therefore, pursuant to 18 C.F.R. § 388.112, GRDA requests privileged designation of these reports in their entirety and that the Commission maintain these reports in its non-public file. As required by Commission regulation and guidance, each page of the cultural resources studies has been labeled as privileged and confidential, designated as CUI//PRIV, and marked "DO NOT RELEASE." *See id.* § 388.112(b)(1).

If there are any questions or comments regarding this submittal, please contact me by phone at (918) 981-8472 or by email at Darrell.Townsend@grda.com.

Sincerely,

Darrell Townsend II, Ph.D.
Vice President
Grand River Dam Authority

Enclosure-USR

cc: Distribution list (see attached)

Stakeholder Distribution List
September 2022

* Denotes correspondence was mailed to relicensing participants without a known email address.

Federal Agencies:

Dr. John Eddins
Advisory Council on Historic Preservation
Federal Permitting, Licensing and Assistance Section
401 F Street NW, Suite 308
Washington DC 20001-2637
jeddins@achp.gov

Mr. Andrew Commer, Chief
U.S. Army Corps of Engineers, Tulsa District
Attn: CESWT-RO (Regulatory Branch)
2488 East 81st Street
Tulsa, OK 74137
Andrew.Commer@usace.army.mil

Mr. Mike Abate
U.S. Army Corps of Engineers
2488 East 81st Street
Tulsa, OK 74137
mike.r.abate@usace.army.mil

Ms. Jennifer Aranda
U.S. Army Corps of Engineers
2488 East 81st Street
Tulsa, OK 74137
jennifer.a.aranda@usace.army.mil

Mr. William Chatron
U.S. Army Corps of Engineers
2488 East 81st Street
Tulsa, OK 74137
william.a.chatron@usace.army.mil

Mr. Scott Henderson
U.S. Army Corps of Engineers
2488 East 81st Street
Tulsa, OK 74137
scott.a.henderson@usace.army.mil

Ms. Dawn Rice
U.S. Army Corps of Engineers
2488 East 81st Street
Tulsa, OK 74137
dawn.rice@usace.army.mil

Mr. Terry Rupe
U.S. Army Corps of Engineers
2488 East 81st Street
Tulsa, OK 74137
terry.d.rupe@usace.army.mil

Mr. David Williams
U.S. Army Corps of Engineers
2488 East 81st Street
Tulsa, OK 74137
david.j.williams@usace.army.mil

Ms. Eva Zaki-Dellitt
U.S. Army Corps of Engineers
2488 East 81st Street
Tulsa, OK 74137
eva.a.zaki-dellitt@usace.army.mil

Mr. Eddie Streater
Regional Director
U.S. Bureau of Indian Affairs
Eastern Oklahoma Regional Office
PO Box 8002
Muskogee, OK 74401-6206
eddie.streater@bia.gov

Mr. Mosby Halterman
Division Chief
U.S. Bureau of Indian Affairs
PO Box 8002
Muskogee, OK 74401
mosby.halterman@bia.gov

Ms. Allison Ross
Environmental Protection Specialist
U.S. Bureau of Indian Affairs
Eastern Regional Office
PO Box 8002
Muskogee, OK 74401
allison.ross@bia.gov

Mr. William Brant
Regional Archaeologist
U.S. Bureau of Indian Affairs
Eastern Regional Office
PO Box 8002
Muskogee, OK 74401
william.brant@bia.gov

Ms. Lisa Atwell
U.S. Bureau of Indian Affairs
Eastern Regional Office
PO Box 8002
Muskogee, OK 74401
lisa.atwell@bia.gov

Mr. James Schock
Regional Director
U.S. Bureau of Indian Affairs
Southern Plains Office
PO Box 368
Anadarko, OK 73005
james.schock@bia.gov

Ms. Crystal Keys
Water Program Manager
U.S. Bureau of Indian Affairs
Southern Plains Office
PO Box 368
Anadarko, OK 73005
crystal.keys@bia.gov

Mr. John Worthington
Natural Resources Officer
U.S. Bureau of Indian Affairs
Southern Plains Regional Office
PO Box 368
Anadarko, OK 73005
john.worthington@bia.gov

Mr. Robert Pawelek
Field Manager
U.S. Bureau of Land Management
Oklahoma Field Office
201 Stephenson Parkway, Suite 1200
Norman, OK 73072
rpawelek@blm.gov
blm_nm_comments@blm.gov

U.S. Department of the Army *
1645 Randolph Road
Fort Sill, OK 73503

Mr. Conor Cleary
U.S. Department of the Interior
Tulsa's Field Office of the Solicitor
7906 East 33rd Street, Suite 100
Tulsa, OK 74145
conor.cleary@sol.doi.gov

Ms. Valery Giebel
Attorney
Tulsa Field Solicitor's Office
U.S. Department of the Interior
P.O. Box. 470330
Tulsa, Oklahoma 74147
valery.giebel@sol.doi.gov

Ms. Kimeka Price
NEPA Project Manager
U S Environmental Protection Agency
Region 6
Fountain Place
1201 Elm Street
Dallas, TX 75202-2760
price.kimeka@epa.gov

Mr. Ken Collins
U.S. Fish and Wildlife Service
9014 E 21st Street
Tulsa, OK 74129-1428
ken_collins@fws.gov

Mr. Daniel Fenner
U.S. Fish and Wildlife Service
9014 E 21st Street
Tulsa, OK 74129-1428
daniel_fenner@fws.gov

Mr. Kevin Stubbs
bU.S. Fish and Wildlife Service
9014 E 21st Street
Tulsa, OK 74129-1428
kevin_stubbs@fws.gov

Chief Vicki Christiansen
U.S. Forest Service
1400 Independence Avenue, SW
Washington, DC 20250
vcchristiansen@fs.fed.us

Jason Lewis, Director
U.S. Geological Survey
Oklahoma Water Science Center
202 NW 66th Street, Building 7
Oklahoma City, OK 73116
jmlewis@usgs.gov

Acting Chief Terry Cosby
U.S. Natural Resources Conservation Service
1400 Independence Avenue, SW Room 5744-S
Washington DC 20250
Terry.cosby@usda.gov

Mike Reynolds
Regional Director
National Park Service
12795 Alameda Parkway
Denver, CO 80225
IMRextrev@nps.gov

Ms. Nicole McGavock
National Weather Service
Tulsa, OK Weather Forecast Office
10159 E 11th Street, Suite 300
Tulsa, OK 74128
nicole.mcgavock@noaa.gov

Mr. James Paul
National Weather Service
Tulsa, OK Weather Forecast Office
10159 E 11th Street Suite 300
Tulsa, OK 74137
james.paul@noaa.gov

Tyler Gipson
Southwestern Power Administration
1 W 3rd Street, Suite 1600
Tulsa OK 74103
tyler.gipson@swpa.gov

William Hiller
Southwestern Power Administration
1 W 3rd Street, Suite 1600
Tulsa OK 74103
william.hiller@swpa.gov

State Agencies:

Dr. Kary Stackelbeck
State Archeologist
Oklahoma Archeological Survey
University of Oklahoma
111 East Chesapeake Street, Room 102
Norman, OK 73019-5111
kstackelbeck@ou.edu

Mr. Scott Mueller
Secretary of Commerce and Workforce Development
Oklahoma Department of Commerce
900 North Stiles Avenue
Oklahoma City, OK 73104
scott.mueller@okcommerce.gov

Mr. Brooks Tramell
Director of Monitoring, Assessment & Wetlands
Oklahoma Conservation Commission
2800 North Lincoln Boulevard, Suite 200
Oklahoma City, OK 73105
brooks.tramell@conservation.ok.gov

Ms. Shanon Phillips
Director of Water Quality Division
Oklahoma Conservation Commission
2800 North Lincoln Boulevard, Suite 200
Oklahoma City, OK 73105
shanon.phillips@conservation.ok.gov

Chairman Todd Hiett *
Director of Administration
Oklahoma Corporation Commission
2101 North Lincoln Boulevard
Oklahoma City, OK 73105
contacttoddhiett@occ.ok.gov
jana.slatton@occ.ok.gov

Mr. Blayne Arthur
Commissioner
Oklahoma Department of Agriculture Food and Forestry
2800 North Lincoln Boulevard, Suite 100
Oklahoma City, OK 73105
blayne.arthur@ag.ok.gov

Mr. Joe Long
Environmental Programs Manager
Watershed Planning Section
Oklahoma Department of Environmental Quality
PO Box 1677
Oklahoma City, OK 73101-1677
joe.long@deq.ok.gov

Ms. Elena Jigoulina
Environmental Programs Specialist
Oklahoma Department of Environmental Quality
PO Box 1677
Oklahoma City, OK 73101-1677
elena.jigoulina@deq.ok.gov

Mark Gower
Oklahoma Office of Emergency Management
PO Box 53365
Oklahoma City, OK 73152-3365
mark.gower@oem.ok.gov

Commissioner Lance Frye*
Oklahoma Department of Health
1000 NE 10th Street
Oklahoma City, OK 73117

Mr. Tim Gatz
Executive Director
Oklahoma Department of Transportation
200 NE 21st Street
Oklahoma City, OK 73105
tgatz@odot.org

Mr. Jerry Winchester
Executive Director
Oklahoma Tourism and Recreation Department
900 North Stiles Avenue
Oklahoma City, OK 73104
jerry.winchester@travelOK.com

Ms. Kris Marek
State Parks and Resorts
Oklahoma Tourism and Recreation Department
900 North Stiles Avenue
Oklahoma City, OK 73104
kris.marek@travelOK.com

Mr. JD Strong
Director
Oklahoma Department of Wildlife Conservation
PO Box 53465
Oklahoma City, OK 73152
jd.strong@odwc.ok.gov

Mr. Wade Free
Assistant Director
Oklahoma Department of Wildlife Conservation
PO Box 53465
Oklahoma City, OK 73152
wade.free@odwc.ok.gov

Mr. Josh Johnston
NE Region Fisheries Supervisor
Oklahoma Department of Wildlife Conservation
PO Box 1201
Jenks, OK 74037
josh.johnston@odwc.ok.gov

Mr. Josh Richardson
Wildlife Biologist
Oklahoma Department of Wildlife Conservation
PO Box 53465
Oklahoma City, OK 73152
josh.richardson@odwc.ok.gov

Mr. Bill Dinkines
Chief of Wildlife Division
Oklahoma Department of Wildlife Conservation
PO Box 53465
Oklahoma City, OK 73152
bill.dinkines@odwc.ok.gov

Mr. Brad Johnston
Fisheries Biologist
Oklahoma Department of Wildlife Conservation
61091 E 120 Road
Miami, OK 74354
brad.johnston@odwc.ok.gov

Mr. Ken Cunningham
Chief of Fisheries
Oklahoma Department of Wildlife Conservation
PO Box 53465
Oklahoma City, OK 73152
kenneth.cunningham@odwc.ok.gov

Richard Snow
Assistant Chief of Fisheries Division
Oklahoma Department of Wildlife Conservation
PO Box 53465
Oklahoma City, OK 73152
richard.snow@odwc.ok.gov

Mr. Mike Plunkett
NE Region Wildlife Supervisor
Oklahoma Department of Wildlife Conservation
9097 N 34th Street West
Porter, OK 74454
mike.plunkett@odwc.ok.gov

Ms. Lynda Ozan
Deputy State Historic Preservation Officer
Oklahoma Historical Society
800 Nazih Zuhdi Drive
Oklahoma City, OK 73105-7917
lynda.ozan@history.ok.gov

Ms. Kristina Wyckoff
Oklahoma Historical Society
800 Nazih Zuhdi Drive
Oklahoma City, OK 73105-7917
kristina.wyckoff@history.ok.gov

Ms. Julie Cunningham
Executive Director
Oklahoma Water Resources Board
3800 North Classen Boulevard
Oklahoma City, OK 73118
julie.cunningham@owrb.ok.gov

Mr. William Cauthron
Acting Director, Water Quality Division
Oklahoma Water Resources Board
3800 North Classen Boulevard
Oklahoma City, OK 73118
bill.cauthron@owrb.ok.gov

Ms. Nikki Davis
Staff Secretary, Water Quality Division
Oklahoma Water Resources Board
3800 North Classen Boulevard
Oklahoma City, OK 73118
nikki.davis@owrb.ok.gov

Mr. Lance Phillips
Environmental Programs Manager
Oklahoma Water Resources Board
3800 North Classen Boulevard
Oklahoma City, OK 73118
lance.phillips@owrb.ok.gov

Mr. Monty Porter
Section Head, Water Quality Standards
Oklahoma Water Resources Board
3800 North Classen Boulevard
Oklahoma City, OK 73118
monty.porter@owrb.ok.gov

Mr. Chris Neel
Planning and Management Division
Oklahoma Water Resources Board
3800 North Classen Boulevard
Oklahoma City, OK 73118
chris.neel@owrb.ok.gov

Harold Thompson
Office of State Fire Marshal
2401 NW 23rd Street, Suite 4
Oklahoma City, OK 73107
harold.thompson@fire.ok.gov

Tribal Organizations:

Inter-Tribal Council Inc. *
PO Box 1308
Miami, OK 74355

Chief Nelson Harjo
Alabama-Quassarte Tribal Town
PO Box 187
Wetumka, OK 74883
nharjo@alabama-quassarte.org

Chairman Bobby Komardley
Apache Tribe of Oklahoma
511 E Colorado
Anadarko, OK 73005
info@apachetribe.org

Chairman Bobby Gonzalez
Caddo Nation of Oklahoma
PO Box 487
Binger, OK 73009
bgonzalez@mycaddonation.com

Mr. Jonathan Rohrer
Caddo Nation of Oklahoma
Tribal Historic Preservation Officer
PO Box 487
Binger, OK 73009
jrohrer@mycaddonation.com

Chief Chuck Hoskin, Jr.
Cherokee Nation
PO Box 948
Tahlequah OK 74465
chuck-hoskin@cherokee.org

Ms. Elizabeth Toombs
Cherokee Nation
Tribal Historic Preservation Officer
PO Box 948
Tahlequah, OK 74465
elizabeth-toombs@cherokee.org

Mr. Tom Elkins
Administrator
Cherokee Nation Environmental Programs
PO Box 948
Tahlequah, OK 74465
tom-elkins@cherokee.org

Ms. Deborah Dotson
President
Delaware Nation
PO Box 825
Anadarko, OK 73005
ddotson@delawarenation.com

Katelyn Lucas
Delaware Nation
PO Box 825
Anadarko, OK 73005
klucas@delawarenation-nsn.gov

Dr. Brice Obermeyer
Historic Preservation Office
Delaware Tribe of Indians
1200 Commercial Street
Roosevelt Hall, Room 212
Emporia KS 66801
bobermeyer@delawaretribe.org

Chief Glenna J. Wallace
Eastern Shawnee Tribe of Oklahoma
70500 E 128 Road
Wyandotte, OK 74370
gjwallace@estoo.net

Chairman Edgar B. Kent, Jr.
Iowa Tribe of Oklahoma
335588 E 750 Road
Perkins, OK 74059
ekent@iowanation.org

Ms. Renee Hagler *
Acting Tribal Administrator
Iowa Tribe of Oklahoma
335588 E 750 Road
Perkins, OK 74059

Ms. Kellie Lewis
Acting Tribal Historic Preservation Officer
Kiowa Tribe Office of Historic Preservation
PO Box 369
Carnegie, OK 73015
kellie@tribaladminservices.org

Ms. Regina Gasco-Bentley *
Little Traverse Bay Bands of Odawa Indians
7500 Odawa Circle
Harbor Springs, MI 49740
tribalchair@ltbbodawa-nsn.gov

Chief Douglas G. Lankford
Miami Tribe of Oklahoma
PO Box 1326
Miami, OK 74354
dlankford@miamination.com

Julie Olds
Miami Tribe of Oklahoma
PO Box 1326
Miami, OK 74354
jolds@miamination.com

Ms. Robin Lash
General Counsel
Miami Tribe of Oklahoma
PO Box 1326
Miami, OK 74354
rlash@miamination.com

Mr. Joe Halloran
Counsel for Miami Nation
Jacobson Law Group
180 East 5th Street, Suite 940
St. Paul, MN 55101
jhalloran@thejacobsonlawgroup.com

Mr. Phil Mahowald
Jacobson Law Group
180 East 5th Street, Suite 940
St. Paul, MN 55101
pmahowald@thejacobsonlawgroup.com

Mr. Jeff Holth
Jacobson Law Group
180 East 5th Street, Suite 940
St. Paul, MN 55101
jholth@thejacobsonlawgroup.com

Chief Bill Follis
Modoc Nation
22 N Eight Tribes Trail
Miami, OK 74354
modoctribe@cableone.net

Chief David Hill
Muscogee (Creek) Nation
PO Box 580
Okmulgee, OK 74447
dhill@mcn-nsn.gov

Ms. RaeLynn Butler
Historic and Cultural Preservation
Department, Manager
Muscogee (Creek) Nation
PO Box 580
Okmulgee, OK 74447
raebutler@mcn-nsn.gov

Chief Geoffrey Standing Bear *
Osage Nation
627 Grandview Avenue
Pawhuska, OK 74056
gdstandingbear@osagenation-nsn.gov

Dr. Andrea Hunter
Osage Nation Historic Preservation Office
627 Grandview Avenue
Pawhuska, OK 74056
ahunter@osagenation-nsn.gov

Ms. Eden Hemming
Archaeologist
Osage Nation Historic Preservation Office
627 Grandview Avenue
Pawhuska, OK 74056
eden.hemming@osagenation-nsn.gov

Chairman John Shotton
Otoe-Missouria Tribe of Indians
8151 Hwy 177
Red Rock, OK 74651
jshotton@omtribe.org

Ms. Elsie Whitehorn
Tribal Historic Preservation Officer
Otoe-Missouria Tribe of Indians
8151 Hwy 177
Red Rock, OK 74651
ewhitehorn@omtribe.org

Chief Ethel Cook
Ottawa Tribe of Oklahoma
PO Box 110
Miami, OK 74354
cethel.oto@gmail.com

Ms. Rhonda Hayworth
Tribal Historic Preservation Officer
Ottawa Tribe of Oklahoma
PO Box 110
Miami, OK 74354
rhonda.oto@gmail.com

Chief Craig Harper
Peoria Tribe of Oklahoma
118 South Eight Tribes Trail
Miami, OK 74354
chiefharper@peoriatribe.com

Charla EchoHawk
Director of Cultural Preservation
Peoria Tribe of Oklahoma
118 South Eight Tribes Trail
Miami, OK 74354
cechohawk@peoriatribe.com

Chairman Joseph T. Byrd
Quapaw Tribe of Oklahoma
PO Box 765
Quapaw, OK 74363
joseph.byrd@quapawnation.com

Mr. Everett Bandy
Quapaw Tribe of Oklahoma
PO Box 765
Quapaw, OK 74363
ebandy@quapawnation.com

Chief Justin Wood
Sac and Fox Nation of Oklahoma
920883 S Hwy 99, Building A
Stroud, OK 74079
justinwood@sacandfoxnation-nsn.gov

Chief Charlie Diebold
Seneca-Cayuga Nation
PO Box 453220
Grove, OK 74345-3220
cdiebold@sctribe.com

Mr. William Tarrant
Tribal Historic Preservation Officer
Seneca Cayuga Nation
23701 South 665 Road
Grove, OK 74344
wtarrant@sctribe.com

Richard Schlottke
Seneca Cayuga Nation
23701 S 665 Road
Grove, OK 74344
rschlottke@sctribe.com

Chief Ben Barnes
Shawnee Tribe of Oklahoma
PO Box 189
Miami, OK 74354
chief@shawnee-tribe.com

Ms. Tonya Tipton
Tribal Historic Preservation Officer
Shawnee Tribe of Oklahoma
PO Box 189
Miami, OK 74355
tonya@shawnee-tribe.com

President Russell Martin
Tonkawa Tribe of Oklahoma
1 Rush Buffalo Road
Tonkawa OK 74653
rmartin@tpmlawatribe.com

Chief Joe Bunch
United Keetoowah Band of Cherokees
PO Box 746
Tahlequah, OK 74465
jbunch@ukb-nsn.gov

Director Ernestine Berry
United Keetoowah Band of Cherokees
PO Box 1245
Tahlequah, OK 74465
eberry@ukb-nsn.gov

President Terri Parton
Wichita and Affiliated Tribes
PO Box 729
Anadarko, OK 73005
terri.parton@wichitatribe.com

Mr. Gary McAdams
Tribal Historic Preservation Officer
Wichita and Affiliated Tribes
PO Box 729
Anadarko, OK 73005
gary.mcadams@wichitatribe.com

Chief Billy Friend
Wyandotte Tribe of Oklahoma
64700 East Highway 60
Wyandotte, OK 74370
bfriend@wyandotte-nation.org

Ms. Sherri Clemons
Tribal Historic Preservation Officer
Wyandotte Tribe of Oklahoma
64700 East Highway 60
Wyandotte, OK 74370
sclemons@wyandotte-nation.org

Mr. Norman Hildebrand, Jr.
Second Chief
Wyandotte Nation
64700 East Highway 60
Wyandotte, OK 74370
nhildebrand@wyandotte-nation.org

Mr. Christen Lee
Environmental Director
Wyandotte Nation
64700 East Highway 60
Wyandotte, OK 74370
clee@wyandotte-nation.org

Congressional Delegation:

The Honorable James Mountain Inhofe
United States Senate
205 Russell Senate Office Building
Washington DC 20515
dan_hillenbrand@inhofe.senate.gov

The Honorable James Lankford
United States Senate
316 Hart Senate Office Building
Washington DC 20510
michelle_altman@lankford.senate.gov

The Honorable Markwayne Mullin
1113 Longworth House Office Building
Washington DC 20515
benjamin.cantrell@mail.house.gov

The Honorable Michael Bergstrom
Oklahoma State Senate, District 1
2300 North Lincoln Boulevard, Room 522
Oklahoma City, OK 73105
michael.bergstrom@oksenate.gov

The Honorable Marty Quinn
Oklahoma State Senate, District 2
2300 North Lincoln Boulevard, Room 417B
Oklahoma City, OK 73105
marty.quinn@oksenate.gov

The Honorable Blake Stephens
Oklahoma State Senate, District 3
2300 North Lincoln Boulevard, Room 325
Oklahoma City, OK 73105
blake.stephens@oksenate.gov

The Honorable Josh West
House of Representatives, District 5
2300 North Lincoln Blvd, Room 242A
Oklahoma City, OK 73105
josh.west@okhouse.gov

The Honorable Rusty Cornwell
House of Representatives, District 6
2300 North Lincoln Boulevard, Room 509
Oklahoma City, OK 73105
rusty.cornwell@okhouse.gov

The Honorable Steve Bashore
House of Representatives, District 7
2300 North Lincoln Boulevard
Oklahoma City, OK 73105
steve.bashore@okhouse.gov

The Honorable Tom Gann
House of Representatives, District 8
2300 North Lincoln Boulevard, Room 500
Oklahoma City, OK 73105
tom.gann@okhouse.gov

The Honorable Kevin Stitt*
Governor of Oklahoma
2300 North Lincoln Boulevard, Suite 212
Oklahoma City, OK 73105
governor@gov.ok.gov

The Honorable Kenneth (Ken) Wagner
Secretary of Energy and Environment
204 North Robison, Suite 1010
Oklahoma City, OK 73102
kenneth.wagner@ee.ok.gov

Other Governmental Entities:

Afton Public Works Authority
PO Box 250
Afton, OK 74331
phyllistoa@att.net

Ms. Debbie Bottoroff
Assistant City Manager
City of Grove
104 West 3rd
Grove, OK 74344
dbottoroff@sbcglobal.net

Mayor Bless Parker
City of Miami
PO Box 1288
Miami, OK 74355
bparker@miamiokla.net

Mr. Bo Reese
City Manager
City of Miami
PO Box 1288
Miami, OK 74355
breese@miamiokla.net

Ms. Barbara S. Jost
Davis Wright Tremaine LLP
1919 Pennsylvania Avenue, NW
Suite 800
Washington, DC 20006-3401
barbarajost@dwt.com

Mr. Craig Gannett
Davis Wright Tremaine LLP
1201 Third Avenue, Suite 2200
Seattle, WA 98101
craiggannett@dwt.com

Shannon O'Neil
Associate
Davis Wright Tremaine LLP
1301 K Street, NW, Suite 500 East
Washington DC 20005
shannononeil@dwt.com

Mr. Walker Stanovsky
Davis Wright Tremaine LLP
1201 Third Avenue, Suite 2200
Seattle, WA 98101
walkerstanovsky@dwt.com

Ms. Amber Prewett
City of Miami
PO Box 1288
Miami, OK 74355
aprewett@miamiokla.net

Fire Chief Robert Wright
City of Miami
PO Box 1288
Miami, OK 74355
rwright@miamiokla.net

Police Chief Thomas Anderson
City of Miami
PO Box 1288
Miami, OK 74355
tanderson@miamiokla.net

Kevin Browning
Public Works Director
City of Miami
PO Box 1288
Miami, OK 74355
kbrowning@miamiokla.net

Coo-Y-Yah Museum *
847 Highway 69
South 8th Street
Pryor, OK 74361

Mr. Lowell Walker
Craig County Commissioner
District 1
210 W Delaware Avenue, Suite 106
Vinita, OK 74301
ccd1@junct.com

Mr. Hugh Gordon
Craig County Commissioner
District 2
210 W Delaware Avenue, Suite 106
Vinita, OK 74301
ccd2@ruralinet.net

Mr. Dan Peetom
Craig County Commissioner
District 3
210 W Delaware Avenue, Suite 106
Vinita, OK 74301
joni.jones_18@yahoo.com

Mr. Morris Bluejacket
Craig County Flood Plain Manager
210 West Delaware, Suite 103
Vinita, OK 74301-4236
ccem@junct.com

Amanda Montgomery
District Conservationist
Craig County Conservation District
235 West Hope Avenue
Vinita, OK 74301-1302
amanda.montgomery@ok.usda.gov

Mr. David Poindexter
Delaware County Commissioner
District 1
2001 Industrial 10 RD
Grove, OK 74344
delcohwy1086@gmail.com

Mr. Jake Callihan
Delaware County Commissioner
District 2
327 South 5th Street
Jay, OK 74346
delbarn2@yahoo.com

Martin Kirk
Delaware County Commissioner
District 3
327 South 5th Street
Jay, OK 74346
delco.d3@gmail.com

Mr. Travis Beesley
Delaware County Floodplain Administrator
PO Drawer 309
429 South 9th Street
Jay, OK 74346-0309
delawarecountyem@yahoo.com

Delaware County Historical Society & Museum *
538 Krause Street
Jay, OK 74346

Delaware County Conservation District
2749 State Highway 20
Jay, OK 74346
delawareccd@conservation.ok.gov

Eastern Trails Museum
215 West Illinois Avenue
Vinita, OK 74301
etmuseum@junct.com

Ms. Jill Lambert
Ketchum Public Works Authority
PO Box 958
Ketchum, OK 74349
jclabornkpwa@wavelinx.net

Mr. Matt Swift
Mayes County Commissioner
District 1
One Court Place, Suite 140
Pryor, OK 74361
mswift@mayes.okcounties.org

Ms. Darrell Yoder*
Mayes County Commissioner
District 2
One Court Place, Suite 140
Pryor, OK 74361

Mr. Ryan Ball
Mayes County Commissioner
One Court Place, Suite 140
Pryor, OK 74361
rball@mayes.okcounties.org

Mayes County Conservation District
4238 N E 1st
PO Box 36
Pryor, OK 74362
mayesccd@conservation.ok.gov

Mr. Johnny Janzen
Mayes County Floodplain Manager
One Court Place, Suite 140
Pryor, OK 74361
mayescountyem@yahoo.com

Mr. Jeremy Hogan
Superintendent
Miami Public Schools
26 N Main Street
Miami, OK 74354
jhogan@mpswardogs.com

Cindy Morris
Director
Miami Regional Chamber of Commerce
11 South Main
Miami, OK 74354
cmorris@miamiokchamber.com

Mr. Brian Estep
Council Member
NE Ward 1
PO Box 1288
Miami, OK 74355-1288
bestep@miamiokla.net

Mr. Kevin Dunkel
Council Member
NE Ward 2
PO Box 1288
Miami, OK 74355-1288
kdunkel@miamiokla.net

Mr. Ryan Orcutt
Council Member
SW Ward 3
PO Box 1288
Miami, OK 74355-1288
ward3@miamiokla.net

Mr. Chad Holcom
Ottawa County Emergency Management
Certified Floodplain Manager
123 East Central Ave., Suite 103
Miami, OK 74354

Mike Furnas
Ottawa County Commissioner
District #1
102 East Central Avenue, Suite 202
Miami, OK 74354
ottawacountyd1@sbcglobal.net

Mr. Steven Chasteen
Ottawa County Commissioner
District #2
310 West Walker
Wyandotte, OK 74370
d2commissioner@ottawa.okcounties.org

Mr. Russell Earls
Ottawa County Commissioner
District #3
102 East Central Avenue, Suite 202
Miami, OK 74354
rearls@ruralinet.net

Ottawa County Conservation District
630 East Steve Owens Boulevard, Suite 3
Miami, OK 74354-7800
ottawaccd@conservation.ok.gov

Ottawa County Historical Society *
(Dobson Museum)
110 A Street SW
Miami, OK 74354

Mr. Matt Outhier
RWD #3 Delaware County
PO Box 1228
Jay, OK 74346
aquazena@yahoo.com

RWD #3 Mayes County – Disney
PO Box 279
Disney, OK 74340
mayesrwd3@grand.net

Town of Afton *
PO Box 250
Afton, OK 74331

Town of Bernice *
209 S Broadway
Bernice, OK 74331

Town of Disney
PO Box 318
Disney, OK 74340
townofdisney@outlook.com

Town of Fairland *
PO Box 429
Fairland, OK 74343

Town of Ketchum *
PO Box 150
Ketchum, OK 74349

Ms. Melissa Yarbrough
Town of Langley
PO Box 760
Langley, OK 74350
myarbrough@langleyok.org

City of Vinita *
PO Box 329
104 East Illinois Avenue
Vinita, OK 74301

Town of Wyandotte *
212 South Main
Wyandotte, OK 74370

Non-Governmental Organizations:

American Rivers
1101 14th Street NW Suite 1400
Washington DC 20005
akober@americanrivers.org

American Whitewater
PO Box 1540
Cullowhee, NC 28723
info@americanwhitewater.org

Nathan Johnson
Ducks Unlimited
Regional Director
1812 Cinnamon Ridge Road
Edmond, OK 73025
njohnson@ducks.org

Grand Lake Audubon Society *
PO Box 1813
Grove, OK 74345-1813

Mr. Bruce Watson, Squadron Commander
Grand Lake Sail and Power Squadron
31380 S 628 Lane
Grove, OK 74344
lakepappy@gmail.com

Grand Lake Watershed Alliance Foundation
PO Box 451185
Grove, OK 74345-1185
glwafadmin@gmail.com

Ms. Rebecca Jim
Local Environmental Action Demanded Inc.
223 A Street SE
Miami, OK 74354
rjim@neok.com

Ms. Melissa Shackford
Director of Land Protection
The Nature Conservancy
408 NW 7th Street
Oklahoma City, OK 73102
mshackford@tnc.org

Ms. Katie Gillies
The Nature Conservancy
408 NW 7th Street
Oklahoma City, OK 73102
katie.gillies@tnc.org

Mr. Mike Fuhr
Director of Conservation
The Nature Conservancy
10425 S 82nd E Avenue, Suite 104
Tulsa, OK 73133
mfuhr@tnc.org

Mr. Chris Wood, President
Trout Unlimited
1777 N Kent Street, Suite 100
Arlington, VA 22209
cwood@tu.org

Mr. John Kennington
President
Tulsa Audubon Society
PO Box 330140
Tulsa, OK 74133
johnkennington@gmail.com

Public/Citizens:

Larry Bork
GSEP
515 S. Kansas Ave.
Topeka, KS 66603
gsep@gseplaw.com

Mr. Andy Stewart
Shoreline, LLC
PO Box 6586
Grove, OK 74344
andy@patriciaisland.com

Ms. Alicia Hampton
Assistant General Manager
Patricia Island Country Club
PO Box 451500
Grove OK 74345
alicia@patriciaisland.com

Dr. Robert Nairn
School of Civil Engineering
The University of Oklahoma
202 West Boyd Street, Room 334
Norman, OK 73109-3073
nairn@ou.edu

Dr. Robert Knox
School of Civil Engineering
The University of Oklahoma
202 West Boyd Street, Room 334
Norman, OK 73109-3073
knox@ou.edu

Dr. Randy Kolar
School of Civil Engineering
The University of Oklahoma
202 West Boyd Street, Room 334
Norman, OK 73109-3073
kolar@ou.edu

Oklahoma State University
Burns Hargis, President
107 Whitehurst
Stillwater, OK 74078
debbie.lane@okstate.edu

Mr. Kyle Stafford
President
Northeastern Oklahoma A & M College
200 I Street NE
Miami, OK 74354
kyle.j.stafford@neo.edu

Mr. Mark Rasor
Vice President for Business
200 I Street NE
Miami OK 74354
mrasor@neo.edu

Dr. Keith Martin
Dean, Professor of Biology
Rogers State University
1701 West Will Rogers Boulevard
Claremore, OK 74017
kmartin@rsu.edu

Miami Flood Mitigation Advisory Board *
City of Miami
PO Box 1288
Miami, OK 74355-1288

Rusty Fleming
Executive Director
Grand Lakers United Enterprise
PO Box 1
Langley, OK 74350
grandtimesongrandlake@gmail.com
Mr. Jay Cranke
Director Grand Lake Association
9630 US Highway 59, Suite B
Grove, Oklahoma 74344
jay@glaok.com

Mr. Donnie Crain *
President
Grove Area Chamber of Commerce
9630 US Highway 59
Grove, OK 74344

South Grand Lake Area Chamber of Commerce
PO Box 215
Langley, OK 74350
grandlakechamber@gmail.com

Oklahoma Association of Realtors *
9807 Broadway Ext
Oklahoma City, OK 73114-6312

Har-Ber Village *
4404 West 20th Street
Grove, OK 74344

Dr. Mark Osborn *
301 2nd Avenue SW
Miami, OK 74354

Mr. Jack Dalrymple *
54297 E 75 Road
Miami, OK 74354

Mr. Mike Williams
Director of Communications & Gov't Relations
Shangri-La Marina
57151 East Highway 125
Afton, OK 74331
mike.williams@shangrilaok.com

Mr. Joe Harwood
Owner
Arrowhead Yacht Club (North & South)
PO Box 600
Ketchum, OK 74349
joeharwood@aol.com

Mr. Jeff Rose
Regional Manager
Safe Harbor Marinas
14785 Preston Road, Suite 975
Dallas, TX 75254
jrose@shmarinas.com

Mr. Jerry Cookson
Manager
Cedar Port Marina
PO Box 600
Ketchum, OK 74349
jerry.cookson@cedarport.com

Mr. Todd Elson
Manager
Indian Hills Resort and Marina
PO Box 3747
Bernice, OK 74331
indianhillsok@aol.com

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GRAND RIVER DAM AUTHORITY

PENSACOLA HYDROELECTRIC PROJECT
FERC No. 1494

UPDATED STUDY REPORT

September 30, 2022

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List of Abbreviations and Terms

1D	One-Dimensional
ABB	American Burying Beetle
APE	Area of Potential Effect
Commission	Federal Energy Regulatory Commission
CRWG	Cultural Resources Work Group
CHM	Comprehensive Hydraulic Model
DLA	Draft License Application
DHM	Downstream Hydraulic Model
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FRM	Flood Routing Model
GIS	Geographic Information Systems
Grand Lake	Grand Lake O’ the Cherokees
GRDA	Grand River Dam Authority
H&H Study	Hydrologic and Hydraulic Modeling Study
HEC	Hydrologic Engineering Center
HPMP	Historic Properties Management Plan
ILP	Integrated Licensing Process
ISR	Initial Study Report
Kerr Dam	Robert S. Kerr Dam (Markham Ferry Hydroelectric Project)
LiDAR	Light Detection and Ranging
MISR	Model Input Status Report
NDAA 2020	National Defense Authorization Act for Fiscal Year 2020
NHPA	National Historic Preservation Act
NOI	Notice of Intent
NRHP	National Register of Historic Places
NWI	National Wetland Inventory
ODWC	Oklahoma Department of Wildlife Conservation
OM	Operations Model
PAD	Pre-Application Document
Pcf	Per Cubic Foot
PD	Pensacola Datum
Project	Pensacola Hydroelectric Project
PSP	Proposed Study Plan
Qals	Quarternary landforms
RAS	River Analysis System
REAS	1998 Real Estate Adequacy Study
RM	River Mile
ROI	Region of Influence
RSP	Revised Study Plan
RWM	USACE’S RiverWare Model
SBP	Sub-bottom Profiler
SHPO	State Historic Preservation Officer
SMD	Study Modification Determination

SPD	Study Plan Determination
SSC	Suspended Sediment Concentration
STM	Sediment Transport Model
TCP	Traditional Cultural Properties
UHM	Upstream Hydrologic Model
USACE	United States Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
USR	Updated Study Report
WSEL	Water Surface Elevation

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1.0 GENERAL

This document presents Grand River Dam Authority's (GRDA's) Updated Study Report (USR) for the Pensacola Hydroelectric Project (Project), Federal Energy Regulatory Commission (FERC or Commission) Project No. 1494. The USR—the culmination of nearly four years of intensive, highly collaborative, and closely scrutinized environmental study regarding the Project—presents GRDA's progress in implementing and completing the approved study plan and schedule by providing the data collected and summarizing the results of comprehensive reports for both the First Study Season and the Final Study Season. The purpose of the USR is also to provide an explanation of variances from the approved study plans and schedules and modifications to ongoing studies (if any) or new studies proposed by GRDA (if any).

The study plan and schedule first originated in the Revised Study Plan (RSP), which was filed by GRDA in September 2018[1] and approved by the Commission in its November 8, 2018[2] study plan determination (SPD) (FERC 2018) and further clarified in its January 23, 2019, Order on Request for Clarification and Rehearing (FERC 2019).

In September 2021[3], GRDA filed its Initial Study Report (ISR) (GRDA 2021) and recommended modifications to the Sedimentation Study and Terrestrial Species of Concern Study. In response to the ISR, relicensing participants requested modifications to the Hydrologic and Hydraulic Modeling (H&H) Study, Sedimentation Study, Aquatic Species of Concern Study, Cultural Resources Study, Socioeconomic Study, and Infrastructure Study. In addition, the relicensing participants also requested a new study for Contaminated Sediment Transport.

In the Commission's February 2022[4] Study Modification Determination (SMD) (FERC SMD 2022) modifications to the Hydrologic and Hydraulic Modeling Study, Aquatic Species of Concern Study, and the Infrastructure Study were approved. At that time, the Commission deferred a decision on the Sedimentation Study, but its SMD did not accept proposed modifications to the Terrestrial Species of Concern Study, Cultural Resources Study, and Socioeconomics Study. Also, consistent with its November 2018 SPD, the Commission in its SMD did not approve a proposed Contaminated Sediment Transport Study.

In April 2022[5], GRDA provided the Commission with an updated Sedimentation Study Plan (GRDA 2022). In May 2022[6], the Commission approved the updated Sedimentation Study Plan with Commission staff-recommended modifications (FERC Determination 2022).

Variances to the approved study plan and schedule are outlined in Section 3.0.

As documented in this USR, all study plan objectives and methodologies set forth in the Commission-approved study plan—including in the November 2018 SPD, February 2022 SMD, and May 2022 approval of the Sedimentation Study Plan—have been fully met, and all studies are complete. Therefore, no further modifications to the approved studies or new studies are necessary or appropriate for the

[1] GRDA's Revised Study Plan, P-1494-438 (September 24, 2018).
[2] Study Plan Determination, P-1494-438 (November 8, 2018).
[3] GRDA's Initial Study Report, P-1494-438 (September 30, 2021).
[4] FERC's Determination on Requests for Study Modifications and New Studies, P-1494-438 (February 24, 2022).
[5] GRDA's Response Comments on Sedimentation Study and Submission of Updated Study Plan, P-1494-438 (April 27, 2022).
[6] FERC's Determination on Requests for Study Modifications for Pensacola Hydroelectric Project, P-1494-438 (May 27, 2022).

Commission to meet its obligations under the Federal Power Act, National Environmental Policy Act, or any other review requirement in this relicensing effort.

Appendices 2 through 11 of this USR contain the individual reports for the ten studies identified in the RSP. A summary of the studies and the status of each is provided in **Table 1**.

Table 1. Summary of studies included in this USR

Study	Study Consultant(s)	Study Requirements and Status
Hydrologic and Hydraulic Modeling	Mead & Hunt	Develop a Comprehensive Hydraulic Model (CHM) (Section 2 of the Upstream Hydraulic Model (UHM) and Downstream Hydraulic Model (DHM) report) using updated 2019 bathymetry and calibrate the CHM using six historical events (Section 3 of the UHM and Section 2 of the DHM report in Appendix 2)-***Complete***. Validate model results against RiverWare (RWM)[7] output (Section 5 of the Operations Model (OM) report in Appendix 2)-***Complete***. Compare water surface elevations observed at the USGS gage on the upstream side of the dam to simulated stage hydrographs for the December 2015 and October 2009 inflow events (Section 5.3 of the OM report in Appendix 2)-***Complete***. Run a sensitivity analysis on the effect of switching to the most recent (i.e., 2019) bathymetry data in the OM (Section 5.4.4 of the OM report in Appendix 2)-***Complete***. Perform a flood frequency analysis of peak inflow to estimate a 100-year event flow at Pensacola Dam (Section 4 of the UHM report in Appendix 2)-***Complete***. Determine the duration and extent of inundation under the current license (baseline) operations of the Project and anticipated change in these operations that occurs during several measured inflow events starting at elevation 734 Pensacola Datum (PD) up to and including elevation 757 PD (Sections 7 through 10 of the UHM report and Sections 3 through 6 of the DHM report in Appendix 2)-***Complete***. Report the frequency, timing (i.e., seasonality), amplitude (i.e., elevation), and duration for each of the simulated inflow events with starting elevations between 734 feet PD and 757 feet PD for the baseline analysis and under any anticipated change in operations (Sections 8 and 10 of the UHM report and Sections 4 and 6 of the DHM report in Appendix 2)-Complete. Section 11 of the UHM report in Appendix 2 provides the timing (seasonality) information-***Complete***. Provide the model results in a format that can inform other analyses (to be completed separately) of

[7] United States Army Corps of Engineers (USACE) RiverWare Model.

Study	Study Consultant(s)	Study Requirements and Status
		Project effects, if any, in several resource areas including the production of Lentic and Lotic Maps for baseline and anticipated operations, as needed, in the Aquatic Species of Concern, the Terrestrial Species of Concern, and the Wetland and Riparian Study (Section 11 and electronic attachment of the UHM report in Appendix 2)-***Complete***. Provide the means necessary to complete any additional return (flood) frequency analysis that may be deemed necessary following review of the USR (UHM report in Appendix 2 electronic attachment)-***Complete***. Determine the feasibility of implementing anticipated operations scenarios, if applicable, that may be proposed by GRDA as part of the relicensing effort (Section 10 of the UHM report and Section 6 of the DHM report in Appendix 2)-***Complete***.
Bathymetry[8]	U.S. Geological Survey (USGS)	See Appendix 3-***Complete***.
Sedimentation	Anchor QEA and Simons and Associates	Compile Existing Data and review literature on suspended sediments, sediment properties, flow, and water levels (Section 2 of the report in Appendix 4)-***Complete***. Collect additional field measurements and data (Section 2 of the report in Appendix 4)-***Complete***. Collect 10 vibracore samples in the delta feature (Section 2 of the report in Appendix 4)-***Complete***. Conduct a bathymetric change analysis (Section 4 of the report in Appendix 4)-***Complete***. Develop a Sediment Transport Model (STM) using Hydrologic Engineering Center River Analysis System (HEC-RAS) to determine the fate of sediment upstream of river mile (RM) 100 (Section 5 of the report in Appendix 4)-***Complete***. Calibrate the STM to measured bed changes based on the historical surveys (Section 6 of the report in Appendix 4)-***Complete***. Complete a qualitative analysis to understand the general trends in the system and how the stream has evolved over time (Section 4 of the report in Appendix 4)-***Complete***. Complete a quantitative engineering analysis of sediment transport in the study area focusing on the delta feature and downstream of RM 100 (Section 4 of the report in Appendix 4)-***Complete***.

[8] The collection of new bathymetric data in 2019 is not listed as a separate study in the Commission's November 8, 2018 SPD. In the letter, it is incorporated into the H&H Study section. However, in this table only it is listed as a separate study only to illustrate it is being completed by the USGS and a report independent of the H&H Study was provided.

Study	Study Consultant(s)	Study Requirements and Status
		Characterize Sedimentation impacts on upstream water levels over a 50-year period for baseline and anticipated operations (Sections 7 and 8 of the report in Appendix 4)-***Complete***. Analyze the effects of sediment on storage capacity in Grand Lake O' the Cherokees (Grand Lake) using hydraulic outputs from the STM and the United States Army Corps of Engineers (USACE) sediment trapping efficiency calculations downstream of RM 100 (Section 4 of the report in Appendix 4)-***Complete***.
Aquatic Species of Concern	Olsson	Gather existing information and map areas of known areas of paddlefish spawning (Section 4 of the report in Appendix 5)-***Complete***. Review existing information (including density) for Neosho mucket to characterize the physical habitat preferences and spatial and temporal patterns of the species (Section 3 of the report in Appendix 5)-***Complete***. Review existing information (including density) for Neosho madtom to characterize the physical habitat preferences and spatial and temporal patterns of the species (Section 4 of the report in Appendix 5)-***Complete***. Review existing information for Neosho smallmouth bass to characterize the physical habitat preferences and spatial and temporal patterns of the species (Section 4 of the report in Appendix 5)-***Complete***. Review existing information (including density) for rabbitsfoot mussel to characterize the physical habitat preferences and spatial and temporal patterns of the species (Section 4 of the report in Appendix 5)-***Complete***. Review existing information (including density) for winged mapleleaf mussel to characterize the physical habitat preferences and spatial and temporal patterns of the species (Section 4 of the report in Appendix 5)-***Complete***. Conduct targeted field surveys for Neosho mucket in the Spring River between Warren Branch and the confluence with the Neosho River and in the Neosho River between the City of Miami and the confluence with the Spring River), after consultation with the U.S. Fish and Wildlife Service (USFWS), EcoAnalysts, and Tar Creek Trustee Council on the survey design to develop density estimates, availability of spawning habitat during the spawning season, and estimates of the distribution of the species in relevant reaches (Section 4 of the report in Appendix 5)-***Complete***. Conduct targeted field surveys for Neosho madtom to develop density estimates, availability of spawning habitat during the spawning season, and estimates of the distribution of the species in

Study	Study Consultant(s)	Study Requirements and Status
		relevant reaches (Section 4 of the report in Appendix 5)-***Complete***. Assess potential effects of project operation, if any, on the Neosho mucket (Section 4 of the report in Appendix 5)-***Complete***. Assess potential effects of project operation, if any, on the Neosho madtom (Section 4 of the report in Appendix 5)-***Complete***. Assess potential effects of project operation, if any, on the Neosho smallmouth bass (Section 4 of the report in Appendix 5)-***Complete***.
Terrestrial Species of Concern	Horizon Environmental Services	Produce maps that delineate the riverine reaches that would be converted to lentic habitat, over a range of inflow conditions, as the result of water level management associated with Project operations (Section 4 of the report in Appendix 6)-***Complete***. Assess the degree to which anticipated operations would inundate the main entrance to Beaver Dam Cave and compare the frequency of inundation with that associated with baseline operations (Section 4 of the report in Appendix 6)-***Complete***. Determine whether the secondary exit at Beaver Dam Cave suffices to provide an alternative access by gray bats to the cave (during times of inundation) (Sections 3 and 4 of the report in Appendix 6)-***Complete***. Sample for American Burying Beetle (ABB) during the active season in locations that are determined in consultation with the USFWS during the first and final study season (Section 2 of the report in Appendix 6)-***Complete***. If ABB are found within the study area, compare distributions of beetles to inundation maps generated by the CHM for characterizing the effects of Project operations. If areas that support beetles will be inundated as the result of Project operations, coordinate with the USFWS to estimate the level of impact, if any (Section 5 of the report in Appendix 6)-***Complete***.
Wetlands and Riparian Habitat	Horizon Environmental Services	Develop base maps in geographic information systems (GIS), using source data from the National Wetland Inventory (NWI) and potentially other resources of wetland cover types in the Project study area. Cover type maps will be produced from existing resources that will include riparian and wetland vegetation throughout the study area (Attachment A of the report in Appendix 7)-***Complete***. Use the results of the H&H Study to produce maps that depict the change in inundation areas due to anticipated operations versus baseline operations overlayed on the wetland base maps showing the

Study	Study Consultant(s)	Study Requirements and Status
		current Project boundary (Attachment A of the report in Appendix 7)-***Complete***. Assess potential impacts to wetlands and riparian areas by identifying the extent, duration, and seasonality (timing) of inundation occurring in the Project area (Section 2 of the report in Appendix 7)-***Complete***. Verify the accuracy of the base maps through ground-truthing if it is determined anticipated operations are impacting wetlands. Ground-truthing is only required for any major deviations from the preliminary wetland cover-type maps (Section 2 of the report in Appendix 7)-***Complete.***
Recreation Facilities Inventory and Use	Mead & Hunt	Conduct recreation observation surveys at the required recreation facilities (Section 5 of the report in Appendix 8)-***Complete***. Conduct recreation visitor use interviews at the required recreation facilities (Section 5 of the report in Appendix 8)-***Complete***. Conduct facility condition assessments at the required recreation facilities (Section 5 of the report in Appendix 8)-***Complete***. Collect boat launch elevation data (Section 5 of the report in Appendix 8)-***Complete***. Characterize current recreation use and future demand for recreation use at the required recreation facilities (Section 5 of the report in Appendix 8)-***Complete***.
Cultural Resources[9]	Wood E&I Solutions Algonquin Consultants, Inc.	**Wood E&I Solutions** Complete background research and archival review-***Complete***. Complete cultural resource investigations (Section 4 of the report in Appendix 9)-***Complete***. Develop a Historic Properties Management Plan (HPMP)-***Ongoing; updated draft HPMP to be included in the Draft License Application (DLA); final HPMP to be included in the Final License Application***. **Algonquin Consultants, Inc.** Conduct Tribe-specific Traditional Cultural Properties Inventories (Appendix 9)-***Complete***.

[9] Due to the sensitive nature of the cultural resource information, these study reports will not be available to the public, rather, they will be filed with FERC as Privileged. The report will be reviewed by the Cultural Resources Working Group (CRWG).

Study	Study Consultant(s)	Study Requirements and Status
Socioeconomics	Enercon	Describe baseline socioeconomic information and gather/analyze additional economic information (Sections 1 and 2 of the report in Appendix 10)-***Complete***. Assess cumulative socioeconomic impacts (Section 3 of the report in Appendix 10)-***Complete***.
Infrastructure	Mead & Hunt	In consultation with stakeholders, determine a list of infrastructure types to be included in the recommended infrastructure study (Section 4 of the report in Appendix 11)-***Complete***. Analyze the impact of baseline and anticipated operation on the inundation of critical upstream infrastructure by providing maps and tables (Sections 5, 6, and 7 of the report in Appendix 11)-***Complete***.

Each study report is a comprehensive study report that includes information obtained during both the first study season and the final study season. Each study report provides all information specified under FERC's Integrated Licensing Process (ILP) requirements (18 CFR § 5.15) and is generally organized under the following headings:

- Introduction
- Study objectives
- Study area
- Methods
- Results
- Conclusions
- References
- Appendices

2.0 PROCESS AND SCHEDULE OVERVIEW

The current schedule in this ILP began with the Notice of Intent to Relicense (NOI) being filed on February 1, 2017 and is expected to be completed by the time the current license expires on May 31, 2025. The following activities listed in chronological order have dictated the schedule following the filing of the NOI.

2.1 Abeyance Period

On February 15, 2017, Commission staff issued a letter order[10] holding the relicensing process in abeyance until the Commission acted on GRDA's May 6, 2016, request to amend the project's license.[11] The Commission issued an order amending the project license[12] on August 15, 2017, and on August 24,

[10] Letter Order Holding the Pensacola Project's Pre-filing process in Abeyance (February 15, 2017).

[11] GRDA's Application for Non-Capacity Related Amendment of License (May 6, 2016).

[12] Grand River Dam Authority, 160 FERC ¶ 61,001 (2017).

2017, Commission staff issued a letter order[13] (Abeyance Order) that lifted the abeyance and provided an ILP process plan and schedule. As a result, the ILP process resumed on January 12, 2018, and the September 26, 2019, deadline for filing the ISR under 18 CFR § 5.15(c)(1) was established.

2.2 Study Plan Development

According to the Abeyance Order, the deadline for GRDA to file a Proposed Study Plan (PSP) under 18 CFR § 5.11(a) was established as April 27, 2018. On April 27, 2018, GRDA filed its PSP[14] with the Commission and hosted a meeting on the PSP according to 18 CFR § 5.8(b)(3)(viii) on May 30 and 31, 2018. Following the meeting, comments were received on the PSP under 18 CFR § 5.12. GRDA filed its Revised Study Plan (RSP) on September 24, 2018,[15] under 18 CFR § 5.13(a).

2.3 Study Plan Determination

As required under 18 CFR § 5.13(c), on November 8, 2018, within 30 days of the filing of the RSP, the Commission issued its SPD[16] approving the RSP with staff recommended modifications. The SPD made study recommendations outlined in **Table 2**.

Table 2. Summary of Commission Staff Recommendations

Study	Staff Recommendation(s)	Recommended Modification(s)
Hydrologic and Hydraulic Modeling	Approved with modifications	• Increase range of inflow events and starting elevations. • Lotic and lentic mapping for anticipated operations. • Update bathymetry. • Define material difference in Model Input Status Report. • Validate model with RWM. • Use Pensacola Datum. • Provide access to model.
Sedimentation	Approved with modifications	• Update bathymetry. • Create Sediment Transport Model. • Describe observed or predicted effects of sedimentation on the power pool. • Provide access to model.
Aquatic Species of Concern	Approved with modifications	• Estimate proportion of Neosho Smallmouth Bass spawning habitat affected by anticipated operations by literature review in Item 1 and, if necessary, survey under Item 2. • Add Neosho Smallmouth Bass lentic and lotic paddlefish evaluation in Item 3. • Review of existing population density estimates in the Project vicinity for Neosho Mucket, Rabbitsfoot Mussel, Winged Mapleleaf Mussel, and Neosho Madtom.

[13] Letter Order Lifting Abeyance and Providing a Revised ILP Process Plan and Schedule, P-1494-438 (August 24, 2017).
[14] GRDA's Proposed Study Plan, P-1494-438 (April 27, 2018).
[15] GRDA's Revised Study Plan, P-1494-438 (September 24, 2018).
[16] Study Plan Determination, P-1494-438, (November 8, 2018).

Study	Staff Recommendation(s)	Recommended Modification(s)
		• If necessary, survey existing population to estimate density in the Project vicinity for Neosho Mucket, Rabbitsfoot Mussel, Winged Mapleleaf Mussel, and Neosho Madtom.
Terrestrial Species of Concern	Approved	None
Wetlands and Riparian Habitat	Approved	None
Recreation Facilities Inventory and Use	Approved with modifications	• Add Spring River, Council Cove, and Willow Park Survey Sites. • Add Wildlife Viewing as an option in question 10. • Add new question about hunting and wildlife viewing recreation activities participated in near Grand Lake in the past year. • Add rating scale to question 13.
Cultural Resources	Approved with modifications to study plan	• Consult with and request concurrence from the Oklahoma State Historic Preservation Officer (SHPO) and THPOs for tribes with lands within the Project boundary on the final Area of Potential Effect (APE). • Final APE should clearly identify the Project boundary, lands outside the Project boundary that are included in the APE, and the specific locations of any tribal trust lands that GRDA and Bureau of Indian Affairs determine are within the Project boundary. • For the Traditional Cultural Properties (TCP) Inventory, GRDA, to the best of its ability, should prepare a summary of study results to date to be filed with the USR, file individual TCP reports for each tribe upon their completion, and file a final comprehensive TCP report that contains the TCP results for all tribes with the final license application. • Obtain concurrence on survey methods with the SHPO. • Evaluate sites in Section 6.9 of the Pre-Application Document in consultation with the Cultural Resources Working Group. • Include a discussion of any project-related effects to identify TCPs during the TCP Inventory including, but not limited to effects associated with recreation in the cultural resources study report. • File sensitive cultural resources information as “privileged” on the Commission’s website. • Documentation on known sites of cultural property should not be shared with all tribes if the cultural property is traceable to a particular tribe or tribes.
Socioeconomics	Approved with modifications	• Include an appendix in the study report containing electronic copies of documents submitted by

Study	Staff Recommendation(s)	Recommended Modification(s)
		stakeholders and links to publicly accessible web sites containing such documents. • Include within the study report, a summary of the socioeconomic conditions in the four-county study area, but also tabular data on these conditions reported at the county and census tract level, where such data exist. The study report should clearly state which data source was used for each level of aggregation.
Infrastructure	Complete new study requirements	• In consultation with stakeholders, determine a list of infrastructure to be included in the Infrastructure Study. • Using H&H output, determine the range of inflow conditions for which model results show Project operations and other purposes in combination with the USACE'S flood control operations are likely to have an effect on the frequency and depth of flooding. • Provide maps and table identifying the frequency and depth of flooding for each infrastructure item under existing operations and operations for other purposes. • Provide additional maps and tables based on any alternative operating scenarios proposed or developed through consultation.

2.4 Modification of Relicensing Plan and Schedule

On May 20, 2019, GRDA requested a modification of the relicensing plan and schedule. It amended its request on June 17, 2019. The modification was requested because of the unanticipated delays due to the abeyance process, the time required to update the bathymetric data, and the need for the updated bathymetric data before the Hydrologic and Hydraulic Model and the Sedimentation Model could be fully developed. On September 9, 2019, the Commission issued an order extending the license term and modifying the relicensing plan and schedule (Extension Order). The Extension Order waived the one-year requirement under 18 CFR § 5.14(c)(1) and established the deadline for submitting the ISR as September 30, 2021.

2.5 National Defense Authorization Act

On December 20, 2019, Congress enacted the National Defense Authorization Act for Fiscal Year 2020 (NDAA 2020).[17] Importantly, NDAA 2020 includes special legislation applicable only to the Pensacola Project, and it significantly changes the scope of the ongoing relicensing for this Project.

First, NDAA 2020 resolves a long-standing dispute between GRDA and the City of Miami regarding Project lands and lands over which GRDA has a responsibility to obtain title pursuant to Article 5 of its license.[18] In response to the City of Miami's assertion that GRDA has a license obligation to obtain title to

[17] Pub. L. No. 116-92 (2019).

[18] See, e.g., Formal Complaint of the City of Miami, Oklahoma, Project No. 1494-445 (filed Dec. 26, 2018).

"approximately 13,000 acres of land, including much of the City of Miami" due to periodic flooding,[19] Congress in NDAA 2020 forbids any such requirement in at least three ways:

- First, NDAA 2020 provides that "[t]he licensing jurisdiction of the Commission for the project shall not extend to any land or water outside the project boundary."[20] Thus, NDAA statutorily prohibits the Commission from imposing any license obligation outside of the Project boundary as it existed as of Congress' enactment of NDAA 2020—including any obligation to purchase lands outside the Project boundary.

- Second, NDAA 2020 provides that "[a]ny land, water, or physical infrastructure or other improvement outside the project boundary shall not be considered to be part of the project."[21] This language also confirms that GRDA cannot be required under its license to obtain title to the approximately 13,000 acres identified by the City of Miami.[22] This provision is consistent with the Act of Congress in 1946, which returned the Project to GRDA following World War II, and in doing so retained "all lands or interests therein of the United States above elevation seven hundred and fifty feet mean sea level necessary or desirable for operation of the Grand River Dam project at a pool election of seven hundred and fifty-five feet above mean sea level at the Grand River Dam"—i.e., lands that are needed to support USACE's flood control operations.[23] The savings clauses in NDAA 2020 expressly preserve this provision.[24]

- Third, NDAA 2020 allows FERC to amend the Project boundary "only with the expressed written agreement of" GRDA.[25] If GRDA does not consent to a Project boundary amendment, NDAA 2020 provides that the Commission's responsibilities under the Federal Power Act (FPA) are met without any change to the Project boundary.[26]

Additionally, NDAA 2020 confirms—consistent with the Corps' long-standing jurisdiction under section 7 of the Flood Control Act of 1944[27]—that the Corps has "exclusive jurisdiction and responsibility for management of the flood pool for flood control operations at Grand Lake O' the Cherokees."[28] In addition to confirming the Corps' exclusive jurisdiction for flood control, Congress in NDAA 2020 prohibits the Commission or any other federal or state agency from imposing any license condition related to surface water elevations. NDAA 2020 provides:

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[19] Id. at 2, 37; see also id. at 24–30.
[20] Pub. L. No. 116-92, § 7612(b)(3)(A).
[21] Id. § 7612(b)(3)(B).
[22] See 16 U.S.C. § 796(11) (defining the "project" to include "lands, or interest in lands the use and occupancy of which are necessary or appropriate in the maintenance and operation of" the unit of development); compare Standard Article 5, Form L-3, 54 F.P.C. 1817, 1818–19 (requiring GRDA to acquire lands "necessary or appropriate for the construction, maintenance, and operation of the project").
[23] Pub. L. No. 79-573, § 3, 60 Stat. 743, 744 (1946).
[24] Pub. L. No. 116-92, § 7612(e)(3).
[25] Id. § 7612(b)(3)(C).
[26] Id.
[27] 33 U.S.C. § 709.
[28] Pub. L. No. 116-92, § 7612(c).

> Except as may be required by the Secretary [of the Army] to carry out responsibilities under section 7 of the Flood Control Act of 1944 (33 U.S.C. 709), the Commission or any other Federal or State agency shall not include in any license for the project any condition or other requirement relating to—
>
> (i) surface elevations of the conservation pool; or
>
> (ii) the flood pool (except to the extent it references flood control requirements prescribed by the Secretary).[29]

The only exception to this broad prohibition is a requirement for the Project to "remain subject to the Commission's rules and regulations for project safety and protection of human health."[30]

2.6 Model Input Status Report

As outlined in the RSP, confirmed in the SPD, and clarified in the Commission's Order on Request for Clarification and Rehearing dated January 23, 2020[31], a Model Input Status Report (MISR) was developed and provided to the relicensing participants on March 30, 2021. GRDA held a Technical Conference on April 21, 2021, to summarize the MISR and answer questions.

On June 23, 2021, the City of Miami, OK filed comments on the MISR with the Commission.[32] The City of Miami's comments were addressed in the UHM report contained in **Appendix 2**.

2.7 Initial Study Report

On September 30, 2021, GRDA electronically filed its ISR pursuant to 18 C.F.R. § 5.15(c)(1). In addition to providing a progress report on the completion of the studies, GRDA recommended modifications to the Sedimentation Study and Terrestrial Species of Concern Study.

GRDA also listed variances for the H&H Study, Sedimentation Study, Cultural Resources Study, and Infrastructure Study. For the Sedimentation Study, GRDA requested a schedule variance to provide the calibrated STM by December 31, 2021.

Lastly, the ISR included an agenda for the ISR meeting required to be held within 15 days of the filing of the ISR.

2.8 Initial Study Report Meeting

Consistent with requirements under 18 CFR § 5.15(c)(2), GRDA held a virtual meeting with agencies and other interested parties and Commission staff to discuss the 2021 study results reported in the ISR and plans for completing the study program. The meeting took place on October 12 and 13, 2021.

[29] Id. § 7612(b)(2)(A).

[30] Id. § 7612(b)(2)(B).

[31] Grand River Dam Authority, 170 FERC ¶ 61,027 (2020).

[32] Comments of Tetra Tech on Behalf of the City of Miami, Oklahoma (Corrected) on Mead & Hunt's H&H Modeling Upstream Hydraulic Model Input Status Report on behalf of GRDA, June 23, 2021.

2.9 Initial Study Report Meeting Summary

As required under 18 CFR § 5.15(c)(3), GRDA filed a meeting summary on October 29, 2021, including any proposed modifications to ongoing studies and no new studies were proposed.

2.10 Initial Study Report Comments

Pursuant to 18 CFR § 5.15(c)(4) and in response to the ISR, within 30 days of the filing of the meeting summary, requests for modifications to the H&H Study, Sedimentation Study, Aquatic Species of Concern Study, Cultural Resources Study, Socioeconomic Study, and Infrastructure Study were made by relicensing participants. In addition, a Contaminated Sediment Transport Study was requested as a new study.

2.11 GRDA Response to Comments and Updated Sedimentation Study Report

In accordance with 18 CFR § 5.15(c)(5), and within 30 days of receipt of the request for modifications and new studies, GRDA, on December 29, 2021, filed its responses to comments on the ISR. In addition to the responses to comments, GRDA included an updated Grand Lake Sedimentation Report[33] (Appendix D of the filing), proposed several enhancements and other modifications to the study plans for the final study season including a detailed proposed modified study plan for the Sedimentation Study (Appendix E of the filing) and an invitation for relicensing participants to attend a technical meeting about the proposed modified study plan on January 14, 2022.

Based on comments received from agencies and other relicensing participants, GRDA modified its second season study plans as provided in the subsections that follow.

2.11.1 H&H Study

As stated in the ISR, GRDA proposed the following activities during the final study season for the H&H Study:

- Update OM as described in OM ISR and based upon comments.
- Update Upstream Model based upon comments.
- Update Downstream Model based upon comments.
- Run anticipated operations for upstream and downstream model.
- Provide Lentic and Lotic Maps for current and anticipated operations, as needed, in the Aquatic Species of Concern, the Terrestrial Species of Concern, and the Wetland and Riparian Study.

Based on comments received from resource agencies and other relicensing participants, GRDA proposed the following additional activities for the H&H Study during the final study season:

- In response to comments from Commission staff, the title of Table 1 of the Upstream Hydraulic Modeling Report has been updated to: “Summary of historical event boundary conditions used in Upstream Hydrologic Model (UHM) calibration.” The revised table title more accurately describes the information included in the table. In addition, GRDA has included the following tables in the appendices of the USR:

[33] In the September 30, 2021, ISR, GRDA proposed a schedule variance to provide an updated report including a calibrated STM by December 31, 2021.

- Tables of maximum water surface elevation (feet, PD) for each simulation.
- Tables of maximum extent of inundation (feet) for each simulation.[34]
- Tables of duration of inundation (hours) for each simulation.

- In response to comments from the City of Miami, now that the OM has been validated against RWM output, the Operations Model has been updated to include the 2019 elevation-storage data. Because the OM simulations were updated as part of the USR development, the updated simulation results were used to review the CHM results and the CHM simulations were re-run. The conclusions of the CHM simulations did not change. Therefore, the studies that depended upon the conclusions of the CHM did not change.

- In response to comments from the City of Miami, GRDA simulated the inflow hydrographs from the Federal Emergency Management Agency's (FEMA) 2019 study (including the Neosho River hydrograph with a peak flow of 165,000 cfs at the Commerce gage) despite the methodological flaws in the 2019 FEMA study hydrology. GRDA simulated starting reservoir elevations as low as 734 feet PD and as high as 757 feet PD. Water surface elevation profiles for this set of simulations were included as Appendix B to GRDA's December 29, 2021 response to comments. Despite the methodological flaws in the 2019 FEMA study, the results are very similar to the 100-year event simulation results in the ISR. A starting reservoir elevation difference of 23 feet resulted in no appreciable difference in maximum water surface elevation at the City of Miami. Inflow hydrographs from the 2019 FEMA study and the hydraulic results displayed in Appendix B of the December 29, 2021 filing should not be misconstrued as a replacement of the 100-year event results included in GRDA's UHM Report. GRDA completed this exercise as a courtesy to the City of Miami, following the ISR. The purpose of the work was to show relicensing participants how the modification to the 100-year inflow hydrographs would not change the conclusions of the H&H Study. GRDA did not propose to conduct further analysis of the 2019 FEMA hydrographs in the second study season.

- In response to comments from the City of Miami on the ISR, GRDA performed a sensitivity analysis to determine the impact of the abandoned railway bridge high chord on upstream water surface elevations. Of all the historical inflow events used in the simulation scenarios (see Section 7 of the UHM ISR), only the July 2007 event exceeded the high chord of the bridge in the Neosho River channel. Two geometries were tested in the sensitivity analysis: (1) the original geometry used in the ISR, and (2) a flat deck with the bridge trusses completely removed from the high chord. Water surface elevation profiles from the sensitivity analysis were included as Appendix C of the December 29, 2021 response. The results showed that removing the trusses from the high chord of the bridge resulted in no appreciable difference in maximum water surface elevation upstream of the bridge. The results of the sensitivity analysis displayed in Appendix C of the December 29, 2021 response should not be misconstrued as a replacement of the results included in GRDA's UHM ISR. GRDA completed this exercise as a courtesy to the City of Miami, after receiving the City of Miami's comments on the ISR. The purpose of the work was to show

[34] As discussed in Section 2.13, the Commission staff clarified in its February 24, 2022 determination letter that GRDA should report maximum extent of inundation in acres.

relicensing participants how the simulation results were insensitive to the bridge high chord. GRDA did not propose to change the bridge high cord as set forth in the UHM during the second study season.

2.11.2 Sedimentation Study

As stated in the ISR, GRDA proposed to complete the following activities during the final study season for the Sedimentation Study:

- Update Sediment Transport Model based upon comments;
- Run Sediment Transport Model for current operation;
- Run Sediment Transport Model for anticipated operations; and
- Describe observed or predicted effects of sedimentation on the power pool.

In addition, the ISR included an interim study report for the sedimentation modeling work conducted at the time of the ISR, noting GRDA's expectation that a full report would be completed by December 31, 2021, once calibration of the model was complete. GRDA completed the work and a full Grand Lake Sedimentation Study report was included in Appendix D of GRDA's December 29, 2021 response. Based on GRDA's completed calibration effort, GRDA proposed significant changes to the Commission-approved Sedimentation Study. Because GRDA's calibration efforts were ongoing at the time GRDA completed the ISR, as well as during the ensuing meetings and comment period and only completed the work in late December 2021, GRDA proposed a final-season modification to the Sedimentation Study, which appeared in Appendix E of the December 29, 2021 response.

The revision to the FERC-approved study plan for the Sedimentation Study was warranted for several reasons:

- The information provided by the City of Miami during the PSP and RSP stages of study plan development, alleging that the bed of the river/reservoir system consisted primarily of sand and that cohesive sediment need not be considered, proved to be incorrect. Field data proved that the sediment being transported down the rivers and into the reservoir consists primarily and predominantly of silt and clay which are cohesive in nature. This required collection of core samples and laboratory testing of cohesive sediment using SEDflume.

- SEDflume analysis demonstrated that the cohesive sediment characteristics, including density, critical shear stress and erosion rate, vary widely with depth below the sediment surface (485%, 3000%, and 10,000%, respectively). These characteristics also tend to vary over time as cohesive sediment tends to consolidate and gain strength as time goes on.

- While HEC-RAS in the sediment transport mode allows sediment density to change over time, it only allows one set of parameters for cohesive erosion characteristics which does not vary with depth below the sediment surface and does not change over time. As a result, any selected set of parameters can significantly misrepresent the complexity of cohesive sediment modeling.

- Testing of the STM demonstrated significant inconsistencies with reality which indicate it cannot reasonably be expected to simulate the complexities of cohesive and non-cohesive sediment found in this river and reservoir system with any acceptable degree of confidence.

- Sediment transport (whether cohesive or non-cohesive) is driven by the hydraulic shear stresses exerted by flowing water over the bed of a river or reservoir. Analysis of the distribution of hydraulic shear stresses as they vary over the longitudinal extent of the river/reservoir system can be related to the pattern of sedimentation that occurred over the time period from 2009 to 2019 when cross-section and bathymetry data are available.

Further, the City of Miami cited the “widely-accepted ASCE Manual” in their comments on GRDA’s RSP, stating “where full calibration is not possible, ‘model tests are devised so that engineering judgment can be used to assess the credibility of the calculated results.’” As detailed in the Sedimentation Study Report, tests were performed, and the results were incorrect, leading to the conclusion that the STM was unreliable as a predictive tool for sedimentation.

As a result of the conclusion regarding the unreliable predictive nature of the STM, GRDA planned to convene a technical meeting to present the results of the STM calibration. Since GRDA concluded that the STM recommended by Commission staff in its SPD would not simulate the complexities of cohesive and non-cohesive sediment found in this river and reservoir system with any acceptable degree of confidence, the technical meeting presented an opportunity for relicensing participants to discuss GRDA’s proposed modification to the Sediment Study plan.

The technical meeting was held on January 14, 2022.

Finally, based on comments received from resource agencies and other relicensing participants, in Section 5.1.2.1 of the ISR for the Sedimentation Study appearing in Appendix D to the December 29, 2021 response, GRDA clarified in detail how flow roughness factors were changed to calibrate the model. The section also included explanations for those changes.

2.11.3 Aquatic Species of Concern Study

2.11.3.1 Neosho Mucket

As stated in the ISR, GRDA proposed the following activities during the final study season for the Neosho mucket:

- The study area would consist of the Elk River from the Oklahoma/Missouri State line to the confluence of Buffalo Creek.
- A phased sampling design incorporating both Qualitative and Quantitative methods would be used.
- Qualitative surveys would characterize the substrate, identify potential mussel beds, and potential presence of live mussels within the study area.
- A minimum search time of five person-hours (divided into five one person-hour searches) would be conducted within the delineated search area.
- If no live mussels are encountered after the first three one-person hour searches, surveys within this location would cease and it would be assumed no live mussels are present.

- At the end of each search period, collected mussels would be identified and enumerated.
- If no new species of mussels were collected during the fifth search period, the survey was complete.
- If at least one new mussel species was collected in the fifth search period, additional one person-hour search periods were required until no new species were collected.
- Visual, combined with tactile searching (hand-grubbing into the top 1-4 inches of substrate to increase detection of more-deeply buried mussels) would be used.
- Searchers would select a shoreline and begin searching from downstream to upstream moving back and forth across the stream, ensuring that all the delineated search area was sufficiently covered.
- If listed mussels were detected, initial surveys would immediately cease, and quantitative methods would commence.
- Quantitative surveys would involve sampling on mussel beds identified during qualitative surveys to quantify the mussel populations.
- Quantitative point sampling would be conducted on mussel beds by randomly selecting 0.25 m^2 quadrats plots within each bed.
- Systematic sampling would incorporate three random starts with 2 additional quadrats selected at 1-m intervals (9 quadrats per sample/site).
- Additional, randomly selected quadrat points would be available to replace locations that do not provide mussel habitat (e.g., too close to shore, water depth, poor substrate).
- Quantitative surveys would be performed by visual and tactile searches of randomly placed 0.25 m^2 quadrats placed at random locations as outlined above.
- Substrate within the quadrats would be excavated to a depth of 20 cm and sieved, as this increases the likelihood of detecting juvenile mussels.
- All live individuals would be identified, enumerated, and returned to the approximate location of collection.
- Shell material would also be collected and quantified during sampling from the stream and classified as fresh dead (FD; intact periostracum and lustrous nacre), weathered dead (WD; intact periostracum, weathered and chalky nacre), or subfossil (SF; shell chalky, no periostracum).

2.11.3.2 Rabbitsfoot

As explained in the ISR, GRDA completed all requirements of the FERC-approved study plan relative to the rabbitsfoot mussel in the first study season. Because records received by GRDA indicated that neither the rabbitsfoot nor its host species have been present at sampling events in the Neosho, Spring, and Elk Rivers over the past 18 years, any additional study on this species was unwarranted.

In their comments on the ISR, no relicensing participant recommended any proposal to modify this study during the second study season, nor did any relicensing participant disagree with GRDA's conclusion that no further study on the rabbitsfoot was needed. Accordingly, GRDA maintained its view that any additional study of the rabbitsfoot was unwarranted. However, GRDA agreed to report any occurrences of rabbitsfoot in the survey for the Neosho mucket.

2.11.3.3 Winged Mapleleaf

As explained in the ISR, GRDA completed all requirements of the FERC-approved study plan relative to the winged mapleleaf mussel in the first study season. A 5-year review of the species completed in 2015 indicated the species is considered extirpated from the Neosho River and Spring River in Kansas and no known populations occur within the larger Grand Lake watershed or the Neosho River Basin. For that reason, GRDA concluded that any additional study on this species was unwarranted.

In their comments on the ISR, no relicensing participant recommended any proposal to modify the study during the second study season, nor did any relicensing participant disagree with GRDA's conclusion that no further study on the winged mapleleaf was needed. Accordingly, GRDA maintained its view that any additional study of the winged mapleleaf was unwarranted. However, GRDA would report any occurrences of winged mapleleaf in the survey for the Neosho mucket.

2.11.3.4 Neosho Madtom

As stated in the ISR, GRDA proposed the following activities during the final study season for the Neosho madtom:

- A 20-mile stretch of the river from HWY60 to the county border would be assessed in locations that contain riffles and moderate to low-velocity gravel bar habitats. Fish sampling would be conducted between late summer and early fall at selected sites where riffles and gravel bars are identified via review of aerial imagery that are readily accessible via public roads, bridges, or access points.

- Fish sampling would be conducted by kick-seining (4.6 m x 1.8 m seine with 3.2 mm mesh) by one or two individuals thoroughly disturbing the substrate beginning four meters upstream from a stationary seine and then kicking in a downstream direction to the seine's lead line.

- Kick-seining would start at the downstream end of a habitat and proceeded laterally and then upstream with multiple kick-seine efforts until all habitat less than one meter deep at a site had been sampled.

- All fishes captured would be identified to species, measured for total length to the nearest millimeter, counted, and then returned to the stream.

Both Commission staff and USFWS submitted clarifying comments and questions related to GRDA's proposed study of the Neosho madtom during the final study season. Based on comments received, GRDA proposed the following changes for the Neosho madtom component of the Aquatic Species of Concern study:

- On the Neosho River, instead of surveying downstream to the HWY60 bridge, GRDA agreed to limit the study area to the Interstate 44 bridge. This decision was based on further consideration of the habitat requirements of the Neosho madtom, current information, and knowledge of existent habitat conditions downstream of this point as indicated by other studies in the ISR. The upstream range of the studies would extend to the "Neosho 2" site. Neosho 2 is located near the originally proposed Craig and Ottawa county border.
- Based on comments received on the ISR, GRDA agreed to expand surveys to include the Spring River. On the Spring River, GRDA planned to survey between the Interstate 44 bridge to the HWY 10 Bridge. Methods used for assessment on the Spring River would be identical to the Neosho River.

2.11.3.5 Neosho Smallmouth Bass

As stated in the ISR, GRDA proposed a modification to FERC's SPD to eliminate any future work on the Neosho smallmouth bass. GRDA explained that records show that a smallmouth bass population is present within the drainages surrounding the Project, but that there was no determination that the Neosho subspecies was identified. Because the Neosho smallmouth bass has no state or federal listing, and the cost of the additional work was expected to be approximately $100,000, GRDA did not believe that the results of any study would justify the cost.

Based on comments received from Commission staff and the Oklahoma Department of Wildlife Conservation (ODWC) and based on further consultation with ODWC following the ISR meetings, GRDA maintained its view that any additional study of the Neosho smallmouth bass was unwarranted.

2.11.3.6 Paddlefish

As stated in the ISR, GRDA proposed a modification to FERC's SPD to eliminate any surveys or additional work on paddlefish spawning habitat during the final study season. GRDA explained that the background research completed in the first study season showed the availability of continuous high flows during spawning has a significant effect upon paddlefish spawning success. The H&H Modeling Study demonstrated Project operation has an immaterial impact on upstream water surface elevations and consequently the hydraulic conditions which paddlefish seek at upstream spawning sites during high inflow conditions. Because inflow events—regardless of any future operations of the Project—will continue to dominate hydraulic conditions at upstream spawning sites, and because there is an abundance of paddlefish spawning habitat, additional studies were unwarranted.

In comments filed on the ISR, no relicensing participant recommended any proposal to modify this study during the final study season, nor did any relicensing participant disagree with GRDA's conclusion that no further study on the paddlefish was needed. Accordingly, GRDA maintained its view that any additional study of the paddlefish was unwarranted.

2.11.4 Terrestrial Species of Concern Study

2.11.4.1 American Burying Beetle

As stated in the ISR, GRDA proposed to discontinue the survey for ABB for the final study season. GRDA explained that the results of the H&H Modeling Study demonstrate that future operational changes that may be implemented by GRDA within the conservation pool of Grand Lake will not appreciably influence water levels beyond the current Project boundary. Moreover, GRDA explained that because ABB only uses areas with a soil and/or leaf litter substrate and vegetated cover (as opposed to bare rocky or sandy shorelines), suitable habitat within the Project boundary is limited.

In comments filed on the ISR, no relicensing participant recommended any proposal to modify this study during the second study season, nor did any relicensing participant disagree with GRDA's conclusion that no further study on the ABB was needed. Accordingly, GRDA maintained its view that any additional study of the ABB was unwarranted.

2.11.4.2 Gray Bat

As stated in the ISR, GRDA proposed to continue gray bat surveys during the final study season, as provided in the FERC-approved study plan, with no modifications.

In their comments on the ISR, no relicensing participant recommended any proposal to modify this study during the final study season. Accordingly, GRDA maintained its view that the gray bat surveys should continue during the second study season in accordance with the FERC-approved study plan, with no modifications.

2.11.5 Wetland and Riparian Habitat Study

As stated in the ISR, GRDA proposed the following activities during the final study season for the Neosho mucket:

- Once the lentic and lotic maps were produced by the H&H Study, changes in wetland inundation and riparian habitat due to anticipated operations would be analyzed.

- If it was determined that anticipated operations would be impacting wetlands, the accuracy of the base maps would be verified, as necessary, through ground-truthing.

Based on comments received from resource agencies and other relicensing participants, GRDA proposed the following additional activities for the Wetland and Riparian Habitat Study during the final study season:

- In response to a comment from Commission staff, GRDA would file the GIS data layers for the survey as part of the USR.

2.11.6 Recreation Facilities Inventory and Use Study

As explained in the ISR, GRDA completed all requirements of the FERC-approved study plan relative to the Recreation Facilities Inventory and Use Study. Therefore, GRDA proposed no further activities for this study during the final study season.

In their comments on the ISR, no relicensing participant recommended any proposal to modify this study during the final study season, nor did any relicensing participant disagree with GRDA's conclusion that the Recreation Facilities Inventory and Use Study was complete. Accordingly, GRDA maintained its view that any additional study of recreation resources was unwarranted.

2.11.7 Cultural Resources Study

As explained in the ISR, GRDA made substantial progress in meeting the requirements of the Commission-approved studies for cultural resources in the first study season. Working closely with the CRWG, GRDA completed a cultural historic investigation, archaeological investigations in 2019, 2020, and 2021, and initiated efforts to complete a TCP inventory within the Project's APE.

As noted in the ISR, the following additional work was planned to occur during the final study season:

- Report results of the archaeological reconnaissance on five sites not included in the ISR.
- Determine National Register of Historic Places (NRHP) eligibility on recommended sites in consultation with CRWG.
- Report the results of the surveys on the remaining bluff areas not included in the ISR.
- Complete surveys and report the results of the remaining three (3) areas in the USR.
- Continue with TCP inventory.
- Continue to adjust the testing interval density for quaternary landforms (Qals) based upon in-field conditions as necessary during remaining surveys using the adjusted survey methods for buried archaeological deposits.

In addition, on December 13, 2021, GRDA held its quarterly meeting with the CRWG, in which it presented its proposed fieldwork plan for the final study season. CRWG participants reviewed the plans and GRDA implemented the 2022 fieldwork based on feedback from the CRWG.

Also, based on written comments received from CRWG in response to the ISR, GRDA proposed several activities for the Cultural Resources Study during the final field season.

Most comments on GRDA's Cultural Resources Study from CRWG members highlighted the desire for ongoing fieldwork. GRDA appreciates these comments and committed to completing the work outlined above. GRDA noted that while CRWG members' requests were consistent with GRDA's overall Cultural Resources Study Plan, some of the fieldwork would not be possible in 2022, as GRDA would need to shift its efforts to preparing the HPMP. The work that could not be completed in 2022 would be completed pursuant to the requirements of the HPMP.

2.11.8 Socioeconomic Study

As explained in the ISR, GRDA completed all requirements of the FERC-approved study plan relative to the Socioeconomics Study. Therefore, GRDA proposed no further activities for this study during the final study season.

GRDA received a number of proposed modifications to the Socioeconomics Study—all from the City of Miami. GRDA did not propose to adopt any of the proposed modifications. Rather, GRDA maintained its view that the Socioeconomics Study was complete and that any additional study of socioeconomic resources was unwarranted.

GRDA recognized that, should conclusions of the H&H Modeling Study change during the final study season, GRDA would update the other studies, including the Socioeconomic Study, as needed. Any such changes would appear in the USR.

2.11.9 Infrastructure Study

As explained in the ISR, GRDA completed all requirements of the FERC-approved study plan relative to the Infrastructure Study. Therefore, GRDA proposed no further activities for this study during the final study season.

GRDA received two proposed modifications to the Infrastructure Study—both from the City of Miami. GRDA did not propose to adopt either of the proposed modifications. Rather, GRDA maintained its view that the Infrastructure Study was complete and that any additional study of infrastructure was unwarranted.

GRDA recognized that should conclusions of the H&H Modeling Study change during the final study season, GRDA would update the other studies, including the Infrastructure Study, as needed. Any such changes would appear in the USR.

2.12 Sedimentation Study Technical Meeting

On January 14, 2022, GRDA held a virtual technical meeting for the Sedimentation Study. The purpose of the technical meeting was to review the results of the Sedimentation Study since the ISR and discuss GRDA's proposed modified study plan for the study as described in its December 29, 2021 response.

The list of attendees for the meeting was attached along with the presentation.

2.13 Determination on Requests for Study Modifications and New Studies

On February 24, 2022, pursuant to 18 CFR § 5.15(c)(5), the Commission issued its SMD containing determinations on requests for modifications to the approved study plans. Comments on the ISR had been submitted by the Bureau of Indian Affairs, the ODWC, the City of Miami, USFWS, Oklahoma Archaeological Survey, and the Cherokee Nation. GRDA responded to comments received on the ISR on December 7, 2021 in addition to its December 29, 2021 response outlined in Section 2.11.

Several of the comments on the ISR did not request study modifications, but provided additional information, recommended protection, mitigation, and enhancement measures, discussed ongoing and future consultation, or requested additional information that depends upon future study results. Therefore, those comments were not addressed in the Commission's February 2022 SMD.

According to section 18 CFR § 15(d), requested study modifications must include a showing of good cause and must include demonstration that the approved study was not conducted as provided for in the approved study plan or the study was conducted under anomalous environmental conditions or environmental conditions have changed in a material way. Based on this standard, Commission staff in its SMD recommended modifications for the H&H Study, Aquatic Species of Concern Study, and the Infrastructure Study.

Staff approved the following modifications to the H&H Study:

- Make the OM, model inputs, and model outputs, without commercially-sensitive financial information, available to Commission staff and relicensing participants within 60 days of February 24, 2022.
- Run operating scenarios starting at elevation 734 feet PD and extending up to and including elevation 757 feet PD.
- Provide the following information in the USR in tabular form: (1) maximum water surface elevation (feet); (2) maximum extent of inundation (acres); and (3) duration of inundation (hours).
- Report the frequency, timing (i.e., seasonality)[35], amplitude (i.e., elevation), and duration for each of the simulated inflow events with starting elevations between 734 feet and 757 feet PD.
- Compare water surface elevations observed at USGS gage no. 0719500 (Neosho River near Langley, OK) to the simulated HEC-RAS state hydrographs for the December 2015 and October 2009 inflow events on the upstream side of the dam.
- Provide a graphical comparison of the simulated and observed water surface elevations over a daily time step for the duration of the flood event.

Staff approved the following modifications to the Aquatic Species of Concern Study:

- Conduct a targeted freshwater mussel survey in the Spring River between Warren Branch and the confluence with the Neosho River and in the Neosho River between the City of Miami and the confluence with the Spring River as recommended by the USFWS, after consultation with FWS, EcoAnalysts, and TCTC on the survey design.

[35] The terms "timing" and "seasonality" are interchangeable as stated in Section 2.6.2 of the Wetlands and Riparian Habitat Study RSP submitted to the Commission on September 24, 2018.

Staff approved the following modifications to the Infrastructure Study:

- Depict, on maps, and in tabular format, the change in flood depth and frequency for each affected infrastructure location with the same starting elevations required in the H&H Study.

- Include inundation maps and tabular data for the June 2004 (1-year flood), and October 2009 (3-year flood) in addition to the September 1993, July 2007, and December 2015 events.

- Revise the Infrastructure Study report to present tables and maps that clearly show both the depth and frequency of flooding (i.e., return period) for each modeled event.

All other requested modifications were not approved by Commission staff.

According to Section 18 CFR § 15(e), requests for new studies must include an explanation of any material change in any applicable law or regulation, why the goals and objectives of the approved study could not be met with the approved methodology, why the request was not made earlier, significant new information has become available, and why the new study satisfies the criteria of 18 CFR § 5.9 (b). Based on this standard, Commission staff did not approve the City of Miami's request for a Contaminated Transport Study.

Finally, Commission staff's February 2022 SMD deferred its decision regarding the Sedimentation Study. Instead, staff allowed relicensing participants 30 days to file comments on the first study season report on the Sedimentation Study, followed by a 30-day period for GRDA to respond to comments. Staff's February 2022 SMD indicated that they would issue its decision on the Sedimentation Study following their review of these comments.

2.14 Second Proposed Study Modification for the Sedimentation Study

In response to the Commission's creation of additional opportunities to provide comments on the Sedimentation Study, the City of Miami filed comments on March 28, 2022. GRDA responded to the City of Miami's comments in its April 27, 2022 filing.

In addition to responding to the City of Miami's comments, GRDA proposed a compromise solution, in an effort to resolve the difference of opinion between GRDA and the City of Miami on how best to investigate sedimentation in Grand Lake.[36] The updated study plan proposed by GRDA in its April 27 filing satisfied the goals and objectives established by Commission staff for the Sedimentation Study and proposed a new approach that used the STM using HEC-RAS, but truncated to the upper reach of Grand Lake and the Neosho and Spring Rivers in which the City has expressed its greatest interest. The new approach also considered other methodologies to address the complexities of the silts and clays dominating the system.

[36] The Commission later refers to the Updated Study Plan in its May 27, 2022 determination letter as the second proposed plan modification.

2.15 Operations Model Technical Conference

On April 20, 2022, GRDA held a technical conference to allow relicensing participants to ask questions regarding the Operations Model, discuss planned improvements to the model, and present the results of two historical validation cases recommended by the Commission.

2.16 Determination on Requests for Study Modifications to Sedimentation Study Plan

On May 27, 2022, pursuant to 18 CFR § 5.15 (c)(5) the Commission provided a letter containing determinations on requests for modifications to the approved Sedimentation Study plan.

Commission staff approved the following modifications to the Sedimentation Study:

- Extend the downstream modeling limit for HEC-RAS to the U.S. Route 59 crossing at RM 100.
- Analyze the effects of sediment on storage capacity in Grand Lake using hydraulic outputs and the USACE sediment trapping efficiency calculations downstream of RM 100.
- Run the UHM model with the 2019 geometry to provide a baseline for comparison against predicted geometry results.
- Run the UHM using, at a minimum, starting reservoir elevations of 740, 745, and 750 feet PD to understand the effects of project operation and predicted channel geometry on upstream water levels.
- Run the UHM with the predicted channel geometries and starting reservoir elevations of 740, 745, and 750 feet PD and using, at a minimum, the simulated 100-year inflow event and the historic July 2007 inflow event to determine operational scenarios most-likely to result in significant effects on the upstream water surface elevations.

All other requested modifications were not approved.

2.17 Reporting Timeline through the USR Process

Following submittal of this USR and consistent with requirements under 18 CFR § 5.15(c)(2), GRDA will, (within 15 days following the filing of the USR), hold a meeting with agencies and other interested parties and Commission staff to discuss the 2022 study results reported in the USR. The meeting will take place on October 12 and 13, 2022 beginning at 9:00 a.m. The meeting will be held virtually.

Under 18 CFR § 5.15(c)(3), within 15 days following the USR meeting or by October 30, 2022, GRDA will file a meeting summary. Under 18 CFR § 5.15(c)(4), FERC staff or any agency and other interested party may file a disagreement concerning GRDA's meeting summary within 30 days of its issuance or by November 29, 2022. This filing must set forth the basis of any disagreement with the material content of GRDA's meeting summary and propose any desired alternative modifications to ongoing studies or new studies. Under 18 CFR § 5.15(c)(5), GRDA will then have 30 days to respond to any disagreements by

December 29, 2022. Within 30 days of GRDA's response or by January 28, 2023, under 18 CFR § 5.15(c)(6), any remaining disagreements will be resolved by the Commission, and the study plan will be amended as appropriate.

The proposed timeline for these actions, as modified by the Commission's 2019 license Extension Order, is presented in **Table 3**.

Table 3. Reporting and review opportunities associated with the ISR and USR

Activity or Information Sharing	Commission Deadline
File USR	September 30, 2022
Hold USR meeting (meeting on study results and any proposals to modify study plan)	October 12 and 13, 2022
File USR Meeting Summary	October 30, 2022
File Meeting Summary Disagreements	November 29, 2022
File Responses to Disagreements	December 29, 2022
Commission Resolution of Disagreements	January 28, 2022

3.0 STUDY VARIANCES

Under 18 CFR § 5.15(f), the USR must include "an explanation of any variance from the study plan and schedule." As discussed below, this USR includes only one variance from the FERC-approved study plan.

As noted in **Table 1**, GRDA encountered only one variance from the Commission-approved study plan during the final study year. As described in Section 3.1, this variance occurred in the Sedimentation Study.

3.1 Study Variances

Sedimentation

The Sedimentation Study was completed in accordance with the RSP, as modified by the Commission staff in both the November 8, 2018 SPD, and May 27, 2022 Determination letter except for one variance in the usable dataset.

As outlined in the April 27, 2022 Updated Study Plan (second proposed plan modification), GRDA planned to include the entire 2009 OWRB survey dataset of Grand Lake to calibrate the STM.

However, as stated in Section 2.1.1.5.1 of the updated Sedimentation Study report included as **Appendix 4** of this USR regarding the 2009 OWRB dataset, GRDA explained:

> *"Although it is the best available dataset from this timeframe, it shows significantly more sedimentation than is realistic given incoming sediment loads. The total incoming sediment volume from 1940 to 2019 is approximately 234,974 acre-feet with an incoming sediment load of approximately 327,044,375 tons,*

which converts to a sediment density of 63.9 pounds per cubic foot (pcf). The same calculation based on volume change and sediment load from 1940 to 2009 results in a computed sediment density of approximately 115.5 pcf, whereas the 2009 to 2019 calculation results in a sediment density of 10.6 pcf. This disparity of calculated sediment densities between the 1940 to 2009 and 2009 to 2019 data demonstrates the issue with the bathymetric surveys compared to sediment load. The issue with this dataset is not simply that deposition was near the dam because hyperpycnal flows are capable of bringing sediment to the lower reservoir. The issue is the total volume of deposition given the incoming sediment load."

To explain the total volume disparity, an April 20, 2022 e-mail exchange between GRDA's representative and USGS indicated the USGS had not found any major issues with the 2009 bathymetric dataset. However, the USGS also believed the 2009 dataset tends to show much greater variability in flat areas compared with 2019 data. GRDA suspects that the disparity had to do with correction processes such as GPS and temperature correction issues and boat movements.

The impossibly high deposition in the lower reservoir led GRDA to use only the portion of the 2009 OWRB dataset above RM 100 for calibration purposes. In GRDA's analysis, the reservoir downstream of RM 100 was evaluated using the total change from 1940 to 2019. This preserved a reasonable long-term estimate of total deposition in the conservation pool while not utilizing portions of the 2009 OWRB dataset where USGS noted greater variability in the data and where GRDA's analysis showed more-than-realistic sedimentation, given incoming sedimentation loads.

Because the dataset has documented quality control and there is a known date of data collection, GRDA used the 2009 data for calibration and validation upstream of RM 100. However, as explained above, deposition in the lower reservoir is not realistic given the sediment loading between 1940 and 2009, so the 2019 USGS survey was used for long-term evaluation data below RM 100.

The use of the 2009 OWRB dataset upstream of RM 100 and not downstream of RM 100 is a variance from the approved Sedimentation Study Plan.

As outlined in **Table 4** below, the partial use of the 2009 OWRB dataset is the only variance to any of GRDA's approved Study Plans in development of this USR.

Table 4. Study Variances During Final Study Year

Study	Variance(s)
Hydrologic and Hydraulic Modeling	None
Sedimentation	Partial Use of 2009 OWRB Bathymetric dataset for calibration.
Aquatic Species of Concern	None
Terrestrial Species of Concern	None
Wetland and Riparian Habitat	None
Recreation Facilities Inventory and Use	None

Study	Variance(s)
Cultural Resources	None
Socioeconomics	None
Infrastructure	None

4.0 STUDY SUMMARIES

4.1 Hydrologic and Hydraulic Study

The H&H Study was included as a study in the relicensing process because Project operations influence water levels both upstream and downstream of the Pensacola Dam. The H&H Study was intended to quantify the influences and improve the understanding of the magnitude, duration, and frequency of influences. Also, it identified operational sources of such influences and was intended to assist in analyzing resource-level effects that could be associated with the influences. The H&H Study was also intended to help identify changes in areas that are inundated, if any, that may be associated with any changes to baseline operations that are anticipated by GRDA.

An H&H Study was first proposed by GRDA as part of the Pre-Application Document (PAD).

The Commission staff requested a "Flooding and Sedimentation Study" which became the H&H Study in their Study Request Letter dated March 13, 2018[37]. Staff's reasoning for requesting the study is best outlined in their stated nexus which was as follows:

> "GRDA does not propose any changes in current operation. However, upstream flooding has been an ongoing issue in the project area. Information gathered through this study would allow stakeholders to develop an understanding of the interactions between project operation and flooding, the specific factors or project elements that can influence flooding, and associated effects on other resources…" The collection of data from this study would provide the basis for potential license requirements pertaining to project operational constraints and/or environmental measures necessary to protect, mitigate for, or enhance aquatic, terrestrial, recreation, and cultural resources around the project. This information would also be important in determining whether the current project boundary is appropriate."

The RSP states the nexus for H&H Study as the following:

> "Project operation influences water levels of the Grand/Neosho River, as well as some tributaries, both upstream and downstream of Pensacola Dam. The H&H Study will help quantify these influences; improve understanding of the magnitude, duration, and frequency of such influences; identify the operational sources of such influences (e.g., hydroelectric operations or USACE flood control operations); and assist in analyzing resource-level effects that could be associated with these influences. The H&H Study will also help identify changes in areas

[37] Staff Comments on the Pre-Application Document and Study Request for the Pensacola Hydroelectric Project, P-1494-438 (March 13, 2018).

inundated, if any, that may be associated with any changes to current operations that may be proposed by GRDA as part of the relicensing effort."

The study plan was first presented in the PSP and was later modified by Commission staff in its SPD based upon relicensing participant comments for the RSP. Following the ISR, Commission staff again required some refinements to the study plan, as set forth in the February 24, 2022 SMD.

The H&H Study has two main areas:

- Determine the effect of initial water surface elevations (WSELs) on the extent of inundation upstream of Pensacola Dam; and
- Provide lentic and lotic maps for baseline and anticipated operations to be used for the analysis in the Aquatic Species of Concern, the Terrestrial Species of Concern, and the Wetland and Riparian Studies, should GRDA anticipate any changes to Project operations.

The H&H Study is divided into three separate study efforts: the OM, the UHM, and the DHM. The OM provides input to upstream and downstream studies.

4.1.1 Operations Model

USACE's RWM period-of-record model is a tool used by USACE Southwestern Division, Tulsa District to simulate reservoir operations on the Arkansas River system upstream of USGS gage number 07250500 at Van Buren, Arkansas, including the Project. This model uses a daily time step and includes over 30 reservoirs.

A Flood Routing Model (FRM) was developed to replicate, as closely as possible, the Project flow routing decisions in the USACE RWM period-of-record model as an input to the OM required for the upstream and downstream study efforts. The FRM was needed to investigate hypothetical events and operating scenarios that would be difficult and time-consuming to program into the RWM. The FRM includes three reservoirs (Pensacola, Kerr, and Fort Gibson), which operate as a subsystem for flow routing, and uses daily time steps like the RWM.

The OM simulates flow routing, hydropower scheduling, and other constraints on an hourly time step to support the Project relicensing effort. Because electricity prices vary widely within a day, hourly time steps provide improved accuracy for hydropower operations simulation. Output from the FRM – most importantly the average daily total discharge – is used as an input to the OM. The OM seeks to optimize the hydropower generation revenue at each facility while simultaneously satisfying various physical and operational constraints, including the flow routing decisions based on the RWM model as simulated in the FRM. The OM includes Pensacola Dam and Kerr Dam (Markham Ferry Hydroelectric Project), which is downstream of Pensacola Dam. Both Pensacola Dam and Kerr Dam are owned and operated by GRDA, and flow routing decisions at both projects are regulated by USACE under certain conditions.

The FRM and OM have been validated against the RWM using the common metrics of the Coefficient of Determination and the Nash-Sutcliffe Efficiency to evaluate modeled total discharge and elevation. The OM was also validated by comparing the WSEL results to USGS gage data upstream of Pensacola Dam for two historical events recommended by the Commission. Sensitivity of OM results to stage-area-storage table updates were calculated.

The OM was used to simulate the reservoir levels resulting from different combinations of starting elevations, flow events, existing and future stage-storage relationships, and baseline or anticipated operation scenarios. The OM was also used to simulate the effects of changing elevation-storage relationships over time in support of the STM. Lastly, the OM was also used to simulate the effects of anticipated operations on reservoir water levels in support of the aquatic species study, terrestrial species study, wetlands and riparian habitat study, and assessment of recreation navigation impacts.

The UHM and model inputs and outputs have been made available to relicensing participants for download upon request.

The OM Study report is available in **Appendix 2**.

The study report for the updated bathymetry is available in **Appendix 3**.

4.1.2 Upstream Model

The HEC-RAS model, previously developed by the City of Miami's consultant Tetra Tech, was used as the base for the UHM development. A detailed review of Tetra Tech's Model identified ways in which the model should be improved. The Tetra Tech Model was transformed into the UHM by updating the version of HEC-RAS from a beta version to a full release version, modifying the geometry to contain larger flood events and to improve model stability and accuracy, updating bridge geometry, adding the Spring River and the Elk River, replacing the reservoir bathymetry to reflect newly surveyed conditions, and by using computational parameters recommended by the HEC-RAS development team. This resulted in an improved hydraulic model of Grand Lake and the river system upstream of Pensacola Dam.

The UHM was calibrated using measured data, including USGS gage elevations, high water marks, and recorded data from loggers installed by the project team. Six historical events were used to calibrate the model. Manning's n-values were adjusted until simulated water surface elevations reasonably matched measured data. Flow roughness factors were used to fine-tune the model.

A flood frequency analysis was performed for the study area using data from USACE. Data from 1940 (dam construction date) to 2019 (latest available data at time of data delivery from USACE) were used and a graphical frequency analysis of peak inflows was performed. The analysis estimated a 100-year event flow at Pensacola Dam of approximately 300,000 cubic feet per second (cfs). The largest events of recent record did not meet or exceed the 100-year event threshold at Pensacola Dam. The July 2007 event was scaled so the peak flow at Pensacola Dam approximately matched the estimated 100-year event, with a daily inflow volume to Pensacola Dam that approximately matched the results of a statistical analysis of historical inflow volumes.

The calibrated UHM was used to analyze five historical inflow events and one synthetic event with a range of starting pool elevations at Pensacola Dam. Maximum WSEL values and inundation extents were extracted from HEC-RAS and analyzed.

The results of the UHM demonstrate that starting pool elevations at Pensacola Dam within GRDA's anticipated operational range have an immaterial impact on upstream WSELs, inundation, and duration for a range of inflow events. Compared to starting elevations within GRDA's anticipated operational range, only a different natural inflow event caused an appreciable difference in maximum WSEL, maximum inundation extent, or duration. The differences in WSEL, inundation extent, and duration due to the size of the natural inflow event were orders of magnitude greater than the differences in WSEL, inundation extent, and duration due to the initial stage at Pensacola Dam. The maximum impact of nature typically ranged from over 10 times to over 100 or even over 1,000 times the maximum simulated impact of GRDA's anticipated operational range.

Even if extreme, hypothetical starting pool elevations outside GRDA's anticipated operational range are used, the maximum impact of nature is much greater than the maximum simulated impact of an extreme, hypothetical starting stage range of 23 feet. The impact of nature typically ranged from 2 times to 10 or even 100 times the impact of the extreme, hypothetical starting stage range.

Comparing anticipated operations to baseline operations for a suite of simulations that spanned the FERC-requested range of starting pool elevations and inflow event magnitudes, the results of the UHM demonstrate that anticipated operations have an immaterial impact on upstream WSELs, inundation, and duration as compared to baseline operations.

All conclusions on potential lentic or lotic conversion areas are discussed in each of the individual biological assessment reports.

The UHM, and model inputs and outputs have been made available to relicensing participants for download upon request.

The UHM Study report is available in **Appendix 2**.

The study report for the updated bathymetry is available in **Appendix 3**.

4.1.3 Downstream Model

The DHM was developed using a one-dimensional (1D) HEC-RAS Model extending from just downstream of Pensacola Dam and through Lake Hudson (also referred to as the Markham Ferry Hydroelectric Project) to the Robert S. Kerr Dam, where flood control operations are also regulated by USACE. The model geometry was developed from the best available topographic and bathymetric data. Bridge structures within the model were represented based on record drawings obtained from various agencies. The model was calibrated to four historical events based on measurements at the USGS stream gage near Langley, OK (USGS Gage No. 07190500) and observed WSEL at Kerr Dam.

The calibrated HEC-RAS model was used to analyze a range of operating conditions at Pensacola Dam utilizing results from the OM. Five historical flow events and one synthetic event were analyzed for a range of starting pool elevations at Pensacola Dam. An additional suite of simulations was computed to analyze an alternate operational scenario anticipated by GRDA for Pensacola Dam. Inflows to Lake Hudson for the synthetic 100-year event were derived from a statistical analysis of historical inflow volumes. Maximum WSEL values and inundation extents were extracted from HEC-RAS and analyzed.

The results of the DHM demonstrate that initial stages at the Project within GRDA's anticipated and extreme, hypothetical operational ranges have an impact on downstream WSELs and out-of-bank inundation. As the analysis shows, downstream WSELs, stages at Kerr Dam, and inundation extents are dependent on the magnitude and volume of releases from the Project, which in turn are dependent on initial stage at the Project. Out-of-bank inundation downstream of the Project is the result of spillway releases which are directed by the USACE. Under authority of Section 7 of the 1944 Flood Control Act, the Tulsa District of the USACE is responsible for prescribing and directing the flood control operations of the Project. The USACE is also responsible for directing spillway releases in accordance with the procedures for system balancing of flood storage outlined in the Arkansas River Basin Water Control Master Manual. This authority is reinforced by Section 7612 (c) of the NDAA 2020 which states that "The Secretary [of the Army] shall have exclusive jurisdiction and responsibility for management of the flood pool for flood control operations at Grand Lake O' the Cherokees."

In comparing anticipated operations to baseline operations for a suite of simulations that spanned the FERC-requested range of starting pool elevations and inflow event magnitudes, the results of the DHM demonstrate that anticipated operations have an immaterial impact on downstream WSELs and inundation as compared to baseline operations.

The DHM model inputs and outputs have been made available to relicensing participants for download upon request.

The DHM Study report is available in **Appendix 2**.

The study report for the updated bathymetry is available in **Appendix 3**.

4.2 Sedimentation Study

The Commission staff originally requested a "Flooding and Sedimentation Study" which became the H&H Study in their Study Request Letter dated March 13, 2018. Their reasoning for requesting the study is best outlined in their stated nexus which was as follows:

> "GRDA does not propose any changes in current operation. However, upstream flooding has been an ongoing issue in the project area. Information gathered through this study would allow stakeholders to develop an understanding of the interactions between project operation and flooding, the specific factors or project elements that can influence flooding, and associated effects on other resources…" The collection of data from this study would provide the basis for potential license requirements pertaining to project operational constraints and/or environmental measures necessary to protect, mitigate for, or enhance aquatic, terrestrial, recreation, and cultural resources around the project. This information would also be important in determining whether the current project boundary is appropriate."

The study plan was proposed in the PSP, modified per relicensing participants' comments for the RSP, modified per Commission staff recommendations provided in the SPD, and again modified per Commission staff recommendations in the May 27, 2022 determination letter.

As part of this study, GRDA developed the STM using the HEC-RAS fluvial modeling software. Data needed for model development ranged from topographic information to stream discharge volumes, WSELs, and sediment parameters both in the lake and streambeds and moving into the system through major tributaries. GRDA evaluated publicly available data sources to compile parameters necessary for model development and to determine where additional field work was required to fill data gaps.

Topographic and bathymetric data are available from a range of sources. Grand Lake itself was surveyed by the OWRB in 2009, then again by the USGS in 2019. Surveys upstream of RM 120.1 on the Neosho River and Spring River, and upstream on the Elk River were performed as part of the 1998 Real Estate Adequacy Study (REAS), and USGS surveyed those reaches again in 2017. Topographic information was available from surveys performed in support of the REAS and Light Detection and Ranging (LiDAR) flights conducted in 2011. Other topographic information was obtained from the USGS National Elevation Dataset one-third, arc-second datasets where LiDAR information was unavailable. Circa-1940 topographic maps were digitized for analysis of conditions at the time of dam construction. Additionally, stage storage curves were available from circa-1940 USACE as-built drawings as well as the more recent Grand Lake bathymetry surveys.

Other data are available from USGS gaging stations located throughout the Grand Lake watershed. WSEL data and stream discharge information are available along the Neosho, Spring, and Elk rivers, as well as on Tar Creek. These stations also provide sediment transport data in the form of suspended sediment concentration (SSC) measurements taken throughout the period of record at each gage.

Data gaps existed within the period of record for the USGS gaging stations within the Grand Lake watershed, and the gaging network lacked spatial density. As a result, the study team developed a field monitoring system to track WSEL throughout the study area and fill data gaps. A set of 16 monitoring locations were selected, and pressure loggers were installed at each site in December 2016. Pressure and temperature were recorded at 30-minute intervals. The record provided a detailed dataset of water levels that were used for model development and calibration.

Other data gaps identified were related to sediment properties. Sediment conditions within the basin were evaluated using grab samples to evaluate grain size distributions. In general, the streambeds consist of gravel with limited sand; the lake is primarily silt and clay. Due to the presence of cohesive material (silt and clay) in the lake, GRDA also collected core samples for SEDflume erosion analysis. The erosion analysis was used to determine parameters for sediment movement as part of model development.

Subsurface investigations included sub-bottom profiler (SBP) surveys and core sampling. SBP surveys and core sampling were used to estimate the thickness of deposited silt and clay material in the region of the delta feature. Core samples were also used to provide sediment grain size information and evaluate approximate date of deposition through cesium-137 analysis. Findings indicated a thick layer of cohesive material that is in continual flux, i.e., not consistently depositional on the delta feature.

Sediment transport rates were the final missing parameters. The aforementioned SSC measurements occur only occasionally, and samples taken during large flow events are limited. Researchers were also unable to find bedload sediment transport measurements at any location in the watershed. GRDA field work included trips to gather additional SSC measurements to help close data gaps in the record. Technicians also sampled bedload sediment transport and found that even under large flows, the bulk of sediment transport occurs as cohesive silt and clay in suspension rather than along the bed.

Hydraulic calibration of the model consisted of tuning roughness parameters to match measured peak WSELs for a range of flow events. Events that occurred between July 2007 and April 2017 were used for hydraulic calibration. Model tuning relied on adjusting hydraulic roughness coefficients and flow roughness factors. Calibration datasets included the USGS gages throughout the model domain, high water marks, and the GRDA monitoring stations. Model results showed good agreement with the gaged locations.

HEC -RAS has limited capabilities to accurately model cohesive sediment. GRDA discussed this at length in the Updated Study Plan submitted in April 2022 and proposed using a quantitative analysis of bathymetric change in addition to an STM focused on the upper regions of the study area.

In issuing their May 27, 2022 determination letter, Commission staff allowed development of the quantitative analysis and also agreed that HEC-RAS could be used to model portions of the study area above river mile 100, and that trapping efficiency and modeled sediment outflows could be used to evaluate sedimentation within the lower portion of the reservoir.

GRDA conducted a qualitative analysis to understand the general trends in the system and how the stream has evolved over time. The qualitative analysis discovered how several physical features affect the geomorphology of the rivers in the study area that either exist naturally or have been constructed. Such features include Pensacola Dam, bridges, and geologic and geomorphic features. Because bridges constrict flow and often encroach on the river floodplain (an extreme case is the railroad bridge downstream of Twin Bridges), they typically cause backwater effects and sediment deposition upstream of the bridge. Reaches of river that are confined by the vertical rock banks, rock valley bottoms, and rock thalweg bottoms from the Ozark Uplift constrict the flow and reduce steepness of the river valley. The reduced steepness (as shown in the 1938 valley bottom profile from RM 108 to RM 115) the reduced steepness), causes upstream backwater effects and sediment deposition.

At the confluence of the Neosho River and Elk River, some of the sediment load from the tributary is deposited. The Ozark Uplift crossing the Neosho River at the confluence, combined with the attendant potential for the formation of a tributary bar, also suggest a natural tendency for sediment deposition at this location.

GRDA used a quantitative analysis of sedimentation to evaluate future deposition within the study area. A relationship between hydraulic bed shear stress as evaluated using a fixed bed HEC-RAS model and measured sediment deposition was developed for this purpose. After evaluation, the results indicated that sediment deposition would occur primarily on the downstream face of the delta feature, which follows typical evolution patterns of such deposits. The delta feature is not expected to grow in height over the coming license period.

Sediment model calibration showed reasonable agreement with measured sediment deposition between the circa-1940 datasets and more modern surveys. Discrepancies are attributable to measurement uncertainties, particularly due to the significant limitations of the circa-1940 survey information.

Predictive 50-year simulations included analyses of High and Low Sedimentation simulations to account for the uncertainties of the available datasets. The calibrated sediment inflows were used to evaluate expected results under both baseline and anticipated operations; the High and Low Sedimentation simulations were used to bound the maximum and minimum sedimentation volumes that could reasonably occur in the upcoming license period under anticipated operations. These analyses showed that the sediment primarily accumulates on the downstream face of the delta feature, as predicted by literature sources. The predicted geometry was then imported to the 1D UHM to evaluate impacts to water levels.

Evaluation with the 1D UHM allowed assessment of changes to water levels based on sedimentation. The 1D UHM was used to evaluate the July 2007 flow event and a synthetic 100-year event on the Neosho River for three separate starting pool elevations.

Model results were compared to determine the relative impacts of 50 years of sediment accumulation under expected loading, High Sedimentation versus Low Sedimentation rates, and baseline operations versus anticipated operations. The results indicated that sediment loading, a natural phenomenon outside GRDA’s control, generally has the largest impact on upstream water levels in the Neosho River, overshadowing any impacts caused by Project operations. The impacts to water levels in the City of Miami for all evaluations are immaterial. Project operations, sediment loading, and future geometry show immaterial changes to water levels in the vicinity of the City of Miami. GRDA does not control the volume of incoming sediment, and the simulations indicate that, much like the findings of the Hydrologic and Hydraulic Study, nature dictates incoming sediment loads and therefore water levels in the study area, not Project operations.

The sedimentation model inputs and outputs have been made available to relicensing participants for download upon request.

The comprehensive Sedimentation Study Report for both study seasons is available in **Appendix 4**.

4.3 Aquatic Species of Concern Study

USFWS originally requested in their letter dated March 12, 2018[38], an "Inundation Study" which became in part the Aquatic Species of Concern Study. Their reasoning for requesting the study is best outlined in their stated goals and objectives, which were as follows:

> "The goals and objectives of this study are to determine the inundation effects of raising the target elevation to 745 feet."

In the March 12 letter, the USFWS also states their resource management goals to which the inundation effects are to be evaluated for. They were stated as follows:

> "*The Service has management goals for maintaining and enhancing habitat for federally-listed species and other trust resources. The Service has been involved in previous management of listed species, fisheries such as paddlefish, and wetlands in the project area and we see great potential for future management-related enhancements."*

The ODWC originally requested a study to quantify the effects of increased water level within the Grand Lake watershed, a study of the impacts of Grand Lake elevation manipulation on headwater river hydrology and paddlefish spawning/recruitment, and an impoundment fluctuation study. The requests were made in their letter dated March 13, 2018, to the Commission and became the Aquatic Species of Concern Study. Their reasonings for the study requests are all centered around identifying the potential effects on aquatic species (Neosho mucket, Neosho madtom, Neosho smallmouth bass, and paddlefish) by raising the target elevation to as high as 745 feet PD.

The study plan was not originally proposed in the PSP, but based upon relicensing participant comments, the proposed study was included in the RSP, modified per Commission staff recommendations provided in the SPD, and again modified by Commission staff recommendations in the February 24, 2022 determination letter.

The Aquatic Species of Concern Study gathered existing information on the potential species of concern and based on that existing information, identifies the species that are proposed for additional investigation needed to assess the effects of the Project, if any. The sensitive species reviewed as part of this study are the Neosho mucket, rabbitsfoot, winged mapleleaf, Neosho madtom, Neosho smallmouth bass, and paddlefish. A summary of the existing information for each species is outlined in the following sections.

4.3.1 Neosho Mucket

The Neosho Mucket (*Lampsilis rafinesqeana*) is a freshwater mussel species endemic to the Arkansas River system with recorded distributions located within the Verdigris, Illinois, and Neosho River basins. Within the Pensacola Project basin, the Neosho, Spring, and Elk River all have documented populations. According to a 5-year status review by the USFWS, the most recent freshwater mussel surveys conducted in 2016-2017 indicate that no live Neosho Mucket specimens were located with the Project

[38] Letter from Jonna E. Polk, Field Supervisor-USFWS to Kimberly Bose, Secretary-FERC, P-1494-438, (March 12, 2018).

boundary or upstream of the area of probable effects on the Spring or Neosho Rivers. These findings are consistent with other mussel surveys completed on the Spring and Neosho Rivers over the past 30 years. Therefore, on the Neosho and Spring Rivers we conclude that the Neosho Mucket is unlikely to occur.

On the Elk River, the current Project boundary overlaps about a one mile stretch of Critical Habitat named NM2 which includes 20.3 rkm (12.6 rmi) of the Elk River from Missouri Highway 59 at Noel, McDonald County, Missouri, to the confluence of Buffalo Creek immediately downstream of the Oklahoma and Missouri State line, Delaware County, Oklahoma. The most recent survey on the Missouri side of the state line as well as other historic surveys indicate that a viable population of Neosho Mucket exists within this stretch of river, however no data could be located with respect to the density or distribution of the mussel on the Oklahoma state line or within Project boundary.

Surveys were conducted during the week of July 18th, 2022. Overall, 188 mussels represented by 12 species were collected from 13 sites during 57 person-hours of total survey effort. Bluefer (Potamilus purpuratus) was the most abundant species, with 108 individuals collected. The next most abundant species was Fragile Papershell (Leptodea fragilis), with 23 individuals collected. Threehorn Wartyback (Obliquaria reflexa) and Pink Papershell (Potamilus ohiensis) were the next most abundant species overall, with 19 and 17 individuals collected, respectively. No Neosho Muckets were collected during this study.

4.3.2 Rabbitsfoot

The Rabbitsfoot (*Quadrula cylindrica cylindrica*) freshwater mussel is a historically widespread species with a range from the Lower Great Lakes to the Lower Mississippi River. Within the Arkansas River Basin, the Neosho and Spring Rivers are considered historical range. Within the study area, the most recent 5-year review indicated that in 2016-2017, surveys on the Neosho River 1.5 RM downstream of Miami to the Kansas State line did not locate any specimens. Similarly, surveys conducted in 2016-2017 on the Spring River from the confluence of the Neosho North did not locate any live specimens from the Oklahoma Portion of the Spring River. No data were located on the status of the Rabbitsfoot from recent or historical sources for the Elk River.

The rabbitsfoot is a freshwater mussel typically found in small-to-medium-sized rivers that have a moderate current and clear, relatively shallow water. It prefers river bottoms that are a mixture of sand and gravel substrates. The rabbitsfoot spawns from May to June. Three species of minnows have been determined to be suitable hosts for the rabbitsfoot larval stage: whitetail shiner, spotfin shiner, and bigeyed chub; however, it’s possible that other cyprinid (species) may be suitable hosts. Records received from the OWRB, show none of the host species have been present at sampling events in the Neosho, Spring, and Elk Rivers draining into the Project area from 2003-2018.

Based on the literature and data available it is not likely that a population would occur within the study area and no further species-specific studies were conducted. However, during the Neosho madtom and Neosho mucket studies, observations were made for the occurrence of this species. No occurrences were identified.

4.3.3 Winged Mapleleaf

The Winged Mapleleaf (*Quadrula fragosa*) has a historic range that spans the greater Mississippi basin. Current known locations for this species include locations in Missouri, Wisconsin, Arkansas, and Oklahoma. A 5-year review of the species completed in 2015 indicates this species is considered extirpated from the Neosho River and Spring River in Kansas and no known populations occur within the larger Grand Lake watershed or the Neosho River Basin. Historical and the most recent mussel surveys conducted on the Spring and Neosho Rivers have no record of this species and the species has not been documented on the Elk River based on our available data. Known host fish for this species include Channel Catfish (*Ictalurus punctatus*) and Blue Catfish (*Ictalurus furcatus*), both of which occur within the Project boundary.

Personal contact with the Sam Nobel Museum, Oklahoma State invertebrate collection department and ODWC indicate that no specimens have been previously found within the Neosho, Spring, and Elk Rivers or surrounding drainages leading up to the reservoir. The only recognized population in Oklahoma is within the Little River which is 175 miles from the study area. It is not likely that there is a population within the study area and no further studies were conducted. However, during the Neosho madtom and Neosho mucket studies, observations were made for the occurrence of this species. No occurrences were identified.

4.3.4 Neosho Madtom

The Neosho madtom is a small catfish commonly 1.75–2.75 inches long; the maximum is about 3 inches long. The density of Neosho madtom populations is much greater in the Neosho system (i.e., the Neosho and Cottonwood Rivers combined) than in the Spring River. Extant Oklahoma populations of the Neosho madtom are restricted to the Neosho River upstream from Grand Lake.

Neosho madtoms have been found in the highest numbers during daylight in riffles in late summer and early fall, after young of the year are estimated to have recruited to the population. Neosho madtoms prefer the interstitial spaces of unconsolidated pebbles and gravel, moderate-to-slow flows, and depths averaging 0.23 meters. Adults hide in the interstices of loose gravel riffles during the day and feed nocturnally on the aquatic insects. Young of the year are said to inhabit slower flowing waters downstream from riffles and use pools and backwaters as nursery areas.

Neosho madtoms have been found in the drainages of the Project area from 1969-2007. The last sampling attempts near the Project area occurred in 2016. The closest collection point within the Project was conducted in 1991.

Targeted surveys for Neosho mucket were completed on the Neosho on Spring Rivers in July and August of 2022. Neosho madtoms were found to be present on the Neosho River, but not found on the Spring River.

Using historical data in the CHM to represent normal events including 1-year flood events, the output of the H&H Study produced a comparison of the mean WSEL under baseline operations versus the mean WSEL under anticipated operations for the May 15 to July 8 period each year. In the area of the Neosho River where the Neosho madtoms were identified during the 2022 survey the lines representing the mean WSEL for baseline operations are coincident with the lines representing mean WSEL for anticipated operations.

The CHM also calculated section-averaged velocities for cross-sections extracted at each Neosho madtom sampling location under both the baseline operations and anticipated operations. The predicted velocities for baseline operations are nearly identical to the predicted velocities for anticipated operations.

4.3.5 Neosho Smallmouth Bass

The Neosho smallmouth bass is a genetically distinct subspecies of smallmouth bass. The Neosho smallmouth bass is found in the western extent of the Ozark Highlands ecoregion and is known to occur in the Spring River, the Elk River, the Neosho River, Spavinaw Creek, Spring Creek, the Illinois River, Baron Fork, Sallisaw Creek, Lee Creek, Clear Creek, the Mulberry River, Big Piney Creek, and the Illinois Bayou.

The Neosho smallmouth bass is found in streams that have watersheds with coarse-textured soils within the Ozark and Boston Mountain ecoregions. Generally, the smallmouth bass is found in clear streams, but the Neosho smallmouth bass can persist in some streams that are often spring fed and have relatively high sediment loads. Though Neosho smallmouth bass are found in pool habitats, larger streams that have various channel units, including runs and riffles, are necessary for abundant populations.

Spawning habitat for the Neosho smallmouth bass consists of low-velocity, nearshore waters that are close to cover. The Neosho smallmouth bass also prefers to construct nests in areas that have fine sediment substrates and avoids areas that have thick layers or silts and clays. In years that have low stream flows, low water velocity at the nest site was found to be important for nest success. In years that have elevated discharge events, nest success was influenced by streamflow, temperature, and distance to shore.

Several records show that a smallmouth bass population is present within the drainages surrounding the Project, but during the sampling there was no determination that the Neosho subspecies was identified. It is likely that all records of smallmouth bass are not of the Neosho strain because the smallmouth bass that may occur within Grand Lake and the stretches of the Neosho, Spring, and Elk Rivers in Oklahoma are likely to be reservoir-strain fish. ODWC sampling efforts, which looked for both the Neosho and reservoir subspecies, did not detect the Neosho subspecies of the smallmouth bass within this Project or surrounding drainages. The latest surveys occurred in 2019.

Maps were generated from the results of the CHM to depict the change in inundation areas due to anticipated operations. Using historical data to represent normal events including 1-year flood events, the output of the H&H Study produced a comparison of the mean WSEL under baseline operations versus the mean WSEL under anticipated operations for the May 15 to July 8 period each year (a critical time for the species). The results show the mean WSEL is higher for anticipated operations than for baseline operations during the critical time period.

The Neosho smallmouth bass has no state or federal listing and there is no need to collect any additional information to determine if there is an adverse effect upon the species.

No additional work on the Neosho smallmouth bass on was required in the final study season.

4.3.6 Paddlefish

Paddlefish are native to large rivers and lakes of the Mississippi River drainage and nearby gulf slope drainages. In Oklahoma, paddlefish were originally present in most large rivers of the Arkansas system (including the Neosho and Grand Rivers), the Little River, and the Red River.

Adult paddlefish inhabit deep slow-moving pools of large rivers and associated lakes and reservoirs. They typically inhabit areas with depths greater than 9.8 ft and current velocities below 1.6 feet per second (ft/s) in reservoirs. Appropriate spawning habitats are more specific and require riverine habitats. Paddlefish spawning occurs in aggregations over hard substrates such as washed cobble within river environments. In Oklahoma, spawning peaks in late March and early April. Spawning appears to be episodic, often initiated by rising water levels and occurring during periods of high flow, and year-class recruitment is often highest in years that have extended high flow conditions during the spring spawning period. Paddlefish spawn demersal eggs that become adhesive upon fertilization and stick to the substrate. Hard substrates such as gravel and cobble are key to spawning success.

Previous research has quantified the amount of hard spawning substrates within the Neosho and Spring Rivers upstream of Grand Lake. This study compiled spawning substrate data and developed maps to evaluate the amount and spatial distribution of paddlefish spawning substrate within the area that may be impacted by Project operation.

At the maximum extent evaluated, a total of over 2,647 acres of potential habitat occurs, of which 1,701 acres (64 percent) consist of hard substrates presumably suitable for paddlefish spawning. Specifically, 997 acres of paddlefish spawning substrates (69 percent of available) were identified within the Neosho River and 704 acres (59 percent of available) were identified in the Spring River. The availability of hard substrates generally increases moving upstream from the river/reservoir interface. Within the Project boundary, 696 acres of paddlefish spawning substrate was identified within the Neosho River and 493 acres of spawning substrate was observed within the Spring River. Therefore, 70 percent of the available spawning substrate within the Neosho River falls within the Project boundary and 55 percent of the available spawning habitat in the Spring River falls within the Project boundary.

In the SPD, Commission staff recommended an assessment of potential effects on anticipated operations on the spawning areas for paddlefish because increasing reservoir elevations would broaden and deepened the Grand Lake tributaries, slow water velocities, and deposition of soft, fine substrates to occur further upstream than currently occurs.

The availability of continuous high flows during spawning has a significant effect upon Paddlefish spawning success. The H&H Study has demonstrated Project operation (initial stage at Pensacola Dam) has an immaterial impact on upstream water surface elevations and consequently the hydraulic conditions which Paddlefish seek at upstream spawning sites during high inflow conditions.

Regardless of the anticipated operation of the Project, the inflow events will continue to dominate the hydraulic conditions at the upstream spawning sites during high inflow events and dominate spawning success. Therefore, based upon the abundance of spawning habitat, the minimal impact of anticipated operations on upstream inundation, and the dominance of inflow events over successful paddlefish spawning, no additional work on Paddlefish was required in the final study season.

The comprehensive Aquatic Species of Concern Study Report for both study seasons is available in **Appendix 5**.

4.4 Terrestrial Species of Concern Study

The USFWS originally requested in their letter dated March 12, 2018, an "Inundation Study" which became the Terrestrial Species of Concern Study. Their reasoning for requesting the study is best outlined in their stated goals and objectives which were as follows:

> "The goals and objectives of this study are to determine the inundation effects of raising the target elevation to 745 feet."

In the March 12, 2018 letter, the USFWS also states their resource management goals, which the inundation effects are to be evaluated for. They were stated as follows:

> "The Service has management goals for maintaining and enhancing habitat for federally-listed species and other trust resources. The Service has been involved in previous management of listed species, fisheries such as paddlefish, and wetlands in the project area and we see great potential for future management-related enhancements."

The study plan was not originally proposed in the PSP, but based upon relicensing participant comments, the proposed study was included in the RSP.

The Terrestrial Species of Concern Study gathered existing information on the potential species of concern and based on that existing information, identified the species for which additional investigation was needed to assess the effects of the Project, if any. The sensitive species reviewed as part of this study are the federally threatened American Burying Beetle (*Nicrophorus americanus*; ABB) and the federally endangered Gray Bat (*Myotis grisescens*). A summary of the existing information and proposed additional investigation for each species is outlined in the following sections.

4.4.1 American Burying Beetle Survey

Two presence/absence surveys for the ABB were conducted in 2021 and 2022 to determine whether the ABB, a federally threatened species, may be present within the study area and may be impacted by Project operations according to the H&H Study. The area of potential impact is the ABB's current range but does not include any conservation priority area as defined by the USFWS.

On July 18, 2021 and June 6, 2022, ABB Specialist Stephanie Rainwater (permit number TE-00284A) placed six (6) traps to cover representative samples of all suitable habitat types within the area of potential impact.

The traps were designed, baited, and checked following the guidelines of the American Burying Beetle Range-wide Presence/Absence Survey Guidance. Trap locations were oriented in Delaware and Ottawa

Counties only, but confirmed with Kevin Stubbs, USFWS National Species Lead as sufficiently representative of the overall four county area.

The six traps were checked daily for a total of five nights with valid weather parameters and yielded no positive ABB findings. The negative survey findings indicate that the ABB is not active within the study area.

The negative results indicate GRDA's change from baseline operations to anticipated operations are not expected to have a negative impact on ABB populations.

4.4.2 Gray Bat Survey

This study was an assessment of species utilization of colonies of the federally endangered Gray Bat in caves DL-2 and DL-91, in Delaware County, Oklahoma. In Oklahoma, Gray Bats represent a contingent in North America that are year-round, obligate cave dwelling species.

Infrared-illuminated entrance and night vision optics were used to conduct non-intrusive exit surveys and population estimates of Gray Bat colonies exiting caves DL-2 and DL-91 in the 2021 summer maternity and post-maternity season. Such surveys are used to document habitation, assist in estimating colony size at the respective caves, and monitor movements of the colony during potential high water and flood events on Grand Lake.

Exit surveys were conducted at cave DL-2 on June 22, 2021 and June 27, 2022. The population was estimated to be 11,800 in 2021 and 13,300 in 2022. On June 24, 2021, July 16, 2021, May 10, 2022, June 22, 2022, and August 4, 2022 cave DL-91 was surveyed. The post-maternity colony population estimate at cave DL-91 during late summer 2021 was 20,440 and within the range of 10,000 to 29,905 bats (average=18,245) over the past decade. The post-maternity colony population estimate at cave DL-91 during late summer 2022 was within the range of 10,000 to 29,905 bats (average=19,877) over the past decade.

Observations from exit surveys support historical evidence that during high water or flood events during the maternity season, a maternity colony of the gray bat vacates cave DL-2 (Beaver Dam Cave) where the original exit lies below the flood pool elevation of Grand Lake. The maternity colony then migrates to an alternative cave.

The persistent threat of cave inundation increases the likelihood of "take" of adult females and young. Complete inundation of the cave passage of DL-2 occurs at about elevation 752 feet PD. When Grand Lake is at about elevation 751 feet PD, only about one foot of flyway exists between the top of the water in the cave and the rock ceiling of the flyway, forcing evacuation of the colony.

In October 2008, a small, high passage within cave DL-2 was identified and minimally excavated and enlarged. Enlarging this passage was suspected to provide an alternative escape route for exiting bats, particularly during high water. Additional excavation and enlargement of this second-high passage was completed in October 2013. The length of the high passage was about 5m and was widened to about 0.40 meters wide by 0.50 meters tall.

An inspection of the passage following flood events since 2011 revealed scattered guano in the enlarged passage indicating use by bats. A post-inundation monitoring visits to the cave following a flood event in 2019 failed to give any indication that take had occurred as a result of inundation, and that the colony had successfully vacated to another location.

Management efforts at cave DL-91 over the past 40 years have improved the security and potential for the colony's persistence. The average post-maternity colony size illustrates relative consistency, ranging from 15,200 to 29,905 bats with an average colony size of 19,288 Gray Bats for the past 10 years.

As a product of the CHM, specific to the Gray bat analysis, percentages of time the reservoir would be above the key reservoir elevations of 746 feet PD, 751 feet PD, and 752 feet PD for both the baseline and anticipated operations during the key season of April 1 to July 31 each year were provided.

The CHM analysis shows under the anticipated operations of the Project, the Grand Lake Reservoir will exceed 746 feet PD, the reservoir elevation at which water flows into the entrance of cave DL-2 (Beaver Dam) is 16.5% under baseline operations and 16.9% under anticipated operations. The anticipated operations will cause this situation to occur 0.4% more frequently.

Evacuation of DL-2 generally does not begin to occur until Grand Lake reaches an elevation of approximately 751 feet PD. According to the CHM analysis, under the anticipated operations of the Project, the Grand Lake Reservoir will exceed 751 feet PD, 2.9% under baseline operations and 2.7% under anticipated operations. The anticipated operations will cause this situation to occur 0.2% less frequently.

A Grand Lake Reservoir elevation of 752 feet PD results in a complete inundation of the cave passage in DL-2 forcing evacuation. According to the CHM analysis, under the anticipated operations of the Project, the Grand Lake Reservoir will exceed 752 feet PD, 1.9% under baseline operations and 1.9% under anticipated operations. The anticipated operations will cause this situation to occur the same percentage of time as the baseline operations.

The CHM analysis shows very little increase (0.4%) in the potential for water to enter the cave opening of DL-2 at an elevation of 746 feet PD and very little decrease in the potential for water to enter the cave to an elevation of 751 feet PD that possibly forces an evacuation of the colony to the alternative cave. Lastly, the CHM results indicate there is no change in the percentage of time the passage in cave DL-2 becomes entirely submerged at an elevation of 752 feet PD under the anticipated operations.

As a result, the findings of the gray bat study indicate the secondary exit suffices to provide an alternative access by gray bats in cave DL-2. Regardless of the efficacy of the alternative access, the entrance to cave DL-2 does not become completely inundated to elevations 751 feet PD and greater (complete inundation is 752 feet PD) any more frequently under the anticipated operations than it becomes inundated under the baseline operations.

The comprehensive Terrestrial Species of Concern Study Report for both study seasons is available in **Appendix 6**.

4.5 Wetland and Riparian Habitat Study

The ODWC originally requested "Impoundment Fluctuation Studies" and "Wetland Documentation." The requests were made in their March 13, 2018 letter to the Commission and became the Wetland and Riparian Habitat Study. Their reasonings for the study requests are all centered around identifying the potential aerial extent of riparian habitat and potential aerial extent and change in type of wetland habitats by raising the target elevation to as high as 745 feet PD.

The study was not originally proposed in the PSP, but based upon relicensing participant comments, the proposed study was included in the RSP.

The purpose of the Wetland and Riparian Habitat Study is to quantify and refine the potential impacts associated with the proposed operations of the Project (a potential raise in target elevation to as high as 745 feet PD or anticipated operations). Base mapping was completed to identify, display, and describe the current composition of wetland communities within and adjacent to the area that may be impacted by anticipated operations.

In the area studied, according to NWI data 54,980.72 acres of wetland habitat types and 4,236.06 acres of riparian habitat types were identified. Once the lentic and lotic maps according to anticipated operations are developed through the H&H Study, the potential impacts of any anticipated operations can be outlined in the USR.

Overall, GRDA's anticipated operations result in water level fluctuations ranging from 742 to 745 feet PD or three feet. Whereas, baseline operations result in water level fluctuations ranging from 741 to 745 feet PD or four feet. As a result, overall impacts to wetlands are expected to be less under the anticipated operations than the baseline operations.

Using historical data to represent normal events including 1-year flood events, the output of the H&H Study produced a comparison of the mean WSEL under baseline operations versus the mean WSEL under anticipated operations for the growing season period (March 30-November 2). The mapped output when overlayed on other sources of data included the NWI data, showed very small differences along shorelines that result in a net increase in wetlands because the anticipated operations have a higher mean elevation during the growing season than do the baseline operations.

The comprehensive Wetland and Riparian Habitat Study Report for both study seasons is available in **Appendix 7**.

4.6 Recreation Facilities Inventory and Use

A recreation inventory and use survey was first proposed by GRDA as part of the PAD. The study was refined based upon relicensing participant comments on the PSP, modified based upon relicensing participant comments for the RSP, and again modified per Commission staff recommendations provided in the SPD.

During the months of May through September of 2020, a total of 30 recreation observation surveys were conducted on 20 separate recreation sites as outlined in the RSP and recommended in the SPD. In addition, bi-monthly surveys were completed along river channel sites below the Pensacola Dam.

The surveys included counting individuals and vehicles at each site, classifying primary and secondary activities, and interviewing people at the sites. Photos were taken at recreation sites, which focused on the water level at boat ramps and typical activities.

During visitor interviews, participants were asked various questions based on their input for sites visited. If additional sites were visited in the Project area, other than the interview site location, the survey requested visitor input for each site visited.

During at least one site visit to the five FERC-approved recreation sites, state parks, and other public access sites, the condition of each recreation facility and its immediate vicinity were assessed, and an inventory of recreation enhancements was made.

Although there is a large amount of recreational use in the Project area, there are numerous non-commercial quality recreation access sites available around the Project shoreline. All but one recreation site has adequate capacity for the near future and this study did not identify a need for any additional access sites to be established as part of the relicensing process. It is recommended recreation use be surveyed every six years during the future license term to assure adequate recreation access is maintained during the term of the future license.

No additional work on this study was required in the final study season. The Recreation Facilities Inventory and Use Study report is available in **Appendix 8**.

4.7 Cultural Resources Study

A cultural resources study was first proposed by GRDA as part of the PAD. The study was refined based upon relicensing participant requests for the PSP, modified based upon relicensing participant comments for the RSP, and again modified per Commission staff recommendations provided in the SPD.

The Cultural Resources Study is composed of the following efforts:

- Cultural Historic Investigation
- Archaeological investigations in 2019 and 2020-Volume I
- Archaeological investigations in 2020 and 2021-Volume II
- Archaeological investigations in 2021 and 2022-Volume III
- Ethnography Study
- Finalize the area of potential effect (APE) based on the results of the H&H Study, other relicensing studies, and information gathered during the first year of the cultural resources study and file the information in the USR.
- Develop a proposed HPMP and file the proposed HPMP in the DLA.

The five study reports are incorporated as **Appendix 9** but have been filed with the Commission as privileged information.

4.7.1 Area of Potential Effect

The APE is currently defined in the RSP and confirmed in the SPD as:

> *"...all lands within the FERC-approved project boundary. The APE also includes lands or properties outside the project boundary where project operations or project-related recreation activities or other enhancements may cause changes in the character or use of historic properties, if any such properties exist."*

APE is consistent with the requirements of Section 106 and the definition of a project's APE provided at 36 CFR 800.16(d), which would encompass project-related effects both within and outside the Project boundary.

GRDA has been completing studies under this standard definition of the APE in the initial study period, recognizing that the APE could fluctuate if the results of other relicensing studies (e.g., the H&H Study) demonstrate potential effects of Project operations outside the Project boundary.

In the RSP and confirmed by Commission staff in SPD, after the initial study period, GRDA should consult with the CRWG to refine the APE, if necessary.

Since the initial establishment of the APE, the H&H Study determined that starting pool elevations at Pensacola Dam within GRDA's anticipated operational range have an immaterial impact on upstream WSELs, inundation, and duration for a range of inflow events. Compared to starting elevations within GRDA's anticipated operational range, only a different inflow event caused an appreciable difference in maximum WSEL, maximum inundation extent, or duration. The differences in WSEL, inundation extent, and duration due to the size of the inflow event were orders of magnitude greater than the differences in WSEL, inundation extent, and duration due to the initial stage at Pensacola Dam. The maximum impact of nature typically ranged from over 10 times to over 100 or even over 1,000 times the maximum simulated impact of GRDA's anticipated operational range.

Comparing anticipated operations to baseline operations for a suite of simulations that spanned the FERC-requested range of starting pool elevations and inflow event magnitudes, the results of the H&H Study demonstrate that anticipated operations have an immaterial impact on upstream WSELs and inundation compared to baseline operations.

Since the APE already encompasses land up to an approximate elevation of 750 feet and any anticipated Project operations authorized by FERC under the license will not exceed 745 feet PD (due to the USACE's exclusive jurisdiction and responsibility for management of the flood pool beginning at 745 feet PD or even less for flood control operations at Grand Lake), the APE does not require modification. It already encompasses all the areas where Project operations under the FERC license potentially have an effect. Therefore, there is no basis for conducting additional cultural resources investigations beyond the APE that has been established for several years, and the current suite of studies fulfills GRDA's obligations under Section 106 of the NHPA.

4.7.2 Cultural Historic Investigation

The investigation was conducted to document and evaluate the potential effects of the operation of the Project on known historic resources, including the Pensacola Dam Historic District and the Splitlog Church. In addition, a resource survey was conducted for unknown above ground historic properties within the APE. The APE consists of areas within the current Project boundary and includes lands or properties outside the Project boundary where Project operations or Project-related recreation activities or other enhancements may cause changes in the character or use of historic properties. The survey was conducted, assessing any associated buildings or structures over 50 years old for their respective eligibility for listing on the NRHP. Identified historic resources were also evaluated for the potential effects from the renewal of the license for the Project.

The Pensacola Dam Historic District was established in 2003 when the Dam and its associated structures were determined eligible for the NRHP and listed at that time. The Splitlog Church was determined eligible for the NRHP and listed in 1972. The investigation has determined the renewal of the license for the Project has no adverse effect on the Pensacola Historic District or the Splitlog Church.

Two bridges, the Stepps Ford Bridge and the Spring River Bridge over State Highway 10, were previously recommended as eligible for listing on the NRHP. However, these two bridges have since been demolished and replaced with modern structures. An additional eighteen historic bridges were also identified within the APE. Of the eighteen bridges, thirteen had been previously surveyed, with the remaining five newly identified. However, all eighteen bridges were deemed not eligible for listing on the NRHP based on a lack of historic significance and/or material integrity, with six of the bridges recently replaced with modern structures. The investigation has determined the renewal of the license for the Project has no adverse effect on the twenty bridges identified.

4.7.3 Archaeological Investigations in 2019 and 2020.

The 2019-2020 field season was divided into two distinct mobilizations with two distinct goals. During the first mobilization between November 5 and December 12, 2019, an archaeological reconnaissance was conducted on 34 previously recorded sites within and immediately adjacent to the Pensacola Project APE that were designated as “high priority” by members of the CRWG. In early 2020, four additional sites were added to the list of high priority sites requested for assessment by the CRWG, for a final priority site total of 38. The goal of the site reconnaissance efforts was to relocate the 38 sites and assess their current condition, integrity, and document ongoing disturbances. During the 2019-2020 field effort, the mapped locations of 37 of the 38 sites, totaling 239.1 acres, were visited. Findings from the reconnaissance investigations varied. Many sites were found to be completely inundated within the body of the reservoir. Some could not be accessed due to landowner restrictions or were found to be mis-plotted, while others necessitated systematic testing to establish condition and integrity. Of the revisited sites, seven sites were considered “potentially threatened” due to their locations, current condition, and/or other mitigating factors. Additional management actions were recommended for the seven sites.

The second mobilization of the 2019-2020 field season was conducted between February 19 and March 10, 2020 and consisted of the systematic archaeological survey of high-archaeological potential Quarternary alluvial landforms (Qals) previously identified in the Pre-Fieldwork Study commissioned by GRDA (Cerimele et al. 2019). The 29 Qals located within the Pensacola Project APE were determined by the CRWG to have high potential to retain intact archaeological deposits. Ten Qals were investigated during the winter 2020 field mobilization. The total acreage of the surveyed landforms was 838 acres (339.1 hectares). Eight previously unrecorded archaeological sites were identified, delineated, and fully documented. Three isolated finds were also recorded. Five of the newly recorded sites are recommended for additional archaeological investigations to determine eligibility to the NRHP. Two sites are also recommended for additional work to fully delineate the site boundaries beyond the Project APE.

4.7.4 Archaeological Investigations in 2020 and 2021

The 2020-2021 field season (November 2020 to March 2021) builds upon the efforts reported in Volume I (Bissett et al. 2020). The total survey area for this project fell within the Pensacola Project APE. The 2020-2021 investigations consisted of relocating and assessing conditions at 11 previously recorded sites, surveying 16 Qals determined to have a high potential for cultural materials (Cerimele et al. 2019), and a visual inspection of exposed bluffs along the lake edge to identify potential rock shelters and caves. Additionally, one site outside of the Project APE was revisited at the request of the CRWG.

Archaeological reconnaissance was conducted on 11 previously recorded sites within and immediately adjacent to the Pensacola Project APE that were not revisited during the 2019-2020 field efforts. The goal of the site reconnaissance efforts was to relocate the sites and, if relocated, to assess their current condition, document ongoing disturbances, and assess integrity if possible. Five sites were not able to be reported on as part of this ISR. One site is a Cherokee cemetery that required a tribal monitor who could not attend due to Cherokee Nation Covid-19 protocols. One site was located within the protective buffer around an active bald eagle nest.

The locations of six of the 11 previously recorded sites investigated during the 2019-2020 season were visited during the current survey, but the sites could not be relocated. The remaining five of the 11 were relocated and assessed. Four are recommended as potentially eligible and require additional work to determine NRHP eligibility.

The second task of the 2020-2021 field season consisted of the systematic archaeological survey of previously identified Qals. Sixteen were surveyed in the 2020-2021 field season. Survey included pedestrian survey and shovel test excavations. Additionally, 13 islands were surveyed. In total, 2,108 acres were encompassed between the 16 Qals and 13 islands surveyed. Eleven new archaeological sites were identified and preliminarily evaluated. Three isolated finds were also recorded. Six of the newly recorded sites are recommended for additional archaeological investigations to determine eligibility to the NRHP.

The bluff face survey was based on the findings of the Pensacola Project Pre-Fieldwork Report that delineated 60.4 linear miles of high potential exposed bluff faces. Bluff areas are visually inspected to identify potential rock shelters or caves that may contain archaeological deposits. Portions of three areas, and an additional 22 full areas, originally could not be reached by boat, but have been completed. The reports for the additional areas will be included in the USR.

4.7.5 Archaeological Investigations in 2021 and 2022

The 2021-2022 field season (November 2021 to March 2022) builds upon the efforts reported in Volumes I and II. The total survey area for this project fell within the Pensacola Project APE. The 2021-2022 investigations consisted of relocating and assessing conditions at five previously recorded sites, surveying three Late Qals determined to have a high potential for cultural materials, survey of an unnamed island, and completion of the visual inspection of exposed bluffs along the lake edge to identify potential rockshelters and caves.

Wood conducted archaeological reconnaissance of five previously recorded sites within and immediately adjacent to the Pensacola Project APE that were not revisited during the previous field efforts. The goal of the site reconnaissance efforts was to relocate the sites and, if relocated, to assess their current condition, document ongoing disturbances, and assess integrity if possible. The last remaining previously recorded site that was mapped within the Project APE that was not revisited was determined to be on a ridgetop 50 to 100 feet above the 745 pool and well outside of any potential Project impact. GRDA does not believe a revisit to the plotted location is warranted.

Of the five previously recorded sites investigated during the 2021-2022 season (sites a, b, c, d, and e)[39], sites a and b revisited in Ottawa County did not reveal evidence of an archaeological presence at either location plotted within the Project APE. Site a was determined to be located on an undisturbed terrace setting outside of the Project APE, and site b was determined to be grossly mis plotted. No evidence of cultural materials was identified at the mapped location and archival documentation places the recorded portion of the site well away from the currently plotted site. GRDA recommends that the locations and boundaries of both sites a and b be adjusted in the Oklahoma Archaeological Survey database to accurately reflect their location. Three sites (sites c, d, and e) were able to be relocated and assessed. Sites c and d are Post-Contact Cherokee priority site locations. While attempts were made at locating site c during the 2020-2021 field effort, it was found that the mapped location of the site was erroneous. Additional archival research revealed the accurate location of site c, and it was visited in January of 2022. While the true location of site c is located well outside of the Project APE and is not subject to any Project related impacts, it was found that no indications remain of site c, and construction/development activities relating to the adjacent RV park have impacted the ground surface. Site d was visited in August of 2021 and appears to be well maintained. This site is positioned outside of the Project APE and does not appear to be prone to any Project related effects. Site e is located on a high bluff below the Pensacola Dam. The site was found to consist of a mixed Pre-Contact and Post-Contact assemblage. Site e is currently being affected by disturbances in the form of all-terrain vehicle trails and traffic and is recommended as potentially eligible with additional work to determine NRHP eligibility.

The second task of the 2021-2022 field season consisted of the completion of the systematic archaeological survey of previously identified Late Qals located within the Pensacola Project APE that have been determined by the CRWG as having high potential to retain intact archaeological deposits. A total of 29 of these Qals have been identified within the APE. GRDA was able to investigate all but three of these landforms during previous field sessions, with only Qals 2, 3, and 7 remaining. Survey methods included pedestrian survey and shovel test excavations. However, portions of several Qals in the northern reaches of the Project APE were determined to have a thick layer of recent alluvial deposits. After consultation with the CRWG in 2020, a modified survey methodology was devised that used auger testing and/or examination of exposed cutbanks to investigate any areas where older, intact soils were too

[39] Generic identifiers are assigned to the sites in this summary to protect potentially sensitive information.

deeply buried beneath recent alluvial deposits to be accessible using standard survey methods (e.g., shovel testing).

The three Qals remaining for survey totaled 259.5 acres in size. One new archaeological site was identified on Qal 3 and preliminarily evaluated. The newly recorded site is recommended for additional archaeological investigations to determine eligibility to the NRHP. In addition to survey of the Qals, a single unnamed island located in the main channel of the Grand River south of the confluence of the Neosho and Spring Rivers was surveyed. The island encompasses approximately 124.3 acres of low-lying landform with little relief that appears to be prone to regular and prolonged periods of inundation. No cultural resources were identified during the island survey.

The defined bluff face survey area was based on the findings of the Pensacola Project Pre-Fieldwork Report that delineated 60.4 linear miles of high potential exposed bluff faces divided into 83 areas of various lengths. During the 2020-2021 field season, GRDA used boats to access and visually inspect 58 of these predetermined bluff areas to identify potential rockshelters or caves that may contain archaeological deposits. During January of 2022, GRDA completed 14 linear miles of the remaining bluff face survey by watercraft during leaf-off conditions to allow for relatively clear views of the bluff faces. Two of the potential bluff areas remain inaccessible and were not inspected during the 2021-2022 field effort, although GRDA does not believe these locations would be viable for bluff shelters.

The results of the 2021-2022 effort are contained in the Volume III report available in **Appendix 9**.

4.7.6 Ethnography Study

To address the need to manage NRHP-eligible TCPs located within the Project APE, GRDA completed an ethnographic study designed to obtain information about the locations, types, and number of TCPs within the Project APE from members of the Native American Tribes represented among the Cultural Stakeholders. This information was collected and compiled from interviews with Tribal members. Information about TCPs within the Project APE is considered privileged and confidential at the explicit request of Native American Tribes, and access to data on the nature and locations of individual TCPs is restricted to the cultural consultant conducting the study, to each respective Tribe, and to GRDA.

4.7.7 Historic Properties Management Plan

As part of the approved Cultural Resources Study plan, GRDA has been developing an HPMP in consultation with the CRWG.

HPMPs are compliance and management plans that integrate the entirety of Federal and State cultural resources program requirements with ongoing practices such as hydropower generating activities, allowing for the identification of potential compliance and preservation actions that may occur over the course of a license period. The intent is to ensure that historic properties, as that term is defined under federal law, that may be affected by the generation of hydropower are appropriately managed for scientific research, education, and cultural, religious, and traditional uses for future generations. This HPMP is designed to comply with the requirements of applicable federal and state laws and regulations, including the NHPA, Native American Graves Protection and Repatriation Act of 1990, Archaeological Resources Protection Act of 1979, and the Commission guidelines for development of the HPMP.

GRDA prepared and circulated a draft HPMP to participants of the CRWG on July 1, 2022. As of the date of this USR, GRDA is reviewing the comments received and will include an updated draft HPMP as part of the DLA to be filed by January 1, 2023. The final HPMP is expected to be filed with the FLA and ultimately approved by FERC when it issues the new license for the Project.

4.8 Socioeconomics Study

The study plan was proposed in the PSP, modified based upon relicensing participant comments on the RSP, and again modified per Commission staff recommendations provided in the SPD.

The Socioeconomic Study presents information including land use patterns, population, and employment of the Project and the State of Oklahoma. The region of influence (ROI) for socioeconomic impacts are defined as Craig, Delaware, Mayes and Ottawa Counties, Oklahoma. Socioeconomic and demographic data establish baseline conditions consist of publicly available information about the ROI and, to provide perspective, the State of Oklahoma.

The population of the State of Oklahoma increased consistently between 2000 and 2020 and is 3,959,353 in the latest decennial census in 2020. The population in the ROI increased between 2000 and 2010 but decreased between 2010 and 2020 and is 123,835 in the latest decennial census in 2020. Oklahoma is expected to see a population increase up to 5,560,007 by 2075, with the population in the ROI expected to reach 198,444 for the same time-period.

GRDA sent letters to various stakeholders, including local tribes, organizations, and businesses, in the ROI to request additional socioeconomic information. GRDA requested additional information on industry trends (e.g., goods and services, agricultural use), trends in land and resource values (e.g., hunting, fishing, ecotourism, outfitting, trapping, recreation, exploration, and mining activities), as well as other socioeconomic information that may be relevant to a socioeconomic analysis. Responses were received from eight stakeholders and are attached in the report.

The presence of the Project provides significant economic benefit to the economy in the ROI. The City of Miami, tribes, and other interested parties have raised the issue of flooding in the area and potential economic impacts on the community. The H&H Study provides information to evaluate any reasonably foreseeable effect that has a reasonably close causal relationship to the Project operations and USACE flood control operations.

The cumulative socioeconomic impact analysis has concluded that the continued operation of the Pensacola Dam will result in continued significant economic benefits for the region.

No additional work on this study was required in the final study season. The Socioeconomic Study report is available in **Appendix 10**.

4.9 Infrastructure Study

The study plan was not originally proposed by GRDA in the PSP or the RSP because GRDA wanted to assure there was a nexus for such a study. If a nexus was determined to exist through work on the H&H Study in the first study period, the study information would be gathered and outlined in the application.

However, based on Commission staff recommendations provided in the SPD, the Infrastructure Study was included in the list of approved studies and again modified by Commission staff recommendations in the February 24, 2022 determination letter.

The Commission recommended an Infrastructure Study to determine a range of inflow conditions for which H&H Model results show Project operations may influence the frequency or depth of flooding. Specifically, the Commission requested maps and tables identifying the frequency and depth of inundation for each item of infrastructure.

The H&H Model of the area upstream of the Project, along with a range of extreme, hypothetical starting pool elevations (ranging from 734 feet PD to 757 feet PD) considerably outside GRDA's anticipated operational range and inflow events representing a range of flood frequencies, were used for the study. Hydraulic results were extracted at infrastructure locations. Infrastructure locations were mapped, and tabular data of inundation depth were developed. The difference in depth between different starting reservoir elevations was also tabulated.

According to analysis results, only 7% of the infrastructure locations studied experience an appreciable increase in maximum inundation depth for different starting reservoir elevations within GRDA's anticipated operational range of 742 feet PD to 745 feet PD. In addition, all appreciable increases in maximum inundation depth occur during high-flow conditions when the USACE controls the flood control operations under the Flood Control Act of 1944 and its other statutory mandates, except when the time of maximum inundation depth is solely a function of inflow event arrival time and not reservoir elevation, meaning the time of maximum depth at the infrastructure location was completely independent of the Project reservoir elevation. The inflow event moved down the river and then arrived at the infrastructure location completely independent of Project operations. Therefore, infrastructure locations are not adversely affected by GRDA's Project operations.

Additionally, except for two parks, a reduction in reservoir operational elevation to 734 feet PD would not decrease the loss of infrastructure use for any of the inflow events studied. The first park, Wolf Creek Park, was designed (and partially funded) by GRDA to avoid being impacted by inflow events, and only a low-lying portion of the park near Grand Lake would experience a difference in inundation for the October 2009 (3-year) inflow event. Therefore, any potential adverse impacts have already been mitigated and enhanced by GRDA through their assistance in designing and funding the recent improvements to the park.

At the second park, Grove Springs Park, low-lying portions of the park would experience a difference in inundation for the October 2009 (3-year) inflow event. Decreasing the low end of the anticipated operation range from 742 to 734 feet PD, a difference of 8 feet in operational elevation, would only change infrastructure adverse impacts slightly at Grove Springs Park.

Because infrastructure such as parks are generally sited in areas that are subject to frequent flooding and are the most-resistant type of infrastructure being reviewed in the Infrastructure Study, the minor potential reduction in impacts to infrastructure identified through operating at an extreme, hypothetical elevation of 734 feet PD do not significantly decrease loss of infrastructure use at the Project.

Extreme, hypothetical operational levels up to and including 757 feet PD were analyzed. If GRDA operated at 757 feet PD, a reservoir elevation that is 12 feet higher than the top of GRDA's anticipated operational range and an elevation equal to the top of dam, infrastructure locations would be inundated by depths similar to or greater than those depths for operational levels within GRDA's anticipated operational range. Practically speaking, increasing the top of the operational range to 757 feet PD is simply not possible.

Infrastructure locations are not adversely affected by GRDA's existing or anticipated operations of the Project, which consist of reservoir levels within an operational range of 742 feet PD to 745 feet PD. Even under the hypothetical and extreme operational level of 734 feet PD, only two parks would experience a minor decrease in the loss of infrastructure use.

The comprehensive Infrastructure Study Report for both study seasons is available in **Appendix 11**.

5.0 FULFILLMENT OF STUDY OBJECTIVES AND REQUIREMENTS

The following descriptions provide in detail how the objectives and requirements of each of the approved study plans have been fulfilled. The descriptions demonstrate no further modifications to any of the approved study plans are required.

5.1 Hydrologic and Hydraulic Study

The objective of the H&H Study is to provide information, through modeling and mapping, to support the determination of the effects, if any, of GRDA's operations under the FERC-issued license for the Project upon several resource areas. Specifically, the H&H Study was intended to: (1) determine the duration and extent of inundation under the current license operations of the Project during several measured inflow events; (2) determine the duration and extent of inundation under any proposed change in these operations that occurs during several measured or synthetic inflow events; (3) provide the model results in a format that can inform other analyses (to be completed separately) of Project effects, if any, in several resource areas; and (4) determine the feasibility of implementing alternative operation scenarios, if applicable, that may be proposed by GRDA as part of the relicensing effort.

More specifically, the H&H Study met the objectives of the study by following the recommendations outlined in the RSP, staff's November 8, 2018 determination letter and its February 24, 2022 determination letter which recommended the following activities to be completed. In the list of activities below all items have been completed and each item identifies where in each study report the activity is discussed:

- Develop a CHM using updated 2019 bathymetry and calibrate the CHM using several historical events.
    - Section 2 of the UHM report in **Appendix 2** explains how the UHM was developed using a HEC-RAS model, previously developed by Tetra Tech, as the base for UHM development. A detailed review of Tetra Tech's model was conducted and identified ways in which the model should be improved. As part of the study, the Tetra Tech model was transformed by updating the version of HEC-RAS from a beta version to a full release version, modifying the geometry to contain larger flood events and to improve

model stability and accuracy, updating bridge geometry, adding the Spring River and the Elk River, replacing the reservoir bathymetry to reflect newly surveyed conditions, and by using computational parameters recommended by the HEC-RAS development team. This resulted in an improved hydraulic model of Grand Lake and the river system upstream of Pensacola Dam.

- Section 2 of the DHM report in **Appendix 2** explains how the DHM was developed using a 1D HEC-RAS model extending from just downstream of Pensacola Dam and through Lake Hudson to the Robert S. Kerr Dam (also referred to as the Markham Ferry Hydroelectric Project), where flood control operations are also regulated by USACE. The model geometry was developed from the best available topographic and bathymetric data. Bridge structures within the model were represented based on record drawings obtained from various agencies.

- Section 3 of the UHM report in **Appendix 2** documents how the model was calibrated using measured data, including USGS gage elevations, high water marks, and recorded data from loggers installed by the project team. Six historical events were used to calibrate the model. Manning's n-values were adjusted until simulated water surface elevations reasonably matched measured data. Flow roughness factors were used to fine-tune the model.

- Section 2 of the DHM report in **Appendix 2** documents how the model was calibrated to four historical events based on measurements at the USGS stream gage near Langley, OK (USGS Gage No. 07190500) and observed WSELs at Kerr Dam.

- Validate model results against RiverWare (RWM) output.
  - Section 5 of the OM report in **Appendix 2** provides an explanation of how the OM was validated against the RWM using the common metrics of the Coefficient of Determination and the Nash-Sutcliffe Efficiency to evaluate modeled total discharge and elevation.

- Compare water surface elevations observed at the USGS gage on the upstream side of the dam to simulated stage hydrographs for the December 2015 and October 2009 inflow events.
  - Section 5.3 of the OM report in **Appendix 2** provides an explanation of how the OM was validated by comparing the water surface elevation WSEL results to USGS gage data upstream of Pensacola Dam for the historical events recommended by the Commission.

- Run a sensitivity analysis on the effect of switching to the most recent (i.e., 2019) bathymetry data in the OM.
  - Section 5.4.4 of the OM report in **Appendix 2** provides an explanation of how sensitivity of OM results to stage-area-storage table updates were calculated and summarizes the results.

- Perform a flood frequency analysis of peak inflow to estimate a 100-year event flow at Pensacola Dam.

  - Section 4 of the UHM report in **Appendix 2** clarifies how a flood frequency analysis was performed for the study area using data from USACE. Data from 1940 (dam construction date) to 2019 (latest available data at time of data delivery from USACE) were used and a graphical frequency analysis of peak inflows was performed. The analysis estimated a 100-year event flow at Pensacola Dam of approximately 300,000 cubic feet per second. The largest events of recent record did not meet or exceed the 100-year event threshold at Pensacola Dam. The July 2007 event was scaled so the peak flow at Pensacola Dam approximately matched the estimated 100-year event, with a daily inflow volume to Pensacola Dam that approximately matched the results of a statistical analysis of historical inflow volumes.

- Determine the duration and extent of inundation under the current license (baseline) operations of the Project and anticipated change in these operations that occurs during several measured inflow events starting at elevation 734 Pensacola Datum (PD) up to and including elevation 757 PD.
  - Sections 7 through 10 of the UHM report demonstrate how the calibrated UHM was used to analyze five historical inflow events and one synthetic event with a range of starting pool elevations at Pensacola Dam. Maximum WSEL values and inundation extents were extracted from HEC-RAS and analyzed.

  - Sections 3 through 6 of the DHM report in **Appendix 2** demonstrate how the calibrated HEC-RAS model was used to analyze a range of operating conditions at Pensacola Dam utilizing results from the OM. Five historical flow events and one synthetic event were analyzed for a range of starting pool elevations at Pensacola Dam. An additional suite of simulations was computed to analyze an alternate operational scenario anticipated by GRDA for Pensacola Dam. Inflows to Lake Hudson for the synthetic 100-year event were derived from a statistical analysis of historical inflow volumes. Maximum WSEL values and inundation extents were extracted from HEC-RAS and analyzed.

- Report the frequency, timing (i.e., seasonality), amplitude (i.e., elevation), and duration for each of the simulated inflow events with starting elevations between 734 feet PD and 757 feet PD for the baseline analysis and under any anticipated change in operations.
  - Section 8 of the UHM report in **Appendix 2** demonstrates that starting pool elevations at Pensacola Dam within GRDA’s anticipated operational range have an immaterial impact on upstream WSELs, inundation, and duration for a range of inflow events. Compared to starting elevations within GRDA’s anticipated operational range, only a different natural inflow event caused an appreciable difference in maximum WSEL, maximum inundation extent, or duration. The differences in WSEL, inundation extent, and duration due to the size of the natural inflow event were orders of magnitude greater than the differences in WSEL, inundation extent, and duration due to the initial stage at Pensacola Dam. The maximum impact of nature typically ranged from over 10 times to over 100 or even over 1,000 times the maximum simulated impact of GRDA’s anticipated operational range.

  - Even if extreme, hypothetical starting pool elevations outside GRDA’s anticipated operational range are used, the maximum impact of nature is much greater than the maximum simulated impact of an extreme, hypothetical starting stage range of 23 feet. The impact of nature typically ranged from 2 times to 10 or even 100 times the impact of the extreme, hypothetical starting stage range.

- Section 10 of the UHM report in **Appendix 2** demonstrates that, compared to baseline operations, anticipated operations have an immaterial impact on maximum WSELs, maximum inundation extent, and duration.

- Section 4 of the DHM report in **Appendix 2** demonstrates that initial stages at the Project within GRDA's anticipated and extreme, hypothetical operational ranges have an impact on downstream WSELs and out-of-bank inundation. As the analysis shows, downstream WSELs, stages at Kerr Dam, and inundation extents are dependent on the magnitude and volume of releases from the Project, which in turn are dependent on initial stage at the Project. Out-of-bank inundation downstream of the Project is the result of spillway releases which are directed by the USACE. Under authority of Section 7 of the 1944 Flood Control Act, the Tulsa District of the USACE is responsible for prescribing and directing the flood control operations of the Project. The USACE is also responsible for directing spillway releases in accordance with the procedures for system balancing of flood storage outlined in the Arkansas River Basin Water Control Master Manual. This authority is reinforced by NDAA 2020 which states that "The Secretary [of the Army] shall have exclusive jurisdiction and responsibility for management of the flood pool for flood control operations at Grand Lake O' the Cherokees".

- Section 6 of the DHM report in **Appendix 2** demonstrates that, compared to baseline operations, anticipated operations have an immaterial impact on maximum WSELs, maximum inundation extent, and duration.

- Section 11 of the UHM report in **Appendix 2** explains the analysis for the timing (seasonality) information requested to inform other analyses of Project effects.

- Provide the model results in a format that can inform other analyses (to be completed separately) of Project effects, if any, in several resource areas including the production of Lentic and Lotic Maps for baseline and anticipated operations, as needed, in the Aquatic Species of Concern, the Terrestrial Species of Concern, and the Wetland and Riparian Study
  - Section 11 of the UHM report in **Appendix 2** explains the simulations that were run to inform other analyses to assess changes in Project effects from changing from the baseline operations to anticipated operations.

- Provide the means necessary to complete any additional return (flood) frequency analysis that may be deemed necessary following review of the USR.
  - As outlined in the UHM report in **Appendix 2**, GRDA has included the return frequency analysis (i.e., flood frequency analysis) as an electronic attachment to the USR.

- Determine the feasibility of implementing anticipated operations scenarios, if applicable, that may be proposed by GRDA as part of the relicensing effort.
    - Section 10 of the UHM report in **Appendix 2** compares anticipated operations to baseline operations for a suite of simulations that spanned the FERC-requested range of starting pool elevations and inflow event magnitudes. The results of the UHM demonstrate that anticipated operations have an immaterial impact on upstream WSELs, inundation, and duration as compared to baseline operations.

    - Section 6 of the DHM report in **Appendix 2** compares anticipated operations to baseline operations for a suite of simulations that spanned the FERC-requested range of starting pool elevations and inflow event magnitudes. The results of the DHM demonstrate that anticipated operations have an immaterial impact on downstream WSELs, inundation, and duration as compared to baseline operations.

The Hydrologic and Hydraulic Study is complete, and no additional work is planned.

5.2 Sedimentation Study

Since sediment transport processes in the Project area were relatively unknown, and as such, the linkages between Project operations, bed changes, and potential upstream flooding were not clearly understood, the primary objective of the Sedimentation Study was to determine the potential effect of Project operations on sediment transport, erosion, and deposition in the lower reaches of tributaries to Grand Lake upstream of Pensacola Dam. Additionally, the Sedimentation Study is designed to provide an understanding of the sediment transport processes and patterns upstream of Grand Lake on the Neosho, Spring, and Elk rivers and Tar Creek. The Sedimentation Study complements GRDA's H&H Study in determining the impact of Project operations, if any, on bathymetric changes and upstream inundation levels.

The objective of the Sedimentation Study is also to investigate the overall trends and impact of sedimentation within the Project boundary. Specifically, this study will analyze the amount of sedimentation that has occurred in the reservoir; evaluate sediment transport, erosion, and deposition in Grand Lake and its tributaries; and characterize the impact that sedimentation may have on flood extents and duration throughout the study area under potential future operation scenarios.

More specifically, the Sedimentation Study meets the objectives of the study by following the recommendations outlined in the RSP, the November 8, 2018 SPD, and the May 27, 2022 determination letter which recommended the following activities to be completed:

- Compile existing data and review literature on suspended sediments, sediment properties, flow, and water levels.
    - Section 2 of the Sedimentation Study report in **Appendix 4** explains the efforts to compile existing data on suspended sediments, sediment properties, flow and water levels.

- Collect additional field measurements and data.

- Section 2 of the Sedimentation Study report in **Appendix 4** also outlines efforts in collecting additional field measurements and data resulting in a major change in available information that the sediment moving through the study area was dominated by cohesive material rather than sand and gravel.

- Collect sediment core samples at ten locations in the delta feature.
  - Section 2.2.5 of the Sedimentation Study describes the subsurface investigations completed in the delta feature.

- Conduct a bathymetric change analysis.
  - Section 4.5 of the Sedimentation Study report in **Appendix 4** outlines how the quantitative analysis of sediment transport consists of using the basic data and quantitative tools to analyze the hydrology, hydraulics, and resulting effect on sedimentation in Grand Lake.

  - The analysis uses the historical bathymetric data combined with the hydraulic analysis of historical flows and reservoir operation to develop a relationship between hydraulic shear stress and sedimentation pattern. Hydraulic shear stress is the driving force behind the transport and deposition of sediment. Hydraulic shear stress is the basic variable used in many sediment transport equations for both cohesive and non-cohesive sediments to determine whether sediment is eroded or deposited, and the rate at which sediment is transported.

- Develop a Sediment Transport Model (STM) using HEC-RAS to determine the fate of sediment upstream of RM 100.
  - Section 5 of the Sedimentation Study report in **Appendix 4** explains how the STM was developed using HEC-RAS v. 6.2 as available from USACE. The software is one of the leading fluvial system modeling packages and is frequently used for flood evaluations, hydrologic and hydraulic studies, and sediment transport estimates. The original version of the STM as submitted in December 2021 was built in HEC-RAS v. 5.0.7. This decision to use the newer software was made to take advantage of more robust sediment transport code that was included with the software updates.

  - The STM directly models the system above RM 100. Truncating the STM at RM 100 allows more accurate modeling of sediment deposition patterns by focusing primarily on the non-cohesive portion of sediment loading (and cohesive sedimentation not defined by density currents) and its impacts on water levels, which HEC-RAS was developed to evaluate. HEC-RAS is less well-suited to model the cohesive sediment that is found lower in the reservoir.

  - The results of the STM were exported to a 1D UHM for hydraulic evaluation. The 1D UHM was based on the STM and was developed in HEC-RAS v. 6.2 to maintain consistency with the STM. The 1D UHM is distinct from the UHM and STM. It was run in fully unsteady hydraulic-only mode.

- Calibrate the STM to measured bed changes based on the historical surveys.
    - Section 6 of the Sedimentation Study report in **Appendix 4** describes how the STM calibration was performed in two components. As with any model calibration procedure, it is easiest to start with the simplest format available, ensure accuracy, then increase complexity. For the STM, that meant beginning with hydraulic calibration and neglecting sediment movement, erosion, and deposition. Once the hydraulics were well-calibrated, sediment transport was added to the STM, and the sediment model parameters were finalized.

    - Sediment calibration and validation simulations ran from 1942 to 2019. Results were then compared against measured data from REAS surveys, the 2009 OWRB survey, and USGS surveys performed in 2017 and 2019.

    - The overall goal of this step was to create a baseline geometry using the 2019 terrain dataset that could be used to predict future sediment transport, erosion, and deposition patterns.

- Complete a qualitative analysis to understand the general trends in the system and how the stream has evolved over time.
    - Section 3 of the Sedimentation Study report in **Appendix 4** outlines in the qualitative analysis how several physical features affect the geomorphology of the rivers in the study area that either exist naturally or have been constructed. Such features include Pensacola Dam, bridges, and geologic and geomorphic features.

    - The analysis shows that sediment forming the delta feature is transported a considerable distance downstream into the reservoir. Because sands and gravels tend to drop out of the water column sooner, if a significant portion of the sediment load consisted of bed material load (sand and gravel), the delta feature would have begun forming much farther upstream near the head of the reservoir. Therefore, the delta feature location further supports what field sampling showed: the feature consists primarily of fine sediment.

    - Because bridges constrict flow, the analysis shows they typically cause backwater effects upstream of the bridge. The backwater effects include increased WSELs and reductions in velocity. At the bridges themselves, the reduced flow areas result in increased velocities. Bridges also potentially trap debris such as floating logs, which further constricts the flow and increases the backwater effect. The effects of hydraulic constrictions at bridges potentially cause sediment deposition upstream of the structure due to the reduced velocities. An extreme example of bridge encroachment on the river and floodplain is the railroad bridge just downstream of the Twin Bridges area below the confluence of the Neosho and Spring rivers. At the bridge, flow is constricted to just 20% of the river width upstream of the railroad embankment, creating significant backwater at this location.

- Vertical rock banks are evident in various reaches along the Neosho River. Reaches of river that are confined by vertical rock banks disconnect the floodplain and confine the flow to a relatively narrow cross section, which constricts the flow, potentially causing upstream backwater effects and sediment deposition.

- Separate from the geologic features, there are also flood protection levees upstream that disconnect the river from the floodplain and confine the flow to a relatively narrow cross section, which constricts the flow, potentially causing upstream backwater effects and sediment deposition.

- Submerged ridges in the now-submerged valley can act as stable points. Many of these ridges are perpendicular to downstream flow in the valley and can also cause sediment to deposit between and amongst the submerged ridges. These stable points are also capable of contributing to the creation and evolution of the delta feature that is shown in the 2019 USGS profile and the 2009 OWRB profile from RM 100 upstream to RM 122. The Ozark Uplift causes the narrowing and stable points (grade control) in the now-submerged valley. Dendritic drainage patterns from the surrounding uplands entering the submerged valley impede the transport of sediment downstream into the lower reaches of the reservoir and cause aggradation of sediment in these sections of submerged river valley. Additional evidence of ridges composed of limestone and chert within the now-submerged valley can be observed in the grade changes of the 1938 bank line elevation profile (the other profile lines display submerged thalweg elevations not submerged valley elevations). The bank line grade change begins at RM 108 and extends upstream to approximately RM 115.

- At a confluence of a tributary, some of the sediment load from the tributary is frequently deposited, forming a tributary bar within the river. Tributary bars form because the slope of the tributary is typically steeper than the river into which it flows, so some portion of the sediment load cannot be readily transported downstream resulting in sediment deposition. This process also occurs when the tributary transports a high sediment load or a coarser sediment load than the main river. The Ozark Uplift crosses the Neosho River at the confluence of the Elk River. This feature, combined with the steeper slope of the Elk River and the attendant potential for the formation of a tributary bar, suggest a natural tendency for sediment deposition at this location. Although these geomorphic features affect potential sedimentation patterns at this location, it is not possible to quantify these effects on the overall sedimentation pattern.

- Complete a quantitative engineering analysis of sediment transport in the study area focusing on the delta feature and downstream of RM 100.

  - Section 4 of the Sedimentation Study report in **Appendix 4** describes the quantitative analysis and how it developed a relationship between hydraulic shear stress and the pattern of sedimentation specifically in terms of the percent of sediment passing each cross section based on the change in historical bathymetry using historical flows and operation.

  - The quantitative analysis of the future 50 years of hydrology and operation shows no significant sediment deposition on top of the delta feature that would adversely affect existing hydraulic control in upstream reaches. Most of the sediment delivered to the reservoir is transported past the top of the delta feature, farther downstream to the downstream face of the feature. Approximately 98% to 99% of the incoming sediment load is transported past RM 110. The future flows with baseline operations cause slightly reduced deposition on the downstream face of the delta feature and shift the deposition slightly downstream compared to the anticipated operation. This comparison of computed sediment deposition pattern demonstrates the very small effect of Project operations on sedimentation rates and patterns.

  - In addition, after evaluation, the results indicated that sediment deposition would occur primarily on the downstream face of the delta feature, which follows typical evolution patterns of such deposits. The delta feature is not expected to grow in height over the next 50 years.

- Characterize Sedimentation impacts on upstream water levels over a 50-year period for baseline and anticipated operations.
  - Section 7 of the Sedimentation Study report in **Appendix 4** shows after model calibration, predictive simulations were performed to evaluate future conditions within the study area and evaluate the impact of sedimentation on upstream water levels.

  - The results indicate that the impacts of sedimentation on WSEL are immaterial in urbanized areas, regardless of loading rates, Project operations, or future versus current geometry. This finding further confirms the fact that Project operations are not a major contributor to increased upstream water levels in the City of Miami or other urbanized portions of the study area. Downstream of Miami, sediment loading, a natural phenomenon outside GRDA's control, has the biggest impact on WSEL.

- Analyze the effects of sediment on storage capacity in Grand Lake using hydraulic outputs from the STM and the USACE sediment trapping efficiency calculations downstream of RM 100.
  - Section 4 of the Sedimentation Study report in **Appendix 4** explains, based on the quantity of sediment computed using the sediment transport rating curves over the 50-year future scenario, approximately 109 million tons of sediment are delivered to Grand Lake. This converts to a volume of 71,587 acre-feet at 70 per cubic foot (pcf) and 86,398 acre-feet at 58 pcf (assuming a 100% trapping efficiency). This volume of sediment (storage loss from the reservoir) would be distributed according to the results of the

hydraulic shear stress analysis for the anticipated (or baseline) operations. The analysis shows that virtually no sediment is deposited upstream of RM 116, approximately 10% of the sediment is deposited between RM 116 and RM 105 (Elk River confluence), approximately 22% is deposited between RM 105 and RM 100, and the remaining 68% is deposited between RM 100 and the dam.

The Sedimentation Study is complete, and no additional work is planned.

5.3 Aquatic Species of Concern Study

The objective of the Aquatic Species of Concern Study is to gather existing and additional information on certain species of concern to assess the effects of the Project, if any, on those species. The sensitive species reviewed as part of this study are the Neosho mucket, rabbitsfoot, winged mapleleaf, Neosho madtom, Neosho smallmouth bass, and paddlefish.

More specifically, the Aquatic Species of Concern Study meets the objectives of the study by following the recommendations outlined in the RSP, the November 8, 2018 determination letter and the February 24, 2022 determination letter, which recommended the following activities to be completed. In the list of activities below, all items have been completed and each item identifies where in each study report the activity is discussed:

- Gather existing information and map areas of known areas of paddlefish spawning.
    - Known areas of paddlefish spawning were identified and outlined in Figures 4 through 6 of the Aquatic Species of Concern Study report in **Appendix 5**.

- Review existing information (including density) for Neosho mucket to characterize the physical habitat preferences and spatial and temporal patterns of the species.
    - Existing information for Neosho mucket was identified and outlined in Section 3 of the Aquatic Species of Concern Study report in **Appendix 5** and was utilized to determine parameters for additional field studies on the species.

- Review existing information (including density) for Neosho madtom to characterize the physical habitat preferences and spatial and temporal patterns of the species.
    - Existing information for Neosho madtom was identified and outlined in Section 4 of the Aquatic Species of Concern Study report in **Appendix 5** and was utilized to determine parameters for additional field studies on the species and it has been repeated in the USR.

- Review existing information for Neosho smallmouth bass to characterize the physical habitat preferences and spatial and temporal patterns of the species.
    - Existing information for Neosho madtom was identified and outlined in Section 4 of the Aquatic Species of Concern Study report in **Appendix 5**.

- Review existing information (including density) for rabbitsfoot mussel to characterize the physical habitat preferences and spatial and temporal patterns of the species.
    - Existing information for rabbitsfoot mussel was identified and outlined in Section 4 of the Aquatic Species of Concern Study report in **Appendix 5**.

- Review existing information (including density) for winged mapleleaf mussel to characterize the physical habitat preferences and spatial and temporal patterns of the species.
  - Existing information for winged mapleleaf mussel was identified and outlined in Section 4 of the Aquatic Species of Concern Study report in **Appendix 5**.

- Section 3 of the Aquatic Species of Concern Study report in **Appendix 5** explains how targeted field surveys for Neosho mucket were conducted in the Spring River between Warren Branch and the confluence with the Neosho River and in the Neosho River between the City of Miami and the confluence with the Spring River, after consultation with the USFWS, EcoAnalysts, and Tar Creek Trustee Council on the survey design to develop density estimates, availability of spawning habitat during the spawning season, and estimates of the distribution of the species in relevant reaches.
  - Targeted surveys for Neosho mucket were completed during the week of July 28, 2022 at thirteen sites.

  - Twelve species were collected. Bluefer (Potamilus purpuratus) was the most abundant species. The next most abundant species was Fragile Papershell (Leptodea fragilis). Threehorn Wartyback (Obliquaria reflexa) and Pink Papershell (Potamilus ohiensis) were the next most abundant species overall. No Neosho Muckets were collected during this study.

- Section 3 of the Aquatic Species of Concern Study report in **Appendix 5** documents targeted field surveys for Neosho madtom to develop density estimates, availability of spawning habitat during the spawning season, and estimates of the distribution of the species in relevant reaches.
  - Targeted surveys for Neosho mucket were completed on the Neosho on Spring Rivers in July and August of 2022. Neosho madtoms were found to be present on the Neosho River, but not found on the Spring River.

- Included in Sections 3 and 4 of the Aquatic Species of Concern Study report in **Appendix 5** respectively, GRDA assesses potential effects of Project operation, if any, on the Neosho mucket and Neosho madtom.
  - As described in Section 11 of the H&H Study UHM report contained in **Appendix 2**, maps were generated from the results of the CHM to depict the change in inundation areas due to anticipated operations. The shape file information from the maps was used to overlay aerial photography to evaluate the impacts to aquatic habitat in the area where the species were identified during the surveys. Specifically, using historical data to represent normal events including 1-year flood events, the output of the H&H Study produced a comparison of the mean WSEL under baseline operations versus the mean WSEL under anticipated operations for the May 15 to July 8 each year.

  - The UHM also calculated section-averaged velocities for cross-sections extracted at each Neosho madtom sampling location under both the baseline and anticipated operations.

- Included in Section 4 of the Aquatic Species of Concern Study report in **Appendix 5**, GRDA assesses potential effects of Project operation, if any, on the Neosho smallmouth bass.
  - As described in Section 11 of the H&H Study UHM report contained in **Appendix 2**, maps were generated from the results of the CHM to depict the change in inundation areas due to anticipated operations. The shape file information from the maps was used to overlay aerial photography to evaluate the impacts to aquatic habitat in the area where the species were identified during the surveys. Specifically, using historical data to represent normal events including 1-year flood events, the output of the H&H Study produced a comparison of the mean WSEL under baseline operations versus the mean WSEL under anticipated operations for the May 15 to July 8 period each year (a critical time for the species).

The Aquatic Species of Concern Study is complete, and no additional work is planned.

5.4 Terrestrial Species of Concern Study

The objective of the Terrestrial Species of Concern Study is to gather existing and additional information on certain species of concern and assess the effects of the Project, if any. The sensitive species reviewed as part of this study are the ABB and gray bat.

More specifically, the Terrestrial Species of Concern Study meets the objectives of the study by following the requirements of the RSP. In the list of requirements below all items have been completed and each item identifies where in each study report the activity is discussed:

- Section 4 of the Terrestrial Species of Concern report in **Appendix 6** discusses how maps were produced that delineate the riverine reaches that would be converted to lentic habitat, over a range of inflow conditions, as the result of water level management associated with Project operations.
  - As described in Section 11 of the H&H Study UHM report contained in **Appendix 2**, maps were generated from the results of the CHM to delineate areas that would be converted to lentic habitat under the anticipated operations. The shape file information from the maps can be used to determine if areas that support ABB are impacted under the anticipated operations more than the baseline operations.

- Section 4 of the Terrestrial Species of Concern report in **Appendix 6** assess the degree to which anticipated Project operations would inundate the main entrance to Beaver Dam Cave and compare the frequency of inundation with that associated with baseline operations.
  - The CHM analysis shows under the anticipated operations of the Project, the Grand Lake Reservoir will exceed 746 feet PD, the reservoir elevation at which water flows into the entrance of cave DL-2 (Beaver Dam), is 16.5% under baseline operations and 16.9% under anticipated operations. The anticipated operations will cause this situation to occur 0.4% more frequently.

  - Evacuation of DL-2 generally does not begin to occur until Grand Lake reaches an elevation of approximately 751 feet PD. According to the CHM analysis, under the anticipated operations of the Project, the Grand Lake Reservoir will exceed 751 feet PD, 2.9% under baseline operations and 2.7% under anticipated operations. The anticipated operations will cause this situation to occur 0.2% less frequently.

  - A Grand Lake Reservoir elevation of 752 feet PD results in a complete inundation of the cave passage in DL-2 forcing evacuation. According to the CHM analysis, under the anticipated operations of the Project, the Grand Lake Reservoir will exceed 752 feet PD, 1.9% under baseline operations and 1.9% under anticipated operations. The anticipated operations will cause this situation to occur the same percentage of time as the baseline operations.

- Sections 3 and 4 of the Terrestrial Species of Concern report in **Appendix 6** determined whether the secondary exit at Beaver Dam Cave suffices to provide an alternative access by gray bats to the cave (during times of inundation).
  - The average post-maternity colony size illustrates relative consistency, ranging from 15,200 to 29,905 bats with an average colony size of 19,877 gray bats for the past 10 years. Efforts should be concentrated on maintaining strong ties with the landowner of the access to cave DL-2, so that similar security efforts can continue there for the long-term. In sum, the gray bat colony sharing caves DL-2 and DL-91 each summer appears to maintain a stable population size.

  - The findings of the gray bat study indicate the secondary exit suffices to provide an alternative access by gray bats in cave DL-2. Regardless of the efficacy of the alternative access, the entrance to cave DL-2 does not become completely inundated to elevations 751 feet PD and greater (complete inundation is 752 feet PD) any more frequently under the anticipated operations than it becomes inundated under the baseline Project operations.

- Section 3 of the Terrestrial Species of Concern report in **Appendix 6** outlines the sampling for American Burying Beetle (ABB) during the active season in locations that are determined in consultation with the USFWS during the first study and final study season.
  - Sampling for ABB in consultation with the USFWS on trap locations was completed 2021 and 2022. Six traps were set on July 18, 2021 and six traps were set on June 9, 2022.

- Section 3 of the Terrestrial Species of Concern report in **Appendix 6** explains the ABB survey results. If ABB were found within the study area, GRDA would compare distributions of beetles to inundation maps generated by the CHM for characterizing the effects of Project operations. If areas that support beetles would be inundated as the result of Project operations, GRDA would coordinate with the USFWS to estimate the level of impact, if any.
  - As outlined in the Terrestrial Species of Concern report, ABB surveys were completed in 2021 and 2022 in consultation with the USFWS on the locations to place traps. No ABBs were collected during the 2021 and 2022 surveys. Therefore, it is unnecessary to characterize the effects of anticipated operations on the distribution of beetles.

The Terrestrial Species of Concern Study is complete, and no additional work is planned.

5.5 Wetland and Riparian Habitat Study

The objective of the Wetland and Riparian Habitat Study is to gather existing and additional information to assist in the evaluation of potential Project effects to wetlands and riparian habitat.

More specifically, the Wetland and Riparian Habitat Study meets the objectives of the study by following the requirements of the RSP. In the list of requirements below all items have been completed and each item identifies where in each study report the activity is discussed:

- Develop base maps in GIS, using source data from the NWI and potentially other resources, of wetland cover types in the Project study area. Cover type maps will be produced from existing resources that will include riparian and wetland vegetation throughout the study area.
    - Wetland and riparian habitat maps from the NWI were developed and included in the ISR.

- Use the results of the H&H Study to produce maps that depict the change in inundation areas due to anticipated operations versus baseline operations overlayed on the wetland base maps showing the current Project boundary.
    - As described in Section 11 of the H&H Study UHM report contained in **Appendix 2**, maps were generated from the results of the CHM to depict the change in inundation areas due to anticipated operations. The shape file information from the maps is being used to overlay wetland base maps to evaluate the impacts to wetlands are greater under the anticipated operations more than the baseline operations.

    - As described in Section 2 of the Wetland and Riparian Habitat Study report, overall, GRDAs anticipated operations result in water level fluctuations ranging from 742 to 745 feet PD or three feet. Whereas, baseline operations result in water level fluctuations ranging from 741 to 745 feet PD or four feet. As a result, overall impacts to wetlands are expected to be less under the anticipated operations than the baseline operations.

- Assess potential impacts to wetlands and riparian areas by identifying the extent, duration, and seasonality (timing) of inundation occurring in the Project area.
    - As outlined in Section 2 of the Wetland and Riparian Habitat Study report, using historical data to represent normal events including 1-year flood events, the output of the H&H Study produced a comparison of the mean WSEL under baseline operations versus the mean WSEL under anticipated operations for the growing season period (March 30-November 2). The mapped output when overlayed on other sources of data included the NWI data, showed very small differences along shorelines that result in a net increase in wetlands because the anticipated operations have a higher mean elevation during the growing season than do the baseline operations.

- Verify the accuracy of the base maps through ground-truthing if it is determined anticipated operations are impacting wetlands. Ground-truthing is only required for any major deviations from the preliminary wetland cover-type maps.
    - As discussed in Section 2 of the Wetland and Riparian Habitat Study report, no major deviations from the preliminary wetland cover-type maps that could not be resolved using

other accurate desktop methods such as aerial photography were identified that required ground-truthing.

The Wetland and Riparian Habitat Study is complete, and no additional work is planned.

5.6 Recreation Facilities Inventory and Use Study

The goals of the Recreation Facilities Inventory and Use Study are to gather information regarding current recreational use and identify recreation resources and activities that may be affected by the continued operation of the Project. Consistent with FERC's study request, the specific objectives of the study are to:

- Characterize current recreational use of the Project area,
- Estimate future demand for public recreation use at the Project,
- Gather information on the condition of GRDA's FERC-approved recreation facilities,
- Identify any need for improvement, and
- Evaluate the potential effects of continued operation of the Project on recreation resources and public access in the Project area.

More specifically, the Recreation Facilities Inventory and Use Study meets the objectives of the study by following the recommendations outlined in the RSP and the November 8, 2018 determination letter which recommended the following activities to be completed. In the list of activities below all items have been completed and each item identifies where in each study report the activity is discussed:

- Conduct recreation observation surveys at the required recreation facilities.
    - Section 5 of the Recreation Facilities Inventory and Use Study report in **Appendix 8** contains the data gathered as part of the recreation observation surveys. Surveyed recreation sites range in size, usage, facilities, and accessibility. Survey results indicate the most popular sites include three state parks (Bernice, Honey Creek, Little Blue) and one FERC-approved site (Wolf Creek). Most of these sites are relatively large, easily accessible, and have diverse facilities. Little Blue State Park has one of the highest number of visitors even though it is a smaller site. This site cannot be expanded due to topography. Little Blue State Park provides a scenic setting and the high volume of visitors can be attributed to its seasonal access point to the river channels and water below the easternmost spillway of the Pensacola Dam system. It is a popular destination for swimming and shoreline fishing, as well as other activities.
    - The most popular recreational activities at the surveyed sites include camping, shoreline fishing, boat fishing, boating, and picnicking. Visitors and vehicles that visited the sites during the 30 survey dates were counted. The counts are approximate and were tallied at each site over the course of the 30 one-hour visits.

- Conduct recreation visitor use interviews at the required recreation facilities.
  - Section 5 of the Recreation Facilities Inventory and Use Study report in **Appendix 8** explains the visitor use interview. Visitor interviews were conducted at sites between May and September 2020, except for Big Hollow and Willow Park. The observed use at Big Hollow is minimal; no visitors were observed during survey times and therefore no visitors could be interviewed. Willow Park is a boat launch facility, and although visitors were observed, they generally were not available for interviews as they were on the water.

  - A total of 163 visitor interviews were conducted, with the majority (23) conducted at Bernice State Park. The number of interviews at each site reflects the availability of visitors at that recreation site. Sites with a greater number of campsites had more visitors to interview, while sites with high boating usage had fewer visitors to interview, as they were typically on the water. Repeat and regular site visitors were not interviewed more than once. Most repeat visitors utilized smaller sites such as Spring River, Connors Bridge, Riverview Park, Seaplane Base, and Council Cove. First time visitors were more likely to visit larger sites such as Bernice State Park and Honey Creek State Park. Regular visitors traveled an average of 48.8 miles to recreate in the vicinity of Grand Lake. By comparison, first time visitors traveled an average of 177.06 miles. On survey days with excessive amounts of rain and/or high water, no visitors were available for interviews.

- Conduct facility condition assessments at the required recreation facilities.
  - Section 5 of the Recreation Facilities Inventory and Use Study report in **Appendix 8** outlines the process and results of the facility condition assessment. Both a recreation facility inventory and site condition assessment were completed at each of the five FERC-approved recreation sites on either September 22 or 23, 2020. Each site condition assessment is explained and any subsequent recommendations are made.

- Collect boat launch elevation data.
  - Section 5 of the Recreation Facilities Inventory and Use Study report in **Appendix 8** explains boat launch elevations were photo-documented at all recreation sites with a boat launch. Photos are provided showing high water and low water elevations at these sites are provided. Twin Bridges Upper State Park, Little Blue State Park, Cherokee Main State Park, and river channel sites do not have a boat launch. The top of the reservoir conservation pool is 745.00 feet PD. Over the course of the survey dates, Grand Lake elevation fluctuated between 742.20 and 748.29 feet PD. All survey dates and the corresponding reservoir elevation acquired from USACE are listed. The highest reservoir elevation was recorded on May 30, 2020, and the lowest on September 26, 2020 (last survey day). Inundation occurred at various sites on May 27 and May 30, 2020. GRDA assessed boat launch elevations to evaluate the reservoir surface elevation range at which the boat ramps are accessible. At the lowest recorded water elevation during the survey of 742.2 feet PD all boat launches appeared to be accessible. At the highest and second highest recorded water elevations during the survey of 748.29 or 747.83 feet PD nine of the sixteen boat launch sites are accessible.

- Characterize current recreation use and future demand for recreation use at the required recreation facilities.
    - Section 6 of the Recreation Facilities Inventory and Use Study report in **Appendix 8** explains the most popular sites include three state parks (Bernice, Honey Creek, Little Blue) and one FERC-approved site (Wolf Creek). Most of these sites are relatively large, easily accessible, and have diverse facilities. Little Blue State Park has one of the highest number of visitors because it provides a unique recreational experience.

    - The most popular recreational activities at the surveyed sites include camping, shoreline fishing, boat fishing, boating, and picnicking.

    - A comparison of projected population data for Ottawa, Craig, Delaware, and Mayes Counties shows that between the years 2010 and 2020, these counties had a population growth of (4.9%), (6.1%), 2.6%, and (5.4%) respectively. If the projected population growth experienced from 2010 to 2020 continues at this rate for the region, the public can further utilize any of the surveyed recreation sites that have unused capacity, which would absorb the needs of the growing population. It is generally not feasible to expand the highly-used sites due to physical and/or geographical barriers, seasonal high water events, and private property surrounding most sites. Very few visitor comments referenced overcrowding at recreation sites. Data indicates additional recreation sites or addition of camping sites to existing state parks is not necessary.

The Recreation Facilities Inventory and Use Study is complete, and no additional work is planned.

5.7 Cultural Resources Study

The objectives of the Cultural Resources Study are: (1) to identify historic properties within the Project's APE that are being adversely affected by Project operations (if any), including properties of traditional religious and cultural importance; and (2) to develop a HPMP in consultation with the SHPO, Oklahoma Archaeological Survey, and Native American Tribes that provides for the long-term management of historic properties within the APE over the term of the new license.

More specifically, the Cultural Resources Study meets the objectives of the study by following the recommendations outlined in the RSP and the November 8, 2018 determination letter which recommended the following activities to be completed. In the list of activities below all items have been completed and each item identifies where in each study report the activity is discussed:

- Complete background research and archival review.
    - In preparation for the Cultural Historic Investigations and any archaeological investigations and as outlined in Volume I, II, and III of the reports, background and archival research was completed as a precursor to any field investigations such that the requirements of Section 106 of the NHPA are fulfilled.

- Complete cultural resource investigations.

    - Section 4 of the Cultural Resources Study report in **Appendix 9** explains how Volume III of the report contained in **Appendix 9** builds upon the results contained in Volume I and Volume II of the report previously submitted with the Commission as sensitive information, pursuant to 18 CFR § 388.112(b) and 388.113(c)(1) and have special treatment of the reports in their entirety as Privileged material by maintaining these reports in the Commission's non-public file.

    - The total survey area for this project fell within the Pensacola Project APE. The 2021-2022 investigations consisted of relocating and assessing conditions at five previously recorded sites, surveying three Late Qals determined to have a high potential for cultural materials, survey of an unnamed island, and completion of the visual inspection of exposed bluffs along the lake edge to identify potential rockshelters and caves.

- Develop a HPMP.
    - As part of the approved Cultural Resources Study plan, GRDA has been developing an HPMP in consultation with the CRWG.

    - The HPMP is a compliance and management plan that integrate the entirety of Federal and State cultural resources program requirements with ongoing practices such as hydropower generating activities, allowing for the identification of potential compliance and preservation actions that may occur over the course of a license period. The intent is to ensure that historic properties, as that term is defined under federal law, that may be affected by the generation of hydropower are appropriately managed for scientific research, education, and cultural, religious, and traditional uses for future generations. This HPMP is designed to comply with the requirements of applicable federal and state laws and regulations, including the NHPA, Native American Graves Protection and Repatriation Act of 1990, Archaeological Resources Protection Act of 1979, and the Commission guidelines for development of the HPMP.

    - The HPMP will be included in the DLA and the final HPMP is expected to be included as a requirement of FERC's new license, which will become effective following expiration of the existing license.

- Conduct Tribe-specific Traditional Cultural Properties Inventories.
    - GRDA completed an ethnographic study designed to obtain information about the locations, types, and number of TCPs within the Project APE from members of the Native American Tribes represented among the Cultural Stakeholders. This information was collected and compiled from interviews with Tribal members. Information about TCPs within the Project APE is considered privileged and confidential at the explicit request of Native American Tribes, and access to data on the nature and locations of individual TCPs is restricted to the cultural consultant conducting the study, to each respective Tribe, and to GRDA.

With the exception of development of a final HPMP, which GRDA expects to include in the Final License Application, the Cultural Resources Study Phase I work is complete, and no additional work is planned. Based on the results of the Phase I study, the final HPMP will address the recommended Phase II field work.

5.8 Socioeconomics Study

The goal of the Socioeconomics Study is to gather, synthesize, and report on existing information necessary to qualitatively evaluate the socioeconomic effects of the Pensacola Project in the study area.

More specifically, the Socioeconomic meets the objectives of the study by following the requirements of the RSP and the recommendations outlined in the November 8, 2018 determination letter which recommended the following activities to be completed. In the list of activities below all items have been completed and each item identifies where in each study report the activity is discussed:

- Describe baseline economic conditions in the Project study area.
    - Section 1 of the Socioeconomic Study Report in **Appendix 10** presents information on the socioeconomics, including land use patterns, population, and employment, of the Project and the State of Oklahoma. The region of influence ROI for socioeconomic impacts are defined as Craig, Delaware, Mayes and Ottawa County, Oklahoma, where the project impacts is located. Socioeconomic and demographic data establish baseline conditions that consist of publicly available information about the ROI and, to provide perspective, the state of Oklahoma.

- Broadly assess the cumulative socioeconomic impacts of the Project within the study area.
    - Section 3 of the Socioeconomic Study Report in **Appendix 10** presents information on a cumulative impacts analysis that involves determining if there is an overlapping or compounding of the anticipated impacts of the continued operation of the Pensacola Dam during the proposed operating term with past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such actions.

- Identify the socioeconomic contribution of the Project within the study area.
    - Sections 1 and 3 of the Socioeconomic Study Report in **Appendix 10** explains the economic activity of GRDA continues to contribute a large portion of the GDP in the ROI as well as a measurable contribution to the state. Job opportunities, low electricity rates, recreational opportunities, and quality of life will continue to attract individuals to Oklahoma and are expected to continue into the foreseeable future. As such, GRDA has a large beneficial impact to the local economy and, to a lesser extent, to the entire State of Oklahoma. Economic impacts due to additional local economic stimulation are expected to contribute to the large beneficial reasonably foreseeable effect that has a reasonably close causal relationship associated with the continued operation of the Pensacola Dam.

The Socioeconomic Study is complete, and no additional work is planned.

5.9 Infrastructure Study

The objective of the Infrastructure Study is to determine a range of inflow conditions for which H&H Model results show Project operations may influence the frequency or depth of flooding. Specifically, the Commission requested maps and tables identifying the frequency and depth of inundation for each item of infrastructure.

More specifically, the Infrastructure Study meets the objectives of the study by following the recommendations outlined in the November 8, 2018 determination letter and the February 24, 2002 determination letter which recommended the following activities to be completed. In the list of activities below all items have been completed and each item identifies where in each study report the activity is discussed:

- In consultation with stakeholders, determine a list of infrastructure types to be included in the recommended infrastructure study.
    - Section 4 of the Infrastructure Study report in **Appendix 11** explains how GRDA compiled infrastructure locations from available data sources. The primary data source for GIS features and location information was Oklahoma Digital Data Online. Features obtained from this source were supplemented with data obtained from the USGS Geographic Names Information System, EPA's Facility Registry Service, Federal Aviation Administration, and Homeland Infrastructure Foundation Level Database.

    - GRDA also refined and supplemented the list of infrastructure, local emergency management agencies were contacted and given the opportunity to provide information on and/or the location of infrastructure features of concern to their jurisdictions. These contacts included county, city, and tribal emergency management entities, as well as the State of Oklahoma and USACE, Tulsa District Office.

    - Additional infrastructure locations identified through coordination with emergency management entities were added to the facilities GIS data layer.

- Analyze the impact of baseline and anticipated operation on the inundation of critical upstream infrastructure by providing maps and tables.
    - Sections 5, 6, and 7 of the Infrastructure Study report in **Appendix 11** explains According to analysis results, only 7% of the infrastructure locations studied experience an appreciable increase in maximum inundation depth for different starting reservoir elevations within GRDA's anticipated operational range of 742 feet PD to 745 feet PD. In addition, all appreciable increases in maximum inundation depth occur during high-flow conditions when the USACE controls the flood control operations under the Flood Control Act of 1944 and its other statutory mandates, except when the time of maximum inundation depth is solely a function of inflow event arrival time and not reservoir elevation, meaning the time of maximum depth at the infrastructure location was completely independent of the Project reservoir elevation. The inflow event moved down the river and then arrived at the infrastructure location completely independent of Project operations. Therefore, infrastructure locations are not adversely affected by GRDA's Project operations.

- Additionally, except for two parks, a reduction in reservoir operational elevation to 734 feet PD would not decrease the loss of infrastructure use for any of the inflow events studied. The first park, Wolf Creek Park, was designed (and partially funded) by GRDA to avoid being impacted by inflow events, and only a low-lying portion of the park near Grand Lake would experience a difference in inundation for the October 2009 (3 year) inflow event. Therefore, any potential adverse impacts have already been mitigated by GRDA through their assistance in designing and funding the recent improvements to the park.

- At the second park, Grove Springs Park, low-lying portions of the park would experience a difference in inundation for the October 2009 (3 year) inflow event. Decreasing the low end of the anticipated operation range from 742 to 734 feet PD, a difference of 8 feet in operational elevation, would only change infrastructure adverse impacts slightly at Grove Springs Park.

- Because infrastructure such as parks are generally sited in areas that are subject to frequent flooding and are the most-resistant type of infrastructure being reviewed in this Study, the minor potential reduction in impacts to infrastructure identified through operating at an extreme, hypothetical elevation of 734 feet PD do not significantly decrease loss of infrastructure use at the Project.

- Extreme, hypothetical operational levels up to and including 757 feet PD were analyzed. If GRDA operated at 757 feet PD, a reservoir elevation that is 12 feet higher than the top of GRDA's anticipated operational range and an elevation equal to the top of dam, infrastructure locations would be inundated by depths similar to or greater than those depths for operational levels within GRDA's anticipated operational range. Practically speaking, increasing the top of the operational range to 757 feet PD is simply not possible.

- In summary, infrastructure locations are not adversely affected by GRDA's existing or anticipated operations of the Project, which consist of reservoir levels within an operational range of 742 feet PD to 745 feet PD. Even under the hypothetical and extreme operational level of 734 feet PD, only two parks would experience a minor decrease in the loss of infrastructure.

The Infrastructure Study is complete, and no additional work is planned.

6.0 REQUESTED STUDY MODIFICATIONS AND REQUESTED NEW STUDIES

At the USR stage of the ILP, any proposal to modify an approved study must show good cause and demonstrate that: (1) the approved study was not conducted as described in the approved RSP or (2) that it was conducted under anomalous environmental conditions, or that environmental conditions have changed in a material way since the study plan's approval. 18 C.F.R. §§ 5.15(f) (referencing the criteria in § 5.15(d)).

With regard to proposed new studies at the USR stage, any such proposal must "demonstrate extraordinary circumstances warranting approval. 18 C.F.R. § 5.15(f), moreover, any new study proposal at the USR stage must include an appropriate statement explaining: (1) any material changes in the law or regulations applicable to the information request, (2) why the study's goals and objectives cannot be met via the approved study's methodology, (3) why the request was not made earlier, (4) significant changes in the proposal or significant new information has become available that affects the study, and (5) why the study request meets the criteria of 18 CFR 5.9(b).

6.1 Proposed Study Modifications

Based upon the results of the studies conducted in both study seasons described herein, all study plan objectives have been met, therefore, as shown in Table 5, GRDA does not propose any modifications to the approved studies as part of this USR. As detailed in Section **5**, all study plan objectives have been met.

Table 5. Proposed Study Modifications

Study	Proposed Modification(s)
Hydrologic and Hydraulic Modeling	None
Sedimentation	None
Aquatic Species of Concern	None
Terrestrial Species of Concern	None
Wetland and Riparian Habitat	None
Recreation Facilities Inventory and Use	None
Cultural Resources	None
Socioeconomics	None
Infrastructure	None

6.2 Requested New Studies

Based upon the study results of the studies conducted in the first study season and the final study season, all study objectives have been met and GRDA does not propose any new studies as part of this USR.

7.0 STATEMENT OF LICENSE APPLICATION

The relicensing studies addressed in the USR will provide the information necessary for determining and characterizing Project impacts and identifying appropriate protection, mitigation, and enhancement measures relevant to those impacts. As provided in 18 CFR § 5.16(c), GRDA has elected to prepare a Draft License Application (DLA) in lieu of a preliminary licensing proposal. The DLA will conform to the contents required by 18 CFR § 5.18. The DLA will be filed with FERC no later than January 1, 2023.[40]

Following the 90-day comment period on the DLA, as provided in 18 CFR § 5.16(e), GRDA will prepare and file the Final License Application no later than May 31, 2023.[41]

[40] Due no later than 150 days prior to deadline for filing of License Application (18 CFR §5.16(a)).

[41] Due no later than 2 years prior to license expiration (18 CFR § 5.17(a)).

8.0 REFERENCES

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FERC (Federal Energy Regulatory Commission). 2018 Staff Comments on the Pre-Application Document and Study Request for the Pensacola Hydroelectric Project, Letter dated March 13, 2018.

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ODWC (Oklahoma Department of Wildlife Conservation). 2018. Comment on Water Control Manual and Water Control Agreement for Pensacola Dam and Reservoir. Letter dated March 13, 2018.

USFWS (U.S. Fish and Wildlife Service). 2018. Letter from Jonna E. Polk, Field Supervisor-USFWS to Ms. Kimberly Bose, Secretary-FERC. Letter dated March 12, 2018.

ALL USR APPENDICES HAVE BEEN PREVIOUSLY FILED WITH THE COMMISSION AND HAVE NOT BEEN DUPLICATED HERE TO MINIMIZE DOCUMENT SIZE