**Draft**

# Environmental Assessment for the Left Embankment Repair, Emmett Sanders Lock and Dam #4

## EAXX-202-00-M4O-1733920550

## Jefferson County, Arkansas

US Army Corps of Engineers®
Little Rock District

# ENVIRONMENTAL ASSESSMENT ORGANIZATION

This Environmental Assessment (EA) evaluates the potential environmental and socioeconomic impacts of the proposed Left Embankment Repair. This EA will facilitate the decision process regarding the Proposed Action and alternatives.

| | |
|---|---|
| *SECTION 1* | *INTRODUCTION* of the Proposed Action summarizes the purpose of and need for the Proposed Action, provides relevant background information, and describes the scope of the EA. |
| *SECTION 2* | *PROPOSED ACTION AND ALTERNATIVES* examines alternatives for implementing the Proposed Action and describes the recommended alternative. |
| *SECTION 3* | *AFFECTED ENVIRONMENT* describes the existing environmental and socioeconomic setting.<br><br>*ENVIRONMENTAL CONSEQUENCES* identifies the potential environmental and socioeconomic effects of implementing the Proposed Action and alternatives. |
| *SECTION 4* | *CUMULATIVE IMPACTS* describes the impact on the environment that may result from the incremental impact of the action when added to other past, present, and reasonably foreseeable actions. |
| *SECTION 5* | *COMPLIANCE WITH ENVIRONMENTAL LAWS* provides a listing of environmental protection statutes and other environmental requirements. |
| *SECTION 6* | *IRRETRIEVABLE AND IRREVERSIBLE COMMITMENT OF RESOURCES* identifies any irreversible and irretrievable commitments of resources that are involved in the Proposed Action. |
| *SECTION 7* | *PUBLIC AND AGENCY COORDINATION* provides a listing of individuals and agencies consulted during preparation of the EA. |
| *SECTION 8* | *REFERENCES* provides bibliographical information for cited sources. |
| *SECTION 9* | *ACRONYMS/ABBREVIATIONS* |
| *SECTION 10* | *LIST OF PREPARERS* identifies persons who prepared the document and their areas of expertise. |
| *ATTACHMENT A* | National Environmental Policy Act (NEPA) Coordination and Scoping |
| *ATTACHMENT B* | *COMPENSATORY MITIGATION PLAN* |
| *ATTACHMENT C* | *EMISSION ANALYSES* |

## Table of Contents

## List of Figures



## List of Tables

This page intentionally left blank.

**Draft**
**ENVIRONMENTAL ASSESSMENT**

**Left Embankment Repair, Emmett Sanders Lock and Dam #4,**

**Jefferson County, Arkansas**

## SECTION 1: INTRODUCTION

The US Army Corps of Engineers (USACE) Little Rock District has prepared this draft Environmental Assessment (EA) to evaluate proposed Left Embankment Repair (LER) and associated works at the Emmett Sanders Lock and Dam #4 (ESLD).

While ER 200-2-2, Section 9.a. authorizes categorical exclusions (CatEX) for repair work at completed USACE projects, the removal of up to 1.6 acres of bottomland hardwood forest (BHF) and required mitigation exceeds the standard for CatEXs, therefore an environmental assessment (EA) has been prepared. This EA analyzes the potential impacts to the human and natural environment from implementing proposed changes to the authorized project in accordance with the National Environmental Policy Act (NEPA) of 1969, as amended (42 United States Code [USC] §4321 et seq.), Fiscal Responsibility Act, and US Army Corps of Engineers (USACE) Engineer Regulation (ER) 200-2-2: Procedures for Implementing NEPA (33 CFR 230).

### 1.1. PROJECT DESCRIPTION

ESLD is located at navigation mile (NM) 66 on Arkansas River within the Lower Arkansas River Watershed and is a part of the McClellan-Kerr Arkansas River Navigation System (MKARNS). It is located within Jefferson County, Arkansas, east of Pine Bluff and west of Altheimer. The ESLD is the 4$^{th}$ L&D of the 18 L&Ds along the MKARNS, with U.S Route 79 running directly over it. The MKARNS is 445 miles long and stretches from the Port of Catoosa near Tulsa, Oklahoma, downstream to the confluence of the Mississippi River in southeast Arkansas. The project area as displayed in Figures 1-1,2-2, and 2-3 resides completely within USACE federal property and will not involve in any part of the Arkansas River. However, it will use a part of the Sheppard Island Public Use Area as a temporary lay down area for repair and construction equipment and for place of where the mitigation would occur.

The area of water that ESLD controls and maintains (Pool) begins at ESLD, and proceeds upstream to Maynard L&D #5, NM 86. The spillway length is 1,190 ft, and consists of with 17 tainter gates, that are 60 ft wide; 9 of these tainter gates have a height of 28 ft, and 8 tainter gates have a height of 23 ft tall. The authorized purpose of the ESLD is to provide for navigation with the larger MKARNS having to support for recreation, fish and wildlife, water supply, and irrigation.


**Figure 1-1. Project Area and Location.**

## 1.2. PURPOSE OF AND NEED FOR THE ACTION

The purpose is to increase protection and resilience of the left embankment from erosion and scouring during future flood events.

The need for the Proposed Action arises from the 2019 flood event, after which temporary measures were put in place, however, a more permanent solution is needed as the current solution does not adequately protect against larger flood events. Without increased protection, the embankment that ties in the L&D and road are at a higher risk of substantial damage during future flood events.

## 1.3. SCOPE OF THE ACTION

The project's scope is to implement permanent repairs to the left embankment at ESLD. The project is a follow up effort resulting from unfiltered seepage through the embankment found on the downstream face of the left embankment. The work would consist of removal and replacement and or installation of impermeable materials, random fill, scour protection, and pavement materials to restore the left embankment to original design intent based on the dimensions, plans, and specifications. The design intent is to provide an embankment to design grade resilient against internal erosion failure modes such as backwards erosion piping (BEP) armored sufficiently to protect against external erosion (overtopping, scour, wave- action). Additionally, up to 1.6 acres of bottomland hardwood forest (BHF) would need to be cleared to prevent future void formation in the embankment materials and to allow for the safe passage of emergency vessels. Work may require grading specified soil and rock, meeting specified compaction of soil and rock, placement of geosynthetics, and cutting, clearing, and grubbing trees, shrubs, and other tall vegetation.

Mitigation for the loss of up to 1.6 acres of BHF would occur via planting and maintaining up to 1.75 acres of fallow field to BHF within the Sheppard Island Public Use Area.

## SECTION 2: PROPOSED ACTION AND ALTERNATIVES

The purpose of the Proposed Action Alternative is to implement the Left Embankment Repair (LER) and associated works at the Emmett Sanders Lock and Dam #4(ESLD). Two alternatives were developed for evaluation including a No Action Alternative.

### 2.1. ALTERNATIVE 1: NO ACTION ALTERNATIVE

The No Action Alternative serves as a basis for comparison to the anticipated effects of proposed action alternatives, and its inclusion in this EA is required by NEPA and CEQ regulations. Under the No Action Alternative, the USACE would not implement the repairs to the ESLD left embankment and associated works. The lock and dam would continue to provide its authorized purposes, including navigation. The failure to implement the proposed repairs and associated works would contribute to and exacerbate future damages that would occur as the result of flooding including the potential breach of the left embankment. The existing 1.6 acres of BHF would not be removed and be allowed to continually mature. The No Action Alternative, while it does not meet the purpose or need for the project, serves as a benchmark of existing conditions against which federal actions can be evaluated.

### 2.2. ALTERNATIVE 2: PROPOSED ACTION ALTERNATIVE

Under the Proposed Action Alternative, the repairs and associated works to the ESLD left embankment would be coordinated with the public and be implemented.

The repairs would consist of existing emergency repair material being replaced with a new engineered soil composition. Then rip-rap will be placed on top for erosion control during flooding events. To accommodate all of this new material, the left embankment toe/heel locations will be readjusted. The base of the embankment will not be widened; however the top would be.

The associated works would consist of building an access road on the left embankment crown, as well as navigation pass through it. The access road is needed to allow repair and emergency vehicles access to the left embankment armoring on the Arkansas River, however the elevation of the embankment crown will not be changed. The navigation pass is needed to facilitate the safe of passage of emergency vessels through the L&D when the gates are closed. Then up to 1.6 acres of BHF to the north of the left bank would be removed in accordance with Engineering Technical Letter 1110-2-583. This is needed to further protect the left embankment from future damage as result of trees falling over further damaging the L&D. The removal would also allow safe passage of emergency vessels to the navigation pass during high water events.

Please refer to the below Figures 2-1, 2-2, and 2-3 for a display of the location and extent of the Proposed Action. Figure 2-1 shows the area of trees to be cut 0.63 acres, however this area may be expanded up to 1.6 acres as displayed in Figure 1-1 pending any last minute changes to the project requirements.


**Figure 2-1. Display of the Location and extent of Repair and Associated Work Part 1of3.**

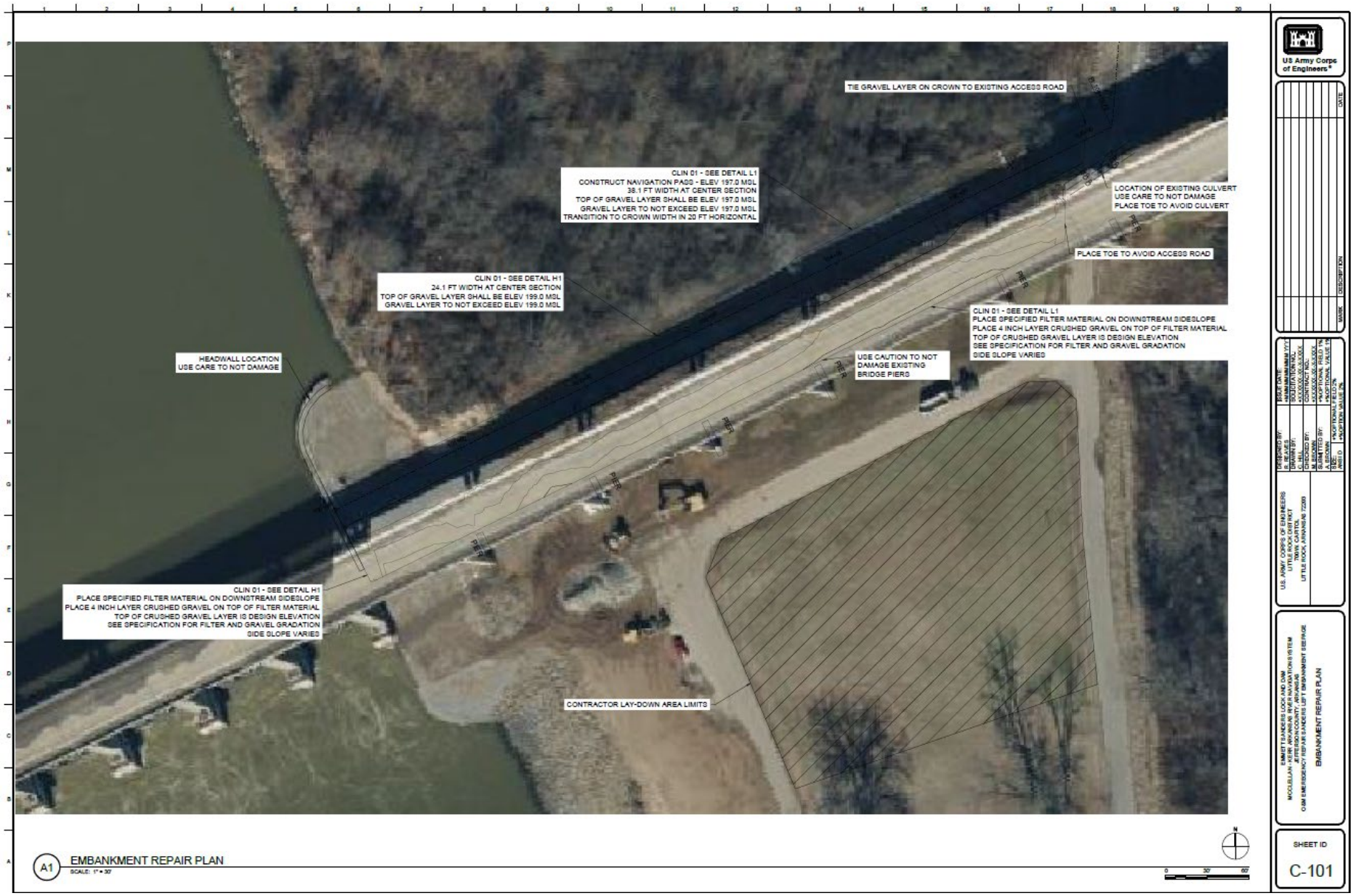


**Figure 2-2. Display of the Location and extent of Repair and Associated Work Part 2of3.**


**Figure 2-3. Display of the Location and extent of Repair and Associated Work Part 3of3.**

Per Engineer Regulation (ER) 1105-2-100, all BHF are listed as a significant resource, which must be mitigated for or compensated via mitigation bank credits when losses cannot be avoided. To mitigate for the loss of BHF, there would be up to 1.75 acres of BHF planted at the Sheppard Island Public Use Area within the LER project area as displayed in Figure 1-1 and would be monitored to ensure success of the planting. Refer to Attachment B for the Compensatory Mitigation Plan for details associated with this mitigation. Mitigation efforts would begin prior to or commensurate with the start of the BHF removal.

## 2.3. ALTERNATIVES CONSIDERED BUT ELIMINATED FROM FURTHER CONSIDERATION

Other alternatives to the Proposed Action Alternative were initially considered as part of the scoping process for this EA. However, none met the purpose and need for the project or current USACE regulations and guidance. Therefore, no other alternatives are being carried forward for analysis in this draft EA.

## SECTION 3: AFFECTED ENVIRONMENT AND CONSEQUENCES

This section of the EA describes the potential impacts of the No Action and Proposed Action Alternatives on the natural, cultural, and social resources found within the LER project boundary. Only those resources that have the potential to be affected by implementation of either alternative will be analyzed in this EA. The following resources were excluded from further impact analysis because the No Action nor the Proposed Action would not have any impact on them: recreation, socioeconomics and risk communities, topography, geology, soils (prior two resources would have been grouped together with this resource), water resources, and hazardous, toxic and radioactive waste (prior two resources would have been grouped together with this resource).

Impacts (consequence or effect) can be either beneficial or adverse and can be either directly related to the action or indirectly caused by the action. Direct effects are caused by the action and occur at the same time and place. Indirect effects are caused by the action and are later in time or further removed in distance but are still reasonably foreseeable. As discussed in this section, the alternatives may create temporary (less than 1 year), short-term (up to 3 years), long-term (3 to 10 years following the master plan revision), or permanent effects.

In considering whether the effects of the proposed action are significant, agencies shall analyze the potentially affected environment and degree of the effects of the action. In considering the potentially affected environment, agencies should consider, as appropriate to the specific action, the affected area (national, regional, or local) and its resources, such as listed species and designated critical habitat under the Endangered Species Act. In considering the degree of the effects, agencies should consider the following, as appropriate to the specific action: both short- and long-term effects, both beneficial and adverse effects, effects on public health and safety, effects that would violate Federal, State, Tribal, or local law protecting the environment. For the purpose of this analysis, the intensity of impacts will be classified as negligible, minor, moderate, or major. The intensity thresholds are defined as follows:

- Negligible: A resource would not be affected, or the effects would be at or below the level of detection, and changes would not be of any measurable or perceptible consequence.
- Minor: Effects on a resource would be detectable, although the effects would be localized, small, and of little consequence to the sustainability of the resource. Mitigation measures, if needed to offset adverse effects, would be simple and achievable.
- Moderate: Effects on a resource would be readily detectable, long-term, localized, and measurable. Mitigation measures, if needed to offset adverse effects, would be extensive and likely achievable.
- Major: Effects on a resource would be obvious and long-term, and would have substantial consequences on a regional scale. Mitigation measures

to offset the adverse effects would be required and extensive, and success of the mitigation measures would not be guaranteed.

## 3.1. LAND USE

The ESLD constructed as part of the MKARNS to provide for safe and reliable navigation. The Sheppard Island Public Use Area lies adjacent to the ESLD. This park is open year round and offers free boat launch and picnic facilities. In addition to these recreational opportunities, this area also provides shoreline fishing and mowed areas that can be used for various sports like soccer, volleyball, baseball, and football.

### 3.1.1. Alternative 1: No Action

The No Action Alternative for the LER is defined as the USACE taking no action, which means the proposed repairs and associated work would not occur. Implementation of the No Action Alternative would have moderate, adverse, short- and long-term impacts on land use within and around LER project area. The absence of permanent repairs could result in the existing seepage to worsen and possibly causing a breach of the left overflow embankment. A breaching flood would result in the inability for maintenance and emergency vehicles to access the ESLD during flood events. These impacts are anticipated to be temporary until the repairs have been made and would continue to occur until permanent repairs were made.

### 3.1.2. Alternative 2: Proposed Action

The implementation of the Proposed Action would have moderate, beneficial , short- and long-term impacts on land use within and around LER project area. This determination is based on the Proposed Action repairing the erosion on the left embankment and reducing the risk of a future breach. Emergency and repair vehicles would continue to have access to the ESLD during flood events. Partial temporary single lane closures along Shephard Island Road may be implemented to ensure the safety of project workers and the public.

## 3.2. CLIMATE

The LER project area lies in the east central part of the state of Arkansas. The region has a warm, temperate, continental climate with cool winters and hot, humid summers. The mean annual temperature is about 73.2 degrees Fahrenheit (°F) (NOAA, 2024A). January, the coldest month, has an average temperature of 42.5 F and average minimum daily temperature of about 33.2°F. July, the warmest month, has an average daily temperature of 82.4°F and average maximum daily temperature of 91.8°F. The average length of the growing season is 239 days (NOAA 2022B). The ESLD lies within the USDA Plant Hardiness Zone 8B, which is determined by the winter extreme low temperatures, with 8B having normal winter lows between 15°F and 20°F. Average monthly temperature and precipitation is provided in Figure 3-1.

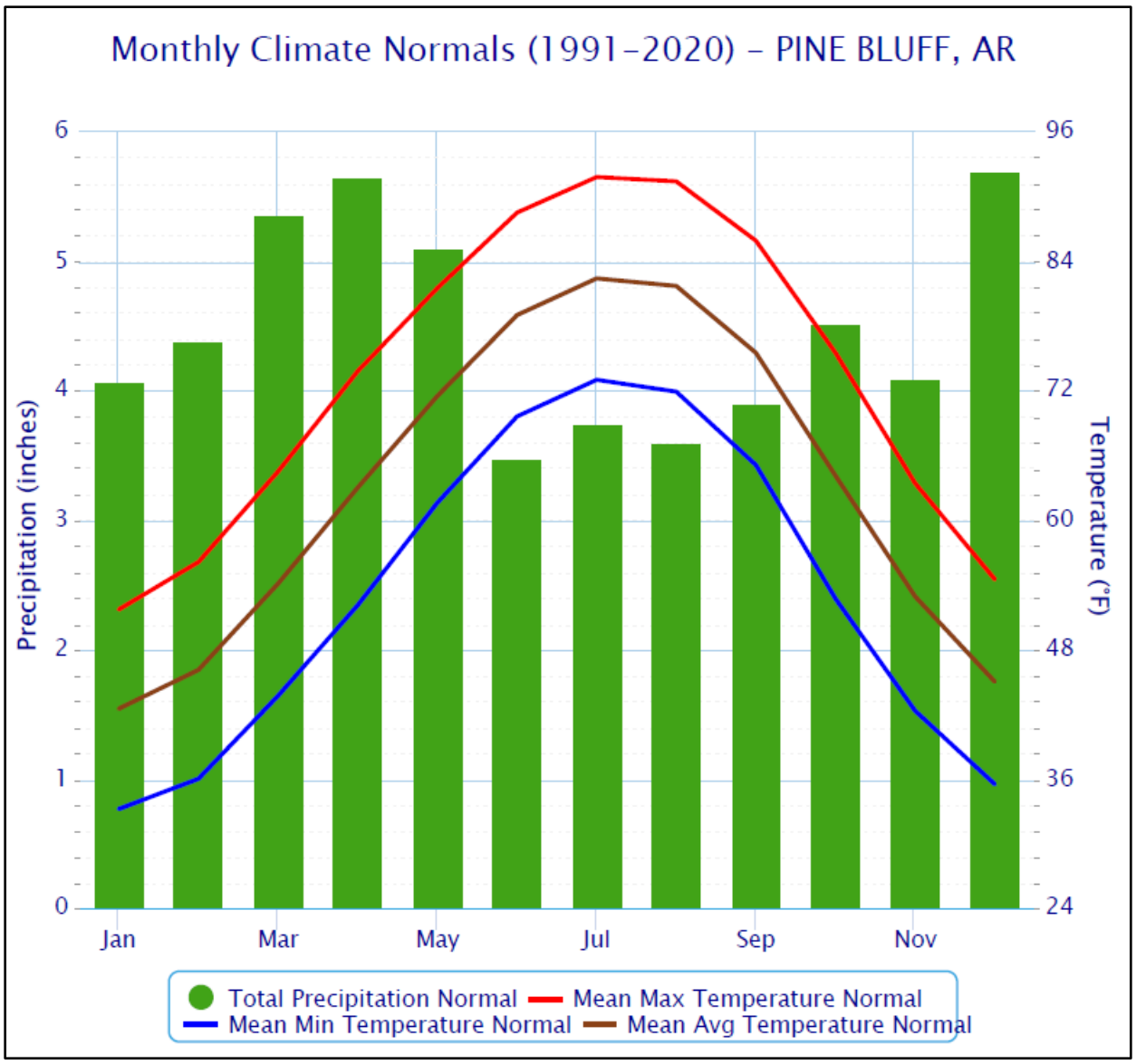


**Figure 3-1. Average Monthly Climate Pine Bluff, 1991 – 2020**
Source: NOAA, 2024A.

The normal annual precipitation is 53.58 inches with greater precipitation during spring and fall, and less precipitation during summer and winter.

The U.S. Global Change Research Program (USGCRP) looks at potential impacts of changing conditions globally, nationally, regionally, and by resource (e.g., water resources, ecosystems, human health). The LER project area lies within the Southeast Region of analysis. The Southeast Region past temperature data shows a rising trend are leading to increased demand for water and energy and impacts on agricultural practices. Over the last few decades, the Southeast Region has seen fewer cold days in winter and more hot days in summer, as well as changes to precipitation patterns. The decrease in the cold days has resulted in an overall increase of the frost-free growing season. Within this region, there has been an increase in average

temperatures of 1°–2°F since 1901 (Kloesel et al., 2018). The changing precipitation patterns in the region has led to more frequent extreme droughts, storms, and flood events.

#### 3.2.1. Alternative 1: No Action

The No Action Alternative does not involve any activities that would contribute to changes in existing conditions. There would be no impacts on climate as a result of implementing the No Action Alternative.

#### 3.2.2. Alternative 2: Proposed Action

The implementation of Proposed Action would have no impact on the climate of the study area. There would be no impacts on climate as a result of implementing the Proposed Action.

### 3.3. AIR QUALITY

The U.S. Environmental Protection Agency (EPA) established nationwide air quality standards to protect public health and welfare in 1971. The State of Arkansas has adopted the National Ambient Air Quality Standards (NAAQS) as the state's air quality criteria. NAAQS standards specify maximum permissible short- and long-term concentrations of various air contaminants including primary and secondary standards for six criteria pollutants: Ozone ($O_3$), Carbon Monoxide (CO), Sulfur Dioxide ($SO_2$), Nitrogen Oxide ($NO_x$), particulate matter (PM10 and PM2.5), and Lead (Pb). If the concentrations of one or more criteria pollutants in a geographic area is found to exceed the regulated "threshold" level for one or more of the NAAQS, the area may be classified as a non-attainment area. Areas with concentrations that are below the established NAAQS levels are considered either attainment or unclassifiable areas. After reviewing EPA (2024D) "Nonattainment and Maintenance Area Population Tool" the project area is in an attainment area for all criteria air pollutants and has no de minimis benchmarks to meet at this time.

#### 3.3.1. Alternative 1: No Action

The No Action Alternative does not generate emissions from soil disturbing activities since no changes are made to the project site and, for purposes of this study, the emissions over the 50-year lifespan for FWOP are negligible. The No Action Alternative would not have any impact on air quality.

#### 3.3.2. Alternative 2: Proposed Action

For the Proposed Action Alternative, the main source of emissions is generated from tasks associated with repairing the embankment itself and excavating the surface area of the project site. In general, the Proposed Action Alternative consists of repairing the left embankment, installing rip rap control, clearing vegetation, paving asphalt road, and constructing a navigation pass. Since the project is centered on embankment repair, there are no changes in anticipated Operations and Maintenance (O&M) tasks outside of periodic attention to landscaping schedules.

For the Proposed Action Alternative, an estimate of equipment to be used, their operation hours, and anticipated crew sizes alongside their estimated manpower hours were used to construct a rough calculation for the duration of the project and associated air pollutant emissions. These estimates provided by Cost Engineering were conservative since the awarded contractor may use similar or different equipment during the project. To remain consistent with conservative estimates, the higher engine power ratings were elected from an array of similar equipment documented in Table 3-2 of the 1110-1-8 Region 6 Construction Equipment Ownership and Operating Expense Schedule Engineering Pamphlet. Diesel load factors were used in calculations over gasoline load factors since the majority of equipment chosen used diesel engines and fuel. The minority of equipment utilizing gasoline included two small-scale engine landscaping components operating for less than 48 hours and were assumed to have a relatively small deviation between anticipated emissions based on diesel load factors or gasoline factors. Emission factors for non-road equipment were based on equipment ranges of a similar type and horsepower range. Due to lack of data correlation between nitrous oxide and the variety of equipment, total emissions for nitrous oxide per equipment were based on a ratio of nitrous oxide to methane generation per gallon of diesel fuel combusted in non-road vehicles. Crew details were assumed to consist of passenger vehicles with the crew working six 8-hour days per week. A commuting distance of 50 miles was also assumed since the project location is considerably rural, requiring longer travel distances to and from the site. For purposes of this study, the construction-related emissions over the 50-year lifespan for the Proposed Action are negligible.

The following tables summarize the calculations for the emissions from implementing the Proposed Action Alternative. Table 3-1 presents air pollutant emissions per activity and for the overall project generated from both equipment use and the commuting process for the crew. The project is expected to result in 71MT of carbon dioxide emissions, followed by 669lbs of nitrogen oxides and 499lbs of carbon monoxide as the highest emissions generated. Table 3-2 presents the emissions resulting from equipment operation. The main activities anticipated to be a large contributor to air emissions are excavating the project site for stone placement and repairing the embankment. Table 3-3 summarizes emissions from the crew's commuting arrangements where the most emission intensive activity is the commute required during repair of the embankment itself. Table 3-4 estimates the durations of the activities involved in the project given an 8-hour six-day work week. Evaluating construction by activity, the estimated duration of the project is about 220 days or 7.5 months. Project activities are not anticipated to overlap, so the durations per activity were in succession. Refer to Attachment C – Air Emissions Analyses for additional information on the air pollutant analytical results.

Based on this information, the Proposed Action would result short term negligible adverse impacts to air quality from the use of construction equipment.

**Table 3-1. Activity and Overall Project Emissions**

| Activity | VOC * | CO* | $SO_x$ * | $NO_x$ * | PM * | PM2.5 * | PM10 * | $CO_2$ * | $CH_4$ * | $N_2O$ * |
|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Clear vegetation | 3.12 | 22.32 | 0.09 | 10.90 | 1.09 | 1.21 | 1.41 | 7,592.15 | 0.23 | 0.19 |
| Unload Stone B | 10.66 | 48.77 | 0.19 | 68.64 | 5.82 | 5.40 | 5.67 | 12,769.17 | 0.45 | 0.37 |
| Place Stone B | 7.11 | 51.01 | 0.25 | 65.47 | 5.82 | 5.78 | 6.09 | 16,415.16 | 0.62 | 0.55 |
| Unload Stone A | 1.26 | 6.87 | 0.04 | 8.62 | 0.43 | 0.46 | 0.52 | 2,961.10 | 0.08 | 0.06 |
| Place Stone A/gravel | 12.21 | 79.36 | 0.39 | 96.43 | 7.66 | 7.74 | 8.31 | 27,901.41 | 1.06 | 0.92 |
| Repair Embankment | 22.49 | 151.55 | 0.66 | 164.41 | 11.70 | 12.08 | 13.22 | 50,190.91 | 2.11 | 1.50 |
| Repair Crown | 3.38 | 23.35 | 0.10 | 32.15 | 2.28 | 2.29 | 2.45 | 7,093.06 | 0.23 | 0.17 |
| Surface Excavation | 16.86 | 115.42 | 0.52 | 221.94 | 14.73 | 14.40 | 14.98 | 31,642.15 | 1.17 | 0.80 |
| Overall Emissions | 77.10 | 498.64 | 2.24 | 668.56 | 49.53 | 49.36 | 52.64 | 156,565.12 | 5.94 | 4.57 |

*Emissions [lbs]

**Table 3-2. Activity and Overall Project Equipment Emissions**

| Activity | VOC* | CO* | $SO_x$* | NOx* | PM* | PM2.5* | PM10* | $CO_2$* | $CH_4$* | $N_2O$* |
|---|---|---|---|---|---|---|---|---|---|---|
| Clear Vegetation | 0.77 | 3.81 | 0.03 | 9.35 | 0.89 | 0.86 | 0.89 | 1,593.91 | 0.13 | 0.12 |
| Unload Stone B | 9.22 | 37.46 | 0.15 | 67.69 | 5.70 | 5.19 | 5.35 | 9,103.58 | 0.38 | 0.33 |
| Place Stone B | 5.20 | 35.93 | 0.20 | 64.21 | 5.66 | 5.49 | 5.66 | 11,527.70 | 0.53 | 0.49 |
| Unload Stone A | 0.60 | 1.72 | 0.02 | 8.19 | 0.37 | 0.36 | 0.37 | 1,294.93 | 0.05 | 0.04 |
| Place Stone A/Gravel | 7.55 | 42.69 | 0.28 | 93.34 | 7.27 | 7.06 | 7.27 | 16,016.00 | 0.85 | 0.78 |
| Repair Embankment | 11.52 | 65.18 | 0.39 | 157.14 | 10.78 | 10.46 | 10.78 | 22,199.11 | 1.61 | 1.17 |
| Repair Crown | 2.21 | 14.09 | 0.07 | 31.37 | 2.19 | 2.12 | 2.19 | 4,093.94 | 0.18 | 0.14 |
| Surface Excavation | 15.08 | 101.37 | 0.48 | 220.76 | 14.58 | 14.14 | 14.58 | 27,087.93 | 1.09 | 0.74 |
| Overall Emissions | 52.15 | 302.25 | 1.62 | 652.03 | 47.45 | 45.68 | 47.09 | 92,917.10 | 4.81 | 3.81 |

*Emissions [lbs]

**Table 3-3. Activity and Overall Project Commuting Emissions**

| Activity | VOC* | CO* | $SO_x$* | $NO_x$* | PM* | PM2.5* | PM10* | $CO_2$* | $CH_4$* | $N_2O$* |
|---|---|---|---|---|---|---|---|---|---|---|
| Clear Vegetation | 2.35 | 18.51 | 0.06 | 1.56 | 0.20 | 0.35 | 0.52 | 5,998.24 | 0.11 | 0.07 |
| Unload Stone B | 1.44 | 11.31 | 0.04 | 0.95 | 0.12 | 0.21 | 0.32 | 3,665.59 | 0.07 | 0.04 |
| Place Stone B | 1.92 | 15.08 | 0.05 | 1.27 | 0.16 | 0.28 | 0.43 | 4,887.46 | 0.09 | 0.06 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Unload Stone A | 0.65 | 5.14 | 0.02 | 0.43 | 0.05 | 0.10 | 0.15 | 1,666.18 | 0.03 | 0.02 |
| Place Stone A/Gravel | 4.66 | 36.67 | 0.11 | 3.09 | 0.39 | 0.69 | 1.04 | 11,885.41 | 0.21 | 0.14 |
| Repair Embankment | 10.97 | 86.37 | 0.27 | 7.27 | 0.92 | 1.62 | 2.44 | 27,991.80 | 0.50 | 0.33 |
| Repair Crown | 1.18 | 9.25 | 0.03 | 0.78 | 0.10 | 0.17 | 0.26 | 2,999.12 | 0.05 | 0.04 |
| Surface Excavation | 1.79 | 14.05 | 0.04 | 1.18 | 0.15 | 0.26 | 0.40 | 4,554.22 | 0.08 | 0.05 |
| Overall Emissions | 24.95 | 196.39 | 0.61 | 16.53 | 2.09 | 3.68 | 5.55 | 63,648.02 | 1.14 | 0.76 |

Notes:
VOC = Volatile Organic Compounds
CO = carbon monoxide
$SO_x$ = sulfur oxides
$NO_x$ = nitrogen oxides
PM = Particulate Matter
PM 2.5 = Particulate Matter 2.5 microns
PM 10 = Particulate Matter 10 microns
$CO_2$ = carbon dioxide
$CH_4$ = methane
$N_2O$ = nitrous oxide
MT= Metric Tons

**Table 3-4. Activity and Project Durations**

| Activity | Duration (days) |
|---|---|
| Clear vegetation | 18 |
| Unload Stone B | 11 |
| Place Stone B | 22 |
| Unload Stone A | 5 |
| Place Stone A/gravel | 38 |
| Repair Embankment | 63 |
| Repair Crown | 12 |
| Surface Excavation | 19 |
| Unique Days Worked | 188 |
| Overall Duration (6-Day Work Week) | 220 |

## 3.4. NATURAL RESOURCES

*Vegetation*

The LER project area is located within the Mississippi Alluvial Plains Level III Ecoregion. This ecoregion is divided into 15 distinct Level IV Ecoregions. The project area is located in the Arkansas/Ouachita River Holocene Meander Belt Ecoregion, which is a flat to nearly flat floodplain containing the meander belts of the present and past courses of the lower Arkansas River and Ouachita Rivers and the outlying creeks and channels contributing to them. The trees that typify this region are bald cypress (*Taxodium distinchum*), water tupelo (*Nyssa aquatica*), overcup oak (*Quercus lyrata*), and water hickory (*Carya aquatica*).

The Mississippi Alluvial Plains ecoregion, like many other ecological regions in Arkansas, has undergone significant changes in the past 150 years. Although habitat for wildlife is present throughout the entire ecological region, populations vary considerably within sub-regions. The diversity and configuration of the plant

communities on the landscape influence wildlife populations. Factors impacting historic plant communities include fragmentation of once continuous habitat into smaller, isolated land holdings due largely to conversion to row crop agriculture. Conversion of woodland habitat to improved pastures or urban and rural developments does occur in this level Iv ecoregion, but to a much lesser extent than row crop conversion. The lack of proper wildlife and habitat management can also adversely affect native vegetation.

*Fisheries and Wildlife Resources*

The LER project area lies directly on the Arkansas River which provides habitat for an abundance of fish species. Predominant game fish species in the river include white crappie (*Pomoxis annularis*), black crappie (*Pomoxis nigromaculatus*), largemouth bass (Micropterus salmoides), channel catfish (Ictalurus punctatus), blue catfish *(Ictalurus furcatus*), yellow (flathead) catfish (*Pylodictis olivaris*), white bass (*Morone chrysops*), and hybrid bass *(Morone chrysops x Morone saxatilis*). Nongame fish species include longnose gar (*Lepisosteus osseus*), spotted gar (*Lepisosteus oculatus*), smallmouth buffalo (*Ictiobus bubalus*), freshwater drum (*Aplodinotus grunniens*), gizzard shad (*Dorosoma cepedianum*), and various sunfishes (*Centrarchidae spp.*). Nonnative fish species include common carp (*Cyprinus carpio*) and grass carp (*Ctenopharyngodon Idella*).

Before Anglo settlement, the region was habitat for bison (*Bison bison*), pronghorn antelope (Antilocapra americana), mountain lion (*Puma concolor*), bobcat (*Lynx rufus*), ocelot (*Leopardus pardalis*), black bear (*Ursus americanus*), collared peccary (*Pecari tajacu*), white tailed deer (*Odocoileus virginianus*), red wolf (*Canis lupus rufus*), coyote (*Canis latrans*), red fox (*Vulpes vulpes*), gray fox (*Urocyon cinereoargenteus*), badger (*Taxidea taxus*), river otter (*Lontra canadensis*), and many species of birds. Much of the original forest has been converted to cropland and pasture or cleared for urbanization, leading to a loss of habitat for native species.

Presently the undeveloped forested areas surrounding the LER project area provides habitat for mammals including white-tailed deer (*Odocoileus virginianus*), coyotes (*Canis latrans*), gray foxes (*Urocyon cinereoargenteus*), bobcats (*Lynx rufus*), eastern cottontail rabbit (*Sylvilagus floridanus*), fox squirrel (*Sciurus niger*), nine-banded armadillo (*Dasypus novemcinctus*), striped skunks (*Mephitis mephitis*), raccoons (*Procyon lotor*), and American beaver (*Castor canadensis*). Feral hog (*Sus scrofa*) may be present as well.

The area also provides habitat for a diverse range of birds and acts as a stopover for migratory birds, including bald eagles (*Haliaeetus leucocephalus*) and a wide array of waterfowl.

### 3.4.1. Alternative 1: No Action

The implementation of the No Action Alternative would have no impacts on natural resources.

### 3.4.2. Alternative 2: Proposed Action

The implementation of the Proposed Action would have minor, beneficial , short-and long-term impacts on natural resources within and around LER project area. The loss of up to 1.6 acres of mature BHF would result in minor, short term adverse impacts; however, up to 1.75 acres of BHF seedings would be planted as mitigation in low quality habitat area that has potential to support it. This mitigation would result in long term minor beneficial impacts. As the new seedlings grow, they will provide a changing habitat landscape for migratory birds and some mammals.

## 3.5. THREATENED AND ENDANGERED SPECIES

The Endangered Species Act was enacted to provide a program for the preservation of endangered and threatened species(terrestrial, birds, and freshwater aquatic organisms) and to provide protection for the ecosystems upon which these species depend for their survival. The USFWS is the primary agency responsible for implementing the Endangered Species Act. The USFWS responsibilities under the Endangered Species Act include (1) the identification of threatened and endangered species; (2) the identification of critical habitats for listed species; (3) implementation of research and recovery efforts for these species; and (4) consultation with other federal agencies concerning measures to avoid harm to listed species.

An endangered species is a species officially recognized by USFWS as being in danger of extinction within the foreseeable future throughout all or a significant portion of its range. Proposed species are those that have been formally submitted to Congress for official listing as threatened or endangered. Species may be considered eligible for listing as endangered or threatened when any of the five following criteria occur: (1) current/imminent destruction, modification, or curtailment of their habitat or range; (2) overuse of the species for commercial, recreational, scientific, or educational purposes; (3) disease or predation; (4) inadequacy of existing regulatory mechanisms; and (5) other natural or human-induced factors affecting their continued existence. Candidate species are those species the USFWS has identified as candidates for listing as a result of identified threats to their continued existence. The candidate designation includes those species for which USFWS has sufficient information to support proposals to list as endangered or threatened under the Endangered Species Act; however, proposed rules have not yet been issued because such actions are precluded at present by other listing activity. Although not afforded protection by the Endangered Species Act, candidate species may be protected under other federal or state laws.

The USFWS's Information for Planning and Consultation (IPaC) database (2025) lists the threatened and endangered species and trust resources that may occur within the project area (see USFWS Species List and the IPaC Report in Attachment A). Based on the IPaC report, there are six federally listed and proposed species that could be found within the project area: alligator snapping turtle, eastern black rail, monarch butterfly, piping plover, rufa red knot, and tricolored bat (USFWS 2025). These species are presented in Table 3-5. The species identified as Threatened, Endangered or Rare Species by Arkansas Game & Fish Commission (AGFC) (2024) that are not federally listed are included in Attachment A as well as a list of Species of Greatest Conservation

Need (SGCN) for the Mississippi Alluvial Plain Ecoregion (AGFC, 2006). No Critical Habitat has been designated within or near the project area.

**Table 3-5. Federally Listed Threatened & Endangered Species with Potential to Occur within the project area.**

| Common Name | Scientific Name | Federal Status | State Status |
|---|---|---|---|
| **Alligator Snapping Turtle** | *Macrochelys temminckii* | Proposed Threatened | Not Listed |
| **Eastern Black Rail** | *Laterallus jamicensis ssp. Jamaicensis* | Threatened | Endangered |
| **Monarch Butterfly** | *Danaus plexippus* | Proposed Threatened | Not Listed |
| **Piping Plover** | *Charadrius melodus* | Threatened | Endangered |
| **Rufa Red Knot** | *Caiidris canutus rufa* | Threatened | Endangered |
| **Tricolored Bat** | *Perimyotis subflavus* | Proposed Endangered | Not Listed |

The USFWS lists the alligator snapping turtle as proposed threatened (USFWS, 2023A). The species is a freshwater turtle that can tolerate fresh to brackish waters. The species can be found in rivers, creeks, bays, bayous, swamps, marshes, and ponds. It is carnivore that feeds by ambushing its prey by luring them in by waving its tongue around to mimic a worm. The work zone does not contain any structure as preferred by the species despite the site being directly next to their preferred habitat. This lack of preferred habitat present reduces the likelihood of the species being present in those areas.

The USFWS lists the eastern black rail (*Laterallus jamicensis ssp. Jamaicensis*) as endangered wherever it is found (USFWS, 2023B). The USFWS lists the project area as an area that the species may occur in. The species primarily feeds on small aquatic and terrestrial invertebrates as well as small seeds along the edges of marshes and open water, where it will probe along the bottom with its beak and pick at the surface of plants. Most populations of the eastern black rail are migratory species, while others are non-migratory and yearlong residents. The species prefers dense marshes, these can be in areas that are impounded or are tidally influenced. Salinity does not influence its preference. It tolerates some shrubs but prefers grasses (NatureServe, 2023C). Based on this information the species is not expected to occur within the project area.

The USFWS lists Monarch Butterfly (*Danaus plexippus*) as a proposed threatened (USFWS, 2023C). It is an orange butterfly with black stripes and white dots on its wings, whose span can be up to 5cm (NatureServe, 2023B). Its breeding habitat consists primarily of milkweed species (*Asclepias sp.*), which its larvae feeds exclusively on. When it is in North America and is migrating, the species can be found pretty much wherever blooming flowers found. The project area does contain an abundance of blooming flowers and as well as milkweed, this and along with numerous recent sittings confirms that this species is common within the area when it is migrating and during breeding season.

The piping plover (*Charadrius melodus*) is a threatened shorebird listed as endangered in the watershed of the Great Lakes of North America and as threatened in the remainder of its range, which includes the Northern Great Plains, the Atlantic Coast, the Gulf Coast, the Bahama Islands, and the West Indies (USFWS, 1996 and 2023D). The USFWS (2023D) identifies the project area as "situated within the probable migratory pathway between breeding and winter habitats [of the Northern Great Plains population].

The Northern Great Plains population of piping plover spends up to 10 months a year on its wintering ground along the Gulf Coast and arrives on prairie breeding grounds in early May. During migration periods, they use large rivers, reservoir beaches, mudflats, and alkali flats (NatureServe 2023A). They feed on a variety of aquatic and terrestrial invertebrates. The species is not expected to occur within the project area and that is because of the lack of preferred habitat.

The rufa red knot (*Calidris canutus rufa*) is a migratory shorebird listed as threatened wherever found (USFWS, 2023E). The project area is listed as a location where the red knot is "known or believed to occur" and is located within the probable migratory path, between breeding in the Arctic tundra and winter habitats in the southern U.S and Central and South America. Red knots forage along sandy beaches and mud flats. The species is not expected to occur within the project area because of the lack of preferred habitat.

The USFWS lists the tricolored bat (*Perimyotis subflavus*) as proposed endangered (USFWS, 2023F), and the LER project area as a location where the species may occur. Should the listing status change to a higher level of protection, then the USACE would avoid cutting trees within the Tricolored Bat pupping season (May 15-July 31).Tricolored bats seasonally migrate between winter hibernacula and summer nursery sites. Roosting may take place in tree cavities, caves, mines, rock crevices, piles of dead leaves, under dead & live leaves, and buildings. Tricolored bats forage along the edge of forests and across waterways near roosting and hibernating sites. They emerge at dusk and feed on various insect species from over water and tops of trees (NatureServe, 2023D). The species may be present within the project area due to the availability of summer roost habitat present.

*Arkansas Natural Heritage Commission*

The Arkansas Natural Heritage Commission (ANHC 2024), administered by Arkansas Department of Parks, Heritage, and Tourism (AR) manages and disseminates information on occurrences of natural communities and rare, threatened, and endangered species. The USACE contacted the ANHC for information for regarding potential species presence in or near the LER project area. The ANHC had no record of state sensitive species occurrences for the project area.

### 3.5.1. Alternative 1: No Action

The implementation of the No Action Alternative would have no effect on federally listed or proposed threatened, endangered, or candidate species potentially occurring in

the LER project area. Nor would there be impacts to migratory birds. Should a breach occur in the left embankment, no suitable habitat would be impacted.

### 3.5.2. Alternative 2: Proposed Action

The Proposed Action Alternative will cause the permanent removal of up to 1.6 acres of BHF that could provide summer roost habitat for listed bat species. This removal would require compensatory mitigation. This would be done by planting and maintaining up to an additional 1.75 acres of BHF near the project site. This mitigation will provide habitat for many non-listed species, but will take several decades before becoming potential suitable bat roosting habitat. No shoreline work is being done that would otherwise impact Piping Plover, and Rufa Red Knot. Nor would any wetlands be impacted that would otherwise be habitat for the Eastern Black Rail. Alligator Snapping Turtle would not be impacted despite project area being directly next their preferred habitat, and that is because there isn't preferred structure available.

Migratory birds listed in the USFWS Species List in Attachment A would not experience any new adverse impacts, as tree clearing would occur outside of their nesting period of March 1 to August 31. If tree clearing must occur during this time period, then a USACE biologist will survey the trees for nests. If found, then the tree would be avoided until the nest is vacant.

The USACE has determined that under the context of Section 7 of the ESA, the implementation of the Proposed Action would have no impact the threatened Eastern Black Rail, Piping Plover, and Rufa Red Knot. The USACE also determined that the Proposed Action would not jeopardize the continued existence of the proposed threatened Alligator Snapping Turtle, Monarch Butterfly, or Tricolored Bat. However, due to the required tree cutting as part of the Proposed Action, should the Tricolored Bat be listed prior to or during construction, USACE would determine the project to may affect, not likely to adversely Tricolored Bat. As such, the USACE has submitted a Northern Long-eared Bat and Tricolored Bat Range-wide Determination Key to the USFWS for review and received a Concurrence Letter with an agreement on the USACE determination on the Tricolored Bat (Attachment A). This determination was reached with the understanding that if the listing status changes to a higher level of protection, then the USACE would avoid cutting trees within the Tricolored Bat pupping season (May 15-July 31).

## 3.6. INVASIVE SPECIES

An invasive species is defined as a plant or animal that is non-native (or native nuisance) to an ecosystem and whose introduction causes, or is likely to cause, economic and/or environmental harm, or harm to human health. Invasive species can thrive in areas beyond their normal range of dispersal. These species are characteristically adaptable, aggressive, and have high reproductive capacity. Their vigor, along with a lack of natural enemies or controls, often leads to outbreak populations with some level of negative effects on native plants, animals, and ecosystem functions and are often associated with disturbed ecosystems and human activities.

Table 3-6 lists many of the invasive and noxious native species found within Jefferson County Arkansas with possibility of occurring within the LER project area. Other species are currently being researched for their invasive characteristics.

**Table 3-6.Invasive and Noxious Native Species Found at Jefferson County with Possibility of Occurring Within Emmett Sanders Lock and Dam.**

| Common Name | Scientific Name | Native/Non-native |
|---|---|---|
| **Cowbird** | *Molothrus ater* | Native |
| **House sparrow** | *Passer domesticus* | Non-native |
| **Red imported fire ant** | *Solenopsis invicta* | Non-native |
| **Emerald Ash Borer** | *Agrilus planipennis* | Non-native |
| **Asian Lady Beetle** | *Harmonia axyridis* | Non-native |
| **Chinese tallow** | *Tridica sebirefa* | Non-native |
| **Japanese honeysuckle** | *Lonicera japonica* | Non-native |
| **Kudzu** | *Pueraria montana* | Non-native |
| **Heavenly Bamboo** | *Nandina domestica* | Non-native |
| **Johnson grass** | *Sorghum halepense* | Non-native |
| **Zebra mussel** | *Dreissena polymorpha* | Non-native |
| **White Nose Syndrome** | *Pseduogymnoascus destructans* | Non-native |

Although native, cowbirds (*Molothrus ater*) have become problematic due to their expanding range associated with agriculture and human development and are considered a nuisance. The close proximity to urban landscaping has led to many common landscape plants becoming aggressive colonizers and are now invasive at Jefferson County, Arkansas.

### 3.6.1. Alternative 1: No Action

The implementation of the No Action Alternative would have a minor, adverse, temporary impacts from invasive species. A breach of the embankment would create disturbed soils that are easily colonized by invasive plant species.

### 3.6.2. Alternative 2: Proposed Action

The implementation of the Proposed Action would have short-and long-term beneficial impacts on invasives within and around LER project area. Repairs to the eroded area on the embankment would decrease the amount of disturbed soil on the site, which will reduce available area for invasive species encroachment. All heavy equipment would be cleaned prior to entering and exiting the LER project area. Other best management practices would also be implemented to prevent the spread of invasive species in the LER project area.

## 3.7. CULTURAL RESOURCES

Cultural resources preservation and management is an equal and integral part of all resource management at USACE-administered operational projects. The term “cultural resources” is a broad term that includes, but is not limited to, historic and prehistoric

archaeological sites, deposits, and features; burials and cemeteries; historic and prehistoric districts comprised of groups of structures or sites; cultural landscapes; built environment resources such as buildings, structures (such as bridges), and objects; Traditional Cultural Properties (TCP) and sacred sites. These property types may be listed on the National Register of Historic Places (NRHP) if they meet the criteria specified by 36 CFR 60.4 as authorized by the NHPA, reflecting significance in architecture, history, archaeology, engineering, and culture. Cultural resources that are identified as eligible for listing in the NRHP are referred to as "historic properties," regardless of category. A TCP is a property that is eligible for inclusion in the NRHP based on its associations with the cultural practices, traditions, beliefs, lifeways, arts, crafts, or social institutions of a living community. Ceremonies, hunting practices, plant-gathering, and social practices which are part of a culture's traditional lifeways, are also cultural resources.

Stewardship of cultural resources on USACE Civil Works water resources projects is an important part of the overall Federal responsibility. Numerous laws pertaining to identification, evaluation, and protection of cultural resources, Native American Indian rights, curation and collections management, and the protection of resources from looting and vandalism establish the importance of cultural resources to our Nation's heritage. With the passage of these laws, the historical intent of Congress has been to ensure that the Federal government protects cultural resources. Guidance is derived from a number of cultural resources laws and regulations, including but not limited to Sections 106 and 110 of the National Historic Preservation Act (NHPA) of 1966 (as amended); Archaeological Resources Protection Act (ARPA) of 1979; Native American Graves Protection and Repatriation Act (NAGPRA); and 36 CFR Part 79, Curation of Federally Owned and Administered Archeological Collections. Implementing regulations for Section 106 of the NHPA and NAGPRA are 36 CFR Part 800 and 43 CFR Part 10, respectively. All cultural resources laws and regulations should be addressed under the requirements of the National Environmental Policy Act (NEPA) of 1969 (as amended), as applicable. USACE summarizes the guidance provided in these laws in ER and EP 1130-2-540.

## CULTURAL CONTEXT

This cultural setting provided below is a summation that provides a general framework for archaeological patterns found in Arkansas. The following is intended to be general enough to provide the reader with a sense of prehistoric and historic lifeways. It is organized by broad chronological periods; as such, the focus is on broader trends of human adaptations.

### 3.7.1. Precontact Context

The precontact period is generally divided into the Paleoindian (13,500-10,000 B.P.), Archaic (10,000-2500 B.P.), Woodland (2500-1100 B.P.), and Mississippian (1100-450 B.P.) periods. A brief overview of cultural developments is discussed below, elaborating on certain character defining features for each period.

*Paleoindian Period (13,500-10,500 B.P.)*

The Paleoindian period corresponds to the late Pleistocene Epoch, during which the climate was cool and dry, and sea levels were significantly lower than current conditions. The classic Paleoindian subsistence model centers on big-game hunting, but direct evidence for megafauna exploitation is rare in the region (Dunbar and Waller 1983). It is likely that Paleoindian groups practiced a much more generalized subsistence strategy. Few details are known about the settlement systems of these groups, although they are frequently assumed to have lived in small social units that were highly mobile, moving seasonally in response to different resources. Traditional hypotheses regarding human entry into the Americas have focused on access over the Bering land bridge and an ice-free corridor to the lower part of the continent thought to have existed around 13,500 B.P. But, the origins of the first Americans and the dates of their arrival have been the subject of debate among archaeologists. Sites in the central and eastern U.S., such as Meadowcroft Rockshelter in Pennsylvania (Adovasio 1978; Adovasio et al. 1990), the Cactus Hill site in Virginia (McAvoy and McAvoy 1997), the Topper site in South Carolina (Goodyear 2005; 2006), the Gault site in south Texas (Collins 2002), the Big Eddy site in Missouri (Chandler 2001; Lopinot et al. 2000; Ray et al. 2000), and at Chiquihuite Cave in Mexico (Ardelean et al. 2018) suggest a potential for earlier North American occupations. However, the radiocarbon dates for these sites are not universally accepted (Fiedel 2013). Recent investigations of the Page- Ladson site in Jefferson County, Florida yielded stone tools in association with butchered mastodon bones in an undisturbed context. These deposits were radiocarbon dated to circa 14,550 B.P. (Halligan et al. 2016). To date, no pre-Clovis sites have been identified in Arkansas.

Paleoindian sites are found throughout the state but are concentrated in northeastern Arkansas (Morse and Morse 1983). Paleoindian peoples relied upon nomadic hunting of a variety of species including megafauna, such as mastodons and bison, along with smaller game (Anderson et al. 1992; Morrow 2006). Settlement patterns included small, mobile bands living in a series of temporary camps. Lanceolate and fluted points, including Clovis, Crowley's Ridge, Folsom, Gainey, Pelican, Redstone, and Sedgewick types, are commonly associated with this period (Morrow 2006; Morse and Morse 1983). Other tools included scrapers, gravers, burins, along with unifacial and bifacial knives.

*Dalton Period (10,500-10,000 B.P.)*

The Dalton period, or phase, is understood to be a transitional period between the Paleoindian and Archaic stages. The time frame has been widely debated, but generally dates from around 10,500 to 10,000 B.P. (McNutt 1996; Morse and Morse 1983). Throughout most of the southeast the Dalton technology is typically associated with either the terminal Paleoindian Period or the emergent Archaic Period. However, because of the presence of other Late Paleoindian/Early Archaic subperiod point types in the region, the cultural group is separated from the main periods. These include Scottsbluff and San Patrice points, Albany scrapers, and other small side and corner notched points such as Kiethville (Coleman 2014; Wycoff 1985).

The hallmark Dalton projectile point is characterized as an unfluted medium to large auriculate point with serrations and typically a concave, ground base. Other tools associated with this period include adzes, spokeshaves, and abraders (Chapman 1975; Goodyear 1974; Walthall 1998). Dalton sites are typically found in the uplands along stream terraces and in riverine settings (Coleman 2014; Gillam 1999). The climatic changes towards the end of the Pleistocene led to the reduction of prairies and an increase in forestation, causing a shift in subsistence strategies (Dunbar 2006). Excavations at the Rodgers Shelter site in southwest Missouri identified evidence of deer hunting supplemented by smaller game during the Dalton phase (Sabo et al. 1990). Evidence of hickory nuts and walnuts as part of the Dalton diet has also been identified (Kay 1982).

*Archaic Period (10,000-2500 B.P.)*

The Archaic period dates from circa 10,000-2500 B.P. and was a time of climate change with the onset of Holocene climatic conditions, which was warmer and wetter than the late Pleistocene. In addition to these changes in temperature and precipitation, there was a significant rise in sea levels as continental glaciers began to melt. Archaic populations' response to these changes included increased population, expansion into new environmental zones, and regional variations in lithic technology.

Archaic groups are commonly assumed to have been highly mobile in response to the seasonality of available resources. Site types are often divided into base camps (residential) and resource extraction or task-specific sites (Phelps 1983). The increase in tool diversity and site locations are widely interpreted as a result of an expanded subsistence and settlement system. Specialized economies developed during the Archaic Period based on available resources, such as deer, shellfish, and nuts. Early Archaic settlements of residentially stable hunting and gathering societies eventually gave way to a generalized resource exploitation strategy with increased sedentism. Sites in the Arkansas River Lowland appear on remnants of ancient terraces, and by the Middle Archaic subperiod, settlements are found on meander belt ridges (House 1982). Projectile points associated with the Early and Middle Archaic subperiods include a variety of corner- and side-notched points, such as Big Sandy, Rice Lobed, and White River, along with stemmed and contracting stemmed types, including Rice Lanceolate, Searcy, and Hidden Valley types (House 1996). Additionally, ground stone technologies were utilized during this period to a higher degree than previously.

By the Late Archaic, a regional specialization using generalized subsistence technology enabled people to efficiently exploit locally available resources (Sabo et al. 1990). The Late Archaic subperiod was dynamic in terms of settlement patterns, subsistence strategies, and site types. Seasonal and long-term formal base camps are common, as is resource-exploitation. Late Archaic populations experimented with horticulture and cultivated several species, including sunflowers (*Helianthus annus*) and squash (*Cucurbita* sp.) (Sabo et al. 1990). Other subsistence practices during the Late Archaic included the gathering and storage of mast (mostly hickory and walnut) and the exploitation of various fauna, including deer, opossums, raccoons, beavers, rabbits, squirrels, muskrats, minks, foxes, wildcats, groundhogs, turkeys, turtles, and fish.

*Woodland Period (2500-1100 B.P.)*

By the Early Woodland subperiod, the climate had stabilized to modern conditions, allowing for even greater sedentism. The first permanently occupied and self-sufficient villages appear during this period. Hunting and gathering remained extremely important subsistence strategies, even as reliance on horticulture (particularly starchy and oily seeded domesticates) increased, setting the stage for the agricultural based economies of the later Mississippian period (Anderson 2005). Seasonal and permanent base camps were common during the Woodland period, as were the more elaborate and regionally specific cultural traditions, such as links to Lower Mississippi River Valley in the eastern part of the state and the Arkansas River Valley Caddoan in the west (Sabo et al. 1990).

Woodland sites have been found in a variety of settings, from bluff shelters to settlements that focused on long-term residential sites on creek and stream floodplains. During the Woodland period, overall climate stability, predictable food resources, and food storage practices encouraged sedentism. During the Woodland period, lithic technology also shifted. The stemmed point tradition of the Archaic period was replaced, overwhelmingly, by the production of smaller, triangular points. Many researchers have noted a probable correlation between point size and time and attributed this to the adoption of the bow and arrow at various times throughout the Southeast (Harris 2010:120; Murphy and Murphy 2010:138).

The Early Woodland in the Ouachita/Ozark Mountains is represented by the Fourche Maline culture (Sabo et al. 1990; Schambach 2001; 2002). This culture is thought to be a continuation of the earlier Wister phase, and sites tend to be located south of the Arkansas River. The overall artifact assemblage is similar to the Late Archaic subperiod. However, ceramic technology appeared during this time. This early pottery was grog-tempered and typically plain. Associated lithic technology included Gary projectile points and double-bitted axes.

Northwest of the project area, the Gober complex (ca. 1300-1000 B.P.) appeared along the Arkansas River during the Late Woodland subperiod. This phase was first identified at the Spinach Patch site in Franklin County and has since also been found in the Lee and Mulberry Creek valleys (Sabo et al. 1990). Gober complex artifacts are similar to the Fourche Maline phase and were originally thought to be related to this culture, but the sites contain evidence of an Emergent Mississippian culture with complex villages, wattle-and-daub houses, and mounds (Schambach 2002). The Gober complex is thought to be the easternmost manifestation of the proto-Spiroan population in the Arkansas Valley. Schambach (2002:100–101) has suggested this phase be renamed the Mulberry River culture to better describe the cultural manifestation that took place during this time.

Southeast of the project area was another Late Woodland subperiod culture, the Plum Bayou (ca. 1300-1000 B.P.). This culture was first defined at Toltec Mounds in Lonoke County, southeast of the City of Little Rock. The site consists of a ceremonial center with 18 mounds, two plazas, and an earthen embankment (Rolingson 1982; 2002; Rolingson and Mainfort 2002). Plum Bayou settlements consisted of permanent

villages and hamlets, with a reliance on hunting, gathering, and farming, including the intensive use of a cereal grain. A variety of ceramic types were produced, such as Baytown Plain, Coles Creek Incised, and Officer Punctuated. Projectile points included Gary variety of Camden and Means Stemmed dart points along with Honey Creek, Rockwall, and Scallorn point types (Nassaney 1996; Rolingson 2002).

*Mississippian Period (1100-450 B.P.)*

The Mississippian period represents an era of complex social arrangements that are recognized archaeologically by hierarchical site relationships, ceremonial mounds, and evidence of agricultural based economies. Although the culture extended over a large portion of the Mississippi River Valley and its tributaries, this period is locally poorly documented due to the lack of identified sites. The Mississippian culture is best represented in the northeastern Arkansas and the Northern Caddo in the western part of the state (Morse and Morse 1983; Sabo 1986).

The general consensus among archaeologists is that a defining characteristic of Mississippian society was their organization into chiefdoms (Anderson 1990; Hally 1975; Pauketat 1994; Peebles 1978; Schroedl 2009; Smith 2000), although a few have recently argued that the chiefdoms were not as rigidly organized as has been portrayed but rather were more fluid (Byers 2009; 2013; Pauketat 2007). Mound sites of this period were typically used for social-ceremonial functions, rather than for mortuary activities, and comprised parts of larger villages or towns. Their subsistence practices incorporated maize and other crops, although hunting and gathering remained important (Hally 1975; Hally and Langford 1988:52; Windham et al. 2008:45).

Shell tempered ceramics and increased “symbol-rich and elaborate ceremonialism” are hallmarks of the Mississippian period (Anderson 2005; Jenkins and Krause 2009). The hafted bifaces of the era remain relatively unchanged from the preceding Woodland period and were small and triangular in form. Settlements consisted of small villages and fortified large towns, sometimes containing temple mounds. In general, permanent settlements were on floodplains of large rivers but smaller sites, probably reflecting extractive or special activities, also occurred and small hamlets existed. Structural remains at these and other small, un-mounded sites surrounding large mound complexes indicate that these peripheral sites, which tend to be found near arable cropland, were more permanently occupied than earlier cultural analogues.

Mississippian deposits have been identified in the Ozark Mountain region. These sites are typically found in alluvial valleys along major streams, but also bluff shelters and uplands sites have been documented. In neighboring Conway County, the Alexander and Point Remove sites contain Mississippian occupations (Hemmings and House 1985; Sabo et al. 1990). The Alexander site was a multi-seasonal camp or small domestic settlement. The artifact assemblage included shell tempered-incised and red filmed pottery, Keota and Sequoyah points, and a variety of tools for food preparation tasks (Hemmings and House 1985).

*Protohistoric and Historic Native American (A.D. 1541-1700)*

The Protohistoric period in Arkansas refers to the time of initial contact and exploration of the Southeast by European societies. The earliest Spanish expedition in Arkansas was Hernando de Soto's (1541-1542), who spent most of the time looking for gold and an overland route to Mexico. During this time, they encountered Native American societies that had emerged from the Late Mississippian cultures (Hudson 1993; Stewart-Abernathy and Watkins 1982). Unfortunately, Spanish contact also introduced diseases that had devastating effects on Native American societies. European-borne diseases, principally smallpox, decimated aboriginal populations and caused the collapse of traditional social, economic, and political institutions (Hudson 1997; Ramenofsky 1982).

In the seventeenth century, the Osage occupied northern Arkansas and the Quapaw were in the area to the east around the confluence of the Mississippi and Arkansas Rivers (Key 2019; Sabo 2019). Both spoke the Dhegiha dialect of the Siouan language group and share cultural features. During this time, Osage villages were encountered by Europeans in southwest Missouri while northwestern Arkansas was primarily used by the Osage for hunting. Based on the language family, it is believed the Osage moved into the area from the Mississippi or Ohio River valleys, possibly as late as the sixteenth century (Sabo 2019). The Osage practiced seasonal agriculture, such as corn, beans, and squash, along with hunting and gathering resources. During the spring, the Osage lived in villages with longhouses, sweat houses, and large meeting houses surrounded by agricultural fields. Buffalo hunts were an important part of their seasonal cycle and occurred in the plains during the summer. During the winter, families would camp in southwest Missouri and northern Arkansas along rivers (Sabo 2019). The Osage built a trade network with the French and Spanish and, in exchange, received horses and manufactured trade goods, such as firearms, tools, and clothing. This alliance led to the strengthening of the Osage's control in the region.

Based on the Quapaw oral traditions, they immigrated to the Arkansas River Valley from the Ohio River Valley in the sixteenth century, likely between de Soto's 1542 exploration and the arrival of the French (Key 2019). The first European account of the Quapaw was in 1673 when French explorers, led by Father Jacques Marquette and Louis Joliet, encountered Quapaw villages within the Mississippi River Valley (Key 2019).

At this time, Quapaw were primarily farmers who supplemented their diet with hunting, fishing, and gathering. Their villages consisted of longhouses, a central plaza, and council houses. Quapaw populations were greatly affected by smallpox epidemics and raids by other tribes in the late seventeenth through the eighteenth century. The population decline led to the unification of the Tourima and Tongigua villages in 1721 in Desha and Arkansas Counties in eastern Arkansas (Key 2019). The Quapaw were trade allies with the French and fought on their side during the French and Indian War.

### 3.7.2. Historic Context

The historic period is generally divided into exploration and early settlement, Native American removal, early statehood through the Civil War, Civil War and reconstruction, new south (1875-1929) and modern Arkansas (1930+). A historic context unique to the USACE Lock & Dam No. 4 is presented focusing on the lock as a whole and its component parts.

*Exploration and Early Settlement*

After Hernando de Soto's initial expedition, it would be another 130 years before the next Europeans set foot in Arkansas. In the summer of 1673, a Jesuit missionary, Father Jacques Marquette, and Louis Joliet, a trader, led a French expedition into the territory. The primary goal of the expedition was to the find the mouth of the Mississippi River, which they hoped would be a route to the Pacific Ocean, and additionally, to set up a French Indian trade system. Near the mouth of the Arkansas River, the explorers encountered the Quapaw, who they would call the Arkansas, spawning a new name for the river and region as well (Key 2019).

In 1682, Sieur de La Salle and Rene-Robert Cavelier travelled up the Mississippi to the mouth of the Arkansas River, at which time LaSalle claimed the Mississippi River valley for France, naming the territory Louisiana after King Louis XIV. Throughout most of the colonial period, Arkansas remained part of Louisiana (Mitchell 2013). Henri de Tonti, who travelled with La Salle, established the Arkansas Post, located on the Arkansas River about 30 miles southeast of Little Rock, in 1686. The Arkansas Post was the first permanent European settlement established in the Mississippi Valley, and would serve as the area's governmental, military, and trade headquarters into the 1800s (DuVal 2017). In central Arkansas, the line of settlement would follow the Arkansas River northwest from the Post.

In 1803, the United States purchased the Louisiana Territory from France. The area totaled over 800,000 square miles of land, approximately one quarter of the contiguous U.S. stretching from New Orleans to Canada. The transaction remains the largest land acquisition in American history and enabled the U.S. to open up the territory to western settlement and use the port of New Orleans duty-free. It also granted territorial status to its white citizens. In Arkansas, it meant the end of European dominance as American pioneers settled the area (Baker 2017). In 1812, after Louisiana gained statehood, the remaining area was renamed the Missouri Territory. The following year, Arkansas County was established, comprising approximately two-thirds of the State's current boundary, along with part of eastern Oklahoma (Horvath et al. 2020). Arkansas became a separate territory in 1819 and was divided into the five counties.

The first permanent post-Purchase settlement in central Arkansas was located near the intersection of the Arkansas River and Cadron Creek, approximately six miles north of Lollie. What is known as the "Cadron Settlement" refers to approximately 30 white families scattered in the area (Peterson and Norman 2018). One of the first settlers was John McElmurry, a trader that settled in the area as early as 1810 and claimed pre-emption rights under the Act of Congress of April 12, 1814. One of the earliest mail

routes in the Arkansas Territory, established in 1816, was a route to Cadron, which then crossed the river and continued south to Hot Springs (Arkansas Historic Preservation Program 1974). In 1818, McElmurry laid out a town with as many as 14 blocks surrounding a central square (Peterson and Norman 2018). Cadron was seriously considered as a site for the Territorial Capitol, but Little Rock won out, and Cadron would eventually be abandoned (Arkansas Historic Preservation Program 1974).

*Native American Removal*

Due to pressures from encroaching European settlers, people from the Cherokee and Choctaw tribes east of the Mississippi were migrating into Arkansas beginning in the late 1700s. The Cherokee were given permission to settle in this area by the Quapaw, who lived near the mouth of the Arkansas River, even though the Osage had claimed the territory as their own (Branam and Tully 2016). By the early 1800s, more than 1,000 Cherokee were living along the Arkansas River near current-day Russellville, in lands that were used as hunting grounds by the Osage of southwest Missouri. As a result of the attacks on the Cherokee by the Osage, in 1817 the government established an official reservation for the Cherokee, which numbered around 3,000 by this time. The reservation occupied a sizable portion of northwestern Arkansas (Davis 1976). The reservation's eastern boundary ran from Point Remove Creek, just west of present-day Morrilton, to the White River just upstream from Batesville. In the west, it ran from the area of present-day Harrison to Fort Smith, which was also established as a military post to prevent attacks between the tribes (Logan 1997). Fort Smith Military Post was the first major Euro-American settlement in western Arkansas. The Choctaw also owned a large swath of land, south of the Arkansas River, that was granted to them in the treaty of Doak's Stand in 1820.

In 1825 and 1828 respectively, the Choctaw and Cherokee in Arkansas signed treaties exchanging their Arkansas reservation for lands west of the territorial border. This preceded the removal of the Cherokee, Muscogee, Choctaw, Chickasaw, and Seminole from their tribal lands in the southeastern United States to Indian Territory (present-day Oklahoma), under the 1830 Indian Removal Act, on what is known as "The Trail of Tears." Although many routes, both land and water, were used during Indian Removal, all of them traveled through Arkansas.

One of these routes was the military road between Little Rock and Fort Smith on the Oklahoma border, and on to Cantonment Gibson in the newly established Indian Territory, which passed the project area on its way to Cadron (Paige et al. 2003: 2). All through the 1830s, large groups of Native Americans were a common site on the roads. Estimates are that approximately 40,000 trial peoples moved through the area during this time. "Indeed, it can be safely said that what is now North Little Rock and its surrounding area, was the site of more concentrated activities related to the removal of the five large southeastern tribes than any other place along the projected Trail of Tears National Historic Trail" (Paige et al. 2003: 2). The significance of the site is linked to its location at the intersection of the major transportation routes through the state at the time, which were the rivers, specifically the Arkansas, which crossed the territory east-west. Little Rock was situated at the highest easily navigable point on the river.

*Early Statehood Through the Civil War*

The Territory of Arkansas was granted statehood in 1836 and settlement was encouraged by a few different Federal acts. The first was the 1829 Act Restricting the Location of Certain Land and Claims in the Territory of Arkansas, which set aside the sixteenth section of each township to fund public education. The Preemption Act of 1841 granted 500,000 acres of land to Arkansas and eight other states to sell at 1.25 dollars per acre to raise revenue for improvements within the state, with squatters given the option to purchase. The third act was the Federal Swamp Land Act of 1850 that transferred ownership of all unclaimed swamp and overflow lands to the states, which raised additional revenue. By 1850, over 200,000 non-native people had settled in Arkansas (Horvath et al. 2020:3–11).

As the railroad would not arrive until after the Civil War, trade was still conducted primarily along primitive roads and rivers using simple flatboats and keelboats. The arrival of steamboats during the mid-1800s improved trade potential and consequently, encouraged more settlement and the establishment of towns along the trade routes (Horvath et al. 2020:3–12).

Although hunters and trappers were among Arkansas' earliest settlers, farmers made up more than 90 percent of the state's population during territorial times (Williams 2019). "A typical hill country farm through most of the nineteenth century had about thirty acres in cultivation—ten acres of corn, five acres of cotton, and the rest in cereal grains, sometimes tobacco (particularly in the Ozarks), potatoes, and vegetables. The remaining property was open range for livestock, was used for hunting or fishing, and was a source for firewood, wood for tool handles, roofing shingles, and other needs" (Williams 2019). Commercial agriculture would eclipse subsistence farming by 1850, with cotton as the dominant crop. Until the early 1800s, cotton was a minor crop grown throughout the state, but the fertile soil of the Mississippi Delta on the east side of the state proved very hospitable to its cultivation. Several Delta plantations were many thousand acres in size. By the Civil War, Arkansas, along with Alabama and Mississippi, produced three-fourths of the cotton grown in the United States (Santeford and Martin 1980:50).

The plantation economy was driven by slavery. The first enslaved individuals entered the territory with settlers as early as 1720. By 1810, the state census recorded 188 enslaved individuals in a total population of 1,062 persons, approximately twenty percent of the population. That number grew to 4,576 in 1830; 19,935 in 1840; 47,100 in 1850; and 111,115 in 1860, at which point enslaved individuals made up 25 percent of the total population of the state (Moneyhon 2020). On average, one out of every four citizens owned or leased enslaved individuals. Ten enslaved individuals would have been considered a large holding. However, some of the larger plantation owners in the rich valley and delta lands along the state's waterways had much larger holdings. Elisha Worthington owned more that 500 enslaved individuals at his plantation in Chicot County prior to the Civil War (Moneyhon 2020).

*Civil War and Reconstruction*

On the eve of the Civil War, most Arkansans remained loyal to the Union, while still supporting slavery and hoping for a peaceful resolution. After Lincoln's election and the secession of seven southern states at the end of 1860, a convention was held in the Spring of 1861 to consider Arkansas' position. Though an attempt to pass a secession ordinance was barely rebuffed, the delegates agreed that any attempt by the Federal government to force the seceded states back into the Union would be grounds for Arkansas to join them in secession. That action came when President Lincoln called for men from Arkansas to help suppress the rebels after Confederate forces fired on a Federal garrison at Fort Sumter in Charleston, South Carolina. The reassembled Secession Convention voted 69-1 in favor of secession and Arkansas left the United States at 4:00 pm on May 6, 1861 (DeBlack 2018).

Although delegates were almost unanimous in their vote to secede, many ordinary citizens opposed the move, particularly those in the northwestern portion of the state, where slavery-based agriculture was much less prevalent. In the southern and eastern sections of the state, secession was largely supported, and Arkansas supplied a larger proportion of military-age fighting men than any other state in the Confederacy (DeBlack 2018). Most men were shipped east, though some stayed to serve in their home state. Arkansas would not see any fighting until February 1862, after which there were several confrontations, mainly in the eastern part of the state. One major battle was fought in Jefferson County, Arkansas called the "Battle at Pine Bluff" or the "Action at Pine Bluff." This battle was fought on October 25, 1863, by a confederate cavalry division against a small union garrison at Pine Bluff following the capture of Little Rock. The purpose of the battle for the confederacy was to return the strategic initiative in their favor for retaking Little Rock. The confederate army failed to capture back Pine Bluff, resulting in confederate losses totaling 40 dead and wounded (Christ 2024). A brief skirmish occurred at Pine Bluff on June 17, 1864, at Monticello Road. This brief engagement resulted in the confederates being defeated retreating down the road and their camp being destroyed by the union army. This union victory was the result of patrolling and information gathering outside the union stronghold at Pine Bluff (Sesser 2023).

*New South (1875-1929)*

Arkansas experienced a period of economic and social change following the Reconstruction period because of the expansion of the state's infrastructure. During this time, statewide efforts were made to return Arkansas to pre-war levels of production and to bring the state back into the economic mainstream of the nation (Moneyhon 1997:3). These steps included diversifying and increasing agricultural production and stimulating manufacturing. Transportation systems were improved and expanded during this period; improved transportation through the construction of better roads and railroads expanded industry.

Cotton continued to be a primary cash crop in northeast Arkansas until the mid-to-late twentieth century, but Arkansas had become the second leading rice producer in the nation by 1919 (Moneyhon 1997:97). Some lands were converted from cotton production during this rice boom and thousands of acres of new bottomland were

cleared for the first time to facilitate rice production. Arkansas also experienced a surge in manufacturing. The number of manufacturing firms jumped from 547 to 1,167 in the first decades of the twentieth century (Johnson 2000:4).

Draining and clearing opened central Arkansas up for agricultural development. The period from 1875 to 1950 is known as the tenant period and is named for the sharecropping or tenant farm labor system that was a significant characteristic of southern U.S. agriculture after the Civil War. The decentralization of the former plantation system developed during the reconstruction period as a means of stabilizing labor relations between freedmen and landowners.

The importance of the tenant farm period in the archaeological record is that it probably represents the maximum occupation of the Eastern Lowlands prior to the recent development of non-farm rural settlement. Stewart-Abernathy and Watkins (1982:HA18) suggest that there are between 30,000 and 50,000 tenant period sites in eastern Arkansas. The issue of these rural farmsteads (i.e., tenant) period sites' NRHP significance status has generated some commentary (Wilson 1990). Tenant settlement patterns can be clearly observed on 1930s era quadrangle sheets and aerial photographs, with structures aligned along roads and bayous at regular spacings (100-400 m). The dispersed settlement pattern of the tenant period is in sharp contrast to the clustered settlement pattern prior to 1865 (Orser and Nekola 1985:68).

The archaeological characteristics of tenant period sites include high frequencies of Kitchen Group artifacts (up to 85 percent), primarily bottle glass and ceramics, all dating from the late nineteenth century to the mid-twentieth century (Buchner 1992). The ceramics are typically cheaper types, often from mismatched sets, and many of these types can be identified following C.R. Prices work on 19th century ceramics (Price 1979). Mean ceramic dates are often not calculated for these sites due to the long span of whiteware production (1830 to present), as well as problems relating to temporal lag. Omitting the brick counts, the Architecture Group artifacts are generally about as frequent as Activity Group artifacts (approximately 5 percent each). Only trace frequencies of other artifact groups are found (Arms, Clothing, Personal, Biological), and in small assemblages, these minority group types are often not represented. The cultural material at tenant period sites is typically from near surface, plowzone contexts, as a result of the structures typically being elevated on brick, concrete, or cypress stump piers. Occasionally, tenant period sites are multi-component, i.e., co-occur with prehistoric material; this is largely dependent on the natural setting of the site. However, it's important to note that many tenant period sites are located on silty clay (backswamp/backslope) soils that were not suitable for human habitation until after drainage improvements were made.

*Modern Arkansas (1930+)*

Arkansas was hit hard by the Depression. Roosevelt's Federal Emergency Relief Administration (FERA) was distributing relief resources to 15% of Arkansas's families by the fall of 1933 (Johnson 2000:16). Failed farmers and displaced tenants often found employment in isolated sawmill company towns before the Depression, but that industry was devastated by the economic downturn. Employment in the lumber industry declined

by 60% and production declined by 80% between 1925 and 1932 (Johnson 2000: 24). The Depression hit agricultural regions such as northeast Arkansas especially hard at the same time.

Plummeting cotton prices at the turn-of-the-twentieth century and a rising demand for soybeans and rice in the early twentieth century spurred landowners to push for more flood control so that more and more marginal flood-prone land could be brought into agricultural production (Johnson 2000:180). Levee systems were improved during this time. The Civilian Conservation Corps (CCC) put over 200,000 Arkansas men to work. There were 77 CCC companies in four regions across the state taking on 100 different types of tasks, including building parks, hiking trails, planting trees, and fighting soil erosion. The CCC in Arkansas was responsible for construction of 446 buildings, 6,400 miles of road, eight dams, 250 miles of fence, 86 forest observation towers, planted 19,463,745 trees, and installed 8,600 miles of telephone line. CCC workers were responsible for multiple improvements and structures in Arkansas's first state park, Petit Jean State Park. The Works Progress Administration (WPA) also employed rural laborers in building bridges, courthouses, dams, roads, parks, schools and recreational facilities.

Much of Arkansas's virgin forests were removed and its great swamps drained to increase arable land, and rice eventually surpassed cotton in importance in northeast Arkansas beginning in the mid twentieth century (Brown et al. 1980:2). Despite the increase in arable bottomland, the sharecropping/tenancy system of labor continued until midcentury when the tenant labor force began to be displaced by the wage-labor-dependent system of mechanized farming in the 1950s.

As Holley (2000:71) has noted:

> As a result of New Deal agricultural policies [,] plantations took the first steps away from decentralized tenant farms and toward large-scale, consolidated, mechanized, and wage labor-dependent operations. Planters took advantage of federal programs to increase their income, and at the same time these programs enabled them to cut costs, particularly labor costs.

*Emmett Sanders Lock and Dam No. 4*

The construction of the USACE Lock & Dam #4 started in 1964 and was completed in 1968. This lock and dam and its associated features are part of the system called the McClellan-Kerr Arkansas River Navigation System (MKARNS). The creation of the MKARNS would enable the Arkansas River to be controlled resulting in reliable transportation and commerce on the river.

A series of floods in the first decades of the twentieth century led the U.S. Congress to pass several Flood Control Acts. The first, in 1917, was enacted to control flooding on the Mississippi, Ohio, and Sacramento rivers. The second was the Flood Control Act of 1928 that was enacted as a result of the Great Flood of 1927 in which unrelenting rains soaked the Mississippi and Ohio River valleys during the first four months of 1927. At this time the Corps of Engineers and the Federal Power Commission were charged with developing a list of some 200 rivers on which navigation and hydroelectric power might

be developed (Bolton 1995). For the Arkansas River this resulted in the “Arkansas River 308 Report” which examined in great detail the possibility of a nine-foot-deep navigational channel from the Mississippi River to the vicinity of Tulsa, Oklahoma. The navigation route would begin at the mouth of the White River and follow the natural cutoff to the Arkansas River and then continue up the Arkansas to the Verdigris River and follow it to Catoosa, Oklahoma. This waterway would travel 537 miles and require 40 locks with an average lift of 11 feet (Bolton 1995). Additional flooding in the 1930s led to the Flood Control Act of 1936 passed by President Franklin D. Roosevelt (Horvath et al. 2020), which recognized flood control as a national responsibility and approved a large number of projects to implement the concept. In 1943, the USACE southwestern division submitted a new report that would become the basis for the McClellan-Kerr Arkansas River Navigation System and was published in 1947 as House Document No. 758 (Bolton 1995). In 1956 Congress passed a Public Works appropriation and President Eisenhower signed it into law funding the construction of the Dardanelle Lock and Dam, Keystone Dam and the Eufaula Reservoir starting the overall multi-purpose plan for the Arkansas River and leading ultimately to the construction of the Emmett Sanders Lock and Dam No. 4, including its left overflow embankment.

The Emmett Sanders Lock and Dam No. 4 was authorized by the River and Harbors Act of 24 July 1946. The features composing Lock and Dam No. 4 include an overflow embankment on the left bank; a concrete training wall; a concrete gate-controlled dam across the main portion of the river; a navigation lock along the right side of the river; and a short overflow embankment on the right bank extending from the lock esplanade to the mound where the resident office is located and an access road on the right embankment (USACE 1964).

The purpose of the overflow embankment is to pass floodwaters. A Lock & Dam can be configured multiple ways as long as it is able to pass the probable maximum flood during high flows and maintain a minimum navigation depth during low flows. Several different structure configurations are considered during the design process such as the length of the concrete gated weir, number of gates, raising levees, purchasing flowage easement, length of overflow embankments, etc. Passage of this discharge may be exclusively through a gated spillway, but a portion could pass over the lock, the esplanade, and overflow weirs or embankments extending across the waterway overbanks (USACE 1987). The relatively low embankment sections used on the Arkansas River were designed for submerged conditions with head differentials of up to three feet. These riprap protected embankments are either access or non-access embankments having trapezoidal cross sections with a 1V on 3H (or one foot vertical for every three feet horizontal) upstream face and a 1V on 4H (or one foot vertical for every four feet horizontal) downstream face. The access embankments have a paved roadway on the crown of the embankment (USACE 1987).

### Cultural Resources within One Kilometer of the Area of Potential Effect (APE)

The APE and a one-kilometer buffer surrounding it (i.e., indirect effects), was examined for the presence of any known historic properties using the AAS Automated

Management of Archaeological Site Data in Arkansas (AMASDA) database, the Arkansas Historic Preservation Program (AHPP) GIS data, historic maps/aerials, etc. This review found four previous cultural resource surveys that took place within a kilometer of the APE (Table 3-7). These inventories didn't locate any archaeological sites; however, one archaeological site was identified, not by a cultural resource survey, but through the USACE laying subsurface telephone cables near the USACE Pine Bluff project office near Lock & Dam No. 4. This identified site is within a kilometer of the APE. The APE hasn't been covered by a previous cultural resource survey.

**Table 3-7. Cultural Resource Surveys within a kilometer of the APE.**

| ear | Report Title | Authors |
|---|---|---|
| 989 | Cultural Resources and Geomorphological Reconnaissance of the McClellan-Kerr, Arkansas River Navigation System, Pools 1 through 9 | Bennett et al. |
| 991 | Archeological Survey and Testing AHTD Job Number 20071, Lock and Dam Number 4 Demonstration Project, Jefferson County, Arkansas | McClurkan, B. |
| 005 | Cultural Resource Reconnaissance and Inventory of 72 Army National Guard Local Training Areas in Arkansas | Pan American Consultants, Inc. |
| 008 | Phase I Cultural Resource Survey of the Proposed Sparta Aquifer Conversation Project, Jefferson County, Arkansas | Albertson, E. |

The USACE defined the APE and USACE archaeologists intensively surveyed the APE to identify historic properties that have the potential to be affected by constructing the undertaking, in accordance with Section 106 of the NHPA.

### 3.7.3. Alternative 1: No Action

There will be no foreseeable horizontal or vertical impact to the known historic property within the fee boundary, aside from the natural formation processes that occur over time.

### 3.7.4. Alternative 2: Proposed Action

The Area of Potential Effect (APE) as defined in 36 CFR 800.16(d) was established and subjected to an intensive cultural resource survey. One precontact isolated occurrence was identified and recorded during the survey. Isolated occurrences are categorically considered to be not eligible to the National Register of Historic Places (NRHP). One architectural resource was identified during the survey-JE1350. This historic architectural resource was assessed as to its potential eligibility for listing on the NRHP. Resource JE1350 is determined to be eligible under Criteria A, as a contributing element to the overall interpretation of Lock and Dam No. 4 and to the MKARNS system as a whole. Resource JE1350 will be directly impacted by this undertaking, but the repair/modifying of JE1350 will not adversely affect it. The repair/modifying of JE1350 will not alter the integrity of the left overflow embankment in any way that will diminish its role as a contributing element to the overall interpretation of Lock and Dam No. 4, or the larger MKARNS system for which it is a part. Although being subjected to many years of maintenance, JE1350 retains a high level of integrity as it retains its overall location, design, setting and association still serving the function for which it was constructed. The two associated features to JE1350 (two pile clusters) will not be

impacted at all by this undertaking and will be left in place undisturbed. JE1350 will be repaired/modified, but it will still function as originally designed having no effect on the navigability of the MKARNS. The performance of this undertaking will not hinder JE1350's ability to convey its significance. Based on these factors, this has led the USACE Little Rock District to determine that this portion of the proposed undertaking will not adversely affect any historic properties (36 CFR 800.5 (b)).

The results of this cultural survey were written up in a Section 106 report and submitted to the office of the Arkansas State Historic Preservation Officer (SHPO), the Caddo Nation, the Cherokee Nation, the Choctaw Nation, the Muscogee (Creek) Nation, the Osage Nation and the Quapaw Nation. After a period of 30 calendar days responses were received from the Arkansas SHPO, the Quapaw Nation, the Cherokee Nation, the Choctaw Nation and the Osage Nation. The Arkansas SHPO and the Tribal Nations that responded within the 30 days each concurred with the results of the survey, the eligibility determination and the effects determination for the undertaking.

## 3.8. AESTHETIC RESOURCES

The LER project area is situated on the Arkansas River, of which it provides public access to this river. This access allows the public the opportunity to view the aesthetics of the river as well as the surrounding landscape and vegetation. The landscape can be best described by relatively flat terrain with interspersed farms, forests, and marshes.

### 3.8.1. Alternative 1: No Action

There would be no impacts on aesthetic resources as a result of implementing the No Action Alternative.

### 3.8.2. Alternative 2: Proposed Action

The implementation of the Proposed Action would have minor impacts on the aesthetics around the LER project area. The impacts would come from the permanent removal of the BHF and then mitigating it with planting it nearby. The size of the BHF and of what is being replaced with as well as the relative abundance BHFs in the surrounding area is what would make this a minor impact.

## 3.9. HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

In order to complete a feasibility level HTRW evaluation for the Emmett Sanders Project, a records search was conducted following the rules and guidance of ER 1165-2-132: HTRW Guidance for Civil Works Projects, and ASTM E1527-13: Standard Practice for Environmental Site Assessment: Phase 1 Environmental Site Assessment Process. In the records review, files, maps and other documents that provide environmental information about the project area are obtained and reviewed. To complete the records review, USACE reviewed publicly available databases and sources, using the proposed footprint of the project, along with an approximate 1 mile search distance for each of the sources. The records search revealed no HTRW sites in the vicinity of the project area. There were facilities and sites with NPDES permits but since none were listed with any incidents, they would not be considered as a REC.

Regarding the potential environmental contamination and the sources of releases to the environment in and around the Emmett Sanders Project, contaminants could enter the Emmett Sanders environment via air or water pathways. The highways and roads, marinas, and private residences in the vicinity of the waterway could also provide sources of contaminants. There are multiple marine terminals at Emmett Sanders and 1 that provides boat fueling service. This fuel dock is regulated by the USCG with regard to spill containment and cleanup requirements. There have been no major releases of boating fuel to the waterway in the past 5 years per the Toxic Release Inventory database. There are also numerous public recreation areas/parks around the waterway that could contribute small amounts of hazardous materials and waste to the watershed. Illegal trash dumping on nearby lands by individuals and businesses, is a common problem. Golf courses and numerous private residences and commercial facilities also surround the waterway, and fertilizer and pesticide/herbicide use at those locations could contribute minor amounts of hazardous materials to the waterway. Public trash and garbage pickup and disposal is provided for all properties in the surrounding area by commercial solid waste removal contractors.

#### 3.9.1. Alternative 1: No Action

There will be no short- or long-term, minor, moderate, or major, beneficial, or adverse impacts on hazardous, toxic, or radioactive wastes (HTRW) as a result of implementing the No Action Alternative, as there will be no changes to the existing conditions.

#### 3.9.2. Alternative 2: Proposed Action

There will be no short- or long-term, minor, moderate, or major, beneficial, or adverse impacts on hazardous, toxic, or radioactive wastes (HTRW) as a result of executing the project, as there is not an HTRW concern at the site.

### 3.10. HEALTH AND SAFETY

ESLD authorized purposes include navigation, and water supply. This enables the ESLD protect the areas downstream of the ESLD from flooding and provides surrounding residents with a steady supply of drinking water. These authorized purposes also ensure that the ESLD provides for safe passage of commercial and recreational vessels that wouldn't be able to if it wasn't there. The USACE regularly inspects the ESLD to ensure that is functioning properly and ensures that it is well maintained as well as the nearby Sheppard Island Park. The Sheppard Island Park boat ramp is closed whenever unsafe boat launching conditions are deemed present.

#### 3.10.1. Alternative 1*:* No Action

There would be negligible adverse impacts on health and safety as a result of implementing the No Action Alternative. The impacts would come from the ESLD would still be unable to allow for emergency vessels to safely navigate through the ESLD in highwater events.

#### 3.10.2. Alternative 2: Proposed Action

The implementation of the Proposed Action would have negligible impacts on health and safety within and around LER project area. The impacts would come from the

ESLD being able to allow emergency vessels to safely navigate through the ESLD in highwater events.

## 3.11. SUMMARY OF CONSEQUENCES AND BENEFITS

Table 3-8 provides a tabular summary of the consequences and benefits for the No Action and Proposed Action Alternatives for each of the 10 assessed resource categories.

## Table 3-8. Summary of Consequences and Benefits

| Resource | Change Resulting from the Proposed Action | Environmental Consequences: No Action Alternative | Environmental Consequences: Proposed Action Alternative | Benefits Summary |
|---|---|---|---|---|
| **Land Use** | No change, will help to maintain existing land uses as they presently are. | Moderate, short- and long-term, adverse impacts because of the eventual temporary change of water level which will impact nearby land use. | Provides moderate, beneficial , short-and long-term impacts by maintaining existing land use. | Will prevent the repeated wait on temporary repairs to the ESLD before land uses can be restored. |
| **Climate** | No change. | No Impacts. | No Impacts. | No added benefit. |
| **Air Quality** | No change | No Impacts. | No impacts. Various BMPs will be in place to limit dust emission as a result of the repairs, construction, and tree clearing activities. | No added benefit. |
| **Natural Resources** | No change, will help to maintain existing land uses as they presently are. | Minor, short- and long-term, adverse impacts because of the eventual temporary change of water level which will destroy the existing habitat for that area. | Provides minor short- and long-term impacts by removing and mitigating a BHF. | Mitigates for the loss of up to 1.6 acres of BHF with planting up to 1.75 acres of BHF nearby. |

| Resource | Change Resulting from the Proposed Action | Environmental Consequences: No Action Alternative | Environmental Consequences: Proposed Action Alternative | Benefits Summary |
|---|---|---|---|---|
| **Threatened and Endangered Species, including SGCN species.** | No change, will help to maintain existing land uses as they presently are. | Will have no effect on federally listed species under the context of Section 7 of the ESA. | Will have no effect on federally listed species under the context of Section 7 of the ESA with the exception of the Tricolored Bat which would have May Affect, Not Likely to Adversely Effect. | No added benefit. |
| **Invasive Species** | No change, will help to maintain existing land uses as they presently are. | Minor, adverse, temporary impacts because a breach of the embankment would create disturbed soils that are easily colonized by invasive plant species. | Will have short-and long-term impacts on invasives within and around LER project area. Will have various BMPS in place to prevent the spread of invasive species while construction is going on. | Reduces the spread of invasives species, by reducing the opportunities for their spread from the creation of barren lands. |
| **Cultural Resources** | No change, will help to maintain existing land uses as they presently are. | No Potential to Affect. | Will not adversely affect any historic properties. | No added benefit. |
| **Aesthetic Resources** | No change, will help to maintain existing land uses as they presently are. | No Potential to Affect | Minor impacts by removing and mitigating for the BHF. | Would mitigate the permanent loss of up to 1.6 acres with planting up to 1.75 acres BHF nearby . |
| **Hazardous, Toxic, and Radioactive Waste** | No change, will help to maintain existing land uses as they presently are. | No impacts. | No impacts | No added benefit. |

| Resource | Change Resulting from the Proposed Action | Environmental Consequences: No Action Alternative | Environmental Consequences: Proposed Action Alternative | Benefits Summary |
|---|---|---|---|---|
| **Health and Safety** | No change, will help to maintain existing land uses as they presently are. | Negligible adverse impacts because of the ESLD would be unable to allow for emergency vessels to safely navigate through the ESLD in highwater events. | Negligible beneficial , impacts by providing passage for emergency vessels. | Allows for emergency vessels to safely navigate through the ESLD in highwater events. |

## SECTION 4: CUMULATIVE IMPACTS

NEPA regulations require that cumulative impacts of a proposed action alternative be assessed and disclosed in an EA. Cumulative impact is an impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Impacts can be positive or negative.

By Memorandum dated June 24, 2005 from the Chairman of the CEQ to the Heads of Federal Agencies entitled "Guidance on the Consideration of Past Actions in Cumulative Effects Analysis", CEQ made clear its interpretation that "…generally, agencies can conduct an adequate cumulative effects analysis by focusing on the current aggregate effects of past actions without delving into the historical details of individual past actions…" and that the "…CEQ regulations do not require agencies to catalogue or exhaustively list and analyze all individual past actions." CEQ guidance also recommends narrowing the focus of cumulative impacts analysis to important issues of national, regional, or local significance.

The initial step of the cumulative impact analysis uses information from the evaluation of direct and indirect impacts in the selection of environmental resources that should be evaluated for cumulative impacts. A Proposed Action would not contribute to a cumulative impact if it would not have a direct or indirect effect on the resource.

Based on a review of the likely environmental impacts analyzed in Section 3 (Affected Environment and Consequences) the USACE determined that the analysis of cumulative impacts will be limited to: land use, water resources, climate, air quality, topography, geology, soils, natural resources, threatened and endangered species, invasive species, cultural resources, historical resources, archeological resources, recreation, aesthetic resources, and health and safety. With respect to the remaining resource topics such as climate, air quality, socioeconomics, at risk communities, natural resources, invasive species, HTRW, water resources, and Health and Safety both the No Action and Proposed Action alternatives will either:

1. Not result in any direct or indirect impacts and therefore will not contribute to a cumulative impact; or,

2. That the nature of the resource is such that impacts do not have the potential to cumulate. For example, impacts related to geology are site specific and do not cumulate; or,

3. That the future with or future without project condition analysis is a cumulative analysis and no further evaluation is required. For example, because changing conditions is global in nature, the future without project condition and future with project condition analysis is inherently a cumulative impact assessment.

The zone of interest for all resources except economy is Jefferson County, Arkansas. The zone of interest for economics is the same used in Section 3.10.

## 4.1. PAST IMPACTS WITHIN THE ZONE OF INTEREST

ESLD was originally authorized and still is a part of the MKARNS Navigation System. The construction of the MKARNS began in 1957 with the major components being completed in December of 1970. The construction of the USACE Lock & Dam #4 started in 1964 and was completed in 1968. The authorized purpose of the MKARNS is to provide for navigation, fish and wildlife, recreation, water supply and irrigation needs. The total project area at MKARNS that the USACE Little Rock District manages encompasses 46,430.7 acres, including the 46,163.6 acres of surface water. The zone of interest for cumulative impact analysis will be limited to the area surrounding the LER project area.

## 4.2. CURRENT AND REASONABLY FORESEEABLE PROJECTS WITHIN AND NEAR THE ZONE OF INTEREST

At the time of this publication, there are not any major projects like road expansion, new industrial centers, neighborhoods being built, and new hiking trails in and around the LER project area.

## 4.3. ANALYSIS OF CUMULATIVE IMPACTS

Impacts on each resource were analyzed according to how other actions and projects within the zone of interest might be affected by the No Action Alternative and Proposed Action Alternative. Impacts can vary in degree or magnitude from a slightly noticeable change to a total change in the environment. For the purpose of this analysis the intensity of impacts will be classified as negligible, minor, moderate, or major. These intensity thresholds were previously defined in Section 3.0. No growth and development are expected in the vicinity of LER project area and cumulative adverse impacts on resources will not be expected when added to the impacts of activities associated with the Proposed Action or No Action Alternatives. A summary of the anticipated cumulative impacts on each resource is presented below.

### 4.3.1. Land Use

Impacts would occur if any action were inconsistent with adopted land use plans (but the impact could be beneficial or adverse, depending on what it is). Major impact would occur if an action would substantially alter those resources required for, supporting, or benefiting the current land use. Under the No Action Alternative, land use would not change. However, overtime the impacts from not doing the repairs would eventually lead to the demise of the ESLD and the associated bridge that traverses it. The impact from not doing the associated work would make it harder if not impossible for emergency vessels to navigate through the ESLD in highwater events. It would also make it harder for future repairs to be done on the left embankment because repair vehicles would not easily be able to traverse the crown of the embankment. However, the BHF would still be left to mature on its own accord. The removal of the BHF is small in comparison to the surrounding area of BHF. Therefore, cumulative impacts on land use within the area surrounding LER project area, when combined with past and proposed actions in the region, are anticipated to be negligible.

### 4.3.2. Topography, Geology, and Soils

A major impact could occur if a proposed future action exacerbates or promotes long-term erosion, if the soils are inappropriate for the proposed construction and would create a risk to life or property, or if there would be a substantial reduction in agricultural production or loss of Prime Farmland soils. The Proposed Action Alternative does include ground-disturbing activities; however these are relatively small in nature, and there is not any Prime Farmland soils present within the LER project area. Cumulative impacts on topography, geology, and soils within the area surrounding the LER project area, when combined with past and proposed actions in the region, are anticipated to be negligible.

### 4.3.3. Threatened and Endangered Species

The Proposed Action and No Action Alternatives will not adversely impact threatened, endangered and ANHC species within the area with the exception of Tricolored Bat. It is the Proposed Action that would have an impact to the Tricolored Bat, and that is May Effect, Not Likely to Adversely Effect (pending USFWS approval). The impact to Tricolored Bat comes from the removal of the BHF that serves as potential pup rearing habitat for the species. However, with the planting of up to 1.75 acres of BHF nearby, this roosting habitat would eventually comeback for the species. Other than to Tricolored Bat, no reasonably foreseeable future impacts on federal and state listed threatened and endangered species are anticipated.

### 4.3.4. Cultural, Historical, and Archaeological Resources

The Proposed Action Alternative would not adversely impact the identified historic property (JE1350) within the APE. No cumulative effects to JE1350 are anticipated; however, future planning with the left overflow embankment and around it at Lock and Dam No. 4 should make a reasonable and good faith effort to account for adverse effects that are reasonably foreseeable, may occur later in time, be farther removed in distance, or be cumulative and appropriately avoid or mitigate them in accordance with 36 CFR Part 800.

### 4.3.5. Recreation

The LER project area provides locally significant outdoor recreation benefits including a variety of recreation opportunities. The Proposed Action does not reduce nor increase the amount recreational opportunities available. Therefore, the Proposed Action Alternative, when combined with other existing and proposed projects in the region, will have no cumulative impacts on area recreational resources.

### 4.3.6. Aesthetic Resources

Minor impacts on visual resources would occur as a result of implementing the repairs and associated work to the surrounding area. The Proposed Action Alternative would cause the permanent removal of up to 1.6 acres of BHF and the mitigation of it by planting up to 1.75 acres of BHF nearby would change the aesthetics of the area.

*This page intentionally left blank*

## SECTION 5: COMPLIANCE WITH ENVIRONMENTAL LAWS

This EA has been prepared to satisfy the requirements of all applicable environmental laws and regulations and has been prepared in accordance with the CEQ's implementing regulations for NEPA, 42 U.S.C 4321 et seq, Fiscal Responsibility Act, and the USACE ER 200-2-2, *Environmental Quality: Procedures for Implementing NEPA*. The Proposed Action would be consistent with the USACE's Environmental Operating Principles. The following is a list of applicable environmental laws and regulations that were considered in the planning of this project and the status of compliance with each:

Fish and Wildlife Coordination Act of 1958, as amended – The USACE initiated public involvement and agency scoping activities to solicit input on the Proposed Action, and identify significant issues related to the Proposed Action Alternative. Information provided by USFWS, AGFC, and ANHC on fish and wildlife resources has been utilized in the development of this draft EA.

Endangered Species Act of 1973, as amended – Current lists of threatened or endangered species were compiled for the proposed LER. The USACE has determined that there will be No Effect on all federally-listed species with implementation of either alternative with the exception of the Proposed Action and that is on the Tricolored Bat and that impact would be May Affect, Not Likely to Adversely Effect(pending the USFWS concurrence).

Executive Order 13186 (Migratory Bird Habitat Protection) – Sections 3a and 3e of EO 13186 directs federal agencies to evaluate the impacts of their actions on migratory birds, with emphasis on species of concern, and inform the USFWS of potential negative impacts on migratory birds. The proposed LER would not result in adverse impacts on migratory birds or their habitat.

Migratory Bird Treaty Act – The Migratory Bird Treaty Act of 1918 extends federal protection to migratory bird species. The nonregulated "take" of migratory birds is prohibited under this act in a manner similar to the prohibition of "take" of threatened and endangered species under the Endangered Species Act. The timing of the permanent BHF removal would be coordinated to avoid impacts on migratory and nesting birds.

Clean Water Act (CWA) of 1977, as amended – The Proposed Action Alternative is in compliance with all state and federal CWA regulations and requirements. A state water quality certification pursuant to Section 401 of the CWA is not required for the LER. There will be no change that will impact water quality.

National Historic Preservation Act (NHPA) of 1966, as amended –Compliance with the NHPA of 1966, as amended, requires identification of all historic properties in the APE listed in, or eligible for listing in, the NRHP. The results of the cultural resource survey of the APE were written up in a Section 106 report and submitted to the office of the Arkansas SHPO, the Caddo Nation, the Cherokee Nation, the Choctaw Nation, the Muscogee (Creek) Nation, the Osage Nation and the Quapaw Nation. After a period of

30 calendar days responses were received from the Arkansas SHPO, the Quapaw Nation, the Choctaw Nation and the Osage Nation. The Arkansas SHPO and the Tribal Nations that responded within the 30 days each concurred with the results of the survey, the eligibility determination and the effects determination for the undertaking. The identified historic property (JE1350) will not be adversely affected by construction of the Proposed Action.

Native American Graves Protection and Repatriation Act (NAGPRA) of 1990, as amended – The LER project area has no known NAGPRA resources that would be impacted through implementation of the Proposed Action.

Archaeological Resources Protection Act (ARPA) of 1979, as amended – ARPA does not apply to the Proposed Action as the USACE does not permit itself.

Clean Air Act of 1977 – The USEPA established nationwide air quality standards to protect public health and welfare. The Proposed Action would be in compliant with the Clean Air Act.

Farmland Protection Policy Act (FPPA) of 1980 and 1995 – The FPPA's purpose is to minimize the extent to which Federal programs contribute to the unnecessary and irreversible conversion of farmland to non-agricultural uses. There are no Prime Farmland and farmland of state importance within the LER project area.

Executive Order 11990, Protection of Wetlands, as amended – EO 11990 requires federal agencies to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in executing federal projects. The 2024 Proposed Action complies with EO 11990.

Executive Order 11988, Floodplain Management – This EO directs federal agencies to evaluate the potential impacts of proposed actions in floodplains. Both alternatives comply with EO 11988, as neither will have impacts to the existing floodplain within the surrounding area.

CEQ Memorandum dated August 11, 1980, Prime or Unique Farmlands – Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and is also available for these uses. There are no Prime Farmland present within the project area.

## SECTION 6: IRRETRIEVABLE AND IRREVERSIBLE COMMITMENT OF RESOURCES

NEPA requires that Federal agencies identify "any irreversible and irretrievable commitments of resources which will be involved in the Proposed Action should it be implemented" (42 U.S.C. § 4332). An irreversible commitment of resources occurs when the primary or secondary impacts of an action result in the loss of future options for a resource. Usually, this is when the action affects the use of a nonrenewable resource, or it affects a renewable resource that takes a long time to regenerate. The impacts for this project from the repairs and associated work would not be considered an irreversible commitment because the repairs work can still be modified after they are

completed, the 1.6 acres(up to) of BHF though would be permanently lost would be mitigated for via planting and maintaining up to 1.75 acres for 10 years in the Sheppard Island Public Use Area which in turn would equate in a no loss, and the road and navigation pass would only improve upon the ESLD. An irretrievable commitment of resources is typically associated with the loss of productivity or use of a natural resource (e.g., loss of production or harvest). No irreversible or irretrievable impacts on Federally protected species or their habitat is anticipated from implementing the Proposed Action.

*This page intentionally left blank*

## SECTION 7: PUBLIC AND AGENCY COORDINATION

The USACE initiated public involvement and agency scoping activities to solicit input on the Proposed Action for the LER. The USACE will begin its public involvement process with a public comment period to provide an avenue for public and agency stakeholders to ask questions and provide comments. This public scoping meeting will held online with the public comment period beginning on May 14, 2025 and ending on June 13, 2025. This meeting will introduce the public to the draft EA and begin the 30-day public review period of the proposed repairs to the ESLD, draft EA and draft Finding of No Significant Impact (FONSI). The USACE, Little Rock District, will place advertisements on the USACE webpage, social media platforms, and issue a news press release to local media outlets.

Comments received during the draft EA will be incorporated, as appropriate, in the final EA.

Attachment A to this draft EA includes the agency coordination letters, and the coordination letters published as of the time of draft EA public release. The draft EA has been coordinated with agencies having legislative and administrative responsibilities for environmental protection.

## SECTION 8: BIBLIOGRAPHY


Adovasio, J. M. 1978. Meadowcroft Rockshelter, 1977, An Overview. *American Antiquity* 43(4):632–651.

Adovasio, J. M., J. D. Gunn, and R. Stuckenrath. 1990. The Meadowcroft Rockshelter Radiocarbon Chronology 1975-1990. *AmericanAntiquity* 55:348–354.

Albertson, E. 2008. *Phase I Cultural Resource Survey of the Proposed Sparta Aquifer Conversation Project, Jefferson County, Arkansas*. Panamerican Consultants, Inc. Report on file, Arkansas Archeological Survey.

Anderson, D. G., K. E. Sassaman, and C. Judge. 1992. *Paleoindian and Early Archaic Period Research in the Lower Southeast: A South Carolina Perspective*. Council of South Carolina Professional Archaeologists, Columbia, South Carolina.

Anderson, D. G.

1990. Political Change in Chiefdom Societies: Cycling in the Late Prehistoric Southeastern United States. Ph.D. Dissertation, Department of Anthropology, University of Michigan, Ann Arbor, Michigan.

2005. The Earliest Americans Theme Study: Southeastern Regional Context. National Park Service, U.S. Department of the Interior.

Ardelean, C.F., Lorena Becerra-Valdivia, and M.W. Pedersen. 2018. Evidence of Human Occupation in Mexico Around the Last Glacial Maximum. *Nature* 572.

Arkansas Department of Health. 2024. Fish Advisories. Retrieved from https://www.healthy.arkansas.gov/programs-services/topics/fish-advisories

Arkansas Department of Energy and Environment (ADEQ) (2024). The 2022 Draft 2022 Impaired Waters List. Retrieved from https://www.adeq.state.ar.us/water/planning/integrated/303d/list.aspx

Arkansas Department of Parks, Heritage, and Tourism (AR). Arkansas Natural Heritage Commission (ANHC). 2024. Elements of Special Concern Emmett Sanders Lock & Dam Jefferson County, Arkansas. Formal communication between the USACE and ANHC on July 3, 2024.

Arkansas Game & Fish Commission (AGFC). 2006. The Arkansas Wildlife Action Plan. Retrieved from https://www.agfc.com/education/arkansas-wildlife-action-plan/

AGFC. 2024. Endangered Species List. Retrieved from https://apps.agfc.com/regulations/P1.01/?_gl=1*1w20u95*_gcl_au*Mjc3Mzc0ODc1LjE3NDU0Mjc0ODY.*_ga*MTcwOTc1NzU3NC4xNzQ1NDI3NDg2*_ga_4C9QCEC47W*MTc0NTQyNzQ4Ni4xLjAuMTc0NTQyNzQ4Ni42MC4wLjA.

Arkansas Historic Preservation Program. 1974. Cadron Settlement. *Arkansas Historic Preservation Program*. Electronic document, http://www.arkansaspreservation.com/national-register-listings/cadronsettlement, accessed December 22, 2024.

Baker, L. F. 2017. Louisiana Purchase. *Encyclopedia of Arkansas*. Electronic document, https://encyclopediaofarkansas.net/entries/louisiana-purchase-2383/ accessed December 13, 2024.

Bennett, W. J. JR., P. L. Breland and L.M. Smith. 1989. *Cultural Resources and Geomorphological Reconnaissance of the McClellan-Kerr, Arkansas River Navigation System, Pools 1 through 9*. Report on file, Arkansas Archeological Survey.

Bolton, C. S., 1995.*25 Years Later-A History of the McClellan-Kerr Arkansas River Navigation System in Arkansas*. U.S. Army Corps of Engineers Little Rock District. P.O. Box 867, Little Rock, AR 72203. On file at the USACE Little Rock District.

Branam, C. and B. Tully. 2016. *Cultural Resources Survey of the Proposed Lollie Road Bridge Improvement in Faulkner County, Arkansas*. Flat Earth Archaeology, LLC, Cabot, Arkansas.

Brown, J. H., C. E. McFadden, and W. A. Gore. 1980. *Soil Survey of Randolph County, Arkansas*. U.S. Department of Agriculture, Soil Conservation Service in Cooperation with the Arkansas Agricultural Experiment Station.

Buchner, C. A. 1992. *Archaeological Investigations at the Lewis Site (3LE266): A Twentieth-Century Black Owned Farmstead on the St. Francis Floodway, Lee County, Arkansas.* Garrow and Associates, Inc. Submitted to the U.S. Army Corps of Engineers, Memphis District.

Byers, M. A.

2009. *Cahokia: A World Renewal Cult Heterarchy*. University Press of Florida, Gainesville, Florida.

2013. *From Cahokia to Larson to Moundville: Death, World Renewal, and the Sacred in the Mississippian Social World of the Late Prehistoric Eastern Woodlands*. Newfound Press, University of Tennessee Libraries, Knoxville, Tennessee.

Chandler, J. M. 2001. Fragile History: The Big Eddy Site. *Mammoth Trumpet* 16(3):1-3, 20.

Chapman, H.C. 1975. *Archaeology of Missouri*. University of Missouri Press, Columbia, Missouri.

Christ, M. K. 2024. Action at Pine Bluff. *Encyclopedia of Arkansas*. Electronic document, https://encyclopediaofarkansas.net/entries/action-at-pine-bluff-520/accessed January 7, 2025.

Coleman, R. E. 2014 *Archaeological Investigation at the Brooks Hollow Site (3PI418), A Dalton Period Retooling Station, Pike County, Arkansas*. USDA, Ouachita National Forest, Hot Springs, Arkansas.

Collins, M. B. 2002. The Gault Site, Texas, and Clovis Research. *People of the Americas Athena Review* 3(2).

Cushing, E.M., Boswell, E.H., and Hosman, R.L.(1964). General Geology of the Mississippi Embayment. United States Department of the Interior. Retrieved from extension://efaidnbmnnnibpcajpcglclefindmkaj/https://pubs.usgs.gov/pp/0448b/report.pdf

Davis, H. E. 1976. *The Fledgling Province: Social and Cultural Life in Colonial Georgia, 1733-1776*. Published for the Institute of Early American History and Culture, Williamsburg,Va., by the University of North Carolina Press, Chapel Hill.

DeBlack, T. A. 2018. Civil War through Reconstruction, 1861 through 1874. *Encyclopedia of Arkansas*. Electronic document, https://encyclopediaofarkansas.net/entries/civil-war-through-reconstruction-1861-through-1874-388/, accessed November 29, 2024.

Dunbar, J. S. 2006. Paleoindian Archaeology. In *First Floridians and Last Mastodons: The Page-Ladson Site in the Aucilla River*, edited by S. David Webb, pp. 403–438. Volume 26, Topics in Geobiology. Dordrecht, Netherlands.

Dunbar, J. S., and B. I. Waller. 1983. A Distribution Analysis of the Clovis/Suwannee Paleo-Indian Sites of Florida: A Geographic Approach. *Florida Anthropologist* 36(1–2):18–30.

DuVal, K. 2017.The Arkansas Post. *Encyclopedia of Arkansas*. Electronic document, https://encyclopediaofarkansas.net/entries/arkansas-post-3/ accessed December 12, 2024.

Environmental Protection Agency (EPA) (2024A) Climate and Economic Justice Screening Tool. Explore the Map. Retrieved from https://screeningtool.geoplatform.gov/en/

EPA. 2024B. Ecoregion Download Files by State - Region 6 – Arkansas. Retrieved from https://www.epa.gov/eco-research/ecoregion-download-files-state-region-6

EPA. 2024C. Climate and Economic Justice Screening Tool. Methodology. Retrieved from https://screeningtool.geoplatform.gov/en/methodology

EPA. 2024D. Nonattainment and Maintenance Area Population Tool: https://epa.maps.arcgis.com/apps/MapSeries/index.html?appid=7935a00e2554440a8daf6cc035b9455e

Fiedel, S. J. 2013. Is That All There Is? The Weak Case for Pre-Clovis Occupation of Eastern North America. In *The Eastern Fluted Point Tradition*, edited by Joseph A.M. Gingerich, pp. 333–354. University of Utah Press, Salt Lake City, Utah.

Gillam, C. J. 1999. Paleoindian Settlement in Northeastern Arkansas. In *Arkansas Archaeology*, edited by Robert Mainfort and Marvin Jeter, pp. 99–118. University of Arizona Press, Fayetteville, Arkansas.

Goodyear, A. C., III

1974. *The Brand Site: A Techno-functional Study of a Dalton Site in Northeast Arkansas*. Arkansas Archaeological Survey Research Series 7. Arkansas Archaeological Survey, Fayetteville, Arkansas.

2005. Summary of the Allendale Paleoindian Expedition: 2003 and 2004 Field Seasons.*Legacy* 9(1–2):4–11.

2006. Evidence for Pre-Clovis Sites in the Eastern United States. In *Paleoamerican Origins: Beyond Clovis*, edited by Bonnichsen, Robson, Lepper, Bradley T.,Stanford, Dennis, and Waters, Michael R., pp. 103–112. Texas A&M University Press, College Station, Texas.

Halligan, J. J., M. R. Waters, A. Perrotti, I. J. Owens, J. M. Feinberg, M. D. Bourne, B. F., B. Winsborough, D. Carlson, D. C. Fisher, T. W. Stafford, and J. S. Dunbar. 2016. Pre-Clovis Occupation 14,550 Years Ago at the Page-Ladson site, Florida, and the Peopling of the Americas. *Science Advances* 2(5):e1600375.

Hally, D. J. 1975. The Mississippian Period. *Early Georgia* 3(1):37–52.

Hally, D. J., and J. B. Langford. 1988. *Mississippi Period Archaeology of the Georgia Valley and Ridge Province*. University of Georgia Laboratory of Archaeology Series Report No. 25. Athens, Georgia.

Harris, Ron L. 2010.The Carolina Piedmont During the Woodland Period. *Central States Archaeological Journal* 57(3):120–121.

Hemmings, T. E., and J. H. House. 1985. *The Alexander Site: Conway County, Arkansas*. Research Series No. 24. Arkansas Archeological Survey, Fayetteville, Arkansas.

Holley, D. 2000. *The Second Emancipation: The Mechanical Cotton Picker, Black Migration, and How They Shaped the Modern South*. University of Arkansas Press, Fayetteville.

Horvath, E., A. Jenkins, C. Scupholam, A. Ross, K. Baar, and M. Prentice. 2020. *Cultural Resource Assessment Survey Report, McClellan-Kerr Arkansas River Navigation System (MKARNS)*. Archaeological Consultants, Inc., Sarasota, Florida.

House, J. H.

1982. SE Study Unit 2: Archaic Occupation. In *A State Plan for the Conservation of Archeological Resources in Arkansas*, edited by H.A. Davis, pp. SE5–SE8. Research Series No. 21. Arkansas Archeological Survey, Fayetteville, Arkansas.

1996. East-Central Arkansas. In *Prehistory of the Central Mississippi Valley*, edited by Charles H. McNutt, pp. 137–154. University of Alabama Press, Tuscaloosa, Alabama.

Hudson, C.

1993. Reconstructing the De Soto Expedition Route West of the Mississippi River: Summary and Conclusion. In *The Expedition of Hernando De Soto West of the Mississippi, 1541–1543. Proceedings of the de Soto Symposia, 1988 and*

*1990*, edited by Gloria Young and Michael P. Hoffman, pp. 155-172. The University of Arkansas Press, Fayetteville, Arkansas.

1997. *Knights of Spain, Warriors of the Sun*. University of Georgia Press, Athens,Georgia.

Jenkins, N. J., and R. A. Krause. 2009. The Woodland-Mississippian Interface in Alabama, ca. A.D 1075-1200: An Adaptive Radiation? *Southeastern Archaeology* 28:202–219.

Johnson, B. F., III. 2000.*Arkansas in Modern America, 1930–1999*. University of Arkansas Press, Fayetteville.

Kay, M. 1982. *Holocene Adaptation within the Lower Pomme de Terre River Valley, Missouri*. Illinois State Museum Society, Springfield, Illinois.

Key, J. 2019. Quapaw. *Encyclopedia of Arkansas History and Culture*. Electronic document, https://encyclopediaofarkansas.net/entries/quapaw-550/, accessed December 6, 2024.

Kloesel, K., B. Bartush, J. Banner, D. Brown, J. Lemery, X. Lin, C. Loeffler, G. McManus, E. Mullens, J. Nielsen-Gammon, M. Shafer, C. Sorensen, S. Sperry, D. Wildcat, and J. Ziolkowska, 2018: Southern Great Plains. In Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 987–1035. doi: 10.7930/NCA4.2018.CH23

Logan, C. R. 1997. *The Promised Land: The Cherokees, Arkansas, and Removal, 1794-1839*. Arkansas Historic Preservation Program, Little Rock, Arkansas.

Lopinot, N. H., J. H. Ray, and M. D. Conner. 2000. *The 1999 Excavations at the Big Eddy Site (23CE26) in Southwest Missouri*. Special Publication No. 3. Southwest Missouri State Center for Archaeological Research, Springfield, Missouri.

McAvoy, J. M., and L. D. McAvoy. 1997. *Archaeological Investigations of Site 44SX202, Cactus Hill, Sussex County, Virginia*. Research Report Series 8. Virginia Department of Historic Resources, Richmond, Virginia.

McClurkan, B. 1991. *Archeological Survey and Testing AHTD Job Number 20071, Lock and Dam Number 4 Demonstration Project, Jefferson County, Arkansas*. Arkansas Highway and Transportation Department. Report on file, Arkansas Archeological Survey.

McNutt, C. H.1996. The Central Mississippi Valley: A Summary. In *Prehistory of the Central Mississippi Valley*, edited by Charles H. McNutt. University of Alabama Press, Tuscaloosa, Alabama.

Mitchell, S. T. 2013. *Phase I Cultural Resources Survey Report for the Proposed Central Arkansas Pipeline Enhancement Project in Faulkner and Pulaski Counties, Arkansas*. AK Environmental, LLC, Mechanicsburg, Pennsylvania.

Moneyhon, C. H.

1997. *Arkansas and the New South, 1874–1929*. University of Arkansas Press, Fayetteville.

2020. Slavery. *Encyclopedia of Arkansas*. Electronic document, https://encyclopedia ofarkansas.net/entries/slavery-1275/ accessed November 30, 2024.

Morrow, J.2006. The Paleoindian Period in Arkansas, Between Approximately 13,500 and 12,260 calendar years ago. *Field Notes: Newsletter of the Arkansas Archeological Society* 331:3–9.

Morse, D. F., and P. A. Morse. 1983. *Archaeology of the Central Mississippi Valley*. Academic Press, New York, New York.

Murphy, P. G., and A. J. Murphy. 2010.Some Woodland Period Sites of North Carolina's Piedmont. *Central States Archaeological Societies, Inc.* 57(3):138–139.

Nassaney, M. S.1996. The Contributions of the Plum Bayou Survey Project, 1988-1994, to the Native Settlement History of Central Arkansas. *Arkansas Archaeologist* 35:1–50.

National Oceanic and Atmospheric Administration (NOAA), National Weather Service Forecast Office. 2024A. Monthly Climate Normals (1991-2021) for Pine Bluff. Retrieved from https://www.weather.gov/wrh/climate?wfo=lzk

NOAA, National Weather Service Forecast Office. 2024B. First/Last Occurrence Summary for Pine Bluff from 1990 to 2021. Retrieved from https://www.weather.gov/wrh/climate?wfo=lzk

NOAA, 2024C. NWS Little Rock, AR - Pine Bluff Climate Summary (Jan 2024). Retrieved from https://www.weather.gov/lzk/clmjan2024b.htm

Natural Resources Conservation Service (NRCS). 2024. Custom Soil Resource Report for Jefferson County, Arkansas. Retrieved from https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx.

NatureServe. 2023A. *Charadrius melodus*. Piping Plover. Retrieved from https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.106046/Charadrius_melodus

NatureServe. 2023B. *Danaus plexippus*. Monarch . Retrieved from https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.108245/Danaus_plexippus

NatureServe. 2023C. *Laterallus jamaicensis*. Black Rail. Retrieved from https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.105641/Laterallus_jamaicensis

NatureServe, 2023D. *Perimyotis subflavus* Tricolored Bat. Retrieved from https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.102580/Perimyotis_subflavus

Office of the State Geologist (OSG). 1993. Geologic Map of Arkansas. Retrieved from https://www.geology.arkansas.gov/maps-and-data/geologic_maps/geologic-map-of-arkansas-1993-revised-from-1976-edition.html

Orser, C.E., and A.M. Nekola. 1985. Plantation Settlement from Slavery to Tenancy: An Example from a Piedmont Plantation in South Carolina. In *The Archaeology of Slavery and Plantation Life*, edited by T.A. Singleton, pp. 67–94. Academic Press, Orlando.

Paige, A. L., F. L. Bumpers, and D. F. Littlefield Jr. 2003. *The North Little Rock Site on the Trail of Tears National Historic Trail*. American Native Press Archives, University of Arkansas at Little Rock.

Panamerican Consultants, Inc.2005 *Cultural Resource Reconnaissance and Inventory of 72 Army National Guard Local Training Areas in Arkansas*. Report on file, Arkansas Archeological Survey.

Pauketat, T. R.

1994. *The Ascent of Chiefs: Cahokia and Mississippian Politics in Native North America*. University of Alabama Press, Tuscaloosa, Alabama.

2007. *Chiefdoms and Other Archaeological Delusions*. AltaMira Press, New York, New York.

Peebles, C. S.1978. Determinants of Settlement Size and Location in the Moundville Phase. In *Mississippian Settlement Patterns*, edited by Bruce D. Smith, pp. 369–416. Academic Press, New York, New York.

Peterson, D., and B. Norman. 2018. Cadron Settlement. *Encyclopedia of Arkansas*. Electronic document,https://encyclopediaofarkansas.net/entries/cadron-settlement-1107/ accessed December 6, 2024.

Phelps, D. S. 1983. Archaeology of the North Carolina Coast and Coastal Plain: Problems and Hypotheses. In *The Prehistory of North Carolina, an Archaeological Symposium*, edited by Mark A. Mathis and Jeffrey L. Crow, pp. 1–51. North Carolina Division of Archives and History, Department of Cultural Resources, Raleigh, North Carolina.

Price, C.R.1979. *19th Century Ceramics in the Eastern Ozark Border Region.* Monograph Series No.1. Center for Archaeological Research, Southwest Missouri State University, Springfield.

Ramenofsky, A. P. 1982. The Archaeology of Population Collapse: Native American Response to the Introduction of Infectious Disease. Dissertation, Department of Anthropology, University of Washington, Seattle, Washington.

Ray, J. H., N. H. Lopinot, E. R. Hajic, and R. Dr. Mandel. 2000. Possible Pre-Clovis-age Artifacts from the Big Eddy Site. *Current Research in the Pleistocene* 17:68–71.

Rolingson, M. A.

1982. *Emerging Patterns of Plum Bayou Culture: Preliminary Investigations of the Toltec Mounds Research Project*. Arkansas Archeological Survey Research Series No. 18. Arkansas Archeological Survey, Fayetteville, Arkansas.

2002. Plum Bayou Culture of the Arkansas-White River Basin. In *The Woodland Southeast*. University Alabama Press, Tuscaloosa.

Rolingson, M. A. and R. C. Mainfort Jr. 2002. Woodland Period Archaeology of the Central Mississippi Valley. In *The Woodland Southeast*, pp. 20–43. The University of Alabama Press, Tuscaloosa, Alabama.

Sabo, G. III, ed.

1986. *Contributions to Ozark Prehistory*. Research Series No. 27. Arkansas Archeological Survey, Fayetteville, Arkansas.

2019. Osage. *Encyclopedia of Arkansas*. Electronic document, https://encyclopediaofarkansas.net/entries/osage-551, accessed December 6, 2024.

Sabo, G. III, A. M. Early, J. C. Rose, B. A. Burnett, L. Vogele Jr., and J. P. Harcourt 1990. *Human Adaptation in the Ozark-Ouachita Mountains*. Research Series No. 31. Arkansas Archeological Survey, Fayetteville, Arkansas.

Santeford, L. G. and W. A. Martin. 1980 *The Conway Water Supply: Results of Archeological Survey and Testing and a Historical Survey of a Proposed Reservoir Area in Conway County, Arkansas*. Arkansas Archaeological Survey, Fayetteville, Arkansas.

Schambach, F. F.

2001. Fourche Maline and Its Neighbors: Observations on an Important Woodland Period Cultural of the Trans-Mississippi South. *Arkansas Archaeologist* 40:21–50.

2002. Fourche Maline: A Woodland Period Culture of the Trans-Mississippi South. In *The Woodland Southeast*, edited by David G. Anderson and Robert C. Mainfort, Jr., pp. 91-112. University of Alabama Press, Tuscaloosa, Alabama.

Schroedl, G. F. 2009. Mississippian Culture. *The Tennessee Encyclopedia of History and Culture*. Electronic document, http://tennesseeencyclopedia.net/entry.php?rec=928, accessed December 12, 2024.

Sesser D. 2023. Skirmish at Pine Bluff. *Encyclopedia of Arkansas*. Electronic document, https://encyclopediaofarkansas.net/entries/skirmish-at-pine-bluff-6776/ accessed January 7, 2025.

Smith, M. T. 2000. *Coosa: The Rise and Fall of a Southeastern Mississippian Chiefdom*. University Press of Florida, Gainesville, Florida.

Stewart-Abernathy, L. C., and B. Watkins 1982. Historical Archeology. In *A State Plan for the Conservation of Archeological Resources in Arkansas*, edited by H.A. Davis. Arkansas Archeological Survey Research Series 21. Fayetteville.

U.S. Army Corps of Engineers (USACE)

1964. *Arkansas River Lock and Dam No. 4, Design Memorandum No. 7 Dam*. U.S. Army Engineer District, Little Rock Corps of Engineers, Little Rock, Arkansas. April 1964.

1987. *Engineering and Design-Hydraulic Design of Navigation Dams-EM 1110-2-1605*. Department of the Army, U.S. Army Corps of Engineers, Washington D.C. 20314-1000. Engineering Manual 1110-2-1605.

U.S Census Bureau (2024). County. Jefferson County, Arkansas. Retrieved from https://data.census.gov/profile/Jefferson_County,_Arkansas?g=050XX00US05069

U.S. Fish & Wildlife Service (USFWS). 1996. Piping Plover (*Charadrius melodus*) Atlantic Coast Population Revised Recovery Plan. Retrieved from https://www.fws.gov/northeast/pipingplover/recovery.html

U.S. Fish and Wildlife Service (USFWS). 2016. Classification of Wetlands and Deepwater Habitats of the United States https://www.fws.gov/wetlands/.

USFWS. 2023A. Environmental Conservation Online System (ECOS). Species Profile: Alligator Snapping Turtle (*Macrochelys temminkii*). Retrieved from https://ecos.fws.gov/ecp/species/4658

USFWS. 2023B. ECOS. Species Profile: Eastern Black rail (*Laterallus jamaicensis ssp. jamaicensis*). Retrieved from https://ecos.fws.gov/ecp/species/10477

USFWS. 2023C. ECOS. Species Profile: Monarch Butterfly (*Danaus plexippus*). Retrieved from https://ecos.fws.gov/ecp/species/9743

USFWS 2023D. ECOS. Species Profile. Piping Plover (*Charadrius melodus*). Retrieved from https://ecos.fws.gov/ecp0/profile/speciesProfile?sId=6039

USFWS 2023E. ECOS. Species Profile: Red knot (*Calidris canutus rufa*). Retrieved from https://ecos.fws.gov/ecp0/profile/speciesProfile?sId=1864

USFWS, 2023F. ECOS. Species Profile: Tricolored bat (*Perimyotis subflavus*). Retrieved from https://ecos.fws.gov/ecp/species/10515

USFWS. 2025. IPAC: Information, Planning, and Consultation System, Environmental Conservation Online System. Official Species List. Project Code:2024-0104941. Created on April 22, 2025. https://ecos.fws.gov.

USFWS. 2024. National Wetlands Inventory website. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. Retrieved on 02 October 2024 from http://www.fws.gov/wetlands/.

Walthall, J. A. 1998. Rockshelters and Hunter-Gatherer Adaptation to the Pleistocene/Holocene Transition. *American Antiquity* 63(11):223–228.

Williams, F. C. 2019 Agriculture. *Encyclopedia of Arkansas*. Electronic document, https://encyclopediaofarkansas.net/entries/agriculture-385/, accessed November 28, 2024.

Wilson, J. S. 1990. We've Got Thousands of These! What Makes an Historic Farmstead Significant? *Historical Archaeology* 24(2):23–33.

Windham, J. R., C. Espenshade, S. M. Patch, L. B.-Raymer, S. Brannan, K. C. Seramur, and J. Coco.2008 *A Middle Woodland Household: Archaeological Investigations of the Hardin Bridge Site (9BR34), Bartow County, Georgia*. New South Associates, Inc., Stone Mountain, Georgia.

Wycoff, D. G.1985. The Packard Complex: Early Archaic, Pre-Dalton Occupations on the Prairie-Woodlands Border. *Southeastern Archaeology* 4:1–26.

This page intentionally left blank.

## SECTION 9: ACRONYMS/ABBREVIATIONS

| | |
|---|---|
| % | Percent |
| ° | Degrees |
| § | Section |
| ‘ | Feet |
| ac-ft | acre-feet |
| AQCR | Air Quality Control Region |
| BMP | Best Management Practice |
| BP | Before Present |
| CAP | Climate Action Plan |
| CEQ | Council on Environmental Quality |
| CFR | Code of Federal Regulations |
| cfs | cubic feet per second |
| CO | Carbon Monoxide |
| $CO_2$ | Carbon Dioxide |
| CO2e | CO2-equivalent |
| CRMP | Cultural Resources Management Plan |
| CWA | Clean Water Act |
| EA | Environmental Assessment |
| EIS | Environmental Impact Statement |
| EO | Executive Order |
| EP | Engineer Pamphlet |
| ER | Engineer Regulation |
| ERS | Environmental Radiation Surveillance |
| ESA | Environmentally Sensitive Area |
| F | Fahrenheit |
| FAA | Federal Aviation Administration |
| FONSI | Finding of No Significant Impact |
| GHG | Greenhouse Gas |
| gpm | gallons per minute |
| HDR | High Density Recreation |
| HTRW | Hazardous, Toxic, Radioactive Wastes |
| IFR | Inactive/Future Recreation |
| IPAC | Information for Planning and Consultation (USFWS) |
| LMP | Lakeshore Management Plan |
| LDR | Low Density Recreation |
| MP | Master Plan |
| MRML | Multiple Resource Management Lands |
| msl | mean sea level |
| NAAQS | National Ambient Air Quality Standards |
| NEPA | National Environmental Policy Act |
| NGVD | National Geodetic Vertical Datum |
| NHPA | National Historic Preservation Act |
| NO | Nitrogen Oxide |
| NRCS | Natural Resources Conservation Service |
| NRHP | National Register of Historic Places |

| | |
|---|---|
| NRRS | National Recreation Reservation Service |
| NWI | National Wetlands Inventory (USFWS) |
| $O_3$ | Ozone |
| OAQPS | Office of Air Quality Planning and Standards |
| Pb | Lead |
| PCB | Polychlorinated Biphenyls |
| PCPI | Per Capita Personal Incomes |
| PL | Public Law |
| $PM_{2.5}$ | Particulate Matter Less than 2.5 Microns |
| $PM_{10}$ | Particulate Matter Less than 10 Microns |
| PO | Project Operations |
| RM | River Mile |
| ROD | Record of Decision |
| RPEC | Regional Planning and Environmental Center |
| SGCN | Species of Greatest Conservation Need |
| $SO_2$ | Sulfur Dioxide |
| TCLP | Toxicity Characteristic Leaching Procedure |
| TDS | Total Dissolved Solids |
| U.S. | United States |
| U.S.C. | U.S. Code |
| USACE | U.S. Army Corps of Engineers |
| USCG | U.S. Coast Guard |
| USEPA | U.S. Environmental Protection Agency |
| USFWS | U.S. Fish and Wildlife Service |
| USGCRP | U.S. Global Change Research Group |
| VOC | Volatile Organic Compounds |
| ZOI | Zone of Interest |

## SECTION 10: LIST OF PREPARERS

Paul E. Roberts - Biologist, Regional Planning and Environmental Center, Fort Worth District- 11 years of USACE experience.

# Attachment A – WILDLIFE DOCUMENTS

**Items included in Attachment A:**

IPaC Report – USFWS

Northern Long-eared Bat and Tricolored Bat Range-wide Determination Key-USFWS

SGCN List – AGFC

State Listed Species – AGFC

# Attachment B- COMPENSATORY MITIGATION PLAN

# Attachment C- Emissions Analyses

**Formulas**

***Emissions from Emission Factors (g/hp-hr) : Non-Road Vehicles***

Emissions [g] = Horsepower [HP] x Load Factor [ - ] x Operation Hours [hr] x Emission factor [g/HP-hr]

This calculation was used to estimate emissions in grams for nonroad equipment given emission factor with the units of grams per horsepower-hour. Emission factors were sourced from a USACE project involving similar activities near water channels. The categories of grouped emission factors were for Crawler Tractor/ Dozers, Excavators, Tractors/Loaders/Backhoes, Cranes, and Other Construction Equipment. All equipment was classified as “Construction and Mining Equipment” with both engine and fuel type being diesel.

***Emissions from Emission Factors (lb/hr) : Non-Road Vehicles***

Emissions [lb] = Operation Hours [hr] x Emission factor CH4 [lb/hr]

This calculation used to estimate emissions in pounds was from emission factors that are in pounds per hour from off-road mobile source emission factors sourced from the South Coast Air Quality Management District in 2024. The emission factors used from this source were categorized by horsepower, so varying engine power ratings were factored into this calculation implicitly.

***Methane to Nitrous Oxide Ratio : Non-Road Vehicles***

| Vehicle Type | Fuel Type | $CH_4$ Factor (g $CH_4$ / gallon) | $N_2O$ Factor (g $N_2O$ / gallon) | $N_2O/CH_4$ Ratio |
|---|---|---|---|---|
| Agricultural | Diesel Equipment | 1.27 | 1.07 | **0.84** |
| Construction /Mining | Diesel Equipment | 1.01 | 0.94 | **0.93** |
| Construction /Mining | Diesel-off trucks | 0.91 | 0.56 | **0.62** |
| Lawn/Garden | Diesel | 0.66 | 0.49 | **0.74** |

The method used in this analysis to estimate nitrous oxide emissions was to relate emission factors between nitrous oxide and methane from the EPA (2023) Inventory of Greenhouse Gas Emissions and Sinks. The last column is the appended ratio calculation from the $CH_4$ Factor and $N_2O$ Factor.

***Load Factors***

The load factors used in the emissions calculations were sourced from Tables A-89 of the EPA (2023) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2021 (Annexes). Diesel load factors were chosen to propagate the emission calculation tables.

***Emissions from Emission Factors (lbs/mi) : Commuting Vehicles***

Emissions [lbs] = N x TL x EF

N = number of trips

TL = trip length (miles/day)

EF = emission factor (pounds per mile)

The emissions calculated in pounds for crew commuting vehicles are based on emission factors in pounds per mile for passenger vehicles from the Highest (Most Conservative) EMFAC2007 (version 2.3) Scenario Year 2025.

***Methane and Nitrous Oxide Emissions : Commuting Vehicles***

| $CH_4$ (g /mi) | $N_2O$ (g/mi) |
|---|---|
| 0.009 | 0.006 |

The emissions for methane and nitrous oxide for commuting vehicles in grams was calculated from emission factors in grams per mile from Table 10: Category 7: Employee Commuting: Passenger Car of the Emission Factors for Greenhouse Gas Inventories.

**Calculations**

***Equipment Details***

| Equipment | EQ Type | HP EP1110-1-8 | Fuel Type | Load Factor | Operation Hours |
|---|---|---|---|---|---|
| UNLOAD FROM BARGE: Stone B | Chipper | 85 | Gasoline | 0.78 | 24 |
| UNLOAD FROM BARGE: GEN C05Z1210 CHAIN SAW, 36"-60" (91CM-150CM) GUIDE BAR | Saw | 9 | Gasoline | 0.78 | 48 |
| UNLOAD FROM BARGE: GEN L35Z4260 LOADER, FRONT END, CRAWLER, 3CY-4CY (2.3M3-3.1M3) BUCKET | Loader | 225 | Diesel Offroad | 0.59 | 24 |
| UNLOAD FROM BARGE: EP B25HB011 BUCKET, CLAMSHELL, 4.0 CY, HEAVY DUTY/DIGGING | Clamshell | NONE | | | 21.34 |
| UNLOAD FROM BARGE: Map C85LB021 CRANES, MECHANICAL, LATTICE BOOM, CRAWLER, DRAGLINE/CLAMSHELL, 150 TON, 100' BOOM (ADD BUCKET)(7 TRUCK LOADS FOR MOB/DMOB) | Crane | 284 | Diesel Offroad | 0.43 | 21.34 |
| PLACEMENT: Stone B: EP H25CA069 HYDRAULIC EXCAVATOR, ATTACHMENT, CONCRETE PULVERIZER, 40.1" JAW OPENING (ADD 40,000 LB MIN HYDRAULIC EXCAVATOR) | Excavator | NONE | | | 42.86 |
| PLACEMENT: Stone B: EP H25KM003 HYDRAULIC EXCAVATOR, CRAWLER, 43,115 LBS, 0.48 CY - 1.24 CY BUCKET, 19' 7" MAX DIGGING DEPTH | Excavator | 115 | Diesel Offroad | 0.59 | 42.86 |
| PLACEMENT: Stone B: EP T15CA011 TRACTOR, CRAWLER (DOZER), 258 HP, LOW GROUND PRESSURE, W/6.57 CY VARIABLE PITCH ADJUSTABLE TILT BLADE (ADD ATTACHMENTS) | Tractor/ Crawler | 258 | Diesel Offroad | 0.59 | 42.86 |
| UNLOAD FROM BARGE: Stone A: EP B25HB011 BUCKET, CLAMSHELL, 4.0 CY, HEAVY DUTY/DIGGING | Clamshell | NONE | | | 9.07 |
| UNLOAD FROM BARGE: Stone A: Map C85LB021 CRANES, MECHANICAL, LATTICE BOOM, CRAWLER, DRAGLINE/CLAMSHELL, 150 TON, 100' | Crane | 284 | Diesel Offroad | 0.43 | 9.07 |

| | | | | | |
|---|---|---|---|---|---|
| BOOM (ADD BUCKET)(7 TRUCK LOADS FOR MOB/DMOB) | | | | | |
| UNLOAD FROM BARGE: Stone A: NON XX0XX750 WORK BARGE, FLAT DECK, 2000 TON WITH RAMP | Barge | NONE | | | 27.21 |
| PLACEMENT: Stone A: EP H25CA069 HYDRAULIC EXCAVATOR, ATTACHMENT, CONCRETE PULVERIZER, 40.1" JAW OPENING (ADD 40,000 LB MIN HYDRAULIC EXCAVATOR) | Attachment | NONE | | | 11.43 |
| PLACEMENT: Stone A: EP H25KM003 HYDRAULIC EXCAVATOR, CRAWLER, 43,115 LBS, 0.48 CY - 1.24 CY BUCKET, 19' 7" MAX DIGGING DEPTH | Excavator | 115 | Diesel Offroad | 0.59 | 11.43 |
| PLACEMENT: Stone A: EP T15CA011 TRACTOR, CRAWLER (DOZER), 258 HP, LOW GROUND PRESSURE, W/6.57 CY VARIABLE PITCH ADJUSTABLE TILT BLADE (ADD ATTACHMENTS) | Tractor/ Crawler | 258 | Diesel Offroad | 0.59 | 11.43 |
| Crush Gravel: GEN L15Z4040 LANDSCAPING EQUIPMENT, SPREADER, 54CF (1.5 M3) DRY CHEMICAL (ADD 55 HP FARM TRACTOR) | Farm Tractor | 55 | Diesel Offroad | 0.59 | 48.2 |
| Crush Gravel: GEN R50Z5600 ROLLER, VIBRATORY, SELF-PROPELLED, SINGLE DRUM, PAD FOOT, 5.5 T (5.0 MT), 50" (1.27 M) WIDE, 3X2, SOIL COMPACTOR | Roller | 74 | Diesel Offroad | 0.59 | 48.2 |
| Crush Gravel: GEN T15Z6520 TRACTOR, CRAWLER (DOZER), 181-250 HP (135-186 KW), POWERSHIFT, LGP, W/UNIVERSAL BLADE | Tractor/ Crawler | 250 | Diesel Offroad | 0.59 | 48.2 |
| Compact Select Fill: GEN A15Z0140 AIR COMPRESSOR, 265 CFM (7.5 CMM), 205 PSI (1413 KPA), TRAILER MTD (ADD HOSE) | Air Compressor | 122 | Diesel Offroad | 0.43 | 66.05 |
| Compact Select Fill: GEN A20Z0400 BREAKER-FOUR BOLT, 60 LB (27.2 KG) (ADD 65 CFM (1.8 CMM) COMPRESSOR & BIT COSTS) | Breaker | NONE | | | 132.1 |
| Compact Select Fill: GEN A20Z0480 AIR HOSE, 1.50" (38MM), 100' (31M), AIR DRILL 500 | Air Drill | NONE | | | 132.1 |
| Compact Select Fill: GEN T15Z6520 TRACTOR, CRAWLER (DOZER), 181-250 HP (135-186 KW), POWERSHIFT, LGP, W/UNIVERSAL BLADE | Tractor/ Crawler | 250 | Diesel Offroad | 0.59 | 48.56 |
| Compact Select Fill: GEN T50Z7710 DUMP TRUCK, HIGHWAY, 80KGVW (36.3MT), 6 AXLE (3 RETRACTABLE) WITH REAR 16 - 20 CY (12.2-15.3 M3) DUMP BODY | Dump Truck | 400 | Diesel Offroad | 0.21 | 97.13 |
| Repair Crown: GEN T15Z6440 TRACTOR, CRAWLER (DOZER), 76-100 HP (57-75 KW), POWERSHIFT, W/UNIVERSAL BLADE | Tractor/ Crawler | 100 | Diesel Offroad | 0.59 | 22.86 |
| Cut: GEN T15Z6440 TRACTOR, CRAWLER (DOZER), 76-100 HP (57-75 KW), POWERSHIFT, W/UNIVERSAL BLADE | Tractor/ Crawler | 100 | Diesel Offroad | 0.59 | 6.77 |

| | | | | | |
|---|---|---|---|---|---|
| Disposal: EP T15CA011 TRACTOR, CRAWLER (DOZER), 258 HP, LOW GROUND PRESSURE, W/6.57 CY VARIABLE PITCH ADJUSTABLE TILT BLADE (ADD ATTACHMENTS) | Tractor/ Crawler | 258 | Diesel Offroad | 0.59 | 0.78 |
| Disposal: EP T15CA012 TRACTOR, CRAWLER (DOZER), 270 HP, W/8.98 CY SEMI-U BLADE (ADD ATTACHMENTS) | Tractor/ Crawler | 270 | Diesel Offroad | 0.59 | 0.78 |
| Disposal: GEN T55Z7720 TRUCK, OFF-HIGHWAY, RIGID FRAME, 31.7 CY (24.2 M3), 42T (38.1 MT), 4X4, REAR DUMP | Truck | 487 | Diesel Offroad | 0.59 | 8.33 |
| Fill: GEN T15Z6440 TRACTOR, CRAWLER (DOZER), 76-100 HP (57-75 KW), POWERSHIFT, W/UNIVERSAL BLADE | Tractor/ Crawler | 100 | Diesel Offroad | 0.59 | 6.27 |
| Fill: GEN T15Z6520 TRACTOR, CRAWLER (DOZER), 181-250 HP (135-186 KW), POWERSHIFT, LGP, W/UNIVERSAL BLADE | Tractor/ Crawler | 250 | Diesel Offroad | 0.59 | 0.4 |
| Excavation 1: GEN T15Z6440 TRACTOR, CRAWLER (DOZER), 76-100 HP (57-75 KW), POWERSHIFT, W/UNIVERSAL BLADE | Tractor/ Crawler | 100 | Diesel Offroad | 0.59 | 29.29 |
| Excavation 1: GEN T15Z6520 TRACTOR, CRAWLER (DOZER), 181-250 HP (135-186 KW), POWERSHIFT, LGP, W/UNIVERSAL BLADE | Tractor/ Crawler | 250 | Diesel Offroad | 0.59 | 1.87 |
| Disposal: EP T15CA011 TRACTOR, CRAWLER (DOZER), 258 HP, LOW GROUND PRESSURE, W/6.57 CY VARIABLE PITCH ADJUSTABLE TILT BLADE (ADD ATTACHMENTS) | Tractor/ Crawler | 258 | Diesel Offroad | 0.59 | 3.37 |
| Disposal: EP T15CA011 TRACTOR, CRAWLER (DOZER), 258 HP, LOW GROUND PRESSURE, W/6.57 CY VARIABLE PITCH ADJUSTABLE TILT BLADE (ADD ATTACHMENTS) | Tractor/ Crawler | 258 | Diesel Offroad | 0.59 | 3.37 |
| Disposal: GEN T55Z7720 TRUCK, OFF-HIGHWAY, RIGID FRAME, 31.7 CY (24.2 M3), 42T (38.1 MT), 4X4, REAR DUMP | Truck | 487 | Diesel Offroad | 0.59 | 18.01 |
| Haul: GEN T50Z7710 DUMP TRUCK, HIGHWAY, 80KGVW (36.3MT), 6 AXLE (3 RETRACTABLE) WITH REAR 16 - 20 CY (12.2-15.3 M3) DUMP BODY | Dump Truck | 400 | Diesel Onroad | 0.59 | 62.38 |

***Equipment Emission Factors***

| | VOC (gr/hp-hr) | PM (gr/hp-hr) | PM2.5 (gr/hp-hr) | PM10 (gr/hp-hr) | CO (gr/hp-hr) | $CO_2$ (gr/hp-hr) | $NO_X$ (gr/hp-hr) | $SO_X$ (gr/hp-hr) | $CH_4$ (lb/hr) |
|---|---|---|---|---|---|---|---|---|---|
| UNLOAD FROM BARGE: Stone B: GEN B20Z0890 BRUSH CHIPPER, 12" (30 CM) CAPACITY, | 0.031163284 | 0.00602173 | | | 0.361647 | 54.42415 | 0.221169 | 0.000655 | 0.002812 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| DRUM TYPE, TRAILER MTD | | | | | | | | | |
| UNLOAD FROM BARGE: GEN C05Z1210 CHAIN SAW, 36"-60" (91CM-150CM) GUIDE BAR | 0.014729575 | 0.004315321 | | | 0 | 7.689605 | 0.0838 | 0.0000929 | 0.001329 |
| UNLOAD FROM BARGE: GEN L35Z4260 LOADER, FRONT END, CRAWLER, 3CY-4CY (2.3M3-3.1M3) BUCKET | 0.903249529 | 0.636718042 | 0.617617 | 0.636718042 | 3.519114 | 623.8077 | 5.564499 | 0.011268 | 0.005715 |
| UNLOAD FROM BARGE:Map C85LB021 CRANES, MECHANICAL, LATTICE BOOM, CRAWLER, DRAGLINE/CLAM SHELL, 150 TON, 100' BOOM (ADD BUCKET)(7 TRUCK LOADS FOR MOB/DMOB) | 0.247285365 | 0.152470041 | 0.147896 | 0.152470041 | 0.706243 | 530.294 | 3.354178 | 0.009213 | 0.005281 |
| PLACEMENT: Stone B: EP H25KM003 HYDRAULIC EXCAVATOR, CRAWLER, 43,115 LBS, 0.48 CY - 1.24 CY BUCKET, 19' 7" MAX DIGGING DEPTH | 0.298413099 | 0.449987272 | 0.436488 | 0.449987272 | 3.422762 | 595.2534 | 3.581676 | 0.010514 | 0.004045 |
| PLACEMENT: Stone B: EP T15CA011 TRACTOR, CRAWLER (DOZER), 258 HP, LOW GROUND PRESSURE, W/6.57 CY VARIABLE PITCH ADJUSTABLE TILT BLADE (ADD ATTACHMENTS) | 0.228405014 | 0.193139698 | 0.187346 | 0.193139698 | 0.972475 | 536.1391 | 2.867401 | 0.009187 | 0.008339 |
| UNLOAD FROM BARGE: Stone A: Map C85LB021 CRANES, MECHANICAL, LATTICE BOOM, CRAWLER, DRAGLINE/CLAM SHELL, 150 TON, 100' BOOM (ADD | 0.247285365 | 0.152470041 | 0.147896 | 0.152470041 | 0.706243 | 530.294 | 3.354178 | 0.009213 | 0.005281 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| BUCKET)(7 TRUCK LOADS FOR MOB/DMOB) | | | | | | | | | |
| PLACEMENT: Stone A: EP H25KM003 HYDRAULIC EXCAVATOR, CRAWLER, 43,115 LBS, 0.48 CY - 1.24 CY BUCKET, 19' 7" MAX DIGGING DEPTH | 0.298413 099 | 0.449987 272 | 0.436 488 | 0.449987 272 | 3.422 762 | 595.2 534 | 3.581 676 | 0.0105 14 | 0.004 045 |
| PLACEMENT: Stone A: EP T15CA011 TRACTOR, CRAWLER (DOZER), 258 HP, LOW GROUND PRESSURE, W/6.57 CY VARIABLE PITCH ADJUSTABLE TILT BLADE (ADD ATTACHMENTS) | 0.228405 014 | 0.193139 698 | 0.187 346 | 0.193139 698 | 0.972 475 | 536.1 391 | 2.867 401 | 0.0091 87 | 0.008 339 |
| Crush Gravel: GEN L15Z4040 LANDSCAPING EQUIPMENT, SPREADER, 54CF (1.5 M3) DRY CHEMICAL (ADD 55 HP FARM TRACTOR) | 0.325752 193 | 0.362138 748 | 0.351 275 | 0.362138 748 | 3.171 077 | 595.1 703 | 3.853 669 | 0.0109 42 | 0.002 854 |
| GEN R50Z5600 ROLLER, VIBRATORY, SELF-PROPELLED, SINGLE DRUM, PAD FOOT, 5.5 T (5.0 MT), 50" (1.27 M) WIDE, 3X2, SOIL COMPACTOR | 0.314721 577 | 0.320570 142 | 0.310 953 | 0.320570 142 | 1.492 965 | 535.8 776 | 3.877 125 | 0.0096 16 | 0.003 539 |
| GEN T15Z6520 TRACTOR, CRAWLER (DOZER), 181-250 HP (135-186 KW), POWERSHIFT, LGP, W/UNIVERSAL BLADE | 0.228405 014 | 0.193139 698 | 0.187 346 | 0.193139 698 | 0.972 475 | 536.1 391 | 2.867 401 | 0.0091 87 | 0.008 339 |
| Compact Select Fill: GEN A15Z0140 AIR COMPRESSOR, 265 CFM (7.5 CMM), 205 PSI | 0.314721 577 | 0.320570 142 | 0.310 953 | 0.320570 142 | 1.492 965 | 535.8 776 | 3.877 125 | 0.0096 16 | 0.002 6 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| (1413 KPA), TRAILER MTD (ADD HOSE) | | | | | | | | | |
| Compact Select Fill: GEN T15Z6520 TRACTOR, CRAWLER (DOZER), 181-250 HP (135-186 KW), POWERSHIFT, LGP, W/UNIVERSAL BLADE | 0.228405 014 | 0.193139 698 | 0.187 346 | 0.193139 698 | 0.972 475 | 536.1 391 | 2.867 401 | 0.0091 87 | 0.008 339 |
| Compact Select Fill: GEN T50Z7710 DUMP TRUCK, HIGHWAY, 80KGVW (36.3MT), 6 AXLE (3 RETRACTABLE) WITH REAR 16 - 20 CY (12.2-15.3 M3) DUMP BODY | 0.306230 491 | 0.293727 438 | 0.284 916 | 0.293727 438 | 2.136 034 | 535.9 032 | 4.572 203 | 0.0095 14 | 0.010 595 |
| Repair Crown: GEN T15Z6440 TRACTOR, CRAWLER (DOZER), 76-100 HP (57-75 KW), POWERSHIFT, W/UNIVERSAL BLADE | 0.259846 516 | 0.299421 689 | 0.290 439 | 0.299421 689 | 1.281 915 | 536.0 439 | 3.143 197 | 0.0095 14 | 0.005 491 |
| Cut: GEN T15Z6440 TRACTOR, CRAWLER (DOZER), 76-100 HP (57-75 KW), POWERSHIFT, W/UNIVERSAL BLADE | 0.259846 516 | 0.299421 689 | 0.290 439 | 0.299421 689 | 1.281 915 | 536.0 439 | 3.143 197 | 0.0095 14 | 0.005 491 |
| Disposal: EP T15CA011 TRACTOR, CRAWLER (DOZER), 258 HP, LOW GROUND PRESSURE, W/6.57 CY VARIABLE PITCH ADJUSTABLE TILT BLADE (ADD ATTACHMENTS) | 0.228405 014 | 0.193139 698 | 0.187 346 | 0.193139 698 | 0.972 475 | 536.1 391 | 2.867 401 | 0.0091 87 | 0.008 339 |
| Disposal: EP T15CA012 TRACTOR, CRAWLER (DOZER), 270 HP, W/8.98 CY SEMI- | 0.228405 014 | 0.193139 698 | 0.187 346 | 0.193139 698 | 0.972 475 | 536.1 391 | 2.867 401 | 0.0091 87 | 0.008 644 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| U BLADE (ADD ATTACHMENTS) | | | | | | | | | |
| Disposal: GEN T55Z7720 TRUCK, OFF-HIGHWAY, RIGID FRAME, 31.7 CY (24.2 M3), 42T (38.1 MT), 4X4, REAR DUMP | 0.306230491 | 0.293727438 | 0.284916 | 0.293727438 | 2.136034 | 535.9032 | 4.572203 | 0.009514 | 0.010676 |
| Fill: GEN T15Z6440 TRACTOR, CRAWLER (DOZER), 76-100 HP (57-75 KW), POWERSHIFT, W/UNIVERSAL BLADE | 0.259846516 | 0.299421689 | 0.290439 | 0.299421689 | 1.281915 | 536.0439 | 3.143197 | 0.009514 | 0.005491 |
| Fill: GEN T15Z6520 TRACTOR, CRAWLER (DOZER), 181-250 HP (135-186 KW), POWERSHIFT, LGP, W/UNIVERSAL BLADE | 0.228405014 | 0.193139698 | 0.187346 | 0.193139698 | 0.972475 | 536.1391 | 2.867401 | 0.009187 | 0.008339 |
| Excavation 1: GEN T15Z6440 TRACTOR, CRAWLER (DOZER), 76-100 HP (57-75 KW), POWERSHIFT, W/UNIVERSAL BLADE | 0.259846516 | 0.299421689 | 0.290439 | 0.299421689 | 1.281915 | 536.0439 | 3.143197 | 0.009514 | 0.005491 |
| Excavation 1: GEN T15Z6520 TRACTOR, CRAWLER (DOZER), 181-250 HP (135-186 KW), POWERSHIFT, LGP, W/UNIVERSAL BLADE | 0.228405014 | 0.193139698 | 0.187346 | 0.193139698 | 0.972475 | 536.1391 | 2.867401 | 0.009187 | 0.008339 |
| Disposal: EP T15CA011 TRACTOR, CRAWLER (DOZER), 258 HP, LOW GROUND PRESSURE, W/6.57 CY VARIABLE PITCH ADJUSTABLE TILT BLADE (ADD ATTACHMENTS) | 0.228405014 | 0.193139698 | 0.187346 | 0.193139698 | 0.972475 | 536.1391 | 2.867401 | 0.009187 | 0.008339 |
| Disposal: EP T15CA011 | 0.228405014 | 0.193139698 | 0.187346 | 0.193139698 | 0.972475 | 536.1391 | 2.867401 | 0.009187 | 0.008339 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| TRACTOR, CRAWLER (DOZER), 258 HP, LOW GROUND PRESSURE, W/6.57 CY VARIABLE PITCH ADJUSTABLE TILT BLADE (ADD ATTACHMENTS) | | | | | | | | | |
| Disposal: GEN T55Z7720 TRUCK, OFF-HIGHWAY, RIGID FRAME, 31.7 CY (24.2 M3), 42T (38.1 MT), 4X4, REAR DUMP | 0.306230491 | 0.293727438 | 0.284916 | 0.293727438 | 2.136034 | 535.9032 | 4.572203 | 0.009514 | 0.010676 |
| Haul: GEN T50Z7710 DUMP TRUCK, HIGHWAY, 80KGVW (36.3MT), 6 AXLE (3 RETRACTABLE) WITH REAR 16 - 20 CY (12.2-15.3 M3) DUMP BODY | 0.306230491 | 0.293727438 | 0.284916 | 0.293727438 | 2.136034 | 535.9032 | 4.572203 | 0.009514 | 0.010595 |

The first two rows of the table are emission factors in pounds per hour for diesel engines of similar sizes to the gasoline engines of the chipper and saw equipment. This estimation was made because comparative emission factors for gasoline engine sizes of this small size were minimal, for the purpose of this project, operation and engine power ratings are small for this equipment to allow a rough estimation with diesel engine approximations.

***Equipment Emissions***

| | VOC (lbs) | PM (lbs) | PM2.5 (lbs) | PM10 (lbs) | CO (lbs) | $CO_2$ (lbs) | $NO_X$ (lbs) | $SO_X$ (lbs) | $N_2O$ (lbs) | $CH_4$ (lbs) |
|---|---|---|---|---|---|---|---|---|---|---|
| UNLOAD FROM BARGE: Stone B: GEN B20Z0890 BRUSH CHIPPER, 12" (30 CM) CAPACITY, DRUM TYPE, TRAILER MTD | 0.748 | 0.145 | 0.000 | 0.000 | 8.680 | 1,306.180 | 5.308 | 0.016 | 0.050 | 0.067 |
| UNLOAD FROM BARGE: Stone B: GEN C05Z1210 CHAIN SAW, 36"-60" (91CM-150CM) GUIDE BAR | 0.707 | 0.207 | 0.000 | 0.000 | 0.000 | 369.101 | 4.022 | 0.004 | 0.047 | 0.064 |
| UNLOAD FROM BARGE: Stone B: GEN L35Z4260 LOADER, FRONT END, CRAWLER, 3CY-4CY (2.3M3-3.1M3) BUCKET | 6.344 | 4.472 | 4.338 | 4.472 | 24.718 | 4,381.580 | 39.085 | 0.079 | 0.128 | 0.137 |
| UNLOAD FROM BARGE: Stone B: Map C85LB021 CRANES, MECHANICAL, LATTICE BOOM, | 1.421 | 0.876 | 0.850 | 0.876 | 4.058 | 3,046.718 | 19.271 | 0.053 | 0.105 | 0.113 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| CRAWLER, DRAGLINE/CLAMSHELL, 150 TON, 100' BOOM (ADD BUCKET)(7 TRUCK LOADS FOR MOB/DMOB) | | | | | | | | | | |
| PLACEMENT: EP H25KM003 HYDRAULIC EXCAVATOR, CRAWLER, 43,115 LBS, 0.48 CY - 1.24 CY BUCKET, 19' 7" MAX DIGGING DEPTH | 1.913 | 2.885 | 2.798 | 2.885 | 21.944 | 3,816.262 | 22.963 | 0.067 | 0.161 | 0.173 |
| PLACEMENT: EP T15CA011 TRACTOR, CRAWLER (DOZER), 258 HP, LOW GROUND PRESSURE, W/6.57 CY VARIABLE PITCH ADJUSTABLE TILT BLADE (ADD ATTACHMENTS) | 3.285 | 2.778 | 2.695 | 2.778 | 13.987 | 7,711.442 | 41.243 | 0.132 | 0.333 | 0.357 |
| UNLOAD FROM BARGE: Stone A: Map C85LB021 CRANES, MECHANICAL, LATTICE BOOM, CRAWLER, DRAGLINE/CLAMSHELL, 150 TON, 100' BOOM (ADD BUCKET)(7 TRUCK LOADS FOR MOB/DMOB) | 0.604 | 0.372 | 0.361 | 0.372 | 1.725 | 1,294.926 | 8.191 | 0.022 | 0.045 | 0.048 |
| PLACEMENT: Stone A: EP H25KM003 HYDRAULIC EXCAVATOR, CRAWLER, 43,115 LBS, 0.48 CY - 1.24 CY BUCKET, 19' 7" MAX DIGGING DEPTH | 0.510 | 0.769 | 0.746 | 0.769 | 5.852 | 1,017.729 | 6.124 | 0.018 | 0.043 | 0.046 |
| PLACEMENT: Stone A: EP T15CA011 TRACTOR, CRAWLER (DOZER), 258 HP, LOW GROUND PRESSURE, W/6.57 CY VARIABLE PITCH ADJUSTABLE TILT BLADE (ADD ATTACHMENTS) | 0.876 | 0.741 | 0.719 | 0.741 | 3.730 | 2,056.505 | 10.999 | 0.035 | 0.089 | 0.095 |
| Crush Gravel: GEN L15Z4040 LANDSCAPING EQUIPMENT, SPREADER, 54CF (1.5 M3) DRY CHEMICAL (ADD 55 HP FARM TRACTOR) | 1.123 | 1.249 | 1.211 | 1.249 | 10.935 | 2,052.283 | 13.288 | 0.038 | 0.116 | 0.138 |
| Crush Gravel: GEN R50Z5600 ROLLER, VIBRATORY, SELF-PROPELLED, SINGLE DRUM, PAD FOOT, 5.5 T (5.0 MT), 50" (1.27 M) | 1.460 | 1.487 | 1.443 | 1.487 | 6.927 | 2,486.169 | 17.988 | 0.045 | 0.159 | 0.171 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| WIDE, 3X2, SOIL COMPACTOR | | | | | | | | | | |
| Crush Gravel: GEN T15Z6520 TRACTOR, CRAWLER (DOZER), 181-250 HP (135-186 KW), POWERSHIFT, LGP, W/UNIVERSAL BLADE | 3.580 | 3.027 | 2.936 | 3.027 | 15.242 | 8,403.318 | 44.943 | 0.144 | 0.374 | 0.402 |
| Compact Select Fill: GEN A15Z0140 AIR COMPRESSOR, 265 CFM (7.5 CMM), 205 PSI (1413 KPA), TRAILER MTD (ADD HOSE) | 2.404 | 2.449 | 2.375 | 2.449 | 11.405 | 4,093.558 | 29.617 | 0.073 | 0.160 | 0.172 |
| Compact Select Fill: GEN T15Z6520 TRACTOR, CRAWLER (DOZER), 181-250 HP (135-186 KW), POWERSHIFT, LGP, W/UNIVERSAL BLADE | 3.607 | 3.050 | 2.958 | 3.050 | 15.356 | 8,466.081 | 45.279 | 0.145 | 0.377 | 0.405 |
| Compact Select Fill: GEN T50Z7710 DUMP TRUCK, HIGHWAY, 80KGVW (36.3MT), 6 AXLE (3 RETRACTABLE) WITH REAR 16 - 20 CY (12.2-15.3 M3) DUMP BODY | 5.508 | 5.283 | 5.125 | 5.283 | 38.422 | 9,639.473 | 82.242 | 0.171 | 0.633 | 1.029 |
| Repair Crown: GEN T15Z6440 TRACTOR, CRAWLER (DOZER), 76-100 HP (57-75 KW), POWERSHIFT, W/UNIVERSAL BLADE | 0.773 | 0.890 | 0.864 | 0.890 | 3.812 | 1,593.906 | 9.346 | 0.028 | 0.117 | 0.126 |
| Cut: GEN T15Z6440 TRACTOR, CRAWLER (DOZER), 76-100 HP (57-75 KW), POWERSHIFT, W/UNIVERSAL BLADE | 0.229 | 0.264 | 0.256 | 0.264 | 1.129 | 472.036 | 2.768 | 0.008 | 0.035 | 0.037 |
| Disposal: EP T15CA011 TRACTOR, CRAWLER (DOZER), 258 HP, LOW GROUND PRESSURE, W/6.57 CY VARIABLE PITCH ADJUSTABLE TILT BLADE (ADD ATTACHMENTS) | 0.060 | 0.051 | 0.049 | 0.051 | 0.255 | 140.339 | 0.751 | 0.002 | 0.006 | 0.007 |
| Disposal: EP T15CA012 TRACTOR, CRAWLER (DOZER), 270 HP, W/8.98 CY SEMI-U BLADE (ADD ATTACHMENTS) | 0.063 | 0.053 | 0.051 | 0.053 | 0.266 | 146.866 | 0.785 | 0.003 | 0.006 | 0.007 |
| Disposal: GEN T55Z7720 TRUCK, OFF-HIGHWAY, RIGID FRAME, 31.7 CY (24.2 M3), 42T (38.1 MT), 4X4, REAR DUMP | 1.616 | 1.550 | 1.503 | 1.550 | 11.271 | 2,827.786 | 24.126 | 0.050 | 0.055 | 0.089 |
| Fill: GEN T15Z6440 TRACTOR, CRAWLER | 0.212 | 0.244 | 0.237 | 0.244 | 1.045 | 437.174 | 2.563 | 0.008 | 0.032 | 0.034 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| (DOZER), 76-100 HP (57-75 KW), POWERSHIFT, W/UNIVERSAL BLADE | | | | | | | | | | |
| Fill: GEN T15Z6520 TRACTOR, CRAWLER (DOZER), 181-250 HP (135-186 KW), POWERSHIFT, LGP, W/UNIVERSAL BLADE | 0.030 | 0.025 | 0.024 | 0.025 | 0.126 | 69.737 | 0.373 | 0.001 | 0.003 | 0.003 |
| Excavation 1: GEN T15Z6440 TRACTOR, CRAWLER (DOZER), 76-100 HP (57-75 KW), POWERSHIFT, W/UNIVERSAL BLADE | 0.990 | 1.141 | 1.107 | 1.141 | 4.884 | 2,042.236 | 11.975 | 0.036 | 0.150 | 0.161 |
| Excavation 1: GEN T15Z6520 TRACTOR, CRAWLER (DOZER), 181-250 HP (135-186 KW), POWERSHIFT, LGP, W/UNIVERSAL BLADE | 0.139 | 0.117 | 0.114 | 0.117 | 0.591 | 326.021 | 1.744 | 0.006 | 0.015 | 0.016 |
| Disposal: EP T15CA011 TRACTOR, CRAWLER (DOZER), 258 HP, LOW GROUND PRESSURE, W/6.57 CY VARIABLE PITCH ADJUSTABLE TILT BLADE (ADD ATTACHMENTS) | 0.258 | 0.218 | 0.212 | 0.218 | 1.100 | 606.336 | 3.243 | 0.010 | 0.026 | 0.028 |
| Disposal: EP T15CA011 TRACTOR, CRAWLER (DOZER), 258 HP, LOW GROUND PRESSURE, W/6.57 CY VARIABLE PITCH ADJUSTABLE TILT BLADE (ADD ATTACHMENTS) | 0.258 | 0.218 | 0.212 | 0.218 | 1.100 | 606.336 | 3.243 | 0.010 | 0.026 | 0.028 |
| Disposal: GEN T55Z7720 TRUCK, OFF-HIGHWAY, RIGID FRAME, 31.7 CY (24.2 M3), 42T (38.1 MT), 4X4, REAR DUMP | 3.494 | 3.351 | 3.250 | 3.351 | 24.369 | 6,113.857 | 52.162 | 0.109 | 0.118 | 0.192 |
| Haul: GEN T50Z7710 DUMP TRUCK, HIGHWAY, 80KGVW (36.3MT), 6 AXLE (3 RETRACTABLE) WITH REAR 16 - 20 CY (12.2-15.3 M3) DUMP BODY | 9.939 | 9.533 | 9.247 | 9.533 | 69.327 | 17,393.140 | 148.394 | 0.309 | 0.407 | 0.661 |

***Commute Details***

| Activity | Number of Laborers/cars in group | Manhours per laborer | Full Days worked | Avg Milage to/from site | Total miles traveled per car | Total miles traveled for group |
|---|---|---|---|---|---|---|
| Trees Cleared | 3 | 144 | 18 | 50 | 1800 | 5400 |
| B Stone: Unload B | 3 | 85.371 | 11 | 50 | 1100 | 3300 |
| B Stone: Place B | 2 | 171.428 | 22 | 50 | 2200 | 4400 |

| | | | | | | |
|---|---|---|---|---|---|---|
| A Stone: Unload A | 3 | 36.285 | 5 | 50 | 500 | 1500 |
| A Stone: Place A | 2 | 48.571 | 7 | 50 | 700 | 1400 |
| A Stone: Crush Gravel | 3 | 241.011 | 31 | 50 | 3100 | 9300 |
| Repair Embankment: Compact Select Fill | 4 | 500.213 | 63 | 50 | 6300 | 25200 |
| Repair Crown: Misc. | 2 | 34.285 | 5 | 50 | 500 | 1000 |
| Repair Crown: Cut | 2 | 10.115 | 2 | 50 | 200 | 400 |
| Repair Crown : Disposal | 3 | 12.998 | 2 | 50 | 200 | 600 |
| Repair Crown : Fill | 3 | 10.010 | 2 | 50 | 200 | 600 |
| Remove Aggregate | 1 | 3.943 | 1 | 50 | 100 | 100 |
| Surface Excavation: Excavation 1 | 3 | 46.732 | 6 | 50 | 600 | 1800 |
| Surface Excavation: Disposal | 3 | 38.217 | 5 | 50 | 500 | 1500 |
| Surface Excavation: Surface Excavation: Hauling | 1 | 62.381 | 8 | 50 | 800 | 800 |

The crew sizes were assumed to equate one person to one passenger vehicle. A typical workday was set to 8 hours. The total unique worked days requiring commuting is estimated to be 188 days. Accounting for a 6-day work week, the overall construction duration is 220 days or rounded to 7.5 months.

***Estimated Project Duration***

| Activity | Duration (days) |
|---|---|
| Clear vegetation | 18 |
| Unload Stone B | 11 |
| Place Stone B | 22 |
| Unload Stone A | 5 |
| Place Stone A/gravel | 38 |
| Repair Embankment | 63 |
| Repair Crown | 12 |
| Surface Excavation | 19 |
| Unique 8-hr Days Worked | 188 |
| Overall Duration (6-Day Work Week) | 220 |

### *Commute Emissions*

| | CO (lbs) | $CO_2$ (lbs) | $NO_x$ (lbs) | PM (lbs) | PM2.5 (lbs) | PM10 (lbs) | $SO_x$ (lbs) | VOC (lbs) | $N_2O$ (lbs) | $CH_4$ (lbs) |
|---|---|---|---|---|---|---|---|---|---|---|
| Trees Cleared | 18.5079 | 5,998.2428 | 1.5577 | 0.1966 | 0.3466 | 0.5227 | 0.0578 | 2.3514 | 0.0714 | 0.1071 |
| B Stone: Unload B | 11.3104 | 3,665.5928 | 0.9519 | 0.1202 | 0.2118 | 0.3194 | 0.0353 | 1.4370 | 0.0437 | 0.0655 |
| B Stone: Place B | 15.0805 | 4,887.4571 | 1.2692 | 0.1602 | 0.2824 | 0.4259 | 0.0471 | 1.9160 | 0.0582 | 0.0873 |
| A Stone: Unload A | 5.1411 | 1,666.1786 | 0.4327 | 0.0546 | 0.0963 | 0.1452 | 0.0161 | 0.6532 | 0.0198 | 0.0298 |
| A Stone: Place A | 4.7983 | 1,555.1000 | 0.4038 | 0.0510 | 0.0899 | 0.1355 | 0.0150 | 0.6096 | 0.0185 | 0.0278 |
| A Stone: Crush Gravel | 31.8746 | 10,330.3071 | 2.6827 | 0.3386 | 0.5969 | 0.9001 | 0.0995 | 4.0497 | 0.1230 | 0.1845 |
| Repair Embankment: Compact Select Fill | 86.3700 | 27,991.7999 | 7.2692 | 0.9175 | 1.6173 | 2.4391 | 0.2696 | 10.9733 | 0.3333 | 0.5000 |
| Repair Crown: misc | 3.4274 | 1,110.7857 | 0.2885 | 0.0364 | 0.0642 | 0.0968 | 0.0107 | 0.4355 | 0.0132 | 0.0198 |
| Repair Crown: Cut | 1.3710 | 444.3143 | 0.1154 | 0.0146 | 0.0257 | 0.0387 | 0.0043 | 0.1742 | 0.0053 | 0.0079 |
| Repair Crown:Disposal | 2.0564 | 666.4714 | 0.1731 | 0.0218 | 0.0385 | 0.0581 | 0.0064 | 0.2613 | 0.0079 | 0.0119 |
| Repair Crown:Fill | 2.0564 | 666.4714 | 0.1731 | 0.0218 | 0.0385 | 0.0581 | 0.0064 | 0.2613 | 0.0079 | 0.0119 |
| Repair Crown:Remove Aggregate | 0.3427 | 111.0786 | 0.0288 | 0.0036 | 0.0064 | 0.0097 | 0.0011 | 0.0435 | 0.0013 | 0.0020 |
| Surface Excavation: Excavation 1 | 6.1693 | 1,999.4143 | 0.5192 | 0.0655 | 0.1155 | 0.1742 | 0.0193 | 0.7838 | 0.0238 | 0.0357 |
| Surface Excavation: Disposal | 5.1411 | 1,666.1786 | 0.4327 | 0.0546 | 0.0963 | 0.1452 | 0.0161 | 0.6532 | 0.0198 | 0.0298 |
| Surface Excavation: Hauling | 2.7419 | 888.6286 | 0.2308 | 0.0291 | 0.0513 | 0.0774 | 0.0086 | 0.3484 | 0.0106 | 0.0159 |

### *Air Emissions Summary*

| | VOC (lbs) | CO (lbs) | $SO_x$ (lbs) | $NO_x$ (lbs) | PM (lbs) | PM2.5 (lbs) | PM10 (lbs) | $CO_2$ (lbs) | $CH_4$ (lbs) | $N_2O$ (lbs) |
|---|---|---|---|---|---|---|---|---|---|---|
| Clear vegetation | 3.12 | 22.32 | 0.09 | 10.90 | 1.09 | 1.21 | 1.41 | 7,592.15 | 0.23 | 0.19 |
| Equipment used in clearing vegetation | 0.77 | 3.81 | 0.03 | 9.35 | 0.89 | 0.86 | 0.89 | 1,593.91 | 0.13 | 0.12 |
| Commute as apart clearing vegetation | 2.35 | 18.51 | 0.06 | 1.56 | 0.20 | 0.35 | 0.52 | 5,998.24 | 0.11 | 0.07 |
| Unload Stone B | 10.66 | 48.77 | 0.19 | 68.64 | 5.82 | 5.40 | 5.67 | 12,769.17 | 0.45 | 0.37 |
| Equipment used in unloading stone | 9.22 | 37.46 | 0.15 | 67.69 | 5.70 | 5.19 | 5.35 | 9,103.58 | 0.38 | 0.33 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Commute in unloading stone | 1.44 | 11.31 | 0.04 | 0.95 | 0.12 | 0.21 | 0.32 | 3,665.59 | 0.07 | 0.04 |
| Place Stone B | 7.11 | 51.01 | 0.25 | 65.47 | 5.82 | 5.78 | 6.09 | 16,415.16 | 0.62 | 0.55 |
| Equipment used in placing stone b | 5.20 | 35.93 | 0.20 | 64.21 | 5.66 | 5.49 | 5.66 | 11,527.70 | 0.53 | 0.49 |
| Commute used in placing stone b | 1.92 | 15.08 | 0.05 | 1.27 | 0.16 | 0.28 | 0.43 | 4,887.46 | 0.09 | 0.06 |
| Unload Stone A | 1.26 | 6.87 | 0.04 | 8.62 | 0.43 | 0.46 | 0.52 | 2,961.10 | 0.08 | 0.06 |
| Equipment used in unloading stone A | 0.60 | 1.72 | 0.02 | 8.19 | 0.37 | 0.36 | 0.37 | 1,294.93 | 0.05 | 0.04 |
| Commute in unloading stone A | 0.65 | 5.14 | 0.02 | 0.43 | 0.05 | 0.10 | 0.15 | 1,666.18 | 0.03 | 0.02 |
| Place Stone A/gravel | 12.21 | 79.36 | 0.39 | 96.43 | 7.66 | 7.74 | 8.31 | 27,901.41 | 1.06 | 0.92 |
| Equipment used in placing A/gravel | 7.55 | 42.69 | 0.28 | 93.34 | 7.27 | 7.06 | 7.27 | 16,016.00 | 0.85 | 0.78 |
| Commute in placing A/gravel | 4.66 | 36.67 | 0.11 | 3.09 | 0.39 | 0.69 | 1.04 | 11,885.41 | 0.21 | 0.14 |
| | | | | | | | | | | |
| Repair Embankment | 22.49 | 151.55 | 0.66 | 164.41 | 11.70 | 12.08 | 13.22 | 50,190.91 | 2.11 | 1.50 |
| Equipment used in repairing embankment | 11.52 | 65.18 | 0.39 | 157.14 | 10.78 | 10.46 | 10.78 | 22,199.11 | 1.61 | 1.17 |
| Commute in repairing embankment | 10.97 | 86.37 | 0.27 | 7.27 | 0.92 | 1.62 | 2.44 | 27,991.80 | 0.50 | 0.33 |
| | | | | | | | | | | |
| Repair Crown | 3.38 | 23.35 | 0.10 | 32.15 | 2.28 | 2.29 | 2.45 | 7,093.06 | 0.23 | 0.17 |
| Equipment used in repairing crown | 2.21 | 14.09 | 0.07 | 31.37 | 2.19 | 2.12 | 2.19 | 4,093.94 | 0.18 | 0.14 |
| Commute in repairing crown | 1.18 | 9.25 | 0.03 | 0.78 | 0.10 | 0.17 | 0.26 | 2,999.12 | 0.05 | 0.04 |
| Surface Excavation | 16.86 | 115.42 | 0.52 | 221.94 | 14.73 | 14.40 | 14.98 | 31,642.15 | 1.17 | 0.80 |
| Equipment used in | 15.08 | 101.37 | 0.48 | 220.76 | 14.58 | 14.14 | 14.58 | 27,087.93 | 1.09 | 0.74 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| surface excavation | | | | | | | | | | |
| Commute in surface excavation | 1.79 | 14.05 | 0.04 | 1.18 | 0.15 | 0.26 | 0.40 | 4,554.22 | 0.08 | 0.05 |
| **Overall Project Emissions** | 77.10 | 498.64 | 2.24 | 668.56 | 49.53 | 49.36 | 52.64 | 156,565.12 | 5.94 | 4.57 |