Draft
Clean Water Act Section 404(b)(1) Analysis

Keystone Dam Safety Modification Study

Arkansas River Basin

Tulsa County

Oklahoma

March 2024

Tulsa District

U.S. Army Corps of Engineers

Table of Contents

List of Figures

List of Tables

1 Project Description

This Clean Water Act (CWA) Section 404(b)(1) Analysis has been prepared by the U.S. Army Corps of Engineers (USACE) Tulsa District (SWT) to evaluate the Keystone Dam Safety Modification Study (DSMS). In addition to this analysis, SWT has prepared a Draft Environmental Assessment (EA). It has been prepared in accordance with 33 Code of Federal Regulations (CFR) Part 230 and the 1978 Council on Environmental Quality (CEQ) regulations 40 CFR Parts 1500-1508. In fulfillment of these and all other legal, regulatory, and policy requirements, this EA describes the purpose and need for the action, the range of alternatives considered, and discloses the environmental impacts of the alternatives.

1.1 Purpose and Need

The purpose of this DSMS, including the DSMR and EA, is to evaluate Risk Management Plans (RMPs) and identify a plan to reduce risk associated with Keystone Dam.

The Tulsa metro area and adjacent communities is the immediate impact area affected by a failure of Keystone Dam. Tulsa has a population of nearly 400,000 with a metropolitan area population of nearly one million. The city is the second most populous in the state and Tulsa County is also the most densely populated county in the state. Population projections for the area are anticipated to increase over the next 50 years. Failure of Keystone Dam could result in impacts along the Arkansas River throughout Oklahoma and Arkansas.

Development in the Tulsa area on the southern bank of the Arkansas River is primarily commercial and industrial and includes the Holly Refinery, along with numerous other manufacturing, chemical and oil and gas facilities. The northern bank of the river is marked by a mix of residential, commercial and industrial development. There are also numerous levee systems along the entire Arkansas River.

The greatest life safety risk in the event of a breach would be in the populated areas just below Keystone Dam. As discussed, this area has noteworthy commercial/industrial along with residential development.

1.2 Location

Keystone Dam is a high hazard potential dam located in Tulsa County at mile 538.8 on the Arkansas River 15 miles west of the City of Tulsa, Oklahoma, as shown below in Figure 1. This site is located about 2 miles downstream from the confluence of the Cimarron and Arkansas Rivers.

The features comprising the dam include right and left embankment sections, right and left concrete gravity spillway non-overflow sections, a gated concrete gravity spillway section, and a two-unit power plant. The right embankment section is 1,965 feet ft-long, and the left embankment is 1,023 ft-long. The maximum height of the dam above the streambed is about 121 ft. Figure 2 below shows an overhead view of the project features.

Figure 1. Keystone Dam Location

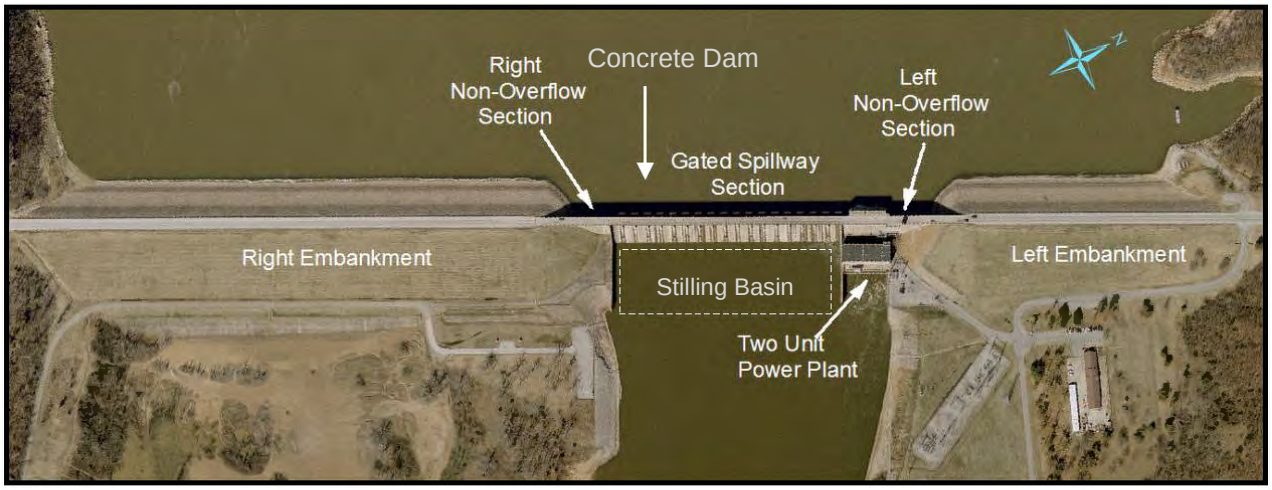

Figure 2. Keystone Dam Pertinent Features

1.3 Project Authority

Keystone Dam was originally authorized by Congress in the Flood Control Act of May 17, 1950 (Project Document SD 107, 81st Congress, 1st Session). The authorized purposes of Keystone Dam are flood control, water supply, hydroelectric power, navigation, and fish and wildlife enhancement. Following authorization, construction of Keystone Dam began in January 1957 and the project was placed in operation in September 1964 for flood control. The two generating units for hydroelectric power became operational in May 1968.

The authorized project purposes, including flood risk management, continues to be fulfilled by the operation of Keystone Dam. An estimated $59.8M in annual flood risk management benefits are provided by the dam. Continued federal investment to address dam safety issues is warranted. No changes to the authorized project purposes appear warranted at this time.

2 Alternatives Evaluation

2.1 Description of Alternatives Evaluated

After plan formulation to develop RMPs and the screening process, five RMPs were included in the final array for the Keystone DSMS. To evaluate these RMPs a conceptual level design and cost estimate for each RMP was developed. A general basis of design was developed to support the rough order-of-magnitude (ROM) cost estimate and to facilitate evaluating environmental concerns, estimating risk reduction, real estate considerations, and Operations and Maintenance (O&M) considerations. These designs were largely based on existing available information with the intent of refining the design for the TSP.

The final array of RMPs is shown below.

- RMP 5a – Dam Raise with Stilling Basin Modification
- RMP 5c – Dam Raise with Stilling Basin Modification and Erosion Control Wall
- RMP 6e – New Gated Spillway with Stilling Basin Modifications
- RMP 6g – New Labyrinth Spillway with Stilling Basin Modifications
- RMP 7 – New Gated Spillway and Decommission Existing Spillway and Stilling Basin
- RMP 9 – No Action

Nine additional alternatives (RMP's 5b, 6a-d, 6f, and 6h-j) were also evaluated but were eliminated for not meeting design criteria during initial phases of analysis.

2.1.1 No Action Alternative (RMP 9)

The No Action Alternative or Future Without-Action Condition (FWAC), while it does not meet the purpose or need of minimizing dam safety concerns, serves as a benchmark of existing conditions against which Federal actions can be evaluated and, therefore, is included in this EA pursuant to CEQ regulations 40 CFR § 1502.14(c). Under the No Action Alternative, no ground-disturbing activities would be undertaken by USACE.

It is assumed that the Tulsa District will continue to operate and maintain Keystone Dam in accordance with the O&M Manual and the Water Control Manual. The Keystone Dam Surveillance Plan will be followed which establishes weekly, daily, and 24-hour surveillance monitoring thresholds for different pool elevations. The thresholds are captured in the 2019 update of the Emergency Action Plan.

As a summary, the following is anticipated over the next 50 years, absent a Federal action:

- Implementation of enhanced flood warning measures by local communities downstream;
- USACE would continue to operate and maintain the project, including monitoring existing instrumentation, with no changes to operations anticipated;
- Climate Change is not anticipated to impact probability of extreme events;
- No significant development impacting watershed hydrology is anticipated; and
- No significant changes to downstream channel capacity along the Arkansas River is anticipated.

2.1.2 RMP 5a and 5c – Dam Raise and Modification of the Existing Stilling Basin

The primary purpose of the dam raise is to store additional floodwater behind Keystone Dam until it can be passed through the existing controlled spillway structure (addresses PFM 30). Increasing the height of the dam will provide a higher potential elevation to hold water above the current top of flood storage pool. It would not result in any operational change of the dam as described in the current water control manual, including the elevation of the conservation pool and the top of flood pool.

The purpose of modifying the existing stilling basin is to stabilize the stilling basin structure to protect the foundation of the concrete spillway from erosion (PFMs 66 and 73). Risk Management Plans 5a and 5c are similar plans and only differ in the measures included in the modification of the existing stilling basin. Risk Management Plan 5c includes an erosion control wall at the downstream end of the stilling basin to reduce the potential for erosion to migrate upstream into the stilling basin (PFM 73). This feature was added to RMP 5a to improve its effectiveness and reduce the potential of erosion of the riverbed downstream during large releases. Risk Management Plan 5c also includes 1 ft of freeboard to provide additional storage capacity in the event a gate fails to open (PFM 65).

Dam Raise

The dam will be raised by approximately 10.5 ft, along with the bridge (Highway [HWY] 151) over the spillway (Figure 3). Additional earthen material will be added to the left

and right embankments of the dam and concrete added to the dam structure for additional height.

Figure 3. Risk Management Plan 5c

Modification of the Existing Stilling Basin

The existing stilling basin slabs will be anchored to the foundation and include a new overlay of concrete. The existing baffle blocks (energy dissipation block within the stilling basin) will be replaced with new strengthened blocks of similar size.

The right stilling basin training wall will be anchored to reinforce the structure while the stilling basin is de-watered. The general footprint of the existing spillway stilling basin and stilling basin walls is approximately 3.5 acres. All work is expected to occur within the existing footprint.

Figure 4. General Location of Stilling Basin

Stilling Basin Cofferdam

A cofferdam, or barrier, will be constructed on the downstream side of Keystone Dam to allow for dewatering of the stilling basin so construction can be completed in dry conditions. Two permanent dividers walls will be constructed within the stilling basin to facilitate construction. The permanent dividers walls will be extended downstream of the stilling basin ~250 feet using temporary coffercells. Releases from the reservoir will be made from two-thirds of the basin while work is accomplished in the remaining third. An erodible earthen cofferdam would be constructed “in-the-wet” on the downstream side of the stilling basin between the temporary coffercells. In case of flooding, all gates may need to be used to pass the flood waters and this erodible cofferdam may be washed downstream (Figure 5). Temporary bridges will be used to access each de-watered section of the stilling basin. These bridges may be placed from either the right or left side of the stilling basin. Construction of the temporary earthen cofferdam and coffercells will be from rockfill roadways constructed downstream of the coffercells. The rockfill roadways and earthen cofferdams will be replaced as needed when releases from Keystone Dam are required and erode the fill material.

Figure 5. Bridge and Cofferdam Locations

2.1.3 RMP 6e – 804-ft-wide Gated Auxiliary Spillway with Stilling Basin Modifications.

This alternative involves constructing a new gated spillway in the right abutment. With this alternative, approximately 151 acres of new, permanent ground disturbance would be required to fully construct and operate the new structure.

The purpose of the new gated spillway is to provide a means to release additional water from Keystone Dam to prevent overtopping (PFM 30). It allows the project to restore most of the original design freeboard, or distance from the water surface to the lowest elevation at which water overflows the dam (PFMs 30 and 65). The additional releases provided by this RMP would also improve energy dissipation within the stilling basin (PFM 73).

The addition of a new spillway would not result in a change to the existing conservation pool elevation or normal top of the flood pool elevation. The new spillway would be utilized during extreme events after the existing spillway gates are fully opened.

The stilling basin modifications would include stabilizing the stilling basin structure to protect the rock foundation downstream of the concrete spillway from erosion (PFMs 66 and 73).

New Gated Auxiliary Spillway

An 804-ft-wide gated spillway would be constructed in the Keystone Dam right abutment and would have approximately 14 - 50-ft wide spillway bays (see Figure 6). The existing HWY 151 alignment would be modified to cross over this new gated spillway. An approach channel would be constructed upstream of the gated spillway. The total estimated excavation is 11,000,000 cubic yards (cys) of material. No releases from the new gated spillway are expected to occur until the existing gates are fully opened or if the new gated spillway is used for normal operation of the project.

Disposal of excavated material may be placed on USACE-owned property, as well as private off-site locations. If placed on USACE-owned property, the sites would be outside of the 1/100-year floodplain and accessible by “on-road” vehicles. Sites designated for material disposal on USACE fee-owned land have not been identified; however, it can be expected that the material may be used to supplement shoreline protection, other approved projects, or on sites with low habitat quality to avoid significant resources. If on-site, the estimated area would require 155 acres, resulting in a direct and permanent impact. A Supplement to this EA may be required to evaluate disposal locations to adequately address natural and cultural resources if this alternative is selected for implementation.

Modification of the Existing Stilling Basin

The existing stilling basin slabs will be anchored to the foundation and include a new overlay of concrete. The existing baffle blocks will be replaced with new strengthened blocks of similar size.

The right stilling basin training wall will be anchored to reinforce the structure while the stilling basin is de-watered. There would be no change to the existing footprint of the stilling basin.

Stilling Basin Cofferdam

A cofferdam described in RMP 5a/5c will be required to construct the features of work in the stilling basin.

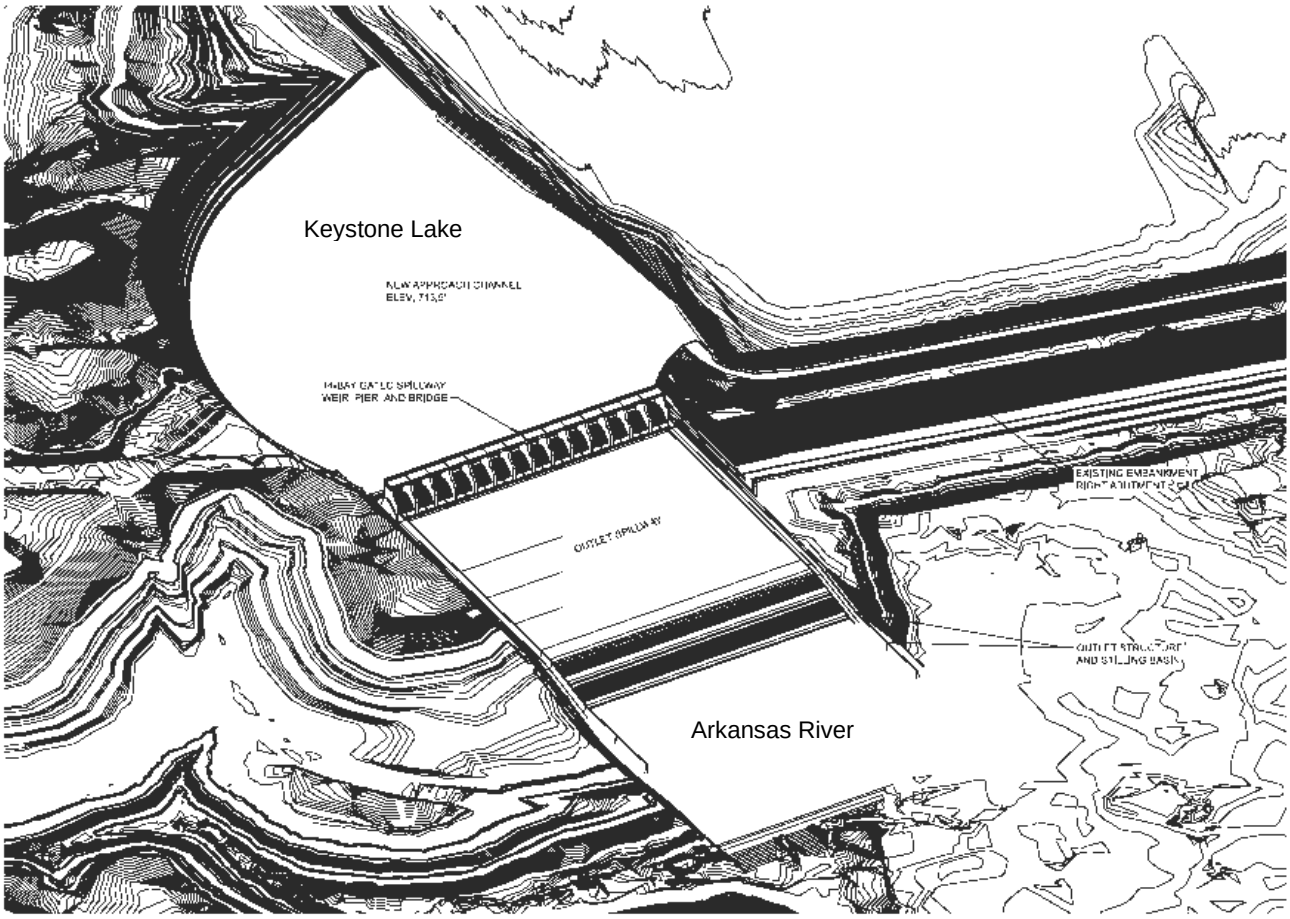

Figure 6. Isometric Illustration of RMP 6e

2.1.4 RMP 6g – 803-ft-wide Labyrinth Auxiliary Spillway with Stilling Basin Modifications

This alternative involves constructing a new un-gated spillway in the right abutment. With this alternative, approximately 40 acres of new, permanent direct ground disturbance would be required to fully construct and operate the new structure.

The purpose of the new un-gated spillway would be to provide a means to release additional water from Keystone Dam to prevent overtopping (PFM 30). A hydraulic baffle, used to dissipate the waters energy, will be constructed across the face of the existing spillway to protect the gates and superstructure during pool elevations greater

than the original design elevation (766 ft NGVD20). The additional releases provided by this RMP would also improve energy dissipation within the stilling basin (PFM 73).

The addition of a new spillway would not result in a change to the existing conservation pool elevation or normal top of flood pool elevation. The new spillway would be utilized during extreme events after the existing spillway gates are fully opened.

The purpose of modifying the existing stilling basin is to stabilize the stilling basin structure to protect the lower portion of the concrete spillway from erosion (PFMs 66 and 73).

New Labyrinth Auxiliary Spillway

An 803-ft-wide labyrinth spillway would be constructed in the right abutment (see Figure 7). A new HWY 151 bridge would be constructed over the new spillway exit channel. A total of approximately 5,500,000 CY of excavation is estimated for the construction of RMP 6g. An approximately 600-ft approach channel would be constructed upstream of the new spillway. Similar to RMP 6e, on-site and off-site disposal will be considered and may require Supplemental compliance for environmental and cultural resources. If on-site, the estimated area would require 70 acres resulting in a direct and permanent impact.

Existing Stilling Basin Modification

The existing stilling basin slabs will be anchored to the foundation and include a new overlay of concrete. The existing baffle blocks (energy dissipation block within the stilling basin) will be replaced with new strengthened blocks of similar size.

The right stilling basin training wall will be anchored to reinforce the structure while the stilling basin is de-watered. There would be no change to the existing footprint of the stilling basin.

Stilling Basin Cofferdam

A cofferdam described in RMP 5a/5c will be required to construct the features of work in the stilling basin.

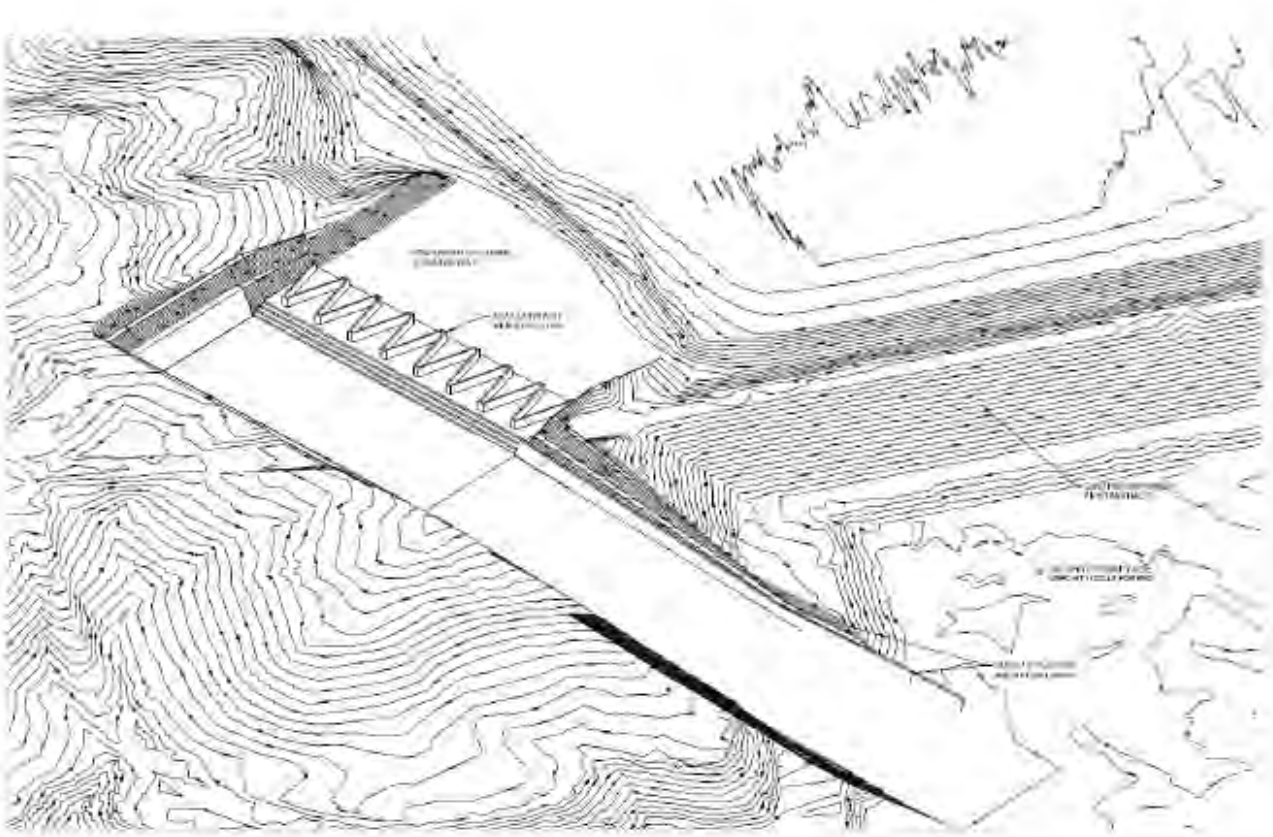

Figure 7. Isometric Illustration of RMP 6g

2.1.5 RMP 7 – 904-ft-wide Gated Auxiliary Spillway with Dam Raise and Decommissioning of Existing Service Spillway

This alternative involves constructing a new gated spillway in the right abutment. With this alternative, approximately 120 acres of new, permanent direct ground disturbance would be required to fully construct and operate the new structure.

The purpose of the new gated spillway is to replace the existing spillway at Keystone Dam with a new more robust structure (PFMs 66 and 73). The existing spillway would be decommissioned, and the dam raised by approximately 4 feet (PFM 30).

New Gated Spillway/Dam Raise

A new 904-ft-wide gated spillway would be constructed in the right abutment and consists of 19 – 40 ft-wide spillway bays. The existing HWY 151 alignment would be modified to cross over this new gated spillway. A total of approximately 20,000,000 CY of excavation is estimated for the construction of RMP 7. An approach channel will be constructed upstream of the spillway. Similar to RMP 6e, on-site and off-site disposal will be considered and may require Supplemental analysis for environmental and

cultural resources for disposal on 295 acres of land. Additional details regarding excavation elevations would be determined during the PED phase.

The gated spillway would be operated to match the operation of the existing spillway. The existing spillway would be decommissioned with only the existing sluice gates (valves designed to seal in one direction) remaining in service.

The embankment would be raised by approximately 4 ft and HWY 151 would continue over the proposed decommissioned spillway. Dam embankment material would be excavated to tie the dam raise into the existing embankment.

Existing Spillway Modification

The existing spillway would be decommissioned and filled with concrete to create a permanent dam. The existing sluice gates and the existing stilling basin would be left in-place.

Existing Spillway Cofferdam

To facilitate the abandonment of the existing service spillway, cofferdams upstream of the spillway in the lake, and downstream of the stilling basin would be required. After completion of construction, a portion of the cofferdam would be removed to allow for hydropower generation and the use of the existing sluice gates.

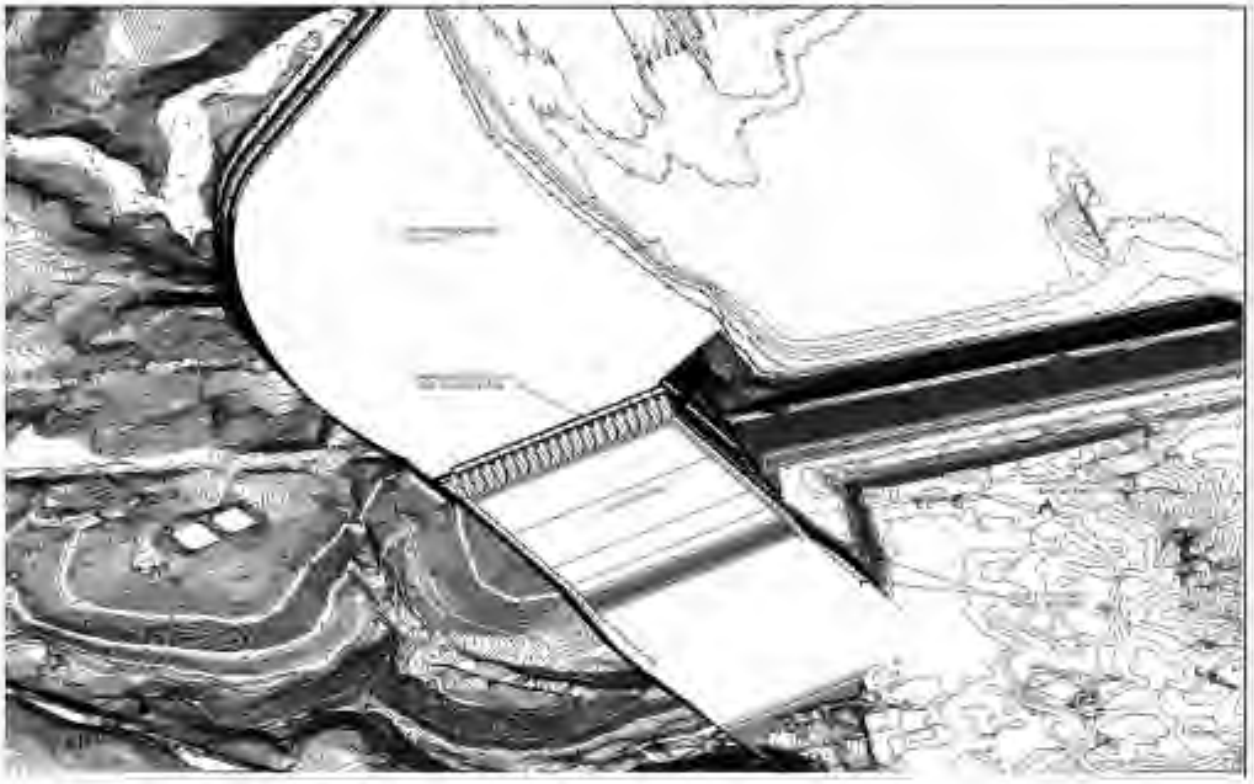

Figure 8. Isometric Illustration of RMP 7 Gated Spillway

2.1.6 As-Low-As-Reasonably-Practicable Consideration (ALARP)

Modifications to the selected RMP that can be implemented from an ALARP perspective were considered for the following PFMs:

- PFM 29 (Internal Erosion into Right Abutment Upper Rock)
    - Recommended ALARP measure discussed in more detail below.
- PFM 65 (Mechanical/Electrical Gate Failure)
    - Additional freeboard would be added to the dam raise to account for the inability to open a Tainter Gate during an extreme flood.

PFM 29 (Internal Erosion into Right Abutment Upper Rock)

The proposed filter berm for PFM 29 is intended to cover the area of existing seepage in the right abutment. The proposed filter berm would provide a filtered exit, collection system, and weir to monitor the quantity of seepage.

The filter berm would generally be constructed of three materials; fine filter aggregate (ASTM C33 concrete fine aggregate), random fill, and topsoil to support vegetation growth. Existing random fill areas (including waste fill zones) may need to be excavated along with limited intact bedrock to facilitate construction of the berm. Existing waste fill material could potentially be re-used as random fill in the filter berm. Any existing seepage collection system would be removed, and all seepage collected to a common location for minimal future maintenance and inspection activities.

2.1.7 Screening and Evaluation Criteria

The initial array of brainstormed measures included the No Action Alternative and mandatory RMPs described in ER 1110-2-1156. Measures were screened against the primary study objective of reducing the incremental dam safety risk associated with the dam to meet the Societal Tolerable Risk Limit. Measures were then screened out based on being ineffective at reducing risk, low efficiency, having unacceptable risk, or having unacceptable impacts. Tulsa District considered the initial measures utilizing the following criteria:

1. Effectiveness – the extent to which a measure meets the study objectives.
2. Constructability/Implementability – the extent to which a measure can be constructed, implemented, and/or increase project risk during construction.
3. Cost Efficiency – the magnitude cost compared to other measures.
4. Risk Transfer – the potential for the measure to transfer the existing conditions risk from one area of the study to another.
5. Non-Breach Consequences – the extent to which the measure impacted non-breach risk.
6. Social Effects – assessing impacts to the local community, transportation impacts, as well as recreation and other social aspects.

7. Environmental/Cultural Impacts - the extent to which the measure would impact the natural and human environment.

8. Real Estate Impacts – the extent to which the measure would require the acquisition of additional real estate.

9. Impacts to Authorized Project Purposes – the extent to which the measure would impact the other authorized project purposes of water supply, hydroelectric power, navigation, recreation, and fish and wildlife enhancement.

2.2 Common Features for Each Alternative

2.2.1 Staging, Laydown, and Haul Routes

All construction alternatives evaluated would include the implementation of staging, laydown, and haul routes. Staging and laydown areas are proposed for five separate locations, but it should be noted not all areas may be necessary because only approximately 10 acres in total will be needed during construction (Figure 9). Shrubs and trees would be cleared, and gravel laid down to allow for appropriate drainage and surface conditions. However, due to the location of the proposed staging and laydown areas there is very little vegetation clearing expected. All proposed staging areas are described below, but some may be screened out during the preconstruction, engineering, and design (PED) phase due to accessibility for large construction equipment.

Haul route locations are not known but expected to be further developed during the PED phase. New haul routes are not expected to require vegetation clearing and would be avoided/minimized to the extent practicable. Existing roads may be expanded with appropriate road base to allow two-way traffic for large construction equipment.

All impacts from staging, laydown, and haul routes would be temporary in nature and fully restored with native vegetation upon completion of construction features.

Figure 9. Proposed Staging and/or Laydown Areas

2.2.2 On-site Concrete Batch Plant

A 20-acre concrete batch plant will be established near the dam site for construction within the White-Water Off-road Vehicle (ORV) Park (Figure 10). The batch plant will be established on non-wetland soils that have been previously disturbed by off-road vehicle use. Use of the batch plant includes laydown areas and storage areas of materials such as sand, concrete, and gravel. Additionally haul routes will be established to truck in the necessary equipment and materials for the batch plant as well as construction but are not expected to disturb existing trees.

Figure 10. Proposed Location of Concrete Batch Plant

2.3 Impacts to Jurisdictional Wetlands/Waters of the U.S.

As part of the alternative evaluation process, a semi-quantitative assessment of permanent impacts to wetlands, streams, and open water was conducted for the TSP to allow for a relative comparison of impacts. Impacts that were considered included the permanent excavation of material in jurisdictional waters such as the construction of the new spillway and installation temporary construction features such as cofferdams in Keystone Lake and the Arkansas River (Table 1). For purposes of the analysis, jurisdictional features were defined as any aquatic resource below the historic high-water mark of Keystone Lake, which was previously impacted during the construction of the dam safety project.

Table 1. Impacts to Jurisdicitonal Wetlands/Waters of the U.S.

Risk Management Plan	Acres
RMP 5a	15
RMP 5c	15
RMP 6e	60
RMP 6g	51
RMP 7	70

The study determined there were five practicable alternatives, as discussed in Section 2.1 above. Only these alternatives sufficiently meet the overall project purposes (summarized as life and property risk reduction from flooding) to be considered practicable. Risk Management Plans 6e and 6g would have essentially the same aquatic ecosystem impact. However, RMP 7 is more costly and would require more disturbance along the Keystone Lake shoreline. RMP 5a and 5c would cost less and require considerably less real estate for construction based on the design and materials used to improve dam performance. Based on primarily life safety considerations, in addition to potential environmental, cultural, Environmental Justice impacts, and costs, RMP 5a was selected as the TSP.

3 Least Environmentally Damaging Practicable Alternative

It was determined by USACE that RMP 5a was the Least Environmentally Damaging Practicable Alternative compared to the other evaluated alternatives, because RMP 5c met the overall purpose and need of the project and reduced impacts to the human and natural environment. However, it is understood there will be temporary adverse impacts to Waters of the U.S. resulting from RMP 5a.

In total, there will be approximately 15 acres of temporary adverse impacts to Waters of the U.S. resulting from construction. It is assumed a cofferdam is necessary to construct modifications to the stilling basin and a dewatering of the area will be required.

4 Recommended Plan

4.1 Project Description

Based on the comparison of the final array of plans, the TSP is RMP 5a (Dam Raise with Modification of the Existing Stilling Basin). This plan meets study objectives of addressing dam safety issues and deficiencies; defining, estimating, and communicating risk; addressing non-breach and incremental risk through permanent flood risk management measures; and reducing incremental dam safety risk to tolerable levels. This alternative also avoids or minimizes impacts to the ecological resources and

human environment in the project area. Implementation of the TSP is temporary in duration and limited in spatial extent and is not anticipated to impact the overall project area.

The features of work of RMP 5a include:

- Modify existing service spillway
    - Demolish existing spillway bridge
    - Construct concrete baffle
    - Construct new spillway bridge
    - Construct dam raise and parapet wall
- Construct embankment raise (earthen/parapet wall combination)
- Modify existing service spillway stilling basin
    - Construct stilling basin divider walls, cofferdam, basin dewatering system, and instrumentation
    - Stabilize right training wall with anchors
    - Install 2 ft slab overlay (continuous reinforcement and water stops) with post-tensioned anchors in stilling basin
    - Remove and replace existing baffle blocks and strengthen endsill

4.2 General Description of Dredged or Fill Material

4.2.1 General Characteristics of Material

The main soil series within the Keystone study area is the Niotaze-Bigheart-Rock outcrop complex, 15 to 25 percent slopes, extremely stony soil. The Niotaze soil occurs in 0-40 inch thick surface layers, normally found on hill slopes, is somewhat poorly drained, and contains loamy colluvium derived from sandstone over clayey residuum weathered from shale. The Bigheart soil occurs in a 0-20 inches thick surface layers, normally found on hill slopes, is well drained, and contains residuum weathered from sandstone. The Rock Outcrop occurs in a 0-2 inches thick surface layers, and normally found on hill slope areas.

Fill materials are expected to be obtained from approved commercial borrow sites.

4.2.2 Quantity of Material

The TSP is located within previously disturbed federal property. Approximately 15 acres will be impacted by placement of fill material for the dam raise. Temporary adverse impacts to surface soils would occur. Surface soils of the dam and its abutments will be affected by placement of new soils, contouring, and grading; as well as the readjustment of State Highway 151.

4.3 Description of the Discharge Site(s)

4.3.1 Location

The temporary discharge site is located immediately downstream of Keystone Dam. Because the material discharged into Waters of the U.S. will be removed upon completion of construction, the net cubic yard (cy) increase of material will not exceed what previously existed in the Arkansas River.

4.3.2 Size

The combined total of discharge is 1.6 million cys and temporary impacts to 15 acres of open water.

4.3.3 Type(s) of Sites

All aquatic sites that will be temporarily impacted by sediment discharge will be within approximately 550 feet of the Keystone Dam and exist in previously disturbed locations used for construction of the stilling basin.

4.3.4 Type(s) of Habitat

As discussed, upland sites will be used for staging, laydown, and haul routes. However, approximately 15 acres of open water impact will be used during construction and modification of the dam stilling basin. There will not be a net loss of wetlands or Waters of the U.S. as a result of discharge.

4.3.5 Waters and Wetlands

All waters within the project's dredge and disposal operations are considered jurisdictional and will be temporarily impacted due to the TSP.

4.3.6 Timing and Duration of Discharge

Construction of each of the project features would be timed to occur during low flow periods to minimize impacts to the aquatic system. A more detailed schedule would be developed during the Pre-construction, Engineering, and Design (PED) phase. Construction is expected to be completed after approximately eight years.

4.4 Description of Disposal Method

Heavy construction vehicles and equipment would be needed to construct any in-water project features. The vehicles and equipment would operate outside of existing wetlands and drainages to the extent possible.

An assortment of wheeled and tracked equipment necessary to handle large loads of soil, such as backhoes, track hoes, bulldozers, dump trucks, and front-end loaders, could be used for construction. Project work would take place during safe and low flow conditions.

The temporary staging and storage of construction materials and vehicles would be situated in areas that are currently disturbed or are recommended to be cleared from the construction of the project components described above. All staging and storage areas would be outside of biological wetlands. Best management practices (BMPs) in staging areas would include erosion control and spill prevention measures.

4.5 Factual Determinations

4.5.1 Physical Substrate Determinations

4.5.1.1 Substrate Elevation and Slope

The existing substrate elevation for the Arkansas River within the project area is approximately 640 feet above mean sea level (msl) and an average slope of 1H:5V. The

elevation of the riverbed would increase in areas with cofferdam construction. The stream channel would remain within the Arkansas River's current footprint and flow/slope within the channel would remain as is to allow for continued water flow conditions as they exist today. Elevation would return to baseline conditions upon completion of construction.

4.5.1.2 Sediment Type

Sediment used for temporary in-water construction features will be obtained from an approved commercial borrow source.

4.5.1.3 Dredge/Fill Material Movement

Fill material consisting of rock and soil would be used to construct the cofferdams necessary for stilling basin measures. After construction is complete, all fill areas would be removed and baseline conditions restored. No manmade materials or debris, such as concrete or asphalt, will be used as fill material. The Arkansas River will continue to flow freely through wetland and open water disposal sites. Water velocities associated with the river will carry deposited sediments further downstream. The rate of transport will be dependent upon future rain events. Extreme precipitation events, such as a 100-year flood are more likely to force water and sediment at a faster rate downstream, as compared to a two- or five-year flood.

4.5.1.4 Physical Effects on Benthos

Placement of fill material and structures smothers or buries benthic communities. Placement activities can cause ecological damage to benthic organisms due to physical disturbance, mobilization of sediment contaminants, and increasing concentrations of suspended sediments (Montagna et al., 1998).

It is likely that the discharges in open water habitat will smother bottom-dwelling immobile organisms and require mobile benthos to migrate to areas unaffected by placement. However, it is likely benthic forms would recolonize discharge sites that have appropriate elevations within the water because the discharge would be very similar to sediments found throughout the project due to regularly occurring sedimentation.

4.5.1.5 Other Effects

Temporary impacts to aquatic organisms and fish will occur during fill disposal activities with the potential for temporary sedimentation and water quality degradation within the river. However, the aquatic organisms would be expected to return upon settling of sediment and the eventual restoration of baseline conditions.

4.5.1.6 Actions Taken to Minimize Impacts

Actions would be minimized to the extent possible by scheduling construction to coincide with low flow periods. Silt fences and geotextile filters would be placed to

minimize sediment transport downstream. Staging and construction access areas would avoid wetlands and aquatic habitats to minimize temporary disturbances and provide distance between aquatic habitats and exposed sediments.

4.5.2 Water Circulation, Fluctuation, and Salinity Determinations

4.5.2.1 Salinity

The project would not impact salinity within the Arkansas River.

4.5.2.2 Water Chemistry

Disposal actions will result in short-term and localized impacts and would not be expected to degrade the long-term water quality within the project area. These patterns should return to their previous condition following completion of construction. Temporary changes to dissolved oxygen (DO), nutrients, turbidity, and contaminant levels may occur due to fill placement. Temporary DO decreases may also happen from aerobic decomposition from short-term increases in organic matter suspended within the water column.

4.5.2.3 Clarity

There would be some temporary increase in local turbidity during placement operations. Water clarity is expected to return to normal background levels shortly after operations were completed.

4.5.2.4 Color

Water immediately surrounding the construction area will be discolored temporarily due to disturbance of the river's sediment during disposal actions but is expected to return to normal after operations cease.

4.5.2.5 Odor

No changes to odor are expected to occur during or after construction.

4.5.2.6 Taste

No changes to taste are expected to occur during or after construction.

4.5.2.7 Dissolved Gas Levels

Negligible amounts of hydrogen sulfide are expected. Hydrogen sulfide and other gases like methane are associated with high amounts of decaying organic matter and are not expected to be present in placed materials. Dissolved gases have not been identified as a problem with the current channel. Localized oxygen reductions associated with disposal are expected to be short lived and would return to normal soon after the work is complete.

4.5.2.8 Nutrients

No change in nutrient levels would occur following construction.

4.5.2.9 Eutrophication

Nutrients are not expected to reach levels high enough for periods long enough to lead to eutrophication of the surrounding waters.

4.5.3 Current Patterns and Circulation

4.5.3.1 Current Patterns and Flow

Flows from Keystone Dam will be minimized during construction of cofferdams and while cofferdams are in place for modification of the stilling basin. Current patterns and flow will be returned to normal conditions when cofferdams are no longer needed for construction efforts.

4.5.3.2 Velocity

The Federal Emergency Management Agency (FEMA) Flood Insurance Study for Tulsa County and incorporated areas lists several peak discharges associated with a probability of occurrence in any given year for the Arkansas River in the Tulsa area. These peak discharges are:

- 10-percent (10-year event): 90,000 cfs
- 2-percent (50-year event): 155,000 cfs
- 1-percent (100-year event): 205,000 cfs
- 0.2-percent (500-year event): 490,000 cfs

4.5.3.3 Stratification

Stratification in the project area does not occur now nor would it occur following project implementation.

4.5.3.4 Hydrologic Regime

While cofferdams are installed, the hydrologic regime of the immediate area is expected to decrease to minimal levels in order to ensure dewatering efforts are successful. The hydrologic regime will return to baseline conditions upon completion of construction.

4.5.3.5 Normal Water Level Fluctuations

A characteristic of the river hydraulics in the project area are high-frequency, large amplitude flow fluctuations resulting from large rain events. Flows within the study area regularly fluctuate from little to no water to large flows from storms.

4.5.3.6 Salinity Gradients

No changes to salinity gradient would occur as a result of the TSP.

4.5.3.7 Actions Taken to Minimize Impacts

In Oklahoma, the Oklahoma Department of Environmental Quality (ODEQ) is the permitting authority and administers the National Pollutant Discharge Elimination System (NPDES). Operators of construction activities that disturb 5 or greater acres must prepare a Storm Water Pollution Prevention Plan (SWPPP), submit a Notice of Intent to ODEQ and obtain authorization under OKR10, conduct onsite posting and periodic self-inspection, and follow and maintain the requirements of the SWPPP. During construction, the operator shall assure that measures are taken to control erosion, reduce litter and sediment carried offsite (silt fences, hay bales, sediment retention ponds, litter pick-up, etc.), promptly clean-up accidental spills, utilize BMPs onsite, and stabilize site against erosion before completion.

4.5.4 Suspended Particulate and Turbidity Determinations

4.5.4.1 Expected Changes in Suspended Particulates/Turbidity Levels in Vicinity of Disposal Site

Only minor temporary increases in suspended particulates and turbidity levels would likely occur during construction of the TSP. A SWPPP would be prepared, which would outline site-specific BMPs to minimize erosion and the potential for sediment to enter receiving waters during construction activities. The potential for suspended sediments would be further reduced using measures like a cofferdam, so that in-water construction would not occur. Therefore, except for a large storm event that might occur during project construction, most fill would occur within areas in a dry state. Best Management Practices, such as silt curtains, would be used to reduce impacts.

4.5.4.2 Effects (degree and duration) on Chemical and Physical Properties of the Water Column

Light Penetration: Changes to light penetration would occur during construction and flood events would be associated with minor to temporary major turbidity increases. Appropriate erosion and sedimentation controls would be implemented to reduce impacts to downstream waters. After project completion and stabilization, the clarity of the river would return to pre-construction levels.

Dissolved Oxygen: Temporary lowering of dissolved oxygen could occur during construction but would be very temporary in both time and extent. Following modification of the stilling basin, pre-construction conditions would return.

Toxic Metals and Organics: No water testing was conducted in the immediate stilling basin area. The TSP would not result in the introduction of additional toxics into the Arkansas River or its sediments over those that currently exist in the watershed. Businesses on the lands surrounding the study area include oil and petroleum industries, utilities, manufacturing, recycling, and concrete services, in addition to the usual automobile service centers, tire shops, and gasoline service stations that can be found in any community. In accordance with Resource Conservation and Recovery Act

(RCRA), facilities that generate, transport, treat, store, or dispose of hazardous waste must provide information about their activities to state environmental agencies.

Pathogens: Sediments are not expected to contain or influence pathogens.

Others as Appropriate: No other effects to water column are anticipated.

4.5.4.3 Effects on Biota

Displacement of local biota would occur during construction as mobile species would emigrate to adjacent habitats. Although sessile species would be impacted during construction activities, over time and upon project completion, it is anticipated that biota would recolonize the project site at the same diversity and density as currently present under pre-project conditions.

Primary Production, Photosynthesis: Any vegetation within open water disposal sites would also be suffocated by sediment but is likely to return. Primary producers would be restored over time within these disposal locations.

Suspension/Filter Feeders: Any suspension/filter feeders that are located within the water of the river channel would simply disperse to undisturbed areas. Best Management Practices would be established to control erosion and sedimentation downstream that may otherwise impact filter feeders. Once modification of the stilling basin is complete, suspension and filter feeders would repopulate to the current level. There would be insignificant loss of suspension/filter feeders as a result of project construction.

Sight Feeders: Sight feeders would be temporarily displaced during disposal activities. Sight feeders are expected repopulate to the current extent upon completion of the TSP. Some net loss of sight feeders could occur, but these effects would be minor.

4.5.4.4 Actions Taken to Minimize Impacts

4.5.5 Contaminant Determinations

No known contaminants are present within the construction areas.

4.5.6 Aquatic Ecosystem and Organism Determinations

4.5.6.1 Effects on Plankton and Nekton

Plankton and nekton that occupy the sediments and water columns in the existing site of the project features would be adversely impacted by disposal activities, but it is anticipated that the impact would be temporary and short-term as these species would recolonize the sites once disposal is complete.

4.5.6.2 Effects on Benthos

No additional effects other than those previously discussed have been identified.

4.5.6.3 Effects on Aquatic Food Web

Temporary disruptions to the food web would occur during construction. However, following construction it is anticipated that species at all levels of the food web would return to the same level as currently exists in the proposed dewater areas. Therefore, no net loss of species or negative impacts to trophic levels are anticipated as the result of the TSP.

4.5.6.4 Effects on Special Aquatic Sites

Sanctuaries and Refuges: No fish and wildlife sanctuaries or refuges occur within the project area.

Wetlands: There will be no net loss of wetlands as a result of the TSP.

Mudflats: There are no mudflats that occur within the project area.

Vegetated Shallows: Due to the existing disturbance of the immediate construction area associated with Keystone Dam; there are no expected impacts to vegetated shallows resulting from the TSP.

Riffle and Pool Complexes: There are no riffle and pool complexes within the project area.

Threatened and Endangered Species: The USACE has determined that the construction and operation of the TSP may affect, but is not likely to adversely affect, the tricolored bat (Perimyotis subflavus), the American Burying Beetle (*Nicrophorus americanus*), and the alligator snapping turtle (*Macrochelys temminckii*). A Biological Assessment (Appendix H-4) has been prepared and will be submitted to the U.S. Fish and Wildlife Service (USFWS) Oklahoma Ecological Services Office as part of a request for formal consultation under the Endangered Species Act. In total, up to approximately 10 acres of American Burying Beetle habitat would be temporarily impacted from construction of staging, laydown, and haul routes. Impacts to the Tricolored Bat will be avoided through the use of BMPs, in particular, limiting any tree clearing to the fall/winter months to avoid impacting pup season and when they are most likely to be hibernating in caves.

Other Wildlife: Wildlife inhabiting the aquatic habitats within the project area will be temporarily displaced during fill disposal. Mobile species would emigrate to nearby adjacent habitats. Although sessile species would be impacted during construction activities, they would be expected to return to suitable habitat areas following construction.

In addition to immediate temporary habitat loss, these species would also be impacted by the loss of breeding and nesting areas, escape cover, travel corridors, and preferred food sources for resident and transient wildlife species associated with emergent and forested wetland and open water habitats.

4.5.6.5 Other Effects

Land Use, Transportation, and Utilities: Temporary, adverse impacts to residential land use, recreation, and transportation will occur near construction areas, construction

easements, along haul routes, and in open areas such as parking lots of maintained fields.

Some utilities including water, electricity, sewer, telecommunications, etc. may be temporally or permanently relocated, but not cut off entirely, in order to construct the TSP. Temporary, adverse impacts to utilities may occur near construction areas, construction easements, along haul routes, and in open areas such as parking lots of maintained fields as utilities are relocated. During utility relocations, scheduled temporary outages may be needed. These temporary outages would be announced to the public in advance so adequate preparations can be made.

Cultural Resources: Potential impacts to cultural resources include disturbance of known or previously undiscovered archaeological material at the construction sites, as well as haul routes, and construction laydown areas. If it is determined that the dam itself is eligible for listing in the National Register of Historic Places, construction impacts to the Keystone Dam could constitute an adverse effect under Section 106 of the National Historic Preservation Act. In addition to direct impacts that may be caused by construction of the TSP, changes to the viewshed of any historic properties determined to be present may also occur. A draft programmatic agreement (PA) to avoid, minimize, and mitigate potential adverse effects in accordance with 36 CFR 800.14 has been developed. The executed final PA will be included in the final EA.

4.5.7 Disposal Site Determinations

4.5.7.1 Mixing Zone Determination

Mixing zone will be located within the limits of the project.

4.5.7.2 Determination of Compliance with Applicable Water Quality Standards

Potential impacts on water quality may occur during construction. During the construction phase, stormwater runoff would have the potential to transport sediment and other pollutants to receiving waters. However, implementation of standard construction BMPs (e.g., silt fences, coffer dams) during construction and revegetation following construction would minimize the risk. The ODEQ stormwater permit (NPDES construction permit) would establish practices to be implemented to protect water quality. As result, the potential for adverse impacts on water quality during construction would be short-term and minor.

Long-term, the operation of the modifications to Keystone Dam would facilitate life and property risk reduction by reducing risk of overtopping during large storm events. Water quality is strongly influenced by land uses. In general, waters in the Arkansas River have relatively high levels of turbidity and suspended solids. Decreased water quality within the Arkansas River (OK120420010130_00) led to the listing of this segment in the ODEQ 2020 303(d) List as impaired by Enterococcus. The TSP would not be expected to change these impairment statuses.

4.5.7.3 Potential Effects on Human Use Characteristics

Municipal and Private Water Supply: Municipal and private water supplies in the action area rely on surface water from area reservoirs. Implementation of the TSP would have no impact on local water supply.

Recreational and Commercial Fisheries: No major adverse or long-term effects to other recreational or commercial fisheries will occur.

Water-related Recreation: Long-term moderate adverse impacts are expected to occur to water-related recreation as a result of the TSP.

Aesthetics: Temporary adverse impacts to aesthetics will occur during construction. Construction features are not pleasing to the eye. However, the effects will be temporary once the areas are revegetated.

Parks, National and Historic Monuments, National Seashores, Wilderness Areas, Research Areas, and Similar Preserves: No parks, national or historic monuments, national seashores, wilderness areas, or research sites will be negatively impacted by the project.

5 Determination of Cumulative Effects of the Aquatic Ecosystem

The TSP is not expected to have significant adverse cumulative effects on the aquatic environment. Most impacts will be localized within the construction areas. The TSP in combination with other planned projects, either recently completed, ongoing, or proposed within the project area of Keystone Dam, are not expected to add significant cumulative effects to natural, physical or human environments with the majority of effects being negligible to minorly adverse regarding habitat but moderately beneficial in terms of life safety.

6 Determination of Secondary Effects on the Aquatic Ecosystem

Best Management Practices to minimize impacts associated with construction activities have been identified and would be refined during design activities, as would construction timing considerations. The BMPs are expected to include schedules of activities, prohibitions of practices, maintenance procedures, structural controls, local ordinances, and other management practices to prevent or reduce the discharge of pollutants. The BMPs also include treatment requirements, operating procedures, and practices to control construction site runoff, spills or leaks, waste disposal, or drainage from raw material storage areas. Cofferdams, turbidity curtains, and appropriate dewatering measures would be implemented for in-water work. Additional erosion control and stabilization practices may include but are not limited to: establishment of temporary or permanent vegetation, mulching, geotextiles, sod stabilization, vegetative buffer strips, protection of existing vegetation, temporary velocity dissipation devices, flow diversion mechanisms, silt fencing, sediment traps, and the prompt revegetation of disturbed areas. These measures would reduce potential impacts to water quality. Implementation of sediment and erosion controls during construction activities would maintain runoff water quality at levels comparable to existing conditions.

7 Summary of 404(b)(1) Analysis, Findings of Compliance or Non-Compliance with Restrictions on Discharge

Section 404 (b)(1) of the Clean Water Act of 1972 requires that any recommended discharge of dredged or fill material into waters of the United States must be evaluated using the guidelines developed by the Administrator of the U.S. Environmental Protection Agency (EPA) in conjunction with the Secretary of the Army. These guidelines are located in Title 40, Part 230 of the Code of Federal Regulations. The Section 404 (b)(1) evaluation in this Appendix analyzes all activities associated with the TSP that involve the discharge of dredged or fill material into waters of the United States.

Under the 404(b)(1) guidelines, no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the recommended discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences. An alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes. 40 CFR 230.10(a)(2).

A comprehensive alternatives analysis was done as part of the Keystone DSMS and EA. The study determined there were five practicable structural alternatives, and the No Action Alternative, as discussed in Section 2.1 above. Only the five practicable structural alternatives sufficiently meet the overall project purposes (summarized as life and property risk reduction from flooding) to be considered practicable. Risk Management Plans 6e and 6g would have essentially the same aquatic ecosystem impact. However, RMP 7 is more costly and would require more disturbance along the Keystone Lake shoreline. RMPs 5a and 5c would cost less and require considerably less real estate for construction based on the design and materials used to improve levee performance. Based on primarily life safety considerations, in addition to potential environmental, cultural, Environmental Justice impacts, and costs, RMP 5a was selected as the TSP.

While implementation of the TSP would involve the discharge of fill material and a temporary impact due to dewatering to 15 acres of open water habitat in the Arkansas River, this disposal would not violate established State water quality standards or the Toxic Effluent Standards of Section 307 of the Clean Water Act of 1977, as amended, nor harm any endangered species or their critical habitat. Implementation of the TSP would not result in significant adverse effects on human health and welfare, including municipal and private water supplies, recreation and commercial fishing, plankton, fish, shellfish, wildlife, and special aquatic sites. Appropriate steps to minimize potential adverse impacts of discharge in aquatic systems include use of suitable erosion control technologies together with the implementation of procedures to protect against erosion and sedimentation during and after construction. In Oklahoma, ODEQ is the permitting authority and administers the NPDES. Operators of construction activities that disturb five or greater acres must prepare a SWPPP, submit a Notice of Intent to ODEQ and obtain authorization under OKR10, conduct onsite posting and periodic self-inspection, and follow and maintain the requirements of the SWPPP. During construction, the

operator shall assure that measures are taken to control erosion, reduce litter and sediment carried offsite (silt fences, hay bales, sediment retention ponds, litter pick-up, etc.), promptly clean-up accidental spills, utilize BMPs onsite, and stabilize site against erosion before completion.

A concrete batch plant is expected to be established within the 1/100-year floodplain on approximately 20 acres. This batch plant will be constructed on terrestrial soils, but due to the location a berm would be required to ensure significant washout does not occur due to extreme flood events in accordance with ODEQ's OKG11MT General Permit "General Wastewater Disposal Permit for Mobile Concrete Batch Plants." Berms associated with this concrete batch plant must be 1H:3V if in use for longer than 180 days. Discharge of wastewater is not allowed under this permit.

Upon completion of the current Keystone DSMS and beginning of the PED phase wherein more details will be developed regarding design and placement of proposed features, all resource agencies, including the ODEQ, will be invited to review updated figures, designs, and alignments to ensure plans are sufficient and appropriate permits will be obtained prior to construction.

8 Findings Declaration

The proposed project will impact 15 acres of Waters of the U.S. Project activities include modification of the existing service spillway, construction of an embankment/dam raise, and modification of the existing service stilling basin.

The proposed placement site for discharge of fill material complies with Section 404(b)(1) Guidelines. A pre-filing meeting request and water quality certification request will be submitted to ODEQ.

The project proponent hereby certifies that all information contained herein is true, accurate, and complete to the best of my knowledge and belief. The project proponent hereby requests that the certifying authority review and take action on this CWA 401 certification request within the applicable reasonable period of time.

9 References

Montagna, P.A., S.A. Holt, and K.H. Dunton. 1998. Characterization of Anthropogenic and Natural Disturbance on Vegetated and Unvegetated Bay Bottom Habitats in the Corpus Christi Bay National Estuary Program Study Area. Final Project Report, Corpus Christi Bay National Estuary Program, Corpus Christi, Texas.

10 List of Preparers

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