

CHAPTER 8

RECOMMENDED PLAN

8-01. Selected Alternative and Rationale.

a. Seismic Selected Alternative. Based on the value engineering study results, expert recommendations, the cost estimates of the selected options, and the analysis of their environmental impact, the alternative described below was selected for detailed design.

- Upstream slope stabilization.
 - Create a working platform on the upstream slope, at least 70 feet wide. Construction will start with a rockfill dike built under water immediately upstream of the lower limit of the 1:6 slope (elevation 1050) and extended above the water to elevation 1075. The dike will be built initially from existing rock above elevation 1100, leaving an upstream slope of the embankment above this elevation of 1(v):2(h). Fill the space between dike and dam with granular material, and raise the resulted platform up to elevation 1090. The rock and some of the granular material may be placed under water. Turbidity curtains will be utilized to minimize the suspended particles. After beginning of soil stabilization operation, drilling spoils will also be used in lieu of rock/granular material to create the platform and for final grading.
 - Pre-drill holes through platform and embankment fill (approximately 75 feet, between elevations 1090 and 1015). Line the holes with PVC pipe. Number and location of holes should be determined based on test site results. Preliminary analysis determined a necessary area replacement ratio of 0.4 (i.e. the volume of the stabilization columns should represent 40% of the total volume of the stabilized zone). A pattern with a longitudinal wall, buttresses, and transverse walls is recommended (see Figure 7.23 in Appendix VI). Based on conservative assumptions about the strength of the soil stabilized with cement the resulting necessary width of the stabilization zone is 70 feet. The final design should consider the results of tests on stabilized soil taken from the test site and the results of the deformation analysis.
 - At the pre-drilled hole locations stabilize both silty clay in the foundation blanket and loose sand (between elevations 1022 and 992, i.e. 30 feet deep) with soil-cement. Either jet grouting or deep mixing equipment can be used, although only jet grouting is believed applicable. The downstream portion of the treated material (the longitudinal wall consisting of 2 lines of adjacent or secant columns) should be extended to rock to provide seepage cutoff of limited width (approximately 5 feet). The elevation of bedrock varies between 975 and 955 (average 960) with an ancient channel extending to below elevation 930 near Station 50+00.

- Drawdown of the lake below multipurpose level (pool elevation 1075) for this construction is not anticipated. Temporary suspension of the construction activity and removal of the equipment from the working platform is necessary if the pool rises to the elevation of the top of platform and a higher pool is forecasted.
 - It is anticipated that high lake levels would require that upstream equipment be demobilized seven or eight times during the course of the project (Table 8.1, Figure 8.1 and Figure 8.2). Each time the lake level rises above the work platform, historic records and modeling indicate that upstream work would be prohibited for 25 to 78 days per event (Table 8.3). During construction, high lake levels would prohibit work from 6 to 19 percent of the time (Table 8.4). Assuming a daily delay rate of \$36,000, inundation delays between \$5.5 and \$17.5 million could be expected over the project period depending on the exact design and construction sequencing (Table 8.11). Delay costs are included in the estimates discussed subsequently.
 - Due to the nature of the drainage basin and the extreme lake level fluctuations at Tuttle Creek, temporary lowering of the lake level by 25 feet during construction would not reduce the number of times that the work platform would be flooded but would reduce the duration of the work stoppage for each event. Temporary lowering of the lake could save between \$3.7 and \$5.5 million in inundation delays. However, the costs of offsetting the impacts of a 25-foot pool drawdown and the lessened property values, lost revenues, and social impacts would be expected to far exceed these amounts. Therefore, temporary lake drawdown is not considered appropriate and is not necessary to implement the selected alternative.
 - The upstream working platform will remain in place upon the completion of construction and all slope protection on the upstream portion of the embankment will require replacement.
- Downstream slope stabilization.
 - Excavate the embankment berm starting at the elevation 1040 (immediately above the pervious drain) and up to the junction between the 1:6 and 1:3 slopes (elevation 1095). The temporary excavation will open for treatment a length of no more than 300 to 500 feet parallel to the axis at a time and will ensure a temporary slope of at least 1:2.75. The berm material will be deposited in a temporary storage area.
 - From the working platform created at elevation 1040, stabilize both silty clay in the foundation blanket and loose sand between elevations 1025 and 983 (i.e. 42 feet deep). Deep soil mixing is the recommended technology. The pattern of stabilization columns layout should be similar to that under the upstream slope,

with longitudinal walls and transverse buttresses. Based on the preliminary calculations the necessary width of the stabilized zone should be 115 feet wide, ensuring stabilization of 40% of the volume of soil within the treated zone.

- An additional stabilization zone should be installed from the existing road between the downstream toe of the dam and the collector ditch, to protect the relief wells (contamination with cement of the relief wells is not a problem because all relief wells located upstream of the collector ditch have been abandoned). One or two lines of soil-cement columns should provide 40% area replacement ratio to an equivalent 4-foot zone between elevations 1020 and 990).
- Restore the original permeability of the pervious drain, between elevations 1025 and 1040, filling with granular material the holes within this interval. Restore the random fill to the original slopes (1:3 between elevations 1040 and 1060, 1:6 between 1060 and 1095).
- Repeat the above operations until the entire problem zone is remediated.
- No pool restriction is necessary during stabilization of the foundation soil under the downstream slope. However, maintaining the pool near multipurpose level (1075) is desirable. If the pool rises to approximate elevation 1090 and a higher pool is forecasted, the normal construction activity may be suspended and backfilling of the temporary excavation may be initiated. The warning pool elevation (assumed 1090) should be revised in accordance with measured piezometric levels at the toe of the temporary excavated slope; the maximum acceptable piezometric level is approximately elevation 1040, the top of the working platform.
- The extent of the problem zone is at least between Stations 35+00 and 70+00 (3,500 feet). Additional investigation is necessary to determine the level of effort necessary to stabilize the reaches between Stations 25+00 and 35+00 and between Stations 70+00 and 75+00 (totaling 1,500 feet). For the purpose of cost evaluation it was considered at this time that the stabilization effort in these zones is approximately 50% of that in the already established problem zone, for a total equivalent length of the zone to be stabilized of $3,500 + (0.5 \times 1,500) = 4,250$ feet.
- The current technologies of Jet Grouting and Deep Soil Mixing are proposed, however, as technologies improve and develop, adjustments to the exact nature of the soil stabilization equipment, techniques, and admixtures may be made. It may also be possible that the either technology may be used both upstream and downstream to avoid weather and pool related delays.

- The implementation of soil stabilization would include conducting additional exploratory borings and soil testing, a test drilling program through the embankment, a soil stabilization technology demonstration during design and replacement of upstream slope protection due to construction damage and disturbance
- The total construction only cost of this portion of the selected alternative is \$170.3 million including \$159.7 million for the foundation treatment (inundation delays included) and \$10.6 million for slope protection replacement.

b. **Interim Risk Management.** As an interim measure to enhance downstream community safety before and during construction, a dam failure warning system and evacuation plan is proposed for installation as soon as possible. This system is discussed in more detail in Section 7 of the Environmental Impact Statement. The system would be tied to automated instrumentation on, in, and below the dam. In the event of major dam deformation (not flooding), the system would provide warning for the area from the dam to the confluence of the Big Blue and Kansas Rivers where the highest population density and lowest warning times exist. Coordination with local authorities in development of an evacuation plan for the area covered by the warning system would also be undertaken. The total construction only cost of this portion of the selected alternative is \$1.8 million.

c. **Hydrologic Adequacy.** The risk of wave action overtopping the dam at the peak of the Probable Maximum Flood will be addressed by the replacement of the upstream highway guardrail across the crest of the dam with anchored concrete traffic barriers or “bin blocks” to withstand wave action. The total construction only cost of this portion of the selected alternative is \$1.9 million.

d. **Tainter Gate Reliability.** In order to address the spillway gates that do not meet current design criteria, general spillway and spillway gate modification and painting including the addition of bracing members, strut cover plates, and repositioning of the gate dogging system is recommended. The total construction only cost of this portion of the selected alternative is \$6 million.

e. **Implementation.** The anticipated implementation time for the alternative components summarized above is anticipated to be from seven to ten years. . The implementation costs associated with the above selected alternative components totals \$25.7 million. This amount includes a technology and drilling program demonstration, construction management, engineering, planning, design, contract acquisition, regulatory coordination, quality assurance testing, lands and damages, project closeout and other miscellaneous costs to execute the selected alternative.

f. The Total Project Cost of all aspects of the preferred alternative is approximately \$205.7 million including engineering, planning, design, construction, implementation, oversight, management and lands and damages. This estimate increased from \$194.8 million in the Draft Evaluation Report based on the inclusion of revised rates for ground modification equipment and appropriate quality control measures.

g. Economic Analysis. For the economic analysis of the selected alternative, all annual costs associated with the modification were compared with the total project annual benefits.

The annual cost of the recommended plan is based on an estimated first cost of \$205,700,000, interest during construction of \$49,400,000, the current Federal interest rate of 6 1/8 percent, and a remaining economic life of 50 years. Operation, maintenance, repair, replacement and rehabilitation costs are not expected to change. The annual cost of the modification is \$16,500,000

The Tuttle Creek project provides average annual benefits of approximately \$56,200,000 (October 2001 values). This estimate includes benefits for flood-control, recreation, and navigation. Benefits for water supply, water quality and fish and wildlife enhancement are not included in this estimate of total project benefits. The annual benefits of the existing project exceed the annual cost of the proposed modification, with net benefits of \$39,700,000, and a benefit cost ratio of 3.4 to 1.

8-02. Schedule of Funding Requirements.

General funding requirements are shown below. It should be noted that FY03 funding has not been budgeted in the Operation and Maintenance (O&M) program. FY03 funding is required to be provided by the Corps of Engineers Headquarters Dam Safety Assurance Program Construction General Wedge funding. .

The budgets shown in the schedule are approximate and are provided for evaluation of the magnitude and duration of funding. They are based on October 2001 costs and do not include escalation beyond that point. This schedule cannot be used for detailed budgeting purposes until a detailed design and construction schedule has been developed. This schedule is subject to weather, reservoir levels, funding limitations, and other impacts beyond the control of the Corps of Engineers.

FY02	\$695,000*	Finalize EIS/Evaluation Report
FY03	\$8 million	Design/Warn. System/Tech Demo/Damages
FY04	\$10 million	Contract Acq./ Spillway Mods
FY05	\$23 million	Implementation Start
FY06-FY12	\$23 million per year	Full Scale Implementation
FY13	\$3 million	Implementation Completion
FY14	\$715,000	Documentation**

* Currently Operations and Maintenance funded.

** Given that implementation of the remedial measures is likely to be in the form of a cost reimbursable construction contract, closeout of the contract will require a specific Construction General line item for several years after construction for contract close out and documentation.

8-03. Cost Sharing.

Section 1203 of the 1986 Water Resources Development Act (Public Law 99-662) states that 15 percent of the costs of modification for dam safety are to be assigned to project purposes for cost sharing.

A series of contracts between the United States and the State of Kansas for Water Storage Space in Tuttle Creek Lake, Kansas, requires the Kansas Water Office to reimburse the Government for 2.49 percent of the cost of joint-use operation and maintenance expense, major replacement items, and joint-use reconstruction, rehabilitation and replacement costs of project features which may be required to continue satisfactory operation of the project. The sponsor is also required to pay the actual annual operation and maintenance expense specifically attributable to water supply storage and all costs allocated to water supply of any necessary reconstruction, rehabilitation, or replacement of project features required to continue satisfactory operation of the project. A copy of the most recent contract is in Appendix II-C.

No part of a dam safety assurance action is allocated specifically to water supply. Therefore, the combined effect of Section 1203 of P.L. 99-662 and the water supply contract with the State of Kansas is that the sponsor will be required to reimburse the Government for 0.3735 percent [2.49 percent of 15 percent ($0.0249 \times 0.15 = 0.003735$)] of the cost of Dam Safety Assurance studies and/or construction.

Coordination with the Kansas Water Office is ongoing and its views solicited on the analyses being performed, the contract cost requirements, and the potential for construction of remedial measures. The Kansas Water Office will be kept apprised of progress, status, and cost through out the life of the project.

8-04. Local Cooperation.

No local cooperation agreements are in effect for the Tuttle Creek Project. The water supply storage contracts with the State of Kansas recognize the obligation to pay a part of the joint-use reconstruction, rehabilitation, and replacement cost of features which may be required to continue satisfactory operation of the project. Article 5(b) of the contract provides for payment of these costs incrementally during construction or upon completion of construction in lump sum with interest during construction. Article 7(b) provides that the costs will be established by the District Engineer and repayment arrangements shall be in writing in accordance with the terms and conditions set forth in Article 5(b) and be made a part of the water supply contract.

8-05. U.S. Fish and Wildlife Service – Coordination Act Report.

The U.S. Fish and Wildlife Service in their Draft Coordination Act Report (CAR), dated March 12, 2002 (Appendix B of the DEIS), provided the following recommendations. These recommendations were based on the initially identified preferred alternative, Stabilize Foundation Soil With Drawdown, which included a 25-foot drawdown of the lake to elevation 1,050 feet, mean sea level, during a 7-10 year construction period. Based on additional coordination with the Kansas Department of Wildlife and Parks and U.S. Fish and Wildlife Service, along with additional analysis of environmental affects, potential mitigation and costs associated with the Stabilize Foundation Soil With Drawdown alternative, the Corps recommends Stabilize the Foundation Soil Without Drawdown as the preferred alternative described in the DEvR/DEIS. The decision concerning the preferred alternative was made at a point in time during the evaluation that revisions to the Draft CAR by USFWS would not be possible considering the scheduled release of the DEvR/DEIS. In reviewing recommendations by USFWS most recommendations were easily classified as being directly related to the proposed construction activity or being directly related to the proposed drawdown. The Corps has evaluated the recommendations provided by USFWS considering which recommendations would continue to pertain if no drawdown was utilized to accomplish the work. The Corps realizes that at this point, both USFWS and KDWP have not had an opportunity to provide input concerning the proposed construction of the upstream work platform in the wet, but overall believe that the short term affects associated with construction of the work platform in the wet are far less adverse than the anticipated affects of a 7-10 year lake drawdown. The following are the recommendations of the USFWS and the Corps response. If not addressed with a response the Corps has determined that the recommendation pertained to impacts associated with the drawdown aspect of the Stabilize Foundation Soil with Drawdown alternative.

Recommendations

A number of measures will be necessary to re-create a reasonable lake and downstream fishery with implementation of the Preferred Alternative. Mitigation measures should be developed to provide the best possible fishing in the project area during and after project construction. It would not be in the best public interest to provide a fishery or wildlife enjoyment opportunities less than the full potential provided by the present day project.

Before the Corps prepares a final estimate for the Congress or decision makers on the cost of construction, we recommend a series of measures to develop an estimate of those project costs that will be required to lessen the damage to fish and wildlife values as much as possible. These measures include the following:

- I. The Kansas Department of Wildlife and Parks, in cooperation with the U.S. Fish and Wildlife Service and the Corps develop a conceptual fishery management plan and cost estimates for implementing the plan for project waters during FY 2003. This will require expanding upon the general fishery management concepts presented in this report. Confirming studies and cost estimates should be developed for the following aspects of the fishery management plan.
 - A. Cost of extending the boat ramps at Tuttle Cove Park and Spillway State Park, concurrent with drawdown, to elevation 1050.
 - B. Coordinate the lake drawdown schedule such that lake refilling can begin in Mid-April and rise slowly until boat ramps are accessible or conservation pool is reached.
 - C. Coordinate and schedule reseeding of the exposed lake bed to cut down on wind and wave erosion and to provide a substrate for fish food and escape cover when inundated. Japanese millet is a candidate for reseeding efforts.
 - D. Develop, coordinate and implement a water level management plan for the year/s after 1075 m.s.l. is reestablished to enhance survival of the previous years spawn and development of a strong second consecutive years spawn. This may entail a 2-foot pool raise above conservation pool.
 - E. Develop and implement a plan to replace or mitigate the loss of the put and take trout fishing program below the dam. A small deep trout pond that captures the remaining seep water is a possibility.

CORPS RESPONSE: Comment I. E., Loss of the put and take trout fishery is a direct impact of the Stabilize the Foundation Soil alternative with or without drawdown. Therefore, the Corps will coordinate with KDWP to develop a replacement for the put and take trout fishery in River Pond State Park that utilizes the remaining seep water.

- F. Develop recommendations for and schedule stocking of Tuttle Creek Lake to compensate for the fishery flushed from the lake.
- G. Develop a contingency plan for restocking the lake if the entire fishery collapses as a result of drawdown. The cost of the restocking the lake should be a project cost.
- H. Develop, fund and implement a monitoring program to determine the status and utilization of the lake fishery, the tailrace fishery, and the River Pond fishery during project construction and post project construction.

The Corps should pursue an add-on study prior to implementation of a Safety Assurance Program to address this issue.

CORPS RESPONSE: Comment I. H. The lake fishery and fisherman access to the lake would not be affected by the Stabilize the Foundation Soil Without Drawdown alternative. In addition, access to River Pond and the tailrace would be available at existing levels under the Stabilize Foundation Soil without Drawdown alternative. The Corps has determined that fish populations and angler use of these areas would not be affected by the preferred alternative and therefore Corps sponsored studies of these resources are not warranted.

- I. Determine structural integrity and develop engineering cost for repair of the Rocky Ford tainter gate and levee if it becomes necessary to lower the river pond and pass river flows across the gate apron. There is concern that excessive amounts of flow could cause structural damage to State owned and managed facility.

II. The Kansas Department of Wildlife and Parks as the agency designated to manage the majority of the project wildlife lands, the Service and the Corps develop a conceptual wildlife management plan during FY2003 including cost estimates for implementing the plan on project lands. The Corps should develop engineering cost estimates for any structures proposed in the concept plan.

- A. Develop, coordinate and implement a post project water level management plan that benefits waterfowl and shore bird habitat of the project area. Inundation of emergent vegetation in the fall of the year should be emphasized.
- B. Implement a plan assuring availability of water in the artificial marshes (Fancy Creek Marsh, Swede Creek Marsh, Timber Creek Marsh and Black Vermillion Marsh) during the fall and winter of the drawdown year. Lake proper wetland habitat maybe limited or inaccessible while the lake is drawdown decreasing waterfowl hunting opportunity.
- C. Extend or develop a boat launching facility on the river or in the upper reach of the reservoir before or during the drawdown year so that waterfowl hunters have access to northern extremities of the lower pool in the fall of that year.
- D. Develop and implement a plan to protect the riparian habitat adjacent to the River Pond from dredging impacts. This entails establishing safe zones or dredging limits to protect the island and established riparian habitat that serves as bald eagle perch trees or nesting habitat for colonial nesting birds. The plan will have to take into consideration noise impacts and human disturbance factors during critical nesting periods.

RESPONSE: Comment II. D. The Corps will coordinate with USFWS

and KDWP during the development of any plans to use the River Pond area as a borrow source. This coordination will include consideration of environmental and aquatic resources along with recreational use of the area to develop a plan that would avoid and/or minimize impacts to these resources to the greatest extent practicable. The primary reason this area was identified as a potential borrow source was to remove any material that may have been deposited in River Pond as a result of the 1993 Flood that may be in conflict with existing recreational use of the lake. In addition, the proposed borrow source is immediately adjacent to the proposed construction access road that would be constructed as part of

each of the construction alternatives. KDWP has indicated that leaving this road in place upon completion of construction would benefit recreation use of the area.

- II. The Kansas Department of Wildlife and Parks and the Corps develop during FY 2003 a conceptual recreation management plan including cost estimates for implementing the plan within the State Park Area.

Tuttle Creek State Park ranks fourth in the State Park System in terms of visitation and revenue. The River Pond area is the main area for the park and will be heavily impacted by construction activities. The Department anticipates a 65% reduction in visitation and revenues, a loss in capitol improvement projects, a loss of campsite infrastructure and loss of the Country Stampede that Generates several million dollars annually for the Manhattan community and over \$485,000 annually to the State Park. The Department has developed potential mitigation measures to help offset devastating losses to Tuttle Creek State Park and the State Park system as a whole. (KDW&P, March 4, 2002). Before the Corps of Engineers prepares a final estimate on the cost of constructing the Safety Assurance Program at Tuttle Creek the Corps and the Department need to develop estimates of those project costs that will be required to lessen impacts to State Park activities, facilities and infrastructure. The cost to benefit ratio should reflect the level of funding required to carry out mitigation/compensation recommendations mutually acceptable to the Department and the Corps.

CORPS RESPONSE: The Corps recognizes the importance of KDWP licensed facilities and Corps operated facilities downstream of Tuttle Creek Dam that would be directly affected by the proposed construction activity. These areas are not only important economically to KDWP as an agency, but to the local economy, and socially to the public as a major recreation area for the Manhattan area and the State of Kansas. Designation of the Corps' preferred alternative, Stabilize the Foundation Soil Without Drawdown, avoids impacts to most resources and recreational users of Tuttle Creek Lake upstream of the dam. In addition, under the Stabilize the Foundation Soil Without Drawdown alternative recreational users of River Pond State Park and the Outlet Area would have nearby recreational areas adjacent to the main lake that would not be affected by the proposed project. The DEIS includes a complete evaluation of the Kansas Department of Wildlife and Parks letter dated March 4, 2002, which

provides KDWP's assessment of direct impacts of the construction activity and the affects of a proposed lake drawdown and includes the Corps analysis and initial response to their recommendations. In addition, the Real Estate Plan, Appendix 10, outlines the Corps responsibilities and limitations for mitigation under our license agreement with Kansas Department of Wildlife and Parks. The Corps will continue to coordinate with KDWP and USFWS to ensure that all practicable measure to avoid and/or minimize adverse affects of the proposed project on fish and wildlife resources and the recreational users of Tuttle Creek Lake are fully considered during development of the recommended action and that mitigation, where appropriate and within the authority of the Corps, is included.

The Corps has reviewed the DCAR and provided the USFWS with recommendations for minor changes to the report in order for it to be considered final. The recommendations are included in the Corps' letter to USFWS, dated July 2, 2002, and included in Appendix B. In that letter the Corps requested that USFWS prepare a supplement to the Final CAR that would provide additional input on the proposed work on the upstream face of the dam without drawdown, and the proposed measures to offset impacts to recreational users of River Pond State Park. This supplemental information will be considered prior to a final decision by the Corps. In their July 3, 2002 letter, included in Comments Received in Response to the DEvR/DEIS, the Department of Interior, which includes USFWS, noted that the Stabilize Foundation Soil without Drawdown was a major improvement over alternatives originally presented for consideration by USFWS. The Final Coordination Act Report was received from the USFWS on July 25, 2002. This document is included in Appendix B.

The USFWS in a letter dated September 10, 2002, and included in Appendix B of the FEIS, provided the Supplemental CAR. In this Supplemental CAR, USFWS commended the Kansas City District for the decision to eliminate drawdown of the lake during the construction phase and for siting construction laydown areas to avoid native vegetation that provides important wildlife habitat. USFWS noted that many of the recommendations provided in the Final CAR were related to adverse effects associated with drawdown of the lake during a 7-10 year construction period. Since drawdown of the lake during the construction period is not a component of the preferred alternative, USFWS provided a revised list of recommendations from the Final CAR, that would continue to apply to the Stabilize Foundation Soil without Drawdown alternative. Each of these recommendations has been addressed above.