

Special Committee on Energy, Natural Resources, and Environment

SEISMIC RISK AROUND KANSAS RESERVOIRS

CONCLUSIONS AND RECOMMENDATIONS

The Special Committee on Energy, Natural Resources, and Environment recommends that the solution for the seismic risk associated with Tuttle Creek Reservoir be one which will have the least impact on water quantity, water quality, and the state's ability to fulfill its water contracts at the least possible costs to water users. Consequently, the Committee does not believe that removal of the dam is an option. The Committee does believe these recommendations need to occur while taking into consideration the safety of the population. The Committee encourages the House Environment and Senate Natural Resources Committees and the Kansas Legislature as a whole to continue to have input into the decision-making process of the Corps of Engineers with respect to the actions taken to address the seismic risk around Tuttle Creek Reservoir. The Committee wishes to note its appreciation for the dialogue which is occurring between officials with the U.S. Army Corps of Engineers and officials and citizens of the State of Kansas on this very important issue.

Proposed Legislation: None

BACKGROUND

The Legislative Coordinating Council assigned the Special Committee on Energy, Natural Resources, and Environment the study of reviewing the Army Corps of Engineers' plans for maintenance of federal reservoirs affected by fault lines.

In 1971, the Lower San Fernando Dam in California almost failed during an earthquake. This event prompted the U.S. Army Corps of Engineers (Corps) to develop techniques to evaluate the behavior of dams built on or of soils during earthquake events. As a result of this work the Corps developed a program

under which the safety of existing dams can be compared against new data or state-of-the-art design and construction methods for earthquake and flood design. This program is called the Dam Safety Assurance Program. The Program is specialized and is applicable to the investigation of major earthquake and flood issues around Corps' dams. Projects under this program are studied extensively within the Corps culminating in the preparation of a report called an Evaluation Report. Corps approval of the Evaluation Report is required before a detailed design of any measures to address the dam safety issues can be initiated. The Corps has been using the Dam Safety Program to evaluate dams across the country including those

Corps structures in the State of Kansas. (For example, Milford Dam near Junction City was evaluated in the 1980s and was found to meet the earthquake safety criteria at that time.)

Tuttle Creek Reservoir and Identifying the Risk

An evaluation of Tuttle Creek Dam is underway under the Corps' Dam Safety Assurance Program. By way of background, Tuttle Creek Lake was constructed in the 1950s, completed in 1962, and the pool was filled by April 29, 1963. The reservoir is operated by the U.S. Army Corps of Engineers. The dam is located about five miles north of Manhattan. The purposes of the lake are flood control, water supply, recreation, fish and wildlife conservation, water quality control, and navigation supplementation. The lake normally covers about 13,350 acres, extends some 16 miles above the dam, and averages a mile in width. At the flood control pool, the lake covers about 54,050 acres and extends upstream 35 miles. The Big Blue River basin which drains into Tuttle Creek Reservoir comprises a total area of 9,628 square miles. Three-fourths of the basin is situated in Nebraska, and the remainder in Kansas.

During the design of the dam, the potential for earthquakes was recognized and the intake tower was evaluated for resistance to earthquakes. Even modern evaluations have determined that the original design of the intake tower meets current standards. However, the need for specific earthquake evaluations of soil structures (the dam) was not recognized and the techniques to perform the evaluations had not yet been developed at the time of construction.

Since construction, Tuttle Creek Dam has been evaluated by worldwide experts using state-of-the-art techniques to predict its behavior during a major earthquake. These models show that the dam could be significantly damaged to the point that the lake could wash out the dam. Although the probability of an earthquake of the size necessary to damage the dam is very small, due to the potential consequences, this possibility is being evaluated.

The steps the Corps uses to identify and correct a dam safety issue are summarized below:

- ! Determine the changes to the state-of-the-art evaluation techniques or the criteria for evaluating dam safety since the dam was designed and constructed.
- ! Make a budget request to provide funding for investigation of the situation.
- ! On receipt of funding, perform a "Phase I" evaluation to determine if these changes will require modification to the dam to bring it into compliance with current standards. This process is likely to involve data gathering, field investigations, testing, computer modeling and other evaluations.
- ! If the Phase I evaluation indicates that the dam is not in compliance with the new design standards or criteria, another budget request is prepared to provide funding for a "Phase II" investigation.
- ! The Phase II investigation is performed to determine, in detail, the extent of the dam safety issues that

exist and determine the best solution to address these issues. Community input is critical in this phase. **This is the phase the Tuttle Creek Dam is in for 2001.**

- ! An Evaluation Report, and in the case of Tuttle Creek Dam, an Environmental Impact Statement is then prepared and forwarded for approval to the Dam Safety Officer in the Corps of Engineers Headquarters.
- ! Assuming approval of these documents, the Assistant Secretary of the Army for Civil Works is notified of a "New Start."
- ! Assuming that some type of construction is necessary, detailed design and preparation of plans and specifications for a construction contract begins.
- ! Implementation and construction of the selected alternative then begins.

Earthquake Assessment in the Tuttle Creek Area

Tuttle Creek Dam and the surrounding communities are located in a region that has the potential of experiencing moderate to large earthquakes.

More than 25 earthquakes with epicenters in the borders of Kansas have been felt during the past 133 years, beginning with the earthquake of April 24, 1867, near Wamego, Kansas. This earthquake had a magnitude of 5.1 and is the largest earthquake known to have occurred in Kansas. This earthquake cracked walls in Manhattan, caused areas of the Kansas River valley sands to liquefy south of Wamego, and caused

minor damage in Wamego, Junction City, Lawrence, and Kansas City. The earthquake was felt as far away as Indiana, Kentucky, and Arkansas.

An earthquake of magnitude 4.7 occurred on January 7, 1906. This earthquake was centered in the Manhattan area with smaller aftershocks continuing until late January. Again in 1929, a series of four earthquakes with magnitudes between 3.2 and 4.2 occurred in the area surrounding Manhattan between September and December. Before 1867, earthquakes generally went unreported because there were few newspapers or other ways to record the occurrence and effects of earthquakes.

Since the 1960s, earthquake epicenters and magnitudes have been recorded on sensitive seismic instruments, including microseismic earthquakes that cannot be felt and have no noticeable effect at the surface. Detailed microseismic studies using very sensitive equipment have been performed by the Kansas Geological Survey and have been funded partially by the U.S. Army Corps of Engineers. These studies have shown that very small earthquakes occur routinely in Kansas. The majority of these very small earthquakes are related to the Nemaha Ridge/Humboldt fault zone, and other deep fault zones that show very little or no evidence of faults at the surface.

The potential for significant earthquakes is present in east-central Kansas, however, this activity is typically of limited size and frequency. Nonetheless, in the case of critical structures such as a major dam and reservoir, there is reason for caution given the potential for damage even with a low probability of an earthquake.

COMMITTEE ACTIVITIES

The Special Committee on Energy, Natural Resources, and Environment held hearings on this issue during its August 27, 2001 meeting. The Committee heard from a variety of conferees at that meeting.

One spokesperson representing the US Army Corps of Engineers indicated that the main problem appears to be the sand foundation of Tuttle Creek Dam. Stabilization of the dam may require deep soil mixing, installing columns of concrete, or adding stone columns. A variety of options were presented to members of the Committee, including the option of removal of the dam altogether. Another conferee representing the Corps explained the likelihood of an upcoming earthquake in the Wamego area within the next 100 years and the effect it would have on the Tuttle Creek Dam area. This conferee speculated that if such an earthquake were to occur, the dam would not crumble immediately but rather water would likely come through cracks in the dam, with an estimate that it would take six days to drain the lake. The options to avoid catastrophic reactions to an earthquake were detailed along with a time line and schedule of projected costs. The alternative of doing nothing also was explained as the lake pool which holds Tuttle Creek Dam may silt in on its own before any earthquake occurs. Under a repair scenario, the members of the Committee learned that the lake might have to be drawn down for four to six years during the repair stage and that this could cause a major problem if the work occurs during a drought period. Under this scenario, the state might be required to call into service the uncommitted storage at Milford and Perry Reservoirs.

The Committee was informed that stabilizing the foundation soil would be very expensive since additional soil would have to be brought in from an offsite location. The idea of working with the existing silt in the pool of Tuttle Creek also has been explored as well as the digging of an eight-mile tunnel for overflow. This latter option would be extremely expensive (estimated at \$250 million) according to the conferee. If the original dam site is used, the work would fluctuate from one side to the other.

A representative of the Manhattan Chamber of Commerce Public Affairs Committee explained the Committee's position and plan of action through the Dam Safety Assurance Program. The conferee suspected there would be very little reaction from the community regarding the impending risk of an earthquake, but the business community would certainly be supportive of any improvements that could be made to the dam and definitely were in favor of retaining the Tuttle Creek Reservoir in their community.

The State Geologist and Director of the Kansas Geological Survey at the University of Kansas reviewed the seismic hazards of the Tuttle Creek Dam area and stated that the probability of a large earthquake in the region grows each year.

A spokesperson from the Kansas Water Office explained that the Corps of Engineers' charge to assess possible impact of seismic activity on the stability of the Tuttle Creek Dam and Reservoir cannot be ignored. The Committee was reminded that at the time the dam was built, the safety issues regarding seismic activity and impact were not in place. The Committee learned of the importance

of the dam to the Kansas River and residents of Kansas downstream as well as to other persons living in the Midwest. It was noted that the state would be required to pay its portion of any repair to the dam since the state owns water storage supply capacity in Tuttle Creek Reservoir.

A spokesperson from the Kansas River Water Assurance District No. 1 opposed the option of the removal of the Tuttle Creek Dam and noted that the removal of the dam would jeopardize the drinking water source for 1.5 million citizens of Kansas. The members of the Committee were urged not to propose any action until there had been an opportunity for full input from all citizens involved.

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seismic risk associated with Tuttle Creek Reservoir be one which will have the least impact on water quantity, water quality, and the state's ability to fulfill its water contracts at the least possible costs to water users. Consequently, the Committee does not believe that removal of the dam is an option. The Committee does believe these recommendations need to occur while taking into consideration the safety of the population. The Committee encourages the House Environment and Senate Natural Resources Committees and the Kansas Legislature as a whole to continue to have input into the decision-making process of the Corps of Engineers with respect to the actions taken to address the seismic risk around Tuttle Creek Reservoir. The Committee wishes to note its appreciation for the dialogue which is occurring between officials with the U.S. Army Corps of Engineers and officials and citizens of the State of Kansas on this very important issue.