

STATEMENT OF WORK

PEER REVIEW

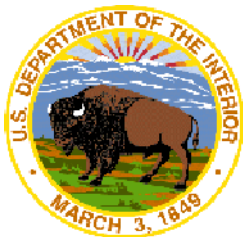
OF

FLOOD HYDROLOGY STUDIES

FOR

TOMAHAWK DAM

**TOMAHAWK NATIONAL WILDLIFE REFUGE
NORTH DAKOTA**



**FWS: REGION 6
ENGINEERING DIVISION
134 UNION BLVD., SUITE 230
LAKEWOOD, CO., 80228**



1. GENERAL SCOPE AND BACKGROUND

Tomahawk Dam is owned and operated by the U.S. Fish and Wildlife Service (FWS). The dam is a low hazard structure subject to periodic inspections by the FWS. The most recent formal Safety Evaluation of Existing Dams (SEED) inspection of the dam was completed on September 11, 2003. The SEED inspection revealed a number of deficiencies which later prompted funding for rehabilitation of the dam.

A contract was awarded on December 13, 2010, to W.W. Wheeler and Associates (Wheeler), of Denver, Colorado to prepare designs and estimates for rehabilitation of the dam. This contract included a requirement to perform flood studies to determine the Inflow Design Flood (IDF), as required under FWS dam safety regulations.

Wheeler has submitted the results of the flood study analyses at the fifty-percent design level. The FWS has reviewed the analyses and has made comments concerning the data and results.

Several previous flood studies have been prepared for Tomahawk Dam, which resulted in differing inflow volumes and peak flood inflow rates.

Final selection of an appropriate IDF directly impacts the feasible design options and cost for critical features such as embankment height, service spillway, and low-level outlet works.

The FWS Refuges Program has requested a Peer Review to assist in the final determination of an appropriate IDF for use in evaluation of dam rehabilitation design alternatives. The purpose of this Statement of Work is to describe the tasks required for a Peer Review of the flood hydrology studies previously completed for Tomahawk Dam.

2. DESCRIPTION OF TOMAHAWK DAM

Tomahawk Dam is located northwest of Valley City, North Dakota, about one mile east of Rogers, in the Rogers Township of Barnes County, North Dakota (Section 32, T.142 N., R. 59 W.). The dam is located on an easement refuge (federal dam on private land) and is managed by the Valley City Wetlands Management District, which is under the jurisdiction of the Arrowwood National Wildlife Refuge.

The point of contact (POC) for the refuge is Kurt Tompkins, District Manager, Valley City Wetland Management District, 1515 River Road, Valley City, North Dakota 58072 (701-845-3466).

Tomahawk Dam was originally constructed in 1936 to provide improved waterfowl and wildlife habitat. The crest of the dam is currently used as a gravel-surfaced, local Township road, currently designated as 110th Ave. S.E. The public has access to the crest road and vehicle traffic varies from passenger cars to school buses and large commercial farm equipment. Final design alternatives must consider the requirements associated with safe passage of large farm equipment (80,000 lbs. GVW) and school buses.

According to the 1982 SEED (Safety Evaluation of Existing Dams) inspection report, the embankment was constructed by placement of soils from adjacent sidehills, hauled and placed by farm tractors pulling Fresno scrapers. Subbase preparation was apparently limited to stripping of some sod from the dam site. The original spillway had a 50-foot base width and 10H:1V side slopes, so that it could be crossed by vehicles. The 50-foot bottom width and the first 20-feet on each side were built with rubble masonry, while the rest of the spillway slopes were covered with hand-placed riprap and gravel. The original spillway depth was 5 feet, and the spillway also included a rubble masonry sloped drop and an apron with sloping masonry side walls.

In 1951 and 1952, the spillway was reported as repaired/improved by addition of concrete cutoff walls. In 1954, a section of the masonry spillway slab was reportedly replaced with a concrete slab and cutoff wall. Sometime between 1965 and 1979, it is reported that the spillway, as originally designed, was replaced with the current configuration, including the two CMP arch culverts. The arch culverts were reportedly placed directly on the previously existing concrete slab. The culverts were undersized to pass flood flows resulting in overtopping flood events in 2009, 1993, and 1979. Overtopping events have been partly attributable to culvert blockage. From landowner reports, overtopping has typically been about 6 inches deep over the crest of the dam. In 2011, the CMP arch culverts were removed from the site revealing a concrete slab Texas crossing.

The dam is located on a tributary of the Sheyenne River and impounds flows from the tributary, creating a reservoir with a normal pool elevation of 1402.4 feet, a surface area of about 77 acres, and approximately 369 acre-feet of active storage capacity. The drainage basin area has most recently been estimated to cover approximately 30 square miles. Based on FWS criteria, the dam is classified as small, low-hazard.

Tomahawk Dam has a structural height of 10.6 feet, crest length of 500 feet, crest elevation of 1406.5 feet and crest width of 23 feet. The upstream slope is 2H:1V and the downstream slope is 2.5H:1V. The dam is equipped with a FWS spillway consisting of one concrete Texas crossing located near the left abutment. The dam has no outlet works or emergency spillway.

3. TASKS TO BE PERFORMED BY THE PEER REVIEW CONSULTANT (PRC)

The selected Peer Review Consultant (PRC) shall provide professional hydrologic and hydraulic design review services to evaluate previously completed flood studies for Tomahawk Dam.

The PRC shall prepare a report of findings containing review comments for the FWS. The report shall discuss the validity of previous flood hydrology studies that are described in this Statement of Work.

The following Attachments are provided for use by the PRC in performing the Peer Review:

- Attachment A: Inflow Design Flood (IDF) analyses, by W.W. Wheeler and Associates, 2011
- Attachment B: Review of W.W. Wheeler IDF analyses, by FWS Region 6 Water Resources Division, 2011

- Attachment C: HEC-1 analysis, by FWS Region 6 Water Resources Division, 1999
- Attachment D: IDF analyses, by Robert Peccia and Associates, 2006
- Attachment E: IDF analyses, by FWS, 1984 SEED Report
- Attachment F: Drainage area mapping, by Moore Engineering, 2011
- Attachment G: 2003 SEED Report

The tasks required under this Statement of Work shall be divided into the following elements:

- Element A: Review of Previous Engineering and Supporting Data
- Element B: Review of Attachments A and B.
- Element C: Review of Attachments C, D, E, and F
- Element D: Summary Peer Review Analysis and Conclusions
- Element E: Optional Independent Flood Study and Analysis

Additional detailed information on each element is outlined below:

Element A: Review of Previous Engineering and Supporting Data

The PRC shall review the description of Tomahawk Dam, and other supporting data, including Attachment G, to become familiar with the existing dam structure, topography, and the methods used to determine the recommended IDF.

Designs for rehabilitation of the dam are required to incorporate FWS Dam Safety standards with regard to the Inflow Design Flood (IDF). Current standards are published by the FWS at:

<http://www.fws.gov/policy/361fw1.html>
<http://www.fws.gov/policy/361fw2.html>

FWS Dam Safety standards will require sufficient hydraulic performance of the dam to safely pass the greater of the maximum theoretical 100 year flood event, or actual recorded data, without causing failure or major damage to the structure.

The PRC may use outside sources to assist in verification of the data and assumptions used in the previous flood hydrology analyses. Agencies of interest may include, but are not limited to, the U.S. Army Corps of Engineers, North Dakota Dam Safety Office, Barnes County, private consultants, North Dakota Department of Transportation, and the Barnes County Water Resource District.

Element B: Review of Attachments A and B

The PRC shall first review Attachments A and B, including the data and assumptions, for accuracy and applicability to the structure and the FWS dam safety standards. The PRC shall develop review comments concerning the calculations related to determination of the design hydrologic event, runoff estimates, resulting inflow rates, routing, and resulting flood peak volume, and duration.

The PRC may wish to review North Dakota Dam Safety regulations, North Dakota Water Resource Bulletins, and USGS gage data to offer an opinion regarding the process and assumptions. Factors such as rainfall rate, soils, antecedent moisture, drainage area, time of concentration, and other assumptions should be reviewed in detail for validity.

Element C: Review of Attachments C, D, E, and F

Following the work to complete Element B, the PRC shall review and examine the previous analyses given in Attachments C, D, and E. The PRC shall develop review comments concerning the validity of these methods in relation to the analyses completed under Attachments A and B.

The PRC shall review the various flood studies previously prepared. Any data and/or assumptions that appear to be questionable, not typical of industry standards, not in compliance with FWS dam safety standards, and/or not applicable to site conditions shall be noted in the Peer Review Summary.

The PRC shall review the information contained in Attachment F and comment on whether this data is appropriate for inclusion in the IDF determination.

Element D: Summary Peer Review Analysis and Conclusions

The PRC shall prepare a written draft report and commentary on the studies performed under Contract Elements A, B, and C. The PRC shall make recommendations concerning which of the previous studies is the most supportable and would provide the best compliance with FWS dam safety standards and industry standard practices. The PRC will comment on the need for refinement of data, study assumptions, or other factors that would assist in the determination of an appropriate IDF.

The PRC shall allow FWS personnel at maximum of 15 days for review and comment on the report. Representatives of the PRC and the FWS will hold a meeting to discuss the draft report findings. The FWS will submit review comments to the PRC within five working days of the meeting. The PRC will incorporate review comments from the FWS into the report and produce a final report for submittal to the FWS.

Element E: OPTIONAL Independent Flood Study and Analysis

The FWS may choose to direct the PRC to perform an independent flood hydrology study of Tomahawk Dam.

An independent study would be performed only if FWS personnel determine there is adequate justification and benefit to the project and that such additional effort is warranted to determine an appropriate IDF.

If Element E is awarded, the PRC will utilize approved flood modeling software to route the IDF through the reservoir and dam structure for the purpose of determining proper sizing for the dam embankment, service spillway, low-level outlet works, and emergency spillway, as applicable.

Options which have previously been considered, and which the PRC will be required to evaluate, include: resizing or replacement of the existing service spillway, rehabilitation and raising of the dam embankment, and installation of a low-level outlet works.

The independent flood study and analysis would need to assume various combinations of these features which are best suited to pass the IDF without overtopping of the embankment. The independent study would rely on data and assumptions that are based solely on the PRC's best judgment and professional advice for the structure.

4. DELIVERABLES

- Summary Peer Review Analysis and Conclusions - Draft Report for review by FWS.
- Summary Peer Review Analysis and Conclusions - Final Report to FWS.
- Hard copies of any newly developed data and work performed by the PRC.
- If Element E of the Contract is exercised, provide copies of any digital data, including input data/assumptions, modeling analyses, and output.
- Digital data/electronic copies to be provided on CD-ROM, including source files. Include the final Summary Peer Review Analysis and Conclusions report in PDF file format.

5. SCHEDULE

The schedule outlined below represents the Contract duration and shall begin after the Contracting Officer has awarded the Contract and has issued a Notice to Proceed (NTP).

Description	Calendar Days
Element A - Review of Previous Engineering and Supporting Data	10
Element B - Review of Attachments A and B	15
Element C - Review of Attachments C, D, E, and F	10
Element D - Summary Peer Review Analysis and Conclusions	10
FWS Review of Draft Summary Report	15
PRC/FWS Meeting to Discuss Summary Report	5
PRC Revision of Draft Summary Report	5
Final submission of Deliverables	5
Total Task Order Time (not including Element E)	75

6. DESIGNATED REPRESENTATIVES

ATTACHMENT A

Inflow Design Flood (IDF) analyses, by W.W. Wheeler and Associates, 2011

ATTACHMENT B

Review of W.W. Wheeler IDF analyses, by FWS Region 6 Water Resources Division, 2011

ATTACHMENT C

HEC-1 analysis, by FWS Region 6 Water Resources Division, 1999

ATTACHMENT D

IDF analyses, by Robert Peccia and Associates, 2006

ATTACHMENT E

IDF analyses, by FWS, 1984 SEED Report

ATTACHMENT F

Drainage area mapping, by Moore Engineering, 2011

Background Information - Drainage Area Mapping by Moore Engineering

The Barnes County Water Resource District recently contracted with Moore Engineering (Moore) of West Fargo, North Dakota, to perform drainage studies in the local area. Moore collected available data and performed field surveys to determine the extent of the Tomahawk Basin among other tasks. As a result of the recent studies, Moore has defined a larger contributing drainage basin for Tomahawk Dam than had previously been estimated. The larger contributing area was apparent during the 2011 flooding events in North Dakota. Details concerning the studies by Moore are given below.

Moore used 2008 Light Detection and Ranging (LIDAR) data for the delineation of the basin. This data was 5 meter data used in a previous Corps of Engineers Hydrologic Modeling System (HEC-HMS) study of the Upper Red River Basin. The data was chosen because a large amount of time had been spent during the HEC-HMS study to scan the LIDAR data and "burn" culverts to hydrologically correct the digital elevation model (DEM). The basin delineation was accomplished using ArcHydro and Geo-HMS tool extensions in the Geographic Information system (GIS). Moore has provided copies of GIS shape files with various coverages for the basin. The following files are available for use upon request:

1. The Subbasin.shp file is the watershed boundary with basin breaks at various culvert locations.
2. The River.shp file is the river layer for the previously mentions subbasin file.
3. The LongestFlowPath.shp is the longest flow path for each individual subbasin.
4. The Depression.shp contains all the depressions that at the time the LIDAR was flown would fully contain a 100 year runoff.
5. The DepressionDA.shp represents the drainage areas for each depression "noncontributing Areas". The depression and depressions drainage area were derived through an iterative process using the depression analysis function and a 100 year runoff grid. These shape files were created during the iterative process which was completed as part of the HMS modeling.

After completing the basin delineation, and a review of non-contributing areas, Moore engineers met with local residents. The local residents explained that most of the previously assumed "non-contributing areas" had filled due to the flooding and could now be categorized as contributing areas. The largest of the previously "non-contributing" areas was Ten Mile Lake which adds a large amount of drainage area to Tomahawk Lake.

Contact information for the Barnes County Water Resource District is:

Contact information for Moore Engineering is:

Attachment F contains a map of the Moore study area with highlighted drainage areas. Also attached is a coverage map for the drainage area defined by the R6 Water Resources Division under the study area that was assumed in Attachment D.

ATTACHMENT G

2003 SEED Report