

Technical Memorandum



To: Mr. Ron Hansen, P.E., P.S.
CC: Mr. David Kepler
From: Paul D. Drew, P.E., CFM
Date: April 12, 2021
Re: 100-year Floodplain Evaluation (Secord and Smallwood Dams)
Four Lakes Task Force (FLTF)
Midland, Michigan
GEI Project No. 2002879

Introduction

Following the May 19, 2020 storm event that resulted in minor downstream erosion to the Secord Dam, severe erosion to the Smallwood Dam and a catastrophic failure the Edenville and Sanford Dams, the Four Lakes Task Force (FLTF) requested GEI Consultants of Michigan, P.C. (GEI) to provide conceptual designs to reconstruct and/or rehabilitate the four dams formerly owned by Boyce Hydro (Boyce). In support of the conceptual designs, GEI performed a flood study with the following goals:

- Update PMF Inflow Hydrographs (*To be completed by Ayres Associates, Inc. [Ayres]*).
- Develop a hydraulic computer model (HEC-RAS) to establish flood elevations from Secord Dam to Sanford Dam.
- Evaluate spillway configurations to pass at a minimum the ½ Probable Maximum Flood (PMF) in accordance with State of Michigan EGLE requirements.
- Develop floodplain inundation mapping to identify roads, highways, habitable structures, and other critical infrastructure impacted from the proposed spillway configurations.

The supporting documentation for the GEI flood study is summarized in the *GEI Flood Study of the of the Tittabawassee River from Secord to Sanford Dam*, dated April 9, 2021 (Ref, GEI 2021).

We understand that the Secord and Smallwood Dam rehabilitation projects will be partially financed through United States Department of Agriculture (USDA) funding. As a result, the USDA has requested that GEI perform flood routing to demonstrate no adverse impacts to the 100-year floodplain (no increase in water surface elevations) following the rehabilitation of both Secord and Smallwood Dams located in Gladwin County, Michigan.

Elevations listed herein are referenced to the North American Vertical Datum of 1988 (NAVD 88).

100-year Peak Discharges and FEMA Floodplain

The majority of the lands bordering the Tittabawassee Rivers are Federal Emergency Management Agency (FEMA) “Zone A” Floodplains, meaning base-flood elevations were not established by a detailed study and the floodplain limits were determined by approximate methods. At Secord Dam, a FEMA Letter of Map Amendment (LOMA) was completed by Mill Road Engineering in 2015 resulting in a 100-year flood

elevation of 753.3 in Secord Lake. At Smallwood Dam, a FEMA LOMA was also completed by Mill Road Engineering in 2015 resulting in a 100-year floodplain elevation of 705.6 in Smallwood Lake. 100-year floodplain elevations are not established downstream of both Secord and Smallwood Dams (FEMA Zone A).

Flood frequency estimates (100-year flood peak discharges) were derived from the State of Michigan EGLE (formerly DEQ Flood Discharge Database). **Table 1** summarizes the 100-year peak discharges and water surface elevations (WSEL) at both Secord and Smallwood Dams.

Table 1: 100-Year Peak Discharge and Floodplain Elevations

Project	100-year EGLE Discharge	100-Year WSEL (DFIRM)
	(cfs)	(feet)
Secord	4,300	753.3
Smallwood	6,700	705.6

Existing Conditions Spillway Capacity

In April 2020, the FLTF requested that GEI review the available hydraulic information and develop new spillway discharge rating curves for each project (Ref. GEI 2020). At Secord Dam, the GEI estimated the Tainter gate spillway capacity at the 100-year elevation (El. 753.3) is approximately 5,775 cfs with the gates fully open.

The GEI computed existing conditions Smallwood Tainter gate spillway capacity 100-year elevation (El. 705.6) is approximately 6,900 cfs with the gates fully open.

Proposed Conditions Spillway Capacity

GEI performed a hydraulic analysis to evaluate the proposed spillway upgrades to safely pass the ½ PMF with residual freeboard below the dam crest. Another design criterion of the proposed spillway modifications is to provide equivalent or greater flood discharge capacity for the 100-year storm and not increase current 100-year floodplains elevations in either Secord or Smallwood Lakes. The proposed configurations consist of reconstruction or rehabilitation of earthfill embankments, demolition, and replacement of the primary Tainter gate spillways with new, larger hydraulic crest control gates, and new passive overflow spillways. **Table 2** summarizes the 100-year flood elevations and the existing and proposed spillway capacity assuming the existing Tainter gates and proposed crest gates are fully open.

Table 2: Secord and Smallwood 100-Year Flood Elevations and Spillway Capacity

Project	100-year EGLE Discharge	100-Year WSEL (DFIRM) ¹	Existing Spillway Capacity at 100-year WSEL ¹	Proposed Spillway Capacity at 100-year WSEL ²
	(cfs)	(feet)	(cfs)	(cfs)
Secord	4,300	753.3	5,775	9,400
Smallwood	6,700	705.6	6,900	9,000

Notes:

1. Existing Tainter Gates Fully Open (10-feet)
2. Proposed Crest Gates Fully Open (16-feet)

2D HEC-RAS Model

GEI developed a hydraulic computer model using the USACE HEC-RAS, Version 5.0.7. computer model to evaluate the spillway capacity of the existing and proposed dam configurations and develop inundation mapping to illustrate the floodplain limits at critical locations upstream and downstream of the FLTF dams. For the purposes of this analysis, GEI routed the EGLE 100-year peak discharges through the existing and proposed spillway configurations at both Secord and Smallwood Dams to demonstrate that the proposed spillway modifications provide equivalent or greater flood discharge capacity for the 100-year storm and do not increase 100-year floodplain elevations in either Secord or Smallwood Lakes.

The HEC-RAS model was developed from multiple Digital Elevation Models (DEMs) including Pre-May 2020 flood 2017 LiDAR from Gladwin County and available lake and river sounding and bathymetric contours. The 2D hydraulic calculations were performed in the HEC-RAS model using unsteady flow simulations with a variable time step based on the courant number calculated for cells within the computational mesh. The full momentum equations were used in the 2D model calculations.

See the GEI 2021 Flood Study for more information (Ref, GEI 2021).

Secord Dam Results

For the existing spillway configuration, the 100-year peak discharge of 4,300 cfs was routed through the Tainter gate spillway with the gates opened 5.0 feet resulting in peak stage of El. 753.2 (nearly matching the LOMA peak stage of 753.3). For the proposed spillway configuration, the 100-year peak discharge of 4,300 cfs was routed through the crest gate spillway with the gates opened 8.0 feet resulting in a lower peak stage of El. 752.6. The flood routing results provided in **Table 3** suggest that with the increased spillway capacity in the proposed condition, the Secord Lake 100-year floodplain elevation will not be increased as result of the project. Secord Dam inundation mapping illustrating the existing and proposed 100-year floodplain is provided in **Figure 1**.

Table 3: Secord Dam 100-Year Flood Routing

Secord Dam	100-year EGLE Discharge	100-Year WSEL (DFIRM) ¹	Gate Opening
	(cfs)	(feet)	feet
Existing Conditions	4,300	753.2	5.0
Proposed Conditions	4,300	752.6	8.0

Smallwood Dam Results

For the existing spillway configuration, the 100-year peak discharge of 6,700 cfs was routed through the Tainter gate spillway with the gates opened 7.5 feet resulting in a peak stage of El. 705.6 (matching the LOMA peak stage). For the proposed spillway configuration, the 100-year peak discharge of 6,700 cfs was routed through the crest gate spillway with the gates opened 12.5 feet resulting in a lower peak stage of El. 705.2. The flood routing results provided in **Table 4** suggest that with the increased spillway capacity in the proposed condition, the Smallwood Lake 100-year floodplain elevation will not be increased as a result of the project. Smallwood dam inundation mapping illustrating the existing and proposed 100-year floodplain is provided in **Figure 2**.

Table 4: Smallwood Dam 100-Year Flood Routing

Smallwood Dam	100-year EGLE Discharge	100-Year WSEL (DFIRM) ¹	Gate Opening
	(cfs)	(feet)	feet
Existing Conditions	6,700	705.6	7.5
Proposed Conditions	6,700	705.2	12.5

Closing

The results of this hydraulic analysis demonstrate that both the existing and proposed configurations require gate operations to safely pass the 100-year flood. Furthermore, we are also providing a significant increase in spillway capacity with the proposed new crest gates and will provide equivalent or greater flood discharge capacity for the 100-year storm and will not increase currently established 100-year floodplains elevations in either Secord or Smallwood Lakes. These results are not final as the project is currently at the 30% design development stage. As the final design progresses, we will collaborate with the USDA and provide crest gate rule opening curves to demonstrate that the currently established Secord and Smallwood Lake water surface elevations are not exceeded, and the gate openings are set to not increase peak discharges downstream of the dams during the 100-year storms.

References

(GEI, 2020). "Discharge Rating Curves (Secord, Smallwood, Edenville and Sanford Projects)." GEI Consultants of Michigan, P.C., April 2020.

(GEI, 2021). "Flood Study of the Tittabawassee River from Secord to Sanford Dam." GEI Consultants of Michigan, P.C., March 2021.

Enclosed

- Figure 1 – Secord Dam 100-Year Flow Inundation Mapping
- Figure 2 – Smallwood Dam 100-Year Flow Inundation Mapping