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BROWN BRIDGE DAM REMOVAL ENVIRONMENTAL ASSESSMENT

U.S. Fish and Wildlife Service
Green Bay Fish and Wildlife Conservation Office
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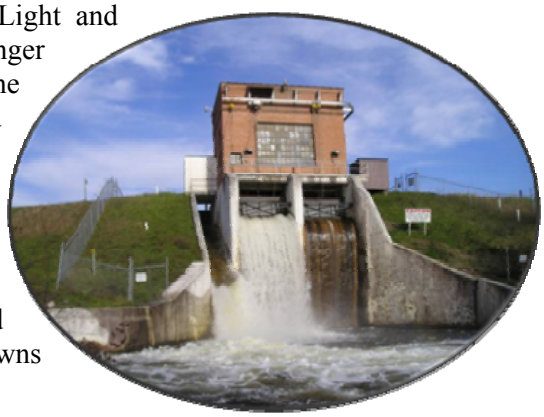
List of Abbreviations and Acronyms

ACR	Andrews Cultural Resources
AMEC	AMEC Environmental & Infrastructure, Inc.
BMIC	Bay Mills Indian Community (BMIC)
BGS	below grade surface
BMP	Best Management Practice
BRDC	Boardman River Dams Committee
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
EA	Environmental Assessment
ECT	Environmental Consulting & Technology, Inc.
°F	degrees Fahrenheit
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
GLEC	Great Lakes Environmental Center
GLFT	Great Lakes Fishery Trust
GTB	The Grand Traverse Band of the Ottawa and Chippewa Indians
GTCD	Grand Traverse Conservation District
IT	Boardman River Dams Settlement Agreement Implementation Team
LWD	large woody debris
LRB	Little River Band of Ottawa Indians
LTBB	Little Traverse Bay Bands of Odawa Indians
MDEQ	Michigan Department of Environmental Quality
MDNR	Michigan Department of Natural Resources
mg/kg	milligrams per kilogram
NREPA	Natural Resources Environmental Protection Act
NEPA	National Environmental Policy Act
NFIP	FEMA National Flood Insurance Program
NRCS	Natural Resource Conservation Service
NRHP	National Register of Historic Places
PNA	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PEC	Probable Effect Concentration
PMF	probable maximum flood
SVOC	semi-volatile organic compound
SHPO	State Historic Preservation Office
SSM	Sault Ste. Marie Tribe of Chippewa Indians
STS	STS Consultants
TCLP	Traverse City Light and Power
TEC	Threshold Effect Concentration
TEK	Tribal Traditional Ecological Knowledge
URS	URS Corporation
USACE	United States Army Corps of Engineers
USC	United States Code
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WWTP	Wastewater Treatment Plant

1.0 THE PURPOSE AND NEED FOR THE PROPOSED ACTION

1.1 BACKGROUND

Brown Bridge Pond is an impounded water body located on the Boardman River near Traverse City, Michigan (Figure 1-1). The Brown Bridge Dam was initially constructed in 1921 for use in producing hydropower, but in 2004 Traverse City Light and Power (TCLP) determined that it was no longer economically feasible to produce hydropower on the Boardman River. Consequently, TCLP made a decision in 2006 to discontinue use of Brown Bridge Dam, Boardman Dam, and Sabin Dam by relinquishing their Federal Energy Regulatory Commission license for the purpose of generating hydropower. TCLP leased the three dams from the owners of the dams (City of Traverse City [City] and Grand Traverse County) until 2005. The City owns Brown Bridge Dam.



Composed of hydraulic fill (e.g., earthen materials and concrete), the dam has a structural height of 46 feet, a head of 33 feet, and a total length of 1,650 feet. It consists of a 1,200-foot long right earthen embankment and 400-foot long left earthen embankment, with a concrete and brick powerhouse with a spillway structure. The earthen embankments are constructed of a hydraulic fill core with a granular fill outer shell. Additionally, there is an abandoned fish ladder that intersects the right embankment near the powerhouse/spillway structure. The pond encompasses approximately 158 acres (subsequent to 3-foot drawdown in 2008) and has a watershed of nearly 290 square miles (MDNR, 2011a).

1.2 NATIONAL ENVIRONMENTAL POLICY ACT

The National Environmental Policy Act ([NEPA], 42 United States Code [USC] § 4321-4347) is a federal law that establishes a national environmental policy and provides a framework for planning and decision making by federal agencies. Specifically, NEPA requires that federal agencies integrate an interdisciplinary environmental review process that evaluates a range of alternatives, including the No Action Alternative as part of the decision-making process. This process also establishes a need to include interagency coordination and public participation in the process. In summary, NEPA is intended to promote informed decision making by federal governmental agencies and public participation in the process, as appropriate. Because federal funds administered by the Department of Interior are anticipated for use in removal of Brown Bridge Dam, the United States Fish and Wildlife Service (USFWS) is the lead Federal agency for this proposed action.

1.3 PROPOSED ACTION

The four dams (Brown Bridge, Boardman, Sabin and Union Street) on the Boardman River System (the Boardman Dams) are aging structures that are damaging the ecosystem of the project area. The proposed action considered in this Environmental Assessment (EA) is to remove Brown Bridge Dam and promote the restoration of the Boardman River and its associated bottomlands. The proposed action will increase habitat continuity and restore the thermal and hydrologic regime of the Boardman River to be consistent with a coldwater river. At Brown Bridge Dam, it is estimated

that the restored river channel would be approximately 11,900 linear feet, with total functional benefits (e.g., flow and sediment transport processes upstream of Brown Bridge Pond) to approximately 17,000 linear feet of river.

1.4 NEED FOR PROPOSED ACTION

Several key issues contribute to the need for the removal of Brown Bridge Dam. These needs include those associated with the age and existing condition of the dam, the effects of the dam and associated pond on the local ecosystem, and the opportunities for ecosystem restoration on the Boardman River.

1.4.1 Dam Age and Condition

Brown Bridge Dam is an earthen dam which, along with the associated powerhouse, was constructed in 1921. The facility served in the production of hydropower until decommissioning of the dam in 2006. In 2003, the existing spillway at the Brown Bridge Dam was determined to be incapable of passing the probable maximum flood (PMF). The facility is in aging condition and has notable documented deficiencies that indicate a safety problem. Prior inspections of the Brown Bridge Dam (STS, 2008) coupled with a review of previous hydrologic, hydraulic, and stability analyses resulted in several conclusions regarding the safety of the existing facility. Specific findings regarding the existing facility included:

The spillway capacity is likely inadequate for the current high-hazard rating, and does not meet the dam safety requirements of Part 315, which requires that high hazard dams 40 feet in height or greater must be capable of safely passing half the PMF (50 PMF).

Active seeps and wet spongy conditions are evident over most of the downstream toe of the right (as facing downstream) embankment, which are indicative of movement of fines out of the embankment. While it is understood that seepage has been present since original construction, the development of localized settlement and movement of fines appeared to be gradually increasing over time (STS, 2008). Furthermore, previous slope stability analyses indicated factors of safety under normal pool conditions which are less than typically required for a high hazard embankment dam. Surveys performed during a 2008 inspection showed that the downstream slopes are actually steeper than assumed during the previous analyses, which would yield an even lower safety factor. As a result, it was concluded that the embankment does not have an adequate factor of safety against failure and is meta-stable under normal pool, steady state seepage conditions.

1.4.2 Ecosystem Degradation

This effect has been documented in work performed by the Michigan Department of Natural Resources (MDNR) Fisheries Division over the last three decades and encompasses a number of key characteristics including the following:

- **Habitat Fragmentation**. The presence of Brown Bridge Dam has the effect of segmenting the Boardman River into three discontinuous reaches (Figure 1-2) that include the Boardman River from the "Forks" area to Brown Bridge Pond, Brown Bridge Pond, and the Boardman River from below Brown Bridge Dam to Boardman Pond. Such segmentation has a particularly adverse impact on resident brook and brown trout by increasing their vulnerability to adverse environmental conditions (e.g., pollution, habitat degradation, wetland filling) while reducing the opportunity for genetic exchange between segmented populations. Fragmentation also

limits access to areas with suitable spawning habitat, optimal food availability, and protection from predators (US Army Corps of Engineers [USACE], 2006).

- **Habitat Degradation**. As a result of the above-referenced habitat fragmentation and its hydrologic alterations, habitats within the Boardman River and its associated bottomlands have been modified and degraded, resulting in adverse impacts on aquatic species mix, diversity, and populations. This habitat degradation is expressed in several characteristic ways:
  - Interruption of Downstream Transport Processes. The presence of the dam has the effect of interrupting and limiting the downstream transport of woody debris and plant propagules critical to sustaining healthy populations of trout and other desirable fish and invertebrate species. Woody debris provides food, refuge, cover and channel diversity to fish and invertebrate species, and provides protection from excessive riverbank erosion (USACE, 2006).
  - Alteration of Surface Water and Groundwater Flow Patterns. Impoundment of the Boardman River at Brown Bridge Dam has had the effect of altering surface water and groundwater flow patterns. Maintenance of the impoundment at Brown Bridge not only creates still water ("lentic") habitat within the pond itself that contributes to bank failure and erosion (Figure 1-3), but it also has the associated effect of creating backwater within the river upstream of the pond. As a result, surface water flows are modified from that of a natural flowing river which has the effect of increased sedimentation and altering instream habitat. Backwater effects also result in the "perching" groundwater in the upstream vicinity of the pond thereby altering groundwater flow and discharge characteristics.
  - Interruption and Alteration of Sedimentation Processes. Downstream transport of sediments naturally carried by the river is also interrupted by the presence of Brown Bridge Dam. Consequently, the natural equilibrium associated with riverine sediment transport processes is disrupted. As is evident in Figure 1-4, reduced water velocities at the upper end of Brown Bridge Pond have had the effect of causing extensive sedimentation within this upper delta area and within the pond itself. Analysis of the stream profile in the vicinity of Brown Bridge Pond coupled with field sampling within the pond suggest that sediment depths in the delta area range from 6 feet to nearly 12 feet (Inter-Fluve, 2012). This alteration in sedimentation pattern effectively "starves" downstream areas (particularly areas immediately below Brown Bridge Dam and extending approximately 1 mile downstream) by reducing sediment loads resulting in increased bank and riverbed erosion in those downstream reaches. Dam impoundments trap and immobilize sediment due to decreased flow velocities and, in so doing, modify the instream substrates of natural habitats (including the Boardman River upstream of Brown Bridge Dam), thereby compromising spawning areas for invertebrates and fish species (USACE, 2006).

- **Thermal Disruptions**. Sampling and analysis by the MDNR Fisheries Division has documented the adverse impacts of the Boardman Dams on water temperature, a critical consideration for the health and sustainability of coldwater fish species such as brook and brown trout. For example, historical studies of discharges from Brown Bridge Pond from May to August found waters immediately downstream of the dam to be an average of 6 degrees Fahrenheit warmer than upstream channel waters (Figure 1-5); notably in excess of the two degree difference allowed under the state's Water Quality Standards (Rule 75, Part 4, Natural Resources and Environmental Protection Act, 1994 PQ 451). The presence of the Brown Bridge Dam has also been observed to adversely affect diurnal water temperature fluctuations, resulting in lower temperatures at night and higher temperatures during the day. These thermal disruptions have a variety of impacts on coldwater species that can include compromised

growth rates, alteration of metabolism and timing of spawning/hatching, reduced populations and, in some instances, can result in temperatures lethal to fish.

- **Induced Species Disruptions**. The thermal disruptions described above have had a resultant impact upon specific coldwater species (e.g., brook and brown trout) and their composition and abundance in the resident fish community. Elevated water temperatures caused by the solar insolation (exposure to the sun's rays) of Brown Bridge Pond induce competition from cool-water species that would not otherwise have a significant presence in those river reaches. The MDNR Fisheries Division has documented 17 such species in the dam impoundments, and noted that unnatural warming of downstream reaches can induce such species to migrate out of the impoundments and compete with coldwater species for food, cover and related habitat characteristics (USACE, 2006).

Construction of the Boardman Dams has also facilitated establishment of zebra mussel (*Dreissena polymorpha*) populations in Brown Bridge Pond. Slow flowing water favors the establishment of zebra mussels and well established populations are known to occur in Brown Bridge Pond and on the hard substrates of the powerhouse as well as in the Boardman River channel downstream of the dam, extending approximately 0.5 miles.

1.4.3 Expansion of Natural Rivers System

The Boardman River is a designated Natural River under the State of Michigan Natural Rivers Program. Outside of the project area, it features 36 linear miles of Blue Ribbon Trout Stream designated by the MDNR Fisheries Division. The river is considered one of the top ten best trout streams in Michigan and supports self-sustaining populations of brown, brook and rainbow trout.

1.5 APPLICABLE REGULATORY REQUIREMENTS AND COORDINATION

The following sections describe local, state, and federal regulatory requirements that must be addressed as part of the NEPA process, as well as coordination with the public, Native American tribes and government agencies.

1.5.1 Public and Agency Involvement

Public involvement and coordination with local, Tribal, state, and federal resource management agencies is a vital component of the NEPA process. The USFWS and the City of Traverse City as well as the Boardman River Dams Settlement Agreement Implementation Team (IT) have engaged the public in a variety of ways during the development of this EA. A public meeting was hosted by USFWS at the Grand Traverse Civic Center on June 21, 2011 to solicit general input from the public about the proposed dam removal. Approximately 45 people attended that meeting. Meeting exhibits were displayed that communicated the project purpose and need, environmental setting and key project features, project alternatives under consideration, and elements of the NEPA process. Comments were received at the meeting and subsequently by mail and e-mail throughout preparation of the EA. A summary of the scoping meeting and public comments received is included in Appendix A. Key topics raised by respondents included those focused on the potential benefits of the proposed action regarding its restoration of environmental habitats and processes, recreational benefits (canoeing/kayaking), the openness of the public process, and the alternatives under consideration (active restoration, the availability of alternatives, and consideration of sediment management measures). Negative comments pertained to loss/changes to the existing ecosystem, potential for invasive species, loss of opportunities for hydropower, the failure to

sufficiently engage the public in the process, and that the schedule for dam removal was not fast enough.

Public involvement has been a key aspect of the all planning activities associated with the Boardman Dams project. For example, over a period of three years, the Boardman River Dams Committee (BRDC) conducted more than 180 public meetings during which the issues associated with dam removal have been discussed.

This Draft EA has been made available for public review and has been posted to the Boardman Dams website (theboardman.org).

The City of Traverse City and Grand Traverse County organized the BRDC to gather community feedback, encourage community involvement and manage an engineering and feasibility study to assess the engineering, environmental, economical and societal benefits and detriments of retaining, modifying and removing the Boardman River Dams (2005 through 2008). The IT is a collaboration body formed in 2005 to provide oversight of the process. The BRDC had a varied membership that was composed of members of the public, representatives of local political jurisdictions (e.g., City of Traverse City, Grand Traverse County), as well as representatives from federal, state, tribal and local agencies. This "interagency" study team met monthly since 2005 and during the preparation of this EA. Agencies that have participated in the process, which has included the scoping process for this EA, have included but are not limited to the following:

- USFWS
- City of Traverse City
- Grand Traverse County
- The Grand Traverse Band of Ottawa and Chippewa Indians (GTB)
- MDNR
- Michigan Department of Environmental Quality (MDEQ)
- Grand Traverse Conservation District (GTCD)
- Michigan Hydro-Relicensing Coalition
- Conservation Resource Alliance
- Rotary Camps and Services
- Watershed Center Grand Traverse Bay
- Trout Unlimited
- Brown Bridge Advisory Committee
- USACE
- Grand Traverse Road Commission
- Natural Resource Conservation Service

This working group provided input to the project team on the regulatory requirements, environmental resources, and overall direction of the project. Agency representatives were also available at the public meeting conducted on June 21, 2011 to answer questions regarding agency involvement and authorizations for the project.

Correspondence was also conducted with representative agencies to solicit input to the NEPA planning process. Agency correspondence is provided in Appendix B. Responses were obtained from the MDNR, MDEQ, GTCD, Adams Chapter of Trout Unlimited, and Senator Stabenow. Key issues raised by agencies included potential concerns regarding potential impacts to wetlands, surface water quality impacts, sediment transport and deposition, potential sediment contamination

and transport, the dam removal process and stream restoration techniques, and invasive species management.

1.5.2 Permitting

A number of permits and other authorizations must be obtained to implement the action under consideration. The primary permitting action that governs dam removal is specified by Part 315 of the Michigan Natural Resources Environmental Protection Act and is administered by the MDEQ. After the permit application is submitted and reviewed, a hydraulic review may be requested as it relates to floodplain hydraulic engineering analyses if deemed necessary by the MDEQ. Additional permitting is expected in accordance with Soil Erosion and Sedimentation Control (Part 91) in support of the final drawdown/dam removal and associated ecosystem restoration activities.

The permits/approvals that may be required for the removal of the dam and ecosystem restoration are listed in Table 1-1.

1.5.3 Tribal Coordination

The USFWS, The City of Traverse City, Grand Traverse County and the BRDC have coordinated with GTB throughout the planning process. The GTB is a member of the IT and has participated extensively throughout the planning process and is a co-funder of the proposed action. GTB is the most proximate federally recognized Indian Tribe to the project area and is one of five federally recognized 1836 Treaty tribes with adjudicated treaty rights in the project area (Figure 1-6). Despite GTB's on-going role and participation as an IT member, formal correspondence with GTB has also been conducted to solicit input to the NEPA process (Appendix B). Consultation with GTB has included their input and participation in various engineering and environmental studies of the Brown Bridge project area as well as the investigation and integration of Tribal Traditional Ecological Knowledge (TEK) as part of project designs as feasible, and formal commenting on project concept design plans (dam removal and ecosystem restoration) and elements of the Bottomland Management Plan. The GTB will continue to provide input through the development of this EA. Additionally, when the Ottawa and Chippewa Tribes ceded lands to the U.S. Government; the Tribes retained their usufructuary rights of occupation on the lands and waters. The federal courts have upheld this property right to the resources under article 13, Treaty of Washington, 1836. Further, consultation with the remaining 4 four federally recognized Tribes within the 1836 Treaty Ceded Territory, including the Little River Band of Ottawa Indians (LRB), the Little Traverse Bay Bands of Odawa Indians (LTBB), the Sault Ste. Marie Tribe of Chippewa Indians (SSM) and the Bay Mills Indian Community (BMIC), occurred through formal written correspondence requesting comments of the Draft Environmental Assessment as distributed by the USFWS.

Table 1-1. Authorizations Required for Brown Bridge Dam Removal and Ecosystem Restoration Activities

Agency	Authority	Requirement	Activity Covered
Michigan Department of Environmental Quality	Natural Resources Environmental Protection Act	Part 301	Activities in inland lakes and streams, fill placement/stream alteration
	Natural Resources Environmental Protection Act	Part 303	Dredge/fill activities in wetlands
	Michigan Natural Rivers Act	Part 305	Removal/demolition of Brown Bridge Dam; Bridge construction within Natural Rivers Floodplain
	Federal Clean Water Act 33 CFR 330	Section 401 Section 404	Fill activities in "waters of the State"
		Section 402	Land disturbance activities
Michigan State Historic Preservation Office	National Historic Preservation Office	Section 106	Consultation and clearance regarding potential effect to historic properties
U.S. Army Corps of Engineers	Federal Clean Water Act 33 CFR 330	Section 404 Permit	Cooperative Consultation with MDEQ on Section 404/401 permitting actions
U.S. Fish & Wildlife Service	Bald and Golden Eagle Protection Act	Federal Take Permit	Disturbance of bald eagle nesting area from impoundment drawdown
Grand Traverse County Drain Commissioner	Part 91, Soil Erosion and Sedimentation Control (NREPA 1994 PA 451), Grand Traverse County Soil Erosion and Storm Water Runoff Control Ordinance	Soil Erosion and Sedimentation Control (Part 91)	Soil erosion and sedimentation control during demolition activities
Grand Traverse County Construction Codes Dept.	Grand Traverse County Construction Code, Asbestos NESHAP (40 CFR Part 61, Subpart M)	Demolition Permit	Removal/demolition of Brown Bridge Dam powerhouse
East Bay Township	Article VI, Specific Standards and Requirements for Land Uses, East Bay Charter Township Zoning Ordinance	Land Use Permit	Alteration of land use

2.0 ALTERNATIVES

2.1 DESCRIPTION OF BROWN BRIDGE DAM AND ASSOCIATED FACILITIES

2.1.1 Dam

The Brown Bridge Dam (ID No. 0511) is a high hazard dam located on the Boardman River approximately 14 miles upstream of Traverse City, Michigan. Since TCLP relinquished its Federal Energy Regulatory Commission (FERC) license in November 2006, the dam has been regulated under Part 315, Dam Safety, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (Act 451), Sections 31501 through 31529. Information provided in this section is derived from the report Safety Inspection Report of Brown Bridge Dam (STS, 2008) regarding Brown Bridge Dam and its associated structures.

2.1.2 Embankments

The lower portion of the embankments of the Brown Bridge Dam consists of hydraulic fill, and the upper portion of the embankments consists of compacted fill. There is a concrete core wall along the entire upstream length of both earth embankments with a nominal top elevation of 798.4 feet. Historical project drawings show that the core wall extends vertically to a depth of 8 feet except at the powerhouse/spillway structure where it functions as a cutoff wall and extends vertically below the upstream wall of the powerhouse/spillway structure and is keyed 2 feet into the clayey till. The wall extends laterally at this depth left and right of the upstream approach walls for a distance of 20 feet beyond the wall footings. The minimum crest elevation of the embankments identified during the 2008 centerline survey was 802.0 feet. Based on the original design drawings, the design embankment crest elevation was 802.4 feet. The embankment crest width varies from 12 to 15 feet. The downstream slopes are reported to vary from 2:1 (horizontal to vertical) to 2.5:1; however, the 1994 stability analysis assumed downstream slopes as steep as 1.8:1. Cross-sections surveyed during the 2008 inspection showed downstream slopes on the right embankment as steep as 1.5:1. The left embankment adjacent to the powerhouse/spillway structure wall appeared to be steeper than 1.5:1.

2.1.3 Spillway

As part of the combined powerhouse/spillway structure, the Brown Bridge spillway contains two upper 12-foot wide by 5.5-foot high tainter gates. The upper spillway sill is at elevation 792.5 feet. The two lower 12-foot wide by 5.5-foot high tainter gates function as a turbine bypass and cannot be opened if the water level is above an elevation 791 feet. The lower spillway sill is at elevation 786.7 feet. In addition, there is a log chute with a slide gate measuring 6-foot wide by 6-foot high adjacent to the powerhouse. The log chute sill is at elevation 792.5 feet. The log chute is intended for additional discharge capacity, but has been used to pass base river flows since November 2006.

2.1.4 Powerhouse

The powerhouse is a brick structure supported on a reinforced concrete substructure. The powerhouse contains two vertical shaft Francis turbines with an installed capacity of 830 kilowatt. The turbines consist of one Leffel Type Z rated at 690 horsepower and one Leffel Type F rated at 375 horsepower. The powerhouse, constructed in 1921, is an integral part of the original dam project and was in continuous operation until November 2006 when TCLP surrendered its operating license and decommissioned the plant. All of the turbine-generating and control equipment remain in the powerhouse.

2.1.5 Intake and Outlet Structures

The intake structure is integral to the powerhouse. Left and right concrete approach (wing) walls flank either side of the intake bays. Inclined trash racks are located on the upstream side of the intake. In the current mode of operation with the upper tainter gates open and the wicket gates closed, water passes through the inclined trash racks and flows over the upper tainter gate concrete sill at elevation 792.5 feet. With the wicket gates open, water passes through a set of horizontal trash racks inside the structure at elevation 792.5 feet, through turbines, and drops into a short tailrace under the powerhouse. The tailrace discharges to the spillway apron at invert elevation of 756.5 feet.

2.1.6 Reservoir

The Brown Bridge Dam is operated as a run-of-river facility. The headwater elevation of the Brown Bridge Reservoir since the 2008 drawdown has been 794.5 feet. At this pool elevation, the surface area of the pond is 158 acres, and the storage volume is approximately 1,870 acre-feet. Major sedimentation within the upper reservoir is evident that extends into the Boardman River upstream of Brown Bridge Pond (Figure 2-1).

2.2 ALTERNATIVE DEVELOPMENT

This section describes the process used by USFWS to develop and consider a range of alternatives consistent with the requirements of NEPA. USFWS considered what actions could reasonably address the purpose and need in light of the objectives established for the proposed action and in consideration of public scoping comments. The formulation of alternatives has progressed using a step-wise process that included the following:

1. Data review and analysis
2. Identification of project needs
3. Formulation of initial alternative concepts
4. Solicitation of stakeholder input (public, resource/regulatory agencies, other)
5. Development of Design Concepts
6. Development of EA alternatives

The following sections provide an overview of the alternatives considered in this process and a description of the alternatives retained for detailed analysis within this EA.

2.3 DESIGN CONCEPT ALTERNATIVES

The process by which initial planning for options related to dam removal and ecosystem restoration was initiated at the conceptual level and then refined to three more detailed Design Concepts. Several considerations and key inputs contributed to the development of project alternatives including the following:

- Objectives associated with the project Purpose and Need (see Section 1.4):
    - Need for dam removal
    - Need for ecosystem restoration to address: habitat fragmentation, habitat degradation, thermal disruptions, and induced species disruptions
    - Opportunity to expand the Michigan Natural Rivers system
- Information and data previously developed as a result of the Boardman River Feasibility Study and the public involvement process.
- Comments/input from the public scoping process.

- Field reconnaissance activities to identify and assess characteristics of the Boardman River fluvial geomorphology (channel characteristics, channel stability, sediment transport and depositional patterns, habitat characteristics, etc.).
- Field reconnaissance activities to identify and assess characteristics of the wetlands in the Brown Bridge project area (community type, hydrologic relationships to Boardman River/Brown Bridge Pond and groundwater discharge, etc.).
- Engineering studies regarding site topography/bathymetry, river profile and cross- sectional information, sediment depth and chemical composition, hydrologic analysis of the Boardman River, biological/ecological data, and other information.

Based on these considerations, three Design Concept alternatives, as presented in Figure 2-2, were developed and presented to project stakeholders for input (Inter-Fluve, 2012). Concepts were developed that included dam removal (common to all "action" alternatives under consideration) and varying ecosystem restoration approaches.

2.3.1 Dam Removal

Dam removal for all Design Concepts consists of the construction of a dewatering structure to facilitate the controlled removal of water from the pond, demolition of the existing powerhouse, removal of construction debris for off-site disposal, and grading the embankment to provide for channel development and flood conveyance. While prior assessments of potential alternatives included partial dam removal (ECT, 2009e), this was not determined to be consistent with the objectives of the project purpose and need; consequently partial dam removal was eliminated from consideration.

Details with respect to the dam removal component of the "action" alternatives are provided in Section 2.5.2.

2.3.2 Ecosystem Restoration

Options for ecosystem restoration are distinctive for each of the three design concepts and ranged from active to passive restoration as follows:

- Design Concept 1 – 100 Percent Active Restoration
- Design Concept 2 – 50 Percent Active/50 Percent Passive Restoration
- Design Concept 3 – 100 Percent Passive Restoration

Active restoration involves the construction of a restored channel and its associated floodplain within a short-time period following dam removal. As such, all attendant features are constructed in-place for the development of a functioning river channel, along with the installation of plant materials to establish plant communities that are intended to meet long-term objectives regarding restored habitats and composition. In contrast, passive restoration includes limited, if any, active restoration within the channel, and typically limited management of the resulting colonizing vegetation. The passive approach allows the river itself to act as the mechanism to re-establish the river channel and its attendant floodplain.

Restoration activities are differentially applied within the upper portion of the Brown Bridge Pond (upper impoundment) relative to the lower portion (lower impoundment) based on inherent differences in characteristics of depth, need for sediment management, etc.) (Figure 2-2). The following sections describe the differences in restoration approaches for each of the Design Concept alternatives presented above.

2.3.2.1 Design Concept 1 – 100 Percent Active Restoration

Active restoration of the Brown Bridge impoundment involves the active construction of the physical attributes of the pre-dam river corridor. This approach focuses largely on the use of earth moving equipment to remove accumulated sediment in the upper impoundment as well as active planting, seeding, and management of the associated vegetation community in both the upper and lower impoundments to reduce the establishment of invasive plant species. Bank treatments to provide immediate bank stabilization would be installed in the absence of active flow; dewatering and flow exclusion measures would be required for this alternative. Floodplains would be excavated on either side of the 55-foot wide channel to a distance of 40 feet. The total width of the floodplain at 80 feet is consistent with the range estimated in areas above and below the dam based on the results of the hydraulic model (Section 3.2.1).

Under this alternative, re-vegetation efforts consisting of installed plantings would be concentrated within the 40-foot floodplain corridor paralleling each side of the river channel. Following drawdown and the completion of site grading activities seeding would be conducted for all exposed areas using a native seed mix. Large woody debris (LWD) would be installed at regular intervals along the length of the river channel to provide rapid development of in-stream habitat creation and enhancement.

Active wetland development for this alternative includes the shallow excavation and planting of approximately 30 acres of wetlands in the lower impoundment. The excavated wetland would be selectively planted with wetland species and stabilized using a seed mix designed to promote native wetland development. In addition, special attention will be given to areas along the north shore of the lower impoundment which is expected to be characterized by steep slopes that may be more difficult to stabilize naturally.

2.3.2.2 Design Concept 2 – 50 Percent Active/50 Percent Passive Restoration

The 50 Percent Active/50 Percent Passive approach to restoration of the Brown Bridge impoundment is a balanced approach that integrates much of the sediment management and native plant establishment benefits of Alternative 1 to minimize the establishment of invasive plant species. Under this alternative the excavated floodplain would be limited to 20 feet on either side of the established river channel.

Under this alternative re-vegetation efforts consisting of installed plantings would be concentrated within the 20-foot floodplain corridor paralleling the each side of the river channel. Following drawdown and the completion of site grading activities seeding would be conducted for all exposed areas using a native seed mix. This alternative would also include installation of LWD at regular intervals along the length of the river channel to provide rapid development of in-stream habitat creation and enhancement.

Active wetland development for this alternative includes the shallow excavation and planting of approximately 15 acres of wetlands in the lower impoundment. The excavated wetland would be selectively planted with wetland species and stabilized using a seed mix designed to promote native wetland development. In addition, special attention will be given to areas along the north shore of the lower impoundment which are expected to be characterized by steep slopes that may be more difficult to stabilize naturally.

This alternative also integrates greater flexibility relative to project implementation and allows for a phased approach whereby restoration components may be completed over a period of years based on the availability of project funding.

2.3.2.3 Design Concept 3 – 100 Percent Passive Restoration

The passive restoration of the Brown Bridge Pond involves only the removal of the dam without active restoration throughout the impoundment. Under this alternative, some limited sediment management (e.g., sediment traps) and perhaps vegetation management may be integrated at a relatively low cost. The resulting landscape will look very similar to the partially drawdown Boardman Pond. Sediment mobilized from the delta by head-cutting would be transported to areas within Brown Bridge bottomlands and to the river downstream. The high banks similar to those present at Boardman Pond will be exposed and may remain un-vegetated on their face, composed largely of sand. However, once the initial flush of sediment is moved out to form the channel, these banks will contribute sand overtime to the overall sediment load of the Boardman River.

View of partially drawdown at Boardman Pond

Vegetation will re-establish on level to gently sloping areas within the lower impoundment from the existing seed bank or from seed transported in by wind, water or wildlife. In the upper impoundment, the seed bank will remain buried under the delta deposits and re-vegetation will occur from seed dispersed by the river or wildlife. Riparian zones will become vegetated over time by recruitment and establishment of willow and alder from upstream seed sources. Until such time as this riparian zone is established, the channel banks will be relatively unstable and susceptible to erosion. No supplemental seeding would be conducted under this alternative.

View of exposed sandy banks within partially drawdown at Boardman Pond

No active wetland development will be performed for this alternative. Wetland development will be subject to areas having a low landscape position and sufficient source of hydrology (groundwater or surface water) to promote the development of a wetland community dominated by hydrophytic species.

2.4 ALTERNATIVES ELIMINATED FROM FURTHER CONSIDERATION

USFWS conducted an analysis of the above Design Concepts that involved project stakeholders to identify and recommend those alternatives that warrant further consideration as part of this EA. This analysis integrated an interdisciplinary process that considered all appropriate elements of alternative attributes including their effectiveness in meeting the project purpose and need, engineering factors, cost, factors related to the environment. Specific environmental factors considered in this analysis included hydrology, water quality, sedimentation potential, aquatic and terrestrial ecology, wetlands, sensitive species, cultural resources, hazardous waste, recreation, visual quality/aesthetics, natural area development, and other factors. As a result of this process, USFWS determined that two Design Concepts did not warrant further consideration. Alternatives eliminated from further consideration include the following:

Design Concept 1 – 100 Percent Active Restoration. This alternative was eliminated as it did not offer significant advantages in addressing the elements of the Purpose and Need (relative to Design Concept 2) and was not reasonable in consideration of the available funding. The benefits of this alternative relate to the additional construction effort that could be expended to install additional

project features, thereby shortening restoration timelines. However, it was determined that such a greater level of construction is not fiscally feasible.

Design Concept 3 – 100 Percent Passive Restoration. This alternative was eliminated based on its high potential impact. The absence of sediment management measures as part of this alternative would result in greater, potentially significant impact to downstream areas where sediment deposition would potentially result in in-stream habitat impacts and greater flooding of adjacent properties. Such impacts are considered to be inconsistent with the objectives of the project Purpose and Need and are therefore a basis for the elimination of this alternative.

2.5 ALTERNATIVES RETAINED FOR DETAILED CONSIDERATION

Further alternative development was conducted to clarify the action represented within a blended approach that represents a refinement of the 50 Percent Active/50 Percent Passive approach. As a result, the following two alternatives warrant detailed consideration in this EA:

- Alternative A – No Action. Keep the dam, powerhouse, pond, etc.
- Alternative B – Dam Removal with Blended Restoration (Design Concept 2). Remove the dam, powerhouse, and pond; initiate blended approach for restoration and actively manage sediment in the delta.

The major components of Alternative A – No Action and Alternative B – Dam Removal with Blended Restoration are provided in Table 2-1.

These alternatives are reasonable and representative of a range of responsible actions that integrate varying degrees of active restoration with a sufficient level of sediment management to minimize off-site (downstream) impacts. USFWS coordinated with the City of Traverse City, as owners of Brown Bridge Dam, to develop plans for this "action" alternative to assess their likely environmental impacts, as well as the short- and long-term costs associated with each alternative. Each of these alternatives is described in detail below.

In addition to the action alternative, the No Action Alternative was also reviewed. The No Action Alternative is included in any NEPA analysis, and it represents what would happen if a proposed action did not take place. It provides a basis for understanding the impacts (both positive and negative) of the action alternatives.

2.5.1 Alternative A – No Action

The No Action Alternative would involve taking no action to improve fish passage and habitat or reduce the City of Traverse City's cost and safety liabilities associated with ownership of Brown Bridge Dam. Existing facilities including the powerhouse and the turbines would remain in-place and would continue to impede fish passage. Additionally, the dam would continue to impound water and retain Brown Bridge Pond. While the pond would persist, it would also continue to perpetuate the ecosystem degradation currently evident as it would:

- Sustain the fragmented habitats within the Boardman River system.
- Act as a barrier inhibiting downstream transport processes (plant propagules, LWD, etc.).
- Continue to alter surface water and groundwater flow patterns.
- Continue to alter sedimentation patterns.
- Result in sustained thermal disruptions in the Boardman River, and
- Continue to result in a disrupted aquatic species distribution between the Boardman River upstream of Brown Bridge Pond, Brown Bridge Pond itself, and the Boardman River downstream.
- Continue to serve as a production zone for zebra mussels

The City of Traverse City would continue to maintain the facilities, and would eventually be obligated to address the safety issues (e.g., dam failure) associated with the existing facility. Use of the dam for hydropower is not an option under this alternative as the City of Traverse City has made a determination that hydropower at this facility is not economically feasible.

Table 2-1. Summary of Alternative Elements

	Alternative A – No Action	Alternative B – Dam Removal with Blended Restoration
Dam Removal and Demolition	Powerhouse and Dam remain	Powerhouse removal – 100 percent[2]. Embankment removal – approximately 15 percent.
Fish Passage	Barrier in-place, no fish passage	Fish passage
Aquatic Ecosystem Type	Brown Bridge Pond – 158- acres[1]	Free-flowing river – 11,900 linear feet
Excavation/Sediment Management	No sediment management/ excavation	Lower impoundment – no excavation. Upper impoundment – excavation of delta to expose a 55-foot wide main channel and 40-foot wide floodplain[3]. Total sediment excavation between 170,000 and 200,000 cubic yards[3].
In-channel Habitat	No enhancements to in-channel habitat	Bedforms such as pools, riffles, and runs are likely presented but muted due to deposition in the upper impoundment but should develop quickly during subsequent flood events.
Riparian Zone/ Wetlands/Uplands	No active riparian zone/wetland/upland enhancements	A corridor will be actively seeded 20 feet to either side of the top of bank. Seeding of entire site with native seed mix.
Steep Slope Re-vegetation	Not applicable	Soil amendments/seeding of about 5 acres of steep slopes within exposed bottomland.
Construction Staging	Not applicable	Construction operations would occur at dam/ powerhouse and at Brown Bridge delta.

[1]based on 2008 drawdown conditions
[2]Note: concrete basement slab to remain
[3]Subject to revision based on final design, may include substantial reduced excavation coupled with construction and management of sediment traps to maximize retention of sediment on site.

Additionally, under this alternative the sedimentation processes currently observed within the system would continue and would over time, result in further alteration and degradation of habitat through channel aggradation. Causing reductions in pool volumes further exacerbating thermal impacts. The concerns of the City of Traverse City regarding safety for river users as well as with people climbing on the dam or entering the powerhouse would continue.

The estimated cost of rehabilitation of the existing dam to mitigate the identified safety issues and prevent failure was previously estimated by ECT to be approximately $380,000 to $1,360,000 (ECT, 2008c).

2.5.2 Alternative B (Preferred) – Dam Removal with Blended Restoration

The "action" alternative that incorporates dam removal and blended restoration is presented in this section. Details for each of these components of the action alternative are provided in the following subsections.

2.5.2.1 Dam Removal and Dewatering

Removal of the dam will include two components: dewatering/drawdown of the headpond and partial demolition of the dam. Options considered for dewatering the headpond and partial demolition of the dam are summarized in the following subsections.

Dewatering Activities – Methodology

Dewatering/drawdown of the headpond can be conducted in either an uncontrolled or controlled manner. In 2009, Prein & Newhof evaluated four methods for drawdown, including the use of explosives, by-pass pumping, embankment breaching, and installation of a temporary drawdown structure. Explosives and embankment breaching were eliminated as alternatives due the lack of control of water flow during the dam breach and given that each would be irreversible. By-pass pumping and temporary drawdown structure were evaluated in greater detail.

By-pass pumping would include pumping water over or around the dam until the headpond and tailwater are equalized, at which point the dam would be breached to allow final flow to occur while the powerhouse is partially removed and the embankment components of the dam are re-graded. This alternative was deemed by Prein & Newhof to be more expensive than a temporary drawdown structure (total cost ranging from $1,143,300 to $1,486,290). It was estimated by Prein & Newhof that between 300 and 400 cubic feet per second (135,000 to 180,000 gallons per minute) must be pumped to maintain the existing flow and empty the impoundment. It is believed that this alternative would require constant maintenance and 24-hour per day, 7-day per week operation to ensure that limited to no flow set-backs occur. Further, this type of system may incur flow set-backs should large storm events occur.

A temporary drawdown structure was also evaluated by Prein & Newhof. This structure consisted of a sheeted, braced, excavation with stop log gates that would extend through the embankment on either side of the powerhouse. This alternative was estimated by Prein & Newhof to cost $735,640 to $956,332.

However, after a detailed review of the existing dam and powerhouse structure, it has been determined that a methodology that is both effective and cost efficient is to use the former openings in the existing powerhouse as the primary water control structure. The powerhouse contains former temporary openings in each of the two bays that extend from the upstream wall of the powerhouse to an interior wall located immediately upstream of the powerhouse draft tubes/discharges; these two temporary openings were presumably used for temporary water by-pass during construction of the powerhouse and have a sill at approximately elevation 769 feet. Prior to completion of construction of the powerhouse, these temporary openings were closed by installation of the reinforced concrete bulkheads at each wall, and by filling the area between the walls with sand. Headpond drawdown will be accomplished by installation of a sheeted, braced cofferdam with stop-log gates immediately upstream of one bay of the powerhouse (approximately 20 feet by 20 feet in plan). This sheeted, braced cofferdam would be much smaller in size and less costly than the dewatering structure proposed by Prein & Newhof. This sheeted structure would provide a means to dewater the area immediately upstream of one of the bays of the powerhouse and allow the concrete bulkheads and sand fill within that bay to be removed safely in the dry. Once the bulkheads and sand are removed, an opening would be available to pass the water through

the powerhouse. The stop-log gates in the sheeted structure would be used to lower the headpond in a controlled manner down to the bulkhead sill at approximately elevation 769 feet. Dewatering of the headpond below elevation 769 feet would be by controlled and sequential demolition of the powerhouse below that temporary opening sill level.

Dewatering Activities – Timing

Dewatering activities would be initiated following permitting by the MDEQ and other local agencies as presented in Table 1-1 and would be expected to be undertaken concurrently with dam removal in the late summer/fall 2012. Sequencing of dewatering activities will be a process that integrates the timing and needs of the dam and powerhouse removal as well as the river restoration and sediment management activities within the delta. The controlled drawdown of the pond would limit water level reduction to less than 0.5 feet per day. This slow drawdown process will serve to reduce sediment transport but will also promote the movement of fish to concentrated areas within Brown Bridge Pond and thereby improve the efficiency of fish salvage activities conducted by the MDNR. Drawdown of the pond in late summer will also avoid unnecessary mortality of juvenile fishes, and herptetofauna that may have been produced during the spring/early summer reproductive season.

Dam Removal – Work Area Isolation and Dam Removal

The "action" alternative under consideration would involve partial removal of Brown Bridge Dam and the related structures, grading of the dam area, and restoration of the river to near natural flow conditions (Figures 2-3, 2-4, and 2-5). The removal of Brown Bridge Dam would address the issues related to dam safety and its associated liability, fish passage and habitat degradation, as stated in the Purpose and Need, by removing the impediment to fish passage, expanding available habitat for native fish, and removing the facilities that pose cost and safety hazard concerns for the City of Traverse City. The proposed sequence and method of dam removal and site restoration are described below.

The following actions would be undertaken as part of dam removal, but may be subject to some modification based on final design and contractor approach:

- Removal and sale of existing powerhouse facilities (scrap or reuse value).
- Upgrade of existing access road to right embankment dam to allow access to powerhouse from both the right and left sides of the powerhouse.
- Installation of temporary sheeted, braced cofferdam and stop-log structure upstream of one powerhouse bay as discussed above.
- Dewatering of the area between the sheeted cofferdam and powerhouse.
- Demolition of the former temporary opening bulkheads and removal of the sand from the former temporary opening in the dry.
- Drawdown/dewatering of the headpond to elevation 769 feet (former temporary opening sill) through the cofferdam stop-log structure.
- Demolition and removal of powerhouse and associated structures (such as the forebay retaining wall and log sluice on the left side of the powerhouse) in the dry to elevation 769 feet.
- Excavation and grading of top of earthen dam sequentially with the powerhouse demolition downward to elevation 769 feet.
- Removal of temporary sheeted cofferdam upstream of powerhouse.
- Demolition and removal of powerhouse and associated structures in the wet below elevation 769 feet, including forebay retaining walls and apron and tailrace apron, to the bottom of the powerhouse and new channel elevation.

- Final re-grading of the embankment on each side of the now-removed powerhouse to include covering the existing wave protection wall.

The removal of the dam would occur in two general phases subsequent to dewatering activities in one work season. Phasing of work at the dam would be integrated with the needs for water level management as part of river restoration and sediment management. Access to the dam by construction equipment will be provided via an existing access road via Brown Bridge Road (see Figure 2-6). Temporary work mats will be used as needed to cross smaller low-lying areas at the base of the dam embankment. Additionally, minor grading will be required along the northern boundary of the existing pond to facilitate access to the delta by construction vehicles.

The initial phase would involve installation of the sheeted cofferdam and stop-log structure, dewatering of the headpond to elevation 769 feet, and demolition of the powerhouse and adjacent portion of the embankments to elevation 769 feet (top of the former temporary sill openings). The subsequent phase would consist of demolition of the powerhouse below elevation 769 feet in the wet, and re-grading of the embankments on each side of the powerhouse to the final channel configuration.

The powerhouse consists of a steel framed and brick superstructure above the operating floor (crest of the dam), and the substructure consists of concrete piers, walls, and slabs that have a maximum thickness of 2 to 3 feet. Because of the relatively small thickness of the concrete, standard hydraulic track hoes mounted with hydraulic rams and shears will be able to break and remove the concrete. The concrete and reinforcing steel will be removed down to the existing foundation subgrade. The concrete, steel and brick construction debris will be disposed of off-site in accordance with local and state regulations.

Dam Removal – Localized Cofferdams and Silt Curtain

During the initial phase, a temporary sheeted cofferdam with stop-log gate would be installed upstream of the powerhouse to allow removal of former temporary opening in the powerhouse (in the dry) and for drawdown of the headpond.

During the subsequent phase, additional localized cofferdams may be constructed downstream or upstream of, and parallel to, the dam to serve as a work platform and isolate areas from river flows to allow for final dam removal and re-grading activities. Fish would also be salvaged from this cofferdam according to the Fish Rescue Plan being formulated by MDNR and in consultation with GTB. In addition, a floating silt curtain would be suspended downstream of the dam to control sediment that may be washed downstream of the work area. Silt curtains are impermeable barriers constructed of a flexible reinforced material with a float on the top and a weight on the bottom to hold the curtain in-place. These curtains would be placed in different locations for each phase of demolition to create isolated areas with no water flow and minimize the risk of contamination from construction-related materials. During the subsequent phase, cofferdams would be constructed from either large angular rock or bulk bags containing sand and gravel, or constructed using port-a-dam or aqua barrier dam systems.

Localized cofferdams may be constructed in the subsequent phase of work to isolate the channel in two halves to allow final demolition and grading to occur on one side (e.g., the left side) in a dry condition while the flow is passed on the other side (right side) of the channel. Flow would be diverted to the left side to allow final demolition and grading to occur on the right side. Fish would be collected (i.e., rescued) from the isolated area immediately after the cofferdam is in-place and moved to areas where they would not be stranded and potentially harmed from the diversion of river flows to the north side of the channel.

2.5.2.2 Restoration and Sediment Management Measures

This restoration alternative consists of the integration of active sediment management practices within the Brown Bridge delta coupled with partially active ecosystem restoration measures elsewhere.

Restoration of the Brown Bridge impoundment under this alternative involves the active construction of the physical attributes of the pre-dam river corridor (Figures 2-6 and 2-7). It is expected that the restoration activities will be conducted over a 60-90 day timeframe during the late summer/fall of 2012. Earth moving equipment will be used to remove accumulated sediment in the upper impoundment within a 55-foot wide reconstructed river channel. Equipment operating in water will be required to utilize vegetable oil (e.g., rapeseed or canola) as a lubricant as a means to reduce potential impacts to water quality. Floodplains would be excavated in appropriate areas along the 55-foot wide channel to a distance of approximately 20 feet. According to the hydraulic model for the Boardman River, additional natural widening of the floodplain may be expected under this alternative to a total width of approximately 40 feet on either side of the river channel.

Based on the characteristics of the material at the proposed channel excavation site within the delta, hydraulic dredging may be used to remove some material. If used, it is expected that a standard floating dredge will be mounted on a floating barge. The immediate work area will be isolated from the flow of the Boardman River and silt curtains will be used in the immediate dredge work area to control turbidity. Dredged materials will be transported via pipeline to a contained disposal facility constructed within the upland areas of the delta or on other exposed lands above the 100-year floodplain. Because the dredged material will consist predominantly of sands (see Section 3.2.3), these materials are expected to drain readily. Decanted water will be returned from the disposal site using BMP's such as use of sandbags, turbidity curtains and other means to ensure good water quality. Following the completion of the dredging process, material will be graded in-place, and seeded with a native plant species mix to promote rapid vegetative recovery.

Other techniques will be incorporated into the restoration approach to minimize downstream sediment transport. In particular, it is expected that sediment traps of varying size and location will be incorporated into the final design to manage and retain sediments within the basin to the maximum extent practicable (see Figure 2-6). For example, a sediment trap will be installed and maintained in the upper part of the delta to trap sediments mobilized by the drawdown from upstream areas. Additionally, other sediment traps may be constructed within the basin below the delta to manage and retain sediment during drawdown and channel restoration. Size and configuration of these sediment basins may vary considerably to allow for maximum flexibility (i.e., reducing active earthwork in favor of passive sediment transport processes) in the selection of the final river restoration implementation plan.

This alternative also incorporates a number of elements that will promote natural community establishment including:

- Active seeding and management of the associated vegetation community in both the upper and lower impoundment using species selected from the list in Table 2-2. Following drawdown, and subject to project funding, seeding would be conducted for all exposed areas within the lower impoundment using a native seed mix.
- Active seeding of exposed areas around the former dam site with native vegetation that is ecologically appropriate for the riparian area.
- Amendments of soils in steeply sloping areas within the lower impoundment to promote slope stability and vegetative establishment. Special attention will be given to areas along the north shore of the lower impoundment which are expected to be characterized by steep slopes that may be more difficult to stabilize naturally. These amendments will include mulching of

selected areas and hydro-seeding of approximately 5 acres of steeply sloped areas using a slurry mix.

Soils comprising the former embankment would be distributed on the south and north side of the riverbank in the lower impoundment to provide a substrate for plant establishment in sloping areas observed to be especially sandy or gravelly. Any haul routes would be scarified and de-compacted to encourage soil fertility and plant growth. However, selected haul routes may be retained in a compacted condition to support future development of a recreational trail within the bottomland.

Table 2-2. List of Plant Species Proposed for Installation as Part of Brown Bridge Pond Ecosystem Restoration

Floodplain Mix		Upland/Slope Stabilization Mix	
Botanical Name	**Common Name**	**Botanical Name**	**Common Name**
Andropogon gerardii	Big bluestem	*Andropogon gerardii*	Big bluestem
Carex hystericina	Porcupine sedge	*Coreopsis lanceolata*	Coreopsis
Carex stricta	Tussock sedge	*Elymus canadensis*	Canada wild rye
Carex vulpinoidea	Fox sedge	*Panicum virgatum*	Switch grass
Elymus Canadensis	Canada wild rye	*Rudbeckia hirta*	Black eyed Susan
Elymus virginicus	Virginia wild rye	*Schizachyrium scoparium*	Little bluestem
Hierochloe hirta	Sweet grass	*Sorghastrum nutans*	Indian grass
Juncus effuses	Common rush	*Sporobolus cryptandrus*	Sand dropseed
Leersia oryzoides	Rice cut grass		
Panicum virgatum	Switch grass		
Schoenoplectus acutus	Hardstem bulrush		
Scirpus atrovirens	Dark green rush		
Scirpus cyperinus	Wool grass		
Scirpus validus	Great bulrush		
Spartina pectinata	Cord grass		

Note: Each mix should include an annual nurse crop such as annual rye (*Lolium multiflorum*), oats (*Avena sativa*), or similar.

Several potential environmental enhancements may also be implemented in the future, subject to the availability of funds. Such potential future enhancements may include:

- Aggregates of LWD could be installed at regular intervals along the length of the river channel to provide rapid development/enhancement of in-stream habitat.
- Active wetland development by shallow excavation and planting within lower impoundment to promote shallow/deep marsh community development.
- Streambank stabilization using live stakes to promote riparian zone establishment.
- Riparian/wetland zone plantings using potted plants to promote wetland community development.

This alternative also integrates a high degree of flexibility relative to project implementation and allows for a phased approach whereby restoration components may be completed over a period of years based on the availability of project funding.

2.5.2.3 Tribal Traditional Ecological Knowledge (TEK)

The ancestors of many Indian Tribes indigenous to the region have shared a longstanding and vital role in the management and uses of natural resources in the Boardman River valley. As its original name (Ottaway) suggests, Tribal communities have co-existed with the delicate ecology of this river since time immemorial, and to this day continue to share a deep spiritual and cultural connection and commitment to restore the Boardman to as close as practical to its native condition as the ancestors of GTB members, among other Tribes in the region saw it more than two centuries ago. Further, given the efforts of GTB through professional assistance, the contemporary and traditional understanding of river restoration and management, coupled with TEK elements will continue to serve as an essential resource through consultation, acquisition, educational promotion

and application of TEK. In part, TEK refers to the knowledge, innovations and practices of the GTB developed from experience gained over the centuries and transmitted orally from generation to generation. For example, the process of collecting and assembling TEK may identify unique locations, plant species, or fish and wildlife species of traditional and/or cultural significance to various aspects of the project. As such, TEK will be considered as key inputs for future ecological restoration, planting plans, wildlife management, fisheries management, recreation, interpretive features, construction/implementation, and similar project elements. The base of TEK will not only benefit the project but will also help preserve the natural resources, cultural resources, and significant cultural values of the GTB, among other tribal communities. Both contemporary scientific and TEK have been incorporated into the development of this EA and the collection, understanding and utilization of TEK will continue throughout the planning, design, and implementation phases of the project.

Representative plant species selected for establishment within the restored bottomland by seed are included in Table 2-2 and consist of exclusively native species. The restoration concept as part of this alternative integrates the TEK into the selection of plant species for bottomland restoration. Certain plant species may be considered important to the GTB, past or present, as a food item, medicinal item, ceremonial item, fiber or dye. Some of these species have been identified by interviews with representatives of the GTB which have established uses by Native Americans (Andrews Cultural Resources, 2011a).

2.5.2.4 Cost Estimate

The estimated construction cost, including engineering and contingency, of dam removal and restoration for this alternative is approximately $3.9 million (subject to refinement through detailed design and refinement of methods).

2.5.3 Comparison of Alternatives and Project Objectives

The ability of these alternatives to meet the project objectives (the objectives identified in the Purpose and Need) are compared in Table 2-3. Alternative B meets each of the objectives identified for this project, while Alternative A (No Action alternative) does not address the objectives.

The anticipated environmental impacts for each project alternative under consideration are summarized in Table 2-4. The Environmental Consequences chapter provides a more detailed explanation of these impacts.

2.6 ENVIRONMENTALLY PREFERRED ALTERNATIVE

The environmentally preferred alternative is determined by applying the six criteria suggested in the NEPA (1969), which guides the Council on Environmental Quality (CEQ). The CEQ provides direction that the environmentally preferable alternative is the alternative that would promote the national environmental policy as expressed in NEPA §101.

- Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.
- Assure for all generations safe, healthful, productive, and aesthetically and culturally pleasing surroundings.
- Attain the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences.
- Preserve important historic, cultural and natural aspects of our national heritage and maintain, wherever possible, an environment that supports diversity and variety of individual choice.

- Achieve a balance between population and resource use that will permit high standards of living and a wide sharing of life's amenities.
- Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

Table 2-3. Summary of Alternative Consistency with Project Objectives

Project Objectives	Alternative	
	Alternative A No Action	**Alternative B Dam Removal with Blended Restoration**
Address Dam Stability/Safety Issue	Dam to remain in-place, safety issue unresolved.	Dam removed, safety issue resolved.
Habitat Fragmentation	Fragmentation imposed by dam and barrier to aquatic species movement unchanged.	Barrier to aquatic species movement and aquatic habitat fragmentation removed.
Habitat Degradation	On-going interruption of downstream transport processes, sediment transport processes, alteration of surface water and groundwater flow patterns, and interruption and alteration of sedimentation processes.	Downstream transport of propagules, woody debris and other materials enabled.
Thermal Disruptions	Thermal loading of downstream areas by solar heating from Brown Bridge Pond continues and results in elevated temperatures downstream and unnatural diel variations.	Thermal regime restored to normalized riverine conditions. Thermal loading subject to natural diel variation and lower temperature maxima due to removal of Brown Bridge Dam. Reduced delay in achieving this condition due to benefits of installed vegetation to promote restoration and recovery of riparian zone tree canopy.
Induced Species Disruptions	Composition and abundance of coldwater fish communities remain distinct between Boardman River upstream, Brown Bridge Pond, and Boardman River downstream.	Composition and abundance of coldwater fishes above and below Brown Bridge Dam to become more consistent and uniform due to restoration of thermal regime and removal of fish movement barrier.
Opportunity for Expansion of Michigan Natural Rivers System	No additional opportunity to expand Michigan Natural Rivers system.	Opportunity to expand Michigan Natural Rivers System to include 11,900 feet of restored river within Brown Bridge Pond.

Table 2-4. Environmental Impact Summary by Alternative

Impact Topic	Alternative A – No Action	Alternative B – Dam Removal with Blended Restoration
Water Resources		
Hydrology and Floodplains	Sustained disparity in hydrology of natural riverine hydrology due to impounded system.	No significant alteration in hydrology or increase in peak flood levels.
Water Quality	Continued disruption of thermal regime.	Restoration of natural riverine thermal regime associated with coldwater stream.
Sediments	Continued accretion of sediments within delta, resulting in long-term loss of aquatic habitat.	Naturalized sediment transport processes; potential adverse impacts of sediment remobilization and transport mitigated through extensive sediment management measures (excavation, sediment traps, etc.).
Groundwater Resources	No impact to groundwater patterns or uses.	No adverse impacts on groundwater uses.
Ecology		
Aquatic Ecology	Sustained induced species disruptions due to modified thermal regime; continued fragmentation of habitat and disruption of natural transport of biotic and abiotic materials; Long-term in-filling of open water zone by sediment accretion resulting in loss of aquatic habitat.	Restoration of coldwater thermal regime and naturalization of river aquatic biotic communities; loss of cool water fish community and associated habitats of Brown Bridge Pond.
Terrestrial Ecology	Sustained terrestrial plant and animal communities for short- to moderate-term. Long-term in-filling of open water resulting in additional terrestrial habitat formation.	Restoration of bottomland habitats through long-term successional development; resident water-dependent species will be displaced; however, no significant adverse impact on terrestrial fauna/wildlife.
Sensitive Species	Sustained support for common loon and trumpeter swan in near-term. Long-term loss of habitat due to sediment accretion and habitat alteration; continued fragmentation of habitat for wood turtle and similar species.	Displacement of water dependent wildlife species to other habitats in the region as a result of habitat conversion; potential restoration of habitats suitable to wood turtle, Blandling's turtle, and other species. Potential disturbance to bald eagle due to alteration/loss of foraging area. Benefits to eastern massasauga rattlesnake – a candidate species under ESA.
Wetlands	Sustained hydroperiod of adjacent and down-gradient wetlands, long-term accretion of sediments resulting in wetland modification over time.	Net gain of approximately 21.6 acres of wetlands due to hydrologic alteration and bottomland restoration.
Noxious/Invasive Species	On-going management needs for invasive species.	Intermediate term needs for management of invasive species due to exposed soils (by "others"). Decontamination practices used during construction to limit invasive species introduction.
Land Use	No impact	No impact

Table 2-4. Environmental Impact Summary by Alternative

Impact Topic	Alternative A – No Action	Alternative B – Dam Removal with Blended Restoration
Socioeconomics		
Demographics	No impact	No impact
Community Facilities/Services	No impact	No significant impact
Recreation	No impact	Potential increase in tourism and recreational expenditures
Economics	No impact	Positive economic benefit due to increase uses associated with fishing and paddling.
Property Ownership	No impact	No impact
Environmental Justice	No impact	No impact
Cultural and Historic Resources	No impact	No impacts to historic structures or other cultural resources.
Visual Quality and Aesthetics	No impact	Alteration of visual landscape due to removal of powerhouse and pond, progressive replacement of unsightly exposed bottomland with vegetated and restored ecosystem.
Transportation	No impact	No significant impact
Air Quality	No impact	No significant impact
Noise	No impact	No significant impact
Human Health and Safety	Does not resolve potential liability associated with existing structure.	Removes existing structure and eliminates liability. Construction related safety issues to be mitigated using good health and safety practices/management.

Alternative A, No Action, only minimally meets the above six evaluation factors because it retains the existing facilities that do not address the components of the project Purpose and Need by not resolving the existing dam safety issue and by not providing a solution to the environmental degradation issues currently evident as a result of Brown Bridge Dam. Additionally, the No Action Alternative does not respond to the opportunity to establish a restored river system that could be added to Michigan's Natural River system.

Alternative B, Dam Removal with Blended Restoration, is the environmentally preferred alternative because this alternative best address these six criteria/evaluation factors. This alternative meets the objectives of the project Purpose and Need, and integrates significant mitigative commitments (e.g., sediment management measures, ecosystem restoration and enhancement, etc.) that will ensure that impacts of this action are not significant.

No new information was identified from public scoping or consultation with other agencies to necessitate the development of any new alternatives, other than those described and evaluated in this document. Because it meets the Purpose and Need for the project, the project objectives, and is the environmentally preferred alternative, Dam Removal with Blended Restoration is also recommended as the USFWS Preferred Alternative. For the remainder of the document, this alternative will be referred to as the Preferred Alternative.

3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

3.1 GEOLOGY AND SOILS

3.1.1 Affected Environment

The Boardman River Watershed encompasses a variety of physiographic systems and landforms due to three glacial ice advances and retreats during the Wisconsinan glaciation of the Pleistocene Epoch, approximately 16,000 to 10,000 years ago. Current soils and landforms of the watershed, and the terrestrial habitats that they support, developed in response to this mosaic of glacial deposits, which may reach depths greater than 500 feet. The river valley is composed of flat, sandy outwash plains, ranging from 6 to 14 miles wide and pitted by small, shallow depressions. To the north and south, the river basin is bound by the east-west running ridges of the Port Huron Moraine. Lakeplains occur in the northwest portion of the watershed in the Traverse City area adjacent to Grand Traverse Bay (ECT, 2007a).

The dry, sandy, and acidic soils derived from glacial outwash deposits are classified mostly as those of the Rubicon-Grayling and Rubicon-Kalkaska series. These soils are very permeable and have low nutrient availability. Much of the river's flow volume is derived from groundwater discharge through these permeable glacial outwash soils. At its headwaters upstream of Kalkaska, broad areas of peat and muck soils have also developed. The morainal deposits have developed into sandy loam soils with sand and reddish clay substrata, primarily classified as those of the Emmet and Roselawn series. Depending upon the percentage of sand, these soils are generally dry and acidic with low to medium nutrient availability. These soils play a major role in shaping the native plant communities of the Boardman River Watershed (ECT, 2007a)

Soils surrounding the dam and pond at Brown Bridge are located on both level and sloping terrain. Soils in the vicinity of the dam and surrounding much of the pond to the south and east are generally level and do not exhibit signs of erosion. However, portions of the north bank of Brown Bridge Pond have a history of bank failure and slumping.

3.1.2 Environmental Consequences

Alternative A – No Action

If no action is taken and the dam remains in-place, sandy sediment will continue to build up within Brown Bridge Pond. There is currently a sediment delta that primarily exists along the eastern end of Brown Bridge Pond (see Figure 2-1) where the river velocity slows as it enters the impoundment, causing sandy sediment to drop out of the water column, contributing to delta formation (see Figure 1-4). This sedimentation is a soil-forming process and will continue to expand the delta, eventually filling the impounded area.

Alternative B – Dam Removal with Blended Restoration

Removal of Brown Bridge Dam will result in soil disturbance from three actions: dam removal, sediment management within the delta, and soil amendments on steep slopes within the lower impoundment.

In the vicinity of the dam, the existing soil embankment will be partially removed and will be graded to facilitate the restored river channel. Grading as shown on Figure 2-4 will result in 3:1 slopes that will be stabilized by seeding and the use of erosion control measures.

Within the vicinity of the delta, the drawdown of the impoundment will proceed slowly, (approximately 0.5 feet per day) such that minimal sediment will be released downstream. This in part is because the primary sediment load is located at the delta along the eastern edge of Brown Bridge Pond and is not readily available to be re-suspended and subsequently discharged to the river downstream from the dam. The sediment consists primarily of sand and does not remain suspended in the water column once flow velocities are reduced.

Under this alternative, a stream channel and adjacent "floodplain" will be actively restored for the full length of stream channel (approximately 12,000 linear feet). The "floodplains" on each side of the channel will initially be constructed as 20 feet wide, but will adjust over time based on river flow.

As a result of these activities, soils (sediments) within the delta in the upper impoundment will be excavated and placed in appropriate areas above the 100-year floodplain of the Boardman River. This will result in the development of upland areas having soils that are slightly elevated (approximately 5 feet) relative to the surrounding terrain. Slopes of these upland areas; however, are designed to be gentle and not subject to erosion. These soils will be stabilized by seeding and the application of other erosion control measures, as appropriate.

The Boardman River valley side slopes adjacent to the river in the area of the former impoundment may initially be unstable as dewatering occurs. In particular, the bathymetry data from Brown Bridge Pond suggests that the north slope of the exposed area may be particularly steep and vulnerable to erosion and slumping. In recognition of this potential concern, a commitment has been made to treat these steeper slopes with more aggressive erosion control and vegetative establishment measures. For example, these areas will be stabilized with mulch consisting of compost material mixed with native seed mix to promote and establish permanent vegetative cover that will minimize this effect.

3.2 WATER RESOURCES

3.2.1 Hydrology and Floodplains

Analysis of hydrology and floodplains in conjunction with Brown Bridge Dam removal are summarized here based upon the Evaluation of Impacts of Brown Bridge Dam Removal on Downstream Floodplain and Bridge Scour Potential Technical Memorandum (Appendix C).

Executive Order 11988 requires Federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by flood plains in carrying out its responsibilities" for the following actions:

- acquiring, managing, and disposing of federal lands and facilities;
- providing federally-undertaken, financed, or assisted construction and improvements;
- conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing activities.

3.2.1.1 Affected Environment

100-Year Floodplain

The Boardman River floodplain has been mapped for the National Flood Insurance Program (NFIP). Within the boundaries of Traverse City, has been mapped with detailed analyses, including the publication of Base Flood (i.e., the one percent annual risk flood, or 100-year flood) Elevations (BFE's) and flood profiles. Updated preliminary mapping was presented in June 2011, but has not yet been approved and become effective. Upstream of the Traverse City boundary and in the vicinity of Brown Bridge Dam, no official NFIP mapping has been published that identifies the 100-year floodplain. However, preliminary Zone A floodplain mapping has been made available by FEMA for review by the local community (Figure 3-1). Published detailed elevation information such as profile, BFEs, and regulatory floodway are lacking in the Brown Bridge area. At Brown Bridge, the preliminary Flood Insurance Rate Maps (FIRMs) reflects the expanded, impounded water within the Brown Bridge reservoir. However, along the Boardman River channel the preliminary FIRMs identify a 100-year Zone A floodplain having a variable width, ranging from 150 to 300 feet wide between the confluence with East Creek and the confluence with Carpenter Creek.

Existing Water Level Control on the Boardman River

The Brown Bridge Dam, powerhouse, and discharge control equipment, collectively referred to as the Brown Bridge structure, were constructed in 1921. As a result of dam safety concerns and regulatory compliance, the water level of Brown Bridge Pond was "temporarily" lowered from the historic normal water level of 797.5 feet to 794.5 feet by authorization granted by the MDEQ via a Joint Permit Application dated October 13, 2008. With regard to the Brown Bridge structure, the existing condition is the condition existing subsequent to the implementation of the temporary drawdown permit. More specifically, the existing condition includes use of the operable discharge facilities (the Tainter gates and log chute) to discharge flows as required to maintain a water level of 794.5 feet.

To determine existing condition high water levels downstream of Brown Bridge, the specifics regarding the Boardman structure and the Sabin structure must also be defined, since the operation of these structures has also been changed from the historic conditions.

The water level in the Boardman Dam structure pool, known as Boardman Pond (or Keystone Pond), was lowered from a historic regulated water level of 653.8 to 637.5 feet following a January 2007 consent agreement between MDEQ and Grand Traverse County. This lowering was also associated with dam safety concerns. However, at Boardman Dam further changes occurred, including the removal of the turbines, runners, and generators.

The existing condition for the Sabin structure is defined by a controlled water level of 614.0 feet, the same as the historic regulated pool level during power generation. The Sabin pool level was lowered during 2011 by the authority of an MDEQ Joint Application Permit for initial lowering of the pond associated with eventual dam removal. However, the lowering of the regulated pool had no associated irreversible changes; while the turbine and runner have been removed the spillway facilities have not been irreversibly changed and the Sabin regulated pool level could be restored to its historic regulated level.

The fourth dam on the Boardman River, the Union Street Dam has no power generating equipment and neither the structure nor the operation has been changed from the historic condition.

3.2.1.2 Environmental Consequences

Alternative A– No Action

Under the No Action Alternative, hydrologic conditions currently evident on the Boardman River in the vicinity of Brown Bridge Pond will remain unaltered. As such the natural flowing regime of the river will be interrupted by a still water (lentic) system. Accordingly the slower flowing water evident in Brown Bridge Pond will continue to promote sedimentation within the river upstream and within the impoundment. Eventually the impounded area will gradually become shallower due to sedimentation. Similarly, the extent of the 100-year floodplain will remain unchanged from the existing condition.

Alternative B– Dam Removal with Blended Restoration

Flood Discharge Frequency

Previous recent estimates of flood discharge frequency data for the Boardman River have been based on United States Geological Survey (USGS) regional regression equations (Holtschlag and Croskey, 1984). Estimates have been provided by the MDNR through the floodplain database program. The regression equations are relatively complex in terms of watershed physiography, and include parameters describing five different watershed characteristics. One of those characteristics is soil types and may involve between one and seven parameters, depending on the diversity of soil types existing in the watershed (i.e., parameters include percentage of the watershed for each of seven different soil type categories) based on geologic mapping (Farrand and Bell, 1984). One of the parameters is the percent of the watershed main channel length passing through marshes or lakes. Presumably the large majority of such water features on streams used for development of the regression equations were natural marshes and lakes. While the specific storage volume and discharge characteristics of the Brown Bridge, Boardman, and Sabin structures are not represented in the regression equations, a rational representation of the effect of these man-made water bodies on peak flood discharges can be provided by the regression equations. The accuracy of the method will depend on how closely the influence of these man-made structures on peak discharges resembles the influence of typical marshes and lakes. However, the regression equations can not be expected to accurately predict the control on peak discharges exerted by these structures as a traditional routing analysis that incorporates the structure-specific elevation-storage and elevation-discharge relationships. This is particularly true because of the operable discharge equipment (e.g., Tainter gates) used at each of the structures.

For this impact analysis, a rainfall runoff and routing model (HEC-HMS) was developed to use the site-specific elevation, storage, and discharge data for each structure and more precisely determine impacts on peak discharges. However, it is recognized that regulatory (MDEQ) and FEMA National Flood Insurance Program (NFIP) flood discharge frequency estimates may continue to be based on the regression equations. As a matter of consistency and efficiency, FEMA generally prefers the use of USGS regression equations. Consequently, even though a rainfall runoff model can be calibrated to approximately reproduce regression equation discharge frequency estimates while simultaneously allowing the more accurate prediction of the affect of the structures on peak flows, MDEQ and/or FEMA may in the future choose to rely on continued use of regression equations to estimate flood discharge frequency data for regulatory purposes. This analysis therefore used both a modeling approach (HEC-HMS) and the regression equations to evaluate potential hydrology impacts.

The status of NFIP information is relevant to the assessment of impacts to floodplains. There is currently detailed study floodplain mapping information for the Boardman River only within the City of Traverse City, with limited Zone A (100-yr floodplain) mapping of the Boardman River

beyond the Traverse City boundaries. FEMA is in the process of updating the NFIP information. The information generated by the USACE for the dam removal feasibility study completed in 2008 was used to provide Zone A mapping for the Boardman River from the Traverse City boundary upstream beyond Brown Bridge Dam. However, detailed information, including flood discharge frequency information and flood elevations, is still provided only for the reach of the Boardman River within Traverse City. Regulatory requirements for "development" projects affecting Zone A streams is normally limited to complying with the local community's floodplain development ordinance since no Base Flood Elevations (i.e., 100-year flood elevations) have been established for the stream beyond the Traverse City boundaries.

The USGS regional regression equation predict 100-year flood peak flow rates of 1,000 cubic feet per second (cfs) at the Brown Bridge Dam location and 1,700 cfs at the Boardman Dam location for the existing condition. With the removal of Brown Bridge Dam, and the resulting loss of the 1.3 mile long storage area that provides flood runoff peak discharge attenuation, the regression equations predict 100-year flood peak flow rates of 1,017 cfs and 1,726 cfs.

The HEC-HMS model results indicate a decrease (i.e., a "negative" increase) in peak discharges due to dam removal (Table 3-1). It was noted that the changes in peak discharge, which are small relative to the magnitude of the flows, are sensitive to assumptions regarding the operation of the gated discharge structures and the discharge capacity rating relationship for the Brown Bridge structure. The discharge rating relationship reflects the discharge rate for a set of gate openings and a given reservoir water level. Additionally, the structure operation reflects the assumed gate openings for a given reservoir level. In the real world, the gate operation reflects not only the current reservoir water level, but also the uncertain anticipated reservoir inflow rate. HEC-HMS does not have the capability to factor reservoir inflow information into the calculations, but does assume the ability to instantaneously, or continuously, adjust gate openings in accordance with the assumed operation plan. The existing condition model reflects essentially no increase in Brown Bridge Pond level while passing high flow events. The pond elevation increased by approximately 0.01 foot for the 100-year flood event (i.e., the temporary detention storage was approximately 2 acre-feet).

This result is possible, although unlikely, if the discharge capacity exists, but it would require very intensive monitoring of water levels and very accurate gate operation during high runoff to maintain a precise target pool elevation. In reality, due to imperfect knowledge of inflow rates and gate discharge capacity and the impracticality of continuously adjusting gate openings, the Brown Bridge pool level would likely increase slightly or, potentially, decrease below target elevation if gate openings were larger than required; either of these would result in a slightly different prediction of impacts of Brown Bridge Dam removal. The model-predicted decrease in peak discharge results from no temporary detention storage for the existing condition, but with floodplain storage within the Brown Bridge reach, as calculated by the HEC-RAS model, for the condition with Brown Bridge Dam removed.

The HEC-HMS model peak flows are somewhat higher than the discharge frequency data from the USGS regional regression equations. The HEC-HMS runoff volumes for the events are similar to the statistical flood discharge volume estimates from the two USGS streamflow stations in the watershed. The higher, shorter duration peak flows predicted by HEC-HMS would tend to over-predict the impact of the structures impact on peak discharges compared with a less-peak flood runoff hydrograph inflowing to Brown Bridge pond.

Table 3-1. HEC-HMS Model Results, Peak Discharge, Existing and Proposed Conditions, 10- and 100-Year Events

Location	HEC-HMS Element	Drainage Area (sq mi)	Peak Discharge (cfs) Existing (cfs)	Peak Discharge (cfs) Proposed (cfs)	Increase (cfs)	Increase (%)
100-Year						
Brown Bridge Road/ USGS Station	J-M23.7	97	1044.6	1044.6	0	0.00
Brown Bridge Dam	J-M20.0	151	1718.4	1718.4	0	0.00
Brown Bridge Dam	BB Pond	151	1718.4	1690.5	-27.9	-1.62
Swainston Cr	J-M18.8	205	2473	2387.3	-85.7	-3.47
Jaxon Creek	J-M11.9	228.33	2845.4	2729.4	-116	-4.08
Boardman Dam	J-M06.3	240.9	3012.3	2880.7	-131.6	-4.37
Boardman Dam	Keystone Pond	240.9	2798.3	2718.5	-79.8	-2.85
Sabin Dam	J-M05.6	242.18	2834.5	2754.3	-80.2	-2.83
Sabin Dam	Sabin Pond	242.18	2817.3	2740.4	-76.9	-2.73
Union St Dam	J-M01.1	248.74	2838.3	2756.4	-81.9	-2.89
Union St Dam	Boardman Lake	248.74	2356.1	2325.8	-30.3	-1.29
10-Year						
Brown Bridge Road/ USGS Station	J-M23.7	97	585	585	0	0.00
Brown Bridge Dam	J-M20.0	151	955.3	955.3	0	0.00
Brown Bridge Dam	BB Pond	151	955.3	946.6	-8.7	-0.91
Swainston Cr	J-M18.8	205	1354.4	1327.2	-27.2	-2.01
Jaxon Creek	J-M11.9	228.33	1509.4	1476.3	-33.1	-2.19
Boardman Dam	J-M06.3	240.9	1581.7	1544.8	-36.9	-2.33
Boardman Dam	Keystone Pond	240.9	1549.7	1522.3	-27.4	-1.77
Sabin Dam	J-M05.6	242.18	1584.5	1557	-27.5	-1.74
Sabin Dam	Sabin Pond	242.18	1574	1547.7	-26.3	-1.67
Union St Dam	J-M01.1	248.74	1583.2	1555.4	-27.8	-1.76
Union St Dam	Boardman Lake	248.74	1230.1	1222.5	-7.6	-0.62

Flood Elevations/HEC-RAS Model Analysis

The HEC-RAS hydraulic model developed by the USACE for the USACE's dam removal feasibility study was obtained and reviewed. Some modifications were made where corrections or improvements were deemed appropriate. The modifications included input discharge rating data (known water levels) at Sabin, Boardman, and Brown Bridge dams reflecting existing regulated water levels and structure discharge capacities. The resultant model was used to evaluate the impacts of the Brown Bridge Dam removal on Boardman River flood elevations.

Based on the flood discharge frequency impacts estimated by the rainfall runoff model, there is a small decrease in peak discharges and, therefore, a small lowering of flood elevations. These decreases are based on discharge capacity estimates and assumptions regarding flood event operation of the discharge facilities (gates) that may over estimate the ability to control water levels and, therefore, minimize affect of the Brown Bridge structure on peak discharge. Based on these considerations, the conclusion is that the HEC-HMS models indicate that removal of Brown Bridge

Dam would not increase peak discharges downstream. No hydraulic analysis is needed for that result.

The impact on flood discharge frequency data predicted by the USGS regional regression equations is approximately a 1.3 to 1.7 percent increase in discharges along the river downstream from Brown Bridge Dam. The impacts at each location are approximately the same percentage for all flood frequencies. The 100-year flood elevations increase as a result of the discharge rate increases. The largest water level increases occur upstream of locations with constricted flow, such as bridge openings. The increases along the river are indicated in Figure 3-1. The largest 100-year flood increase is 0.13 foot upstream of the South Airport Road crossing. Increases for the 100-year flood were 0.10 foot or less at all other locations. Approximately 0.08 foot of the increase at South Airport Road results from an increase at Union Street Dam that carries upstream through Boardman Lake.

These small discharge increases predicted by the USGS regional regression equations produce similarly small increases in potential scour at bridges that were evaluated. No bridges evaluated were determined to have severe predicted potential scour. The bridge scour equations are design equations that are generally conservative, over-predicting scour depths. Increases in potential scour depths in terms of percent increase, were of similar magnitude as the discharge increases.

100-Year Floodplain

The 100-year floodplain within the former Brown Bridge Pond boundaries is expected to have a width similar to the narrower portions of the existing natural riverine portions of the river in the vicinity of Brown Bridge Pond. In constructed channel and floodplain reaches, the constructed total floodplain width will be approximately 95 to 100 ft. However, it is expected that this is the lower range of a long-term equilibrium floodplain width and that the river may further adjust; the long-term typical width may be slightly wider and in the range of 100 to 150 ft. The long-term floodplain width is expected to be variable, as are natural floodplains, and will adjust over time.

Summary

The hydrologic and hydraulic analyses completed indicate that removal of Brown Bridge Dam will not significantly change flood flow rates and, therefore, flood elevations or local scour at bridges. The estimated discharge capacity and operating plan for the Brown Bridge structure indicate a capacity to pass even large floods with little increase in water level and storage volume. Predictions are sensitive to assumed operations of the gated structures. The Brown Bridge reach when restored will provide floodplain storage that, while not large, is larger than the Brown Bridge Pond temporary storage, resulting in a theoretical reduction in peak discharges resulting from dam removal. Assuming non-optimum flood event operations for the existing condition scenario may occur, the conclusion is that the dam removal will not increase peak discharges.

As specified in Executive Order 11988 the lead Federal agency must provide leadership in reducing the risk of flood loss, minimizing the impact of floods on human safety, health, and welfare, and in restoring and preserving the natural and beneficial values served by flood plains. In accordance with this Executive Order and as demonstrated above, the proposed action does not adversely increase the risk of flooding. However, it does provide substantial benefits in restoring and preserving the natural and beneficial values of floodplains by virtue of restoration of the bottomland of the Boardman River upstream of Brown Bridge Dam. Natural functions and values offered by floodplains and provided by Alternative B include natural flood storage, sediment retention, nutrient retention/removal, wildlife support, fish spawning and reproduction, natural

heritage values (sensitive species support), and other functions. Consequently, it is concluded that Alternative B is consistent with the requirements of Executive Order 11988.

3.2.2 Water Quality

3.2.2.1 Affected Environment

The Boardman River is located in Grand Traverse and Kalkaska counties in Northwest Michigan and includes 130 miles of river and tributary streams. There are a total of approximately 290 square miles in the watershed, producing one-third of the water volume of Grand Traverse Bay located in the Traverse City, Michigan area (MDNR, 2011a).

The potentially affected environment is considered to be the lentic (still water) environment of Brown Bridge Pond (impounded area behind the dam) and the lotic (flowing water) sections of the Boardman River upstream of the dam as well as a section of the Boardman River downstream of the dam. The area upstream includes the full extent of the impoundment and river reach continuing upstream where stream water velocities diminish in response to changes in stream gradient due to the Brown Bridge Dam and associated deposited sediment. The area downstream of the dam includes the extent of the river where water quality (primarily temperature) has been affected by release of water at the dam. The upstream (relative to Brown Bridge Dam) area extends approximately two river miles (including a non-sinuous length of the impoundment) to at least the confluence of Grasshopper Creek, as evidenced by the bed material composition (Inter-Fluve, 2012). The downstream extent is estimated to be to Boardman Dam based on observed temperature impacts from release of the warmer water of Brown Bridge Pond (ECT, 2007b).

Water quality upstream and downstream from the effects of Brown Bridge Dam is generally considered excellent, supporting Blue Ribbon trout stream fisheries (MDNR, 2011d). The primary water quality parameter affected in the area of influence of the dam at Brown Bridge Pond is water temperature (and associated dissolved oxygen content). Water temperature is elevated in the impoundment area due to the effects of solar heating where both the water surface area and retention time is increased. The release of surface water from the pond results in elevated water temperatures downstream of the dam.

Recording temperature sensing probes were placed by the MDNR in the Boardman River upstream of the Brown Bridge Pond and downstream of the dam in 2011. Water temperature was recorded hourly. Recent data collected from May through September of 2011 (GTCD, 2011) indicates that the average monthly temperature difference in the Boardman River between upstream and downstream locations exceeded four degrees Fahrenheit (°F) from June to September and peaked at 6°F in August (Table 3-2). Temperature plots for both up and downstream sites for the recent 2011 data are shown in Figure 3-2.

Table 3-2. Temperature Summary Statistics at Locations Upstream and Downstream of Brown Bridge Pond in 2011

	Month				
Summary Statistic	**May**	**June**	**July**	**Aug**	**Sept**
Downstream-Upstream Temperature Difference (monthly mean °F)	2.0	4.1	5.4	6.0	4.7
Upstream-Downstream Monthly Max. Temp. (°F)	-3.3	0.8	-3.6	3.0	3.2
Upstream-Downstream Monthly Min. Temp. (°F)	2.4	6.2	11.5	7.5	5.8

Source: GTCD, 2011.

In a study by Lessard and Hayes (2003), ten dams (including the Brown Bridge Dam) and associated stream sections were evaluated to examine the effects of summer temperature increases due to impoundment on downstream fish and macroinvertebrate communities in coldwater streams. Several water quality parameters were measured at each site including stream temperature, dissolved oxygen, conductivity and total phosphorus concentrations.

Mean summer water temperature below the Brown Bridge Dam was found to increase by approximately 7°F. Furthermore, the study found that in the test streams, water quality variables that were often changed downstream of deep water release dams, such as total phosphorus, conductivity and dissolved oxygen, were not significantly altered by the dams in the study.

Lassard and Hayes (2003) concluded that mean summer temperature was the only stream habitat parameter that was significantly different between upstream and downstream sections apart from what would be predicted for unregulated streams. In general, Lassard and Hayes (2003) found that mean summer temperature was substantially increased downstream by the small, surface release facilities. These increases in temperature were maintained at least 1.25 mile below the dams. These findings are consistent with observed water temperatures at studied sites upstream and downstream of Brown Bridge Dam.

3.2.2.2 Environmental Consequences

Alternative A – No Action

Under the No Action Alternative, conditions promoting a warm water species aquatic community in the affected environment will result for an indeterminate period. Downstream water quality will continue to be degraded by thermal loading from Brown Bridge Pond. Eventually the impounded area will gradually become shallower due to sedimentation and warming will occur more rapidly, resulting in increased temperatures relative to those observed today.

Alternative B – Dam Removal with Blended Restoration

Alternative B entails the integration of dam removal and active sediment management measures as part of the proposed action (see Section 2.5.2). Removal of the dam and restoration of a free-flowing river will result in the restoration of the natural thermal regime of the Boardman River. Immediately following dam removal, the thermal regime is expected to improve due to the greatly diminished surface area exposed to solar radiation and the reduced residence time of water flowing through the former pond area. Over time, riparian zone vegetation will form along the banks of the restored channel which will provide shading and further reduce the effects of solar heating.

Some increases in turbidity within downstream areas are expected to occur in conjunction with this alternative due to the effects of headcutting and the mobilization of sediments within the former impoundment. However, sediment management measures (both active and passive) implemented under this alternative will consist of the excavation and isolation of sediments (approximately 170,000-200,000 cubic yards, see Section 2.5). The removal of these materials will be conducted as part of the development of a stream channel and its associated "floodplain" within the delta of the upper impoundment. As a result of these measures, sediments that may be mobilized to downstream areas will be retained within the upper portion of the former impoundment. Accordingly, any elevated turbidity levels within the lower Boardman River will be limited and of relatively short duration.

Vegetative reestablishment under this alternative is expected to occur rapidly due to the commitment to active seeding of exposed lands following drawdown. Consequently, erosion from exposed areas and the resultant increases in turbidity are also expected to be relatively minor and of short duration.

3.2.3 Sediments

3.2.3.1 Affected Environment

Information regarding sediment characteristics within the project area is summarized below and includes the results from three separate sampling events within Brown Bridge Pond (2005, 2010, and 2012) as well as visual observations of the Boardman River and Brown Bridge Pond as part of a field reconnaissance survey performed by Inter-Fluve in June 2011 (Inter-Fluve, 2011).

Brown Bridge Sediment Quality

Sediment chemical characteristics within Brown Bridge Pond are understood as a result of several sampling efforts that utilized both coring and surface grab sampling techniques as summarized below:

- 2005: Core sampling was performed by the USEPA at six locations within Brown Bridge Pond. Six sediment samples were analyzed by the Michigan Department of Environmental Quality's (MDEQ's) Environmental Laboratory for the presence of pesticides, polychlorinated biphenyls (PCBs), semi-volatile organic compounds (SVOCs) and ten metals (arsenic, barium, cadmium, chromium, copper, lead, mercury, selenium, silver and zinc). Sample hold times were exceeded for pesticides, PCBs, and mercury and flagged accordingly. (ECT, 2009f).
- 2010: Sediment sampling was performed by Great Lakes Environmental Center (GLEC) at the approximate same sediment sample locations from the 2005 sampling event. These sediment samples were analyzed for ten metals, nickel, manganese, PCBs, SVOCs, organochlorine pesticides, total organic carbon and percent moisture (GLEC, 2011).
- 2012: Additional sampling was performed by AMEC in areas within the exposed bottomland of Brown Bridge Pond in the winter of 2012. Sampling also included the collection of composite samples of material to be dredged as part of the proposed sediment management and restoration activities. Sampling consisted of the collection of six surface soil samples (0 to 6-inches below grade surface (bgs)) in the exposed bottomlands, the collection of eight surface grab samples (0 to 2 feet bgs) within the exposed delta area and 30 sediment core samples collected along the proposed restored river channel centerline. The sediment core samples were vertically composited sediment samples from each boring location to provide a representative sample of the material to be dredged. All the samples were analyzed for

polynuclear aromatic hydrocarbons (PAHs), PCBs and 12 total metals (arsenic, barium, cadmium, chromium, copper, lead, manganese, mercury, nickel, selenium, silver and zinc).

The sampling performed in 2005, 2010 and 2012 did not detect any pesticides, PCBs, or SVOCs (including PNAs what are PNAs? Not listed in abbreviations section) above the respective method detection limits. Metals were consistently detected in the sediments and varied in concentration with the parameter, sample depth and location. While neither the EPA nor MDEQ have an overarching set of sediment quality guidelines or criteria, sediment metal concentrations were also compared to the MDEQ's Generic Direct Residential Contact or Statewide Default Background Level Criteria for metals in soil as these sediments may become exposed as a results of the potential removal of Brown Bridge Dam.
While these samples are representative of sediment samples and not surface soil samples (and technically, cannot be compared to criteria for other media), results from all three sampling events were compared to the MDEQ's Generic Residential Direct Contact Criteria for soils. Only arsenic was found to exceed the Generic Residential Direct Contact Criteria for soils (7.6 milligram per kilogram (mg/kg). As summarized in Table 3-3, arsenic concentrations in the sediments within Brown Bridge Pond from 2005 ranged from 6.1 to 17.9 mg/kg, whereas values from the samples in 2010 ranged from 7.6 to 31.0 mg/kg. Sediments having higher concentrations of arsenic were primarily associated with the lower (western portion of Brown Bridge Pond) portion of the impoundment. Samples collected during the most recent supplemental surface sampling (0 to 6-inches bgs) in 2012 detected arsenic at concentrations ranging from 3.3 to 18.0 mg/kg.

Table 3-3. Summary of Criteria and Arsenic Results from Sediment Samples Collected in Brown Bridge Pond and the Delta Area.

Sample Location/Type	MDEQ Generic Residential Direct Contact Criteria (mg/kg)	EPA Ecological Soil Screening Level[1] (mg/kg)	Proposed Site-Specific Direct Contact Criteria[3] (mg/kg)	Number of Samples	Range of Values (mg/kg)[2]	Mean Value (mg/kg)	Standard Deviation
Brown Bridge Pond Core Samples (2005)	7.6	Plants (18) Birds (43) Mammals (45)	36	6	6.1 to 17.9	10.5	4.13
Brown Bridge Pond Core Samples (2010)				6	7.6 to 31.0	18.9	8.66
Brown Bridge Pond Surface Samples (2012)				6	3.3 to 18.0	9.33	6.61
Delta Area Core Samples (2012)				30	0.79 to 4.3	1.82	0.85
Delta Area Surface Samples (2012)				8	0.85 to 3.6	2.00	1.00

[1]Source: USEPA, 2005
[2]Metals, Method 6020A, 7471
[3]Calculated based on two days per week of contact, 35 weeks per year.

With respect to sediment samples collected by the USEPA and GLEC, it is also important to note that these samples were all composite samples. The core lengths from each sample location varied and were mixed as a composite sample. Consequently, the concentrations of arsenic detected in the

composite soil sample submitted for analysis is not assumed to be characteristic of concentrations that would be detected in the newly exposed bottomlands after dam removal.

Additional sampling within the delta area in 2012 reflected a sediment chemical composition typically low in arsenic. Composite core samples from the delta area and other dispositional sediments within the river upstream of the delta area were coarsely grained and the concentrations of sediment detected at considerably lower concentrations. The concentration of arsenic detected in the 30 composite core samples ranged from 0.79 mg/kg to 4.3 mg/kg. Together, these results suggest that arsenic concentrations within the sediments of Brown Bridge Pond are variable, and that finer sediments from deeper portions of the pond are likely to contain higher concentrations of arsenic. Conversely, the more coarsely grained sediments such as those associated with the delta area represented by sediments lower in arsenic.

Sediment Physical Characteristics and Transport Processes

Field reconnaissance work was performed in June 2011 to provide information regarding sediment physical characteristics and transport processes within the Boardman River and Brown Bridge Pond. The area upstream of the confluence of the north and south branches of the Boardman River was assessed downstream to Brown Bridge Pond. Based on these observations, it was determined that the natural equilibrium in sediment transport processes is disrupted in the vicinity of Brown Bridge Pond. Significant sandy sediment deposits were noted in the upper reaches, and this sediment load is expected to continue working its way downstream (Inter-Fluve, 2011). There were few contemporary sources for the sand evident, indicating that it is likely a relic from historic land use in the Boardman River watershed (logging, early transportation routes) as well as land use practices and unpaved roadways common during the previous century until the 1980s.

Bed load within the Boardman River downstream of Brown Bridge Dam to the first significant tributary (East Creek) is sediment deprived and includes little fine or sandy material (Inter-Fluve, 2011). This is primarily due to the gradient of the stream at that location in combination with the relatively clear sediment free discharge water from the dam. The bed load in this area appears to be stable with no significant down-cutting or lateral bank erosion noted during the June 29, 2011 reconnaissance float trip (Inter-Fluve, 2011). At the confluence, with East Creek approximately 0.8 mile downstream of the dam, sedimentation within the channel of the Boardman River is more pronounced. East Creek appears to provide a substantial sediment load to the river that results in the presence of sand depositions in the margins of the channel and along the inside point bars. Swainston Creek is a second major tributary located about 0.4 mile below East Creek that also appears to contribute a significant sediment load to the Boardman River. Sediment characteristics of the Boardman River below these two creeks were noted to be similar to that observed upstream of Brown Bridge Pond. Few, if any, signs of bank erosion were noted during field reconnaissance, suggesting that the river below Brown Bridge is relatively stable and is not characterized by a sediment deficit.

3.2.3.2 Environmental Consequences

Alternative A – No Action

If no action is taken and the dam remains in-place, sandy sediment will continue to build up within the delta at the upper end of Brown Bridge Pond (see Figure 1-4). This delta is actively accreting and will continue to expand, eventually filling the impounded area. The ultimate effect would be to reduce the amount and quality of available aquatic habitats and result in their eventual transformation to wetland/upland habitats.

Alternative B – Dam Removal with Blended Restoration

Removal of Brown Bridge Dam would result in temporary disturbance of the sediments which have been deposited in Brown Bridge Pond. Sediment management activities are integrated in the effort to restore the river channel within the delta, and to minimize sediment transport downstream. Drawdown of the impoundment will proceed slowly (approximately 0.5 feet per day) such that a minimal amount of sediment will be released downstream.

Following drawdown, the river will begin incising through the sediment deposits behind the dam until a stable slope is reached upstream from the dam site. Finer sediments will suspend and be transported more quickly and at greater distances than coarser sediments. The amount of sediment in water flowing downstream from the dam will possibly increase for a short duration immediately following dam removal. As the impoundment sediments are transported downstream, the total suspended solids and turbidity levels would gradually diminish with distance and would not be discernable from naturally occurring sediment beyond the area immediately downstream of the dam. Eventually, the amount of sediment in river water would reach a stable condition with normal river flows. The first high water event following dam removal would likely flush additional sediment from the formerly impounded area to the downstream river channel. Each subsequent high water event would likely have decreasing sediment concentrations.

In the long-term, removal of the Brown Bridge Dam would also restore more natural processes of sediment transport to the Boardman River, resulting in the re-establishment of the equilibrium in natural sediment transport. Once the dam is removed, the sediment accumulated behind the dam since its construction would be left behind or transported downstream. This will depend on the rate of discharge and volume of water discharging. The amount of sediment moving downstream in the long-term will in part depend on natural events such as weather, rainfall and snowmelt events. Because the predominant sandy soils of the Boardman River watershed are well drained, precipitation and runoff events are moderated. Rainfall and snowmelt infiltrate into the sandy soils, thus attenuating rapid surface water runoff. Because of this, the sediment remaining in-place behind the former dam is more likely to be re-vegetated and stabilized, especially over time as plant communities become established and progress through natural stages of succession.

Other hydrologic and geologic features such as tributaries and adjacent slopes will be affected to some degree by the dewatering of the impoundment. Tributaries will downcut, and headcuts may form as the natural gradient of the tributary is reestablished. These effects are likely to occur fairly early after impoundment dewatering. Once vegetation is re-established and the original (pre-dam) gradient attained, the tributary channels are expected to become stable.

After the removal of the Brown Bridge Dam, the channel immediately downstream from the dam would be expected to exhibit the greatest changes. Sediments transported below the dam would be expected to be deposited at locations where velocities are naturally lower, resulting in the creation of point bars and other depositional features. These would be expected to be similar to those currently observed downstream of the locations where East and Swainston Creeks enter the Boardman River.

Several factors however, are expected to minimize the release (and the associated impact) of sediments to downstream areas:

- **Seeding of Exposed Land Areas**. Land surfaces exposed by receding water will be actively seeded during and following drawdown to establish ground cover. Seed mixes will consist of native species and, together with natural recruitment of vegetation from the existing seed bank

within sediments in Brown Bridge Pond, will reduce surface runoff and erosion (sedimentation) from these areas.

- **Limited Sediment Depths within the Lower Impoundment**. Based on the reconnaissance work performed in May 2011, sediment depths in Brown Bridge Pond were observed to be relatively minor within the lower portion of the impoundment (Figure 1-4). Following drawdown, natural head-cutting within the lower impoundment is expected to mobilize and transport some sediment to downstream areas. However, because the depth of the sediment is relatively shallow, sediment transport to downstream areas is expected to be limited and of short duration.
- **Active Sediment Management in the Upper Impoundment.** The delta in the upper impoundment has been documented as having sediments that are as much as 12 feet in depth. In the absence of active management, these sediments may be expected to be mobilized through head-cutting processes and transported to downstream areas, potentially resulting in substantial impacts to the aquatic environment. However, active sediment management will be conducted in the upper impoundment that will consist of the excavation of a stream channel and associated floodplain. Sediment release will also be minimized in part because these sediments consist primarily of sand that do not remain suspended in the water column once flow velocities are reduced.
- **Use of Sediment Traps.** Multiple sediment traps will be used to manage and control sediment movement during the construction phase and maximize retention of sediments within the Brown Bridge bottomland. Traps will be variously located (upstream end of delta, immediately below the delta work area, and lower impoundment) and variously sized to promote the retention of sediments during the construction phase.

As a result of these factors, release of sediment downstream will be minimized such that the impacts are expected to be small. The gradient and sinuosity will be established more rapidly with the end result of less sediment being transported downstream. In addition, the seeding effort will optimize the vegetation that is re-established which will promote stabilization of the sediment deposits, as well as promote other beneficial characteristics such as wildlife cover, shading and discouragement of invasive species.

In terms of sediment quality, Alternative B is not expected to result in significant concerns regarding sediment (soil) quality either in terms of sediment potentially transported downstream of the dam (during or after dam removal) or in terms of recreational or wildlife use of the exposed bottomland. Support for this assessment is summarized by the following:

- **Low Potential for Impact Resulting from Wildlife Use.** As summarized in Table 3-3, USEPA has provided ecological screening levels for arsenic. None of the values reported from the site during any sampling event exceed the screening values for either birds or wildlife.
- **Low Potential for Impact to Aquatic Biota.** A review of the sediment data by MDEQ Water Resource Division determined that there is no need for additional testing as the concentrations of contaminants do not pose an unacceptable toxicological risk to aquatic biota.
- **Site-specific versus Generic Residential Direct Contact Criteria.** While the sediment arsenic levels in a number of locations within the lower (western) portion of the Brown Bridge Pond exceed the MDEQ's Generic Residential Direct Contact Criteria. Based on the proposed removal of the dam and resulting exposure of the majority of the previously inundated bottomlands, a proposed Site-Specific Recreational Use Direct Contact Criterion for arsenic was developed by AMEC as presented in Table 3-3. As discussed in Section 3.5.3, dam removal and bottomland restoration is expected to increase use of the 1,310-acre Brown Bridge Quiet Area by approximately 300 annual use days (16 percent). Distribution of these users is

likely to be widespread within the Brown Bridge Quiet Area, but expectedly a portion of these visitors will likely use the exposed bottomlands following the development of a suitable trail and/or boardwalk system. Use levels (and actual exposure to soils with elevated arsenic levels) are expected to be considerably less than the two days for each of 35 weeks per year that AMEC has used in development of the proposed site specific criterion. Following dam removal, continued coordination with MDEQ will be conducted to review the proposed site-specific recreational direct contact criteria for arsenic based on potential expose pathways.

- **Commitment to Management and Mitigation Measures.** Potential impacts associated with the elevated arsenic levels within some of the sediments within the Brown Bridge Pond are dependent upon the type and nature of construction activities (e.g., excavation, soil deposition, grading, etc.), the resultant soil concentrations, degree of vegetative establishment and cover, and potential for human contact. In order to ensure that there is a low potential for impact the following measures will be implemented:

  1. Conduct additional soil sampling within the bottomlands to characterize the extent of arsenic in surface soils in areas where direct contact is a potential.
  2. Maintain consultation with MDEQ to establish appropriate site-specific recreational direct contact criteria for the site, which could vary based on expected exposure.
  3. Restrict public use within the exposed bottomlands for a period of two years to maximize the establishment of plant community establishment and restoration.
  4. Develop appropriate management approaches to prevent human contact of soils containing elevated arsenic levels (e.g., soil cover, use of boardwalks, signage for restricted use areas, etc.).

3.2.4 Groundwater

3.2.4.1 Affected Environment

The potentially affected environment regarding groundwater drawdown was considered in an assessment utilizing modeling techniques by URS Corporation (URS) to be the Grand Traverse County area surrounding Brown Bridge Pond. The URS evaluation was performed under contract to the USACE. A separate assessment was also performed for this EA and focused on the area extending approximately one-half mile away from the current water's edge of Brown Bridge Pond.

Glacial deposits in the area may reach depths up to 500 feet (ECT, 2007a) and consist largely of glacial outwash sand and gravel, post glacial alluvium, and end moraines of coarse textured till (Farrand and Bell, 1982). Private water supply wells completed within a half mile of the Brown Bridge Pond are completed in the glacially deposited saturated sand or gravel. Interbedded clay zones are commonly noted in the well logs.

The one-half mile distance area of concern that was evaluated includes a number of private water supply wells where records were available from the State of Michigan on-line database (Figure 3-3). Twelve of the wells are located at the outer perimeter of the area (one-half mile distance) and are either downstream of the dam in the river valley, or located to the north and west of Brown Bridge Pond and are closer to another surface water body (Arbutus Lake) than they are to Brown Bridge Pond. One well is approximately one-half mile to the south of the Boardman River and is upstream of the primary Brown Bridge Pond and the three remaining wells are located to the north, west or south of Brown Bridge Pond

Total depths of these wells ranged from 35 feet below ground surface to 243 feet below ground surface with the average well depth approximately 105 feet. Total depths in ten of the wells range

from 35 feet to 83 feet. Groundwater surface static water level elevations associated with the wells range from 752 feet to 884 feet (national geodetic vertical datum). All the wells are completed in glacial deposits (versus deeper bedrock aquifers) and static water levels rise in the well casings anywhere from 25 to 143 feet. Table 3-4 presents information summarizing the wells in the project area identified in Figure 3-3.

Table 3-4. Summary of Information Regarding Private Water Supply Wells in the Vicinity of Brown Bridge Pond

Well ID	Approx. Ground Elev. (feet)	Total Well Depth (TD) (feet)	Static Water Level (SWL) (feet)	FDD[1] Elev. (feet)	Estimated SWL Elev. (feet)	FDD Elevation below SWL Elev. (Y/N)	Estimated Well TD Elev. (feet)	FDD Elev. Below Well TD Elev. (Y/N)
962	866	235	100	770	766	No	631	No
963	882	159	130	770	752	No	723	No
964	769	40	10	772	759	No	729	No
965	774	43	10	772	764	No	731	No
966	777	35	3	772	774	Yes	742	No
967	776	53	10	772	766	No	723	No
968	775	65	2	772	773	Yes	710	No
969	910	155	26	772	884	Yes	755	No
9513	774	83	7	772	767	No	691	No
9679	900	80	38	772	862	Yes	820	Yes
10028	880	243	100	772	780	Yes	637	No
10109	901	153	107	772	794	Yes	748	No
10428	920	140	105	788	815	Yes	780	No
11114	886	153	98	783	788	Yes	733	No
12587	768	48	2	772	766	No	720	No
13101	767	55	0	772	767	No	712	No
13777†	812	42	17	772	795	Yes	770	No

[1] FDD=Estimated Final Drawdown water elevation
[2] This is caretaker's well (replaced 11-04-2009).
Note: Approximate ground surface elevation from DeLorme Topo mapping software.

Surficial aquifers in the project area also support wetland communities. In particular, groundwater was frequently observed discharging from the toe of the valley wall at numerous locations in the Brown Bridge area. Discharge rates were observed to be particularly high in the vicinity of Century Creek, which also perpetuates wetlands along the south side of Brown Bridge Pond (see Section 3.3.4, Wetlands). Additionally, shallow groundwater was observed discharging from the north valley wall at the upstream end of Brown Bridge Pond, thereby contributing to the hydrology of Wetland A (see Section 3.3.4). Surficial aquifers upstream of Brown Bridge Pond are also likely influenced by a backwater effect from the impoundment. As described in Section 3.3.4, this backwater effect may be an important contributor to the hydrology of wetlands on the northeast side of Brown Bridge Pond.

3.2.4.2 Environmental Consequences

Alternative A – No Action

If no action is taken, the Brown Bridge Dam will remain for an indeterminate period and pond water levels, as well as the associated shallow groundwater surface extending outward from the pond; will likely remain as they are at this time. As such, there are no anticipated consequences to the existing private water supply wells in the area regarding static water level drawdown in the wells. Similarly, no impact to the surficial aquifer and its dependent wetlands is expected under this alternative.

Alternative B – Dam Removal with Blended Restoration

Under this alternative, the dam will be removed and the impoundment behind Brown Bridge Dam will be drained to a restored gradient of the Boardman River.

The broad modeling approach used by URS for the USACE for assessing impacts to groundwater was to estimate the groundwater surface elevations for existing conditions and those with the dam removed. The groundwater surfaces were developed using a point file of first water surfaces provided to URS by Dr. Lusch of Michigan State University (personal communication between Dr.Lusch and Mr. Troy Naperala of URS, 2011) for Grand Traverse County. Those points are a subset of the data set used to develop the groundwater table maps for the entire State of Michigan (Lusch, 2005). This data was used in the vicinity of the dam to reflect future conditions with a restored river in-place of the impoundment. In addition, other points near each of the impoundments representing water well measurements and wetlands were removed in case those points were influenced by the impoundment's water surface elevation. URS reports that those point files were then interpolated into a continuous surface using the natural neighbor technique. The two surfaces (pre-drawdown and post drawdown) were compared using the "minus" command in ArcGIS.

Results of the comparison for the URS assessment showed differences only near the dam, which is expected, since that is where the proposed change will occur. According to the model, the water surface elevation dropped a maximum of approximately 23 feet at Brown Bridge Dam. Based on these values it is possible that water wells less than 40 feet deep will be impacted. URS reports that no wells have screened zones that are above the groundwater table after dam removal. Thus, based on that model and analysis and known locations of wells at the time, there should be no impact from dam removal. URS also reports that some wells may be shallow and have depths less than 40 feet. According to URS, given the uncertainty associated with the analysis, some of the wells may experience supply issues and some of them are at a potentially greater risk of contamination from localized release of contaminants because screens would potentially be closer to the water table surface. This may make them more susceptible to contamination that may infiltrate or migrate through poorly constructed wells compared to wells with a greater saturated thickness between the well screen and the water table surface. This effect may be contaminant-specific.

The separate assessment of potential groundwater drawdown in water supply wells performed by AMEC focused on the wells within one-half mile of the Brown Bridge Pond water's edge. Well logs were obtained from the State of Michigan's on-line data- base (Michigan State University, 2011). Approximate ground surface elevation (obtained from DeLorme Topo 8 commercial topographic software), well depth, screen placement and depth to water from the well logs were used to estimate the potential drawdown in each well resulting from drawing down the Brown Bridge Pond water elevation to final drawdown elevations. Well information and potential drawdown information is summarized in Table 3-4.

This information basically agrees with the URS assessment in that none of the well's screened intervals (total depth) were above the estimated water table surface, consequently, none are predicted to be dewatered (see Table 3-4). The assessment did indicate that the final drawdown water surface elevation was below the static water levels of nine wells, indicating that stored groundwater within the well casing might be diminished. Individual aquifer characteristics associated with the wells, such as transmissivity or specific yield, was not evaluated.

Data in Table 3-4 indicates that the total depth of one well (well 9679) is above the projected Brown Bridge Pond final drawdown elevation, but that well's total depth is currently above the Brown Bridge Pond water elevation in its present pre-drawdown state. This indicates that the water level in that particular well is likely independent of the Brown Bridge Pond water level and not subject to impact by dam removal.

Dam removal and drawdown of the pond under this alternative will impact the shallow surficial aquifer by lowering the hydrostatic head (static water level) in the area that is in hydraulic communication with Brown Bridge Pond. Consequently, this change in the near-surface hydrology (particularly which is due to backwater effect from the impoundment) is also expected to result in parallel changes in the hydroperiod of dependent wetlands. It should be noted however, that in the vicinity of Century Creek (Wetland B) and along the toe of the north valley wall (Wetland A) groundwater was observed discharging from the valley wall at a height not likely to be influenced by backwater effect from the impoundment (see Section 3.3.4.1). As a result, it is expected that the hydrologic contribution to these wetlands will be sustained even in the absence of Brown Bridge Pond. However, because the groundwater discharge patterns are complex and often dependent on local stratigraphy (e.g., the presence of clay lenses in the glacial till), the potential impact of dewatering on discharge from the valley walls is difficult to predict with certainty.

3.3 ECOLOGY

3.3.1 Aquatic Ecology

3.3.1.1 Affected Environment

Aquatic Communities

Aquatic communities within the project area are compositionally different based on the inherent differences in habitat, flow characteristics and water quality. As discussed in Section 1.4.2, the reaches of the project area are characterized by habitat fragmentation and thermal disruptions that have had the effect of inducing species disruptions as exhibited in Table 3-5. Accordingly, the characterization of the aquatic communities is discussed for each of the three reaches: upstream of Brown Bridge Pond, Brown Bridge Pond itself, and downstream of Brown Bridge Pond.

Table 3-5. Coldwater Fish Abundance Upstream and Downstream of Brown Bridge Dam

Species	Upstream of Brown Bridge Pond Inlet	Downstream of Dam
Brown trout	585	342
Brook trout	234	18
Slimy sculpin	1,124	277
Total	**1,943**	**637**

Source: USACE, 2006

Fish communities occurring within the Boardman River upstream of Brown Bridge Pond are dominated by such species as brown trout, brook trout, and slimy sculpin (Lessard, 2001). Other species found within this reach include American brook lamprey, blacknose dace, blacknose shiner, bluegill, central mudminnow, common shiner, creek chub, finescale dace, grass pickerel, largemouth bass, mimic shiner, northern brook lamprey, northern pike, northern redbelly dace, rainbow trout, rock bass, smallmouth bass, spottail shiner, white sucker, and yellow perch (ECT, 2009). Densities and growth rates of the trout species were average to good in 2004 to 2005 MDNR surveys, but adult individuals were scarce (ECT, 2009).

Macroinvertebrate communities upstream of Brown Bridge Pond are relatively diverse (20 insect families) and are numerically dominated by non-biting midges (Chironomidae). Other common taxa include blackflies (Simuliidae), riffle beetles (Elmidae), and small minnow mayflies (Baetidae) (Lessard, 2001).

Brown Bridge Pond is a lentic (still water) aquatic habitat that is characterized by slow flow, greater depth, and the predominance of depositional substrates relative to the flowing environments of the Boardman River. Habitat within Brown Bridge Pond consists of the open water pelagic zone, benthic habitats and the fringing zone of submersed aquatic vegetation. Representative plant species associated with this aquatic vegetation fringe include coontail *Certophyllum demersum),* stonewart *(Chara spp.),* pondweeds *(Potomogeton, spp.),* wild celery *(Valisneria americana),* and common waterweed *(Elodea canadensis*) (ECT, 2009a). The submersed aquatic vegetation within Brown Bridge Pond provides useful habitat and structure that may be used by invertebrates and fish for feeding, spawning or nursery areas.

In Brown Bridge Pond, rock bass was the most abundant species in a 2007 survey (ECT 2007b). Other common species included bluegill, pumpkinseed, white sucker, yellow perch, largemouth bass, smallmouth bass, and northern pike (Table 3-6). Each of the game fish populations had moderate to high levels of harvestable individuals. No data from macroinvertebrate collections in the pond were obtained.

Table 3-6. Coolwater Fish Species in Brown Bridge Pond

Scientific Name	Common Name
Esox lucius	Northern pike
Lepomis gibbosus	Pumpkinseed sunfish
Lepomis macrochirus	Bluegill
Ameiurus melas	Black bullhead
Ambloplites rupestris	Rock bass
Catostomus commersonii	Common white sucker
Micropterus salmoides	Largemouth bass
Luxilus cornutus	Common shiner
Micropterus dolomieu	Smallmouth bass
Perca flavescens	Yellow perch
Notemigonus crysoleucas	Golden shiner

Source: USACE, 2006

On the Boardman River downstream of Brown Bridge Pond, previous fish surveys have demonstrated that the most abundant species are brown trout, blacknose dace, white sucker, sculpins (mottled and slimy), and creek chub (ECT, 2007b). Brook trout were also occasionally abundant. Densities of the trout species were generally moderate for brown trout and low for brook trout. Both species exhibited average to above average growth rates in comparison to state-wide

data. However, both brown and brook trout had relatively few older individuals in their populations.

Macroinvertebrate communities downstream of Brown Bridge Pond are somewhat diverse (17 insect families) and are numerically dominated by non-biting midges (Chironomidae), riffle beetles (Elmidae), and hydropsychid caddisflies (Lessard, 2001). Other commonly encountered taxa from this river segment include the mayfly families Baetidae and Ephemeridae, the caddisfly family Brachycentridae, and the dipteran family Tipulidae. Oligochaete worms and leeches were also common downstream of Brown Bridge Pond.

Representative Important Species

Representative important species considered in this section are generally those that are recreationally important. In most cases, these species are also sensitive to environmental degradation and can be used as surrogates for the health of the aquatic ecosystem. No federal or state listed species (threatened or endangered) have been collected from the study area. Brown trout and brook trout are recreationally important in the Boardman River, and bluegill, yellow perch, largemouth bass, smallmouth bass, and northern pike are recreationally important in Brown Bridge Pond.

Brown trout (*Salmo trutta*) is native to Europe and Western Asia which was introduced into North America in the late 1800s (Dehring and Krueger, 1985). The average adult size is 10 to 13 inches in length and weighs less than 2 pounds, but they can exceed 30-inches and 20 pounds. Their preferred habitat is cold (50 to 60°F), well-oxygenated upland waters, but they can tolerate temperatures greater than 70°F (ODNR, no date [nd][1]). Brown trout spawn in the fall and can live 10 to 12 years (Steiner, 2000). Brown trout can migrate between lakes and rivers or live their entire lives in either type of system (Michigan Sea Grant, 2009). They eat aquatic and terrestrial invertebrates and increasing proportions of fish as they grow larger (Steiner, 2000). They are highly esteemed as a sport fish for their excellent taste and because of the difficulty in catching the older, warier individuals (Becker, 1983). Brown trout are abundant in segments of the Boardman River both upstream and downstream of Brown Bridge Pond.

Unlike the brown trout, the brook trout (*Salvelinus fontinalis*) is a species native to North America (Steiner, 2000). They are smaller than the brown trout, with mature individuals typically less than 10-inches in length and weighing less than a pound (Becker, 1983). They are also shorter lived than brown trout, rarely surviving past 5 to 6 years (Dehring and Krueger, 1985). Brook trout spawn in the fall, with activity peaking in mid-November (Becker, 1983). Its natural habitat is small, cold (50 to 55°F) streams, but they have adapted to living in lakes and ponds (Dehring and Krueger, 1985). They feed on aquatic and terrestrial insects, crustaceans, and small fish (Steiner, 2000). They are popular sport fish, as they are easy to catch and have an excellent taste (Becker, 1983). Brook trout are abundant in the Boardman River upstream of Brown Bridge Pond. They are occasionally numerous in the river downstream of the pond, but less so than brown trout.

Each of the species described below is common to abundant in Brown Bridge Pond, with populations exhibiting moderate to high levels of harvestable individuals.

Northern pike (*Esox lucius*) is a voracious predator species primarily found in large river systems and impounded areas (ODNR, nd[2]). They usually live about seven years, but can survive up to 25 years (Becker, 1983). Individuals 18 to 20 inches in length and two pounds in weight are the most commonly caught by anglers (Mecozzi, 1989). They prefer clear, slow-moving water with

abundant aquatic vegetation (ODNR, nd[2]). They are popular with anglers because of their fighting ability and propensity to bite (Mecozzi 1989).

Bluegill (*Lepomis macrochirus*) is a diversely distributed member of the family Centrarchidae. In the eastern United States, it is present in most medium-sized streams to large rivers, and in nearly all lakes (Becker, 1983). Their preferred habitat is clear, warm lakes with some rooted vegetation (ODNR, nd[3]). Bluegill is a popular sport fish because of its abundance, scrappiness as a fighter, and excellent taste (Dehring and Krueger, 2008). Adults can attain 7-inches in length and one-half pound in weight at the end of seven years, but specimens exceeding 12-inches and three pounds have been recorded (Becker, 1983).

Smallmouth bass (*Micropterus dolomeiu*) is another centrarchid species that is common in rocky-bottomed streams and large clearwater lakes in the eastern United States (Becker, 1983). Adults average from 12- to 15-inches in length and weights between 1 and 2 pounds, but may reach lengths of 20-inches and weights of eight pounds (ODNR, nd[4]). Smallmouth bass spawn in May to early June (Steiner, 2000). They are a popular sport fish, and are a high quality food fish (Becker, 1983).

Largemouth bass (*Micropterus salmoides*) prefers slower moving water than the related smallmouth bass, and is generally found associated with weeds or underwater structures such as stumps or downed logs (Steiner, 2000). They are distributed throughout the US except for areas adjacent to the Rocky Mountains (Becker, 1983). Adults average 13- to 16-inches in length and 1.5 to 3 pounds in weight, but can exceed 25-inches and over 12 pounds (ODNR, nd[5]). Largemouth bass spawn in the spring and early summer (Steiner, 2000). It is another highly popular species for anglers (Becker, 1983).

Yellow perch (*Perca flavescens*) is a member of the family Percidae and is distributed throughout much of northern North America (Becker, 1983). They are predominantly a lake, pond, or impoundment species, and prefer clear water with moderate vegetation over sand or gravel (ODNR, nd[6]). Adults average 7- to 10-inches in length and generally weigh less than one pound (Holton. 1990). Yellow perch spawn from mid-April through early May (ODNR, nd[6]). They are valued as a sport species because of their abundance, propensity to bite, and for their excellent taste (Becker, 1983).

Nuisance Species

The zebra mussel (*Dreissena polymorpha*) is a small bivalve native to the Caspian Sea that was introduced into North America in the 1980s (Cary Institute of Ecosystem Studies [CIES], 2011). It subsequently spread from the Great Lakes through its tributaries into nearly all the major river systems of the central and eastern US (USGS, 2008). Zebra mussels occur in Brown Bridge Pond as evidenced by the presence of many shells on the exposed shoreline and have been documented as having extensive populations established on the hard structures of the powerhouse. Populations are also established within the Boardman River channel downstream of the dam and are progressively reduced downstream. Zebra mussels are extremely prolific and can be found in high densities on nearly any type of aquatic substrate, including living organisms. They are a nuisance due to their competition with native species for food and habitat, and by fouling the intake structures of power plants, municipal water supplies, and other industries (National Atlas, 2011). They are controlled by chemical pesticides in closed systems, but in natural systems no effective control method is thus far available (USGS, 2008).

The sea lamprey (*Petromyzon marinus*) is an anadromus fish species that was inadvertently introduced into the Great Lakes through shipping canals in the 1800s (USGS, 2008). Its normal life cycle is for adults to migrate from the ocean into fresh water to spawn, dying soon afterward (USFWS, 2010). In the Great Lakes, their voracious feeding behavior was destructive to the native fish populations, and they were considered the major cause of the collapse of the lake trout, whitefish, and chub fisheries in the Great Lakes during the 1940s and 1950s (USGS, 2008). Subsequently, sea lamprey populations have been controlled using a chemical lampricide, physical barriers to upstream migration, and other methods (University of Minnesota, Sea Grant, 1998). Sea lampreys have not been collected in the study area, but this species has been found in the system downstream of the study area (below Union Street Dam, Boardman Lake and below Sabin Dam). Lampricide treatments were conducted in the summer of 2011 above Union Street Dam to control sea lamprey within this reach of the Boardman River. A planning process is also underway and is supported by the USFWS, USACE, IT and the City of Traverse City to design and install a permanent sea lamprey barrier at Union Street Dam to prevent future migration of sea lamprey upstream.

3.3.1.2 Environmental Consequences

Alternative A – No Action

If the No Action alternative is chosen, the three ecosystems: the pond and the riverine segments upstream and downstream of the pond, will remain fragmented and populations within the Boardman River will remain discontinuous and disrupted. Within the Boardman River upstream of Brown Bridge Pond, the existing backwater condition will continue to exist which will maintain the pattern of sediment deposition and its resultant habitat degradation within the Boardman River.

Within Brown Bridge Pond, the warm water temperature regime will continue, resulting in the maintenance of aquatic communities of different composition than those of the adjoining riverine segments. Consequently, the existing limitations of bottom and near shore habitat for aquatic fauna will continue to be limited. Furthermore, additional sedimentation within the pond over time will result in shallowing over time and a consequent reduction of deep water habitat.

Downstream of Brown Bridge Pond, the presence of the dam will continue to impede fish passage and will continue to impede the movement of reproductive propagules and allochthonous food sources from upstream areas. Additionally, the downstream reach of the Boardman River will continue to exhibit an unnatural and disrupted thermal regime due to the release of warm water from the pond.

To summarize, the No Action Alternative does not address the objectives outlined in the Purpose and Need. This alternative leaves the problem of an aging and deteriorating structure, and leaves this segment of the Boardman River fragmented into three systems with limited biological transfer among them.

Alternative B – Dam Removal with Blended Restoration

The dam removal will consist of de-watering activity to remove standing water from Brown Bridge Pond, followed by partial demolition and removal of the existing powerhouse and associated embankment. The remaining embankment will be graded to allow a natural water transfer downstream to the Boardman River channel. The blended restoration approach to the former impoundment consists of re-vegetation of 20-foot wide riparian corridors and seeding all exposed areas.

Upstream of Brown Bridge Pond, this alternative will result in the elimination of sedimentation associated with water "back-up" from the pond and improve in-stream habitat quality. Upstream aquatic communities will also be reconnected to those downstream by virtue of a restoration of fish passage and continuity of similar aquatic ecosystems.

This alternative will also result in substantial restoration of a riverine ecosystem within Brown Bridge Pond. The composition of aquatic communities in this area will shift from predominantly warm and cool water species (centrarchids, northern pike, yellow perch) to one dominated by coldwater species (trout, sculpins).

In-stream habitat will be enhanced by the restoration of natural riverbed substrates, and the establishment of riffle/run/pool complexes that should be directly beneficial to fish and to the aquatic life stages of insects, which are the primary food sources for the fish. Riparian habitat establishment and enhancement will also be directly beneficial to the aerial (adult) life stages of aquatic insects and thus indirectly beneficial to the fish species that feed upon them.

Downstream of Brown Bridge Pond the removal of the dam will:

- Restore natural fish passage to upstream environments.
- Restore a pathway for reproductive propagules of upstream populations of aquatic organisms.
- Restore a pathway for allochthonous food sources from upstream areas.
- Eliminate warm water inputs from upstream.
- Result in the establishment of a natural balance in the brown trout/brook trout ratios due to restored temperature regimes.
- Modify in-stream habitats (notably immediately below the dam) by deposition of sediments transported from upstream areas.

In summary, Alternative B addresses the objectives outlined in the Purpose and Need. Additionally, it benefits each of the three ecosystems considered, particularly Brown Bridge Pond and the Boardman River downstream of the pond.

3.3.2 Terrestrial Ecology

3.3.2.1 Plant Communities

Affected Environment

Plant communities within the vicinity of Brown Bridge Dam are part of the Northern Lower Peninsula Ecoregion (MDNR, 2011b). This area is characterized by extensive, sandy outwash plains and large moraines. Plant communities typical of this region include northern hardwood forests of sugar maple, American beech, eastern hemlock and white pine. In upland areas, the ecoregion also supported large areas of fire-dependent ecosystems such as jack pine barrens, oak-pine barrens, and white pine-red pine forest. Within more low-lying or depressional areas, the plant communities within the plant communities within the ecoregion consist of bogs, northern fen, northern wet meadow, hardwood-conifer swamp and rich conifer swamps (MDNR, 2011b)

Land cover types within the vicinity of Brown Bridge Dam are illustrated in Figure 3-4. Dominant types of plant communities within Grand Traverse County include deciduous forest (32.5 percent), row crops (14.1 percent), evergreen forest (12.5 percent) and grassland herbaceous (10.2 percent) (Table 3-7).

However, as illustrated in Figure 3-4, the dominant plant communities in the immediate vicinity of Brown Bridge Dam include wooded wetlands (associated with the Boardman River valley), mixed

forest and evergreen forest (associated with uplands). Representative plant species of communities observed during field reconnaissance in 2011 are listed in Table 3-8.

Table 3-7. USGS Land Use/Land Cover of Grand Traverse County

Land Use/Land Cover Type	Total Area (acres)	Percent
Bare Rock/Sand/Clay	12	0.0
Commercial/Industrial/Transportation	2,447	0.8
Deciduous Forest	102,123	32.5
Emergent Herbaceous Wetlands	2,551	0.8
Evergreen Forest	39,277	12.5
Grasslands/Herbaceous	32,095	10.2
High Intensity Residential	2,140	0.7
Low Intensity Residential	1,436	0.5
Mixed Forest	26,209	8.4
Open Water	17,029	5.4
Pasture/Hay	15,348	4.9
Quarries/Strip Mines/Gravel Pits	69	0.0
Row Crops	44,087	14.1
Transitional	825	0.3
Urban/Recreational Grasses	1,279	0.4
Wooded Wetland	26,851	8.6
Total	**313,778**	**100**

Source: USGS, 2002.

Table 3-8. Plant Species Observed During Field Reconnaissance of the Brown Bridge Area, June 2011

			Location/Relative Abundance[1]			
Species Name	**Common Name**	**Layer[2]**	**Successional /Old Field**	**Uplands**	**Wetlands**	**Dam Area**
Abies balsamea	Balsam fir	S,T	O	O	O	
Acer rubrum	Red maple	S,T		U	O	
Achillea millefolium	Yarrow	H		O		
Adiantum pedatum	Maidenhair fern	H	O		O	
Agrostis alba	Redtop	H	C			C
Alnus rugosa	Speckled alder	S			C	
Ambrosia artemissiifolia	Common ragweed	H				O
Anemone canadensis	Meadow anemone	H			O	
Apocynum cannabinum	Prairie dogbane	H	U			
Arisaema triphyllum	Jack-in-the-pulpit	H			O	
Asclepias incarnata	Swamp milkweed	H			O	
Asclepias syriaca	Common milkweed	H				U
Betula allegeniensis	Yellow birch	T			O	
Betula papyrifera	White/Paper birch	S,T	O	O	U	

Table 3-8. Plant Species Observed During Field Reconnaissance of the Brown Bridge Area, June 2011

			Location/Relative Abundance[1]			
Species Name	**Common Name**	**Layer[2]**	**Successional /Old Field**	**Uplands**	**Wetlands**	**Dam Area**
Bromus inermis	Smooth brome	H				A
Carex sp (upland)	Sedge	H		O		
Carex sp.	Sedge	H			C	
Carex bromoides	Hummock sedge	H			O	
Carex frankii	Bristly cat-tail sedge	H			O	
Carex stricta	Tussock sedge	H			A	
Carex vulpinoidea	Fox sedge	H			O	
Carpinus caroliniana	Blue beech	S,T			O	
Centaurea stoebe	Spotted knapweed	H				C
Cerastium vulgare	Mouse-ear chickweed	H	O		O	
Chara sp.	Stonewort	H			O	
Chrysanthemum leucanthemum	Ox-eye daisy	H		O	U	
Cirsium vulgare	Bull thistle	H	C		U	
Cornus stolonifera	Red osier dogwood	S	O		O	
Cypripedium reginae	Showy lady's slipper	H	C	U		
Dactylis glomerata	Orchard grass	H				
Daucus carota	Queen Anne's lace	H	O			
Dirca palustris	Leatherwood	S		C		
Eleagnus angustifolia	Russian olive	S				
Eleocharis sp.	Spikerush	H			C	
Elodea canadensis	Common waterweed	H			O	
Equisetum arvense	Common horsetail rush	H				
Erigeron philadelphicus	Marsh fleabane	H			U	
Eupatorium perfoliatum	Boneset	H	O		O	O
Eupatorium maculatum	Spotted Joe Pye weed	H	O	O	O	
Frangula alnus	Glossy buckthorn	S				
Fraxinus nigra	Black ash	T			O	
Gaylussacia buccata	Black huckleberry	S	O	O-C		
Glyceria striata	Fowl manna grass	H	O		C	
Hamemelis virginiana	Witch hazel	S		C		
Hieraceum auranthiacum	Orange hawkweed	H		O		
Impatiens capensis	Jewelweed	H			C	
Juncus sp.	Rush	H	C		C	
Juncus effusus	Soft rush	H			O	
Juncus tenuis	Poverty rush	H			C	C
Krigia biflora	Two-flower dwarf dandelion	H		O		
Larix larcina	Tamarack	S,T			O	
Leersia oryzoides	Rice cut-grass	H			O	
Lycopus americanus	American water horehound	H	U		O	
Melilotus sp.	Clover	H	C			C
Monarda sp.	Bergamot/Beebalm	H	C	C		
Myosotis scorpiodes	True forget-me-not	H				
Onoclea sensibilis	Sensitive fern	H	O		C	

Table 3-8. Plant Species Observed During Field Reconnaissance of the Brown Bridge Area, June 2011

			Location/Relative Abundance[1]			
Species Name	**Common Name**	**Layer[2]**	**Successional /Old Field**	**Uplands**	**Wetlands**	**Dam Area**
Osmunda cinnamamoea	Cinnamon fern	H			U	
Osmunda claytoniana	Interrupted fern	H	O	O	O	
Ostrya virginiana	American hophornbeam	S	O	U		
Phalaris arundinacea	Reed canarygrass	H	O		C	
Phasyeocarpus opulifolius	Common ninebark	S	O			
Phleum pratense	Timothy	H		C		
Phragmites australis	Common reed	H	C		C	
Physocarpus opulifolius	Ninebark	S	O		O	O
Pinus banksiana	Jack pine	T	O	O		
Pinus resinosa	Red pine	T	O			
Pinus strobus	Eastern white pine	T	O	C		
Plantago lanceolata	Narrowleaf plantain	H	O	O		
Plantago major	Common plantain	H				
Poa compressa	Canada bluegrass	H	O	C	O	
Poa pratensis	Kentucky bluegrass	H				
Populus deltoides	Eastern cottonwood	S,T	O	O		
Populus grandidentata	Bigtooth Aspen	S,T	O	C		O
Populus tremuloides	Quaking aspen	S,T	O	C		
Potentilla simplex	Common cinquefoil	H		O		O
Potomogeton zosteriformis	Flatstem pondweed	H	U		O	
Prunus serotina	Black cherry	S,T		O		
Prunus virginiana	Chokecherry	S				
Pteridium aquilinianum	Bracken fern	H		A		O
Quercus alba	White oak	T				
Quercus rubra	Red oak	T	O	C		
Rhamnus cathartica	Common buckthorn	S	O			
Rubus sp.	Blackberry	S	O	O		
Rumex acetosela	Sheep sorrel/red sorrel	H				O
Sagittaria latifolia	Broadleaf arrowhead	H			O	
Salix sp.	Willow	S		U	C	
Schoenoplectus acutus	Hardstem bulrush	H			C	
Scirpus atrovirens	Green bulrush	H			O	
Scirpus cyperinus	Wool grass	H			O	
Scirpus validus	Softstem bulrush	H	O		C	
Senecio sp.	Ragwort	H		O	O	
Silene latifolia	Bladder campion/white campion	H	O	O		O
Solidago canadensis	Canada goldenrod	H	O	O		
Spinulum annotinum	Stiff clubmoss	H		O		
Thalictrum dioicum	Early meadow-rue	H	U		C	
Thelypteris palustris	Eastern marsh fern	H			O	
Thuja occidentalis	Northern white cedar	T			C	
Toxicodendron radicans	Poison ivy	H				

Table 3-8. Plant Species Observed During Field Reconnaissance of the Brown Bridge Area, June 2011

			Location/Relative Abundance[1]			
Species Name	**Common Name**	**Layer[2]**	**Successional /Old Field**	**Uplands**	**Wetlands**	**Dam Area**
Tragopogon dubium	Yellow salsify	H				U
Trifolium agrarium	Yellow hop clover	H				O
Trifolium pratense	Red clover	H		O		
Trifolium repens	White clover	H				
Tsuga canadensis	Eastern hemlock	T		C	C	
Typha latifolia	Broadleaf cattail	H			O	
Verbascum thapsus	Common mullein	H		U		
Vitis riparia	Riverbank grape	V			O	

1 Relative Abundance: A-abundant, C-common, O-occasional, U-uncommon
2 Layer: H-herbaceous, S-shrub, T-tree, V-vine

Environmental Consequences

Changes in land use/land cover associated with Alternative B are primarily associated with the alteration of the open water category. Under this alternative, the open water cover type will be modified to a complex of wetland and transitional upland categories that form in response to the natural patterns of succession within the region. Native seeding will be conducted to promote the establishment of plant communities typical of the regional and representative of the habitats characterized in Table 3-8.

Restoration of the bottomland of Brown Bridge Pond to these natural land cover types will also benefit the restoration of these lands to traditional uses. TEK of the GTB regarding the traditional uses of these lands will provide valuable inputs to future management of these lands.

It is expected that early successional communities will be dominated by similar plant associations as those represented by the old field communities found in the vicinity of Brown Bridge Pond (see Table 3-8). In time, plant communities of the exposed bottomland will be replaced by more forested communities dominated by species similar to those upland and forested associations currently established in the vicinity of Brown Bridge Pond. Additionally, invasive species establishment within the Brown Bridge bottomland will also be managed (by others) to promote the proliferation and development of a native plant community.

3.3.2.2 Wildlife

Affected Environment

Plant communities within the project area support a diverse array of wildlife species. Tables 3-9, 3-10, and 3-11 provide representative lists of wildlife species expected to occur in the vicinity of the project site based on previous surveys and consultations with resource agencies, state biologists and mammologists. Wildlife habitats immediately near Brown Bridge Pond and Dam include the shoreline along Brown Bridge Pond, the Brown Bridge delta (above Brown Bridge Pond), and the riparian corridor along the Boardman River. These habitats support a diverse wildlife community characterized by waterfowl (ducks, geese), swans, wading birds (sandpipers), shorebirds (herons), raptors (hawks, bald eagle), various mammal species (whitetail deer, cottontail rabbit, and other rodents), and herpetofauna (snakes, frogs, toads, turtles, salamanders).

The upland communities in the vicinity of the Brown Bridge Dam and Pond also support a diversity of wildlife, but fewer water-dependent species and more taxa that are typically associated with more mesic (moist) and drier habitats. Bird communities in these areas are more dominated by species that frequent trees and shrubs such as songbirds, woodpeckers and other cavity-nesting species, as well as neotropical migratory birds (warblers) and upland game birds (wild turkey, ruffed grouse). Additionally, these uplands support a different assemblage of mammals including a variety of bat species, rodents (groundhog, squirrels, chipmunks, white-footed mouse, etc.), and carnivorous species (red and gray fox, raccoon, striped skunk, etc.).

Wildlife species occurrence data are available from the Boardman River Feasibility Study: An Interim Report on Boardman River Wildlife Data (ECT, 2009c) (FS Report). The FS includes a records review to identify wildlife species reported near the Brown Bridge Pond and Brown Bridge Dam. Components of the ECT (2009c) FS report include:

- Breeding Bird Atlas Data for Grand Traverse County, Kalamazoo Nature Center,
- USGS Breeding Bird Survey Data for the two routes closest to the project area (Routes 49029, 49230),
- Waterfowl and songbird surveys conducted by ECT in 2007,
- A furbearer survey by the GTB in 2005 and 2006,
- Brown Bridge Pond Small Mammal Survey conducted by ECT in 2007,
- Boardman River Frog and Toad Survey conducted by ECT in 2007,
- Data obtained as part of a state-wide MDNR's Frog and Toad Survey and
- A species list compiled by ECT based on consultation from state biologists and mammalogists.

Table 3-9. Birds in the Vicinity of the Brown Bridge Dam and Pond

Common Name	Scientific name	Breeding Bird Atlas*	Breeding Bird Survey-Route 029†	Breeding Bird Survey-Route 230†	Brown Bridge Pond Waterfowl Survey**	Brown Bridge Oaks**	Brown Bridge Boardwalk**	Brown Bridge Delta**	Brown Bridge Landing**
Spotted sandpiper	*Actitis macularia*	X						X	X
Red-winged blackbird	*Agelaius phoeniceus*	X	X	X			X	X	X
Wood duck	*Aix sponsa*	X	X					X	
Grasshopper sparrow	*Ammodramus savannarum*	X	X	X					
Mallard	*Anas platyrhynchos*	X		X	X		X	X	
American black duck	*Anas rubripes*	X	X		X				
Ruby-throated hummingbird	*Archilochus colubris*	X							
Great blue heron	*Ardea herodias*	X							
Ring-necked duck	*Aythya collaris*				X				
Tufted titmouse	*Baeolophus bicolor*	X		X			X		X
Upland sandpiper	*Bartramia longicauda*			X					
Cedar waxwing	*Bombycilla cedrorum*	X	X	X					
Ruffed grouse	*Bonasa umbellus*	X							
Canada goose	*Branta canadensis*	X	X		X		X	X	X
Great horned owl	*Bubo virginianus*	X							
Bufflehead	*Bucephala albeola*				X				
Common goldeneye	*Bucephala clangula*				X				
Red-tailed hawk	*Buteo jamaicensis*	X	X	X					
Red-shouldered hawk	*Buteo lineatus*	X							
Broad-winged hawk	*Buteo platypterus*	X	X						
Green heron	*Butorides virescens*	X							
Whip-poor-will	*Caprimulgus vociferus*			X					
Northern cardinal	*Cardinalis cardinalis*	X	X	X					
Pine siskin	*Carduelis pinus*	X							
American goldfinch	*Carduelis tristis*	X	X	X					X
House finch	*Carpodacus mexicanus*	X	X	X					
Purple finch	*Carpodacus purpureus*	X	X						
Turkey vulture	*Cathartes aura*	X	X	X					
Veery	*Catharus fuscescens*	X				X			
Hermit thrush	*Catharus guttatus*	X	X	X					X
Brown creeper	*Certhia americana*	X	X						
Killdeer	*Charadrius vociferus*	X	X	X				X	
Yellow-billed cuckoo	*Coccyzus americanus*	X	X			X			X
Black-billed cuckoo	*Coccyzus erythropthalmus*	X							
Northern flicker	*Colaptes auratus*	X	X	X					
Eastern wood-pewee	*Contopus virens*	X	X	X		X	X		X
American crow	*Corvus brachyrhynchos*	X	X	X		X	X	X	X

Table 3-9. Birds in the Vicinity of the Brown Bridge Dam and Pond

Common Name	Scientific name	Breeding Bird Atlas*	Breeding Bird Survey-Route 029†	Breeding Bird Survey-Route 230†	Brown Bridge Pond Waterfowl Survey**	Brown Bridge Oaks**	Brown Bridge Boardwalk**	Brown Bridge Delta**	Brown Bridge Landing**
Common raven	*Corvus corax*	X	X						X
Blue jay	*Cyanocitta cristata*	X	X	X		X	X		X
Trumpeter swan	*Cygnus buccinator*				X			X	X
Mute swan	*Cygnus olor*	X							
Black-throated blue warbler	*Dendroica caerulescens*	X							
Yellow-rumped warbler	*Dendroica coronata*	X	X	X		X	X		X
Blackburnian warbler	*Dendroica fusca*	X							
Magnolia warbler	*Dendroica magnolia*	X							
Chestnut-sided warbler	*Dendroica pensylvanica*	X		X					
Yellow warbler	*Dendroica petechia*	X	X	X					
Pine warbler	*Dendroica pinus*	X	X	X		X			X
Cape May warbler	*Dendroica tigrina*	X		X					
Bobolink	*Dolichonyx oryzivorus*	X	X	X					
Gray catbird	*Dumetella carolinensis*	X	X	X					
Alder flycatcher	*Empidonax alnorum*	X		X					
Least flycatcher	*Empidonax minimus*	X	X						
Willow flycatcher	*Empidonax traillii*	X							
Brewer's blackbird	*Euphagus cyanocephalus*	X						X	X
Merlin	*Falco columbarius*	X							
American kestrel	*Falco sparverius*	X	X	X					
Common loon	*Gavia immer*	X			X		X	X	X
Common yellowthroat	*Geothlypis trichas*	X	X	X			X	X	X
Bald eagle	*Haliaeetus leucocephalus*	X				X			
Barn swallow	*Hirundo rustica*	X	X	X					
Wood thrush	*Hylocichla mustelina*	X				X			
Baltimore oriole	*Icterus galbula*	X	X	X		X			
Ring-billed gull	*Larus delawarensis*	X	X	X	X		X		X
Hooded merganser	*Lophodytes cucullatus*				X				
Belted kingfisher	*Megaceryle alcyon*	X		X			X	X	X
Red-bellied woodpecker	*Melanerpes carolinus*	X		X		X			
Pileated woodpecker	*Melanerpes erythrocephalus*	X	X	X		X	X		X
Red-headed woodpecker	*Melanerpes erythrocephalus*	X							
Wild turkey	*Meleagris gallopavo*	X	X	X					
Swamp sparrow	*Melospiza georgiana*	X	X						
Song sparrow	*Melospiza melodia*	X	X	X			X	X	X
Tree swallow	*Melospiza melodia*	X	X	X			X	X	X
Common merganser	*Mergus merganser*				X				

Table 3-9. Birds in the Vicinity of the Brown Bridge Dam and Pond

Common Name	Scientific name	Breeding Bird Atlas*	Breeding Bird Survey-Route 029†	Breeding Bird Survey-Route 230†	Brown Bridge Pond Waterfowl Survey**	Brown Bridge Oaks**	Brown Bridge Boardwalk**	Brown Bridge Delta**	Brown Bridge Landing**
Northern mockingbird	*Mimus polyglottos*	X		X					
Black-and-white warbler	*Mniotilta varia*	X	X	X					X
Brown-headed cowbird	*Molothrus ater*	X	X	X					
Great crested flycatcher	*Myiarchus crinitus*	X	X	X		X	X		X
Mourning warbler	*Oporornis philadelphia*	X	X	X					
Tennessee warbler	*Oreothlypis peregrina*	X							
Northern waterthrush	*Parkesia noveboracensis*	X							
House sparrow	*Passer domesticus*	X		X					
Savannah sparrow	*Passerculus sandwichensis*	X	X	X					
Indigo bunting	*Passerina cyanea*	X	X	X					
Cliff swallow	*Petrochelidon pyrrhonota*	X							
Ring-necked pheasant	*Phasianus colchicus*			X					
Rose-breasted grosbeak	*Pheucticus ludovicianus*	X	X	X					
Downy woodpecker	*Picoides pubescens*	X	X	X		X			
Hairy woodpecker	*Picoides villosus*	X							
Scarlet tanager	*Piranga olivacea*	X	X	X		X	X		
Pied-billed grebe	*Podilymbus podiceps*						X		X
Black-capped chickadee	*Poecile atricapillus*	X		X			X		X
Vesper sparrow	*Pooecetes gramineus*	X	X	X					
Common grackle	*Quiscalus quiscula*	X	X	X					X
Golden-crowned kinglet	*Regulus satrapa*	X							
Bank swallow	*Riparia riparia*	X	X	X					
Ovenbird	*Seiurus aurocapilla*	X	X	X		X			X
American redstart	*Setophaga ruticilla*	X		X		X			
Black-throated green warbler	*Setophaga virens*	X	X	X					
Eastern bluebird	*Sialia sialis*	X	X	X					
Eastern kingbird	*Sialia sialis*	X	X	X					
Red-breasted nuthatch	*Sitta canadensis*	X	X						
White-breasted nuthatch	*Sitta carolinensis*	X	X	X		X			
Yellow-bellied sapsucker	*Sphyrapicus varius*	X	X						
Chipping sparrow	*Spizella passerina*	X	X	X		X			X
Field sparrow	*Spizella pusilla*	X	X	X					
Northern rough-winged swallow	*Stelgidopteryx serripennis*	X		X					X
Barred owl	*Strix varia*	X							
Eastern phoebe	*Sturnella magna*	X		X					
European starling	*Sturnus vulgaris*	X	X	X					

Table 3-9. Birds in the Vicinity of the Brown Bridge Dam and Pond

Common Name	Scientific name	Breeding Bird Atlas*	Breeding Bird Survey-Route 029†	Breeding Bird Survey-Route 230†	Brown Bridge Pond Waterfowl Survey**	Brown Bridge Oaks**	Brown Bridge Boardwalk**	Brown Bridge Delta**	Brown Bridge Landing**
Brown thrasher	*Toxostoma rufum*	X	X	X					
House wren	*Troglodytes aedon*	X		X		X			
Winter wren	*Troglodytes hiemalis*	X	X	X					
American robin	*Turdus migratorius*	X	X	X		X			X
Eastern meadowlark	*Tyrannus tyrannus*	X	X	X					
Golden-winged warbler	*Vermivora chrysoptera*	X							
Nashville warbler	*Vermivora ruficapilla*	X	X	X					
Yellow-throated vireo	*Vireo flavifrons*	X							
Warbling vireo	*Vireo gilvus*	X	X	X			X		
Red-eyed vireo	*Vireo olivaceus*	X	X	X		X	X	X	X
Blue-headed vireo	*Vireo solitarius*	X	X	X					
Canada warbler	*Wilsonia canadensis*	X		X					
Mourning dove	*Zenaida macroura*	X	X	X					
White-throated sparrow	*Zonotrichia albicollis*	X	X	X					
Species Richness		**114**	**70**	**76**	**11**	**22**	**21**	**15**	**32**

* Breeding Bird Atlas Data for Grand Traverse County, Kalamazoo Nature Center, 2001-2006.
†The 2005 USGS Breeding Bird Survey Data for Routes 49029 and 49230.
** Waterfowl and Songbird Surveys conducted by Environmental Consulting & Technology in 2007.

Table 3-10. Mammals in the Vicinity of Brown Bridge Dam and Pond

Common Name	Scientific Name	Furbearer Survey*	Boardman River 2007 Survey†	Boardman River Region**
Southern flying squirrel	*Glaucomys volans*			X
Short-tailed shrew	*Blarina brevicauda*			X
Coyote	*Canis latrans*	X		X
Beaver	*Castor canadensis*			X
Thirteen-lined ground squirrel	*Citellus tridecimlineatus*			X
Red-backed vole	*Clethrionomys gapperi*			X
Star-nosed mole	*Condylura cristata*			X
Opossum	*Didelphis virginiana*	X		X
Big brown bat	*Eptesicus fuscus*			X
Red bat	*Lasiurus borealis*			X
Hoary bat	*Lasiurus cinereus*			X
River otter	*Lutra canadensis*	X		X
Bobcat	*Lynx rufus*	X		X
Ground hog	*Marmota monax*			X
Striped skunk	*Martes americana*	X		X
Pine marten	*Mephitis mephitis*	X		X
Meadow vole	*Microtus pennsylvanicus*		X	X
Long-tailed weasel	*Mustella frenata*	X		X
Mink	*Mustella vison*	X		X
Little brown bat	*Myotis lucifugus*			X
White-tailed deer	*Odocoileus virginana*			X
Muskrat	*Ondatra zibethicus*			X
White-footed mouse	*Peromyscus leucopus*		X	X
Raccoon	*Procyon lotor*	X		X
Eastern mole	*Scalopus aquaticus*			X
Eastern gray squirrel	*Sciurus caarolinensis*			X
Meadow jumping mouse	*Sciurus niger*			X
Masked shrew	*Sorex cinereus*			X
Water shrew	*Sorex palustris*			X
Eastern cottontail	*Sylvilagus floridanus*			X
Eastern chipmunk	*Tamias striatus*		X	X
Gray fox	*Urocyon cynareoagenteus*	X		X
Red squirrel	*Tamiasciurus hudsonicus*			X
Black bear	*Ursus americanus*			X
Red fox	*Vulpes vulpes*	X		X
Fox squirrel	*Zapus hudsonius*		X	X
Species Richness		**11**	**4**	**36**

* Furbearer Survey by the GTB.
† Brown Bridge Pond Small Mammal Survey conducted by Environmental Consulting & Technology, Inc in 2007
** Mammals of the Boardman Valley reported by Environmental Consulting & Technology, Inc. in 2007.

Table 3-11. Reptiles and Amphibians in the Vicinity of Brown Bridge Dam and Pond

Common Name	Scientific Name	Boardman River Region*	Boardman River 2007 Survey†
Lizards			
Five-lined skink	*Eumeces fasciatus*	X	
Snakes			
Blue racer	*Coluber constictor*	X	
Eastern hog-nosed snake	*Heterodon platyrhinos*	X	
Northern water snake	*Nerodia sipedon*	X	
Smooth green snake	*Opheodrys vernalis*	X	
Northern brown snake	*Storeria dekayi*	X	
Red-bellied snake	*Storeria occipitomaculata*	X	
Ribbon snake	*Thamnophis sauritus*	X	
Garter snake	*Thamnophis sirtalis*	X	
Turtles			
Painted turtle	*Chrysemes picta*	X	
Wood turtle	*Glyptemys insculpta*	X	
Common snapping turtle	*Cvhelydra serpentina*	X	
Blanding's turtle	*Emydoidea blandingii*	X	
Frogs and Toads			
American toad	*Bufo americanus*	X	X
Gray tree frog	*Hyla versicolor*	X	X
Spring peeper	*Pseudacris crucifer*	X	X
Striped chorus frog	*Pseudacris triseritata*	X	X
Bull Frog	*Rana catesbiana*	X	
Green frog	*Rana clanitans*	X	X
Northern leopard frog	*Rana pipiens*	X	X
Wood frog	*Rana sylvatica*	X	X
Salamanders			
Blue-spotted salamander	*Ambystoma laterale*	X	
Spotted salamander	*Ambystoma maculatum*	X	
Mudpuppy	*Necturus maculosa*	X	
Eastern newt	*Notophthalmus viridescens*	X	
Red-backed salamander	*Plethodon cinereus*	X	
Species Richness		**26**	**7**

* Reptile and Amphibian Species of the Boardman River reported by Environmental Consulting and Technology, Inc. in 2007.

† Boardman River Frog and Toad Survey Conducted in 2007 by Environmental Consulting and Technology, Inc.

Typical bird species expected to occur include a mix of songbirds and waterfowl such as red-winged blackbird (*Agelaius phoeniceus*), tufted titmouse (*Baeolophus bicolor*), black-capped chickadee (*Poecile atricapillus*), American robin (*Turdus migratorius*), Canada goose (*Branta canadensis*), mallard (*Anas platyrhynchos*), eastern wood-pewee (*Contopus virens*), American crow (*Corvus brachyrhynchos*), blue jay (*Cyanocitta cristata*), common yellowthroat (*Geothlypis trichas*), red-eyed vireo (*Vireo olivaceus*), belted kingfisher (*Megaceryle alcyon*), pileated woodpecker (*Melanerpes erythrocephalus*), song sparrow (*Melospiza melodia*), tree swallow (*Melospiza melodia*), and great crested flycatcher (*Myiarchus crinitus*). Table 3-9 also provides a summary of all of the bird species previously reported by the above-mentioned sources.

Mammal species expected to occur in the vicinity of the project include white-tailed deer (*Odocoileus virginana*), eastern cottontail (*Sylvilagus floridanus*), opossum (*Didelphis virginiana*), eastern gray squirrel (*Sciurus carolinensis*), fox squirrel (*Sciurus niger*), meadow vole (*Microtus pennsylvanicus*), white-footed mouse (*Peromyscus leucopus*), coyote (*Canis latrans*), groundhog (*Marmota monax*), beaver (*Castor canadensis*), river otter (*Lontra canadensis*), muskrat (*Ondatra zibethicus*), bobcat (*Lynx rufus*), striped skunk (*Mephitis mephitis*), raccoon (*Procyon lotor*), gray fox (*Urocyon cinereoargenteus*), red fox (*Vulpes vulpes*), big brown bat (*Eptesicus fuscus*), little brown bat (*Myotis lucifugus*), red bat (*Lasiurus borealis*), and hoary bat (*Lasiurus cinereus*). A complete list of mammals observed or expected to occur near the project site is presented in Table 3-10.

A complete list of herpetofauna (reptiles and amphibians) species expected to occur in the vicinity of the project is presented in Table 3-11. Turtles that could be found near the project site include the eastern painted turtle (*Chrysemys picta*), common snapping turtle (*Cvhelydra serpentina*), wood turtle (*Clemmys insculpta*), and Blanding's turtle (*Emydoidea blandingii*). Frogs and toads expected near the project site include american toad (*Bufo americanus*), gray tree frog (*Hyla versicolor*), spring peeper (*Pseudacris crucifer*), northern leopard frog (*Rana pipiens*), striped chorus frog (*Pseudacris triseritata*), green frog (*Rana clanitans*), and wood frog (*Rana sylvatica*). The red-backed salamander (*Plethodon cinereus*), spotted salamander (*Ambystoma maculatum*), and blue-spotted salamander (*Ambystoma laterale*) are species that should occur near the Brown Bridge project site. Snakes believed to occur near the project site include blue racer (*Coluber constictor*), eastern hog-nosed snake (*Heterodon platyrhinos*), northern water snake (*Nerodia sipedon*), smooth green snake (*Opheodrys vernalis*), northern brown snake (*Storeria dekayi*), red-bellied snake (*Storeria occipitomaculata*), ribbon snake (*Thamnophis sauritus*) and garter snake (*Thamnophis sirtalis*).

Environmental Consequences

Alternative A – No Action

Under the No Action Alternative, dam maintenance would still be needed and there would be no construction related to the project with any changes to wildlife occurring over time in response to natural changes in habitat or vegetation communities. Maintaining the dam would continue to segregate river reaches causing discontinuity between wildlife habitats.

Alternative B – Dam Removal with Blended Restoration

Under Alternative B impacts to wildlife result from the conversion of available habitats used by mammals, birds, reptiles, and amphibians that inhabit areas near the project site. Wildlife habitats immediately near Brown Bridge Pond and Brown Bridge Dam include the shoreline along Brown Bridge Pond, the Brown Bridge delta, and the riparian corridor along the Boardman River. After dam removal, areas that were once part of Brown Bridge Pond will be converted back to a more natural pre-dam condition that includes the original river channel and the riparian corridor along this reach of river which will encompass newly formed wetlands. Expansion of the distribution of terrestrial fauna (white-tailed deer, coyote, foxes, beaver, bobcat, raccoon, opossum, etc.) into newly established habitats is anticipated for Alternative B. These species are expected to utilize the newly exposed bottomland on an intermittent basis immediately after drawdown and dam removal, but will establish themselves within the new habitats as restoration progresses. Once vegetation is re-established, wildlife species are likely to make use of the project area again, especially for herbivorous wildlife that will make use of the fresh browse from the re-established vegetation. Full habitat restoration is expected to take many years, but faunal use patterns within the bottomland may be expected to follow trends in successional development as plant communities develop greater complexity to support a highly diverse wildlife population.

Semi-aquatic species including frogs, toads, turtles and wading birds will be variously impacted by the loss of Brown Bridge Pond. While the abundance of open water will be eliminated, the aquatic and semi-aquatic habitats of the restored river and associated wetlands are expected to provide suitable habitat for many of these species. Additionally, the removal of Brown Bridge Dam is also expected to benefit wildlife as it will enhance continuity in habitats associated with the riverine environment upstream and downstream of the dam.

Dam removal and restoration is expected to result in the displacement of waterfowl and water-dependent fauna that currently utilize the open water of Brown Bridge Pond. Waterfowl in particular, are expected to be displaced to other open water habitats in the region. Because of the abundance of these habitats in the project vicinity, no significant adverse impacts to waterfowl are anticipated.

3.3.3 Sensitive Species

3.3.3.1 Affected Environment

Table 3-12 provides a tabulation of sensitive species identified through correspondence with resource agencies and those that may be listed federally or by the State of Michigan as endangered, threatened, candidate or species of special concern as potentially occurring in the vicinity of the Brown Bridge project site. There are no federally listed species within the project site; however, the Eastern massasauga rattlesnake (*Sistrurus catenatus*) is a candidate for federal listing. Additionally, there are seven species listed by the State of Michigan as either threatened or a species of special concern that could occur within the project vicinity. Common loon (*Gavia immer*), trumpeter swan (*Cygnus buccinator*), and red-shouldered hawk (*Buteo lineatus*) are each listed by the State of Michigan as threatened. Threatened species are protected under the Endangered Species Act of the State of Michigan. Bald eagle (*Haliaeetus leucocephalus*), wood turtle (*Clemmys insculpta*), Blanding's turtle (*Emydoidea blandingii*), and northern leopard frog (*Rana pipiens*) are each listed by the State of Michigan as a species of special concern. Species of special concern are not protected under the Endangered Species Act; however, their populations have been designated by the State of Michigan as declining.

Table 3-12. Sensitive Species in the Vicinity of the Brown Bridge Project Site

Common Name	Scientific Name	Status
Red-shouldered hawk	*Buteo lineatus*	Michigan state listed as threatened
Wood turtle	*Glyptemys insculpta*	Michigan state listed as species of special concern
Trumpeter swan	*Cygnus buccinator*	Michigan state listed as threatened
Blanding's turtle	*Emydoidea blandingii*	Michigan state listed as species of special concern
Common loon	*Gavia immer*	Michigan state listed as threatened
Bald eagle	*Haliaeetus leucocephalus*	Michigan state listed as species of special concern
Eastern massasauga rattlesnake	*Sistrurus catenatus*	Michigan state listed as species of special concern Federal candidate species

<u>Common Loon</u>

The common loon is not a federally listed species, but is listed by the State of Michigan as threatened (see Table 3-12). This species is also protected by the provisions of the Migratory Bird Treaty Act. Breeding loons were commonly reported during the 19th century with much less abundant numbers reported in the 20th century. The decline of loon numbers during this time has been attributed to the expansion of human settlement, egg collection, and sport shooting. Systematic surveying of breeding pairs was initiated in the 1980s that documented only 300 pairs in the state and thus provoked the inclusion of common loons onto the state's Threatened Species

List. More recent impacts to common loon declines include habitat destruction, disease, heavy metals, human recreation, and botulism toxins. These botulism toxins grow in fish like the round goby (*Neogobius melanostomus*). Once the fish-eating loon ingests an infected fish, the toxin causes paralysis and eventually drowns (*Gibson*, 2007).

In Michigan, common loons typically breed on inland lakes greater than 40 acres in size during late March and April. Copulation takes place on land. Nests are formed out of aquatic and terrestrial vegetation and contain one or two eggs that are incubated for 26 to 31 days. Re-nesting may occur in the event of a nest failure (Gibson, 2007).

Within the project area, common loons have been observed nesting at Brown Bridge Pond. A floating nesting platform was established on the pond in 1992 and loons have been documented to have successfully reproduced an estimated 26 individuals (GTCD, 2012). Common loons were also documented as part of 2007 surveys at Brown Bridge Pond and as part of the Breeding Bird Atlas for Grand Traverse County (see Table 3-9). A breeding pair was observed on Brown Bridge Pond in 2011. However, no successful reproduction occurred, possibly due to a high water event in the spring (Largent, personal communication). The position of the floating nesting platform on Brown Bridge Pond may be a contributor to the periodic nest failure observed at this location.

Trumpeter Swan

The trumpeter swan is not a federally listed species, but is listed by the State of Michigan as threatened (see Table 3-12). This species is also protected by the provisions of the Migratory Bird Treaty Act. Trumpeter swans were abundant through the 18th century, but once the settlement of America began in the 1800s, trumpeter numbers plummeted. Factors related to the settlement of America and the sharp decline of trumpeter swans included clearing of lands, draining and filling of marshes, and the harvest of trumpeter swans for their down and quills. Only an estimated 66 trumpeter swans remained in the United States by 1933. A re-introduction program started in the 1980s has raised trumpeter swans in Michigan to an estimated 400 individuals for the year 2000 (MDNR, 2011c).

Trumpeter swans live on land, but are always near water such as wetlands, rivers, or streams (Robins, 2011). Trumpeter swans do not reach sexual maturity until four years of age. In Michigan, nesting occurs in late April to late July (Michigan Natural Resources Inventory, 2007). Nests are surrounded by water, constructed from aquatic and terrestrial vegetation, and contain four to six eggs that are incubated for 32 to 37 days (Robins, 2011).

Within the project area, a lone pair of trumpeter swans was observed by ECT during their 2007 surveys at Brown Bridge Pond. This pair was not nesting, but could be establishing a nesting territory for future years (ECT, 2009b and Table 3-9). Nesting was observed by GTCD in 2009 and 2010 (GTCD, 2012), and in 2011, a nesting pair was observed that had produced six cygnets.

Red-shouldered Hawk

The red-shouldered hawk is not a federally listed species, but is listed by the State of Michigan as threatened (see Table 3-12). This species is also protected by the provisions of the Migratory Bird Treaty Act. Prior to the 20th century, red-shouldered hawks were one of the most common hawks within eastern North America; however, through most of the 20th century population densities declined due to hunting and loss of wet hardwood forests. Today, threats to red-shouldered hawks include habitat loss, poisons such as insecticides and industrial pollutants, and human disturbance to nest sites by logging operations (Kirschbaum and Miller, 2000).

Red-shouldered hawks utilize mature forested floodplain habitat with the majority of the nests found in mature deciduous or mixed forests in close proximity to wetlands. Red-shouldered hawks are highly territorial with their nest sites and will re-use those nest sites year after year. Nests are constructed out of twigs and leaves and contain two to four eggs that are incubated for one month. In Michigan, breeding red-shouldered hawks have shifted from their historical range in the southern Lower Peninsula to the current location of the northern Lower Peninsula (Cooper, 1999).

Two red-shouldered hawks were recorded in 2004 midway between Brown Bridge Pond and Boardman Pond (ECT, 2009b), but have not been observed near the project site since then. Red-shouldered hawks were also documented as part of the Breeding Bird Atlas for Grand Traverse County (see Table 3-9).

Bald Eagle

Although the bald eagle is no longer a federally listed species, it is listed by the State of Michigan as a species of special concern (see Table 3-12), and is protected under the Bald and Golden Eagle Protection Act of 1940 (as amended), Provisions of this Act prohibits anyone, without a permit issued by the Secretary of the Interior, from "taking" bald eagles, including their parts, nests, or eggs. The Act defines "take" as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb." This species is also protected by the provisions of the Migratory Bird Treaty Act.

Historically, bald eagles experienced severe population declines as a result of wetland habitat loss and degradation (Gehring, 2006) and hunting. Bald eagles were hunted for their feathers and due to the misconception that they posed a threat to livestock (Harris, 2002). More recently, during the mid to late portion of the 20th century, bald eagles experienced sharp population declines due to the pollutant dichlorodiphenyltrichloroethane (DDT) that caused the thinning of egg shells (Gehring, 2006). The banning of DDT and the protection under the Endangered Species Act steadily restored bald eagle populations to stable levels, resulting in de-listing them as an endangered species.

Bald eagles inhabit areas associated with water where they can readily find fish, a staple of their diet. They nest in large mature trees, nest platforms, or utility poles. In Michigan, these large nest trees are typically found in white pine (*Pinus strobus*), red pine (*Pinus resinosa*), yellow birch (*Betula lutea*), maple (*Acer* spp.), oak (*Quercus* spp.), and aspen (*Populus* spp.). Nests are very large, constructed out of limbs, twigs, and other terrestrial vegetation, and usually contain one to four eggs that are incubated for approximately 35 days (Gehring, 2006).

In the vicinity of the project area, bald eagles were documented as part of the Breeding Bird Atlas for Grand Traverse County and as part of the surveys conducted by ECT in 2007 (see Table 3-9). Additionally, a bald eagle pair has been documented as having nested at Brown Bridge Pond since 2002. The pair was observed in 2006 and 2007, but was unsuccessful in producing young in 2007 (ECT, 2009b). Repeated observations of bald eagles at Brown Bridge have been made subsequently, including observations in 2011. The nest has been identified within Wetland B south of the Brown Bridge impoundment. The nest failed to produce young in 2011, but produced two young in each of 2010 and 2009.

Wood Turtle

The wood turtle is not a federally listed species, but is listed by the State of Michigan as a species of special concern (see Table 3-12). In Michigan, these turtles are found in the northern Lower Peninsula and the Upper Peninsula. Over the previous 20 to 30 years, wood turtle populations have

significantly decreased mainly from commercial pet trade, collection by the general public, and more recently habitat degradation (Lee, 1999a).

Wood turtles have very specific habitat requirements (hard substrate bottom of streams or river, herbaceous vegetation for foraging and sandy nesting substrate); thus alterations to habitat from human activities can pose a threat to wood turtles. However, wood turtles can endure even with moderate habitat alteration as long as adequate habitat is maintained with sandy conditions for nesting (Lee, 1999a). Mating occurs primarily in June and females produce one clutch per year of 5 to 18 eggs. In addition to the sandy substrate, nesting areas have a slope less than 40 degrees, virtually no vegetation present, sunlight for most of the day, and located near water. Sexual maturity of wood turtles is not reached until 12 to 20 years of age (Lee, 1999a).

Wood turtles were documented in the Brown Bridge Quiet Area in a 1992 survey by Reese (Largent, 1993). However, in recent surveys no wood turtles have been reported in the project vicinity. Habitat along the Boardman River does meet their habitat requirements. As a consequence, wood turtles are listed as a species of the Boardman River Region (ECT, 2009b).

Blanding's Turtle

Blanding's turtle is not a federally listed species, but is listed by the State of Michigan as a species of special concern (see Table 3-12). In Michigan, the Blanding's turtle has been reported in nearly the entire Lower Peninsula and in the central Upper Peninsula. Declining population levels are attributed to habitat loss and fragmentation. Blanding's turtles require clean, shallow water with abundant aquatic vegetation. These specific habitat needs make them more susceptible to habitat alteration (Lee, 1999b).

Blanding's turtles are active as early as April and are often found in shallow, clean water with aquatic vegetation and a soft bottom over firm substrate such as a marsh, swamp, bog, wet prairie, backwater, slough, cove, embayment, or lake shallow. During the mating season of the spring and summer, Blanding's turtles are found in upland areas. Nesting occurs in open, sandy areas with a clutch of 6 to 21 eggs that hatch in 50 to 75 days. Blanding's turtles exhibit delayed sexual maturity, not reaching sexual maturity until an age of 14 to 20 years (Lee, 1999b).

No specific information is available regarding the presence of Blanding's turtles within the project vicinity. Habitat along the Boardman River does meet their habitat requirements. As a consequence, Blanding's turtles are listed as a species of the Boardman River Region (ECT, 2009b).

Eastern Massasauga Rattlesnake

Eastern massasauga rattlesnake is not a federally listed species, but it is a candidate species and is listed by the State of Michigan as a species of special concern (see Table 3-12). In Michigan, the eastern massasauga rattlesnake has been reported in a majority of the Lower Peninsula. The greatest threats to population numbers have come in the form of habitat loss and degradation due to human activities such as the draining of wetlands for agricultural purposes, development of roads and residential areas and the associated vehicle mortality (Lee and Legge, 2000).

Eastern massasauga rattlesnakes are normally active between April and late October. In the spring, fall, and winter this species inhabits wetland habitats such as fens, bogs, swamps, wet meadows, moist grasslands, wet prairies, and floodplain forests. In the summer, they migrate to drier, more upland areas such as forest openings, old fields, and agricultural land. Mating occurs in the spring, summer, and fall. Females reach sexual maturity at age 3 or 4, giving birth to litters of 5 to 20

young during August or early September in mammal burrows or fallen logs of upland habitats (Lee and Legge, 2000).

No specific information is available regarding the presence of eastern massasauga rattlesnakes within the project vicinity. However, habitat along the Boardman River does meet some of their habitat requirements.

3.3.3.2 Environmental Consequences

Alternative A – No Action

Under the No Action Alternative, dam maintenance would still be needed and there would be no impact to sensitive species in the near term. Maintaining the dam would however, continue to segregate river reaches causing discontinuity between the habitats of sensitive species. Over time, aquatic habitats will infill due to sediment accretion, resulting in reduced suitability of habitat for species such as the common loon and trumpeter swan.

Alternative B – Dam Removal with Blended Restoration

Common loons and trumpeter swans are two waterfowl species listed by the State of Michigan as threatened. Within the project area, common loons have been observed nesting at Brown Bridge Pond and were active there in summer months. Removal of the dam will certainly impact breeding common loons and the trumpeter swan pair since these species typically bred and nest near inland lakes. However, given the vast amount of open water and inland lakes in the region, project-related impacts to common loons and trumpeter swans from Alternative B are expected to be small.

The red-shouldered hawk is listed by the State of Michigan as threatened. Two red-shouldered hawks were recorded in 2004 midway between Brown Bridge Pond and Boardman Pond, but have not been documented in recent years. These birds nest in mature trees and forage near wetland areas such as beaver ponds, wet meadows, and forest lowland. The removal of the Brown Bridge Dam will not alter the mature forests near the project site. Although some wetland areas will be lost by the conversion to riverine conditions, the restored wetlands within the Brown Bridge bottomland resulting from the restored river system will provide expanded foraging opportunity for red-shouldered hawks. Thus, project-related impacts to red-shouldered hawks from Alternative B are expected to be positive and small.

Bald eagle is protected under the Bald and Golden Protection Act and is listed by the State of Michigan as a species of special concern. The nesting pair of bald eagles at Brown Bridge may have chosen their nest sites because of its secluded location and the proximity to the impoundment. Under the proposed action (Alternative B) no impacts to the bald eagle nest tree or surrounding roost trees would occur. Additionally, because the construction area would be more than 900 feet from the nest, no significant noise related impacts are expected to occur. As a consequence of Alternate B the impoundment would be drawn down and eliminated, thereby altering the immediate availability of aquatic foraging habitat for this particular nesting pair. Bald eagles may utilize a large foraging area with a linear foraging distance exceeding 4 miles (USEPA, 2002), thus the nearby waterbodies will be available as continuing foraging area. Additionally, the restored river system and its associated restored wetlands within the Brown Bridge bottomland would become available to the nesting pair as foraging areas. Bald eagles not only utilize aquatic environments for foraging, but also are very opportunistic relying on other prey items such as carrion and other live birds and mammals. Consequently, the potential impacts to bald eagle are expected to be small. However, due to the potential for nest disturbance from impoundment drawdown, a federal take permit will be applied for through the USFWS (see Table 1-1). Additionally, the recommendations for minimizing disturbance to bald eagles based on the

National Bald Eagle Management Guidelines (USFWS, 2007) will be maintained throughout construction.

The two sensitive turtle species within the project site and vicinity are the wood turtle and Blanding's turtle. Both species are listed by the State of Michigan as species of special concern. Wood turtles prefer the hard substrate bottom of streams or rivers, while the Blanding's turtle prefers the shallow, clean water and soft bottom over firm substrate of a marsh, swamp, or bog. Both species require sandy conditions for nesting. These specific habitat needs of the wood turtle and Blanding's turtle will be improved, enhanced, and created with the dam removal and subsequent conversion of the pond to a more natural free-flowing river. The conversion to riverine conditions will also provide connectivity to other preferred habitats. Thus, project-related impacts to wood turtles and Blanding's turtles from Alternative B are expected to be positive and small.

Eastern massasauga rattlesnake is not a federally listed species, but it is a candidate species and is listed by the State of Michigan as a species of special concern. Specimens of this species have not been reported within the project vicinity. However, habitat along the Boardman River does meet some of their habitat requirements. The removal of the Brown Bridge Dam will not alter the upland areas near the project site that they may use in the summer months. Under Alternative B, approximately 21.6 acres of wetland habitat are expected to be gained as a result of bottomland restoration. Consequently, project-related impacts to the eastern massasauga rattlesnake from Alternative B are expected to be beneficial and small.

3.3.4 Wetlands

State wetland rules are provided in Part 303 of Michigan's Natural Resources and Environmental Protection Act (NREPA). In accordance with Part 303 of the NREPA, wetlands are regulated by the State of Michigan if they are:

- Connected to one of the Great Lakes or Lake St. Clair.
- Located within 1,000 feet of one of the Great Lakes or Lake St. Clair.
- Connected to an inland lake, pond, river, or stream.
- Located within 500 feet of an inland lake, pond, river or stream.
- Not connected to one of the Great Lakes or Lake St. Clair, or an inland lake, pond, stream, or river, but are greater than 5-acres in size.
- Not connected to one of the Great Lakes or Lake St. Clair, or an inland lake, pond, stream, or river, and less than 5-acres in size, but the MDEQ has determined that these wetlands are essential to the preservation of the state's natural resources and has notified the property owner.

In 1984, Michigan received authorization from the federal government to administer Section 404 of the federal Clean Water Act in most areas of the state. As such, wetlands in the study area are regulated at both the state and federal level by the MDEQ.

In addition, wetlands are also protected in accordance with Executive Order 11990. The purpose of Executive Order 11990 is to "minimize the destruction, loss or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands". To meet these objectives, the Order requires Federal agencies to consider alternatives to wetland sites and limit potential damage if an activity affecting a wetland cannot be avoided.

3.3.4.1 Affected Environment

Wetlands of the Brown Bridge area include forested, scrub shrub and emergent complexes that area associated with the bottomlands along the Boardman River and the area surrounding Brown Bridge Pond. Additionally, submersed aquatic vegetation communities have been identified within the fringing areas of Boardman Pond (see Section 3.3.1).

Wetlands in the study area were identified in the summer and fall of 2011 in accordance with the Corps of Engineers Wetlands Delineation Manual (USACE, 1987) and the Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: North Central and Northeast Region (USACE, 2009). The four wetland areas identified in the vicinity of Brown Bridge Pond are referred to as Wetlands A, B, C and D (Figure 3-6) and are described below.

Wetland A is a 32-acre forested wetland located upstream of and immediately adjacent to Brown Bridge Pond on the north side of the Boardman River. Common species in Wetland A include northern white cedar (*Thuja occidentalis*), red maple (*Acer rubrum*), balsam fir (*Abies balsamea*), and eastern white pine (*Pinus strobus*). Soils are mapped as Au Gres-Saugatuck sands, 2 to 6 percent slopes and Tawas-Roscommon complex. Au Gres-Saugatuck sands are not mapped as a hydric soil but typically have a shallow depth to the water table (approximately 6 to 18 inches). The Tawas-Roscommon complex; however, is mapped as a hydric soil with a water table typically at the soil surface (NRCS, 2011). In the field, soils were observed to consist of saturated black, mucky layers of varying thickness over sandy material. Groundwater appears to be the primary source of hydrology at Wetland A. Although groundwater discharge may be artificially enhanced by the backwater effects of the impoundment, seeps and springs were observed in various locations throughout the interior of the wetland and along the toe of the north valley wall at elevations ranging from ten to 20 feet above the surface water elevation of Brown Bridge Pond.

Wetland B is an 87-acre wetland system on the south shore of Brown Bridge Pond consisting of both emergent and forested wetland communities. Common emergent species include various sedges (*Carex* spp.), cattail (*Typha latifolia*), hardstem bulrush (*Schoenoplectus acutus*), softstem bulrush (*Scirpus validus*), and wool grass (*Scirpus cyperinus*). Common forested species include red maple, northern white cedar, and balsam fir. Hydric soils mapped within Wetland B include Kerston muck, Lupton muck, Roscommon mucky loamy sand, and Tawas-Roscommon complex. Mapped non-hydric soils are less common and include Au Gres-Saugatuck sands, 2 to 6 percent slopes, and Croswell loamy sands, 2 to 6 percent slopes. A portion of Wetland B has been mapped by the Natural Resource Conservation Service (NRCS) as Freshwater Marsh which is listed as an unknown soil type (NRCS, 2011). Soils in the field were observed to be a mixture of sand and muck. Groundwater is the apparent source of hydrology at Wetland B. Although groundwater discharge may be artificially enhanced by the backwater effects of the impoundment, groundwater discharge was observed in numerous locations along the toe of the south valley wall at elevations approximately 20 feet above the surface water elevation of Brown Bridge Pond.

Wetland C is a 43.5-acre forested wetland complex immediately below Brown Bridge Dam. Although this wetland complex is divided into two distinct sections by an old road/trail, the wetland sections are connected via culverts and are thus considered a single wetland community. Common wetland vegetation includes boneset (*Eupatorium perfoliatum*), sensitive fern (*Onoclea sensibilis*), tag alder (*Alnus incana*, a.k.a. *A. rugosa*), and northern white cedar. According to the NRCS (2011), soils in Wetland C are mapped as Lupton muck (hydric) and Croswell loamy sands, 0 to 2 percent slopes (not hydric). In the field soils were observed to consist of silty and sandy loams. Although large volumes of impounded water seeping through the dam into Wetland C is

readily apparent, evidence of groundwater discharge below the dam along the toe of the north valley wall was not observed in the field. As such, the primary source of hydrology at Wetland C appears to be seep water through the earthen dam.

Wetland D consists of 2.3-acres of emergent wetland located in the narrow relict stream channels in the delta. Although the entire delta area was previously identified as wetland (ECT, 2009a), this area has dried out substantially since the 3-foot reduction in the operating water level of the pond nearly four years ago. In 2008 the water elevation in Brown Bridge Pond was lowered as a safety measure following concerns of dam integrity. This change in operating water level has resulted in a loss of wetland hydrology throughout all areas of the delta except for the relict channels which, due to lower elevations, persist with saturated soils and in some places contain surface water. Soils in the delta are primarily unmapped but a small portion is mapped as Kerston muck (NRCS, 2011). In the field, soils were observed to be primarily sand and common wetland vegetation consisted of rice cut grass (*Leersia oryzoides*), wool grass, black bulrush (*Scirpus atrovirens*) and various sedges.

3.3.4.2 Environmental Consequences

Alternative A – No Action

Under the No Action Alternative, wetlands in the vicinity of Brown Bridge Pond would persist in the near term under current hydrologic conditions. In the long-term however, open water areas of the pond would continue to gradually transition to wetland and then to upland areas due to the deposition of sediment and pond infilling. Maintaining the dam would, therefore, allow the existing wetlands to persist but long-term alterations in habitat type, from open water to wetland and from wetland to upland, would continue. Short-term wetland impacts under the No Action Alternative are not anticipated.

Alternative B – Dam Removal with Blended Restoration

Wetland alteration is anticipated as a result of dam removal and the associated ecosystem restoration efforts. Permits from the MDEQ will be required for impacts to waters of the United States. Following drawdown, the dam will be breached at the location of the powerhouse. As such, construction-related wetland impacts associated with dam breaching are not anticipated. Furthermore, staging areas and temporary access roads will be sited to avoid existing wetlands as mapped in Figure 3-5. Additionally, accidental fuel/oil tank leaks and stormwater runoff that could enter wetlands and impair water quality and damage wetland plants and wildlife will be mitigated by implementation of appropriate best management practices (BMPs) and establishment of staging/refueling areas in uplands.

Removal of Brown Bridge Dam would remove the impounded water in Brown Bridge Pond, lowering the active water level elevation resulting in the transition to a flowing riverine environment. As a result, it is expected that the lowered surface water level will alter the hydrologic conditions of existing adjacent wetland areas and expose new areas to hydrologic conditions that could support formation of new wetlands.

While long-term data correlating groundwater in wetland areas with riverine surface water elevation are not available, surface water elevations in the Boardman River are known to be very stable and lack large fluctuations typically associated with many flood-prone rivers (see Section 3.2). In addition, anecdotal observations of wetlands described adjacent to Boardman Pond indicate that the wetlands persisted even after a 6-foot drawdown of the pond level in fall 2011. Indeed, as discussed in Section 3.3.4.1, groundwater discharge from the valley wall at Wetlands A and B occurs at elevations well above that would be influenced by backwater effect from Brown

Bridge Pond. At Wetland A, saturated soils were observed in areas approximately three feet higher in elevation than adjacent areas where soils were not saturated. Furthermore, groundwater has been observed discharging at relatively high elevations along the toe of the valley walls. In both Wetlands A and B, groundwater discharge and saturated soils were observed at elevations approximately 20-feet higher than the surface water elevation of Brown Bridge Pond. Because of these influences, it is expected that groundwater discharge will continue to sustain the majority of Wetlands A and B, while some wetland loss may occur due to the influence and removal of the impoundment.

The primary source of hydrology at Wetland C, below the dam, appears to be water seeping through the dam itself. Seep zones in the dam have been problematic for a number of decades prompting concerns over dam safety. Drain tiles and pipe have been installed through the dam in an attempt to manage the seep water. Although groundwater discharge areas along the toe of the north valley wall below the dam were not obvious hydrology inputs during wetland delineation reconnaissance, wetlands were historically observed in this area as indicated in the 1839 Government Land Office (GLO) survey notes for Grand Traverse County. According to the survey notes recorded for the western boundary of Section 15 (Township 26N, Range 10W), "swamps" occupied approximately 40% of this section line between the Boardman River and the toe of the valley wall north of the river. Following dam removal wetlands below the dam are expected to return to historic levels. As such, wetland impacts with dam removal and river restoration are anticipated to result in the conversion of approximately 60 percent of Wetland C to non-wetland.

The primary source of wetland hydrology for the remaining wetlands in the delta (Wetland D) is the Boardman River. The delta area will undergo substantial earthwork during dam removal and river restoration. Portions of the delta will be excavated to form the new river channel and portions of the delta may be used to spoil the excavated materials. Because of the planned earthwork and the loss of hydrology associated with dam removal, Wetland D is expected to be completely converted to non-wetland habitat.

Based on information from hydraulic modeling, site conditions, and anecdotal evidence from general observations, it is estimated that dam removal would result in the loss of approximately 61.1 acres of wetlands in the vicinity of Brown Bridge Dam (Table 3-13). This would be offset by the estimated addition of approximately 74 acres of wetlands that are expected to develop in the newly exposed areas following dam removal (Inter-Fluve, 2012). Overall, the removal of Brown Bridge Dam to restore the Boardman River to a natural condition would result in a net gain of approximately 13 acres of wetlands. These wetlands may be of different types in terms of vegetation community structure but would persist as fully functioning floodplain and riverine wetland systems. In areas where wetland loss is expected to occur, the wetlands should be inspected for rare plant species of interest or species identified as culturally significant in the TEK process. Such species may be targeted for seed collection or relocation into persisting or newly formed wetland areas surrounding Brown Bridge Pond.

Table 3-13. Anticipated Wetland Impacts

Wetland ID	Size (acres)	Community Type	Estimated Impact
Estimated Losses			
Wetland A	32.0	Forested	(6.5 acres)
Wetland B	87.0	Forested/Emergent	(17.5 acres)
Wetland C	43.5	Forested	(26.1 acres)
Wetland D	2.3	Emergent	(2.3 acres)
		Subtotal	(52.4 acres)
Estimated Gains			
Restored Wetlands in Bottomland	74.0	Successional transition from emergent, to scrub shrub, and eventually forested	74.0 acres
Net Total Estimated Gain (acres)			**21.6 acres**

In accordance with the provisions of Executive Order 11990, it is the responsibility of the lead Federal agency to evaluate a range of factors when considering an action having potential effects on wetlands. As stated above, Alternative B does not result in the direct conversion of wetlands through fill activities. Expected losses associated with alteration of hydrology are expected to be off-set by gains in the development of wetlands within the Boardman River bottomland upstream of Brown Bridge Dam. In conjunction with the bottomland restoration, it is also expected that Alternative B will result in the conservation and long term productivity of existing flora and fauna, species and habitat diversity and stability, hydrologic utility, fish, wildlife, timber, and food and fiber resources. The availability of the proposed restored bottomland and its associated wetlands to the public will also promote and support the uses of the wetlands for recreational, scientific and cultural interests. Consequently, it is concluded that Alternative B is consistent with the requirements of Executive Order 11990.

3.3.5 Noxious/Invasive Species

3.3.5.1 Affected Environment

Non-native species are those species that arrived in and colonized an area only with direct or indirect human assistance, even if they are native elsewhere in the state. Non-native species may also be called "non-indigenous", "alien", "exotic", "adventive" or "naturalized" species. Invasive species, as defined by Executive Order 13112, includes alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health. According to Executive Order 13112, each federal agency whose actions may affect the status of invasive species shall, to the extent practicable and permitted by law, prevent the introduction of invasive species; detect and control populations of such species; monitor invasive species populations; and provide for the restoration of native species in ecosystems that have been invaded.

Despite the high quality of terrestrial habitats in the Brown Bridge area, 25 invasive plants were identified during a 2011 survey conducted by the GTCD. Of the 25 species, 12 species are considered high priority species in the region and include a moderately high number of invasive species have been identified. High priority herbaceous invasive plant species include spotted knapweed (*Centaurea stoebe*), Canada thistle (*Cirsium arvense*), European swamp thistle (*C. palustre*), bull thistle (*C. vulgare*), wild parsnip (*Pastinaca sativa*), garlic mustard (*Alliaria petiolata*), reed canary grass (*Phalaris arundinacea*), non-native phragmites (*Phragmites*

australis), autumn olive (*Elaeagnus umbellata*), invasive honeysuckle (*Lonicera* sp.), and narrow-leaved cattail (*Typha angustifolia*).

Invasive species have been identified within the riparian corridor surrounding Brown Bridge Pond and areas immediately upstream along the Boardman River. An Invasive Species Management Plan (AMEC, 2011) has been prepared to identify and prioritize species to be controlled and provides the methods and procedures for control of invasive species during dam removal and subsequent river/floodplain restoration.

3.3.5.2 Environmental Consequences

Alternative A – No Action

Under the No Action Alternative, invasive species in the vicinity of Brown Bridge Pond would persist under current operating conditions as an impoundment. Without routine management as described in the Invasive Species Management Plan (AMEC, 2011), populations of invasive species even under the No Action Alternative would continue to expand.

Alternative B – Dam Removal with Blended Restoration

Dam removal will create opportunities for invasive species to become established. In particular, dam removal will create large expanses of previously inundated and un-vegetated soils that may be colonized by invasive plant species which may out-compete desirable native plant species. Furthermore, the change in aquatic habitat type from reservoir to free-flowing river may also provide opportunities for aquatic invasive species to become established or spread. The Invasive Species Management Plan (AMEC, 2011) was written as a tool to mitigate the threat associated with invasive species establishment following dam removal and restoration. As such, full implementation of this plan during construction (i.e., application of appropriate equipment decontamination practices) and following dam removal will be instrumental in preventing invasive species from becoming a serious threat to native ecosystems.

3.4 LAND USE

3.4.1 Affected Environment

3.4.1.1 Historic and Current Land Uses

Prior to settlement of the region, the Boardman River watershed and Brown Bridge Pond area primarily consisted of a combination of pine and hardwood forest along with mixed conifer and hardwood swamp communities.

Historic land use activities in the Boardman River basin included logging, agriculture, industrial (in Traverse City), and power generation (including Brown Bridge Dam). The logging industry was the primary influence in the Grand Traverse region from the 1850s to the early 1900s. Fruit orchards and manufacturing, including the production of cigars, candy, farm implements, and limited car and truck manufacturing, were common land uses in the 1900s along the Boardman River especially within the city limits of Traverse City. Agriculture still abounds in Grand Traverse County with corn, alfalfa, and cherries being the primary crops produced (Cummings et. al., 1990).

Because of the forested ecosystems surrounding the Brown Bridge area, logging operations were the major land use activity in the mid to late 1800s.

According to the Grand Traverse County Comprehensive Plan, land uses in the project area consist of water, wetlands, and forests/open lands (Williams and Works, 2002). Current land uses in the vicinity of Brown Bridge Dam consist variously of low density residential uses, undeveloped open space, and recreational lands (Figure 3-4). The Brown Bridge Quiet Area is a designated recreational area that is owned by the City of Traverse City and managed by the GTCD with input from the Brown Bridge Advisory Committee.

3.4.1.2 Natural Rivers

The Boardman River is also classified and managed as a natural river under Part 305, P.A. 451 of 1994. Specifically, the mainstream of Boardman River has a classification as "Country and Scenic" from north boundary of Grand Traverse County property in Section 27, T27N, R11W, Garfield Township to Brown Bridge Dam, Section 15, T26N, R10W, East Bay Township (13 miles). Additionally, from above Brown Bridge Dam to the "Forks" the mainstem Boardman River has the classification of "Wild and Scenic."

A Natural Rivers District is established within 400 feet on either side of the river and includes building setbacks that regulate development within the Natural Rivers District. For the Wild and Scenic Reach, the building setback along the mainstem Boardman River is established at 150 feet, whereas the setback in the Country Scenic Reach is 100 feet.

3.4.2 Environmental Consequences

3.4.2.1 Alternative A – No Action

No activities resulting in land use alteration would occur under the No Action Alternative. Additionally, no improvements or restoration activities to Brown Bridge Pond would occur that would result in its transformation from an impounded area to a free flowing reach of river would occur. Accordingly, the No Action Alternative would not result in the expansion of the Michigan Natural Rivers System.

3.4.2.2 Alternative B – Dam Removal with Blended Restoration

In conjunction with Alternative B, the existing developed lands associated with the dam at Brown Bridge Quiet Area will be transformed to a restored bottomland consisting of open space. Land uses associated with the impoundment are currently considered open space and will continue to be designated as such, but altered in their character to a river corridor and associated floodplain. Recreational uses of these lands will continue and it is expected that future improvements within the project area will consist of the development of recreational trails to accommodate pedestrian uses as deemed appropriate by the City of Traverse City and the Brown Bridge Advisory Committee. Restoration of the bottomland of the Boardman River will also provide an opportunity to restore traditional uses to the land in this area as may be contained in the TEK of the GTB or other Native American tribes.

The proposed restoration activities to Brown Bridge Pond would also result in its transformation from an impounded area to a free flowing reach of river. Accordingly, Alternative B would result in a restored ecosystem that would potentially expand the Michigan Natural Rivers System.

3.5 SOCIOECONOMIC ENVIRONMENT

3.5.1 Demographics

3.5.1.1 Affected Environment

Table 3-14 summarizes the demographic characteristics of the project area and project setting. The Grand Traverse County population reported for 2005 through 2009 is 85,076 (USCB, 2010). Minority groups make up approximately four percent of the population. The total number of housing units to support this population is 41,599. Median household income in 2009 was $49,076 with approximately 11 percent of the population below poverty level. Information on Traverse City and the State of Michigan is provided in Table 3-14.

Table 3-14. Demographic Characteristics, 2010

Category	Grand Traverse County	Traverse City	Michigan
Total Population	86,986	14,674	9,883,640
Housing Units	41,599	7,358	4,532,233
Occupied Housing Units	34,193	6,574	3,860,160
Median Household Income (2009)*	$49,076	$40,280	$45,254
Persons Below Poverty Level (2009)*	11.0%	14.7[a]%	16.1%
Race			
White	95.4%	94.4%	78.9%
Black	1.2%	0.7%	14.2%
American Indian/Alaska Native	1.2%	1.8%	0.6%
Asian	0.7%	0.7%	2.4%

* American Community Survey not yet available for the 2010.
Source: US Census, 2010.

3.5.1.2 Environmental Consequences

A relatively small labor force (less than 25 workers) would be required to remove the Brown Bridge Dam and implement the proposed restoration measures identified for Alternative B. The required labor is expected to be available from Grand Traverse County and no changes to resident populations are expected. Given that no changes in residential population are expected, no changes in property values, traffic volume, and median household incomes or poverty levels are expected.

Under the Alternative A: No Action, there would be no impacts on the demographic characteristics of resident populations in the Grand Traverse County area, as this alternative would not result in any population changes.

3.5.2 Community Facilities and Services

3.5.2.1 Affected Environment

Community services refer to those services provided to support residential developments that include water and wastewater treatment, law enforcement, and fire and emergency medical treatment (EMT) services. This section describes the available services in and around Grand Traverse County including the area in the vicinity of Brown Bridge Dam and the potential for impacts to these community provided services.

The County's water source is provided by two groundwater wells located near Cherry Knoll Elementary on Three Mile Road, two ground water wells located off Carlisle Road, two ground water wells located in Holiday East Subdivision, one ground well located on Three Mile Road by

the iron removal plant, and a water booster station on Five Mile Road. None of these public water supply systems is located in the proximity of Brown Bridge Pond.

Wastewater treatment is provided by the Grand Traverse County Septage Treatment Facility. The service area for the facility is defined as all townships within Grand Traverse County and Elmwood Township in Leelanau County. According to the Grand Traverse Area Water Systems Master Plan (Wilcox Professional Services, LLC with Black & Veatch Corporation, 2008), the treatment plant has a capacity of 20 million gallons per day (mgd) with current demands at 14 mgd.

The Grand Traverse Rural Fire Department provides services to the townships of Blair, Fife Lake, Grant, Green Lake, Long Lake, Mayfield, Paradise, Union, and Whitewater. The Rural Department also provides service to the Village of Kingsley and to Springfield Township in Kalkaska County. The division has approximately 150 volunteer fire service personnel working out of six battalions (http://www.gtfire.org/).

Police protection is provided by the Grand Traverse Sheriff's Office. The Sheriff's office has 65 sworn officers for a county that is roughly 466 square miles with a population of around 85,000.

3.5.2.2 Environmental Consequences

Alternative A – No Action
Under the No Action Alternative, no changes would occur to the use of the project area that would require an increase in police, fire/ambulatory or any other community services. Consequently, there would be no impacts to community services in Grand Traverse County.

Alternative B – Dam Removal with Blended Restoration
Removal of the Brown Bridge Dam is expected to be carried out by local contractors from the Grand Traverse County area, and no relocations to the area are anticipated. Under the proposed action local fire, police and medical services would not be affected since no relocations to the area are expected from the removal action. Future uses of the project location will continue to be non-residential recreational/open space. Consequently, there would be no impacts to community services.

3.5.3 Recreation

3.5.3.1 Affected Environment

The Brown Bridge Dam and project area are located within the 1,310-acre Brown Bridge Quiet Area. The lands within the Brown Bridge Quiet Area are open space recreational lands that include Brown Bridge Pond (no-wake boat use), a public boat launch and a trail and boardwalk systems. Recreational opportunities in the vicinity of Brown Bridge Dam consist of recreational fishing, canoeing/kayaking and non-motorized trail use. The characteristics of each of these recreational opportunities are presented in the following subsections.

Recreational Fishing
The Boardman River system offers a variety of fishing experiences. Brown Bridge Pond is classified as a warm water fishery (see Section 3.3.1) whereas the river above and below the pond support self-sustaining populations of brown and brook trout. Currently, upstream portions of the Boardman River are rated as top-quality trout streams by the MDNR. As described by ECT (2008b) each of these reaches (Brown Bridge Pond and adjoining upstream and downstream reaches) are considered to receive moderate to heavy fishing pressure. The number of angler days (residents and visitors) associated with each of these reaches is shown on Table 3-15.

Table 3-15. Annual Number of Angler Days on the Boardman River in the Vicinity of Brown Bridge Dam

Reach	Number of Angler Days
Below Brown Bridge Pond*	2,100 to 3,400
Brown Bridge Pond	1,200 to 1,900
Above Brown Bridge Pond†	2,200 to 3,400

* Approximately 6 miles
† Upstream to the Forks
Source: ECT, 2008b.

Paddling

The Boardman River offers both canoeing and kayaking (hereafter, paddling) opportunities to recreators. According to Trails.com (2010), the Boardman is "[a] spirited, attractive stream that flows past conifer forests and north-country cottages before emptying into Grand Traverse Bay. The Boardman ranks as one of the Lower Peninsula's finest rivers for paddling. Possessed of a moderate current and a winding river corridor that passes through a broad valley of cedar, pine, and assorted hardwoods, it also features one of Lower Michigan's rare bursts of light whitewater."

The Traverse Areas Paddle Club is a recreational organization that promotes paddling in Grand Traverse County and has a national affiliation with the American Canoe Association. The Club organizes numerous paddling trips in the Grand Traverse County area, a majority of which take place on the Boardman River. As reported by ECT (2008b), the annual estimate ranges from more than 5,000 days to nearly 17,000 days. However, the reaches of the Boardman River above and below Brown Bridge Pond support the highest level of use with 2,500 to 6,000 days above Brown Bridge Pond and 1,000 to 3,000 days below Brown Bridge Pond.

The Boardman River enhances the recreation experience for a variety of trail activities, including hiking, walking, biking, and horseback riding. Several segments of the Boardman River support designated trails, particularly around the impoundments. In the segments farther upstream, portions of the Michigan Shore-to-Shore Riding Trail and the North Country Trail follow the Boardman River. According to the information in Table 3-16, each of the three reaches in the vicinity of the Brown Bridge Dam contain trails that offer opportunities for hiking and walking.

The trail system at Brown Bridge is an integrated part of the Brown Bridge Quiet Area and is particularly scenic. This trail system is largely located on the uplands north and south of the Boardman River Valley. However, a boardwalk on the northeast side of Brown Bridge Pond includes a boardwalk that traverses low-lying lands and wetlands.

Table 3-16. Trails Along the Boardman River in the Vicinity of Brown Bridge Dam

Reach	Name of Trail	Number of Trail Miles	Scenic Beauty
Below Brown Bridge Pond[1]	None	6.9[2]	4.6
Brown Bridge Pond	Brown Bridge "Quiet Area" Trails	6.0[3]	5.0
Above Brown Bridge Pond[4]	Includes portions of the North Country Trail and the Michigan Shore-to-Shore Riding Trail	6.7	4.8

[1]Approximately 6 miles.
[2]This estimate is based on river miles.
[3]This estimate is calculated from the map on the GTCD website.
[4]Upstream to the Forks.

Source: ECT, 2008b.

The estimated use of the trail system of the Brown Bridge Quiet Area ranges from 1,500 to 1,875 visitor use-days per year.

3.5.3.2 Environmental Consequences

Alternative A – No Action

If the Brown Bridge Dam remains in place and no changes are made to the dam, recreational fishing, paddling, and trail activities will be unchanged. Recreational anglers would continue to spend 1,200 to 1,900 days fishing Brown Bridge Pond; paddlers would take about 703 trips to the pond, and trail users would spend at least 6,000 days on trails in the Brown Bridge Quiet Area annually. No additional recreators would be expected to visit the Brown Bridge Pond area.

Alternative B – Dam Removal with Blended Restoration

Recreational uses on and near the Boardman River are expected to change with removal of the Brown Bridge Dam. The resulting transition from impoundment to river channel and accompanying changes to wetlands and formation of new upland habitat will affect recreational uses of the Brown Bridge reach. Table 3-17 summarizes changes to recreation that can be expected with the removal of Brown Bridge Dam. Tourism and recreational expenditures likely will increase with the transition of an impoundment to a river.

3.5.4 Economic Setting

3.5.4.1 Affected Environment

The project area is located in a rural portion of Grand Traverse County that is characterized by low density residential development and passive recreational uses. The area is primarily known for tourism that is attributable to the attractiveness of the Lake Michigan coastline, but also inland areas, featuring the Boardman River, and several large lakes and forests. It is also known as the world leader in cherry production, and celebrates the Cherry Festival annually at the end of June in Traverse City. The County also has a diverse economic base, including plastics manufacturing, woodworking, food processing, medical technology, and others (InfoMichigan, 2012). Among others, The GTB is recognized as a major tax payer that in 2010 reported the payment of more than $4.7 million (GTB, 2011).

Table 3-17. Expected Changes to Recreation with the Removal of Brown Bridge Dam

Category	Expected Change
Recreational fishing	Anglers targeting warm water fish species will seek other impoundments or lakes. Anglers targeting coldwater fish species; particularly brook and brown trout, will visit the Brown Bridge Reach of the river.
Paddling	More paddlers will be attracted to the Brown Bridge reach as the natural flow and stronger current of the river return and paddlers can traverse Segments 6 through 8 without portage.
Trail activities	Trail users will see changing views from scenic overlooks along trails near the Brown Bridge reach as the impoundment transitions to river. Wildlife viewing may change as the diversity and number of wildlife change. Hunters of migrating waterfowl will have fewer hunting opportunities along the Brown Bridge reach because of less favorable habitat for the waterfowl. .

Sources: MDNR, 2002; ECT, 2008b

Grand Traverse County is a small, growing community of roughly 86,986 residents, and the median household income as of 2009 was $49,076 (see Table 3-14) The major industries in Grand Traverse County in terms of annual earnings include construction, manufacturing, retail, finance and insurance. Government and government enterprises also account for a large portion of the Grand Traverse economy. The vast majority of the governmental institutions in Grand Traverse County are related to state and local governments (ECT, 2009d).

Employment by industry closely matches these high earning industries: retail trade represents roughly 15 percent of private employment, with construction and manufacturing accounting for nine percent and 12 percent of total private employment, respectively. Previous studies divided the Boardman River into distinct segments to facilitate the analysis of recreation impacts (ECT, 2009d). Brown Bridge Pond comprises Segment 7 (the Brown Bridge Reach) of the Boardman River as identified in Figure 1-2.

3.5.4.2 Environmental Consequences

Alternative A – No Action

If no action is taken, Brown Bridge Pond will remain an impoundment, and the quality of the fishery, paddling site, and trails in the Brown Bridge Quiet Area will be unchanged. The physical environment will also be unchanged.

Alternative B – Dam Removal with Blended Restoration

Once Brown Bridge Dam is removed, the impoundment will transition to approximately 2 miles of restored river. The natural flow of the river will return and the depth of the Brown Bridge Reach will become similar to the lower portions of the Boardman River's mainstream, 1 foot to 6 feet deep. As described in Section 3.3.4 wetlands are expected to form along the river and within the bottomland after drawdown of the impoundment. The transition to river and additional wetlands will change the wildlife habitat and recreational uses of the river, affecting recreational fishing, hunting, and wildlife viewing. Removing the Brown Bridge Dam will potentially have economic impacts that correspond to these changes in recreational fishing, paddling, and trail activities. This section provides a quantitative assessment of impacts to recreational fishing and paddling activities,

where significant changes are likely. A qualitative assessment of impacts is provided for trail activities where significant changes are considered unlikely.

With the removal of the Brown Bridge Dam and the resulting transition from impoundment to river channel, wetlands will change and new upland habitat will form. Channel erosion may occur and then stabilize as vegetation grows. Wetlands along Brown Bridge Pond will change to riparian wetlands. These gradual changes can also be expected to result in:

- Replacement of warm water fish species in Brown Bridge Pond.
- Coldwater fish species, particularly brook and brown trout, migrating into the Brown Bridge Reach as the colder water of the Boardman River replaces the warmer water of the former impoundment and restores a portion of high-quality trout stream.
- Natural reproduction of trout possibly improving with removal of the dam, increasing the trout population in the Brown Bridge Reach and coldwater segments of the river.
- The natural flow and stronger current returning to the Brown Bridge Reach.
- Changes to the view from scenic overlooks along trails near the Brown Bridge Reach, including the Brown Bridge Quiet Area.
- Changes in the diversity and location of wildlife.

Quantification of Recreational Fishing Impacts

The removal of Brown Bridge Dam will affect the composition of species caught as the fishery transitions from warm water to coldwater. Currently, anglers catch bluegill; common white sucker; largemouth bass, smallmouth bass, rock bass; northern pike; pumpkinseed; and yellow perch from Brown Bridge Pond. Once Brown Bridge Dam is removed, the fishery in the Brown Bridge Reach is expected to be similar to Segments 6 and 8 of the Boardman River (see Figure 1-2), both coldwater fisheries, where anglers catch brook, brown, and rainbow trout. The trout population in Segment 6 may increase as trout migrate in the river. An increase in the trout population likely will attract trout anglers to the Brown Bridge Reach. Anglers targeting warm water species no longer visit the Brown Bridge Reach and will visit other water bodies instead.

To quantify the socioeconomic impacts arising from these changes, baseline site characteristic data is assembled in a model of Michigan recreational fishing behavior. The model includes the mathematical linkages, system parameters, and the geographic and population-specific data that relate model structure and parameters to implications of removing the Brown Bridge Dam. A high-quality, Michigan-specific, recreational-angling model that provides insight on how Michigan anglers chose where to fish based on the attributes of available fishing sites is employed (Lupi et al., 1998). This model is applied to local fishing sites as described in Bingham et al. (2008). Substitute sites modeled include nine other segments of the Boardman River, segments of the Rouge River, segments of the Manistee River, Houghton Lake, Lake Leelanau, Long Lake, Green Lake, and Higgins Lake. Important site characteristics include distances by ZIP code and variables related to fishery quality. In this model relevant site characteristics include acreage of a warm water fishery and length and quality (top and second) of a coldwater fishery.

For quantitative modeling, the Brown Bridge Reach is modeled in the base case to be 190-acres of warm water fishery receiving 1,048 warm water fishing trips per year. For the change case, the Brown Bridge Reach is modeled to be unavailable during 2012 and 2013. After dam removal, the Brown Bridge Reach is expected to gradually resemble other coldwater stretches of the Boardman River. The MDNR designated the Boardman River as a "Blue Ribbon" trout stream, one of Michigan's best, providing a quality trout-fishing experience and supporting excellent stocks of wild trout (ECT, 2008b; GTCD, 2003; and MDNR, 2002 and 2005). After 2014, the Brown Bridge Reach is modeled to transition to 2 miles of a second quality coldwater river. The Brown Bridge

Reach remains a second quality coldwater river until 2020. At that point, it transitions to become 2 miles of a top quality coldwater river. It remains in this state over the analysis period which continues through 2042. This process results in a loss of 1,048 warm water fishing trips annually for the remainder of the analysis period (through 2042). During 2012 and 2013, there are no fishing trips of any sort to this segment. Beginning in 2014, the Brown Bridge Reach receives 1,284 coldwater fishing trips. As the Brown Bridge Reach transitions to a top quality coldwater river, trips increase to 1,321 and remain at that level throughout the remainder of the analysis period. The economic impact in net present value of this outcome is calculated be identifying per-year net values (trips gained of one type versus lost of another) and then discounting by three percent. This process yields a net present value of the stream of a positive benefit of $2,830 in 2011 dollars.

Quantification of Paddling Impacts

The Boardman River is an attractive destination for canoeists and kayakers. Some paddlers report that the Boardman River is "one of the Lower Peninsula's finest rivers" and some portions of the river are Class II rapids[1] (REI 2011; Szeremet 2010; Trails.com 2010). Currently, portions of Brown Bridge Pond are sometimes too shallow for paddlers. Also, paddling in Brown Bridge Pond can be less enjoyable due to slow water and headwinds. With the removal of Brown Bridge Dam, natural flow and current will return which will improve paddling conditions.

To quantify the socioeconomic impacts arising from these changes, baseline site characteristic data is assembled in a model of paddling behavior. The process applied is similar to the approach for angling and details are also available in Bingham et al. (2008). However, unlike angling, in this case, the empirically-estimated parameters that are available were not estimated in the same geographic area. Appropriate calibration and professional judgment is used to scale site characteristic variables. Because these variables are already scaled relative to one another, this is straightforward and results in site quality specifications across the variables of whitewater quality, parking availability, crowding, scenic rating and water level predictability that range from zero to five like the original study (Hynes et al. 2007). Modeled substitute sites include other segments of the Boardman River, as well as the Au Sable, Betsie, Pine, and Platte rivers.

For quantitative modeling, the Brown Bridge Reach is modeled in the base case with a rating of 0.0 for whitewater quality, 4.3 for parking, 4.3 for crowding, 4.4 for water quality, 5.0 for scenic beauty rating, and 4.4 for paddling predictability. Under these modeled conditions, the Brown Bridge Reach receives 703 paddling trips per year. With the removal of Brown Bridge Dam, the Brown Bridge Reach is modeled as unavailable in 2012. Whitewater quality is rated as 2.0 beginning in 2013. After dam removal, the scenic beauty of the Brown Bridge Reach is expected to decline to 3.0 in 2013, 4.0 in 2014, and 5.0 for the remainder of the analysis period. As modeled, trips through the Brown Bridge Reach are 902 in 2013, 1,506 in 2014, and 2,395 from 2015 through 2041. The economic impact (net present value) of this outcome is $237,230 in 2011 dollars.

[1] Class II rapids are moderate with medium-quick water. The rapids have regular waves and clear and open passages between rocks and ledges. Maneuvering is required. Class II rapids are best handled by paddlers with intermediate skills, who can maneuver canoes and read water (Gordon, 2001).

Trail Use
It is expected that future planning following the removal of Brown Bridge Dam will include the development of a trail system within the bottomlands. This trail system is expected to be developed within the uplands using a prepared earthen path, whereas water saturated bottomlands will be crossed on boardwalks. Once developed, these additional trails are expected to increase in the visitor use level within the Brown Bridge Quiet Area to between 1,750 and 2,175 (16 percent increase) to annual visitor use days (ECT, 2008b). However, trails and access to the bottomlands will not be allowed for a period of two (2) years following dam removal in order to promote the establishment and recovery of plant communities within the bottomlands.

The experience of recreators using trails near Brown Bridge Pond will differ from the current state with the removal of Brown Bridge Dam and the transition of impoundment to river. For example, the scenery near trails can be expected to change substantially. Emergent wetlands will likely be dominated by species such as blue vervain, common cattail, black and hardstem bulrush, spotted Joe pye weed, and jewelweed, some of which do not grow there now. Eventually the acreage of wetlands will become a restored river valley consisting of a mosaic of natural communities.

Wildlife watchers using trails near Brown Bridge Pond can expect changes in the sighting of wildlife inhabiting Segment 7 with the removal of Brown Bridge Dam and the transition of impoundment to river. For example, many of the migrating wildfowl listed in Table 3-9that used Brown Bridge Pond for stopover will displaced and find other suitable habitats.

3.5.5 Property Ownership

3.5.5.1 Affected Environment

Brown Bridge Dam is owned by the City of Traverse City. Lands encompassing the dam and the associated Brown Bridge Pond are also owned by the City of Traverse City. There are no private landowners within the immediate project area.

Lands along the Boardman River upstream and downstream are characterized by low density residential use and as such are owned by private landowners.

3.5.5.2 Environmental Consequences

Alternative A – No Action
Under the No Action Alternative, the dam would remain in-place and no changes in land ownership or use would occur.

Alternative B – Dam Removal with Blended Restoration
Under Alternative B, the dam would be removed and land ownership of the immediate area formerly occupied by the powerhouse would be retained by the City of Traverse City. No other changes in land ownership or use would occur.

3.5.6 Environmental Justice

3.5.6.1 Affected Environment

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, 59 Federal Register 7629 (1994), directs federal agencies to incorporate environmental justice in their decision making process. Federal agencies are directed to identify and address as appropriate, any disproportionately high and adverse environmental effects of their programs, policies, and activities on minority or low income populations.

As of the 2005 through 2009 American FactFinder, minority groups make up 4.5 percent of the Grand Traverse County population. Native Americans comprise 0.6 percent and blacks 1 percent of the County's population. The median household income is $50,774, and families below poverty level represent 5.7 percent of the population. Brown Bridge Dam is located in a rural portion of Grand Traverse County and no low income or minority populations are known to occur in the project vicinity.

3.5.6.2 Environmental Consequences

No low income or minority populations are known to occur in the project vicinity. No changes to the population, income, or ethnic makeup of Grand Traverse County would occur with either the No Action Alternative or Alternative B. Neither of the alternatives would produce environmental pollution. Additionally, no minority or low income populations would be displaced or negatively affected in any other way by the proposed action or any of the other alternatives. Consequently, no environmental justice impacts would occur with either of the alternatives under consideration.

3.6 CULTURAL AND HISTORIC RESOURCES

3.6.1 Affected Environment

3.6.1.1 Historic Architecture

The Brown Bridge Dam and associated powerhouse was reviewed for potential eligibility to the National Register of Historic Places (NRHP) and was not considered eligible for inclusion on the NRHP (ECT, 2008a) as it lacks the required level of integrity, design, materials, or association required to meet NRHP listing criteria. Concurrence regarding the ineligibility of the Brown Bridge Dam for NRHP listing was included in a letter from Mr. Brian Conway, State Historic Preservation Office (SHPO) to Mr. Les Weigum of the USACE in 2007 (ECT, 2008a).

3.6.1.2 Archaeological Resources

A review of the records of the Office of the State Archaeologist, SHPO as well as the extant professional and historical literature was conducted by Mr. Wes Andrews of Andrews Cultural Resources (ACR) to identify any previously known cultural resources that may exist with the Boardman River watershed that would be potentially affected by the proposed removal of Brown Bridge Dam.

Interest in the potential effects to undiscovered archaeological resources was also expressed by the SHPO in the 2007 letter to Mr. Les Weigum in which the SHPO requested that an archaeological survey be completed for the former shoreline areas following drawdown of the pond. This requested survey was performed at Brown Bridge in September 2011, subsequent to the initial drawdown. As a result of that survey, one previously unrecorded site was identified. None of the artifacts recovered were diagnostic specimens upon which a determination can be made about their association with any cultural phase or age. The identified site is not considered archaeologically significant and is not eligible for the NRHP (ACR, 2011b).

No previously recorded archaeological sites were identified in the immediate project area. The following narrative, however, provides a basis for characterizing the cultural setting of the Brown Bridge Dam area and its potential for holding previously unidentified archaeological resources within the former impoundment area.

Very few previously known archaeological resources are known within the Boardman River watershed. A small cluster of these sites had been reported within what is now the City of Traverse City and most are believed to have been destroyed by urban development.

Another location where a concentration of archaeological sites is found to exist is in an area to the southwest of Traverse City along several tributaries that flow from the west into the Boardman River. These sites are very small and all predate the arrival of Europeans to North America. They consist of a light scatter of lithic debris and are considered to be insignificant from an archaeological perspective, and are not eligible for listing on the NRHP.

The low probability for the existence of archaeological cultural resources to exist within and adjacent to Brown Bridge Pond is further evidenced by the topography of the watershed. The pre-dam landscape immediately adjacent to the Boardman River, especially downstream from what is now the Brown Bridge Pond, was subject to frequent flooding, erosion, and comprised a wetland landscape for most of its recent geological history. Typical plant communities within the pre-pond landscapes included mixed hardwood swamps, cedar swamps, and mixed conifer swamps. Some of these low-lying lands were later classified and sold as 'State Swamp Lands.' At locations more distant from the main river channel, the ground elevation rises sharply, and then levels out to forested areas that were primarily Beech-Sugar Maple-Hemlock forest and Sugar-Maple Yellow-Birch forest in the period before ca. 1850.

Prior to Europeans entering the Great Lakes Region there is very limited documentation about Native American people's utilization of the Boardman River watershed. Early historic maps of the Great Lakes from the 1680s show that Grand Traverse Bay and the Boardman River were known to Europeans by that time. No name is provided on these early maps for the river until the early nineteenth century when several cartographers label it the "Ottaway River." The name Boardman came to be applied to the river about the mid-nineteenth century, and was taken from the name of a lumberman who operated in the region.

Native people during the last 400 years exhibited a seasonal pattern of land use in which they used the shores of the Great Lakes, such as Grand Traverse Bay during the summer months, and then dispersed into small family groups for winter hunting along interior rivers that flow into the Great Lakes. This winter hunting pattern continued into the first half of the nineteenth century and is documented among the GTB. One family has an oral tradition that they spent their winters in the upper reaches of the Little Muskegon River, southwest of what is today Big Rapids, which was reached via an overland trail from the foot of Grand Traverse Bay. There is also evidence that the Chain-of-Lakes in Antrim County near Elk Rapids was another wintering location. During the same time period, other Grand Traverse Bay Native people went to the Manistee and Au Sable rivers in Michigan during the winter, while some went as far as the Kankakee River in what is now the State of Illinois.

The reduced use of the Boardman River watershed by Native people was perhaps influenced by the lack of accessibility of the river for transportation. During the mid- nineteenth century, the first Euroamericans who came to log the pine from the region described that the Boardman River was clogged with trees and was impassible. One of these obstructions of fallen trees within the river was reported to be 10 miles long. The river had to be cleared of these obstructions before any logging could be performed.

Following the logging of pine within the Boardman River watershed during the latter half of the nineteenth century, blueberries became more abundant in cutover areas and were used by the GTB for food and trade.

The first federal land surveys that were conducted of the Boardman River watershed during the first half of the nineteenth century reveal an area that was probably maintained and utilized by Native people in the upper reaches of the river valley. In particular, an area characterized by fire disturbance and beaver flooding was located about 5.5 miles upstream of the Brown Bridge Dam, at the confluence of the north and south branches of the Boardman River (Segment 8) (see Figure 1-2). This area measured about 2.5 miles long (east to west) and 1.5 miles wide (north to south) and was labeled on the government survey maps as "Pine Plains and Openings." This area would have been accessible via the trail used by GTB Native people who wintered along the Little Muskegon River which began at the foot of Grand Traverse Bay. The "Pine Plains and Openings" may have been subject to regular burning by Native people to maintain blueberry and other resources, a practice which is known from other areas in the Great Lakes Region.

3.6.2 Environmental Consequences

In consideration of the absence of NRHP eligible archaeological sites in the project area and the prior determination that the Brown Bridge Dam and powerhouse are not eligible for NRHP listing, no impacts to historic properties are expected with either alternative under consideration.

However, the exposure of land forms and restoration of the Boardman River valley as part of Alternative B, may provide an opportunity to restore the cultural landscapes and thereby augment the TEK knowledge base of the GTB. TEK knowledge, innovations and practices of the GTB developed from experience gained over the centuries and transmitted orally from generation to generation is available via consultation with the GTB. Use of this TEK can be important to future planning in identifying unique locations, plant species, or fish and wildlife species as culturally significant inputs to the project.

3.7 VISUAL QUALITY AND AESTHETICS

3.7.1 Affected Environment

The project area contains a combination of human created and natural features that contribute to the overall visual composition of the site. The installation of the Brown Bridge Dam and associated structures altered the flow of the Boardman River creating Brown Bridge Pond, which reshaped the surrounding natural viewscape.

A public parking lot, boat launch and dock are located at the southwest corner of the pond, with an observation deck used by fishermen and nature observers. Hiking and running trails traverse uplands, wetlands and river corridors occupy both the north and south sides of Brown Bridge Pond and along the Boardman River upstream of the pond. Viewscapes along these trails are scenic, consisting of natural upland and wetland habitats and views of Brown Bridge Pond and the Boardman River. The pond attracts visitors throughout much of the year for fishing, boating, and canoeing. There are several private cabins and a camp site located upstream of the pond along the banks of the Boardman River. A Caretakers' residence is located immediately south of the dam.

The Boardman River is a designated Natural River under the State of Michigan Natural Rivers Program (see Section 3.4). The river is considered one of the top ten best trout streams in Michigan and supports self-sustaining populations of brown, brook and rainbow trout. The dam

was originally constructed to provide hydropower power for the local community. Though it is no longer actively in use for electricity production, the dam and powerhouse add to the visual interest of the site, but detract from the natural aesthetics of this scenic river.

3.7.2 Environmental Consequences

3.7.2.1 Alternative A – No Action

The No Action Alternative would not alter the visual quality and aesthetics of the project area.

3.7.2.2 Alternative B – Dam Removal with Blended Restoration

For this alternative, the drawdown of the pond and removal of the dam, powerhouse and associated structures would remove these features and thereby alter the visual character of the project area. During and following the drawdown of the pond, the majority of the land previously submerged under the pond would be exposed and is likely to be unsightly in the short-term. Early successional species from the seed bank and carried in by wind, water and wildlife will re-vegetate these exposed areas. Slowly over time these areas will begin to resemble the existing floodplains and riparian zones that presently exist upstream and downstream along the Boardman River.

A primary river channel will be excavated in the delta to restore the natural aesthetics of the pre-dam river flow path. The channel formation between the existing dam and the redeveloped channel in the delta will occur via natural processes. The construction equipment, staged materials and construction activities prior to and during the dam removal and river channel excavation in the delta will result in a short-term alteration in the visual quality of the site.

Active planting, seeding, and management of the associated vegetation community in both the upper and lower impoundment with native species will accelerate the restoration of the exposed areas to appear more like the natural river ecosystem that presently occurs upstream and downstream along the Boardman River. Views from overlooks will transition over time as the exposed bottomland initially characterized as an herbaceous community, gives way to scrub shrub and eventually forested communities. These active vegetation management practices will also help to prevent invasive species from becoming established and will shorten the overall adverse effects on the visual quality and aesthetics of the project site.

While the removal of the dam, powerhouse and pond will diminish the visual quality of the project site for some visitors, the river corridor will in time be returned to near natural, pre-dam flow conditions and the natural scenic aesthetics of the river ecosystem will be restored.

3.8 TRANSPORTATION

3.8.1 Affected Environment

The local transportation network in the vicinity of the project area consists of county and local roads that serve the local residents and communities. County Route 611 (Garfield Road) is the primary connector roadway in the area and provides service between the City of Traverse City and the town of Kinsley to the south. Local roadways in the immediate vicinity of Brown Bridge Dam include Arbutus Hill Road to the west, Brown Bridge Road to the south, and Ranch Rudolph Road to the north.

3.8.2 Environmental Consequences

The No Action Alternative will not alter transportation and infrastructure patterns within the project area and will therefore, not impact these resources.

For Alternative B, construction activities will require the mobilization of construction equipment and workers to the project site. It is expected that this will entail the use of a small number of additional vehicles and will not result in congestion or the degradation of roadway levels of service. Additionally, following the construction phase, it is expected that levels of use at the site and related traffic levels on adjacent roadways will return to existing levels. Consequently, no significant adverse impacts to transportation are expected with this alternative.

3.9 AIR QUALITY

3.9.1 Affected Environment

Grand Traverse County has historically met the Federal USEPA EPA standards for national air quality. It has been deemed an "attainment/unclassifiable" area and continues to meet national air quality standards. A Michigan Air (MIair) monitoring station was established in Traverse City and the county consistently remains in the moderate to good air quality categories (USEPA, 2011).

3.9.2 Environmental Consequences

3.9.2.1 Alternative A – No Action

The No Action Alternative will not result in any increased emissions and consequently, will not impact air quality.

3.9.2.2 Alternative B – Dam Removal with Blended Restoration

This alternative would result in minor short-term air emissions related to construction activities during the removal of the dam and powerhouse and the excavation of the river channel in the delta. Emissions from construction equipment will be controlled by compliance with any applicable state and local requirements. The emissions are expected to be of short duration, and not result in a degradation of local or regional air quality. Consequently, impacts to air quality are expected to be non-significant and small.

3.10 NOISE

3.10.1 Affected Environment

The existing noise environment in the vicinity of Brown Bridge Dam is one that is characterized by natural ambient noise sources that include sounds from wildlife, wind, water movement, and other sources. Noises are occasional from adjacent roadways, but these roads are low volume roads that do not represent significant continuous sources of noise.

3.10.2 Environmental Consequences

3.10.2.1 Alternative A – No Action

The No Action Alternative will not result in any increased noise emissions and consequently, will not impact noise levels in the vicinity of Brown Bridge Dam.

3.10.2.2 Alternative B – Dam Removal with Blended Restoration

Removal of Brown Bridge Dam and the activities associated with ecosystem restoration will result in the short-term increases in the noise environment during the construction phase. Noise emissions will be short term and construction equipment use will be limited to daytime hours only. Following the construction phase, noise levels are expected to return to those similar to the baseline levels currently evident in the project vicinity. Consequently, impacts resulting from noise emissions are considered to be of short-term duration and small.

3.11 HUMAN HEALTH AND SAFETY

3.11.1 Affected Environment

Prior to 2006, the Brown Bridge Dam was operated by TCLP for the purpose of generating hydroelectric power and was regulated as run-of-river under FERC Project License No. 2978. Brown Bridge Dam power operations were decommissioned by TCLP in 2006. The generating equipment at Brown Bridge Dam is still present but the generators have been disconnected and the turbine wicket gates closed. If needed, the operator has the ability to open the wicket gates manually to pass some portion of flow or, by closing the head gates, drain the turbine bays. Overall, in the opinion of STS (2008), the dam was well-maintained and in generally fair condition. Based on the results of their inspection and review of previous hydrologic, hydraulic, and stability analyses, STS concluded the following:

1. The spillway capacity is likely inadequate for the current high-hazard rating. High hazard dams 40 feet in height or greater must be capable of safely passing half the probable maximum flood (50 percent PMF). PMF studies performed by Mead and Hunt (2001) established the PMF at 8,100 cubic feet per second (cfs), therefore 50 percent PMF is equal to 4,050 cfs. No information was available at the time of reporting that provides the spillway capacity through the upper tainter gates plus sluice gate only.

2. Active seeps and wet spongy conditions were observed over most of the downstream toe of the right (as facing downstream) embankment. A blanket of washed stone and drainage pipes was placed over several areas by TCLP during the 1990s. Most all of the drainage pipes were observed flowing ranged from a low of 1 to 2 gallons per minute to as high as 4 to 5 gallons per minute. Localized ground settlement upstream of the drainage pipes and movement of sand (piping) from the embankment was observed. Probing with a 5-foot-long piece of 1/2-inch diameter rebar revealed very loose, saturated conditions along much of the lower third of the slope and along the downstream toe of the dam. Many of the seeps showed evidence of movement of fines out of the embankment. While it is understood that seepage has been present since original construction, the development of localized settlement and movement of fines appeared to be gradually increasing over time. Furthermore, previous slope stability analyses indicated factors of safety under normal pool conditions which are less than typically required for a high hazard embankment dam. Surveys performed during the 2008 inspection showed that the downstream slopes are actually steeper than that assumed during the previous analyses, which would yield an even lower safety factor. Using the 2008 survey and well data (Piezometers 3 and 4), STS performed revised stability analyses of the embankment for normal, seismic, and rapid drawdown conditions. Based on those results, STS concluded that the embankment does not have an adequate factor of safety against failure and is meta-stable under normal pool, steady state seepage conditions.

In response to the 2008 STS inspection report, the water level of the impoundment has been drawn down approximately 3 feet in order to mitigate safety concerns to some degree. Operation of the dam is no longer the responsibility of TCLP who leased the dam from the owner, the City of Traverse City.

In addition to the concerns previously discussed, there are minimal security measures at the dam site to limit potential trespassing and vandalism. The dam is a barrier for recreational boaters and boaters in the reservoir risk impingement on the dam. The aging dam and facilities are unsafe from both a dam safety and public safety perspective.

Investigations of possible contaminants within the sediments stored behind the dam by USEPA in June 2005 and by GLEC in 2010 found traces of heavy metals from unknown upstream sources (possibly naturally occurring).

3.11.2 Environmental Consequences

3.11.2.1 Alternative A – No Action

If no action is taken, the Brown Bridge Dam will remain for an indeterminate period, and pond water levels will likely remain as they are at this time (3 feet lower than at the time of the 2008 STS inspection). The condition of the dam and associated structures will deteriorate over time without modification of the emergency spillway and overall maintenance of associated structures. The following recommendations for dam related actions were made in the STS report (2008):

- A formal operation, maintenance, and monitoring plan should be developed and implemented by the City.
- Perform an evaluation of spillway capacity and flood routing under the design flood inflow hydrograph (50 percent PMF) under various lowered normal permanent pool scenarios, taking into account environmental and recreational considerations. The analysis should take into account loss of head due to the trash racks (including some amount of clogging) and updated weir flow and orifice coefficients. The analysis should also consider the option of modifying (larger bar spacing) or completely removing the trash racks, because of their susceptibility to zebra mussel clogging. Provide recommendations for modification to the dam spillway and project operational procedures, as needed, to safely pass the design flood with adequate freeboard.
- Implement the recommended modifications to the dam spillway and reservoir operation procedures, as needed, to safely pass the design flood.
- Stabilize the right and left embankments, taking into account the effect of a lowered normal permanent pool on the phreatic levels within the embankment. Stability measures could include flattening the downstream slope and/or installing a drainage system, which could control seepage gradients, lower the phreatic surface, and reduce the potential for sliding or piping. Specific design requirements should be based on re-evaluation of the phreatic regime within the embankment after the pool has been drawn down to the new, lower pool elevation for a period of 1 to 3 years.
- Perform concrete repairs to the powerhouse/spillway structure. Remove the existing severely deteriorated concrete support for the log sluice gate hoist and design, fabricate, and install a new steel hoist support frame. Repair the deteriorated concrete around the upper spillway gates. Repair the localized severely deteriorated concrete on the training walls and log sluice spillway.
- Update the project Operation and Maintenance Plan.

- Update the project Emergency Action Plan to account for the status of the project spillway capacity.

Without these actions (Alternative A, No Action), the dam and associated structures will ultimately fail with potentially catastrophic results. However, for the purposes of this EA, it is assumed that the City of Traverse City would address its liability risk by correcting the potential safety concerns and would implement appropriate measures to avoid catastrophic dam failure as required by the MDEQ and MDNR.

3.11.2.2 Alternative B – Dam Removal with Blended Restoration

Dam removal would eliminate the public safety hazards and liability risk for the City of Traverse City associated with the current and anticipated condition of the dam (without proper spillway modification and maintenance). Demolition activities could pose a short-term risk to public safety. These safety concerns would be addressed in a site-specific Health and Safety Plan prepared by the construction contractor in accordance with 20 Code of Federal Regulations (CFR) 1910.120 and applicable state and local regulations governing worker's protection and health and safety. The Health and Safety Plan would identify known or suspected hazards associated with contamination and working conditions. The plan would include guidance for excavation, spill prevention, confined space entry, hearing and respiratory protection, and emergency response.

To protect public safety during the construction phase, warning signs and construction barriers will be used as appropriate and in accordance with the provisions of the Bottomland Management Plan (in preparation). Worker safety and safety of the public will also be managed during the construction process through adherence to a Health and Safety Plan as administered by the Site Health and Safety Officer.

Develop and post warning and information signs and waterway markers at access points, at boat ramps, and the upstream and downstream ends of the work site for a period of at least 3 weeks before any activity or closure to alert boaters and other waterway users of the location and nature of the navigational changes made to the river.

The City of Traverse City will maintain these signs for the length of the project. Signs would be posted at these upstream and downstream project boundaries instructing boats of the hazards and to keep out of the project area. Signs would be posted at nearby boat launches to inform river users of the closed areas.

The removal of Brown Bridge Dam, the powerhouse, and other structures would eliminate the identified safety hazards at the site. The dam and associated structures would no longer present a public safety risk. Similarly, the risk of the dam to boaters would be removed. The long-term risk of dam failure would also be abated.

Boardman River valley side slopes adjacent to the impoundment and the river in the area of the former impoundment may initially be unstable due to dewatering during the drawdown period and an indeterminate relatively brief period afterwards (e.g. months to several years). There may be some slumping along steep slopes depending on soil makeup, rate of dewatering and vegetative cover. These areas are expected to become increasingly more stable with time after re-vegetation occurs. Due to the increased slope instabilities, there is a potential human health and safety concern for individuals traveling in these areas. Hikers, walkers or paddlers who go ashore may be at some risk if they walk across these areas. Potential collapse of the river bank, unconsolidated soils, or adjacent slopes, may cause falls or result in personal injury

Closing certain sections of the river (other than just the construction zone) for a period of time sufficient to allow stabilization may be necessary. Placement of signs and advertisement notifying river closure locations will be necessary, as well as warning of the new dangers associated with the changed river conditions until normal riverine stabilization is attained. It should, however, be noted that rivers by nature are dynamic systems.

The project design incorporates measures to limit sedimentation and impacts to water quality. Construction debris will be handled and disposed of in accordance with applicable regulations.

As areas of impoundment sediment are dewatered and dry out, some will remain as unsaturated soil. Sediment sampling detected the presence of arsenic at varying concentrations within the sediments of Brown Bridge Pond. However, as previously discussed in Section 3.2.3, Alternative B is not expected to result in significant concerns regarding recreational use of the exposed bottomland. Potential impacts associated with the elevated arsenic levels within some of the sediments within the Brown Bridge Pond are dependent upon the type and nature of construction activities (e.g., excavation, soil deposition, grading, etc.), the resultant soil concentrations, degree of vegetative establishment and cover, and potential for human contact. In order to ensure that there is a low potential for impact the following measures will be implemented:

1. Conduct additional soil sampling within the bottomlands to characterize the extent of arsenic in surface soils in areas where direct contact is a potential.
2. Maintain consultation with MDEQ to establish appropriate site-specific recreational direct contact criteria for the site, which could vary based on expected exposure.
3. Restrict public use within the exposed bottomlands for a period of two years to maximize the establishment of plant community establishment and restoration.
4. Develop appropriate management approaches to prevent human contact of soils containing elevated arsenic levels (e.g., soil cover, use of boardwalks, signage for restricted use areas, etc.)

3.12 CUMULATIVE EFFECTS

A cumulative impact analysis must consider the potential impact on the environment that may result from the incremental impact of the project when added to other past, present, and reasonably foreseeable future actions (40 CFR 1508.7). The methodology for performing such analyses is set forth in "Considering Cumulative Effects under the NEPA" (CEQ, 1997) and includes the following:

1. Identification of the geographic area in which effects of the project may be felt;
2. Assessment of the impacts that are expected in that area from the project;
3. Identification of other actions (past, present, and reasonably foreseeable) that have had or are expected to have impacts in the same geographic area;
4. Assessment of the impacts or expected impacts from these other actions, and
5. Assessment of the overall impact that can be expected if the individual impacts are allowed to accumulate.

For this project, cumulative impacts were assessed within the context of two geographic areas. The geographic areas for analysis were selected based on the environmental effects that may occur to each of the primary resources under consideration. Primary resource categories and their associated geographic areas are as follows.

1. **Water-Related Effects***:* The area in which water quality-related effects of the project may be evident was determined to include the project site and the mainstem Boardman River

extending from the confluence of the Forks to the upper end of Boardman Pond. Selection of a portion of the Boardman River upstream of the project site was designed to allow for consideration of actions occurring in upstream areas and their potential for cumulative impacts on downstream areas. Limitation of the downstream extent of this geographic area is supported by the relatively insignificant effects of Brown Bridge Dam removal on increasing discharge of the Boardman River below Brown Bridge Dam.

2. **Aquatic Ecosystem-related Effects***:* The area in which aquatic ecosystem-related effects of the project may be evident was determined to include the project site and the mainstem Boardman River extending from the confluence of the Forks to the Union Street Dam.

3.12.1 Water-Related Effects

3.12.1.1 Geographic Area of Analysis

The geographic area of analysis for evaluation of water quality effects is appropriately limited to the following areas:

1. Immediate Vicinity of Brown Bridge Dam/Pond. This area contains the proposed action (dam removal and ecosystem restoration) and is the area of direct effect.
2. Upstream of Brown Bridge Pond to the Forks. This area is limited to the reach of Boardman River that is influenced by backwater and altered sedimentation regimes of Brown Bridge Pond. As discussed in Section 3.2.2, this area is primarily evident as extending from the delta upstream to Grasshopper Creek. For the purposes of this cumulative effects analysis, the geographic area is extended above Grasshopper Creek to the confluent of the North and South Branches of the Boardman River ("The Forks").
3. Downstream of Brown Bridge Pond to Boardman Pond. The downstream limit of the geographic area of analysis corresponds to that area in which negligible hydrologic changes will occur due to the removal of Brown Bridge Dam. As described in Section 3.2.1, changes in the hydro-regime of the Boardman River are negligible below Brown Bridge Dam. However, it is recognized that sediment transport processes will be restored that will convey sediments to downstream reaches of the Boardman River. Because of the commitment to sediment management measures at Brown Bridge Pond, these effects are expected to be attenuated to more normalized sedimentation processes that are in equilibrium downstream of the pond despite the removal of the sediment-trapping dam. Additionally, disruption of the thermal regime in the Boardman River is known to extend below Brown Bridge Pond. To provide conservatism in the cumulative effects analysis, the geographic area is expanded downstream (approximately 12 miles) to Boardman Pond.

Collectively this geographic area is illustrated as the area containing Segments 6, 7 and 8 in Figure 1-2. This area provides a sufficiently large enough context within which the potential water-related cumulative effects of the project may be analyzed.

3.12.1.2 Identification of "Other Actions"

Table 3-18 identifies recent past, present, and reasonably foreseeable future actions within this geographic area that can be assessed to determine cumulative effects on the resource issues of concern. This information was developed from general research and interviews with local agencies to identify potential actions that could in aggregate, result in larger, and potentially significant adverse impacts to the resources of concern.

Relevant "Other Actions" that are considered in this cumulative effects analysis are limited to the past culvert replacement projects (Carpenter Creek Road, Mayfield Road, and Wood Road), the proposed action (future action), the potential development of two pedestrian bridges across the

Boardman River (one at the former Brown Bridge Dam location, one upstream of former pond), and the Hoch Road waste water treatment plan (WWTP) development (future action). No present or on-going actions were identified that are relevant to this analysis.

3.12.1.3 Analysis of Cumulative Effects

A proper analysis of potential cumulative impacts to water quality must consider that both direct and indirect water-related effects of a given project (including the proposed removal of Brown Bridge Dam) will be mitigated, as described in more detail throughout this document. These "built-in" mitigative measures include such features as extensive sediment management within the upper impoundment, use of BMPs in construction areas to minimize erosion and sedimentation in receiving waters, hydro-seeding and mulching of steep slopes on the north side of Brown Bridge Pond, and extensive seeding of the exposed bottomland using a native seed mix.

Potential impacts associated with the past projects identified in Table 3-18 are considered to be minimal and non-contributing to additional water-related impacts associated with Brown Bridge Dam removal. Each of these past projects is small in scope and located at large distances from the Boardman River mainstem. Additionally, their impacts are expected to have been mitigated by appropriate BMPs, short-term in duration, and localized. Consequently, no additional synergistic and cumulative effects from these actions are identified.

In anticipation of the potential removal of Brown Bridge Dam, interest has been expressed regarding the potential for constructing a two new pedestrian bridges at the former dam site and upstream of the former Brown Bridge Pond to provide access across the Boardman River. This facility is assumed to be of a "drop-in-place" type design that will minimize/avoid any substantial impacts to the water quality of the Boardman River. Required construction of this feature is assumed to only include the field fabrication of bridge abutments to support the bridge spans. Impacts from these abutments are expected to minimal and localized as summarized in Table 3-18. Consequently, no additional synergistic and cumulative effects from these actions are identified.

The proposed Hoch Road WWTP development has been in the planning stages for a number of years. This project entails the construction of an improved regional WWTP that will discharge water to the Boardman River near Boardman Pond. The project would include a discharge (either 2.25 or 2.5 million gallons per day) that would represent a minor increase in the flow of the Boardman River (1.2 to 2.5 percent). However, the facility would also result in a significant reduction in the loading of total suspended solids (TSS) from 2,127 to 434 pounds per day to the Boardman River (Gourdie Frasier, Inc., 2001). Because of these improvements in water quality and the likelihood that the proposed facility will not contribute to any changes in other water quality parameters (e.g., temperature), no additional synergistic and cumulative effects from these actions are identified.

In terms of impacts to wetlands and streams; no significant cumulative impacts are anticipated.

Table 3-18. Summary of Other Past, Present[1] or Reasonably Foreseeable Future Actions in the Vicinity of Brown Bridge Dam

	Water Resource Affected, Location	Date/Year	Description	Wetland Impact	Aquatic Ecology Effect	Water Quality Effect
Past Projects	**Carpenter Creek Road Culvert Replacement, Grand Traverse County Highway Department**					
	Carpenter Creek, ~2.5 miles upstream of confluence with Boardman River at The Forks	2011	Install 27 foot x 10.6 foot' box culvert	0	Localized/short-term	Localized/short-term
	Twenty-two Creek, ~3.5 miles upstream of confluence with Boardman River at The Forks	2010	Install 27 foot x 10.6 foot box culvert	0	Localized/short-term	Localized/short-term
	Jackson Creek, ~6.5 miles upstream of confluence with Boardman River and East Creek	2009	Install 42-inch by 29-inch arch pipe.	0	Localized/short-term	Localized/short-term
Reasonably Foreseeable Future Projects	**Brown Bridge Dam Removal, City of Traverse City**					
	Brown Bridge Pond/ Boardman River	Jul-2012	Dam Removal/ Ecosystem Restoration	Net creation of 12.9 acres	Restoration of fish passage; restoration of cool water to coldwater fishery.	Localized/short-term increases in turbidity/sedimentation, extensive/long-term restoration of temperature.
	Pedestrian Bridge Installation, Brown Bridge Dam Area	<5 years	Installation of two pre-cast pedestrian bridges	Less than 0.1 acre (footings only)	No impact, bridge assumed to be "drop in place" design.	May have minor, localized increases in turbidity due to construction of footings.
	Hoch Road WWTP Development, Grand Traverse County					
	Boardman River, near Keystone Pond	<5 years	Construct new WWTP	0	Beneficial due to improved water quality.	Positive, 80 percent reduction in loading of TSS to Boardman River.
	Sabin Dam Removal, Grand Traverse County					
	Sabin Pond/Boardman River	2-5 years	Dam Removal/ Ecosystem Restoration	Undetermined, assumed to be net gain	Restoration of fish passage; restoration of cool water to coldwater fishery.	Localized/short-term increases in turbidity, extensive/long-term restoration of temperature.
	Boardman Dam Removal, Grand Traverse County					
	Boardman Pond/ Boardman River	>5-10 years	Dam Removal/ Ecosystem Restoration	Undetermined, assumed to be net gain	Restoration of fish passage and restoration of cool water to coldwater fishery.	Localized/short-term increases in turbidity, extensive/long-term restoration of temperature.

[1] None identified

3.12.2 Aquatic Ecology Effects

3.12.2.1 Geographic Area of Analysis

The geographic area of analysis for evaluation of aquatic ecology effects is appropriately limited to the following areas:

1. Immediate vicinity of Brown Bridge Dam/Pond. This area contains the proposed action (dam removal and ecosystem restoration) and is the area of direct effect.
2. Upstream of Brown Bridge Pond to the Forks. This area is limited to the reach of Boardman River that is influenced by backwater and altered sedimentation regimes of Brown Bridge Pond that alter in-stream habitat characteristics. As discussed in Section 3.2.2, this area is primarily evident as extending from the delta upstream to Grasshopper Creek. For the purposes of this cumulative effects analysis, the geographic area is extended above Grasshopper Creek to the confluent of the North and South Branches of the Boardman River ("The Forks").
3. Downstream of Brown Bridge Pond to Union Street Dam. The downstream limit of the geographic area of analysis corresponds to that area in which other considered actions may affect fish passage and overall ecosystem contiguity and function. Considered removals of Boardman Dam and Sabin Dam are recognized and appropriately evaluated in terms of fish passage. The reach below Union Street Dam is excluded as this structure is recognized as having important function in limiting the movement of undesirable aquatic species (salmon, sea lamprey, goby, etc.) to upstream reaches of the Boardman River. It is also assumed that the on-going commitment of USFWS and other stakeholders will maintain and improve the effectiveness of the Union Street Dam as a barrier that will limit the geographic distribution of these species.

3.12.2.2 Identification of "Other Actions"

Table 3-18 identifies recent past, present, and reasonably foreseeable future actions within this geographic area that can be assessed to determine cumulative effects on the resource issues of concern.

Relevant "Other Actions" that are considered in this cumulative effects analysis are limited to the potential foreseeable future actions of removal of Brown Bridge, Boardman and Sabin dams. Past culvert replacement projects (Carpenter Creek Road, Mayfield Road, and Wood Road), the proposed action (future action) are also considered in terms of ecosystem contiguity and fish passage.

The Hoch Road WWTP development (future action) is not considered in this analysis as it is not considered to contain project elements or impacts that are relevant to either fish habitat or passage issues. No present or on-going actions were identified that are relevant to this analysis.

3.12.2.3 Analysis of Cumulative Effects

Potential impacts associated with the past projects identified in Table 3-18 are considered to be positive as it relates to aquatic ecosystem contiguity and function. It is likely that the improved (and larger) culvert openings at each of these road crossings is effective in maintaining proper hydrologic conveyance between upstream and downstream areas (and therefore, greater capacity for movement and passage by aquatic biota). Because of the positive and beneficial aspects of these past projects in supporting contiguity of aquatic biological communities, no additional synergistic and cumulative effects from these actions are identified.

Potential future actions are being considered on the lower Boardman River that includes the removal of Boardman and Sabin Dams. Because funding for these large construction projects has not been secured, there is some uncertainty about their actual timing and their "foreseeability." Furthermore, detailed designs for these potential actions (and their associated ecosystem restoration measures) have not been developed. Because these details are lacking, this analysis is limited to a conceptual consideration of dam removal and the restoration of fish passage. As discussed in Section 3.3.1, the removal of dams has the potential to restore the movement of reproductive propagules and allochthonous food sources from upstream areas at each dam location which will have localized effects in restoring functionality within the system. This cumulative effect analysis however, focuses on the larger issues associated with fish passage.

Potential beneficial effects of dam removal include the restoration of fish passage from downstream to upstream habitats at each location. Depending on particular movement patterns of each species, populations may be subject to broader gene pool exchange, thereby enhancing overall population condition and health. Potential concerns (negative impacts) that could contribute to cumulative adverse effects to the aquatic biological community of the Boardman River are related to the introduction of undesirable species. For example, the removal of all barriers to fish movement within the Boardman River (including Union Street Dam) could (hypothetically) allow the expansion of sea lamprey and other undesirable species into the entire Boardman River watershed. This would result in direct impacts to the aquatic biological community and would also place a large financial burden on aquatic resource managers (USFWS, MDNR) in developing appropriate alternatives to treat/manage such undesirable species. However, because Union Street Dam is being maintained and managed as a barrier to upstream movement of undesirable species, the potential future removal of Boardman and Sabin dams is not considered to have adverse impacts to fish passage. Furthermore, because the removal of these dams will also provide for additional restoration of thermal regime of the Boardman River the habitat contiguity and natural balance in the distribution of coldwater/cool water species will be enhanced. Because of the positive and beneficial aspects of these future projects in restoring fish passage and enhancing contiguity of aquatic biological communities, no additional synergistic and cumulative effects from these actions are identified.

3.12.3 Summary

In summary, there will not be any significant cumulative adverse environmental impact from the Brown Bridge Dam removal project when considered together with other past, present, and reasonably foreseeable future projects in the area.

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Figures

Appendix A

Summary of Scoping Meeting and Public Comments

MEMORANDUM

DATE:	**August 1, 2011**
FROM:	**William Elzinga**
SUBJECT:	**NEPA Public Meeting Summary**
TO:	**MACTEC Project File Number: 33100009**

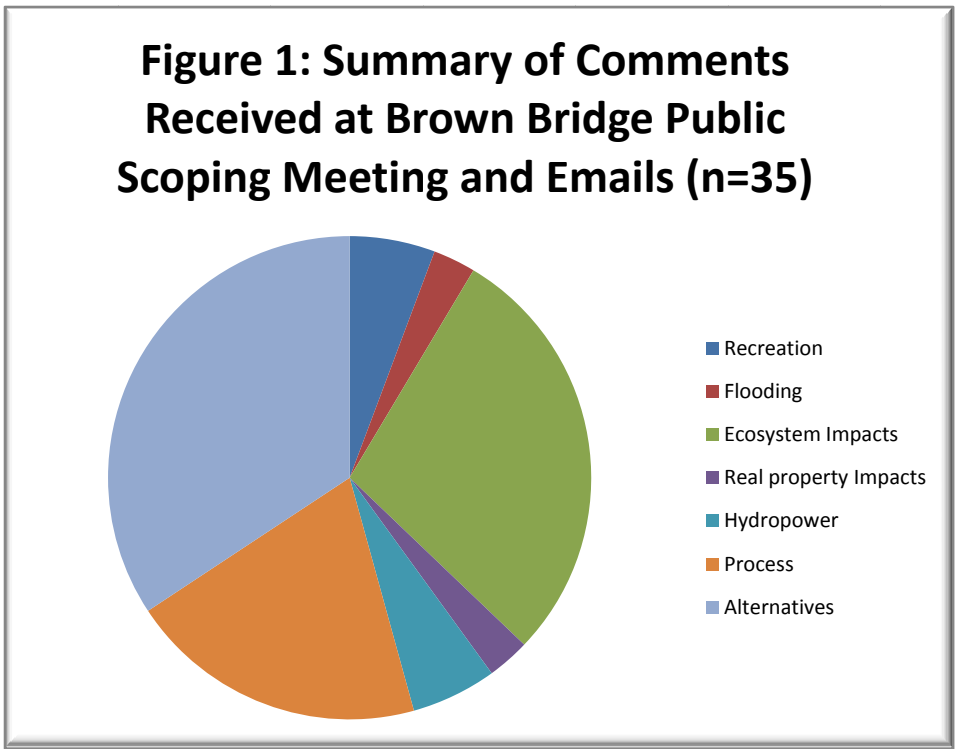
Title: Brown Bridge Environmental Assessment Public Scoping Meeting Summary—June 21, 2011

Purpose and Content:
A public scoping meeting was held on June 21, 2011 at the Grand Traverse Civic Center to solicit public input regarding the proposed removal of Brown Bridge Dam. The meeting was held in an open house format and included the distribution of the Brown Bridge EA Fact Sheet and comment form to all attendees. Exhibits prepared for the meeting and used to communicate project information included the following:

- Exhibit 1:"Purpose of Tonight's Meeting"
- Exhibit 2 "Brief Project History"
- Exhibit 3: "Brown Bridge Pond Existing Conditions"
- Exhibit 4: "Project Alternatives"
- Exhibit 5: "General Project Timeline" (and NEPA Process Diagram)
- Exhibit 6: "Project Purpose and Need"

Results:

A total of 32 people attended the meeting from the general public or other interested parties. Supporting personnel included representatives from the U.S. Fish and Wildlife Service, Grand Traverse County, Michigan Department of Natural Resources, Michigan Department of Environmental Quality, Conservation Resource Alliance, Grand Traverse Band of the Ottawa and Chippewa Indians, Grand Traverse County Conservation District, and MACTEC Engineering and Consulting, Inc. A total of 17 individuals or organizations provided written comments either at the meeting or subsequently via email. Content of the comments are summarized in Figure 1 and Table 1 as presented below:



The general response regarding the proposed action was generally split between those who offered positive comments (15) verses those who expressed negative comments (12). Eight (8) comments were received that were either observations or questions and not considered to be either positive or negative. Most positive comments were focused on the potential benefits of the proposed action regarding its restoration of environmental habitats and processes, recreational benefits (canoeing/kayaking), the openness of the public process, and the alternatives under consideration (active restoration, the availability of alternatives, and consideration of sediment management measures). Negative comments pertained to loss/changes to the existing ecosystem, potential for invasive species, loss of opportunities for hydropower, the failure to sufficiently engage the public in the process, and that the schedule for dam removal was not fast enough.

Summary findings of the public comments received at the meeting will be included in the Draft Environmental Assessment.

Table 1: Summary of Issues and Comments Received at Brown Bridge Public Scoping Meeting, June 21, 2011

Comment Issue and Content	No. Comments
Recreation	
Quality of the Boardman River and its value/use by canoeists/kayakers	2
Flooding	
Potential impacts of flooding downstream following dam removal	1
Ecosystem Impacts	
Negative effects-loss of pond, 100-yr environment, invasive species control, etc.	3
Positive effects-dam removal, restoration of original environment, cold water fisheries restoration	7
Real property Impacts	
Concern about loss/lost value of real property	1
Hydropower	
Hydropower should be/should have been considered	2
Process	
Keep politics out of process	1
Process has not been open	1
Process has been open	1
Schedule is not fast enough	2
Schedule should be slow enough to allow wildlife to acclimate	1
Legal process requires referendum and citizen vote	1
Alternatives	
Support removal/desire to pursue active restoration	5
Need to manage sediment as a funding priority	1
Use adaptive management to address problem areas	1
Alternatives to drawdown were not evaluated	1
Desire to remove earthen berms	1
Appreciate the consideration of multiple alternatives	1
Leave ponds as they are and maintain as necessary	1
Existing river layout allows for diversity	1

Appendix B

Correspondence

DEBBIE STABENOW
MICHIGAN

COMMITTEES:
AGRICULTURE, NUTRITION, AND FORESTRY
BUDGET
ENERGY AND NATURAL RESOURCES
FINANCE

United States Senate

133 HART SENATE OFFICE BUILDING
WASHINGTON, DC 20510-2204

July 22, 2011

Ryan Aylesworth
U. S. Fish and Wildlife Service, Region 3
1 Federal Dr
Fort Snelling, MN 55111

I am writing . . .

. . . on behalf of my constituent, Norbert J. Tutlis, who contacted me regarding his question in Section III about an Environmental Assessment pertaining to the proposed removal of the Boardman River Dams in Grand Traverse County, Michigan.

I have enclosed background materials about this issue. I would appreciate your review of the information and being advised of your findings.

If you have questions or need additional information, please contact Brandon Fewins in my Northern Michigan office at 231-929-1031. Any written materials can be sent to 3335 South Airport Road West Ste 6B, Traverse City, MI 49684 or by fax at 231-929-1250.

Thank you for your assistance. I look forward to hearing from you.

Sincerely,

Debbie

Debbie Stabenow
United States Senator

DS:bf

221 W. LAKE LANSING ROAD
SUITE 100
EAST LANSING, MI 48823
(517) 203-1760

243 W. CONGRESS STREET
SUITE 550
DETROIT, MI 48226
(313) 961-4330

432 N. SAGINAW STREET
SUITE 301
FLINT, MI 48502
(810) 720-4172

3335 S. AIRPORT ROAD W.
SUITE 6B
TRAVERSE CITY, MI 49684
(231) 929-1031

3280 BELTLINE COURT
SUITE 400
GRAND RAPIDS, MI 49525
(616) 975-0052

1901 W. RIDGE
SUITE 7
MARQUETTE, MI 49855
(906) 228-8756

PRINTED ON RECYCLED PAPER

913999 1

The Honorable Debbie Stabenow Norbert J. Tutlis
3335 So. Airport Rd. W Boardman Valley Preservation Society
Suite 6B preserveourdams.com
Traverse City, MI. 49684 4565 Buckhorn Dr. Traverse City, MI. 49684
231-929-1031 231-929-2928
April 22, 2011
REQUEST IMMEDIATE REVIEW OF POTENTIAL DANGEROUS SITUATION.

Let me begin by thanking you for protecting the freedoms I enjoy.

I. The irony in this situation is best seen in the letter from Grand Traverse County to FERC dated Oct. 24, 2006 wherein County Administrator Dennis Aloia repeatedly states: part"#1..Transfer of Exemption to GTC where the county questions the ability to transfer the exemptions worth about $2,000,000.00 to the county because they feel they belong to Traverse City Light and Power and can not be transferred and then he goes on to say "#2"the County has no intention or ability to utilize these dams for power generation, #3 the County is not in a position, nor do we desire, to do any electrical generation during that time, #4 The County is not "amendable" or agreeable to have the license transferred to the County, #5 As stated previously, we do not want to operate a power generator nor take
responsibility for the license, #6 Again, as stated previously, we have no desire to be in the power generation business." Nevertheless, two years later they are applying for a permit to apply for a license so they can block any one else from getting the permit to produce power from the same dams they are removing. They did this with no intention of applying for a license.
II. The safety of our citizens is at risk because the local agencies are not letting the United States Army Corps of Engineers use Best Engineering Practices. In February 2007, the USACE reported it would take $7,200,000.00 with $2,520,000.00 being the local share to remove the three dams, under study on the Boardman River. The work would take 4 to 7 years and did not include any monies for Cass Road Bridge ($9.6 million as reported by Grand Traverse County Road Commission 2011) nor land to use for storing soil, equipment etc. while breeching the dams takes place. The owners have circumvented this study by bringing in an outside, unqualified engineering firm with no experience in dam removal. Who will over see this process? Who is responsible to whom? The layers just keep building up and the responsibility and accountability gets more opaque as more groups get in between. Oh, and the cost keep increasing with disregard for whose money it is. Could you look into why the owners will not let the USACE be the lead agency and do their business without being manipulated by project sponsors (owners): Grand Traverse County, City of Traverse City and the Michigan Department of Natural Resources? *Project Authority is Section 506 of the Water Resources Development Act of 2000.
By letting the project sponsors order removal a la carte they are creating a disaster in Traverse City, Michigan. Could you check to see if the USACE has any recourse to the sponsors for Boardman River Project for circumventing their processes?

III. To date, no Environmental Assessment has been made nor is one being talked about. What is at risk are the fish and fowl, who will be negatively impacted when contaminated fish are

allowed, free access to the upper reaches of the Boardman River. So far the public statements coming from the Michigan Department of Natural Resources are, "they will go somewhere else if they don't like the new watershed. If it does not kill them, they will multiply and survive. *"The Golden and Bald Eagles Protection Act, known as "The Eagle Act" 16 USC 668-668c enacted 1940 has been ignored, and the *Migratory Bird Treaty Act 16 USC 703-712 of 1918 & 1972 is not discussed. Eagles are still species of special interest. Both the MDNR&E and the US Fish and Wildlife Service have been silent and I feel they are being negligent in their sworn duties to safeguard the resources listed above and below. The USFWS Region #3 has the following mission statement *"Prevent contaminant impacts to fish, wildlife, plants and their habitats, and restore those resources that have been impacted by environmental contaminants." However, I do not see how they can have it both ways. There are three species of special concern in our Grand Traverse County area; they are the Kirtland's Warbler (endangered), Pitcher's Thistle (threatened) and Eastern Mississauga (candidate). The USFWS was supposed to look at the risks and benefits of all three issues, (contaminants, non-native fish species (sea lamprey, Coho, Chinook, round gobies , zebra mussels and others) , and fish passage and make a recommendation on the best course of action based on the Best Available Information and the Service's existing authorities, policies, and guidelines. Will you be able to find out how they are progressing on an Environmental Assessment report? Has a new updated Environmental Impact Statement been completed by the USACE?

IV. While all this is going on the County also is ignoring their promise to control erosion and monitor and control invasive species in the exposed bottomlands they claim to own. The question that remains unanswered is: If the draw down does not make the dams any safer (seeing they have not been declared unsafe) , why draw the ponds down? The ponds were supposed to remain at the level ordered by FERC in their 2006 decommissioning order (see V below). Could you get the ponds restored to their historical if not strictly legal lake levels? Those of us who have counted on the ponds at Sabin, Boardman, and Brown Bridge for recreation, swimming, fishing, scuba and snorkel diving, kayaking, canoeing, power boating, bird watching (loons, swans, mergansers, eagles, kingfisher, great blue herons, meadowlarks, cardinals, etc.), nature walks and many other pastimes would like our ponds back. We have enjoyed them for over 100 years and would enjoy having them again so we can preserve America the Beautiful.

V. The parties to the license surrender, the owners of the dams being Grand Traverse County (Boardman and Sabin Dams), and the City of Traverse City (Brown Bridge Dam) were ordered by the Federal Energy Regulatory Commission,*" The licensee exempted has proposed to surrender the projects which would include decommissioning of the generating facilities but would not include removal of any of the dams. No construction activities are proposed and existing conditions (I.e. lake levels, etc) will remain." Could you find out what orders or laws would trump this federal order and allow the owners to lower the ponds, remove tainter gates, remove the equipment in the powerhouses and generally thumb their noses at the FERC order? * MDNR&E cites the Jan. 2007 Consent Agreement between them and the dam owner as authority for lowering Boardman Pond even though it violates FERC order, see above. Section 4 of that "agreement" has five issues in total and the parties have failed to enforce the other four concentrating on the pond lowering without explaining in a coherent manner why. Could you find out why the MDNR&E has insisted on the ponds being lowered when the have no positive reason for so doing?

Thank you for your consideration and action in this matter. Time is of the essence. We request an immediate cessation of all dam removal activity until these matters have been researched and resolved.

Respectfully,

Norbert J. Tutlis

* Asterisk denotes citation, law, public act, legal paper, legal opinion on record, important point.

**supporting documentation is attached as a file.

The Adams Chapter of Trout Unlimited - # 676

Box 2129. Traverse City, MI. 49685-2129

July 20, 2011

Mr. Rick Westerhof, Fish Biologist
USFWS, Green Bay Fish and Wildlife Conservation Office
6644 Turner Road
Elmira, MI 49730

Dear Mr. Westerhof:

As President of the Traverse City based Adams Chapter of Trout Unlimited I want to thank you for this opportunity to comment on the Environmental Assessment regarding the proposed removal of Brown Bridge Dam.

The Boardman River is the Chapter's main river of concern. Over the years, the Chapter has invested thousands of dollars toward erosion control and instream habitat improvement. Chapter members have also volunteered their valuable time and energy through numerous hands-on work bees to restore eroding streambanks and public accesses.

While we wholeheartedly support the removal of Brown Bridge Dam, our main concern is that if it is not done properly, the habitat that we've worked so hard all these years to restore and protect downstream of the Dam will become smothered in sediment that will take years, if not decades to flush through the system. The Boardman River cannot handle additional sediment.

To that end, the Adams Chapter of Trout Unlimited supports **Dam Removal with Active Restoration.**

We envision active restoration to include:

- Restoration of the newly formed streambanks.
- Introduction of woody-cover for all age classes of fish.
- Managed public access.
- Sensitive riparian area protection.
- 100% Sediment control within the project area during deconstruction (no-release downstream)

The Chapter is in the final stage of adopting a formal position statement for the Boardman that I will forward to you upon its completion. Among other issues, the Chapter's Boardman River Statement will address: Dams; Great Lakes Fish Passage; Recreational Use; Instream Habitat; and Trout Regulations.

Once again, thank you for this opportunity to comment and please let me know if you have any questions. I may be reached by email at JLJ@envlaw.com or by phone at (231) 946-0044.

Sincerely,

Jeffery L. Jocks, President
Adams Chapter Trout Unlimited

Cc: Nate Winkler, CRA, Dam Removal Project Manager
Todd Kalish, MDNR, IT Chair

United States Department of the Interior

FISH AND WILDLIFE SERVICE

5600 American Boulevard West, Suite 990
Bloomington, Minnesota 55437-1458

IN REPLY REFER TO:

FWS/EA

SEP - 9 2011

Honorable Debbie Stabenow
United States Senate
Washington D.C. 20510

Dear Senator Stabenow:

Thank you for your recent inquiry relating to the Fish and Wildlife Service's (Service) environmental review of the proposed removal and modification of the Boardman River Dams in Grand Traverse County, Michigan. The Service is the lead Federal agency for the proposed removal of Brown Bridge Dam and is preparing an Environmental Assessment (EA) pursuant to the requirements of the National Environmental Policy Act (NEPA) to evaluate the consequences of the proposed action. We are being supported in this effort by a consulting team led by AMEC E&I, Inc., which is particularly well qualified in performing this work having extensive experience in dam removals. As required under NEPA, we will be evaluating the potential for significant impacts of this action on public health and safety; and on any historic, natural, and cultural resources, including species listed, or proposed to be listed, under the Endangered Species Act. Included as part of this review, will be a review of the environmental issues that your constituent raised in his letter dated April 22, 2011. Our Green Bay Fish and Wildlife Conservation Office (sub-office located in Elmira, Michigan) is actively working with all partners and the Boardman River Implementation Team to complete the EA for the proposed removal of the Brown Bridge Dam.

A public scoping meeting to discuss the EA was held in Traverse City, Michigan on June 21, 2011. We anticipate that the draft EA will be available for public comment in late December 2011 or in January 2012. In addition to our efforts, please be advised that the U.S. Army Corps of Engineers is currently working on an Environmental Impact Statement that will focus on the proposed removal of Boardman and Sabin dams and modification of Union Street Dam. If you have any further questions, please do not hesitate to contact me.

Sincerely,

Thomas O. Melius

Thomas O. Melius
Regional Director

cc: Your Traverse City, MI Office

United States Department of the Interior

U.S. FISH AND WILDLIFE SERVICE
Green Bay Fish and Wildlife Conservation Office
6644 Turner Road
Elmira, Michigan 49730

July 27, 2011

Mr. Derek J. Bailey, Tribal Chairman
Grand Traverse Band of Ottawa & Chippewa Indians
2605 N West Bay Shore Dr
Peshawbestown, MI 49682-9275

Re: Request for Information, Environmental Assessment of the Removal of Brown Bridge Dam on the Boardman River

Dear Mr. Bailey:

In accordance with the requirements of the National Environmental Policy Act of 1969 (NEPA), the U.S. Fish and Wildlife Service (USFWS) as lead agency is preparing an Environmental Assessment (EA) to evaluate the effects of the removal of Brown Bridge Dam on the Boardman River in Grand Traverse County, Michigan. As part of the planning and evaluation process, the USFWS is requesting information and input from the Grand Traverse Band of Ottawa and Chippewa Indians (GTB) in order to evaluate potential impacts of the proposed action.

Brown Bridge Pond is an impounded waterbody on the Boardman River located near Traverse City, Michigan. Brown Bridge Dam is located at approximate coordinates 44.643366 N, -85.509400 W (WGS 84). A project vicinity map is provided in the attached Figure 1. The pond encompasses approximately 191 acres and has a watershed of nearly 165 square miles. It was initially formed in 1921 for use in the generation of hydropower, but in 2004 Traverse City Light and Power (TCLP) determined that it was no longer economically feasible to produce hydropower on the Boardman River. Consequently, TCLP made a decision in 2006 to discontinue use of Brown Bridge Dam, Boardman Dam, and Sabin Dam relinquishing their lease for the purpose of generating hydropower. In 2009, the City of Traverse City decided to remove Brown Bridge Dam.

The presence of the Brown Bridge Dam has caused adverse impacts to the corresponding portion of the Boardman River ecosystem by fragmenting and separating habitats, altering sedimentation patterns, disrupting hydrology, and increasing water temperature, consequently altering the composition of resident fish populations. The benefits of removing Brown Bridge Dam include enhancement and restoration of the river and bottomland ecosystem and increasing habitat continuity, shifting the Boardman River to a

more natural, free-flowing cold water river. At Brown Bridge Dam it is estimated that the restored river channel would be approximately 17,000 linear feet.

As you know, restoration planning is currently in progress that has included support from the GTB. This includes cultural resource assessments, and integration of Tribal Traditional Ecological Knowledge (TEK) as part of the restoration designs.

In order that potential environmental effects of the project may be fully evaluated and considered, the USFWS is hereby requesting that you provide input regarding issues or concerns relevant to the GTB. We request that you respond in writing concerning any beneficial or adverse impacts relative to the interests of your agency. Please send your comments to me by September 26, 2011.

Thank you for your attention to this matter. If you have any questions, please do not hesitate to contact me at (231) 584-3553 or at rick_westerhof@fws.gov.

Sincerely,

US Fish and Wildlife Service

Rick Westerhof

Rick Westerhof
Fish Biologist

Attachments: Figure 1: Project Vicinity Map

cc:

Brett Fessel, Grand Traverse Band of Ottawa and Chippewa Indians
Frank Dituri, Grand Traverse Band of Ottawa and Chippewa Indians
Tim Patronski, United States Fish and Wildlife Service
Mark Holey, United States Fish and Wildlife Service

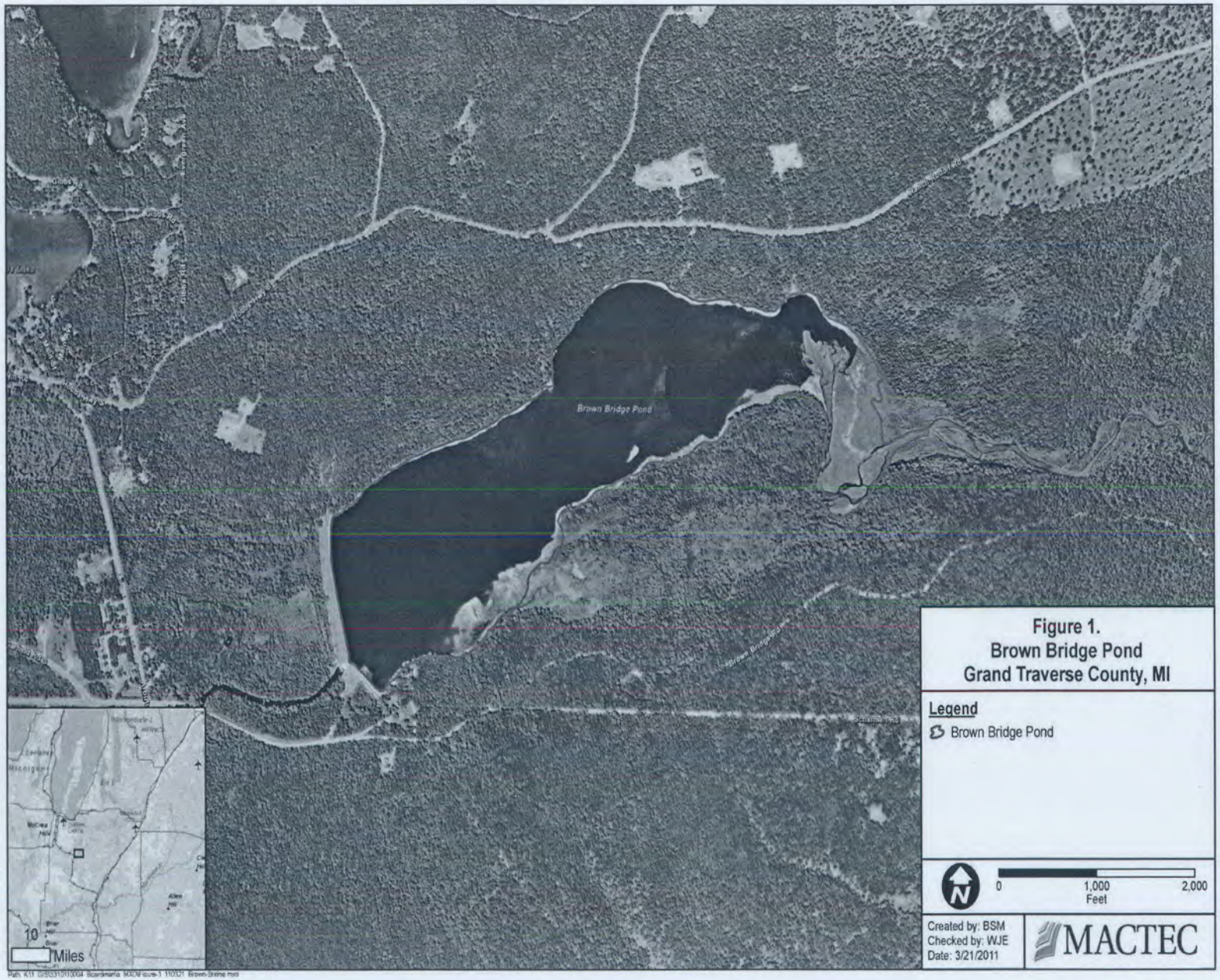


Figure 1.
Brown Bridge Pond
Grand Traverse County, MI

United States Department of the Interior

U.S. FISH AND WILDLIFE SERVICE
Green Bay Fish and Wildlife Conservation Office
6644 Turner Road
Elmira, Michigan 49730

July 27, 2011

Mr. Lew Coulter, Executive Director
Grand Traverse Conservation District
1450 Cass Rd.
Traverse City, MI 49685

Re: Request for Information, Environmental Assessment of the Removal of Brown Bridge Dam on the Boardman River

Dear Mr. Coulter:

In accordance with the requirements of the National Environmental Policy Act of 1969 (NEPA), the U.S. Fish and Wildlife Service (USFWS) as lead agency is preparing an Environmental Assessment (EA) to evaluate the effects of the removal of Brown Bridge Dam on the Boardman River in Grand Traverse County, Michigan. As part of the planning and evaluation process, the USFWS is requesting information and input from Grand Traverse Conservation District (GTCD) in order to evaluate potential impacts of the proposed action.

Brown Bridge Pond is an impounded waterbody on the Boardman River located near Traverse City, Michigan. Brown Bridge Dam is located at approximate coordinates 44.643366 N, -85.509400 W (WGS 84). A project vicinity map is provided in the attached Figure 1. The pond encompasses approximately 191 acres and has a watershed of nearly 165 square miles. It was initially formed in 1921 for use in the generation of hydropower, but in 2004 Traverse City Light and Power (TCLP) determined that it was no longer economically feasible to produce hydropower on the Boardman River. Consequently, TCLP made a decision in 2006 to discontinue use of Brown Bridge Dam, Boardman Dam, and Sabin Dam relinquishing their lease for the purpose of generating hydropower. In 2009, the City of Traverse City decided to remove Brown Bridge Dam.

The presence of the Brown Bridge Dam has caused adverse impacts to the corresponding portion of the Boardman River ecosystem by fragmenting and separating habitats, altering sedimentation patterns, disrupting hydrology, and increasing water temperature, consequently altering the composition of resident fish populations. The benefits of removing Brown Bridge Dam include enhancement and restoration of the river and bottomland ecosystem and increasing habitat continuity, shifting the Boardman River to a

more natural, free-flowing cold water river. At Brown Bridge Dam it is estimated that the restored river channel would be approximately 17,000 linear feet.

As you know, restoration planning is currently in progress that has included support from the GTCD. This includes GTCD's general consultation support and management activities related to invasive species within the Boardman River watershed.

In order that potential environmental effects of the project may be fully evaluated and considered, the USFWS is hereby requesting that you provide input regarding issues or concerns relevant to your agency. We request that you respond in writing concerning any beneficial or adverse impacts relative to the interests of your agency. Please send your comments to me by September 26, 2011.

Thank you for your attention to this matter. If you have any questions, please do not hesitate to contact me at (231) 584-3553 or at rick_westerhof@fws.gov.

Sincerely,

US Fish and Wildlife Service

Rick Westerhof

Rick Westerhof
Fish Biologist

Attachments: Figure 1: Project Vicinity Map

cc:

Steve Largent, Grand Traverse Conservation District
Mark Holey, United States Fish and Wildlife Service

Figure 1.
Brown Bridge Pond
Grand Traverse County, MI

Legend

Brown Bridge Pond

Grand Traverse
Conservation District

26 September 2011

Mr. Rick Westerhof, Fish Biologist
U.S. Fish and Wildlife Service
Green Bay Fish and Wildlife Conservation Office
6644 Turner Road
Elmira, MI 49730

Re: Request for Information, Environmental Assessment of the Removal of Brown Bridge Dam on the Boardman River

Dear Mr. Westerhof:

Thank you for this opportunity to comment on the Environmental Assessment for the proposed removal of Brown Bridge Dam. Our primary concerns are with the management of the sediment that has accumulated for nearly 90 years in the upper part of the reservoir and with the short and long-term management of invasive species.

Since 1992 the Grand Traverse Conservation District (GTCD) has contracted with the City of Traverse City to provide natural resource management services for the Brown Bridge Quiet Area. Also during this same period of time, the GTCD restored over 250 erosion sites on the Boardman River. Many of these sites occurred above Brown Bridge Pond and were primarily the result of human activity. Most likely a great deal of the sediment from these sites migrated downstream to the Pond.

The GTCD is also the coordinating agency for the Invasive Species Network (ISN) where GTCD staff surveyed and mapped the extent of invasive species in the Brown Bridge Quiet Area and have even began control efforts. This depth of experience gives us a unique perspective to comment on the pending removal of Brown Bridge Dam and the potential impacts on the Boardman River both up and down stream of the Dam and the newly exposed bottomlands.

The dams on the Boardman River have been recognized as having detrimental effects on the ecosystem, including habitat fragmentation, habitat degradation, thermal disruptions, and invasive species establishment. Removing Brown Bridge dam and the ensuing restoration will address these ecosystem needs and help restore a natural riverine ecosystem. However, the removal of Brown Bridge dam and the subsequent river and floodplain restoration raise some concerns, most specifically relating to the mitigation of sediment and invasive species management and control.

In the recently submitted Brown Bridge Dam Removal Concept Design Report prepared by Inter-Fluve, in association with AMEC, it is estimated that 84,000 cubic yards of sand could potentially be mobilized during drawdown and dam removal activities. In this report, Inter-Fluve states "the

1450 Cass Rd. · Traverse City, MI 49685 · t 231.941.0960 · f 231.941.0837 · www.natureiscalling.org

sediment deficit below Brown Bridge dam exists for only a short distance below the dam before tributary inputs return the sediment load to what might be considered a more normal range." Also, the highly permeable soils that comprise a majority of the watershed provide for the groundwater inputs that make the Boardman River "very stable" from a hydrology standpoint. In other words, because of this stability, the Boardman River does not receive the "flushing flows" necessary to transport the sediment through the system where it may exist for decades if not longer. Measures to minimize, to the extent possible, the amount of sediment that is released downstream during dam removal is critical.

Because reservoir drawdown, dam removal, and ecosystem restoration will result in large areas of newly exposed soil, it is important to recognize the potential for invasive species to become established. Upland areas above the existing pond are excellent seed sources for the establishment of invasive species in the newly exposed bottomlands. The GTCD conducted an extensive survey of the entire 1,310-acre Quiet Area and found over 24 invasive species currently established, of which 12 species are on ISN's Top 20 Priority List.

During the drawdown, dam removal, and restoration process, priority should be placed on restoring a natural river system, wetlands, and floodplain while minimizing the colonization or spread of invasive species. During restoration efforts, erosion control and soil conservation measures should focus on appropriate native vegetative cover. Prioritization should be given to native species from the region to preserve local genotypes and should help maintain high quality habitat and species diversity.

Once again thank you for this opportunity to comment and feel free to contact me, Steve Largent, or Christine Crissman at (231) 941-0960 if you have questions.

Sincerely,

Lew Coulter
Executive Director

Cc: Christine Crissman, GTCD Director of Conservation
Steve Largent, GTCD Boardman River Program Coordinator

United States Department of the Interior

U.S. FISH AND WILDLIFE SERVICE
Green Bay Fish and Wildlife Conservation Office
6644 Turner Road
Elmira, Michigan 49730

July 27, 2011

Mr. Dan Wyant, Director
Michigan Department of Environmental Quality
525 West Allegan
Constitution Hall, Sixth Floor
Lansing MI 48933

Re: Request for Information, Environmental Assessment of the Removal of Brown Bridge Dam on the Boardman River

Dear Mr. Wyant:

In accordance with the requirements of the National Environmental Policy Act of 1969 (NEPA), the U.S. Fish and Wildlife Service (USFWS) as lead agency is preparing an Environmental Assessment (EA) to evaluate the effects of the removal of Brown Bridge Dam on the Boardman River in Grand Traverse County, Michigan. As part of the planning and evaluation process, the USFWS is requesting information and input from Michigan Department of Environmental Quality in order to evaluate potential impacts of the proposed action.

Brown Bridge Pond is an impounded waterbody on the Boardman River located near Traverse City, Michigan. Brown Bridge Dam is located at approximate coordinates 44.643366 N, -85.509400 W (WGS 84). A project vicinity map is provided in the attached Figure 1. The pond encompasses approximately 191 acres and has a watershed of nearly 165 square miles. It was initially formed in 1921 for use in the generation of hydropower, but in 2004 Traverse City Light and Power (TCLP) determined that it was no longer economically feasible to produce hydropower on the Boardman River. Consequently, TCLP made a decision in 2006 to discontinue use of Brown Bridge Dam, Boardman Dam, and Sabin Dam relinquishing their lease for the purpose of generating hydropower. In 2009, the City of Traverse City decided to remove Brown Bridge Dam.

The presence of the Brown Bridge Dam has caused adverse impacts to the corresponding portion of the Boardman River ecosystem by fragmenting and separating habitats, altering sedimentation patterns, disrupting hydrology, and increasing water temperature, consequently altering the composition of resident fish populations. The benefits of removing Brown Bridge Dam include enhancement and restoration of the river and

bottomland ecosystem and increasing habitat continuity, shifting the Boardman River to a more natural, free-flowing cold water river. At Brown Bridge Dam it is estimated that the restored river channel would be approximately 17,000 linear feet.

In order that potential environmental effects of the project may be fully evaluated and considered, the USFWS is hereby requesting that you provide input regarding issues or concerns relevant to your agency. We request that you respond in writing concerning any beneficial or adverse impacts relative to the interests of your agency. Please send your comments to me by September 26, 2011.

Thank you for your attention to this matter. If you have any questions, please do not hesitate to contact me at (231) 584-3553 or at rick_westerhof@fws.gov.

Sincerely,

US Fish and Wildlife Service

Rick Westerhof

Rick Westerhof
Fish Biologist

Attachments: Figure 1: Project Vicinity Map

cc:

Jim Palowski, Michigan Department of Environmental Quality
Mark Holey, United States Fish and Wildlife Service

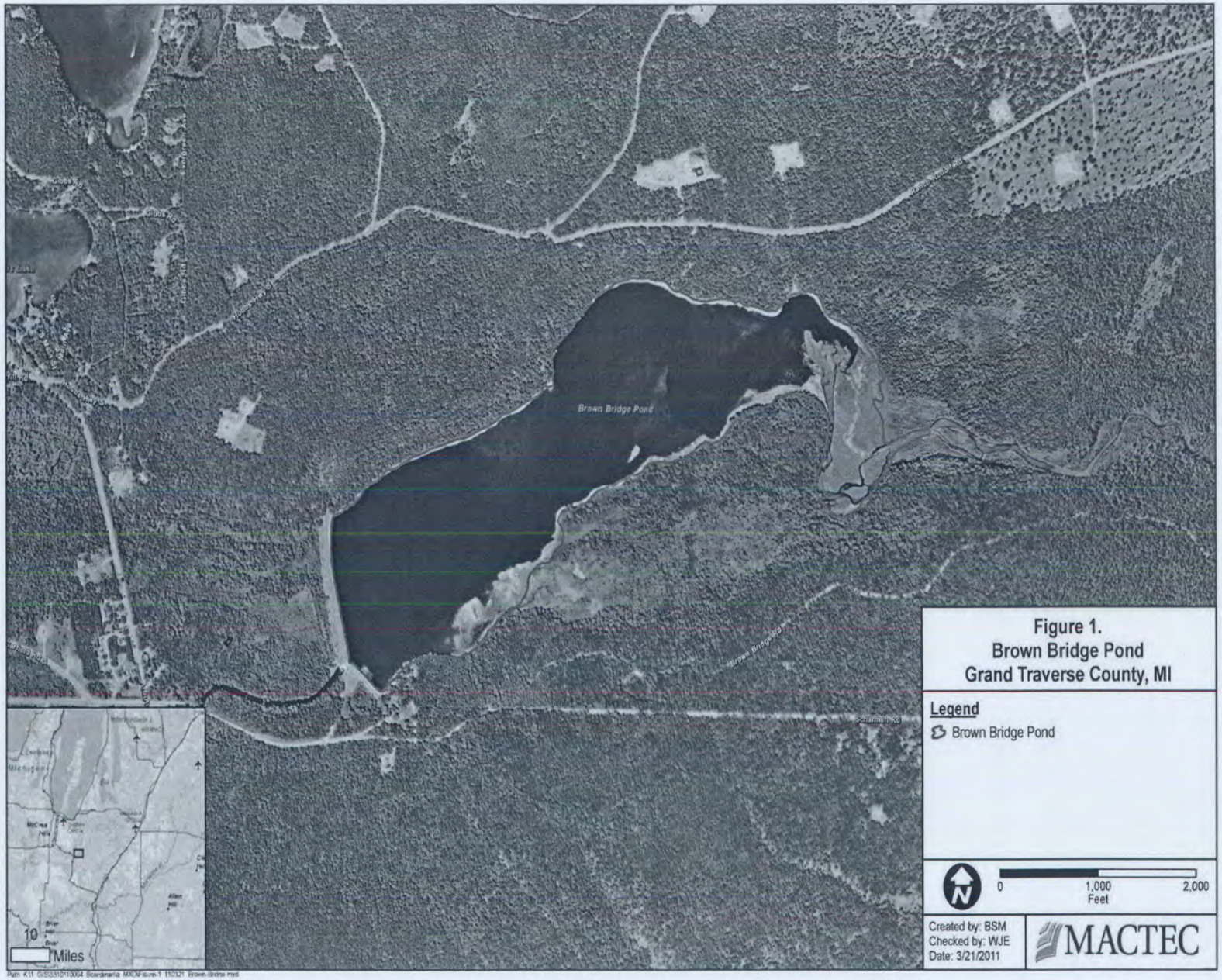


Figure 1.
Brown Bridge Pond
Grand Traverse County, MI

Legend

Brown Bridge Pond

STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY
LANSING

RICK SNYDER
GOVERNOR

DAN WYANT
DIRECTOR

September 26, 2011

Mr. Rick Westerhof
United States Fish and Wildlife Service
Green Bay Fish and Wildlife Conservation Office
6644 Turner Road
Elmira, Michigan 49730

Dear Mr. Westerhof:

Thank you for your letter of July 27, 2011, to Director Dan Wyant, Department of Environmental Quality (DEQ), concerning the Environmental Assessment (EA) for the Removal of the Brown Bridge Dam on the Boardman River in Grand Traverse County. Director Wyant has referred your letter to the DEQ's Water Resources Division (WRD) for response.

As you are aware, WRD staff has been intimately involved in the planning for the disposition of four dams on the Boardman River, including Brown Bridge, Boardman, Sabin, and Union Street Dams. Preparations are now underway for the removal of the Brown Bridge Dam, which, of the four dams that are being studied for disposition, is the uppermost dam on the river.

WRD staff has been active in the discussion of the EA for the Brown Bridge Dam, including attendance at the public meeting concerning the EA that the United States Fish and Wildlife Service (USFWS) hosted in Traverse City, Michigan. The WRD has identified several areas of concern or potential impacts that should be considered in the EA for this project. These concerns include, but are not limited to:

- Impacts to wetlands (both existing areas and areas of potential wetland creation).
- Surface water quality impacts.
- Sediment transport and deposition.
- Sediment contamination and potential transport.
- Dam removal process and procedures.
- Stream restoration techniques.
- Invasive species monitoring and management.

Based on our staff involvement to date, we are comfortable that these issues are being addressed or will be addressed during the EA and subsequent application for permit for removal of the dam.

As a reminder, a permit for the removal of the dam will be required under the authority of Part 301, Inland Lakes and Streams; Part 303, Wetlands Protection; and Part 315, Dam Safety, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. As part of the WRD's application process, the United States Environmental Protection Agency will also review the application, specifically any aspects involving contaminated sediment.

If you have any further questions regarding this matter, please contact Mr. Jim Pawloski, Gaylord Field Office, WRD, at 989-705-3443; pawloskij@michigan.gov; or DEQ, 2100 West M-32, Gaylord, Michigan 49735-9282; or you may contact me.

Sincerely,

Michael Masterson, Chief
Field Operations Section – Lakes Michigan and Superior
Water Resources Division
517-335-1065

cc: Mr. Mark Holey, USFWS
Mr. Dan Wyant, Director, DEQ
Mr. Jim Sygo, Deputy Director, DEQ
Mr. William Creal, DEQ
Ms. Robyn Schmidt, DEQ
Mr. Jim Pawloski, DEQ

United States Department of the Interior

U.S. FISH AND WILDLIFE SERVICE
Green Bay Fish and Wildlife Conservation Office
6644 Turner Road
Elmira, Michigan 49730

July 27, 2011

Mr. Rodney Stokes, Director
Michigan Department of Natural Resources
Mason Building, Sixth Floor
P.O. Box 30028
Lansing MI 48909

Re: Request for Information, Environmental Assessment of the Removal of Brown Bridge Dam on the Boardman River

Dear Mr. Stokes:

In accordance with the requirements of the National Environmental Policy Act of 1969 (NEPA), the U.S. Fish and Wildlife Service (USFWS) as lead agency is preparing an Environmental Assessment (EA) to evaluate the effects of the removal of Brown Bridge Dam on the Boardman River in Grand Traverse County, Michigan. As part of the planning and evaluation process, the USFWS is requesting information and input from Michigan Department of Natural Resources in order to evaluate potential impacts of the proposed action.

Brown Bridge Pond is an impounded waterbody on the Boardman River located near Traverse City, Michigan. Brown Bridge Dam is located at approximate coordinates 44.643366 N, -85.509400 W (WGS 84). A project vicinity map is provided in the attached Figure 1. The pond encompasses approximately 191 acres and has a watershed of nearly 165 square miles. It was initially formed in 1921 for use in the generation of hydropower, but in 2004 Traverse City Light and Power (TCLP) determined that it was no longer economically feasible to produce hydropower on the Boardman River. Consequently, TCLP made a decision in 2006 to discontinue use of Brown Bridge Dam, Boardman Dam, and Sabin Dam relinquishing their lease for the purpose of generating hydropower. In 2009, the City of Traverse City decided to remove Brown Bridge Dam.

The presence of the Brown Bridge Dam has caused adverse impacts to the corresponding portion of the Boardman River ecosystem by fragmenting and separating habitats, altering sedimentation patterns, disrupting hydrology, and increasing water temperature, consequently altering the composition of resident fish populations. The benefits of removing Brown Bridge Dam include enhancement and restoration of the river and

bottomland ecosystem and increasing habitat continuity, shifting the Boardman River to a more natural, free-flowing cold water river. At Brown Bridge Dam it is estimated that the restored river channel would be approximately 17,000 linear feet.

In order that potential environmental effects of the project may be fully evaluated and considered, the USFWS is hereby requesting that you provide input regarding issues or concerns relevant to your agency. We request that you respond in writing concerning any beneficial or adverse impacts relative to the interests of your agency. Please send your comments to me by September 26, 2011.

Thank you for your attention to this matter. If you have any questions, please do not hesitate to contact me at (231) 584-3553 or at rick_westerhof@fws.gov.

Sincerely,

US Fish and Wildlife Service

Rick Westerhof

Rick Westerhof
Fish Biologist

Attachments: Figure 1: Project Vicinity Map

cc:

Todd Kalish, Michigan Department of Natural Resources
Mark Holey, United States Fish and Wildlife Service

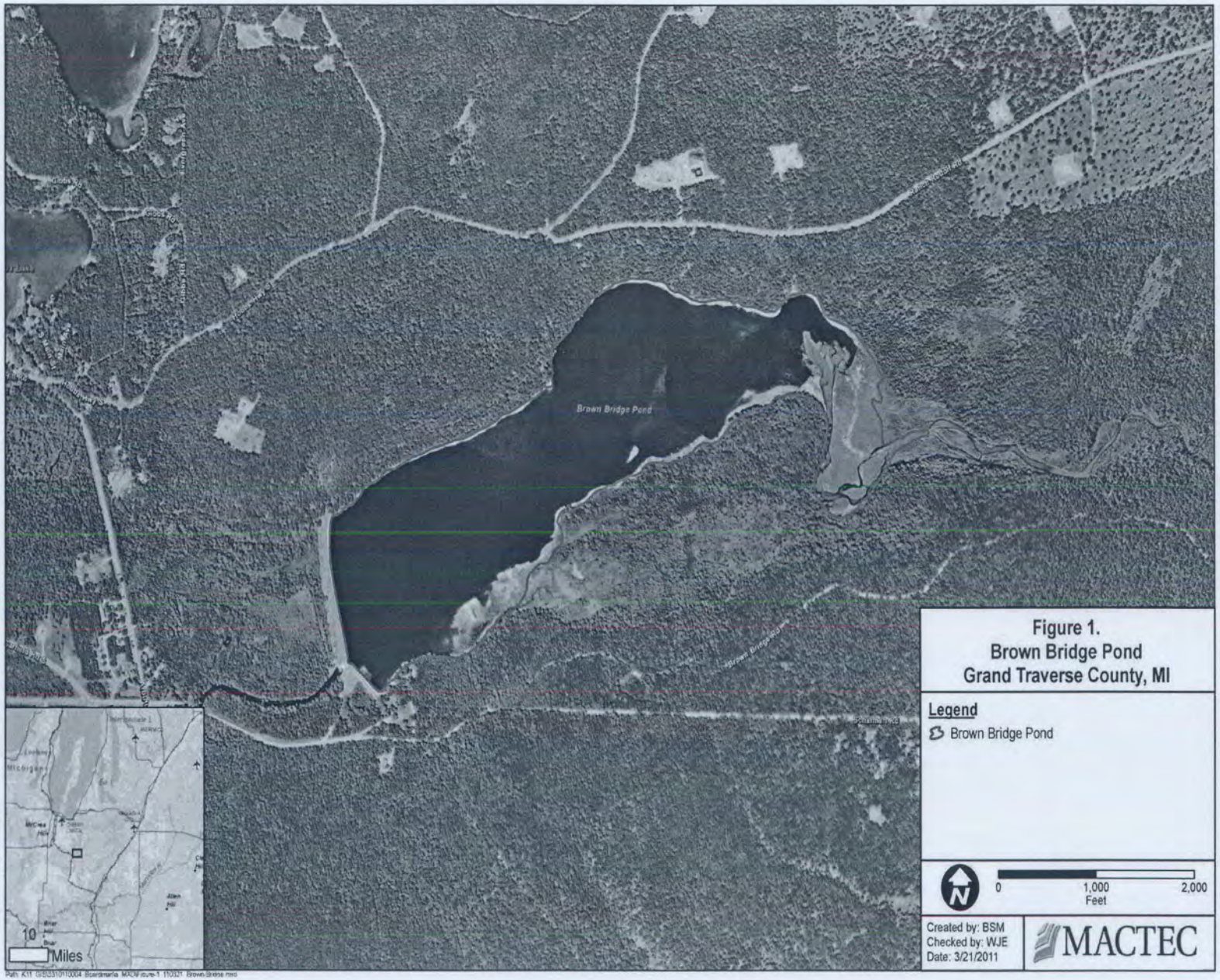


Figure 1.
Brown Bridge Pond
Grand Traverse County, MI

Legend

Brown Bridge Pond

Created by: BSM
Checked by: WJE
Date: 3/21/2011

MACTEC

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United States Department of the Interior

U.S. FISH AND WILDLIFE SERVICE
Green Bay Fish and Wildlife Conservation Office
6644 Turner Road
Elmira, Michigan 49730

July 27, 2011

Mr. Brian D. Conway, State Historic Preservation Officer
Michigan State Historic Preservation Office
702 Kalamazoo Street
P.O. Box 30740
Lansing, MI 48909-8240

Re: Section 106 Consultation, Environmental Assessment of the Removal of Brown Bridge Dam on the Boardman River

Dear Mr. Conway:

In accordance with the requirements of the National Environmental Policy Act of 1969 (NEPA), the U.S. Fish and Wildlife Service (USFWS) as lead agency is preparing an Environmental Assessment (EA) to evaluate the effects of the removal of Brown Bridge Dam on the Boardman River in Grand Traverse County, Michigan. As part of the planning and evaluation process, the USFWS is requesting information and input from the State Historic Preservation Office in order to evaluate potential impacts of the proposed action.

Brown Bridge Pond is an impounded waterbody on the Boardman River located near Traverse City, Michigan. Brown Bridge Dam is located at approximate coordinates 44.643366 N, -85.509400 W (WGS 84). A project vicinity map is provided in the attached Figure 1. The pond encompasses approximately 191 acres and has a watershed of nearly 165 square miles. It was initially formed in 1921 for use in the generation of hydropower, but in 2004 Traverse City Light and Power (TCLP) determined that it was no longer economically feasible to produce hydropower on the Boardman River. Consequently, TCLP made a decision in 2006 to discontinue use of Brown Bridge Dam, Boardman Dam, and Sabin Dam relinquishing their lease for the purpose of generating hydropower. In 2009, the City of Traverse City decided to remove Brown Bridge Dam.

The presence of the Brown Bridge Dam has caused adverse impacts to the corresponding portion of the Boardman River ecosystem by fragmenting and separating habitats, altering sedimentation patterns, disrupting hydrology, and increasing water temperature, consequently altering the composition of resident fish populations. The benefits of removing Brown Bridge Dam include enhancement and restoration of the river and

bottomland ecosystem and increasing habitat continuity, shifting the Boardman River to a more natural, free-flowing cold water river. At Brown Bridge Dam it is estimated that the restored river channel would be approximately 17,000 linear feet.

Restoration planning is currently in progress that includes a plan to conduct a Phase I archaeological survey of exposed bottomlands after the drawdown of Brown Bridge Pond. Furthermore, our study process integrates cultural resource assessments, consultation with the Grand Traverse Band of the Ottawa and Chippewa Tribe (GTB), and integration of Tribal Traditional Ecological Knowledge (TEK) as part of the restoration designs.

In order that potential environmental effects of the project may be fully evaluated and considered, the USFWS is hereby requesting that you provide input regarding issues or concerns relevant to your agency. We request that you respond in writing concerning any beneficial or adverse impacts relative to the interests of your agency. Please send your comments to me by September 26, 2011.

Thank you for your attention to this matter. If you have any questions, please do not hesitate to contact me at (231) 584-3553 or at rick_westerhof@fws.gov.

Sincerely,

US Fish and Wildlife Service

Rick Westerhof

Rick Westerhof
Fish Biologist

Attachments: Figure 1: Project Vicinity Map

cc:

Mark Holey, United States Fish and Wildlife Service

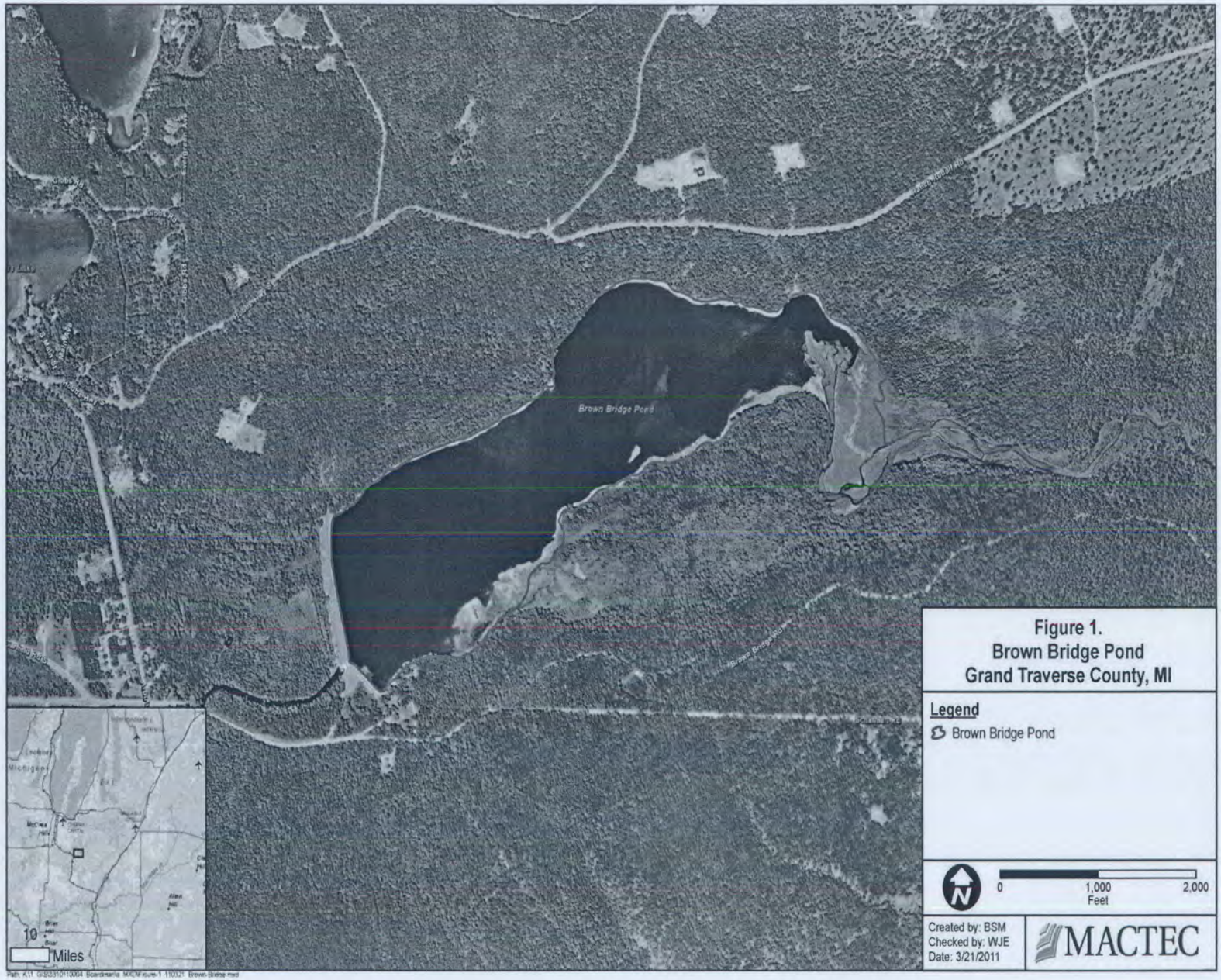


Figure 1.
Brown Bridge Pond
Grand Traverse County, MI

STATE OF MICHIGAN
DEPARTMENT OF NATURAL RESOURCES
LANSING

RICK SNYDER
GOVERNOR

RODNEY A. STOKES
DIRECTOR

August 10, 2011

Mr. Rick Westerhof, Fish Biologist
U.S. Fish and Wildlife Service
Green Bay Fish and Wildlife Conservation Office
6644 Turner Road
Elmira, Michigan 49730

Dear Mr. Westerhof:

Thank you for your July 27, 2011, letter to Director Rodney A. Stokes, requesting information regarding the Environmental Assessment of the removal of the Brown Bridge Dam on the Boardman River. Director Stokes asked the Fisheries Division to respond to your letter. The Department of Natural Resources (DNR) Fisheries Division supports the removal of the Brown Bridge Dam and subsequent restoration of the project area.

This project is part of a larger dam removal initiative on the Boardman River that began in 2005 when Traverse City Light and Power Department discontinued electricity production at Brown Bridge Dam. An Implementation Team was formed in 2005 to convene and facilitate a public process to assess various dam disposition options. From 2005-2009, over 1,000 citizens, numerous non-profit environmental groups, a scientific consultant team, federal, state, tribal, and local governmental agencies collaborated to assess and document the economic, social, and environmental impacts of various dam disposition alternatives. Thirteen Technical Reports (available at theboardman.org) were compiled through this initiative. These reports document that approximately 156 acres of wetlands, 25 acres of upland habitat, and 1.5 miles of high gradient river will be restored through the removal of the Brown Bridge Dam.

The removal of Brown Bridge Dam will also eliminate the negative affects the impoundment has on aquatic species and habitat. Specifically, native populations of sculpin (*Cottus sp.),* naturalized populations of brown trout (*Salmo trutta*), and native brook trout (*Salvelinus fontinalis*) will benefit due to elimination of thermal degradation and habitat fragmentation (Lessard and Hayes 2003)[1]. Removal will also restore the natural flow dynamics, sediment and organic material transport capacity, and high gradient riffle habitat currently impounded.

[1] **Literature Cited**

Lessard, J. L., and D. B. Hayes. 2003. "Effects of elevated temperature on fish and macroinvertebrate communities below small dams." *River Research and Applications* 19: 721–732.

The removal of Brown Bridge Dam is consistent with the Fisheries Division's mission to enhance fish and other aquatic life and habitat and is specifically consistent with management objectives and recommendations to remove the dam outlined in Fisheries Division's Boardman River Assessment (in press).

Thank you for the opportunity to comment on this Environmental Assessment.

Sincerely,

James L. Dexter, Acting Chief
Fisheries Division
517-373-3375

cc: Mr. Rodney A. Stokes, Director, DNR
Dr. Kelley Smith, Acting Natural Resources Deputy, DNR
Mr. Todd Kalish, DNR

Appendix C

Evaluation of Impacts of Brown Bridge Dam Removal on Downstream Floodplain and Bridge Scour Potential

DRAFT MEMORANDUM

DATE:	**February 15, 2012**
FROM:	**AMEC**
SUBJECT:	**Floodplain Impacts Assessment for Brown Bridge Dam Removal**
TO:	**AMEC Project File Number: 3310110009**

Title: Evaluation of Impacts of Brown Bridge Dam Removal on Downstream Floodplain and Bridge Scour Potential.

Purpose:

Brown Bridge Pond is an impounded water body located on the Boardman River near Traverse City, Michigan (Figure 1). The Brown Bridge Dam was initially constructed in 1921 for use in producing hydropower, but in 2004 Traverse City Light and Power (TCLP) determined that it was no longer economically feasible to produce hydropower on the Boardman River. Consequently, TCLP made a decision in 2006 to discontinue use of Brown Bridge Dam. TCLP leased the three dams from the owners of the dams (City of Traverse City [City] and Grand Traverse County) until 2005, after which time the City became owner of the Brown Bridge Dam. The purpose of this technical memorandum is to determine impacts of Brown Bridge Dam removal on downstream flood discharge frequency characteristics and flood elevations; assess impact of flood discharges on scour potential at Boardman River bridge crossings. Results of this analysis will be used to support the preparation of an Environmental Assessment being prepared to assess the impacts of dam removal.

Results:

Floodplain impacts for purposes of this section are changes to flood discharge – frequency relationships, and therefore high water elevation - frequency relationships, along the Boardman River that may be altered by the removal of Brown Bridge Dam. In addition to high water elevations, the increase in scour potential at constricted bridge openings was assessed. An increase in high flows may create an incremental increase in risk of failure due to destabilizing the foundation or supporting substructure of bridges. To determine the floodplain impacts of the proposed action, the floodplain conditions for the existing conditions are compared to the conditions associated with the proposed future condition.

1.0 Description of Existing Conditions

1.1 100-Year Floodplain

The Boardman River floodplain has been mapped for the National Flood Insurance Program (NFIP). Within the boundaries of Traverse City, has been mapped with detailed analyses, including the publication of Base Flood (i.e., the one percent annual risk flood, or 100-year flood) Elevations (BFE's) and flood profiles. Updated preliminary mapping was presented in June 2011, but has not yet been approved and become effective. Upstream of the Traverse City boundary and in the vicinity of Brown Bridge Dam, no official NFIP mapping has been published that identifies the 100-year floodplain. However, preliminary Zone A floodplain mapping has been made available by FEMA for review by the

local community (Figure 2). Published detailed elevation information such as profile, BFEs, and regulatory floodway are lacking in the Brown Bridge area. At Brown Bridge, the preliminary Flood Insurance Rate Maps (FIRMs) reflects the expanded, impounded water within the Brown Bridge reservoir. However, along the Boardman River channel the preliminary FIRMs identify a 100-year Zone A floodplain having a variable width, ranging from 150 to 300 feet wide between the confluence with East Creek and the confluence with Carpenter Creek.

1.2. Existing Water Level Control on the Boardman River

Brown Bridge Dam, powerhouse, and discharge control equipment, collectively referred to as the Brown Bridge structure, were constructed around 1930. As a result of dam safety concerns and regulatory compliance, the Brown Bridge water level was "temporarily" lowered from the historic normal water level of 797.5 feet to 794.5 feet in accordance with a permit received from the Michigan Department of Environmental Quality (MDEQ) dated October 13, 2008. With regard to the Brown Bridge structure, the existing condition is the condition existing subsequent to the temporary drawdown that occurred in 2008. More specifically, the existing condition includes use of the operable discharge facilities (the Tainter gates and log chute) to discharge flows as required to maintain a water level of 794.5 feet.

There are three dams located downstream from Brown Bridge Dam: Boardman Dam, Sabin Dam and Union Street Dam (i.e., from upstream to downstream). All of the dams except Union Street Dam were utilized for hydropower. To determine existing condition high water levels downstream of Brown Bridge Dam, the specifics regarding the Boardman structure and the Sabin structure must also be defined, since the operation of these structures have also been changed from the historic conditions.

The water level in the Boardman Dam pool, known as Boardman Pond (or Keystone Pond), was lowered from a historic regulated water level of 653.8 to approximately 637.5 feet following a January 2007 consent agreement between the Michigan Department of Natural Resources (MDNR) and Grand Traverse County (owner of Sabin and Boardman Dams). This lowering was also associated with dam safety concerns. However, at Boardman Dam, further changes occurred that included the removal of the turbines, runners, and generators.

The existing condition for the Sabin structure is defined by a controlled water level of 614.0 feet, the same as the historic regulated pool level during power generation. The Sabin pool (impoundment) level was lowered during 2011 by the authority of a MDEQ permit dated September 14, 2011 for the initial lowering of the impoundment associated with eventual dam removal. However, the lowering of the regulated pool had no associated irreversible changes. The turbine and runner have been removed; however, the spillway facilities have not been irreversibly changed and the Sabin regulated pool level could be restored to its historic regulated level. A summary of existing conditions at Brown Bridge, Boardman, and Sabin dams is presented in Table 1. The Union Street Dam has no power generating equipment and neither the structure nor the operation has been changed from the historic condition.

2.0 Environmental Consequences

2.1 No Action Alternative

Under the No Action Alternative, hydrologic conditions currently evident on the Boardman River in the vicinity of Brown Bridge Pond will remain unaltered. As such the natural flowing regime of the river will be interrupted by a still water (lentic) system. Accordingly the slower flowing water evident in Brown Bridge Pond will continue to promote sedimentation within the river upstream and within the impoundment. Eventually the impounded area will gradually become shallower due to sedimentation. Similarly, the extent of the 100-year floodplain will remain unchanged from the existing condition.

2.2 Dam Removal Alternative

The only change assumed as a result of the proposed action is the removal of the Brown Bridge Dam and resulting re-creation of a natural stream channel and floodplain in the reach now occupied by the existing Brown Bridge impoundment. The effects of potential removal of other dams on the Boardman River are not considered in this analysis.

2.2.1 Hydrology

A complete discussion of the hydrology of the Boardman River is beyond the scope of this discussion. A conventional steady flow hydraulic analysis for flood flows requires only peak discharge frequency estimates to predict flood elevations and scour potential.

Previous estimates of flood discharge frequency data for the Boardman River have been based on the United States Geologic Survey (USGS) regional regression equations (Holtschlag and Croskey, 1984). Estimates have been provided by MDNR through the floodplain database program. The regression equations are relatively complex in terms of watershed physiography and they include parameters describing five different watershed characteristics. For example, one of those characteristics is soil types and may involve between one and seven parameters, depending on the diversity of soil types existing in the watershed (i.e., parameters include percentage of the watershed for each of seven different soil type categories) based on geologic mapping (Farrand and Bell, 1984). Another parameter is the percent of the watershed main channel length that passes through marshes or lakes. Presumably the large majority of such water features on streams used for development of the regression equations were natural marshes and lakes. While the specific storage volume and discharge characteristics of the Brown Bridge, Boardman, and Sabin structures are not represented in the regression equation, these structures were operated as run-of-the-river power generation facilities without a flow control objective and a rational representation of these man-made water bodies may be provided by the regression equations. The accuracy of the method will depend on how closely the influence of these man-made structures on peak discharges resembles the influence of typical marshes and lakes. It should be noted however, that the regression equations cannot be expected to as accurately predict the control on peak discharges exerted by these structures as a traditional routing analysis that incorporates the structure-specific elevation-storage and elevation-discharge relationships. This is particularly true because of the operable discharge equipment (e.g., Tainter gates) used at each of the structures and the gated culverts used at the Union Street structure.

For this impact analysis, a rainfall runoff and routing model (HEC-HMS) was used that incorporates the site-specific elevation, storage, and discharge data for each structure and more precisely determine impacts on peak discharges. However, it is recognized that regulatory (MDNR) and Federal Emergency Management Agency (FEMA) National Floodplain Insurance Program (NFIP) flood discharge frequency estimates may continue to be based on the regression equations. As a matter of consistency and efficiency, FEMA generally prefers use of USGS regression equations. Consequently, even though a rainfall runoff model can be calibrated to approximately reproduce regression equation discharge frequency estimates while simultaneously allowing the more accurate prediction of the affect of the structures on peak flows, MDNR and/or FEMA may in the future choose to rely on continued use of regression equations to estimate flood discharge frequency data for regulatory purposes.

The status of NFIP information is relevant. There is currently detailed floodplain mapping information for the Boardman River only within the City of Traverse City, with limited Zone A mapping of the Boardman River beyond the City boundaries. Zone A mapping is approximate mapping, not based on detailed hydraulic analysis and 100-year flood elevations, or Base Flood Elevations, are not provided. FEMA is in the process of updating NFIP information (see Figure 2 for Interim 100-year floodplain). The information generated by the United States Corps of Engineers (USACE) for the dam removal feasibility study was used to provide Zone A mapping for the Boardman River from the Traverse City boundary upstream beyond Brown Bridge Dam. However, detailed information, including flood discharge frequency information and flood elevations, is still provided only for the reach of the Boardman River within Traverse City. Regulatory requirements for "development" projects affecting Zone A streams is normally limited to complying with the local community's floodplain development ordinance since no Base Flood Elevations (i.e., 100-year flood elevations) have been established for the stream.

2.2.1.1 USGS Regional Regression Equations

The MDNR provided flood discharge frequency estimates upon request~~s~~ for the Boardman River Dam Removal feasibility study (USACE), as well as other requests that are documented on MDNR's Flood Discharge Database. These estimates are summarized in Table 2. While inputs to the regression equations are theoretically reproducible, there is in fact some judgment/interpretation required to estimate inputs to the regression equations. Efforts to reproduce the MDNR estimates were not successful, resulting in a need to adjust estimates to reduce differences to approximately reproduce MDNR estimates. Discharge frequency data for the existing condition for MDNR locations, and additional locations, are provided in Table 3. Discharge frequency data for the proposed condition reflecting the removal of Brown Bridge Dam are provided in Table 4. These estimates at locations downstream of Brown Bridge Dam result from a reduction of 1.3 miles of stream passing through the Brown Bridge impoundment.

Differences in discharge frequency data associated with removal of Brown Bridge Dam are summarized in Table 4. The discharges are increased by approximately 1.3 to 1.7 percent by the removal of Brown Bridge Dam.

2.2.1.2 HEC-HMS Rainfall Runoff Model

A HEC-HMS rainfall runoff model was created. Actually, two different models were created using two different approaches. Both models utilized the methods as summarized in Table 5. One model utilized an approach included in Mead & Hunt, Incorporated's (Mead & Hunt) Probable Maximum Flood (PMF) analyses for the Brown Bridge and Boardman structures (2001). That approach included calculating four separate runoff hydrographs for each defined sub-basin; each hydrograph representing a portion of the subbasin with soils falling within one of the four different infiltration capacity ranges. Mead & Hunt presented those estimated areas within HEC-1 model inputs. Mead & Hunt defined two sub-basins, one for Brown Bridge Dam and one for the drainage area between Brown Bridge Dam and Boardman Dam. Mead & Hunt's HEC-1 model was said to have been calibrated based on observed runoff into Brown Bridge Pond and rainfall, although it is not clear from the report where the observed flow data used for model calibration were measured or how the flow measurements were made.

The HEC-HMS model was created based on the Mead & Hunt HEC-1 model approach and inputs. However, to provide increased geographic detail in peak discharge estimates, the two sub-basins were divided into two sub-basins upstream of Brown Bridge Dam (model junctions at RM 23.7 and RM 20.0) and three sub-basins between Brown Bridge Dam and Boardman Dam. The model input utilized the Mead & Hunt rainfall loss inputs; the HEC-HMS Clark unit hydrograph inputs between Brown Bridge Dam and Boardman Dam (model junctions at RM 18.8, RM 11.9, and RM 6.3) were based on Mead & Hunt inputs. However, one modification was made regarding the Clark hydrograph inputs. It was assumed that the high infiltration capacity zones contribute flow through interflow and groundwater discharge and not as surface runoff. The Clark time of concentration and storage coefficients were increased for the high infiltration soil zones to reflect this concept of streamflow. The model predicts flood runoff hydrographs with sharper peaks (i.e., more rapid rise and more rapid fall in the high flow range) than any flood hydrographs observed at USGS Station 04126970 which has been in operation since September 1997.

The model was also extended to include Sabin Dam and Union Street Dam. Input data for Clark hydrograph development were estimated based on the values used for the single Mead & Hunt hydrograph. The two channel reach routing operations defined also match the single Muskingum routing reach included in the Mead & Hunt HEC-1 model, which was indicated to have been based on matching output from a UNET (Unsteady flow NETwork hydraulic model, Robert Barkau, USACE) unsteady routing analysis.

The second HEC-HMS model used a more conventional approach to calculating the direct runoff hydrographs for each defined sub-basin (i.e., only a single runoff hydrograph generated based on a single rainfall loss estimate). The "initial loss" parameter used by Mead & Hunt, and the first HEC-HMS model, was 0.0 inch (i.e., no initial loss reflecting initial abstraction, depression storage, etc.). This appears to be an unusual assumption given the nature of the watershed. While this assumption may be appropriate for a PMF analysis that assumes a wet antecedent moisture condition, it was also used for the calibration events.

The second HEC-HMS model also includes conceptual storage routing operations at several locations in the system as calibration components. The basis of that approach was that the model development was to loosely calibrate peak flows to the regression equation peak discharges and because of the anticipated inability of the Clark unit hydrograph method to reflect the base flow (interflow and groundwater discharge) of the watershed. The recession constant base flow method was used with initial base flow inputs established by discharge per unit drainage area to be similar to normal or slightly elevated streamflow prior to the modeled storm events. Standard procedures for estimating base flow indicate that base flow constitutes approximately 92 to 94 percent of the flow volume in the Boardman River. This HEC-HMS model produced hydrographs with a more gradual rise and fall, appearing more similar to the observed runoff hydrographs upstream of Brown Bridge Pond.

2.2.1.3 Storage Routing Through Structures

Basic assumptions for storage routing through the man-made structures were as described in Table 1. Discharge rating relationships were calculated based on the best available information. The Brown Bridge discharge is through Tainter gates and a log sluice, which are relatively straight-forward calculations. No flow was assumed through the turbines. Discharge at Boardman structure includes flow through power plant penstocks and the scroll case for the turbine, which is not as straight-forward. Brown Bridge elevation-discharge data are presented in Table 6. Routing data for the Boardman and Sabin structures, for both existing and proposed conditions, are presented in Tables 7 and 8, respectively. The storage – discharge relationship for the Proposed Condition routing through the Brown Bridge reach are provided in Table 9.

The first HEC-HMS model (i.e., with soil infiltration rate zones) for the existing condition was modified to create a model for the proposed condition with Brown Bridge Dam removed. The modification replaced the level pool storage routing representing the Brown Bridge structure with a storage-discharge routing representing the channel and floodplain reach through what is the Brown Bridge impoundment of the existing condition model. The storage - discharge relationship was estimated from the HEC-RAS model for that reach. The HEC-RAS model assumed some future channel development through sediments deposited within the Brown Bridge reach. The ultimate re-created channel and floodplain cross-section is anticipated to be larger, resulting in more storage volume than reflected by the storage-discharge relationship used for the proposed condition HEC-HMS model routing).

2.2.1.4 HEC-HMS Model Results

The discharge - frequency results from the HEC-HMS model that uses the zoned infiltration rate approach are summarized in Table 10. Peak discharges for the 10-year and 100-year, 24-hour storm events at selected locations for the existing condition (No Action) and the proposed condition (dam removal) are presented, along with the modeled increases in peak discharges resulting from the Brown Bridge Dam removal. The model results indicate a decrease in peak discharges due to dam removal (indicated by the negative value of the increase due to dam removal). These results are from the HEC-HMS model using the infiltration rate zones. The alternate HEC-HMS model produced runoff hydrographs with a more delayed response and with a less pronounced peak, but provided similar results with regard to magnitude of peak flow changes resulting from Brown Bridge Dam removal.

These results warrant some explanation. It was noted that the changes in peak discharge, which are small relative to the magnitude of the flows, are sensitive to assumptions regarding the discharge rating relationship for the Brown Bridge structure, which includes the estimates of discharge capacity of the facility at any give pool elevation and the assumed operation of the gates. The existing condition model reflects essentially no increase in Brown Bridge pool level while passing the high flow. The pool elevation increased by approximately 0.01 foot for the 100-year flood event (i.e., the temporary detention storage was approximately 2 acre-feet). This result is possible if the discharge capacity exists, but it would require very intensive monitoring of water levels and very accurate gate operation during high runoff to maintain a precise target pool elevation. In reality, due to imperfect knowledge of inflow rates, gate discharge capacity information, etc., the Brown Bridge pool level would increase slightly or, potentially, decrease below target elevation if gate openings were larger than required, and either of these could result in a slightly different prediction of impacts of Brown Bridge Dam removal.

It is unlikely that the gates could be operated in an optimum manner to maintain the regulated pool level during a large runoff event. Consequently, it appears appropriate to assume that some temporary storage may be created in Brown Bridge Pond during a large runoff event. If the pool elevation increase were approximately 0.5 feet, then the flood storage volume would be approximately 100 acre-feet and approximately equal to the predicted floodplain storage in the Brown Bridge reach after dam removal.

2.2.2 Flood Elevations / HEC-RAS Model Analysis

The HEC-RAS hydraulic model developed by the USACEs' dam removal feasibility study was obtained. The model was as it existed in early 2011 (the USACE has subsequently continued with further work on the dam removal feasibility study project and may have revised the model). The model was used to evaluate the impacts of the Brown Bridge Dam removal on Boardman River flood elevations.

The USACEs' HEC-RAS model was reviewed prior to use for the evaluation and the following modifications and/or changes were made.

- Additional flow change locations were added to better reflect tributary locations and increase the geographic resolution of flow rates (e.g., at East Creek outlet).
- The model was revised at South Airport Road to create a split flow model (new channel reach through the eastern channel and culvert); the culvert cross sections and culvert geometry for the eastern single culvert were corrected (the USACE's model did not reflect the culvert shape and the single-reach, divided flow sequence of cross sections did not accurately represent actual hydraulic conditions).
- The Beitner Road bridge geometry was revised to:
    - better define the arch profile of the low beam,
    - change outside support structures from input as piers to abutments, and
    - define the center support structure as a pier.
- Because of the complex discharge structures at Sabin Dam for the existing condition, known water surface elevations were input on the upstream side of Sabin Dam (RS 28776.65) for each profile based on externally calculated discharge rating data..
- The Boardman Dam spillway and gate input were revised to reflect design plan geometry (the spillway was moved to left (no substantive change) and two penstock gates defined (added one gate) with bottom at actual penstock invert elevation.

- The cross-sections at the Boardman Dam intake channel (RS 32534.37 to RS 32883.33) were revised to reflect the constructed intake channel geometry as shown on plans and three automatically interpolated cross sections were re-interpolated. .
- Bank stations at RS 32833.33 to RS 37088 (Keystone Pond) were moved inward to reflect lowered normal water level and resultant changes in Manning roughness values at newly exposed area with new vegetation.
- Bridge scour analyses input data were added for Beitner Road structure (RS 44503), a private bridge on River Drive (RS 55623), and a private bridge on Shumsky Road (RS 70841).

Based on the flood discharge frequency impacts estimated by the rainfall runoff model, there is a decrease in peak discharge and, therefore, a small lowering of flood elevations. This decrease is based on discharge capacity estimates and assumptions regarding flood event operation of the discharge facilities (gates) that may overestimate the ability to optimally control water levels and, therefore, minimize affect of the Brown Bridge structure on peak discharge. Based on these considerations, the conclusion is that the HEC-HMS models indicate that removal of Brown Bridge Dam would not increase peak discharges downstream. No hydraulic analysis is needed for that result.

Boardman River flood discharge estimates based on USGS regional regression equations are increased by the removal of Brown Bridge Pond. The percentage of main channel passing through marshes and lakes, which for the existing condition ranges from approximately 38 percent at Brown Bridge Dam to approximately 30 percent at Sabin Dam, is reduced by the removal of Brown Bridge Pond by approximately 3 percent at Brown Bridge Dam and 2 percent at Sabin Dam. The impact on flood discharge frequency data predicted by the regression equations is approximately a 1.3 to 1.7 percent increase in discharges along the river downstream from Brown Bridge. The impacts at each location are approximately the same percentage for all flood frequencies. The 100-year flood elevations increase as a result of that discharge rate increase. The largest increases occur upstream of locations with constricted flow, such as bridge openings. The increases along the stream are indicated in Figure 3. The largest 100-year flood increase is 0.13 foot upstream of the South Airport Road crossing. Increases for the 100-year flood were 0.10 foot or less at all other locations. Approximately 0.08 foot of the increase at South Airport Road results from an increase at Union Street Dam that carries upstream through Boardman Lake.

These small discharge increases predicted by the USGS regional regression equations produce similarly small increases in potential scour at bridges that were evaluated. No bridges evaluated were determined to have severe predicted potential scour. Incremental increases in predicted maximum scour depth as a percent of existing condition depths were in the range of two to four percent, similar to the discharge increases from the USGS regression equations.

2.2.3 100-Year Floodplain

The 100-year floodplain within the former Brown Bridge Pond boundaries is expected to have a width similar to the narrower portions of the existing natural riverine portions of the river in the vicinity of Brown Bridge Pond. It is expected that the floodplain width within the former reservoir/delta area will typically be approximately 150 feet wide (50-feet wide channel and combined left and right overbank width of approximately 100 feet).

3.0 Summary

The hydrologic and hydraulic analyses completed indicate that removal Brown Bridge Dam will not significantly change flood flow rates and, therefore, flood elevations or local scour at bridges. The estimated discharge capacity of the Brown Bridge structure and the operating plan for the structure indicate a capacity to pass even large floods with little increase in water level and storage volume. The Brown Bridge reach when restored will provide floodplain storage that, while not large, is larger than the Brown Bridge Pond temporary storage predicted by flood routing analyses using structure-specific data, resulting in a theoretical reduction in peak discharges resulting from dam removal. Assuming non-optimum flood event operations may occur, the conclusion is that the dam removal will not increase peak discharges.

4.0 References

Farrand, W. R. and Bell D. L., reprinted 1984. Quaternary Geology of Michigan with Surface Water Drainage Divides, Michigan Department of Natural Resources, Geological Survey Division.

Holtschlag, J.D. and H.M. Croskey,1984. Statistical Models for Estimating Flow Characteristics of Michigan Streams, Water-Resources Investigation Report 84-4207. USGS.

Mead & Hunt, December 2001. Probable Maximum Flood Study, Brown Bridge and Boardman Hydroelectric Projects, FERC Project Nos. 2978 and 2979. Prepared for City of Traverse City Light and Power Department.

TABLES

Table 1. Summary of Structure Assumptions for Existing Conditions

Structure	Regulated Pool Elevation (feet NAVD 1988)	Discharge Facilities		
Brown Bridge	794.5	Upper Tainter Gates (two – 12 feet by 5.5 feet high; crest elevation 792.5 feet)	Log Chute (one – 6 feet by 6 feet with lift gate; sill elevation 792.5 feet)	Lower Tainter Gates (two – 12 feet by 5.5 feet, crest elevation 787.5 feet)
Boardman [a]	637.5	Penstocks (no turbines) with controlling channel entrance flow line elevation 637.6 feet	Gated Spillway (18 feet wide, sill elevation 641.6 feet)	
Sabin [a]	614.0	One – 18-feet wide Tainter Gate (crest elevation 608.3 feet)	32-feet long auxiliary spillway with stop-logs and sill at 612.2 feet	six culverts, flow line 603.5 feet, (inoperable; blocked by timber gates)

[a]Applies for both Existing and Proposed Conditions

NAVD 1988 = North American Vertical Datum of 1988

Table 2. MDNR Peak Discharges from USACE's HEC-RAS Model

Location	Drainage Area (sq mi)[b]	HEC-RAS RS [a]	River Mile [c]	Peak Discharge (cubic feet per second)							
				2 year	5 year	10 year	25 year	50 year	100 year	200 year	500 year
Brown Bridge Road	141	129567	24.54	410	550	600	700	800	850	950	1000
Brown Bridge Dam	160	105577	20.00	500	650	750	850	950	1000	1100	1300
Sarnes Road	241	58704	11.12	750	950	1100	1300	1400	1500	1700	1900
Beitner Road	245	44516	8.43	750	950	1100	1300	1400	1500	1700	1900
Boardman Dam	267	32472	6.15	800	1000	1200	1400	1500	1700	1900	2200
Sabin Dam	268	28696	5.43	800	1000	1200	1400	1600	1700	1900	2000
Eighth Street	275	7748	1.47	850	1100	1300	1500	1600	1800	1900	2100

[a]RS = River Station

[b]sq mi = square miles

[c]River Mile = miles along channel upstream from Grand Traverse Bay

Table 3. Peak Discharges Calculated from USGS Regression Equations

Location	HEC-RAS RS [a]	River Mile	Peak Discharge (cubic feet per second)							
			2 year	5 year	10 year	25 year	50 year	100 year	200 year	500 year
Brown Bridge Road	129567	24.54	410	550	600	700	800	850	950	1000
Inflow to Brown Bridge Pond	112440	21.30	500	642	724	832	938	994	1094	1194
Brown Bridge Dam	105577	20.00	500	650	750	850	950	1000	1100	1300
Garfield Road	99264	18.80	656	806	936	1067	1193	1269	1369	1569
Private Bridge	73920	14.00	660	810	954	1120	1241	1350	1450	1650
Shumsky Road	71808	13.60	705	905	1048	1241	1335	1429	1629	1829
Sarnes Road	58704	11.12	750	950	1100	1300	1400	1500	1700	1900
Beitner Road	44516	8.43	750	950	1100	1300	1400	1500	1700	1900
Boardman Dam	32472	6.15	800	1000	1200	1400	1500	1700	1900	2200
Sabin Dam	28696	5.43	800	1000	1200	1400	1600	1700	1900	2000
Eighth Street	7748	1.47	850	1100	1300	1500	1600	1800	1900	2100

[a]RS = River Station

Table 4. Peak Discharge Calculated from USGS Regression Equations (Brown Bridge Dam Removed)

Discharge Increase (percent)	HEC-RAS RS [a]	River Mile	Peak Discharge (cubic feet per second)							
			2 year	5 year	10 year	25 year	50 year	100 year	200 year	500 year
0.0	129567	24.54	410	550	600	700	800	850	950	1000
0.0	112464	21.30	500	642	724	832	938	994	1094	1194
1.7	105577	20.00	509	661	763	864	966	1017	1119	1322
1.6	99264	18.80	667	819	951	1084	1212	1290	1391	1595
1.7	73920	14.00	671	824	970	1139	1262	1373	1475	1678
1.6	71808	13.60	717	920	1064	1261	1356	1452	1655	1858
1.6	58704	11.12	762	965	1118	1321	1422	1524	1727	1930
1.6	44516	8.43	762	965	1118	1321	1422	1524	1727	1930
1.5	32472	6.15	812	1015	1218	1421	1523	1726	1929	2233
1.5	28696	5.43	812	1015	1218	1421	1624	1726	1929	2030
1.3	7748	1.47	861	1114	1317	1520	1621	1823	1925	2127

[a]RS = River Station

Table 5. HEC-HMS Boardman River Model Hydrologic Methods

Procedure	Method
Rainfall Loss	Initial and Constant
Unit Hydrograph	Clark
Base Flow	Recession Constant
Channel Routing	Muskingum

Table 6. Brown Bridge Structure Discharge Data (Existing Condition)

Elevation (feet)	Discharge (cubic feet per second)
770.0	0
794.48	2
794.50	2000
795.0	2200
796.0	2220
797.6	2250
798.0	2400
799.0	2620
800.0	2870
803.0	3500
804.0	3700

Table 7. Boardman Structure Existing Condition Elevation – Discharge and Elevation– Area Data

Elevation (feet)	Discharge (cubic feet per second)	Elevation (feet)	Area (acres)
620.0	0	618	0.11
639.0	1	620	0.79
639.1	200	624	4.76
640.0	500	626	6.80
641.0	1000	628	10.84
642.0	1500	630	15.85
643.7	2000	632	20.99
645.0	2200	634	25.30
650.0	3300	636	31.74
657.0	5200	638	39.90
660.0	6200	640	47.13
665.0	10000	642	53.44
		644	57.67
		646	61.04
		648	65.28
		650	71.18
		652	74.26
		654	76.31
		656	76.53
		658	76.54
		660	76.54

Table 8. Sabin Structure Existing Condition Elevation – Discharge and Elevation– Area Data

Elevation (feet)	Discharge (cubic feet per second)	Elevation (feet)	Area (acres)
600.0	0.	600	0
614.00	1.	602	0.3
614.01	1060.	604	1.6
615.0	1660.	605	2.7
616.0	2230.	606	4.9
617.0	4000.	608	8.5
620.0	10000.	610	18.7
		612	35.3
		613	39
		614	40
		615	41
		617	45
		618	48
		620	55

Table 9. Brown Bridge Reach Storage – Discharge Relation, Proposed Condition

Storage (acre-feet)	Discharge (cubic feet per second)
0	0
14	85
22	155
50	500
60	642
66	724
74	832
83	938
87	994
88	994
95	1094
104	1194
200	2000
500	5000

Table 10. HEC-HMS Model Results, Peak Discharge, Existing and Proposed Conditions, 10- and 100-Year Events

Location	HEC-HMS Element	Drainage Area	Peak Discharge		Increase[1]	
			Existing	Proposed		
		(sq mi)	(cfs)	(cfs)	(cfs)	(%)
100-Year Event:						
Brown Bridge Road/ USGS Station	J-M23.7	97	1045	1045	0	0.00
Brown Bridge Dam – inflow	J-M20.0	151	1718	1718	0	0.00
Brown Bridge Dam - outflow	Brown Bridge Pond	151	1718	1691	-28	-1.62
at Swainston Creek	J-M18.8	205	2473	2387	-86	-3.47
at Jaxon Creek	J-M11.9	228.33	2845	2729	-116	-4.08
Boardman Dam - inflow	J-M06.3	240.9	3012	2881	-132	-4.37
Boardman Dam- outflow	Keystone Pond	240.9	2770	2695	-75	-2.71
Sabin Dam – inflow	J-M05.6	242.18	2806	2730	-76	-2.69
Sabin Dam - outflow	Sabin Pond	242.18	2805	2729	-75	-2.69
Union St Dam – inflow	J-M01.1	248.74	2829	2748	-81	-2.87
Union St Dam - outflow	Boardman Lake	248.74	1998	1984	-14	-0.72
10-Year Event:						
Brown Bridge Road	J-M23.7	97	585	585	0	0.00
Brown Bridge Dam – inflow	J-M20.0	151	955	955	0	0.00
Brown Bridge Dam - outflow	Brown Bridge Pond	151	955	947	-9	-0.91
at Swainston Creek	J-M18.8	205	1354	1327	-27	-2.01
at Jaxon Creek	J-M11.9	228.33	1509	1476	-33	-2.19
Boardman Dam – inflow	J-M06.3	240.9	1582	1545	-37	-2.33
Boardman Dam - outflow	Keystone Pond	240.9	1543	1517	-25	-1.65
Sabin Dam – inflow	J-M05.6	242.18	1578	1552	-26	-1.63
Sabin Dam – outflow	Sabin Pond	242.18	1572	1547	-25	-1.60
Union Street Dam – inflow	J-M01.1	248.74	1581	1555	-27	-1.68
Union Street Dam - outflow	Boardman Lake	248.74	1435	1429	-7	-0.45

[1]Note: a negative (-) increase reflects a modeled reduction or decrease
cfs = cubic feet per second

FIGURES

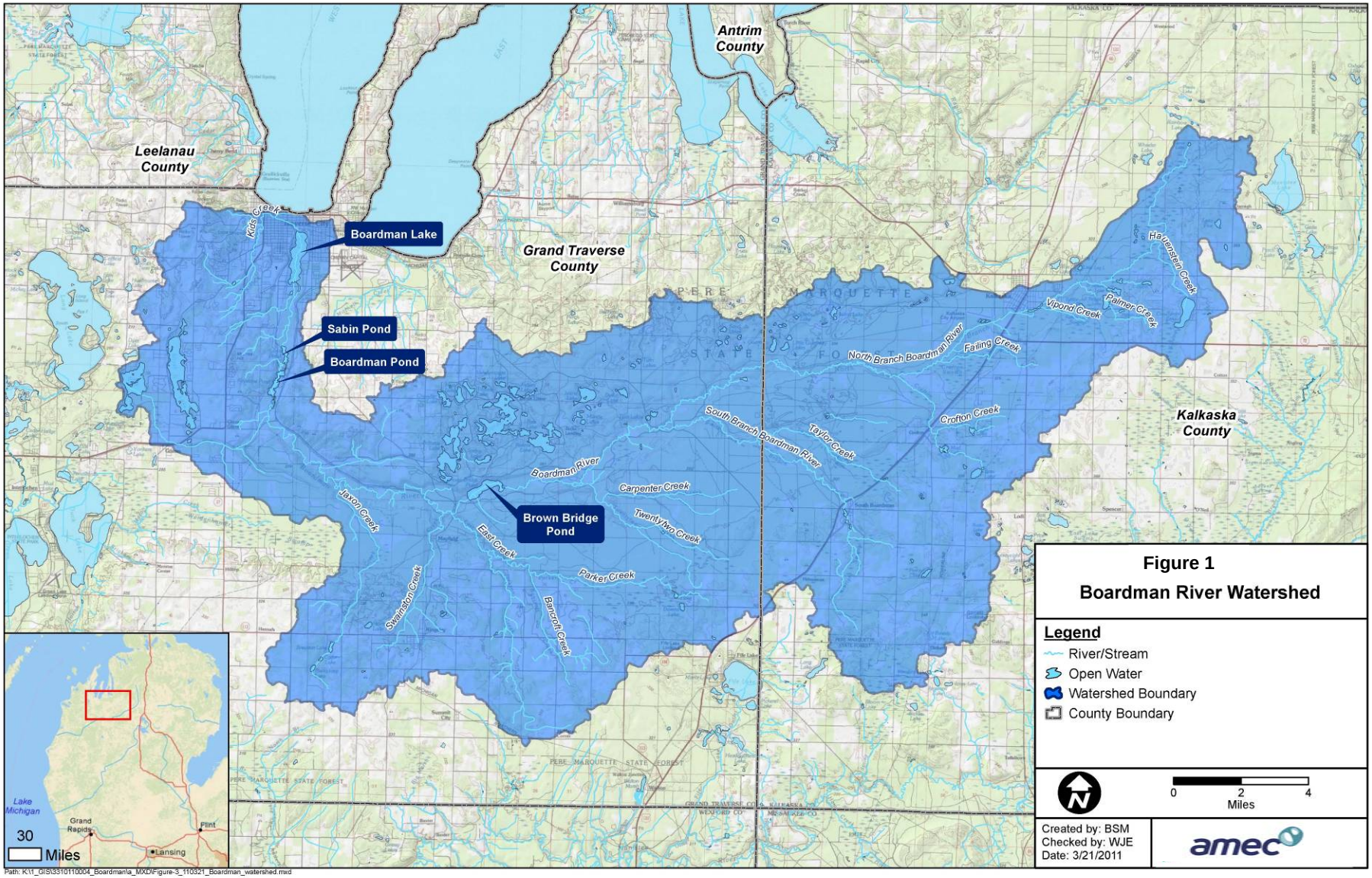


Figure 1

Boardman River Watershed

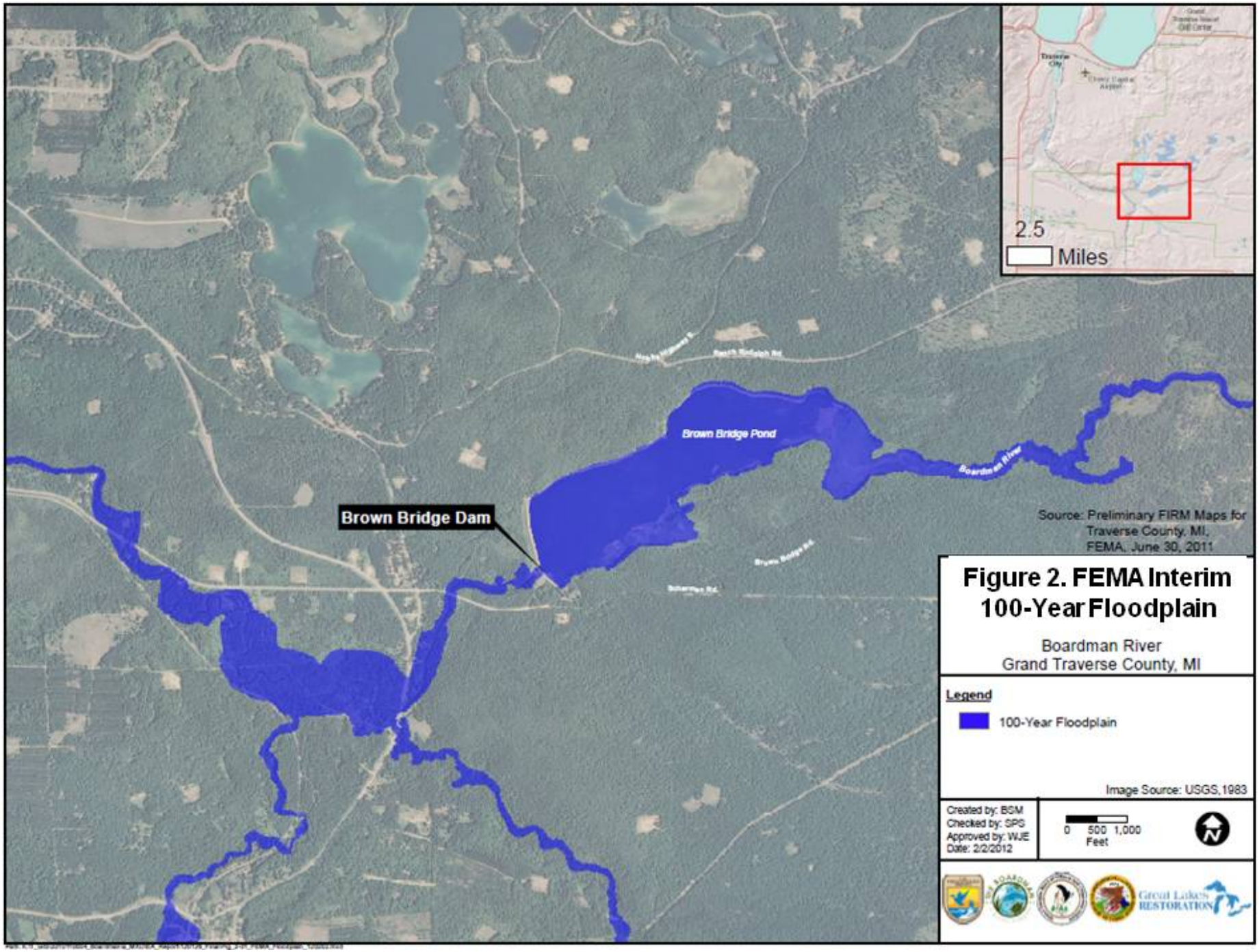
Legend

- River/Stream
- Open Water
- Watershed Boundary
- County Boundary

Created by: BSM
Checked by: WJE
Date: 3/21/2011

amec

Path: K:\1_GIS\3310110004_Boardman\a_MXD\Figure-3_110321_Boardman_watershed.mxd


Brown Bridge Pond
Boardman River
Brown Bridge Dam
2.5
Miles
Source: Preliminary FIRM Maps for Traverse County, MI, FEMA, June 30, 2011
Figure 2. FEMA Interim 100-Year Floodplain
Boardman River
Grand Traverse County, MI
Legend
100-Year Floodplain
Image Source: USGS, 1983
Created by: BGM
Checked by: SPS
Approved by: WJE
Date: 2/2/2012
0 500 1,000
Feet
Great Lakes RESTORATION

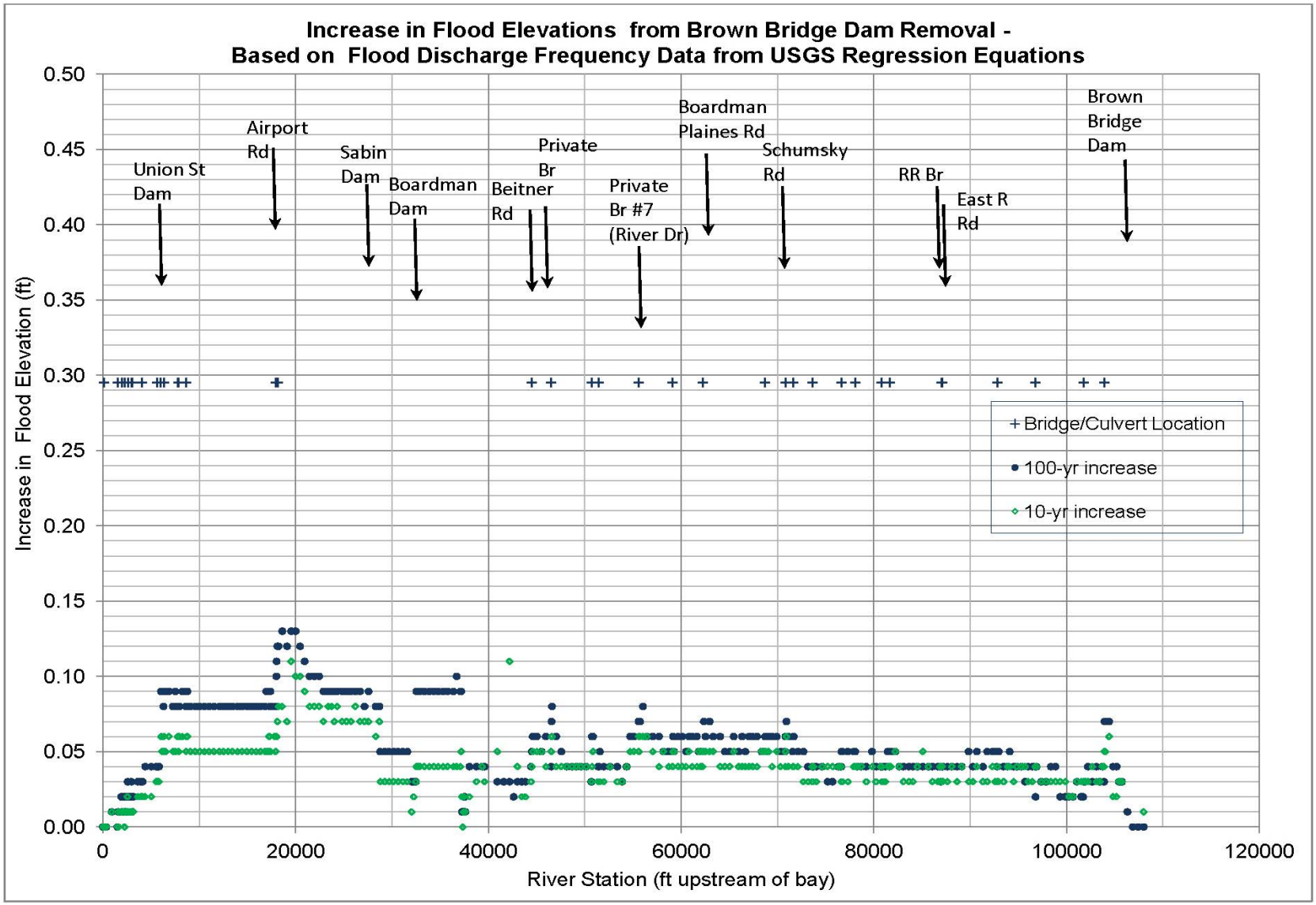


Figure 3. Flood Elevation Increases Based on Flood Discharge Changes with Brown Bridge Dam Removal (USGS Regional Regression Equations)