2023

Horlick Dam: Root River Restoration Racine, Wisconsin

Section 506 Great Lakes Fishery & Ecosystem Restoration Program

Integrated Feasibility Report & Environmental Assessment

Chicago District
US Army Corps of Engineers
5/19/2023

DRAFT
FINDING OF NO SIGNIFICANT IMPACT*

Horlick Dam: Root River Restoration
Racine, Wisconsin
Section 506 Great Lakes Fishery & Ecosystem Program
Integrated Feasibility Report & Environmental Assessment

The U.S. Army Corps of Engineers, Chicago District (Corps) has conducted an environmental analysis in accordance with the National Environmental Policy Act of 1969, as amended. The Draft Integrated Feasibility Report and Environmental Assessment (IFR/EA) dated _____, for the Horlick Dam: Root River Restoration addresses altered stream hydrology and hydraulics, native riverine fish community degradation, habitat fragmentation and supports unique bedrock communities, increased native species richness, native migratory fishes, and human safety in the City of Racine, Wisconsin.

The Draft IFR/EA, incorporated herein by reference, assessed and evaluated various alternatives that would restore natural riverine processes within the study area for native fish, wildlife and plant communities. The recommended plan is the National Ecosystem Restoration (NER) plan and includes:

- Demolition and removal of the Horlick Dam to the natural bedrock elevation
- An incremental removal of the Horlick Dam to ensure that restored sediment transport does not exceed the average annual sediment budget for a stream and watershed of this size and type
- Appropriate recycling and disposal of all man-made materials generated from the dam demolition and removal
- Use of machinery and equipment specifically designed and environmentally safe for aquatic work
- Sowing of temporary native cover crops on exposed banks, new upland soils or fine sediment bars that become exposed during the incremental dewatering and removal process
- A three-year construction period to support staged removal, monitoring and adaptive management
- A three-year post construction monitoring period to determine success and future sustainability

In addition to a “no action” plan, 5 additional alternatives were evaluated. The alternatives were evaluated by an iterative screening process. The process identified several plans for restoration that were incrementally justified by their cost per habitat benefit. After taking into considerations costs, habitat benefits, USACE policy, risk and uncertainty along with plan acceptability, completeness, efficiency, and effectiveness, the NER plan was selected**.**

For all alternatives, the potential effects were evaluated, as appropriate. A summary assessment of the potential effects of the recommended plan are listed in Table 1:

Table 1: Summary of Potential Effects of the Recommended Plan

	Insignificant effects	Insignificant effects as a result of mitigation*	Resource unaffected by action
Aesthetics	☐	☐	☒
Air quality	☐	☐	☒
Aquatic resources/wetlands	☐	☐	☒
Invasive species	☒	☐	☐
Fish and Wildlife habitat	☐	☐	☒
Threatened/Endangered species/critical habitat	☐	☐	☒
Historic properties	☐	☐	☒
Other cultural resources	☐	☐	☒
Floodplains	☒	☐	☐
Hazardous, toxic & radioactive waste	☐	☐	☒
Hydrology	☐	☐	☒
Land use	☒	☐	☐
Navigation	☒	☐	☐
Noise levels	☒	☐	☐
Public infrastructure	☒	☐	☐
Socio-economics	☒	☐	☐
Environmental justice	☐	☐	☒
Soils	☐	☐	☒
Tribal trust resources	☐	☐	☒
Water quality	☐	☐	☒
Climate	☐	☐	☒

All practicable and appropriate means to avoid or minimize adverse environmental effects were analyzed and incorporated into the recommended plan. Best management practices (BMPs) as detailed in the IFR/EA will be implemented, if appropriate, to minimize impacts. Examples of BMPs include hydroseeding, installation of silt fences, surface water isolation, etc., see Section 5.3.5 for full discussion.

The proposed project would result in beneficial effects to the ecosystem. Restoration of natural riverine processes, hydrology and channel morphology will provide the means for stream habitat restoration. Any impacts to adjacent recreational opportunities from construction of the proposed project would be short term and temporary in nature, except for the elimination of power boating within the former impoundment.

No compensatory mitigation is required as part of the recommended plan.

Public review of the draft IFR/EA and FONSI was completed on _____ 2023. All comments submitted during the public review period are responded to in the Final IFR/EA and FONSI.

Pursuant to section 7 of the Endangered Species Act of 1973, as amended, the U.S. Army Corps of Engineers determined the recommended alternative would have 'no effect' on federally listed species or their designated critical habitat. Coordination with the USFWS is ongoing, and the U.S. Army Corps of Engineers anticipates concurrence with the determination of "no effect."

All applicable laws, executive orders, regulations, policy and local government plans were considered in the evaluation of alternatives. Based on this report, the reviews by other Federal, State and local agencies, Tribes, input of the public, and the review by my staff, it is my determination that the recommended plan would not cause significant adverse effects on the quality of the human environment; therefore, preparation of an Environmental Impact Statement is not required.

Pursuant to section 106 of the National Historic Preservation Act of 1966, as amended, the U.S. Army Corps of Engineers determined that there would no historic properties affected by the recommended plan. A finding of No Historic Properties Affected was submitted to the Wisconsin State Historic Preservation Office (SHPO) on November 15, 2021. The SHPO responded with a request for more information on November 30, 2021. This requested information was provided on November 30, 2021. As the SHPO did not respond to the Corps' finding within 30 days, agreement with the finding of No Historic Properties Affected is assumed per 36 CFR 800.3 (c)(4).

Pursuant to the Clean Water Act of 1972, as amended, the discharge of dredged or fill material associated with the recommended plan has been found to be compliant with section 404(b)(1) Guidelines (40 CFR 230). The Clean Water Act Section 404(b)(1) evaluation is found in Appendix B of the IFR/EA.

A water quality certification pursuant to section 401 of the Clean Water Act is consistent with the Nationwide Permit 27, *Aquatic Habitat Restoration, Establishment, and Enhancement Activities,* which the Wisconsin Department of National Resources has previously certified compliance with section 401 of the Clean Water Act. All conditions of the water quality certification shall be implemented in order to minimize adverse impacts to water quality.

A determination of consistency with the Wisconsin Coastal Zone Management program pursuant to the Coastal Zone Management Act of 1972 has been sought from the Wisconsin Department of Natural Resources dated_____. The Corps received concurrence for the consistency determination on _____.

All applicable environmental laws have been considered and coordination with appropriate agencies and officials has been completed.

Technical, environmental, and cost effectiveness criteria used in the formulation of alternative plans were those specified in the Water Resources Council's 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. All applicable laws, executive orders, regulations, and local government plans were considered in evaluation of alternatives. Based on this report, the reviews by other Federal, State and local agencies, Tribes, input of the public, and the review by my staff, it is my determination that the recommended plan would not cause significant adverse

effects on the quality of the human environment; therefore, preparation of an Environmental Impact Statement is not required.

Date

Paul Culberson
Colonel, U.S. Army
District Commander

EXECUTIVE SUMMARY*

The non-Federal sponsor, the Racine County Public Works (RCPW) requested that the U.S. Army Corps of Engineers (USACE) Chicago District initiate a study under the Great Lakes Fishery & Ecosystem Restoration Section 506 of WRDA 2000 (as amended) to ascertain the feasibility of restoring important riverine habitat and connectivity for fishes, mussels and wildlife along a stretch of the Root River. The Integrated Feasibility Report/ Environmental Assessment (IFR/EA) documents whether a project is warranted for federal participation based on a feasibility level assessment of estimated costs, potential benefits, and possible environmental impacts of various alternatives per USACE planning and policy guidelines.

The study area is located in Racine County, Wisconsin and is an approximately 6.5-mile reach on the Root River that is affected by the presence of the Horlick Dam. The current dam is a large run-of-the-river dam located on the Root River in Racine, Wisconsin at river mile 6; 6 miles upstream of Lake Michigan. An upstream 60-acre impoundment is created on the north side of Northwestern Ave between Old Mill Dr to the west and Green Bay Rd to the east, which consists of various parcels of different land uses and ownership. Historically, the Root River in the study area was comprised of a relatively small but scenic bedrock gorge bordered by naturally occurring communities of wetland, woodland, savanna and prairie. The construction of the original Horlick dam in 1834 and following reconstructions, contributed to a significant loss of natural parameters and process that sustain and create native riverine and riparian habitats. The current Horlick dam was rebuilt in 1974 and continues to fragment the river and is the most significant fish passage obstruction on the Root River, blocking upstream passage to 160.2 miles of river and tributary habitat and an estimated 6,176 acres of connect wetlands. The purpose of the proposed project is to restore riverine habitat and connectivity to a stretch of river chronically impacted by the presence of the Horlick Dam. The need for the proposed project is driven by the presence of an impoundment that has changed riverine habitat (lotic) to lake-like (lentic) conditions, induced abnormal hydrogeomorphic settings, fragmented the river system, degraded substrate transport and sorting above and below the dam, and has degraded water quality within the study reach.

Five (5) alternative plans including the No Action Plan were generated from the set of three (3) alternatives input into the IWR Planning Software for the formulation and evaluation of ecosystem restoration alternative plans. The planning application identified one cost effective plan and three non-cost-effective plans; non-cost effective means another plan(s) provided the same benefits or more at a less cost. Based on plan formulation analyses, study problems, study objectives, acceptability to the non-Federal sponsor, and meeting cost effectiveness criteria, it is recommended to carry forward alternative plan (A) Full Dam Removal as the NER plan. The NER plan would restore hydrology and connectivity to Lake Michigan. Dam removal would begin with staged dewatering to slowly draw down the impoundment levels as part of a passive sediment management plan. Once the staged dewatering has removed all existing dam stop logs, dismantling of the structure can begin. The use of hydraulic equipment such as excavators would be used to demolish the entire spillway and dam structure.

The NER plan would provide 16.3 net average annual habitat units over approximately 7 miles of restored riverine habitat and provide fish passage for the entire native fish assemblage. The total project cost is $1,980,000 (2023 price levels). The estimated Federal cost share of the project is approximately $1,287,000 and the non-Federal share is approximately $693,000. The USACE will accomplish the plans and specifications phase, which includes additional design studies and plans and specifications, contract for construction, overall supervision during construction, prepare an operation and maintenance manual, and participate in a portion of the post construction monitoring.

Integrated Feasibility Report and Environmental Assessment

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CHAPTER 1 – INTRODUCTION*

1.1 – Report Organization

This Integrated Feasibility Report and Environmental Assessment (IFR/EA) presents the results of the Horlick Dam: Root River Ecosystem Restoration study. This IFR/EA identifies problems and opportunities, evaluates several different alternatives and recommends the most cost effective, technically feasible and acceptable solution to restore ecological integrity to a portion of the Root River located in Racine, Wisconsin.

1.2 – Study Authority

GREAT LAKES FISHERY & ECOSYSTEM RESTORATION (SECTION 506 WRDA 2000, as amended)

(a) Findings - Congress finds that—

(1) the Great Lakes comprise a nationally and internationally significant fishery and ecosystem;

(2) the Great Lakes fishery and ecosystem should be developed and enhanced in a coordinated manner; and

(3) the Great Lakes fishery and ecosystem provides a diversity of opportunities, experiences, and beneficial uses.

(b) Definitions - In this section, the following definitions apply:

(1) Great Lake

(A) In general- The term "Great Lake" means Lake Superior, Lake Michigan, Lake Huron (including Lake St. Clair), Lake Erie, and Lake Ontario (including the St. Lawrence River to the 45th parallel of latitude).

(B) Inclusions- The term "Great Lake" includes any connecting channel, historically connected tributary, and basin of a lake specified in subparagraph (A).

(2) Great Lakes Commission- The term "Great Lakes Commission" means the Great Lakes Commission established by the Great Lakes Basin Compact (82 Stat. 414).

(3) Great Lakes Fishery Commission- The term "Great Lakes Fishery Commission" has the meaning given the term "Commission" in section 931 of Title 16.

(4) Great Lakes State- The term "Great Lakes State" means each of the States of Illinois, Indiana, Michigan, Minnesota, Ohio, Pennsylvania, New York, and Wisconsin.

(c) Great Lakes fishery and ecosystem restoration

(1) Support plan

(A) In general- Not later than 1 year after December 11, 2000, the Secretary shall develop a plan for activities of the Corps of Engineers that support the management of Great Lakes fisheries.

(B) Use of existing documents- To the maximum extent practicable, the plan shall make use of and incorporate documents that relate to the Great Lakes and are in existence on December 11, 2000, such as lakewide management plans and remedial action plans.

(C) Cooperation- The Secretary shall develop the plan in cooperation with—

(i) the signatories to the Joint Strategic Plan for Management of the Great Lakes Fisheries; and

(ii) other affected interests.

(2) Reconnaissance studies- Before planning, designing, or constructing a project under paragraph (3), the Secretary shall carry out a reconnaissance study—

(A) to identify methods of restoring the fishery, ecosystem, and beneficial uses of the Great Lakes; and

(B) to determine whether planning of a project under paragraph (3) should proceed.

(3) Projects- The Secretary shall plan, design, and construct projects to support the restoration of the fishery, ecosystem, and beneficial uses of the Great Lakes.

(4) Evaluation program

(A) In general- The Secretary shall develop a program to evaluate the success of the projects carried out under paragraph (3) in meeting fishery and ecosystem restoration goals.

(B) Studies- Evaluations under subparagraph (A) shall be conducted in consultation with the Great Lakes Fishery Commission and appropriate Federal, State, and local agencies.

(d) Cooperative agreements- In carrying out this section, the Secretary may enter into a cooperative agreement with the Great Lakes Commission or any other agency established to facilitate active State participation in management of the Great Lakes.

(e) Relationship to other Great Lakes activities- No activity under this section shall affect the date of completion of any other activity relating to the Great Lakes that is authorized under other law.

(f) Cost sharing

(1) Development of plan- The Federal share of the cost of development of the plan under subsection (c)(1) of this section shall be 65 percent.

(2) Project planning, design, construction, and evaluation- Except for reconnaissance studies, the Federal share of the cost of planning, design, construction, and evaluation of a project under paragraph (3) or (4) of subsection (c) of this section shall be 65 percent.

(3) Non-Federal share

(A) Credit for land, easements, and rights-of-way- The Secretary shall credit the non-Federal interest for the value of any land, easement, right-of-way, dredged material disposal area, or relocation provided for carrying out a project under subsection (c)(3) of this section.

(B) Form- The non-Federal interest may provide up to 100 percent of the non-Federal share required under paragraphs (1) and (2) in the form of services, materials, supplies, or other in-kind contributions.

(4) Operation and maintenance- The operation, maintenance, repair, rehabilitation, and replacement of projects carried out under this section shall be a non-Federal responsibility.

(5) Non-Federal interests- In accordance with section 1962d-5b of this title, for any project carried out under this section, a non-Federal interest may include a private interest and a nonprofit entity.

(g) Authorization of appropriations

(1) Development of plan- There is authorized to be appropriated for development of the plan under subsection (c)(1) of this section $300,000.

(2) Other activities- There is authorized to be appropriated to carry out paragraphs (2) and (3) of subsection (c) of this section $100,000,000.

1.3 – Study Purpose & Need

The Racine County Public Works (RCPW) requested that the U.S. Army Corps of Engineers (USACE) Chicago District initiate a study under the Great Lakes Fishery & Ecosystem Restoration Section 506 of WRDA 2000 (as amended) to ascertain the feasibility of restoring important riverine habitat and connectivity for fishes, mussels and wildlife along a stretch of the Root River.

This IFR/EA documents whether a project is warranted for federal participation based on a feasibility level assessment of estimated costs, potential benefits, and possible environmental

impacts of various alternatives per USACE planning and policy guidelines. The purpose of the proposed project is to restore riverine habitat and connectivity to a stretch of river chronically impacted by the presence of the Horlick Dam. Generally, the need for the proposed project is driven by the presence of an impoundment that has changed riverine habitat (lotic) to lake-like (lentic) conditions, induced abnormal hydrogeomorphic settings, fragmented the river system, degraded substrate transport and sorting above and below the dam, and has degraded water quality within the study reach. These adverse habitat, connectivity, and water quality conditions reduce both abundance and species richness (i.e., number of different species) of riverine specific species. If an alternative is found to be worth the investment, the next steps include approval of the decision document, signing of a Project Partnership Agreement (PPA) and development of a contract set of Plans and Specifications (P&S) and project implementation.

1.4 – Study Area

The Root River watershed upstream of the focused study area is approximately 198 square miles encompassing portions of Waukesha, Milwaukee, Kenosha and Racine counties (Figure 1). The study area reach is affected by the presence of the Horlick Dam. The current dam is a large run-of-the-river dam located on the Root River in Racine, Wisconsin at river mile 6; 6 miles upstream of Lake Michigan. The impoundment is created on the north side of Northwestern Ave between Old Mill Dr to the west and Green Bay Rd to the east, which consists of various parcels of different land uses and ownership (Figure 2 & Figure 3).

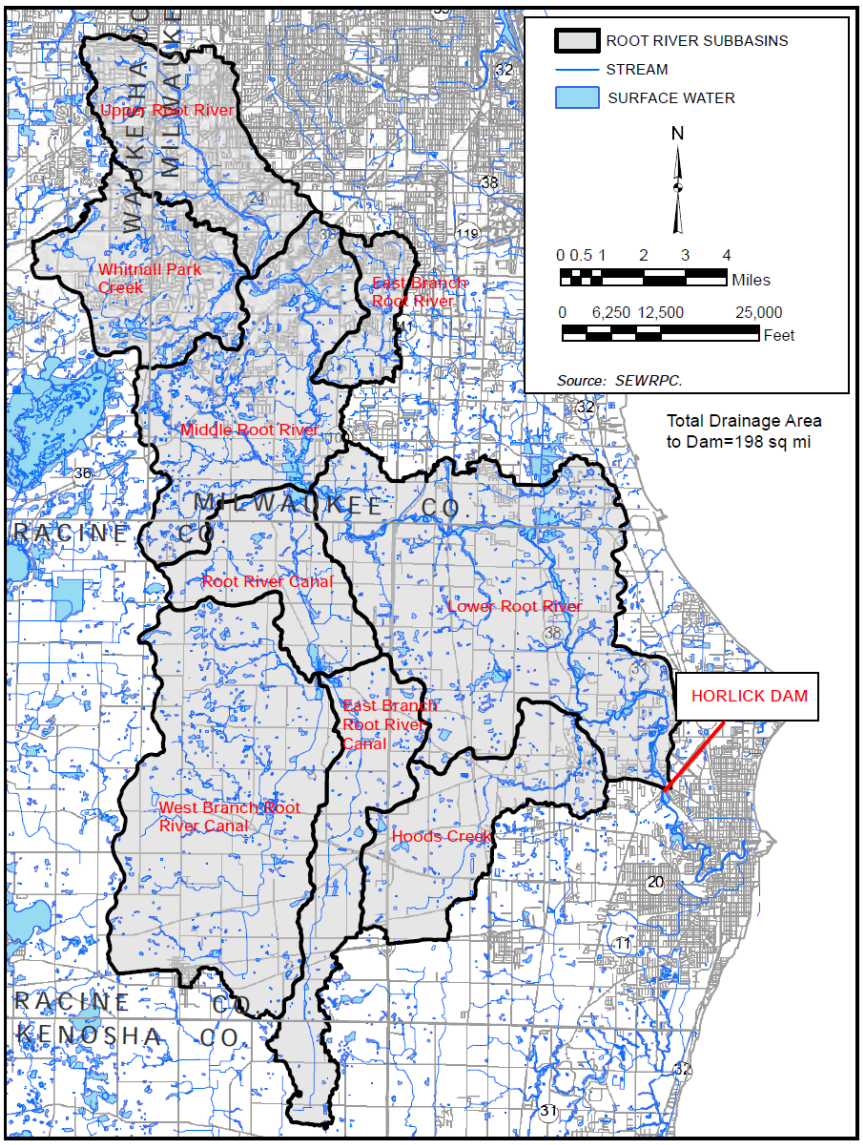


Figure 1: Horlick Dam Location within Root River Watershed

Figure 2: Study Area of Horlick Dam

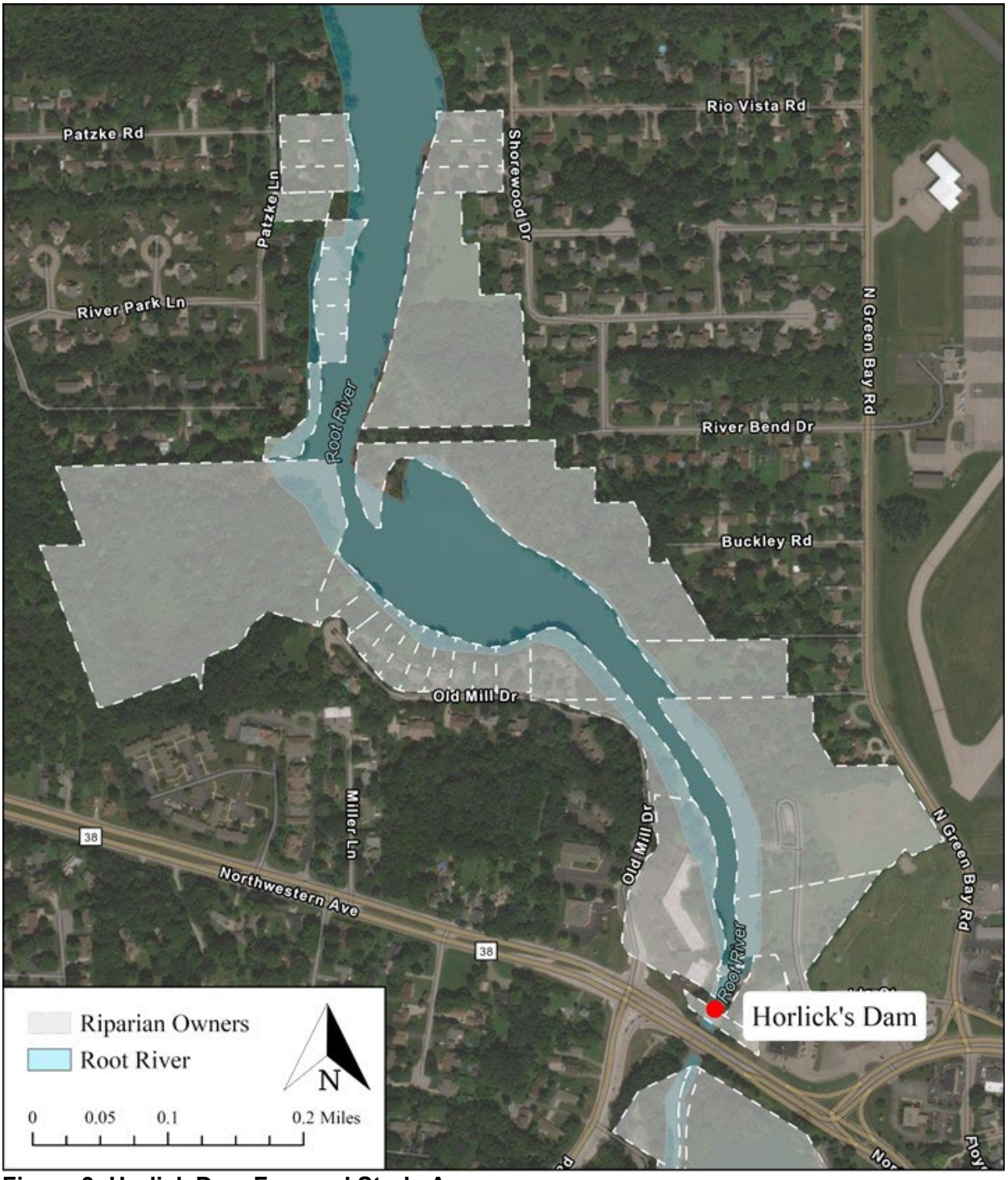


Figure 3: Horlick Dam Focused Study Area

1.5 – The Horlick Dam(s)

The Horlick Dam is classified as a Low Hazard Dam with a hydraulic height of 17 feet and a structural height of 19 feet. The upstream impoundment surface area is approximately 60 acres. In addition to the concrete dam, there is a 119.5-foot concrete spillway on the east bank. The

stop log section is 6.7 feet wide and is approximately 36 feet from the west side of the main spillway. The main spillway has one horizontal bend, approximately 59 feet from the east side of the dam. The current dam was constructed in 1975 to replace the deteriorating Horlick Dam. The original dam was constructed in 1834 and operated as a sawmill until 1870. The dam was rebuilt in 1873 and in 1885 with a fish-way and was operated as a grist mill until 1940. After 1940, the dam was used to maintain the upstream impoundment for recreational purposes. The current Horlick Dam was rebuilt in 1975, downstream of the former structure. Partially removed stone and masonry footing and wall remain upstream of the existing dam (Figure 4 & Figure 5).

Figure 4: Horlick Dam in 1915, 1975 and Pre and Post Construction

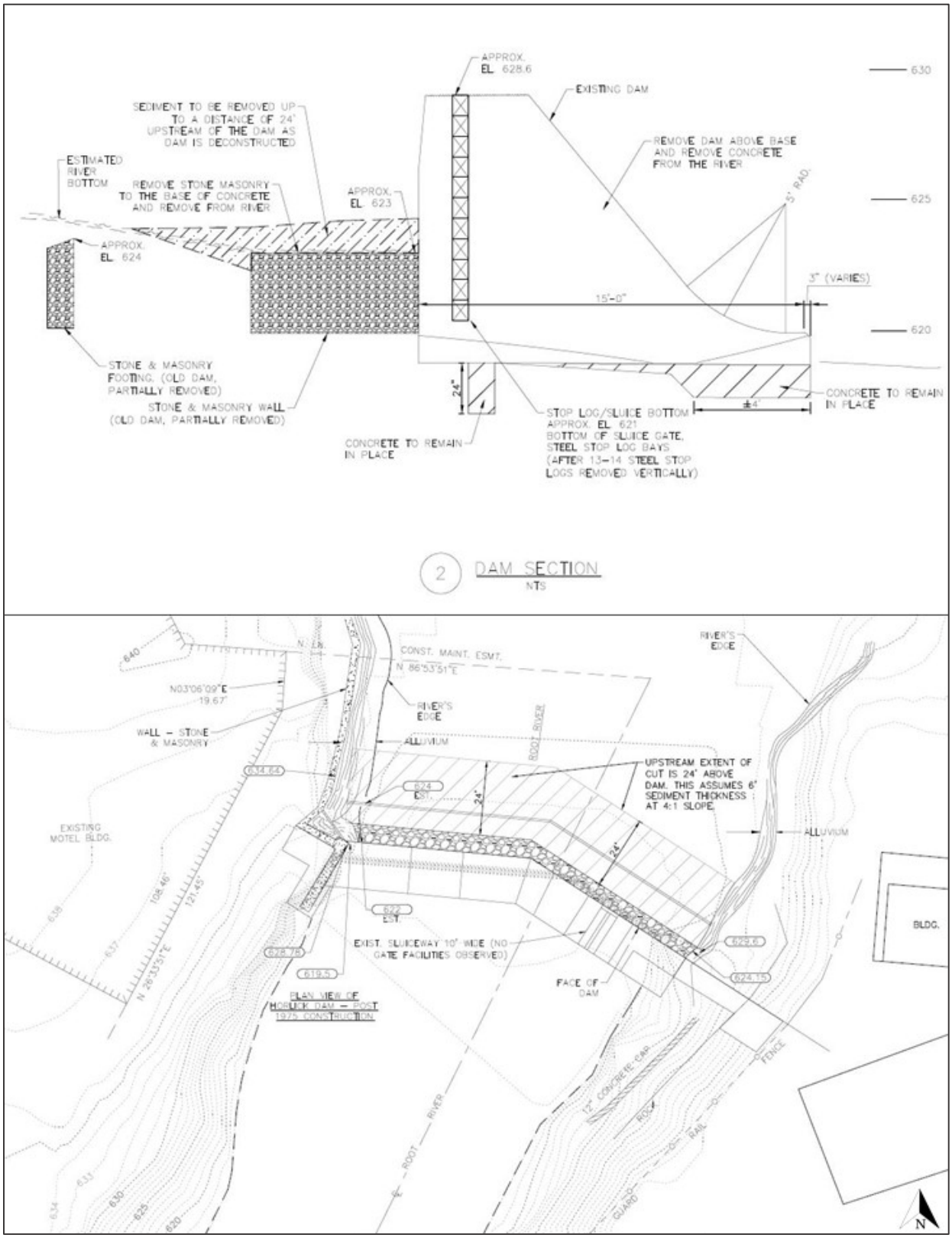


Figure 5: General Schematic of the Existing Horlick Dam

1.6 – Pertinent Information & Projects

Reports & Studies

- *2013. Inspection & Operation Plan Horlick Dam Racine County. Racine County Public Works* – Describes the plan of inspection, operation and maintenance of the Horlick Dam.

- *2013. Baseline Assessment of Water Quality in support of the Root River Watershed Restoration Plan – Data Analysis Report, Southeastern Wisconsin Regional Planning Commission* – Provides an accurate baseline of the microbiological, chemical, and physical integrity of the watershed deemed necessary to guide future restoration actions. This report specifically addresses habitat, water quality, fish, and macroinvertebrate community assessments throughout the Root River watershed, including the Lower Root River which encompasses the Horlick Dam site.

- *2014. A Restoration Plan for the Root River Watershed. Southeastern Wisconsin Regional Planning Commission* – Provides information on natural resources, affected environment, and watershed restoration goals.

- *2020. Horlick Dam Abandonment & Removal Plan. Racine County Public Works* – Funding support provided by Wisconsin Department of Natural Resources (WIDNR) and Southeastern Wisconsin Regional Planning Commission (SEWRPC) – Provides a complete plan for removal of the dam and restoration of the river channel:

    - Real Estate / Ownership Documentation / Easements / Residential Owners List
    - Land Use / Zoning / Topography (5-ft contours)
    - Draft Plan Sheets
    - Hydrologic & Hydraulic Analysis / FIS Modeling with & without Dam
    - Sediment Management Plan / Staged Drawdown / New HEC-RAS Model
    - Wild Rice Restoration Potential
    - 401 WQ Permitting Information
    - Federal and State T&E Determinations
    - Historic & Cultural Resources Coordination

- 2020. *Federal Interest Determination for the Horlick Dam Removal GLFER 506. US Army Corps of Engineers, Chicago District.* - Identified at least one policy consistent solution appropriate for GLFER authority to address restoration of the Root River via removal of the Horlick Dam. Also determined that further federal interest in a feasibility study was warranted.

Projects

- Wisconsin Department of Natural Resources: Root River Steelhead Facility – This facility was built in 1993 approximately two river miles downstream of Horlick Dam to help the WIDNR manage Lake Michigan's trout and salmon fishery through the collection of eggs for hatchery-raised fish. The facility is Wisconsin's primary source of steelhead eggs and brood stock. The process is described below.

- Area 1 – Weir (dam) and fish ladder entrance: An in-stream dam blocks upstream fish migration during their spawning run. Large grates can be raised or lowered to block fish or allow fish passage under certain water conditions. Fish respond to the instinct to swim into the flow of water and swim toward the large volume of water from the fish ladder.
- Area 2 – Fish ladder: The ladder is a 90-foot long chute with steep sides and a series of steps with flowing water. When fish pass over the final step at the top of the ladder they enter a large 40-foot holding pond.
- Area 3 – Holding Pond: This area has a mixture of river water and well water pumped into it continuously. The water can be circulated through an aerator to increase oxygen. The pond is sloped toward the fish ladder which allows water to flow down the ladder and steps.
- Area 4 – Work Area: WIDNR crews process fish from the holding pond. Fish are removed from the pond via a basket and placed in a tank with carbon dioxide enriched water as an anesthetic for better handling. Eggs are squeezed from females, fertilized, and stored for transportation to the hatchery for incubation and rearing. After processing, fish are placed in oxygen-rich water for recovery and returned to the river.

- Waukesha Water Supply Pipeline – The City of Waukesha began construction of a water supply pipeline from Lake Michigan in December 2020 to address the high levels of radium and depleted water levels in the aquifer in the current drinking water supply. As part of the 2008 Great Lakes Compact, the City of Waukesha is required to return 100% of the water it withdraws back to Lake Michigan, with the plan to utilize the Root River for the return. Project details are highlighted below.
  - The City of Waukesha's request to source water from Lake Michigan was approved in 2016 by the Great Lakes Compact Council.
  - Current plans call for a water supply pipeline to begin at a pumping station in Milwaukee and travel approximately 13 miles to Waukesha.
  - A return pipeline will travel approximately 23 miles from the Clean Water Plant in Waukesha to an outfall point in Franklin emptying into the Root River.
  - The return pipeline will empty an average of 8.2 million gallons a day of treated wastewater into the Root River.
  - This additional 8 million gallons of water is anticipated to raise the base flow of the Root River by as much as 6.5 inches during low-flow conditions.
  - The proposed location of the outfall at the Root River is near the intersection of West Oakwood Rd and South 60th St in Franklin, WI with approximately 19.5 river miles upstream of Horlick Dam.
  - Construction of both pipelines currently slated for completion in 2023.

CHAPTER 2 – PLAN FORMULATION

Plan formulation is an iterative process resulting in the development, evaluation and comparison of alternative plans to address identified study problems by achieving the outlined objectives. The Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) (1983) established four accounts to facilitate the evaluation and display of the effects of alternative plans. These accounts are national economic development/ national ecosystem restoration (NED/NER), environmental quality (EQ), regional economic development (RED), and other social effects (OSE).

These four accounts encompass all significant effects of a plan on the human environment as required by the National Environmental Policy Act (NEPA) (42 U.S.C. 4321 et seq.) and social well-being as required by Section 122 of the Flood Control Act of 1970 (Pub. L. 91-611, 84 Stat. 1823). While the NER account is the direct objective account for this study and EQ addresses NEPA, the January 5, 2021 *Memorandum for Commanding General, U.S. Army Corps Of Engineers, Policy Directive – Comprehensive Documentation of Benefits in Decision Documents* supplements the guidance provided in the Planning Guidance Notebook (ER 1105-2-100) by requiring comprehensive consideration of total project benefits including economics, environmental, and social categories. Project delivery teams (PDTs) must identify and analyze benefits in total and equally across a full array of benefit categories. The level of the analysis will vary based on the magnitude of the change, its relevance to decision-making, and the availability of data, tools, and procedures to quantify or monetize the benefit or impact.

To facilitate the plan formulation process, the methodology outlined in the Corps' Engineering Circular 1105-2-404, "Planning Civil Work Projects under the Environmental Operating Principles," was used. The steps in the methodology, combined with updates to plan formulation policies, are summarized below:

1. Identify a primary project goal/purpose/objective, which is NER for this study.
2. Formulate management measures to achieve planning objectives and avoid planning constraints, where measures are the building blocks of alternative plans.
3. Formulate, evaluate, and compare an array of alternative plans to achieve the primary NER purpose and identify cost effective plans.
4. Perform an incremental cost assessment on the cost-effective plans to support selection of the NER plan.
5. Perform an effects assessment following Council on Environmental Quality (CEQ) and NEPA guidelines to identify and disclose potential impacts to environmental and cultural resources.
6. Identify and analyze benefits in total and equally across a full array of benefit categories (NER, EQ, RED, OSE).
7. Select the NER plan, which is synonymous with the recommended plan or preferred plan.
8. If the comprehensive benefits described in step 6 warrant, a PDT may recommend an alternative that is not the NER plan. However, doing so requires a policy waiver that is coordinated through Headquarters USACE and the Assistant Secretary for the Army (Civil Works).

2.1 – Problems & Opportunities

Problem and opportunity statements were framed in terms of the federal objective and the specific study planning objectives. Problems and opportunities were defined in a manner that does not preclude the consideration of all potential alternatives and does not include discussion of potential solutions. The problem and opportunity statements provided below were evaluated and modified at multiple times during plan formulation, therefore accounting for the dynamics of the iterative planning process.

Historically, the Root River in the study area was comprised of a relatively small but scenic bedrock gorge bordered by naturally occurring communities of wetland, woodland, savanna and prairie. By the late 1800s, the river channel and many of these natural communities were converted to agricultural use. Subsequently, there was a significant loss of natural parameters and processes that sustain and create native riverine and riparian habitats. These disturbances specifically included stream channelization, bank armoring, wetland draining, agricultural runoff, dam building, introduction of invasive/non-native species, urbanization pressures, and water quality degradation.

One of the primary causes of natural habitat and species loss within the Great Lakes is attributed to the damming of confluent river and stream channels. Biodiversity is decreased through the loss of hydrogeomorphic function (i.e., interaction of hydrologic processes with landforms and the interaction of geomorphic processes with surface and subsurface water), fluvialgeomorphic function (i.e., interactions between the physical shape of the river, its surface water and sediment transport processes, and riverine landform creation), other natural processes, and connectivity. Not only are ecosystems adversely affected, but natural services such as flood moderation, maintenance of water quality, stocks of native food fishes, aesthetics and human safety/health can be adversely affected by the presence of dams. The Horlick Dam has had a major influence on the physical structure, biodiversity, and historic character of the Root River ecosystem, suppressing the natural processes that created and sustained a once pristine riverine gorge.

Horlick Dam at River Mile 6 is the most significant fish passage obstruction on the Root River and has been a barrier for upstream fish migration and genetic exchange since the 1870s. The dam blocks fish passage to 160.2 miles of upstream river and tributary habitat and an estimated 6,176 acres of connected wetlands. The main problems imparted on the Root River by Horlick Dam are as follows:

- Riverine fragmentation
    - Prevents fish/mussel passage during all flows, inhibiting natural migrations and genetic exchange contributing to upstream biodiversity loss
    - Prevents riparian corridor passage for certain amphibians, reptiles, and mammals
    - Possibly impedes migratory fishes from Lake Michigan, such as Longnose Sucker (*Catostomus catostomus*), and important fishery species like Northern Pike (*Esox lucius*) Smallmouth Bass (*Micropterus dolomieu*) and Walleye (*Sander vitreus*)
    - Possibly impacting native mussel propagation and dispersal

- Alters natural fluvial processes by dam
    - Alters natural riverine hydraulics by impounding flows and creating lentic (lake) conditions

- Alters sediment transport by trapping bedload (sands, gravels, cobbles)
- Accelerates bedload transport downstream of the dam creating substrate/habitat scouring
- Artificially induces wetlands by raising water table upstream of dam within the impoundment thus creating unsustainable hydrology
- Loses ability to absorb flood pulses

- Alters Riparian Zone
  - Creates a loss of native plant communities, including wild rice wetlands
  - Creates a loss of woodland habitat and associated species, including habitat utilized by birds and small mammals
  - Creates a loss of native organic and large woody debris inputs to the river

- Water Quality Degradation
  - Impoundment causes water to warm up and lose dissolved oxygen
  - Impoundment allows for the accumulation of fine sediments that typically store nutrients, further lowering dissolved oxygen through algal blooms; further decreasing dissolved oxygen
  - Super-critical flows (waterfall conditions) can strip nitrogen from the water column or super saturated water with dissolved gases

- Human Safety
  - Creates hazardous conditions for recreating around the dam, including presence of entraining roller
  - Impedes and fragments blue trail (water course for paddling/floating); creates the need to portage down steep banks

- Aesthetic Degradation
  - Presence of dam detracts from gorge and scenic river vistas
  - Collects foreign debris and trash
  - Reoccurring algal blooms and turbid waters
  - Accumulate sediment with nutrients can give off decaying odors

Opportunities to remedy these issues have been studied in detail by the non-federal sponsor (i.e., RCPW), SEWRPC, and WIDNR; and the USACE under this study. Methods can be employed to manipulate physical parameters to naturalize fluvial processes for the purposes of restoring riverine and riparian habitat while provide passage for riverine and riparian organisms, reconnecting access from Lake Michigan to the upstream reaches of the Root River watershed.

2.2 – Goals, Objectives & Constraints

The primary goal of this feasibility study is to determine a cost-effective restoration plan that solves identified problems, is acceptable to the non-federal sponsor and stakeholders, and meets the federal goal and objectives.

2.2.1 – Goal

The principal goal of a resulting project is to restore riverine habitats and connectivity for residential and migratory fish and wildlife for a reach of the Root River.

2.2.2 – Objectives

Planning objectives are statements that describe the desired results of the planning process by solving the problems and taking advantage of the opportunities identified. The planning objectives must be directly related to the problems and opportunities identified for the study and will be used for the formulation and evaluation of plans. Objectives must be clearly defined and provide information on the effect desired, the subject of the objective (what will be changed by accomplishing the objective), the location where the expected result will occur, the timing of the effect (when would the effect occur) and the duration of the effect.

Federal Objective

The federal objective of water and related land resources planning is to contribute to the protection, restoration, conservation and management of environmental resources in accordance with numerous national environmental statutes, applicable executive orders and other federal planning requirements and policies. The use of the term “federal objective” is distinguished from planning/study objectives, which are more specific in terms of expected or desired outputs whereas the federal objective is considered more of a national goal. Water and related land resources project plans shall be formulated to alleviate problems and take advantage of opportunities in ways that contribute to study objectives and to the federal objective. Contributions to national improvements are increases in the net value of the national output of goods, services and ecosystem integrity. Contributions to the federal objective include increases in the net value of those goods, services and ecosystems that are or are not marketable.

Protection of the Nation’s environment is achieved when damage to the environment is eliminated or avoided and important cultural and natural aspects of our nation’s heritage are preserved. Various environmental statutes and executive orders assist in ensuring that water resource planning is consistent with protection. The objectives and requirements of applicable laws and executive orders (EO) are considered throughout the planning process in order to meet the federal objective. The following laws and executive orders that specifically provided guidance for this study are not limited to, but include:

- Safeguarding the Nation from the Impacts of Invasive Species (EO 13751)
- Nonindigenous Aquatic Nuisance Prevention & Control Act of 1990, as amended (16 U.S.C. 4701 et seq.)
- National Invasive Species Act of 1996 (Public Law 104 – 332)
- Endangered Species Act of 1973, as amended (16 USC 1531 et seq.)
- Fish and Wildlife Coordination Act, as amended (16 USC 661)
- Migratory Bird Treaty Act of 1918, as amended (16 USC 703 et seq.)
- Responsibilities of Federal Agencies to Protect Migratory Birds (EO 13186)
- Clean Water Act of 1977, as amended (33 USC. 1251 et seq.)
- Clean Air Act of 1970, as amended (42 USC 7401)
- National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.)
- Resource Conservation and Recovery Act of 1976, as amended (42 USC 6901, et seq.)
- Protection and Restoration of the Great Lakes (EO 13340)
- Protection and Enhancement of Environmental Quality (EO 11514)
- Floodplain Management (EO 11988)
- Protection of Wetlands (EO 11990)

- φ Wild and Scenic Rivers Act of 1968 (16 USC 1271-1287 Public Law 90-542 82 Stat. 906)
- φ Tackling the Climate Crisis at Home and Abroad (EO 14008)

Study Objectives

Reestablish **quality** and **connectivity** of riverine habitats.

The Root River has experienced channel fragmentation and significant loss of habitat due to the presence of the Horlick Dam. These impairments include impeding riverine hydraulics, sediment transport, channel development (riffles/pools) and substrate sorting, and result in a loss of structural habitat heterogeneity (geomorphology). This objective seeks to reestablish hydrologic connectivity, natural fluvial-geomorphic parameters (velocities/substrates) and structure (morphology/habitat) to support, sustain and connect riverine habitats within the study area. The targeted location of these effects would be within river/stream channel. These effects would be sustained over the life of the project (50-year period of analysis) and, optimistically, in perpetuity. Improvement would be measured via the predicted increase in quality of riverine habitat as evaluated by the Qualitative Habitat Evaluation Index (QHEI) for Midwestern streams and rivers. Connectivity is a “yes or no” objective.

2.2.3 – Constraints

Planning constraints are items of consideration that limit the planning process and are used along with the objectives in the formulation and evaluation of solutions. The establishment of planning constraints is done in concert with the entire study team and in cooperation with stakeholders. A list of planning constraints for the NER purpose follows.

Any measures/alternatives implemented should:

- Avoid flooding impacts to offsite landowners and public roads
- Limit release of sediment pulses equal to or less than the average annual sediment budget for study reach

Planning Considerations

- Consider the necessity for additional measures to prevent or limit upstream movement of non-native and invasive species; must be justified via data and cost-effective analysis for recommendations
- Promote improvements in water and sediment quality
- Promote the growth of native vegetation in stream, bank and riparian zones
- Support blue-way trails for paddling and floating

2.2.4 – Conceptual Ecosystem Model for Horlick Dam/Root River

USACE typically follows a conceptual ecosystem/habitat model (Figure 6) that breaks down components into functions of hazard(s), performance and consequences. These three (3) concepts are utilized to illustrate models of change, which focus the effectiveness of potential ecosystem restoration alternatives under consideration for federal investment.

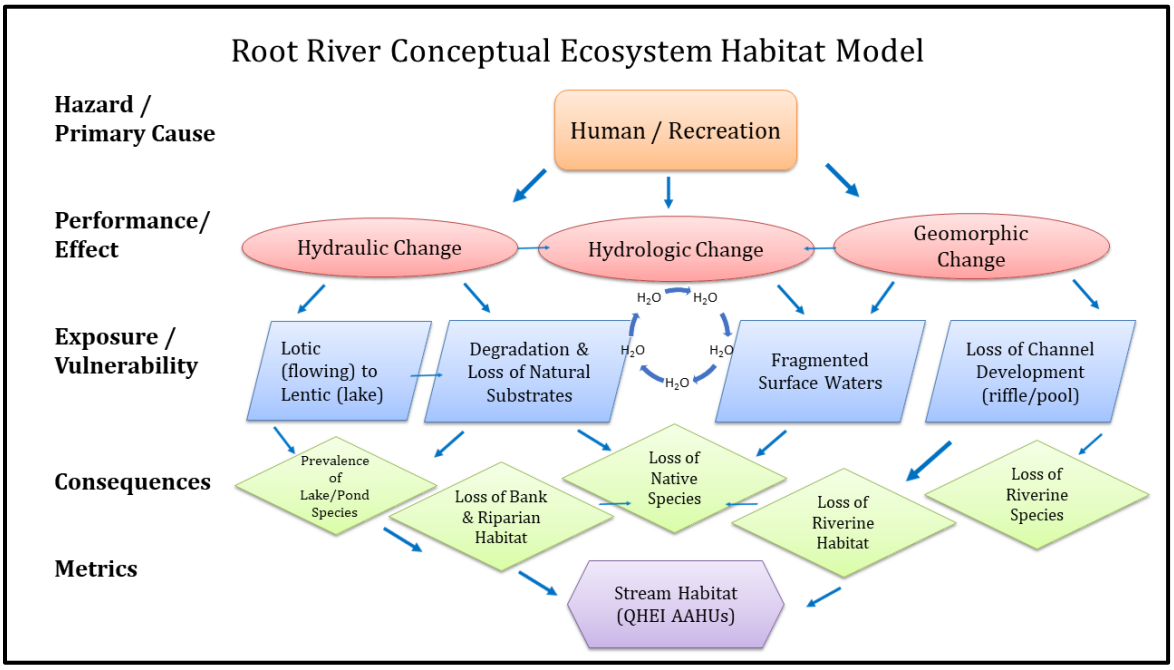


Figure 6: Conceptual Ecosystem Model for the Root River Study Area

Hazard

The hazard, or potential cause for harm, refers to the major changes made to the river channel via building the Horlick Dam for the human purpose of recreation.

Performance

Performance refers to the system's reaction to the hazard, or how the Root River ecosystem changed, or is anticipated to change based on major land use, hydrologic and geomorphic changes. Performance in this study is primarily tied to the presence of the dam. A description of the existing system's performance in terms of ecological function is presented in Chapter 4 Affected Environment & Effects Determination. Performance has been impaired in terms of riverine habitat and subsequent native species composition, richness, and abundances.

Consequence

Consequences are measured in terms of metrics such as economic damage, acreage of habitat lost, and value of crops damaged. This study specifically looks at the consequences of lost riverine habitat and connectivity. The consequence of lost habitat would specifically be measured by QHEI, whereas connectivity is a "yes or no" concept.

2.3 – Management Measures as Building Blocks

Management measures are features or activities that can be implemented at a specific geographic location to address all or a portion of the identified study problems. Measures can directly address the hazards and the way the hazards behave (performance), or indirectly address them through eliminating or reducing the consequences. Measures considered for this study are categorized as hydrogeomorphic, native plant community, adaptive management and

best management practices. There are natural, nature-based and structural measures being considered for alternative development per Section 1185 WRDA 2016.

The following measures have been frequently used in past restoration projects within the USACE Lakes and Rivers Division (LRD) area. These measures were developed in a fashion so that parametric costs can be applied for plan formulation purposes. The measures as building blocks would then have additive costs as they are mixed and matched to build the alternatives. Most measures do not inherently have benefits associated with them, so must be combined with other measures to achieve habitat outputs. These are "rubber meets the road" measures in which ultimately the contract set of plans and specifications for any ER implementation would consist of. The following provides the potential breadth of specific measures that can be combined, or in some instances stand alone to solve problems and achieve the planning objectives.

2.3.1 – Hydrogeomorphic Measures

The following is a list of potential measures for restoring and creating the hydrogeomorphic setting(s) for native riverine communities. The following outline provides a brief overview of potential actions followed by specific parametric measure descriptions:

- Demolition
  - Removal of dam and spill way
  - Removal of loose fragments and foreign debris
- Earthwork
  - Bypass channel
  - Sediment removal
  - Grading
- Channel / Habitat Structures
  - Fish ladders
  - Large woody debris (LWD)
  - Native stone riffles, step-pools, clusters, etc.

Demolition – this measure entails those activities associated with the removal of structures within the channel, bank and floodplain zones. Specific structures that could be removed include but are not limited to a dam (Photo 1), drain tiles, culverts, pipes, outfalls and other defunct infrastructure. Specific materials to be removed under this measure include but are not limited to large foreign debris, concrete, metal, angular riprap, clay drainage tiles, plastic drain tiles, concrete pipe, etc. All materials removed would be appropriately reused, recycled or disposed of.

Photo 1: Demolition of the Hofmann Dam, AER

Earthwork – Bypass Channel – this measure includes the excavation and disposal of material for creation of a bypass channel around the dam structure (Photo 2) to achieve connectivity objectives. This measure may need to be coupled with native rock structure measures to provide appropriate hydraulics for both channel stability and fish passage. The bypass channel would need to be carved out of bedrock for this study area.

Photo 2: Bypass Channel on Big Rock Creek, Kendall County, IL

Earthwork – Sediment Removal – this measure includes removal of sediment that is deemed unacceptable to remain in the river's natural sediment transport system. Quantities of material would be dredged from behind the dam before dam removal and properly disposed according to the material's composition. Typically, fine sediment of silt and clay would be removed via mechanical dredging (Photo 3) and transported via water-tight trucks to a landfill type according to the material quality.

Photo 3: Mechanical Riverine Dredging of Sediments, USEPA

Earthwork - Grading – this measure includes the movement of earthen materials to achieve required geomorphologies and hydrology for native communities in disturbed areas around the dam and potentially upstream banks and terraces. Large to small earth moving machines would be utilized to spread, smooth and undulate surface soils to specific elevation as required by the targeted native community.

Photo 4: Grading Bank to Mimic Natural Slopes & Morphology at Nippersink Creek, AER

Channel Structures – Fish Ladders Over or Around Dam – this measure includes the installation of a metal and/or concrete fish ladder structure to pass fish over or around the side of the dam.

Photo 5: Fish Ladder on St. Charles Dam, Fox River, IL

Channel Habitat - Large Woody Debris Structures – this measure includes the placement of large woody debris (LWD) into the stream channel for habitat and stability components. This measure would be applicable to those channel areas that require stabilization until native vegetation can take the function over. Large woody debris consists of trees, their major branches, their root wads, and combinations of such. Typically, larger trees (20"+ DBH) removed for excavation, grading or native plant community restoration are retained and utilized. These structures may consist of one to many trees placed into the stream channel and bank zones in various configurations to provide habitat and temporary stability. Depending on the forces exhibited in the area targeted, LWD may or may not need to be keyed into with rock and/or tethered to the stream floor or earthen bank.

Photo 6: Large Woody Debris Structure and Soil Terracing, AER

Native Rock Structures – this measure includes the placement of rock/stone into the stream channel to provide required geomorphology and substrates for a native stream community. This

measure would be more applicable to those channel reaches that exhibit higher stream velocities. Large to small construction machinery would place rock slabs, boulders and/or cobbles that are of the same make up and general shapes as natural reaches with similar gradient. Rock/stone materials would take on various configurations as necessitated by the particular stream parameters present at the restoration site. Different configurations of rock structures would include but not be limited to slab-rock, riffle, boulder cluster, j-hook, cross-vane and cobble bar. All stone structure materials would be appropriately sized based on in-channel parameters. All materials would be sourced from local permitted sources to ensure that they are clean and inert. This measure is combinable with a variety of measures as it can add critical habitat and stability components.

2.3.2 – Native Plant Community Measures

- Native Species Planting
  - Seeding
  - Dormant rootstock
  - Live plugs
  - Shrubs and trees
- Native Species Establishment
  - Herbivory control
  - Invasive species control

Native Plantings – this measure includes the procurement and planting of native plant species to restore native plant communities. Native planting lists would be developed by community type, specifying the rates of native seed, live root stock, live plugs and live tree/shrub containers. Current potential for general types include aquatic bed, marsh, meadow, prairie, savanna, woodland and forest.

Photo 7: Planting Native Wetland Plugs at Eugene Field Park, AER

Native Plant Establishment – this measure includes those elements required to establish and maintain newly created or restored plant communities. Specific elements include but are not limited to invasive species management, herbivory control, protective fencing, limited short-term watering, general plant survival, growth and coverage, etc.

Photo 8: Common Carp and Canada Geese Protection for Newly Planted Wetlands Plugs, AER

2.3.3 – Adaptive Management Measures

A 3-year contract would be utilized to ensure recruitment and establishment of native riverine communities (abiotic and biotic) is successful. All demolition and earthwork would be accomplished within the first two years of the contract to be in sync with the river's average annual sediment budget. Options would be placed in the contract for future adaptive management measures that could be exercised at any point of the contract duration, but most likely in years 2, and 3. These may include but are not limited to changing or adjusting features to achieve the required hydrology, hydraulics and/or geomorphology; additional native plant treatments; or other improvements. All adaptive management decisions and exercising of contract options would be driven by monitoring. To be conservative, three adaptive management options would be included under this measure for high, medium and low adaptive adjustment needs. These would be Option A – for more intensive adjustments of geomorphology or hydrology $75,000; Option B – for more moderate adjustments of habitat and/or additional plantings $25,000; Option C – for minor habitat adjustments or additional plantings $10,000.

2.3.4 – Best Management Practices

Soil erosion and sediment control measures will be tailored during the design phase and will comply with local, state and federal environmental requirements. The minimum measures required at the project site may include:

- Hydroseeding, seeding and mulching with native cover crop to stabilize exposed sediment bars, banks and other disturbed areas
- Installation of silt fences around graded slopes and stockpile areas
- Surface water isolation of areas utilized to manage removed sediment

- Stabilization of construction entrances to limit soil disturbance at the ingress/egress from the site
- Installation of erosion blankets over unprotected finished grades that are to be unplanted for at least two weeks, but not within the river's flood zone as the blankets would be washed away.

Photo 9: Adaptive Management of Seeps 1st and 2nd Year of Construction Red Mill Pond AER

2.4 – Alternative Development

(A) Full Dam Removal – This alternative would include demolition measures to break, remove and dispose of the concrete dam and spillway, including parts of the structure that may be keyed into the riverbed. The concrete wing walls would be left in place for stability purposes. All concrete and refuse materials generated during breaking of the dam would be properly recycled or disposed of. This alternative assumes that sediment is acceptable in terms of pollution/contamination to remain as part of the Root River's natural sediment transport. To naturalize and mimic the river's natural sediment transport load, the dam would be removed in increments to allow currently impounded sediments downstream within the average annual sediment budget of the system. This will allow sediment to sort, form substrates and provide riverine habitats instead of temporarily covering higher gradient habitats. As the impoundment water levels slowly drop, new exposed sediment flats would be planted with an appropriate native cover crop under best management practice measures to ensure stability and compliance with water quality regulations. This alternative is considered a natural feature that will require no operation and maintenance (O&M) once dynamic equilibrium is achieved within 3 to 5 years.

(B) Full Dam Removal w/ Sediment Removal – This alternative would include the same measures as (A) Full Dam Removal with the additional earthwork measure of removing and

disposing of sediment that has been identified as unclean and likely to be mobile. Contaminated sediments in areas that are likely to remain stable, could be capped and isolated in place if technically feasible and acceptable to resource agencies and the public. This alternative is considered a natural feature that will require no O&M once dynamic equilibrium is achieved within 3 to 5 years.

(C) Bypass Channel – This alternative would include excavation and grading measures, coupled with in-channel native rock structures to maintain stability, and provide appropriate gradient for passing fishes. This alternative would also include native plantings in order to further stabilize and provide cover for the bypass channel. This alternative is considered a structural feature that will require O&M during the entire project life cycle.

(D) Fish Ladder – This alternative would include a fish ladder that would be fashioned to pass fish over the dam. The fish ladder would be constructed of steel, concrete, or a combination of both. The ladder would be anchored to the stream bed at the bottom and be notched into the dam at the top. A typical fish ladder consists of baffles that induce artificial and homogenous step-pools for fish to climb. This alternative is considered a structural feature that will require O&M during the entire project life cycle.

(E) Instream Habitat – This alternative would include LWD and native rock structures placed in the channel to restore or to induce the channel to restore itself by manipulating flow velocities. Since the study area exhibits reaches of confined bedrock channel, LWD would need to be 2/3 the width of the channel in order not to be washed away, and if possible, tethered or keyed into the bank/stream bed. This alternative is considered a nature-based feature; however, the intent and use of the LWD features for this project would require O&M for its life cycle as it is a degradable material.

(F) Riparian Zone Plantings – This alternative would include measures to establish and maintain native riparian plant communities. This alternative is considered a natural feature that will require limited to no O&M within 10 to 15 years.

Table 1: Initial Alternative Array & Measure Composition

	Alternative					
Measure	**A**	**B**	**C**	**D**	**E**	**F**
Demolition	X	X				
Excavation		X				
Bypass Channel			X			
Grading	X	X	X			
Fish Ladder				X		
Native Rock Structures			X		X	
Large Woody Debris					X	
Invasive Species Removal						X
Native Plantings			X		X	X
Native Community Establishment			X			X
Adaptive Management	X	X	X	X	X	X
BMPs	X	X	X	X		

2.5 – Preliminary Alternative Screening

(NA) No Action – The No Action plan exhibits the Future Without Project conditions and is always retained as a baseline for alternatives analyses and to comply with NEPA/CEQ guidelines.

(A) Full Dam Removal – This alternative was supportive of all the planning criteria as it is a single, acute feasible action to restore ~6,500 feet of riverine habitat, while providing maximum connectivity for all aquatic organisms. This plan is fully acceptable to the non-federal sponsor, USACE and various other federal, regional, state and local agencies. The plan may not be acceptable to other stakeholders that view the presence of the dam as a barrier to non-native species, a benefit to angling trapped fish, and/or other reasons. This alternative was retained for further evaluation.

(B) Full Dam Removal w/ Sediment Removal – The only difference between this alternative and (A) Full Dam Removal is the loss in efficiency of producing outputs since removal of sediments would be required that would drive up costs while benefits remain the same. This alternative was eliminated for further evaluation since sediment within the impoundment has been identified as clean for resuming its function in creating riverine substrates and habitat features.

(C) By-Pass Channel – This alternative can more effectively pass a larger suite of fishes from the entire riverine fish assembly than ramps and ladders, but still has issues with fish finding the bypass channel due to hydraulic and other unknown sensory queues; and the larger the dam, the more difficult. Also, this alternative would not restore or improve habitat and water quality conditions in the river. This alternative would require a large area of land adjacent to the dam in order to create a small stream channel, which is limited at the dam site/study area. This lack of space causes the bypass channel to become steeper and more engineered as opposed to having a shallow slope with a more natural stream design, in turn lessening the effectiveness of fish passage. Previously constructed bypass channels have shown to be susceptible to clogging with sediment and debris, which significantly drives up O&M costs. These bypass channels also attract canoe and kayak activities, which has safety implications and/or may drive design changes that benefit watercraft more than fishes. Additional features may be required to exclude paddlers, increasing cost. This alternative was eliminated from further evaluation due to the reasons provided above and in the screen matrix in Appendix A, as depicted by the low screening score.

(D) Fish Ladder – This alternative can somewhat pass a certain sub-suite of fishes from the entire riverine fish assembly, but fish ladders tend to not provide for small native fishes such as juveniles of all species, minnows, madtoms, darters, etc. Also, this alternative would not restore or improve habitat and water quality conditions in the river. Priority species targeted for fish ladders include large bodied, powerful swimming fish such as Bass, Sucker and Catfish. One of the main issues with these structures is frequent clogging with debris after storms. These engineered features, especially ladders, breakdown relatively quick and need to be cleaned and repaired annually to maintain full functionality. The cost of continual maintenance of these structures loses palatability overtime by managers, usually causing them to become non-functional relatively quick. Photo 5 depicts an unfunctional ladder; fish are not able to swim through a column of white water and the structure is clogged with woody debris. This alternative was eliminated from further evaluation due to the reasons provided above and in the screen matrix in Appendix A, as depicted by the low screening score.

The alternatives (C) Bypass Channel and (D) Fish Ladders are/were traditional means to pass or attempt to pass fish over a fragmenting structure within a riverine system; however, these are not effective if the goal is to pass fish species other than large bodied, strong swimmers, which are typically commercial or sport fishes; (Knaepkens et al 2006; Noonan et al 2011; Bunt et al 2012; Kemp 2012). Yet, even with the placement of these structures, there are still issues passing commercial and sport fishes effectively (Brown et al 2013). Studies have shown that the pool behind the dam can also impede fish passage due to a lack of riverine hydraulics and habitat (Raymond 1979; Agostinho et al 2002; Pelicice & Agostinho 2008). In addition to not effectively passing fish and associated mussels that require fish for transport, these methods do not restore riverine habitat. Therefore, these alternatives do not meet the dual study objective of passing riverine organisms and restoring riverine habitat. Along with these shortcomings, alternatives (C) and (D) also have intensive operation and maintenance issues along with associated high costs due to mechanical breakdown of parts, slumping and sedimentation, and clogging with debris. Finally, adding more manmade structures to the river instead of taking them out can cause additional habitat and aesthetic degradation, safety issues and flooding concerns.

(E) Instream Habitat – Due to the limited improvements this alternative could impart on a system hydrogeomorphically impaired, and the unnecessity of such actions should the main hydrogeomorphic impairment be fully addressed (i.e. the dam), this alternative was eliminated from further evaluation.

(F) Riparian Zone Plantings – Due to the limited availability of land, the non-federal sponsor's objective of improving riverine habitat, and not being necessary to fully achieve the study objectives, this alternative was eliminated from further evaluation.

2.6 –Final Alternative Array*

Screening of the initial alternatives resulted in one (1) action alternative, plus the No-Action Alternative, being carried forward as the Array of Alternatives slated for evaluation. Since there are no other alternatives that meet the federal and study objectives, alternative (A) would be evaluated with habitat units and costs to ensure the alternative is cost effective for federal investment.

- No Action
- (A) Full Dam Removal

Although (A) Full Dam Removal is the only alternative with merit to move on to evaluation, alternatives (C) By-Pass Channel and (E) Instream Habitat will be part of the evaluation to provide clarity on benefits gained.

CHAPTER 3 – ALTERNATIVE EVALUATION

3.1 – Study Reaches

Reaches for this ecosystem evaluation can be considered similar to reaches under flood risk management or navigation evaluations. Ecosystem numerical modeling was utilized to evaluate/compare these reaches for the final alternative array. Ecological evaluation of improvement was conducted using an approved ecosystem model for future-with- and future-without-project (FWP and FWOP, respectively) conditions with a base year of 2022 and a period of analysis of 50 years (2072). Study reaches were delineated as the length of stream above and below the dam that would be affected fluviogeomorphically by the FWP and FWOP conditions. The length of geomorphic affect was derived from the geomorphic assessment (non-federal sponsor), depth of refusal survey (SEWRPC) and hydrologic modeling (non-federal sponsor & USACE) of the study area. The reaches identified also helped in defining the Area of Potential Effects (APE).

3.2 – Habitat Assessment Methodology

The Habitat Suitability Index (HSI) is the quality portion of the USACE's habitat assessment procedure to analyze measures, alternatives or plans in terms of ecosystem improvement. The HSI is an algebraic function or cumulative index that typically uses various habitat structure components as indicators, such as cover, food, and natural processes, or biological components of species richness, abundance, evenness, etc. A riverine HSI that was certified (11 December 2014) by the USACE's Center of Expertise for Ecosystem Restoration (EcoPCX) was used for this study; the Qualitative Habitat Evaluation Index (QHEI) reflects the stream's physical habitat quality in terms of usability by fishes and macroinvertebrates (Rankin 1989, 1995; Ohio EPA 2006). The index was utilized to quantify existing (EX), FWOP and FWP conditions for the riverine study reaches. Fish and wildlife are highly indicative of habitat quality for riverine health, since they are highly responsive to primary (hydrology/hydraulics/geomorphology) and secondary (plants/habitat structure) ecosystem driver changes. Changes in habitat would directly affect the richness, abundance and distribution of study area fish and wildlife.

3.2.1 – Qualitative Habitat Evaluation Index (QHEI)

The QHEI is a physical habitat index designed to provide a numerical evaluation of the lotic (flowing) macrohabitat characteristics that are important to native fish communities. A detailed analysis of the development and use of the QHEI is available in Rankin (1989) and Rankin (1995). The QHEI is composed of six principal metrics each of which are described in *Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI), 2006*. The maximum possible QHEI score is 100, and the lowest (0) zero. Each of the metrics are scored individually and then summed to provide the total QHEI segment score. The QHEI protocol also standardizes definitions for riverine habitats, for which a variety of existing definitions and perceptions exist; consistency for these was derived from Platts et al. (1983).

Figure 7: Habitat Delineated Study Reaches for Alternative Evaluation.

3.2.2 – QHEI as the HSI

The QHEI has acceptable application for USACE HSI procedures in that the scoring of metrics and calculating an overall score is simple and output interpretation is straightforward – a comprehensive checklist of riverine habitat (see MEMORANDUM FOR CECW-LRD Recommendation for Regional Approval for Use of the Qualitative Habitat Evaluation Index 11 December 2014). The USACE utilized the Ohio Environmental Protection Agency's (EPA) protocol to collect data and score QHEI for the identified Root River study reaches. Table 2 provides the existing habitat conditions for the Root River. Raw data sheets may be found in *Appendix A*. The data required for input was gathered firsthand by USACE (August 2020).

Table 2: Existing Condition (EX) QHEI Score for the Root River at Horlick Dam

Category	Impoundment pool (Upstream Reach)	Below Horlick Dam (Downstream Reach)
Substrate	1	19
In-stream Cover	5.5	15
Channel Morphology	6	19
Riparian Zone	5.5	5
Pool/Glide Quality, Current Velocity	7	10.5
Riffle/Run Quality	0	8
Gradient	2	7
QHEI Score (EX)	27	83.5 (Rounded to 84)

Since the QHEI model output is a score between 0-100, it is easily normalized to a score between 0 and 1.0; this provides uniform and useful information across alternatives, models and other USACE ecosystem studies. EX HSI scores for the Root River study reaches upstream of the dam are 26 near the boat launch, and 28 near river mile 7, both of which are classified as "very poor" stream habitat. These two were then averaged to create the Upstream Reach QHEI score of 27. The EX HSI score for reaches below the dam and downstream near the bridge are 81 and 86, respectively, both of which are classified as an "excellent" stream habitat. These two were then averaged to create the Downstream Reach QHEI score of 84. The equation to normalize the QHEI score to a value between 0 and 1.0 is:

- QHEI Score / 100 = HSI_{QHEI}
- Upstream Reach > 27/100 = 0.27_{QHEI}
- Downstream Reach > 84/100 = $.84_{QHEI}$

3.2.3 – Stream Length as Quantity Measure

USACE planning guidelines require that there be a quantity component to the habitat assessment for determining FWOP and FWP conditions. Stream miles, feet and acres are typically utilized for USACE river restoration studies. Affected stream lengths are typically used for studies that consider dam removal to ensure quantity measures are indicative of natural riverine morphologies. Since stream length remains constant whether impounded or free flowing, a derived stream length unit equivalent to an acre of habitat was used for this study. The average width of free-flowing sections of the river within the study area is about 60-feet

wide (ArcGIS, Online Mapping). Since an acre is 43,560 ft^2, the length to achieve 1 acre of habitat on the Root River within the study area would be about 726 feet or 43,560 feet /60 feet = 726 feet.

The length of the reach upstream of the Horlick Dam that could be affected by with FWP alternatives is about 24,000 feet (4.5 miles). The derived equivalent length units for this reach is 24,000 feet / 726 feet = 33.1 units. The length of the reach downstream of the Horlick Dam that could be affected by FWP alternatives is 11,000 feet (2 miles). The derived equivalent length units for this reach is 11,000 feet / 726 feet = 15.2 units.

3.2.4 – Stream Average Annual Habitat Units (AAHUs)

In order to equally assess measures, alternatives or plans, the benefit portion of the analysis must be annualized just as the costs are. The method per USACE planning guidelines typically assigns benefits over a 50-year period of analysis. Based on the non-federal objectives and the use of natural and nature-based features, this study used 50-years as a reasonable period of analysis, noting that the benefits may be accrued into the unforeseeable future. Habitat Units (HUs) were calculated by:

- HSI_{QHEI} x Stream Length Units Affected = Habitat Units (HUs)
- Upstream Reach: 0.27 x 33.1 = 8.9 HU_{EX}
- Downstream Reach: 0.84 x 15.2 = 12.7 HU_{EX}
- Total Reach: 8.9 + 12.7 = 21.6 HU_{EX}

FWOP and FWP Average Annual HSI (Table 4) are calculated by:

- HSI_{n50} / 50 years = AAHSI

Average Annual Habitat Units (AAHUs) (Table 4) are calculated by:

- AAHSI x Stream Length Units = AAHUs

To ensure that existing benefits are not claimed by potential actions, only the net benefits gained are utilized. This unit is called the Net Average Annual Habitat Unit (NAAHU), which is represented as:

- FWP AAHUs – FWOP AAHUs = Net Average Annual Habitat Units ($NAAHU_{QHEI}$)

3.3 – Future Without-Project Conditions (FWOP)

The most likely scenario for the FWOP condition of the Root River within the study area is that it would remain impaired by the Horlick Dam. Current funding and priority scenarios for the non-federal sponsor indicate that the spillway would be repaired so that the dam would remain in place. Since the dam would most likely remain in place without a federal investment/project, and that the river within the study area is in dynamic equilibrium with the dam, the existing conditions described in this report would perpetuate into the future. Therefore, the future without project conditions (FWOP HSI_{n50}) are considered to be equivalent to the existing conditions (EX HSI) for the Root River within the study area (Table 3 & Figure 9).

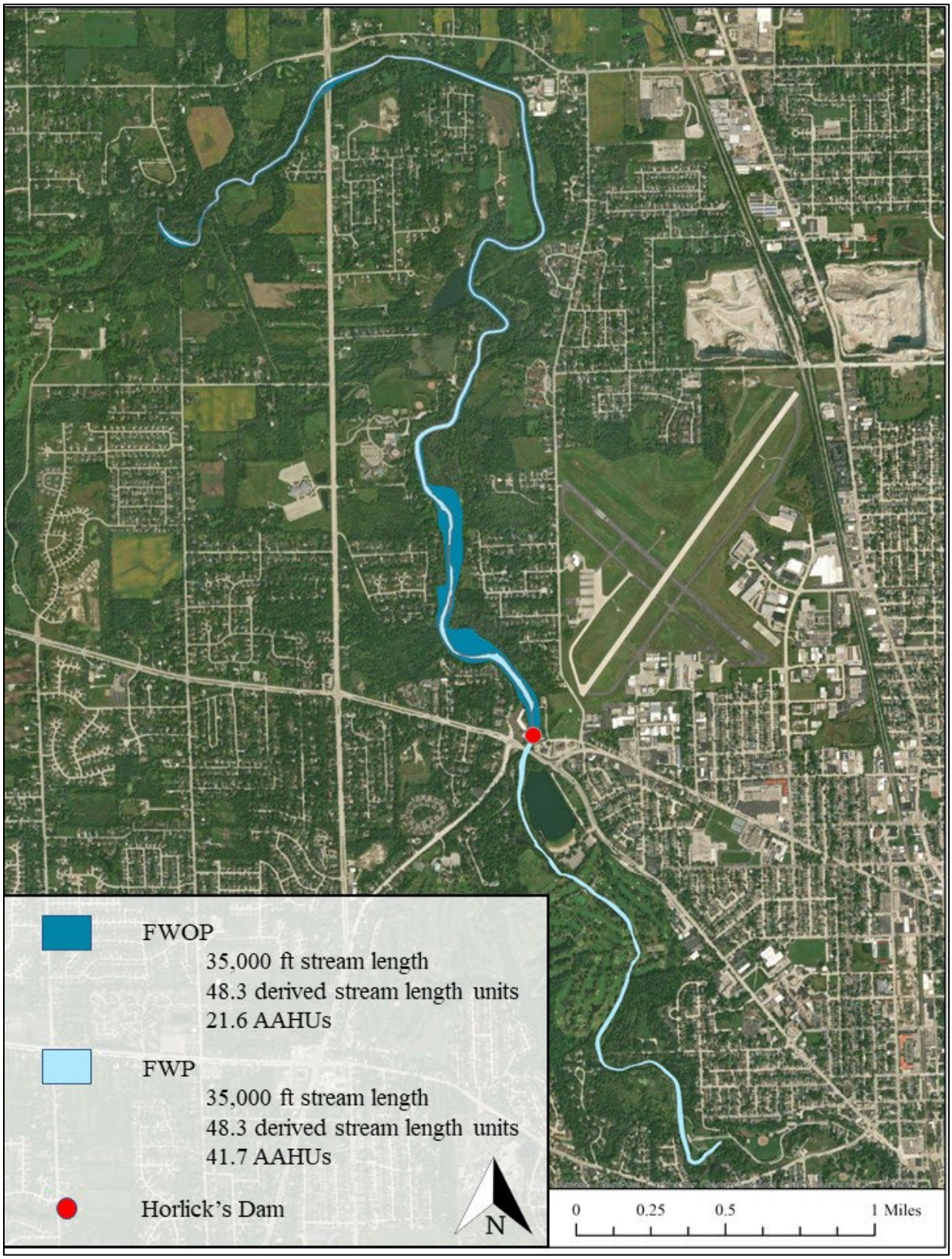
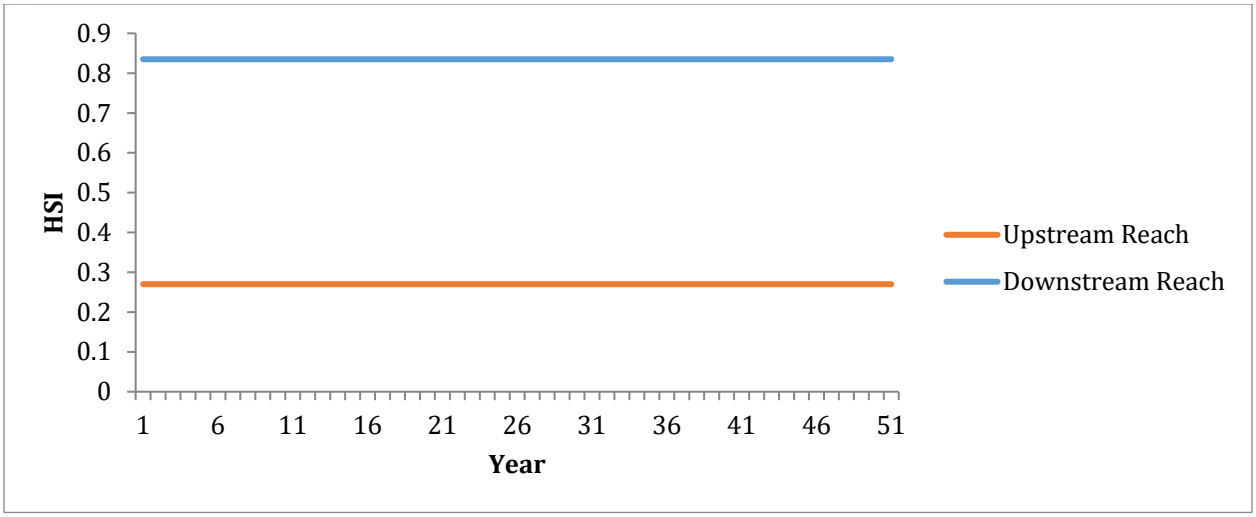


Figure 8: Future with project and Future without project

Table 3: Future Without-Project Conditions for Study Reaches

Description	Habitat Types	Length Units	HSI_{Ex}	HSI_{FWOP}	HU_{Ex}	$AAHU_{FWOP}$
Existing 2023	Upstream Reach	33.1	0.27		8.9	
	Downstream Reach	15.2	0.84		12.7	
No Action / FWOP	Upstream Reach	33.1		0.27		8.9
	Downstream Reach	15.2		0.84		12.7

Figure 9: Future Without-Project Conditions Average Annual Habitat Suitability per the QHEI



3.4 – Alternative Benefits (Future With-Project)

The evaluation of habitat benefits is a comparison of the FWP and FWOP conditions for each alternative. A comparison of the FWOP and FWP HUs was performed to determine the level of benefits accrued by one or a combination of alternatives. The alternatives for this study were evaluated with the HSI methodology described in Section 3.2.2 (see *Appendix A* for FWP calculations and QHEI calculations).

There was only one action alternative carried forward for evaluation that would be in the federal interest for meeting the federal objective, planning objectives, acceptability to the non-Federal sponsor, and efficiently and effectively restores a significant portion of the Root River. This alternative is (A) Full Dam Removal.

Alternative methods for restoring the Root River within the study area were investigated that have been used in the past, in which none of them can provide the dual function (meeting both objectives) of 1) restoring riverine habitat and 2) providing fish passage for the entire native fish assemblage. For the sake of comparison, two alternatives were theoretically added to this evaluation to provide clarity, or a baseline, on the lack of benefits in either restoring riverine habitat or providing inclusive fish passage. Planning level cost thresholds were applied as to not exceed the cost of alternative (A) Full Dam Removal, as cost effectiveness logic provides one would stop spending funds once the maximum amount of benefits was accrued, as alternative (A) provides. Alternative (C) By-Pass Channel was theoretically added to address the fish

passage objective; and alternative (E) Instream Habitat would place extensive amounts of large woody debris in two rows forming a chute in the center of upstream study reach (within the impoundment) to address the habitat objective. The QHEI or habitat improvements in the upstream study reach would not improve by putting in a by-pass channel, so it retains the FWOP QHEI score (Table 4). Conversely, there would be no fish passage, but the QHEI would slightly increase in the upstream reach only with alternative (E), so a theoretical QHEI score was calculated for the large woody debris chute conditions. Large woody debris is a natural feature that needs to be continuously supplied by natural inputs as the river undergoes meandering. This has implications to alternative (E) deteriorating overtime and being swept downstream in pieces, which loses the function and outputs of the alternative. The combination of alternatives (C) and (E) would begin to address both objectives, but accordingly doubles the cost.

Table 4: Future With-Project QHEI Scores for Alternative Evaluation

Category	(A) Full Dam Removal	(C) By-pass Channel	(E) Instream Habitat
Substrate	19	1	2
In-stream Cover	19	5.5	11
Channel Morphology	15	6	6
Riparian Zone	10	5.5	6.5
Pool/Glide Quality, Current Velocity	10	7	7
Riffle/Run Quality	8	0	0
Gradient	6	2	2
QHEI Score (EX)	87	27	34.5

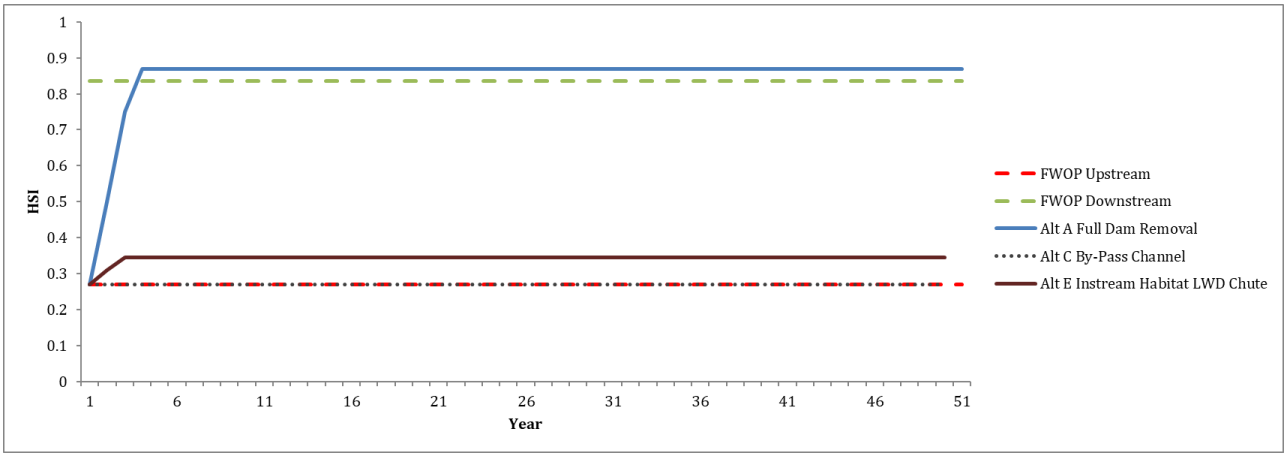


Figure 10: Future With-Project Average Annual HSI Scores per the QHEI

Table 5: Net Average Annual Habitat Units (NAAHU) per Alternative

Description	Alternative	Length Units	HSI_{FWOP}	HSI_{FWP}	$AAHU_{FWOP}$	$AAHU_{FWP}$	NAAHU
FWOP	Upstream Reach	33.1	0.27		8.9		
	Downstream Reach	15.2	0.84		12.7		
	FWOP Total	48.3			21.6		
Action / FWP	(A) Upstream Reach	33.1		0.86		28.5	15.8
	(A) Downstream Reach	15.2		0.87		13.2	0.5
	(A) Total	48.3				41.7	**16.3**
	(C) Upstream Reach	33.1		0.27		8.9	0.0
	(C) Downstream Reach	15.2		0.84		12.7	0.0
	(C) Total	48.3				21.6	**0.0**
	(E) Upstream Reach	33.1		0.34		11.3	2.4
	(E) Downstream Reach	15.2		0.84		12.7	0.0
	(E) Total	48.3				24.0	**2.4**

3.5 – Alternative Costs

The Detailed discussion on planning level feature costs is presented in *Appendix F – Cost Engineering*. Conceptual, planning level cost estimates were prepared for measures/features that were identified by the study team in conjunction with the non-federal sponsor (Table 6). Estimates were developed using cost information from previous studies, lump sum and unit prices, and for plant, labor, and material methods. The following costs were originally established in 2021, however there was an 18-month administrative pause on this project until 2023. Cost estimates and subsequent analyses will be updated to reflect 2023 costs for the final report.

Cost Annualization: Annualizing costs is a method where the project costs are discounted to a base year then amortized over the period of analysis. The base year for this project was determined to be the year in which the first phase of the project is to be completed (calendar year 2022). Costs that occur prior to this year need to be compounded to the base year, while those occurring after the base year need to be discounted to the base year. The period of analysis for the Section 506 project is 50 years. Discounting to the base year and summing values gives net present value. Costs are compounded or converted to present value for the base year then the amortization of the net present value (NPV) yields average annual equivalent value. Discount rate was determined by the appropriate Economic Guidance Memorandum 21-01, Federal Interest Rates for Corps of Engineers, which is currently 2.5%. The proposed with project alternatives have the construction period spread out over a 3 to 5-year contract. Each year per alternative is either compounded or discounted to the base year. Calculation of the measures Average Annual Cost (AA Cost) is completed by multiplying the present value to the 50-year amortization factor. The IWR Planning Suite II was utilized to calculate AA costs per alternative (see *Appendix A* for Annualization Modules).

Real Estate: The value of the lands, relocations, and disposal (LERRD) areas required for the Project was determined by a cost estimate performed by the U.S. Army Corps of Engineers District Appraiser on or about June 10, 2021. Total LERRDs were estimated at $88,852.00, comprising of $53,210.00 in land costs, a 20% incremental cost of $10,642.00, and sponsor administrative costs of $25,000.000. A 2023 administrative review and update to the original

2021 cost estimate is currently underway and will be completed before finalization of this report. Full details are provided in *Appendix I Real Estate Plan*.

Table 6: Planning Level Cost Annualization Factors & Outputs, IWR Planning Suite II.

	(A) Full Dam Removal	(C) By-Pass Channel	(E) Instream Habitat
Base Year	2022	2022	2022
Period of Analysis	50	50	50
Discount Rate	2.5%	2.5%	2.5%
Construction Months	36	60	60
Periods/Year	12	12	12
Construction Cost	$ 1,727,643	$ 1,727,643	$ 1,727,643
Real Estate	$ 65,000	$ 71,000	$ 60,000
Monitoring	$ 60,000	$ 100,000	$ 120,000
PED	$ 250,000	$ 350,000	$ 250,000
Total Initial Cost	$ 2,102,643	$ 2,248,643	$ 2,157,643
IDC	$ 65,600	$ 111,179	$ 111,179
Total Investment Cost	$ 2,168,243	$ 2,359,822	$ 2,268,822
Present Value	$ 2,168,243	$ 2,359,822	$ 2,268,822
Average Annual Cost	$ 76,448	$ 83,203	$ 79,994

* Adaptive management measures for each alternative are included in the construction cost for the alternative

3.6 – Cost Effectiveness & Incremental Cost Analysis

Cost effectiveness and incremental cost analysis (CE/ICA) are two distinct analyses that must be conducted to evaluate the effects of alternative plans according to USACE policy. First, it must be shown through cost effectiveness analysis that a restoration plan's output cannot be produced more cost effectively by another alternative. *Cost effective* means that, for a given level of non-monetary output, no other plan costs less and no other plan yields more output at a lower cost. Subsequently, through incremental cost analysis, a variety of alternatives and various-sized alternatives are evaluated to arrive at a "best" level of output within the limits of both the sponsor's and the USACE's capabilities.

The subset of cost-effective plans are examined sequentially (by increasing scale and increment of output) to ascertain which plans are most efficient in the production of environmental benefits. Those most efficient plans are called "best buys." As a group of measures, they provide the greatest increase in output for the least increases in cost. They have the lowest incremental costs per unit of output. In most analyses, there will be a series of best buy plans, in which the relationship between the quantity of outputs and the unit cost is evident. As the scale of best buy plans increases (in terms of output produced), average costs per unit of output and incremental costs per unit of output will increase as well. The incremental analysis by itself will not point to the selection of any single plan. The results of the incremental analysis must be synthesized with other decision-making criteria (i.e., significance of outputs, acceptability, completeness, effectiveness, risk and uncertainty, reasonableness of costs) to help the study team select and recommend a particular plan.

Five alternative plans including the No Action Plan were generated (Table 7) from the set of 3 alternatives input into the IWR-Planning Suite II. The analysis identified that one cost effective plan (A) and three non-cost effective plans (C, E and C&E); non-cost effective means another

plan(s) provided the same benefits or more at a lesser cost. The No Action Plan is always considered a best buy; however, one action alternative plan was identified as a “best buy”, which was (A) Full Dam Removal (Figure 12); this alternative has an average cost of $49,090 per habitat unit gained.

Table 7: Alternative Plan Cost Effectiveness

Alt Plan	Alt Plan Description	AA Cost	NAAHUs	Cost Effective	Cost per HU
	No Action	$0	0	Cost Effective / Best Buy	$ -
A	Full Dam Removal	$76,448	16.3	Cost Effective / Best Buy	$ 46,900
C	Bypass Channel	$83,203	0	Non-Cost Effective	$ -
E	Instream Habitat LWD	$79,994	2.4	Non-Cost Effective	$ 333,301
C & E	Combo	$163,197	2.4	Non-Cost Effective	$ 679,981

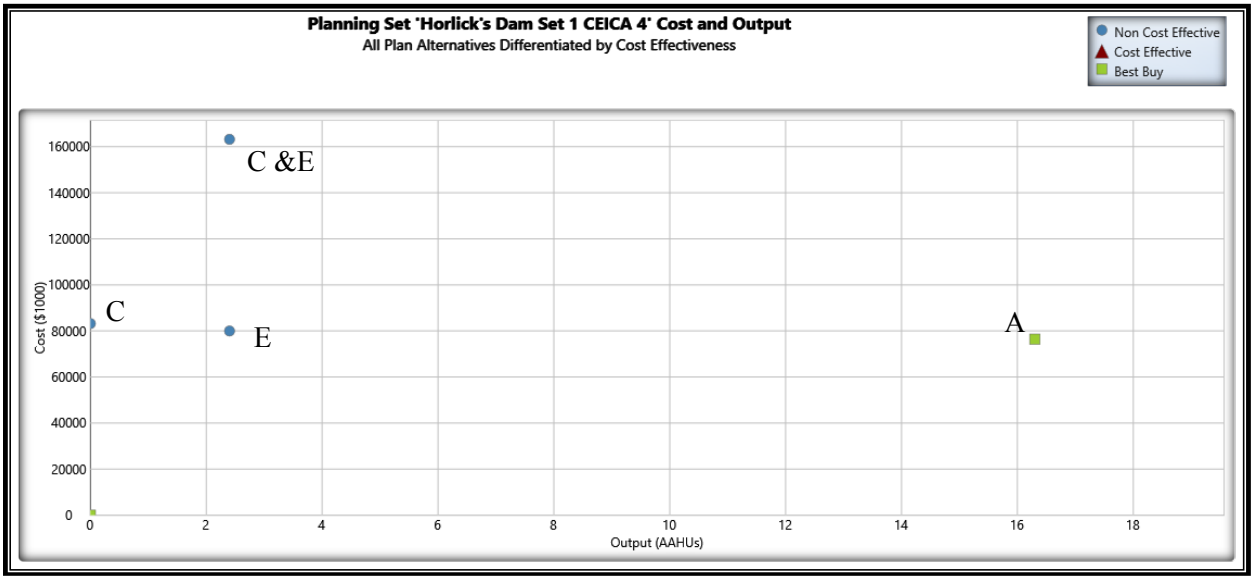


Figure 11: Cost Effective Analysis on All Plan Combinations

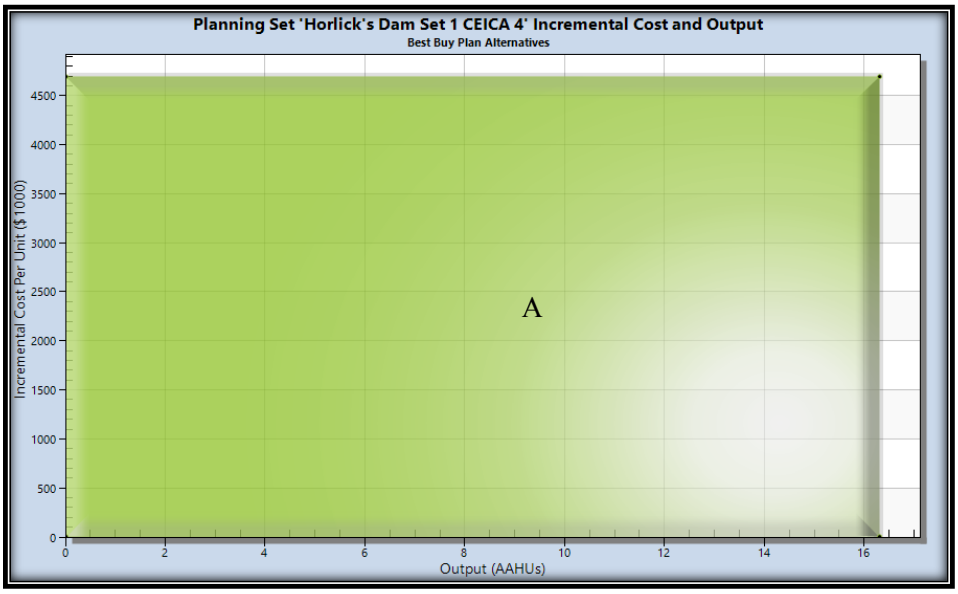


Figure 12: Graphical Representation of Incremental Costs vs. Benefits

3.7– The Four Accounts Assessment of Benefits

The January 5, 2021 Memorandum for Commanding General, U.S. Army Corps of Engineers, Policy Directive – Comprehensive Documentation of Benefits in Decision Document supplements the guidance provided in ER 1105-2-100 by requiring comprehensive consideration of total project benefits including economics (NED/NER/RED), environmental (EQ), and social categories (OSE). PDTs must identify and analyze benefits in total and equally across a full array of benefit categories. The level of the analysis will vary based on the magnitude of the change, its relevance to decision-making, and the availability of data, tools, and procedures to quantify or monetize the benefit or impact.

3.7.1 – National Ecosystem Restoration (NER)

The use of the terms “federal objective” and “NER” are defined as the national goal, typically called National Ecosystem Restoration. Water and related land resources project plans are formulated to alleviate problems and take advantage of opportunities in ways that contribute to the NER. Contributions to national improvements are typically increases in the net value of the national output of marketable or non-marketable goods (food, medicine, timber), services (flood temperance, water quality) and ecosystem integrity (fish & wildlife, habitat).

Table 8 shows the monetary investment layout and benefits gained towards the federal objective. Alternative (A) Full Dam Removal clearly maximizes benefits towards the federal objective, has the lowest federal and non-federal expenditure, and requires no operations and maintenance since the alternative restores the natural feature by removing a manmade structure and returning riverine processes.

Table 8: Summary of NER Benefits for Alternative Array in $1000s

	(A) Full Dam Removal	(C) By-Pass Channel	(E) Instream Habitat	(C & E) Combo
Total Project First Costs	$ 2,103	$ 2,249	$ 2,157	$ 5,137
Interest During Construction	$ 65	$ 111	$ 111	$ 284
Total Gross Investment	$ 2,168	$ 2,360	$ 2,269	$ 5,421
AA Cost of Total Gross Investment	$ 76	$ 83	$ 80	$ 191
Annual OMRR&R Costs	$ -	$ 40	$ 60	$ 100
Total AA Costs	$ 76	$ 123	$ 140	$ 291
Net NER Benefits (NAAHUs)	16.3	0	2.4	2.4
Total NER Benefits (AAHUs)	41.7	0	21.6	21.6
Cost Per Habitat Unit	$ 47	$ -	$ 333	$ 672
CE / ICA Cost Effective	Yes	No	No	No

All monetary values are in Fiscal Year 2021 price levels
All annualized values are discounted using a Fiscal Year 2021 Federal discount rate of 2.5 percent; 50-year period of analysis

3.7.2 – Environmental Quality (EQ)

A summary of EQ benefits (Table 9) is provided to help decision makers evaluate whether the condition of the resources affected by the alternatives are improved or not. The environmental benefits of the alternatives analyzed may be considered as non-supportive = 0; partial support = 1; or most supportive = 2.

Table 9: Environmental Quality Benefit Summary Table

EQ Benefit Categories	(A) Full Dam Removal	(C) By-Pass Channel	(E) Instream Habitat	(C & E) Combo
Climate Change	1	0	0	0
Riverine Habitat	2	0	1	1
Riverine Connecitivy	2	1	0	1
Native Riverine Species	2	1	1	1
Wetlands, Riverine	2	0	0	0
Geology	2	0	0	0
Water Quality	2	0	1	1
Sediment Quality	2	0	1	1
Hydrology	2	0	0	0
Flooding	1	0	0	0
Human Safety	2	0	0	0
Human Health	2	0	0	0
Total EQ Points	20	2	4	5

3.7.3 – Regional Economic Development (RED)

The project contributes to the regional economy by way of expenditures associated with the following: (1) construction and (2) annual operation and maintenance (O&M). The regional economic impacts of Alternatives A, C, E, and C&E were evaluated using the USACE Regional Economic System (RECONS) 2.0 model. RECONS is a USACE-certified regional economic model, designed to provide accurate and defensible estimates of regional economic impacts and contributions associated with USACE projects, programs and infrastructure. Regional economic activity is measured as economic output (sales), jobs, income, and value added. Estimates are provided for three levels of geographic impact area: local, state, and national. These activities and resulting estimates of regional economic activity are summarized below. Dollar values are presented in Fiscal Year (FY) 2021 price levels; job estimates are presented as full-time equivalence (FTE).

Project construction expenditures are assumed to occur over 36 months from FY22-FY24 at a total project cost of $2.103 million ($FY21 price levels) for Alternative A. For Alternatives C, E, and C&E, project expenditures are assumed to occur over 60 months and at costs of $2.249, 2.157, and $5.137 million respectively (FY21 price levels). These estimates include costs of preconstruction engineering and design activities, as well as real estate, monitoring, and construction activities. Construction activity would result in spending on goods and services (e.g., materials and labor), and is a stimulus to the regional economy.

In total, construction expenditures associated with Alternative A would support about 29 full-time equivalent jobs, $1.8 million in labor income, $1.6 million in the value added, and $2.8 million in economic output in the Racine County, WI local impact area. Nationally, these expenditures would support 46 full-time equivalent jobs, $3.1 million in labor income, $3.6 million in value added, and $6.4 million in economic output.

Construction expenditures associated with Alternative C would support about 31 full-time equivalent jobs, $1.9 million in labor income, $1.7 million in the value added, and $2.9 million in economic output in the Racine County, WI local impact area. Nationally, these expenditures would support 49 full-time equivalent jobs, $3.4 million in labor income, $3.9 million in value added, and $6.8 million in economic output.

Construction expenditures associated with Alternative E would support about 30 full-time equivalent jobs, $1.9 million in labor income, $1.7 million in the value added, and $2.8 million in economic output in the Racine County, WI local impact area. Nationally, these expenditures would support 47 full-time equivalent jobs, $3.2 million in labor income, $3.7 million in value added, and $6.6 million in economic output.

Construction expenditures associated with Alternative C&E would support about 72 full-time equivalent jobs, $4.5 million in labor income, $3.9 million in the value added, and $6.7 million in economic output in the Racine County, WI local impact area. Nationally, these expenditures would support 112 full-time equivalent jobs, $7.6 million in labor income, $8.9 million in value added, and $15.6 million in economic output.

The economic activity supported by the selected project alternative during its construction is proportional to project expenditures in a given year (e.g., if 20% of expenditures are in incurred in FY23, approximately 20% of the total economic activity is attributed to FY23).

Average Annual O&M for Alternatives C, E, and C&E is estimated to be $40,000, $60,000, and $100,000 respectively (FY21 prices) from FY26 through FY76. Alternative A does not require annual O&M expenditures. Annual O&M expenditures, when applicable, are a stimulus to the regional economy. In total, average annual O&M expenditures for Alternative C would support about 0.4 full-time equivalent jobs, $30,000 in labor income, $33,000 in value added, and $47,000 in economic output in the Racine County, WI local impact area. Nationally, these expenditures support about 0.8 full-time equivalent jobs, $56,000 in labor income, $68,000 in value added and $111,000 in economic output.

Average annual O&M expenditures for Alternative E would support about 0.5 full-time equivalent jobs, $45,000 in labor income, $49,000 in value added, and $71,000 in economic output in the Racine County, WI local impact area. Nationally, these expenditures support about 1.1 full-time equivalent jobs, $84,000 in labor income, $103,000 in value added and $166,000 in economic output.

Average annual O&M expenditures for Alternative C&E would support about 1.1 full-time equivalent jobs, $75,000 in labor income, $82,000 in value added, and $118,000 in economic output in the Racine County, WI local impact area. Nationally, these expenditures support about 1.9 full-time equivalent jobs, $141,000 in labor income, $171,000 in value added and $277,000 in economic output.

Although construction expenditures related to the implementation of Alternatives A,C, and E are similar, the difference in construction expenditures drives a slight difference between the regional economic impacts between the two alternatives. These differences are roughly proportional to the small differences in construction expenditures between alternatives; since Alternative C is the costliest of the three, it also supports slightly more jobs and contributes slightly more to economic output. Additionally, since Alternative C&E is a much more expensive combination of Alternatives C and E, the higher project expenditures support more jobs and contribute more to economic output, relative to the other three alternatives. The differences in output, jobs, labor income, and value added between the four alternatives is summarized in Table 10.

Table 10: Summary of Local and National Economic Impacts of Construction Expenditures ($FY21)

		Alternative A	Alternative C	Alternative E	Alternative C&E
Local Impact Area (Racine County, WI)	Construction Costs	$2.103M	$2.249M	$2.157M	$5.137M
	Jobs Supported	29	31	30	72
	Labor Income	$1.8M	$1.9M	$1.9M	$4.5M
	Value Added	$1.6M	$1.7M	$1.7M	$4M
	Economic Output	$2.8M	$2.9M	$2.8M	$6.7M
United States	Construction Costs	$2.103M	$2.249M	$2.157M	$5.137M
	Jobs Supported	46	49	47	112
	Labor Income	$3.1M	$3.4M	$3.2M	$7.7M
	Value Added	$3.6M	$3.9M	$3.7M	$8.9M
	Economic Output	$6.4M	$6.8M	$6.6M	$15.6M

Similar logic applies to average annual O&M expenditures, in that larger up-front expenditures support comparably more jobs and induce comparably more economic impact. The economic

impacts of average annual O&M expenditures across the four alternatives are summarized below in Table 11. As Alternative A does not incur O&M costs, it is omitted from Table 11.

Table 11: Summary of Local and National Economic Impacts of Annual O&M Expenditures ($FY21)

		Alternative C	Alternative E	Alternative C&E
Local Impact Area (Racine County, WI)	Avg Annual O&M Costs	$40,000	$60,000	$100,000
	Jobs Supported	0.4	0.6	1.1
	Labor Income	$30,000	$45,000	$75,000
	Value Added	$33,000	$49,000	$82,000
	Economic Output	$47,000	$71,000	$118,000
United States	Avg Annual O&M Costs	$40,000	$60,000	$100,000
	Jobs Supported	0.8	1.1	1.9
	Labor Income	$56,000	$84,000	$141,000
	Value Added	$68,000	$103,000	$171,000
	Economic Output	$111,000	$166,000	$277,000

The comparative RECONS output in Table 10 and Table 11 represent short-term economic impacts. If more economic impact is induced by an alternative that is not selected, the difference in impacts can be viewed as an opportunity cost of the selected alternative. For example, if Alternative C is selected, 41 additional local jobs that would have been supported under Alternative C&E are not supported. Similar logic holds for labor income, value added, and output.

While this line of thinking is important to note, Alternative A has been determined to be the only cost-effective alternative among the four.

In its entirety, this RED evaluation demonstrates the regional economic activity that would be supported by the implementation of Alternative A (FY22-24) and Alternatives C, E, and C&E (FY22-26), and the O&M activities expected to occur over the project evaluation period (FY26-FY76). Regional economic activity (impacts and contributions) is measured as economic output (sales), jobs, income, and value added. Estimates were provided for three levels of geographic impact area: local, state and national. All dollar values in this document are presented in FY21 price levels and job estimates are presented as full-time equivalence. Overall, there is only a marginal difference when estimating the regional economic impacts between Alternatives A, C, and E, and it should be noted that Alternative A is the only alternative of the four determined to be cost-effective by the PDT. While Alternative C&E supports comparably more jobs and induces comparably more economic impact by virtue of its large up-front expenditures, these same expenditures contribute to the fact that this alternative is not cost-effective.

More information about RECONS and the specifics of how this RED analysis was conducted can be found in *Appendix A.*

3.7.4 – Other Social Effects (OSE)

See Section 4.2.5 for a discussion of the effects of the alternative array on hydrology and hydraulics. Because the existing dam functionally does not provide any flood storage, there will be no noticeable impacts to base flows or flood flows because of the dam removal. Therefore, the removal of the dam will not cause any foreseeable change in life-safety risks.

See Section 4.4.1 for a discussion of the socio-economic makeup of the surrounding municipalities. None of the proposed alternatives are likely to have any adverse effects on the area's social properties and would likely create a more aesthetically pleasing environment for users of these areas. Increased traffic and aesthetic impacts such as noise during construction would be highly localized and temporary. In addition, the county has to currently spend taxpayer funds to maintain the structural integrity of the dam. This burden on taxpayers would be lessened in the event that removing the dam requires no further O&M.

See Section 4.4.4 for an in-depth discussion of the alternatives' impacts on recreation. In short, the proposed project may have temporary short-term impacts from construction and would not have any long-term adverse effects (with the potential for beneficial impacts to recreation).

The implementation of the proposed project would remove the largest fish passage obstruction on the Root River, which would eliminate the dense concentration of fish above the dam that anglers take advantage of. However, this would also open up passage for these fish to travel upstream to additional fishing locations. Bedrock could potentially be exposed in the immediate vicinity of Horlick Dam, upstream of the dam in the newly exposed riparian zone. This will provide extended area for fly fishing that was previously unavailable.

Additional beneficial impacts to recreation include expanded paddling and kayaking opportunities. With the removal of the dam, paddlers would be able to continue their journey downstream up to 6 miles to Lake Michigan.

3.8 – Significance of Alternative Outputs

Because of the challenge of dealing with non-monetized benefits, the concept of output significance plays an important role in ecosystem restoration evaluation. Along with information from cost effectiveness and incremental cost analyses, information on the significance of ecosystem outputs can help determine whether the proposed environmental investment is worth its cost and whether a particular alternative should be recommended. A summary of significance points (Table 12) is provided to help decision makers evaluate whether the value of the resources of any given restoration alternative are worth the costs incurred to produce them. The significance of the Horlick Dam Root River restoration outputs is herein recognized in terms of institutional, public, and technical importance. Scoring is 0 = non-supportive; 1 = partial support; 2 = most supportive.

Table 12: Summary of Significance Points for Alternative Evaluation

Points of Significance	(A) Full Dam Removal	(C) By-Pass Channel	(E) Instream Habitat	(C & E) Combo
Institutional Recognition				
Migratory Bird Treaty Act (1918)	2	0	1	1
EO 13186 Responsibilities of Federal Agencies to Protect Migratory Birds	2	0	1	1
EO 13340 Great Lakes A National Treasure	2	0	1	1
Fish and Wildlife Conservation Act of 1980	2	0	1	1
EO 11514 Protection and Enhancement of Environmental Quality	2	0	1	1
EO 11990 Protection of Wetlands	2	0	1	1
EO 13112 Invasive Species	2	0	1	1
Endangered Species Act of 1973	2	0	1	1
Clean Water Act	2	0	1	1
EO 13653 Preparing the United States for the Impacts of Climate Change	2	0	1	1
Root River Watershed Plan (SEWRPC)	2	0	1	0
Federal Level Support	1	0	2	1
State Level Support	1	0	2	1
County/Municipal Support	2	0	0	0
Public Recognition				
Stakeholder Support	1	1	1	1
Technical Recognition				
Restores Hydrology	2	0	0	0
Restores Geomorphology	2	0	0	1
Restores Scarce & Limited Habitats	2	0	0	0
Restores Habitat Connectivity	2	2	0	2
Restores Habitat for T&E Species	1	0	0	0
Increases Native Biodiversity	2	0	0	0
Total Significance Points	38	3	16	16

CHAPTER 4 – AFFECTED ENVIRONMENT & ENVIRONMENTAL IMPACTS*

The purpose of this step of the planning process is to develop an inventory and forecast of critical resources (physical, environmental, social, etc.) relevant to the problems and opportunities under consideration in the planning area. This information is used to define and characterize the problems and opportunities. A quantitative and qualitative description of these resources is made for both current and future conditions and is used to define existing and future without-project conditions. Existing conditions are those at the time the study is conducted. The forecast of the FWOP condition reflects the conditions expected during the period of analysis. The FWOP condition provides the basis from which alternative plans are formulated and impacts are assessed. Since impact assessment is the basis for plan evaluation, comparison and selection, clear definition and full documentation of the FWOP condition are essential. Gathering information about historic and existing conditions requires an inventory. Gathering information about potential future conditions requires forecasts, which should be made for selected years over the period of analysis to indicate how changes and other conditions are likely to have an impact on problems and opportunities. Information gathering and forecasts will continue throughout the planning process. As such, this chapter contains the following:

- An inventory of relevant historic conditions;
- An inventory of relevant current conditions and the studies that have been completed to identify those conditions; and
- A forecast of FWOP conditions.

This chapter also presents the effects associated with implementing any of the alternatives identified in Section 2.6 Final Alternative Array. The No Action Alternative is required by NEPA and other laws and regulations; and is briefly described as the FWOP condition presented under each resource category in this chapter as Existing Condition. The evaluation of effects is based upon a comparison of what the federal action alternative would have on resource categories considering historic, existing and FWOP conditions. The FWP Condition, presented as Alternative Impact, describes what is anticipated to prevail in the future if the proposed alternative is implemented. As well, this analysis makes distinction between adverse and beneficial effects.

4.1 – Effects Analysis

The following environmental consequences section follows the 2020 NEPA Regulations or 2020 Rule (85 FR 43304 [July 16, 2020]), which took effect on September 14, 2020 which was the most recent NEPA regulation at the time of writing this report before the project went into an 18-month administrative pause from 2021 to 2023. A consequence, or effect (the terms “effects” and “impacts” may be used synonymously (40 C.F.R. § 1508.8)), is defined as a modification to the human or natural environment that would result from the implementation of an action. The three types of effects that may occur when an action takes place are direct, indirect, and cumulative. Direct effects are caused by an action and occur at the same time and place. Indirect effects are caused by an action and are realized at a later point in time or at a greater geospatial distance but are logically foreseeable. Cumulative effects result from the collection of federal and non-federal actions taking place over the same period of time.

Effects may be short-term (temporary), long-term (long lasting), or permanent. Short-term effects are defined as those that would occur during construction of one of the alternatives. Long-term effects are defined as those that would extend from the end of the construction period through some point within the project life-cycle. Permanent effects are assumed to be present throughout the period of analysis.

Significance thresholds for each resource are used to categorize effects (Figure 13). The effects on each resource may be significant and unavoidable, significant, less than significant, or have no effects. Significant impacts are those that would result in substantial changes to the environment and receive the greatest attention in the decision-making process. Where significant effects are identified, recommended mitigation measures, best management practices (BMPs), and/or other environmental commitments are provided in order to avoid, minimize, or reduce environmental impacts to less than significant.

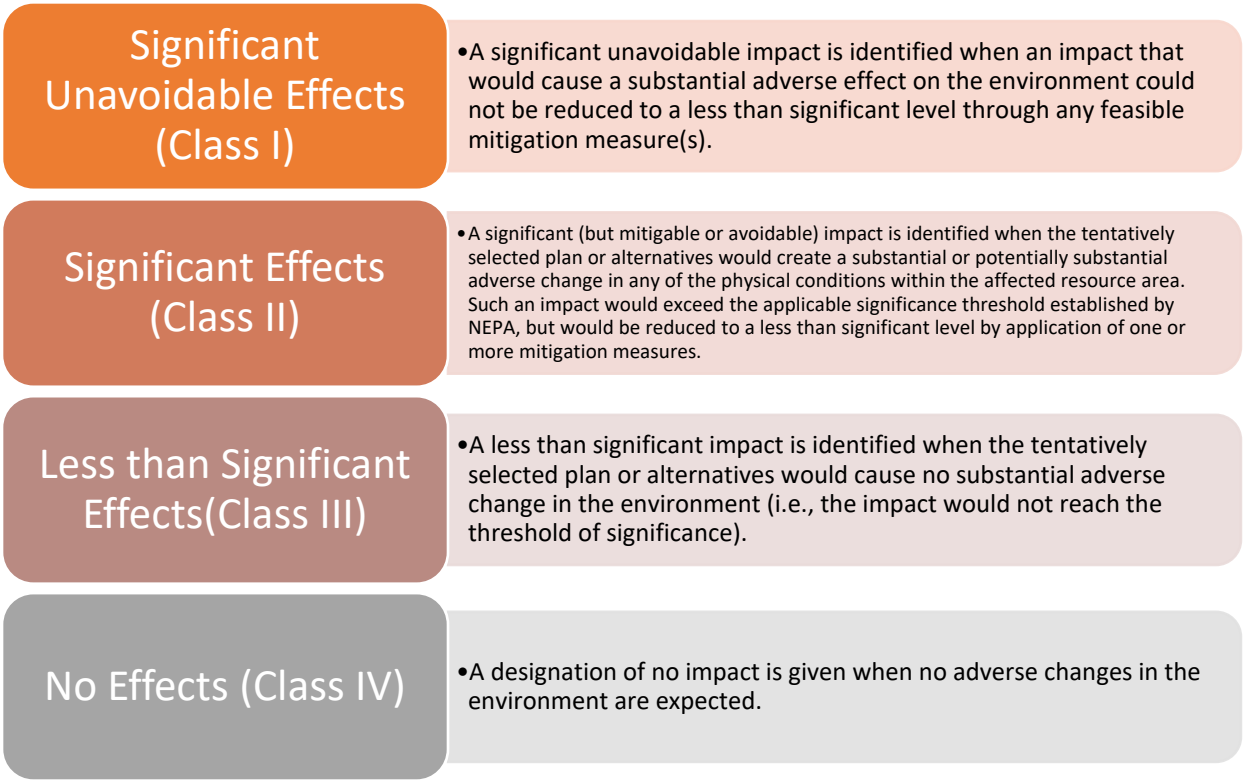


Figure 13: Classification of Effects Thresholds Based on CEQ Guidelines

4.2 – Physical Resources

4.2.1 – Weather, Climate & Climate Change

Existing Condition

The climate of the study area is predominantly continental with some modification by Lake Michigan. The National Oceanic and Atmospheric Administration's (NOAA) Online Weather Data was queried for the Racine, WI area. Daily and monthly normals for temperature, precipitation, and snowfall between 1989 and 2010 were available (NOAA 2021). The mean winter high temperature is 30.0°F while the mean winter low temperature is 16.2°F (January). The mean summer high temperature is 78.4°F while the mean summer low temperature is

64.6°F (July). Annual total precipitation normal for the Racine, WI area is 38.19 inches (Table 13 and Figure 14. In winter, total snowfall is generally heavy with an annual total snowfall normal for the Racine, WI area of 44.1 inches (Table 14 and Figure 15). The majority of snowfall occurs between December and March with total snowfall normals ranging from 5.2 inches (i.e., March) to 13.8 inches (i.e., January) during this timeframe. Climate change modeling using the current high emissions indicates that the climate of Racine, WI in the year 2080 would be similar to that of today's Chester, Pennsylvania. The typical winter in Chester, Pennsylvania is 10.8 °F (6 °C) warmer and 96% wetter than winter in Racine (WICCI 2021).

Table 13: Precipitation and Temperature normals for the Racine, WI area. (NOAA 2021).

Month	Total Precipitation Normal (inches)	Mean Max Temperature Normal (°F)	Mean Min Temperature Normal (°F)	Mean Avg Temperature Normal (°F)
January	1.89	30.0	16.2	23.1
February	1.87	32.4	19.0	25.7
March	2.49	41.1	28.3	34.7
April	3.79	50.8	37.5	44.2
May	4.33	61.1	46.8	54.1
June	4.22	71.9	57.2	64.6
July	3.29	78.4	64.6	71.5
August	3.85	77.4	64.7	71.0
September	3.36	70.5	56.8	63.7
October	3.15	58.7	44.2	51.4
November	2.53	46.0	32.6	39.3
December	2.06	34.4	21.7	28.1
Annual	**38.19**	**54.5**	**40.9**	**47.7**

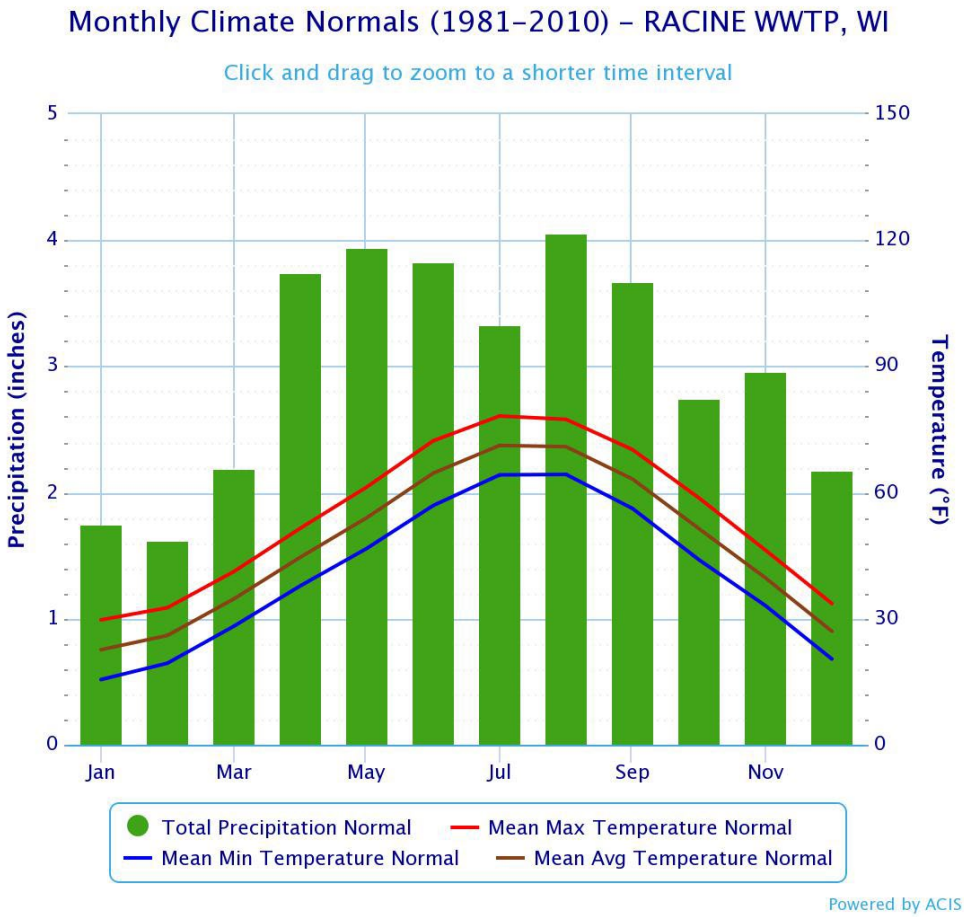


Figure 14: Precipitation and temperature Normals for the Racine, WI area between 1981 and 2010 (NOAA 2021).

Table 14: Snowfall normal for the Milwaukee, WI area between 1989 and 2020 (NOAA 2021).

Month	Total Snowfall Normal (inches)
July	0.0
August	0.0
September	0.0
October	0.1
November	2.0
December	8.2
January	13.8
February	11.1
March	5.2
April	0.9
May	0.1
June	0.0
Annual	**44.1**

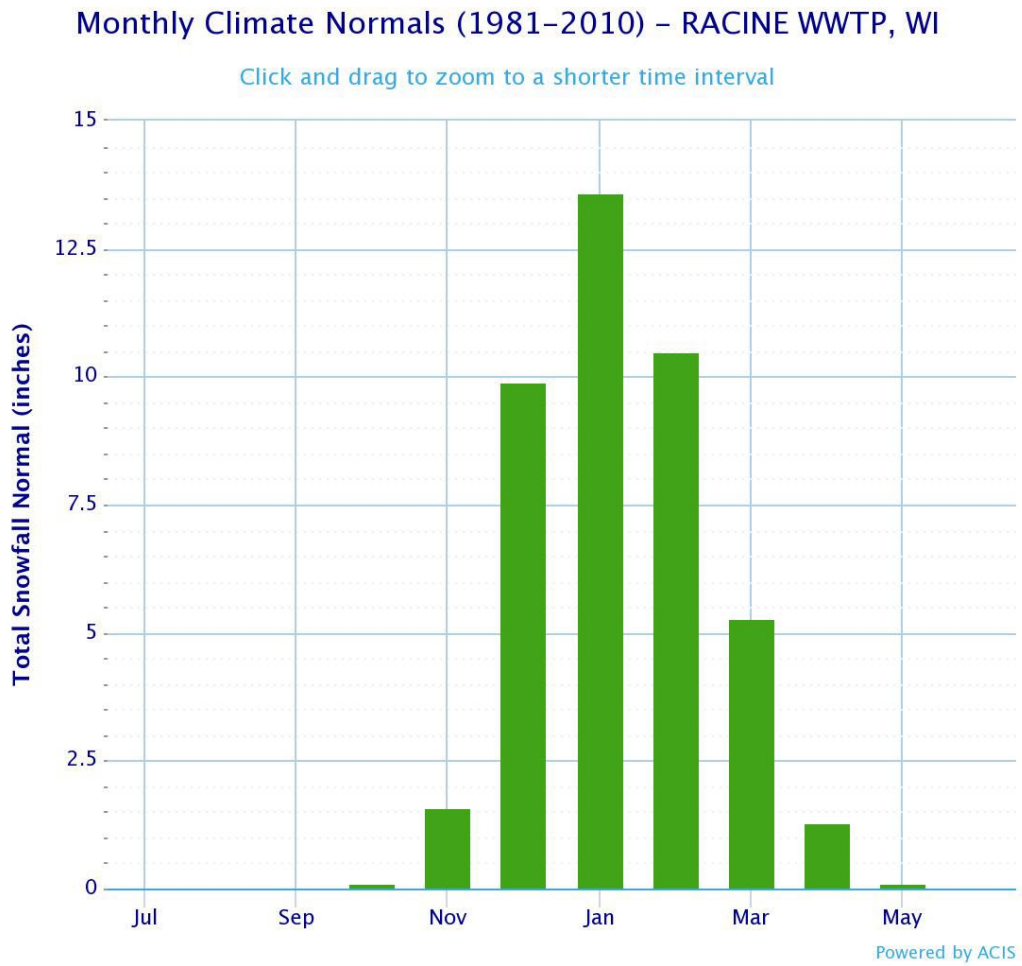


Figure 15: Snowfall normal for the Racine, WI area between 1981 and 2010 (NOAA 2021).

Alternative Impact

Construction of the tentatively selected plan would not have any short-term or long-term impacts to climate. Additional fossil fuels would be needed during the dam dismantling process for the operation of associated construction vehicles. However, there would be no measurable impact on climate, even though there may be localized increases in greenhouse gas emissions during operations. Once dam removal is complete, additional fossil fuels would not be needed for any operations.

4.2.2 – Air Quality

Existing Condition

The Federal Clean Air Act requires the U.S. Environmental Protection Agency (USEPA) to set national ambient air quality standards (NAAQS) for six criteria pollutants (carbon monoxide, lead, nitrogen dioxide, particulate matter, ozone, and sulfur oxides) which are considered harmful to public health and the environment. Areas not meeting the NAAQS for one or more of the criteria pollutants are designated as “nonattainment” areas by the USEPA. For many years, the local air quality in Racine County, Wisconsin was considered “non-attainment” for ozone under the Clean Air Act. This status was typical for the region, due to the large population living between Milwaukee, Wisconsin south through Chicago, Illinois, and into the northern Indiana

industrial belt. Continued progress in controlling air emissions and improving air quality has resulted in the re-designation of Racine County to attainment, as of April 2020[1]. Recent air monitoring data show the Racine area now meets the national standard set to protect public health and the re-designation was published in the federal register on April 17, 2020 but will not be finalized until after a public comment period.

NAAQS	Area Name	Most Recent Year of Nonattainment	Current Status	Classification
1-Hour Ozone (1979) – NAAQS revoked	Milwaukee-Racine, WI	2004	-	Severe-17
8-Hour Ozone (1997) – NAAQS revoked	Milwaukee-Racine, WI	2011	Maintenance (since 2012)	Moderate
PM-2.5 (2006)	Milwaukee, WI	2013	Maintenance (since 2014)	Former Subpart 1
8-Hour Ozone (2015)	Milwaukee, WI	2021	-	Marginal

Alternative Impact

The local air quality in Racine County is considered 'attainment' under the Clean Air Act. The proposed project is within the attainment zone. Due to the small scale and short duration of these projects, the main sources of emissions would be vehicle emissions and dust associated with the construction activities. The project does not include any stationary sources of air emissions, and a General Conformity Analysis was not completed. The temporary mobile source emissions from this project is de minimis in terms of the NAAQs and the State Implementation Plan. The project is not expected to be a significant source of Green House Gas emissions. All construction vehicles will comply with federal vehicle emission standards. USACE and its Contractors comply with all federal vehicle emissions requirements. USACE follows EM 385-1-1 for worker health and safety and requires all construction activities to be completed in compliance with Federal health and safety requirements.

4.2.3 – Geology

Existing Condition

The study area was likely glaciated multiple times during the most recent ice age, which ended around 12,000 years ago. The Wisconsin ice sheet was the last to retreat and is responsible for most of the geologic features in and around the study area today. The retreating ice sheet left glacial features including outwash plains, till plains, and ground moraines (Figure 14) (Fryxell, 1927). This resulted in a rough and heterogeneous landscape in which variable soil series and ecosystem types can be found depending on landscape position. The primary landform in the inland area is level to gently rolling ground moraine, while subdue ridge-and-swale topography, beach and dune complexes and wave-cut clay bluffs exist near Lake Michigan. Land surface elevation ranges from 577 to 978 feet within this southern Lake Michigan coastal ecological landscape (WIDNR 2015)

[1] USEPA News Release, April 20, 2020, Accessed at: https://www.epa.gov/newsreleases/epa-and-wisconsin-announce-kenosha-area-now-meets-federal-air-quality-standard-ozone

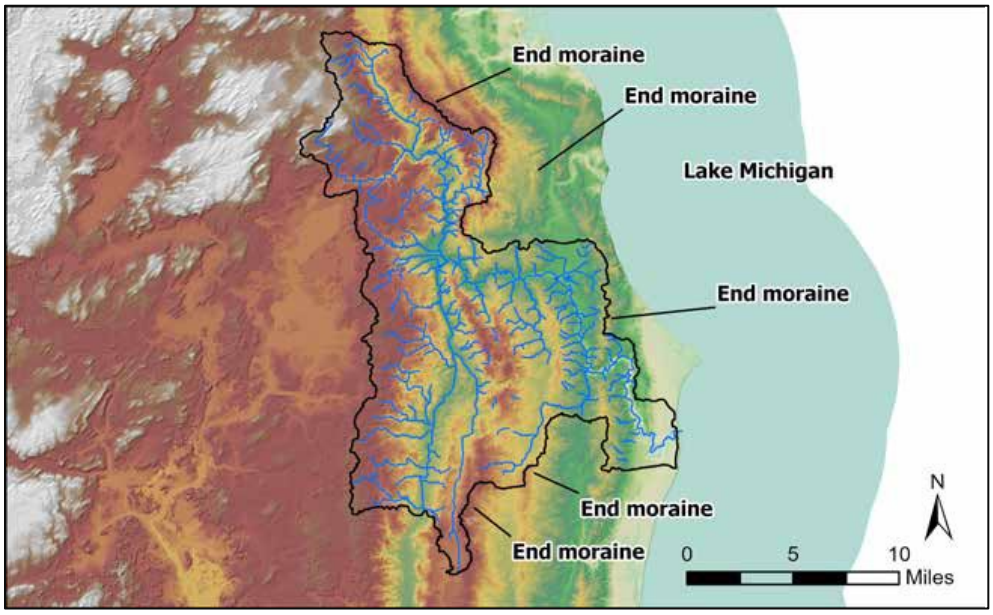
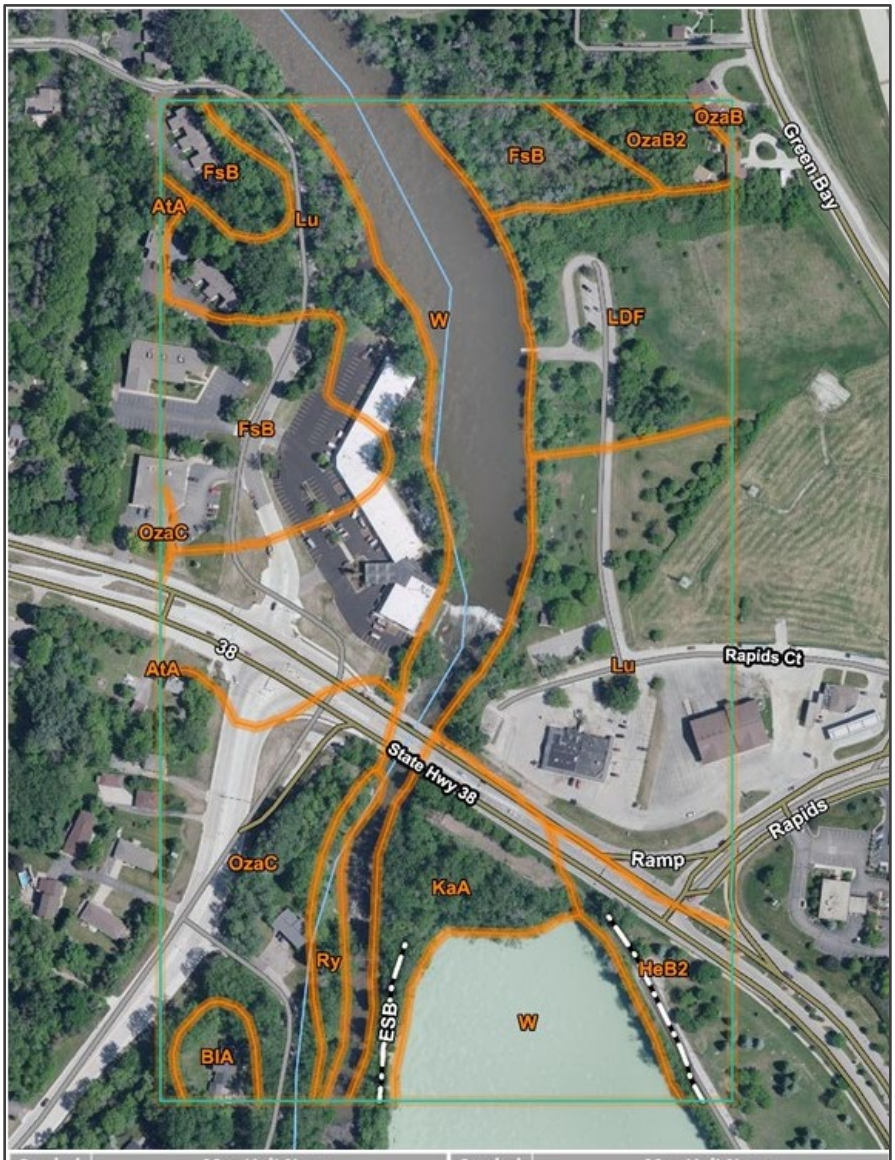


Figure 16: Topography and major glacial features of the Root River watershed (solid black line).

The underlying regional bedrock is dolomite with a light gray color and many fossils and is exposed adjacent to the existing Horlick Dam. This bedrock was formed during the Silurian Period about 419-440 million years ago from the marine deposition from when the Great Lakes region was the floor of a tropical sea. The exposed dolomitic outcropping is included in the Horlickville Bluffs and Quarries, which is of scientific and historic importance in southeastern Wisconsin. This area has exposures of richly fossiliferous Racine Dolomite reef strata producing the largest known diversity of fossil marine organisms from any Silurian reef in the world. The Horlickville Bluffs and Quarries have not been designated as a National Historic Landmark in the History of Science and there is no pending application for designation.
According to WIDNR Well Driller Maps, the generalized soil profile (of a well driller boring taken near the top embankment of the Horlick Dam area) typically consisted of 10 to 15-foot layer of topsoil, followed by native blue clay with sand before it reaches bedrock at about 30 to 35 feet depth. Moisture contents, soil strengths and blow count information were not available from the referenced site.

The USDA Natural Resources Conservation Service Soil Survey database indicates that surficial soils around the Horlick Dam site consist of 2 to 6 percent slopes of Fox silt loam, loamy sand, 1 to 3 percent slopes of Kane loam, 6 to 12 percent slopes of Ozaukee silt loam, some rough broken land, and some varied landfill at the northeast section (Figure 15). Neither of these soils are overly organic (6.0% or less) and potential frost-free period ranges from 124 to 195 days (USDA 2021).

According to readily available Wisconsin Geological and Natural History Survey sources, there are no documented coal, frac sand and iron mining operations in near vicinity to the project site and seismic activity is noted to be very low.



Symbol	Map Unit Name	Symbol	Map Unit Name
AtA	Ashkum silty clay loam, 0 to 2 % slopes	Lu	Loamy land
BlA	Blount silt loam, 1 to 3 % slopes	OzaB	Ozaukee silt loam, 2 to 6 % slopes
FsB	Fox silt loam, 2 to 6 % slopes	OzaB2	Ozaukee silt loam, 2 to 6 % slopes, eroded
HeB2	Hebron loam, 2 to 6 % slopes	OzaC	Ozaukee silt loam, 6 to 12 % slopes
KaA	Kane loam, 1 to 3 % slopes	Ry	Rough broken land
LDF	Landfill	W	Water

Figure 17: Soil Map of focused project area

Alternative Impact

The proposed project would not adversely affect geology or glacial stratigraphy. The removal of the dam could have a beneficial impact on geology as more Silurian dolomitic bedrock could potentially be exposed in the immediate vicinity of the Horlick Dam, upstream of the dam in the newly exposed riparian zone, and in the de-silted river bottom.

4.2.4 – Fluvial Geomorphology

Existing Condition

Natural Processes

The headwaters of the Root River begin near the City of New Berlin, on a glacial ridge. Glaciers shaped the drainage area of the Root River, creating clay bluffs, lake plains, ground moraines and ridge and swales on top of the Niagara Dolomite. The soils are comprised mostly of silt-loams overlying loamy and clay–like tills, which are commonly poorly drained. About 72 percent of the Root River watershed has poorly drained soils with low permeability with moderate to low groundwater recharge potential (SEWRPC, 2014).

Glacial features and bedrock exposures dictate long-term channel evolution and sediment transport processes in the reaches around the Horlick Dam. Upstream from the impoundment, the river is relatively steep as it cross-cuts a glacial end moraine. Coarse materials remaining in the channel from the end moraine (lag material) control bed elevations to create low channel gradient about 5 miles upstream. Downstream from the impoundment, the river is again steep as it drops over bedrock. The longitudinal profile of the Root River from river mile 14 to Lake Michigan shows that the elevation of the Root River ranges from 650 feet to approximately 580 feet at the mouth, with the largest drop in elevation of 12 feet occurring at the Horlick Dam (approximately River Mile 6) (Figure 16). The LiDar data, used to create the profile, indicates that the backwater from the dam impoundment may propagate nearly 4 miles upstream to river mile 10.

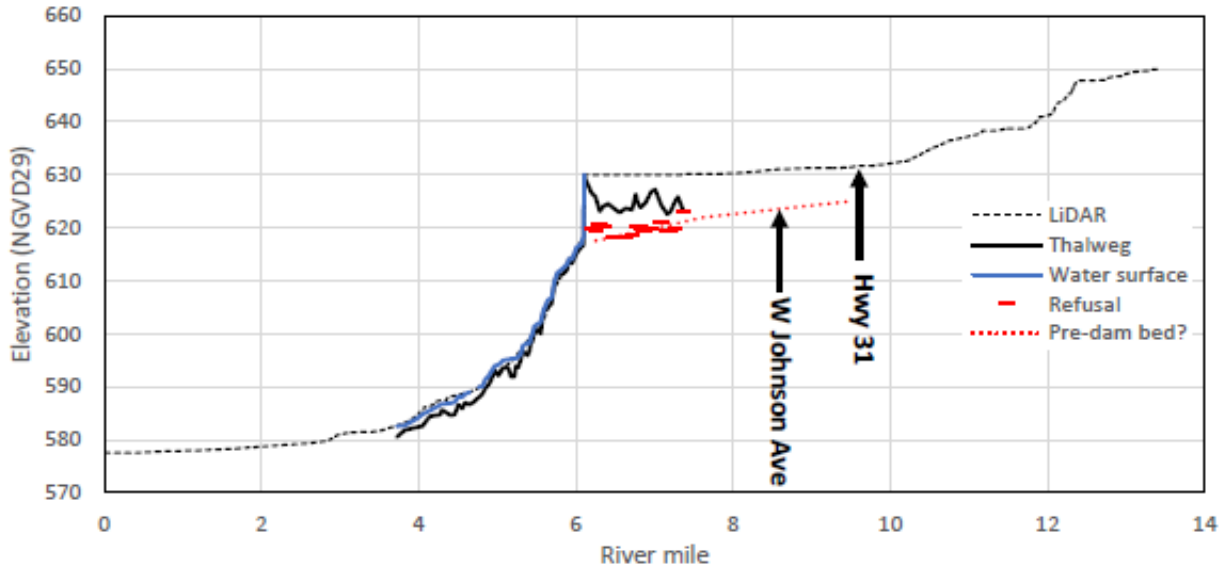


Figure 18: Longitudinal profile of the Root River between Lake Michigan and River Mile 14 (Fish Creek Restoration 2019).

Digital Elevation Models (DEM) are now commonly used to delineate topography in applications using georeferenced data as Geographic Information Systems (GIS) datasets. The DEM displayed in Figure 17 provides elevations in color ramp throughout the Horlick Dam study area. Elevation ranges from 750 feet above sea level in the higher areas to 600 feet in the floodplain at the downstream end of the study area. The primary driver of topographic development throughout the study area has been drainage to Root River.

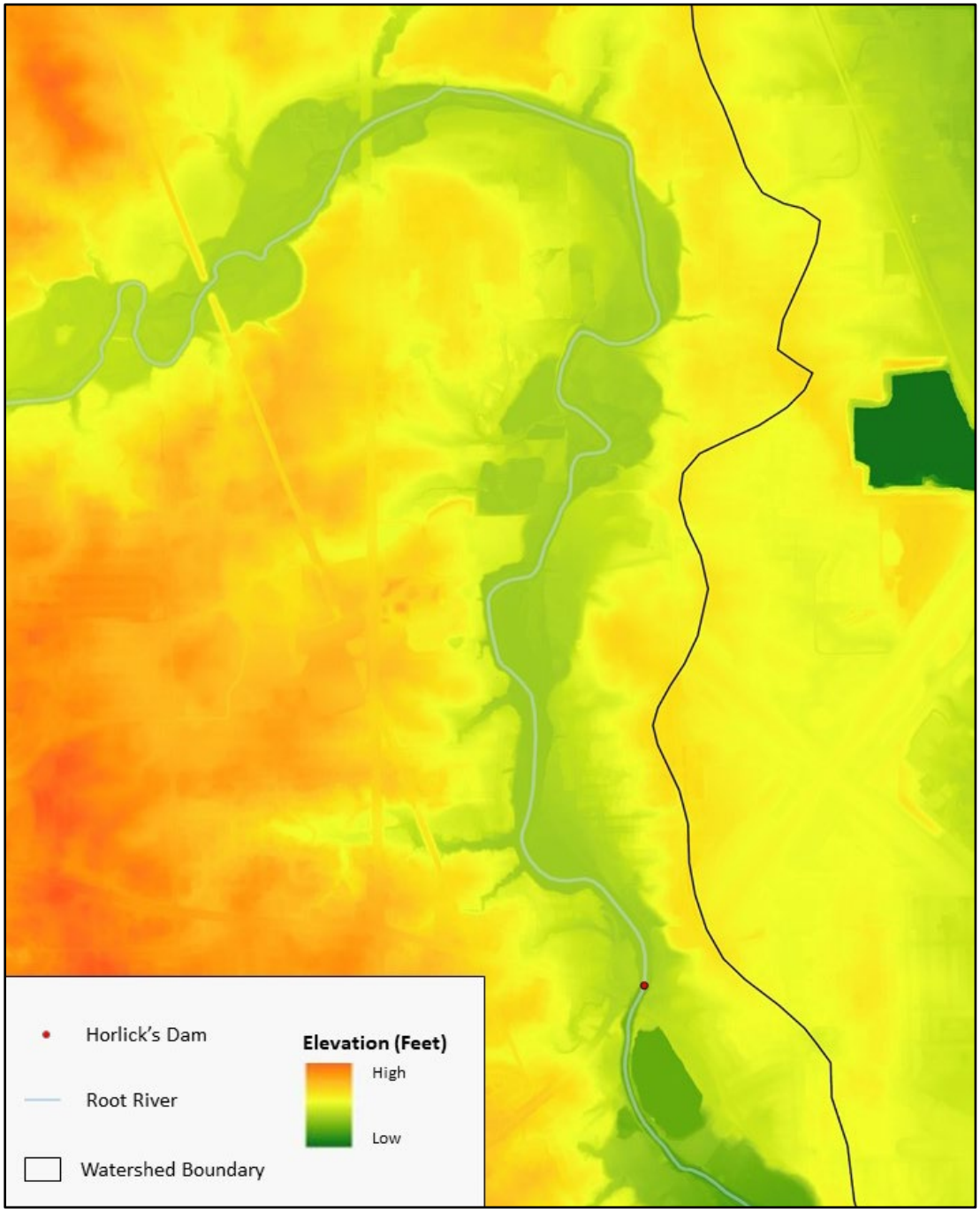


Figure 19: Horlick Dam area Digital Elevation Model

Channel Morphology

The Root River has a mixture of gradients, with low-gradient reaches dominated by pools and glides with sand, silt, organic and glacial till bottom and bank sediments. Other reaches are higher- gradient with pool and riffle sequences with gravel, cobble and bedrock substrates. The banks of the river are mostly earthen, with vegetation providing bank stability, but there are

some areas of erosion and bank failures typical of urbanizing watersheds. The lower reaches of the river in the highly urbanized area of the City of Racine have sheetpile banks.

Immediately upstream of the Horlick Dam, the impoundment area reflects a more lentic system than riverine with low sinuosity and slow water velocity. This upstream reach also lacks riffle/pool complexes that are observed further upstream, outside of the area of impact from the Horlick Dam. The banks are earthen with vegetation upstream of the dam and at the dam there are Silurian dolomite outcroppings.

Substrates & Sediment
The accumulated impoundment sediment thicknesses behind Horlick Dam were measured in a series of cross sections by manual probing. SEWRPC surveyed existing impoundment bed grades and refusal elevations in 2011 and stated that the upstream extent of impoundment sediment was about 7,000 feet upstream of the dam, adjacent to the Riverbend Nature Center (river mile 7.4) (SEWRPC, 2014). In December 2019, on behalf of the WIDNR, consulting firms Fish Creek Restoration LLC (FCR) and Graef surveyed many of the same impoundment cross sections completed by SEWRPC in 2011 as verification of refusal elevations.

The estimated total accumulated fine sediment volume by SEWRPC (2014) was 109,000 cubic yards, and the volume estimated with 2019 data was 142,400 cubic yards. The volume corresponds to material between the dam and the upstream end of the River Bend Nature Center at river mile 7.4. SEWRPC measured additional cross sections upstream of the Nature Center but found that most of the material was coarser sand and gravel. Because the SEWRPC data were not collected with survey equipment capable of measuring elevations, it is difficult to discern in profile if a coarse delta deposit is present (Figure 18). The depth of the deposits is unknown; however, fitting a line between the refusal data and river mile 10.0 suggests that there probably is not more than 3-4 feet of accumulation. These coarse deposits were not accounted for in the estimate of accumulated sediment volume.

Immediately downstream of the Horlick Dam, the substrate and any sediments have been scoured away such that only bedrock remains as instream substrate.

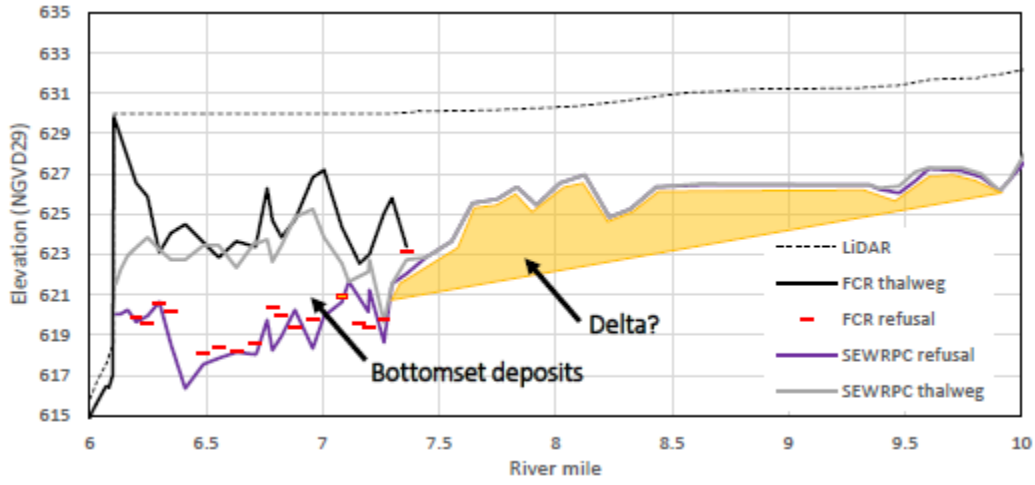


Figure 20: Longitudinal profile of the Root River around Horlick Dam.

Sustainability & Resilience

The existing fluvial geomorphology of the Root River at Horlick Dam would allow for continued sediment to accumulate behind Horlick Dam, further limiting a sustainable and natural sediment transportation downstream.

Alternative Impact

Implementation of the proposed project would result in long-term beneficial effects to fluvial geomorphology within the project area limits. Restoration of the stream channel morphology will aid in the restoration of sediment transport and critical hydraulic parameters. Fluvialgeomorphic processes would be further restored by restoring the upstream impoundment back to a more natural riverine system. No short-term or long-term adverse effects to fluvial geomorphology and topography are expected resulting from implementation of the preferred plan.

4.2.5 – Hydrology & Hydraulics

Existing Condition

Hydrology

The hydrology at Horlick Dam is well documented because there is a U.S. Geological Survey (USGS) river gage (USGS 04087240 Root River at Racine, WI) located approximately 350 feet downstream of the dam near State Trunk Highway 38 (WIS 38), also known as Northwestern Ave. Per the USGS National Water Information System (NWIS) website for the gaging station, the Root River has a tributary area of approximately 190 square miles at the gage with a contributing drainage area of 188.76 square miles. Daily streamflow statistics at this location started in 1963 and peak annual statistics are available for water years 1964 to 2018 (USGS, 2021). A graph of the annual peak streamflow values at the gage from 1864 to 2018 is provided in Figure 14. The 2008 event is the event of record with a computed peak discharge of 8,050 cfs.

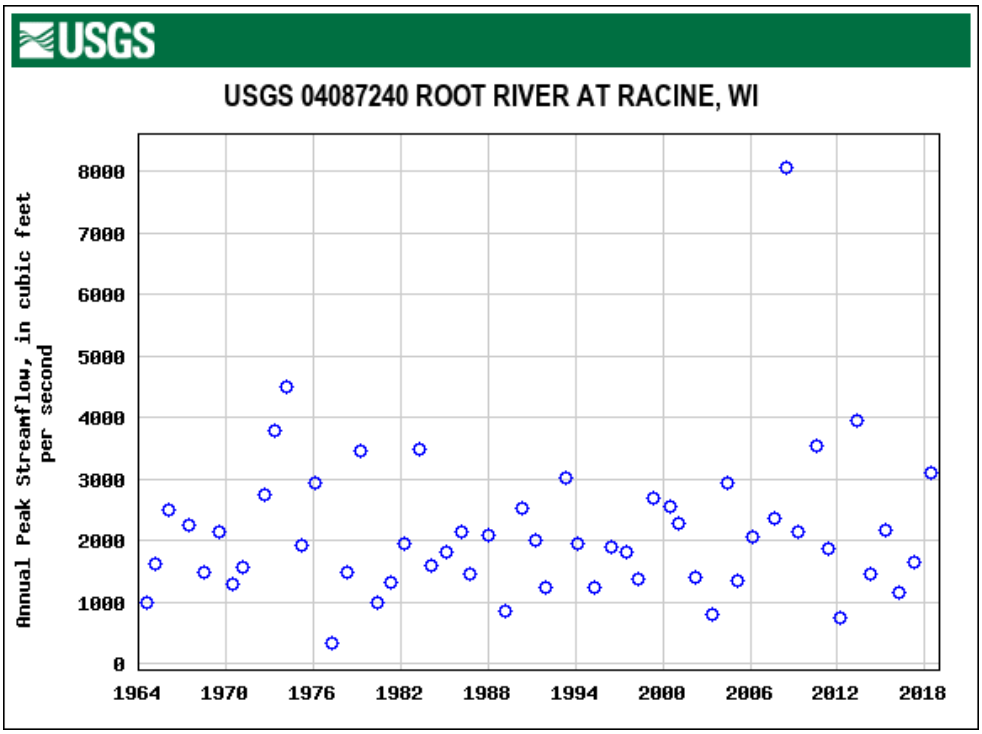


Figure 21. Plot of annual peak discharges at USGS Root River gage at Racine, WI.

GRAEF and Fish Creek Restoration, Ltd., a sub-consultant, are the local sponsor's consultants for this project, who assisted with a sediment management analysis for the Horlick Dam removal project. As a part of their engineering analysis for the sediment management plan, they used average daily flow data from the USGS Root River gage at Racine to create flow duration curves for the Root River. The curves were based on 30 years of data from 1989 through 2019. The flow duration curve represents the chance that a particular flow will be met or exceeded on any given day. The computed flow duration analysis is provided in Table 15.

Table 15. Flow duration analysis results for USGS 04087240 Root River at Racine, WI gage.

Daily Exceedance Probability	Discharge (cfs)
90%	11.6
50%	66.3
10%	451

Data from the Root River gage, along with other gages around the state were used in a 2017 USGS study titled, "Flood-Frequency Characteristics of Wisconsin Streams." The purpose of the study was to develop flood-frequency regression equations for Wisconsin that can be used for, "the design of bridges, culverts, highways, flood-protection structures, and for effective flood-plain management" (Walker, Peppler, Danz, & Hubbard, 2017, p. 1). Annual exceedance probability (AEP) flow frequency estimates using the USGS Bulletin 17B methodology at the Root River gage were completed as a part of this study and are provided in Table 16. The period of record for the USGS gaging station used in the analysis was 46 years from 1964 to 2010. This record was supplemented with research of historical floods, which suggested that the 2008 flood was the flood of record and allowed the record length for the analysis to be extended back to 1843, which adds 121 years to the period of record for the analysis, for a total of 166 years.

Table 16. Annual exceedance probability flows at State Highway 38, just downstream of Horlick Dam, used in the sediment management analysis.

Annual Exceedance Probability	Discharge (cfs)	Source
66.7-percent	1,520	Fish Creek Restoration
50-percent	1,862 (1,907)	Fish Creek Restoration (USGS)
20-percent	2,721	USGS
10-percent	3,282	USGS
4-percent	4,016	USGS
2-percent	4,579	USGS
1-percent	5,155	USGS
0.5-percent	5,748	USGS
0.2-percent	6,563	USGS

Racine's consultants used the flows from Table 16 to inform their sediment management plan. AEP flows that are more frequent than those computed in the USGS were supplemented with an additional AEP analysis completed by Racine's consultants. The selected 66.7 and 50-percent AEP flows were from the Fish Creek Restoration analysis while the 10-percent and less frequent AEP flows were directly from the USGS report.

The City of Racine and Racine County participate in the Federal Emergency Management Agency's (FEMA) National Flood Insurance Program (NFIP). The project reach of the Root River is a zone AE studied floodplain. The effective Flood Insurance Study (FIS) for Racine County, Wisconsin and Incorporated Areas was revised February 1, 2019 with the initial county-wide effective FIS data of May 2, 2012. The effective analysis was completed in a Southeastern Wisconsin Regional Planning Commission (SEWRPC) study that was completed in 1979. The FIS mentions, "the Hydrocomp Simulation Program was used for the Wind Lake Drainage Canal subwatershed and the Root River watershed (including Hoods Creek) under other SEWRPC planning projects" (FEMA, 2019, p. 14), but the exact source of the FIS Summary of Discharges table is unknown. An excerpt of the Summary of Discharges table for the Root River is provided in Table 17.

Table 17. Excerpt of the summary of discharges table for the Root River from the effective FIS for Racine County WI.

Flooding Source and Location	Drainage Area	Peak Discharges (cfs)			
	(sq. miles)	10-Percent Annual Chance	2-Percent Annual Chance	1-Percent Annual Chance	0.2-Percent Annual Chance
ROOT RIVER					
Mouth at Lake Michigan	193.00	3,240	5,410	6,685	10,805
1,000 feet upstream of Luetke Court Bridge	190.00	3,230	5,335	6,510	10,110
State Highway 38	186.00	3,130	5,200	6,380	10,200
Just upstream of confluence with Hoods Creek	165.00	2,900	4,960	6,200	10,200

A comparison of flows from the effective FIS to those computed in the USGS report, "Flood-Frequency Characteristics of Wisconsin Streams," shows that the flows are in the same order of magnitude. The FIS flows are higher for the less frequent storm events, while the USGS flows are slightly higher for the more frequent AEP discharges. The comparison is provided in Table 18.

Table 18. Comparison of AEP discharges at State Highway 38 between the USGS report and the FEMA effective FIS.

Annual Exceedance Probability	Peak Discharge (cfs)	
	USGS Report	FEMA FIS
10-percent	3,282	3,130
2-percent	4,579	5,200
1-percent	5,155	6,380
0.2-percent	6,563	10,200

Ultimately, the flow duration curve and frequent AEP flows are used in the sediment management plan analysis while the FIS flows are used in floodplain determination and mapping applications.

An unrelated project in the vicinity of the Root River will change the base flow conditions in the near future. The City of Waukesha has received conditional approval for a diversion from Lake Michigan to supply drinking water to the municipality. As a condition of this approval, all water diverted from the Lake Michigan watershed must be returned to the Lake Michigan watershed. The selected return method for treated wastewater is the Root River. A return flow discharge site (RFDS) near the intersection of W. Oakwood Rd and S. 60th St in Franklin, WI, approximately 19.5 miles upstream from Horlick Dam has been selected. The supply pipeline is currently under construction with an anticipated completion date in 2023. The proposed diversion is designed for an annual average daily demand of 8.2 million gallons per day (MGD) at final build-out with an anticipated return flow as high as much as 9.3 MGD. This is a flow equivalent to approximately 17.3 cfs, assuming equal flow throughout a 24-hour period.

The additional return flow of up to 17.3 cfs on average will provide an increase to the daily average flows. It represents a 49%, 26%, and 3.8% increase to the 90, 50 and 10-percent average daily flows computed by GRAEF and Fish Creek Restoration and provided in Table 15, respectively. The increase will be visible during normal “sunny day” flows but will have a negligible impact during flood flows as they are significantly larger than the return flow discharge to the Root River.

Hydraulics

A new HEC-RAS (version 5.0.7) hydraulic model of the Root River was created by GRAEF to assess the impacts of the dam removal on the Root River. The model geometry was a combination of several previous models and newly collected survey data. The effective FEMA FIS geometry was used as a base, which stretches from Horlick Dam at river mile 6 upstream to river mile 11.46 near the confluence with Hoods Creek. The approximately 6-mile long reach downstream of the dam, extending to Lake Michigan, was comprised of geometry from a 2014 Horlick Dam failure analysis model that was approved by the WIDNR. This model was then updated with new surveyed in-stream cross-sections that were collected in 2019 and 2020. The overbank areas at the new cross-sections were based on LiDAR data. Updated cross-sections stretched from the existing dam up to approximately river mile 10.15. Bridge data from previous models was retained except the State Highway 31 bridge near river mile 9.6. This bridge opening was surveyed to assess any impacts the dam may have on the bridge structure since it is located within the dam impoundment.

The Root River geometry file was paired with steady-state flows, mentioned in the hydrology section above, to assess the existing conditions of the dam. During the 90-percent chance daily exceedance flow, the influence of the dam ends approximately 3.74 miles upstream to river mile 9.71. The dam has a hydraulic height of 12 feet during the 50-percent chance daily exceedance flow. Velocities downstream of the dam and upstream of WIS 38 range from 0.6 ft/s to 3.3 ft/s during the 50-percent chance daily exceedance flow. The dam has a hydraulic height of 10.8 feet during the 1-percent AEP flow. Velocities downstream of the dam and upstream of WIS 38 range from 6.6 ft/s to 7.9 ft/s during the 1-percent AEP flow.

The existing structure is a run-of-the-river type dam and does not provide any effective storage during flood events.

Alternative Impact

Hydrology

Implementation of the proposed project will have negligible impacts on the flow regime of the Root River because the existing dam is a run-of-the-river type dam and does not provide any flood storage. There will be no noticeable impacts to base flows or flood flows because of the dam removal. The benefits of the project are more focused on riverine habitat restoration, hydrologic connectivity, fish passage, and other water quality improvements within the dam impoundment.

Hydraulics

Implementation of the proposed project will result in changes to the current hydraulics of the river to promote a healthier and more diverse ecosystem. The removal of the dam will resume its natural process of sediment transport ultimately providing diverse substrates and channel morphology.

The most significant hydraulic impacts upstream of the dam will be limited to the impoundment area, which extends approximately 3.74 miles upstream to river mile 9.71. During average flows, the water surface will drop approximately 7 feet at the dam location and 1 foot near highway WIS 31. The 1-percent AEP flood event water surface profile will be impacted, reduced at least 0.1 feet, up to approximately river mile 10.44, which is 4.47 miles upstream of Horlick Dam. Flow velocities will increase in the former impoundment as well as during both normal flows and flood flows.

Significant permanent hydraulic impacts are not anticipated downstream of the dam, however, as with any dam removal, sediment from the impoundment will be transported downstream with coarser sediments depositing closer to the dam and finer sediments potentially flowing to Lake Michigan. The reach immediately downstream of the dam is steep compared to the impoundment and as such it has higher flow velocities so it is unlikely there will be significant sediment deposition in this area. Spring Street is approximately 2.6 miles downstream of Horlick Dam and marks the start of a relatively flat section of the channel. This area is likely to accumulate some sediment from the impoundment, but it is difficult to predict due to the wide range of factors that play into the sediment transport process.

A sediment management plan has been developed to manage and reduce sediment releases downstream. The plan is to utilize existing stoplogs in the dam to perform a staged drawdown of the impoundment prior to dam removal. It allows a new channel to form in the impoundment sediment and for the banks to begin stabilizing with vegetation prior to the dam removal. The intended effect is to reduce and disperse the sediment pulse that would occur if the dam was removed without any management strategy. A monitoring plan is also part of the management strategy. Cross-sections will be taken at approximately half mile intervals downstream of the dam at the beginning of the project, after each 2-foot drop during the drawdown process, and at 6 months and 12 months after the dam removal has been completed. The data will be reviewed to determine the location and depth of sediment accumulation so that corrective action may be taken, if deemed necessary. The sediment management plan is described further in section 5.2.2 and is included as an attachment to Appendix D: Hydrology, Hydraulics, and Climate Change.

4.2.6 - Water Quality

Existing Condition

The Root River is considered to have impaired water as determined by WIDNR. The impairments include chronic aquatic toxicity, low dissolved oxygen (DO), degraded biological community, and acute aquatic toxicity. The pollutants found were total phosphorus, chloride, sediment/total suspended solids (TSS). These pollutants have a mix of point source and non-point source, depending on the river reach. These findings were made in the 2012 303(d) impaired waters list and have continued to show no changes to impairment since then as indicated by the lists from 2014 through 2020. However, the 2020 list indicates that there is a Watershed Plan in place to address these issues.

Alternative Impact

Short term adverse impacts are expected to be short in duration and would be minor since the proposed plan includes a slow draw down and BMPs will be followed. Adverse long-term effects to water quality stemming from construction activities are not anticipated, since erosion controls and BMPs will follow the Wisconsin Water Quality Standards. Turbidity and erosion will be monitored and controlled during construction activities and until the project area is stabilized with new plant growth.

Long-term, the project is expected to have beneficial effects to water quality. Implementation of the project would reduce hundreds of acres of surrounding non-point source erosion, which is expected to cause a decrease in TSS concentrations. The project may also contribute to reduced nutrient loading, since natural ecosystems and wetlands will not be a source of nutrients unlike current agricultural land use. Finally, long term localized increases in DO concentrations are expected from the restored lotic waters, especially those in the newly exposed riffles that reside in the current impoundment area.

The NER plan would have incidental water quality benefits through the removal of the dam, which would improve DO.

As described in Appendix B - 404/401 Evaluation and Coordination, this project would obtain 401 Water Quality certification through authorization under Nationwide Permit 27 *Aquatic Habitat Restoration, Establishment, and Enhancement Activities* The project would be subject to general and specific permit conditions to protect water quality, including minimizing the amount of fill necessary, using non-erodible materials, implementing a restoration plan, and establishing a management and monitoring plan.

4.2.7 – Sediment Quality

Existing Condition

In 2011 the SEWRPC surveyed existing sediment refusal elevations. Graef was hired by Racine County, and partnering with Fish Creek Restoration LLC in 2019 and 2020 surveyed many of the same cross sections as well as continued further upstream for a total of approximately 4 miles upstream of Horlick Dam. From the dam to the River Bend Nature Center, River Mile 7.4 approximately 1.25 miles upstream, the sediment thickness was estimated as averaging about 4 feet. In December 2020 Graef collected sediment samples from four locations on the river for grain size distribution analysis. The cores represented fine sediment to a depth of about 3 feet.

In December 2020 Graef also collected six sediment samples from the river for chemical characteristic testing. Sediment was collected from the surface to refusal. The average thickness of samples ranged from 5.5-6.0 feet closest to the dam to less than 18 inches at the northern end of the sample area. Samples were analyzed for Total Arsenic, Total Barium, Total Cadmium, Total Chromium, Total Lead, Total Mercury, Total Selenium, and Total Silver, Polycyclic aromatic hydrocarbons (PAHs), Polychlorinated biphenyls (PCBs), and Pesticides Method 8081. At the reporting limits the laboratory could achieve, these compounds were not detected in the samples. The compounds are below the thresholds found in the WDNR Consensus-Based Sediment Quality Guidelines. The samples were also analyzed for nutrients which included Ammonia Nitrogen, Total Nitrate Nitrogen, Total Nitrite Nitrogen, Total Nitrogen Kjeldahl (TKN), Total Phosphorus, and Total Organic Carbon. See HTRW Attachment 1 (Appendix H) for a map of sampling locations and table of results.

Alternative Impact

The proposed project would result in no adverse impact to sediment quality within the Root River. The implementation of the proposed project would reduce the lake-like impoundment back to a riverine system, through a slow drawdown with the dam removal. The impounded sediment has no detected levels of compounds listed above, therefore the implementation of the proposed project is not expected to release any of these compounds into the downstream reaches of the Root River.

4.3 – Ecological Resources

4.3.1 - Riverine Habitat

Existing Condition

The riverine habitat upstream of the Horlick Dam is more similar to that of a lentic system than a lotic system. The impoundment surface area is approximately 60 acres and noticeably backs up one mile upstream of the dam, but potentially propagates 4 miles upstream (see discussion in section 4.2.4). Upstream of the dam, the substrate includes extensive silt and muck throughout with a mixture of sand and gravel in the furthest reaches upstream from the dam. Instream cover is sparse with limited overhanging vegetation, logs and woody debris. Further upstream from the dam there are some oxbows and backwaters that can provide some instream cover for fishes. Development is poor with no functional riffles in the impoundment as the area is a large pool with slow water velocity (Figure 22).

Immediately, downstream of the dam, the Root River's habitat changes back to a lotic system. The substrate and sediments have been largely scoured away down to the bedrock, with exposed boulders and slabs which creates some nooks and crevices for potential habitat. There is moderate instream cover with a variety of coverage of boulders, shallows, logs, woody debris, pools and rootmats. functional pools, riffles and runs are observed throughout the downstream reach, providing heterogenous habitats for fishes (Figure 23).

Alternative Impact

Implementation of the proposed project would result in beneficial effects to riverine habitat upstream of the dam. With the removal of the dam, the lake-like impoundment area will return to a flowing lotic system. Over time, the extensive muck, detritus and silts within the impoundment will decrease with the restoration of natural sediment transportation processes, and additional substrates such has boulders and cobble are likely to be made available for habitat use. It is likely that bedrock would be exposed within the vicinity of the existing dam. Additional

discussion on sediment transport can be found in Section 4.2.5 Alternative Impact. The restored stream channel will increase the amount of functional pools, riffles and runs in the reach as well as the potential for oxbows and backwater areas. Overall, riverine habitat heterogeneity will increase and no adverse effects to riverine habitat are expected resulting from implementation of the preferred plan.

Figure 22: Root River impoundment upstream at Horlick Dam

Figure 23: Root River downstream riverine habitat

4.3.2 – Wetland Habitat

Existing Condition

The National Wetlands Inventory (NWI) from the U.S. Fish and Wildlife Service was utilized to review the existing wetlands within the study area. The NWI identified wetlands throughout the study area that are directly adjacent to the Root River (Figure 24). There was only one wetland type identified, freshwater forested/shrub wetland. These wetlands are palustrine forested or shrub-shrub with broad-leaved deciduous vegetation that have a seasonally flooded water regime. Forested/shrub wetlands are often associated with glacial lake basins or river systems and have seasonally high-water tables. In southern Wisconsin, forested/shrub wetlands often occur in the floodplains of rivers and are dominated by hardwood species such as silver maple, green ash, and eastern cottonwood, as well as deciduous shrubs such as dogwoods and willows. Figure 25 shows the existing inundation map for the 10% daily exceedance flows (DEF) with two focused wetland areas around the impoundment area and the River Bend Nature Center. Daily exceedance flow represents the percent of days the flow is at or above 451 cfs for the Root River. Currently, the 10% DEF of the focused area shows that flows only partially inundate the forested/shrub wetlands and not the wetland in its entirety.

The National Wetlands Inventory did not identify any freshwater emergent wetlands such as marshes. However, during site visits in August 2020, several emergent fringe wetland stands were noted sporadically throughout the impoundment area. These vegetation stands were typically arrowhead, sedges, or irises and are considered unsustainable due to their reliance on impoundment water levels to remain inundated.

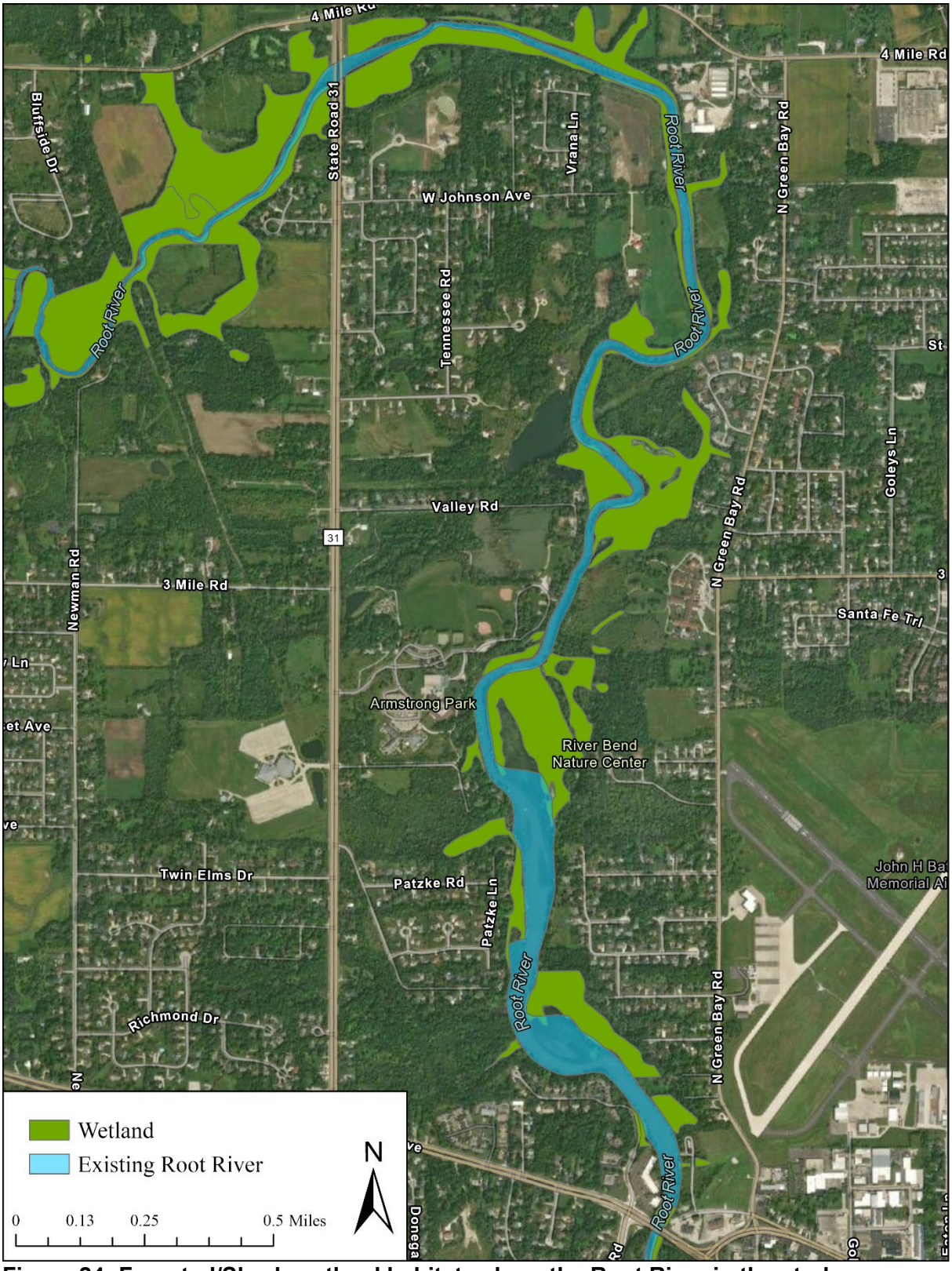


Figure 24: Forested/Shrub wetland habitats along the Root River in the study area.

Alternative Impact

Implementation of the proposed project will have negligible impacts on wetlands adjacent to the Root River as the existing wetlands are forested/shrub wetlands that are seasonally flooded with the current hydrology and will remain seasonally flooded with fewer inundations with the future hydrology at several locations of the study area. Additionally, the proposed project does not include plans to temporarily or permanently fill or place dredged materials in wetlands for construction staging or access to the dam.

The negligible impact to wetlands is considered an indirect impact due to changing the hydrology of the Root River back into a riverine system from a lotic system in the study area. Wetland areas upstream of the River Bend Nature Center are less likely to see changes in inundation frequency due to the smaller influence of the impoundment hydrology. Wetlands near the River Bend Nature Center and the impoundment area that are currently inundated during 10% DEF (flow of 451 cfs) would not be inundated at those flows post dam removal due to the reduction of water levels in the impoundment area. Rather those wetland areas would be inundated during flood flows more consistent with the 50% annual exceedance probability (flow of 1,907 cfs) as seen in Figure 25. The 50% annual exceedance probability represents the chance that the flow of 1,907 cfs will occur in any single year. Therefore, these wetland areas have a 50% chance of being inundated in a single year, which is less frequent than the current hydrology inundates the area. The Hydrology & Hydraulics appendix has additional maps and cross sections detailing the change in hydrology for the two focused wetland areas.

Forested/shrub wetlands do not require full inundation of water throughout the entire growing season for sustaining the woody and/or herbaceous deciduous vegetation. Therefore, even with the drop in inundation frequency, the plant communities are anticipated to remain relatively the same with the current tree canopy. The understory of these wetlands may experience a shift of the water tolerant species to be spatially closer to the water table with more upland species filling in the drier areas.

The unsustainable fringe wetlands of arrowhead, sedge, and iris stands are anticipated to disappear from the impoundment's water edge with the drop in water levels. However, there is the possibility that they will propagate near the new water's edge of the restored river. As these species have been in the area, it is likely that there are seeds currently in the seed bank of the soil that will germinate and grow into sustainable fringe wetlands with the restored hydrology.

There is the possibility of the creation of new wetlands in the newly exposed area after the water draw down. Plans include planting a cover crop in the newly exposed areas as a means of erosion control and bank stabilization before native vegetation grows. These areas will experience seasonal flooding with the restored hydrology, and it is likely that after the cover crop, the next phase of vegetation to grow would be sedges and water tolerant herbaceous species. As the newly exposed areas move toward dynamic equilibrium, the vegetation is anticipated to follow natural plant community succession with herbaceous deciduous species found in shrub wetlands and eventually succeeding to woody deciduous species of the forested wetland.

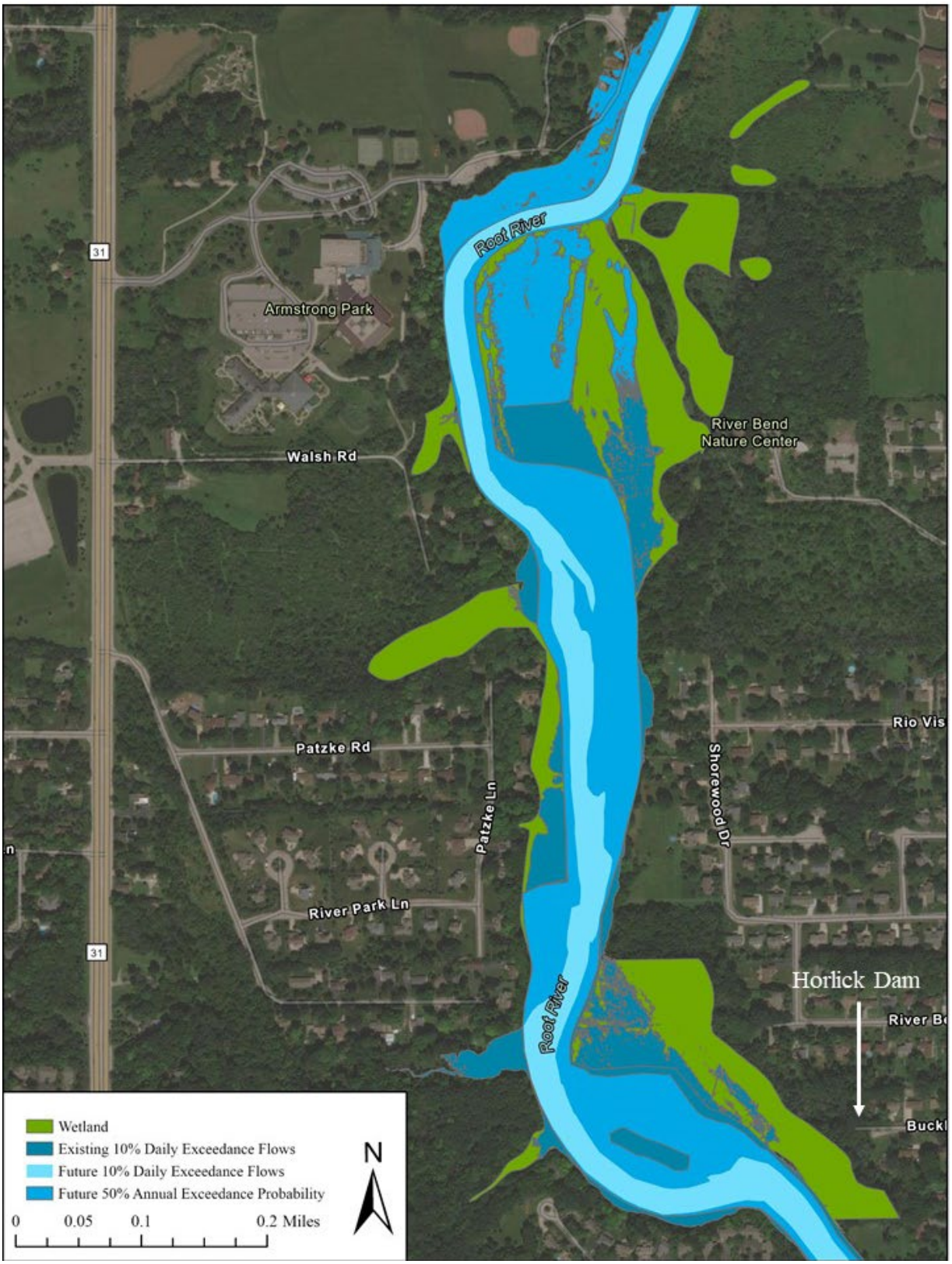


Figure 25: Inundations of wetland areas near impoundment and River Bend Nature Center.

4.3.3 – Native Plants

Existing Condition

The riparian vegetation of the Root River is composed of a variety of woody and herbaceous species. In the agricultural land use portions of the stream, there are often thin strips of non-crop vegetation present. Middle-aged silver maples (*Acer saccharinum*), eastern cottonwood (*Populus deltoides*), and willow trees (*Salix spp.*) are scattered along the river. Both forbs and grasses, including reed-canary grass, are also present, with few shrubs intermixed throughout. There are 11 documented natural community types within the near vicinity of the Root River. The most common of these natural communities is the Southern Mesic Forest and Southern Dry-mesic Forest. There are also 18 known rare plant species (four listed as state endangered, four as state threatened, and 10 as special concern) within the near vicinity of the Root River. Aquatic macrophytes found in the Root River include sago pondweed (*Stuckenia pectinata*), coontail (*Ceratophyllum demersum*), eurasian watermilfoil (*Myriophyllum spicatum*), Elodea (*Elodea canadensis*), curly-leaf pondweed (*Potamogeton crispus*), and bur-reed (*Sparganiumsp*).

In the vicinity of the Horlick Dam, the riparian vegetation includes a variety of tree species: river birch (*Betula nigra*), staghorn sumac (*Rhus typhina*), trembling aspen (*Populus tremuloides*), white mulberry (*Morus alba),* cockspur hawthorn (*Crataegus crus-galli*), as well as cottonwoods (*Populus spp.*), willows (*Salix spp.)*, and maples (*Acer spp.)* (USACE 2020). Herbaceous species include grasses, sedges, irises, and other typical riparian species. Several notable species observed were goldenrod (*Solidago sp.*), cutleaf coneflower (*Rudbeckia laciniata*), spotted Joe-Pye weed (*Eutrochium maculatum)*, and common milkweed (*Asclepias syriaca*).

Alternative Impact

There would be no long-term adverse impacts on native plants with the implementation of the preferred plan, however there could be temporary short-term negligible impacts to native plants within the staging area for the project. Trees and native plants may need to be removed within the staging area for the construction equipment to have access to the river and dam. The preferred plan includes planting a cover crop in the newly exposed riparian area to provide bank stability. In addition to the cover crops, these areas are expected to revegetate dependent upon the vegetation in the immediate area and upon the property owner's landscaping maintenance.

4.3.4 – Macroinvertebrates

Existing Condition

The WIDNR and SEWRPC conducted sampling for macroinvertebrates throughout the Root River Watershed from 1979 and 2011 at various locations. While there are no samples collected at Horlick Dam, there are several sample locations approximately 3 miles upstream and 2 miles downstream. Common taxa at these locations were isopod (*Caecidotea intermedia*), caddiesflies of the genera *Cheumatophysche*, chironomids, worms of the family Tubificidae, and the caddisfly *Hydropsyche bettei*.

Live mussel surveys were conducted in 1977 and in 2012 throughout the Root River watershed. Although no sites were sampled in the immediate vicinity of Horlick Dam, several locations upstream and downstream of the dam were (Table 1). Three species of mussels were collected only below the dam, one species, creeper (*Strophitus undulates*) was collected at other locations upstream of the dam. However, both the fragile papershell (*Leptodea fragilis*) and zebra mussel (*Dreissena polymorpha*) were only collected downstream of the dam out of all of

the sample locations in the Root River watershed (Table 19). The fragile papershell is a sensitive native mussel, while the Zebra mussel is an introduced and invasive species.

Table 19: Live mussels collected in 2012 at sites 2 miles above and below Horlick Dam.

Common Names	Species	Above Dam	Below Dam
White Heelsplitter	*Lasmigona complanate*		X
Creeper	*Strophitus undulatus*	X	X
Giant Floater	*Pyganodon grandis*	X	X
Fat Mucket	*Lampsilis siliquoidea*	X	X
Fragile Papershell	*Leptodea fragilis*		X
Zebra Mussel	*Dreissena polymorpha*		X

Alternative Impact

The project would temporarily disturb benthic communities in the vicinity of the dam since benthic invertebrates that do not move or that exhibit low vagility would be removed or covered during dam removal and the drawdown of sediments. Riverine macroinvertebrates are well adapted to sediment transport and deposition that occurs during and after strong floods. The sediment management plan with the slow drawdown would eliminate or minimize disturbance caused by fine sediment deposition. Effects would be like those imparted during a natural flood event. After the construction period, the natural processes of sediment transport will be restored and recolonization from upstream and downstream macroinvertebrates is expected to occur. The restoration of a natural ecosystem and fluvial processes would be a positive change overall. The newly formed hydraulic zones in the channel and increased riverine habitats are expected to provide diverse habitats for macroinvertebrates. The reestablishment of the river connectivity can foster the upstream movement for the fragile papershell mussel, as this species utilizes host fish during its larval stage, glochidia, for movement. There is little concern for upstream movement of zebra mussels or quagga mussels from Lake Michigan due to their larval stage being restricted to a planktonic form, veliger, that utilizes water currents. Overall, the project would have a beneficial impact on macroinvertebrate populations.

4.3.5 – Fishes

Existing Condition

The Root River is a warm-water habitat that is classified for DNR fish and aquatic life standards and supports a warmwater sport fish community. There are areas of good quality within parts of the Root River watershed, but also areas of impairment due to agricultural and urban impacts. The greater percentage of stream channel miles is moderately to highly disturbed or modified from the natural condition within the Root River watershed, with less than one percent of the stream channel being in conduit and none lined with concrete. Fish IBI ratings range from very poor to fair near river mile 7 and downstream (SEWRPC, 2014).

The Horlick Dam is the most significant fish passage obstruction on the Root River, which has been a barrier to upstream passage for native fish species even before the earliest recorded fish sample taken in 1902. Based on SEWRPC investigations, over the last 100 years there has been a loss of multiple fish species throughout the Root River watershed. This loss of species has been disproportionately greater among reaches that are further away from a connection

with Lake Michigan. Comparison of historical versus current fish species richness within the Root River indicates that historical total native fish species upstream of Horlick Dam was higher compared to the total native species downstream of the dam, whereas presently, downstream of Horlick Dam has a higher number of native fish species compared to upstream.

Fish collections from the Root River watershed were queried from the Fishes of Chicago Region Database (Table 20). Two hundred and forty-eight collections were recorded from 1902 – 2002. Rare occurrences include Pirate Perch (*Aphredoderus sayanus*), Slenderhead Darter (*Percina phoxocephala*) and Northern Hogsucker (*Hypentelium nigricans*). Downstream from the Horlick Dam the river supports a stocked trout and salmon fishery with the aid of the Root River Steelhead Facility.

Lake species (L) were only recorded near the mouth of the Root River in Lake Michigan. There was only one occurrence for Smallmouth Bass (*Micropterus dolomieu*) below the dam within the entire watershed, which should be a common sportfish found in bedrock river reaches. Introduced (I) fisheries species included the European Brown Trout (*Salmo trutta*) and Pacific Rim Salmonids – Rainbow Trout/Steelhead (*Oncorhynchus mykiss*), Chinook Salmon (*Oncorhynchus tshawtscha*), and Coho Salmon (*Oncorhynchus kisutch*), which are stocked in the Root River downstream of Horlick Dam. In 2013, Longnose sucker (*Catostomus catostomus*) were photo documented in the Root River Steelhead Facility's weir and were likely migrating upstream for spawning. While the Longnose sucker (*Catostomus catostomus*) is not state threatened in Wisconsin, it is state threatened just over the border in Illinois.

Upstream from the dam, the river supports a poor-quality fishery with relatively few species. This section of the stream is dominated by species tolerant of poor water quality, with few top predators (SEWRPC, 2014). Additional sampling upstream of the Horlick Dam was conducted in August 2020 in which the following species were caught: Common Carp (*Cyprinus carpio*), Golden Shiner (*Notemigonus crysoleucas*), Largemouth Bass (*Micropterus salmoides*), Black Crappie (*Pomoxis nigromaculatus*), Bluntnose Minnow (*Pimephales promelas*), White Sucker (*Catostomus commersonii*), Northern Pike (*Essox lucius*) and several sunfish species (Bluegill [*Lepomis macrochirus*], Green Sunfish [*Lepomis cyanellus*], Pumpkinseed [*Lepomis gibbosus*], and Warmouth [*Lepomis gulosus*]). Fish species collected downstream of Horlick Dam included the following: Stonecat (*Noturus flavus*), Rainbow Trout, White Sucker, Creek Chub (*Semotilus atromaculatus*), Channel Catfish (*Ictalurus punctatus*), Golden Shiner, and Bluegill.

There are no records indicating Sea Lamprey (*Petromyzon marinus*) are in the Root River below Horlick Dam. There was potentially one Sea Lamprey found attached to a salmonid in the Root River Steelhead Facility's raceway pre-2010. After discovery, it was subsequently removed and killed; there was no specimen or photo for confirmation of species. The USFWS conducted a Sea Lamprey production potential survey in 2021 and identified no larval lamprey above the Horlick Dam, stating that the risk of sea lamprey infestation above Horlick Dam is low (USFWS 2021).

Sea Lamprey is part of a group of species that have specific requisites for spawning and reproduction. Requisites include but are not limited to good water quality, riffle dynamics with gravel and sand, sediment bar formation, and a high-quality source of plankton and nekton for ammocoete filter feeding (Applegate 1950, Marion & 1980). Typically, southern Lake Michigan streams are for the most part not suitable for the Sea Lamprey to reproduce and recruit due to low gradient and lack of required spawning substrates; however, the reach between the Horlick Dam and the WIDNR dam does provide required spawning

conditions for this species. Control measures have been successfully conducted in the Great Lakes basin since the mid–1960s and have reduced Sea Lamprey populations by 90% in most areas.

Table 20: Fishes collected 1902 – 2002 in the Root River Watershed & Lake Michigan

Species	Common Name		Species	Common Name
Acipenser fulvescens	Lake Sturgeon (L)		*Luxilus cornutus*	Common Shiner
Alosa pseudoharengus	Alewife (I)		*Lythrurus umbratilis*	Redfin Shiner (ST)
Ambloplites rupestris	Rockbass		*Micropterus dolomieu*	Smallmouth Bass
Ameiurus melas	Black Bullhead		*Micropterus salmoides*	Largemouth Bass
Ameiurus natalis	Yellow Bullhead		*Morone chrysops*	White Bass
Ameiurus nebulosus	Brown Bullhead		*Moxostoma erythrurum*	Golden Redhorse
Aphredoderus sayanus	Pirate Perch		*Myoxocephalus thompsonii*	Deepwater Sculpin (L)
Campostoma anomalum	Central Stoneroller		*Nocomis biguttatus*	Hornyhead Chub
Campostoma oligolepis	Largescale Stoneroller		*Notemigonus crysoleucas*	Golden Shiner
Carassius auratus	Goldfish (I)		*Notropis atherinoides*	Emerald Shiner
Catostomus commersonii	White Sucker		*Notropis dorsalis*	Bigmouth Shiner
Coregonus hoyi	Bloater Chub (L)		*Notropis heterodon*	Blackchin Shiner
Coregonus johannae	Deepwater Cisco (L)		*Notropis heterolepis*	Blacknose Shiner
Coregonus nigripinnis	Blackfin Cisco (L/Ex)		*Notropis stramineus*	Sand Shiner
Coregonus reighardi	Shortnose Cisco (L)		*Notropis volucellus*	Mimic Shiner
Cottus ricei	Spoonhead Sculpin (L)		*Noturus flavus*	Stonecat
Culaea inconstans	Brook Stickleback		*Noturus gyrinus*	Tadpole Madtom
Cyprinella spiloptera	Spotfin Shiner		*Oncorhynchus mykiss*	Rainbow Trout (I)
Cyprinus carpio	Common Carp (I)		*Oncorhynchus tshawytscha*	Chinook Salmon (I)
Dorosoma cepedianum	Gizzard Shad		*Osmerus mordax*	Rainbow Smelt (I)
Erimyzon sucetta	Lake Chubsucker		*Perca flavescens*	Yellow Perch
Esox americanus	Grass Pickerel		*Percina maculata*	Blackside Darter
Esox lucius	Northern Pike		*Percina phoxocephala*	Slenderhead Darter
Etheostoma exile	Iowa Darter		*Phoxinus erythrogaster*	Southern Redbelly Dace
Etheostoma microperca	Least Darter		*Pimephales notatus*	Bluntnose Minnow
Etheostoma nigrum	Johnny Darter		*Pimephales promelas*	Fathead Minnow
Fundulus notatus	Blackstripe Topminnow		*Pomoxis annularis*	White Crappie
Hybognathus hankinsoni	Brassy Minnow		*Pomoxis nigromaculatus*	Black Crappie
Hypentelium nigricans	Northern Hogsucker		*Rhinichthys cataractae*	Longnose Dace
Ictalurus punctatus	Channel Catfish		*Rhinichthys obtusus*	Blacknose Dace
Lepomis cyanellus	Green Sunfish		*Salmo trutta*	European Brown Trout (I)
Lepomis gibbosus	Pumpkinseed		*Salvelinus fontinalis*	Brook Char
Lepomis gulosus	Warmouth		*Semotilus atromaculatus*	Creek Chub
Lepomis humilis	Orangespot Sunfish		*Umbra limi*	Central Mudminnow

Alternative Impact

Overall, the proposed plan would not have any adverse effects to the study area's fish population but would instead increase species richness and abundance through improved riverine hydraulics by removing the most significant fish passage obstruction on the Root River.

Lake Michigan fishes would be reconnected to the upstream Root River watershed, once again allowing natural upstream passage which has not occurred in over 100 years. Fish eggs and larvae of the several tolerant species occupying the stream may be disturbed or smothered by the proposed in-stream activity if construction activities occur during reproductive or rearing seasons; however, these are insignificant and negligible based on the existing poor quality of the stream versus the restoration that would result from the project.

4.3.6 – Resident & Migratory Birds

Existing Condition

The western shoreline of Lake Michigan is recognized as "one of the most important flyways for migrant songbirds in the United States by many ornithologists and birdwatchers worldwide" (Shilling and Williamson) and is considered globally significant. U.S. Fish and Wildlife Service's (USFWS) IPaC program listed 17 potential migratory birds that could be found at the project location (Appendix A). Over 202 species of resident and migratory bird species have been recorded within a one-mile radius of the Horlick Dam removal study area (Appendix A). Of the 17 IPaC listed potential migratory birds at the project location, 12 species have been observed in the area, several notable species include bald eagle (*Haliaeetus leucocephalus*), American bittern (*Botaurus lentiginosus*) and lesser yellowlegs (*Tringa flavipes*). Additionally, active barn swallow (*Hirundo* rustica) nests were observed on the underside of the Rt. 38 bridge, downstream of the Horlick Dam during an August 2020 site visit.

Alternative Impact

The proposed plan would not have any adverse effects to resident and migratory birds and has the potential to provide beneficial impacts with the newly exposed riparian habitat. There is the possibly of temporary construction noise that could deter species from using the area for foraging and resting. However, this impact would be short-term in duration, only lasting as long as construction is occurring. Additionally, there could be a temporary increase in birds during the water draw down with the potential for temporary invertebrate prey increase in newly exposed areas. The restoration of the stream channel morphology will aid in the development of heterogenous riparian habitat. This increase in habitat can provide stopover areas for migratory birds and diverse year-round habitat for resident bird species.

4.3.7 – Mammals

Existing Condition

The Root River watershed includes mammals such as: muskrat (*Ondatra zibethicus*), white-tailed deer (*Odocoileus virginianus*), gray squirrel (*Sciurus carolinensis*), eastern cottontail (Sylvilagus floridanus), Virginia Opossum (*Didelphis virginiana*), shrews (*Blarina spp.*), eastern mole (*Scalopus aquaticus*), bats, eastern chipmunk (*Tamias striatus*), American beaver (*Castor canadensis*), voles (*Microtus spp.*), mice (*Peromyscus spp.*), coyote (*Canis latrans*), red fox (*Vulpes vulpes*), gray fox (*Urocyon cinereoargenteus*), raccoon (*Procyon lotor*), weasels (*Mustela spp.*), river otter (*Lontra canadensis*), and striped skunk (*Mephitis mephitis*). There are no known endangered, threatened, or special concern mammals within the near vicinity of the project area. However, the USFWS IPaC site noted the potential presence of northern long-eared bat. Refer to Section 4.3.7 for a discussion on the potential presence of this species in the project area.

Alternative Impact

The proposed plan would not have any adverse effects to mammals within the study area. Rather, the proposed plan would increase species richness and abundance through improved habitat and hydrology. The return of the upstream impoundment area to a more riverine system

would improve riparian habitat for mammals. There is the possibly of temporary construction noise that could deter species from using the area for foraging and as a movement corridor. However, this impact would be short-term in duration, only lasting as long as construction is occurring.

4.3.8 – Threatened & Endangered Species

Existing Condition

A query of the USFWS IPaC (Project Code: (2023-0084008) identified several threatened or endangered species that may be present at the site. These species include: federally endangered northern long-eared bat (*Myotis septentrionalis*), federally proposed endangered tricolored bat (*Perimyotis subflavus*), federally threatened red knot (*Calidris canutus rufa*), federally endangered rusty patched bumble bee (*Bombus affinus*) and federally candidate monarch butterfly (*Danaus plexippus)*. The wooden riparian area may provide opportunities for summer roosting of the northern long-eared bat, however a query of the Wisconsin Natural Heritage Inventory Data revealed that there are no records of this species in Racine County. Additionally, the project site does not overlap with the rusty patched bumble bee (*Bombus affinis*) Primary Dispersal Zone.

Alternative Impact

The project area lacks suitable habitat for the red knot, monarch butterfly, and is in the low potential dispersal zone for the rusty patched bumble bee. Therefore, the Corps has determined the implantation of the proposed action would have 'no effect' on these species.

Species Name	Federal Status	Habitat	Potential to Occur
Northern long-eared bat (*Myotis septentrionalis*)	Endangered	Hibernates in caves and mines – swarming in surrounding wooded areas in autumn. Roosts and forages in upland forests and woods during the summer.	**Not expected to occur**; No known hibernacula. Wooded riparian areas may provide opportunities for summer roosting, but no records of species in the county (WI DNR 2023)
Tricolored Bat (*Perimyotis subflavus*)	Proposed Endangered	Hibernates in caves and mines – swarming in surrounding wooded areas in autumn. Roosts and forages in upland forests and woods during the summer.	**Not expected to occur**; No known hibernacula. Wooded riparian areas may provide opportunities for summer roosting, but no records of species in the county (WI DNR 2023)
Red knot (*Calidris canutus rufa*)	Threatened	Sandy beaches, saltmarshes lagoons, mudflats, mangrove swamps, and shorelines of large lakes.	**Not expected to occur**; lack of suitable habitat.
Rusty patched bumble bee (*Bombus affinus)*	Endangered	Natural and semi-natural upland grassland, shrubland, woodlands and forests	**Not expected to occur**; project area outside of high potential dispersal zone.

Species Name	Federal Status	Habitat	Potential to Occur
Monarch butterfly (*Danaus plexippus)*	Candidate	Prefer grassland ecosystems with native milkweed and nectar plants.	**Not expected to occur**; lack of suitable habitat.

For the northern long-eared bat and the tricolored bat there are no known hibernacula within the vicinity of the project area and the species is not expected to be in the area during hibernation. These bat species could potentially be in the vicinity of the project area during the summer as there is potential habitat in the project area; however, there are no records of the northern long-eared bat or the tricolored bat within the county. In addition, the recommended alternative does not include any tree removal.

Therefore, the Corps determined the recommended alternative would have 'no effect' on the northern long-eared bat and tricolored bat. If scope of work changes and impacts to trees located near the project site would occur, the following items would be complied with to minimize any potential impacts to northern long-eared bat roosting habitat:

- No cutting of any trees suitable for bat roosting (i.e., greater than 5 inches diameter at breast height (DBH), living or dead, with loose hanging bark, or with cracks, crevices, or cavities) from April 1 through September 30.
- Plant five trees, at least 2 inches DBH for each tree which is removed that is ten inches or greater DBH.

Coordination with the USFWS and the Wisconsin Department of Natural Resources (WIDNR) was commenced on October 30, 2020 with a project scoping letter. The project area was entered into the USFWS IPaC system on May 19, 2023. The resulting IPaC Official Species List is included in Appendix A. Coordination with the USFWS is ongoing and the U.S. Army Corps anticipates a concurrence with the 'no effect' determination.

4.4 – Cultural Resources

4.4.1 – Social Properties

Existing Condition

The Horlick Dam study area lies completely within Racine County, WI, and has upstream reaches of the Root River in the Village of Caledonia, Horlick Dam reach in Village of Mt. Pleasant, and downstream reaches in the City of Racine, WI. The U.S. Census Bureau's American Fact Finder and Quick Facts (U.S. Census Bureau 2021) for the Village of Caledonia, Village of Mt. Pleasant, City of Racine, Racine County, and Wisconsin were reviewed for socioeconomic information presented in Table 21.

Table 21: U.S. Census Bureau Data for Caledonia, Mt. Pleasant, Racine, Racine County and Wisconsin

Category	Caledonia	Mt. Pleasant	Racine	Racine Co.	WI
Population					
Population estimates, July 1, 2019, (V2019)	27,082	25,277	76,760	196,311	5,822,434
Persons under 5 years	6.4%	5.2%	6.8%	6.0%	5.7%
Persons under 18 years	20.2%	21.1%	27.3%	22.9%	21.8%
Race					
White	83.8%	90.7%	65.1%	83.3%	87.0%
Black or African American	7.2%	4.7%	23.1%	12.0%	6.7%
American Indian and Alaska Native	0.3%	1.7%	0.4%	0.7%	1.2%
Asian	3.4%	1.5%	0.9%	1.3%	3.0%
Native Hawaiian and Other Pacific Islander	0.1%	0.0%	0.00%	0.10%	0.10%
Two or More Races	2.7%	1.0%	5.2%	2.6%	2.0%
Hispanic or Latino	9.4%	8.9%	22.4%	13.6%	7.1%
Education					
High School Graduate or Higher	94.1%	93.6%	84.4%	90.5%	92.2%
Bachelor's degree or higher	32.5%	30.8%	16.6%	25.2%	30.1%
Income & Poverty					
Median Household Income	$69,485	$80,659	$44,056	$61,336	$61,747
Persons in Poverty	7.3%	6.0%	21.0%	12.4%	10.4%

Alternative Impact

The Preferred Plan/NER plan will not have any adverse effects on the area's social properties. Surrounding properties will see the conversion of the upstream impoundment to a riverine system and an increase in riparian habitats. This would create a more aesthetically pleasing environment for users of these areas.

Short-term, negligible/minor impacts during construction would include increased traffic congestion due to construction vehicles and construction personnel. Transportation impacts would be localized to the area in the immediate vicinity of Horlick Dam and would be intermittent. Employment could increase slightly during construction, and the region's labor force should be sufficient to provide the necessary workers. No long-term beneficial or adverse impacts to employment due to implementation of the proposed project are anticipated. Ambient noise levels within the project area would be increased due to construction activities and increased truck traffic. Noise attenuates fairly rapidly, and construction activities would be restricted to between 7:00 a.m. and 3:30 p.m. The nearest residence to the construction activity is 600 feet away, at which point the noise is expected to attenuate to ambient levels. Any aesthetic impacts would be negligible and temporary, lasting only the duration of construction. An overall beneficial impact to aesthetics is anticipated with the removal of the dam. Finally, the proposed project would have no significant adverse effect on human health or welfare, municipal or private water supplies, or aesthetic values.

4.4.2 – Archaeological & Historical Properties

Existing Condition

The USACE has coordinated its review of cultural resources impacts under Section 106 of the National Historic Preservation Act (NHPA). The Area of Potential Effect (APE) for the undertaking encompasses the project area, including staging and access routes, and totals approximately 227 acres. The USACE believes that the APE is sufficient to identify and consider potential effects of the proposed project.

An archival review was completed for the project APE on the Wisconsin Historic Preservation Database (WHPD) and the National Register of Historic Places (NRHP). There are no previously known archaeological sites or historic properties located within the project APE. The current dam was constructed in 1975 to replace the deteriorating Horlick Dam. The original dam was constructed in 1834 and operated as a sawmill until 1870. The dam was rebuilt in 1873 and in 1885 with a fish-way and was operated as a grist mill until 1940. After 1940, the dam was used to maintain the upstream impoundment for recreational purposes. The current Horlick Dam was rebuilt in 1975, downstream of the former structure and no longer retains the historic integrity of the original dam and does not meet the age or significance threshold to be considered eligible for the NRHP.

Due to archival research and riverine disturbance in the project footprint, the Corps has determined that there would be no historic properties affected by the proposed undertaking. A finding of No Historic Properties Affected was submitted to the Wisconsin State Historic Preservation Office (SHPO) on November 15, 2021. The SHPO responded with a request for more information on November 30, 2021. This requested information was provided on November 30, 2021. As the SHPO did not respond to the Corps' finding within 30 days, agreement with the finding of No Historic Properties Affected is assumed per 36 CFR 800.3 (c)(4).

Alternative Impact

The proposed project would have no effect on historic properties, as there are no known historic properties in the area of potential effects.

In the event that previously unidentified cultural remains are discovered during the project, the Chicago District archaeologist will be notified immediately, and work will cease to allow for consultations with the Wisconsin State Historic Preservation Office and Tribes to take place.

4.4.3 – Land Use History

Existing Condition

Prior to European settlement the study area was an oak forest, and oak savanna matrix interspersed with prairies, wet prairies and marshes in the low-lying areas and along the Root River floodplain (WIDNR 2015). The first European settlers came to what is now Racine County in 1834. They quickly began to harvest timber and converted the land to primarily agricultural use. Much of the study area would have been too wet to farm, so drainage ditches were dug and drain tiles were installed to lower the water table and make the land dry enough for agriculture. Today the study area is a mix of row crop agriculture, residential, wetland/woodland, and recreational along the Root River floodplain (Figure 26).

Alternative Impact

The proposed project would result in beneficial effects to land use within the watershed with the conversion of unnatural lentic waterbody to riparian habitats. The implementation of the proposed project would reduce the lake-like impoundment back to a riverine system, increasing the riparian zone. This would include increases in wetland and woodland habitats along the Root River. The current land use can be seen in Figure 26, with some portions that are designated as waterbody (light blue) being expected to convert to natural areas (light green). Significant adverse effects as a result of implementing the proposed project are not expected to occur.

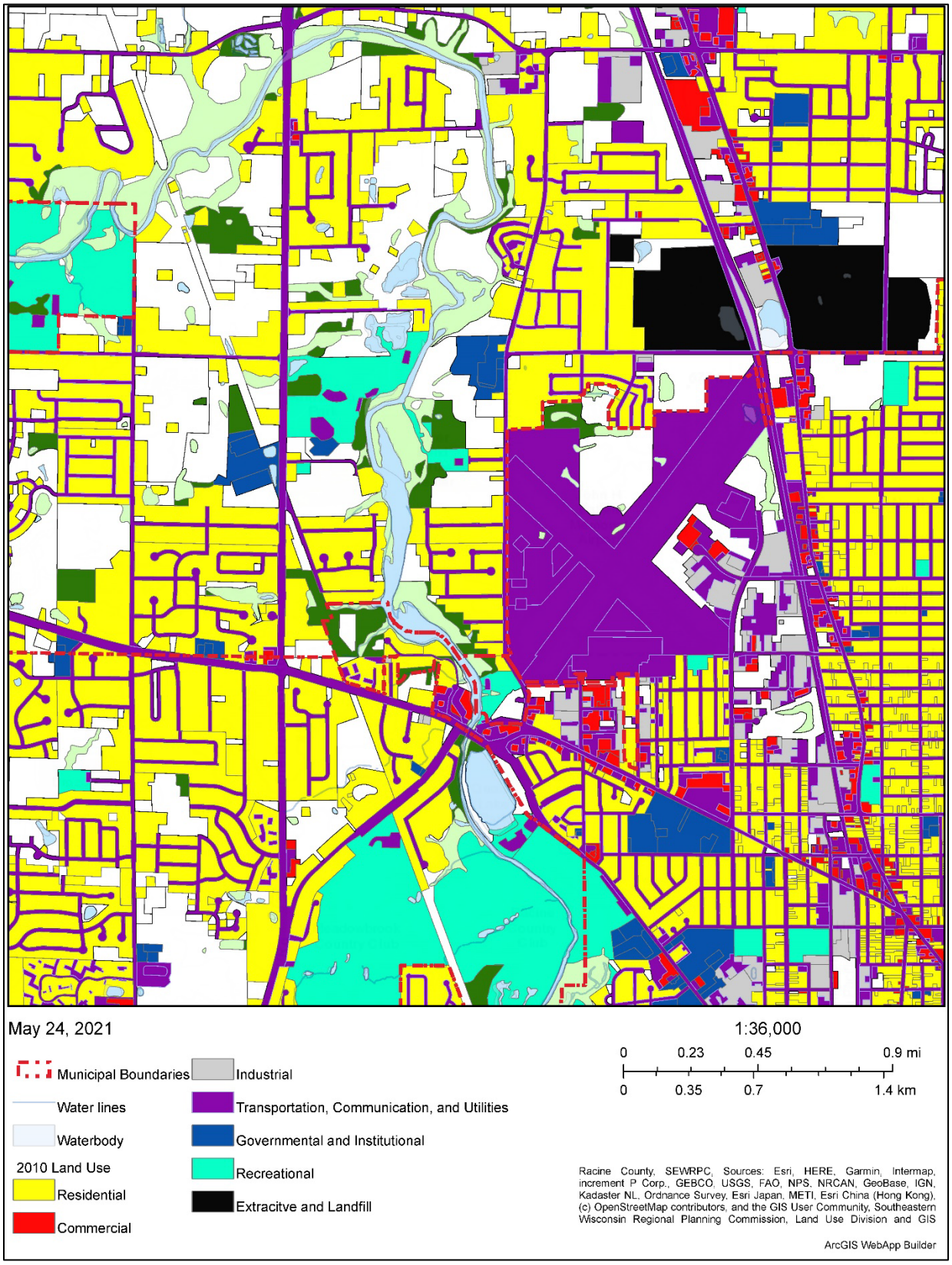


Figure 26: Land Use in Horlick Dam study area

4.4.4 – Recreation

Existing Condition

There are several existing recreation facilities in the vicinity of the Horlick Dam study area. The Racine County Parks Department owns and maintains 694 acres across the City of Racine, Village of Caledonia, and Town of Raymond, with several parks and facilities on or near the Root River. The Root River Parkway/Horlick Property is approximately 14 acres of parkland adjacent to the Horlick Dam on the east bank. This park offers a picnic shelter, green space along the Root River with opportunities for fishing and a boat launch for small boats, canoes, and kayaks. The River Bend Nature Center provides environmental education and outdoor recreation on 78 acres with 4,000 feet of Root River frontage at river mile 7.4. In addition to educational programs and classes, the center offers hiking trails, bird watching, archery range, cross country skiing, fishing, and a boat launch for kayaks and canoes.

There are several recreational areas downstream of the Horlick Dam, these include a golf course, dog parks, and open parks. The recreational areas are owned by either Racine County, the City of Racine, or the Village of Mt. Pleasant and include: Quarry Lake Park, Karen A. Nelson Memorial Dog Park, Racine Country Club, Colonial Park, and Lincoln Park. Recreational opportunities include but are not limited to golfing, bird watching, biking, hiking, swimming, paddling, kayaking, and fishing.

The Horlick Dam is a popular fly-fishing spot on the Root River for Rainbow Trout/Steelhead, Chinook Salmon, Coho Salmon and Brown Trout. While these species are introduced, they are popular and highly sought after by sport fishermen during the spawning runs in the spring and fall. These species' eggs are collected at the Root River Steelhead Facility during the spawning runs, afterward the fish are released upstream of the facility. The fish then continue their journey upstream and tend to "stack up" at the Horlick Dam as it is the largest obstruction for upstream fish passage (Figure 27). Anglers use this towards their advantage and fly fish at the base of the dam for easier angling. Steelhead and salmonid angling activity on the Root River is typically seen from Lincoln Park up to Horlick Dam. Fishing for other species such as Largemouth Bass and sunfishes occur throughout the summer season upstream of Horlick Dam from land or boat.

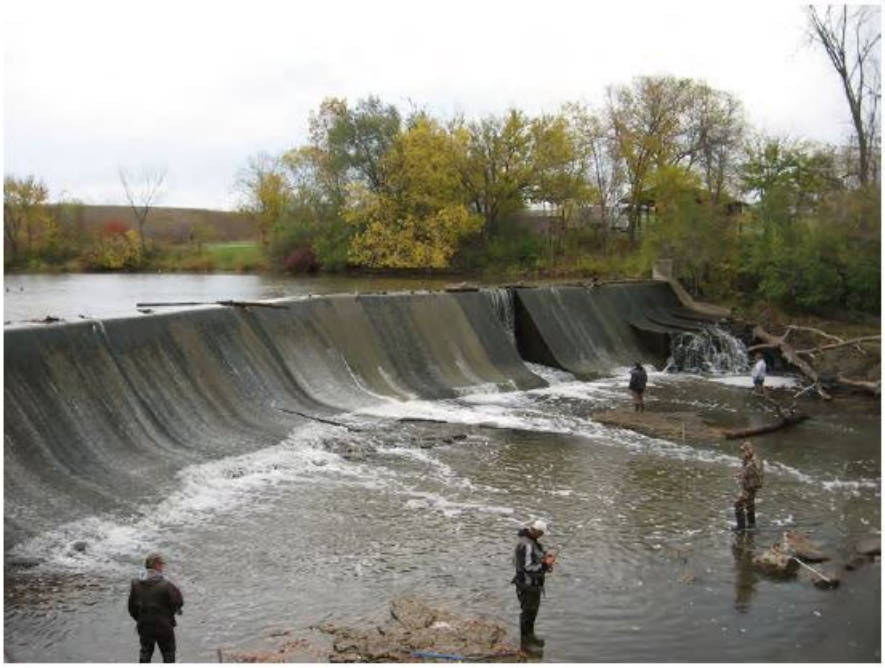


Figure 27: Fishermen angling for salmon and trout at Horlick Dam (SEWRPC 2014).

The Root River is a popular kayaking route for locals and visitors alike. There are several locations to put in or take out upstream of Horlick Dam, including the River Bend Nature Center and at the Root River Parkway. Common paddling routes include putting in at 5 Mile Rd and traveling 7.75 miles downstream to the boat ramp at the Root River Parkway/Horlick Dam or putting in at the River Bend Nature Center and either paddling upstream 2 miles to Highway 31 bridge or downstream 1.3 miles to Horlick Dam. The paddling community note that upstream of the Highway 31 bridge (free from the influence of the Horlick Dam impoundment) the reaches are curvy with riffles while downstream of the bridge, reaches in the impoundment are quiet, lake-like paddling and enjoy the scenic rural woodlands to parks and wetlands. Paddlers can kayak with their own equipment, rent equipment through the River Bend Nature Center, or participate in races such as the annual Root River Paddle Challenge (Figure 28).

Figure 28: Paddlers staging kayaks for the Kayaking in the Root River Challenge 2019 (photo credit: Eddee Daniel / awealthofnature.org).

Alternative Impact

The proposed project may have temporary short-term impacts from construction and would not have any long-term adverse effects with the potential for beneficial impacts to recreation. During the demolition of the dam, access to the Root River and the picnic shelter at the Root River Parkway/Horlick Property may be restricted for the staging of construction equipment. Additionally, any instream angling downstream of the dam would be restricted for safety reasons while construction is occurring. Implementation of the proposed project would be planned to minimize interference between recreational opportunities and construction activities related to the project. Any impacts to recreational opportunities from construction of the proposed project would be temporary in nature.

The implementation of the proposed project would remove the largest fish passage obstruction on the Root River, which would the remove the prolific “stacking up” of salmonids during the spawning season that anglers take advantage of, as well as open up passage for these salmonids to travel further upstream for additional fishing locations. It is anticipated there will still be an elevation change at the site of the removed dam, with a potential 4-foot drop over the distance of 35-40 feet. This would create a riffle area that fish, and more specifically, salmonid species would still utilize and have the potential to “stack up” as they swim upstream through the rapids, that anglers can fish at. Additional riffle areas are anticipated to be created upstream with similar fishing opportunities as there is the potential for up to 500 feet of bedrock to be exposed, in addition to pre-dam gravel channel bottom substrates that could be ideal for fly fishing habitat. Overall, fishing opportunities are anticipated to increase in the Root River.

Additional beneficial impacts to recreation include the expanded paddling and kayaking opportunities. With the removal of the dam, paddlers are able to continue their journey downstream with the potential to travel 6 miles to Lake Michigan. The site of the removed dam could also provide an opportunity for small rapids due to the elevation change described above. The rapids provide paddlers with a challenge and opportunity to paddle through differing water conditions that they would not have access to while the dam is in place. Overall, the implementation of the proposed project may have short-term temporary construction related impacts and potentially long-term beneficial impacts to recreation.

4.5 – Hazardous, Toxic & Radioactive Waste (HTRW) Analysis

Existing Condition

A HTRW Phase I Environmental Site Assessment was prepared for the study area and is included in Appendix H – Hazardous, Toxic and Radioactive Waste (HTRW) Report. No HTRW issues were identified during the investigation. Newly exposed banks should be planted to reduce erosion.

Alternative Impact

Project implementation is not expected to result in a release of HTRW. The risk of encountering HTRW in the project area has been reduced with the completion of a HTRW Phase I Environmental Site Assessment. The study area does not contain any Recognized Environmental Condition (REC) within its boundaries. Erosion and sediment controls will be maintained during construction to reduce movement of soil and sediment. No HTRW response actions are anticipated or required prior to project implementation.

Impacts resulting from the unintended release of hazardous or toxic construction equipment fluids, including fuel and oil spills or leaks during project implementation, would be mitigated by requiring construction contractors to develop an accidental spill prevention and response plan for all hazardous materials that may be used onsite, develop a solid and hazardous materials and waste management plan prior to starting work, and comply with all applicable local, regional, state, and Federal laws, policies, and regulations regarding the transportation, storage, handling, management, and disposal of hazardous materials and wastes. In the event of a spill or release of hazardous substances at the construction site, the contaminated soil would be immediately contained, excavated, and treated per Federal and state regulations developed by the USEPA, as well as local hazardous waste ordinances.

4.6 – 17 Points of Environmental Quality

The 17 points are defined by Section 122 of Rivers, Harbors & Flood Control Act of 1970 (P.L. 91-611). Effects to these points are discussed as follows:

Noise: The alternative plan would cause minor and temporary increase in noise levels during the day beyond the current conditions. The minor noise effects would stem from machinery utilized for the dam removal. Construction would be limited to weekdays and between the hours of 7:00 a.m. and 3:30 p.m. to minimize potential temporary noise impacts to nearby sensitive receptors. Long term, significant effects in terms of noise are not expected.

Displacement of People: The alternative plan would not displace local residents within the township of the study area since work would only be conducted on parcels owned by the non-federal sponsor. In addition, the proposed project would not induce flooding leading to the potential displacement of people.

Aesthetic Values: The alternative plan would not permanently reduce the aesthetic values of the study area. Temporary deteriorations in aesthetics would occur from the newly exposed riparian zone from the reduced stream channel before a cover vegetation has established. These effects on aesthetics are minor and temporary as vegetation would sufficiently cover the ground after establishment. The conversion of the lentic impoundment area to the lotic stream would provide an increase in aesthetic values.

Community Cohesion: The alternative plan would not disrupt community cohesion. A constructed project would provide additional open space for community activities in the newly exposed banks.

Desirable Community Growth: The alternative plan would not adversely affect community growth and would potentially attract people to a more aesthetically pleasing area based on project restoration measures.

Desirable Regional Growth: The alternative plan would not adversely affect regional growth.

Tax Revenues: The alternative plan would not adversely or beneficially affect tax revenues.

Property Values: The alternative plan would not have adverse effects on property values. A constructed project would have the potential to increase surrounding land values.

Public Facilities: The alternative plan would temporarily impact access to public facilities at the Root River Parkway/Horlick Property during construction. However, access to these public facilities would be fully restored once construction of the project is complete. There would be no long-term adverse impact to public facilities.

Public Services: The alternative plan would not adversely affect public services.

Employment: The alternative plan would not adversely affect employment, but would temporarily increase employment during construction activities.

Business and Industrial Activity: The alternative plan would not adversely or beneficially affect local commerce.

Displacement of Farms: None of the alternative plans would adversely affect farmland since restoration areas do not occur on active agricultural fields.

Man-made Resources: Any of the alternative plans would not adversely or beneficially affect man-made resources. The purpose of the proposed action is to remove the man-made Horlick dam, resulting in the loss of this man-made feature. However, SHPO coordination has indicated that the dam is not eligible as a historical property.

Natural Resources: The No Action Alternative allows for the continued degradation of native species, rare communities, and significant habitats. The proposed project would not adversely affect natural resources but improve them greatly.

Air: Any of the alternative plans would have a similar *de minimis* impact on the area, due to construction equipment emissions. These emissions would be fully compliant with federal law and would not rise to a level of significance under the Clean Air Act.

Water: None of the alternative plans would adversely affect water quality; however, the removal of the dam is expected to improve dissolved oxygen, sediment transport, and provide substrate for denitrifying bacteria.

4.7 – Environmental Compliance

The NER /Preferred Plan presented is in compliance with appropriate statutes and executive orders including the National Historic Preservation Act of 1966, as amended; Endangered Species Act of 1973 as amended, 33 U.S.C. §§ 1251-1388; the Fish and Wildlife Coordination Act of 1934 as amended, 16 U.S.C. §§ 661-667g-2; Coastal Zone Management Act (CZMA), 16 U.S.C. 1451, 1456 et seq and implementing regulations at 15 CFR Part 930; Executive Order 12898 (Environmental Justice); Executive Order 11990 (Protection of Wetlands); Executive Order 11988 (Floodplain Management); and the Rivers and Harbors Act of 1899 as amended, 33 U.S.C. § 403; the Clean Air Act, as amended, 42 U.S.C. §§ 4701-7671q, and the National Environmental Policy Act of 1969, 42 U.S.C. §§ 4321-4347, as amended.

Environmental Justice EO 12898

All of the proposed alternative plans would not cause adverse human health effects or adverse environmental effects on minority populations or low-income populations. Executive Order 12898 (environmental justice) requires that, to the greatest extent practicable and permitted by

law, and consistent with the principles set forth in the report on the National Performance Review, each Federal agency make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions, the District of Columbia, the Commonwealth of Puerto Rico, and the Commonwealth of the Mariana Islands.

From the data seen in Table 21, there does not appear to be a minority population nor is there a significant children population (when compared to the County and the State for these populations). Racine has a low-income population, but since the overall project is considered ecosystem restoration and will only benefit the surrounding environment and communities, no adverse effects to any low-income populations are expected.

Clean Air Act

The temporary source emissions from this project, for any alternative, are *de minimis* in terms of the NAAQSs and the State Implementation Plan. Construction emissions will not cause or contribute to any new violation of NAAQS, increase the frequency of an existing violation, or delay the attainment of standard, interim emission reduction, or other milestone. Due to the small scale and short duration of this project, a General Conformity Analysis was not completed. All construction vehicles will comply with federal vehicle emission standards. USACE and its Contractors comply with all Federal vehicle emissions requirements. USACE follows EM 385-1-1 for worker health and safety, and requires all construction activities to be completed in compliance with Federal health and safety requirements. The project is not expected to be a significant source of GHG emissions.

Section 404 & 401 of the Clean Water Act

A Section 404(b)(1) analysis was completed for the preferred plan. Features addressed by the 404(b)(1) analysis include the removal of the concrete dam. No permanent fill material would be placed during the construction of the project. No adverse effects to water quality or aquatic habitat were determined.

Section 401 Water Quality Certification is granted under Nationwide Permit 27, *Aquatic Habitat Restoration, Enhancement, and Establishment Activities*. All aspects and project features fall within the guidelines of Nationwide Permit 27. In-stream work would be subject to General Conditions of Nationwide Permit 27 and any specific regional requirements that must be implemented during project design and construction. These requirements include minimizing the amount of backfill necessary to achieve project goals, utilizing clean, non-erodable materials, using low ground-pressure equipment or timber mats for work in wetland areas, incorporating erosion control measures and BMPs to protect against sedimentation/siltation in the stream, avoiding activities in spawning areas during spawning seasons to the maximum extent possible and implementing a management and monitoring plan for restoration activities. No adverse effects to water quality or aquatic habitat were determined.

USFWS Section 7

The USFWS IPaC website was used to determine whether endangered, threatened, proposed, or candidate species could potentially be present in the action area, and if the action area overlapped with any designated or proposed critical habitat. The results of the IPaC search are

shown in Section 4.3.7. Using the list provided by IPaC, the Chicago District used best available information to evaluate whether the species on the IPaC list would be potentially affected by the action. Pursuant to Section 7 of the Endangered Species Act of 1973, as amended, the U.S. Army Corps of Engineers determined the recommended plan will have "no effect" on federally listed species or their designated critical habitat, due to the projects occurring in areas where there is no suitable habitat present for the identified species. No further consultation is required when there is a finding of "no effect". During the NEPA Scoping process the USFWS was sent a letter on November 9, 2020 requesting information on potential species in the area and any potential impacts. Coordination with the USFWS is ongoing, the U.S. Army Corps of Engineers anticipates a concurrence of the 'no effect' determination.

USFWS Fish and Wildlife Coordination Act (FWCA)

During the NEPA Scoping process the USFWS was sent a letter on November 9, 2020 requesting information on potential species in the area and any potential impacts to habitat pursuant to the Fish and Wildlife Coordination Act (FWCA) (16 U.S.C. 661-666(e)). Any comments or recommendations received during the public and agency review period will be reviewed, considered, and incorporated into the final EA, as appropriate. Coordination with the USFWS is ongoing.

USFWS Sea Lamprey Control Program

Coordination with the USFWS for the potential removal of the Horlick Dam was initiated by a letter dated May 5, 2014 to the State of Wisconsin, who at the time was contemplating removal of the dam due to issues with the spillway not functioning properly. The letter indicated there was little to no support for the project based on the potential to provide the non-native Sea Lamprey (*Petromyzon marinus*) access to spawning and recruitment habitat. The basis for this decision was the concept of barriers against migration of spawning Sea Lamprey. The Sea Lamprey Program (Program) identified the Horlick Dam as the last effective barrier to migration. Information on how this was determined was not available.

In 2020, the Chicago District USACE was tasked to complete a feasibility study to determine the most beneficial, cost effective and acceptable plan to restore riverine habitat and connectivity within the reach of the Horlick Dam. In doing so, the District began gathering historic and existing data, while firsthand coordination with the Program commenced. An initial meeting in October 2020 set the stage for determining important factors in the decision process for potential adaptive management measures should the Horlick Dam be removed. The primary task that would be accomplished by the USFWS was a survey of the Root River system to determine if habitat upstream of the dam would contribute to increasing abundances of Sea Lamprey. The primary task that would be accomplished by the USACE was to determine a need for a monitoring and adaptive management plan should Sea Lamprey be determined as a potential issue after dam removal.

The USFWS conducted a Sea Lamprey habitat survey and provided additional information in November 2021, which is presented in Appendix A. In a letter dated November 30, 2021, the USFWS stated "Our sampling found quality larval lamprey habitat is available for sea lamprey production; however, the absence of native lamprey in our surveys suggests that risk of sea lamprey recruitment is relatively low for this system…While the risk of sea lamprey infestation above Horlick Dam is low, the…Program would like to pursue designs for an alternative barrier

to block sea lamprey should infestation occur once Horlick Dam is removed…sea lamprey surveys must continue above the site in order to quickly document recruitment."

In February 2022, the USACE Chicago District, USFWS, and WIDNR held a coordination meeting to discuss the results of the USFWS Sea Lamprey habitat survey and to establish a path forward. All parties concurred that there was a low risk of sea lamprey infestation above the Horlick Dam based on previous knowledge and the USFWS production potential report. All parties discussed the possibility of utilizing the WIDNR Root River Steelhead Facility weir as a potential seasonal sea lamprey barrier if the need arises. USACE will not design or study mitigation measures for sea lamprey as part of this Section 506 project, however USACE will continue coordination with USFWS and WIDNR. Additionally, focus habitat and incidental sea lamprey monitoring will occur during post construction as discussed in the Monitoring & Adaptive Management Plan. The USACE is also aware of a recent fish survey conducted in the lower Root River system by the WIDNR; data provided would be incorporated into the Final EA.

In preparation for determining and justifying monitoring, adaptive management, and mitigation measures for this potential issue, the USACE conducted fish, habitat, and structural investigations, and coordinated with USFWS and WIDNR to determine the current condition of the system in terms of its potential for Sea Lamprey propagation.

The first key factor discovered was that the Horlick Dam is not the last effective barrier on the system. There is a WIDNR fisheries dam/weir located 2 river miles downstream that can block the movement of any species by closing the weir gates, the same as is done for sequestering spawning Salmonids. This establishes the same condition for Future-Without or Future-With the Horlick Dam removal.

The second key factor is that Sea Lamprey have not been documented in the Root River system, nor at the mouth in Lake Michigan based on data gathered between 1902 and 2002. Recent documentation between 2002 and present also indicate no specimens identified. These data and sources were provided to the USFWS Lamprey Program for review. There is one anecdotal account of a Sea Lamprey being attached to a Salmonid individual at the WIDNR fisheries facility, however, there is no voucher or confirmation of the species; this area is also within the native range of the Chestnut (*Ichthyomyzon castaneus*) and Silver (*Ichthyomyzon unicuspis*) Lamprey. Also, a single attached feeding lamprey does not indicate a spawning population. Therefore, unless some specific conditions recently found in the field that would manifest in Lamprey propagation due to the Horlick Dam removal are provided to inform this study, the Future-With and Future-Without Project conditions are considered to be the same.

The third factor is the presence of viable spawning and recruiting habitat for lamprey already occurring below the dam and above the WIDNR fisheries weir. Immediately below the dam (~500-ft) the stream is scoured to the bedrock, and there are little other substrates required by Lamprey and other fishes for spawning. However, as one moves down stream these substrates start to increase. The presence of sand and gravel over bedrock with large boulders in moderate to swift current, with available silt bars downstream would have the potential to serve as available Sea Lamprey spawning habitat (Applegate 1950; Marion & Hanson 1980). This may be indication to Sea Lamprey not using the Root River system, as no Sea Lamprey have been collected or observed in this reach. In addition, in restoring riverine processes, the reach below the dam and within the existing impoundment would also have conditions improved for Lamprey spawning. The Future With-Project condition would increase spawning lamprey habitat

as described by Applegate (1950); however, this same habitat is required by native lamprey, a suite of native stream fishes and mussels, and stocked fishes for angling.

The Chicago District fully supports concepts of eliminating, reducing and restricting dispersal of non-native aquatic and terrestrial species. Many of the Chicago District projects have focus on these types of issues, however, to prescribe and justify a solution under an adaptive management plan (options within the contract) for ecosystem restoration (NER), there must be a transparent and quantifiable benefit predicted. Without new information or data on the presence of Sea Lamprey within the already accessible habitats connected with Lake Michigan, the USACE is unable to quantify or qualify habitat/species units lost in the Future-With Project condition, as well as habitat/species units protected in the Future Without Project condition (ER 1105-2-100). Therefore, it is recommended that required monitoring for this project include sampling those existing and future habitat reaches that may provide lamprey spawning requirements as due diligence; subsequently reporting out findings in real-time.

Federal Aviation Administration (FAA)

The Department of the Army is a party to the 2003 *Memorandum of Agreement Between the Federal Aviation Administration, the U.S. Air Force, the U.S. Army, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, and the U.S. Department of Agriculture to address Aircraft-Wildlife Strikes*. Land uses and changes in land uses within five miles of an airport's air operations area are of interest when assessing whether a land use is a potentially hazardous wildlife attractant. The project site is within one (1) mile of the Batten International Airport, with Horlick Dam located near the end of the runway. Currently, the impoundment area upstream of Horlick Dam is an attractant for Canada Goose, a common bird hazard. The nature of the project with the removal of the dam and reestablishment of the riverine system eliminates the impoundment area and would greatly reduce the hazard of Canada Goose in the immediate vicinity. A scoping letter, requesting that the FAA provide their guidance for coordination, effects assessment, and monitoring requirements for habitat restoration was sent on October 30, 2020.

Coastal Zone Management Act of 1972

The project site is within the Wisconsin Coastal Zone which is defined as all counties bordering the Great Lakes. The project will protect the public interest by reestablishing quality habitat and riverine connection to Lake Michigan. The USACE has determined that the proposed activities would be "consistent to the maximum extent practicable" (as defined in 16 USC 1456, Coastal Zone Management Act, approved 1978) with the enforceable policies of the Wisconsin Coastal Management Program (WCMP). A letter providing the USACE's coastal consistency determinations was provided on May 10,2023, to the Federal Consistency Coordinator of the Wisconsin Coastal Management Plan for their review and concurrence.

State of Wisconsin Historic Preservation Act

Due to archival research and riverine disturbance in the project footprint, the Corps has determined that there would be no historic properties affected by the proposed undertaking. A finding of No Historic Properties Affected was submitted to the Wisconsin State Historic Preservation Office (SHPO) on November 15, 2021. The SHPO responded with a request for more information on November 30, 2021. This requested information was provided on November 30, 2021. As the SHPO did not respond to the Corps' finding within 30 days,

agreement with the finding of No Historic Properties Affected is assumed per 36 CFR 800.3 (c)(4).

Tribal Coordination

Pursuant to regulations for Section 106 (36 CFR § 800) of the NRHP (16 USC 470), the USACE has consulted with the Citizen Potawatomi of Oklahoma, the Forest County Potawatomi Community of Wisconsin, Fort Belknap Indian Community of the Fort Belknap Reservation of Montana, Little Traverse Bay Bands of Odawa Indians, Miami Tribe of Oklahoma, Menominee Indiana Tribe of Wisconsin, Ottawa Tribe of Oklahoma, Lac du Flambeau Band of Lake Superior Chippewa Indians of the Lac du Flambeau, and the Prairie Band Potawatomi Nation.

Public Interest

The NEPA Scoping Process involved the notification and request for input on the proposed project from Federal, State, and local agencies along with stakeholders. A Draft Environmental Assessment (EA) was prepared for the project and sent to Federal, State, and local agencies along with the general public for review. A 30-day Public Review period was held from May 26, 2023 to June 30, 2023 for the Draft Environmental Assessment.

Conclusion

In accordance with the National Environmental Policy Act of 1969, 42 U.S.C. § 4332, and Section 122 of the River and Harbor Act of 1970, Pub. L. No. 91-611, 84 Stat. 1818, 1823, the U.S. Army Corps of Engineers has assessed the environmental impacts associated with this project. The purpose of this EA is to evaluate the impacts that would be associated with the restoration of the Root River at Horlick Dam. The proposed project has been determined to be in full compliance with the appropriate statutes, executive orders and USACE regulations.

The assessment process indicates that this project would not cause significant effects on the quality of the human environment. The assessment process indicates that this project would have only beneficial impacts upon the ecological, biological, social, or physical resources of this area, and would provide environmental benefits to the Great Lakes Region. The findings indicate that that the proposed action is not a major Federal action significantly affecting the quality of the human environment.

CHAPTER 5 – DESCRIPTION OF THE NER PLAN*

5.1 –Tentatively Selected Plan (TSP) / NER Plan Selection

A comparison of the effects of various plans must be made and tradeoffs among the differences observed and documented to support the final recommendation. Based on the analyses presented in Chapter 2 – Plan Formulation, Chapter 3 – Alternative Evaluation and Chapter 4 – Environmental Impacts, the NER is the recommended plan, which is alternative (A) Full Dam Removal. This is supported by analyses addressing problems and meeting planning objectives, being acceptable to the non-federal sponsor, showing significant merit in restoring the environment, being cost effective, and not imparting any permanent adverse effects to the environment under NEPA.

5.2 – TSP / NER Plan Components

5.2.1 – Site Preparation

The first actions for construction would be to properly alert local agencies and citizens that work is starting. This would be followed by the contractor setting up staging and access and then mobilizing equipment and materials to the site. The construction site and any staging/storage areas would have exclusionary fencing, depending on local requirements and necessities. The construction site and supporting areas would also have signage placed to indicate the federal project, as well as agencies and contractors participating.

5.2.2 – Staged Dewatering

A passive sediment management plan with a staged drawdown has been selected as the preferred sediment management strategy for TSP. This methodology will use the existing stoplogs within the dam to slowly draw down the impoundment levels and allow a new channel to begin forming in the impoundment sediment upstream of the dam. It will allow the sediment to be transported downstream at a relatively gradual pace as opposed to a large pulse that would occur with a fast dam removal. The three considered alternatives, active sediment management, passive sediment management, and passive sediment management with a staged drawdown are compared in the attached Sediment Management Plan. The positives of the selected option are that it has a medium risk of turbidity and suspended solids over an elongated period of time, allows for an adaptive management plan to be implemented, and has a low cost compared to an active sediment management approach. The following sequence outlines the plan for dam removal and sediment management:

1. Begin the first stop log removal near the end of April. This time coincides approximately with the end of spring Longnose Sucker and Northern Pike migration and the beginning of the growing season.

2. Remove one stop log per week until they are all gone. The exact number of stop logs is unknown; however, there are likely at least 10. This will require at least two months over which the impoundment would be drawn down.

3. Remove the remaining concrete structure. The top portion of the dam will be removed first rather than chipping away at the base. This will allow more time for vegetation to establish on new, exposed sediments before base level is further lowered.

4. The dam will be removed down to at least 2 feet below the existing channel bed unless bedrock is encountered first.

5. The edge of the dam will be left intact on both sides to buttress the existing retaining walls with the option to add riprap if necessary. At least an 80-foot wide opening will be removed to match the anticipated new channel width.

6. Remnant material from the previous, upstream dam structure will be removed.

Possible adjustments to the rate of drawdown may be necessary during the removal. High turbidity or sediment deposition could cause the process to be delayed." (GRAEF, 2021, p. 26) The potential impacts due to sediment transport from the impoundment or the new flow regime that will reemerge within the old impoundment are discussed in the following sections.

5.2.3 – Dam & Spillway Demolition

Plan, profile, and section of the proposed dam removal areas per Horlick Dam Removal Application (prepared by GRAEF and can be found in Appendix G) are shown in Figures G-8, G-9, and G-10, respectively. The entire spillway will be removed to the base of the structure, as well as the remaining rock and masonry portion of the old dam and the sediment impoundment at the upstream portion of the dam (shown in Figure G-10). A portion of the dam at the banks will be left in place from the base of the dam to the top of the wall on the west side to support the wall (at a 1:1 slope cut), and to the top of the bank on the east side (at a 1:1 slope cut) as shown in Figure G-9. Also, the toe of the apron and the keyway will also be left in place.

Dam removal procedures start with dewatering of the sediment impoundment, creating a shallow notch at the top of the dam to slowly draw the water down, then removing of the stop logs. Once the stop logs are removed, dismantling of the structure can begin. The dam appears to be mass concrete with some reinforcing steel. The use of hydraulic equipment such as excavators (equipped with a breaker or jack hammer) should be sufficient for this operation. Blasting is not recommended for this operation due to its potential vibration impact on a commercial building (Riverside Inn) and a bridge structure that are in close proximity to the dam removal area.

5.2.4 – Recycling & Disposal

The removed portions of concrete dam and the excavated masonry rubble from the old dam (shown in Figures G-9 and G-11) shall be disposed or recycled. Dredged sediments from the dam removal process (limits of removal shown in Figure G-9 and G-11) will need to be dewatered and disposed as needed. The subcontractor will arrange with Racine County upon disposal and treatment of the removed materials. Also, movement of sediments from the upstream shall be controlled to minimize buildup at the downstream.

5.2.5 – Utilities

There are four utility crossing locations located within the former impoundment near River Miles 6.2, 7.2, 8.3 and 8.6, based on the HEC-RAS model River Miles. The crossing at River Mile 6.2 is the only one located within the "erodible" section of the impoundment. According to collected data, the utility is a 24" sanitary sewer main that is located between 8 and 10 feet beneath the

riverbed. Based on the sediment survey, the "erodible" portion of the channel is only expected to degrade by a maximum of 4.2' at this location. The utility crossing at Rive Mile 7.2 is a 20" sanitary sewer main that is set at the river bottom. Although the channel bed is not as erodible in this area, the expected channel velocities at this location for the 66.7% AEP flow are expected to nearly double from about 2 ft/s to 4 ft/s. As part of the adaptive management measures, an option would be added to the contract for stone should scouring occur. The Sediment Management Plan provides utility maps and documentation in Appendix G.

5.2.5 – Best Management Practices

Soil erosion and sediment control measures will be tailored during the design phase and will comply with local, state and federal environmental requirements. Typically, a sediment and wastewater plan is fashioned by the contractor that complies with state regulations. The minimum measures required at the project site may include:

- Hydroseeding, seeding and mulching with native cover crop to stabilize exposed sediment bars, banks and other disturbed areas
- Installation of silt fences around stockpile areas
- Protection of the waterway with silt fencing to prevent sediments from traveling into the waterway from the movement of construction equipment along the channel bank.
- Surface water isolation of areas utilized to manage removed sediment
- Stabilization of construction entrances to limit soil disturbance at the ingress/egress from the site
- Installation of erosion blankets over bank areas that become exposed as the water is drawn down and the dam is removed. Erosion blankets would only be installed along exposed bank areas that are to be unplanted for at least two weeks.
- Lowering of the pool by stoplog management to limit the release of accumulated sediments behind the dam.

5.2.6 – Monitoring & Adaptive Management Plan

Section 2039 of WRDA 2007, 33 U.S.C. § 2330a, directs the Secretary to ensure that when conducting a feasibility study for a project (or a component of a project) for ecosystem restoration that the recommended project can include a plan for monitoring the success of the ecosystem restoration for a period of up to ten years from completion of construction of an ecosystem restoration project This monitoring shall be cost-shared.

A monitoring plan will be implemented for this project (*Appendix C*). The USACE, Chicago District would conduct monitoring in conjunction with the non-federal sponsor to determine the success of the project. The principal goal of a resulting project is to restore stream connectivity to provide upstream migration for local fish. Baseline data for current conditions in the Root River at Horlick Dam are detailed in this IFR/EA. The following specific monitoring objectives were established to determine the effectiveness of this project:

- Restore stream habitat as measured by the presence of naturalized stream hydrology and hydraulics
- Reestablish natural fluvialgeomorphic parameters (hydraulics, substrates) and structures to support riverine and riparian habitats within the study area. Improvement is measured via the predicted increase in quality of riverine habitat (QHEI)

5.2.7 – Operation, Maintenance, Repair, Replacement & Rehabilitation (OMRR&R)

The OMRR&R costs of the project are estimated to a total cost of $0. The natural of the alternative as turning the river back to nature does not require anything further than taking the dam out and letting the river flow.

5.3 – Risk and Uncertainty

Land, easements, rights of way, relocations and disposal (LERRD)
Budget and Schedule Risk: A cost estimate was performed by appraisal staff during feasibility. Updates to the analysis with more detailed information may result in an increase or decrease in the proportion of LERRDs as compared to the total project costs. A 20% Incremental Real Estate Cost (formerly contingency cost) was added to the cost estimate to account for project unknowns. Incremental Real Estate costs added to base cost estimate, reduce the overall risk of underestimating LERRD costs, which is already low.

HTRW
Budget Risk: Contaminated sediments could be present behind the dam. The feasibility cost estimate already includes 50K for sediment sampling. Initiate Phase I and Phase II early in Feasibility Study to further buy down the identified risk. Sediment sampling occurred in December of 2020, and results indicated tested compounds were not detected. With a low level of severity and a low likelihood, the overall risk factor is considered to be low.

Hydraulic Analysis
Scope Risk: H&H Model was run for a finite number of storm events. With a medium level of severity and a medium likelihood, the overall risk factor is considered to be medium. Buy down of this risk through the scoping process during Feasibility Phase. Steady state flows were modeled for both planning and FIS flows, with no additional runs anticipated. The risk can be reduced from medium to low.

Permit Requirements
Scope Risk: LRC is new to working in the Racine County project area, so State and local permit requirements are not yet fully understood. With a medium level of severity and a low likelihood this risk will go unmitigated, the overall risk factor is considered to be low. During the Feasibility Phase, coordination with the WIDNR was initiated and continues with the later project phases to buy down this risk. Additional lessons learned from other Wisconsin projects were incorporated. The overall risk of low can be reduced further.

Section 106 Coordination
Scope Risk: Bedrock around the dam is being considered for National Historic Landmark status. Potential for dam structure to be granted historical status. Buy down this risk through the scoping process during Feasibility Phase. An investigation has shown that National Historic Landmark status has not been granted and is not pending. The risk can be reduced from medium to low.

Invasive Species
Scope Risk: Removal of the Horlick Dam opens up 160 miles of previously obstructed stream that may or may not provide non-native Sea Lamprey and Round Goby habitat requisites. USFWS conducted Sea Lamprey production potential surveys in 2021 and discovered no larval lamprey above Horlick Dam and stated that the risk of infestation was low. Additionally,

coordination with USFWS and WIDNR on the results of the USFWS report and discussion of contingency plans forward occurred in February 2022. Therefore, based on existing data and coordination, the Future without-project is the same as the Future with-Project for Sea Lamprey and Round Goby. The absence of said species within the river system, the existing availability of preferred habitats and the ability to block migration of fishes by the WIDNR fisheries dam has reduced the risk from medium to low. Coordination with WDNR and USFWS will continue through Agency & Public Reviews to glean new inventory and data regarding Sea Lamprey to inform the monitoring plan. Refer to Section 4.7 for discussion on coordination activities.

Cost Estimating
Scope Risk: Bedrock is assumed to support the dam based on the as-built drawings available. In addition, it is assumed that the inner dam design is composed of a concrete monolith as shown in the as-built drawings. Confirmation of the dam design and bearing material assumptions will be needed for the dam removal cost-estimation. Additional geotechnical investigation may be added to supplement the concrete core sampling and testing completed by the subcontractor (PSI Intertek, 2021). Additional geotechnical investigation to included coring at the upstream crest of the dam and downstream toe to bearing material to confirm inner dam design and bearing material (if bedrock). With this additional geotechnical investigation performed, overall risk can be reduced to low.

5.4 – Real Estate

Land required for this project consists of 37.61 acres including 0.09 acres of fee simple estate currently held as such by the non-federal sponsor and 37.52 acres of temporary work area easements on lands held by the non-federal sponsor and private landowners for access, staging, and a temporary, unmaintained cover planting. This plan involves the drawdown of the Root River upstream of Horlick Dam, followed by the removal of Horlick Dam altogether. In Wisconsin, title of riparian landowners runs to the thread of the stream unless otherwise restricted by deed, and riparian owners maintain title to lands created by accretion on rivers and streams. Newly accreted lands will be treated with a single cover planting in the area between the existing and newly established ordinary high-water marks (OHWM) for the purposes of erosion prevention and bank stabilization until natural vegetation regeneration can occur. This cover planting will not be maintained or used to calculate ecosystem benefits as part of the project.

Project area will be accessed from public roadways and disposal of soil will be done on site. Concrete, bar, and other spoil from dam removal will be recycled or disposed of appropriately.

Project lands have been valued at $53,210.00. A 20% contingency has been added to the land costs to account for uncertainty related to acquiring the necessary easements from private landowners. Non-federal sponsor administrative costs are estimated at $25,000.00, for a project LERRD total of $88,852.00. A 2023 administrative review and update to the original 2021 cost estimate is currently underway and will be completed before finalization of this report. Details are provided in *Appendix I - Real Estate Plan*.

5.5 – Plans & Specifications

During the design phase, a detailed set of plans and specifications will be developed to solicit and award a construction contract. Also, prior to finalization of the plans and specifications, assurance will be made that all areas to be prepared by the non-federal sponsor shall follow ER 1165-2-132, federal, state, and local regulations.

5.6 – Capability & Views of the Non-Federal Sponsor

In accordance with regulation ER1105-2-100, Appendix D, where the non-federal sponsor's capability is clear, as in the instances where the sponsor has sufficient funds currently available or has a large revenue base and a good bond rating, the statement of financial capability need only provide evidence of such. The non-federal sponsor is committed to its specific cost share of the Design & Implementation (D&I) Phase and expresses willingness to share in the costs of construction to the extent that can be funded.

5.7 – Division of Responsibilities

The Racine County Public Works has agreed to serve as the local cost-sharing sponsor for the Horlick Dam Root River Restoration Section 506 project. The cost-sharing requirements and provisions will be formalized with the signing of the Project Partnership Agreement (PPA) between the local sponsor and USACE prior to initiation of contract award activities. In this agreement, the local sponsor will agree to cost sharing requirements. Based on the cost sharing requirements, the total project cost (2023 price levels) and pertinent cost-sharing information for the restoration project are summarized in Table 22 and Table 23 .

Table 22: Total Project Cost, FY 2023

Item	Cost
Integrated Feasibility Report	$310,000
P&S	$350,000
Construction	$1,000,000
Recreation Features 10% TPC	$160,000
Monitoring	$75,000
LERRDs	$85,000
Total	$1,980,000
Feasibility Breakout	
Federal Share	$205,000
Non-Federal Share	$105,000
WIK	$48,100
Cash	$56,900
Ecosystem Breakout	
Federal Share	$981,500
Non-Federal Share	$528,500
WIK	$48,100
LERRDs	$85,000
Cash	$395,400
OMRR&R*	$500

Item	Cost
Recreation Breakout	
Federal Share Rec Features	$80,000
NFS Share Rec Features Cash	$80,000

Notes:
Includes Construction Management and Relocation costs
Total Project Cost exclude feasibility costs
Average annual cost for OMRR&R, 100% Non-Federal

Table 23: Total Project Cost FY Breakout, FY 2023

Item	Cost	FY20	FY21	FY24	FY25
Integrated Feasibility Report	$ 310,000	$ 100,000	$ 210,000		
P&S	$ 350,000			$ 100,000	$ 250,000
Construction	$ 1,000,000				$1,000,000
Recreation Features 10% TPC	$ 160,000				$ 160,000
Monitoring	$ 75,000				$ 75,000
LERRDs	$ 85,000				$ 85,000
Total	$ 1,980,000	$ 100,000	$ 210,000	$ 100,000	$1,570,000
Total Fed	$ 1,287,000	$ 100,000	$ 105,000	$ 65,000	$1,020,500
Total Non-Fed	$ 693,000	$ -	$ 105,000	$ 35,000	$ 549,500
Federal Share	$ 1,287,000				
Non-Federal Share	$ 693,000				
WIK	$ 48,100				
LERRDs	$ 85,000				
Cash	$ 559,900				
OMRR&R*	$ 500				

Notes:
Feasibility costs above $100,000 are split at 65/35 cost share
Average annual cost for OMRR&R, 100% Non-Federal

Responsibilities

Federal - The estimated federal cost share for implementation of the project is $1,287,000. The USACE would accomplish the plans and specifications phase, which includes additional design studies and plans and specifications, contract for construction, overall supervision during construction, prepare an operation and maintenance manual, and participate in a portion of the post construction monitoring.

Non-Federal Responsibilities - Prior to initiation of the design phase, the Federal Government and the non-federal sponsor will execute a PPA. The LERRDs and OMRR&R of the project will be the responsibility of the non-federal sponsor for the proposed project. The estimated non-federal cost share for implementation of the project is $693,000 and will be covered by LERRDs credit of $85,000 and a cash contribution of $559,900. The non-federal sponsor shall, prior to implementation, agree to perform the following items of local cooperation:

1. Provide 35 percent of the separable project costs allocated to environmental restoration as further specified below
    a) Provide the non-federal share of all complete planning and design work upon execution of the PPA
    b) Provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform or ensure the performance of all relocations determined by the government to be necessary for the construction and O&M of the project
    c) Provide or pay to the government the cost of providing all features required for the construction of the project
    d) Provide, during construction, any additional costs as necessary to make its total contribution equal to 35 percent of the separable project costs allocated to environmental restoration
2. Provide all recreation costs in excess of 10 percent of the federal ecosystem restoration costs.
3. Contribute all project costs in excess of the USACE implementation guidance limitation of $10,000,000
4. Shall not use the project or lands, easements, and rights-of-way required for the project as a wetlands bank or mitigation credit for any other project
5. For so long as the project remains authorized, operate, maintain, repair, replace, and rehabilitate the completed project or the functional portion of the project at no cost to the government in accordance with applicable federal and state laws and any specific directions prescribed by the government
6. Give the government a right to enter, at reasonable times and in a reasonable manner, upon land that the local sponsor owns or controls for access to the project for the purpose of inspection and, if necessary, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project
7. Assume responsibility for operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) of the project or completed functional portions of the project, including mitigation features, without cost to the government in a manner compatible with the project's authorized purpose and in accordance with applicable federal and state laws and specific directions prescribed by the government in the OMRR&R manual and any subsequent amendments thereto
8. Comply with Section 221 of Public Law (P.L.) 91-611, Flood Control Act of 1970, as amended, and Section 103 of the WRDA of 1986, as amended, 33 U.S.C. § 2213, which provides that the Secretary of the Army shall not commence the construction of any water resource project or separable element thereof until the nonfederal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element
9. Hold and save the United States free from damages due to construction of or subsequent maintenance of the project except those damages due to the fault or negligence of the United States or its contractors
10. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly reflect total project costs
11. Perform or cause to be performed such investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 *U.S. Code* 9601 through 9675, that may exist in, on, or under lands, easements, or rights-of-way necessary for the construction, and O&M of the project, except that the nonfederal sponsor shall not perform investigations of lands, easements, or rights-of-way that the government determines to be subject to navigation servitude without prior written direction by the government
12. Assume complete financial responsibility for all necessary cleanup and response costs for CERCLA-regulated material located in, on, or under lands, easements, or rights-of-way that the government determines necessary for the construction and O&M of the project
13. To the maximum extent practicable, conduct OMRR&R of the project in a manner that will not cause liability to arise under CERCLA
14. Prevent future encroachment or modifications that might interfere with proper functioning of the project

15. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, P.L. 91-646, as amended in Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987, P.L. 100-17, and the uniform regulation contained in Part 24 of Title 49, *Code of Federal Regulations* (CFR), in acquiring lands, easements, and rights-of-way for construction and subsequent O&M of the project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said acts
16. Comply with all applicable federal and state laws and regulations, including Section 601 of Title VI of the Civil Rights Act of 1964, P.L. 88-352, and Department of Defense Directive 5500.11 issued pursuant thereto and published in 32 CFR, Part 300, as well as Army Regulation 600-7 entitled "Non-Discrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"
17. Provide 35 percent of that portion of the total cultural resource preservation, mitigation, and data recovery costs attributable to environmental restoration that are in excess of 1 percent of the total amount authorized to be appropriated for environmental restoration
18. Shall not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefor, to meet any of the non-Federal obligations for the project unless the Federal agency providing the Federal portion of such funds verifies in writing that expenditure of such funds for such purpose is authorized

CHAPTER 6 – RECOMMENDATION*

I have considered all significant aspects of the problems and opportunities as they relate to restoring natural riverine processes within the Horlick Dam study area for native fish, wildlife, and plant communities. Those aspects include environmental, social, and economic effects, as well as engineering feasibility.

I recommend Alternative Plan (A) Full Dam Removal, which consists of establishing a diverse self-sustaining and connected reach of the Root River. Alternative (A) is the National Ecosystem Restoration Plan. The recommended plan has a total project cost of approximately $1,980,000 (2023 price levels) and provides 16.3 net average annual habitat units over approximately 7 miles of riverine habitat. All costs associated with the restoration of the Root River at Horlick Dam have been considered.

Paul Culberson
Colonel, U.S. Army
District Commander

CHAPTER 7 – BIBLIOGRAPHY AND ACRONYMS*

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LIST OF ACRONYMS AND ABBREVIATIONS

AA	Average Annual
AAHSI	Average Annual Habitat Suitability Index
AAHUs	Average Annual Habitat Units
AEP	Annual Exceedance Probability
AER	Aquatic Ecosystem Restoration
APE	Area of Potential Effects
BMP	Best Management Practice
CECW	Headquarters Civil Works
CE/ICA	Cost Effectiveness & Incremental Cost Analysis
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CFS	Cubic Feet per Second
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DBH	Diameter at breast height
DEF	Daily Exceedance Flows
DEM	Digital Elevation Model
DNR	Department of Natural Resources
DO	Dissolved Oxygen
EA	Environmental Assessment
EcoPCX	USACE's Center of Expertise for Ecosystem Restoration
EO	Executive Order
EPA	Environmental Protection Agency
EQ	Environmental Quality
ER	Engineering Regulation
ESA	Endangered Species Act
EX	Existing
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FIS	Flood Insurance Study
FONSI	Finding of No Significant Impact
FR	Federal Register
FRC	Fish Creek Restoration
FTE	Full-time Equivalence
FWCA	Fish and Wildlife Coordination Act
FWOP	Future Without Project
FWP	Future With Project
FY	Fiscal Year
GLFER	Great Lakes Fishery & Ecosystem Restoration
GIS	Geographic Information System
H_2O	Water
HEC-RAS	Hydrologic Engineering Center River Analysis System
H&H	Hydrology and Hydraulics
HSI	Habitat Suitability Index
HTRW	Hazardous, Toxic and Radioactive Waste
HU	Habitat Units
I	Introduced Species
IBI	Index of Biotic Integrity
IFR/EA	Integrated Feasibility Report and Environmental Assessment
IPAC	Information for Planning and Consultation
IWR	Institute for Water Resources

L	Lake Species
LiDAR	Light Detection and Ranging
LLC	Limited Liability Company
LRD	USACE Lakes and River Division
LERRD	Lands, Easements, Rights-of-Way, Relocations, and Disposal
LWD	Large Woody Debris
MGD	Million Gallons per Day
NAAHU	Net Average Annual Habitat Unit
NAAQS	National Ambient Air Quality Standards
NED	National Economic Development
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NFIP	National Flood Insurance Program
NFS	Non-Federal Sponsor
NHPA	National Historic Preservation Act
NOAA	National Oceanic and Atmospheric Administration
NPV	Net Present Value
NRHP	National Register of Historic Places
NWI	National Wetland Inventory
NWIS	National Water Information System
OHWM	Ordinary High-Water Mark
O&M	Operation and Maintenance
OMRR&R	Operation, Maintenance, Repair, Replacement & Rehabilition
OSE	Other Social Effects
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychloroinated Biphenyls
PM	Particulate matter
PDT	Project Delivery Team
P&G	Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies
PL	Public Law
PPA	Project Partnership Agreement
P&S	Plans and Specifications
QHEI	Qualitative Habitat Evaluation Index
RCPW	Racine County Public Works
REC	Recognized Environmental Condition
RECONS	USACE Regional Economic System
RED	Regional Economic Development
RFDS	Return Flow Discharge Site
SEWRPC	Southeastern Wisconsin Regional Planning Commission
SHPO	State Historic Preservation Office
T&E	Threatened and Endangered
TKN	Total Nitrogen Kjeldahl
TPC	Total Project Cost
TSP	Tentatively Selected Plan
TSS	Total Suspended Solids
USACE	U.S. Army Corps of Engineers
USC	United States Code
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WCMP	Wisconsin Coastal Management Program

WHPD	Wisconsin Historic Preservation Database
WIDNR	Wisconsin Department of Natural Resources
WIK	Work In Kind
WIS	Wisconsin Highway
WRDA	Water Resources Development Act
WQ	Water Quality