Matrix Solutions Inc.
A Montrose Environmental Company

EMBRO DAM
CLASS ENVIRONMENTAL ASSESSMENT

Prepared for:
UPPER THAMES CONSERVATION AUTHORITY

Prepared by:
MATRIX SOLUTIONS INC.

Version 1.0
June 2024
Guelph, Ontario

Unit 7B, 650 Woodlawn Rd. West
Guelph, ON, Canada N1K 1B8
T 519.772.3777 F 226.314.1908
www.matrix-solutions.com

EMBRO DAM

CLASS ENVIRONMENTAL ASSESSMENT

prepared for Upper Thames Conservation Authority, June 2024

Mariëtte, Pushkar, M.Sc., P.Geo.
Project Management
Principal Fluvial Geomorphologist

reviewed by

Jeff Prince, P.Eng.
Principal Water Resources Engineer

DISCLAIMER

We certify that this report is accurate and complete and accords with the information available during the site investigation. Information obtained during the site investigation or provided by third parties is believed to be accurate but is not guaranteed. We have exercised reasonable skill, care, and diligence in assessing the information obtained during the preparation of this report.

This report was prepared for Upper Thames Conservation Authority. The report may not be relied upon by any other person or entity without our written consent and that of Upper Thames Conservation Authority Any uses of this report by a third party, or any reliance on decisions made based on it, are the responsibility of that party. We are not responsible for damages or injuries incurred by any third party, as a result of decisions made or actions taken based on this report.

Contributors

Name	Job Title	Role
Mariëtte Pushkar, M.Sc., P.Geo	Senior Project Manager and Principal Fluvial Geomorphologist	Project Management and Coordination, Report development
Wolfgang Wolter	Senior Restoration Specialist	Project co-manager, Dam Safety Assessment, Alternatives and Evaluation
Jeff Prince, P.Eng.	Principal Water Resource Engineer	Pond Assessment, Hydrotechnical, Alternatives, Project Implementation
Mackenzie Clark, H.BASc, M.BEMA, EPt	Ecosystem Restoration Technologist	Terrestrial Field Reconnaissance and Reporting
Bryce Miller, M.Sc.	Fluvial Specialist	Geomorphic Assessment and Report Updates
Jessica Piette, H.B.ES	Terrestrial Ecologist	Natural Heritage Review
Scott Robertson, P.Eng.	Senior Water Resource Engineer	Technical Review
Rebecca Swabey, P.Eng.	Water Resource Engineer	Draft report, hydrology, bathymetric assessment
Chris Tasker, P.Eng	Manager, Water & Information Management (UTRCA)	UTRCA management, Dam Operations and Maintenance
Sarbjit Singh, EIT	Water Control Structures Technologist (UTRCA)	Public Input Compilation; Potential Funding Sources 2022/23 Public Consultation coordination and UTRCA input coordination
Erin Carroll	Aquatic Biologist (UTRCA)	Aquatic Ecological Assessment and Reporting
Brenda Gallagher	Vegetation Specialist and Forestry Technician (UTRCA)	Terrestrial Field Reconnaissance and Reporting
Scott Gillingwater	Species at Risk Biologist (UTRCA)	Natural Environment Review and Reporting
Cathy Quinlan	Terrestrial Biologist (UTRCA)	Terrestrial Field Reconnaissance and Reporting
Tara Tchir, B.Sc., M.Sc.	Watershed Science Coordinator (UTRCA)	Natural Features 2022/23 Natural Heritage and Reporting

Version Control

Version	Date	Issue Type	Filename	Description
	6-Jun-2016		RPT-Embro Dam EA - June 6- 16	Issued to client for review
	18-Feb-2017	Draft	RPT-Embro Dam EA - Feb 28-17 DRAFT	Issued to client for review
	7 Jun-2017	Final	RPT – Embro Dam EA – jn9-17 updated	Issued to client for review
V0.1	10-Mar-2023	Draft	35549-528 R 2022-11-01 draft V0.1.docx	Issued to client for review
V1.0	11-Jun-2024	Final	35549-528 R 2023-06-11 final V1.0.docx	Issued for Environmental Assessment Review Period

Executive Summary

Introduction

The Upper Thames River Conservation Authority (UTRCA) is responsible for the maintenance and operations of Embro Dam, situated in Zorra Township (Figure i), with 100% funding from the Township of Zorra following provincial cuts in 1995. Results of a 2007 (Acres) Dam Safety Assessment that assessed the structure against federal and provincial standard guidelines revealed deficiencies related to spillway capacity, freeboard, embankment stability, and the safe conveyance of flood flows through the emergency spillway. A subsequent 2008 (Naylor/LVM) embankment stability analysis study also concluded that the Embro Dam did not meet Dam Safety Guidelines stability criteria and was not considered stable under existing conditions. The dam is classified as having a 'Low Hazard Potential', based on federal and provincial criteria, due primarily to the low consequence of a failure with no assessed risk to life and minimal or reversible risk to property, environmental and/or cultural – built heritage losses.

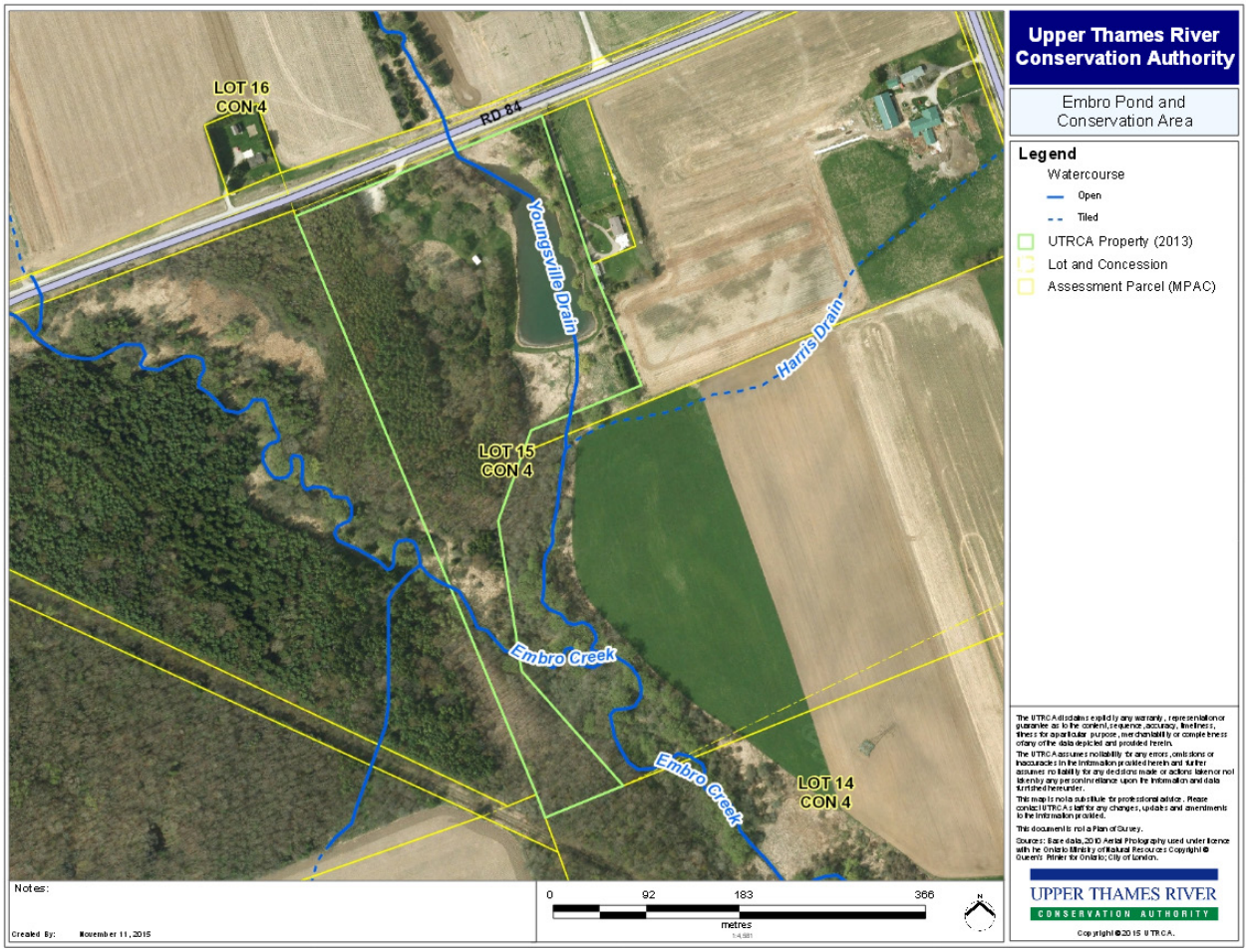


Figure i Embro Conservation Area (Outlined in Green; Source: UTRCA)

The UTRCA, in partnership with Zorra Township, initiated a Class Environmental Assessment (EA) in 2015 due to the significant concerns related to the structural integrity and hydraulic capacity of the Embro Dam. The objective of this EA study was to further understand and contextualize the dam's environment (as defined by the EA Act), identify and evaluate as series of alternative solutions, including the mandatory Do-Nothing option and, ultimately, to recommend an alternative that will allow the UTRCA and Township to move forward with resolution to the problem statement regarding the future of Embro Dam.

Through the 2015-2017 EA study process, additional study needs were identified and the EA study was not brought to completion at that time. UTRCA obtained funding to complete a cultural heritage assessment and results became available in 2022. The EA study was subsequently re-initiated and select updates were completed regarding existing conditions (cultural heritage, environmental screening, site condition review, sediment quality data assessment), and the identification and evaluation of alternatives. Public consultation was initiated and Public Information Centre 4 was held in 2023.

Background

The Embro Dam is situated 2 km north of the Village of Embro, in Embro Conservation Area (ECA). The dam is situated on Spring Creek which is also commonly referred to as the Youngsville Drain, though not classified as a municipal drain, which is situated in the Town of Embro, includes a dam and pond; both are under UTRCA ownership.

The ECA, within which the dam and pond are situated, supports a system of hiking and cross-country skiing trails. The Embro Pond Association entered into a lease agreement with UTRCA in 1999 for maintenance of ECA excepting the dam. Various initiatives have been undertaken that have included planting of native trees and wildflowers. A hardwood forest regeneration project was also implemented in the Conservation Area.

Existing Conditions

Review of background materials and site conditions was completed to define and confirm the problem statement. Characterization of existing conditions was completed through review of background information; completion of field investigations, data collection, data analyses and monitoring. This included a general assessment of the study area and investigations of Youngsville Creek downstream and upstream of the dam, and within pond.

Youngsville Drain is a tributary of the North Branch Creek within the Mud Creek watershed. The drainage area to the dam and pond is approximately 7.0 km^2; this is made up of mostly agricultural lands.

Bathymetric surveys of Embro pond completed in 2015 showed that approximately 27 to 35% of the available pond volume has filled with sediment. The sediment testing, when compared to Ministry of Environment, Conservation, and Parks (MECP) Table 2.1 standards, shows that one parameter (Cyanide - a weak acid dissociable) was outside of standard limits when considering offsite reuse.

Analysis of the accumulated sediment indicated that the sediment was not defined as hazardous waste according to Schedule 4 Leachate quality criteria (Ontario, 2015) but did exceed MECP (2022) Table 2.1 standards for Cyanide and Boron when considering sediment for agricultural, residential, or Industrial/commercial/community property reuse.

The wooded area of ECA (CA) is part of a larger significant natural heritage feature that includes the Oxford County Forest. Results of a three-season botanical inventory carried out by UTRCA in 2015 revealed that 31% of the species within the 5.4 ha of Embro CA are non-native; no plant species at-risk, or rare or uncommon or sensitive species were found on the land or in the reservoir/pond. The reservoir has a dense growth of rooted aquatic waterweeds and pondweeds, but all three native species are common. There are very few rooted emergent wetland plants along the edges of the pond owing to the steep sides and constant water levels. The overall quality of the vegetation within Embro CA was rated as average or moderate.

Monarch butterflies, considered a Species of Special Concern under the Endangered Species Act (ESA) and therefore considered a Species of Conservation Concern, were recorded incidentally by UTRCA in 2015. The continued presence of the tallgrass prairie plots and milkweed in Embro is a positive step for this species and the removal of the Embro Dam and reservoir should not impact this species or their food.

During the three-season bird survey undertaken by UTRCA in 2015, 40 species (common and mostly forest birds) were recorded. Barn Swallow, and Eastern Wood Pewee considered Species of Special Concern under the ESA (and therefore considered Species of Conservation Concern) were observed although no evidence of nesting was found. The reservoir provides limited significance for a few resident waterfowl for raising broods (e.g., Wood Ducks, Canada Geese). Migrating waterfowl make little use of the Embro reservoir during spring migration, likely due to the isolation of this pond from other ponds or lakes in the area.

Snapping Turtles, considered a Species of Special Concern under the ESA (and therefore considered a Species of Conservation Concern), were recorded incidentally by UTRCA in 2015. Snapping Turtles spend most of their life in water, and were seen in the Embro reservoir.

The possible removal of the Embro Dam and reservoir may impact individual turtles that use the pond; however, appropriate mitigation will be included in the detailed design to protect the species. This may include but not limited to, relocation, the creation of turtle habitat, turtle fencing, slow drawdown of the pond, and the creation of offline ponds.

Downstream of Embro Dam, Youngsville Drain Creek appeared to have been previously straightened and was considered to be stable. Through the aquatic assessment, twenty-seven (27) different fish species were recorded downstream of the dam (based on 2009 – 2022 UTRCA sampling records); the diverse community included cold water species and both permanent and seasonally present warm water species. The presence of coldwater and many coolwater species (e.g., Blacknose dace, Fantail Darter, Central Stoneroller, etc.) indicates the cooling effect of numerous seeps and of aquatic vegetation. Northern Sunfish considered a Species of Special Concern under the ESA (and therefore considered a Species of Conservation Concern), was found above and below the dam (according to Department of Fisheries and Oceans (DFO) screening map and UTRCA sampling in 2019, respectively), indicating the presence of slow-moving, clean water with plenty of aquatic vegetation. Northern Sunfish are not tolerant of siltation or turbidity and are considered an indicator species of good quality habitat. Juveniles are linked to pondweed (Potamogeton spp) which is identified as being prevalent in the reservoir (Collingsworth and Kohler 2010). It is recommended that the pond be resurveyed at detail design to confirm the presence of Northern Sunfish to consider including habitat features that support the species during pond design.

Benthic analyses revealed pollution tolerant taxa in this section of the creek that were indicative of ‘fairly poor’ water quality. Measurements of water temperature revealed warmer water downstream than upstream of the pond; the pond appears to provide a warming effect.

Youngsville Drain, upstream of the backwater effects due to the pond was considered to be geomorphologically ‘in transition’ and was considered to be aggradation. Results from the aquatic assessment suggested that this portion of Youngsville Drain provides good quality cold water habitat. Upstream of the backwater influence, only nine fish species were recorded, the low species diversity likely reflects the barrier to fish migration due to the dam. Benthic analyses revealed that pollution sensitive taxa were observed in this portion of the creek that were indicative of ‘fairly poor’ water quality. Water temperature was cooler upstream than downstream of the dam.

The footprint of Embro pond was determined to have no archaeological potential. The cultural heritage assessment indicated that the area pond and dam at the study site had been constructed in the late 1950s to serve as water supply and to serve as a recreational area within

the newly established Embro Pond Conservation Area. The assessment indicated that the site does not meet the O.Reg 9/06 criteria for designation as a cultural heritage site.

Alternative Selection and Evaluation

Through review of study findings, seven potential alternative solutions were identified to address the dam and embankment instability concerns that were defined in the Acres (2007) and Naylor (2008) studies. These included:

- Do Nothing
- Repair Dam
- Remove Dam and Establish Natural Channel
- Remove Dam and Construct One or More Offline Ponds/Wetlands with a Natural Channel
- Partially Remove Dam, Lower Crest and Naturalize the Remaining Perimeter

Evaluation of the potential alternatives was completed for each of the technical, environmental, socio-cultural and economic categories as defined in MOE (2014). The specific criteria that were evaluated were selected based on study area characteristics and factors considered especially relevant by the study team and/or the community. Ranking of each criterion was undertaken to determine the preferred alternative considering an equal category weighting.

The preferred alternative, resulting from both the equal and the weighted evaluation processes, was Alternative 4 (Figure ii). In this alternative, the dam would be removed and a naturalized channel with offline ponds or wetlands would be established. The alternative recognizes the benefit of removing the dam to improve fish migration opportunities into cold water habitat while providing flood control, diverse ecosystems to enhance aquatic habitat and species diversity.

Subsequent to Public Information Centre 3, a member of the public proposed an additional alternative. This alternative was reviewed and considered by the study team. That alternative shows thoughtful consideration for the reduction of liability and cost associated with any works in the area. The alternative included elements that are similar to Alternatives 2, and 5 and was thus not advanced to an additional alternative for inclusion in the evaluation process. Instead, draining the pond and lowering the dam crest to accommodate a fish ladder could be considered as a variation on Alternative 5 that incorporates elements of Alternative 3 (i.e., naturalized channel in area of exposed pond bottom).

Prior to development of detailed design, additional study is required to further characterize Youngsville Drain hydrology, reassess pond sediment quality, examine potential effects of pond removal on nearby groundwater wells, and undertake further archaeological assessment as outlined in the Archaeology Research and Associates (ARA 2015) report. A Community Liaison Committee should be established to allow for public participation in the design process.
The detailed design should address and incorporate elements considered important by the community that include walking trials and viewing areas for birds, habitat creation for turtles and amphibians, and other resident wildlife.

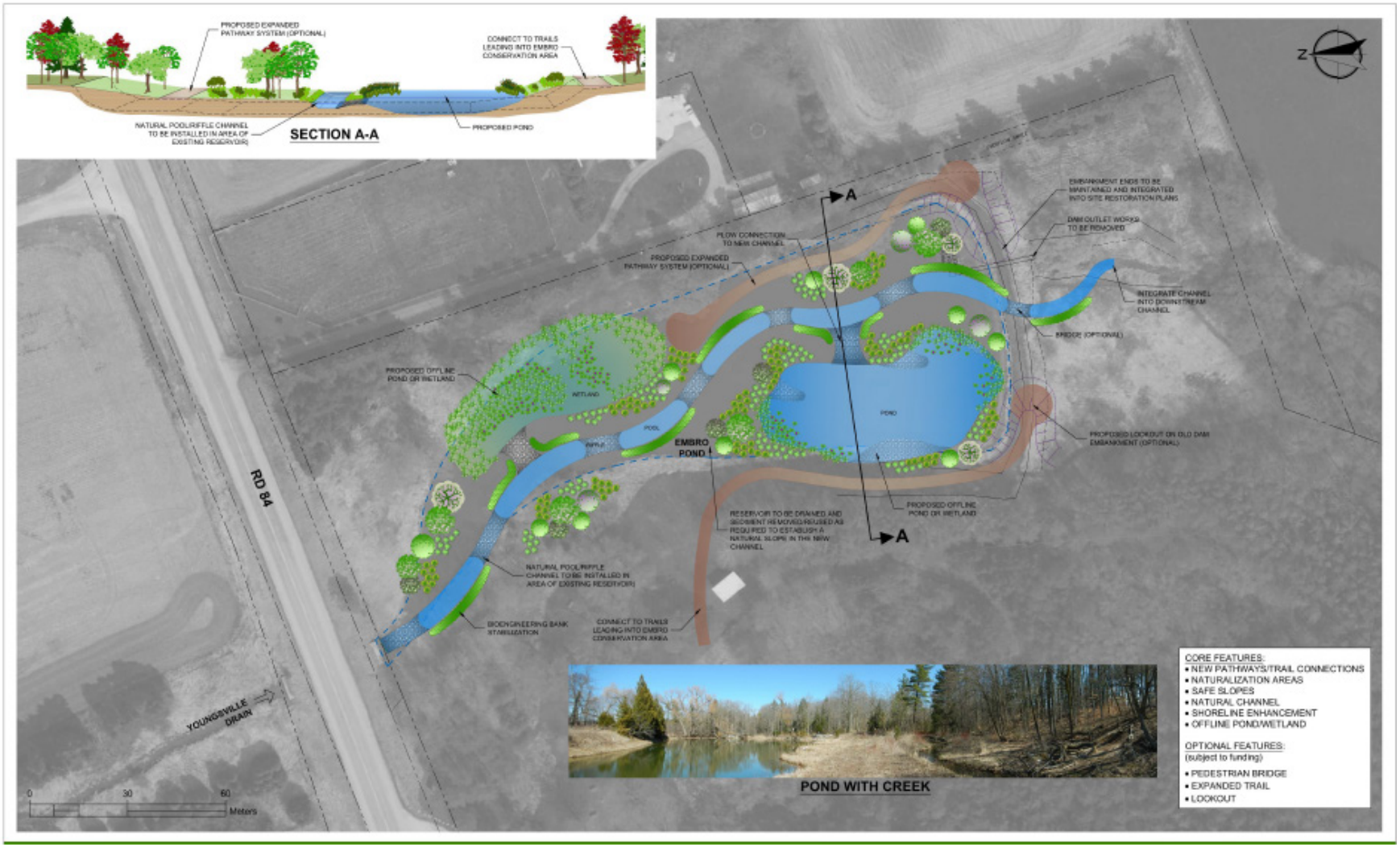


Figure ii Preferred Alternative

Public Consultation

Public Consultation was undertaken throughout the study process which included not only the immediate community, but also First Nations, organizations that may be interested in the project, and/or agencies that must be consulted during the Class EA process. Public meetings were held to communicate study findings and study process to the community and to obtain public feedback to consider and incorporate into the study. In addition to four public information centres (PIC), UTRCA also participated in additional communication with a community member who was actively engaged in the study process. All public notices, PIC presentation materials and draft reports were posted on the UTRCA website to provide public access. Additionally, during the public consultation process in 2022-2023, six members of public expressed interest in participating in a Community Liaison Committee (CLC). Two meetings were held with the CLC that was established in 2023.

Public comment and feedback received during the PICs and subsequent questionnaires were reviewed and used to inform the alternative evaluation process and refinement of the preferred alternative. No comments were provided by the First Nations. While the preferred alternative is generally accepted by the community; a variation of Alternative 5 was felt, by a community member, to provide a more cost-effective approach that would also reduce UTRCA liability for failure. This variation provides limited environmental benefits and could, in fact, contribute to adverse environmental conditions.

Conclusion

An EA study was initiated by UTRCA with the intent of identifying the preferred alternative for addressing the failure of Embro Dam to meet Dam Safety Guidelines with respect to its spillway and embankment. Review of existing conditions through background review and field studies demonstrated environmental impacts of the pond on water quality, fish species diversity, and channel function. No constraints were identified that would limit works associated with any of the potential alternatives. Through the evaluation process, Alternative 4 (remove dam and naturalize channel with constructed offline pond[s] or wetland[s]) was determined to be preferred. Preparation of design drawings for the preferred alternative should consider design elements that would support existing community use of the ECA and provide habitat creation and/or enhancement opportunities. Consideration should be given to initiating a Dam Safety Review if implementation of the preferred alternative is delayed. MNRF (2011) recommends that Dam Safety Reviews be completed on a maximum 10-year cycle; the last reviews were completed in 2007 and 2008.

Table of Contents

Executive Summary iii

1 Introduction 1

1.1 Study Problem 1
1.2 Study Area 1
1.3 Background 2

1.3.1 History 2
1.3.2 Embro Conservation Area 3
1.3.3 Dam Safety Assessment 3
1.3.4 Hazard Classification 4
1.3.5 Legislative Network 5

1.4 Study Objectives 6

2 Environmental Assessment Process 6

2.1 Ontario's Environmental Assessment Act 6
2.2 Conservation Ontario Class Environmental Assessment Process 7
2.3 Part II Order 8

3 Existing Conditions 10

3.1 Drainage Network and Watershed 10
3.2 Physiography, Geology and Subsurface Conditions 13
3.3 Embro Dam and Pond 15

3.3.1 Configuration and Stability 15
3.3.2 Dam Operations and Maintenance 16
3.3.3 Sedimentation 17
3.3.4 Pond Sediment Quality and Grain Size 19

3.4 Hydrotechnical Environment 22

3.4.1 Hydrology 22
3.4.2 Groundwater 23

3.5 Fluvial Geomorphology 24

3.5.1 Reach 1: Downstream of Embro Pond 27
3.5.2 Reach 2: Embro Pond Inlet to 85 m Upstream of Road 84 28
3.5.3 Reach 3: From 85 m to 235 m Upstream of Road 84 29

3.6 Natural Environment 30

3.6.1 Background Review 31
3.6.2 Identified Features 31
3.6.3 Vegetation and Wildlife Inventory 31

3.6.3.1 Vegetation 32

3.6.3.2 Wildlife 34
3.6.4 Aquatic Ecology 36
3.6.4.1 Fisheries Resources 36
3.6.4.2 Benthic Resources 38
3.6.5 Significant Wildlife Habitat 41
3.6.6 Species at Risk 43
3.6.6.1 Results 44
3.7 Surface Water Quality 45
3.8 Socio-cultural Environment 48
3.8.1 Existing Use 48
3.8.2 Archaeological Assessment 49
3.8.3 Cultural Heritage Assessment 50
4 Alternative Solutions 52
4.1 Alternatives 52
4.1.1 Alternative 1: Do Nothing 52
4.1.2 Alternative 2: Repair Dam (Install Granular Shell on Both Sides of the Embankment, Remove Vegetation, Extend Outlet Pipe, Provide Emergency Spillway, Install Rock Protection) 53
4.1.3 Alternative 3: Remove Dam and Establish Natural Channel 53
4.1.4 Alternative 4: Remove Dam and Construct One or More Offline Ponds/Wetlands 54
4.1.5 Alternative 5: Partially Remove Dam, Lower Crest and Naturalize the Remaining Perimeter 55
4.1.6 Additional Alternative Consideration 59
4.2 Alternative Cost Estimates and Funding Opportunities 60
4.2.1 Construction and Maintenance 60
4.2.2 Potential Funding Sources 61
5 Evaluation of Alternatives 63
5.1 Evaluation Criteria 63
5.2 Evaluation Matrix 65
6 Public Consultation 67
6.1 Notice of Intent 67
6.2 Public Information Center #1 68
6.3 Public Information Center #2 69
6.4 Public Information Center #3 70
6.5 Public Information Centre #4 71
6.6 Additional Consultation 72

7 Selection of Preferred Alternative 73
7.1.1 Preferred Alternative 73
7.2 Potential Impacts and Mitigation 76
7.2.1 Technical 76
7.2.2 Environmental 77
7.2.3 Social and Cultural 79
7.2.4 Financial 79
8 Project Implementation 79
8.1 Next Steps 79
8.2 Design Considerations 80
8.3 Permits and Approvals 81
8.4 Preliminary Cost Estimate 83
8.5 Construction Phasing and Timing Windows 84
8.5.1 Project Phasing 84
8.5.2 Construction Windows 84
8.6 Mitigation Measures and Monitoring Program 86
8.6.1 Mitigation 86
8.6.2 Construction Monitoring 89
8.6.3 Post-Construction Monitoring 90
9 References 91

List of Figures

Figure i Embro Conservation Area (Outlined in Green; Source: UTRCA) v
Figure ii Preferred Alternative xi
Figure 1 Embro Conservation Area (Outlined in Green; Source: UTRCA) 2
Figure 2 Conservation Ontario Class Environmental Assessment Process 9
Figure 3 Location of the Embro Conservation Area in the Mud Creek Watershed 11
Figure 4 Mud Creek Watershed in Relation to Upper Thames Watershed 12
Figure 5 Elevation of Embro Conservation Area 13
Figure 6 Surficial Geology of the Area 15
Figure 7 Comparison of Water Depth Between 1974 and 2015 Bathymetric Surveys 17
Figure 8 Sediment Profiles in Embro Pond 18
Figure 9 Rate of Pond Infilling (based on A: 1959-2015 and B: 1974-2015 sedimentation rates) 19
Figure 10 Known Wells in the Area of Embro Conservation Area 23
Figure 11 Groundwater Recharge (mm/y) of the Area around Embro Conservation Area 24
Figure 12 Reach Delineation Along Youngsville Drain 26
Figure 13 Surveyed Channel Bed Profile Along Youngsville Drain 26

Figure 14 Embro Dam Area Benthic and Fish Sampling Sites (Source: UTRCA; Appendix C) 39
Figure 15 Embro Pond Water Quality Sampling Sites 2015 (Source: UTRCA; Appendix B) 47
Figure 16 Temperature Upstream and Downstream of Embro Pond 48
Figure 17 Archaeological Assessment Results for Embro Dam Conservation Area 51
Figure 18 Alternative 1: Do Nothing 56
Figure 19 Alternative 2: Repair Dam 57
Figure 20 Alternative 3: Remove Dam and Establish Natural Channel 57
Figure 21 Alternative 4: Remove Dam and Construct Offline Pond(s) or Wetland(s) 58
Figure 22 Alternative 5: Lower Dam Crest and Outlet and Naturalize New Pond Perimeter 58
Figure 23 Preferred Alternative 75
Figure 24 Topographic Profile Through Study Area 76

List of Tables

Table 1 Water Quality Ranges for Family Biotic Index Values 40
Table 2 Comparison of Family Biotic Index Values for Embro Conservation Area, Mud Creek, and UTRCA Watershed (Source: UTRCA) 41
Table 3 Cost Estimates of Alternatives 61
Table 4 Potential Funding Sources 62
Table 5 Alternatives Evaluation Criteria 64
Table 6 Evaluation Ranking Criteria 65
Table 7 Alternative Evaluation Matrix 66
Table 8 Summary of Public Information Centre 2 Questionnaire Results 70
Table 9 Overview of Permit Requirements 81

Appendices

APPENDIX A-1 Embro Dam and Conservation Area Existing Environmental Conditions Report (includes appended report "Flow Characteristics of Harrington Creek at Harrington Dam and Youngsville Drain at Embro Dam"). Prepared by UTRCA, Updated October 2016
Appendix A-2 Addendum to the Embro and Conservation Area – Existing Environmental Conditions (2016). Prepared by UTRCA, updated November, 2022
APPENDIX B Embro Pond Water Quality Assessment. Prepared by UTRCA, Updated October 2016
APPENDIX C Embro Dam Area Fish and Benthic Records 2015 - 2022. Prepared by UTRCA, Updated October 2022
APPENDIX D Embro Conservation Area Vegetation and Bird Inventory. Prepared by UTRCA, Updated October 2016

APPENDIX E	Borehole Logs and Site Maps (Extracted from Embro Dam Embankment Stability Assessment). Prepared by Naylor Engineering Associates, September 2008
APPENDIX F	Embro Dam Class Environmental Assessment Fluvial Geomorphology Report. Prepared by ERI, February, 2017
APPENDIX G	Stage 1 Archaeological Assessment. Prepared by Archaeological Research Associates, 2015.
APPENDIX H	Dam Hazard Classification Memo. Prepared by ERI, July 2015
APPENDIX I	Sediment Testing Results. Prepared by ALS, September 2015
APPENDIX J	Agency and Public Correspondence
APPENDIX K	Formal Meetings
APPENDIX L	Community Liaison Committee

1 Introduction

1.1 Study Problem

The Upper Thames River Conservation Authority (UTRCA) acquired the Embro Dam, situated in Zorra Township, in 1958. The UTRCA is responsible for its maintenance and operations and, in 2002, initiated a Dam Safety Assessment which was completed by Acres in 2007. Results of their assessment identified concerns about insufficient spillway capacity, spillway instability, insufficient freeboard, embankment stability and the conveyance of flood flows through the emergency spillway. A suite of recommended repairs, if found to be feasible, were recommended for each structure to address these issues. An embankment stability analysis was subsequently undertaken by Naylor (LVM) in 2008 to further investigate the structural integrity of the dam. That study concluded that the dam did not meet current standards and was not considered stable under existing conditions. Recommendations for long-term stability of the dam were included in the 2008 report.

Due to the significant concerns raised in the engineering assessments, related to the structural integrity and hydraulic capacity of the Embro Dam, a Class Environmental Assessment (EA) was initiated by the Upper Thames River Conservation Authority (UTRCA), in partnership with Zorra Township. The objective of this study was to identify and evaluate alternatives (including Do-Nothing), and ultimately to recommend an alternative that will allow the UTRCA to move forward with resolution as to how best to address the dam and spillway deficiencies while balancing technical, social, and environmental responsibilities.

1.2 Study Area

The Embro Dam is located 2 km north of the village of Embro, and in the Embro Conservation Area (ECA; Figure 1). Embro CA is on County Road 84 in Oxford County, Township of Zorra, Lot 15, Concession 4. The Embro Dam is situated on Spring Creek which is also known as Youngsville Drain; it is a tributary of North Branch Creek (Mud Creek Watershed) which flows into the Middle Thames River. Since 1958, the dam, pond and surrounding area have been used for recreational purposes.

Immediately upstream from the reservoir, at the north end of the site, Youngsville Drain crosses under Oxford Road 84 (Country Road 16) through a culvert. The entrance to the dam, pond and park area is from Country Road 16. The site is bounded by a driveway/residential property to the east, forested lands to the west, agricultural lands to the south and Country Road 16 to the north.

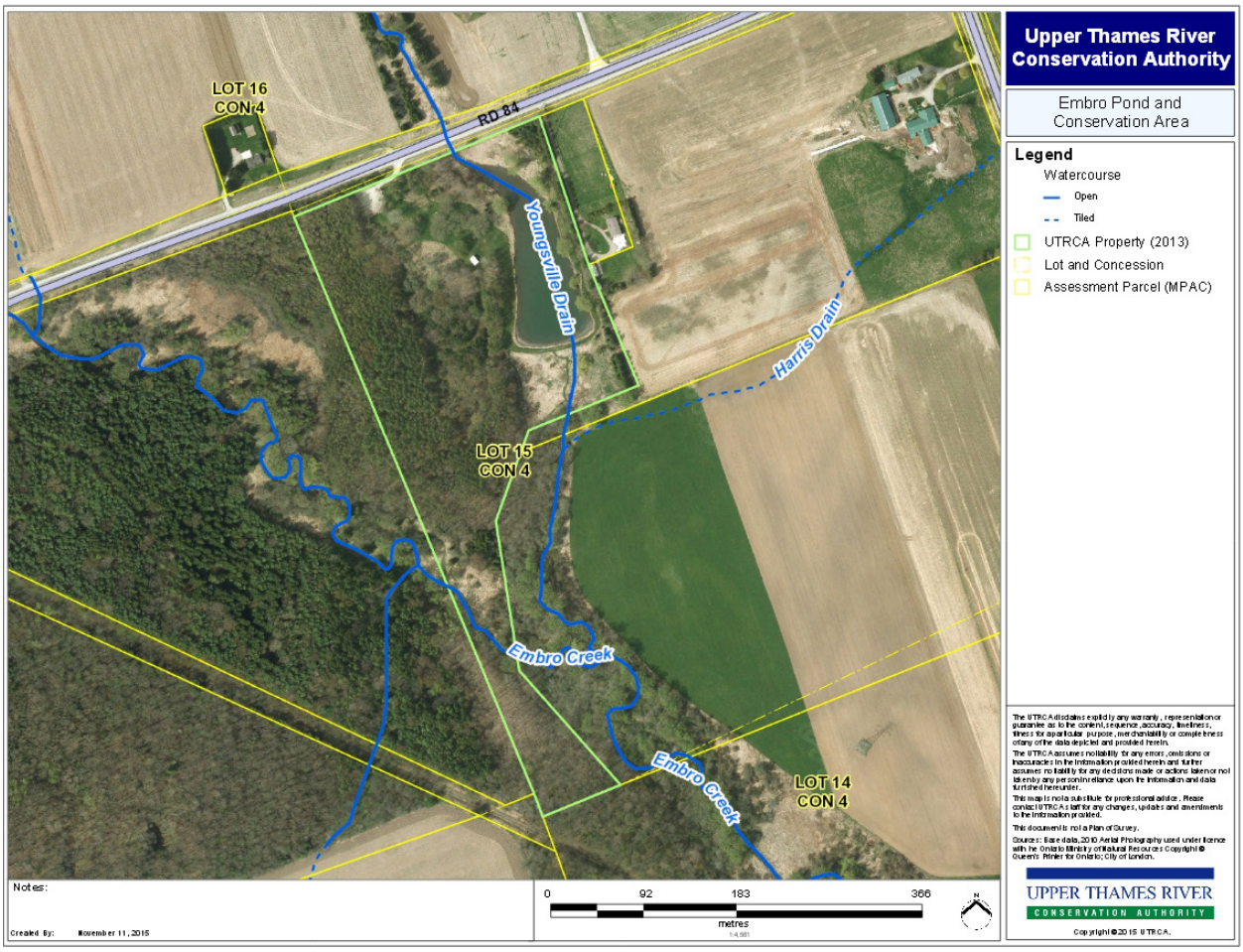


Figure 1 Embro Conservation Area (Outlined in Green; Source: UTRCA)

1.3 Background

1.3.1 History

The UTRCA acquired the Embro Dam in 1958 which involved the purchase of 5.7 hectares of the Oxford County Forest and 2.7 hectares of the Charles Harris property. At that time, the dam was in poor condition and the spillway was damaged (note; the original date of construction is unclear). In 1959, the dam was replaced with a 91 m structure; a 183 m long and 91 m wide lake/pond was created upstream of the dam. The pond was intended for recreational and water supply purposes. The ECA officially opened on October 26, 1959.

In 1995, the provincial operating funding support for Conservation Authority “small dams” was cut and as a result, the Township of Zorra contributes 100% of the operating costs. The dam was overtopped in the summer of 2000, but only minor damage was reported (Acres 2007).

1.3.2 Embro Conservation Area

Today, the Embro Dam Pond and Conservation Area attracts local residents and visitors to the site for recreational purposes including hiking (2.4 km of trails) and picnicking. The Embro Dam is a significant landmark to the local community and adjacent residents.

1.3.3 Dam Safety Assessment

In 2002, UTRCA initiated dam safety studies and Acres International was retained to undertake a Dam Safety Review of the Embro Dam. The Dam Safety Assessment (DSA) was carried out based on the draft "Ontario Dam Safety Guidelines" (ODSG) published by the Ministry of Natural Resources under the Lakes and Rivers Improvement Act and the Canadian Dam Association Safety Guidelines.

The Acre International report was completed in 2007 and includes an assessment of the dam and components, detailed site inspections, identification of repairs/maintenance, preparation of an emergency action plan, assessment of operation and equipment and associated documentation. Key highlights of the DSA include:

- The dam classification is small based on height and reservoir size.
- The dam is classified as having a "Very Low" Incremental Hazard Potential (IHP) structure for a dam failure during a flood event.
- The inflow design flood (IDF) is the flood resulting from the 50year, 8-day spring snowmelt event (i.e., 9.4 cms; Acres 2007).
- With three stop logs removed in the fall, the dam is overtopped during the passage of the IDF and has inadequate freeboard.
- The spillway has inadequate capacity to pass the IDF.
- Upstream and downstream embankment slopes do not meet stability acceptance criteria.
- Excavation of the emergency spillway is required in order to properly convey flood flows away from the left downstream toe of the dam.

Based on their DSA, Acres (2007) recommended that additional investigations be undertaken to assess embankment stability. Recommendations were also provided, if implementation was feasible, including: concrete repairs and embankment repairs including flattening slopes/adding berms, excavation of the emergency spillway to create a path away from the dam toe, removal

of large vegetation from embankments, shoreline and outlet erosion protection, debris removal, sign installation, regrading and adding riprap to the downstream channel, and redesign of the emergency spillway. The costs associated with maintenance repairs to ensure ongoing safe operation were estimated to be $62,350 in 2004 (Acres) and about $80,820 in 2007 (Acres); these costs were updated by Burnside in 2010 to be approx. $188,000, which included additional works pertaining to the upstream and downstream slopes of the dam embankment. These number quotes were based on cost estimates of the general scope of work and similar projects in Ontario.

In 2008, Naylor Engineering Associates Ltd was retained by the UTRCA to perform a visual inspection and assess the geotechnical stability of the Embro Dam embankment and to provide recommendations for addressing any deficiencies that would meet current Dam Safety Guidelines. Key findings from their investigation included the following:

- The dam at Embro pond comprised of silt and sand fill over native silt, peat, clay and glacial till
- Groundwater was measured within the fill in the dam during the field work
- The existing dam did not meet Dam Safety Guidelines and stability criteria and was not considered stable under existing conditions
- Recommendations included extending and flattening upstream and downstream embankments and re-construction of the dam were provided

1.3.4 Hazard Classification

In August 2011, the Ministry of Natural Resources released the "Dam Safety Review Best Management Practices" document. Under the jurisdiction of the Lakes and Rivers Improvement Act (LRIA), the Ministry of Natural Resources and Forestry has the authority to govern design, construction, operation, maintenance and safety of dams in Ontario. The best management practices have been developed to ensure safe management of Ontario dams. As part of the Dam Safety Review (DSR) process, all factors affecting the safety of a dam are reviewed based on current knowledge and standards.

Results of the original Embro Dam DSR (Acres International, 2007) classified the dam hazard as follows:

- Loss of Life: VERY LOW
- Economic and Social Losses: VERY LOW
- Environmental Losses: VERY LOW

Using the updated (2011) Dam Hazard Classification, Ecosystem Recovery (now Matrix Solutions) re-evaluated the hazards for Embro Dam, resulting in the following classifications (See Appendix H):

- Life safety: LOW
- Property Losses: LOW
- Environmental Losses: LOW
- Cultural-Built Heritage Losses: LOW

The low hazard associated with dam failure is due, primarily, to the rural area in which the dam is situated and the few permanent dwellings in the area.

1.3.5 Legislative Network

The Ministry of Natural Resources, through the LRIA, regulates alterations, improvements, and repairs to existing dams. Under Section 16 of the LRIA, "no person shall alter, improve, or repair any part of a dam… unless the plans and specifications … have been approved" by the Ministry of Natural Resources and Forestry. Likewise, under Section 2(1)(b) of Ontario Regulation 454/96, Ministry (MNR 2007) approval is required to make alterations, improvements, or repairs to a dam that holds back water in a river, pond, or stream if these may affect the dam's safety, structural integrity, the waters or natural resources. Section 2(2) of Ontario Regulation 454/96 further specifies that LRIA Section 16 approval is required before a person operates a dam in a manner different from that contemplated by previously approved plans and specifications (see: https://www.ontario.ca/page/dam-management, https://www.ontario.ca/page/alterations-improvements-and-repairs-existing-dams for additional information).

Any works submitted for LRIA approval requires supporting reports, supporting analyses and calculations, and drawings that are completed by a Professional Engineer. LRIA approval may be issued if the proposed works meet the standards outlined in the LRIA technical bulletins (https://www.ontario.ca/page/alterations-improvements-and-repairs-existing-dams#section-2.

Ministry standards for dam safety in Ontario are outlined in the LRIA Administrative Guide (MNR 2011) and associated technical bulletins (http://www.owa.ca/assets/files/policy/LRIA-Administration-Guide.pdf).

1.4 Study Objectives

The UTRCA, in partnership with Zorra Township initiated a Class EA study under the Conservation Ontario Class Environmental Assessment for Remedial Flood and Erosion Control Projects (2013). The objective of the study is to identify, evaluate, and ultimately recommend an alternative that will allow the UTRCA to move forward with resolution to the problem statement regarding the future of Embro Dam, in the Township of Zorra.

The specific objectives of a dam focused EA such as this study are to identify alternatives that:

- Address the dam stability concerns identified in the DSA studies
- Provides environmental enhancements wherever possible
- Provide opportunities for continued and/or enhanced public use of the Embro CA
- Minimizes environmental impacts during, and post, construction
- Results in low future maintenance
- Minimizes capital and maintenance costs

2 Environmental Assessment Process

2.1 Ontario's Environmental Assessment Act

The Embro Dam study is subject to the provisions of Ontario's Environmental Assessment Act. The Act requires that an EA of any major public sector project that has the potential for significant environmental effects be undertaken prior to implementation to determine the ecological, cultural, economic and social impact of the project.

The Act exists to "provide for the protection, conservation, and wise management of Ontario's environment". The Act mandates clear terms of reference, focused assessment hearings, ongoing consultation with all parties involved - including public consultation - and, if necessary, referral to mediation for decision. EA is a key part of the planning process and must be completed before decisions are made to proceed on a project.

To comply with the requirements of the Act, two types of EA processes can be applied to projects:

- **Individual Environmental Assessment** (under Part II of the Act): This process includes the development of a project-specific terms of reference that is submitted for review and approval to the Minister of the Environment. This process is typically applied to large,

unique or complex projects that do not have precedents that demonstrate a predictable and manageable environmental impact.

- **Class Environmental Assessment**: This process applies to routine projects that have predictable and manageable environmental effects, and follow a terms of reference that has been previously approved for certain types of projects. Provided that the approved Class EA process is followed, the project will comply with Section 13(3) a, Part II.1 of the Environmental Assessment Act.

2.2 Conservation Ontario Class Environmental Assessment Process

Conservation Ontario has developed the Class Environmental Assessment for Remedial Flood and Erosion Control Projects document to specify a planning and design process which ensures that environmental effects are considered when undertaking remedial flood and erosion control projects.

According to the Conservation Ontario Class EA document, a remedial flood and erosion control project includes projects undertaken by Conservation Authorities which are required to protect human life and property from impending flood or erosion problems.

The Conservation Ontario Class EA process includes the following tasks:

- Initiate the Class EA and publish Notice of Intent.
- Prepare a baseline environmental inventory. For this EA, the baseline inventory included characterization of existing conditions, such as hydraulics, some components of the natural environment, broad Ecological Land Classification (ELC) classifications of natural vegetation communities, fish and benthic surveys (note: mussel surveys were not completed) and incidental observations of birds, insects and reptiles and geomorphology.
- Develop alternative remedial measures and select the preferred measure.
- Conduct a generaln analysis of environmental impact based on baseline conditions.
- Prepare study report documentation.

The Conservation Ontario Class EA process is illustrated in Figure 2.

2.3 Part II Order

A project that is carried out following an approved Class Environmental Assessment process will comply with Part II of the *Environmental Assessment Act*, and will thus not require an Individual Environmental Assessment and approval from the Minister of the Environment. However, if during the project planning and consultation process there are agency or public concerns that cannot be resolved through consultation, negotiation, or revisions to the environmental study report, then the concerned party may make a request to the Minister of Environment for a Part II Order to comply with Part II of the Environmental Assessment Act (i.e., a higher level of assessment) before proceeding with the proposed undertaking. Such a request is called a "Part II Order".

The request for a Part II Order should be made only when there are outstanding significant environmental issues that cannot be resolved during the Class EA process. The Part II Order must focus on potential environmental effects of the project, and must not be made for the sole purpose of delaying or stopping the project or include issues that are not related to the project.

The request must be made in writing to the Minister of the Environment, within 30 days after the proponent has issued a Notice of Completion of the environmental study report.
The proponent must also be copied on the request. Ministry staff will review the request, consider evaluation criteria, consult with other technical staff and make a recommendation to the Minister. Depending on the project, the Ministry's review typically lasts between 30 and 66 days. The Minister can:

- Deny the Part II Order request, with or without conditions
- Refer the matter to mediation
- Require that an Individual EA be prepared in order to comply with Part II of the Act

If a Part II Order request is made prior to filing of the Notice of Completion, the requestor will be advised to bring the concerns to the attention of the proponent (i.e., the UTRCA).

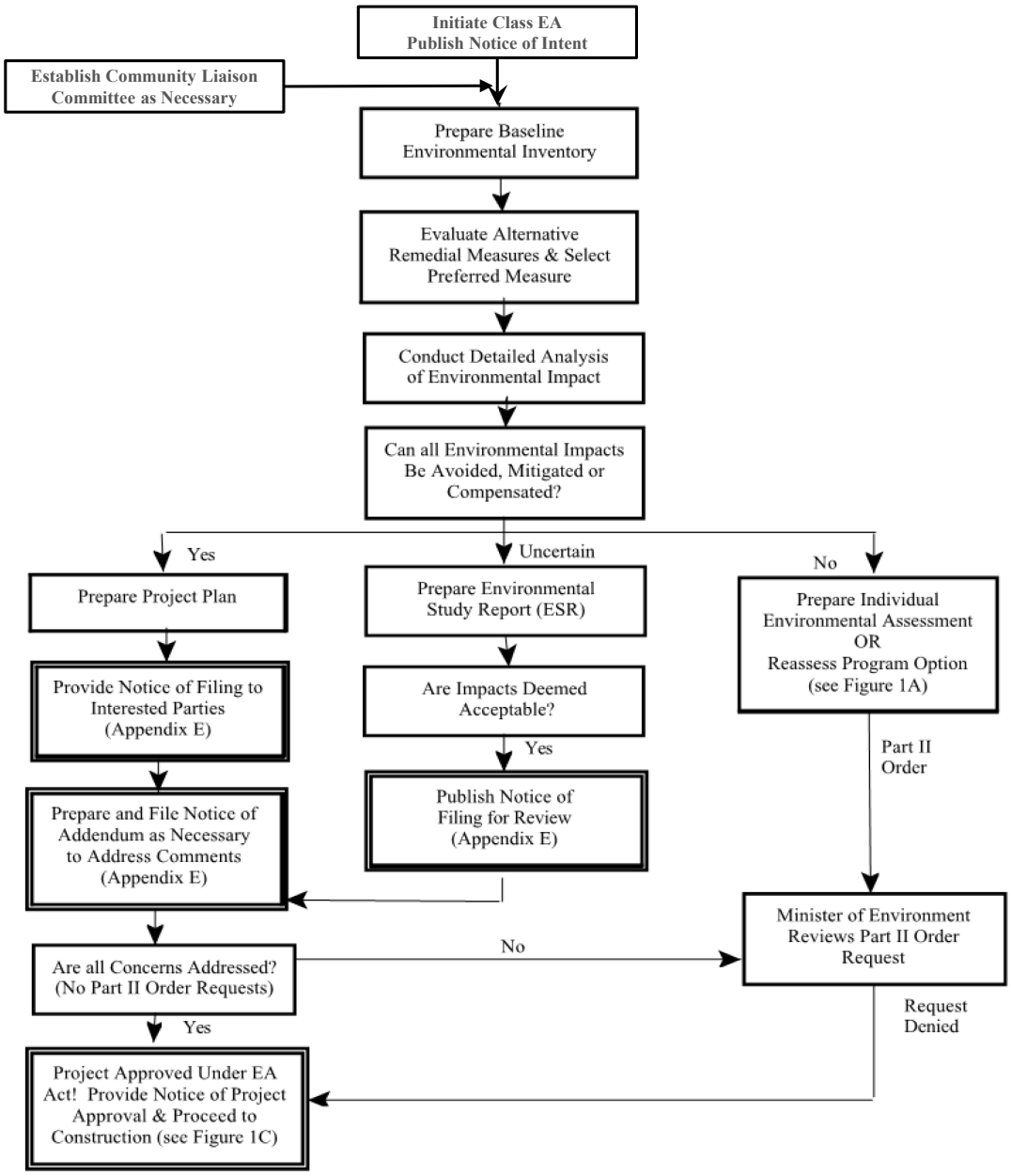


Figure 2 Conservation Ontario Class Environmental Assessment Process

(http://conservationontario.ca/images/Policy__Planning/Class_EA/Class_EA_June_2013.pdf)

3 Existing Conditions

Existing and historical conditions of Embro Dam, the pond, and adjacent area were characterized to provide an effective basis for the evaluation of potential alternatives that could address the concerns identified through the DSA (Acres 2007). Components included in the characterization focused on the geology and physiography, hydrotechnical (i.e., hydrogeology hydrology and hydraulics), fluvial geomorphology, aquatic and terrestrial environments, water quality, and socio-cultural settings.

The data required to characterize site conditions were gathered through a combination of site visits, field investigations, and desktop reviews of existing reports and mapping and are summarized in this chapter. The characterization of existing conditions was completed through a collaborative effort with UTRCA staff. Reports prepared by UTRCA are provided, in full, in Appendices A, B, C and D. A summary is provided in the sub-sections below.

3.1 Drainage Network and Watershed

The Embro Dam is located on Youngsville Drain (also called Spring Creek) which is a tributary of North Branch Creek (Mud Creek Watershed). Embro Dam and its pond occur in the ECA (see Figure 1) which is situated within the Mud Creek watershed, a subwatershed of the Middle Thames River (See Figures 3 and 4). An overview of the watershed is provided in Appendix A.

From the downstream limit of the Embro Dam Pond, Youngsville Drain flows south for approximately 300 m before its confluence with the North Branch Creek (west). From this point, the North Branch Creek (west) flows south through the village of Embro, and crosses under 37th Line/Huron Street at three locations. The lower limit of the Mud Creek watershed is approximately 1.7 km south of the village of Embro. The Mud Creek watershed includes Zorra Township (69%, 109 km^2) and the Township of East Zorra-Tavistock (31%, 48 km^2).

The drainage area to the dam and pond is approximately 7.0 km^2; this is made up of mostly agricultural lands. The catchment area of Embro pond includes the Sutherland-McDonald Drain, Ross Drain, Glendinning Drain, Matheson-McCorquodale Drain and Matheson Smith Drain.

The general topographic setting of Embro CA in the downstream reaches of Youngsville Drain catchment is shown on the map in Figure 5. North Branch Creek meets Embro Creek immediately south of Embro CA. The lowest elevation point in the catchment area is 315 m where Embro Creek leaves the Conservation Area. Embro CA is located in some of the highest elevations in the UTRCA watershed.

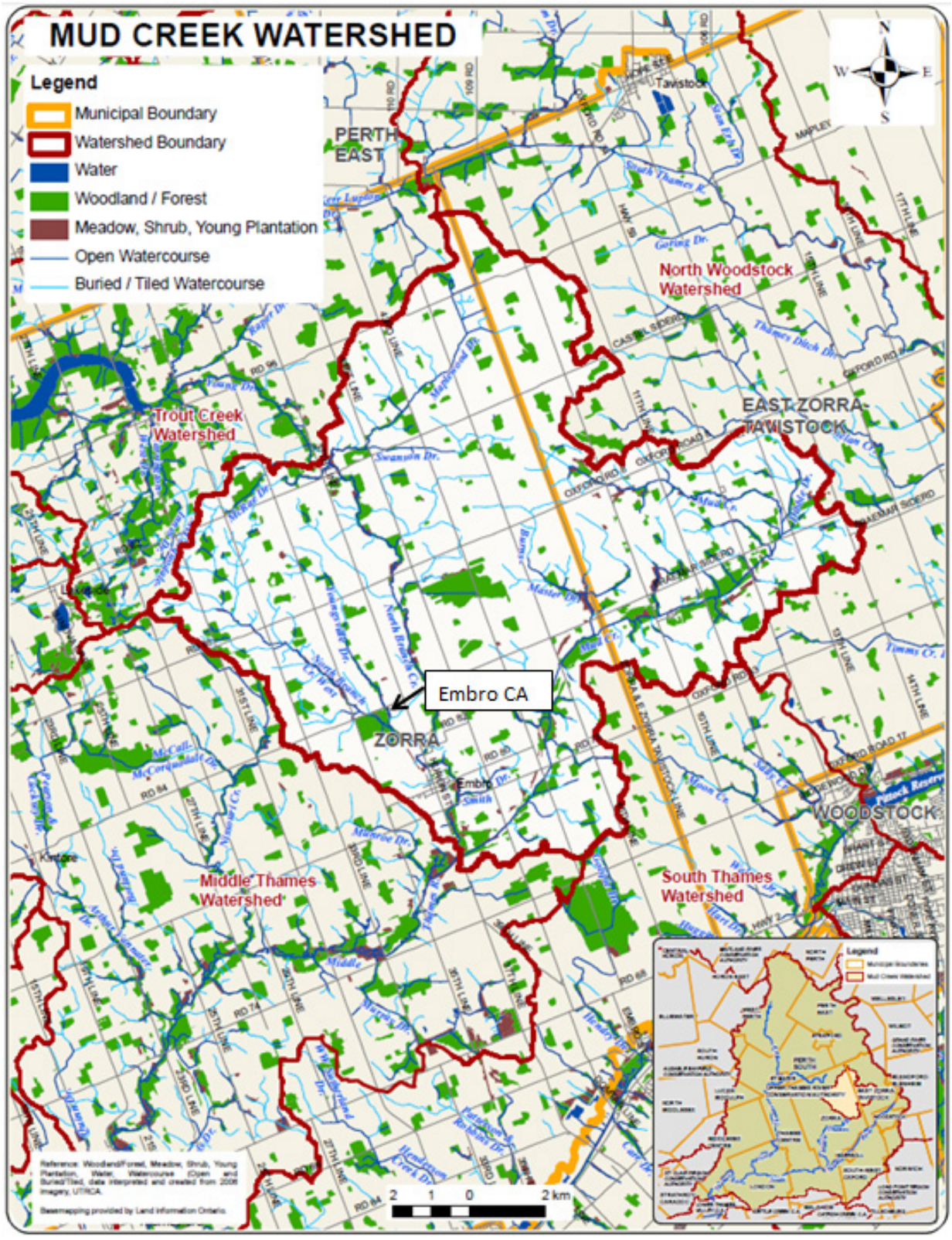


Figure 3 Location of the Embro Conservation Area in the Mud Creek Watershed
(Source: UTRCA 2015; Appendix A)

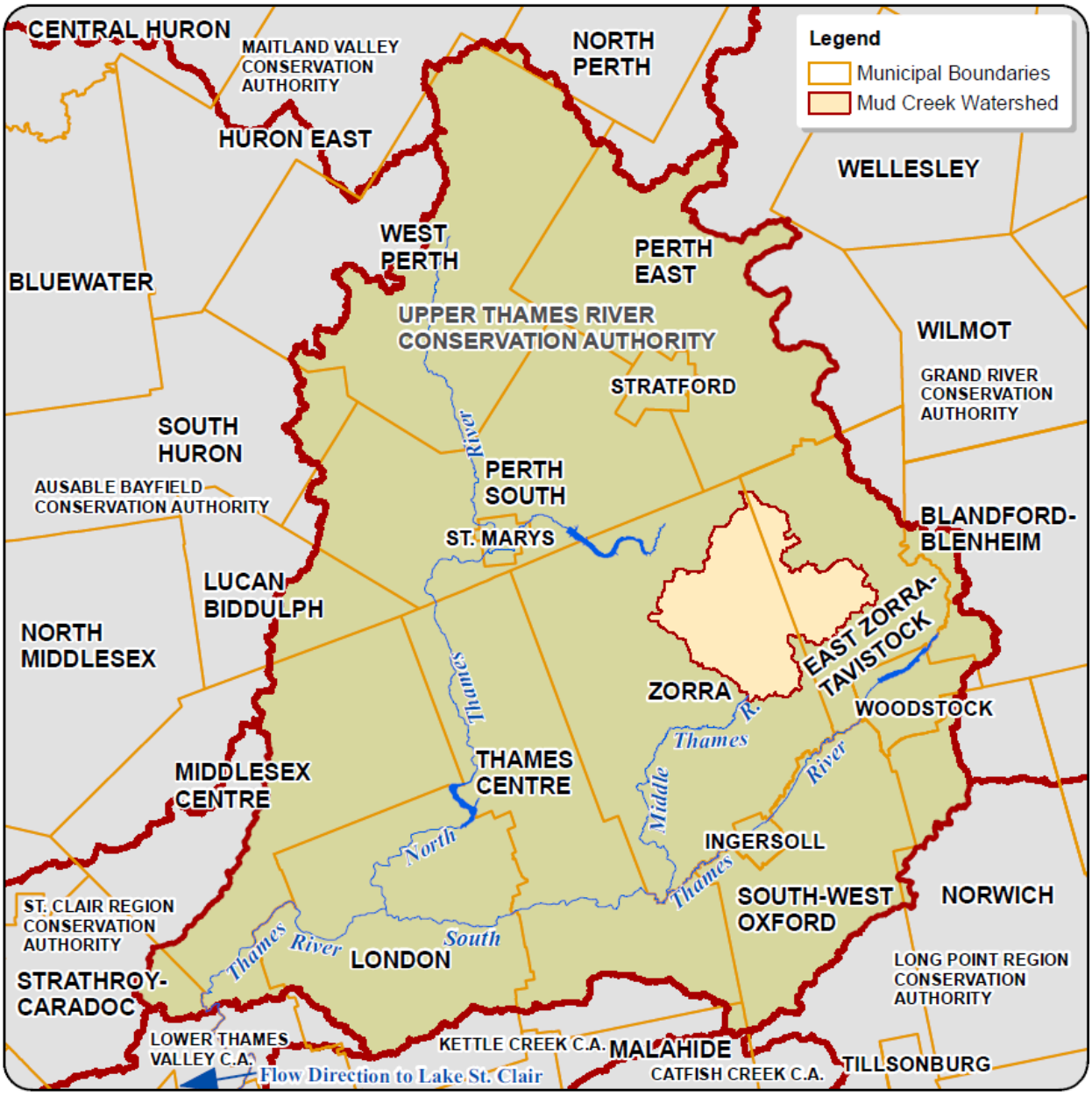


Figure 4 Mud Creek Watershed in Relation to Upper Thames Watershed
(Source: UTRCA 2015; Appendix A)

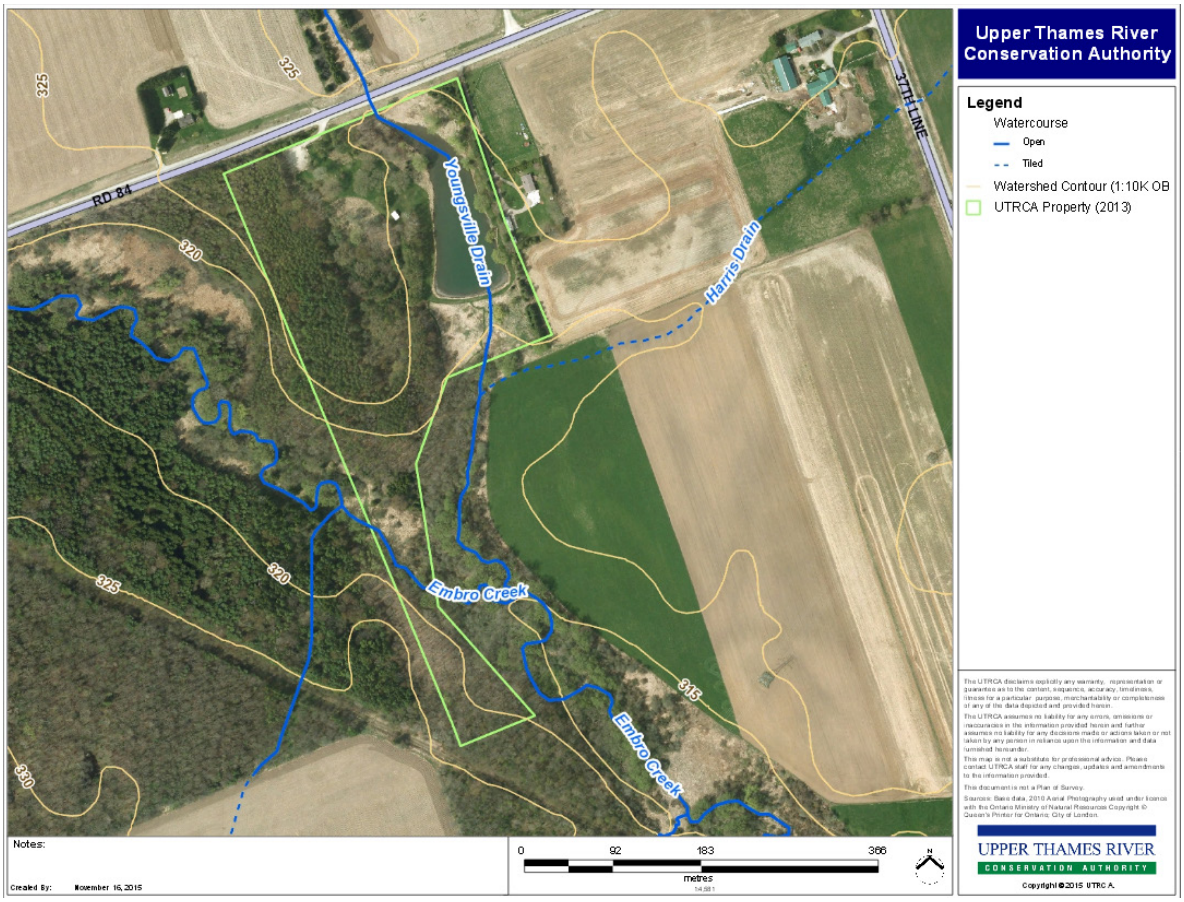


Figure 5 **Elevation of Embro Conservation Area** (Source: UTRCA 2015; Appendix A)

3.2 Physiography, Geology and Subsurface Conditions

An overview of study area geology was provided in the Naylor (2008) report which has been extracted and copied below:

> The Embro Conservation Area is situated in the Oxford Till Plain Physiographic Region of Southern Ontario. The region is occupied by a drumlinized till plain with glacial meltwater valleys. The dominant soil materials are silt and sand tills.
>
> The region is underlain by Middle Devonian Bedrock of the Paleozoic System. The predominant rock type is limestone of the Dundee Formation. The soil cover over these rocks is approximately 30 m thick, although the bedrock is exposed in the ancient river valleys, notably in Beachville. The bedrock is approximately 400 million years old and was formed in a shallow sea environment.

Insight into subsoil conditions was also provided in the Naylor (2008) report and is as follows (borehole and cross-section data are provided in Appendix E):

In general, the subsurface stratigraphy at the site comprises fill overlying native glacial till.

Peat was encountered 2.2 to 3.4 m below existing grade in a borehole (BH 4) that was drilled on the west embankment of the dam. The peat comprises black amorphous peat with wood. The moisture content of the peat was 108%, indicating saturated conditions.

Silt and clay deposits were contacted beneath the fill (of the embankment). It comprises loose to dense brown silt with trace clay and sand.

Glacial till was encountered beneath the fill, peat, silt and/or clay in all of the boreholes. The glacial till extended below the termination depths of the boreholes. The texture ranged from silty-clay with some sand and trace gravel, to sandy silt with some gravel and trace clay.

Further detail regarding the subsurface materials is in the Naylor (2008) report.

Mapping of the surficial geology of the study area was provided by UTRCA (2015) and is shown on Figure 6.

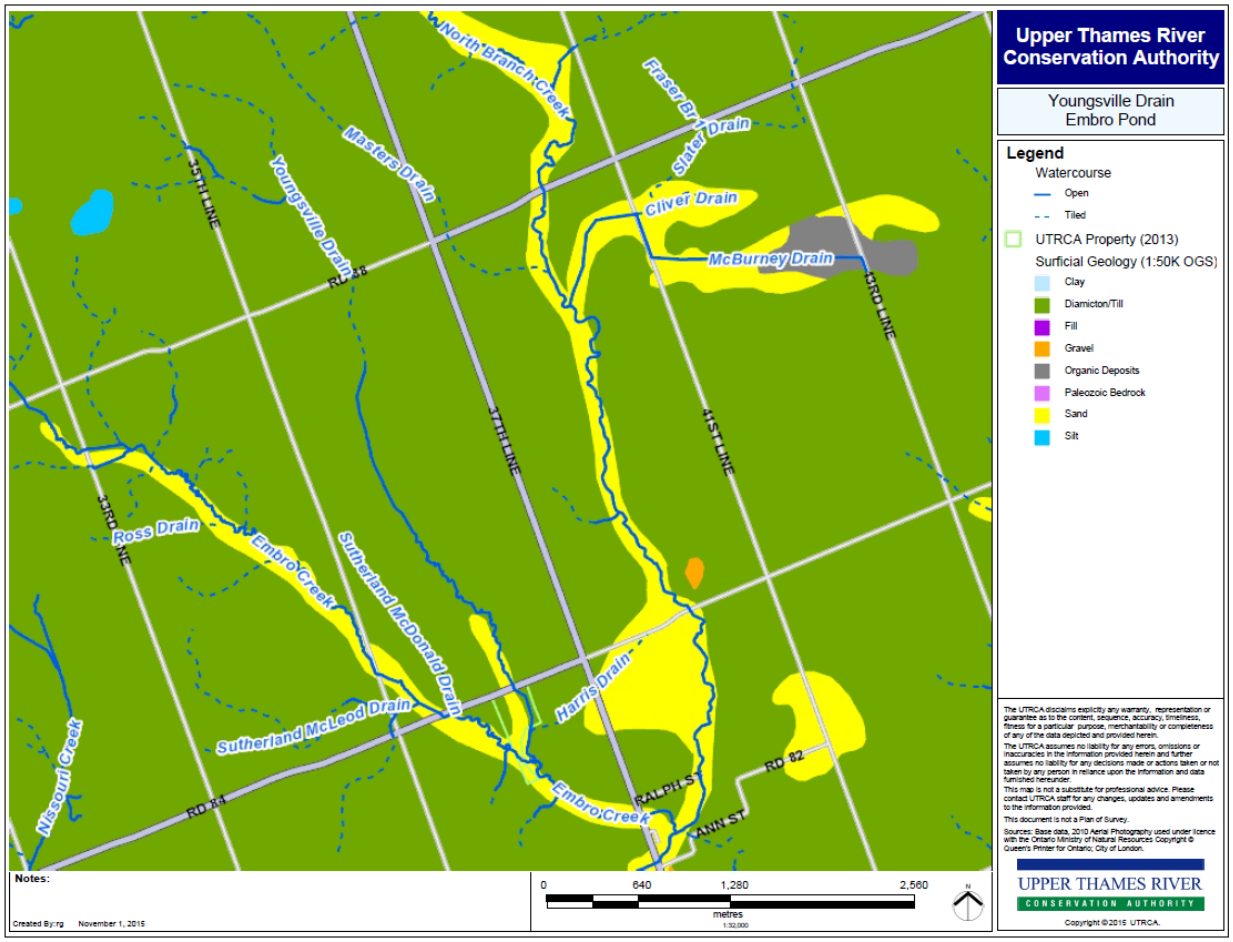


Figure 6 Surficial Geology of the Area

3.3 Embro Dam and Pond

3.3.1 Configuration and Stability

The original construction date of the Embro Dam and pond are unknown; the dam was considered for acquisition in 1947 and was purchased by UTRCA in 1958. The Embro Dam controls a small drainage area of 7 km^2 comprised of mostly agricultural land. The dam forms a reservoir of approximately 0.5 ha (length of ~ 190 m) with an estimated volume of 0.03×10^6 m^3. The dam (~ 100 m long) incorporates low earth fill embankment along the south end of the pond; the entire dam is situated on overburden. The dam has a height of approximately 4.5 m and freeboard of 1.1 m. The dam impounds water year-round and includes approximately 3.4 m of head acting across the dam. Upstream pond slopes are inclined between 3 and 4:1. Downstream slopes of the dam are inclined between 2 and 3:1.
The downstream slope is densely vegetated with grass, bushes and some trees; two gullies have

eroded on this slope, as a result of the emergency spillway overflow and heavy discharge through the concrete pipe conduit (Acres 2007). There is no slope protection on the pond side of the embankment and the slope is overgrown with cattails and marsh vegetation.

Results of the Acres (2007) stability analyses indicate that neither the upstream nor downstream embankment slopes meet criteria for load combinations pertaining to normal water level. (i.e., acceptance criteria is 1.5; calculated values are 1.24 and 1.16 for the upstream and downstream slopes respectively). The downstream slope also does not meet the acceptance criteria (1.3) for the extreme event (i.e., IDF; calculated value of 1.16).

The outlet of the dam includes a concrete bottom draw inlet structure covered with grated trash-rack at the top of the inlet. This outlet consists of 11 or 12 stoplogs that can be used to control the water level in the reservoir. A 762 mm diameter bottom draw concrete pipe conveys flow from the reservoir into the outlet control structure wherein it flows over the stoplog controls (11 or 12 logs) before dropping into the downstream side of the control for conveyance out of the pond via discharge pipe. Should flows / levels exceed the capacity of the low flow system, additional capacity through the outlet structure is available through the top, inverted “V” grating system.

A grassed, emergency spillway is located at the left abutment. This spillway has a clear width of about 4.0 m; inlet invert is 0.6 m below the crest of the dam. The spillway runs parallel to the outlet channel before its confluence with the watercourse. The spillway is not well-defined downslope of the crest of the dam.

Results of the DSA completed by Acres (2007), and the subsequent geotechnical assessment of the embankment by Naylor (2008; i.e., the upstream and downstream embankment slopes do not meet slope stability acceptance criteria) revealed that the Embro Dam did not meet Dam Safety Guidelines, including instability of earth embankments. Improvements to the embankments and spillways were recommended. A summary of the dam assessments was provided in Section 1.3.

3.3.2 Dam Operations and Maintenance

Typical operations at the Embro Dam are straightforward and are carried out twice annually, in late spring and fall, with the objective of adjusting water elevations in the reservoir. The water level in the reservoir is regulated with the use of stoplogs in the outlet control structure. Historically there would be up to three logs removed in the fall to provide additional active storage volume in the reservoir through winter and spring freshet, with the logs replaced in spring to maintain a higher operating level through the summer months.

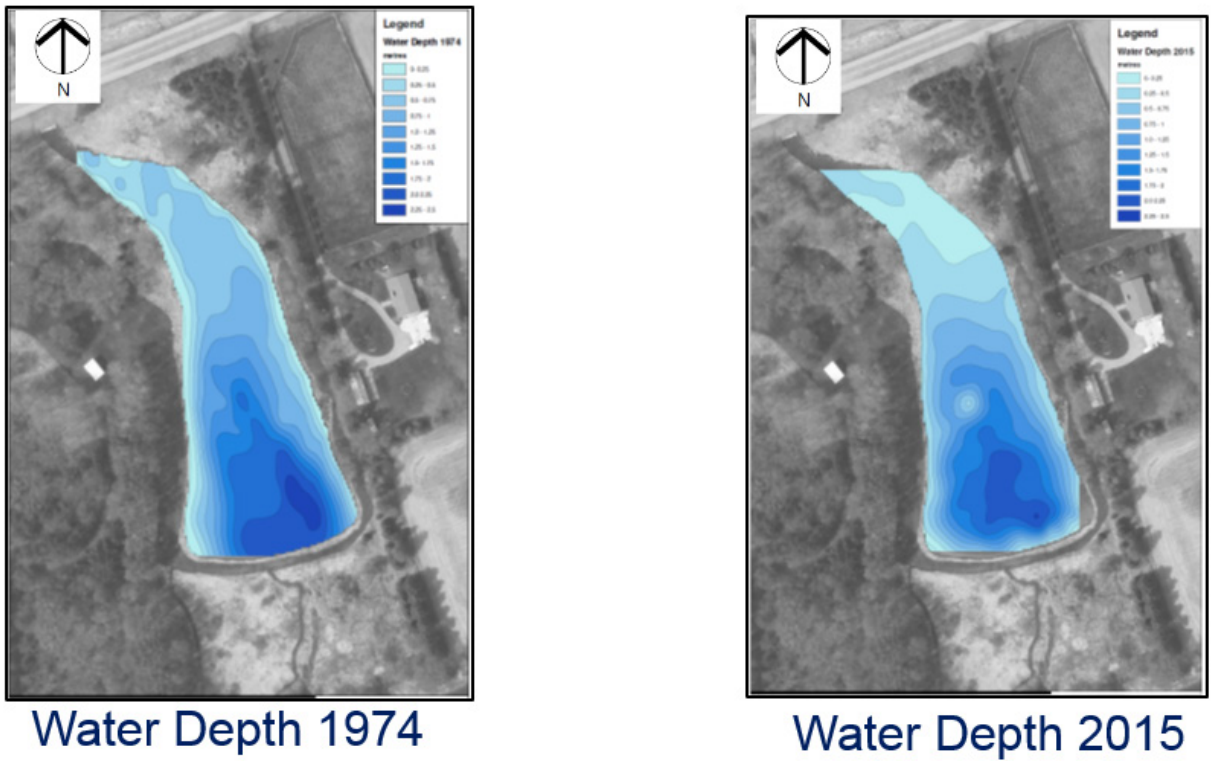
Due to sedimentation of the bottom draw outlet pipe and reservoir more generally, current operating practice is limited to one log being pulled and replaced seasonally rather than three.

Annual regular maintenance for this structure also includes removal of debris that has been deposited against the outlet. A visual dam inspection is performed by the technical staff of the UTRCA on an annual basis.

Non-routine maintenance activities are typical of small dams and include activities such as debris removal from around the outlet structure, signage repair, and repair of localized erosion.

3.3.3 Sedimentation

The pond bed elevation was assessed in 1974 and again in 2015, as part of the current study. Figures showing water depth in each of the time periods were prepared by UTRCA and are illustrated in Figure 7. While the actual values may not be clearly legible, the figures show a decrease in area of deep water (dark blue) and a corresponding increase in shallow water (light blue) over time.



Water Depth 1974

Water Depth 2015

Figure 7 Comparison of Water Depth Between 1974 and 2015 Bathymetric Surveys

Results of the water depth assessments were plotted on a profile through Embro pond (Figure 8). The figure shows that infilling appears to have been greatest at the pond inlet; this is expected since sediment load from Youngsville Drain will drop from suspension as flows enter a slower velocity area.

The bathymetric data were used to quantify the volume of sediment in the pond (i.e., difference between top of sediment as determined through sediment probing). The total volume of sediment was 5,864 m^3; based on the data, it is clear that the Embro pond is approx. 27 to 35% full of sediment. It is uncertain if the bottom of sediment represents 1974 or 1959 conditions. If the bottom of sediment represents 1974 conditions, then the average rate of infilling is 143 m^3/year and complete infilling of the pond at this rate would occur in 124 years. If the bottom of sediment represents 1959 conditions, then the average rate of infilling is 104.7 m^3/ year; complete filling-in of the pond at this sedimentation rate would occur in approx. 172 years. It is important to keep in mind that the impetus for this study is the safety of the dam structure and not the sedimentation.

Note: members of the public present at the PIC suggested that dredging of the Embro pond occurred in 1980. No official record of this dredging event was available. If the pond was indeed dredged in the 1980s, then the rate of sedimentation as presented in this report may underestimate the actual rate of infilling.

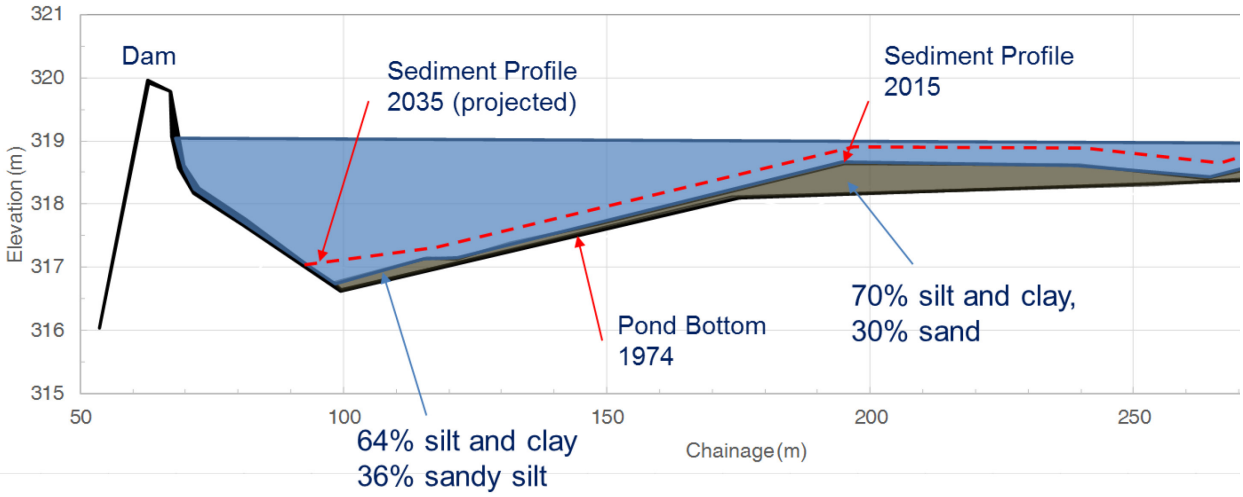


Figure 8 Sediment Profiles in Embro Pond

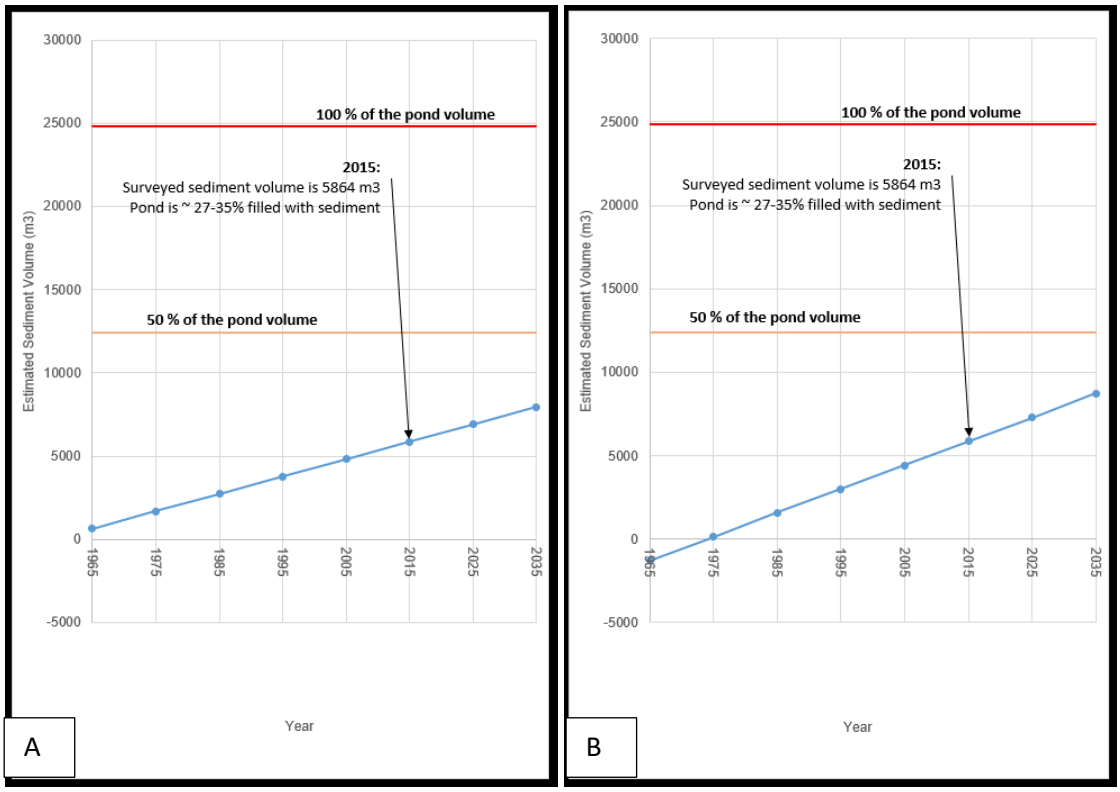


Figure 9 Rate of Pond Infilling
(based on A: 1959-2015 and B: 1974-2015 sedimentation rates)

3.3.4 Pond Sediment Quality and Grain Size

Sampling of pond sediment was completed to assess sediment quality for the context of sediment management in the event of dredging. The analytical results are based on one sediment sample collected in the downstream end of the pond. The intent of the sampling was to investigate parameters including: metals and inorganics, volatile organic compounds, petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), organo-chlorinated pesticides, conductivity, pH, sodium adsorption ratio, grain size analysis.

The sediment testing results were summarized and compared to Ministry of Environment, Conservation, and Parks (MECP; 2022) Table 2.1 standards, O. Reg. 406/19 under Part XV.1 of the Environment Protection Act. The Table 2.1 standards pertain to the potential for reuse, or disposal of sediment, if excavated and transported offsite. The results are compiled in Appendix I.

The sediment testing, when compared to MECP Table 2.1 standards, shows that one parameter (Cyanide - a weak acid dissociable) was outside of standard limits. The cyanide (weak acid dissociable) concentration (0.102 mg/kg) is double the recommended threshold (0.051 mg/kg)

at the upstream sampling location, when considering offsite reuse.. Results for the downstream sample location were below the MOE limits.

Through the public consultation process, concerns were identified by a member of the public regarding the cyanide levels and potential implications for public health. The threshold values for exposure is 5 to 11 mg/kg for oral ingestion and 11 to 100 mg/kg for inhalation or dermal exposure. These thresholds are higher than the threshold value for sediment reuse (0.051 mg/kg) as defined by MOE under the Environment Protection Act, and that measured in the samples examined. Hence, there is minimal concern for health risk to inhalation or dermal exposure due to cyanides. The origin of the cyanide could be variable and include algae, plants, apple seeds (note, anecdotal history of throwing apples into pond), and agricultural runoff. Given the low concentration relative to risk to humans, no further investigation has been undertaken.

Further investigation will be required as part of detailed design and/or ongoing maintenance planning will be required to determine if dredged sediment should be landfilled. Additional aspects to consider both within this Class EA process and as part of detailed design include:

- The results above are based on a single sample from within the pond and, as such, caution is suggested at drawing too many conclusions from that limited data set. It should be expected that a more comprehensive program of multiple samples will yield different results, based solely on random settling characteristics.

- The number of soil samples and laboratory testing that would be required is dependent on the volume of material anticipated for removal and offsite transport. If, for example, it were to be assumed that all non-native sediment required dredging and transport/reuse offsite, as many as 39 environmental quality samples (35 samples, plus 4 QA/QC duplicate samples) would be required to satisfy the regulation, plus an additional 8 leachate samples (7 leachate samples, plus one QA/QC duplicate). Analyses would require at a minimum:

    - petroleum hydrocarbons (F1 through F4), including BTEX
    - metals and hydride forming metals
    - PAHs
    - electrical conductivity (EC), sodium adsorption ratio, and cyanide
    - leachate analyses for specific contaminant of concern

- The MECP (2022) requirements related to management of excess soil only apply to offsite reuse. Sediment retained onsite – i.e., within the ECA – would not require any special consideration.

- Similarly, sediment transported and reused offsite on another property owned by the proponent (UTRCA) would only be required to illustrate that the transported soils were of equal or better quality than that on the receiving lands, as it pertains to parameters that don't meet Table 2.1 requirements. In this case, for example, the receiving lands would have to be shown to have in-situ cyanide concentrations greater than that of the dredged sediment.

Numerous parameters included in the sediment samples were not detectable below a set limit due to the constraints of the laboratory testing and samples. The MECP parameter limit was, at times, below the detection limit of the laboratory and/or samples. In such cases, whether or not the samples exceeded the MOE limits is unknown. Additional sediment analyses should be considered during detailed design, to further evaluate the opportunities for sediment management if sediment dredging is required.

The Toxic Characteristic Leaching Procedure (TCPL) was also applied to the samples to identify the potential management strategy of the sediment in conjunction with works required to implement an alternative. The TCLP results are included with the sediment testing results in Appendix I and are compared to Schedule 4 Leachate quality criteria (Ontario 2015), O. Reg. 461/05 under the Environmental Protection Act which forms the basis for the definition of hazardous waste. The TCLP results did not exceed regulation limits set out in Schedule 4 and was thus not defined as hazardous waste.

Grain size analyses of the sediment samples were completed to determine the percentage of sands, and silts and clays. Results of the sampling indicated that the sediment was dominated by silt and clay and had a smaller fine sand component. The distribution in grain sizes was similar between the upstream and downstream samples collected in the pond; pond (upstream): 70% silt and clay, and 30% fine sand (sandy silt, trace clay) and pond (downstream): 64% silt and clay, and 36% sand (silt and sand, trace clay; See Figure 8).

3.4 Hydrotechnical Environment

3.4.1 Hydrology

At the Embro Dam, the surface drainage area, consisting predominantly of agricultural land use, is 7 km^2. An estimate of the peak flood flows and hydrographs for the 2-to-500-year return period flows was undertaken as part of the Acres (2007) report. Since the study area is not located at, or near, an appropriate Water Survey of Canada monitoring station, the estimate of flood flows was based on modelling as outlined in the Acres (2007) report. Acres (2007) determined that the 8-day snowmelt volume of 9.4 cms would have a recurrence interval of 1:50 years; this corresponds to the IDF (see Canadian Dam Association (2007) Dam Safety Guidelines). This recurrence interval is more frequent than predicted by other methods outlined in the Acres (2007) report, but considered to be reliable.

The surface water hydrology of Youngsville Drain was studied by UTRCA staff (see separate report in Appendix A). The purpose of the analyses was to determine average flow rates and the unit area flow rate for each catchment area, to assess the response of the stream to drought and low water conditions, to assess the contribution of the stream to the overall flow from its subwatershed, and to examine the effect of the water control structures on upstream and downstream flow rates. A summary of key findings is provided below.

- Analyses have demonstrated that the 645.6 hectare catchment area of Youngsville Drain contributed greater unit area flow rates to the Thames River than those monitored at the following nearby stream gauging stations:
    - Trout Creek near Fairview
    - Avon River above Stratford
    - Fish Creek
    - Trout Creek near St. Mary's
- Based on monitoring undertaken in 2011, 2012, and 2015, Youngsville Drain, downstream of Embro Dam contributes 3.5%, 12.4%, and 6.4% respectively, of the total flow measured downstream of Thamesford. These flow contributions are approximately 67% to 470% more than the amount that would be expected than a contributions based on only the size of the catchment area.
- Based on the relationship in flows between Harrington Creek and Youngsville Drain, the groundwater recharge characteristics of the Youngsville catchment area, field observations of springs in the catchment area, and the close proximity to shallow overburden aquifers, it

is predicted that Youngsville Drain has a high resiliency to drought/low flow conditions. This resiliency is likely due to groundwater contributions.

- Flow measurements during baseflow conditions indicated that the flow upstream of the backwater effects of Embro Dam was approximately 92% of the flow measured downstream of Embro Dam. This represents an 8% increase in flows through the pond (i.e., from upstream to downstream, which is likely attributable to groundwater contributions.

3.4.2 Groundwater

The UTRCA reviewed internal thematic mapping and Ministry of Environment and Climate Change (MOECC) well records to characterize the general hydrogeological setting of ECA and the local surrounding area. The well records were examined and classified as shallow or deep on Figure 10. The shallows wells generally represent those that were drilled in association with field studies rather than those used for other purposes (drinking water).

Figure 10 Known Wells in the Area of Embro Conservation Area
(Data Source: MOECC; Appendix A; deep wells are in blue, shallow wells are yellow)

Mapping reveals that the catchment area is dominated by till (Figure 6); the groundwater occurs in the fill layer that is above the glacial till. The groundwater flow gradient is from the north to the south, towards the community of Embro. Thematic mapping indicates that there is a moderate groundwater recharge rate (Figure 11).

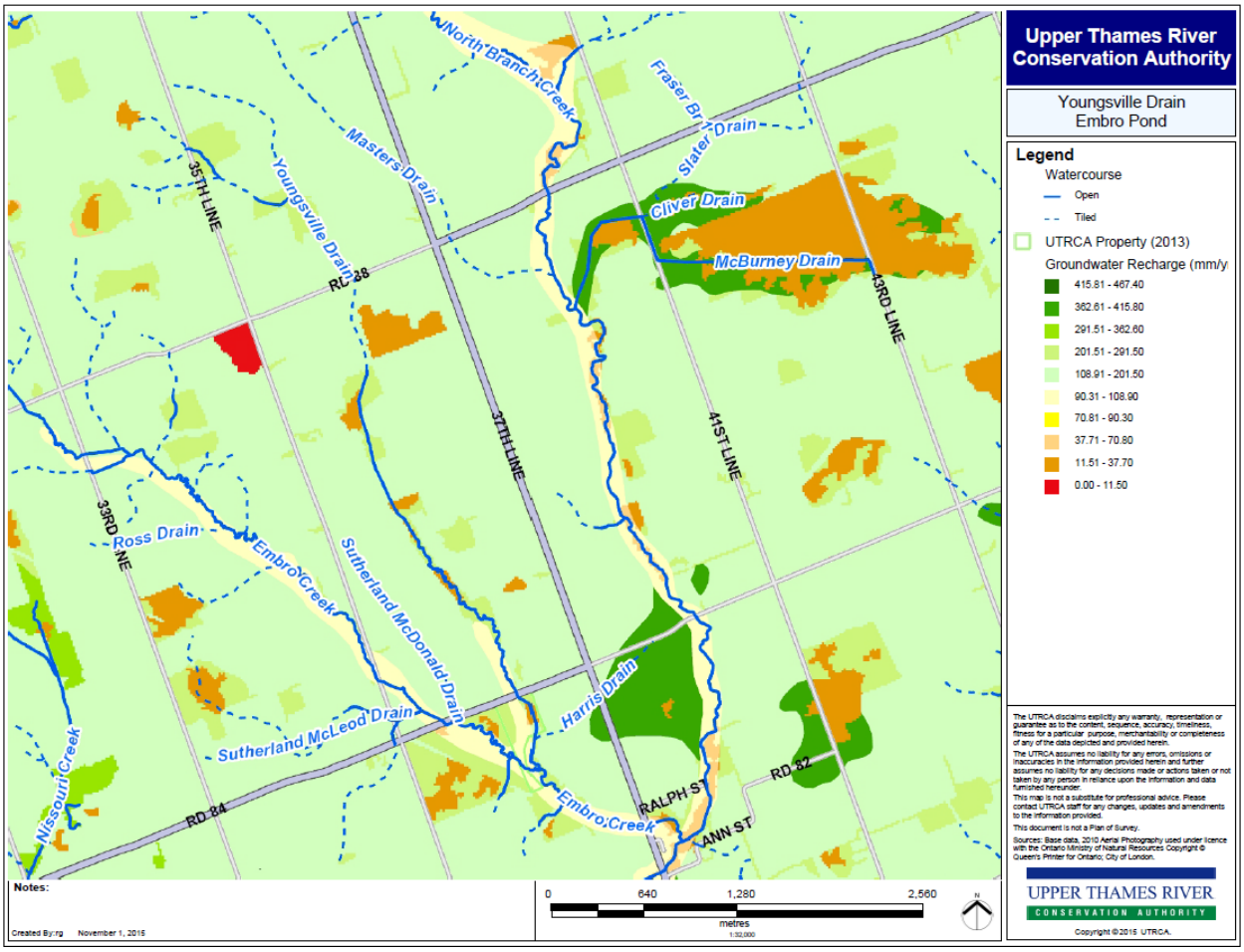


Figure 11 Groundwater Recharge (mm/y) of the Area around Embro Conservation Area (Source: UTRCA; Appendix A)

3.5 Fluvial Geomorphology

The intent of the fluvial geomorphic assessment was to characterize channel form and gain insight into channel processes along Youngsville Drain in the vicinity of Embro pond. Youngsville Drain is a tributary of Mud Creek and flows from a north to southerly direction.

A review of historical channel conditions was completed to gain insight into changes that have occurred within the study area. UTRCA provided airphotos dated from 1955, 1972, 1989, 2000, 2010; additional aerial imagery was available from Google Earth (2015). Key observations are

summarized below; a collection of historical airphotos and recent photos depicting existing conditions in the study area is provided in Appendix F.

- In 1955, Embro pond was not yet constructed south of Road 84 and Youngsville Drain meandered within its floodplain. Upstream of Road 84, Youngsville Drain was sinuous and appears to be situated in a field (grasses, herbaceous plants) with few trees. A hedgerow occurs east of the creek and separates the creek from active land use.

- In 1972, construction of Embro pond was complete (note: pond was completed in 1959). Channel realignment/straightening occurred, beginning at approx. 95 m north of Road 84. Channel modifications appear to have occurred at the outlet of the dam (widening, deepening, and straightening).

- In 1989, floodplain vegetation west of Youngsville Drain, and north of Road 84, appears to be naturalizing and increasing in diversity. Some channel planform development appears to be occurring at the upstream limit of the channel straightening.

- In 2000 and 2010, overall, no change in planform configuration is evident in comparison to the 1989 aerial image.

A geomorphic field investigation was undertaken on June 11, 2015 to assess existing conditions along Youngsville Drain, both upstream and downstream of Embro pond. During the field assessment, three reaches were identified. A second field visit was completed on November 18, 2022, to reassess site conditions since the initial investigation. A brief description of dominant channel characteristics is provided by reach below. The reach delineation is demonstrated on Figure 12 the surveyed channel bed profile is illustrated in Figure 13 which includes a profile through Embro pond based on 2015 water depth mapping provided by the UTRCA.

Figure 12 Reach Delineation Along Youngsville Drain

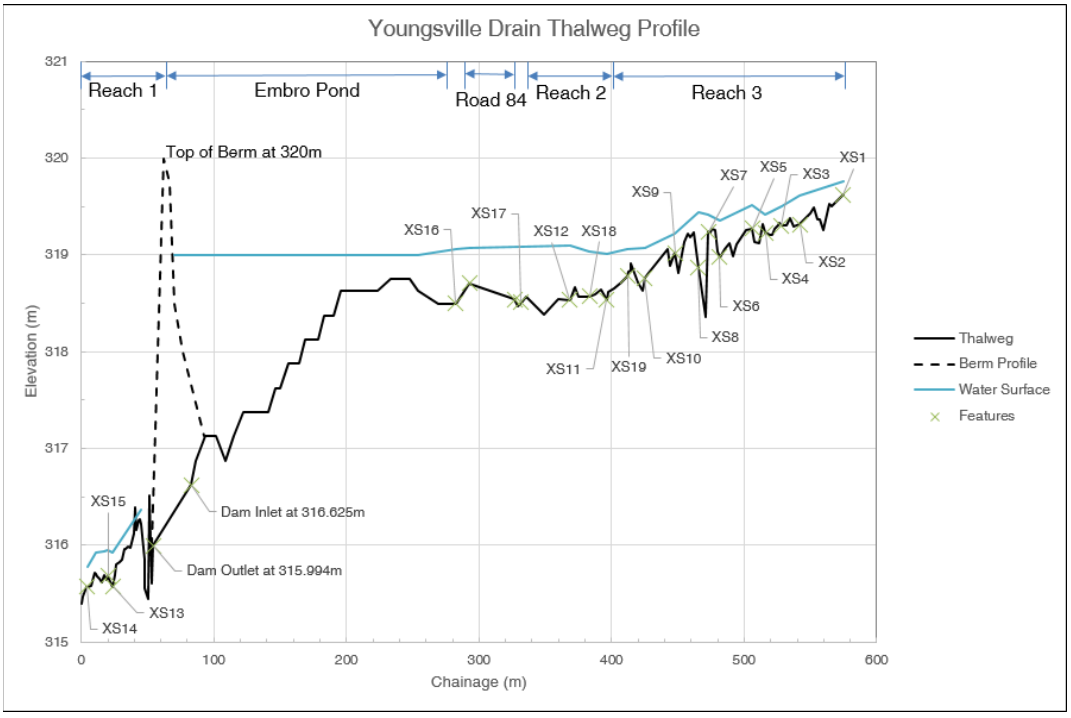


Figure 13 Surveyed Channel Bed Profile Along Youngsville Drain

3.5.1 Reach 1: Downstream of Embro Pond

2015

- From the outlet of Embro pond to the end of the UTRCA property, the watercourse was relatively straight; a slight meander was beginning to form near the downstream limit of the reach. The creek was likely straightened in conjunction with construction of the dam.

- The channel cross-sections were generally symmetrical in shape and trapezoidal, with a measured bankfull width of 3.70 m and a water depth of 0.29 m. The cross-sections were set within a larger channel. Riparian vegetation consisted of dense grasses and herbaceous plants; roots extended to the bottom of the banks. Towards the downstream end of the reach, shrubs and trees were overhanging into the creek.

- The dominant bed morphology along the entire reach was riffle/run with shallow pools. The channel bed consisted primarily of cobbles and gravel. Glacial till was exposed along the toe of the bank along a pool.

- Overall, the Youngsville Drain appeared to be stable throughout the reach.

- A pool was observed at the outlet of the dam culvert. Fish species have been observed in this pool.

2022

- Reach maintained similar characteristics as 2015.

- Dominant morphology consisted of small riffles and runs with shallows pools up to 0.35 m deep. The substrate is primarily unconsolidated gravels and cobbles, but transitions to sand and gravel towards the downstream extent.

- Some erosion was noted along the west bank immediately downstream of the scour pool, along with a potential chute further downstream, creating a medial bar.

- Rapid Geomorphic Assessment results suggested that this reach is 'in transition' with a dominant 'degradation' process (i.e., channel bed lowering).

- Fish continued to be observed within the pool situated at the outlet of the dam.

3.5.2 Reach 2: Embro Pond Inlet to 85 m Upstream of Road 84

2015

- In this portion of the watercourse, Youngsville Drain appeared to be under backwater conditions and influenced by water levels from Embro pond. The backwater conditions extended 85 m upstream of Road 84; the channel was straight.

- The cross-sections were well-connected to the floodplain. The cross-section configuration was generally trapezoidal and did include a defined thalweg position. The bankfull width was measured to be 3.8 m, with bankfull depths average 0.5 m, with a maximum depth of 0.66 m. The channel width increased in the downstream direction as expected in a backwater condition; the width:depth ratio for the two cross-sections was relatively narrow and ranged from 6.66 to 9.32.

- Channel banks were well vegetated with grasses and herbaceous plants; the fine and dense rooting network extended to the water surface. The bank configuration was generally irregular which is characteristic of banks influenced by backwater conditions in which hydration of bank materials leads to erosion. The relatively low banks indicate good floodplain accessibility during high flows.

- The channel bed morphology was poorly developed and was relatively uniform in configuration. Channel bed materials consisted primarily of silt and sand sized particles with few gravels. The bed materials were 'soft' due to their hydrated condition. Submerged aquatic plants were observed on the channel bed.

- Application of the Rapid Geomorphic Assessment (RGA) for this reach indicated that the channel is 'in regime'. The dominant process within the reach is deposition. Gradual widening of the cross-section is expected due to the hydration effect typically associated with backwater conditions.

2022

- Water levels appear lower than noted at the 2015 site visit, but backwater conditions remained beyond Road 84.

- Downstream of Road 84 the channel had a water depth of 0.30 m, wetted width of 2.94 m and a defined bankfull width of 6.74. The channel had fine sediment depth measured to 0.19 m within the centre of the channel. The channel narrowed moving upstream, with a measured bankfull width of 4.37 m and a water depth of 0.43 m. Banks remained well vegetated with trees, grasses, and shrubs.

- Culvert under Road 84 had large deposits of fine sediment up to 0.26 m, directing low flows to the western side of the outlet.

- Upstream of Road 84, the channel maintains a meandering thalweg within the channel between alternating bars of dense aquatic vegetation. Within the thalweg, the channel bed is primarily sand with fine gravel, and shows some developed bedforms such as dunes, while the aquatic vegetation is seated within organic material and silts.

- An RGA completed for this reach resulted in a Stability Index rating of 0.313 (transitioning) with the primary characteristic of this reach being aggradation.

3.5.3 Reach 3: From 85 m to 235 m Upstream of Road 84

2015

- In Reach 3, Youngsville Drain was a meandering watercourse that was situated towards the west side of a ~ 30 m wide channel corridor that was separated from adjoining agricultural land uses by a row of cedar trees. The watercourse was situated towards the west side of this corridor. Riparian vegetation typically consisted of grasses and herbaceous plants along the east bank, and cedar or willow trees along the west bank. The vegetation and fine dense rooting network typically extended to the water surface.

- Along the east side of the channel, two locations were identified at which surface drainage was actively being conveyed over the bank into the creek. The source of water was not investigated.

- The cross-sections were generally uniform in configuration and well-connected to the channel banks, with bankfull widths averaging 3.90 m for riffles and 4.09 m for pools, while average depths were 0.44 m and 0.56 m respectively. This reflects the control of grassy and herbaceous bankside vegetation on channel form.

- Banks were generally steep. No active erosion was noted. Undercutting of the banks was generally minimal (up to 8 cm), but measured up to 24 cm underneath a root wad (17 cm) and occurred at the bottom of the rooting zone and/or the interface with underlying stratigraphic materials. Along the lower bank, a soft rock was observed which resembled a conglomerate rock type (i.e., round gravels situated within a fine matrix of silt and sand sized particles. The cobble and gravel sized sediment observed on the channel bed consisted of this conglomerate material; pressure exerted onto the particles would cause it to break into smaller pieces.

- The channel bed morphology has developed into the soft conglomerate sedimentary rock. Field measurements revealed that from distance from the top of this unit to the channel bed was 30 cm, suggesting that the channel has incised this depth into the materials. The dominance of riffle/run features along the channel bed is a result of this resistant bed material. Shallow pools have formed and occur along the outside bends of meanders. The underlying bedrock controls profile development and reflects the relatively small difference in depth between pool and riffle sections. The deepest pool evident on Figure 13 was 0.87 m deep; in general, all other pool depths were considered to be shallow (i.e., residual depths ranged from 0.15 - 0.28 m).

- Analysis of the topographic channel bed profile, provided by UTRCA, was undertaken. This revealed that the average water surface grade during the field survey (June 11, 2015) was 0.32 % and the average bankfull grade was 0.43 %.

- Application of the RGA for this reach indicated that the channel is 'in transition' and is dominated by aggradation processes. Indicators of aggradation include lateral bars of silt and very fine sands which were observed along the channel.

2022

- Within Reach 3, the channel maintains a meandering planform through a narrow riparian corridor between agricultural lands. The banks are well vegetated with grasses, shrubs, and tree which have deposited large amounts of woody debris into the channel.

- The channel is well connected to the floodplain within the riparian corridor. dimensions measured in the reach show an average bankfull width of 4.4 m, and an average water depth of 0.22 m. Undercutting of banks was observed towards the downstream extent of the study area, measuring 0.22 m deep in some locations.

- The substrate increased in roughness further upstream, and was primarily large and cobbles which formed small, submerged riffles, along with occasions boulders within the channel.

- The RGA for this reach indicated that the channel was in transition and is primarily widening; this explains the observed bank undercutting and large amounts of woody debris in the form of fallen trees.

3.6 Natural Environment

Assessment of the natural environment was completed by UTRCA and documented in their 2015 study reports (see Appendices A to D of this report).

In 2022, Matrix conducted a reconnaissance level site visit to confirm conditions previously identified by the UTRCA. This included a high-level application of ELC, vegetation inventory and incidental wildlife.

A summary of the key findings from all field assessments is provided in the sub sections below and details are presented in Appendix C and D.

3.6.1 Background Review

The purpose of the vegetation and bird study completed by the UTRCA in 2015 was to document vegetation communities and bird species within the ECA to establish baseline conditions and to identify sensitive species that need protection or consideration prior to any potential changes to the Embro Dam or reservoir. This included review of eBird records.

Fish and benthic surveys were conducted in order to understand the existing conditions of the aquatic community upstream and downstream of the Embro Dam. Existing aquatic community information will help inform decision makers as to how to best manage this aquatic resource.

3.6.2 Identified Features

The UTRCA used a 100-metre area of adjacent land around the ECA to identify Areas of Natural and Scientific Interest (ANSI), Significant woodlots, and wetlands (such as Provincially Significant Wetlands - PSWs) around the study area, further referred to as the Embro Dam study area. No PSWs or ANSI's were identified; however, the following features were identified within the Embro Dam study area:

- The wooded areas of Embro CA area part of a larger significant natural heritage feature that includes the Oxford County Forest
- Youngsville Drain supports a healthy fish population, characterized as a coldwater stream with permanent springs and seeps.

3.6.3 Vegetation and Wildlife Inventory

The UTRCA completed field investigations to examine the vegetation, birds, and wildlife of Embro CA to identify any rare or sensitive species that might be impacted if changes to the Embro Dam and reservoir are undertaken. A detailed report of the vegetation, bird, and other wildlife inventory can be found in Appendix D. The following sections provide a summary of those investigations.

Assessment of the natural environment consisted of a three-season, non-quantitative assessment of vegetation, as well as incidental observations of birds and other wildlife in May, July and August, as well as broad ELC classifications of natural vegetation communities, within the ECA and within 100m of the reservoir by UTRCA staff in 2015. A total of four vegetation communities were delineated by the UTRCA in 2015 and include a cultural savannah, a cultural meadow, a mixed forest and a shallow aquatic community associated with Embro pond. Of the 198 plant species that were recorded, 31% were non-native. No plant Species-at-Risk or Special Concern species were found in the study area (on the land or in the water) and no records of plant species at risk were found within a 2 km radius. Four provincially rare plant species with SRanks of S1-S3 (rare or uncommon) were observed; however, have all been planted in the two tallgrass prairie plots in the cultural savannah.

Three-season bird surveys were undertaken by UTRCA in 2015 in early spring (April 22), spring (May 5, 14, 26), summer (June 24). A minimum of four hours, with particular effort around the pond, was spent in the spring and early summer visits. Incidental observations in spring (May 27 and 28), summer (July 8 and 10), and later summer (August 26 and 28) were also undertaken. 40 species were recorded. Other than Barn Swallow and Eastern Wood Pewee, both considered Species of Special Concern under the Endangered Species Act (ESA; and therefore considered Species of Conservation Concern), the species were common and mostly forest birds.

3.6.3.1 Vegetation

Methods

A three-season botanical inventory was completed in 2015 of 5.4 ha of the ECA, within 100 m of the reservoir. The entire study area was walked for two days in May, 2 days in July and 2 days in August. The four ELC vegetation communities were mapped onto 2010 colour ortho-imagery and vascular plants in each vegetation community were recorded on field sheets. A full checklist, complete with plant metrics, was developed for each community and for the entire site.

Results

A total of four vegetation communities were delineated by the UTRCA in 2015 and include a cultural savannah, a cultural meadow, a mixed forest and a shallow aquatic community associated with Embro pond. A description of these communities is provided below.

Cultural Savanna (CUS): This community is 2.1 ha in size and encompasses both sides of the reservoir in the north. This community has several small habitats within it, including a day use area with mowed grass and scattered shade trees, small naturalized areas of meadow/marsh along the shore of the pond, and by Road 84, and two planted tallgrass prairie plots. Mature

trees include Silver Maple (Acer saccharinum), Red Pine (Pinus resinosa) and White Birch (Betula papyrifera) with younger Sugar Maple (Acer saccharum), Red Oak (Quercus rubra), and Burr Oak (Quercus macrocarpa). Naturalized areas have raspberries (Rubus sp), dogwoods (Cornus sp), and Choke Cherry (Prunus virginiana).

A total of 168 plant species were identified, of which 115 were native. The large number of plant species is due to the diversity of micro-habitats within the community. The MCC of 3.8 is a moderate score, and there is a slight predominance of wetland plants. 32 % of the plants are non-native, which is average for the Upper Thames watershed and reflects the disturbances from past land use changes and day use activities.

Cultural Meadow (CUM). This community is 0.7 ha in size and is a riparian area encompassing both sides of the Youngsville Drain south (downstream) of the reservoir. Tree cover is sparse and include ashes (Fraxinus sp), willows (Salix sp), Black Cherry (Prunus serotina), Black Walnut (Juglans nigra) and White Elm (Ulmus americana). Joe Pye-weed (Eutrochium maculatum), jewelweeds (Impatiens sp), asters (Symphyotrichum sp), goldenrods (Solidago sp), teasel (Dipsacus sp), thistles (Cirsium sp), milkweeds (Asclepias sp) and grasses dominate the herbaceous layer.

A total of 92 species were identified, or which 61 were native. The MCC of 3.0 is a moderate score. 34% of the plants are non-native, which is average for the Upper Thames watershed and reflects the natural and human disturbances this community experiences.

Mixed Forest (FOM): This community is 1.6 ha in size and occurs in the study area (within 100 m of the reservoir), but part of a larger woodland that extends westward. Comprised of conifers planted 50 years ago, with naturally seeded in and recently planted deciduous trees filling in amongst the dying pines. The forest is young to mid-age and consists of Red Pine (in decline), Black Cherry, Silver Maple and Sugar Maple. Understory trees include ashes, Black Cherry, Black Walnut, and apple (Malus sp). Common shrubs are raspberries and Choke Cherry

A total of 101 species were identified, or which 77 were native. The MCC of 3.5 is a moderate score. 24% of the plants are non-native, which indicates the habitat is moderately good for the Upper Thames watershed.

Shallow Aquatic (SA): This community is part of The Embro Pond / reservoir. Over the years, the pond has accumulated a large amount of sediment and now has an average depth of 0.5 m with a very soft bottom substrate. It is estimated that 50% of the reservoir volume is filled with aquatic vegetation consisting of Duckweed (Lemna sp) and algae floating on the surface. Additionally, four rooted aquatic species consisting of Broad-leaved Arrowhead (Sagittaria

latifolia), Broad Waterweed (Elodea canadensis), Curly-leaved Pondweed (Potamogeton crispus), and Slender Pondweed (Potamogeton pusillus) were observed. The clarity of the water and surplus of nutrients means there is heavy growth of the pondweeds and waterweeds, while there are smaller amounts of arrowheads. There are very few wetland emergent plants growing along the edges of the ponds, likely because of the steep sides and that the water in the pond is kept at the same elevation. The vegetation is considered to provide good cover for fish species such as juvenile Northern Sunfish, considered a Species of Special Concern under the ESA (and therefore considered a Species of Conservation Concern), that are linked to Potamogeton (pondweed) found in the Embro pond.

Findings from the field assessment indicated that, of the 198 plant species found, 31% were non-native; this represents an average or moderate number in comparison to other natural areas and parks within the Upper Thames watershed. The overall quality of the terrestrial habitats (Cultural Savanna, CUM, and Mixed Forest) was assessed as average or moderate. Previous efforts to plant native trees and tallgrass prairie plants into the CA have added diversity to the study area. The reservoir has a dense growth of rooted aquatic waterweeds and pondweeds, but all three native species are common. There are very few rooted emergent wetland plants along the edges of the pond owing to the steep sides and constant water levels.

No plant species-at-risk or Special Concern species were found in the study area (on the land or in the water) and no records of plant species at risk were found within a 2 km radius.
Four provincially rare plant species with SRanks of S1-S3 (rare or uncommon) were observed; however, have all been planted in the two tallgrass prairie plots in the cultural savannah. These species include: Tall coreopsis (Coreopsis tripteris), Gray-headed coneflower (Ratibida pinnata), giant ironweed (Vernonia gigantea), culvert's root (Veronicastrum viginicum).

3.6.3.2 Wildlife

Methods

An incidental three-season bird survey was undertaken by UTRCA in 2015 in early spring (April 22), spring (May 5, 14, and 26 to 28), summer (June 24, July 8 and 10) and late summer (August 26, 28) A minimum of four hours, with particular effort around the pond, was spent in the spring and early summer visits. Additional information regarding incidental observations of wildlife was received from UTRCA's Species at Risk Biologist and included in the results below. Mussel surveys, bat surveys, and amphibian surveys were not conducted, and that bird surveys did not follow breeding bird or marsh bird monitoring protocols.

Results

Most of the 40 species of birds recorded by UTRCA staff in the study area are common species and most are forest birds. The reservoir does provide limited significance for a few common resident waterfowl for raising broods such as Wood Ducks and Canada Geese. Migrating waterfowl were observed to make little use of the Embro reservoir during spring migration, likely due to the isolation of this pond from other ponds or lakes in the area. Barn Swallow and Eastern Wood Pewee, considered Species of Special Concern, under the ESA (and therefore considered Species of Conservation Concern), were seen in the study area; however, no nesting was observed. Outside of the UTRCA incidental survey, Embro CA is listed as an eBird hotspot, with 114 species recorded, records which are collated from individuals and groups that have visited the site. Species associated with wet areas noted in eBird for Embro CA include: Mallard, Belted Kingfisher, Canada Goose, Killdeer, Solitary Sandpiper, Great Blue Heron, Common Yellowthroat, Least Sandpiper, Red-winged Blackbird, Swamp Sparrow, Green Heron, Spotted Sandpiper, Green-winged Teal, Hooded Merganser, Common Loon (2020), and Yellow-headed Blackbird (1953).

Other notable species recorded on the property in general, via eBird (https://ebird.org/hotspot/L7268288), include Wood Thrush, Barn Swallow, Bobolink, Peregrine Falcon (2019), Chimney Swift (2018), Canada Warbler (2009), and Red-headed Woodpecker (1981). Note that in the absence of long-term survey data, eBird provides some good background information, and any species at risk or locally rare species observed via eBird are peer reviewed by eBird admins before acceptance.

Monarch butterflies, considered a Species of Special Concern under the ESA (and therefore considered a Species of Conservation Concern), were recorded incidentally by UTRCA in 2015. The continued presence of the tallgrass prairie plots and milkweed in Embro is a positive step for this species and the removal of the Embro Dam and reservoir should not impact this species or their food. Midland Painted and Snapping turtle species have been incidentally observed basking over the years by the UTRCA's Species at Risk Biologist; these are listed federally under Species at Risk Act (SARA) as Special Concern. The Snapping Turtle, a Species of Special Concern under the ESA (and therefore considered a Species of Conservation Concern), was observed within the reservoir and should be given consideration when evaluating the alternatives. Although nesting sites of this species have not been confirmed, any sunlit and south-facing area with limited vegetation is likely used. Additionally, it was noted that the pond may be important for amphibians, such as frogs that most likely use the pond for breeding.

Through the public consultation process, a resident indicated that an Eastern Red-backed Salamander was observed on his property (i.e., not in, or adjacent to Embro CA). Red-backed

salamanders carry out most life processes, including egg-laying, in terrestrial habitats and primarily within forested areas, making them less susceptible to construction activities adjacent to the existing pond. Aquatic breeding species (Spotted Salamander, Blue-Spotted Salamander, Ambystoma unisexual, and Red-spotted Newt) are not confirmed for the area, though their presence should not be discounted entirely. No salamanders were observed by the UTRCA during incidental wildlife surveys.

In conclusion, based on the UTRCA assessment of vegetation, fish, birds and wildlife as documented in Appendix D, there are no species at risk, rare vegetation communities or plants observed by the UTRCA within the study area. However, five species (Barn Swallow, Eastern Wood Pewee, Monarch, Snapping Turtle, and Northern Sunfish) are considered a Species of Special Concern under the ESA (and therefore considered a Species of Conservation Concern), Species listed as Special Concern do not receive protection under the *Endangered Species Act*; however, are protected under the Provincial Policy Statement and are recognized as Species of Conservation Concern.

3.6.4 Aquatic Ecology

3.6.4.1 Fisheries Resources

Methods

Youngsville Drain has been sampled extensively in the past, both upstream and downstream of pond. From 2015 to 2022, upstream reaches were sampled for fish on 12 occasions and downstream of the dam was sampled 6 times. Sampling sites are shown on Figure 14.

Two samples on upstream reaches (May 7, 2015 and November 2014) were deemed adequate to confirm fish community composition. In an effort to augment existing data, an electrofishing survey of Embro pond and Youngsville Drain downstream of the dam was conducted on April 15, 2015. The site downstream of the dam was surveyed two more times (July 8 and October 19, 2015) to provide three-season data. Additional sampling from 2015 to 2022 augments previous fisheries records. The upstream site was visited on 12 occasions and 6 times at the downstream site from 2015 to 2022. All specimens were identified to species, recorded, and released. Sample records, including historic records, are tracked in the KiECO module of UTRCA's WISKI database and are provided in Appendix C.

A modified Ontario Stream Assessment Protocol (2017) Single Pass Survey approach, has been used for UTRCA fish sampling. This type of survey can be used to generate a list of common fish species and characterize fish communities at a site, as long as all habitats are sampled.

While this survey can provide a qualitative assessment of species abundance at a site, it cannot provide quantitative estimates of population abundance.

Fish populations at each site were assessed using electrofishing. This technique is used widely to examine freshwater fish communities, using electricity to attract and stun fish. This method allows netters to remove the fish from the water using dipnets. Captured fish are held in aerated buckets until all fish are identified, and then are returned unharmed to the area from which they were captured.

Settings were adjusted at each site depending on environmental variables such as conductivity, which were measured at the start of each survey using a handheld water quality meter.

Each individual fish was identified to species level using "The ROM Field Guide to Freshwater Fishes of Ontario" (2009) and recorded.

Results

Results of the 2015-2022 sampling, and previous fish surveys, reveal a large discrepancy in species diversity between up, and downstream, of the pond (i.e., 9 species recorded upstream and 27 species downstream). The low species diversity is likely reflective of the impact of the barrier to fish movement that is due to the Embro Dam and pond. The diverse downstream community includes cold and cool water species and both permanent, and seasonally present, warm water species.

Six of the eight fish species historically found upstream of the Embro Dam were located during recent sampling (conducted in 2016, 2019, and 2022). One additional species; the Bluntnose Minnow was detected. Two species: Creek Chub and Northern Redbelly Dace, were previously found upstream, but not detected in the most recent sampling events. As species recently detected were primarily the most commonly encountered fish in previous surveys, this is considered to be a fairly stable fish community.

Twenty of the 27 fish species sampled downstream of the Embro pond were found during the November 2015 to July 2022 sampling. Of the 20 species, five were new species detections. Of note, Northern Sunfish, considered a Species of Special Concern under the ESA (and therefore considered a Species of Conservation Concern), was detected at the downstream site on August 13, 2019. Prior to 2016 Northern Sunfish did not have Special Concern status. The Northern Sunfish status was assessed to be of Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) May 2016. The Committee on the Status of Species at Risk in Ontario (COSSARO) assessed Northern Sunfish status to be Special Concern

December 2016. The main threat to Northern Sunfish is declining habitat quality.
This species likes slow-moving, clean water with plenty of aquatic vegetation and is not tolerant of muddy or polluted waters. Seven (7) species; Bluegill, Golden Shiner, Greenside Darter, Rock Bass, Rosyface Shiner, Smallmouth Bass, and Striped Shiner were previously found downstream, but not detected in the most recent sampling events. Results of the recent fish sampling indicate that Embro Dam continues to be an effective barrier to fish movement and it limits the upstream fish community diversity.

During the field assessments, it was noted that there was a significant pool situated at the outlet of the dam which provided habitat, allowing fish species to congregate.

3.6.4.2 Benthic Resources

Methods

Benthic invertebrate sampling was conducted in the spring (May 5) and fall (September 23) of 2015, May 2016, September 2017, September 2019, and September 2021 incorporating a riffle (if present) both up upstream of Embro pond and downstream of the dam. Sampling was conducted using a traveling kick and sweep method and a 500 µm D-frame net, and samples handled and analyzed using methods consistent with provincial (OBBN) and Federal (CABIN) protocols. Samples were preserved in the field (in ethanol), randomly subsampled in the laboratory and identified to the Family taxonomic level. Resulting data were entered into, and analyzed, using an MS Access database. Sample records (including historic records) with calculated Family Biotic Index (FBI) are provided in Appendix C. The water quality ranges for the FBI values can be seen in Table 1.

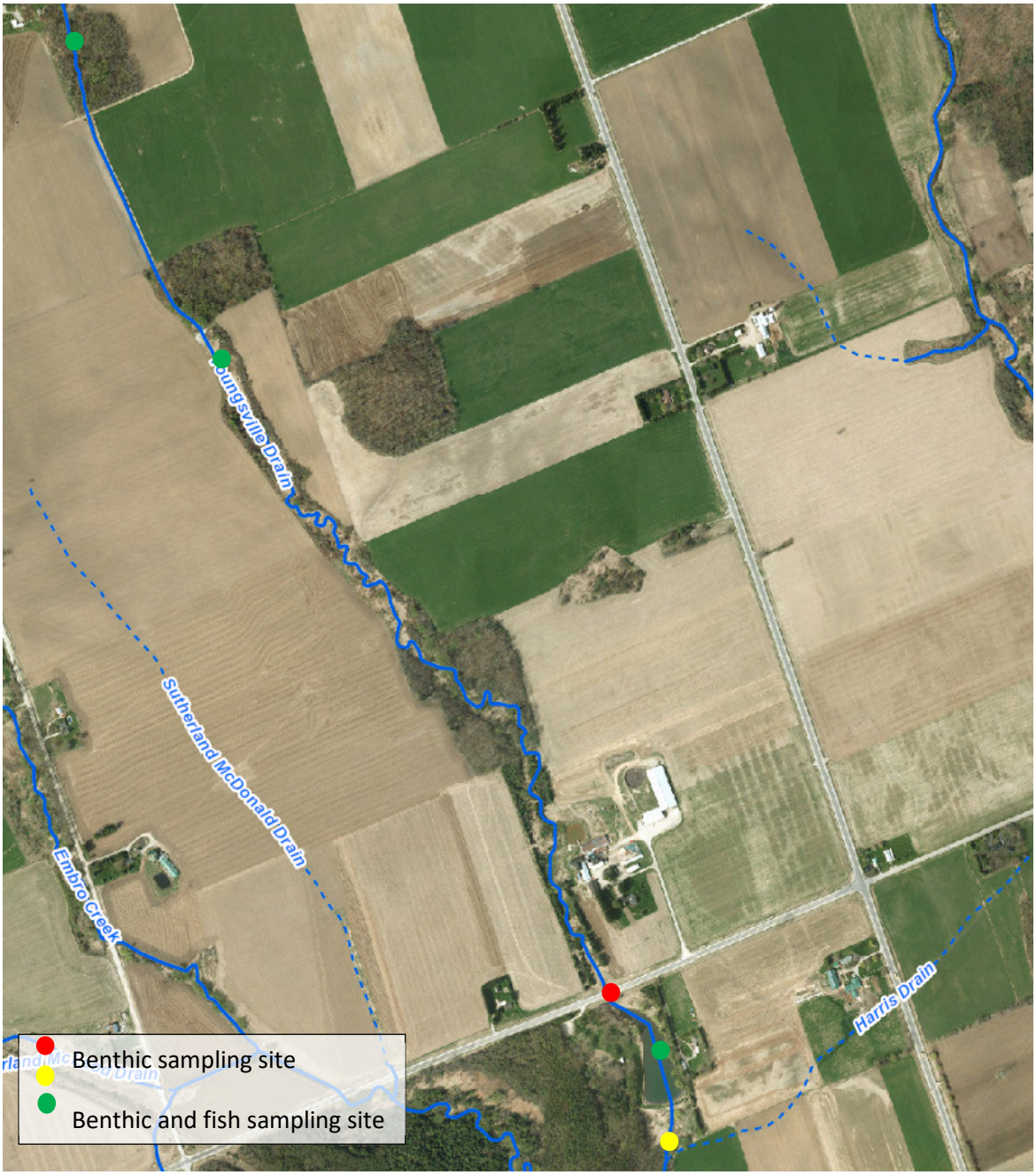


Figure 14 Embro Dam Area Benthic and Fish Sampling Sites (Source: UTRCA; Appendix C)

Results

While the 2015 spring results were almost identical between the two sites, better water quality was evident upstream than downstream in the fall; pollution sensitive taxa found above the pond were replaced by more pollution tolerant taxa (primarily aquatic worms) below the dam. Fall sampling conducted in 2017, 2019 and 2021 showed better water quality downstream of the Embro Dam compared to upstream. Conversely, the spring 2016 sample showed better

water quality upstream. The average FBI for the upstream and downstream sites shows little difference in FBI score (6.00 upstream compared to 6.13 downstream). The minimal difference between upstream and downstream results could indicate that the upstream site is suffering somewhat from nutrient enrichment and the negative pond effects are counteracted by some nutrient filtering and assimilation. FBI scores between upstream and downstream sites vary depending on season and on year. A list of recorded fish and benthic species, separated into sampling location, is provided in Appendix C.

Historic benthic invertebrate data for Youngsville Drain is limited to two samples upstream of Embro pond (2003 FBI = 6.11, 2008 FBI = 6.04), and a one-time sample downstream of Embro Dam in 2010 (FBI = 5.81). All three historical FBI values indicate “fairly poor” water quality.

Table 2 below compares the FBI values reported in the 2016 Embro Dam Existing Conditions Report (2015 values) and recent 2016 - 2021 values from Youngsville Drain to average FBI values for the Mud Creek and Upper Thames watersheds. The Embro values indicate slightly poorer water quality than the average value for all samples of the Upper Thames 2017 watershed report card (FBI = 5.97). Youngsville Drain values are similar to the value for the most recent (2012) Mud Creek Watershed Report Card (FBI = 6.05). All values are within the same water quality range of “fair” to “fairly poor”, which is below the provincial guideline target of “good” water quality (FBI < 5.00).

Table 1 Water Quality Ranges for Family Biotic Index Values

FBI Value	Water Quality
< 4.25	Excellent
4.25 - 5.00	Good
5.00 - 5.75	Fair
5.75 - 6.50	Fairly Poor
6.50 - 7.25	Poor
> 7.25	Very Poor

Table 2 Comparison of Family Biotic Index Values for Embro Conservation Area, Mud Creek, and UTRCA Watershed (Source: UTRCA)

	2016 Existing Conditions Report Sample Dates		2022 Addendum Report Benthic Sampling Dates						
Benthic Sample Location	Spring 2015 FBI	Fall 2015 FBI	Spring 2016	Fall 2017	Fall 2019	Fall 2021	Average FBI From 2017 EA	Average 2015 - 2021	Water Quality
Youngsville Drain upstream of Embro Pond	5.82	6.06	6.09	6.07	6.02	5.84	5.94	6.00	Fairly poor
Youngsville Drain downstream of Embro Dam	5.84	6.37	7.17	5.82	5.6	5.75	6.12	6.13	Fairly poor
Mud Creek watershed 2017 report Card (2011-2015 data)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.05	Fairly poor
UTRCA watershed 2017 report Card (2011-2015 data)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5.97	Fairly poor
Provincial Guideline (target only)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	< 5.00	Good

3.6.5 Significant Wildlife Habitat

Significant Wildlife Habitat (SWH) is identified under Section 2.3 of the Provincial Policy Statement (PPS), as areas where plants, animals, and other organisms live and find adequate amounts of food, water, shelter, and space needed to sustain their populations. Specific wildlife habitats of concern may include areas where species concentrate at a vulnerable point in their annual or life cycle and areas which are important to migratory or non-migratory species. Wildlife habitat is considered significant where it is ecologically important in terms of features, functions, representation, or amount, and contributing to the quality and diversity of an identifiable geographic area or natural heritage system. The MNRF created draft SWH Ecoregion Criteria Schedules that support the Significant Wildlife Habitat Technical Guide (SWHTG; MNRF 2000) and includes descriptions of wildlife habitat, wildlife species, and outlines the conditions required to determine SWH. The Town of Embro falls under SWH Ecoregion Criterion Schedule 6E (MNRF 2015).

Wildlife habitat is divided into four broad categories as described in the SWHTG, as follows:

- seasonal concentration areas
- rare vegetation communities or specialized habitats for wildlife
- habitats of Species of Conservation Concern, excluding the habitats of endangered and threatened species
- animal movement corridors

Methods

Using available background information and field survey results, the study area was assessed for suitable geographic criteria and habitat characteristics of each candidate Significant Wildlife Habitat, as outlined in the MNRF SWHTG.

Results

The SWH screening found the criteria for three Significant Wildlife Habitats were met.
These included the following:

Confirmed Significant Wildlife Habitat

Special Concern and Rare Wildlife Species – The study area includes confirmed habitat for Snapping Turtle within Embro pond. Confirmed Monarch, Eastern Wood Peewee, and Barn Swallow habitat is located within ECA in the CUM, and FOM communities. Note that Northern Sunfish, also considered a Species of Special Concern, is protected under the Fisheries Act.

Candidate Significant Wildlife Habitat

Bat Maternity Colonies – The FOM communities within the study area may contain suitable habitat and have confirmed cavities observed during site visits.

Turtle Wintering Areas – Confirmed Snapping Turtle (SA) within the study area suggest the Embro pond may be suitable for over wintering.

Permanent springs; seeps coldwater stream, Seepage areas, springs, and small streams provide habitat for numerous cold and cool water species that were recorded onsite.

The following SWH should be considered "candidate" as they were not specifically inventoried:

- Amphibians : includes the woodland communities
- Terrestrial crayfish: includes small, naturalized areas of meadow/marsh along the shore of the pond and by Road 84 in the CUS community
- Turtle nesting: includes non-vegetated, south-facing areas in the CUS community

3.6.6 Species at Risk

SAR are defined as species that are listed as either threatened (THR) or Endangered (END) under the ESA. Individual species, as well as their habitat, are protected in Ontario. Species listed as Special Concern (SC) under the ESA receive protection under the PPS and their habitat is considered SWH. Terrestrial species listed under SARA are only protected on federal land, as part of projects that are otherwise being permitted by a federal agency. SARA also requires consideration for any migratory bird listed on Schedule 1 where critical habitat has been identified; however, should the species also be listed under ESA and provides equal or greater protection, the ESA take precedence. The requirement for a SARA permit for construction or development project in or near fish habitat will be determined by the Department of Fisheries and Oceans (DFO) through the request for review process.

Methods

Background information from several available online wildlife atlases, and the data collected from wildlife surveys were used to identify potential species at risk within and adjacent to the subject lands. Based on the vegetation communities identified through ELC, the study area was assessed for the presence of suitable Species at Risk (SAR) habitat. The results summarize the findings of onsite surveys and the background information. All wildlife lists can be found in Appendix D.

The following background resources were reviewed and included within the screening:

- Embro Conservation Area Vegetation and Bird Inventory (UTRCA 2015)
- Natural Heritage Information Centre (NHIC)
- Municipal Official Plans
- Upper Thames Valley Conservation Authority (URTCA) mapping and data
- Land Information Ontario open data (MNRF 2020)
- DFO's Aquatic Species at Risk Mapping (2019)
- Ontario Breeding Bird Atlas (OBBA; Birds Canada et al., 2020)
- Ontario Butterfly Atlas (TEA 2020)
- Ontario Herpetofauna Atlas (Ontario Nature 2019)
- Ontario Mammal Atlas (Dobbyn 1994)
- eBird (the Cornell Lab of Ornithology 2020)
- iNaturalist (California Academy of Sciences and National Geographic 2020)

3.6.6.1 Results

A total of 20 terrestrial SAR species were identified as potentially occurring within the study area. This number was refined based on habitat characteristics present within the study area as observed through field investigations. This resulted in four species, Barn Swallow (Hirundo rustica; foraging), Eastern Wood Pewee (Contopus virens), Monarch (Danaus plexippus), Snapping Turtle (Chelydra serpentina) and 4 bat species with candidate habitat within the study area. The full screening can be found in Appendix D.

Upon a search of the DFO species at risk database no critical habitat for aquatic species at risk was identified within the study area; however, Northern Sunfish a Species of Special Concern was identified as potentially found within the study area. Confirmation of SAR fish and mussels happens during the DFO RFR process, as well from additional correspondence with the MECP when required.

Confirmed SAR

Barn Swallow (Hirundo rustica; SC) – Barn Swallow is listed as Species of Conservation Concern provincially and federally. It is typically found within close proximity to humans, building cup-shaped mud nests almost exclusively on human made structures such as in culverts, under bridges and in barns. They prefer unpainted, rough-cut wood, as opposed to smooth surfaces. Barn Swallow populations are decreasing by as much as 65% (MNRF 2018). Foraging habitat confirmed in CUM within the study area.

Eastern Wood Pewee (Contopus virens; SC) – Eastern Wood Pewee live in mid-canopy layers of forest clearings and edges of deciduous and mixed forests and early successional clearings. Habitat confirmed in mixed forest (FOM) within the study area.

Snapping Turtle (Chelydra serpentina; SC) – Snapping turtles live in shallow wetland habitats with slow-moving water and soft bottoms; ponds, sloughs, shallow bays, river edges, or slow streams. Nesting occurs on sandy or gravel banks or man-made structures such as roads, dams, and aggregate pits. Overwintering occurs underwater, underneath logs, sticks, or overhanging banks, deep in mud in marshy areas, or underneath floating mats of vegetation. Habitat confirmed in Embro pond, SA within the study area.

Monarch (Danaus plexippus; SC) – Monarchs live in open or disturbed habitats such as roadsides, fields, wetlands, prairies, and open forests. They may also exist in trees along the north shore of the Great Lakes are used for roosting before migrating across open water. Caterpillars are confined to meadows and open areas where milkweed grows. Habitat confirmed in CUM within the study area.

Northern Sunfish (Lepomis peltastes; SC), Northern Sunfish was detected at the downstream site on August 13, 2019 and mapped by DFO throughout the project area. The main threat to Northern Sunfish is declining habitat quality. This species likes slow-moving, clean water with plenty of aquatic vegetation and is not tolerant of muddy or polluted waters.

Candidate SAR

SAR Bats (Little Brown Myotis, Eastern Small-footed Myotis, Northern Long-eared Myotis and Tricolored Bat) (END) – Suitable habitat is present within the mixed forest (FOM) as well as within some of the larger trees found in the CUS community in the study area.

3.7 Surface Water Quality

An assessment of surface water quality in the study area was undertaken by UTRCA staff to supplement data that had been collected between 1986 and 1994 as part of a past targeted watershed study and remediation work. A comprehensive report is provided in Appendix B. Key findings are provided within this section.

The 2015 field program included the collection of five water samples at four locations in the area of Embro CA (i.e., one upstream of the pond, two in the pond, and one downstream of the dam as illustrated on Figure 15). Given the limited duration, and seasonal timing of the sampling, the monitoring provides only a snapshot of water quality that is limited to the conditions extending from April to October 2015.

No further water sampling has been conducted since 2016 (UTRCA 2022).

Most water quality samples were taken during low flow conditions. The dry conditions in the summer and fall of 2015 resulted in minimal opportunity to monitor runoff conditions. There was some variation in flow based on minimal rain but only one date had rain with runoff conditions (June 1).

Samples were analyzed at ALS Laboratories in London for Nitrate, Nitrite, Total Kjeldahl Nitrogen, Total Phosphorus, Orthophosphate, *E. coli*, Chloride, and Suspended Solids. Field measurements were taken with an YSI multi-parameter meter for Dissolved Oxygen, pH, Conductivity, and temperature. Continuous temperature measurements (i.e., half hour intervals) were taken from June 1 to September 23 using a datalogger. Results are presented in Appendix B and summarized here. Data from the 1986 to 1994 monitoring work has been included in the evaluation of the 2015 monitoring results.

In general, the water quality in Youngsville Drain where it was sampled upstream, downstream and in Embro pond, showed good results for 2015; numbers were typical of the Middle Thames watershed and other Upper Thames streams. The headwaters of this area include some healthy riparian areas with groundwater recharge creating the potential for good quality coldwater stream.

Most parameters showed similar results to the historic data with *E. coli* showing some improvement. Most parameters had relatively low levels except for nitrate which was consistently above the guideline both historically and in 2015. In Appendix B, results of the water quality sampling are plotted and discussed in further detail.

Temperature differences are apparent between upstream (lower) and downstream (higher) of the pond during the 2015 continuous monitoring, with consistently cooler temperatures upstream. Differences in temperature increased as the summer progressed and is considered attributable to the warming effect of the pond. During the 2015 sampling, temperature differences between upstream and downstream ranged from 0°C to over 7.0°C, with an average difference of 2.5°C between locations.

Water temperature affects aquatic habitat and the survival potential of eggs and health of fish. For example, on Figure 16, the optimal temperature range for Brook and Rainbow Trout spawning/egg survival, and the mean critical temperature for fish survival as defined by Hasnain (2010) are plotted on the temperature graph. Results clearly demonstrate that the water is often warmer both upstream and downstream of the dam than the optimal spawning/egg survival temperatures.

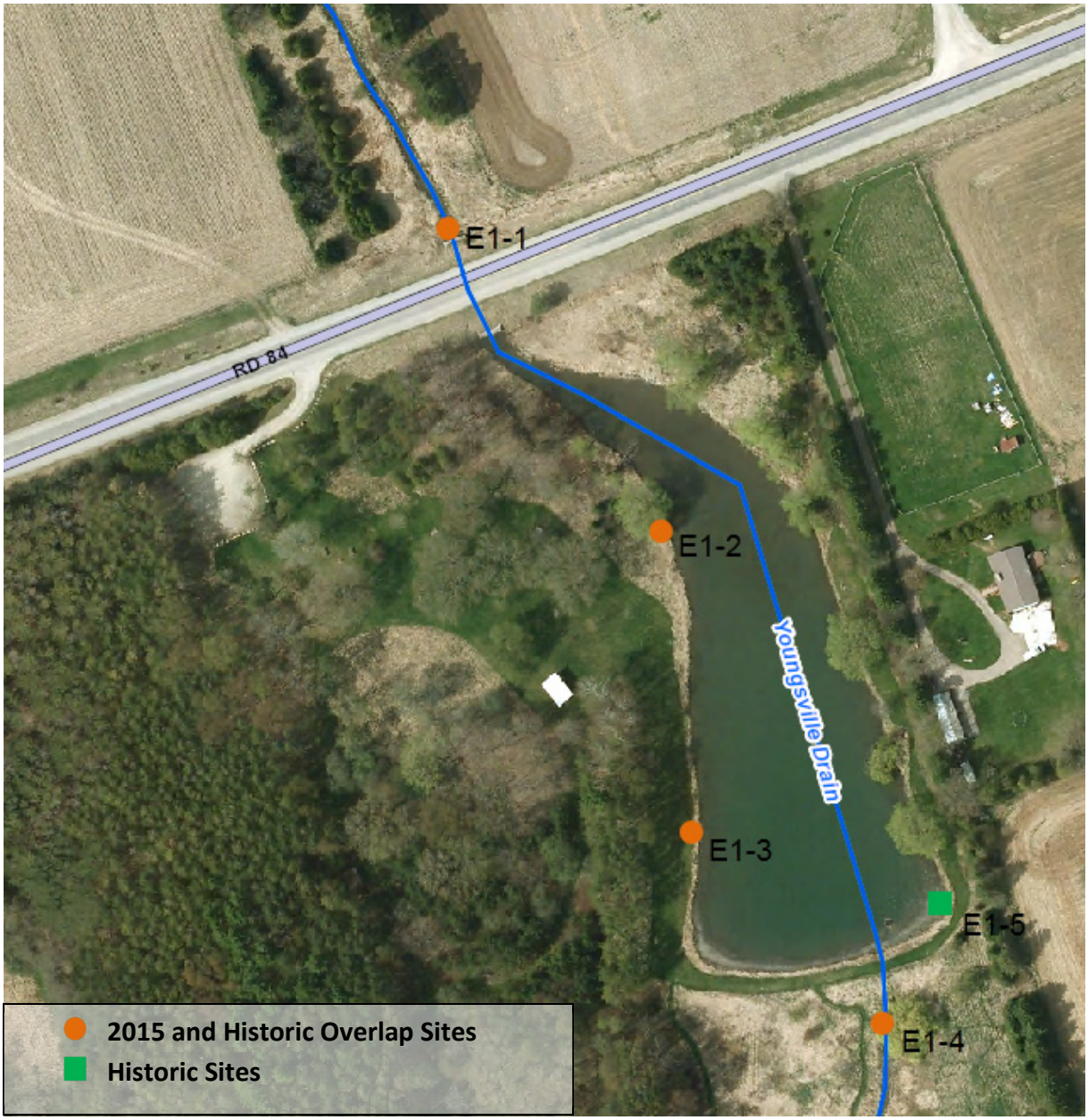


Figure 15 **Embro Pond Water Quality Sampling Sites 2015** (Source: UTRCA; Appendix B)

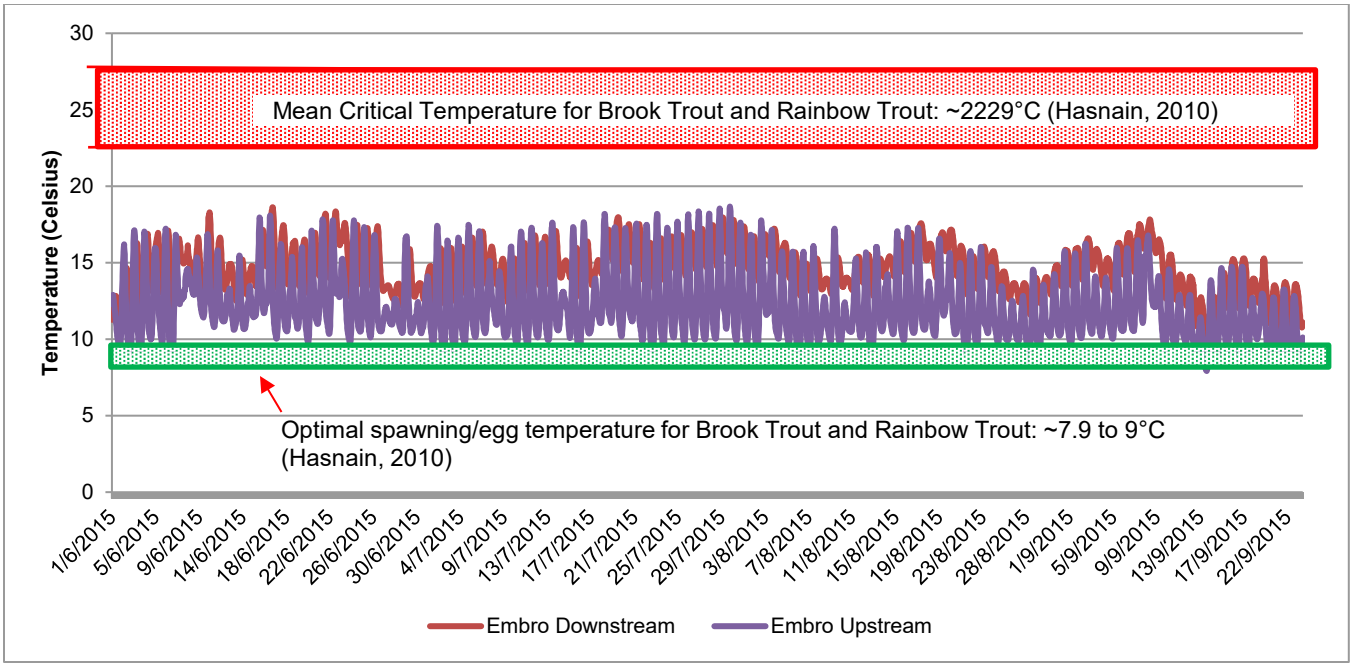


Figure 16 Temperature Upstream and Downstream of Embro Pond
(Source: UTRCA, Appendix B)

3.8 Socio-cultural Environment

3.8.1 Existing Use

The Embro Dam and pond are located in ECA. The ECA officially opened on October 26, 1959. In 1968, the Conservation Area was expanded to accommodate the general public (UTRCA 1973). The ECA encompasses an area of approximately 11.7 ha, including the dam and pond. In 1993, the Embro Pond Community Association took over management of the Conservation Area.

Today (2016), ECA is approximately 8.5 ha with approximately 5.7 ha in tree cover, some of it is defined as mixed plantation and some as natural woodland; approximately 2 ha consist of manicured lawn, unmanicured grass/marsh with a scattering of shade trees. The footprint of the reservoir/pond area is approximately 0.5 ha.

The ECA supports a system of hiking and cross-country skiing trails, totaling 2.4 km in length, within the plantation of the ECA and neighbouring Oxford County Forest. The trails are accessible from the Conservation Area parking area, off Road 84. Picnic tables and shelters are also located in the ECA.

Various initiatives have been undertaken within the watershed that have benefited the ECA. This includes the UTRCA Community Nature Program which resulted in the planting of over 80 trees and 2,800 native wildflowers and grasses by 75 students at ECA. In 2010-2011, a hardwood forest regeneration project was implemented at ECA; in addition to planting 2,100 native hardwood seedlings, UTRCA thinned a 5 ha conifer plantation to encourage regeneration of the forest. That project was funded by Oxford County and the Clean Water Program (CWP).

In July 2015, a "Memorial Tree Sign" was unveiled within the ECA. In a program run through the Township of Zorra, in the future, memorial trees purchased through UTRCA may be planted within the Conservation Area. About six memorial trees have been planted in the ECA in previous years.

3.8.2 Archaeological Assessment

A Stage 1 Archaeological Assessment was conducted in order to determine the archaeological potential of the study area; this includes identification of previously known archaeological sites, if any, and to provide recommendations for further assessment if necessary. The results of the archaeological assessment for Embro Dam are summarized in Figure 17 and in Appendix G.

The background information revealed no record of previously completed work, reports, or known archaeological sites within the study area. The Embro Dam study area has the potential for archaeological sites based on location, drainage and topography, and based on the application of land-use modelling. The Youngsville Drain, historically surveyed roadways (Road 84 and 37 Line), and an area of early Euro-Canadian settlement represent local indicators of archaeological potential.

The existing condition of the study site has a reduced archaeological potential due to sloped lands greater than 20 degrees, permanently wetlands, and extensive land alterations. In terms of archaeological potential, the Embro Dam study area is characterized by 2.09 ha (66.8% of study area) of archaeological potential and 1.05 ha (33.2% of study area) of land identified as areas of no archaeological potential. The 2.09 ha of lands identified as having archaeological potential are within 300 m of a feature of archaeological potential and it is noted that test pit surveying is required for further assessment in the event that any works are proposed for the area (ARA 2015).

3.8.3 Cultural Heritage Assessment

As a result of public consultation, a cultural heritage assessment was completed by TMHC Inc. for the Embro Dam and pond. A review of historical documents shows a pond and grist mill had existed in the area, these features have since been removed and are not visible on current site. The pond and dam at the study site had been constructed in the late 1950s to serve as water supply and to serve as a recreational area within the newly established Embro Pond Conservation Area. Due to the recent construction of the Embro Dam and pond, and the lack of historic structures, cultural or visual significance, the Embro Dam was found to not meet the O.Reg 9/06 Criteria.

Figure 17 Archaeological Assessment Results for Embro Dam Conservation Area (see Appendix G)

4 Alternative Solutions

Alternative solutions were developed for Embro Dam, to address the identified issues with the dam structure, and to achieve the objectives of the project, with consideration of the technical, environmental, social and economic aspects of the dam. Previous studies have identified concerns about insufficient spillway capacity, insufficient freeboard, embankment stability and flood flow conveyance through the emergency spillway. A subsequent embankment stability analysis (Naylor/LVM in 2008) was completed to further investigate the structural integrity of the dam; the study indicated that the dam does not meet current standards and is not considered stable under existing conditions.

4.1 Alternatives

Alternative solutions to address the identified issues were identified and are presented below for further evaluation and consideration. Conceptual plans of the alternative solutions are included on the following pages (Figures 18 to 22). It is relevant to note that any alteration, improvement, or repair of any part of a dam must be approved by the Ministry of Natural Resources and Forestry under the LRIA. It is likely that, the Ministry will apply 2007 Dam Safety Guidelines. Approval must also be obtained for dam removal projects.

4.1.1 Alternative 1: Do Nothing

No significant works would be undertaken to address stability issues at the dam, or to enhance the natural or social environment in the project area. The existing aesthetic and current uses would be maintained, although, over time, the aesthetic would deteriorate due to continued sediment infilling.

Regular monitoring would be completed and minor limited works would be undertaken to provide temporary stabilization of the dam; however, these are not anticipated to be effective in mitigating risk to public safety. The risk of dam failure would persist with associated environmental consequences (flooding, erosion, uncontrolled/ unmanaged sediment movement) and potential risk to the public; liability of the UTRCA in the event of failure would not be reduced and insurance costs may increase. There would be no improvement to water quality or fish passage potential.

4.1.2 Alternative 2: Repair Dam (Install Granular Shell on Both Sides of the Embankment, Remove Vegetation, Extend Outlet Pipe, Provide Emergency Spillway, Install Rock Protection)

In this alternative, dam repairs would be implemented as outlined in the embankment stability analysis report (Naylor 2008) to create a stable structure and spillway. This would enable compliance with Dam Safety Guidelines (CDA 2007), and would maintain the current aesthetic and uses of the pond.

Dam repairs would incur a moderate cost, relative to the other alternatives identified for this study. The dam will impede the continuity of downstream sediment movement and thus continue to induce sediment deposition within the reservoir; this will reduce the visual aesthetic over time, or require future maintenance. The pond will continue to accumulate sediment over time, which will affect the aesthetic appearance and/or require future maintenance. No improvements to upstream fish passage potential and water quality (temperature) would be made.

4.1.3 Alternative 3: Remove Dam and Establish Natural Channel

The existing earthen dam, outlet structure, and spillway would be decommissioned and removed. A natural channel would be established for Youngsville Drain in the location of the existing reservoir and dam structure, and the surrounding lands would be restored with natural vegetation. The channel would be restored based on principles of fluvial geomorphology and would be intended to convey the bankfull (approx. 1.6 year) flow event; larger flows would spill onto the adjacent floodplain.

This alternative removes the risk of dam failure, provides an opportunity to diversify terrestrial habitat, enables a continuity of sediment transport, reconnects upstream and downstream in-stream aquatic habitat, and maintains creek temperatures (i.e., no warming due to water residence time in pond). Opportunities for public recreation enhancement can be developed, if funding is available, to develop additional pathways (east side of pond), to include a bridge over the new channel, and to create look-out points.

Sediment that is dredged or excavated may be reused on-site, where feasible to create floodplain materials. It is expected that some sediment will require offsite disposal.

Establishment of a natural channel may be feasible by removing the dam and allowing the flow to develop a new path within the pond sediment. Management of this process would need to occur to consider gradual dewatering and to reduce the volume of sediment that enters the

downstream watercourse. Consultation with agencies regarding dewatering and sediment management will be important. In the event that native substrate (gravel) is not present under the pond sediment to provide appropriate in-stream habitat, then augmentation of substrate may be necessary. Should pond sediment not sufficiently dry and retain a bank shape along the channel, then further restoration may be necessary and include a naturalized channel design and associated construction.

Dam removal and restoration of a naturalized channel will have a low to high cost; the need for sediment excavation and disposal off-site would be a large cost item. Likewise, the need to construct the channel and bring in gravels/cobbles will increase cost.

This alternative changes the current aesthetic by removing the open water feature. Any shallow wells that might be affected by this alternative are at risk and may need to be mitigated (i.e., shallow wells drilled deeper); a study to identify all shallow wells that might be affected, and which should be mitigated, will need to be completed prior to initiating detailed design.

4.1.4 Alternative 4: Remove Dam and Construct One or More Offline Ponds/Wetlands

Alternative 4 includes the decommissioning and removal of the existing earthen dam, outlet structure and spillway. A naturalized channel would be restored for Youngsville Drain and one or more offline ponds and/or wetlands would be constructed within the footprint of the existing reservoir.

This alternative provides an opportunity to remove risks associated with dam failure, to remove the barrier to upstream fish migration and to reconnect upstream and downstream aquatic habitat, to provide a continuity for sediment transport, and to maintain water temperature. The offline pond/wetland will provide an open water view/aesthetic, although this will be different than under existing conditions. The offline ponds/wetlands would provide aquatic habitat for waterfowl and terrestrial species. The ponds would be connected to the watercourse during higher than baseflow levels (or another design storm event) to allow for water inputs/augmentation, flushing effect, and flow circulation. Risk of algal growth would be managed through offline pool design; some risk for mosquito borne diseases may exist. The surrounding lands would be restored with extensive natural vegetation and provide for a diversity of aquatic and terrestrial habitat, including waterfowl.

Sediment that is dredged or excavated may be reused on-site, where feasible to create floodplain materials or landscape features. It is expected that some sediment will require offsite disposal.

Establishment of a natural channel may be feasible by removing the dam and allowing the flow to develop a new path within the pond sediment with minimal intervention. Management of this process would need to occur to consider gradual dewatering and to reduce the volume of sediment that enters the downstream watercourse. Construction phasing should be considered with respect to offline pool creation; that is, drainage of the pond sediment is necessary so that any excavated pool will be able to retain its shape. Consultation with agencies regarding dewatering and sediment management will be important. In the event that native substrate (gravel) is not present under the pond sediment to provide appropriate in-stream habitat, then augmentation of substrate may be necessary. Should pond sediment not sufficiently dry and retain a bank shape along the channel, then further restoration may be necessary and include a naturalized channel design and associated construction.

Dam removal and restoration of a naturalized channel will have a low to high cost; the need for sediment excavation and disposal off-site would be a large cost item. Likewise, the need to construct the channel and bring in gravels/cobbles will increase cost.

The cost of implementing this alternative is relatively high and changes the aesthetic of the existing area. Opportunities for public recreation enhancement can be developed, if funding is available, to develop additional pathways (east side of pond), include a bridge over the new channel and create look-out points.

4.1.5 Alternative 5: Partially Remove Dam, Lower Crest and Naturalize the Remaining Perimeter

In this alternative, the existing dam crest would be lowered and the spillway capacity increased to address the identified stability issues. Further enhancement of the berm may be necessary to address concerns and incorporate recommendations identified by Naylor (2008) to ensure long-term stability. The risk for dam failure is thus reduced.

In this alternative, the size of the reservoir would decrease which would reduce the solar heat gain in comparison to existing conditions. This alternative maintains the current aesthetic of an open, but smaller, water feature. The exposed area previously occupied by the pond water would be restored with natural vegetation. Upstream of the ponded water, a naturalized channel will need to be established to maintain aquatic habitat continuity and to maintain concentration of flow up to bankfull flows. Implications of a lower pond on the backwater conditions that occur upstream of County Road 84 will need to be considered and mitigated. The presence of a dam feature will continue to impede upstream fish passage and affect water temperatures seasonally. A fish ladder could be constructed; this would typically be effective in

providing fish passage to only a portion of fish species (i.e., those species that can negotiate the slope and flow velocities occurring in a ladder. A geotechnical assessment should be completed to determine if a fish ladder would compromise berm stability and/or identify measures to mitigate such effects. The dam will impede the continuity of downstream sediment movement and thus continue to induce sediment deposition within the reservoir; this will reduce the visual aesthetic over time, or require future maintenance. Sediment that is dredged or excavated may be reused on-site, where feasible to create floodplain materials or landscape features. It is expected that some sediment will require off-site disposal.

The cost of this alternative is relatively high due to berm stabilization measures, sediment removal and naturalization work.

Figure 18 Alternative 1: Do Nothing

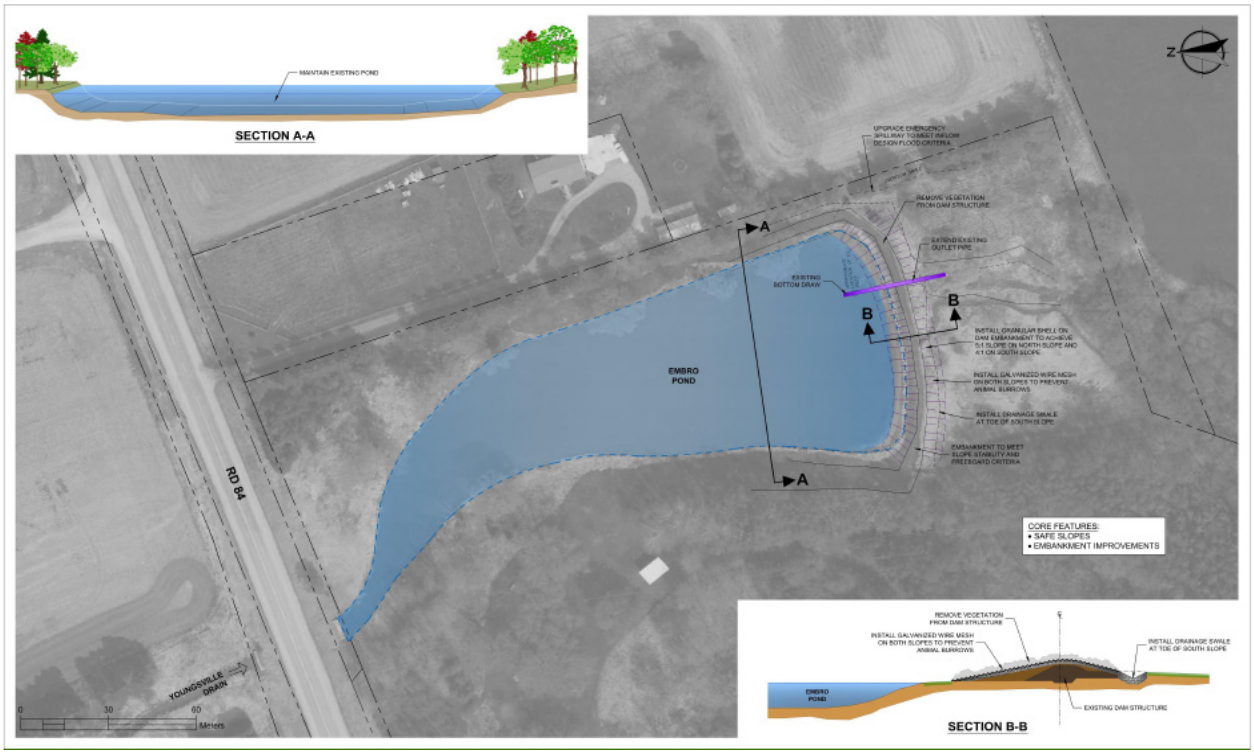


Figure 19 Alternative 2: Repair Dam

Figure 20 Alternative 3: Remove Dam and Establish Natural Channel

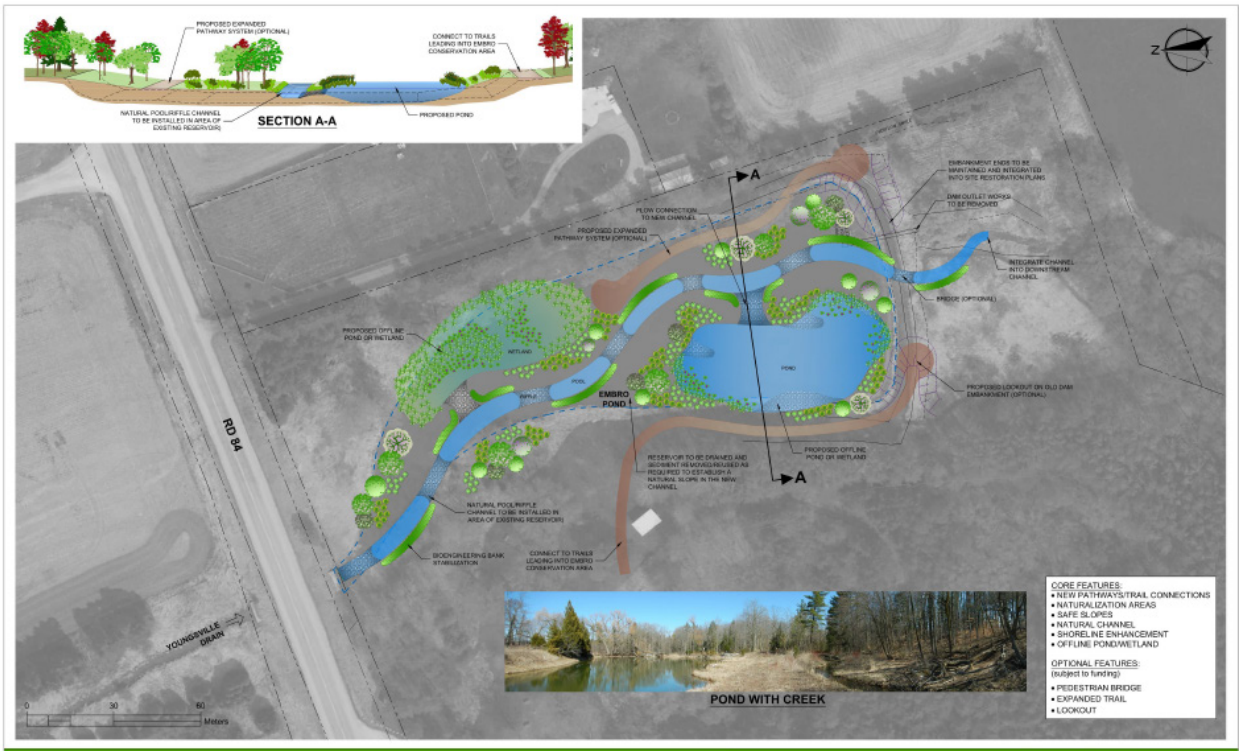


Figure 21 Alternative 4: Remove Dam and Construct Offline Pond(s) or Wetland(s)

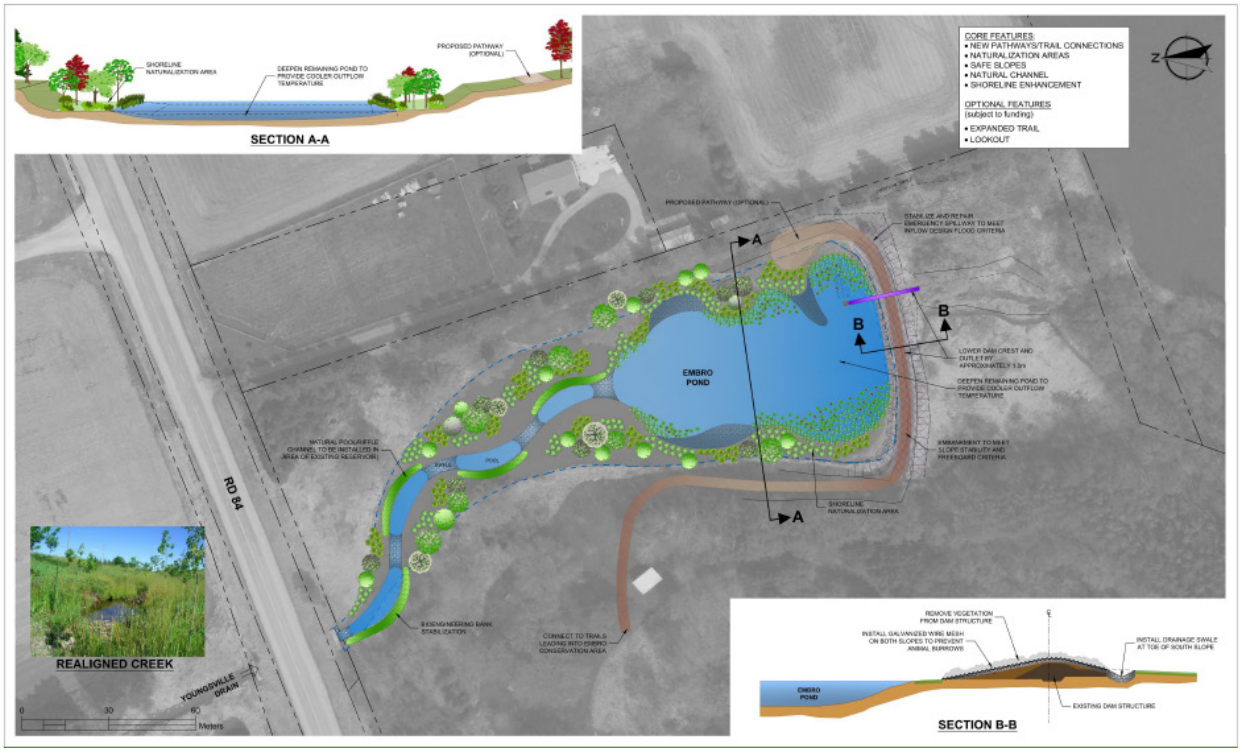


Figure 22 Alternative 5: Lower Dam Crest and Outlet and Naturalize New Pond Perimeter

4.1.6 Additional Alternative Consideration

Through the public consultation process, a member of the public provided additional ideas for consideration in the alternatives, following PIC 3 (see documentation in Appendix J). These ideas, quoted from the public correspondence are briefly presented (*in italics*) and discussed below.

> Drain pond and repair overflow with consideration of a fish ladder from outflow pipe to new creek level. Draining of the pond would reduce wetness factors and seepage factors in the berm, making the repairs suggested by Naylor unnecessary. This option assumes that funding is available for flood control as well as dam removal.

This alternative maintains existing dam infrastructure and changes how the water in the pond is managed; the impounded area would function similarly to an on-line stormwater management facility. A reduction in pond footprint would require some restoration/naturalization for a channel within the now exposed areas of the pond bottom to ensure continuity of flow and habitat. Consideration for the effect of pond lowering on the upstream channel (i.e., currently backwatered) would need to be given which may require in-stream works to reduce negative impacts.

Inclusion of a fish ladder would require local modification (lowering) of the berm (note: a fish ladder can also be included in Alternatives 2 and 5). During high flow events, some impoundment of the flood waters would continue, behind remaining portions of the berm. Confinement of flow at the pond outlet may exert additional stress on the adjacent portions of berm and may require reinforcement of the berm. Typically, fish ladders are only effective at providing access to a portion of the fish species within a watercourse due to configuration of the fish ladder and associated hydraulic conditions. In this regard, fragmentation of aquatic habitat will continue.

The effect of the alternative on adjacent channel sections and aquatic environment will need to be considered with respect to geomorphic form, water quality (e.g., temperature), and continuity of aquatic habitat and flow. If the proposed alternative includes restoration of a channel, then the alternative becomes a hybrid of Alternative 3 and 5, but not an improvement from an environmental perspective. From an overall function perspective, the proposed alternative is closest to Alternative 5 and is not expected to result in substantial cost savings.

Similar to Alternative 5, the alternative variation suggested by the private citizen will require approval by the Ministry of Natural Resources and Forestry for a change in water level operations. Similarly, the implication of berm modifications on berm stability will need to be

assessed from a geotechnical perspective and consider the altered hydraulic conditions at the berm outlet to the fish ladder.

Overall, the alternative suggested by the private citizen shows thoughtful consideration for the reduction of liability and cost associated with any works in the area. The alternative includes elements that are similar to Alternatives 2, and 5 (See Sections 4.1.2 and 4.1.5), and was thus not advanced to an additional alternative for inclusion in the evaluation process. Instead, draining the pond and lowering the dam crest to accommodate a fish ladder could be considered as a variation on Alternative 5 that incorporates elements of Alternative 3 (i.e., naturalized channel in area of exposed pond bottom).

4.2 Alternative Cost Estimates and Funding Opportunities

As part of the economic evaluation of the alternatives, construction and maintenance costs, and the potential availability for funding is considered (Section 5.1). This section provides an overview of cost estimates and funding opportunities.

4.2.1 Construction and Maintenance

A preliminary estimate of the potential costs was developed for each alternative, from a construction and maintenance perspective. These estimates were intended to inform the evaluation process, to inform the UTRCA regarding potential funding estimates, and to inform the public. In addition to construction costs, additional study (sediment testing, shallow well depths) is required, consultation and permitting with regulatory agencies, and detailed design will need to be undertaken.

The cost estimates were based on unit costs for similar projects undertaken by Matrix Solutions, UTRCA, and others. In this regard, the key components of the work necessary to construct the alternative were identified and typical costs applied (e.g., site mobilization, pond dredging, sediment disposal, embankment improvements, spillway construction, dam removal, site restoration etc.). The costs include estimates for mitigating impacts to nearby shallows wells (i.e., drill deeper wells). All costs are estimated in Table 3.

Components of operation and maintenance activities are not required annually; some maintenance activity (e.g., dredging) may occur once every 10 years. Costs for maintenance activities were provided by UTRCA. The estimated costs were reduced to an annual rate, to enable better comparison between alternatives. This data can also be used for budget planning purposes by the UTRCA. In addition to costs pertaining to maintenance and operations, the effect of the alternatives on insurance costs should be considered.

Table 3 Cost Estimates of Alternatives

Alternatives	Primary Elements/ Factors Influencing Costs	Initial Costs (1 to 5 years)	Operations and Maintenance
Alternative 1 Do Nothing	Repairs to concrete structures. Site / sediment restoration in the event of failure (future) Dam Safety Assessment	Approximately $245,000 (over a 4 – 5 year schedule, and assuming that the provincial Funding, i.e., Water and Erosion Control Infrastructure Funding (WECI) is received for all the planned projects)	$1,500 to $5,000 per year, Site /sediment restoration ($80,000) [(1)]
Alternative 2 Repair Dam	Improve dam embankment and outlet by reconstructing dam, construct emergency spillway, rock protection	Prohibitively expensive (no budget for reconstruction in UTRCA 4-year capital budget for structure) $200,000	$1,500 to $20,000 per year, Dam retirement (75 years) costs $80,000
Alternative 3 Remove dam and establish natural channel	Dam removal, channel establishment, construction, sediment removal, site restoration	$110,000	$1,500 to $3,000 per year
Alternative 4 Remove dam and construct offline pond / wetland	Dam removal, channel establishment/ construction, sediment removal, offline pond construction, site restoration	$140,000	$1,500 to $5,000 per year
Alternative 5 Partially Remove Dam, Lower Crest and Naturalize Remaining	Partial dam removal, channel modifications, site restoration	$84,000	$1,500 to $3,000 per year

4.2.2 Potential Funding Sources

Implementation of any alternative, except Alternative 1, will require funding in excess of that collected to date for routine maintenance and operations. Potential funding sources or partners that may be available to assist the Township and UTRCA is summarized in Table 4. The actual funding sources that may be accessible to the project, which will depend on the preferred alternatives and components thereof, should be confirmed in advance of detailed design/construction; that is, some funding sources may no longer be available and/or new funding opportunities may exist.

Table 4 Potential Funding Sources

Source	Description	Alternatives
Municipal Contributions	Zorra Township provides funding to the UTRCA for operation and maintenance, and required studies and repairs.	All alternatives
Habitat Stewardship Program for Aquatic Species at Risk	Department of Fisheries and Oceans (DFO) established this program in 2000, with the goal of contributing towards the recovery of endangered, threatened, and other species at risk. https://www.dfo-mpo.gc.ca/species-especes/sara-lep/hsp-pih/about-sur/index-eng.html	Alternatives 3 and 4
Canadian Nature Fund for Aquatic Species at Risk (CNFASAR)	The fund enables multi-species, place-based and threat-based approach to recovery and protection.	Alternatives 3, 4 and 5
Water and Erosion Control Infrastructure Funding (WECI)	Funding is provided to Conservation Authorities for owned or maintained water control infrastructure major maintenance projects, and includes dam decommissioning projects. Cost Share funding is provided through the Ministry of Natural Resources and Forestry.	All alternatives
Great Lakes Community Fund Grant – GL	As part of Ontario's Great Lakes Strategy and to support the Great Lakes Protection Act, the Great Lakes Guardian Community Fund was set up to help people take action to protect and restore their corner of the Great Lakes. Non-profit organizations like UTRCA are eligible for funding for projects in the connecting watersheds to Lake Erie.	Alternative 3
Ontario Rivers Alliance	Ontario Rivers Alliance (ORA) has a broad overarching perspective in our approach to protecting, conserving and restoring Ontario's freshwater ecosystems. The ORA can assist UTRCA in identifying various funding avenues for the restoration projects.	Alternatives 3 and 4
Ducks Unlimited	Funding may be available from this non-profit organization for wetland creation.	Alternative 3
Fundraising	Financial donations from residents and/or organizations could also be obtained to support implementation, or enhancement of an alternative.	Alternatives 3, 4, 5
Species at Risk Stewardship Program	Created under the Endangered Species Act, this program is to encourage people and organizations to get involved in protecting and recovering species at risk and their habitat through stewardship activities. The program is administered by the Ontario Ministry of Environment, Conservation and Parks. https://www.ontario.ca/page/species-at-risk-stewardship-program	Alternatives 3 and 4
Municipal Contributions	Zorra Township provides funding to the UTRCA for operation and maintenance, and required studies and repairs.	All alternatives

Source	Description	Alternatives
Habitat Stewardship Program for Aquatic Species at Risk	DFO established this program in 2000, with the goal of contributing towards the recovery of endangered, threatened, and other species at risk. https://www.dfo-mpo.gc.ca/species-especes/sara-lep/hsp-pih/about-sur/index-eng.html	Alternatives 3 and 4

5 Evaluation of Alternatives

The process of evaluating alternatives is clearly outlined in the MOE (2014) Code of Practise: Preparing, Reviewing and Using Class EAs in Ontario and in the Class Environment Assessment for Remedial Flood and Erosion Control Projects (Conservation Ontario 2012). Evaluation of each of the alternatives is accomplished systematically by identifying evaluation criteria and completing a comparative evaluation process. This chapter provides an overview of the evaluation process that was used to determine the preferred alternative. As part of the EA process, the technical steering committee and public provided input into the final evaluation process used in this study.

5.1 Evaluation Criteria

To identify the alternative that best addresses study objectives, each alternative outlined in Section 4 was rated against evaluation criteria that are broadly set out by MOE (2014) and includes consideration for technical, economic, environmental, and social factors relevant to the study area. MOE (2014) recommends specific criteria within each factor that should be evaluated; the final selection of criteria is informed by the study area characteristics, findings, and concerns of the public. The evaluation criteria are listed in Table 5 below.

Table 6 shows the rating scale used to assess each alternative against the evaluation criteria and in comparison to the other alternatives. The rating provides a numerical basis for evaluation in contrast to symbols, which are more difficult to tabulate.

Typically, the weighting of each category score is adjusted to be out of 25% (i.e., equally weighted) since each criteria category is considered to be equally important (note: this weighting may change in response to further consideration and input from the public and stakeholders); this is in keeping with the MOE (2014) Environmental Assessment process. Once each category score is calculated and normalized/weighted, then these are summed to derive an overall category score (i.e., technical, economic, environmental and social). The category scores allow for a comparison between alternatives. Tabulation of all category scores is completed to define an overall score. The top score is ranked as preferred.

Table 5 Alternatives Evaluation Criteria

Criteria	Description
Technical/Engineering (25% of score)	
Dam Safety	Effectiveness of the alternative to meet Dam Safety Guidelines, reduce risk of failure
Protection of Properties	Effectiveness of the alternative in mitigating risk (flooding, failure) to adjacent properties
Constructability	Potential to implement the project using conventional, accepted practices
Implementability	Potential to implement the alternative, based on common accepted management practise
Approvability	Potential for regulatory agencies to grant approval for implementation
Natural Environment (25% of score)	
Aquatic (Creek) Habitat Impacts/Enhancement	Effectiveness of the alternative to enhance fisheries resources; fish diversity, food source, and fish passage
Aquatic (Pond) habitat Impacts/Enhancements	Effectiveness of the alternative to enhance pond habitat (fish, fowl, wildlife) resources, diversity, food source
Terrestrial Habitat Impacts/Enhancement	Potential for impact and/or enhancement to connectivity and terrestrial habitat (amphibian, avian, mammal) due to implementation of the alternative
SAR Impacts/Enhancement	Potential for impact and/or enhancement to wildlife habitat and existing SAR in the project area
Geomorphology/Sediment Transport	Effectiveness of the alternative to promote dynamic stability of channel processes and mitigate sediment impacts
Groundwater Impacts/Enhancement	Potential for impact and/or enhancement to groundwater regimes in the project area (baseflow, recharge, water table, etc.)
Water Quality Impacts/Enhancement	Effectiveness of the alternative to improve water quality, TSS, phosphorous, nutrient uptake
Social/Cultural (25% of score)	
Impact to Private Property	Measure of the impact to adjacent private property (i.e., loss of property, access to property)
Impact to Public Access	Measure of impact to public access (e.g., trails, recreation - picnic, fish, boat)
Impact to Public Safety	Measure of the impact to public safety in the surrounding area resulting from the alternative
Impact to Cultural/Heritage Features	Potential impact to existing cultural and/or heritage features in the project area
Recreational Impacts/Enhancement	Measure of the impact to existing recreation and opportunities to enhance recreational activities in the project area
Economic (25% of score)	
Construction Costs	Relative measure of the initial costs to install/construct the proposed works, including environmental mitigation, sediment management etc.
Maintenance/Future Costs	Relative measure of the ongoing maintenance costs following implementation (or continued maintenance)
Availability of Funding	Estimate of the availability for funding to implement the alternative

Table 6 Evaluation Ranking Criteria

Score	Description
1	Least positive, or negative impact Most cost Environmental degradation Difficult to implement
2	Minor negative impact
3	Neutral impact
4	Positive impact
5	Most positive or beneficial impact Least cost Environmental improvement/gain

5.2 Evaluation Matrix

The alternative evaluation is shown in Table 7. Each of the criteria identified in Table 5 was assigned a rank (Table 6). The evaluation matrix received input from each of the discipline leads involved in this study based on their knowledge of their study findings; public input received through the public consultation process was also considered through the evaluation process. The completed matrix was subject to further review, input, and adjustment from the technical steering committee. Thus, the evaluation matrix was subject to a rigorous evaluation process.

Table 7 Alternative Evaluation Matrix

Criteria	Description	Alternative 1 Do Nothing	Alternative 2 Repair Dam	Alternative 3 Remove Dam and Construct a Natural Channel	Alternative 4 Remove Dam and Construct Offline Pond(s) or Wetland(s)	Alternative 5 Lower Dam Crest and Outlet and Naturalize New Pond Perimeter
TECHNICAL/ENGINEERING						
Flooding Impacts/Enhancement	Effectiveness of the alternative to manage or reduce flooding, or not cause negative impacts to flooding	1	3	5	4	4
Dam Safety/Integrity	Effectiveness of the alternative to address dam safety requirements, reduce risk of failure	1	4	5	5	4
Protection of Properties	Effectiveness of the alternative in mitigating risk (flooding, failure) to adjacent properties	1	3	5	5	4
Constructability	Potential to construct the project using conventional, accepted construction and engineering practices	5	5	5	5	5
Implementability	Potential to implement the alternative, based on common accepted management practise	5	1	5	5	3
Approvability	Potential for regulatory agencies to grant approval for implementation	5	1	3	5	2
	TOTAL CATEGORY SCORE	**18**	**17**	**28**	**29**	**22**
	NORMALIZED CATEGORY SCORE (26% WEIGHTING)	**16**	**15**	**24**	**25**	**19**
	CATEGORY RANKING (1 = least preferred; 5 = most preferred)	**2**	**1**	**4**	**5**	**3**
NATURAL ENVIRONMENT						
Aquatic (Creek) Habitat Impacts/Enhancement	Effectiveness of the alternative to enhance fisheries resources: fish diversity, food source, and fish passage	1	2	5	4	3
Aquatic (Pond) habitat Impacts/Enhancements	Effectiveness of the alternative to enhance pond habitat (fish, fowl, wildlife) resources, diversity, food source	2	4	1	5	2
Terrestrial Habitat Impacts/Enhancement	Potential for impact and/or enhancement to connectivity and terrestrial habitat (amphibian, avian, mammal) due to implementation of the	3	3	4	5	3
SAR Impacts/Enhancement	Potential for impact and/or enhancement to potential SAR in the project area	2	2	4	5	1
Geomorphology/Sediment Transport	Effectiveness of the alternative to promote dynamic stability of channel processes and mitigate sediment impacts	1	1	5	5	1
Groundwater Impacts/Enhancement	Potential for impact and/or enhancement to groundwater regimes in the project area (baseflow, recharge, water table, etc.)	5	5	1	3	5
Water Quality Impacts/Enhancement	Effectiveness of the alternative to improve water quality, temperature, TSS, phosphorous, nutrient uptake	1	3	4	5	3
	TOTAL CATEGORY SCORE	**15**	**20**	**24**	**32**	**18**
	NORMALIZED CATEGORY SCORE (31% WEIGHTING)	**13**	**18**	**21**	**28**	**16**
	CATEGORY RANKING (1 = least preferred; 5 = most preferred)	**1**	**3**	**4**	**5**	**2**
SOCIAL / CULTURAL ENVIRONMENT						
Impact to Private Property	Measure of the impact to adjacent private property (i.e., loss of property, access to property)	5	5	5	5	5
Impact to Public Access	Measure of impact to public access (e.g., trails, recreation - picnic, fish, boat)	5	5	3	3	5
Impact to Public Safety	Measure of the impact to public safety in the surrounding area resulting from the alternative	1	1	5	3	3
Impact to Cultural/Heritage Features	Potential impact to existing cultural and/or heritage features in the project area	5	4	2	2	4
Recreational Impacts/Enhancement	Measure of the impact to existing recreation and opportunities to enhance recreational activities in the project area	3	3	3	4	4
	TOTAL CATEGORY SCORE	**19**	**18**	**18**	**17**	**21**
	NORMALIZED CATEGORY SCORE (19% WEIGHTING)	**14**	**14**	**14**	**13**	**16**
	CATEGORY RANKING (1 = least preferred; 5 = most preferred)	**4**	**3**	**3**	**1**	**5**
ECONOMIC						
Construction Costs	Relative measure of the initial costs to install/construct the proposed works, including environmental mitigation, sediment management, etc.)	5	4	2	1	3
Maintenance/Future Costs	Relative measure of the ongoing maintenance costs following implementation (or continued maintenance)	1	2	5	4	3
Availability of Funding	Estimate of the availability for funding to implement the alternative	1	1	4	5	3
	TOTAL CATEGORY SCORE	**7**	**7**	**11**	**10**	**9**
	NORMALIZED CATEGORY SCORE (25% WEIGHTING)	**12**	**12**	**18**	**17**	**15**
	CATEGORY RANKING (1 = least preferred; 5 = most preferred)	**2**	**2**	**5**	**4**	**3**
	OVERALL NORMALIZED CATEGORY SCORE (100% WEIGHTING)	**55**	**58**	**78**	**83**	**66**
	PREFERRED OVERALL RANKING (1 = least preferred; 5 = most preferred)	**1**	**2**	**4**	**5**	**3**

6 Public Consultation

Public Information Centres (PICs) are the primary method to consult with members of the public, communicate important project details, and request feedback on the Class EA process and results. The main objectives of the public consultation process include the following:

- Inform the public and stakeholders about the project
- Fully inform agencies and regulators of the Class EA progress in order to solicit early feedback
- Develop public support for the preferred project solutions
- Meet or exceed the requirements of the Class EA process

The UTRCA established a web page that provided all study documentation available for public review. This included copies of presentation materials (slide shows, boards), questionnaires and public feedback received, and draft study reports. The webpage for the Embro Dam Class EA can be accessed using the following link: https://thamesriver.on.ca/water-management/recreational-dams/classea-harrington-embro-dams/embro-dam-class-ea/. Appendix J contains all documentation prepared through the public consultation process.

The UTRCA Board of Directors endorsed the EA study, and approved proceeding with the final posting of the Class EA on January 30, 2024 (Appendix K).

The Council at the Township of Zorra endorsed the Embro Dam EA Study on January 17, 2024 (Appendix K).

A Community Liaison Committee (CLC) was established for the study. The purpose of the CLC is to provide additional input concerning the planning and design process, and implementation of the preferred alternative (Section 6.7).

6.1 Notice of Intent

A comprehensive stakeholder contact list has been developed to support the public consultation process, this included identifying agencies and organizations that may be interested in the project and/or agencies that must be consulted during the Class EA process. Likewise, those First Nations that may have interest in the study area were identified with reference to the Chiefs of Ontario Websites or direct communication. This contact list was formed on the basis of project mailings (Commencement/ Completion Notice, Notice of PIC, etc.). Only the Oneida First Nations responded.

A Notice of Intent was prepared to inform the public of the project and provide contact information for Ecosystem Recovery (now Matrix Solutions) and UTRCA staff for interested members of the public. This notice was mailed to recipients on the contact list. In addition, the Township set-up a project-specific page on their website with a summary of the project and links to the UTRCA website where copies of presentations, draft reports, and notices were available. A notice of commencement was also posted to the project website (http://thamesriver.on.ca/water-management/recreational-dams/classea-harrington-embro-dams/). A copy of the Notice is included in Appendix J.

6.2 Public Information Center #1

The first PIC was held on June 23, 2015 at the Embro Community Centre. The purpose of this PIC was to outline the EA process, present background information and the methodology that was used to complete the characterization of existing conditions at the project site.

The PIC consisted of a presentation of PIC materials followed by an open house format with presentation boards displaying project information. Ecosystem Recovery (now Matrix Solutions Inc.) and UTRCA staff hosted the PIC and were available to address questions and concerns from attendees. Thirteen people recorded their attendance on the PIC sign-in sheet.

A detailed questionnaire was prepared and provided to attendees, providing a guided tool to obtain high quality feedback on the projects. Two questionnaires were completed by attendees and submitted to the project team, with the following input:

- “Would be better to restore creek to original condition. Coldwater species are resident above Embro pond. Thames River Anglers hatchery has raised and reintroduced them. Downstream of the pond supports some Brook Trout but no reproduction takes place due to water quality and temperature. Removing the pond would remedy this.”

- “Good visual exhibits and clear PowerPoint. Difficult to manage some questions but speakers remained polite and informative. Thank you. Perhaps draw e.g., of Woodstock Pond where residents opposed suggestion to drain pond and authorities listened. The pond remains.

Questionnaires and PIC presentation material can be found in Appendix J.

6.3 Public Information Center #2

The second PIC was held on May 10, 2016 at the Embro Community Centre. The meeting was attended by three councillors and the mayor of Zorra Township and two members of the public. The purpose of this PIC was to present a summary of findings from the completed studies and site inventories and to present the different potential alternative for the dam. Solicitation of public feedback was undertaken with respect to the study components, the potential alternatives, identification of additional alternatives, and consideration of elements to be considered in the evaluation of alternatives.

The PIC consisted of an open house format with a formal presentation of study findings and a review of the potential alternatives that were presented on display boards. The PIC was hosted by UTRCA and Ecosystem Recovery (now Matrix Solutions Inc.). UTRCA staff who had been involved with the project were available to address questions and concerns from attendees.

A detailed questionnaire was prepared and provided to attendees to guide the feedback process on the project. Comments were provided by one of the member of the public in attendance at the meeting, and two stakeholder groups (Thames River Anglers Association [TRAA] and Stewardship Oxford [SOX]), a summary of key items raised by the groups and community member is as follows:

- Alternatives that perpetuate status quo, deteriorating environmental conditions, or lack of upgrade to contemporary environmental status are not preferred.
- Cost-benefit analyses of Alternatives 2 and 4 may be beneficial to better assess these alternatives.
- Preference for wetland over pond for Alternative 4.
- Dislike for artificial structures.
- Management for pond or wetland may be required into the future to ensure no adverse impacts on the watercourse.
- Preferred alternative should be cheaper of taking out the dam and develop a natural watercourse or follow the Acres and Naylor reports and refurbish the dam.
- Recommendations were provided to further consider climate change effects, liability, and to undertake additional documentation and review of existing conditions (water temperature, fish species, etc.)

Suggestions for enhancement of the technical study reports and/or clarification of specific findings presented at PIC 2 and/or within the draft existing condition reports that had been made available to the public were addressed through updates to the report, where these were within the scope of an EA study and/or direct communication with the author of the letter. A copy of correspondence is provided in Appendix J.

All respondents were asked which alternative they liked best. Several respondents provided more than one answer and several respondents provided general considerations that were summarized above. Based on the questionnaire, the respondents indicated that they liked Alternative 3 most (see Table 8); this is reflected in the comments summarized above.

Table 8 Summary of Public Information Centre 2 Questionnaire Results

Alternative	Number of Individuals Who Liked this Alternative Most
1. Do nothing	
2. Repair dam	1
3. Remove dam and construct a natural channel	3
4. Remove dam and construct offline ponds or wetlands	
5. Lower dam crest and outlet and naturalize new pond perimeter	

One member of the public provided correspondence which outlined various questions and concerns relating to specific study area findings and study process. UTRCA undertook additional consultation with this private citizen as outlined in Section 6.6

A copy of the PIC presentation materials, questionnaire and a summary of the discussions that followed the presentation can be found in Appendix J.

6.4 Public Information Center #3

The third PIC was held on October 17, 2016 at the Embro Community Centre. The meeting was attended by three councillors and eight (8) members of the public, including representatives of non-government agencies. The purpose of this PIC was to present the alternative evaluation process, and to confirm the preferred alternative for the dam.

The PIC consisted of an open house format with a formal presentation that provided a brief overview of the project, the preliminary alternatives, a summary of PIC 2 feedback, the evaluation process, and selection of the preferred alternative. Presentation boards displaying the evaluation matrix and preferred alternative were provided for review and discussion throughout the open house. Ecosystem Recovery (now Matrix Solutions Inc.) and UTRCA staff hosted the PIC and were available to address questions and concerns from attendees.

A questionnaire was prepared to obtain feedback regarding the preferred alternative. Three responses were received after the PIC, two of which were from non-government agencies (NGO; Ontario Rivers Alliance, TRAA) and one from an active member of the public. The content of the responses is summarized below:

- The two NGO's indicated strong support for the preferred alternative. Feedback from the private resident questioned various components of the EA study, the evaluation process, derivation of the preliminary cost estimates for each alternative, and encouraged further exploration alternatives that would be less costly and reduce liability for UTRCA.

A copy of the PIC presentation materials, questionnaire and a summary of the discussions that followed the presentation can be found in Appendix J.

Based on the public comments received, UTRCA initiated further dialogue with the private resident as outlined in Section 6.6.

6.5 Public Information Centre #4

The fourth PIC was held on January 30, 2023 at the Embro Zorra Community Centre, within the Township of Zorra. The event was an informal, open house that consisted of display boards, containing information regarding site, project background, and conceptual drawings of the five alternative solutions.

21 members of the public attended the PIC#4, including general public, Zorra Heritage Committee members, Embro Pond Association members, a representative of Ducks Unlimited, Zorra Council members, and UTRCA board members. The staff from both UTRCA and Matrix were present to guide, assist, and provide answers to any questions.

Public were able to provide their input using Public Input Forms and Evaluation Tables. Public was invited to provide 'Expressions of Interest' to join a Community Liaison Committee. Three individual responses were received from those attending. Opportunity to provide additional input was provided until February 13, 2023.

6.6 Additional Consultation

In response to comments provided by one member of the public, UTRCA project staff undertook additional consultation with this private citizen. Ecosystem Recovery (now Matrix Solutions Inc.) provided technical support to UTRCA in all communications provided to this citizen. The additional consultation occurred after both PIC 2 and PIC 3.

In conjunction with feedback regarding the alternatives presented at PIC 2, the private citizen provided comprehensive written communication that outlined various concerns regarding study findings. In response, updates to relevant sections of the existing condition reports, and figures, were made, to provide additional clarification and/or to provide context for the results questioned. A copy of all written communications is provided in Appendix J.

Following PIC 3, the private citizen provided additional correspondence. UTRCA met with the citizen to discuss various items raised in the correspondence which included further discussion regarding the EA evaluation process and to further explore his suggestions for additional dam alternatives. A formal response was provided by the study team in response to key concerns and suggestions raised in the written communications (see Appendix J). Consideration of the alternative suggestions provided by the citizen are included in Section 4.1.6.

Subsequent to PIC#4, public were able to provide further input over a 2-week period, lasting till the end of February 13, 2023. UTRCA received public input from eight individuals. The public were generally recognized the environmental benefits of both Alternative 3 and Alternative 4. However, Alternative 4 was most favoured based on public input (see Appendix J for all public comments).

Community Liaison Committee (CLC)

The purpose of the CLC is to provide a forum for additional public input concerning the planning and design process of a project. UTRCA invited ‘expressions of interest’ during the fourth PIC, and during the 2-week public input period (January 30, 2023 to February 13, 2023) from interested persons, interest groups, Indigenous communities, or agencies to be a part of a CLC. Six members of public expressed interest in being a part of the CLC. Thereafter, the members for the CLC committee were shortlisted based on their representation in five areas: local community involvement, heritage, environmental knowledge, economic knowledge, representation from First Nation(s), and membership in the Embro Pond Association. Subsequently, a seven-member mailing list was developed.

The CLC will review information and provide input to the UTRCA including implementation of the preferred alternative solution. The CLC will identify areas of concern. The CLC and its members are expected to be important in the dissemination of information to the community and feedback from the community. Embro Dam Community Liaison Committee Terms of Reference (Appendix L) contains more information regarding the purpose, scope, membership, and tentative schedule for the CLC.

An introductory, first meeting, for the CLC was held virtually on September 08, 2023.
The second meeting was held virtually on November 22, 2023, during which the consultant provided a presentation to the CLC members. The meeting minutes for both meetings and the presentation are included in Appendix L.

7 Selection of Preferred Alternative

The purpose of the Class EA is to evaluate the existing technical, natural, social, and economic conditions related to the identified problem or opportunity, to develop and evaluate potential alternatives to address the problem, and to select a preferred alternative that would proceed to implementation. This section describes the results of the alternative evaluation process which included input received from the public, and describes the preferred approach for addressing identified erosion issues in the study area.

7.1.1 Preferred Alternative

The preferred alternative, determined through the evaluation process is Alternative 4 (Figure 23). In this alternative, the dam would be removed, and a naturalized channel would be established with integrally linked offline ponds or wetlands. The preferred alternative creates an opportunity to remove risk of dam failure, to limit future maintenance costs, and to enhance both the aquatic and terrestrial environments. In addition to the alternative description provided in Section 4.1, further description of the preferred alternative is provided below. Additional studies, as outlined in Section 8.1, will need to be undertaken to support the detailed design process.

The existing embankment and dam outlet would be modified/removed. The opening of the embankment would be sufficiently wide to enable conveyance of design floods. The remaining ends of the embankment would be maintained and integrated into the site restoration works; this could include re-vegetation and/or establishment of a lookout area.

Establishment of a defined channel within the existing footprint of the Embro Dam impoundment is a key defining feature of the preferred alternative. While it is recognized that

Youngsville Drain has adjusted to the grade control that has been exerted by Embro Dam, review of the topographic profile through the creek and impounded area behind the dam reveals a nearly 1.5% grade (Figure 24). If it is assumed that minimal excavation of the area behind the dam has occurred in conjunction with establishment of the dam (though some excavation is expected to have occurred in conjunction with any dredging activity), then the topographic profile of the ground surface approximates the original slope of the land, prior to dam establishment. The 1.5% slope shown on the profile is within the natural range of a riffle-pool watercourse and should pose no constraints to the re-establishment of a geomorphologically stable and functioning channel. The proposed design will need to be mindful of the implication of dam removal on the currently backwatered areas upstream of Road 84. Similarly, the design will need to be mindful of the transition into the downstream, existing channel. Proposed works should not contribute to an increase in erosion/deposition within the adjacent portions of the Youngsville Drain.

While allowing the flow from Youngsville Drain to re-establish a defined watercourse can be considered, such an approach should be mindful of the fact that the impounded area has been modified due to dredging activity and accumulation of fine sediment. A loss of channel boundary forming materials has occurred (i.e., to establish channel banks). Thus, while allowing some natural processes to re-shape the channel (e.g., upstream of Road 84) may be considered, it is recommended that some active channel restoration work be undertaken.

The restored watercourse should incorporate principles of fluvial geomorphology and include, where possible, aquatic habitat elements that are beneficial/preferred by resident species. The planform and profile (e.g., riffle-pool) configuration of the watercourse should be suitable for the energy and bankfull flow conditions (i.e., recurrence interval of approx. 1.6 years) that occur within the study area, provide floodplain connectivity (i.e., for larger than bankfull flows), and consider implication of larger flow events on both the floodplain and the channel.

The establishment of a pond(s) or wetland(s) within the existing footprint of the Embro Dam impoundment is a key defining feature of the preferred alternative. The pond(s) or wetland(s) should incorporate a definitive flow connection or be offline (no flow connection) from the naturalized channel for flood water retention purposes. Pond(s) or wetland(s) should be connected to the naturalized channel by riprap riffle channels or berms which would allow for inflow at designated water levels (flood flow). The pond(s) or wetland(s) should provide open water/pond habitat and a diversity of aquatic habitat elements that are beneficial/preferred by resident species while maintaining, where applicable, some of the open water aesthetic of the original Embro Dam Pond.

Incorporation of bioengineered materials is recommended to minimize risk of erosion and channel failure in the area immediately post-construction. Vegetative plantings that enhance bank stability through the rooting network are recommended. Woody debris could be implemented in the design.

Establishment of a trail leading into the Conservation Area, from the area near the picnic shelter should be considered. A bridge could be incorporated into the design, subject to funding availability, to enable a crossing over the watercourse, and connectivity to a trail along the east side of pond. A viewing area could be established along the creek. Educational signage could be established within the area to educate the public regarding the history of the ECA and the restoration works that have been undertaken.

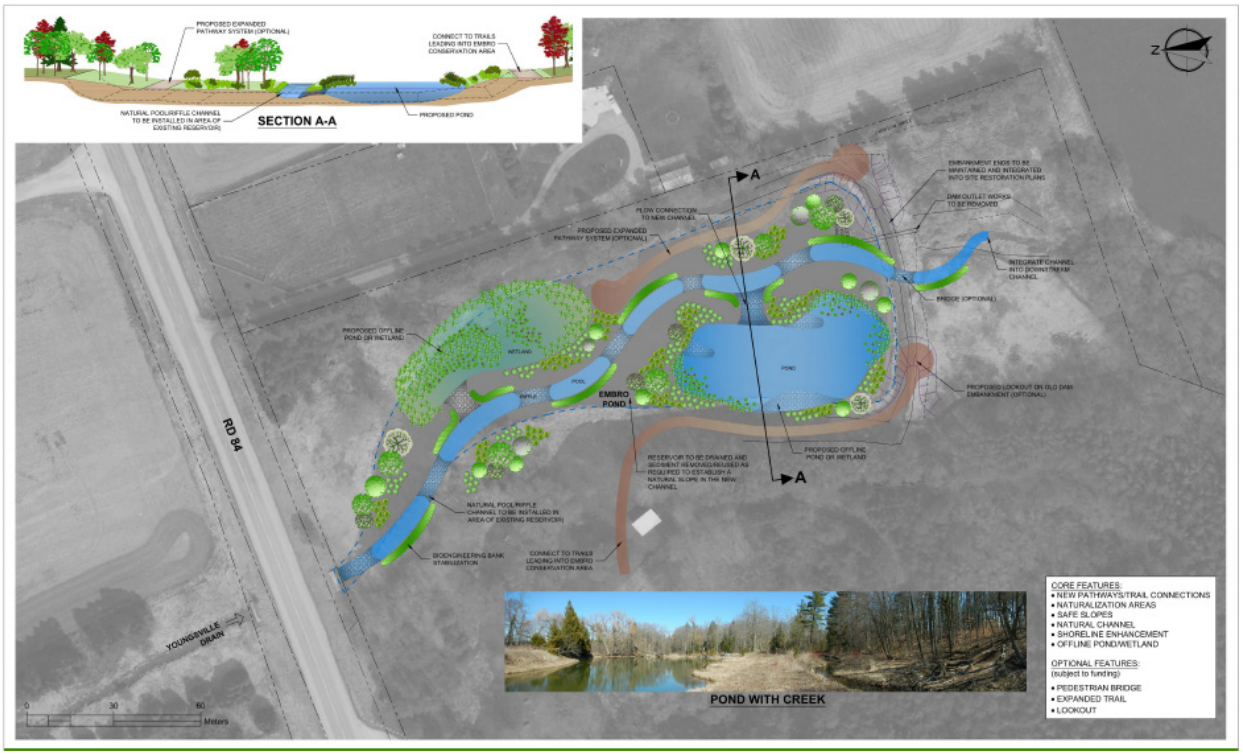


Figure 23 Preferred Alternative

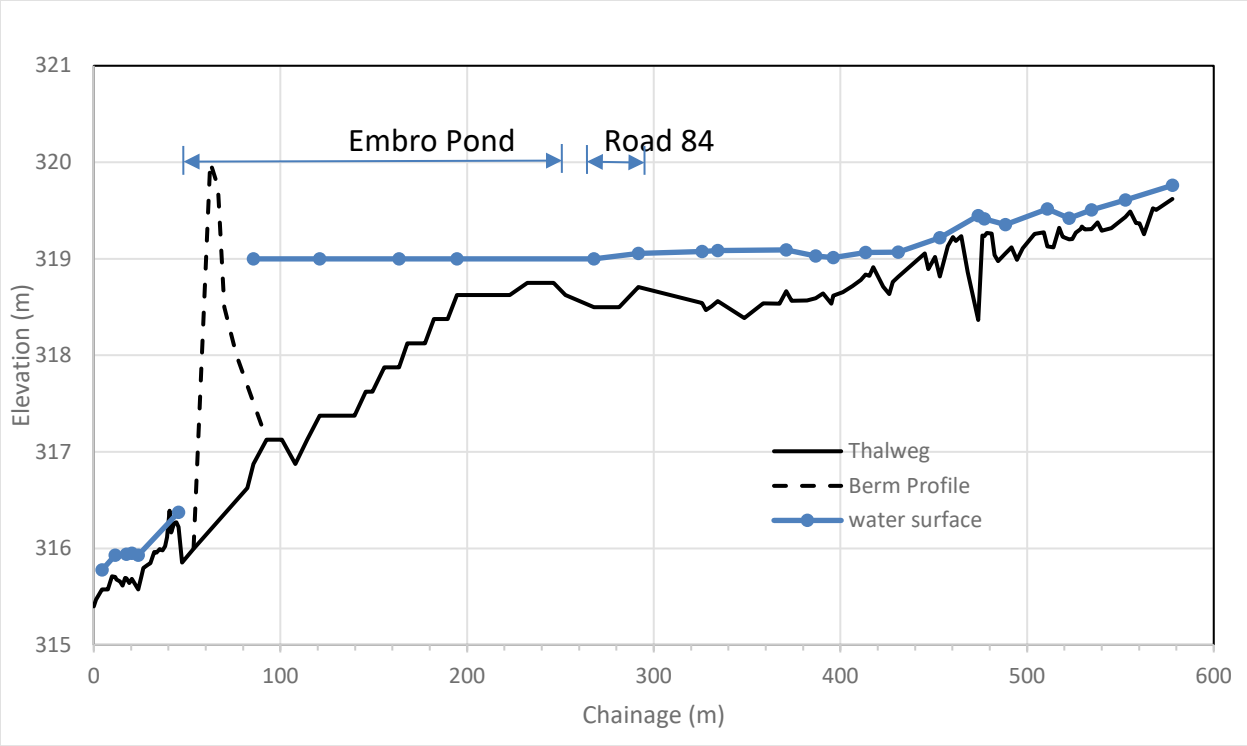


Figure 24 Topographic Profile Through Study Area

7.2 Potential Impacts and Mitigation

Regardless of which alternative is determined to be preferred through the evaluation process, implications of the alternative on one or more of the criteria in the evaluation matrix can be foreseen. A review of key impacts and potential mitigation measures associated with the preferred alternative are summarized below.

7.2.1 Technical

Removal of the dam and the associated impoundment may interfere with nearby shallow groundwater wells. It is recommended that a shallow well inventory/assessment be completed to identify and further assess potential impacts of dam removal on the operation of these wells. If impacts are identified, then new (deeper) wells should be drilled.

Removal of the dam and impounded area, in conjunction with the re-establishment of a defined 'bankfull' channel, will decrease backwater effects into the Youngsville Drain upstream of Road 84. Flood events (i.e., larger than the bankfull or 2-year flow) will spill onto a newly established floodplain adjacent to the designed watercourse; this floodplain connectivity will provide for temporary water storage and thus mitigate peak flows during flood events.

7.2.2 Environmental

From an environmental perspective, a loss of open water conditions will occur with removal of the dam. This could represent a loss for waterfowl and for any resident fish, turtle, frog, and mussel species within the pond.

To ensure a net benefit for the proposed works, the current impounded area will be replaced with terrestrial vegetation and habitat, offline pond(s) or wetland(s), and an open watercourse feature. Opportunities to enhance the terrestrial corridor and to provide enhanced diversity of vegetation will occur through the planting of a variety of native trees, shrubs and seed.
The vegetation will contribute to improved water-cooling conditions and will enable capture of sediment and other pollutants during flood events (i.e., on the floodplain). It is also anticipated that through the planting of native trees, shrubs and seed foraging habitat for Monarch, Barn Swallow, and Eastern Wood Pewee, as well as roosting and maternity habitat for SAR bats will be enhanced. Opportunities to enhance terrestrial conditions are provided through grading on the floodplain as well as through the removal of non-native and invasive species. Additionally, opportunities exist to include a number of wildlife habitat elements within the design to enhance existing wildlife habitat. Elements to be considered at detailed design include but not limited to bird boxes, bat boxes, T-perches, Raptor posts, bird nesting boxes, debris piles, root wads, downed woody debris, etc.

Removal of the fish migration impediment that is created by the dam would help in restoring natural stream processes, increase the habitat connectivity of Youngsville Drain and enable access to upstream habitat. River-adapted species such as fish and freshwater mussels, are especially susceptible to alteration, loss and fragmentation of critical habitat features, as well as the change in flow regime, caused by damming. The removal of the dam will contribute to an increase in genetic and in fish species diversity of local river-adapted populations. Aquatic habitat enhancement will occur through the naturalized channel restoration and riparian vegetation. Removing the dam is likely to have benefits for the cold and cool water fish population for the following reasons:

1. **Habitat Restoration and Spawning Habitat:** Dams can negatively impact cold and cool water fish species that require clean, cold, and fast-flowing water to spawn. Dams can alter stream flows and temperatures. Removing the dam can help restore natural stream flows, natural thermal regime, improve water quality, and provide overall improved downstream habitat for cold and cool water fish species.

2. **Fish Movement and Migration:** cold and cool water fish species need to move upstream and downstream to find suitable habitat and food sources. Dams can block their movement and limit their ability to migrate, which can negatively impact their survival. Removing the dam can help restore natural stream connectivity and allow fish species to access previously inaccessible habitats.

3. **Genetic Diversity:** Dams can isolate fish populations, reducing genetic diversity and making the fish more vulnerable to disease and environmental stressors. Removing the dam can help reconnect fragmented populations and promote genetic diversity within the cold and cool water fish species populations.

Since only native fish species were detected in the vicinity below the dam, competition from invasives is not currently a concern. However, Youngsville Drain and offline ponds should continue to be monitored.

It was noted through the field assessments that a significant pool occurs at the outlet of the dam where fish species congregate. It is recommended that this habitat feature be maintained so that it does not become a sediment trap post construction. Incorporation of elements that may concentrate flow enable a flushing of sediment and maintain a deeper pool for fish should be integrated in the detailed design, if feasible. The pool would be used by fish for resting and as a thermal refuge.

Recognizing that there are very few wetlands of an appreciable size in the watershed, preventing/reducing the loss of wetland habitat and creating an offline pond and/ or wetland is a net benefit. The offline wetland can be an important summer habitat for wading birds and waterfowl, as well as a popular stopover site for migrating birds in spring and fall. The offline wetland will also be important for turtle species, such as Snapping Turtle and Midland Painted Turtle that have been observed in the area, as well as for frogs and salamanders that can use the wetland for breeding. Allowing the creek to move freely, but still ensuring an offline wetland is available, will help reduce the loss of wetlands in the watershed, conserve herptile species habitat, and maintain biodiversity. The volume and area of the wetland should be maximized to the extent feasible to provide habitat and consider future longevity and potential implications of climate change (e.g., considerations of appropriate depth).

Improvements to water quality are anticipated, specifically with respect to water temperature. It is anticipated that the removal of the ‘online’ pond that is behind the dam will decrease the warming effect that occurs with impounded water and that the establishment of vegetation will provide shade to the area and contribute to cooling.

Implementation of the preferred alternative will require a lowering of the reservoir, to mitigate impacts to frogs, turtles, and potential mussels, a slow summer-time drawdown of the reservoir should safeguard any amphibians that use the pond for breeding individuals (frogs) by allowing them to move into nearby stream habitats, and ultimately, back into the restored area within Embro CA.

7.2.3 Social and Cultural

The recreational opportunities currently associated with the Embro Dam and pond will change. A loss of fishing and recreational boating (canoe) will occur through the preferred alternative. The recreational opportunities that may be implemented include trail enhancement, educational signage, and enhanced opportunities for 'birding' and viewing of other wildlife species.

7.2.4 Financial

Funding to support implementation of the preferred alternative would include funds that may be available from the Upper Thames Conservation Authority, Zorra Township, provincial and federal funding sources, and non-profit groups. A summary of currently available, and possible future funding sources is provided in Table 4.

8 Project Implementation

8.1 Next Steps

It is recommended that the UTRCA proceed with implementation of the preferred alternative as described in Section 7, subject to budgetary constraints. Funding for this alternative will define the time frame for implementation. Once funding is available, additional study requirements should be reviewed, and initiated as relevant, to inform the detailed design process; these could include, but are not limited to, the following:

- Locate and assess all shallow wells that may be affected by implementation of the preferred alternative and identify what, if any, mitigation measures will need to be incorporated into the detailed design.
- Hydrologic study review/update to quantify design flows for the study area.
- Determine sediment disposal options with additional sediment samples.

- Determine composition of native materials underneath pond sediment to determine suitability for creek substrate (i.e., to confirm potential for gradual drawdown and natural re-establishment of a channel).

- Update environmental screening and review aquatic species in pond to determine appropriate environmental mitigation measures. This could include fish, mussel, turtles, amphibian, crayfish, and bird species.

- Complete detailed breeding bird survey prior to detailed design to confirm species presence.

- Confirm requirements/need for Phase 2 archaeological assessment.

- Initiate discussion with regulatory agencies regarding re-establishing Youngsville Drain through the Embro pond sediments.

Detailed design and supporting analyses are required to determine the appropriate restoration/mitigation approach and materials given the flow characteristics through Youngsville Drain. Engineering drawings for tender and construction will need to be produced. Following the completion of design and acquisition of the required permits and approvals (Section 8.2), eligible contractors should be evaluated on the basis of their previous creek rehabilitation and erosion control experience, with particular emphasis on in-water work experience, to help contribute to the quality and effectiveness of implementation.

Consideration should be given to initiating a DSR if implementation of the preferred alternative is delayed. MNRF (2011) recommends that Dam Safety Reviews be completed on a maximum 10-year cycle; the last reviews were completed in 2007 and 2008.

8.2 Design Considerations

The detailed design should incorporate findings from the EA study as outlined in this report, be supplemented with additional study as outlined in Section 8.1, implement strategies outlined in Section 7.2, and other data needs necessary to support the design process. The design should be based on sound engineering practise with due consideration for enhancement of the natural environment. The selection of restoration materials (substrate gradation, bank treatments) should replicate natural conditions and include diversity that will sustain various ecosystem components that will enhance the health of Youngsville Creek (e.g., macroinvertebrates). Similarly, the design parameters should support a functioning and geomorphically stable

watercourse. Overall, the project should result in net benefit to the environment. Specific design considerations include:

- Minimize impact to area surrounding the dam and pond (i.e., limit impact to footprint of the area being restored, to the extent possible).
- Ensure that channel morphology is suitable for energy regime.
- Maintain or establish a deep pool to provide fish habitat, similar to the pool currently situated at the outlet of the dam which provides habitat in which fish species congregate. The design must consider the potential for flow to flush fine sediment so that it does not become infilled over time.
- Planting of native species and providing diversity to enhance habitat.
- Provide similar or enhance habitat as existing for species in the study area (e.g., turtles, frogs, salamanders).
- Consider habitat for birds observed in the area.
- Review the feasibility of developing appropriate turtle nesting sites on south-facing, sunlit slopes should be considered in consultation with the UTRCA.

8.3 Permits and Approvals

The detailed design of the dam removal and channel naturalization must be submitted to regulatory agencies for review and approval or authorization. The following (Table 9) provides an overview of the permit applications that should be submitted as of 2024; the design team will need to verify all agency permit requirements current to the date of design/construction.

Table 9 Overview of Permit Requirements

Agency	Explanation
Upper Thames Region Conservation Authority (UTRCA)	Conservation authority approval for the "Application for Development, Interference with Wetlands and Alterations to Shorelines and Watercourses" form is required.
Department of Fisheries and Oceans (DFO)	Approval required under the Fisheries Act to determine if there is a Harmful Alteration, Disruption or Destruction (HADD) of aquatic habitat in the study area. A Letter of Advice may be issued or further review and application for Authorization may be required as per DFO.

Agency	Explanation
Ministry of Natural Resources and Forestry	Plans and specifications approval required due to modification of dam structure and operation covered under Section 16 of the Lakes and Rivers Improvement Act (LRIA) and Section 2(2) of Ontario Regulation 454/96 respectively. Ministry approval is required to make alternations improvements or repairs to a dam that holds back water in a river, pond, or stream if these may affect the dam's safety, structural integrity, the waters, or natural resources. Section 2(1)(b) of as per Ontario Regulation 454/96 (https://www.ontario.ca/page/alterations-improvements-and-repairs-existing-dams). Wildlife Scientific Collectors Authorization and Animal Care: No wildlife is to be handled or relocated without a Wildlife Scientific Collectors Authorization from the MNRF. This permit shall be obtained by a qualified individual prior to construction. Fish Collection License: A fish salvage shall be completed in during dewatering. The acquisition of a Scientific Fish Collection License for Scientific Purposes and a Wildlife Scientific Collectors Authorization by a qualified individual shall be obtained from the MNRF.
Ontario Ministry of Environment, Conservation, and Parks (MECP)	No approval is required under the Endangered Species Act due to no threatened or endangered species identified in the proposed design area. Compliance with the Clean Water Act and the Ontario Water Resources Act is adhered to by UTRCA requirements.
Zorra Township	Any potential future structure construction onsite will require municipal approvals under the Building Code Act of Ontario (BCAO; as applicable). Local Site Alteration By-laws approvals are covered by Conservation Authorities Act Section 28 and Ontario Regulation 157/06 with completion of "Application for Development, Interference with Wetlands and Alterations to Shorelines and Watercourses" form (as applicable). Woodlands Bylaw is exempted if the activities are undertaken by a municipality or a local board of a municipality (as applicable).

An application for design approval will need to be submitted to UTRCA along with the completed "Application for Development, Interference with Wetlands and Alterations to Shorelines and Watercourses" form (pursuant to Ontario Regulation 157/06), prior to any construction activities taking place.

An application for review and/or authorization from the DFO under the *Fisheries Act* is required to determine if a Harmful Alteration, Disruption or Destruction (HADD) of aquatic habitat in the study area. Upon completing their review, DFO may provide a Letter of Advice, or require further review and application for an Authorization.

Under Section 16 of the LRIA, 'no person shall alter, improve, or repair any part of a dam… unless the plans and specifications for whatever is to be done have been approved' by the Ministry of Natural Resources and Forestry. Likewise, under Section 2(1)(b) of Ontario Regulation 454/96, Ministry approval is required to make alternations improvements or repairs to a dam that holds back water in a river, pond, or stream if these may affect the dam's safety, structural integrity, the waters or natural resources. Further, Section 2(2) of Ontario Regulation 454/96 specifies that LRIA Section 16 approval is required before a person operates a dam in a manner different from that contemplated by previously approved plans and specifications (see: https://www.ontario.ca/page/alterations-improvements-and-repairs-existing-dams for additional information).

Other provincial permits maybe required from the Ontario MECP, under *Endangered Species Act; Source Water Protection Act; and, Ontario Water Resources Act.*

Additionally, municipal approvals may be required for:

- Under Building Code Act of Ontario – for any structures that are proposed as part of the design plan.
- Local Site Alternation By-laws – for excavation/ filing.
- Woodlands by-laws – for any impacts/ removal of protected woodlands/ trees, including for construction access.

8.4 Preliminary Cost Estimate

A preliminary cost estimate was prepared for the preferred alternative, including all works associated with removal of the dam outlet, embankment, drilling of deeper wells, channel restoration, restoration plantings and trail, based on the concept design description in current dollars and market conditions. The preliminary cost estimate (2024) for the preferred alternative is $140,000 for construction in Years 2 and 3 of implementation. Additional costs associated with completion of the additional studies, agency consultation, monitoring, and staged drawdown activities will be experienced in Year 1; many of the additional studies can be completed by UTRCA using internal resources. The actual total costs will vary depending on when implementation will be executed, findings from the groundwater well assessment, need for offsite sediment disposal, need for design channel construction, and on materials used as some materials tend to have fluctuating costs such as rock and armourstone.

8.5 Construction Phasing and Timing Windows

Construction of any project must adhere to construction timing windows that are intended to protect species during critical life stages. This relates primarily to consideration of bird nesting, fish spawning, and amphibian overwintering/hibernation. Consideration should also be given to project phasing to mitigate potential impacts as outlined in Section 7.2.

8.5.1 Project Phasing

As outlined in Section 7.2, gradual drawdown of the reservoir is recommended to allow for aquatic species to naturally relocate to other appropriate habitat. This requires consideration of appropriate timeframes to minimize impact on species and life stage needs. Similarly, active relocation of any species within the pond and preventing re-entry will need to occur during appropriate seasons (e.g., implementing fish screens, relocating turtles etc.). A Wildlife Scientific Collectors Authorization and Fish Collection License are required before any species are actively relocated. It is possible that multiple active removals of species need to occur during construction (e.g., should the area become flooded, fish screens fail etc.).

8.5.2 Construction Windows

To prevent impact to species during critical life stages, there are various regulations and guidelines that are relevant to the study area, which outline the typical time period during the year during which works that could impact habitat is prohibited. These are outlined below; the proponent of design and construction will need to consult with all relevant agencies to confirm the window during which the preferred alternative may be implemented. Input from agencies may provide additional recommendations for mitigation of impacts to species.

- **Construction Timing**: With the species established at the site for many decades, de-watering and dredging could result in high mortality of frogs, turtles and other species dependent on the pond. In this regard, the timing and method of implementation stage will be vital. Recognizing that there are often delays with these types of projects, such delays could result in mortality of the species impacted:

- **Fisheries timing windows** should be determined in consultation with the MNRF. For fall spawning fish, in-water works are typically not permitted between October 1 and May 31 (this should be confirmed).

- **For mussels,** an early September drawdown is best. June – August temperatures can exceed mussel tolerances and any mussels exposed on the shoreline will die.

- **For frogs and turtles**, avoid fall and winter since the pond could potentially be overwintering habitat and animals will establish there long before cold weather settles in.

- **For turtles,** September drawdown could put turtles, and likely a large number of amphibians, at risk of loss, as most turtle species return to their overwintering sites in September. August drawdown would be better, to allow enough time for animals to locate a new brumation/hibernation site location. Manual removal of turtles is also sometimes necessary, as they may bury into the mud for many weeks, and not exit the pond experiencing the drawdown.

- **To mitigate impacts to breeding birds,** any tree and site clearing should take place between September and March 31 and avoid the months of April through August. This is to ensure that works do not disturb any potentially nesting birds. This is in accordance with the Migratory Birds Convention Act. Should tree clearing be scheduled within the months of April through August, comprehensive breeding bird surveys need to be conducted prior to tree clearing to ensure there is no disturbance of nesting/breeding birds. Surveys should document the location of breeding pairs and potential location of nests. Should nests/breeding pairs be discovered within the clearing area, the location should be clearly marked/flagged and a 10-metre buffer surrounding the nest be implemented. The space within this buffer should be protected until the young are fully fledged. An ecologist with ornithological experience should conduct the surveys and monitor the nests (should nests be discovered) periodically. Clearing can only be undertaken if the ecologist is satisfied there are no breeding/nesting pairs within the affected area.

- **For Species at Risk (SAR) bats,** their habitats are protected by the ESA (Government of Ontario 2007). In order to avoid impact to bats and their habitat, it is recommended that if trees need to be removed, then that the removal occur outside of the bat active roosting period, which extends from approximately April 1 to September 30.

- For **Monarch butterflies,** vegetation removal should occur after mid-October once the butterflies have migrated south, or before June when the butterflies arrive.

8.6 Mitigation Measures and Monitoring Program

8.6.1 Mitigation

The potential negative effects to the natural environment as a result of the proposed work can be reduced with the implementation of standard mitigation measures. The following describes general mitigation measures that are recommended for implementation during the proposed works:

Construction Procedures

- Mitigation measures must be used for erosion and sediment control to prohibit sediment from entering the surrounding natural areas. The primary principles associated with sedimentation and erosion protection measures are to: (1) minimize the duration of soil exposure, (2) retain existing vegetation, where feasible, (3) encourage re-vegetation, (4) divert runoff away from exposed soils, (5) keep runoff velocities low, and (6) trap sediment as close to the source as possible. To address these principles, the following mitigation measures are proposed:

    - Extensive sediment and erosion control measures (e.g., silt fencing, trenching) should be established prior to the commencement of any construction activities, to divert runoff away from exposed soils, and reduce runoff velocity, and remain in place until all disturbed areas are fully stabilized to retain sediment onsite and prevent its entry to the creek and wetland communities, (OPSD 219.110).

    - All surfaces susceptible to erosion should be re-vegetated through the placement of seeding, mulching or sodding immediately upon completion of construction activities.

    - All dewatering required for construction is to be discharged to a sediment trap at least 15 m away from the watercourse.

    - Sediment and erosion control measures are to trap sediment as close to the source as possible.

    - Site grading and runoff controls should be developed to mitigate potential stormwater runoff impacts to the surrounding natural areas, providing for post-construction contours that minimize runoff to the natural areas.

- Reinforced sediment control measures, such as double silt fencing, is recommended for select locations in order to provide enhanced containment and erosion protection for adjacent environmentally sensitive areas.

- Site grading and runoff controls should be developed during final design to mitigate potential stormwater runoff impacts to the surrounding natural areas. This plan should provide for post-construction contours that direct runoff to the wetland pocket and creek.

- The proposed timing of construction, e.g., winter and/or summer, does not conflict with fish spawning times (MNR restricted in-water work timing window), which for fall spawning fish is from October 1 to May 31.

- Machinery will arrive onsite in a clean, washed condition and is to be maintained free of fluid leaks.

- Washing, fuel and material storage, re-fuelling and servicing and inspection of all construction equipment should take place no less than 30 metres away from the creek to ensure no leakage of any deleterious substances to the creek or the local environment.

- All activities, including maintenance procedures, shall be controlled to prevent the entry of petroleum products, debris, rubble, concrete, or other deleterious substances into the creek.

- Construction material, excess fill, construction debris, stockpiling and empty containers should be stored no less than 30 m away from the water to ensure no runoff of any deleterious substances to the creek occurs.

Vegetation and Plantings

- Prior to the onset of construction, a reconnaissance level site visit to the study area is recommended to clearly identify the location of any sensitive species, including birds, bats, and insects, that may require relocation prior to construction and to assist in construction access route and laydown area selection.

- Clearing of riparian trees and/or shrubs should be minimized such that physical and biological functional attributes of the terrestrial vegetation can be maintained as they relate to aquatic ecological function.

- Re-vegetation of disturbed areas should be completed promptly through the placement of seeding, mulching or sodding immediately upon completion of construction activities and

through consultation with UTRCA. Ensure milkweed species (*Asclepias spp.*) are included in the vegetation mix for Monarchs. The vegetation plan should consider proposed habitat restoration goals (e.g., turtle nesting sites should have limited vegetation).

- If trees larger than 150 mm diameter at breast height (DBH) need to be removed during construction, the goal should be to replace native tree species at a 2:1 ratio. Ensure that there is no wildlife (e.g., birds, bats) nesting or roosting in the tree prior to removal (note: tree removal must comply with the Migratory Bird Convention Act).

- Invasive Species Management and Control: Construction shall follow the Clean Equipment Protocol (2016) during construction activities to prevent the further spread of invasive species. Removal of all invasive species within the construction limits shall occur, including root systems. Disposal of invasive species shall be administered in an appropriate manner following accepted and approved disposal guidelines from governing agencies.

- A restoration planting plan should be developed at detailed design for areas along the restored creek and offline pond/wetland feature. This plan should include recommendations for the removal of non-native species and the planting of a mixture of native trees, shrubs and herbaceous species appropriate to the ecology of the area. In addition, the plan should include wildlife habitat features such as but not limited to bird or bat boxes, perches, nesting boxes, brush piles, downed woody debris piles etc.

- Salvage pondweed plants from the existing Embro pond, if appropriate, and transfer to the created pond / wetland to assist in maintaining juvenile Northern Sunfish habitat.

Wildlife

- Wildlife or Sensitive Species Encounters: If sensitive or SAR species are suspected, contact a qualified ecologist immediately to inquire on next steps. If the species is identified as SAR, do not handle the individual unless it's in immediate danger and a setback should be established to protect the species until guidance has been received. Details regarding the size and implementation of the setback should be determined in consultation with the MECP. If the species is NOT identified as SAR, direct the species away from the construction footprint to the nearest natural area; if unsure of where to relocate the species, contact a trained ecologist for guidance. Should the species be identified within the construction footprint, a relocation plan may be drafted in consultation with the appropriate agencies. In order to conduct any type of wildlife handling or relocation, a Wildlife Scientific Collectors Permit from the MNRF will be required.

- Installation of Reptile and Amphibian Exclusionary Fencing: A qualified ecologist or trained construction monitor should assess the construction footprint prior to the onset of construction for the presence of any reptiles or amphibians. Any species encountered may require relocation outside of the construction footprint. This should be completed in consultation with appropriate agencies and with the required permitting (e.g., Wildlife Scientific Collectors Permit etc.) Once construction footprint is cleared exclusionary fencing should be installed along the perimeter of the area using protocols outlined in the MNRF Species at Risk Best Practices Technical Notes for Reptile and Amphibians Exclusion Fencing version 1.1 (July 2013).

Watercourse

- All dewatering required for construction is to be discharged to a sediment trap at least 15 m away from the watercourse.

- Mitigations to minimize the impact to aquatic species, including salvage and rescue of fish, reptiles and mussels should be done in consultation with the UTRCA. Fish and mussels should be released in proximity to the work area (e.g., upstream) and prevented from re-entering the work site. Dewatering pump intakes should be screened (*Freshwater Intake End-of-Pipe Fish Screen Guidelines*, DFO) in a manner that prevents fish from becoming impinged and injured. Fish passage must be maintained at all times, see Section 3.2.4 - *Fish Passage.* Silt and debris accumulated around the temporary cofferdams should be removed prior to the removal of all isolation materials to prevent entry of sediments to the watercourse.

- Use dams made of non-earthen material, such as water inflated portable dams, pea gravel bags, concrete blocks, steel or wood walls, clean rock, sheet pile, or other appropriate designs to separate the dewatered work site from flowing water.

8.6.2 Construction Monitoring

Construction monitoring is undertaken during the implementation of proposed works to ensure that methods for mitigating concerns and for environmental enhancement are performed as planned and approved, and that any problems that may arise during construction are effectively addressed. Construction activities are to be undertaken in accordance with all applicable guidelines, policies, regulations and statutes.

Construction monitoring is to be undertaken by the proponents of the project (e.g., UTRCA) or agents thereof.

Responsibilities for construction monitoring include:

- Effectiveness of erosion and sediment control measures.
- Ensuring adherence to the approved design and monitoring requirements.
- Meetings with project construction staff to ensure the function and correct installation of mitigation measures are understood.
- Providing direction in unplanned situations with the potential for environmental impacts.
- Addressing noted deficiencies promptly, as required, with construction staff and proponents.

Detailed monitoring and compliance records are to be developed as construction progresses, and submitted to the project proponents for review on request.

8.6.3 Post-Construction Monitoring

Post-construction monitoring of the creek remediation works is recommended to assess the effectiveness and environmental performance of the project. For the preferred alternative, the following components and features should be monitored following completion of construction, as required:

- Locations where erosion control works appear to be deficient, if any, through indications of erosion or channel migration.
- Movement of rock or other erosion control works from installed locations.
- Indications of additional/excess sedimentation in the channel.
- Degree of establishment of bioengineering installations.
- Success of site restoration measures and riparian plantings.
- Algae or excessive plant growth in the channel.
- Fish, mussel, turtles, amphibian, crayfish, and bird monitoring for minimum three years post construction.
- Description and/or photographs of any fish or other wildlife observed.

- Signs of vandalism or other social-based encroachments onto the creek corridor, outside of established pathways and bridges.

The post-construction monitoring report should include, as required:

- An assessment of the effectiveness of the undertaking in addressing the identified issues of the EA.
- Documentation of follow-up maintenance.
- A summary of the baseline inventory with respect to any potential impacts that were identified.
- Documentation of any changes in the baseline conditions as a result of the remedial works, including a photographic record.
- Identification of measures that will be undertaken to address any identified impacts.
- A schedule for ongoing maintenance and monitoring.

9 References

Acres International. March 11, 2004. Dam Safety Program Revisions - Embro Spillway Rehabilitation. Prepared for Upper Thames River Conservation Authority.

Acres International. July, 2007. Dam Safety Assessment Report for Embro Dam. Prepared for Upper Thames River Conservation Authority.

Archaeological Research Associates Ltd. (ARA). June 2015. Stage 1 Archaeological Assessment

Burnside. August 15, 2008. Embro Plan Drawing Number E1.

Burnside. August 15, 2008. Embro Profile Drawing E2.

Canadian Dam Association (CDA), 2007. Dam Safety Guidelines

Collingsworth, P.D., and C.C. Kohler. 2010. Abundance and habitat use of juvenile sunfish among different macrophyte strands. Lake and Reservoir Management 26:35-42.

Conservation Ontario, 2012. Class Environment Assessment for Remedial Flood and Erosion Control Projects.

Ministry of the Environment, Conservation and Parks (MECP), 2022. Rules for Soil Management and Excess Soil Quality Standard.

Ministry of the Environment (MOE). (2014). Code of Practise: Preparing, Reviewing and Using Class Environmental Assessments in Ontario.

Naylor Engineering Associates. September 2008. Geotechnical Investigation Embro Dam Embankment Stability Assessment.

Ontario. (2015). Schedule 4 Leachate quality criteria. R.R.O. 1990, Reg. 347: GENERAL - WASTE MANAGEMENT under Environmental Protection Act, R.S.O. 1990, c. E. 19

Upper Thames Conservation Authority. 2012. Mud Creek Watershed Report Card.

Upper Thames River Conservation Authority. October 20, 2010. Short Fact Sheet Embro.

Upper Thames River Conservation Authority. November, 2022. Addendum to the Existing Conditions.