Warden Avenue Road Widening between 16th Avenue and Major Mackenzie Drive in the City of Markham – A York Region Reconstruction Project in an Environmentally Sensitive Area

Project Overview

Warden Avenue is a major north-south arterial roadway under the jurisdiction of The Regional Municipality of York (York Region). It is located in the City of Markham and lies within the Rouge River watershed, under the management of the Ministry of Natural Resources (MNR) and Toronto and Region Conservation Authority (TRCA).

In 2013 and 2014, Warden Avenue was transformed under a unique road improvements project that comprised of widening and reconstructing a two kilometre section of Warden Avenue between 16th Avenue and Major Mackenzie Drive **(Appendix 1)**.

Warden Avenue prior to transformation

Warden Avenue's two-lane rural road section between 16th Avenue and Major Mackenzie Drive no longer met the needs of the growing population as traffic volumes continued to increase from high residential development in the area. Sections of Warden Avenue within this area were also prone to periodic flooding/overtopping of the roadway during large storm events at one or more of the watercourse crossings.

In response to proposed development growth, the Class Environmental Assessment (EA) Study for the project identified that additional roadway capacity was needed and recommended that the section of roadway be widened to a four-lane urban cross-section.

Transforming Warden Avenue

York Region widened and reconstructed Warden Avenue from a 2-lane rural cross-section to 4-lane urban cross-section and installed curbs, storm sewers, retaining walls, traffic noise barriers, multi-use pathways and three bridges, with a $22 million overall project cost. The roadway was also re-profiled to improve sightlines. Construction commenced spring 2013, included a six month road closure and was substantially completed by the winter of 2014.

This project was particularly challenging as there were three significant and sensitive watercourse crossings to consider: Carlton Creek, Berczy Creek South and Berczy Creek North, as well as the required Berczy Creek Outlet Stabilization works performed at the southwest corner of the Major Mackenzie Drive and Warden Avenue intersection.

Carlton Creek flows from west to east beneath Warden Avenue to where it flows into Berczy Creek, approximately 100m downstream of Warden Avenue. Prior to construction, the watercourse flowed through a twin 1500mm diameter culvert that was severely blocked at the inlet due to a large wood/debris jam and significant sediment deposit.

Berczy Creek South flows from west to east beneath Warden Avenue (previously via a 6 metre by 3 metre concrete box culvert). Both upstream and downstream of the Warden Avenue crossing, the creek represents pool/run/riffle channel morphology, moderate gradients, abundant in-stream cover in the form of woody debris and overhanging vegetated banks, large sediment deposits and erosion sites.

Appendix 4: Warden Avenue Achievements

Warden Avenue before construction

Warden Avenue during construction

Warden Avenue after construction

Carlton Creek before construction

Carlton Creek during construction

Carlton Creek after construction

Berczy Creek South before construction

Berczy Creek South during construction

Berczy Creek South after construction

Berczy Creek North before construction

Berczy Creek North during construction

Berczy Creek North after construction

Berczy Creek North flows east to west, flowing beneath Warden Avenue (pre-construction via a 5,700 mm x 3,600 mm CSP Arch culvert). Upstream of Warden Avenue, the creek flows in a southerly direction within a forested valley with large subdivision lots backing onto it. The channel morphology consists of naturally meandering pool/run/riffle sequencing with gravel and cobble dominated substrates.

York Region retained McCormick Rankin Corporation (now MMM Group), to undertake the engineering design and prepare a construction tender package for the project. Additionally, York Region retained Azimuth Environmental Consulting Inc. to undertake environmental monitoring during construction.

Environmental Considerations: Protecting and Enhancing the Environment

Throughout the Class EA process, potential effects of the road widening on the watercourse crossings were key concerns for York Region, MNR, TRCA, Department of Fisheries and Oceans (DFO) and general public. In light of this, the primary goal of the Class EA was created: "*The Region is committed to working with the Toronto Regional Conservation Authority and other organizations during the design and construction to minimize negative impacts and enhance the existing ecosystem"*

Within the construction limits, Carlton Creek and Berczy Creek host Redside Dace (Clinostomus elongates). The species was upgraded to endangered status in 2009 under Ontario's Endangered Species Act, 2007 as a result of observed declines and threats to remaining Ontario populations. This area was also classified by MNR as environmentally sensitive due to the presence of Redside Dace.

To achieve this goal, the key attributes and functions of the stream crossings were described and the existing and potential future loss of environmental function associated with the proposed road widening was identified. Mitigation methods were also required to protect environmentally sensitive features at this location. Design recommendations (i.e. pre-cast bridge structures, retaining walls, temporary and permanent erosion and sediment control (ESC) measures) were aimed at minimizing stream impacts, reducing loss of wildlife (i.e. road kill), managing storm water runoff quality and accommodating a multi-use pathway within the right-of-way, which in turn would minimize the overall "footprint" of the road widening project and enhance the natural environment **(Appendix 2)**.

As a result, the ecological and hydrological functions of the stream crossings were enhanced and the plants and animals the watercourses support, were protected throughout the project.

The watercourses were also protected by minimizing the width of the road through the design and construction of the environmentally sensitive area.

High levels of environmental protection and enhancement measures ensured the natural environment was protected and improved beyond existing conditions. Additional enhancements implemented throughout the project provided net benefits to the environment and inhabitants and included:

- Improved RD habitats (winter habitat creation, water quality improvement, fish passage improvements and cover)
- Minimized disruption to channel flow/fish passage during construction by deploying temporary bypass flumes
- Created RD habitat and environmentally sustainable self-cleaning winter pools
- Provided naturalized habitat area in the valleys around/under the bridges and naturalized channel form by increasing the bridge span
- Built three new low profile bridges and retaining walls that provided space underneath to encourage wildlife passage and reduced the road and structure footprint on natural habitat areas
- Improved terrestrial wildlife passages from culverts to bridges
- Built bridges rather than culverts, resulting in increased infrastructure service life (100+ years versus 15+ years respectively) which will reduce the frequency of maintenance interactions and ultimately, environmental impacts over the life of the infrastructure
- Planted species native to the local environment and vegetated creek areas to provide the required habitat necessary for RD survival
- Substituted natural growth media (i.e. compost logs) rather than traditional rock (rip-rap) for flow control
- Increased design capacity of oil grit separators to improve quality storm water impacts on watercourses
- Replaced traditional straw bales and silt fence protection with filter media logs to improve protection and water quality during construction
- Installed a multi-use path allowing cyclists and pedestrians access along the right of way, thereby encouraging the use of alternative modes of transportation for commuters and encouraging the community to engage in and appreciate the local environment
- Constructed live-staked/seeded retained soil system walls and permanent filtrexx check dams to promote growth and enhance the project's interface with the natural environment

The EA identified replacing all culverts at each watercourse crossing. The constructed engineering design of the single span pre-cast structures crossing each watercourse exceeded the proposal approved by the Ministry of the Environment (MOE) under the EA.

York Region also proposed and implemented the following to not only meet the conditions of the Endangered Species Act, but to also benefit RD and its habitat and to provide environmental enhancements within the project limits:

- Created and restored new valley habitat, providing an overall net increase of approximately 977 square metres of habitat
- Removed and replaced existing culvert crossings at Berczy Creek North, Berczy Creek South and Carlton Creek with single span precast bridge structures to restore natural channel function and characteristics and remove barriers to fish passage
- Provided riparian plantings for shade and cover for fauna and for the watercourses
- Restored natural channel function for the watercourses at roadway crossings, that also provided for improved fluvial geomorphic form and function beyond project limits
- Removed and reconstructed the existing outfall structure located at the Major Mackenzie Drive and Warden Avenue intersection, out-letting to Berczy Creek

- Rebuilt the existing ditch on the south side of Major Mackenzie Drive (west of the Warden Avenue intersection) and accompanied storm sewer with an energy dissipating drop structure
- Removed stones from Berczy Creek by hand (at the inlet of the Berczy Creek culvert crossing beneath Warden Avenue/Major Mackenzie Drive intersection) to eliminate a fish barrier and limit environmental risk exposure

Monitoring

Monitoring prior to, during and post-construction was an essential component of the environmental approvals process and incorporated the following goals:

- Ensure best management practices were implemented and enforced during construction
- Direct post-construction changes that may need to be made to the project
- Provide information regarding the efficacy of mitigation measures so lessons can be learned and applied to future projects
- Help ensure public confidence in the process is maintained

Pre-Construction Monitoring: Baseline surveys of the environmentally sensitive area were performed to enhance the design and further develop the monitoring plan during and post construction.

Construction Monitoring: To minimize disturbance to the wetland and its inhabitants, construction of the four-lane road through the environmentally sensitive area commenced after July 1, effectively avoiding sensitive fish spawning and bird nesting seasons.

Post-Construction Monitoring: Major construction was completed in December 2014. York Region has committed to monitor the environmentally sensitive area post construction for two years starting January 2015. Monitoring in 2015 will focus on viability/stability of the 2014 planted vegetation and seeded areas and will continue to monitor all constructed and/or natural features for site stability, integrity and condition.

The new channels and associated habitat features will be monitored over the next two years, 2015 to 2016, to ensure they continue to function, support and host RD and diverse species within the system.

Project Innovation

Throughout this project, the use of innovation assisted in solving environmental problems while mitigating potential issues:

- Worked closely with environmental approval agencies during planning and design and with the contractor during construction which led to an environmentally sustainable and ultimately constructible design and the successful construction of the project
- Developed a customized environmental monitoring program; employed specialized environmental monitors; provided multi-discipline protection
- Installed multiple extra-large OGS tanks (Stormceptors) at all crossings to improve water quality within the natural areas
- Provided contingency protection items (provisional) for emergencies included in contract

- Prequalified specialized environmental contractors performed in-stream works without incident
- Used specialized precast BEBO bridges versus cast-in-place to increase quality control and reduce environmental impacts and risks. Production was done in a controlled facility in parallel with construction of the footings/abutments, which increased erection speed and decreased exposure of environmental risks, and facilitated the fabrication and erection of the structures within permitted fish timing constraints
- Used the specialized precast high performance concrete bridges versus cast-in-place facilitated the design and fabrication of low profile structures, which decreased the footprint of the structures and the overall impact on the environmentally sensitive area
- Utilized innovative ESC technology including green walls, bio-engineering, Enviro-tanks, multiple settling ponds and sand filters, enhanced filter bags, recycling of dirty water
- Advanced, rearranged and modified work sequencing during construction to better suit site conditions, to optimize scheduling and to mitigate potential environmental risks to better align with permitted timing constraints and improve outcomes

Construction Phasing

Planned stream relocation work in the construction tender provided for two years of construction. Working with MNR and the contractor, the schedule was modified to reflect site conditions (i.e. removal of concrete box culvert at Carlton Creek) and provide for stream realignment and restoration and structural work within one construction season. This limited actual in-stream work to within the fish timing window and reduced risk exposure to the environment while working in, around and above the watercourses to one season.

The contract was separated into two unique phases, each with interim completion dates. Phase durations were determined by considering the operational constraints for the allowable timing of in-water works and seasonal weather construction limitations.

Phase One (March 1, 2013 to December 31, 2013)

Key construction activities focusing on watercourse crossing work included:

- Implementing a six month road closure to expedite the construction of three bridges within the environmental permit constraints
- Removal of existing culverts and implementation of bypass culverts
- Sheet pile installation and construction of deep caisson footings
- Construction of complete bridge crossings at Berczy Creek South and North
- Partial construction of bridge crossing at Carlton Creek
- Channel restoration at all watercourses
- Outside of environmentally regulated areas, remaining contract works were completed to base asphalt with temporary pavement markings and the roadway was re-opened to two lanes of traffic

Phase Two (January 1, 2014 to January 31, 2015)

- Final restoration and compensation plantings for environmentally regulated areas
- Completion of bridge structure at Carleton Creek
- Completion of retaining wall between Carlton Creek and Berczy Creek South

- Top surface asphalt and permanent pavement markings for the entire contract area

Penalties and Incentives

Contract specifications outlined that should Phase One works, including a six month road closure at the watercourse crossings, extend further than December 31, 2014, liquidated damages would be applied for the late road reopening. However, if the contractor reopened the road earlier, an incentive bonus of $5,500 for each working day, to a maximum of $110,000, would be awarded. Similarly, if the contractor opened the road to four lanes of traffic earlier than December 30, 2014, an incentive bonus of $2,500 for each working day, to a maximum of $50,000, would be awarded.

Achievements

Initial planning and preparation of a detailed construction schedule during design was imperative to properly coordinate critical activities needing to be completed within the allotted six month road closure. Despite its challenges, construction was implemented in a manner that demonstrated that the engineer's construction milestone requirements were realistic and achievable.

During construction, a slope stabilization issue developed at the southwest corner of Warden Avenue and Major Mackenzie Drive, necessitating the need to advance the outlet restoration work on Berczy Creek outfall and a redesign of the ditch upstream from Phase Two to Phase One of construction **(Appendix 3)**.

At the Carlton Creek watercourse crossing, the contractor unearthed an unknown concrete box structure. Working closely with MNR, work was reorganized to remove the structure. Realignment and restoration of Carlton Creek, completion of the footings and bridge substructure was all advanced to Phase One of construction.

During Phase One, the contractor encountered a significant unplanned quantity of poor sub-surface soils, requiring removal and replacement with granular fill at the bridge and retaining wall structures. This resulted in work progressing slower than anticipated. To overcome this challenge and meet the requirement to have two lanes opened to traffic by the end of 2013, some work was reorganized and deferred to Phase Two.

In addition to the poor sub-surface soils, during the dewatering operations waste water (effluent) with fine particulates was generated from the excavation areas. This effluent passed through filtration media and posed a hazard to the watercourse and the environmentally sensitive area. Through the implementation of additional ESC technology, the work was able to continue without incident to the environmentally sensitive area. ESC technology implanted on site included temporary and permanent Filtrexx check dams, sedimentation pools, sand filters, Enviro-tanks, sediment settling tanks, filter bags, Filtrexx logs and riffle pools, and ultimately trucking effluent water offsite.

Through careful timing of the critical work in the environmentally sensitive areas, strong communication links with environmental permitting authorities and the cooperation of a good contractor, Phase One, including reopening the road, was completed two months

ahead of schedule. As a result, the contractor received the $110,000 incentive bonus. Phase Two was completed on schedule as planned **(Appendix 4)**.

Financial implications

Work was adjusted due to the Endangered Species Act permit. Initial estimated costs to replace/extend all culverts were $2.5 million. To minimize disruption and enhance the environment, culverts were replaced with three pre-fabricated BEBO arch bridges and retaining walls costing $11.8 million. Additionally, the cost of the in-stream restorations and compensation plantings was $1.1 million. A six month road closure was implemented to complete environmentally sensitive work, resulting in indirect costs to the community.

Overall Applicability to Transportation

To mitigate environmental risks and improve sensitive areas, design strategies are required during road projects.

This project's innovative planning and use of technology is a best practice for other Regional projects. Although the risk around work requiring an Endangered Species Act permit can be high, issues can be minimized by proactive design techniques early in the project.

Additional lessons learned from this environmentally sensitive project include:

- Plan for the unknown. Establish communications protocols and identify key stakeholders (designer, project manager, construction administrator, contractor, environmental authorities, etc.) and their roles, responsibilities and ultimate authority. This provides continuity through a crisis and moves the project forward to positive outcomes.
- Clearly understand the potential risks of the work within the limits of an environmentally sensitive area, the planned mitigation measures to address those risks and the spatial and temporal constraints.
- Proactively advise, educate and plan with the contractor to prepare for challenging environmentally sensitive area works and contingencies for related and ancillary issues.
- Working closely with contractors/subcontractors and product suppliers allows you to know what ESC products are available, what are the best practices for effective implementation and what product limitations exist

Conclusion

By preparing for and working diligently with stakeholders during planning and design phases of all road improvements projects, potential environmental effects can be prevented or mitigated. During construction, additional environmental improvements and opportunities can also be identified and achieved when strong leadership and communication is in place.

Ensuring all parties worked closely with environmental permitting authorities, York Region successfully achieved and exceeded its goal to minimize negative impacts and enhance the existing ecosystem throughout the Warden Avenue project.

This project's innovative planning, efficacy of mitigation, use of technology and lessons learned are wisely being applied to future projects.

LOCATION PLAN

CONTRACT 12-102, PROJECT 98670
WARDEN AVENUE from Major Mackenzie Drive to 16th Avenue
City of Markham

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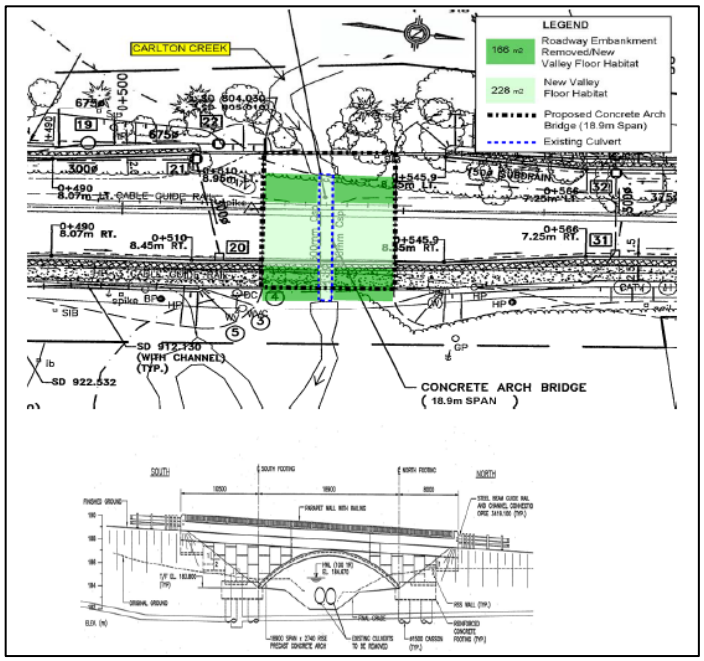
York Region yorkmaps

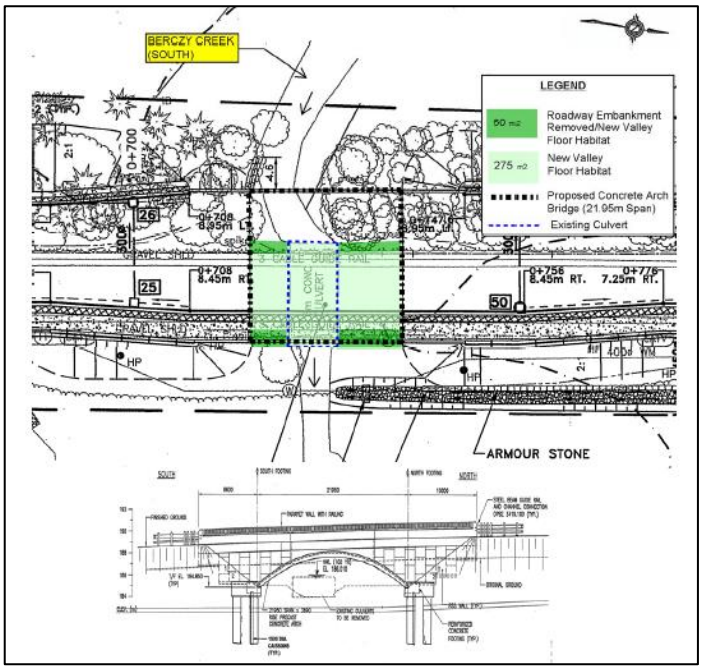
Produced by:
Capital Delivery - Roads
Transportation and Community Planning

0 105 210 420 630 840 Meters

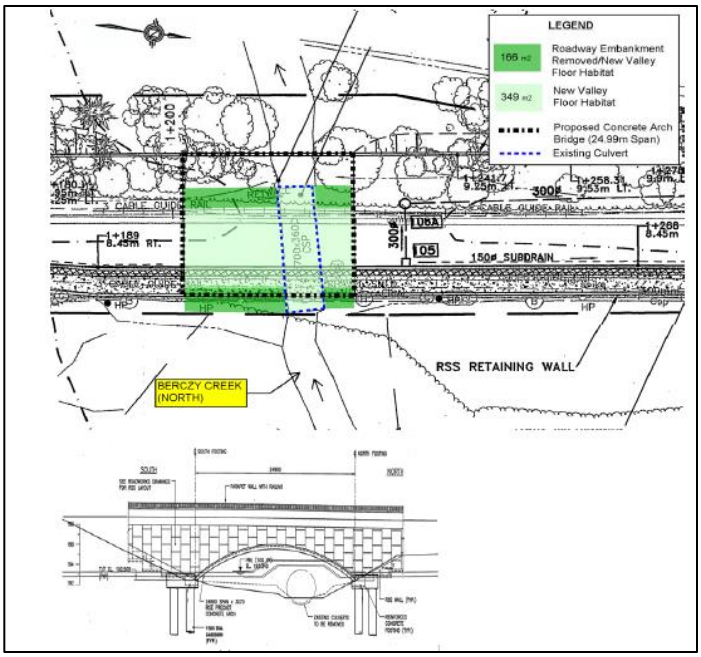
Appendix 2: Design Drawings



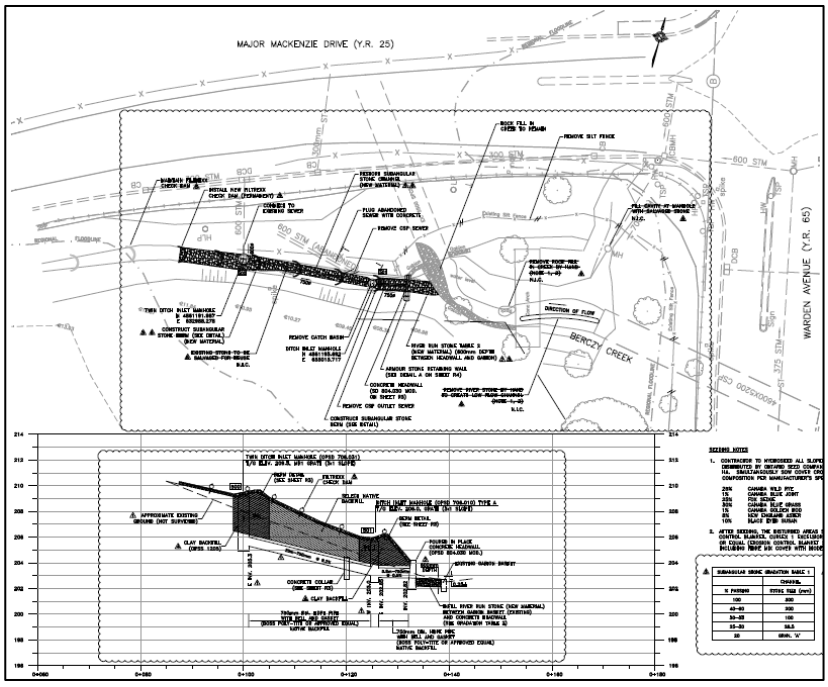
CARLTON CREEK BRIDGE



BERZY CREEK BRIDGE (SOUTH)



BERZY CREEK BRIDGE (NORTH)



OUTLET RESTORATION AT MAJOR MACKENZIE DRIVE AND WARDEN AVENUE

Appendix 3: Major Mackenzie Outlet Failure and Restoration

Major Mackenzie Outlet Before

Major Mackenzie Outlet After