BURNSIDE

NOTTAWASAGA VALLEY CONSERVATION AUTHORITY

Drains
Done Differently.

South Innisfil Creek Drain (SICD) Improvement
Ecological Enhancements

Unique Innovations

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Ecological Enhancements - Unique Innovations

TWO-STAGE DRAIN

"A Guide for Engineers working under the Drainage Act in Ontario," OMAFRA Publication 852 (Pub852), references a two-stage drain as an alternative design to a traditional trapezoidal drain; the Guide indicates that such a design is more likely to mimic a channel that exists naturally. Selected by the Burnside Drain Team and endorsed by staff from Fisheries and Oceans Canada (DFO), and the Nottawasaga Valley Conservation Authority (NVCA), a two-stage drain was selected as the design standard for those portions of the South Innisfil Creek Drain (SICD) Main Drain proposed for improvement by deepening and widening (approximately 4,000m).

The recommended minimum design criterion for an open drain as per Pub852 is the 2-year return period storm. The guide indicates that climate change and freeboard should also be considered as part of the design. Freeboard is a design safety factor defined as the difference between the water surface elevation within a drain (for a specific event) and the surrounding land; the recommended minimum freeboard is between 0.1m and 0.3m.

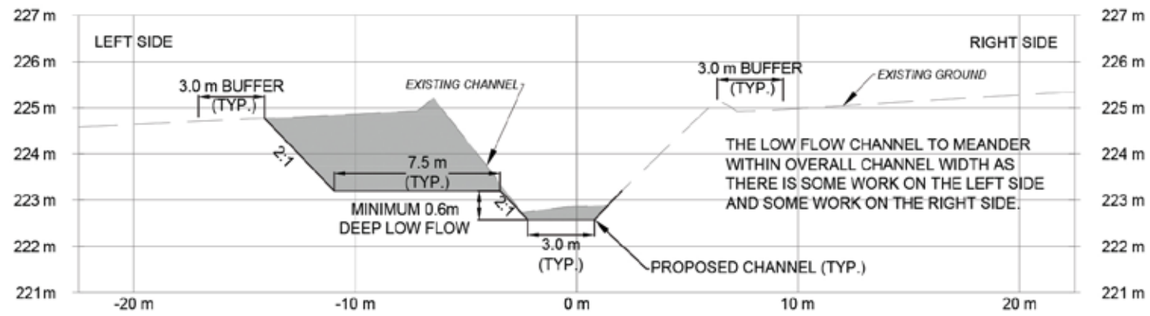
The SICD Improvement design included modelling a 2-year standard event, a 2-year climate change event, and a 2-year hybrid event, as well as producing a cross section for each. The final design was a two-stage drain to contain the 2-year standard peak flow, in accordance with Pub852, while also providing some freeboard to accommodate future climate change impacts. The approved drain cross-section (see drawing below) included a minimum 0.6m deep by 3.0m wide main flow path with maximum 2H:1V sideslopes to accommodate base flow(s). Additionally, a floodplain bench was excavated in the form of a 7.5m widening (typically on one side) and completed with a maximum 2H:1V sideslope to match to the existing ground at the inside of a 3.0m buffer.

The SICD Improvement two-stage drain near the downstream end of the proposed deepening and widening was designed for the following: a watershed of approximately 7,700 Ha; a drain bottom gradient of 0.04%; a 2-year standard flow of approximately 14 m^3/s; and a 2-year hybrid flow of approximately 20 m^3/s.

Benefits

In a two-stage drain, the low or main flow path accommodates the drain's base flow, promotes higher flow velocity and the transport of sediment, reduces laminar flow and sediment deposition, and tends to

Typical cross-section – two-stage drain



decrease the frequency of drain maintenance. This would also help keep private tile outlets open and free-flowing.

Drain stability is improved by distributing the more erosive velocity of larger flow events onto and over the wider vegetated floodplain bench. A well vegetated bench slows down the flow velocity, allows sediment to deposit on the bench, and reduces sediment loading in the drain; sediments deposited on the bench provide soil to support vegetation growth.

Vegetation on the bench also provides shade for the low flow path, reduces water temperature thereby improving aquatic habitat, and provides terrestrial habitat. Aquatic habitat in the low flow path is improved by allowing for variations in water depth, and by creating refuge and cover.

Sediment that accumulates on the floodplain bench should be much easier to remove as part of future maintenance, resulting in a lower environmental impact as it can be removed in the dry. This maintenance may even avoid the need for an in-water timing restriction, which would provide more flexibility for implementation by the Drainage Superintendent.

Costs

By implementing a two-stage drain as the final design for the SICD Improvement project, it is believed there were cost savings. DFO-approved fish exclusion under the direction of an Aquatic Biologist, was completed on smaller 100m to 150m sections of the drain before any in-water work was initiated. Existing sediment and debris in each smaller section was removed from the drain bottom within the main flow path without the need for pumping, thereby reducing costs. With base flows contained within the main flow path, the Contractor was able to steadily excavate and widen the drain (section by section) in an upstream direction and establish the 7.5m wide floodplain bench in the dry, also reducing costs.

Furthermore, as noted in sub-section 1.1, if sediment only needs to be removed from the floodplain bench as part of future maintenance, there may be a possibility that normal in-water timing restrictions may not apply, thereby also serving to reduce future maintenance costs.

Post construction – floodplain bench alternating from side to side

Pre-construction

Construction – north bench

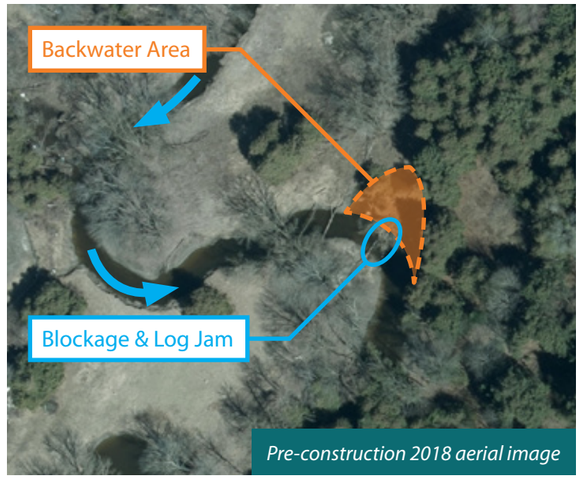
Construction – north & south bench

LEAKY BERM

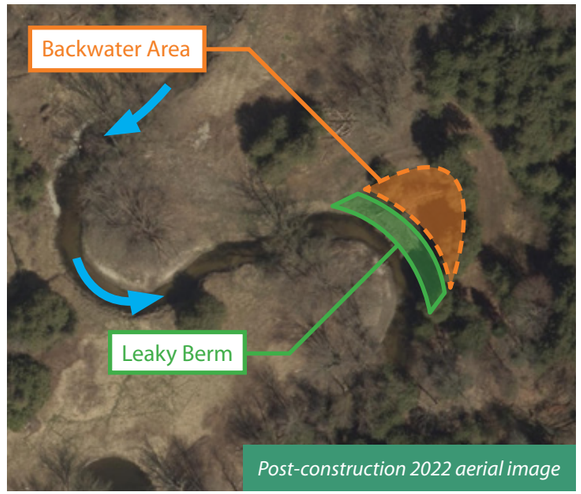
Debris and sediment accumulation were blocking the flow of water at a 90-degree bend in the Drain. The flowpath had to be re-established, but the blockage had created a backwater area that had value for habitat refuge, as well as flood storage during higher run-off / flow events.

It was deemed appropriate to improve this area of the drain with a unique innovation dubbed the "Leaky Berm" as follows:

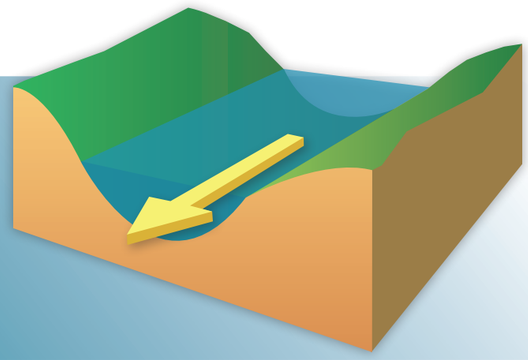
- The existing Woody Material (WM) was removed from the obstruction and used to begin to establish the Leaky Berm;
- The sediment buildup was excavated and the thalweg or main flow path in the Drain was re-established;
- The WM placed in the Leaky Berm was supplemented with additional locally sourced WM; the upstream end of the WM was buried into the drain bank;
- Ballast (the removed sediment) was added on top of the WM; sod mats were placed on the exposed drain banks; the ballast, sod mats, and WM was tamped into place;
- The WM structure was securely pinned in place with the excavator by inserting or pushing pairs of overlapping and abutting sharpened wood pieces of appropriate diameter (150 to 200mm) and length (3.0 to 4.0m) at about 45-degrees to the drain bottom to ensure the material was held down and prevented from floating or lifting during high flows; and
- The main flow path was re-checked to ensure it was adequate after manipulating all of the materials in the Leaky Berm.



Pre-construction 2018 aerial image



Post-construction 2022 aerial image



DEFINITION: A thalweg is the line of lowest elevation within in a channel or drain, and thus the line of fastest flow or deepest water.


Pre-construction existing condition


During construction (looking upstream); log jam and blockage pulled/pushed right to open the drain and establish the main flow path


Post construction (looking downstream); woody material directs larger flows to the right to outlet; but also allows surcharge into backwater area to the left


Spring 2022 (looking downstream); woody material still directing larger flows to the right to outlet; and allowing surcharge into backwater area behind the leaky berm

Benefits:

Minimal clearing was required along the top of the drain bank around the feature, and terrestrial and aquatic habitat in the refuge area behind the Leaky Berm was protected. In addition, flood and high-flow storage was provided in the backwater area, and a natural feature that "blended in" was preserved. The main flow path used and needed to transport sediment was maintained, and the WM in the Leaky Berm collects sediment and floating debris.

Costs:

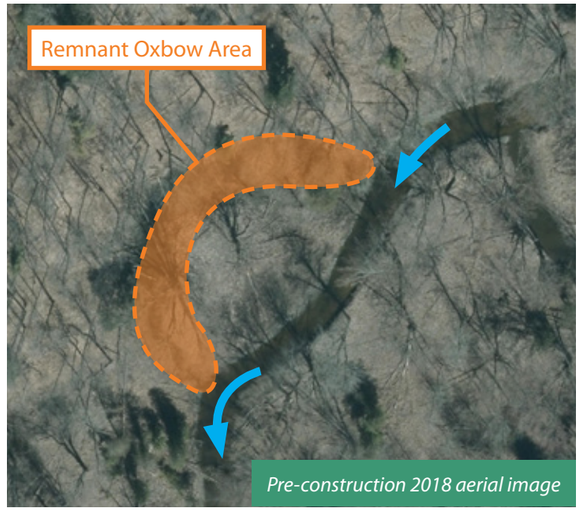
In order to complete this type of work, the Contractor would typically require: an excavator with a claw attachment, well-equipped labourers, chainsaw, winches, chains, ropes, etc. Because the exact extent of the work is difficult to determine since each WM structure and its location on the drain is unique, payment on an hourly basis for equipment, labour, and material is recommended.

OFFSET WETLAND

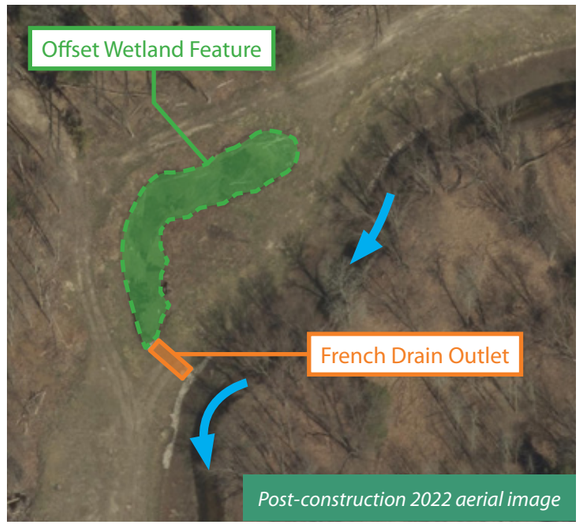
A remnant oxbow adjacent to the main drain acted as flood storage during high runoff events and provided terrestrial habitat.

Therefore, it was considered appropriate to incorporate this remnant oxbow, and with minor improvements, establish it as a unique off-set wetland feature as follows:

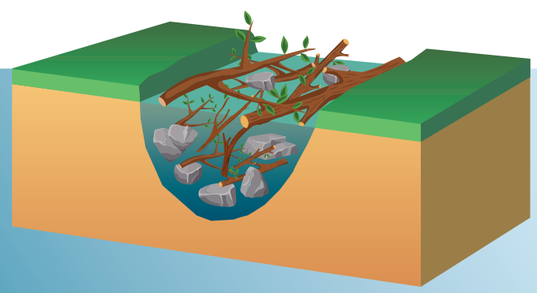
- Supplement the remnant oxbow by felling trees into the bottom to provide additional refuge and habitat;
- The oxbow was not filled and the spoils from the widening of the adjacent portion of the SICD were pushed east and west to maintain the existing feature; and



Pre-construction 2018 aerial image



Post-construction 2022 aerial image



DEFINITION: A French drain is a trench filled with wood and rock that redirects surface water and groundwater away from an area.

- A positive outlet was installed above the wetland bottom (a wood and stone French Drain) for partial emptying of the wetland after a major event, while still retaining adequate capacity in it to provide the intended function as habitat for green frogs, turtles, and waterfowl.

Benefits:

Habitat was established in a new wetland feature, flood and high-flow storage in the remnant oxbow was maintained, a natural feature that "blends in" was enhanced, and a high environmental return was realized on a minimal capital investment feature/venture.

Costs:

Minimal work, time and effort was required by the Contractor, the few trees felled into the remnant oxbow were part of the clearing effort for the drain widening, and the only "constructed" item was the (natural) combination log and stone French Drain outlet.


Remnant oxbow area after clearing woodlot and felling deciduous trees (conifers salvaged for later WD structures)

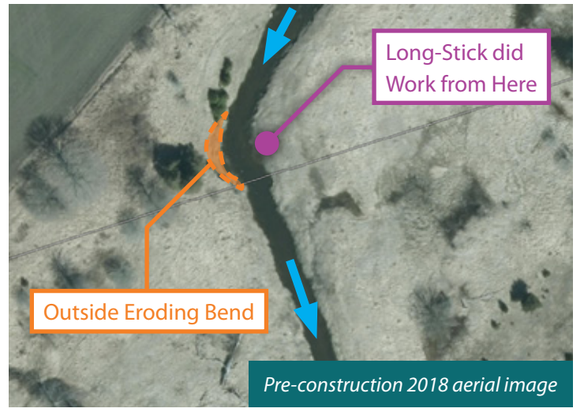

New offset wetland feature c/w french drain outlet

Consequently, payment for the work described was on an hourly basis and included equipment, labour, and material, for a total investment less than $2,500.00.

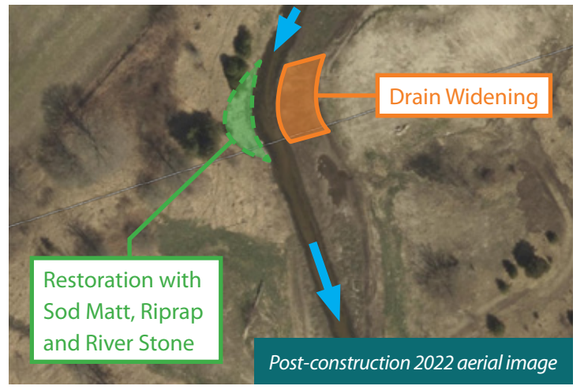
STABILIZATION OF A BANK SWALLOW NESTING AREA

The first bend in the Drain downstream of a major highway required extensive stabilization work. It was severely eroded and slumping (see 2018 Spring Aerial and Pre-Construction photo), and the almost vertical bank was approximately 3.0-4.0m in height above the base flow water surface.

A number of abandoned nests were discovered in the upper 1.0-1.2m of the bank. Bank Swallow (a threatened species) activity was observed in this area during a 2019 field reconnaissance. Therefore, it became a project objective to improve Bank Swallow habitat in the area and the work was completed as follows:



Pre-construction 2018 aerial image



Post-construction 2022 aerial image

- Using a long stick excavator from the opposite drain bank (before the drain was widened), the toe of the eroding slope was built-out with a mixture of large stone and the main flow path was slightly narrowed;
- Riprap was placed on the eroding slope above the base (low) flow water level and river stone was placed along the water line extending down to the bottom of the drain;
- Sod mats were placed by the excavator at the upstream and downstream extents of the bend and combined with the river stone;
- The upper 1.0 to 1.2m of the bank was left vertical and the overhanging potential swallow predator access vegetation was hand-trimmed and removed; and
- No Bank Swallow habitat was impacted, and habitat conditions were enhanced.

Benefits:

The unstable drain bank was rehabilitated and protected from flood and high-flow events as required but with NO loss of Bank Swallow habitat. The result was a high environmental return on a minimal capital investment which protected and maintained a unique existing terrestrial feature.

Post-construction – August 2021

Blow-up of active nests, Spring 2022

Pre-construction - Spring 2018

Costs:

The work completed to stabilize the lower and middle portions of the drain bank was specified in the Report and was required to mitigate erosion, protect private property, and reduce sediment deposition in the drain. Minimal additional work, time and effort was required by the Contractor on the upper 1.0 to 1.2m of the bank, which was left as a vertical face in the existing silt and sand deposit. The hand trimming and the removal of the overhanging vegetation at the top of the bank to eliminate potential access by swallow predators was easily and quickly completed. Payment for the work directly related to the Bank Swallow nesting area was considered part of the mandatory bank restoration work, and the total "extra" investment was less than $100.00.

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Ministry of Agriculture, Food & Rural Affairs

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