How to Drain Stormwater Without Ditches or Stormsewer and Catchbasins

Winnie Wong
Project Manager
R.V. Anderson Associates Limited
Toronto, ON
winnie.wong@rvanderson.com

Peter Cho
Principal
R.V. Anderson Associates Limited
Toronto, ON
pcho@rvanderson.com

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Acknowledgements

Town of Ajax

Abstract

Range Line Road is a two-lane road located in a residential area in the Town of Ajax, Ontario. Under existing conditions, it has a rural cross section on the west portion and an urbanized cross section on the east. Stormwater runoff drains toward Lake Ontario carried by ditches and culverts in the rural west portion, and by storm sewers in the urbanized east. With Carruthers Creek to the north and Lake Ontario to the south, a section of the road is within Toronto and Region Conservation Authority's (TRCA) regulatory floodplain limit. Consultation with TRCA and local residents reveal that water from Lake Ontario can overtop Range Line Road during heavy rainfalls. Site investigations show there is minimal slope in the existing ditches and that groundwater levels are high. This is evident from culverts heaving up and cracking in the existing pavement along Range Line Road and adjacent driveways.

After consultation with the public the Town reaffirmed their decision to rehabilitate the road pavement and to extend the existing sidewalk on Range Line Road through the rural west section as part of their ongoing effort to improve road safety and active transportation network connectivity. The sidewalk extension will fill in the existing ditches to minimize grading impacts onto adjacent residential properties. Normally, storm flows drained by gravity sewers would be proposed but this will not work

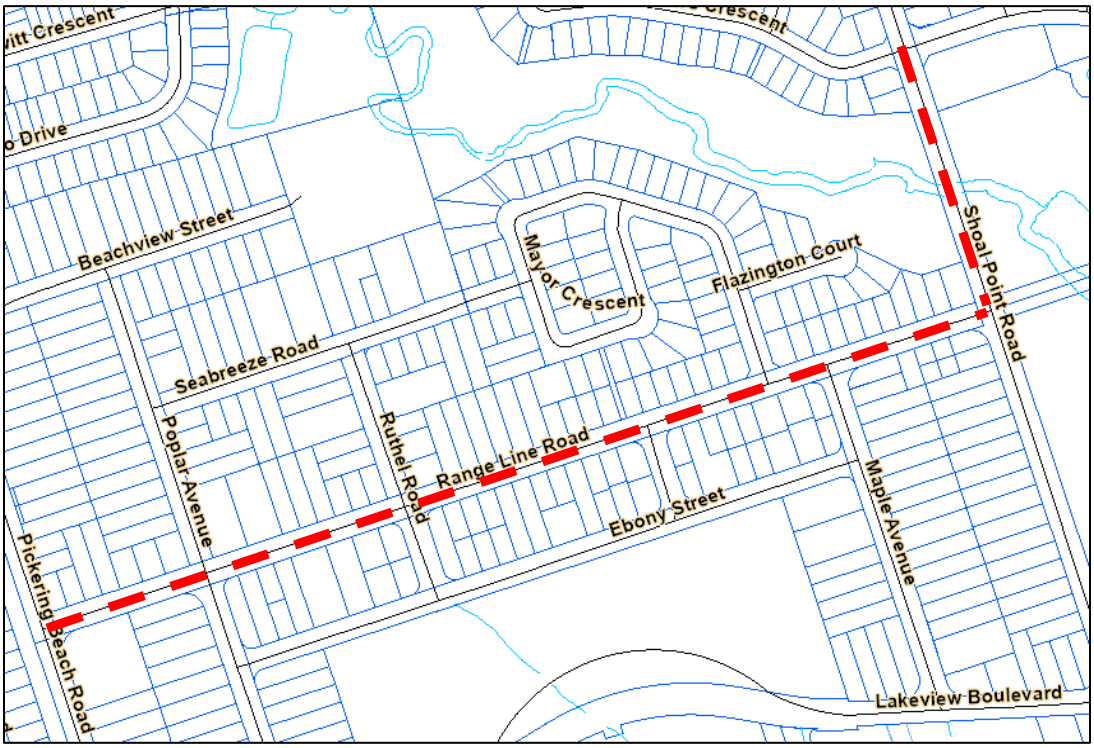
here because of the limited ground cover available due to the minimal difference in elevation between the road and the lake. Without a viable drainage system to drain water away from the road, the new pavement will not reach its expected service life, and the new culverts will continue to heave up against the new pavement.

Through extensive collaboration with the Town and a well-known manufacturer, the project team delivered a design that achieved the Town's objective in extending the sidewalk while utilizing a unique slot-drain system along the new curb and gutter in lieu of the conventional stormsewer and catchbasin system to facilitate drainage and thus improve the new pavement's chances of reaching its expected service life. While the same product has been used before on one of MTO's Highway 401 projects, the Town of Ajax is one of the first municipalities in Ontario to use it on their roads. Main design challenges include demonstrating the product's durability, constructability, and maintenance effort to Town's Road Operations. All construction work was completed in December 2023.

Introduction

The Town of Ajax (Town) retained R.V. Anderson Associates Limited (RVA) in 2020 to undertake the detailed design for Range Line Road and Shoal Point Road following Schedule 'A+' of the Municipal Class Environmental Assessment (amended 2011). The scope of work involves road pavement rehabilitation (including pavement cracking due to culvert heaving), new sidewalk installation, implementation of new traffic calming measures, and overall stormwater drainage improvements for Range Line Road. The scope also included road pavement rehabilitation for Shoal Point Road.

Figure 1. Project Limits Key Map



Source: Town of Ajax

One of the Town's objectives for this detailed design project is to extend the existing sidewalk on Range Line Road to connect to the multi-use path along Pickering Beach Road and expand their active transportation network connectivity.

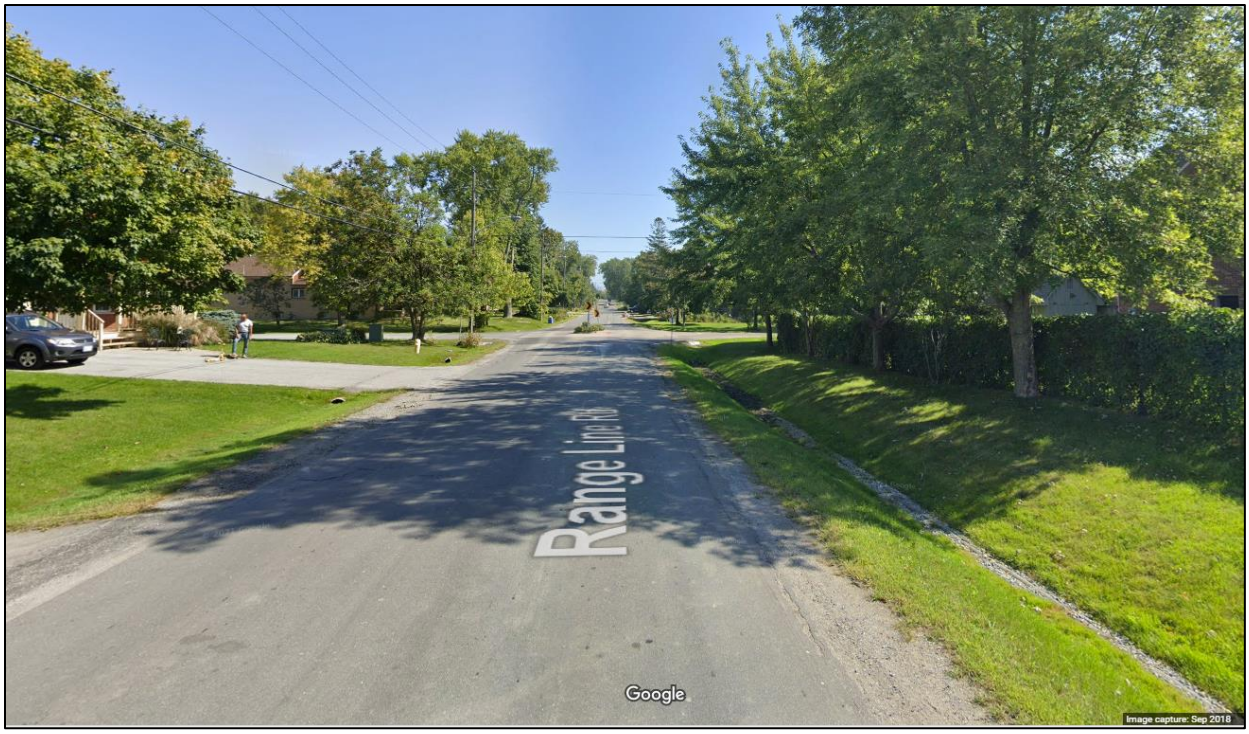
Existing Conditions

Road Characteristics

Range Line Road is a two-lane road measuring approximately 825m in length with limits from Pickering Beach Road to Shoal Point Road. Classified as an arterial road in the Town's Official plan, it is located within a residential area serving as an east-west connection in Ajax southeast area. The existing road right-of-way (ROW) is approximately 20m wide. Under existing conditions, it has a rural cross section from Pickering Beach Road to west of Cherry Street with paved shoulders and ditches. From west of Cherry Street to Shoal Point Road, it has an urban cross section with curb and gutter completed with an existing sidewalk on the north side of the road. Lined with residential driveways, Range Line Road is also filled with mature trees typical of residential setting. Hydro poles and overhead hydro lines are found on the north side of the road while above ground utility vaults/ boxes belonging to Bell and Rogers are located throughout. An Enbridge gas line is also present on the south side of Range Line Road within the project limits.

During RVA's site investigations, the project team noted the existing road crossing culverts at Poplar Avenue and Ruthel Road intersections together with some driveway culverts have heaved with pavement cracking which indicates insufficient road cover or high groundwater levels. The boreholes from geotechnical investigation; however, did not encounter free water and the report noted the groundwater level in this area is "…expected to fluctuate seasonally and will be influenced by major weather events."[1].

Figure 2. Existing Range Line Road between Pickering Beach Road and Poplar Avenue (Rural Section)



Source: Google

Existing Drainage

The project team further noted the existing ditch profile slope is flat and generally follows the road profile. Water ponding was observed in the existing ditches. Between Pickering Beach Road and Poplar Avenue, the ditches on north and south side of Range Line Road drain eastward towards Poplar Avenue and then continue southwards along Poplar Avenue. Between Poplar Avenue and Ruthel Road, the ditches on north and south side of Range Line Road drain eastward towards Ruthel Road and then continue southwards along Ruthel Road towards Lake Ontario. Between Ruthel Road and west of Cherry Street, the ditches on north and south side of Range Line Road drain westward towards Ruthel Road and continue southwards along Ruthel Road. East of Cherry Street the road is urbanized with catchbasins directing the stormwater into an existing stormsewer system that drains towards Shoal Point Road.

On both sides of Range Line Road within the rural section, the project team observed outlet pipes from adjacent private properties draining into the roadside ditch. The Town noted that all the residential homes in the area have sump pumps outletting into the existing ditch due to their proximity to Lake Ontario which is approximately 300m south of Range Line Road. In addition, most of the homes along Range Line Road have connected their downspouts to underground pipes leading to the ditch. During a rain event, the existing ditch conveys surface run-off, as well as is conveying water from the adjacent homes' basements and downspouts.

Existing Flooding Issue at Range Line Road and Ruthel Road Intersection

Consultation with local residents and TRCA revealed that the Ruthel Road and Range Line Road intersection is prone to flooding. Residents recalled that during a recent heavy rainfall event Ebony Street, the road that is just south of and parallel to Range Line Road, was overtopped with water from

Lake Ontario and extending up to the intersection of Ruthel Road and Range Line Road. On TRCA's regulation mapping, this intersection and a section of Range Line Road is within TRCA's regulated limits and flooding limits that extend from Carruthers Creek in the north to Lake Ontario to the south. A dedicated stormwater management study will be required to resolve this existing flooding issue and not part of Range Line Road's detailed design project scope. The Town and TRCA has completed mitigation work by installing a new wetland at Range Line Road and Ebony Street intersection, south of the project area.

Detailed Design

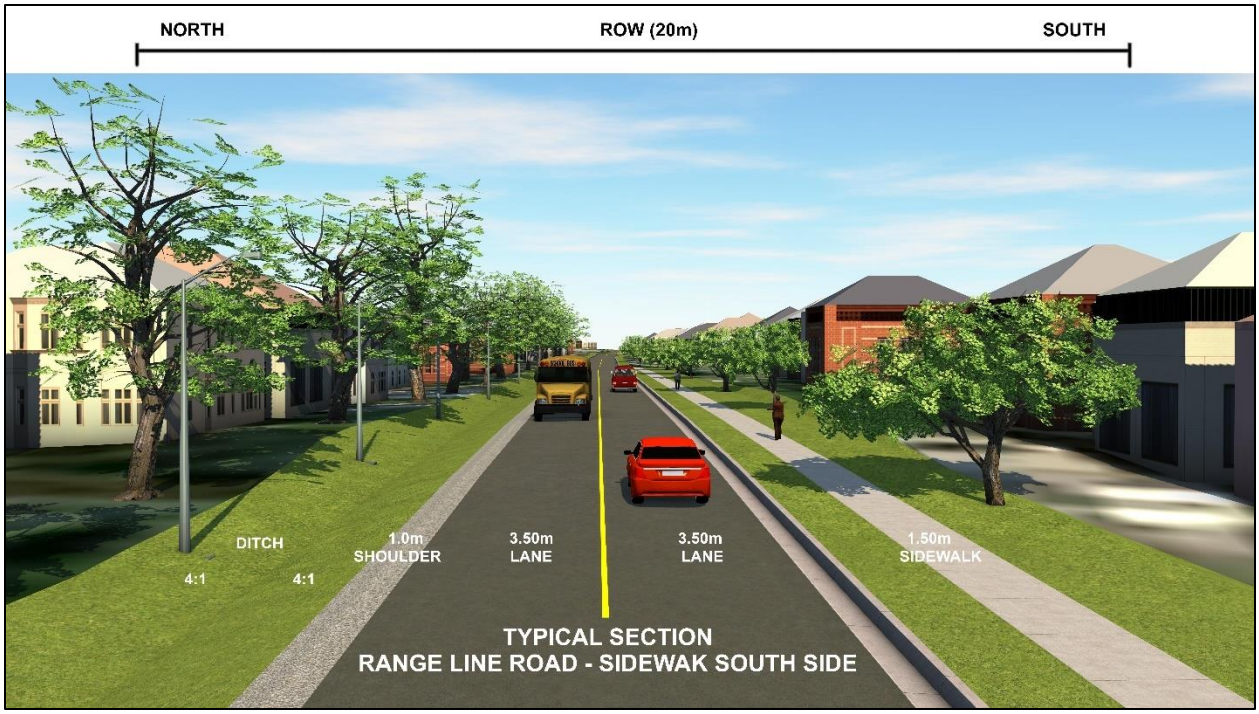
Design Constraints

At the project onset, since Range Line Road is located within a residential area, the Town instructed RVA to minimize property impacts and utility relocation. To achieve the Town's objective of expanding their active transportation network, the existing sidewalk on the north side of Range Line Road would be extended from west of Cherry Street to Ruthel Road. Since the north side had more driveways and hydro poles, the new sidewalk will transition across Range Line Road at Ruthel Road and continue along the south side towards Pickering Beach Road to minimize conflicts. Due to the tight ROW, the new sidewalk would be constructed on top of the existing ditch to avoid property acquisition and minimize tree removals. The rural section will become half urbanized with new curb and gutter on the side with new sidewalk.

As-built drawings and topographic survey showed the elevation difference between Range Line Road and Lake Ontario is approximately 1m resulting in the maximum achievable ditch slopes along Poplar Avenue and Ruthel Road of 0.3%, which is flat and confirms with the project teams' field observations. The road profile slope on Range Line in the rural section is generally flat, falling within 0.5% to 1.5%. To minimize property impacts the proposed road and roadside ditch profiles would need to match the grade closely – i.e. cannot be steepened to improve drainage. The proposed stormwater drainage system therefore will be constrained by the outlet elevation at Lake Ontario as well as Range Line Road's profile slope.

In RVA's initial consultation with Toronto and Region Conservation Authority's (TRCA) noted that the existing drainage pattern in the area must be maintained. Quality control was not required for Range Line Road because it was "…located within the zone of influence from Lake Ontario and backwater effect from the lake are anticipated to affect the proposed drainage conveyance infrastructure. As such it was not feasible implement quality controls such as OGS units or infiltration trenches." [2] Quantity control was also not required for Range Line Road as the wetland south of Ebony Street and Ruthel Road intersection recently constructed by TRCA was providing treatment at the downstream outlet.

Figure 3. Proposed Range Line Typical Cross Section – Sidewalk on South Side



Alternatives Considered

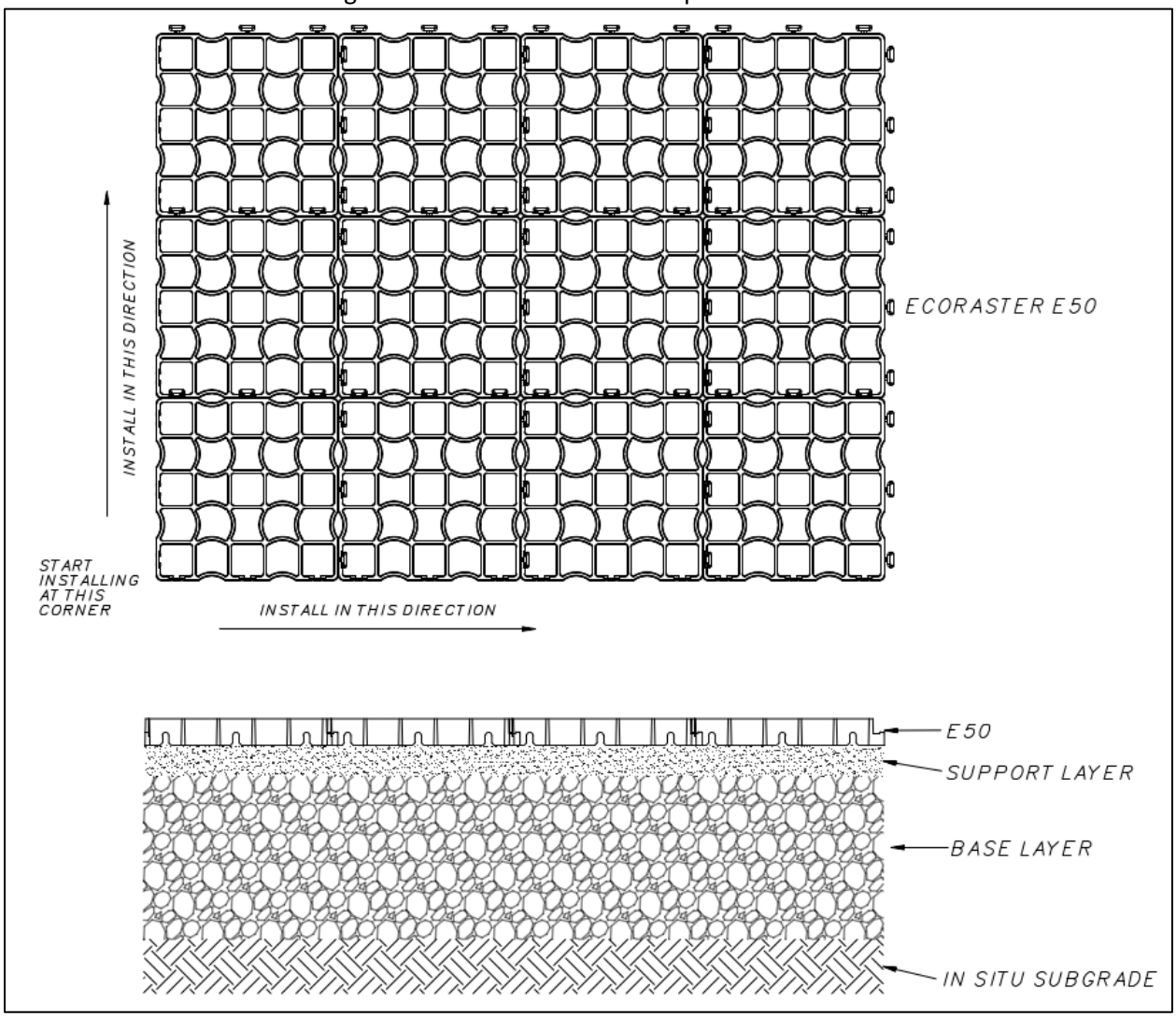
To minimize property impacts and due to the limited ROW, the new sidewalk would be installed along the existing ditch line and a new stormwater drainage system would be needed to drain surface stormwater runoff away from the newly rehabilitated pavement. Three alternatives were proposed and evaluated as part of the detailed design:

1. Catchbasin manhole and stormsewer
2. Permeable pavers along the new curb and gutter (e.g. Ecoraster)
3. Slotted drain system along the new curb and gutter (e.g. Duraslot)

In Alternative #1 a new stormsewer system completed with catchbasins and manholes was proposed between Pickering Beach Road and Ruthel Road and the current rural section of Range Line Road will be urbanized with curb and gutter. The new stormsewer system will follow the existing drainage pattern draining from west to east and then outlet to the ditches along Poplar Avenue and Ruthel Road. Due to the generally flat topography in the area the proposed stormsewer pipe was constrained by the downstream outlet elevation at Lake Ontario and the proposed catchbasins would not be able to achieve the required cover. As such, Alternative #1 was not feasible.

In Alternative #2, permeable pavers such as Ecorasters was proposed at the edge of the road along the new curb and gutter to capture the stormwater runoff in lieu of catchbasins. The permeable pavers have a cellular design which would be filled with a permeable substructure to allow surface stormwater to infiltrate into the soil below along the new curb. During discussions with the Town's Road Operation team; however, there were concerns that the snow plough blades would catch these cells and remove the pavers completely from the road. The efficiency of these pavers to allow water to infiltrate over time was also a concern, with road salt and sediment typically accumulating along the curb and gutter where these pavers will be located. As such, Alternative #2 was not preferred due to concerns with the product's longevity and its ability to water infiltration within a reasonable amount of time.

Figure 4. Permeable Paver Example - Ecoraster

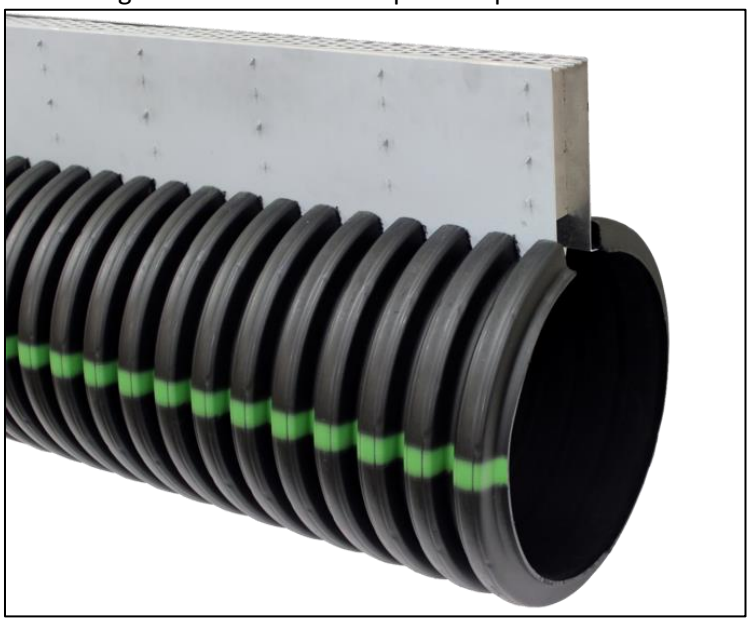


Source: Ecoraster

In Alternative #3, a slotted drain system such as Duraslot was proposed at the edge of the road along the new curb and gutter to capture the stormwater runoff in lieu of catchbasins. The system consists of a slotted drain opening along the face of the new curb to allow surface stormwater runoff to drain into a HDPE pipe running directly underneath the new curb and gutter. The HDPE pipe drains towards to nyloplast drain basins which then outlets to the ditches on Poplar Avenue and Ruthel Road, matching the existing drainage pattern. The slotted drain system design is intended for shallow install applications such as the case with Range Line Road. During discussions with the Town's Road Operation team there were concerns with the road flooding due to the HDPE pipe clogging from the road salt and sedimentation built up or from falling leaves blocking the slotted drain along the curb. Furthermore, because this was a new product to the Town there was no maintenance program in place. In addition, to withstand live traffic loading the slotted drain would need to be encased in concrete for support which would make it hard to be replaced in the future if needed.

While these are valid concerns from the Town's Road Operation team, the project team noted Range Line Road is a unique case where a conventional stormsewer and catchbasin design would not be feasible due to property and drainage constraints, which will require a new alternative drainage system that the Town most likely had not used in the past to provide proper drainage for the rehabilitated road pavement. Unlike the Ecoraster, the slotted drain will sit immediately next to the face of curb and slightly lower than the gutter, out of the typical reach of the snow plough blades. The road salt and sedimentation built up in the HDPE pipe can be routinely flushed out through the nyloplast drain basins to minimize risk of clogging and road flooding. ADS, the manufacturer of Duraslot, also noted that MTO had recently installed the same product successfully on one of their highway projects. To address the Town's maintenance concerns, ADS also developed a brief maintenance manual recommending the flushing and cleanout frequency. Although the concrete encased slot drain system will be difficult to replace in the future, the encasement allows the slotted drain to withstand live traffic loads which should be minimal of due to its location next to the curb. ADS also confirmed the service life of their slotted drain is typically 20 years. As such, the Town approved Alternative #3 to proceed to detailed design.

Figure 5. Slotted Drain Pipe Example - Duraslot



Source: ADS

Design of the Preferred Alternative

Although the proposed slotted drain system will drain the surface stormwater runoff away from the road, but subdrains were still required to drain water away from the pavement structure. Subdrains are typically located underneath the curb and gutter just beneath the pavement structure. With the proposed slotted drain system, the subdrain was moved in front of the new curb and gutter to collect water and drain it towards the same nyloplast drain basins that the slotted drain pipe drains into and outlets into the ditch.

With the new sidewalk replacing the existing ditch on Range Line Road, an alternative drainage outlet was needed for the sump pumps and downspouts. To minimize the risk of stormwater back flowing into

homes, a backwater valve was proposed at the end of the existing sump pump outlet pipes, within the Town's ROW. For future maintenance purposes, a valve cleanout with cap and lock was installed on top of the backwater valve. For the downspouts, residents were advised to disconnect them from the underground outlet pipe and change it to overland drainage directed to their lawns and greenspace to alleviate the burden on the new slotted drain system. Refer to figure below for the slotted drain system integration with subdrain and sump pump outlet design.

Figure 6. Slotted Drain System Design Integrating Subdrain and Sump Pump Outlets

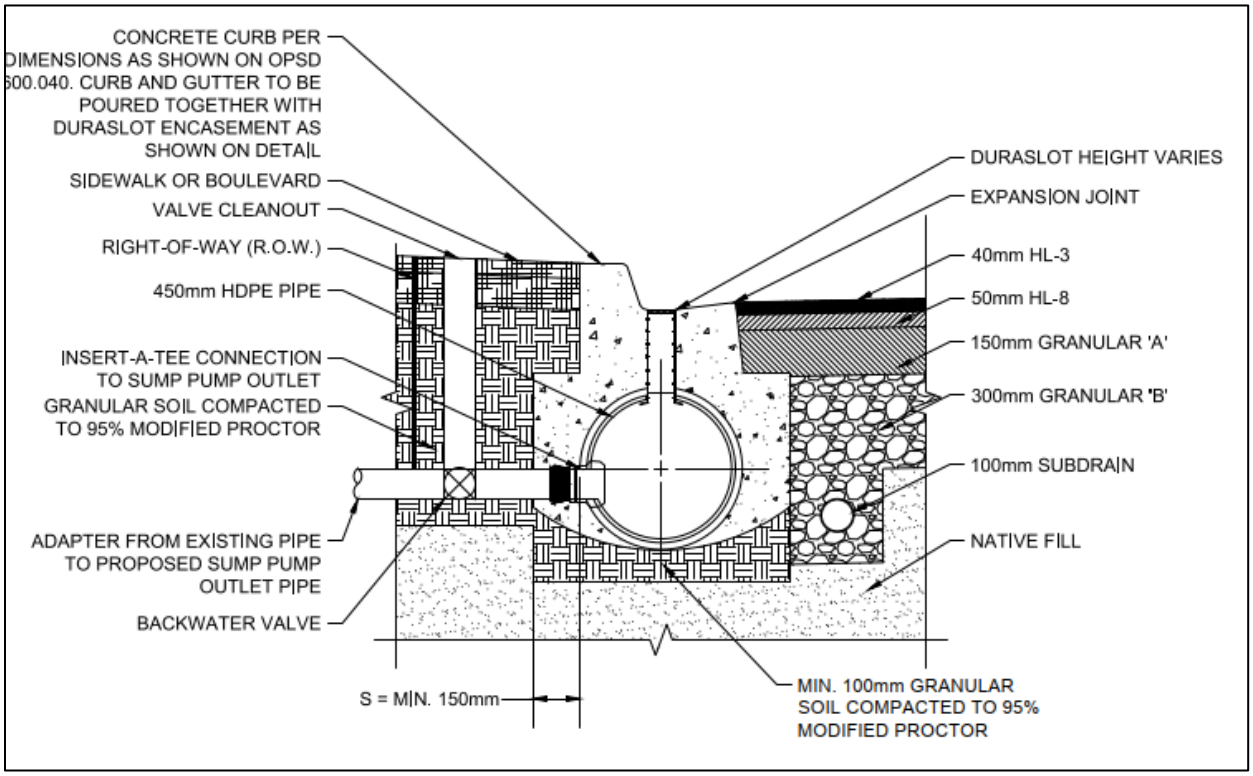
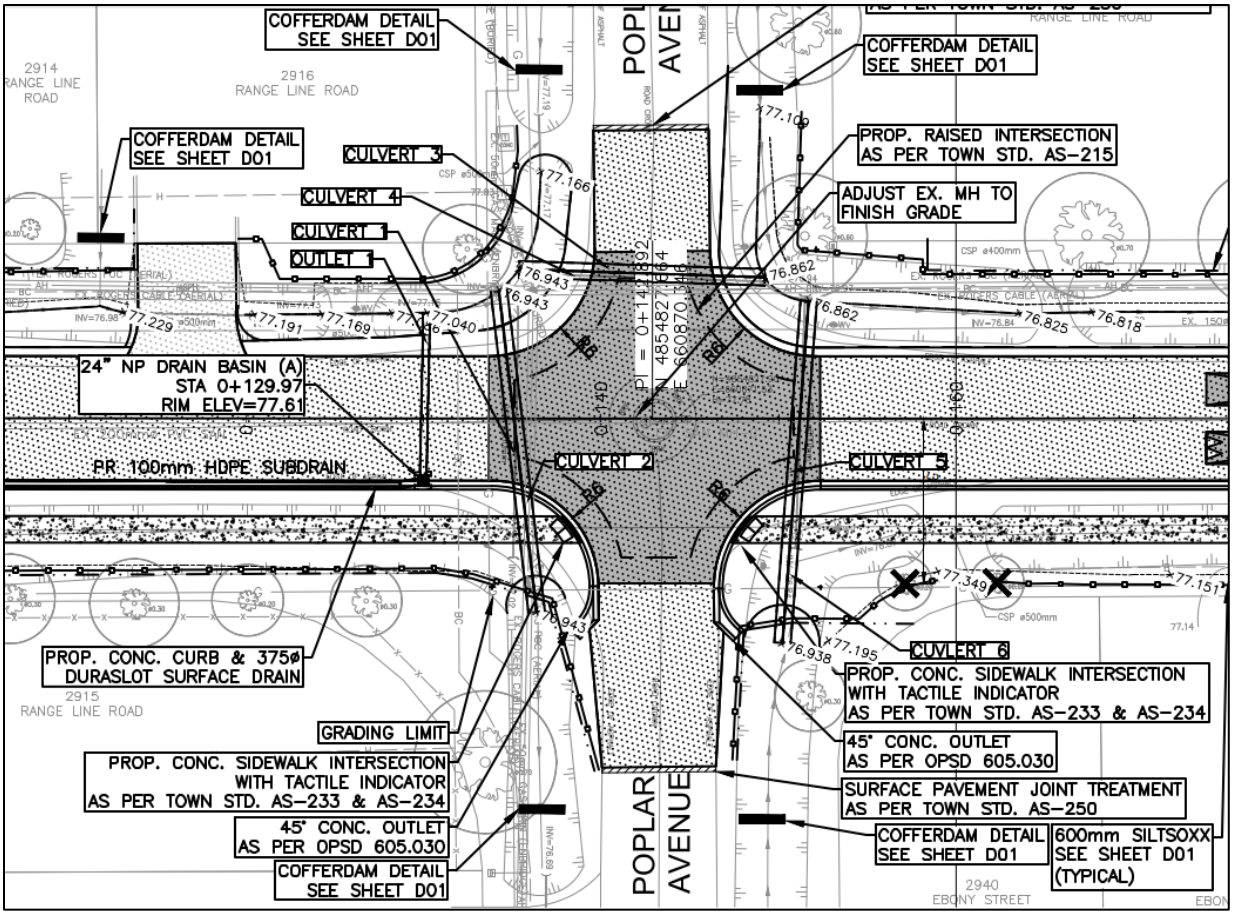


Figure 7. Intersection Layout with Slotted Drain System, Subdrain, and Culvert



Construction

During detailed design one of the constructability risk identified was the installation of the slotted drain pipe system - Duraslot. Although the same product has been used in the United States and on one of MTO's highway projects, Town of Ajax is one of the first Ontario municipalities to use this system on their roads. Dufferin Construction, the contractor retained by the Town for Range Line Road construction project was also the same contractor who installed Duraslot for MTO's highway project. Their experience working with Duraslot was one of the key factors in the successful delivery of the project.

Duraslot is prefabricated and delivered on site in sections and assembled. As such, the project team needed to specify the height of the slot drain at the top of the pipe for each section. During construction, Dufferin identified areas where the proposed slotted drain conflicted with existing utilities in the road. Realigning the slotted drain to avoid the conflict was not an option since the height of the slot drain is specific to the section of Range Line Road profile to which it was designed. The existing buried utilities were buried much shallower than typical on Range Line Road, most likely due to the high ground water levels that Dufferin also noted during their replacement of the culverts at the intersections.

The existing culverts at the intersections were heaving as noted by the project team's initial site investigation. As part of the Town's traffic calming measures, a new raised intersection was proposed at

Poplar Avenue and Ruthel Road. The additional asphalt layer at the intersection provided the needed additional cover on top of the culverts. To further reduce the risk of heaving, RVA also instructed Dufferin Construction to install additional subdrains along the new culverts to drain the water at the subgrade level.

Figure 8. Duraslot with Nyloplast Drain Basin along Range Line Road

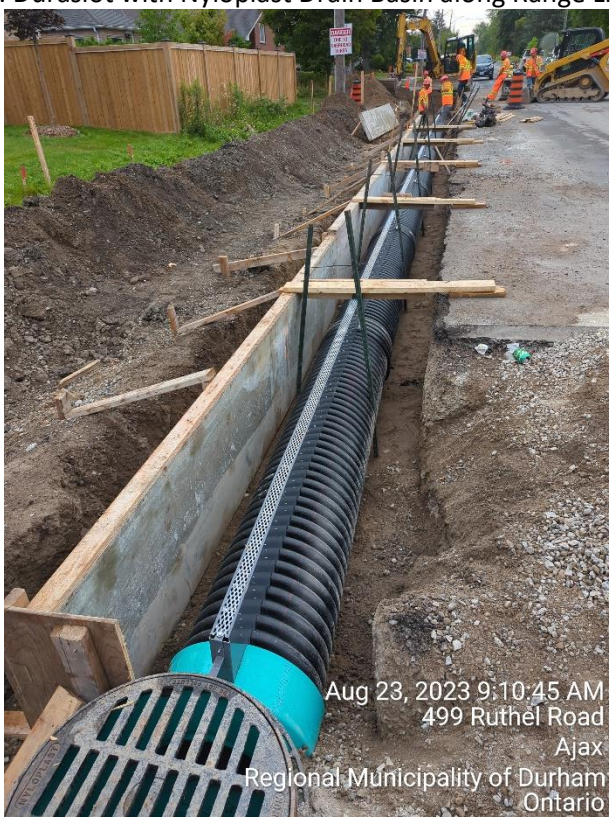


Figure 9. Concrete Encasement of the new Duraslot

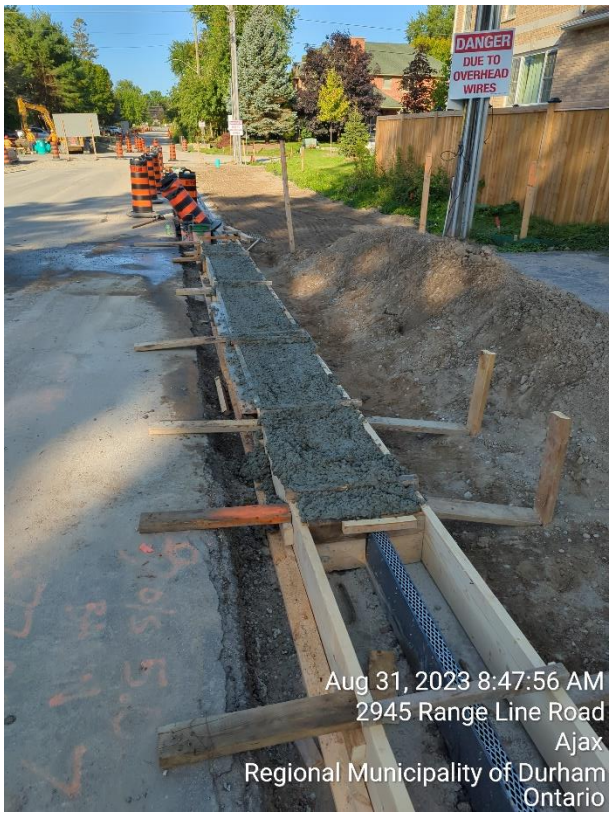
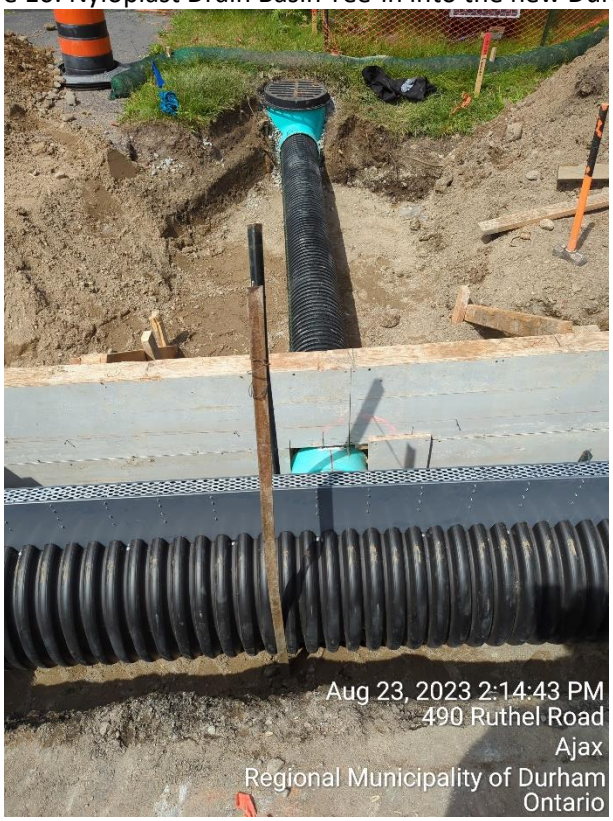


Figure 10. Nyloplast Drain Basin Tee-in into the new Duraslot



Current Condition

The construction work for Range Line Road was completed in December 2023. To date Range Line Road has no issue with drainage or flooding caused by the new Duraslot system. In Winter 2024, RVA returned to the newly constructed road to observe the drainage condition and note that aside from water accumulation in the new nyloplast drain basins, which is similar to the water ponding in the ditches under pre-construction conditions, the surface stormwater is draining into the Duraslot as intended.

Figure 11. Range Line Road – Post Construction

Figure 12. Range Line Road – Post Construction

Figure 13. Range Line Road – Post Construction Ditches

References

[1] Terraprobe Inc, “GEOTECHNICAL INVESTIGATION AND DESIGN REPORT RANGE LINE ROAD FROM SHOAL POINT ROAD TO PICKERING BEACH ROAD” Ajax, ON: Terraprobe Inc. p. 4. (2023)
[2] R.V. Anderson, “Stormwater Memo to TRCA – Range Line Road” Toronto, ON: Matthew De Wit. p. 2. (2022)