4.3 Priority Site #1: Exposed Sanitary Sewer Crossing, Maintenance Hole, and Lateral Risk to Sanitary Sewer

Priority Site #1 is located in Reach N1 of Newtonbrook Creek. Channel widening and planform adjustment has exposed the concrete encasement surrounding a 675 mm diameter sanitary trunk sewer and its downstream maintenance hole. Widening of the channel has outflanked the aforementioned sanitary sewer maintenance hole, exposing the structure within the southern bank of the channel (**Figure 4-1**). On the opposite side of the channel a pedestrian trail runs adjacent to the creek. Active erosion along the outside of the meander bend is encroaching towards the edge of the pedestrian trail (**Figure 4-2**) creating a potential risk to public safety should the ground beneath the trail become undercut or unstable.

The meander of the creek at this site is sharp, contributing to significant erosion of the local channel bed and bank materials (**Figure 4-3**). The exposed sewer encasement is flush with the bed of the channel, partially exposed in a location upstream of the maintenance hole. The sewer crosses the channel at an oblique angle passing underneath an island formed from the deposition of large gravel and cobble sized materials (**Figure 4-4**). The gradient of the channel overtop of the exposed sewer crossing is relatively steep and it is anticipated that if the site is left unaddressed further exposure of the sewer crossing and maintenance hole structure is likely to occur increasing the risk of failure/damage. Undertaking site restoration works to infill and stabilize the eroding bank around the exposed maintenance hole, and increase the depth of cover over the sanitary sewer crossing, is recommended. When developing design alternatives consideration should also be given to protecting the pedestrian trail system.

Figure 4-1: Exposed Sanitary Maintenance Hole in Bank

Figure 4-2: Erosion along the Outer Meander Bend Encroaching Towards the Pedestrian Trail

Figure 4-3: Significant Bank Erosion Between the Exposed Sewer Crossing and Downstream Maintenance Hole

Figure 4-4: Upstream of the Exposure. Note gravel Island to the Right of the Photograph.

Sanitary Sewer and Maintenance Hole parameters relevant to this priority site are summarized in **Table 4-4** with a drawing illustrating the existing conditions of the project site presented in **Figure 4-5**.

Table 4-4: Summary of Priority Site #1 Maintenance Hole and Sanitary Sewer Parameters

Parameter	Sanitary Trunk Sewer	Exposed Maintenance Hole
Toronto Water Asset ID	SL4033582	MH4856914969
Year of Construction	1960	1960
Diameter	675	Unknown
Depth of Cover	0 m	0 m
Estimated Time to Contact	0 years	0 years
Erodibility of Adjacent Substrate	Moderate High	Moderate High

4.3.1 Priority Site #1 – Description of Restoration Alternatives

Alternative 1: Do Nothing – The exposed sanitary sewer crossing and maintenance hole structure will continue to be at risk of failure due to continued widening and downcutting of the channel. Active erosion along the outside of the meander bend may also undermine the existing pedestrian trail creating a risk to public safety. Future emergency works may be required if any of the at-risk infrastructure begins to fail.

Alternative 2: Local Works – Apply channel engineering works for about 50 metres of channel length within reach N1, focused on a fixed engineered riffle centered overtop of the exposed sanitary sewer to provide a minimum of 0.3 metres depth of cover. Pools will bound the riffle on either side facilitating a transition into existing conditions. The existing gravel island will be removed and infilled to facilitate minor adjustment to channel planform. An armourstone retaining wall is to be installed along both sides of the channel to benefit the pedestrian trail system and exposed sanitary sewer maintenance hole. The armourstone retaining will require a railing on the north side to provide fall protection for trail users and will transition into an engineered vegetated buttress at the downstream and upstream extents of the proposed local works solution.

Alternative 3: Sub-Reach-Based Works – Apply natural channel design for approximately 350 metres of channel length including riffle-pool morphology and bioengineered bank treatments (vegetated buttresses). The proposed works will start just upstream of the confluence between Newtonbrook Creek and the Don River. Adjustments to the longitudinal profile, planimetric alignment and typical channel dimensions will look to stabilize the downstream half of Reach N1 from a geomorphic perspective, eliminating an observed knick-point that has the potential to migrate further upstream if left unaddressed. The proposed solution will increase the depth of cover over the exposed sanitary sewer crossing by a minimum of 1.0 m, and will have the added benefit of also increasing the depth of the cover over sanitary sewer crossing #1, located downstream of this priority site, from an estimated 1.58 metres to a minimum of 2.0 m. Failed engineered bed and bank treatments, and accumulated debris, will be removed with riffle-pool morphology established through the placement of engineered substrate. Vegetated buttresses will be placed along the outside of each meander bend for erosion protection. The channel and pedestrian trail system will also be realigned near the exposed sanitary sewer crossing to provide an increased erosion buffer between the channel and the trail/exposed sanitary sewer maintenance hole. These works would transition into the proposed sub-reach-based works solution for Priority Site 2.

Preliminary concept drawings illustrating Alternative 2 and Alternative 3 are provided in **Figure 4-6**.

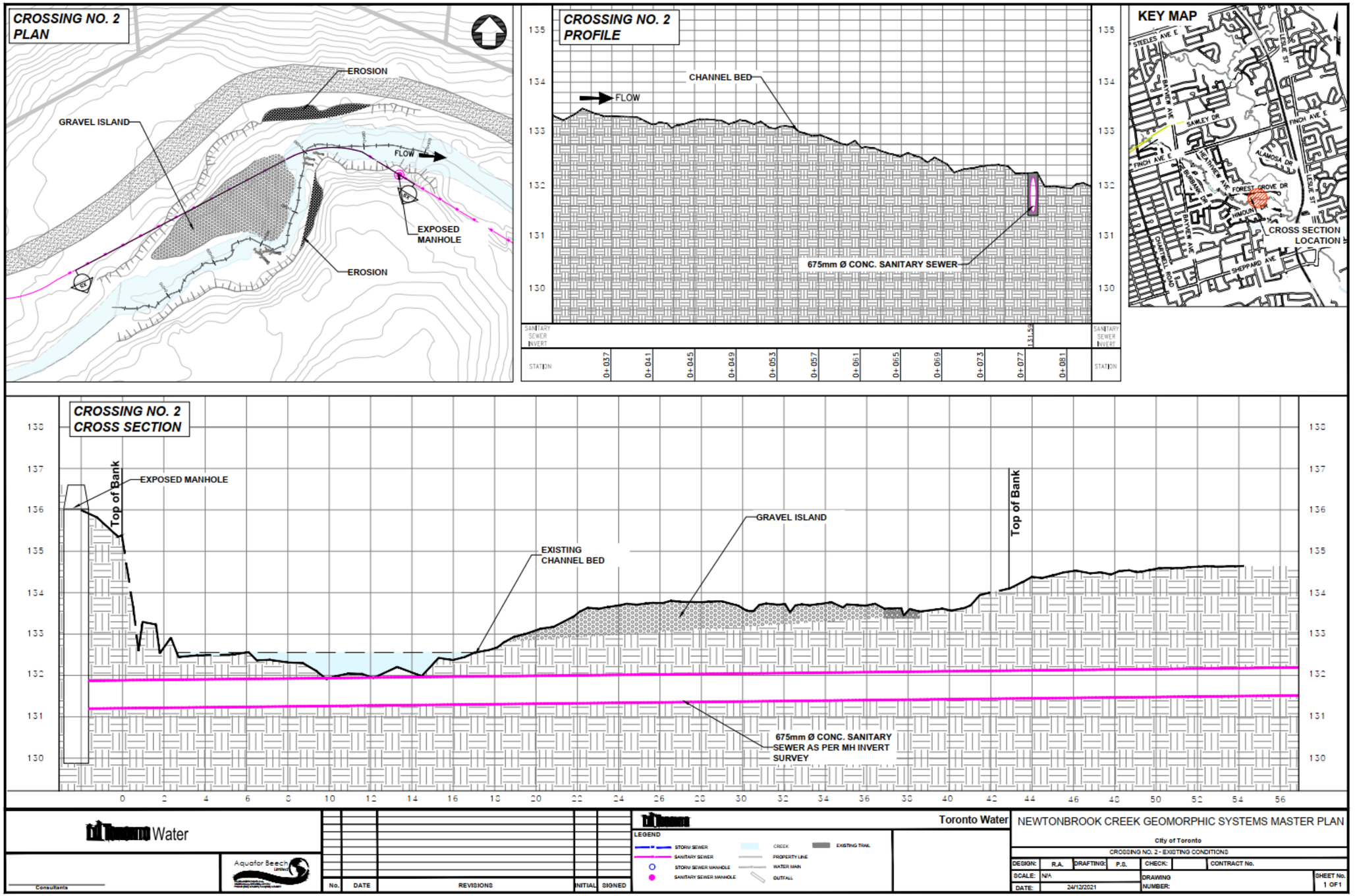

Figure 4-5: Existing Conditions - Priority Site #1

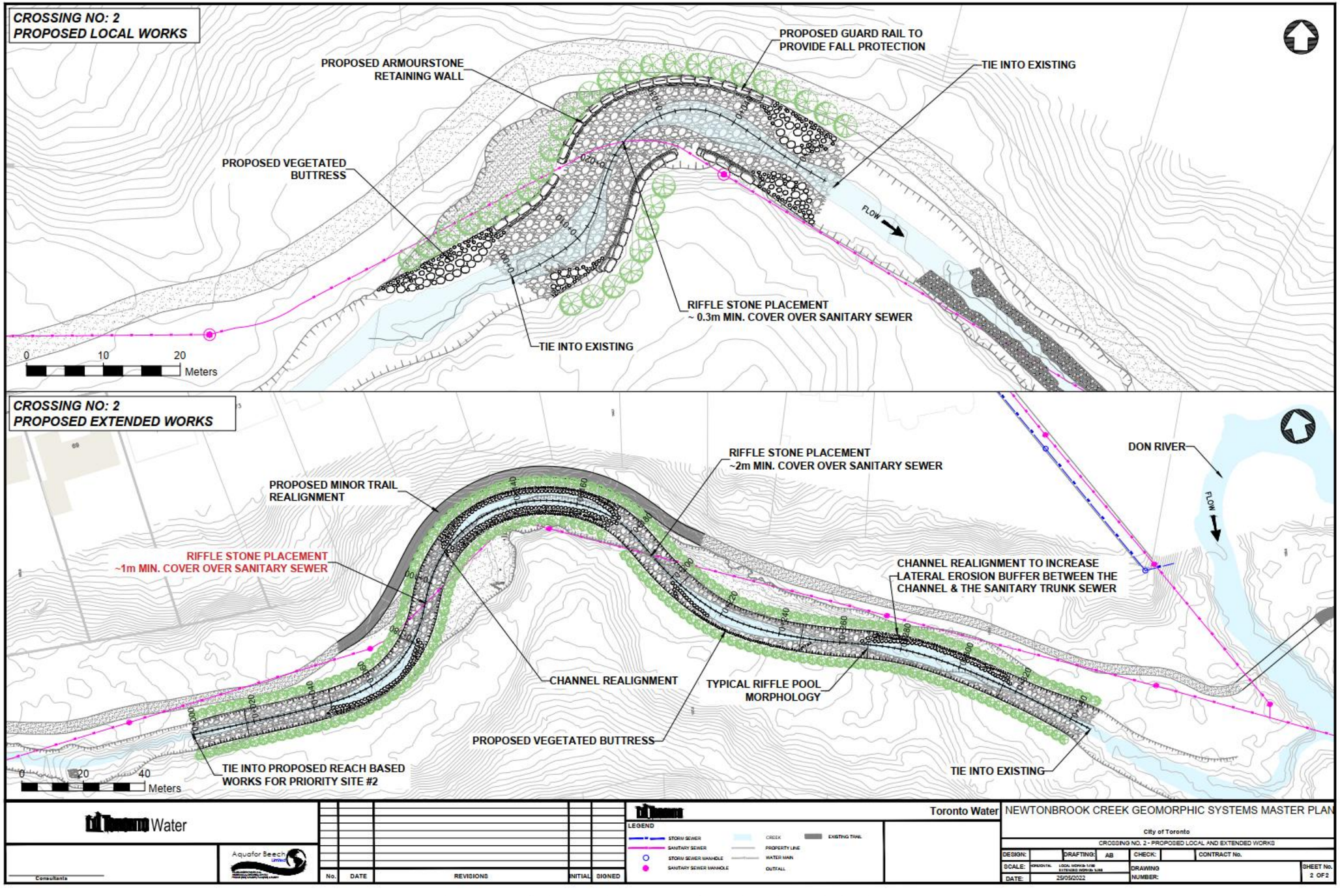

Figure 4-6: Preliminary Design Concepts Alternative 2 & 3 – Priority Site #1

4.3.2 Priority Site #1 – Evaluation of Restoration Alternatives

Restoration Alternatives for Priority Site #1 were evaluated using the methodology outlined in **Section 4.2.** Based on this evaluation process, Alternative 3 - Sub-Reach-Based Works was selected as the preferred alternative.

4.3.3 Priority Site #1 – Selection of the Preferred Alternative

As per the evaluation table, the Sub-Reach-Based Works option was selected as the preferred alternative for Priority Site #1 with a total score of 77.00/100. The local works solution was the second preferred alternative with a total score of 60.87/100 while the Do-Nothing alternative was the least preferred alternative with a total score of 41.80/100.

Key elements of the Sub-Reach-Based Works alternative include:

- Removal of channel debris and failed erosion control structures.
- Apply approximately 350 metres of channel restoration work using natural channel design principles to establish riffle-pool morphology.
- Where feasible, lower and regrade channel banks to restore floodplain connectivity.
- Protect the exposed sanitary sewer maintenance hole through a combination of minor channel realignment and the establishment of vegetated buttress bank protection works.
- 140 metres of minor pedestrian trail realignment and restoration work.
- Provide a minimum of 1.0 metres of cover overtop of the exposed 675 mm diameter sanitary sewer crossing.
- Increase the depth of cover overtop of the downstream sanitary sewer crossing (identified as Priority Site #42 - SL4033032) to a minimum of 2.0 m.
- Help mitigate future potential lateral erosion risks to sanitary sewer infrastructure and the Pedestrian Trail system through a combination of minor channel realignment and the construction of vegetated buttress bank protection works.
- Transition into the proposed sub-reach-based works solution for Priority Site #2 - SL4032406 at the upstream tie-in point.
- Establish a geomorphically stable transition into existing channel conditions at the downstream tie-in point, which is located approximately 80 metres upstream of the confluence between Newtonbrook Creek and the Lower Don River.
- Apply restoration plantings to compensate for construction-related vegetation removals and to help stabilize regraded slopes.

4.4 Priority Site #2: Exposed Sanitary Sewer Crossing at Restwell Crescent

Priority Site #2 is located in Reach N1 of Newtonbrook Creek, approximately 180 metres upstream of Priority Site #1. This portion of the channel was previously anthropogenically hardened & narrowed through the installation of gabion basket retaining walls on both channel banks (**Figure 4-7**). The narrowing of the channel and hardening of the banks has forced the channel to down cut at this location, undermining the gabion basket retaining walls and causing them to slump downwards into the creek (**Figure 4-8**). Portions of the gabion basket wire mesh have failed releasing gabion stone into the channel (**Figure 4-9**). Degradation of the channel bed has also exposed a concrete encasement surrounding a 675 mm diameter sanitary trunk sewer that crosses the creek at an oblique angle. At the downstream extents of the site, the gabion basket retaining walls have completely dislodged themselves from the channel banks and fallen into the creek. In turn the exposed banks behind the failed gabions basket retaining wall have rapidly eroded, widening the channel (**Figure 4-10**) and creating a potential long-term risk to the pedestrian trail system, that runs parallel to the creek on the north side, if these banks continue to erode. Undertaking site restoration works to remove the failed gabion baskets, establish a more geomorphically stable channel geometry, and increase the depth of cover over the sanitary sewer crossing, is recommended.

Figure 4-7: Narrowed Channel due to Gabion Basket Slumping and Woody Debris, Upstream of Crossing

Figure 4-8: Undercut Gabion Basket Retaining Walls Slumping Downwards into Channel

Figure 4-9: Broken Gabion Wire Mesh Leading to the Deposition of Dislodged Gabion Stone in Newtonbrook Creek

Figure 4-10: Failed Gabion Basket Retaining Wall and Widened Channel due to Unprotected Eroding Banks Downstream of the Exposed Sewer Crossing

Sanitary Sewer parameters relevant to this priority site are summarized in **Table 4-5**, and a drawing illustrating the existing conditions of the project site is presented in **Figure 4-11**.

Table 4-5: Summary of Priority Site #2: Sanitary Sewer Parameters

Parameter	Sanitary Trunk Sewer
Toronto Water Asset ID	SL4032406
Year of Construction	1960
Diameter	675
Depth of Cover	0 m
Estimated Time to Contact	0 years
Erodibility of Adjacent Substrate	Moderate High

4.4.1 Priority Site #2 – Description of Restoration Alternatives

Alternative 1: Do Nothing – The exposed sanitary sewer crossing will continue to be at risk of failure due to continued widening and downcutting of the channel. Active erosion downstream of the failed gabion baskets may also undermine the existing pedestrian trail creating a risk to public safety. Future emergency works may be required if any of the at-risk infrastructure begins to fail.

Alternative 2: Local Works – Apply channel engineering works for about 80 metres of channel length within reach N1, focused on a fixed engineered riffle centered overtop of the exposed sanitary sewer crossing to provide a minimum of 0.3 metres depth of cover. Pools will bound the riffle on either side facilitating a transition into existing conditions. The failed gabion basket retaining walls and accumulated debris will be removed as part of the channel restoration works, and major erosion scars filled in. The previously narrowed segment of the creek will be widened slightly to allow for the establishment of a more geomorphically stable channel cross-section. A vegetated buttress will also be installed along the northern bank to provide enhanced erosion protection for the adjacent pedestrian trail system.

Alternative 3: Sub-Reach-Based Works – Apply natural channel design for approximately 500 metres of channel length including riffle-pool morphology and bioengineered bank treatments (vegetated buttresses). The proposed works will tie-into the proposed sub-reach-based works solution for Priority Site #1 on the downstream end, and extend upstream an additional 500 m. If implemented in conjunction with the aforementioned sub-reach-based works solution for Priority Site #1, it would represent an opportunity to restore the most degraded segments of Reach N1 from a geomorphic perspective. The sub-reach-based nature of this solution allows for significant adjustments to the creek's longitudinal profile, thereby increasing the depth of cover over the exposed sanitary sewer crossing by a minimum of 1.0 m. When compared to the local works solution this alternative also offers the benefit of increasing the depth of cover over Sanitary Sewer Crossing #4, located upstream of Priority Site #2, from approximately 0.8 metres to a minimum of 1.8 m. Failed engineered bed and bank treatments (i.e., gabion baskets), and accumulated debris, will be removed with riffle-pool morphology established through the placement of engineered substrate. Vegetated buttresses will be placed along the outside of each meander bend for erosion protection, with an armourstone retaining wall to be implemented near the exposed sewer crossing for enhanced protection of the sewer and trail systems. The channel system will also be realigned at select locations to provide an increased erosion buffer and reduce lateral erosion risks to the pedestrian trail and sanitary trunk sewer. To this end, the proposed channel realignment will increase the erosion buffer at lateral risks sites #2 & #3.

Preliminary concept drawings illustrating Alternative 2 and Alternative 3 are provided in **Figure 4-12**.

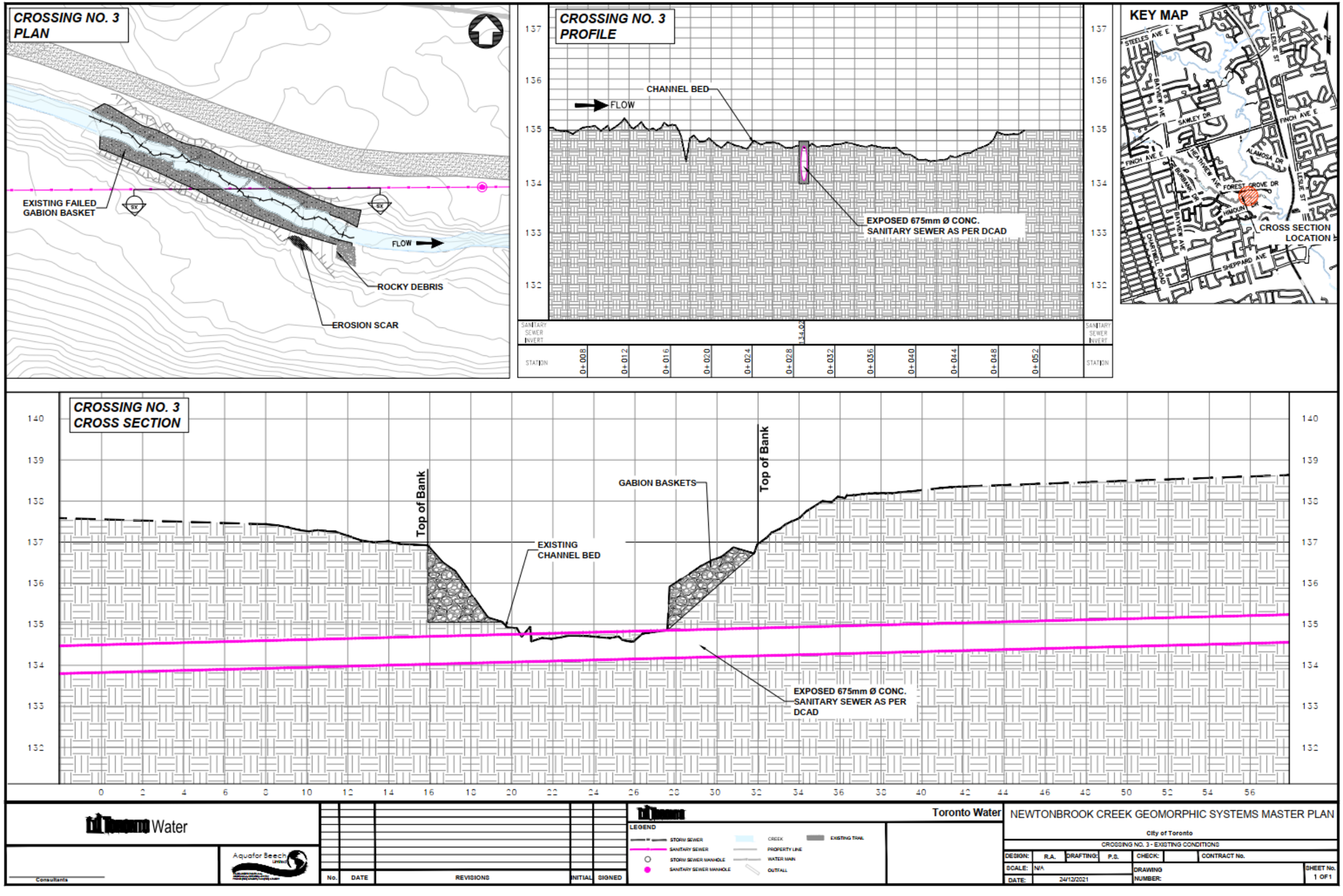

Figure 4-11: Existing Conditions - Priority Site #2

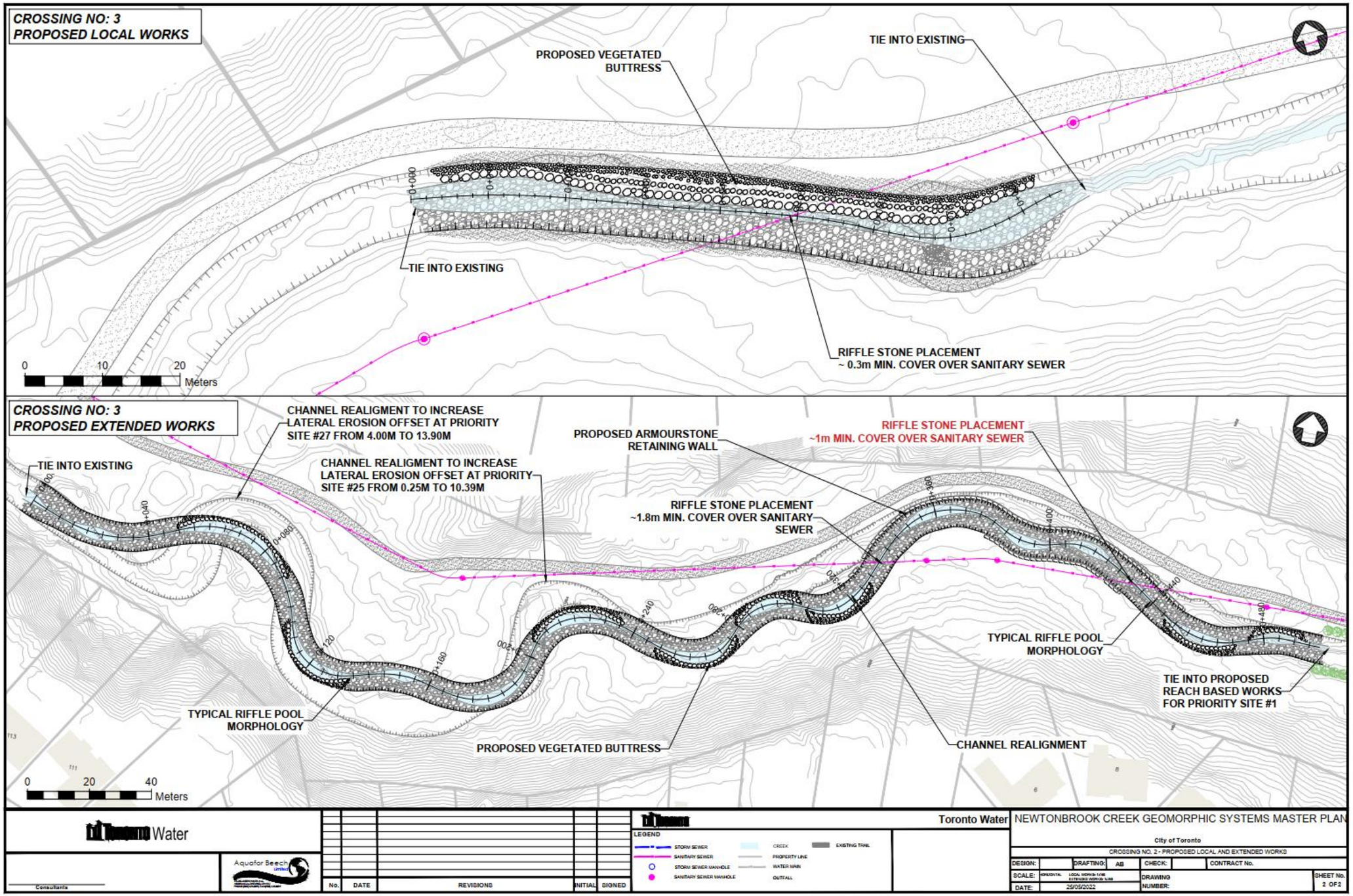

Figure 4-12: Preliminary Design Concepts Alternative 2 & 3 – Priority Site #2

4.4.2 Priority Site #2 – Evaluation of Restoration Alternatives

Restoration Alternatives for Priority Site #2 were evaluated using the methodology outlined in **Section 4.2.** Based on this evaluation process, Alternative 3 - Sub-Reach-Based Works was selected as the preferred alternative.

4.4.3 Priority Site #2 – Selection of the Preferred Alternative

As per the evaluation table, the Sub-Reach-Based Works option was selected as the preferred alternative for Priority Site #2 with a total score of 77.40/100. The local works solution was the second preferred alternative with a total score of 62.80/100 while the Do-Nothing alternative was the least preferred alternative with a total score of 42.40/100.

Key elements of the Sub-Reach-Based Works alternative include:

- Removal of channel debris and failed erosion control structures (i.e., Gabion Baskets).
- Apply approximately 500 metres of channel restoration work using natural channel design principles to establish riffle-pool morphology.
- Where feasible, lower and regrade channel banks to restore floodplain connectivity.
- Provide a minimum of 1.0 metres of cover overtop of the exposed 675 mm diameter sanitary sewer crossing.
- Increase the depth of cover overtop of the upstream sanitary sewer crossing (Priority Site #34 - SL4032404) to a minimum of 1.8 m.
- Mitigate secondary lateral risk sites (Priority Site #25 - SL4032404 and Priority Site #27 - SL4033583) through a combination of channel realignment and the construction of vegetation buttress bank protection works.
- Transition into the proposed sub-reach-based works solution for Priority Site #1 - MH4856914969 at the downstream tie-in point.
- Establish a geomorphically stable transition into existing channel conditions at the upstream tie-in point.
- Apply restoration plantings to compensate for construction-related vegetation removals and to help stabilize regraded slopes.

4.5 Priority Site #3: Detached Storm Sewer Outfall and Exposed Maintenance Hole at Forest Grove Drive

Priority Site #3 is located in Reach N1 of Newtonbrook Creek, immediately downstream of the Forest Grove Drive Culvert, and approximately 580 metres upstream of Priority Site #2. A 675 mm CMP storm sewer outlets to the creek downstream of the road culvert. The outfall pipe is integrated into a low-rise stone retaining wall setback 5-10 metres from the main channel (**Figure 4-13**). Flows from the outfall are directed towards the creek through a stone lined outlet channel that is in poor condition and is starting to fail and fall into the creek (**Figure 4-14**).

The outlet pipe itself is heavily clogged with accumulated debris. Significant instances of localized slope erosion are visible behind the outfall, along the length of the outlet pipe, in the form of erosion gullies and sinkholes. This erosion of the slope has contributed to detachment of several lengths of CMP pipe (**Figure 4-15**) and exposure of the nearest upstream maintenance hole structure (**Figure 4-16**). The City of Toronto recently completed a CCTV investigation of the upstream 675 mm CMP storm sewer. Based on the results of the CCTV inspection it is recommended that the corrugated metal pipe be removed and replaced with a new concrete pipe between Forest Grove Drive and the Creek Outfall.

Figure 4-13: Stormwater Outlet Clogged with Organic Debris

Figure 4-14: Degraded Outfall Channel with Loose Angular Stone

Figure 4-15: Location of Visible Pipe Detachment Upslope of the Outlet

Figure 4-16: Exposed Maintenance Hole in the Slope of Forest Grove Drive Road Embankment

Storm sewer parameters relevant to this priority site are summarized in **Table 4-6** with a drawing illustrating the existing conditions of the project site presented in **Figure 4-17**.

Table 4-6: Summary of Priority Site #3 Outfall and Maintenance Hole Parameters

Parameter	Exposed Maintenance Hole
Toronto Water Asset ID	MH4854914320
Year of Construction	1956
Diameter	N/A
Erodibility of Adjacent Substrate	High

Parameter	Failed Outfall
Toronto Water Asset ID	OF4854214333
Year of Construction	1956
Diameter	Medium (250 – 1200 mm)
Shape	Circular
Headwall	Armourstone
Outfall Condition	Very Poor
Erodibility of Adjacent Substrate	High

4.5.1 Priority Site #3 – Description of Restoration Alternatives

Alternative 1: Do Nothing – If left unaddressed the slope behind the failed outfall will continue to erode due to storm flows discharging partway up the unprotected slope where the CMP has become dislodged or damaged. Additional pipe segments may become exposed and dislodged, while continued gullying may create risks to private property, Forest Grove Drive and the upstream culvert crossing.

Alternative 2: Local Works – Repair/replace three segments of the failed CMP pipe (total length of approximately 88 m), as per the City's recommendation maintaining the same pipe alignment in planform. Care must be taken to construct the pipes with appropriate bedding and backfill materials, as per City standards, to prevent future failure. All sewer repair/replacement works must be coordinated with other City departments / basement flooding projects.

The exposed storm sewer maintenance hole should also be retrofitted to incorporate new inlet and outlet pipes with any structural deficiencies/damage repaired. Erosion sinkholes and gullies to be infilled with engineered fill and appropriately compacted. At the detailed design stage, consideration should also be given to completing a slope stability assessment, with slope stabilization measures (i.e., soil anchors, coir logs, etc.) to be applied as required. The failing stone retaining wall and outlet channel will be removed, along with any accumulated debris, and replaced with a new concrete headwall with armourstone wingwalls. The new outfall will discharge into an engineered scour pool. The scour pool will be designed to drain into a newly constructed outfall channel composed of an engineered substrate mix, with armourstone retaining walls along the banks. The outfall channel will be orientated to flow into the creek at an oblique angle.

Alternative 3: Sub-Reach-Based Works – Complete the same local works solutions proposed above (Alternative 2) for Priority Sites #3 and #24, as part of a larger project, intended to apply natural channel works along the upstream portion of Reach N1. This will include approximately 110 metres of channel restoration works intended to help stabilize the eroded channel from a geomorphic perspective. The proposed works will extend from the Forrest Grove Drive culvert outlet downstream to the upstream limit of the sub-reach-based works solution for Priority Site #2. The proposed channel restoration works will include a combination of riffle-pool morphology coupled with a mixture of engineered bank treatments (i.e., vegetated buttresses). Adjustments to the longitudinal profile, planimetric alignment and typical channel dimensions will look to stabilize the creek and provide lateral erosion protection to both the multi-use trail system and private properties along Burbank Drive.

Preliminary concept drawings illustrating Alternative 2 and Alternative 3 are provided in **Figure 4-18**.

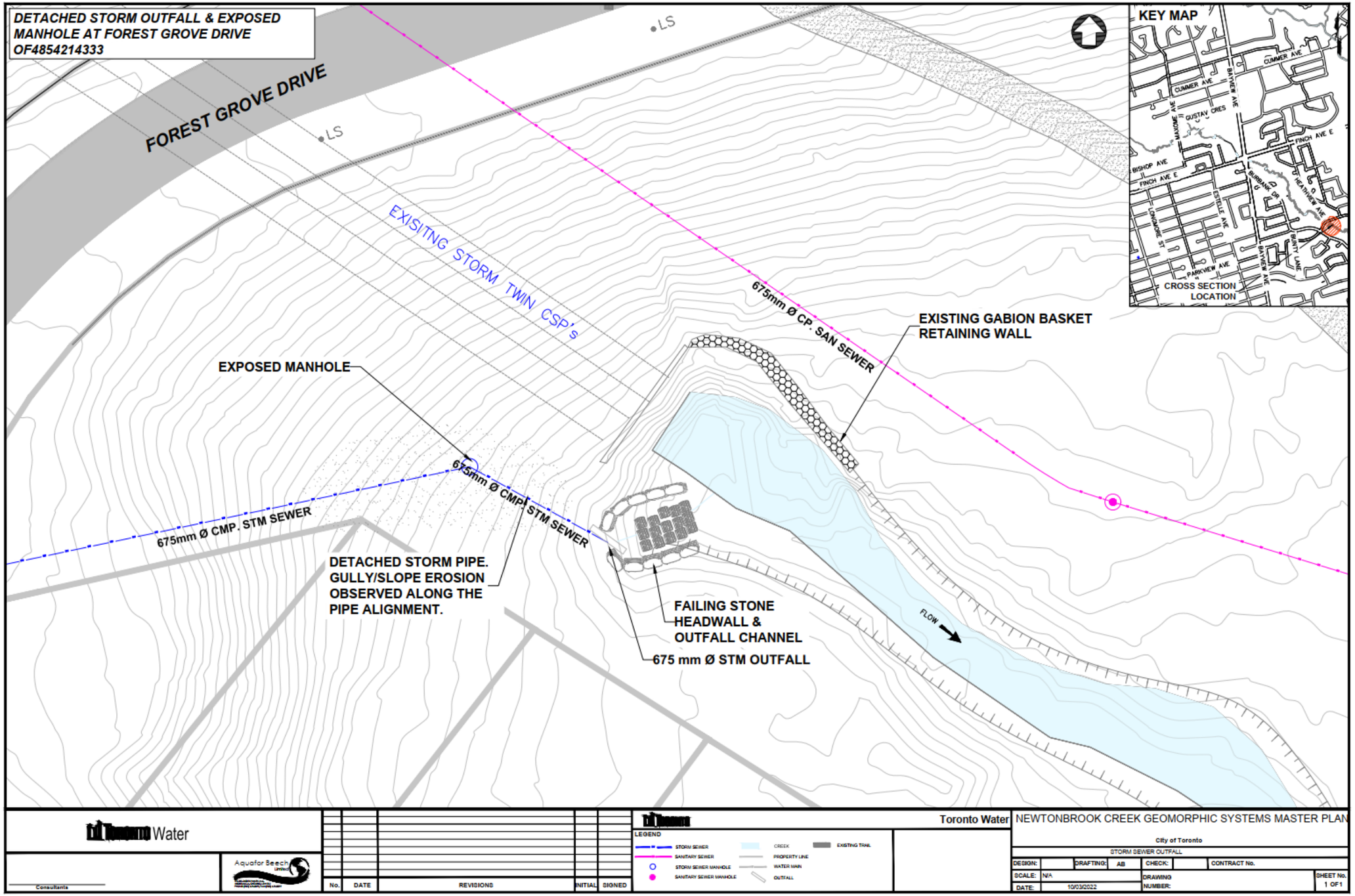

Figure 4-17: Existing Conditions - Priority Site #3

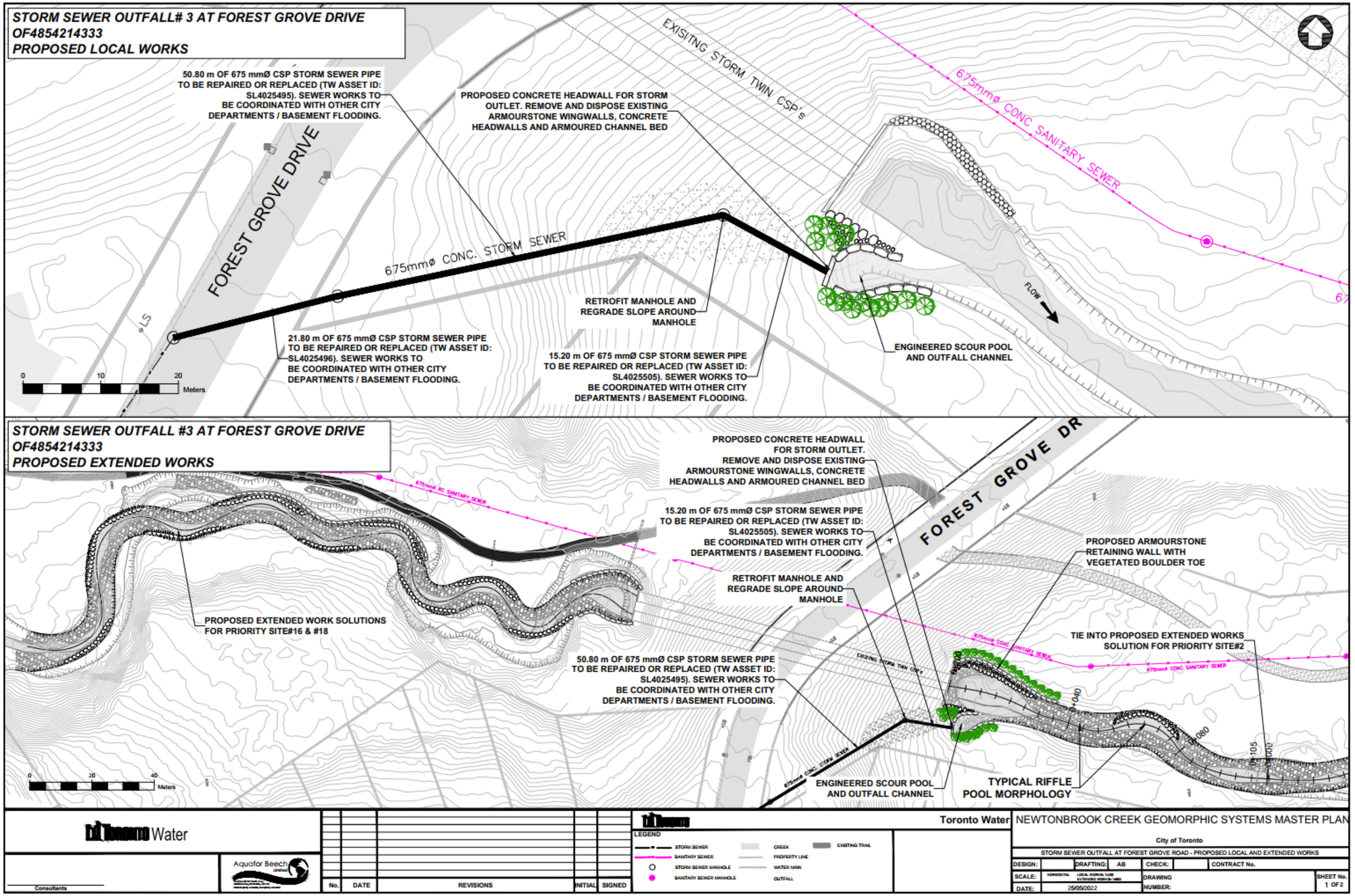

Figure 4-18: Preliminary Design Concepts Alternative 2 & 3 – Priority Site #3

4.5.2 Priority Site #3 – Evaluation of Restoration Alternatives

Restoration Alternatives for Priority Site #3 were evaluated using the methodology outlined in **Section 4.2.** Based on this evaluation process, Alternative 2 - Local Works was selected as the preferred alternative.

It should be noted the evaluation of alternatives for this site assumed the local works solutions for Priority Sites #3 and #24 would be bundled into one capital works project to help achieve schedule and cost efficiencies.

4.5.3 Priority Site #3 – Selection of the Preferred Alternative

As per the evaluation table, the Local Works option was selected as the preferred alternative for Priority Site #3 with a total score of 79.20/100. The sub-reach-based works solution was the second preferred alternative with a total score of 74.80/100, while the Do Nothing alternative was the least preferred alternative with a total score of 40.40/100.

Key elements of the Local Works alternative include:

- Removal of channel debris, failed erosion control works (i.e., stone lined outfall channel, gabion basket bank treatments, etc.), and failed Toronto Water Infrastructure (i.e., failed outfall and storm sewer pipe segments).
- Retrofit/repair the exposed storm sewer maintenance hole as needed.
- Repair/Replace approximately 88 metres of failed corrugated metal storm sewer pipe, maintaining the same general pipe alignment in planform. Sewer repair/replacement works to be coordinated with other City departments and Basement Flooding Projects.
- Restore the failed slope through regrading and infilling of observed sinkholes and gullies with appropriately compacted fill materials. Apply additional slope stabilization measures (i.e., soil anchors, coir logs, etc.) as defined at the detailed design phase.
- Replace the failed outfall structure.
- Construct an engineered scour pool with an armourstone lined outfall channel that transitions into the main branch of Newtonbrook Creek at an oblique angle.
- Mitigate the lateral risk site on the opposite bank (Priority Site #24 - SL4033584) through the construction of a buried armourstone retaining wall with vegetated buttress toe protection.
- Establish a geomorphically stable transition into existing channel conditions where engineered works adjoin the natural channel corridor.
- Apply restoration plantings to compensate for construction-related vegetation removals and to help stabilize regraded slopes.