



To: **Sturgeon County** Date: **August 21, 2017**
Attention: **Jeff Yanew, C.E.T., Utility Operations Supervisor** Project No.: **14929**
Cc: **Greg Germain, E.I.T**
Reference: **Hamlet of Cardiff – Sanitary Sewer Condition Assessments**
From: **Stephen McCauley, P.Eng., & Priyanka Joshi, E.I.T**

1.0 Background

The Hamlet of Cardiff (Cardiff) is suspected to have high rates of inflow and infiltration (I/I) in its sanitary sewer collection system. To avoid the possibility of capacity constraints in the sanitary system due to I/I, Sturgeon County (County) completed a comprehensive inspection program of the sanitary sewer system, using Closed-Circuit Television (CCTV) technology.

ISL Engineering and Land Services Limited (ISL) was engaged by the County in April of 2017 to assist with reviewing and analyzing the results of the recently completed sanitary sewer inspection program and address any issues that could facilitate I/I into the system. A site visit to inspect the manholes and downspouts suspected to be tied into the sanitary system was also included in ISL's scope.

In May of 2017, recorded videos of the CCTV inspections were provided to ISL. In June of 2017, ISL completed their assessment of the CCTV recordings and provided their findings, rehabilitation recommendations, priority rating, and preliminary pricing in excel format to the County for review and comments. ISL's site inspection was also conducted in May/June 2017.

The objective of this memorandum is to summarize the findings of the analysis and inspection completed by ISL and the resulting rehabilitation and staging recommendations, along with the corresponding financial implications.

2.0 Inflow and Infiltration

Along with the CCTV inspection videos, ISL was also provided with the flow meter readings in the new lift station for the month of May in 2016 and 2017. ISL was also provided with the pump run times in the station for May 2017. This data was requested by ISL to better understand and quantify the extent of inflow and infiltration on Cardiff's sanitary system. Inflow is stormwater that enters into the sanitary system from points of direct connection to the sanitary system such as roof leaders, downspouts and pick holes in manholes. Infiltration refers to groundwater that enters the sanitary system through leaks and cracks in the sanitary collection pipes and manholes.

Figure 2.1 illustrates the sewage volumes recorded by the lift station flow meter in May of 2016 and 2017 graphically. As can be seen from the figure, compared to May 2016, the lift station accumulated a larger volume of wastewater in May of 2017. Provided there was no significant population and/or per capita consumption increase in Cardiff between the period of May 2016 and May 2017, the increased volumes in May 2017 can be attributed to heavy precipitation, thus resulting in high volumes of I/I into the system. However it is not possible to quantify how much of the increased flow is due to inflow and how much is resulting from infiltration from the data presented in Figure 2.1 alone.

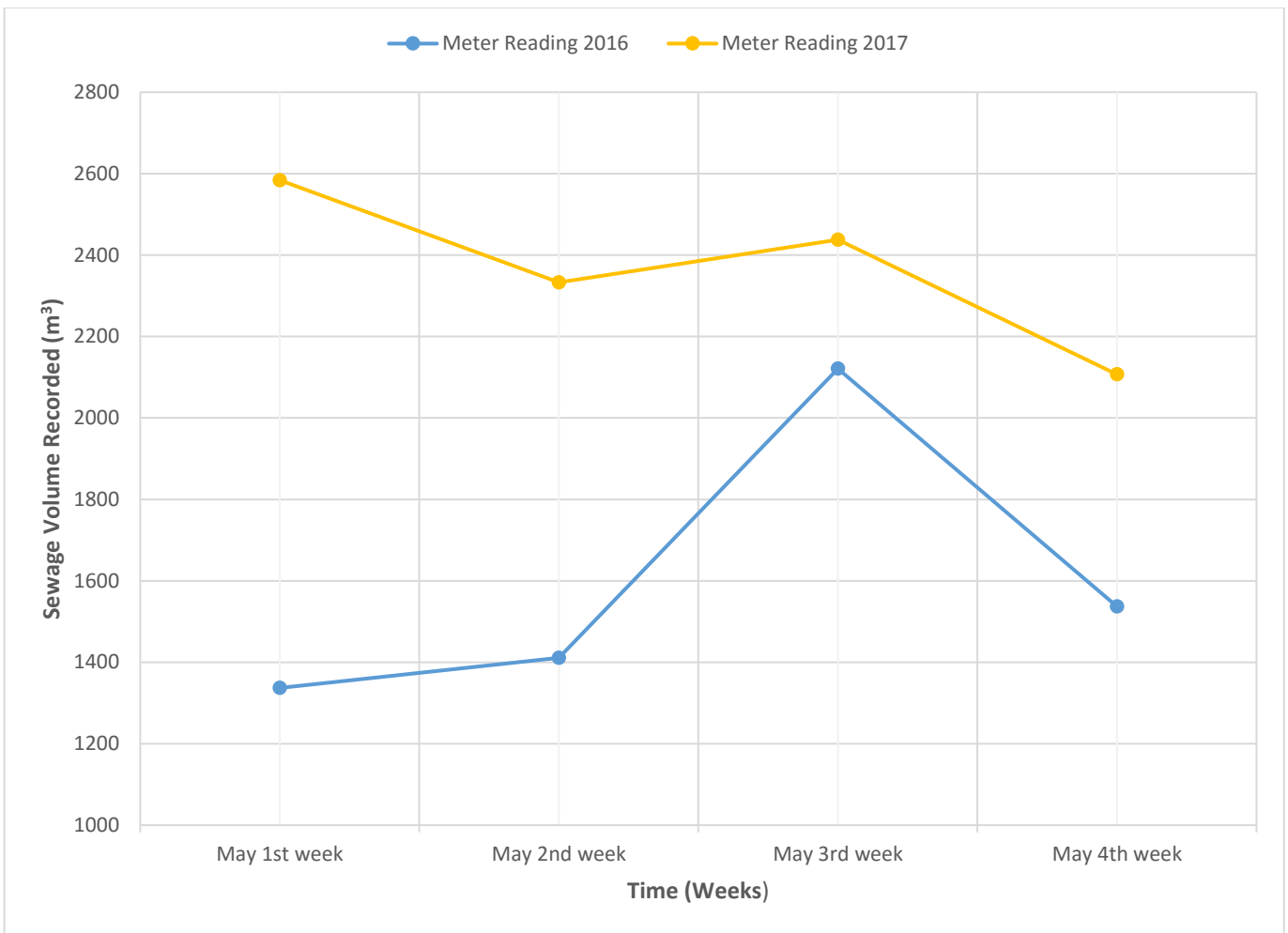


Figure 2.1: May 2016 and May 2017 Lift Station Flow Meter Readings

In an attempt to further understand whether the primary contributor of the higher flows in May 2017 was inflow or infiltration, ISL compared the pump run times for May 2017 provided by the County with the historical rainfall data for the Hamlet of Namao (Namao) for May 2017, obtained from the Weather Network. No rainfall data was available for Cardiff, therefore rainfall data for Namao was used for this analysis. Figure 2.2 provides a graphical representation of the pump run times and the rainfall data during the month of May 2017. It is evident from Figure 2.2 that the peak rainfall events do not exactly coincide with the peaks in the pump run times. There is a lag of about 1 to 2 days in the spike in pump run times after each heavy rainfall event. This is an indication that the increase in flows is more likely a result of infiltration and less likely from inflow.

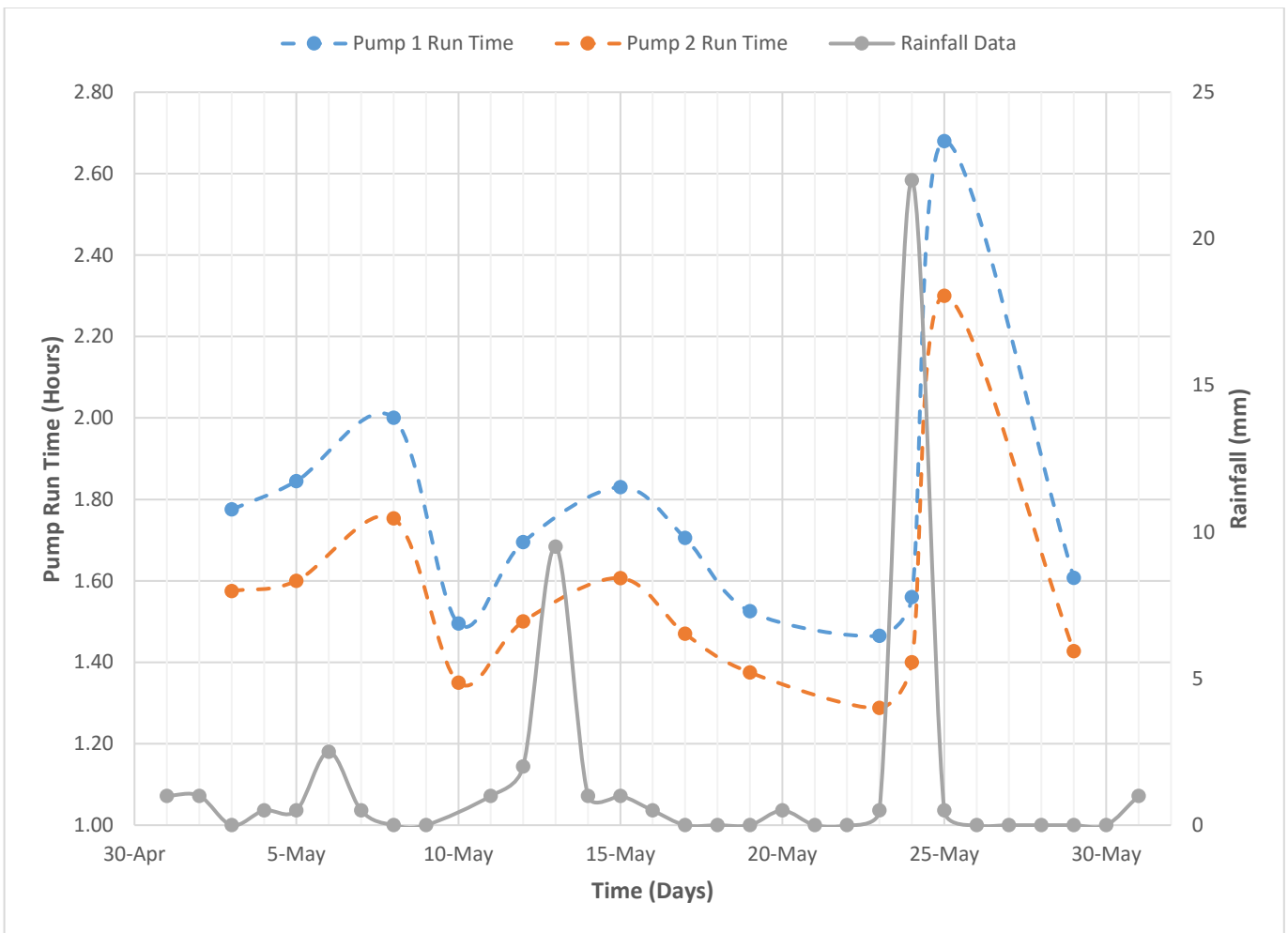


Figure 2.2: May 2017 Pump Run Times and Rainfall Data

It is important to keep in mind that this I/I analysis completed by ISL is based on limited and manually entered data (only for selected days in May 2017 and not data from the SCADA system) and a number of assumptions (no significant population/per capita consumption increase, rainfall data for Namao identical to rainfall data for Cardiff). It is strongly recommended that the County closely monitor data from their rainfall gauge and data collected by their SCADA system (continuous data) prior to, during and immediately after multiple rainfall events to verify the governance of inflow vs infiltration in Cardiff.

The county also provided ISL with a map of all the locations of manholes and a map showing the locations of houses with downspouts suspected to be connected to the sanitary system within the hamlet of Cardiff. These maps are provided in Appendix A of this memorandum. ISL conducted a visual inspection of the manholes and downspouts illustrated on the maps during a rainfall event. The following pages summarize images of the manholes and downspouts suspected to be problematic with respect to I/I.

ISL would like to point out that although previously thought to be connected to the sanitary system, the downspouts from Houses 34 and 83 are not tied into the sanitary system.



Image 2.1 Downspout House 29



Image 2.2 Downspout House 34
(Not connected to sanitary system)



Image 2.3 Downspout House 36

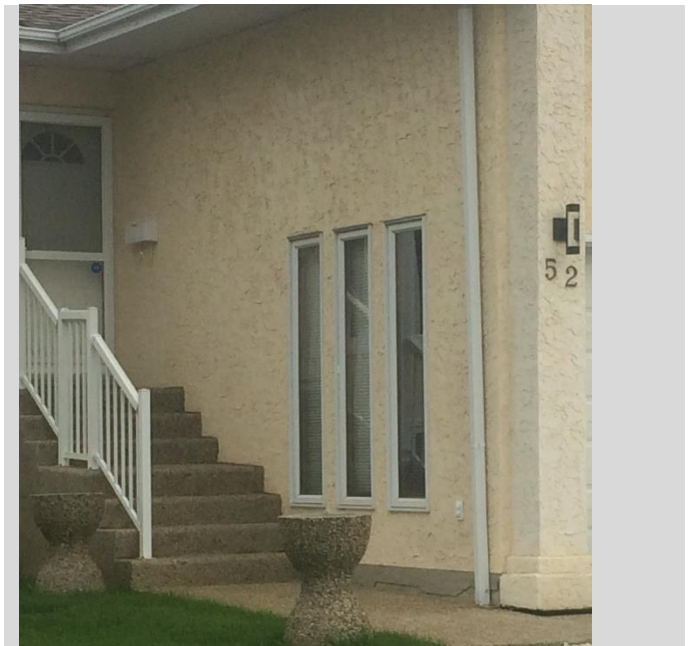


Image 2.4 Downspout House 52



Image 2.5 Downspout House 59



Image 2.6 Downspout House 69



Image 2.7 Downspout House 83
(Not connected to sanitary system)



Image 2.8 Downspout House 100



Image 2.9 Manhole 122



Image 2.10 Manhole 125 (2)



Image 2.11 Manhole 125



Image 2.12 Manhole 128



Image 2.13 Manhole 131



Image 2.14 Manhole 137



Image 2.15 Manhole 141



Image 2.16 Manhole 147 (2)



Image 2.17 Manhole 155



Image 2.18 Manhole 166



Image 2.19 Manhole 168 (2)



Image 2.20 Manhole 168



Image 2.21 Manhole 175

The following manholes could not be located during ISL's inspection:

- 130, 133, 135, 140, 156, 176, and 177

The following manholes did not appear to be susceptible to inflow:

- 121, 123, 126, 127, 128 (2), 129, 130, 132, 134, 136, 135, 138, 139, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 157, 158, 159, 160, 161, 163, 164 (2), 164, 165, 175, 167, 169, 170, 171, 173, 174, 176, and 178

3.0 CCTV Assessment Summary

This section summarizes ISL's findings from analyzing the CCTV inspection videos of the sanitary system. Along with the findings, this section also provides a rating for each location using the grading system developed by the Water Research Center (WRc) and the National Association of Sewer Service Companies (NASSCO). Finally, a preliminary level budgetary cost for resolving each issue has also been summarized in this section.

The classification grading system developed by the Water Research Center (WRc) and the National Association of Sewer Service Companies (NASSCO) assigns a score based on the severity of the implication or issue for a structural or operational -related finding. This grading system was utilized by ISL to determine a priority rating for each location. The priority rating was assigned so as to assist the County with planning for future upgrades.

The NASCCO/WRc grading system for both a structural and operational -related item are summarized in Table 3.1 and 3.2 below, respectively.



Table 3.1: Structural Grading System (NASSCO/WRc)

| Grade | Implication |
|-------|--|
| 5 | Failed or Failure Imminent |
| 4 | Very Poor Condition/High Structural Risk |
| 3 | Poor Condition/Moderate Structural Risk |
| 2 | Fair Condition/Minimal Structural Risk |
| 1 | Acceptable Condition |

Table 3.2: Operational Grading System (NASSCO/WRc)

| Grade | Issue |
|-------|--|
| 5 | Severe roots / debris / grease / intruding lateral (less than 75% CSA) |
| 4 | Heavy roots (mass) / encrustation / debris / sags /grease / intruding lateral (50-75% loss of CSA) |
| 3 | Medium roots / encrustation / debris / sags/ grease / intruding lateral (20-50% loss of CSA) |
| 2 | Light roots / encrustation / debris / grease / intruding lateral (5-20% loss of CSA) |
| 1 | Acceptable condition (less than 5% loss of CSA) |

The priority rating scale developed by ISL based on the NASSCO (WRc) rating is summarized in Table 3.3 below. As seen from the table, each priority rating corresponds to a specific timeline. For instance, Priority 1 refers to urgent issues/items that are in need of high priority upgrades and must be completed immediately.

Table 3.3: ISL's Priority Rating System

| Priority | Description |
|----------|---|
| 1 | Repair or service immediately |
| 2 | Repair or service within the next 5 years |
| 3 | Re-inspect in 5 to 10 years |

Table 3.4 summarizes the number of Priority 1,2 and 3 locations with the budgetary cost for each priority class. High flows were observed during ISL's inspection of the CCTV recordings for events 78 to 101. However determining whether the high flows are a result of I/I or a water main break/leak is not possible from the CCTV recordings alone. Further investigation is required to define the cause of high flows within these locations and thus ISL is unable to rate these locations and provide recommendations at this time.

Table 3.4: Summary of CCTV Inspection

| Issues | Event No. | Preliminary Budgetary Cost |
|------------------------------|-----------|--|
| Priority 1 Issues | 1 to 6 | \$30,960 |
| Priority 2 Issues | 7 to 25 | \$65,880 |
| Priority 3 Issues | 26 to 77 | \$171,720 |
| Further Exploration Required | 78 to 101 | Cost to be determined after further investigation. |



Table 3.5 provides the recommendations for all the “Priority 1” locations from ISL’s analysis of the CCTV inspection videos in detail, along with the budgetary cost for each location.

Table 3.6 presents the recommendations for all the “Priority 2” locations from ISL’s analysis of the CCTV inspection videos in detail, along with the budgetary cost for each location.

Table 3.7 provides the recommendations for all the “Priority 3” locations from ISL’s analysis of the CCTV inspection videos in detail, along with the budgetary cost for each location.

Table 3.8 lists the locations that require further exploration.

A key determination from the CCTV review was that the system is generally in good condition. While, the majority of service connections to the main sewers were made without the use of Tee fittings, the connections appear well sealed and therefore are not a significant contributing factor to infiltration.

4.0 Conclusions and Recommendations

Based on the analysis and comparison of the pump run times and rainfall data for Namao during May 2017, it appears that the additional flows entering the sanitary system in Cardiff during wet weather events are primarily due to infiltration rather than inflow. However, as per ISL’s analysis, the CCTV recordings show no evidence of infiltration.

To address this discrepancy and assess the issue of infiltration in Cardiff in more detail, ISL recommends that the County obtain and monitor data from their rainfall gauge and data collected by the flow meter at the station system prior to, during and immediately after multiple historical and future rainfall events. Furthermore, the manholes and downspouts suspected to be problematic with respect to I/I as well as the suggestions made by ISL based on the CCTV inspection are also recommended to be addressed.



Table 3.5: Priority 1 Locations, Recommendations, and Budgetary Costs

| Event No | Location | | Characteristics | | | | | | Assessment | | | | | Dripper, Runner, Gusher | Preliminary Budget Pricing Based on Nominal Bury Depth of (3-4m) | | | | | | |
|----------|----------|----------------|-----------------|--------------------|---------------------|-----------|----------------|---------------|---------------|------------|----------|-------------------------------------|---|-------------------------|--|------------------------------|-------------------------|-------------------------|-------------------------|---------------------------------|-------------------------------|
| | | | | | | | | | | | | | | | Flush and Camera per m | Spot Repair Excavation per m | 150mm Spot Repair Liner | 200mm Spot Repair Liner | 250mm Spot Repair Liner | Install Additional Manhole Ring | Total Price for each Priority |
| | District | Street | Upstream MH | Downstream MH | Length at Event (m) | Depth (m) | Pipe Dia. (mm) | Pipe Material | Struct. Grade | Ops. Grade | Priority | Condition Remarks | Rehabilitation Comments | | \$20 | \$1,200 | \$2,900 | \$3,200 | \$3,500 | \$800 | - |
| 1 | Cardiff | Echo Ave | COA4-4 | main line Echo Ave | 1.2 | Unknown | 150 | PVC | 5 | 1 | 1 | Broken Pipe | Dig and Replace one length of piping | - | - | \$5,160 | - | - | - | - | - |
| 2 | Cardiff | Prospect Place | B-1 | B-1 | N/A | Unknown | N/A | N/A | 1 | 1 | 1 | Infiltration from unknown pipe | - | Gusher | - | \$5,160 | - | - | - | - | - |
| 3 | Cardiff | Menalta Road | D-9 | D-8 | 8.0 | Unknown | 200 | PVC | 5 | 1 | 1 | Seal gasket is dislodged | Dig and Replace one length of piping | Gusher | - | \$5,160 | - | - | - | - | - |
| 4 | Cardiff | Menalta Road | D-7 | D-5 | 14.7 | Unknown | 200 | PVC | 5 | 1 | 1 | Seal gasket is dislodged | Dig and Replace one length of piping | Runner | - | \$5,160 | - | - | - | - | - |
| 5 | Cardiff | Echo Ave | A-7 | A-7 | N/A | Unknown | N/A | N/A | 1 | 1 | 1 | High flow in pipes | Further exploration, possible connection to storm sewer, suggest site visit to confirm cross connection | Gusher | - | \$5,160 | - | - | - | - | - |
| 6 | Cardiff | Echo Ave | A4-1 | A-7 | 89.0 | Unknown | 200 | PVC | 5 | 1 | 1 | Crack in main piping (can see soil) | Dig and Replace one length of piping | - | - | \$5,160 | - | - | - | - | - |
| | | | | | | | | | | | | | | | - | \$30,960 | - | - | - | - | \$30,960 |



Table 3.6: Priority 2 Locations, Recommendations, and Budgetary Costs

| Event No. | Location | | Characteristics | | | | | | Assessment | | | | | Dripper, Runner, Gusher | Preliminary Budget Pricing Based on Nominal Bury Depth of (3-4m) | | | | | | | |
|-----------|----------|-----------------------------|-----------------|--------|-------------|---------------|---------------------|-----------|----------------|---------------|---------------|--|--|-------------------------|--|-------------------------|------------------------|------------------------------|-------------------------|-------------------------|-------------------------|---------------------------------|
| | | | District | Street | Upstream MH | Downstream MH | Length at Event (m) | Depth (m) | Pipe Dia. (mm) | Pipe Material | Struct. Grade | Ops. Grade | Priority | | Condition Remarks | Rehabilitation Comments | Flush and Camera per m | Spot Repair Excavation per m | 150mm Spot Repair Liner | 200mm Spot Repair Liner | 250mm Spot Repair Liner | Install additional manhole ring |
| | \$20 | \$1,200 | | | | | | | | | | | | | | | \$2,900 | \$3,200 | \$3,500 | \$800 | - | |
| 7 | Cardiff | Green Space | A1-1 | A-2 | 39.3 | Unknown | 150 | PVC | 3 | 1 | 2 | Infiltration from around pipe | Installation of T-liner | Runner | - | - | \$2,900 | - | - | - | - | - |
| 8 | Cardiff | Cardiff Place | A-5 | A-4 | 25.4 | Unknown | 250 | PVC | 4 | 1 | 2 | Crack (2 mm), high flow in pipe | Dig and Replace one length of piping, investigate flow further | Runner | - | \$5,160 | - | - | - | - | - | |
| 9 | Cardiff | Cardiff Place | A-5 | A-4 | 17.7 | Unknown | 250 | PVC | 3 | 1 | 2 | Infiltration from around pipe | Installation of T-liner | Runner | - | - | - | - | \$3,500 | - | - | |
| 10 | Cardiff | Mill Road | C-6 | C-5 | 6.2 | Unknown | 200 | PVC | 3 | 1 | 2 | Pipe not sealed | Installation of T-liner | - | - | - | - | \$3,200 | - | - | - | |
| 11 | Cardiff | Mill Road | C-6 | C-5 | 61.8 | Unknown | 200 | PVC | 3 | 1 | 2 | Infiltration from around pipe | Installation of T-liner | Runner | - | - | - | \$3,200 | - | - | - | |
| 12 | Cardiff | Green Space | D-1 | B-3 | 29.9 | Unknown | 200 | PVC | 3 | 1 | 2 | Broken service piping | Installation of T-liner | Runner | - | - | - | \$3,200 | - | - | - | |
| 13 | Cardiff | Menalta Road | D-8 | D-7 | 6.0 | Unknown | 200 | PVC | 3 | 1 | 2 | Seal gasket is dislodged | Dig and Replace one length of piping | Runner | - | \$5,160 | - | - | - | - | - | |
| 14 | Cardiff | Starkey Place | B1-3 | B1-2 | 35.1 | Unknown | 200 | PVC | 3 | 1 | 2 | Service piping is broken (Can see soil) | Installation of T-liner | - | - | - | - | \$3,200 | - | - | - | |
| 15 | Cardiff | Discovery Ave and Mill Road | COB2-1 | B2-3 | 56.2 | Unknown | 200 | PVC | 4 | 1 | 2 | Crack in main piping (2mm) | Dig and Replace one length of piping | - | - | \$5,160 | - | - | - | - | - | |
| 16 | Cardiff | Discovery Ave and Mill Road | COB2-1 | B2-3 | 56.5 | Unknown | 200 | PVC | 1 | 5 | 2 | Service is plugged | Flush service from access point | - | \$1,680 | - | - | - | - | - | - | |
| 17 | Cardiff | Discovery Ave | B2-2 | B2-1 | 47.4 | Unknown | 200 | PVC | 4 | 1 | 2 | Crack in piping, infiltration from around pipe (2mm) | Installation of T-liner | Dripper | - | - | - | - | - | - | - | |
| 18 | Cardiff | Discovery Ave | B2-1 | B-6 | 55.2 | Unknown | 200 | PVC | 4 | 1 | 2 | Crack in piping (3mm) | Dig and Replace one length of piping | - | - | \$5,160 | - | - | - | - | - | |
| 19 | Cardiff | Discovery Ave | B2-1 | B-6 | 93.7 | Unknown | 200 | PVC | 3 | 1 | 2 | Infiltration from around pipe | Installation of T-liner | Runner | - | - | - | \$3,200 | - | - | - | |
| 20 | Cardiff | Discovery Ave | B-8 | B-7 | 58.1 | Unknown | 200 | PVC | 3 | 1 | 2 | Crack in main piping (2mm) | Installation of T-liner | - | - | - | - | \$3,200 | - | - | - | |
| 21 | Cardiff | Echo Ave | B-12 | B-11 | 67.8 | Unknown | 200 | PVC | 3 | 1 | 2 | Infiltration from around pipe | Installation of T-liner | Runner | - | - | - | \$3,200 | - | - | - | |
| 22 | Cardiff | Echo Ave | B-12A | B-12 | 13.4 | Unknown | 200 | PVC | 3 | 1 | 2 | Infiltration from around pipe | Installation of T-liner | Runner | - | - | - | \$3,200 | - | - | - | |
| 23 | Cardiff | Discovery Ave | B-9 | B-8 | 73.4 | Unknown | 200 | PVC | 4 | 1 | 2 | Crushed Piping (4"x4") | Installation of T-liner | - | - | - | - | \$3,200 | - | - | - | |
| 24 | Cardiff | Discovery Ave | B-9 | B-8 | 96.7 | Unknown | 200 | PVC | 4 | 1 | 2 | Crack in main piping(3mm) | Dig and Replace one length of piping | - | - | \$5,160 | - | - | - | - | - | |
| 25 | Cardiff | Echo Ave | A-8 | A-7 | 11.8 | Unknown | 200 | PVC | 4 | 1 | 2 | Seal dislodged from service | Installation of T-liner | - | - | - | - | \$3,200 | - | - | - | |
| | | | | | | | | | | | | | | | \$1,680 | \$25,800 | \$2,900 | \$32,000 | \$3,500 | - | \$ 65,880 | |

Table 3.7: Priority 3 Locations, Recommendations, and Budgetary Costs

| Event No. | Location | | Assessment | | | | | | | | Dripper, Runner, Gusher | Preliminary Budget Pricing Based on Nominal Bury Depth of (3-4m) | | | | | | | | | |
|-----------|----------|----------------|-------------|---------------|---------------------|---------|-----------|---------------|---------------|------------|-------------------------|--|--|-------------------------|-------------------------|-------------------------|---------------------------------|-------------------------------|---------|--------|---|
| | | | | | | | | | | | | Flush and Camera per m | Spot Repair Excavation per m | 150mm Spot Repair Liner | 200mm Spot Repair Liner | 250mm Spot Repair Liner | Install additional manhole ring | Total Price for each Priority | | | |
| | District | Street | Upstream MH | Downstream MH | Length at Event (m) | Depth m | Pipe Dia. | Pipe Material | Struct. Grade | Ops. Grade | | Priority | Condition Remarks | Rehabilitation Comments | \$20 | \$1,200 | \$2,900 | \$3,200 | \$3,500 | \$800 | - |
| 26 | Cardiff | Cardiff Place | A2-3 | A2-3 | N/A | N/A | N/A | N/A | N/A | N/A | 3 | Manhole cover is below or even with ground level | Add manhole ring to raise rim above ground level | - | - | - | - | - | - | \$ 800 | - |
| 27 | Cardiff | Green Space | A1-1 | A1-1 | N/A | N/A | N/A | N/A | N/A | N/A | 3 | Manhole cover is below or even with ground level | Add manhole ring to raise rim above ground level | - | - | - | - | - | - | \$ 800 | - |
| 28 | Cardiff | Mill Road | C-3 | C-3 | N/A | N/A | N/A | N/A | N/A | N/A | 3 | Manhole cover is below or even with ground level | Add manhole ring to raise rim above ground level | - | - | - | - | - | - | \$ 800 | - |
| 29 | Cardiff | Mill Road | B2-3 | B2-3 | N/A | N/A | N/A | N/A | N/A | N/A | 3 | Manhole cover is below or even with ground level | Add manhole ring to raise rim above ground level | - | - | - | - | - | - | \$ 800 | - |
| 30 | Cardiff | Green Space | B1-2 | B1-2 | N/A | N/A | N/A | N/A | N/A | N/A | 3 | Manhole cover is below or even with ground level | Add manhole ring to raise rim above ground level | - | - | - | - | - | - | \$ 800 | - |
| 31 | Cardiff | Green Space | COB1-1 | COB1-1 | N/A | N/A | N/A | N/A | N/A | N/A | 3 | Manhole cover is below or even with ground level | Add manhole ring to raise rim above ground level | - | - | - | - | - | - | \$ 800 | - |
| 32 | Cardiff | Green Space | COB1-3 | COB1-3 | N/A | N/A | N/A | N/A | N/A | N/A | 3 | Manhole cover is below or even with ground level | Add manhole ring to raise rim above ground level | - | - | - | - | - | - | \$ 800 | - |
| 33 | Cardiff | Green Space | COB1-4 | COB1-4 | N/A | N/A | N/A | N/A | N/A | N/A | 3 | Manhole cover is below or even with ground level | Add manhole ring to raise rim above ground level | - | - | - | - | - | - | \$ 800 | - |
| 34 | Cardiff | Menalta Road | B1-6 | B1-6 | N/A | N/A | N/A | N/A | N/A | N/A | 3 | Manhole cover is below or even with ground level | Add manhole ring to raise rim above ground level | - | - | - | - | - | - | \$ 800 | - |
| 35 | Cardiff | Mill Road | C-2 | C-1 | 5.5 | Unknown | 200 | PVC | 2 | 1 | 3 | Infiltration from around pipe | Installation of T-liner | Dripper | - | - | - | \$ 3,200 | - | - | - |
| 36 | Cardiff | Mill Road | C-2 | C-1 | 25.6 | Unknown | 200 | PVC | 2 | 1 | 3 | Infiltration from around pipe | Installation of T-liner | Dripper | - | - | - | \$ 3,200 | - | - | - |
| 37 | Cardiff | Mill Road | C-2 | C-1 | 36.7 | Unknown | 200 | PVC | 2 | 1 | 3 | Infiltration from around pipe | Installation of T-liner | Dripper | - | - | - | \$ 3,200 | - | - | - |
| 38 | Cardiff | Mill Road | C-3 | C-2 | 19.0 | Unknown | 200 | PVC | 2 | 1 | 3 | Infiltration from around pipe | Installation of T-liner | Dripper | - | - | - | \$ 3,200 | - | - | - |
| 39 | Cardiff | Mill Road | C-3 | C-2 | 56.8 | Unknown | 200 | PVC | 2 | 1 | 3 | Infiltration from around pipe | Installation of T-liner | Dripper | - | - | - | \$ 3,200 | - | - | - |
| 40 | Cardiff | Cardiff Place | A2-1 | A-4 | 69.8 | Unknown | 250 | PVC | 2 | 1 | 3 | Infiltration from around pipe | Installation of T-liner | Dripper | - | - | - | \$ 3,200 | - | - | - |
| 41 | Cardiff | Prospect Place | B-1 | A-1 | 11.9 | Unknown | 200 | PVC | 2 | 1 | 3 | Infiltration from around pipe | Installation of T-liner | Dripper | - | - | - | \$ 3,200 | - | - | - |
| 42 | Cardiff | Prospect Place | B-1 | A-1 | 43.9 | Unknown | 200 | PVC | 2 | 1 | 3 | Infiltration from around pipe | Installation of T-liner | Dripper | - | - | - | \$ 3,200 | - | - | - |



| Event No. | Location | | Assessment | | | | | | Dripper, Runner, Gusher | Preliminary Budget Pricing Based on Nominal Bury Depth of (3-4m) | | | | | | | | | | | |
|-----------|----------|-----------------------------|-------------|---------------|---------------------|---------|-----------|---------------|-------------------------|--|------------------------------|--|--------------------------------------|-------------------------|---------------------------------|-------------------------------|----------|----------|----------|-------|---|
| | | | | | | | | | | Flush and Camera per m | Spot Repair Excavation per m | 150mm Spot Repair Liner | 200mm Spot Repair Liner | 250mm Spot Repair Liner | Install additional manhole ring | Total Price for each Priority | | | | | |
| | District | Street | Upstream MH | Downstream MH | Length at Event (m) | Depth m | Pipe Dia. | Pipe Material | | Struct. Grade | Ops. Grade | Priority | Condition Remarks | Rehabilitation Comments | \$20 | \$1,200 | \$2,900 | \$3,200 | \$3,500 | \$800 | - |
| 43 | Cardiff | Mill Road | C-4 | C-3 | 31.3 | Unknown | 200 | PVC | 2 | 1 | 3 | Infiltration from around pipe | Installation of T-liner | Dripper | - | - | - | \$ 3,200 | - | - | - |
| 44 | Cardiff | Mill Road | C-5 | C-4 | 7.1 | Unknown | 200 | PVC | 3 | 1 | 3 | Broken service piping (hairline) | Installation of T-liner | - | - | - | \$ 3,200 | - | - | - | |
| 45 | Cardiff | Green Space | A-4 | A-3 | 25.0 | Unknown | 200 | PVC | 2 | 1 | 3 | Infiltration from around pipe | Installation of T-liner | Dripper | - | - | - | \$ 3,200 | - | - | - |
| 46 | Cardiff | Cardiff Place | A2-2 | A2-1 | 10.3 | Unknown | 200 | PVC | 2 | 1 | 3 | Service blocked by main piping | Installation of T-liner | Dripper | - | - | - | \$ 3,200 | - | - | - |
| 47 | Cardiff | Cardiff Place | A3-1 | A-6 | 48.0 | Unknown | 200 | PVC | 2 | 1 | 3 | Infiltration from around pipe | Installation of T-liner | Dripper | - | - | - | \$ 3,200 | - | - | - |
| 48 | Cardiff | Cardiff Place | A3-1 | A-6 | 65.0 | Unknown | 200 | PVC | 3 | 1 | 3 | Crack in piping around service(hairline) | Installation of T-liner | - | - | - | \$ 3,200 | - | - | - | |
| 49 | Cardiff | Green Space | B-3 | B-2 | 27.0 | Unknown | 250 | PVC | 2 | 1 | 3 | Infiltration from around pipe | Installation of T-liner | Dripper | - | - | - | - | \$ 3,500 | - | - |
| 50 | Cardiff | Menalta Road | D-6 | D-5 | 5.5 | Unknown | 200 | PVC | 3 | 1 | 3 | Seal gasket is dislodged | Dig and Replace one length of piping | - | - | \$ 5,160 | - | - | - | - | - |
| 51 | Cardiff | Menalta Road | D-6 | D-5 | 13.5 | Unknown | 200 | PVC | 3 | 1 | 3 | Seal gasket is dislodged | Dig and Replace one length of piping | - | - | \$ 5,160 | - | - | - | - | - |
| 52 | Cardiff | Menalta Road | D-6 | D-5 | 21.6 | Unknown | 200 | PVC | 3 | 1 | 3 | Seal gasket is dislodged | Dig and Replace one length of piping | - | - | \$ 5,160 | - | - | - | - | - |
| 53 | Cardiff | Menalta Road | D-6 | D-5 | 25.6 | Unknown | 200 | PVC | 3 | 1 | 3 | Seal gasket is dislodged | Dig and Replace one length of piping | - | - | \$ 5,160 | - | - | - | - | - |
| 54 | Cardiff | Menalta Road | D-6 | D-5 | 33.5 | Unknown | 200 | PVC | 3 | 1 | 3 | Seal gasket is dislodged | Dig and Replace one length of piping | - | - | \$ 5,160 | - | - | - | - | - |
| 55 | Cardiff | Menalta Road | D-9 | D-8 | 19.8 | Unknown | 200 | PVC | 3 | 1 | 3 | Seal gasket is dislodged | Dig and Replace one length of piping | - | - | \$ 5,160 | - | - | - | - | - |
| 56 | Cardiff | Menalta Road | D-7 | D-5 | 10.7 | Unknown | 200 | PVC | 3 | 1 | 3 | Seal gasket is dislodged | Dig and Replace one length of piping | - | - | \$ 5,160 | - | - | - | - | - |
| 57 | Cardiff | Menalta Road | D-7 | D-5 | 30.3 | Unknown | 200 | PVC | 3 | 1 | 3 | Seal gasket is dislodged | Dig and Replace one length of piping | - | - | \$ 5,160 | - | - | - | - | - |
| 58 | Cardiff | Menalta Road | D-8 | D-7 | 22.0 | Unknown | 200 | PVC | 3 | 1 | 3 | Seal gasket is leaking | Dig and Replace one length of piping | - | - | \$ 5,160 | - | - | - | - | - |
| 59 | Cardiff | Menalta Road | B1-6 | B1-5 | 21.8 | Unknown | 200 | PVC | 3 | 1 | 3 | Seal gasket is dislodged | Dig and Replace one length of piping | - | - | \$ 5,160 | - | - | - | - | - |
| 60 | Cardiff | Discovery Ave and Mill Road | COB2-1 | B2-3 | 11.7 | Unknown | 200 | PVC | 1 | 2 | 3 | Roots protruding around service | Installation of T-liner | - | - | - | - | \$ 3,200 | - | - | - |
| 61 | Cardiff | Discovery Ave and Mill Road | COB2-1 | B2-3 | 27.0 | Unknown | 200 | PVC | 3 | 1 | 3 | Pipe is buckled (dimple is 10mm) | Dig and Replace one length of piping | - | - | \$ 5,160 | - | - | - | - | - |
| 62 | Cardiff | Discovery Ave and Mill Road | COB2-1 | B2-3 | 35.2 | Unknown | 200 | PVC | 1 | 1 | 3 | Service blocked by main piping | Installation of T-liner | - | - | - | - | \$ 3,200 | - | - | - |



| Event No. | Location | | Assessment | | | | | | Preliminary Budget Pricing Based on Nominal Bury Depth of (3-4m) | | | | | | | | | | | | |
|-----------|----------|-----------------------------|-------------|---------------|---------------------|---------|-----------|---------------|--|------------------------|------------------------------|---|---|-------------------------|---------------------------------|-------------------------------|----------|----------|----------|-----------|---|
| | | | | | | | | | Dripper, Runner, Gusher | Flush and Camera per m | Spot Repair Excavation per m | 150mm Spot Repair Liner | 200mm Spot Repair Liner | 250mm Spot Repair Liner | Install additional manhole ring | Total Price for each Priority | | | | | |
| | District | Street | Upstream MH | Downstream MH | Length at Event (m) | Depth m | Pipe Dia. | Pipe Material | | Struct. Grade | Ops. Grade | Priority | Condition Remarks | Rehabilitation Comments | \$20 | \$1,200 | \$2,900 | \$3,200 | \$3,500 | \$800 | - |
| 63 | Cardiff | Discovery Ave and Mill Road | COB2-2 | B2-3 | 50.7 | Unknown | 200 | PVC | 1 | 1 | 3 | Service blocked by main piping | Installation of T-liner | - | - | - | - | \$ 3,200 | - | - | - |
| 64 | Cardiff | Discovery Ave and Mill Road | B2-3 | B2-2 | 80.8 | Unknown | 200 | PVC | 2 | 1 | 3 | Infiltration from around pipe | Installation of T-liner | Dripper | - | - | - | \$ 3,200 | - | - | - |
| 65 | Cardiff | Discovery Ave and Mill Road | B2-3 | B2-2 | 110.1 | Unknown | 200 | PVC | 2 | 1 | 3 | Infiltration from around pipe | Installation of T-liner | Runner | - | - | - | \$ 3,200 | - | - | - |
| 66 | Cardiff | Discovery Ave | B2-2 | B2-1 | 14.3 | Unknown | 200 | PVC | 2 | 1 | 3 | Service blocked by main piping, high flow in pipe | Installation of T-liner and further exploration | Runner | - | - | - | \$ 3,200 | - | - | - |
| 67 | Cardiff | Discovery Ave | B2-2 | B2-1 | 28.9 | Unknown | 200 | PVC | 3 | 1 | 3 | Crack in main piping (hairline) | Installation of T-liner | - | - | - | - | \$ 3,200 | - | - | - |
| 68 | Cardiff | Discovery Ave | B2-1 | B-6 | 55.4 | Unknown | 200 | PVC | 1 | 1 | 3 | Service blocked by main piping | Installation of T-liner | - | - | - | - | \$ 3,200 | - | - | - |
| 69 | Cardiff | Discovery Ave | B-8 | B-7 | 12.5 | Unknown | 200 | PVC | 1 | 1 | 3 | Service blocked by main piping | Installation of T-liner | - | - | - | - | \$ 3,200 | - | - | - |
| 70 | Cardiff | Discovery Ave | B-8 | B-7 | 74.5 | Unknown | 200 | PVC | 1 | 1 | 3 | Deposits on wall (25%) | Flush out piping | - | \$2,380 | - | - | - | - | - | - |
| 71 | Cardiff | Echo Ave | B-12 | B-11 | 14.9 | Unknown | 200 | PVC | 2 | 1 | 3 | Infiltration from around pipe | Installation of T-liner | Dripper | - | - | - | \$ 3,200 | - | - | - |
| 72 | Cardiff | Echo Ave and Discovery Road | B-10 | B-9 | 93.0 | Unknown | 200 | PVC | 3 | 1 | 3 | Seal gasket is dislodged | Dig and Replace one length of piping | - | - | \$ 5,160 | - | - | - | - | - |
| 73 | Cardiff | Echo Ave | A-7 | A-6 | 41.7 | Unknown | 200 | PVC | 3 | 1 | 3 | Crack in main piping(hairline) | Dig and Replace one length of piping | - | - | \$ 5,160 | - | - | - | - | - |
| 74 | Cardiff | Echo Ave | A-7 | A-6 | 71.6 | Unknown | 200 | PVC | 2 | 1 | 3 | Infiltration from around pipe | Installation of T-liner | Dripper | - | - | - | \$ 3,200 | - | - | - |
| 75 | Cardiff | Echo Ave | A4-1 | A-7 | 65.9 | Unknown | 200 | PVC | 3 | 1 | 3 | Crack in main piping (hairline) | Dig and Replace one length of piping | - | - | \$ 5,160 | - | - | - | - | - |
| 76 | Cardiff | Echo Ave | A4-2 | A4-1 | 25.9 | Unknown | 200 | PVC | 3 | 1 | 3 | High flow in pipe, crack in main piping (3mm) | Installation of T-liner, further exploration | Runner | - | - | - | \$ 3,200 | - | - | - |
| 77 | Cardiff | Echo Ave | A4-2 | A4-1 | 68.9 | Unknown | 200 | PVC | 3 | 1 | 3 | Crack in main piping | Installation of T-liner | - | - | - | - | \$ 3,200 | - | - | - |
| | | | | | | | | | | | | | | \$2,380 | \$72,240 | - | \$86,400 | \$ 3,500 | \$ 7,200 | \$171,720 | |

Table 3.8: Further Exploration Required Locations

| Event No. | Location | | Characteristics | | | | | | Assessment | | | | | Dripper, Runner, Gusher |
|-----------|----------|------------------------------|-----------------|--------------------|---------------------|-----------|----------------|---------------|---------------|------------|-------------------------|-------------------|-------------------------|-------------------------|
| | District | Street | Upstream MH | Downstream MH | Length at Event (m) | Depth (m) | Pipe Dia. (mm) | Pipe Material | Struct. Grade | Ops. Grade | Priority | Condition Remarks | Rehabilitation Comments | |
| 78 | Cardiff | Green Space | A1-1 | A-2 | 2.0 | Unknown | 150 | PVC | 1 | 1 | TDB after investigation | High flow in pipe | Further exploration | Runner |
| 79 | Cardiff | Echo Ave | COB3-2 | main line Echo Ave | 4.8 | Unknown | 150 | PVC | 1 | 1 | TDB after investigation | High flow in pipe | Further exploration | Gusher |
| 80 | Cardiff | Mill Road | C-2 | C-1 | 36.0 | Unknown | 200 | PVC | 1 | 1 | TDB after investigation | High flow in pipe | Further exploration | Runner |
| 81 | Cardiff | Mill Road | C-3 | C-2 | 19.3 | Unknown | 200 | PVC | 1 | 1 | TDB after investigation | High flow in pipe | Further exploration | Dripper |
| 82 | Cardiff | Mill Road | C-3 | C-2 | 38.3 | Unknown | 200 | PVC | 1 | 1 | TDB after investigation | High flow in pipe | Further exploration | Runner |
| 83 | Cardiff | Mill Road and Prospect Place | C-1 | A-1 | 29.1 | Unknown | 250 | PVC | 1 | 1 | TDB after investigation | High flow in pipe | Further exploration | Gusher |
| 84 | Cardiff | Mill Road | C-5 | C-4 | 44.8 | Unknown | 200 | PVC | 1 | 1 | TDB after investigation | High flow in pipe | Further exploration | Runner |
| 85 | Cardiff | Mill Road | C-5 | C-4 | 60.5 | Unknown | 200 | PVC | 1 | 1 | TDB after investigation | High flow in pipe | Further exploration | Runner |
| 86 | Cardiff | Cardiff Place | A2-3 | A2-2 | 46.3 | Unknown | 200 | PVC | 1 | 1 | TDB after investigation | High flow in pipe | Further exploration | Runner |
| 87 | Cardiff | Green Space | D-3 | D-2 | 70.8 | Unknown | 200 | PVC | 1 | 1 | TDB after investigation | High flow in pipe | Further exploration | Gusher |
| 88 | Cardiff | Menalta Road | D-8 | D-7 | 21.3 | Unknown | 200 | PVC | 1 | 1 | TDB after investigation | High flow in pipe | Further exploration | Runner |
| 89 | Cardiff | Green Space | B1-5 | B1-4 | 35.1 | Unknown | 200 | PVC | 1 | 1 | TDB after investigation | High flow in pipe | Further exploration | Runner |
| 90 | Cardiff | Green Space | B1-5 | B1-4 | 89.4 | Unknown | 200 | PVC | 1 | 1 | TDB after investigation | High flow in pipe | Further exploration | Gusher |
| 91 | Cardiff | Green Space | B1-5 | B1-4 | 103.0 | Unknown | 200 | PVC | 1 | 1 | TDB after investigation | High flow in pipe | Further exploration | Runner |
| 92 | Cardiff | Discovery Ave and Mill Road | B2-3 | B2-2 | 41.4 | Unknown | 200 | PVC | 1 | 1 | TDB after investigation | High flow in pipe | Further exploration | Runner |
| 93 | Cardiff | Discovery Ave | B2-1 | B-6 | 78.3 | Unknown | 200 | PVC | 1 | 1 | TDB after investigation | High flow in pipe | Further exploration | Runner |
| 94 | Cardiff | Discovery Ave | B2-1 | B-6 | 82.2 | Unknown | 200 | PVC | 1 | 1 | TDB after investigation | High flow in pipe | Further exploration | Gusher |
| 95 | Cardiff | Discovery Ave | B-7 | B-6 | 25.4 | Unknown | 200 | PVC | 1 | 1 | TDB after investigation | High flow in pipe | Further exploration | Runner |
| 96 | Cardiff | Discovery Ave | B-8 | B-7 | 29.1 | Unknown | 200 | PVC | 1 | 1 | TDB after investigation | High flow in pipe | Further exploration | Runner |
| 97 | Cardiff | Discovery Ave | B-12 | B-11 | 25.2 | Unknown | 200 | PVC | 1 | 1 | TDB after investigation | High flow in pipe | Further exploration | Runner |
| 98 | Cardiff | Echo Ave | A4-1 | A-7 | 34.6 | Unknown | 200 | PVC | 1 | 1 | TDB after investigation | High flow in pipe | Further exploration | Runner |
| 99 | Cardiff | Echo Ave | A4-1 | A-7 | 72.8 | Unknown | 200 | PVC | 1 | 1 | TDB after investigation | High flow in pipe | Further exploration | Runner |
| 100 | Cardiff | Echo Ave | A4-2 | A4-1 | 22.9 | Unknown | 200 | PVC | 1 | 1 | TDB after investigation | High flow in pipe | Further exploration | Runner |
| 101 | Cardiff | Echo Ave | A4-2 | A4-1 | 89.1 | Unknown | 200 | PVC | 1 | 1 | TDB after investigation | High flow in pipe | Further exploration | Runner |

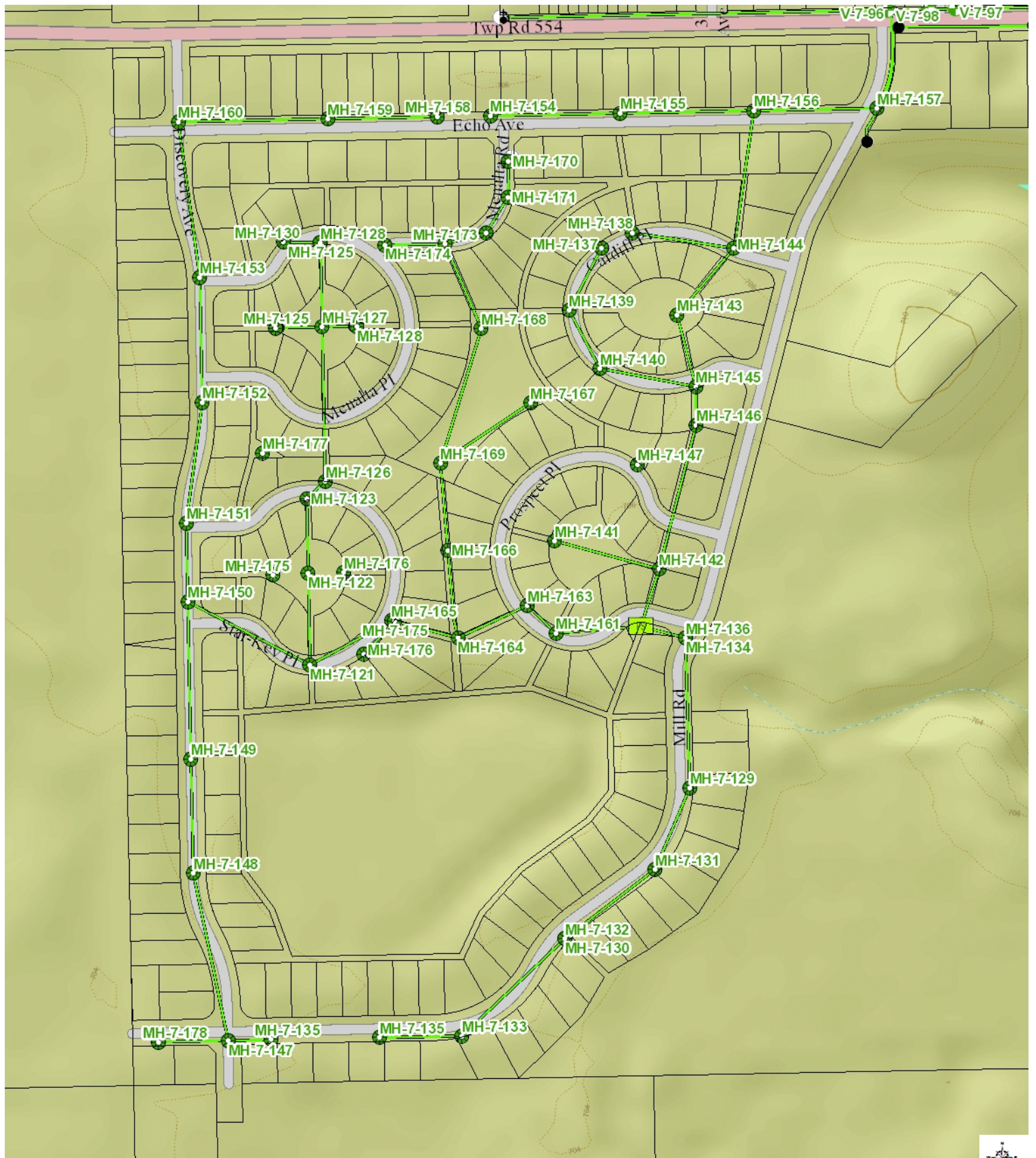


Appendix A
Location Identification Maps



Cardiff I&I

Manhole Identifiers



0 Distance / 2 Distance Units

Notes

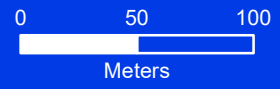
NAD_1983_UTM_Zone_10TM
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14,000

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Downspout Inspection

Visual Inspection of Cardiff Echoes



Sturgeon County



Legend

Downspouts

- Into Ground

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Date: 12/5/2016