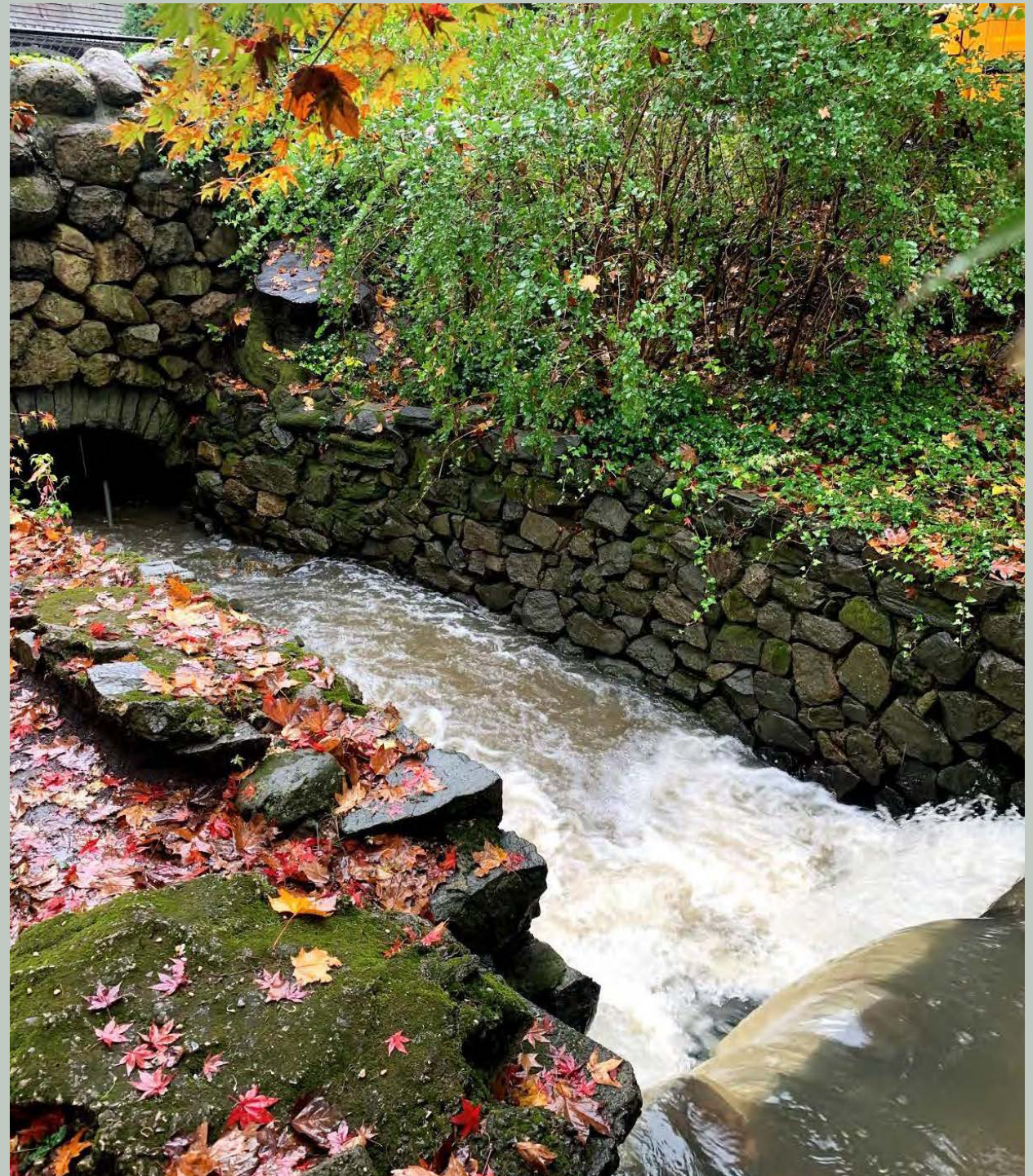
South Wayne Drainage Improvements Feasibility Study

June 7, 2022

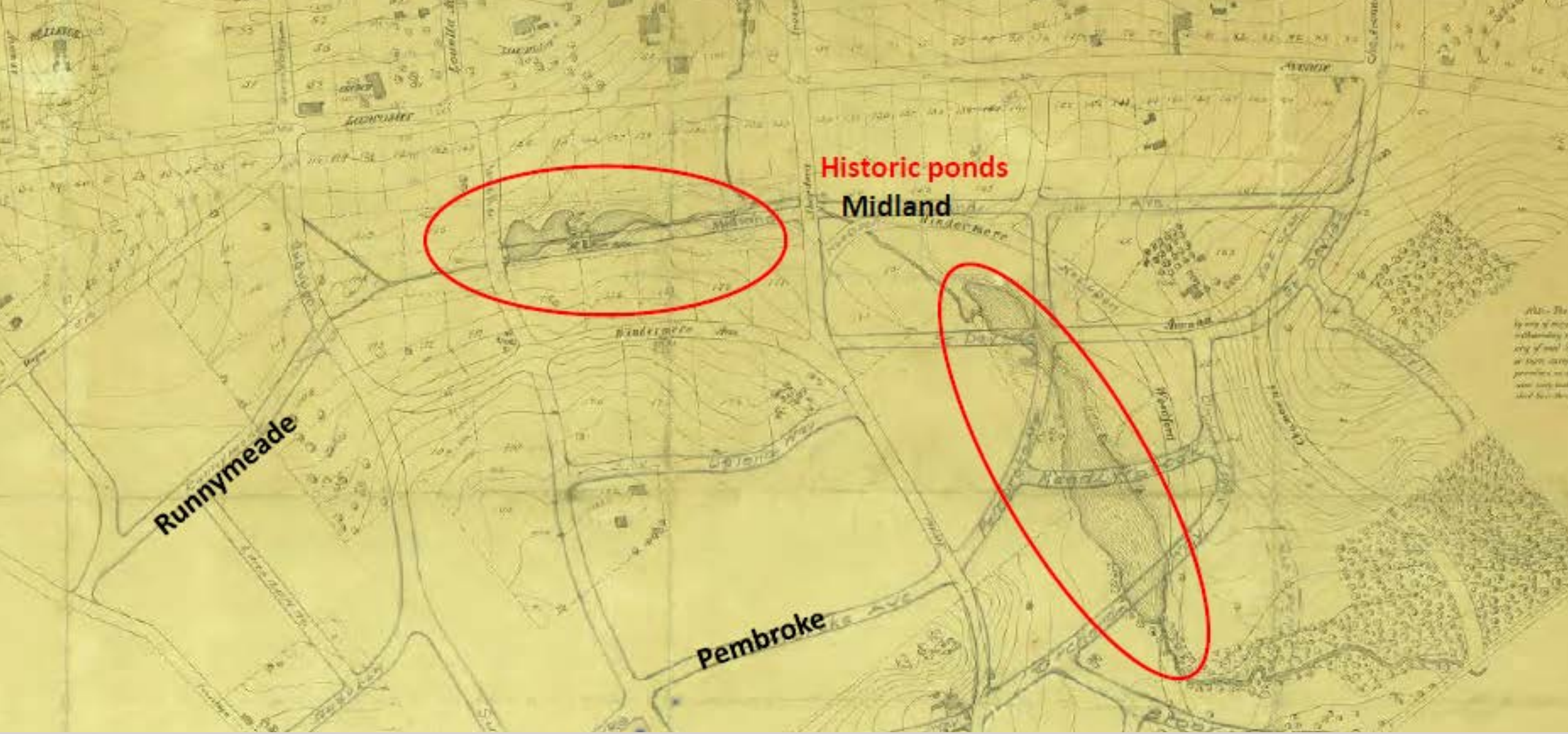


OUTLINE

01 INTRODUCTION

Based on the results of this study, we note that **Ithan Creek**, which was historically a meandering stream with various intermittent ponds, has been severely encroached upon by residential development over the previous 150-years.

This development has led to the addition of impervious surface, which has contributed to a significant increase in stormwater flow rates to the stream. Consequently, many stream cross-sections identified in the Feasibility Study are deficient in their ability to convey all design year storms.



HISTORIC MAPS: SOUTH WAYNE FROM 1880

HISTORIC MAPS: SOUTH WAYNE FROM 1880

HISTORIC MAPS: SOUTH WAYNE FROM 1880

02 PURPOSE

1. **Identify the geometry of each unique portion of the stream/culvert.**

   - Stream/culvert bed slope
   - Stream/culvert dimensions
   - Side slopes
   - Channel depth
   - Composition of the stream bottom

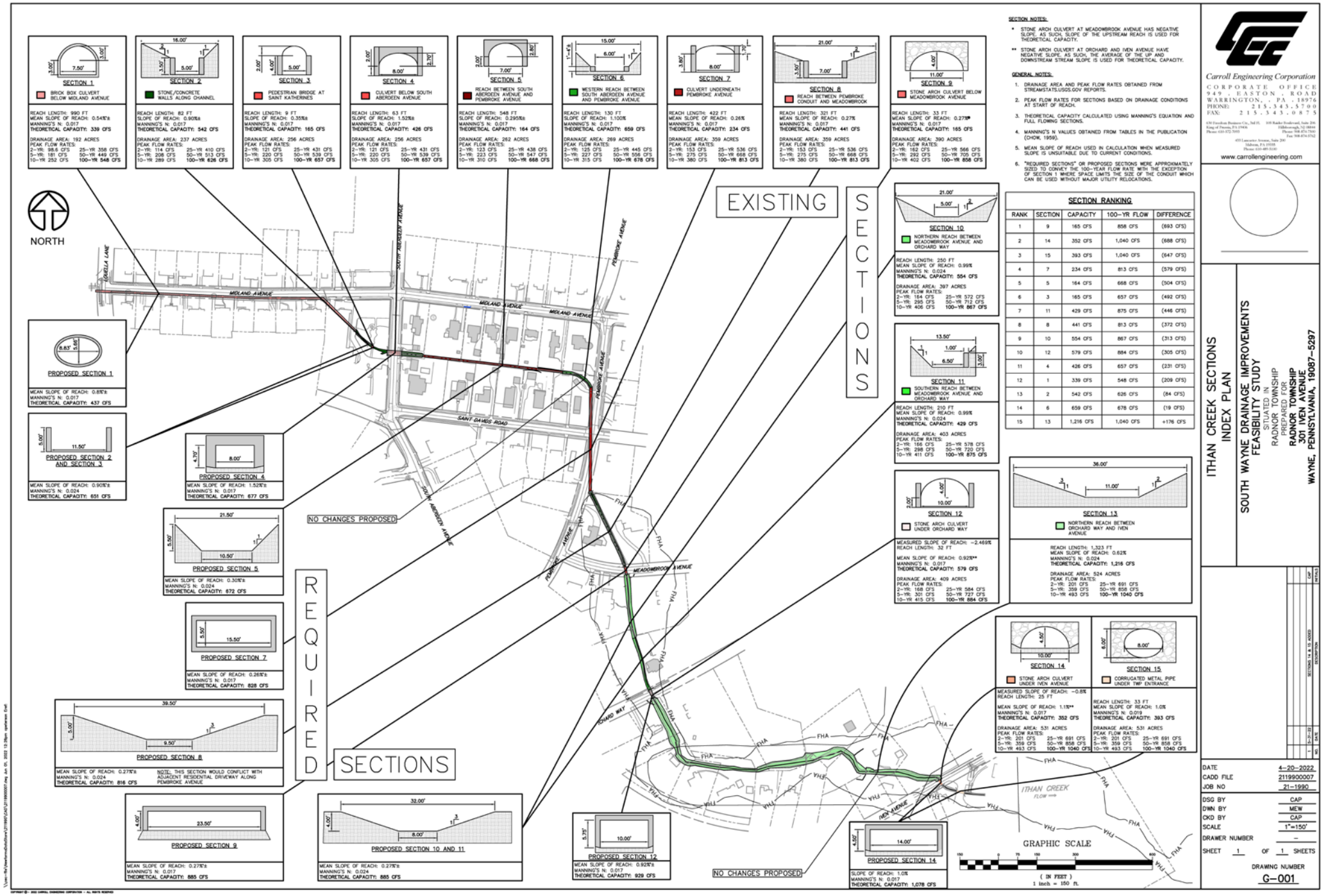
2. **Identify the drainage area and flow rate for each design year storm for each portion.**

3. **Determine the flow capacity of each portion.**

4. **Identify short-term, intermediate, and long-term solutions; and determine the approximate size required to convey a 100-yr storm.**

5. **Prepare a conceptual plan for storm sewer infrastructure along Midland Avenue and St. Davids Road**

6. **Prepare a conceptual plan for a storm sewer bypass from Pembroke Avenue south of Midland to Encke Park**



Carroll Engineering Corporation
CORPORATE OFFICE
949 - EASTON - ROAD
WARRINGTON, - PA - 18976
PHONE: 215.343.5700
FAX: 215.343.0875
www.carrollengineering.com

ITHAN CREEK SECTIONS INDEX PLAN

SOUTH WAYNE DRAINAGE IMPROVEMENTS FEASIBILITY STUDY

SITUATED IN
RADNOR TOWNSHIP
PREPARED FOR
RADNOR TOWNSHIP
301 IVEN AVENUE
WAYNE, PENNSYLVANIA, 19087-5297

NO.	DATE	DESCRIPTION
1	5-20-22	SECTIONS 14 & 15 ADDED

DATE 4-20-2022
CADD FILE 2119900007
JOB NO 21-1990

DSG BY CAP
DWN BY MEW
CKD BY CAP
SCALE 1"=150'
DRAWER NUMBER --
SHEET 1 OF 1 SHEETS

DRAWING NUMBER
G-001

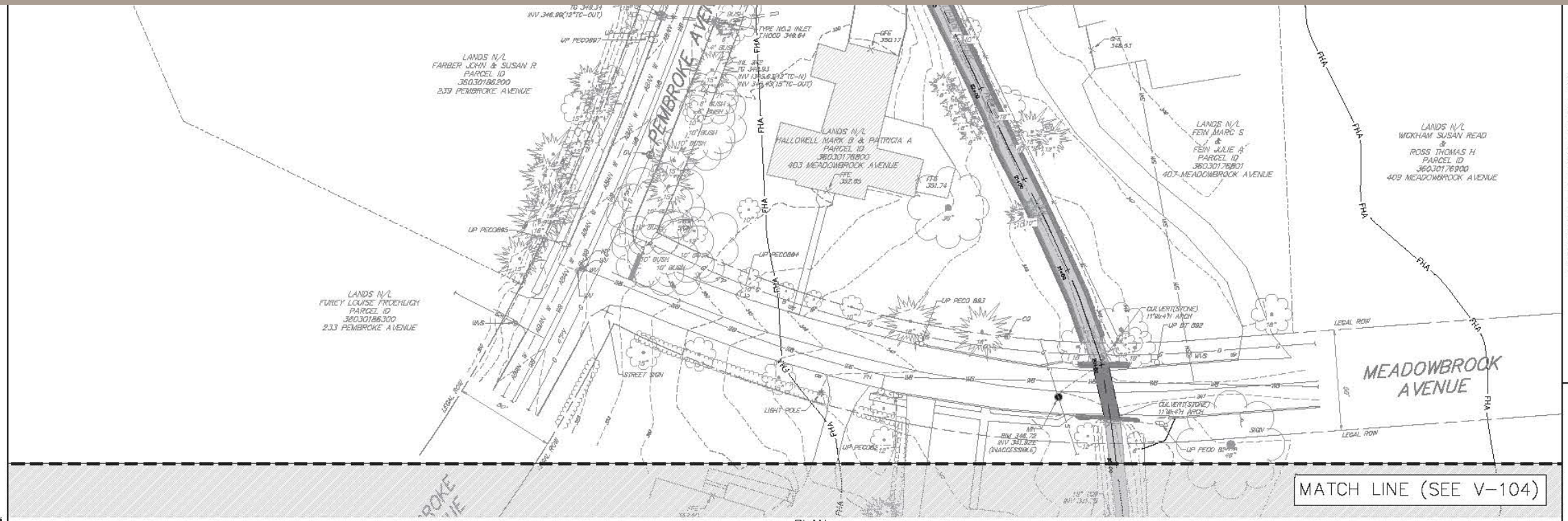
03 SHORT TERM RECOMMENDATIONS

Sediment Removal Downstream of Pembroke Avenue Culvert

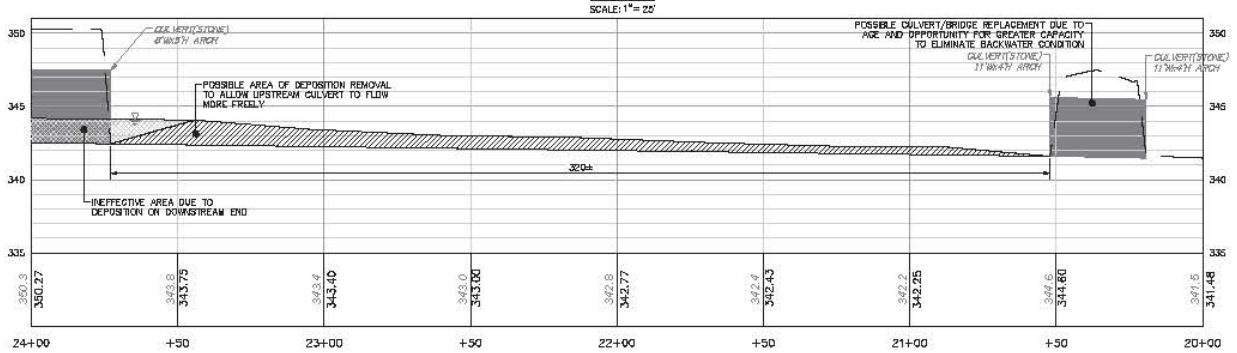
$40,000 - $50,000

There is sediment deposition in the stream which effectively reduces the overall carrying capacity of the upstream Pembroke Avenue closed conduit by approximately 1½ feet. As such, it is recommended that the sediment be removed along approximately 320 feet of the stream to allow the Pembroke Conduit to freely outfall and utilize its full carrying capacity.

EXISTING FEATURES PLAN – PEMBROKE AVENUE & MEADOWBROOK AVENUE



PLAN
SCALE: 1"= 25'



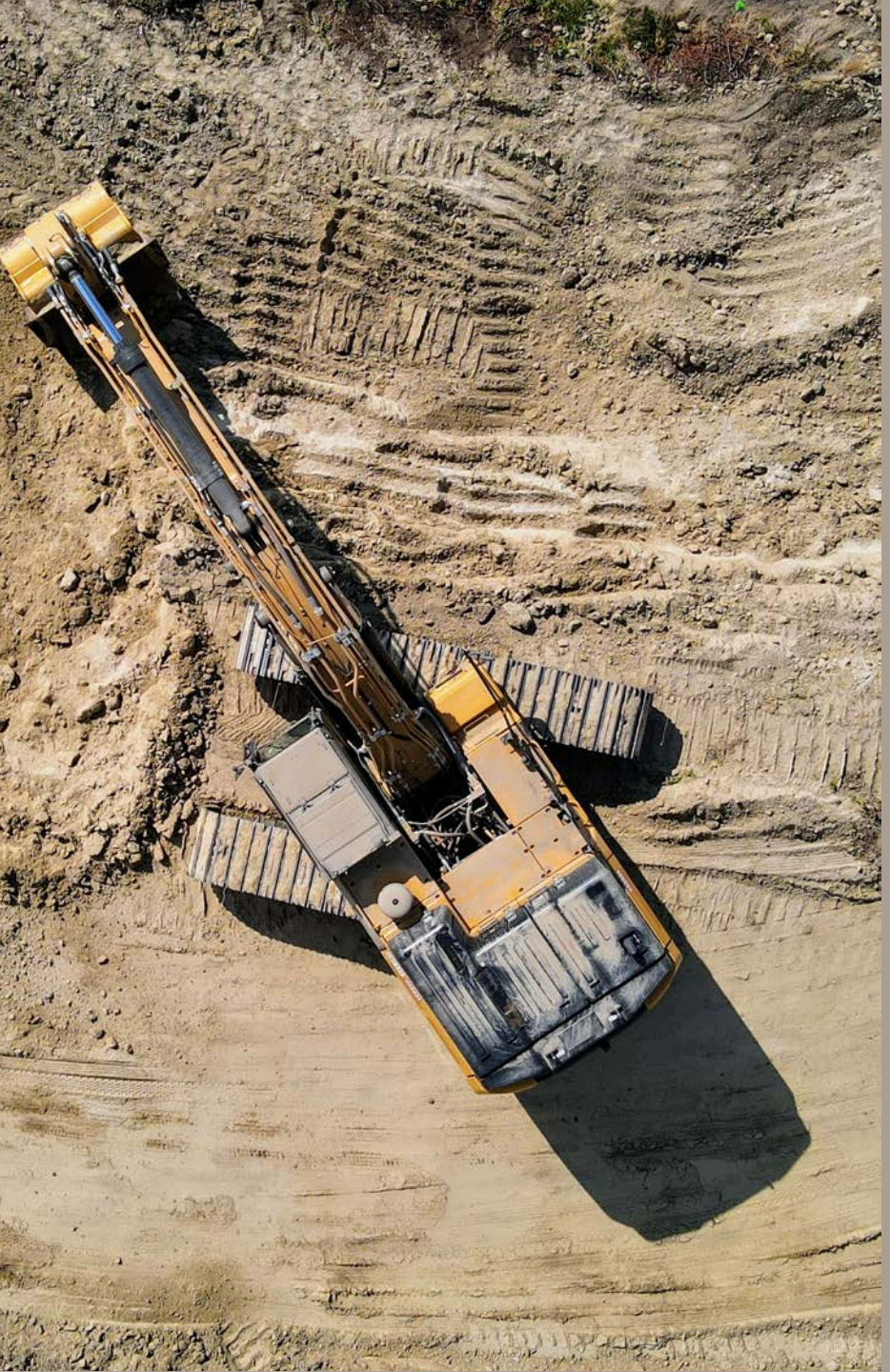
PRIMARY DRAINAGE PROFILE
SCALE: HORIZ 1"=25'
VERT 1"=5'

GRAPHIC SCALE
(IN FEET)
1 inch = 25 ft.

EXISTING FEATURES PLAN
PEMBROKE AVENUE & MEADOWBROOK AVENUE
SOUTH WAYNE DRAINAGE IMPROVEMENTS
FEASIBILITY STUDY
SITUATED IN
RADNOR TOWNSHIP
PREPARED FOR
RADNOR TOWNSHIP
301 IVEN AVENUE
WAYNE, PENNSYLVANIA, 19087-5297

DATE	4-1-2022
CADD FILE	21199000D2
JOB NO	21-1990
DSG BY	CAP
DWN BY	TSB
CKD BY	CAP
SCALE	1"=25'
DRAWER NUMBER	–
SHEET	7 OF 17 SHEETS

DRAWING NUMBER
V-105

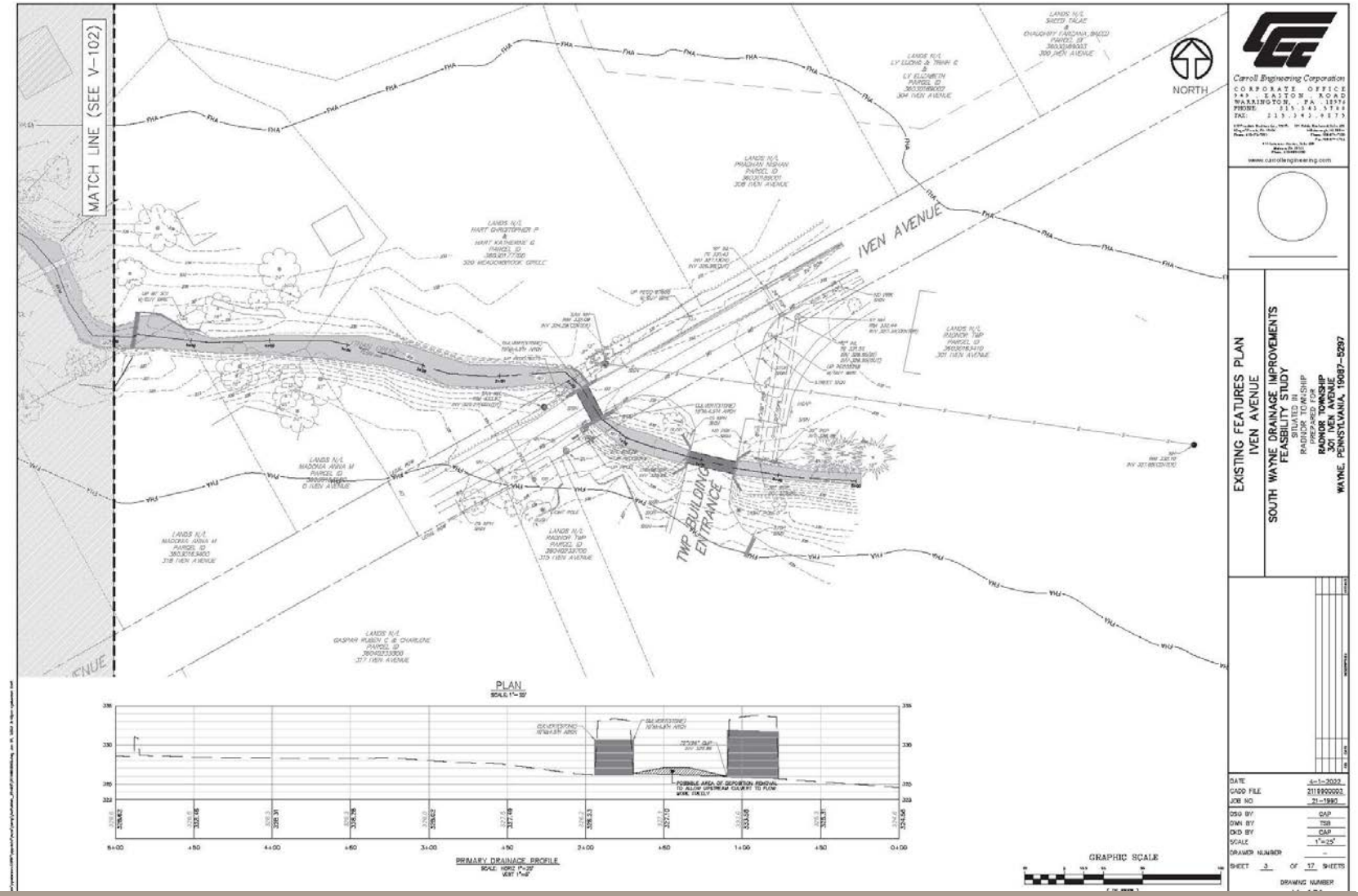


SHORT TERM RECOMMENDATIONS

Sediment removal downstream of Iven Avenue Culvert

$10,000 - $15,000

There is sediment deposition in the stream which effectively reduces the overall carrying capacity of the culvert under Iven Avenue by approximately 1 foot. As such, it is recommended that the sediment be removed along approximately 60 feet of the stream to allow the Iven Avenue culvert to freely outfall and utilize its full carrying capacity. This would be an advantageous time to also to remove any sediment in the adjacent corrugated metal pipe beneath the Township Building entrance drive.



EXISTING FEATURES PLAN - IVEN AVENUE

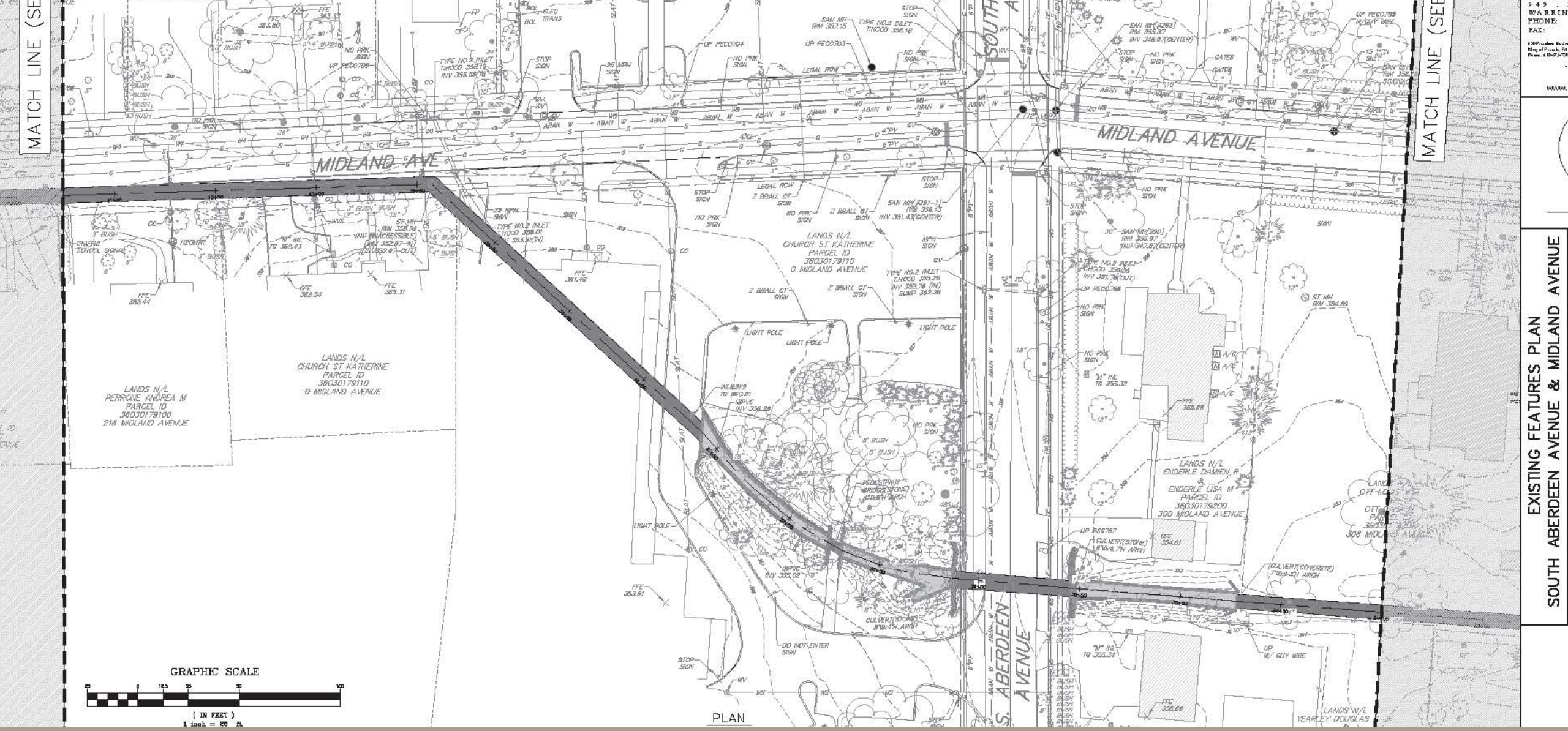
SHORT TERM RECOMMENDATIONS

Pedestrian Bridge Removal at Saint Katherine's

$15,000 - $20,000

A stone masonry pedestrian bridge is located on the eastern portion of the Saint Katherine of Siena School property. This decorative feature leads to a garden area near the intersection of Midland Avenue and South Aberdeen Avenue. This bridge serves as a significant "choke point" having a maximum flow capacity between the 5- and 10-yr storm and does not serve a particular function.

It is recommended that this feature be removed which would require an easement to be granted by Saint Katherines to facilitate the demolition work. Once the demolition is completed the channel would more closely resemble the upstream cross-section with the capacity to convey between a 50- and 100-year peak flow rate.



EXISTING FEATURES PLAN - SOUTH ABERDEEN AVENUE & MIDLAND AVENUE

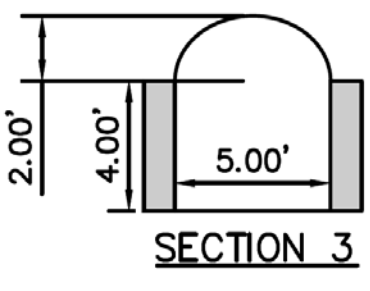
Pedestrian Bridge

Location:

This section is a stone masonry pedestrian bridge over the stream located on the eastern portion of the Saint Katherine of Siena School property. This is a decorative feature leading to a garden area near the intersection of Midland Avenue and South Aberdeen Avenue.

Section Material & Geometry:

This creek section is a 5 feet wide culvert with a 2 feet stone arch above 4 feet stacked stone walls (see graphic representation and photograph).



Section Capacity and Reach Geometry:
Length = 9 feet
Reach slope = 0.35% ±
Manning's n = 0.017
Theoretical Capacity = 165 CFS
Drainage Area = 256 acres

100-year peak flow rate = 657 CFS
50-year peak flow rate = 539 CFS
25-year peak flow rate = 431 CFS
10-year peak flow rate = 305 CFS
5-year peak flow rate = 220 CFS
2-year peak flow rate = 121 CFS

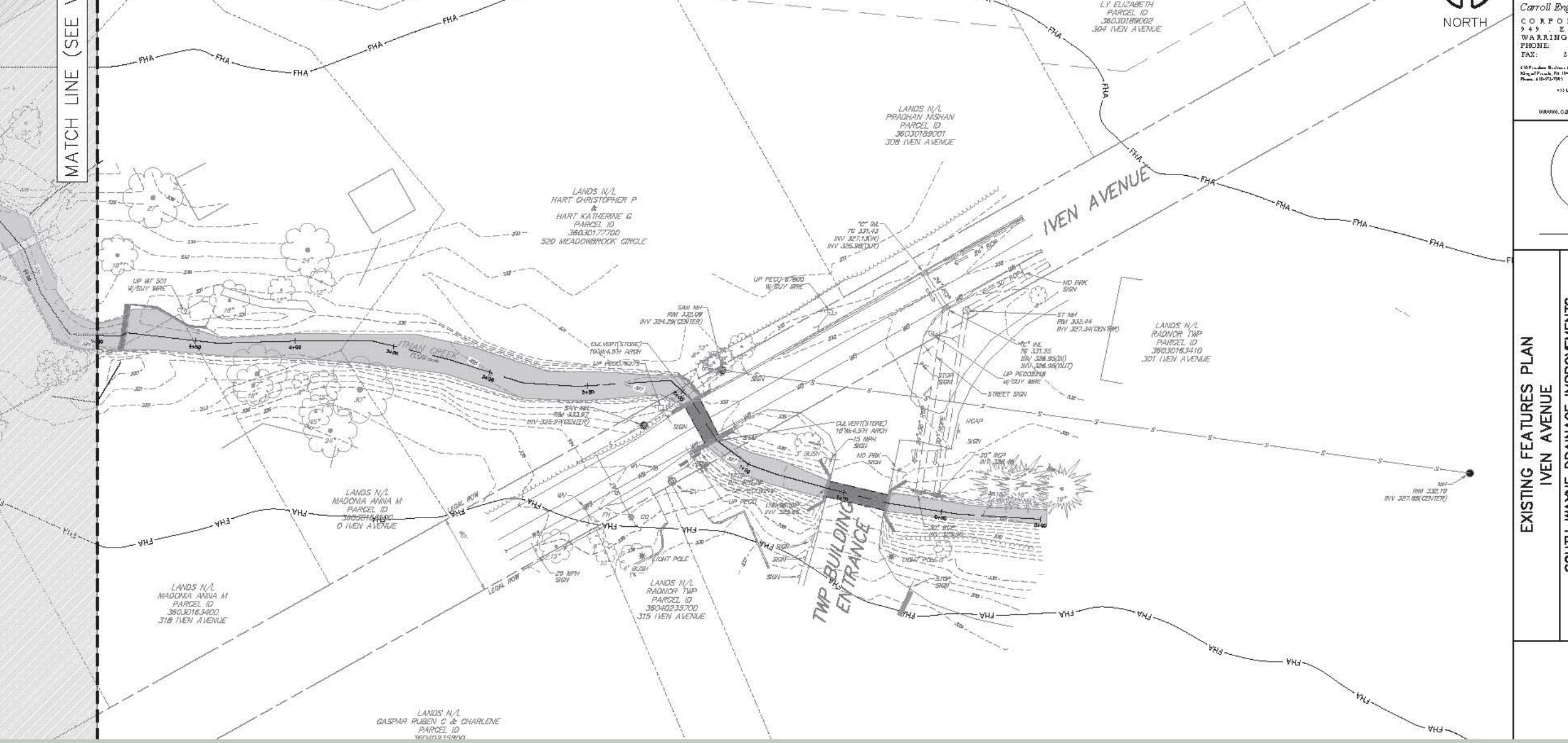
04 INTERMEDIATE RECOMMENDATIONS

Replace the Stone Arch Culvert at Iven Avenue & Township Building Entrance Drive

$1.2 to 1.5 million (for both culverts)

The theoretical capacity of the culverts at these locations are nearly equivalent to the 5-year peak flow rate and are considered vastly undersized based on the tributary flows. These culverts serve as a substantial “choke point” due to their low theoretical capacity and the hydraulic losses of stormwater entering a closed conduit from an open channel.

It is recommended the Township replace both culverts in the future to increase their opening size to adequately pass the 100-year peak flow rate and reduce any flooding upstream due to this constriction. This would result in the culvert(s) being wider (approximately 14 feet) while maintaining its somewhat limited height at 4½ to 6 feet. These locations would be well suited for a CON/SPAN bridge or similar system. The short-term recommendation to remove sediment between these culverts could also be completed at this time.



EXISTING FEATURES PLAN - IVEN AVENUE

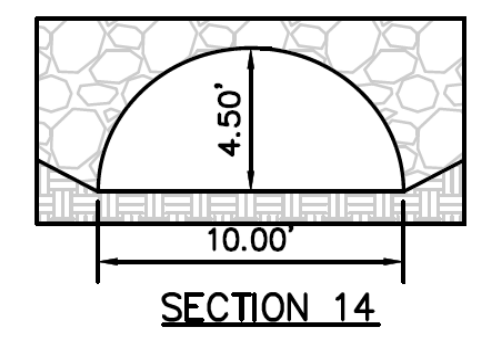
Iven Avenue Culvert

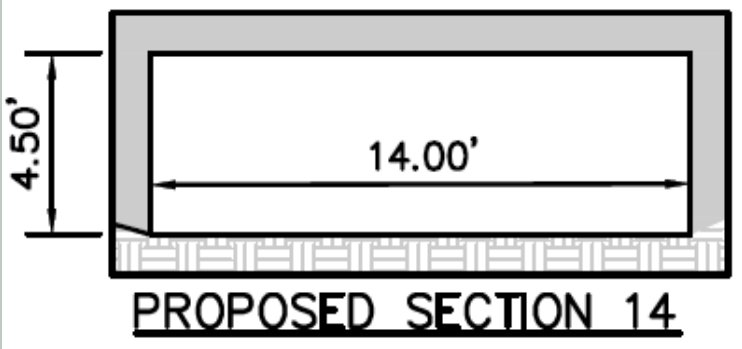
Location:

This section is a stone arch culvert beneath Iven Avenue.

Section Material & Geometry:

This section is a 10 feet wide culvert with 4½ feet stone arch (see graphic representation and photograph).





Section Capacity and Reach Geometry:
Length = 25 feet
Measured Reach Slope = -0.8%
Mean Reach slope = 1.1% ±
Manning's n = 0.017
Theoretical Capacity = 352 CFS
Drainage Area = 531 acres

100-year peak flow rate = 1,040 CFS
50-year peak flow rate = 858 CFS
25-yr peak flow rate = 691 CFS
10-yr peak flow rate = 493 CFS
5-yr peak flow rate = 359 CFS
2-yr peak flow rate = 201 CFS

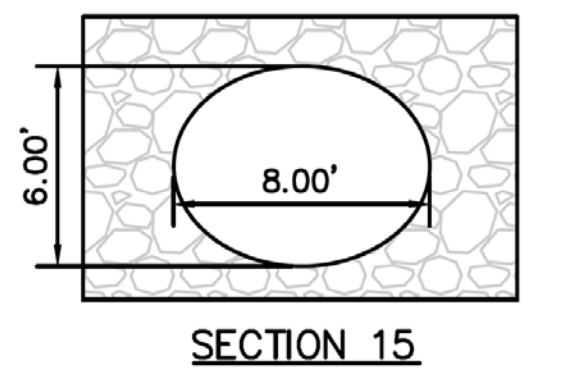
Township Building Entrance

Location:

This section is a corrugated metal culvert beneath the Township Building Entrance Drive.

Section Material & Geometry:

This section is an 8 feet by 6 feet corrugated metal pipe (see graphic representation and photograph below).



Section Capacity and Reach Geometry:
Length = 33 feet
Mean Reach slope = 1.0% ±
Manning's n = 0.019
Theoretical Capacity = 393 CFS
Drainage Area = 531 acres

100-year peak flow rate = 1,040 CFS
50-year peak flow rate = 858 CFS
25-yr peak flow rate = 691 CFS
10-yr peak flow rate = 493 CFS
5-yr peak flow rate = 359 CFS
2-yr peak flow rate = 201 CFS

INTERMEDIATE RECOMMENDATIONS

Replace the Stone Arch Culvert at Meadowbrook Avenue

$500,000 to $600,000

- The theoretical capacity of the existing stone culvert is nearly equivalent to the 2-year peak flow rate and is considered vastly undersized based on the tributary flows. This culvert likely serves as a substantial “choke point” due to its low theoretical capacity. Additionally, this culvert was determined to have a negative slope based on the topographic survey.

- It is recommended the Township replace the culvert in the future largely due to its assumed advanced age as part of the Township’s general infrastructure replacement programs. The opening of the bridge could be maximized at that time to adequately pass the 100-year peak flow rate and reduce any flooding upstream due to this constriction. This would result in the culvert being wider (approximately 23 to 24 feet) while maintaining its somewhat limited height at 4 feet. This location would be well suited for a CON/SPAN bridge or twin box culverts.

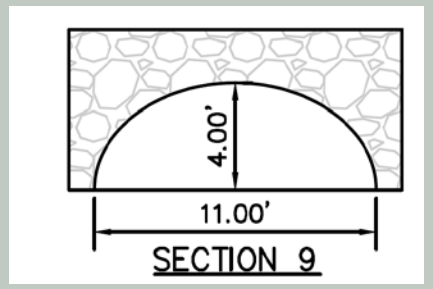
Meadowbrook Culvert

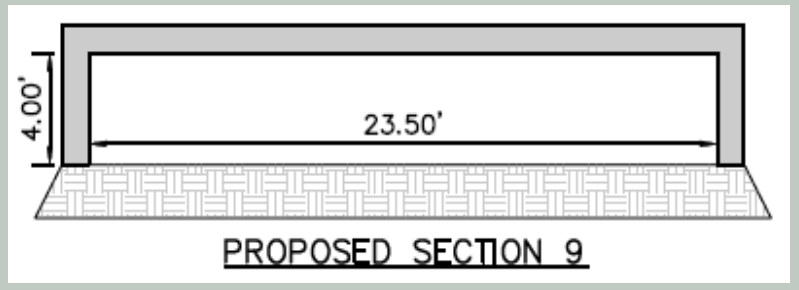
Location:

This culvert is located beneath Meadowbrook Avenue.

Section Material & Geometry:

This culvert section is an 11 feet wide 4 feet tall stone arch culvert (see graphic representation and photograph below).





Section Capacity and Reach Geometry:
Length = 33 feet
Measured Reach Slope: -0.1%
Mean Reach slope = 0.27% ±
Manning's n = 0.017
Theoretical Capacity = 165 CFS
Drainage Area = 390 acres

100-year peak flow rate = 858 CFS
50-year peak flow rate = 705 CFS
25-yr peak flow rate = 566 CFS
10-yr peak flow rate = 402 CFS
5-yr peak flow rate = 292 CFS
2-yr peak flow rate = 162 CFS

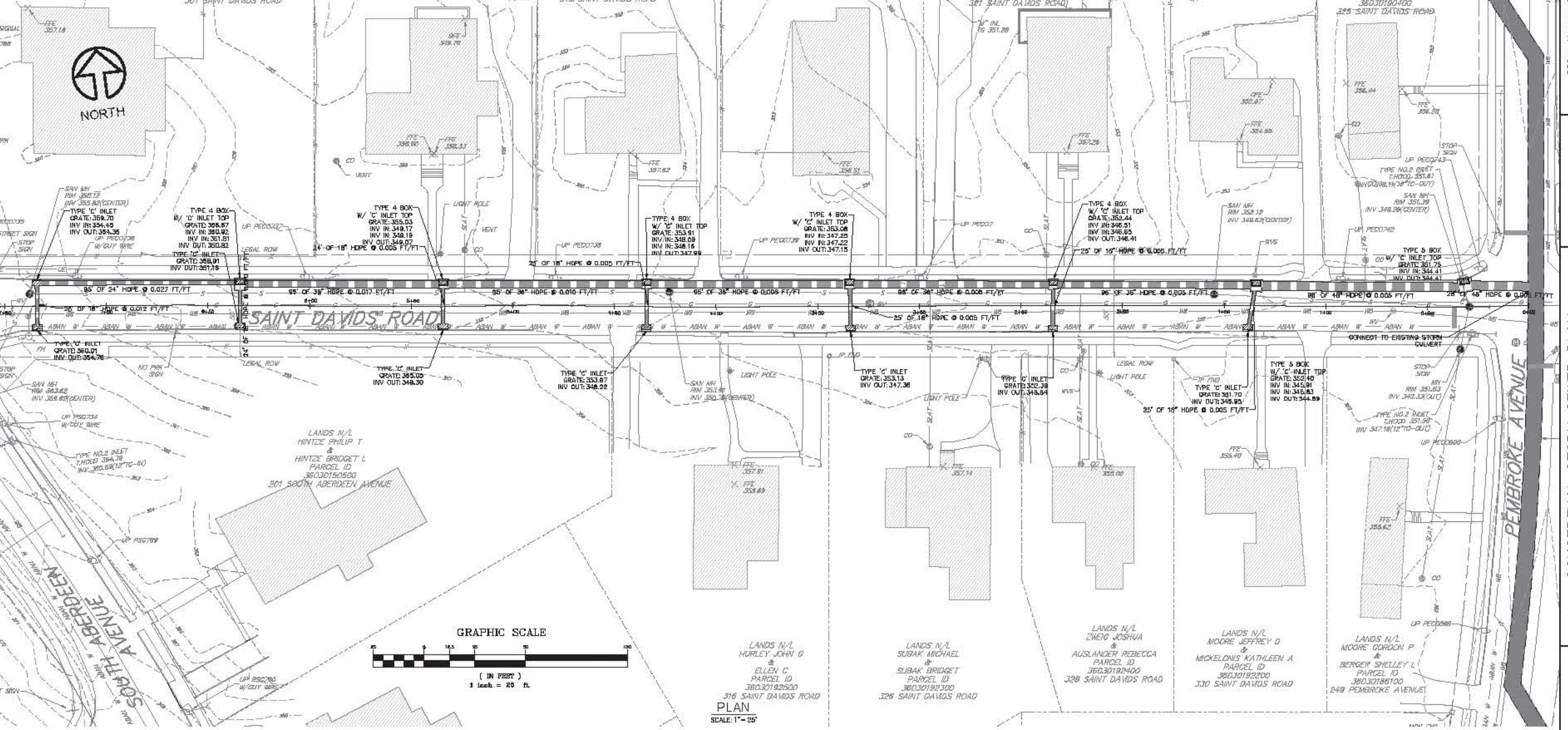
INTERMEDIATE RECOMMENDATIONS

New Storm Sewer Along Saint David's Avenue (between S. Aberdeen and Pembroke Avenue)

$500,000 to $600,000

Photo Courtesy of Autodesk Forum, 2022

A high-level conceptual sketch of a new storm sewer is provided in the Feasibility Report (C-105) which proposes a series of stormwater inlets along Saint David's Road where there is presently little to no stormwater infrastructure. The alignment runs west to east with inlets spaced at approximately 100 feet on the north and south side of the roadway and ultimately discharges into the Pembroke conduit where a tie-in will be required. This stormwater system provides a means for conveying runoff to the receiving watercourse and will reduce flooding on Saint David's Avenue at all storm intervals (i.e., 2-through 100-year).



CONCEPTUAL STORM SEWER PLAN – SAINT DAVIDS BTW PEMBROKE & S. ABERDEEN

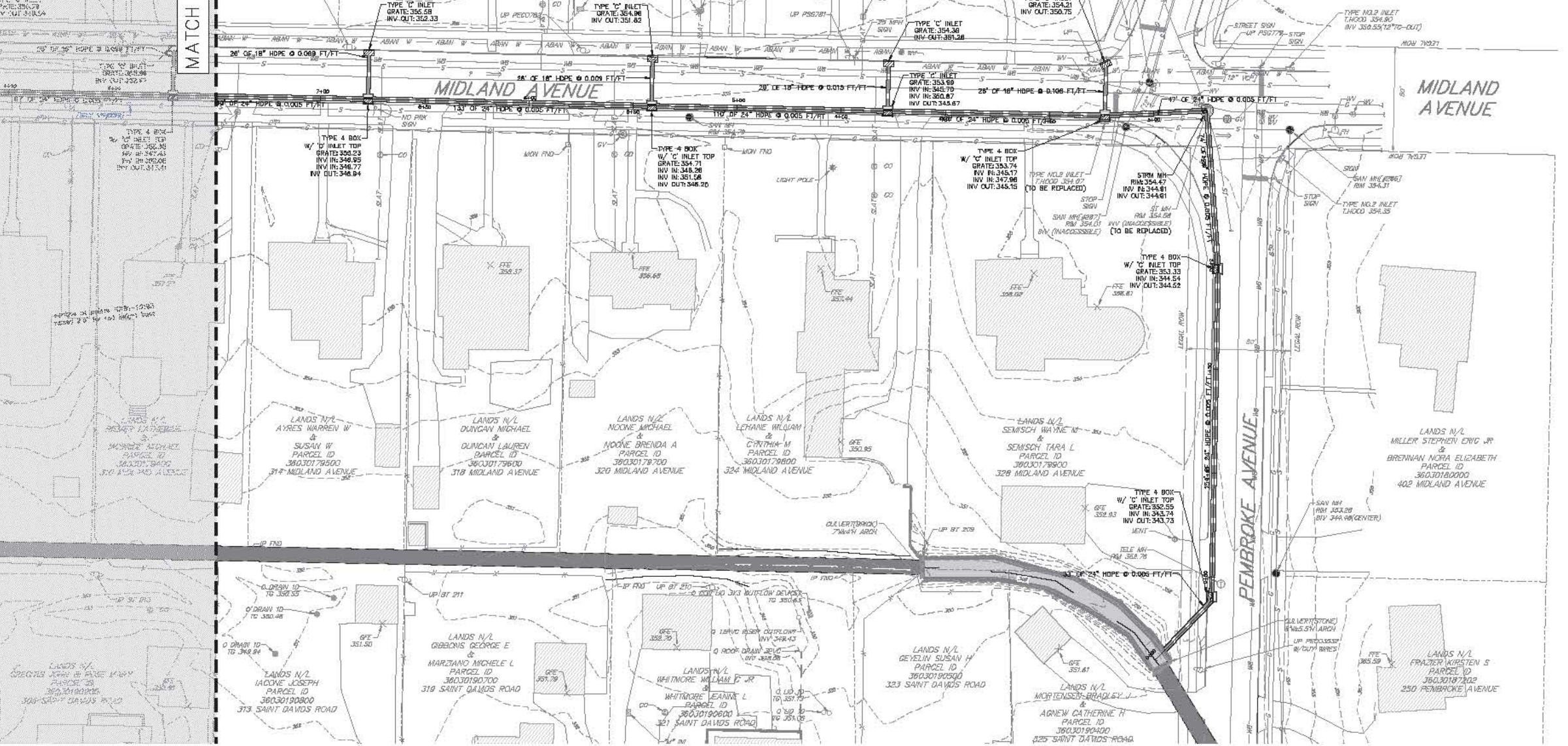
INTERMEDIATE RECOMMENDATIONS

New Storm Sewer along Midland (between S Aberdeen and Pembroke)

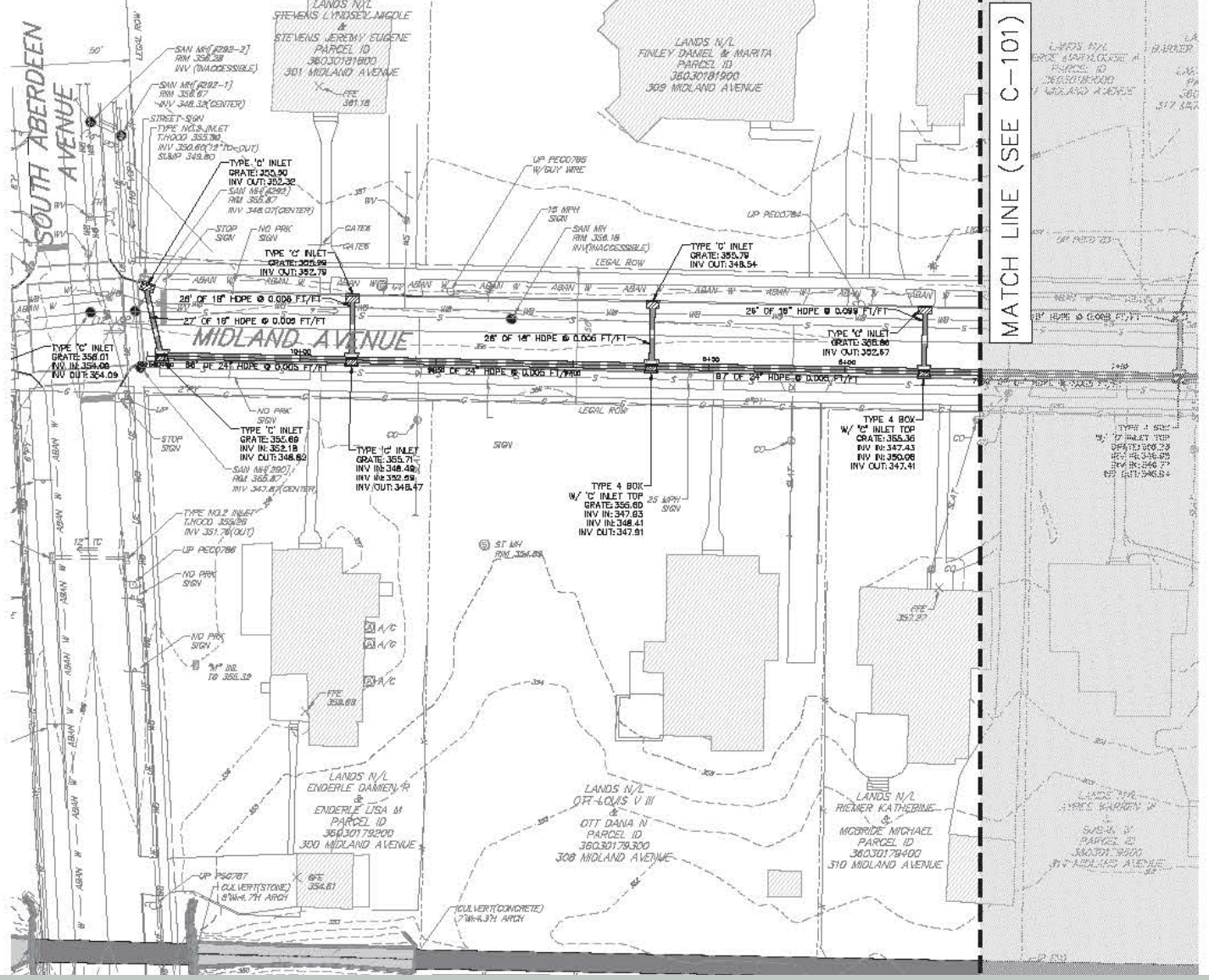
$600,000 to $700,000

A high-level conceptual sketch of a new storm sewer is provided in the Feasibility Study (C-101 and C-102) which proposes a series of stormwater inlets on the north and south side of Midland Avenue where there is presently little to no stormwater infrastructure. This storm sewer system would ultimately discharge to the open channel portion of the Ithan Creek before it enters the Pembroke Avenue closed conduit. Inlets were spaced at approximately 100 feet. Two (2) existing city inlets and one (1) stormwater manhole are also proposed to be replaced at the intersection of Midland Avenue and Pembroke Avenue. This stormwater system provides a means for conveying runoff to the receiving watercourse and will reduce flooding along Midland Avenue at all storm intervals (i.e., 2- through 100-year).

Photo Courtesy of Autodesk Forum, 2022



CONCEPTUAL STORM SEWER PLAN – MIDLAND AVENUE BTW PEMBROKE & S. ABERDEEN



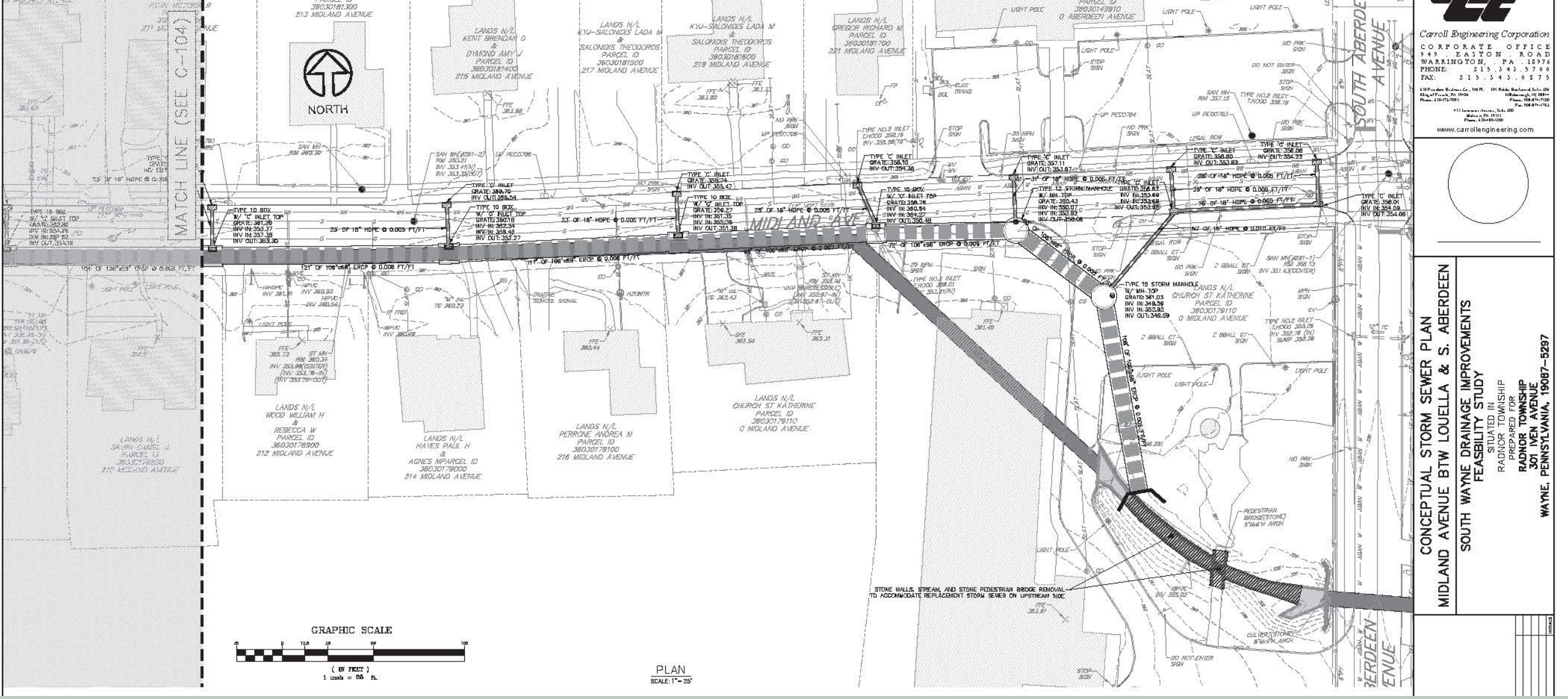
CONCEPTUAL STORM SEWER PLAN – MIDLAND AVENUE BTW PEMBROKE & S. ABERDEEN

INTERMEDIATE RECOMMENDATIONS

New Storm Sewer along Midland between Louella and S Aberdeen

$1,250,000 to $1,500,000

A high-level conceptual sketch of a new storm sewer is provided in the Feasibility Report (C-103 and C-104) which proposes that the existing brick culvert along Midland Avenue be replaced with the largest elliptical concrete pipe available which is equivalent to an 84-inch diameter round pipe. This is likely the largest size pipe that can be accommodated in this area due to existing cover available and the adjacent existing utilities. This alternate proposes to modify the existing alignment to remove the portion located beneath the Saint Katherines of Sienna School and outfall to the existing open channel on the eastern portion of this parcel. This requires that the existing pedestrian bridge be removed, and the stream lowered by approximately 2½ feet (previously noted as a short-term recommendation). Inlets were spaced at approximately 100 feet on the north and south side of Midland Avenue with three (3) existing city inlets being replaced. This work requires a permanent stormwater easement to be granted by Saint Katherines and would be a significant temporary interruption to the residents along this portion of Midland Avenue.

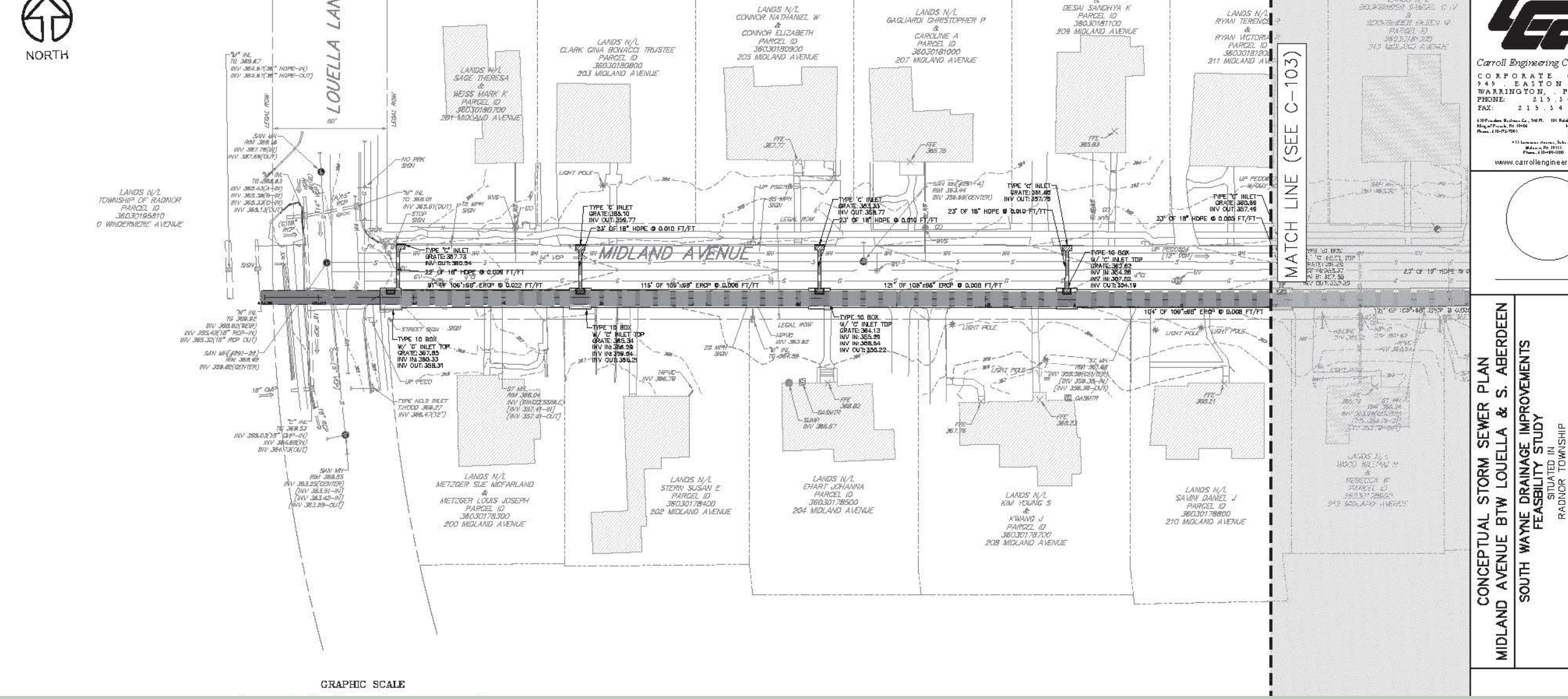


Carroll Engineering Corporation
CORPORATE OFFICE
949 EASTON ROAD
WARRINGTON, PA 18976
PHONE: 215.343.5700
FAX: 215.343.0875
www.carrollengineering.com

CONCEPTUAL STORM SEWER PLAN
MIDLAND AVENUE BTW LOUELLA & S. ABERDEEN

SOUTH WAYNE DRAINAGE IMPROVEMENTS
FEASIBILITY STUDY
SITUATED IN
RADNOR TOWNSHIP
PREPARED FOR
RADNOR TOWNSHIP
301 IVEN AVENUE
WAYNE, PENNSYLVANIA, 19087-5297

CONCEPTUAL STORM SEWER PLAN – MIDLAND AVENUE BETWEEN LOUELLA & S. ABERDEEN



CONCEPTUAL STORM SEWER PLAN – MIDLAND AVENUE BETWEEN LOUELLA & S. ABERDEEN

04 LONG TERM RECOMMENDATIONS

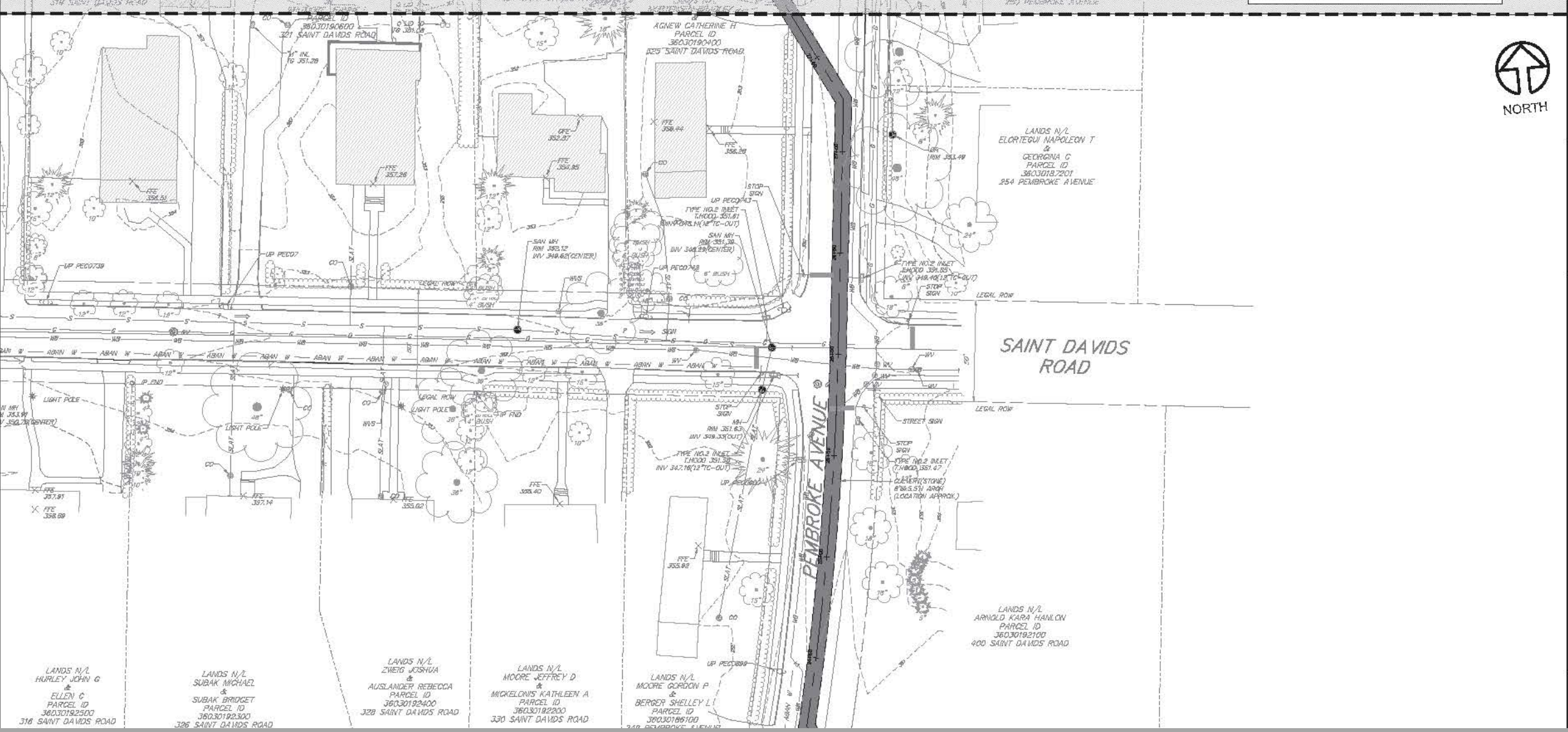
Replace Culvert Under Pembroke Avenue with larger Box Culvert

$2.5 to 2.75 million

The theoretical capacity of this stone culvert is just above 5-year peak flow rate and likely serves as a substantial “choke point” for flow along the stream. It is recommended that this closed conduit be ultimately replaced with a larger concrete box culvert beneath Pembroke Avenue. Since the alignment of the stream runs along Pembroke Avenue, options for open channel flow are not feasible without the Township acquiring private property from the adjacent residents.

The proposed box culvert would need to be approximately 15½ feet wide by 5½ feet in height to accommodate the 100-year peak flow rate. This project will likely need to be completed in phases with the first phase of the work focused on relocating miscellaneous utilities in the right-of-way to accommodate the eventual replacement.

Photo Courtesy of Wieser Concrete, 2022



EXISTING FEAURES PLAN – PEMBROKE AVENUE & SAINT DAVIDS ROAD

LONG TERM RECOMMENDATIONS

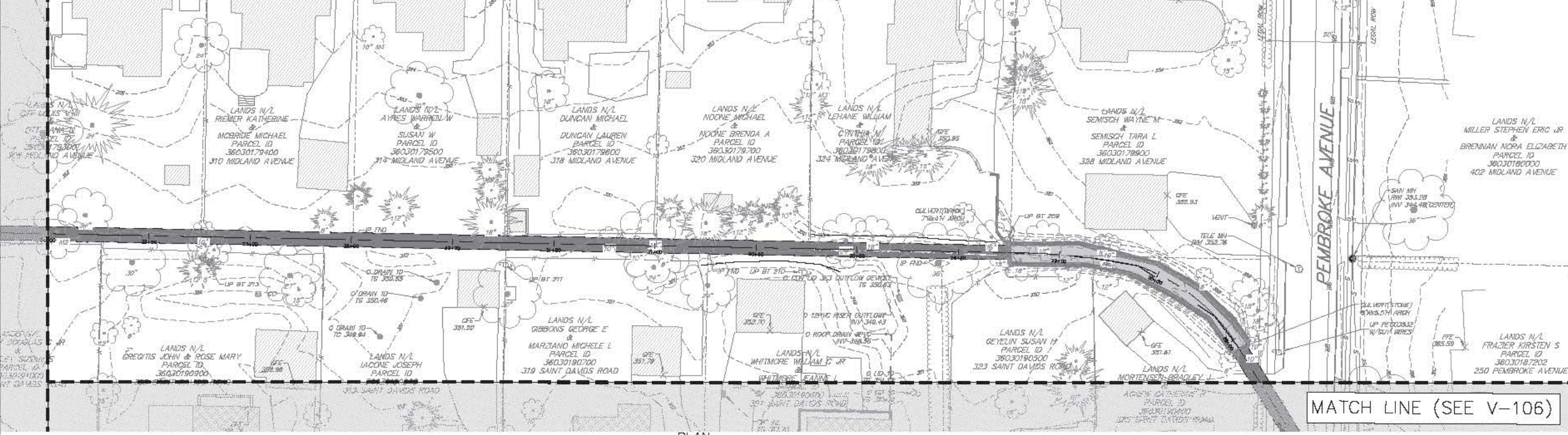
Replace Culvert Under Rear yards along Midland and Saint David's with open channel

$1 to 1.25 million

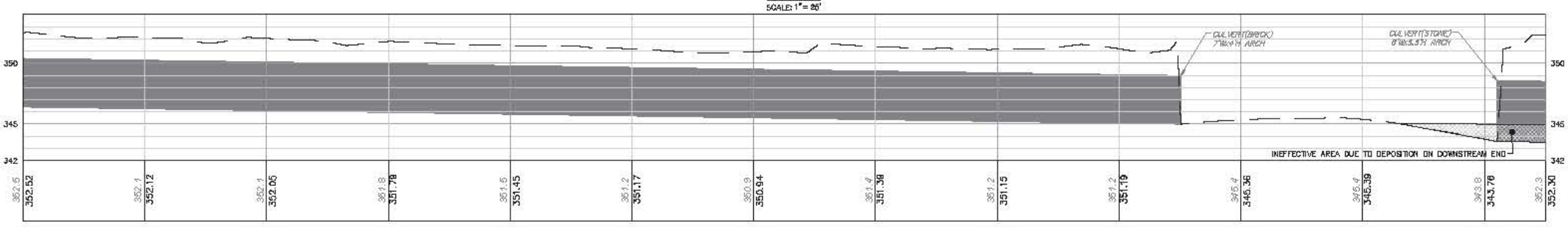
The theoretical capacity of this stone culvert falls below the 5-year peak flow rate and likely serves as a substantial "choke point" for flow along the stream. It is recommended that this closed conduit be ultimately replaced with an open channel having a bottom width of approximately 10½ feet, with 1:1 side slopes, and an approximate top width of 21½ feet.

Typically, new channels would be designed to have 3:1 side slopes or less to minimize any bank erosion and allow for ease of maintenance. However, there are number of existing features which are in close proximity to the stream which preclude the channel from having more gradual side slopes.

Photo Courtesy of Bussen-Mayer Engineering Group



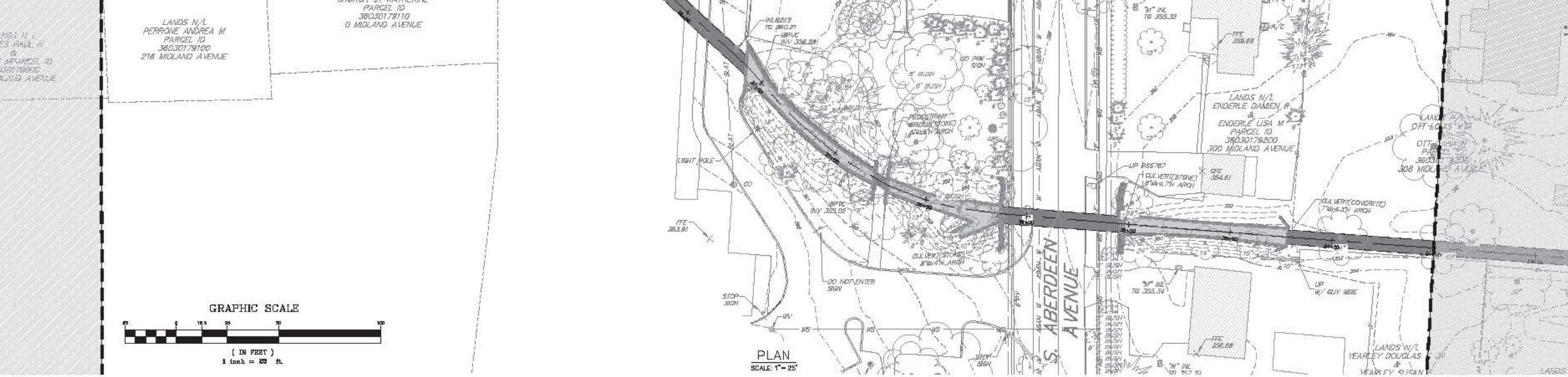
PLAN
SCALE: 1"= 25'



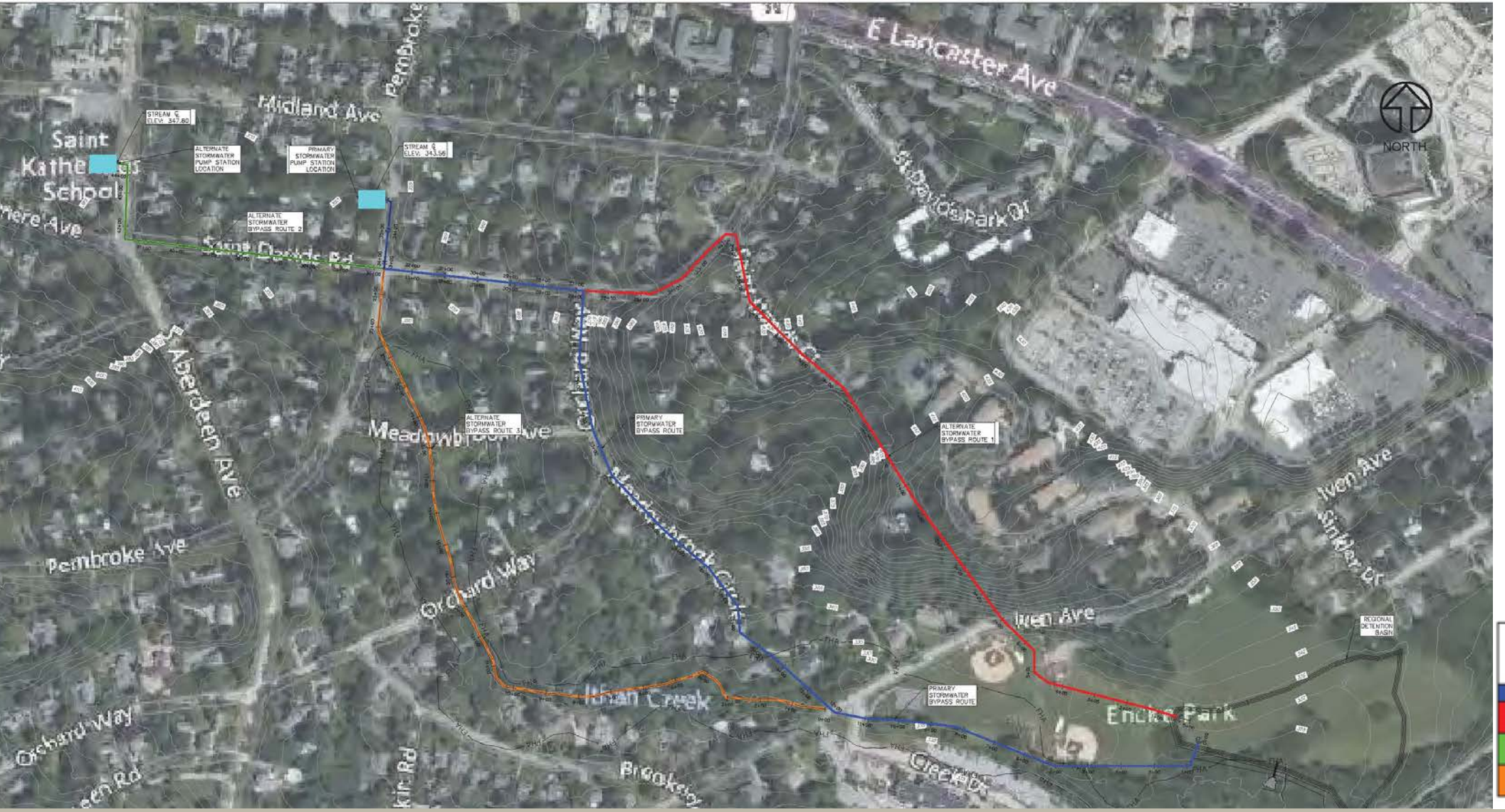
PRIMARY DRAINAGE PROFILE
SCALE: HORIZ 1"=25'
VERT 1"=5'

GRAPHIC SCALE
(IN FEET)
1 inch = 25 ft

EXISTING FEAURES PLAN – PEMBROKE AVENUE & MIDLAND AVENUE

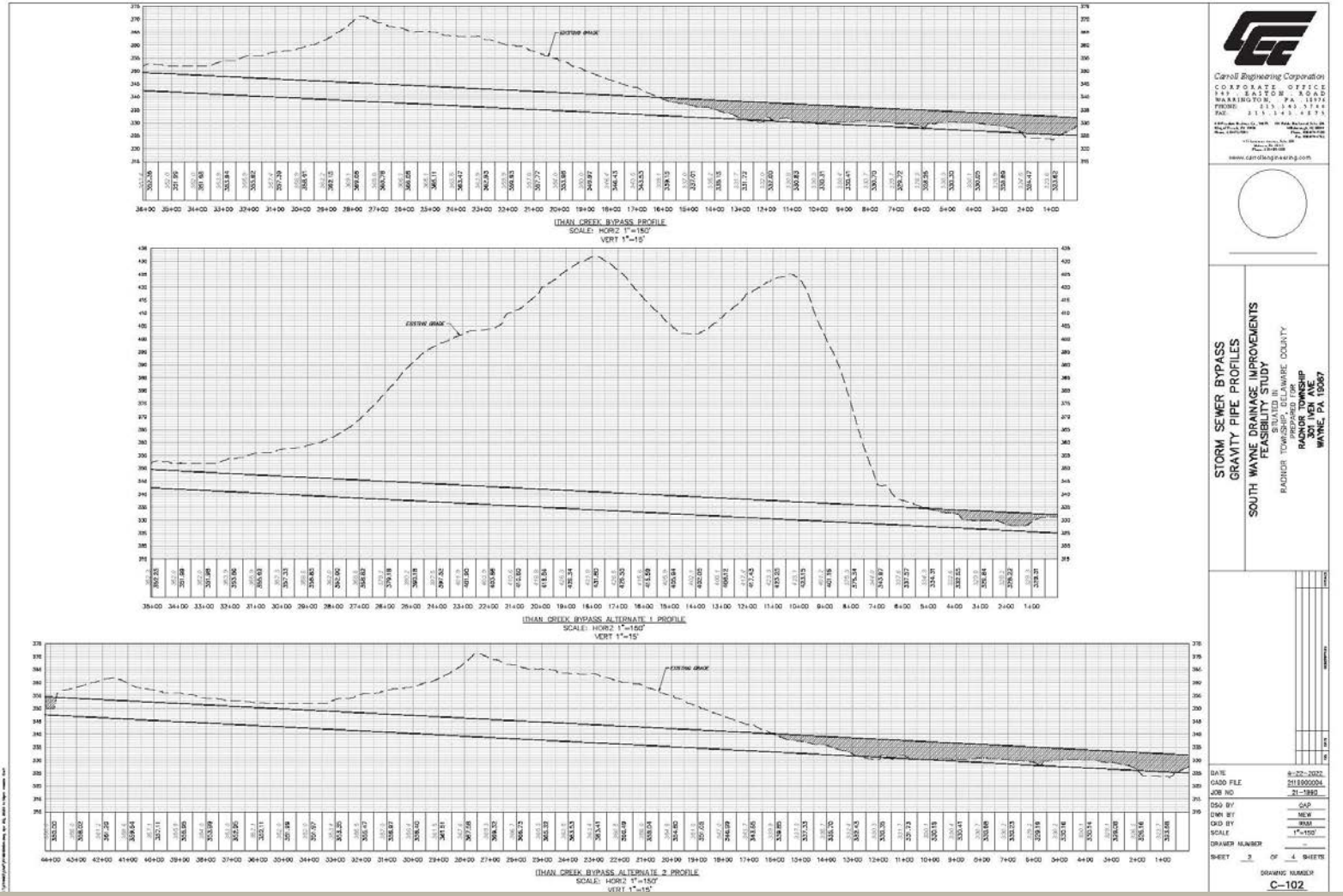


EXISTING FEAURES PLAN – SOUTH ABERDEEN AVENUE & MIDLAND AVENUE



	STORMWATER BYPASS SUMMARY TABLE		
		PIPE DIA. (IN)	TOTAL LENGTH
	PRIMARY BYPASS	84	3601 LF
	ALTERNATE BYPASS 1 (SAINT DAVIDS)	84	3506 LF
	ALTERNATE BYPASS 2 (SAINT KATHERINE'S PS LOCATION)	84	4422 LF
	ALTERNATE BYPASS 3 (PARALLEL TO ITHAN CREEK)	84	3818 LF

STORM SEWER BYPASS – CONCEPTUAL PLAN



STORM SEWER BYPASS – GRAVITY PIPE PROFILES

STORM SEWER BYPASS CONCLUSION

After careful consideration of the existing topography, **the storm water bypass** has been determined ***to not be feasible*** for a variety of reasons which are discussed in detail in the Feasibility Study. The major hinderances include issues **with constructability, insufficient hydraulic grade, and permitting limitations**. As such, this office would ***not recommend*** the Township commit further funding to the exploration of this alternative and instead focus efforts on making incremental improvements to the existing stream corridor.

05 CLOSING