Town of Ulysses

10 Elm Street

Trumansburg, NY 14886

ENGINEERING FEASIBILITY STUDY

for the

TOWN OF ULYSSES
CULVERT REPLACEMENT PROJECT

Project Picture (if available)

May 2024

MRB Group Project No. 2104.23002

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I. Executive Summary

A. Introduction

The Town of Ulysses has experienced issues with several culverts throughout the Town that have hydraulic limitations, are structurally compromised, or have aquatic connectivity issues. This report will evaluate six (6) of the existing culverts prioritized by the Town of Ulysses. The proposed improvements to the culverts will improve the flow of the waterways, improve public safety, and facilitate the movement of aquatic life while reducing erosion of the stream systems. The improvements will provide a cost-effective solution to correct the damage to Town facilities, such as roads and land within the Town Right of Way.

B. Project Location

The project involves the analysis of six (6) failing culverts within the Town of Ulysses. The culverts are located on the following streams within the Town (based on the roads in Ulysses they traverse):

- Tributary to Cayuga Lake (Minor Tribs to Cayuga Lake, Southwestern, PWL ID: 0705-0068)
  - Maplewood Road
  - Garrett Road
- Taughannock Creek Tributary (Taughannock Creek, Lower, and tribs, PWL ID: 0705-0069)
  - Agard Road
- Bolter Creek Tributary (Taughannock Creek, Upper, and tribs, PWL ID: 0705-0013)
  - Curry Road
- Taughannock Creek Tributary (Taughannock Creek, Upper, and tribs, PWL ID: 0705-0013)
  - Reynolds Road
  - Iradell Road

C. Project Need

The six (6) existing culverts evaluated all have characteristics that show they will need to be replaced. Several have proven to be undersized as residents and the Town have either witnessed where the flow has over-topped the roadway at the culvert crossing, or close to it. Due to the age of some of the culverts and the long-term impacts of road salt, some of the structures have deteriorated beyond repair. Several of the culverts have invert elevations that do not match the stream bed with large drops from the end of the culvert to the stream bed below. This creates scouring and erosion on the downstream side of the culvert and limits the movement of aquatic life along the stream. The closed-bottom culverts do not meet the New York State Department of Environmental Conservation (DEC) Best Management Practices (BMPs) for Stream Crossings requirements for embedment, which creates aquatic connectivity issues.

II. OBJECTIVES/PURPOSES OF THE PROJECT

The following project objectives have been identified for the design:

1. Structural improvements to meet current codes and standards.

   The current culverts have deteriorated beyond repair due to long-term exposure to road salt, age, as well as heavy stormwater flows causing erosion to supporting soils and stone materials. The culverts require improvements prior to further deterioration, which could create safety risks for vehicular traffic, as well as increase the impacts seen due to the insufficient capacity of these culverts.

2. Hydraulic improvements to meet current codes and standards:

   Several of the culverts have been proven to be undersized. Due to the increased intensity of storm events as well as possible unknown changes in upstream conditions, these culverts may be seeing flows beyond what was originally intended.

3. Improve aquatic connectivity in natural habitats:

   Currently, many culverts have various features that limit, or fully eliminate connectivity between natural habitats that may exist upstream and downstream of each culvert. These limitations include the lack of natural stream bedding within the culverts, as well as barriers to the passage of aquatic life due to large drops from the culvert outlet invert elevation to the stream bed below. The proposed improvements seek to address these issues where viable to benefit the natural habitats within the stream.

4. Minimize financial and maintenance impacts to the Town:

The proposed improvements to address the issues outlined above shall be designed to have minimal maintenance requirements, as well as an extended service life with sufficient durability to hold up to the traffic loads and conditions placed upon it. A cost-effective solution shall be developed to minimize the up-front cost, as well as the long-term cost due to maintenance and repairs.

III. Existing Conditions

The below describes the existing conditions of the culverts evaluated within each of the defined streams/tributaries. U.S. Geological Survey (USGS) StreamStats was used to generate peak flow statistics to analyze the hydraulic conditions for each of the existing culverts during various storm events. Hydraulic models were performed on each of the existing culverts to evaluate capacity during the 50-year and 100-year storm events generated by StreamStats. Existing condition drawings can be found within **Appendix B.**

A. Tributary to Cayuga Lake (Minor Tribs to Cayuga Lake, Southwestern, PWL ID: 0705-0068)

There are two (2) culverts within this defined tributary that were evaluated for this report.

1. Maplewood Road

The existing culvert at Maplewood Road was constructed in the early 1900s by the U.S. Army Corps of Engineers as described by Town personnel. This is a four-sided box culvert with an approximate 8’-11” span and 7’-9” rise. The culvert conveys runoff from a large waterfall upstream. The Town indicated they have never witnessed the road overtopped at this location or signs of flow limitations.

Upon a field investigation, several structural deficiencies were noted and are listed below:

- The north wing wall, on the upstream side of the box culvert, is displaying signs of failure, with the wing wall rotating away from the retained soil behind. The wall was measured to have up to a 1:12 slope past vertical.
- The upstream north wing wall is also experiencing horizontal cracking, along with material loss, along its face. In addition, a significant void has developed behind the wing wall.
- The upstream south wing wall is also in poor shape, with heavy spalling at the base

of the concrete section of wall and loose stone and concrete below the concrete gravity retaining block section of wall.

- The culvert ceiling has a noticeable deflection at midspan, with extensive cracking, concrete spalling and exposed reinforcement occurring along its length.
- Both walls of the box culvert have heavy concrete spalling with some loss of concrete at the wall face.
- .
- The concrete on the downstream side of the culvert is also in poor condition with exposed reinforcement, heavy concrete spalling, deep cracking, and loss of material along the exposed face of the walls..

The upstream and downstream invert elevations appear to closely resemble the elevation and slope of the stream bottom. The concrete on the bottom of the structure is exposed so there is no embedment of the natural stream bed substrate.

Please refer to Table III.1 below for additional information on the Maplewood Road existing culvert.

Table III.1: Maplewood Road Existing Culvert Structure Data

Data	Existing Structure
Structure Type & Material	Concrete Rectangular 4-Sided Box Culvert
Number of Culverts	1
Span (in.)	107
Rise (in.)	93
Culvert Length (ft.)	38
Slope (%)	4.58
Lane Width(s) (ft.)	11.5
Shoulder Width(s) (ft.)	N/A

Based on the StreamStats data and hydraulic modeling results for the existing Maplewood Road culvert, it was identified that the culvert is adequately sized for 50-year and 100-year storm events. The hydraulic modeling results can be found in **Appendix D**. Although the culvert appears to be appropriately sized hydraulically per the 100-year storm, the structural deficiencies and the lack of aquatic connectivity outlined above justify a full replacement. Photographs of the existing culvert are included in **Appendix E.** Non-Tidal

Aquatic Connectivity Crossing Data prepared by the North Atlantic Aquatic Connectivity Collaborative (NAACC) can be found in **Appendix F**.

Table III.2 below summarizes the data provided by StreamStats and the hydraulic modeling results for the existing Maplewood Road culvert.

Table III.2: Maplewood Road Existing Culvert Hydrologic and Hydraulic Analysis

Data	Existing Conditions
Drainage Area (square miles)	0.9
Low Shoulder/Edge of Pavement Elev.	419.83
Centerline Road Elev.	420.54
50-Year Storm Peak Flow (cfs)	234
50-Year Storm Water Elev.	412.69
100-Year Storm Peak Flow (cfs)	262
100-Year Storm Water Elev.	413.05

2. Garrett Road

The existing culvert at Garrett Road is comprised of several materials and sizes. The inlet side is circular concrete with a 54” inside diameter and portions lined with metal. The outlet side is corrugated metal pipe (CMP) with an elliptical shape. The rise is 49” and the span is 45.75”. The Town previously extended the culvert outlet outwards approximately 15’ to help prevent downstream erosion of the road shoulder. This is where the pipe material and size transition occur. The metal liner on the inside of the culvert is heavily corroded and the concrete on the bottom of the pipe is spalling with the aggregate exposed.

The concrete headwall on the upstream side of the concrete is still in a good, serviceable condition. When the Town extended the culvert on the outlet side, three (3) courses of approximately 36” tall gabion baskets were installed around the outlet. These gabion baskets have remained intact. The Town also installed rip-rap stone on the downstream side of the culvert to limit erosion. This stone has since been washed out and the stream bank has become heavily eroded on the downstream side of the culvert, requiring additional stabilization improvements.

There is nearly a 2' drop from the culvert outlet invert to the stream bed below. This is contributing to the erosion of the stream bank on the downstream side and creates a barrier to the passage of aquatic life. There is no embedment of the natural streambed material within the culvert which inhibits aquatic connectivity. Photographs of the existing culvert are included in **Appendix E.** Non-Tidal Aquatic Connectivity Crossing Data prepared by the NAACC can be found in **Appendix F**.

Please refer to Table III.3 below for additional information on the Garrett Road existing culvert.

Table III.3: Garrett Road Existing Culvert Structure Data

Data	Existing Structure
Structure Type & Material	Circular Concrete at Inlet Elliptical CMP at Outlet
Number of Culverts	1
Span (in.)	54 at Inlet 45.75 at Outlet
Rise (in.)	54 at Inlet 49 at Outlet
Culvert Length (ft.)	53
Slope (%)	5.09
Lane Width(s) (ft.)	10
Shoulder Width(s) (ft.)	3.5

Based on the StreamStats data and hydraulic modeling results for the existing Garrett Road culvert, it was identified that the culvert is adequately sized for 50-year and 100-year storm events. The hydraulic modeling results can be found in **Appendix D**. Although the culvert appears to be appropriately sized hydraulically per 100-year storm, the structural deficiencies, deteriorated condition of the pipe(s) and the lack of aquatic connectivity outlined above justify a full replacement.

Table III.2 below summarizes the data provided by StreamStats and the hydraulic modeling results for the existing Garrett Road culvert.

Table III.4: Garrett Road Existing Culvert Hydrologic and Hydraulic Analysis

Data	Existing Conditions
Drainage Area (square miles)	0.28
Low Shoulder/Edge of Pavement Elev.	630.45
Centerline Road Elev.	630.15
50-Year Storm Peak Flow (cfs)	62.5
50-Year Storm Water Elev.	626.83
100-Year Storm Peak Flow (cfs)	68.2
100-Year Storm Water Elev.	627.07

B. TAUGHANNOCK CREEK TRIBUTARY (TAUGHANNOCK CREEK, LOWER, AND TRIBS, PWL ID: 0705-0069)

There is one (1) culvert within this defined tributary that was evaluated for this report.

1. Agard Road

The existing culvert at Agard Road is an elliptical shaped corrugated metal pipe with a 65" span and a 46.5" rise. The culvert is starting to show some signs of corrosion on the bottom of the pipe. On the downstream side of the culvert there is a large area of tall cattails. The Town has noted that the culvert is hydraulically limited as the road has been overtopped at this crossing location multiple times within the last ten years. From their experience, a rain event of 2" – 4" within 12 hours typically causes significant hydraulic issues in the area which has the potential to further damage the roadway and other infrastructure.

The Agard Road existing culvert has some embedment of the natural streambed substrate. The existing upstream and downstream invert elevations appear to closely resemble the elevation and slope of the stream bottom. Photographs of the existing culvert are included in **Appendix E.** Non-Tidal Aquatic Connectivity Crossing Data prepared by the NAACC can be found in **Appendix F**.

Please refer to Table III.5 below for additional information on the Agard Road existing culvert.

Table III.5: Agard Road Existing Culvert Structure Data

Data	Existing Structure

Structure Type & Material	Elliptical CMP
Number of Culverts	1
Span (in.)	65
Rise (in.)	46.5
Culvert Length (ft.)	38
Slope (%)	0.34
Lane Width(s) (ft.)	10
Shoulder Width(s) (ft.)	3.5

Based on the StreamStats data and hydraulic modeling results for the existing Agard Road culvert, it was identified that the culvert is significantly undersized for 50-year and 100-year storm events. The model shows the road is overtopped during both storm events. The hydraulic modeling results can be found in **Appendix D**.

Table III.6 below summarizes the data provided by StreamStats and the hydraulic modeling results for the existing Agard Road culvert.

Table III.6: Agard Road Existing Culvert Hydrologic and Hydraulic Analysis

Data	Existing Conditions
Drainage Area (square miles)	1.82
Low Shoulder/Edge of Pavement Elev.	865.05
Centerline Road Elev.	865.76
50-Year Storm Peak Flow (cfs)	389
50-Year Storm Water Elev.	866.65
100-Year Storm Peak Flow (cfs)	442
100-Year Storm Water Elev.	866.77

C. Bolter Creek Tributary (Taughannock Creek, Upper, and tribs, PWL ID: 0705-0013)

There is one (1) culvert system within this defined tributary that was evaluated for this report.

1. Curry Road

The existing culvert at Curry Road consists of two (2) parallel culverts. Both culverts are elliptical shaped corrugated metal pipe with a 190” span and 120” rise. There is an approximate separation of 156” between the two (2) culverts. Based on the FEMA flood maps, these culverts do fall within the 100-year floodplain. Upon a field investigation, it was noted that one of the culverts has appeared to settle at the outlet. A section of this pipe had been cut out and removed in this area so that concrete could be poured in to alleviate some of the erosion and settlement that had occurred.

The Town has noted that these culverts are hydraulically limited. The stream has nearly overtopped the road before. From their experience, a rain event of 4” – 5” within 12 – 24 hours nearly overtops the road as documented with video of the event shared by the town.

The existing culverts at Curry Road have no embedment of natural stream bed substrate within the culverts which inhibits aquatic connectivity. The upstream inverts appear to closely resemble the elevation of the streambed. The downstream inverts have a vertical drop of at least 18” from the culvert outlet invert to the stream bottom below. This creates a barrier to the passage of aquatic life which was proven during the field investigation as a dead trout was found on the downstream side of the culvert. Photographs of the existing culvert are included in **Appendix E.** Non-Tidal Aquatic Connectivity Crossing Data prepared by the NAACC can be found in **Appendix F**.

Please refer to Table III.7 below for additional information on the Curry Road existing culverts.

Table III.7: Curry Road Existing Culvert Structure Data

Data	Existing Structure
Structure Type & Material	Elliptical CMP
Number of Culverts	2
Span (in.)	East Culvert: 190 West Culvert: 190
Rise (in.)	East Culvert: 120 West Culvert: 120
Culvert Length (ft.)	East Culvert: 59 West Culvert: 60
Slope (%)	East Culvert: 0.8 West Culvert: 1.9
Lane Width(s) (ft.)	10.5

Shoulder Width(s) (ft.)	1

Based on the StreamStats data and hydraulic modeling results for the existing Curry Road culverts, it was identified that the culverts are undersized for 50-year and 100-year storm events. The model shows the road is overtopped during the 100-year storm event. The hydraulic modeling results can be found in **Appendix D**.

Table III.8 below summarizes the data provided by StreamStats and the hydraulic modeling results for the existing Curry Road culvert.

Table III.8: Curry Road Existing Culvert Hydrologic and Hydraulic Analysis

Data	Existing Conditions
Drainage Area (square miles)	11.5
Low Shoulder/Edge of Pavement Elev.	948.27
Centerline Road Elev.	948.94
50-Year Storm Peak Flow (cfs)	1800
50-Year Storm Water Elev.	948.30
100-Year Storm Peak Flow (cfs)	2050
100-Year Storm Water Elev.	949.23

D. TAUGHANNOCK CREEK TRIBUTARY (TAUGHANNOCK CREEK, UPPER, AND TRIBS, PWL ID: 0705-0013)

There are two (2) culverts within this defined tributary that were evaluated for this report.

1. Reynolds Road

The existing culvert at Reynolds Road consists of two (2) parallel culverts. Both culverts are elliptical shaped riveted steel pipe with a 71.5" span and 63.5" rise. There is an approximate separation of 48" between the two (2) culverts. 24" stone blocks are set at the inlet side to act as a headwall. The center blocks between the two (2) culverts have started to settle and shift. The inside of both culverts are showing signs of corrosion. There is a buildup of debris on the inlet side of both pipes.

The Town has noted that these culverts are hydraulically limited. They have indicated that the stream has nearly overtopped the road before.

The existing culverts at Reynolds Road have some embedment of the natural streambed substrate. The existing upstream and downstream invert elevations appear to closely resemble the elevation and slope of the stream bottom. Photographs of the existing culvert are included in **Appendix E.** Non-Tidal Aquatic Connectivity Crossing Data prepared by the NAACC can be found in **Appendix F**.

Please refer to Table III.9 below for additional information on the Reynolds Road existing culvert.

Table III.9: Reynolds Road Existing Culvert Structure Data

Data	Existing Structure
Structure Type & Material	Elliptical Steel
Number of Culverts	2
Span (in.)	East Culvert: 71.5 West Culvert: 71.5
Rise (in.)	East Culvert: 63.5 West Culvert: 63.5
Culvert Length (ft.)	East Culvert: 48 West Culvert: 47
Slope (%)	East Culvert: 0.1 West Culvert: 0.3
Lane Width(s) (ft.)	10.5
Shoulder Width(s) (ft.)	N/A

Based on the StreamStats data and hydraulic modeling results for the existing Reynolds Road culverts, it was identified that the culverts are significantly undersized for 50-year and 100-year storm events. The model shows that the road is overtopped during both storm events. The hydraulic modeling results can be found in **Appendix D**.

Table III.10 below summarizes the data provided by StreamStats and the hydraulic modeling results for the existing Reynolds Road culverts.

Table III.10: Reynolds Road Existing Culvert Hydrologic and Hydraulic Analysis

Data	Existing Conditions
Drainage Area (square miles)	3.26
Low Shoulder/Edge of Pavement Elev.	1070.34
Centerline Road Elev.	1070.65
50-Year Storm Peak Flow (cfs)	697
50-Year Storm Water Elev.	1071.51
100-Year Storm Peak Flow (cfs)	792
100-Year Storm Water Elev.	1071.71

2. Iradell Road

The existing culvert at Iradell Road is an elliptical shaped riveted steel pipe with a 78.5” span and a 71” rise. The pipe appears to be from an old freight car petroleum containment vessel that was repurposed as a culvert pipe. The rivets at the midpoint of the pipe are corroded and falling apart.

There is nearly a 2’ drop from the culvert outlet invert to the stream bed below. This is contributing to erosion of the stream bank on the downstream side and creates a barrier to the passage of aquatic life. The deep pool at the downstream side of the culvert is evidence of this erosion. There is nearly no embedment of natural streambed material within the culvert which inhibits aquatic connectivity. The pipe inlet is lower than the stream level, causing rocks and debris to build up at the inlet. Photographs of the existing culvert are included in **Appendix E.** Non-Tidal Aquatic Connectivity Crossing Data prepared by the NAACC can be found in **Appendix F**.

Please refer to Table III.11 below for additional information on the Iradell Road existing culvert.

Table III.11: Iradell Road Existing Culvert Structure Data

Data	Existing Structure
Structure Type & Material	Concrete Rectangular 4-Sided Box Culvert
Number of Culverts	1
Span (in.)	78.5
Rise (in.)	71

Culvert Length (ft.)	72
Slope (%)	2.4
Lane Width(s) (ft.)	10
Shoulder Width(s) (ft.)	3.5

Based on the StreamStats data and hydraulic modeling results for the existing Iradell Road culvert, it was identified that the culverts are undersized for 50-year and 100-year storm events. While the road is not overtopped in the model during either storm events, the headwater depth exceeds what is defined as the allowable headwater in the Flood Risk Management Guidelines for Culverts on Non-Critical Highways in Exhibit 8-12 of Chapter 8 of the New York State Department of Transportation (NYSDOT) Highway Design Manual. The hydraulic modeling results can be found in **Appendix D**.

Table III.12 below summarizes the data provided by StreamStats and the hydraulic modeling results for the existing Iradell Road culvert.

Table III.12: Iradell Road Existing Culvert Hydrologic and Hydraulic Analysis

Data	Existing Conditions
Drainage Area (square miles)	1.09
Low Shoulder/Edge of Pavement Elev.	1120.01
Centerline Road Elev.	1120.73
50-Year Storm Peak Flow (cfs)	345
50-Year Storm Water Elev.	1119.14
100-Year Storm Peak Flow (cfs)	394
100-Year Storm Water Elev.	1120.85

IV. PROJECT DESCRIPTION

A. DESIGN OBJECTIVES

The project being undertaken by the Town involves the rehabilitation/reconstruction of the above-described existing culverts. As described in Section II, the possible solutions for each culvert are to provide structural integrity, sufficient capacity for expected flows and high-flow events up to the 100-year intensity event, provide connectivity between natural habitat areas, and be cost effective for the Town in the short and long term. The objective is for the designed crossing to replicate the stream's natural conditions, where allowable.

B. Culvert Design and Installation Recommendations

The New York State Department of Environmental Conservation (NYSDEC) has developed a list of Best Management Practices (BMPs) for Stream Crossings. These recommendations are used to assist with the design, installation, and replacement of stream crossings to protect stream continuity and to maintain healthy habitat for fish and wildlife. See **Appendix G** for the NYSDEC's BMPs for Stream Crossings. Some of the design installation and recommendations are as follows:

<u>Width</u>

The crossing opening should be 1.25 times the normal width of the streambed, measured bank to bank at ordinary high water level or to the edges of terrestrial, rooted vegetation.

<u>Natural Substrate</u>

The natural substrate used in the crossing should match those found up and downstream and resist displacement from natural flows and during levels of high water or floods. Metal and concrete are not appropriate materials for species that travel along the streambed. Additionally, closed bottom culverts such as four-sided concrete box culverts or circular culverts must be embedded to at least 20 percent of the culvert height at the downstream invert with natural substrate. Embedded culverts must be installed in flat streambeds, where the slope is not steeper than 3 percent.

Additional culvert design recommendations were used from Chapter 8 – Highway Drainage of the NYSDOT Highway Design Manual. Section 8.6 covers the design of culverts. Some of the design criteria that was used to assist with the conceptual design of the proposed culverts are as follows:

<u>Allowable Headwater</u>

Allowable headwater (AHW) is defined as the maximum depth of water which can be tolerated at the inlet of the culvert. It is measured from the elevation at the inlet of the culvert to the water surface necessary to achieve the hydraulic design requirements at the location. The AHW is defined in Exhibit 8-12 – Flood Risk Management Guidelines for Culverts in Chapter 8 of the NYSDOT Highway Design Manual. The guidance criteria used is for non-critical highways. Critical roadways are defined by the NYSDOT as part of a designated evacuation route or provide sole access to any of the following facilities where practical detour routes are not available in case of loss or closure:

- Facilities designed for bulk storage of chemicals, petrochemicals, hazardous or toxic substances or floatable materials.
- Hospitals, rest homes, correctional facilities, dormitories, patient care facilities.
- Major power generation, transmission, or substation facilities.
- Major communications centers, such as civil defense centers.
- Major emergency service facilities, such as central fire and police stations.

None of the culverts evaluated for this report appear to be along roadways that fall within the definitions outlined above. Table IV.1 below summarizes the guidance criteria that was used from Exhibit 8-12 for culverts along non-critical highways from the NYSDOT Highway Design Manual.

Table IV.1: NYSDOT Flood Risk Management Guidelines for Culverts

Design/Checked Flood Frequency (Years)	**Guidance Criteria**			
	Rise D ≥ 5 ft.		**Rise D < 5 ft.**	
	Allowable Headwater /Depth Ratio (AHW/D)	**Check Elevation (ft)**	**Allowable Headwater /Depth Ratio (AHW/D)**	**Check Elevation (ft)**
50 Design	≤1 for D > 5 ft. ≤1.2 for D = 5 ft.	--	≤1.5 for D ≤4 ft. ≤1.2 for D > 4 ft. < 5ft.	--
100 Check	--	Below bottom of subbase[1]	--	Below bottom of subbase[1]

Notes:

1. Where the elevation of the subbase is not known, two feet below the low shoulder for non-critical culverts or three feet below the low shoulder for critical culverts may be used as the check storm elevation.

A summary of the results for the existing and proposed culverts based on the NYSDOT Flood Risk Management Guidelines for Culverts can be found in **Appendix H** and

Appendix I, respectively.

Culvert Design Life

The culvert design life is defined in Chapter 8 of the NYSDOT Highway Design Manual as the number of years of in-service performance which the pipe is desired to provide. The design life is assigned by location and takes the following factors into consideration:

- The initial cost of the pipe material, installation, backfill, etc.
- The cost to rehabilitate or replace.
- Disruption to traffic during rehabilitation or replacement once an installation reaches the end of its design life.

The culvert design lives that should be considered based on the type of crossing according to Chapter 8 of the NYSDOT Highway Design Manual is summarized in Table IV.2 below.

Table IV.2: NYSDOT Culvert Location Design Lives

Location	Design Life (Years)
Driveways	20
Significant Locations[1]	70
Other Locations	50

Notes:

1. Significant locations are defined as follows:
   a. Highways functionally classified as interstates and other freeways.
   b. Natural watercourses, or channels, such as perennial streams.
   c. Under high fills ≥15 ft.
   d. Locations with high traffic volumes.
   e. Locations where long detours would be required if the culvert failed.

C. CULVERT TYPES

Various culvert materials and types were evaluated for cost effectiveness and longevity. Anticipated service life is provided for each culvert type, but is based on the NYSDOT Highway Design Manual, Chapter 8 – Highway Drainage. The actual anticipated service life will vary based on the conditions each culvert is installed at including but not limited to, the abrasive stream bed loads, velocity of the stream, corrosive soils or water, and coating/gauge thickness of metal. Due to the required culvert sizes for each, some culvert types were eliminated from the proposed selection for each.

Three-Sided Concrete Box Culvert

Three-sided box culverts are comprised of steel reinforced concrete. They are versatile with an anticipated service life of 70 years. Their shape maximizes the flow area for its span and height. They have a minimum cover requirement of around 2', so can be used in areas where there is limited cover. Three-sided box culverts typically have low maintenance costs. Due to the fact they are three-sided, there are no embedment requirements.

The disadvantages of three-sided concrete box culverts are that they require the installation of footings which involve deeper excavations and larger equipment. This and the structure itself typically yield a higher construction cost.

Structural Plate Arch Culvert

Structural plate arch culverts are offered in either steel or aluminum. They have an anticipated service life of 50 years or higher, depending on the material and type of coating used. The structural plates are advantageous for locations with shipment limitations. Arch culverts provide flow characteristics of a circular pipe, with a reduced height at sites with limited cover. The minimum cover height for arch culverts is around 1.5'. The cost is typically lower when compared to the cost of a concrete box culvert. Structural plate arch culverts have no bottom, so the natural stream bottom is used, therefore they do not have any embedment requirements.

The disadvantages of structural plate arch culverts are that they require the installation of large footings. They have a smaller flow area for their span and rise when compared to box culverts. While there is an extensive list of sizes that are offered, the maximum span to rise ratio for arch culverts is higher than it is for concrete box culverts, so the flow area is maximized more with concrete box culverts on sites with low cover.

Structural Plate Box Culvert

Structural plate box culverts are offered in either steel or aluminum. They have an anticipated service life of 50 years or higher, depending on the material and type of coating used. Structural plate box culverts are relatively flat across the top and offer a low height with a wide profile. This shape provides a larger flow area based on the span and rise when compared to structural plate arch culverts. The minimum cover height for structural plate box culverts is around 1.5’. Structural plate box culverts come at a lower cost in comparison to concrete box culverts. This type of culvert does not have a bottom to the structure, so the natural stream bottom is used, meaning they do not have any embedment requirements.

The disadvantages of structural plate box culverts are that they require the installation of large footings. While they do have a large flow area, it is still lower when compared to concrete box culverts. The maximum span to rise ratio for structural plate box culverts is still higher than it is for concrete box culverts, so the flow area is maximized more with concrete box culverts on sites with low cover.

<u>Four-Sided Concrete Box Culvert</u>

Four-sided concrete box culverts are comprised of steel reinforced concrete. They have an anticipated service life of 70 years. Their shape maximizes the flow area for its span and height. The minimum cover height is around 2. Four-sided concrete box culverts are resilient and typically have low maintenance costs. They do not normally require the installation of footings which minimizes excavation and construction duration.

The disadvantages of four-sided box culverts are that they have a closed bottom. Based on the New York State Department of Environmental Conservation’s (NYSDEC) Best Management Practices (BMPs) for Stream Crossings, closed bottom culverts must be installed in only flat streambeds, where the slope is not steeper than 3% and be embedded to at least 20% of the culvert height at the downstream invert. The maximum slope requirements limit the locations where these types of culverts can be installed. The embedment requirements cause the structure to be oversized to meet the needed flow area after embedment.

<u>Circular/Elliptical Culvert</u>

Circular/elliptical culverts can be manufactured from various materials such as metal, plastic, and concrete. The anticipated service life is variable but typically ranges from 25 to 70 years. Of culvert options evaluated, circular/elliptical culverts have the lowest cost and are the fastest to install. These factors typically make this type of culvert the most efficient for small intermittent streams.

The disadvantages of circular/elliptical culverts are that they typically require more cover

over the pipe to accommodate vehicle loadings. Since circular/elliptical culverts have a closed bottom, they must follow the NYSDEC's BMPs for Stream Crossings. The maximum slope requirements limit the locations where these types of culverts can be installed. To meet the embedment requirements, the pipes need to be oversized to meet the needed flow area after embedment. Smaller circular/elliptical culverts can be difficult to embed. The NYSDEC's BMPs for Stream Crossings also recommend the width of the crossing is 1.25 times the normal width of the streambed. At larger spans the rise heights are either the same (if circular) or still large, which does not fit for all crossings.

D. Hydrologic and Hydraulic (H&H) Analysis

An H&H analysis was conducted for all six (6) crossing locations. The hydrologic portion determines the amount of runoff contributing to each location evaluated while the hydraulic analysis determines the ability of the culvert and the contributing drainage area to convey the runoff through the crossing. The H&H analysis as well as the NYSDEC and NYSDOT guidelines outlined above were used to conceptually size the proposed culvert replacements.

Hydrology Methodology and Input Parameters

StreamStats utilizes USGS data to develop the drainage basin boundary and basin characteristics for an identified location. StreamStats provides estimates of various streamflow statistics for the selected location by solving regression equations. The regression equations are developed through a process, known as regionalization, which involves the use of regression analysis to relate streamflow statistics computed for a group of selected stream gauges, that are typically within the same state, to basin characteristics measured for the stream gauges. The basin characteristics that were measured by StreamStats are entered into the resulting equations to develop estimates for the streamflow statistics for ungauged sites. The StreamStats report for each crossing location evaluated can be found in **Appendix D**.

Hydraulic Analysis

Hydraflow Express Extension for Autodesk Civil 3D by Autodesk, Inc. was used to model each of the existing culverts evaluated and to size the proposed replacement culverts. The peak flow statistics provided by StreamStats were used to obtain the 50-year and 100-year storm runoff rates at each crossing location. The existing conditions used to develop the model were gathered by a field survey. Each existing culvert was modeled with 50-year and

100-year flows to check to see if the road was overtopped. The headwater depths generated in the model were also compared to the AHW provided in Chapter 8 of the NYSDOT Highway Design Manual. The modeling results of the existing culverts during 50-year and 100-year storms can be found in **Appendix D**.

The proposed culvert replacements were sized to accommodate the 50-year and 100-year storm events as well as the NYSDOT and NYSDEC guidelines. Models were developed for the proposed culverts using Hydraflow Express. The modeling results of the proposed culverts during 50-year and 100-year storm events can be found in **Appendix D**.

1. Maplewood Road

The Maplewood Road culvert is at the lowest elevation and the closest to Cayuga Lake. The hydraulic analysis of the existing culvert identified that the culvert is adequately sized. Field investigation of the existing culvert proved it is structurally compromised and will need to be replaced. The downstream side of the culvert is connected to a precast retaining wall maintained by private residents, so the span of the new culvert will need to match existing.

The proposed culvert replacement is a concrete rectangular three-sided box culvert with a 9’-0” span and 8’-8” rise with concrete headwalls on the inlet and outlet side of the culvert and concrete wingwalls on the inlet side.

Please refer to Table IV.3 below for additional information on the Maplewood Road proposed culvert.

Table IV.3: Maplewood Road Proposed Culvert Structure Data

Data	Proposed Structure
Structure Type & Material	Concrete Rectangular 3-Sided Box Culvert
Number of Culverts	1
Span (in.)	108
Rise (in.)	104
Culvert Length (ft.)	38
Slope (%)	4.58
Streambed Width (ft.)	N/A
Minimum Required	N/A

Culvert Width[1] (ft.)	

Notes:

1. The NYSDEC's BMPs for Stream Crossings recommends the width of the crossing is 1.25 times the width of the streambed.

A concrete box was selected as the preferred replacement option to match the existing culvert geometry. A three-sided box culvert was selected over a four-sided box culvert to avoid the 20 percent embedment requirements that are outlined in the NYSDEC's BMPs for Stream Crossings. The natural bottom substrate in the culvert will improve aquatic connectivity of the stream.

Table IV.4 below summarizes the data provided by StreamStats and the hydraulic modeling results for the Maplewood Road culvert.

Table IV.4: Maplewood Road Proposed Culvert Hydrologic and Hydraulic Analysis

Data	Proposed Conditions
Drainage Area (square miles)	0.9
Low Shoulder/Edge of Pavement Elev.	419.83
Centerline Road Elev.	420.54
50-Year Storm Peak Flow (cfs)	234
50-Year Storm Water Elev.	412.63
100-Year Storm Peak Flow (cfs)	262
100-Year Storm Water Elev.	412.98

The hydraulic modeling results can be found in **Appendix D**.

2. Garrett Road

The Garrett Road culvert is the furthest upstream culvert within the tributary to Cayuga Lake of those evaluated. The hydraulic analysis of the existing culvert identified that the culvert is adequately sized. The field investigation of the culvert identified that it is structurally compromised due to corrosion and spalling of the concrete. These factors prove the existing culvert will need to be replaced.

The proposed culvert replacement is a structural plate arch with a 7'-0" span and a 2'-4 ½" rise with a concrete headwall and wingwalls on the inlet side.

Please refer to Table IV.5 below for additional information on the Garrett Road proposed culvert.

Table IV.5: Garrett Road Proposed Culvert Structure Data

Data	Proposed Structure
Structure Type & Material	Structural Plate Arch Culvert
Number of Culverts	1
Span (in.)	84
Rise (in.)	28.5
Culvert Length (ft.)	53
Slope (%)	8.34
Streambed Width (in.)	N/A
Minimum Required Culvert Width[1] (in.)	N/A

Notes:

1. The NYSDEC's BMPs for Stream Crossings recommends the width of the crossing is 1.25 times the width of the streambed.

A structural plate arch was selected as the preferred replacement option due to it being the most economical option that would still meet the criteria for the NYSDEC and NYSDOT. A circular culvert was considered but would need to be embedded to a minimum of 20 percent of the downstream invert, so the pipe would need to be oversized. Additionally, the streambed slope must be less than 3 percent for embedded culverts. This cannot be accommodated at this crossing location without greatly revising the elevations of the stream and upstream drainage conditions.

The existing culvert is prohibitive to aquatic connectivity due to there being no embedment and the nearly 2' vertical drop from the culvert outlet invert to the stream bed below. The proposed culvert will improve aquatic connectivity by lowering the culvert outlet invert to match the streambed elevation more closely and by providing a natural bottom substrate through the crossing.

Table IV.4 below summarizes the data provided by StreamStats and the hydraulic modeling results for the Garrett Road culvert.

Table IV.6: Garrett Road Proposed Culvert Hydrologic and Hydraulic Analysis

Data	Proposed Conditions
Drainage Area (square miles)	0.28
Low Shoulder/Edge of Pavement Elev.	630.45
Centerline Road Elev.	630.15
50-Year Storm Peak Flow (cfs)	62.5
50-Year Storm Water Elev.	626.46
100-Year Storm Peak Flow (cfs)	68.2
100-Year Storm Water Elev.	626.69

The hydraulic modeling results can be found in **Appendix D**.

3. Agard Road

The existing culvert at Agard Road has proven to be the most hydraulically limited culvert based on the results of the hydraulic model and from the Town witnessing the road overtopped several times within the last ten years at this crossing.

The proposed culvert replacement is a concrete rectangular three-sided box culvert with a 19'-6" span and a 3'-9" rise with concrete wingwalls on the inlet side of the culvert.

Please refer to Table IV.7 below for additional information on the Agard Road proposed culvert.

Table IV.7: Agard Road Proposed Culvert Structure Data

Data	Proposed Structure
Structure Type & Material	Concrete Rectangular 3-Sided Box Culvert
Number of Culverts	1
Span (in.)	234
Rise (in.)	45
Culvert Length (ft.)	70

Slope (%)	0.34
Streambed Width (in.)	84
Minimum Required Culvert Width[1] (in.)	105

Notes:

1. The NYSDEC's BMPs for Stream Crossings recommends the width of the crossing is 1.25 times the width of the streambed.

The Agard Road crossing has limited cover from the streambed to the road. To maximize the flow area at this crossing, a concrete box culvert was selected as the preferred replacement option. A three-sided concrete box culvert was selected over a four-sided concrete box culvert to avoid the embedment requirements that would have caused the culvert to be oversized.

The existing culvert does not meet the minimum required culvert width as outlined in the NYSDEC guidelines. The proposed culvert exceeds the minimum required width by over a factor of two (2). The reason for this is to attempt to meet the NYSDOT Flood Risk Management Guidelines for Culverts as outlined in Table IV.1. These guidelines recommend that the Allowable Headwater/Depth (AHW/D) ratio is less than 1.5 during a 50-year storm event for culverts with a rise less than 4'. The proposed culvert meets this recommendation.

The recommendation for a 100-year storm event is for the headwater elevation to not reach a level higher than the bottom of the subbase material for the road, or 2' below the low shoulder at the crossing if the bottom of the subbase is not known. Since the elevation of the bottom of the subbase is not known at this crossing, 2' below the low shoulder elevation was used as the check elevation.

Based on the hydraulic model of the proposed culvert, the 100-year storm headwater elevation exceeds the 100-year check elevation. This is with the culvert at the maximum span, before being classified as a bridge, which would create additional costs to comply with additional New York regulations, that may provide minimal to any additional benefit. A larger span would not only classify the proposed culvert replacement as a bridge but would also then exceed the maximum recommended span to rise ratio. Therefore, the culvert rise would need to be increased, which would exceed the maximum rise allowed to establish the minimum recommended cover over the culvert. Even with the check elevation exceeded based on the hydraulic model of the proposed culvert, the 100-year headwater elevation is over 1' below the low edge of pavement elevation at the crossing making it a suitable selection although not 100% aligning with reference standards.

Table IV.8 below summarizes the data provided by StreamStats and the hydraulic modeling results for the Agard Road culvert.

Table IV.8: Agard Road Proposed Culvert Hydrologic and Hydraulic Analysis

Data	Proposed Conditions
Drainage Area (square miles)	1.82
Low Shoulder/Edge of Pavement Elev.	865.05
Centerline Road Elev.	865.76
50-Year Storm Peak Flow (cfs)	389
50-Year Storm Water Elev.	863.92
100-Year Storm Peak Flow (cfs)	442
100-Year Storm Water Elev.	864.13

The hydraulic modeling results can be found in **Appendix D**.

4. Curry Road

The Curry Road crossing is shown to see the most flow of all the crossings evaluated based on the StreamStats data. The hydraulic model has proven that the existing culvert is undersized.

The proposed culvert replacement is a concrete rectangular three-sided box culvert with a 27'-0" span and a 9'-0" rise with concrete wingwalls on the inlet and outlet side of the culvert.

Please refer to Table IV.9 below for additional information on the Curry Road proposed culvert.

Table IV.9: Curry Road Proposed Culvert Structure Data

Data	Proposed Structure
Structure Type & Material	Concrete Rectangular 3-Sided Box Culvert
Number of Culverts	1
Span (in.)	324
Rise (in.)	108
Culvert Length (ft.)	60
Slope (%)	4.58
Streambed Width (in.)	222
Minimum Required Culvert Width[1] (in.)	278

Notes:

1. The NYSDEC's BMPs for Stream Crossings recommends the width of the crossing is 1.25 times the width of the streambed.

Due to the high runoff that this culvert needs to convey, a concrete box culvert was selected as the preferred replacement option to maximize the flow area. This reduces the width and overall footprint of the proposed culvert while still conveying the necessary flows. A three-sided concrete box culvert was selected over a four-sided concrete box culvert to avoid the embedment requirements that would have caused the culvert to be oversized.

The proposed culvert exceeds the minimum required culvert width as outlined by the NYSDEC guidelines. The NYSDOT Flood Risk Management Guidelines for Culverts are met for the AHW/D ratio for 50-year storm events and the check elevation is not exceeded during a 100-year storm event based on the hydraulic model.

As outlined in the existing conditions for the Curry Road culvert, the crossing has been prohibitive to aquatic connectivity. The existing culverts have no embedment, and the downstream inverts have a vertical drop of at least 18" from the culvert outlet invert to the stream bottom below, which creates a barrier to the passage of aquatic life through the crossing. The proposed culvert will improve aquatic connectivity by lowering the culvert outlet invert to match the streambed elevation more closely and by providing a natural bottom substrate through the crossing.

Table IV.10 below summarizes the data provided by StreamStats and the hydraulic modeling results for the Curry Road culvert.

Table IV.10: Curry Road Proposed Culvert Hydrologic and Hydraulic Analysis

Data	Proposed Conditions
Drainage Area (square miles)	11.5
Low Shoulder/Edge of Pavement Elev.	948.27
Centerline Road Elev.	948.94
50-Year Storm Peak Flow (cfs)	1800
50-Year Storm Water Elev.	945.49
100-Year Storm Peak Flow (cfs)	2050
100-Year Storm Water Elev.	946.22

The hydraulic modeling results can be found in **Appendix D**. With increasing the hydraulic capacity of this culvert, the Town should perform a Drainage Area Assessment both upstream/downstream prior to any improvements to understand any hydraulic impacts. It is expected that both NYSDEC and USACE would require this analysis giving its location within the flood plain.

5. Reynolds Road

The hydraulic model for the existing Reynolds Road culvert has proven that it is undersized.

The proposed culvert replacement is a concrete rectangular three-sided box culvert with a 19’-6” span and a 6’-6” rise with concrete wingwalls on the inlet and outlet side of the culvert.

Please refer to Table IV.11 below for additional information on the Reynolds Road proposed culvert.

Table IV.11: Reynolds Road Proposed Culvert Structure Data

Data	Proposed Structure
Structure Type & Material	Concrete Rectangular 3-Sided Box Culvert
Number of Culverts	1
Span (in.)	234
Rise (in.)	78
Culvert Length (ft)	48
Slope (%)	0.65
Streambed Width (in.)	185
Minimum Required Culvert Width[1] (in.)	231

Notes:

1. The NYSDEC's BMPs for Stream Crossings recommends the width of the crossing is 1.25 times the width of the streambed.

The Reynolds Road crossing has limited cover from the streambed to the road. Based on the NYSDEC guidelines for the minimum required crossing width along with the NYSDOT Flood Risk Management Guidelines for Culverts, maximizing the flow area with a concrete box culvert is most practical to avoid a span that would classify the culvert as a bridge, which would create additional costs to comply with additional New York regulations.

The existing culverts at the Reynolds Road crossing have minimal embedment. The proposed culvert replacement will have natural bottom substrate along the crossing which will improve the aquatic connectivity of the stream.

Table IV.12 below summarizes the data provided by StreamStats and the hydraulic modeling results for the Reynolds Road culvert.

Table IV.12: Reynolds Road Proposed Culvert Hydrologic and Hydraulic Analysis

Data	Proposed Conditions
Drainage Area (square miles)	3.26
Low Shoulder/Edge of Pavement Elev.	1070.34
Centerline Road Elev.	1070.65
50-Year Storm Peak Flow (cfs)	697
50-Year Storm Water Elev.	1067.84
100-Year Storm Peak Flow (cfs)	792
100-Year Storm Water Elev.	1068.30

The hydraulic modeling results can be found in **Appendix D**.

6. Iradell Road

The hydraulic model of the existing Iradell Road culvert identified the culvert is undersized.

The proposed culvert replacement is a structural plate arch with a 15’-0” span and a 6’-1 ½“ rise.

Please refer to Table IV.13 below for additional information on the Iradell Road proposed culvert.

Table IV.13: Reynolds Road Proposed Culvert Structure Data

Data	Proposed Structure
Structure Type & Material	Structural Plate Arch Culvert
Number of Culverts	1

Span (in.)	180
Rise (in.)	73.5
Culvert Length (ft)	72
Slope (%)	4.68
Streambed Width (in.)	144
Minimum Required Culvert Width[1] (in.)	180

Notes:

1. The NYSDEC's BMPs for Stream Crossings recommends the width of the crossing is 1.25 times the width of the streambed.

The proposed culvert width was selected based on the NYSDEC's guidelines for the minimum required crossing width. Due to there not being a limited amount of cover from the streambed to the road surface and the ability to pass a large volume of flow through the minimum required width, a structural plate arch culvert was found to be the most economical option, since maximizing the flow area with a box culvert is not necessary.

A circular culvert was considered but would need to be embedded to a minimum of 20 percent of the downstream invert, so the pipe would need to be oversized. Additionally, the streambed slope must be less than 3 percent for embedded culverts. Based on the existing slope along the crossing, this cannot be accommodated without revising the elevations of the stream.

The existing culvert is prohibitive to aquatic connectivity due to there being no embedment and the nearly 2' vertical drop from the culvert outlet invert to the stream bed below. The proposed culvert will improve aquatic connectivity by lowering the culvert outlet invert to match the streambed elevation more closely and by providing a natural bottom substrate through the crossing.

Table IV.14 below summarizes the data provided by StreamStats and the hydraulic modeling results for the Iradell Road culvert.

Table IV.14: Iradell Road Proposed Culvert Hydrologic and Hydraulic Analysis

Data	Proposed Conditions
Drainage Area (square miles)	3.26

Low Shoulder/Edge of Pavement Elev.	1070.34
Centerline Road Elev.	1070.65
50-Year Storm Peak Flow (cfs)	697
50-Year Storm Water Elev.	1067.84
100-Year Storm Peak Flow (cfs)	792
100-Year Storm Water Elev.	1068.30

The hydraulic modeling results can be found in **Appendix D**.

V. ANTICIPATED REGULATORY APPROVALS AND PERMITS

The following are the anticipated regulatory permits and approvals required for the culvert replacements:

1. State Environmental Quality Review (SEQR)

   SEQR is required under 6NYCRR Part 617. Culvert replacement projects are typically considered Type II Actions under SEQR and may require completion of Part 1 of a Short Environmental Assessment Form.

2. Section 404 General Permit (USACE)

   The U.S. Army Corps of Engineers (USACE) under Section 404 of the Clean Water Act is responsible for evaluating the discharge of dredged or fill material into waters and/or vegetated wetlands of the United States. Most culvert replacements with minimal adverse environmental impacts are covered under a general nationwide permit. Typically, culvert replacements are covered under USACE Nationwide Permit #3 – Maintenance. This is defined by the USACE as:

   - The repair, rehabilitation, or replacement of any previously authorized, currently serviceable structure or fill, provided that the structure or fill is not to be put to uses differing from those uses specified or contemplated for it in the original permit of the most recently authorized modification.

3. Section 401 Water Quality Certification (NYSDEC):

   Under Section 401 of the Clean Water Act, a federal agency may not issue a permit or license to conduct any activity that may result in any discharge into waters of the United

States, unless a Section 401 Water Quality Certification (WQC) is issued, verifying compliance with state water quality requirements.

In New York, the NYSDEC is responsible for approving or denying a WQC for USACE Section 404 Nationwide Permits. Nationwide Permit #3 is granted blanket coverage under Section 401 in New York, provided that the project complies with the WQC conditions.

Additionally, as part of the Nonpoint Source Planning Grant Program, the NYSDEC will need to perform a review and issue approval of this project. There may be additional permitting requirements based on the location of the crossing, but those requirements are normally addressed as part of the SEQR process.

VI. COST ESTIMATES

The preliminary cost estimates for the culvert replacements are in Appendix J and are summarized as follows:

1. Maplewood Road
2. Garrett Road
3. Agard Road
4. Curry Road
5. Reynolds Road
6. Iradell Road

VII. RECOMMENDATIONS

There is a need for the replacement of all six (6) existing culverts evaluated in this report. Grant opportunities exist that could assist with making these projects more affordable including the Non-Agricultural Nonpoint Source Planning Grant for Culvert Repair and Replacement through NYSDEC

The recommended schedule of replacement for the existing culverts considers the condition of the culvert, the environmental impacts from the culvert, and the flow capacity. The Priority Ranking system for a replacement schedule is as follows:

1. Maplewood Road

The existing culvert is structurally compromised and does not promote aquatic connectivity. This location is in need of complete replacement prior to a structural failure occurring.

2. Agard Road

Based on the hydraulic modeling results, the existing Agard Road culvert is the most hydraulically limited of the six (6) culverts evaluated. These results are supported by the Town witnessing the road overtopped several times at this crossing location within the last ten years.

3. Curry Road

Of all the culverts evaluated for this report, the hydrologic data identifies that the Curry Road crossing receives the most runoff. The hydraulic model has revealed that the culverts at this crossing are undersized. Neither culvert has any embedment and they both block the passage of aquatic life through the crossing due to the large elevation difference between the outlet invert and the stream bottom below. The Town will need to consider a comprehensive evaluation of the drainage basin to understand increasing the hydraulic capacity of the culvert.

4. Garrett Road

Although the hydraulic analysis for the Garrett Road culvert identified the culvert is adequately sized, upon a field investigation of the existing culvert, several issues were noted structurally and in relation to aquatic connectivity. The culvert is corroded, and the concrete is spalling. There is a large drop from the outlet invert to the stream bed below and no embedment throughout the pipe.

5. Reynolds Road

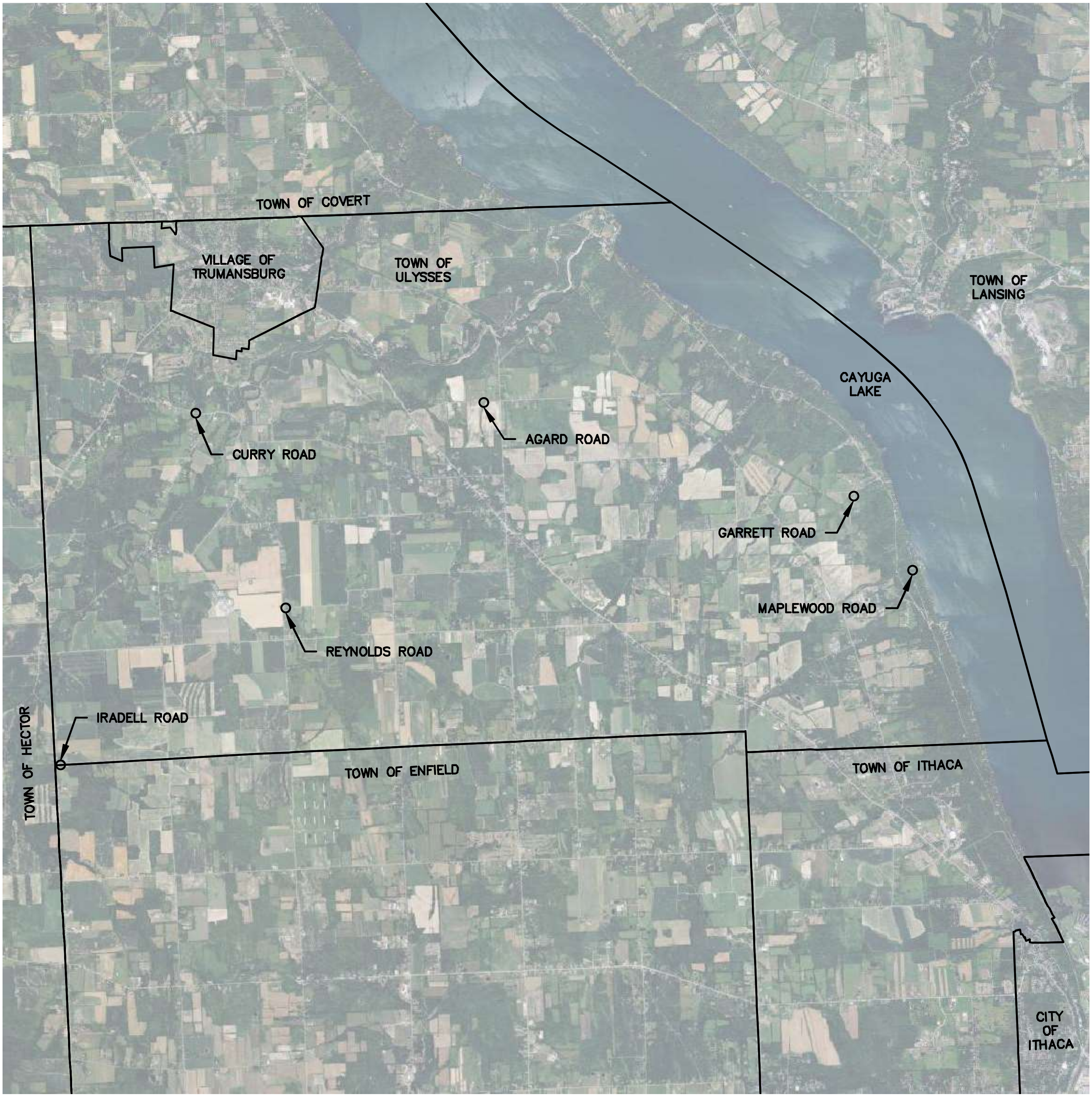
The existing Reynolds Road crossing consists of two (2) parallel culverts. The hydraulic model revealed the culverts are undersized. The pipes have limited embedment as well, which is prohibitive to aquatic connectivity.

6. Iradell Road

The existing Iradell Road culvert is made from an old freight car petroleum containment vessel converted to a pipe. The hydraulic model identified it as hydraulically limited. The drop from the outlet invert to the stream bed below creates a barrier for the passage of aquatic life and is contributing to erosion on the downstream side of the culvert. The lack of embedment limits the aquatic connectivity though the crossing. However, the pipe still can be assumed to have useful service life which is why it is the lowest on the ranking system.

APPENDIX A

CULVERT LOCATIONS MAP



CULVERT LOCATIONS MAP

Project Name:	2024 NONPOINT SOURCE PLANNING GRANT - CULVERT REPAIR & REPLACEMENTS TOWN OF ULYSSES TOMPKINS COUNTY, NY	Project No. 2104.15000

MRB group

Engineering, Architecture & Surveying, D.P.C.
The Culver Road Armory, 145 Culver Road, Suite 160, Rochester, New York 14620
Phone: 585-381-9250
www.mrbgroup.com

Drawn By:	CAH
Checked By:	MRM
Scale:	1" = 6500'
Date:	APRIL 2024

No.	Revisions	By	Date

Distribution:

Sheet No. FIG. 1

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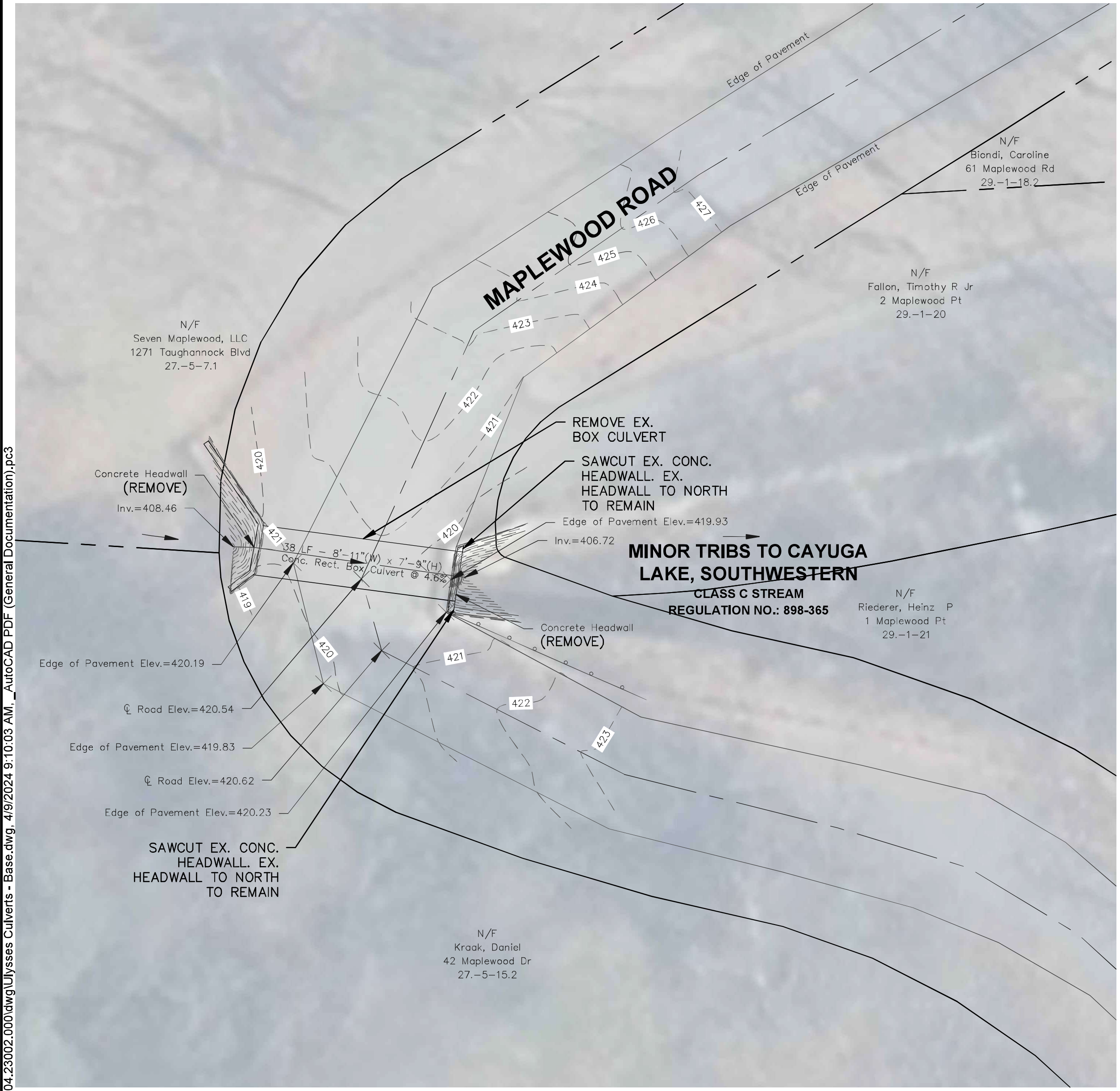
APPENDIX B

EXISTING CONDITIONS PLANS



FLOODPLAINS

PER THE TOWN OF ULYSSES FLOOD INSURANCE RATE MAP (FIRM) DATED FEBRUARY 19, 1987, PANEL # 360854 0005 B, IT HAS BEEN DETERMINED THAT THIS CULVERT FALLS OUTSIDE THE 100-YEAR FLOODPLAIN.

PROPERTY NOTES:

PROPERTY LINES ARE BASED ON MOST CURRENT TAX MAPS FOR TOMPKINS COUNTY.

LEGEND

——— — — ———	EXISTING PROPERTY LINE
— — — - 750 - — — —	EXISTING MAJOR CONTOUR LINE
— — — - 745 - — — —	EXISTING MINOR CONTOUR LINE
——— — ———	EXISTING CENTER LINE
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GRAPHIC SCALE

20 0 10 20 40 80

(IN FEET)
1 inch = 20 ft.

DRAWING ALTERATION
THE FOLLOWING IS AN EXCERPT FROM THE NEW YORK EDUCATION LAW ARTICLE 145 SECTION 7209 AND APPLIES TO THIS DRAWING.
"IT IS A VIOLATION OF THIS LAW FOR ANY PERSON UNLESS HE IS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER OR LAND SURVEYOR TO ALTER AN ITEM IN ANY WAY. IF AN ITEM BEARING THE SEAL OF AN ENGINEER OR LAND SURVEYOR IS ALTERED, THE ALTERING ENGINEER OR LAND SURVEYOR SHALL AFFIX TO THE ITEM HIS SEAL AND THE NOTATION "ALTERED BY" FOLLOWED BY HIS SIGNATURE AND THE DATE OF SUCH ALTERATION AND A SPECIFIC DESCRIPTION OF THE ALTERATION".

No.	REVISIONS AND DESCRIPTIONS	BY	DATE

Project Title:
CULVERT REPLACEMENT PROJECT
TOWN OF ULYSSES
TOMPKINS COUNTY, NEW YORK

Drawing Title:
MAPLEWOOD RD. - EX. / DEMO PLAN

Drawn By: CAH
Checked By: MRM
Scale: AS SHOWN
Date: 3/2024

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Sheet No. G-1
1 of 12
Project No. 2104.23002

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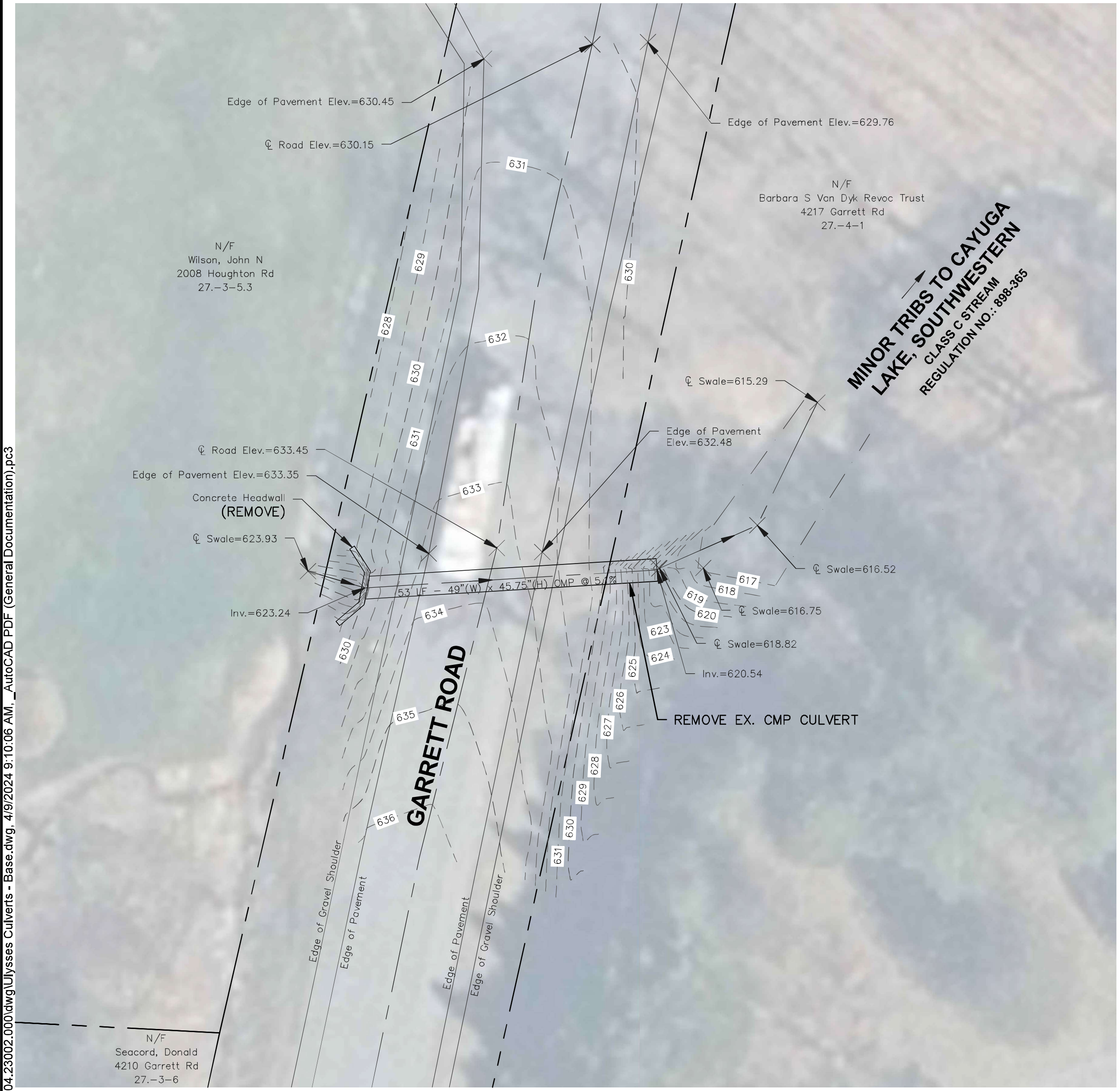

FLOODPLAINS

PER THE TOWN OF ULYSSES FLOOD INSURANCE RATE MAP (FIRM) DATED FEBRUARY 19, 1987, PANEL # 360854 0005 B, IT HAS BEEN DETERMINED THAT THIS CULVERT FALLS OUTSIDE THE 100-YEAR FLOODPLAIN.

PROPERTY NOTES:

PROPERTY LINES ARE BASED ON MOST CURRENT TAX MAPS FOR TOMPKINS COUNTY.

LEGEND

- EXISTING PROPERTY LINE
- 750 — EXISTING MAJOR CONTOUR LINE
- 745 — EXISTING MINOR CONTOUR LINE
- EXISTING CENTER LINE
- EXISTING APPROXIMATE STREAM EDGE

GRAPHIC SCALE

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(IN FEET)
1 inch = 20 ft.

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No.	REVISIONS AND DESCRIPTIONS	BY	DATE

Project Title: CULVERT REPLACEMENT PROJECT
TOWN OF ULYSSES
TOMPKINS COUNTY, NEW YORK

Drawing Title: GARRETT RD. - EX. / DEMO PLAN

Drawn By: CAH
Checked By: MRM
Scale: AS SHOWN
Date: 3/2024

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Sheet No. G-2
2 of 12
Project No. 2104.23002

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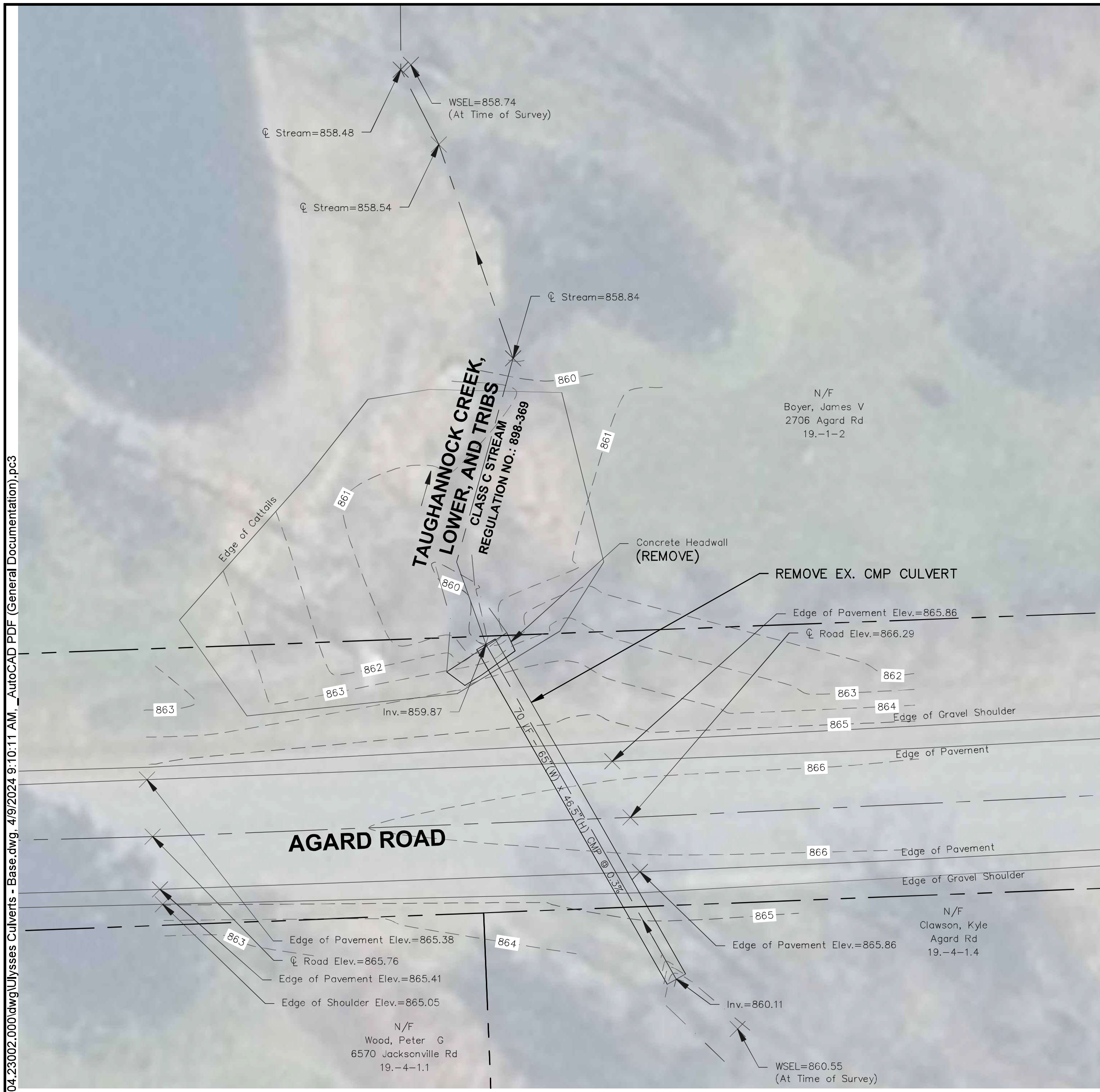

FLOODPLAINS

PER THE TOWN OF ULYSSES FLOOD INSURANCE RATE MAP (FIRM) DATED FEBRUARY 19, 1987, PANEL # 360854 0005 B, IT HAS BEEN DETERMINED THAT THIS CULVERT FALLS OUTSIDE THE 100-YEAR FLOODPLAIN.

PROPERTY NOTES:

PROPERTY LINES ARE BASED ON MOST CURRENT TAX MAPS FOR TOMPKINS COUNTY.

LEGEND

——— — — ———	EXISTING PROPERTY LINE
— — — — - 750 - — — — —	EXISTING MAJOR CONTOUR LINE
— — — — - 745 - — — — —	EXISTING MINOR CONTOUR LINE
———— — ————	EXISTING CENTER LINE
— · — · — · —	EXISTING APPROXIMATE STREAM EDGE

(IN FEET)
1 inch = 20 ft.

DRAWING ALTERATION
THE FOLLOWING IS AN EXCERPT FROM THE NEW YORK EDUCATION LAW ARTICLE 145 SECTION 7209 AND APPLIES TO THIS DRAWING.
"IT IS A VIOLATION OF THIS LAW FOR ANY PERSON UNLESS HE IS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER OR LAND SURVEYOR TO ALTER AN ITEM IN ANY WAY. IF AN ITEM BEARING THE SEAL OF AN ENGINEER OR LAND SURVEYOR IS ALTERED, THE ALTERING ENGINEER OR LAND SURVEYOR SHALL AFFIX TO THE ITEM HIS SEAL AND THE NOTATION "ALTERED BY" FOLLOWED BY HIS SIGNATURE AND THE DATE OF SUCH ALTERATION AND A SPECIFIC DESCRIPTION OF THE ALTERATION".

No.	REVISIONS AND DESCRIPTIONS	BY	DATE

Project Title: CULVERT REPLACEMENT PROJECT
TOWN OF ULYSSES
TOMPKINS COUNTY, NEW YORK

Drawing Title: AGARD RD. - EX. / DEMO PLAN

Drawn By: CAH
Checked By: MRM
Scale: AS SHOWN
Date: 3/2024

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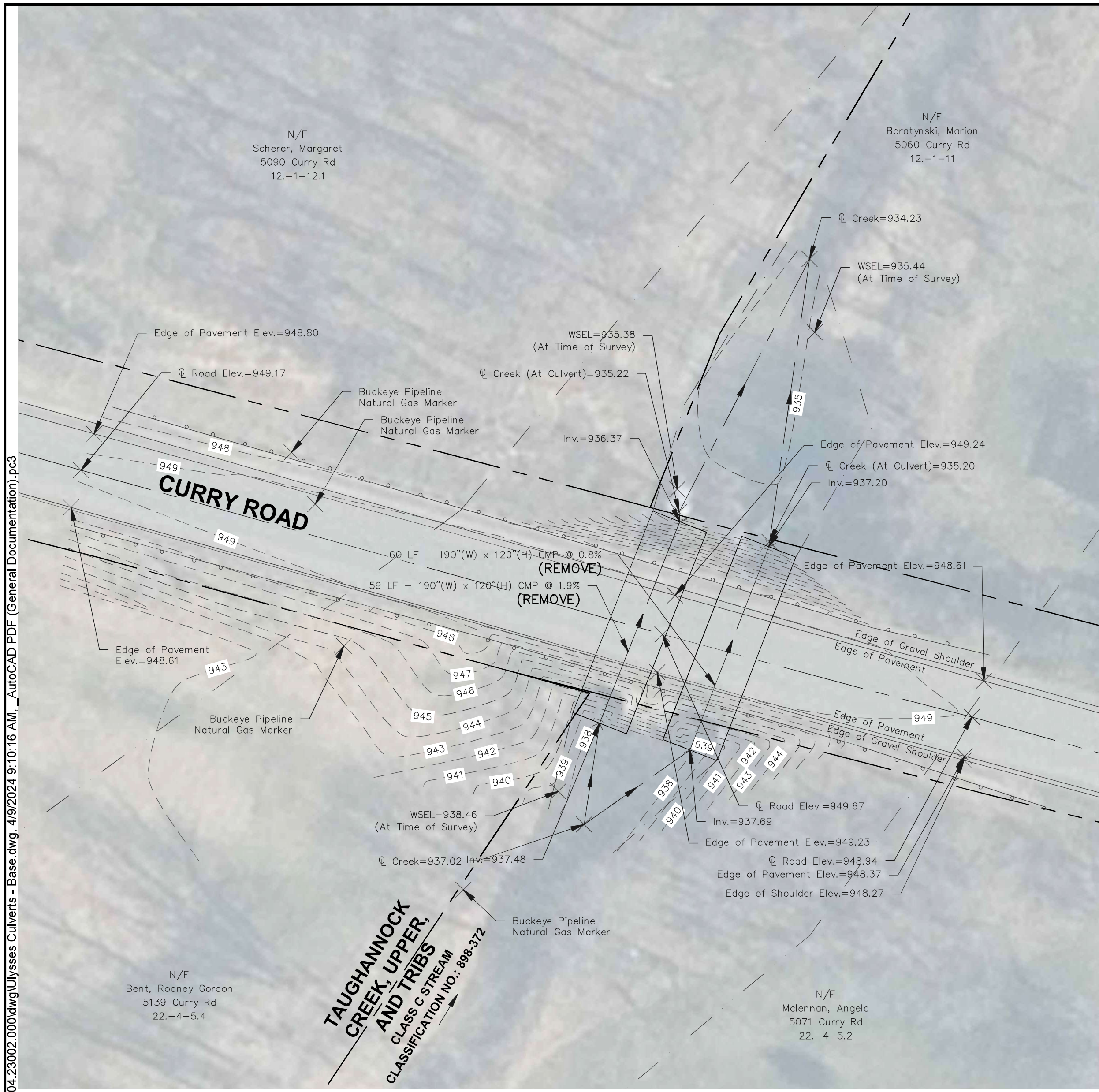
Sheet No. G-3
3 of 12
Project No. 2104.23002



FLOODPLAINS

PER THE TOWN OF ULYSSES FLOOD INSURANCE RATE MAP (FIRM) DATED FEBRUARY 19, 1987, PANEL # 360854 0005 B, IT HAS BEEN DETERMINED THAT THIS CULVERT FALLS WITHIN THE 100-YEAR FLOODPLAIN.

PROPERTY NOTES:

PROPERTY LINES ARE BASED ON MOST CURRENT TAX MAPS FOR TOMPKINS COUNTY.

LEGEND

- EXISTING PROPERTY LINE
- EXISTING MAJOR CONTOUR LINE (750)
- EXISTING MINOR CONTOUR LINE (745)
- EXISTING CENTER LINE
- EXISTING GUARDRAIL
- EXISTING APPROXIMATE STREAM EDGE
- EXISTING APPROXIMATE 100-YEAR FLOODPLAIN

GRAPHIC SCALE

30 0 15 30 60 120

(IN FEET)
1 inch = 30 ft.

DRAWING ALTERATION
THE FOLLOWING IS AN EXCERPT FROM THE NEW YORK EDUCATION LAW ARTICLE 145 SECTION 7209 AND APPLIES TO THIS DRAWING.
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No.	REVISIONS AND DESCRIPTIONS	BY	DATE

Project Title: CULVERT REPLACEMENT PROJECT
TOWN OF ULYSSES
TOMPKINS COUNTY, NEW YORK

Drawing Title: CURRY RD. - EX. / DEMO PLAN

Drawn By: CAH
Checked By: MRM
Scale: AS SHOWN
Date: 3/2024

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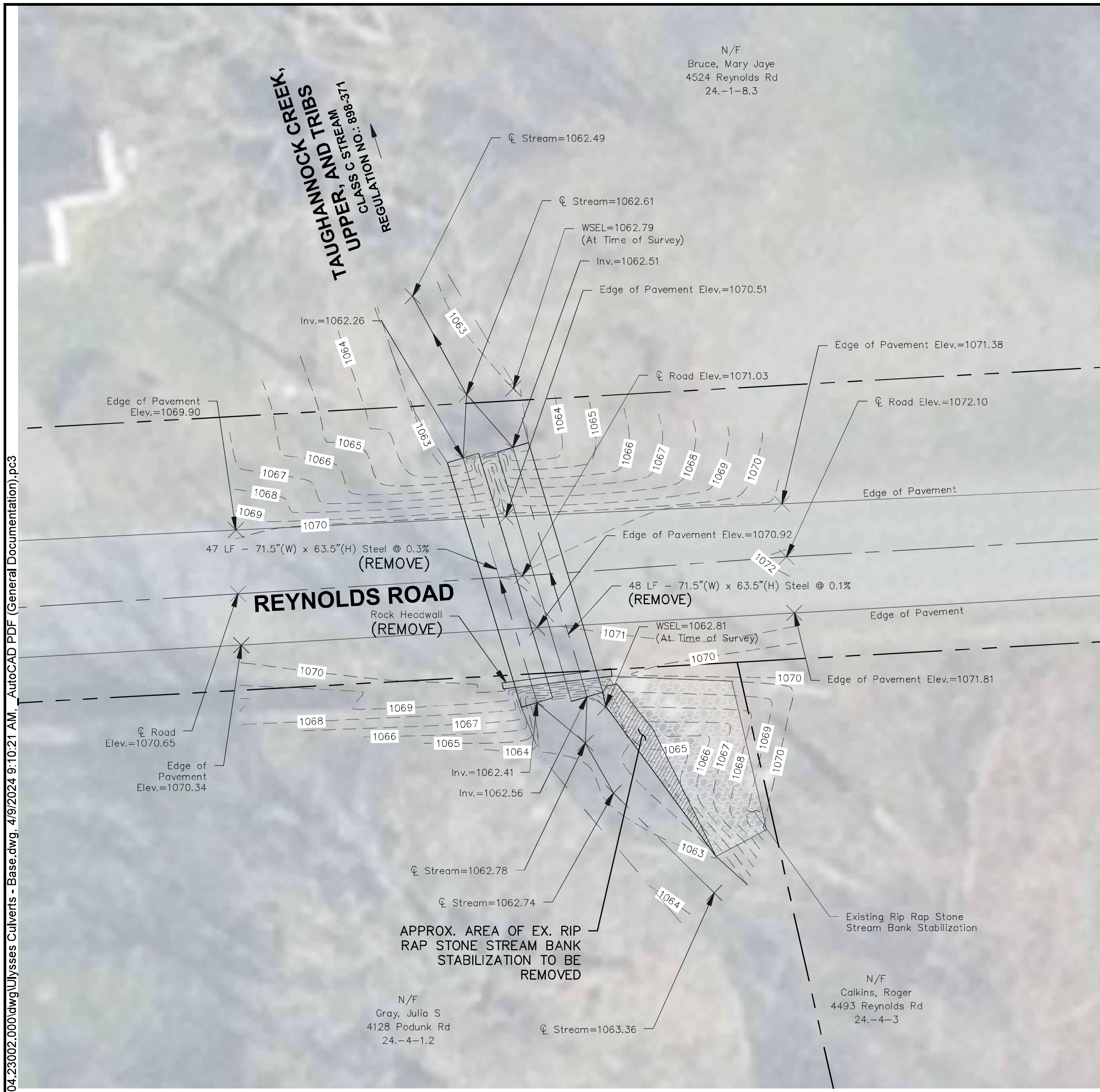
4 of 12
Project No. 2104.23002



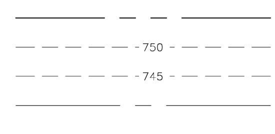
FLOODPLAINS

PER THE TOWN OF ULYSSES FLOOD INSURANCE RATE MAP (FIRM) DATED FEBRUARY 19, 1987, PANEL # 360854 0005 B, IT HAS BEEN DETERMINED THAT THIS CULVERT FALLS OUTSIDE THE 100-YEAR FLOODPLAIN.

PROPERTY NOTES:

PROPERTY LINES ARE BASED ON MOST CURRENT TAX MAPS FOR TOMPKINS COUNTY.

LEGEND



GRAPHIC SCALE

(IN FEET)
1 inch = 20 ft.

DRAWING ALTERATION
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No.	REVISIONS AND DESCRIPTIONS	BY	DATE

Project Title: CULVERT REPLACEMENT PROJECT
TOWN OF ULYSSES
TOMPKINS COUNTY, NEW YORK

Drawing Title: REYNOLDS RD. - EX. / DEMO PLAN

Drawn By: CAH
Checked By: MRM
Scale: AS SHOWN
Date: 3/2024

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5 of 12
Project No. 2104.23002

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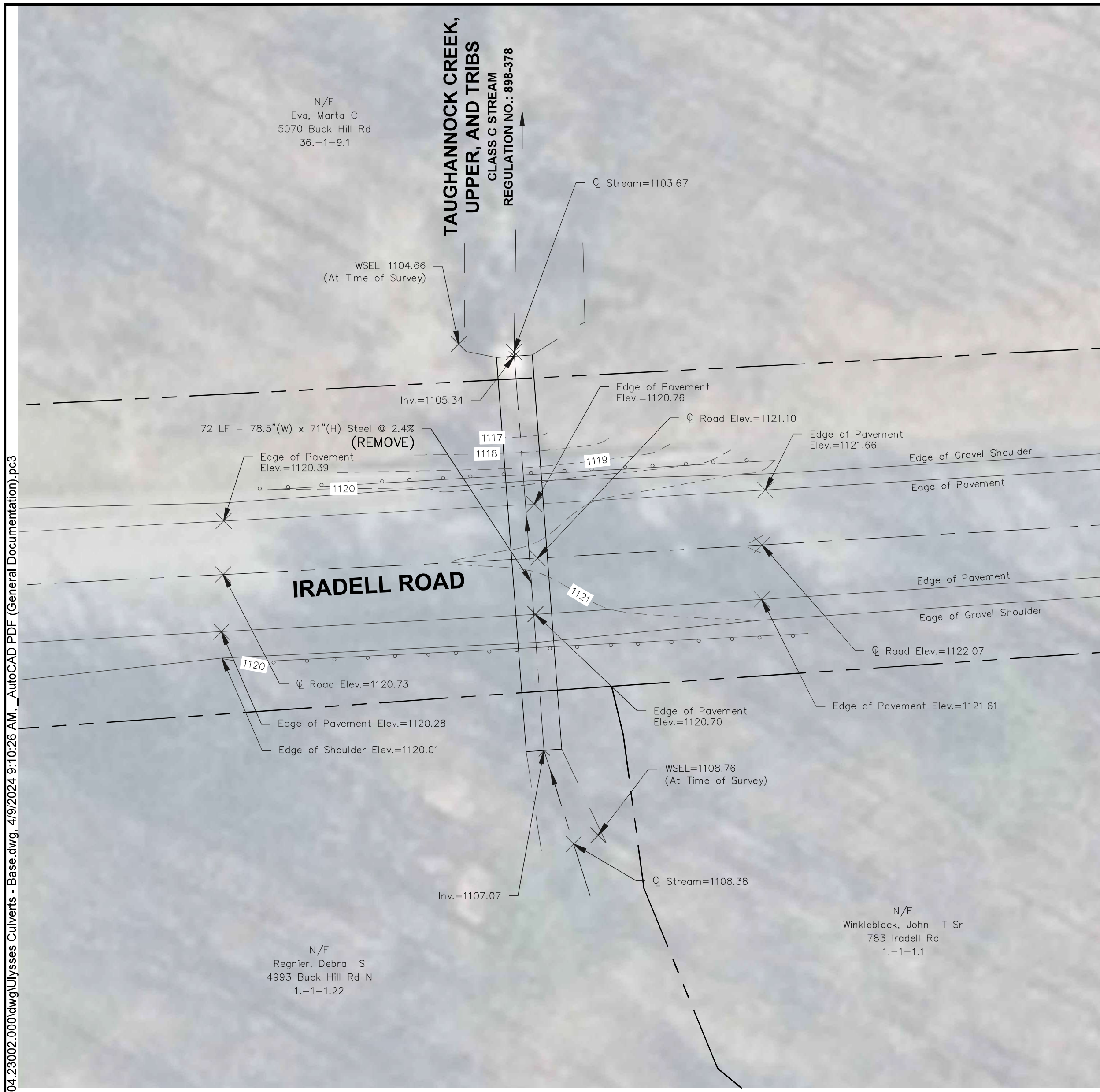

FLOODPLAINS

PER THE TOWN OF ULYSSES FLOOD INSURANCE RATE MAP (FIRM) DATED FEBRUARY 19, 1987, PANEL # 360854 0005 B, IT HAS BEEN DETERMINED THAT THIS CULVERT FALLS OUTSIDE THE 100-YEAR FLOODPLAIN.

PROPERTY NOTES:

PROPERTY LINES ARE BASED ON MOST CURRENT TAX MAPS FOR TOMPKINS COUNTY.

LEGEND

- EXISTING PROPERTY LINE
- EXISTING MAJOR CONTOUR LINE (750)
- EXISTING MINOR CONTOUR LINE (745)
- EXISTING CENTER LINE
- EXISTING GUARDRAIL
- EXISTING APPROXIMATE STREAM EDGE

GRAPHIC SCALE

20 0 10 20 40 80

(IN FEET)
1 inch = 20 ft.

DRAWING ALTERATION
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No.	REVISIONS AND DESCRIPTIONS	BY	DATE

Project Title: CULVERT REPLACEMENT PROJECT
TOWN OF ULYSSES
TOMPKINS COUNTY, NEW YORK

Drawing Title: IRADELL RD. - EX. / DEMO PLAN

Drawn By: CAH
Checked By: MRM
Scale: AS SHOWN
Date: 3/2024

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Project No. 2104.23002

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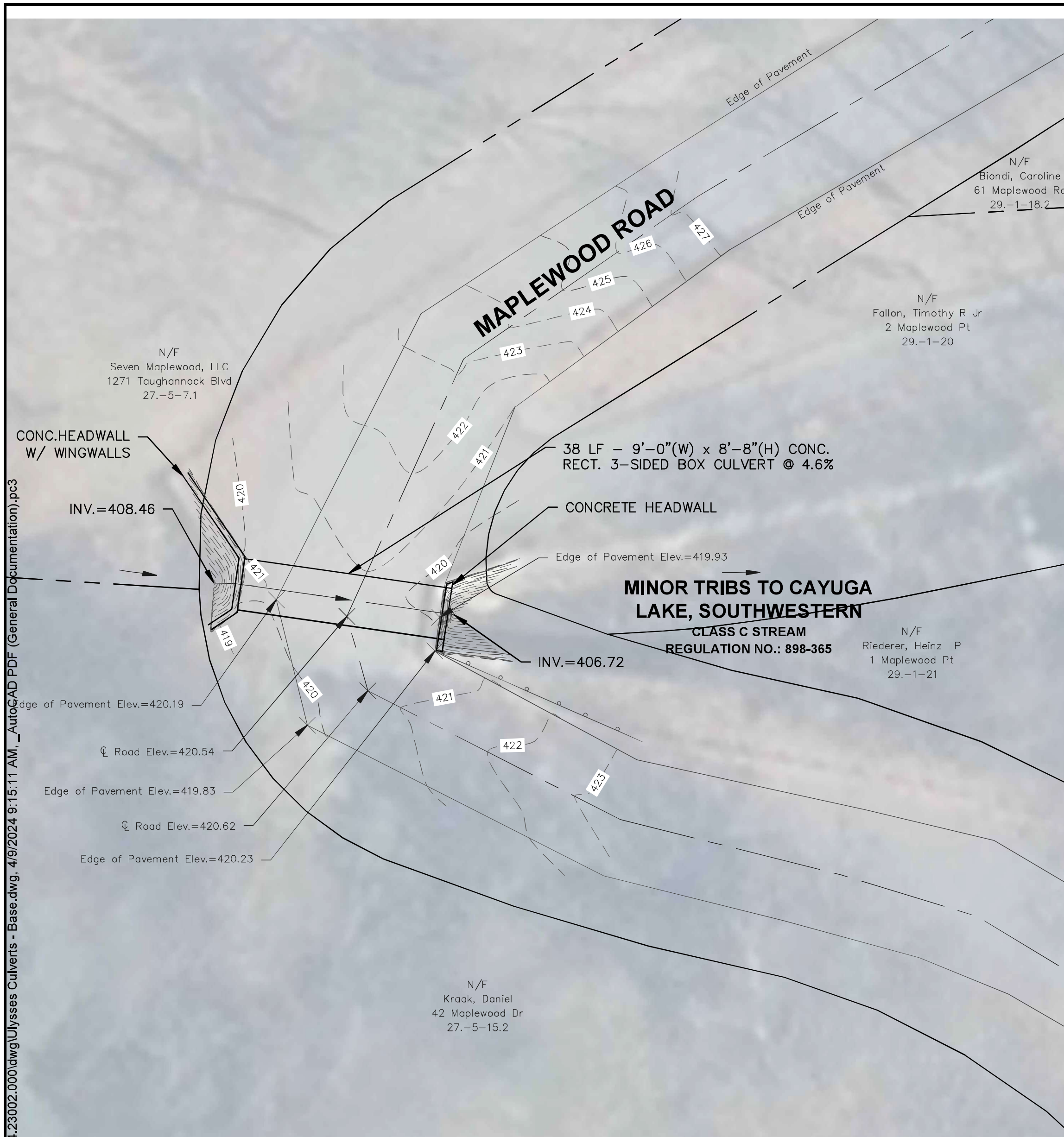
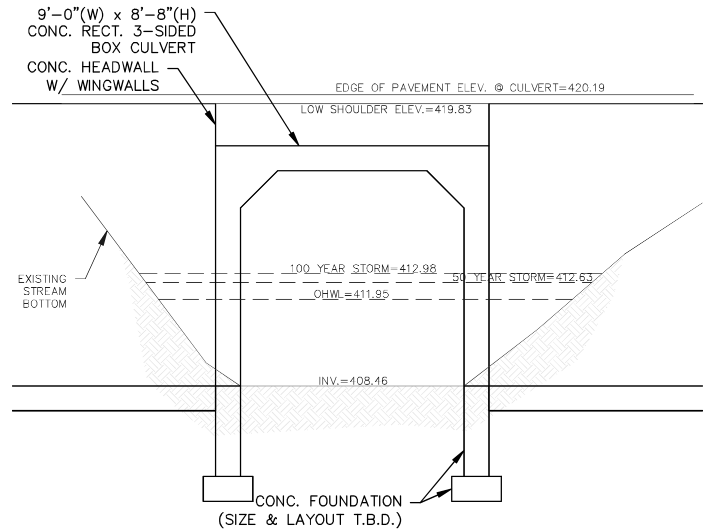
APPENDIX C

PROPOSED CONDITIONS PLANS





MAPLEWOOD ROAD CULVERT CROSS SECTION DETAIL

N.T.S.

FLOODPLAINS

PER THE TOWN OF ULYSSES FLOOD INSURANCE RATE MAP (FIRM) DATED FEBRUARY 19, 1987, PANEL # 360854 0005 B, IT HAS BEEN DETERMINED THAT THIS CULVERT FALLS OUTSIDE THE 100-YEAR FLOODPLAIN.

PROPERTY NOTES:

PROPERTY LINES ARE BASED ON MOST CURRENT TAX MAPS FOR TOMPKINS COUNTY.

LEGEND

- EXISTING PROPERTY LINE
- EXISTING MAJOR CONTOUR LINE (750)
- EXISTING MINOR CONTOUR LINE (745)
- EXISTING CENTER LINE
- EXISTING GUARDRAIL

GRAPHIC SCALE

20 0 10 20 40 80

(IN FEET)
1 inch = 20 ft.

DRAWING ALTERATION
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No.	REVISIONS AND DESCRIPTIONS	BY	DATE

Project Title: CULVERT REPLACEMENT PROJECT
TOWN OF ULYSSES
TOMPKINS COUNTY, NEW YORK

Drawing Title: MAPLEWOOD RD. - PROPOSED PLAN

Drawn By: CAH
Checked By: MRM
Scale: AS SHOWN
Date: 3/2024

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Project No. 2104.23002

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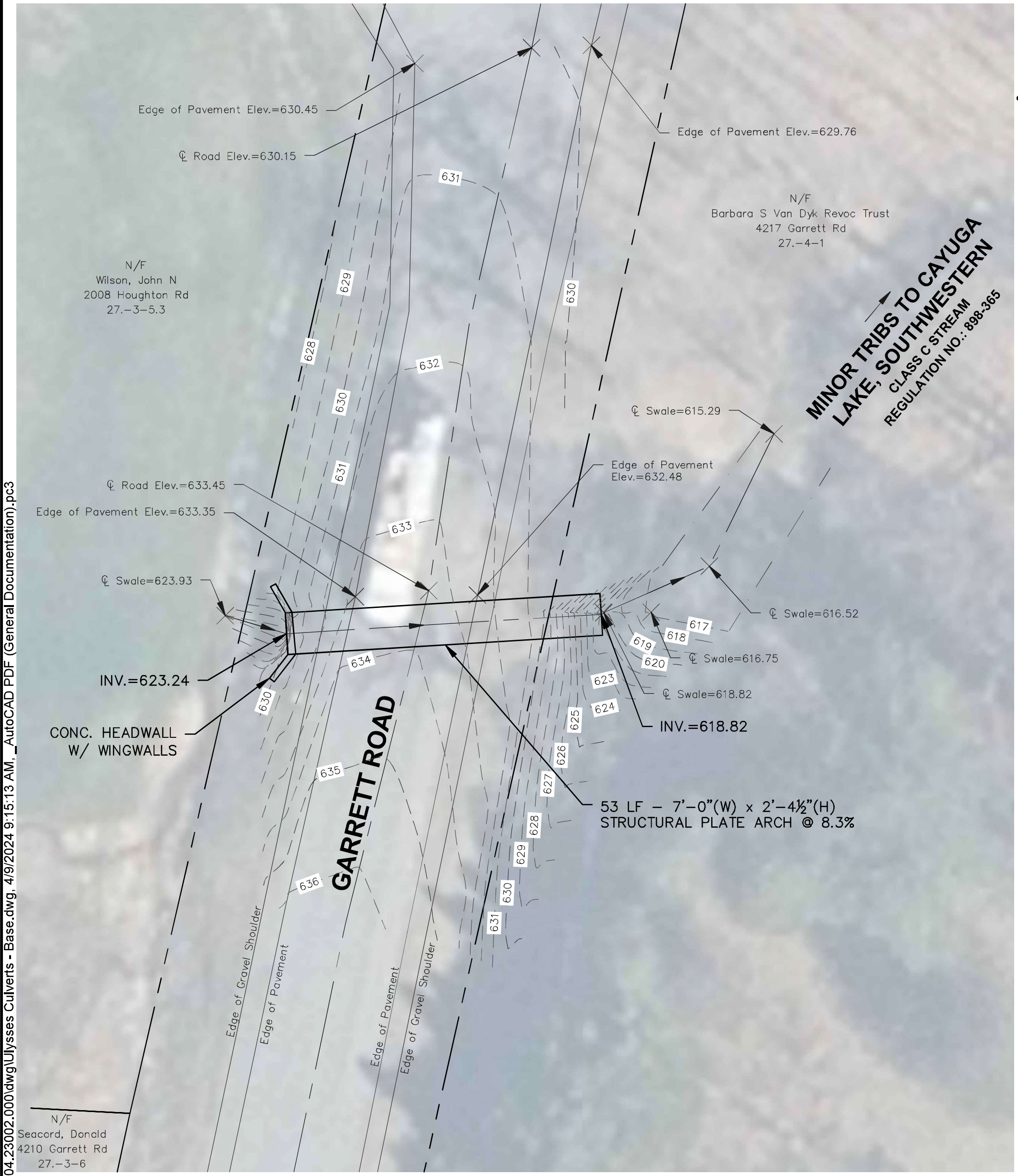

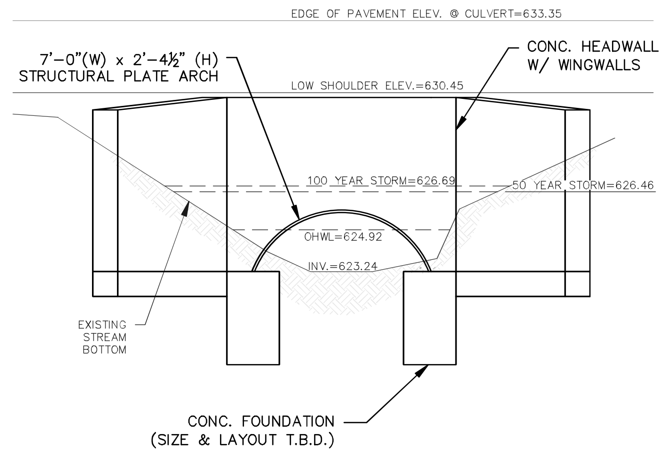

GARRETT ROAD CULVERT CROSS SECTION DETAIL

N.T.S.

FLOODPLAINS

PER THE TOWN OF ULYSSES FLOOD INSURANCE RATE MAP (FIRM) DATED FEBRUARY 19, 1987, PANEL # 360854 0005 B, IT HAS BEEN DETERMINED THAT THIS CULVERT FALLS OUTSIDE THE 100-YEAR FLOODPLAIN.

PROPERTY NOTES:

PROPERTY LINES ARE BASED ON MOST CURRENT TAX MAPS FOR TOMPKINS COUNTY.

LEGEND

- EXISTING PROPERTY LINE
- 750 EXISTING MAJOR CONTOUR LINE
- 745 EXISTING MINOR CONTOUR LINE
- EXISTING CENTER LINE
- EXISTING APPROXIMATE STREAM EDGE

GRAPHIC SCALE

20 0 10 20 40 80

(IN FEET)
1 inch = 20 ft.

DRAWING ALTERATION
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No.	REVISIONS AND DESCRIPTIONS	BY	DATE

Project Title: CULVERT REPLACEMENT PROJECT
TOWN OF ULYSSES
TOMPKINS COUNTY, NEW YORK

Drawing Title: GARRETT RD. - PROPOSED PLAN

Drawn By: CAH
Checked By: MRM
Scale: AS SHOWN
Date: 3/2024

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8 of 12
Project No. 2104.23002

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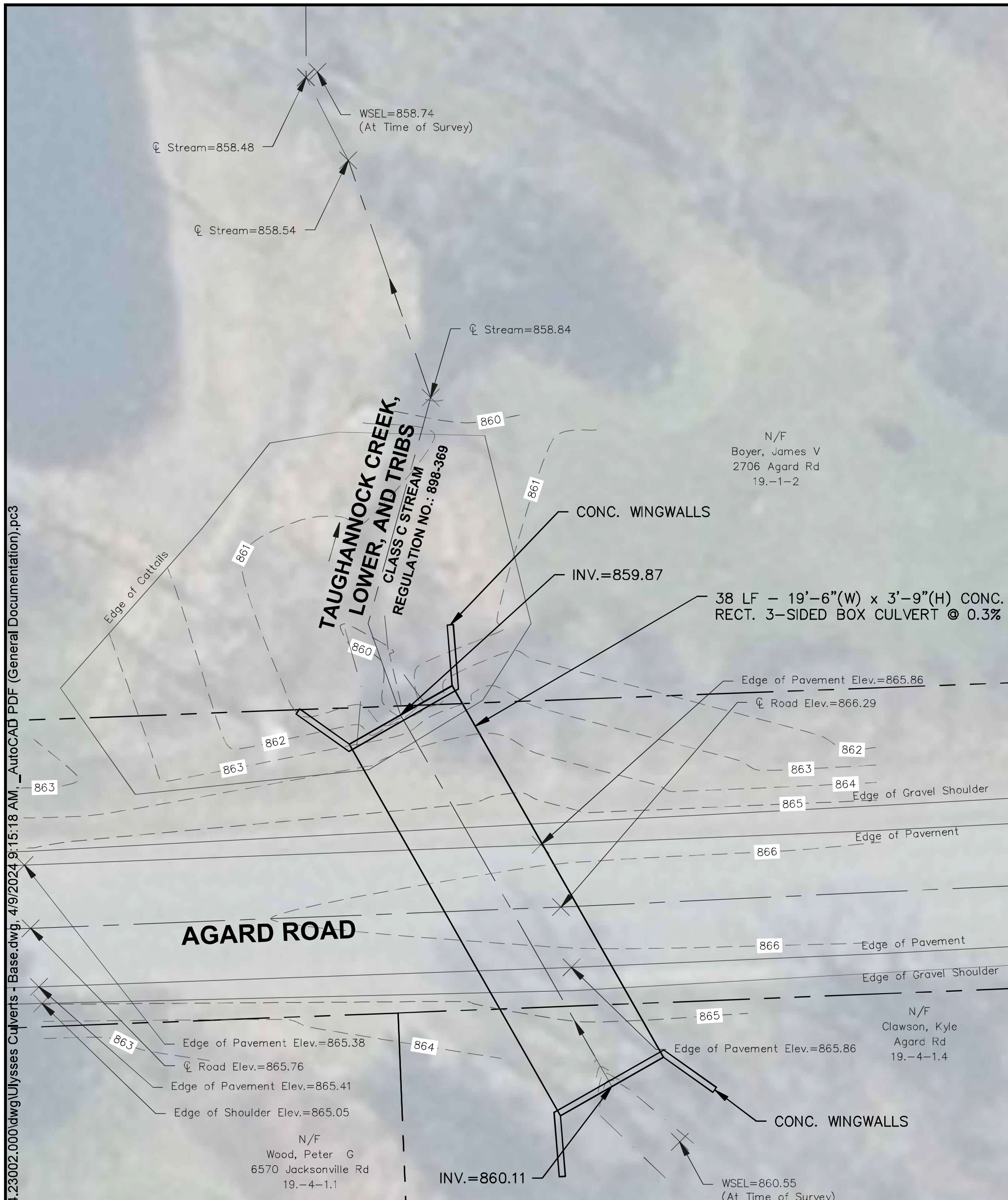

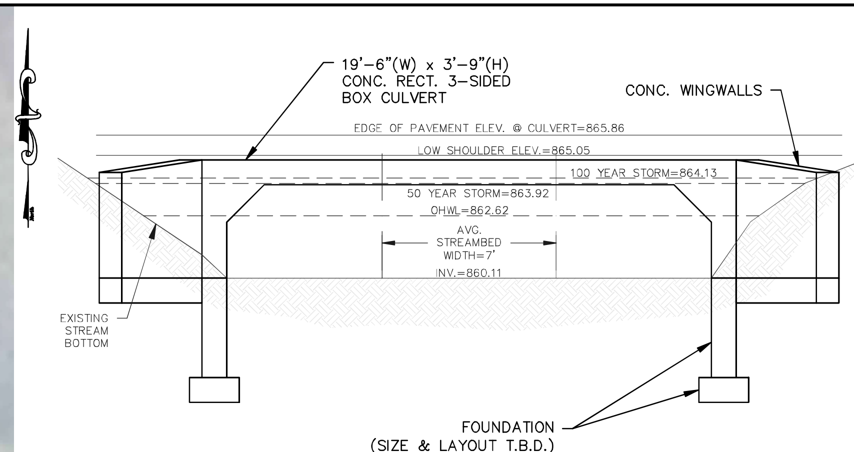

AGARD ROAD CULVERT CROSS SECTION DETAIL

N.T.S.

FLOODPLAINS

PER THE TOWN OF ULYSSES FLOOD INSURANCE RATE MAP (FIRM) DATED FEBRUARY 19, 1987, PANEL # 360854 0005 B, IT HAS BEEN DETERMINED THAT THIS CULVERT FALLS OUTSIDE THE 100-YEAR FLOODPLAIN.

PROPERTY NOTES:

PROPERTY LINES ARE BASED ON MOST CURRENT TAX MAPS FOR TOMPKINS COUNTY.

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- EXISTING PROPERTY LINE
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- 745 EXISTING MINOR CONTOUR LINE
- EXISTING CENTER LINE
- EXISTING APPROXIMATE STREAM EDGE

GRAPHIC SCALE

20 0 10 20 40 80

(IN FEET)
1 inch = 20 ft.

DRAWING ALTERATION
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No.	REVISIONS AND DESCRIPTIONS	BY	DATE

Project Title: CULVERT REPLACEMENT PROJECT
TOWN OF ULYSSES
TOMPKINS COUNTY, NEW YORK

Drawing Title: AGARD RD. - PROPOSED PLAN

Drawn By: CAH
Checked By: MRM
Scale: AS SHOWN
Date: 3/2024

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9 of 12
Project No. 2104.23002

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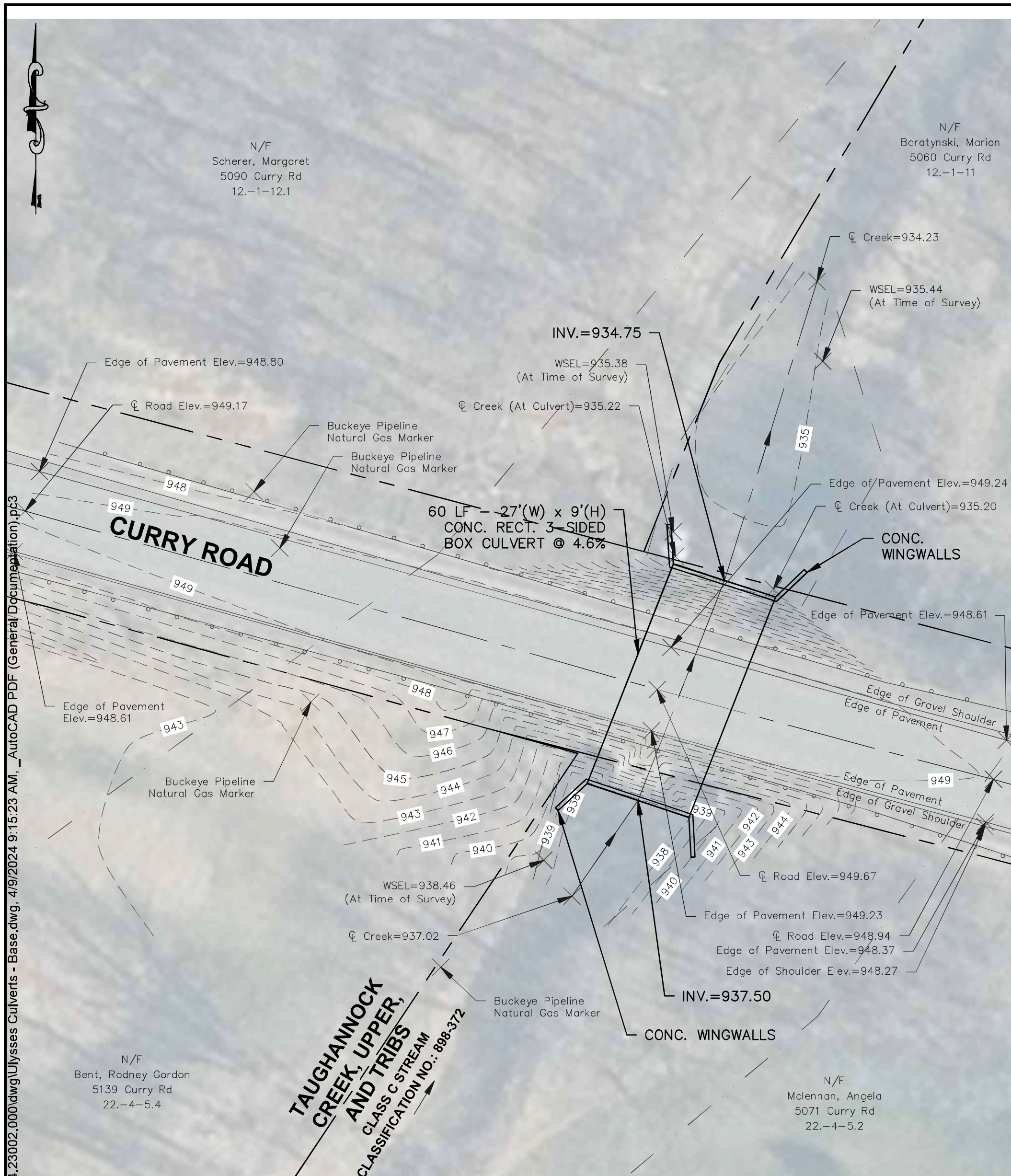

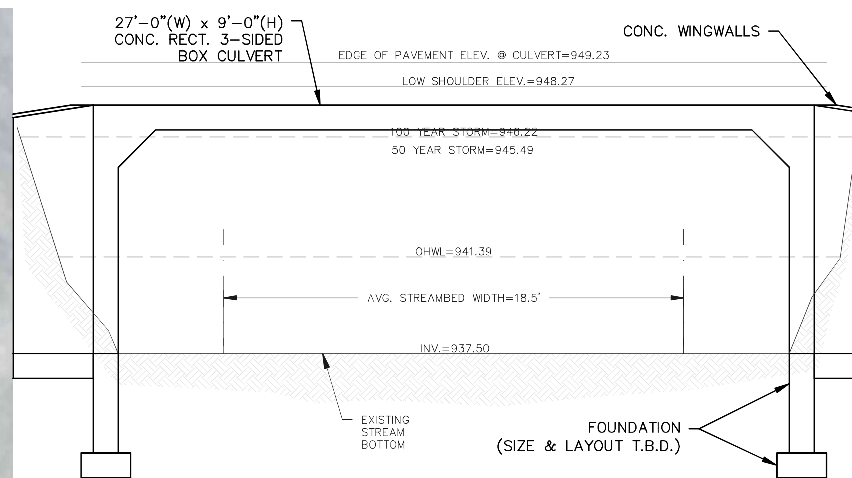

CURRY ROAD CULVERT CROSS SECTION DETAIL

N.T.S.

FLOODPLAINS

PER THE TOWN OF ULYSSES FLOOD INSURANCE RATE MAP (FIRM) DATED FEBRUARY 19, 1987, PANEL # 360854 0005 B, IT HAS BEEN DETERMINED THAT THIS CULVERT FALLS WITHIN THE 100-YEAR FLOODPLAIN.

PROPERTY NOTES:

PROPERTY LINES ARE BASED ON MOST CURRENT TAX MAPS FOR TOMPKINS COUNTY.

LEGEND

- EXISTING PROPERTY LINE
- EXISTING MAJOR CONTOUR LINE (750)
- EXISTING MINOR CONTOUR LINE (745)
- EXISTING CENTER LINE
- EXISTING GUARDRAIL
- EXISTING APPROXIMATE STREAM EDGE
- EXISTING APPROXIMATE 100-YEAR FLOODPLAIN

GRAPHIC SCALE

30 0 15 30 60 120

(IN FEET)
1 inch = 30 ft.

DRAWING ALTERATION
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No.	REVISIONS AND DESCRIPTIONS	BY	DATE

Project Title: CULVERT REPLACEMENT PROJECT
TOWN OF ULYSSES
TOMPKINS COUNTY, NEW YORK

Drawing Title: CURRY RD. - PROPOSED PLAN

Drawn By: CAH
Checked By: MRM
Scale: AS SHOWN
Date: 3/2024

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10 of 12
Project No. 2104.23002

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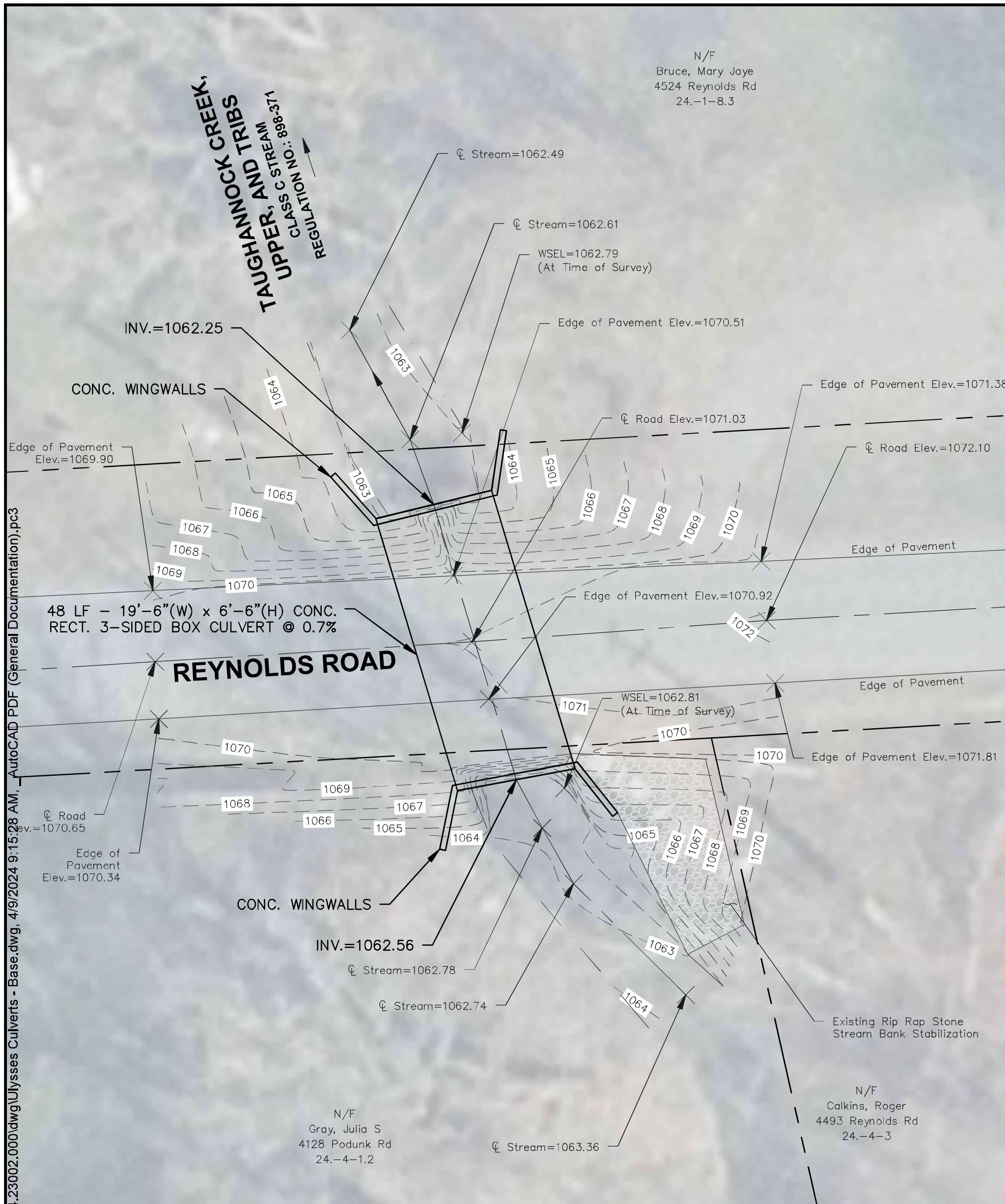

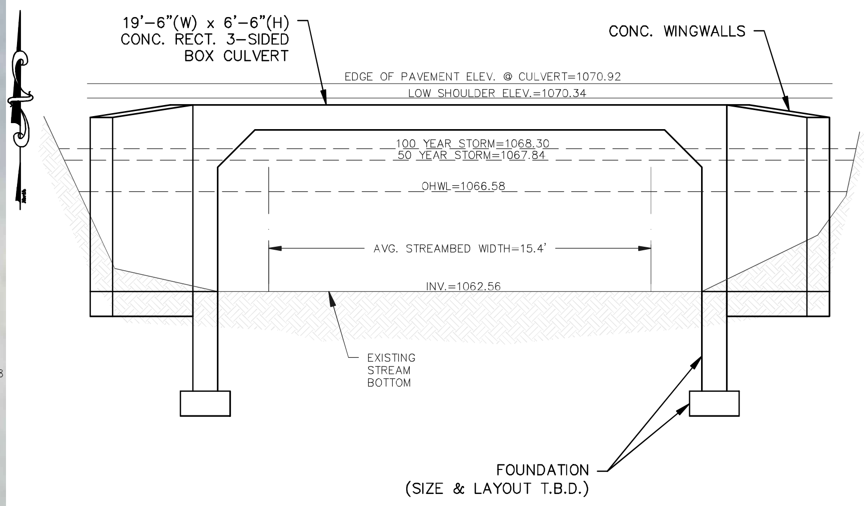

REYNOLDS ROAD CULVERT CROSS SECTION DETAIL

N.T.S.

FLOODPLAINS

PER THE TOWN OF ULYSSES FLOOD INSURANCE RATE MAP (FIRM) DATED FEBRUARY 19, 1987, PANEL # 360854 0005 B, IT HAS BEEN DETERMINED THAT THIS CULVERT FALLS OUTSIDE THE 100-YEAR FLOODPLAIN.

PROPERTY NOTES:

PROPERTY LINES ARE BASED ON MOST CURRENT TAX MAPS FOR TOMPKINS COUNTY.

LEGEND

- EXISTING PROPERTY LINE
- 750 EXISTING MAJOR CONTOUR LINE
- 745 EXISTING MINOR CONTOUR LINE
- EXISTING CENTER LINE
- EXISTING APPROXIMATE STREAM EDGE

GRAPHIC SCALE

20 0 10 20 40 80

(IN FEET)
1 inch = 20 ft.

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No.	REVISIONS AND DESCRIPTIONS	BY	DATE

Project Title: CULVERT REPLACEMENT PROJECT
TOWN OF ULYSSES
TOMPKINS COUNTY, NEW YORK

Drawing Title: REYNOLDS RD. - PROPOSED PLAN

Drawn By: CAH
Checked By: MRM
Scale: AS SHOWN
Date: 3/2024

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11 of 12
Project No. 2104.23002

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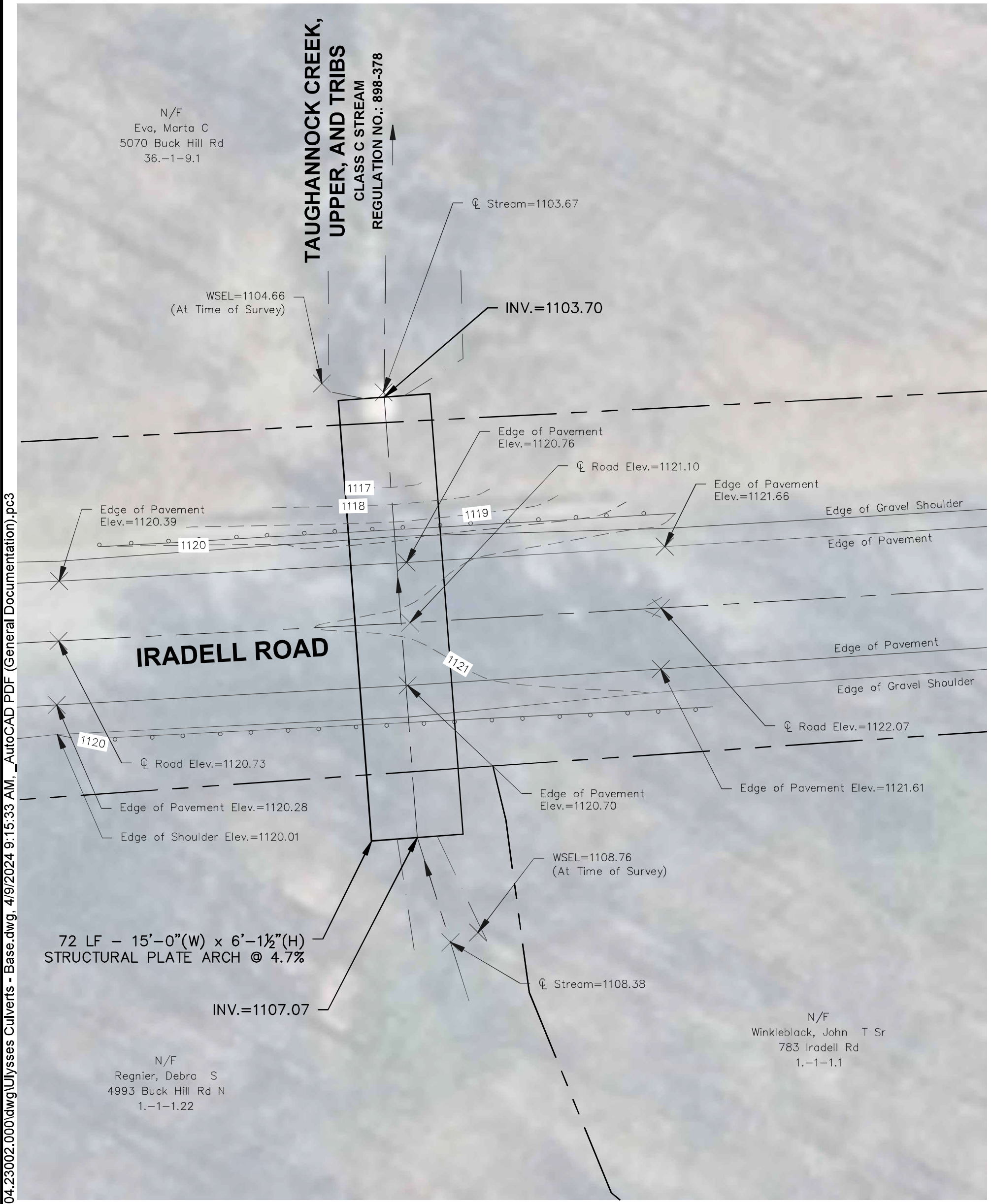

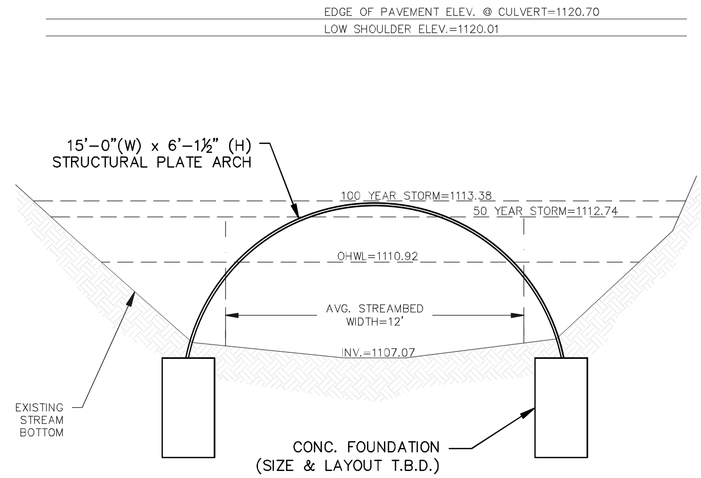

IRADELL ROAD CULVERT CROSS SECTION DETAIL

N.T.S.

FLOODPLAINS

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- EXISTING GUARDRAIL
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GRAPHIC SCALE

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(IN FEET)
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No.	REVISIONS AND DESCRIPTIONS	BY	DATE

Project Title: CULVERT REPLACEMENT PROJECT
TOWN OF ULYSSES
TOMPKINS COUNTY, NEW YORK

Drawing Title: IRADELL RD. - PROPOSED PLAN

Drawn By: CAH
Checked By: MRM
Scale: AS SHOWN
Date: 3/2024

MRB group
Engineering, Architecture & Surveying, D.P.C.
The Culver Road Armory, 145 Culver Road, Suite 160, Rochester, New York 14620
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12 of 12
Project No. 2104.23002

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APPENDIX D

HYDROLOGIC AND HYDRAULIC ANALYSIS

Maplewood Road Culvert StreamStats Report

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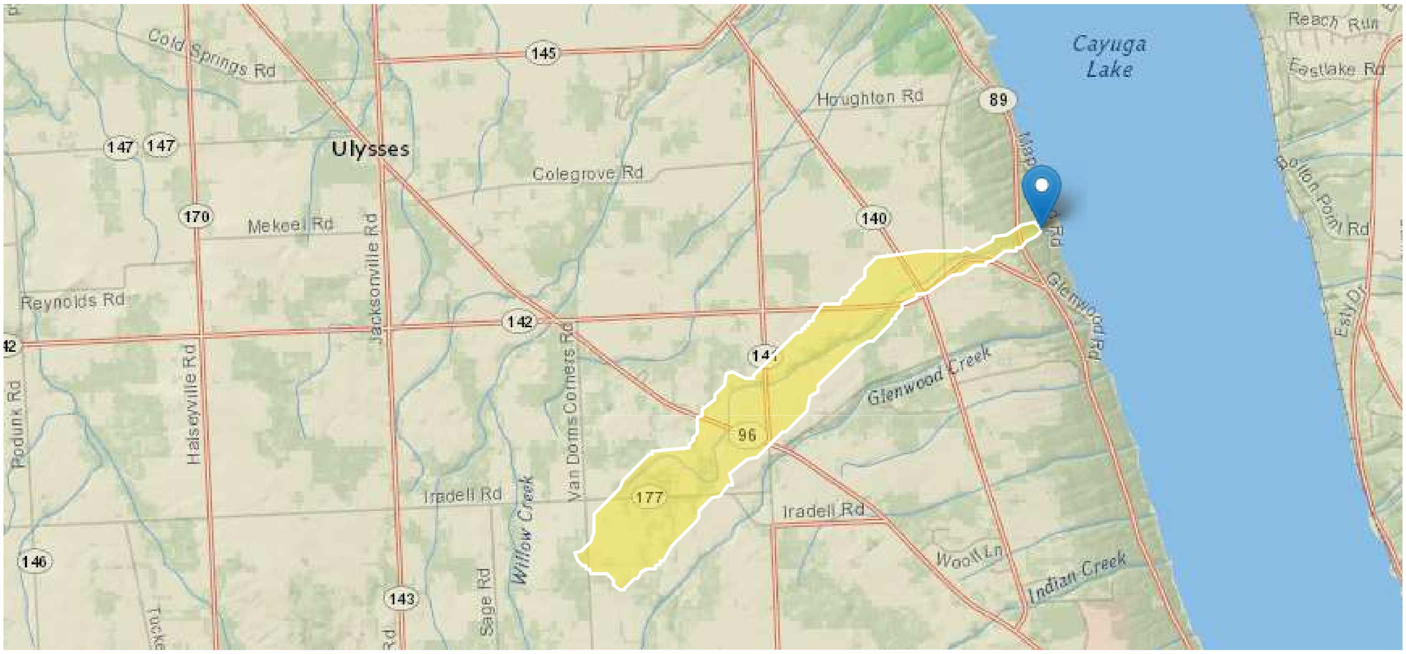
Time: 2024-02-28 16:13:03 -0500



Collapse All

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
BSLOPCM	Mean basin slope determined by summing lengths of all contours in basin mulitplying by contour interval and dividing product by drainage area	243	feet per mi
CENTROIDX	Basin centroid horizontal (x) location in state plane coordinates	370632.2	meters
CENTROIDY	Basin centroid vertical (y) location in state plane units	4705238.6	meters
CONTOUR	Total length of all elevation contours in drainage area in miles	2.19	miles
CSL1085LO	10-85 slope of lower half of main channel in feet per mile.	226	feet per mi
CSL1085UP	10-85 slope of upper half of main channel in feet per mile.	110	feet per mi
CSL10_85	Change in elevation divided by length between points 10 and 85 percent of distance along main channel to basin divide - main channel method not known	152	feet per mi
DRNAREA	Area that drains to a point on a stream	0.9	square miles
EL1200	Percentage of basin at or above 1200 ft elevation	17.5	percent
FOREST	Percentage of area covered by forest	21.9	percent
JULAVPRE	Mean July Precipitation	3.53	inches

Parameter Code	Parameter Description	Value	Unit
JUNAVPRE	Mean June Precipitation	3.97	inches
JUNMAXTMP	Maximum June Temperature, in degrees F	75.8	degrees F
LAGFACTOR	Lag Factor as defined in SIR 2006-5112	0.0237	dimensionless
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	8.5	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	1.07	percent
LENGTH	Length along the main channel from the measuring location extended to the basin divide	3.76	miles
MAR	Mean annual runoff for the period of record in inches	15	inches
MAYAVPRE	Mean May Precipitation	3.25	inches
MXSNO	50th percentile of seasonal maximum snow depth from Northeast Regional Climate Center atlas by Cember and Wilks, 1993	12.2	inches
OUTLETX	Basin outlet horizontal (x) location in state plane coordinates	373095	feet
OUTLETY	Basin outlet vertical (y) location in state plane coordinates	4706765	feet
PRECIP	Mean Annual Precipitation	33.9	inches
PRJUNAUG00	Basin average mean precip for June to August from PRISM 1971-2000	10.9	inches
SLOPERATIO	Ratio of main channel slope to basin slope as defined in SIR 2006-5112	0.63	dimensionless
SSURGOA	Percentage of area of Hydrologic Soil Type A from SSURGO	5.17	percent
SSURGOB	Percentage of area of Hydrologic Soil Type B from SSURGO	48.1	percent
STORAGE	Percentage of area of storage (lakes ponds reservoirs wetlands)	0	percent

Peak-Flow Statistics

Peak-Flow Statistics Parameters [2006 Full Region 6]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.9	square miles	0.58	2467
SLOPERATIO	Slope Ratio NY	0.63	dimensionless	0.019	0.698
EL1200	Percentage of Basin Above 1200 ft	17.5	percent	0	100
STORAGE	Percent Storage	0	percent	0	5.98
MAR	Mean Annual Runoff in inches	15	inches	9.49	22.77

Peak-Flow Statistics Flow Report [2006 Full Region 6]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE	ASEp	Equiv. Yrs.
80-percent AEP flood	54.4	ft^3/s	34.7	34.7	2.3

Statistic	Value	Unit	SE	ASEp	Equiv. Yrs.
66.7-percent AEP flood	68.8	ft^3/s	33.3	33.3	2
50-percent AEP flood	87.1	ft^3/s	32.3	32.3	1.9
20-percent AEP flood	134	ft^3/s	32.2	32.2	2.4
10-percent AEP flood	165	ft^3/s	32.9	32.9	3.1
4-percent AEP flood	205	ft^3/s	34.4	34.4	3.9
2-percent AEP flood	234	ft^3/s	35.8	35.8	4.5
1-percent AEP flood	262	ft^3/s	37.2	37.2	4.9
0.5-percent AEP flood	291	ft^3/s	39	39	5.2
0.2-percent AEP flood	328	ft^3/s	41.4	41.4	5.5

Peak-Flow Statistics Citations

Lumia, Richard, Freehafer, D.A., and Smith, M.J.,2006, Magnitude and Frequency of Floods in New York: U.S. Geological Survey Scientific Investigations Report 2006–5112, 152 p. (http://pubs.usgs.gov/sir/2006/5112/)

Application Version: 4.19.4
StreamStats Services Version: 1.2.22
NSS Services Version: 2.2.1

Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. — Friday, Mar 1 2024

Maplewood Road Existing Culvert - 50 Year Storm

Invert Elev Dn (ft)	=	406.72
Pipe Length (ft)	=	38.00
Slope (%)	=	4.58
Invert Elev Up (ft)	=	408.46
Rise (in)	=	93.0
Shape	=	Box
Span (in)	=	107.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Flared Wingwalls
Culvert Entrance	=	30D to 75D wingwall flares
Coeff. K,M,c,Y,k	=	0.026, 1, 0.0347, 0.81, 0.4

Embankment

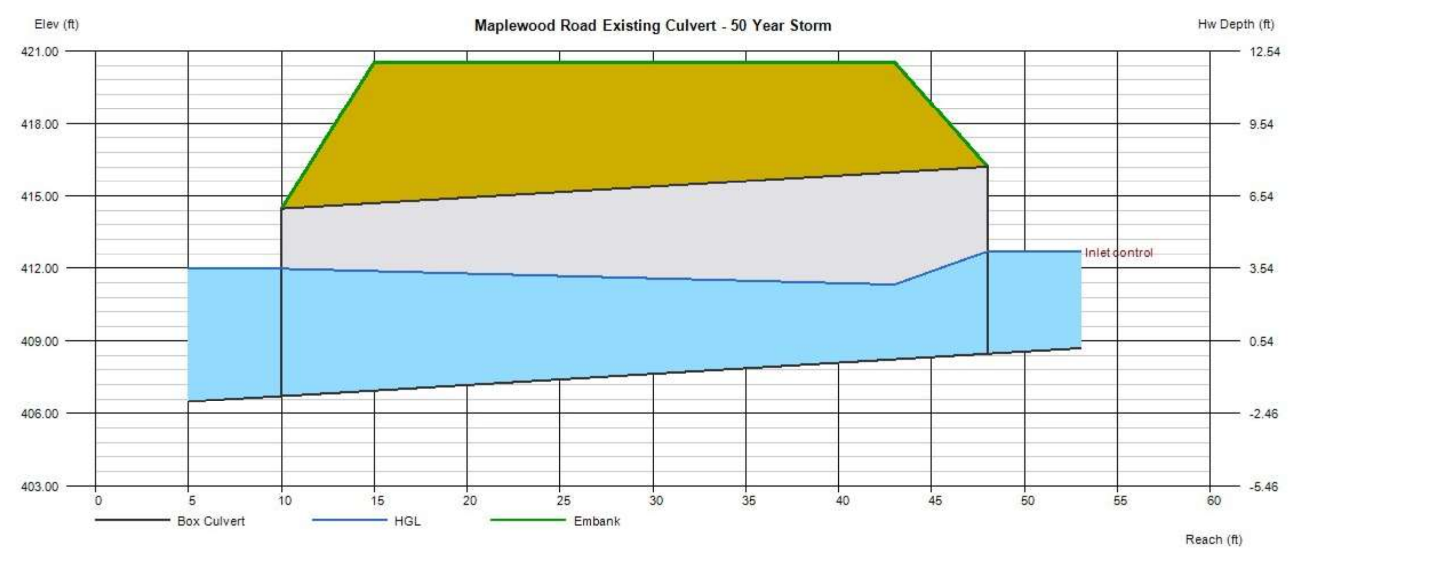
Top Elevation (ft)	=	420.54
Top Width (ft)	=	28.00
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	234.00
Qmax (cfs)	=	234.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	234.00
Qpipe (cfs)	=	234.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	4.99
Veloc Up (ft/s)	=	9.46
HGL Dn (ft)	=	411.98
HGL Up (ft)	=	411.23
Hw Elev (ft)	=	412.69
Hw/D (ft)	=	0.55
Flow Regime	=	Inlet Control



Culvert Report

Maplewood Road Existing Culvert - 100 Year Storm

Invert Elev Dn (ft)	=	406.72
Pipe Length (ft)	=	38.00
Slope (%)	=	4.58
Invert Elev Up (ft)	=	408.46
Rise (in)	=	93.0
Shape	=	Box
Span (in)	=	107.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Flared Wingwalls
Culvert Entrance	=	30D to 75D wingwall flares
Coeff. K,M,c,Y,k	=	0.026, 1, 0.0347, 0.81, 0.4

Embankment

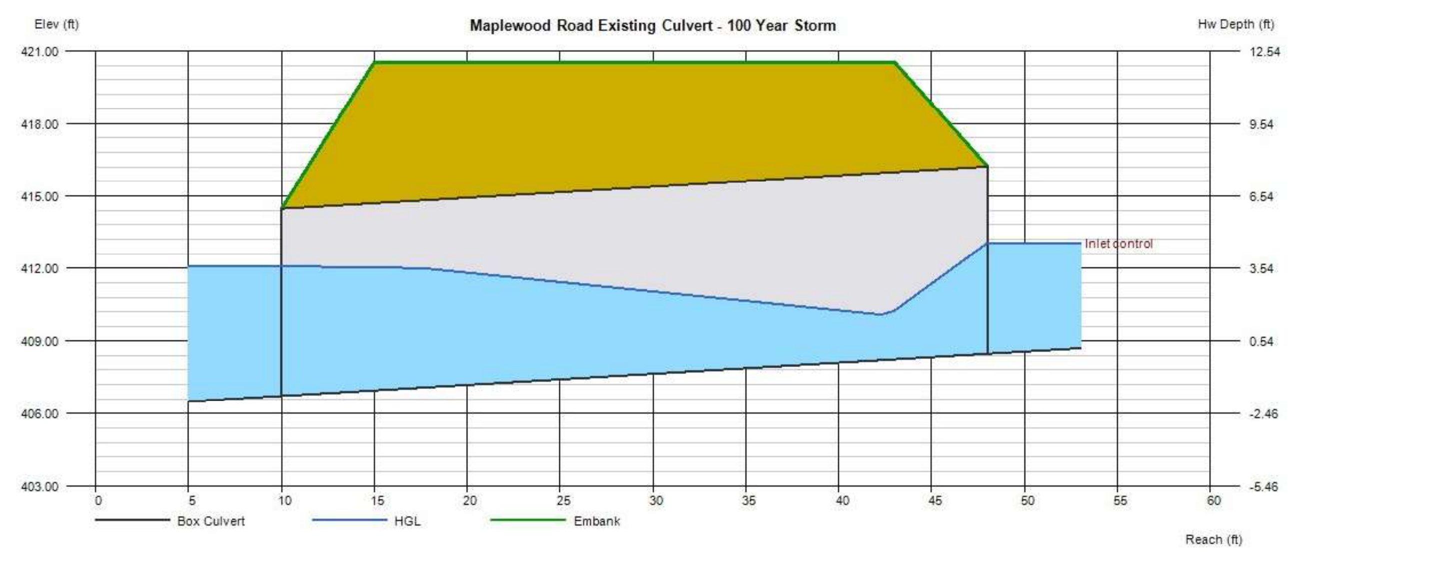
Top Elevation (ft)	=	420.54
Top Width (ft)	=	28.00
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	262.00
Qmax (cfs)	=	262.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	262.00
Qpipe (cfs)	=	262.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	5.47
Veloc Up (ft/s)	=	9.82
HGL Dn (ft)	=	412.09
HGL Up (ft)	=	411.45
Hw Elev (ft)	=	413.05
Hw/D (ft)	=	0.59
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Friday, Mar 15 2024

Maplewood Road Proposed Culvert - 50 Year Storm

Invert Elev Dn (ft)	= 406.72
Pipe Length (ft)	= 38.00
Slope (%)	= 4.58
Invert Elev Up (ft)	= 408.46
Rise (in)	= 104.0
Shape	= Box
Span (in)	= 108.0
No. Barrels	= 1
n-Value	= 0.035
Culvert Type	= Flared Wingwalls
Culvert Entrance	= 30D to 75D wingwall flares
Coeff. K,M,c,Y,k	= 0.026, 1, 0.0347, 0.81, 0.4

Embankment

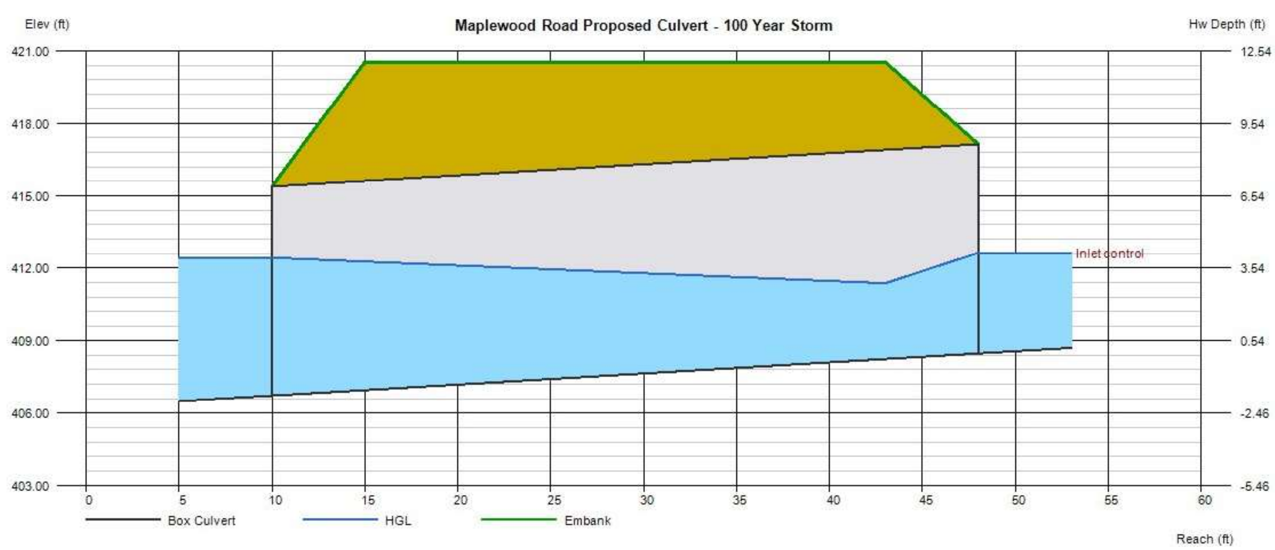
Top Elevation (ft)	= 420.54
Top Width (ft)	= 28.00
Crest Width (ft)	= 100.00

Calculations

Qmin (cfs)	= 234.00
Qmax (cfs)	= 234.00
Tailwater Elev (ft)	= (dc+D)/2

Highlighted

Qtotal (cfs)	= 234.00
Qpipe (cfs)	= 234.00
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 4.55
Veloc Up (ft/s)	= 9.43
HGL Dn (ft)	= 412.43
HGL Up (ft)	= 411.22
Hw Elev (ft)	= 412.63
Hw/D (ft)	= 0.48
Flow Regime	= Inlet Control



Culvert Report

Maplewood Road Proposed Culvert - 100 Year Storm

Invert Elev Dn (ft)	= 406.72
Pipe Length (ft)	= 38.00
Slope (%)	= 4.58
Invert Elev Up (ft)	= 408.46
Rise (in)	= 104.0
Shape	= Box
Span (in)	= 108.0
No. Barrels	= 1
n-Value	= 0.035
Culvert Type	= Flared Wingwalls
Culvert Entrance	= 30D to 75D wingwall flares
Coeff. K,M,c,Y,k	= 0.026, 1, 0.0347, 0.81, 0.4

Embankment

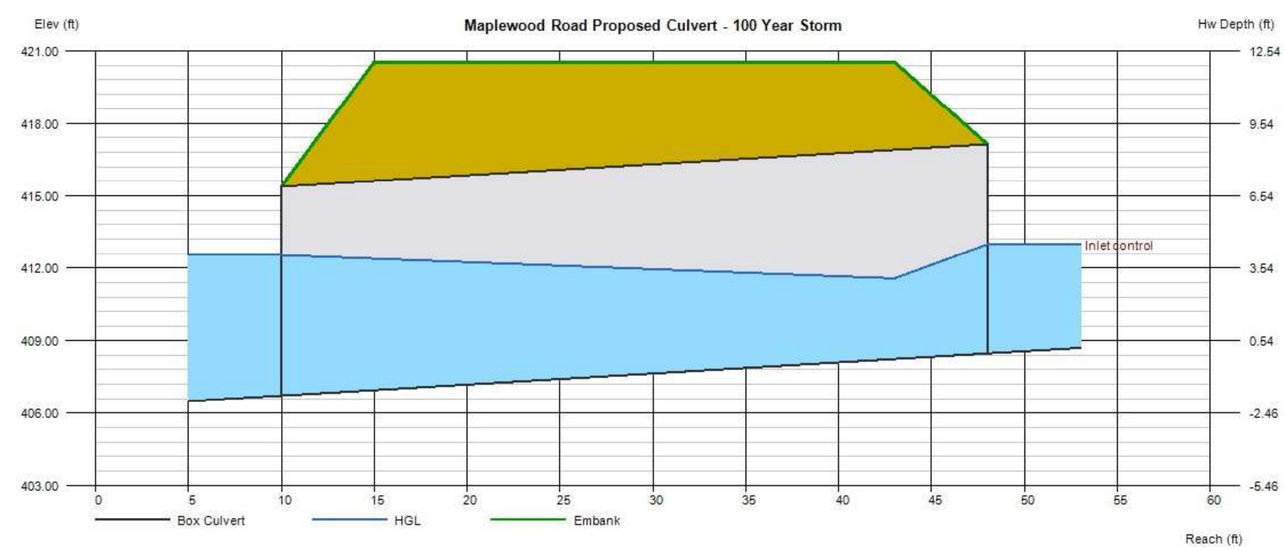
Top Elevation (ft)	= 420.54
Top Width (ft)	= 28.00
Crest Width (ft)	= 100.00

Calculations

Qmin (cfs)	= 262.00
Qmax (cfs)	= 262.00
Tailwater Elev (ft)	= (dc+D)/2

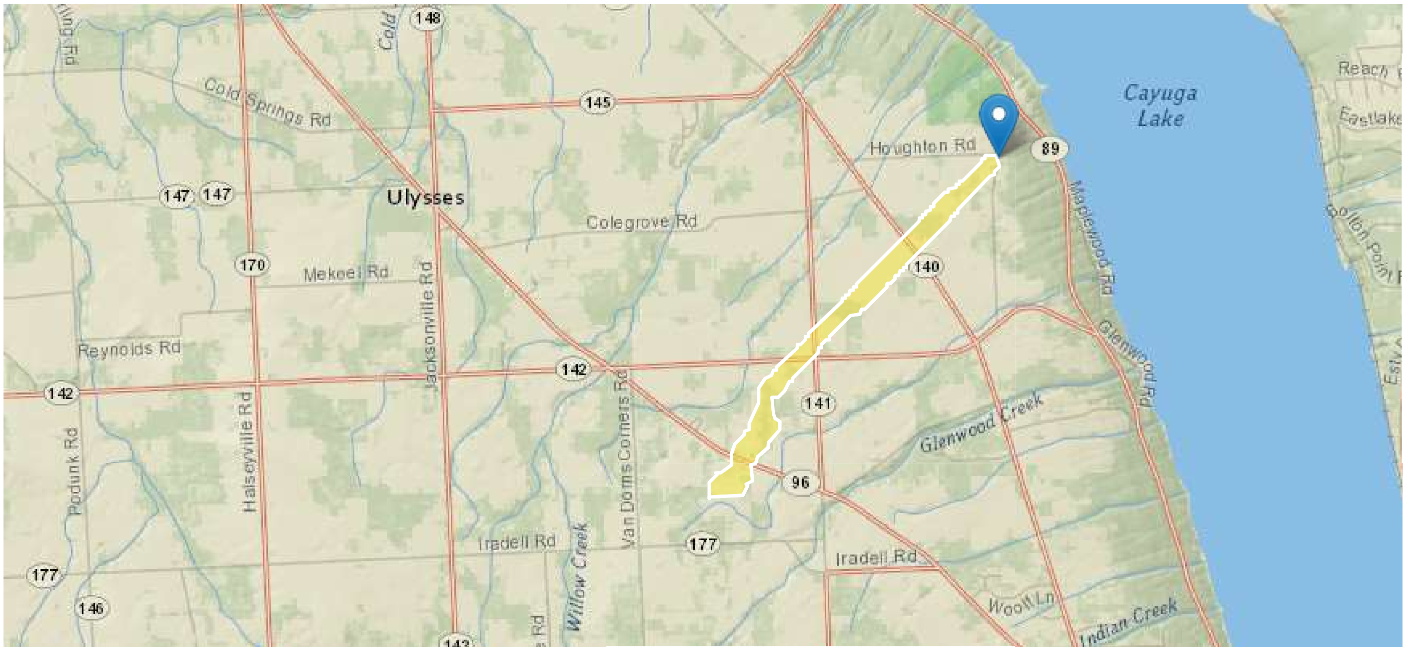
Highlighted

Qtotal (cfs)	= 262.00
Qpipe (cfs)	= 262.00
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 5.00
Veloc Up (ft/s)	= 9.79
HGL Dn (ft)	= 412.54
HGL Up (ft)	= 411.43
Hw Elev (ft)	= 412.98
Hw/D (ft)	= 0.52
Flow Regime	= Inlet Control



Garrett Road Culvert StreamStats Report

Region ID: NY
Workspace ID: NY20240229131444620000
Clicked Point (Latitude, Longitude): 42.51233, -76.55459
Time: 2024-02-29 08:15:06 -0500



Collapse All

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
BSLOPCM	Mean basin slope determined by summing lengths of all contours in basin mulitplying by contour interval and dividing product by drainage area	211	feet per mi
CENTROIDX	Basin centroid horizontal (x) location in state plane coordinates	370870	meters
CENTROIDY	Basin centroid vertical (y) location in state plane units	4706380	meters
CONTOUR	Total length of all elevation contours in drainage area in miles	0.6	miles
CSL1085LO	10-85 slope of lower half of main channel in feet per mile.	244	feet per mi
CSL1085UP	10-85 slope of upper half of main channel in feet per mile.	130	feet per mi
CSL10_85	Change in elevation divided by length between points 10 and 85 percent of distance along main channel to basin divide - main channel method not known	180	feet per mi
DRNAREA	Area that drains to a point on a stream	0.28	square miles
EL1200	Percentage of basin at or above 1200 ft elevation	0	percent
FOREST	Percentage of area covered by forest	27.2	percent
JULAVPRE	Mean July Precipitation	3.48	inches

Parameter Code	Parameter Description	Value	Unit
JUNAVPRE	Mean June Precipitation	3.89	inches
JUNMAXTMP	Maximum June Temperature, in degrees F	76.3	degrees F
LAGFACTOR	Lag Factor as defined in SIR 2006-5112	0.0148	dimensionless
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	6.19	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	0.56	percent
LENGTH	Length along the main channel from the measuring location extended to the basin divide	2.66	miles
MAR	Mean annual runoff for the period of record in inches	15.1	inches
MAYAVPRE	Mean May Precipitation	3.2	inches
MXSNO	50th percentile of seasonal maximum snow depth from Northeast Regional Climate Center atlas by Cember and Wilks, 1993	12.2	inches
OUTLETX	Basin outlet horizontal (x) location in state plane coordinates	372285	feet
OUTLETY	Basin outlet vertical (y) location in state plane coordinates	4707835	feet
PRECIP	Mean Annual Precipitation	33.9	inches
PRJUNAUG00	Basin average mean precip for June to August from PRISM 1971-2000	10.7	inches
SLOPERATIO	Ratio of main channel slope to basin slope as defined in SIR 2006-5112	0.85	dimensionless
SSURGOA	Percentage of area of Hydrologic Soil Type A from SSURGO	0	percent
SSURGOB	Percentage of area of Hydrologic Soil Type B from SSURGO	49.4	percent
STORAGE	Percentage of area of storage (lakes ponds reservoirs wetlands)	0	percent

Peak-Flow Statistics

Peak-Flow Statistics Parameters [2006 Full Region 6]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.28	square miles	0.58	2467
SLOPERATIO	Slope Ratio NY	0.85	dimensionless	0.019	0.698
EL1200	Percentage of Basin Above 1200 ft	0	percent	0	100
STORAGE	Percent Storage	0	percent	0	5.98
MAR	Mean Annual Runoff in inches	15.1	inches	9.49	22.77

Peak-Flow Statistics Disclaimers [2006 Full Region 6]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Peak-Flow Statistics Flow Report [2006 Full Region 6]

Statistic	Value	Unit
80-percent AEP flood	18.4	ft^3/s
66.7-percent AEP flood	22.6	ft^3/s
50-percent AEP flood	27.7	ft^3/s
20-percent AEP flood	39.9	ft^3/s
10-percent AEP flood	47.4	ft^3/s
4-percent AEP flood	56.2	ft^3/s
2-percent AEP flood	62.5	ft^3/s
1-percent AEP flood	68.2	ft^3/s
0.5-percent AEP flood	74	ft^3/s
0.2-percent AEP flood	80.9	ft^3/s

Peak-Flow Statistics Citations

Lumia, Richard, Freehafer, D.A., and Smith, M.J.,2006, Magnitude and Frequency of Floods in New York: U.S. Geological Survey Scientific Investigations Report 2006–5112, 152 p. (http://pubs.usgs.gov/sir/2006/5112/)

Application Version: 4.19.4
StreamStats Services Version: 1.2.22
NSS Services Version: 2.2.1

Culvert Report

Garrett Road Existing Culvert - 50 Year Storm

Invert Elev Dn (ft)	=	620.54
Pipe Length (ft)	=	53.00
Slope (%)	=	5.09
Invert Elev Up (ft)	=	623.24
Rise (in)	=	45.8
Shape	=	Circular
Span (in)	=	45.8
No. Barrels	=	1
n-Value	=	0.023
Culvert Type	=	Circular Corrugate Metal Pipe
Culvert Entrance	=	Headwall
Coeff. K,M,c,Y,k	=	0.0078, 2, 0.0379, 0.69, 0.5

Embankment

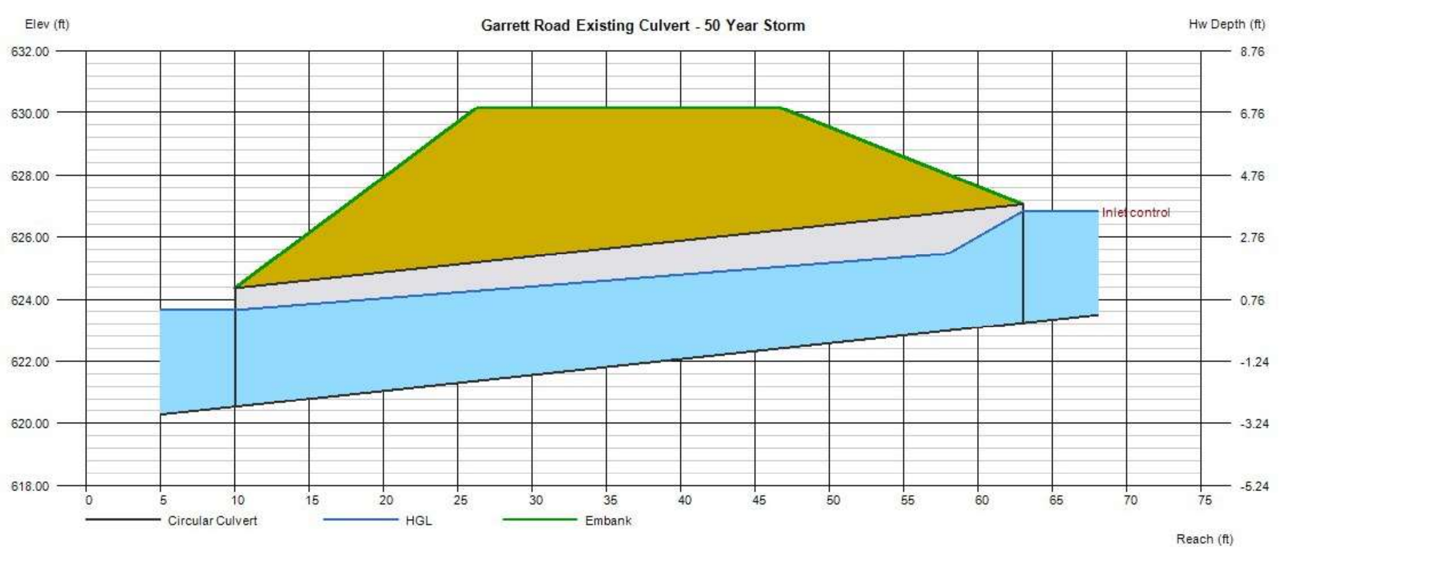
Top Elevation (ft)	=	630.15
Top Width (ft)	=	20.50
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	62.50
Qmax (cfs)	=	62.50
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	62.50
Qpipe (cfs)	=	62.50
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	6.25
Veloc Up (ft/s)	=	8.19
HGL Dn (ft)	=	623.66
HGL Up (ft)	=	625.66
Hw Elev (ft)	=	626.83
Hw/D (ft)	=	0.94
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Friday, Mar 1 2024

Garrett Road Existing Culvert - 100 Year Storm

Invert Elev Dn (ft)	=	620.54
Pipe Length (ft)	=	53.00
Slope (%)	=	5.09
Invert Elev Up (ft)	=	623.24
Rise (in)	=	45.8
Shape	=	Circular
Span (in)	=	45.8
No. Barrels	=	1
n-Value	=	0.023
Culvert Type	=	Circular Corrugate Metal Pipe
Culvert Entrance	=	Headwall
Coeff. K,M,c,Y,k	=	0.0078, 2, 0.0379, 0.69, 0.5

Embankment

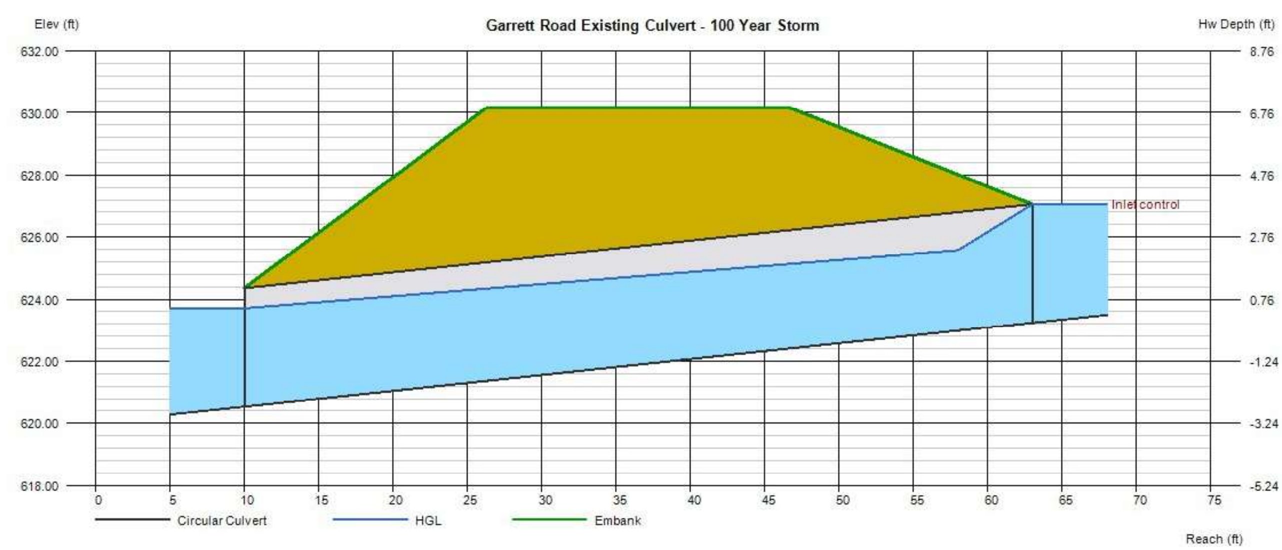
Top Elevation (ft)	=	630.15
Top Width (ft)	=	20.50
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	68.20
Qmax (cfs)	=	68.20
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	68.20
Qpipe (cfs)	=	68.20
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	6.71
Veloc Up (ft/s)	=	8.48
HGL Dn (ft)	=	623.71
HGL Up (ft)	=	625.77
Hw Elev (ft)	=	627.07
Hw/D (ft)	=	1.00
Flow Regime	=	Inlet Control



Culvert Report

Garrett Road Proposed Culvert - 50 Year Storm

Invert Elev Dn (ft)	=	618.82
Pipe Length (ft)	=	53.00
Slope (%)	=	8.34
Invert Elev Up (ft)	=	623.24
Rise (in)	=	28.5
Shape	=	Elliptical
Span (in)	=	84.0
No. Barrels	=	1
n-Value	=	0.035
Culvert Type	=	Elliptical Inlet Face (E)
Culvert Entrance	=	Tapered inlet-thin edge, prejecting (E)
Coeff. K,M,c,Y,k	=	0.547, 0.8, 0.0598, 0.75, 0.7

Embankment

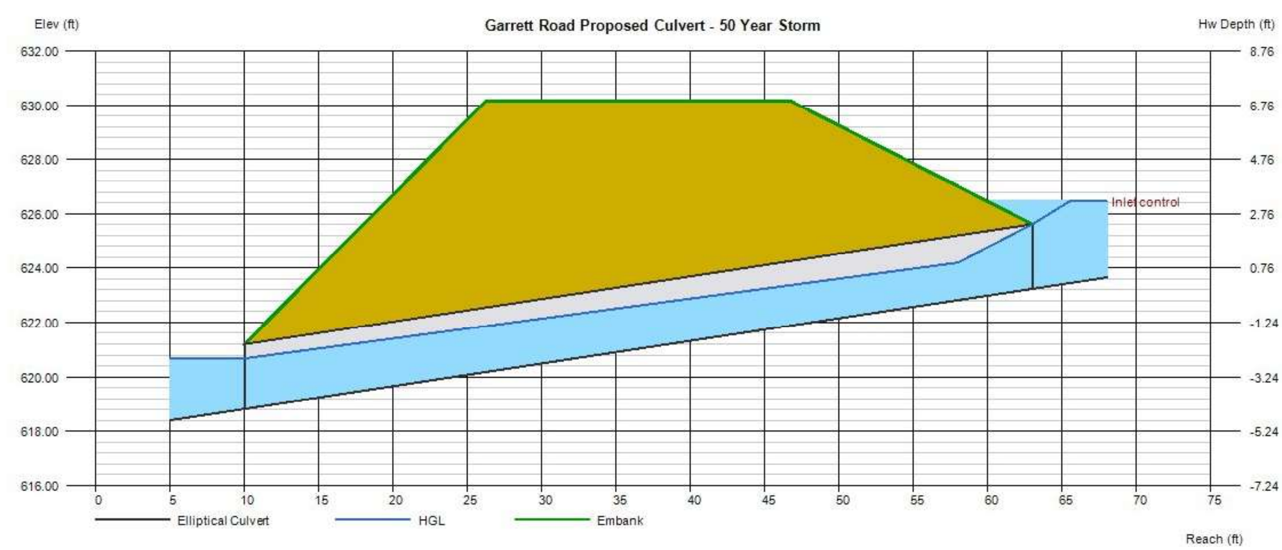
Top Elevation (ft)	=	630.15
Top Width (ft)	=	20.50
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	62.50
Qmax (cfs)	=	62.50
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	62.50
Qpipe (cfs)	=	62.50
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	5.50
Veloc Up (ft/s)	=	8.18
HGL Dn (ft)	=	620.67
HGL Up (ft)	=	624.57
Hw Elev (ft)	=	626.46
Hw/D (ft)	=	1.35
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Mar 18 2024

Garrett Road Proposed Culvert - 100 Year Storm

Invert Elev Dn (ft)	=	618.82
Pipe Length (ft)	=	53.00
Slope (%)	=	8.34
Invert Elev Up (ft)	=	623.24
Rise (in)	=	28.5
Shape	=	Elliptical
Span (in)	=	84.0
No. Barrels	=	1
n-Value	=	0.035
Culvert Type	=	Elliptical Inlet Face (E)
Culvert Entrance	=	Tapered inlet-thin edge, prejecting (E)
Coeff. K,M,c,Y,k	=	0.547, 0.8, 0.0598, 0.75, 0.7

Embankment

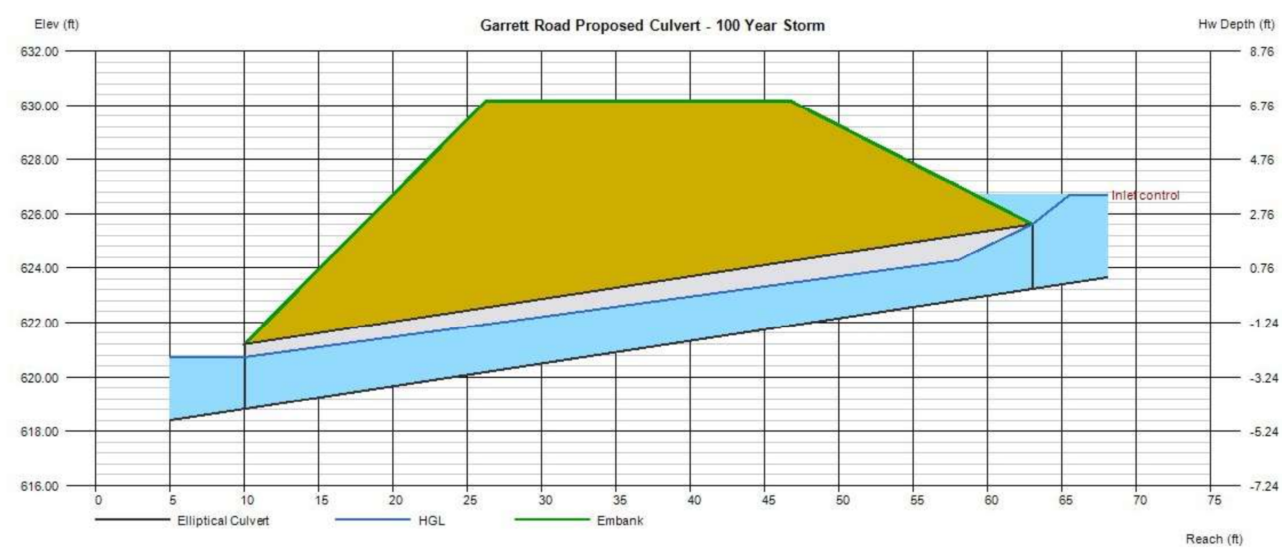
Top Elevation (ft)	=	630.15
Top Width (ft)	=	20.50
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	68.20
Qmax (cfs)	=	68.20
Tailwater Elev (ft)	=	(dc+D)/2

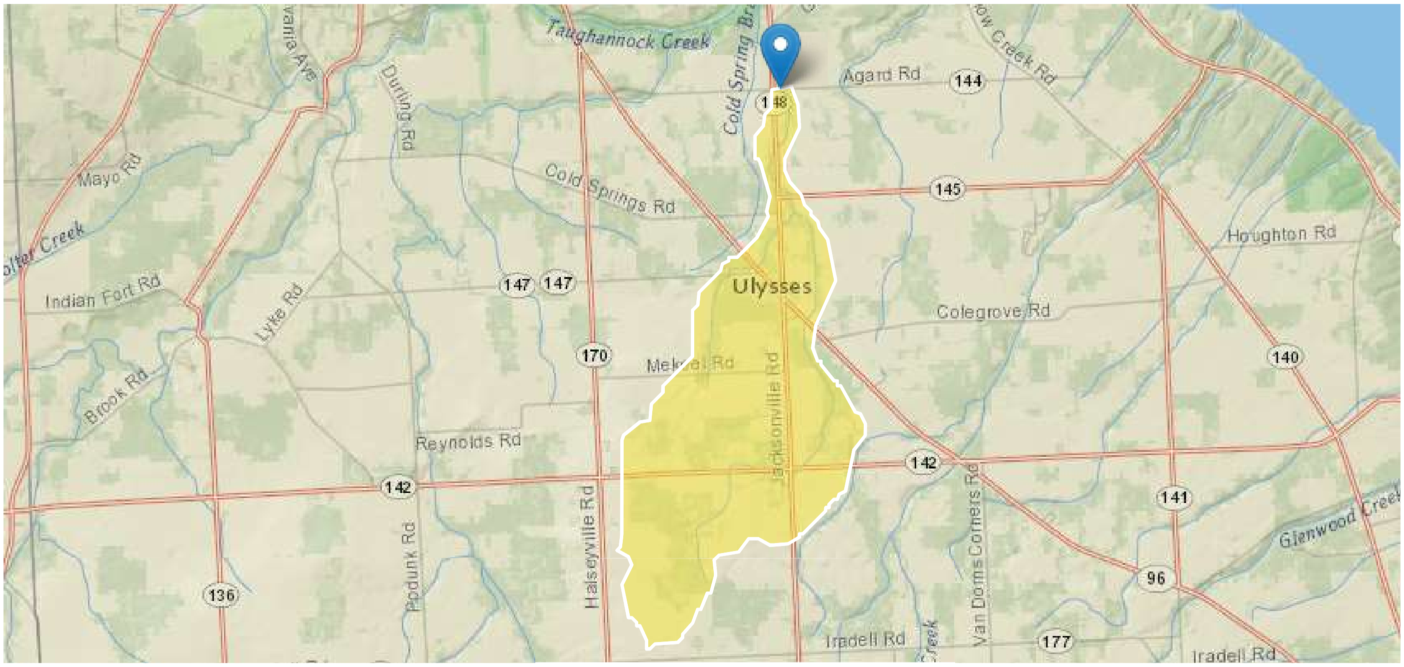
Highlighted

Qtotal (cfs)	=	68.20
Qpipe (cfs)	=	68.20
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	5.77
Veloc Up (ft/s)	=	8.10
HGL Dn (ft)	=	620.72
HGL Up (ft)	=	624.67
Hw Elev (ft)	=	626.69
Hw/D (ft)	=	1.45
Flow Regime	=	Inlet Control



Agard Road Culvert StreamStats Report

Region ID: NY
Workspace ID: NY20240229133657922000
Clicked Point (Latitude, Longitude): 42.52434, -76.61506
Time: 2024-02-29 08:37:18 -0500



Collapse All

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
BSLOPCM	Mean basin slope determined by summing lengths of all contours in basin mulitplying by contour interval and dividing product by drainage area	210	feet per mi
CENTROIDX	Basin centroid horizontal (x) location in state plane coordinates	366951.4	meters
CENTROIDY	Basin centroid vertical (y) location in state plane units	4706503.6	meters
CONTOUR	Total length of all elevation contours in drainage area in miles	3.82	miles
CSL1085LO	10-85 slope of lower half of main channel in feet per mile.	118	feet per mi
CSL1085UP	10-85 slope of upper half of main channel in feet per mile.	119	feet per mi
CSL10_85	Change in elevation divided by length between points 10 and 85 percent of distance along main channel to basin divide - main channel method not known	113	feet per mi
DRNAREA	Area that drains to a point on a stream	1.82	square miles
EL1200	Percentage of basin at or above 1200 ft elevation	30.4	percent
FOREST	Percentage of area covered by forest	33.8	percent

Parameter Code	Parameter Description	Value	Unit
JULAVPRE	Mean July Precipitation	3.55	inches
JUNAVPRE	Mean June Precipitation	4.04	inches
JUNMAXTMP	Maximum June Temperature, in degrees F	75.6	degrees F
LAGFACTOR	Lag Factor as defined in SIR 2006-5112	0.034	dimensionless
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	6.31	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	0.89	percent
LENGTH	Length along the main channel from the measuring location extended to the basin divide	4.08	miles
MAR	Mean annual runoff for the period of record in inches	14.4	inches
MAYAVPRE	Mean May Precipitation	3.28	inches
MXSNO	50th percentile of seasonal maximum snow depth from Northeast Regional Climate Center atlas by Cember and Wilks, 1993	12	inches
OUTLETX	Basin outlet horizontal (x) location in state plane coordinates	367345	feet
OUTLETY	Basin outlet vertical (y) location in state plane coordinates	4709265	feet
PRECIP	Mean Annual Precipitation	33.6	inches
PRJUNAUG00	Basin average mean precip for June to August from PRISM 1971-2000	11	inches
SLOPERATIO	Ratio of main channel slope to basin slope as defined in SIR 2006-5112	0.54	dimensionless
SSURGOA	Percentage of area of Hydrologic Soil Type A from SSURGO	0.0613	percent
SSURGOB	Percentage of area of Hydrologic Soil Type B from SSURGO	68.1	percent
STORAGE	Percentage of area of storage (lakes ponds reservoirs wetlands)	0.27	percent

Peak-Flow Statistics

Peak-Flow Statistics Parameters [2006 Full Region 6]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.82	square miles	0.58	2467
SLOPERATIO	Slope Ratio NY	0.54	dimensionless	0.019	0.698
EL1200	Percentage of Basin Above 1200 ft	30.4	percent	0	100
STORAGE	Percent Storage	0.27	percent	0	5.98
MAR	Mean Annual Runoff in inches	14.4	inches	9.49	22.77

Peak-Flow Statistics Flow Report [2006 Full Region 6]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE	ASEp	Equiv. Yrs.
80-percent AEP flood	83.5	ft^3/s	34.7	34.7	2.3
66.7-percent AEP flood	106	ft^3/s	33.3	33.3	2
50-percent AEP flood	136	ft^3/s	32.3	32.3	1.9
20-percent AEP flood	214	ft^3/s	32.2	32.2	2.4
10-percent AEP flood	267	ft^3/s	32.9	32.9	3.1
4-percent AEP flood	337	ft^3/s	34.4	34.4	3.9
2-percent AEP flood	389	ft^3/s	35.8	35.8	4.5
1-percent AEP flood	442	ft^3/s	37.2	37.2	4.9
0.5-percent AEP flood	495	ft^3/s	39	39	5.2
0.2-percent AEP flood	566	ft^3/s	41.4	41.4	5.5

Peak-Flow Statistics Citations

Lumia, Richard, Freehafer, D.A., and Smith, M.J.,2006, Magnitude and Frequency of Floods in New York: U.S. Geological Survey Scientific Investigations Report 2006–5112, 152 p. (http://pubs.usgs.gov/sir/2006/5112/)

Application Version: 4.19.4
StreamStats Services Version: 1.2.22
NSS Services Version: 2.2.1

Culvert Report

Agard Road Existing Culvert - 50 Year Storm

Invert Elev Dn (ft)	=	859.87
Pipe Length (ft)	=	70.00
Slope (%)	=	0.34
Invert Elev Up (ft)	=	860.11
Rise (in)	=	46.5
Shape	=	Elliptical
Span (in)	=	65.0
No. Barrels	=	1
n-Value	=	0.023
Culvert Type	=	Elliptical Inlet Face (E)
Culvert Entrance	=	Tapered inlet-thin edge, prejecting (E)
Coeff. K,M,c,Y,k	=	0.547, 0.8, 0.0598, 0.75, 0.7

Embankment

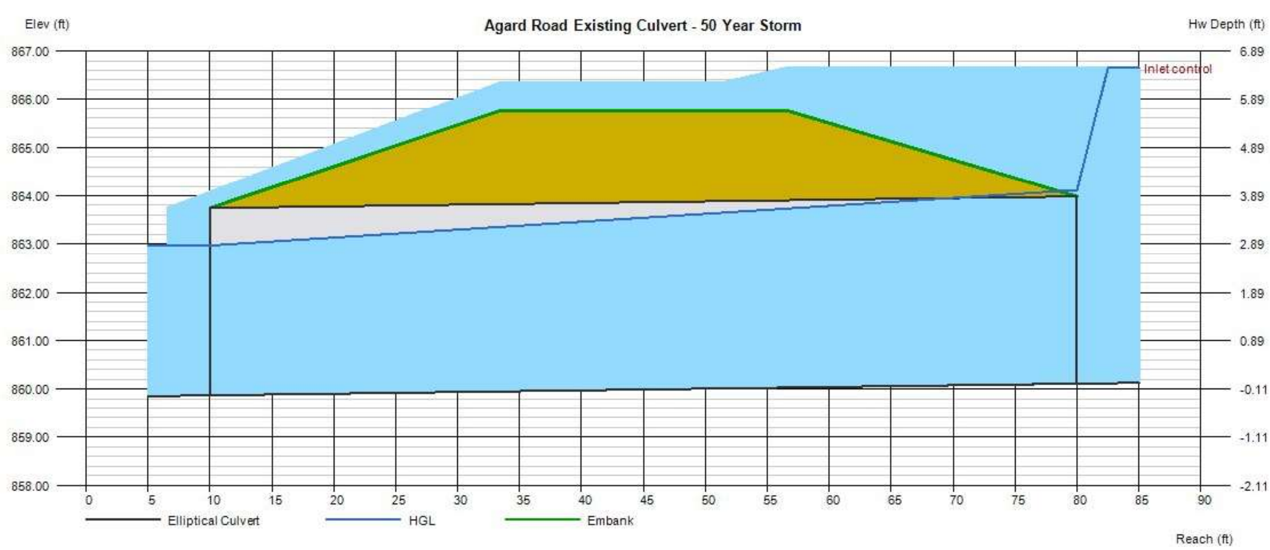
Top Elevation (ft)	=	865.76
Top Width (ft)	=	23.00
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	389.00
Qmax (cfs)	=	389.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	389.00
Qpipe (cfs)	=	128.68
Qovertop (cfs)	=	260.32
Veloc Dn (ft/s)	=	8.97
Veloc Up (ft/s)	=	7.81
HGL Dn (ft)	=	862.97
HGL Up (ft)	=	864.12
Hw Elev (ft)	=	866.65
Hw/D (ft)	=	1.69
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. — Friday, Mar 1 2024

Agard Road Existing Culvert - 100 Year Storm

Invert Elev Dn (ft)	= 859.87
Pipe Length (ft)	= 70.00
Slope (%)	= 0.34
Invert Elev Up (ft)	= 860.11
Rise (in)	= 46.5
Shape	= Elliptical
Span (in)	= 65.0
No. Barrels	= 1
n-Value	= 0.023
Culvert Type	= Elliptical Inlet Face (E)
Culvert Entrance	= Tapered inlet-thin edge, prejecting (E)
Coeff. K,M,c,Y,k	= 0.547, 0.8, 0.0598, 0.75, 0.7

Embankment

Top Elevation (ft)	= 865.76
Top Width (ft)	= 23.00
Crest Width (ft)	= 100.00

Calculations

Qmin (cfs)	= 442.00
Qmax (cfs)	= 442.00
Tailwater Elev (ft)	= (dc+D)/2

Highlighted

Qtotal (cfs)	= 442.00
Qpipe (cfs)	= 130.68
Qovertop (cfs)	= 311.32
Veloc Dn (ft/s)	= 8.76
Veloc Up (ft/s)	= 7.93
HGL Dn (ft)	= 863.05
HGL Up (ft)	= 864.10
Hw Elev (ft)	= 866.77
Hw/D (ft)	= 1.72
Flow Regime	= Inlet Control

Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Mar 18 2024

Agard Road Proposed Culvert - 50 Year Storm

Invert Elev Dn (ft)	=	859.87
Pipe Length (ft)	=	70.00
Slope (%)	=	0.34
Invert Elev Up (ft)	=	860.11
Rise (in)	=	45.0
Shape	=	Box
Span (in)	=	234.0
No. Barrels	=	1
n-Value	=	0.035
Culvert Type	=	Flared Wingwalls, Top Edge Bevel
Culvert Entrance	=	18D to 33.7D wingwall flare, d=0.083D
Coeff. K,M,c,Y,k	=	0.486, 0.667, 0.0249, 0.83, 0.2

Embankment

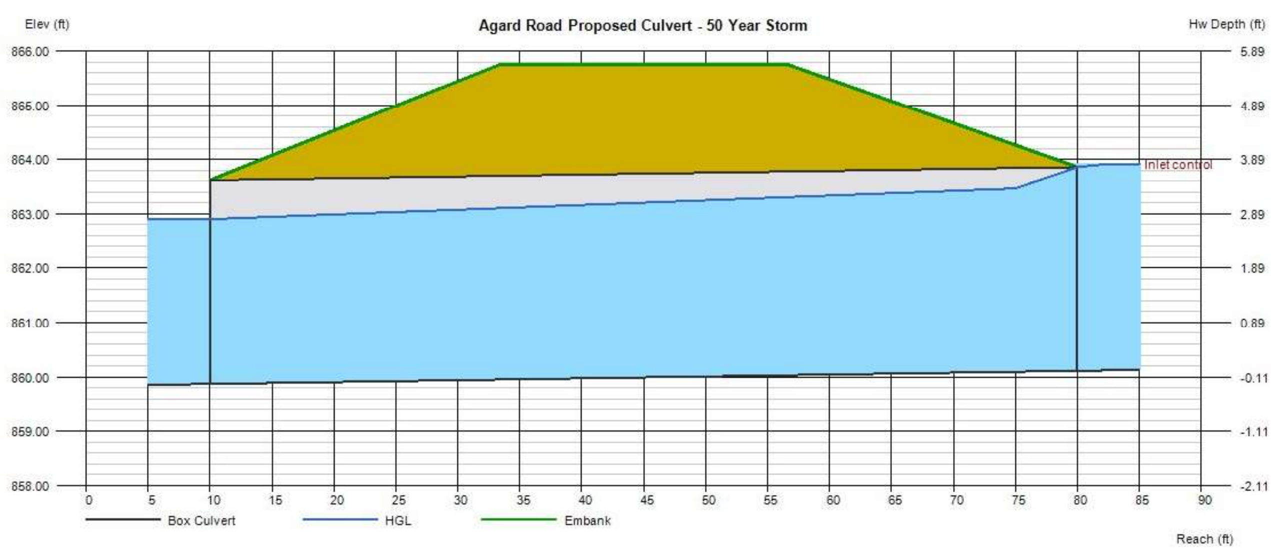
Top Elevation (ft)	=	865.76
Top Width (ft)	=	23.00
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	389.00
Qmax (cfs)	=	389.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	389.00
Qpipe (cfs)	=	389.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	6.58
Veloc Up (ft/s)	=	5.86
HGL Dn (ft)	=	862.90
HGL Up (ft)	=	863.51
Hw Elev (ft)	=	863.92
Hw/D (ft)	=	1.02
Flow Regime	=	Inlet Control



Culvert Report

Agard Road Proposed Culvert - 100 Year Storm

Invert Elev Dn (ft)	=	859.87
Pipe Length (ft)	=	70.00
Slope (%)	=	0.34
Invert Elev Up (ft)	=	860.11
Rise (in)	=	45.0
Shape	=	Box
Span (in)	=	234.0
No. Barrels	=	1
n-Value	=	0.035
Culvert Type	=	Flared Wingwalls, Top Edge Bevel
Culvert Entrance	=	18D to 33.7D wingwall flare, d=0.083D
Coeff. K,M,c,Y,k	=	0.486, 0.667, 0.0249, 0.83, 0.2

Embankment

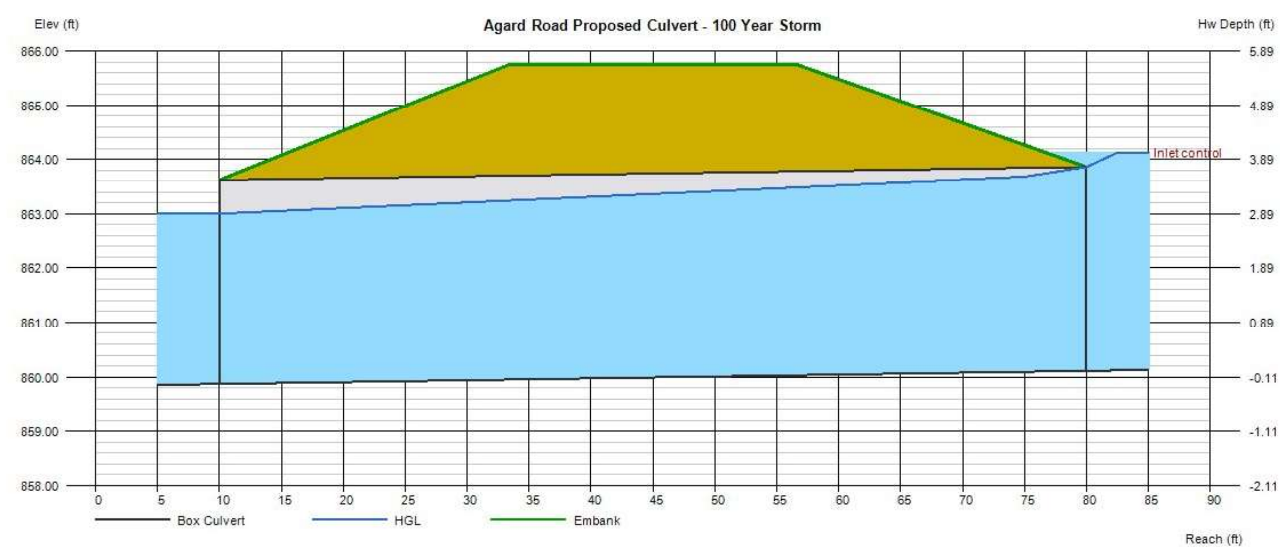
Top Elevation (ft)	=	865.76
Top Width (ft)	=	23.00
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	442.00
Qmax (cfs)	=	442.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	442.00
Qpipe (cfs)	=	442.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	7.23
Veloc Up (ft/s)	=	6.25
HGL Dn (ft)	=	863.00
HGL Up (ft)	=	863.73
Hw Elev (ft)	=	864.13
Hw/D (ft)	=	1.07
Flow Regime	=	Inlet Control



Curry Road Culvert StreamStats Report

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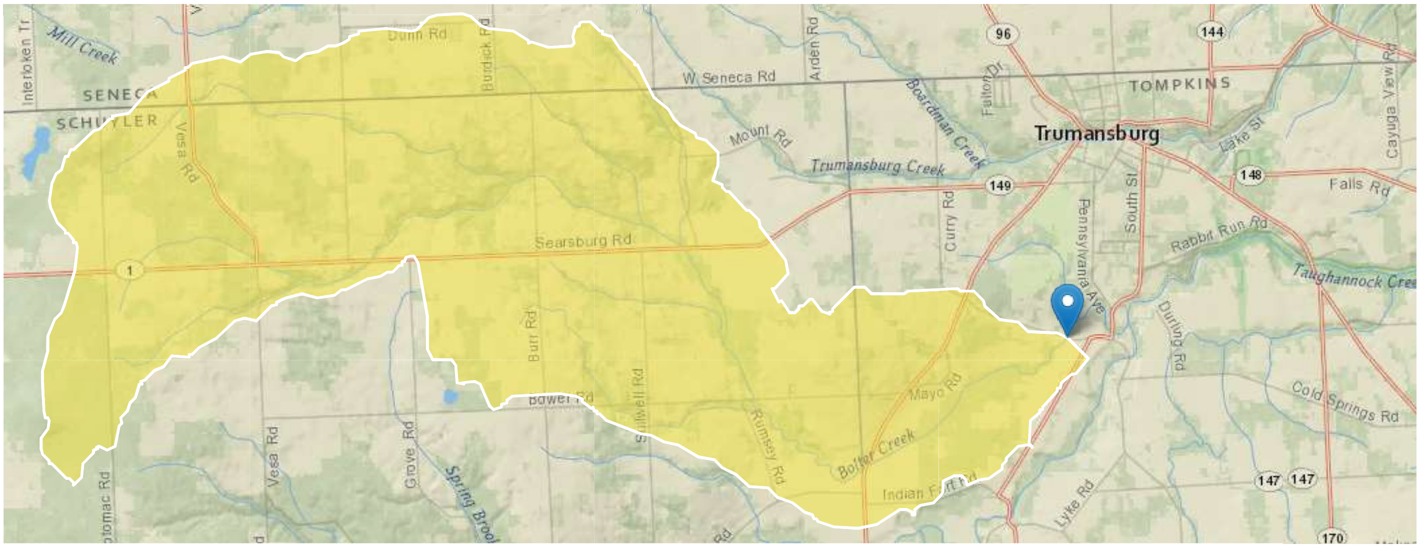
Workspace ID: NY20240229140051415000
Clicked Point (Latitude, Longitude): 42.52272, -76.66816
Time: 2024-02-29 09:01:13 -0500



Collapse All

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
BSLOPCM	Mean basin slope determined by summing lengths of all contours in basin mulitplying by contour interval and dividing product by drainage area	260	feet per mi
CENTROIDX	Basin centroid horizontal (x) location in state plane coordinates	357256.9	meters
CENTROIDY	Basin centroid vertical (y) location in state plane units	4710050.2	meters
CONTOUR	Total length of all elevation contours in drainage area in miles	29.98	miles
CSL1085LO	10-85 slope of lower half of main channel in feet per mile.	46.5	feet per mi
CSL1085UP	10-85 slope of upper half of main channel in feet per mile.	138	feet per mi
CSL10_85	Change in elevation divided by length between points 10 and 85 percent of distance along main channel to basin divide - main channel method not known	90	feet per mi
DRNAREA	Area that drains to a point on a stream	11.5	square miles
EL1200	Percentage of basin at or above 1200 ft elevation	68.6	percent
FOREST	Percentage of area covered by forest	42.4	percent
JULAVPRE	Mean July Precipitation	3.85	inches
JUNAVPRE	Mean June Precipitation	4.16	inches
JUNMAXTMP	Maximum June Temperature, in degrees F	74.8	degrees F
LAGFACTOR	Lag Factor as defined in SIR 2006-5112	0.12	dimensionless
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	3.6	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	0.43	percent
LENGTH	Length along the main channel from the measuring location extended to the basin divide	10.1	miles
MAR	Mean annual runoff for the period of record in inches	13.4	inches
MAYAVPRE	Mean May Precipitation	3.36	inches
MXSNO	50th percentile of seasonal maximum snow depth from Northeast Regional Climate Center atlas by Cember and Wilks, 1993	11.7	inches

Parameter Code	Parameter Description	Value	Unit
OUTLETX	Basin outlet horizontal (x) location in state plane coordinates	362975	feet
OUTLETY	Basin outlet vertical (y) location in state plane coordinates	4709165	feet
PRECIP	Mean Annual Precipitation	32.5	inches
PRJUNAUG00	Basin average mean precip for June to August from PRISM 1971-2000	11.6	inches
SLOPERATIO	Ratio of main channel slope to basin slope as defined in SIR 2006-5112	0.35	dimensionless
SSURGOA	Percentage of area of Hydrologic Soil Type A from SSURGO	6.18	percent
SSURGOB	Percentage of area of Hydrologic Soil Type B from SSURGO	31.2	percent
STORAGE	Percentage of area of storage (lakes ponds reservoirs wetlands)	0.0465	percent

Peak-Flow Statistics

Peak-Flow Statistics Parameters [2006 Full Region 6]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	11.5	square miles	0.58	2467
SLOPERATIO	Slope Ratio NY	0.35	dimensionless	0.019	0.698
EL1200	Percentage of Basin Above 1200 ft	68.6	percent	0	100
STORAGE	Percent Storage	0.0465	percent	0	5.98
MAR	Mean Annual Runoff in inches	13.4	inches	9.49	22.77

Peak-Flow Statistics Flow Report [2006 Full Region 6]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE	ASEp	Equiv. Yrs.
80-percent AEP flood	377	ft^3/s	34.7	34.7	2.3
66.7-percent AEP flood	479	ft^3/s	33.3	33.3	2
50-percent AEP flood	612	ft^3/s	32.3	32.3	1.9
20-percent AEP flood	969	ft^3/s	32.2	32.2	2.4
10-percent AEP flood	1220	ft^3/s	32.9	32.9	3.1
4-percent AEP flood	1550	ft^3/s	34.4	34.4	3.9
2-percent AEP flood	1800	ft^3/s	35.8	35.8	4.5
1-percent AEP flood	2050	ft^3/s	37.2	37.2	4.9
0.5-percent AEP flood	2320	ft^3/s	39	39	5.2
0.2-percent AEP flood	2680	ft^3/s	41.4	41.4	5.5

Peak-Flow Statistics Citations

Lumia, Richard, Freehafer, D.A., and Smith, M.J.,2006, Magnitude and Frequency of Floods in New York: U.S. Geological Survey Scientific Investigations Report 2006–5112, 152 p. (http://pubs.usgs.gov/sir/2006/5112/)

Application Version: 4.19.4

StreamStats Services Version: 1.2.22

NSS Services Version: 2.2.1

Culvert Report

Curry Road Existing Culvert - 50 Year Storm

Invert Elev Dn (ft)	=	937.20
Pipe Length (ft)	=	60.00
Slope (%)	=	0.82
Invert Elev Up (ft)	=	937.69
Rise (in)	=	120.0
Shape	=	Elliptical
Span (in)	=	190.0
No. Barrels	=	2
n-Value	=	0.023
Culvert Type	=	Elliptical Inlet Face (E)
Culvert Entrance	=	Tapered inlet-thin edge, prejecting (E)
Coeff. K,M,c,Y,k	=	0.547, 0.8, 0.0598, 0.75, 0.7

Embankment

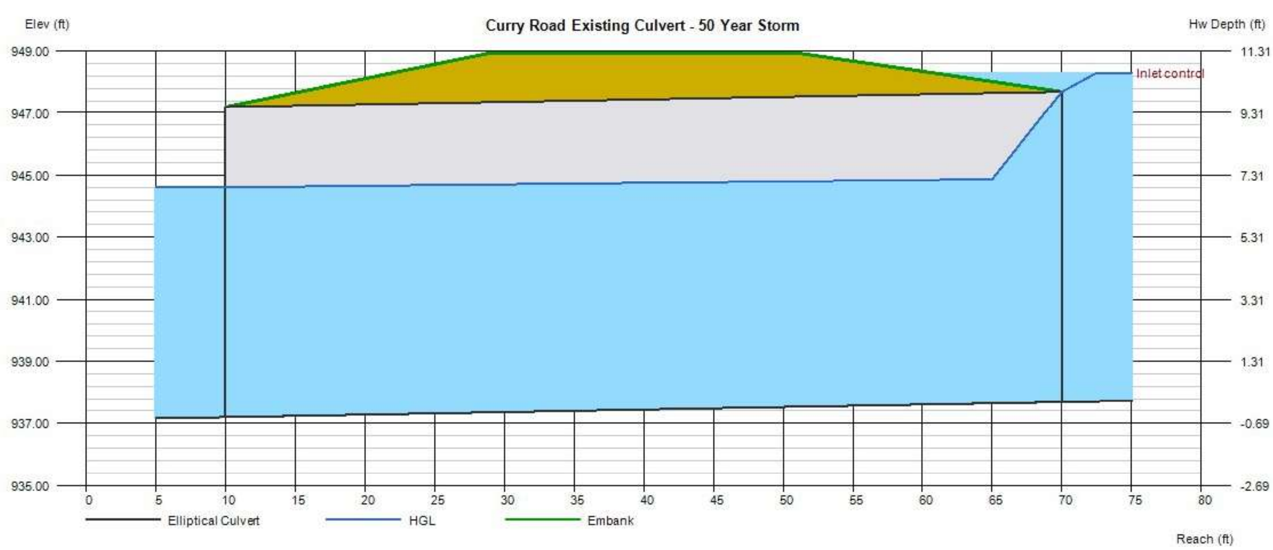
Top Elevation (ft)	=	948.94
Top Width (ft)	=	22.00
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	1800.00
Qmax (cfs)	=	1800.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	1800.00
Qpipe (cfs)	=	1800.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	8.67
Veloc Up (ft/s)	=	9.10
HGL Dn (ft)	=	944.60
HGL Up (ft)	=	944.89
Hw Elev (ft)	=	948.30
Hw/D (ft)	=	1.06
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Friday, Mar 1 2024

Curry Road Existing Culvert - 100 Year Storm

Invert Elev Dn (ft)	=	937.20
Pipe Length (ft)	=	60.00
Slope (%)	=	0.82
Invert Elev Up (ft)	=	937.69
Rise (in)	=	120.0
Shape	=	Elliptical
Span (in)	=	190.0
No. Barrels	=	2
n-Value	=	0.023
Culvert Type	=	Elliptical Inlet Face (E)
Culvert Entrance	=	Tapered inlet-thin edge, prejecting (E)
Coeff. K,M,c,Y,k	=	0.547, 0.8, 0.0598, 0.75, 0.7

Embankment

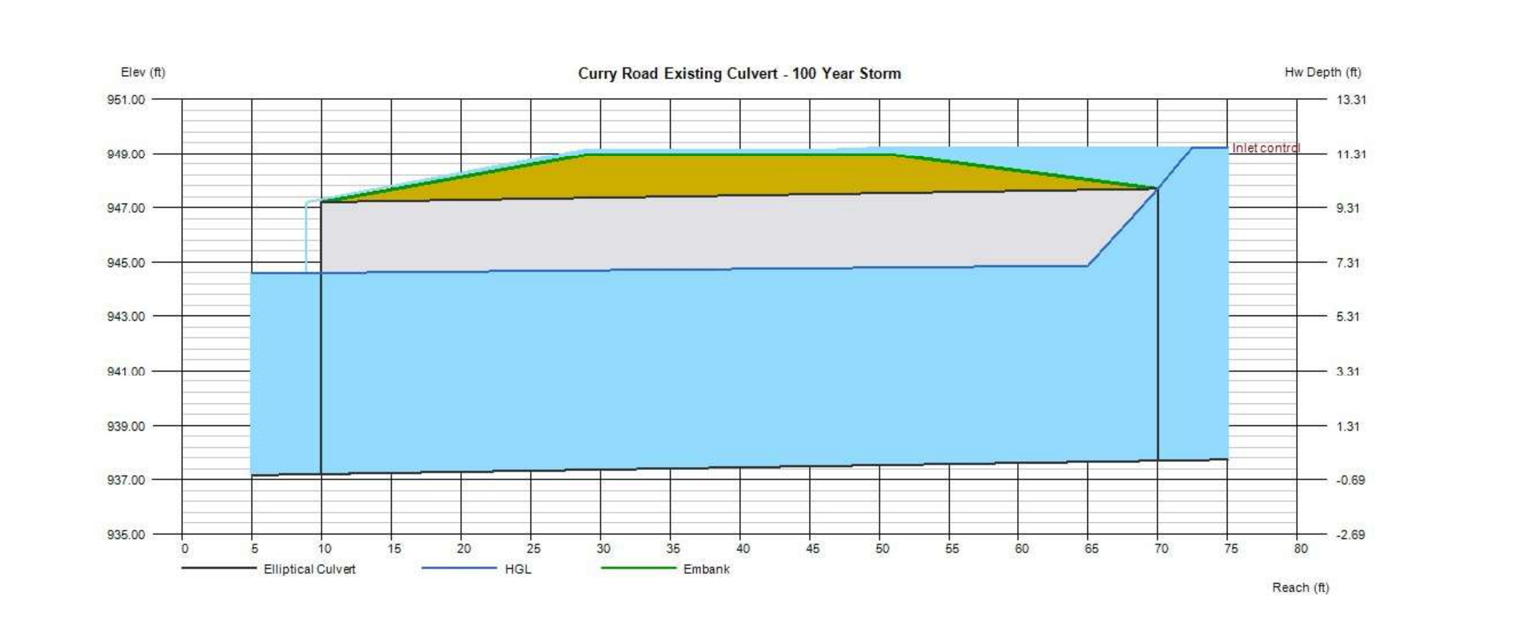
Top Elevation (ft)	=	948.94
Top Width (ft)	=	22.00
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	2050.00
Qmax (cfs)	=	2050.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	2050.00
Qpipe (cfs)	=	2000.74
Qovertop (cfs)	=	49.26
Veloc Dn (ft/s)	=	9.63
Veloc Up (ft/s)	=	10.12
HGL Dn (ft)	=	944.60
HGL Up (ft)	=	944.89
Hw Elev (ft)	=	949.23
Hw/D (ft)	=	1.15
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Mar 20 2024

Curry Road Proposed Culvert - 50 Year Storm

Invert Elev Dn (ft)	=	934.75
Pipe Length (ft)	=	60.00
Slope (%)	=	4.58
Invert Elev Up (ft)	=	937.50
Rise (in)	=	108.0
Shape	=	Box
Span (in)	=	324.0
No. Barrels	=	1
n-Value	=	0.035
Culvert Type	=	Flared Wingwalls, Top Edge Bevel
Culvert Entrance	=	18D to 33.7D wingwall flare, d=0.083D
Coeff. K,M,c,Y,k	=	0.486, 0.667, 0.0249, 0.83, 0.2

Embankment

Top Elevation (ft)	=	948.94
Top Width (ft)	=	22.00
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	1800.00
Qmax (cfs)	=	1800.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	1800.00
Qpipe (cfs)	=	1800.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	9.42
Veloc Up (ft/s)	=	12.92
HGL Dn (ft)	=	941.83
HGL Up (ft)	=	942.66
Hw Elev (ft)	=	945.49
Hw/D (ft)	=	0.89
Flow Regime	=	Inlet Control