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December 18, 2019

Mr. Sky Schelle
City of Piqua
201 West Water Street
Piqua, OH 45356

Re: City of Piqua–Franz Pond Ditch Stormwater Evaluation

Dear Sky,

Enclosed please find a draft copy of the Franz Pond Ditch Stormwater Evaluation technical memorandum and referenced appendices for your review and comment. This technical memorandum summarizes the analysis of existing conditions along Franz Pond Ditch and the evaluation of alternatives to potentially reduce erosion along the ditch.

Please let me know if you have any questions or comments.

Sincerely,

STRAND ASSOCIATES, INC.®

Christopher J. Rust, P.E.

Enclosure: Technical Memorandum

Technical Memorandum
City of Piqua, Ohio

Franz Pond Ditch Stormwater Evaluation

Prepared by:

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www.strand.com

December 2019

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INTRODUCTION

The City of Piqua, Ohio (City) captures and stores runoff at Franz Pond, Echo Lake, and Swift Run Lake and uses the stormwater as a source of drinking water that is filtered at its water works treatment plant. Recurring erosion of the open channel drainage swale or ditch upstream of Franz Pond has resulted in sedimentation issues at Franz Pond, which has also impacted the filtering system at the treatment plant. The prolonged erosion of the ditch that the City refers to as Franz Pond Ditch has also resulted in property loss at numerous private properties because of incision or downcutting of the ditch and bank failure. Stormwater runoff from the drainage area upstream of Franz Pond Ditch that is generally uncontrolled or not detained results in erosive flows during certain rainfall events that contribute to the ongoing erosion of the ditch. Figure 1 displays the location and approximate alignment of Franz Pond Ditch. The City has retained Strand Associates, Inc.® (Strand) to complete a stormwater evaluation of Franz Pond Ditch, including an assessment of existing conditions and an analysis of stormwater management alternatives intended to reduce the frequency and magnitude of erosion. This technical memorandum summarizes the results of the stormwater evaluation.

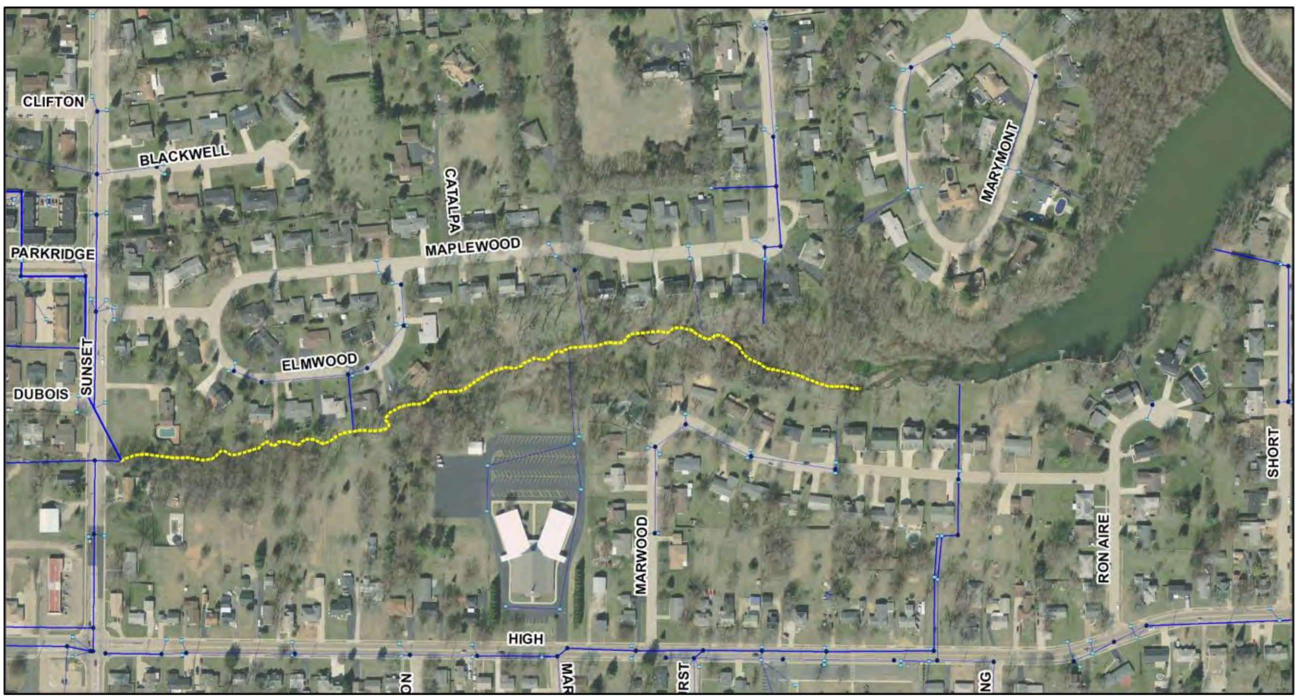


Figure 1 Franz Pond Ditch Location and Alignment

The goals of the stormwater evaluation include the following:

- Evaluate existing conditions to determine the flow rate of stormwater runoff that causes erosion, also referred to as the critical flow rate or $Q_{critical}$, along Franz Pond Ditch.
- Identify a variety of potential alternatives or projects to control and reduce stormwater runoff flowing into Franz Pond Ditch during rainfall events.
- Evaluate viable alternatives to determine the estimated reduction of bank erosion along Franz Pond Ditch, including the development of opinions of probable construction cost.

DRAINAGE AREA

Utilizing available geographic information system (GIS) data, including topography and the City's storm system infrastructure, Strand delineated a drainage area tributary to the upstream end of Franz Pond Ditch and the entire drainage area tributary to Franz Pond. The drainage area tributary to the upstream end of the ditch at North Sunset Drive is approximately 320 acres. The land use within the drainage area includes dense residential areas west of North Sunset Drive, commercial and industrial properties along High Street, and farm property farther west along Piqua-Clayton Road. Only a few small existing detention or retention facilities appear to be present within the drainage area (along High Street), resulting in a significant amount of impervious surfaces from previous developments that are not effectively detained during rainfall events. Stormwater runoff is generally collected in the City's storm sewer system and conveyed in an eastern direction toward Franz Pond Ditch, where two outfalls at North Sunset Drive discharge runoff at the upstream end of the ditch. An additional 148 acres of drainage east of North Sunset Drive flows into Franz Pond, resulting in a total drainage area of approximately 468 acres to Franz Pond. Figure 2 displays the outfall pipes that discharge at the upstream end of Franz Pond Ditch, and Figure 3 displays the total drainage area tributary to Franz Pond. The two storm sewers that discharge to the ditch are 24-inch- and 54-inch-diameter pipes.

Figure 2 Storm Sewer Outfalls to Ditch

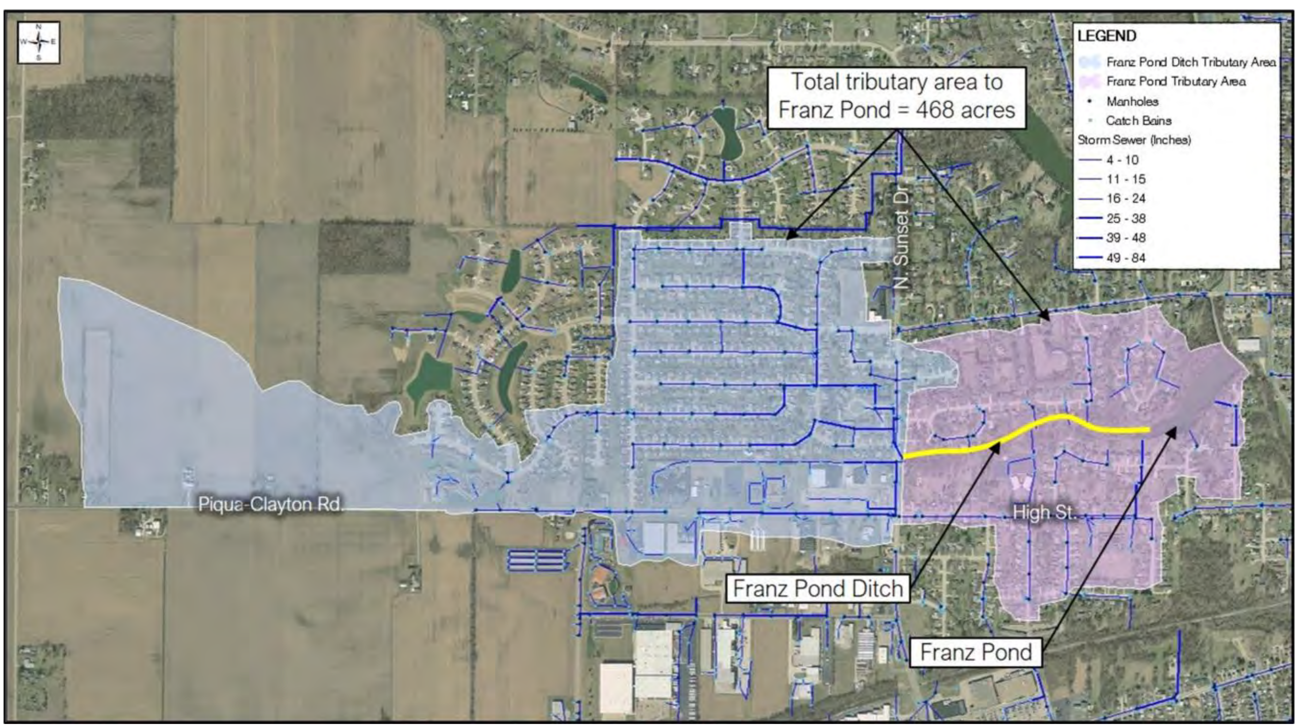


Figure 3 Franz Pond Drainage Area

EVALUATION OF FRANZ POND DITCH

A site visit was conducted along the length of Franz Pond ditch to collect data in the field and to assess and document existing conditions. Strand's subconsultant, Sustainable Streams, LLC, conducted the site visit that included a cursory fluvial geomorphic field assessment of the ditch. Several of the observations from the assessment included the following:

- Bad scour at the storm sewer outfalls near North Sunset Drive at the upstream end of the ditch.
- Several areas lacking a riparian buffer, such as turf grass mowed to the edge of the bank, where erosion or bank failure is evident.
- More evident channel widening in the downstream reaches of the ditch.
- Instability near a concrete sidewalk and retaining wall immediately adjacent to the ditch.
- Undermined banks with leaning trees from downcutting and widening.
- More extensive bank failures and mass wasting toward the downstream reaches of the ditch.
- Exposed infrastructure including overhanging storm system outfalls and an aerial sewer crossing with undermining evident as a result of erosion.

The overall assessment of Franz Pond Ditch confirmed that chronic instability of the ditch is driven by the incision-based channel evolution trajectory, with the majority of the reach showing signs of incision, widening, and aggradation. The most extensive instability in the approximate downstream third of the ditch has the potential ability to continue migrating upstream through continued incision or headcutting. Additionally, much of the existing channel armoring, retaining walls, and other structures along the ditch indicate signs of instability, undermining, and flanking risk. Routine erosive flows above the $Q_{critical}$ threshold are the most likely cause of the continued erosion along the entire length of the ditch, which does not allow enough time for vegetation to become established on deposited sediment at the toe of the bank, which has the potential to gradually improve channel stability and habitat.

Figure 4 displays several examples where erosion was documented along Franz Pond Ditch.

Figure 4 Significant Bank Erosion Along Franz Pond Ditch

Data was collected in the field to better understand the physical characteristics of the ditch and to help determine the critical flow rate ($Q_{critical}$) that begins mobilizing streambed particles, leading to the evident downcutting and bank erosion along the ditch. Extensive armoring and chronic channel instability limited the ability to collect representative data at multiple sites, so one specific location of the ditch was used to collect the data. Cross sectional data was collected, along with a longitudinal profile and an assessment of the bed material size and gradation. At the location where data was collected, the bankfull depth of the ditch was approximately 2.7 feet, the slope of the ditch along the profile was approximately 1.2 percent, and the average bed material size (also referred to as d_{50}) was approximately 67 millimeters. Figure 5 displays graphs of data collected.

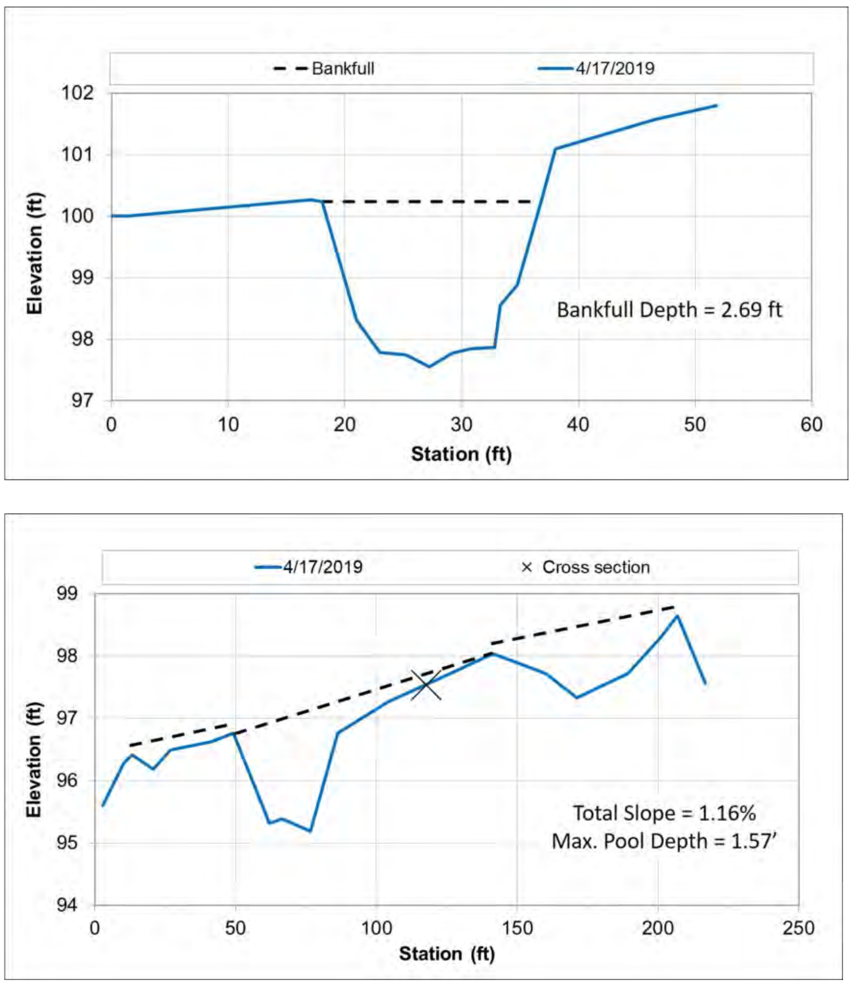


Figure 5 Graphs of Stream Data Collected in Field

The data suggests that a representative estimate of $Q_{critical}$ is approximately 40 percent of the peak flow rate during a 24-hour duration design storm with a recurrence interval of two years in undeveloped conditions. This estimate is consistent with other regional estimates of $Q_{critical}$. The recurrence interval is a simplified term portraying the probability that a given storm event will be equaled or exceeded in any given year. For example, the 2-year storm interval does not necessarily mean a storm only happens once every two years, but rather a storm with a 50 percent chance of occurring in any given year. The rainfall volumes corresponding to design storms are based on the *Rainfall Frequency Atlas of the Midwest*

(Bulletin 71) for West Central Ohio. Bulletin 71 reports a total rainfall depth of 2.69 inches for a 2-year 24-hour design storm. For Franz Pond Ditch, $Q_{critical}$ has been estimated to be approximately 20 cubic feet per second (cfs) using the Soil Conservation Service (SCS) Method for calculating peak flow rates.

Stormwater runoff flow rates that exceed this $Q_{critical}$ threshold of 20 cfs would be expected to result in erosive flows that mobilize streambed particles. The SCS Method was also used to estimate the peak flow rates that discharge into Franz Pond Ditch in order to understand the frequency and magnitude at which $Q_{critical}$ is exceeded. The results are summarized in the following:

- 3-month 24-hour event (1.38 inches) = 34 cfs
- 6-month 24-hour event (1.74 inches) = 63 cfs
- 1-year 24-hour event (2.15 inches) = 101 cfs
- 2-year 24-hour event (2.69 inches) = 156 cfs
- 10-year 24-hour event (3.80 inches) = 280 cfs
- 25-year 24-hour event (4.46 inches) = 358 cfs

Based on these estimated peak flow rates, even the smaller design storms exceed the $Q_{critical}$ threshold. As a result, rainfall events that produce erosive flows and cause streambed particles along Franz Pond Ditch to mobilize have the probability of occurring at least several times annually. Figure 6 displays a runoff hydrograph of the three month storm event in relation to the $Q_{critical}$ estimate. The portion of the hydrograph that exceeds $Q_{critical}$ represents the duration when erosive flows are occurring.

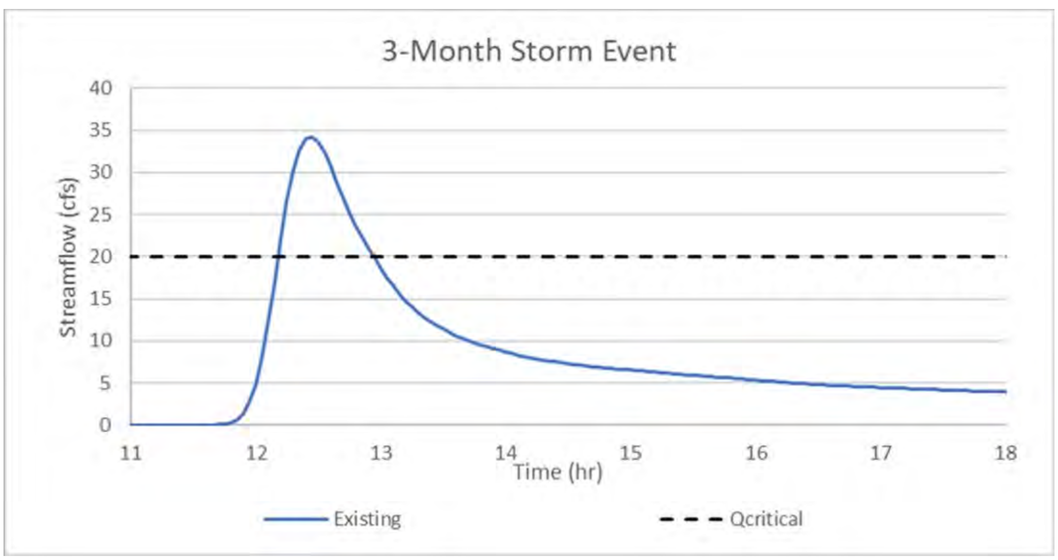


Figure 6 3-Month Storm Event Hydrograph Compared to $Q_{critical}$

The overall summary of the fluvial geomorphic assessment of Franz Pond Ditch was presented to the City during a meeting in June 2019. A copy of this presentation is included in Appendix A of this technical memorandum for reference.

EVALUATION OF ALTERNATIVES

Strand evaluated the feasibility of several stormwater management alternatives to reduce the erosion of Franz Pond Ditch. The alternatives evaluated included the following:

- Alternative No. 1–Storm Sewer Rerouting or Diversion
- Alternative No. 2–Upstream Detention
- Alternative No. 3–In-Stream Stabilization and Rehabilitation
- Alternative No. 4–Bankfull Detention

Alternative No. 1–Storm Sewer Rerouting or Diversion

Alternative No. 1 considered the feasibility of rerouting or diverting stormwater runoff from the upstream drainage area tributary to Franz Pond Ditch. As previously indicated, the drainage area to the two storm sewer outfalls at North Sunset Drive is approximately 320 acres. Stormwater runoff from the drainage area is generally conveyed through the City's storm sewer system. Therefore, rerouting or diverting stormwater runoff must consider the location, depth and size (diameter) of the existing storm sewer system within the drainage area, as well as at potential locations where runoff could be rerouted. Diverting stormwater runoff from one location to another must also consider the potential impact of additional stormwater runoff at the new location in order to avoid creating a new issue such as flooding or erosion. The locations considered for rerouting of stormwater runoff included Park Avenue to the north of the ditch, High Street to the south of the ditch, and the open channel system south of High Street. Figure 7 shows the general location of these locations in relation to Franz Pond Ditch.

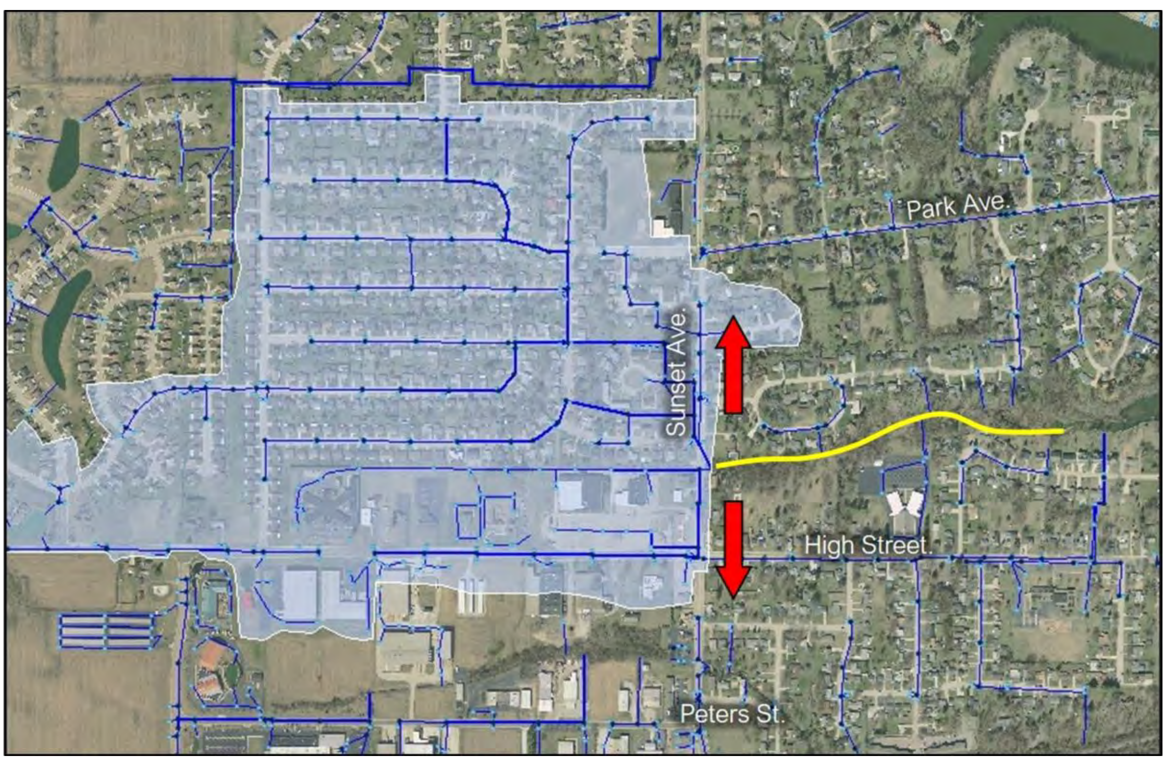


Figure 7 Storm Sewer Rerouting Options

The existing storm sewer system along Park Avenue (east of Sunset Drive) to the north of Franz Pond Ditch is relatively shallow (less than 10 feet) according to the City's GIS data. The pipe diameter is also relatively small, ranging from 15 inches in diameter at the upstream end to 24 inches in diameter at the downstream end. Rerouting stormwater runoff from the south or west to this location would require a significantly deeper and larger storm sewer conveyance system over a length of approximately 4,000 linear feet.

The existing storm sewer system along High Street (east of Sunset Drive) to the south of Franz Pond Ditch is also relatively shallow (less than 10 feet) according to the City's GIS data. The pipe diameter ranges from 18-inches in diameter at the upstream end to 27-inches in diameter at the downstream end. Rerouting stormwater runoff from the north or west to this location would require a significantly deeper and larger storm sewer conveyance system over a length of approximately 3,500 linear feet. An open channel system or drainage ditch is located farther south of High Street near Peters Street. This drainage ditch is already experiencing erosion issues that have impacted several residential properties near Peters Street as displayed in Figure 8. Therefore, contributing additional stormwater flow to this drainage ditch is not recommended.

Figure 8 Significant Bank Erosion Along Peters Street Ditch to the South

Because of the size of the drainage area and the magnitude of stream erosion observed along the ditch, stormwater rerouting options only considered opportunities to divert or offload significant drainage areas as opposed to small drainage areas that are not anticipated to provide a meaningful benefit as a stand-alone alternative. Either option of new storm sewer conveyance along Park Avenue or High Street is anticipated to be a challenging project for the City. The anticipated depth, size, and length of new storm sewer conveyance for either of these potential locations will be a multimillion project that may not be feasible for the City to consider as a viable option to addressing the erosion issue at Franz Pond Ditch. As a result, stormwater rerouting and diversion alternatives were not evaluated to a higher level of detail for this evaluation.

Alternative No. 2–Upstream Detention

Alternative No. 2 considered the feasibility of constructing new stormwater detention basins within the upstream drainage area tributary to Franz Pond Ditch. As previously indicated, very minimal stormwater detention or retention facilities exist upstream of the ditch. The majority of the development in this part of the City likely occurred before stormwater regulations that now require management of runoff (e.g., detention) on new development or redevelopment projects to minimize the impact of increased runoff volume and flows on downstream areas. Detention basins provide a stormwater runoff reduction benefit through the capture, storage, and slow release of stormwater runoff during and after rainfall events.

Specific potential locations for new detention basins must consider available land areas, topography, drainage area capture, and depths of existing storm sewers that could be routed into a detention basin. Because of the size of the drainage area and the magnitude of stream erosion observed along the ditch, stormwater detention options only considered opportunities to capture significant drainage areas as opposed to small drainage areas that aren't anticipated to provide a meaningful benefit as a stand-alone alternative. As a result, the locations considered for new stormwater detention basins included the following:

- Western side of the City on farm property just north of Piqua-Clayton Road.
- Open space area (partially owned by the City) near Lambert Drive and Wilshire Drive.
- Open space areas north of several commercial properties north of High Street.

Figure 9 displays the potential detention basin locations and footprints within the drainage area upstream of Franz Pond Ditch.

Figure 9 Detention Basin Opportunities (Green Areas)

The westernmost detention basin opportunity would be intended to capture the drainage from the farm areas west of the City, while the other three detention basin opportunities would be intended to capture runoff from more developed areas through storm sewer daylighting. A preliminary grading plan was developed for each of these locations based on topography and depths of existing storm sewers. Figure 10 displays the preliminary grading plan for the detention basin near Lambert Road and Wilshire Drive. A significant amount of excavation would be necessary in all locations to provide meaningful storage volumes that can effectively provide storage and attenuation of peak flow rates during rainfall events. The magnitude of excavation is a key factor when considering the potential cost for implementation of detention basins, along with costs for property acquisition. A preliminary opinion of probable construction cost was developed for the detention basin locations, and the construction cost is anticipated to be between $2 to $2.5 million. The detention basin locations identified would only reduce flow rates to Franz Pond Ditch that currently discharge through the 24-inch diameter outfall pipe from the High Street area. Because of the dense residential land use west of Sunset Drive, no significant detention basin opportunities are feasible within that area that ultimately discharges through the 54-inch-diameter outfall pipe.

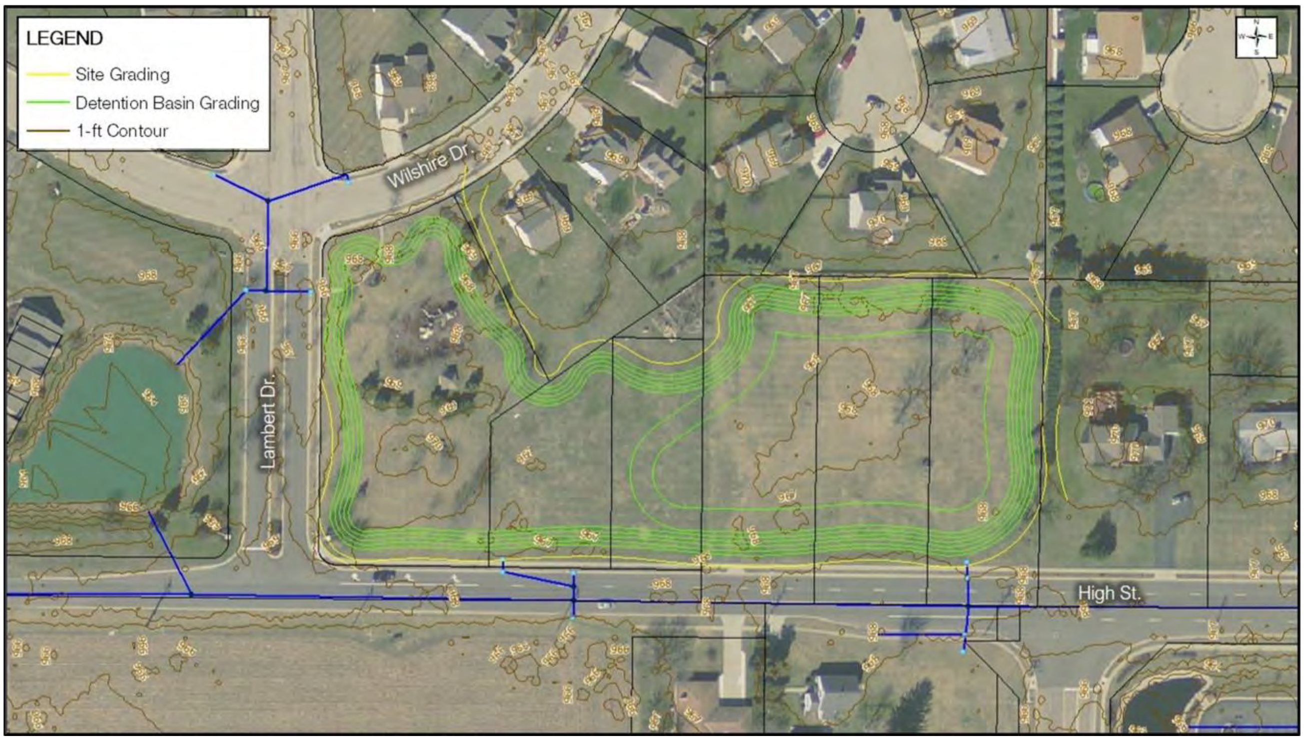


Figure 10 Preliminary Detention Basin Grading at Lambert Drive

Although new detention basins within the drainage area tributary to Franz Pond Ditch can help reduce peak flow rates during rainfall events, the available locations are somewhat limited to be considered as a stand-alone alternative to reduce the recurring erosion at the ditch. Particularly because very little detention opportunities are available within the dense residential area. As a result, stormwater detention basins are only feasible if implemented in combination with other alternatives to reduce stream erosion.

Alternative No. 3–In-Stream Stabilization and Rehabilitation

Alternative No. 3 considered the feasibility of implementing in-stream stabilization measures along the length of Franz Pond Ditch to reduce the prolonged erosion. Because of the conditions of the ditch, the in-stream stabilization and rehabilitation strategy focused on an aggregate-based or stone solution of pools and riffles across the bed and side slopes of the ditch, with live stakes in areas immediately upslope from the edge of aggregate. This type of strategy is effective at dissipating energy and erosive flows within the ditch while providing stabilization to minimize continued incision of the ditch or erosion of the banks. Figure 11 displays an example schematic of this type of in-stream stabilization solution, which has been successfully implemented in other locations by Strand and Sustainable Streams with demonstrated results of resisting erosive flows to minimize erosion.

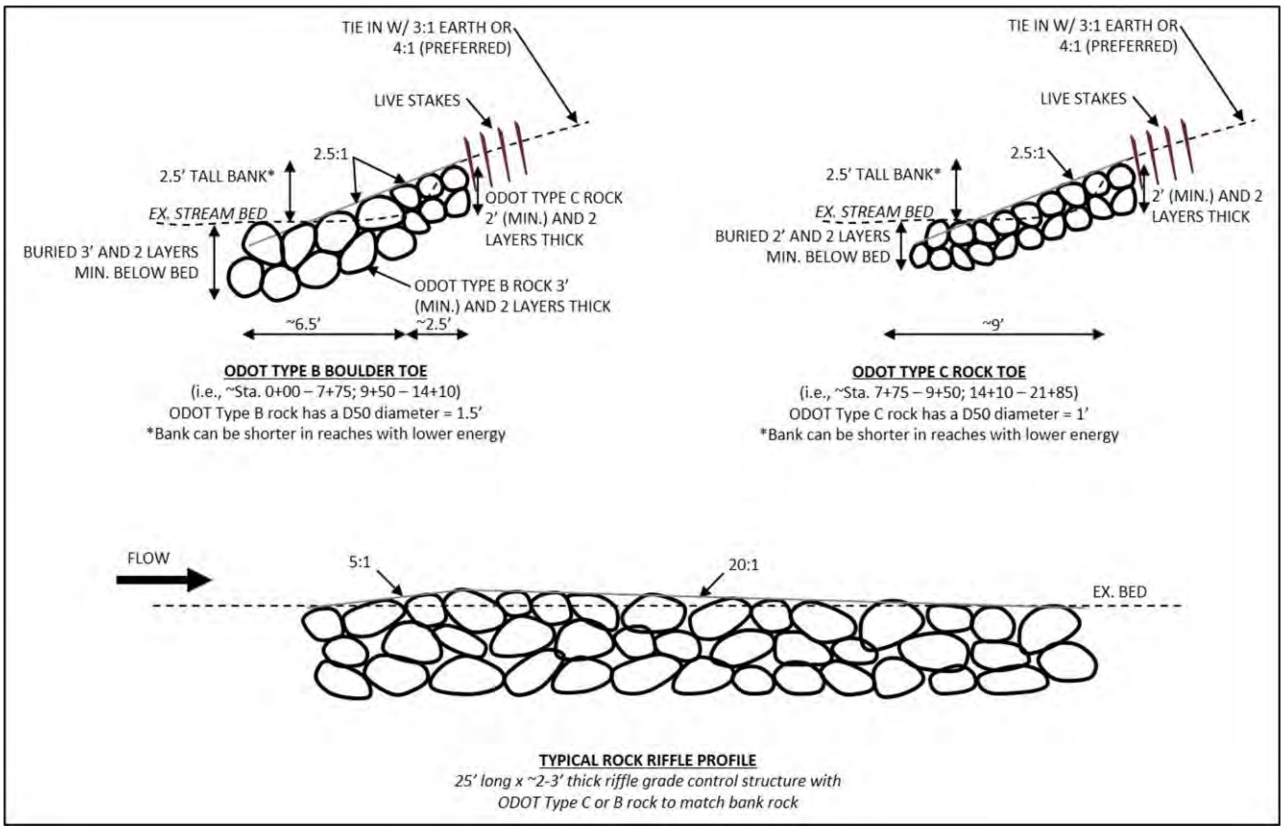


Figure 11 In-Stream Stabilization and Rehabilitation Strategies

Several ranges of stabilization strategies were considered for this evaluation. The first includes full bank protection along the entire alignment of Franz Pond Ditch. A series of aggregate-based pools and riffles would span the entire length of the ditch, encroaching upon approximately 50 residential properties on either side of the ditch. The planning-level opinion of probable construction cost the full bank protection option as displayed in Figure 12 is approximately \$1.8 million. The second option includes select stream bank and infrastructure protection primarily focused on the downstream half of the ditch to prevent erosion from continuing to migrate upstream. This option would encroach upon approximately 25 residential properties on either side of the ditch. The planning-level opinion of probable construction cost of the full bank protection option as displayed in Figure 13 is approximately \$1.3 million.

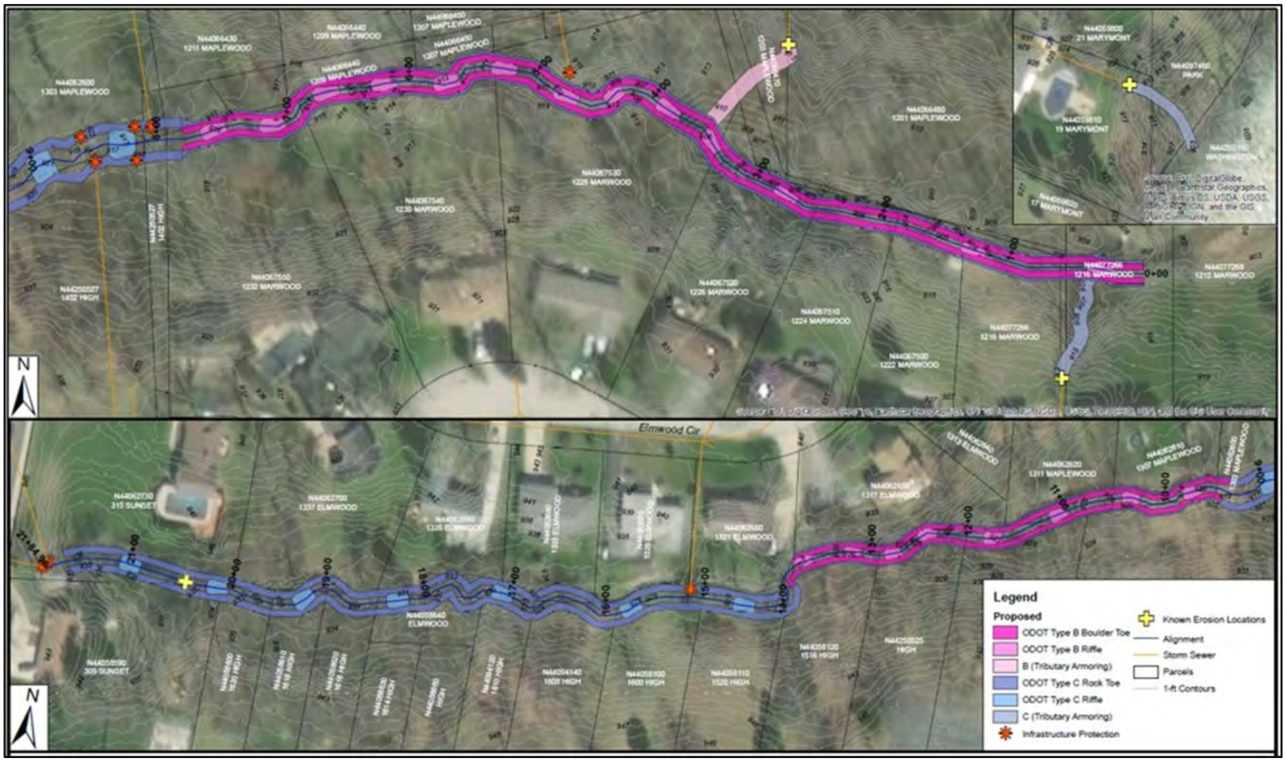


Figure 12 In-Stream Stabilization with Full Bank Protection

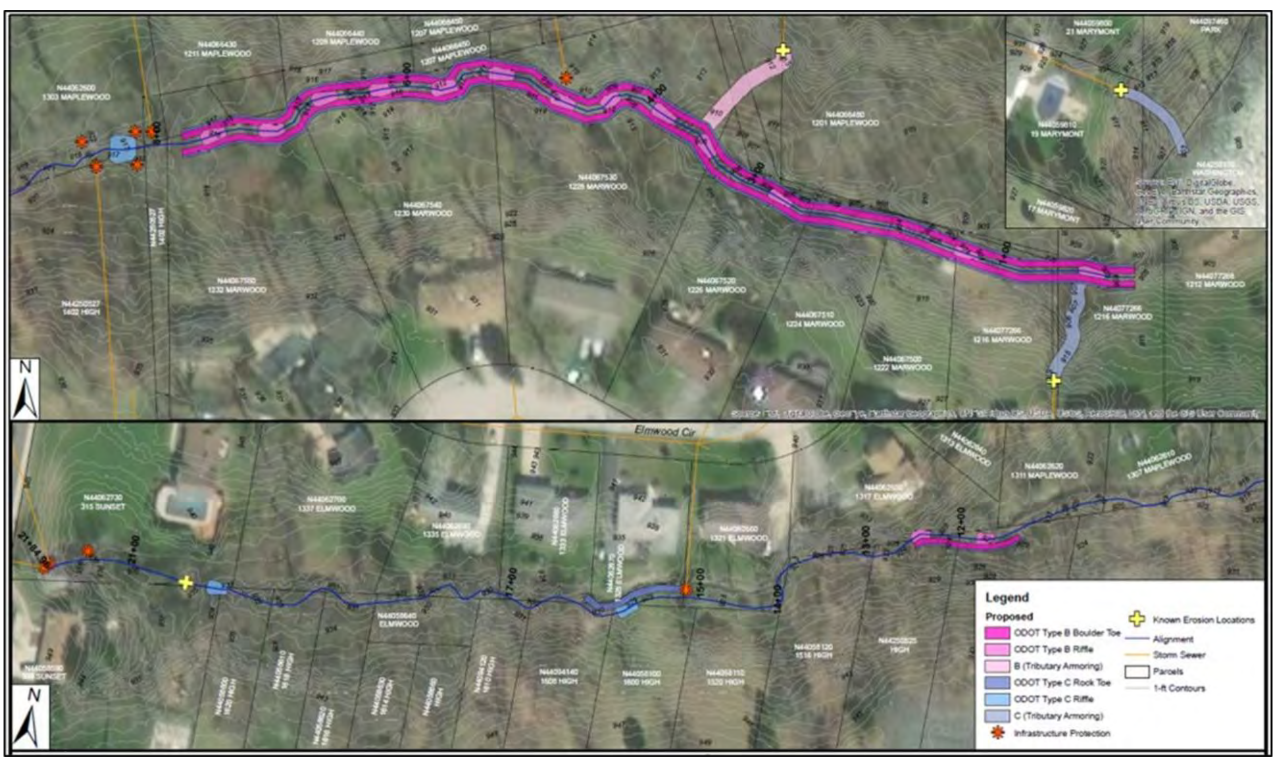


Figure 13 In-Stream Stabilization with Select Bank Protection

One of the biggest challenges corresponding with in-stream stabilization strategies is cooperation with all the property owners along Franz Pond Ditch. The ditch is located on private property and falls within approximately 50 parcel boundaries. The City does not currently have the ability to access and improve the ditch due to a lack of easements. The feasibility of in-stream stabilization and rehabilitation strategies is predicated upon the cooperation and participation from the property owners. Figure 14 displays the parcel boundaries of all the properties within the vicinity of Franz Pond Ditch.

Figure 14 Franz Pond Ditch and Private Property Parcels

Alternative No. 4–Bankfull Detention

Alternative No. 4 considered the feasibility of bankfull detention area immediately adjacent to Franz Pond Ditch. Bankfull detention features are located in the floodplain and are designed to reduce the depth, velocity, and erosive power of the stream flow during events that would otherwise exceed $Q_{critical}$ by adding storage volume immediately adjacent to the channel. Water quality benefits includes promoting deposition of suspended solids, adsorption of charged particles, metals, and nutrients in the trapped sediment, biological uptake of nutrients, and reduced bacteria levels through ultraviolet exposure over a longer residence time. They also expand "off-channel" habitats that can be important elements of a healthy riparian ecosystem. Figure 15 displays photos from a previous bankfull detention project designed by Strand and Sustainable Streams.

Figure 15 Example Bankfull Detention Project

An initial location has been identified as the most feasible placement of a bankfull detention area adjacent to Franz Pond Ditch, primarily based on open space areas and topography. The location is on the south side of the ditch, in between the storm sewer outfalls at North Sunset Drive and the parking lot of the church on High Street. Several iterations of preliminary grading plans were developed to determine a practical footprint for the bankfull detention area while also providing the storage volume necessary to have a meaningful impact on the erosive flows through the ditch. The grading plan is based on 1-foot GIS contours and is likely to be adjusted based on site-specific topographic data that could be collected in the future. Based on the grading plan, the bankfull detention area provides approximately 2.7 acre-feet of storage volume and has a maximum depth of ponding water of five feet. Conceptually, flow within the Franz Pond Ditch would spill over into the bankfull detention area through a rock-armored connection point at the upstream end, and slowly released back into the ditch through another rock-armored connection point at the downstream end. The bankfull detention area is anticipated to impact approximately 10 properties and would require cooperation and participation from all property owners for the feature to be effective. This alternative would likely require the City to acquire the property around the perimeter of the bankfull detention area, and easements for future access for maintenance.

Figure 16 displays the preliminary location, grading, and size of the bankfull detention area.

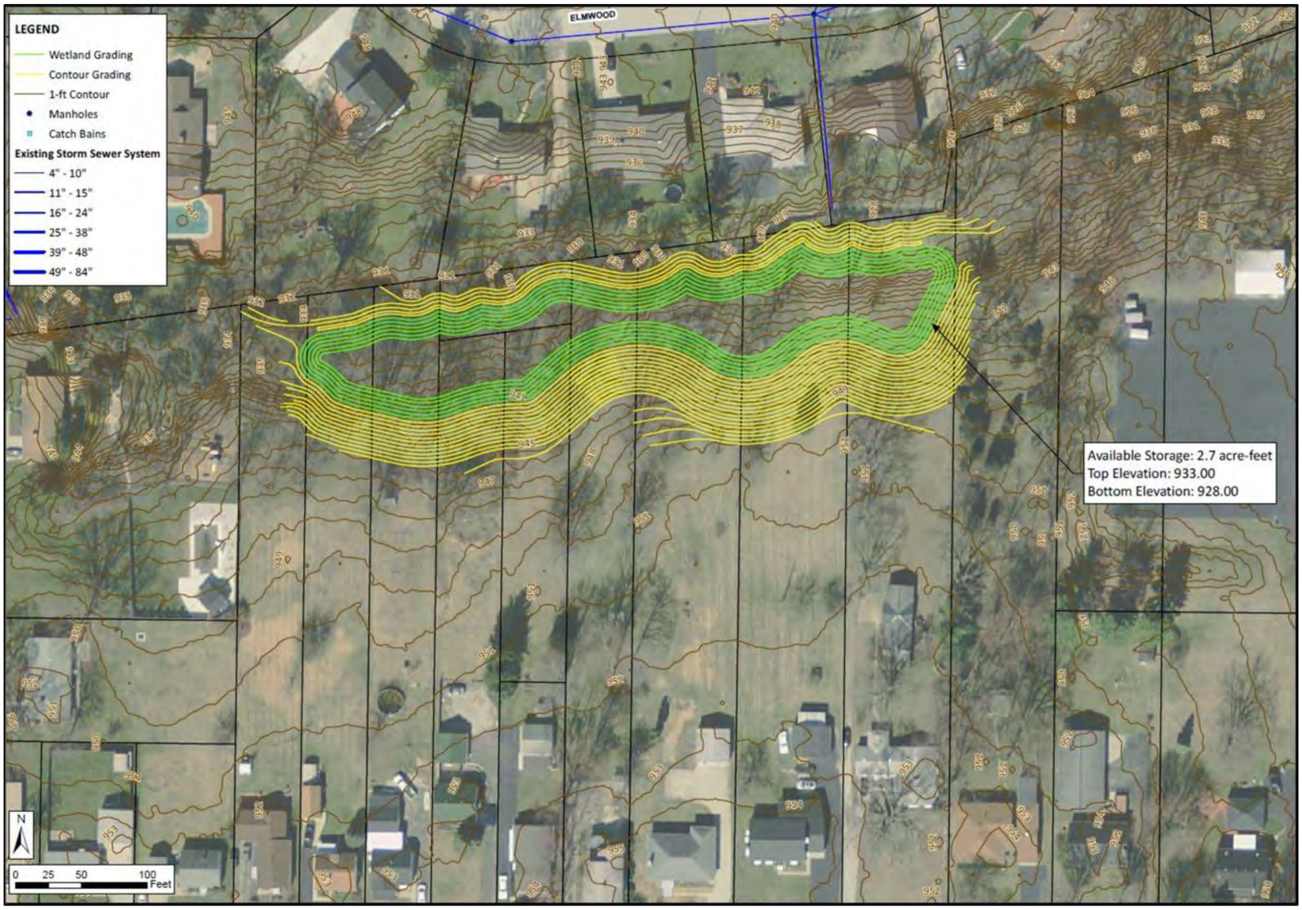


Figure 16 Preliminary Bankfull Detention Conceptual Grading

With approximately 2.7 acre-feet of storage, the proposed bankfull detention feature can be optimized during a future design phase to create meaningful reductions in the erosive portion of relatively frequent design storms such as the three month and six-month hydrographs, depending on the connection's configuration. Preliminary analyses suggest that the bankfull detention feature also has the potential to contribute to reduced erosive flows in the 1-year and 2-year hydrographs. Although the bankfull detention area would be unlikely to have meaningful improvements for extreme events such as the 100-year storm, the potential reductions in the erosive portions of the hydrograph for the more frequent events would be a significant improvement over current conditions in the system.

Creation of bankfull detention features may not entirely replace the need for bank stabilization measures, particularly in areas where mass wasting has already begun. That is, banks that are currently geotechnically unstable will likely continue to be unstable after the bankfull detention feature is installed. However, reducing the frequency and magnitudes of disturbance events provides for a greater likelihood for vegetation to become established on deposited sediment at the toe of the bank, which has the potential to gradually improve channel stability and habitat. Vegetation growth on deposited sediment can also help to reduce fine sediment loads that would otherwise be transferred downstream.

To assist the City with meetings with property owners that would be impacted by a bankfull detention area, Strand and Human Nature, Inc. have developed conceptual graphic renderings of this alternative.

Figure 17 displays a preliminary rendering of the bankfull detention area.

Figure 17 Preliminary Bankfull Detention Conceptual Rendering

Based on the preliminary grading of the bankfull detention area, a preliminary opinion of probable construction cost has been developed. This alternative is anticipated to have a construction cost ranging between $500,000 and $800,000.

The overall summary of the existing conditions along Franz Pond and the evaluation of alternatives was presented to the Citizen's Advisory Committee during a meeting in October of 2019. A copy of this presentation is included in Appendix B of this technical memorandum for reference.

STORMWATER OUTFALL EROSION

In addition to erosion along the length of Franz Pond Ditch, several stormwater outfalls from residential areas discharge farther up the slope of the ditch that have experienced erosion. These include storm sewer outfall locations at 1216 Marwood Drive and 1201 Maplewood Drive (refer to Figure 18). Although these locations have much smaller drainage areas to the point of discharge, the channel incision or downcutting at each headwall shows clear evidence of erosive flows that are contributing to the sedimentation issue. To address erosion at these locations, rock armoring is recommended from the outfall to the point where flow enters Franz Pond Ditch. Figure 19 displays a concept plan that highlights the area of stabilization at these two stormwater outfalls. The preliminary opinion of probable construction cost for the stabilization at these two outfalls is approximately $220,000.

Figure 18 1201 Maplewood Dr. Outfall

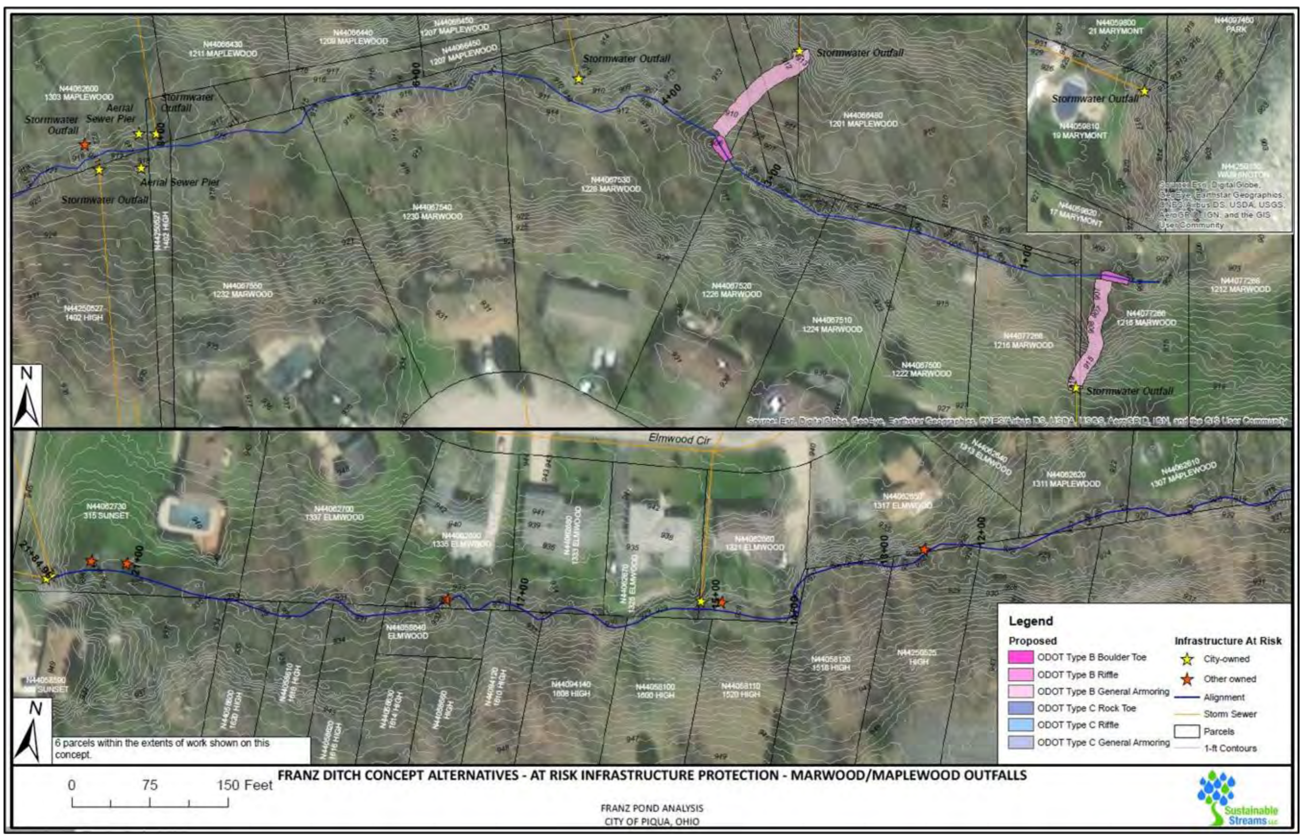


Figure 19 Armoring at 1201 Maplewood Drive and 1216 Marwood Drive

CONCLUSION

Significant erosion at Franz Pond Ditch has resulted in sedimentation issues for the City at Franz Pond and the water works treatment plant, as well property loss and damage for numerous residential property owners on both sides of the ditch. Routine erosive flows above the $Q_{critical}$ flow rate contribute to the mobilization of streambed particles, resulting in stream incision or downcutting and bank failures. The erosive flows are primarily driven by uncontrolled stormwater runoff from previous development and corresponding impervious surfaces during rainfall events. If not addressed, the erosion along the ditch is anticipated to continue getting worse over time, with headcutting potentially migrating upstream along the alignment of the ditch.

To help address the erosion issue, Strand evaluated the four alternatives previously described in this technical memorandum. A brief summary of these alternatives is provided in the following.

- Alternative No. 1 considered stormwater rerouting or diversion in the drainage area upstream of the ditch. The implementation of meaningful rerouting or diversion appears to be infeasible because of topographic constraints and the need for significant new storm sewer infrastructure to adequately convey the routed flow. Diverting runoff also poses a risk of causing a stormwater issue elsewhere because of additional flow and volume.

- Alternative No. 2 considered stormwater detention options in the drainage area upstream of the ditch. Very minimal amounts of detention currently exist upstream of the ditch. Although several locations were identified, no opportunities are feasible within the residential area to the west of North Sunset Avenue where runoff is ultimately discharged through a 54-inch-diameter outlet pipe. New detention basin opportunities are not necessarily low-cost options due to significant excavation requirements to create storage and property acquisition needs.

- Alternative No. 3 considered in-stream stabilization and rehabilitation strategies along Franz Pond Ditch. This alternative would most likely provide the most significant improvement to reduce the erosion of the ditch but would require considerable participation by approximately 50 property owners and a need for easements for future City access. A planning-level opinion of probable construction cost of $1.8 million for full bank protection could also make this a cost-prohibitive option without some type of outside funding such as stormwater grants.

- Alternative No. 4 considered a bankfull detention area within the floodplain adjacent to Franz Pond Ditch that would help reduce the frequency and magnitude of erosive flows beyond $Q_{critical}$, particularly during smaller storm events (e.g. 2-year event and smaller). This alternative also requires participation from approximately 10 property owners, but could be a more feasible option at a planning-level opinion of probable construction cost of $500,000 and $800,000. Future design phases of this alternative will allow for optimization of the bankfull detention area to reduce erosive flows at Franz Pond Ditch.

APPENDIX A
FRANZ POND DITCH ASSESSMENT SUMMARY

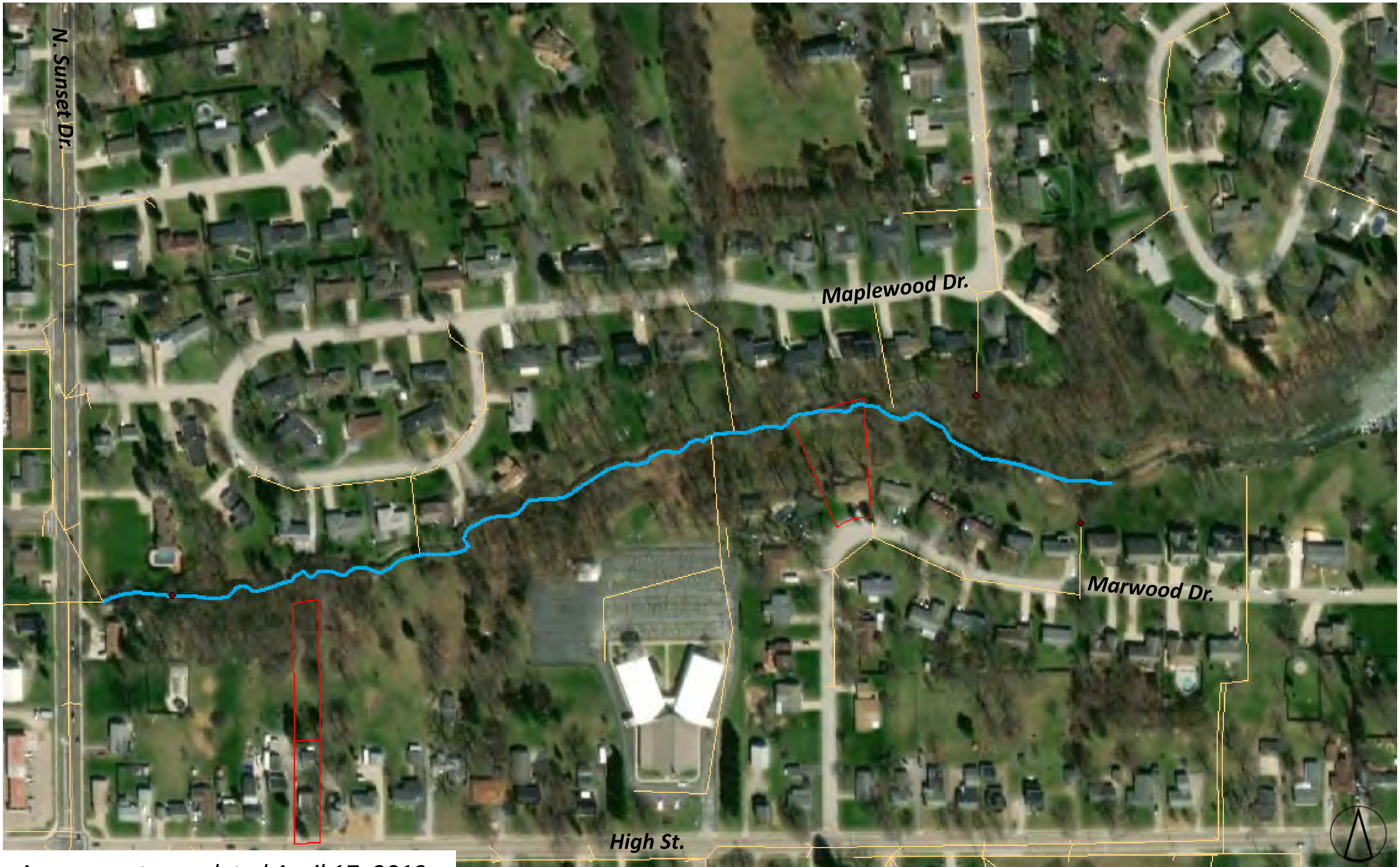
Franz Pond Ditch

Fluvial Geomorphic Assessment,
Preliminary $Q_{critical}$ Estimate, &
Conceptual Stabilization/Rehab Strategies

Sustainable Streams, LLC

June 2019

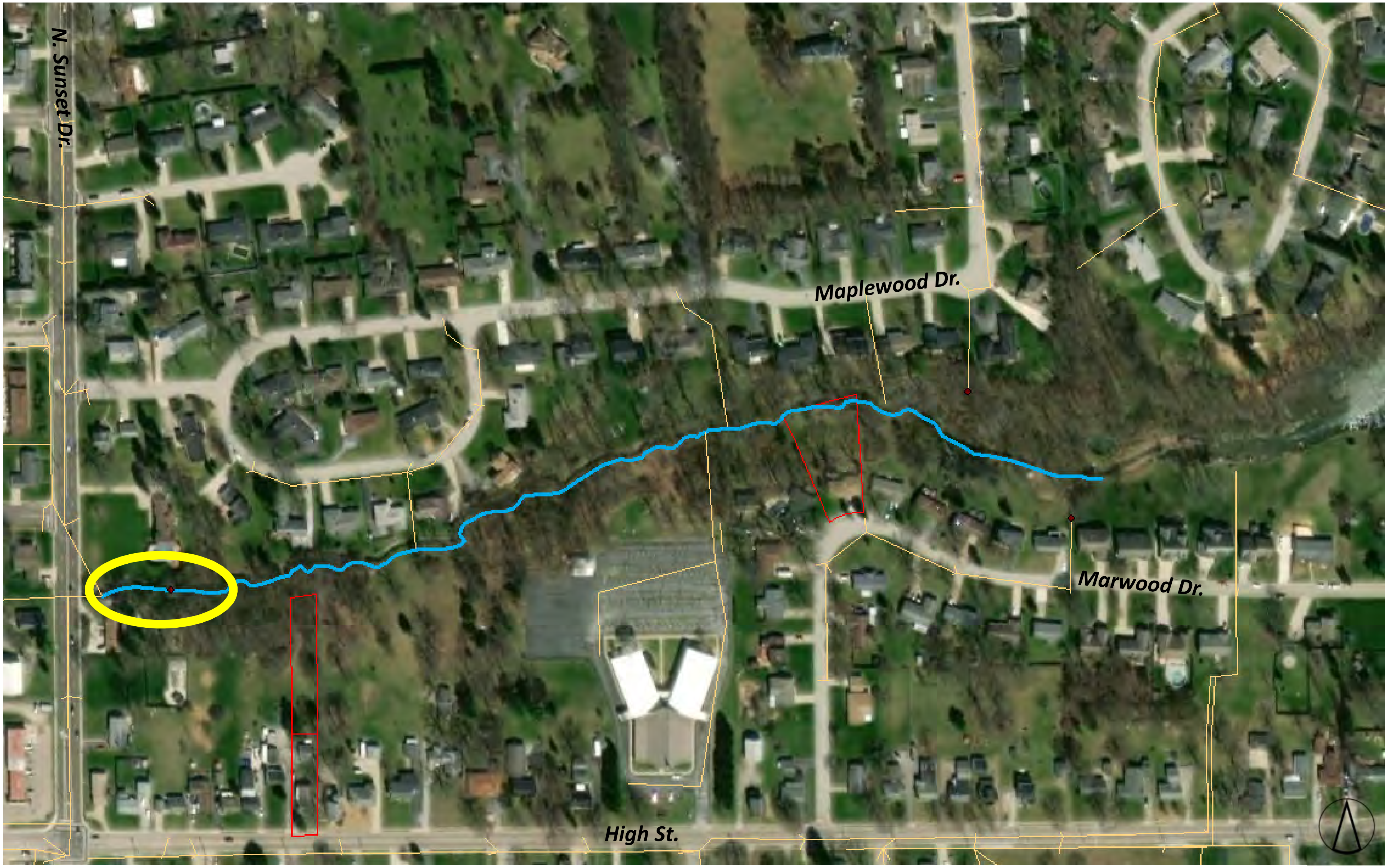
Franz Pond Ditch Assessment Extents



Assessment completed April 17, 2019

Franz Pond Ditch Assessment

Completed April 2019



Franz Pond Ditch Assessment

- Bed scour at culvert outlets
- Stone abutment flanking on left bank

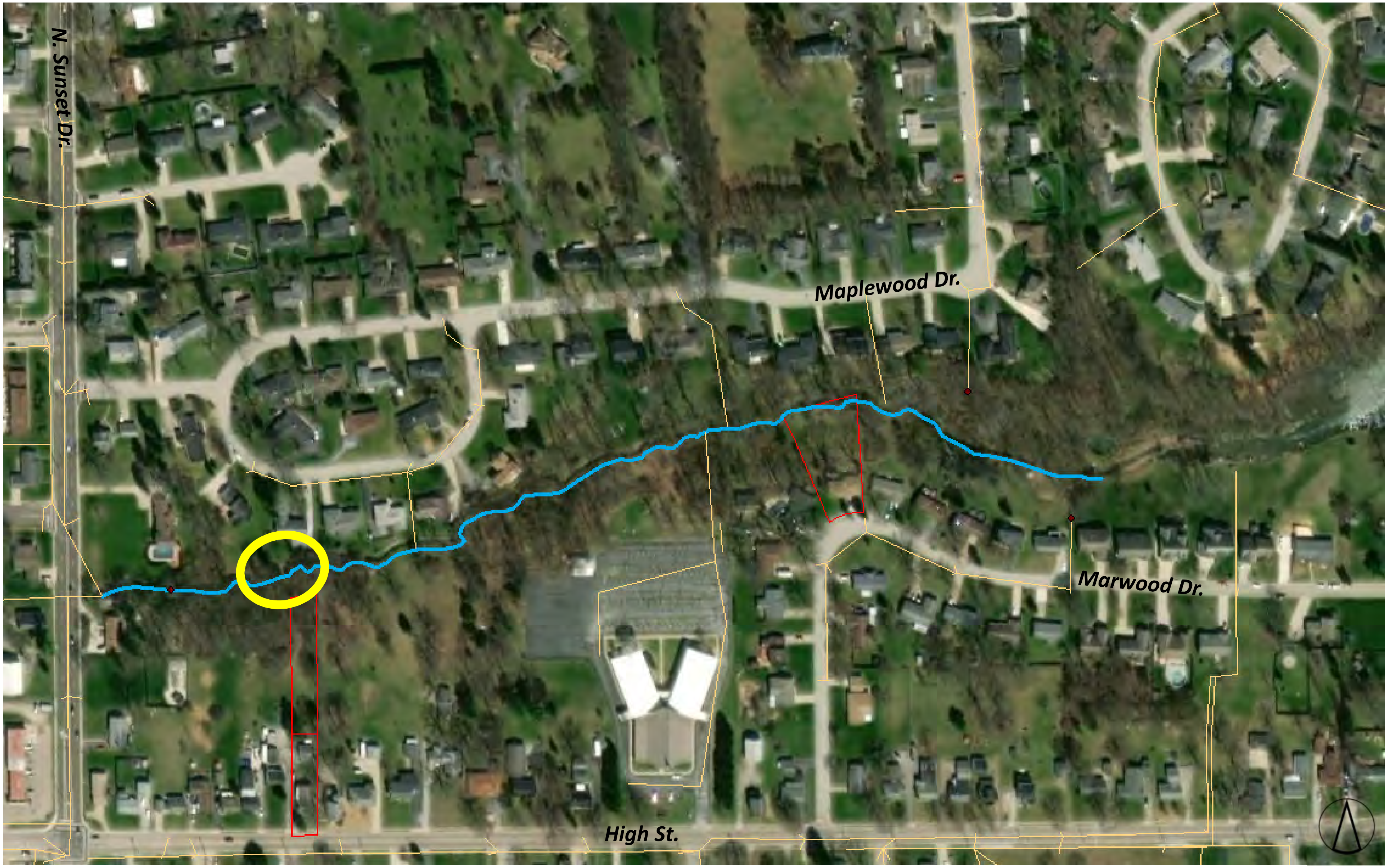
Franz Pond Ditch Assessment

- Left bank lacking riparian buffer (mowed to edge) experiencing erosion
- Base of telephone pole exposed

Franz Pond Ditch Assessment

- Failing grade control
- Exposed tile drains (~4' exposed) and failing trees

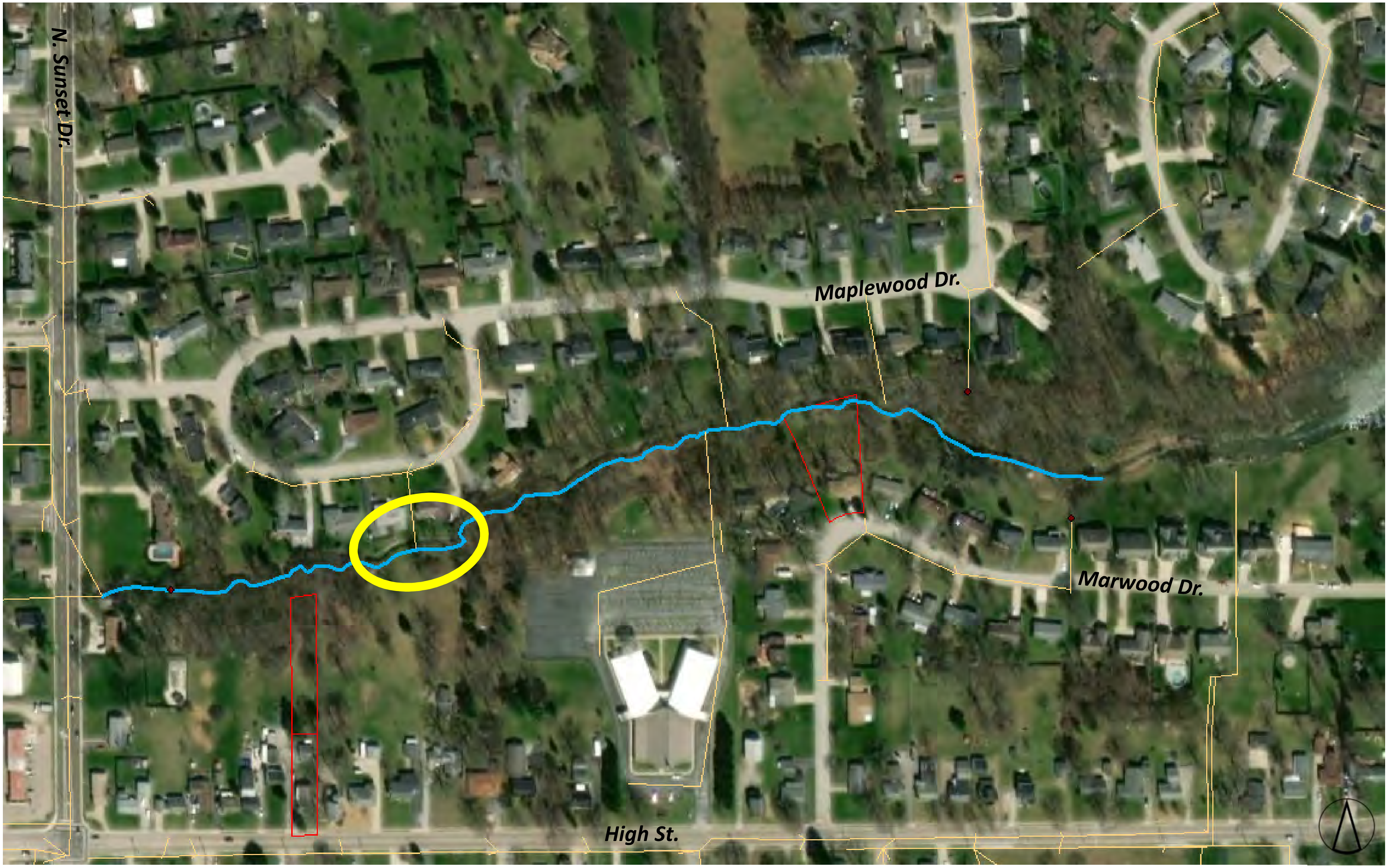
Franz Pond Ditch Assessment



Franz Pond Ditch Assessment

- Less downcutting than downstream reaches, but channel widening evident in unarmored sections
- Pedestrian bridge exhibiting widening beneath
- Private shed in close proximity to bank on left bank

Franz Pond Ditch Assessment



Franz Pond Ditch Assessment

- Extensive instability near concrete sections
- Right bank lacking riparian buffer (mowed to edge) experiencing erosion
- Fish noted upstream of concrete

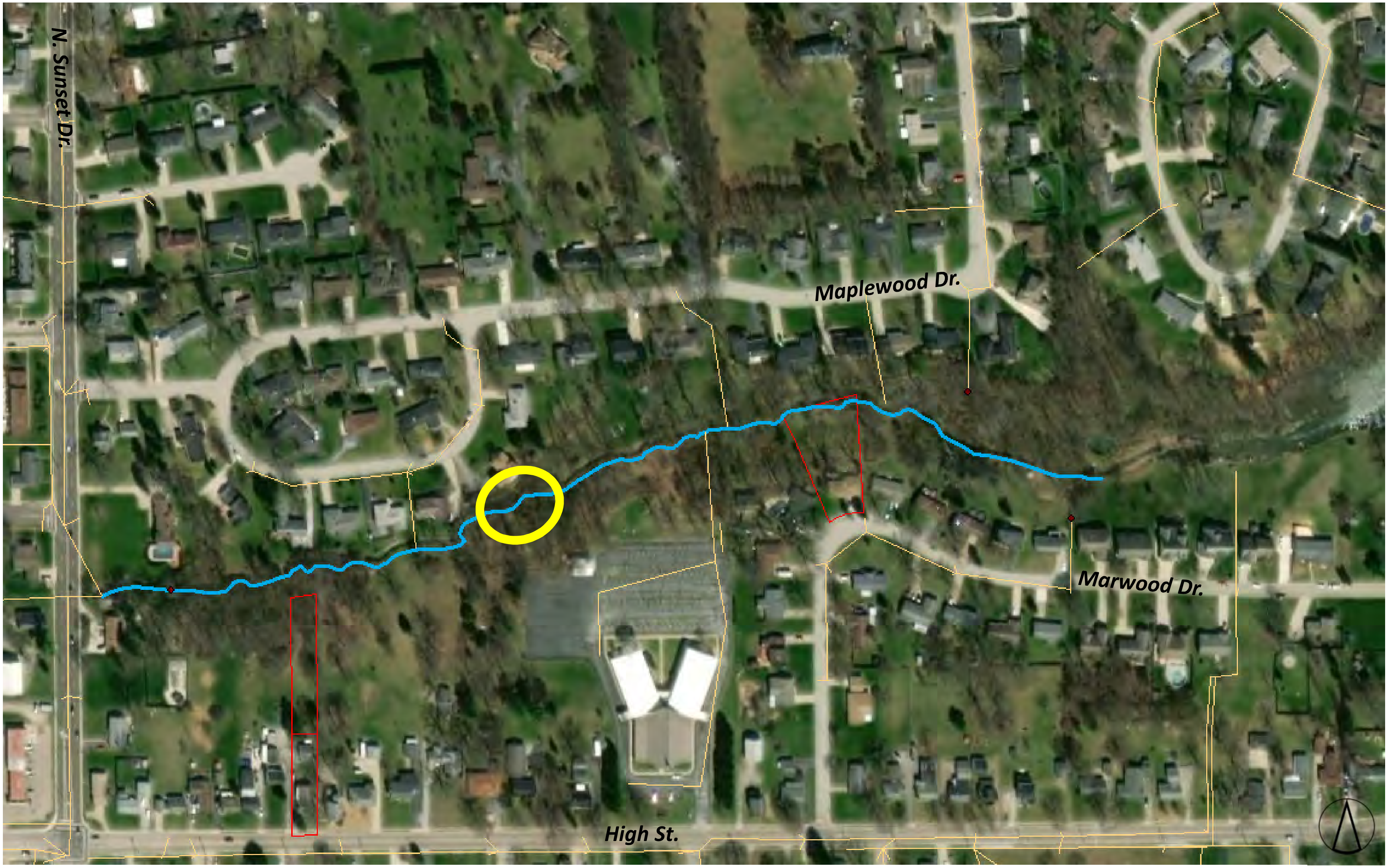
Franz Pond Ditch Assessment

- Stormwater outfall downstream of concrete grade control
- Channelized and armored section with downcutting starting to impact armoring

Franz Pond Ditch Assessment

- Failing retaining wall with driveway at top
- Channelized and armored section

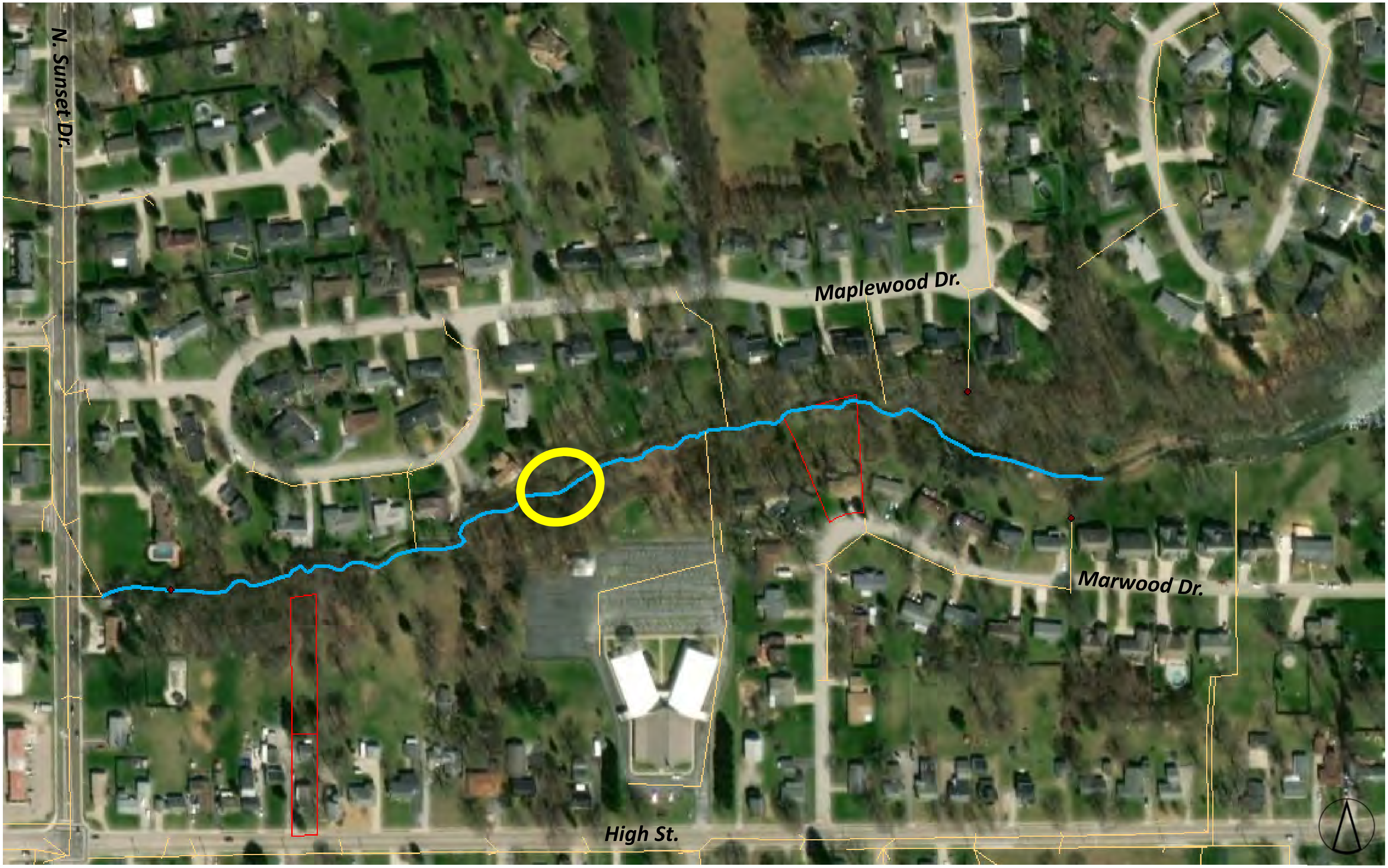
Franz Pond Ditch Assessment



Franz Pond Ditch Assessment

- Failed concrete armoring on right bank with possible grade control also failed
- Conduit (possibly fiber optic) runs in channel
- Over-widened in non-armored sections

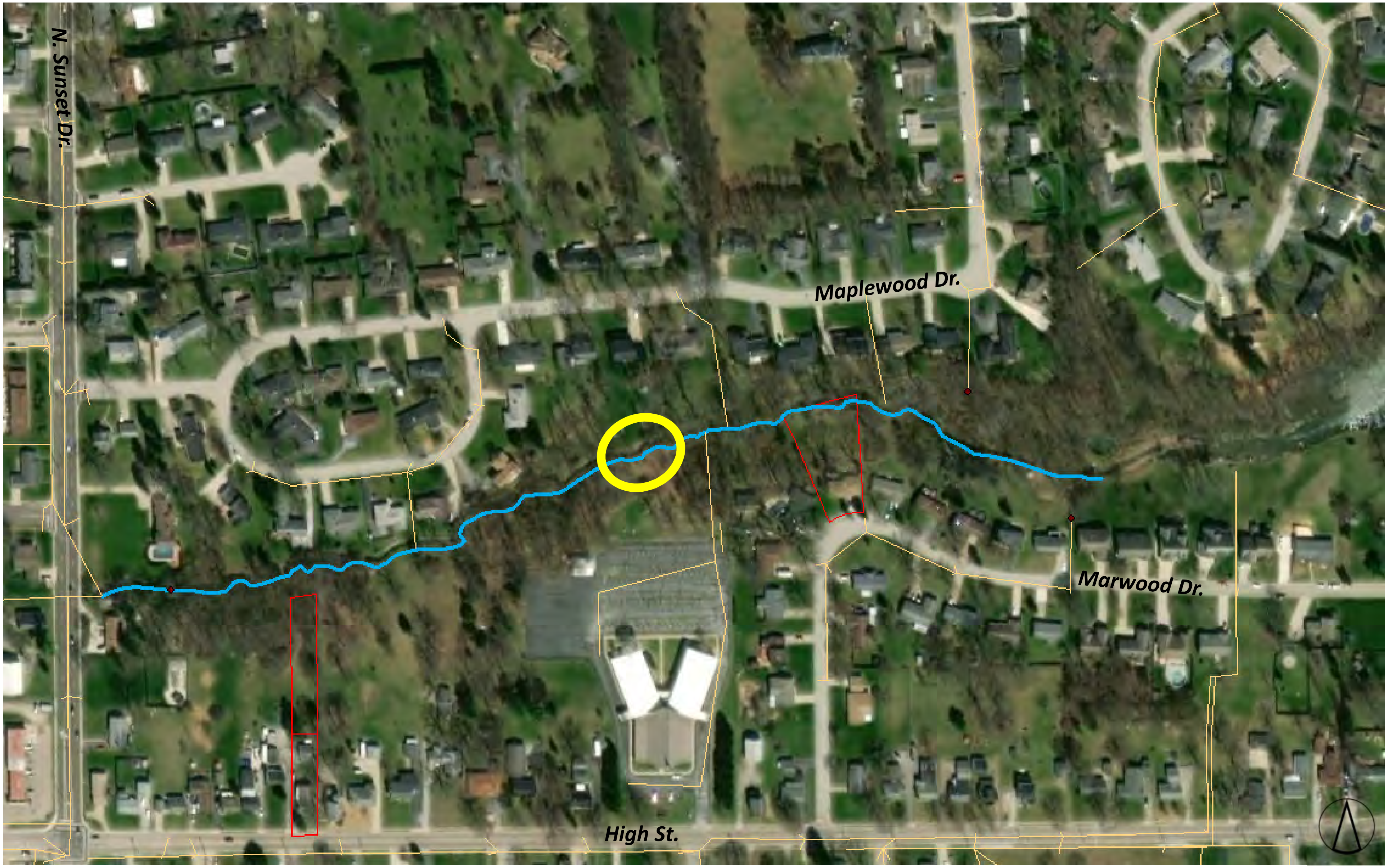
Franz Pond Ditch Assessment



Franz Pond Ditch Assessment

- Banks undermined with leaning trees
- Downcutting and widening
- Crayfish noted in this reach

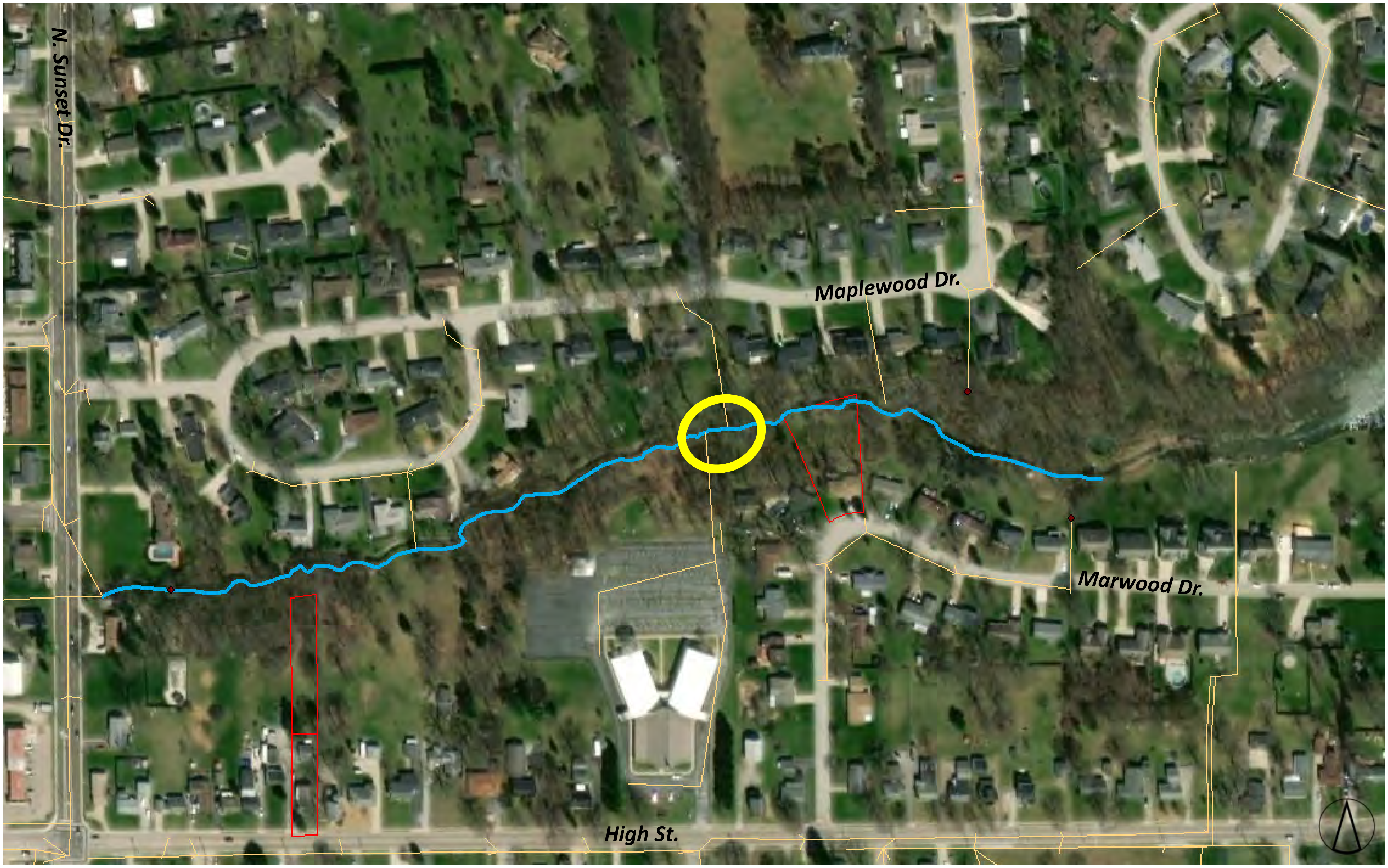
Franz Pond Ditch Assessment



Franz Pond Ditch Assessment

- Some yards lacking riparian buffers
- Downcutting and widening evident

Franz Pond Ditch Assessment



Franz Pond Ditch Assessment

- Entrenched reach with evidence of widening and downcutting
- Overhanging and undercut stormwater outfalls
- Aerial sewer crossing

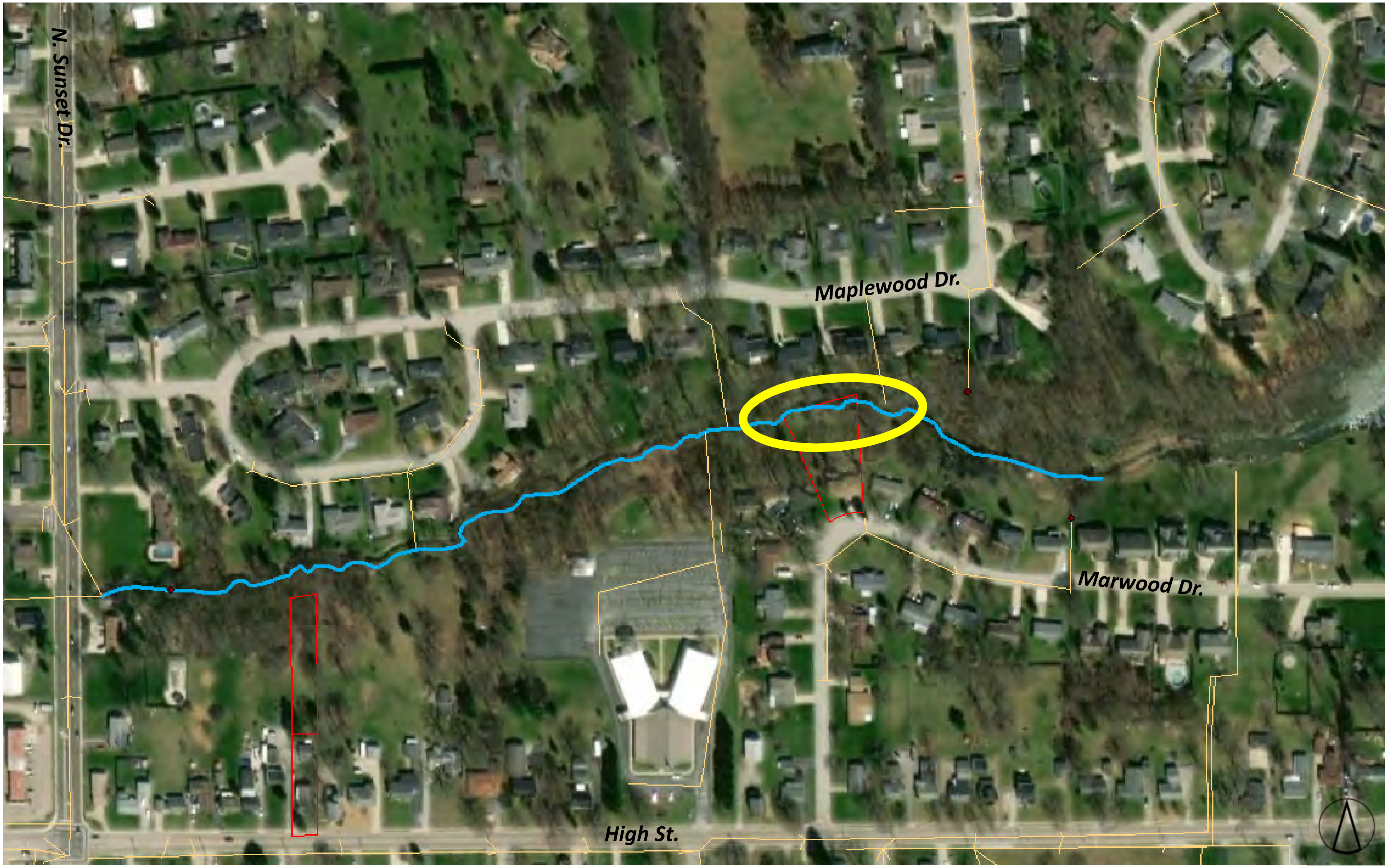
Franz Pond Ditch Assessment

- 15” overhanging outfall by ~4-5 feet
- Pier of aerial pipe undermined/exposed base

Franz Pond Ditch Assessment

- 12” overhanging outfall by ~4 feet
- Undercut banks with exposed roots, fence footing
- Concrete bed in select locations

Franz Pond Ditch Assessment



Franz Pond Ditch Assessment

- Entrenched reach with failed concrete
- Severely undermined banks

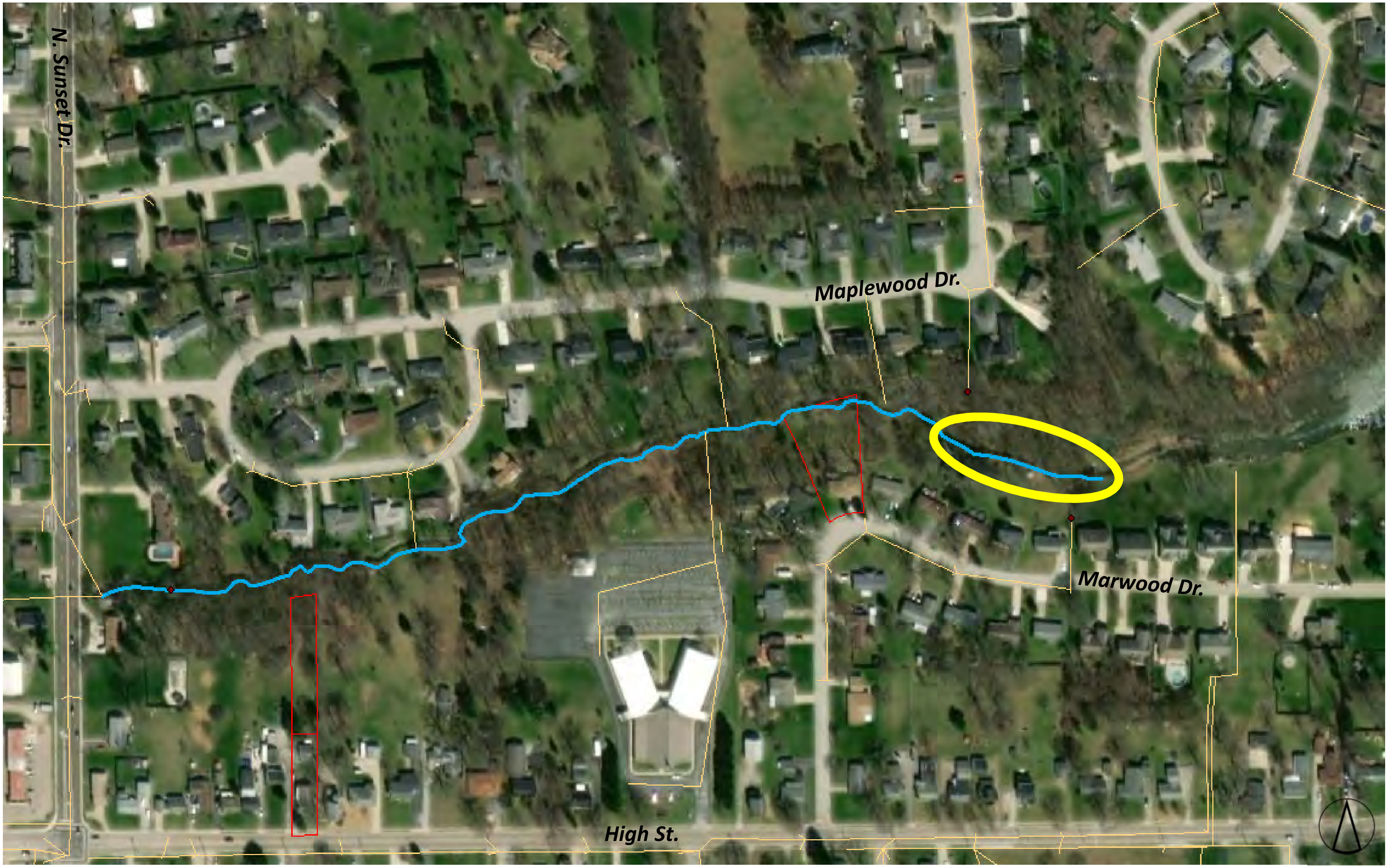
Franz Pond Ditch Assessment

- Mass wasting evident (~8-ft banks)
- Poor riparian vegetation buffers

Franz Pond Ditch Assessment

- Mass wasting evident (~8-ft banks)
- Poor riparian vegetation buffers
- Hanging 12” outfall (~4-5 ft)

Franz Pond Ditch Assessment



Franz Pond Ditch Assessment

- 10’+ of bank erosion evident by exposed drain
- Poor riparian vegetation buffers

Franz Pond Ditch Assessment

- Extensive downcutting and undercut, unstable banks
  - → Tree falls into channel
  - → Large amounts of woody debris in channel
  - → Increased flow roughness and habitat complexity

Franz Pond Ditch Assessment

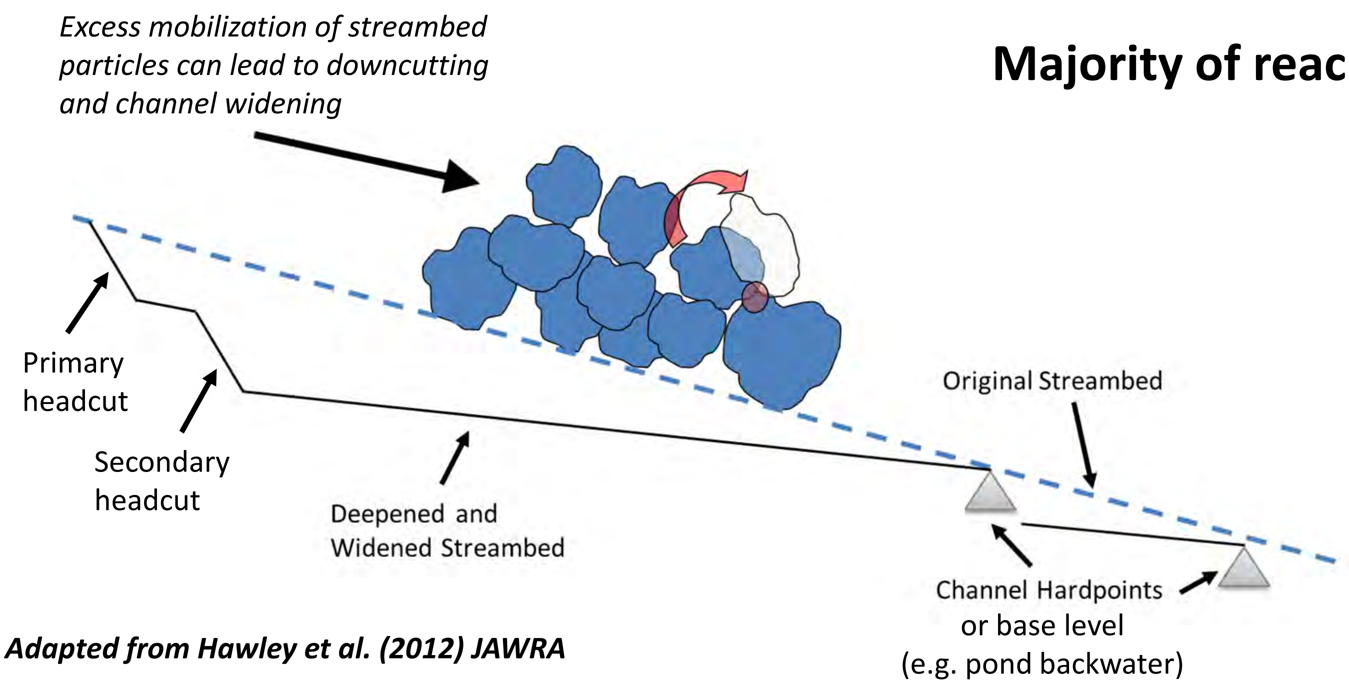
- Pedestrian bridge at risk of undermining
- Severe downcutting and headcutting in gully draining 15” outfall

Franz Pond Ditch Assessment

- Downcutting and bank heights less extensive at pond backwater zone

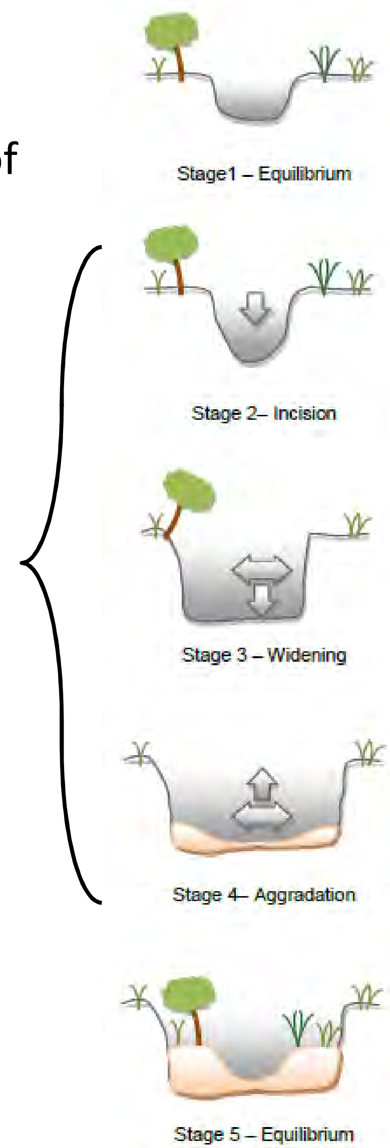
Franz Pond Ditch Assessment – Overall Summary

- Chronic instability driven by incision-based (downcutting) channel evolution trajectory *(examples below and right)*
- The most extensive instability in the most downstream ~third of the ditch has the ability to migrate upstream via headcutting
- Much of the existing channel armoring, retaining walls, and other structures indicate signs of instability, undermining, flanking risk, etc.

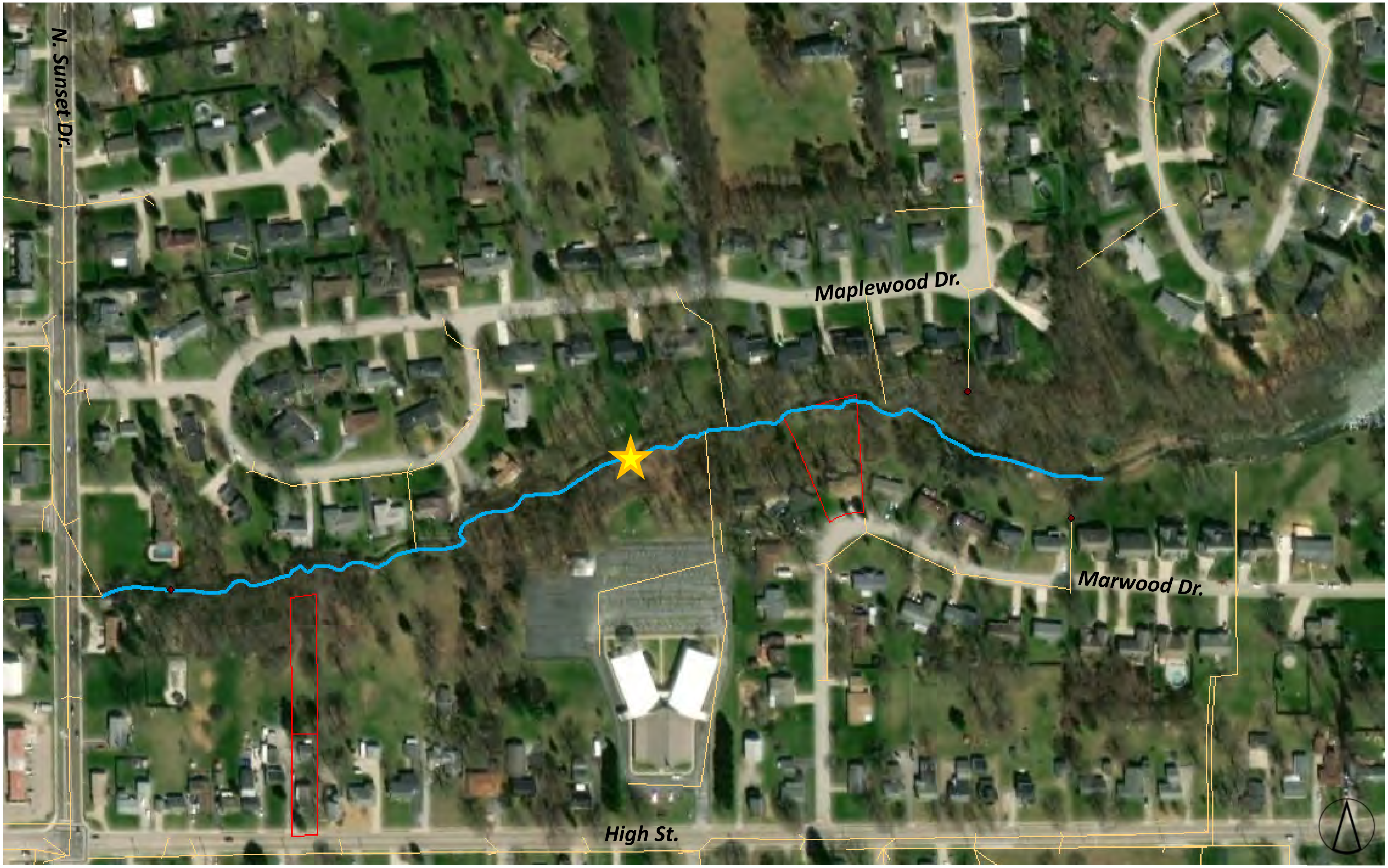


Adapted from Hawley et al. (2012) JAWRA

Majority of reach



Franz Pond Ditch – Data Collection



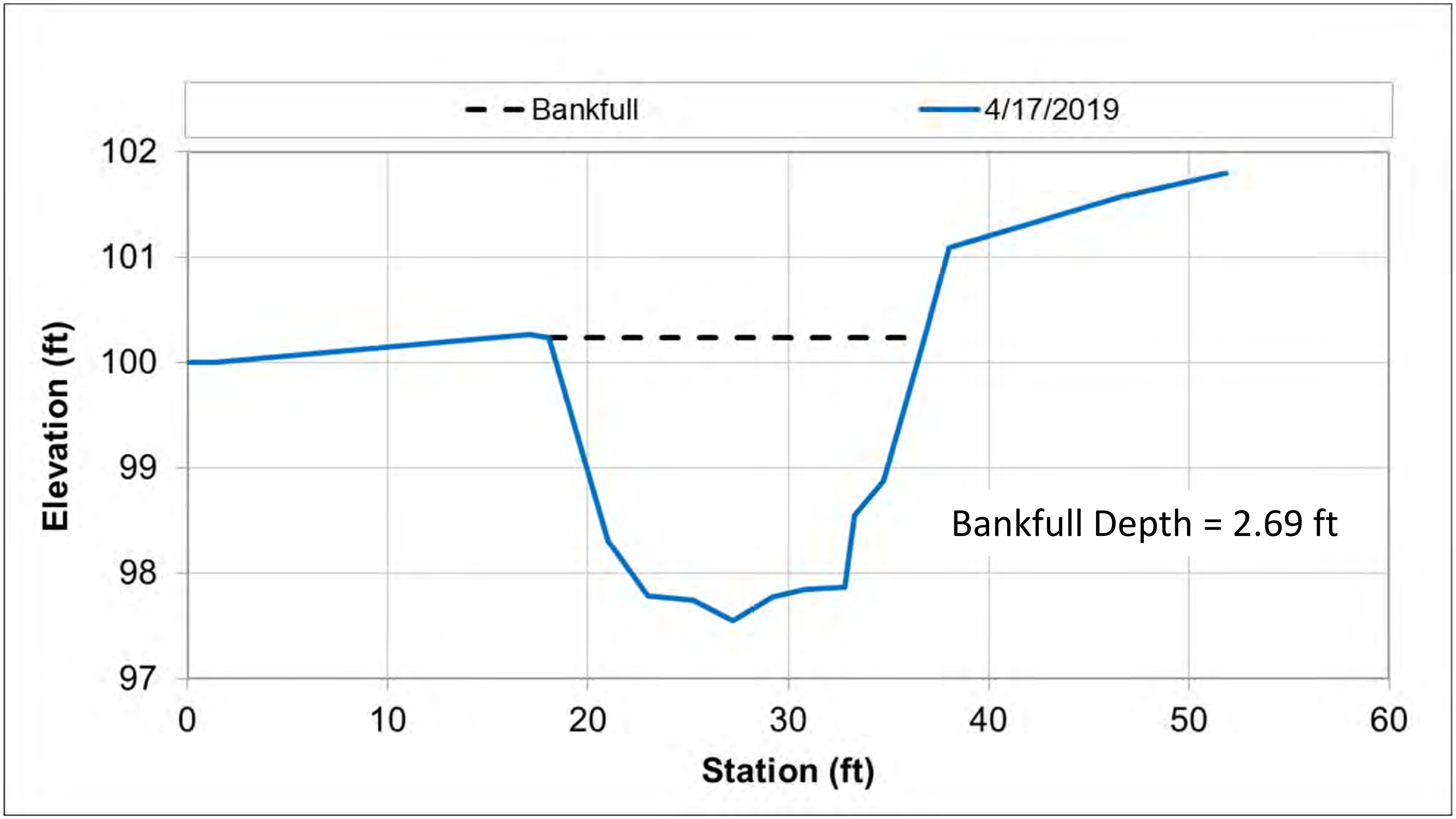
Looking upstream from cross section location


Looking downstream from cross section location


Left bank at cross section location

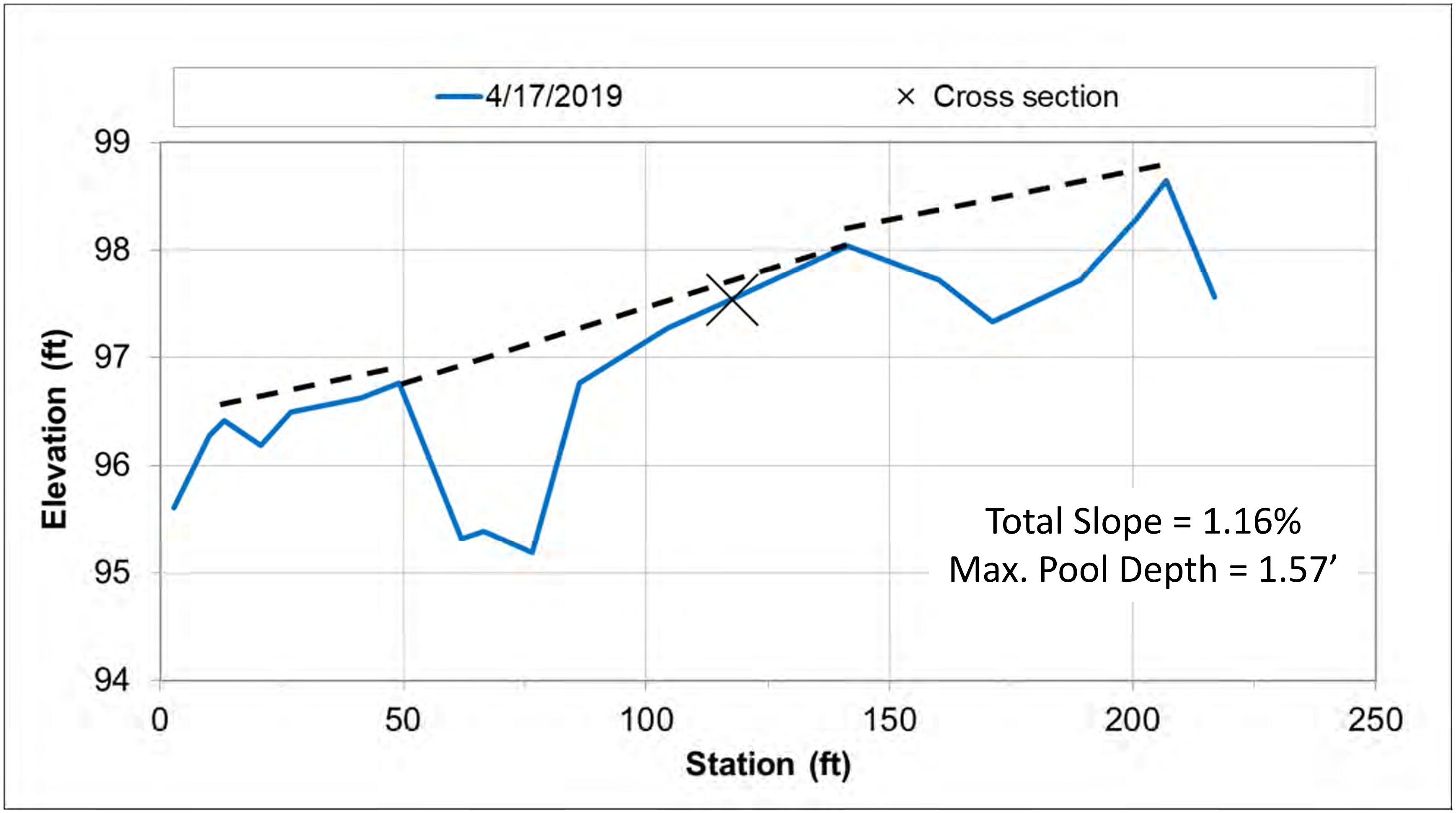

Right bank at cross section location

Cross Section

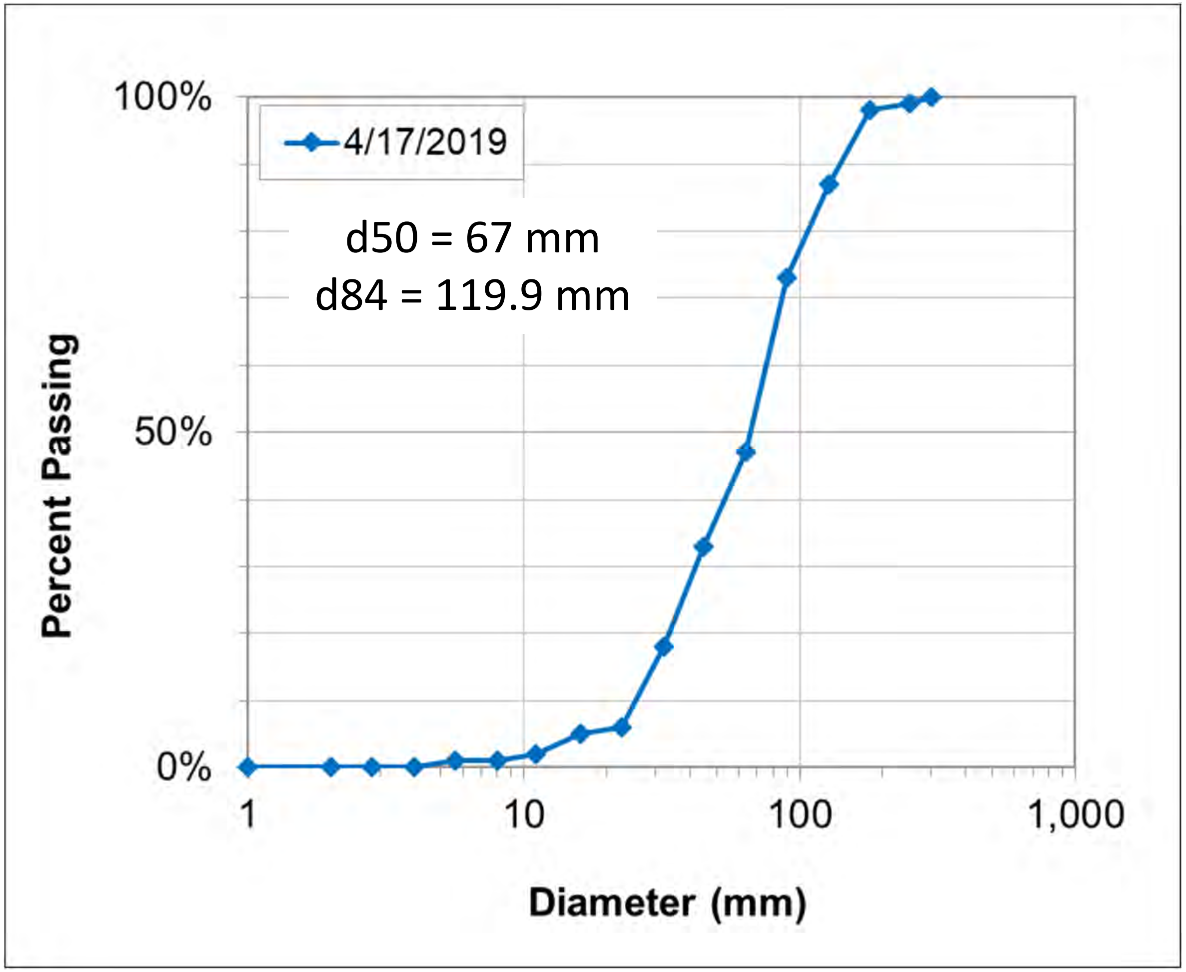


Cross section oriented looking downstream

Profile

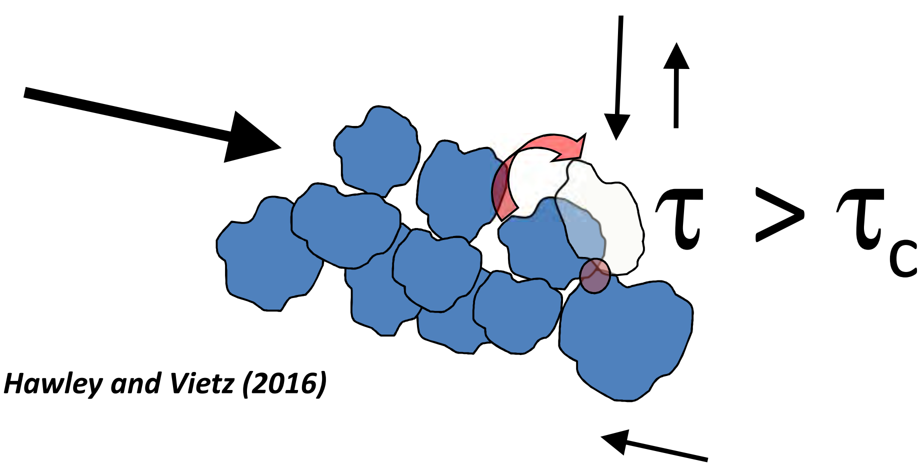

4/17/2019
× Cross section
99
98
97
96
95
94
Elevation (ft)
0
50
100
150
200
250
Station (ft)
Total Slope = 1.16%
Max. Pool Depth = 1.57'

Bed Material Gradation



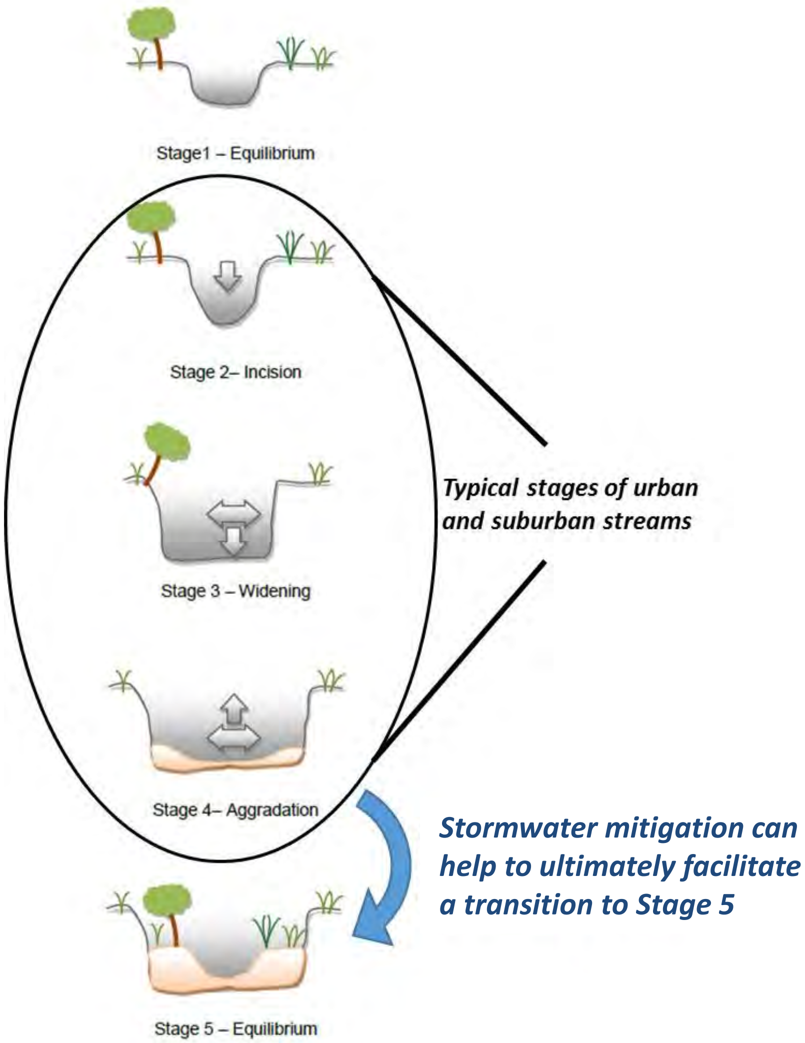
Preliminary $Q_{critical}$

- Extensive armoring and chronic channel instability limited the ability to collect representative data at multiple sites
- Drainage Area = ~0.81 sq. mi.
- **Data suggest a representative $Q_{critical}$ of ~40% of the undeveloped Q_2**
  - Consistent with other regional estimates
  - $Q_{critical}$ for bed erosion also coincides with threshold for unarmored, vegetated bank



Qcritical methods outlined by Hawley and Vietz (2016) Freshwater Science

Stormwater-based Mitigation Alternatives



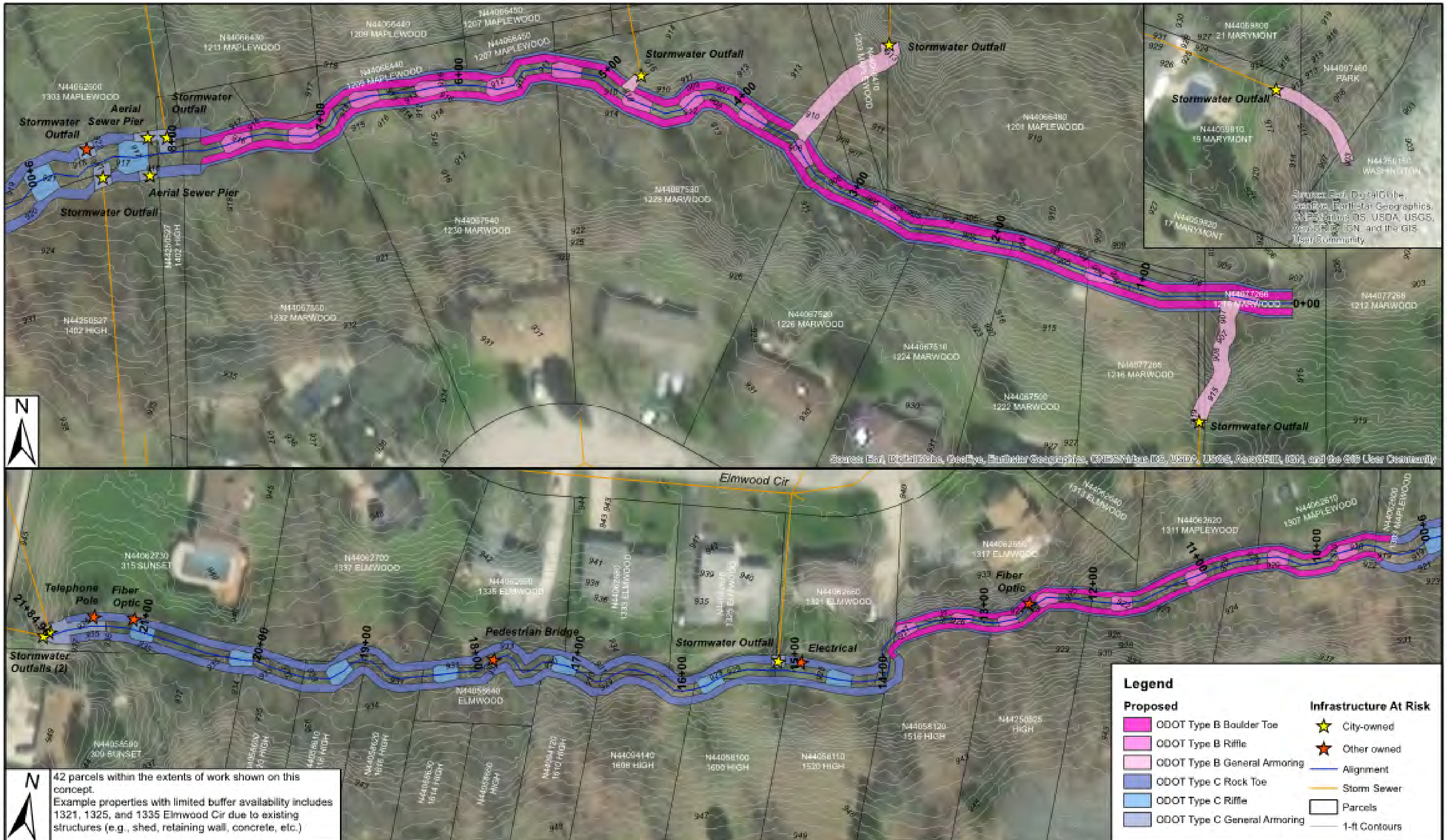
Adapted from Hawley et al. (2017) JAWRA

- Installing stormwater controls to restore a more natural disturbance regime can ultimately promote a transition from Stages 2 & 3 of the Channel Evolution Model to Stage 4, and ultimately Stage 5.
- However, even with highly restrictive stormwater controls, banks and structures that are already unstable will be likely to continue to fail without physical stabilization.

"Stage 3" reaches with geotechnically unstable banks are still likely to fail even with stormwater interventions

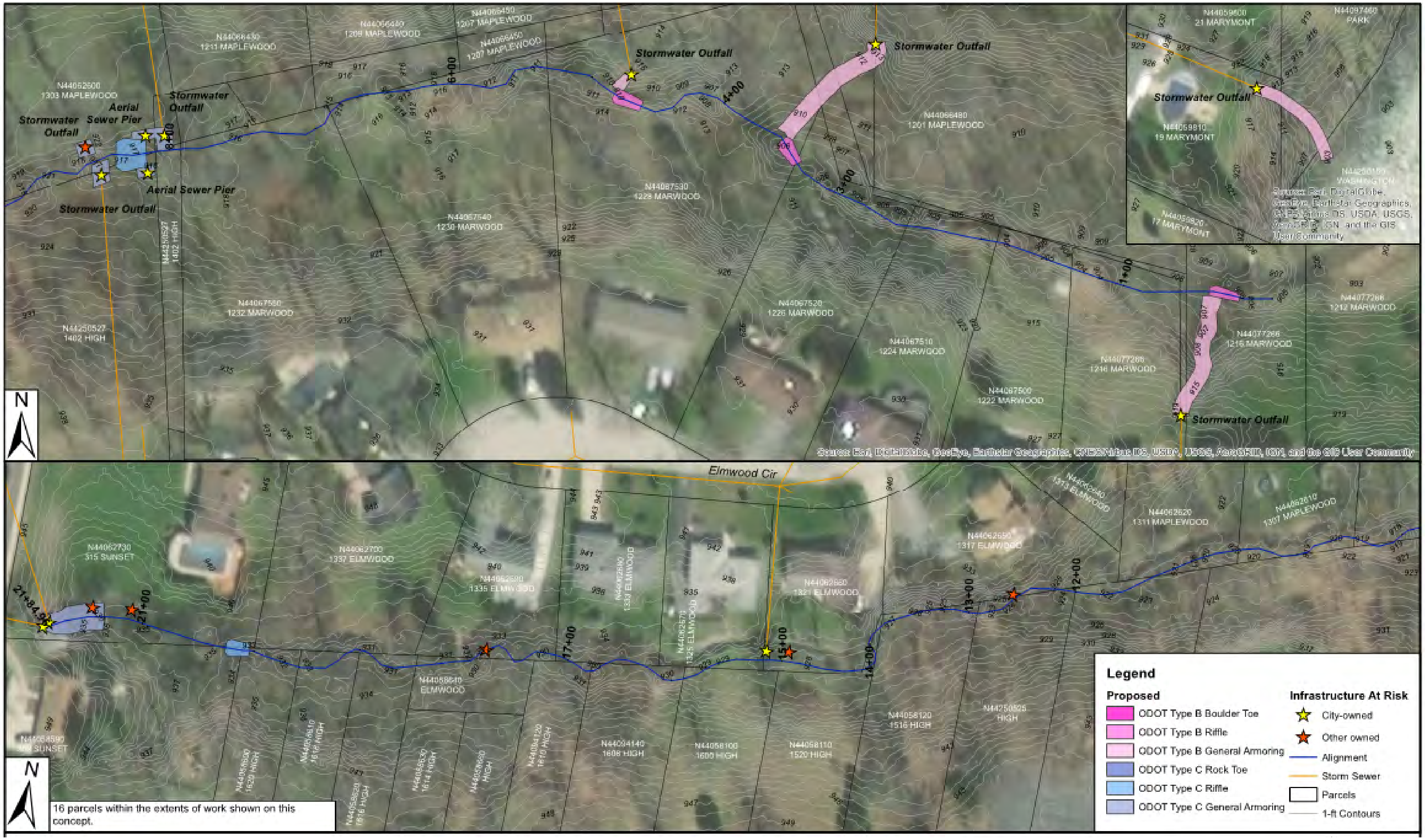
In-Stream Stabilization/Rehabilitation Strategies

Full Bank Protection

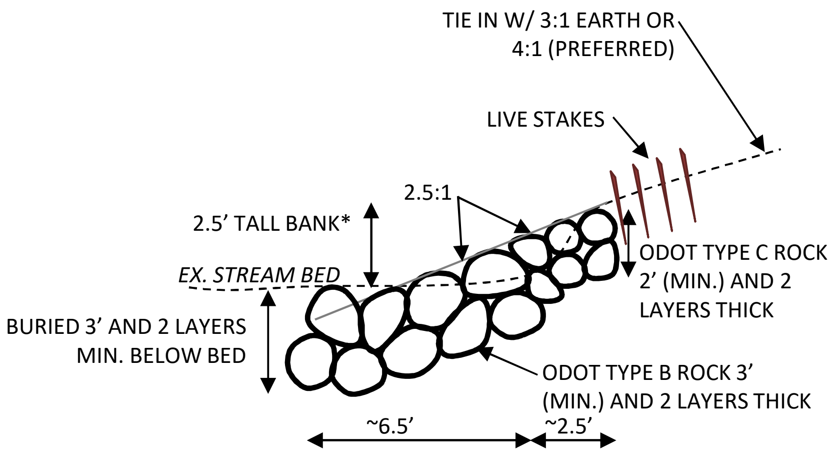


In-Stream Stabilization/Rehabilitation Strategies

Select Bank/Infrastructure Protection



In-Stream Stabilization/Rehabilitation Strategies

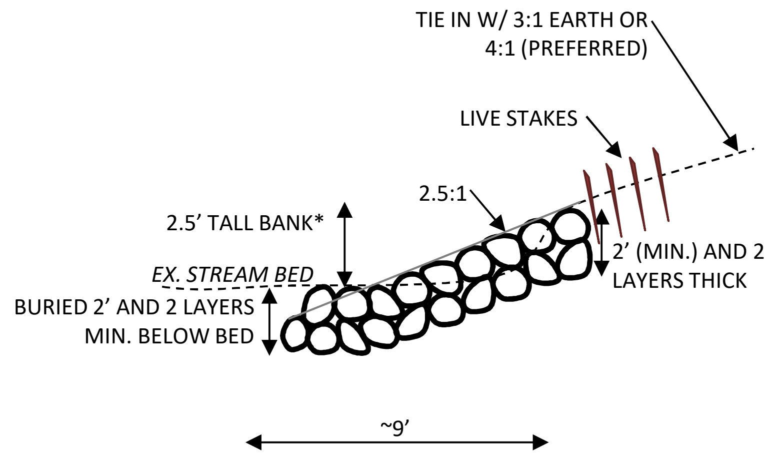


ODOT TYPE B BOULDER TOE

(i.e., ~Sta. 0+00 – 7+75; 9+50 – 14+10)

ODOT Type B rock has a D50 diameter = 1.5'

*Bank can be shorter in reaches with lower energy

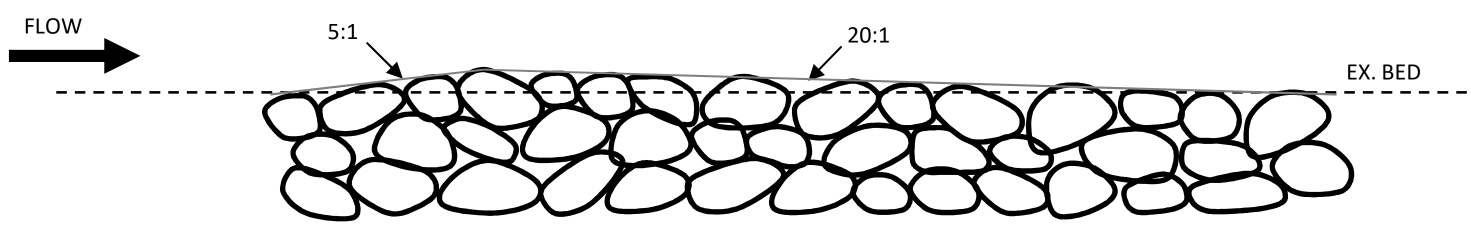


ODOT TYPE C ROCK TOE

(i.e., ~Sta. 7+75 – 9+50; 14+10 – 21+85)

ODOT Type C rock has a D50 diameter = 1'

*Bank can be shorter in reaches with lower energy



TYPICAL ROCK RIFFLE PROFILE

25' long x ~2-3' thick riffle grade control structure with
ODOT Type C or B rock to match bank rock

In-Stream Stabilization/Rehabilitation Strategies

- Full Bank Protection
  - 42 parcels within extents of work
  - Preliminary OPCC: ~$1,766,000

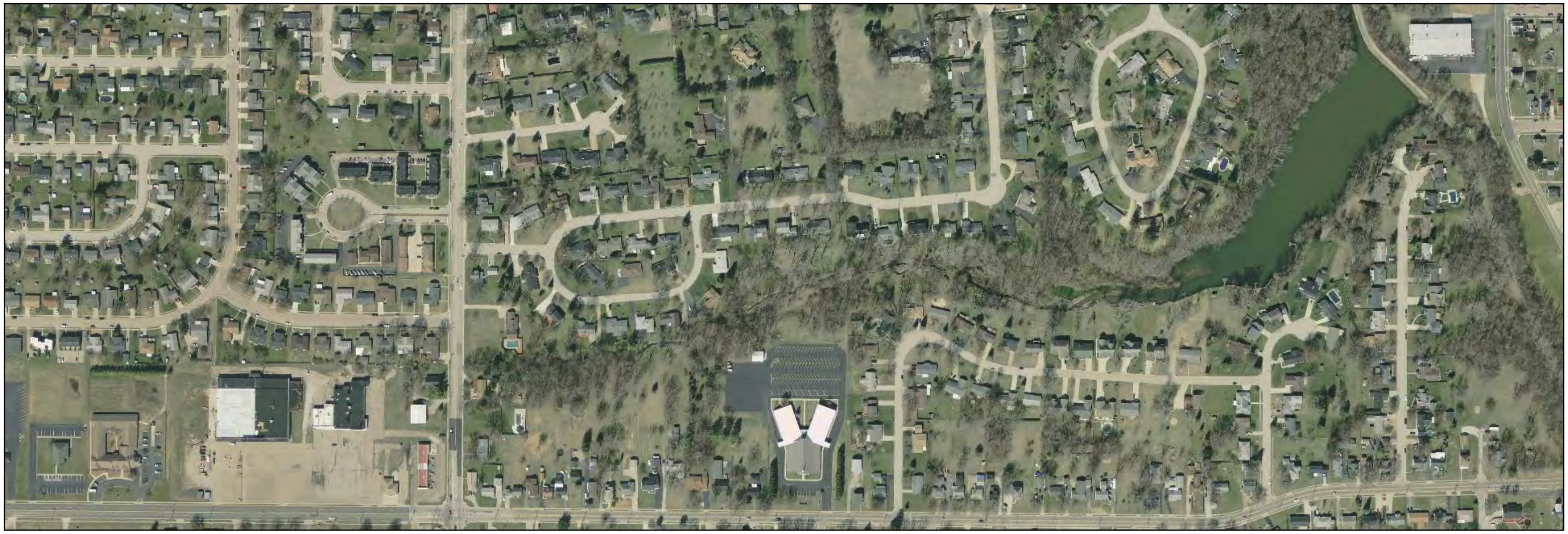
- Select Bank/Infrastructure Protection
  - 16 parcels within extents of work
  - Preliminary OPCC: ~$433,000

In-Stream Stabilization/Rehabilitation Strategies

- Survey will need to identify private utilities (observed several private electric)
- Grant funding sources often require conservation easements that would overlap with existing concrete walks, driveways, retaining walls, etc.

APPENDIX B
FRANZ POND DITCH EVALUATION PRESENTATION TO PUBLIC

Strand Associates, Inc.® (SA)



Franz Pond Ditch Evaluation and Opportunities

City of Piqua, Ohio
October 14, 2019

Strand Associates, Inc.
Chris Rust, P.E.

Project Overview

Develop Project Goals

Evaluate Existing Conditions

Identify Potential Opportunities

STRAND ASSOCIATES®

Project Goals

- Evaluate existing conditions to determine the flow rate of stormwater runoff that causes erosion along Franz Pond ditch ($Q_{critical}$).
- Identify a variety of potential alternatives or projects to control and reduce stormwater runoff during rainfall events.
- Evaluate viable alternatives to determine estimated reduction of bank erosion along the ditch, as well as opinions of probable construction cost.

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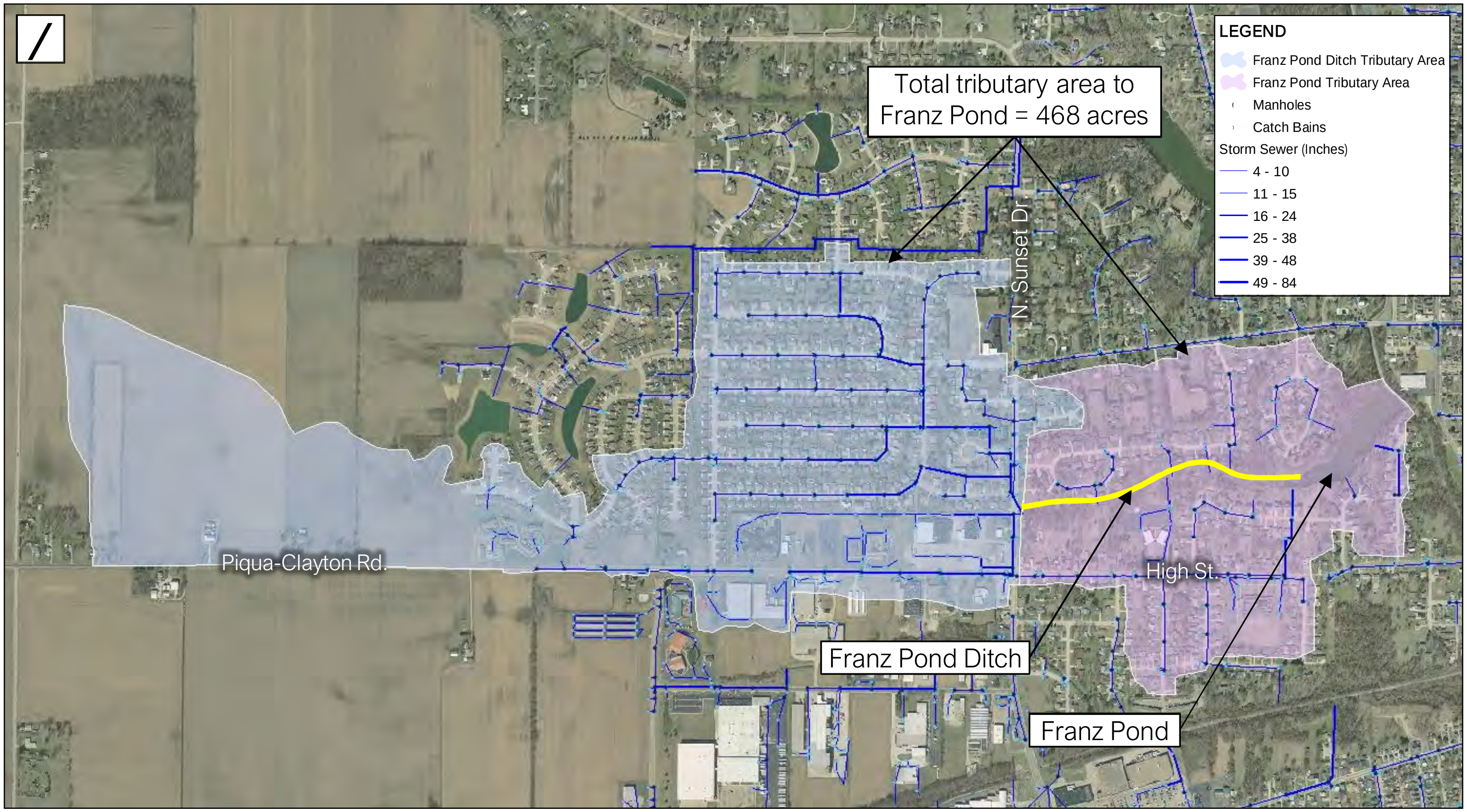
Existing Conditions



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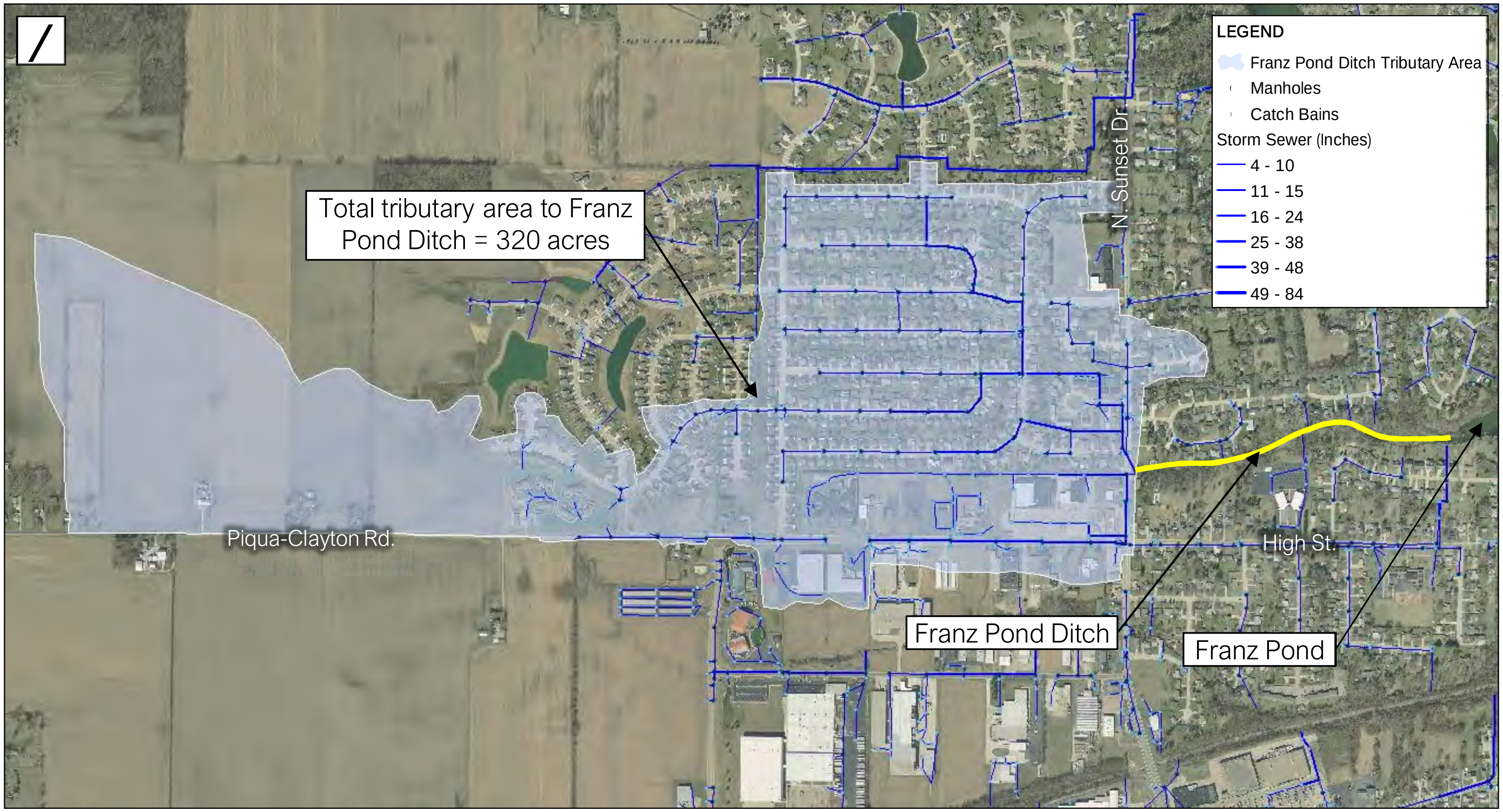
Existing Conditions



Existing Conditions

- Storm sewer outfalls from upstream drainage area at North Sunset Dr.

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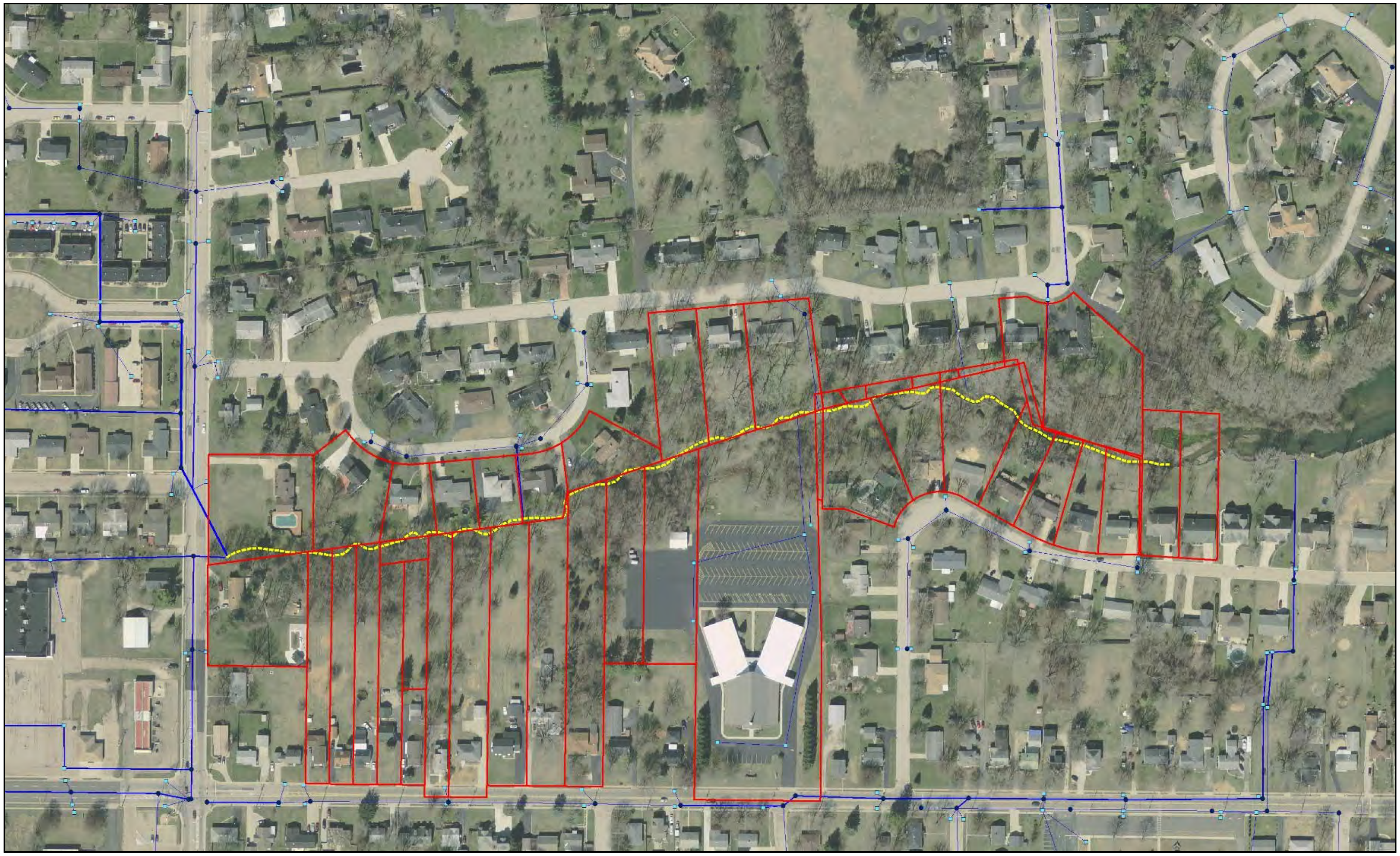
Existing Conditions

➢ Total length of Franz Pond ditch is approximately 2,200 linear feet.

Existing Conditions



- Total number of parcels along the ditch is approximately 40 to 50.

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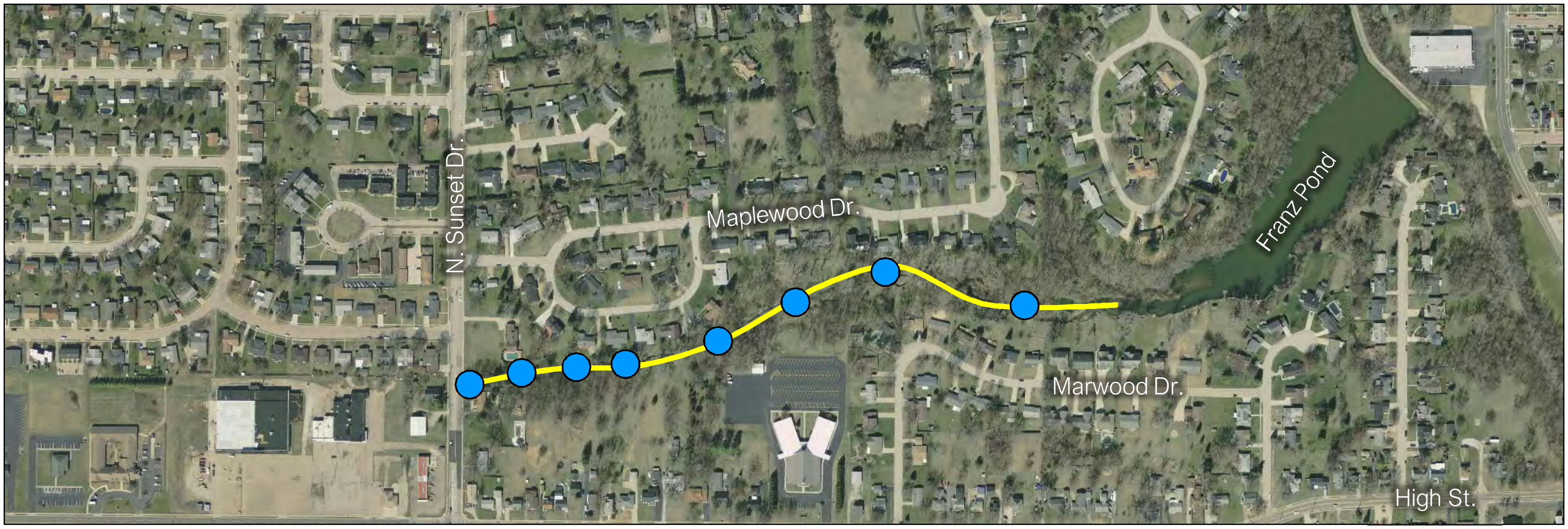

N. Sunset Dr.
Maplewood Dr.
Franz Pond
Marwood Dr.
High St.

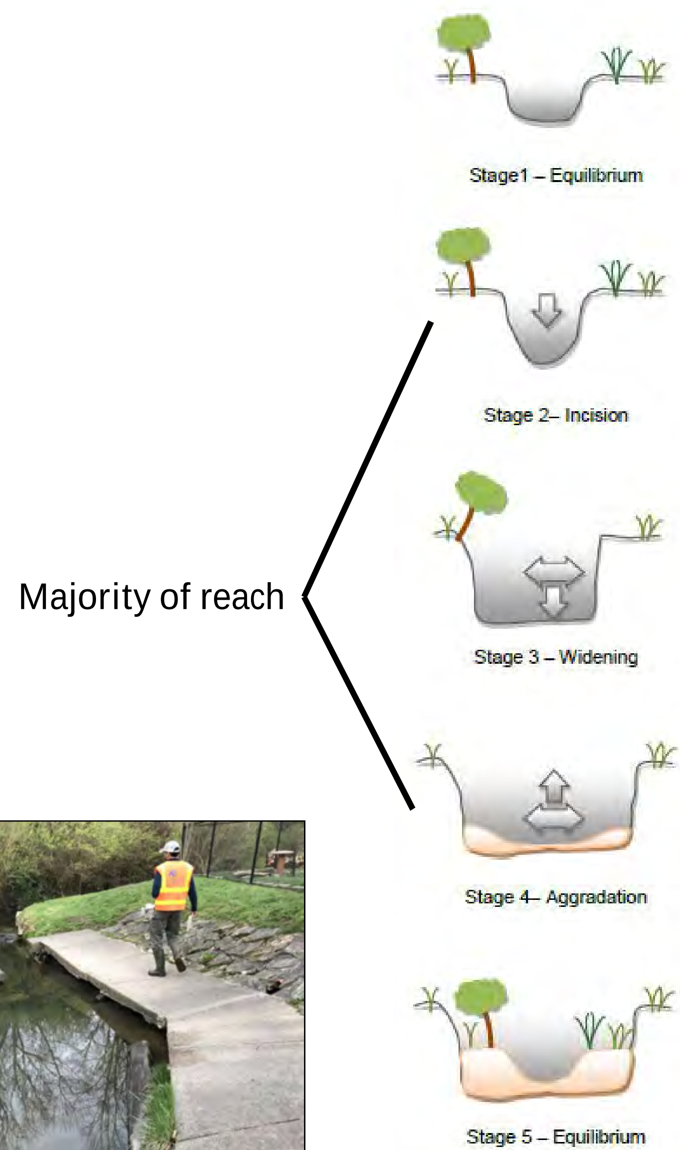



Franz Pond Ditch Assessment

- Chronic instability driven by incision-based (downcutting) channel evolution trajectory

- Extensive instability in downstream portion of ditch with ability to migrate upstream via headcutting

- Existing armoring is undermined and unstable



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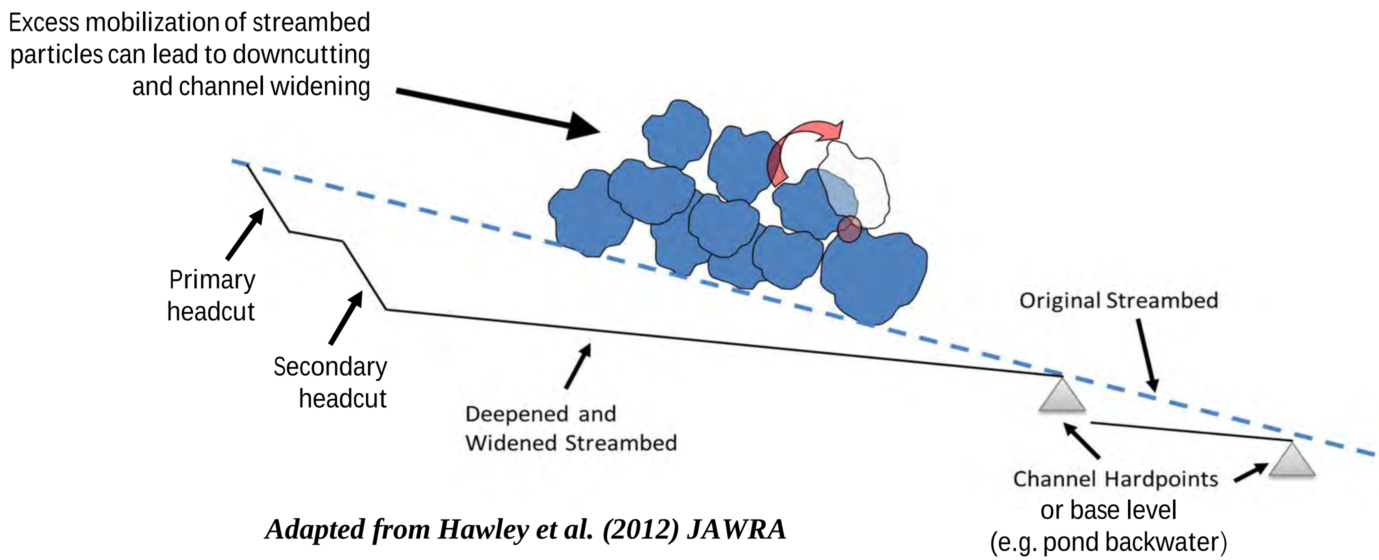
Franz Pond Ditch Assessment



Adapted from Hawley et al. (2012) JAWRA

- $Q_{critical}$ is the stormwater runoff flow rate at which streambed particles begin mobilizing
- Reducing or minimizing the amount of time in which $Q_{critical}$ is exceeded will reduce streambank erosion

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Potential Opportunities

Storm Sewer
Re-Routing / Diversion

Upstream
Detention

In-Stream
Bank Stabilization

Bankfull
Detention

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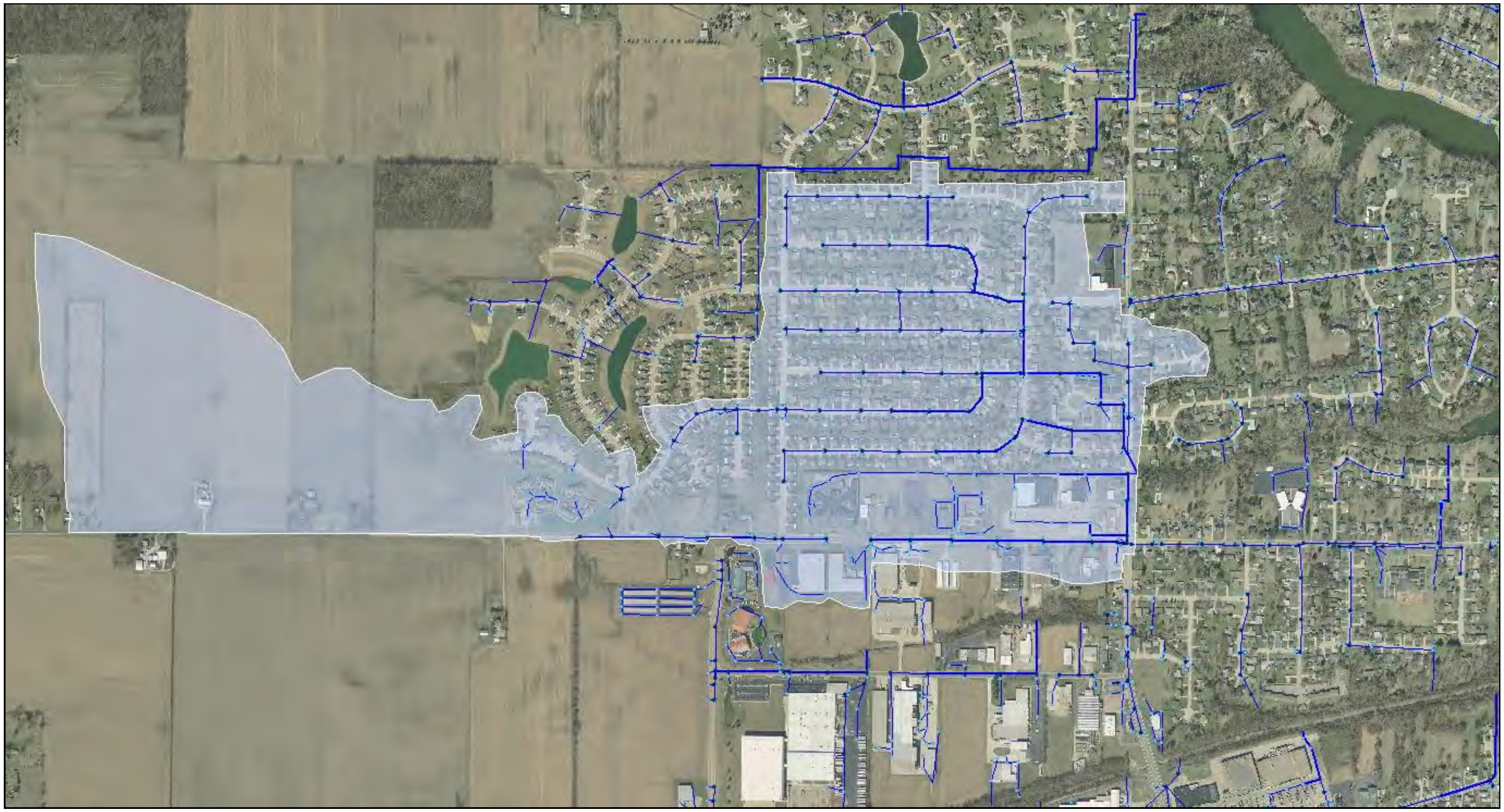
Storm Sewer Re-Routing / Diversion



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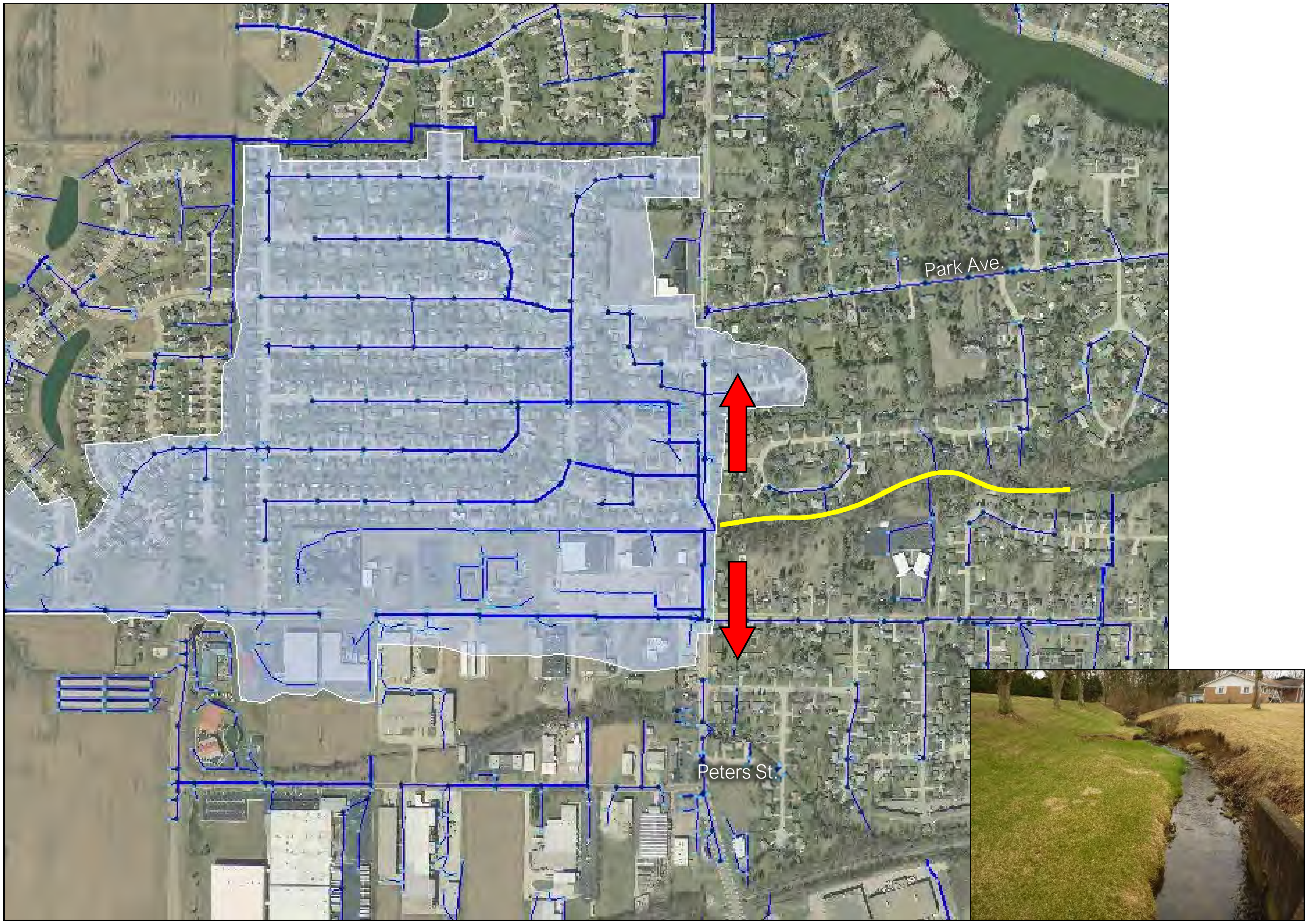
Storm Sewer Re-Routing / Diversion



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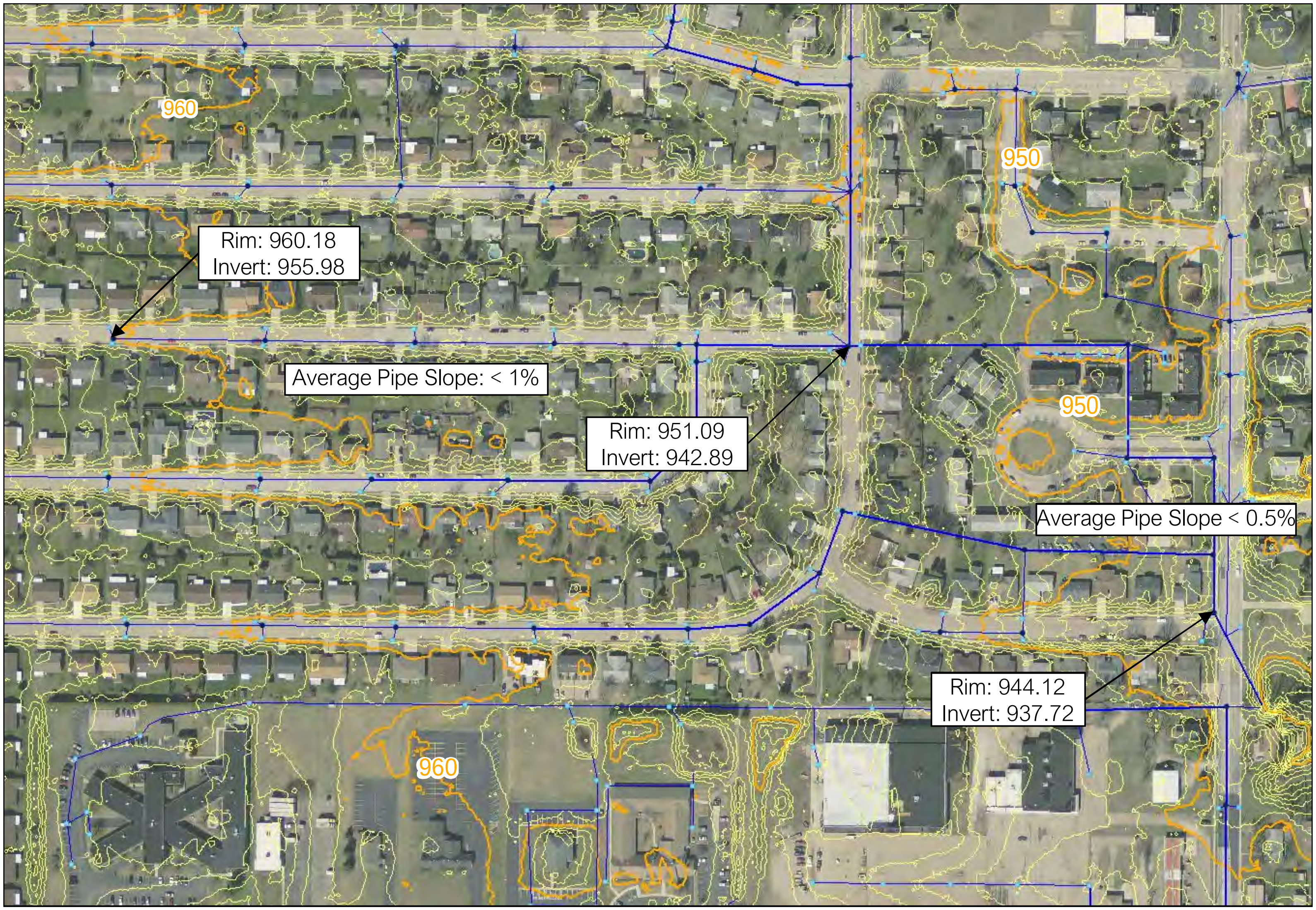
Storm Sewer Re-Routing / Diversion



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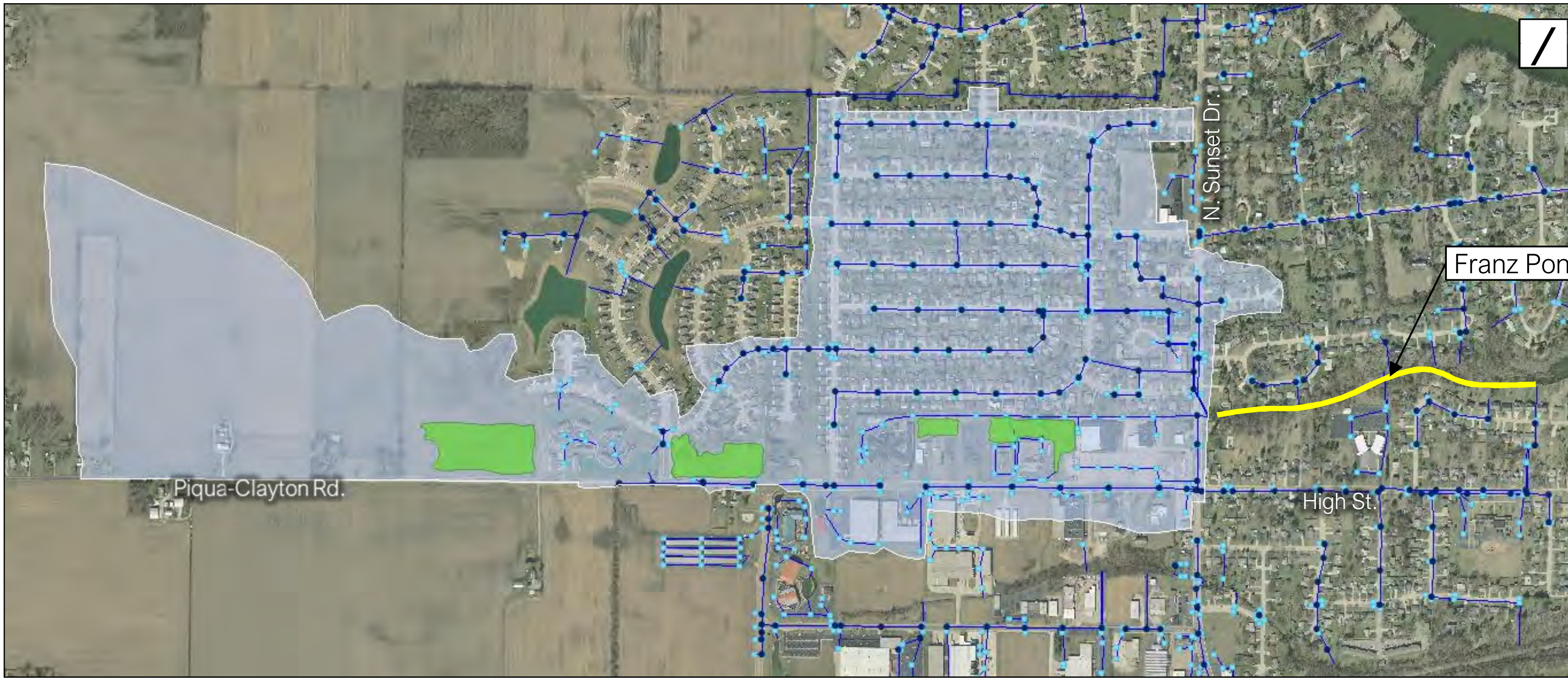
Upstream Detention

Dry Detention Basins

Wet Retention Ponds

Upstream Detention



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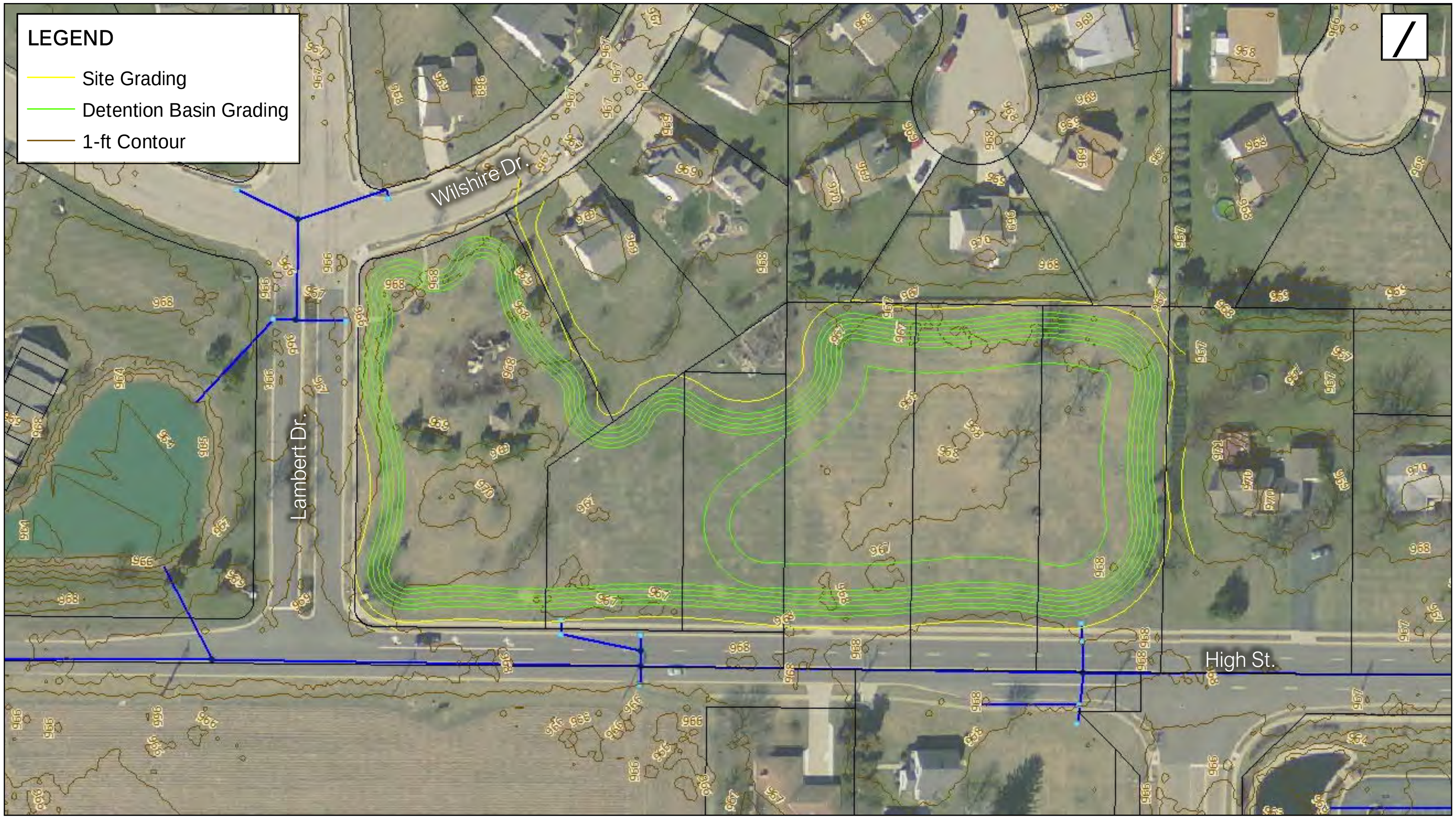
Upstream Detention

STRAND ASSOCIATES®

Upstream Detention



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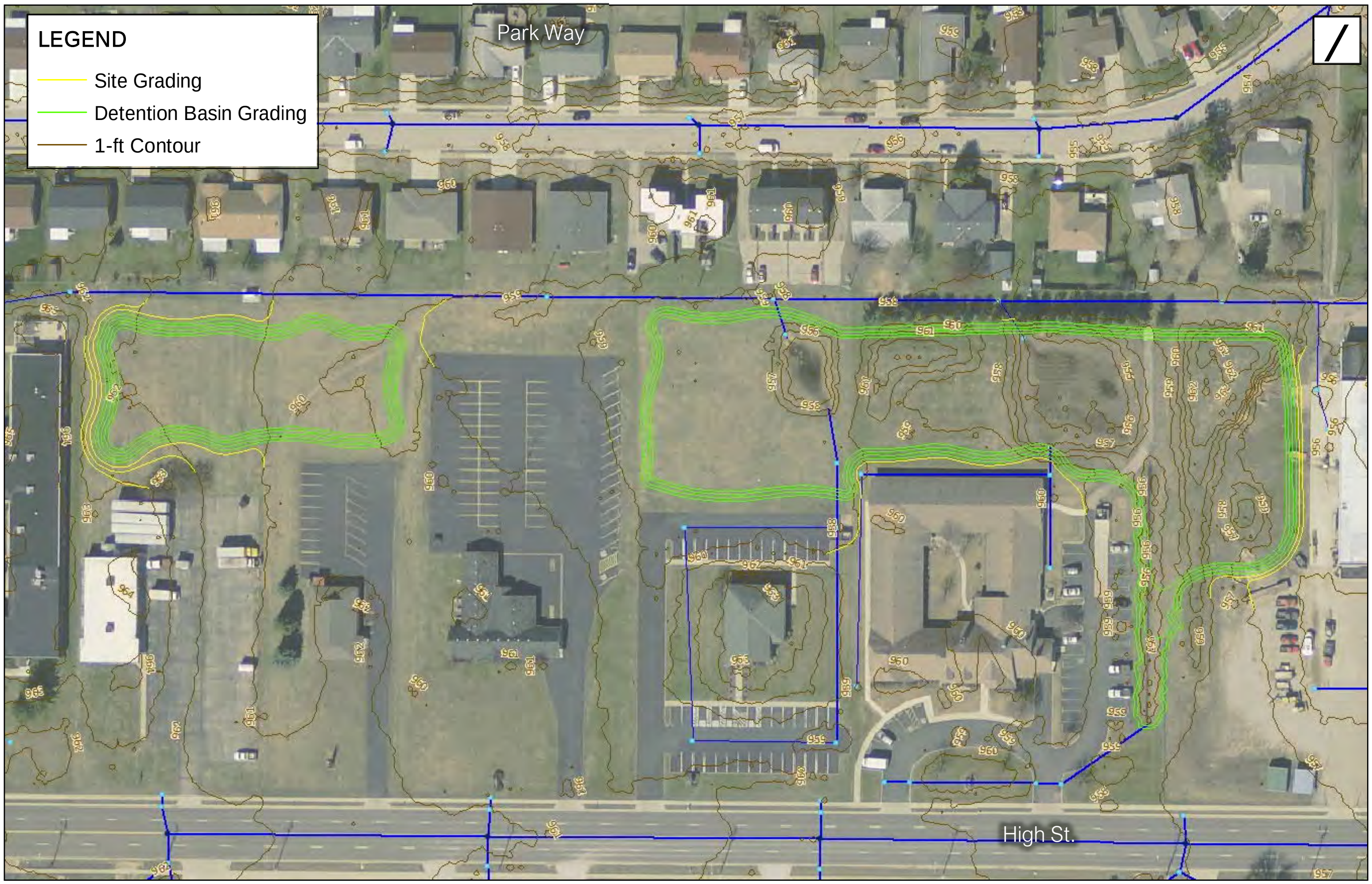
Upstream Detention



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Upstream Detention

- Very limited opportunities for stormwater detention in the residential area that discharges into Franz Pond ditch

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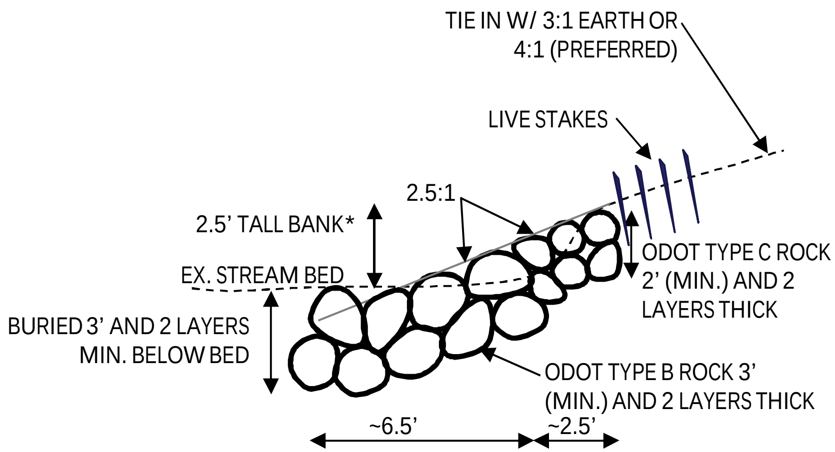
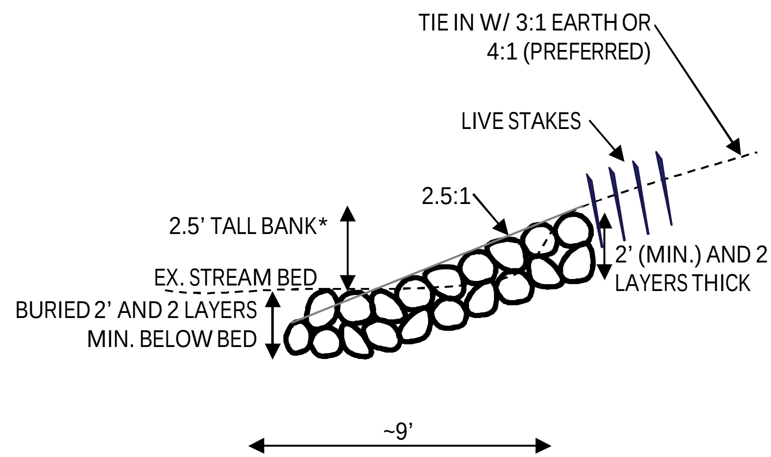
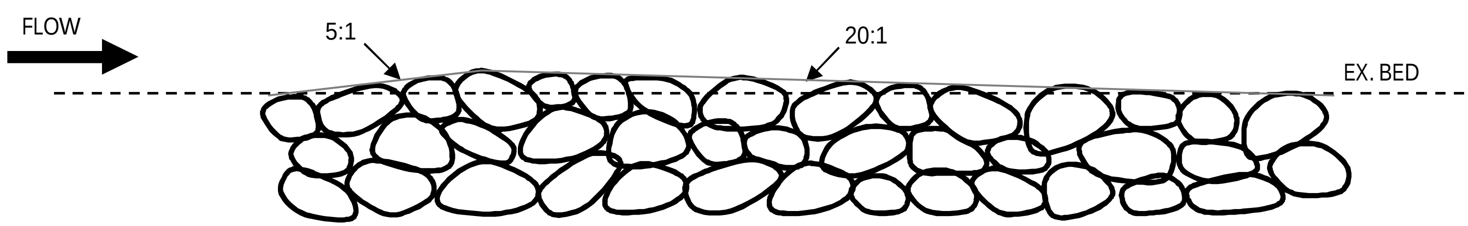
In-Stream Stabilization and Rehabilitation



ODOT TYPE B BOULDER TOE
(i.e., ~Sta. 0+00 – 7+75; 9+50 – 14+10)
ODOT Type B rock has a D50 diameter = 1.5'
*Bank can be shorter in reaches with lower energy



ODOT TYPE C ROCK TOE
(i.e., ~Sta. 7+75 – 9+50; 14+10 – 21+85)
ODOT Type C rock has a D50 diameter = 1'
*Bank can be shorter in reaches with lower energy



TYPICAL ROCK RIFFLE PROFILE
25' long x ~2-3' thick riffle grade control structure with
ODOT Type C or B rock to match bank rock

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In-Stream Stabilization and Rehabilitation

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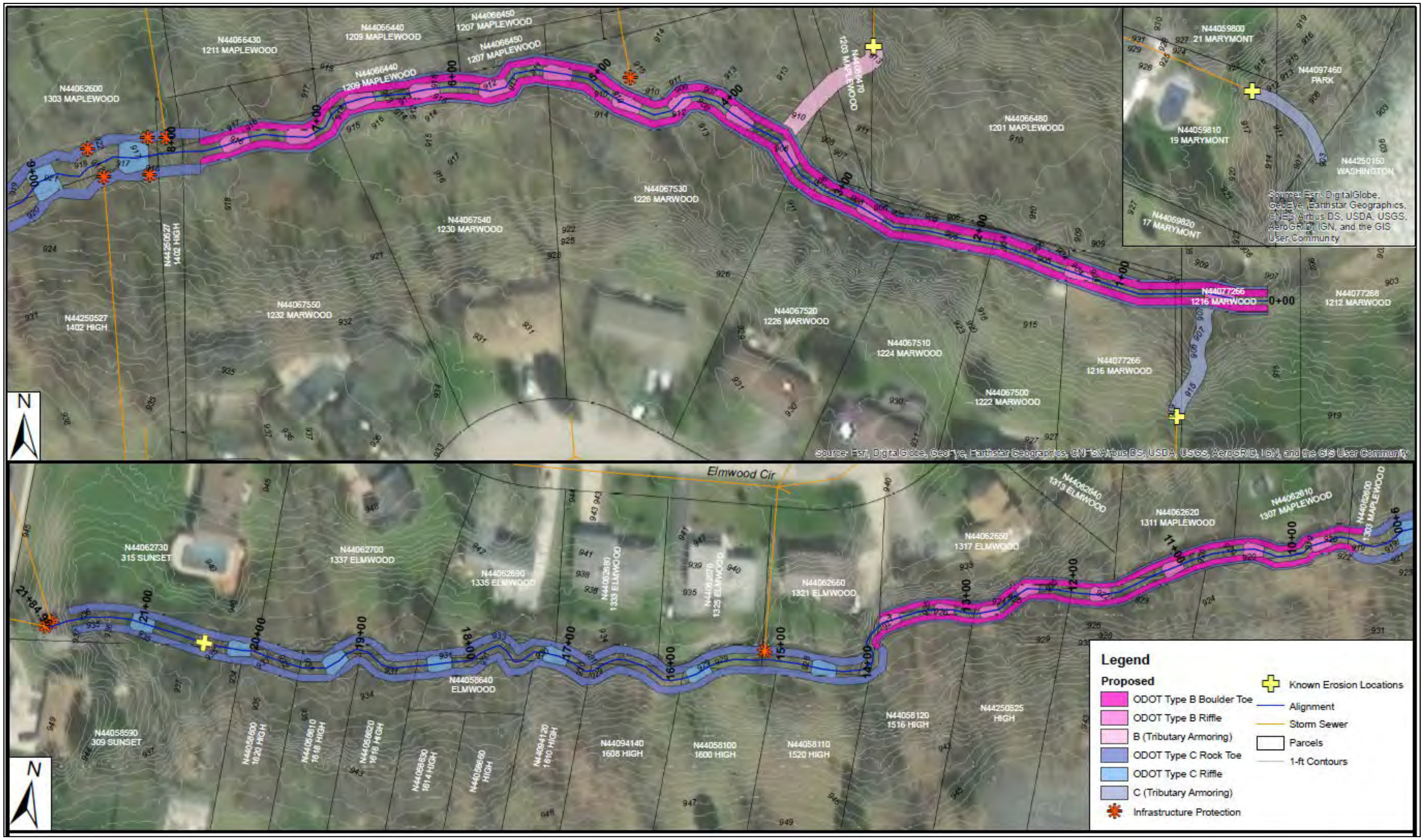
Full Bank Protection



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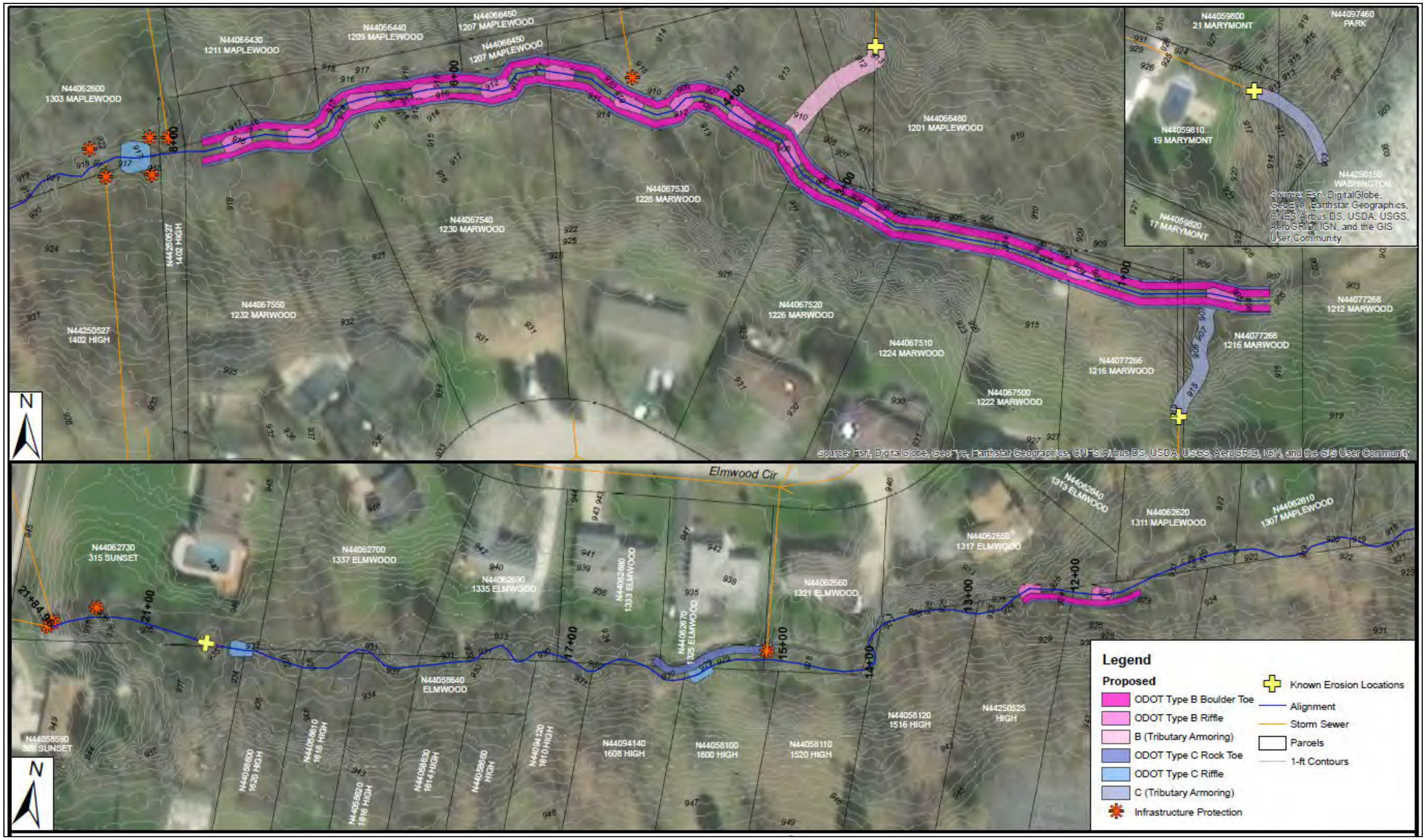
- Preliminary OPCC: $1.8 Million

Select Bank/Infrastructure Protection



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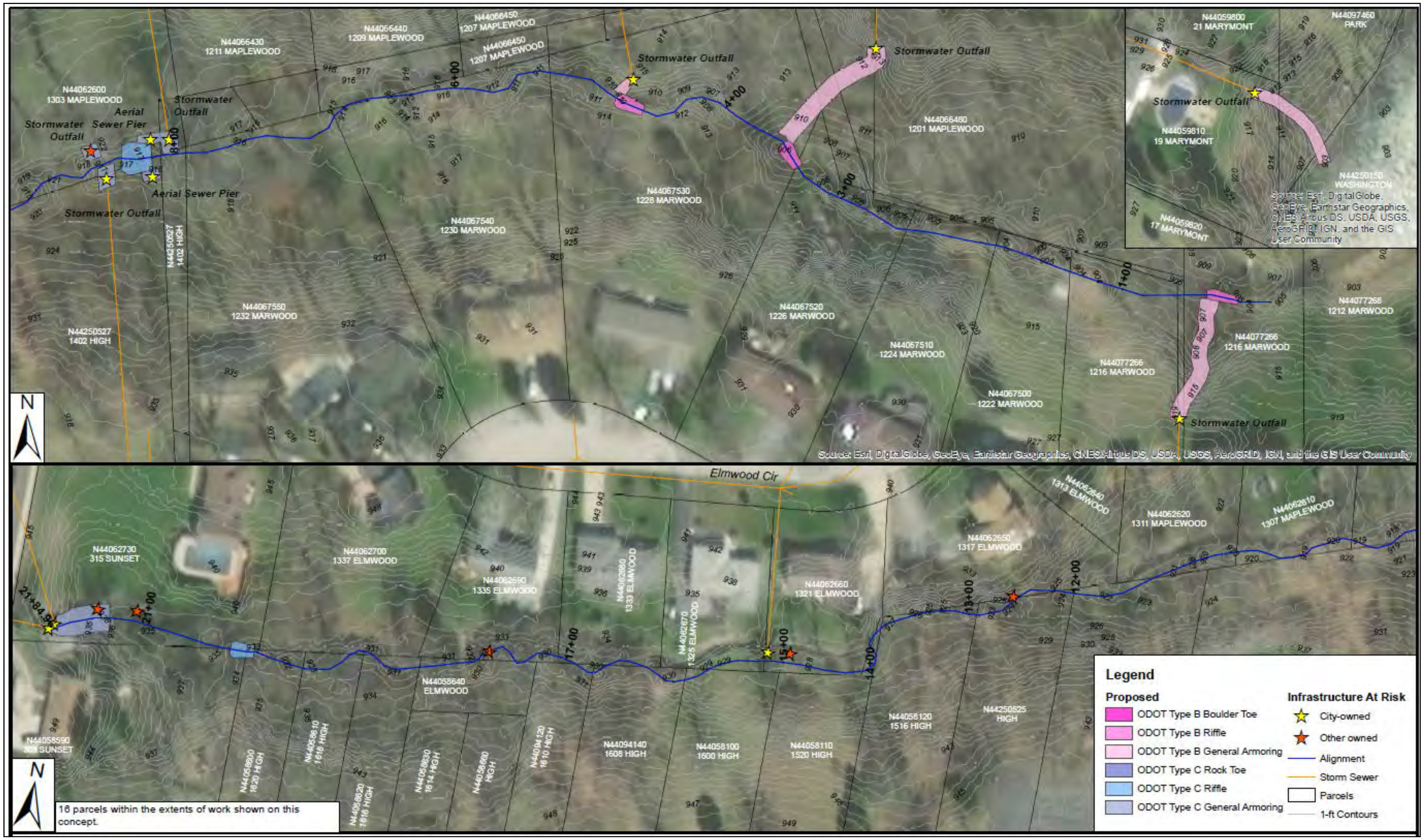
- Preliminary OPCC: $1.3 Million

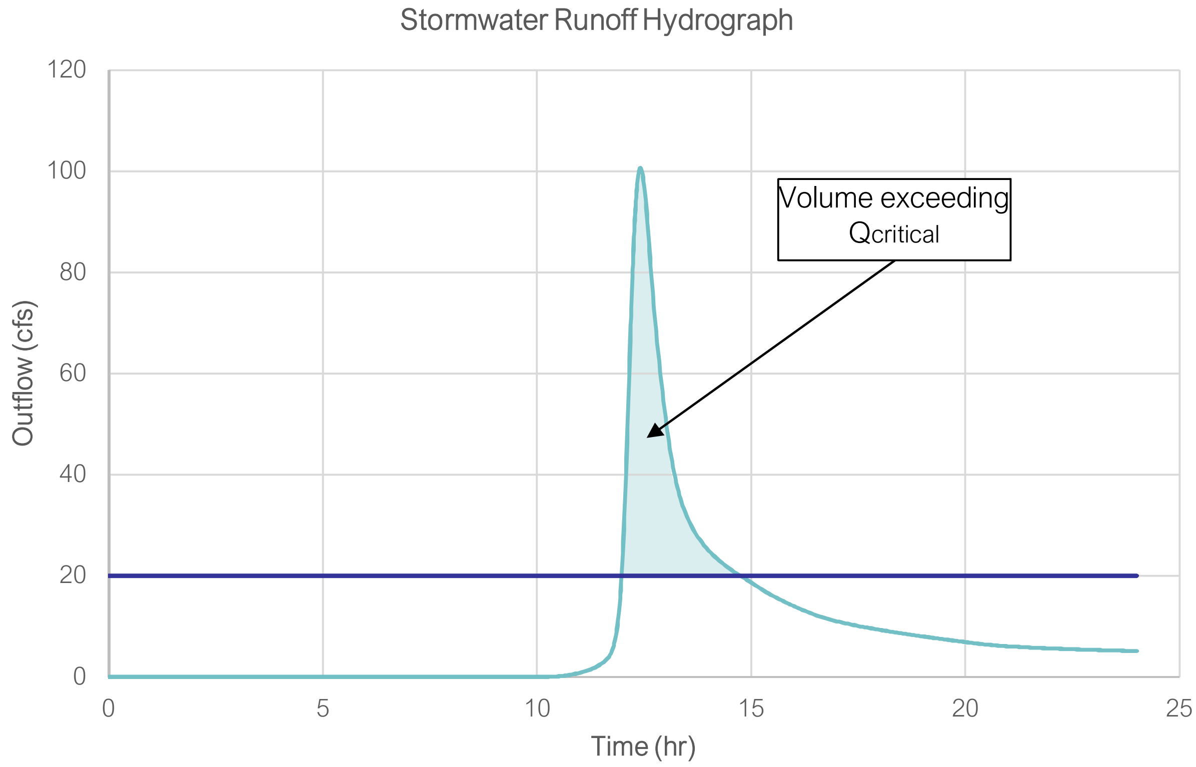
Infrastructure Protection



- Preliminary OPCC: $450,000

Bankfull Detention

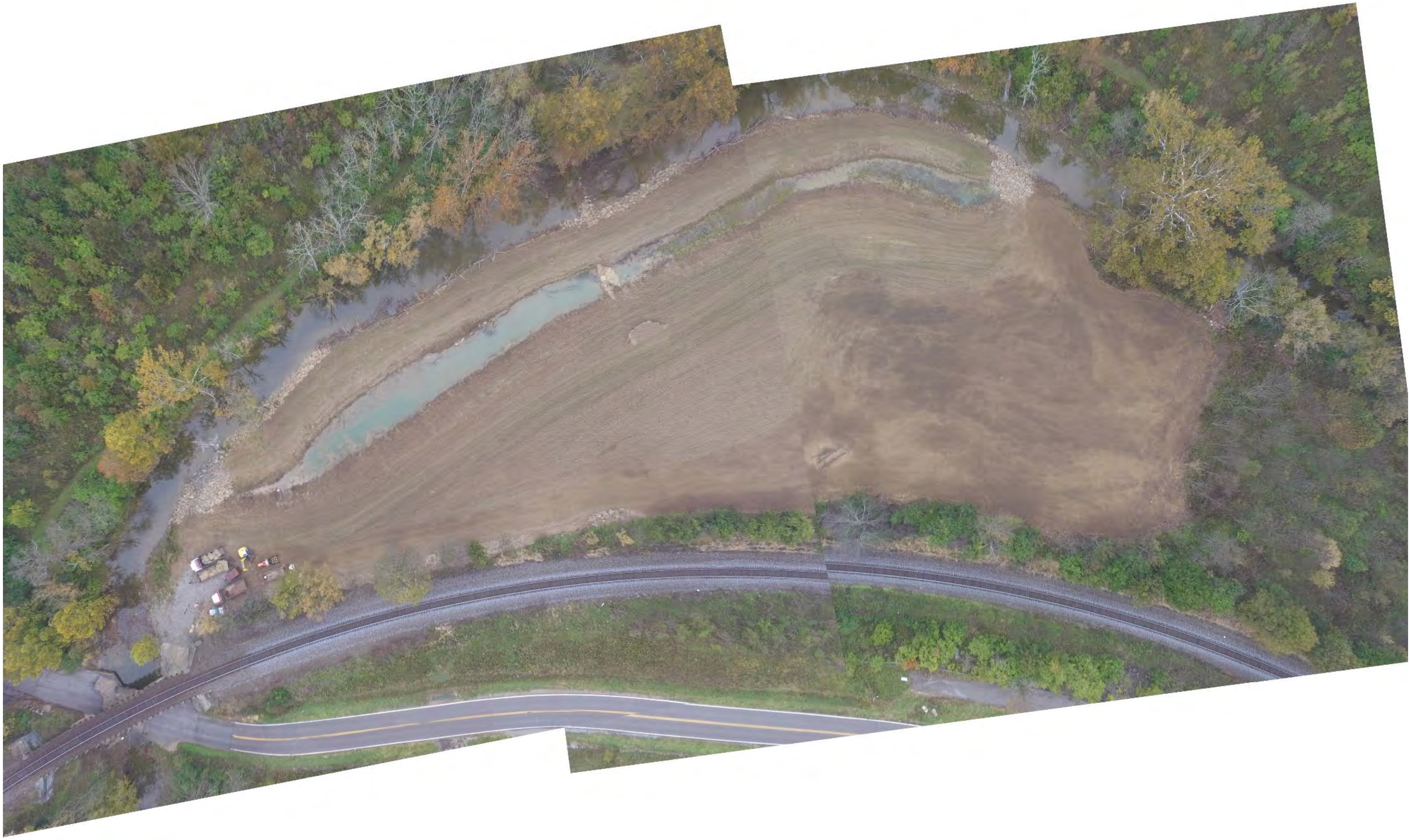
- Benefits are evaluated by comparing storage capacity of the detention cell to the volume exceeding $Q_{critical}$

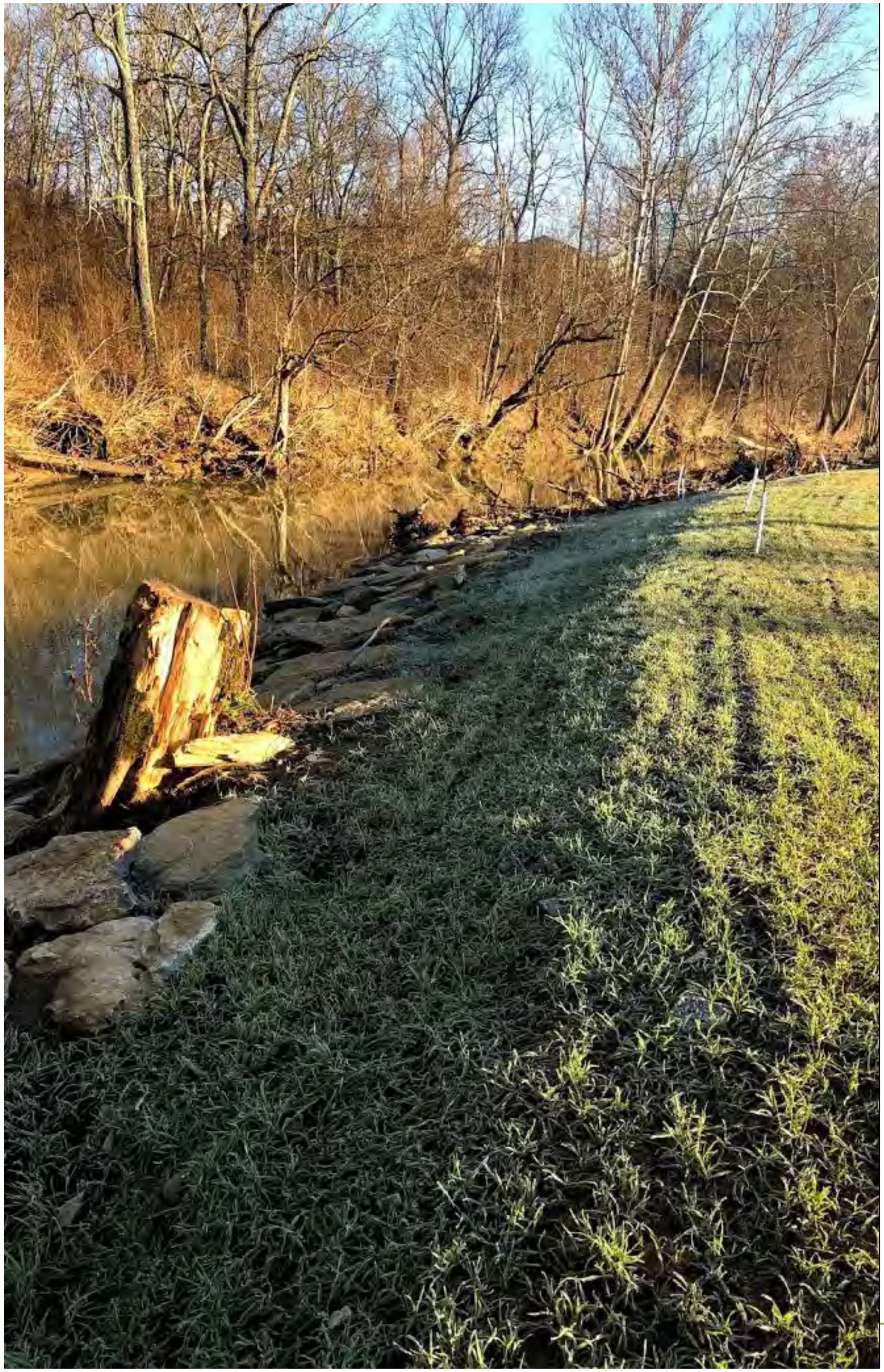


Bankfull Detention

File: S:\CIN\1900--1999\1901\001\Acad\Civil3D\Wolsing Woods\Sheets\Wolsing Woods Plan and Sections.dwg Time: Dec 13, 2017 - 3:58pm

Bankfull Detention






Recap of Potential Opportunities

Storm Sewer
Re-Routing / Diversion

Upstream
Detention

In-Stream
Bank Stabilization

Bankfull
Detention

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Questions and Discussion

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