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Tiber Creek Watershed Study

February 2013

Table of Contents

		Page No.
Table of Contents		i
Section 1	Executive Summary	1
Section 2	Background	2
Section 3	Project Objectives	3
Section 4	Existing Analysis	4
Section 5	Proposed Analysis	9
Section 6	Cost Estimates & Recommendations	18

Tables

1	100-Year Water Surface Elevation Summary	11
2	100-Year Flow Summary	12
3	Proposed Alternative Cost Summary	19

Figures

1 Tiber Creek Watershed

2 Critical Flooding Areas

3 Detention & Stream Restoration Areas

4 Cedarbrook Basin Improvements

5 Maplewood Basin Improvements

6 Cedarbrook Drive Improvements

7 Conveyance System Summary & Critical Maintenance Areas

Appendices

A USGS Report on July 2006 Storm Event

B Flooding Questionnaire Responses

C Proposed Alternative Cost Estimates

D CD with SWMM Model Output & SWMM Electronic Data

Section 1 Executive Summary

Tiber Creek is a small urban stream which drains the southwest portion of the City of Painesville as well as portions of Painesville Township and Concord Township, as shown on Figure 1. At the point at which Tiber Creek discharges into the Grand River, the watershed is approximately 2.3 square miles, which is predominantly comprised of residential development with smaller portions of commercial and light industrial development.

There has been a history of flooding in some areas of the Tiber Creek watershed, with the most significant flooding event occurring on July 27-28, 2006. This event was an extraordinary rain event producing 11.35 inches of rain in 48 hours, which exceeded the 48-hour rainfall estimate for the 1000-year storm event.

Subsequent to this rain event, the City of Painesville hired AECOM in 2008 to study flooding problems in the watershed and recommend storm water improvements to reduce future flooding. This study created an existing hydrologic and hydraulic (H&H) model of the Tiber Creek watershed that extended downstream to the CSX railroad crossing of Tiber Creek. A subsequent phase of this study extended the H&H model to SR 2 and used the model to update the FEMA flood maps for the portion of Tiber Creek between SR 2 and Jackson Street. The Letter of Map Revision was approved by FEMA in January 2011. Additional details of the background of this project are provided in **Section 2** of this report.

The City and Lake County hired ARCADIS to perform this current Tiber Creek Watershed Study to (1) extend the SWMM model to the downstream point of Tiber Creek at the confluence of the Grand River, and (2) evaluate detention and stream restoration improvements not considered in the original 2008 study. For this study, ARCADIS also validated the existing model results through discussions with City and County staff and through gathering and evaluating public observations of flooding problems through a targeted questionnaire mailed to residents. **Section 3** of this report more fully describes project objectives. **Section 4** discusses the extension of the existing H&H model and the validation of the model results.

ARCADIS initially evaluated several potential detention improvements where open land was adjacent to Tiber Creek or its tributaries. The analysis revealed that two potential detention improvements would reduce future flooding. Through our H&H analysis, review of public questionnaire responses, and field observations, we have also identified separate flooding problems that could be addressed by minor storm water system improvements. The detention analysis and miscellaneous improvements are described in **Section 5** of this report. **Section 6** provides cost estimates for the capital improvements as well as recommendations.

Section 2 Background

While portions of the Tiber Creek watershed have experienced persistent flooding, the most severe flooding event to impact the watershed was the extraordinary rain event of July 27-28, 2006. This storm event produced 11.35 inches of rain in 48 hours. For comparison, according to the NOAA Atlas 14, Volume 2 (Version 3), a 1000-year, 48-hour storm in Painesville would produce 8.11 inches of precipitation. This unusual event overwhelmed the storm water conveyance system and resulted in widespread flooding throughout the Tiber Creek watershed. The USGS, in cooperation with FEMA, prepared a detailed report of this rain event in 2007 (Open-File Report 2007–1164), which is included in Appendix A for reference.

The City of Painesville, subsequently hired AECOM in 2008 to study flooding problems in the watershed and recommend storm water improvements to reduce future flooding. The 2008 study developed a hydrologic and hydraulic model of the watershed using the Storm Water Management Model (SWMM) software (version 5.0.11), developed by the USEPA. The model covered the entire upstream area of the watershed within the City and neighboring Concord Township and extended downstream to the CSX railroad crossing of Tiber Creek approximately 2,000 feet south of SR 2. The 2008 study recommended several storm sewer system upgrades.

In 2011, the 2008 SWMM study was extended downstream to SR 2 and used to update the FEMA Flood Insurance Rate Map for Painesville through a Letter of Map Revision (LOMR). The LOMR corrected an erroneous culvert size under SR 2 in the current FEMA analysis, which caused the 100-year flood elevations to be overestimated. In January 2011, FEMA approved the LOMR which lowered the effective 100-year flood elevations along Tiber Creek between SR 2 and Jackson Street.

In 2011, the City and the Lake County Stormwater Management Department hired ARCADIS to extend the SWMM model downstream to the confluence with the Grand River and evaluate detention and stream restoration improvements in the watershed. The objectives of this study are discussed in detail the following section.

Section 3 Project Objectives

The previous studies of the Tiber Creek watershed evaluated storm sewer improvements and recommended upsizing of storm sewers in critical areas to mitigate existing flooding. The primary purpose of this Tiber Creek Watershed Study is to evaluate detention and stream restoration improvements as well. The chief benefit of detention and stream restoration improvements is that peak flows in the storm water conveyance system are reduced thereby enabling existing storm sewers to convey peak flows without upgrading capacity. An additional benefit is that stream restoration improvements may increase capacity of streams and ditches in order to handle higher flows that can result from removing bottlenecks in the upstream storm sewer system.

Secondary objectives of this study were to extend the existing H&H model downstream to encompass the entire Tiber Creek watershed and to validate the previous model results. In order to validate the H&H model, ARCADIS met with City staff from the engineering and service departments as well as the Lake County Engineer and Stormwater Management Director. In addition, we prepared and mailed a flooding questionnaire to residents and businesses in identified flood-prone areas of the watershed and compared the questionnaire responses to model results. A description of the extended model and the model validation process are provided in the following section.

Section 4 Existing Analysis

The first major task to evaluate existing flooding conditions was to extend the SWMM model developed for the 2008 and 2011 studies to the downstream point of Tiber Creek at the confluence with the Grand River. However, prior to extending the model, we reviewed the existing SWMM model in detail and made several minor adjustments.

First, we ran the existing model in the current version of SWMM (Version 5.0.22). Recent updates that the USEPA has made to the SWMM software have fixed various bugs in the software and corrected some computational algorithms. Therefore, we believe using the most recent SWMM version would generate the most reliable results.

The second modification we made to the existing model was to add culvert codes at all conduits with open, culvert-type inlets. The culvert codes (which were not available in Version 5.0.11 used in the 2008 and 2011 studies), allow the SWMM software to consider inlet control for culverts as studied by the FHWA and documented in the Hydraulic Design Series No. 5 report. The addition of the culvert codes provides more accurate results at drive pipes, culvert crossings, and channel enclosures.

The third adjustment was to the overflow conduits in the model, which represent the street network. The overflow conduits, which run parallel to much of the storm sewer system, allow SWMM to calculate flow and water depths in the streets during storm events that exceed the capacity of the storm sewer system. The 2008 and 2011 SWMM models used a closed, rectangular conduit shape for the overflow conduits. We modified the street conduit shape to the open, rectangular option, because the top of a closed conduit would introduce frictional losses in the model which do not actually occur when water flows down streets.

The final system wide adjustment to the model concerned storage unit elements that were included at the inlet of most of the open channel conduits as well as many closed conduits. These storage unit elements were possibly used in lieu of standard node elements in the 2008 and 2011 SWMM models in order to maintain numerical stability in the model. We found that with Version 5.0.22, the existing model achieved numerical stability when these storage units were replaced with standard nodes. The aggregate effect of adding dozens of nodes with small amounts of artificial storage could possibly be to underestimate flood elevations. We therefore removed these storage units and replaced them with standard node elements.

Other miscellaneous adjustments we made to the SWMM model included adding overland flow connections between the Maplewood Basin, the Cedarbrook Basin, and the downstream channel to the west based on contour information, and changing the Maplewood Basin outlet based on our field observations. (The 2008 and 2011 models showed a 24-inch culvert outlet,

but we found a 25-inch concrete weir outlet feeding a 60-inch culvert as shown in Photos 4 and 5 in Section 5.)

Existing Model Extension

After updating and adjusting the SWMM model from the 2008/2011 studies, we extended the model to the Grand River. This included adding open channel conduits for Tiber Creek from SR 2 to just north of Richmond Road (approximately 4,300 feet along Tiber Creek) as well as the five culvert crossings within this portion of Tiber Creek. Drainage areas to this extended portion of Tiber Creek were determined from Lake County contour data and were field verified. We collected field survey of Tiber Creek, the culvert crossings, and storm sewers in the additional contributory drainage area, and built the extended model using this data. The extended portion of Tiber Creek is far less developed than the upstream portion and generally flows through an open ravine as shown in Photos 1 and 2, which follow.

Photo 1 – Tiber Creek in Extended Portion of Model

Photo 2 – Tiber Creek Driveway Crossing in Extended Portion of Model

Existing Model Validation

Meetings with City and County Staff

The second major task to evaluate existing flooding conditions was to validate the existing model results through consultation with City staff as well as representatives of the Lake County Engineer and Stormwater Management Department and through engaging the residents of the watershed through a targeted questionnaire. Through meetings with City and County staff, we verified model results that revealed that the most significant flooding issues in the watershed are along Cedarbrook Drive (particularly near Chestnut Street) and along Newell Street and the adjacent Hayer Drive, Elberta Road, Green Court and Michael Court. We evaluated the information gathered from the City and County personnel and compared it to the SWMM model results. We found general conformance between the model results and reported flooding and made few changes to the model to improve its accuracy and reliability.

Flooding Questionnaire

Based on this information, we collectively decided to mail a flooding questionnaire to the residents and businesses in the critical areas noted above as well as a couple other targeted areas as shown on Figure 2. The purpose of the flooding questionnaire was to improve our

understanding of the flooding issues in these areas with respect to flooding type, frequency, source, etc. Over 30 questionnaire responses were returned out of the 392 questionnaires that were mailed. The questionnaire responses are included in Appendix B.

The questionnaire responses both confirmed and clarified our understanding of the existing flooding problems in the watershed. Specifically, the questionnaires confirmed that the storm sewer system in the Cedarbook/Chestnut area has insufficient capacity causing street flooding. Questionnaires also reported water from the Maplewood Basin overflowing west towards the properties on Hickory Lane. In addition, the questionnaire responses in the Newell Street/Hayer Drive area confirmed that flooding along Tiber Creek and surcharging of the tributary storm sewers has caused flooding of the low-lying residences. The responses from the residences adjacent to the Michael Court detention basins explained how the damaged embankment of the north basin had allowed water from the basin to enter their yards until the City reconstructed the basin embankment. Finally, the responses along Elberta Road identified a lack of an adequate drainage system on this road. As a result of these surveys, we inspected this street specifically, confirmed that the street lacked an adequate drainage system, and included recommendations to address this deficiency in Section 5.

Newell Street Culvert Replacement

During the course of our study, the City began replacing the culvert under Newell Street with an 8-foot x 4-foot precast concrete box culvert as shown in Photo 3 below. The new culvert has a larger cross sectional flow area than the 9-foot by 3.5-foot corrugated metal pipe arch culvert it is replacing. In addition, the new culvert's smoother walls reduce the frictional losses through the culvert. A final hydraulic benefit of the new culvert is that it extends downstream to replace two additional smaller drive culverts and removes sharp stream deflections and smaller culvert openings where debris and sediment collection can contribute to flooding problems.

As expected, the SWMM model revealed that the new culvert under Newell Street will reduce upstream peak water surface elevations with no adverse impacts downstream. In order to convey the benefits of this new culvert, the model results presented in Section 5 include a "Pre-Exiting" scenario which represents conditions existing at the beginning of our study with the 9-foot by 3.5-foot CMP culvert under Newell Street. In addition, results for the "Existing" scenario are provided in Section 5, which reflects the new culvert under Newell Street, fully constructed.

Photo 3 – New Tiber Creek Culvert under Newell Street

Section 5 Proposed Analysis

The existing calibrated SWMM model was used to develop and evaluate proposed improvements based on the existing flooding concerns identified by the City and County staff and public questionnaire responses. Since the intent of this study was to evaluate detention and stream restoration improvements, we began by identifying potential areas for these improvements.

Potential areas for detention improvements were selected based on two criteria. First, potential areas had to be significant undeveloped areas where a basin could be constructed or stream floodplain restored. Second, in order for detention improvements to be cost-effective, potential areas had to be in naturally low-lying areas that receive storm water runoff. The following potential detention and stream restoration areas were identified and evaluated:

Area 1 – Detention area upstream of Glenwood Drive;

Area 2 – Detention area upstream of Norfolk Southern Railroad, northeast of the intersection of Cedarbrook Drive and Chestnut Street (referred to as the Cedarbrook Basin throughout this report);

Area 3 – Detention area upstream of Norfolk Southern Railroad behind Red Raider Preschool on Cedarbrook Drive (referred to as the Maplewood Basin throughout this report);

Area 4 – Stream restoration area adjacent to Tiber Creek between Jackson Street and Newell Street.

These potential detention and stream restoration areas are identified on Figure 3.

Tiber Creek flows through open, mostly undeveloped areas at the downstream end between SR 2 and Richmond Road. However, this area was not evaluated as a potential stream restoration area, because according to City and County staff and our existing analysis there are no flooding concerns along this segment of Tiber Creek.

After meeting with City and County staff, potential detention Area 1 was eliminated, because there weren't significant flooding concerns along Glenwood Drive, Hawkins Drive, Southington Boulevard, and Malvern Drive. Our preliminary analysis confirmed that while a detention basin in Area 1 would significantly lower peak flows, the trunk sewers on these streets did not appear to be overtaxed under existing conditions.

Area 4 was also eliminated, because the potential stream restoration would have to be constructed in residential rear yards, which would require the acquisition of up to 15 easements. In addition, due to the limited space available for floodplain restoration, our preliminary analysis did not show a significant reduction in peak flows if stream restoration was constructed in this area.

Based on our meetings with City and County staff, Areas 2 and 3 seemed like feasible potential detention improvements. We therefore further analyzed these improvements to develop the following proposed alternatives.

Proposed Alternative A

Proposed Alternative A consists of expanding the existing retention basin located in Area 2 above. This improvement (called the Cedarbook Basin) showed the greatest potential to reduce flooding in one of the most flood-prone areas of the watershed. As discussed in Section 4, the intersection of Chestnut Street and Cedarbrook Drive and the streets north and east of this intersection have experienced persistent flooding. Alternative A would reduce the risk of flooding in this area by lowering flood elevations in the trunk sewers along Chestnut Street and Cedarbrook Drive and thereby greatly reduce water flowing in the streets and adjacent property.

As shown in Figure 4, Alternative A consists of expanding the existing Cedarbrook Basin to essentially fill the undeveloped area. The existing outlet of the Cedarbrook basin is a 12-inch culvert that drains the basin under the Norfolk Southern railroad to the north. The Alternative A improvements do not include any proposed changes to this culvert outlet, because a larger outlet would allow higher flows downstream in a system that couldn't handle the higher flows. The basin would therefore remain a partially wet basin at all times. The expansion of the Cedarbrook Basin would reduce the risk of flooding in this area in two ways. First, the larger basin would provide additional detention volume to temporarily store storm water and thereby reduce downstream peak flows. Second, the expanded basin would lower the peak water surface in the basin during severe storm events, which reduces the risk of basin overtopping and flooding of adjacent properties.

In order to utilize the expanded retention area, new connecting sewers from the trunk sewers on Cedarbrook Drive, Hickory Lane, and Chestnut Street to the Cedarbrook Basin would need to be constructed. These three connecting sewers were sized using the SWMM model, and the optimum pips sizes are shown on Figure 4. The location and alignment of each connecting sewer was selected based on available undeveloped property. The western connection from the Cedarbrook/Chestnut intersection is necessary to drain the low spot in the street. The middle and eastern connections are necessary, because the 15-inch trunk sewer on Cedarbrook Drive has insufficient capacity which results in storm sewer surcharging. According

to our analysis, the most important of these connections is the western connection, which is essential to allow the Cedarbrook Basin to drain the low spot. The middle connection is the next most important as it would relieve the overtaxed Cedarbrook sewer and significantly reduce sewer surcharging. The eastern connection could be omitted to reduce the cost of Alternative A, but under significant storm events the Cedarbrook sewer would surcharge and the excess flow in the street would be collected west of this connection near the other two connections.

If Alternative A were constructed, the SWMM model shows that street flooding would be eliminated during a 100-year storm as shown on Figure 4 and Table 1 below. The improvements in Alternative A would greatly reduce flood risk in one of the most flood-prone areas of the watershed.

Table 1 – 100-Year Water Surface Elevation Summary

Peak Water Surface Elevations

Location	SWMM Node	Pre-Existing	Existing	Proposed Option A	Proposed Option B
Cedarbrook/Chestnut Area					
MH 110' north of intersection	00030STM	685.22	685.22	683.20	683.20
MH at intersection of Cedarbrook Dr. /East Ct.	00045STM	687.49	687.49	684.23	684.23
MH at intersection of Cedarbrook Dr. /Glenwood Dr.	00040STM	693.15	693.15	687.85	687.85
Cedarbrook Basin	Cedarbrook Retention Basin	683.28	683.28	683.10	682.80
Hickory Lane Area					
Maplewood Basin	Maplewood Retention Basin	689.27	689.27	689.27	688.32
Newell/Hayer Area					
Upstream of Newell Street	10	644.79	644.60	644.55	644.51

Table 2 – 100-Year Flow Summary Peak Flow in cfs (% Reduction from Existing)					
Location	**SWMM Link**	**Pre-Existing**	**Existing**	**Proposed Option A**	**Proposed Option B**
Chestnut St. Reach					
	111	23.7	23.7	14.0 (40.9%)	14.7 (38.0%)
Walnut St. Reach					
	1	45.3	45.3	45.3 (0.0%)	43.3 (4.4%)
Newell St. Reach					
	66	66.7	66.9	64.4 (3.7%)	62.6 (6.1%)

Proposed Alternative B

Due to the significant benefits in reduced flood risk offered by Alternative A, we developed Alternative B assuming Alternative A is constructed as well as additional detention improvements in Area 3, called the Maplewood Basin. During significant storm events, the existing Maplewood Basin backs up into the railroad ditch to the west which ordinarily drains into the basin. When the water level in the basin gets high enough (approximately 688.5), the water can spill through the back yards of the houses on the north side of Hickory Lane. If water flows on to Hickory Lane, it causes the trunk sewer to surcharge resulting in flooded streets. Moreover, when storm water from the Maplewood Basin overflows through the railroad ditch or across Hickory Lane, it enters the Cedarbrook Basin exacerbating the flooding problems near the intersection of Cedarbrook/Chestnut. According to the existing model, 50 percent of the storm water volume for the 100-year storm which enters the Cedarbrook Basin is overflow from the Maplewood Basin.

As shown in Photo 4 below, the Maplewood Basin is a relatively large, permanently wet retention basin behind Red Raider Preschool. The basin has a concrete weir outlet that drains north through a short ditch to a 60-inch CMP culvert under the railroad tracks. Unlike the Cedarbrook Basin, the Maplewood Basin cannot be enlarged by excavating around the basin to expand its footprint, because it currently occupies most of the open space behind the school. However, additional detention volume could be added to this basin by lowering the basin outlet. The current normal water surface elevation of the Maplwood Basin (685.6) is approximately 3.5 feet higher than the receiving ditch on the north side of the railroad tracks. This is due to the fact that the concrete weir outlet sits higher than the culvert inlet, the culvert barrel has a significant slope, and the culvert outlet has a drop into the receiving ditch as shown in Photo 5. If the culvert under the railroad were replaced with a lower

culvert laid at a flatter slope and the weir reconstructed, we estimate that the normal water elevation of the basin could be lowered by 2.6 feet.

For the Alternative B improvements, we sized a 27-inch smooth-line culvert laid at a 0.5 percent slope, which would lower the normal water elevation from 685.6 to 683. As shown on Figure 5, Alternative B also includes cleaning and minor grading to the railroad ditch in order to release a controlled amount of water to the Cedarbrook Basin and significantly reduce the flood elevations along the rear yards of the houses on the north side of Hickory Lane.

The 27-inch outlet culvert was sized to maintain or slightly reduce peak flows in the downstream ditch, and the railroad ditch grading was designed to release water to the enlarged Cedarbrook Basin such that the 100-year water elevation in the Cedarbrook Basin would not exceed 683. If the peak water elevation in the Cedarbrook Basin is maintained below 683, the enlarged basin will not overtop and would not cause flooding at the Cedarbrook/Chestnut intersection and surrounding properties.

As shown in Table 1, the Alternative B improvements would lower the peak water elevations in the Maplewood Basin significantly reducing the flood risk along Hickory Lane. While these detention improvements would be accomplished without any anticipated grading to the basin, it is important to note that that the lowered basin outlet would reduce the normal water depth in the basin which would alter the aesthetics of the basin.

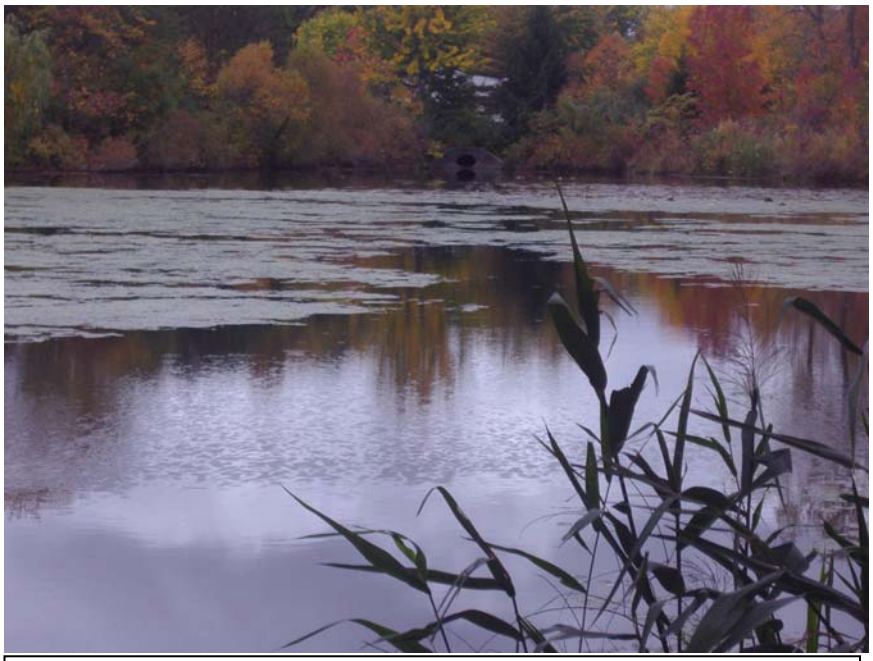

Photo 4 – Existing Maplewood Basin

Photo 5 – Existing Maplewood Basin Outlet Culvert under Norfolk

Miscellaneous Improvements

Cedarbrook Drive

In addition to the Chestnut Street area, Cedarbrook Drive has experienced flooding during intense rain events near the intersections of Glenwood Drive/Hickory Lane, Southington Boulevard, and Malvern Drive. However, the SWMM model does not show significant deficiencies in the storm sewer capacity in this area. From conversations with City staff, we suspected this may be due to curb inlets that are clogged or have inadequate capacity. We therefore identified the type and location of curb inlets along Cedarbrook Drive that we found through a site visit, and evaluated the inlet capacity separate from the SWMM model. This analysis showed that additional curb inlets are needed at certain locations to collect storm water draining to the streets as shown on Figure 6. In order to reduce the probability of inlet clogging, we recommend combination curb opening and grate style inlets (such as ODOT CB No. 3 or 3A) for any new or replacement pavement inlets.

Newell Street

As described in Section 4, one of the most flood-prone areas of the Tiber Creek watershed is the area along Newell Street between the CSX railroad and Jackson Street and the surrounding streets of Michael Court, Green Court and Hayer Drive. Tiber Creek flows from south to north through this area crossing Newell Street from east to west approximately half way between the CSX railroad and Jackson Street. As described in Section 4, the City has recently began replacing the 9-foot by 3.5-foot CMP culvert under Newell Street with an 8-foot by 4-foot box culvert. Besides enlarging and improving the hydraulic efficiency of the culvert, this culvert project will remove debris catching stream bends and smaller culvert inlets, because the new culvert extends further downstream replacing two smaller drive culverts. This project will therefore reduce the likelihood of flooding created or exacerbated by blockages in the stream and culverts in this area.

Keeping Tiber Creek cleared of debris and significant amounts of sediment is particularly important in the Newell Street area, because our analysis reveals that the stream and nearby sewers have the capacity to convey peak storm flows if the entire system is kept clear. According to the SWMM model, the 100-year depth of flow in Tiber Creek in this area is approximately 2.5 feet, which is consistent with the FEMA base flood elevations shown on the recent Letter of Map Revision. The challenge with the Newell Street area is that the conveyance system does not have adequate overflow paths. Storm sewers and stream channels typically only have the capacity to convey smaller design storms, and when their capacity is reached, excess storm water can be carried by stream floodplains and down streets in shallow depths. Unfortunately, in the Newell Street area, Tiber Creek does not have an extensive floodplain due to the close proximity of the houses. In addition, street overflow paths are not available in this area, because many of the houses have driveways that slope back to the garages as shown in Photo 6 below. Therefore, relatively shallow flow depths in the streets can cause water to flow back to the houses resulting in structure flooding.

As shown in Table 1, the new culvert under Newell Street will reduce the upstream 100-year water surface elevation by 0.19 feet, as reflected by the difference between the Pre-Existing and Existing elevations. However, the reduction in the 100-year water surface elevation probably understates the hydraulic benefit of this culvert improvement. As described above, the new culvert is significantly less prone to clogging than the prior culvert and therefore the typical reduction in upstream water elevations during actual storm events is likely much greater than 0.19 feet.

In 2011, the City also reconstructed the north embankment of the northern detention basin on the Michael Court cul-de-sac. According to our analysis, this improvement will enable the northern basin to detain storm water as originally designed, and will help protect the houses on

Green Court and the east side of Newell Street from flooding. The questionnaire responses confirm that this improvement seems to have reduced the risk of flooding in this area.

Photo 6 – Houses on Hayer Drive with Driveways Sloping to Houses

Elberta Road

Another area that has experienced flooding problems according to the questionnaire responses is Elberta Road. While this street is near the Newell Street segment of Tiber Creek, the specific problem appears to be somewhat different. The SWMM model showed no drainage system on Elberta Road. We inspected the site to confirm this and found only shallow roadside swales in some areas and no drainage system in others as shown in Photo 7. Based on our site visit and the questionnaire responses, we believe the primary drainage problem along Elberta Road is due to the inadequate storm water conveyance system. Because Elberate Road is uncurbed, the recommended storm water system would be comprised of shallow roadside swales on both sides of the street draining to ditch catch basins which carry the storm water to a trunk sewer along Elberta Road. Because the street slopes west away from Newell Street at an approximate 0.5 percent grade, it would be most feasible to construct a trunk sewer which slopes west and drains to the existing ditch on the east side of Renaissance Parkway. This improvement would significantly improve the street and property flooding along Elberta Road.

Photo 7 – Inadequate Drainage System on Elberta Road

Section 6 Cost Estimates & Recommendations

We developed budgetary cost estimates for the improvements analyzed in Section 5, which are included in Appendix C and summarized below in Table 3. All costs were estimated assuming construction in 2014. Because final designs have not been completed at this stage for these improvements, these costs are approximate and intended as budget-level estimates. It should also be noted that the costs are for construction only and do not include property acquisition costs.

The detention improvements described in Alternatives A and B provide significant benefits in terms of reduced flood risk for the critical area near the intersection of Chestnut Street and Cedarbrook Drive as well as Hickory Lane. Because these improvements reduce overall peak flows in the system, they have additional benefits in terms of reduced flood risk in downstream areas as well. Alternative A provides the greatest benefit to the critical Cedarbrook/Chestnut area, and the most additional detention volume and therefore reduction in downstream peak flows. Accordingly, we strongly recommend the City and County consider Alternative A. The additional benefits derived from Alternative B, while significant, are more modest than the benefits of Alternative A.

The 2008 study recommended upsizing pipes in the Cedarbrook/Chestnut area to address flooding at this intersection, and the estimated cost of this improvement was $1,198,000. As shown below, the costs for the detention Alternatives A and B are higher than this cost. However, Alternatives A and B provide protection against significant street and property flooding for the 100-year storm event, while the storm sewer improvements in the 2008 study would only prevent flooding for the 10-year storm. If either Alternatives A or B were constructed, the storm sewer improvements from the 2008 study for the Cedarbrook/Chestnut area would not be necessary.

In addition to the detention improvements, we recommend the upgrade to the pavement inlet system on Cedarbrook Drive described in Section 5 and shown on Figure 6. A budgetary cost estimate for this improvement is also provided in Appendix C and shown in Table 3 below.

We also recommend the storm sewer improvements on Elberta Road described in Section 5. Because this street lacks an adequate storm water conveyance system, the installation of a new trunk sewer with ditch catch basins collecting runoff from the street and adjacent property will significantly reduce flooding problems along this street. A budgetary cost estimate for this improvement is provided in Appendix C and shown in Table 3 below.

The other area of the watershed that has experienced persistent flooding is the Newell Street area. As described in Sections 4 and 5, our analysis found that the City's recent storm water improvement projects in this area have provided a significant benefit. The new box culvert

under Newell Street will reduce upstream water surface elevations and will be less prone to clogging by debris and sediment. In addition, the repairs to the north basin at the Michael Court cul-de-sac have restored the designed detention in this area and have provided additional protection to the houses on Green Court and Newell Street. As indicated in Section 5, the Newell Street area lacks adequate flood overflow paths. Therefore, we recommend that future maintenance efforts, including ditch and sewer cleaning and debris removal, are focused on this area.

In addition to the Newell Street area, there are other areas of the watershed which require frequent inspection and maintenance due to the volume of flow through these areas and the lack of viable flood overflow paths. Figure 7 provides a schematic map of the watershed conveyance system with 100-year peak flow ranges indicated as shown in the legend. The tributary beginning on the west side of Chestnut Street and flowing northeast across Chestnut Street towards Walnut Avenue conveys significant peak flow rates. In some areas, this tributary navigates through tight spaces between houses on Hartshorn Drive and Nelson Street. Similar to the Newell Street segment of Tiber Creek, this tributary does not have a significant floodplain available. Therefore, as indicated on Figure 7, it is critical that this area remain free of debris obstructions and significant amounts of sediment collection. In addition to the Newell Street area, we recommend maintenance efforts be focused on this critical tributary as well.

Table 3 – Proposed Alternative Cost Summary

Proposed Alternative	Budgetary Cost Estimate
Alternative A Cedarbrook Basin Improvements	$1,431,000
Total	**$1,431,000**
Alternative B Cedarbrook Basin Improvements	$1,431,000
Maplewood Basin Improvements	288,000
Total	**$1,719,000**
Cedarbrook Drive Inlet Improvements	**$196,000**
Elberta Road Sewer Improvements	**$258,000**

* Costs assume construction in 2014. See Appendix C for detailed cost estimates

CITY:(CLEVELAND) DIV/GROUP:(ENV/GIS) DB:L.GREENE LD:E.CURTIS PIC: PM:M. DENNIS TM:
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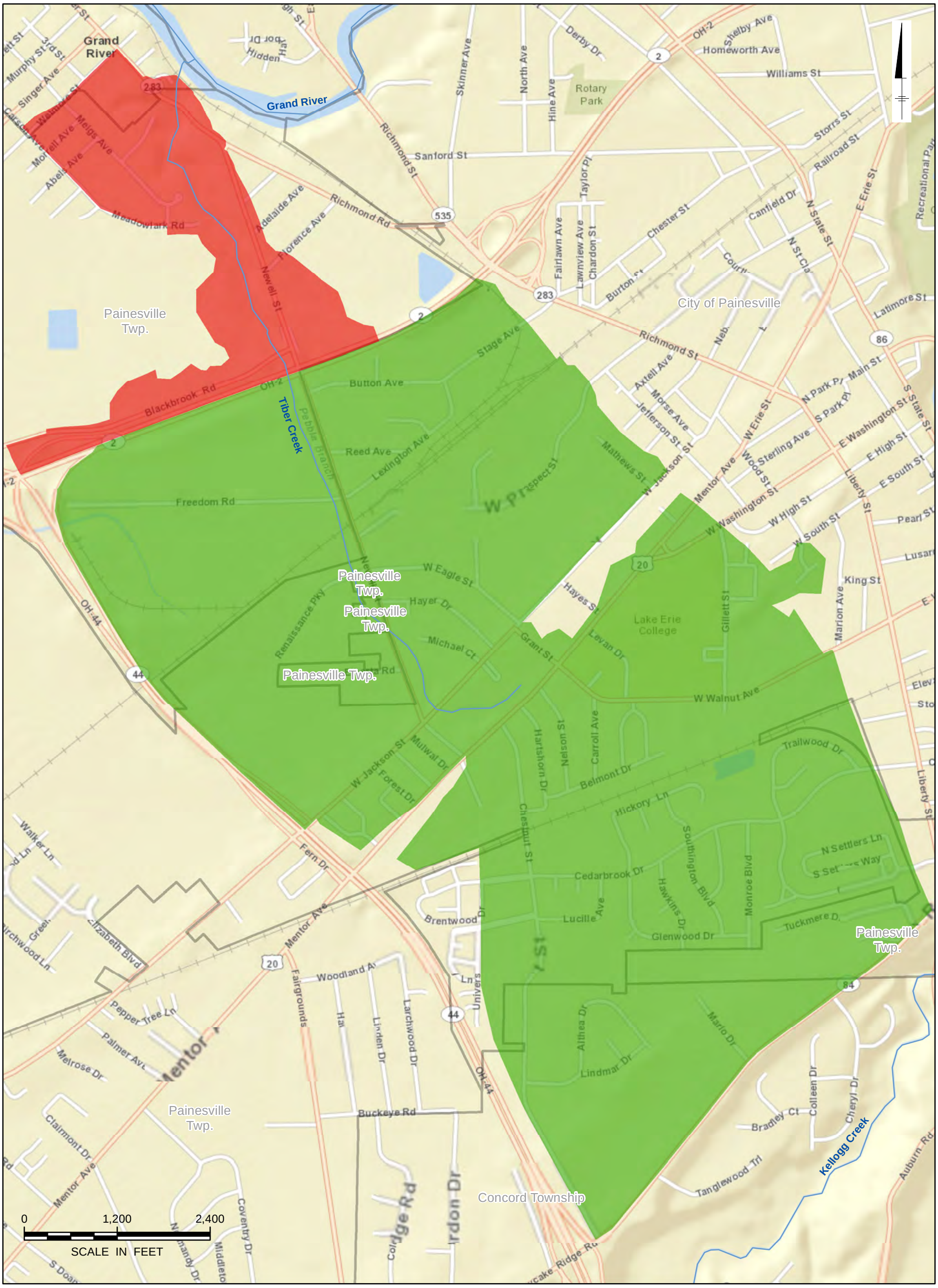

Legend

- EXTENDED WATERSHED BOUNDARY (ARCADIS)
- WATERSHED BOUNDARY (AECOM STUDIES)
- MUNICIPAL BOUNDARIES

LAKE COUNTY STORMWATER MANAGEMENT DEPARTMENT
CITY OF PAINESVILLE

TIBER CREEK WATERSHED STUDY

TIBER CREEK WATERSHED MAP

ARCADIS

FIGURE
1

CITY:(CLEVELAND) DIV/GROUP:(ENV/GIS) DB:L.GREENE LD: PIC: PM: TM:
PROJECT:
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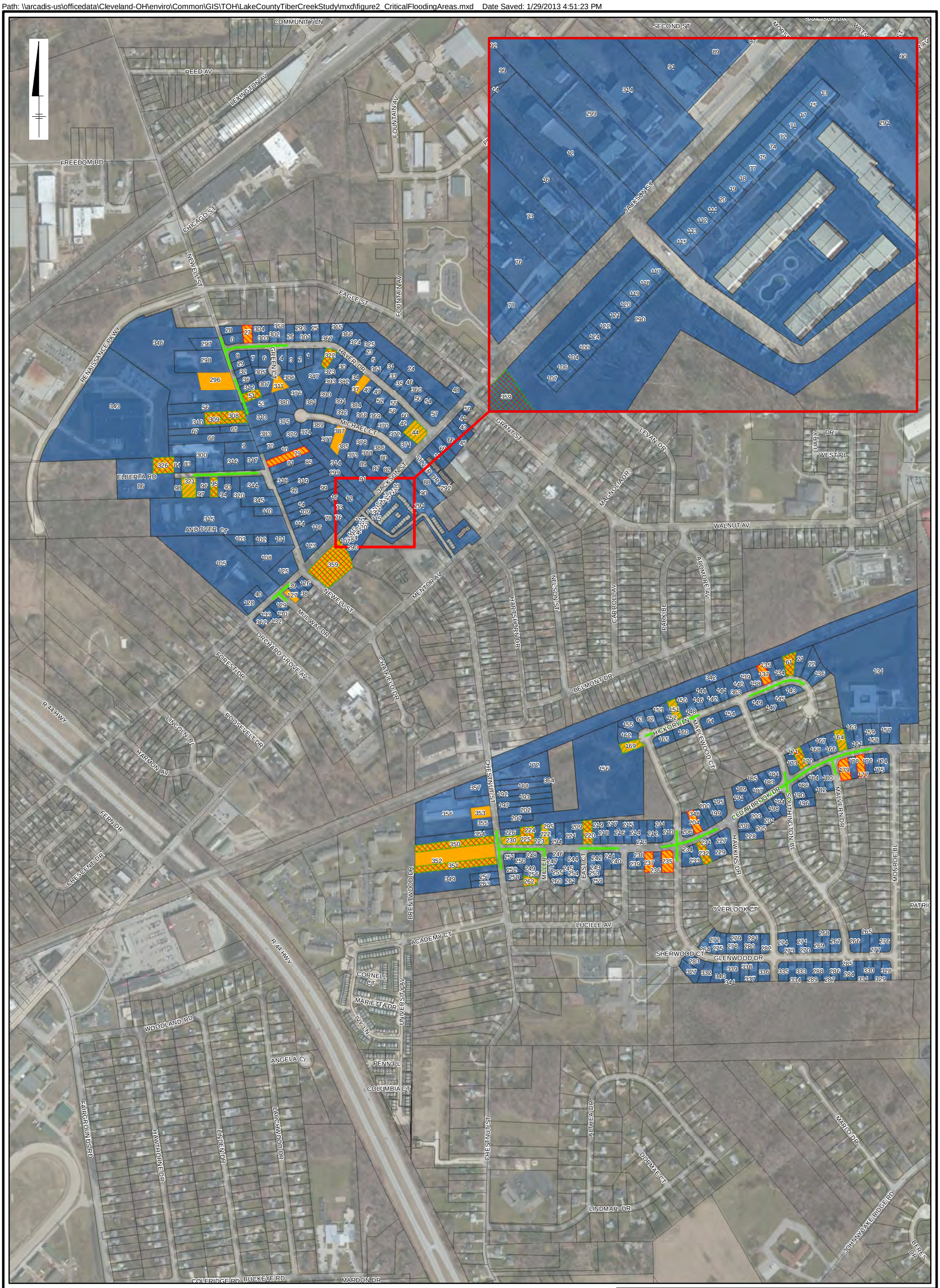


Legend

RoadCenterlinesTiberCreekWatershed

- STREET FLOODING NOTED
- BASEMENT FLOODING NOTED
- YARD FLOODING NOTED
- QUESTIONNAIRE RESPONSES
- QUESTIONNAIRE TARGET AREA
- PARCEL BOUNDARIES

0 650 1,300

SCALE IN FEET

LAKE COUNTY STORMWATER MANAGEMENT DEPARTMENT
CITY OF PAINESVILLE

TIBER CREEK WATERSHED STUDY

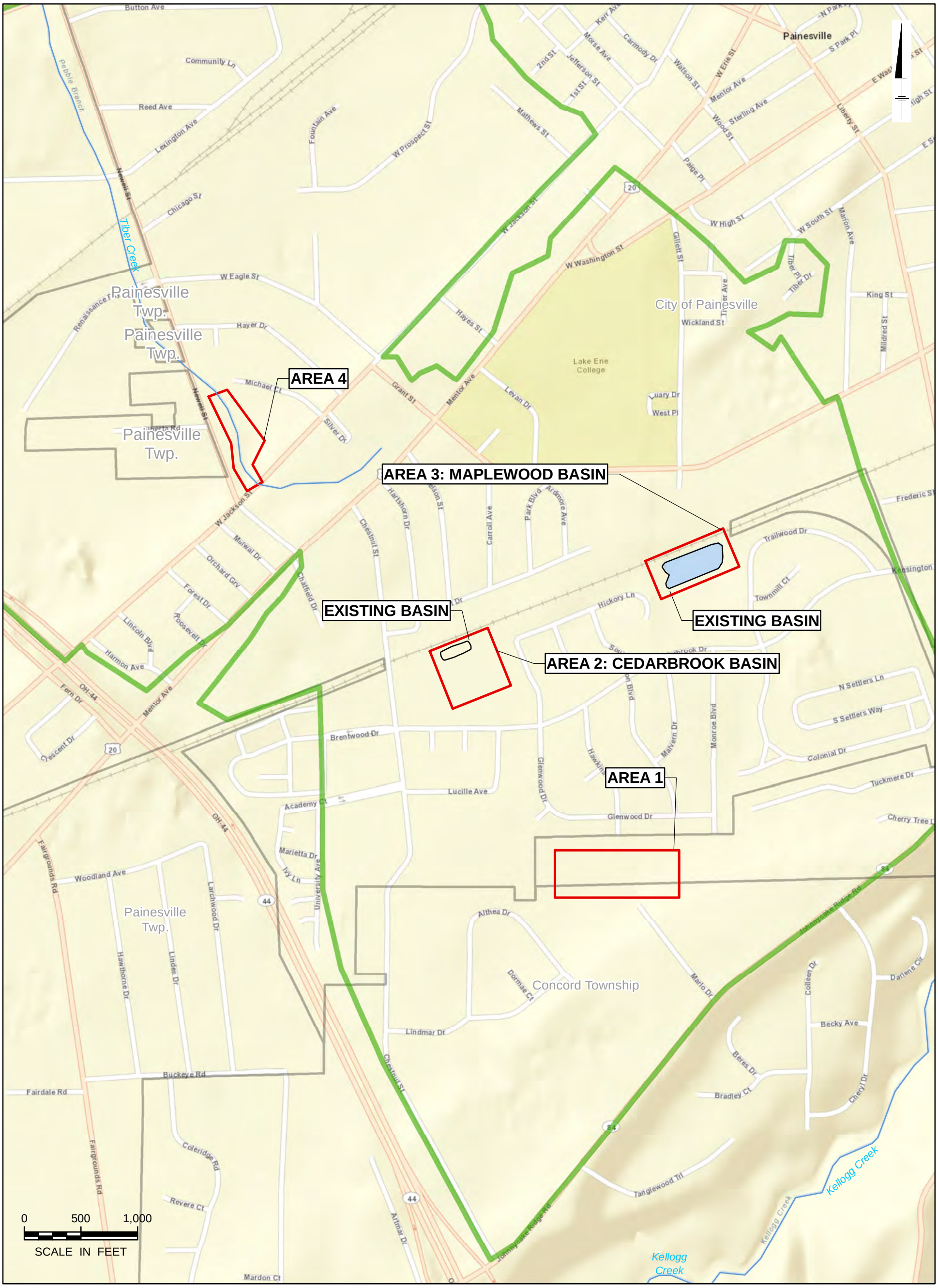
CRITICAL FLOODING AREAS

ARCADIS

FIGURE

2

CITY:(CLEVELAND) DIV/GROUP:(ENV/GIS) DB:L.GREENE LD:E.CURTIS PIC: PM:M. DENNIS TM:
PROJECT: TOHLAK01.ST01
Path: G:\enviro\Common\GIS\TOH\LakeCountyTiberCreekStudy\mxd\figure3_DetentionAndRestorationAreas.mxd Date Saved: 2/11/2013 1:48:32 PM



Legend

- EXISTING BASINS
- DETENTION AND RESTORATION AREAS
- WATERSHED BOUNDARY
- MUNICIPAL BOUNDARIES

LAKE COUNTY STORMWATER MANAGEMENT DEPARTMENT
CITY OF PAINESVILLE

TIBER CREEK WATERSHED STUDY

DETENTION AND STREAM RESTORATION AREAS

ARCADIS

FIGURE
3

CITY:(CLEVELAND) DIV/GROUP:(ENV/GIS) DB:L.GREENE LD:E.CURTIS PIC: PM:M. DENNIS TM:
PROJECT: TOHLAK01.ST01
Path: \\arcadis-us\officedata\Cleveland-OH\enviro\Common\GIS\TOH\LakeCountyTiberCreekStudy\mxd\figure4_Cedarbrook.mxd Date Saved: 1/29/2013 5:18:49 PM

Legend

- PROPOSED STORM SEWER CONNECTIONS
- PROPOSED CONTOURS
- RAILROAD
- EXISTING STORM SEWERS

LAKE COUNTY STORMWATER MANAGEMENT DEPARTMENT
CITY OF PAINESVILLE

TIBER CREEK WATERSHED STUDY

CEDARBROOK BASIN IMPROVEMENTS

ARCADIS

FIGURE
4

CITY:(CLEVELAND) DIV/GROUP:(ENV/GIS) DB:L.GREENE LD:E.CURTIS PIC: PM:M. DENNIS TM:
PROJECT: TOHLAK01.ST01
Path: \\arcadis-us\officedata\Cleveland-OH\enviro\Common\GIS\TOH\LakeCountyTiberCreekStudy\mxd\figure5_Maplewood.mxd Date Saved: 11/2/2012 3:44:37 PM

Legend

PROPOSED CULVERT

RAILROAD

LAKE COUNTY STORMWATER MANAGEMENT DEPARTMENT
CITY OF PAINESVILLE

TIBER CREEK WATERSHED STUDY

MAPLEWOOD BASIN IMPROVEMENTS

ARCADIS

FIGURE

5

Legend

EXISTING AND PROPOSED CATCH BASINS

- PROPOSED COMBINATION GRATE/WINDOW CATCH BASINS
- EXISTING COMBINATION GRATE/WINDOW CATCH BASINS
- MANHOLE
- EXISTING GRATE ONLY CATCH BASIN
- EXISTING WINDOW ONLY CATCH BASIN

RAILROAD

STORM SEWERS

- EXISTING
- PROPOSED

NOTE

1. EXACT LOCATIONS OF CONNECTIVITY OF THE EXISTING CATCH BASINS TO THE EXISTING STORM SEWER ARE UNKNOWN

0 200 400

SCALE IN FEET

LAKE COUNTY STORMWATER MANAGEMENT DEPARTMENT
CITY OF PAINESVILLE
TIBER CREEK WATERSHED STUDY

CEDARBROOK DRIVE IMPROVEMENTS

ARCADIS

FIGURE
6

CITY:(CLEVELAND) DIV/GROUP:(ENV/GIS) DB:L.GREENE LD:E.CURTIS PIC: PM:M. DENNIS TM:
PROJECT: TOHLAK01:ST01
Path: G:\enviro\Common\GIS\TOH\LakeCounty\TiberCreekStudy\mxd\figure6_Cedarbrook.mxd Date Saved: 2/11/2013 2:39:18 PM

CITY:(CLEVELAND) DIV/GROUP:(ENV/GIS) DB:L.GREENE LD:E.CURTIS PIC: PM:M. DENNIS TM:
PROJECT: TOHLAK01.ST01
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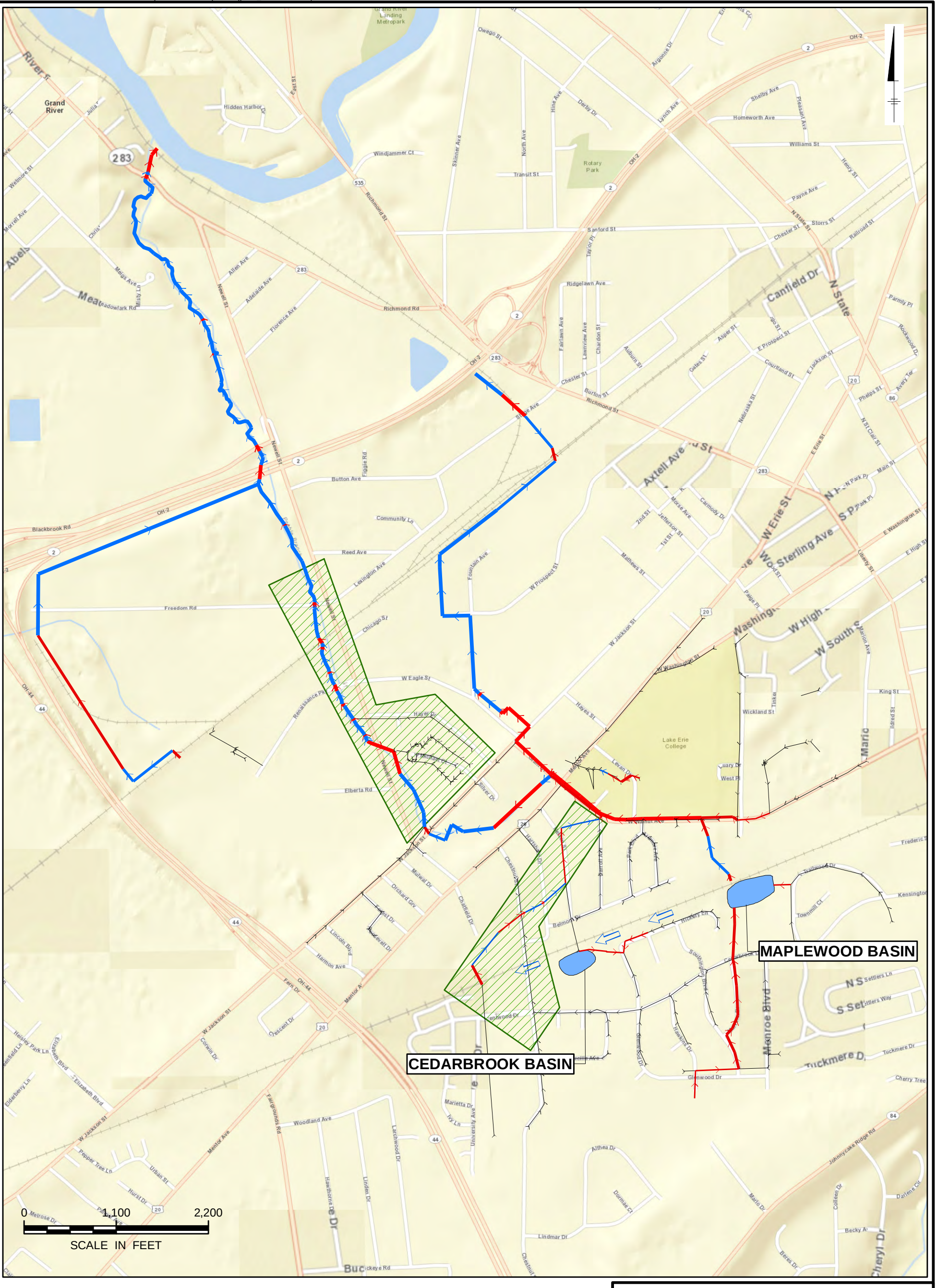

Legend

OPEN CHANNELS

MAXIMUM 100-YEAR FLOW (CUBIC FEET PER SECOND)
- 20 - 40
- 40 - 60
- > 60

PIPES

MAXIMUM 100-YEAR FLOW (CUBIC FEET PER SECOND)
- <20
- 20 - 40
- 40 - 60
- > 60

- CRITICAL MAINTANENCE AREAS
- OVERLAND FLOOD PATH

LAKE COUNTY STORMWATER MANAGEMENT DEPARTMENT
CITY OF PAINESVILLE

TIBER CREEK WATERSHED STUDY

CONVEYANCE SYSTEM SUMMARY & CRITICAL MAINTENANCE AREAS

ARCADIS

FIGURE
7