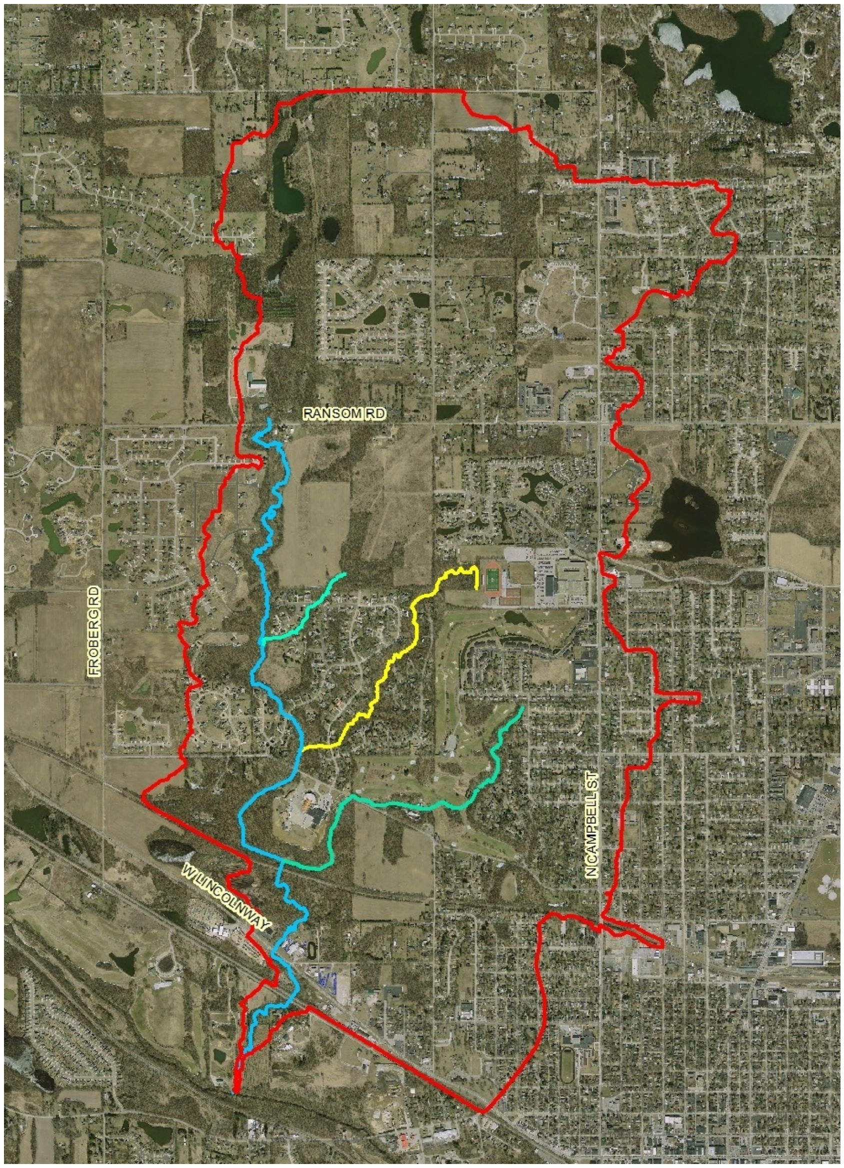
Beauty Creek Watershed Study
April, 2016

City of Valparaiso, Porter County, Indiana



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0.0 EXECUTIVE SUMMARY

Channel and bank erosion along Beauty Creek and the Candlewood Branch, Oakwood Branch and Forest Park Branch has been a long-standing concern for the City of Valparaiso and property owners adjacent to the streams. Bank erosion is approaching some residential structures.

Field reconnaissance documented erosion in the stream channel has exposed underlying fine sand strata, a material that has a low critical shear value (i.e. material that is extremely easy to move in flowing water). Preliminary modeling was used to estimate the existing shear force. The estimated values exceeded the critical shear values for fine sand as well as the allowable shear stress for common stabilization practices such as erosion blankets and smaller riprap stones. The first step in reducing the existing shear stress is to reduce flow depth and stream slope.

This study determined detention in the existing upper ravines can potentially reduce flow rate and depths in the existing channels up to 90% with minimal capital investment. By constructing less expensive berms with outlet structures in the existing ravines or modifying existing outlets as opposed to the excavation of detention ponds, capital costs can be minimized. Minimizing the peak flow rate and therefore the depth of water in the ravines will minimize shear force, allowing common less expensive grade / surface stabilization practices such as surface reinforcement matting or Gabion baskets to be employed to stabilize grades.

1.0 INTRODUCTION

The City of Valparaiso (City) contracted with DLZ, Indiana LLC (DLZ) to perform a study of the Beauty Creek watershed (see **Appendix A)**. Channel and bank erosion in Beauty Creek, the Candlewood Branch, the Oakwood Branch and the Forest Park Branch has been a long-standing concern of the City and adjacent property owners. In addition to the negative impact on water quality of the sediment, bank erosion is impacting residential lots and approaching residential structures.

DLZ efforts included identification of the areas of concern, review of historical aerial photographs, a topographical review and analysis, field reconnaissance, computer modeling and recommendation for remedial actions.

2.0 AREAS OF CONCERN

General streambed erosion and fourteen (14) specific areas of concern were identified:

- Five (5) on Beauty Creek (the confluences with Salt Creek, Forest Park Branch, Oakwood Branch and Candlewood Branch as well as the culvert under Ransom Road);
- The outfall from the Candlewood Trace Subdivision;
- The outfalls from Keystone Crossing Subdivision (2);
- The outfall from the Valparaiso High School (1);

- The overland flow to the west from the Forest Park Golf Course (2);
- A location on the Candlewood Branch approximately 800 feet upstream of Hampstead Court (1) where the stream branches;
- Runoff from the Forest Park Golf Course toward Sherwood Drive and;
- Roadside drainage along Del Vista Drive between Harrison Boulevard and Northview Drive.

3.0 HISTORICAL LAND USE

Historical aerial photographs from 1939, 1954, 1958, 1965 and 1973 were reviewed and copies are provided in **Appendix B, "Historical Aerial Photography"** with the approximate watershed boundary drawn. While the pixel density of the photographs is not up to current standards, it is sufficient to observe the general surface types within the delineated watershed.

The aerial photographs indicate the majority of the watershed has been agricultural since 1939. The Beauty Creek streambed and flood plain as well as the Candlewood, Oakwood and Forest Park branches appear to be the areas that are the exceptions and have remained forested over the years. These areas have likely remained forested due to the difficulty farming steep slopes and the potential for damage from flooding.

The 2013 aerial photographs indicate most of the newer subdivisions have been constructed with detention (e.g. Keystone Commons, Beauty Creek Villas, Meridian Woods, Pine Villages, Greenfield Creek, Golfview Apartments and Candlewood Trace). The detention design methodologies used in the original calculations for the subdivisions included the use of the SCS / NRCS Type II rainfall distribution and a detention release rate based on the existing 10-year release rate. Older subdivisions and areas in the southeast of the Beauty Creek watershed do not appear to include detention including Manchester Meadows, Harrison West, Oakwood Estates and Forest Park.

In general, a change in the surface runoff from agricultural fields to residential use may translate into a decrease in runoff compared to tilled surfaces or a minimal change when compared to planted crop surfaces. However, a change from forested surfaces to residential development will frequently result in an increase in runoff.

4.0 TOPOGRAPHICAL REVIEW / ANALYSIS

A topographical review was conducted using the Porter County 2010 GIS contour data and digital elevation model (DEM). The results of the review are summarized below.

4.1 WATERSHEDS / SUBWATERSHEDS

Initially the overall Beauty Creek watershed was delineated and then divided into subwatersheds to reflect the topographical features observed and areas of concern noted by the City and the public. The overall watershed is approximately 2,220 acres (see **Appendix A)**. Forty-three (43) subwatersheds were then delineated noting areas with detention, isolated depressional areas, larger roadway and railroad crossings, as well as potential areas of future detention.

4.2 DEPRESSIONAL AREAS

Five (5) isolated depressional areas were identified during delineation of the subwatersheds (see **Appendix D**). Four (4) of these watersheds provided no direct runoff to Beauty Creek in the computer modeling phase of this study (see Section 7.0 below). The fifth area contributed runoff only in the 100-year event in the computer model. The total surface area collected by these depressional areas is approximately 78 acres (see **Table 4-1** below).

Table 4-1 : Summary of Depressional Areas

Watershed ID	Area (ac)
Beauty Creek (BC) South Low Area West	8.1
Beauty Creek (BC) South Low Area Mid	8.7
Beauty Creek (BC) South Low Area East	1.8
Harrison Low Area	19.3
Ransom Road Low Area	39.7
Total	**77.6**

Due to the significant total surface area served by theses depressional areas, this report recommends monitoring development in their respective watersheds to ensure their retention capacity is maintained and development does not result in additional runoff to Beauty Creek or its tributaries.

Two additional low areas were also identified during watershed delineations. These areas are not isolated as noted with the areas above, but construction of a control structure such as a berm at the downstream end of these depressional areas could create new detention with minimal construction costs. However, both of these areas provided relatively small storage volumes, appeared to be privately owned and were not therefore included in the modeling.

4.3 STREAM STATIONING

A stream centerline was created for Beauty Creek and the three (3) branches examined by this study based on the 2010 Porter County GIS contour data. Each line was stationed beginning at the downstream end to determine length and for referencing during the modeling phase.

The stream lengths are summarized in **Table 4-2** below.

Table 4-2 : Summary of Study Stream Lengths	
Stream	**Approximate Length (ft)**
Beauty Creek	16,200
Candlewood Branch	2,200
Forest Park Branch	6,200
Oakwood Branch	5,600
Total =	**30,200**

4.4 SLOPE ANALYSIS

The stream centerlines created above were used in conjunction with the 2010 Porter County digital elevation model (DEM) to plot the stream profiles.

In general, the stream slopes are greatest in the upstream areas compared to the downstream areas.

The typical stream slopes are summarized in **Table 4-3** below.

Table 4-3 : Summary of Typical Stream Slopes			
Stream	**Downstream Slope (ft/ft)**	**Upstream Slope (ft/ft)**	**Change**
Beauty Creek	0.0049	0.0057	0.0008
Candlewood Branch	0.012	0.012	0
Forest Park Branch	0.014	0.022	0.008
Oakwood Branch	0.0082	0.023	0.015

5.0 FIELD RECONNIASSANCE

Field reconnaissance was performed on Beauty Creek, Candlewood Branch, Oakwood Branch and the Forest Park Branch along the delineated streambeds (see **Appendix A**). Photographic documentation is provided in **Appendix C** and observations from each stream reconnaissance are discussed below.

5.1 BEAUTY CREEK RECONNAISSANCE

The reconnaissance included over 16,000 feet of streambed on the main branch of Beauty Creek. The streambed south of Harrison Boulevard was observed to be wet and flowing during the reconnaissance. North of Harrison Boulevard, the streambed was dry. Subsequently, the following discussion of the Beauty Creek field reconnaissance will be divided into the lower reach and the upper reach based on this observation.

5.1.1 Lower Beauty Creek

Starting at the confluence with Salt Creek, bank erosion on Beauty Creek is occurring. Picture BC 2 shows the steep outer bank of the creek bend before entering Salt Creek. This bend turns nearly 90 degrees and is at least 8 to 10 feet high. Continuing upstream, log jams were observed as shown in pictures BC 4, BC 13, and BC 31. The stream continues to be incised and deep. The stream bed appears to be primarily sand, possibly deposited from upstream. The bank material varies from clay (picture BC 10) to peat (picture BC 32).

Groundwater seeps appeared to be present based on the reddish discoloration, possibly from dissolved iron being oxidized by exposure to air. These seeps appeared to be more consistent around the section of stream adjacent to St. Paul's Church and School. Seeps with iron can be acidic and could have negative effect on metal especially galvanized metal, shortening the service life.

Various stabilization structures appear to have been constructed previously in the stream around St. Paul's. Gabion baskets (galvanized wire baskets filled with stone) and Reno blankets (galvanized wire blanket filled with stone) appeared to have been installed on the banks around the outside bends. Documentation provided by the City indicates these are around 20 years old. The blankets on the upper bank areas appeared to be in good shape and performing as intended. However, in the lower bank areas the galvanized wire appeared to be deteriorating and undermining of the basket and blankets was observed (see photo BC 54).

Evidence of other stabilizing practices was observed, including what appeared to have been a Gabion dam and a wooden cross vane structure (photos BC 49 and BC 56). A cross-vane structure forms a "V" in the channel with a wide bottom in the "V'" approximately the width of the channel. Both structures appeared to have degraded with the Gabion dam having failed such that the stream has migrated around the dam toward the north bank.

After the turn in the creek from west to north at St. Paul's, the stream bed is straight and appeared to be in stable shape (see photo BC 58). The bed was approximately 30 feet wide and the banks were only 1-2 feet in height. This may be indicative of stable stream geometry.

Lastly, the confined stream with Gabion step dams and sediment trap immediately south of Harrison Boulevard was observed (see photos BC 63 and BC 65). All structures appeared to be in good condition and the sediment trap appeared to have been cleaned recently.

5.1.2 Upper Beauty Creek

The upper branch of Beauty Creek displayed similar erosion problems as observed in the lower branch. Blockages and bend erosion were frequently observed. Examples of the bend erosion can be seen in photos BC 121, BC 143, BC 210 and BC 222. Examples of bend blockages including log jams were noted throughout the stream course covered by this study (see photos BC 139, BC 158, BC 165 through 179, and BC 236). Besides diverting flow into the bank, debris can also create scour holes by creating a hydraulic jump (see photo BC 189 and BC 202).

There was an area where the bank had been stabilized with Reno mattresses (see photo BC 123 and BC 125). The photos show while the bank covered by the mattresses may be more stable than adjoining banks areas, the stream bottom is being eroded as well as the upstream lower corner of one blanket. The streambed undercutting may eventually undercut the base of the blanket and lead to possible failure. In addition, the upstream unprotected bank is eroding which may also cut behind the mattress and lead to failure.

Scour at culvert outlets was observed at William Drive (see photo BC 131) and especially at the culvert under Ransom Road (see photo BC 245). While the scour was only 1-2 feet at William Drive the scour from the seven (7) foot culvert under Ransom Road was over 6 feet deep and approximately 25 wide and 30 feet long.

Debris apparently placed in the stream by property owners was also observed. Old fencing (see photo BC 223), grass clippings (photo BC 163) and brush were found. Photos BC 228 and BC 229 illustrate one the worst situations. While property owners may consider this a good use of the undesirable material, covering the bank can kill live vegetation and eventually be washed downstream contributing to blockages and enhanced erosion or reduce water quality by adding undesirable nutrients from decay byproducts.

A few sections of the stream appeared to be in a state with some degree of stability (see photos BC 200 and BC 234).

5.2 CANDLEWOOD BRANCH RECONNAISSANCE

As observed on Beauty Creek, streambed and bend erosion were the primary concerns especially downstream of Hampstead Court (see photo CW 86). Some residential structures are located close to the streambed (see photo CW 77 and CW 83, CW 90) and the erosion has exposed buried irrigation piping and wire (see photos CW 79 and CW 91).

Similar to Beauty Creek, the soil above sandy strata has been eroded (see photo CW 74 and CW 78). Bend erosion is also prevalent (see photos CW 85 and CW 91) and is undermining trees. Some armoring was observed (photo CW 87) using very large stone. Disposal of grass clipping on the bank was also noted (photo CW 79).

Two sections upstream of Hampstead Court appeared to be in a possible stable configuration (see photos CW 104 and CW 108).

5.3 OAKWOOD BRANCH RECONNAISSANCE

Reconnaissance on the Oakwood Branch began at the Valparaiso High School. Gabion baskets had been placed around the school's storm sewer outlet into the storage area presumably to mitigate erosion (see photo OW 304). However, overtopping of those baskets appeared to be eroding the sides. Additional baskets had been placed downstream of the outlet but the soil around the ends eroded creating a bypass channel (photo OW 305 and OW 306).

The pond outfall appeared to be obstructed by debris (photo OW 314) with woody plant growth in sections of the Gabion basket dam (photo OW 315A). An outfall pipe and slide gate with an energy dissipater on the end appeared to be intact (photo OW 317).

The downstream channel had been stabilized with Gabion baskets to the school property line and appeared in good condition except at the end (photo OW 322). Erosion was observed immediately downstream with bank sloughing (photo OW 324). Immediately upstream of the Gabion basket termination, the apparent outlet of the Golfview Apartments was observed, marked by dumping of debris, presumably to reduce erosion (photo OW 321).

Downstream of the school property line, bank erosion, tree undermining and bank sloughing were observed (photos OW 325, OW 326 and OW 333). In addition, trees and brush were noted in the streambed (photo OW 328).

In another section of the stream, streambed armoring and bank stabilization in the form of large, irregular pieces of broken cement was in process (see photo OW 334 and OW 336) by the property owner. The concrete pieces appeared to be approximately 4 inches thick and as large as 1-2 feet across.

Continuing downstream, additional areas of bank erosion resulting in sloughing (photos OW 342, OW 344 and OW 345), bend erosion in sandy soil (photos OW 348 and OW 349) and debris were observed. Debris lodged in the bend of one of Old Oak Drive culverts was also observed (photo OW 390).

The most stable section appeared to be in the section after Old Oak Drive where the slope was lower than the upper section and the banks were shallowest (photo OW 391)

5.4 FOREST PARK BRANCH RECONNAISSANCE

Field reconnaissance for the Forest Park branch began at the upstream end. The beginning is a 36 inch outfall pipe and scour was observed at this outfall (see photo FP400). The depth was approximately 4-5 feet. The ravine itself is relatively narrow (12 feet wide and approximately 20 feet deep) with additional pipe outfalls above the streambed (see photos FP 401, FP 402 and FP 403), all showing some degree of scour.

In addition to storm sewer outfall erosion, discharge from single family homes was observed to be eroding the banks and contributing to the sediment load (see photos FP 432, FP 433, FP 444 and FP 445). Outlets piped down hills and scouring the ground upon exiting the bottom of the pipe and outlet structures in need of maintenance were noted. Bank sloughing appeared to be occurring in the upper section of the branch (see photos FP 406, FP 407 and FP 426). Undermining of large trees (see photos FP 424 and FP 425) was also occurring in the upper section of the branch.

Consistent with the other streams, bend erosion was noted even in the wider sections.

Potential stable sections of the stream were observed that included low bank hieghts (see photos FP 434, FP 447 and FP 453). The channel through the golf course was notable for its narrow geometry (photos FP 471, FP 474 and FP 476). This may be attributable to the availability of sunlight allowing good cover plants such as grass to grow on the banks.

The outlet channel at Harrison Boulevard culvert appeared to have seen construction activity and in better condition than the channel downstream.

6.0 MODELING

The watershed runoff was estimated using hydrograph routing methods. The hydrographs were generated using the Soil Conservation Service (SCS) / National Resource Conservation Service (NRCS) methodology and XP Solutions Storm Water Management Model (XPSWMM) Software. The SCS/NRCS method requires watershed delineation and specific descriptive variables for each watershed including runoff curve numbers to describe the existing surfaces, the time-of-concentration using the TR-55 methodology, rainfall depths and hydrograph shape factor. The XPSWMM software provides a fully dynamic model for evaluating detention and conveyance using the EPA SWMM engine.

The runoff was then routed by the model through detention ponds, natural streams and roadway culverts. The primary focus of this study was the Beauty Creek, Candlewood, Oakwood and Forest Park stream branches with existing detention in select areas incorporated into the model based on input from the City and the public. These areas included Greenfield Commons, Candlewood Trace, Keystone Crossing, the Valparaiso High School, Golfview and Beauty Creek Villas.

6.1 Model Input:

The input parameters and the results of the modeling are discussed below. Examples of the input data are provided in **Appendix E.**

6.1.1 Watershed Delineation

As discussed in **Section 4.1**, 43 sub-watershed areas were delineated using the 2010 Porter County GIS Contour data (see **Appendix A**). Each sub-watershed was included in the XPSWM model with its specific associated model variables (time-of-concentration, curve number, area, etc.).

6.1.2 Time-of-Concentration

Due to the large watershed and the level of detail of this study (i.e. the study did not include details of the various local conveyance systems such as subdivision storm sewers), the delineation of a time-of-concentration path would have been arbitrary with multiple assumptions. As a result, the times-of-concentration (Tc) were conservatively estimated based on the development type or the watershed size. The “typical” Tc’s used are summarized in **Table 6-1** below.

Table 6-1 : Typical of Watershed Times-of-Concentration		
Watershed Description	**Size (ac)**	**Tc (min)**
Agricultural / Woods/ Residential	200	45
Subdivisions	79	35
Open Space	40	20

6.1.3 Soil Types and Curve Numbers

GIS based soil and surface data for Porter County was used to establish soil types and curve numbers present in each subwatershed. Initially, the 2011 National Land Cover Database (NLCD) for Porter County was intersected with the 2008 NRCS soil database to add the soil types to each NLCD polygon. Next, a column was created and the Hydrologic Soil Group (HSG) was added based on each specific soil type as listed NRCS Soil database. Another column was then added and the Curve number (CN) was added in this column based on the NLCD grid code (describing the land cover) and the HSG. **Appendix E** provides a copy of the table with grid Code (listed as "GIS Value") and the associated CN based on the HSG. For example, grid code 24 is described as Developed, high intensity surface with a CN of 94 for HSG "C". The resulting expanded database included all of Porter County.

The expanded database was then clipped using the subwatershed polygons, producing a smaller database that included the subwatershed name. Another column was added to this subwatershed data and the area of each grid code polygon was calculated. A second column addition was made and filled with the product of the CN times the area. Finally, the subwatershed database was exported to a Microsoft Excel spreadsheet where a pivot table was created to complete the calculation of the grid code areas and the CN x area sums to determine the average CN for each subwatershed. The results are summarized in **Appendix E.**

6.1.4 Rainfall Data

Rainfall depths from the City of Valparaiso design manual were used in the modeling. The current NOAA Atlas 14, Volume 2 depths from the NOAA website for the 100-year events were compared as a point of reference. The Atlas 14 values were observed to be generally lower by 0.30 inches to 0.92 inches, indicating the City rainfalls depths may be considered conservative and provide an extra measure of protection. **Table 6-2** below provides a comparison of the events.

Table 6-2 : Comparison of 100-Year Rainfall Depths		
Storm Duration (hr)	**City of Valparaiso (in)**	**NOAA Atlas 14 (in)**
1	3.90	2.98
2	4.50	3.89
3	5.00	4.28
6	5.60	5.30
12	7.00	6.04
24	8.10	7.20

6.1.5 Detention Pond Volumes

The existing and prospective detention pond volumes were determined using the Porter County GIS contour data and the average area method. The proposed total volumes of each pond were entered into the XPSWMM software. Selected ponds are summarized in **Table 6-3** below.

Table 6-3 : Selected Pond Volumes	
Pond No.	**Volume (ac-ft)**
Valparaiso High School	5.59
Ransom Road Depressional Area	45.5
Hampstead Court Pond 1	6.31
Beauty Creek – Ransom Road Culvert Upstream	7.62
Forest Park Pond 1	0.39
Forest Park Pond 2	2.39
Forest Park Pond 3	2.12
Forest Park Pond 4	1.2
Total	**71.12**

As noted previously, elevations were primarily taken from the 2010 Porter County contour data supplemented with field measurements / verification of outfall diameters at key locations. Likewise, the contour data was used to estimate pond volumes and overflow elevations. Outflow pipe elevations from ponds were taken from plans or assumed to be at the lowest contour elevation for the respective pond.

6.1.6 Stream Cross-Sections

Conveyance through Beauty Creek, Candlewood, Oakwood and Forest Park Branches was modeled through "natural" channel cross-sections. These cross-sections were created using the 2013 Digital Elevation Model (DEM) and extracting the points along a line representing the cross-section. Cross-sections were created at approximate locations where there are changes in geometry and / or large changes in slope occurred.

A total of 45 cross-sections were created. In addition to point-elevation data, a Manning's roughness coefficient (n) for the channel and overbank was required for modeling. Almost all of the streams segments in this study could be described with a winding channel and forested overbanks areas (i.e. floodplains). Per Table 3.1 of the USACE HEC-RAS Hydraulic Reference Manual, a clean winding channel with some pools and shoals would have a normal Manning's n value of 0.040 and floodplains with a trees, a heavy stand of timber, a few down trees, little undergrowth and flow below the branches would have a Manning's n value of 0.100. Representative cross-section plots and a copy of the USACE HEC-RAS are provided in **Appendix E.**

The use of the natural geometry of the stream cross-section creates an actual representative depth of flow that can be used to provide an estimate of the shear force in the stream beds as discussed in Section 6.7 below.

6.2 MODEL RESULTS (EXISTING CONDITIONS)

The results of the XPSWMM model as shown in **Table 6-4** below.

Table 6-4 : Summary of Existing Peak 100-Year Flows

Location	Peak Flow* (cfs)
Greenfield Creek	216
Ransom Road Culvert	363
Candlewood Trace Subdivision	42
Keystone Crossing Subdivision	83
Oakwood @ Confluence	379
Candlewood Branch @ Confluence	138
Valparaiso High School	108
Golfview	16
Forest Park Golf Course	950
Hampstead Court Culverts	139
Forest Park @ Confluence	1083
Beauty Creek Outfall	727

*Different Storm Durations

The results indicate the discharge from the Ransom Road culvert, Oakwood Branch and the Forest Park Branch are some of the largest contributors to overall flow in Beauty Creek. Also noteworthy is the attenuation of the peak discharge by the natural floodplain. For example, the peak discharge from the Forest Park Confluence was 1083 cfs, but after routing through the Beauty Creek flood-plain the overall peak was reduced by approximately 30% to 727 cfs.

6.2.1 Keystone Commons

Keystone Commons is located adjacent to the Valparaiso High School on the north side. The subdivision includes five (5) primary ponds, four (4) of which are interconnected by five (5) rows of 36 inch culverts between each pond. The downstream end of the interconnected ponds is in the southwest corner of the subdivision between Smallwood Trail cul-de-sac and the south cul-de-sac of Windsor Trail. These ponds serve a total watershed area of approximately 116 acres. The fifth pond has an independent outfall to the west and lies between Vale Park Road and Smallwood Trail. Both the 10 inch pipe outfall and the overflow from the fifth pond leave the subdivision to the natural overland flow path to the southwest. This pond serves an area of approximately 21 acres (see **Appendix G** for the subdivision aerials).

The normal outflow pipe from the southwest Keystone pond and its overflow route are in two different directions. The normal outflow pipe appears to be 24 inches in diameter per the 1992 Valparaiso High School plans and flows south into the Oakwood Branch sub-watershed. The Pond overflow discharges to the northwest and into the field with the fifth pond outflow, which is the Candlewood sub-watershed.

The Keystone Commons record drawings by PTGR suggest the location of the Keystone Commons southwest pond was in a natural isolated low area with an existing 18 inch pipe flowing to the Oakwood Branch prior to construction of Keystone Commons. This existing low area appeared to include additional excavation to create the Keystone Commons pond. The subdivision plans do not indicate this pipe was changed. As a conservative estimate, a 24 inch pipe was used in the XPSWMM model.

The model results are summarized in **Table 6-5** below.

Table 6-5 : Summary of Existing Keystone Commons Release Rates

	Peak Runoff (cfs)			
	Keystone Northwest Pond		Keystone Southwest Pond	
Storm Event	Pipe	Overflow	Pipe	Overflow
100-Year 1hr	3.4	14.5	29.4	0.7
100-Year 2hr	3.4	14.1	29.5	20
100-Year 3hr	3.4	15.6	29.5	25
100-Year 6hr	3.3	11.2	29.5	18
100-Year 12hr	3.4	15.2	29.5	35
100-Year 24hr	3.3	11.6	29.5	27

The table shows both ponds produce significant overflows to the Candlewood Sub-watershed all storm events with the exception of the southwest pond during the 1-hour event.

6.2.2 Valparaiso High School Detention

The Valparaiso High School detention was constructed in the wooded ravine area at the west end of the site. This ravine area drains to the Oakwood Branch of Beauty Creek and serves a watershed of approximately 57 acres. The control structure was constructed of a Gabion wall with a 30 inch outfall pipe. The pipe includes a slide gate on the downstream end. Per the 1992 Design Memorandum prepared by Lawson-Fisher Associates, the pond was designed to serve 65 acres and used the SCS Type II rainfall distribution. Five (5) of those acres had been allotted for a future extension of Vale Park Road. The primary outlet was a 30 inch pipe with an inlet elevation of 794 feet and an overflow weir at an elevation of 806 feet. The Design memorandum indicates the 806 elevation would provide approximately five (5) acre-feet of storage, the rainfall depth used was 5.60 inches for the 100-year, 24-hour storm, the school site curve number (CN) was 83 and another 2 acres of impervious area was accounted for presumably for Vale Park Road as well as 3 acres of pervious area.

The High School sub-watershed delineation based on the 2010 Porter County Contour data resulted in a watershed area of 56.9 acres. The curve number using the NLCD was calculated as approximately 66. However, the original design memorandum CN value of 83 was used for modeling purposes. Also the rainfall distribution used in the model was the Huff rainfall distribution as opposed to the SCS Type II used in the original design.

The model results are summarized in **Table 6-6** below.

Table 6-6 : Summary of Existing Valparaiso High School Release Rates and Elevations

Storm Event	Peak Runoff (cfs)		Peak Elevation
	Pipe	Overflow	
100-Year 1hr	108	0	804.58
100-Year 2hr	102	0	803.68
100-Year 3hr	98	0	803.02
100-Year 6hr	76	0	800.33
100-Year 12hr	65	0	798.87
100-Year 24hr	46	0	797.01

The table indicates some of potential release rates are slightly higher than the original proposed limit of 93 cfs and there is additional detention volume that may be utilized (Overflow = 806 feet per plans).

6.2.3 Candlewood Trace

The Candlewood Trace subdivision is located in the northeast corner of the intersection of Ransom Road and Goodrich Road (see **Appendix G)**. The subdivision includes a single detention pond located at the intersection. The pond has a 36 inch outfall pipe with an overflow overland across the intersection to the southwest. The 36 inch pipe appears to daylight approximately 1900 feet south of the pond into a wooded ravine, eventually joining with the runoff from Keystone Commons and flowing through the culverts under Hampstead Court. The overland flow route appears to follow the same route as the pipe, flowing through a low area south of Ransom Road (**Appendix D**). The Candlewood Trace pond serves a sub-watershed total area of approximately 79 acres and a cumulative curve number of 71.6.

Table 6-7 below summarizes the existing model results for the Candlewood Trace pond.

Table 6-7 : Summary of Existing Candlewood Trace Release Rates		
	Peak Runoff (cfs)	
Storm Event	Pipe	Overflow
100-Year 1hr	41.5	0
100-Year 2hr	41.0	0
100-Year 3hr	40.7	0
100-Year 6hr	38.9	0
100-Year 12hr	39.1	0
100-Year 24hr	37.7	0

The results indicate all storms are contained in the pond with no roadway overflow, assuming no blockage of the outlet pipe.

6.2.4 Greenfield Creek

Greenfield Creek subdivision is located on the west side of Goodrich Road approximately 1500 feet north of the intersection with Ransom Road (see **Appendix G)**. The subdivision includes four (4) wet ponds, three (3) connected in series by corrugated metal arch pipes, approximately 53 inches wide by 41 inches height. These ponds serve a cumulative watershed area of approximately 346 acres and have a final outfall through a 48 inch pipe west of Winter Lane. The fourth or north pond lies north of Jade Boulevard and releases through a 36 inch pipe west of Winter Lane. The north pond serves approximately 106 acres, 92 acres comes from off-site to the north and flows through a wooded low area within the subdivision north of Blue Heron Drive that connects to the pond through a 48 inch culvert.

Table 6-8 provides a summary of the existing model results for Greenfield Creek subdivision.

Table 6-8 : Summary of Existing Greenfield Creek Release Rates

	Peak Runoff (cfs)			
	Greenfield Creek North Pond		Greenfield Creek South Ponds	
Storm Event	**Pipe**	**Overflow**	**Pipe**	**Overflow**
100-Year 1hr	13	40	59	104
100-Year 2hr	13	40	59	97
100-Year 3hr	13	39	61	93
100-Year 6hr	13	37	61	71
100-Year 12hr	13	37	57	69
100-Year 24hr	13	36	61	59

The results indicate significant overflow from both Greenfield Creek final ponds during the shorter duration storms. The model also indicates the depressional area upstream of the north pond is functioning as an extension of the north pond, storing up to almost three (3) feet of runoff.

The south Greenfield Creek pond is overflowing during all 100-year events. The contour data indicates the overflow route may be controlled by the elevation around the lift station located on Winter Lane approximately 175 feet south of the Jade Boulevard intersection. The contour data shows an elevation of 796 feet around the lift station (the overflow route) and this elevation will approach some of the homes and possibly enter the structure at 3902 Winter Lane.

6.2.5 Ransom Road Culvert

The existing Ransom Road culvert is approximately 72 inches in diameter (6 feet). The existing peak flow rate through the culvert is approximately 363 cfs as shown in **Table 6-4** and has severely erode the streambed immediately downstream of the culvert (see photo BC 245, **Appendix C**). The contour data was used to estimate the storage volume immediately upstream of the culvert and this volume entered into the XPSWMM model as detention storage. The model produced a peak elevation of 775.81 upstream of the culvert under current conditions.

As discussed in the topographical review section, this area of backwater immediately upstream of the Ransom Road culvert is privately owned.

6.2.6 Shear Stress

Erosion of the stream bed and banks as well as sediment transport was has been the primary concern of the City and residence adjoining Beauty Creek and its branches. As observed from the field reconnaissance, many areas of the stream beds have eroded and exposed fine sand. Fine sand has minimal resistance to shear forces and is therefore very difficult to stabilize.

For uniform flow, shear stress can be estimated by the following formula:

$T = \gamma * d * S$

Where:

T = shear stress, lb / sq ft (psf)
γ= Unit weight of water, 62.4 lbs/ cu ft
d = depth of flow, ft
S = energy gradient, ft/ft

(For Uniform flow, the energy gradient in uniform flow is parallel to the channel bottom and the channel slope may be substituted.)

The equation above suggests reducing the depth of flow, the energy gradient or both could lower the shear stress.

The above equation is applicable to straight sections of streams. Shear as water flows through bends is increased on the outside of the bend as the water changes direction. The sharper the bend the higher the shear stress. A correction factor (K_b) which is a function of R_c / B can be applied to the calculated value of shear stress for a straight section where:

R_c = radius of curvature (m or ft)

B = bottom width (m or ft).

Rough values of K_b can be initially approximated for bends as follows:

Straight reach	1.0
Mild meanders	1.1 to 1.4
Looping meanders	1.5 to 1.8
Sharp turns	1.9 to 2.1

The sand present in most stream bottoms consist of a fine grain and is non-cohesive. These properties result in a very low shear value before it is moved. Reported values of critical stream bed shear stress for non-cohesive particles (the shear stress at which a particular particle will begin to move) are provided in **Table 6-9** below.

Table 6-9 : Summary of Critical Bed Shear Stress		
Particle Classification	Critical Bed Stress Range* (psf)	
	Lower	Upper
Coarse cobble	2.339165	4.65744
Fine cobble	1.123635	2.33916
Very coarse gravel	0.540932	1.12363
Coarse gravel	0.254802	0.54093
Medium gravel	0.119047	0.25480
Fine gravel	0.056391	0.11905
Very fine gravel	0.027151	0.05639
Very coarse sand	0.009816	0.02715
Coarse sand	0.005639	0.00982
Medium sand	0.004052	0.00564
Fine sand	0.003028	0.00405
Very fine sand	0.002297	0.00303
Coarse silt	0.001725	0.00230
Medium silt	0.001316	0.00173
Fine silt	0.000789	0.00132

*U.S. Geological Survey, Scientific Investigations Report 2008-5093

Using representative values of slopes for the streams from the topographical review and 100-year storm depths from the XPSWMM model, initial shear stress estimates for Beauty Creek and the branches were calculated and are summarized in **Table 6-10** below.

Table 6-10 : Summary of Typical Existing Stream Shear Stress				
	Straight Sections		**Outer Bends (Upstream Cross-Sections)**	
Stream	**Downstream Shear (psf)**	**Upstream Shear (psf)**	**Looping Meanders (psf)**	**Sharp Turns (psf)**
Beauty Creek	1.98	1.54	2.54	3
Candlewood Branch	1.53	1.84	3.04	3.68
Forest Park Branch	4.64	6.07	10	12.1
Oakwood Branch	1.85	4.33	7.15	8.67

The estimated shear stress for straight sections of all the studied stream for the 100-year event are much greater than the critical shear stress for fine sand or very fine sand. Even when a maximum depth of flow of 1 foot is used in the estimate, the resulting shear stress values exceed the critical shear stress (0.3 psf vs. 0.003 psf for fine sand).

Table 6-11 below provides general guidance for channel lining shear stress limits.

Table 6-11 : Typical Shear Force Limits	
Material	Shear Force Limits (psf)
Vegetation (unreinforced)	3
Erosion Control Blanket	3
Rip-Rap (D50 = 18”)	6
Bio-Composite Reinforced Mat	8
Rip-Rap (D50 = 24”)	8
Turf Reinforcing Mat	8
Gabions	8
Articulating Concrete Block	15
Fabric Formed Concrete	20

The shear force on the straight sections of Beauty Creek and Candlewood Branch appear to be low enough to use erosion control blanketing. However, the reader should keep in mind erosion control blankets are generally used where vegetation can be established. Most of the streams studied are in wooded areas where the tree canopy will reduce the available sunlight and potentially prohibit growth of many plants. If a blanket is chosen, it may have to function by itself to reduce erosion and be “permanent”.

Table 6-10 confirms the observations on erosion at the bends of the streams. The values of the shear force begin to exceed the guideline values especially in the upper sections of the Forest Park Branch and the Oakwood Branch. The shear force estimates for the bends in the upper Forest Park Branch even exceed the guide value for Gabions (8 psf for gabions vs. 10 and 12 psf for bends).

6.3 RESULTS (PROPOSED MODEL ALTERNATIVES)

In the shear stress discussion above, reduction of flow depth, channel slope or both need to be considered to reduce the effective shear stress on the channel bottom and sides as well. Options to address changes in slopes are limited and will be discussed later. Alternative channel geometries were also limited by topographical constraints such as the tall ravines. Therefore, the primary focus of this investigation was reduction of depth of flow through detention.

The existing model results indicated many of the existing subdivision detention systems are at or above their detention capacity in the 100-year events. The Valparaiso High School detention pond did appear to have additional potential storage capacity and the topographical review identified five (5) low areas where new detention may be constructed with a minimum capital investment. These areas are shown in **Appendix H** and are identified as Upper Candlewood, the Hampstead Court, Forest Park Golf Course north and Forest Park Golf Course South. The proposed modeling result for each of these areas is discussed below.

6.3.1 Valparaiso High School Detention

Three potential alternatives were explored for the High School detention pond, re-routing the Keystone and Golfview outfall pipes into the pond and maximizing the potential storage volume by raising the existing dam, altering the existing outfall to attenuate low flows and creating a second detention pond downstream of the existing pond on the High School property.

6.3.1.1 Outfall Re-Route and Detention Maximization

As discussed in Section **6.2.2**, the peak storage elevation of the pond in the existing conditions is approximately 804.86 feet, below its original overflow design of 806 feet. Per the Porter County 2010 GIS contour data, the storage volume available from 805 to 806 feet is approximately 1 ac-ft.

The model was altered to route the 24 inch outfall pipe from Keystone Crossing into the High School pond and the resulting flow rate in the stream section downstream of the Golfview Apartments outlet noted. Next, the outlet pipe from Golfview Apartments was re-routed into the detention area and peak flow in the same stream section downstream of the original outfall noted. Finally, additional volume was added to the pond with all three runoff sources (the school, Keystone Crossing and Golfview Apartments) and the outlet size reduced. The additional volume was created by raising the dam in the model to an elevation of 810 feet and estimating the volume increase from the existing contours. The 810 contour provided an elevation that remained within the existing wooded area and below any elevation upstream in the High School parking lots or athletic fields. The additional detention volume from the 806 contour to the 810 contour is approximately 4.92 ac-ft, bringing the total detention volume to 9.56 ac-ft from 4.6 ac ft

The results of all trials are summarized in **Table 6-12** below.

Table 6-12 : Summary of High School Re-Route and Maximized Detention

Scenarios	100-Yr Peak Flow (cfs)*
Existing Conditions (No Pond Modifications or Pipe Re-Routes)	147
Existing Pond + Keystone Outlet	127
Existing Pond + Keystone + Golfview	114
Expanded Pond + Keystone + Golfview +27 inch Outfall	108

*Flow at Cross-section Downstream of Existing Golfview Outfall. This section includes flow from the High School pond outfall, the Keystone Commons outfall pipe and the Golfview outfall pipe prior to re-routing the outfalls to the pond in the XPSWMM model.

The results of the modeling alternatives indicate a reduction in the peak outflow from all contributing sources is possible. By re-routing the Keystone Commons outlet, a reduction in the peak flow is possible. Re-routing the Golfview outlet into the pond as well could result in additional total reduction to the Oakwood Branch. Finally, raising the pond dam and increasing the total volume stored as well as reducing the outlet size could provide up to a 29% reduction in the overall peak flow rate downstream. In addition, the shear stress as a result of the reduced flow is to 3.1 psf from 5.1 psf.

6.3.1.2 Low Flow Attenuation

As a second alternative for the High School pond, the XPSWMM model was revised to attenuate low flows. The outfall was modified with a 1 foot low flow orifice and weir to detain the 2-year storm events before overflowing out of the existing 30 inch pipe. In addition, the existing dam was raised with the overflow elevation at 808 ft. The results are summarized in **Table 6-13** below.

Table 6-13 : Summary of High School Low Flow Attenuation

Storm Event	High School Runoff (cfs)	Keystone Crossing (cfs)	Golfview (cfs)	Est. Total Pond Inflow (cfs)	Existing 30" Orifice (cfs)	Existing 30" Orifice Pond Elevation (ft)	1.0 ft Dia Low Orifice (cfs)	Low Flow Pond Water Elevation (ft)*	% Change
2yr1hr	29	2.5	1.9	33.4	29.7	795.96	9.3	800.19	-68%
2yr2hr	23.4	5	2.4	30.8	24.2	795.84	12.9	799.96	-47%
2yr24hr	11.9	14	3.9	29.8	25.5	795.10	25.4	802.34	-0.4%
10yr 1 hr	63.6	12.8	5.2	81.6	57.8	798.69	51.7	802.46	-10%
10yr2hr	57.1	23.9	7.4	88.4	54.9	798.33	52.8	802.54	-4%
10yr24hr	21.9	30.5	9.2	61.6	56	795.67	57	802.66	+1.8%
100yr1hr	220.6	32.7	16.3	269.6	115	804.58	115	808.05	0%
100yr2hr	161.9	32.7	15.7	210.3	111	803.68	112	806.13	+0.9%
100yr24 hr	46	32.7	15.5	94.2	89	797.01	89.8	803.69	+0.9%

*Pond Overflow set at 808 ft.

The results indicate a large reduction in the 2-year, 1- and 2-hour storm events and a smaller reduction for the 10-year, 1- and 2-hour events. The longer duration storm events, however, show small increases in the runoff rate. This increase can be attributed to the increased elevation due to storage of more water at the beginning of each storm event to attenuate the low flows.

6.3.1.3 Second High School Pond

The third alternative included modifying the XPSWMM model to include a second detention pond downstream of the existing High School pond with a dam at the property line. The ravine elevations at the property line range from 778 feet to 800+ feet per the 2010 Porter County GIS contour data. However, the Indiana Department of Natural Resources (IDNR) regulates dams that have a drainage area greater than 1 square mile, exceed 20 feet in height or impound greater that 100 acre-feet of water. While the proposed second detention pond would not meet the first or third criteria, the ravine depth could allow storage greater than 20 feet in height. As a result, the proposed detention pond storage height was limited to a maximum of 18 feet.

Using the 2010 Porter County GIS contour data, the potential volume available from an elevation of 778 feet to 796 feet was estimated to be approximately 5 acre-feet. The existing High School pond dam was raised and the overflow set at 808 feet as discussed previously to maximize detention upstream. Approximately 10 acre-feet of additional storage total was provided between raising the existing pond and adding the second pond. With this scenario, the Keystone and Golfview outfall pipes were not re-routed, allowing a reduction in the High School pond outfall from 30 inches in diameter to 18 inches to maximize the storage. A 24 inch pipe was used to maximize the detention in the second pond. The results are summarized in **Table 6-14** below.

Table 6-14 : Summary of Double High School Ponds	
Storm Event	**Peak Flow (cfs)***
100-Year, 1-Hour	76
100-Year, 2-Hour	78
100-Year, 3-Hour	79
100-Year, 6-Hour	79
100-Year, 12-Hour	79
100-Year, 24-Hour	78

*Downstream of Second Pond

The results indicate the addition of a second pond and increasing storage in the existing pond can result in a reduction in peak flow. When compared to the existing conditions (see **Table 6-12)** there is an approximate 46% reduction in the peak runoff. A comparison to the increased storage volume and re-routing of Keystone and Golfview outlets scenario for the existing pond indicates a reduction of an additional 27% relative to construction a second pond in this scenario.

6.3.2 Upper Candlewood Branch Detention

Two (2) areas were identified as potential storage areas, a low area in the open field south of Ransom Road and the east and west ravine branches north of Hampstead Court (**Appendix H)**. With the results of the existing model indicating no overland flow from Candlewood Trace to the North and the contributing watershed being undeveloped, the initial detention modeling of the area of the open field south of Ransom Road provided little or no detention and this detention area was removed from consideration.

The topographical information shows west branch of the Hampstead ravine is long with sufficient relief to prevent contours present at the lower end from reaching the beginning of the ravine. In order to maximize the potential storage, the ravine was divided into two (2) storage areas (see **Appendix H**) and various outlet sizes investigated. One outlet and dam was modeled just below the confluence of the east and west branch to minimize potential construction costs.

The results are summarized in **Table 6-15** below.

Table 6-15 : Summary of Upper Candlewood Branch Alternates	
Scenarios	Peak Flow (cfs)
Existing Conditions	61
Headwaters Pond 1*	19.2
Headwaters Pond 1+ Headwaters Pond 2*	19.2

*12 inch outlet pipes

The results indicate the second, upstream pond may not reduce the overall runoff to the Hampstead culverts when compared to the lower, confluence pond. A smaller orifice was not modeled because of potential plugging. The area is heavily wooded and the potential for obstruction by leaves or tree branches is high. Even a 12 inch outlet will required special design considerations and frequent maintenance to reduce obstructions.

6.3.3 Forest Park Branch Detention

With the contributing watershed almost entirely developed, there is little opportunity to create detention in the developed areas. The primary location for detention is the upper ravine along the eastern edge of the Forest Park golf course from the outfall near Lorraine Drive to where it emerges into the golf course near Del Vista Drive. This is the section has depths of over 30 feet and a total fall of almost 40 feet from the upstream outfall to the golf course.

Four (4) detention areas were created from the Porter County topographic data, labeled 1 through 4 sequentially from the outfall down to the golf course. Each was given a depth of 9 to 10 feet and located downstream such that the peak storage elevation of the downstream pond would be at or near the elevation of the outfall of the upstream pond. This minimizes any tailwater impacts.

The results are summarized in **Table 6-16** below.

Table 6-16 : Summary of Forest Park Branch Detention Alternative		
Scenarios	Peak Flow (cfs)	
	Golf Course	Beauty Creek Confluence
Existing Conditions	950	1083
Forest Park Ravine Detention Ponds 1, 2, 3 and 4	57	627

The results indicate a 94% reduction in the peak flow at the golf course. Each pond was modeled with a 24 inch outlet and only pond 1, the uppermost pond, overflows.

6.3.4 Forest Park Golf Course

There are two (2) primary discharge points from the Forest Park golf course to Oakwood Estates. Both of these points are ravines with culverts under Sherwood Drive that could be used as potential storage. The volumes of the ravine areas were entered into the XPSWMM model and the culvert sizes reduced until the stored volume was maximized. The resulting discharges are summarized below.

Table 6-17 : Summary of Golf Course Peak 100-Year Flows		
Location	Peak Flow (cfs)	Peak Elevation
Forest Park Golf Course North	53	788.02
Forest Park Golf Course South	34	787.51

The results indicate a significant reduction in flow will require additional volume for storage, especially the southern discharge point. New Ponds were created expanding the existing contours into the golf course using the 2010 County topographic contour data (see **Appendix H**). In addition, 2.88 acres from the High School practice field was captured and routed into the north pond by creating a 2-3 foot berm from the proposed north pond to the west side of the practice field (**See Appendix H**). The model was revised using these expanded ponds. The outlet in the model was reduced down to 1 foot in diameter. The results are summarized below.

Table 6-18 : Summary of Revised Golf Course Peak 100-Year Flows		
Location	Peak Flow (cfs)	Peak Elevation
Forest Park Golf Course North	5.5	791.00
Forest Park Golf Course South	5.6	787.30

The results indicate a peak flow reduction of 90% is possible for the north outfall and 83.5% for the south outfall. The topographic and aerials indicate the elevation of the structure adjacent on the north side of the south pond is only a foot or two above the peak model elevation. If detention is created for the south watershed, detailed design of an overflow structure will be required to prevent flooding of the structure during an extreme event.

6.3.5 Ransom Road Culvert

The culvert size was reduced in the XPSWMM model to determine the minimum discharge that could be achieved without impacting the existing residence or auxiliary structure reduce the total discharge out of the culvert. The culvert size was reduced by ½ foot to 4.5 feet diameter and the model re-run. The peak flow was reduced from 363 cfs to 268 cfs and the peak elevation was raised from 777 feet to 781 feet. This elevation allows approximately 6 feet of freeboard to the existing structure but is within 20 feet horizontally of the structure.

7.0 PUBLIC MEETINGS / PUBLIC COMMENTS

Two (2) public meetings were held, the first on November 18, 2015 to introduce the study and receive preliminary public input and the second on February 29, 2016 to present the draft report. In addition, written comments were accepted until March 15, 2016. Copies of the written comments submitted are provided in **Appendix J**.

The public comments / concerns included:

- Maintenance of High School pond and outfall as well as any proposed ponds;
- Possible second detention pond on High School property;
- Urgent need to stabilize ravine banks vs. implementation of regional detention;
- Stabilization of roadway culvert outfalls;
- Collection of additional runoff from west side of golf course.

As a result of the public comments, a second pond on the High School property was included in the modeling (see section **6.3.1.3**). In addition, a berm to collect additional runoff from the golf course and high School practice field was added to the detention concept drawing (**Appendix H**, "Golf Course Storage Areas") and the model updated.

8.0 CONCLUSIONS

Erosion and sediment transport in the Beauty Creek watershed is a significant problem. Erosion is occurring primarily in the ravines where the waterways are narrow and the slope is steeper relative to the upland and downstream areas. Historically, much as the upper watershed has been agricultural since the 1930's. Older development in the watershed has not included detention or runoff attenuation while newer development has provided runoff attenuation. Development on the eastern side is older and does not appear to include detention as well as development along the lower sections of the Candlewood, Oakwood and Forest Branches.

Erosion in the waterways has exposed underlying strata of fine sand which is non-cohesive. The critical shear force needed to suspend or move this material is very small, making stabilization difficult. The steps to addressing erosion in the watershed should begin by minimizing the potential shear force through reduction in flow depth and then grade stabilization.

Detention of flow can provide a significant reduction flow and therefore depth / shear force. Modification of the existing storage in the Valparaiso High School detention pond and new storage in existing ravines can provide a significant reduction in flow for the Candlewood, Oakwood and Forest Park branches. Sufficient storage can be created with a minimum of excavation by the construction of berms alone.

A reduction in flow and depth will reduce the sheer force on the fine, non-cohesive sand exposed in much of the stream channels. The reduction in sheer force will allow the use of less expensive surface stabilization practices such as smaller armoring stone or permanent surface reinforcing matting.

In addition to detention, upstream channels where slopes are higher and the channel width is limited by ravine depth, grade stabilization practices must also be included. These structures can create a step and direct the flow such as a cross vane control structure (see **Appendix I)** in straight section of channels and J-hooks on bends. These structures can help maintain channel elevations by creating steps that control slope in channel the segment between steps and control scour.

Areas of erosion include pipe discharges along the upper banks of the ravines from roadway drainage and roof downspouts. Steps to discharge these outfalls at grade or into a stabilized channel must also be included.

In addition to structural remedies, a regular maintenance program should be considered. Numerous areas where obstructions in the waterways resulted in increased bank and bed erosion through re-direction of flow and or the creation of scour holes were noted from the field reconnaissance. Regular removal of blockages such as fallen trees will reduce bank erosion and scouring of the streambed.

Additional non-structural remedies to erosion should also include an educational program. During the field reconnaissance, locations where property owners had placed tree branches, grass clippings or other material in an apparent attempt to stop bank erosion were observed (see Section 6). Material such as branches can force flow into the opposite bank, cause a scour hole to form by constricting the channel width or wash downstream causing a restriction. Each of these situations may cause undesirable erosion. Grass clippings can choke out smaller, surface stabilizing plants and grass clippings are easily washed downstream. Decay of grass clippings and other material can also increase the nutrient load in runoff and lower water quality downstream.

Another non-structural practice with potential to impact erosion is the release rate requirement for new developments in the City of Valparaiso stormwater management standards. Reduction of the current release rate is 0.5 cfs/ ac could be considered. However, the impact on existing stream flows would not be as large as the creation of new detention since large areas of the watershed are already developed. The entire upper Forest Park watershed is developed and would not be expected to see a significant change in runoff. Also, the timeframe for development of the yet undeveloped area is unknown and the benefit from reduction in runoff rate under the current allowable or a further reduced release rate is also unknown. When compared to the potential reduction of flows from construction of regional detention, the benefits of a revision of the existing City allowable release rate is small and revision is not recommended.

9.0 RECOMMENDATIONS / OPINIONS OF PROBABLE CONSTRUCTION COST

The recommended approach to addressing erosion in the Beauty Creek watershed includes the following steps, in order of implementation;

1. Maximize detention upstream;
2. Install grade stabilization practices at culvert outfalls.
3. Install grade stabilizing structures in the streambed to retain sediment and reduce velocity;

4. Construct sediment traps at accessible locations;
5. Begin regular maintenance of the stream;
6. Educate property owners.

All of the following opinions of probable construction cost do not include land acquisition, permitting engineering, survey, geotechnical investigation, or utility relocation.

9.1 DETENTION

The report's recommendation is to increase the detention by modifying the Valparaiso High School detention and constructing new structures in the Candlewood ravines, the Forest Park ravines and on the west side of the Forest Park golf course. Valparaiso High School Detention modification appears to be the simplest and least expensive action to reduce peak flow.

9.1.1 Valparaiso High School Detention

Modification of high school detention system is recommended. There are three (3) steps to the modification including:

1) Reduction of the outlet areas by closing the slide gate or install a steel plate;
2) Raising the existing dam height;
3) Re-routing the Keystone Commons outfall directly to the high school detention, and;
4) Re-routing the outlet from Golfview Apartments directly into the high school detention.

The re-routing of the Keystone Commons pipe will require installation of approximately 175 feet of new 24 inch pipe and the rerouting of the Golfview outlet will require constructing approximately 670 feet of 36 inch pipe and two manholes parallel to the existing high school pipe (see **Appendix H, "High School Storage Area"**).

As noted in **Section 5**, the existing outlet is in need of maintenance. Discussions with the school representatives should include creating a maintenance agreement as well as access easements. Due to the location in a wooded area, maintenance should include regular inspection and cleaning after each significant rainfall event.

The opinions of probable cost are provided below.

Table 9-1 : Opinion of Probable Cost – High School Detention Modification

Scenarios	Cost*
Modification of Existing Pond Dam and Outfall	$122,000.00
Re-Routing of Keystone Outfall	$29,000.00
Re-Routing of Golfview Apartments Outfall	$141,000.00
Total =	**$292,000.00**

*Includes 25% Contingency

Additionally, if supplemental funding is available, a second pond should be considered for the High School property as discussed in **Section 6.3.1.3**.

Table 9-2 : Opinion of Probable Cost – High School Detention Second Pond	
Scenarios	Cost*
Construction of Gabion Dam and Outfall	$305,000.00
Total =	**$305,000.00**

*Includes 25% Contingency

9.1.2 Upper Candlewood Branch Detention

Construction of detention upstream (north) of Hampstead Court is recommended (see **Appendix H, "Candlewood Potential Storage Areas"**. The computer model results indicate the lower pond (Pond 1) alone can provide acceptable results. This pond can be created by constructing a berm with a small outlet pipe and an overflow. This cost does not include property acquisition or permitting. No wetland permitting issues are anticipated.

Table 9-3 : Opinion of Probable Cost – Upper Candlewood Detention	
Scenarios	Cost*
Construction of Gabion Dam and Outfall	$310,000.00
Total =	**$310,000.00**

*Includes 25% Contingency

9.1.3 Forest Park Branch

Construction of detention in the Forest Park watershed is recommended, beginning with Pond 2, proceeding next with Pond 3 and then Pond 4. Pond 1 could be considered last since it has minimal volume. All ponds are assumed to be constructed of Gabion Basket dams. The opinions of probable cost are provided below.

Table 9-4 : Opinion of Probable Cost – Forest Park Branch Detention	
Scenarios	Cost
Forest Park Pond 1	$265,000.00
Forest Park Pond 2	$282,000.00
Forest Park Pond 3	$287,000.00
Forest Park Pond 4	$255,000.00
Total	**$1,089,000.00**

*Includes 25% Contingency

9.1.4 Forest Park Golf Course Detention

Reduction of the peak flow from the golf course into the ravines in Oakwood Estates is recommended. The existing potential storage volume is not sufficient to reduce the peak flows to a desirable level, especially to the north. Discussions on possible location or geometries for detention that minimize impact on the course will be required. Construction is assumed to consist of excavation of earth and installation of a control structure.

Table 9-5 : Opinion of Probable Cost – Forest Park Golf Course Detention	
Scenarios	Cost
North Golf Course Pond	$314,000.00
South Golf Course Pond	$202,000.00
Total	**$516,000.00**

*Includes 25% Contingency

9.2 STREAM CHANNEL AND BANK STABILIZATION

Assuming a reduction in the existing peak flows is accomplished through the steps above, efforts to stabilize of the stream channel and banks can more easily be undertaken. However, the choice of stabilization practices will be unique to each site and no opinions of probable cost are provided.

9.2.1 Ravines

Once the peak discharge through the ravines is minimized, surface and grade stabilization should be undertaken. Some options include:

- Surface reinforcement mat or turf reinforcing mats – These are manufacture materials intended to be anchored onto the surface and rolled on the ends to prevent uplift and under flow at the ends. Permanent types are recommended instead of biodegradable. Alone they can resist shear forces of about 3 psf and vegetated up to 14 psf. Manufacturer's specification should be reviewed. Due to the canopy of the existing trees, plants that grow in shade conditions should be chosen. **Appendix I** includes a list of possible plants for consideration.

- Gabion Baskets - As demonstrated by the high school channel area, gabion baskets can be used. The recommended approach is space then at a distance to create nearly flat sections of streambed or steps. The distance between will depend on the slope of the stream bed and the height of the baskets chosen. The baskets should be galvanized or polymer coated. They need to be buried below the surface to allow for scour and filter fabric or other materials placed on the upstream edge to prevent washout or wash through.

Baskets in the flow line should be placed on a single or double vane configuration (see **Appendix I** for examples).

- Riprap – Riprap can be an economical alternative to implement. Based on the preliminary shear estimates, the minimum size (D50 – median size) should be at least 18 inches. The stones should be angular such they don't roll and filter fabric should be used beneath. The ends of the filter fabric should be buried to prevent undermining.

9.2.2 Ransom Road Culvert

Streambed restoration and construction of an energy dissipater at the outfall of the Ransom Road culvert is recommended. The flow rate is large (approximately 363 cfs) and will require an engineered solution such as a stilling basin, baffled apron or drop structure.

9.2.3 Del Vista Drive

Currently Del Vista Drive is served by side ditches and the slope of the roadway is steep. Runoff in the roadway appears to primarily originate upstream from the other connecting roadways with a minimal amount from the wooded area adjacent to the roadway.

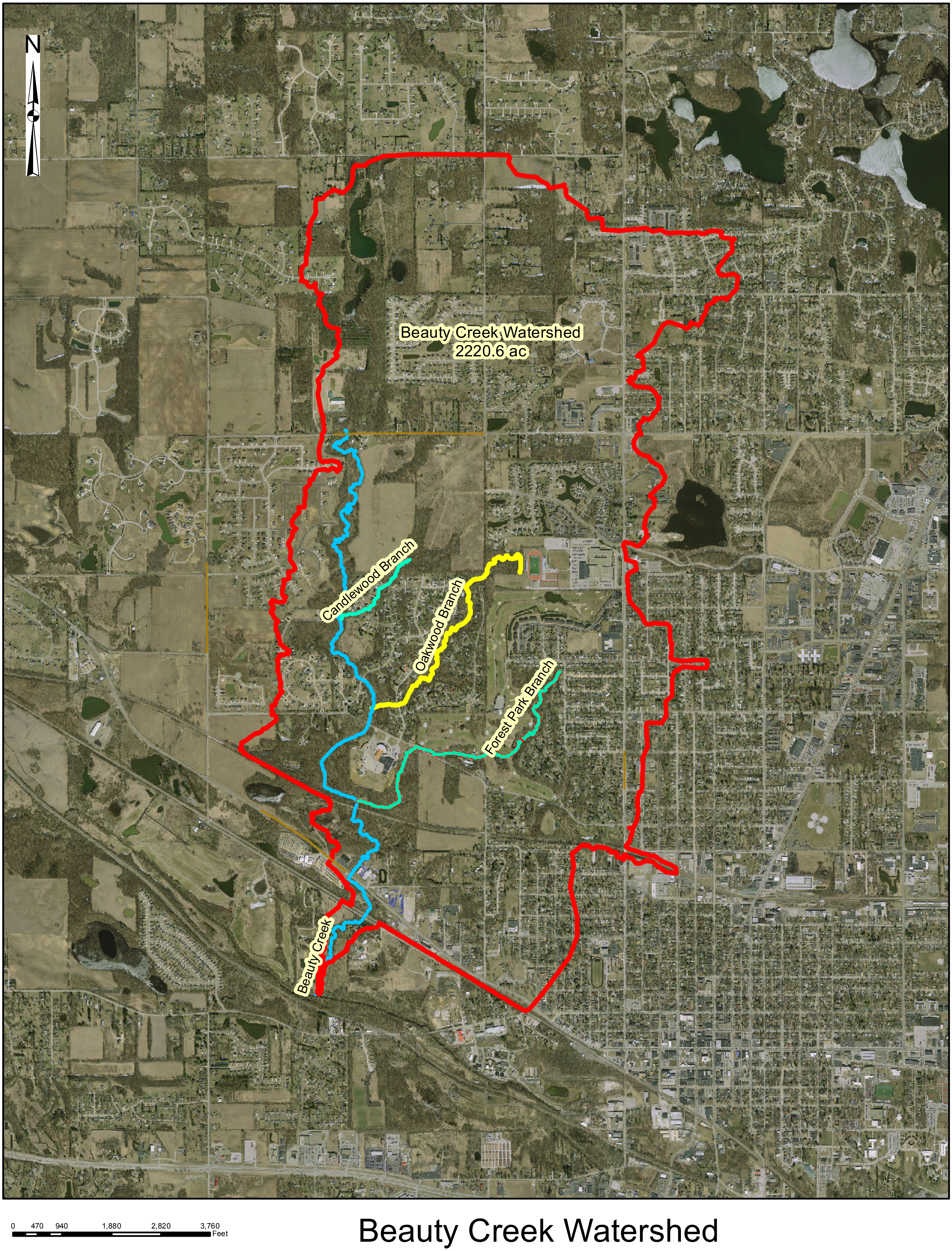
Gutters and storm sewers are recommended to convey the runoff to the bottom of the hill discharge to the golf course where the ground slope is lower. The potential erosive velocities make unpaved side ditches undesirable and paved side ditches would be subject to heave from freeze-thaw action.

9.3 RECOMMENDED PRIORITIES

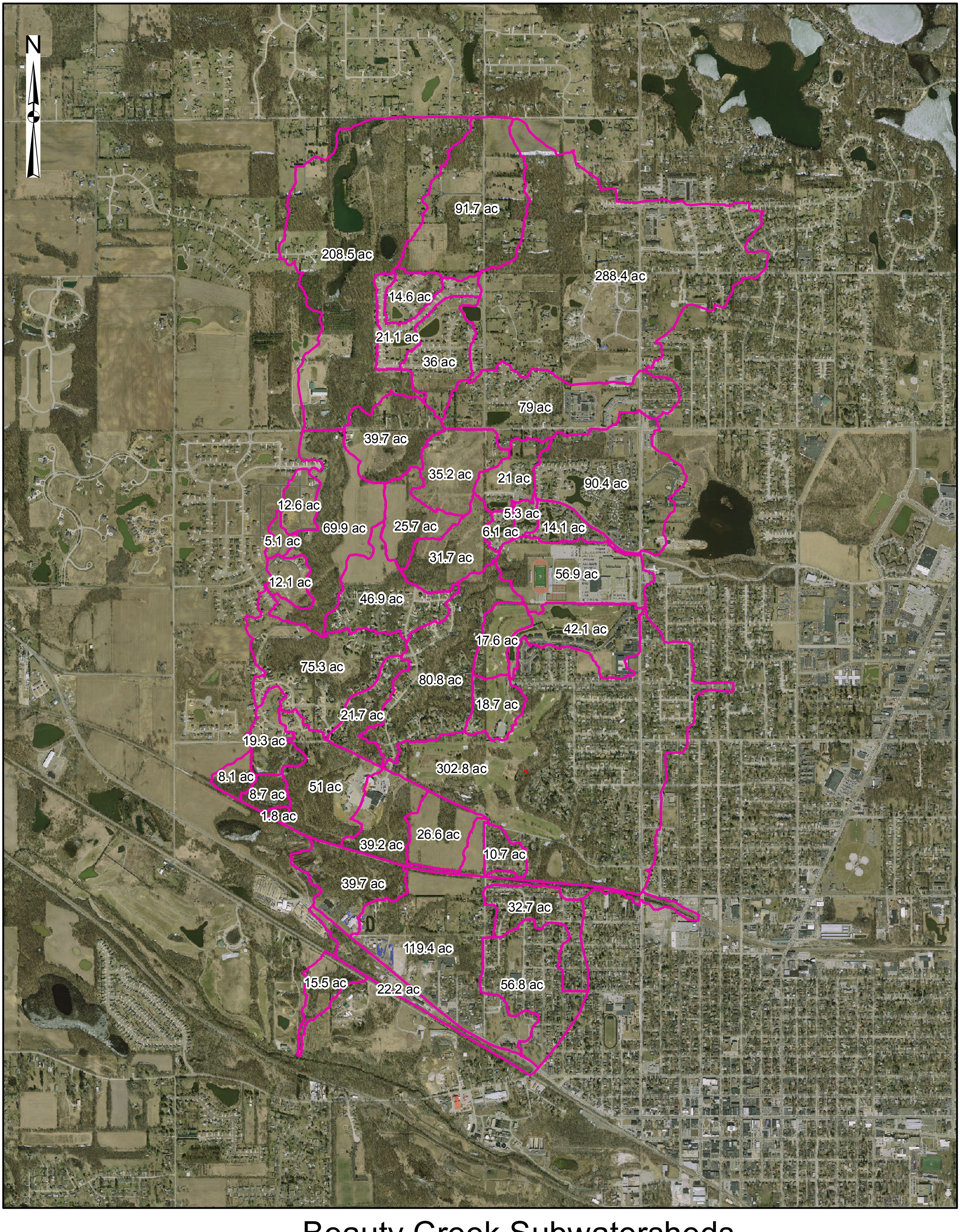
The recommended priorities are:

1. Modification of Valparaiso High School Detention and installation of grade stabilization downstream;
2. Construction of detention in the Upper Candlewood sub-watershed north of Hampstead Court and installation of grade stabilization downstream;
3. Construct new detention for the Forest Park Golf Course discharge points to Oakwood Estates and installation of grade stabilization downstream.
4. Construction of detention in the Forest Park watershed, beginning with Pond 2, proceeding next with pond 3 and then Pond 4. Pond 1 could be considered last since it has minimal volume.

APPENDIX A - **Overall Watershed and Subwatershed Aerial Maps**

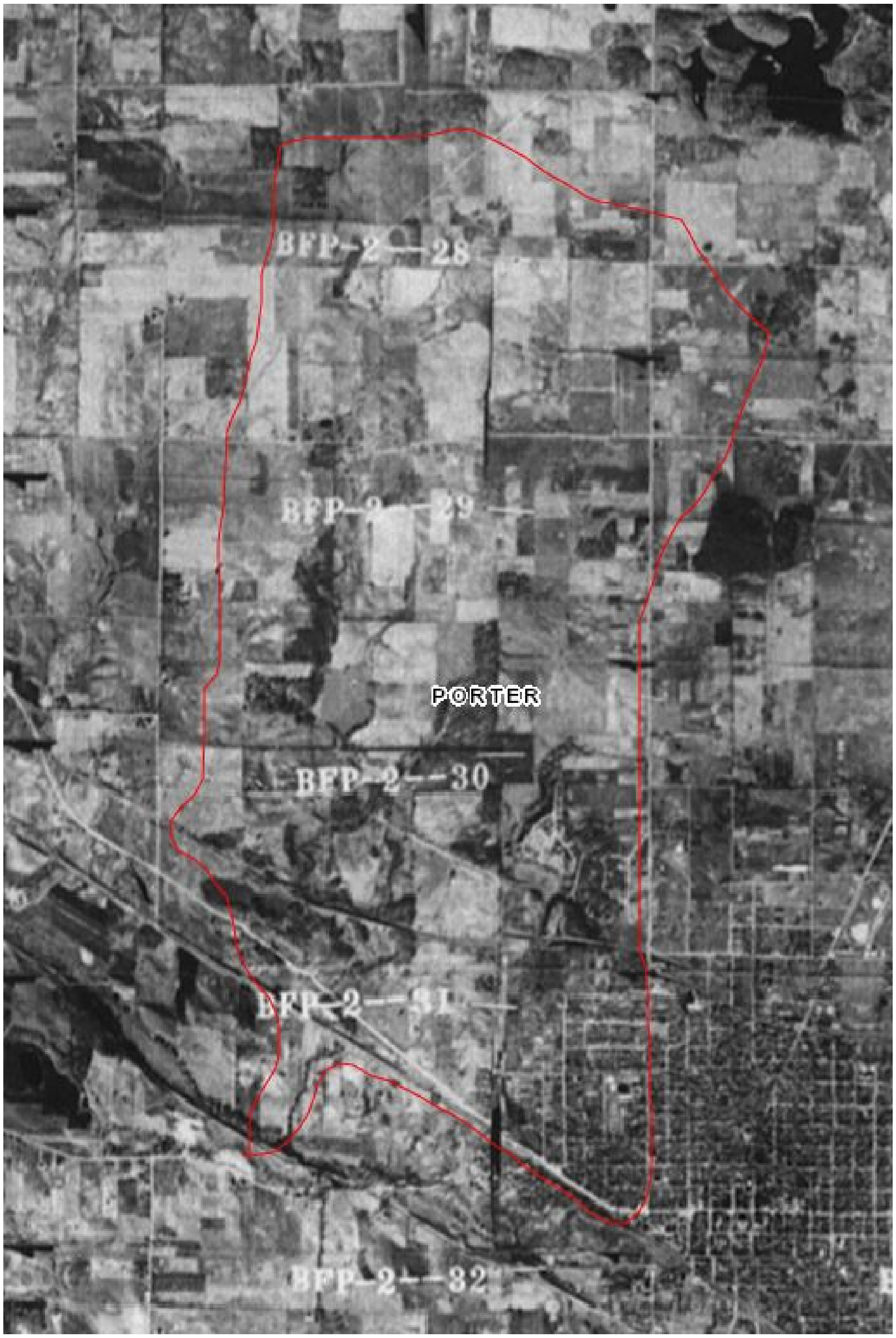


Beauty Creek Watershed

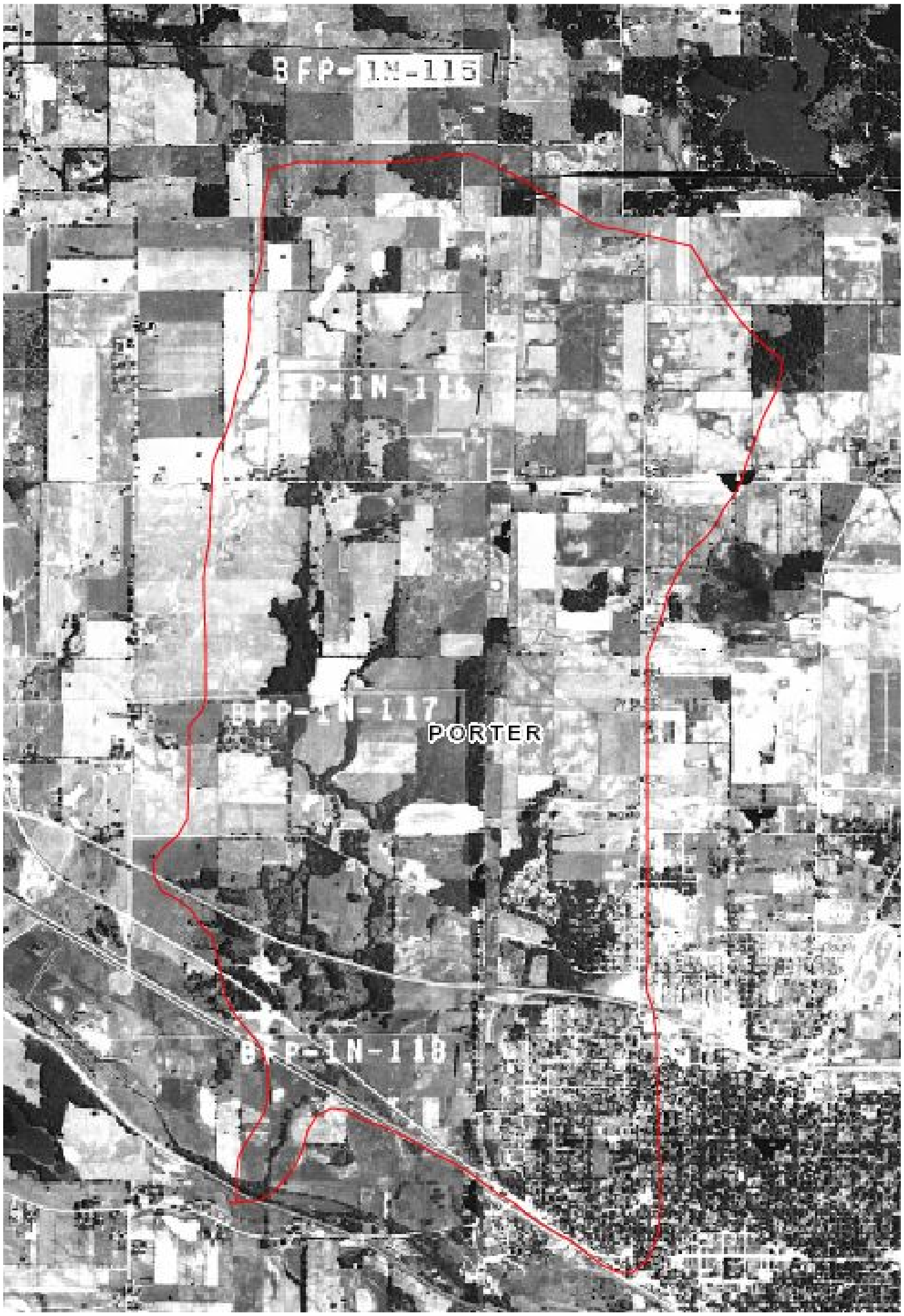


Beauty Creek Subwatersheds

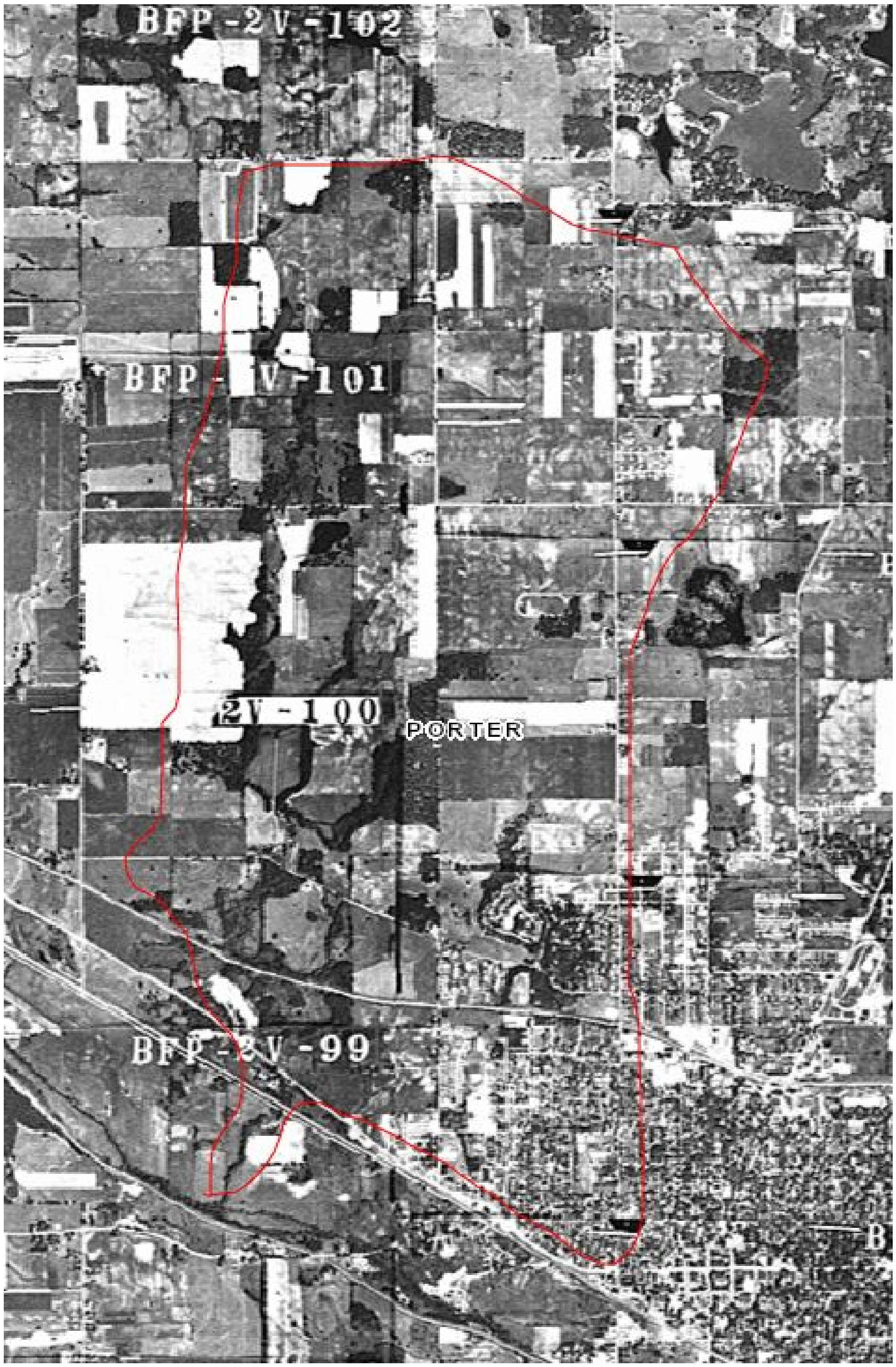
APPENDIX B - **Historical Aerial Photography**



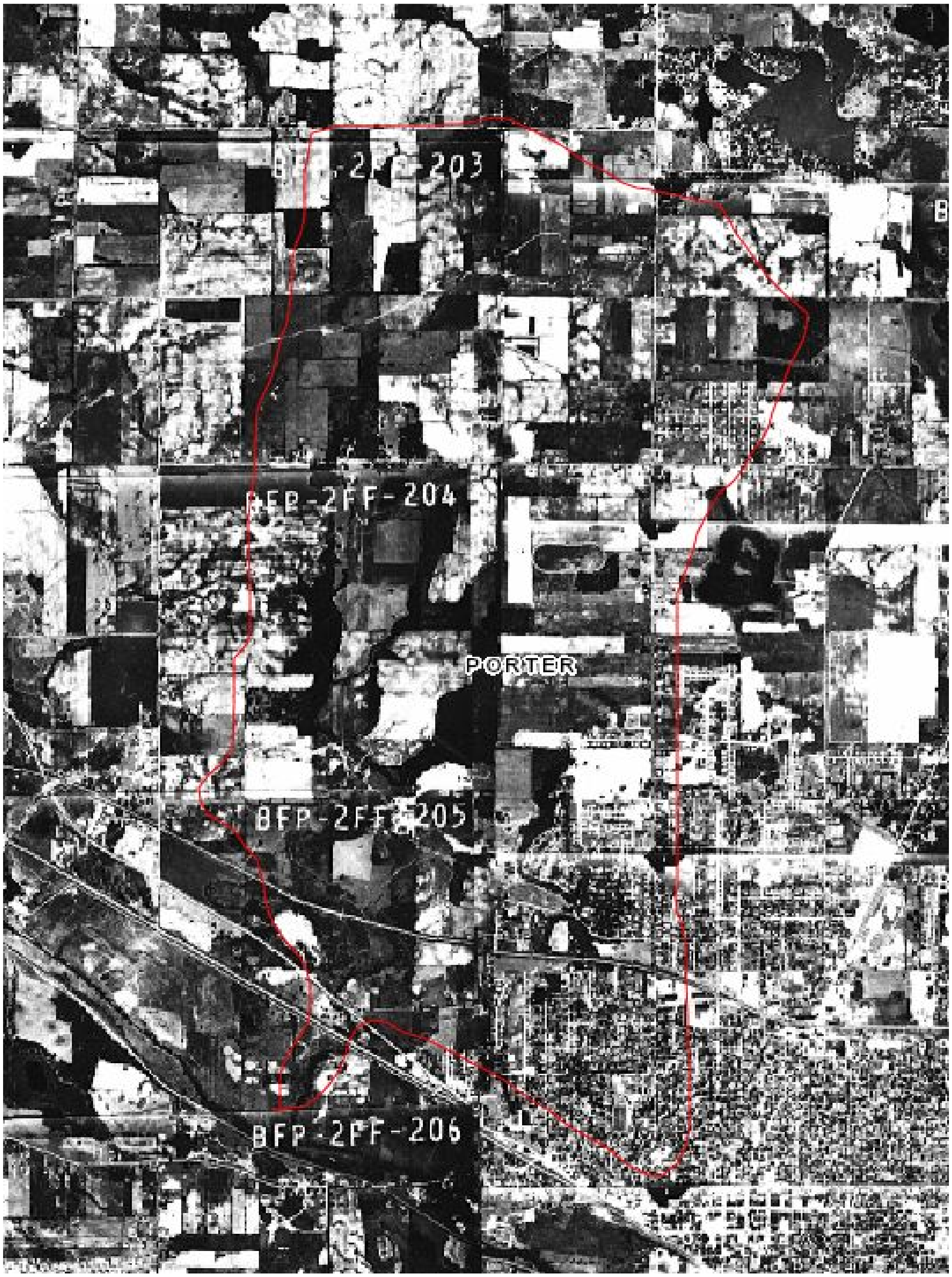
Beauty Creek 1939



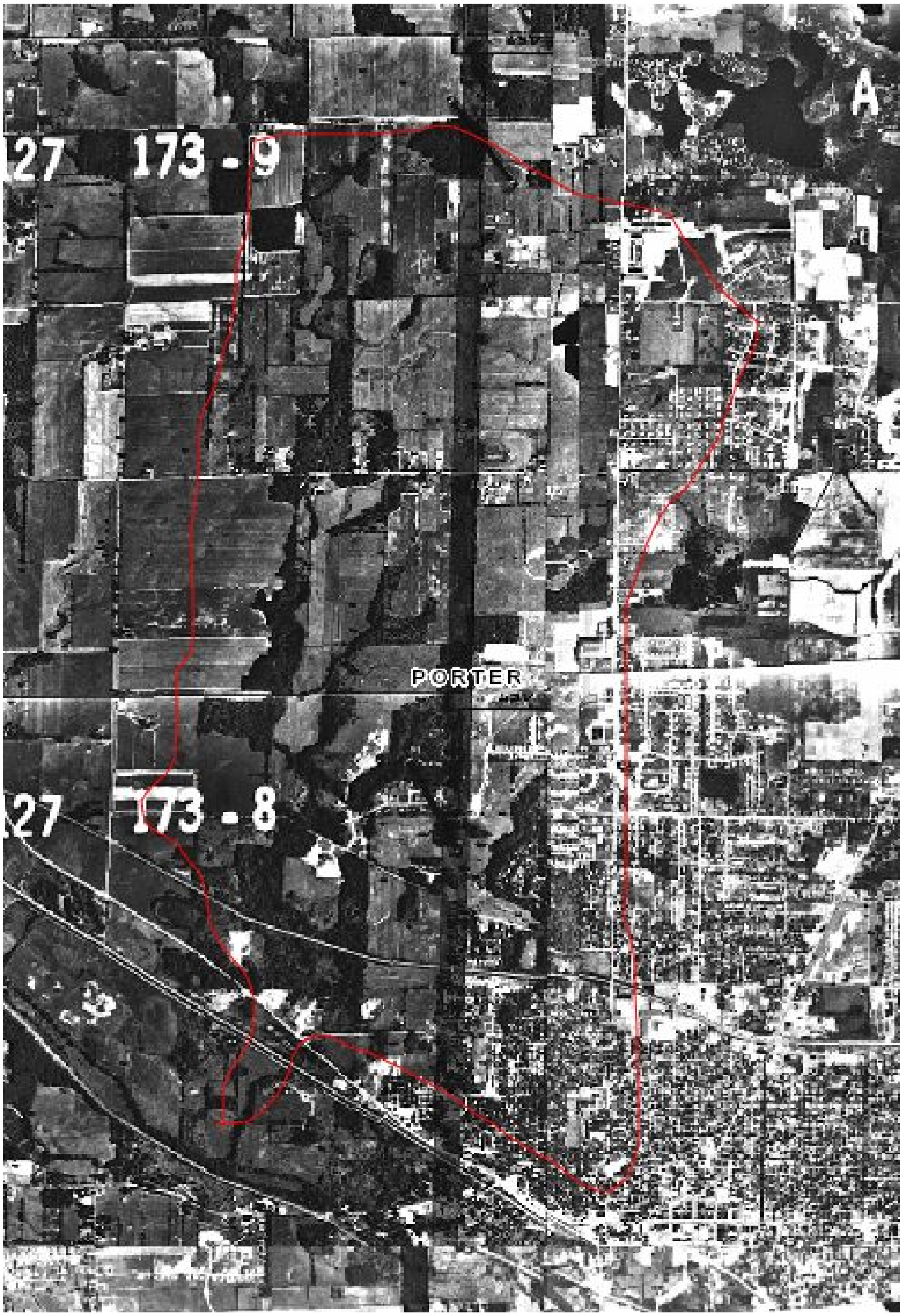
Beauty Creek 1954



Beauty Creek 1958



Beauty Creek 1965



Beauty Creek 1973

APPENDIX C - **Field Reconnaissance Photographs**

BC2 -Eroded Bank

BC4-Log Jam

BC10-Clay Bank

BC13-Log Jam

BC31-Log Jam

BC32-Peat Along Bank

BC49-Failed Man-Made Dam

BC54-West Bank-Stone Wall Sliding

BC56-Man Made Vane

BC58-Netting on Banks

BC63-Dug Out-Water Deep

BC65-North of Shot BC63

BC121-Reno Mattress on West Bank

BC123-Reno Mattress on East Bank

BC125-Reno Mattress Detail

BC131 - William Drive Culvert Erosion

BC139-Tree Blockage And Erosion

BC143-Dry Stream-Flat Area

BC158-Tree Blockage

BC163-Limbs Dumped on Bank

BC165-Tree Blockage And Erosion

BC166-Tree Blockage And Erosion

BC171-Coming into Open Flat Area

BC172-Flat Area-Dry Stream Bed

BC173- South At Bend

BC174-Looking South At Bend

BC175-Looking North

BC176-Looking North-Tree Blockage

BC177-Looking North-Tree Blockage

BC178-Looking North-Tree Blockage

BC179-Looking North-Tree Blockage

BC189-Erosion

BC200-Looking South

BC202-Looking North at Scour Hole

BC223-Wire Fence Roll

BC228-Tree Blockage with Scour Hole

BC229-Tree Blockage with Scour Hole

BC234-Looking NW-Good Area

BC236-Looking South-Tree Blockage At Curve

BC245-Looking North-Culvert Pipe

CW74-Hampstead Ct-Erosion-Steep Banks

CW77-Steep Banks Near Western Home

CW78-Undermined Tree - Steep, Eroded Banks

CW79-Grass Clippings

CW83-Down stream-Dry Stream

CW86-Erosion At Bend

CW90-Home Owner Pipe Drain-West Bank

CW91-Sprinkler Pipes And Head

CW104-Looking NE-Good Area

CW108-Looking SW

OW305-Gabion Near School-Down Stream

OW306-Looking North-Baseball Outfall

OW314-Culvert Entrance on the NE Side-Blocked

OW315A-Blocked NE Side of Culvert

OW317- SW Side of Culvert

OW321- Trash and Debris Dumped

OW322-Blockage with Some Armouring

OW324-Erosion-Armouring End

OW325-Stoney-Erosion-Little Standing Water

OW326-Erosion-Tree Undermined

OW328-Erosion-Tree Blockage

OW333-Bank Erosion-Trees Undermined

OW334-Large Stone -Erosion on Sides

OW336-Large Stone and Fabric

OW342-Bank-Erosion-Trees Undermined

OW344-Downed Trees -Green Leaves

OW345- Downed Trees Near OW344

OW348-Bank Erosion

OW349-Water Cutting into Sandy Bank

OW390- West Side of Old Oak Dr

OW391-West Side of Old Oak Dr-Bank Erosion

FP400-Two Outlets-36 Inch and 21 Inch

FP401-Other Culvert Pipe at FP400-Erosion

FP402-Drainage Pipe -Stones

FP403-Same Pipe as in FP402

FP406-Tree Debris

FP407-Erosion-Tree Undermined

FP424-Erosion-Tree Blockage

FP425-Tree Blockage-Same Location as FP424

FP426-Bank Eroding-Sandy

FP432-East Bank Erosion From Rear Yard Pipe

FP433-Erosion From Rear Yard Pipe-Same FP432

FP434-Sandy-Erosion-Wide Stream Bed

FP444-East Bank-Pipes

FP445-East Bank-Pipes Farther Up Hill

FP447-Old and New Channels

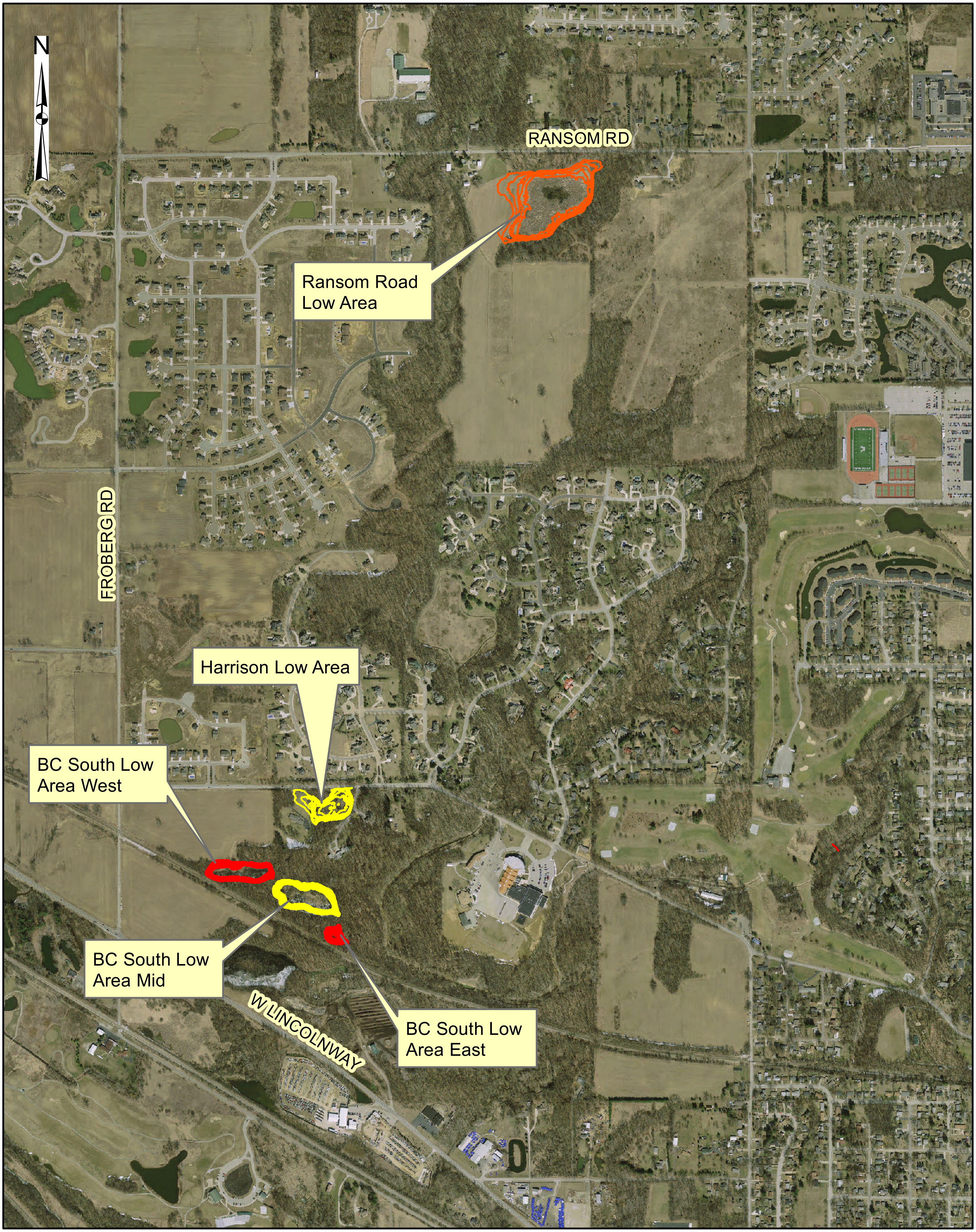
FP453-Erosion-Sandy-15' Wide

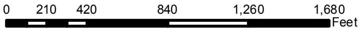
FP471-Sandy-Erosion-Note Slope

FP474-Looking West-Sandy Erosion

FP476-Looking NW-Sandy

APPENDIX D - **Depressional Areas Aerial Map**





Depressional Areas

APPENDIX E - **XPSWMM Model Inputs**

Link Summary

Name	Storm	Roughness	Max Flow	Design Full Fl	Diameter (Hei	Conduit Slope
RanCulv	100yr 1hr Hu	0.024	370.390	235.45	7.000	0.463
RanLowOut	100yr 1hr Hu	0.100	0.000	8.20	2.000	0.000
BCLink10	100yr 1hr Hu	0.013	554.373	9179.08	8.000	-10.900
BCLink13	100yr 1hr Hu	0.013	708.012	2618.00	8.000	0.980
BCLink8	100yr 1hr Hu	0.100	613.052	3288.68	8.000	0.700
BCLink6	100yr 1hr Hu	0.100	485.333	9448.66	8.000	0.530
Link492	100yr 1hr Hu	0.001	131.827	182417.63	4.000	5.000
CndlwdOut2	100yr 1hr Hu	0.013	-232.512	13915.52	4.000	3.910
CndlWdOut1	100yr 1hr Hu	0.013	123.524	18540.53	4.000	6.940
BCLwW_M	100yr 1hr Hu	0.100	0.000	2.61	2.000	0.000
BCLwM_E	100yr 1hr Hu	0.100	0.000	2.61	2.000	0.000
BCLwE_Out	100yr 1hr Hu	0.100	0.000	238.63	2.000	8.370
HarrCulvW	100yr 1hr Hu	0.024	612.839	61.09	10.000	0.000
CndlwdLnk3	100yr 1hr Hu	0.034	64.704	1497.09	2.000	1.067
RR1Culv	100yr 1hr Hu	0.024	706.278	1856.96	14.000	0.710
BCLink14	100yr 1hr Hu	0.100	721.671	8051.05	8.000	4.300
BClink12	100yr 1hr Hu	0.100	557.068	941.43	8.000	0.520
BCLink11	100yr 1hr Hu	0.100	558.979	3279.72	8.000	0.410
BCRRCulv	100yr 1hr Hu	0.024	545.021	428.39	8.000	0.750
BCLink9	100yr 1hr Hu	0.100	713.424	5975.87	8.000	1.580
OWdLink1	100yr 1hr Hu	0.100	201.841	2889.18	8.000	2.770
BCLink1	100yr 1hr Hu	0.100	432.218	1192.72	8.000	-0.490
CandlWd5	100yr 1hr Hu	0.100	147.893	842.70	6.000	0.970
BCLink7	100yr 1hr Hu	0.100	333.595	241.26	5.250	0.480
FPLink4	100yr 1hr Hu	0.100	1021.915	1655.55	7.000	1.280
OWLink4	100yr 1hr Hu	0.100	483.759	2142.77	8.000	0.820
OWLink3	100yr 1hr Hu	0.100	451.191	4617.94	8.000	1.180
GVNLink1	100yr 1hr Hu	0.050	102.250	4525.40	8.000	4.230
GVSLink1	100yr 1hr Hu	0.050	39.414	6358.52	8.000	3.320
CandlWd4	100yr 1hr Hu	0.100	147.877	2629.26	8.000	1.060
CndlwdLnk2	100yr 1hr Hu	0.034	0.000	2468.31	3.000	0.714
Link508	100yr 1hr Hu	0.013	41.549	50.56	3.000	0.575
BCLink2	100yr 1hr Hu	0.100	421.179	4685.89	8.000	0.360
BCLink3	100yr 1hr Hu	0.100	405.350	2758.44	8.000	0.600
BCLink4	100yr 1hr Hu	0.100	405.369	1691.82	8.000	0.480
BCLink5	100yr 1hr Hu	0.100	405.341	3798.92	8.000	0.430
Link431	100yr 1hr Hu	0.034	193.807	1494.40	4.000	1.790
FPLink2	100yr 1hr Hu	0.100	997.591	2129.34	8.000	1.560
HarrPp2	100yr 1hr Hu	0.024	274.642	236.92	6.000	1.070
HarrPp1	100yr 1hr Hu	0.024	274.926	210.69	4.771	1.070
FP4000U	100yr 1hr Hu	0.100	965.216	2342.63	8.000	1.520
OWLink2	100yr 1hr Hu	0.100	215.659	1973.86	8.000	1.740
GVOutN	100yr 1hr Hu	0.013	15.730	14.48	2.000	0.410
HarLowOut	100yr 1hr Hu	0.024	20.674	520.22	2.000	4.350
BCLink14.1	100yr 1hr Hu	0.100	713.179	2438.03	8.000	1.240
BCLink14.2	100yr 1hr Hu	0.100	713.420	903.48	8.000	0.240
BCLink14.3	100yr 1hr Hu	0.100	718.955	1465.18	8.000	0.500
BCLink14.4	100yr 1hr Hu	0.024	721.293	65.48	8.000	0.000
BClink12.1	100yr 1hr Hu	0.100	560.992	5894.18	12.000	0.500
BCLink13.1	100yr 1hr Hu	0.100	706.448	2388.64	8.000	-0.570
BCLink11.1	100yr 1hr Hu	0.100	557.756	4449.07	8.000	1.690
BCLink11.3	100yr 1hr Hu	0.100	557.084	1663.07	8.000	0.380
BCLink11.2	100yr 1hr Hu	0.100	557.841	2870.18	8.000	0.310

Link Summary

Name	Storm	Shape
RanCulv	100yr 1hr Hu	Circular
RanLowOut	100yr 1hr Hu	Trapezoidal
BCLink10	100yr 1hr Hu	Natural
BCLink13	100yr 1hr Hu	Natural
BCLink8	100yr 1hr Hu	Natural
BCLink6	100yr 1hr Hu	Natural
Link492	100yr 1hr Hu	Trapezoidal
CndlwdOut2	100yr 1hr Hu	Trapezoidal
CndlWdOut1	100yr 1hr Hu	Trapezoidal
BCLwW_M	100yr 1hr Hu	Trapezoidal
BCLwM_E	100yr 1hr Hu	Trapezoidal
BCLwE_Out	100yr 1hr Hu	Trapezoidal
HarrCulvW	100yr 1hr Hu	Rectangular
CndlwdLnk3	100yr 1hr Hu	Trapezoidal
RR1Culv	100yr 1hr Hu	Circular
BCLink14	100yr 1hr Hu	Natural
BClink12	100yr 1hr Hu	Natural
BCLink11	100yr 1hr Hu	Natural
BCRRCulv	100yr 1hr Hu	Circular
BCLink9	100yr 1hr Hu	Natural
OWdLink1	100yr 1hr Hu	Natural
BCLink1	100yr 1hr Hu	Natural
CandlWd5	100yr 1hr Hu	Natural
BCLink7	100yr 1hr Hu	Natural
FPLink4	100yr 1hr Hu	Natural
OWLink4	100yr 1hr Hu	Natural
OWLink3	100yr 1hr Hu	Natural
GVNLink1	100yr 1hr Hu	Trapezoidal
GVSLink1	100yr 1hr Hu	Trapezoidal
CandlWd4	100yr 1hr Hu	Natural
CndlwdLnk2	100yr 1hr Hu	Trapezoidal
Link508	100yr 1hr Hu	Circular
BCLink2	100yr 1hr Hu	Natural
BCLink3	100yr 1hr Hu	Natural
BCLink4	100yr 1hr Hu	Natural
BCLink5	100yr 1hr Hu	Natural
Link431	100yr 1hr Hu	Trapezoidal
FPLink2	100yr 1hr Hu	Natural
HarrPp2	100yr 1hr Hu	Circular
HarrPp1	100yr 1hr Hu	Special
FP4000U	100yr 1hr Hu	Natural
OWLink2	100yr 1hr Hu	Natural
GVOutN	100yr 1hr Hu	Circular
HarLowOut	100yr 1hr Hu	Trapezoidal
BCLink14.1	100yr 1hr Hu	Natural
BCLink14.2	100yr 1hr Hu	Natural
BCLink14.3	100yr 1hr Hu	Natural
BCLink14.4	100yr 1hr Hu	Natural
BClink12.1	100yr 1hr Hu	Natural
BCLink13.1	100yr 1hr Hu	Natural
BCLink11.1	100yr 1hr Hu	Natural
BCLink11.3	100yr 1hr Hu	Natural
BCLink11.2	100yr 1hr Hu	Natural

Link Summary

Name	Storm	Roughness	Max Flow	Design Full Fl	Diameter (Hei	Conduit Slope
BCLink9.1	100yr 1hr Hu	0.100	-664.371	2824.70	8.000	0.790
BCLink9.2	100yr 1hr Hu	0.100	704.848	1220.04	9.430	0.540
BCLink9.3	100yr 1hr Hu	0.100	711.122	1581.81	8.000	0.700
BCLink1.1	100yr 1hr Hu	0.100	430.142	2252.72	8.000	0.600
CandlWd5.1	100yr 1hr Hu	0.100	140.982	2666.17	6.210	1.190
CandlWd5.2	100yr 1hr Hu	0.100	145.979	5576.79	8.000	1.070
CandlWd4.1	100yr 1hr Hu	0.100	147.715	1108.70	8.000	0.680
OWLink4.1	100yr 1hr Hu	0.100	468.775	6769.95	8.000	1.320
OWLink4.2	100yr 1hr Hu	0.100	472.202	2067.51	8.000	0.920
OWLink4.4	100yr 1hr Hu	0.100	472.635	2145.17	8.000	0.700
FPLink4.1	100yr 1hr Hu	0.100	1006.758	1750.52	8.000	0.920
FPLink1.1	100yr 1hr Hu	0.100	915.061	2316.12	8.000	0.570
FPLink1.2	100yr 1hr Hu	0.100	925.520	1455.41	7.370	0.960
FPLink1.3	100yr 1hr Hu	0.100	946.336	4171.59	8.000	1.250
FP4000D	100yr 1hr Hu	0.100	949.114	2279.35	8.000	1.220
GVW_GVM	100yr 1hr Hu	0.013	7.117	5.11	1.250	0.630
Link484	100yr 1hr Hu	0.034	16.370	7481.24	4.000	2.390
ChautOut	100yr 1hr Hu	0.013	34.768	61.48	3.000	0.850
Link486	100yr 1hr Hu	0.001	80.476	58386.85	5.000	0.400
Link487	100yr 1hr Hu	0.001	176.589	193038.10	5.000	0.650
Link488	100yr 1hr Hu	0.001	80.419	67833.17	4.000	1.300
Link489	100yr 1hr Hu	0.001	96.350	48495.31	4.000	0.670
Link491	100yr 1hr Hu	0.013	80.419	84.71	3.000	1.610
Link490	100yr 1hr Hu	0.024	96.124	96.59	3.417	1.560
GVM_GVE	100yr 1hr Hu	0.014	-23.091	1.96	3.000	0.000
Link501	100yr 1hr Hu	0.013	15.724	15.16	2.000	0.450
Link502	100yr 1hr Hu	0.013	15.722	50.80	3.000	0.580
Link503	100yr 1hr Hu	0.013	15.721	98.50	3.000	2.180
Link507	100yr 1hr Hu	0.014	34.082	41.13	2.000	3.830
Link506	100yr 1hr Hu	0.014	34.082	20.77	2.000	0.980
Link505	100yr 1hr Hu	0.014	34.082	20.28	2.000	0.930
Link504	100yr 1hr Hu	0.014	34.082	21.60	2.000	1.060
Link509	100yr 1hr Hu	0.075	96.125	6576.99	6.000	2.213

Link Summary

Name	Storm	Shape
BCLink9.1	100yr 1hr Hu	Natural
BCLink9.2	100yr 1hr Hu	Natural
BCLink9.3	100yr 1hr Hu	Natural
BCLink1.1	100yr 1hr Hu	Natural
CandlWd5.1	100yr 1hr Hu	Natural
CandlWd5.2	100yr 1hr Hu	Natural
CandlWd4.1	100yr 1hr Hu	Natural
OWLink4.1	100yr 1hr Hu	Natural
OWLink4.2	100yr 1hr Hu	Natural
OWLink4.4	100yr 1hr Hu	Natural
FPLink4.1	100yr 1hr Hu	Natural
FPLink1.1	100yr 1hr Hu	Natural
FPLink1.2	100yr 1hr Hu	Natural
FPLink1.3	100yr 1hr Hu	Natural
FP4000D	100yr 1hr Hu	Natural
GVW_GVM	100yr 1hr Hu	Circular
Link484	100yr 1hr Hu	Trapezoidal
ChautOut	100yr 1hr Hu	Circular
Link486	100yr 1hr Hu	Trapezoidal
Link487	100yr 1hr Hu	Trapezoidal
Link488	100yr 1hr Hu	Trapezoidal
Link489	100yr 1hr Hu	Trapezoidal
Link491	100yr 1hr Hu	Circular
Link490	100yr 1hr Hu	Special
GVM_GVE	100yr 1hr Hu	Circular
Link501	100yr 1hr Hu	Circular
Link502	100yr 1hr Hu	Circular
Link503	100yr 1hr Hu	Circular
Link507	100yr 1hr Hu	Circular
Link506	100yr 1hr Hu	Circular
Link505	100yr 1hr Hu	Circular
Link504	100yr 1hr Hu	Circular
Link509	100yr 1hr Hu	Trapezoidal

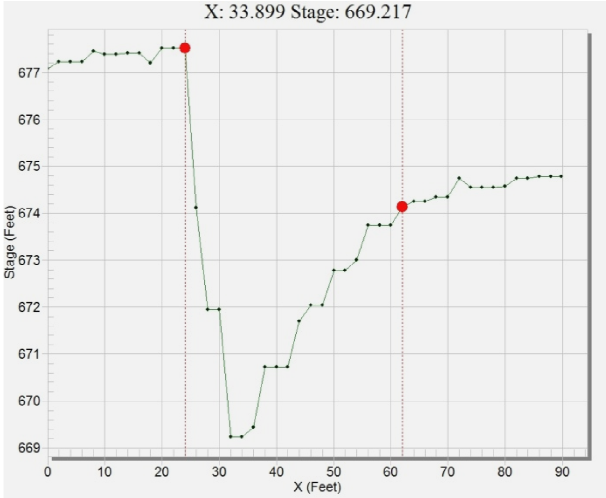
BC Watersheds

Name	Storm	Subcatchm	Area	Time of Conce	Pervious Area	Node Name
RanCulv	100yr 1hr Hu	1	208.500	45.000	71.400	UpBC
RanLowOut	100yr 1hr Hu	1	39.700	20.000	75.100	RanRdLow
BCLink10	100yr 1hr Hu	1	0.000	0.000	0.000	BC5625
BCLink13	100yr 1hr Hu	1	22.200	20.000	75.900	Sta2650
BCLink8	100yr 1hr Hu	1	0.000	0.000	0.000	BC_Oak Jnc
BCLink6	100yr 1hr Hu	1	0.000	0.000	0.000	BC10625
Link492	100yr 1hr Hu	1	91.700	45.000	72.100	GrnFldOSN
CndlwdOut2	100yr 1hr Hu	1	31.700	35.000	58.400	CandlWd2
CndlWdOut1	100yr 1hr Hu	1	25.700	25.000	67.000	CndleWdVal
BCLwW_M	100yr 1hr Hu	1	8.100	15.000	68.400	BClowW
BCLwM_E	100yr 1hr Hu	1	8.700	15.000	59.900	BCLowM
BCLwE_Out	100yr 1hr Hu	1	1.800	15.000	57.100	BCLowE
HarrCulvW	100yr 1hr Hu	1	0.000	0.000	0.000	HarrBC_N
CndlwdLnk3	100yr 1hr Hu	1	35.200	25.000	74.500	CndlWdVPN
RR1Culv	100yr 1hr Hu	1	0.000	0.000	0.000	RR1N
BCLink14	100yr 1hr Hu	1	15.500	20.000	71.600	BC1
BClink12	100yr 1hr Hu	1	0.000	0.000	0.000	LinWayS
BCLink11	100yr 1hr Hu	1	39.700	20.000	49.700	BCLN
BCRRCulv	100yr 1hr Hu	1	0.000	0.000	0.000	RR2N
BCLink9	100yr 1hr Hu	1	51.000	45.000	74.800	BCHarr_S
OWdLink1	100yr 1hr Hu	1	0.000	0.000	0.000	OW4600
BCLink1	100yr 1hr Hu	1	69.770	25.000	80.700	BC16125
CandlWd5	100yr 1hr Hu	1	0.000	0.000	0.000	CW1200
BCLink7	100yr 1hr Hu	1	21.700	20.000	73.200	BCWillS
FPLink4	100yr 1hr Hu	1	0.000	0.000	0.000	FP900
OWLink4	100yr 1hr Hu	1	0.000	0.000	0.000	OW1500
OWLink3	100yr 1hr Hu	1	80.800	25.000	70.000	OW3050
GVNLink1	100yr 1hr Hu	1	0.000	0.000	0.000	SherDrOut
GVSLink1	100yr 1hr Hu	1	0.000	0.000	0.000	GvSOut
CandlWd4	100yr 1hr Hu	1	46.900	15.000	72.400	CW2075
CndlwdLnk2	100yr 1hr Hu	1	79.000	25.000	76.400	CndlWdPOut
Link508	100yr 1hr Hu	1	79.000	25.000	76.400	CndlWdPOut
BCLink2	100yr 1hr Hu	1	0.000	0.000	0.000	BC14700
BCLink3	100yr 1hr Hu	1	0.000	0.000	0.000	BC14200
BCLink4	100yr 1hr Hu	1	0.000	0.000	0.000	BC12300
BCLink5	100yr 1hr Hu	1	0.000	0.000	0.000	BC11800
Link431	100yr 1hr Hu	1	0.000	0.000	0.000	LinSo
FPLink2	100yr 1hr Hu	1	39.200	25.000	77.300	FP2025
HarrPp2	100yr 1hr Hu	1	0.000	0.000	0.000	FP2085
HarrPp1	100yr 1hr Hu	1	0.000	0.000	0.000	FP2275
FP4000U	100yr 1hr Hu	1	302.100	20.000	81.100	FP6180
OWLink2	100yr 1hr Hu	1	0.000	0.000	0.000	OW4300
GVOutN	100yr 1hr Hu	1	42.100	20.000	75.000	GVNHS
HarLowOut	100yr 1hr Hu	1	19.300	25.000	61.800	HarrLow
BCLink14.1	100yr 1hr Hu	1	0.000	0.000	0.000	BC1.1
BCLink14.2	100yr 1hr Hu	1	0.000	0.000	0.000	BC1.2
BCLink14.3	100yr 1hr Hu	1	0.000	0.000	0.000	BC1.3
BCLink14.4	100yr 1hr Hu	1	0.000	0.000	0.000	BC1.4
BClink12.1	100yr 1hr Hu	1	0.000	0.000	0.000	LinWayS.1
BCLink13.1	100yr 1hr Hu	1	0.000	0.000	0.000	Sta2650.1
BCLink11.1	100yr 1hr Hu	1	0.000	0.000	0.000	BCLN.1
BCLink11.3	100yr 1hr Hu	1	0.000	0.000	0.000	BCLN.1.1
BCLink11.2	100yr 1hr Hu	1	0.000	0.000	0.000	BCLN.2

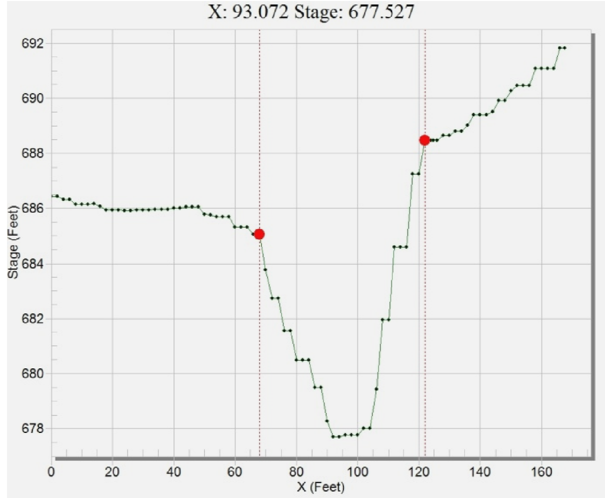
BC Watersheds

Name	Storm	Subcatchm	Area	Time of Conce	Pervious Area	Node Name
BCLink9.1	100yr 1hr Hu	1	0.000	0.000	0.000	BCHarr_S.1
BCLink9.2	100yr 1hr Hu	1	0.000	0.000	0.000	BCHarr_S.2
BCLink9.3	100yr 1hr Hu	1	0.000	0.000	0.000	BCHarr_S.3
BCLink1.1	100yr 1hr Hu	1	0.000	0.000	0.000	BC16000
CandlWd5.1	100yr 1hr Hu	1	0.000	0.000	0.000	CW100
CandlWd5.2	100yr 1hr Hu	1	0.000	0.000	0.000	CW550
CandlWd4.1	100yr 1hr Hu	1	0.000	0.000	0.000	CW1800
OWLink4.1	100yr 1hr Hu	1	0.000	0.000	0.000	OW200
OWLink4.2	100yr 1hr Hu	1	0.000	0.000	0.000	OW450
OWLink4.4	100yr 1hr Hu	1	0.000	0.000	0.000	OW575
FPLink4.1	100yr 1hr Hu	1	0.000	0.000	0.000	FP700
FPLink1.1	100yr 1hr Hu	1	0.000	0.000	0.000	FP3000
FPLink1.2	100yr 1hr Hu	1	0.000	0.000	0.000	FP3500
FPLink1.3	100yr 1hr Hu	1	0.000	0.000	0.000	FP4000
FP4000D	100yr 1hr Hu	1	0.000	0.000	0.000	FP5000
GVW_GVM	100yr 1hr Hu	1	0.000	0.000	0.000	GVWest1
Link484	100yr 1hr Hu	1	0.000	0.000	0.000	Node513
ChautOut	100yr 1hr Hu	1	0.000	0.000	0.000	Node515
Link486	100yr 1hr Hu	1	0.000	0.000	0.000	GfCN
Link487	100yr 1hr Hu	1	0.000	0.000	0.000	GfCS
Link488	100yr 1hr Hu	1	0.000	0.000	0.000	GrFOutN
Link489	100yr 1hr Hu	1	0.000	0.000	0.000	GrFWS
Link491	100yr 1hr Hu	1	0.000	0.000	0.000	GrFNOut
Link490	100yr 1hr Hu	1	0.000	0.000	0.000	GrfWOut
GVM_GVE	100yr 1hr Hu	1	0.000	0.000	0.000	GVMid
Link501	100yr 1hr Hu	1	0.000	0.000	0.000	Node528
Link502	100yr 1hr Hu	1	0.000	0.000	0.000	Node529
Link503	100yr 1hr Hu	1	0.000	0.000	0.000	Node530
Link507	100yr 1hr Hu	1	0.000	0.000	0.000	Node531
Link506	100yr 1hr Hu	1	0.000	0.000	0.000	Node532
Link505	100yr 1hr Hu	1	0.000	0.000	0.000	Node533
Link504	100yr 1hr Hu	1	0.000	0.000	0.000	Node534
Link509	100yr 1hr Hu	1	0.000	0.000	0.000	Node535

APPENDIX F - Typical Stream Cross-Sections



Beauty Creek Xsec BC100



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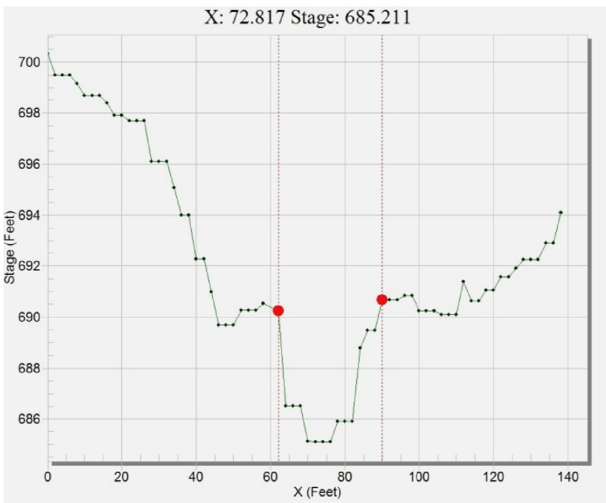

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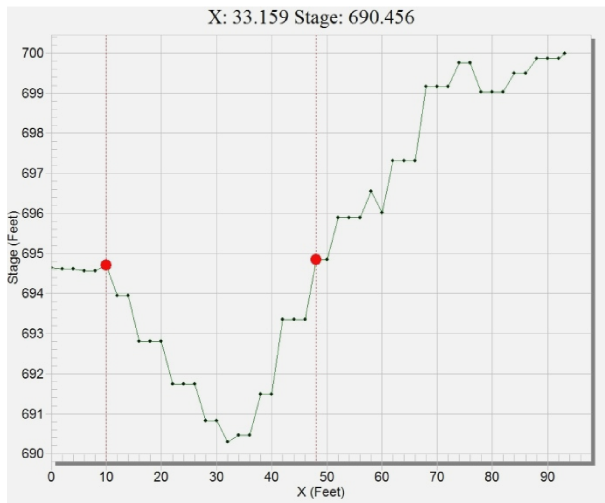

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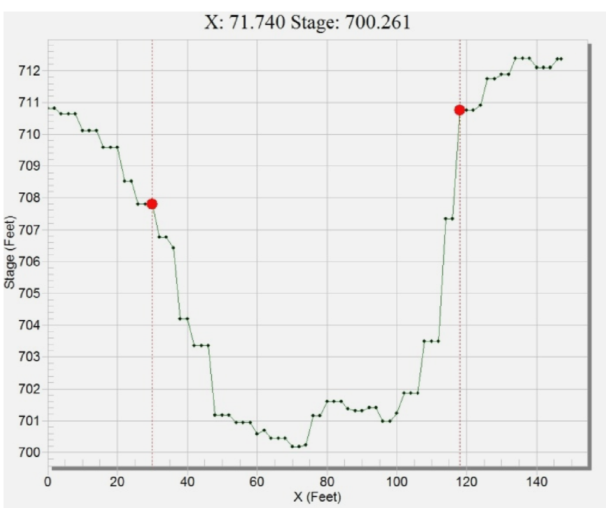

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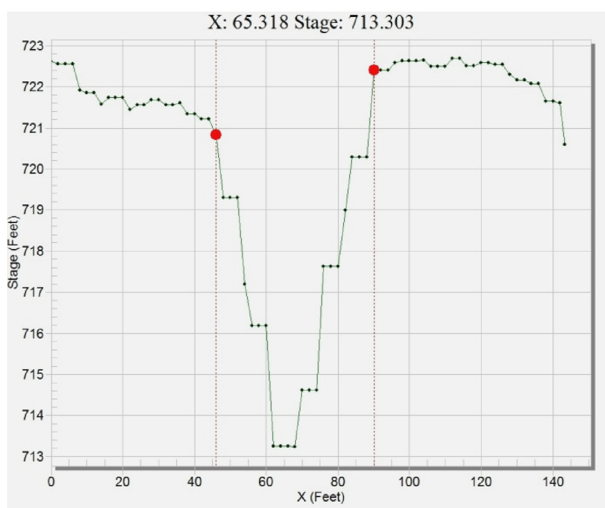

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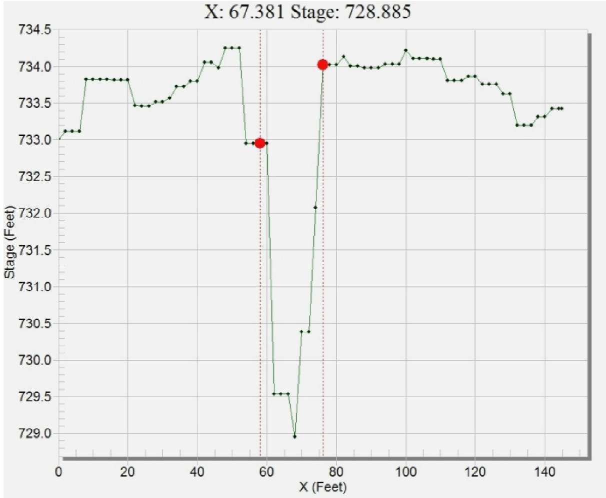
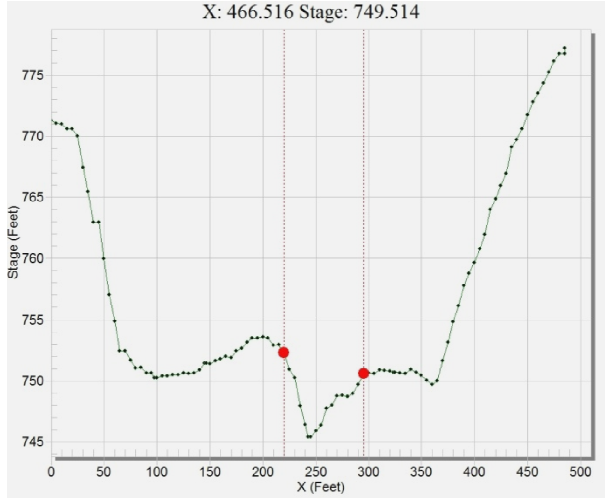


Beauty Creek Xsec BC8900



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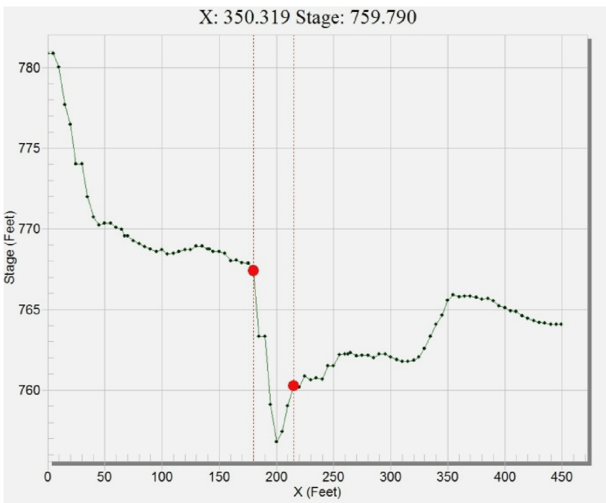
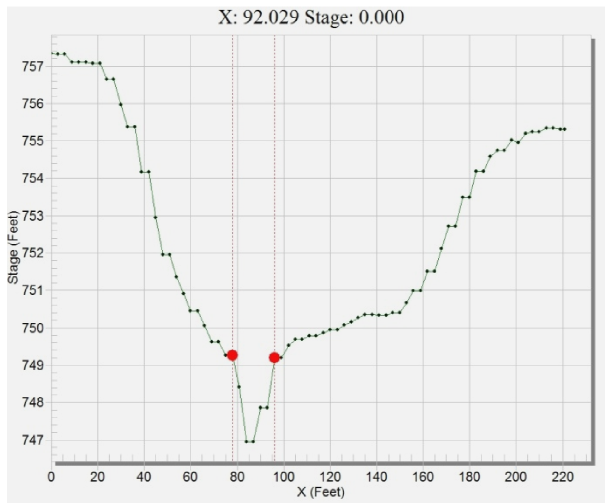
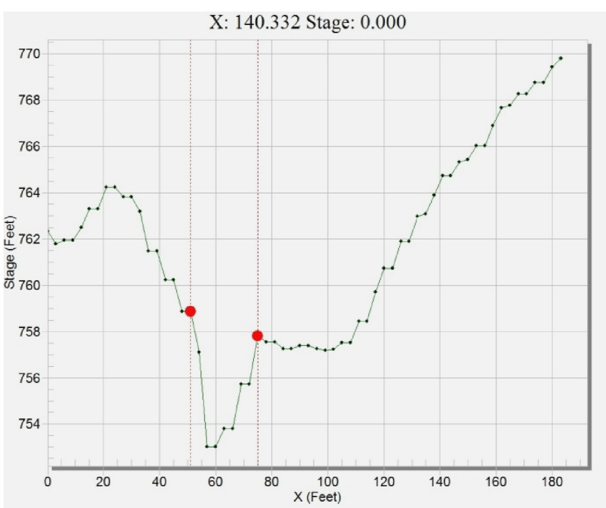


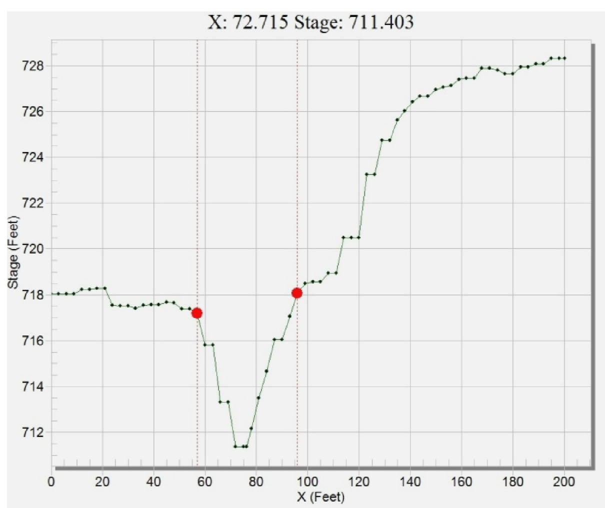
Beauty Creek Xsec BC14200



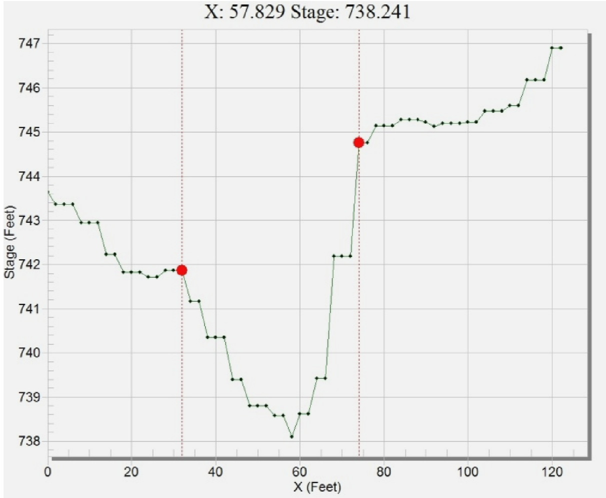
Candlewood Xsec 550



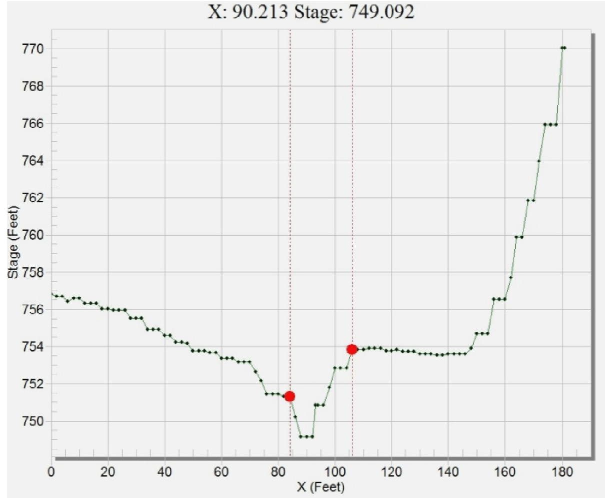
Candlewood Xsec 1200



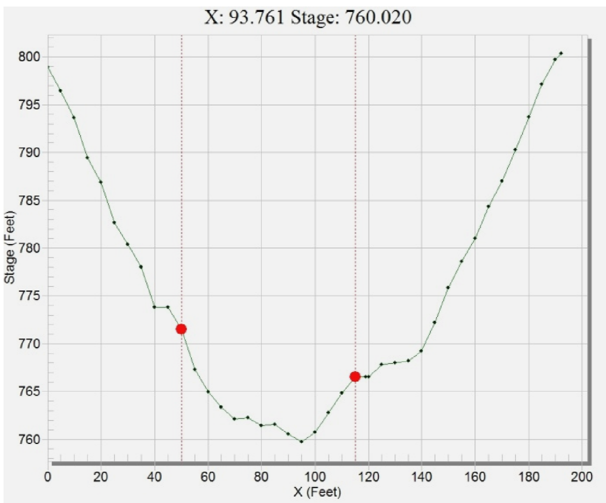
Forest Park Xsec 700



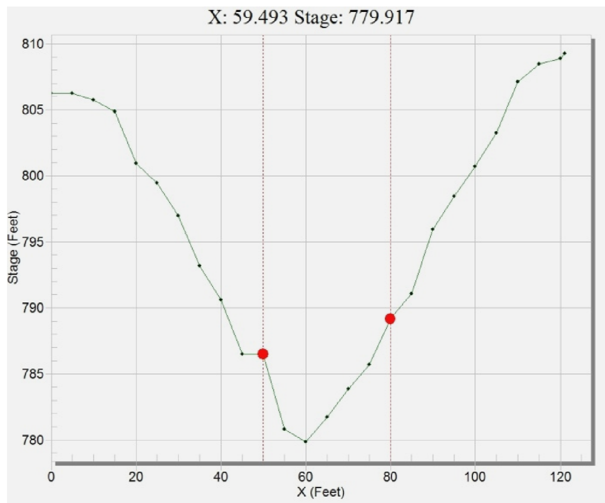
Forest Park Xsec 3000



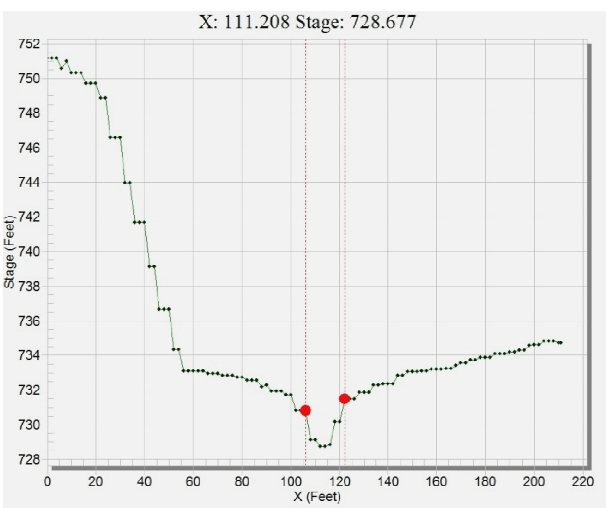
Forest Park Xsec 4000



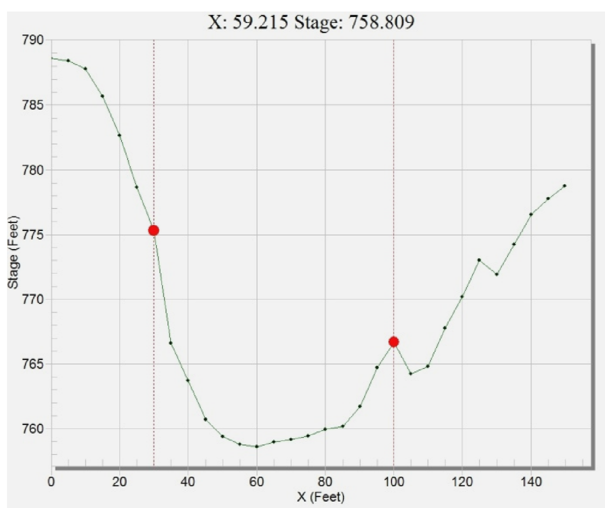
Forest Park Xsec 4915



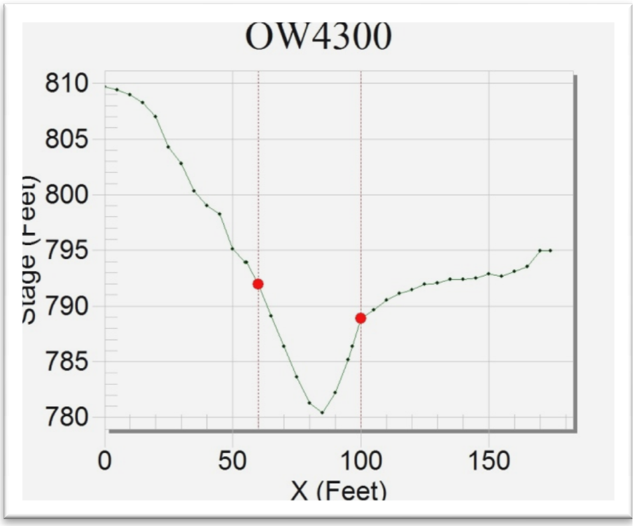
Forest Park Xsec 6065



Oakwood Xsec 200

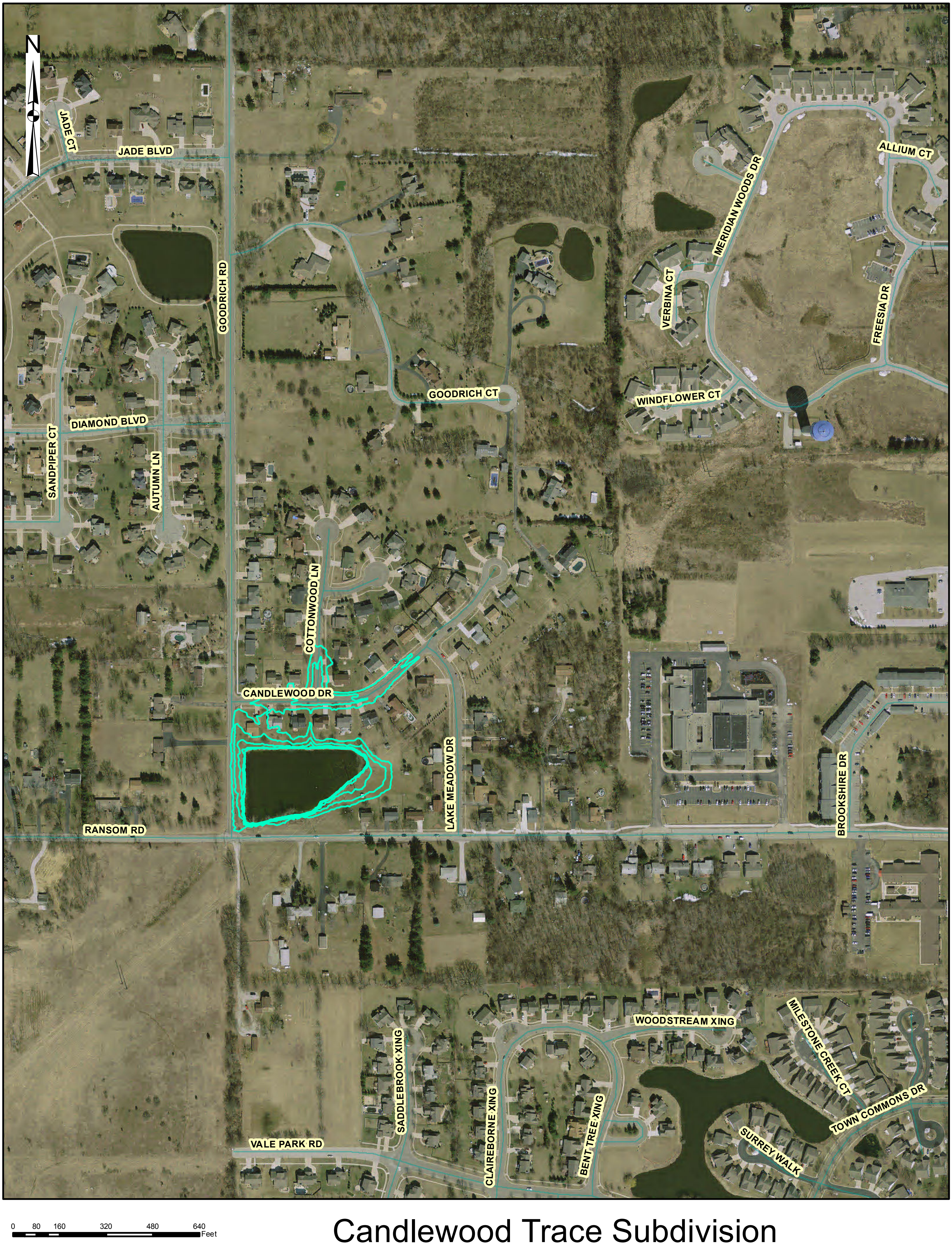


Oakwood Xsec 3050

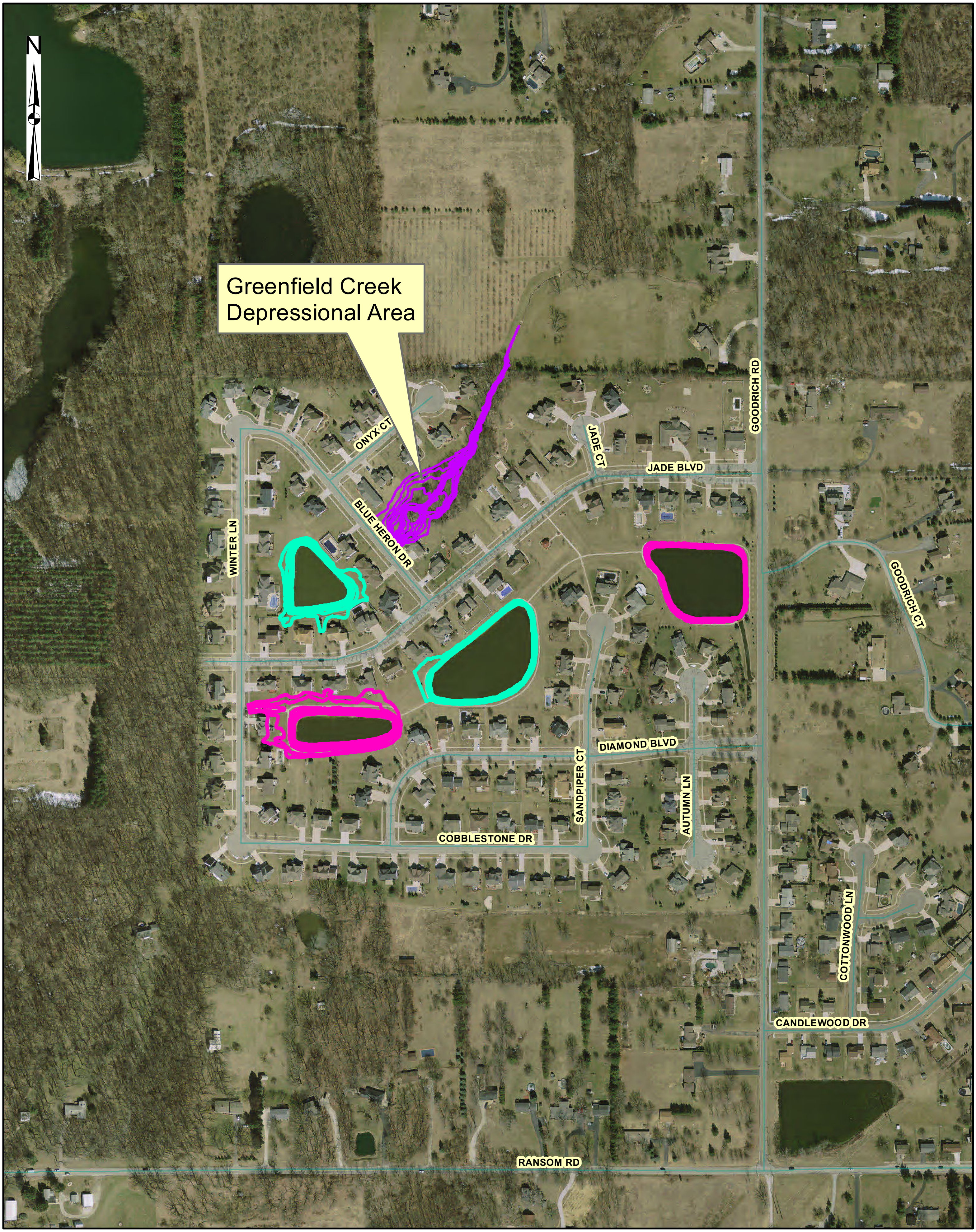


Oakwood Xsec 4300

APPENDIX G - **Subdivision Aerials**

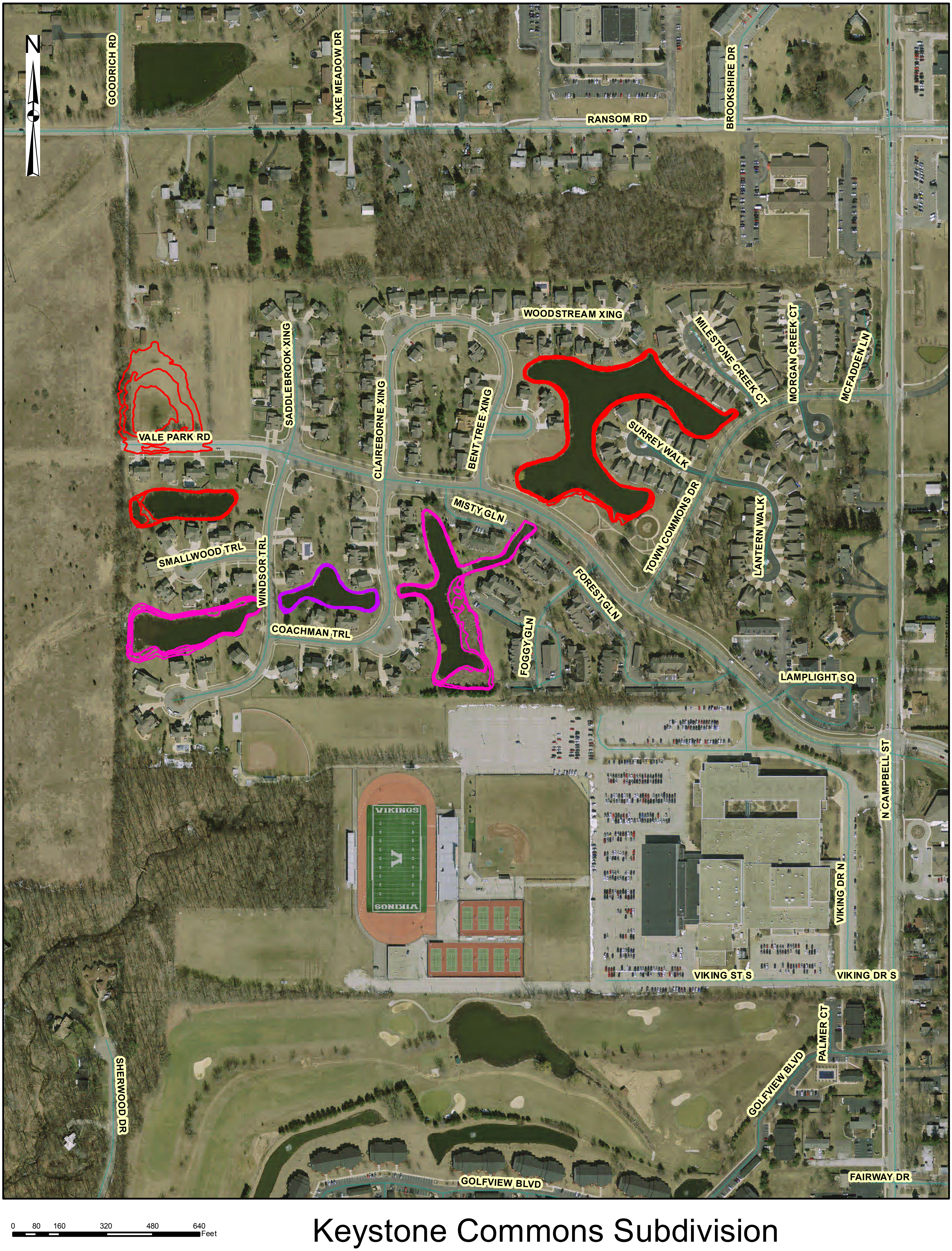


Candlewood Trace Subdivision



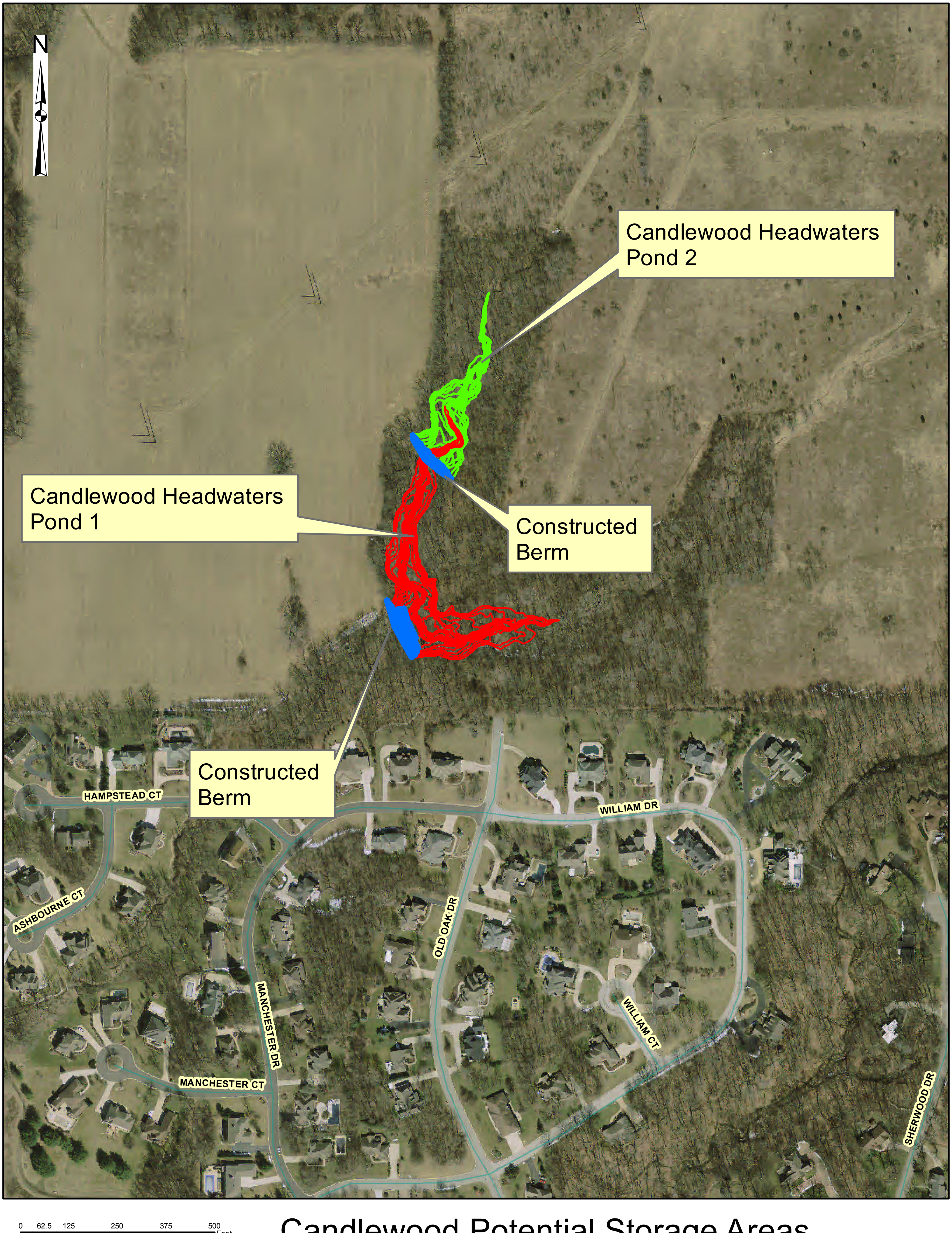
0 80 160 320 480 640 Feet

Candlewood Trace Subdivision

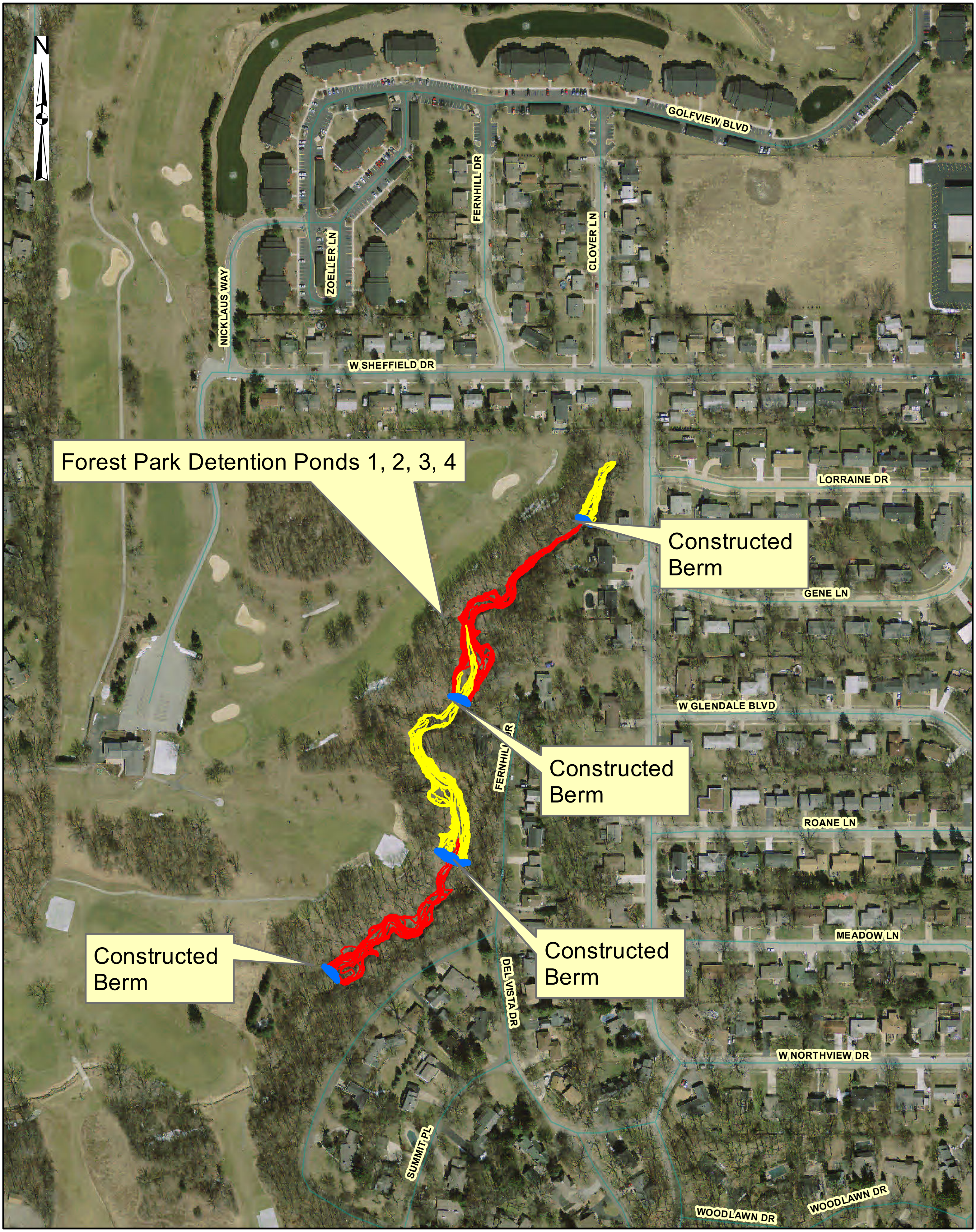


Keystone Commons Subdivision

APPENDIX H - **Storage Areas**

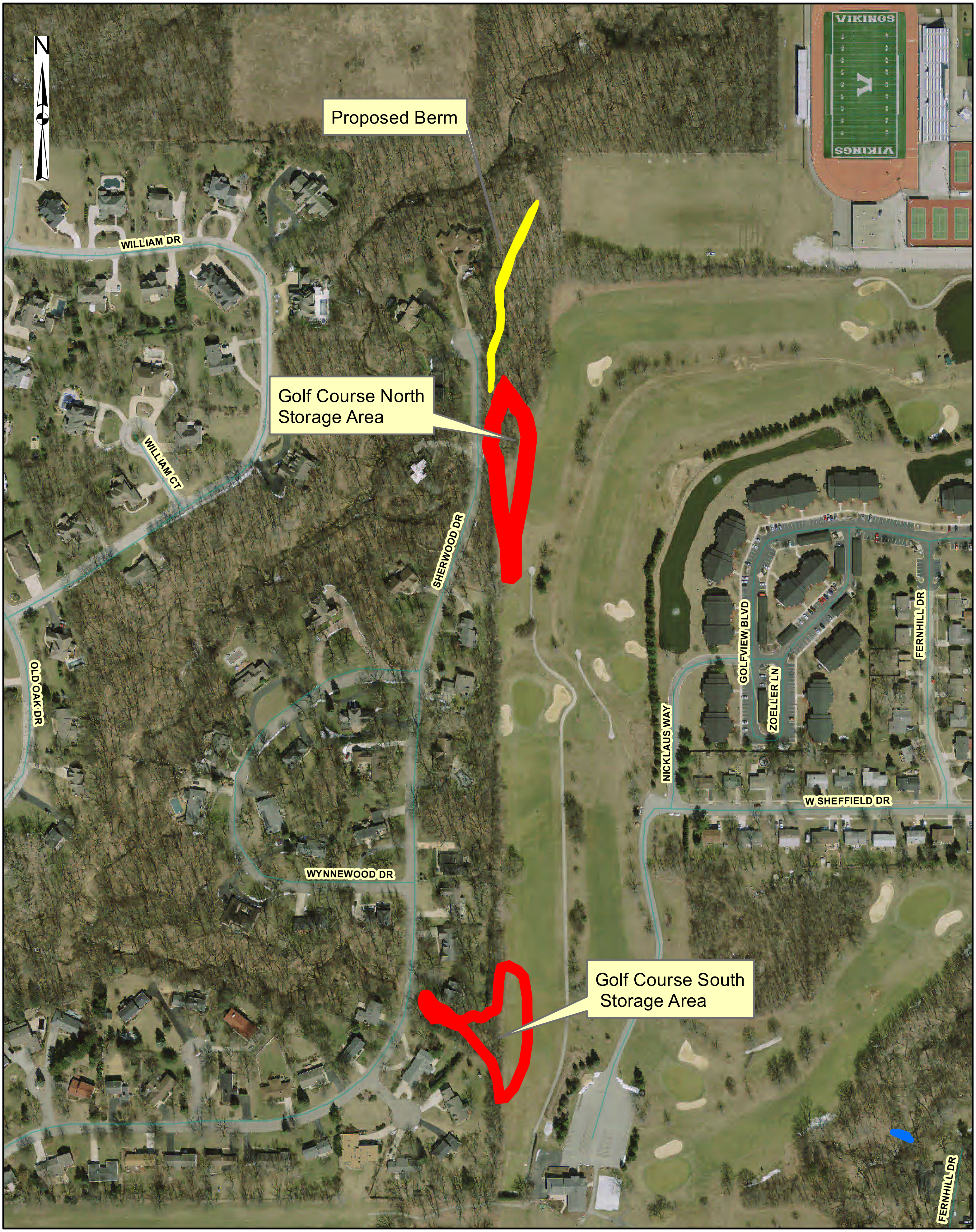


Candlewood Potential Storage Areas



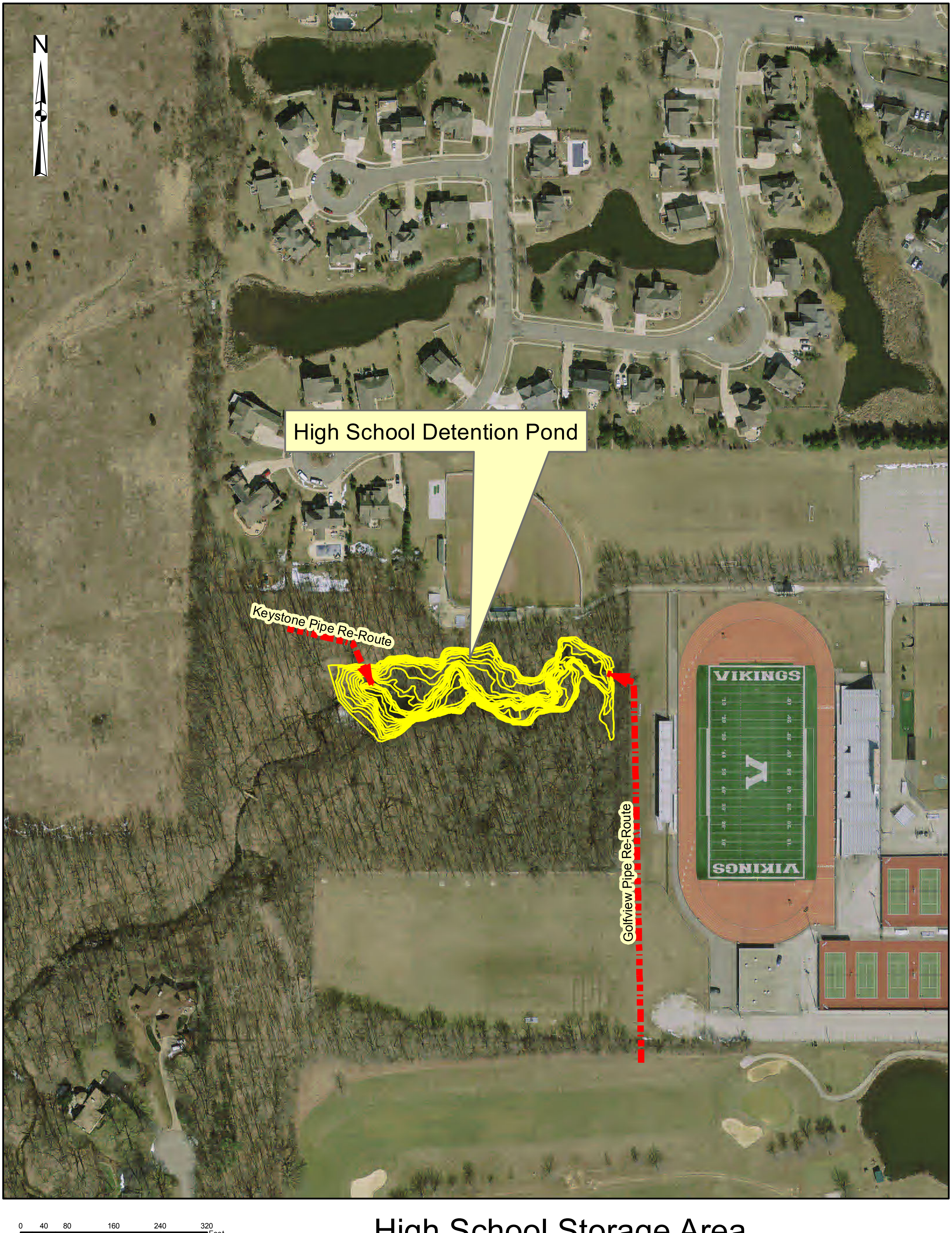
0 62.5 125 250 375 500 Feet

Candlewood Potential Storage Areas



0 62.5 125 250 375 500 Feet

Golf Course Storage Areas



High School Storage Area

INNOVATIVE IDEAS
EXCEPTIONAL DESIGN
UNMATCHED CLIENT SERVICE

APPENDIX I - Typical Stabilization Structures and Plant Guide

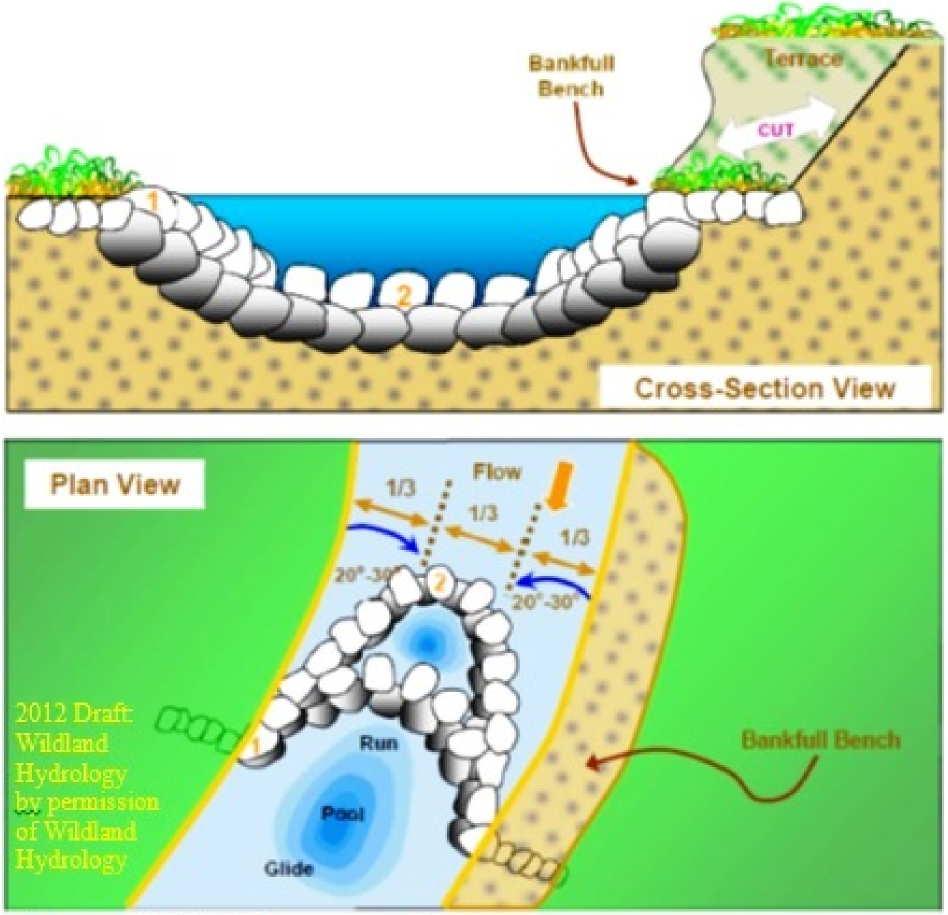


Figure 19: Boulder cross step vane


Figure 20: Double step cross vane with irrigation diversion, 2007

Figure 21: South Platte River "W" weir, 2005

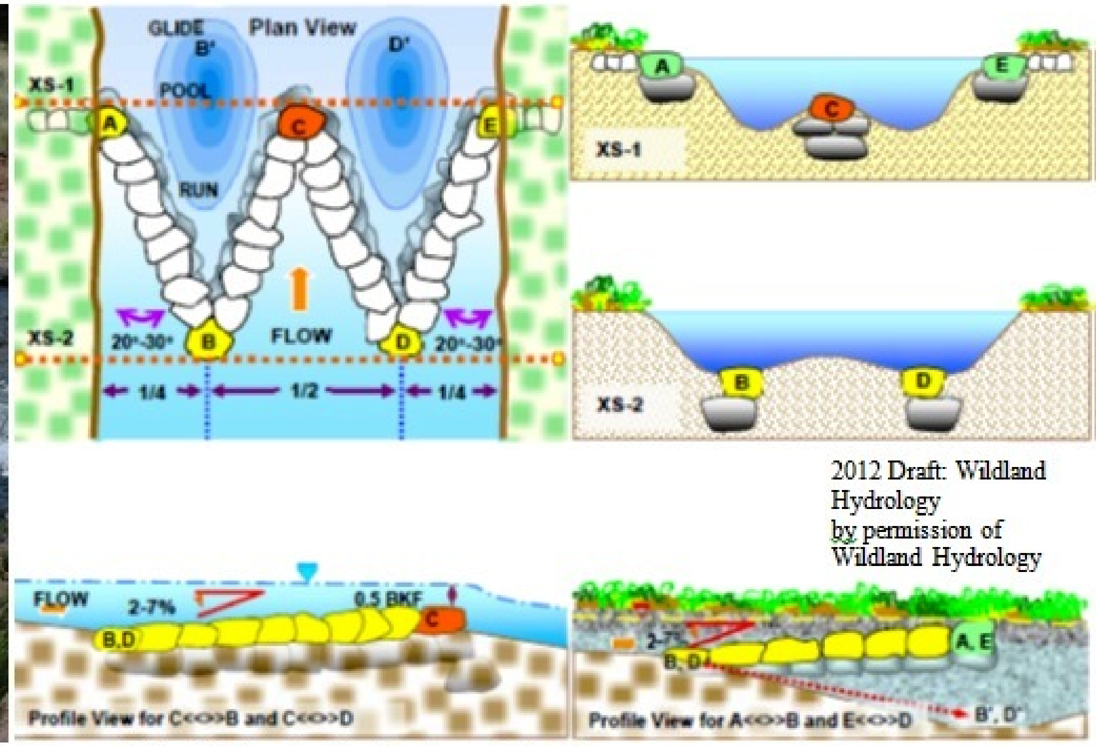
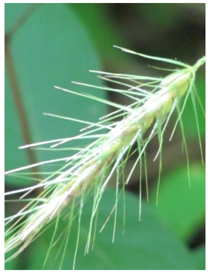


Figure 22: "W" weir illustration of design components

Solar Exposure
Shade
Soil Moisture
Upland Moist (4"-18" above NWL)
Saturated (0"-4" above NWL)
Eco Region
56 - S. Mich/N. Ind Drift Plains

	Scientific Name / Common Name	Height Range	Solar Exposure	Bloom Time	Color	Availability	Description
	Carex crinita Fringed Sedge	24in. /60 in.	Shade Partial Sun Full Sun	May	Green	Common	This clump-forming sedge is easily recognized by its long, drooping, narrow seed heads. Mid-spring, male and female flowers are borne separately on the distinctive infloresence. There is typically one male spikelet that is slender, brownish in color, and 2.5" long and numerous drooping female spikelets that are up to 4" inches long. Growing up to 4' tall, this sedge has narrow green leaves. A wooded wetland plant, it does best in wet soils and full to partial shade, although it can tolerate a sunnier location.
	Carex frankii Bristly Cattail Sedge	12in. /24 in.	Shade Partial Sun Full Sun	Jun Jul	Green	Common	This stout sedge can grow up to 3' tall and has attractive light green leaves that are 1/3" wide. Mid-summer, an inflorescence with 3 to 8 female spikelets and 1 male terminal spikelet emerges. The female spikelets are 2" long and have long bracts and styles on its flower giving the spikelet a bristly appearance. It prefers moist to wet soils in all type of light conditions.
	Carex grayi Common Bur Sedge	12in. /24 in.	Shade Partial Sun	May Jun	Green	Uncommon	This 1' to 2' tall sedge has medium to dark green leaf blades that are 1/3" wide. However, its most distinctive feature is the spiky female component of the inflorescence. The spikelet is 1 to 1.5" in diameter and resembles a medieval knight's mace. Appearing in late spring, the inflorescence will have 1 to 2 of these "maces" and a narrow male spikelet. Pale Sedge thrives in full to partial shade and moist soils.

	Scientific Name / Common Name	Height Range	Solar Exposure	Bloom Time	Color	Availability	Description
	Carex lupulina Common Hop Sedge	24in. /36 in.	Shade Partial Sun Full Sun	May Jun	Green	Common	Common in wet woods, wet prairies, and roadside ditches, this sedge can grow up to 4' tall and has green foliage 2/3" wide. In late spring, male and female flowers are borne on separate 2.5" to 3" spikelets. Male spikelets are singular and slender, and female spikelets are 2 to 5 per stem, cylindrical, and resemble hops. It thrives in all sun conditions, saturated soils, and is salt tolerant.
	Carex lurida Bottlebrush Sedge	24in. /36 in.	Shade Partial Sun Full Sun	May Jun	Green	Common	This sedge's grass-like foliage is 1/2" in width and grows up to 3' tall from its short, stout rhizomes. Its leaves are light to medium green and will maintain attractive longer then other sedges. In May and June, it produces 6" long inflorescences that consist of a single terminal male spikelet and 1 to 4 female spikelets that have a bristly appearance due the the long beaks of the perigynia. This species prefers full sunlight and saturated soils.
	Carex stipata Common Fox Sedge	12in. /36 in.	Shade Partial Sun Full Sun	May Apr	Green	Common	This deer-resistant sedge [may still be browsed on if more palatable species are not available] grows between 1' to 3' tall and has light to medium green, 1/2" wide foliage. During mid to late spring, a 1" to 4" inflorescence appears consisting of several spikelets. The slender, elongated beaks give the spikelets a prickly appearance. This sedge prefers wet soils and all type of sunlight.
	Cinna arundinacea Common Wood Reed	36in. /48 in.	Shade Partial Sun Full Sun	Aug Sep	Green	Uncommon	This attractive grass grows 3' to 4' tall and has attractive grayish-green foliage that is 1/2" in width. In late summer, it produces a drooping, grayish-green bloom. This 12" long inflorescence has multiple arching branches that split several times. is in full foliage in late summer. Found in flooded woodlands and damp savannas, it tolerates all types of sunlight and prefers wet soils.

	Scientific Name Common Name	Height Range	Solar Exposure	Bloom Time	Color	Availability	Description
	Diarrhena americana Beak Grass	12in. /36 in.	Shade Partial Sun	Jul	Green	Uncommon	A great species for a woodland planting, this grass grows between 1' and 3' tall. The erect, shiny, bright green leaf blades are about 1/2" wide and turn tannish-gold in the fall. In July, it produces drooping, 4" to 12" long panicles of green flowers. This species prefers medium soils and full to partial shade.
	Elymus hystrix Bottlebrush Grass	36in. /60 in.	Shade Partial Sun	Jun Jul	Green	Common	This upland woodland grass has a seed head that resembles a bottlebrush. During the summer, it produces a 9" long flowering spikes that have widely spaced spikelets that stand out perpendicular to the main stalk. Growing between 3' and 5' tall, this grass has floppy, dark green foliage that is 2/3" wide. This species is a great choice for an understory garden since it prefers medium soils and full to partial shade.
	Elymus villosus Silky Wild Rye	12in. /36 in.	Shade Partial Sun	Jul	Green	Common	This attractive cool season grass has dark green, long, and slightly hairy leaves and grows 1' to 3' tall. During the summer, it produces a 3" to 4" long nodding raceme of whitish-green spikelets. Commonly found wooded areas, it does best in medium soils and full to partial shade.
	Glyceria striata Fowl Manna Grass	12in. /60 in.	Shade Partial Sun Full Sun	May Jun	Green	Common	A native perennial with short rootstocks, this 1' to 5' tall grass produces erect, leafy shoots in loose tufts. The easily recognizable leaf blades are green to grayish-blue in color, nearly 1/2" wide, and up to 12" long. During late spring, it produces a 1' long airy panicle of pale green to purple spikelets. Commonly found in moist meadows, pastures, and ditches, this species tolerates all types of sunlight exposure and prefers wet soils.

APPENDIX J - Public Comments

GENERAL COMMENTS

The interim report from DLZ was part of a follow up stakeholder presentation for the property owners in the Manchester Meadows and Oakwood subdivisions that have experienced property damage and property loss due to what we perceive as increased storm water flows in the Beauty Creek Watershed over the past 20 years. We note that the City of Valparaiso previously engaged the US Army Corps of Engineers and a report was published in August 2000. It appears to us that none of the specific recommendations from that report were implemented. The current DLZ report updates many of the prior report findings, but does not identify the original causes or directly address the specific problem areas, only recommends installation or expansion of a number of detention ponds as a means of reducing the storm water flow.

We note that our understanding was that the report was initiated by Mayor Costas and the City Council to address the concerns of the Manchester Meadows and Oakwood homeowners that have experienced property damage due to increased storm water flows. The report appears only to look at the big picture to reduce the storm water flows and fails to identify and rectify the property damage matters.

The report appears to be fixated on a storm water management solution to control the discharge of the water by construction of detention ponds. The concern with this approach is that proper maintenance of the detention ponds to ensure that they work will be crucial to success. With specific reference to the High School detention pond, we note the following stated in the DLZ report.

> ***"As noted in Section 5, the existing outlet is in need of maintenance. Discussions with the school representatives should include creating a maintenance agreement as well as access easements. Due to the location in a wooded area, maintenance should include regular <u>inspection and cleaning after each significant rainfall event"</u>.***

We do not believe that the detention pond solution, by itself and without proper maintenance, is the best solution for all of the storm water streams studied. We note that the upstream tributary areas of the Candlewood and Oakwood branches are very different. In the case of the Oakwood upstream watershed, it is a clean almost filtered water due to the grassed areas and ponds at the High School and Forest Park Golf Course. While on the other hand, the upstream Candlewood branch is mainly silty farmland and stream bed. Further, the proposed locations for the Oakwood detention ponds appear to be in an accessible location, while the proposed Candlewood detention pond is in a heavily wooded inaccessible area. Our specific comments are contained in the Candlewood and Oakwood branch parts below.

The comments regarding the scope of work ***"Review the City's storm water release rate of 0.5 cubic feet per second per acre of development"*** restated from the DLZ report below are too ambiguous and need to be better stated with a specific recommendation:

> ***"Another non-structural practice impacting erosion is the release rate reduction requirement for new developments in the City of Valparaiso storm water management standards. The current release rate of 0.5 cfs/ac could be reduced."***

CANDLEWOOD BRANCH

Summary

The root or probable cause was not identified, however, we observe from the Candlewood Branch Tributary Area map that there was likely a substantial increase in the storm water flow due to the development of Keystone Crossing, Cooks Corners Elementary School and others. The DLZ report indicates that the Candlewood Trace subdivision detention ponds appear to adequately capture and retain the subdivision storm water. As stated from the DLZ report below, these areas were previously forested.

> ***"The aerial photographs indicate the entire watershed has been primarily agricultural since 1939. The Beauty Creek streambed and flood plain as well as the Candlewood, Oakwood and Forest Park branches appear to be the areas that have remained forested over the years…"***

We would be interested in seeing a comparison of the original run-off flow calculation from the forested state to the present situation of after-developed state. Our quick simplified calculations indicate the run-off coefficients and subsequent storm water runoff flows have substantially increased with the run-off coefficient increasing from 0.15 to 0.40 resulting in increased per storm water flows from approximately 50 cfs to currently 100 cfs significantly contributing to the increased stream erosion we are experiencing.

Only one area of distress or damage was noted in both the August 2000 Army Corps of Engineers report and the February 2016 DLZ report. We note that there are other erosion areas downstream that are resulting in loss of trees and will damage our bridges if remedial work is not completed. We note that our property owner's association has already had to take actions to stabilize stream banks in order to prevent further erosion to protect our bridge structures and trail system.

We do not believe a detention pond in the proposed location is a true, long-term solution for the Candlewood Branch noting the following:

- We do not understand the reported flows for the proposed detention pond flows, Table 6.13, Summary of Upper Candlewood Alternatives, page 21 states a peak flow at the proposed detention pond under existing conditions of 61 cfs while Table 6.4, Summary of Existing Peak 100 Year Flows, on page 11 states a peak flow under existing conditions at the Hampstead Culverts of 148 cfs
- The proposed location for the proposed Candlewood Branch detention ponds is not easily accessible and will require substantial maintenance, we note from the DLZ report:

  "The area is heavily wooded and the potential for obstruction by leaves or tree branches is high. Even a 12 inch outlet will required special design considerations and frequent maintenance to reduce obstructions."
- We believe that any detention pond constructed on Candlewood Branch will soon become filled with silt as demonstrated downstream of the Hampstead Court culverts, which by the way the City of Valparaiso is obligated to, but has demonstrated a resistance to maintain.
- In addition to the increased cost of inspecting and maintaining detention ponds, the City of Valparaiso has shown in the past that they and others don't maintain them as demonstrated at the High School detention pond.
- The report indicates that erosion control for the Candlewood branch may be minimal.

  "The shear force on the straight sections of Beauty Creek and Candlewood Branch appear to be low enough to use erosion control blanketing."

We believe that other alternatives for stabilization of the Candlewood Branch be investigated.

	Detention Pond	**"V" Gabions**
Land Acquisition Permitting	Required Required	Not required Unknown
Peak Flow at Hampstead Ct.	108 cfs (148 – 40) DLZ to Clarify	148 cfs

Slows Water Velocity, reduces energy	yes	yes
Inspection and Maintenance	Inspect after every major event Remove tree limbs, etc. Silt removal	Not required
Access	Construction of Access Road Road likely not easily accessible Dec. through April	Not Required
Restore Stream Bed	No	Yes
Estimated Costs Construction Annual Maintenance	 TBD TBD	 TBD $0

We suggest the more appropriate solution for the Candlewood Branch at Hampstead Ct. would be as the following recommendations stated by DLZ in section 8.0, RECOMMENDATIONS / OPINIONS OF PROBABLE COST on page 24 as follows:

The recommended approach to addressing erosion in the Beauty Creek watershed includes the following steps, in order of implementation;

1. Maximize detention upstream;

2. Install grade stabilizing structures in the streambed to retain sediment and reduce velocity;

3. Construct sediment traps at accessible locations;

4. Begin regular maintenance of the stream;

As a comment to the above and specifically for the Hampstead Ct. area, we suggest the following:

- Modifications and improvements to the Keystone Commons ponds to reduce the storm water peak discharges
- Install stepped gabions upstream and downstream of Hampstead Court to slow down the water flow, dissipate energy and restore the stream bed to its original depth, this will help to cover the underlying sand layer and prevent undermining of the stream banks
- Rebuild and restore the stream banks downstream of Hampstead Court similar to the work recently completed on Old Oak tributary near Old Oak Drive.
- Block the eastern culvert under Hampstead Court – the eastern culvert appears to be connected to and discharging water from the Manchester Meadows underground storm water sewers - our rough calculations indicate that one (1) 4 ft diameter culvert could easily handle the DLZ calculated 150 cfs. With blocking the eastern culvert, it will still leave 3 open culverts (plus help clear their half-plugged state) and help to distribute the flow. To reinforce our point, the picture below shows the Candlewood Branch downstream of Hampstead Ct. where the stream is a small ditch. Also, DLZ is recommending a 12” culvert discharge from the proposed upstream detention pond, while there are currently 4 x 48” diameter culverts under Hampstead Court.

Comparison of DLZ and Army Corp of Engineers Reports

Candlewood Branch	**DLZ DRAFT REPORT** **Feb. 2016**	**US ARMY CORP OF ENGINEERS** **Aug 2000**
Areas of Concern	As observed on Beauty Creek, stream bed and bend erosion were the primary concerns especially downstream of Hampstead Court (see photo CW 86). Some residential structures are located close to the streambed (see photo CW 77 and CW 83, CW 90) and the erosion has exposed buried irrigation piping and wire (see photos CW 79 and CW 91).	One (1) area Identified: Majority of Candlewood Branch, particularly downstream of Hampstead Court.
Key Data		
Stream Length	*2,200 ft*	3,432 ft (0.65 Miles)
Drainage Area	*356 Acres*	415 acres
Height Differential	*24 ft*	N/A
Peak Flow		
Hampstead Ct	*148 cfs (**Note 1**)*	
Candlewood	*137 cfs*	

Recommendations	Construction of a detention pond upstream of Hampstead Court	Local stream maintenance and adoption program highly recommended to prevent further erosion

Note 1:

We see a discrepancy in the DLZ stated calculated Current Conditions water flows that we do not understand:

- Table 6.13, Summary of Upper Candlewood Alternatives, on page 21 states a peak flow under existing conditions a peak flow of 61 cfs
- Table 6.4, Summary of Existing Peak 100 Year Flows, on page 11 states a peak flow under existing conditions a peak flow at the Hampstead Culverts of 148 cfs

Storm Water Flow Calculations.

- Area estimated at 180 acres for the previous forested condition (approximately ½ of the Candlewood Branch watershed area) and 150 acres for the current condition (with a reduction of 30 acres attributed to the Candlewood trace detention pond)
- Rolling sandy soils
- Peak rainfall of 2” per hour

	Previous Forested	Current Conditions
Run-Off Coefficient	0.15	0.40
Peak Flow	54 cfs	105 cfs

The DLZ report fails to identify other problems. First is upstream of Harrison Blvd. where the City of Valparaiso installed a new drainage duct under Harrison Blvd. after washout of the previous culverts. It appears that the City constructed the new drainage duct approximately 4 ft. lower than the previous culvert invert elevation and has impacted the stream bed elevation at the Manchester Meadows footbridge approximately 50 ft upstream. As can be observed from the photo below, the right bank under the bridge is at a steep slope and there are no protective boulders present. It appears that these boulders have washed or moved downstream to the Harrison street road bridge.

We suggest that DLZ & City consider the installation of stream bed gabions to restore the stream bed depth.

The picture below is just last spring (2015) and one can see the loss bed loss in just 2015!!

The **stream bed** only 5 years ago **was at about where the rocks start on the left!** Lots of sand & silt washed away.

Although there was a picture of the culverts under William Drive in the DLZ report, the report should provide more specific recommendations to restore and stabilize the stream bed. It should be noted that this is the <u>downstream view</u> of this culvert. Note, these **boulders** at the exit of the pipes **were <u>above the pipe lips</u>** only a few years back!

<u>Further downstream</u> of this picture, the MMPOA **lost 7 large-diameter mature trees in one weekend** rain fall last spring (2015) due to the intense scouring of banks and under cutting of the root systems of large trees that previously were the very reason for bank integrity. With these types of catastrophic losses of trees and the very "fabric" stabilizing the banks, it is nearly impossible to re-create a similarly stable bank again.

These tree/bank losses more than **doubled the width of Beauty Creek in this section in <u>one</u> day!**

On the <u>upstream side</u>, as various obstructions have collected in front of the 5 major drain pipes, an island of silt & debris has formed a large blockage for most of the inlets to the drain pipes. This phenomenon somewhat mirrors the Hampstead Court situation where **only 20-25% of the drainage design/system is still operational.**

Note that the far right (southernmost) upstream drain pipe receives the vast majority of the flow and then on the downstream side that intense flow from a single point caused the bank damage and tree loss just shown in the above pictures. **William Drive needs fixed as well, but it was not even given mention by DLZ or the City!**

OAKWOOD BRANCH

Summary

The root or probable cause not identified, however, we observe from the Oakwood Branch Tributary Area map that there was likely a substantial increase in the storm water flow due to the development of the Forest Park Golf Course and the Valparaiso High School detention pond being undersized and/or not maintained. As stated from the DLZ report below, these areas were previously forested.

> ***"The aerial photographs indicate the entire watershed has been primarily agricultural since 1939. The Beauty Creek streambed and flood plain as well as the Candlewood, Oakwood and Forest Park branches appear to be the areas that have remained forested over the years…"***

Again we would be interested in seeing a comparison of the original run-off flow calculation from the forested state to the now after-developed state. We note that the development affecting the conversion of the previously forested areas was and is still owned/operated by the City of Valparaiso (Forest Park Golf Course) and the Valparaiso high school. Further we understand that the discharged storm water is draining onto private property where the city does not have a storm water easement or right of way.

Comparison of DLZ and Army Corp of Engineers Reports

Candlewood Branch	**DLZ DRAFT REPORT** **Feb. 2016**	**US ARMY CORP OF ENGINEERS** **Aug 2000**
Areas of Concern	Did not address damage to private property	Four (4) Problem Areas Identified OW-1 Storm Sewer Discharge OW-2 Upstream of Old Oak Road OW-3Undermined Utility Poles OW-4 Downstream of High School
Key Data		
Stream Length	*4,600 ft*	4,065 ft (0.77 Miles)
Drainage Area	*216 Acres*	230 acres
Height Differential	*73 ft*	N/A
Peak Flow		
Oakwood Confl.	*469 cfs*	
High School	*198 cfs (Note 1)*	
Recommendations	Improve High School Detention Pond Construct 2 new detention ponds	Specific recommendations for each problem area

Note 1: There appears to be a discrepancy in the DLZ reported flows that we do not understand. Table 6.12 flows appear to be counter intuitive in that we would expect the flows to go up with additional outfalls, not down.

- Table 6.12, Summary of High School Alternatives
  - Existing Conditions (Pond Only) 152 cfs
  - Existing Pond + Keystone Outlet 127 cfs
  - Existing Pond + Keystone + Golfview 114 cfs
- Table 6.4, Summary of Peak 100 Year Flows

- Valparaiso High School 198 cfs
- Oakwood at Confluence 469 cfs

As previously noted, the upstream watershed tributary areas for the Oakwood Branch are significantly different from the Candlewood branch. The water appears to be cleaner and the proposed detention ponds are in cleaner and more accessible locations. Further the 2 new proposed detention ponds are located adjacent to the Forest Park golf course and could easily be inspected by the golf course staff when the golf course is open. The proposed detention ponds make sense for Oakwood, but work must be completed to repair and stabilize the property damage directly downstream of the High School detention pond.

Prepared by Reg Groves & Bill Herring for the MMPOA (3/11/16)

From: Bill Herring [fish39@aol.com]
Sent: Friday, March 11, 2016 3:44 PM
To: Adam McAlpine
Cc: Tim Burkman; Bill Oeding; 'Reg Groves'; 'Janet'; 'Kim Minko'; 'Brian Rossmann'; 'Melissa Sorice'; joyfish7@aol.com; 'tom rea'; hebertsare@frontier.com
Subject: MMPOA Response to Beauty Creek Stakeholder Meeting
Attachments: Comments to DLZ Report Mar 11 2016.docx

Adam-

This is a follow up to the second Beauty Creek Watershed Study Stakeholder Meeting. We again want to thank you, the City and DLZ engineers for the opportunity to receive the update and participate in the discussion that followed. As was expressed in the meeting, there are many homeowners in Old Oak and Manchester Meadows that have suffered significant property loss and damage. It was more than apparent that this problem is not new (having begun to be a real issue in the late 90's), but in the last 5 years, these problems have accelerated and certainly are far from resolved.

At the meeting there were two themes that surfaced. One was the DLZ and City approach to the situation is to deal with problems "more regionally" by trying to collect (in retention basins) and release more slowly the upstream waters flowing to & through the variety of "tributaries" of Beauty Creek from the various watersheds. I put tributaries in quotes, as some of the paths these waters decide to take are hardly meant to be a tributary … such as across roads, driveways, lawns and back yards.

The other theme was, what many in attendance came to the meeting to hear about, "but what about my property or my specific situation?" Much of the discussion centered around individual property issues that in some instances are bordering on desperate. Several times you and DLZ were challenged to speak to what are homeowners to do and when can they expect **relief from these situations that are not of their making!**

I understand that the DLZ recommendations and the City's inclination is to put the tourniquet on the patients – Beauty Creek tributaries – to stop the hemorrhaging. I agree that these upstream detention ponds are a quick fix to significantly reduce the magnitude of the problems (water volume and shear forces). However, to some, this approach feels like you chosen to apply the tourniquet around their necks, as there is nothing to relieve them of the past or current problems.

Rather than one or the other path, or a sequential arrangement, **I believe there should be both paths being pursued in tandem**. <u>If the argument is that until the detentions systems are in place, any property remediation is a waste as it will be washed away, then you have clearly stated the concerns of current owners.</u> They have to suffer even more destruction and property damage before they get any relief, maybe 18-24 months from now. Some situations cannot wait without some property owners being placed in substantial jeopardy.

As for the attached response prepared by the MMPOA, we wanted to highlight some of the issues unique to our 100+ home owners. As I stated during the meeting, while I understand that some in Old Oak and a few in Manchester Meadows property owners on the Oakwood Branch suffer more severely, DLZ only briefly gave attention to all of the issues in the rest of Manchester Meadows. You and I have discussed this in the past and again after the meeting, but there are real issues that are only getting worse every season for Manchester Meadows homes, trails and bridges. I do not want our Manchester Meadows situations to escalate and reach the scale of those on Old Oak. Remember, virtually the waters we are addressing from the various watersheds ultimately pass through Manchester Meadows (even those from the Old Oak Branch!) on their trek south to Salt Creek.

In our report you will find our concerns with the detention basin approach, especially for dealing with the Candlewood Branch issues. While such an upstream detention basin could stave off some downstream problems for several years, **unlike the other detention ponds**, this one lacks real accessibility and will for sure be out-of-sight therefore out-of-mind to be maintained (think about the HS system situation for years). This was clearly pointed out in DLZ's own report. If this option is chosen, **without other downstream/in-stream mitigation efforts**, the fact is this will become a future problem and that is quite predictable. Even if a detention basin approach is used on this branch, we would be less than satisfied without the additional recommendations (substantiated by DLZ's own report) downstream and in-stream being instituted as well.

DLZ has done a fine job of capturing a snapshot of the current rather horrific situation that has mushroomed out of control in recent years. What they cannot fully appreciate how quickly & powerfully these problems have occurred or what the situation & landscape looked like only a few years back. There is now a sense of urgency for **all** the stakeholders and we do not want to lose any time getting on with the proposed remediation efforts.

Please feel free to ask any questions, plus we would welcome your feedback and answers to our questions raised in the report.

Best regards,

Bill Herring
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From: hebertsare@frontier.com
Sent: Saturday, March 05, 2016 3:37 PM
To: Adam McAlpine
Subject: Drainage Analysis Presentation Feedback

Adam...

First of all, I want to compliment you and Tim for your consistent attention to detail in this challenging matter. The city has taken great strides in the past two years. As I've stated before, my father-in-law built our home in the late 60's and sought support from the city on several occasions as he fought to keep the creek from eroding the banks behind our house. Other than a bulldozing (created even more problems) and an Army Corps of Engineers' study and subsequent report (not used north of the bridge on Harrison), local government support was non-existent. I've supported the efforts of the city in recent years, but I believe that the proposal to reroute the overflow pipes from Keystone and the Golf Course into the High School's pond and then build onto the High School's deteriorated detention area to increase it's capacity from about 5 acre/feet to 9 acre/feet is throwing good money at an insufficient solution.

The root cause of the problem was clearly identified. Water from Valparaiso High School, Keystone Commons and the Golf View/Golf Course drainage systems dump into the Oakwood Branch too quickly. The Ponds at Keystone and the Pond on the Golf Course discharge water without ANY metering onto the High School's property. Runoff from these sources obviously need to be slowed to reduce downstream problems. It would be frivolous to begin armoring until flow is reduced. While it's encouraging to hear that Valparaiso Community Schools, under Dr. Fratacia's leadership, are "talking" about beginning to maintain their detention area and establish periodic inspections, in reality, they won't be able to get equipment in and out of the current location where it's needed to perform routine maintenance, so we'll be right back where this whole problem started.

I would propose investing in a NEW damn, closer to the west border of the high school's property. Save the money that would have been invested in renovating the old damn and rerouting existing pipes from Keystone and the Golf Course. A new damn could be built to hold back 30-40 acre/feet of water. The new structure should be designed to allow for easy monitoring, provide access for periodic maintenance, and it should meter water out from it's detention area over the course of a couple of weeks rather than a couple of days. It doesn't sound like DLZ has considered this option at all even though we've discussed it before at quarterly meetings.

I'm invested in finding an answer to this problem that can be implemented with a sense of urgency, early in 2016, before anyone gets their "money hungry" attorneys involved, but it ***MUST*** be a ***LONG TERM*** solution. Let's keep moving forward!

Brad Hebert

From: Tom Rea [ltrea@yahoo.com]
Sent: Wednesday, March 09, 2016 4:53 PM
To: Adam McAlpine
Subject: Beauty Creek erosion

Adam,
Thoughts on the watershed study.
I would like to see a berm or a ditch along the western boundary of the golf course. This could divert runoff from the golf course into the two proposed detention areas. Without this, storm water flows across private lawns and around homes into the water shed.
If this berm or ditch could be extended to the north into the nature preserve, I think this would also help alleviate Shawn's flooding?
Thanks
Tom Rea

Sent from my iPad