Land & Resource
Engineering and Survey

Engineering Report For:

Davis Creek Phosphorus Reduction Study

Water Quality Management Planning Grant #8635-0001
American Recovery and Reinvestment Act 2009

Prepared for:
Kalamazoo County Drain Commissioner
Kalamazoo, Michigan

September 16, 2011
Project No. G090661TS

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LIST OF ABBREVIATIONS/ACRONYMS

ARRA	American Recovery and Reinvestment Act
BMP(s)	Best Management Practice(s)
CEE	Channel Erosion Equation
CMI	Clean Michigan Initiative
Davis	Davis Creek Drain
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Association
FTC&H	Fishbeck, Thompson, Carr & Huber, Inc.
GIS	Geographical Information System
KCDC	Kalamazoo County Drain Commissioner
LRES	Land and Resource Engineering & Surveying
L-THIA	Long-Term Hydrology Impact Assessment
MDEQ	Michigan Department of Environmental Quality
MDNR	Michigan Department of Natural Resources
NPDES	National Pollutant Discharge Elimination System
NWI	National Wetland Inventory
NYC	New York Central (Railroad)
PCB	polychlorinated biphenyls
TMDL	Total Maximum Daily Load
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	United States Geologic Survey
Watershed	Davis Creek Watershed
WMP	Watershed Management Plan

1.0 INTRODUCTION AND BACKGROUND

The Davis Creek Drain (Davis) is located in portions of Comstock, Pavilion and Kalamazoo Townships and portions of the Cities of Portage and Kalamazoo (Figure 1). The Davis flows a distance of approximately 8.7 miles and has a 9,424 acre watershed (Figure 2). The 1999 Michigan Department of Environmental Quality's, Surface Water Quality Division report entitled, *Loading Assessment of Phosphorus Inputs to Lake Allegan 1998* showed that the Davis was a major contributor of phosphorus to Lake Allegan and the third highest ranking tributary for loading rate based on pounds per square mile. Presently Lake Allegan has a Phosphorous Total Maximum Daily Load (TMDL) and a Water Quality Improvement (Implementation) Plan which was developed in 2002. However, no implementation activities were recorded that addressed phosphorus loadings coming from the Davis. Subsequently, to address the phosphorus inputs, the Kalamazoo County Drain Commissioner (KCDC) was awarded a Water Quality Management Planning Grant under the American Recovery and Reinvestment Act (ARRA) to identify sources of phosphorus, sediment and other pollutants being transported by the Davis to Lake Allegan.

Prior to this study, a Watershed Management Plan (WMP) was prepared for the Davis in 1999. The WMP identified current and historic land use changes which have significantly impaired water quality and reduced storm water detention areas. The WMP also identified known water quality problems within the Davis, including oil, and toxic chemical releases from adjacent industrial properties, trash, sediment bars, eroded banks, high turbidity, algae blooms and nuisance weed growth. The WMP further identified the need to address sediment and nutrient loadings caused from bank and bed erosion, storm sewer discharges and railroad and roadway crossings. In addition, the plan called for acquiring lands for centralized retention/recharge basins to address flooding concerns. Unfortunately, none of the recommended corrective measures outlined in the WMP were implemented. Subsequent to the 1999 Davis WMP, two engineering studies were completed to further evaluate conditions of the watercourse. Both the 2003 study, completed by Spicer, Inc. and Wetland and Coastal Resources, Inc., and the 2009 study completed by Fishbeck, Thompson, Carr & Huber, Inc. (FTC&H) found that the Davis had multiple areas of instability and poor water quality. However, no action was taken to address concerns identified in either the 2003 or 2009 evaluations.

As part of the ARRA grant, a comprehensive engineering study was conducted to aid in identifying Best Management Practices (BMPs) for seven high priority areas within the Davis to reduce phosphorus and other pollutants from entering Lake Allegan. FTC&H was retained by the KCDC in March 2010 to oversee and conduct the engineering study which identified areas of concern, channel instability, sources of phosphorus and other pollutants. In addition, a review of pertinent existing resource data related to the Davis was conducted to aid in the survey. Land and Resource Engineering & Survey, Inc. (LRES) and FTC&H conducted the comprehensive engineering survey of the Davis and provided BMP recommendations for seven priority areas requiring corrective action to reduce phosphorus and other pollutants. In addition, areas of potential flooding, riparian loss and impacts to infrastructure were also evaluated during the survey.

The purpose of this report is to present results of the engineering study and provide recommendations to address pollutant loads and instability at seven priority areas within the Davis.

2.0 METHODOLOGY

Information including, but not limited to, the 1999 Davis WMP and the 2003 and 2009 engineering studies were evaluated to assist in identification of known impairments, potential pollutant sources and areas of concern within the watercourse. Water chemistry, aquatic and fisheries data from the United States Environmental Protection Agency (Storet), City of Kalamazoo (2004-2009, 2004, 2008), Kalamazoo County (2004, 2008), River Partners Program (1995), Michigan Department of Natural Resources (MDNR, 1977, 1979, 1985, 1991, 1994, 1995, 2005), Michigan Department of Environmental Quality (MDEQ, 2001, 2005) and Western Michigan University (Chan Sheng 1999-2001) were also evaluated. In addition, the Michigan Soil Survey of Kalamazoo County, the Kalamazoo County Land Use Map, Michigan pre-settlement wetland from the MDNR, National Wetland Inventory (NWI) of existing wetlands, Federal Emergency Management Association (FEMA) 100-year floodplain maps, and United States Geologic Survey (USGS) topographic maps were also reviewed. A geomorphologist from FTC&H evaluated Kalamazoo County 2005 and 2009 aerial photography to evaluate morphologic change over time within the Davis' channel and identify critical areas requiring field verification. Information gathered during the data review assisted in identifying potential sources of phosphorus, nutrients and sediment loadings within the Davis.

Throughout the spring and summer of 2010, LRES conducted a general engineering field survey of watershed conditions and walked the main branch of the Davis. Purpose of the field survey was to identify potential sources of phosphorus and other pollutants, areas of erosion and sedimentation, obstructions to flow and potential storm water detention areas. Information gathered from the 2010 engineering survey along with information noted above was used to select seven high priority areas (Figure 3). The seven areas are described in Table 1, below.

Table 1 – Area Description

Area	Description
Area 1 – Colonial Acres Trailer Park	Deadwood Drive to Kirby's Circle – 1,700 feet
Area 2 – East Cork Street	Downstream of New York Central (NYC) Railroad bridge – 700 feet
Area 3 – Canadian National Railroad	Beginning 500 feet upstream of Miller Road at Canadian National Railroad – 900 feet
Area 4 – Canadian National Railroad to Twin Culverts	Immediately upstream of Miller Road and downstream – 2,400 feet
Area 5 – Twin Culverts	Immediately north and south of BR-94 – 750 feet
Area 6 – Stewart Drive to Market Street	Extends 390 feet between the two roads
Area 7 – Brookfield to Springfield	Extends 310 feet between the two roads

Detailed site assessments for the seven priority areas was completed including collection of topographic, cross section and longitudinal data, identification of areas of instability, measurements of erosion rates and identification of potential BMPs.

Identification of potential sources of phosphorus and other nutrients was also completed as part of the engineering field survey. LRES evaluated culvert and tributary outlets and the entire length of the Davis for signs of excessive vegetation and algae growth, which are both potential indicators of high nutrification within a stream system.

Evaluation of other pollutant inputs to the Davis was completed through evaluation of water chemistry data and biological sampling completed by the MDNR, MDEQ and other sources, as signs of chemical pollution are not readily apparent during an engineering survey.

Areas of channel instability were evaluated through identification of bank erosion and in-channel sediment deposition including mid-channel bars and point bars. The presence of actively growing bars provided direct evidence of excessive sediment input to the system. The source of sediment was then identified such as culverts, surface runoff or erosion of channel banks or bed. If sedimentation was found to be associated with a culvert discharge, the culvert and associated channel was traced to the source. In all cases, once the source was identified; the cause of instability and the severity level were noted.

Sediment loads were calculated within each of the seven priority areas, where applicable. The method of evaluating loadings from bank and bed erosion varied by site based on available data; however, in all instances the data was empirical in nature.

Lateral recession rates for the area downstream of BR I-94 (Areas 6 and 7) were estimated based on testimony by local residents on change in channel location over time, review of aerial photography, meander pattern, erodibility of soils and severity as prescribed in the MDEQ *Pollutants Controlled Calculations and Documentation for Section 319 Watersheds Training Manual* (MDEQ 1999). Estimated annual sediment load was calculated from LRES estimates of eroded channel length, associated bank height and lateral channel migration of the channel.

Upstream of BR I-94 (Areas 2, 3, 4 and 5) calculations of sediment load from bank erosion were based on soil type, location of existing channel compared to historic location and by comparing the width and depth to a stable section of channel within the immediate area. In addition, sediment load calculations for Area 3 also incorporated the volume of ballast fill along the Canadian National Railroad and downcutting of the channel bed.

In general, most erosion sites were categorized as severe to moderately severe and assumed to have a lateral recession rate between 0.25 and 0.5 foot per year.

It should be noted that sediment loads were not calculated for Area 1 as bank erosion was not observed in this area.

Photographs were taken to document impairments noted during the field assessment and are included in Appendix 1. It should be noted that select photographs from the 2003 and 2009 study are also included in Appendix 1, as they provide an excellent representation of existing channel conditions.

USGS Topographic maps, pre-settlement and NWI maps and the eight potential areas for creation of centralized retention/recharge, indentified in the 1999 WMP, were reviewed to identify potential areas for storm water detention and/or wetland restoration within the Davis Creek Watershed (Watershed). Based on review of these data sources, areas were selected and field verified to determine their suitability for storm water detention and/or wetland restoration. Potential storm water collection and treatment (wetland and floodplain restoration and creation areas) sites were also identified and evaluated during the survey.

3.0 WATERSHED FEATURES AND CHARACTERISTICS

3.1 LAND USE

The Watershed encompasses primarily residential and industrial areas and some urban parks. It contains two superfund sites within its watershed and, as previously discussed, has been recognized as a degraded watercourse for over 15 years. Extensive networks of roads traverse the watershed including I-94 and BR I-94. The Canadian National Railroad is also located within the watershed and in very close proximity to the watercourse, primarily in the area upstream of Miller Road, Area 3.

3.2 WETLANDS AND FLOODPLAINS

Within the Watershed, there are approximately 1,833 acres of wetland, 20 percent of the watershed, with majority of the wetlands located south of Kilgore Road (Figure 4). The presence of these wetlands was confirmed during the 2009 engineering study completed by FTC&H which found fairly large areas of emergent and farmed wetlands in the upper watershed. North of Kilgore, the NWI maps show a narrow band of wetlands which are mainly limited to the riparian corridor of the Davis. Though the wetland inventory map shows the presence of wetlands along the Davis corridor, field review of this area showed only limited areas of wetlands, with the exception of one moderately large (5.5 acres) marsh upstream of Covington Road.

Pre-settlement wetland data, provided by the MDEQ, shows that majority of wetlands historically present within the Watershed were located upstream of Kilgore Road. This data is consistent with existing wetlands identified on the NWI map and results from field review.

The MDEQ data shows pre-settlement wetlands to be estimated at 1,373 acres, or approximately 15 percent of the entire watershed. Based on this information, one would assume a gain of approximately 460 wetlands acres within the watershed, 1,833 acres (NWI) – 1,373 (pre-settlement). In comparing location of wetlands between the two sources the majority of this apparent gain was shown to have occurred upstream of Kilgore Road. However based on field review, it is unlikely that additional wetlands have evolved or been created in this area since pre-settlement times. Therefore, it is our opinion that there is virtually no change in wetland acres upstream of Kilgore Road. Downstream of Kilgore the pre-settlement data does not show any riparian wetland along the corridor. However, the accuracy of the base data for the pre-settlement map is often insufficient, along small creek and rivers, to make any conclusions regarding historical presence of wetlands. Therefore, it is our opinion that wetland acres within the Davis watershed have not increased since pre-settlement, and considering the high level of urban development in the watershed it is likely wetlands have decreased.

The 2010 USGS 100-year FEMA floodplain data indicates a narrow corridor of floodplain exists downstream of Kilgore Road. Upstream of Kilgore Road, the 100-year floodplain has not been mapped, (Figure 5). However, areas prone to flooding in the upper portion of the watershed were identified during this study. This position is supported by the extensive wetland complexes which exist adjacent to the Davis south of Kilgore Road.

Downstream of Kilgore Road to BR I-94, floodplain access is limited as the Davis flows through large industrial areas and the channel is incised. Downstream of BR I-94, a 2,200 feet diversion channel exists to re-direct storm events directly to the Kalamazoo River and alleviate flooding in the downstream reaches. The diversion channel was constructed in 1978 and consists of 95″ x 67″ twin culverts. Downstream of the diversion, the Davis narrows substantially from the channel dimensions upstream of BR I-94. The Davis at this location flows mainly through a residential area with excellent access to the floodplain. Prior to constructing the diversion, homes in this area would have routinely been subject to extensive flooding; although even with the diversion in place, flooding is still a concern, though to a lesser degree than before.

3.3 AQUATIC HEALTH

Review of MDNR data indicates much of the Davis was managed as a coldwater fishery in the 1940s and that macro invertebrate populations during the early 1970s were rated from good to excellent. However, industrial spills and discharges and increased sediment load during the mid 1970s adversely impacted macro invertebrates and fish populations; resulting in major losses of aquatic organisms. In fact, much of the central portion of the Davis is now considered a “dead zone” for fish and macro invertebrates.

3.4 TOPOGRAPHY

The Davis lies within the Southern Michigan Northern Indiana Till Plans eco-region. The watershed is relatively flat in the upper half where glacial outwash plains are the dominant topographic feature. The outwash plain contains a ponded area, known as East Lake, which is generally recognized as the source of the Davis. The topography of the lower half consists of irregular rolling till plains and low lying lands associated with the floodplain of the Kalamazoo River.

3.5 SOILS

Soils within the Watershed were determined based on observations in the field and U.S. Department of Agriculture (USDA) soil survey maps of Kalamazoo County (Figure 6). The soil types and textures are consistent with those found in glacial outwash plains. Specifically, clay loams, loams, sandy loams and coarse gravel and cobbles were all identified along the Davis. Based on site evaluation, sandy/loam soils were the highest percentage of soils found along the channel of the Davis, with a lower percentage of soils containing silts, clays and organic matter. Areas of the channel with high concentrations of sand size particles have the highest erosion potential due to the unconsolidated and low cohesiveness nature of the soils. In addition, because of the low cohesiveness of the soils they also have relatively low concentrations of pollutants.

Reaches of the Davis which traverse areas containing clay and silt size particles have lower erosion potential than do reaches with courser grained material. These lower erosion rates are directly related to high cohesiveness and compaction of these smaller grained soils. Generally one would expect soils composed of clay and silt to have higher erosion rates, which when cultivated or similarly disturbed, can erode rapidly. However, clay and silt soils along the Davis were found to be stable, not previously cultivated or similarly disturbed, and therefore contain low erosion rates. It should be noted that once eroded, clay and silt sized particles within the Davis can be easily mobilized and transported to downstream areas due to their small grain size, and have potential to contain high concentrations of pollutants due to their highly cohesive properties. Therefore, it is critical to ensure bank stability to minimize phosphorus and other nutrient input to the Davis.

4.0 EVALUATION OF EXISTING CONDITIONS

4.1 GEOMORPHOLOGY

Evaluation of the geomorphology or "the changing shape of the watercourse" is important to understand factors that contribute to its overall stability and/or instability. The fundamental nature of flow in the watercourse relates to the equilibrium between sediment load and particle size, channel slope, and channel discharge. Stable morphology within a watercourse would enable it to consistently transport a given sediment load without erosion or deposition. Impairments within a watercourse that has a stable morphology would not be systemic but rather sporadic and site-specific, resulting from things such as log jams and obstructions.

Factors that may alter morphology within a watercourse include, but are not limited to, changes in volume brought about by land use changes, significant storm events and loss of wetlands and floodplains. Morphology may also be altered by obstructions/blockages, infrastructure such as bridges and culverts, channel incision and construction activities within the channel. In addition, impairments left unchecked for long periods of time, such as log jams and sediment bars, will also alter channel morphology.

Overall, channel morphology within the Davis ranges from poor to fair throughout much of its length. More often than not, impairments are systemic in nature and are the result of inattention to previously identified site-specific concerns, changes in land use and indiscriminant filling within the channel. For example, excessive sediment load being produced within the channel adjacent to the Canadian National Railroad, upstream of Miller Road, is being transported to the over widened and unstable channel downstream of Miller Road. The impacts of this sediment load are found downstream of BR I-94 where the channel morphology has become extremely unstable with rapid bar formation and bank erosion. In addition, construction of the diversion substantially reduced downstream flows resulting in excessive sediment deposition within the Market Street area.

4.2 CONDITION INVENTORY

Overall, the Davis has poor water quality and ranges from poor to good in terms of conveyance, flooding and stability. Major concerns regarding potential flooding were identified as were areas of erosion, sedimentation and overall channel instability. The majority of the Davis is considered to be in poor condition, with seven areas ranking as severely impaired. The highly urbanized nature of the watershed is impacting channel stability due to increased runoff rates and large number of culverts that are creating erosion and sediment deposition. Nearly all of the concerns identified in the 2003 and 2009 studies were noted as still existing during this study and in many cases, impairments were significantly worse and have continued to adversely impact downstream areas at alarming rates. As previously indicated, the purpose of this study was to identify seven priority areas and complete a detailed analysis of each and identify corrective BMPs. A detailed description of impairments noted in each of the seven priority areas is provided below.

Area 1 – Colonial Acres (West of Deadwood) – Colonial Acres is located south of East Kilgore Road (East N Avenue) between Meredith Road and the Kalamazoo Municipal Airport. The channel within this area extends for a distance of approximately 1,700 feet, from Kirby's Circle to E. Deadwood Drive. Within this area, the Davis is over widened with virtually no flow and stagnant water conditions and is considered a safety concern from flooding and water quality. At the time of inspection, the Davis was near top of bank and even a small precipitation event would have likely flooded homes and roads within Colonial Acres. The culvert located under Hamilton Drive, immediately upstream of E. Deadwood Drive, was filled with sediment to within a few inches of the top of the culvert, limiting its ability to pass little, if any, storm water. It is important to note that the lack of flow within this area is not the result of blockages but rather due to an over-widened channel within a topographically low area and a perched culvert at E. Deadwood Drive. Hence, the Davis is functioning more as a wetland complex, storing water rather than conveying it. Water freely flows through the culvert under E. Deadwood Drive; however the invert elevation of this culvert is approximately 2 feet above the culvert under Hamilton Drive.

Area 2 – East Cork Street – For a distance of approximately 700 feet, from just downstream of the NYC Railroad Bridge to East Cork Street, the drain is completely unstable with an erratic pattern, eroding channel banks and multiple bars. The channel within this area has multiple channels, failed culverts and has migrated west where it is undercutting the foundation of an abandoned brick building. A portion of the channel also flows perpendicular to the culverts it used to flow through, and now flows over them creating a small waterfall. In addition to the channel's instability, it is also hydraulically inefficient and poses a safety concern due to various types of debris which have been disposed of in the Davis. Channel instability within this area is, and will continue to adversely impact water quality and channel stability to downstream waters. Lateral bank erosion is occurring at a rate of 0.5 foot per year.

Area 3 – Canadian National Railroad – This area is located along the west side and adjacent to the Canadian National Railroad and extends approximately 900 feet and is characterized by a narrow (3-4 feet), steep gradient and incised channel. Due to the steep gradient of the channel, velocities and erosion potential are high resulting in severe downcutting and bank erosion throughout the channel. As a result of the down cutting, sediment deposits have formed and are causing the channel to meander and erode into the railroad bed creating an unstable slope along the tracks. At various locations, rock riprap, concrete and ballast material has been indiscriminately placed within the channel, assumedly to stabilize the toe and stop downcutting. However, this material is creating blockages in the channel, diverting flow to adjacent banks, and accelerating scour of the bed downstream of the material due to the increased velocities. Within this area, the channel is extremely incised with no available floodplain. The channel, however, has formed small floodplain benches with limited ability to dissipate energy. Bank erosion is estimated to be occurring at a rate of 0.4 foot per year.

Area 4 – Canadian National Railroad to Twin Culverts – The channel within this area is characterized by a linear, substantially over-widened channel with erosion along the east and west banks and numerous mid-channel bars and log jams for a distance of approximately 2,400 feet. Immediately downstream of the Canadian Railroad culvert and Miller Road crossing, large sand bars have formed. The material forming these bars is from erosion of the channel upstream of the railroad and discharge from a culvert on the downstream side of the Miller Road crossing. Due to excessive sediment load coming from upstream areas, the channel bed is increasing in elevation (aggrading), continuing to widen and supply sediment via erosion to the channel. This has resulted in a low efficiency channel with limited ability to transport sediment. Estimated bank erosion rates are 0.25 foot per year.

Area 5 – Twin Culverts – This area is located immediately upstream and downstream of BR I-94 and extends for a distance of approximately 750 feet. Twin culverts within this area have completely failed and the Davis has eroded around them for a distance of approximately 200 feet into the western bank. These culverts pose both a safety risk and have resulted in severe erosion and bank instability to the point that the abandoned railroad bridge is slowly collapsing into the Davis. The KCDC staff indicates that railroad ties regularly fall into the watercourse and are washed downstream on an annual basis causing the need for their removal through maintenance work. Overall, the Davis in this area is extremely unstable and continues to supply large volumes of sediment to downstream areas exacerbating already unstable conditions. Estimated bank erosion rates within this area are approximately 0.5 foot per year.

Area 6 – Stewart Drive to Market Street – This area extends from Stewart Drive to Market Street, a straight line distance of approximately 390 feet. Approximately 700 feet of meandering channel in this area is experiencing extremely unstable morphology, with very tight meander radiuses, short meander spacing, poorly formed or lack of riffles and pools and large width-to-depth ratio. The channel width within this section is substantially wider than an identified stable channel dimension immediately downstream of Market Street. Channel instability is the result of excessive sediment load entering this reach and changes in hydrology caused by construction of the diversion downstream of BR I-94. Problems include bank erosion, sedimentation, log jams and poor drain function. Estimated bank erosion is 0.5 foot per year.

Area 7 – Brookfield Avenue to Springfield Avenue – This area extends from Brookfield Avenue to Springfield Avenue, a straight line distance of approximately 310 feet. Channel morphology is unstable for a stream length of approximately 400 feet due to large volumes of sediment, formation of bars and the presence of triple culverts at both Brookfield and Springfield Avenues. At both crossings, one culvert is almost totally plugged with sediment, a second is partially blocked and the third is functioning. These culvert blockages are causing erosion and sedimentation to occur both upstream and downstream of the culverts. Estimated bank erosion is 0.5 foot per year.

4.3 HYDROLOGY AND HYDRAULICS

Peak discharge estimates along the Davis were provided from the MDEQ hydrologic studies and dam safety unit for frequencies between the 2-year to 100-year return period (rainfall event). A summary of the MDEQ peak discharges at each design point (priority area) is provided in Table 2. A copy of the MDEQ discharge request is included in Appendix 2.

Table 2 – MDEQ Peak Discharges

Area	Contributing Area (square miles)	Peak Flow Rate (cubic feet per second) Return Period and 24-Hour Precipitation Depth (Allegan County)				
		2-Year 2.37-Inches	**5-Year** 3.0-Inches	**10-Year** 3.52-Inches	**25-Year** 4.45-Inches	**100-Year** 6.15-Inches
Area 1 – Colonial Acres Trailer Park	9.4	180	270	340	430	550
Area 2 – East Cork Street	11.6	210	320	400	500	700
Area 3 – Canadian National Railroad	12.6	230	340	430	550	750
Area 4 – Canadian National Railroad to Twin Culverts	13.0	230	350	440	550	750
Area 5 – Twin Culverts	13.0	230	350	440	550	750
*Area 6 – Stewart Drive to Market Street	13.2*	240*	360*	450*	600*	750*
*Area 7 – Springfield to Brookfield	13.2*	240*	360*	450*	600*	750*

** Actual drainage area and peak flow rate is much less due to direct floodway/diversion to Kalamazoo River downstream of BR I-94*

Hydraulic calculations were performed using Manning's Equations at representative cross sections along each area of the Davis to estimate the hydraulic capacity of the channel and corresponding return frequency for both existing and proposed conditions. In general, the Davis currently has approximately a 2-year hydraulic capacity (point at which water surface overtops the low bank) as shown in Table 3, below.

Table 3 - Existing Hydraulic Capacity

Area	Existing Hydraulic Capacity*	
	Peak Flow Rate	**Return Frequency**
Area 1 – Colonial Acres Trailer Park	NA	NA
Area 2 – East Cork Street	300 cfs	> 2-Year
Area 3 – Canadian National Railroad	120 cfs	< 2-Year
Area 4 – Canadian National Railroad to Twin Culverts	274 cfs	> 2-Year
Area 5 – Twin Culverts	274 cfs	> 2-Year
*Area 6 – Stewart Drive to Market Street	20 cfs	2-Year
*Area 7 – Brookfield to Springfield	20 cfs	2-Year

** Hydraulic Capacity = point at which water overtops low bank of channel.*

4.4 POLLUTANT LOAD

The major sources of sediment, phosphorus and other pollutants within the Davis were identified from two major sources: streambank erosion and urban land use practices. Phosphorus and other pollutants are naturally found within soils and enter the Davis through bank erosion. Though sediment may also enter the Davis from urbanized development, this load is small in comparison to bank erosion. However, inputs of phosphorus and other pollutants can be substantial from urban areas as a result of improper land-use practices. Colonial Acres Trailer Park (Area 1) was identified as one such area. Pollutant inputs from Colonial Acres include animal waste, oils and greases and, to a lesser degree, fertilizers.

Within each of the seven areas, pollutant loads were calculated based exclusively on pollutant source. Streambank erosion was identified as the primary pollutant source in Areas 2 through 7. However, pollutant inputs in Area 1 are strictly related to urban land-use practices. As a result, two different methods for calculating pollutant loads were used.

Sediment, phosphorous and nitrogen pollutant loads from in-stream erosion were estimated for Areas 2 through 7, using the channel erosion equation (CEE) as described in the MDEQ *Pollutants Controlled Calculations and Documentation for Section 319 Watersheds Training Manual* (MDEQ 1999). As shown in the equation below, the CEE utilizes a direct volume method, which incorporates the bank height, bank length, lateral recession rate and density of soil to estimate the annual in-stream sediment load:

CEE = Length (feet) x Height (feet) x Lateral Recession Rate (ft/year) x Soil Weight (ton/cubic feet)

Nutrient (phosphorous and nitrogen) loads were estimated based on concentration of total sediment load and soil type using the following equation:

Nutrient Load (lb/yr) = Sediment Load (T/yr) x Nutrient Concentration (lb/lb soil) x 2000 lb/T x correction factor

Standard nutrient concentrations of 0.0005 lb phosphorous/lb of soil for phosphorous and 0.001 lb nitrogen/lb were assumed. Sandier soils, such as those found along portions of the Davis, generally have a lower nutrient capacity. Therefore, a correction factor of 0.85 was employed for estimating the nutrient load along Davis Creek. Overall, streambank erosion for Areas 2 through 7 is estimated to be contributing over 796 tons of sediment, 678 pounds of phosphorous and 1,356 pounds of nitrogen, annually.

Sediment, phosphorous and nitrogen loads from Area 1, Colonial Acres Trailer Park, was calculated using the Long-Term Hydrology Impact Assessment (L-THIA) model available from U.S. Environmental Protection Agency (USEPA) and Purdue University. This model relies on Geographic Information System (GIS) data and takes into account spatial variation of high and low runoff under various land use types to estimate pollutant loads.

A breakdown of the estimated annual pollutant loads for each priority area is summarized below in Table 4.

Table 4 - Existing Pollutant Loads

Area	Reach Length (ft)	Erosion Length (ft)	Left Bank Height (ft)	Right Bank Height (ft)	LRR (ft/yr)	Soil Weight (tons/cft)	Annual Pollutant Load		
							Sediment (tons/yr)	Phos. (lbs/yr)	Nitrogen (lbs/yr)
Area 1 – Colonial Acre Trailer Park	1,700	0	4	4	0.05	0.05	2	55	176
Area 2 – East Cork Street	700	400	4.5	4	0.5	0.05	85	72	144
Area 3 – Canadian National Railroad	900	900	5	7	0.4	0.05	216	184	368
Area 4 – Canadian National Railroad to Twin Culverts	2,400	2,400	5	4	0.25	0.05	270	230	460
Area 5 – Twin Culverts	750	300	6	6	0.5	0.05	90	77	154
Area 6 – Stewart Drive to Market Street	390	800	1	2	0.5	0.05	60	51	102
Area 7 – Springfield to Brookfield	310	400	3.5	4	0.5	0.05	75	64	128
Total		**5,200**					**798**	**733**	**1,532**

4.5 STORM WATER DETENTION STORAGE AREAS

A 5.5-acre regional detention area was constructed during the mid 1970s by the United States Army Corps of Engineers downstream and north of Covington Road behind Wings Stadium. Field survey indicates no other storm water detention or recharge areas exist within the watershed.

4.6 ROAD CULVERTS AND DRAINAGE WAYS

Almost all of the road culverts and drainage ways in the watershed are appropriately sized and, for the most part, functioning as intended. Field survey indicates that only 2 culverts (Area 5 – Twin Culverts) are in a state of total failure and one culvert (Area 1 – Deadwood Road) as requiring modification to better facilitate flow and improve hydraulic efficiency.

4.7 WATER QUALITY AND CHEMISTRY

Low concentrations of dissolved oxygen and high nutrient loads for *e. coli* have been noted since 1999 in Area 1 (Colonial Acres Trailer Park). Based on personal communication with Ms. Janelle Hohm (MDEQ) and from literature review, no water chemistry data exists on phosphorus levels within the Davis. General practice has been to identify areas of excessive vegetative growth to identify potentially high phosphorus input. The 2010 engineering survey did not identify any areas of high nutrification within the Davis or specific sources for phosphorus. Therefore, phosphorus contributions to the Davis are based on phosphorus inputs from bank and bed erosion from six areas and phosphorous introduced from Colonial

Acres Trailer Park. Substances such as toxic mercury, chromium, arsenic, polychlorinated biphenyls (PCB), oils and greases have been confirmed in the Davis and are generally associated with industrial and residential land use. Their identification, other than through existing documentation, was beyond the scope of this project.

4.8 NPDES DISCHARGES

Twenty one National Pollutant Discharge Elimination System (NDPES) discharges are presently permitted to the Davis. Discharge locations are shown in Figure 7. Information regarding permittee and discharge type is provided in Appendix 3.

5.0 EVALUATION OF ALTERNATIVES

Many BMP options exist and were considered to address issues related to flooding, obstructions, erosion and sedimentation and are summarized in Table 5, below.

Table 5 - Available BMPs

Purpose	Best Management Practices	Impairment Identified		
		Flooding	Obstructions	Erosion and Sedimentation
Maintenance	Stream Corridor Management	X	X	X
	In-Stream Structures	X	X	X
	Side Inlet Stabilization			X
Conveyance	Channel Realignment/Bar Removal		X	X
	Channel Redesign	X	X	X
	Low Flow Channel	X		X
	Crossing Capacity and Condition	X		X
Storage	Detention/Retention	X		
	Floodplain Preservation	X		

5.1 MAINTENANCE

Stream Corridor Management

Stream corridor management includes numerous approaches for management of the vegetation and debris present in the stream corridor. Measures include:

- Removal of trash and debris
- In-stream woody debris management (snagging and removal of log jams)
- Selective clearing of tree canopy (0 to 100%) to facilitate vegetative growth on banks for stability
- Removal of brush and vegetation overhanging stream

The use of stream management BMPs outlined above are strongly recommended for use throughout the entire reach of the Davis to ensure overall conveyance, stability and healthy drain system are maintained.

In-Stream Structures

In-stream structures such as cross vanes, vanes, and j-hooks are used to centralize and direct flows while protecting eroding streambanks. In addition, these structures capture sediment from upstream areas and facilitate the creation of 2-stage channels and aid in establishing appropriate width-to-depth ratios. Riffle structures are used to provide grade control and addresses downcutting in channels. In-stream structures provide a practical and cost-effective means for addressing grade control, erosion and sedimentation concerns within any watercourse.

The use of in-stream structures identified above is essential to address impairments in six of the seven priority areas and would also be recommended for use throughout the entire system.

Side Inlet Stabilization

Side inlet stabilization practices (tile outlet protection, rock and vegetated chutes, drop structures, tributary grade control, etc.) reduce the amount of sediment entering watercourse.

The use of side inlet stabilization is recommended for use within the Davis. However, no side inlets were identified as requiring stabilization within the seven priority areas.

5.2 CONVEYANCE

Channel Re-alignment/Bar Removal

Removal of mid-stream bars and selective removal of point bars will facilitate centralized flows and reduced bank erosion. Hydraulics will be improved if these obstructions are removed and depositional areas are managed appropriately. During construction, excavated materials can be placed along the toe of eroding banks to facilitate development of 2-stage channels and reduces construction costs as material is not hauled offsite.

The use of channel re-alignment and bar removal is strongly recommended for use in some of the seven areas. However, to improve long-term stability of this work, upstream sediment loads must be addressed prior to commencement of this work.

Channel Re-design

This alternative involves altering the dimensions, pattern and profile of an unstable channel to create a new channel that will not aggrade or degrade given the projected sediment load and bank-full flow. This approach is used when a channel has been degraded or altered to a point that individual in-stream practices and natural channel evolution will not occur for a very long time. Channels exhibiting very tight meander radiuses, short meander spacing, poorly formed riffles and/or pools are candidates for channel re-design. A stable pattern and profile can be created to facilitate conveyance, reduce erosion and re-establish aquatic habitat.

Some level of channel re-design is highly recommended for six of the seven areas.

Low-Flow Channel

Low-flow channels are created to concentrate flows and increase channel velocity and depth. Watercourses created where soil conditions are highly organic and consist of muck and silts will quickly fill in and limit conveyance and contribute to flooding.

Creating a low-flow channel is recommended within one of the seven areas.

Crossing Capacity and Condition

Culverts that have failed, are improperly sized, located and/or in poor condition can result in increased incidences of flooding and often cause bank erosion and failures.

Removal of failed culverts and/or culvert modification and alteration is recommended within two of the seven areas.

5.3 STORAGE

Detention/Retention

Storm water detention/retention areas offer flood relief and provide opportunity for filtering of pollutants, such as phosphorus, prior to water being released into stream corridors. These areas are not only functional but can be considered aesthetically pleasing when properly designed and installed.

Due to the highly urbanized nature of the watercourse, no potential detention/retention sites were identified beyond what presently exists within the wetlands south of Kilgore and the dam behind Wing's Stadium. Evaluation of potential wetland restoration areas indicates little opportunity to restore lost wetlands due to the highly urbanized nature of the watershed, (Figure 8). In addition, many of the potential wetland restoration areas are relatively small in size and determined to have very limited ability to provide detention or water quality improvement to the Davis.

With regard to detention upstream of the dam, there was insufficient data available concerning the structure to determine if additional storage capacity would be available within the existing wetland. The eight potential centralized retention and recharge areas identified in the 1976 study completed by Wilkins & Wheaton Engineering Company were determined no longer viable due to urban growth within the areas; topographic constraints; and some areas already function to their maximum extent for storage of water. Based on these findings, creation of detention/retention areas to address flooding concerns and uptake of pollutants prior to entering the Davis was determined to not be feasible or a recommended alternative.

Floodplain Preservation

Many of the problems associated with flooding, channel degradation and pollutant loading could be reduced by ensuring appropriate floodplain is maintained within the stream corridor. Unfortunately, much of the floodplain along the corridor has been lost due to industrial, infrastructure and residential development. Prohibiting construction activities within the floodplain through local ordinances and use of county and municipal storm water design criteria may be effective in maintaining or restoring to a pre-settlement condition.

Preservation of floodplain through the use of local ordinances and storm water design criteria are recommended for use in the Davis Creek watershed. However, development of these criterions is outside the scope of this project.

6.0 RECOMMENDATIONS

Based on the 2010 engineering survey and data review, it was determined that a combination of BMPs would provide significant water quality improvement within the seven priority areas, which in turn would bring significant improvement to the Davis in its entirety. It is recommended that corrective BMPs be installed to reduce bank erosion and sediment transport. By doing so, phosphorus and other pollutants contained within the soils will be prevented from entering the Davis, Kalamazoo River and Lake Allegan. Since water chemistry sampling was not part of this study we relied on existing, but limited, water chemistry data and field observations to identify upland sources of phosphorus and other pollutants. Based on results of the field survey, it was determined that specific BMPs to improve detention and uptake of pollutants and nutrients before it enters the Davis would not practical. Therefore, it is our finding that the most prudent and feasible method of reducing phosphorus and improving water quality is implementation of instream stabilization measures.

Corrective BMPs were identified for each of the seven high priority areas and are shown in Appendix 4. Estimated construction costs, implementation priority and timeframe and technical assistance required are also included in Appendix 4. Implementation priority was determined based on each area's severity of impairments and its overall impact on channel stability throughout the entire Davis. In addition, consideration was given to impacts on riparian landowners.

6.1 PROPOSED POLLUTANT REDUCTIONS

A system of BMPs proposed for Areas 2 through 7 assumes that annual pollutant loads from in-stream erosion within the Davis will be completely eliminated through the implementation of the BMPs. However, pollutant reductions will not be achieved in Area 1 simply through implementation of proposed BMPs. Proposed BMPs in Area 1 are intended to address concerns with flooding as bank erosion is not occurring in this area. Pollutant reductions will only be achieved in Area 1 through implementation of changes in land-use practices and upland BMPs within the trailer park. Such BMPs may include pet waste control practices, oil and grease management and altered use of fertilizers. Development of these types of BMPs was not included in the scope of this project but can be addressed through the larger Kalamazoo River Watershed Management Plan.

Should proposed BMPs in Areas 2 through 7 be implemented, it is anticipated that phosphorus and other pollutant load reductions will be achieved in both Davis and Lake Allegan. A breakdown of proposed pollutant reductions by BMP type and within each of the seven priority areas is provided show in Tables 6 and 7 below.

Table 6 – Pollutant Reductions by BMP Type

Type of BMP	BMP		Annual Pollutant Reduction		
	Quantity	Unit	Sediment (tons/yr)	Phosphorous (lbs/yr)	Nitrogen (lbs/yr)
Rock Cross Vane	16	EA	240	204	408
Rock Vane	3	EA	24	21	42
Rock Riffle	21	EA	168	143	286
Rock Riprap	750	SY	251	214	428
Channel Realignment	1,685	LF	113	96	192
Total			**796**	**678**	**1,356**

Table 7 – Pollutant Reduction by Area

Area	Annual Pollutant Reduction		
	Sediment (tons/yr)	Phosphorous (lbs/yr)	Nitrogen (lbs/yr)
Area 1 – Colonial Acres	0	0	0
Area 2 – East Cork Street	85	72	144
Area 3 – Canadian National Rail Road	216	184	368
Area 4 – Canadian National Rail Road to Twin Culverts	270	230	460
Area 5 – Twin Culverts	90	77	154
Area 6 – Stewart Drive to Market Street	60	51	102
Area 7 – Springfield to Brookfield	75	64	128
Total	**796**	**678**	**1,356**

6.2 PROPOSED HYDRAULIC IMPROVEMENTS

Equally important to reducing pollutant loads, the recommended BMPs will also provide considerable improvement to hydraulics as stable channel patterns and profiles are created and maintained. Comparisons of existing and anticipated hydraulic capacities are shown in Table 8 below.

Table 8 - Anticipated Hydraulic Improvements

Area	Existing Hydraulic Capacity*		Proposed Hydraulic Capacity*	
	Peak Flow Rate	Return Frequency	Peak Flow Rate	Return Frequency
Area 1 – Colonial Acres Trailer Park	NA	NA	NA	NA
Area 2 – East Cork Street	300 cfs	> 2-Year	770 cfs	100-Year
Area 3 – Canadian National Railroad	120 cfs	< 2-Year	140 cfs	< 2-Year
Area 4 – Canadian National Railroad to Twin Culverts	274 cfs	>2-Year	289 cfs	>2-Year
Area 5 – Twin Culverts	274 cfs	> 2-Year	289 cfs	> 2-Year
*Area 6 – Stewart Drive to Market Street	20 cfs	2-Year	24 cfs	Bankfull
*Area 7 – Brookfield to Springfield	20 cfs	2-Year	24 cfs	Bankfull

** Hydraulic Capacity = point at which water overtops low bank of channel.*

7.0 CONCLUSION

Currently, the Davis Creek exhibits numerous characteristics indicative of an extremely impaired and degraded watercourse. Over the past 20 years, the Davis has been subject to increased urbanization and unchecked pollutant loadings while receiving few, if any, improvement measures to aid in maintaining overall channel stability and stream health. Implementation of the recommended BMPs in the seven priority areas is an excellent start for revitalizing the Davis. As the seven priority areas are stabilized, impairments currently being transferred downstream from these areas will cease and improvements will slowly be noted throughout other reaches of the Davis. Moreover, phosphorus and pollutants entering Lake Allegan via Davis Creek will also be greatly reduced.

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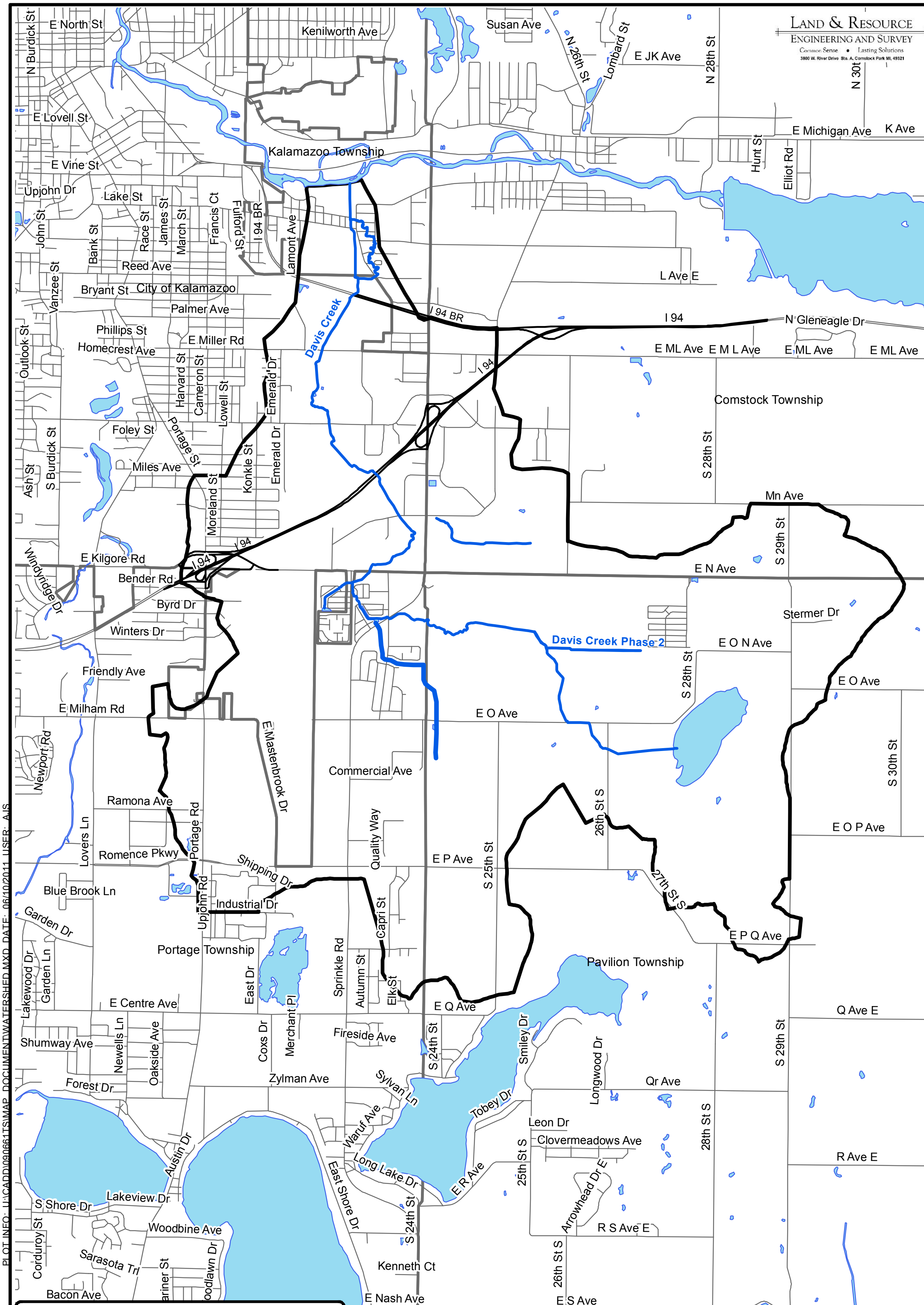
Figures



Legend

Davis Creek Watershed

NORTH

DAVIS CREEK

0 — 2,500 — 5,000 FEET

ftc&h

engineers
scientist
architects
constructors

fishbeck, thompson, carr & huber, inc.

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Kalamazoo County, Michigan

Davis Creek

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PROJECT NO.
G090661TS

FIGURE NO.
1

PLOT INFO: U:\CADD\090661TS\MAP_DOCUMENTS\WATERSHED.MXD DATE: 06/10/2011 USER: AJS

SYMBOL LEGEND

DRAINAGE DISTRICT

DAVIS CREEK

NORTH

DRAINAGE DISTRICT
DAVIS CREEK
NO SCALE

ftc&h

engineers
scientists
architects
constructors

fishbeck, thompson, carr & huber, inc.

Davis Creek Restoration Project

Kalamazoo County, Michigan

Davis Creek
Drainage District Boundary

Drawn By
Designer
Reviewer
Manager

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PROJECT NO.
G090661TS

SHEET NO.
2

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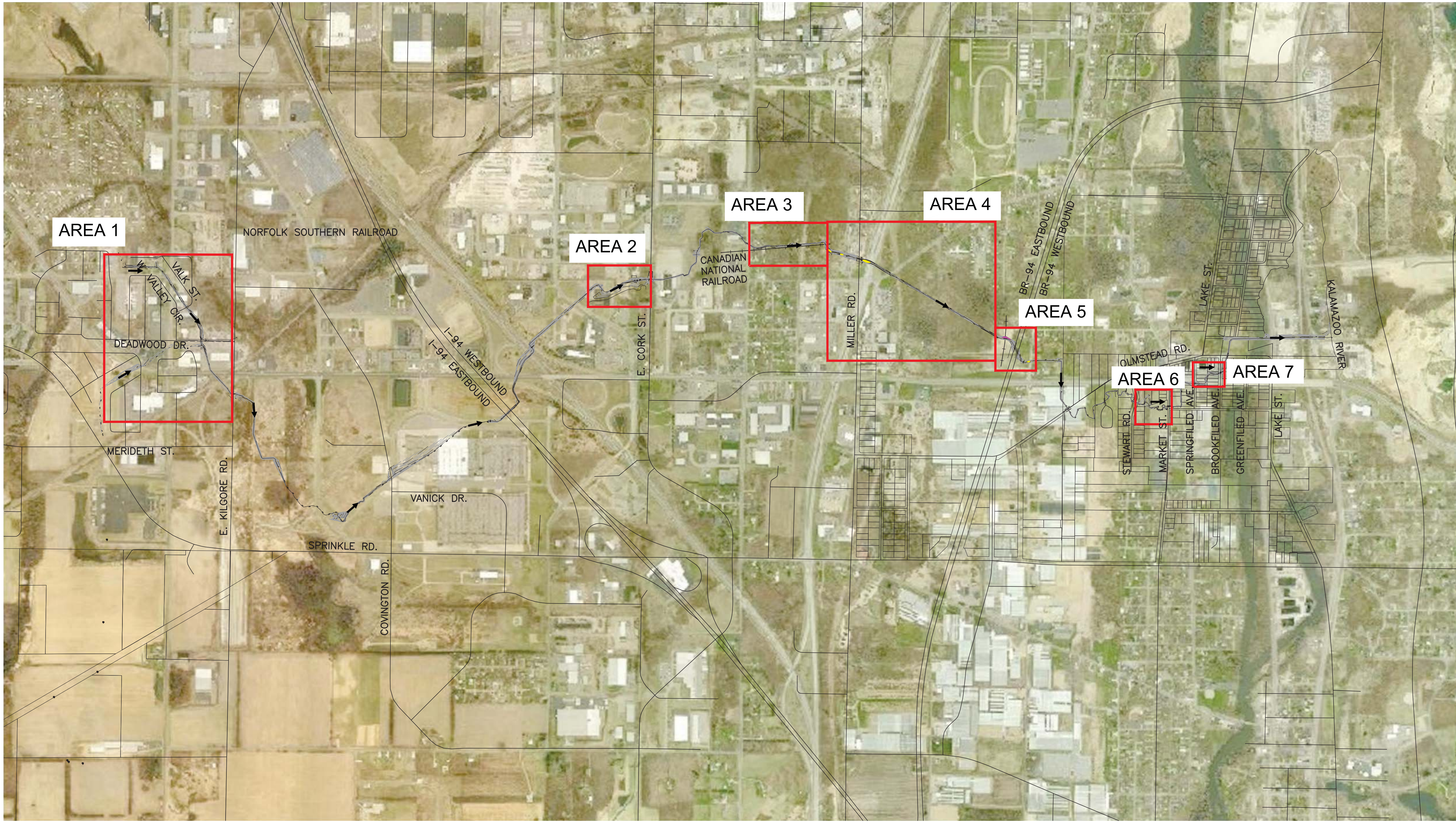

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AREAS OF CONCERN
DAVIS CREEK

SCALE: 1" = 600'
0 300 600 1200

NORTH

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LAND & RESOURCE ENGINEERING AND SURVEY

Davis Creek Restoration Project
Kalamazoo County, Michigan

Davis Creek
Seven Priority Areas

michigan.gov/recovery

Drawn By	AJS
Designer	TRB
Reviewer	CLP
Manager	TRB

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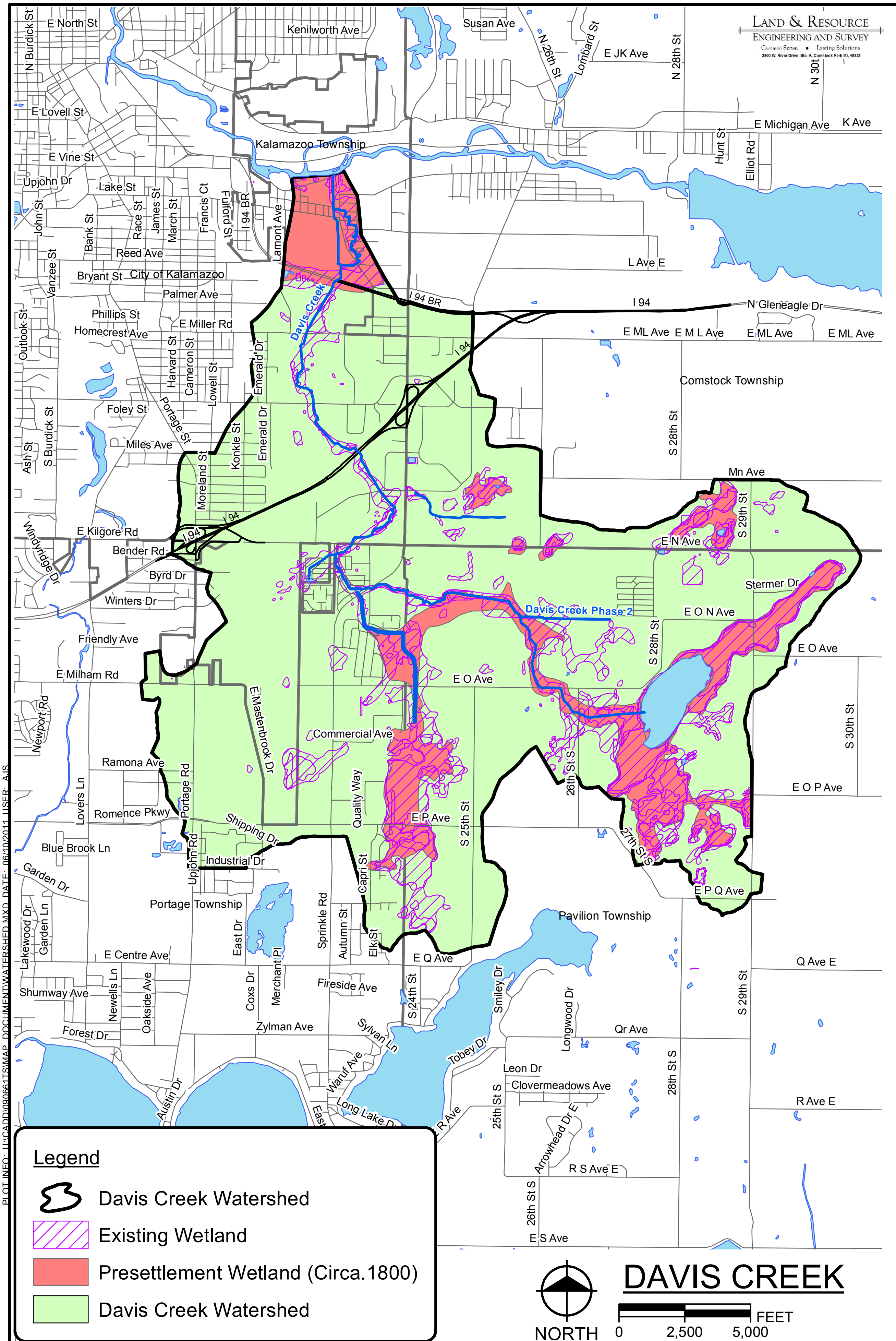
PROJECT NO.
G090661TS

SHEET NO.
3



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Kalamazoo County, Michigan

Davis Creek

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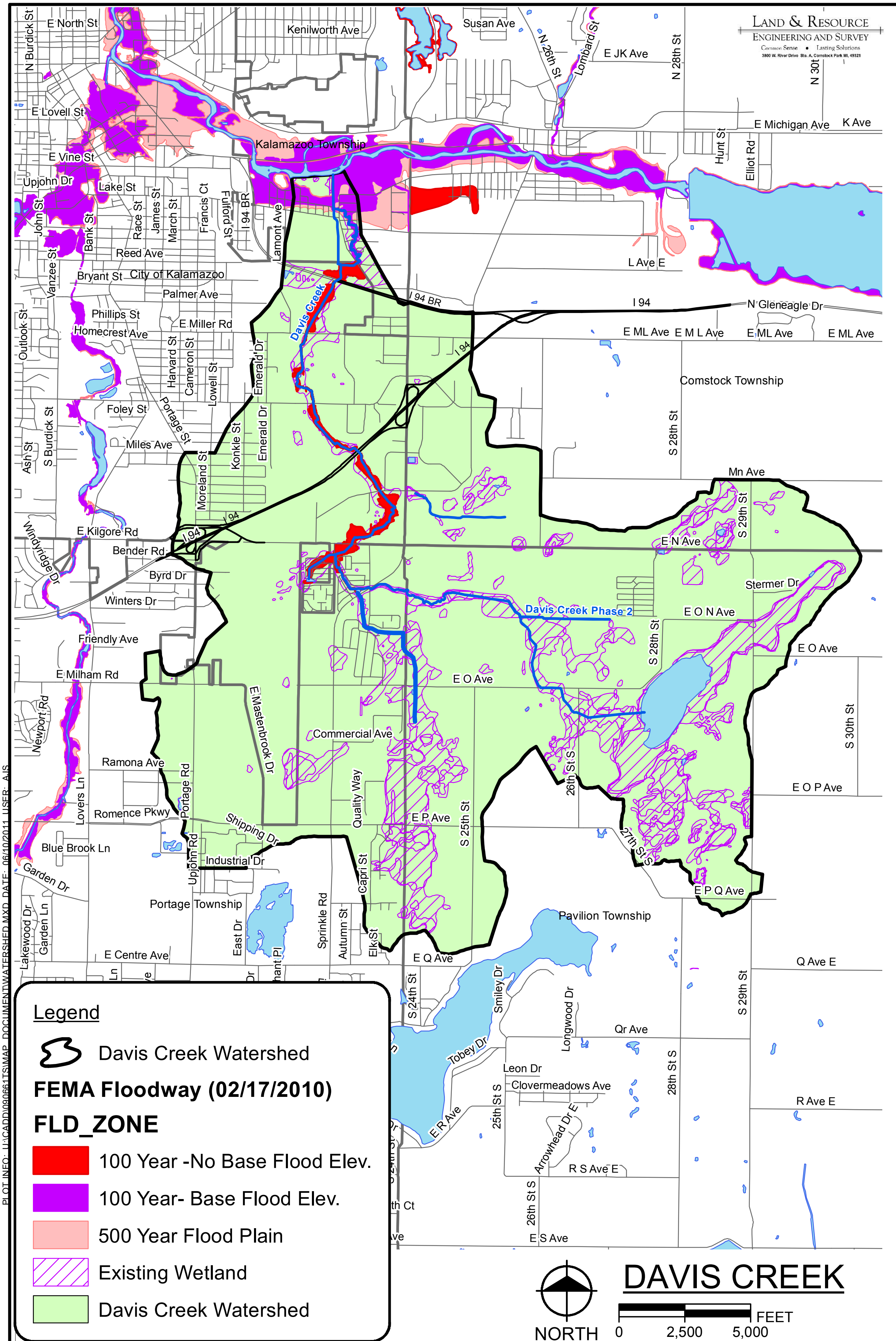
PROJECT NO.
G090661TS

FIGURE NO.
4



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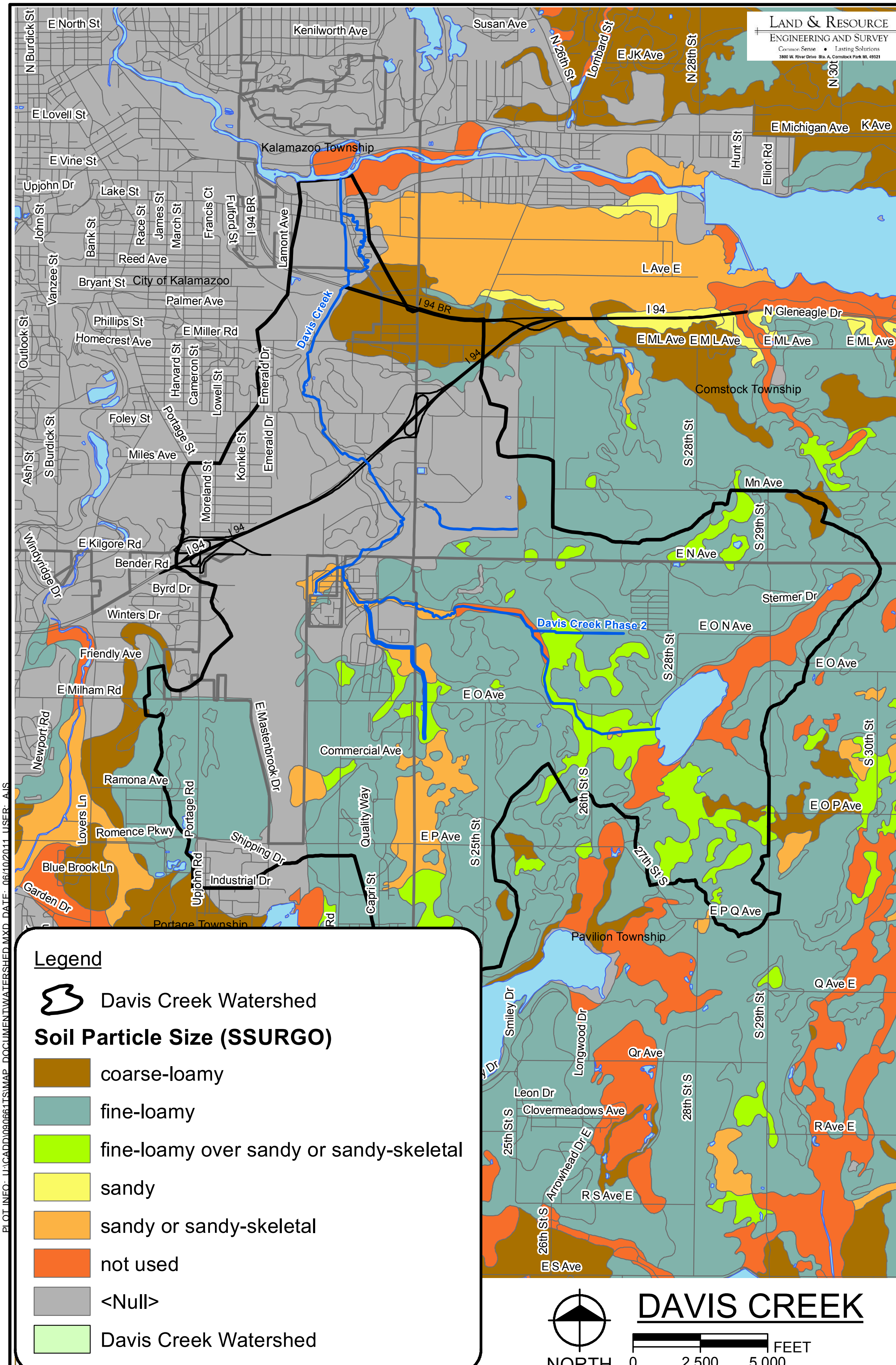
PROJECT NO.
G090661TS

FIGURE NO.
5



DAVIS CREEK

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Kalamazoo County, Michigan
Davis Creek

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PROJECT NO.
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FIGURE NO.
6

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NORTH

0 2000 4000

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Common Sense • Lasting Solutions
3800 W. River Drive Ste. A, Comstock Park MI, 49321

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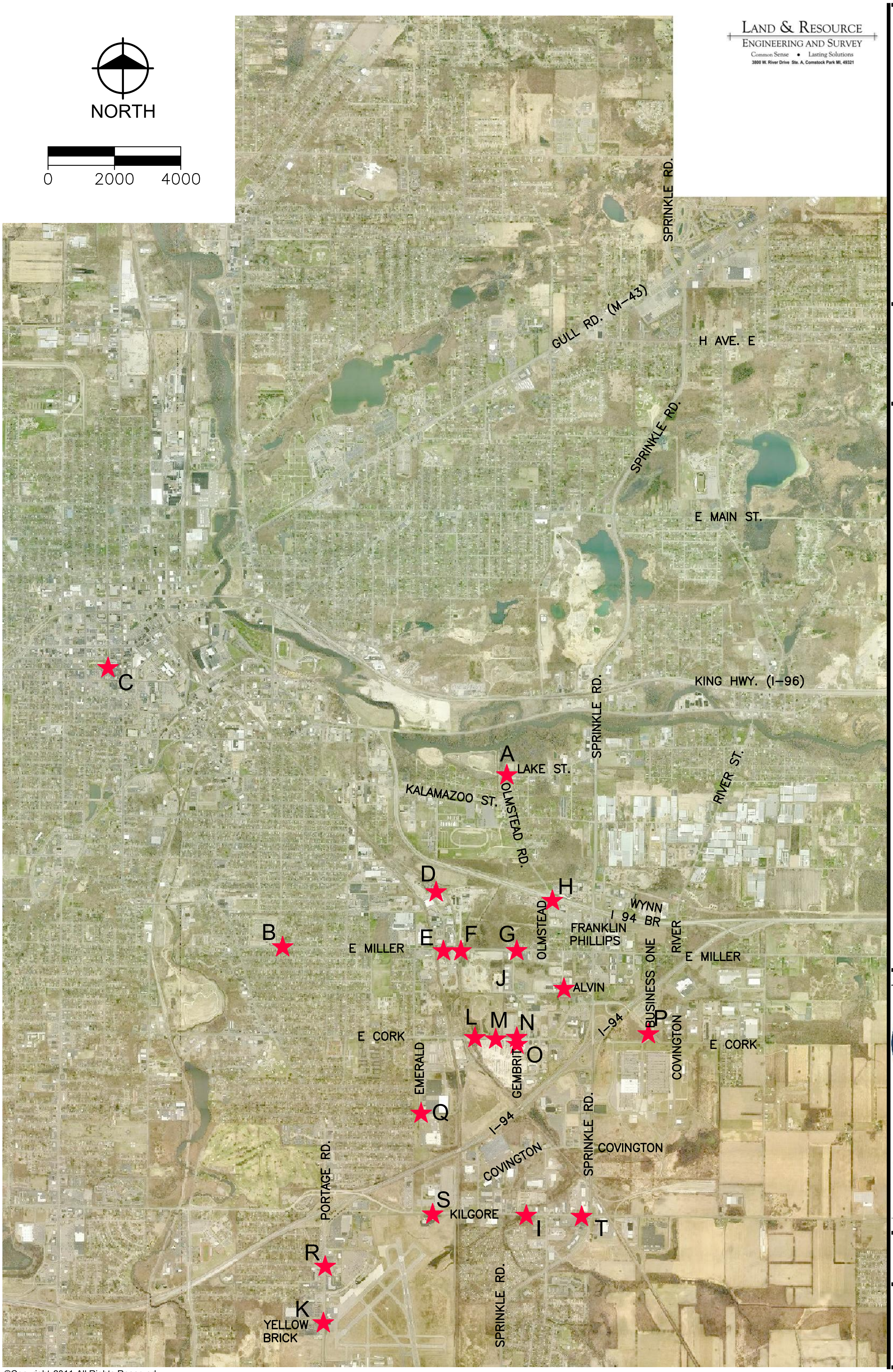

Kalamazoo County Drain Commissioner

Kalamazoo County, Michigan

Davis Creek
NPDES Discharge Locations

RECOVERY.GOV

michigan.gov/recovery

PROJECT NO.
G090661TS

FIGURE NO.
7

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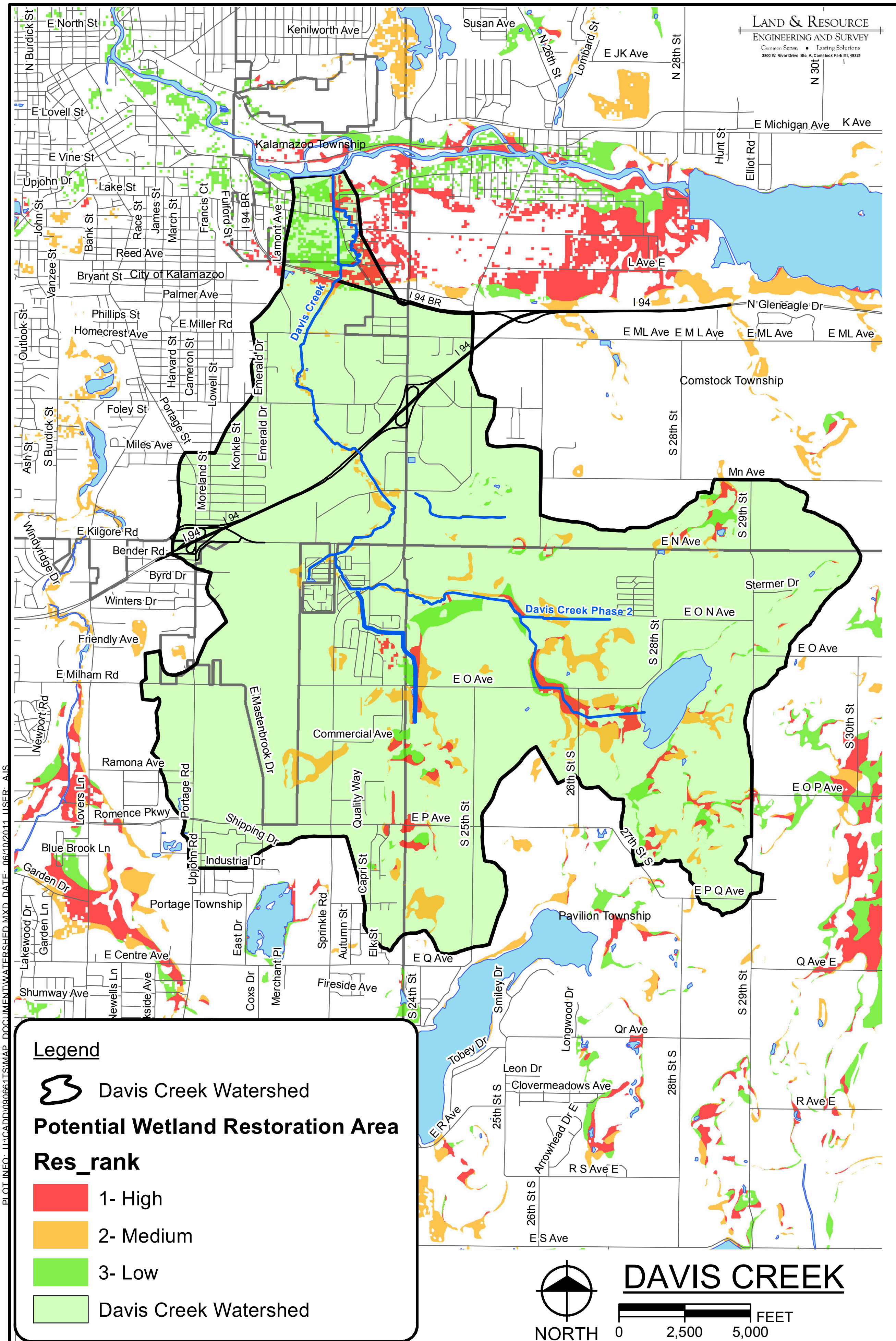

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Kalamazoo County, Michigan

Davis Creek

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PROJECT NO.
G090661TS

FIGURE NO.
8

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Appendix 1

AREA 1 – COLONIAL ACRES

Plugged culvert; stagnant water

Stagnant water conditions; no flow due to mucky and organic silts and soils

Stagnant water; bank erosion; over-widened channel

AREA 2 – EAST CORK STREET

Meandering, unstable channel undercutting building

Sediment bars, blockages and failed culverts

Blockages and debris in channel

Upstream of building – unstable pattern and profile

AREA 3 – CANADIAN NATIONAL RAILROAD

Failed stabilization efforts; excessive grade

Sediment bar forcing flow to adjacent bank with railroad tracks

AREA 4 – CANADIAN NATIONAL RAILROAD TO TWIN CULVERTS

Sediment bar; overwidened channel resulting in undercutting and fallen trees

Bank erosion and debris downstream of railroad tracks

Sediment bar

Over-widened channel; fallen trees

AREA 5 – TWIN CULVERTS

Blockages upstream end of twin culverts; sedimentation

Excessive bank erosion; fallen trees; sedimentation

Failed culverts; bank erosion; blockages; sedimentation

Sedimentation upstream of failed twin culverts

AREA 6 – STEWART DRIVE TO MARKET STREET

Unstable pattern; excessive sediment load

Braided channel; sedimentation; fallen trees; unstable pattern

Sedimentation; fallen trees; unstable pattern

Sediment bars

AREA 7 – SPRINGFIELD TO BROOKFIELD

Sedimentation; point bars

Tight meander pattern

Plugged culvert

Debris; fallen trees

Appendix 2

Fredricks, Daniel

From: Visker, Kyle J.
Sent: Thursday, June 16, 2011 11:43 AM
To: Fredricks, Daniel
Subject: FW: flood or low flow discharge request (ContentID - 168812)

-----Original Message-----
From: DEQ-LWM-QREQ [mailto:DEQ-LWM-QREQ@michigan.gov]
Sent: Thursday, December 16, 2010 1:39 PM
To: Visker, Kyle J.
Subject: RE: flood or low flow discharge request (ContentID - 168812)

This reply is being sent via email only.

We have estimated the flood frequency discharges requested in your email of November 17, 2010 (Process No. 20100471), as follows:

Davis Creek at Brookfield Avenue, Section 24, T2S, R11W, Kalamazoo Township, Kalamazoo County, has a total drainage area of 14.4 square miles and a contributing drainage area of 13.2 square miles. The 50%, 20%, 10%, 4%, 2%, and 1% chance peak flows are estimated to be 240 cubic feet per second (cfs), 360 cfs, 450 cfs, 600 cfs, 700 cfs, and 750 cfs, respectively. (Watershed Basin No. 17 Kalamazoo).

Davis Creek at Market Street, Section 24, T2S, R11W, Kalamazoo Township, Kalamazoo County, has a total drainage area of 14.3 square miles and a contributing drainage area of 13.2 square miles. The 50%, 20%, 10%, 4%, 2%, and 1% chance peak flows are estimated to be 240 cubic feet per second (cfs), 360 cfs, 450 cfs, 600 cfs, 700 cfs, and 750 cfs, respectively. (Watershed Basin No. 17 Kalamazoo).

Davis Creek at Business I-94, Section 25, T2S, R11W, City of Kalamazoo, Kalamazoo County, has a total drainage area of 14.1 square miles and a contributing drainage area of 13 square miles. The 50%, 20%, 10%, 4%, 2%, and 1% chance peak flows are estimated to be 230 cubic feet per second (cfs), 350 cfs, 440 cfs, 550 cfs, 650 cfs, and 750 cfs, respectively. (Watershed Basin No. 17 Kalamazoo).

Davis Creek at Miller Road, Section 25, T2S, R11W, City of Kalamazoo, Kalamazoo County, has a total drainage area of 13.8 square miles and a contributing drainage area of 12.6 square miles. The 50%, 20%, 10%, 4%, 2%, and 1% chance peak flows are estimated to be 230 cubic feet per second (cfs), 340 cfs, 430 cfs, 550 cfs, 650 cfs, and 750 cfs, respectively. (Watershed Basin No. 17 Kalamazoo).

Davis Creek at Cork Street, Section 36, T2S, R11W, City of Kalamazoo, Kalamazoo County, has a total drainage area of 12.8 square miles and a contributing drainage area of 11.6 square miles. The 50%, 20%, 10%, 4%, 2%, and 1% chance peak flows are estimated to be 210 cubic feet per second (cfs), 320 cfs, 400 cfs, 500 cfs, 600 cfs, and 700 cfs, respectively. (Watershed Basin No. 17 Kalamazoo).

Davis Creek at I-94, Section 36, T2S, R11W, City of Kalamazoo, Kalamazoo County, has a total drainage area of 12 square miles and a contributing drainage area of 10.8 square miles. The 50%, 20%, 10%, 4%, 2%, and 1% chance peak flows are estimated to be 200 cubic feet per second (cfs), 300 cfs, 380 cfs, 480 cfs, 600 cfs, and 650 cfs, respectively. (Watershed Basin No. 17 Kalamazoo).

Davis Creek at Kilgore Road, Section 1, T3S, R11W, City of Portage, Kalamazoo County, has a total drainage area of 10.5 square miles and a contributing drainage area of 9.4 square miles. The 50%, 20%, 10%, 4%, 2%, and 1% chance peak flows are estimated to be 180 cubic feet per second (cfs), 270 cfs, 340 cfs, 430 cfs, 500 cfs, and 550 cfs, respectively. (Watershed Basin No. 17 Kalamazoo).

Please include a copy of this letter with your application for permit. These estimates should be confirmed by our office if an application is not submitted within one year. If you have any questions concerning the discharge estimates, please contact Ms. Susan Greiner, Hydrologic Studies and Dam Safety Unit, at 517-241-1210 or by email to greiners@michigan.gov. Any questions concerning the hydraulics or the proper procedure for filing for a permit should be directed to Mr. Ernest Sarkipato, Water Resources Division, Kalamazoo District Office, at 269-567-3564 or email to sarkipatoe@michigan.gov.

-----Original Message-----
From: Kyle Visker [mailto:kjvisker@ftch.com]
Sent: Wednesday, November 17, 2010 4:15 PM
To: DEQ-LWM-QREQ; Nolan, Anne (DTMB)
Subject: flood or low flow discharge request (ContentID - 168812)

Requestor: Kyle Visker
Company: Fishbeck, Thopson, Carr & Huber, Inc.
Address: 1515 Arboretum Drive, SE
City: Grand Rapids, MI
Zip: 49546
Phone: (616) 464-3963
Date: 11/17/2010
F50percent: Yes
F20percent: Yes
F10percent: Yes
F4percent: Yes
F2percent: Yes
F1percent: Yes
ContactAgency: None Selected
ContactPerson:
Watercourse: Davis Creek
LocalName:
CountyLocation: Kalamazoo
CityorTownship: Kalamazoo Township
Section: 24
Town: 2S
Range: 11W
Location: Please provide flood discharges for the following locations along Davis Creek:
1. Davis Creek at Brookfield Avenue, in the SE 1/4 of Section 24.
2. Davis Creek at Market Street, in the SE 1/4 of Section 24.
3. Davis Creek at BR-94, in the N 1/2 of Section 25.
4. Davis Creek at Miller Road, in the W 1/2 of Section 25.
5. Davis Creek at Cork Street, along the S line of Section 25.
6. Davis Creek at I-94, in the NE 1/4 of Section 36.
7. Davis Creek at Kilgore Road, along the S line of Section 36.
FFR1: Other

Content-Length: 426437

Worksheet for Existing Area - 2

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.00250	ft/ft
Normal Depth	4.82	ft
Section Definitions		

Station (ft)	Elevation (ft)
-0+30	808.03
-0+26	808.03
0+00	808.03
0+01	808.03
0+04	808.03
0+12	808.03
0+17	808.03
0+19	805.28
0+19	803.49
0+22	803.39
0+27	803.18
0+29	803.26
0+35	803.48
0+36	805.29
0+37	805.68
0+54	806.84
0+59	807.21
0+77	808.41

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(-0+30, 808.03)	(0+17, 808.03)	0.060
(0+17, 808.03)	(0+37, 805.68)	0.030
(0+37, 805.68)	(0+77, 808.41)	0.060

Worksheet for Existing Area - 2

Results

Discharge		300.83	ft^3/s
Elevation Range	803.18 to 808.41 ft		
Flow Area		122.55	ft^2
Wetted Perimeter		57.56	ft
Top Width		53.68	ft
Normal Depth		4.82	ft
Critical Depth		2.40	ft
Critical Slope		0.03364	ft/ft
Velocity		2.45	ft/s
Velocity Head		0.09	ft
Specific Energy		4.91	ft
Froude Number		0.29	
Flow Type	Subcritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	4.82	ft
Critical Depth	2.40	ft
Channel Slope	0.00250	ft/ft
Critical Slope	0.03364	ft/ft

Cross Section for Existing Area - 2

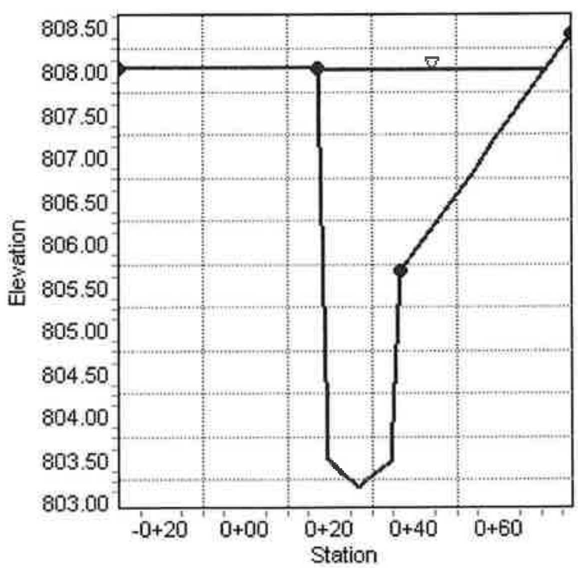
Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.00250	ft/ft
Normal Depth	4.82	ft
Discharge	300.83	ft³/s

Cross Section Image



Worksheet for Proposed Area - 2

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.00250	ft/ft
Normal Depth	5.70	ft

Section Definitions

Station (ft)	Elevation (ft)
-0+30	808.20
-0+17	808.00
-0+06	802.30
0+06	802.30
0+17	808.00
0+30	808.20

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(-0+30, 808.20)	(-0+17, 808.00)	0.060
(-0+17, 808.00)	(0+17, 808.00)	0.030
(0+17, 808.00)	(0+30, 808.20)	0.060

Results

Discharge	769.80	ft^3/s
Elevation Range	802.30 to 808.20 ft	
Flow Area	133.38	ft^2
Wetted Perimeter	37.49	ft
Top Width	34.80	ft
Normal Depth	5.70	ft
Critical Depth	4.01	ft
Critical Slope	0.01008	ft/ft
Velocity	5.77	ft/s
Velocity Head	0.52	ft

Worksheet for Proposed Area - 2

Results

Specific Energy		6.22	ft
Froude Number		0.52	
Flow Type	Subcritical		

GVF Input Data

Downstream Depth		0.00	ft
Length		0.00	ft
Number Of Steps		0	

GVF Output Data

Upstream Depth		0.00	ft
Profile Description			
Profile Headloss		0.00	ft
Downstream Velocity		Infinity	ft/s
Upstream Velocity		Infinity	ft/s
Normal Depth		5.70	ft
Critical Depth		4.01	ft
Channel Slope		0.00250	ft/ft
Critical Slope		0.01008	ft/ft

Cross Section for Proposed Area - 2

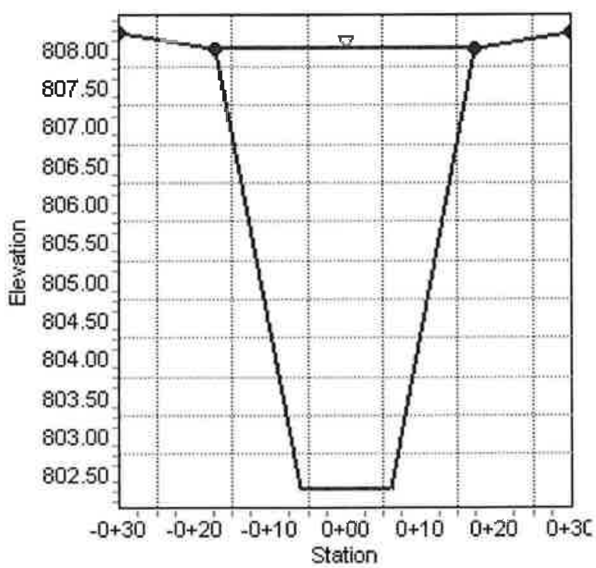
Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.00250	ft/ft
Normal Depth	5.70	ft
Discharge	769.80	ft³/s

Cross Section Image



Worksheet for Existing Area - 3

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.00500	ft/ft
Normal Depth	2.04	ft
Section Definitions		

Station (ft)	Elevation (ft)
-0+20	792.94
-0+06	792.90
-0+04	792.49
-0+03	790.44
0+01	790.36
0+06	790.44
0+08	790.62
0+10	792.40
0+16	792.50

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(-0+20, 792.94)	(-0+04, 792.49)	0.060
(-0+04, 792.49)	(0+10, 792.40)	0.030
(0+10, 792.40)	(0+16, 792.50)	0.060

Results

Discharge	119.63	ft^3/s
Elevation Range	790.36 to 792.94 ft	
Flow Area	25.49	ft^2
Wetted Perimeter	16.43	ft
Top Width	14.57	ft
Normal Depth	2.04	ft
Critical Depth	1.53	ft

Worksheet for Existing Area - 3

Results

Critical Slope		0.01352	ft/ft
Velocity		4.69	ft/s
Velocity Head		0.34	ft
Specific Energy		2.38	ft
Froude Number		0.63	
Flow Type	Subcritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.04	ft
Critical Depth	1.53	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.01352	ft/ft

Cross Section for Existing Area - 3

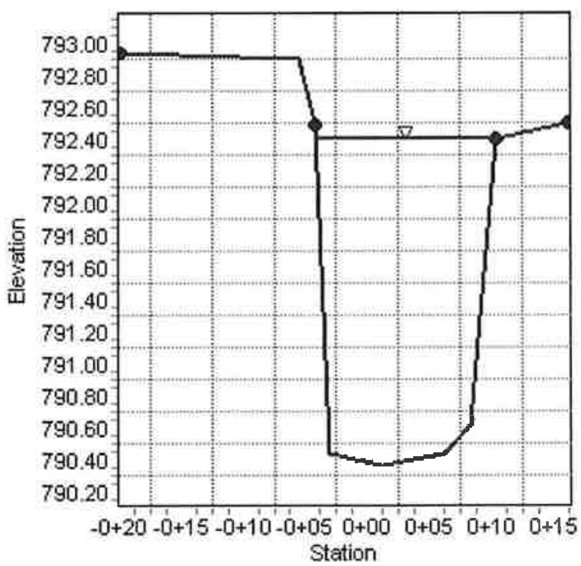
Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.00500	ft/ft
Normal Depth	2.04	ft
Discharge	119.63	ft³/s

Cross Section Image



Worksheet for Proposed Area - 3

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.00500	ft/ft
Normal Depth	1.92	ft

Section Definitions

Station (ft)	Elevation (ft)
-0+11	792.91
-0+06	790.48
0+06	790.48
0+10	792.40

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(-0+11, 792.91)	(0+10, 792.40)	0.030

Results

Discharge	138.30	ft^3/s
Elevation Range	790.48 to 792.91 ft	
Flow Area	30.45	ft^2
Wetted Perimeter	20.62	ft
Top Width	19.72	ft
Normal Depth	1.92	ft
Critical Depth	1.47	ft
Critical Slope	0.01288	ft/ft
Velocity	4.54	ft/s
Velocity Head	0.32	ft
Specific Energy	2.24	ft
Froude Number	0.64	
Flow Type	Subcritical	

Worksheet for Proposed Area - 3

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.92	ft
Critical Depth	1.47	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.01288	ft/ft

Cross Section for Proposed Area - 3

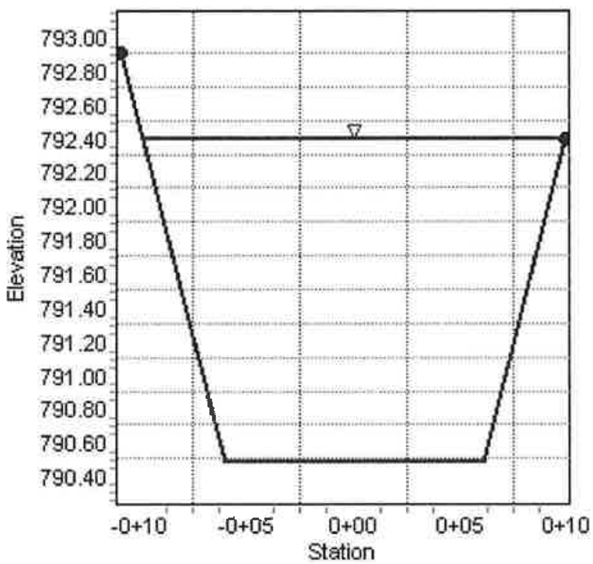
Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.00500	ft/ft
Normal Depth	1.92	ft
Discharge	138.30	ft^3/s

Cross Section Image



Worksheet for Existing Area - 4,5

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.00200	ft/ft
Normal Depth	3.31	ft

Section Definitions

Station (ft)	Elevation (ft)
-0+14	778.00
-0+10	774.97
-0+01	774.33
0+09	774.32
0+12	777.63

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(-0+14, 778.00)	(0+12, 777.63)	0.030

Results

Discharge	274.13	ft^3/s
Elevation Range	774.32 to 778.00 ft	
Flow Area	67.72	ft^2
Wetted Perimeter	27.41	ft
Top Width	25.06	ft
Normal Depth	3.31	ft
Critical Depth	2.02	ft
Critical Slope	0.01194	ft/ft
Velocity	4.05	ft/s
Velocity Head	0.25	ft
Specific Energy	3.56	ft
Froude Number	0.43	
Flow Type	Subcritical	

Worksheet for Existing Area - 4,5

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.31	ft
Critical Depth	2.02	ft
Channel Slope	0.00200	ft/ft
Critical Slope	0.01194	ft/ft

Cross Section for Existing Area - 4,5

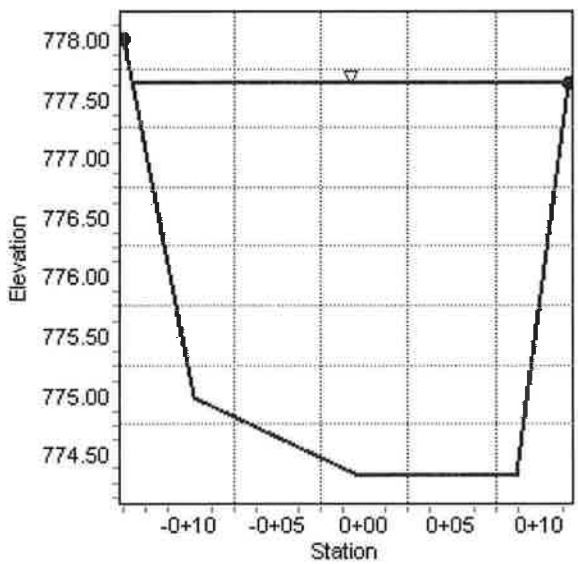
Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.00200	ft/ft
Normal Depth	3.31	ft
Discharge	274.13	ft³/s

Cross Section Image



Worksheet for Proposed Area - 4,5

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.00200	ft/ft
Normal Depth	3.69	ft
Section Definitions		

Station (ft)	Elevation (ft)
-0+14	778.36
-0+06	773.94
0+06	773.94
0+14	777.73

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(-0+14, 778.36)	(0+14, 777.73)	0.030

Results

Discharge	288.96	ft³/s
Elevation Range	773.94 to 778.36 ft	
Flow Area	70.51	ft²
Wetted Perimeter	28.02	ft
Top Width	26.22	ft
Normal Depth	3.69	ft
Critical Depth	2.30	ft
Critical Slope	0.01154	ft/ft
Velocity	4.10	ft/s
Velocity Head	0.26	ft
Specific Energy	3.95	ft
Froude Number	0.44	
Flow Type	Subcritical	

Worksheet for Proposed Area - 4,5

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.69	ft
Critical Depth	2.30	ft
Channel Slope	0.00200	ft/ft
Critical Slope	0.01154	ft/ft

Cross Section for Proposed Area - 4,5

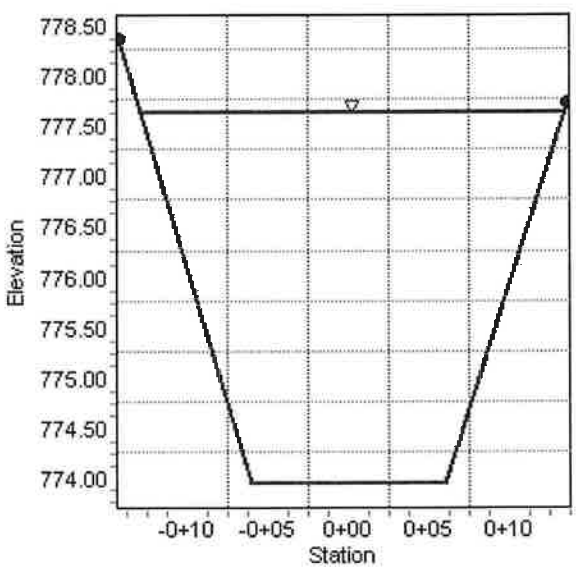
Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.00200	ft/ft
Normal Depth	3.69	ft
Discharge	288.96	ft³/s

Cross Section Image



Worksheet for Existing Area - 6,7

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.00350	ft/ft
Normal Depth	1.09	ft
Section Definitions		

Station (ft)	Elevation (ft)
-0+04	765.24
-0+03	764.55
0+01	764.15
0+05	764.37
0+07	765.94

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(-0+04, 765.24)	(0+07, 765.94)	0.030

Results

Discharge	19.92	ft^3/s
Elevation Range	764.15 to 765.94 ft	
Flow Area	8.04	ft^2
Wetted Perimeter	10.34	ft
Top Width	9.73	ft
Normal Depth	1.09	ft
Critical Depth	0.74	ft
Critical Slope	0.01696	ft/ft
Velocity	2.48	ft/s
Velocity Head	0.10	ft
Specific Energy	1.19	ft
Froude Number	0.48	
Flow Type	Subcritical	

Worksheet for Existing Area - 6,7

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.09	ft
Critical Depth	0.74	ft
Channel Slope	0.00350	ft/ft
Critical Slope	0.01696	ft/ft

Cross Section for Existing Area - 6,7

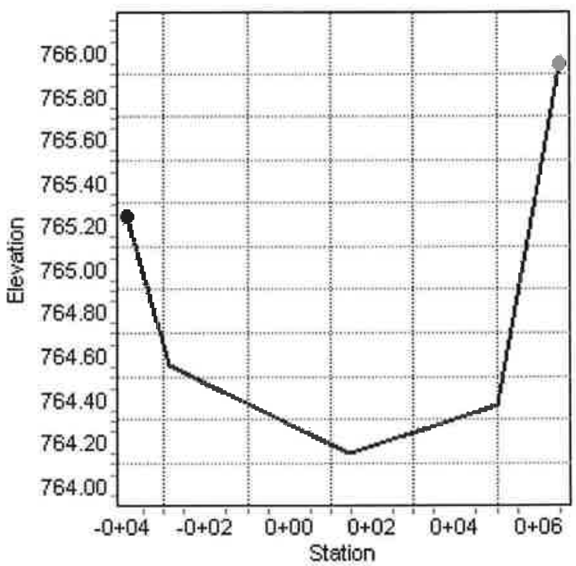
Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.00350	ft/ft
Normal Depth	1.09	ft
Discharge	19.92	ft³/s

Cross Section Image



Worksheet for Proposed Area - 6,7

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.00350	ft/ft
Normal Depth	0.96	ft

Section Definitions

Station (ft)	Elevation (ft)
-0+06	765.23
-0+04	764.28
0+04	764.28
0+07	765.91

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(-0+06, 765.23)	(0+07, 765.91)	0.030

Results

Discharge	23.54	ft^3/s
Elevation Range	764.28 to 765.91 ft	
Flow Area	9.52	ft^2
Wetted Perimeter	12.27	ft
Top Width	11.80	ft
Normal Depth	0.96	ft
Critical Depth	0.61	ft
Critical Slope	0.01670	ft/ft
Velocity	2.47	ft/s
Velocity Head	0.10	ft
Specific Energy	1.06	ft
Froude Number	0.49	
Flow Type	Subcritical	

Worksheet for Proposed Area - 6,7

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.96	ft
Critical Depth	0.61	ft
Channel Slope	0.00350	ft/ft
Critical Slope	0.01670	ft/ft

Cross Section for Proposed Area - 6,7

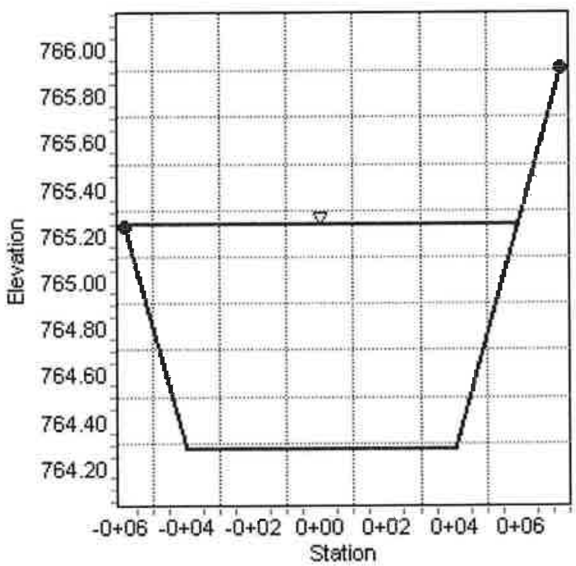
Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.00350	ft/ft
Normal Depth	0.96	ft
Discharge	23.54	ft^3/s

Cross Section Image



Appendix 3

DAVIS CREEK TMDL STUDY REDUCTION
ACTIVE NPDES PERMITS

Site	Designated Name	Permit Number	Type	Address	City
**	Portage MS4-Kalamazoo	MIG610051	MS4	7900 South Westnedge Avenue	Portage
A	Georgia-Pac-Willow Blvd-OU2-SF	MIU990030	STAND	SE Corner of Bus I-94 & Hwy M-9	Kalamazoo
B	USPS-Kalamazoo	MIS110727	INDSW-O	1121 Miller Road	Kalamazoo
C	Kalamazoo MS4-Kalamazoo	MIG610336	MS4	241 West South Street	Kalamazoo
D	Kalamazoo Metal Finishers	MIS1110697	INDSW-O	2019 Glendening	Kalamazoo
E	Schupan & Sons-Miller Road	MIS110722	INDSW-O	2619 Miller Road	Kalamazoo
F	Cytec Ind-Kalamazoo Plt	MIS110315	INDSW-O	2715 Miller Road	Kalamazoo
G	Evergreen Packaging-Kalamazoo	MIS110144	STAND	2315 Miller Road	Kalamazoo
H	Schupan & Sons Inc-Olmstead Rd	MIS110721	INDSW-O	2038 Olmstead Road	Kalamazoo
I	Kalamazoo CRC MS4	MIG601249	MS4	3801 East Kilgore Road	Kalamazoo
J	OmniSource-Kalamazoo	MIS110701	INDSW-O	2730 Millcork Avenue	Kalamazoo
K	Duncan Aviation-Kalamazoo	MIS120613	INDSW-O	5605 Portage Road	Kalamazoo
L	Republic Services-E Cork St	MIS110682	INDSW-O	2800 East Cork Street	Kalamazoo
M	NuCon Schokbeton-Kalamazoo	MIS111474	INDSW-O	3102 East Cork Street	Kalamazoo
N	FedEx Freight East-Kalamazoo	MIS111266	INDSW-O	3326 East Cork Street	Kalamazoo
O	Crutchall Resource Recyc	MIS111509	INDSW-O	3303 Gembrit Circle	Kalamazoo
P	Midlink Business Park-Kalamazoo	MIS111204	INDSW-O	5200 East Cork Street	Kalamazoo
Q	International Paper-Emerald Dr	MIS110726	INDSW-O	4015 Emerald Drive	Kalamazoo
R	Kalamazoo Intl Airport Site	MIS120603	CONST	5235 Portage Road	Kalamazoo
S	Pharmacia & Upjohn-Kilgore	MIS110717	INDSW-O	2605 East Kilgore Road	Kalamazoo
T	Bunting Bearings-Kalamazoo	MIS110684	STAND	4252 East Kilgore Road	Portage

INDSW-O - Industrial Storm water
MS4 - MS4
CONST - Construction
STAND - Other
**Not shown on Figure 7

Appendix 4

DAVIS CREEK TMDL REDUCTION STUDY
BEST MANAGEMENT PRACTICES

Implementation Priority	Area	Impairment	Cause	Solution	Recommended BMPs	Estimated Cost to Implement	Technical Assistance Required	Recommended Implementation Timeframe
7	1 - Colonial Acres	stagnant water, nutrient input	Channel created thru wetland	Reduce flow to park	Excavate channel to create 1,125' low-flow channel; install 24" culvert at Deadwood Drive; install tributary grade control	$45,324	Contractor, engineer	36 months
6	2 - East Cork Street	Erosion, sedimentation; loss of stable plan and profile; blockages	Sedimentation; failed culverts	Create stable plan and profile; increase access to floodplain	Remove 2 failed culverts; realign 200' of channel and adjoining floodplain; install 2 riffles for grade control and stabilize outlets from culverts under railroad; install plunge pool.	$23,750	Contractor, engineer	24 months
5	3 - Canadian National Railroad	Erosion; sedimentation	Incised channel; down cutting; grade too steep; RR tracks too close to drain	Create stable plan and profile; side slopes and floodplain access	Install 9 riffles for grade control; 370' of channel realignment; install rock riprap toe protection along tracks and at upstream end of culvert.	$56,100	Contractor, engineer	24 months
1	4 - Canadian National Railroad to Twin Culverts	Erosion; sedimentation; fallen trees	Over-widened channel; unstable banks	Create stable cross section and width-to-depth ratio; floodplain access	Install 1 vane and 12 cross vanes; remove 3 sediment bars. Install riprap bank protection.	$54,450	Contractor, engineer	6-9 months
2	5 - Twin Culverts	Sedimentation; bank erosion; point bars; over-widening	Failed twin culverts	Create stable cross section and width-to-depth ratio; floodplain access	Remove 2 failed culverts and abandoned railroad tracks; approximately 120' of channel realignment; create floodplain bench; install 3 vanes and 3 cross vanes; install rock riprap bank protection. Remove 50' sediment bar and construct plunge pool.	$27,250	Contractor, engineer	6-9 months
3	6 - Stewart Drive to Market Street	Sedimentation; braided channel; points bars; over-widened channel; fallen trees	Tight radius; high sinuosity; unstable pattern	Create stable pattern and profile	Realign 480' of channel and install 5 riffles for grade control.	$21,240	Contractor, engineer	12-18 months
4	7 - Springfield to Brookfield	Erosion; sedimentation; points bars; undercutting/fallen trees	Unstable meander pattern	Create stable pattern and profile	Realign 360' of channel and install 4 riffles for grade control	$12,180	Contractor, engineer	12-18 months
					TOTAL ESTIMATED CONSTRUCTION*	**$240,294**		

*does not include permitting or engineering fees