TECHNICAL MEMORANDUM

To: Stephanie McNamara, Administrator, VLAWMO

Cc: Brian Corcoran

Tyler Thompson

From: Alex Schmidt, P.E. and Nancy Stowe, P.E.

Through: Chris Otterness, P.E.

Subject: VLAWMO County Ditch 14 Repair Report

Date: July 30, 2018

Project: R177057-0006

INTRODUCTION

The purpose of this memorandum is to analyze and describe potential repairs to the Main Trunk of County Ditch 14 (CD 14) for the Vadnais Lake Area Watershed Management Organization (VLAWMO). This repair report provides hydrologic and hydraulic analysis, repair alternatives, and an Opinion of Probable Cost (OPC), and recommendations based on these findings.

BACKGROUND

CURRENT CONDITION OF PUBLIC DRAINAGE SYSTEM

The CD 14 public drainage system is located within the White Bear Township and the City of Vadnais Heights, in Ramsey County MN. Portions of the ditch are also known as Lambert Creek. The drainage area that contributes runoff to the public drainage system is approximately 4,564 acres (including County Ditch 13 and Goose Lake) and consists of primarily wetlands, and residential developed land use with some commercial and industrial development (see **Appendix A**). CD 14 drains into East Vadnais Lake, which is a source for the St. Paul Regional Water Services water supply.

Houston Engineering Inc. (HEI) completed a *Reestablishment of Ramsey County Ditch 14 Public Drainage System Records* (Records Reestablishment Memorandum (**Appendix B**)), dated June 22, 2018, which documents CD 14 and its branches as it was originally constructed, describes its current geometry, and defines an As-Constructed and Subsequently Improved Condition (ACSIC) alignment and profile. A survey of CD 14's current geometry shows generally that the profile of the existing channel bottom is higher than the ACSIC in multiple locations along the main trunk.

The ACSIC which was determined in the Records Reestablishment Memorandum is the geometry of the public drainage systems as originally constructed including all subsequent legal repairs and alterations, as well as other actions which maintain and are consistent with the general character and efficiency of the drainage systems. The ACSIC establishes the condition to which the system can be repaired consistent with the definition in MS 103E.701.

As described in detail in the following sections, a hydrologic and hydraulic model was developed to assist in identifying areas at risk of damage due to flooding which could potentially benefit from a public ditch repair.

EXISTING HYDRAULIC CONDITION AND CAPACITY

FLOOD EVALUATION (H&H MODEL)

A hydrologic and hydraulic model was created for the purpose of assessing the capacity and risk of flooding along the Main Trunk of CD14. XP-SWMM modeling software was used for this assessment, which has also been integrated into a geodatabase in which all of the inputs for the model are stored (described in **Appendix C,** with associated GIS metadata included in **Appendix D**). An existing conditions model was first developed to simulate the 50%, 10%, 1%, 0.2% annual chance rainfall events (corresponding to the 2-, 10-, 100-, and 500-year recurrence intervals or storm events). The model was then used to predict peak flood stage and discharge along CD 14. Inundated extents are also shown in other parts of the model along the branches of CD 14 (labeled 'low detail') which were not assessed as part of this study and should be considered approximate.

The following assumptions were made in the creation of the existing conditions model:

- The roughness of the channel assumes it is free of logs, food bridges, or any excessive vegetation;
- Culverts are free flowing (free of sediment); and
- The existing conditions includes surveyed channel depths and cross-sections.

Monitoring data at the three flumes along CD 14 was collected by the St. Paul Regional Water Services. Calibration of this model to monitoring data available was not possible due to the nature of the monitoring data. To calibrate to a particular historic rainfall event, multiple flow or water mark readings would be necessary throughout the rising and falling of the hydrograph in order to determine the actual peak discharge. However, only periodic discharge data was observed and recorded with an average frequency of about 10 days. Nonetheless, accepted hydrologic and hydraulic modeling methods were applied, and the model is considered suitable for the purposes of this study.

The peak water surface elevations resulting from a 100-year storm event was evaluated to identify structures at risk of flooding, and the peak water surface elevations resulting from 2-year storm was evaluated to identify regularly inundated properties. These criteria and how they were applied are discussed in more detail in the following sections.

FLOOD RISK TO STRUCTURES

The 100-year flood peak water surface elevations were mapped along the main channel of CD 14.and then used to identify any structures that intersect the flood extents (see **Appendix A**). No primary structures within the study area were found to be directly impacted by the flood mapping extents. The existing conditions model identifies only one structure at risk of inundation in the 100-year storm, which appears to be a garage located near the north end of Lambert Wetland

Furthermore, low entry elevations were surveyed along the main trunk near Pennington Place (area identified by residents along the main channel as susceptible to high waters). These low entry elevations were compared

to the predicted 100-year water surface elevation to determine the extent of freeboard available to protect the structures. The lowest entry elevation is 1.05 feet above the 100-year water surface elevation.

FREQUENTLY INUNDATED PROPERTIES

To assess the risk and extents of inundation on land parcels on a relatively frequent basis, the extents of the 2-year storm event peak water surface elevation was used to identify parcels with a substantial land area subject to frequent inundation. The quantitative results of this Existing Conditions assessment are shown **Table 2** and **Table 4**. The flood extents are shown on maps in **Appendix A**.

It should be noted many parcels partially extend into wetland area, so that decreasing the flood extents in the wetland does not provide a benefit to the property in terms of increased usable land.

REPAIR ALTERNATIVES

The existing conditions XP-SWMM model was then modified to reflect the two repair alternatives. Both of the repair alternatives focus on the hydraulic outlet control of the Lambert Wetland, and results are reported in terms of the peak water surface elevation, or high water level (HWL) of the wetland (see **Figure 1**).

Figure 1 - County Ditch 14 Repair Alternatives

Scale:	Drawn by:	Checked by:	Project No.:	Date:	Sheet:
AS SHOWN	AJS	NS	7057-0006	7/16/2018	

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Repair Alternative 1: Ditch Cleaning

The first repair alternative consists of removing sediment that has accumulated in the open channel near Pennington Place and would continue to the downstream Koehler Road crossing. One to two feet of sediment has accumulated above the ACSIC. This repair would require approximately 4,300 feet of excavation along the open channel from station 31+00 to 74+00 (stationing as shown in **Appendix B**). Excavated sediment and vegetation would be placed on the existing spoil bank on one side of the ditch.

Table 1 and **Table 2** indicate the effects on the water surface elevation[1] (WSEL) and other statistics at Lambert Lake from cleaning out this portion of the ditch. During larger, more infrequent storm events (100- and 500-year), cleaning the ditch will result in only minor benefits. As mentioned previously, only one structure (a garage located near the north end of Lambert Wetland) appears to be at risk of inundation in the 100-year storm). The implementation of Repair Alternative 1 would not significantly reduce the risk of inundation of this structure. The lowest surveyed low floor entry along Pennington Place currently has 1.05 feet of freeboard to the 100-year WSEL and is only slightly increased by 0.06 feet with Repair Alternative1.[2] However, the repair does result in several parcels that undergo a reduction in the 2-year flooded area in terms of land inundated, as shown in **Table 2**. Likely, the effect of a repair will be even greater than identified through the modeling, as the current "roughness" of the channel (due to vegetation, deadfalls, trees, and brush), which is difficult to accurately estimate, will be reduced by the project.

Table 1: Repair 1 Flood Risk Evaluation at Lambert Lake

	Existing	Repair 1	Change
2-yr WSEL	895.06	894.91	-0.15
10-yr WSEL	896.07	895.97	-0.10
100-yr WSEL	896.96	896.90	-0.06
500-yr WSEL	897.67	897.61	-0.06
100-yr Flooded Structures	1	1	0
100-yr Freeboard at Pennington*	1.05	1.11	0.06

* 898.01 is lowest low floor entry elevation of the surveyed homes along Pennington Place

Table 2: Repair 1 Frequently Inundated Properties

Percentage of Parcel Area Flooded in 2-yr Event	Number of Parcels		
	Existing	Repair 1	Change
5% or greater	35	31	-4
10% or greater	29	24	-5
20% or greater	21	16	-5
30% or greater	8	6	-2

[1] All elevations provided in this report are based on North American Vertical Datum of 1988 (NAVD 88).
[2] As a reference, when considering freeboard elevations, MN DNR requires one foot of freeboard from the 100-year HWL to the low entry of a structure for new structures.

The estimated cost of Repair Alternative 1, including construction, legal, administrative, engineering, and regulatory costs is **$105,000** (see **Appendix E** for details).

Additional Considerations:

- Most of this segment of CD 14 is heavily wooded with steep banks that are up to 25 feet above the channel bottom which will make access for the excavation and placement of spoil along the ditch banks/slopes challenging. The estimated costs assume an excavator would traverse along the channel bottom and place spoil at available locations along the ditch. However, additional coordination with an experienced operator is likely required to assess the feasibility of this approach.
- Care should be taken to stabilize or re-slope any unstable channel banks along the channel to avoid future sediment accumulation due to bank and slope erosion. One particularly sensitive area is located along the main channel, downstream of the Branch 5 confluence. Eroding channel slopes should be blanketed and reseeded with deep-rooted plants. This work is included in the cost estimate for this alternative.
- Some of the work proposed for this alternative is within a Public Water (PWI: 62-30). Per the recent DNR guidance document on public drainage system work in public water,[3] no permit is required to maintain or repair a public drainage system as long as the work is undertaken according to drainage law. Furthermore, no permission is required for repairs that do not drain or lower the level of a public water. The work proposed in this alternative would not drain or lower the level of a public water, and would be undertaken according to drainage law, and therefore, per the DNR guidance document, should be exempt from DNR permitting or permissions. However, please note that the drainage authority is still required to notify the DNR prior to proceeding with the work.

Repair Alternative 2: Ditch Cleaning and Culvert Upsizing

A second repair alternative was analyzed in an attempt to provide further flood reduction benefit in the Lambert Wetland area. The modeling demonstrates that the road crossings at Edgerton Street and the upstream crossing of Koehler Road restrict flow and create head loss for each of the storm events modeled. Repair Alternative 2 consists of increasing the hydraulic capacity at these crossings by replacing each 54-inch diameter culvert with 60-inch culverts, in addition to the ditch cleaning as described in Repair Alternative 1.

Table 3 and T**able 4** indicate the reduction in peak water surface elevations provided by Repair Alternative 2. Although this repair alternative would reduce the 100-year water surface elevation (WSEL) by 0.28 feet, and thereby increase the freeboard by the same amount, it would not remove the garage from the extents of the 100-year WSEL, but the repair would r reduce the frequency of inundation of the garage structure. Frequently flooded parcel areas in a 2-year event would only see a slightly higher benefit under Repair Alternative 2 as compared to Repair Alternative 1.

[3] *Public Waters Authority over Work Done in Public Drainage Systems*, Luke Skinner, Director of Division of Ecological And Water Resources, Minnesota Department of Natural Resources, February 28, 2018.

Table 3: Repair 2 Flood Risk Evaluation

	Existing	Repair 2	Change
2-yr WSEL	895.06	894.89	-0.17
10-yr WSEL	896.07	895.84	-0.23
100-yr WSEL	896.96	896.68	-0.28
500-yr WSEL	897.67	897.33	-0.34
100-yr Flooded Structures	1	1	0
100-yr Freeboard at Pennington*	1.05	1.33	0.28

* 898.01 is lowest low floor entry elevation of the surveyed homes along Pennington Place

Table 4: Repair 2 Frequently Inundated Properties

Percentage of Parcel Area Flooded in 2-yr Event	Number of Parcels		
	Existing	Repair 2	Change
5% or greater	35	30	-5
10% or greater	29	24	-5
20% or greater	21	15	-6
30% or greater	8	5	-3

The estimated cost of Repair Alternative 2 including construction, legal, administrative, engineering, and regulatory costs is **$352,000** (see **Appendix E** for details) (which includes the cost of ditch cleaning, i.e. Repair Alternative 1).

Additional Considerations:

- Increasing the culvert size will increase the peak flow rate by approximately 17% during the 100-year recurrence interval event. However, the scope of this report does not include assessing the effect of increased flow to Vadnais Lake. Understanding that this increase in peak flow rate may potentially conflict with the goals of ongoing flood management in the Vadnais Lake watershed, we recommend that the downstream effects be analyzed if the VLAWMO wishes to further pursue this alternative.
- Larger culverts were evaluated to determine if the water surface elevation could be reduced to eliminate the one existing structure (garage) inundated in the 100-year recurrence interval event. However, due to the hydraulic capacity of the ditch, larger capacity culverts provide minimal additional benefit.
- Increasing the size of the culverts under Edgerton Street and Koehler Street may require a permit from the DNR, as this would constitute an improvement to the public drainage system. Resizing the culverts will not impact public waters since normal water levels and high frequency runoff events will remained unchanged. For low frequency, high magnitude rainfalls (e.g. 100-year), ecological conditions related to hydrology in the public water will be improved by decreasing bounce in the wetland.

CONCLUSION AND RECOMMENDATION

Repairs to a public drainage system can be conceptualized to address flooding issues for low frequency, high magnitude events (i.e. flooding of structures); drainage issues for high frequency, low magnitude events (nuisance flooding of backyards); or both. There is currently low flood risk to structures along the Main Trunk of CD 14 associated with high magnitude events, with the exception of one garage structure, which is currently within the 100-year floodplain. Under existing conditions, this assessment has shown that the lowest surveyed low floor entry along Pennington Place currently has over 1 foot of freeboard above the 100-year WSEL. The more substantial issue with the main stem of the CD 14 system appears to be nuisance flooding in backyards, which occurs on numerous lots for rainfall events as small as the 2-year recurrence (50% chance in any given year).

By restoring the function of the drainage system to the as-constructed condition, Alternative 1 addresses this nuisance flooding by decreasing the depth, duration, and extents of this flooding. Repair Alternative 2 also restores the as-constructed drainage function and further reduces the peak flood elevation for high magnitude rainfalls. However, this alternative does not remove the lone existing structure from the 100-year floodplain and provides virtually no additional relief of nuisance flooding. The additional cost of this alternative ($247,000) is likely far greater than the benefit of protecting one accessory structure. For this reason, we do not recommend further consideration of Alternative 2 at this time.

Because the public drainage system open channel is in disrepair (up to 2 feet of sediment), and because adjacent landowners have voiced complaints on the function of the drainage system, we recommend the VLAWMO complete a repair of the CD 14 Main Trunk as envisioned in Alternative 1. Given the nature of the current flooding issue, there does not appear to be an immediate urgency to the repairs, but they should be prioritized and budgeted with the understanding that the drainage function of the system will continue to deteriorate until such time as repairs are completed.

We further recommend that VLAWMO begin an initial investigation in coordination with a trusted operator/contractor to assess the feasibly of various access methods for completing the ditch excavation and tree clearing operations. The recommendations from these discussions will likely further evolve both the extent of tree removal required to complete the work, and the overall cost of the project.

Finally, we recommend that prior to beginning a repair project, that VLAWMO complete extensive engagement with landowners within or neighboring the project area, to educate them regarding the presence of the ditch, the authorities and responsibilities of VLAWMO in managing the drainage system, the necessity of the repairs, and the outcomes of the work. This engagement should also seek input from these landowners on items that are preferred to be protected (e.g. high-value trees, sprinklers, accessory buildings, etc.) and other site conditions.

I hereby certify that the attached plan, specification, or report was prepared by me or under my direct supervision and that I am a duly registered Professional Engineer under the laws of the State of Minnesota.

Nancy Stowe

Nancy Stowe
MN Reg, No 48259

APPENDIX A

Existing Conditions Maps of Peak Flood Events

Appendix A - 2 Year Flood
VLAWMO County Ditch 14

Created By: alschmidt Date Created: 1/26/2016 Date Exported: 7/17/2018 Image: 2014/2015 County NAIP Elevation Data: NA
Horizontal Datum: NAD 1983 UTM Zone 15N Vertical Datum: North American 1983
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Legend

2 Year Flood
StudyDetail
- Main Branch
- Low Detail
- CD 14 Main Trunk
- CD14 Branches
- CD14 Modeled Watershed

N W E S

0 0.125 0.25 0.5
Miles

HoustonEngineering Inc.

Appendix A - 10 Year Flood
VLAWMO County Ditch 14

Created By: alschmidt Date Created: 1/26/2016 Date Exported: 7/17/2018 Image: 2014/2015 County NAIP Elevation Data: NA
Horizontal Datum: NAD 1983 UTM Zone 15N Vertical Datum: North American 1983
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Legend

10 Year Flood
StudyDetail
- Main Branch
- Low Detail
- CD 14 Main Trunk
- CD14 Branches
- CD14 Modeled Watershed

N W E S

0 0.125 0.25 0.5
Miles

HoustonEngineering Inc.

Appendix A - 100 Year Flood
VLAWMO County Ditch 14

Created By: alschmidt Date Created: 1/26/2016 Date Exported: 7/17/2018 Image: 2014/2015 County NAIP Elevation Data: NA
Horizontal Datum: NAD 1983 UTM Zone 15N Vertical Datum: North American 1983
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Legend

100 Year Flood
StudyDetail
- Main Branch
- Low Detail
- CD 14 Main Trunk
- CD14 Branches
- CD14 Modeled Watershed

N W E S

0 0.125 0.25 0.5
Miles

HoustonEngineering Inc.

APPENDIX B

Reestablishment of Ramsey County Ditch 14 Public Drainage System Records
(Records Reestablishment Memorandum)

Technical Memorandum

To: Stephanie McNamara
VLAWMO Administrator

Cc: Brian Corcoran, Tyler Thompson

From: Alex Schmidt, PE
Nancy Stowe, PE
Houston Engineering, Inc.

Subject: Reestablishment of Ramsey County Ditch 14
Public Drainage System Records

Date: June 28, 2018

Project: 7057-0006

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am dully Licensed Professional Engineer under the laws of the State of Minnesota.

Nancy Stowe 6/28/18

Nancy Stowe Date
Reg. No. 48259

Introduction

PURPOSE

The purpose of this memorandum is to provide Vadnais Lake Area Watershed Management Organization (VLAWMO) with the results of the investigation and analysis of Ramsey County Ditch 14 (CD 14) public drainage system, including the main trunk and its branches. Portions of CD 14 are also known as Lambert Creek. This report contains the necessary description of alignment; cross-section; profile; hydraulic structure locations, materials, dimensions, and elevations; and right-of-way of the drainage system to reestablish records. CD 14 is primarily an open channel ditch through many shallow lakes and wetlands, which serves predominantly developed land located across the City of White Bear Lake, the City of Gem Lake, White Bear Township, and the City of Vadnais Heights. CD 14 is currently within the jurisdiction of VLAWMO, which serves as drainage authority over the ditch. CD 14 was transferred by resolution of Ramsey County to VLAWMO in 1986, with powers as established in Minnesota Statute 103B and 103E. VLAWMO exists under the Joint Powers Agreement between its members to protect and manage the Vadnais Lake area watershed. Minnesota Statute 103E.101 subd. 4a allows for the drainage authority to reestablish records if, after an investigation of drainage system records, it is found that the records establishing the alignment, cross-section, profile, or right-of-way of a drainage system are lost, destroyed or otherwise incomplete. The drainage authority may, by order, reestablish records defining the alignment; cross-section; profile; hydraulic structure locations, materials, dimensions, and elevations; and right-of-way of the drainage system which define the “As Constructed and Subsequently Improved Condition” or ACSIC. This report documents the investigation of drainage system records and physical

investigation of the main trunk and branches of the CD 14 public drainage system, used by the engineer to recommend reestablished records to define the alignment, grade and geometry as necessary to maintain the historic function of the drainage system. No other historical reviews or reviews of the as-constructed profile of this system are known to exist.

RELATIONSHIP TO DRAINAGE SYSTEM MAINTENANCE AND REPAIR

This memorandum establishes the ACSIC as the basis for future maintenance and repair of the public drainage system. A repair report to be completed in 2018 is anticipated to include the evaluation of alternatives relative to this system serving as the outlet for municipal stormwater management needs, and address issues related to the volume of runoff, water quality, and flooding. Normally the repair report may include alternatives which adjust the elevation of the open channel and culverts, realign or abandon portions of the public system, or evaluate similar modifications as authorized by MS 103E and consistent with the ACSIC.

DEFINITIONS

This memorandum defines the condition and therefore by inference the capacity (i.e. the existing flow rate in cubic feet per second) of the public drainage systems using three definitions:

As-Designed / Established Condition: The geometry of the public drainage systems as designed in 1916 including all subsequent designs for legal repairs and alterations. A repair or alteration is considered legal if formally authorized in some legal proceedings. The As-Designed / Established Condition may or may not reflect the As-Constructed and Subsequently Improved Condition and is generally shown on construction plans and engineering drawings.

As-Constructed and Subsequently Improved Condition (ACSIC): The geometry of the public drainage systems as constructed in 1916 including all subsequent legal repairs and alterations as well as other actions which maintain and are consistent with the general character and efficiency of the drainage systems. Often, survey data (and only rarely as-built drawings) show that the alignment, grade and geometry (i.e., cross sectional area) of the existing public drainage system is altered from the As-Designed / Established Condition. The definition of As-Constructed and Subsequently Improved Condition (ACSIC) is intended to establish the condition to which the system can legally be repaired consistent with the definition in MS 103E.701, which states:

> The term, "repair" means to restore all or a part of a drainage system, as nearly as practicable to the same condition as originally constructed, and subsequently improved, including re-sloping of ditches and leveling of waste banks if necessary to prevent further deterioration, realignment to original construction if necessary to restore the effectiveness of the drainage system, and routine operations that may be required to remove obstructions and maintain the efficiency of the drainage system. "Repair" also includes:

(1) incidental straightening of a tile system resulting from the tile-laying technology used to replace tiles; and

(2) replacement of tiles with the next larger size that is readily available, if the original size is not readily available.

Available records provide limited information regarding originally constructed (as-built) alignment, grade (profile) and geometry (cross-section) of CD 14. Alterations to the public drainage system alignment, grade and geometry from the As-Designed / Established Condition likely resulted from the use of less accurate survey methods and construction techniques than currently exist, inaccurate culvert and crossing installation, and a need to "fit" the drainage system to the existing topography. Alterations to the public drainage system that are not performed per the requirements of MS 103E (i.e., ditch law) or its predecessors are typically not considered part of the ACSIC. However, modifications that neither obstructed or improved the system were maintained by the public drainage authority and relied upon by benefitted landowners, may be considered part of the ACSIC, where that alteration has been maintained for a sufficient period of time (15 years) to create rights in the benefitted landowners.

Repaired Condition: The condition to which the drainage authority repairs the public drainage system. If the capacity of the Repaired Condition exceeds the ACSIC, the work is considered an improvement under MS 103E and its predecessors. VLAWMO may decide for a variety of reasons to repair the public drainage system to some capacity less than the As-Constructed and Subsequently Improved Condition.

Maintenance: There is no statutory distinction between the terms maintenance and repair. However, historically, drainage authorities have drawn a distinction between the two terms as a function of the scope of work performed for each. The primary difference between maintenance and repair, is that maintenance activities are generally completed at a select (more isolated) location or locations along portions of the public drainage system, rather than a drainage system-wide assessment, analysis, recommendation, or alteration that occurs in association with a repair proceeding. Maintenance activities are those that generally occur at a specific location or some portion of the system.

Maintenance generally includes activities such as vegetation management, the removal of open channel and tile blockages (e.g., beaver dams, sediment), the replacement of tile ruptures, the installation of tile inlets and access manholes, the replacement of portions of a tile system, the stabilization and repair of slopes and spoil material, and the removal of sediment up to the repair condition. Maintenance also includes the resetting or resizing of culverts or other crossings which were inaccurately placed and result in the obstruction of the public drainage system. Maintenance activities are usually exempt from wetland permitting requirements under the Wetland Conservation Act and Section 404 of the Clean Water Act.

Location, General Description and History of the Public Drainage System

LOCATION

The Ramsey County Ditch 14 public drainage system (including its branches) is located in Sections 20, 21, 22, 28, 29 and 30 (T30N R22W) within the City of White Bear Lake, White Bear Township and the City of Vadnais Heights, Ramsey County and generally flows from northeast to southwest from Rice Lake to East Vadnais Lake. East Vadnais Lake is a source for the St. Paul Regional Water Services water supply. The drainage area that contributes to the Ramsey County Ditch 14 public drainage system is approximately 4,564 acres (including County Ditch 13 and Goose Lake) and is in Sections 11, 14, 15, 20, 21, 22, 23, 25, 26, 27, 28, 29, 30, and 32 (T30N R22W). The original benefiting land was agricultural. The current drainage area is predominantly developed land and includes several extensive wetlands and public waters.

HISTORY OF THE PUBLIC DRAINAGE SYSTEM

The Ramsey County Ditch 14 public drainage system appears to have been established in 1916 based on historical documentation. There is no known record of the petition, establishment, or benefiting lands of the public drainage system. The public drainage system consisted of a main trunk and five branches (**Figure 1**). Profiles and cross sections from a 1926 document shows what is referred to as a "tentative" design would have significantly increased the capacity of the entire open channel system and add tile underneath the drainage system. It is assumed that the "tentative" design was never constructed because these modifications are not reflected in any document subsequent to 1926. In addition, there is no subsequent documentation of tile in the system. There is little documentation of maintenance, repairs, improvements, or modifications prior to 1980. However, development did occur prior to 1980 which likely included alterations to CD 14. Both a 1980 engineers report and 1981 plan set describe an Improvement Project which included ditch excavation and culvert modifications along the main trunk of CD 14. In 1986, CD 14 was transferred from Ramsey County to VLAWMO.

A 1987 Storm Water Management Study included a survey, hydrologic and hydraulic computer modeling, and a recommendation for four outlet control structures for detention. This study prompted the installation of outlets on Rice Lake and Grass Lake in 1994 and the Lambert weir in 2004, as well as a realignment of the ditch in the vicinity of the Lambert weir. Various projects have been completed on the system in order to accommodate development, many of which were not documented as alterations to the public drainage system according to Minnesota Statute 103E. Further detail on documented projects that modified the drainage system are listed and described in this memorandum under System Modifications Effecting Function.

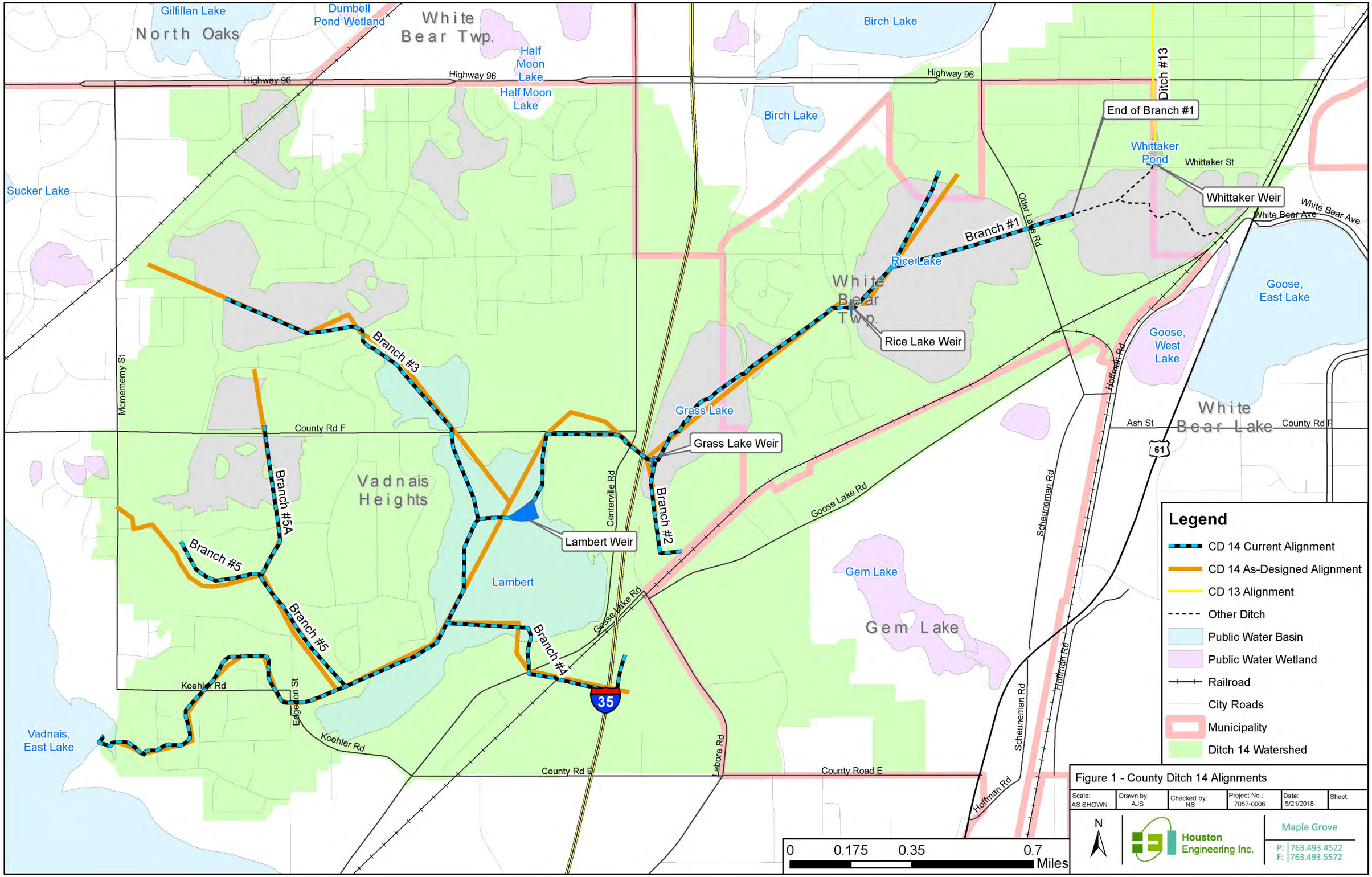

Figure 1 - County Ditch 14 Alignments

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EXISTING/CURRENT ALIGNMENT

This portion of this memorandum describes the current condition of the public drainage system as observed "on-the-ground" (i.e., existing) as determined by a review of the available records, field survey, aerial imagery, and other available historical evidence. CD 14 consists of an open channel ditch with several culvert crossings. The stationing used to describe the alignment proceeds from downstream to upstream. **Figure 1** shows the system's existing alignment compared to an approximation of the As-Designed alignment.

Some clarification is needed related to the ditch branches and extents at the upstream end of CD 14. The As-Designed alignment shows the main trunk of CD 14 starting on the north side of Rice Lake and the As-Designed Branch 1 starting northeast of Rice Lake, across Otter Lake Rd. However, maps and shapefiles provided by VLAWMO, refer to the open channel on the north side of Rice Lake as Branch 1, and the northeast open channel as a component of the Main Trunk. There is no known documentation of ditch proceedings for this change, and for the purposes of this historical review memorandum, the Main Trunk and Branch 1 of CD 14 will remain as designed in the original establishment of the drainage system. Furthermore, the As-Designed Branch 1 terminates northeast 730 feet of Otter Lake Road. This does not include the portion of open channel which continues to Whitaker Street and Whitaker Pond. VLAWMO in its role as drainage authority is not responsible for management of the open channel between the upstream extend of Branch 1 and the beginning of County Ditch 13 (which begins in Whitaker Pond).

A second clarification is needed in relation to Branch 5. Branch 5 splits into two segments on the upstream end. Maps and shapefiles provided by VLAWMO name these segments as Branch 5A (the northeasterly segment of Branch 5) and Branch 5B (the northwesterly segment of Branch 5). The As-Designed alignment includes Branch 5A, as the northeasterly segment, however, the northwesterly segment is a part of the Branch 5 alignment, not named Branch 5B. There is no known documentation of ditch proceedings for the name Branch 5B, and for the purposes of this historical review memorandum, the Branch 5 of CD 14 will remain as designed in the original establishment of the drainage system. Further, the As-Designed upstream end of Branch 5 continued across Colleen Drive to McMenemy Street. This area has since been developed. A review of available historic documentation, existing stormsewer, and field survey revealed no conveyance system crossing Colleen Drive. Therefore, the current alignment of Branch 5 ends south of Colleen Drive.

Main Truck CD 14:

The main trunk alignment begins approximately 200 feet north of the north side of Rice Lake at Sta 193+71 and subsequently enters Rice Lake. It then exits Rice Lake via a weir structure to the west and crosses Oakmede Lane at Sta 166+83. The alignment then extends further southwest, crossing White Bear Pkwy at Sta 149+50 and subsequently enters Grass Lake. It then exists Grass Lake via a weir structure to the west and crosses Interstate 35-E at Sta 126+82 and Centerville Rd at Sta

124+54. The alignment then enters stormsewer and continues west along County Rd F, discharging to the south towards the Lambert Weir structure before turning west to Lambert Lake. It turns south and then southwest before crossing Edgerton St at Sta 47+13. The alignment turns north, crosses Koehler Road at Sta 43+77, loops west and southwest before crossing Koehler Road a second time at Sta 26+16. It then turns west, crosses Oak Creek Drive West at Sta 12+85 and crosses a walking trail along the west line of Section 29 at Sta 5+28 before terminating at Vadnais Lake. According to the available As-Designed documents, the ditch terminates approximately 65 feet west of the section line (Sta 4+63).

Note: The stationing provided herein continues to Sta 0+00 at the outlet of the natural stream channel into the Vadnais Lake. However, the stream channel between 0+00 and 4+63 is not part of the CD 14 public drainage system. It is included in the provided stationing only to facilitate depiction of the outlet condition of the drainage system.

Branch 1:

The Branch 1 alignment begins 730 feet northeast of Otter Lake Road at Sta 28+30 and crosses Otter Lake Road at Sta 21+50. Branch 1 subsequently enters Rice Lake where in joins the main trunk of CD 14.

Branch 2:

The Branch 2 alignment begins at Sta 17+53 heads north and crosses a private road at Sta 7+70 before entering Grass Lake. Branch 2 then connects with the main trunk upstream of the Grass Lake weir.

Branch 3:

The Branch 3 alignment begins east of the development at Oakcrest Drive at Sta 57+39 heading southeast until entering a stormsewer east of Kaitlin Drive. At Sta 32+80 the alignment crosses N Oak Dr and subsequently exists stormsewer. The alignment extends over a large wetland and crosses County Road F at Sta 13+95. Branch 3 then enters Lambert Lake and joins the main trunk downstream of the Lambert Weir structure.

Branch 4:

The Branch 4 alignment begins at Sta 38+87 in a southerly direction along Interstate 35-E before crossing Interstate 35-E at Sta 31+89. The branch crosses a rail road at Sta 23+76 then Centerville road at 19+10 before entering Lambert Lake, where it joins the main branch.

Branch 5:

The Branch 5 alignment begins at Sta 37+34 south of Colleen Drive and continues through a stormwater pond north of Bear Park. Branch 5A joins Branch 5 at Sta 21+25. The ditch enters stormsewer at Sta 18+11 and discharges at Sta 0+75 before joining the main trunk.

Branch 5A:

The Branch 5A alignment begins north of County Road F at Sta 24+08, crosses County Road F at Sta 22+77 and continues southerly. The alignment crosses Bear Avenue North at Sta 8+57, turns southwesterly, and joins with Branch 5.

SOURCE OF SURVEY DATA USED IN THIS ASSESSMENT

Survey data was collected in early 2018 to determine the existing condition of the public drainage system. All survey data collected utilizes the Ramsey County Coordinate System and North American Vertical Datum 1988 (NAVD'88). (Unless otherwise noted, all elevations provided herein are based on NAVD'88 vertical datum).

SYSTEM MODIFICATIONS AFFECTING FUNCTION

In select portions of the public drainage system, the existing open channel alignment, profile, and cross section have experienced modifications from the As-Designed / Established Condition. **Figure 1** shows the current CD 14 main trunk alignment, as identified by available records, aerial photos, LiDAR topography, and field surveys. Each documented modification is described in the following sections and the information source is cited by year. The modifications listed chronologically by system include:

1) The 1926 profile, which shows the As-Designed condition in 1916 as well as the existing conditions in 1926, show the culverts at Edgerton and Koehler (upstream Koehler crossing) as being constructed approximately 2 feet higher than the shown As-Designed profile. Therefore, the ACSIC in this location was set at the original As-Constructed elevation of the culverts.
2) A profile dated August 3, 1939 shows the reconstruction and lowering of Branch 5, below the confluence with Branch 5a, and along Brach 5A up to County Road F. This work is labeled as a "cleaning", but per the working definitions of this document it is considered an improvement. However, the 1939 profile also shows a portion of the CD 14 main trunk that is not below the as-constructed profile and is therefore not considered an improvement.
3) Plans dated December 21, 1971 show the stormsewer along County Road F, which captures CD 14 in a 48" RCP in an alignment along the south side of County Road F.
4) A County Ditch No. 14 "Improvement" Project plan set dated August 21, 1981 shows excavation along various segments of the ditch. Although the project is called an "improvement" the grade of the ditch as well as culverts were constructed at a higher elevation than the As-Constructed. The project also removed culverts and replaced many culverts with larger diameter culverts at raised elevations, to which they currently exist. An engineering report which precedes the project, dated January 18, 1980, recommends some of these culvert modifications (although, the recommended culvert elevations are 0.7 to 1.8 feet higher than what currently exist), as well as a dike (weir) outlet for Grass Lake, near Interstate 35-E.

5) 1986 Oak Creek culvert plans show the installation of a culvert and lowering of the profile of CD 14, upstream and downstream of the culvert.
6) A construction plan set dated July 5th, 1994 includes construction documents for the outlet control structures (weirs) of Grass Lake and Rice Lake. HEI is unaware of any proceedings for these weirs to impound the public ditch.
7) Construction plans entitled Lambert Creek Water Quality Improvement Project, dated January 1st, 2004, show the Lambert weir structure and realignment of the ditch through the wetland. We are unaware of any 103E proceedings for this weir to impound the public ditch.

Analysis of Current Function in Historical Context

AS-CONSTRUCTED AND SUBSEQUENTLY IMPROVED GRADE AND GEOMETRY

The 1926 profiles show the As-Designed profile and "tentative" designs as discussed earlier, as well as the existing conditions at that time. Ideally, the grade (profile) of the ACSIC would be determined through the use of as-built drawings that identify the constructed alignment, grade and geometry. An as-built drawing of the public drainage system from 1936 included surveyed elevations of the public drainage system 10 years after the construction of the ditch. However, over the course of 10 years substantial sedimentation often occurs, and the profile is not likely to reflect the as-constructed condition. Therefore, in this case the as-designed profile (shown in the 1926 profile drawings) is appropriate to begin determination the ACSIC. The 1926 profile plans indicate that the open channel was to be constructed with 1:1 (Horizontal: Vertical) side slopes, and a 4-foot-wide bottom width.

For CD 14, design profiles were based on an assumed vertical datum with no existing benchmark. To determine the ACSIC in a modern vertical datum, soil probes collected during field survey were used to estimate "as-built" excavation depths where the material transitions from accumulated sediment to native mineral soil, estimated by probing until the depth of refusal. Soil probes that did not encounter refusal are noted as "No refusal to this depth (inconclusive)" in the profiles. In addition, five existing culverts in the 1981 "improvement" plan are the same diameter as the culverts shown in the 1926 profiles and are assumed to have not been reconstructed during that time period. These culverts were also used in the determination of the modern vertical datum of the as constructed profiles.

Soil probes to depth of refusal were collected along CD14 and are shown in the profiles in **Appendix A** and **Appendix B**. A statistical comparison of the soil probes, 1981 existing culverts, and original design profile elevations was performed. Through the comparison process, a datum adjustment factor was calculated to convert the design profile from the local datum to NAVD88 (see **Table 1**). An acceptable correlation (within 0.8 feet root mean squared error) was found between soil borings and the design profile.

Table 1: CD 14 Datum Adjustment

Branch	As-Designed Elev. (per 1926)	Survey Elevation	Difference	Absolute Error	Computed Datum 692.55	
					Computed Elevation	Error
Branch 1	-	908.64	Not analyzed; soil prob beyond historic alignment			
Branch 1	216.13	908.80	692.67	0.67	908.53	-0.27
Branch 1	215.48	908.19	692.71	0.71	907.88	-0.31
Branch 1 [2]	216.15	907.65	691.50	0.51	908.55	0.90
Branch 1 [2]	215.95	908.65	692.70	0.69	908.35	-0.30
Branch 1	214.75	905.82	691.10	0.90	907.15	1.30
Branch 1	213.90	905.13	691.23	0.77	906.30	1.17
Main Trunk[1]	211.19	905.98	694.79	2.78	-	-
Main Trunk	210.98	904.26	693.28	1.27	903.38	-0.88
Main Trunk	210.92	904.00	693.08	1.08	903.32	-0.68
Main Trunk[1]	208.75	897.00	688.26	3.75	-	-
Main Trunk[1]	208.28	897.16	688.88	3.13	-	-
Main Trunk[2]	209.65	899.95	690.30	1.71	902.05	2.10
Main Trunk[1,2]	209.65	898.95	689.30	2.71	-	-
Main Trunk	-	894.88	Not analyzed; soil probe not on historic alignment			
Main Trunk	-	891.48	Not analyzed; soil probe not on historic alignment			
Main Trunk[1]	199.81	887.65	687.84	4.17	-	-
Main Trunk	198.29	889.85	691.56	0.44	890.69	0.84
Main Trunk	196.77	889.71	692.94	0.93	889.17	-0.54
Main Trunk [2]	197.15	890.15	693.00	1.00	889.40	-0.60
Main Trunk [2]	196.85	890.10	693.35	1.34	889.20	-0.95
Main Trunk [2]	196.65	889.25	692.60	0.59	889.05	-0.20
Main Trunk [2]	196.35	889.25	692.90	0.89	888.75	-0.50
Main Trunk[1,2]	193.15	887.05	693.90	1.89	-	-
Main Trunk[1,2]	192.85	887.05	694.20	2.19	-	-
Main Trunk	190.99	884.02	693.03	1.02	883.39	-0.63
Main Trunk	189.69	882.51	692.82	0.82	882.09	-0.42
		Average:	**692.01**		**RMSE:**	**0.88**
		Standard Deviation:	**1.83**		**Avg. Error:**	**- 0.01**

RMSE = Root Mean Square Error

[1] Outlier: not used to determine datum conversion

[2] Culvert: Surveyed Elevation is per the 1981 improvement plan existing conditions

The following describes the segments of CD 14 that were modified (with a known, documented modification) at the given year, organized by the type of modification to the public drainage system:

Alignment or Other System Modifications:

1) In 1971, plans show the 48-inch stormsewer from approximate Sta 110+00 to Sta 122+31 along the south side of County Road F, which also modified the CD 14 alignment.
2) In 1981, from Sta 24+68 to 64+38 the grade of the ditch was raised along with the culverts at Koehler Road (both crossings) , and the Koehler Road and Edgerton Street culverts increase in diameter from 48" CMP to 54" RCP. In this segment, the bottom width was maintained at 4-feet, but the side slopes were decreased to 2:1. From Sta 64+38 to approximately 80+50 the ditch was raised and widened to an 8-foot bottom width. Also, from Sta 150+25 to 167+25 the grade of the ditch was raised, a 4-foot bottom maintained, and the side slopes were decreased to 2:1.
3) In 2004, the alignment of the ditch was modified to accommodate the Lambert Weir.

Identified in the profiles shown in **Appendix A** and **Appendix B** is 1981 "improvement" profile which is the profile to which the system has been managed over the last 30+ years. This profile is not equivalent to the ACSIC, as the 1981 construction was higher, rather than lower, than the ACSIC ditch profile. VLAWMO as the drainage authority may choose to manage the public drainage system at a depth less than the ACSIC should it determine that the management strategy will provide an equivalent capacity and level of service as the ACSIC. Recommendations for a repair depth will be provided in a subsequent Repair Report for the public drainage system.

Impoundments:

1) In 1994, the outlet control structures (weirs) of Grass Lake and Rice Lake were constructed, which detain water on the public drainage system.
2) In 2004, a sheet pile weir structure (Lambert Weir) was constructed at Sta 100+64 with the lowest weir elevation at 895.6. A pond was also constructed upstream of the weir to station 100+64with a bottom elevation of 802.5 and 4:1 side slopes.

Each of the three weirs was constructed with the ability to adjust the weir elevation. We are unaware of any 103E proceedings for these weirs to impound the public ditch. However, in 1992 VLAWMO board meeting minutes document public meetings held for what is assumed to be the project for Grass Lake and Rice Lake weirs. Also, public meetings were held in 1998 and 2002 which discussed the Lambert Weir project, and an Environmental Impact Statement, dated January 2004, was conducted for the Lambert Weir.

Improvements:

1) In 1939, on Branch 5 and Branch 5A, the ditch was improved by lowering the grade and installing a 24-inch culvert, which was originally designed as a 12-inch culvert, on Branch 5.

2) In 1981, on Branch 1, from Sta 184+33 to 198+53 the ditch was improved, and the bottom width was widened to 8 feet. The improvement also included the 36-inch CMP culvert at Otter Lake Road being replaced with a 42-inch RCP.
3) In, 1986, from Sta 11+20 to 18+30 the grade of the ditch was lowered, and a culvert was installed at Oak Creek Drive West. The plans show an 8-foot bottom width from 11+20 to 15+68, where a 6-foot bottom width is shown upstream to 18+30.
4) In 2004, from approximate Sta 80+50 to the Lambert Weir structure (Sta 96+20), the ditch was excavated with a 4-foot bottom width with side slopes at 5:1. Upstream of the Lambert Weir, from Sta 100+64 to County Road 'F' culvert at Sta 107+50, the grade of the ditch was excavated with a 4-foot bottom width with side slopes at 5:1.

These projects are considered improvements to the public drainage system and part of the ACSIC. Improvements included changes to the profile and cross sections along segments of CD 14.

Appendix A and **Appendix B** indicate the alignment and grade of the public drainage system as it currently is in place along with the ACSIC profile of CD 14 main trunk and branches, respectively.

OBSERVED PROBLEM AREAS

The following is a summary of known problem areas within the drainage system based on visual observations in the field, inspections, or firsthand accounts from VLAWMO staff. Some problem areas may affect the capacity of the drainage system. Periodic inspections and regular maintenance of the system is recommended to maintain the function of CD 14.

1) VLAWMO has received complaints of abnormally high water and saturated back yards from homeowners along Pennington Place (Sta 65+00 to 71+00).
2) The Lambert Weir structure was built to disperse flows south, through a series of weirs, throughout the wetland through pilot channels for water quality purposes during low flows. During high flows the weir would overtop to the west and then flow through the channel along the alignment of the ditch. Currently, the flow to the south does not disperse into the wetland, but short circuits along the weir to the west. Excessive vegetation was noted in this area as a potential cause. In the past, a sheet pile weir was discussed to prevent the short circuiting.
3) There are many small foot bridges along the channel, some in disrepair, that may affect the drainage capacity of the ditch (see example photos below).

Foot bridge in disrepair at main trunk station 69+06

Foot bridge with steel beam at main trunk station 103+62

4) A few locations along the ditch have fallen trees within the conveyance area (see example photo below).

Fallen trees requiring maintenance in CD 14

RIGHT-OF-WAY

Proceedings for the original establishment of the drainage system awarded damages for the areas physically occupied by the drainage system along with a right of access for the area required for construction activities such as land clearing and spoil disposal. This combination of areas constitutes the right-of-way for the drainage system and is often described as the area reasonably necessary for the drainage authority to perform its repair, maintenance, inspection obligations, along with an area of reasonable set-back to protect the drainage system. **Appendix C** shows the area estimated to have been utilized during construction, along with a table listing all parcel intersecting the right-of-way area. It is estimated using the ACSIC channel depth and spoil area interpreted from aerial photos, LiDAR topography and channel dimensions stated in the Engineer's Report.

RECOMMENDATIONS

The Drainage Authority has not initiated proceedings to correct the drainage system record. If the Drainage Authority wishes to formally correct the public drainage system record, it may need to complete an action to initiate this process. This report having been completed and filed, the Drainage Authority could then schedule, notice and hold a public hearing, and consider adopting corrected records consistent with this report. The corrected drainage system records should be based on the alignment, grade, and geometry described within this historical review and in **Appendix A** and **Appendix B**. The alignment, grade, and geometry are, in the Opinion of the Engineer, necessary to reestablish the historic function of the legal drainage system to be the basis for maintenance and repair of the public drainage systems. We recommend VLAWMO consult its legal counsel regarding necessary steps to take formal action in this process. We further recommend that the District submit the alignment, grade and geometry of the ACSIC to the Minnesota Department of Natural Resources for their review and concurrence.

AVAILABLE INFORMATION / HISTORIC RECORDS

The following documents have been specifically utilized or referenced for this report:

- 1916 Alignment of County Ditch 14 and its branches
- 1926 Proposed Cross Sections, Profile, and Drain Tile
- 1927 Improvement Proposal
- 1939 Reconstruction of Branch 5 5A near Co Rd F
- 1939 Cleaning Profile of Branch 5 and CD 14 near Co Rd F and Centerville Rd
- 1958 Cleaning Profile from Koehler to Edgerton
- 1971 Co Rd F Culvert Plan-Profile
- 1980 Engineers Report
- 1980 Proposed Improvement Map
- 1981 Ditch Improvement Plan-Profile

- 1986 Ditch Transfer Resolution from Ramsey Co to VLAWMO
- 1987 Storm Water Management Study
- 1987 Profiles and Cross Section Survey
- 1994 Rice L and Grass L Weir Plans
- 1998 Lambert Lake WQ Improvement Project Documents
- 2002 Lambert Weir Public Meeting Notes
- 2004 Lambert Weir Plans

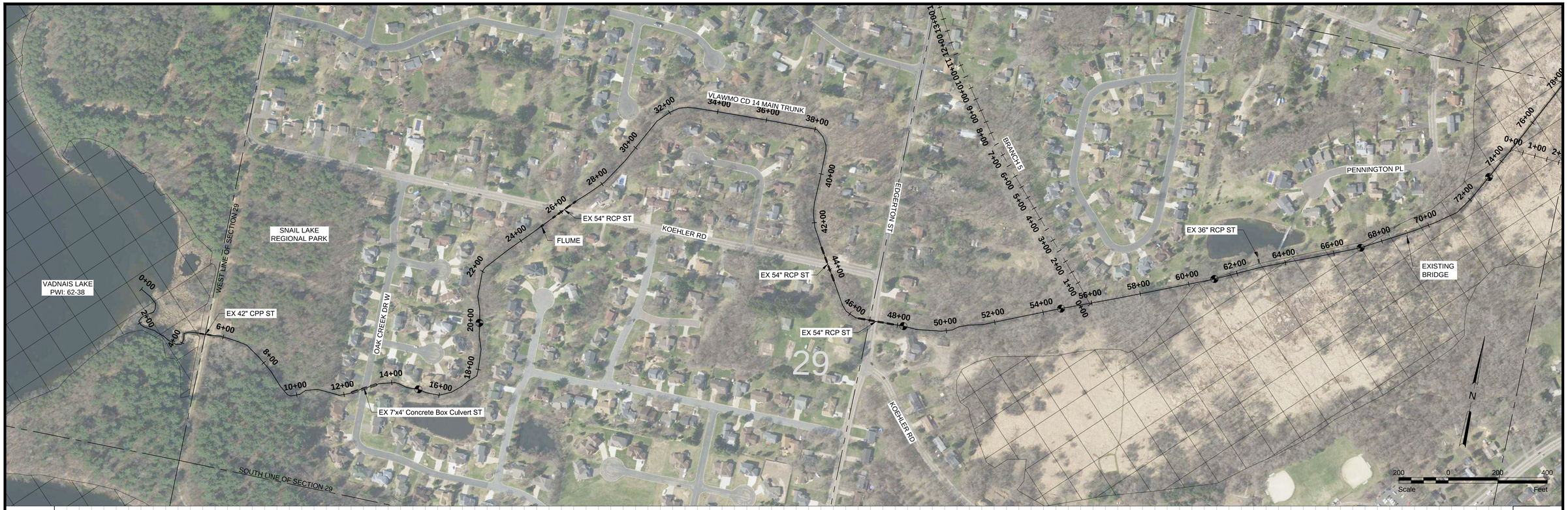
Appendicies

APPENDIX A – PLAN AND PROFILE OF CD 14 MAIN TRUNK AND BRANCH 1

APPENDIX B – PLAN AND PROFILE OF CD 14 BRANCHES

APPENDIX C – RIGHT-OF-WAY ANALYSIS

APPENDIX A – PLAN AND PROFILE OF CD 14 MAIN TRUNK AND BRANCH 1

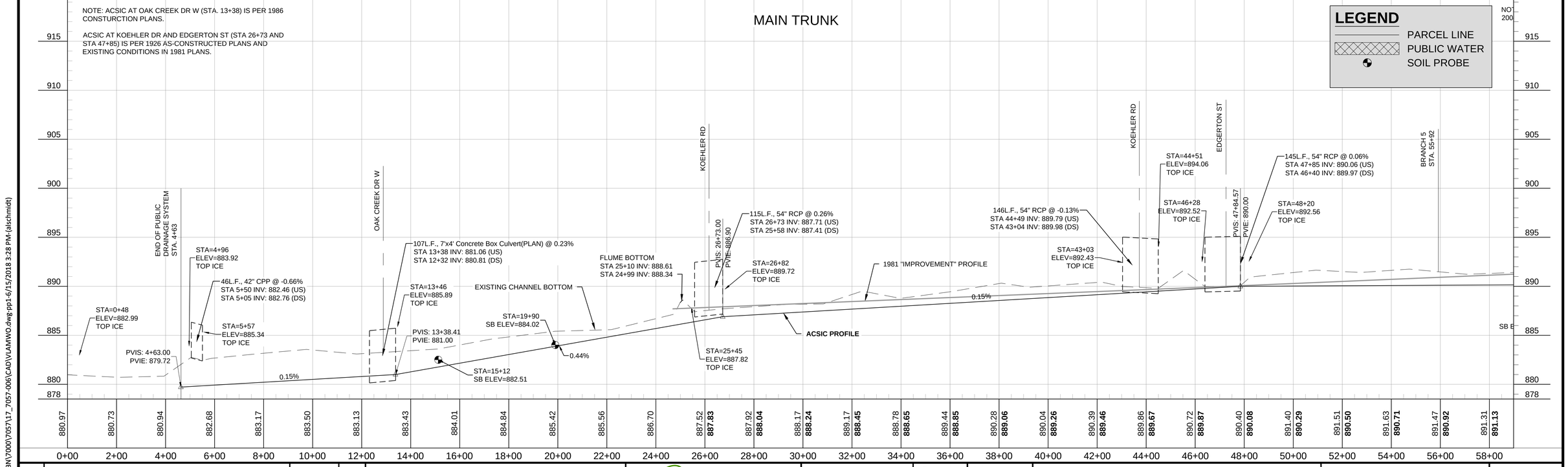


NOTE: ACSIC AT OAK CREEK DR W (STA. 13+38) IS PER 1986 CONSTURCTION PLANS.

ACSIC AT KOEHLER DR AND EDGERTON ST (STA 26+73 AND STA 47+85) IS PER 1926 AS-CONSTRUCTED PLANS AND EXISTING CONDITIONS IN 1981 PLANS.

MAIN TRUNK

LEGEND
- PARCEL LINE
- PUBLIC WATER
- SOIL PROBE



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RAMSEY COUNTY DITCH 14
VADNAIS LAKE AREA
WATER MANAGEMENT ORGANIZATION

Appendix A

PLAN AND PROFILE
MAIN TRUNK

PROJECT NO. 7057-006

SHEET
1 of 5

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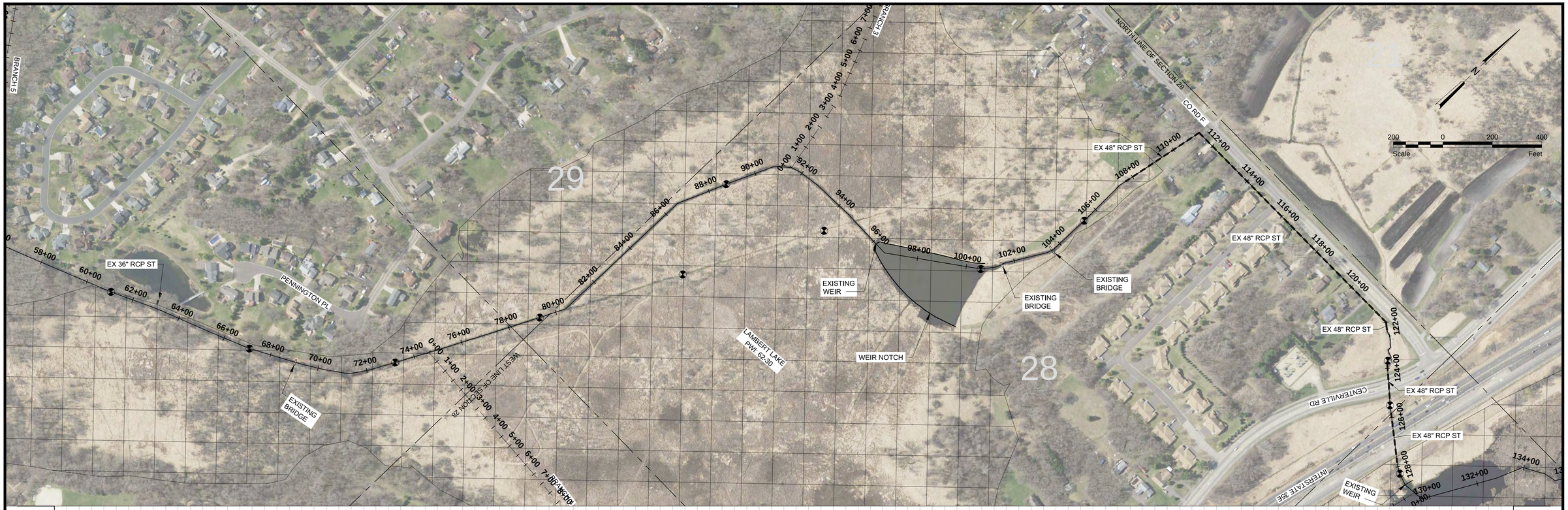

NOTE: ACSIC FROM 80+50 TO 107+66 IS PER 2004 LAMBERT WEIR PLANS

MAIN TRUNK

LAMBERT LAKE
PWI: 62-30

1981 "IMPROVEMENT" PROFILE

STA=61+06
SB ELEV=889.71

STA=67+11
SB ELEV=886.10
NO REFUSAL TO THIS DEPTH
(INCONCLUSIVE)

BRIDGE

STA=69+06
ELEV=893.75
LB

STA=71+22
ELEV=893.60
TOP ICE

STA=73+19
SB ELEV=889.85

BRANCH 4
STA. 74+63

1981 "IMPROVEMENT" PROFILE
CONTINUES ALONG THE AS-DESIGNED
ALIGNMENT AT 0.10% UNTIL THE
STORMSEWER AT COUNTY ROAD F

EXISTING CHANNEL BOTTOM

0.01%

PVIS: 80+50.00
PVIE: 890.43

STA=79+32
SB ELEV=886.46
NO REFUSAL TO THIS DEPTH
(INCONCLUSIVE)

ACSIC PROFILE

BRANCH 3
STA. 93+52

0.20%

STA=88+75
SB ELEV=886.54
NO REFUSAL TO THIS DEPTH
(INCONCLUSIVE)

STA=96+20
ELEV=895.63
WEIR NOTCH
(SOUTH SIDE)

STA=100+59
SB ELEV=891.48

STA=103+62
ELEV=897.54
LB

BRIDGE

BRIDGE

PVIS: 107+65.96
PVIE: 895.73

358L.F., 48" RCP @ 0.12%
STA 111+24 INV: 896.15 (US)
STA 107+66 INV: 895.73 (DS)

1075L.F., 48" RCP @ 0.12%
STA 121+99 INV: 897.41 (US)
STA 111+24 INV: 896.15 (DS)

STA=105+36
SB ELEV=894.88

0.12%

915 910 905 900 895 890 885 880 878

891.13 891.38 891.35 891.13 891.56 890.92 891.76 891.00 891.96 890.86 892.16 890.98 892.36 891.43 892.56 890.71 892.76 890.26 892.96 890.33 891.13 890.83 891.20 891.49 891.11 891.17 891.54 891.91 892.45 893.11 893.77 894.58 895.14 895.15 895.77 896.01 896.24 896.48 896.71

60+00 62+00 64+00 66+00 68+00 70+00 72+00 74+00 76+00 78+00 80+00 82+00 84+00 86+00 88+00 90+00 92+00 94+00 96+00 98+00 100+00 102+00 104+00 106+00 108+00 110+00 112+00 114+00 116+00

LEGEND

- PARCEL LINE
- PUBLIC WATER
- SOIL PROBE

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RAMSEY COUNTY DITCH 14
VADNAIS LAKE AREA
WATER MANAGEMENT ORGANIZATION

Appendix A

PLAN AND PROFILE
MAIN TRUNK

PROJECT NO. 7057-006

SHEET 2 of 5

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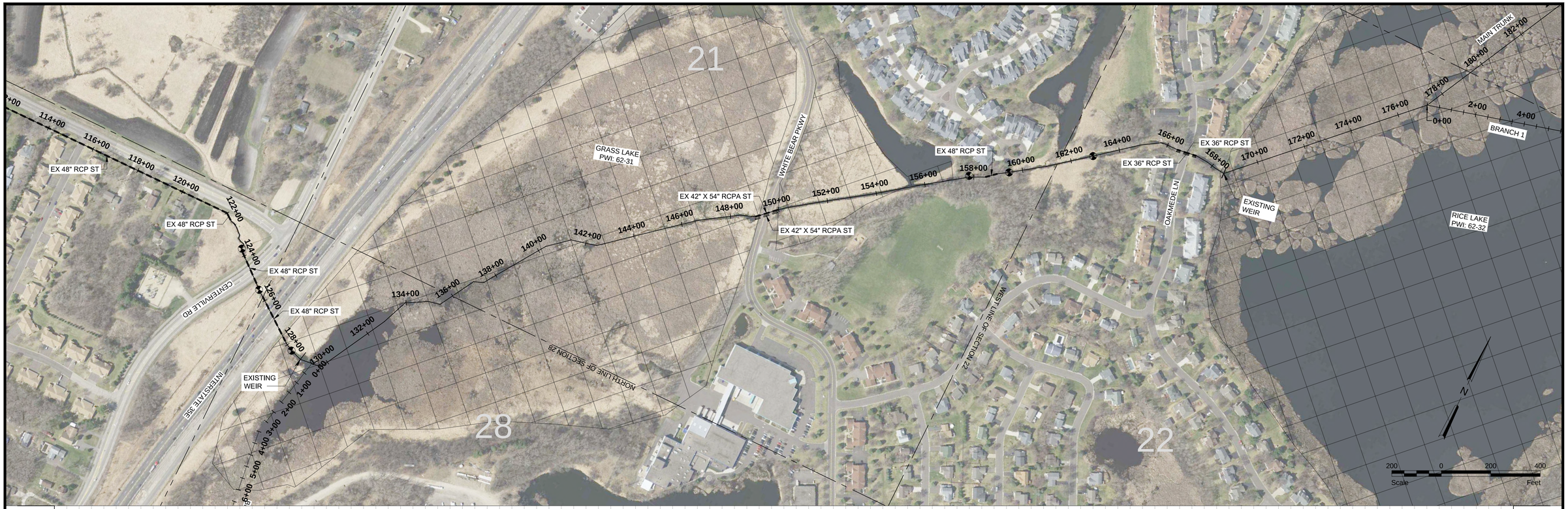

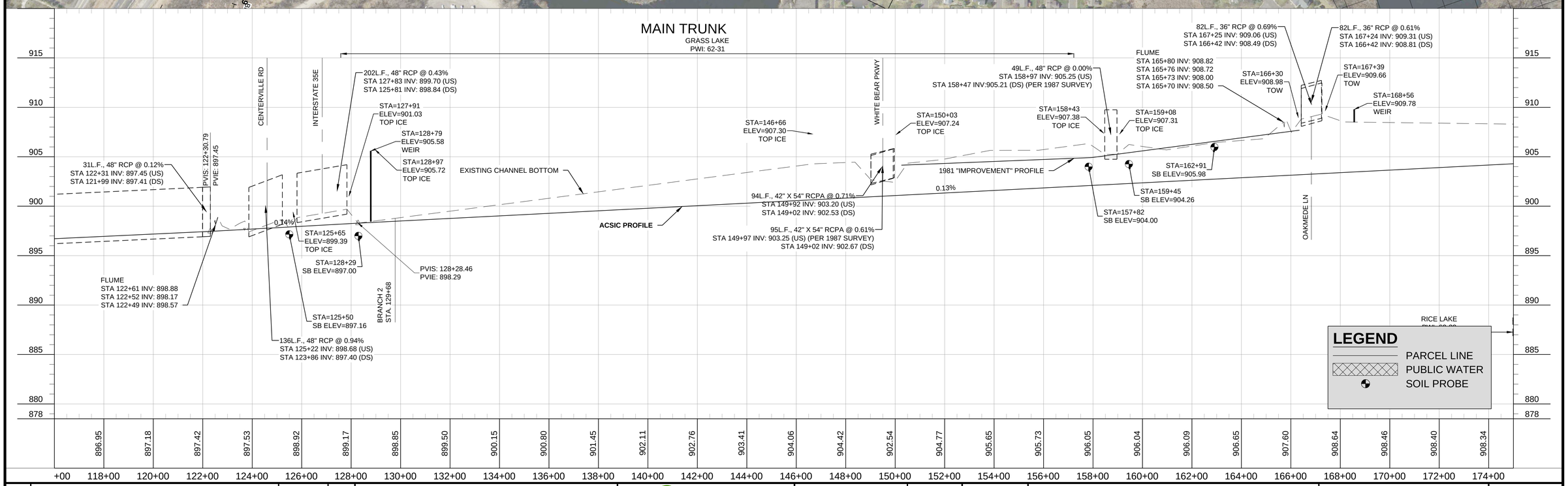

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RAMSEY COUNTY DITCH 14 Appendix A
VADNAIS LAKE AREA
WATER MANAGEMENT ORGANIZATION

PLAN AND PROFILE
MAIN TRUNK

PROJECT NO. 7057-006

SHEET
3 of 5

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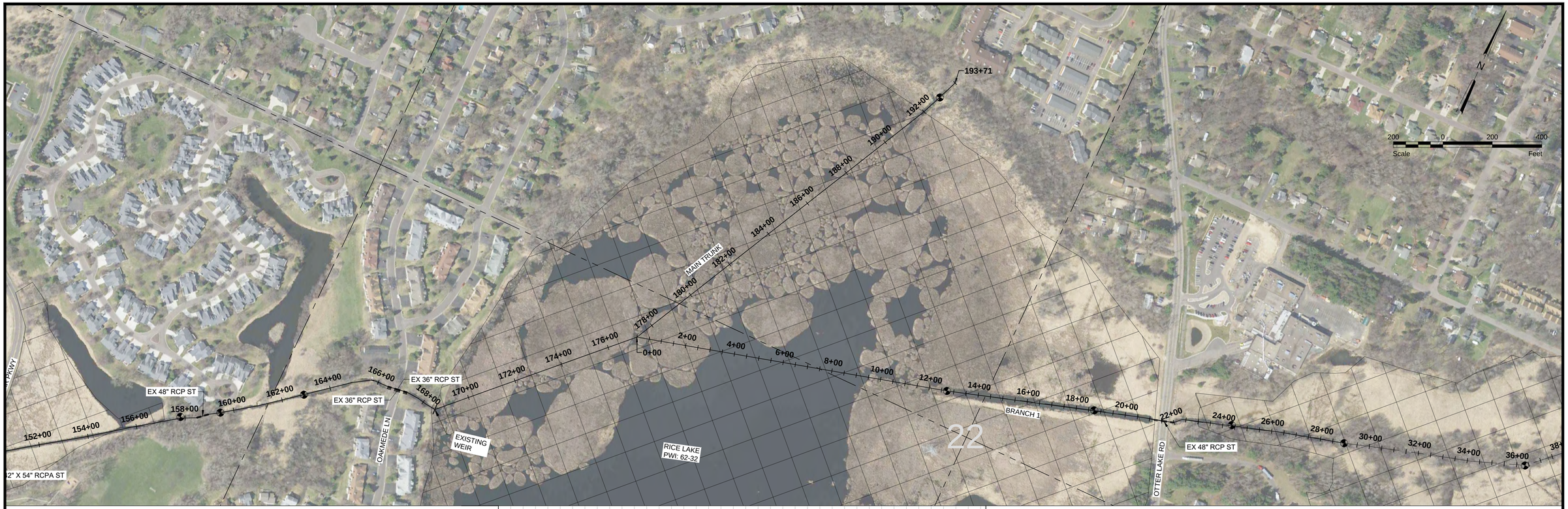

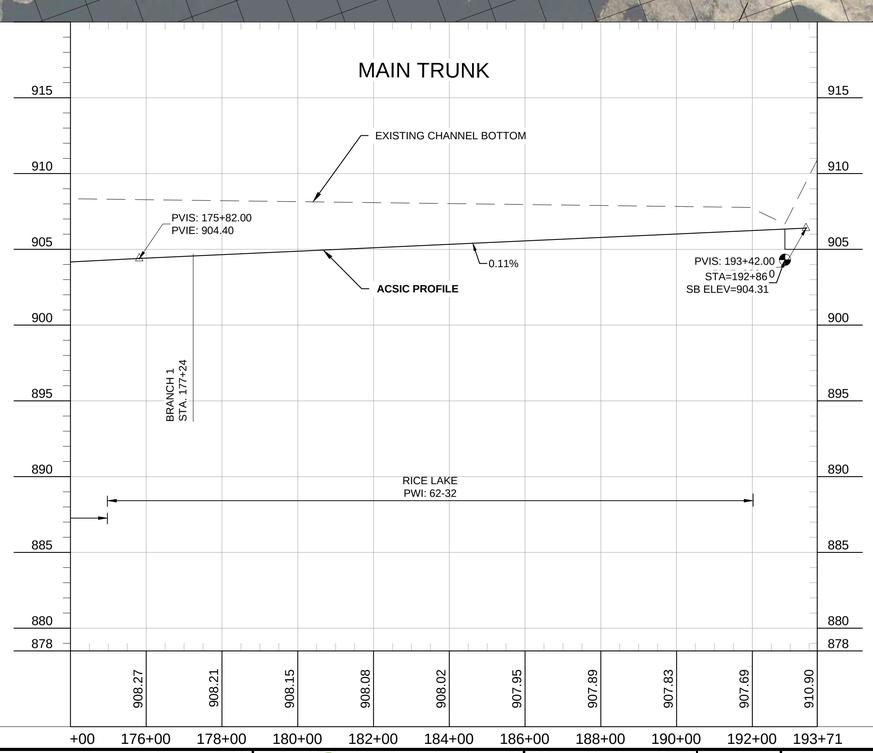

LEGEND

- PARCEL LINE
- PUBLIC WATER
- SOIL PROBE

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RAMSEY COUNTY DITCH 14 Appendix A
VADNAIS LAKE AREA
WATER MANAGEMENT ORGANIZATION

PLAN AND PROFILE
MAIN TRUNK
PROJECT NO. 7057-006

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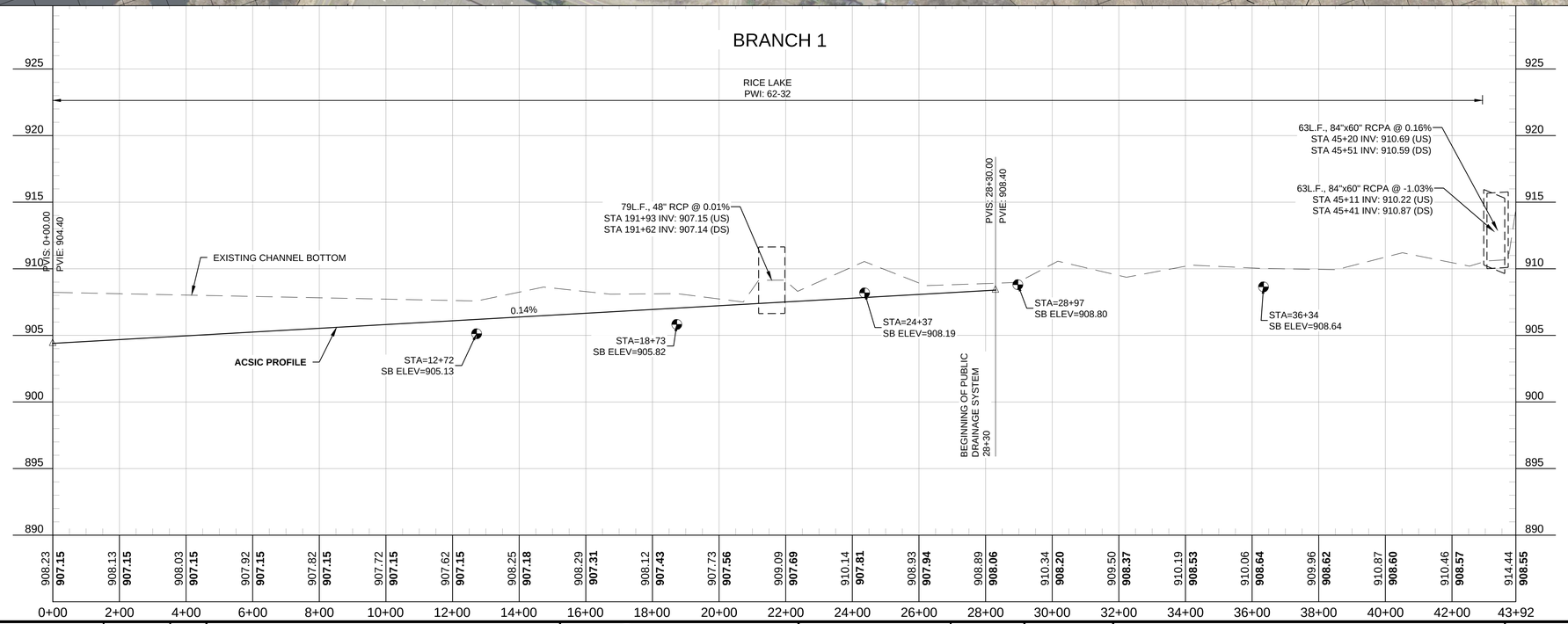
4 of 5



LEGEND

- PARCEL LINE
- PUBLIC WATER
- SOIL PROBE

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RAMSEY COUNTY DITCH 14 — Appendix A
VADNAIS LAKE AREA
WATER MANAGEMENT ORGANIZATION

PLAN AND PROFILE
BRANCH 1

PROJECT NO. 7057-006

SHEET
5 of 5

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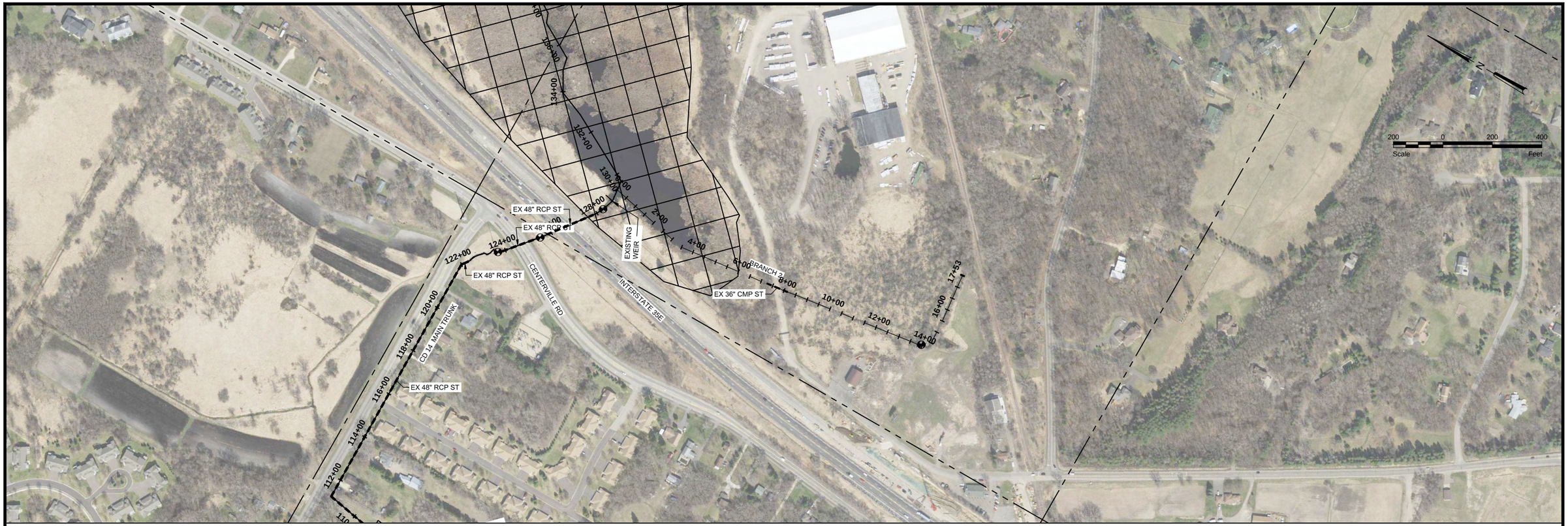
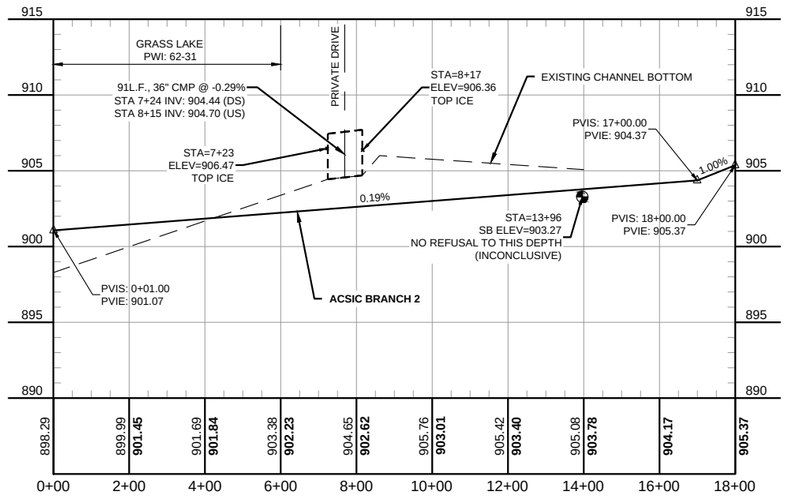
APPENDIX B – PLAN AND PROFILE OF CD 14 BRANCHES



NOTE: ACSIC PROFILE BASED ON THE AS-DESIGNED PROFILE AS SHOWN IN THE 1926 PLANS

BRANCH 2



LEGEND

- PARCEL LINE
- PUBLIC WATER
- SOIL PROBE

Appendix B

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No.	Revision	Date	By

PRELIMINARY
Not for Construction

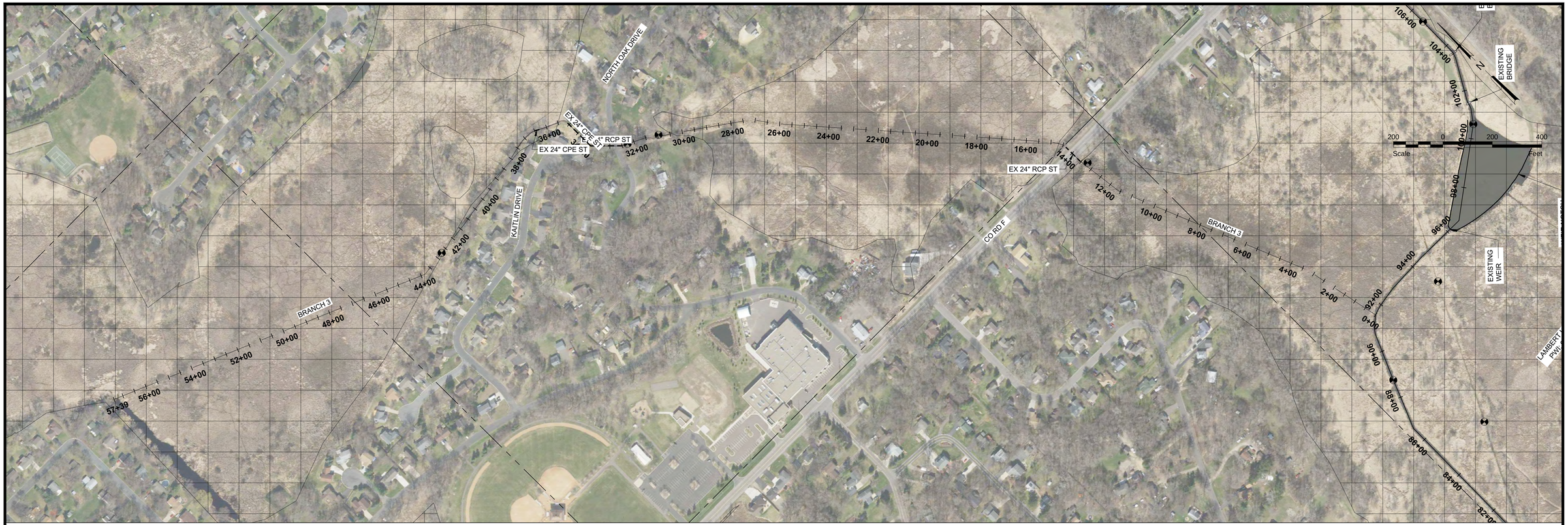
Houston Engineering Inc.
Maple Grove
P: 763.493.4522
F: 763.493.5572

Drawn by	Date
BLJ	6/5/18
Checked by	Scale
NS	AS SHOWN

RAMSEY COUNTY DITCH 14 BRANCH 2, 3. 4, 5, & 5A
VADNAIS LAKE AREA
WATE MANAGEMENT ORGANIZATION

BRANCH 2

PROJECT NO. 7057-006

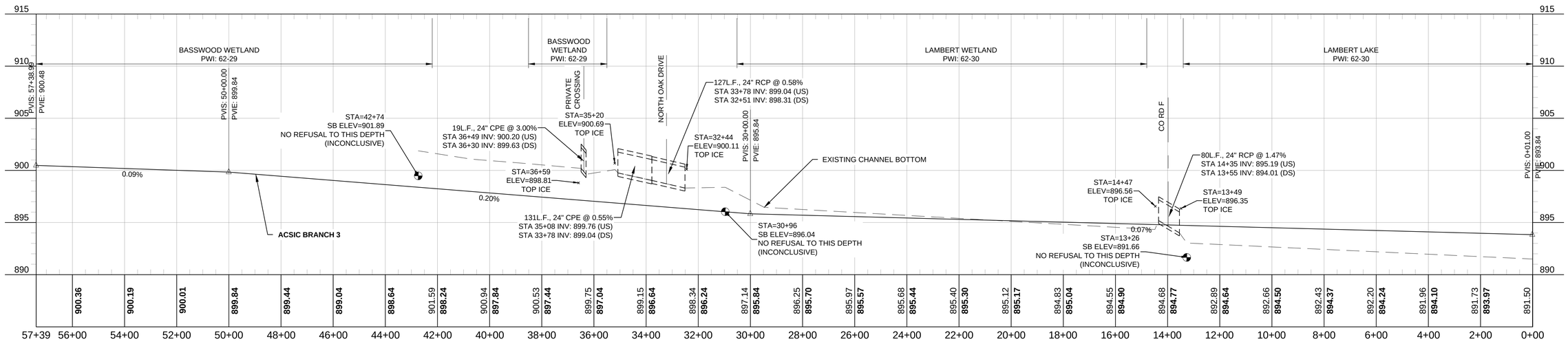


NOTE; ACSIC PROFILE
BASED ON THE
AS-DESIGNED PROFILE AS
SHOWN IN THE 1926 PLANS

LEGEND

- PARCEL LINE
- PUBLIC WATER
- SOIL PROBE

BRANCH 3



Appendix B

No.	Revision	Date	By

PRELIMINARY
Not for Construction

Houston Engineering Inc.
Maple Grove
P: 763.493.4522
F: 763.493.5572

Drawn by	Date
BLJ	6/1/18
Checked by	Scale
NS	AS SHOWN

RAMSEY COUNTY DITCH 14 BRANCH 2, 3. 4, 5, & 5A
VADNAIS LAKE AREA
WATE MANAGEMENT ORGANIZATION

BRANCH 3

PROJECT NO. 7057-006

SHEET 2 of 5

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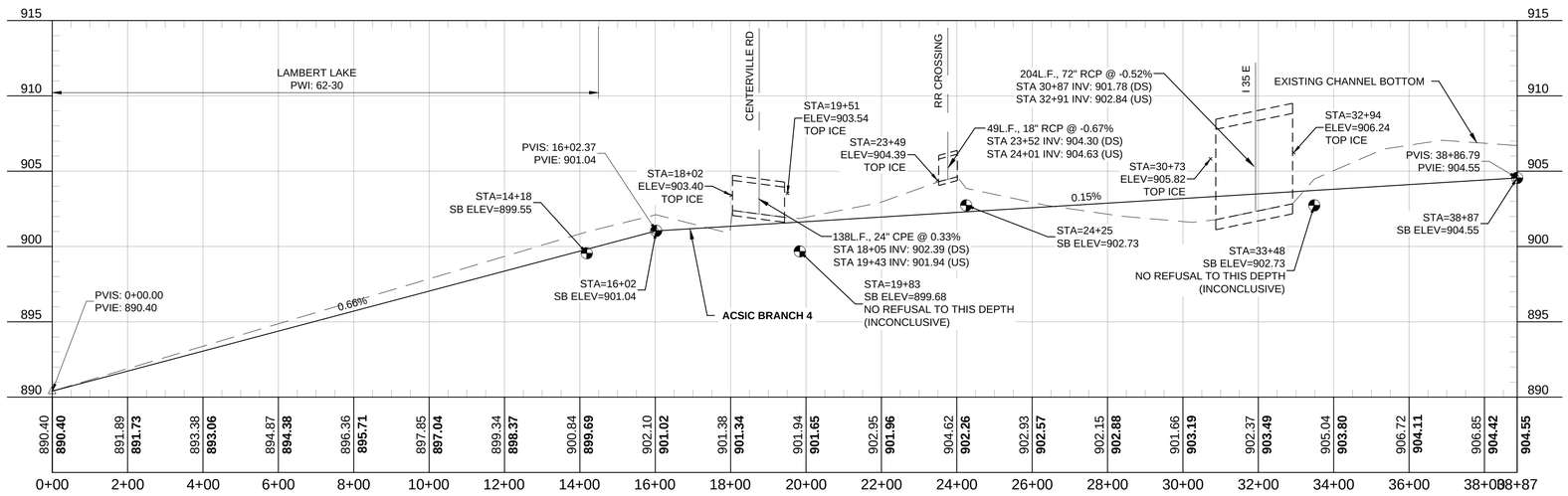
NOTE; ACSIC PROFILE
BASED ON SOIL PROBES

BRANCH 4



LEGEND

- PARCEL LINE
- PUBLIC WATER
- SOIL PROBE

Appendix B

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No.	Revision	Date	By

PRELIMINARY
Not for Construction

Houston Engineering Inc.
Maple Grove
P: 763.493.4522
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Drawn by	Date
BLJ	4/18/18
Checked by	Scale
NS	AS SHOWN

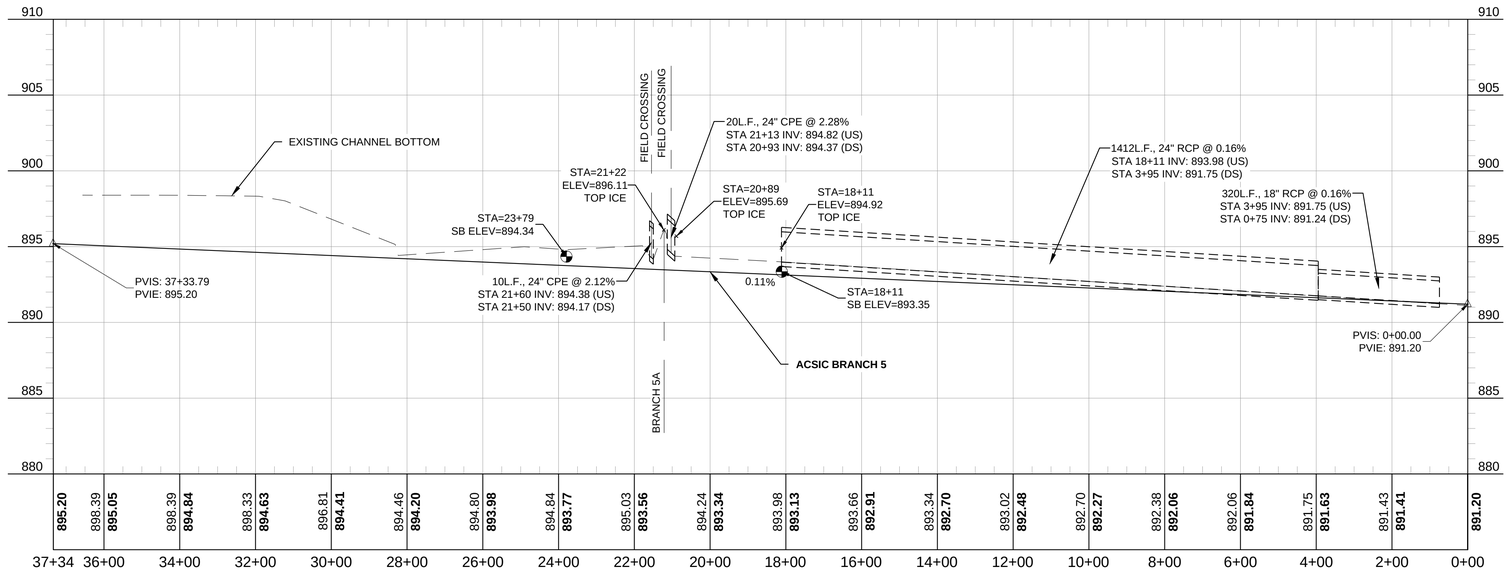
RAMSEY COUNTY DITCH 14 BRANCH 2, 3. 4, 5, & 5A
VADNAIS LAKE AREA
WATE MANAGEMENT ORGANIZATION

BRANCH 4

PROJECT NO. 7057-006

NOTE; ACSIC PROFILE BASED ON
THE 1939 IMPROVEMENT PLANS,
CONFIRMED BY SOIL PROBES

BRANCH 5



LEGEND

- PARCEL LINE
- PUBLIC WATER
- SOIL PROBE

Appendix B

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No.	Revision	Date	By

PRELIMINARY
Not for Construction

Houston Engineering Inc.
Maple Grove
P: 763.493.4522
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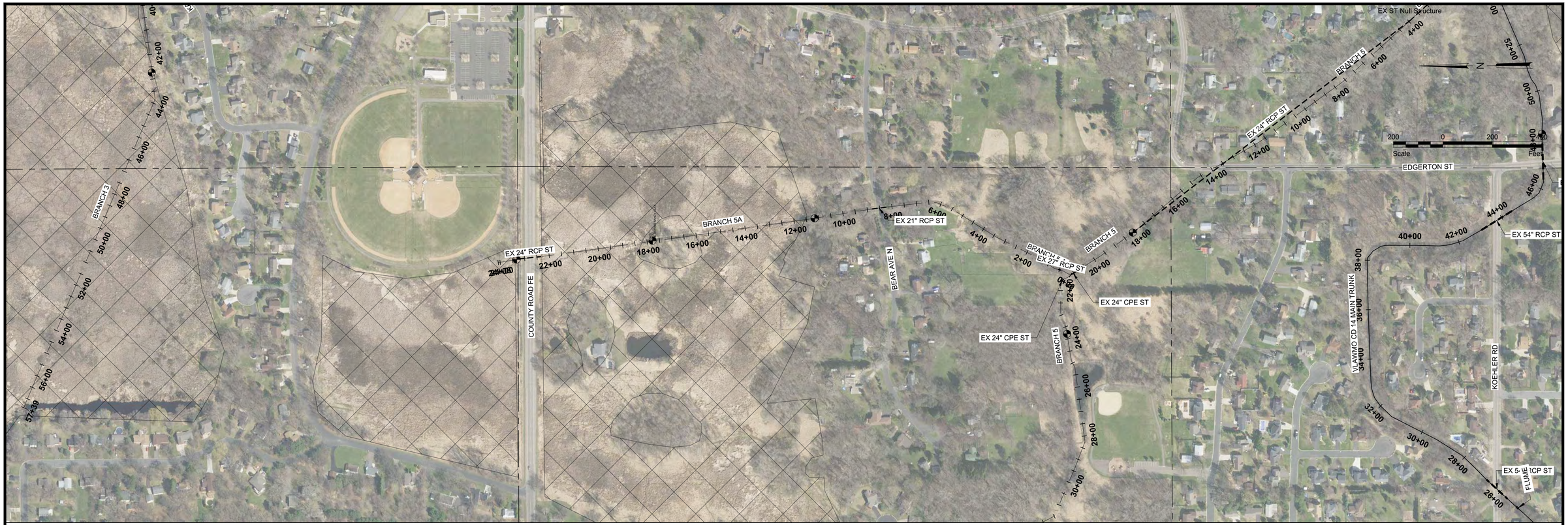
Drawn by	Date
BLJ	6/5/18
Checked by	Scale
NS	AS SHOWN

RAMSEY COUNTY DITCH 14 BRANCH 2, 3. 4, 5, & 5A
VADNAIS LAKE AREA
WATE MANAGEMENT ORGANIZATION

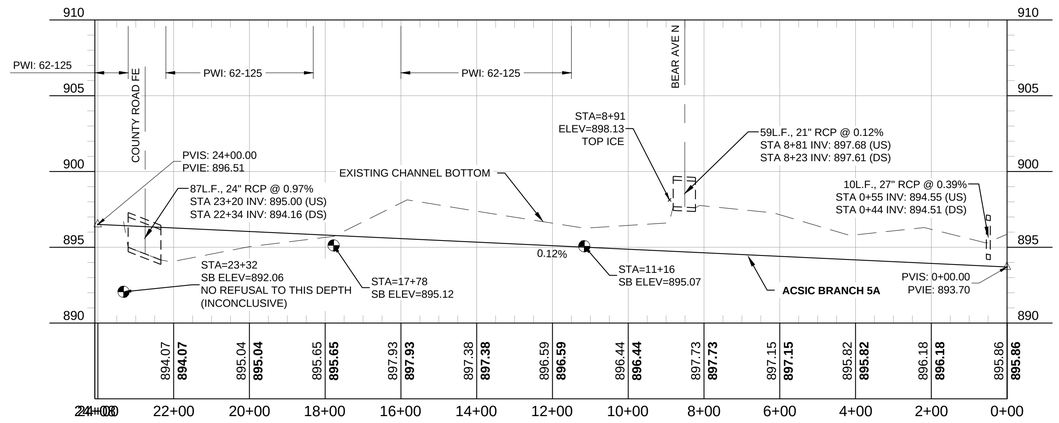
BRANCH 5

PROJECT NO. 7057-006



NOTE; ACSIC PROFILE BASED ON THE 1939 IMPROVEMENT PLANS, CONFIRMED BY SOIL BORINGS

BRANCH 5A



LEGEND

- PARCEL LINE
- PUBLIC WATER
- SOIL PROBE

Appendix B

No.	Revision	Date	By

PRELIMINARY
Not for Construction

Houston Engineering Inc.
Maple Grove
P: 763.493.4522
F: 763.493.5572

Drawn by	Date
BLJ	6/5/18
Checked by	Scale
NS	AS SHOWN

RAMSEY COUNTY DITCH 14 BRANCH 2, 3. 4, 5, & 5A
VADNAIS LAKE AREA
WATE MANAGEMENT ORGANIZATION

BRANCH 5A

PROJECT NO. 7057-006

SHEET 5 of 5

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APPENDIX C – RIGHT-OF-WAY ANALYSIS

Ditch ROW Width
60 feet
80 feet
100 feet

ROW
Public Waters Basins
Parcels

Sheet 2
Sheet 3
Sheet 4
Sheet 5
Sheet 6
Sheet 7
Sheet 8

0 0.25 0.5 0.75 1 1.25 Miles

N

Appendix C:
VLAWMO County Ditch 14 Right of Way Location Map

Scale:	Drawn by:	Checked by:	Project No.:	Date:	Sheet:
AS SHOWN	DJL	AJS	7057_006	6/18/2018	1 of 8

Houston Engineering Inc.
Maple Grove
P: 763.493.4522
F: 763.493.5572

Ditch ROW Width

- 60 feet
- 80 feet
- 100 feet
- ROW
- Public Waters Basins
- Parcels
- Intersecting Parcel

U n n a med

U n n a med

L a m b ert

E a s t V a dnais

W e s t V a dnais

0 0.1 0.2 0.3 0.4 0.5 Miles

N

Appendix C:
VLAWMO Ditch Right of Way

Scale:	Drawn by:	Checked by:	Project No.:	Date:	Sheet:
AS SHOWN	DJL	AJS	7057_006	6/18/2018	2 of 8

Houston Engineering Inc.
Maple Grove
P: 763.493.4522
F: 763.493.5572

Ditch ROW Width

- 60 feet
- 80 feet
- 100 feet
- ROW
- Public Waters Basins
- Parcels
- Intersecting Parcel

Unnamed
Unnamed
Unnamed
Lambert
Lambert
East Vadnais

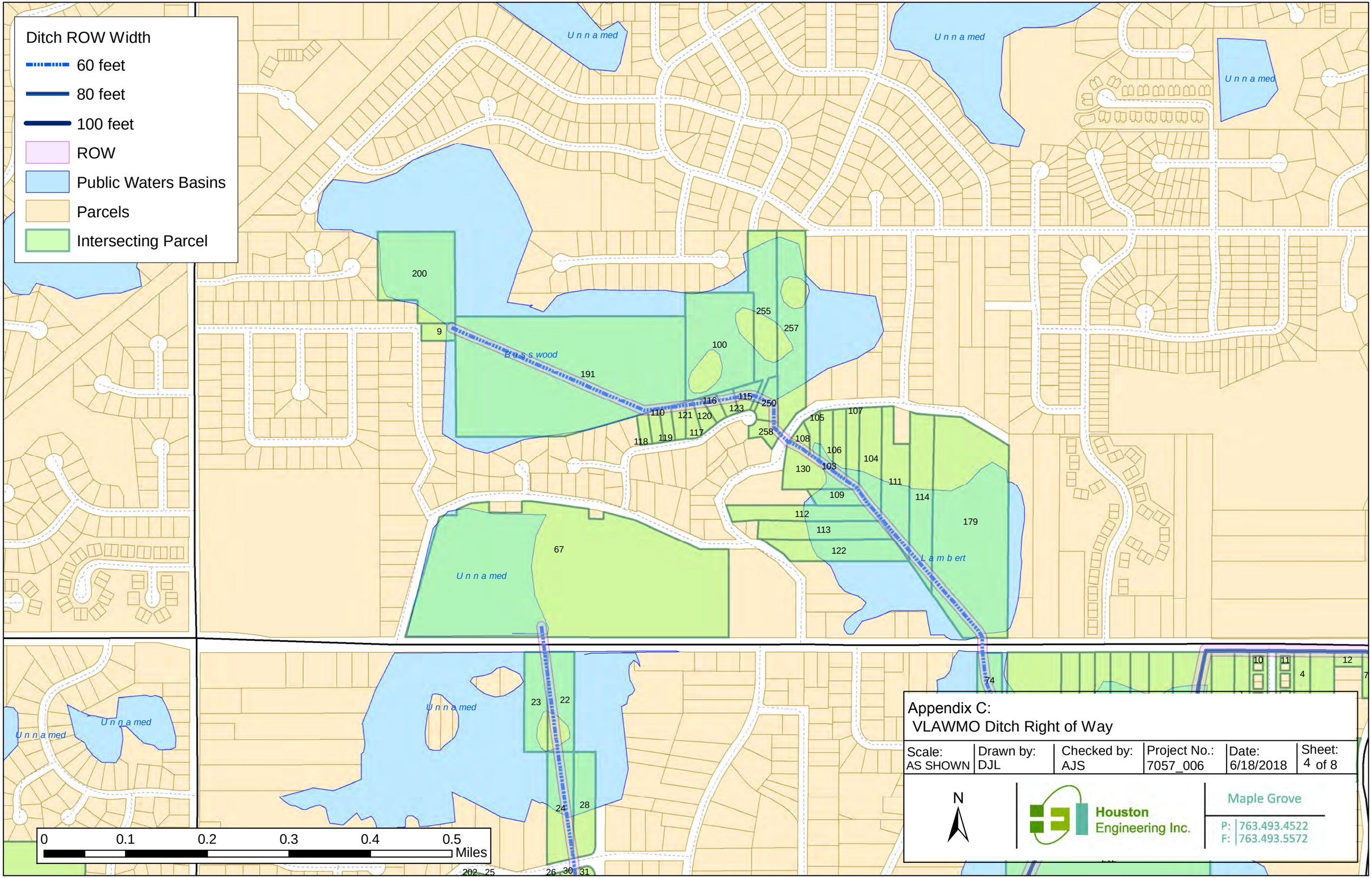
0 0.1 0.2 0.3 0.4 0.5 Miles

N

Houston Engineering Inc.
Maple Grove
P: 763.493.4522
F: 763.493.5572

Appendix C:
VLAWMO Ditch Right of Way

Scale:	Drawn by:	Checked by:	Project No.:	Date:	Sheet:
AS SHOWN	DJL	AJS	7057_006	6/18/2018	3 of 8



Appendix C:
VLAWMO Ditch Right of Way

Scale:	Drawn by:	Checked by:	Project No.:	Date:	Sheet:
AS SHOWN	DJL	AJS	7057_006	6/18/2018	4 of 8

Houston Engineering Inc.
Maple Grove
P: 763.493.4522
F: 763.493.5572

Ditch ROW Width

- 60 feet
- 80 feet
- 100 feet
- ROW
- Public Waters Basins
- Parcels
- Intersecting Parcel

0 0.1 0.2 0.3 0.4 0.5 Miles

N

Appendix C:
VLAWMO Ditch Right of Way

Scale:	Drawn by:	Checked by:	Project No.:	Date:	Sheet:
AS SHOWN	DJL	AJS	7057_006	6/18/2018	5 of 8

Houston Engineering Inc.
Maple Grove
P: 763.493.4522
F: 763.493.5572

Ditch ROW Width

- 60 feet
- 80 feet
- 100 feet
- ROW
- Public Waters Basins
- Parcels
- Intersecting Parcel

0 0.1 0.2 0.3 0.4 0.5 Miles

N

Appendix C:
VLAWMO Ditch Right of Way

Scale:	Drawn by:	Checked by:	Project No.:	Date:	Sheet:
AS SHOWN	DJL	AJS	7057_006	6/18/2018	6 of 8

Houston Engineering Inc.
Maple Grove
P: 763.493.4522
F: 763.493.5572

Ditch ROW Width

- 60 feet
- 80 feet
- 100 feet
- ROW
- Public Waters Basins
- Parcels
- Intersecting Parcel

Unnamed
Sobota Slough
Rice
Grass
Grass
Unnamed
Lambert
35E

0 0.1 0.2 0.3 0.4 0.5 Miles

N

Houston Engineering Inc.
Maple Grove
P: 763.493.4522
F: 763.493.5572

Appendix C:
VLAWMO Ditch Right of Way

Scale:	Drawn by:	Checked by:	Project No.:	Date:	Sheet:
AS SHOWN	DJL	AJS	7057_006	6/18/2018	7 of 8

Ditch ROW Width

- 60 feet
- 80 feet
- 100 feet
- ROW
- Public Waters Basins
- Parcels
- Intersecting Parcel

101 99 193 182 18 214 193 102 136 133 134 135 33 137 131 132 138 129 140 139 142 144 145 141 143 128 150 151 153 149 124 161 155 127 163 158 157 125 162 160 159 126 164 168 171 170 169 167 197 199 21 35 186 194 185 184 174 198 61

Sobota Slough

Unnamed

Rice

Grass

Goose

0 0.1 0.2 0.3 0.4 0.5 Miles

N

Appendix C:
VLAWMO Ditch Right of Way

Scale:	Drawn by:	Checked by:	Project No.:	Date:	Sheet:
AS SHOWN	DJL	AJS	7057_006	6/18/2018	8 of 8

Houston Engineering Inc.
Maple Grove
P: 763.493.4522
F: 763.493.5572

Parcels Intersected by the Right of Way for VLAWMO CD 14 and its Branches

Map ID	Parcel ID	Site Address	Site City St	Owner		Parcel Acreage
1	283022210003	948 County Road F E	Vadnais Heights MN 55127-7506	Thomas M Greeninger	Laurie A Greeninger	1.9
2	283022220003	850 County Road F E	Vadnais Heights MN 55127-7504	Peter J Rivard Trustee	Peter Rivard	3.35
3	283022210006	1008 County Road F E	Vadnais Heights MN 55127-7508	Shirley A Jones		3.28
4	283022210005	996 County Road F E	Vadnais Heights MN 55127-7506	Michael E Lawrence	Karina M Lawrence	0.71
5	283022210002	940 County Road F E	Vadnais Heights MN 55127-7506	Harlen E Bacon	Patricia E Bacon	2.81
6	283022130003	3900 Labore Rd	Vadnais Heights MN 55110-4108	William J Horwath	Carol D Horwath	2.55
7	283022210008	0 County Road F E	Vadnais Heights MN 55127	City Of Vadnais Heights		1.28
8	283022210070	0 Alpine Ave	Vadnais Heights MN 55127	Pine Meadow Hmownr Assoc	Harstad Homes Inc	1.52
9	203022310008	4260 Oak Crest Dr	Vadnais Heights MN 55127-7975	Robert Lee Andre		0.56
10	283022210113	4079 Alpine Ave	Vadnais Heights MN 55127-7165	Philip A Caligiuri	Gail A Caligiuri	0.07
11	283022210115	4080 Alpine Ave	Vadnais Heights MN 55127-7165	William Nielsen		0.07
12	283022210116	1012 County Road F E	Vadnais Heights MN 55127-7508	David Weyer		0.41
13	283022220004	858 County Road F E	Vadnais Heights MN 55127-7504	Gregory D Martz	Gale S Engebretson	2.82
14	283022220012	870 County Road F E	Vadnais Heights MN 55127-7504	Kevin R Kowarsch		2.82
15	283022220013	878 County Road F E	Vadnais Heights MN 55127-7504	Gordon L Haus	Roberta B Haus	3.52
16	283022220014	900 County Road F E	Vadnais Heights MN 55127-7506	Allen Thomsen		3.48

Parcels Intersected by the Right of Way for VLAWMO CD 14 and its Branches

17	283022220015	910 County Road F E	Vadnais Heights MN 55127-7506	Verna N Peterson		4.34
18	223022130023	4370 Otter Lake Rd	White Bear Township MN 55110-3761	Water Gremlin Co		4.62
19	283022210077	0 Alpine Ave	Vadnais Heights MN 55127	Pine Meadow Homeowners Assoc		2.94
20	283022210015	0 Unassigned	Vadnais Heights MN 55127	County Of Ramsey Public Works		2.24
21	213022410242	1278 Pond View Ln	White Bear Township MN 55110-4152	Martha K Cunningham		0.11
22	293022210007	0 County Road F E	Vadnais Heights MN 55127	City Of Vadnais Heights		2.62
23	293022210006	0 County Road F E	Vadnais Heights MN 55127	City Of Vadnais Heights		2.3
24	293022210010	555 Bear Ave N	Vadnais Heights MN 55127-7054	Hg Enterprise Llc		2.83
25	293022240006	514 Bear Ave N	Vadnais Heights MN 55127-7055	Richard D Krannich	Linda R Krannich	1.79
26	293022240016	548 Bear Ave N	Vadnais Heights MN 55127-7055	Michael J Hennessey		2.53
27	293022240017	532 Bear Ave N	Vadnais Heights MN 55127-7055	Edward N Haddon	Dianne V Haddon	1.83
28	293022210009	571 Bear Ave N	Vadnais Heights MN 55127-7054	Robert H Larson	Shirley M Larson	2.18
29	293022240005	524 Bear Ave N	Vadnais Heights MN 55127-7055	Scott T Vanderbosch	Maryann Vanderbosch	1.65
30	293022240002	562 Bear Ave N	Vadnais Heights MN 55127-7055	Joan Pelzer		1.4
31	293022240001	570 Bear Ave N	Vadnais Heights MN 55127-7055	David L Lahlum	Sally A Lahlum	1.94
32	293022230061	3870 Tessier Tr	Vadnais Heights MN 55127	Glen Gleason	Stephanie Gleason	1.5
33	223022320021	4318 Fisher Ln Unit 9A	White Bear Township MN 55110-3687	Laura J Ratcliffe		0.03

Parcels Intersected by the Right of Way for VLAWMO CD 14 and its Branches

34	293022410029	726 Pennington Pl	Vadnais Heights MN 55127-7500	Gregory Townley Loppnow	Andrea Joan Loppnow	0.58
35	213022410140	1280 Pond View Ln	White Bear Township MN 55110-4152	Angela R Molitor	Ronald T Whitcomb	0.1
36	293022310062	471 Koehler Rd	Vadnais Heights MN 55127-7065	Heidi Heller	Ronald J Heller	0.72
37	293022320021	453 Koehler Rd	Vadnais Heights MN 55127-7065	Justin M Bachman		0.82
38	293022330027	440 Koehler Rd	Vadnais Heights MN 55127-7066	Brandon W Mileski	Lyndsay R Capeder	0.39
39	293022310025	483 Koehler Rd	Vadnais Heights MN 55127-7065	Ryan T Yoder	Shelly L Yoder	0.29
40	293022330026	448 Koehler Rd	Vadnais Heights MN 55127-7066	Anthony M Monda	Kimberly A Coyle	0.29
41	293022340001	470 Koehler Rd	Vadnais Heights MN 55127-7066	William L Weigel	Jane L Weigel	0.48
42	293022330025	0 Koehler Rd	Vadnais Heights MN 55127	Michael J Nowak	Julia D Nowak	0.32
43	293022310024	475 Koehler Rd	Vadnais Heights MN 55127-7065	Davin Tormanen	Jodie Tormanen	0.28
44	293022330059	3677 Oak Creek Dr E	Vadnais Heights MN 55127-4064	Bobbi J Knox	Brett A Knox	0.38
45	293022330014	3645 Oak Creek Dr W	Vadnais Heights MN 55127-7000	Brian L Carnes	Julie A Carnes	0.3
46	293022330015	3633 Oak Creek Dr W	Vadnais Heights MN 55127-7000	Rick H Ehrich	Janet E Ehrich	0.3
47	293022330049	411 Oak Creek Dr S	Vadnais Heights MN 55127-7017	Theodore L Steichen	Patricia A Steichen	0.47
48	293022330051	427 Oak Creek Dr S	Vadnais Heights MN 55127-7017	Larry R Larson Trustee	Pamela A Larson Trustee	0.45
49	293022330042	433 Oak Creek Cir	Vadnais Heights MN 55127-7001	Winston Chuck	Margaret K Seibel	0.4
50	293022420043	643 Parkwood Cir	Vadnais Heights MN 55127-7024	Jeffrey L Solomon	Cathy L Solomon	0.26

Parcels Intersected by the Right of Way for VLAWMO CD 14 and its Branches

51	293022420040	3730 Parkwood Ln	Vadnais Heights MN 55127-7027	Wendy L Vidlak	Jess M Holle	0.32
52	293022420046	649 Parkwood Cir	Vadnais Heights MN 55127-7024	Mark F Price	Madonna M Price	0.36
53	293022410030	738 Pennington Pl	Vadnais Heights MN 55127-7500	Antone G Gregory	Mary J Gregory	0.43
54	293022410031	746 Pennington Pl	Vadnais Heights MN 55127-7500	Colleen Tusa		0.56
55	293022420044	645 Parkwood Cir	Vadnais Heights MN 55127-7024	Linda R Peterson		0.27
56	293022420038	3746 Parkwood Ln	Vadnais Heights MN 55127-7027	Edward Wallace Gorr	Jenni Alita Swenson	0.43
57	293022410033	758 Pennington Pl	Vadnais Heights MN 55127-7500	Mark E King	Mary T King	0.45
58	293022420041	635 Parkwood Cir	Vadnais Heights MN 55127-7024	Darrick D Zarling	Susan M Zarling	0.39
59	293022430013	0 Kohler Rd	Vadnais Heights MN 55127	Carol A Krey		5.19
60	293022330036	426 Oak Creek Ct	Vadnais Heights MN 55127-7004	Monika G Sukhatme Trustee	Vasant A Sukhatme Trustee	0.39
61	293022330044	428 Oak Creek Cir	Vadnais Heights MN 55127-7001	Scott P Vander Heiden	Joy A Vander Heiden	0.29
62	293022330034	425 Oak Creek Ct	Vadnais Heights MN 55127-7004	Jonathan M Hager	Nichole M Hager	0.45
63	293022330056	3653 Oak Creek Dr E	Vadnais Heights MN 55127-4064	Mike P Presseller	Tracy A Presseller	0.36
64	293022330057	3661 Oak Creek Dr E	Vadnais Heights MN 55127-4064	Charles Grant Mclennan	Brenda Lou Mclennan	0.33
65	293022330060	3687 Oak Creek Dr E	Vadnais Heights MN 55127-4064	Kevin L Reich	Susann M Reich	0.43
66	293022330062	3705 Oak Creek Dr E	Vadnais Heights MN 55127-4064	Michael J Nowak	Julia D Nowak	0.41
67	203022340064	641 County Road F E	Vadnais Heights MN 55127	City Of Vadnais Heights		35.03

Parcels Intersected by the Right of Way for VLAWMO CD 14 and its Branches

68	293022440001	3677 Centerville Rd	Vadnais Heights MN 55127-7122	Matthew M Kurzhals		5.97
69	293022410011	3693 Centerville Rd	Vadnais Heights MN 55127-7122	Michael J Gennow	Debra Gennow	1.55
70	293022330045	422 Oak Creek Cir	Vadnais Heights MN 55127-7001	Robert W Lange	Susanne K Lange	0.27
71	293022340102	3693 Edgerton St	Vadnais Heights MN 55127-7133	Jacque Meyers	Luann Martin	0.28
72	293022240015	0 Bear Ave S	Vadnais Heights MN 55127	City Of Vadnais Heights		2.16
73	293022140030	745 Stockdale Rd	Vadnais Heights MN 55127-7528	Renae J Brown	Kelly J Brown	3.5
74	293022110001	0 County Road F E	Vadnais Heights MN 55127	City Of Vadnais Heights		1.38
75	293022110020	0 Stockdale Dr	Vadnais Heights MN 55127	City Of Vadnais Heights		0.55
76	293022310037	3752 Brunet Ct	Vadnais Heights MN 55127-7058	Robert J Griesgraber Trustee		0.29
77	293022310069	510 Lambert Creek Ln	Vadnais Heights MN 55127-7043	Mark D Rizzardi	Patricia K Rizzardi	0.51
78	293022310068	506 Lambert Creek Ln	Vadnais Heights MN 55127-7043	Mark H Hanson	Christina Hanson	0.48
79	293022310035	3764 Brunet Ct	Vadnais Heights MN 55127-7058	Douglas P Vanvreede	Barbara I Vanvreede	0.33
80	293022310036	3758 Brunet Ct	Vadnais Heights MN 55127-7058	Michael W Boehm	Corrina S Boehm	0.29
81	293022310034	3767 Brunet Ct	Vadnais Heights MN 55127-7058	Barry A Przybylski	Nancy S Przybylski	0.34
82	293022310063	3737 Thomas Ct	Vadnais Heights MN 55127-7042	Thomas N Falk	Joan B Falk	0.33
83	293022310048	3763 Brunet Ct	Vadnais Heights MN 55127-7058	Michael J Gannon	Heather A Gannon	0.34
84	293022330047	3640 Oak Creek Dr W	Vadnais Heights MN 55127-7028	Kathleen M Backes	Laurie A Backes	0.31

Parcels Intersected by the Right of Way for VLAWMO CD 14 and its Branches

85	293022330046	416 Oak Creek Cir	Vadnais Heights MN 55127-7001	John A Swanson Trustee	Linda L Swanson Trustee	0.34
86	293022330035	430 Oak Creek Ct	Vadnais Heights MN 55127-7004	James M Ed	Julie Ann Ed Trustee	0.42
87	293022330041	427 Oak Creek Cir	Vadnais Heights MN 55127-7001	Ralph J Arrigoni	Cecille M Arrigoni	0.26
88	293022330043	434 Oak Creek Cir	Vadnais Heights MN 55127-7001	Paul Hakamaki	Michaele Hakamaki	0.31
89	293022330050	419 Oak Creek Dr S	Vadnais Heights MN 55127-7017	David J Bohn	Marilyn A Meierhofer	0.53
90	293022330055	3645 Oak Creek Dr E	Vadnais Heights MN 55127-7035	Stephen V Sawntek		0.4
91	293022330058	3669 Oak Creek Dr E	Vadnais Heights MN 55127-4064	Mark L Edson	Diane W Edson	0.36
92	293022330061	3693 Oak Creek Dr E	Vadnais Heights MN 55127-4064	Troy J Mcculloch	Karen A Mcculloch	0.44
93	283022320010	3740 Centerville Rd	Vadnais Heights MN 55127-7124	James E Markham	Linda M Markham	4.37
94	283022310004	3770 Centerville Rd	Vadnais Heights MN 55127-7124	Harl Walbon	Harland Walbon	1.41
95	283022320021	3747 Nature View Trl	Vadnais Heights MN 55127-7134	Morgan Combs	Debra J Combs	1.74
96	283022320022	3749 Nature View Trl	Vadnais Heights MN 55127-7134	Tate V Guckin		0.33
97	283022320041	0 Centerville Rd	Vadnais Heights MN 55127	Paul Hendrickson	Lynette Hendrickson	0.32
98	283022320040	3753 Centerville Rd	Vadnais Heights MN 55127-7121	Walter Mueller		0.87
99	223022240006	0 Park Ct	White Bear Lake MN 55110	Willows Of White Bear Lake		3.53
100	203022420028	0 Unassigned	Vadnais Heights MN 55127	Robert S Moore		6.54
101	223022240002	1480 Park St	White Bear Lake MN 55110-3792	Michael Development Ii Lp		5.05

Parcels Intersected by the Right of Way for VLAWMO CD 14 and its Branches

102	303022120001	0 County Road F E	Vadnais Heights MN 55127	City Of St Paul		159.37
103	203022440006	728 North Oak Dr	Vadnais Heights MN 55127-7959	Lenore H Weber		0.76
104	203022440003	740 North Oak Dr	Vadnais Heights MN 55127-7959	Adelbert A Lovas	Mathilda C Lovas	2.08
105	203022410038	724 North Oak Dr	Vadnais Heights MN 55127-7959	Steven M Widman Trustee	Ellen Mk Widman Trustee	0.47
106	203022440005	732 North Oak Dr	Vadnais Heights MN 55127-7959	Michael A Brown		0.91
107	203022440004	736 North Oak Dr	Vadnais Heights MN 55127-7959	Kelsy A Heiden		1.06
108	203022430021	0 North Oak Dr	Vadnais Heights MN 55127	Steven M Widman Trustee	Ellen Mk Widman Trustee	0.29
109	203022440014	0 Clover Ave	Vadnais Heights MN 55127	City Of Vadnais Heights		0.89
110	203022420018	4171 Kaitlin Dr	Vadnais Heights MN 55127-7903	Michael G Muscanto		0.36
111	203022440002	750 North Oak Dr	Vadnais Heights MN 55127-7959	Daniel G Mcclurg	Linda J Mcclurg	3.07
112	203022430025	4166 Clover Ave	Vadnais Heights MN 55127-7940	Wesley J Smith	Julie A Nacario	2.2
113	203022440007	4142 Clover Ave	Vadnais Heights MN 55127-7940	Richard A Oftedahl	Paulette A Oftedahl	2.59
114	203022440017	758 North Oak Dr	Vadnais Heights MN 55127-7959	Steven R Johnson	Judy L Johnson	3.55
115	203022420034	4185 Kaitlin Dr	Vadnais Heights MN 55127-7903	Paul J Stgeorge	Cindy B Stgeorge	0.52
116	203022420032	4181 Kaitlin Dr	Vadnais Heights MN 55127-7903	Gary P Delaney	Kimberly A Delaney	0.37
117	203022420030	4177 Kaitlin Dr	Vadnais Heights MN 55127-7903	Gavin L Burnham	Kathleen M Burnham	0.42
118	203022420017	4169 Kaitlin Dr	Vadnais Heights MN 55127-7903	Cha Blong Xiong	Cheu Lo Xiong	0.34

Parcels Intersected by the Right of Way for VLAWMO CD 14 and its Branches

119	203022420019	4173 Kaitlin Dr	Vadnais Heights MN 55127-7903	Gregory J Brandt	Robin B Brandt	0.38
120	203022420031	4179 Kaitlin Dr	Vadnais Heights MN 55127-7903	Francis J Tate	Karen M Tate	0.42
121	203022420020	4175 Kaitlin Dr	Vadnais Heights MN 55127-7903	Scott T Richardson	Julie D Richardson	0.45
122	203022440008	4130 Clover Ave	Vadnais Heights MN 55127-7940	Richard Krumm	Patricia Krumm	2.6
123	203022420033	4183 Kaitlin Dr	Vadnais Heights MN 55127-7903	Douglas J Kovala	Anne Elissa Kovala	0.37
124	223022320100	4268 Oakmede Ln Unit 81A	White Bear Township MN 55110-7609	Mark Tan		0.03
125	223022320116	4248 Oakmede Ln Unit 97A	White Bear Township MN 55110-7609	Barbara J Britain		0.03
126	223022320108	4249 Oakmede Ln Unit 89A	White Bear Township MN 55110-7610	Casey M Kaupang	Tory Kaupang	0.03
127	223022320061	4251 Oakmede Ln	White Bear Township MN 55110-7610	Barbara J Britain		0.01
128	223022320092	4278 Fisher Ln Unit 73D	White Bear Township MN 55110-7611	Martin Ohehir		0.03
129	223022320037	4298 Fisher Ln Unit 25A	White Bear Township MN 55110-7611	Manya R Harsch		0.03
130	203022430022	4180 Clover Ave	Vadnais Heights MN 55127-7940	John H Hassel	Doris J Hassel	1.58
131	223022320022	4316 Fisher Ln Unit 10B	White Bear Township MN 55110-3687	Joao A Lima		0.05
132	223022320023	4314 Fisher Ln Unit 11C	White Bear Township MN 55110-3687	Jose A Lima	Ann Lima	0.05
133	223022320024	4312 Fisher Ln Unit 12D	White Bear Township MN 55110-3687	Carol L Hirsch		0.02
134	223022320025	4308 Fisher Ln Unit 13D	White Bear Township MN 55110-3687	Marilyn D Walsh		0.02
135	223022320026	4306 Fisher Ln Unit 14C	White Bear Township MN 55110-3687	Penelope A Zastrow Trustee		0.05

Parcels Intersected by the Right of Way for VLAWMO CD 14 and its Branches

136	223022320027	4304 Fisher Ln Unit 15B	White Bear Township MN 55110-3687	Terence S Bernhardt	Jeanne M Laqua	0.05
137	223022320028	4302 Fisher Ln Unit 16A	White Bear Township MN 55110-3687	Patricia Patzner		0.03
138	223022320038	4296 Fisher Ln Unit 26B	White Bear Township MN 55110-7611	Andrew Martin	Haley Martin	0.05
139	223022320039	4294 Fisher Ln Unit 27C	White Bear Township MN 55110-7611	Cindy Jenkins		0.05
140	223022320040	4292 Fisher Ln Unit 28D	White Bear Township MN 55110-7611	Linda A Guanzini		0.02
141	223022320041	4288 Fisher Ln Unit 29D	White Bear Township MN 55110-7611	Michael A Jost	Jane M Willard	0.02
142	223022320042	4286 Fisher Ln Unit 30C	White Bear Township MN 55110-7611	Mary Beth Fairman		0.05
143	223022320043	4284 Fisher Ln Unit 31B	White Bear Township MN 55110-7611	L M Young Family Trust		0.05
144	223022320044	4282 Fisher Ln Unit 32A	White Bear Township MN 55110-7611	Mary A Lundberg		0.03
145	223022320093	4276 Fisher Ln Unit 74C	White Bear Township MN 55110-7611	Roger W Hinze	Mary Lou Hinze	0.05
146	223022320094	4274 Fisher Ln Unit 75B	White Bear Township MN 55110-7611	Wayne W Aitken		0.05
147	223022320095	4272 Fisher Ln Unit 76A	White Bear Township MN 55110-7611	Lynne Newbauer		0.03
148	223022320101	4266 Oakmede Ln Unit 82B	White Bear Township MN 55110-7609	Kae Ann Stender		0.05
149	223022320102	4264 Oakmede Ln Unit 83C	White Bear Township MN 55110-7609	Diane Kopesky		0.05
150	223022320103	4262 Oakmede Ln Unit 84D	White Bear Township MN 55110-7609	Paul H Kascht		0.03
151	223022320104	4258 Oakmede Ln Unit 85D	White Bear Township MN 55110-7609	Linda J Nellis Trustee		0.02
152	223022320106	4254 Oakmede Ln Unit 87B	White Bear Township MN 55110-7609	Elizabeth M Breneman		0.05

Parcels Intersected by the Right of Way for VLAWMO CD 14 and its Branches

153	223022320107	4252 Oakmede Ln Unit 88A	White Bear Township MN 55110-7609	Rebecca Anne Svendsen	Rebecca A Baltzer	0.03
154	223022320150	4256 Oakmede Ln Unit 86C	White Bear Township MN 55110-7609	Ervin D Merkling	Vivian M Merkling	0.05
155	223022320117	4246 Oakmede Ln Unit 98B	White Bear Township MN 55110-7609	Raymond Romero		0.05
156	223022320118	4244 Oakmede Ln Unit 99C	White Bear Township MN 55110-7609	Cheryl J Carlstrom		0.05
157	223022320119	4242 Oakmede Ln Unit 100D	White Bear Township MN 55110-7609	Leanne E Meier		0.02
158	223022320120	4238 Oakmede Ln Unit 101D	White Bear Township MN 55110-7609	Helen Krutchek	Helen Krutchek Revocabl Trust	0.02
159	223022320121	4236 Oakmede Ln Unit 102C	White Bear Township MN 55110-7609	Teresa A O'brien		0.05
160	223022320122	4234 Oakmede Ln Unit 103B	White Bear Township MN 55110-7609	Christanne M Ferris	Bradly Ferris	0.05
161	223022320123	4232 Oakmede Ln Unit 104A	White Bear Township MN 55110-7609	Bayliss Llc		0.03
162	223022320062	4251 Oakmede Ln	White Bear Township MN 55110-7610	John D Lavigne		0.01
163	223022320063	4251 Oakmede Ln	White Bear Township MN 55110-7610	White Bear Preserve		0.01
164	223022320064	4251 Oakmede Ln	White Bear Township MN 55110-7610	Thomas Fitzpatrick		0.01
165	223022320066	4251 Oakmede Ln	White Bear Township MN 55110-7610	Donald J Ruzin		0.01
166	223022320068	4251 Oakmede Ln	White Bear Township MN 55110-7610	Cheryl J Carlstrom		0.01
167	223022320109	4247 Oakmede Ln Unit 90B	White Bear Township MN 55110-7610	Nancy L Palmer		0.05
168	223022320110	4245 Oakmede Ln Unit 91C	White Bear Township MN 55110-7610	Bethany Lust		0.05
169	223022320111	4243 Oakmede Ln Unit 92D	White Bear Township MN 55110-7610	Darren L Trast		0.02

Parcels Intersected by the Right of Way for VLAWMO CD 14 and its Branches

170	223022320112	4239 Oakmede Ln Unit 93D	White Bear Township MN 55110-7610	Krista L Schuhwerck		0.02
171	223022320113	4237 Oakmede Ln Unit 94C	White Bear Township MN 55110-7610	Thomas J Fitzpatrick	Maureen J Fitzpatric Trustees	0.05
172	223022320114	4235 Oakmede Ln Unit 95B	White Bear Township MN 55110-7610	Barry C Hoyland	Lisa Mondo Hoyland	0.05
173	223022320115	4233 Oakmede Ln Unit 96A	White Bear Township MN 55110-7610	Randy J Petschen	Annelise M Petschen	0.03
174	213022440076	0 White Bear Pkwy	White Bear Township MN 55110	Town Of White Bear		6.87
175	293022240009	470 Bear Ave N	Vadnais Heights MN 55127-7002	Paul A Buzicky		1.21
176	293022240008	486 Bear Ave N	Vadnais Heights MN 55127-7002	Hans J Henning	Megan K Henning	2.04
177	283022320001	3711 Centerville Rd	Vadnais Heights MN 55127-7121	Kenneth H Vodden		3.47
178	283022220010	826 County Road F E	Vadnais Heights MN 55127-7504	Dwight L Thompson	Sydney P Thompson	9.86
179	203022440018	780 North Oak Dr	Vadnais Heights MN 55127-7959	Robert S Brown	Linda M Brown	2.93
180	283022340013	0 County Road E E	Vadnais Heights MN 55127	Dakota Upreit Lp		1.29
181	283022310008	3790 Centerville Rd	Vadnais Heights MN 55127-7124	City Of Vadnais Heights		3.42
182	223022140008	0 Whitaker St	White Bear Township MN 55110-3761	Water Gremlin Company		33.04
183	283022340014	0 County Road E E	Vadnais Heights MN 55127	Dakota Upreit Lp		5.42
184	213022430016	0 I 35 E	Vadnais Heights MN 55110	City Of Vadnais Heights		17.63
185	213022440013	4230 White Bear Pkwy	White Bear Township MN 55110	Town Of White Bear		9.79
186	213022410103	0 White Bear Pkwy	White Bear Township MN 55110	Birch Lake Ponds Hmownrs Asso		7.2

Parcels Intersected by the Right of Way for VLAWMO CD 14 and its Branches

187	293022310005	553 Bear Ave S	Vadnais Heights MN 55127-7076	Robert James Mandell		4.25
188	293022240012	515 Bear Ave S	Vadnais Heights MN 55127-7076	Karen J Ehrisman		2.01
189	293022310004	561 Bear Ave S	Vadnais Heights MN 55127-7076	Edward J Vesel	Sharon A Vesel	2.66
190	293022240013	527 Bear Ave S	Vadnais Heights MN 55127-7076	Dennis A Ulmer Trustee	Lonnie K Ulmer Trustee	2.12
191	203022310037	0 Greenhaven Ct	Vadnais Heights MN 55127	Jeffrey W Moore		24.55
192	223022240007	0 Bibeau Rd	White Bear Township MN 55110	John E Blomquist Inc		36.31
193	223022130022	4370 Otter Lake Rd	White Bear Township MN 55110-3761	Water Gremlin Company		10.77
194	213022410104	0 Unassigned	White Bear Township MN 55110	Town Of White Bear		5.31
195	283022120001	0 Unassigned	Vadnais Heights MN 55110	City Of Vadnais Heights		2.35
196	293022330001	0 Koehler Rd	Vadnais Heights MN 55127	City Of St Paul		14.66
197	213022410094	0 Unassigned	White Bear Township MN 55110	Birch Lake Ponds Hmownrs Asso		3.69
198	283022120005	4000 Labore Rd	Vadnais Heights MN 55110-4168	Structural Wood Sales Company		48.98
199	223022310001	0 Unassigned	White Bear Township MN 55110	Town Of White Bear		2.45
200	203022310005	0 Walker Dr	Vadnais Heights MN 55127	City Of Vadnais Heights		5.9
201	293022230008	3904 Mcmenemy St	Vadnais Heights MN 55127-7062	Mildred M Johnson Trust		2.2
202	293022240007	500 Bear Ave N	Vadnais Heights MN 55127-7055	Troy S Kunze		2.54
203	293022230009	0 Bear Ave S	Vadnais Heights MN 55127	Mildred M Johnson Trust		1.13

Parcels Intersected by the Right of Way for VLAWMO CD 14 and its Branches

204	293022230006	3910 Mcmenemy St	Vadnais Heights MN 55127-7062	Mildred M Johnson Trust		3.62
205	283022320012	3719 Centerville Rd	Vadnais Heights MN 55127-7121	Gerald R Morri	Gwen M Morri	6.04
206	293022240018	465 Bear Ave S	Vadnais Heights MN 55127	City Of Vadnais Heights		1.69
207	283022320008	3757 Centerville Rd	Vadnais Heights MN 55127-7121	Paul V Hendrickson		2.56
208	283022320036	0 Unassigned	Vadnais Heights MN 55127	Jefrey W Moore	Jeffreyw Moore	13.62
209	283022220011	930 County Road F E	Vadnais Heights MN 55127-7506	Joseph M Minwegen		7.07
210	293022230066	3890 Tessier Tr	Vadnais Heights MN 55127-7062	Thomas Klein		0.75
211	293022230067	3880 Tessier Tr	Vadnais Heights MN 55127-7062	Suzanne Jo Klein		0.75
212	283022230001	0 Arcade St	Vadnais Heights MN 55127	City Of Vadnais Heights		40
213	283022130019	3880 Labore Rd	Vadnais Heights MN 55110-4128	North Star Mini Storage Vadnais Heights Llc		7.15
214	223022130016	0 Otter Lake Rd	White Bear Township MN 55110	State Of Mn Trust Exempt		13.82
215	293022430002	0 Edgerton St	Vadnais Heights MN 55127	Maria Flor Vivaldo		1.88
216	293022430003	3696 Edgerton St	Vadnais Heights MN 55127-7130	Brian P Slattery		0.62
217	293022430040	0 Koehler Rd	Vadnais Heights MN 55127-7128	Carol A Krey		7.76
218	293022430001	3720 Edgerton St	Vadnais Heights MN 55127-7009	Steven Richard Gaida	Kathleen Marie Gaida	2.67
219	293022420021	3728 Edgerton St	Vadnais Heights MN 55127-7009	Corey R Carlson	Linda M Carlson	1.32
220	293022420020	3736 Edgerton St	Vadnais Heights MN 55127-7009	Richard A Giese	Courtney M Giese	1.32

Parcels Intersected by the Right of Way for VLAWMO CD 14 and its Branches

221	293022420019	3746 Edgerton St	Vadnais Heights MN 55127-7009	Lisa A Meiners		1.18
222	293022420009	3820 Edgerton St	Vadnais Heights MN 55127-7010	Gregory Patrick Moriarty		0.26
223	293022420010	3812 Edgerton St	Vadnais Heights MN 55127-7010	Gerald R Thelin	Linda L Thelin	0.4
224	293022420012	3790 Edgerton St	Vadnais Heights MN 55127-7009	Norman I Christensen		0.46
225	293022420011	3800 Edgerton St	Vadnais Heights MN 55127-7010	Michael J Bronk	Elizabeth A Bronk	0.54
226	293022420074	622 Stockdale Rd	Vadnais Heights MN 55127-7524	Nicole D Smith		0.87
227	293022420022	3784 Edgerton St	Vadnais Heights MN 55127-7009	Sara Larissa Schmitz	Stephen John Schmitz Jr	0.52
228	293022420015	3778 Edgerton St	Vadnais Heights MN 55127-7009	Leonard J Richter Trustee	Nancy A Richter Trustee	0.92
229	293022420016	3770 Edgerton St	Vadnais Heights MN 55127-7009	Mnsf T2 Spe Llc		0.78
230	293022420017	3760 Edgerton St	Vadnais Heights MN 55127-7009	Ryan Strong	Vanessa Strong	0.92
231	293022420018	3750 Edgerton St	Vadnais Heights MN 55127-7009	Dawn Bloomquist	Benjamin Bloomquist	1.07
232	293022310001	3835 Edgerton St	Vadnais Heights MN 55127-7071	The Joy Joan Boyum Revocable Trust		0.38
233	293022310021	3741 Edgerton St	Vadnais Heights MN 55127-7072	Brittany Johannsen	Sherman Olson	0.51
234	293022310022	3731 Edgerton St	Vadnais Heights MN 55127-7072	Jason L Waters	Faith S Waters	0.86
235	283022310005	0 Centerville Rd	Vadnais Heights MN 55127	Burlington Northern	Co Bnsf Railway Co	8.85
236	283022340006	0 Goose Lake Rd	Vadnais Heights MN 55110	Mccullough And Sons Inc		8.94
237	293022440028	3645 Centerville Rd	Vadnais Heights MN 55127-7122	Independent School Dist 624		16.38

Parcels Intersected by the Right of Way for VLAWMO CD 14 and its Branches

238	293022410038	0 Stockdale Rd	Vadnais Heights MN 55127	City Of Vadnais Heights		4.96
239	293022240014	0 Edgerton St	Vadnais Heights MN 55127	City Of Vadnais Heights		1.69
240	293022340008	0 Koehler Rd	Vadnais Heights MN 55127	County Of Ramsey Public Works		0.56
241	293022410012	3689 Centerville Rd	Vadnais Heights MN 55127-7122	Randall Barstow	Susan Barstow	6.32
242	293022410010	3701 Centerville Rd	Vadnais Heights MN 55127-7121	Mark E Tyler		4.04
243	293022340077	550 Koehler Rd	Vadnais Heights MN 55127-7012	Leroy A Wilke	Marion M Wilke Trustee	1.98
244	293022420039	3738 Parkwood Ln	Vadnais Heights MN 55127-7027	John C Bartolic	Diane J Bartolic	0.32
245	293022420042	639 Parkwood Cir	Vadnais Heights MN 55127-7024	Thomas C Glander	Deborah M Glander	0.28
246	293022420045	647 Parkwood Cir	Vadnais Heights MN 55127-7024	Scott A Sather	Michele T Sather	0.33
247	293022410027	714 Pennington Pl	Vadnais Heights MN 55127-7500	J W Moore		2.42
248	293022410028	720 Pennington Pl	Vadnais Heights MN 55127-7500	Dennis P Chartrand	Linda M Chartrand	0.7
249	293022410032	750 Pennington Pl	Vadnais Heights MN 55127-7500	Thomas P Zarembinski	Theresa A Zarembinski	0.5
250	203022420037	4190 Kaitlin Dr	Vadnais Heights MN 55127-7902	Thomas A Wrzos	Linda A Wrzos	0.71
251	293022310070	515 Lambert Creek Ln	Vadnais Heights MN 55127-7043	Steven C Anderson	Kristine K Anderson	0.39
252	293022310064	3762 Thomas Ct	Vadnais Heights MN 55127-7042	Timothy R Jozwowski	Kelly J Jozwowski	0.48
253	293022310083	530 Bear Ave S	Vadnais Heights MN 55127-7075	Harold Bauer		1.22
254	293022310020	3749 Edgerton St	Vadnais Heights MN 55127-7072	Patrick P Russo		0.54

Parcels Intersected by the Right of Way for VLAWMO CD 14 and its Branches

255	203022420038	0 Kaitlin Dr	Vadnais Heights MN 55127	City Of Vadnais Heights		3.78
256	293022310023	0 Kohler Rd	Vadnais Heights MN 55127	City Of Vadnais Heights		2.52
257	203022420039	695 North Oak Dr	Vadnais Heights MN 55127-7958	Thomas R Yeager	Roslyn M Yeager	5.25
258	203022420040	4188 Kaitlin Dr	Vadnais Heights MN 55127-7902	Ross P Adrian	Karen L Adrian	0.55
259	293022310088	0 Creekview Cir	Vadnais Heights MN 55127-7072	Exceptional Homes By Design Inc		0.44
260	293022310087	0 Creekview Cir	Vadnais Heights MN 55127-7072	Exceptional Homes By Design Inc		0.74

APPENDIX C

Description of Electronic Deliverables

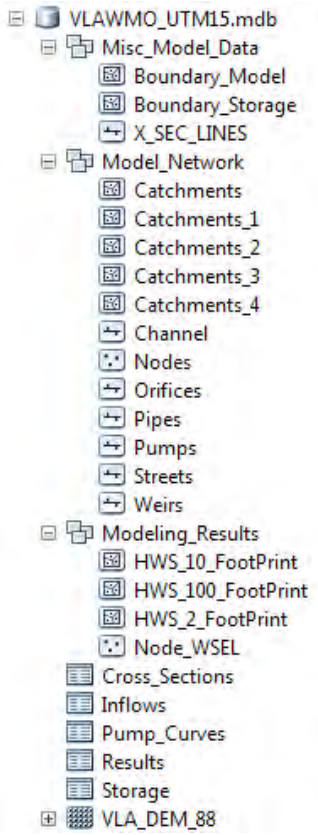
1 DESCRIPTION OF ELECTRONIC DELIVERABLES

Submitted along with this report is a set of electronic deliverables related to this project. These files include digital copies of this model report, model input and output files, GIS databases of pertinent model input and output for existing conditions and each of the repair alternatives, and the GIS spatial data used to generate the maps presented in this report.

The GIS databases developed for this project contain all of the necessary data, documentation, and assumptions required to build the XP-SWMM model, and the accompanying metadata outlines how to quickly map this GIS data directly to the model database. By providing this data, it is possible to work in the ArcGIS framework to develop future scenarios. The resulting scenarios can be easily turned into XP-SWMM scenarios using the metadata and mapping information provided.

The electronic deliverables submitted along with this report are organized as shown in **Figure 1**.

Figure 1. Study area model electronic deliverable structure.



1.1 Model Report

This final report is included in the electronic deliverables in PDF format.

1.2 Model Files

The event-based XP-SWMM model database file (*.xp) for the study area is provided along with the output files generated for each of the storm events. The output files may be viewed independently in a text editor or loaded into XP-SWMM for viewing within the software. The event-based study area model runs include:

- 2-year, 24-hour, Atlas 14, MSE3 distribution
- 10-year, 24-hour, Atlas 14, MSE3 distribution
- 100-year, 24-hour, Atlas 14, MSE3 distribution
- 500-year, 24-hour, Atlas 14, MSE3 distribution

1.3 ArcGIS Geodatabase

A geodatabase was created to store, organize, and manage all the study area model geospatial data and results. Included within this geodatabase is shapefile metadata describing each of the shapefile attributes and how the data can be mapped to XP-SWMM to create the model. Metadata for each of the shapefiles is also included in **Appendix D**. Data within the geodatabase is organized in three feature datasets: miscellaneous model data, model network, and modeling results. Also included within the geodatabase are raster files and additional tabular data. The various components of the geodatabase are described in **Table 1**.

Table 1. Electronic deliverable ArcGIS geodatabase contents.

Geodatabase Component	Component Description	Data	Data Description
Misc Model Data	This feature dataset contains data that is not directly used by the model but is useful geospatial data in combination with the model.	**Boundary_Model**	Polygon shapefile of the model boundary.
		Boundary_Storage	Polygon shapefile of the storage node boundaries used for flood mapping.
		X_SEC_Lines	Cross Section Lines associated with the Cross_Section table data.
Model Network	This feature dataset contains shapefile data that defines the geometric model network. These datasets can be directly imported into XP-SWMM using the information in Appendix D.	**Catchments**	Polygon shapefile of all model catchments (subcatchments 1-5 combined).
		Catchments_1	Polygon shapefile of only model subcatchments 1 (used for model import)
		Catchments_2	Polygon shapefile of only model subcatchments 2 (used for model import)
		Catchments_3	Polygon shapefile of only model subcatchments 3 (used for model import)
		Catchments_4	Polygon shapefile of only model subcatchments 4 (used for model import)
		Catchments_5	Polygon shapefile of only model subcatchments 5 (used for model import)
		Channels	Polygon shapefile of model natural channels (aka Overflows)
		Nodes	Polygon shapefile of model nodes.
		Orifices	Polygon shapefile of model orifices.
		Pipes	Polygon shapefile of model pipes.
		Pumps	Polygon shapefile of model pumps. (NOT USED)
		Streets	Polygon shapefile of model streets. (NOT USED)
		Weirs	Polygon shapefile of model weirs.
Model Results	This feature dataset contains shapefile data that contains specific model results.	**Node_WSEL**	Point shapefile of peak flooding water surface elevations for 2-, 10-, 100-, and 500-year storm events at model node.
		HWS_2_FootPrint	Polygon shapefile of flooding footprint for 2-year, 24-hour storm event.
		HWS_10_FootPrint	Polygon shapefile of flooding footprint for 10-year, 24-hour storm event.
		HWS_100_FootPrint	Polygon shapefile of flooding footprint for 100-year, 24-hour storm event.
		HWS_500_FootPrint	Polygon shapefile of flooding footprint for 500-year, 24-hour storm event.
Raster Data	Raster datasets are contained within the model geodatabase.	**VLA_DEM_88**	Study area DEM raster in feet (NAVD88 datum).
		R_FLD_2yr	Raster file that contains flood mapping results for 2-year, 24-hour event.
		R_FLD_10yr	Raster file that contains flood mapping results for 10-year, 24-hour event.
		R_FLD_100yr	Raster file that contains flood mapping results for 100-year, 24-hour event.
		R_FLD_500yr	Raster file that contains flood mapping results for 500-year, 24-hour event.
Tables	Data tables for both model inputs and result outputs.	**Cross_Sections**	Trapezoidal cross section data used for the street links.
		Pump_Curves	Pump curve data for the model. (NOT USED)
		Inflows	Time series inflow data from adjacent areas. (NOT USED)
		Storage	Stage-area curve table for study area model storage nodes.

APPENDIX D

GIS Metadata

Model Feature Class and Table Attribute Field Schema

Table 1. Catchments_X metadata and XP-SWMM mapping schema.

GIS Link Data	
Object Type	Node
Import/Export	Import Only
Object Creation On Import	Update Existing
Object Creation On Export	N/A
Mandatory Data	
Node Name	NODE_ID
X Pos	NODE_X
Y Pos	NODE_Y

Field Name	Data Type	Field Alias	Description	Mapped XP-SWMM Variable
OBJECTID	Object ID	OBJECTID	Standard ArcGIS attribute	None
SHAPE	Geometry	SHAPE	Standard ArcGIS attribute	None
CATCHMENT_NUMBER	Short Integer	Catchment Number	Catchment number (1-5) corresponding to XP-SWMM subwatershed number	None
RUNOFF_NODE	Text	Runoff Node	Catchment receiving node ID	Node Name
RUNOFF_FLAG	Short Integer	Runoff Flag	Catchment active flag	Sub-Catchment Flag [Subcatch #]
AREA_ACRES	Long Integer	Area acres	Catchment area in acres	Area [Subcatch #]
PCT_IMP_MLCCS	Double	PCT_IMP_MLCCS	Percent impervious using the MLCCS data	None
PCT_IMP_LU	Double	PCT_IMP_LU	Percent impervious using the Metropolitan Council 2010 Generalized Land Use Inventory Dataset and Minneapolis model guidance	None
DCIA_MULT	Double	DCIA_MULT	Directly connected impervious area (DCIA) multiplier	None
ADJIMPMLCCS	Double	ADJIMPMLCCS	DCIA adjusted impervious % used in SWMM based MLCCS	None
ADJIMPLU	Double	ADJIMPLU	DCIA adjusted impervious % used in SWMM based Metropolitan Council 2010 Generalized Land Use Inventory Dataset and Minneapolis model guidance	None
AREA	Long Integer	Area sq ft	Catchment area used to calculate width (sq feet)	None
LENGTH	Double	LENGTH	Catchment length used to calculate width (feet)	None
WIDTH	Long Integer	Catchment Width	Catchment width	Width [Subcatch #]
SLOPE	Long Integer	Catchment Slope	Non-dimensional catchment slope (i.e. 1%=0.01)	Slope [Subcatch #]
IMP_DEP_STR	Double	Impervious Depression Storage	Impervious depression storage (in)	Entered as Global Infiltration Data
PER_DEP_STR	Double	Pervious Depression Storage	Pervious depression storage (in)	Entered as Global Infiltration Data
IMP_MAN_N	Double	Impervious Mannings n	Impervious Manning's roughness coefficient	Entered as Global Infiltration Data
PER_MAN_N	Double	Pervious Mannings n	Pervious Manning's roughness coefficient	Entered as Global Infiltration Data
GA_ZDP	Double	Zero Detention Percentage	Zero detention percentage	Entered as Global Infiltration Data
GA_ACS	Double	Average Capilary Suction	Average Capillary Suction	Entered as Global Infiltration Data
GA_IMD	Double	Initial Moisture Deficit	Initial Moisture Deficit	Entered as Global Infiltration Data
GA_SHC	Double	Saturated Hydraulic Conductivity	Saturated Hydraulic Conductivity	Entered as Global Infiltration Data
CENT_X_FT	Double	CENT_X_FT	Catchment centroid x-coordinate in feet	None
CENT_Y_FT	Double	CENT_Y_FT	Catchment centroid y-coordinate in feet	None
RON_X_FT	Double	RON_X_FT	Receiving node x-coordinate in feet	None
RON_Y_FT	Double	RON_Y_FT	Receiving node y-coordinate in feet	None
TYPE	Text	TYPE	Land use type selected for catchments which fall completely outside of MPLS XP_Landuse shapefile. Blank values correspond to catchments which have some overlap with the XP_Landuse layer. Catchments with land use descriptions in this field were given the hydrology attribute of assigned description. Land uses were assigned by proximity to land use polygons.	None
SHAPE_Length	Double	SHAPE_Length	Standard ArcGIS attribute	None
SHAPE_Area	Double	SHAPE_Area	Standard ArcGIS attribute	None
GRIDCODE	Double	GRIDCODE	Unique ID number used for internal data processing/creation purposes	None
PCNT_IMP_GS	Double	PCNT_IMP_GS	Percent Impervious using MPLS Green Space inventory	None
ADJIMPGS	Double	ADJIMPGS	DCIA adjusted impervious % used in SWMM	Impervious Percentage [Subcatch #]
CATCH_ID	Text	Unique Catchment ID	Unique Identification ID, combination of the runoff node ID and the catchment number	None
ROUTE_METH	Short Integer	ROUTE_METH	Hydrologic routing method	Routing Method [Subcatch #]
INFILTRATION	Text	Infiltration Reference	Infiltration Reference	Infiltration Reference [Subcatch #]

Table 2. Node metadata and XP-SWMM mapping schema.

GIS Link Data	
Object Type	Node
Import/Export	Import Only
Object Creation On Import	Create New or Update Existing
Object Creation On Export	N/A
Mandatory Data	
Node Name	NODE_ID
X Pos	NODE_X
Y Pos	NODE_Y

Field Name	Data Type	Field Alias	Description	Mapped XP-SWMM Variable
OBJECTID	OID	OBJECTID	Internal feature number	None
SHAPE	Shape	SHAPE	Feature geometry	None
NODE_ID	String	NODE_ID	Identifies node in the XP-SWMM model	Node Name
CMT_ID	String	CMT_ID	Comment provided by HEI about ID	None
INV	Double	INV	Node invert elevation (NGVD29, feet)	Invert Elevation
CMT_INV	String	CMT_INV	Comment provided by HEI about node invert elevation	None
SURF	Double	SURF	Node surface elevation (NGVD29, feet)	None
CMT_SURF	String	CMT_SURF	Comment provided by HEI about node surface elevation	None
SPILL	Double	SPILL	Node spill crest elevation (NGVD29, feet)	Ground Elevation (Spill Crest)
CMT_SPILL	String	CMT_SPILL	Comment provided by HEI about node spill crest elevation	None
RUNOFF	Short Int	RUNOFF	Flag denoting node receives runoff	None
STORAGE	Short Int	STORAGE	Flag denoting node has storage	Storage Node Data Flag
INIDEPTH	Double	INIDEPTH	Initial depth of water in storage node (feet)	Initial Depth
SA_CURVE	String	SA_CURVE	Indicates storage area curve ID used for the node storage	None
OUTFALL	Short Int	OUTFALL	Flag denoting node is an outfall	Outfall Flag
XCOORDM	Double	XCOORDM	Node x-coordinate in feet	X Pos
YCOORDM	Double	YCOORDM	Node y-coordinate in feet	Y Pos
CITY	String	CITY	Municipal owner of the stormwater infrastructure	None
INLCAPFLG	Short Int	INLCAPFLG	Flag denoting active inlet capacity	Inlet Capacity Flag
INLCAP	Double	INLCAP	Maximum inlet capacity value	Maximum Inlet Capacity
PONDING	Short Int	PONDING	Indicates ponding type. 0=None, 1=Allowed, 2=Sealed	Ponding Type
STORMETH	Short Int	STORMETH	Indicates storage methodology. 3=Stepwise Linear, 1=Constant	Storage Method
OC_TYPE	Short Int	OC_TYPE	Indicates types of Outlet Control. 1=Free Outfall, 2=Fixed backwater	Type of Outlet Control
OC_BWTR	Short Int	OC_BWTR	Elevation of fixed backwater	Outlet control Backwater
OF_DC	Short Int	OF_DC	Depth Criterion Option. 0=Minimum of critical Depth and normal Depth	Depth Criterion Option
INFFLAG	Short Int	INFFLAG	Flag denoting node has a user created inflow hydrograph	User Inflow Flag
SWP_FLAG	Short Int	SWP_FLAG	Flag denoting that node represents a storm water pond	None
BMP_FLAG	Short Int	BMP_FLAG	Flag denoting that node represents a BMP Location	None
STOR_MEA_FRM	Short Int	STOR_MEA_FRM	Measure storage depth from	Measure Depth From:
Notes	Text	Notes	Notes for use internal to HEI regarding activation in the model for various scenarios	Notes
SUFFIX	Text	SUFFIX	Number Unique identifier suffix of node name	None
CSO_Flag	Short Int	CSO_Flag	Flag Denoting CSO locations	None
INFLOC	Text	INFLOC	Inflow Locations for mapping purposes	None

Table 3. Pipes metadata and XP-SWMM mapping schema.

GIS Link Data	
Object Type	Multi Link
Import/Export	Import Only
Object Creation On Import	Create New or Update Existing
Object Creation On Export	N/A
Mandatory Data	
Channel/Conduit	COND_ID[#]
US Node	US_NODE
DS Node	DS_NODE
Link	LINK_ID

Field Name	Data Type	Field Alias	Description	Mapped XP-SWMM Variable
OBJECTID	OID	OBJECTID	Internal feature number	None
SHAPE	Shape	SHAPE	Feature geometry	None
LINK_ID	Text	LINK_ID	Identifies link in the XP-SWMM model	Link Name
CONDUIT_ID	Text	Conduit ID	Identifies conduit in the XP-SWMM model	Channel/Conduit
CMT_ID	Text	Comment Conduit ID	Comment provided by HEI about ID	None
TYPE	Text	Conduit Type	Conduit type (pipe, street, overflow, orifice, pump, weir)	None
USNODE	Text	Upstream Node	Upstream node ID	US Node
USINV	Double	Upstream Invert Elevation	Upstream conduit invert elevation (NGVD29, feet)	Upstream Invert Elevation
CMT_USINV	Text	Comment Upstream Invert Elevation	Comment provided by HEI about upstream invert	None
DSNODE	Text	Downstream Node	Downstream node ID	DS Node
DSINV	Double	Downstream Invert Elevation	Downstream conduit invert elevation (NGVD29, feet)	Downstream Invert Elevation
CMT_DSINV	Text	Comment Downstream Invet Elevation	Comment provided by HEI about downstream invert	None
MATERIAL	Text	Conduit Material	Construction material of the conduit (determines roughness)	None
CMT_MAT	Text	Comment Conduit Material	Comment provided by HEI about materials	None
ROUGHNESS	Double	Conduit Roughness	Conduit Manning's coefficient (n-value)	Roughness
CONSHAPE	Text	Conduit Shape	Conduit geometry	None
SWMMSHP1	Short Int	Conduit SWMM Shape	Conduit geometry XP-SWMM code	Shape
SWMMSHP2	Short Int	Conduit SWMM Special Shape	Special conduit geometry XP-SWMM code	Special Conduit Shape
CMT_SHAPE	Text	Comment Conduit Shape	Comment provided by HEI about conduit shape	None
DIA_IN	Double	Diameter inches	Diameter of pipe or height of channel (inches)	None
CMT_DIA	Text	Comment Diameter	Comment provided by HEI about conduit diameter or height of channel	None
SWMMDIA	Double	SWMM Diameter feet	Diameter of pipe or height of channel used by XP-SWMM (feet)	Diameter [Height]
SEDDEP	Double	Sediment Depth inches	Sediment depth within conduit (inches)	None
SWMMSEDDEP	Double	SWMM Sediment Depth feet	Sediment depth within conduit used by XP-SWMM (feet)	Sediment Depth
BARRELS	Short Int	Number of Barrels	Number of conduit barrels	Number of Barrels
LENGTH	Double	Conduit Length	Length of conduit (feet)	Length
CMT_LEN	Text	Comment Conduit Length	Comment provided by HEI about conduit length	None
WIDTH_IN	Double	Width inches	Width of special pipe conduit (inches)	None
HEIGHT_IN	Double	Height inches	Height of special pipe conduit (inches)	None
TRAPWIDTH	Double	Trapezoid Bottom Width	Width of special pipe conduit (feet)	None
TRAPLSLP	Double	Trapezoid Left Slope	Not used in pipe conduit type	None
TRAPRSLP	Double	Trapezoid Right Slope	Not used in pipe conduit type	None
CONFF	Short Int	Conduit Factor Flag	Conduit factor flag	Conduit Factor Flag
ENTLOSS	Double	Entrance Loss	Entrance loss coefficient of conduit	Entrance Loss
EXTLOSS	Double	Exit Loss	Exit loss coefficient of conduit	Exit Loss
INLTYP	Double	Inlet Type	Inlet type on conduit	Inlet Type
CITY	Text	City	Municipal owner of the stormwater infrastructure	None
SLOPE	Double	Conduit Slope	Percent slope of pipe from USINV to DSINV	Conduit Slope
C_Flag	Short Int	Conduit Flag	Flag denoting Conduit should be active in model	None
Shape_Length	Double	Shape_Length	Length of feature in internal units.	None
LH_CL	Double	Left Channel Length	Left side of Channel Length	None
RH_CL	Double	Right Channel Length	Right side of Channel Length	None
X_SEC_REF	Text	Cross Section Reference	Reference name of cross section shape	None
BOT_Width	Double	BOT_WIDTH	Width of special pipe conduit (feet)	Bottom Width
Notes	Text	Notes	Notes for use internal to HEI regarding activation in the model for various scenarios	Notes

Table 4. Streets metadata and XP-SWMM mapping schema.

GIS Link Data	
Object Type	Multi Link
Import/Export	Import Only
Object Creation On Import	Create New or Update Existing
Object Creation On Export	N/A
Mandatory Data	
Channel/Conduit	COND_ID[#]
US Node	US_NODE
DS Node	DS_NODE
Link	LINK_ID

Field Name	Data Type	Field Alias	Description	Mapped XP-SWMM Variable
OBJECTID	OID	OBJECTID	Internal feature number	None
SHAPE	Shape	SHAPE	Feature geometry	None
LINK_ID	Text	LINK_ID	Identifies link in the XP-SWMM model	Link Name
CONDUIT_ID	Text	Conduit ID	Identifies conduit in the XP-SWMM model	Channel/Conduit
CMT_ID	Text	Comment Conduit ID	Comment provided by HEI about ID	None
TYPE	Text	Conduit Type	Conduit type (pipe, street, overflow, orifice, pump, weir)	None
USNODE	Text	Upstream Node	Upstream node ID	US Node
USINV	Double	Upstream Invert Elevation	Upstream conduit invert elevation (NGVD29, feet)	Upstream Invert Elevation
CMT_USINV	Text	Comment Upstream Invert Elevation	Comment provided by HEI about upstream invert	None
DSNODE	Text	Downstream Node	Downstream node ID	DS Node
DSINV	Double	Downstream Invert Elevation	Downstream conduit invert elevation (NGVD29, feet)	Downstream Invert Elevation
CMT_DSINV	Text	Comment Downstream Invet Elevation	Comment provided by HEI about downstream invert	None
MATERIAL	Text	Conduit Material	Construction material of the conduit (determines roughness)	None
CMT_MAT	Text	Comment Conduit Material	Comment provided by HEI about materials	None
ROUGHNESS	Double	Conduit Roughness	Conduit Manning's coefficient (n-value)	Roughness
CONSHAPE	Text	Conduit Shape	Conduit geometry	None
SWMMSHP1	Short Int	Conduit SWMM Shape	Conduit geometry XP-SWMM code	Shape
SWMMSHP2	Short Int	Conduit SWMM Special Shape	Special conduit geometry XP-SWMM code	Special Conduit Shape
CMT_SHAPE	Text	Comment Conduit Shape	Comment provided by HEI about conduit shape	None
DIA_IN	Double	Diameter inches	Diameter of pipe or height of channel (inches)	None
CMT_DIA	Text	Comment Diameter	Comment provided by HEI about conduit diameter or height of channel	None
SWMMDIA	Double	SWMM Diameter feet	Diameter of pipe or height of channel used by XP-SWMM (feet)	Diameter [Height]
SEDDEP	Double	Sediment Depth inches	Sediment depth within conduit (inches)	None
SWMMSEDDEP	Double	SWMM Sediment Depth feet	Sediment depth within conduit used by XP-SWMM (feet)	Sediment Depth
BARRELS	Short Int	Number of Barrels	Number of conduit barrels	Number of Barrels
LENGTH	Double	Conduit Length	Length of conduit (feet)	Length
CMT_LEN	Text	Comment Conduit Length	Comment provided by HEI about conduit length	None
WIDTH_IN	Double	Width inches	Width of special pipe conduit (inches)	None
HEIGHT_IN	Double	Height inches	Height of special pipe conduit (inches)	None
TRAPWIDTH	Double	Trapezoid Bottom Width	Width of special pipe conduit (feet)	None
TRAPLSLP	Double	Trapezoid Left Slope	Not used in pipe conduit type	None
TRAPRSLP	Double	Trapezoid Right Slope	Not used in pipe conduit type	None
CONFF	Short Int	Conduit Factor Flag	Conduit factor flag	Conduit Factor Flag
ENTLOSS	Double	Entrance Loss	Entrance loss coefficient of conduit	None
EXTLOSS	Double	Exit Loss	Exit loss coefficient of conduit	None
INLTYP	Double	Inlet Type	Inlet type on conduit	None
CITY	Text	City	Municipal owner of the stormwater infrastructure	None
SLOPE	Double	Conduit Slope	Percent slope of pipe from USINV to DSINV	Conduit Slope
C_Flag	Short Int	Conduit Flag	Flag denoting Conduit should be active in model	None
Shape_Length	Double	Shape_Length	Length of feature in internal units.	Left Channel Length
LH_CL	Double	Left Channel Length	Left side of Channel Length	Right Channel Length
RH_CL	Double	Right Channel Length	Right side of Channel Length	None
X_SEC_REF	Text	Cross Section Reference	Reference name of cross section shape	Natural Section Shape GLDB Reference
Notes	Text	Notes	Notes for use internal to HEI regarding activation in the model for various scenarios	Notes

Table 5. Overflows metadata and XP-SWMM mapping schema.

GIS Link Data	
Object Type	Multi Link
Import/Export	Import Only
Object Creation On Import	Create New or Update Existing
Object Creation On Export	N/A
Mandatory Data	
Channel/Conduit	COND_ID[#]
US Node	US_NODE
DS Node	DS_NODE
Link	LINK_ID

Field Name	Data Type	Field Alias	Description	Mapped XP-SWMM Variable
OBJECTID	OID	OBJECTID	Internal feature number	None
SHAPE	Shape	SHAPE	Feature geometry	None
LINK_ID	Text	LINK_ID	Identifies link in the XP-SWMM model	Link Name
CONDUIT_ID	Text	Conduit ID	Identifies conduit in the XP-SWMM model	Channel/Conduit
CMT_ID	Text	Comment Conduit ID	Comment provided by HEI about ID	None
TYPE	Text	Conduit Type	Conduit type (pipe, street, overflow, orifice, pump, weir)	None
USNODE	Text	Upstream Node	Upstream node ID	US Node
USINV	Double	Upstream Invert Elevation	Upstream conduit invert elevation (NGVD29, feet)	Upstream Invert Elevation
CMT_USINV	Text	Comment Upstream Invert Elevation	Comment provided by HEI about upstream invert	None
DSNODE	Text	Downstream Node	Downstream node ID	DS Node
DSINV	Double	Downstream Invert Elevation	Downstream conduit invert elevation (NGVD29, feet)	Downstream Invert Elevation
CMT_DSINV	Text	Comment Downstream Invet Elevation	Comment provided by HEI about downstream invert	None
MATERIAL	Text	Conduit Material	Construction material of the conduit (determines roughness)	None
CMT_MAT	Text	Comment Conduit Material	Comment provided by HEI about materials	None
ROUGHNESS	Double	Conduit Roughness	Conduit Manning's coefficient (n-value)	Roughness
CONSHAPE	Text	Conduit Shape	Conduit geometry	None
SWMMSHP1	Short Int	Conduit SWMM Shape	Conduit geometry XP-SWMM code	Shape
SWMMSHP2	Short Int	Conduit SWMM Special Shape	Special conduit geometry XP-SWMM code	Special Conduit Shape
CMT_SHAPE	Text	Comment Conduit Shape	Comment provided by HEI about conduit shape	None
DIA_IN	Double	Diameter inches	Diameter of pipe or height of channel (inches)	None
CMT_DIA	Text	Comment Diameter	Comment provided by HEI about conduit diameter or height of channel	None
SWMMDIA	Double	SWMM Diameter feet	Diameter of pipe or height of channel used by XP-SWMM (feet)	Diameter [Height]
SEDDEP	Double	Sediment Depth inches	Sediment depth within conduit (inches)	None
SWMMSEDDEP	Double	SWMM Sediment Depth feet	Sediment depth within conduit used by XP-SWMM (feet)	Sediment Depth
BARRELS	Short Int	Number of Barrels	Number of conduit barrels	Number of Barrels
LENGTH	Double	Conduit Length	Length of conduit (feet)	Length
CMT_LEN	Text	Comment Conduit Length	Comment provided by HEI about conduit length	None
WIDTH_IN	Double	Width inches	Width of special pipe conduit (inches)	None
HEIGHT_IN	Double	Height inches	Height of special pipe conduit (inches)	None
TRAPWIDTH	Double	Trapezoid Bottom Width	Width of special pipe conduit (feet)	None
TRAPLSLP	Double	Trapezoid Left Slope	Not used in pipe conduit type	None
TRAPRSLP	Double	Trapezoid Right Slope	Not used in pipe conduit type	None
CONFF	Short Int	Conduit Factor Flag	Conduit factor flag	Conduit Factor Flag
ENTLOSS	Double	Entrance Loss	Entrance loss coefficient of conduit	None
EXTLOSS	Double	Exit Loss	Exit loss coefficient of conduit	None
INLTYP	Double	Inlet Type	Inlet type on conduit	None
CITY	Text	City	Municipal owner of the stormwater infrastructure	None
SLOPE	Double	Conduit Slope	Percent slope of pipe from USINV to DSINV	Conduit Slope
C_Flag	Short Int	Conduit Flag	Flag denoting Conduit should be active in model	None
Shape_Length	Double	Shape_Length	Length of feature in internal units.	Left Channel Length
LH_CL	Double	Left Channel Length	Left side of Channel Length	Right Channel Length
RH_CL	Double	Right Channel Length	Right side of Channel Length	None
X_SEC_REF	Text	Cross Section Reference	Reference name of cross section shape	Natural Section Shape GLDB Reference
Notes	Text	Notes	Notes for use internal to HEI regarding activation in the model for various scenarios	Notes

Table 6. Weir metadata and XP-SWMM mapping schema.

GIS Link Data	
Object Type	Weir
Import/Export	Import Only
Object Creation On Import	Create New or Update Existing
Object Creation On Export	N/A
Mandatory Data	
Weir Name	WEIR_ID
US Node	US_NODE
DS Node	DS_NODE
Link	LINK_ID

Field Name	Data Type	Field Alias	Description	Mapped XP-SWMM Variable
FID	OID	OBJECTID	Standard ArcGIS attribute	None
SHAPE	Shape	SHAPE	Standard ArcGIS attribute	None
LINK_ID	Text	Link ID	Identifies link in the XP-SWMM model	Link Name
WEIR_ID	Text	Weir ID	Identifies weir in the XP-SWMM model	Weir Name
CMT_ID	Text	Comment Wier ID	Comment provided by HEI about ID	None
TYPE	Text	Conduit Type	Conduit type (pipe, street, overflow, orifice, pump, weir)	None
USNODE	Text	Upstream Node	Upstream node ID	US Node
DSNODE	Text	Downstream Node	Downstream node ID	DS Node
CREST	Double	Weir Crest Elevation	Weir crest elevation (NGVD29, feet)	Weir Crest Elevation
CMT_CREST	Text	Comment Crest Elevation	Comment provided by HEI about weir crest elevation	None
CROWN	Double	Weir Crown Elevation	Weir crown elevation (NGVD29, feet)	Crown or Top of Weir
WLENGTH	Double	Weir Length	Weir length (feet)	Weir Length
CMT_LEN	Text	Comment Weir Length	Comment provided by HEI about weir length	None
WDC	Double	Weir Discharge Coefficient	Weir discharge coefficient	Weir Discharge Coefficient
WTYPE	Short Int	Weir Type	Weir type (0=side or 1=transverse)	Weir Type
CITY	Text	City	Municipal owner of the stormwater infrastructure	None

Table 7. Orifice metadata and XP-SWMM mapping schema.

GIS Link Data	
Object Type	Orifice
Import/Export	Import Only
Object Creation On Import	Create New or Update Existing
Object Creation On Export	N/A
Mandatory Data	
Orifice Name	ORF_ID
US Node	US_NODE
DS Node	DS_NODE
Link	LINK_ID

Field Name	Data Type	Field Alias	Description	Mapped XP-SWMM Variable
OBJECTID	OID	OBJECTID	Internal feature number	None
SHAPE	Shape	SHAPE	Feature geometry	None
LINK_ID	Text	Link ID	Identifies link in the XP-SWMM model	Link Name
ORIFICE_ID	Text	Orifice ID	Identifies orifice in the XP-SWMM model	Orifice Name
CMT_ID	Text	Comment Orifice ID	Comment provided by HEI about ID	None
TYPE	Text	Conduit Type	Conduit type (pipe, street, overflow, orifice, pump, weir)	None
USNODE	Text	Upstream Node	Upstream node ID	US Node
DSNODE	Text	Downstream Node	Downstream node ID	DS Node
ORFINV	Double	Orifice Invert Elevation	Orifice invert elevation (NGVD29, feet)	Orifice Invert Elevation
CMT_ORFINV	Text	Comment Orifice Invert Elevation	Comment provided by HEI about orifice invert	None
ORFAREA	Double	Orifice Area	Orifice area (sq. feet)	Orifice Area
CMT_ORFAREA	Text	Comment Orifice Area	Comment provided by HEI about orifice area	None
ORFDC	Double	Orifice Discharge Coefficient	Orifice discharge coefficient	Orifice Discharge Coeff
ORFTYPE	Double	Orifice Type	Orifice type	Orifice Type
ORFPIPE	Double	Orifice Pipe Shape	Orifice pipe shape	Orifice Shape
CITY	Text	City	Municipal owner of the stormwater infrastructure	None

Table 8. Pump metadata and XP-SWMM mapping schema.

GIS Link Data	
Object Type	Pump
Import/Export	Import Only
Object Creation On Import	Create New or Update Existing
Object Creation On Export	N/A
Mandatory Data	
Pump Name	P_ID
US Node	US_NODE
DS Node	DS_NODE
Link	LINK_ID

Field Name	Data Type	Field Alias	Description	Mapped XP-SWMM Variable
OBJECTID	OID	OBJECTID	Internal feature number	None
SHAPE	Shape	SHAPE	Feature geometry	None
LINK_ID	Text	Link ID	Identifies link in the XP-SWMM model	Link Name
PUMP_ID	Text	Pump ID	Identifies pump in the XP-SWMM model	Pump Name
CMT_ID	Text	Comment Pump ID	Comment provided by HEI about ID	None
TYPE	Text	Conduit Type	Conduit type (pipe, street, overflow, orifice, pump, weir)	None
USNODE	Text	Upstream Node	Upstream node ID	US Node
DSNODE	Text	Downstream Node	Downstream node ID	DS Node
PUMPRB	Short Int	Pump Rated By	Pump Rated By (?=dynamic, 4=static, ?=volume, ?=depth)	Pump Rated By
INIDEPTH	Double	Initial Depth	Initial Depth	Initial Depth
PSTARTS	Double	Pump Start Elevation	Pump starting elevation (NGVD, 29)	Pump Starts
PSTOPS	Double	Pump Stop Elevation	Pump stopping elevation (NGVD, 29)	Pump Stops
PTYPE	Text	Pump Rating Curve Reference	Pump type (data entered by HEI based on City info)	Pump Rating Curve Reference
PSF	Double	Pump Speed Factor	Pump speed factor	Pump Speed Factor
CITY	Text	City	Municipal owner of the stormwater infrastructure	None

Table 9. Storage metadata and XP-SWMM mapping schema.

GIS Link Data	
Object Type	Node
Import/Export	Import Only
Object Creation On Import	Update Existing
Object Creation On Export	N/A
Mandatory Data	
Node Name	NODE_ID
X Pos	NODE_X
Y Pos	NODE_Y

Field Name	Data Type	Field Alias	Description	Domain Name	Domain Type	Mapped XP-SWMM Variable
OBJECTID	Object ID	OBJECTID	Standard ArcGIS attribute			None
NODE_ID	Text	Node ID	Unique identification ID			Node Name
NODE_X	Double	Node X Coordinate	Node x-position coordinate			X Pos
NODE_Y	Double	Node Y Coordinate	Node y-position coordinate			Y Pos
ELEV	Double	Elevation	Stepwise elevation in feet			None
DEPTH	Double	Stepwise Depth	Stepwise depth in feet			Stepwise - Depth
AREA	Double	Stepwise Area	Stepwise area in acres			Stepwise - Surface Area
INV_ELEV	Double	Invert Elevation	Storage node invert elevation			None
SURF_ELEV	Double	Surface Elevation	Storage node ground surface elevation			None
SORT_NODE	Text	Table Node	Used for sorting by node			None

Table 10. Infiltration metadata and XP-SWMM mapping schema.

GIS Link Data	
Object Type	Global Database
Import/Export	Import Only
Object Creation On Import	Create New or Update Existing
Object Creation On Export	N/A
Mandatory Data	
GLDB Name	INF_REF
GLDB Type	GD_TYPE

Field Name	Data Type	Field Alias	Description	Mapped XP-SWMM Variable
OBJECTID	Object ID	OBJECTID	Standard ArcGIS attribute	None
CATCH_ID	Text	Catchment ID	Catchment reference if infiltration by catchment	None
INF_REF	Text	Infiltration Reference	Unique ID of infiltration data to reference in catchment	GLDB Name
INF_METH	Short Integer	Infiltration Method	Infiltration method type	Equation Options
IMP_DEP_STR	Double	Impervious Depression Storage	Impervious depression storage	Inch (Impervious Area) Input
PER_DEP_STR	Double	Pervious Depression Storage	Pervious depression storage	Inch (Pervious Area) Input
IMP_MAN_N	Double	Impervious Mannings n	Impervious Manning's n value	Manning's "n" (Impervious Area) Input
PER_MAN_N	Double	Pervious Mannings n	Pervious Manning's n value	Manning's "n" (Pervious Area) Input
ZDP	Double	Zero Detention Percentage	Zero detention percentage	Zero Detention (%) Input
H_MAX_IR	Double	Horton Max Infiltration Rate	Horton maximum infiltration rate	None
H_MIN_IR	Double	Horton Min Infiltration Rate	Horton minimum infiltration rate	None
H_DECAY	Double	Horton Decay Rate	Horton decay rate	None
H_MAX_IV	Double	Horton Max Infiltration Vol	Horton maximum infiltration volume	None
GA_ACS	Double	Green Ampt Avg Cap Suct	Green Ampt average capilary suction	Average Capilary Suction Input
GA_IMD	Double	Green Ampt Init. Moist Deficit	Green Ampt initial moisture deficit	Initial Moisture Deficit Input
GA_SHC	Double	Green Ampt Sat Hyd Cond	Green Ampt saturated hydraulic conductivity	Saturated Hydraulic Conductivity Input
UL_IL	Double	Uniform Loss Initial Loss	Uniform loss intial loss	None
UL_CL	Short Integer	Uniform Loss Cont Loss Meth	Uniform loss continuing loss method	None
UL_CLA	Double	Uniform Loss Cont. Loss Abs	Uniform loss continuing loss absolute value	None
UL_CLP	Double	Uniform Loss Cont. Loss Prop	Uniform loss continuing loss proportional value	None
SCS_CN	Double	SCS Pervious CN	SCS initial abstraction pervious area curve number	None
SCS_IA_TYPE	Short Integer	SCS Init Abs Type	SCS initial abstraction loss type	None
SCS_IA_D	Double	SCS Init Abs Depth	SCS initial abstraction depth	None
SCS_IA_F	Double	SCS Init Abs Fraction	SCS initial abstraction fraction	None
GD_TYPE	Text	Global Data Type	Global data type, "Infiltration" for infiltration data sets	GLDB Type

Table 11. Cross section metadata and XP-SWMM mapping schema.

GIS Link Data				
Object Type	Global Database			
Import/Export	Import Only			
Object Creation On Import	Create New or Update Existing			
Object Creation On Export	N/A			
Mandatory Data				
GLDB Name	CS_ID			
GLDB Type	GD_TYPE			
Field Name	**Data Type**	**Field Alias**	**Description**	**Mapped XP-SWMM Variable**
OBJECTID	Object ID	OBJECTID	Standard ArcGIS attribute	None
CS_ID	Text	Cross Section ID	Unique ID of cross section data to reference in link	GLDB Name
GD_TYPE	Text	Global Data Type	Global data type, "Natural Section Shape" for cross section data sets	GLDB Type
STA	Double	Station	Cross section station	Station
ELEV	Double	Elevation	Cross section elevation	Elevation
LINK	Text	Link Using XSect	Like ID utilizing cross section	None
L_OB_STA	Double	Left Overbank Station	Left overbank station	Left Overbank Station
R_OB_STA	Double	Right Overbank Station	Right overbank station	Right Overbank Station
L_OB_MAT	Text	Left Overbank Material	Left overbank material	None
MC_MAT	Text	Main Channel Material	Main channel material	None
R_OB_MAT	Text	Right Overbank Material	Right overbank material	None
L_OB_N	Double	Left Overbank Mannings n	Left overbank Mannings n	Left Overbank Manning's n
MC_N	Double	Main Channl Mannings n	Main channl Mannings n	Main Channel Manning's n
R_OB_N	Double	Right Overbank Mannings n	Right overbank Mannings n	Right Overbank Manning's n
NUM_ORDER	Double	NUM_ORDER	Sorting numbers column	None

Table 12. Pump curve metadata and XP-SWMM mapping schema.

GIS Link Data						
Object Type	Global Database					
Import/Export	Import Only					
Object Creation On Import	Create New or Update Existing					
Object Creation On Export	N/A					
Mandatory Data						
GLDB Name	PUMP_ID					
GLDB Type	GD_TYPE					
Field Name	**Data Type**	**Field Alias**	**Description**	**Domain Name**	**Domain Type**	**Mapped XP-SWMM Variable**
OBJECTID	Object ID	OBJECTID	Standard ArcGIS attribute			None
PUMP_ID	Text	Pump ID	Pump unique ID			GLDB Name
RATE	Double	Pump Flow Rate	Pumping rate (cfs)			Pump Flow Rate
D_DH_V	Double	Depth Dyn Head Volume	Depth, dynamic head, or volume			Node Depth, Dynamic Head, Well Volume
GD_TYPE	Text	Global Data Type	Global data type, "Pump Ratings" for pump rating curves	Global_Data_Type	Coded	GLDB Type

Table 13. Inflows metadata and XP-SWMM mapping schema.

GIS Link Data				
Object Type	Node			
Import/Export	Import Only			
Object Creation On Import	Update Existing			
Object Creation On Export	N/A			
Mandatory Data				
Node name	NODE_ID			
X Pos	NODE_X			
Y Pos	NODE_Y			
Field Name	**Data Type**	**Field Alias**	**Description**	**Mapped XP-SWMM Variable**
OBJECTID	Object ID	OBJECTID	Standard ArcGIS attribute	None
NODE_ID	Text	Inflow Node	Unique identification ID	Node name
Hour_	Double	Time (hrs)	Time data in hours	Time
FLOW	Double	Flow (cfs)	Flow data in cubic feet per second	Flow

Table 14. OutX Outflows metadata.

Field Name	Data Type	Description
CFS_2YR	Double	Flow rate at corresponding time step for 2 yr storm event (Cu. ft/sec)
CFS_10YR	Double	Flow rate at corresponding time step for 10 yr storm event (Cu. ft/sec)
CFS_100YR	Double	Flow rate at corresponding time step for 100 yr storm event (Cu. ft/sec)
CuFt_2YR	Double	Cumulative volume at corresponding time step for 2 yr storm event (Cu. ft)
CuFt_10YR	Double	Cumulative volume at corresponding time step for 10 yr storm event (Cu. ft)
CuFt_100YR	Double	Cumulative volume at corresponding time step for 100 yr storm event (Cu. ft)
Peak_Cfs_2YR	Double	Peak flow rate for Outfall 5 during 2 yr storm event (Cu. ft/sec)
Peak_CFS_10yr	Double	Peak flow rate for Outfall 5 during 10 yr storm event (Cu. ft/sec)
Peak_CFS_100yr	Double	Peak flow rate for Outfall 5 during 100 yr storm event (Cu. ft/sec)
Total_CuFT_2yr	Double	Total volume for Outfall 5 during the 2 yr storm event (Cu. ft)
Total_CuFT_10yr	Double	Total volume for Outfall 5 during the 10 yr storm event (Cu. ft)
Total_CuFT_100yr	Double	Total volume for Outfall 5 during the 100 yr storm event (Cu. ft)

Table 15. Node Depth metadata.

Field Name	Data Type	Description

NODE_ID	Text	Identifies node in the XP-SWMM model
INV	Double	Node invert elevation (NGVD29, feet)
SURF	Double	Node surface elevation (NGVD29, feet)
MWE_2yr	Double	Max Water Elevation at the node for the 2 yr storm event
MD_2yr	Double	Max Depth relative to the Node Surface for the 2 yr storm event
MWE_10yr	Double	Max Water Elevation at the node for the 10 yr storm event
MD_10yr	Double	Max Depth relative to the Node Surface for the 10 yr storm event
MWE_100yr	Double	Max Water Elevation at the node for the 100 yr storm event
MD_100yr	Double	Max Depth relative to the Node Surface for the 100 yr storm event

Table 16. Inlet Capacities metadata.

Field Name	Data Type	Description
Catch_ID	Short Int	Identifies corresponding catchment in the XP-SWMM model
CB_Num	Short Int	Count of catch basins within catchment
Capacity_Flow	Double	Estimated capacity flow into storm network based on 4 cfs per catch basin
Peak_Flow	Double	Peak flow rate produced by catchment in 10 yr storm event
Utilization_Rate_Pcnt	Double	Ratio of Peak flow to capacity flow in percentage
NA_Rate_Flag	Short Int	Indicates that catchment should not be qualitatively compared to others based on its nature or unknown factors. (e.g. Railroad catchments, directly draining to river, rooftop private catchments)

Table 17. Runoff Results metadata.

Field Name	Data Type	Description
OBJECTID	OID	Internal feature number
Catchment_ID	Short Int	Identifies corresponding catchment in the XP-SWMM model
RO_Depth_in_2yr	Double	Depth of Runoff over catchment area for 2-yr storm event (inches)
RO_Coeff_2yr	Double	Ratio of runoff volume to rainfall volume for 2-yr storm event
RO_Depth_in_10yr	Double	Depth of Runoff over catchment area for 10-yr storm event (inches)

Table 18. Catchment flow path metadata (miscellaneous data).

Field Name	Data Type	Field Alias	Description	Domain Name	Domain Type
OBJECTID	Object ID	OBJECTID	Standard ArcGIS attribute	N/A	N/A
SHAPE	Geometry	SHAPE	Standard ArcGIS attribute	N/A	N/A
CATCH_ID	Text	Catchment ID	Catchment ID	N/A	N/A
RO_NODE	Text	Catchment Runoff Node	Node that catchment runoff goes to	N/A	N/A
SHAPE_Length	Double	SHAPE_Length	Standard ArcGIS attribute	N/A	N/A
US_ELEV	Double	Flow path US Elev	Upstream elevation of flow path line	N/A	N/A
DS_ELEV	Double	Flow path DS Elev	Downstream elevation of flow path line	N/A	N/A
FP_LEN	Double	Flow path Length	Length of flow path line	N/A	N/A
FP_SLOPE	Double	Flow path Slope	Slope of flow path line	N/A	N/A
FP_WIDTH	Double	Flow path Width	Catchment width	N/A	N/A

Table 19. Storage node storage boundary metadata (miscellaneous data).

Field Name	Data Type	Field Alias	Description	Domain Name	Domain Type
OBJECTID	Object ID	OBJECTID	Standard ArcGIS attribute	N/A	N/A
SHAPE	Geometry	SHAPE	Standard ArcGIS attribute	N/A	N/A
NODE_ID	Text	Node ID	Storage node ID relating to boundary	N/A	N/A
SHAPE_Length	Double	Catchment Runoff Node	Standard ArcGIS attribute	N/A	N/A
SHAPE_Area	Double	SHAPE_Length	Standard ArcGIS attribute	N/A	N/A

APPENDIX E

Opinion of Probable Cost

Repair Alternative 1 - Ditch Cleaning

LINE ITEM	DESCRIPTION	UNIT	EST'D QUANTITY	OPC	
				UNIT PRICE	EXTENSION
1	Mobilization	LS	1	$5,000.00	$5,000.00
2	Tree Clearing	AC	1.8	$6,000.00	$10,800.00
3	Ditch Excavation	LF	4300	$5.00	$21,500.00
4	Spreading and Smoothing of Spoils	LF	4300	$4.00	$17,200.00
5	Seeding	AC	1.8	$3,000.00	$5,400.00
6	Misc Erosion and Sediment Control	LS	1	$3,000.00	$3,000.00
	Construction Sub-Total				$62,900.00
	Contingency			25%	$15,725.00
	Legal and Administration			10%	$6,290.00
	Engineering and Regulatory				$20,000.00
	Total Estimated Cost of Project				**$105,000.00**

Repair 2 - Ditch Cleaning & Culvert Upsizing

LINE ITEM	DESCRIPTION	UNIT	EST'D QUANTITY	OPC UNIT PRICE	OPC EXTENSION
1	Mobilization	LS	1	$15,000.00	$15,000.00
2	Traffic Control	LS	1	$8,000.00	$8,000.00
3	Tree Clearing	AC	1.8	$6,000.00	$10,800.00
4	Ditch Excavation	LF	4300	$5.00	$21,500.00
5	Spreading and Smoothing of Spoils	LF	4300	$4.00	$17,200.00
6	Bit Removal and Replacement	Each	2	$15,000.00	$30,000.00
7	66" RCP	LF	290	$350.00	$101,500.00
8	66" Aprons	LS	4	$5,000.00	$20,000.00
9	Seeding	AC	1.8	$3,000.00	$5,400.00
10	Misc Erosion and Sediment Control	LS	1	$5,000.00	$5,000.00
	Construction Sub-Total				$234,400.00
	Contingency			25%	$58,600.00
	Legal and Administration			10%	$23,440.00
	Engineering and Regulatory			15%	$35,160.00
	Total Estimated Cost of Project				**$352,000.00**