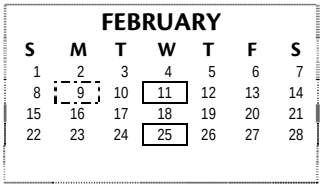
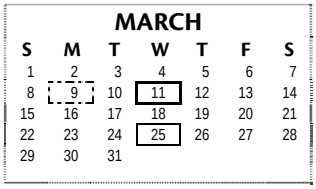
RCWD
RICE CREEK WATERSHED DISTRICT





RCWD Board of Managers Workshop

Monday, February 9, 2015, 2:00 p.m.

Rice Creek Watershed District Conference Room
4325 Pheasant Ridge Drive NE, Suite 611, Blaine, Minnesota

Agenda

NOTE: The District is testing an effort to make the Board of Managers meeting more widely accessible to the public. If you are interested in listening to this meeting by phone, please contact Theresa Stasica at 763-398-3070 by 4:30, February 5, 2015.

Items for Discussion

2:00 Presentation of proposed Washington Judicial Ditches 5, 6, 7 historical review memo

2:40 Discussion on culvert crossing on 137th for Anoka County Ditch 10-22-32.

2:50 Update on proposed Anoka County Ditch 55 area outlet/ Lino Lakes Comprehensive Stormwater Management Plan application.

3:10 Project Updates

- Mirror Pond and Hanson Park projects
- Middle Rice Creek Restoration Project
- Anoka County 31/46 correction of drainage system records

2:00 Presentation of proposed Washington Judicial Ditches 5, 6, 7 historical review memo

Final

MEMO

(External Correspondence)

To: Phil Belfiori
District Administrator, RCWD

Date: January 8, 2015

Cc: Tom Schmidt
John Kolb
Mark Deutschman, PhD., P.E
File 5555-233

From: Garrett Monson, E.I.T.
Nancy Stowe, P.E.

Through: Chris Otterness, P.E.

Subject: Washington County Judicial Ditches 5, 6, and 7 (WJD 5, 6, & 7) Historical Review

INTRODUCTION

The purpose of this memorandum is to provide the Rice Creek Watershed District (RCWD) with a historical review of the Washington Judicial Ditch (WJD) 5, 6, and 7 public drainage systems. This review includes a description of the components of the current systems necessary to maintain a historic function, which is believed equal to when the drainage systems was originally constructed and subsequently improved, as well as an establishment of the As Constructed and Subsequently Improved Condition" (ACSIC[1]). Washington County conveyed jurisdiction of this public drainage systems to the RCWD in 1974. Both documented and undocumented modifications to the WJD 5, 6, & 7 systems have occurred since construction. These documented and undocumented modifications have affected the alignment and function of these public drainage systems. This memorandum describes how the current alignment resulted from modifications to the original constructed condition and the required key components of the systems necessary to provide current and future function equivalent to the historic function.

RELATIONSHIP TO DRAINAGE SYSTEMS MAINTENANCE AND REPAIR

This memorandum establishes the as-constructed and subsequently improved condition as the basis for the maximum legal extent of repair (see definitions) of the public drainage systems. The information in this memorandum will be used in a future repair report which is expected to include an evaluation of additional alternatives intended to provide efficient public drainage systems capable of serving current agricultural and municipal drainage, an evaluation of how the systems perform relative to any potential future municipal stormwater management needs, and an assessment of issues related to the volume of runoff, water quality, and flooding. The repair report may include alternatives which adjust the elevation of the tiles, open channels, or culverts, or alternatives which realign or abandon portions of the public systems. The report may also evaluate similar modifications as authorized by MS 103E. The range of

[1] Note: The U.S. Army Corps of Engineers uses the term "as-built" to describe the originally constructed condition of the public drainage system. The terms as-built and ACSIC are synonymous (see definitions).

6901 E Fish Lake Rd Suite 140, Maple Grove, MN 55369 ● Ph. 763.493.4522 ● Fax 763.493.5572

alternatives evaluated within the repair report would be based in part upon discussions with landowners and other interested parties.

DEFINITIONS

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

As-Designed / Established Condition: The geometry of the public drainage systems as designed in 1921, including all subsequent designs for legal[2] repairs and alterations. A repair or alteration is considered legal if formally authorized in some legal or drainage proceedings. The plan and profiles for WJD 5, 6, & 7 established the dimensions, length, flow direction, and grade elevations for the Main Trunk and branches of each system. 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: The geometry of the public drainage systems as constructed in 1922, including all subsequent legal repairs and alterations. Often survey data (and only rarely as-built drawings) show that the alignment, profile and geometry (i.e., cross sectional area) of the existing public drainage systems are altered from the As-Designed / Established Condition.

The definition of As-Constructed and Subsequently Improved Condition is intended to establish the condition to which the systems 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 hydraulic capacity as originally constructed, and subsequently improved. This may include 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] Documentation may not always be available to determine whether a repair is legal. Circumstances may exist where natural events or unknown human activities, including undocumented drainage authority activities, or activities verbally authorized by the drainage authority, have created changed conditions lasting a sufficient period of time such that people or entities have relied on them when making decisions about the public drainage system. Reasonable discretion on the part of the drainage authority, combined with engineering analysis, is then used to define the as-constructed and subsequently improved condition as well as the "repaired condition."

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

Recent survey data show that the alignment, profile and geometry (i.e., cross sectional area) of the existing public drainage systems have been altered from the As-Designed / Established Condition. Alterations to the public drainage systems alignment, profiles, and geometry from the As-Designed / Established Condition likely resulted from the use of less accurate survey methods and construction techniques than currently exist and because of the need to "fit" the drainage systems to the existing topography. Alterations to the public drainage systems that were not performed per the requirements of MS 103E (i.e., ditch law) or its predecessors are not considered part of the As-Constructed and Subsequently Improved Condition.

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

Maintenance: 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 systems, 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 systems.

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 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 SYSTEMS

The WJD 5, 6, & 7 public drainage systems are located within the Hardwood Creek planning region of the District (**Figure 1)** in Sections 22, 23, 25, 26, 27, 28, 29, 32, 33, and 34 of T 32N, R 21W, within the City of Forest Lake, Washington County. The total land (i.e., drainage area) that contributes runoff to the public drainage systems is approximately 3,296 acres (1,683 of which drains to Forest Lake via WJD 6 drain tile). **Figure 1** shows the hydrologic boundaries for WJD 5, 6, and 7. The drainage areas include several different land uses and cover types such as wetlands, agricultural fields, forest and rural housing. The public drainage systems WJD 5 &7 drain into Washington Judicial Ditch 2 (WJD 2), also referred to as Hardwood Creek. The benefitted area and assessment values for WJD 5, 6, & 7 were filed in 1921 and are shown in **Figures 2, 3, and 4**. The history and description of each system follows.

HISTORY AND DESCRIPTION OF WJD 5 SYSTEM

History of the Public Drainage System and Documented Modifications of WJD 5 System

Washington Judicial Ditch 5 was established in 1921 and constructed in 1922 (see **Figure 5**). The public drainage system, which consists entirely of tile, includes a Main Trunk and one branch. The clay tiles ranged in diameter from 8 to 20 inches on the Main Trunk and 8 to 10 inches on Branch 1. No documented alterations to the drainage system were found in the review of historical records, nor are any alterations of the public drainage system evident when comparing the historic alignment to known current locations of the system. [3] The existing public drainage system is shown in **Figure 6**.

Current Alignment of the WJD 5 System

This portion of the memorandum describes the current condition of the public drainage system as observed "on-the-ground" as determined by a review of the available records, field survey data, aerial imagery and other available evidence. The stationing used to describe the alignment is derived from the existing As-Constructed and Subsequently Improved Alignment (which deviates from the As-Designed alignment in some cases) proceeding from downstream to upstream. The current, functional alignment of the WJD 5 public drainage system is shown in **Figure 6**. **Figures 14 and 15 show the** stationing for WJD 5.

Main Trunk

The alignment begins at Station 0+00 at Hardwood Creek (JD 2). From Station 0+00 to 32+30, the Main Trunk alignment extends to the north as 20-inch tile to station 32+29 and then turns northwest to station 46+22 as 15-inch tile. The Main Trunk continues north as a 15-inch tile to Station 53+28 where it turns northwest to Station 55+55. The Main Trunk continues west to station 64+37 where it intersects Branch 1. The Main Trunk proceeds north through 12-inch tile to Station 77+18. The main trunk continues to the northeast as 10-inch tile to Station 105+45, where it then proceeds northeast as 8-inch tile until it terminates at Station 124+48.

Branch 1

Branch 1 intersects the Main Trunk at Station 65+39. The alignment proceeds west as 10-inch clay tile to Station 13+88 where it turns north. The tile transitions to 8-inch tile at station 21+90 before crossing 195th St N at Station 26+32. The alignment continues on north to Station 27+35 where it turns west, crossing Harrow Ave N to station 28+45. The alignment continues north and terminates at Station 41+21.

[3] Since the WJD 5 public drainage system is almost entirely composed of tile, the existing alignment of the system can only be viewed at failures in the system (i.e. "blow-outs") and at surface inlets.

Problem Areas of WJD 5 System

Tile blowouts, or ruptures, are the primary known problems within the drainage system which need to be addressed. Because of the large contributing drainage area and flat tile grades, the original clay tile system has experienced blowouts at various locations throughout the tile system.

Problem areas on the WJD 5 public drainage system consist primarily of blow outs on both the Main Trunk and Branch 1, as well as tiles that are broken, in poor condition, or plugged with roots on the Main Trunk. These problem areas are shown in **Figure 7**.

Many tile blowouts have been repaired under the RCWD's maintenance program. Although these repairs provide temporary relief from some drainage problems in the system, they do not address the underlying causes of the blowout failures, including the age and condition of the overall system and the lack of capacity in the system to accommodate the runoff volumes generated by the contributing drainage area.

It should be noted that this memorandum is not intended to provide the comprehensive review of the condition of the public drainage system typically provided by a repair report. Rather, the intent of this memorandum is to identify the alignment and profile of the public drainage system within a historical context. The District may elect to proceed with a repair report that will thoroughly review the conditions of the entire public drainage system and conclude with a recommendation for the selection of an alternative which provides the best balance between being economically feasible and its ability to serve current and future needs. To ensure that the interests of the local landowners are fully considered in the recommended alternative, we encourage the District and landowners to voice any and all concerns regarding the existing drainage conditions of this system, as well as concerns regarding current and future drainage needs.

HISTORY AND DESCRIPTION OF WJD 6 SYSTEM

History of the Public Drainage System and Documented Modifications of WJD 6 System

Washington Judicial Ditch 6 was established in 1921 and constructed in 1922 (see **Figure 8**). The public drainage system, which was constructed entirely out of tile, consisted of a Main Trunk and three Branches. The clay tiles ranged in diameter from 14 to 24 inches on the Main Trunk and 10 to 15 inches on Branches 1, 2, & 3.

Since its initial construction, only a few modifications to the WJD 6 have been documented, and most have occurred outside the legal boundary of the RCWD. The only documented work completed on WJD 6 within the RCWD occurred in 1994 when the RCWD approved Permit #94-97 to conduct minor maintenance near the junction of Branch 1 and the Main Trunk.

No alterations to the drainage system within the RCWD were found in the review of historical records. The existing public system is shown in **Figure 9**.

It should be noted that the WJD 6 system is not within the contributing drainage area to Rice Creek, but it instead drains north into the Comfort Lake - Forest Lake Watershed District. Because the RCWD boundary as

it was originally established was defined to include the area encompassing WJD 6, the authority of this system was transferred to the RCWD from Washington County in 1973.

Current Alignment of the WJD 6 System

Main Trunk

A portion of the Main Trunk of WJD 6 (north of 202nd Street N to Forest Lake) exists outside of the RCWD boundary and is not under the authority of the RCWD. The alignment of the Main Trunk within the RCWD boundary begins at Station 0+00 where WJD 6 crosses 202nd St N. The continues west southwest and then south from Station 0+00 to Station 13+15 as 24-inch clay tile. The alignment then continues southwest as 20-inch tile to Station 36+60. The alignment continues southwest as 14-inch clay tile and terminates at Station 60+50.

Branch 1

Branch 1 intersects the Main Trunk at Main Trunk Station 13+15. The alignment proceeds south to Station 25+60 as 15-inch clay tile. The alignment then continues south and then east to Station 39+00 as 12-inch clay tile. The alignment continues north northeast as 10-inch clay tile and terminates at Station 53+75.

Branch 2

Branch 2 intersects the Main Trunk at Main Trunk Station 0+00. The alignment proceeds south to Station 6+00 as open channel. The alignment then continues southeast as 10-inch clay tile and terminates at Station 14+50.

Branch 3

Branch 3 intersects the Main Trunk at Main Trunk Station 36+60. The alignment then continues south and then southeast as 14-inch clay tile to Station 27+70. The alignment then continues north east as 12-inch clay tile and terminates at Station 35+70.

Problem Areas of WJD 6 System

The WJD 6 public drainage system is in general disrepair, with many tiles clogged with sediment and tree roots. Much of the system is located in deep marshes and in forested areas which have accelerated the deterioration of the system. Several open channels have been excavated parallel to or crossing the historic alignment, presumably damaging portions of the tile system (if the tiles were intact at the time of the excavation). Very few remnants of the historic tile system are visible at the surface, even at locations where the excavated channels cross the tile system. Some of the problem areas are shown in **Figure 10**.

HISTORY AND DESCRIPTION WJD 7 SYSTEM

History of the Public Drainage System and Documented Modifications of the WJD 7 system

Washington Judicial Ditch 7 was established in 1921 and constructed in 1922 (see **Figure 11**). The system was originally constructed with clay tile ranging from 8 to 15 inches in diameter. The original petition included the Main Trunk and Branches 1 through 3. The Main Trunk replaced Judicial Ditch 2 Branch 3. Two additional Branches (#4 and #5) were identified in subsequent documentation.

Branch 4 was depicted in a figure included as an attachment to the Comprehensive Ditch Report dated August 14th, 2002, extending north from the Main Trunk near Station 39+00. However, this branch was not described in any of the legal documents reviewed during the preparation of this report, and therefore should not be considered part of the public drainage system without further documentation identifying and supporting its existence. Branch 5 is believed to have been constructed in 1922, based on a 1922 order establishing Branch 5 and ordering its construction.

The RCWD has no additional documentation of modifications to the system until 2001. Beginning in 2001, the RCWD completed a maintenance project of the WJD 7 system, consisting of hydraulic cleaning, televising, and tile repair. The intent of the project was to return the system to its design capacity by repairing known breaks with dual wall corrugated polyethylene tubing and fittings.

In 2009, RCWD completed minor maintenance of Branch 3 under permit 09-067. This project repaired an intake at the upstream extent of the branch, replaced the crushed tile, and repaired the connection of Branch 3 to the Main Trunk. In 2009, RCWD staff reconstructed a headwall at the outlet of the Main Trunk.

No alterations to the drainage system were found in the review of historical records. The existing public system is shown in **Figure 12**.

Current Alignment of the WJD 7 System

The stationing used to describe the alignment is derived from the existing As-Constructed and Subsequently Improved Alignment (which deviates from the As-Designed alignment in some cases) proceeding from downstream to upstream. The current, functional alignment of the WJD 7 public drainage system is shown in **Figure 12**. See **Figures 16 through 18** for stationing on WJD 7.

Main Trunk

The alignment begins at Station 0+00 at Hardwood Creek (JD 2). From Station 0+00 to 28+20, the Main Trunk alignment extends to the west-northwest as 15-inch tile to station 29+71 where it intersects with Branch 3. The Main Trunk continues west-northwest as 15-inch tile to Station 42+22 where it intersects Branch 2. The alignment continues as 15-inch tile to Station 48+12 where it turns north and transitions to 12-inch tile at Station 48+48. The Main Trunk continues north, crossing under 190th St. N., to station 59+68 where it intersects Branch 1. The Main Trunk continues

north through 10-inch tile to Station 76+46. The alignment then proceeds east as 8-inch tile until it terminates at Station 85+21.

Branch 1

Branch 1 intersects the Main Trunk at Main Trunk Station 59+68. The alignment proceeds west-northwest as 10-inch tile to Station 12+49. The alignment proceeds north-northwest to Station 18+39 and then north to Station 23+50. Branch 1 turns west to station 25+70 as 8-inch tile. The alignment continues north and terminates at Station 29+46.

Branch 2

Branch 2 intersects the Main Trunk at Main Trunk Station 42+22. The alignment proceeds west-southwest as 8-inch tile to Station 4+10. The alignment proceeds west to Station 8+43 and then west-northwest to Station 14+85 where it turns west and terminates at Station 20+71.

Branch 3

Branch 3 intersects the Main Trunk at Main Trunk Station 29+71. The alignment extends north-northwest as 8-inch tile, terminating at Station 17+34 and crossing 190th St N near Station 2+60.

Branch 5

Branch 5 appears to extend northeast from the Main Trunk at approximately Station 17+68. Other than an order to construct the branch recorded with Washington County on July 15th, 1922, this branch was not described in any other legal documents reviewed during the preparation of this report. The alignment as shown in **Figure 12** is approximated from LiDAR, and the legal description included as part of the petition to construct Branch 5.

Problem Areas of WJD 7 system

Tile blowouts, or ruptures, are the primary known problems within the drainage system which need to be addressed. Because of the large contributing drainage area and flat tile grades, the original clay tile system has experienced blowouts at various locations throughout the system. Many of these blowouts have been repaired in recent years as indicated in **Figure 13**. Current problem areas on the WJD 7 public drainage system consist of a bad intake and trees on Branch 2 and a blow out and trees on the Main Trunk.

ANALYSIS OF CURRENT FUNCTION WITHIN A HISTORICAL CONTEXT

System Modifications Affecting Function

Figures 6, 9, and 12 show the current network of public[4] tiles, which drain stormwater into and through the WJD 5, 6, & 7 public drainage systems, as identified by aerial photos, and field surveys.

In general, the alignments of WJD 5, WJD 6, and WJD 7 have changed little since originally constructed. Branch 2 of WJD 6 appears to have been converted to open channel from Stations 0+00 to 6+00 and has the capacity to convey the flow the tile system was designed to convey. A few portions of WJD 7 (including parts of Branch 2 and the Main Trunk immediately south of 190th St. N) have been slightly realigned, presumably to accommodate farming practices and rural development. Per discussion with District Staff, all repairs have utilized HDPE tile of a similar diameter to that which was in place, or the next larger available size.

As-Constructed and Subsequently Improved Profile of the WJD 5, 6, & 7 Systems

Ideally, the historical data necessary to determine the As-Constructed and Subsequently Improved Condition would include the construction as-built plans with a verifiable datum or benchmark, legal descriptions and surveyed maps of the original ditch alignment, and documentation of all subsequent changes to the ditch alignment and profile. Unfortunately, rarely are as-built plans available which can be tied to the original construction benchmark. As is the case with WJD 5, 6, & 7, the original design plans are typically based on an assumed datum with a no longer existing benchmark (if one is provided at all).

To determine an as-constructed profile for public drainage systems like WJD 5, 6, & 7, we assume the project was constructed as designed (reflected by the engineer's plans) and approximate the constructed profile using a datum conversion established through comparing elevations between that which is shown on the construction plans and what has been recently surveyed at the same locations . By matching up many locations and comparing the elevations, we determined an "average" datum adjustment.

Note that a profile analysis for WJD 6 was not completed as part of this Historical Review Memorandum because it is not in the contributing area to Rice Creek.

[4] The representation of whether a portion of the drainage system is public or private is based at this time solely upon available written documentation and reference herein to "public" or "private" should not be construed as actual ownership over that portion of the drainage system. The reference to public means the drainage authority is responsible for exercising authorities over this portion of the system under the drainage code.

Available Profile Data

In 1921, profile drawings for the proposed WJD 5& 7 were created, detailing grades and elevations for the Main Trunks and each of the branches. The grades listed in these profiles were based on an assumed (non-sea level) datum. Determinations of the as-constructed and subsequently improved profile for portions of the public drainage systems were completed by the District Engineer and District staff in 1987[5] and 2002.[6] The 1987 profiles included only the downstream ends of WJD 5 and 7 for the purpose of establishing the historic profile of JD 2, into which they discharge. The 2002 alignments and profiles were prepared as part of a tile line survey conducted as part of a WJD 7 maintenance project. Both of these profile determinations were reported in the NGVD 1929 datum.

Datum Adjustment Based on Tile Survey

HEI conducted a survey of exposed tile locations (including inlets, inspection ports, outlets, and blow-outs) in the spring of 2014 to verify the alignment and profile of the systems. Twenty-four exposed tile locations were surveyed along the Main Trunks and Branches of WJD 5 & 7. The surveyed tile inverts at these locations were compared to the corresponding elevations from the 1921 historic profiles and their differences averaged (see **Table 1** and **Table 2**). A standard deviation was then computed from these differences to identify outliers (values greater than one standard deviation from the average). After removing these outliers from each dataset, three potential values for a datum conversion were then evaluated by subtracting the surveyed invert elevation from the design elevation using the datum conversions, then computing a root mean square error for each dataset.

The datum conversion providing the least root mean square error is 752.9 for WJD 5, and 753.2 for WJD 7. **Table 1** and **Table 2** outline the datum adjustment calculations.

Table 1: Datum Conversion Analysis - WJD 5

Branch	Station	Invert Elevation (Surveyed)	1921 Plan Elevation	Plan Elevation with Conversion			Difference Compared to Plan		
Conversion				**752.85**	**752.9**	**752.95**	**752.85**	**752.9**	**752.95**
Main Trunk	111+39	926.3	173.89	926.74	926.79	926.84	-0.44	-0.49	-0.54
Main Trunk	109+96	926.98	173.68	926.53	926.58	926.63	0.45	0.40	0.35
Main Trunk	105+67	925.47	173.04	925.89	925.94	925.99	-0.42	-0.47	-0.52
*Main Trunk	103+45	924.94	172.71	925.56	925.61	925.66	-0.62	-0.67	-0.72
Branch 1	41+20	932.6	179.75	932.59	932.65	932.70	0.00	-0.05	-0.10
*Branch 1	29+09	927.66	173.53	926.37	926.43	926.48	1.28	1.23	1.18
						Root Mean Square Error	1.16	0.4	1.26

* Outlier, not included in determining datum adjustment

[5] *Field Inspection Report for Judicial Ditches 5, 6, and 7* dated June 10, 1987 prepared by E. A. Hickok and Associates for the RCWD.

[6] *Rice Creek Watershed District Comprehensive Ditch Report* dated August 14th, 2002 prepared by Lee Daleiden.

Table 2: Datum Conversion Analysis –WJD 7

Branch	Station	Invert Elevation (Surveyed)	1921 Plan Elevation	Plan Elevation with Conversion			Difference Compared to Plan		
Conversion				**753.1**	**753.2**	**753.30**	**753.1**	**753.2**	**753.3**
Main Trunk	46+70	924.9	171.2995	924.40	924.50	924.60	0.50	0.40	0.30
Main Trunk	29+31	921.23	167.56	920.66	920.76	920.86	0.57	0.47	0.37
Main Trunk	20+30	918.57	165.12	918.22	918.32	918.42	0.35	0.25	0.15
Main Trunk	17+68	918.24	164.41	917.51	917.61	917.71	0.73	0.63	0.53
Main Trunk	8+51	915.58	161.92	915.02	915.12	915.22	0.56	0.46	0.36
Main Trunk	0+17	913.33	159.66	912.76	912.86	912.96	0.57	0.47	0.37
Branch 2	8+43	925.58	172.71	925.81	925.91	926.01	-0.23	-0.33	-0.43
Branch 2	7+64	924.96	172.54	925.64	925.74	925.84	-0.68	-0.78	-0.88
Branch 2	4+10	925.26	171.74	924.84	924.94	925.04	0.42	0.32	0.22
*Branch 3	1+24	921.32	169.20	922.30	922.40	922.50	-0.98	-1.08	-1.18
Branch 3	2+14	922.1	169.72	922.82	922.92	923.02	-0.72	-0.82	-0.92
*Branch 3	2+84	921.59	170.12	923.22	923.32	923.42	-1.63	-1.73	-1.83
*Branch 3	8+72	925.3	173.27	926.37	926.47	926.57	-1.07	-1.17	-1.27
Branch 3	14+75	927.76	175.31	928.41	928.51	928.61	-0.65	-0.75	-0.85
*Branch 3	17+32	930.64	176.17	929.27	929.37	929.47	1.37	1.27	1.17
						Root Mean Square Error	0.56	0.55	0.55

* Outlier, not included in determining datum adjustment

Applying the datum conversions of 752.9 and 753.2 to the 1921 profiles of WJD 5 & 7, respectively, an As-Constructed and Subsequently Improved profile in NAVD '88 datum was determined for both public drainage systems. **Figures 14 through 18** show the As-Constructed and Subsequently Improved profiles for WJD 5 & 7 respectively, based on the historic profile documents and these datum conversions.

Source of Survey Data Used in this Assessment

A survey completed by Houston Engineering, Inc. as the District Engineer during the spring of 2014 was used to assess the relationship between: 1) the historic and current alignments and stationing; and 2) to determine the vertical datum adjustment needed to establish the As-Constructed and Subsequently Improved Condition from the construction plans. All survey data collected by Houston Engineering, Inc. utilizes the NAD '83 Minnesota State Plane Coordinate System, South Zone (U.S. feet) and North American Vertical Datum 1988. (Note: Unless otherwise noted, all elevations provided herein are based on NAVD'88 vertical datum). Final survey data were placed in the RCWD survey geodatabase maintained by the District Engineer.

CURRENT TILE CAPACITY

Understanding current capacity can be used to assess whether the systems are serving their intended purpose as originally envisioned (which is to provide drainage to agricultural lands) and determine whether the drainage systems can support the change in land use envisioned by the City's Comprehensive Land Use Plan. WJD 5 and 7 are primarily tile systems with limited capacity. The City of Forest Lake's 2030 Future Land Use Map shows that parts of the drainage areas of WJD 5 & 7 are zoned for future Business Park and Rural Residential land use. Because of the low permeability of on-site soils and the limited capacity of the public drainage systems, compliance with District stormwater management rules, while fully developing the landscape per the City's Comprehensive Land Use Plan, would be challenging.

One way to quantify capacity is by determining the maximum flow the tile systems can convey before water pressurizes the tile systems. This involves using the tile diameter and slope within Manning's Equation to determine maximum flow under non-pressurized conditions. **Table 3** and **Table 4** specify the As-Designed/Established capacities for segments of the WJD 5 & 7 public drainage systems. Current capacities within the tile systems are expected to be essentially identical to the As-Designed/Established condition.

Table 3: Tile Capacities for WJD 5 System

Branch	Segment	Tile Diameter (inches)	Estimated As-Designed / Established Tile Capacity (cfs)[a]
Main Trunk	North of 200th St N	8	0.5
Main Trunk	Near 200th St N	10	0.8
Main Trunk	Between 195th St N and 200th St N	12	1.4
Main Trunk	Between 195th St N and Branch 1	15	2.1
Main Trunk	South of Branch 1	20	4.6
Branch 1	Along west side of Harrow Ave N	8	0.7
Branch 1	Along west side of Harrow Ave N	8	1.0
Branch 1	Along west side of Harrow Ave N	8	1.0
Branch 1	Between Harrow Ave N and Main Trunk	8	0.8
Branch 1	Between Harrow Ave N and Main Trunk	10	0.8

a) As-Designed/Established Tile Capacity is based on Manning's Equation, assuming no tailwater

Table 4: Tile Capacities for WJD 7 System

Branch	Segment	Tile Diameter (inches)	Estimated As-Designed / Established Tile Capacity (cfs)[a]
Main Trunk	North of Branch 1	8	1.0
Main Trunk	North of Branch 1	10	1.2
Main Trunk	Between Branch 1 and 190th St N	12	1.7
Main Trunk	Between 190th St N and Branch 2	15	3.0
Main Trunk	Between Branch 2 and Branch 3	15	3.4
Main Trunk	South of Branch 3	15	3.4
Branch 1	Northernmost 400' of Branch 1	8	0.7
Branch 1	Between HWY 61 and Main Trunk	10	1.2
Branch 2	Along south side of 190th St N	8	1.2
Branch 2	Along south side of 190th St N	8	0.6
Branch 3	North of 190th St	8	0.9
Branch 3	North of 190th St	8	0.7
Branch 3	South of 190th St	8	0.7

a) As-Designed/Established Tile Capacity is based on Manning's Equation, assuming no tailwater

Adequacy for agricultural drainage not only depends on tile capacity, but also outlet conditions. A large diameter tile may theoretically provide a substantial flow capacity, yet it would be of little value to agricultural users if the outlet is under water during small rainfall events. The tile outlet invert elevations for WJD 5 & 7 are below the peak water surface elevation in JD 2 resulting from a 2-year, 24-hour rainfall event. This indicates that the outlet is temporarily inundated under most rainfall events, resulting in standing water that will drain once the water in JD 2 recedes. However, due to the large drainage area of JD 2 upstream of WJD 5 and 7, long periods of standing water may result.

The subwatersheds drained by the WJD 5, 6, & 7 public drainage systems are situated in soils with low permeability. Based on the capacities determined above and site observations during periods of moderate rainfall or snowmelt, the WJD 5, 6, & 7 public drainage systems do not have sufficient capacity to fully support modern agricultural practices, let alone a change in land use resulting in greater runoff volumes.

RECOMMENDATIONS

Due to the fact that WJD 6 drains to the north out of the RCWD boundary, we recommend that the District enter into discussions with the Comfort Lake Forest Lake Watershed District (CLFLWD) regarding the transfer of the authority of the public drainage system to them. We also recommend that the RCWD collaborate with the Board of Water and Soil Resources (BWSR) and the CLFLWD to modify the district boundaries to more closely reflect the contributing drainage area for both districts. The modification of the district boundaries and transfer of the drainage system authority will likely need occur concurrently.

Figures 14 through 18 show the recommended alignment for the WJD 5 and 7 public drainage systems necessary in the Opinion of the Engineer to reestablish the historic drainage function to benefited lands. The recommended

alignment reasonably ensures the future ability of upstream benefitted lands to drain to the outlet of the systems consistent with the performance of the original drainage systems,[7] while considering documented and undocumented modifications to the legal drainage systems. **Figures 14 through 18** also show the profile of the As Constructed and Subsequently Improved Condition. The proposed profile for the recommended alignment is, in the Opinion of the Engineer, necessary to reestablish the historic capacity of the legal drainage systems. Finally, it is recommended that the alignment and profile of the As-Constructed and Subsequently Improved Condition for WJD 5 and WJD 7 (as shown in **Figures 14 through 18**) be formally adopted by the Board through a legal drainage proceedings per MS 103E.

AVAILABLE INFORMATION / HISTORICAL RECORDS

Historic records for the WJD 5, 6, & 7 public drainage system are available on the District website at the following location: http://rcwd.houstoneng.net/ditchportal/drainagesystemportal.html

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

Historic (Establishment) Files

- Petitions to establish ditches. 1920.
- Historic Alignment. 1921.
- Profiles. 1921.
- Order to Establish/Construct Branch 5. 1922.

Historic Repair Files

- Field Inspection Report for Judicial Ditches 5, 6, and 7. 1987.
- Rice Creek Watershed District Comprehensive Ditch Report. 2002.
- RCWD Engineers Report for Permit 09-067. 2009.

Recent Files

- Rice Creek Watershed District Comprehensive Ditch Report. 2002.

[7] The original drainage systems purpose was agricultural drainage. The requirements for a developed landscape differ from the purpose of agricultural drainage.

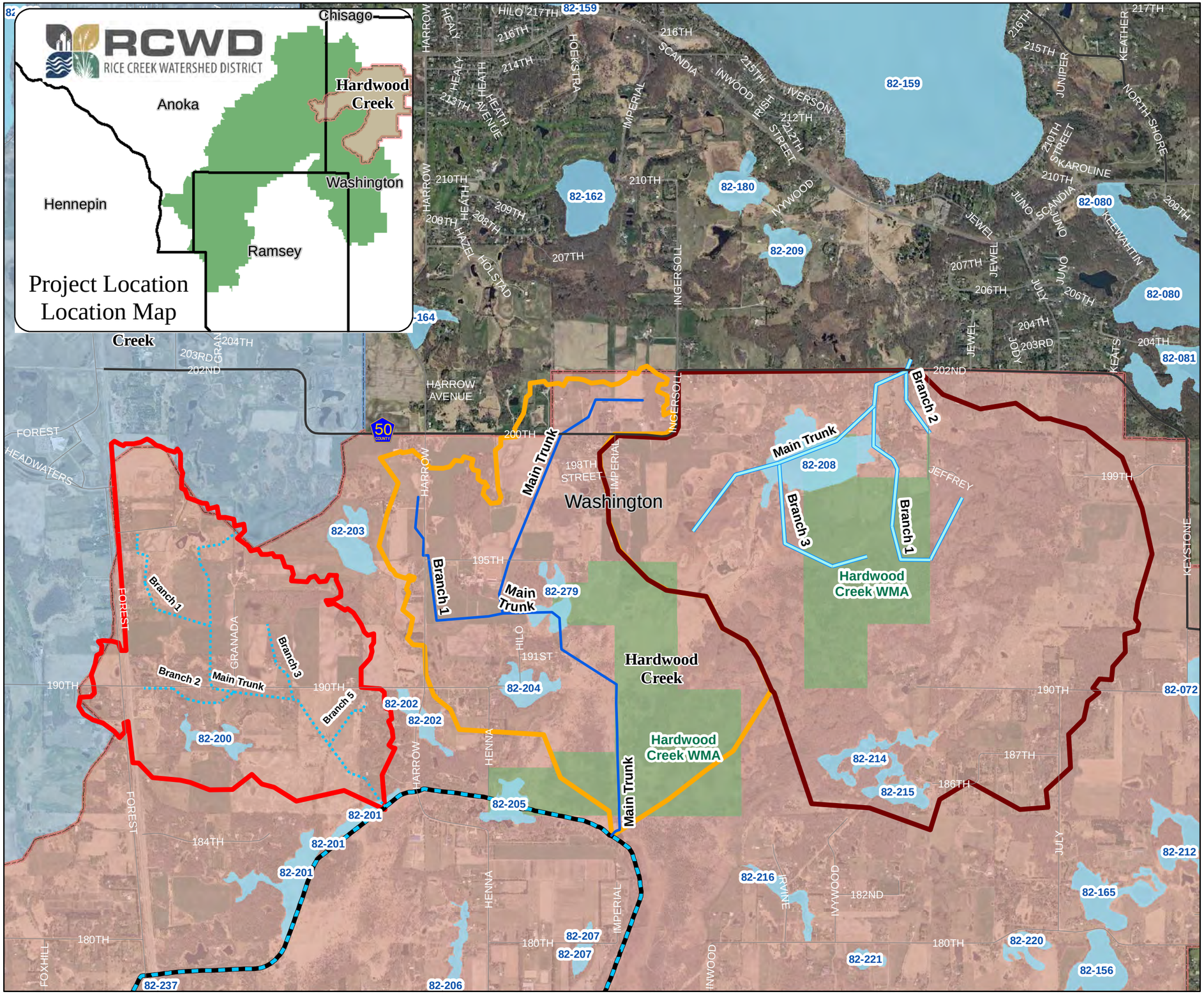
MEMO

I hereby certify that this 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, P.E.
MN Reg. No 48259

Rice Creek Watershed District WJD 5, 6 & 7 Drainage Systems



Legend

- County Roads
- Residential Streets
- WJD 7 Public Drainage System
- WJD 5 Public Drainage System
- WJD 6 Public Drainage System
- JD 2 - Public Drainage System
- Counties
- WJD 5 Hydrologic Boundary
- WJD 6 Hydrologic Boundary
- WJD 7 Hydrologic Boundary
- MN DNR Public Waters
- Wildlife Management Areas
- Hardwood Creek Planning Region
- Upper Rice Creek Planning Region

N
W E
S

0 1,250 2,500 5,000 Feet

Sources: RCWD, TLG, MN DOT, MN DNR

Aerial Imagery: 2010 Twin Cities

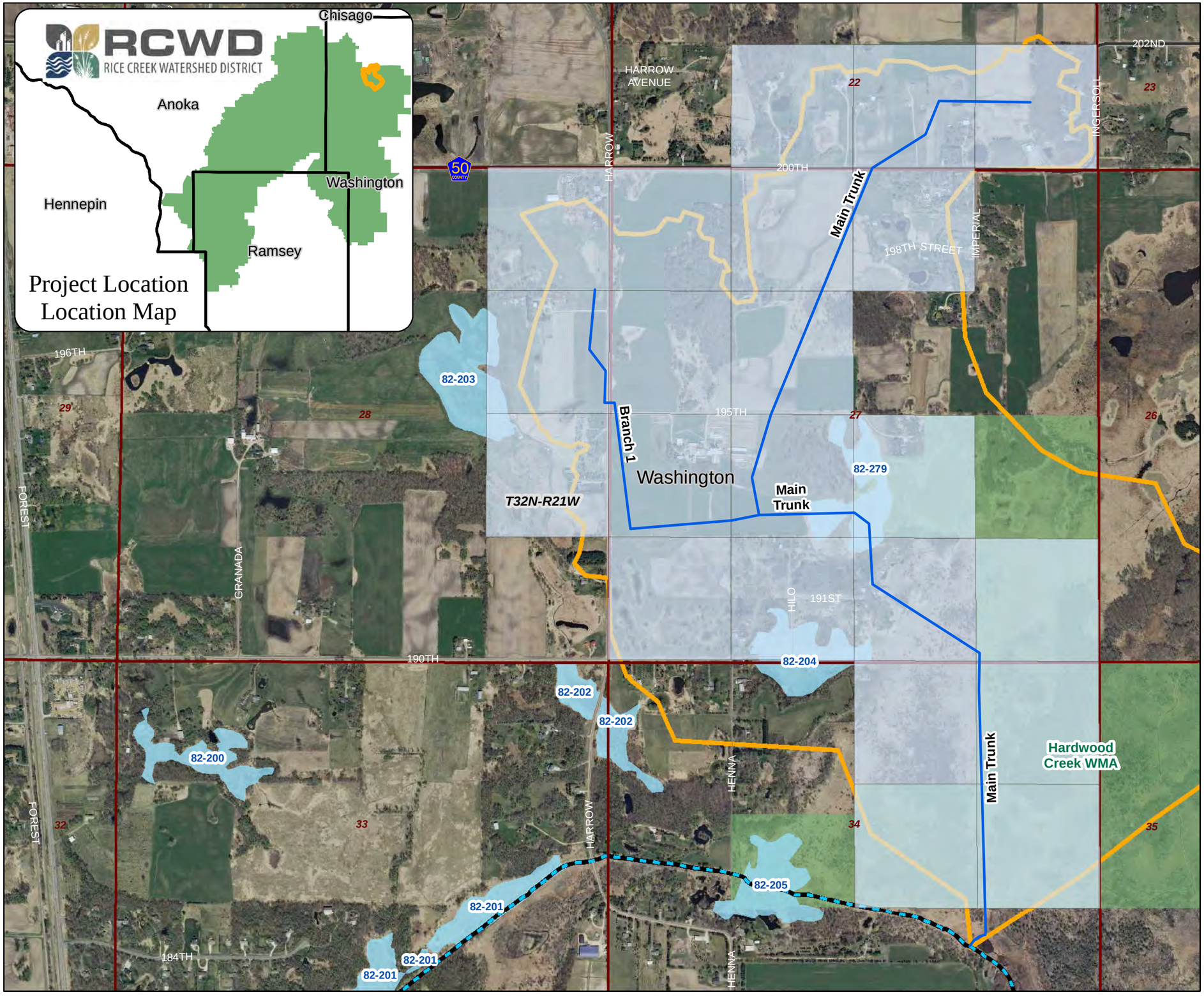
Date Saved: 10/10/2014 2:59:24 PM

Figure 1: WJD 5, 6, & 7 Public Drainage Systems & Hydrologic Boundary

Scale:	Drawn by:	Checked by:	Project No.:	Date:	Sheet:
AS SHOWN	SMW		5555-233	10/10/2014	1 of 1

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

Rice Creek Watershed District Benefitted Lands Washington County Judicial Ditch 5



- WJD 5 - Public Drainage System
- WJD 5 Benefitted Lands from 1921 Assessment Roles
- Sections
- Township and Range
- County Roads
- Residential Streets
- JD 2 - Public Drainage System
- WJD 5 Watershed Boundary
- Counties
- MN DNR Public Waters
- Wildlife Management Areas

N
W E
S

0 750 1,500 3,000 Feet

Sources: RCWD, TLG, MN DOT, MN DNR

Aerial Imagery: 2010 Twin Cities

Date Saved: 10/10/2014 2:29:47 PM

Figure 2: Benefitted Lands - Washington County Judicial Ditch 5

Scale:	Drawn by:	Checked by:	Project No.:	Date:	Sheet:
AS SHOWN	SMW		5555-233	10/10/2014	1 of 1

Houston Engineering Inc.
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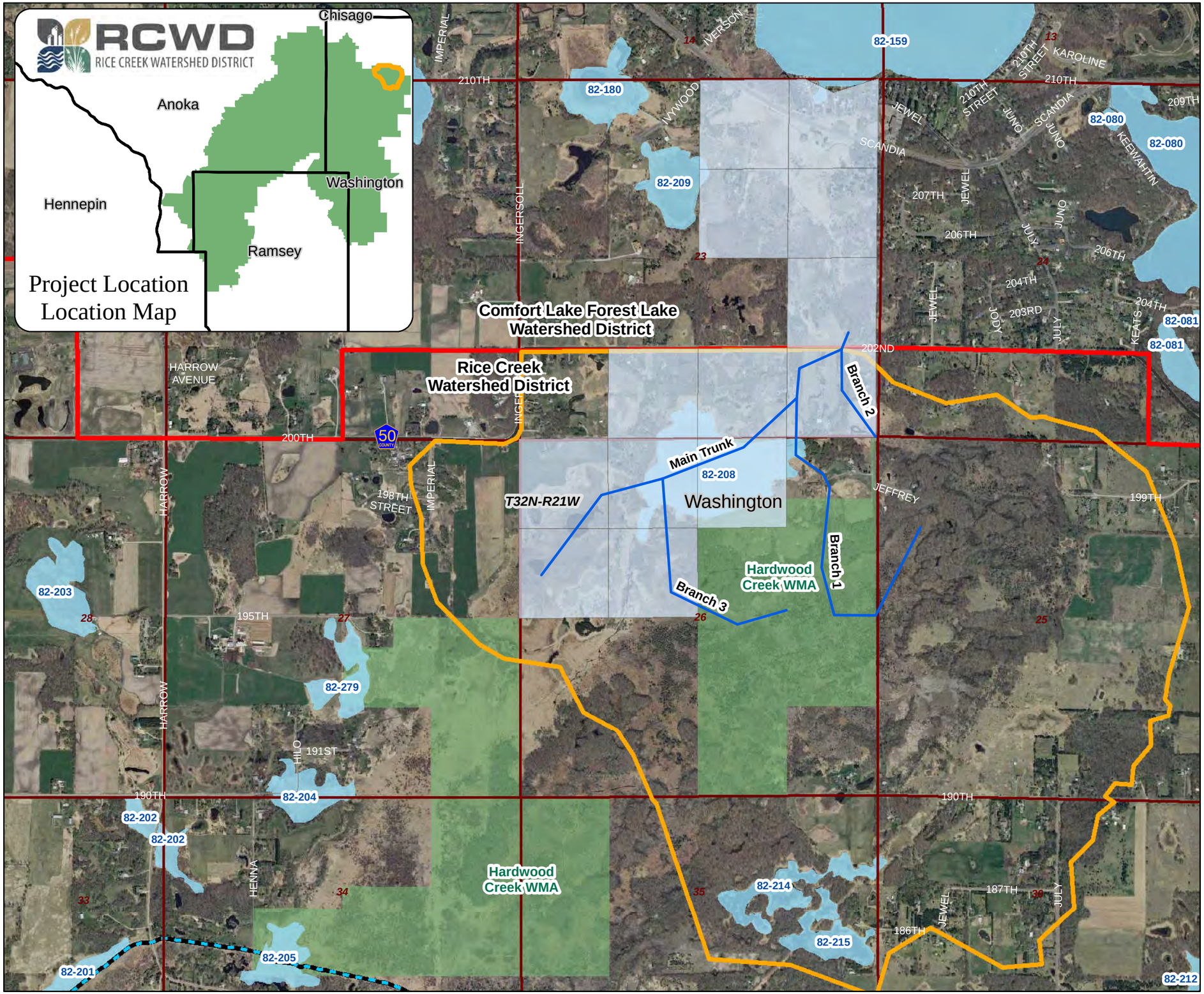
F: 763.493.5572

Rice Creek Watershed District Benefitted Lands Washington County Judicial Ditch 6



- WJD 6 - Public Drainage System
- WJD 6 Benefitted Lands from 1921 Assessment Roles
- WJD6 Watershed Boundary*
- RCWD Legal Boundary
- Sections
- Township and Range
- JD 2 - Public Drainage System
- Counties
- MN DNR Public Waters
- Wildlife Management Areas

*** Drains to Comfort Lake Forest Lake Watershed**

N W E S

0 1,000 2,000 4,000 Feet

Sources: RCWD, TLG, MN DOT, MN DNR

Aerial Imagery: 2010 Twin Cities

Date Saved: 10/10/2014 3:05:30 PM

Figure 3: Benefitted Lands - Washington County Judicial Ditch 6

Scale:	Drawn by:	Checked by:	Project No.:	Date:	Sheet:
AS SHOWN	SMW		5555-233	10/10/2014	1 of 1

Houston Engineering Inc.
Maple Grove
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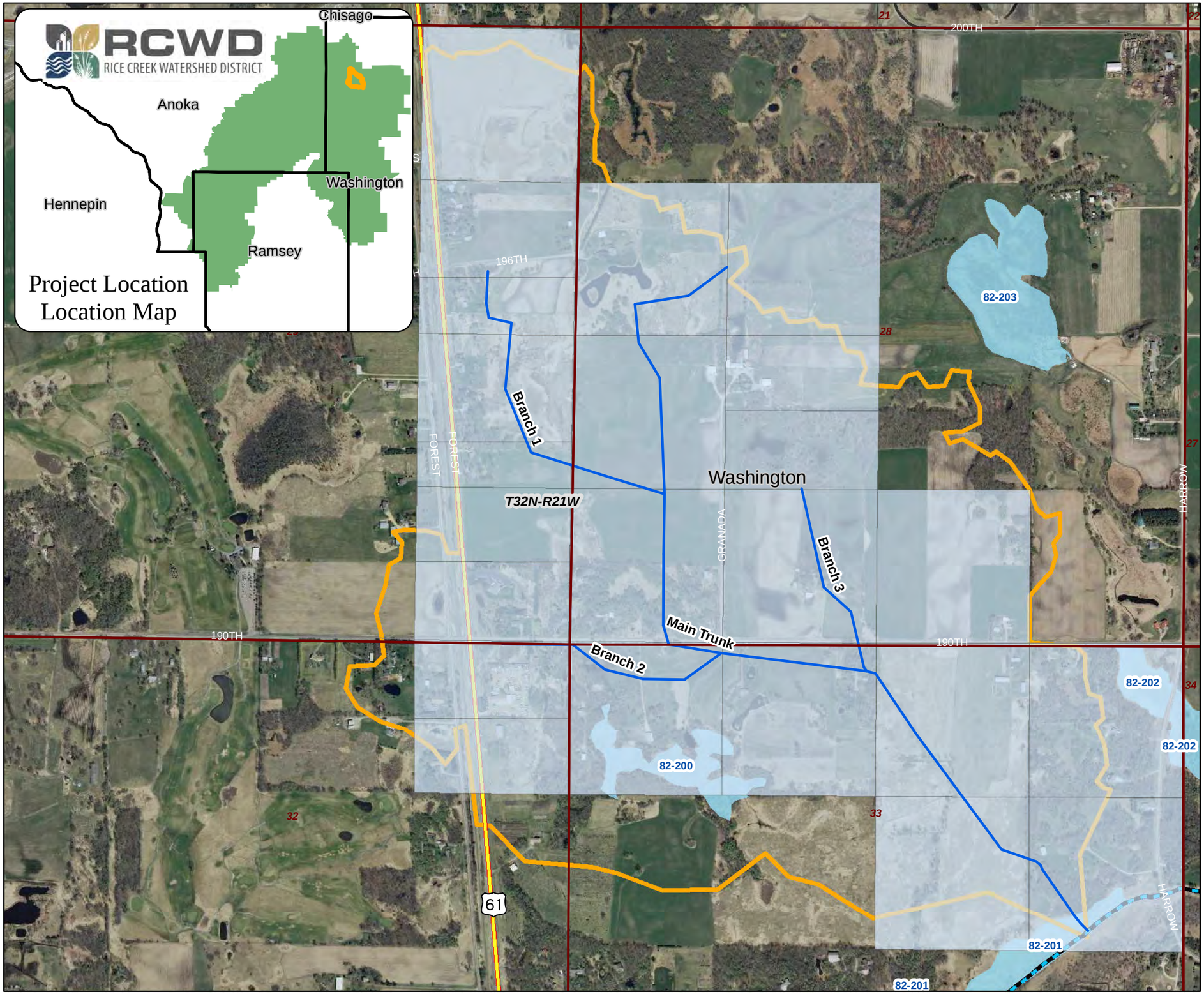
F: 763.493.5572

Rice Creek Watershed District Benefitted Areas Washington County Judicial Ditch 7



- WJD 7 - Public Drainage System
- WJD7 Watershed Boundary
- Sections
- Township and Range
- WJD 7 Benefitted Lands from 1921 Assessment Roles
- JD 2 - Public Drainage System
- US Highway
- County Roads
- Residential Streets
- Counties
- MN DNR Public Waters

N
W E
S

0 625 1,250 2,500 Feet

Sources: RCWD, TLG, MN DOT, MN DNR

Aerial Imagery: 2010 Twin Cities

Date Saved: 10/10/2014 3:39:53 PM

Figure 4: Benefitted Areas - Washington County Judicial Ditch 7

Scale:	Drawn by:	Checked by:	Project No.:	Date:	Sheet:
AS SHOWN	SMW		5555-233	10/10/2014	1 of 1

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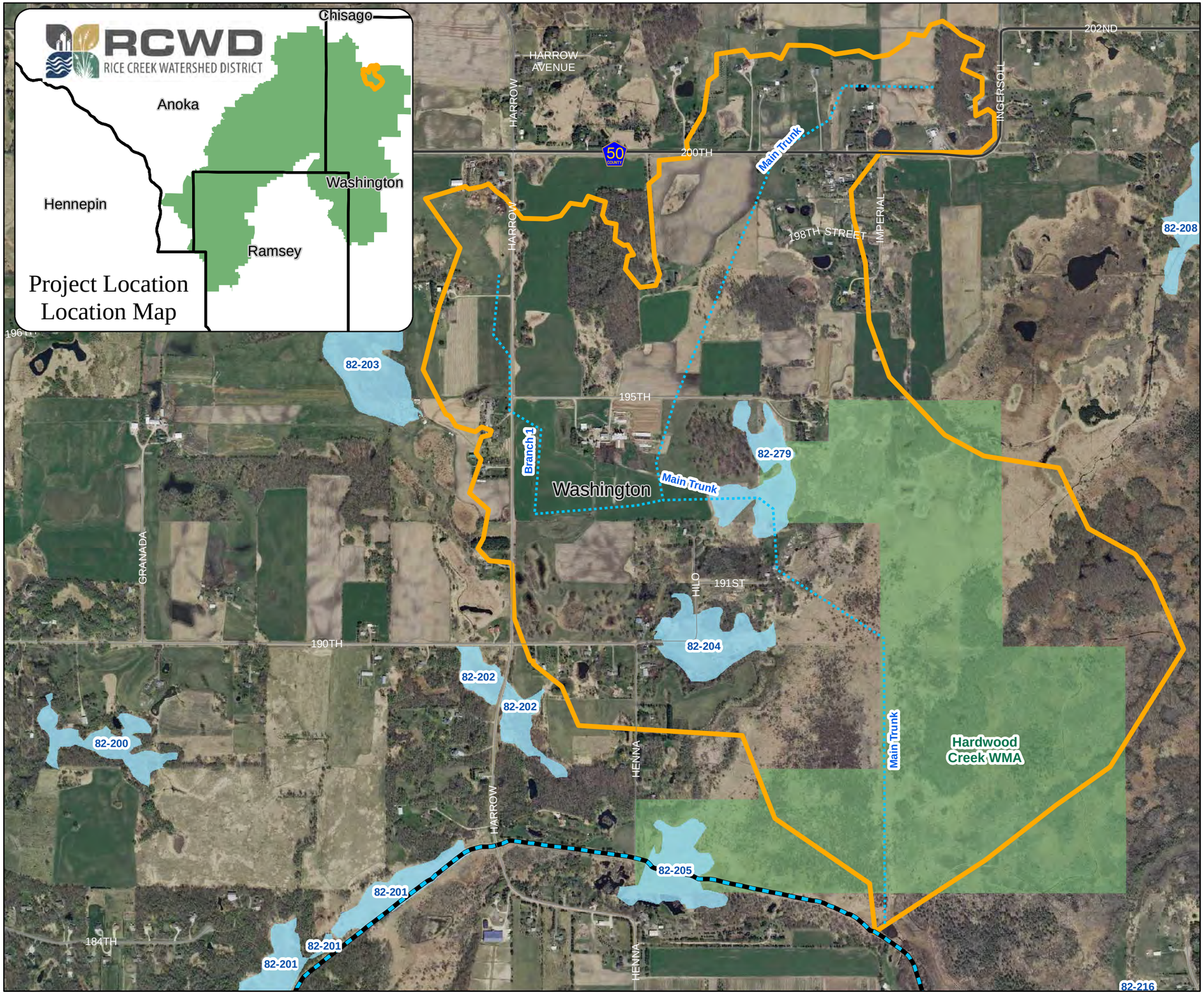
Rice Creek Watershed District
As Designed Alignment
Washington County Judicial Ditch 5



- WJD 5 As Designed Alignment
- JD 2 - Current Alignment
- County Roads
- Residential Streets
- WJD 5 Watershed Boundary
- Counties
- MN DNR Public Waters
- Wildlife Management Areas

N
W E
S

0 750 1,500 3,000 Feet

Sources: RCWD, TLG, MN DOT, MN DNR

Aerial Imagery: 2010 Twin Cities

Date Saved: 10/10/2014 2:39:02 PM

Figure 5: As Designed Alignment - Washington County Judicial Ditch 5

Scale:	Drawn by:	Checked by:	Project No.:	Date:	Sheet:
AS SHOWN	SMW		5555-233	10/10/2014	1 of 1

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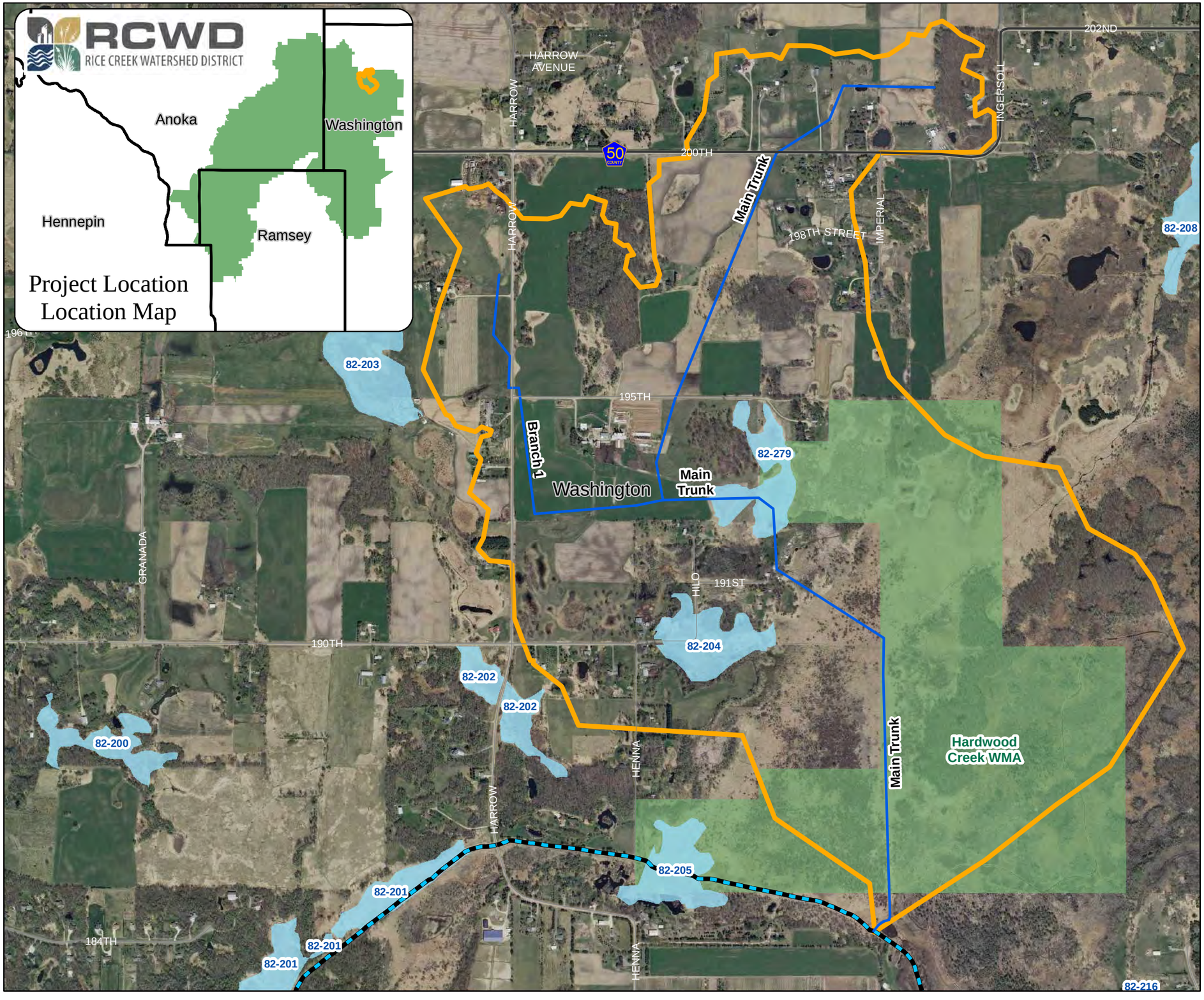
F: 763.493.5572

Rice Creek Watershed District
Current Alignment
Washington County
Judicial Ditch 5



- WJD 5 - Current Alignment
- JD 2 - Current Alignment
- WJD 5 Watershed Boundary
- County Roads
- Residential Streets
- Counties
- MN DNR Public Waters
- Wildlife Management Areas

N
W E
S

0 750 1,500 3,000 Feet

Sources: RCWD, TLG, MN DOT, MN DNR

Aerial Imagery: 2010 Twin Cities

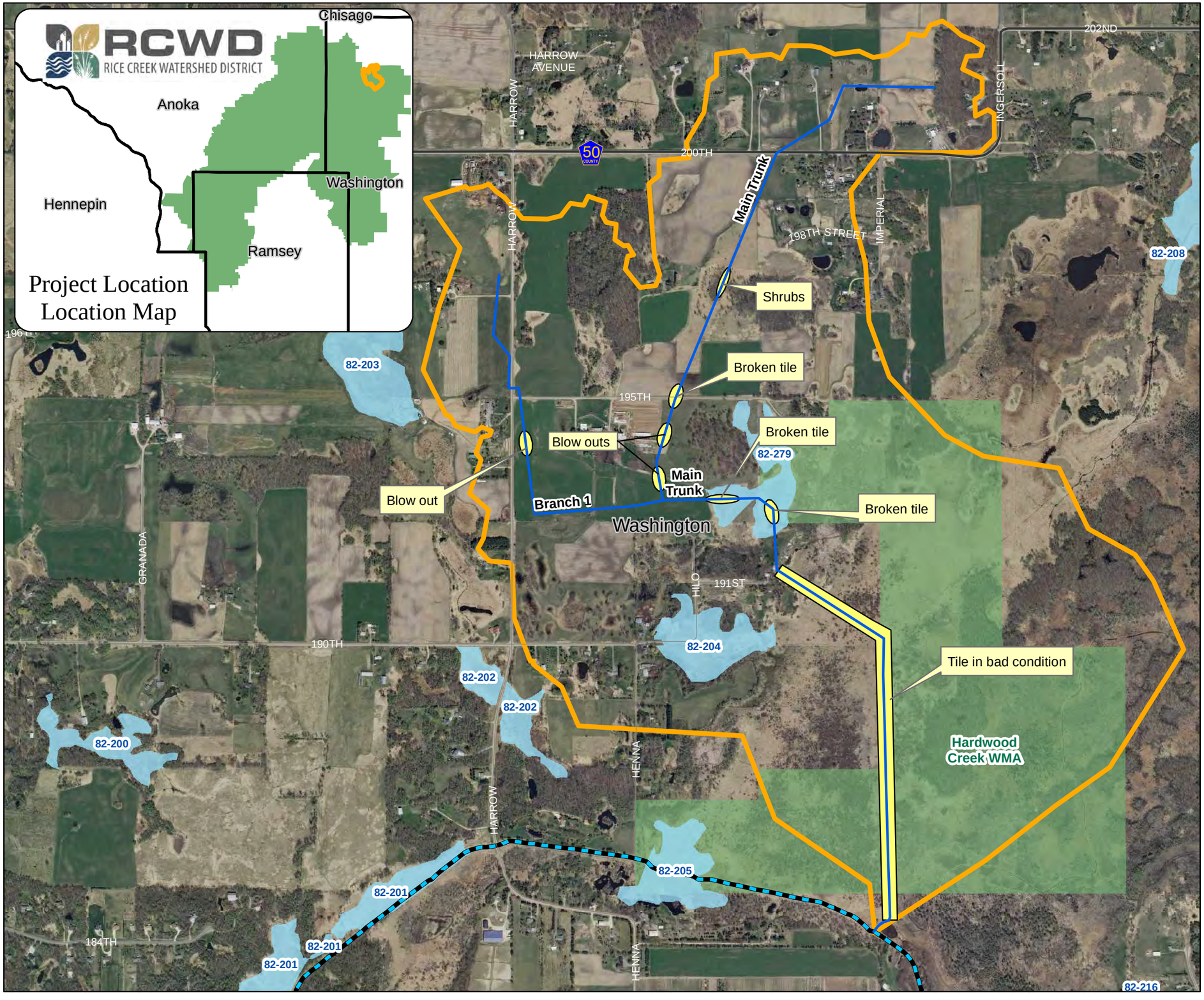
Date Saved: 10/10/2014 2:46:46 PM

Figure 6: Current Alignment - Washington County Judicial Ditch 5

Scale:	Drawn by:	Checked by:	Project No.:	Date:	Sheet:
AS SHOWN	SMW		5555-233	10/10/2014	1 of 1

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

Rice Creek Watershed District Problem Areas Washington County Judicial Ditch 5



- WJD 5 - Current Alignment
- Problem Areas - WJD 5
- Interstate
- County Roads
- Residential Streets
- Ramps
- JD 2 - Current Alignment
- WJD 5 Watershed Boundary
- Counties
- MN DNR Public Waters
- Wildlife Management Areas

N
W E
S

0 750 1,500 3,000 Feet

Sources: RCWD, TLG, MN DOT, MN DNR

Aerial Imagery: 2010 Twin Cities

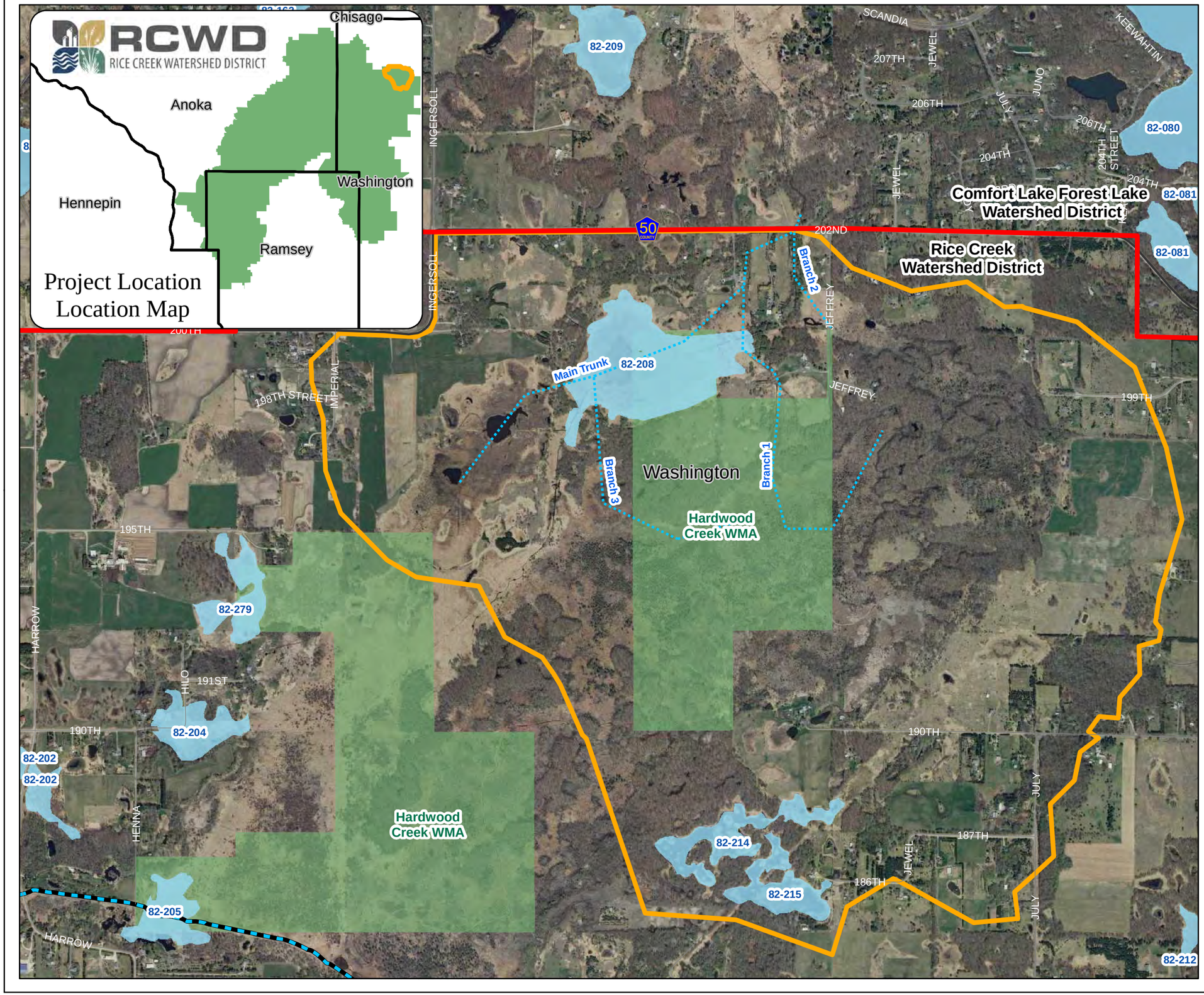
Date Saved: 10/10/2014 2:53:47 PM

Figure 7: Problem Areas - Washington County Judicial Ditch 5

Scale:	Drawn by:	Checked by:	Project No.:	Date:	Sheet:
AS SHOWN	SMW		5555-233	10/10/2014	1 of 1

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

Rice Creek Watershed District As Designed Washington County Judicial Ditch 6



- WJD 6 As Designed Alignment
- County Roads
- Residential Streets
- RCWD Legal Boundary
- WJD6 Watershed Boundary*
- JD 2 - Public Drainage System
- Counties
- MN DNR Public Waters
- Wildlife Management Areas

*** Drains to Comfort Lake Forest Lake Watershed**

N W E S

0 1,000 2,000 4,000 Feet

Sources: RCWD, TLG, MN DOT, MN DNR

Aerial Imagery: 2010 Twin Cities

Date Saved: 10/10/2014 3:02:46 PM

Figure 8: As Designed Alignment - Washington County Judicial Ditch 6

Scale:	Drawn by:	Checked by:	Project No.:	Date:	Sheet:
AS SHOWN	SMW		5555-233	10/10/2014	1 of 1

Houston Engineering Inc.
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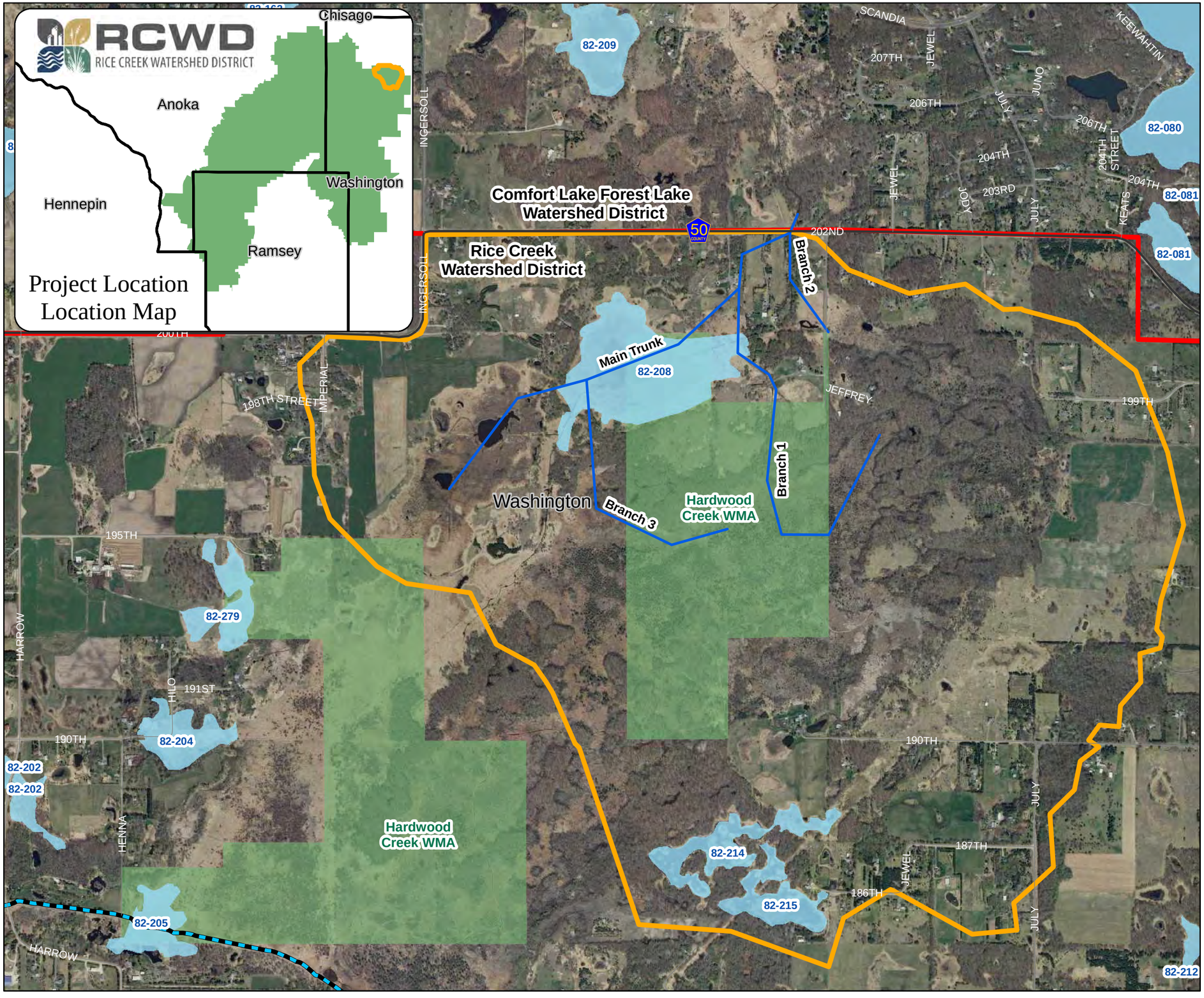
F: 763.493.5572

Rice Creek Watershed District Current Alignment Washington County Judicial Ditch 6



WJD 6 - Current Alignment
County Roads
Residential Streets
JD 2 - Public Drainage System
Counties
WJD6 Watershed Boundary*
RCWD Legal Boundary
MN DNR Public Waters
Wildlife Management Areas

*** Drains to Comfort Lake Forest Lake Watershed**

N
W E
S

0 1,000 2,000 4,000 Feet

Sources: RCWD, TLG, MN DOT, MN DNR

Aerial Imagery: 2010 Twin Cities

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Figure 9: Current Alignment - Washington County Judicial Ditch 6

Scale:	Drawn by:	Checked by:	Project No.:	Date:	Sheet:
AS SHOWN	SMW		5555-233	10/10/2014	1 of 1

Houston Engineering Inc.
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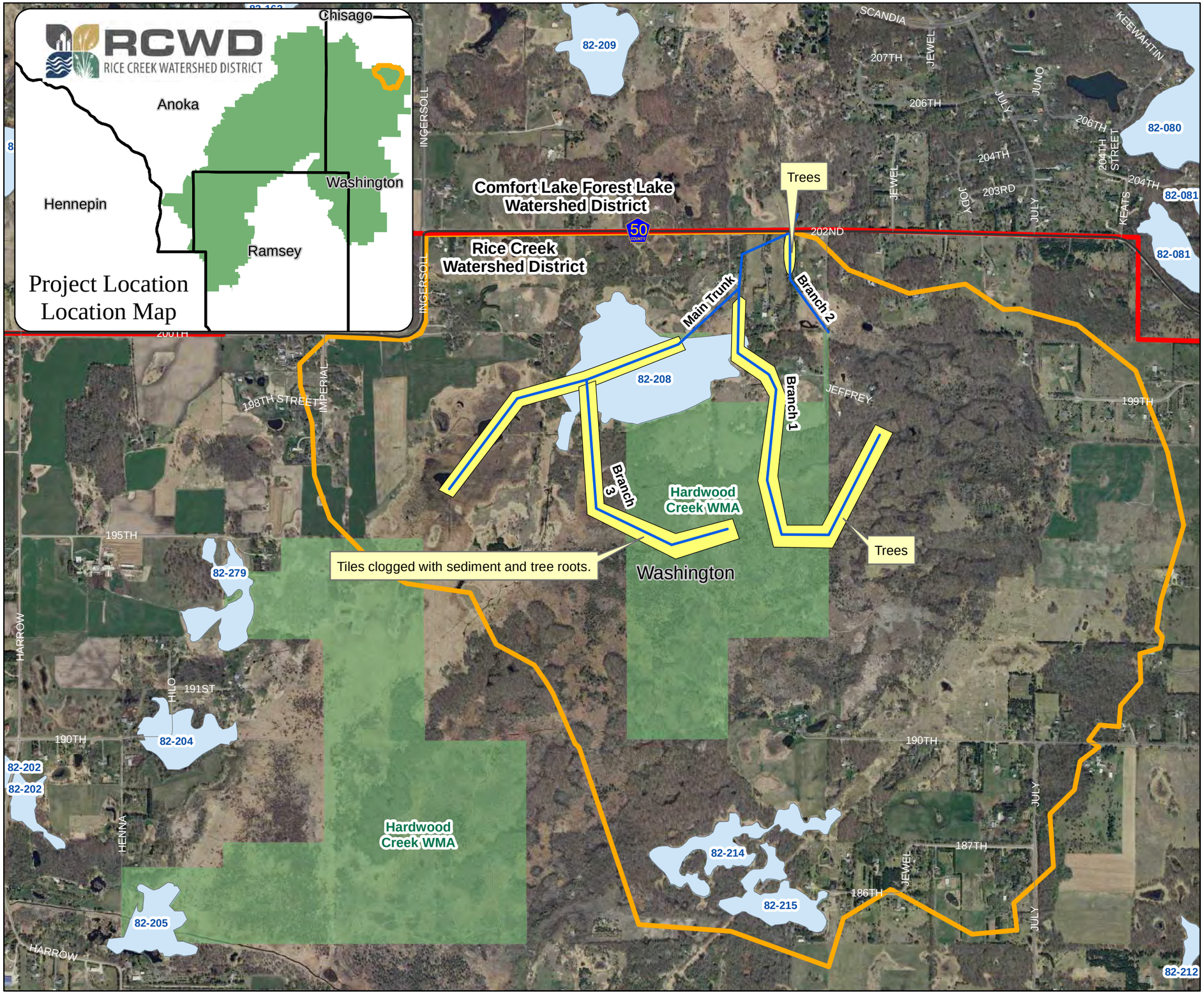
F: 763.493.5572

Rice Creek Watershed District Problem Areas Washington County Judicial Ditch 6



- WJD 6 - Current Alignment
- Problem Areas - WJD 6
- Interstate
- County Roads
- Residential Streets
- Ramps
- RCWD Legal Boundary
- WJD6 Watershed Boundary*
- MN DNR Public Waters
- Counties
- MN DNR Public Waters
- Wildlife Management Areas

*** Drains to Comfort Lake Forest Lake Watershed**

N
W E
S

0 1,000 2,000 4,000 Feet

Sources: RCWD, TLG, MN DOT, MN DNR

Aerial Imagery: 2010 Twin Cities

Date Saved: 9/30/2014 11:18:40 AM

Figure 10: Problem Areas - Washington County Judicial Ditch 6

Scale:	Drawn by:	Checked by:	Project No.:	Date:	Sheet:
AS SHOWN	SMW		5555-233	10/10/2014	1 of 1

Houston Engineering Inc.
Maple Grove
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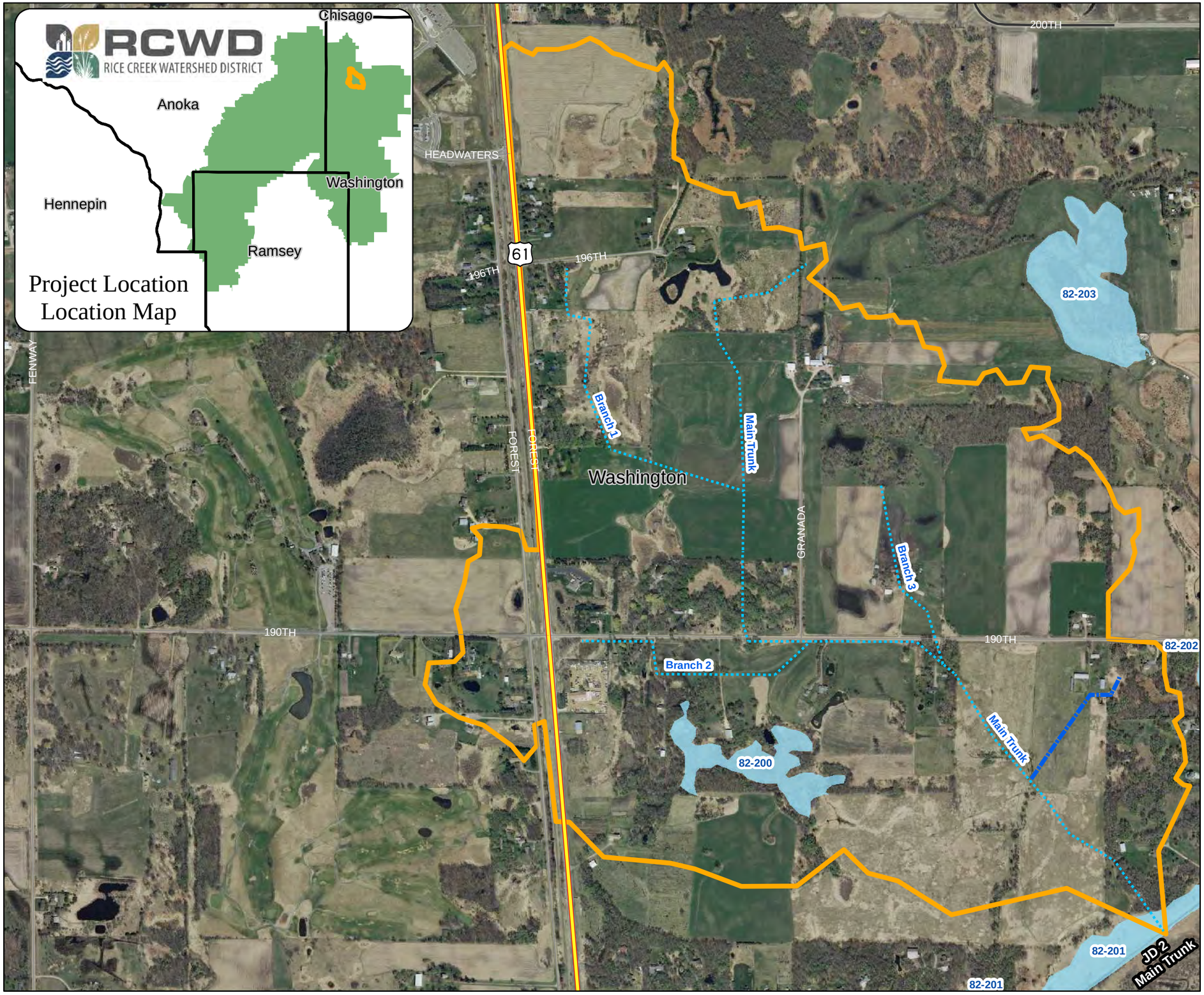
F: 763.493.5572

Rice Creek Watershed District
As Designed Alignment
Washington County Judicial Ditch 7



- US Highway
- County Roads
- Residential Streets
- Branch 5 - Assumed Location
- WJD7 Watershed Boundary
- Counties
- MN DNR Public Waters

N
W E
S

0 625 1,250 2,500 Feet

Sources: RCWD, TLG, MN DOT, MN DNR

Aerial Imagery: 2010 Twin Cities

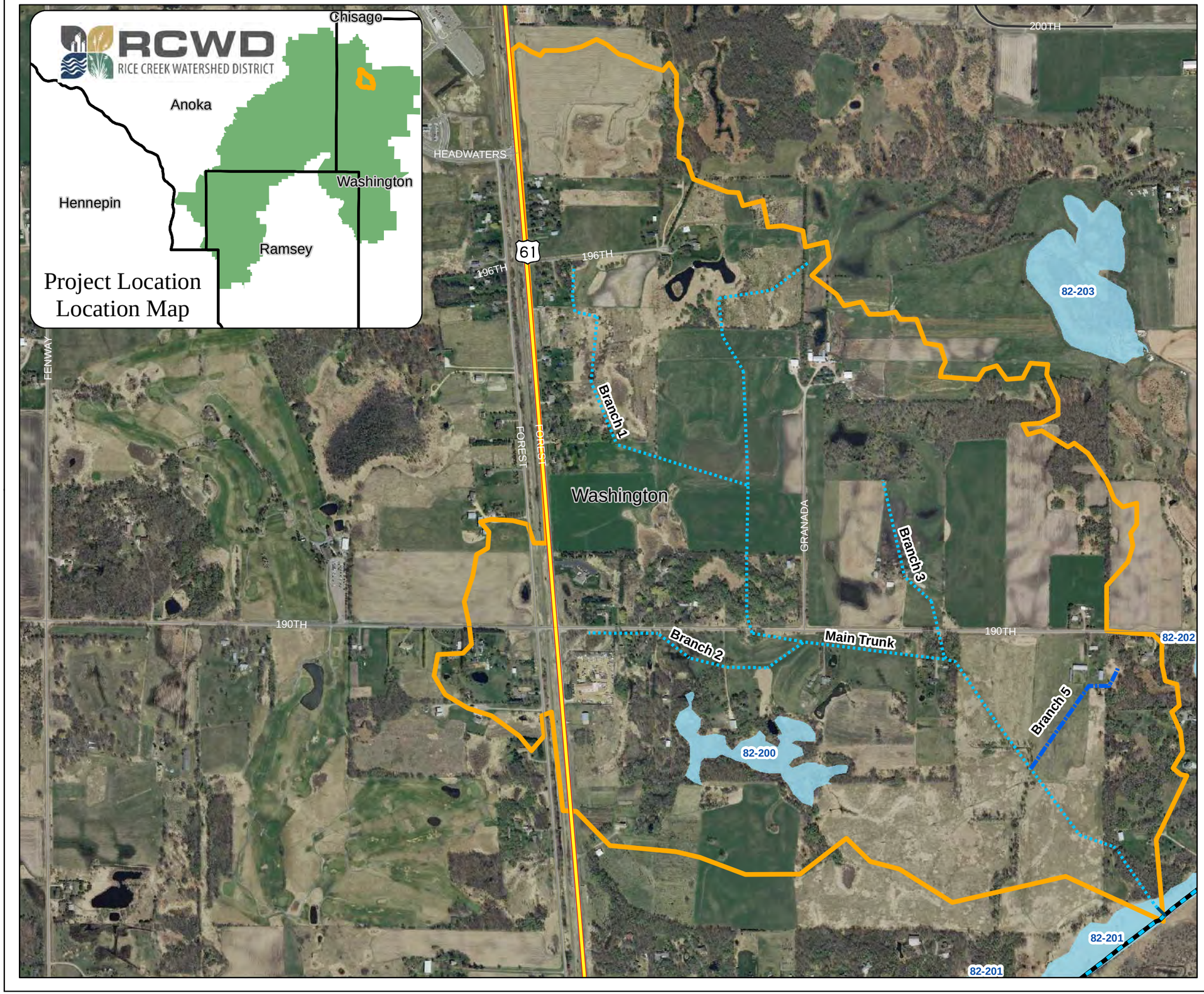
Date Saved: 10/10/2014 3:33:58 PM

Figure 11: As Designed Alignment - Washington County Judicial Ditch 7

Scale:	Drawn by:	Checked by:	Project No.:	Date:	Sheet:
AS SHOWN	SMW		5555-233	10/10/2014	1 of 1

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

Rice Creek Watershed District
Current Alignment
Washington County Judicial Ditch 7



- US Highway
- County Roads
- Residential Streets
- WJD 7 Current Alignment Open Channel (Outlet)
- Tile
- Branch 5 - Assumed Location
- JD 2 - Current Alignment
- WJD7 Watershed Boundary
- Counties
- MN DNR Public Waters

N
W E
S

0 625 1,250 2,500 Feet

Sources: RCWD, TLG, MN DOT, MN DNR

Aerial Imagery: 2010 Twin Cities

Date Saved: 10/10/2014 3:44:01 PM

Figure 12: Current Alignment - Washington County Judicial Ditch 7

Scale:	Drawn by:	Checked by:	Project No.:	Date:	Sheet:
AS SHOWN	SMW		5555-233	10/10/2014	1 of 1

Houston Engineering Inc.
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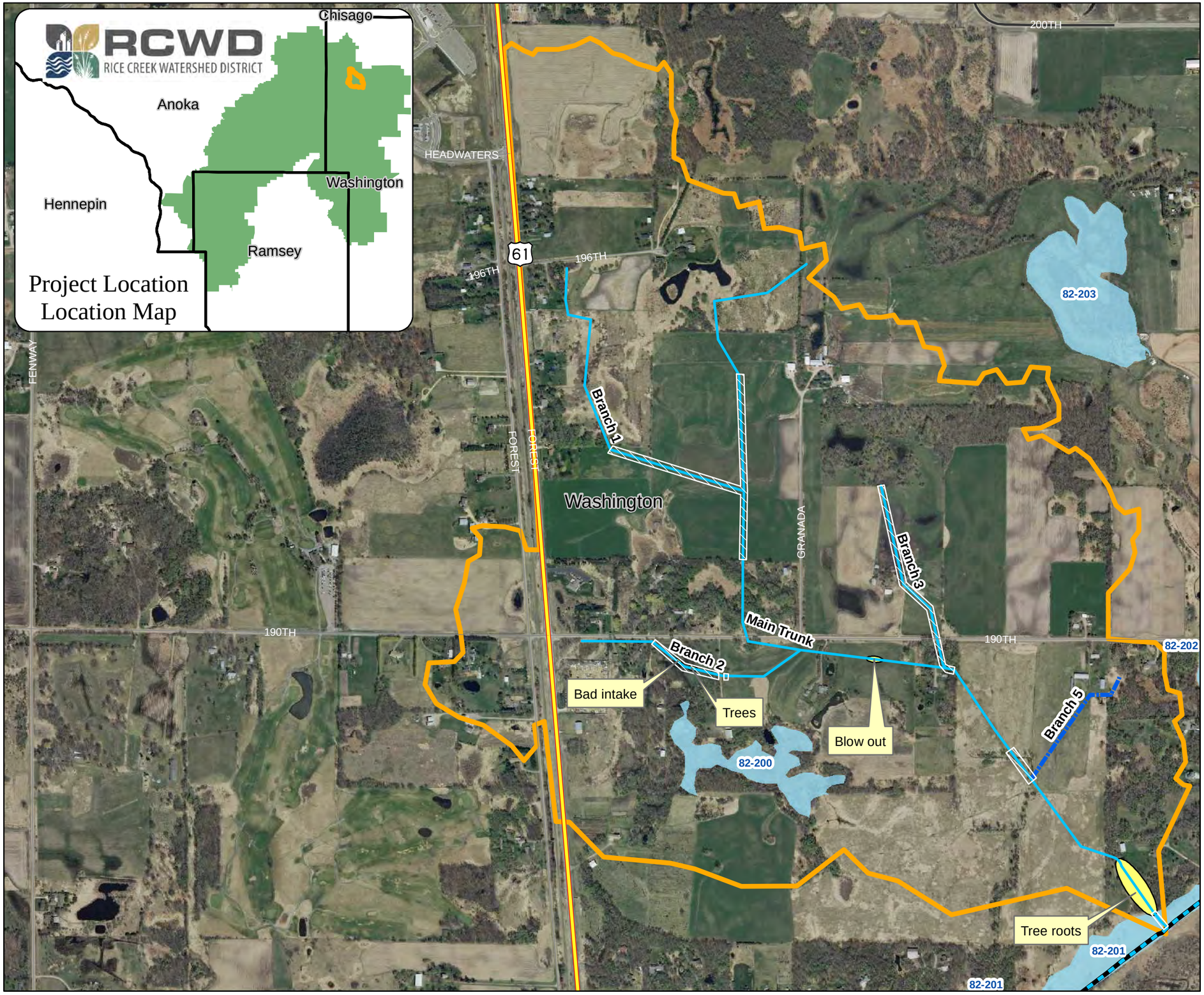
F: 763.493.5572

Rice Creek Watershed District Problem Areas and Completed Maintenance Washington County Judicial Ditch 7



- US Highway
- County Roads
- Residential Streets
- Maintenance Already Completed
- WJD 7 Current Alignment
- Branch 5 - Assumed Location
- Problem Areas - WJD 7
- JD 2 - Current Alignment
- WJD7 Watershed Boundary
- Counties
- MN DNR Public Waters

N
W E
S

0 625 1,250 2,500 Feet

Sources: RCWD, TLG, MN DOT, MN DNR

Aerial Imagery: 2010 Twin Cities

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Figure 13: Problem Areas - Washington County Judicial Ditch 7

Scale:	Drawn by:	Checked by:	Project No.:	Date:	Sheet:
AS SHOWN	SMW		5555-233	10/10/2014	1 of 1

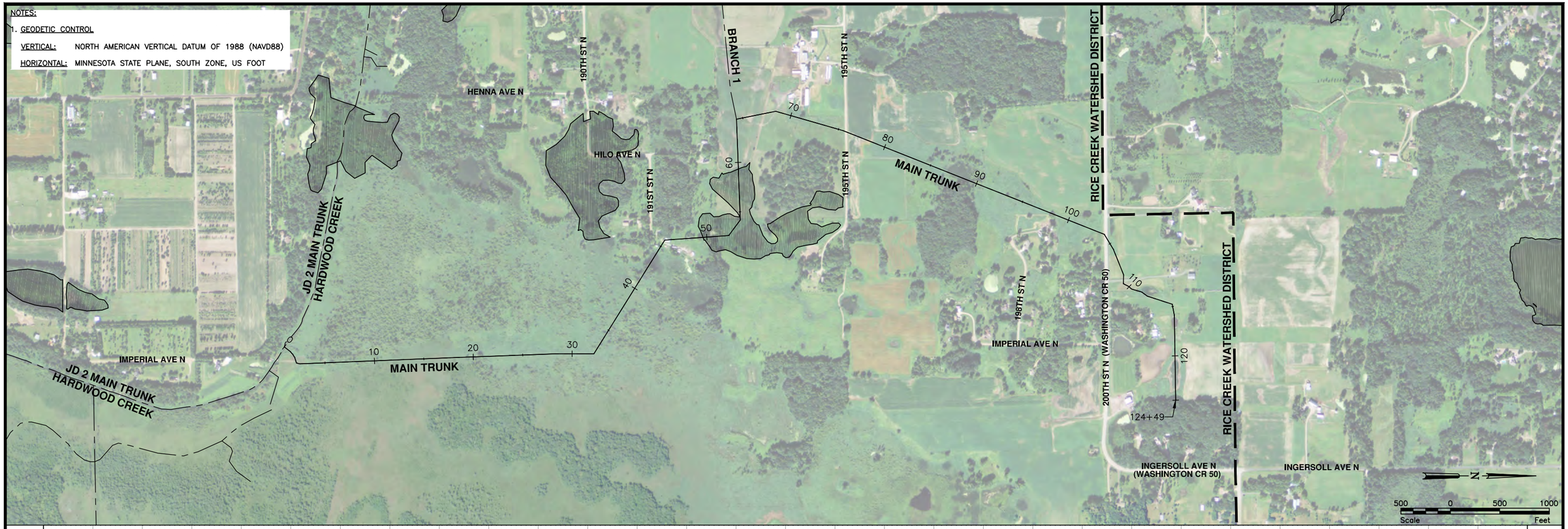
Houston Engineering Inc.
Maple Grove
P: 763.493.4522
F: 763.493.5572

NOTES:

1. GEODETIC CONTROL

   VERTICAL: NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

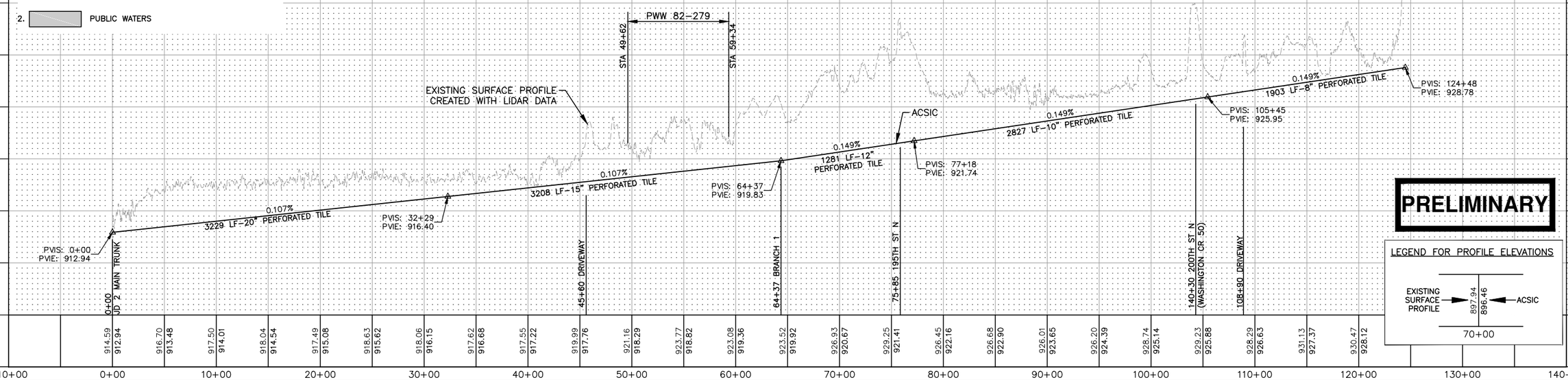
   HORIZONTAL: MINNESOTA STATE PLANE, SOUTH ZONE, US FOOT



WJD 5 MAIN TRUNK

NOTES:

1. AS-CONSTRUCTED AND SUBSEQUENTLY IMPROVED CONDITION (ACSIC) PROFILES ARE BASED ON THE 1921 DESIGN PROFILES WITH A DATUM ADJUSTMENT OF 752.90'.
2. PUBLIC WATERS



No.	Revision	Date	By

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

Signature:_____ Date: 1-8-2015

Printed Name: Nancy A. Stowe License #: 48259

Houston Engineering Inc.

Maple Grove

P: 763.493.4522

F: 763.493.5572

Drawn by	Date
DJL	1-8-15
Checked by	Scale
GM, NAS	AS SHOWN

FIGURE 14
AS-CONSTRUCTED AND SUBSEQUENTLY IMPROVED CONDITION
RICE CREEK WATERSHED DISTRICT
FOREST LAKE, MINNESOTA

WJD 5 MAIN TRUNK
PLAN AND PROFILE
PROJECT NO. 5555-233

SHEET
1 of 1

NOTES:

1. GEODETIC CONTROL

VERTICAL: NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

HORIZONTAL: MINNESOTA STATE PLANE, SOUTH ZONE, US FOOT

HARROW AVE N

HENNA AVE N

HILO AVE N

190TH ST N

191ST ST N

195TH ST N

198TH ST N

JD 2 MAIN TRUNK
HARDWOOD CREEK

BRANCH 1

MAIN TRUNK

RICE CREEK WATERSHED DISTRICT

200TH ST N (WASHINGTON CR 50)

0 10 20 30 40 41+21

N

500 0 500 1000
Scale Feet

WJD 5 BRANCH 1

NOTES:

1. AS–CONSTRUCTED AND SUBSEQUENTLY IMPROVED CONDITION (ACSIC) PROFILES ARE BASED ON THE 1921 DESIGN PROFILES WITH A DATUM ADJUSTMENT OF 752.90'.

2. PUBLIC WATERS

EXISTING SURFACE PROFILE CREATED WITH LIDAR DATA

ACSIC

PVIS: 0+00
PVIE: 920.09

0.128%
2190 LF–10" PERFORATED TILE

PVIS: 21+90
PVIE: 922.89

0.406%
1931 LF–8" PERFORATED TILE

PVIS: 27+36
PVIE: 925.11

0.679%

PVIS: 34+70
PVIE: 930.09

0.317%

PVIS: 41+21
PVIE: 932.15

0+00 WJD 5 MAIN TRUNK
26+32 195TH ST N
28+11 HARROW AVE N
39+00 DRIVEWAY

925.27 920.09
923.35 920.73
925.60 921.37
928.63 922.01
929.87 922.65
930.52 924.15
933.57 926.90
934.75 930.19
935.03 931.77

945 940 935 930 925 920 915 910

−50+00 −40+00 −30+00 −20+00 −10+00 0+00 10+00 20+00 30+00 40+00 50+00 60+00 70+00 80+00 90+00 100+00

PRELIMINARY

LEGEND FOR PROFILE ELEVATIONS

EXISTING SURFACE PROFILE — 897.94 / 896.46 — ACSIC

70+00

No.	Revision	Date	By

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

Signature: _____ Date: 1–8–2015

Printed Name: Nancy A. Stowe License #: 48259

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

Drawn by: DJL
Checked by: GM, NAS
Date: 1-8-15
Scale: AS SHOWN

FIGURE 15
AS-CONSTRUCTED AND SUBSEQUENTLY IMPROVED CONDITION
RICE CREEK WATERSHED DISTRICT
FOREST LAKE, MINNESOTA

WJD 5 BRANCH 1
PLAN AND PROFILE
PROJECT NO. 5555-233

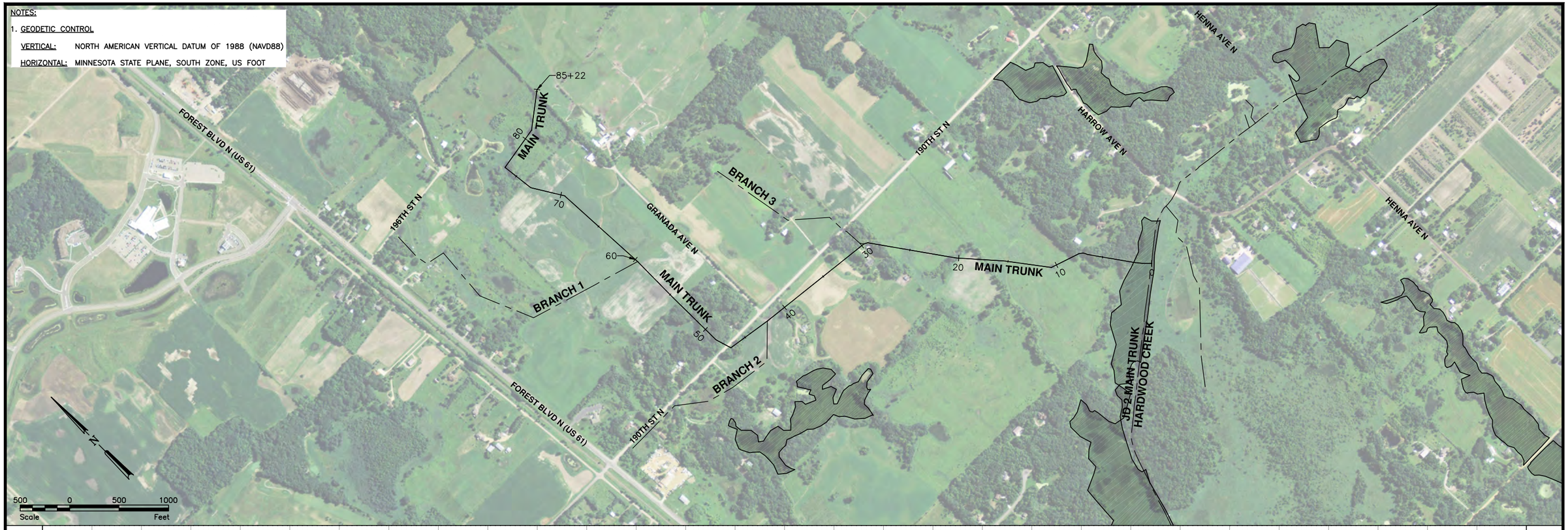
SHEET
1 of 1

NOTES:

1. GEODETIC CONTROL

VERTICAL: NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

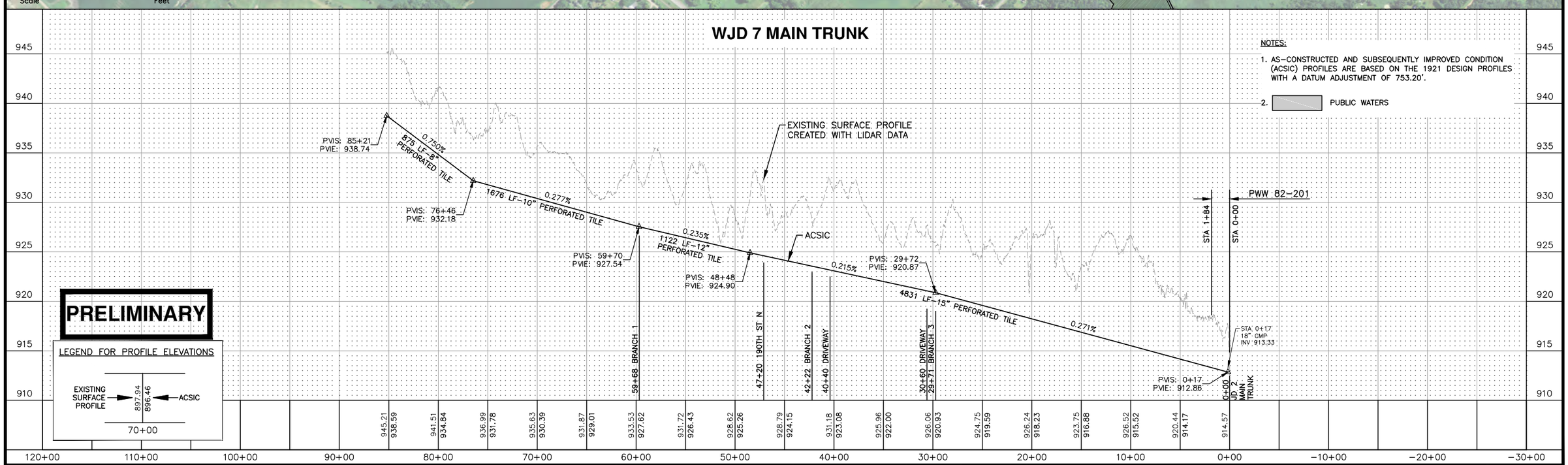
HORIZONTAL: MINNESOTA STATE PLANE, SOUTH ZONE, US FOOT



WJD 7 MAIN TRUNK

NOTES:

1. AS–CONSTRUCTED AND SUBSEQUENTLY IMPROVED CONDITION (ACSIC) PROFILES ARE BASED ON THE 1921 DESIGN PROFILES WITH A DATUM ADJUSTMENT OF 753.20'.
2. PUBLIC WATERS



PRELIMINARY

LEGEND FOR PROFILE ELEVATIONS

EXISTING SURFACE PROFILE 897.94 896.46 ACSIC

70+00

No.	Revision	Date	By

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

Signature:_____ Date: 1–8–2015

Printed Name: Nancy A. Stowe License #: 48259

Houston Engineering Inc.

Maple Grove

P: 763.493.4522

F: 763.493.5572

Drawn by: DJL

Checked by: GM, NAS

Date: 1-8-15

Scale: AS SHOWN

FIGURE 16

AS-CONSTRUCTED AND SUBSEQUENTLY IMPROVED CONDITION

RICE CREEK WATERSHED DISTRICT

FOREST LAKE, MINNESOTA

WJD 7 MAIN TRUNK PLAN AND PROFILE

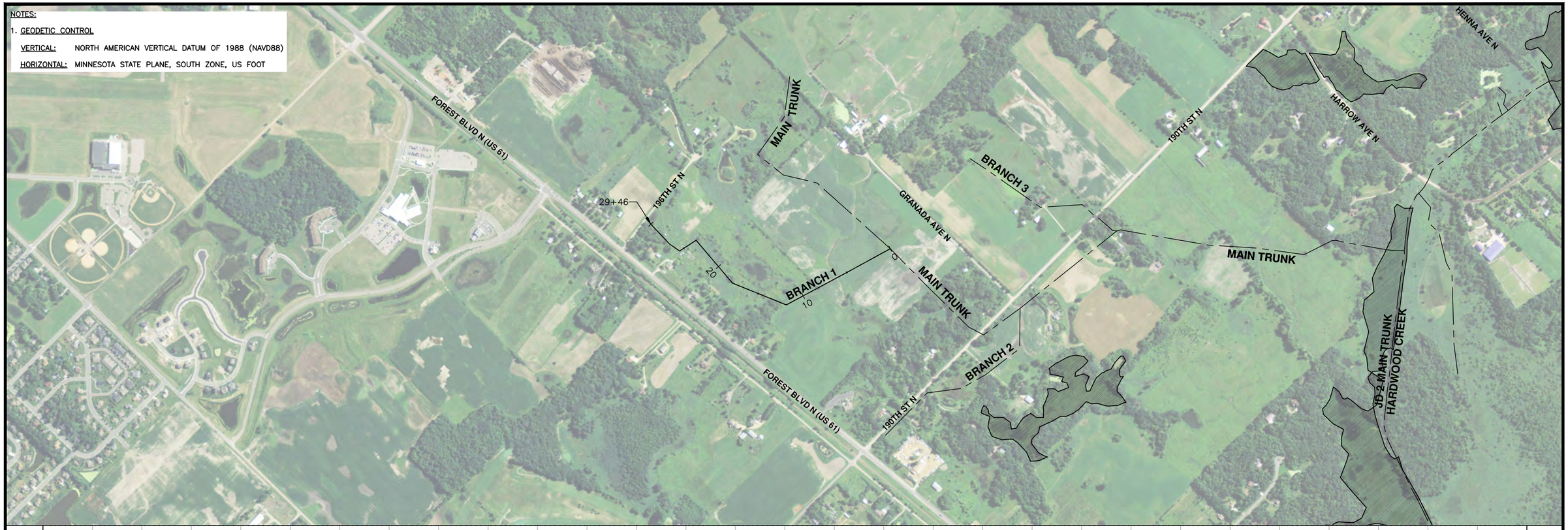
PROJECT NO. 5555-233

NOTES:

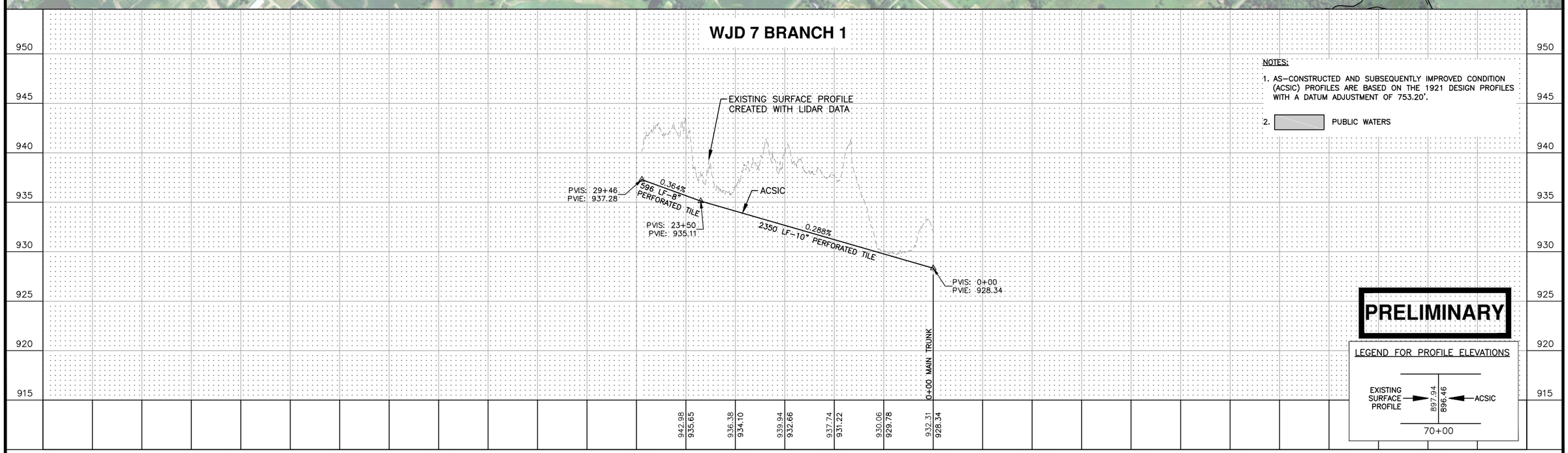
1. GEODETIC CONTROL

VERTICAL: NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

HORIZONTAL: MINNESOTA STATE PLANE, SOUTH ZONE, US FOOT



WJD 7 BRANCH 1



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2. PUBLIC WATERS

PRELIMINARY

LEGEND FOR PROFILE ELEVATIONS

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Signature:_____ Date: 1-8-2015

Printed Name: Nancy A. Stowe License #: 48259

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Maple Grove

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F: 763.493.5572

Drawn by	Date
DJL	1-8-15
Checked by	Scale
GM, NAS	AS SHOWN

FIGURE 17
AS-CONSTRUCTED AND SUBSEQUENTLY IMPROVED CONDITION
RICE CREEK WATERSHED DISTRICT
FOREST LAKE, MINNESOTA

WJD 7 BRANCH 1
PLAN AND PROFILE
PROJECT NO. 5555-233

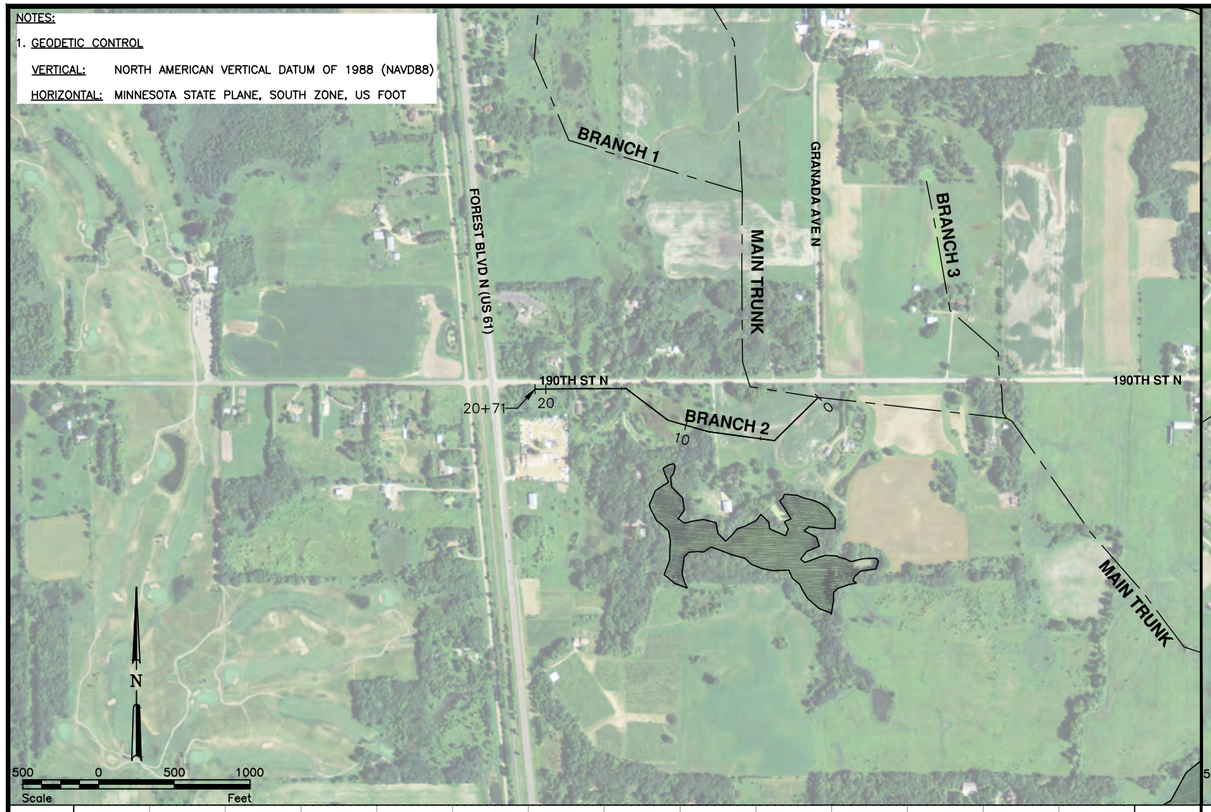
SHEET
1 of 1

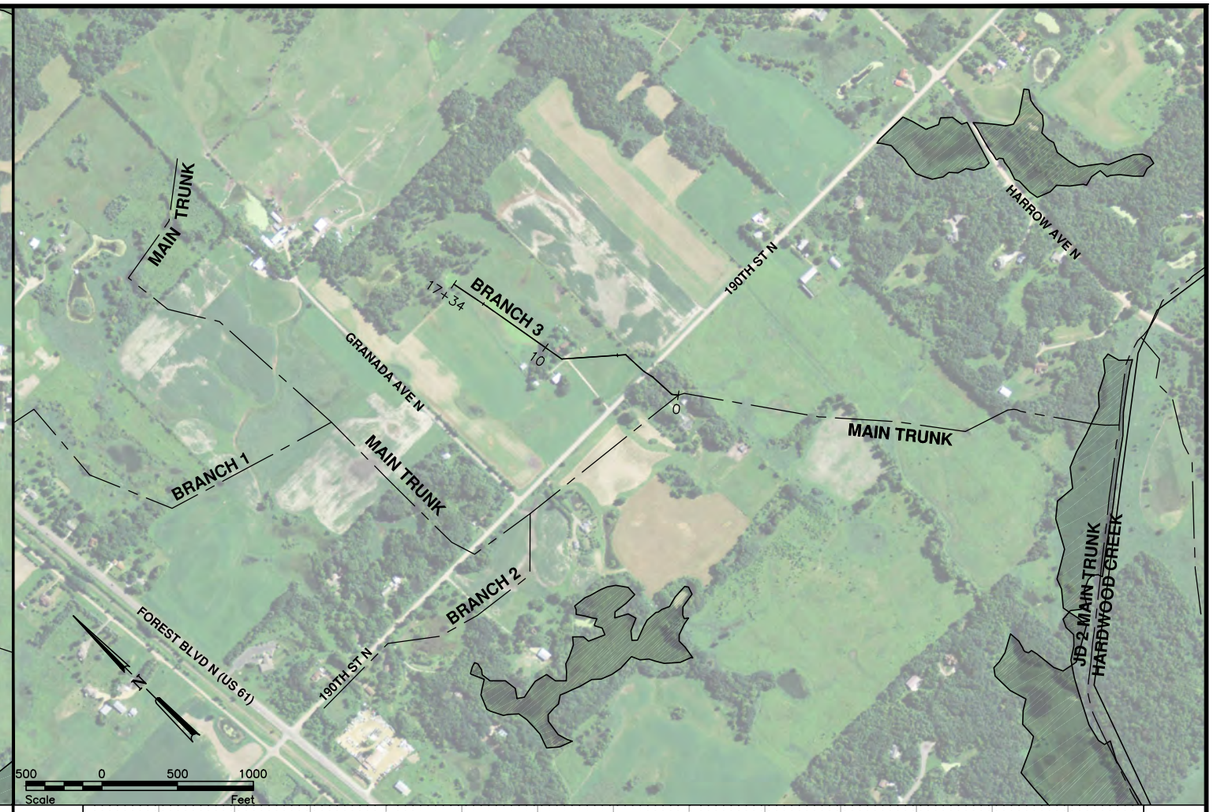
NOTES:

1. GEODETIC CONTROL

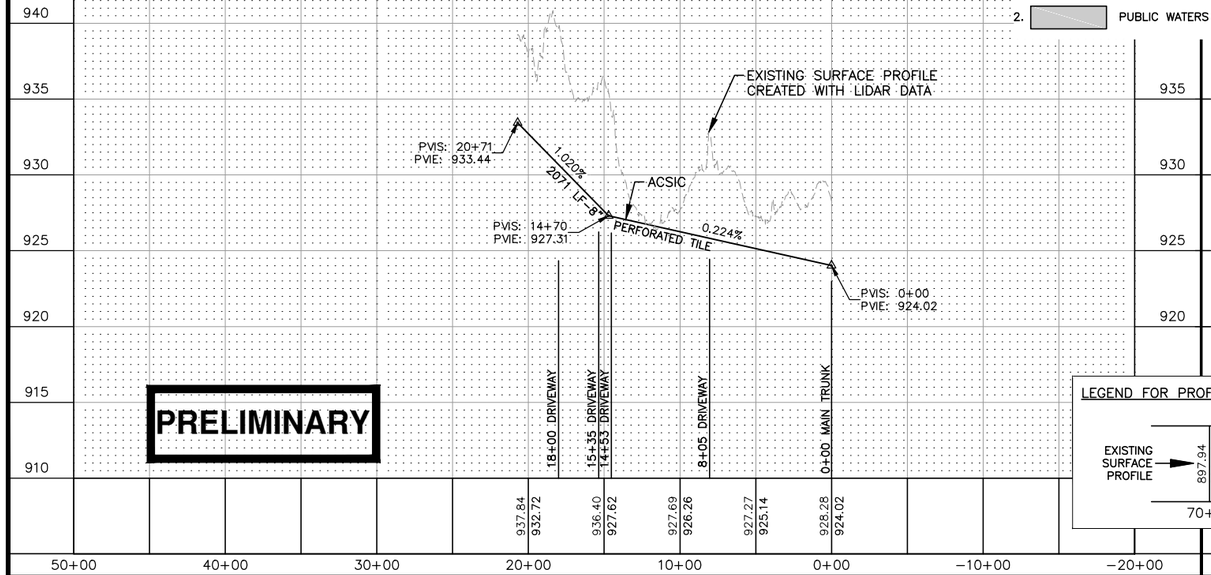
VERTICAL: NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

HORIZONTAL: MINNESOTA STATE PLANE, SOUTH ZONE, US FOOT





WJD 7 BRANCH 2



PRELIMINARY

NOTES:

1. AS-CONSTRUCTED AND SUBSEQUENTLY IMPROVED CONDITION (ACSIC) PROFILES ARE BASED ON THE 1921 DESIGN PROFILES WITH A DATUM ADJUSTMENT OF 753.20'.

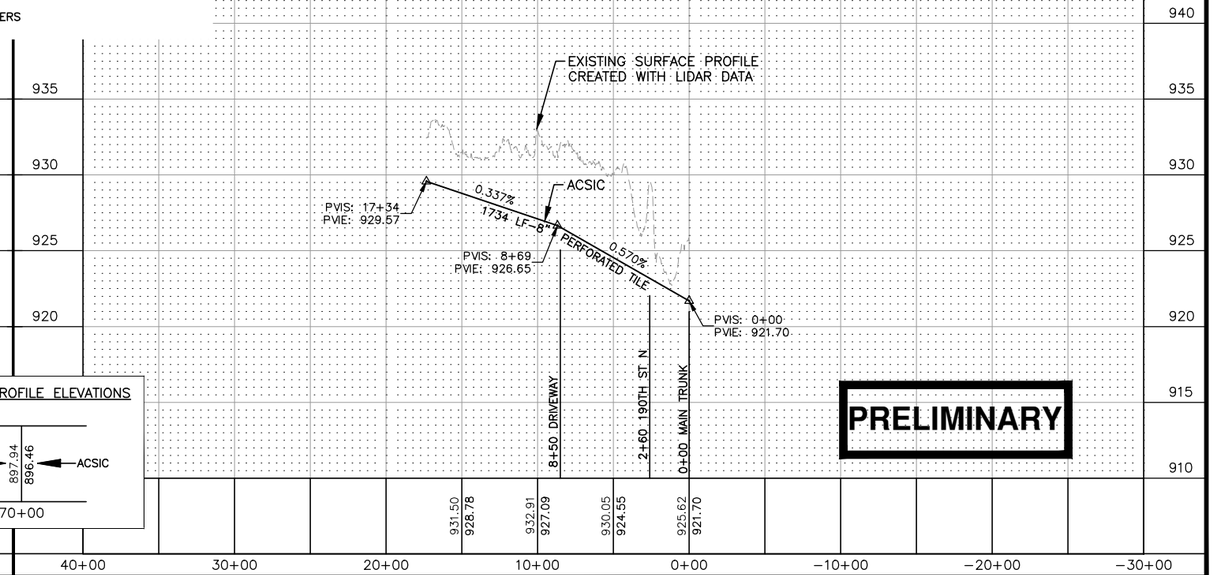
2. PUBLIC WATERS

LEGEND FOR PROFILE ELEVATIONS

EXISTING SURFACE PROFILE 897.94 996.46 ACSIC

70+00

WJD 7 BRANCH 3



PRELIMINARY

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Signature: _____ Date: 1-8-2015

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Maple Grove

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Drawn by	Date
DJL	1-8-15
Checked by	Scale
GM, NAS	AS SHOWN

FIGURE 18
AS-CONSTRUCTED AND SUBSEQUENTLY IMPROVED CONDITION
RICE CREEK WATERSHED DISTRICT
FOREST LAKE, MINNESOTA

WJD 7 BRANCH 2 & BRANCH 3
PLAN AND PROFILE
PROJECT NO. 5555-233

SHEET
1 of 1