Memorandum

To: Michael Grochala, Lino Lakes Community Development Director
Phil Belfiori, VLAWMO Administrator
Diane Hankee, Lino Lakes City Engineer

From: Earth Evans, PE, Director of Water Resources
Tom Hoffman, Engineering Technician
Henry Meeker, EIT

Date: August 10, 2023

Re: Amelia Ditch Study
WSB Project No. 020018-000

EXECUTIVE SUMMARY

The Amelia Lake Ditch study was conducted with the goal of analyzing existing drainage conditions and proposing drainage improvements to the ditch draining to Lake Amelia within the City of Lino Lakes and the Vadnais Lake Area Water Management Organization (VLAWMO). The ditch has known flooding and other stormwater concerns in existing conditions. While these have been addressed in the past with localized private and public projects, the City aims to understand the problems along the entirety of the ditch and find solutions that best serve the surrounding properties

Based on the existing concerns and anticipated future changes to the area, two phases of work are recommended. The short-term phase would consist of conveyance improvements to the section of the ditch currently causing the most problems for landowners. The long-term phase proposes more holistic improvements to the corridor that would occur alongside its eventual development.

HISTORICAL BACKGROUND

Based on the ditch alignment and surrounding topography, all signs indicate this was a constructed channel, not a natural stream. It is likely that the ditch was built and further expanded or modified based on agricultural needs in the surrounding areas. Where it is not serving direct surface flow drainage, the ditch also receives drain tile flows to aid in managing groundwater levels for nearby fields. This is supported by the broken remnants of a clay drain tile pipe found in the ditch during survey.

All evidence indicates that this is and always has been a private ditch. No easement or maintenance records have been found supporting public ownership or management of the ditch. Maintenance has been conducted on a piecemeal basis depending on the needs and concerns of property owners along the ditch.

Historical aerial images of the ditch have been found that date back to 1938. This oldest imagery appears to show the ditch with a slightly different and smaller alignment. However, certain stretches appear to be consistent with the current location. Imagery from 1957 shows the ditch with its current alignment. It appears much of the work bringing the ditch to its current condition occurred around this time. The spoil piles on either side of the channel appear in sharp relief and with minimal vegetation cover. Later historical aerials show little changes to the ditch besides increased vegetation and development of I-35E and residential properties.

EXISTING CONDITIONS

The ditch to Lake Amelia serves a 255-acre drainage area, primarily consisting of agricultural and lightly developed residential areas. See the Existing Conditions Map in **Appendix A** for these drainage areas and **Appendix B** for modeled high water levels (HWLs) and peak flows. **Table 1** below and the Parcels Map of **Appendix A** summarize the properties that cover this study area. Flows to the ditch originate in wetland complexes east of I-35E that collect runoff primarily from grassed and forest cover, with some roadway and residential impervious cover. These basins outlet via storm sewer running under I-35E to the two most upstream branches of the ditch.

Property Address	Parcel ID(s)	Property Owner	Culvert
6518 20th Ave	253122310003 253122320001 253122330001	Frances Burque	A & B
1926 Birch St	263122410002	Farrell Properties LLC	N/A
6483 20th Ave	263122440003	Judith Knabe	D
6443 20th Ave	263122440005	Michael Kriegler	N/A
6433 20th Ave	263122440004	Mathew and Mary Vesel	E
1826 Birch St	263122430001 353122120001	James Cardinal Andrew Cardinal Jr	F

The northern branch of the ditch is in an agricultural area, within drainage areas 3, 4, and 5. There are two small basins on its upstream end that seem to empty in drier periods of the year. Between these basins is Culvert A that appears to have filled with sediment and likely does not provide any significant flows. The ditch section is less defined in this area, with widths varying from 10-20 feet and depths typically around 1-3 feet. The channel is dry much of the year, only seeing consistent water in the spring and around rainfall events. Outside of the channel is largely flat, HWLs are very likely to spill out from the channel and into the surrounding fields.

The southern branch of the ditch is also in an agricultural area, within drainage areas 7 and 8. There is a small basin on its upstream end that seems to empty in drier periods of the year. Culvert B runs below a driveway but similar to Culvert A, it appears to have filled with sediment and likely does not provide any significant flows. The upstream ditch section is roughly 20 feet wide and 2-3 feet deep. Downstream of the driveway crossing, the ditch section narrows to 10-15 feet wide and depths decrease to 1-2 feet. The channel is dry much of the year, only seeing consistent water in the spring and around rainfall events.

These branches converge roughly 300 feet east of 20th Ave, still in an agricultural area. The ditch section here is 20-25 feet wide and about 1 foot deep, with the exception of the pool just east of 20th Ave where the bottom is roughly 6 feet deep. There is a small channel running south to north that also drains into the ditch. Besides the pool, the channel is dry much of the year, only seeing consistent water in the spring and around rainfall events. The space outside the channel is largely flat and there are known flooding concerns in the area.

The ditch crosses below 20th Ave via Culvert C, a 30” RCP. This culvert is well below much of the surrounding ground elevations, but above the bottom elevations of the pools on either side.

Culvert C is likely submerged year-round except during very dry conditions, as such, the condition of this pipe could not be verified during the survey. Modeling does not indicate that HWLs reach a point that the road overtops, even in the 100-year event.

West of 20th Ave, the ditch turns to the southwest and follows a straight alignment through agricultural land. There is a fair degree of accumulated sediment downstream of the pool off Culvert C that settles from larger washout events. The ditch section is well defined here, with a width of 25 feet and depths of 3-5 feet. The channel appears to be inconsistently dry, likely depending more on downstream water levels. Outside of the channel is largely flat, HWLs are likely to spill out from the channel and into the surrounding fields. This ditch section drains through Culvert D on the 6483 20th Ave property. This culvert is 24” CPP with positive drainage, flowing beneath an access path on the property between the eastern and western sides of the ditch.

Downstream of Culvert D, the ditch flows through a grassed and lightly forested area in a well-defined channel with spoils piled on either side. The channel section is 25-35 feet wide and 4-6 feet deep. There is a small tributary ditch north of the property line between 6443 and 6483 20th Ave that runs west to east into the channel that has formed a significant sediment delta, likely impeding flows upstream. The ditch likely has water in this section year-round due to poor downstream drainage. Modeled high water levels are contained in the channel with the exception of a small inundation area in the 6483 20th Ave property. This section of ditch drains through Culvert E on the 6433 20th Ave property. This culvert is 36” CPP that is back sloped and installed above an old culvert that was left in place. As such, Culvert E is higher than the others in the ditch and likely impounds water upstream.

Through the 6483 20th Ave property, the ditch flows in grassed and lightly forested areas in a well-defined channel that has spoils piled on its north side. The channel section is 30-35 feet wide and 5-6 feet deep. Through the 1826 Birch St property, the ditch flows through more agricultural land, although there are some trees lining the channel. The channel section there is 30-40 feet wide and 4-5 feet deep, with flatter topography to the south that floods based on modeled HWLs. Both of these ditch sections likely have water year-round due to the poor condition of the Culvert F and tailwater effects from Lake Amelia. This culvert is a 30” CMP that is in poor condition. The middle of the pipe is heaved upwards, impounding water upstream. Additionally, water was observed flowing beneath the pipe, indicating the potential for Culvert F to wash out in the event of major flows through the ditch.

Downstream of Culvert F, there is a section of ditch that eventually blends into Lake Amelia. The channel is roughly 40 feet wide and 3-5 feet deep where it is still defined as a ditch between agricultural fields. For the sake of this study, the end of the ditch was defined at the boundary between the fields and wetlands surrounding the lake. The water level in this section is functionally hydrostatic with the lake based on its profile and proximity.

In existing conditions, there are known drainage concerns with the low-lying fields around ditch near its crossing of 20th Ave. While a fair amount of these HWLs can be attributed to the very flat nature of the ditch, the problems are exacerbated by sediment loading in the channel and culverts that are too high or in poor condition. The entirety of the ditch is shown as FEMA Zone A floodplain with no flood elevation; however, Lake Amelia has a mapped flood elevation of 910.2. In addition, there are currently no easements over the ditch which has led to confusion around which parties are responsible for its maintenance or impacts to upstream properties when changes are made.

PROPOSED CONDITIONS

Improvements to the ditch are recommended to alleviate drainage problems and more efficiently convey flows. These recommended improvements generally fall into two categories, short-term and long-term. Short-term work is recommended within the next year or two and would consist of less significant work that would provide benefits to ditch conveyance with the goal of reducing flooding and ponded water. Long-term work is recommended with the eventual development of the area. This work would consist more of floodplain storage, BMP construction, and ditch realignment/meandering with the goal of floodplain and water quality improvements. This long-term work would likely come from the City as a recommended concept plan that would then be brought into final design and construction by a developer of the area.

Short-Term Work

The majority of proposed short-term improvements would consist of earthwork within and adjacent to the ditch channel, as shown in the Proposed Conditions Map of **Appendix A**. This work will be limited to the ditch alignment between 20th Ave and Culvert F. The City would obtain easements along the ditch to conduct the work and allow for future maintenance. Excavation is recommended to remove accumulated sediment from upstream loading, channel bed and bank scour, and settling around culverts. Much of this excavation would be within the top foot of the ditch bottom, up to 2 feet where more sediment has accumulated. The main intent of earthwork on the bottom of the channel is to provide a more consistent slope through the ditch. This would increase conveyance and reduce future sediment settling.

Through much of the residential property (6433, 6443, and 6484 20th Ave), the channel slopes are sparsely vegetated and often steeper than 3:1. The proposed earthwork would bring these slopes to 3:1 at most in order to improve stability and reduce sediment loading from bank erosion. Decreasing these slopes would also slightly widen the channel section, further increasing conveyance capacity of the ditch and reducing flood levels. This earthwork on the banks would only expand the channel footprint into the existing spoil piles and not impact the usable lawn areas observed during survey.

This earthwork would also involve vegetation management. In areas not farmed, most of the vegetation observed during survey were lower quality trees and scrub along the banks of the ditch. During earthwork, many of these trees will need to be removed. This will provide an opportunity to replant with native grasses and other vegetation that is more resistant to erosion. Removal of trees will also bring more sunlight to the channel, further improving the uptake of new seeding. This proposed new vegetation would provide more consistent soil cover, stabilizing the banks and reducing sediment loading to the ditch.

Another major component of the short-term work would be replacement of Culvert F. The pipe is recommended to be replaced with a 36” RCP with flared end sections instead of the existing 30” CMP. This replaced culvert would be placed lower to ensure it is not impounding water upstream like it currently does. Additionally, a properly bedded RCP will be more resistant to washing out unlike the risk posed to the current pipe. There is also potential to reseat the back sloped Culvert E as part of this project, but that is not a major priority since it was installed recently and seems to be functioning well.

There is also an opportunity to excavate a small settling basin upstream of Culvert F. This would serve to provide additional settling and pollutant removals before the discharge to Lake Amelia. Expansion to the west would impact upland agricultural area and not require wetland impacts. As this basin would be relatively small with respect to the remaining floodplain and proposed channel excavation, it is not anticipated to impact flood levels in any appreciable manner. Approximately 700 cubic yards of excavation would be needed to create this basin, with an estimated cost of $21,000.

The modeling results presented in **Appendix B** show the drainage improvements expected as a result of this work. Since the short-term work takes place downstream of the 20th Ave road crossing, that's where the majority of the modeled drainage improvements are shown. Within DA 11, the modeled 100-year HWL drops approximately 0.5' from existing conditions due to increased downstream conveyance. This HWL decrease goes up to 3.4' upstream of Culvert F. This pattern is reflected by the increased max flow rates in these same drainage areas. Modest increases from existing flows are shown for areas upstream of Culvert E, while major flow increases are seen leading up to and including the proposed replaced culvert. This will all serve to improve conveyance in the ditch and reduce water levels in major rain events.

While the proposed modeling shows increased flow rates to Lake Amelia, adverse impacts are not anticipated to the lake's hydrology or ecosystem. The ditch is proposed to be restored to as-built conditions, not a major rework of the channel. Much of the increase in flow capacity comes from improved ditch conveyance and replacing a failing culvert. These increased flows will not appreciably increase velocities into the lake due to the hundreds of feet of ditch downstream of the improvements attenuating flows. Additionally, the improved grading and stabilization will better dissipate energetic flow than in current conditions, reducing pollutant loading from erosive forces. This phase of the project is solely focused on conveyance of water to alleviate flooding concerns and does not propose to increase the volume of water reaching Lake Amelia in flood conditions. The increase in flow rates may slightly alter the lake's flood hydrograph, but relative to the rest of the lake's tributary area it is unlikely to increase high water levels.

The majority of work in the short-term would consist of grading the ditch to improve conveyance, clearing nuisance vegetative canopy to encourage understory growth, and the replacement of Culvert F. In all, this work is estimated to cost $252,500 to complete. This cost includes a 30% contingency factor to account for potential changes to ditch conditions prior to work beginning. The estimate does not account for any potential costs for easement acquisition, if they are needed. A detailed breakdown of this estimate can be found in Appendix C.

Long-Term Work

As opposed to the short-term improvements, the long-term work is proposed for the current agricultural areas along the ditch. These properties, namely the 6518 20th Ave and 1926 Birch St parcels, are anticipated to develop into single family residential housing in the next 10-20 years. Development of these properties is currently limited by the lack of sanitary sewers. It is expected that the extension of the sewer from the west will drive development of these parcels. For development, the City could require out lots and easements along the existing ditch alignment to construct these more significant improvements. Alternatively, the City would still request the out lots, but instead recommend these improvements and the developments would take them into consideration for their requisite stormwater management facilities.

With this larger project, the ditch alignment would be proposed to meander similar to a natural stream, as opposed to the current sharp turns and straight channel sections. This meandering portion would have a wider and more gently sloped channel section. The ditch would have improved ecological value as the meander provides a variety of flow conditions and water depths for plant and animal life. In addition, a meandering alignment improves the aesthetics and recreational value of the area. With the potential trail extending through the area from the west, this region could serve as a greenway space for the City.

Another component of the long-term work would be floodplain management in the area. With the known flooding concerns and FEMA floodplain designation, it is evident that the area surrounding the ditch would be well served by increased flood storage capacity. This capacity would come in the form of large basins adjacent to the ditch. In major storm events, the channel would overtop its banks and flow into these basins. This increased storage will reduce flooding concerns for the existing properties downstream, as well as slightly ease flood levels within Lake Amelia.

These basins would also provide ecological value and water quality treatment. Depending on the proposed planting and hydrologic regimes, the basins may be restored to different wetland types. Based on how much of the area is delineated as wetland, these restored wetlands would offset any impacts from development or increase their footprint. Similar to the proposed basins on the Shenandoah Improvement Project, these would be proposed to draw down via evapotranspiration or very slow groundwater infiltration. This abstracted runoff would result in a significant degree of pollutant removals from Lake Amelia as well as provide dynamic habitats for plant and animal life.

For more direct water quality treatment, biofiltration BMPs are proposed on further upstream areas where there is sufficient elevation difference. Soil information indicates in situ soils are conducive to filtration when provided an underdrain. As such, biofiltration basins could be constructed offline from the ditch alignment at minimal cost. These basins would not serve as significant floodplain or ecological value but would further increase pollutant removals.

Significant drainage improvements are seen in the modeling as a result of this proposed work, as summarized in **Appendix B**. Due to impounded flows in the proposed biofiltration basins, HWLs are increased slightly in the drainage areas upstream of them. However, these are not areas with drainage concerns, increased HWLs will not cause major flood area increases. There are HWL decreases of 1.1’ in DA 5 and DA 9 because of the increased storage proposed in the wetlands alongside the ditch channel. Further downstream, HWLs drop more, up to 2.7’. This is both an effect of the ditch cleanout in the short-term and an anticipated replacement of Culvert E in the medium- to long-term. Additionally, flow rates increase significantly across the site, especially around the culverts that would be replaced. Some flow rates were modeled to decrease near the biofiltration basins and wetlands due to changes in flood storage, but overall, the system will allow for greater flows.

This long-term work includes many more benefits to the tributary area to the lake but comes at an increased cost compared to the short-term improvements. The total estimated cost for the work is $1.71 million, plus an additional $150,000 in wetland maintenance and monitoring over the 5 years following the project. The majority of these costs are anticipated from the large volumes of earthwork required to create the wetland and filtration basins. Additional costs come from storm sewer required for the BMPs and the required seeding over the large area of disturbance. This cost includes a 30% contingency factor to account for potential changes between this concept and future design implementation. It should be noted that this estimate is unlikely to be accurate by the time major development is occurring in the area and will need to be revised to reflect updated costs in the future The estimate does not account for any potential costs for easement or property acquisition for the stormwater features. A detailed breakdown of this estimate can be found in Appendix C.

WATER QUALITY MONITORING

Water quality samples were collected monthly within Lake Amelia and the ditch to Lake Amelia from May through August 2022. See the Water Quality Sampling Location map found in **Appendix A**. Data was collected to understand the existing water quality and how the water from the ditch may affect Lake Amelia’s water quality. Samples were analyzed for total phosphorus, orthophosphate, and total suspended solids. Results can be seen in **Figures 1-3** below.

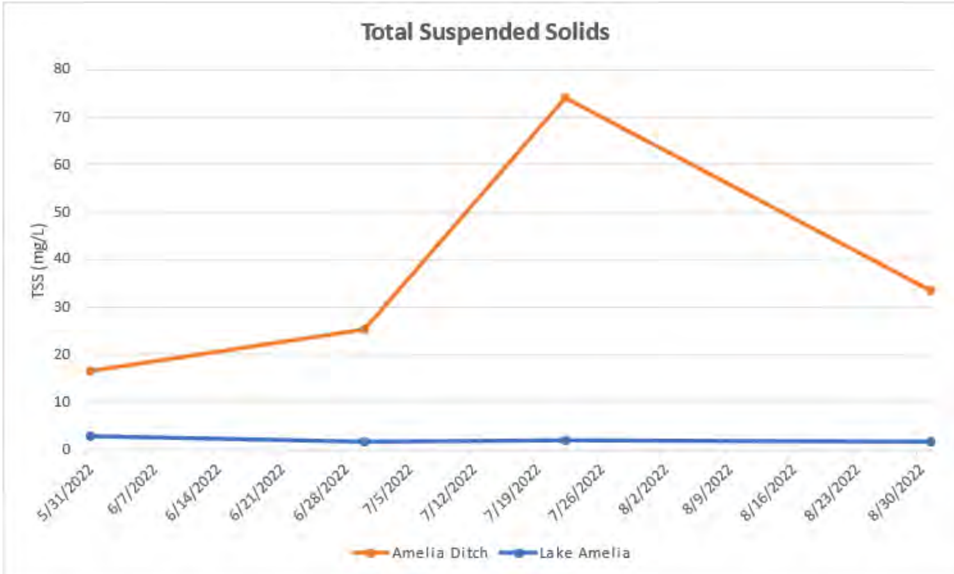


Figure 1: TSS Results

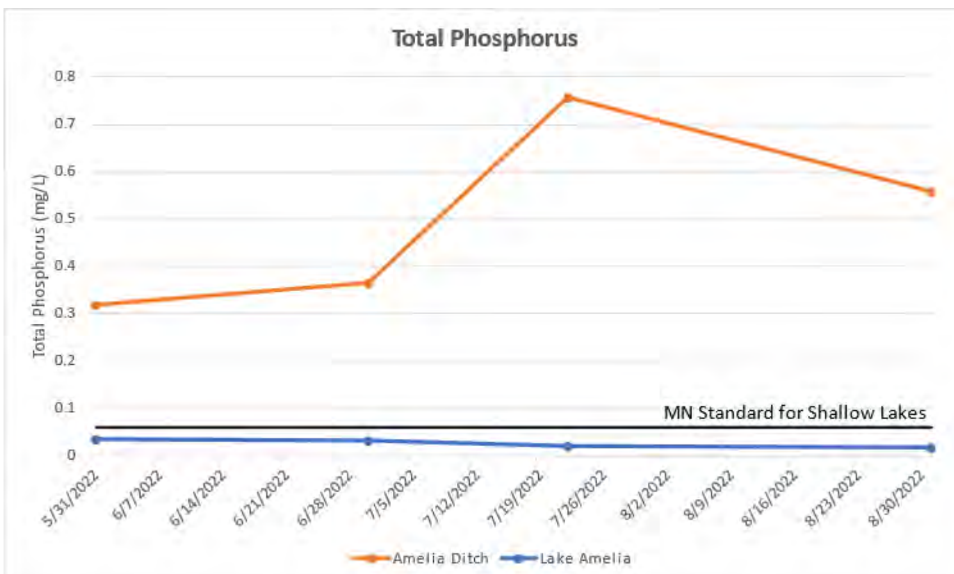


Figure 2: TP Results

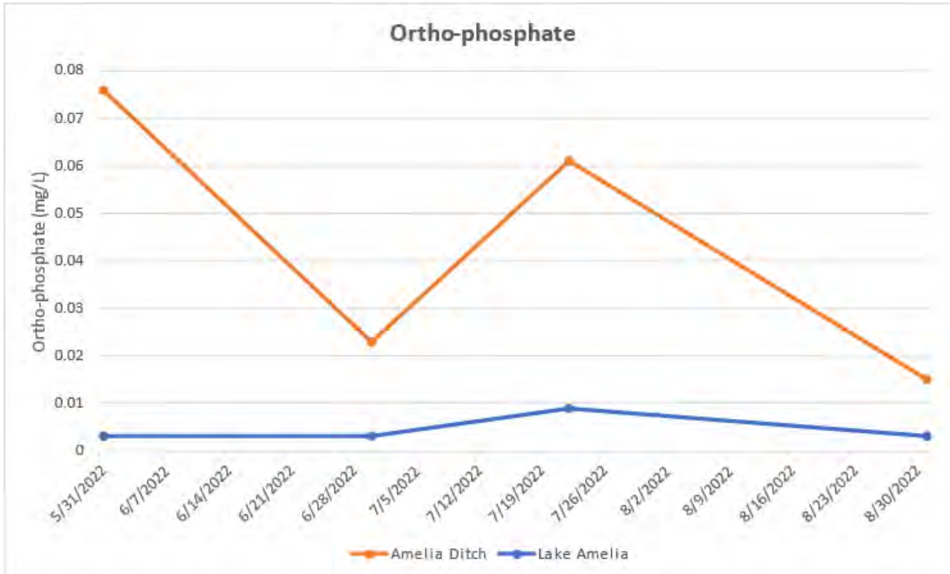


Figure 3: OP Results

Results show Lake Amelia having steady water quality throughout the 2022 season. Total phosphorus levels within the lake were below the state standards for shallow lakes. During sampling events it was noted that the lake was visually clear to the bottom and is heavily vegetated. Overall, the TSS, TP, and OP concentrations are much lower in the lake compared to the ditch. The drought conditions in 2022 provided very low to no flow within the ditch. No visible flow was observed while sampling. Sampling at times of flow would provide better understanding on sediment and nutrient transport into the lake. Increased pollutant loading in the ditch could contribute to an increase of pollutants entering Lake Amelia during large rain events. Dredging existing sediment deltas and stabilizing erosion within the ditch would limit the amount of TP and TSS that would be able to reach the lake.

PERMITTING

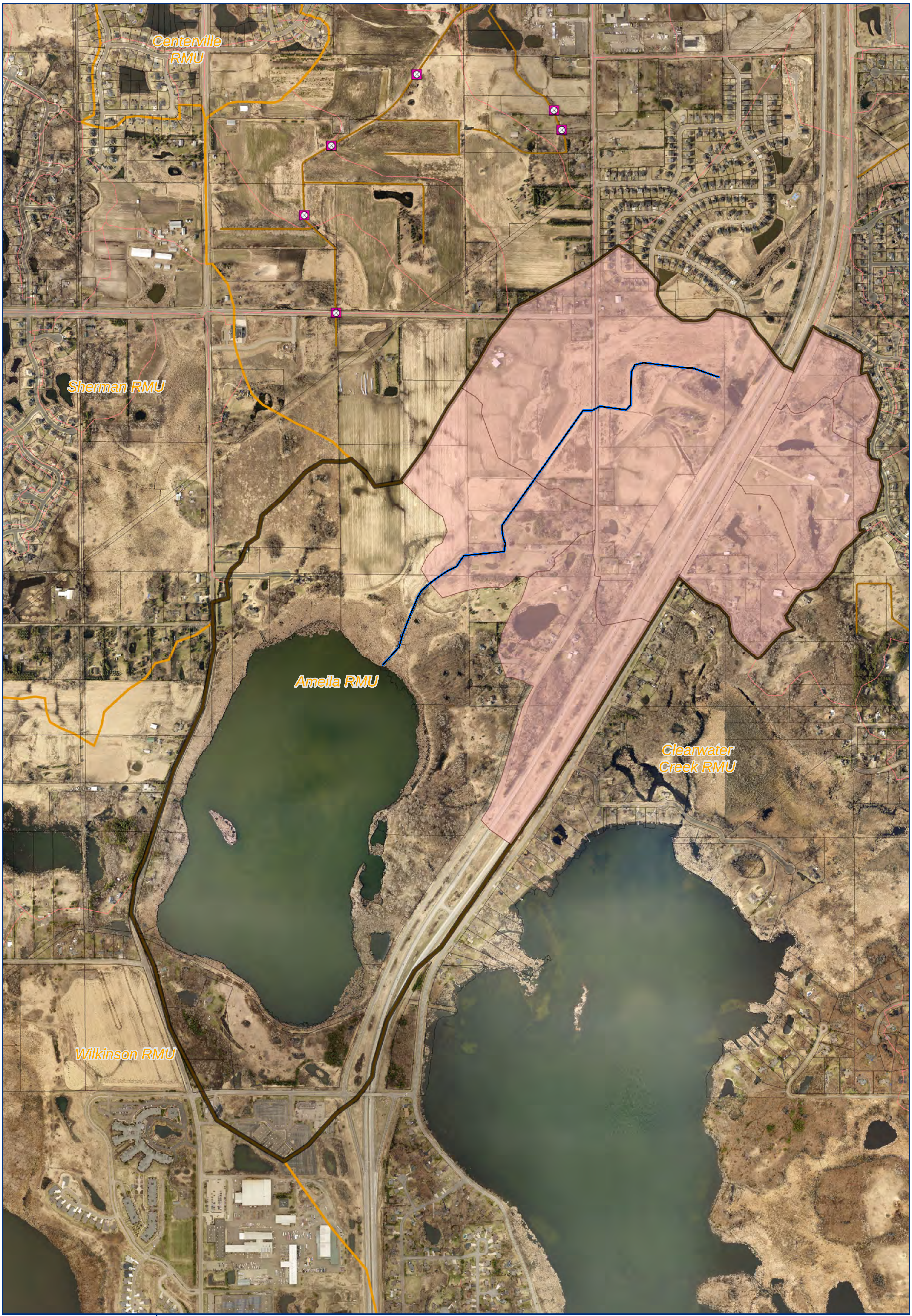
As this work takes place in a ditch draining wetlands to a public water, local, state, and federal permitting will be needed. VLAWMO is the LGU for the Wetland Conservation Act (WCA) and the City of Lino Lakes regulates stormwater management. As this project has been undertaken collaboratively with VLAWMO, communication will continue regarding the required regulations that must be followed for any proposed work.

WCA compliance must be demonstrated for work on drainage systems such as this ditch. Short-term work will consist of maintenance of the ditch to its original capacity based on historical aerials and field visits. There are numerous wetlands around the ditch, however they have not been delineated as part of this phase. These wetlands have current or recent cropping history based on aerial imagery and field visits. Filling or excavation of wetlands not proposed as short-term work will be limited almost entirely to the ditch channel. The full maintenance history of the system is not known as it has been under private ownership; a full cleanout of the ditch has not been performed. Recent maintenance history includes culvert replacement at Culverts D and E by the City, plus evidence of past maintenance of Culvert F based on observations during a field visit. As the proposed long-term improvements will change the drainage system beyond its historical constructed conditions, more involved permitting will be required and factored into final design. Compliance will need to be demonstrated around ditch capacity expansion and excavation and filling of wetlands. Full WCA permitting will be completed as needed before construction for both short- and long-term ditch work.

Lake Amelia is listed as a Minnesota DNR public water (ID 02001400). As such, any work that is proposed within the lake must be permitted through the DNR. Based on preliminary conversations, it is anticipated that DNR regulated activity will be limited to any proposed work downstream of the hydrologic break line at Culvert F. There will be a small amount of earthwork proposed in this section of the ditch with the short-term improvements and as such, a DNR permit must be applied for. Additionally, the ditch is shown as a DNR stream in their online surface water viewer. However, this is a private ditch and has been for more than 50 years. Further coordination will be conducted with the DNR to determine its status as a public waters stream and how it may impact permitting requirements.

Per the US Army Corps of Engineers (USACE), wetlands that drain to a public water are considered within their permitting jurisdiction. Since this ditch is closely related to the formation and draining of its adjacent wetlands and flows to Lake Amelia, these wetlands would likely fall under USACE jurisdiction. As such, any work in the short- or long-term that may impact the hydrology of these wetlands will need to be permitted through the Corps in addition to WCA and the DNR. Much of the area is listed as FEMA floodplain. Therefore, any work that would significantly alter floodplain levels would need review. This would not apply with the proposed short-term work, but the long-term work would likely require federal permitting.

APPENDIX A: PROJECT MAPS



1 inch = 900 feet

Lake Amelia Subwatershed Study Area

City of Lino Lakes

Legend

- Private_Ditch
- Study Area
- Lake_Amelia_watershed

CITY OF LINO LAKES

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CITY OF LINO LAKES

Figure 1: Project Parcels

Amelia Ditch Drainage Study
City of Lino Lakes

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1 inch = 500 feet

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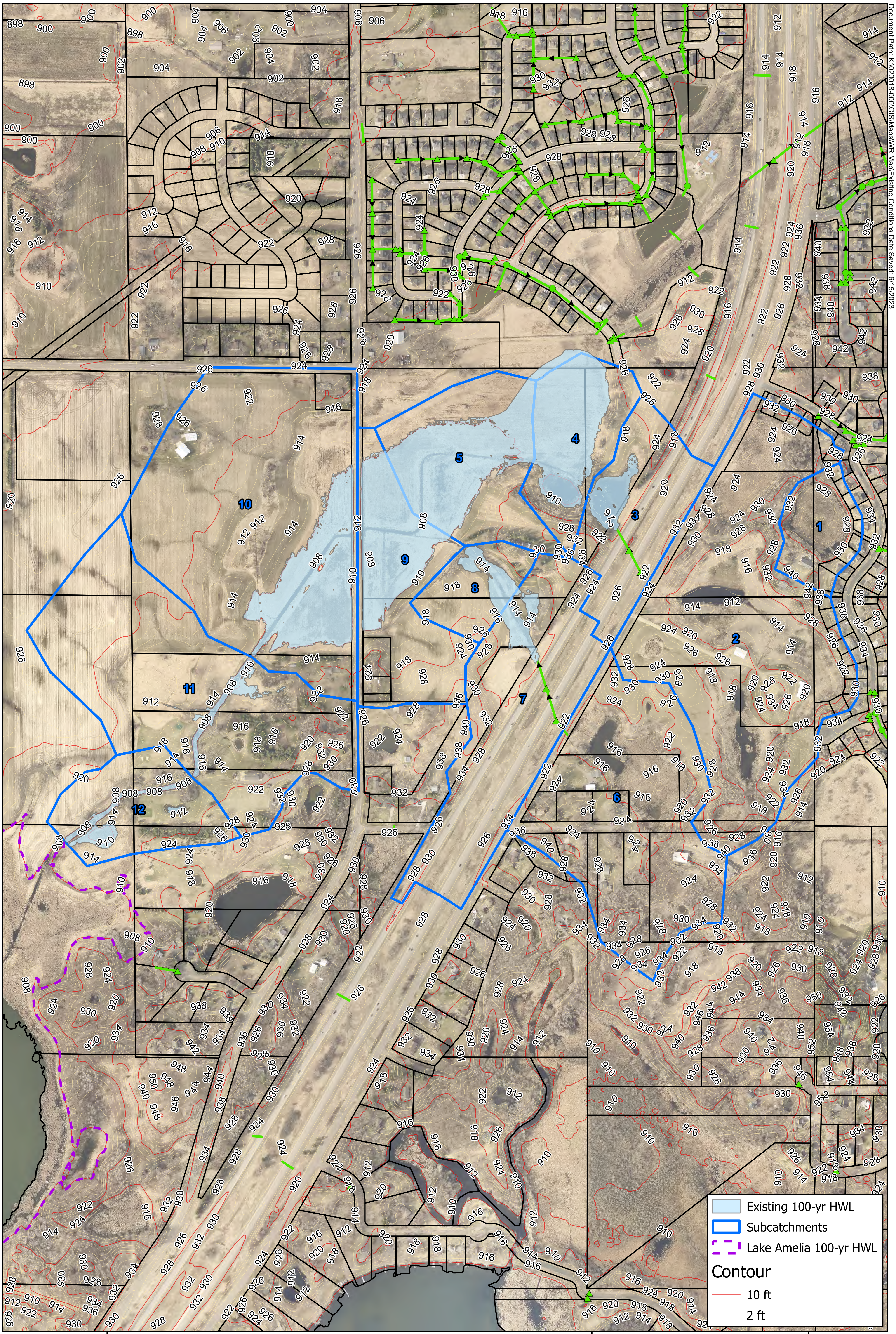

Figure 2: Existing Conditions

Amelia Ditch Drainage Study

City of Lino Lakes

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1 inch = 500 feet

CITY OF LINO LAKES

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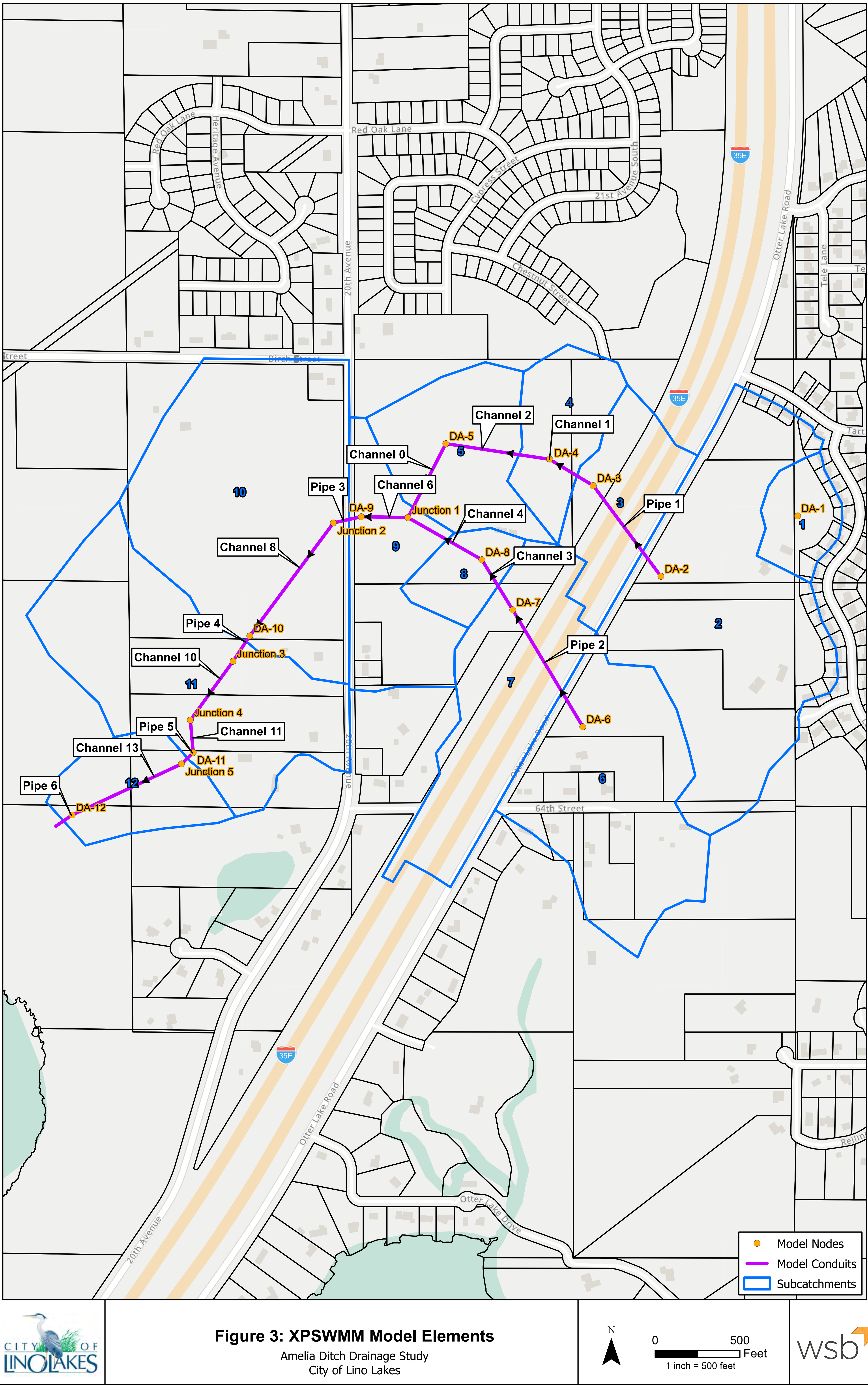
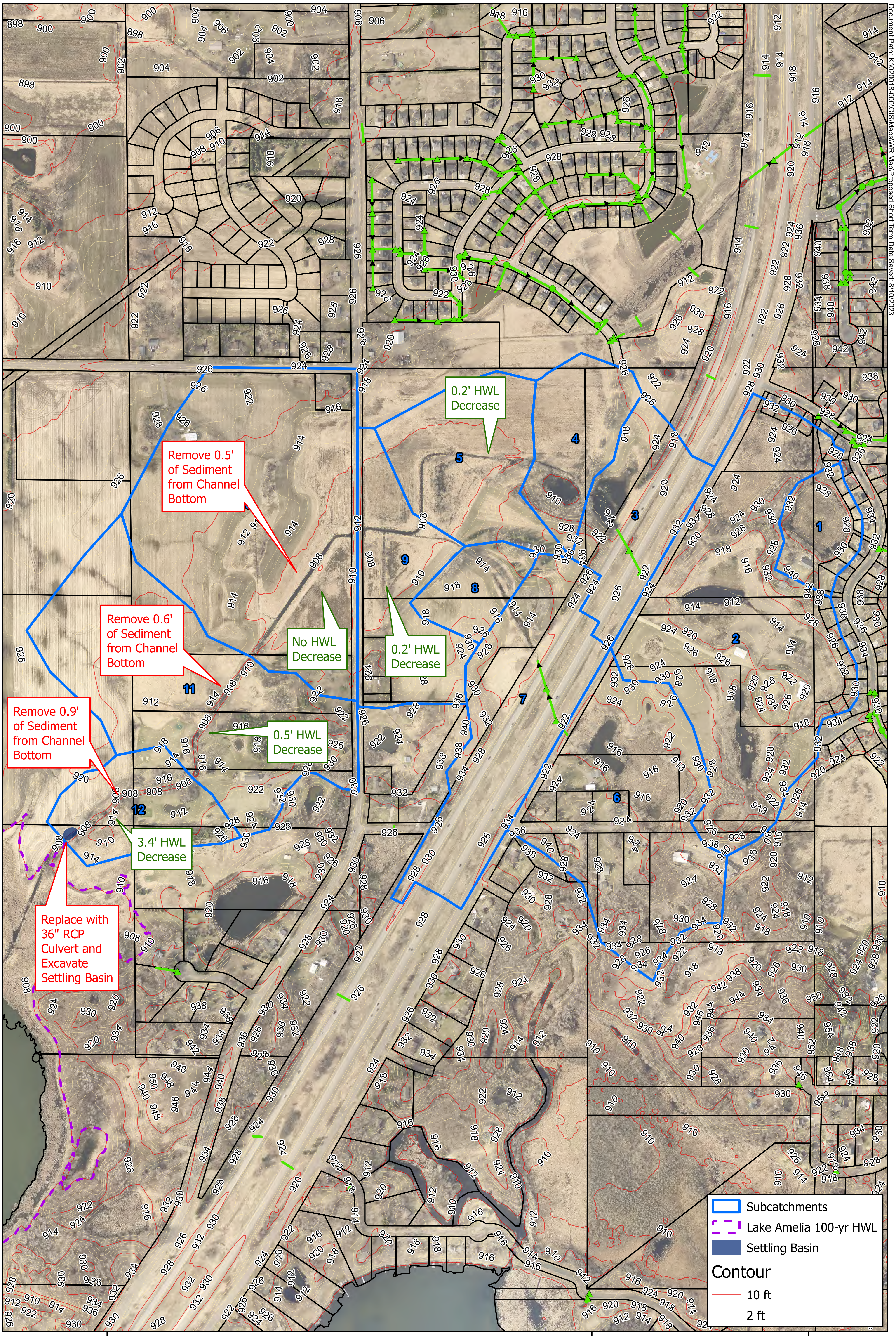


Figure 3: XPSWMM Model Elements

Amelia Ditch Drainage Study

City of Lino Lakes



CITY OF LINO LAKES

Figure 4: Proposed Conditions - Short-Term

Amelia Ditch Drainage Study

City of Lino Lakes

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1 inch = 500 feet

wsb

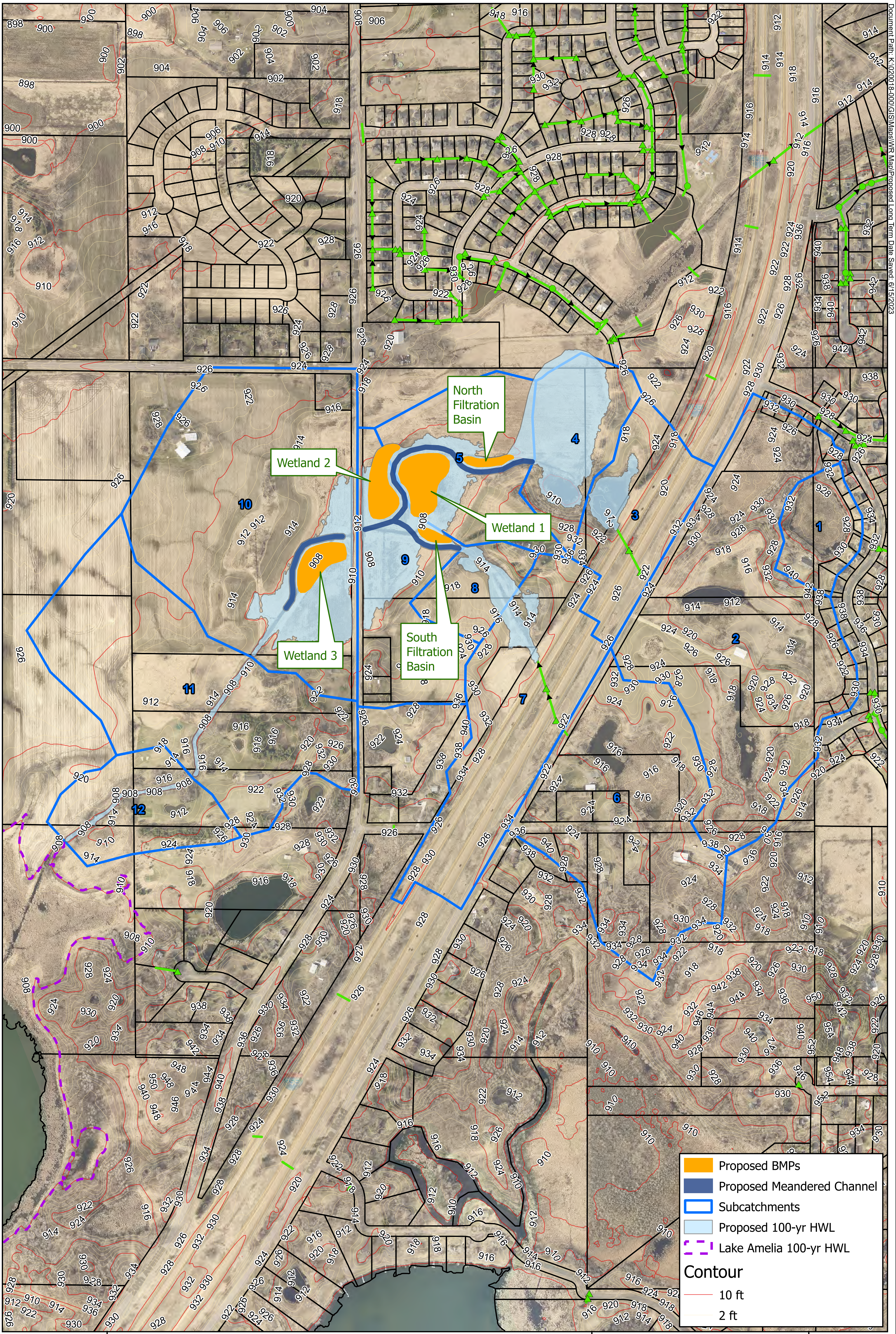

Figure 5: Proposed Conditions - Long-Term

Amelia Ditch Drainage Study

City of Lino Lakes

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0 500 Feet

1 inch = 500 feet

K:\020018-000\Graphics\020018-000 Amelia Ditch

Amelia Ditch Concept Plan

Lino Lakes, MN

July 21, 2023 | WSB Project number: 020018-000

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APPENDIX B: MODELING RESULTS

Table 1: Short-Term Improvements 100-yr HWL Comparison

Model Node	Existing HWL	Proposed HWL	Change
DA-1	928.79	928.79	0
DA-2	915.18	915.18	0
DA-3	913.81	913.81	0
DA-4	911.53	911.53	0
DA-5	910.19	910.02	-0.17
DA-6	916.43	916.43	0
DA-7	915.06	915.06	0
DA-8	915.02	915.02	0
Junction 1	910.19	910.02	-0.17
DA-9	910.19	910.02	-0.17
Junction 2	910.16	910.15	-0.01
DA-10	910.16	910.16	0
Junction 3	911.30	910.81	-0.51
Junction 4	911.30	910.81	-0.51
DA-11	911.30	910.81	-0.49
Junction 5	910.90	908.48	-2.42
DA-12	910.89	907.48	-3.41

Table 2: Short-Term Improvements Max Flow Comparison

Model Connection	Existing Max Flow (cfs)	Proposed Max Flow (cfs)	Change
Pipe 1	29.76	29.76	0
Channel 1	48.80	48.80	0
Channel 2	33.64	33.66	+0.02
Channel 0	14.61	18.08	+3.47
Pipe 2	12.53	12.53	0
Channel 3	80.50	80.51	+0.01
Channel 5	89.93	89.95	+0.02
Channel 6	22.29	26.85	+4.56
Pipe 3	16.13	20.89	+4.76
Channel 8	15.29	20.57	+5.28
Pipe 4	16.39	22.72	+6.33
Channel 10	16.44	22.92	+6.48
Channel 11	16.72	23.16	+6.44
Pipe 5	40.33	71.04	+30.71
Channel 13	39.19	71.17	+31.98
Pipe 6	44.19	104.10	+59.91

Table 3: Long-Term Improvements 100-yr HWL Comparison

Model Node	Existing HWL	Proposed HWL	Change
DA-1	928.79	928.79	0
DA-2	915.18	915.18	0
DA-3	913.81	913.81	0
DA-4	911.53	913.05	+1.53
DA-5	910.19	909.01	-1.18
DA-6	916.43	916.45	+0.02
DA-7	915.06	915.37	+0.31
DA-8	915.02	915.36	+0.34
Junction 1	910.19	909.06	-1.14
DA-9	910.19	909.06	-1.13
Junction 2	910.16	909.56	-0.60
DA-10	910.16	909.76	-0.40
Junction 3	911.30	909.47	-1.84
Junction 4	911.30	909.45	-1.85
DA-11	911.30	909.45	-1.86
Junction 5	910.90	908.58	-2.32
DA-12	910.89	908.13	-2.75

Table 4: Long-Term Improvements Max Flow Comparison

Model Connection	Existing Max Flow (cfs)	Proposed Max Flow (cfs)	Change
Pipe 1	29.76	30.07	+0.31
Channel 1	48.80	48.81	+0.01
Channel 2	33.64	169.28	+135.64
Channel 0	14.61	21.00	+6.39
Pipe 2	12.53	12.10	-0.43
Channel 3	80.50	51.68	-28.82
Channel 5	89.93	41.92	-48.01
Channel 6	22.29	20.44	-1.85
Pipe 3	16.13	22.47	+6.34
Channel 8	15.29	56.13	+40.84
Pipe 4	16.39	75.85	+59.46
Channel 10	16.44	76.94	+60.50
Channel 11	16.72	78.89	+62.17
Pipe 5	40.33	118.23	+77.90
Channel 13	39.19	119.36	+80.17
Pipe 6	44.19	141.03	+96.84

APPENDIX C: COST ESTIMATES

Cost Estimate - Short Term

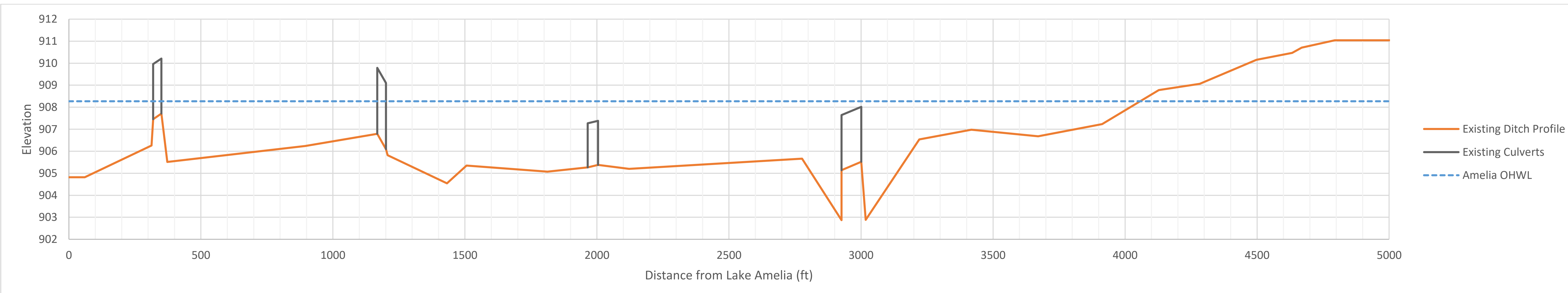
Description	Units	Contract Quantity	Unit Price	Total Price
MOBILIZATION	LS	1	$15,000	$15,000
CLEAR AND GRUB	LS	1	$25,000	$25,000
DEWATERING	LS	1	$20,000	$20,000
COMMON EXCAVATIONC	C Y	700	$30	$21,000
CHANNEL EXCAVATION	C Y	1500	$40.00	$60,000
RANDOM RIPRAP CL III	C Y	30	$120	$3,600
36" RCP	L F	31	$220	$6,820
36" RCP APRON	EACH	2	$3,200	$6,400
STABILIZED CONSTRUCTION ENTRANCE	EACH	1	$1,500	$1,500
FLOATING SILT CURTAIN	L F	20	$40	$800
EROSION CONTROL BLANKET	S Y	3500	$3	$10,500
WOOD FIBER BIOROLL	L F	5500	$3	$16,500
SEEDING	ACRE	1.5	$2,000	$3,000
SEED MIX 33-261	LB	55	$75	$4,125
			30% Contingency	$58,300
			Total:	**$252,500**

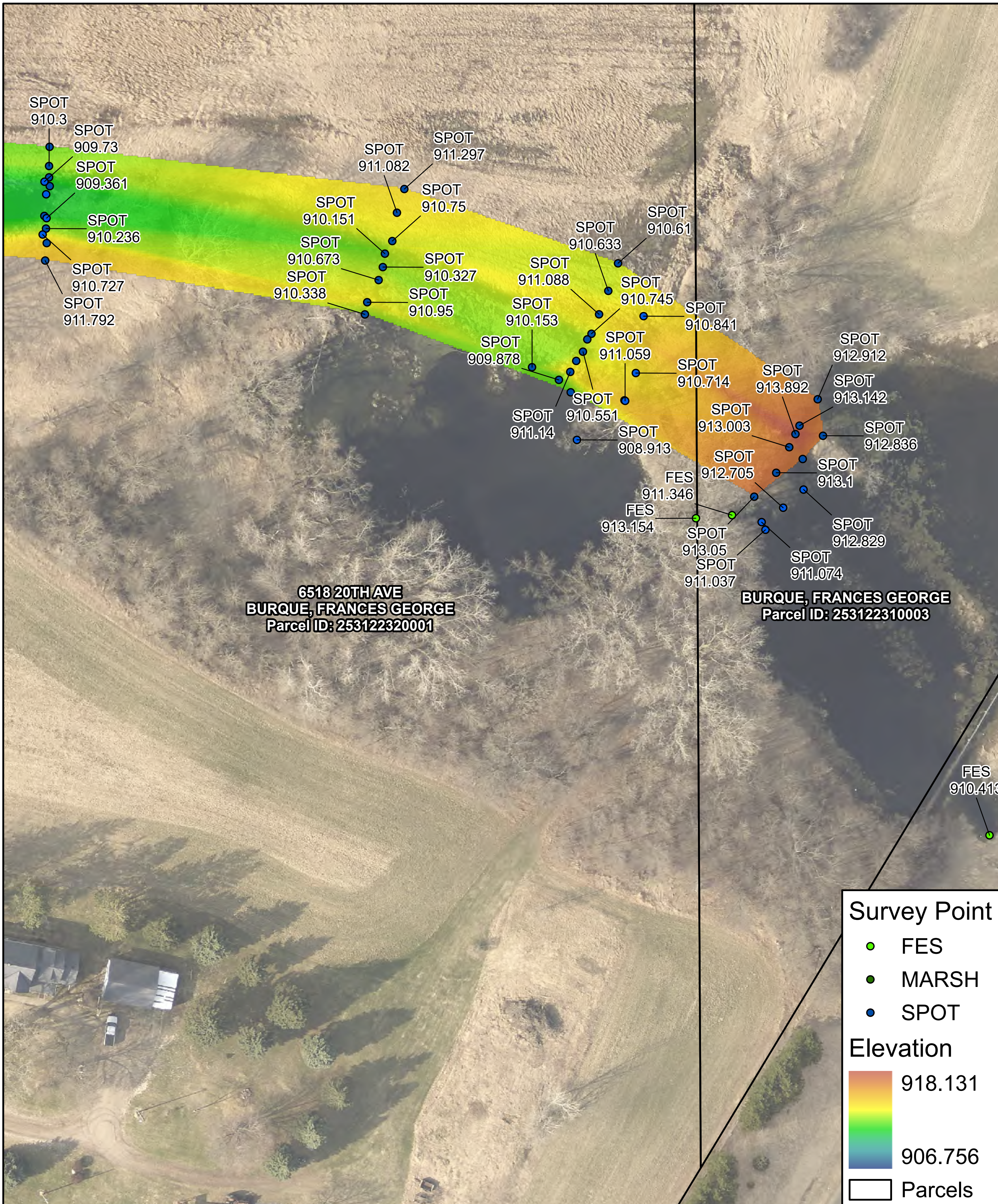
Cost Estimate - Long Term

Description	Units	Contract Quantity	Unit Price	Total Price
MOBILIZATION	LS	1	$150,000	$150,000
CLEAR AND GRUB	EACH	20	$1,000	$20,000
COMMON EXCAVATION	C Y	45000	$20	$900,000
COMMON EMBANKMENT	C Y	4500	$20	$90,000
RANDOM RIPRAP CL III	C Y	30	$120	$3,600
6" PERF HDPE PIPE	LF	860	$24	$20,640
6" PERF HDPE PIPE CLEANOUT	EACH	10	$500	$5,000
15" RCP	L F	75	$100	$7,500
15" RCP APRON	EACH	5	$1,500	$7,500
FLAP GATE/DUCKBILL VALVE	EACH	3	$3,000	$9,000
48" OCS	EACH	2	$10,000	$20,000
STABILIZED CONSTRUCTION ENTRANCE	EACH	1.00	$1,500	$1,500
FLOATING SILT CURTAIN	L F	20	$40	$800
EROSION CONTROL BLANKET	S Y	15000	$3	$45,000
WOOD FIBER BIOROLL	L F	5000	$3	$15,000
SEEDING	ACRE	8	$2,000	$16,000
SEED MIX 33-261	LB	55	$75	$4,125
			30% Contingency	$394,700
			Total:	**$1,710,400**

APPENDIX D: SURVEY DATA AND SITE PHOTOS

Surveyed Ditch Profile





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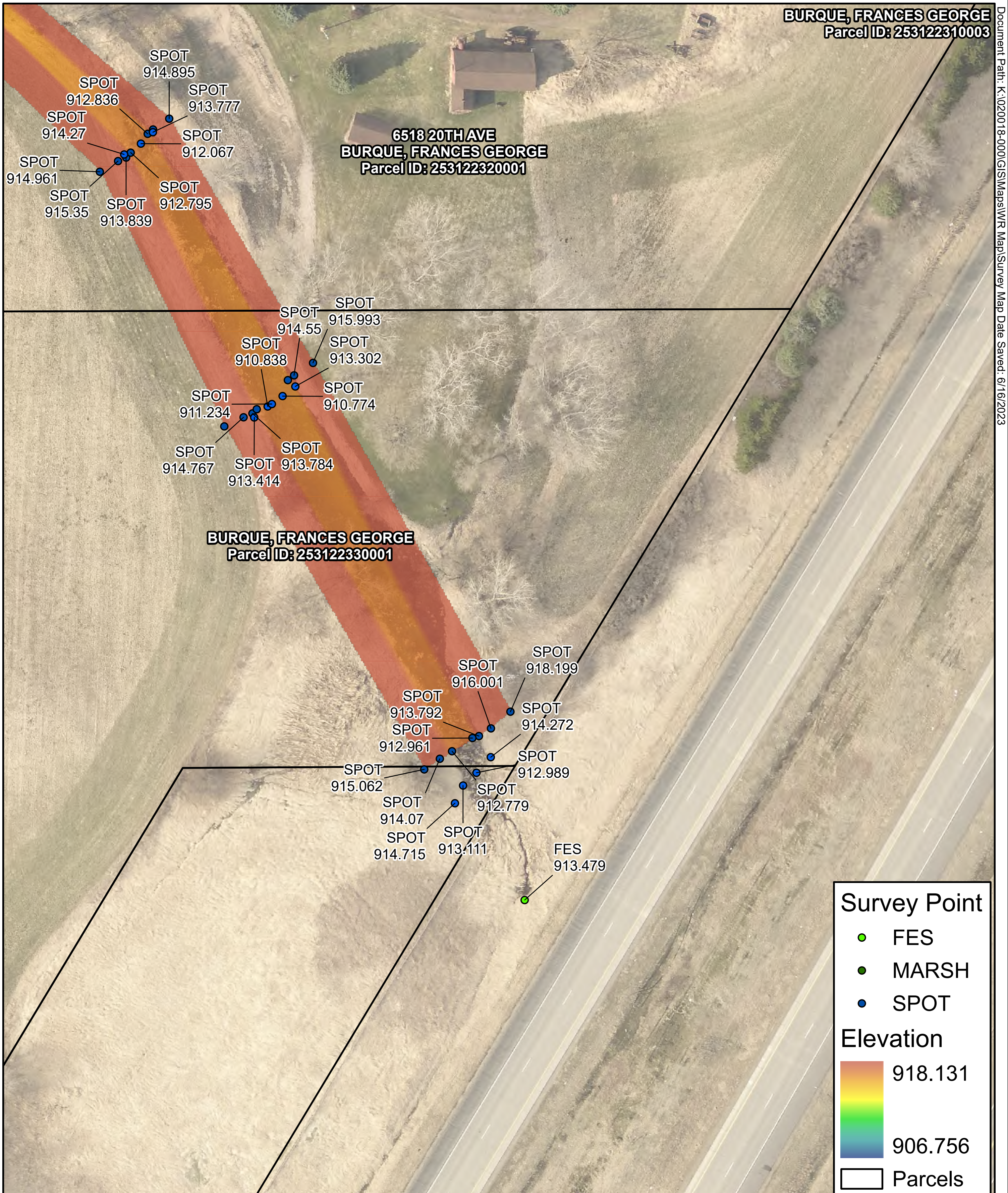
CITY OF LINO LAKES

Survey Map 1

Amelia Ditch Drainage Study
City of Lino Lakes

N
0 80 Feet
1 inch = 80 feet

wsb



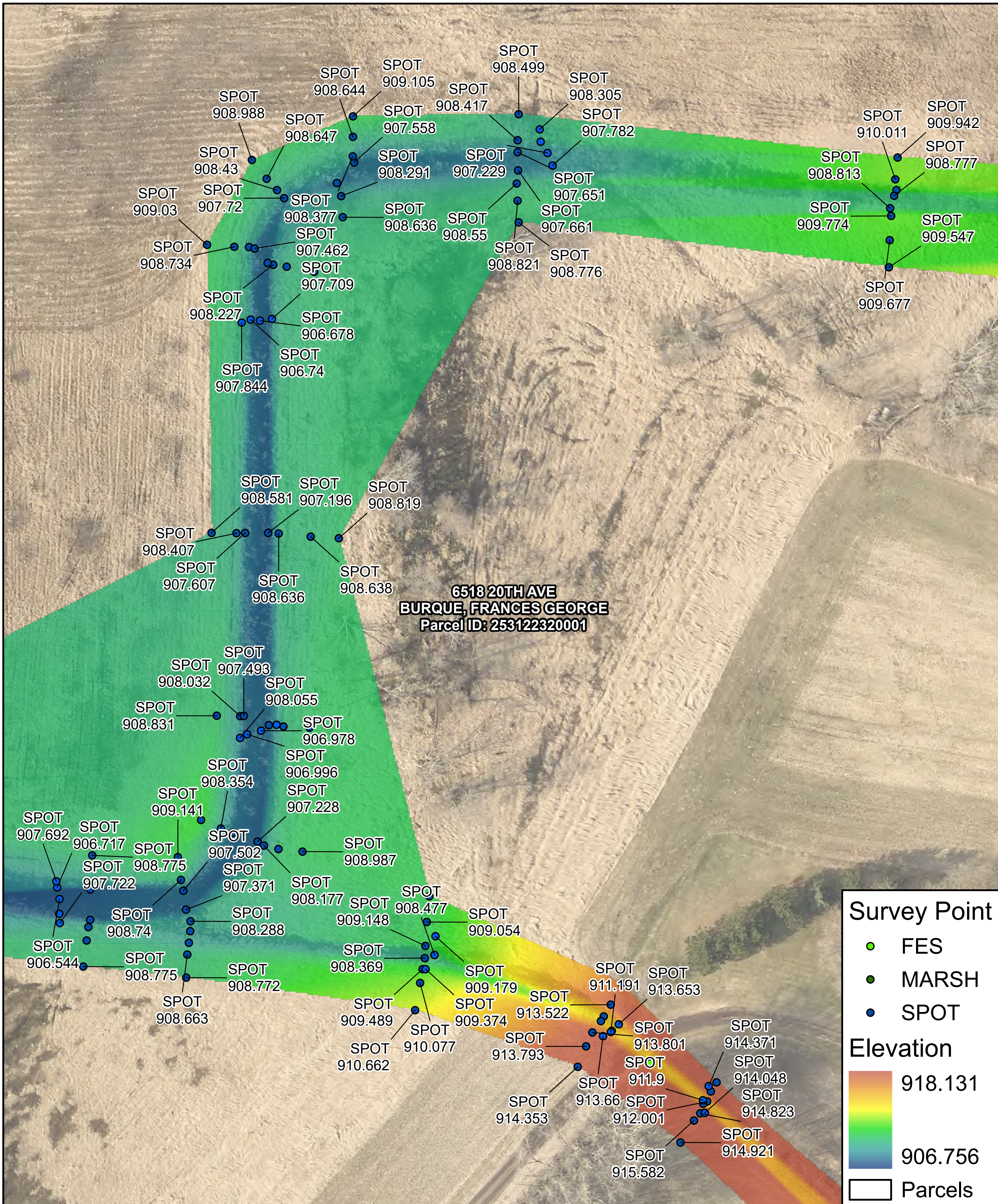
CITY OF LINO LAKES

Survey Map 2

Amelia Ditch Drainage Study
City of Lino Lakes

N
0 80 Feet
1 inch = 80 feet

wsb



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CITY OF LINO LAKES

Survey Map 3

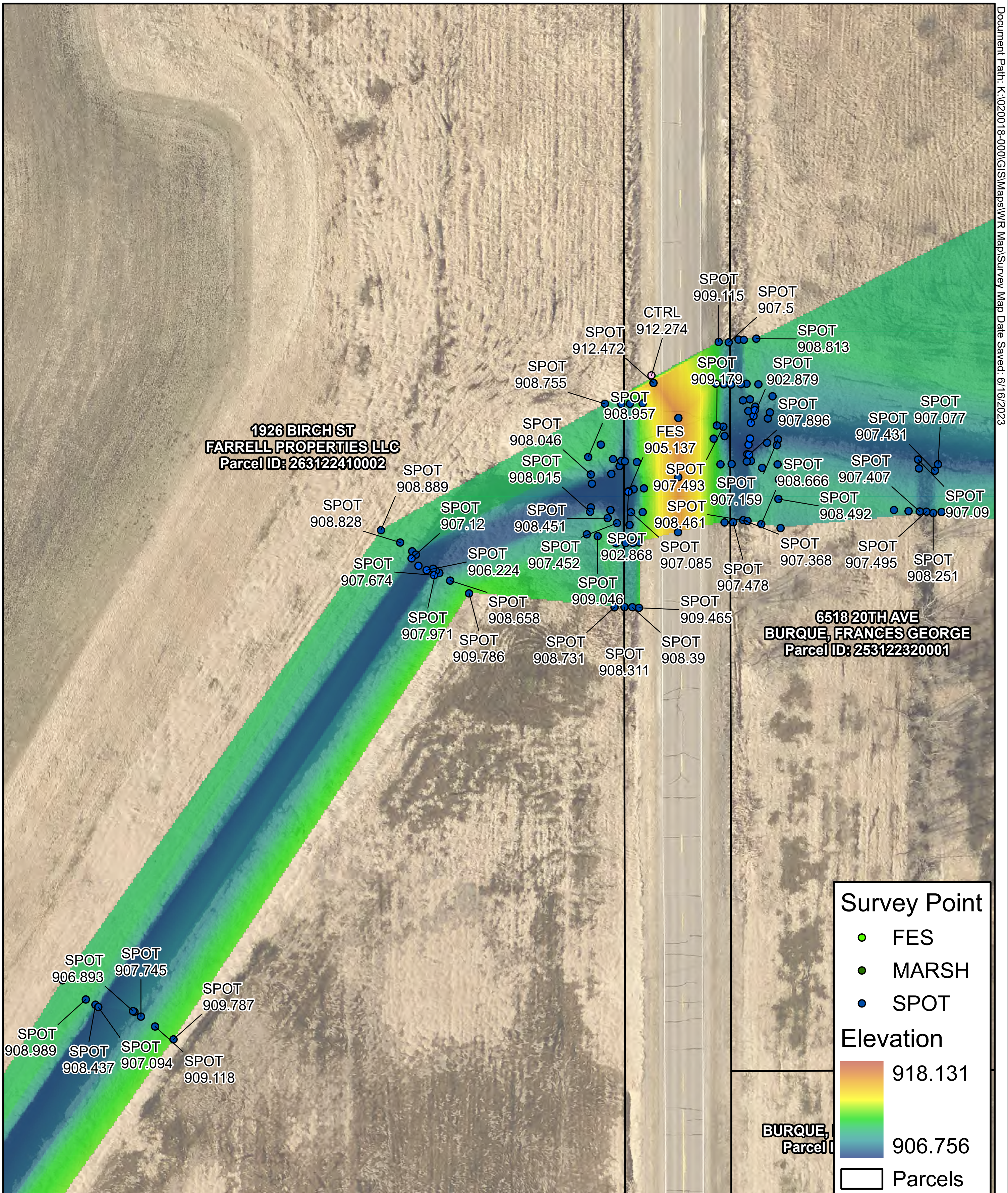
Amelia Ditch Drainage Study
City of Lino Lakes

N

0 80 Feet

1 inch = 80 feet

wsb

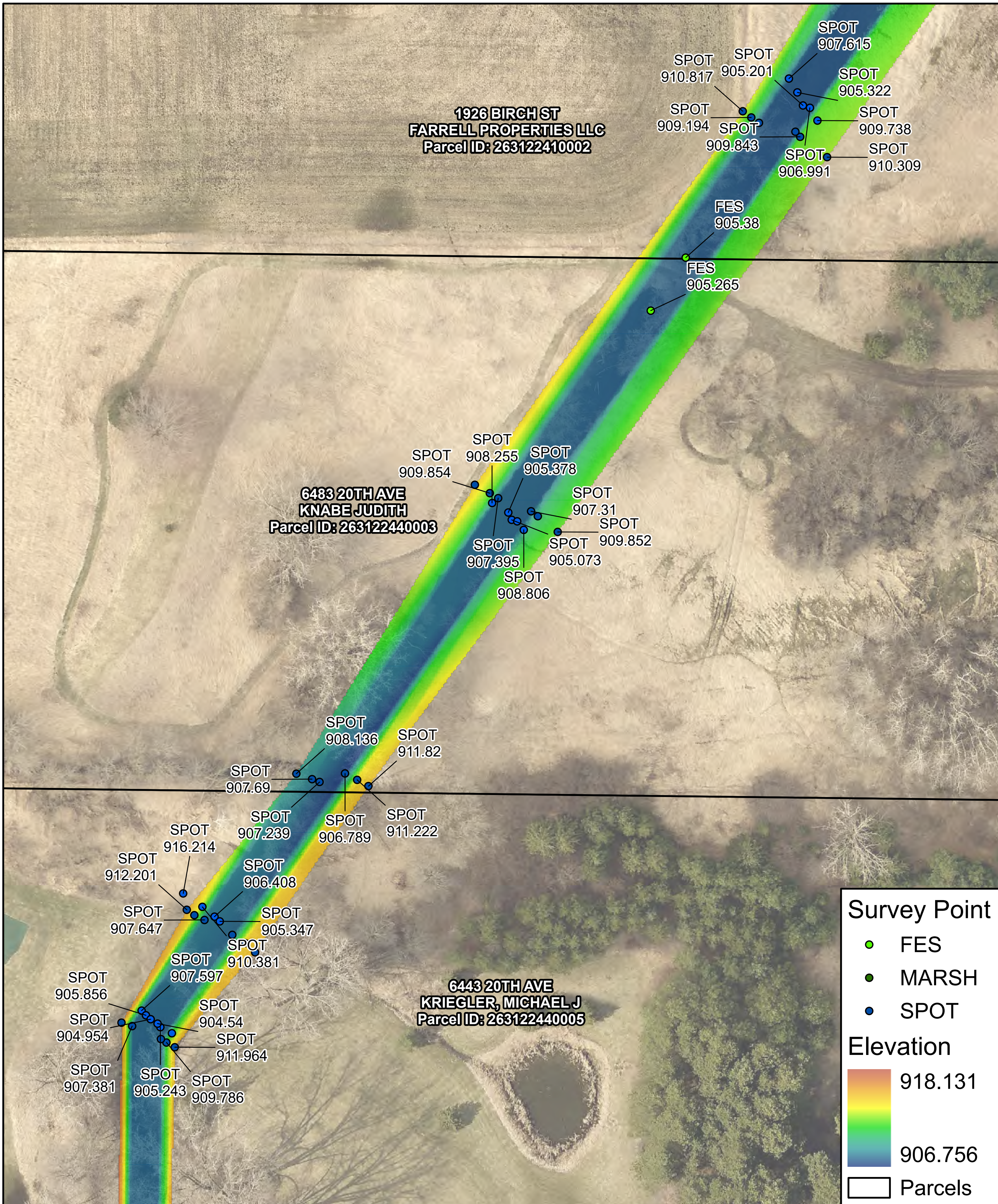


CITY OF LINO LAKES

Survey Map 4

Amelia Ditch Drainage Study
City of Lino Lakes

wsb



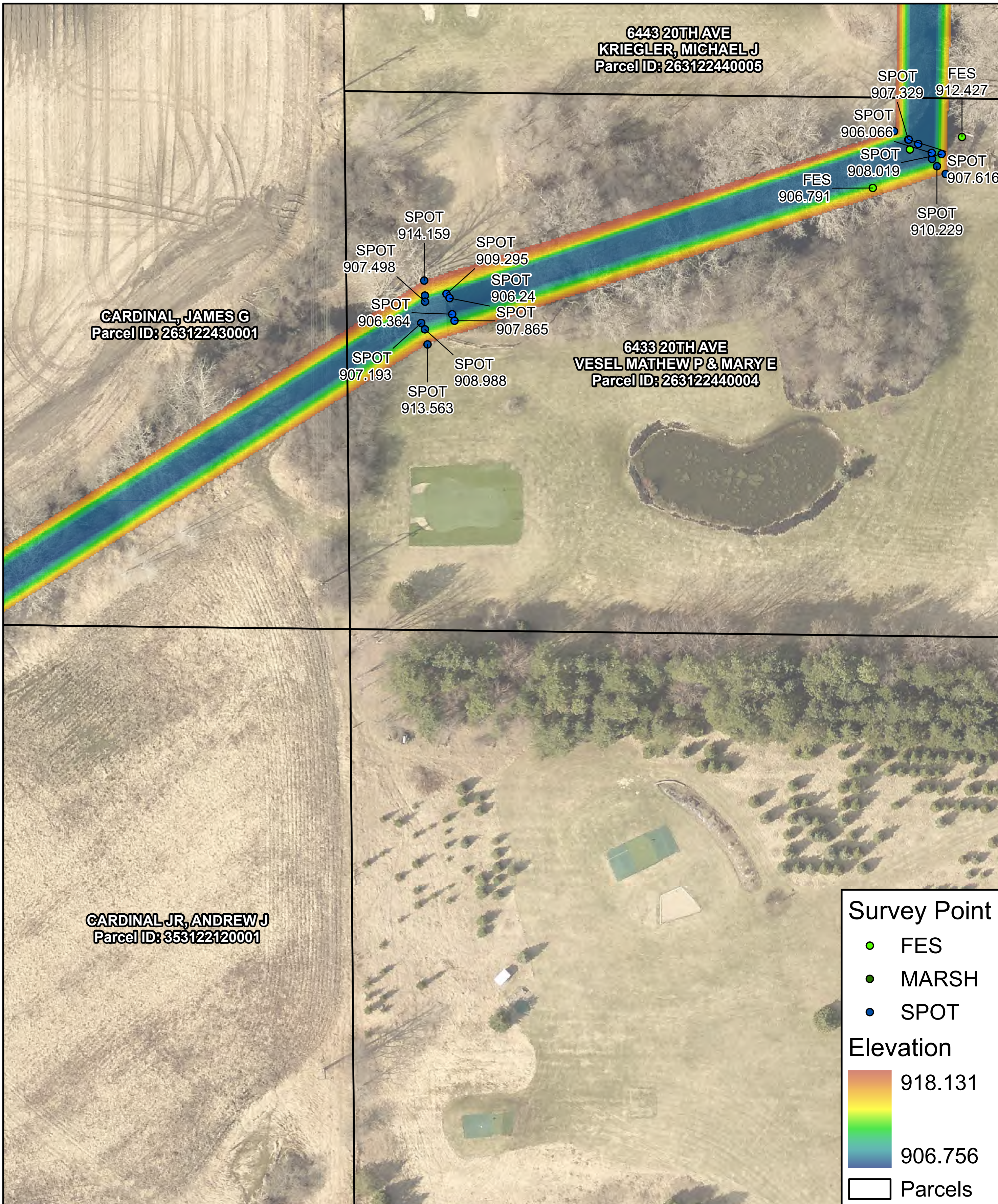
CITY OF LINO LAKES

Survey Map 5

Amelia Ditch Drainage Study
City of Lino Lakes

N
0 80 Feet
1 inch = 80 feet

wsb



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CITY OF LINO LAKES

Survey Map 6

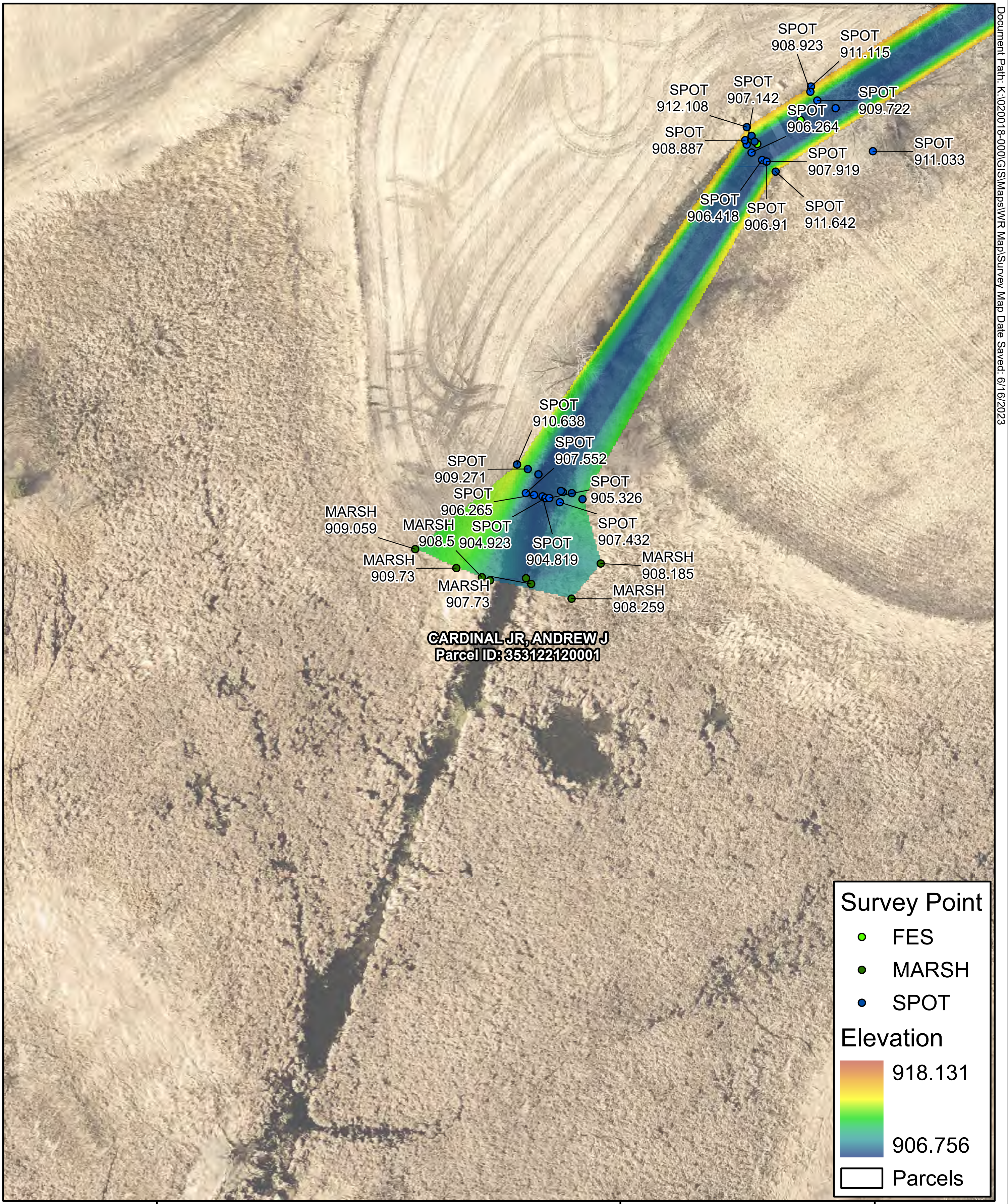
Amelia Ditch Drainage Study
City of Lino Lakes

N

0 80 Feet

1 inch = 80 feet

wsb



Survey Map 7

Amelia Ditch Drainage Study
City of Lino Lakes

N
0 80 Feet
1 inch = 80 feet

CITY OF LINO LAKES

wsb

1 – Culvert C Upstream

2 - North Main Branch

3 - North Side Branch

4 - North Vegetation

5 –Culvert C Downstream

6 – Submerged Downstream End of Culvert C

7 – Channel in 1926 Birch St Property

8 – Channel Upstream of Culvert D

9 –Upstream End of Culvert D

10 –Submerged Upstream End of Culvert D

11 – Channel Downstream of Culvert D

12 –Submerged Downstream End of Culvert D

13 – Looking West Down Tributary Side Ditch

14 – Property Fence South of Side Ditch

15 – Narrowing of Channel Near Side Ditch

16 – Side Ditch Delta

17 – Side Ditch Delta

18 – Looking East Down Tributary Side Ditch

19 – Channel in 6443 20th Ave Property

20 – Channel Debris in 6443 20th Ave Property

21 - Culvert E Upstream Pool

22 - Culvert E Downstream End

23 – Culvert E Downstream End

24 - Culvert E Downstream Channel

25 - 6433 20th Ave Bridge Upstream Channel

26 - 6433 20th Ave Bridge Downstream Channel

27 – Channel Debris in 1826 Birch St Property

28 – Culvert F Upstream Pool

29 – Culvert F Upstream Channel

30 – Culvert F Upstream Channel

31 – Culvert F Downstream End

32 – Culvert F Downstream Erosion

33 – Culvert F Heaving

34 – Culvert F Downstream Channel Debris

35 – Channel to Lake Amelia