SILVER RANCH WATERSHED

FOR

CITY OF BISMARCK, ND

STORMWATER MASTER PLAN REPORT

Volume II of III – Silver Ranch Watershed Modeling Methodology & Analysis

December 2018

AE2S Project #: P00501-2015-013

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SILVER RANCH WATERSHED
STORMWATER MASTER PLAN REPORT
CERTIFICATION

December 2018

I hereby certify that this 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 North Dakota.

This document was originally
issued and sealed by
Jeffrey M. Hruby,
Registration Number
PE-5403
on December 04, 2018
and the original documents
are stored at the offices of
Advanced Engineering &
Environmental Services, Inc.

Prepared by:

Advanced Engineering and Environmental Services, Inc.

1815 Schafer St., Suite 301
Bismarck, ND 58501

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II-1.0 BACKGROUND & SUMMARY

The Silver Ranch Watershed Master Plan study evaluated the existing and proposed runoff conditions for all areas contributing to the Silver Ranch Watershed upstream of East Main Avenue, a tributary to the Apple Creek watershed as shown in ***Figure II - 1***. This watershed encompasses an area of approximately 6.4 square miles (4,095 acres) ***Figure II - 2***. Analysis was generally limited to the three significant drainages located in the Silver Ranch Watershed. These significant drainages, for the purpose of this Master Plan, are identified as the Silver Ranch Coulee, Sunrise Tributary, and Eastern Tributary.

II-1.1 MASTER PLAN PURPOSE

The overarching purpose of this Master Plan is to develop a comprehensive approach that manages stormwater on a watershed scale and provides adequate drainage consistent with the City's ordinances. Achieving this purpose requires compliance with specific goals developed in conjunction with a City-designated Working Group. The intent of the group is to bring the major City departments tasked with implementing this plan into the Master Plan development process. The City Working Group is described in ***Section I-2.0*** of ***Volume I*** of this Master Plan.

The goals developed with the City Working Group were divided into primary and secondary goals that are described in ***Section I-2.1*** and ***I-2.2*** of ***Volume I*** of this Master Plan Report.

II-1.2 ORGANIZATION OF THE MASTER PLAN REPORT

The Silver Ranch Master Plan Report consists of three volumes each with a distinct function. Combined, these three volumes constitute the "Master Plan Report." In general, the three volumes are described as follows:

Volume I – Master Plan Report consists of the purpose and need for the study, key recommendations, stormwater management concepts for development activities, and a summary of identified improvements. Volume I is intended to function as a guide for the implementation of the Silver Ranch Watershed Master Plan.

Volume II - Silver Ranch Watershed Methodology & Analysis details the hydrologic and hydraulic modeling completed for the development of the Silver Ranch Watershed Master Plan. Volume II is intended to document the analysis scenarios utilized in the development of the Master Plan recommendations and stormwater management concepts.

Volume III – Silver Ranch and Hay Creek Watershed Connection Methodology & Analysis details the hydrologic and hydraulic modeling completed for the analysis of the connection between the Silver Ranch and Hay Creek watersheds. Volume III is intended to document the study of the interconnection of the two watersheds and any resulting recommendations.

II-1.3 MODEL SCOPE AND LEVEL OF DETAIL

The general level of detail of the study is such that existing infrastructure such as road crossings, culverts, and other stormwater infrastructure was modeled when located on main drainage-ways or when it was determined appropriate due to upstream land use changes or sensitive nearby infrastructure. For the analysis of future conditions, future crossings of the main drainage-ways were sized and analyzed for collectors and arterials identified by the 2014 Fringe Area Road Master Plan or as identified/requested by the City Working Group.

II-1.4 DATA SOURCES

The following data sources were utilized in this study:

- 2016 LIDAR data (contours and DEM) obtained from the Metropolitan Planning Organization;
- Bismarck 2016 aerial photograph, obtained from the City of Bismarck;
- 2014 Fringe Area Road Master Plan (FARMP) prepared by SRF and HDR, obtained from the City;
- 2014 Bismarck Growth Management Plan (GMP) prepared by URS Corporation, obtained from the City;
- NRCS soils database, Version 36 for Burleigh County, obtained from the NRCS Geospatial Data Gateway January 2017;
- Rainfall depths from the City of Bismarck Draft Stormwater Design Standards Manual;
- Site visits (various dates);
- Survey data collected as part of this project on various dates throughout the fall of 2016 through the spring of 2017;
- Various Stormwater Management Plans and Record Drawings provided by the City of Bismarck; and
- 43rd Avenue Reconstruction draft design documents and hydraulics/hydrology documents provided by Burleigh County Engineering on February 9, 2017.

II-1.5 VERTICAL DATUM

Elevations presented throughout the Master Plan are in the North American Vertical Datum of 1988 (NAVD88), unless otherwise noted.

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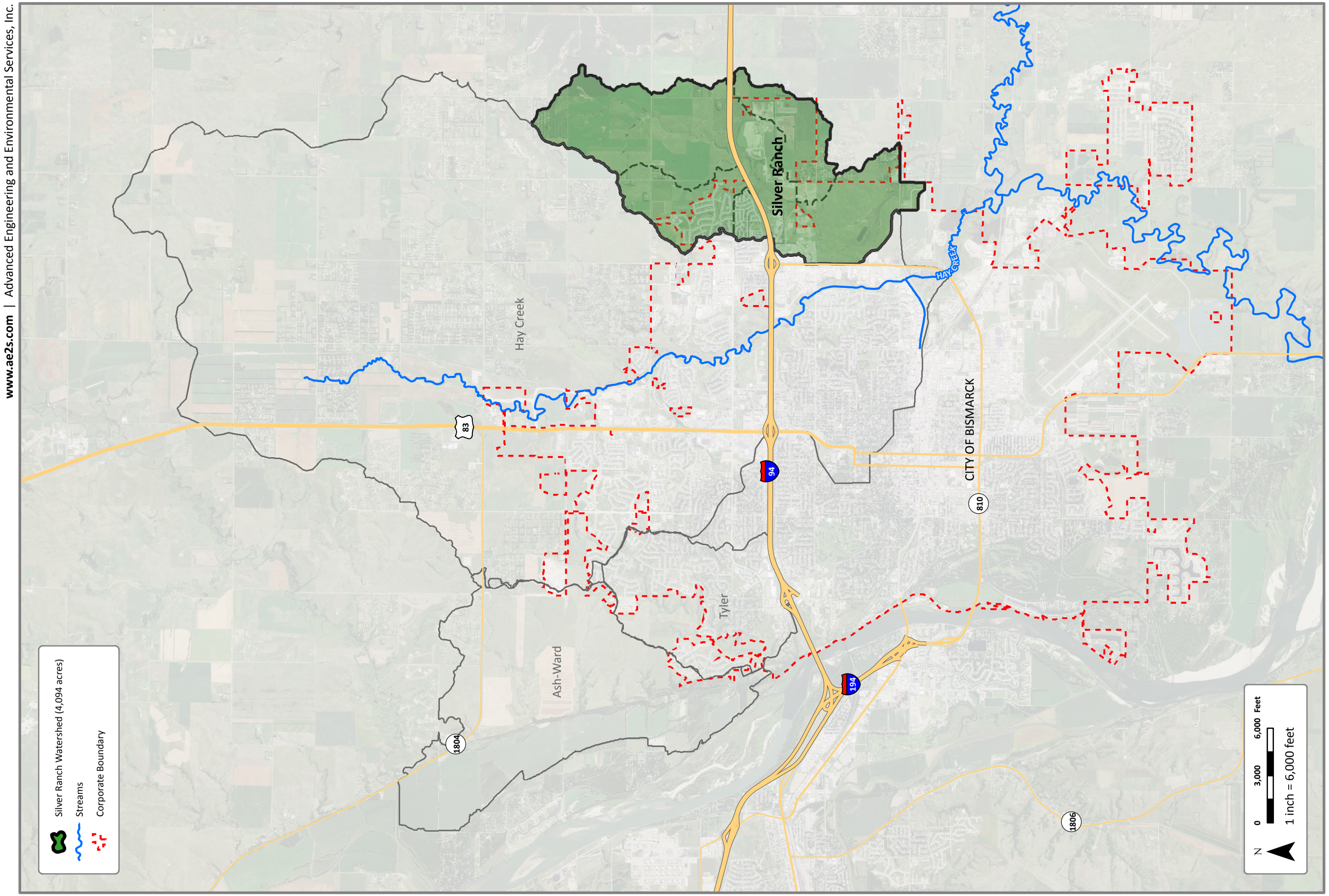

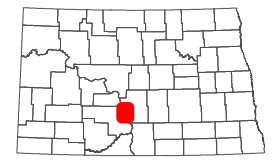

Locator Map Not to Scale

City of Bismarck
Burleigh County, ND

Figure II-1

PROJECT LOCATION MAP

SILVER RANCH
WATERSHED STORMWATER
MASTER PLAN

Date: 10/27/2017

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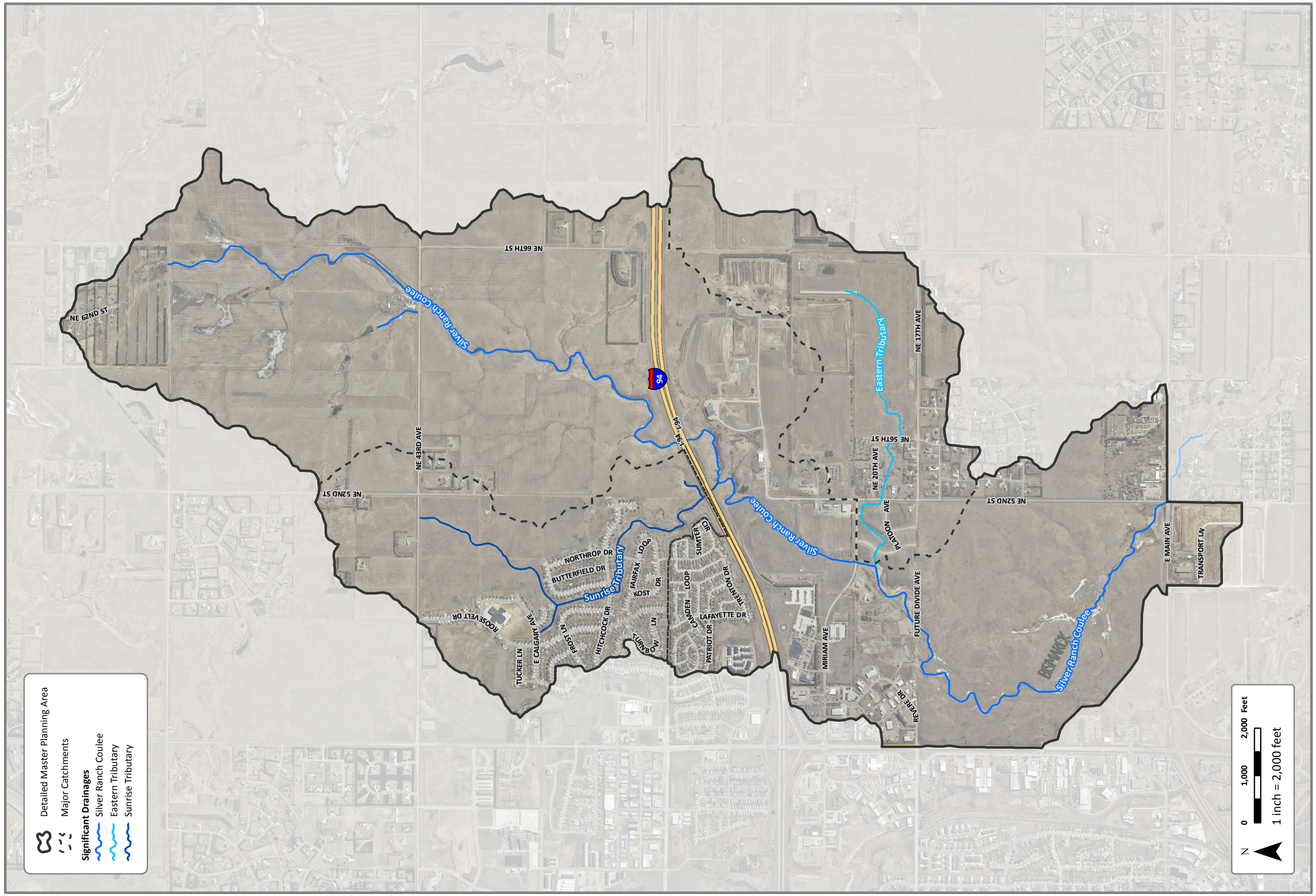

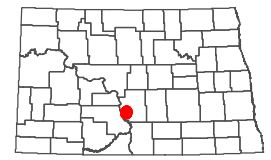

Locator Map Not to Scale

City of Bismarck
Burleigh County, ND

Figure II-2

SILVER RANCH WATERSHED

SILVER RANCH WATERSHED STORMWATER MASTER PLAN

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II-2.0 HYDROLOGIC AND HYDRAULIC MODELING METHODS

The hydrologic and hydraulic modeling methods used for the development of this Master Plan are discussed in the following sections.

II-2.1 HYDROLOGIC AND HYDRAULIC MODEL SUMMARY

The hydrologic and hydraulic analyses were carried out using InfoSWMM, a proprietary GIS-integrated version of EPA SWMM, which is widely accepted for stormwater modeling. Hydrologic inputs included land use characteristics, soils parameters, rainfall depths, and time of concentration parameters. To demonstrate compliance with the Master Plan goals, a set of hydrologic and hydraulic (H&H) model scenarios were developed. The hydraulic features modeled include natural channels, urban and rural storage areas, and culverts. InfoSWMM provides an effective and comprehensive method for modeling complex drainage systems. For this Master Plan, the following H&H scenarios were developed:

1. **Existing Conditions** utilized the existing land use, soils, road system, and drainage conveyance systems that were in-place prior to the start of the Master Plan process.

   This scenario is named "EXISTING" in the InfoSWMM model named "SILVERRANCH_MASTERMODEL_FINAL" and contains sub-scenarios for the 2-, 10-, 25-, and 100-year events.
2. **Future Conditions, No Controls** utilized the future land-use plan, future road system, and drainage system improvements to demonstrate the need for stormwater management. This scenario estimates the watershed response to the planned full build-out without the implementation of the stormwater management practices for peak flow compliance.

   This scenario is named "FUTURE_NOCONTROL" in the InfoSWMM model named "SILVERRANCH_MASTERMODEL_FINAL" and contains sub-scenarios for the 2-, 10-, 25-, and 100-year events.
3. **Future Conditions, Local Pre-Post** utilized the future land-use plan, future road system, and recommended drainage system improvements. Adjustments were made to the time of concentration values (see ***Section II-2.2.7***) to simulate local stormwater management within each sub-watershed. Local stormwater management is when each development constructs facilities to provide detention such that the post-development peak flow leaving the site matches the peak flow leaving the site under existing conditions. This scenario estimates the watershed response to the planned full build-out with the implementation of local or onsite stormwater detention ponds for peak flow compliance.

   This scenario is named "FUTURE_PREPOST" in the InfoSWMM model named "SILVERRANCH_MASTERMODEL_FINAL" and contains sub-scenarios for the 2- and 100-year events. This scenario was utilized to determine the performance of implementing traditional local pre-post detention facilities throughout the watershed.

4. **Master Planned Conditions, Unit Rate** utilized the future land-use plan, future road system, and recommended drainage system improvements to show the performance of the recommended Master Plan management concepts. Adjustments were made to the time of concentration values (see ***Section II-2.2.7***) to simulate use of the Unit Rate requirements within each sub-watershed. This scenario was utilized to determine the performance of implementing a Unit Rate stormwater detention methodology throughout the watershed.

   This scenario is named "FUTURE_ONSITE" in the InfoSWMM model named "SILVERRANCH_MASTERMODEL_FINAL" and contains sub-scenarios for the 2- and 100-year events.

5. **Hydraulic Design for Future Crossings** utilized the existing land use, existing soils, future road system, and recommended drainage improvements. This scenario was utilized for sizing road crossing and conveyance infrastructure for existing and future road crossings. Existing conditions hydrology was used because complete implementation of the Unit Rate requirement may result in lower discharge at some crossings, but the crossings may be constructed prior to complete implementation of the Unit Rate requirements.

   As such, the existing land use condition acts as the "worst case scenario" for peak flows at road crossings (existing and future) in the major drainage-ways for many areas in the watershed. This scenario will occur within the watershed when an improvement is implemented prior to full build-out upstream.

   This scenario is named "EXISTINGWS_PROPCROSSINGS" in the InfoSWMM model named "SILVERRANCH_MASTERMODEL_FINAL" and contains sub-scenarios for the 2-, 25-, and 100-year events.

II-2.2 GENERAL HYDROLOGIC ANALYSIS METHODS

II-2.2.1 Rainfall

The analysis was performed using the NRCS Type II 24-hour synthetic rainfall distribution and Atlas 14 rainfall depths per the City of Bismarck SWDSM. ***Table II - 1*** summarizes the design storm depths.

Table II - 1: Atlas 14, 24-hour Design Storm Depths for Bismarck, ND

Event	Rainfall Depth (in)
2-Year	2.1
10-Year	3.1
25-Year	3.9
100-Year	5.3

II-2.2.2 Existing Land Use

Existing land use was based on shapefiles provided by the City with modifications made to better reflect existing conditions based on aerial imagery, site visits, and input from the City working group. Percent impervious was determined based on values provided in the City's SWDSM when applicable. For land uses not specifically referenced in the SWDSM, percent impervious was determined by reviewing sample areas within the Silver Ranch Watershed. Existing land use in the Silver Ranch Watershed is primarily agricultural land use, which is a mix of pasture/rangeland and cropland as shown in ***Figure II - 3*** and summarized in ***Table II - 2***.

Table II - 2: Silver Ranch Watershed Existing Land Use Summary

Land Use	Area (ac)	Fraction of Watershed	Percent Impervious
High Density Residential	7.6	<1%	70%
Low Density Residential	207.8	5%	38%
Rural Development (>5 acre Lots / Farmsteads)	96.2	2%	5%
Rural Residential, 2-5 acre Lots	135.1	3%	10%
Commercial	128.1	3%	85%
Landfill	249.2	6%	5%
Industrial	65.2	2%	90%
Light Industrial	78.5	2%	50%
Ag - Pasture/Rangeland	2093.9	51%	0%
Ag - Cropland	700.9	17%	0%
Civic	14.1	<1%	50%
Rural ROW	144.8	4%	40%
Urban ROW	78.7	2%	65%
Interstate ROW	94.5	2%	20%
Total	**4,094.3**		

II-2.2.3 Future Land Use

Future land use (full build out) was based on the City of Bismarck Growth Management Plan (Future Land Use Plan) with modifications based on input from the working group. Percent impervious was determined based on values provided in the City's SWDSM when applicable. For land uses not specifically referenced in the SWDSM, percent impervious was determined by reviewing sample areas within the Silver Ranch Watershed. The future land use in the Silver Ranch Watershed is predominantly residential land use. Future land use is presented on ***Figure II - 4*** and ***Table II - 3***.

Table II - 3: Silver Ranch Watershed Future Land Use

Land Use	Area (ac)	Fraction of Watershed	Percent Impervious
High Density Residential	99.6	2%	70%
Medium Density Residential	650.5	16%	60%
Low Density Residential	861.1	21%	38%
Mixed Use	135.7	3%	70%
Rural Residential	146.9	4%	10%
Commercial/Mixed Use	7.9	<1%	80%
Commercial	294.3	7%	85%
Business Park	121	3%	80%
Industrial	378.5	9%	90%
Open Space	705.8	17%	0%
Closed Landfill	249.2	6%	5%
Civic	75.6	2%	50%
Rural ROW	57.3	1%	40%
Urban ROW	213.1	5%	65%
Interstate ROW	98.1	2%	20%
Totals	**4,094.3**		

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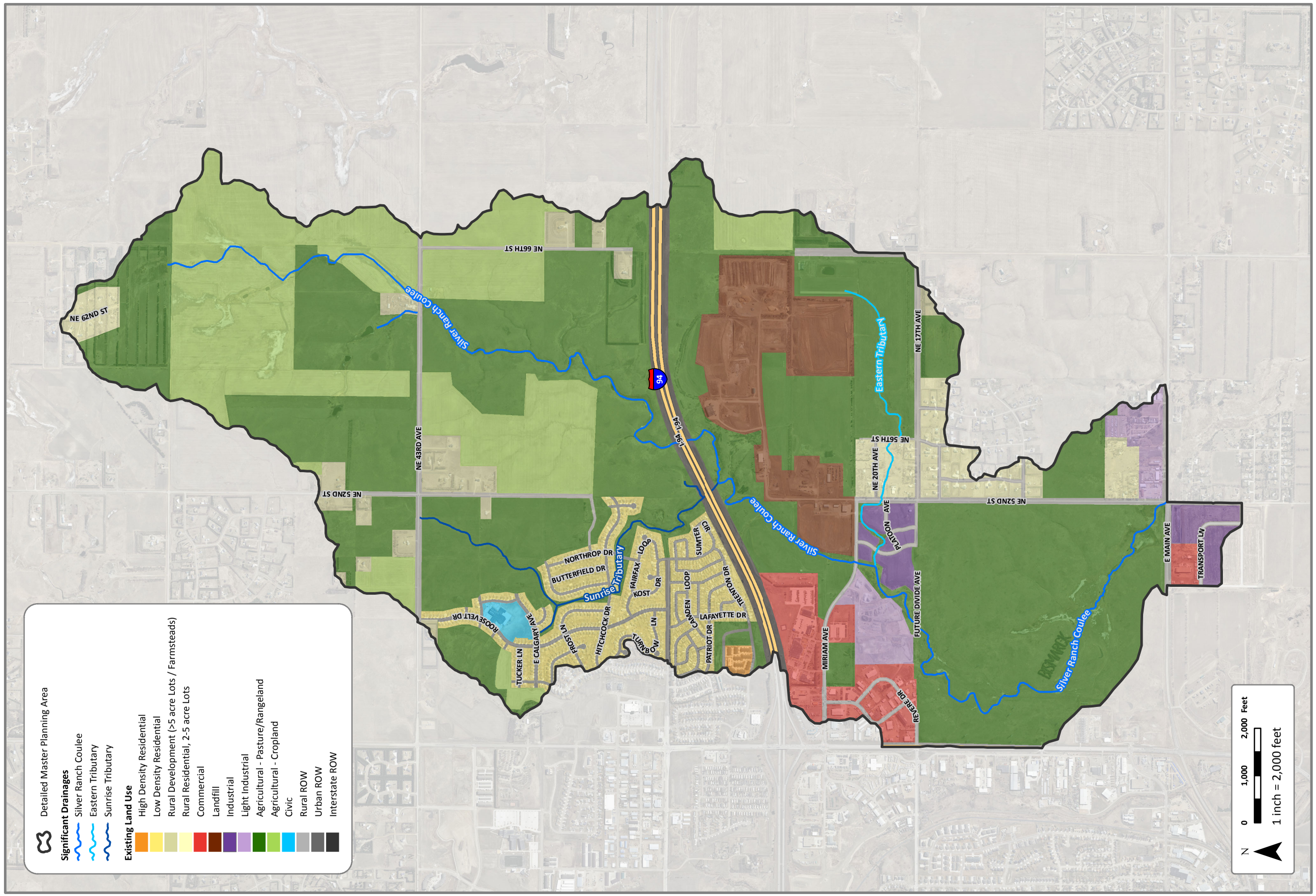

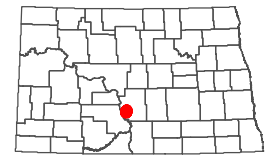

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City of Bismarck
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Figure II-3

SILVER RANCH WATERSHED EXISTING LAND USE

SILVER RANCH WATERSHED STORMWATER MASTER PLAN

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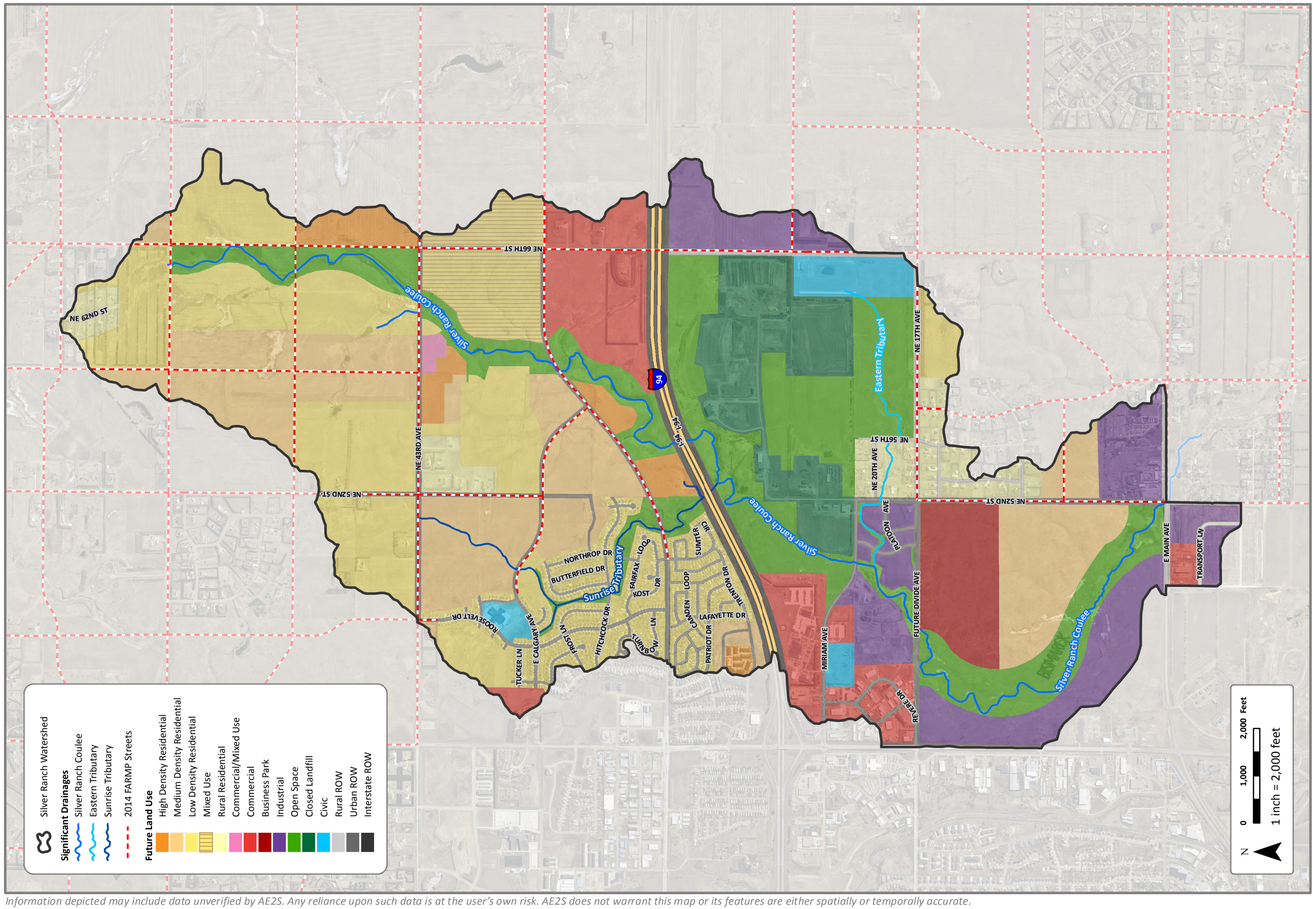

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Figure II-4

SILVER RANCH WATERSHED FUTURE LAND USE

SILVER RANCH
WATERSHED STORMWATER
MASTER PLAN

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II-2.2.4 Soils

Soils were obtained from the NRCS Web Soil Survey. Hydrologic Soil Group (HSG) classifications are presented on ***Figure II - 5***. The watershed is dominated by HSG B soils, with small amounts of HSG A, C, and D soils scattered throughout the watershed.

II-2.2.5 Sub-Watershed Boundaries and Runoff Parameters

Sub-watersheds were delineated based on existing topography, master-planned green space corridors, master-planned major road corridors (such as Century Avenue), and known future plat boundaries (such as Silver Ranch Addition). Therefore, sub-watershed boundaries do not necessarily follow natural topography lines. ***Figure II - 6*** illustrates the Existing sub-watershed boundaries, which are the same as the Future sub-watershed boundaries. ***Figure II - 6*** also summarizes sub-watershed runoff parameters (CN and Tc) for Existing, Future Conditions, No-Controls, and Master-Planned conditions. It should be noted, that the CN and percent impervious for the Future Conditions, No-Controls and the Master-Planned scenarios are the same. Variations in Tc values will be discussed in ***Section II-2.2.7***.

II-2.2.6 Curve Numbers

Sub-watershed runoff was computed using the NRCS Curve Number (CN) and Time of Concentration (Tc) methodology. Runoff was computed separately for pervious and impervious areas rather than producing a single aggregate CN, in order to more accurately simulate runoff. In particular, this practice provides better estimation of runoff generation for smaller storm events.

Pervious area was designated as Open Space (grass in "good" condition), Cropland, or Pasture/Rangeland. ***Table II - 4*** shows the Hydrologic Soil Group (HSG) breakdown for curve numbers utilized for this Master Plan. Impervious area within all land uses was assigned a CN of 98.

Table II - 4: Silver Ranch Watershed Curve Number Summary

HSG	Open Space Curve Number	Cropland Curve Number	Pasture/Rangeland Curve Number	Impervious Curve Number
A	39	62	39	98
B	61	73	61	98
C	74	80	74	98
D	80	84	80	98

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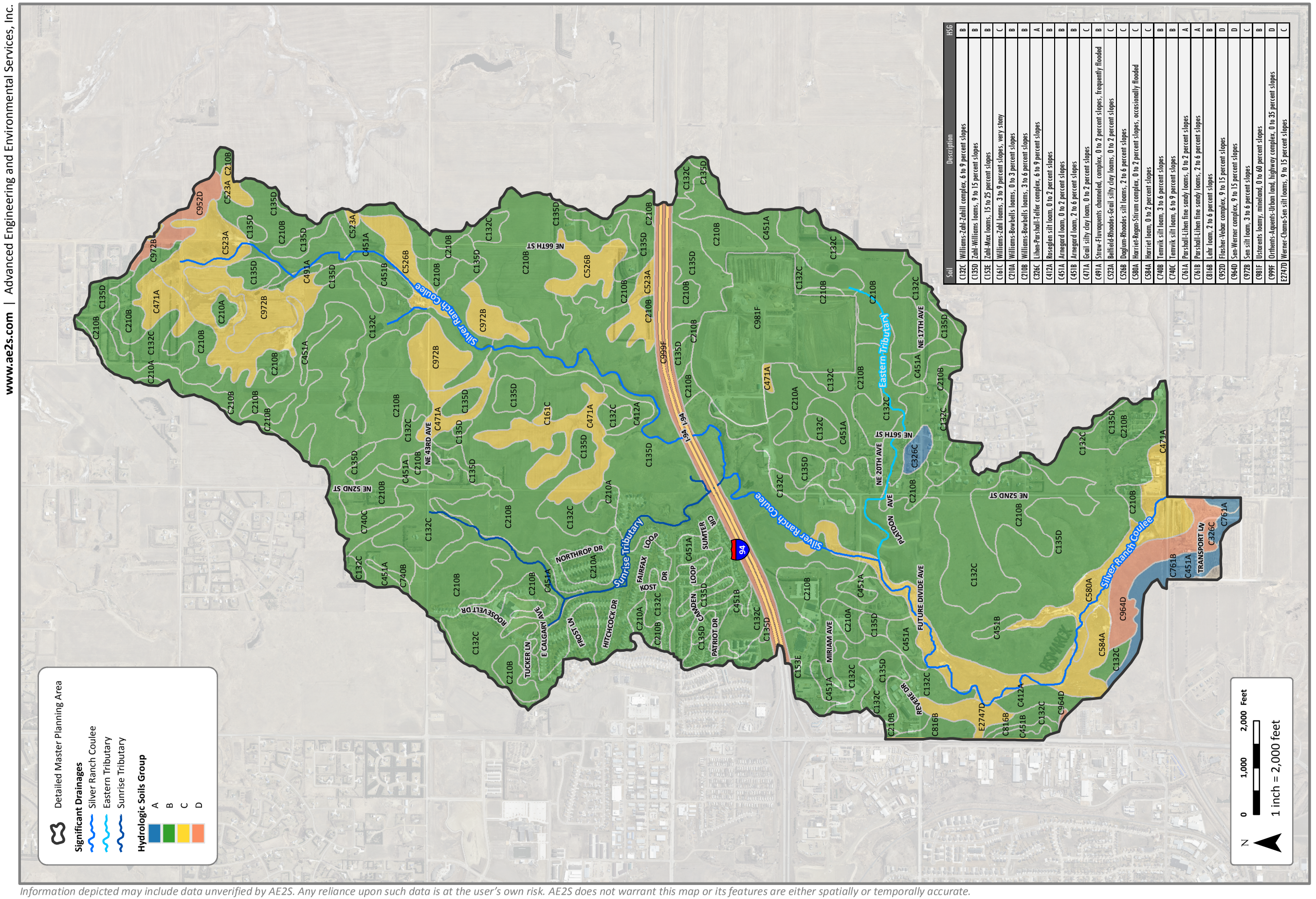

Soil	Description	HSG
C132C	Williams-Zahl-Zahill complex, 6 to 9 percent slopes	B
C135D	Zahl-Williams loams, 9 to 15 percent slopes	B
C153E	Zahl-Max loams, 15 to 25 percent slopes	B
C161C	Williams-Zahl loams, 3 to 9 percent slopes, very stony	C
C210A	Williams-Bowbells loams, 0 to 3 percent slopes	B
C210B	Williams-Bowbells loams, 3 to 6 percent slopes	B
C326C	Lihen-Parshall-Telfer complex, 6 to 9 percent slopes	A
C412A	Rosenglen silt loam, 0 to 2 percent slopes	B
C451A	Arnegard loam, 0 to 2 percent slopes	B
C451B	Arnegard loam, 2 to 6 percent slopes	B
C471A	Grail silty clay loam, 0 to 2 percent slopes	C
C491A	Straw-Fluvaquents channeled, complex, 0 to 2 percent slopes, frequently flooded	B
C523A	Belfield-Rhoades-Grail silty clay loams, 0 to 2 percent slopes	C
C526B	Doglum-Rhoades silt loams, 2 to 6 percent slopes	C
C580A	Harriet-Regan-Straum complex, 0 to 2 percent slopes, occasionally flooded	C
C584A	Harriet loam, 0 to 2 percent slopes	C
C740B	Temvik silt loam, 3 to 6 percent slopes	B
C740C	Temvik silt loam, 6 to 9 percent slopes	B
C761A	Parshall-Lihen fine sandy loams, 0 to 2 percent slopes	A
C761B	Parshall-Lihen fine sandy loams, 2 to 6 percent slopes	A
C816B	Lehr loam, 2 to 6 percent slopes	B
C952D	Flasher-Vebar complex, 9 to 15 percent slopes	D
C964D	Sen-Werner complex, 9 to 15 percent slopes	D
C972B	Sen silt loam, 3 to 6 percent slopes	C
C981F	Ustorents loamy, mineland, 0 to 60 percent slopes	B
C999F	Orthents-Aquents-Urban land, highway complex, 0 to 35 percent slopes	D
E2747D	Werner-Cinema-Sen silt loams, 9 to 15 percent slopes	C

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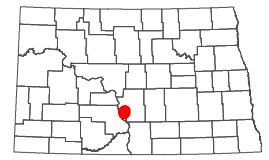

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City of Bismarck
Burleigh County, ND

Figure II-5

SILVER RANCH WATERSHED SOIL TYPES AND HSG CLASSIFICATIONS

SILVER RANCH
WATERSHED STORMWATER
MASTER PLAN

Date: 10/26/2017

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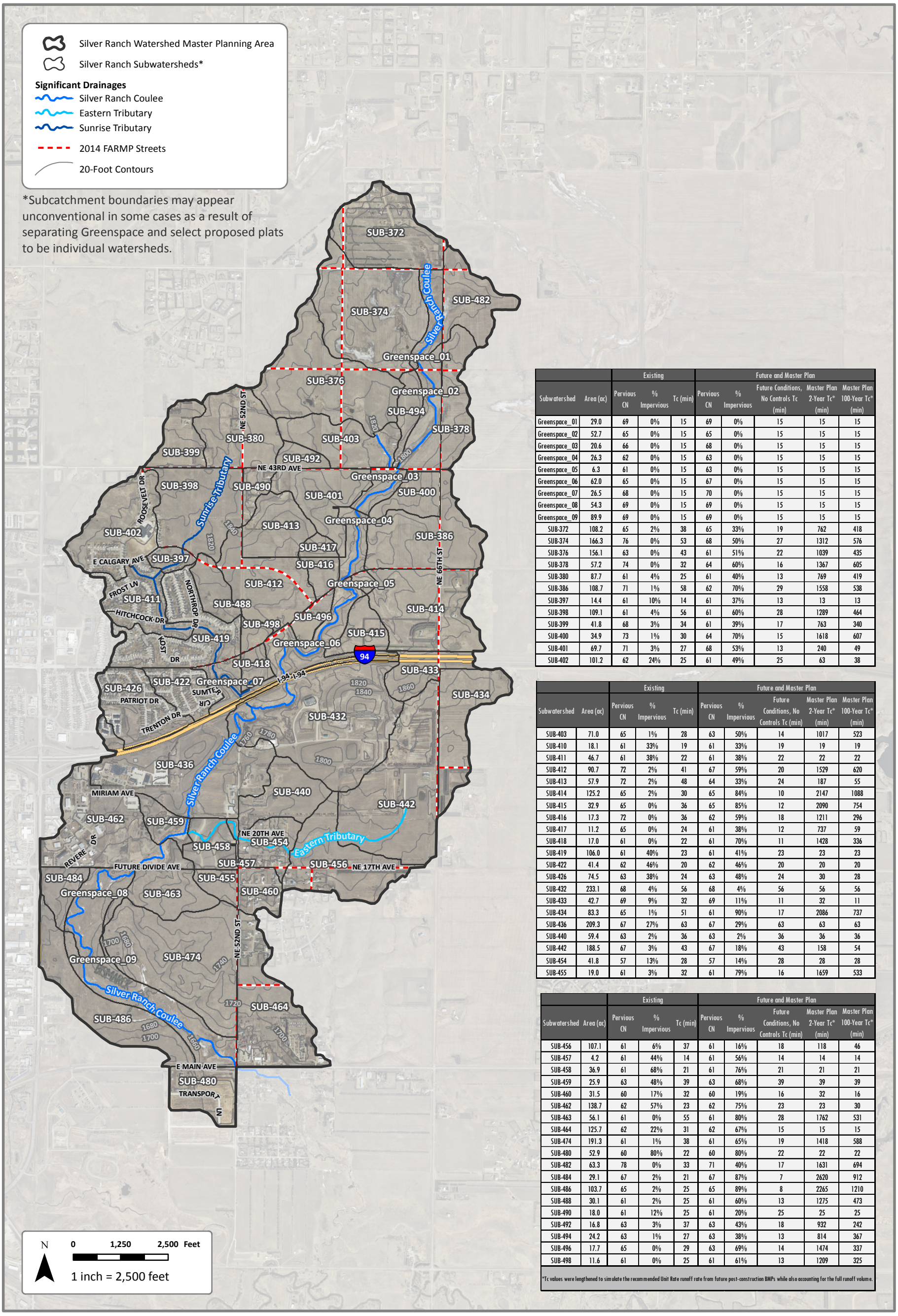
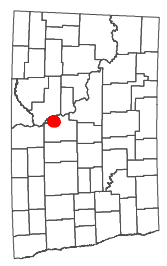


Subwatershed	Area (ac)	Existing Pervious CN	Existing % Impervious	Existing Tc (min)	Future and Master Plan Pervious CN	Future and Master Plan % Impervious	Future Conditions, No Controls Tc (min)	Master Plan 2-Year Tc* (min)	Master Plan 100-Year Tc* (min)
Greenspace_01	29.0	69	0%	15	69	0%	15	15	15
Greenspace_02	52.7	65	0%	15	65	0%	15	15	15
Greenspace_03	20.6	66	0%	15	68	0%	15	15	15
Greenspace_04	26.3	62	0%	15	63	0%	15	15	15
Greenspace_05	6.3	61	0%	15	63	0%	15	15	15
Greenspace_06	62.0	65	0%	15	67	0%	15	15	15
Greenspace_07	26.5	68	0%	15	70	0%	15	15	15
Greenspace_08	54.3	69	0%	15	69	0%	15	15	15
Greenspace_09	89.9	69	0%	15	69	0%	15	15	15
SUB-372	108.2	65	2%	38	65	33%	19	762	418
SUB-374	166.3	76	0%	53	68	50%	27	1312	576
SUB-376	156.1	63	0%	43	61	51%	22	1039	435
SUB-378	57.2	74	0%	32	64	60%	16	1367	605
SUB-380	87.7	61	4%	25	61	40%	13	769	419
SUB-386	108.7	71	1%	58	62	70%	29	1558	538
SUB-397	14.4	61	10%	14	61	37%	13	13	13
SUB-398	109.1	61	4%	56	61	60%	28	1289	464
SUB-399	41.8	68	3%	34	61	39%	17	763	340
SUB-400	34.9	73	1%	30	64	70%	15	1618	607
SUB-401	69.7	71	3%	27	68	53%	13	240	49
SUB-402	101.2	62	24%	25	61	49%	25	63	38

Subwatershed	Area (ac)	Existing Pervious CN	Existing % Impervious	Existing Tc (min)	Future and Master Plan Pervious CN	Future and Master Plan % Impervious	Future Conditions, No Controls Tc (min)	Master Plan 2-Year Tc* (min)	Master Plan 100-Year Tc* (min)
SUB-403	71.0	65	1%	28	63	50%	14	1017	523
SUB-410	18.1	61	33%	19	61	33%	19	19	19
SUB-411	46.7	61	38%	22	61	38%	22	22	22
SUB-412	90.7	72	2%	41	67	59%	20	1529	620
SUB-413	57.9	72	2%	48	64	33%	24	187	55
SUB-414	125.2	65	2%	30	65	84%	10	2147	1088
SUB-415	32.9	65	0%	36	65	85%	12	2090	754
SUB-416	17.3	72	0%	36	62	59%	18	1211	296
SUB-417	11.2	65	0%	24	61	38%	12	737	59
SUB-418	17.0	61	0%	22	61	70%	11	1428	336
SUB-419	106.0	61	40%	23	61	41%	23	23	23
SUB-422	41.4	62	46%	20	62	46%	20	20	20
SUB-426	74.5	63	38%	24	63	48%	24	30	28
SUB-432	233.1	68	4%	56	68	4%	56	56	56
SUB-433	42.7	69	9%	32	69	11%	11	32	11
SUB-434	83.3	65	1%	51	61	90%	17	2086	737
SUB-436	209.3	67	27%	63	67	29%	63	63	63
SUB-440	59.4	63	2%	36	63	2%	36	36	36
SUB-442	188.5	67	3%	43	67	18%	43	158	54
SUB-454	41.8	57	13%	28	57	14%	28	28	28
SUB-455	19.0	61	3%	32	61	79%	16	1659	533

Subwatershed	Area (ac)	Existing Pervious CN	Existing % Impervious	Existing Tc (min)	Future and Master Plan Pervious CN	Future and Master Plan % Impervious	Future Conditions, No Controls Tc (min)	Master Plan 2-Year Tc* (min)	Master Plan 100-Year Tc* (min)
SUB-456	107.1	61	6%	37	61	16%	18	118	46
SUB-457	4.2	61	44%	14	61	56%	14	14	14
SUB-458	36.9	61	68%	21	61	76%	21	21	21
SUB-459	25.9	63	48%	39	63	68%	39	39	39
SUB-460	31.5	60	17%	32	60	19%	16	32	16
SUB-462	138.7	62	57%	23	62	75%	23	23	30
SUB-463	56.1	61	0%	55	61	80%	28	1762	531
SUB-464	125.7	62	22%	31	62	67%	15	15	15
SUB-474	191.3	61	1%	38	61	65%	19	1418	588
SUB-480	52.9	60	80%	22	60	80%	22	22	22
SUB-482	63.3	78	0%	33	71	40%	17	1631	694
SUB-484	29.1	67	2%	21	67	87%	7	2620	912
SUB-486	103.7	65	2%	25	65	89%	8	2265	1210
SUB-488	30.1	61	2%	25	61	60%	13	1275	473
SUB-490	18.0	61	12%	25	61	20%	25	25	25
SUB-492	16.8	63	3%	37	63	43%	18	932	242
SUB-494	24.2	63	1%	27	63	38%	13	814	367
SUB-496	17.7	65	0%	29	63	69%	14	1474	337
SUB-498	11.6	61	0%	25	61	61%	13	1209	325

*Tc values were lengthened to simulate the recommended Unit Rate runoff rate from future post-construction BMPs while also accounting for the full runoff volume.



City of Bismarck
Burleigh County, ND

Figure II-6

SILVER RANCH SUBWATERSHEDS & MODELING PARAMETERS

SILVER RANCH
WATERSHED STORMWATER
MASTER PLAN

Date: 10/26/2017

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II-2.2.7 Time of Concentration

Time of concentration (Tc) was determined using the methodology described in USDA Technical Report 55 – Urban Hydrology for Small Watersheds. Tc calculations for this master plan assumed a maximum sheet flow length of 100 feet and a minimum Tc length of 5 minutes. For each of the scenarios described in ***Section II-2.1,*** the Tc methodology and flow paths were adjusted to account for the conditions being analyzed. The following sections describe the Tc methodology for each scenario.

Existing Conditions Tc Approach

Existing Tc values were determined using LiDAR data and aerial imagery to determine flow path, slope, and surface conditions.

Future Conditions, No Controls

Tc values for Future Conditions, No Controls were estimated using adjustment factors to shorten Tc values determined for existing conditions. The adjustment factors were retrieved from other Master Plans within the City of Bismarck which reviewed representative sites. Applicability of these adjustment factors to the Silver Ranch Watershed was verified by reviewing representative sites within the watershed as a check. These adjustment factors were only applied to watersheds that are significantly undeveloped under existing conditions and will be significantly built-out under future conditions.

The adjustment factors are presented below:

- Undeveloped to Residential: 50% of Existing Tc
- Undeveloped to Commercial/Industrial: 33% of Existing Tc

Because most sub-watersheds had a mix of these land uses, the dominant land use within each sub-watershed was used to assign the adjustment factor.

Future Conditions, Local Pre-Post Tc Approach

In order to determine the overall watershed response to local on-site stormwater management, the Tc was lengthened for each sub-watershed until future conditions peak discharge rates matched existing peak discharge rates. This methodology allows for increases in runoff volume to be properly accounted for in the analysis.

Master Planned Conditions, Unit Rate Tc Approach

As discussed in Volume I of this Master Plan, a key recommendation is that future development be required to meet a specified Unit Rate Release for the 2- and 100-year events. Because it would be impractical to size a detention basin and outlet structure for every sub-watershed in this Master Plan, an approach of lengthening the Tc for each sub-watershed such that the

Master Plan peak runoff for each sub-watershed met the Unit Rate Release criterion. In other words, the longer the Tc is, the lower the peak runoff becomes, so a longer Tc can be used to approximately simulate the effect of a detention basin.

II-2.3 GENERAL HYDRAULIC ANALYSIS METHODS

The hydraulics of the Silver Ranch Watershed main drainage-ways were simulated to reflect existing and future conditions as closely as possible. Hydraulic performance was analyzed using the dynamic wave routing model with InfoSWMM. The hydraulic model network is shown in ***Figure II - 7*** and ***Figure II - 8***. Performance of roadway crossing sizing recommendations were also reviewed in HY8 (a culvert hydraulic computation program) to provide a quality control to the recommendations obtained from InfoSWMM.

Channel flow was modeled in InfoSWMM using natural cross sections assembled from in-field survey and LiDAR data. Culvert sizes, inverts, and material type were determined based on AE2S field survey data, NDDOT data, City of Bismarck survey data, and stormwater management plans provided by the City of Bismarck. Field data collected by AE2S is included as a Survey Map Book in ***Section II-6.0***.

Roughness coefficients were determined based on site visits, site photos, aerial imagery, and Google street view. All vegetated channels, reinforced concrete pipe (RCP), and corrugated metal pipe (CMP) were assigned a roughness of 0.05, 0.013, and 0.024, respectively.

II-2.3.1 Hydraulic Structure Sizing

As part of the Master Plan analyses, hydraulic analysis and structure design was performed for existing crossings, future crossings identified by the 2014 Fringe Area Road Master Plan, and other road crossings identified by the City Working Group. The structure designs and sizes are presented in ***Section II-4.0***. Additional detail is provided in the following sections for various road classifications.

Arterial Roads

Changes to the proposed infrastructure size(s) shall require the Master Plan InfoSWMM model be revised, or other City-approved methods be used, to demonstrate that the upstream headwater and downstream discharge at the crossings comply with the Master Plan. Any crossings not identified by the Master Plan shall be shown to not produce a 100-year headwater that exceeds the Master Plan development setback line and must comply with State Stream Crossing Standards.

Collector Roads

Changes to the proposed infrastructure size(s) shall require the Master Plan InfoSWMM model to be revised, or other City-approved methods be used, to demonstrate that the upstream headwater and downstream discharge at the crossings comply with the Master Plan. Any crossings not identified by the Master Plan shall be shown to not produce a 100-year headwater that exceeds the Master Plan development setback line and must comply with State Stream Crossing Standards.

Local Roads

Design of local road crossings shall be shown to produce a headwater elevation that does not exceed the Master Plan development setback line and shall comply with State Stream Crossing Standards. Analysis of local road crossings shall be performed using HY8 or other method approved by the SWDSM. Flows at quarter section increments are presented on ***Figures I – 9***, ***I – 10***, and ***I – 11*** of ***Volume I***.

II-2.3.2 Development Setback Line

A Development Setback Line was created along the major drainage-ways in the Silver Ranch Watershed by adding 1-foot of freeboard to the maximum water surface elevation at each junction along the major drainage-ways. Maximum water surface elevations were determined by using the higher water surface elevation of the "Existing Conditions," "Master Planned Conditions, Unit Rate," and the "Hydraulic Design for Future Crossings" scenarios. In addition to the development of the Development Setback Line, specific areas were identified as Potential Fill Areas. These are areas that are not critical to the conveyance of water and may be filled to the designated elevation without impacting the conveyance of the drainage-way. Proposed encroachments within the Development Setback Line shall be required to verify conveyance capacity is not impacted and that headwaters are not increased for the 100-year event. Appropriate mitigation measures shall be required for any encroachment to occur with the Development Setback Line. Development Setback Lines and Potential Fill Areas, and elevations corresponding to each are presented on ***Figure II - 9*** and ***Figure II - 10***.

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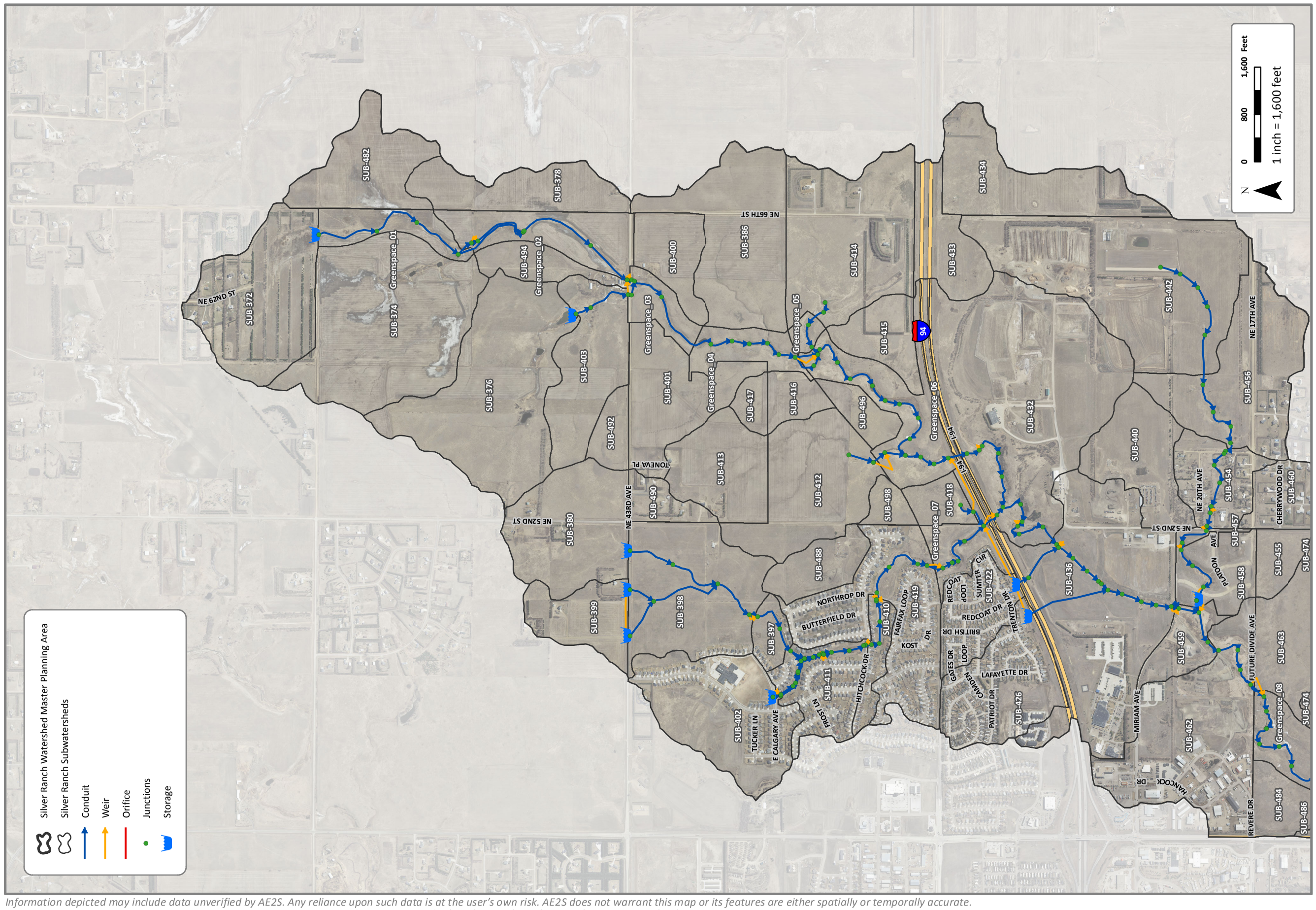

Locator Map Not to Scale

City of Bismarck
Burleigh County, ND

Figure II-7

SILVER RANCH INFOSWMM MODEL NETWORK (NORTH)

SILVER RANCH
WATERSHED STORMWATER
MASTER PLAN

Date: 10/26/2017

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Coordinate System: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Intl | Edited by: dlee | C:\Data\Projects\WAFS\Bismarck\00501-2015-013\GIS\Report Figure II-7- Silver Ranch Silver Ranch InfoSWMM Model Network North.mxd

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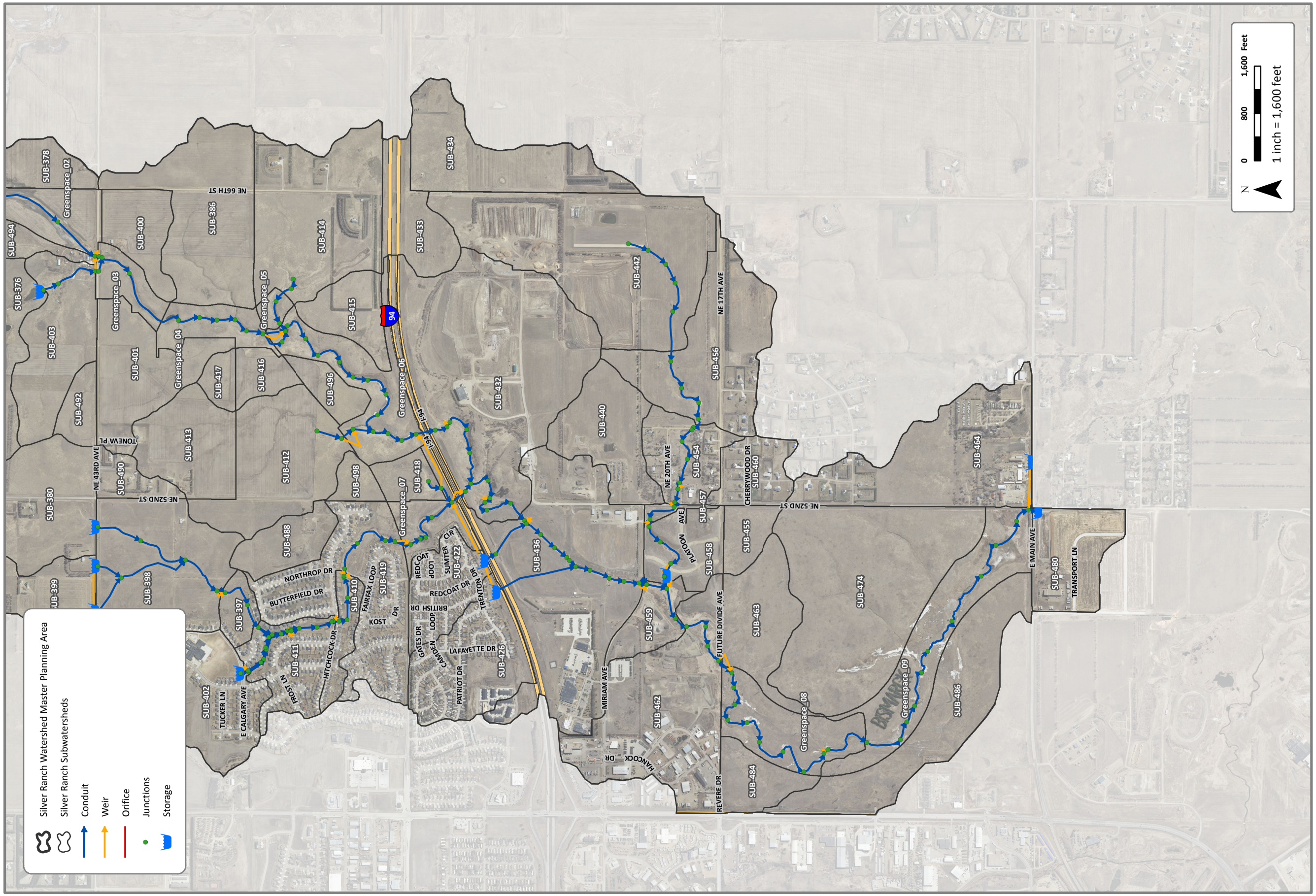

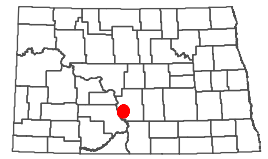

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City of Bismarck
Burleigh County, ND

Figure II-8

SILVER RANCH INFOSWMM MODEL NETWORK (SOUTH)

SILVER RANCH WATERSHED STORMWATER MASTER PLAN

Date: 10/26/2017

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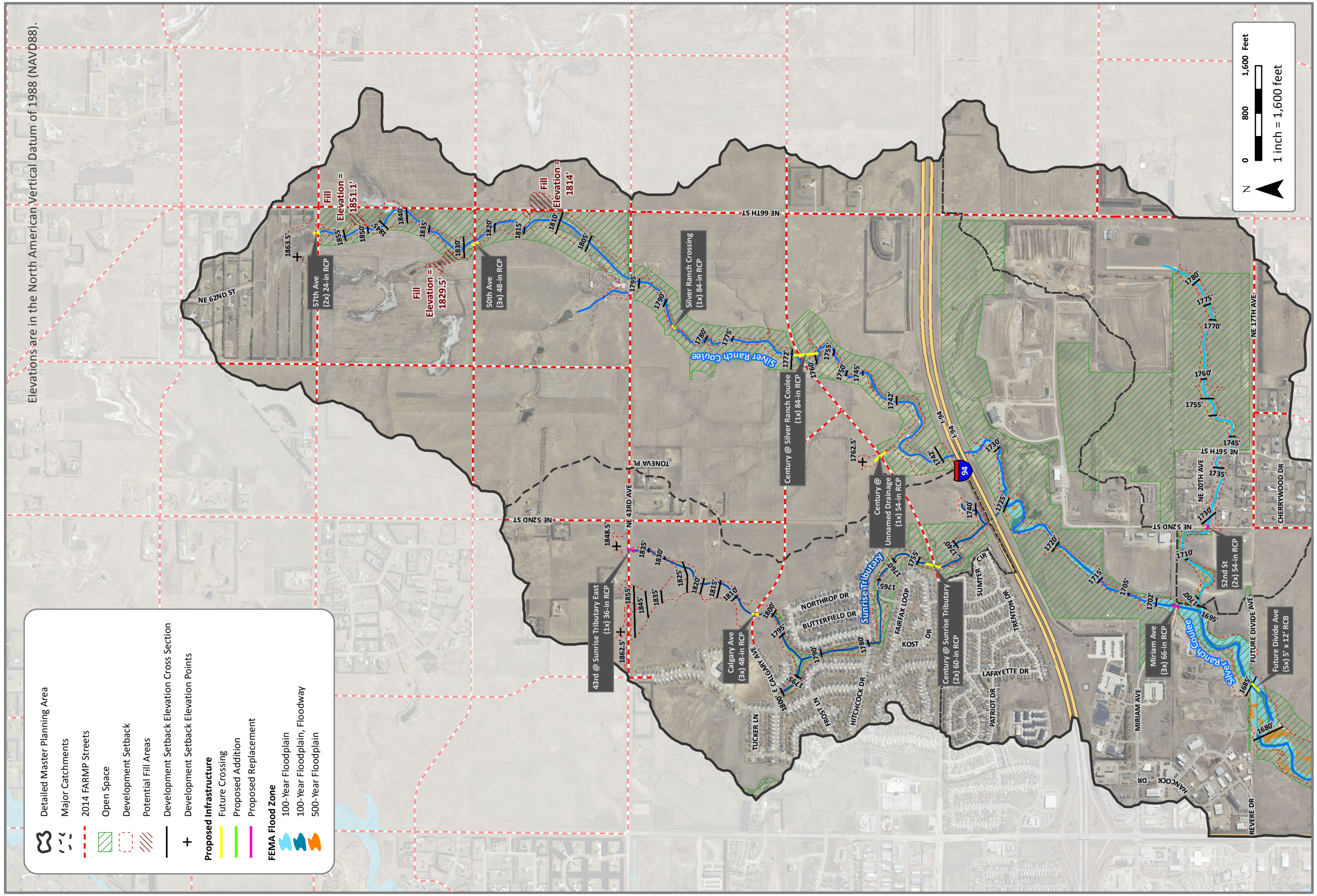
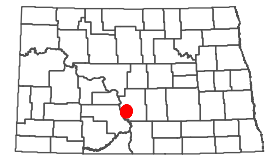
Elevations are in the North American Vertical Datum of 1988 (NAVD88).





Locator Map Not to Scale

City of Bismarck
Burleigh County, ND

Figure II-9

MASTER PLAN IMPROVEMENTS & DEVELOPMENT SETBACK LINE (NORTH)

SILVER RANCH
WATERSHED STORMWATER
MASTER PLAN

Date: 1/17/2018

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Coordinate System: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Intl | Edited by: dlee | C:\Data\Projects\WAFS\Bismarck\00501-2015-013\GIS\Report Figure II-9- Master Plan Improvements North.mxd

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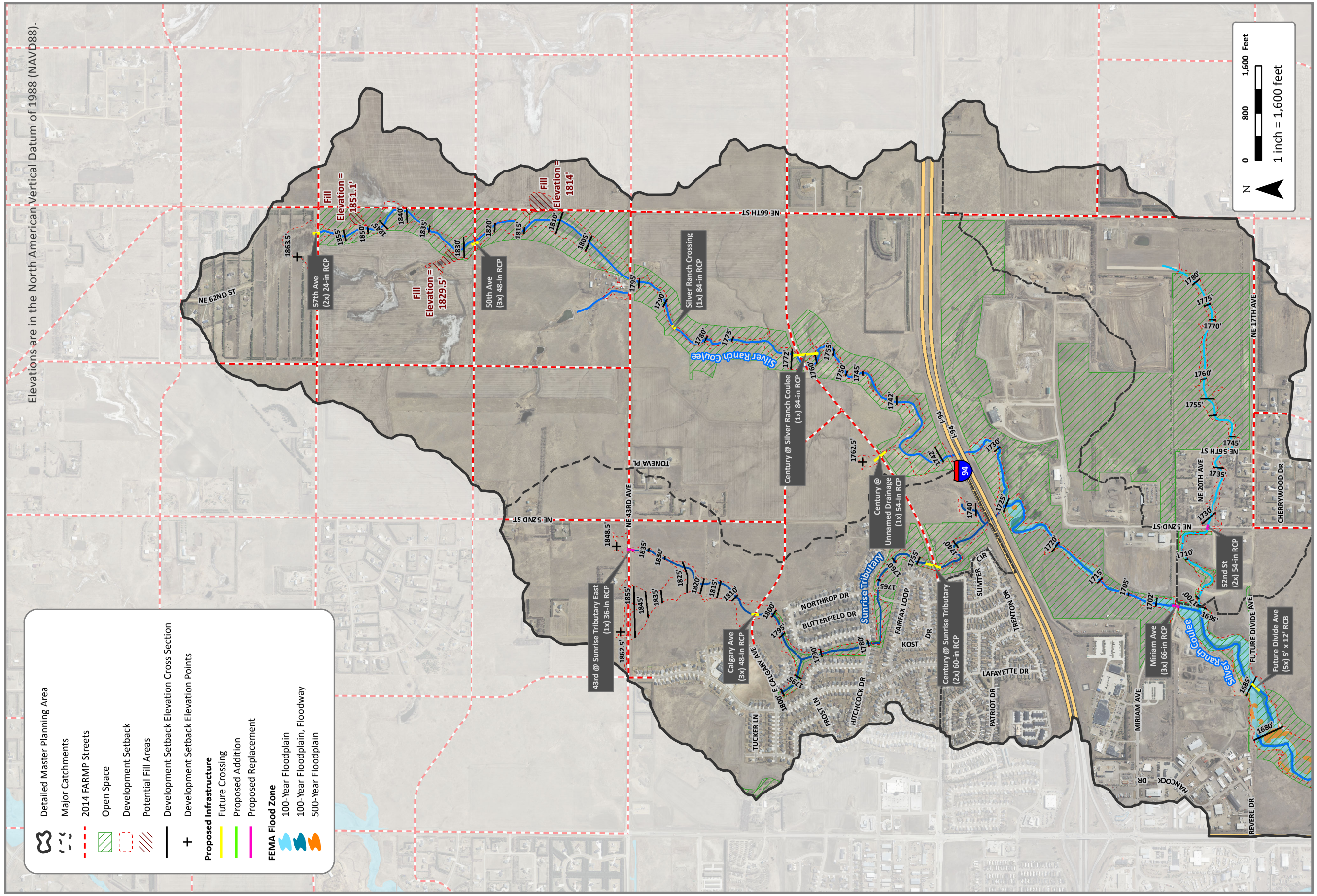

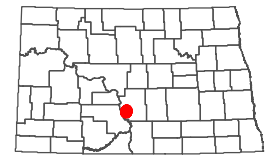

Locator Map Not to Scale

City of Bismarck
Burleigh County, ND

Figure II-9

MASTER PLAN IMPROVEMENTS & DEVELOPMENT SETBACK LINE (NORTH)

SILVER RANCH
WATERSHED STORMWATER
MASTER PLAN

Date: 1/17/2018

Information depicted may include data unverified by AE2S. Any reliance upon such data is at the user's own risk. AE2S does not warrant this map or its features are either spatially or temporally accurate.

Coordinate System: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Intl | Edited by: dlee | C:\Data\Projects\WAFS\Bismarck\00501-2015-013\GIS\Report Figure II-9- Master Plan Improvements North.mxd

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II-3.0 UNIT RATE JUSTIFICATION

In the development of this Master Plan, the following unique concepts were analyzed and reviewed to determine suitability for this watershed:

1. **Local Facilities, Pre-Post** where individual property owners/developers design, construct, and maintain post-construction stormwater Best Management Practices (BMPs) sized such that post-construction runoff did not exceed existing runoff from a site (meeting the City's Code of Ordinances). This method utilizes the traditional pre\post method of peak flow compliance and does not provide a reasonable mitigation for the increased stormwater volumes through-out the watershed.

   Regional Facilities, Pre-Post consisting of large post-construction stormwater BMPs constructed to provide peak flow mitigation and water quality compliance for multiple properties and/or projects. This method utilizes peak flow compliance at strategic locations throughout the watershed that can mitigate for increased stormwater volumes in the watershed by effectively "over-detaining" runoff on a large scale.
2. **Local Facilities, Unit Rate Method** consists of determining an optimal peak rate of runoff from the areas currently undeveloped within the watershed and designating a specific rate of runoff per acre for various storm events to provide peak flow compliance at strategic locations throughout the watershed. This approach is similar to a traditional pre-post approach to managing post-construction runoff, but eliminates the need for determining existing runoff conditions. A Unit Rate method can be applied with onsite or local BMPs.

As described in ***Section I-6.0***, it was determined that the Unit Rate method of stormwater management was the only concept that achieved all of the goals of the Master Plan.

II-3.1 SELECTION OF UNIT RATE FOR STORMWATER MANAGEMENT

The recommended Master Plan approach for meeting peak discharge requirements is to utilize a Unit Rate for stormwater management. Compliance with the Unit Rate release requirements results in all of the Primary Goals for this Master Plan being accomplished. One of the main reasons this requirement was selected is that it allows for stormwater practices to be designed and constructed when and where development occurs and provides flexibility in the location of the stormwater facilities. Please see ***Table II - 5*** for a comparison of the goals and stormwater management methods.

Table II - 5: Master Plan Concept Comparison

Primary Goal	Local Pre-Post	Regional Facilities	Unit Rate
Goal 1: Minimize downstream impacts from urbanization.		✓	✓
Goals 2: Match pace of development.	✓		✓
Goal 3: Flexible funding and minimized financial impacts to City.	✓		✓
Goal 4: Integrate with applicable planning documents.	✓	✓	✓

II-3.2 UNIT RATE DEVELOPMENT

The proposed Unit Rate values were determined using an iterative, trial and error approach with goal compliance being reviewed at the Points of Compliance (***Figures I–5 & I–6***) for each iteration.

Goal 1 was assumed to be met when peak flows and headwaters for the 2- and 100-year events were not increased over existing conditions at the Points of Compliance. If the Unit Rate values used for an iteration produced runoff rates and/or headwaters that did not meet the Goal 1 at the Points of Compliance, the values were adjusted and another iteration was performed and reviewed. This iterative approach was performed until values were identified that adequately achieve compliance with Goal 1.

Post-construction water quality was not analyzed as part of this Master Plan. Post-construction water quality compliance will be required for each development.

II-3.3 UNIT RATE RECOMMENDATIONS

Compliance with the following recommendations is necessary to accomplish the Master Plan Goals:

1. **Achieve peak flow compliance by utilizing local and onsite stormwater BMPs using the Unit Rate Method of sizing.** The Master Plan Condition, Unit Rate H&H model demonstrates that implementing a policy that utilizes local BMPs sized for an allowable Unit Rate can achieve the goals of this study. The allowable Unit Rate for post-construction runoff from the 2- and 100-year 24-hour rainfall events should not exceed the runoff rates calculated using the following values:
    - 2-Year Storm = 0.06 cfs/acre
    - 100-Year Storm = 0.50 cfs/acre

2. **An amount of pervious area equaling up to 10% of the total site area may be discharged directly offsite without being routed through the peak flow BMP**. The allowable Unit Rate was developed assuming that 10% of the future condition pervious area would not be routed through the stormwater detention feature. It can be assumed that during the urbanization of the watershed that topographic and other constraints will result in portions of development sites not being able to drain to stormwater detention ponds. An amount of pervious ground, not to exceed 10% of site's total area, may discharge directly offsite without mitigation in a Post-Construction BMP. This amount of undetained runoff has been accounted for in the development of the recommended Unit Rate.

3. **Development should comply with the stipulations of the Peak Flow Compliance Method Zone within which it is shown on *Figure II - 11*.** Descriptions and stipulations of the Runoff Control Method Zones are provided below:

    a) Follow Unit Rate Method: This zone represents those areas where development and redevelopment activities should follow the recommended Unit Rate discharge. It is understood that significant portions of this zone include areas that in the existing condition have already been developed. The post-construction runoff from these existing development areas has been accounted for in the recommended allowable Unit Rate. After adoption of this master plan, if these existing development areas were to redevelop and require a mandatory stormwater permit, the redevelopment activities should be required to provide mitigation to meet the allowable Unit Rate discharge.

    b) Follow Approved Stormwater Management Plan: These areas are projects that the City noted as having approved Stormwater Management Plans meeting Title 14.1 of the City Code of Ordinances or being in the process of developing such a plan that have not yet completed the development activities. In general, these developments will utilize a traditional pre-post method of stormwater management. It is recommended that if there is significant alternation to the proposed projects, or the projects are not completed, future Plat and Post-Construction Stormwater Management Permit (PCSMP) applications be required to meet the recommend allowable Unit Rate discharges.

    c) Greenway/Open Space, No Control: This area is generally defined under future land use as having an Open Space designation. No development is to occur within this area and runoff within that zone shall discharge directly to the drainage-way without peak flow mitigation. If development or redevelopment activities encroach within this zone, the allowable Unit Rate discharge rates should be applied.

4. **Arterial roads must meet stormwater quality compliance and peak runoff compliance is optional** As a requirement of the MS4 permit, arterial road construction will need to provide water quality compliance. The Master Plan Condition H&H model was developed assuming run-off from arterial roadways was not subject to the allowable Unit Rate as it is often impractical to create large stormwater management practices for linear corridors. Where practical, it is recommended that the City meet the peak flow compliance from arterial roads even though undetained runoff from arterial roads is accounted for in development of the Unit Rate recommendations.

5. **Water quality shall be provided per the SWDSM to meet the City's MS4 Permit**. All development and redevelopment projects that require a PCSMP should provide local or onsite BMPs for stormwater quality compliance. This Master Plan did not recommend any regional or other watershed specific water quality BMPs. Management of post-construction stormwater quality is best achieved with BMPs that match the pace of development.

6. **Development and redevelopment activities should not be allowed to encroach into the Development Setback Line.** A development setback line was developed along major drainages and is presented on

7. ***Figure II - 9*** and ***Figure II - 10*** along with cross sections showing the elevation of the setback. Development or redevelopment activities that encroach into the Development Setback Line should include the following:

    a) Document that the proposed encroachment does not reduce the ability of the conveyance to carry the 2- and 100-year design flows without increasing elevations upstream or downstream of the property;

    b) Document that the proposed encroachment does not reduce the runoff storage capacity of the area or provide for additional, equivalent storage adjacent to the encroachment; and

    c) Document that any structures placed in the proposed encroachment area are sufficiently elevated to protect against flooding.

8. **Existing and future road crossings shall meet the City's level of service criteria and the State's stream crossing standards.** Improvements to road crossings, or construction of future road crossings, should not result in headwater elevations that exceed the Development Setback Line elevation in that specific area.

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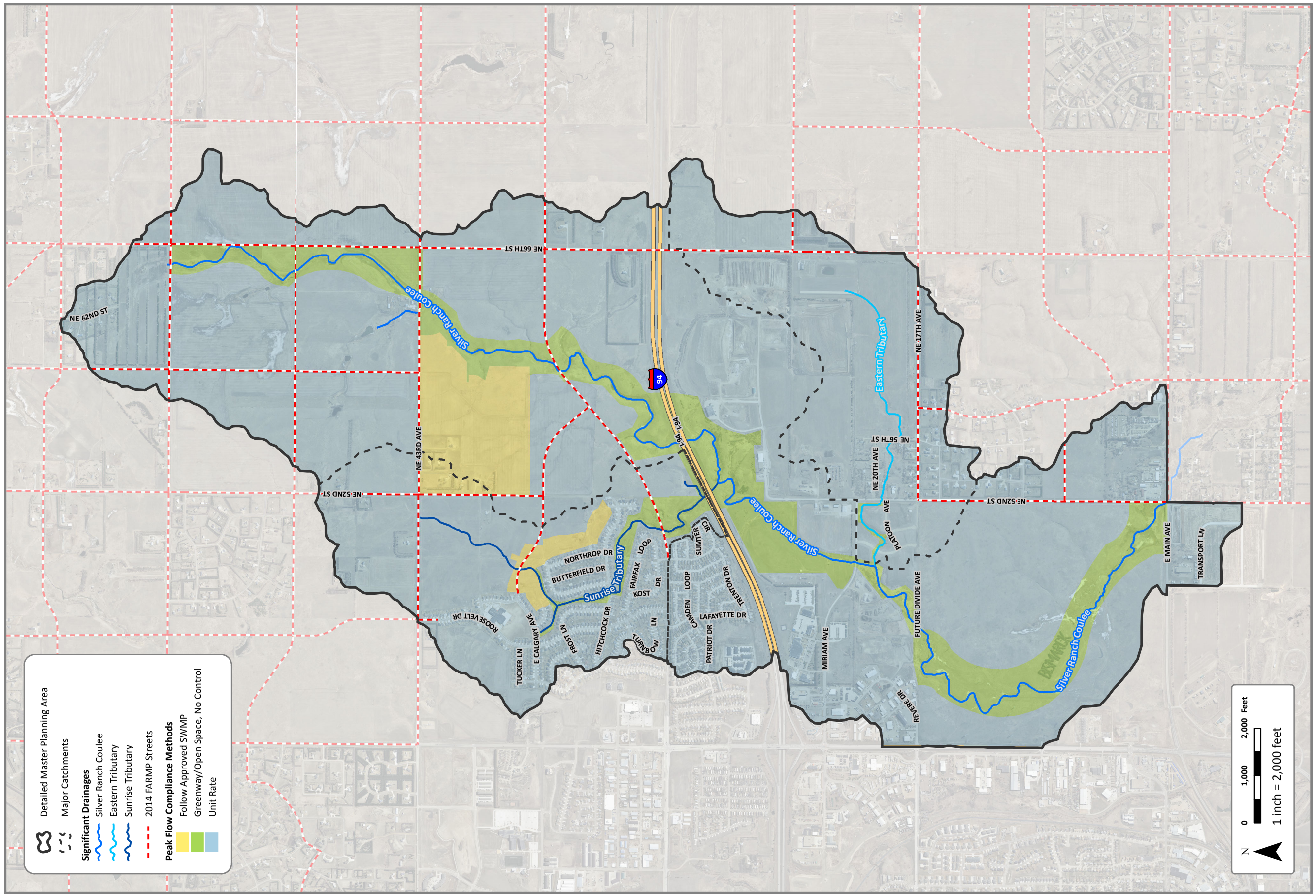

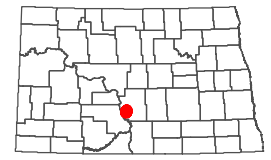

Locator Map Not to Scale

City of Bismarck
Burleigh County, ND

Figure II-11

PEAK FLOW COMPLIANCE METHODS

SILVER RANCH WATERSHED STORMWATER MASTER PLAN

Date: 10/26/2017

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Coordinate System: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Intl | Edited by: dlee | C:\Data\Projects\WAFS\Bismarck\00501-2015-013\GIS\Report Figure II-11- Peak Flow Compliance Methods.mxd

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II-4.0 IMPROVEMENT PLAN

Included in the development of the Master Plan are specific improvement recommendations necessary to achieve the master plan goals. In general, because the stormwater management concept for this Master Plan is to utilize local BMPs with unit rate methodology, there are no specific regional improvements to be implemented other than at existing and future road crossings.

II-4.1 RECOMMENDED IMPROVEMENTS

Conceptual designs for existing and future roadway crossings were developed for all arterial and collector streets identified in the master planning area as well as for local street crossings as identified or requested by the City Working Group. As summary of these crossing and opinion of total costs is provided in the table below.

Table II - 6 Silver Ranch Road Crossing Summary

Crossing ID	Type	Opinion of Total Costs
#1 57th Ave	Future	$375,000
#2 50th Ave	Future	$440,000
#3 43rd Ave 1A & 1B	Existing	$560,000
#4 43rd Ave 2, 3 & 4	Existing	$150,000
#5 Calgary Ave	Future	$275,000
#6 Century Ave 1	Future	$750,000
#7 Century Ave 2	Future	$315,000
#8 Century Ave 3	Future	$430,000
#9 Miriam Ave	Existing	$425,000
#10 52nd St	Existing	$235,000
#11 Future Divide Ave	Future	$5,945,000
#12 East Main Avenue	Existing	$1,275,000
#13 Silver Ranch Rd	Future	$430,000
	Total	**$11,605,000**

The locations of these crossings are shown on ***Figure II - 9*** and ***Figure II - 10.*** Crossing summary "cut sheets" are included in ***Volume I*** for each of the road crossing improvements identified above that summarize the proposed improvement, design criteria, major bid items, and opinion of total costs.

II-4.2 DETAILED OPINION OF PROBABLE COSTS

Detailed costs estimates were developed for each of the crossings for the purpose of allocating the stormwater improvements to the street construction. The costs of constructing the entire roadway were not included (pavement, base material, etc.) and costs were developed utilizing the following general assumptions:

1. Unit costs were developed from similar bid prices on recent regional projects, NDDOT average bid prices, and discussions with suppliers.
2. A 30% contingency has been applied to the estimated major bid items in recognition that not all construction elements have been identified. The detailed opinion of costs are based on feasibility design concepts and general practice is to apply a 30%-50% contingency to this level of cost estimate.
3. Design engineering, construction engineering, and administrative costs have been included as a percentage of the estimated construction costs.
4. Earthwork quantities were estimated to the lower of either 1-foot above the calculated 100-year WSE or the roadway overflow elevation. This method allocated a portion of the roadway embankment to the stormwater improvements while recognizing that the vertical alignment of the road may increase the amount of earthwork necessary. It is assumed that the additional earthwork costs above the stormwater allocation will be applied to the road project.

II-4.3 PRELIMINARY DESIGN EXHIBITS

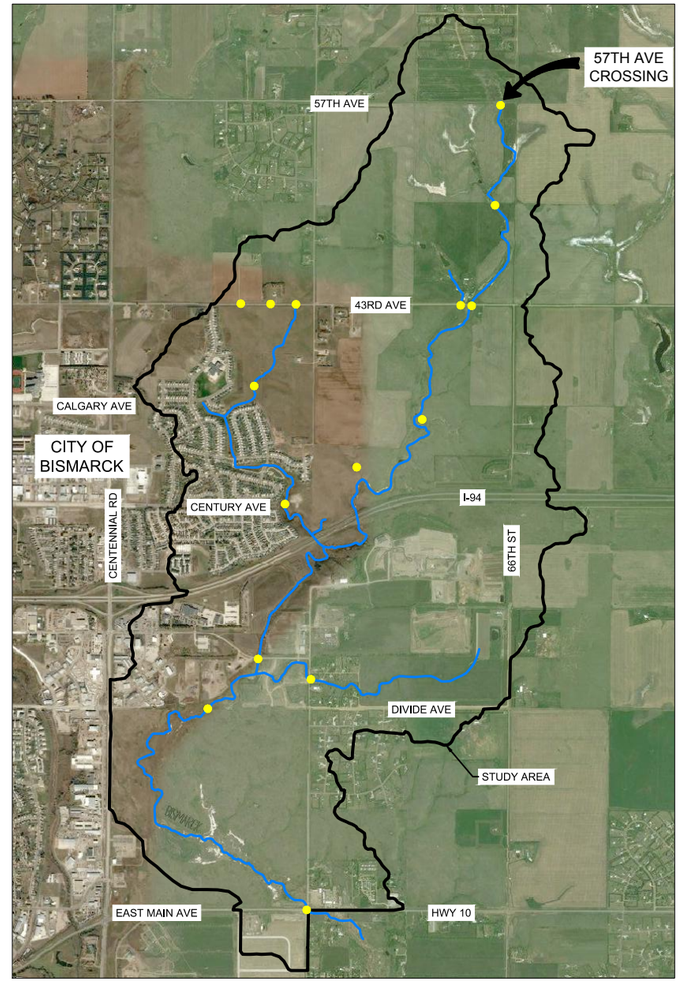
Preliminary grading and hydraulic designs in the form of plan and profile exhibits are provided for the proposed crossings and key existing crossing locations. Preliminary design exhibits were not developed for the following existing crossings:

Crossing #4 43rd Ave 2, 3 & 4: Exhibits were not developed for these crossings as the improvements consist of extending existing culverts to match the embankment limits of a future 43rd Ave conversion from a rural section to an urban section roadway.

Crossing #9 Miriam Ave: Exhibits were not developed for this crossing because the improvements are a recommended upgrade to an existing culvert crossing location and it was assumed that there was no change to the roadway vertical profile or typical section.

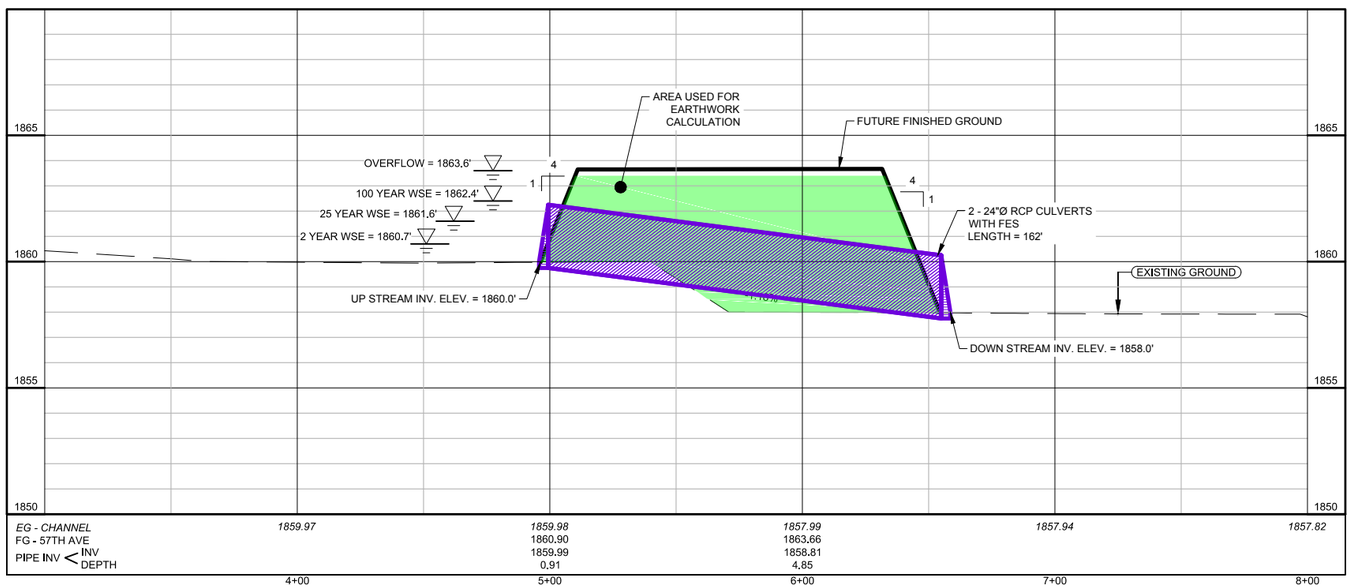
Crossing #10 52nd St: Exhibits were not developed for this crossing because the improvements are a recommended upgrade to an existing culvert crossing location and it was assumed that there was no change to the roadway vertical profile or typical.

Crossing #13 Silver Ranch Rd: Exhibits were not developed for this crossing because the roadway is a local street and will be installed during the normal subdivision improvement process.



LOCATION MAP

SCALE: NONE



ESTIMATED MAJOR QUANTITIES

Spec	Description	Unit	Quantity
202-4.1	Unclassified Excavation	CY	20,000
802-4.5	24" Storm Sewer Pipe	LF	324
802-4.55	24" FES	EA	4
SP	Final Stabilization	SF	205,000

NOTE:
ELEVATIONS ON THIS EXHIBIT ARE IN THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).

PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

AE2S

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
CITY OF BISMARCK
BISMARCK, NORTH DAKOTA
FUTURE 57TH AVENUE ROAD CROSSING

DRAWING TYPE: EXHIBIT
PREPARED BY: TRK
CHECKED / APPROVED: BE / JH
DATE: SEPT 2017
PROJECT NUMBER: P00501-2015-013
SHEET: - of -
DRAWING: 1A

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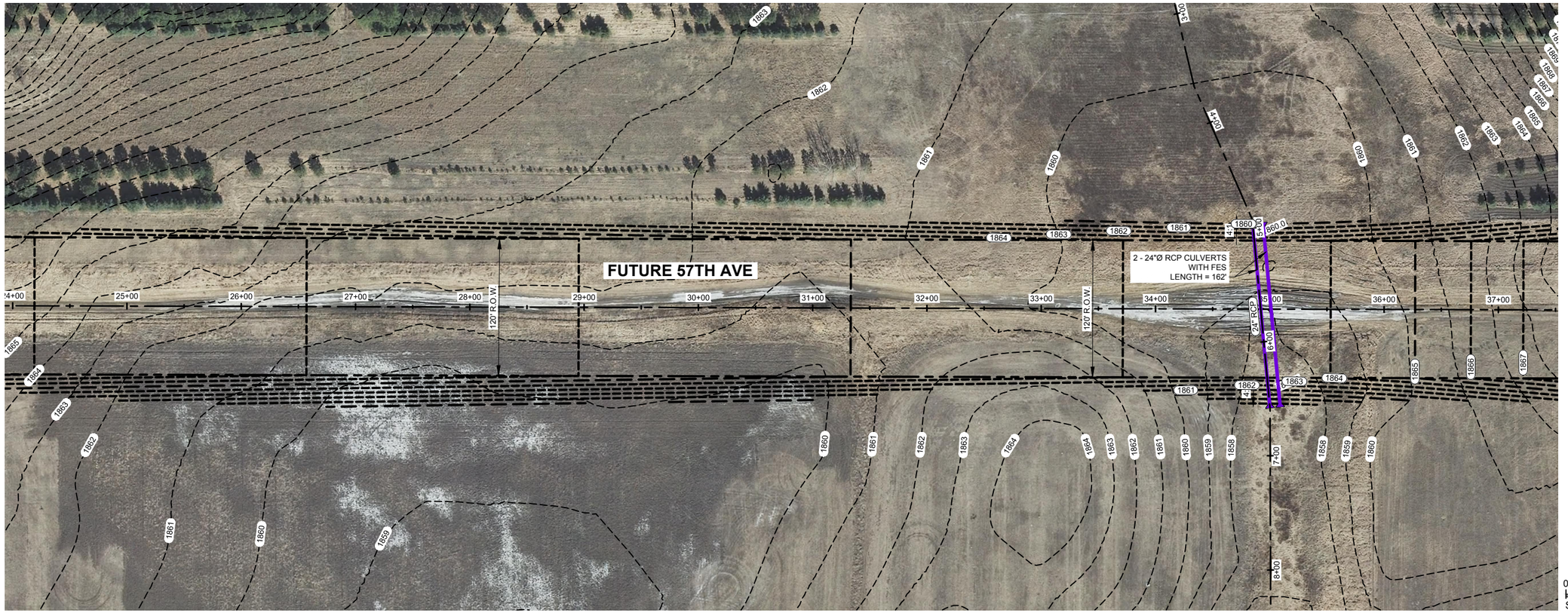
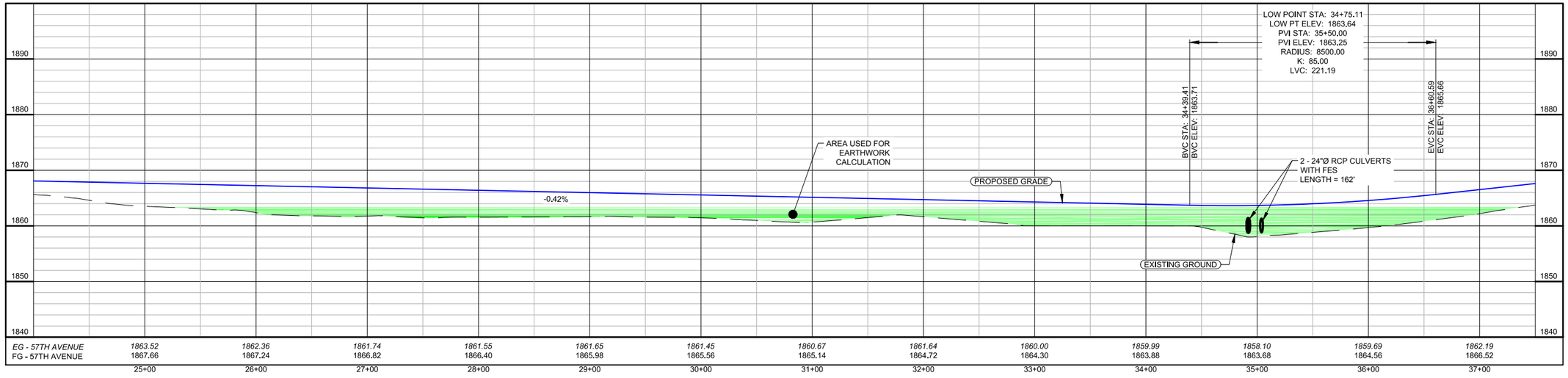


NOTE:
ELEVATIONS ON THIS EXHIBIT ARE IN THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).



PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

AE2S

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
CITY OF BISMARCK
BISMARCK, NORTH DAKOTA
FUTURE 57TH AVENUE ROAD CROSSING

DRAWING TYPE	EXHIBIT
PREPARED BY	TRK
CHECKED / APPROVED	BE / JH
DATE	SEPT 2017
PROJECT NUMBER	P00501-2015-013
SHEET	- of -
DRAWING	1B

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Improvement ID: *57th Ave Crossing*

	Description	Units	Unit Price	Quantity	Total Price
General					
	Insurance and Bonding (3%)	LS	3%		$ 6,700
	Mobilization (6%)	LS	6%		$ 13,300
Pipe Conduit & Culverts					
802-4.5	24" Storm Sewer Pipe	LF	$ 105	324	$ 34,020
End Treatments					
1205-4.1	48" Dia and Smaller	Each	$ 4,000	4	$ 16,000
Earthwork					
202-4.1	Unclassified Excavation	CY	$ 8.00	20,000	$ 160,000
	Vegetation	SF	$ 0.05	205,000	$ 10,250
Unanticipated & Contingency					
	Construction Contingency (30%)	LS	30%		$ 72,081
Subtotal Construction Costs					**$ 312,351**
Administration & Engineering					
	Design Engineering	LS	6%		$ 18,741
	Construction Engineering	LS	10%		$ 31,235
	Administrative	LS	7%		$ 21,865
Subtotal Administration & Engineering					**$ 71,841**
Opinion of Project Construction Costs					**$ 384,192**

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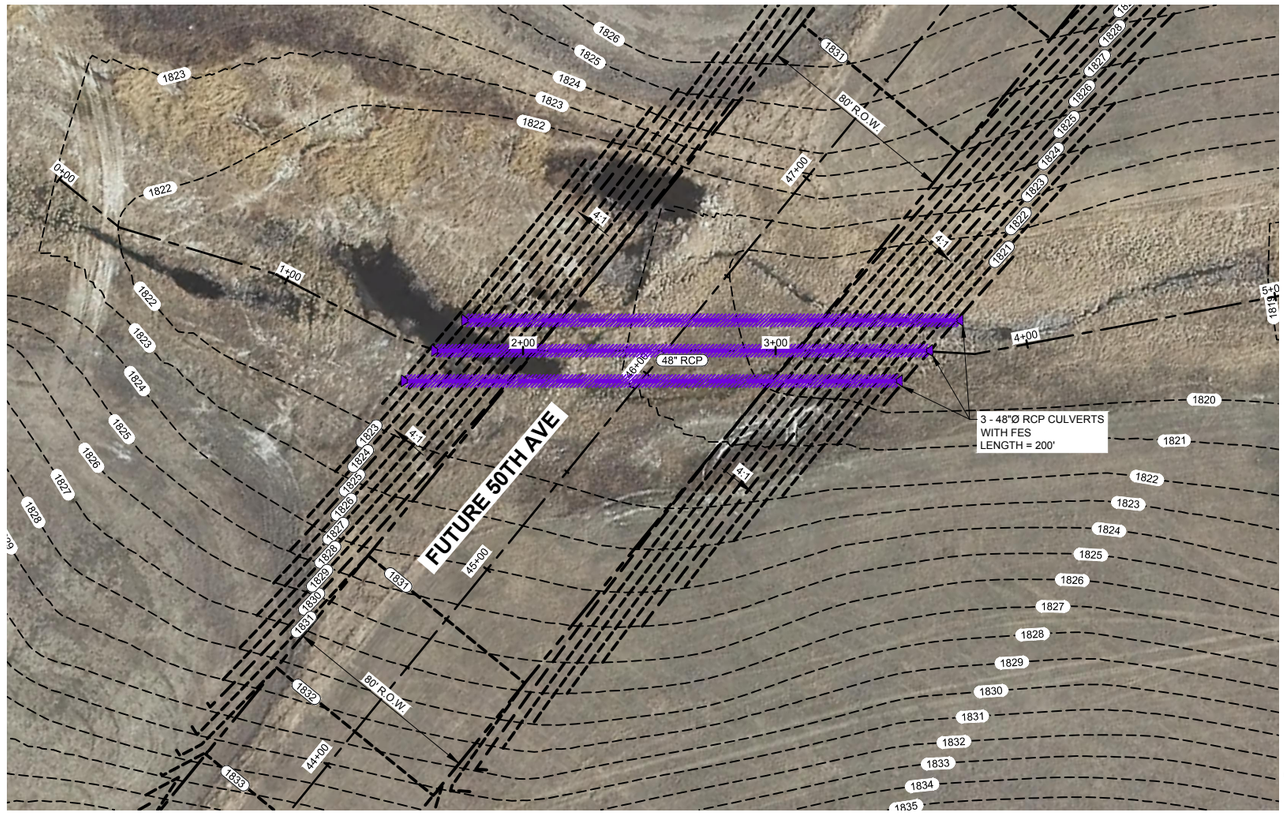
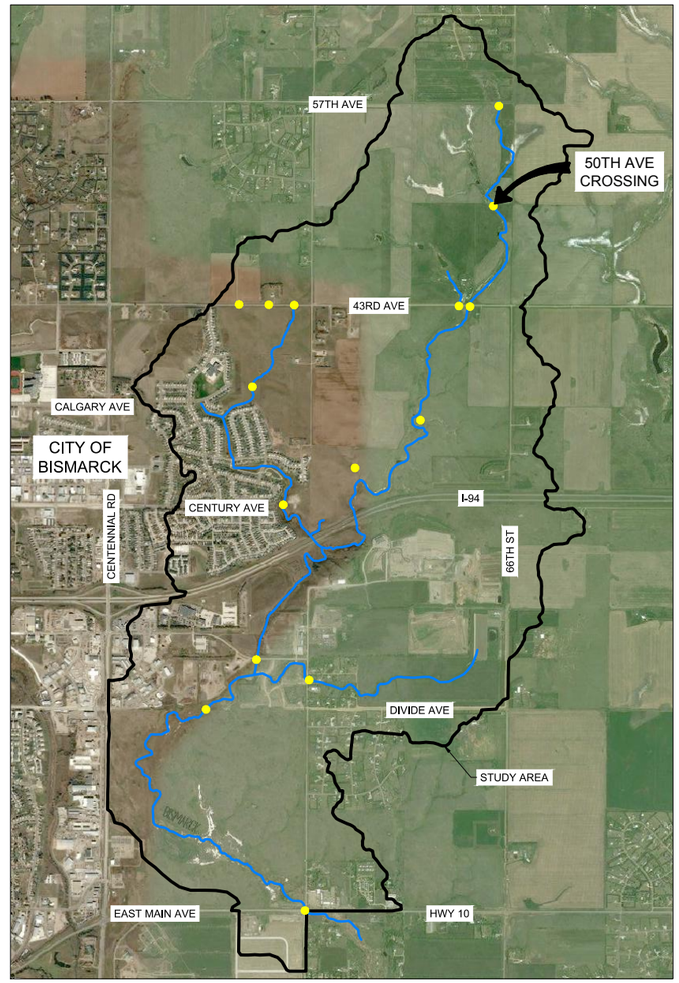
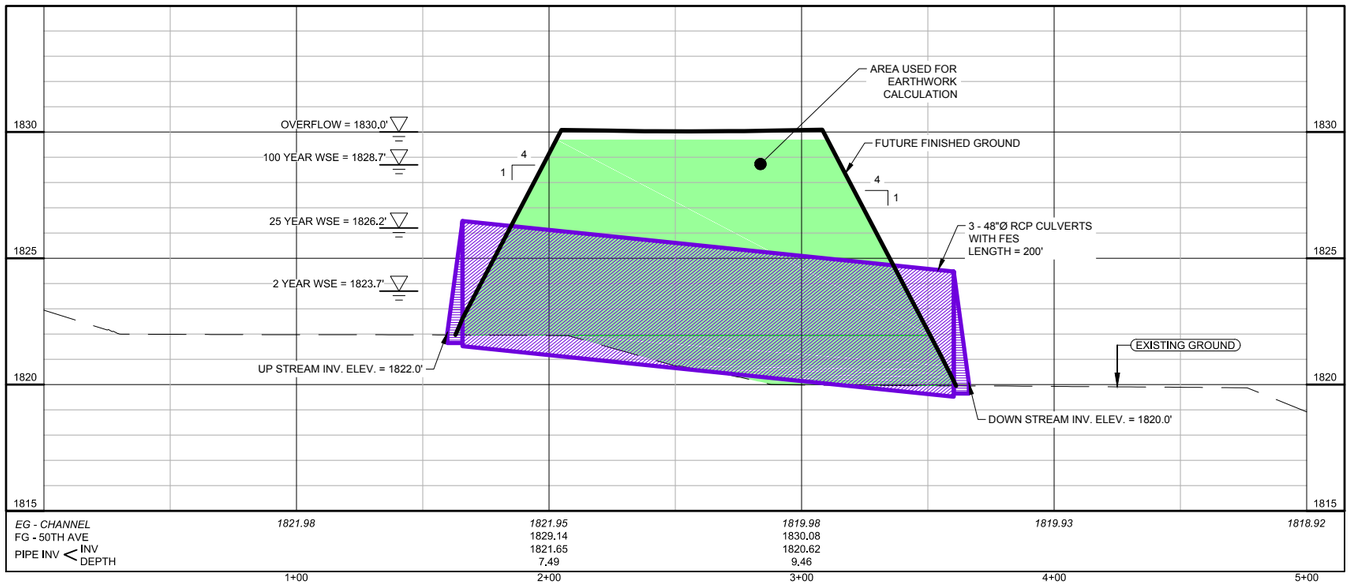




LOCATION MAP

SCALE: NONE



ESTIMATED MAJOR QUANTITIES

Spec	Description	Unit	Quantity
802-4.11	48" Storm Sewer Pipe	LF	600
202-4.1	Unclassified Excavation	CY	12,000
SP	Final Stabilization	SF	46,000
802-4.61	48" FES	EA	6

NOTE:
ELEVATIONS ON THIS EXHIBIT ARE IN THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).

PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

AE2S

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
CITY OF BISMARCK
BISMARCK, NORTH DAKOTA
FUTURE 50TH AVENUE ROAD CROSSING

DRAWING TYPE: EXHIBIT
PREPARED BY: TRK
CHECKED / APPROVED: BM / JH
DATE: SEPT 2017
PROJECT NUMBER: P00501-2015-013
SHEET: - of -
DRAWING: 2A

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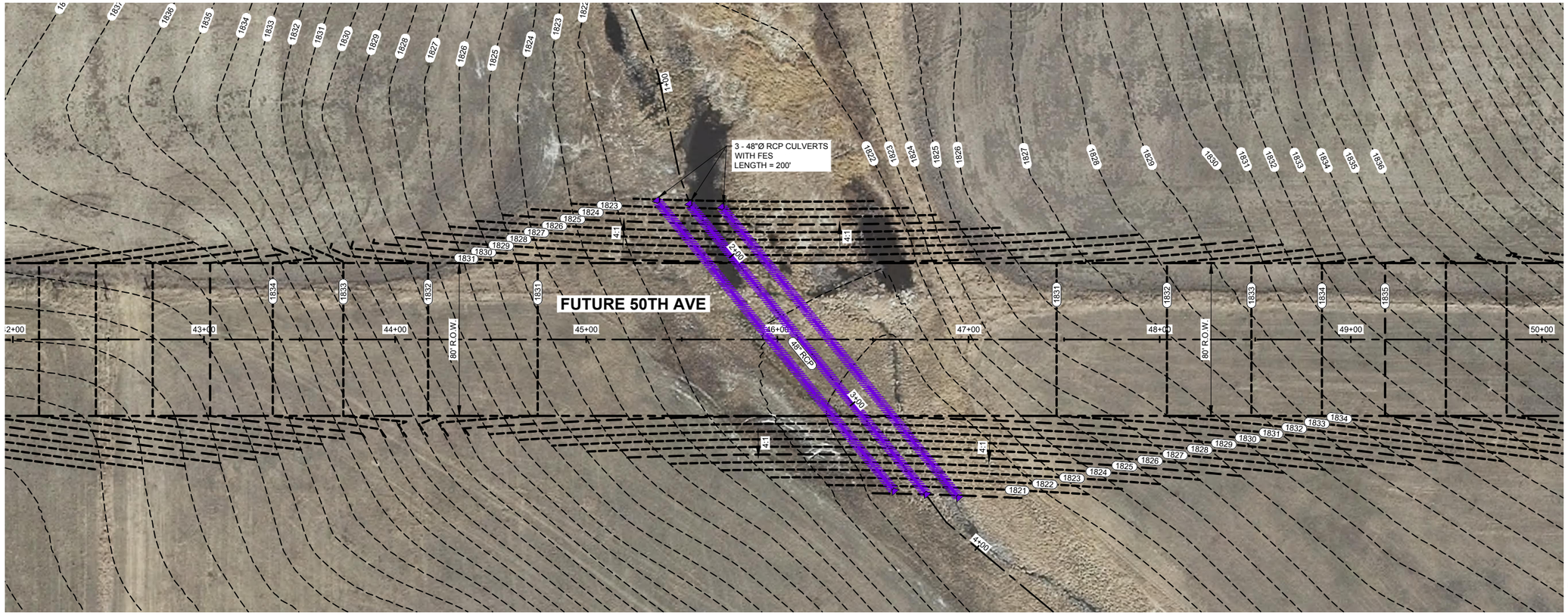
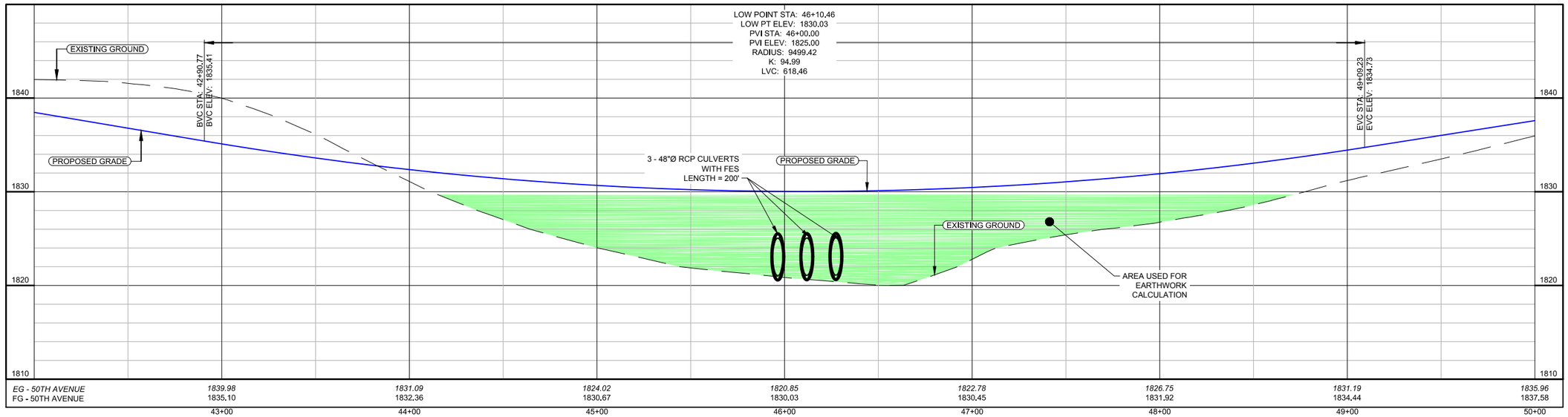


NOTE:
ELEVATIONS ON THIS EXHIBIT ARE IN THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).



PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

AE2S

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
CITY OF BISMARCK
BISMARCK, NORTH DAKOTA
FUTURE 50TH AVENUE ROAD CROSSING

DRAWING TYPE	EXHIBIT
PREPARED BY	TRK
CHECKED / APPROVED	BM / JH
DATE	SEPT 2017
PROJECT NUMBER	P00501-2015-013
SHEET	- of -
DRAWING	2B

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Improvement ID: *50th Ave Crossing*

	Description	Units	Unit Price	Quantity	Total Price
General					
SP	Insurance and Bonding (3%)	LS	3%		$ 7,800
SP	Mobilization (6%)	LS	6%		$ 15,500
Pipe Conduit & Culverts					
802-4.11	48" Storm Sewer Pipe	LF	$ 225	600	$ 135,000
End Treatments					
1205-4.1	48" Dia and Smaller	Each	$ 4,000	6	$ 24,000
Earthwork					
202-4.1	Unclassified Excavation	CY	$ 8.00	12,000	$ 96,000
SP	Final Stabilization	SF	$ 0.05	46,000	$ 2,300
Unanticipated & Contingency					
	Construction Contingency (30%)	LS	30%		$ 84,180
Subtotal Construction Costs					**$ 364,780**
Administration & Engineering					
	Design Engineering	LS	6%		$ 21,887
	Construction Engineering	LS	10%		$ 36,478
	Administrative	LS	7%		$ 25,535
Subtotal Administration & Engineering					**$ 83,899**
Opinion of Project Construction Costs					**$ 448,679**

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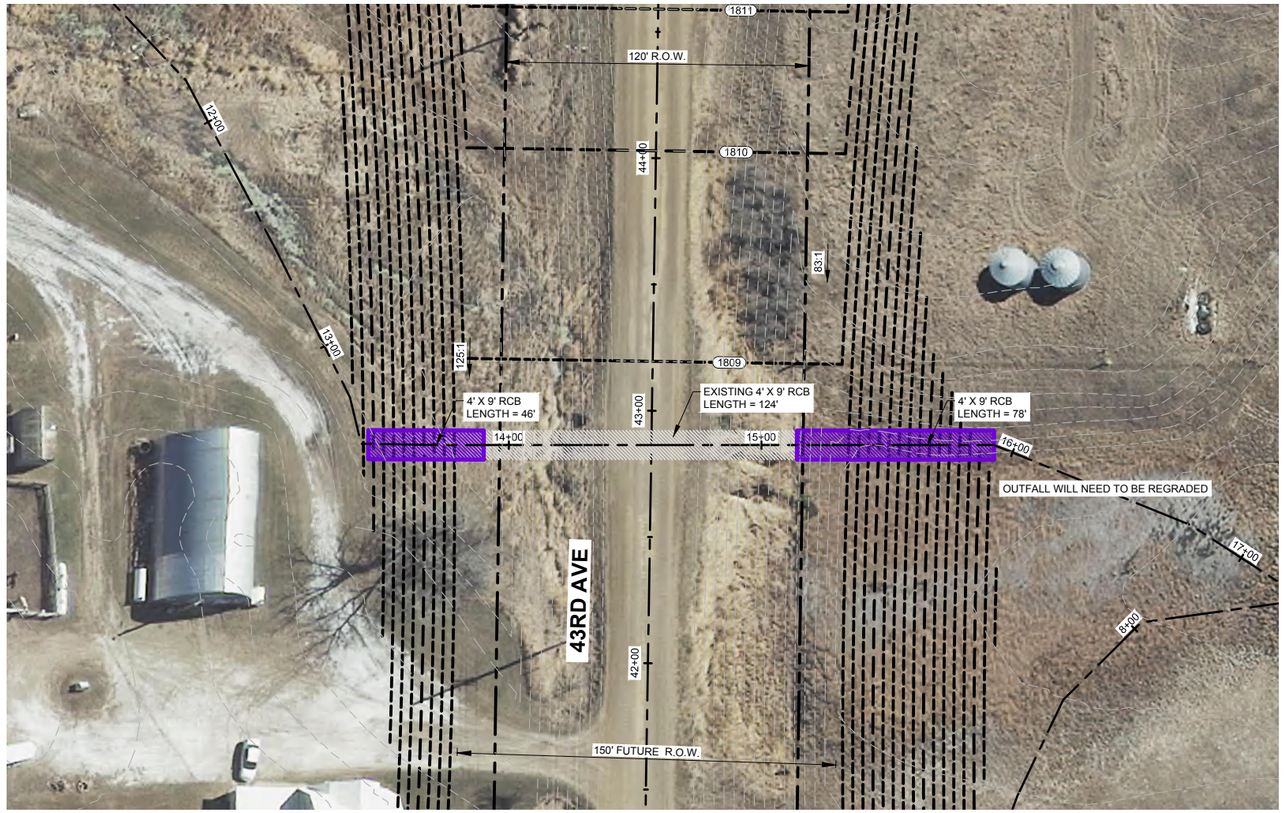
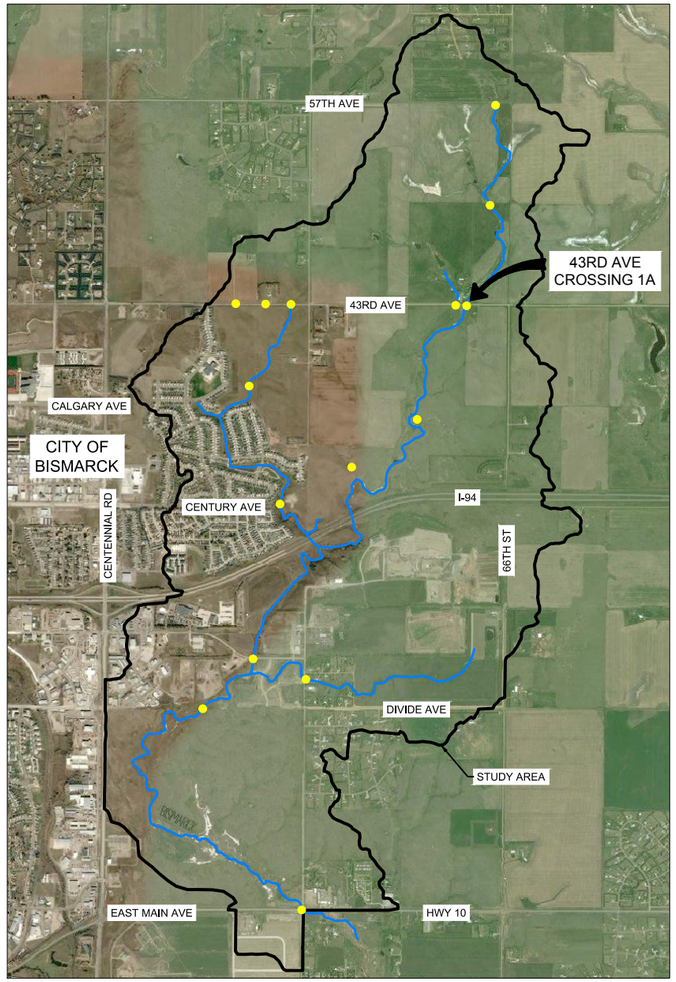
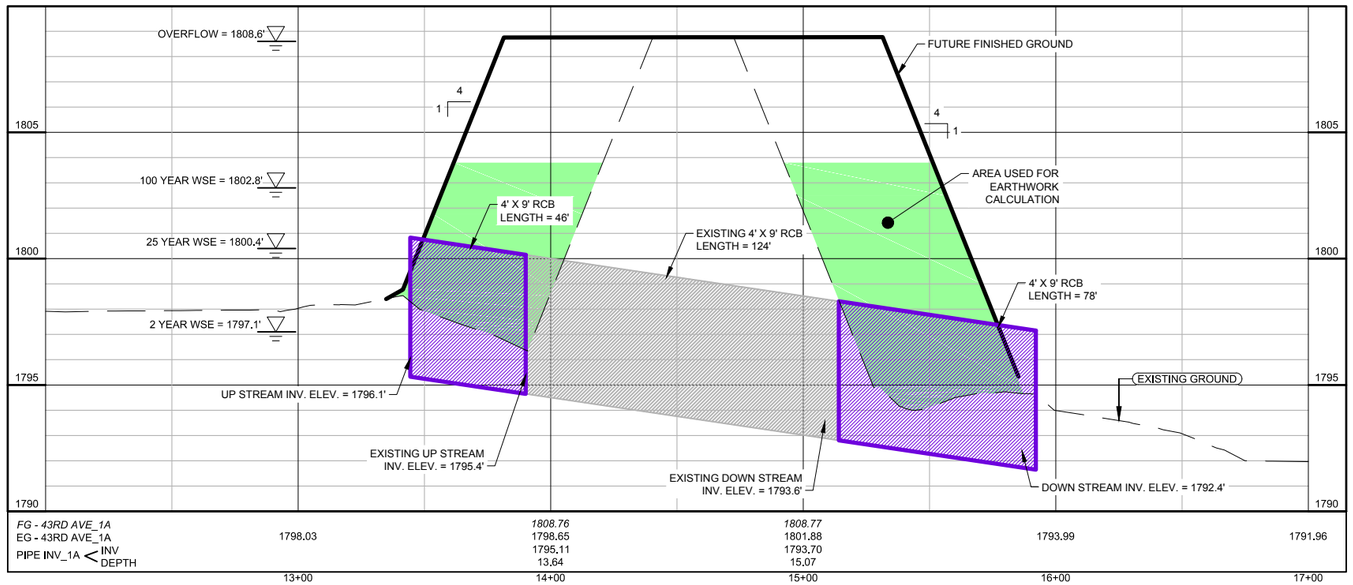




LOCATION MAP

SCALE: NONE



ESTIMATED MAJOR QUANTITIES

Spec	Description	Unit	Quantity
202-4.1	Unclassified Excavation	CY	20,000
802-4.10	42" Storm Sewer Pipe	LF	132
802-4.60	42" FES	EA	2
SP	4 x 9 Precast RCP Culvert	LF	124
SP	4 X 9 Box Culvert Ends	EA	2
SP	Final Stabilization	SF	70,000

NOTE:
ELEVATIONS ON THIS EXHIBIT ARE IN THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).

PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

AES2

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
CITY OF BISMARCK
BISMARCK, NORTH DAKOTA
43RD AVENUE ROAD CROSSING 1A

DRAWING TYPE: EXHIBIT
PREPARED BY: TRK
CHECKED / APPROVED: BM / JH
DATE: SEPT 2017
PROJECT NUMBER: P00501-2015-013
SHEET: - of -
DRAWING: 3A

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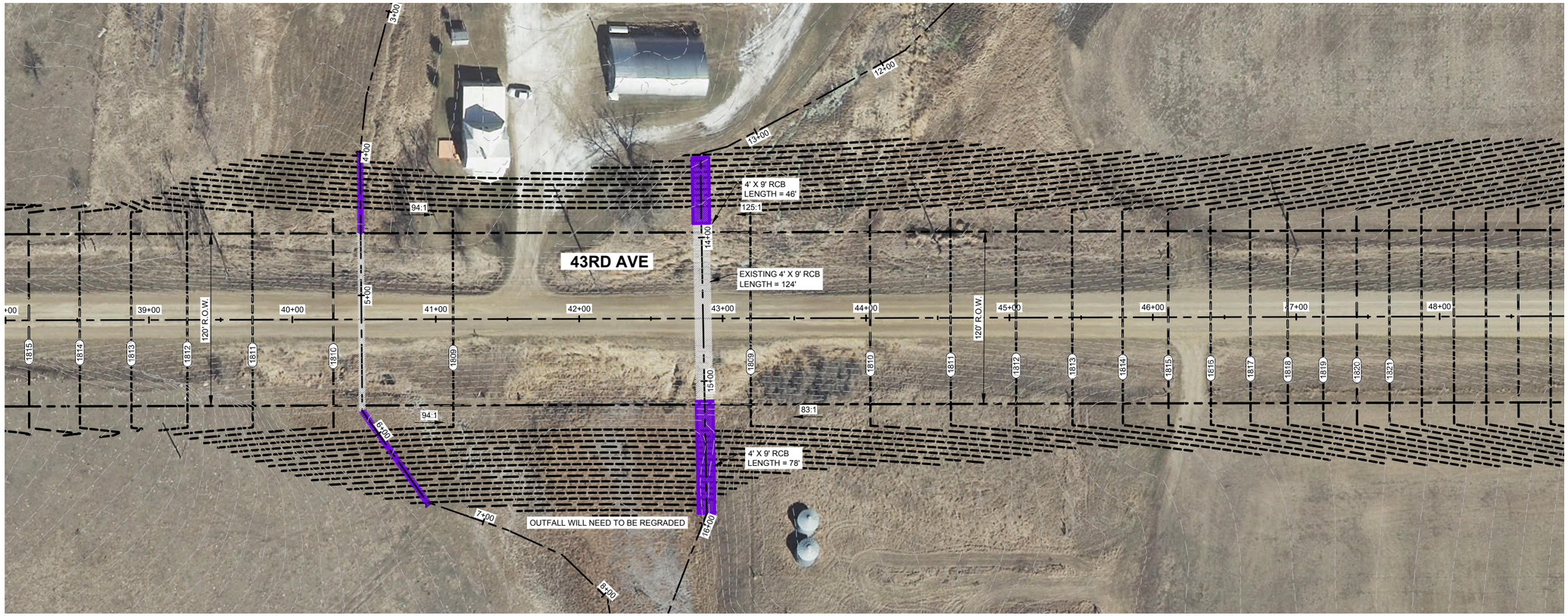
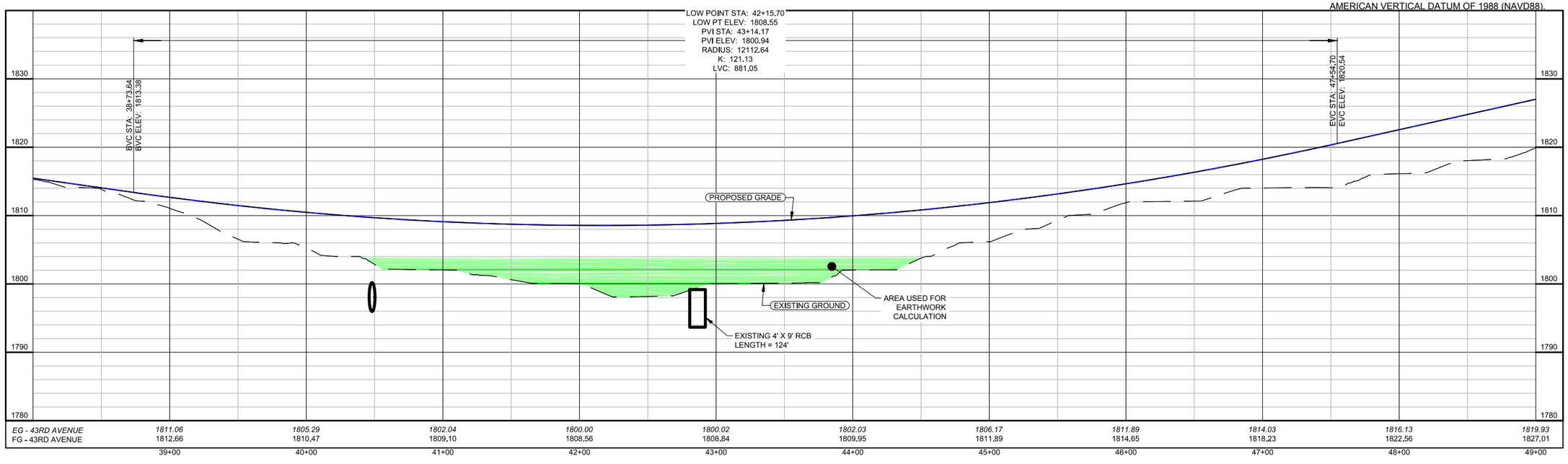


NOTE:
ELEVATIONS ON THIS EXHIBIT ARE IN THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).



PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

AE2S

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
CITY OF BISMARCK
BISMARCK, NORTH DAKOTA
43RD AVENUE ROAD CROSSING 1A

DRAWING TYPE	EXHIBIT
PREPARED BY	TRK
CHECKED / APPROVED	BM / JH
DATE	SEPT 2017
PROJECT NUMBER	P00501-2015-013
SHEET	- of -
DRAWING	3B

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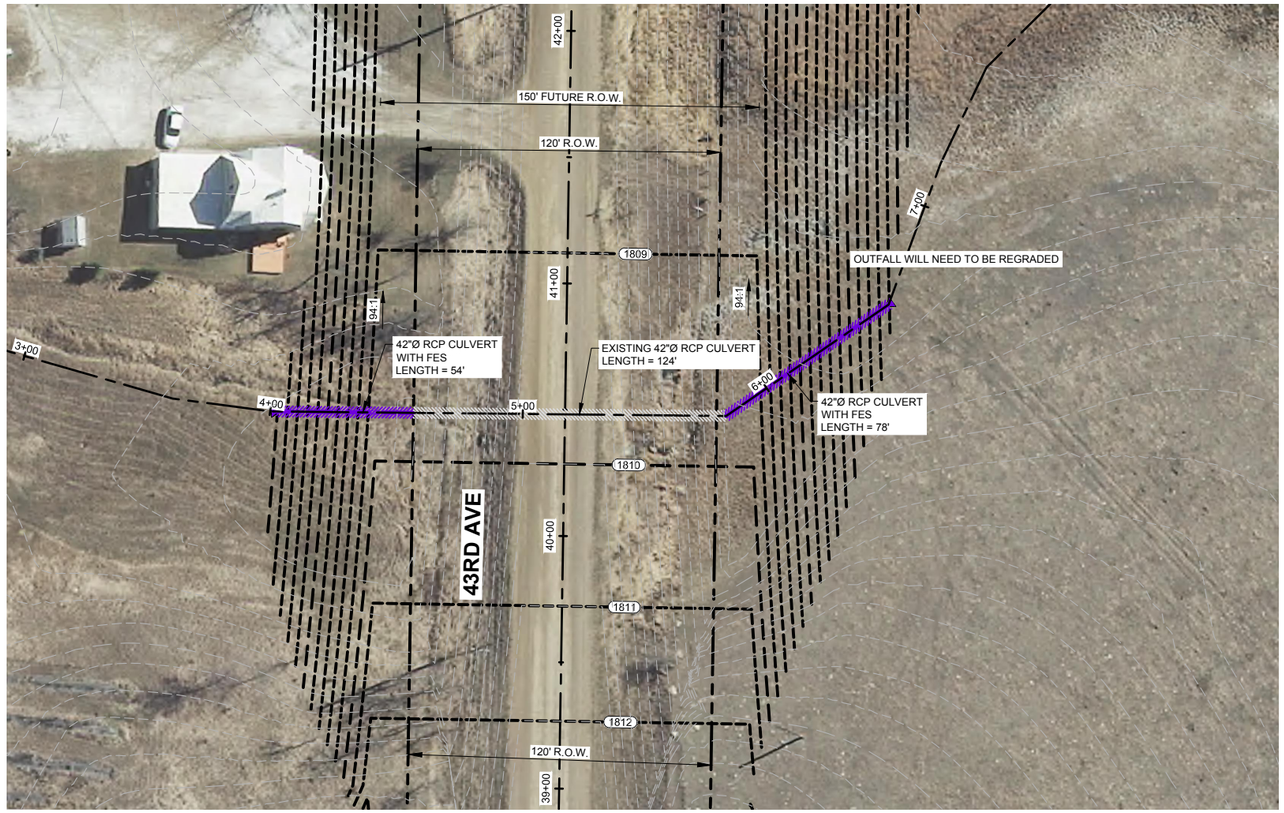
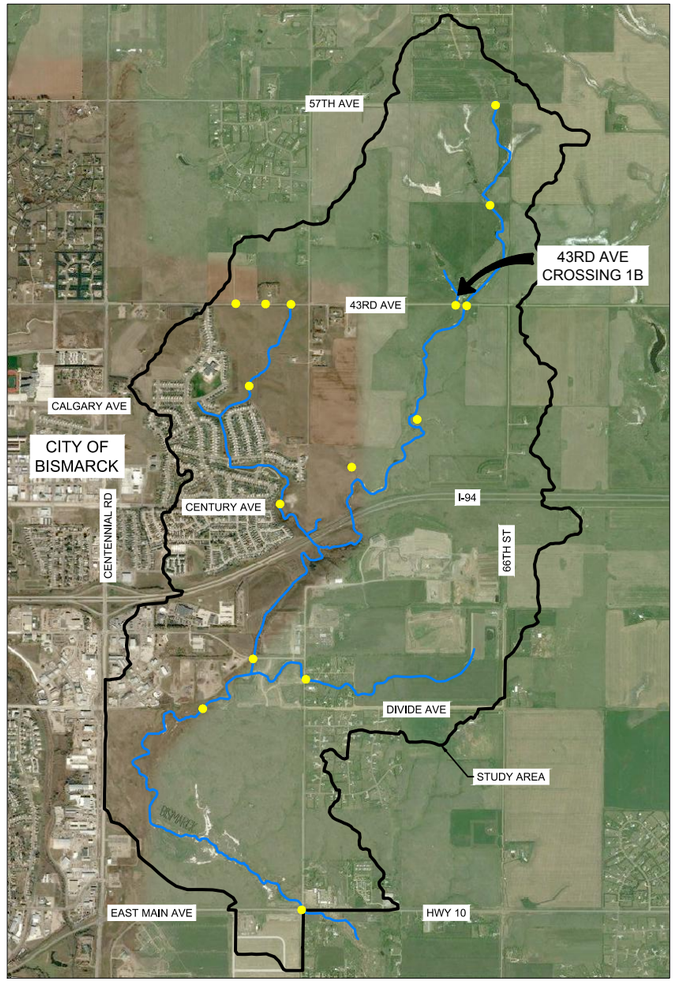
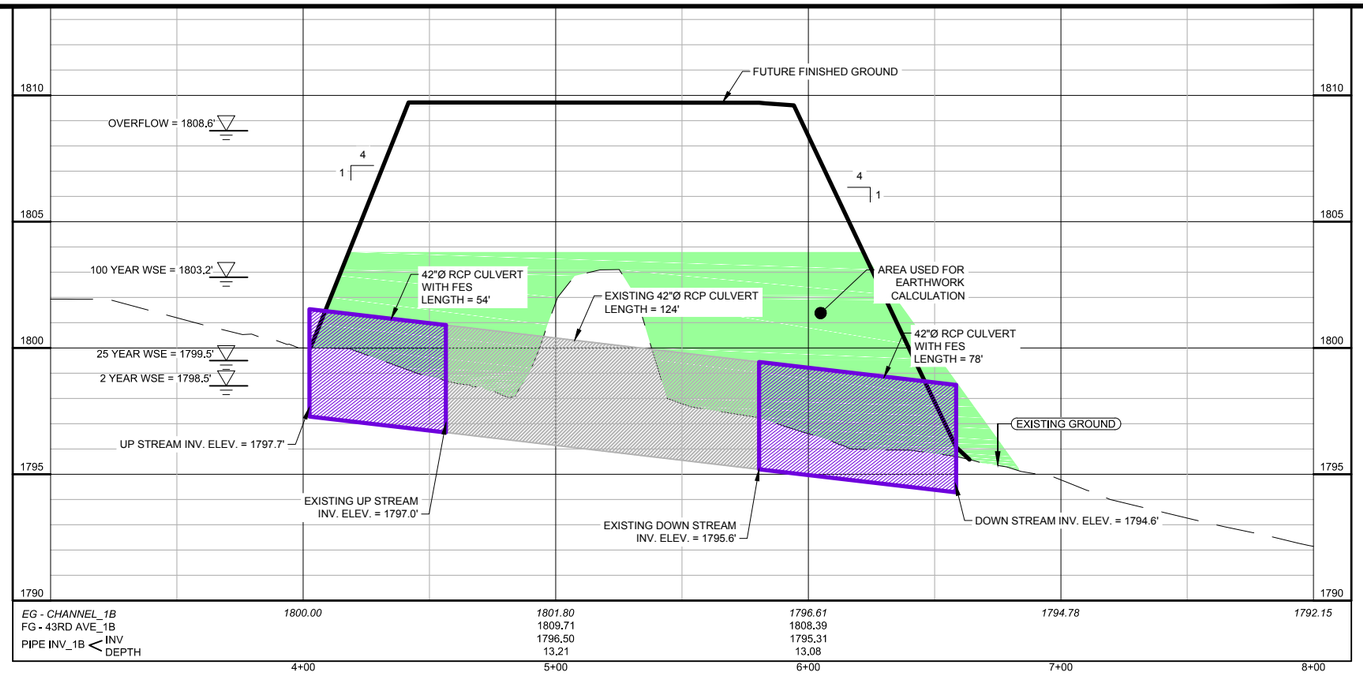




LOCATION MAP

SCALE: NONE



ESTIMATED MAJOR QUANTITIES

Spec	Description	Unit	Quantity
202-4.1	Unclassified Excavation	CY	20,000
802-4.10	42" Storm Sewer Pipe	LF	132
802-4.60	42" FES	EA	2
SP	4 x 9 Precast RCP Culvert	LF	124
SP	4 X 9 Box Culvert Ends	EA	2
SP	Final Stabilization	SF	70,000

NOTE:
ELEVATIONS ON THIS EXHIBIT ARE IN THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).

PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

AE2S

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
CITY OF BISMARCK
BISMARCK, NORTH DAKOTA
43RD AVENUE ROAD CROSSING 1B

DRAWING TYPE: EXHIBIT
PREPARED BY: TRK
CHECKED / APPROVED: BM / JH
DATE: SEPT 2017
PROJECT NUMBER: P00501-2015-013
SHEET: - of -
DRAWING: 4A

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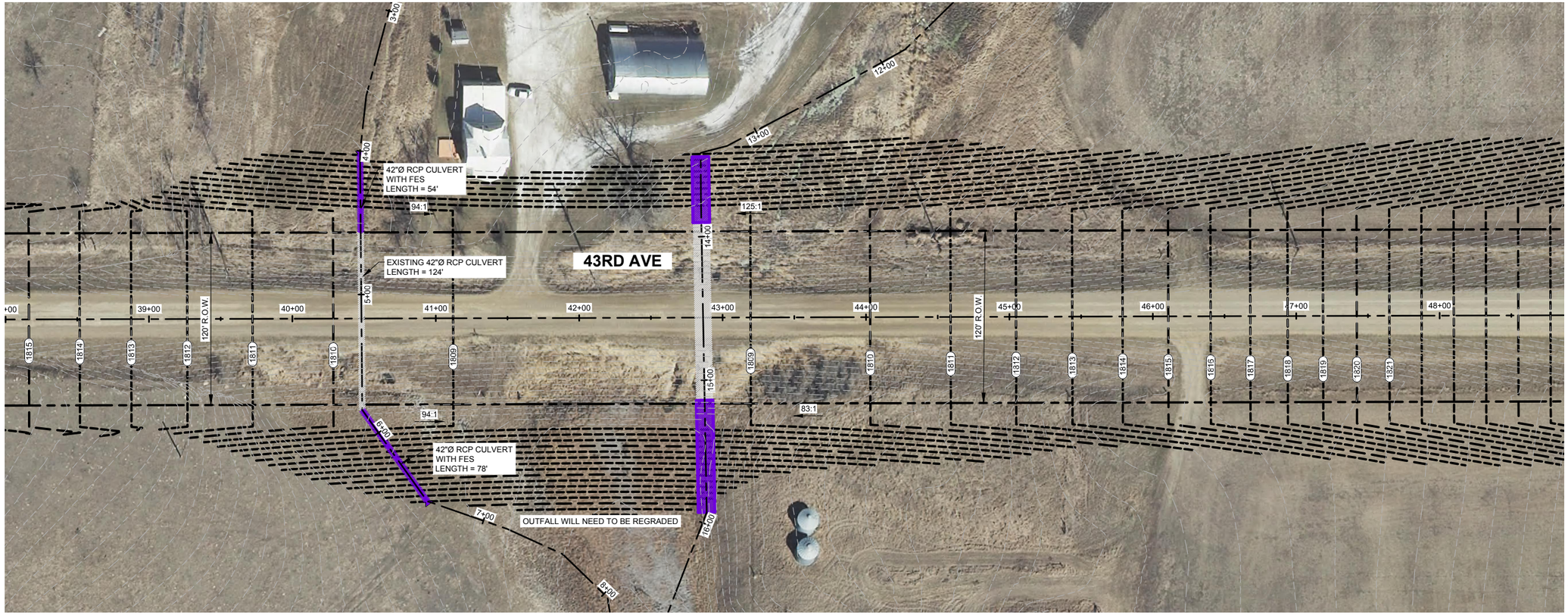
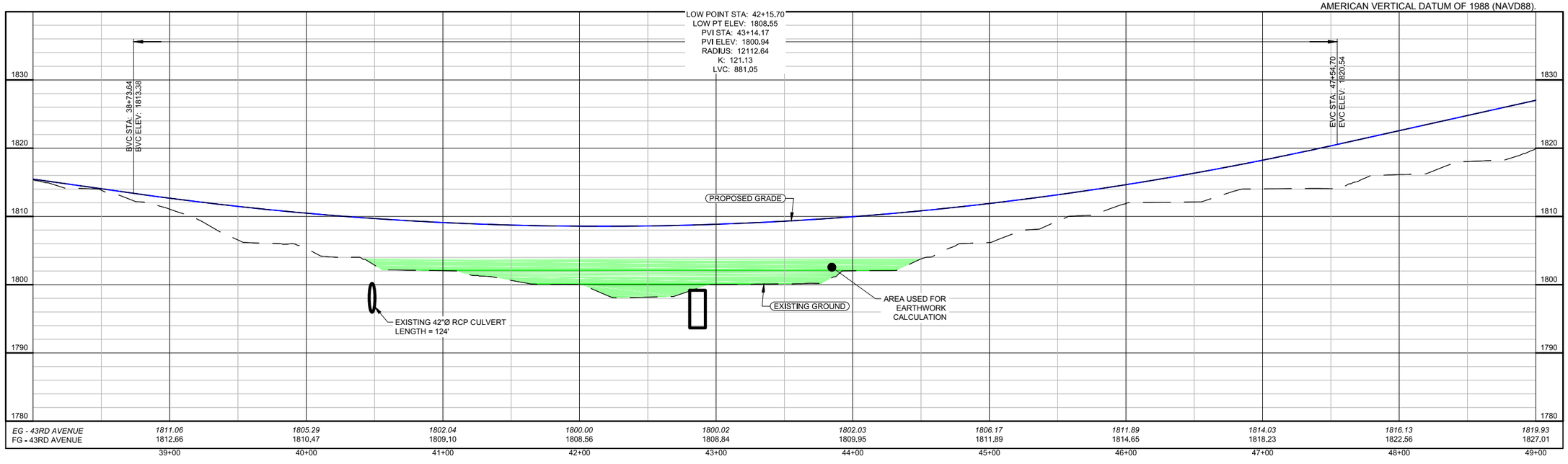


NOTE:
ELEVATIONS ON THIS EXHIBIT ARE IN THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).



PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

AE2S

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
CITY OF BISMARCK
BISMARCK, NORTH DAKOTA
43RD AVENUE ROAD CROSSING 1B

DRAWING TYPE	EXHIBIT
PREPARED BY	TRK
CHECKED / APPROVED	BM / JH
DATE	SEPT 2017
PROJECT NUMBER	P00501-2015-013
SHEET	- of -
DRAWING	4B

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Improvement ID: ***43rd Ave Crossing 1A&1B***

	Description	Units	Unit Price	Quantity	Total Price
General					
	Insurance and Bonding (3%)	LS	3%		$ 11,000
	Mobilization (6%)	LS	6%		$ 21,900
	Traffic Control (5%)	LS	5%		$ 18,300
Pipe Conduit & Culverts					
802-4.10	42" Storm Sewer Pipe	LF	$ 200	132	$ 26,400
SP	9ft x 4ft Precast RCB Culvert	LF	$ 1,100	124	$ 136,400
End Treatments					
1205-4.1	48" Dia and Smaller	Each	$ 4,000	2	$ 8,000
SP	Box Culvert Ends (Incl. permanent erosion protection)	Each	$ 15,000	2	$ 30,000
Earthwork					
202-4.1	Unclassified Excavation	CY	$ 8.00	20,000	$ 160,000
	Vegetation	SF	$ 0.05	70,000	$ 3,500
Unanticipated & Contingency					
	Construction Contingency (30%)	LS	30%		$ 124,650
Subtotal Construction Costs					**$ 540,150**
Administration & Engineering					
	Design Engineering	LS	6%		$ 32,409
	Construction Engineering	LS	10%		$ 54,015
	Administrative	LS	7%		$ 37,811
Subtotal Administration & Engineering					**$ 124,235**
Opinion of Project Construction Costs					**$ 664,385**

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Improvement ID: ***43rd Ave Crossing 2,3&4***

	Description	Units	Unit Price	Quantity	Total Price
General					
	Insurance and Bonding (3%)	LS	3%		$ 2,600
	Mobilization (6%)	LS	6%		$ 5,200
	Traffic Control (5%)	LS	5%		$ 4,300
Pipe Improvements					
	Connect to Existing	Each	$ 1,000	3	$ 3,000
Removal and Disposal					
SP	8" to 36" pipe	LF	$ 25	120	$ 3,000
Pipe Conduit & Culverts					
802-4.2	15" Storm Sewer Pipe	LF	$ 53	100	$ 5,300
802-4.3	18" Storm Sewer Pipe	LF	$ 58	100	$ 5,800
802-4.9	36" Storm Sewer Pipe	LF	$ 200	220	$ 44,000
End Treatments					
1205-4.1	48" Dia and Smaller	Each	$ 4,000	6	$ 24,000
Unanticipated & Contingency					
	Construction Contingency (30%)	LS	30%		$ 29,160
Subtotal Construction Costs					**$ 126,360**
Administration & Engineering					
	Design Engineering	LS	6%		$ 7,582
	Construction Engineering	LS	10%		$ 12,636
	Administrative	LS	7%		$ 8,845
Subtotal Administration & Engineering					**$ 29,063**
Opinion of Project Construction Costs					**$ 155,423**

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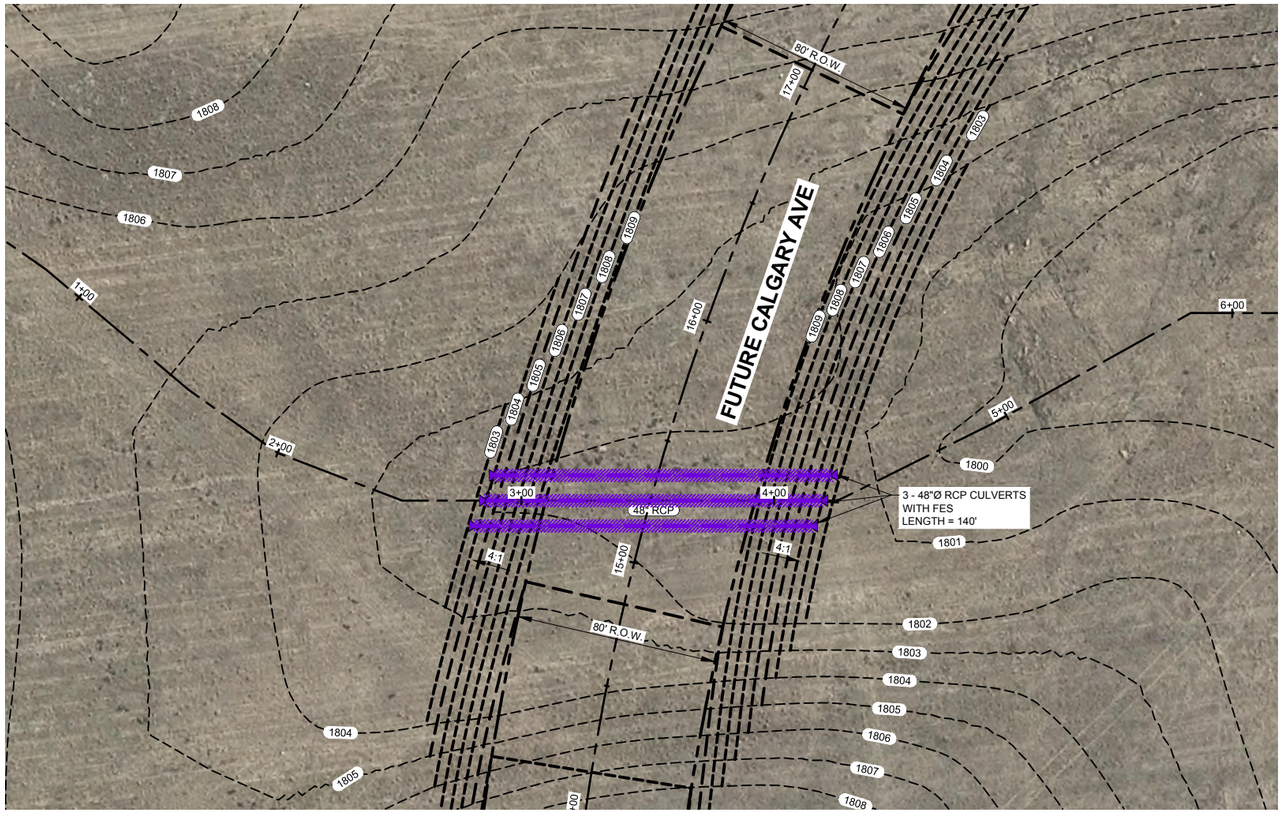
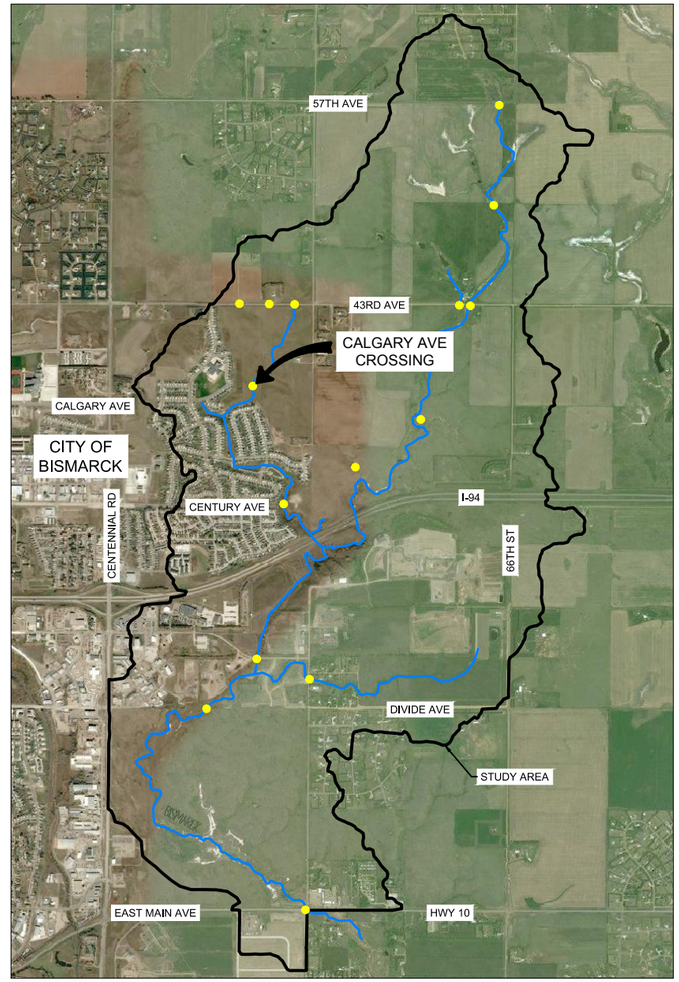
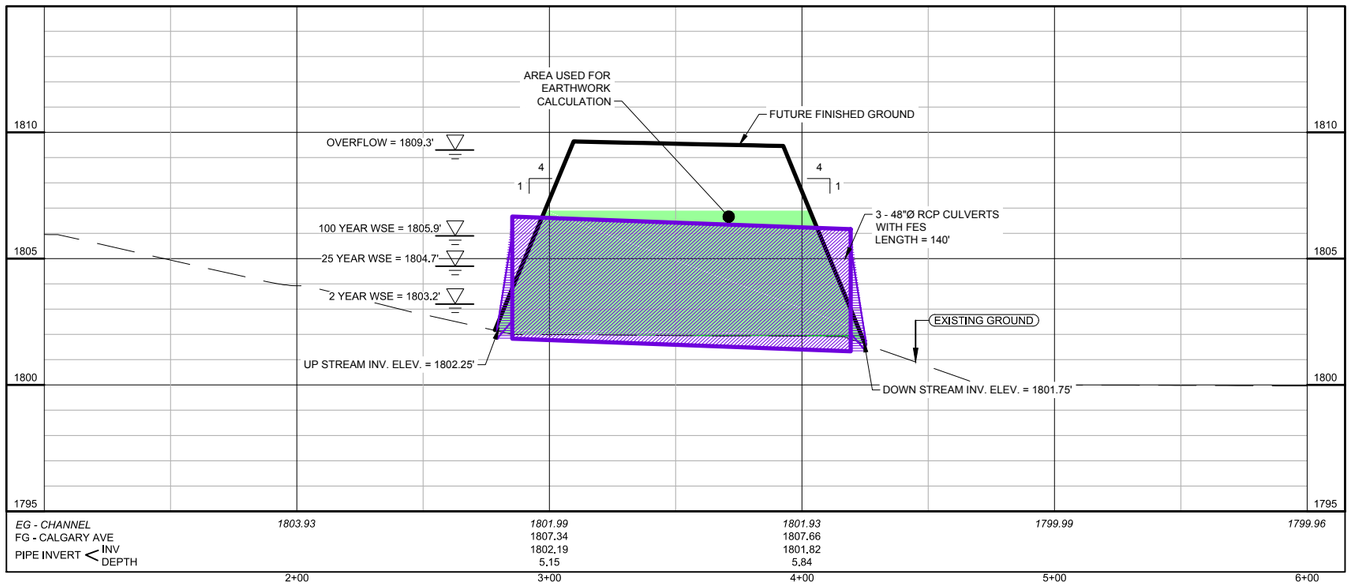




LOCATION MAP

SCALE: NONE



ESTIMATED MAJOR QUANTITIES

Spec	Description	Unit	Quantity
202-4.1	Unclassified Excavation	CY	5,000
802-4.11	48" Storm Sewer Pipe	LF	420
802-4.61	48" FES	EA	6
SP	Final Stabilization	SF	45,000

NOTE:
ELEVATIONS ON THIS EXHIBIT ARE IN THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).

PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

AES 2

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
CITY OF BISMARCK
BISMARCK, NORTH DAKOTA
FUTURE CALGARY AVENUE ROAD CROSSING

DRAWING TYPE	EXHIBIT
PREPARED BY	TRK
CHECKED / APPROVED	BE / JH
DATE	SEPT 2017
PROJECT NUMBER	P00501-2015-013
SHEET	- of -
DRAWING	5A

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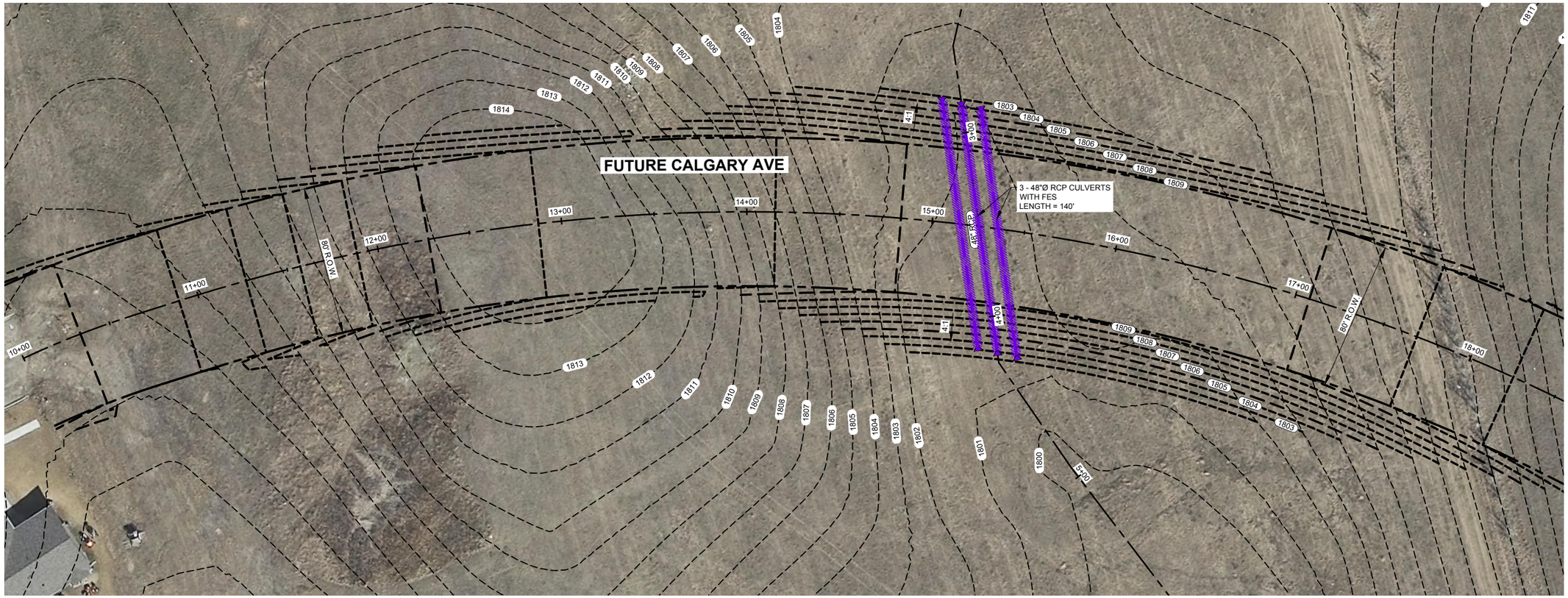
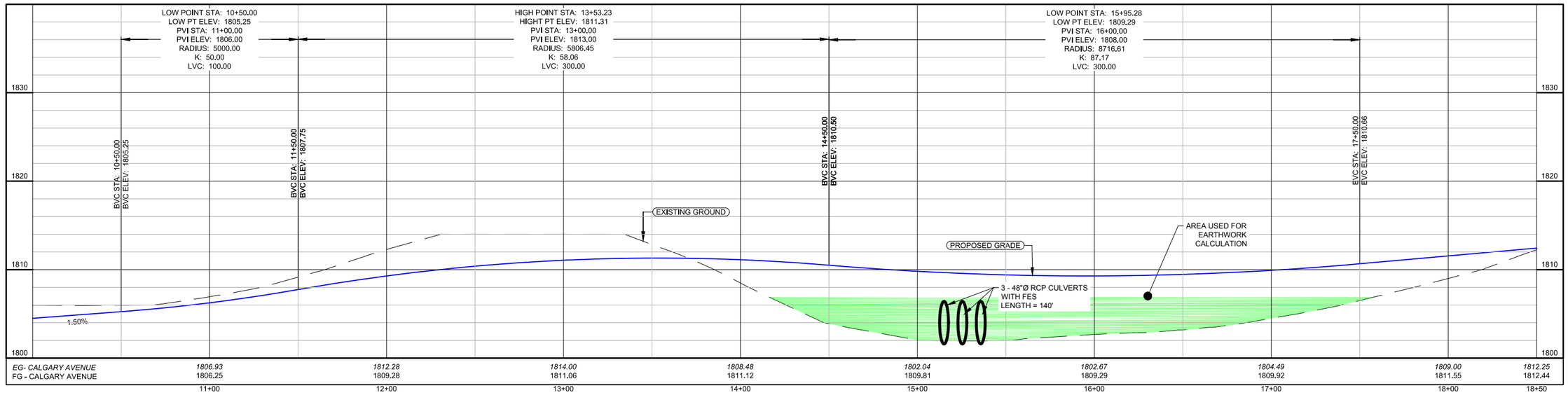


NOTE:
ELEVATIONS ON THIS EXHIBIT ARE IN THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).



Advanced Engineering and Environmental Services, Inc. ● 1815 Schafer St Ste 301 Bismarck, ND 58501 ● (t) 701-221-0530 (f) 701-221-0531 ● www.ae2s.com

PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

AE2S

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
CITY OF BISMARCK
BISMARCK, NORTH DAKOTA
FUTURE CALGARY AVENUE ROAD CROSSING

DRAWING TYPE	EXHIBIT
PREPARED BY	TRK
CHECKED / APPROVED	BE / JH
DATE	SEPT 2017
PROJECT NUMBER	P00501-2015-013
SHEET	- of -
DRAWING	5B

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Improvement ID: *Calgary Ave Crossing*

	Description	Units	Unit Price	Quantity	Total Price
General					
	Insurance and Bonding (3%)	LS	3%		$ 4,900
	Mobilization (6%)	LS	6%		$ 9,700
Pipe Conduit & Culverts					
802-4.11	48" Storm Sewer Pipe	LF	$ 225	420	$ 94,500
End Treatments					
1205-4.1	48" Dia and Smaller	Each	$ 4,000	6	$ 24,000
Earthwork					
202-4.1	Unclassified Excavation	CY	$ 8.00	5,000	$ 40,000
	Vegetation	SF	$ 0.05	45,000	$ 2,250
Unanticipated & Contingency					
	Construction Contingency (30%)	LS	30%		$ 52,605
Subtotal Construction Costs					**$ 227,955**
Administration & Engineering					
	Design Engineering	LS	6%		$ 13,677
	Construction Engineering	LS	10%		$ 22,796
	Administrative	LS	7%		$ 15,957
Subtotal Administration & Engineering					**$ 52,430**
Opinion of Project Construction Costs					**$ 280,385**

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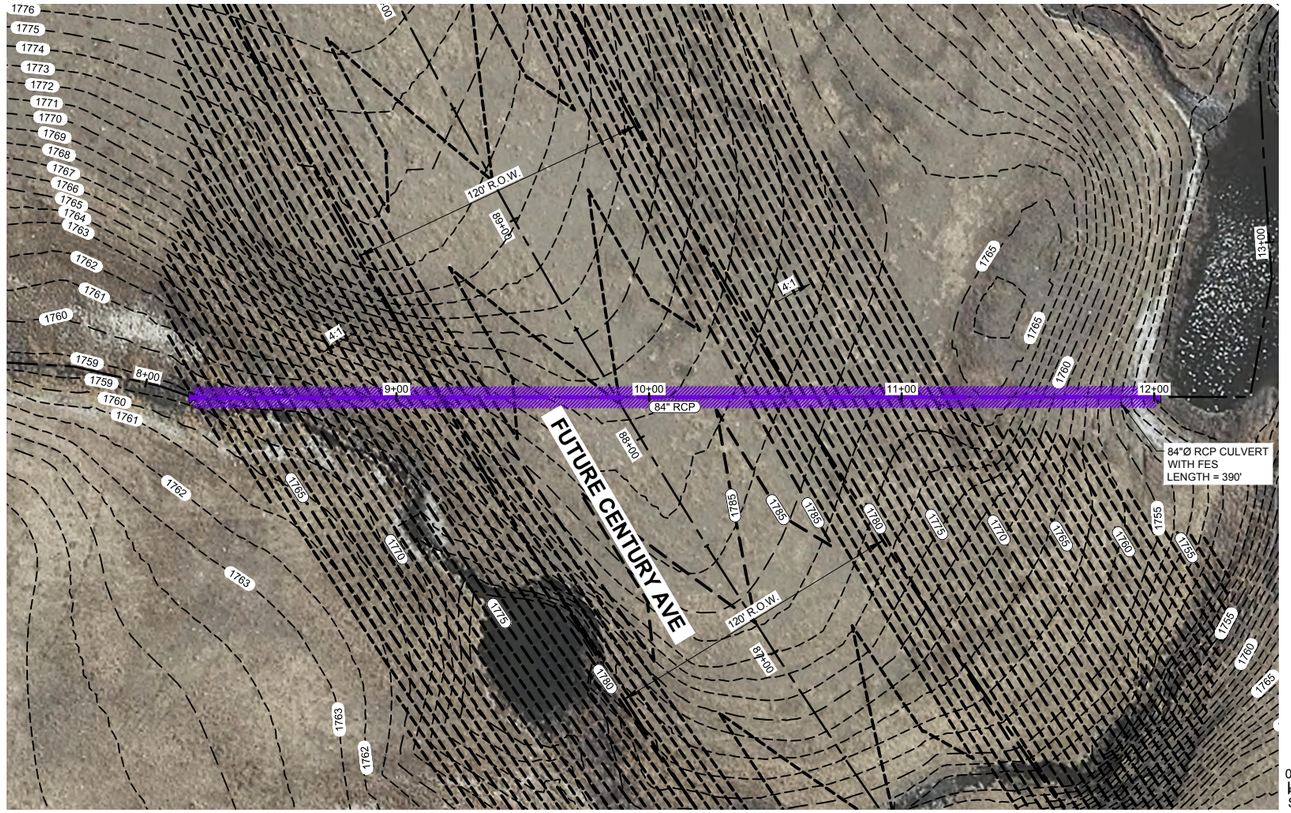
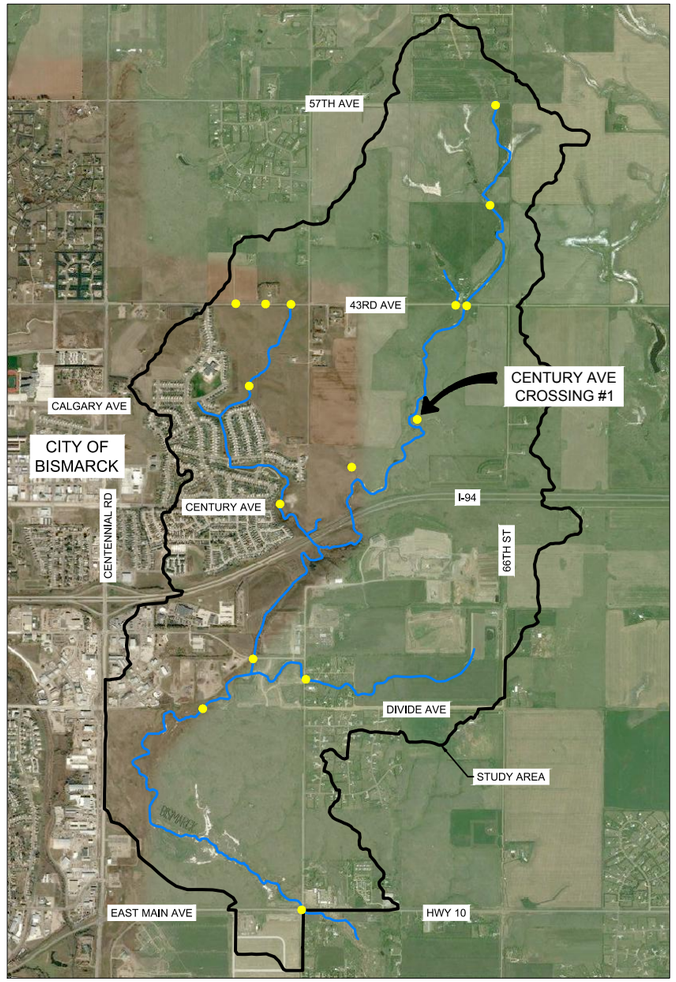
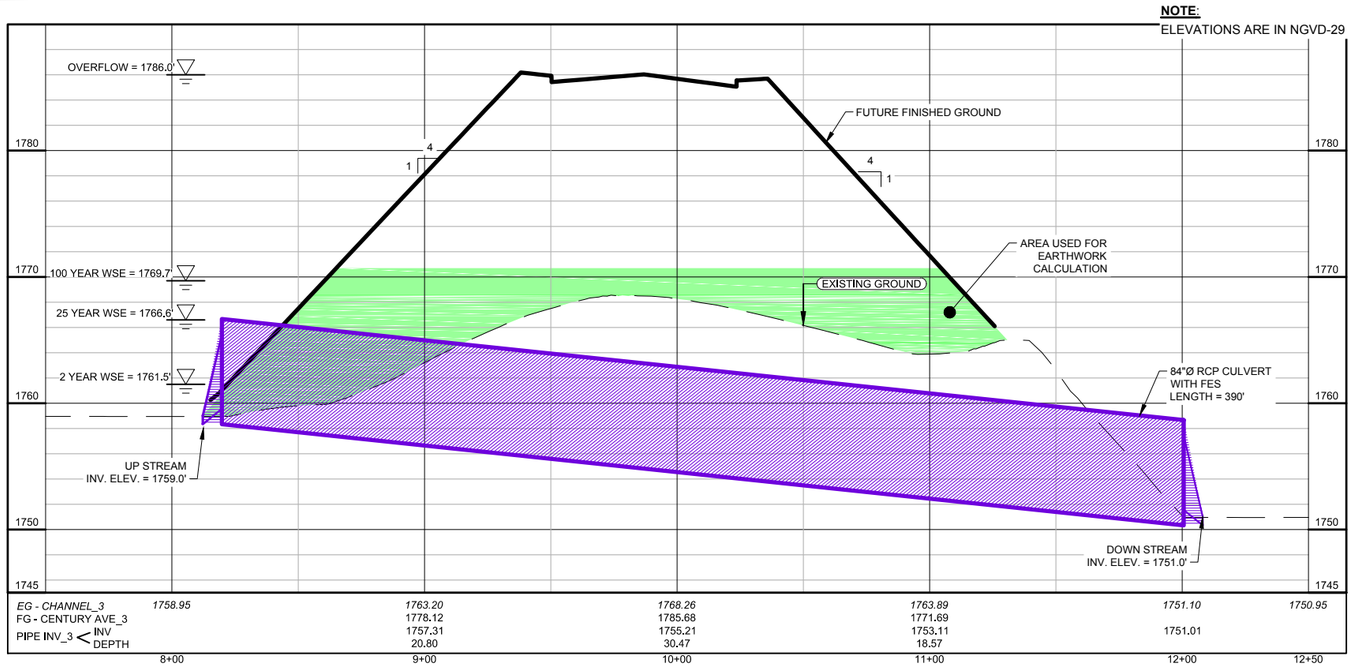




LOCATION MAP

SCALE: NONE



ESTIMATED MAJOR QUANTITIES

Spec	Description	Unit	Quantity
202-4.1	Unclassified Excavation	CY	25,000
802-4.17	84" Storm Sewer Pipe	LF	390
802-4.67	84" FES	EA	2
SP	Final Stabilization	SF	150,000

NOTE:
ALL CONTOURS, ELEVATIONS, AND COORDINATES FOR THIS DRAWING ARE BASED ON BISMARCK GPS CONTROL MONUMENTS, NAD83 STATE PLANE COORDINATE SYSTEM, NORTH DAKOTA SOUTH ZONE AND NGVD-29. TO RELATE ELEVATIONS TO NAVD-88 DATUM USE THE FOLLOWING EQUATION: (NGVD-29 ELEVATION) + 1.3 FT. = NAVD-1988 ELEVATIONS.

PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

AE2S

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
CITY OF BISMARCK
BISMARCK, NORTH DAKOTA
FUTURE CENTURY AVENUE ROAD CROSSING #1

DRAWING TYPE: EXHIBIT
PREPARED BY: TRK
CHECKED / APPROVED: BE / JH
DATE: SEPT 2017
PROJECT NUMBER: P00501-2015-013
SHEET: - of -
DRAWING: 6A

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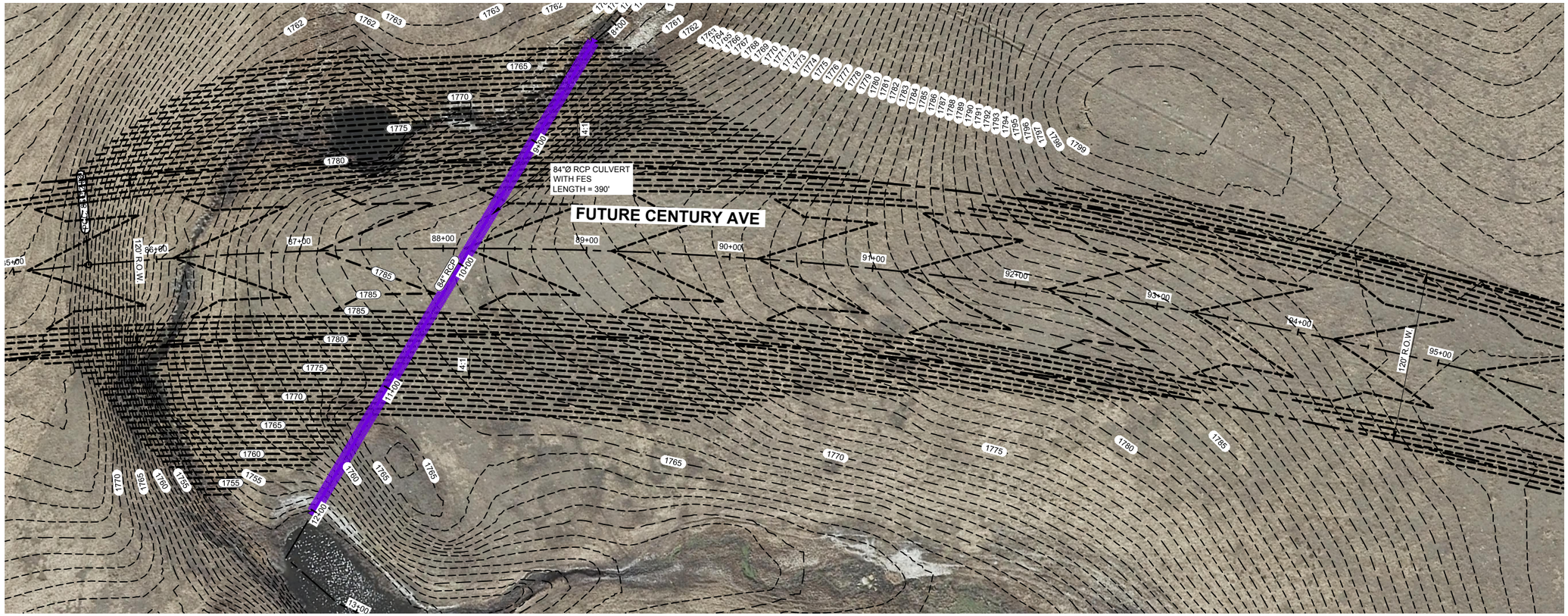

NOTE:
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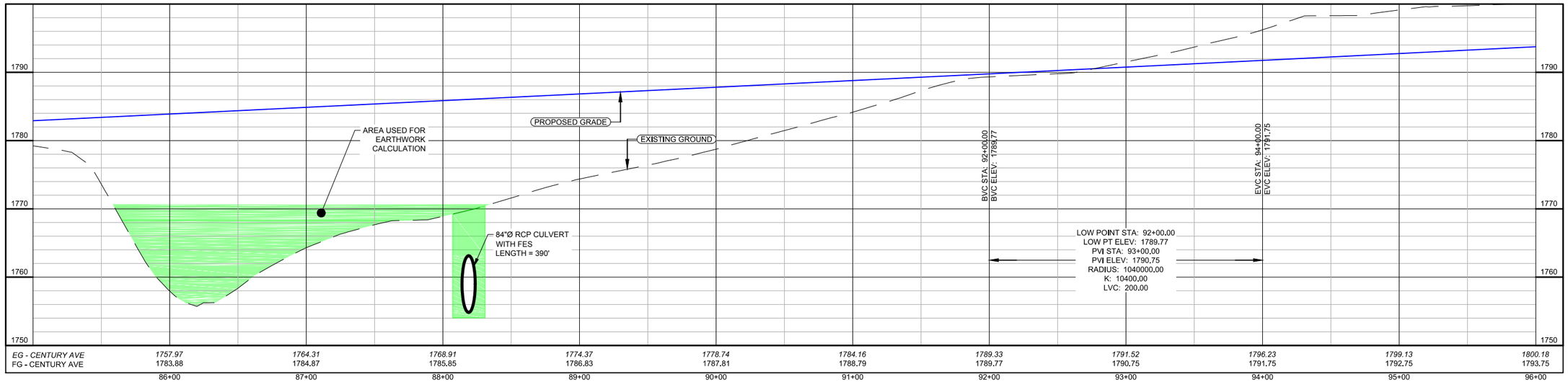

PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

AE2S

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
CITY OF BISMARCK
BISMARCK, NORTH DAKOTA
FUTURE CENTURY AVENUE ROAD CROSSING #1

DRAWING TYPE	EXHIBIT
PREPARED BY	TRK
CHECKED / APPROVED	BE / JH
DATE	SEPT 2017
PROJECT NUMBER	P00501-2015-013
SHEET	- of -
DRAWING	6B

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Improvement ID: ***Century Ave Crossing 1***

	Description	Units	Unit Price	Quantity	Total Price
General					
	Insurance and Bonding (3%)	LS	3%		$ 13,300
	Mobilization (6%)	LS	6%		$ 26,600
Pipe Conduit & Culverts					
802-4.17	84" Storm Sewer Pipe	LF	$ 550	390	$ 214,500
End Treatments					
1205-4.1J	72" and Larger	Each	$ 10,000	2	$ 20,000
Earthwork					
202-4.1	Unclassified Excavation	CY	$ 8.00	25,000	$ 200,000
	Vegetation	SF	$ 0.05	150,000	$ 7,500
Unanticipated & Contingency					
	Construction Contingency (30%)	LS	30%		$ 144,570
Subtotal Construction Costs					**$ 626,470**
Administration & Engineering					
	Design Engineering	LS	6%		$ 37,588
	Construction Engineering	LS	10%		$ 62,647
	Administrative	LS	7%		$ 43,853
Subtotal Administration & Engineering					**$ 144,088**
Opinion of Project Construction Costs					**$ 770,558**

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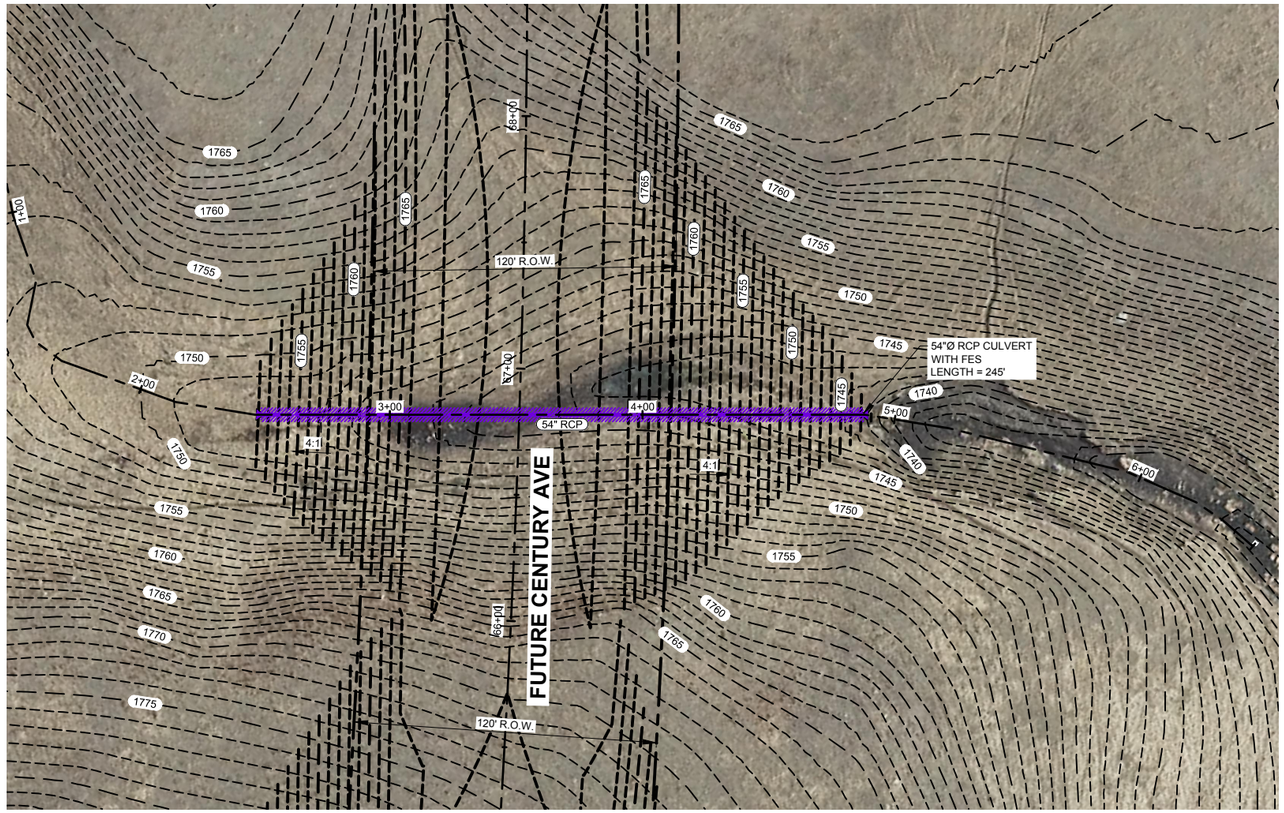
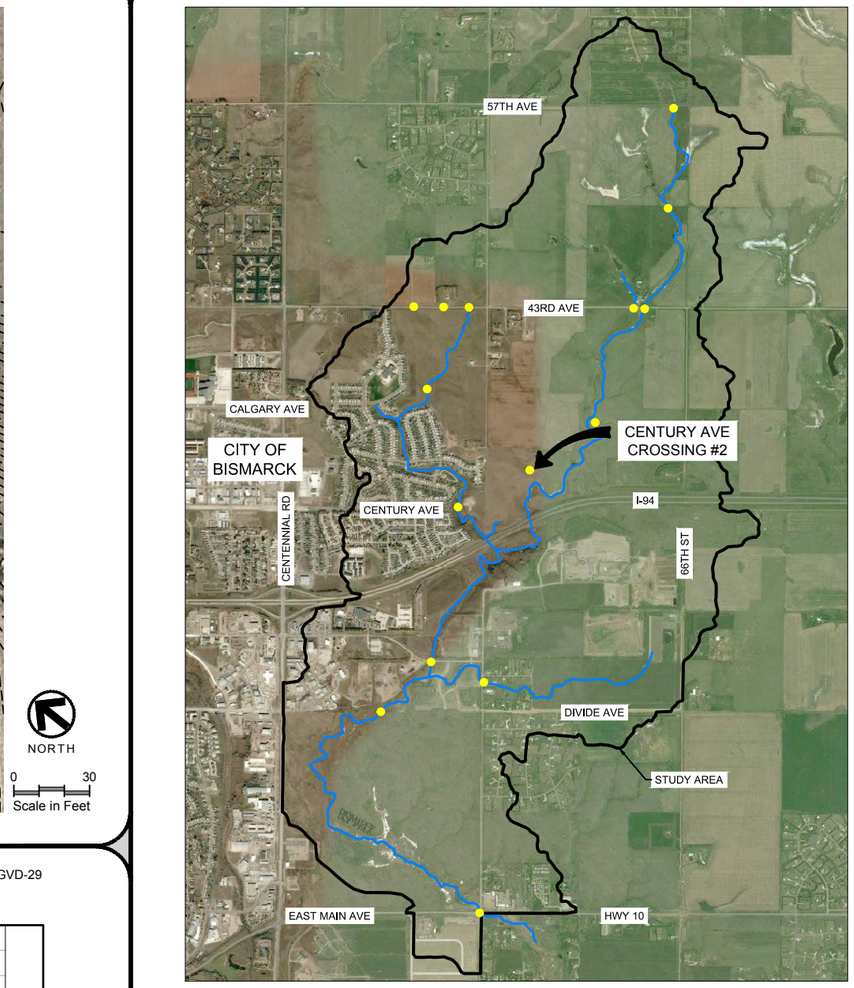




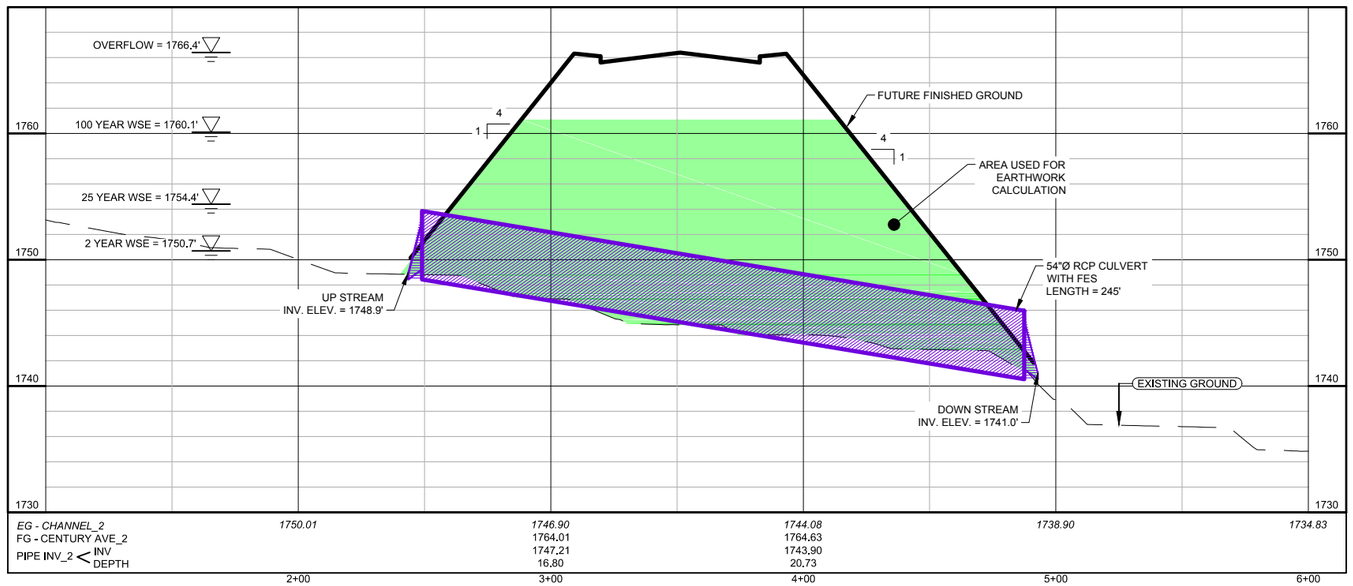
NORTH

0 30
Scale in Feet

LOCATION MAP

SCALE: NONE

NOTE:
ELEVATIONS ARE IN NGVD-29



ESTIMATED MAJOR QUANTITIES

Spec	Description	Unit	Quantity
202-4.1	Unclassified Excavation	CY	14,000
802-4.12	54" Storm Sewer Pipe	LF	245
802-4.45	54" FES	EA	2
SP	Final Stabilization	SF	45,000

NOTE:
ALL CONTOURS, ELEVATIONS, AND COORDINATES FOR THIS DRAWING ARE BASED ON BISMARCK GPS CONTROL MONUMENTS, NAD83 STATE PLANE COORDINATE SYSTEM, NORTH DAKOTA SOUTH ZONE AND NGVD-29. TO RELATE ELEVATIONS TO NAVD-88 DATUM USE THE FOLLOWING EQUATION: (NGVD-29 ELEVATION) + 1.3 FT. = NAVD-1988 ELEVATIONS.

PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

AE2S

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
CITY OF BISMARCK
BISMARCK, NORTH DAKOTA
FUTURE CENTURY AVENUE ROAD CROSSING #2

DRAWING TYPE: EXHIBIT
PREPARED BY: TRK
CHECKED / APPROVED: BE / JH
DATE: SEPT 2017
PROJECT NUMBER: P00501-2015-013
SHEET: - of -
DRAWING: **7A**

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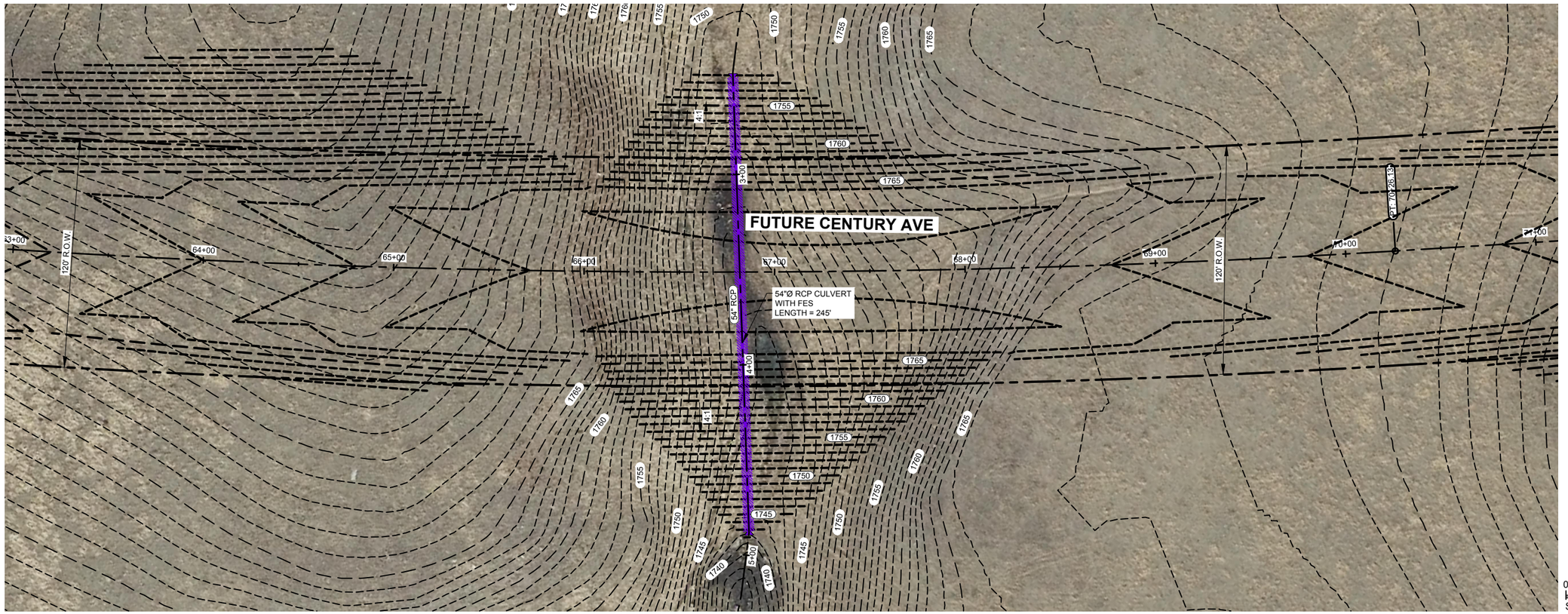

NOTE:
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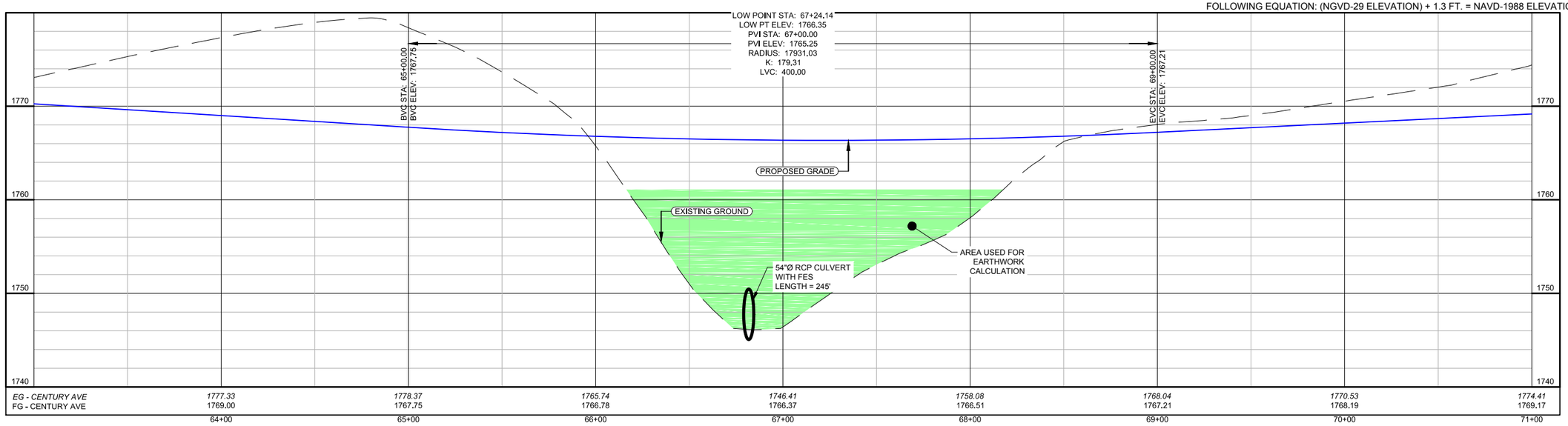

	64+00	65+00	66+00	67+00	68+00	69+00	70+00	71+00
EG - CENTURY AVE	*1777.33*	*1778.37*	*1765.74*	*1746.41*	*1758.08*	*1768.04*	*1770.53*	*1774.41*
FG - CENTURY AVE	1769.00	1767.75	1766.78	1766.37	1766.51	1767.21	1768.19	1769.17

PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

AE2S

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
CITY OF BISMARCK
BISMARCK, NORTH DAKOTA
FUTURE CENTURY AVENUE ROAD CROSSING #2

DRAWING TYPE	EXHIBIT
PREPARED BY	TRK
CHECKED / APPROVED	BE / JH
DATE	SEPT 2017
PROJECT NUMBER	P00501-2015-013
SHEET	- of -
DRAWING	7B

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Improvement ID: ***Century Ave Crossing 2***

	Description	Units	Unit Price	Quantity	Total Price
General					
	Insurance and Bonding (3%)	LS	3%		$ 5,600
	Mobilization (6%)	LS	6%		$ 11,200
Pipe Conduit & Culverts					
802-4.12	54" Storm Sewer Pipe	LF	$ 235	245	$ 57,575
End Treatments					
1205-4.1C	48" to 72" Dia	Each	$ 7,000	2	$ 14,000
Earthwork					
202-4.1	Unclassified Excavation	CY	$ 8.00	14,000	$ 112,000
	Vegetation	SF	$ 0.05	45,000	$ 2,250
Unanticipated & Contingency					
	Construction Contingency (30%)	LS	30%		$ 60,788
Subtotal Construction Costs					**$ 263,413**
Administration & Engineering					
	Design Engineering	LS	6%		$ 15,805
	Construction Engineering	LS	10%		$ 26,341
	Administrative	LS	7%		$ 18,439
Subtotal Administration & Engineering					**$ 60,585**
Opinion of Project Construction Costs					**$ 323,997**

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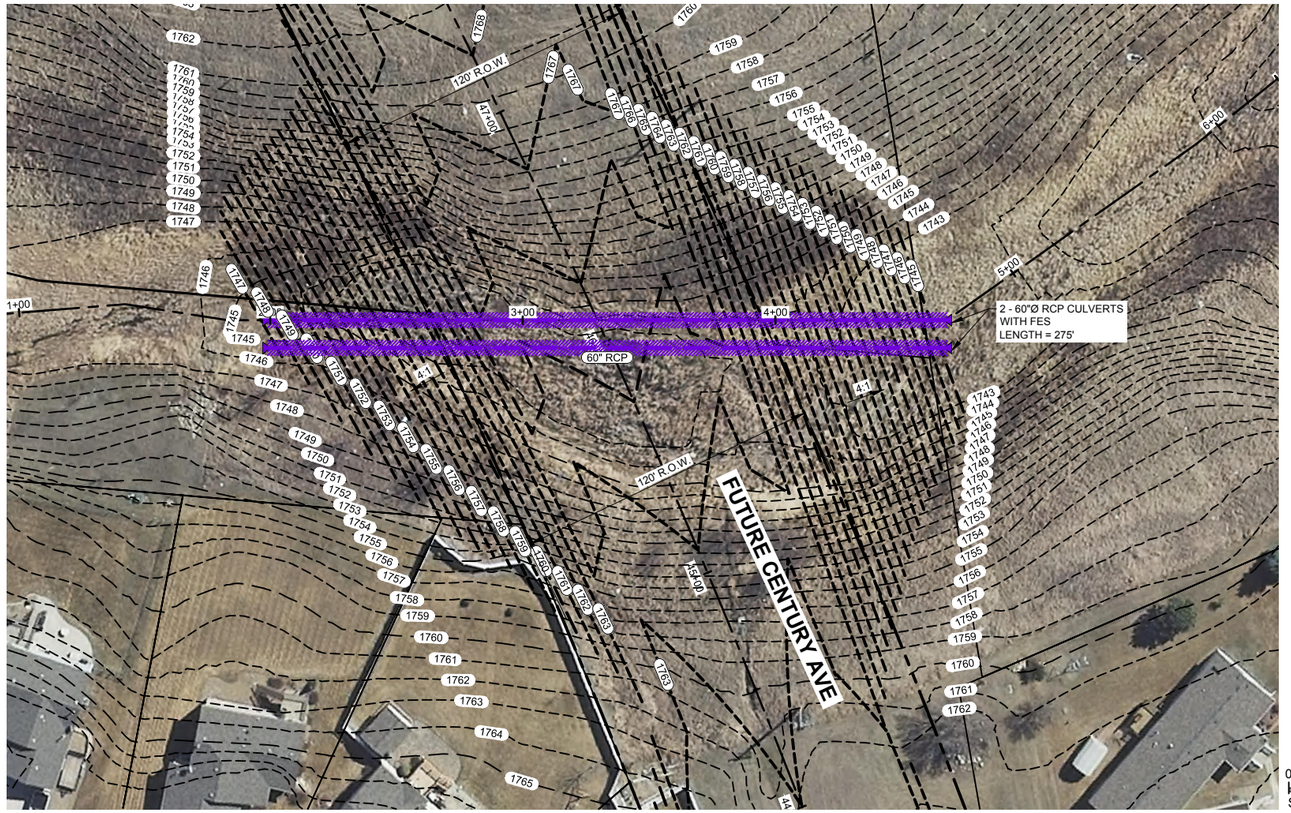
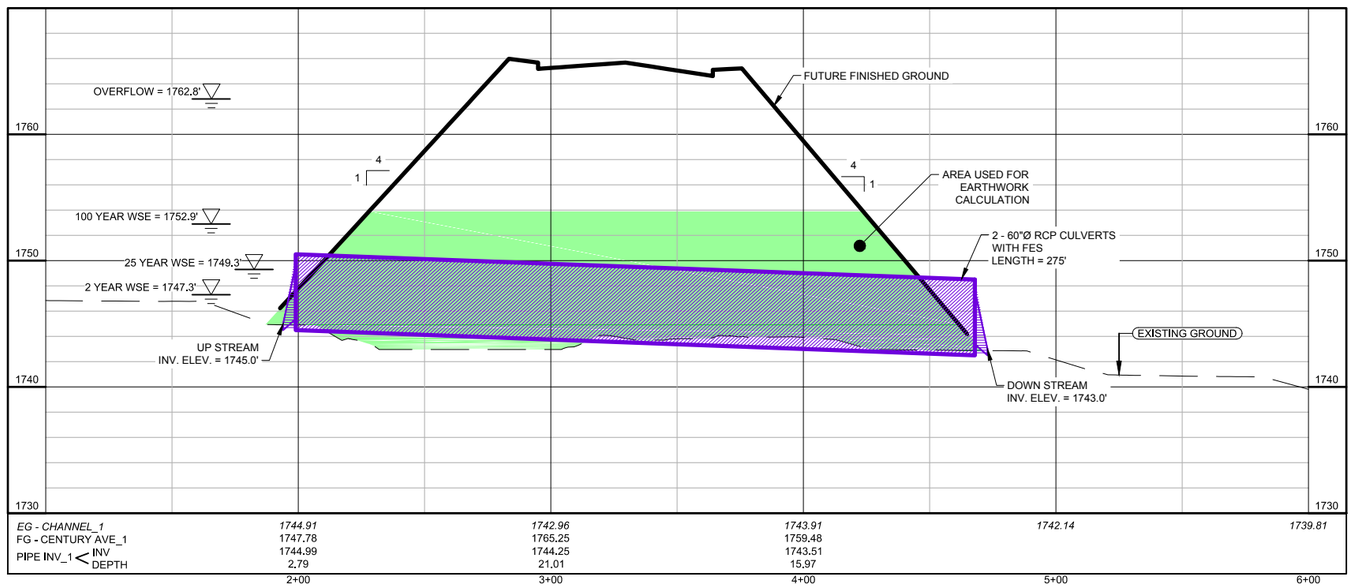
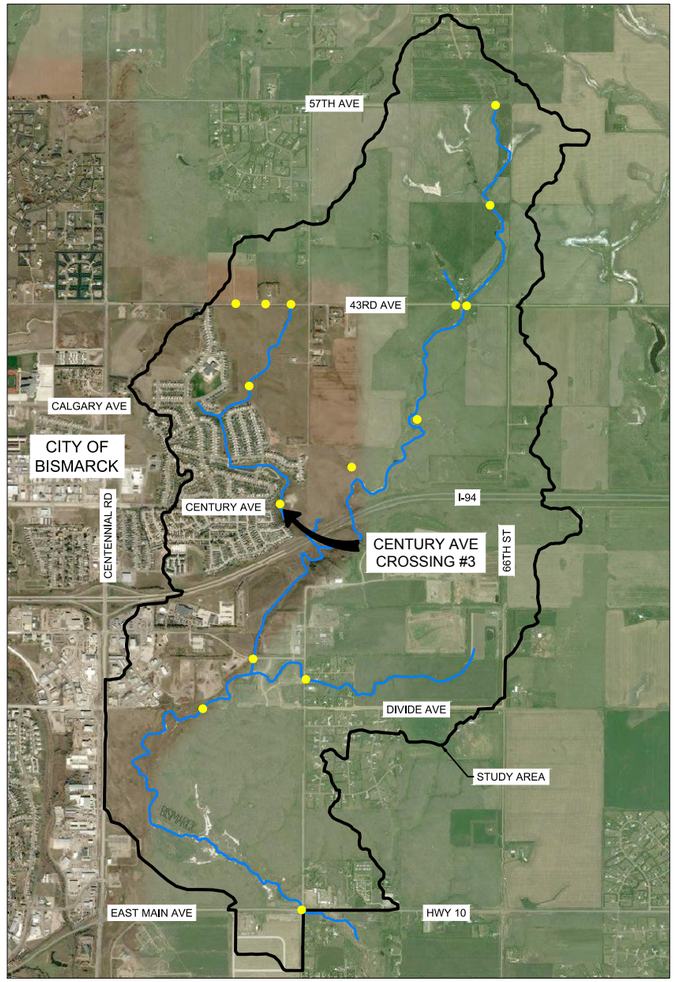


NOTE:
ELEVATIONS ARE IN NGVD-29





LOCATION MAP

SCALE: NONE

ESTIMATED MAJOR QUANTITIES

Spec	Description	Unit	Quantity
202-4.1	Unclassified Excavation	CY	8,000
802-4.13	60" Storm Sewer Pipe	LF	550
802-4.46	60" FES	EA	4
SP	Final Stabilization	SF	60,000

NOTE:
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PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

AE2S

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
CITY OF BISMARCK
BISMARCK, NORTH DAKOTA
FUTURE CENTURY AVENUE ROAD CROSSING #3

DRAWING TYPE: EXHIBIT
PREPARED BY: TRK
CHECKED / APPROVED: BE / JH
DATE: SEPT 2017
PROJECT NUMBER: P00501-2015-013
SHEET: - of -
DRAWING: 8A

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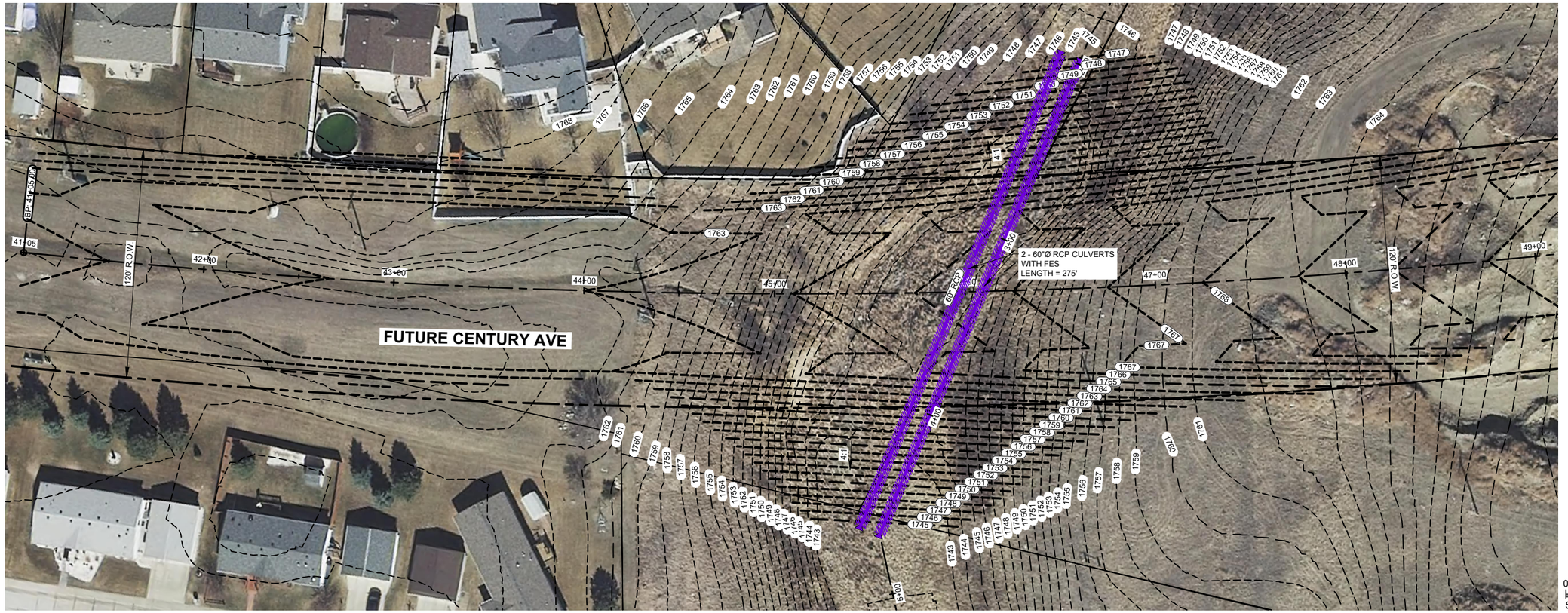
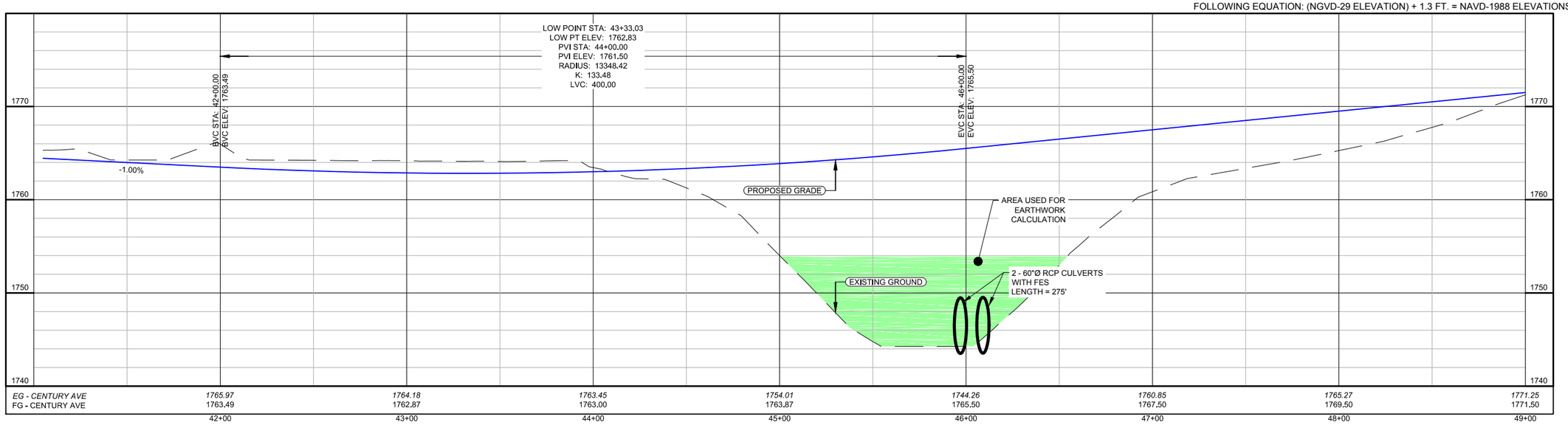


NOTE:
ALL CONTOURS, ELEVATIONS, AND COORDINATES FOR THIS DRAWING ARE BASED ON BISMARCK GPS CONTROL MONUMENTS, NAD83 STATE PLANE COORDINATE SYSTEM, NORTH DAKOTA SOUTH ZONE AND NGVD-29. TO RELATE ELEVATIONS TO NAVD-88 DATUM USE THE FOLLOWING EQUATION: (NGVD-29 ELEVATION) + 1.3 FT. = NAVD-1988 ELEVATIONS.



PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

AE2S

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
CITY OF BISMARCK
BISMARCK, NORTH DAKOTA
FUTURE CENTURY AVENUE ROAD CROSSING #3

DRAWING TYPE	EXHIBIT
PREPARED BY	TRK
CHECKED / APPROVED	BE / JH
DATE	SEPT 2017
PROJECT NUMBER	P00501-2015-013
SHEET	- of -
DRAWING	8B

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Improvement ID: ***Century Ave Crossing 3***

	Description	Units	Unit Price	Quantity	Total Price
General					
	Insurance and Bonding (3%)	LS	3%		$ 7,700
	Mobilization (6%)	LS	6%		$ 15,300
Pipe Conduit & Culverts					
802-4.13	60" Storm Sewer Pipe	LF	$ 290	550	$ 159,500
End Treatments					
1205-4.1	48" Dia and Smaller	Each	$ 4,000		$ -
1205-4.1C	48" to 72" Dia	Each	$ 7,000	4	$ 28,000
1205-4.1J	72" and Larger	Each	$ 10,000		$ -
SP	Box Culvert Ends (Incl. permanent erosion protection)	Each	$ 15,000		$ -
Earthwork					
202-4.1	Unclassified Excavation	CY	$ 8.00	8,000	$ 64,000
202-4.3	Borrow Excavation	CY	$ 10.00		$ -
	Vegetation	SF	$ 0.05	60,000	$ 3,000
Unanticipated & Contingency					
	Construction Contingency (30%)	LS	30%		$ 83,250
Subtotal Construction Costs					**$ 360,750**
Administration & Engineering					
	Design Engineering	LS	6%		$ 21,645
	Construction Engineering	LS	10%		$ 36,075
	Administrative	LS	7%		$ 25,253
Subtotal Administration & Engineering					**$ 82,973**
Opinion of Project Construction Costs					**$ 443,723**

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Improvement ID: *Miriam Ave Crossing*

	Description	Units	Unit Price	Quantity	Total Price
General					
	Insurance and Bonding (3%)	LS	3%		$ 7,000
	Mobilization (6%)	LS	6%		$ 14,000
	Traffic Control (5%)	LS	5%		$ 11,700
Removal and Disposal					
SP	42" to 60" pipe	LF	$ 25	375	$ 9,375
Pipe Conduit & Culverts					
802-4.14	66" Storm Sewer Pipe	LF	$ 400	375	$ 150,000
Surface Restoration					
SP	Street Asphalt Patch (6" of AC on 8" of Class V)	SF	$ 9.00	3200	$ 28,800
SP	Grading and Seeding of Non-Paved Areas	SF	$ 0.20	15000	$ 3,000
End Treatments					
1205-4.1C	48" to 72" Dia	Each	$ 7,000	6	$ 42,000
Unanticipated & Contingency					
	Construction Contingency (30%)	LS	30%		$ 79,763
Subtotal Construction Costs					**$ 345,638**
Administration & Engineering					
	Design Engineering	LS	6%		$ 20,738
	Construction Engineering	LS	10%		$ 34,564
	Administrative	LS	7%		$ 24,195
Subtotal Administration & Engineering					**$ 79,497**
Opinion of Project Construction Costs					**$425,134**

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Improvement ID: *52nd St Crossing*

	Description	Units	Unit Price	Quantity	Total Price
General					
	Insurance and Bonding (3%)	LS	3%		$ 4,000
	Mobilization (6%)	LS	6%		$ 7,900
	Traffic Control (5%)	LS	5%		$ 6,600
Removal and Disposal					
SP	42" to 60" pipe	LF	$ 25	85	$ 2,125
Pipe Conduit & Culverts					
802-4.12	54" Storm Sewer Pipe	LF	$ 235	170	$ 39,950
Surface Restoration					
SP	Street Asphalt Patch (6" of AC on 8" of Class V)	SF	$ 9.00	6400	$ 57,600
SP	Grading and Seeding of Non-Paved Areas	SF	$ 0.20	15000	$ 3,000
End Treatments					
1205-4.1C	48" to 72" Dia	Each	$ 7,000	4	$ 28,000
Unanticipated & Contingency					
	Construction Contingency (30%)	LS	30%		$ 44,753
Subtotal Construction Costs					**$ 193,928**
Administration & Engineering					
	Design Engineering	LS	6%		$ 11,636
	Construction Engineering	LS	10%		$ 19,393
	Administrative	LS	7%		$ 13,575
Subtotal Administration & Engineering					**$ 44,603**
Opinion of Project Construction Costs					**$ 238,531**

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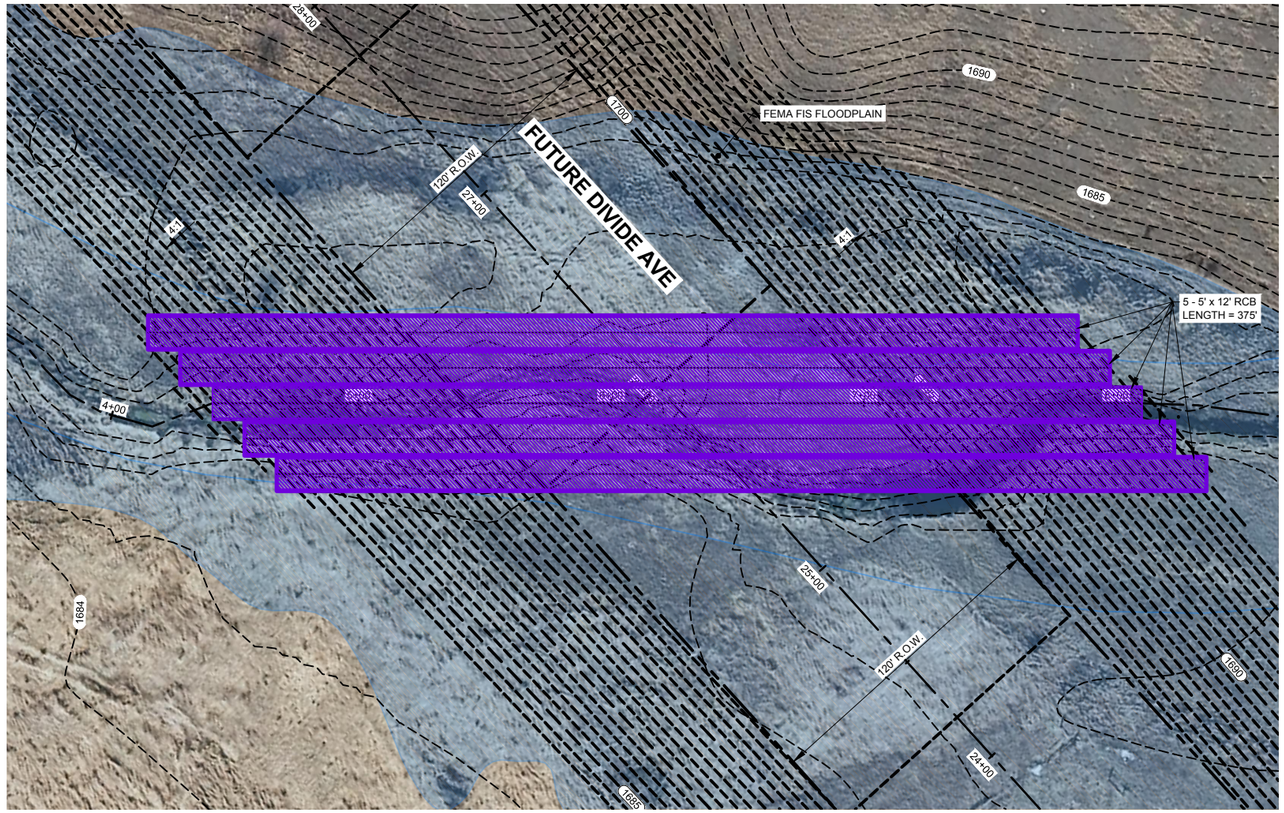
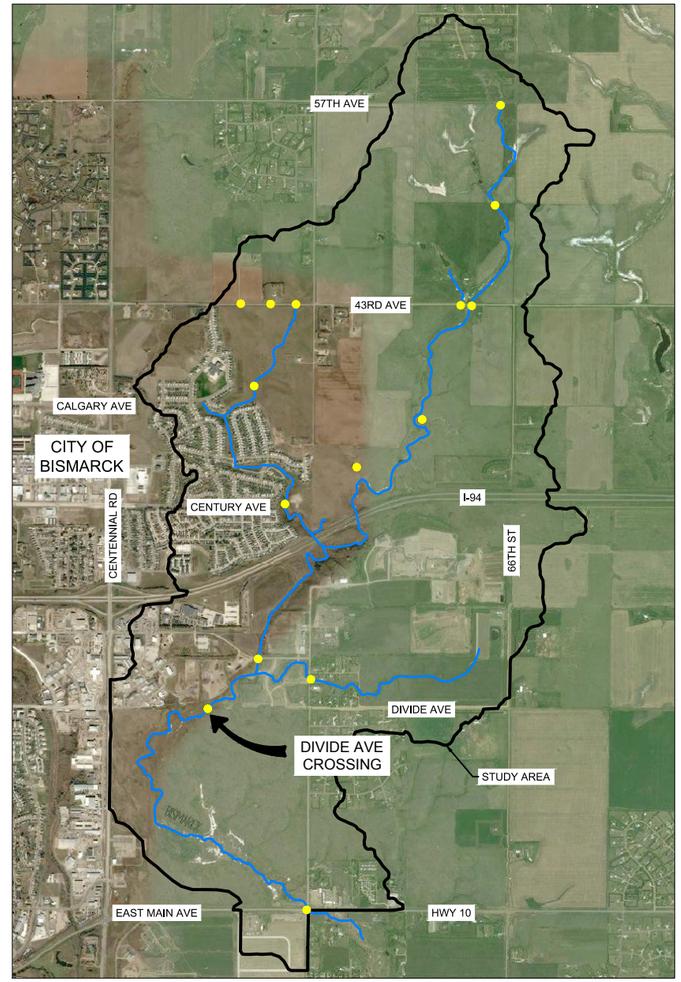
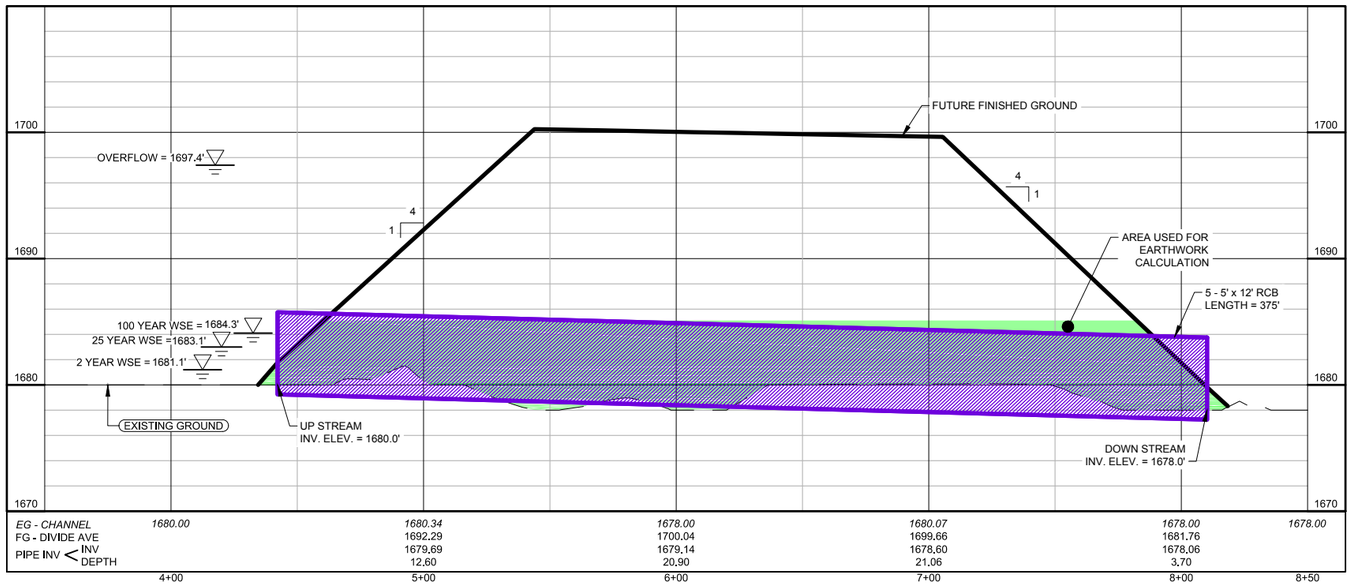




LOCATION MAP

SCALE: NONE



ESTIMATED MAJOR QUANTITIES

Spec	Description	Unit	Quantity
202-4.1	Unclassified Excavation	CY	180,000
SP	12ft x 5ft Precast RCB Culvert	LF	1,875
SP	RCB End Treatments	EA	10
SP	Final Stabilization	SF	450,000

NOTE:
ELEVATIONS ON THIS EXHIBIT ARE IN THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).

PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

AE2S

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
CITY OF BISMARCK
BISMARCK, NORTH DAKOTA
FUTURE DIVIDE AVENUE ROAD CROSSING

DRAWING TYPE	EXHIBIT
PREPARED BY	TRK
CHECKED / APPROVED	BE / JH
DATE	SEPT 2017
PROJECT NUMBER	P00501-2015-013
SHEET	- of -
DRAWING	9A

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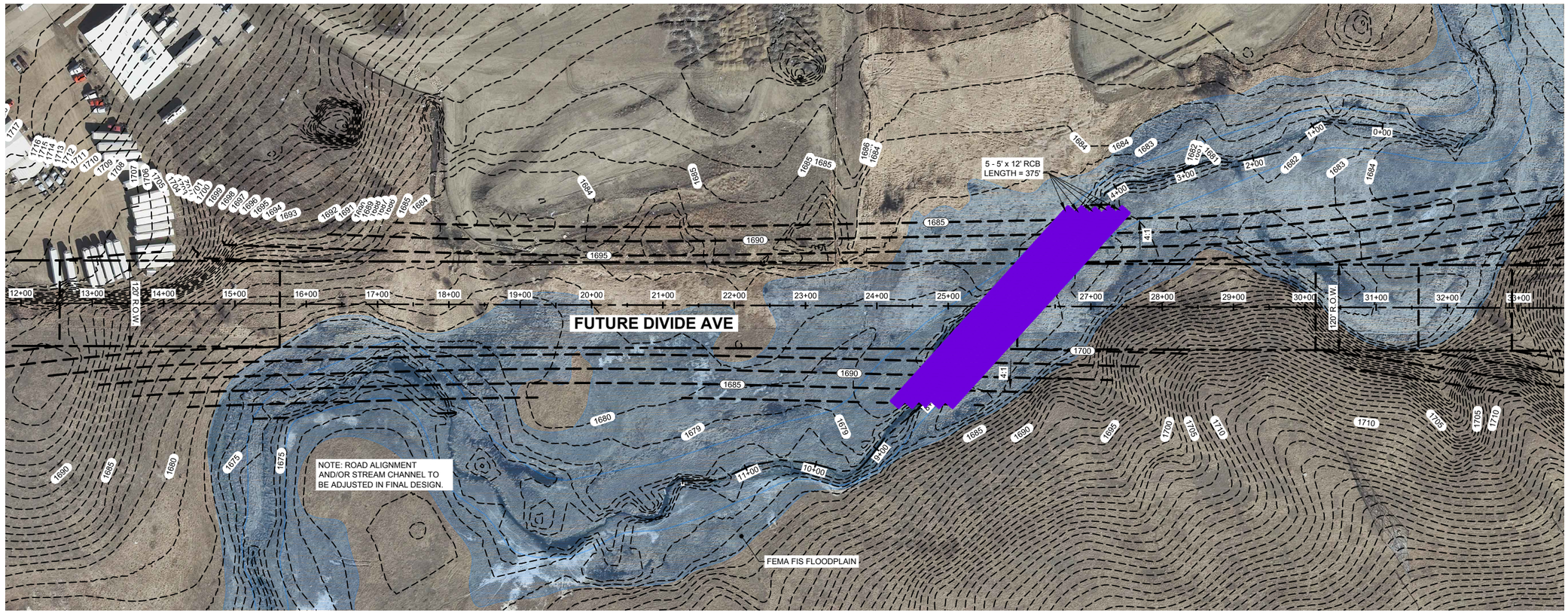
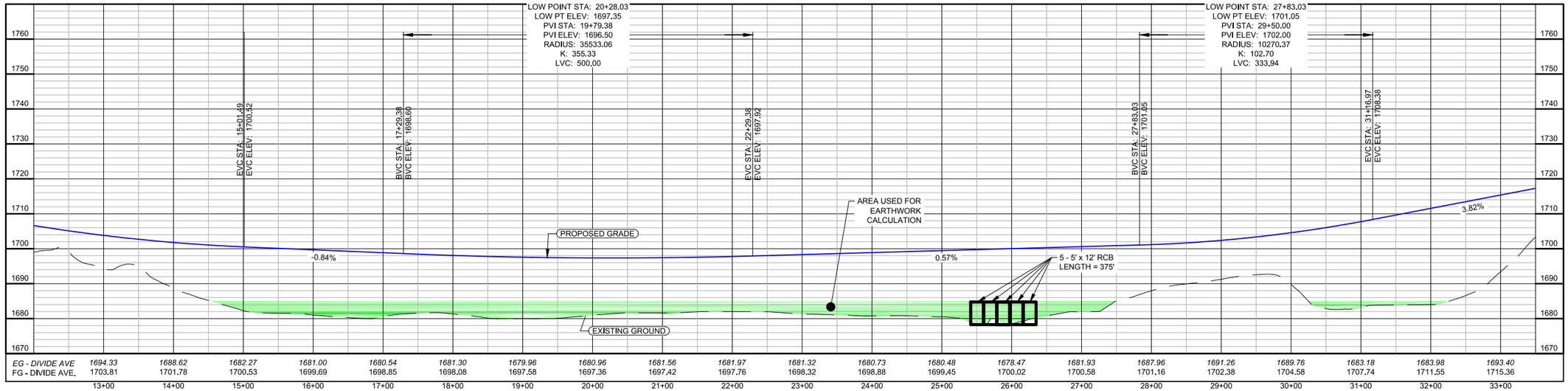


NOTE:
ELEVATIONS ON THIS EXHIBIT ARE IN THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).



PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

AE2S

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
CITY OF BISMARCK
BISMARCK, NORTH DAKOTA
FUTURE DIVIDE AVENUE ROAD CROSSING

DRAWING TYPE	EXHIBIT
PREPARED BY	TRK
CHECKED / APPROVED	BE / JH
DATE	SEPT 2017
PROJECT NUMBER	P00501-2015-013
SHEET	- of -
DRAWING	9B

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Improvement ID: *Future Divide Ave Crossing*

	Description	Units	Unit Price	Quantity	Total Price
General					
	Insurance and Bonding (3%)	LS	3%		$ 104,900
	Mobilization (6%)	LS	6%		$ 209,700
Pipe Conduit & Culverts					
SP	12ft x 5ft Precast RCB Culvert	LF	$ 1,500	1875	$ 2,812,500
End Treatments					
1205-4.1J	72" and Larger	Each	$ 10,000	10	$ 100,000
Earthwork					
202-4.1	Unclassified Excavation	CY	$ 8.00	70,000	$ 560,000
	Vegetation	SF	$ 0.05	450,000	$ 22,500
Unanticipated & Contingency					
	Construction Contingency (30%)	LS	30%		$ 1,142,880
Subtotal Construction Costs					**$ 4,952,480**
Administration & Engineering					
	Design Engineering	LS	6%		$ 297,149
	Construction Engineering	LS	10%		$ 495,248
	Administrative	LS	7%		$ 346,674
Subtotal Administration & Engineering					**$ 1,139,070**
Opinion of Project Construction Costs					**$ 6,091,550**

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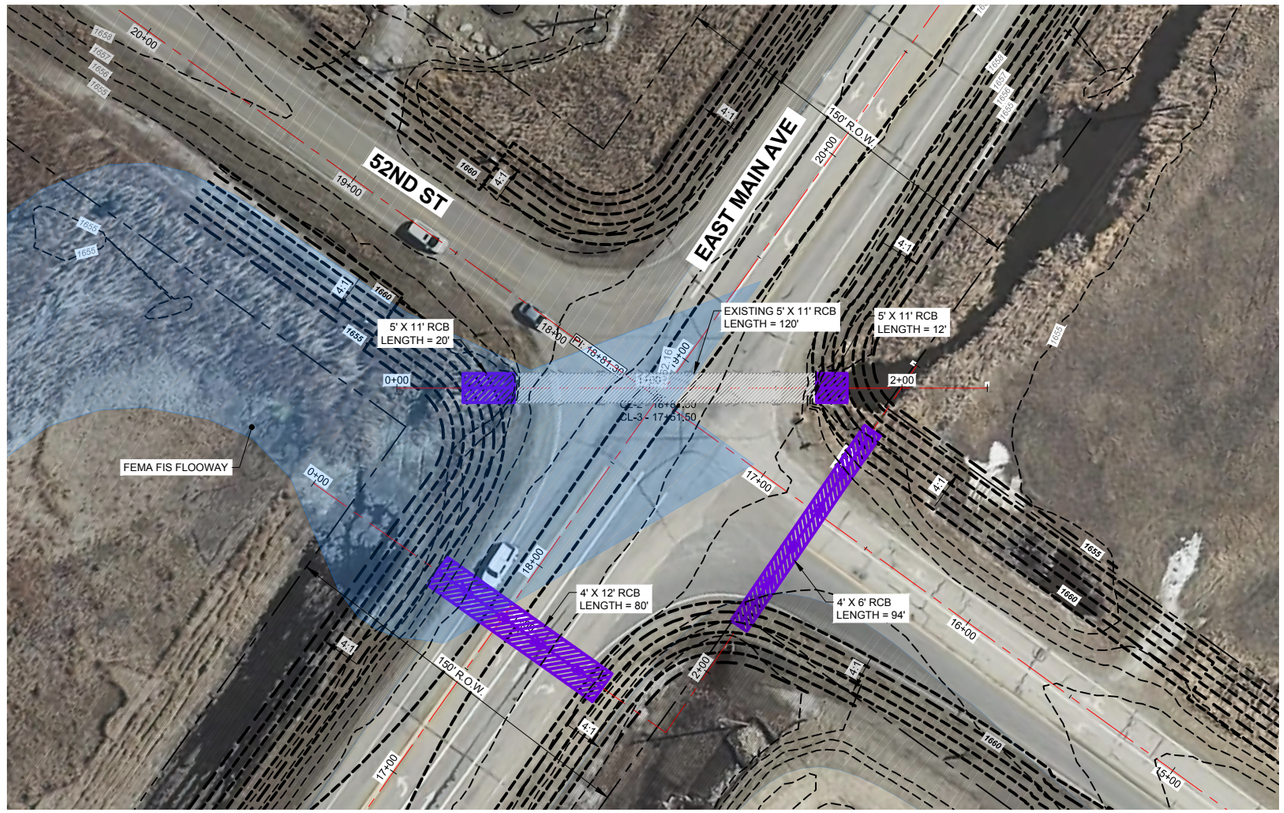
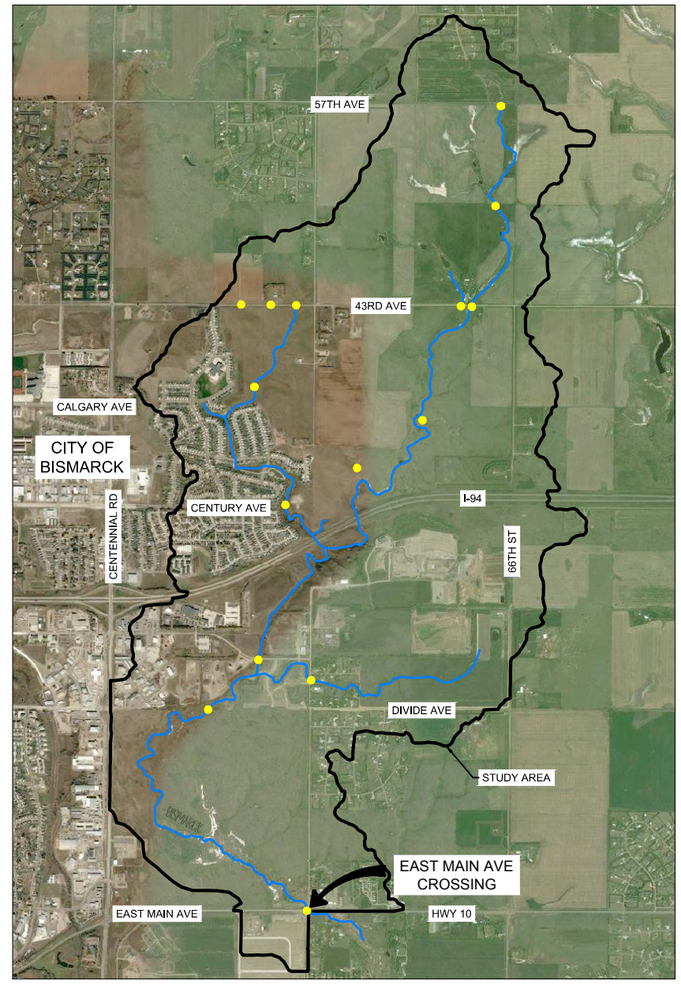
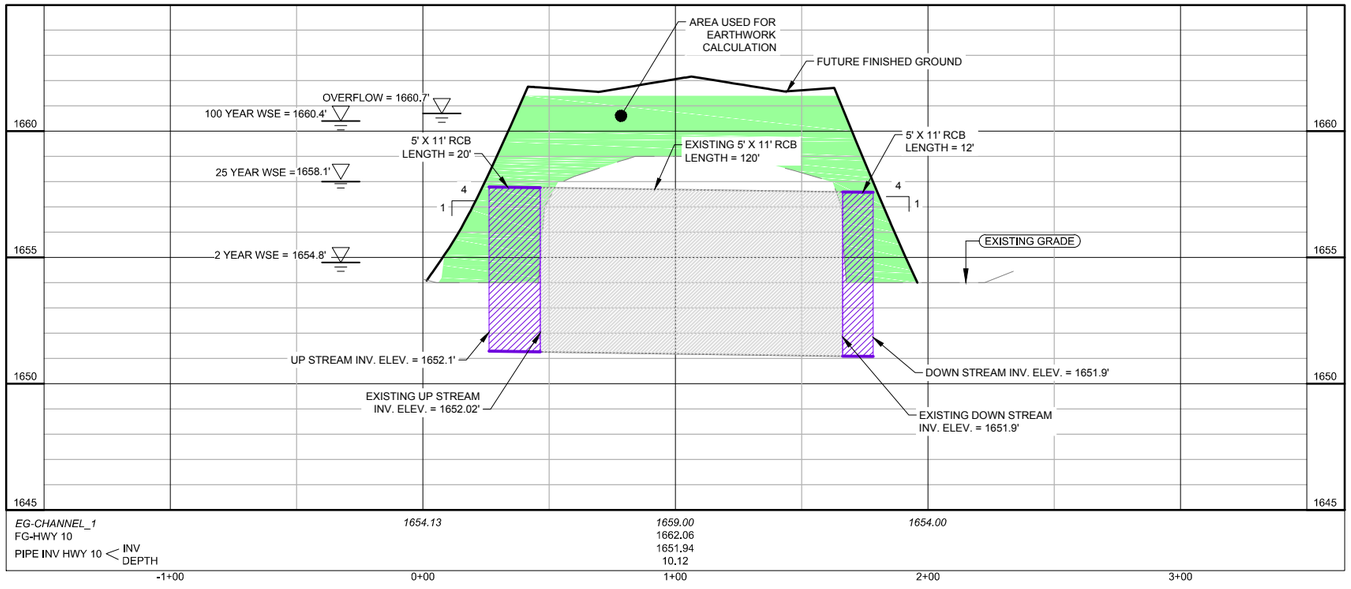




LOCATION MAP

SCALE: NONE



ESTIMATED MAJOR QUANTITIES

Spec	Description	Unit	Quantity
202-4.1	Unclassified Excavation	CY	40,000
SP	6ft x 4ft Precast RCB Culvert	LF	94
SP	11ft x 5ft Precast RCB Culvert	LF	32
SP	12ft x 4ft Precast RCP Culvert	LF	80
SP	Box Culvert End Treatments	EA	6
SP	Final Stabilization	SF	125,000

NOTE:
ELEVATIONS ON THIS EXHIBIT ARE IN THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).

PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

AE2S

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
CITY OF BISMARCK
BISMARCK, NORTH DAKOTA
EAST MAIN AVE ROAD CROSSING

DRAWING TYPE: EXHIBIT
PREPARED BY: TRK
CHECKED / APPROVED: BE / JH
DATE: SEPT 2017
PROJECT NUMBER: P00501-2015-013
SHEET: - of -
DRAWING: **10A**

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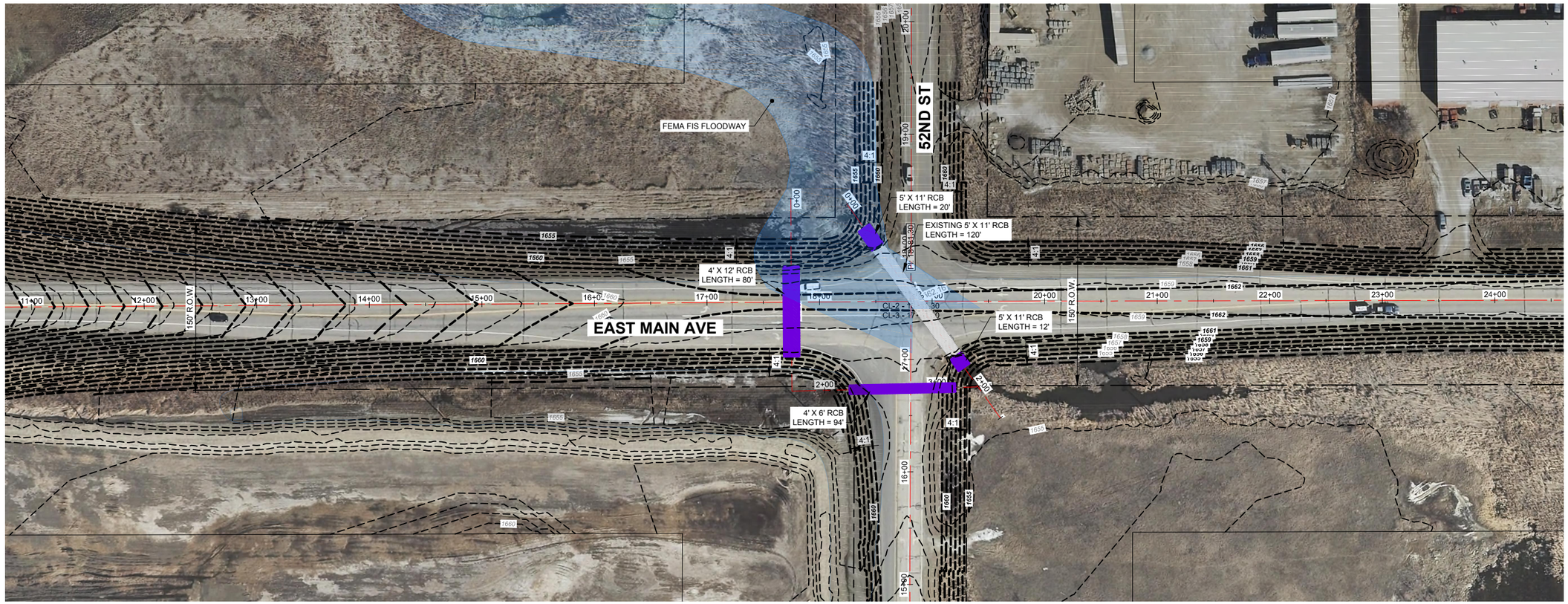

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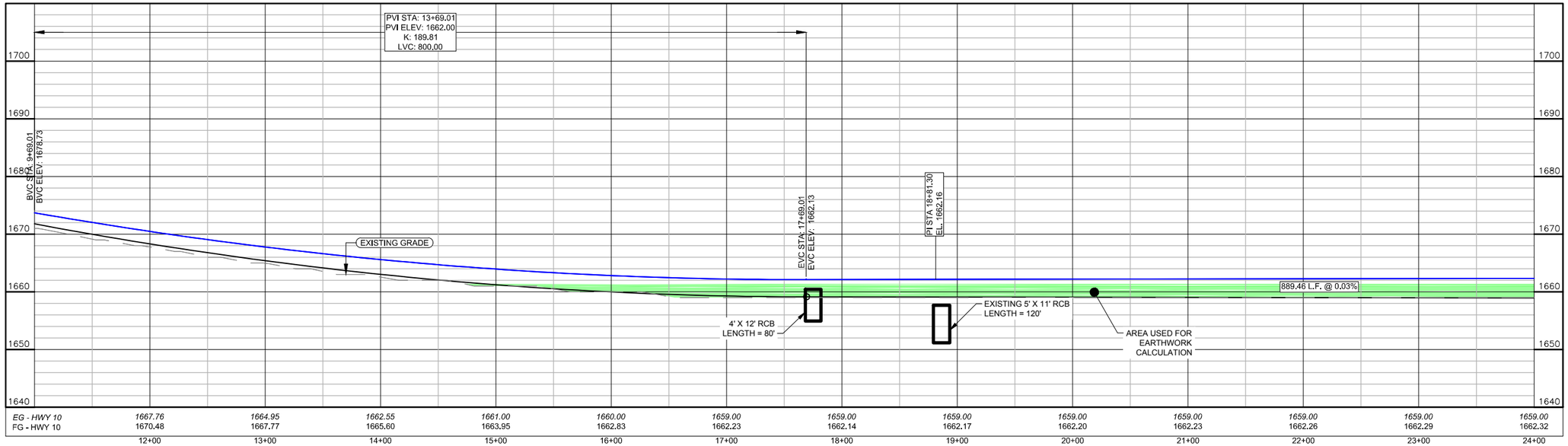

PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

AE2S

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
CITY OF BISMARCK
BISMARCK, NORTH DAKOTA
EAST MAIN AVE ROAD CROSSING

DRAWING TYPE	EXHIBIT
PREPARED BY	TRK
CHECKED / APPROVED	BE / JH
DATE	SEPT 2017
PROJECT NUMBER	P00501-2015-013
SHEET	- of -
DRAWING	10B

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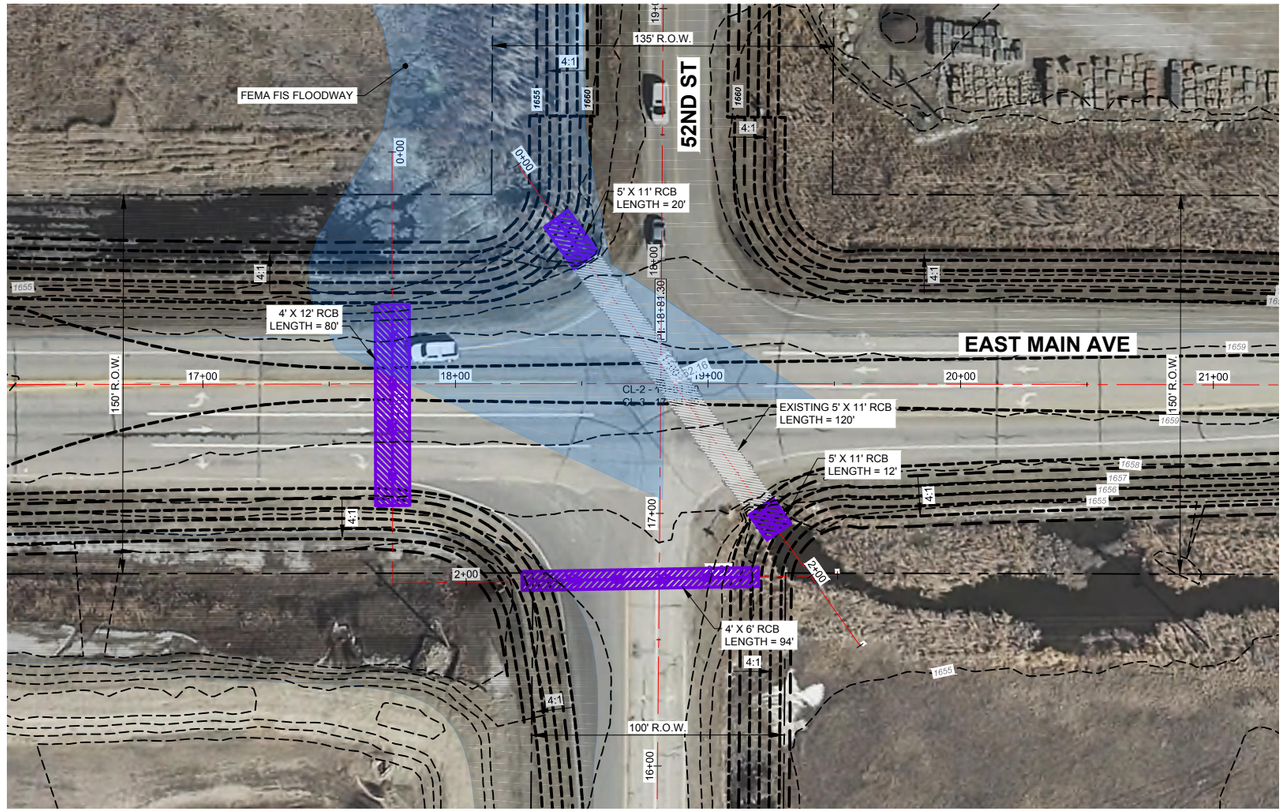

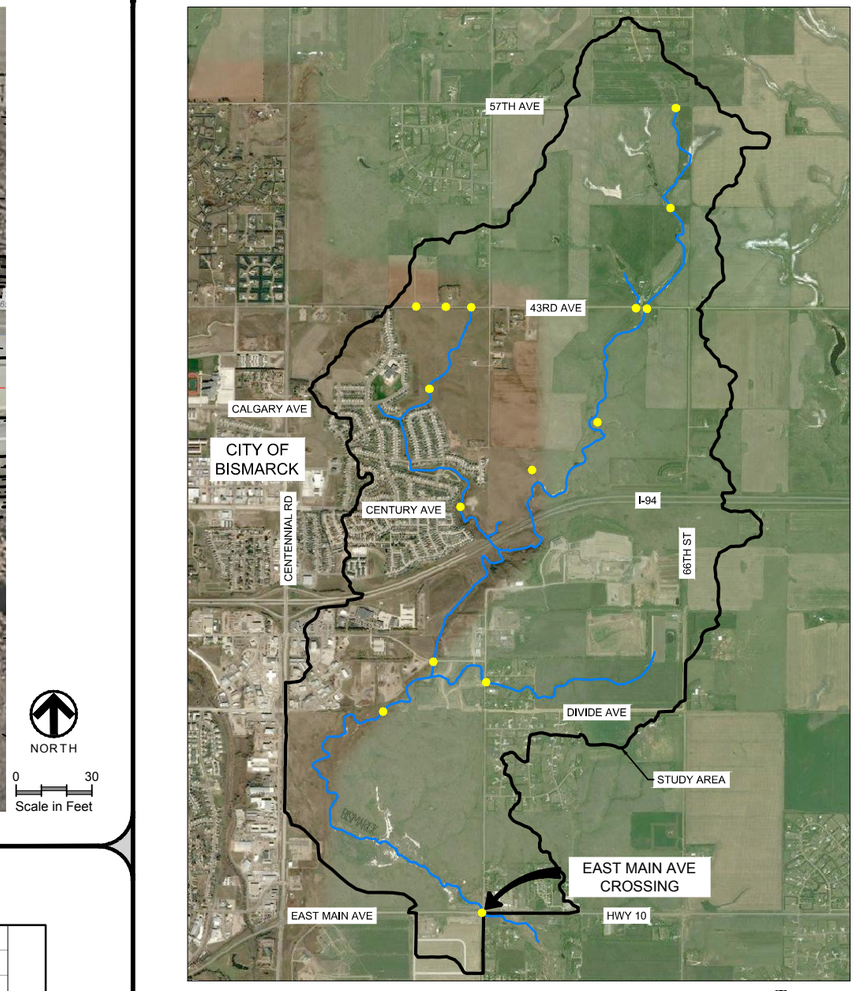

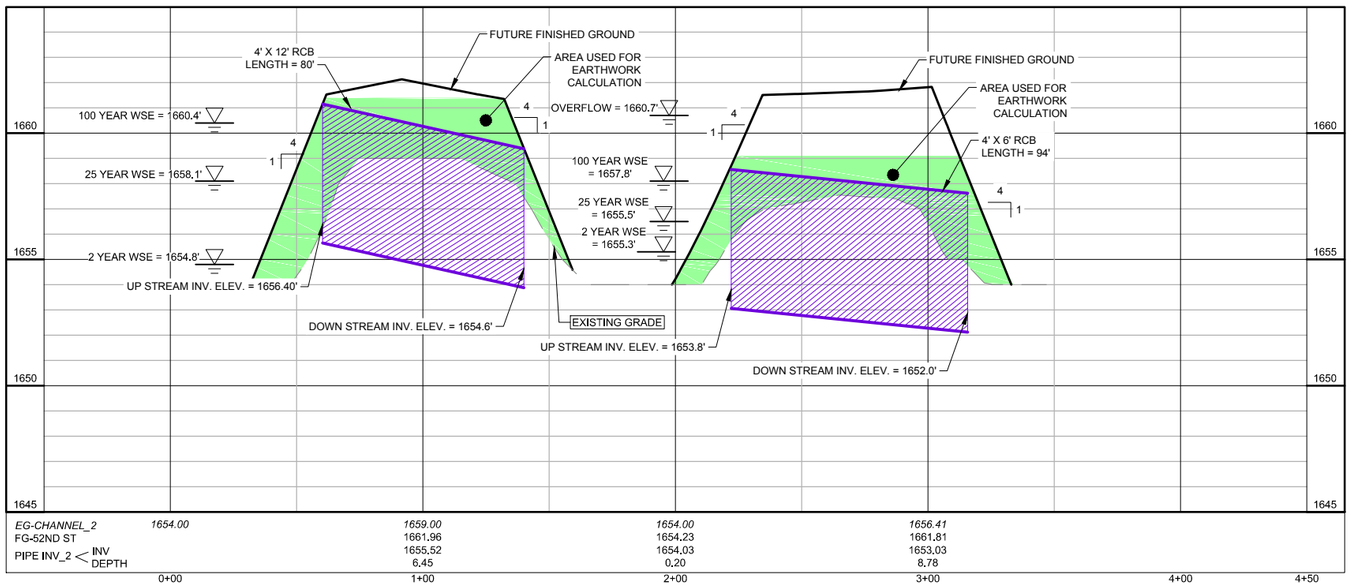

LOCATION MAP

SCALE: NONE

ESTIMATED MAJOR QUANTITIES

Spec	Description	Unit	Quantity
202-4.1	Unclassified Excavation	CY	40,000
SP	6ft x 4ft Precast RCB Culvert	LF	94
SP	11ft x 5ft Precast RCB Culvert	LF	32
SP	12ft x 4ft Precast RCP Culvert	LF	80
SP	Box Culvert End Treatments	EA	6
SP	Final Stabilization	SF	125,000

NOTE:
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PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

AE2S

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
CITY OF BISMARCK
BISMARCK, NORTH DAKOTA
52ND ST AT EAST MAIN AVE CROSSING

DRAWING TYPE: EXHIBIT
PREPARED BY: TRK
CHECKED / APPROVED: BE / JH
DATE: SEPT 2017
PROJECT NUMBER: P00501-2015-013
SHEET: - of -
DRAWING: 11A

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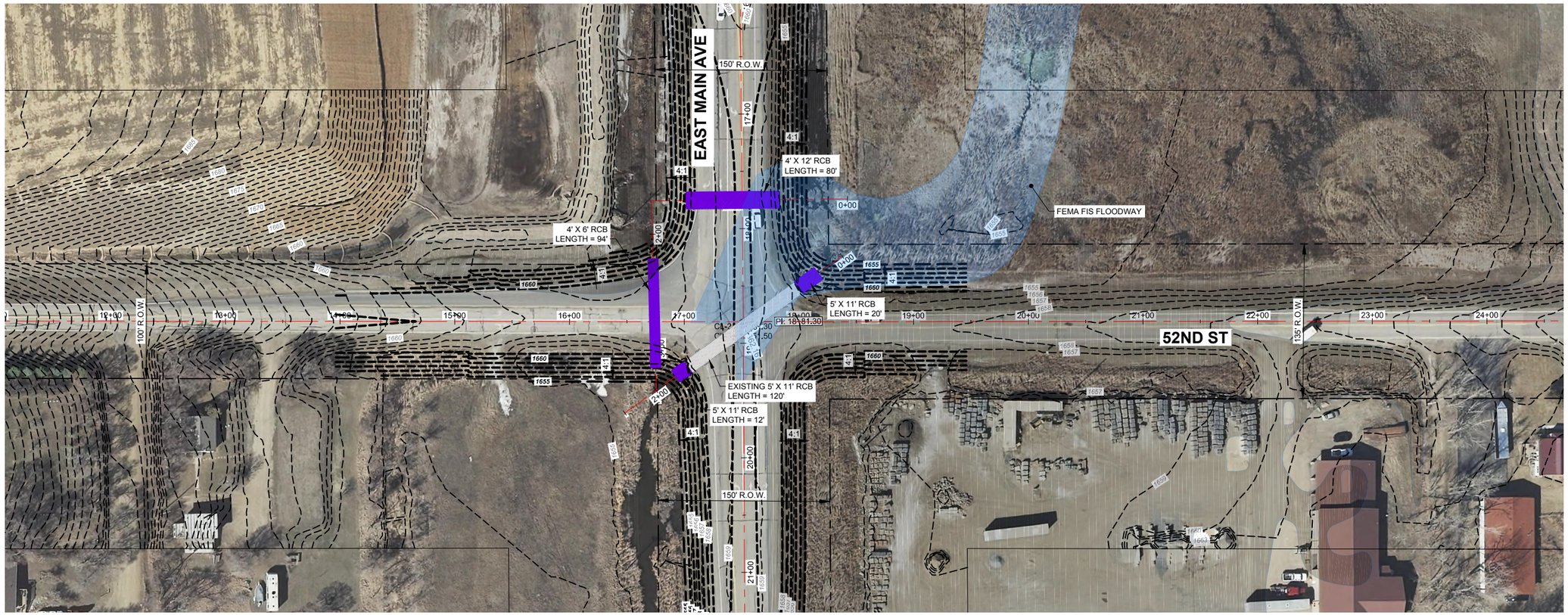

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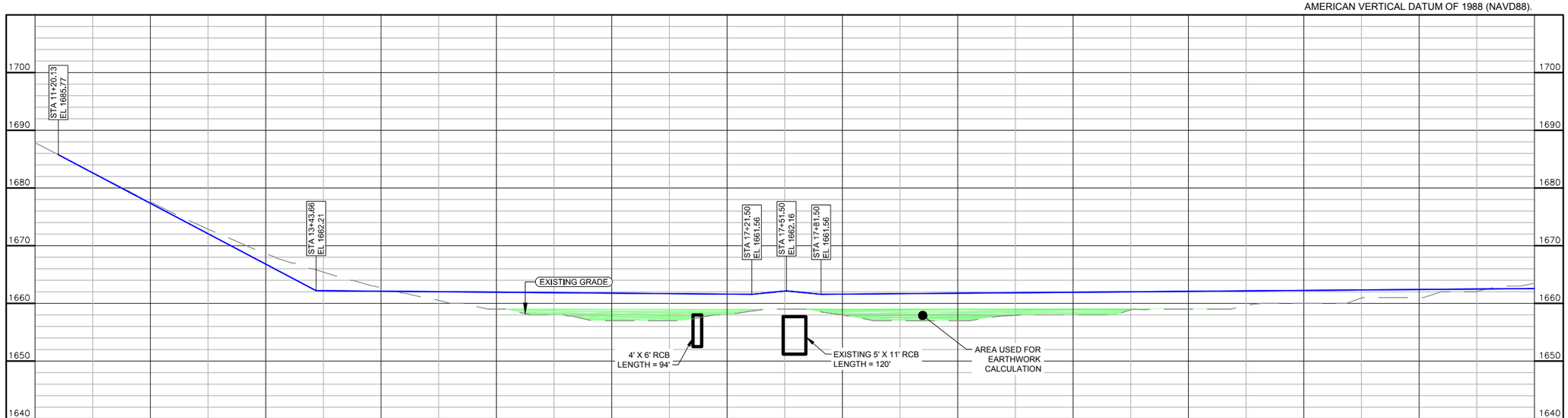

	12+00	13+00	14+00	15+00	16+00	17+00	18+00	19+00	20+00	21+00	22+00	23+00
EG - 52ND ST	*1677.60*	*1668.63*	*1662.70*	*1659.00*	*1657.00*	*1658.00*	*1658.00*	*1657.00*	*1658.00*	*1659.00*	*1660.00*	*1661.00*
FG - 52ND ST	1677.35	1666.81	1662.11	1661.94	1661.77	1661.60	1661.59	1661.76	1661.92	1662.09	1662.26	1662.42

PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

AE2S

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
CITY OF BISMARCK
BISMARCK, NORTH DAKOTA
52ND ST AT EAST MAIN AVE CROSSING

DRAWING TYPE	EXHIBIT
PREPARED BY	TRK
CHECKED / APPROVED	BE / JH
DATE	SEPT 2017
PROJECT NUMBER	P00501-2015-013
SHEET	- of -
DRAWING	11B

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Improvement ID: *East Main Ave Crossings*

	Description	Units	Unit Price	Quantity	Total Price
General					
	Insurance and Bonding (3%)	LS	3%		$ 20,700
	Mobilization (6%)	LS	6%		$ 41,300
	Traffic Control (5%)	LS	5%		$ 34,400
	Misc. Utility Relocation (5%)	LS	5%		$ 34,400
Pipe Conduit & Culverts					
SP	6ft x 4ft Precast RCB Culvert	LF	$ 1,100	94	$ 103,400
SP	10ft x 5ft Precast RCB Culvert	LF	$ 1,500	32	$ 48,000
SP	12ft x 4ft Precast RCB Culvert	LF	$ 1,500	80	$ 120,000
End Treatments					
SP	Box Culvert Ends (Incl. permanent erosion protection)	Each	$ 15,000	6	$ 90,000
Earthwork					
202-4.1	Unclassified Excavation	CY	$ 8.00	40,000	$ 320,000
	Vegetation	SF	$ 0.05	125,000	$ 6,250
Unanticipated & Contingency					
	Construction Contingency (30%)	LS	30%		$ 245,535
Subtotal Construction Costs					**$ 1,063,985**
Administration & Engineering					
	Design Engineering	LS	6%		$ 63,839
	Construction Engineering	LS	10%		$ 106,399
	Administrative	LS	7%		$ 74,479
Subtotal Administration & Engineering					**$ 244,717**
Opinion of Project Construction Costs					**$ 1,308,702**

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Improvement ID: ***Silver Ranch Road Crossing***

	Description	Units	Unit Price	Quantity	Total Price
General					
	Insurance and Bonding (3%)	LS	3%		$ 7,700
	Mobilization (6%)	LS	6%		$ 15,300
Pipe Conduit & Culverts					
802-4.11	48" Storm Sewer Pipe	LF	$ 225	840	$ 189,000
End Treatments					
1205-4.1	48" Dia and Smaller	Each	$ 4,000	12	$ 48,000
Earthwork					
202-4.1	Unclassified Excavation	CY	$ 8.00	2,000	$ 16,000
	Vegetation	SF	$ 0.05	15,000	$ 750
Unanticipated & Contingency					
	Construction Contingency (30%)	LS	30%		$ 83,025
Subtotal Construction Costs					**$ 359,775**
Administration & Engineering					
	Design Engineering	LS	6%		$ 21,587
	Construction Engineering	LS	10%		$ 35,978
	Administrative	LS	7%		$ 25,184
Subtotal Administration & Engineering					**$ 82,748**
Opinion of Project Construction Costs					**$ 442,523**

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II-5.0 STAKEHOLDER COMMUNICATION AND INPUT

II-5.1 CITY WORKING GROUP MEETINGS

During the development of the Silver Ranch Master Plan, seven City Working Group meetings were conducted as summarized below:

Working Group Meeting #1 – January 27th, 2017 Kick-off to review project goals, responsibilities and data collection.

Working Group Meeting #2 – March 1st, 2017 Presentation of the Existing Condition modeling.

Working Group Meeting #3 – April 12th, 2017 Presentation of Master Plan concepts for regional, local, and on-site peak flow mitigation.

Working Group Meeting #4 – May 3rd, 2017 Follow-up on Master Plan concepts to compare onsite local detention to unit rate concepts.

Working Group Meeting #5 – May 17th, 2017 Expansion of Unit Rate concepts.

Working Group Meeting #6 – June 21st, 2017 Presentation of Unit Rate Development and Implementation Policies

Working Group Meeting #7 – August 16th, 2017 Presentation of Unit Rate Development and Draft Master Plan Development

Presentation materials and minutes for each City Working Group meeting were distributed to the members of the group. Recommendations and conclusions of the City Working Group have been incorporated into the Silver Ranch Watershed Master Plan.

II-5.2 AGENCY COMMUNICATION

AE2S completed agency communication that involved coordination with multiple entities, including:

1. Burleigh County Highway Department;
2. Burleigh County Water Resources District;
3. North Dakota Department of Transportation;
4. North Dakota State Land Department; and
5. City of Bismarck Parks and Recreation.

Each the above entities was provided a summary of the Silver Ranch Watershed Master Plan findings and recommendations.

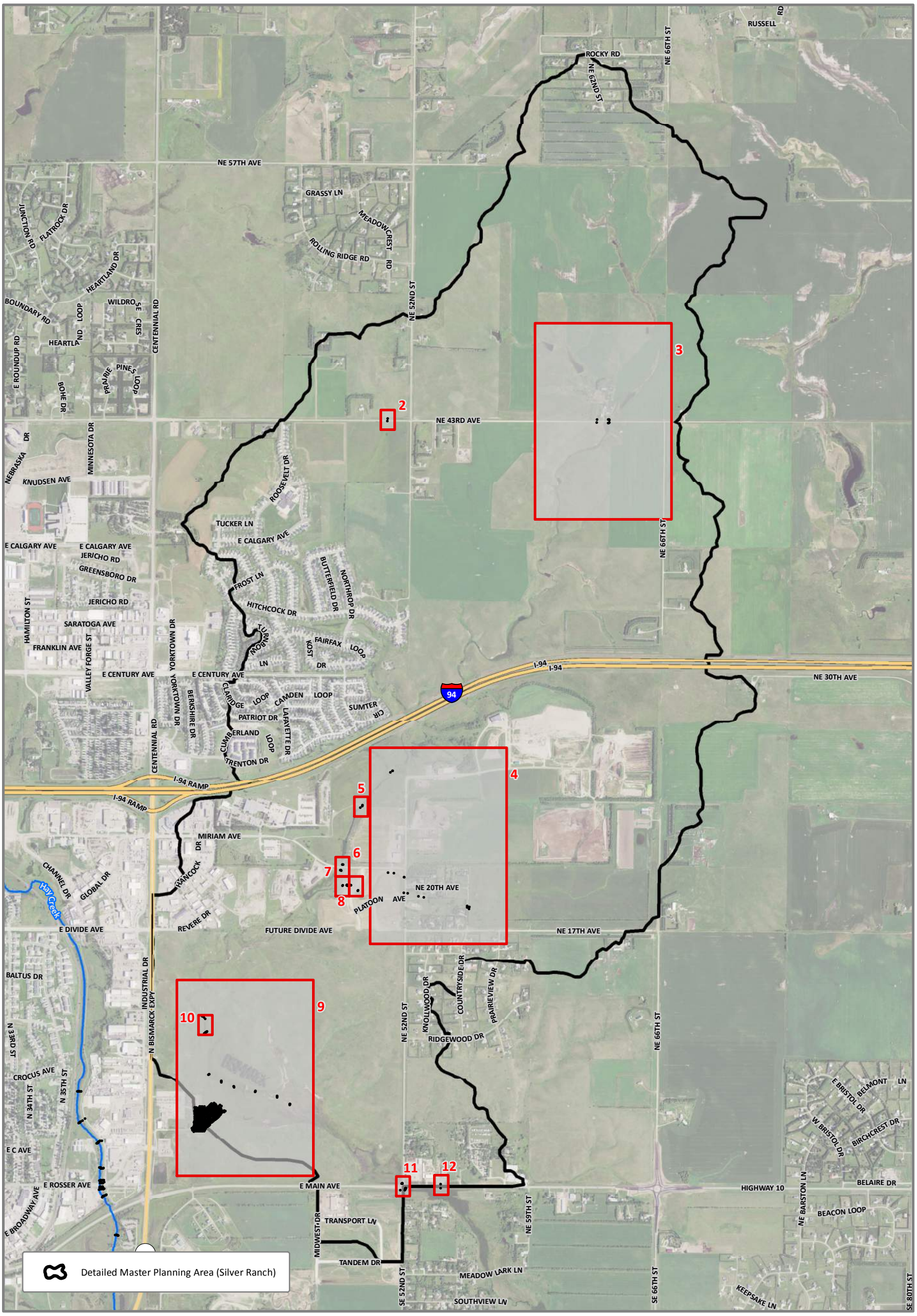
II-5.3 STAKEHOLDER COMMUNICATION

City of Bismarck staff has completed, or will complete, stakeholder communication with the following entities:

1. Silver Ranch Development Group (Chad Wachter & SEH Engineering);
2. Silbernagel Family; and
3. Sattler Development Group.

II-6.0 SURVEY MAP BOOK

Figure II - 12 Survey Map Book



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Coordinate System: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Intl | Edited by: dlee | C:\Data\Projects\WAFS\Bismarck\00501-2015-013\GIS\Report Figure II-12- Silver Ranch Survey Mapbook Index.mxd

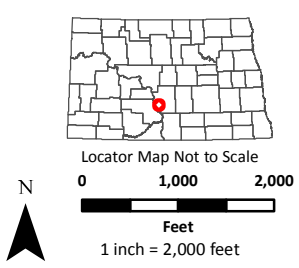

Figure III-12

SILVER RANCH SURVEY MAPBOOK- PAGE 1 (INDEX)

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
City of Bismarck | Burleigh County, ND

Date: 10/27/2017

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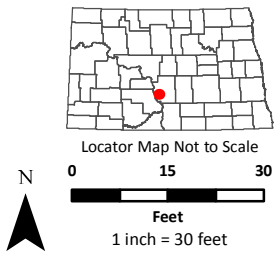

Figure II-12

SILVER RANCH SURVEY MAPBOOK- PAGE 2

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
City of Bismarck | Burleigh County, ND

Date: 10/27/2017

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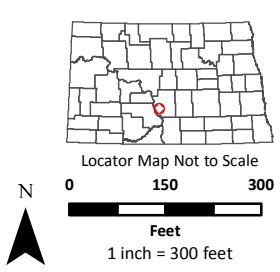

Figure II-12

SILVER RANCH SURVEY MAPBOOK- PAGE 3

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
City of Bismarck | Burleigh County, ND

Date: 10/27/2017

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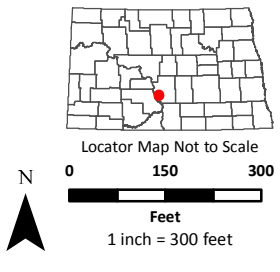

Figure II-12

SILVER RANCH SURVEY MAPBOOK- PAGE 4

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
City of Bismarck | Burleigh County, ND

Date: 10/27/2017

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Coordinate System: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Intl | Edited by: dlee | C:\Data\Projects\WAFS\Bismarck\00501-2015-013\GIS\Report Figure II-12- Silver Ranch Survey Mapbook.mxd

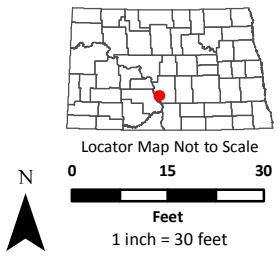

Figure II-12

SILVER RANCH SURVEY MAPBOOK- PAGE 5

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
City of Bismarck | Burleigh County, ND

Date: 10/27/2017

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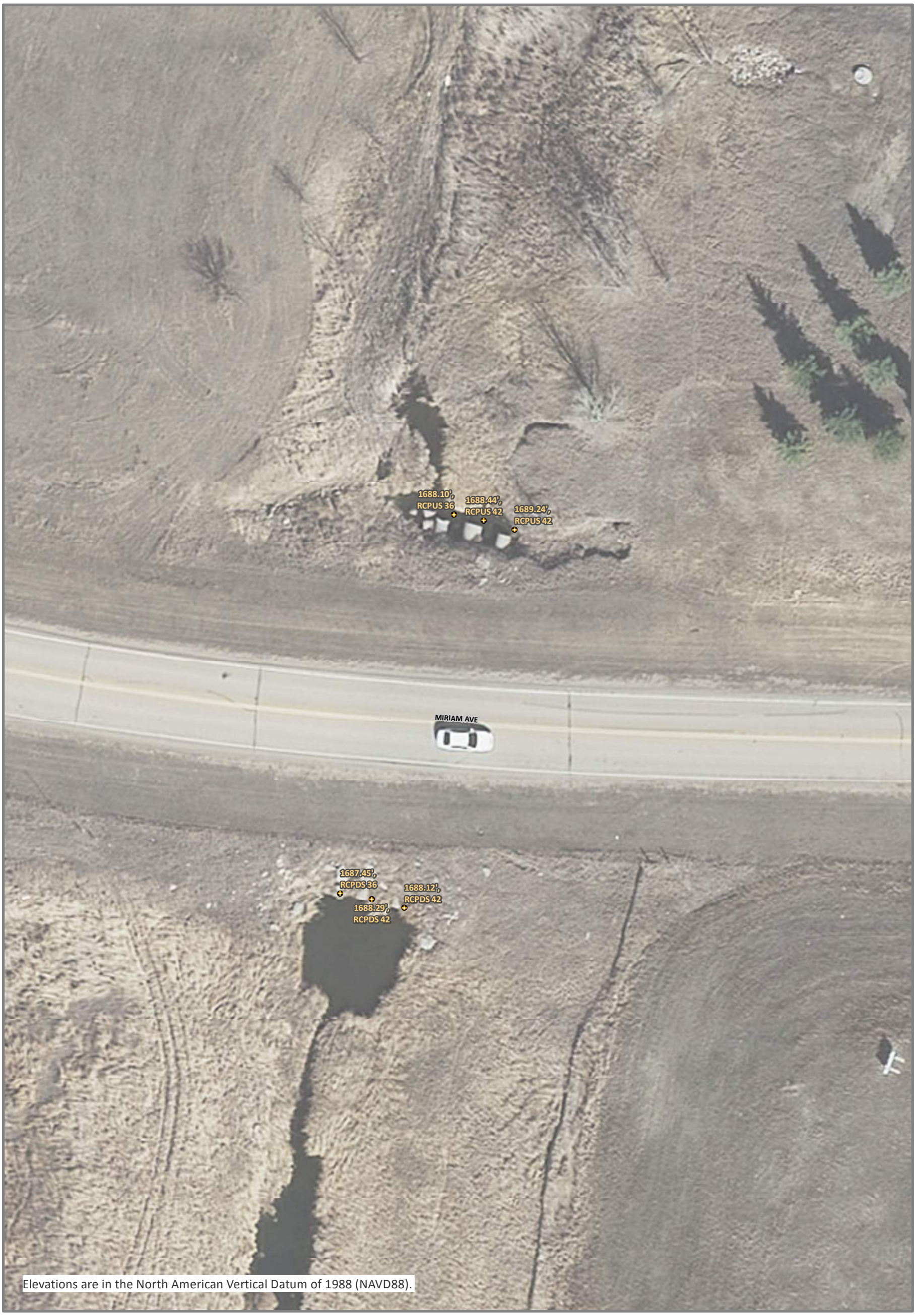

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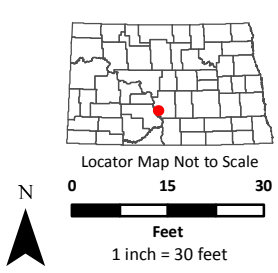

Figure II-12

SILVER RANCH SURVEY MAPBOOK- PAGE 6

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
City of Bismarck | Burleigh County, ND

Date: 10/27/2017

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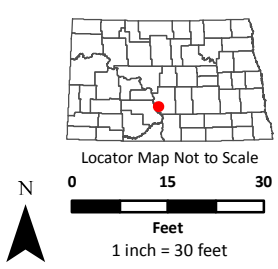

Figure II-12

SILVER RANCH SURVEY MAPBOOK- PAGE 7

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
City of Bismarck | Burleigh County, ND

Date: 10/27/2017

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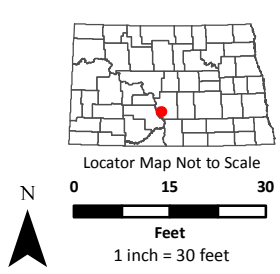

Figure II-12

SILVER RANCH SURVEY MAPBOOK- PAGE 8

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
City of Bismarck | Burleigh County, ND

Date: 10/27/2017

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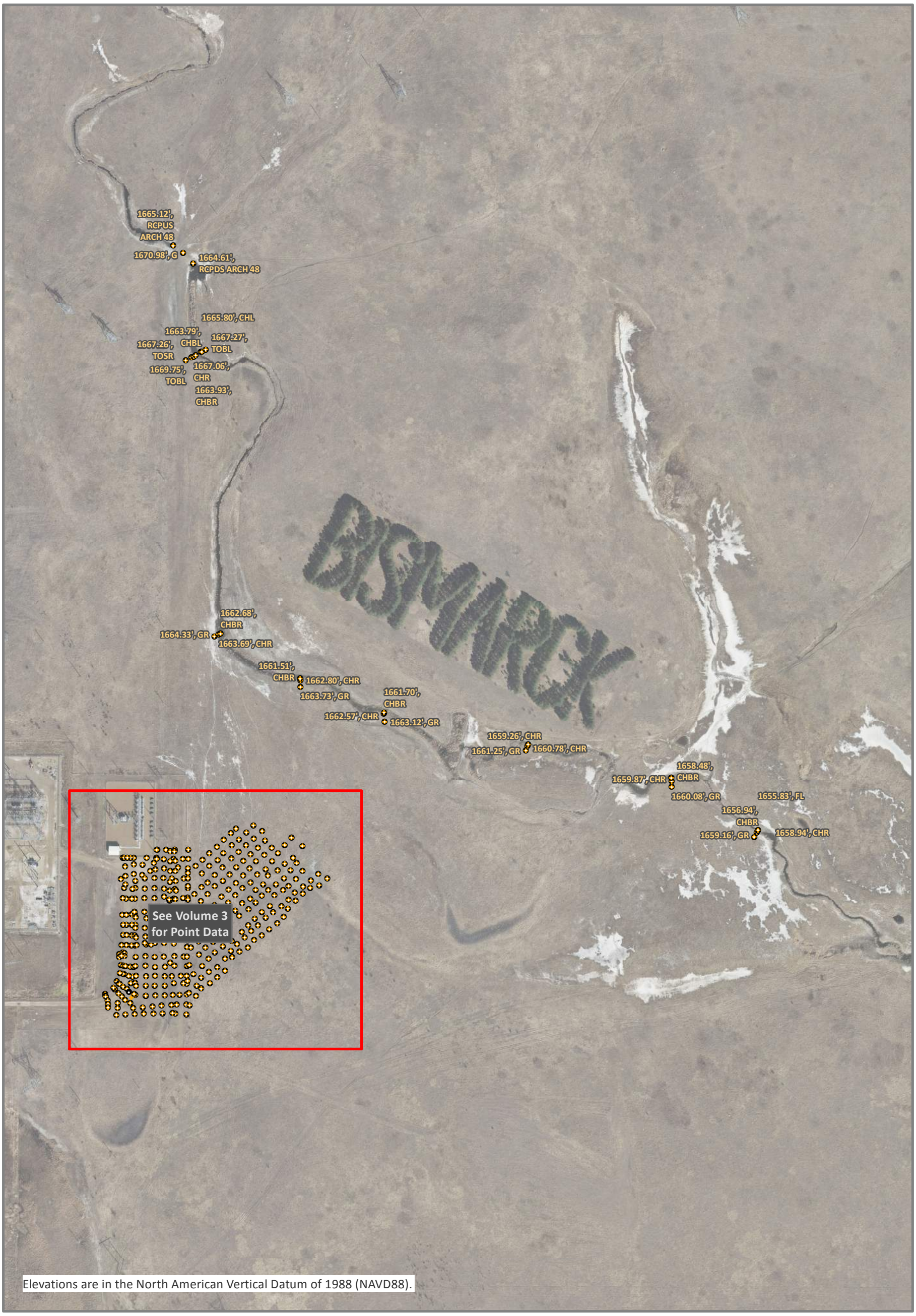

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Coordinate System: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Intl | Edited by: dlee | C:\Data\Projects\WAFS\Bismarck\00501-2015-013\GIS\Report Figure II-12- Silver Ranch Survey Mapbook.mxd

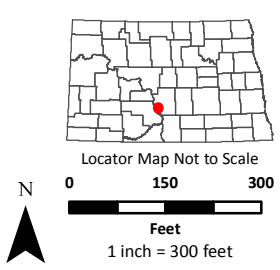

Figure II-12

SILVER RANCH SURVEY MAPBOOK- PAGE 9

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
City of Bismarck | Burleigh County, ND

Date: 10/27/2017

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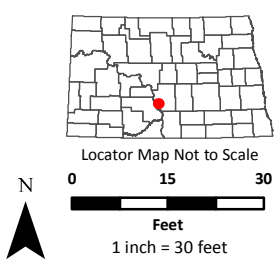

Figure II-12

SILVER RANCH SURVEY MAPBOOK- PAGE 10

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
City of Bismarck | Burleigh County, ND

Date: 10/27/2017

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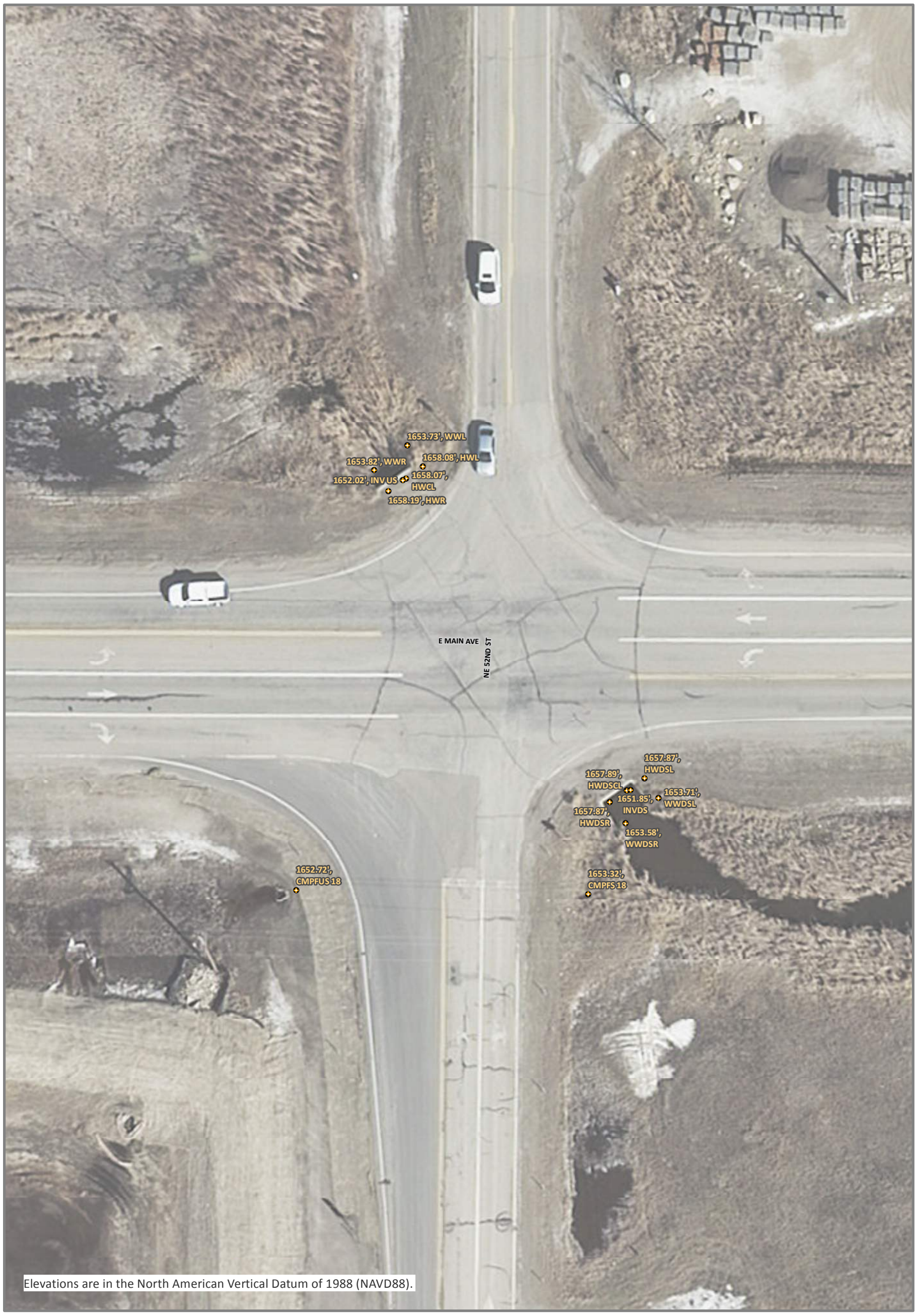

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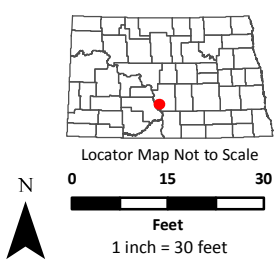

Figure II-12

SILVER RANCH SURVEY MAPBOOK-
PAGE 11

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
City of Bismarck | Burleigh County, ND

Date: 10/27/2017

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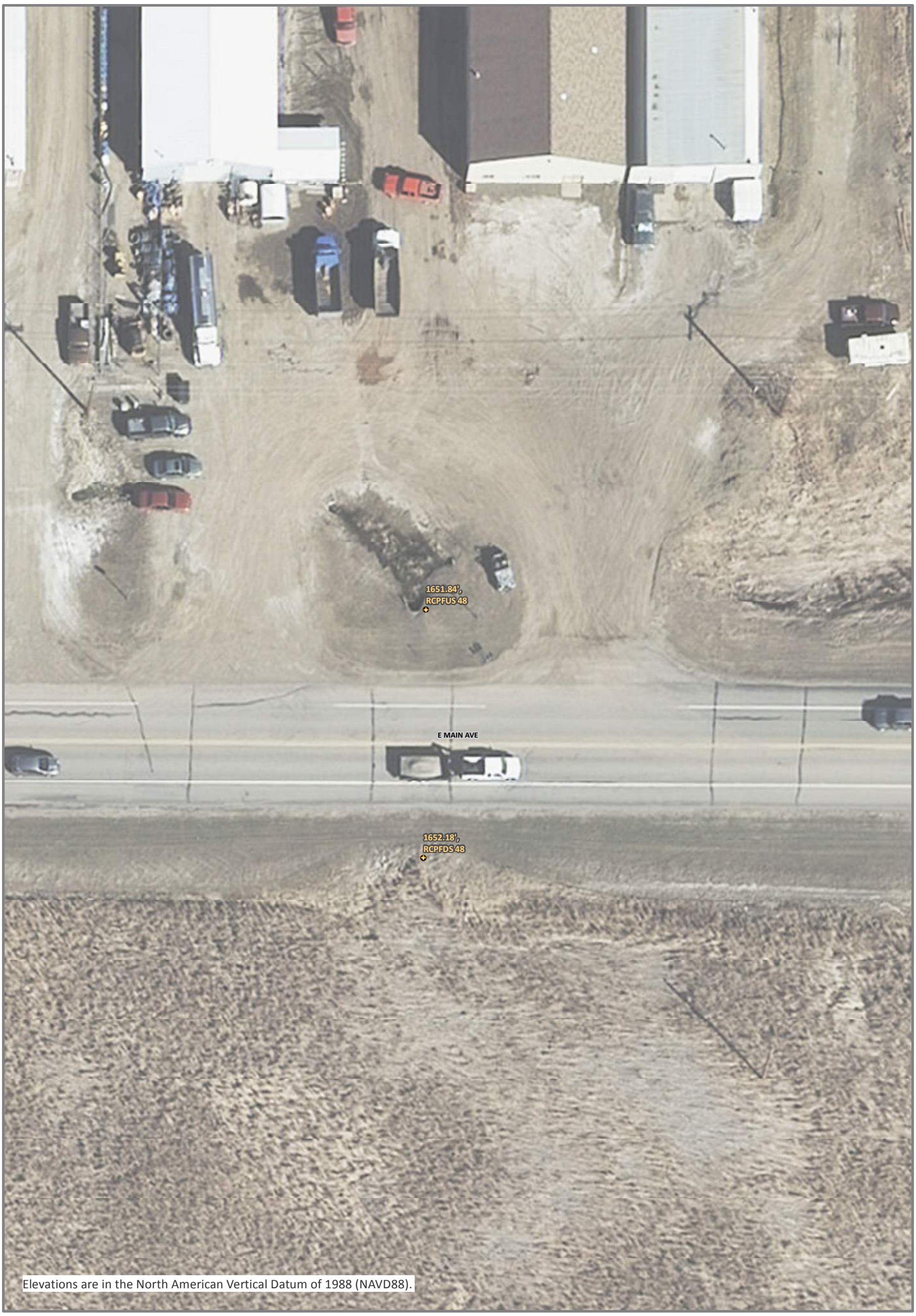

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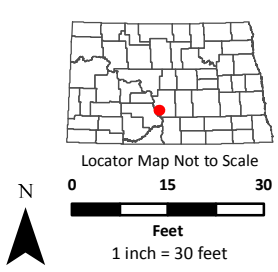

Figure II-12

SILVER RANCH SURVEY MAPBOOK- PAGE 12

SILVER RANCH WATERSHED STORMWATER MASTER PLAN
City of Bismarck | Burleigh County, ND

Date: 10/27/2017

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II-7.0 WORKING GROUP MEETING MATERIALS & MINUTES

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Silver Ranch Watershed Stormwater Master Plan
City Working Group Kick-Off Meeting Minutes

January 27, 2017, 3:00 P.M. (Central Time)
Location: Bismarck Engineering Conference Room

Attendees: Jeff Hruby, Linda Oster, Mike Greer, Brad Wright, Waylon Erdmann, Terry Halstengard, Daniel Nairn, Michelle Klose, Gabe Schell, Jesse Kist

1. **Introductions & Project Roles**
   a. AE2S
      1. Project Manager: Jeff Hruby
      2. Staff Engineer(s): Jesse Kist & Zach Magdol
      3. Project Engineer/Qc: Jon Lefers
   b. City of Bismarck
      1. Main Contact: Waylon Erdmann

         Jeff to send emails directly to group as opposed to sending them to Waylon for distribution.
      2. Working Group

         Daniel, Mike, Brad, Waylon, Terry, Greg Larson (Optional: Linda, Gabe, Michelle)

2. **Project Description**

   Jeff and Jesse briefly described the overall project, goals, and intents. Figures were handed out to the group showing watersheds, landuse (existing and proposed) for comment, and a summary of data collection efforts. The figures are attached to these meeting minutes with comments received.

3. **Project Progress**
   a. Data Collection

      The majority of data collection has been completed (figure was handed out). The significant snowfall resulted in an inability to collect some culvert information, primarily in the upper reaches of the Hay Creek watershed.

      Additionally, AE2S was only able to collect ½ of the channel section through the State trust Lands section. The survey data will be compared with the LiDAR data to determine if any additional information is needed given the planning level of the study.

      City collected data on the culverts under I-94 included upstream and downstream inverts, but not the pipe size, shape, or a description of condition. City recommends contacting NDDOT regarding confirmation of size of I94 culverts.

   b. Existing Conditions Analysis

      The existing conditions model is substantially complete and going through internal QC. Figures were handed out showing the overall watershed study area. Results will be discussed at City Working Group Meeting #1 (see Item 6).

      City noted groundwater issues north of Hwy 10 on the east side of 52nd Street.

c. Future Land Use & Analysis

Figures showing existing and future landuse were handed out for comment. Jeff and Jesse met with Waylon and Daniel earlier in the week to discuss the future landuse assumptions and comments from Daniel were incorporated.

Additional comments received from the group include replacing "Pasture" land use near Trenton Drive to a landuse consistent with R15 zoning. Also revise "Pasture" area south of E Divide Ave to reflect the planned fire station.

City (Daniel) determined it appropriate to not adjust the green space on state land to match FEMA floodplain due to the potential for fill. Leaving it as is in the GMP results in a more conservative approach.

4. <u>Stormwater Analysis and Master Plan Development</u>

Jeff generally described the overall major tasks, including review of the floodplain connection between Silver Ranch and Hay Creek.

a. Existing Conditions Analysis

b. Proposed Conditions – No Controls

c. Concept/Alternative Development

d. Preliminary Grading Plan

e. Implementation Plan

f. Master Plan Report

5. <u>Key Stakeholders</u>

a. Private: Silver Ranch (Wachter/SEH), Sattler, Silbernagel

City agrees with this list.

b. Public: State Lands, NDDOT, Park District

c. City Led vs. AE2S Led

AE2S to lead and send meeting invites to the Working Group. City will coordinate which members of the Working Group will attend.

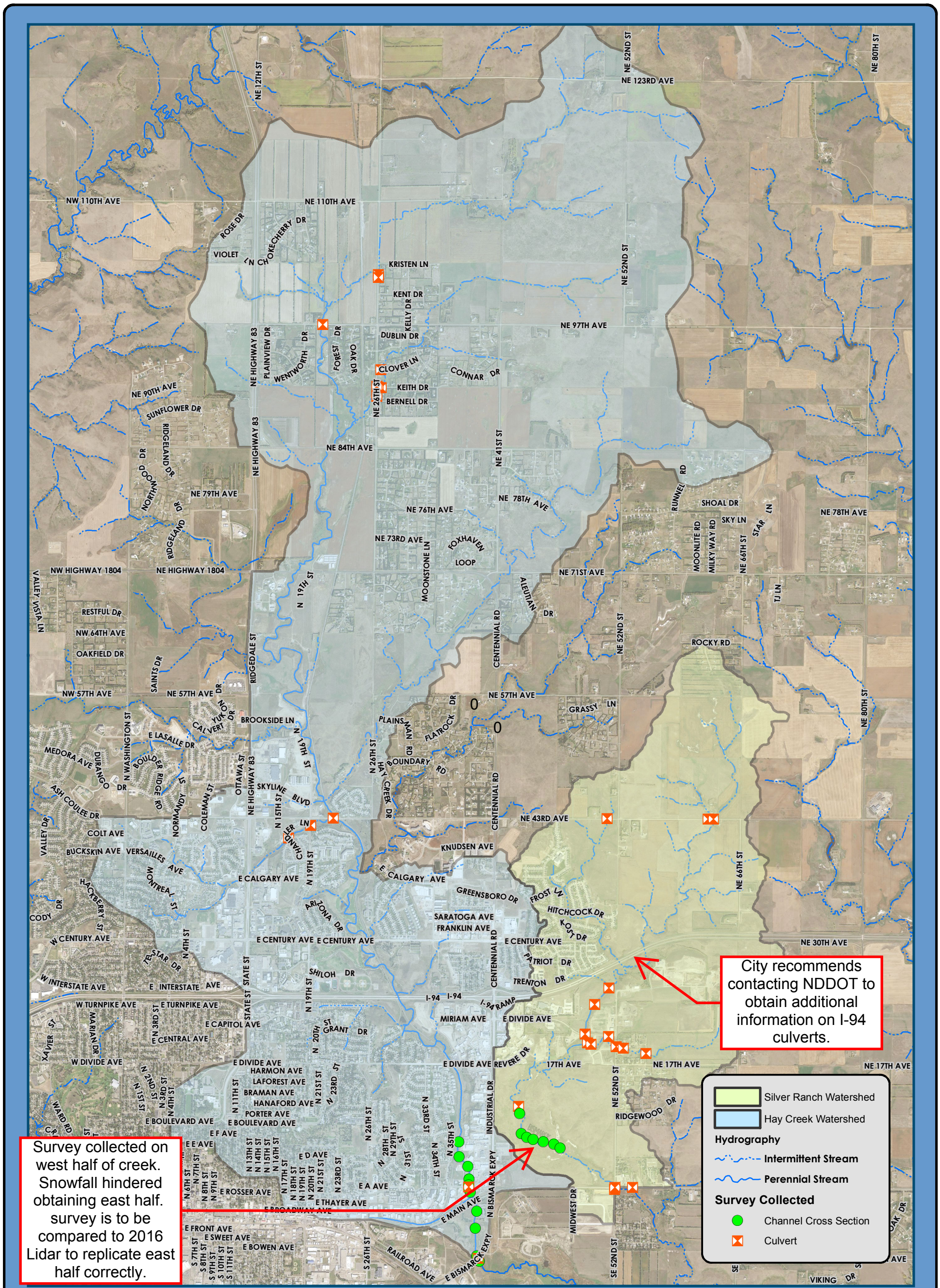
6. Tentative Schedule

Milestone	Date
Kick-off Meeting	January 27, 2017
City Working Group Meeting #1 Presentation of Existing Conditions Analysis	March 1, 2017
City Working Group Meeting #2 Presentation of Master Plan Concepts	April 12, 2017
City Working Group Meeting #3 Presentation of Preliminary Master Plan Alternatives/Choose Preferred Alternative	May 17, 2017
City Working Group Meeting #4 Presentation of Draft Master Plan	June 28, 2017
City Working Group Meeting #5 Review Comments on Draft Master Plan	July 19, 2017
City Working Group Meeting #6 (If Needed) Presentation/Delivery of Final Master Plan	August 9, 2017
City Commission	August 22, 2017
All Deliverables Due	August 31, 2017

7. Final Comments/Questions

*All meetings are to be held on Wednesdays from 1-2:30

*City noted that the County should be contacted regarding the reconstruction of 43rd Avenue to see if they have plans we can review. The County plans to bid in April so an analysis of that crossing beforehand to ensure the proposed culvert is sufficient would be ideal.



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1 inch = 4,000 feet

Locator Map Not to Scale

Data Collection

DRAFT

Silver Ranch Watershed Stormwater Master Plan
City of Bismarck | Burleigh County, ND

AE2S
Advanced Engineering and Environmental Services, Inc.

Date: 1/26/2017 | Coordinate System: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Intl

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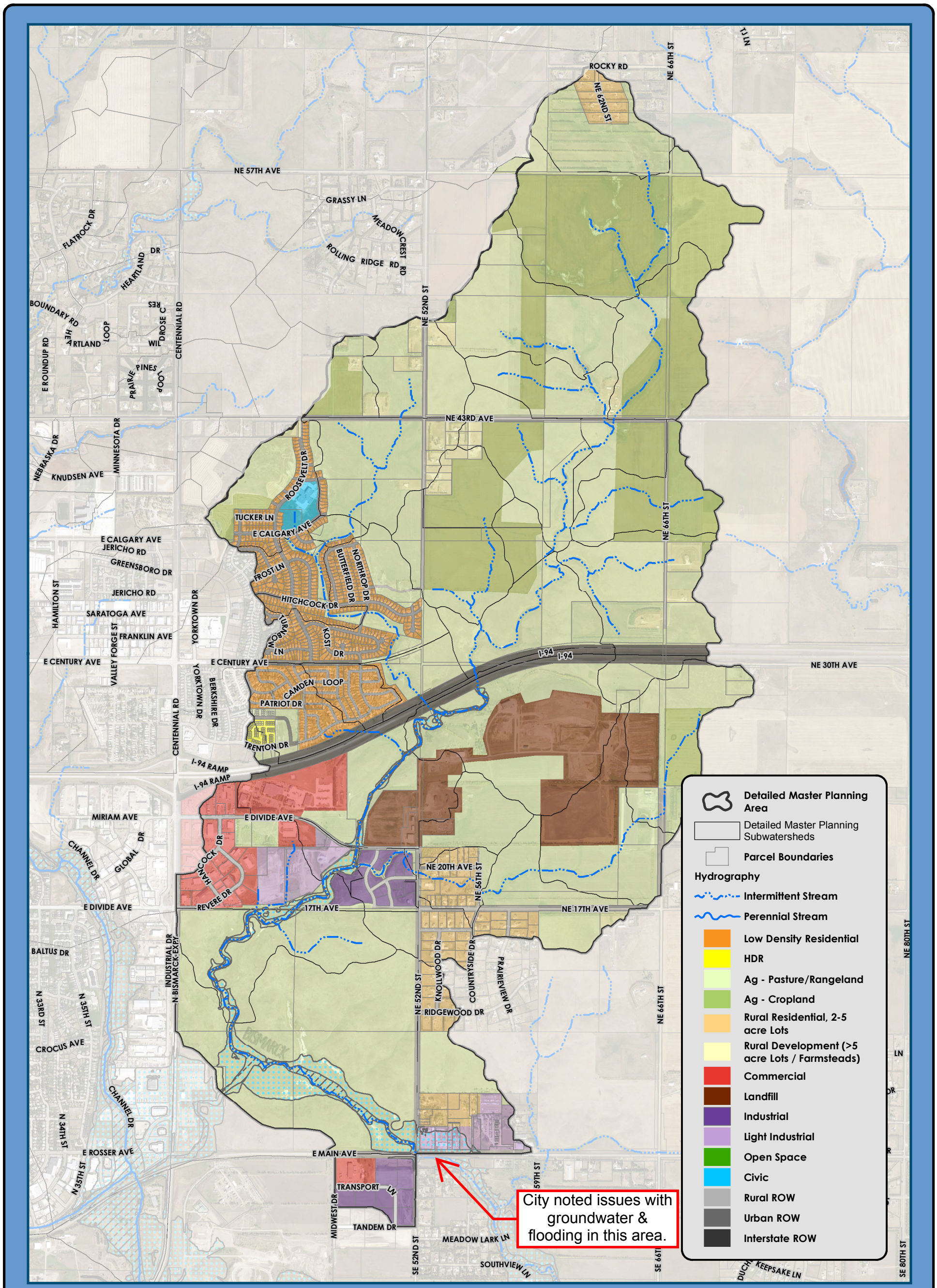

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Existing Land Use

DRAFT

Silver Ranch Watershed Stormwater Master Plan
City of Bismarck | Burleigh County, ND

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Advanced Engineering and Environmental Services, Inc.

Date: 1/27/2017 | Coordinate System: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Intl

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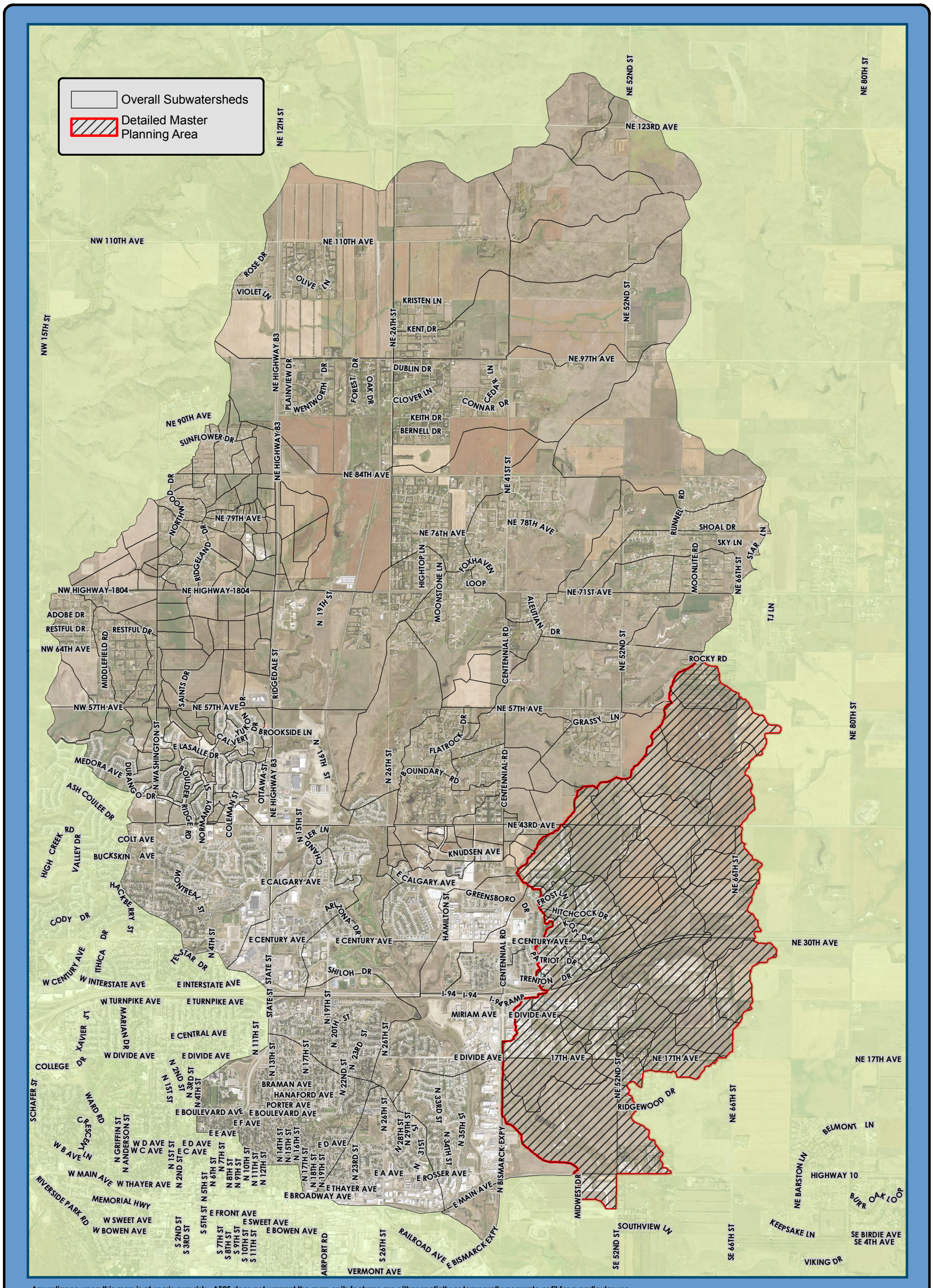

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Existing Watersheds

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Silver Ranch Watershed Stormwater Master Plan
City of Bismarck | Burleigh County, ND

AE2S
Advanced Engineering and Environmental Services, Inc.

Date: 1/27/2017 | Coordinate System: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Intl

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Future road crossing here noted by City.

Change FLU here to be coincide with R15 zoning. Use medium density residential.

Change FLU here. Fire Station to be constructed (low impervious)

Hydrography
- Intermittent Stream
- Perennial Stream
- 2014 FARMP Streets

Future Land Use
- ROW
- Ag - Pasture/Rangeland
- Ag - Cropland
- Civic
- Landfill
- High Density Residential
- Medium Density Residential
- Low Density Residential
- Mixed Use
- Rural Residential
- Commercial/Mixed Use
- Commercial
- Business Park
- Industrial
- Open Space

Silver Ranch Zoning
- Neighborhood Commercial
- Office/Multifamily Residential
- Public Use
- Single Family Residential
- Two Family Residential

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1 inch = 2,000 feet

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Future Land Use

DRAFT

Silver Ranch Watershed Stormwater Master Plan
City of Bismarck | Burleigh County, ND

AE2S Advanced Engineering and Environmental Services, Inc.

Date: 1/27/2017 | Coordinate System: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Intl

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Silver Ranch Watershed Stormwater Master Plan
43rd Avenue Meeting w/ County

February 14, 2017, 3:00 P.M. (Central Time)
Location: Burleigh County Shop - Apple Creek Conference Room

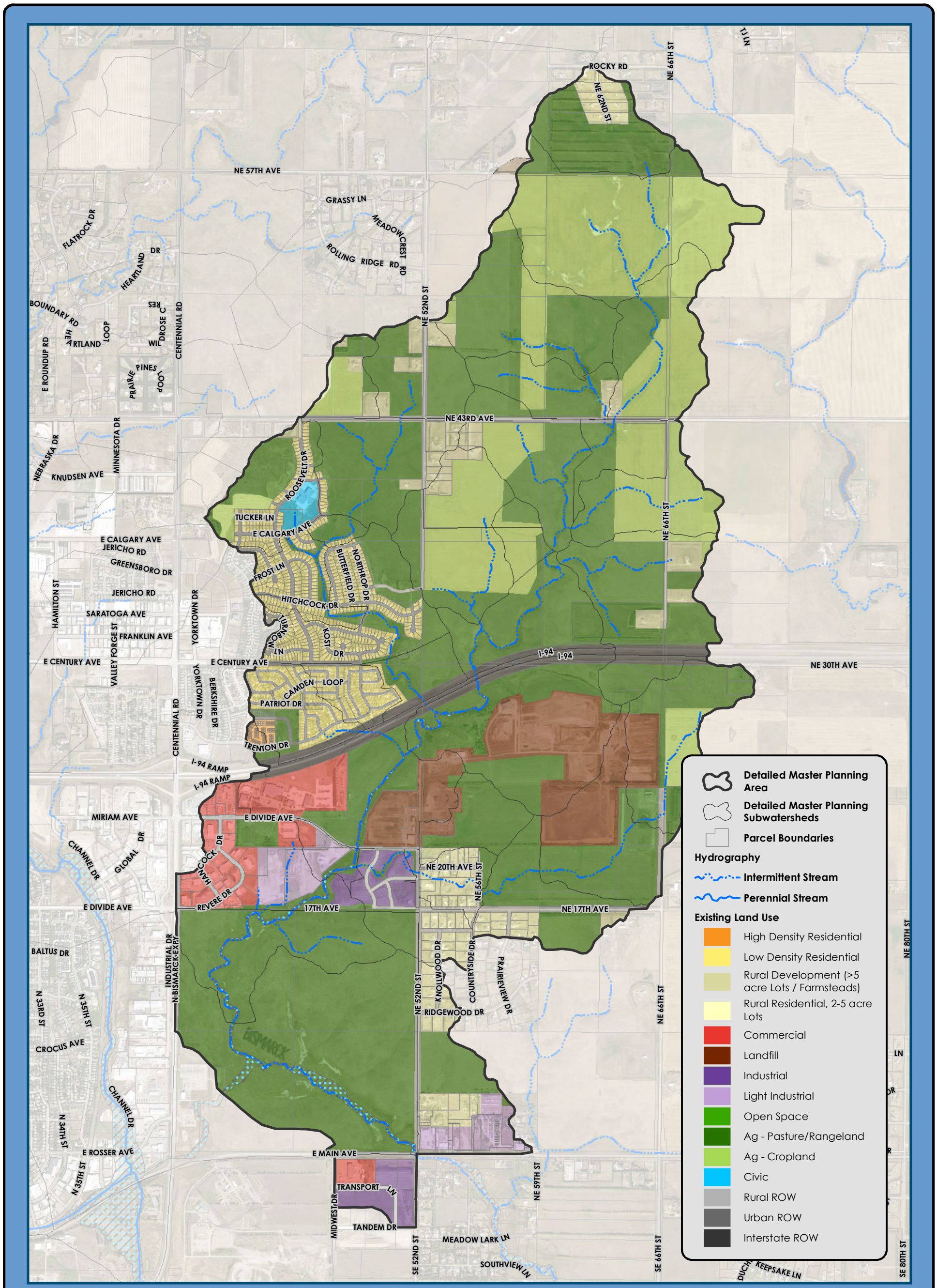
Attendees: Jesse, Jeff, Daniel Nairn, Brad Wright, Waylon Erdmann, Casey Einrem, Marcus Hall, Dan Schriock

1. **Introduce City Silver Ranch Watershed Master Plan**
    a. Master Plan Extents
    b. Master Plan Goals
    c. Project Schedule
2. **County Initial Comment on Areas/Topics of Concern**
    a. Existing Drainage Issues The County was not aware any drainage concerns or areas of input within the Silver Ranch watershed to bring to our attention. Existing land is primarily Ag/Pasture so drainage complaints to the County are not common.
    b. Near-Term County Projects None worth noting for relevancy to this project other than improvements to the 43rd Avenue crossing.
    c. Other Observations Relevant to the Study None were noted.
3. **County 43rd Avenue Project**
    a. Status and Schedule (County-led) The County plans to have the plans finalized by the end of March and the project bid in April.
    b. Project Description and Available Data (County-led) County hired Moore who partnered with Houston to perform hydraulic analyses.
        i. Hydraulics and Crossing Performance Criteria County only has to meet 15-year event stream crossing criteria. 25-year criteria was utilized for this crossing.
        ii. Profile and Alignment Changes County designed corridor to accommodate 55 mph.
    c. AE2S Preliminary Hydrologic and Hydraulic Observations AE2S described initial existing conditions observations and discussed the potential implications to implementing the County's plan. AE2S noted that because, under existing conditions, the roadway overtops in the 100-year event, allowing weir flows of greater than 300 cfs, it is difficult to create enough capacity to convey those flows once the roadway is raised so as to not overtop.

AE2S acknowledged that the peak headwater elevation on the north side of the roadway is not changed in the 25-year event (or smaller events) but is increased by nearly 1.5 feet during a 100-year storm event. Based on 2016 Lidar information, this results in a water elevation that is within inches of entering structures on the property north of the crossing.

d. Next Steps County will take AE2S' observations into consideration and will mention these concerns to Moore/HEI. County does not expect the roadway profile or crossing hydraulic features to change, but will notify AE2S if any changes occur and will provide a set of final plans when complete.

4. **Comments/Questions**



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1 inch = 2,000 feet

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Existing Land Use

Silver Ranch Watershed Stormwater Master Plan
City of Bismarck | Burleigh County, ND

AE2S
Advanced Engineering and Environmental Services, Inc.

Date: 2/14/2017 | Coordinate System: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Intl

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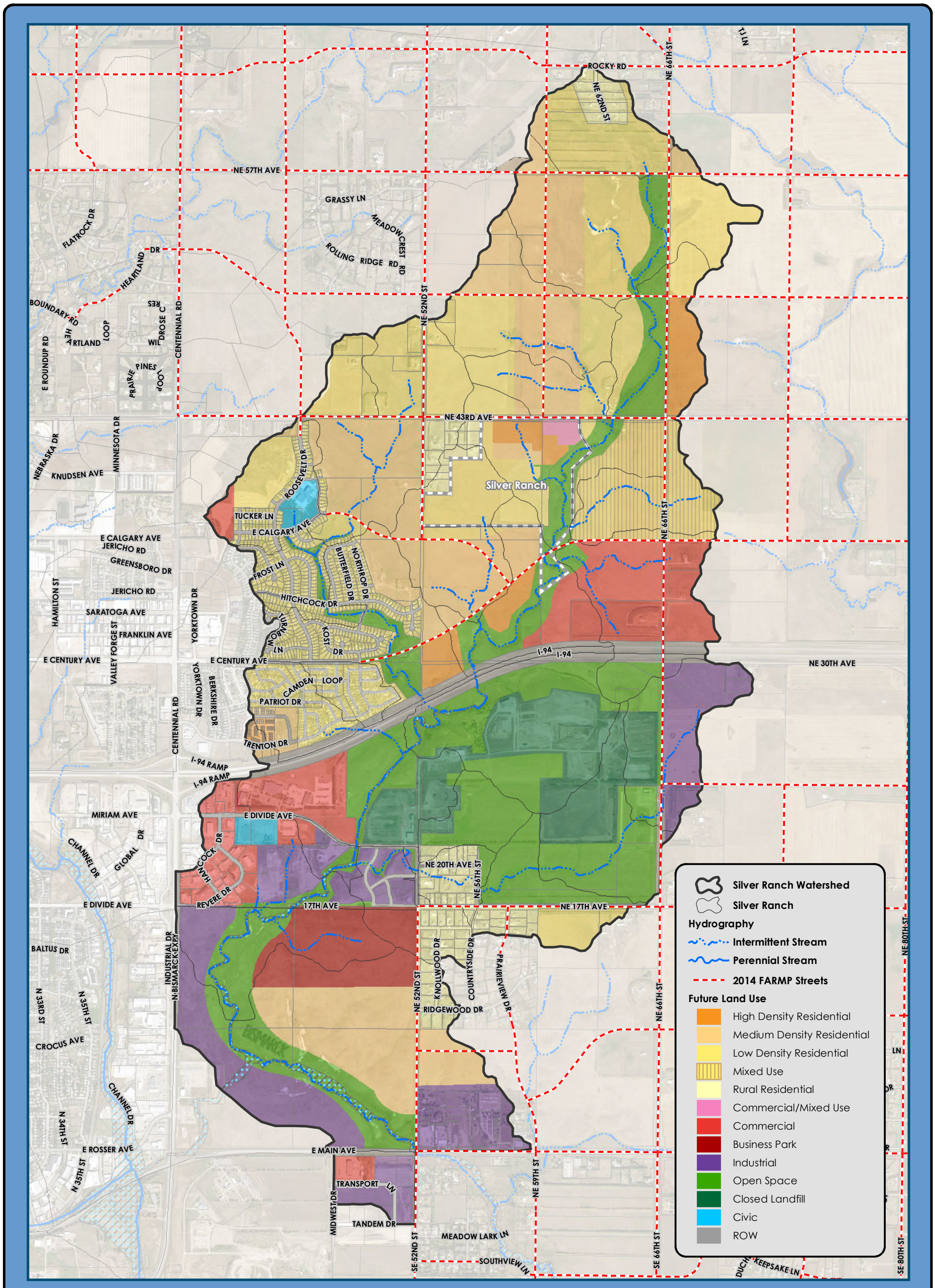

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Future Land Use

Silver Ranch Watershed Stormwater Master Plan
City of Bismarck | Burleigh County, ND

AE2S
Advanced Engineering and Environmental Services, Inc.

Date: 2/14/2017 | Coordinate System: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Intl

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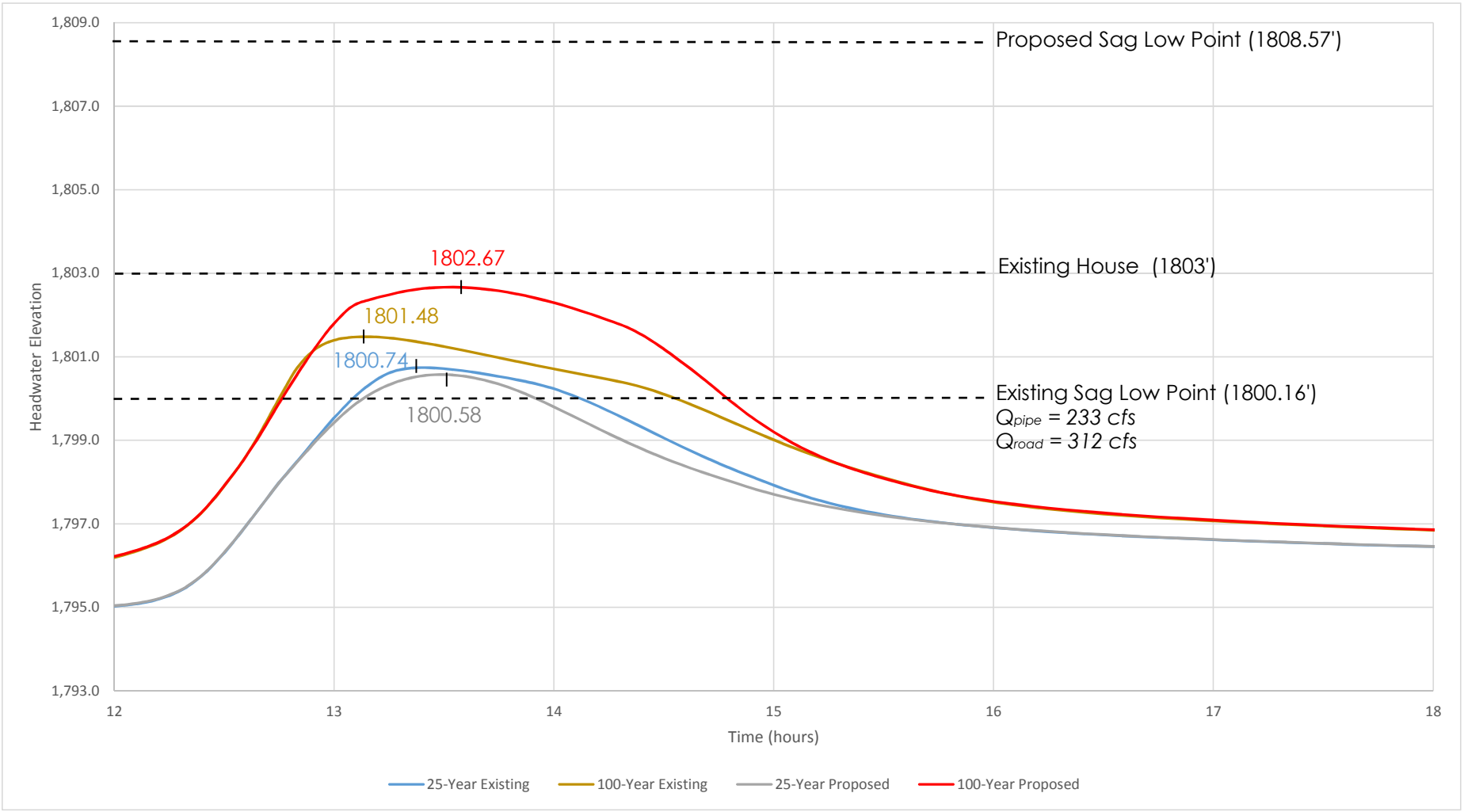
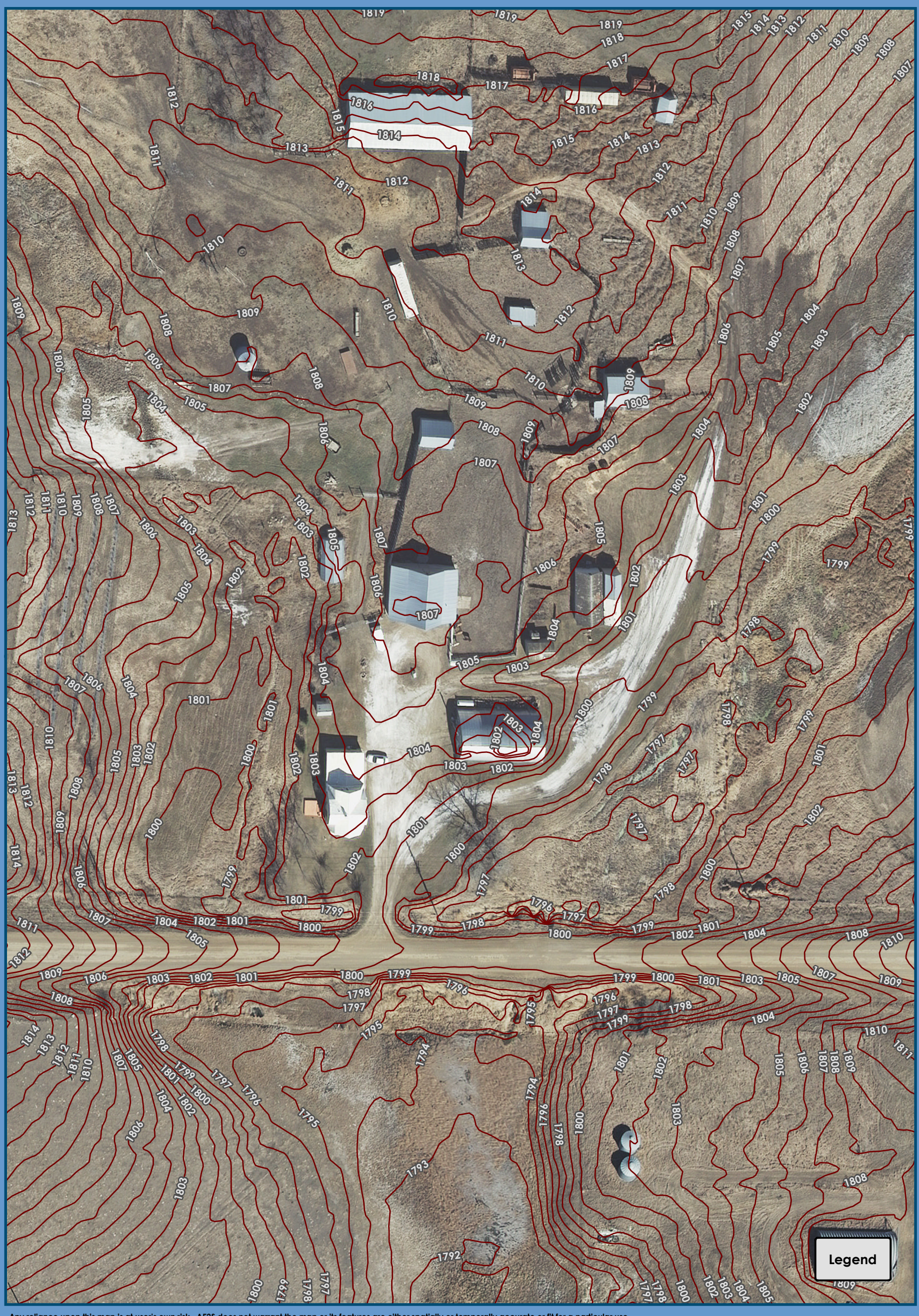
Silver Ranch: 43rd Avenue Crossing Hydraulic Performance





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1 inch = 75 feet

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Silver Ranch 43rd Avenue Crossing

City of Bismarck
Bismarck | Burleigh County, ND

AE2S
Advanced Engineering and Environmental Services, Inc.

Date: 2/14/2017 | Coordinate System: North Dakota State Plane South

Silver Ranch Watershed Stormwater Master Plan
Working Group Meeting #1 (Existing Conditions)

March 1, 2017, 1:00 P.M. (Central Time)
Location: City of Bismarck Engineering Conference Room

Attendees: Jeff Hruby, Daniel Nairn, Brad Wright, Waylon Erdmann, Mike Greer, Linda Oster, Terry Halstengard, Gabe Schell, & Jesse Kist

Key Points

1. Brad noted that the water surface elevation north of Divide Avenue cannot be increased from existing due to closed portions of the landfill.
2. Gabe approved use of County Plans for existing conditions analysis of the Silver Ranch crossing of 43rd Avenue. If the County Plans change, it was determined that the group will discuss how to proceed at that time.
3. City requested analysis of additional alternatives for the Sattler Ponds with a goal of minimizing cost while keeping the 100-year event within the City's easement. The typical requirement of 1-ft of freeboard will likely not be feasible in this case.
4. City (Brad W.) noted that there is a relief culvert under Main Avenue to the west of the box culverts.
    a. AE2S will obtain survey and add this to the model.
5. Gabe requested a plan be developed for the Hay Creek/Silver Ranch connection that does not impact the Silver Ranch Master Plan recommendations whether or not it is constructed.
6. The City noted that the location of the future Century Avenue crossing (as presented in the 2014 FARMP) has some flexibility if stormwater features benefit from adjusting the location.
7. Gabe recommended determining a name for the Silver Ranch drainage for consistency.
    a. Because the Silver Ranch drainage is an intermittent stream, Jeff recommended shying away from using "creek" as part of that name due to potential regulatory associations with that terminology.
8. Gabe expressed interest in looking into options for funding of regional facilities with an ability to "piece meal" developments if necessary.
    a. Jeff recommended a potential meeting with the AE2S Nexus group to discuss general implementation and funding ideas.

CITY OF BISMARCK

Silver Ranch Working Group Meeting #1

Presentation of Existing Conditions Analysis

AE2S

March 1st, 2017

Project Status

Items Completed

1. Data Collection
2. Existing & Future Land Use Review
3. Existing Conditions Analysis
4. Preliminary Improvements Analysis for Sattler Ponds
5. "What-if" Scenario Analysis for Hay Creek Connection
6. Initial Stakeholder Coordination

Existing Conditions

Silver Ranch Methodology & Assumptions

Methodologies

- Runoff computed by NRCS Curve Number and TR-55 Time of Concentration methodologies
  - Subwatersheds in the Silver Ranch watershed are split between impervious and pervious in order to more conservatively estimate runoff
- 24-Hour design storms analyzed (2-, 10-, 25-, and 100-year recurrence intervals)

Incorporation of Existing Stormwater Features

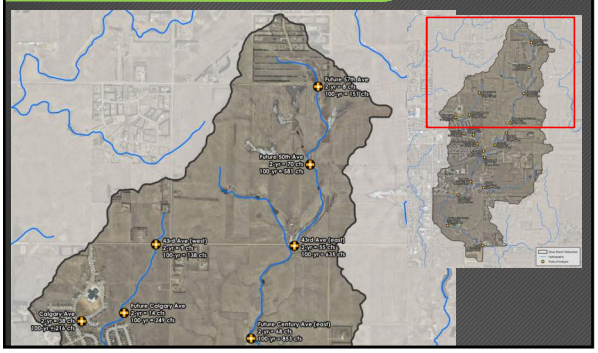
- 2016 LiDAR used to determine geometry of natural channels and storage areas.
  - Conveyance and Storage Features (channels, swales, ponds, etc.) modeled as currently constructed and graded (not necessarily what was planned in SWMPs).
- Survey data, provided by City and AE2S (2016), was used for structures, overtopping elevations, and channel geometry where available.

Points of Analysis

Points of Analysis

Points of Analysis

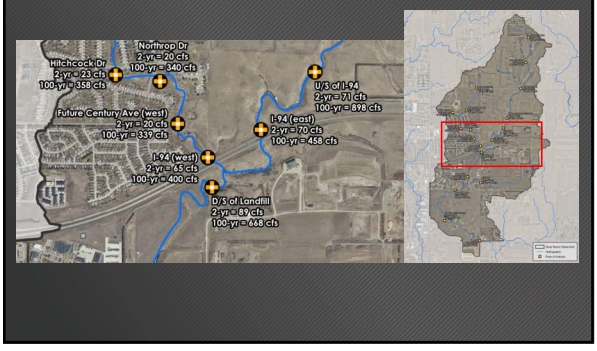
Existing Flows (North)



City notes flexibility of future Century Ave crossing location if stormwater benefits.

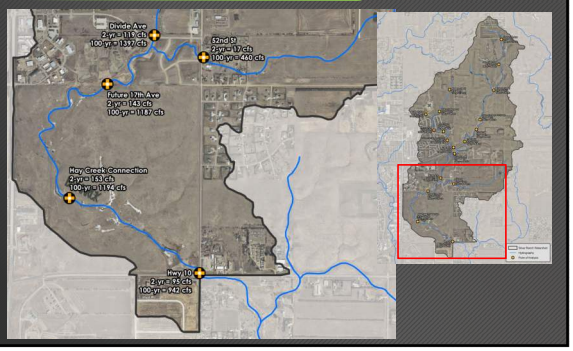
Points of Analysis

Existing Flows (Around I-94)



Points of Analysis

Existing Flows (South)



Brad notes that WSE north of Divide cannot be increased due to closed landfill. Divide may be collector someday. (Mike G.)

Brad notes that Sanitary crosses @ Divide.

Roadway Performance

Road Crossing Performance

Roadway Performance

Criteria

– Crossing Criteria from Updated SWDSM (Draft)

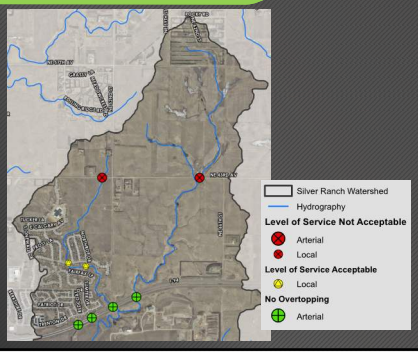
Table 6-8 – *Culvert Allowable Street Overtopping Requirements*

Street Classification	*Storm*	*Requirement*
All Streets	25-year 24-hour Event	No Overtopping
Local	100-year 24-hour Event	6 inches measured to the highest point on the street section (1)
Collector & Arterial	100-year 24-hour Event	No Overtopping

(1) For local urban streets, the highest point is typically the ROW line and for local rural road the highest point is the centerline of the ROW.

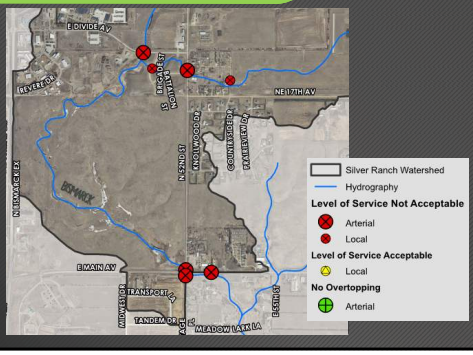
Roadway Performance

Existing Conditions (North)



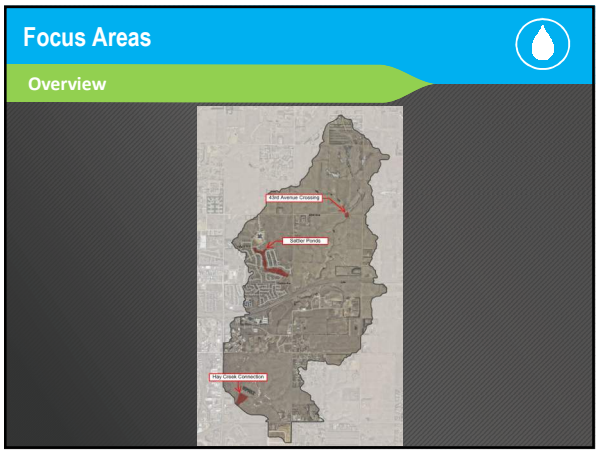
Roadway Performance

Existing Conditions (South)

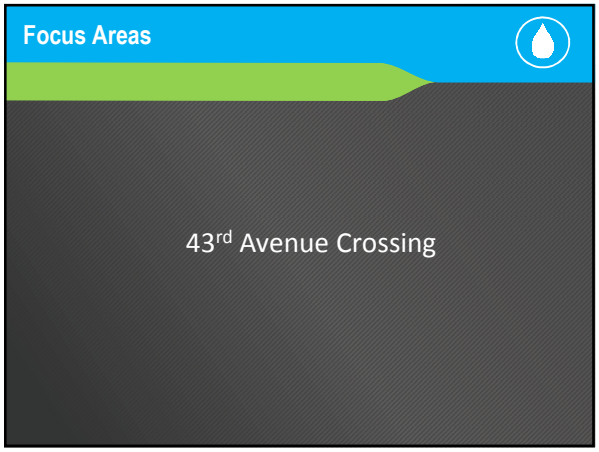


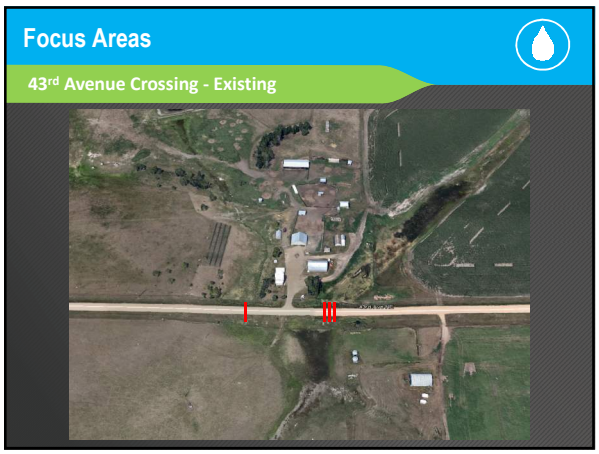
Focus Areas

Focus Areas



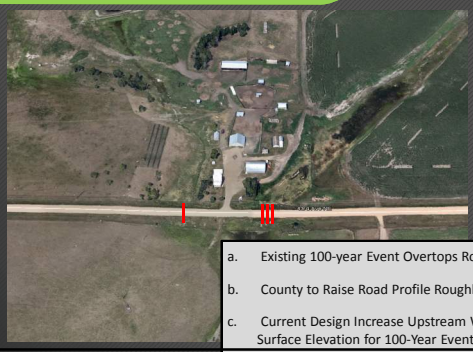
Gabe recommends determining a name to use for Silver Ranch drainage for consistency. Jeff recommends not using "creek" and recommends checking name in FIS if there is a name.





Focus Areas

43rd Avenue Crossing - Existing



a. Existing 100-year Event Overtops Roadway

b. County to Raise Road Profile Roughly 8.5'

c. Current Design Increase Upstream Water Surface Elevation for 100-Year Event.

Focus Areas

43rd Avenue Crossing – Existing Cond. Approach

What should be considered the existing condition for 43rd Ave?

Focus Areas

43rd Avenue Crossing – Existing Cond. Approach

What should be considered the existing condition for 43rd Ave?

Option A: As it is constructed today.

- Things to consider:
  - County plans will likely be implemented prior to finalization of this master plan.

Focus Areas

43rd Avenue Crossing – Existing Cond. Approach

What should be considered the existing condition for 43rd Ave?

Option A: As it is constructed today.

- Things to consider:
  - County plans will likely be implemented prior to finalization of this master plan.

Option B: County Plans = Existing Conditions

- Things to consider:
  - This will result in an increased water surface elevation upstream of 43rd and a flow decrease downstream on large events from what has historically occurred.

Gabe approves use of Option B.

Focus Areas

43rd Avenue Crossing – Existing Cond. Approach

What should be considered the existing condition for 43rd Ave?

Option A: As it is constructed today.

- Things to consider:
  - County plans will likely be implemented prior to finalization of this master plan.

Option B: County Plans = Existing Conditions

- Things to consider:
  - This will result in an increased water surface elevation upstream of 43rd and a flow decrease downstream on large events from what has historically occurred.

AE2S Recommends Option B

Focus Areas

Sattler Ponds

Focus Areas

Sattler Ponds - Existing Inundation (100-year)

Focus Areas

Sattler Ponds - Existing Inundation (100-year)

Focus Areas

Sattler Ponds – Options Reviewed

Improvement Options Intended to Reduce Flood Risk to Homes.

- **Option 1**: City Alternative 2
- **Option 2**: City Alternative 2 Modified to Remove Embankment
- **Option 3**: Install Storm Sewer

Focus Areas

Improvement Options

Option 1: City Alternative 2

Focus Areas

City Alternative 2 - Grading Plan

Focus Areas

100-yr Inundation - City Alternative 2

* Depth Not Shown

Focus Areas

100-yr Inundation - City Alternative 2

Focus Areas

Improvement Options

Option 2: City Alternative 2 Modified

Focus Areas

100-yr Inundation– City Alternative 2 Modified

Focus Areas

100-yr Inundation– City Alternative 2 Modified

Focus Areas

Improvement Options

Option 3: Install Storm Sewer

Focus Areas

100-yr Inundation – 60-inch Storm Sewer

Focus Areas

100-yr Inundation – 60-inch Storm Sewer

City requests that additional options be looked at with a goal of minimizing cost while keeping 100-yr event within the City's easement.

Things to look at:

What if embankment is removed and nothing else done?

Does it pay to excavate southern pond?

Could regrading be done on private lots?

Focus Areas

Sattler Ponds – Future Development Upstream

- NW Contributing Watershed about Half Built-out.
- Limited Potential for Regional Storage Due to Grade.

City (Terry H.) notes potential for pond in southern end of school property. Unsure whether or not this is a possibility.

Focus Areas

Hay Creek Methodology & Assumptions

Methodologies

- Runoff computed by NRCS Curve Number and TR-55 Time of Concentration methodologies
  - Subwatersheds in the Hay Creek watershed use a weighted curve number because less detail is needed
- 24-Hour design storms analyzed (2-, 10-, 25-, and 100-year recurrence intervals)

Incorporation of Existing Stormwater Features

- The previously constructed North Washington, US-83, and Grand Prairie models have been incorporated into the Hay Creek model and assumed to be built-out.
- 2016 LiDAR used to determine geometry of natural channels and storage areas.
  - Conveyance and Storage Features (channels, swales, ponds, etc.) modeled as currently constructed and graded (not necessarily what was planned in SWMPs).
- Survey data, provided by City and AE2S (2016), was used for structures, overtopping elevations, and channel geometry where available.

Focus Areas

Hay Creek Connection – Scenarios Reviewed

- **Existing Inundation**

Focus Areas

Hay Creek Connection – Scenarios Reviewed

- **Existing Inundation**
- **Scenario 1**: Improve/Lower Connection

Focus Areas

Hay Creek Connection – Scenarios Reviewed

- **Existing Inundation**
- **Scenario 1**: Improve/Lower Connection
- **Scenario 2**: Remove/Block Connection

Focus Areas

Hay Creek Connection – Scenarios Reviewed

- **Existing Inundation**
- **Scenario 1**: Improve/Lower Connection
- **Scenario 2**: Remove/Block Connection
- **Scenario 3**: Increase (Double) Capacity of Main Avenue Crossing

Focus Areas

Hay Creek Connection – Scenarios Reviewed

- **Existing Inundation**
- **Scenario 1**: Improve/Lower Connection
- **Scenario 2**: Remove/Block Connection
- **Scenario 3**: Increase (Double) Capacity of Main Avenue Crossing
- **Scenario 4**: Increase (Double) Capacity of Main Avenue Crossing & Remove Culverts under Expressway.

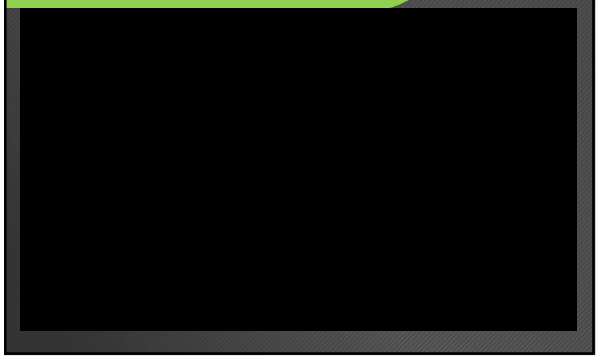
Focus Areas

Hay Creek Connection

Existing Inundation

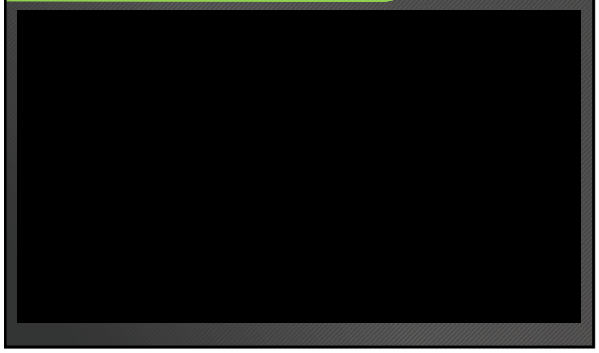
Focus Areas

Hay Creek Connection – Existing Inundation



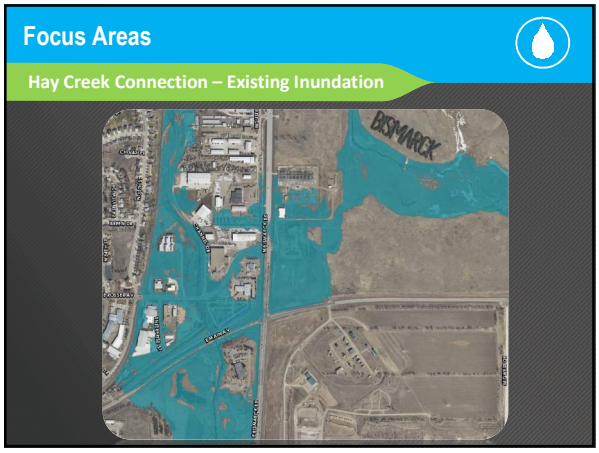
Focus Areas

Hay Creek Connection – Existing Inundation



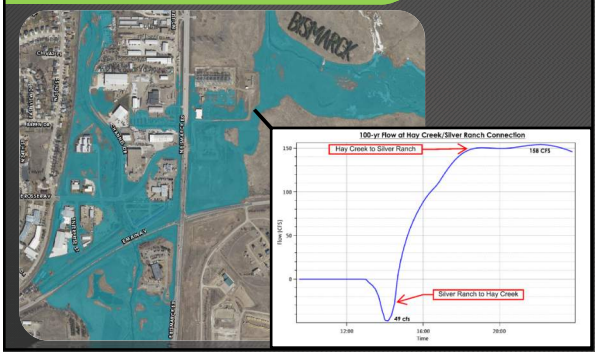
Focus Areas

Hay Creek Connection – Existing Inundation



Focus Areas

Hay Creek Connection – Existing Inundation



Focus Areas

Hay Creek Connection

Scenario 1:

Improve/Lower Connection

Focus Areas

Improve/Lower Hay Creek Connection

Focus Areas

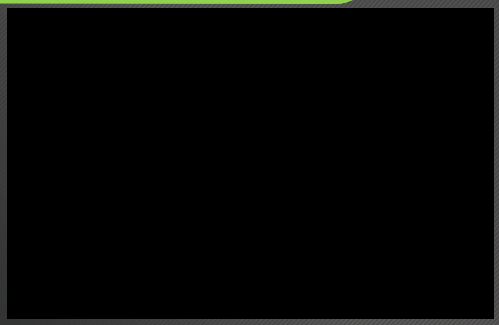
Hay Creek Connection

Scenario 2:

Remove/Block Connection

Focus Areas

Remove Hay Creek/Silver Ranch Connection



Focus Areas

Remove Hay Creek/Silver Ranch Connection

Focus Areas

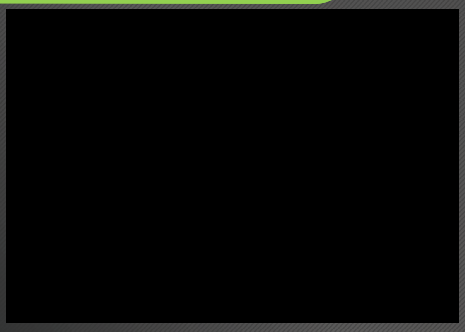
Hay Creek Connection

Scenario 3:

Increase (Double) Capacity of Main Avenue Crossing

Focus Areas

Increase Main Ave Culvert Capacity



Focus Areas

Increase Main Ave Culvert Capacity

Focus Areas

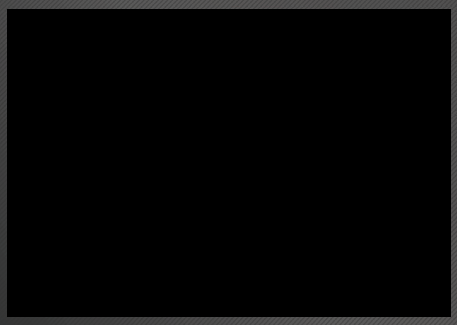
Hay Creek Connection

Scenario 4:

Increase (Double) Capacity of Main Avenue Crossing & Remove Culverts under Expressway.

Focus Areas

Increase Culverts & Remove Culverts



Focus Areas

Increase Culverts & Remove Culverts

Gabe requests a connection plan that does not impact the Silver Ranch master plan recommendations whether or not it is constructed.

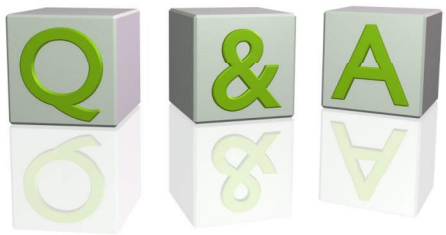
Next Steps

- Proposed Conditions Analysis
- Concept Development

Schedule

	Milestone	Date	
Working Group	Kick-off Meeting	January 27, 2017	✓
	Presentation of Existing Conditions Analysis	March 1, 2017	★
	Presentation of Master Plan Concepts	April 12, 2017	
	Presentation of Preliminary Master Plan Alternatives/Choose Preferred Alternative	May 17, 2017	
	Presentation of Draft Master Plan	June 28, 2017	
	Review Comments on Draft Master Plan	July 19, 2017	
	Presentation/Delivery of Final Master Plan	August 9, 2017	
	City Commission	August 22, 2017	
	All Deliverables Due	August 31, 2017	

Silver Ranch Stormwater Master Plan



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Silver Ranch Watershed Stormwater Master Plan
Working Group Meeting #2 (Master Plan Concepts)

April 12, 2017, 1:00 P.M. (Central Time)
Location: City of Bismarck Engineering Conference Room

Attendees: Jeff Hruby, Daniel Nairn, Michelle Klose, Waylon Erdmann, Mike Greer, Linda Oster, Terry Halstengard, Gabe Schell, & Jesse Kist

Key Points

1. The City recommended waiting to discuss the master plan with Chad Wachter/Silbernagels until after the City meets with them regarding the future of their land.
2. The City chose to refer to the main drainageway as the "Silver Ranch Coulee."
3. The City confirmed that the overall goals of the master plan are to not increase peak flows at key locations within the overall watershed.
4. The Working Group discussed some of the phasing and funding challenges of the typical regional stormwater management practices of the past.
5. Terry noted that Regional provides inspection and maintenance benefits, reducing the total number of facilities to inspect and maintain.
6. The Working Group determined that in order to provide guidance on which alternatives should be further developed, additional analysis needs to be performed regarding what it would take for onsite detention to meet pre-post for the 2-, 10-, & 100-year events at the critical Points of Analysis (primarily I-94 and Main Ave/Hwy 10).

CITY OF BISMARCK

Silver Ranch Working Group Meeting #2

Presentation of Master Plan Concepts

AE2S

April 12th, 2017

Project Status

Status Update

1. Data Collection
2. Existing & Future Land Use Review
3. Existing Conditions Analysis
4. Preliminary Improvements Analysis for Sattler Ponds
5. "What-if" Scenario Analysis for Hay Creek Connection
6. **Initial Stakeholder Coordination**
7. **Preliminary Grading of Road Crossings & Corresponding Culvert Sizing**
8. **Development and Review of Master Plan Concepts**

Contact with Wachter/Silbernagel should wait until after City meets with Wachter and Silbernagels. Gabe will send us contact for Silbernagel Family.

Project Status

Drainage Naming

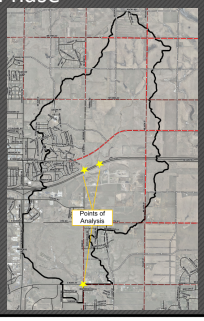
Agreement among group on Sunrise Tributary and Eastern Tributary. Group feels "Drainageway" suggests something man-made. Silver Ranch Coulee was agreed upon by the group because the term "coulee" is used throughout the City.

Project Status

Status Update

Goals of Concept Development Phase

- Meet City Ordinances
- Meet 2-, 10-, & 100-Year Peaks at Points of Analysis

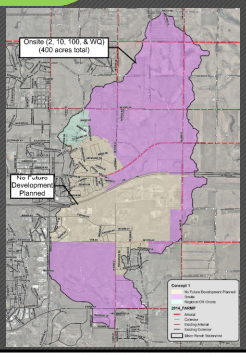


Master Plan Concepts

Concept 1 - Onsite

Concept 1

- Onsite Detention Throughout Entire Watershed



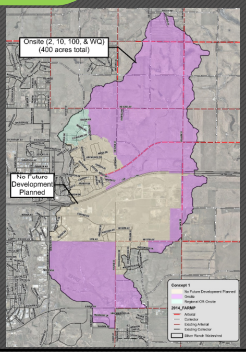
Master Plan Concepts

Concept 1 - Onsite

Concept 1

- Onsite Detention Throughout Entire Watershed

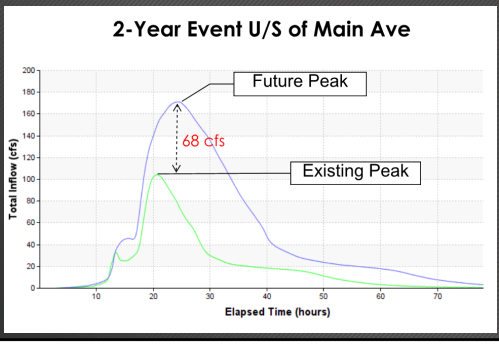
➢ Results in Increased Peak Flows for All Events at I-94 and Main Avenue Crossings



The City confirmed that the overall goals of the master plan are to not increase peak flows at key locations within the overall watershed.

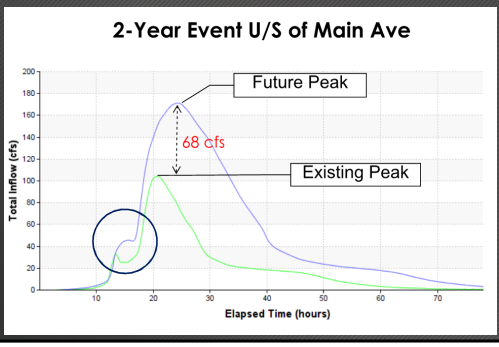
Master Plan Concepts

Concept 1 - Onsite



Master Plan Concepts

Concept 1 - Onsite

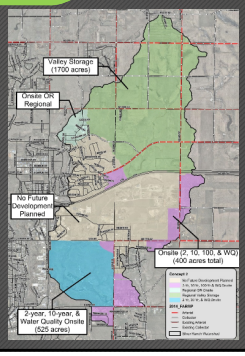


Master Plan Concepts

Concept 2

Concept 2

- Regional Valley Storage Upstream of I-94 for Water Quality, 2-, 10-, & 100-year events.
- Onsite Detention for Select Locations
- 2- & 10-year and Water Quality Onsite for State Land
  - No Peak Flow Mitigation for 100-yr

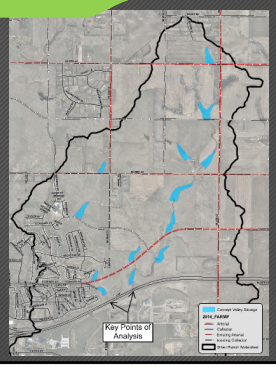


Master Plan Concepts

Concept 2

Valley Storage Basins

- Exact location and number of basins may change during detailed analysis.
- 13 Basins Proposed
  - 7 Upstream of Road Crossings
  - 6 Non-Roadway Embankments
- Basins will Provide:
  - Water Quality
  - 2-, 10-, & 100-Year Peak Flow Mitigation



Gabe questioned if the number of basins could be reduced if the 25-acre foot limit was removed. Jeff confirmed that the number of basins would likely be fewer, though short of regulation changes by the State, this would result in the structures being classified as dams and they would need to be designed and maintained to dam safety standards.

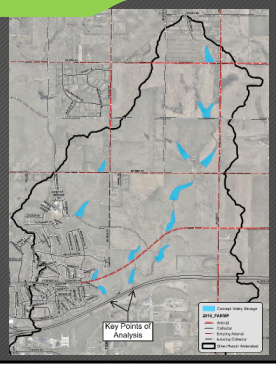
Master Plan Concepts

Concept 2

Valley Storage Basins

- Exact location and number of basins may change during detailed analysis.
- 13 Basins Proposed
  - 7 Upstream of Road Crossings
  - 6 Non-Roadway Embankments
- Basins will Provide:
  - Water Quality
  - 2-, 10-, & 100-Year Peak Flow Mitigation

➢ Compliance Achieved at I-94 Points of Analysis

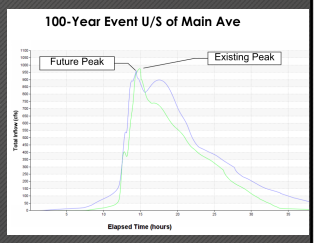


Master Plan Concepts

Concept 2

State Land

- Water Quality Provided Onsite
- Onsite Detention for 2-year & 10-year
  - Increased Peaks to Main Avenue for 2-Year Event and 10-Year Event
  - No Noticeable Increase for the 100-Year Event, despite not detaining 100-year



Master Plan Concepts

Concept 2

State Land

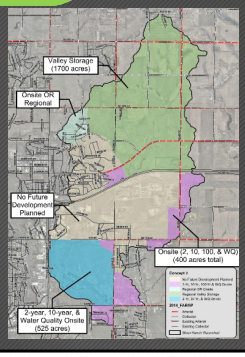
- Recommendation to Meet 2-year and 10-Year:
  - Review Timing of Watersheds Upstream of I-94
  - Review Over Detention for 2-Year Event on State Land
  - Review Need for Additional Storage to Meet Peak Compliance for Smaller Events

Master Plan Concepts

Concept 2

Benefits of Concept 2

- Upstream of I-94
  - Majority of Storage occurs Upstream of Roadways or in Planned Greenway Corridor
- State Land
  - 100-Year Facility Sizing Not Required

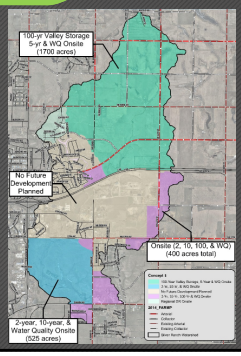


Master Plan Concepts

Concept 3

Concept 3

- Valley Storage Upstream of I-94 for 100-year event.
- Water Quality and Peak Flow Control up to 5-Year Event Provided Onsite for much of the Watershed North of I-94
- Water Quality, 2-, 10-, & 100-year Provided Onsite for Select Areas
- 2-yr, 10-yr, & Water Quality Onsite for State Land

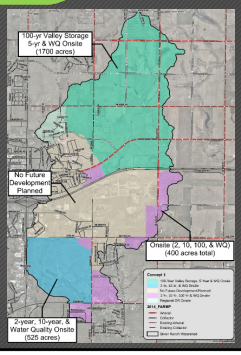


Master Plan Concepts

Concept 3

Benefits of Concept 3

- May Reduce the Overall Number of Regional Basins
- Simplified Outlet Structures in Regional Basins
- Decreased Local & Trunk Storm Sewer Sizes
- Decreased Coulee Scour Issues
- On-Site Water Quality is Flexible to Meet Potentially Changing Requirements



Master Plan Concepts

Concept 3

5-Year & Water Quality Onsite: Pond Footprint

- Commercial Sites: About 5% of site required for pond
- Residential Sites: About 3% of site required for pond

Master Plan Concepts

Concept 4

Regional Storage on State Land

- North of I-94 would comply with Concepts 1, 2, or 3.

Mike recommends checking the distance from the airport due to the 48 hour drainage requirement for ponds within 5000' of the airport. Mike stated that the City typically considers the 48 hours as beginning at the beginning of the storm.

Master Plan Concepts

Benefits of Onsite Control

Potential to Decrease Trunk Storm Sewer Size

Development Type	Site Size (acres)	Pipe Size for Undetained 5-year flow (inches)	Pipe Size with 5-yr Onsite (inches)	Required Pond Footprint (acres)
Residential	50	36	18	0.75
Commercial		42	18	2
Residential	10	18	12	0.15
Commercial		24	12	0.4

Master Plan Concepts

Concept Comparison

	Concept			
	1	2	3	4
North I-94 / *South I-94*	Onsite / Onsite	Regional / Onsite	Regional/Onsite / Onsite	Regional / Regional
Meets 2-, 10-, & 100-Year Peaks at Points of Analysis		✓	✓	✓
Water Quality Flexibility	✓		✓	
Flexible Funding/Phasing	✓		✓	
Minimizes # of Facilities to Maintain			✓	✓
Minimize Conveyance Infrastructure	✓		✓	
Change to Development Policy		✓	✓	✓

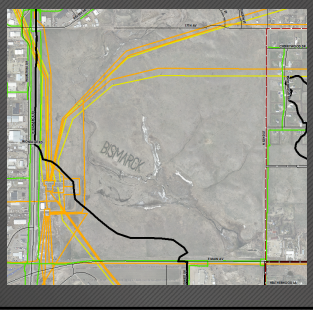
Jeff noted that Concept 4 should not have a check for "change to development policy." Gabe feels there is enough flexibility for water quality in all concepts. Michelle has concerns over regional facility due to assessment practices. Terry prefers regional for inspection and maintenance reasons. The Working Group determined that in order to provide guidance on which alternatives should be further developed, additional analysis needs to be performed regarding what it would take for onsite detention to meet pre-post for the 2-, 10-, & 100-year events at the critical Points of Analysis (primarily I-94 and Main Ave/Hwy 10). Daniel recommends adding "Land Encumbrance" row.

Master Plan Concepts

State Land Utilities

Power Utilities

- WAPA
- Capital Electric
- MDU

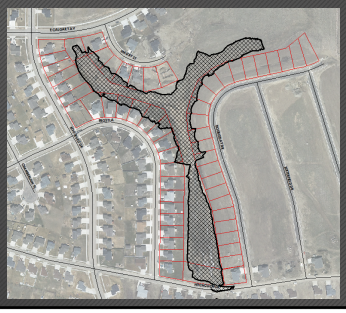


Sattler Improvements

Sattler Ponds – Re-grading Concept

– **Existing Conditions 100-Year Inundation**

- Impacts to Private Property
  - Impacts occur during events as small as the 1 or 2 year event



Sattler Improvements

Sattler Ponds – Re-grading Concept

– **100-Yr Existing Conditions with Northern Pond Re-Grading**

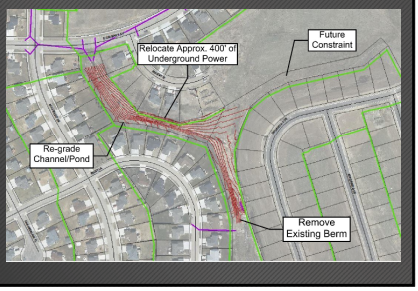
- No Impacts to Private Property
- No Increased Impacts Downstream

Sattler Improvements

Sattler Ponds – Re-grading Concept

Concept: Remove Berm and Re-grade Northern Pond

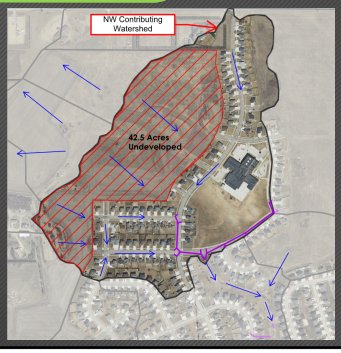
- 14' Trail Bench (south/west side)
- 3:1 Slope to Channel Invert
- Inverts Lowered About 2' by Re-grading
- Grading is Limited to within Stormwater Easement/Park Property
- Results in about 3000 CY of Cut



Focus Areas

Sattler Ponds – Future Development Upstream

- NW Contributing Watershed about Half Built-out.
- Limited Potential for Regional Storage Due to Grade

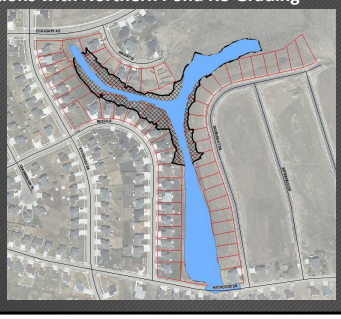


Sattler Improvements

Sattler Ponds – Re-grading Concept

– **100-Yr Future Conditions with Northern Pond Re-Grading**

- Minor/No Impacts to Private Property
- Increased Impacts Downstream (i.e. increased overtopping of Hitchcock)

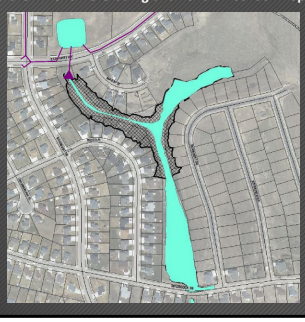


Sattler Improvements

Sattler Ponds – Re-grading Concept

– **100-Yr Future Conditions with Northern Pond Re-Grading and Pond on School Property**

- No Impacts to Private Property
- No Increased Impacts Downstream
- Potential Impacts to Infrastructure Between Future Development and Pond.
  - 5-yr Onsite Could be Considered



Next Steps

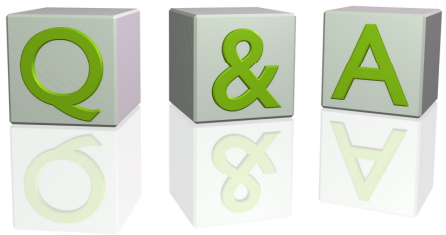
- Alternatives Development/Analysis
- Review How Alternatives React to Various Hay Creek Connection Scenarios

Schedule

	Milestone	Date	
Working Group	Kick-off Meeting	January 27, 2017	✓
	Presentation of Existing Conditions Analysis	March 1, 2017	✓
	Presentation of Master Plan Concepts	April 12, 2017	★
	Presentation of Preliminary Master Plan Alternatives/Choose Preferred Alternative	May 17, 2017	
	Presentation of Draft Master Plan	June 28, 2017	
	Review Comments on Draft Master Plan	July 19, 2017	
	Presentation/Delivery of Final Master Plan	August 9, 2017	
	City Commission	August 22, 2017	
	All Deliverables Due	August 31, 2017	

An additional will meeting will likely be necessary to review the results of the additional on-site detention analysis. The overall project schedule may need to be adjusted to accommodate the additional analysis. The City noted that there is not a hard deadline, so minor schedule adjustments should not cause issue.

Silver Ranch Stormwater Master Plan



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CITY OF BISMARCK

Silver Ranch Special Working Group Meeting

Follow-up on Master Plan Concepts

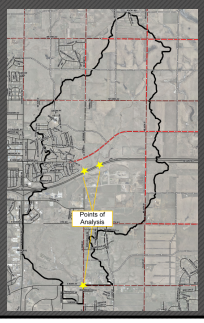
May 3, 2017

Project Status

Status Update

Goals of Concept Development Phase

- Meet City Ordinances
- Meet 2-, 10-, & 100-Year Peaks at Screening Level Points of Analysis

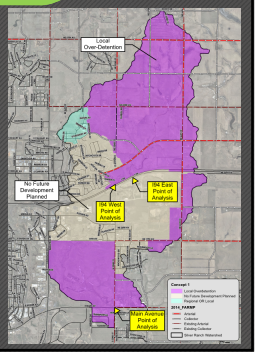


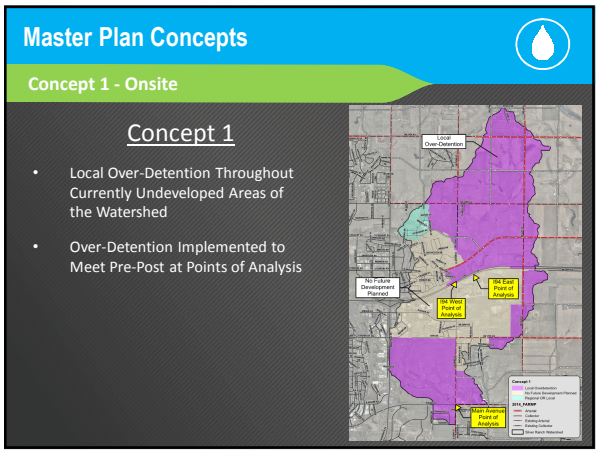
Master Plan Concepts

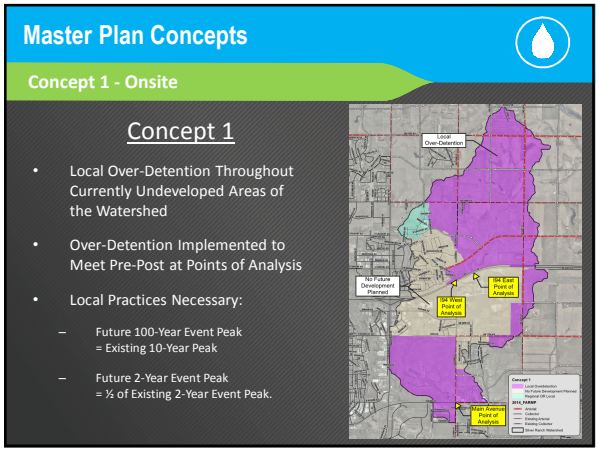
Concept 1 - Onsite

Concept 1

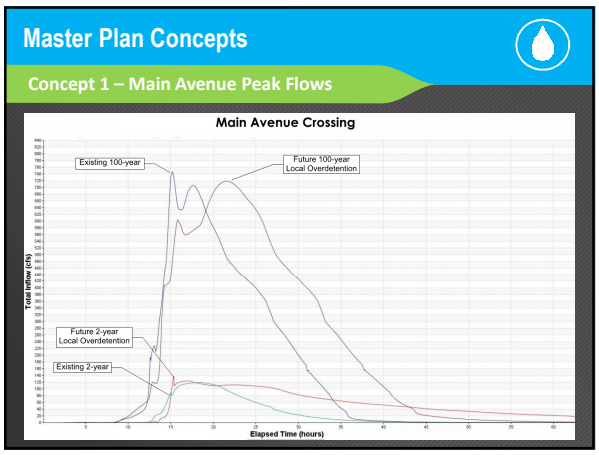
- Local Over-Detention Throughout Currently Undeveloped Areas of the Watershed







Jeff noted that the "Local PRactices Necessary" were determined after several iterations with the model to determine the mitigation necessary. If Concept 1 is selected, it may be best to assign a unit rate of runoff (discharge per acre) for developments.

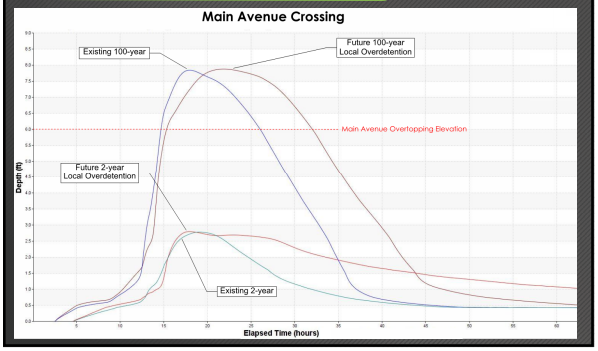


Jeff noted that the increase shown for the Future 2-year Local Overdetention is likely the the result of our screening level modeling approach. Based on AE2S's review, the increase would not be real and would not be present in hydrograph once finer modeling is complete.

w

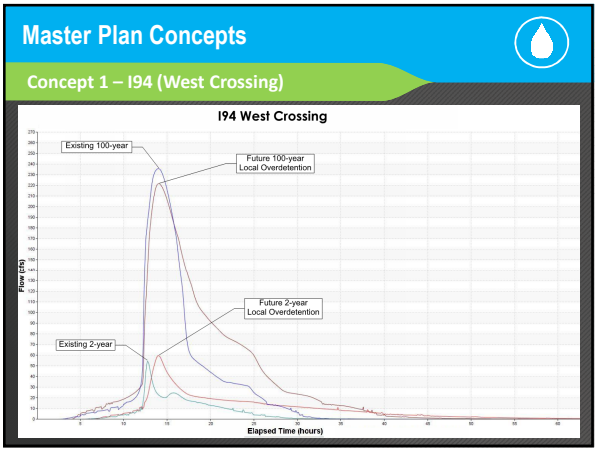
Master Plan Concepts

Concept 1 – Main Avenue Depth



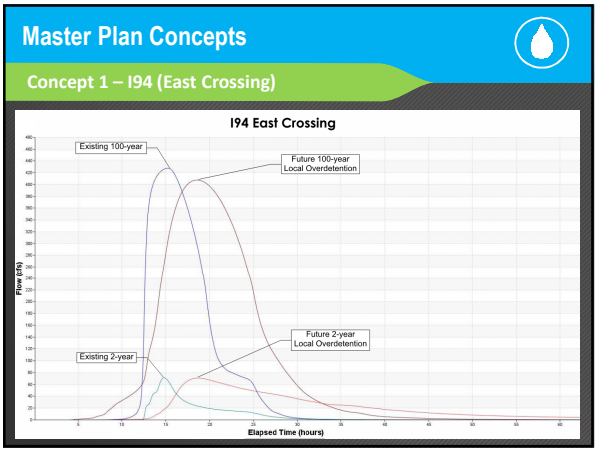
Master Plan Concepts

Concept 1 – I94 (West Crossing)



Master Plan Concepts

Concept 1 – I94 (East Crossing)



Master Plan Concepts

Concept 1 – Comparison to Standard Pre-Post

Ponds for Over Detention vs Standard Pre-Post Ponds

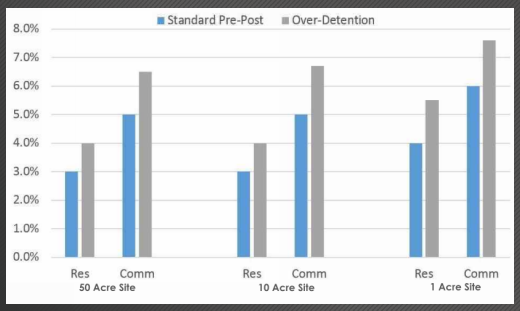
Development Type	Area (acre)	Site % for Standard Pre-Post Pond	Site % for Over Detaining	Increased % of Site	Over Detention Increase Over Pre-Post Pond (acres)	Over Detention Outlet Structure			
						2-yr Orifice	Invert	100-yr Orifice	Invert
Residential	50	3.0%	4.0%	1.0%	0.5	10	0	21	1.3
Commercial		5.0%	6.5%	1.5%	0.75	10	0	21	1.7
Residential	10	3.0%	4.0%	1.0%	0.1	6	0	12	1.4
Commercial		5.0%	6.7%	1.7%	0.17	6	0	14	1.8
Residential	1	4.0%	5.5%	1.5%	0.015	UD*	0	4	1.6
Commercial		6.0%	7.6%	1.6%	0.016	UD*	0	5	2.05

Notes:
5-foot pond depths (4 feet of effective storage)
1-foot of freeboard accounted for
4-inch minimum orifice

*"Can't meet goal with 4". Requires underdrain.

Master Plan Concepts

Concept 1 – Comparison to Standard Pre-Post

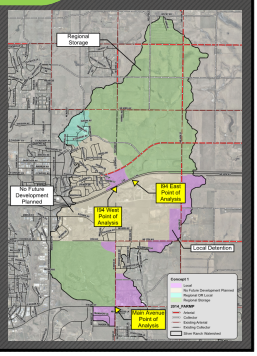


Master Plan Concepts

Concept 2

Concept 2

- Regional Storage to Provide Water Quality, 2-, 10-, & 100-year Events for Most Undeveloped Regions.
- Onsite Detention for Select Locations

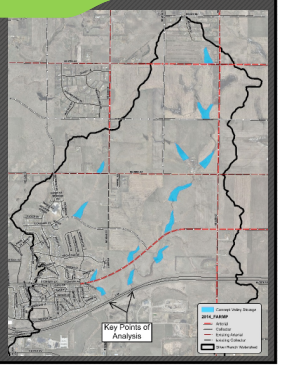


Master Plan Concepts

Concept 2

Valley Storage Basins

- Exact location and number of basins may change during detailed analysis.
- 13 Basins Proposed
  - 7 Upstream of Road Crossings
  - 6 Non-Roadway Embankments
- Basins will Provide:
  - Water Quality
  - 2-, 10-, & 100-Year Peak Flow Mitigation



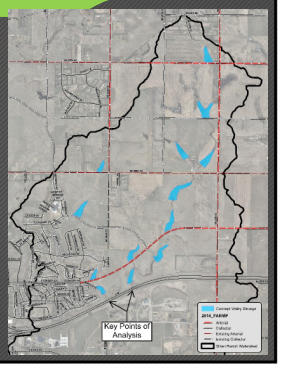
Master Plan Concepts

Concept 2

Valley Storage Basins

- Exact location and number of basins may change during detailed analysis.
- 13 Basins Proposed
  - 7 Upstream of Road Crossings
  - 6 Non-Roadway Embankments
- Basins will Provide:
  - Water Quality
  - 2-, 10-, & 100-Year Peak Flow Mitigation

➢ Compliance Achieved at I-94 Points of Analysis



Master Plan Concepts

Concept 2

State Land

- Water Quality and Peak Flow Mitigation Provided by Regional Facilities
  - Detention may not be required for the 100-year event due to timing of the hydrograph. This will depend on the approach taken in the upstream watershed as well as within the State Land.
  - *Note: Section 36 (State Land) is located in excess of 10,000 feet from the Bismarck Airport and is, therefore, not subject to FAA guidelines.

Master Plan Concepts

Concept Comparison

	Concept		
	Onsite Over-Detention	Regional	Regional/Onsite 5-year & WQ
Meets 2-, 10-, & 100-Year Peaks at Points of Analysis	☺	☺	☺
Water Quality Flexibility	☺	☹	☺
Flexible Funding/Phasing	☺	☹	☺
Minimizes # of Facilities to Maintain	☹	☺	☺
Minimize Conveyance Infrastructure	☺	☹	☺
Change to Development Policy	Yes	No	Yes

Linda wants to discuss the Local Over-Detention or "Unit Rate" option with Finance to understand how potential maintenance assessments might work and to confirm that this is a viable option. Gabe expressed that if the Working Group decides the Unit Rate option is the best option, a method for funding maintenance can be determined.

Next Steps

- Proceed with Further Development of Chosen Alternative(s)
- Review How Alternatives React to Various Hay Creek Connection Scenarios

AE2S will hold off on proceeding with the Next Steps until direction is provided by the Working Group.

Schedule

	Milestone	Date
Working Group	Kick-off Meeting	January 27, 2017 ✓
	Presentation of Existing Conditions Analysis	March 1, 2017 ✓
	Presentation of Master Plan Concepts	April 12, 2017 ✓
	Follow-up on Master Plan Concepts	May 3, 2017 ★
	Presentation of the Preliminary Master Plan Alternative	~~May 17, 2017~~ May 31, 2017
	Presentation of Draft Master Plan	~~June 28, 2017~~ July 12, 2017
	Review Comments on Draft Master Plan	~~July 19, 2017~~ August 2, 2017
	Presentation/Delivery of Final Master Plan	~~August 9, 2017~~ August 23, 2017
	City Commission	~~August 22, 2017~~ September 5, 2017
	All Deliverables Due	~~August 31, 2017~~ September 14, 2017

Because a delay will occur, pending the City determining which approach to pursue, the schedule will likely be delayed additionally. Gabe does not have concern with additional delays to the project schedule.

The Working Group agrees that a combination of Local Post-Construction BMPs (water quality and 5-year onsite) and Regional Post-Construction (10- and 100-year in Regional) is not desirable as it tends to exhibit many of the constraints of both all Regional and all On-site/Local.

Gabe Requests that working group review Benefits and Constraints sections and add to each of these as they feel fitting.

DRAFT

Option	Benefits	Constraints	Maintenance Responsibility
Regional Post-Construction BMPs for Peak Flow & Water Quality	• Watershed goals are met at the points of interests. • Clear guidance for development activities. • Smallest number of BMPs to manage and maintain. • Lowest up front developer costs. • Known and accepted management policy.	• Requires larger conveyance structures. • BMPs are generally installed after development has occurred • Largest amount of Special Assessments with significant amounts held in abeyance. • Current Special Assessment policy requires modification to limit the amount of funds held in abeyance.	**Local BMPs –** Private **Regional BMPs -** City Owned and Operated
Local Post-Construction BMPs for Water Quality Mitigation & 5-Year Peak Flow **Regional Post-Construction BMPs** for 10- and 100-year Peak Flow	• Post-Construction BMP installed with development. • Clear guidance for development activities. • Watershed goals are met for the 100-year event at the point of interests. • Lower Special Assessments for Regional BMPs.	• Reduced useable area in each development. • Increased number of BMPs to manage and maintain. • Increased up front developer costs. • Regional watershed goals may not be achieved for frequent storm events. • May require the adoption of a new policy for inspection and maintenance of privately owned BMPs.	**Local BMPs** – Private and/or City **Regional BMPs** – City
Local Post-Construction BMPs for Water Quality and Peak Flow (Over-Detention)	• Post-Construction BMP installed with development. • Clear guidance for development activities. • Watershed goals will be met for the at the point of interests. • Lowest Special Assessments for Regional BMPs.	• Highest up front development costs. • Reduced useable area in each development. • Challenges for small developments to meet the over-detention criteria due to minimum orifice size. • Results in the largest number of total BMP in the watershed. • May require the adoption of a new policy for inspection and maintenance of privately owned BMPs.	**Local BMPs** – Private and City **Regional BMPs** – City

CITY OF BISMARCK

Silver Ranch Working Group Meeting

Discussion of Unit Rate Development and Draft Implementation Policies

AE2S

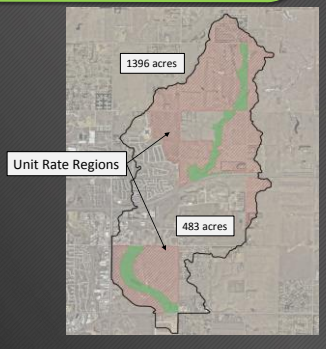
June 21, 2017

Points of Analysis

Unit Rate Determination

- An Iterative Process Adjusting the Times of Concentration.
  - Tc values are lengthened until peak runoff meets the Unit Rate runoff. This is intended to simulate detention.
- System function is then analyzed for compliance at the points of analysis.
- If compliance is not achieved, the Unit Rate is adjusted and Tc values are iterated once again.
- This process is repeated until Unit Rates that achieve compliance are identified.

Unit Rate Designation



Unit Rate Designation

- Preliminary Unit Rates:
  - 2-Year: 0.05 – 0.08 cfs/acre
  - 100-Year: 0.5 – 0.8 cfs/acre

Unit Rate Designation

- Preliminary Unit Rates:
  - 2-Year: 0.05 – 0.08 cfs/acre
  - 100-Year: 0.5 – 0.8 cfs/acre
- Existing Conditions Runoff Rates
  - 2-Year: 0.1 cfs/acre
  - 10-Year: 0.4 cfs/acre
  - 100-Year: 1.5 cfs/acre

Unit Rate Designation

Ponds for Over Detention vs Standard Pre-Post Ponds									
Development Type	*Area (acre)*	*Site % for Standard Pre-Post Pond*	*Site % for Over Detaining*	*Increased % of Site*	*Over Detention Increase Over Pre-Post Pond (acres)*	*Over Detention Outlet Structure*			
						2-yr Orifice	*Invert*	*100-yr Orifice*	*Invert*
Residential	50	3.0%	4.0%	1.0%	0.5	10	0	21	1.3
Commercial		5.0%	6.5%	1.5%	0.75	10	0	21	1.7
Residential	10	3.0%	4.0%	1.0%	0.1	6	0	12	1.4
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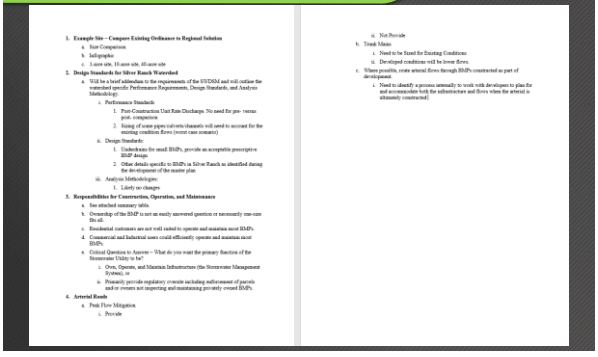
*Can't meet goal with 4". Requires underdrain.

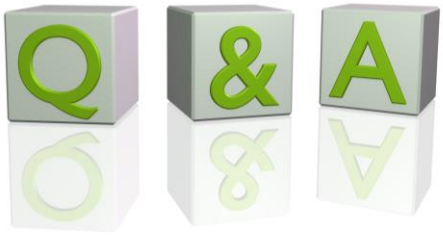
Notes:
5-foot pond depths (4 feet of effective storage)
1-foot of freeboard accounted for
4-inch minimum orifice

Implementation



3. **Example Site – Compare Existing Ordinance to Regional Solution**
   a. Site Comparison
   b. Infographic
   c. 1 acre site, 10 acre site, 40 acre site
5. **Design Standards for Silver Ranch Watershed**
   a. Will be a brief addendum to the requirements of the SWDM and will outline the watershed specific Performance Requirements, Design Standards, and Analysis Methodology:
      i. Performance Standards
         1. Post-Construction Unit Rate Discharge. No need for pre- versus post- comparison
         2. Sizing of some pipes/culverts/channels will need to account for the existing condition flows (worst case scenario)
      ii. Design Standards:
         1. Underdrains for small BMPs, provide an acceptable prescriptive BMP design
         2. Other details specific to BMPs in Silver Ranch as identified during the development of the master plan.
      iii. Analysis Methodologies:
         1. Likely no changes
7. **Responsibilities for Construction, Operation, and Maintenance**
   a. See attached summary table.
   b. Ownership of the BMP is not an easily answered question or necessarily one-size fits all.
   c. Residential customers are not well suited to operate and maintain most BMPs.
   d. Commercial and Industrial users could efficiently operate and maintain most BMPs.
   e. Critical Question to Answer – What do you want the primary function of the Stormwater Utility to be?
      i. Own, Operate, and Maintain Infrastructure (the Stormwater Management System), or
      ii. Primarily provide regulatory oversite including enforcement of parcels and/or owners not inspecting and maintaining privately owned BMPs.
4. **Arterial Roads**
   a. Peak Flow Mitigation
      i. Provide
      ii. Not Provide
   b. Trunk Mains
      i. Need to be Sized for Existing Conditions
      ii. Developed conditions will be lower flows.
   c. Where possible, route arterial flows through BMPs constructed as part of development.
      i. Need to identify a process internally to work with developers to plan for and accommodate both the infrastructure and flows when the arterial is ultimately constructed.

Silver Ranch Stormwater Master Plan



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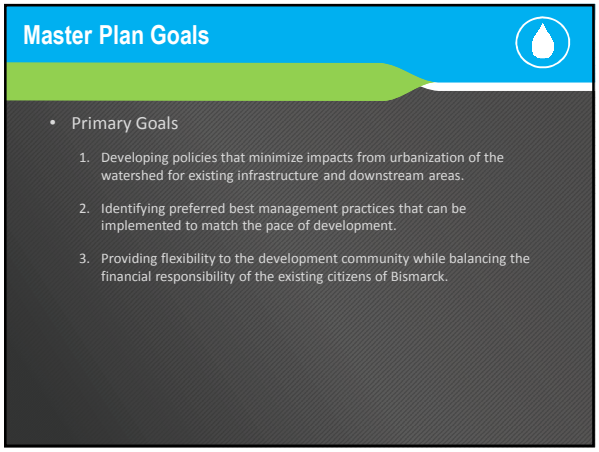
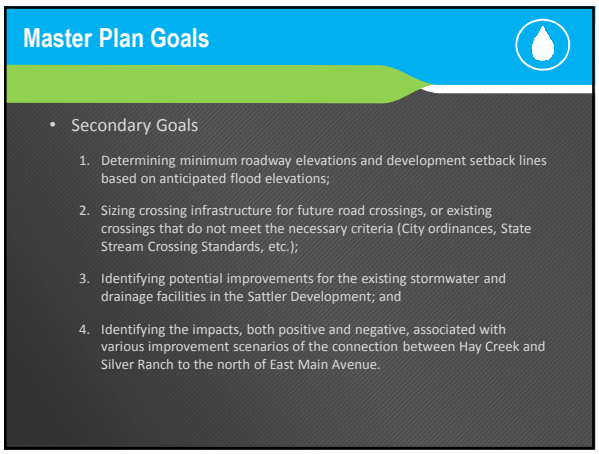
Attendance: Brad Wright, Linda Oster, Terry Halstengard, Gabe Schell, Daniel Nairn, Mike Greer, Waylon Erdmann, Jeff Hruby, & Jesse Kist

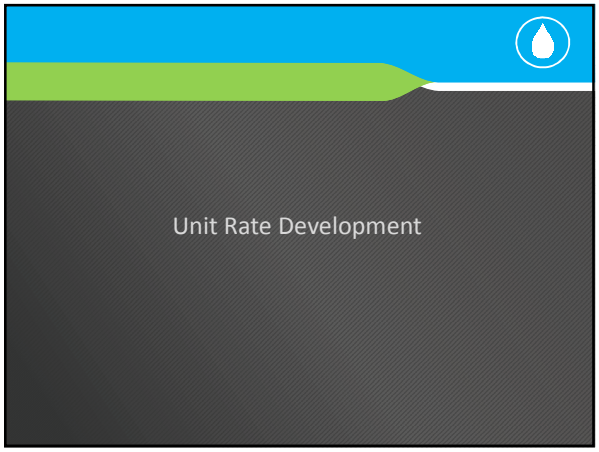


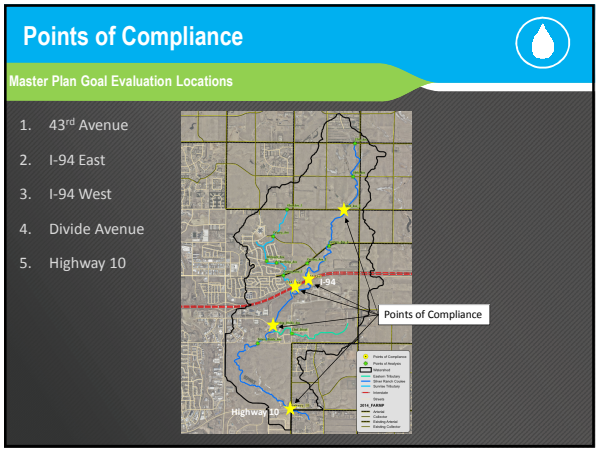
Group would like #3 reworded and would also like an explanation of what is meant by "flexibility."

Add a fourth primary goal regarding the integration with other planning documents (FLUP, FARMP, etc.).



Remove the specific reference to the Sattler Development in #3.





I-94 and Highway 10 primarily used during development of recommended Unit Rate. Other locations checked to verify goals of master plan being met.

Unit Rate Recommendation

- Previously Presented Ranges:
  - 2-year = 0.05 – 0.08 cfs/acre
  - 100-year = 0.5 – 0.8 cfs/acre

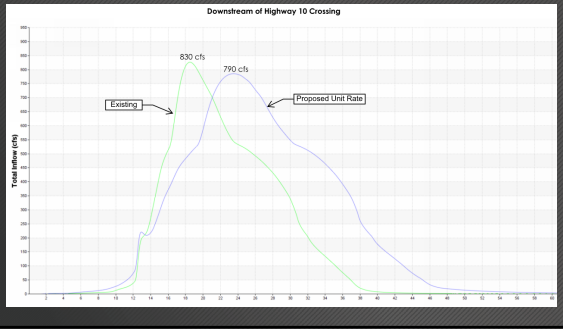
Unit Rate Recommendation

- Previously Presented Ranges:
  - 2-year = 0.05 – 0.08 cfs/acre
  - 100-year = 0.5 – 0.8 cfs/acre
- Master Plan Recommendation:
  - 2-Year Unit Rate = **0.06 cfs/acre**
  - 100-Year Unit Rate = **0.5 cfs/acre**

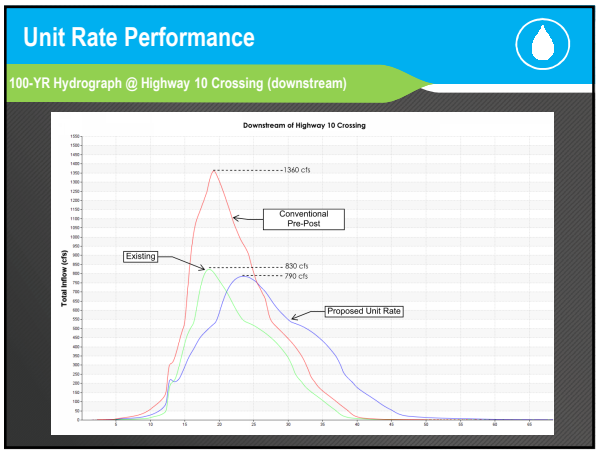
Recommended Unit Rates are within the previously presented ranges.

Unit Rate Performance

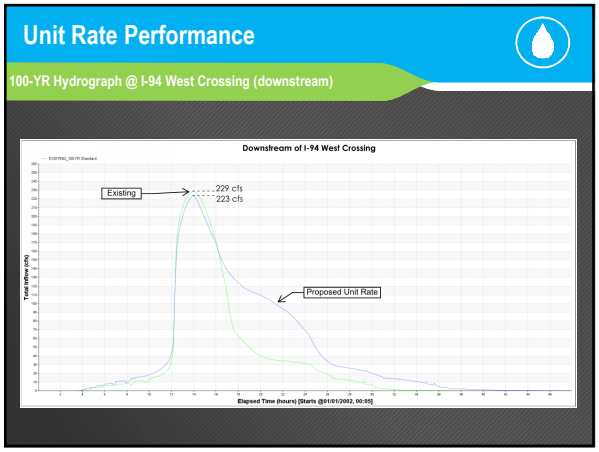
100-YR Hydrograph @ Highway 10 Crossing (downstream)



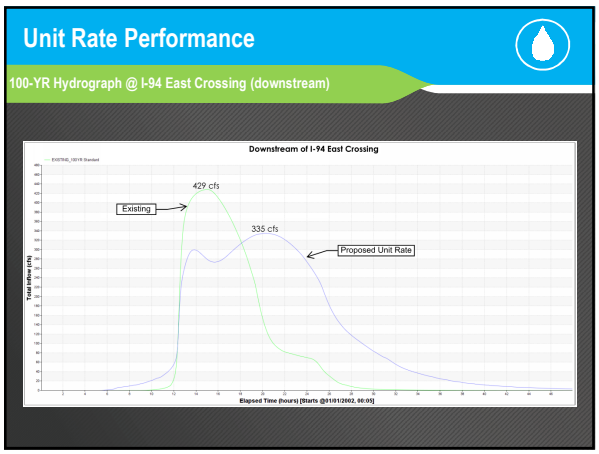
The proposed Unit Rate results in decreased flows downstream of Highway 10 as compared to existing conditions.



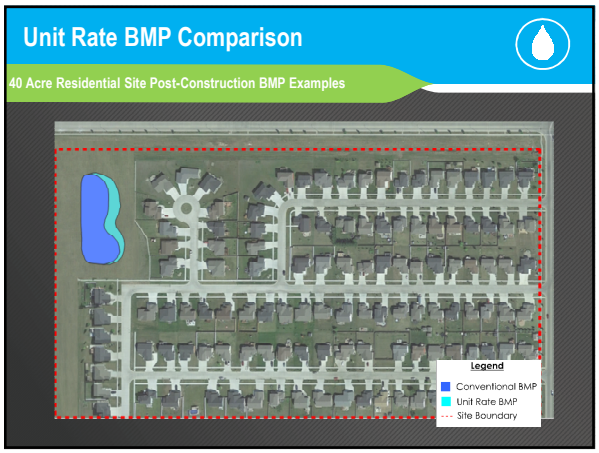
Conventional pre-post results in a significant increase to peak flows downstream of the Hwy 10 crossing as compared to existing conditions and the proposed Unit Rate.

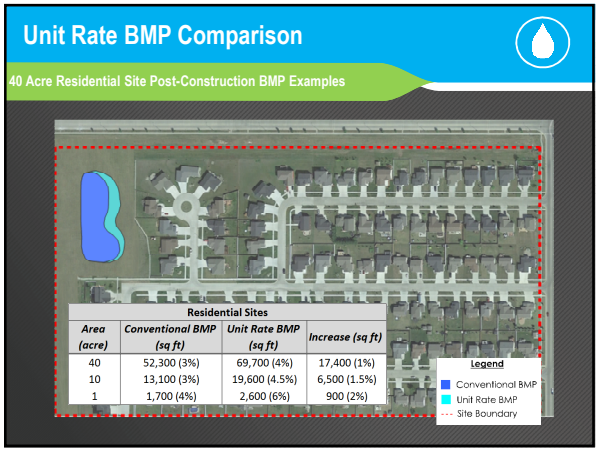


The proposed Unit Rate results in flows being generally unchanged downstream of the I-94 West crossing as compared to existing conditions. Much of the upstream watershed is already developed in existing conditions.

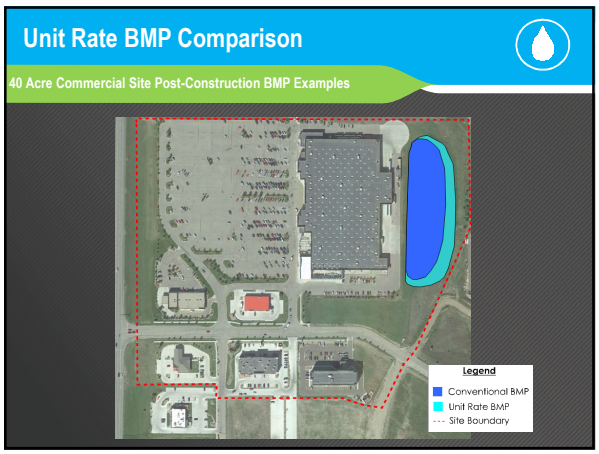


The proposed Unit Rate results in flows being decreased downstream of the I-94 East crossing as compared to existing conditions.





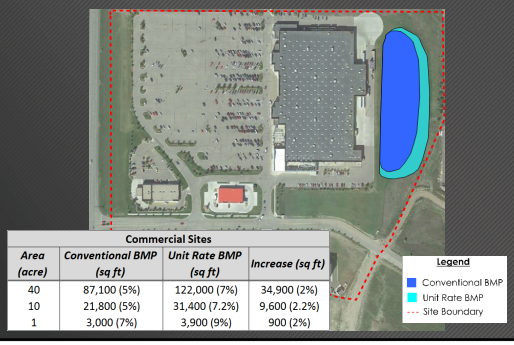
Gabe would like the percentages defined better. Need to clarify that the percentages are in reference to the total site size.



Switch to a site not in Bismarck to avoid possibility of someone trying to compare the concept detention pond to what was built.

Unit Rate BMP Comparison

40 Acre Commercial Site Post-Construction BMP Examples

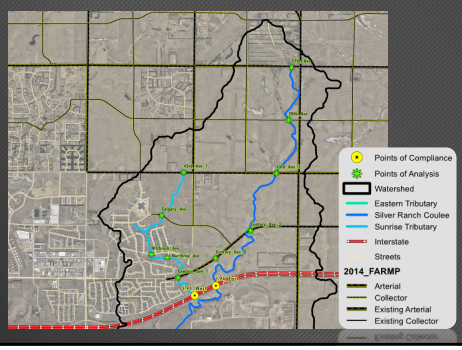


Commercial Sites			
Area (acre)	*Conventional BMP (sq ft)*	*Unit Rate BMP (sq ft)*	*Increase (sq ft)*
40	87,100 (5%)	122,000 (7%)	34,900 (2%)
10	21,800 (5%)	31,400 (7.2%)	9,600 (2.2%)
1	3,000 (7%)	3,900 (9%)	900 (2%)

Road Crossings

Existing and Future Road Crossings

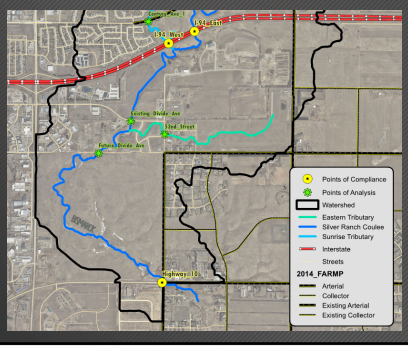
North of I-94



Working group would like the Silver Ranch Crossing added. No other crossings were identified. Flows shall be provided at the Points of Analysis identified as well as at quarter-quarter section lines within the Appendix.

Existing and Future Road Crossings

South of I-94



Existing Divide Avenue shall be referred to as Miriam Avenue and future Divide shall be referred to as Divide Avenue.

Road Crossing Improvements

Sizing Methodology

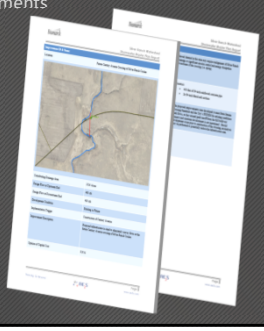
- Crossing Infrastructure Sized Using Existing Conditions Runoff
  - Worst case scenario (i.e. Unit Rate decreases peaks)
  - Sized to meet:
    - State Stream Crossing Standards (25-year Event)
    - City Stormwater Design Standards (100-year Event)

The criteria described are accomplished by all of the proposed crossings except the Highway 10 crossing at the bottom of the watershed.

Proposed Improvement Reporting

Fact Sheet Summaries

- Summarize Proposed Improvements
  - Trigger
  - Scope and Size
  - Opinion of Total Cost



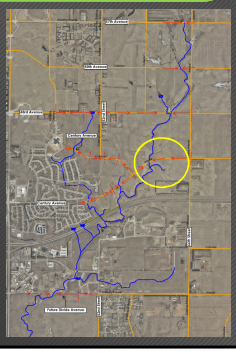
Gabe would like the Opinion of Total Cost to include the embankment necessary for the crossings with the top of embankment placed 1 foot above the 100-year event water surface elevation.

AE2S will complete one and send to the City for approval before proceeding with others.

Drainage from Arterials & Collectors

Arterial Roadway Drainage

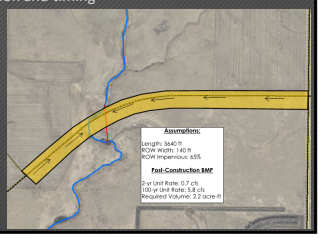
Collectors & Arterials



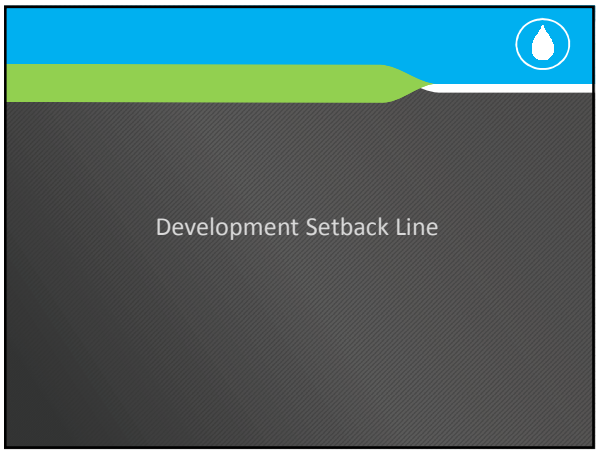
Arterial Roadway Drainage

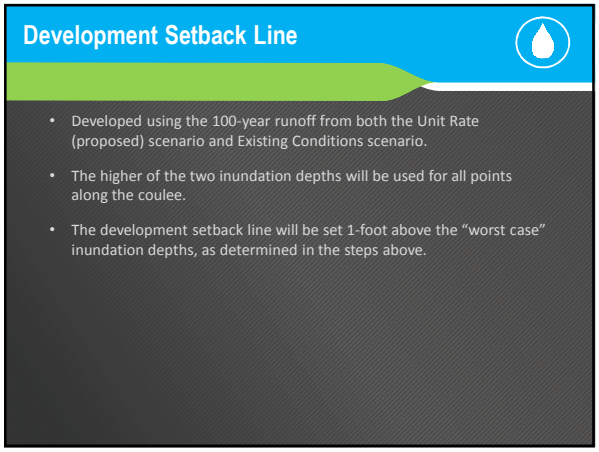
Collectors & Arterials

- Recommendations for Arterial Roads and Trunk Sewers
  - City builds required detention during construction of roadway; or
  - City negotiates with adjacent development to include in a combined facility.
- Scenario is dependent on location and timing

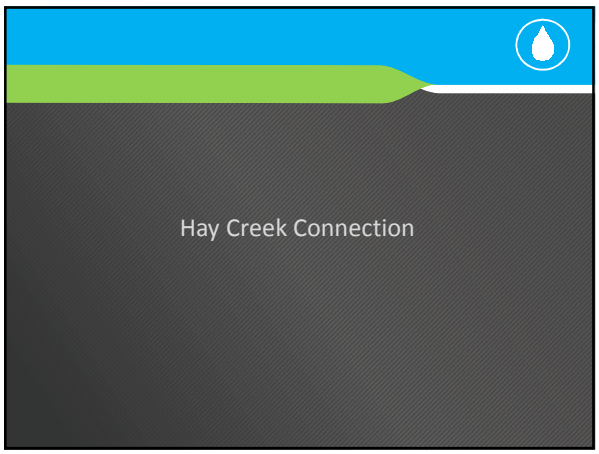


The working group does not want storage volumes provided specifically for arterials and collectors. It should be verified that unmitigated flows from arterials and collectors do not alter the Unit Rate recommendation. Water quality will be provided by means other than ponds. Report should note that water quality only will be required and that the peak is accounted for by Unit Rate.





The development setback line will be developed to guide development away from areas of potential inundation. Appropriate enforcement procedures will need to be determined/developed by the City.



Hay Creek Connection

Scenarios

✓ Master Plan goals are achieved with either scenario!

As previously requested by Gabe, the Master Plan goals are achieved with the Hay Creek connection open or closed.

Hay Creek Connection

Scenarios

✓ Master Plan goals are achieved with either scenario!

1. Leave Connection Open
   - Minimal change in impacts to Silver Ranch or Hay Creek Watersheds

Hay Creek Connection

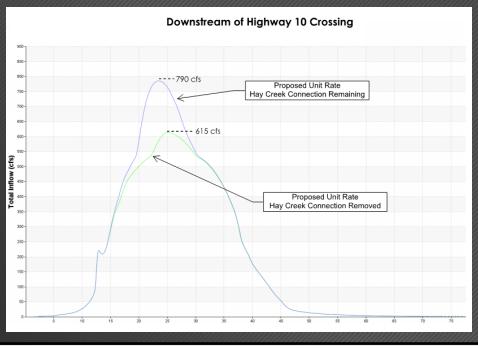
Scenarios

✓ Master Plan goals are achieved with either scenario!

1. Leave Connection Open
   - Minimal change in impacts to Silver Ranch or Hay Creek Watersheds
2. Remove Connection
   - Decreased flows downstream of connection in Silver Ranch Coulee

Hay Creek Connection

Silver Ranch Scenario Hydrographs @ Hwy 10 (downstream)



Closing the connection to Hay Creek decreased flows downstream of Hwy 10 by about 175 cfs.

Hay Creek Connection

Silver Ranch Highway 10 Crossing

Runoff	Connection Status	Overtopping		
		Depth (ft)	*Flow (cfs)*	*Duration (hrs)*
Existing Condition	Open	0.7	230	8
	Blocked	0.5	150	6
Master Planned	Open	0.6	200	11
	Blocked	0.3	60	8

The working group would like AE2S to review the Highway 10 crossing to determine what it would take to eliminate overtopping in the 100-year event. Opinion of Total Cost shall be provided as well.

Hay Creek Connection

Silver Ranch Highway 10 Crossing

Runoff	Connection Status	Overtopping		
		Depth (ft)	*Flow (cfs)*	*Duration (hrs)*
Existing Condition	Open	0.7	230	8
	Blocked	0.5	150	6
Master Planned	Open	0.6	200	11
	Blocked	0.3	60	8
Conventional Pre-Post	Open	1.5	700	13
	Blocked	1.1	430	8

Duration is increased for the Master Planned (Unit Rate) scenario because flows are being detained and released slowly over a longer period of time.

Note significant increases in overtopping depth and duration for conventional pre-post method as compared to existing conditions or the proposed Unit Rate method.

Hay Creek Connection

Scenarios

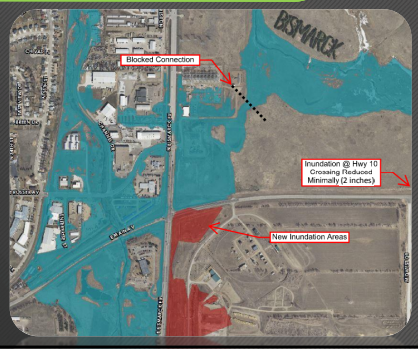
- ✓ Master Plan goals are achieved with either scenario!

1. Leave Connection Open
   - Minimal change in impacts to Silver Ranch or Hay Creek Watersheds
2. Remove Connection
   - Decreased flows downstream of connection in Silver Ranch Coulee
   - Increased flooding on Hay Creek side of connection
   - Requires addition of a 5' x 10' RCB under Main Avenue (in addition to existing culverts)

Increased flooding on Hay Creek occurs primarily in the NE and SE corners of the intersection of Hwy 10 and Expressway.

The addition of a 5' x 10' box culvert at Main Ave in addition to the existing culverts, results in elimination of the extra flooding, and does not increase water surface elevation at the Expressway crossing.

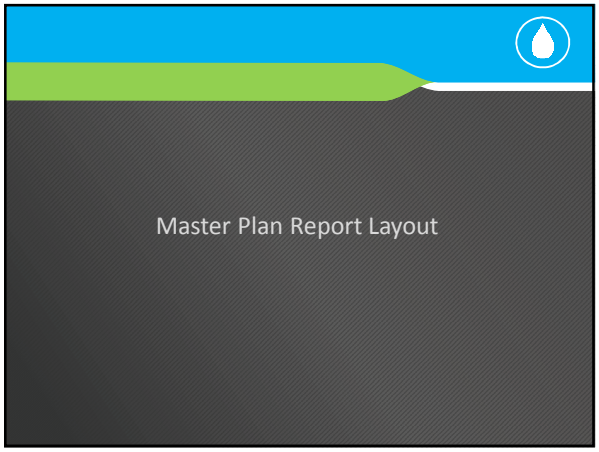
Hay Creek Connection

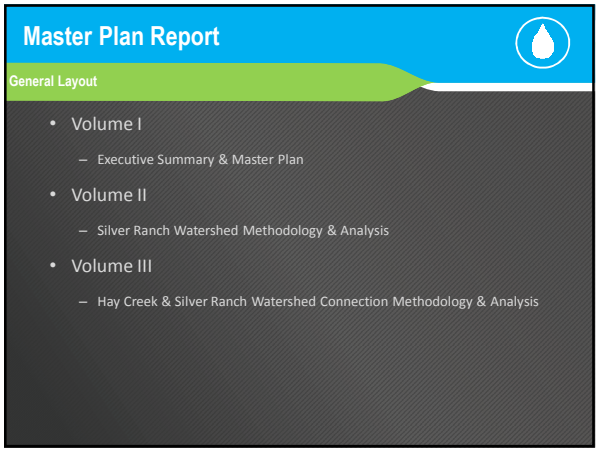


The red area indicates the region of new inundation areas as a result of the Hay Creek connection to Silver Ranch Coulee being blocked without additional capacity being added at Main Avenue crossing of Hay Creek.

Stakeholder Coordination

Working group agreed that the City will lead stakeholder coordination for Wachter Silbernagel, and Sattler. AE2S will lead with Department of Trust Lands. Burleigh County, BCWRD, and NDDOT.





Volume I is the main portion of the master plan that will be utilized 90% of the time. Technical details and documentation of the analysis will be in Volumes II and III.

Master Plan Report

- Volume I
  - Description: Executive Summary and Master Plan Summary
- Contains:
  - Master Plan Recommendations
  - Design Standards
  - Operation and Maintenance of Post-Construction BMPs
  - Public Improvement Plan

Master Plan Report

- Volumes II & III
  - Description: Methodology & Analysis of Silver Ranch and Hay Creek
- Contains:
  - Master Plan Goals
  - Analysis & Methodology
  - Existing Conditions Summary
  - Stormwater Management Concepts
  - Hydrology and Hydraulics
  - Opinion of Probably Costs and Funding Summary
  - Exhibits
  - Survey Data
  - Stakeholder Communication

Schedule

Schedule

Working Group approved the proposed schedule.

9/15 - AE2S to submit Draft Master Plan

9/29 - All Working group comments submitted

10/6 - Working Group meeting to discuss master plan comments from group (if necessary)

10/9 - Begin Stakeholder Outreach

10/20 - Stakeholder Outreach completed and meet to discuss comments (if necessary)

11/3 - Deliver Final Master Plan
11/14 - Present to City Commission

The working group agreed that comments resulting from review of the Draft Master Plan will be provided to AE2S using BlueBeam to prevent duplicate or contradicting comments from members of the working group. AE2S will set up a trial BlueBeam Revue online session to make sure it works with the City's system.

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