

ASH & WARD COULEE WATERSHED

For



City of Bismarck, ND

STORMWATER MASTER PLAN REPORT

Volume I

September 2015

AE2S Project #: P00501-2013-006

ASH & WARD COULEE WATERSHED STORMWATER MASTER PLAN REPORT



September 2015

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.

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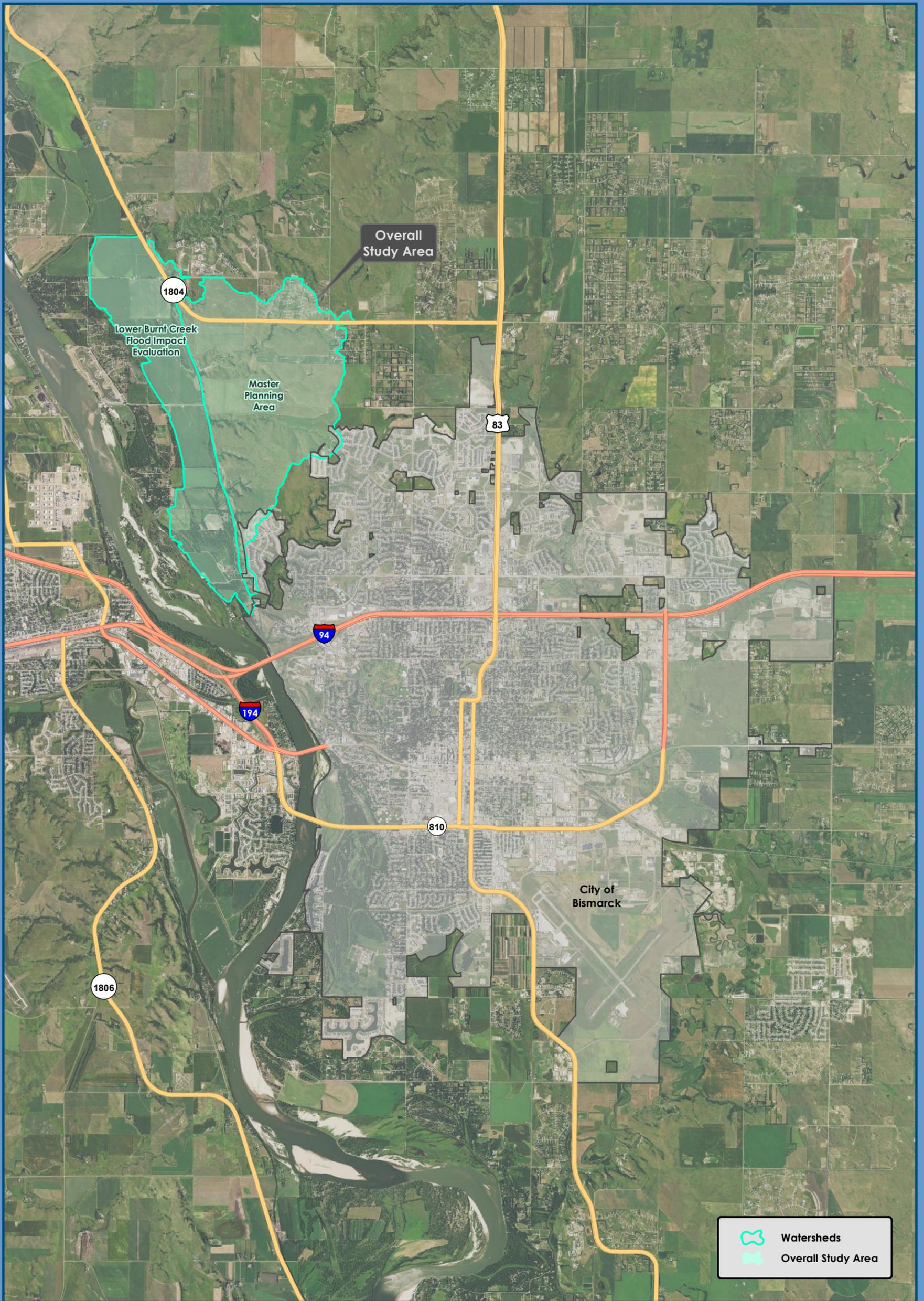
1.0 INTRODUCTION AND BACKGROUND

1.1 Project Background

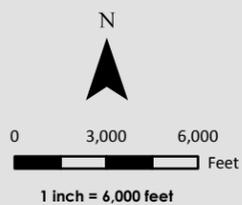
The City of Bismarck is experiencing growth, with development pressure generally expanding to the north. The focus of this stormwater master plan is the Ash & Ward Coulee Watershed located generally east of River Road, south of North Dakota State Highway 1804 (ND 1804), north of the Tyler Coulee Watershed, and west of the N. Washington Street Watershed (*Figure 1-1*). This watershed consists of six coulees, and encompasses an area of approximately 3.9 square miles. For the purposes of this study, the coulees are numbered one to six from north to south (*Figure 1-2*).

The Ash & Ward Coulee Watershed is tributary to Lower Burnt Creek, which is the reach of Burnt Creek that remained after the Burnt Creek Bypass Channel was constructed in the late 1990's. The Lower Burnt Creek has a local contributing watershed of approximately 6.7 square miles that includes the Ash & Ward Coulee Master Plan area, but also receives a small fraction of Burnt Creek flow that discharges into Lower Burnt Creek at the upstream end of the Bypass Channel at ND 1804. The Ash & Ward Coulee Watershed discharges into Lower Burnt Creek through culvert crossings installed under River Road at each of the six coulees previously mentioned.

As the watershed urbanizes, increased stormwater runoff can lead to local flooding and degradation of water quality. The City's general policy is to develop regional stormwater master plans prior to areas developing. The overall goal of a stormwater master plan is to outline the key stormwater and drainage infrastructure that will be needed to provide the appropriate level of service for roadways and meet the City's stormwater management ordinance and design criteria. This Master Plan was developed to act as a stormwater management and drainage guide for the City, landowners, developers, and associated stakeholders as the Ash & Ward Coulee Watershed develops. The scope of this study also includes an evaluation of the conditions within the Lower Burnt Creek Watershed to determine the performance of the proposed stormwater and drainage improvements as they relate to mitigating the potential impacts to Lower Burnt Creek from development of the Ash & Ward Coulee Watershed.



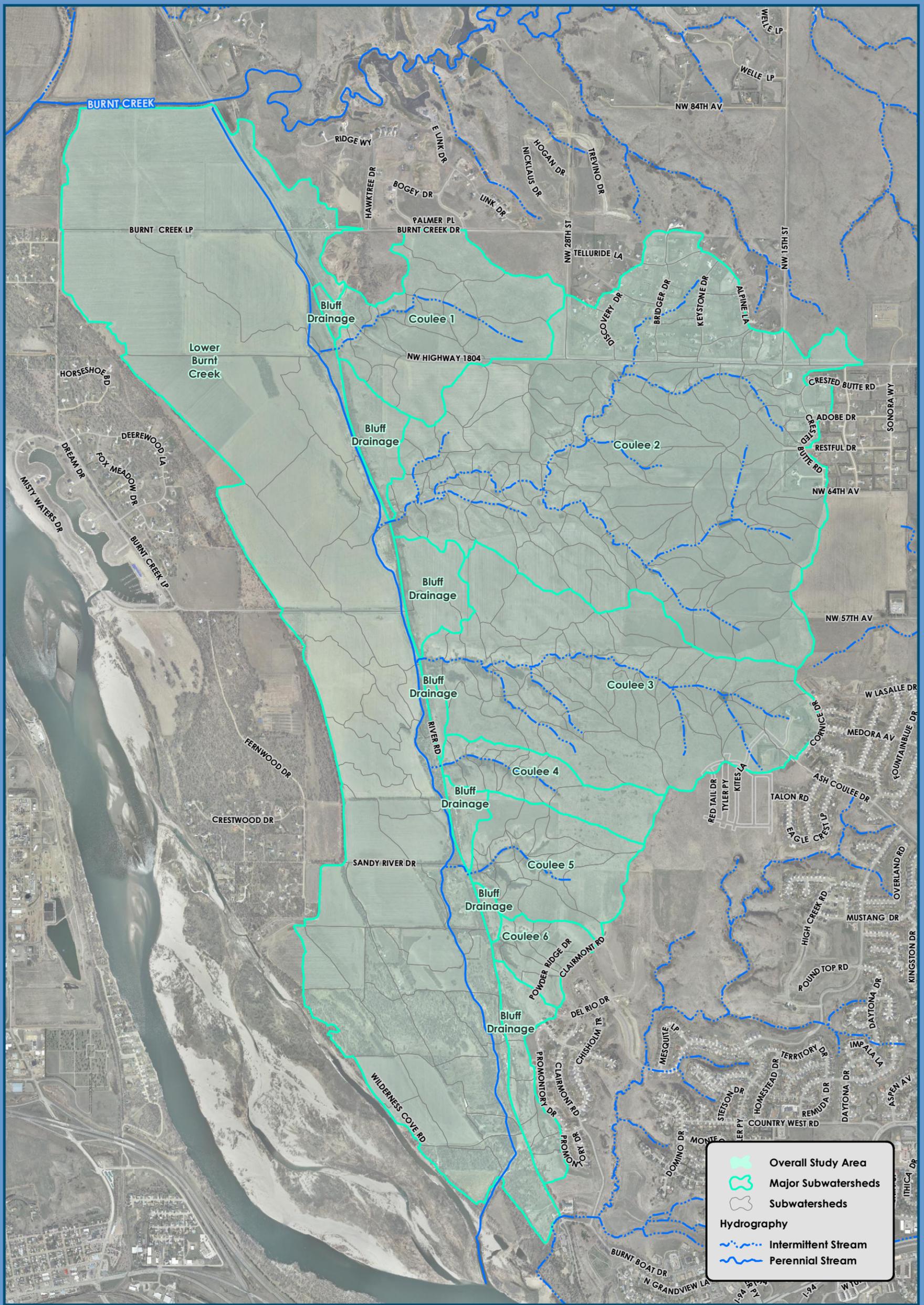
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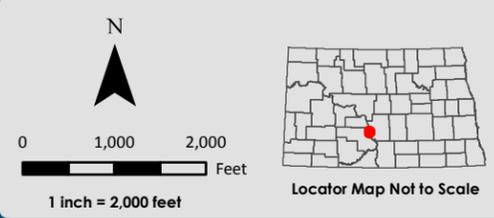
**Figure 1-1:
Project Location Map**

**City of Bismarck
Ash and Ward Coulee Stormwater Master Plan**





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**Figure 1-2:
Watershed Map**
City of Bismarck
Ash and Ward Coulee Stormwater Master Plan



1.2 Master Plan Goals

The overarching goals of this Master Plan were developed with the City Work Group. These goals can be divided into primary and secondary goals.

1.2.1 Primary Goal

The primary goal of the Master Plan is to develop a comprehensive approach that manages stormwater and provides adequate drainage consistent with the City's ordinances. Achieving this goal requires the following:

- Determining sizes and developing preliminary designs for regional detention facilities and major drainage-way crossings;
- Determining minimum roadway elevations based on anticipated flood elevations; and
- Outlining an Implementation Plan for constructing the regional detention and drainage infrastructure that includes key development triggers for construct of regional facilities.

1.2.2 Secondary Goals

Three secondary goals were developed for this Master Plan, which are to:

- Maintain existing flooding depths caused by local watershed runoff on Lower Burnt Creek under full build-out conditions in the Ash & Ward Coulee Watershed;
- Address the unique geotechnical conditions present within the watershed, specifically associated with the stability of the Missouri River bluffs and associated coulees on the east side of the Missouri River. As part of this Master Plan, the City requested that a preliminary geotechnical setback line be developed indicating those areas that are susceptible to geotechnical instability and should be evaluated on a site by site basis if development is proposed; and
- Evaluate the potential for erosion along the coulee valleys and side slopes and develop potential measures that would mitigate for the likely increase in the frequency, duration, and magnitude of shear stress and velocity in locations throughout the coulees.

1.3 Master Plan Performance Criteria

1.3.1 City Requirements

The City of Bismarck includes performance criteria within Title 14.1 of the City's code of ordinances. Additional City design criteria are included within the City's Stormwater Design Standards Manual. Specific applicable criteria are as follows:

1. Regional detention facilities were designed such that flow entering Lower Burnt Creek (at River Road) for each coulee meets the City's requirements, summarized as follows:
 - No increase in post-development flows compared to pre-development flows for the 2-, 10-, and 100-year storm events (14.1-02-03 6.a.). For the purposes of this study, "pre-development" was defined as current conditions and existing land use, and the storm duration was selected to be a 6-hour storm consistent with previous master planning efforts.
 - Meet the City's MS4 permit requirements as outlined in Appendix 1 of the Authorization to Discharge under the North Dakota Pollutant Discharge Elimination System Permit No. NDR04-0000. As described in *Appendix G*, reducing Total Suspended Sediment loads by at least 80 percent on an average annual basis is equivalent to meeting the requirements of Appendix 1 of NDR04-0000.
2. Major drainage-way crossings were sized to meet the City's requirements for streets as follows (per Table No. 6.1 and Section 3 in the Stormwater Design Standards Manual):
 - Local Streets: In the 100-year storm, less than 9" of depth at the crown;
 - Collector Streets: In the 100-year storm, less than 6" of depth at the crown. Based on the typical collector street cross section, the crown of the road is 6" below the edge of the right-of-way; therefore, no overflow in the 100-year event was designed for all the collector street crossings.
 - Arterial Streets: In the 100-year storm, less than 3" of depth at the crown. The typical arterial street cross section would create an edge of right-of-way that is greater than 3 inches above the centerline of the road; therefore, no overflow in the 100-year event was designed for arterial streets as well.
 - Where possible, provide 1 foot of freeboard in the 100-year event on all culvert and roadway crossings.

1.3.2 County (BCWRD and Highway) Requirements

River Road north of Burnt Boat Drive and the area west of River Road are within the County and will likely remain so even as the City continues to expand north. In order to meet County requirements, including maintaining existing flood levels on Lower Burnt Creek, the following criteria were included for this Master Plan:

1. Maximum increase of 0.10' at culvert crossings on Lower Burnt Creek for the 6-hour, 2-, 10-, 25-, and 100-year events (meets secondary goal #1); and
2. No increase in peak discharges at River Road for the 6-hour, 25-year event.

1.3.3 State Requirements

This watershed includes drainages that cross ND 1804 in multiple locations; therefore both North Dakota Department of Transportation (NDDOT) and State Water Commission (SWC) criteria for stream crossings, level of service, and backwater are applicable. These requirements are summarized as follows:

- For regional and urban State Highway roads in the urban system, no roadway overtopping shall occur up to the 25-year event;
- For non-interstate State Highway roads in the rural system, no roadway overtopping shall occur up to the 25-year event; and
- For streams with streambed slopes greater than 10 feet/mile (entire study area), the allowable headwater when passing the design discharge (listed immediately above) shall be no greater than two pipe diameters.

Additionally, in discussions with the NDDOT, they require that the existing 25-year, 24-hour peak flow not be increased in proposed conditions for existing facilities and outlet velocities not exceed 10 feet per second. In cases where peak flows are increased, crossings must be upgraded to maintain compliance with stream crossing standards.

The State Engineer/State Water Commission regulates construction of dams. Per 61-16.1-38 of the Century Code, permits are required for structures retaining more than 25 acre-feet of water for medium- or high-hazard dams. Since these facilities will be constructed in an urban area, it is likely that any detention facility exceeding 25 acre-feet of storage, even if temporary, would be classified as a dam and would require formal approval through the State permitting process.

1.3.4 Supplementary Design Criteria

A number of supplemental design criteria were developed based upon the characteristics of the watershed, discussions with City staff, and professional judgment. These additional design criteria include the following:

- Determine approximate areas along Missouri River bluffs and coulees where additional geotechnical evaluation is needed in order to allow future development (meets secondary goal #2);
- Determine shear stress potential along coulee valleys and list a suite of potential stabilization measures for coulee valleys (meets secondary goal #3);
- Individual detention basins will not have 25 acre-feet or more of storage capacity to avoid the facility being regulated as a dam; and
- For defining roadway level of service, the following criteria were selected:
 - For Minor and Principal arterial streets, no overtopping in the 100-year event.
 - For Collector streets, no overtopping in the 25-year event. (Note that the allowable depth at the crown trumps this criterion for urban roadway sections.)
 - For Local streets, no overtopping in the 25-year event.

- For driveways, no overtopping in the 2-year event.

1.4 Agency and Stakeholder Communication

Agency and stakeholder communication involved coordination with multiple entities, including:

- Burleigh County Highway Department;
- Burleigh County Water Resources District;
- Hay Creek Township;
- Sandy River Drive Neighborhood Association;
- Watershed landowners; and
- Lower Burnt Creek Landowners.

In addition to one-on-one meetings with multiple landowners, a public meeting was held on February 20, 2014 to present the goals of the study, results of the preliminary geotechnical analysis, and solicit anecdotal information on current drainage conditions. On June 4, 2015, the draft master plan was presented at a public meeting followed by a question and answer session. Copies of presentation, attendance sheets, and applicable correspondence are included in *Appendix H*.

1.5 City Work Group

The City assembled a City Work Group that provided input and direction during development of the Master Plan. Since the study area included significant number of Burleigh County Highway Department culverts, the Working Group included a representation from the Highway Department. The City Work Group consisted of the following individuals:

- Brad Wright, P.E. – Project Engineering, Bismarck Engineering Department
- Keith Demke, P.E. – Director of Utility Operations, Bismarck Public Works
- Linda Oster, P.E. - Design and Construction Engineer, Bismarck Engineering Department
- Terry Halstengard – Stormwater Program Coordinator, Bismarck Public Works
- Kim Lee, AICP – Planning Manager, Bismarck Community Development Department, Planning Division
- Marcus Hall, P.E. – County Engineer, Burleigh County Highway Department

1.6 Data Sources

The following data sources were utilized in this study:

- 2013 LIDAR data (contours and DEM) obtained from the Metropolitan Planning Organization;
- Bismarck 2014 aerial photograph, obtained from the City of Bismarck GIS FTP site;
- 2014 Burleigh County National Agricultural Inventory Program aerial photograph, obtained from the Geospatial Data Gateway;

- 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 September 23, 2014;
- Rainfall depths from NOAA Atlas 14;
- Site visits (various dates);
- Survey data collected as part of this project on August 21, September 12, September 19 of 2013; and
- Geotechnical Evaluation Report including coulee valley surface soil samples by Braun Intertec, dated August 26, 2014, completed as part of this project.

2.0 LAND USE

2.1 Existing Land Use

The existing land use in both the overall study area and the Master Planning area is primarily a mix of agricultural, open space (coulees and bluffs), rural residential (2-acre lots), and road right-of-ways (*Figure 2-1* and *Tables 2-1, 2-2*), with pasture making up over half the current land use in the Master Planning area. In the Lower Burnt Creek watershed, the dominant agricultural use is hay or other row crops, which comprises the dominant coverage within the overall study area.

Table 2-1: Summary of Existing Land Use in Master Planning Area Study Area

Land Use Type	Area (acres)*	Fraction of Study Area (%)	Percent Impervious Area (%)
Agriculture - Hay	403.5	15.9%	0% ³
Agriculture - Pasture	1,396.7	55.2%	0% ³
Low Density Residential Existing	10.9	0.4%	45% ¹
Open Space (Coulees and Bluffs)	427.3	16.9%	0%
ROW	74.8	3.0%	40% ³
Rural Residential	218.2	8.6%	12% ³
Total	2,531.4	100.0%	

*Based on Burleigh County parcel data, 2013 aerial photograph, and site observations.

¹Based on 2013 aerial photograph.

²Based on representative sample of residential lots in the study area.

³Based on TR-55 guidance.

Table 2-2: Summary of Existing Land Use in Overall Study Area

Land Use Type	Area (acres)*	Fraction of Study Area (%)	Percent Impervious Area (%)
Agriculture - Hay	1,660.8	38.7%	0% ³
Agriculture - Pasture	1,446.9	33.7%	0% ³
Low Density (Lots > 5 ac)	112.1	2.6%	5% ²
Low Density Residential Existing	10.9	0.3%	45% ¹
Open Space (Coulees and Bluffs)	427.3	9.9%	0%
ROW	152.4	3.5%	40% ³
Rural Residential	244.2	5.7%	12% ³
Woods Grass Mix	238.8	5.6%	0% ³
Total	4,293.3	100.0%	

*Based on Burleigh County parcel data, 2013 aerial photograph, and site observations.

¹Based on 2013 aerial photograph.

²Based on representative sample of residential lots in the study area.

³Based on TR-55 guidance.

2.2 Future Land Use

Future land use was based on combining the land use blocks from the 2014 Growth Management Plan with the road layout prepared as part of the 2014 Fringe Area Road Master Plan (FARMP). The 2014 FARMP was also used to locate the future roadway corridors. The future land use for the Master Planning and overall study area is displayed in *Figure 2-2* and summarized in *Tables 2-3* and *2-4*, respectively.

2.2.1 Land Use Impervious Area

Assumptions for impervious area were based on guidance from the City Work Group as well as creating consistency with previous Master Planning efforts.

A summary of the land use impervious area assumptions is shown in *Tables 2-3* and *2-4*. *Appendix E* contains a detailed discussion on the justification for the land use impervious area percentages.

Table 2-3: Summary of Future Land Use in Master Planning Study Area

Land Use Type	Area (acres)*	Fraction of Study Area (%)	Percent Impervious Area (%)
Commercial	117.8	4.6%	80% ¹
Low Density Residential	850.1	33.5%	35% ¹
Low Density Residential (Urban Reserve)	132.6	5.2%	35% ¹
Low Density Residential Existing	64.3	2.5%	45% ²
Medium Density Residential	311.7	12.3%	65% ¹
Open Space	412.9	16.3%	0%
ROW	279.9	11.0%	40% ³
Rural Residential	362.1	14.4%	12% ³
Total	2,531.4	100.0%	

¹Based on direction from the City of Bismarck

²Based on 2013 aerial photograph.

³Based on TR-55 guidance

Table 2-4: Summary of Future Land Use in Overall Study Area

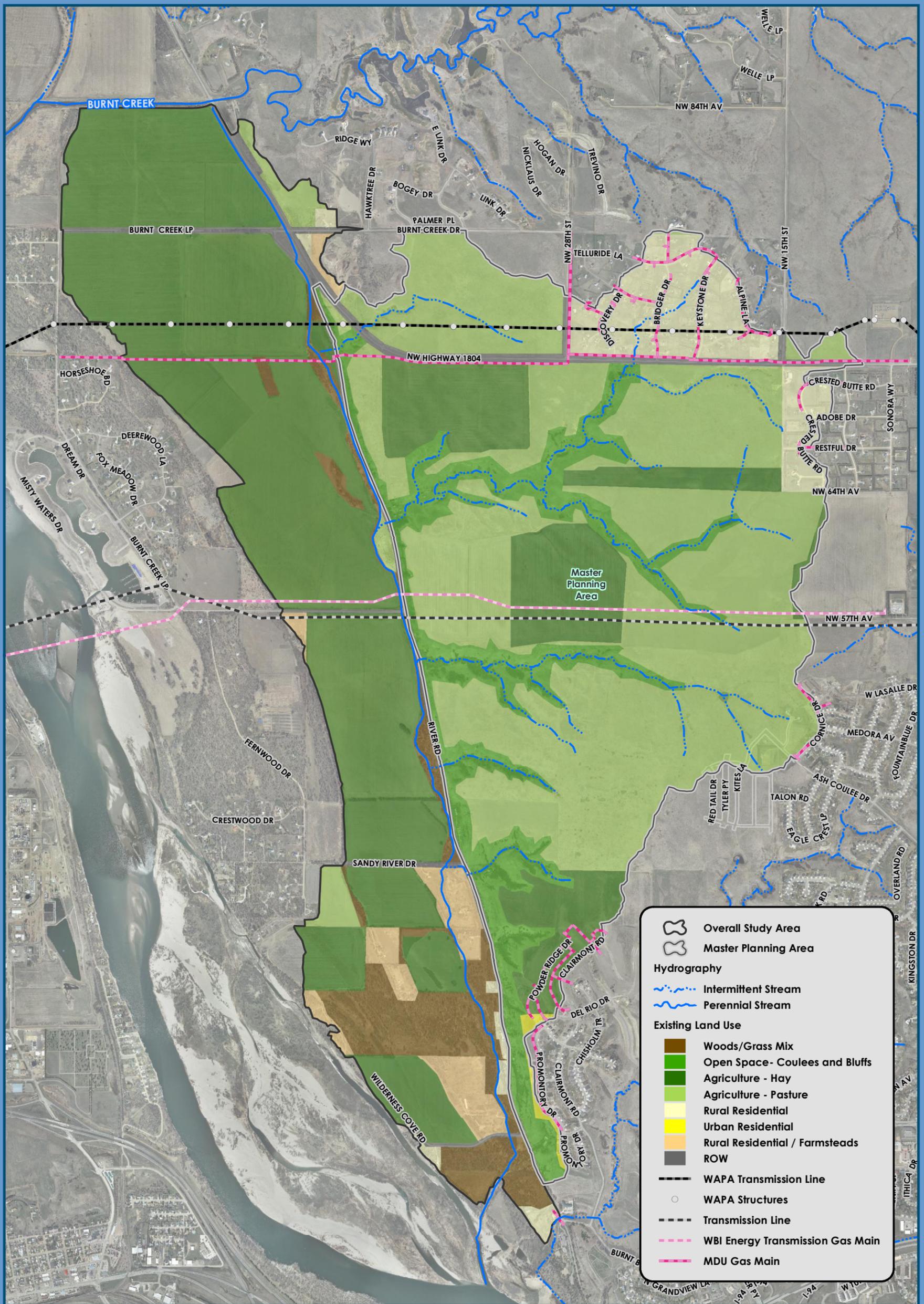
Land Use Type	Area (acres)*	Fraction of Study Area (%)	Percent Impervious Area (%)
Agriculture - Hay	1,257.3	15.9%	0% ³
Agriculture - Pasture	50.2	55.2%	0% ³
Commercial	117.8	4.6%	80% ¹
Low Density (Lots > 5 ac)	112.1	2.6%	5% ²
Low Density Residential	850.1	33.5%	35% ¹
Low Density Residential (Urban Reserve)	132.6	5.2%	35% ¹
Low Density Residential Existing	64.3	2.5%	45% ²
Medium Density Residential	311.7	12.3%	65% ¹
Open Space	412.9	16.3%	0%
ROW	357.6	11.0%	40% ³
Rural Residential	390.9	14.4%	12% ³
Woods Grass Mix	238.8	5.6%	0% ³
Total	4,296.3⁴	100.0%	

¹Based on direction from the City of Bismarck

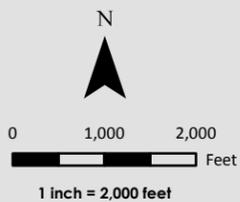
²Based on 2013 aerial photograph.

³Based on TR-55 guidance

⁴Within less than 1% of existing total area



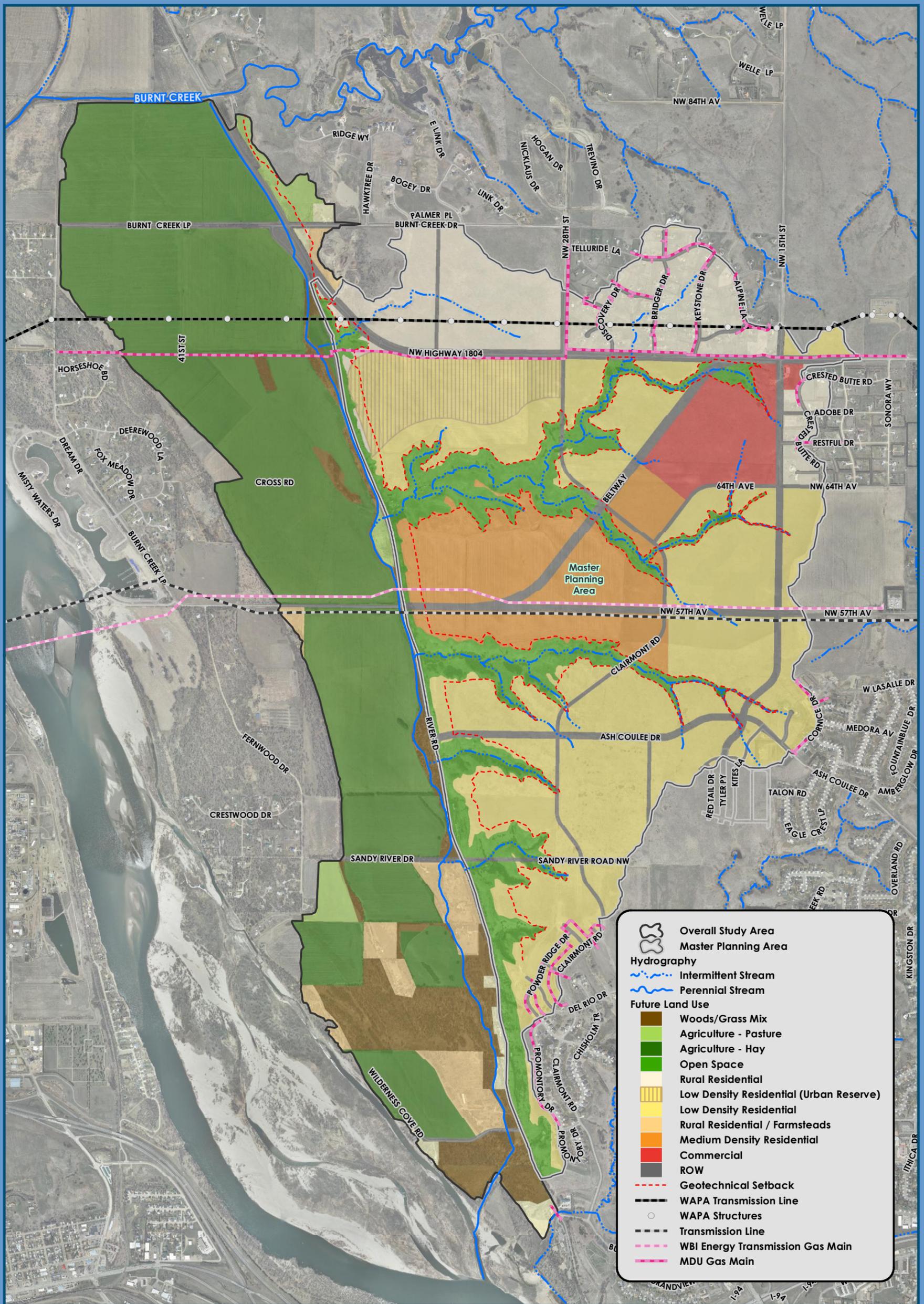
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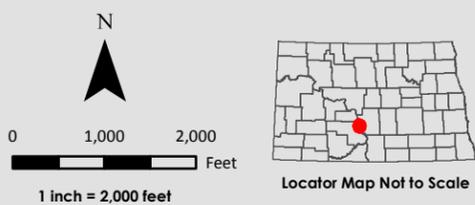
**Figure 2-1:
Existing Land Use**

**City of Bismarck
Ash and Ward Coulee Stormwater Master Plan**





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**Figure 2-2:
Future Land Use**

**City of Bismarck
Ash and Ward Coulee Stormwater Master Plan**



3.0 GEOTECHNICAL CONSIDERATIONS

As noted in Section 1.2.2, addressing the concerns of overall geotechnical stability and coulee scour are two of the secondary goals for the Master Plan. Addressing the potential for increased erosion within the coulees is directly related to stormwater runoff and drainage. However, looking at geotechnical stability is not traditionally included with watershed stormwater master plans. In this case, due to the potential impacts on land use and likelihood that stormwater facilities would be located within geotechnically sensitive areas, the City determined that incorporating a preliminary geotechnical setback analysis into the watershed stormwater master plan was appropriate.

3.1 Geotechnical Setback

Braun Intertec Corporation (Braun) was retained to perform a geotechnical evaluation of the watershed based on generally available data. The intent of the analysis was to identify those areas within the watershed that were potentially susceptible to geotechnical instability. Based upon the analysis performed by Braun and a review of available topographic information, a preliminary geotechnical setback line was developed and was determined to be either the top of slope or the calculated setback line using the following parameters in *Table 3-1*, whichever was more conservative.

Table 3-1: Preliminary Geotechnical Setback Parameters

Slope Height ¹	Setback Distance Gradient Projected From Toe of Slope
<50 Feet	3H:1V
50 Feet ≤ X < 80 Feet	3.5H:1V
80 Feet ≤ X < 120 Feet	4H:1V
≥ 120 Feet	4.5H:1V

¹Slope Height was calculated as the elevation difference between the toe of slope and the top of slope. Toes of slope and top of slope were interpreted based on the available topographic information. In general, the top of slope was always interpreted upslope of areas steeper than 22% (4.5H:1V) and typically was located in areas with slopes between 12%-22%

It is the recommendation of Braun that future development within the footprint of the geotechnical setback line should not be planned unless a detailed, site-specific geotechnical analysis has been conducted. The full Braun report, along with figures showing the preliminary setback line, are included in *Appendix A*.

3.2 Coulee Stability

3.2.1 Background and Data Collection

Based on limited site observations in rural areas within the Master Plan study area, it does not appear that there are significant erosion issues along the coulee valleys as surface vegetation is present or the channel bottoms have self-armored. However, as development occurs within the coulees, an increase in the frequency, duration, and magnitude of flows directed to the coulee valleys will have a higher potential to erode the surface vegetation. Once that vegetation is lost, significant erosion and stability issues can occur in coulees as evidenced in Coulee 6, where development has already started.

Because of this concern, the Master Plan included collecting surficial soil samples at several locations within the coulees, as shown in Appendix C of Geotechnical Evaluation Report (*Appendix A*). The soil samples indicate that the coulee valley soils are typically silty clay loam, silt loam, or loam soils, which are typically fairly erodible soils – reinforcing the need to maintain a stable surface cover above the underlying soils.

3.2.2 Coulee Stability BMP Toolbox

While there are numerous approaches to surface armoring, there are typically different classes of armoring depending on the shear stress and velocity that will occur. The Coulee Stability BMP Toolbox (*Appendix C*) includes several examples and general application guidelines for surface stabilization and armoring approaches such as unreinforced vegetation, reinforced vegetation, riprap, articulated concrete block, grade control devices, and storm sewers.

This toolbox has been developed to assist professionals working in the City of Bismarck in the selection of surface stabilization measures and represents a number of common components for inclusion in site designs. This information is not intended as a substitute for detailed site investigation, design and installation, nor is it meant to exclude other approaches that may be incorporated. Appropriate practices should be individually designed and selected by a professional after a thorough site investigation and analysis has been performed.

4.0 ALTERNATIVE DEVELOPMENT

4.1 Methodology

The hydrology and hydraulics of the study area were modeled using InfoSWMM, which is a proprietary GIS-integrated version of the EPA SWMM model that is widely accepted for use in stormwater modeling. A detailed discussion of the model development, assumptions, and analysis is included in *Appendix E*.

4.2 Detention Approach

The City of Bismarck prefers to utilize regional City-owned and maintained stormwater management facilities versus administering oversight on numerous privately-owned detention basins. This approach has several advantages, one of which is flood peaks are controlled at key locations within a watershed, whereas providing peak rate control on a site-by-site basis does not necessarily ensure that flood peaks within a larger drainage system are not increased. Implementing regional facilities is a much more reliable approach to maintaining peak flow rates at key locations within a larger drainage system. Therefore, this study sets the main compliance points at the downstream end of each of the coulees, at the crossing of River Road. The study also outlines considerations for potential impacts on existing infrastructure within the study area along with approaches to reducing those impacts by reducing flow rates and/or increasing conveyance capacity.

4.3 Alternative Development

The following two preliminary alternatives were developed for City consideration that would meet the numerous performance criteria outlined in *Section 1.3*:

1. Peak flow reduction and water quality treatment utilizing regional detention facilities. Regional detention is provided by valley storage in each of the separate coulees, which reduce peak discharges to pre-development rates as well as provide water quality treatment to meet the City's MS4 permit criteria. On-site detention is required in areas that cannot feasibly drain to a regional detention facility, such as those areas that drain directly to the Missouri River bluffs. All flow would be routed through the existing culverts under River Road to Lower Burnt Creek as it currently flows now.
2. Provide stormwater management similar to the approach described above; however, on-site detention is required to detain up to the 5-Year event and provide water quality treatment meeting the City's MS4 criteria. By providing on-site water quality treatment, the regional detention facilities have a less restrictive outlet structure, and consequently less regional storage volume is required. Larger storm events pass through the on-site detention with minimal attenuation and are detained in the regional detention facilities such that overall pre-post discharge control up to the 100-year event is provided at the coulee outlets.

After reviewing the various concepts presented and weighing the feasibility of implementation, cost considerations, and overall benefit, the City Work Group ultimately selected the first approach as the Master Plan described in *Section 6*, primarily due to the difference in improvements required within the Lower Burnt Creek corridor to mitigate for the impacts of

development within the Ash & Ward Coulee watershed. The master plan alternative (second approach) is described in *Appendix D*.

5.0 EXISTING CONDITIONS

As described previously, the existing land use for the study area is primarily agricultural with a small amount of rural residential north of ND1804. Overall drainage for the study area is from east to west in the coulees, and runoff from the study area ultimately flows under River Road into Lower Burnt Creek prior to discharging into the Missouri River (*Figure 5-1*). The hydraulics of the study area, including Lower Burnt Creek, were simulated to reflect existing conditions as closely as possible.

The Ashwood subdivision located north of ND 1804, west of 15th Street NW, and east of 28th Street is the only existing development with a stormwater management detention feature installed, which consists of a dry basin upstream (north) of ND 1804. In addition to this stormwater management facility, storage that is created by roadway embankments (such as northeast of ND 1804 in Coulee 1) was also included in the analysis because understanding the flow reduction that these “natural” detention areas provide is important to understanding the potential impacts of filling these areas.

5.1 Peak Flows

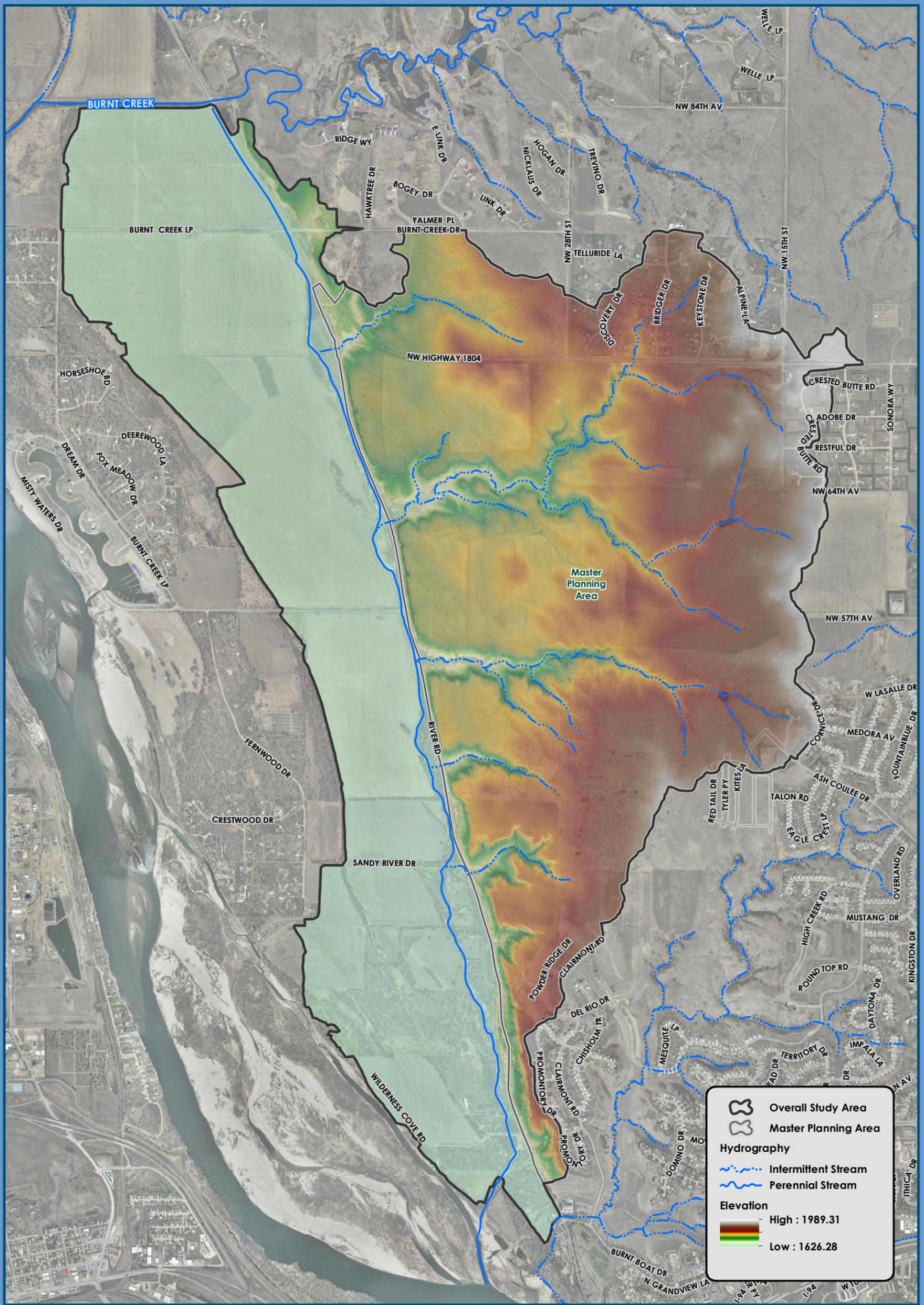
Table 5-1 summarizes the existing peak flows at the main compliance points. The relatively large peak flows in Coulees 2 and 3 for the larger storm events are primarily a result of the relatively steep nature of the watersheds, which reduces the amount of time it takes for the entire watershed to be contributing to the runoff and correspondingly increases the peak discharge. However, the duration of a flood in the coulees is quite short versus a larger watershed that may have similar or lower peak discharges but the duration (and volume) would be greater.

Table 5-1: Summary of Existing Peak Flows (cfs) at Coulee Compliance Points

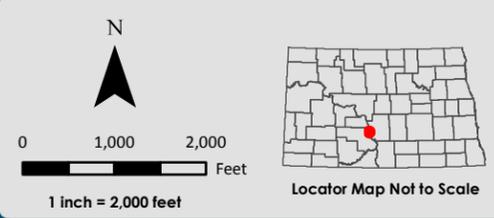
Coulee	6-Hour			
	2-yr	10-yr	25-yr	100-yr
Coulee 1	17	63	110	242
Coulee 2	92	513	1,022	2,135
Coulee 3	27	217	508	1,280
Coulee 4	11	57	119	259
Coulee 5	16	72	179	382
Coulee 6	11	49	105	215

Figure 5-2 illustrates the peak flows (6-hour duration) for the 2-, 10-, 25-, and 100-year events at all the collector and arterial crossings where land use changes upstream are expected.

Peak 25- and 100-year flows for the 24-hour storm duration are shown in *Figure 5-3* at all NDDOT crossings.



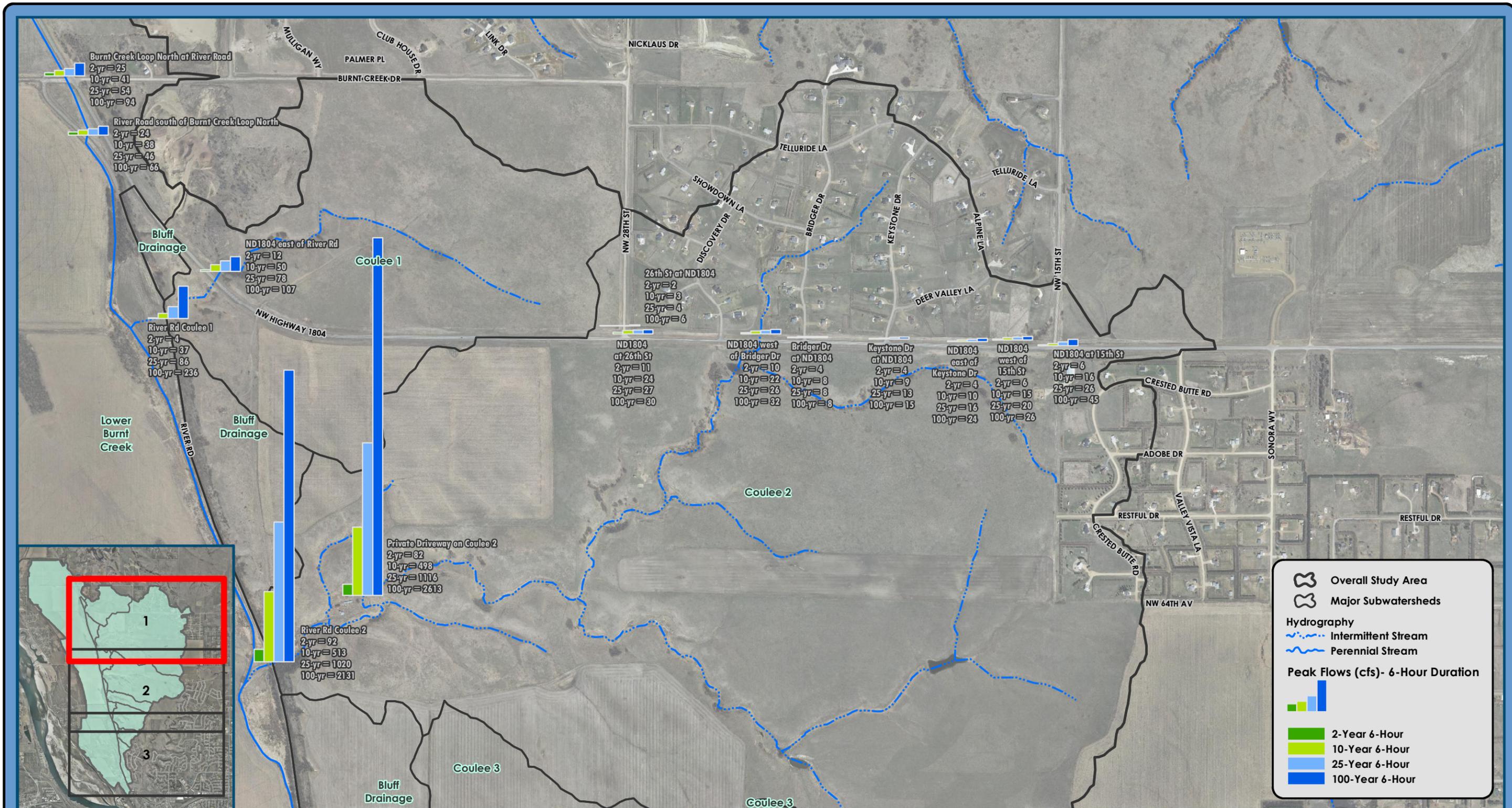
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**Figure 5-1:
Existing Drainage**

City of Bismarck
Ash and Ward Coulee Stormwater Master Plan

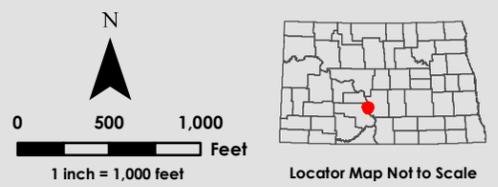


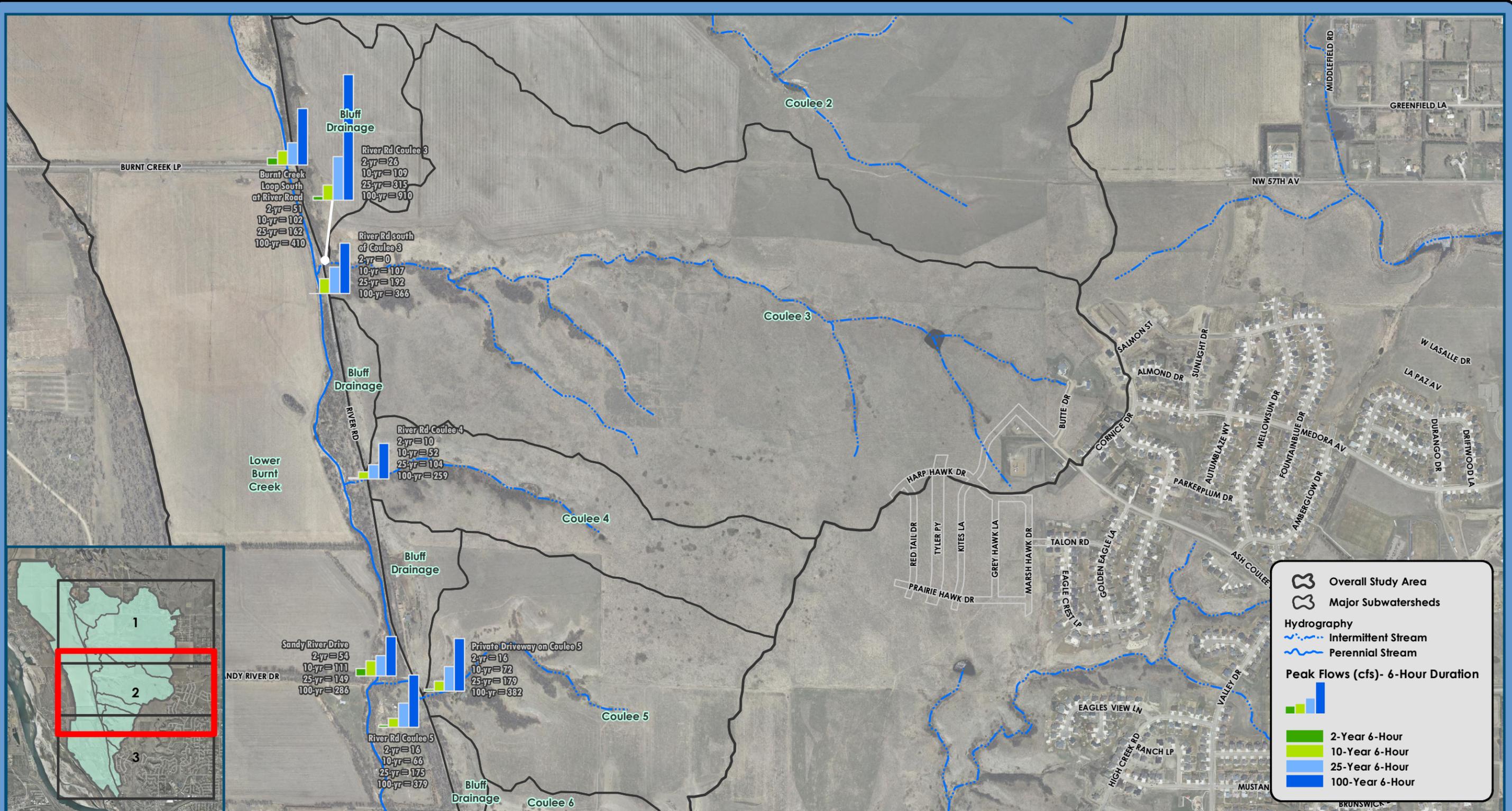


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Figure 5-2: Page 1 of 3
 Existing Peak Flows at Key Crossings

City of Bismarck
 Ash and Ward Coulee Stormwater Master Plan

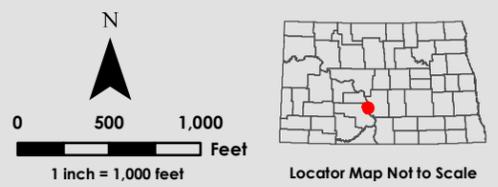


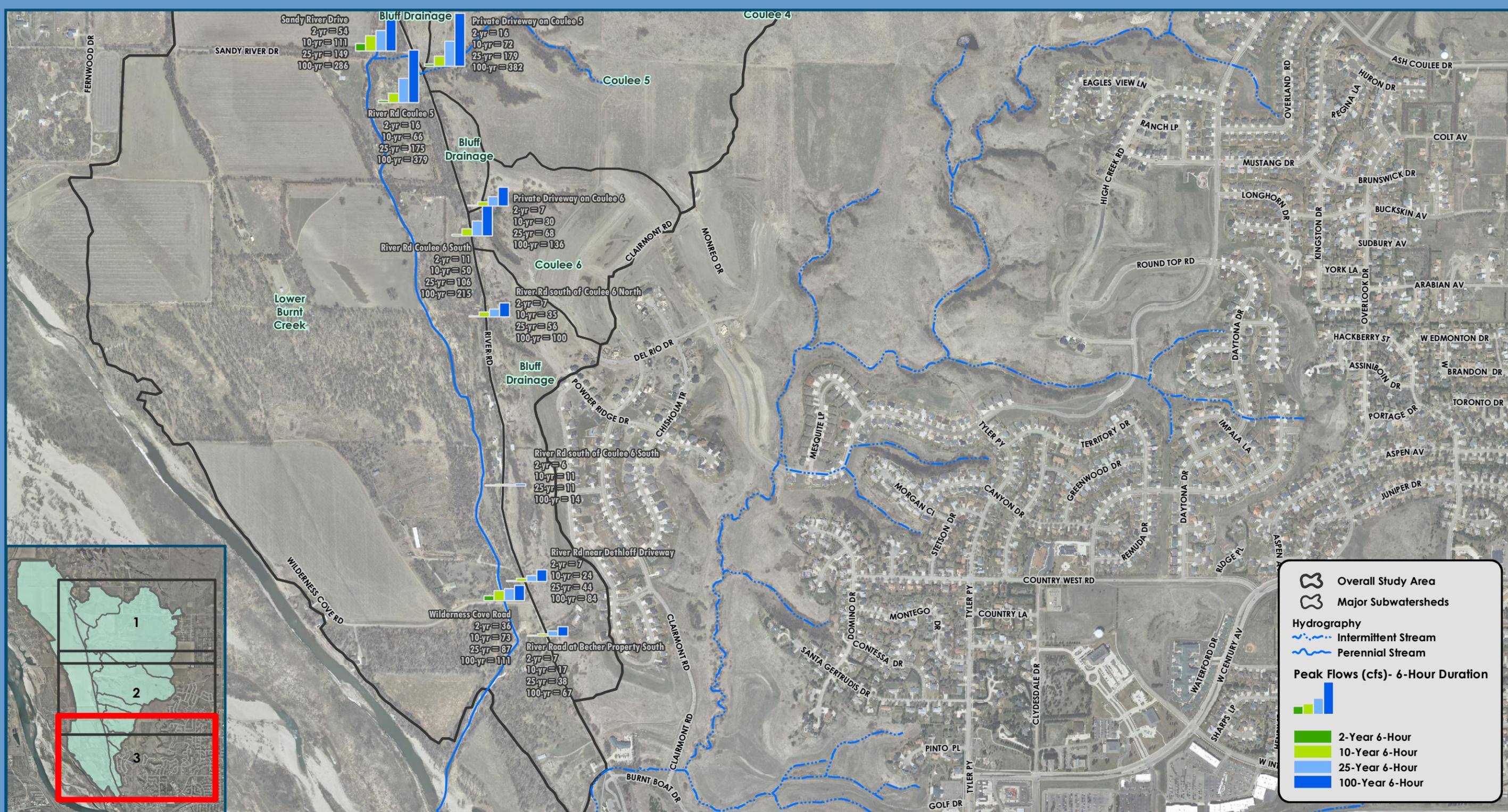


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Figure 5-2: Page 2 of 3
Existing Peak Flows at Key Crossings

City of Bismarck
Ash and Ward Coulee Stormwater Master Plan





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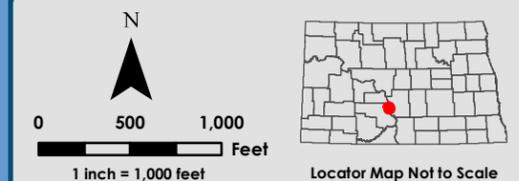
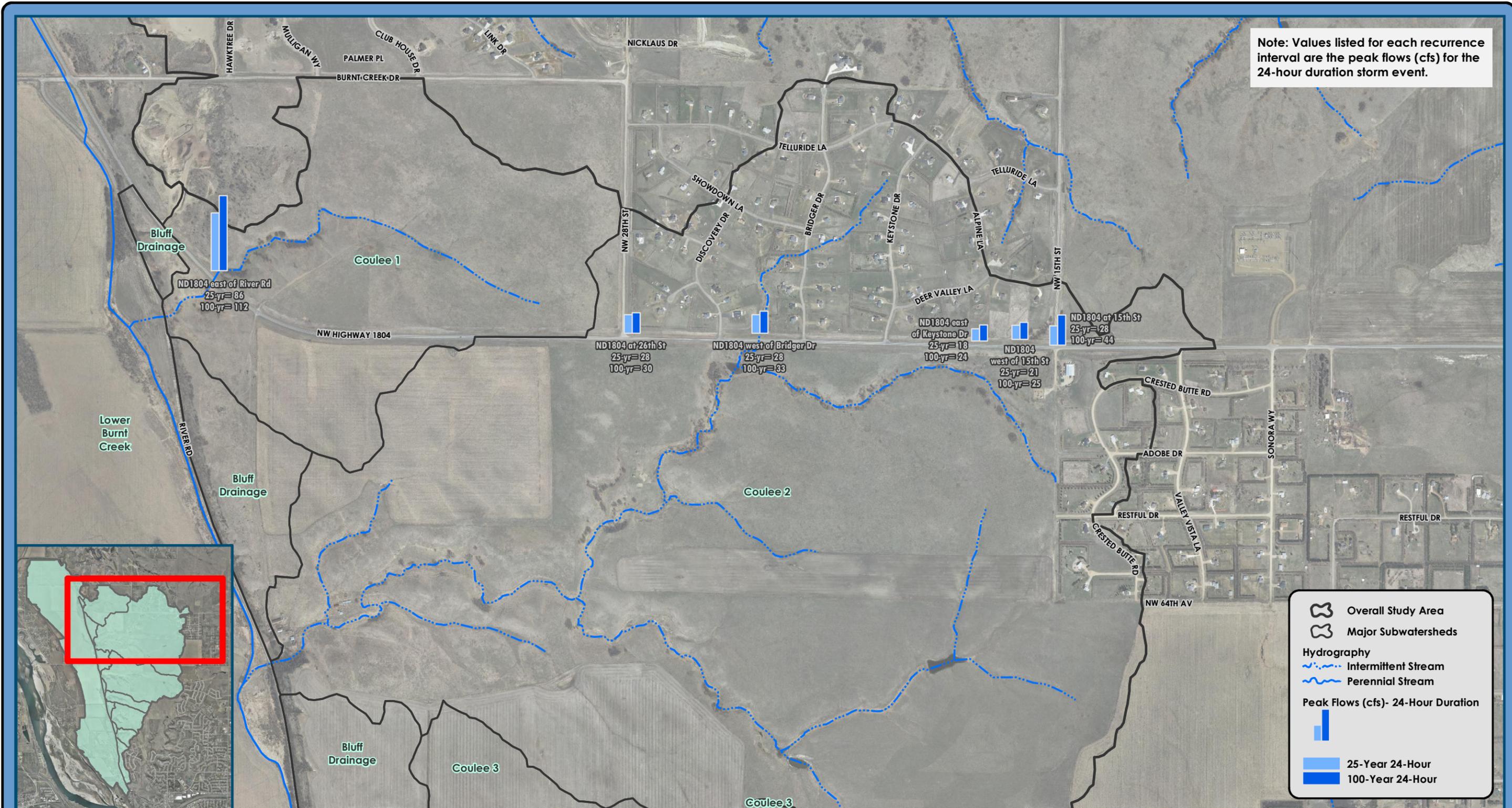


Figure 5-2: Page 3 of 3
 Existing Peak Flows at Key Crossings

City of Bismarck
 Ash and Ward Coulee Stormwater Master Plan

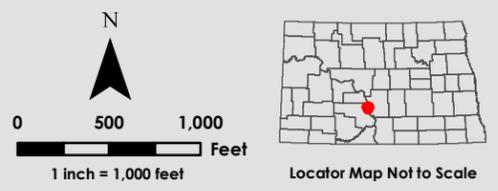




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Figure 5-3:
Existing Peak Flows at NDDOT Crossings

City of Bismarck
Ash and Ward Coulee Stormwater Master Plan



5.2 Road Level of Service

Table 5-2 and *Figure 5-4* display the overtopping frequency of select roadway and driveways on main conveyance routes relative to the required level of service outlined in *Section 1.3.3*. Peak 6-hour, 25- and 100-year stages along with the freeboard of the 100-year peak stage in relation to the overflow elevation (typically crown) are displayed in *Figure 5-5* for all collector street crossings. Since the NDDOT requires evaluation of crossings based on the 24-hour duration, *Figure 5-6* illustrates the peak stages for the 24-hour, 25- and 100-year events, 100-year freeboard, and 25-year outlet velocity.

These figures illustrate the following observations:

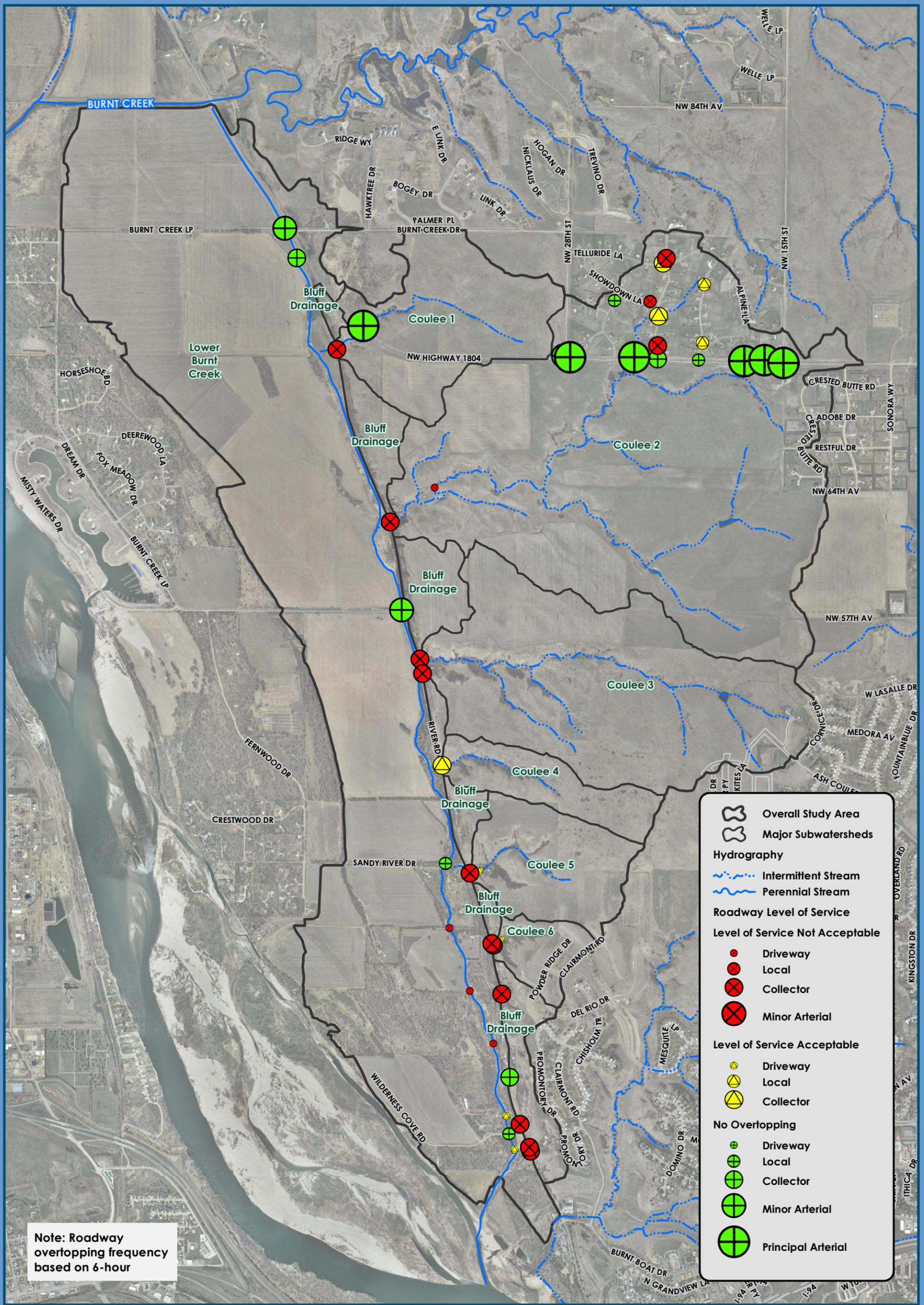
- The culverts under ND 1804 adequately convey the 100 year storm event.
- The majority of the culvert crossings under River Road on the downstream end of the Ash & Ward Coulee Watershed do not meet the level of service under existing conditions (overtopping in the 25 year event).
- Several existing rural residential driveways along River Road also overtop frequently (2- to 10-year event).

Table 5-2: Summary of Existing Roadway Overtopping Conditions at Road Crossings, 6-hr Duration Storm

Road Crossing	Road Overtops			
	2-vr	10-vr	25-vr	100-vr
ND1804 at 15th St				
ND1804 at 26th St				
ND1804 East of Keystone Dr				
ND1804 West of Bridger Dr				
ND1804 East of River Rd				
ND1804 West of 15th St				
26th St at ND1804				
Bridger Dr at ND1804				
<i>Bridger Dr North of ND1804</i>			✓	✓
<i>Bridger Dr North of Telluride Ln</i>		✓	✓	✓
Bridger Dr South of Showdown Ln				✓
<i>Private Driveway on Coulee 2</i>	✓	✓	✓	✓
Private Driveway on Coulee 5		✓	✓	✓
Private Driveway on Coulee 6			✓	✓
Deer Valley Lane at Keystone Dr				✓
Discovery Drive near Showdown Ln				
Keystone Dr at ND1804				
Keystone Dr South of Telluride Ln				✓
<i>River Rd Coulee 1</i>		✓	✓	✓
<i>River Rd Coulee 2</i>		✓	✓	✓
<i>River Rd South of Coulee 3</i>		✓	✓	✓
<i>River Rd Coulee 3</i>		✓	✓	✓
River Rd Coulee 4				✓
<i>River Rd Coulee 5</i>			✓	✓
<i>River Rd South of Coulee 6 North</i>		✓	✓	✓
River Rd South of Coulee 6 South				
<i>River Rd near Dethloff Driveway</i>	✓	✓	✓	✓
<i>River Rd Coulee 6</i>		✓	✓	✓
<i>River Rd Coulee 6 South side of Driveway</i>		✓	✓	✓
<i>River Road at Becher Property South</i>		□	✓	✓
<i>River Road at Becher Property North</i>		✓	✓	✓
<i>Showdown Lane near Bridger Drive</i>		✓	✓	✓
Telluride Ln SE of Bridger Dr				✓
Lower Burnt Creek				
<i>Beck's Driveway</i>	✓	✓	✓	✓
Burnt Creek Loop North at River Road				
Burnt Creek Loop South at River Road				
Dethloff's Driveway				✓
<i>Farm Road</i>	✓	✓	✓	✓
Crossing South of Wilderness Cove Rd			✓	✓
<i>Crossing South of Farm Road</i>	✓	✓	✓	✓
River Road South of Burnt Creek Loop North				
Sandy River Drive				
Wilderness Cove Road				

✓Denotes overtopping condition.

Road crossings in ***bold italics*** indicate road crossings that do not meet level of service criteria.



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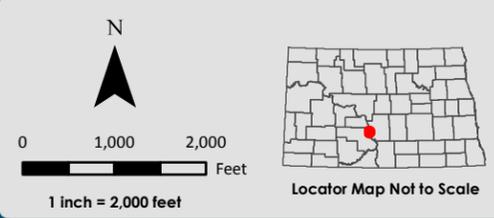
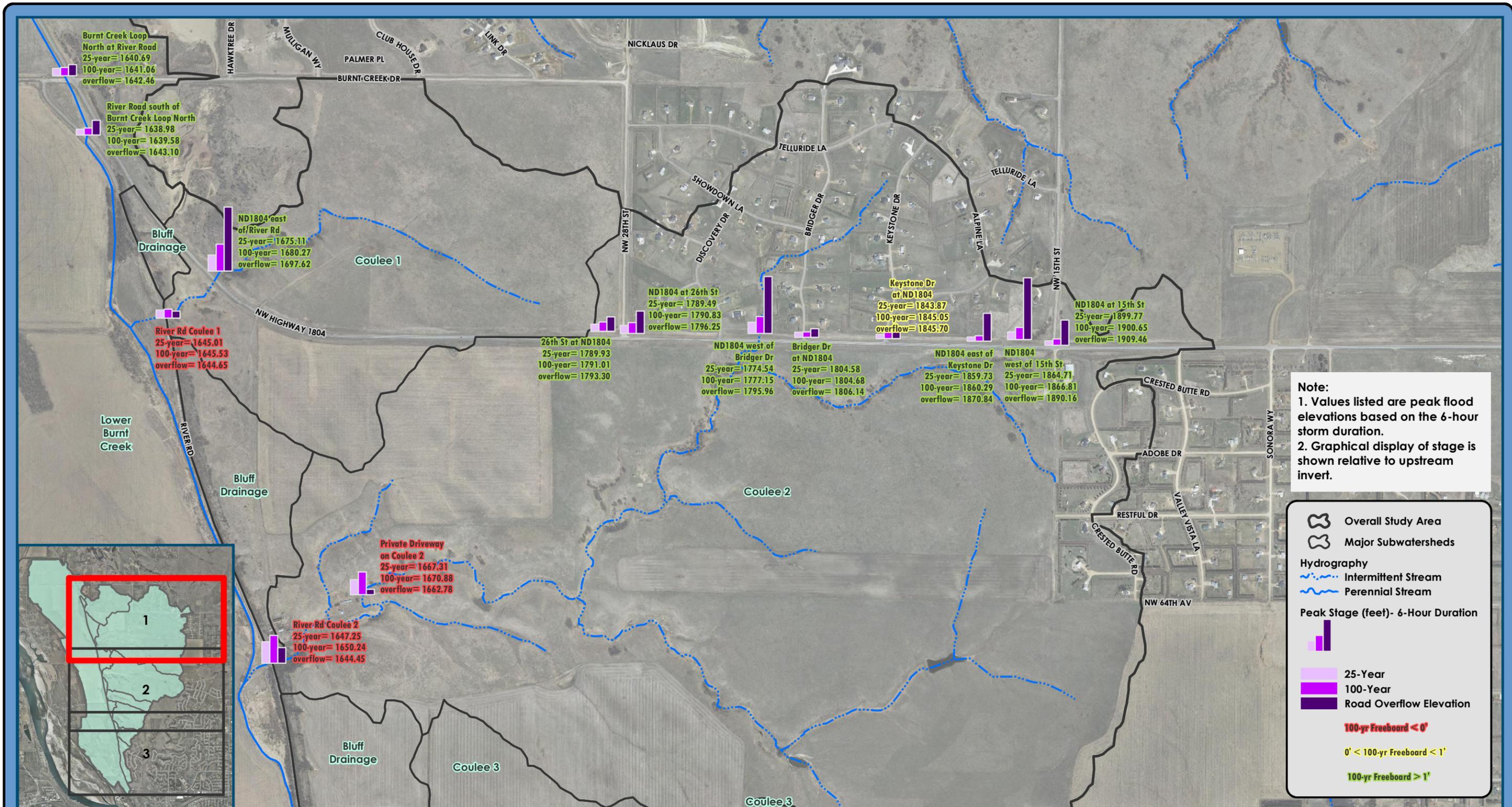


Figure 5-4:
Existing Roadway Level of Service
City of Bismarck
Ash and Ward Coulee Stormwater Master Plan





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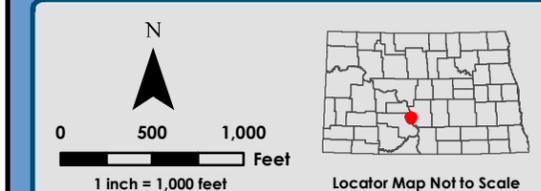
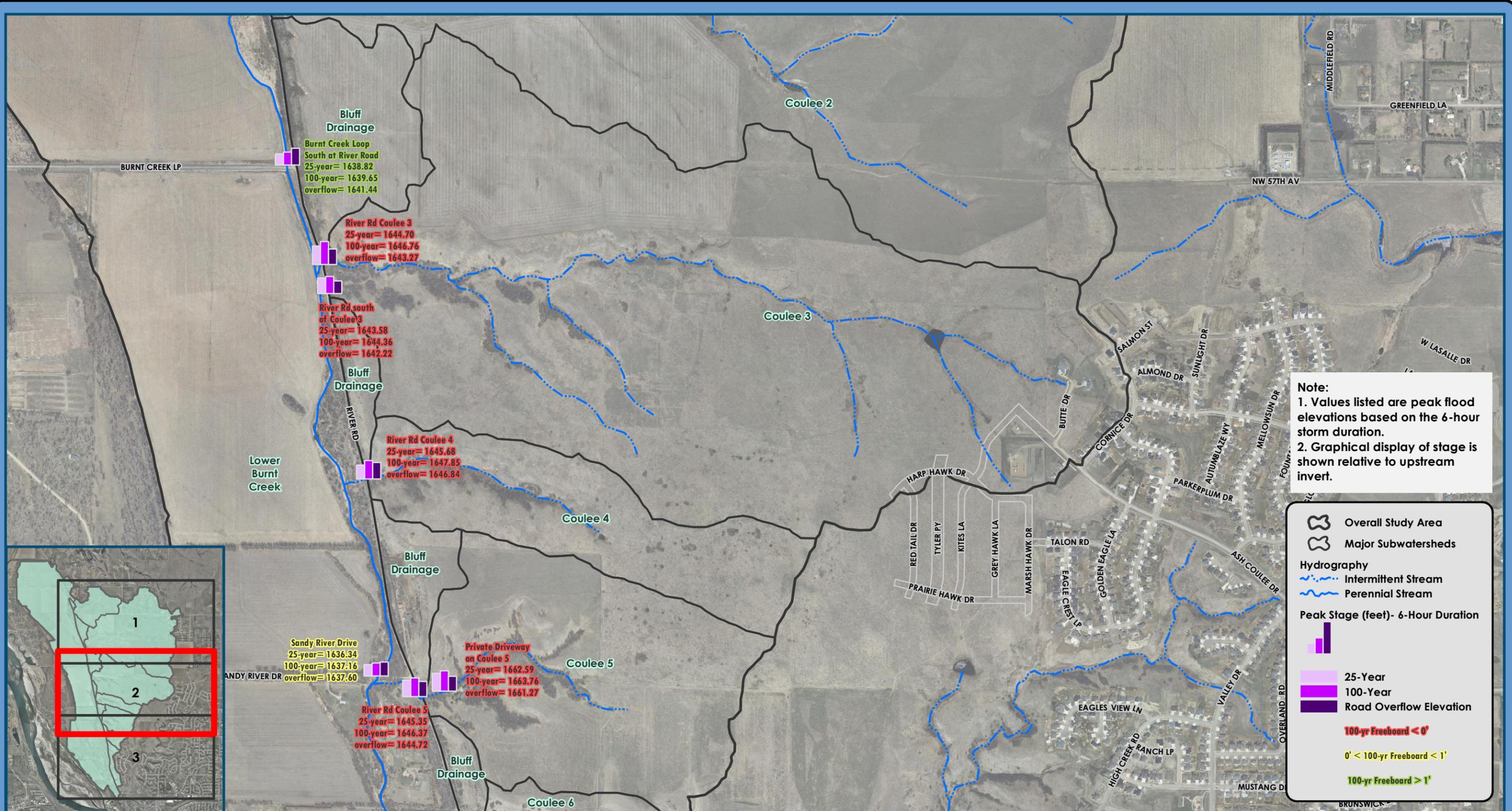


Figure 5-5: Page 1 of 3
 Existing Peak Stages at Key Crossings

City of Bismarck
 Ash and Ward Coulee Stormwater Master Plan

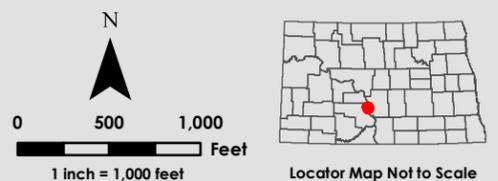


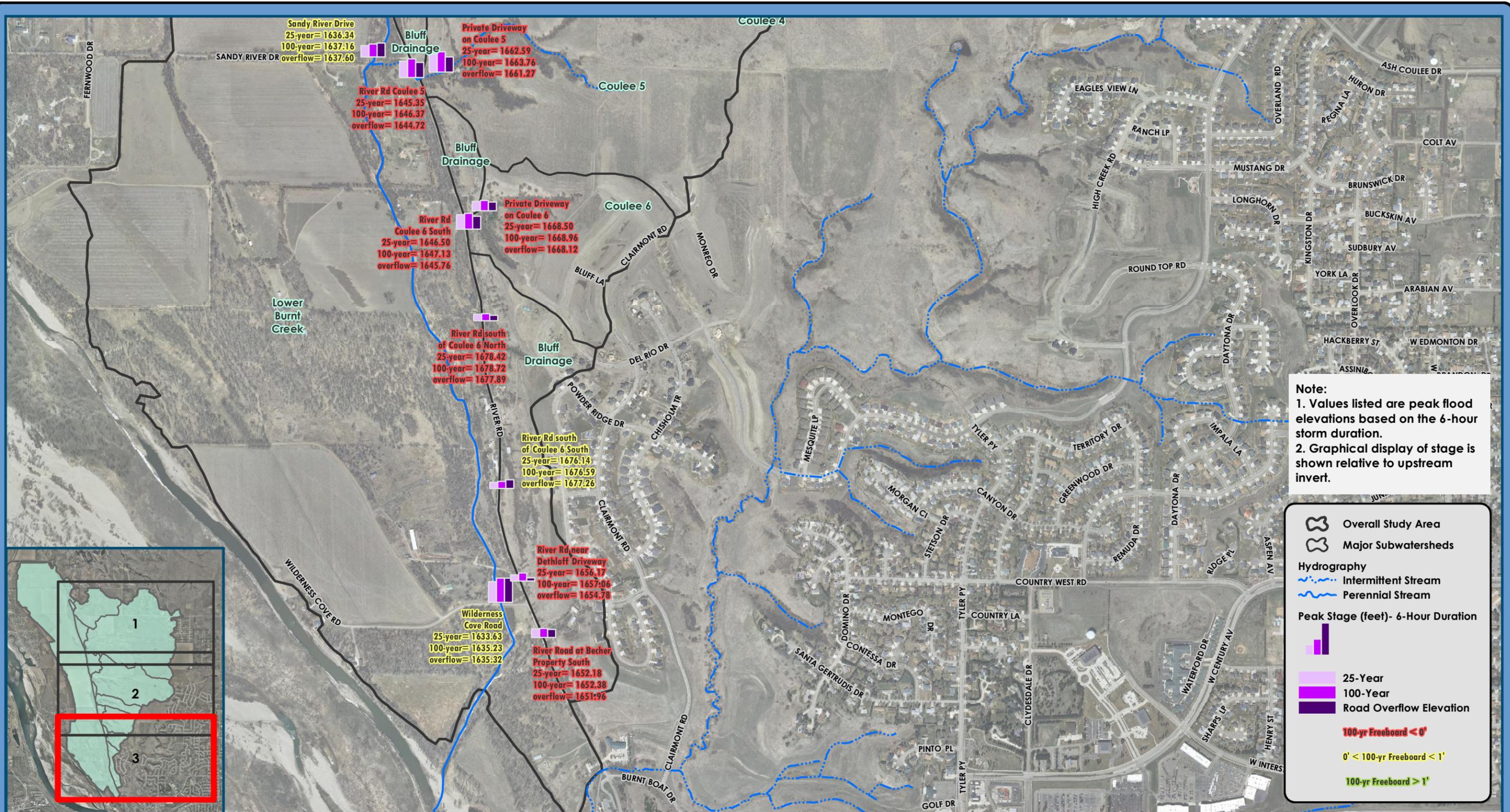


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Figure 5-5: Page 2 of 3
 Existing Peak Stages at Key Crossings

City of Bismarck
 Ash and Ward Coulee Stormwater Master Plan

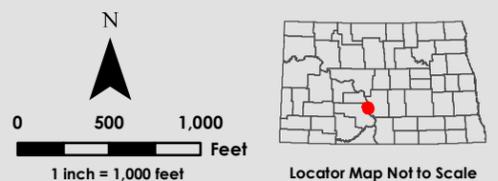


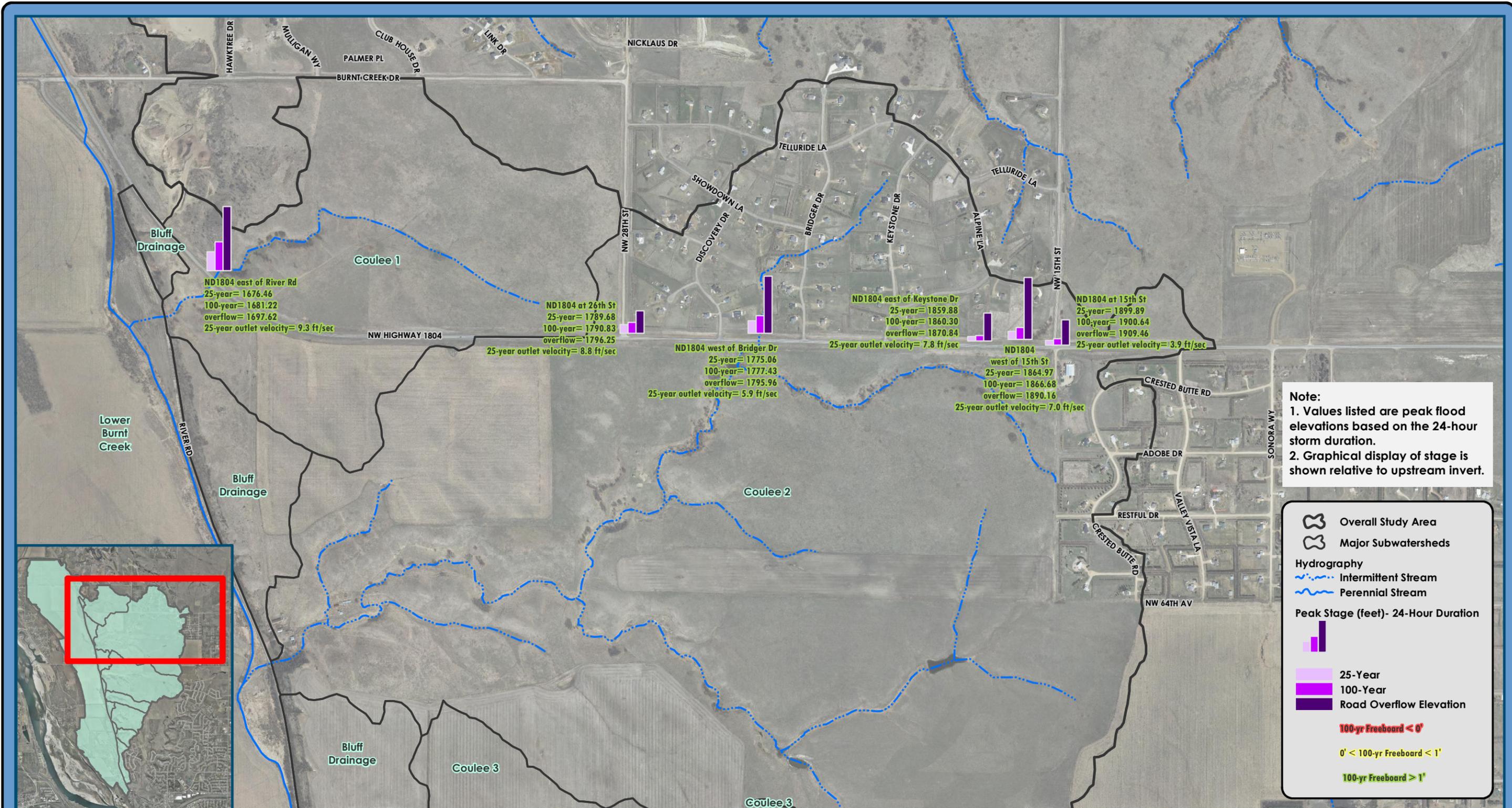


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Figure 5-5: Page 3 of 3
 Existing Peak Stages at Key Crossings

City of Bismarck
 Ash and Ward Coulee Stormwater Master Plan





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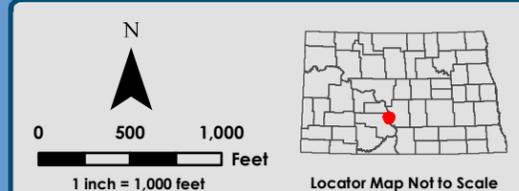


Figure 5-6:
Existing Peak Stages at NDDOT Crossings
 City of Bismarck
 Ash and Ward Coulee Stormwater Master Plan



5.3 Coulee Stability

Figures 5-7 and 5-8 display the relative stability of the existing coulees under existing runoff conditions for the noted classes of protection. As shown, the vast majority of the coulees is stable for the 2-year event, but would need some level of reinforcement to be stable in the 25-year event .

A few locations, most notably Coulee 6 which is already experiencing development, would require some level of additional reinforcement for events as minor as the 2-year event. This conclusion is also supported by recent field observations of sediment washing over River Road at the Coulee 6 outlet during moderate to heavy rainfall events.



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**Figure 5-7:
Existing – Coulee Shear Stress (2-Year)**

**City of Bismarck
Ash and Ward Coulee Stormwater Master Plan**



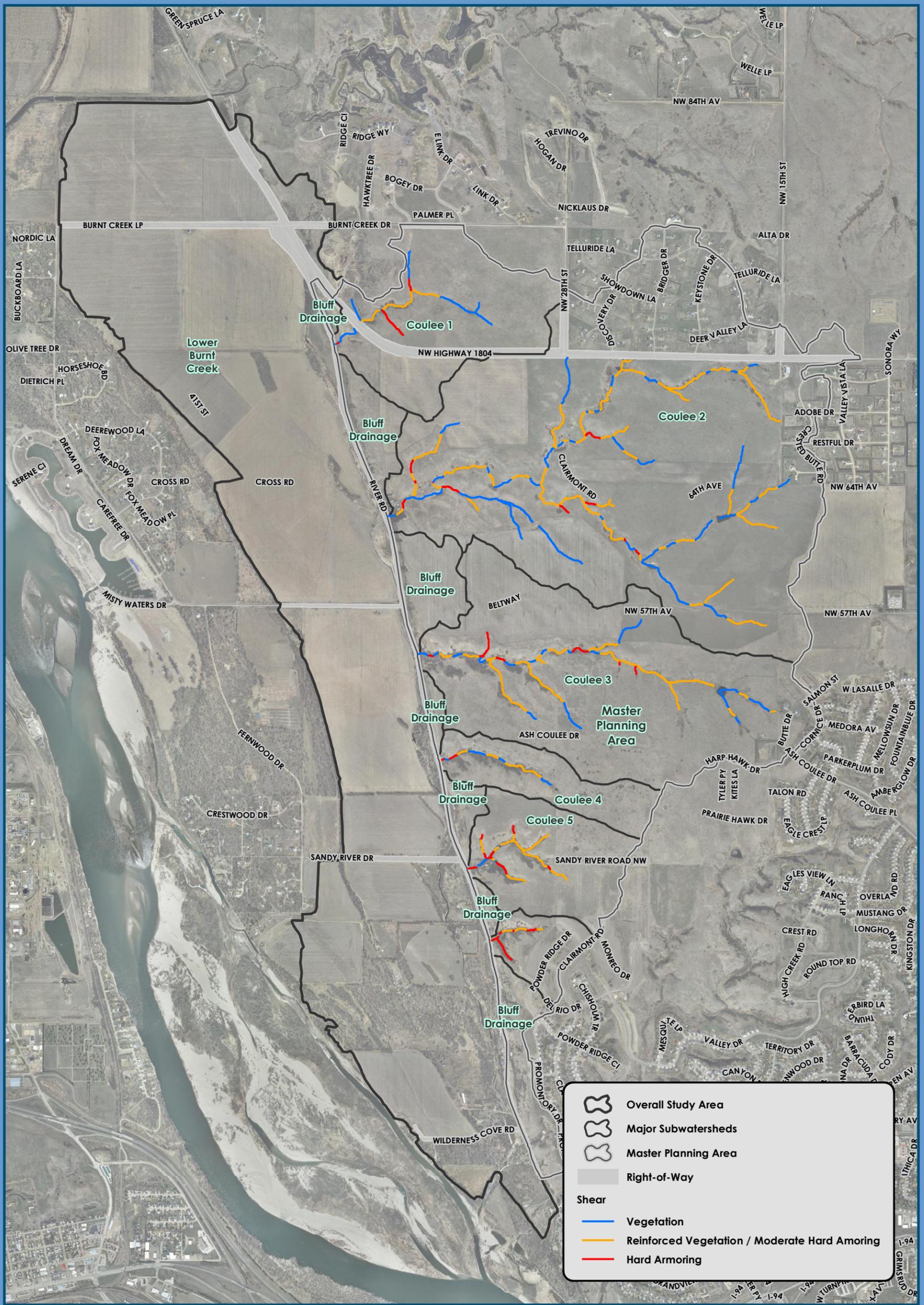




 1 inch = 2,000 feet



 Locator Map Not to Scale



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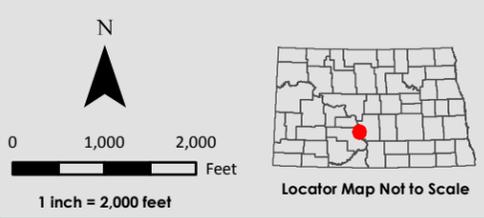


Figure 5-8:
Existing - Coulee Shear Stress (25-Year)
City of Bismarck
Ash and Ward Coulee Stormwater Master Plan



5.4 Lower Burnt Creek

A field investigation was conducted to assess the location, size, and condition of the culverts on Lower Burnt Creek. Survey data for culverts and the Lower Burnt Creek channel is shown in *Appendix B*.

The field investigation indicated that several culverts were washed out, partially crushed, or blocked with debris / sediment. The analysis for Lower Burnt Creek was based on the culverts being in the current condition (rather than newly installed) to most accurately reflect the conditions as they exist when this master planning effort commenced. The details of assumptions for damaged culvert crossings are summarized in *Appendix F*, which was agreed upon with the Burleigh County Water Resource District.

Water levels in Lower Burnt Creek are also subject to backwater effects on the Missouri River. The details for tailwater condition assumptions for Lower Burnt Creek are also included in *Appendix F*, which was agreed upon with the Burleigh County Water Resource District.

5.4.1 Overtopping Frequency at Crossings

Overtopping frequency for culverts / road crossings on Lower Burnt Creek is shown as the gray colored entries in *Table 5-2*, shown previously, and illustrated in *Figure 5-4*. The results indicate that a few driveways overtop frequently, but the public and private roads all meet level of service criteria.

5.4.2 Flooding Depths / Extents

The 2-, 10-, 25-, and 100-year flooding extents on Lower Burnt Creek under existing conditions are shown in *Figures 5-9 through 5-12*. The figures illustrate that during modest rainfall events, flow is primarily limited to along the Lower Burnt Creek channel and near overbank. For more severe rainfall events, however, the flood inundation in the west overbank is extensive because of the flat topography west of River Road. The large inundation extents also illustrates the flood storage and routing that is provide upstream of each road crossing, which is also indicated by comparing the peak discharges from the individual coulees to the overall discharge near the downstream end of Lower Burnt Creek (*Figure 5-2*).

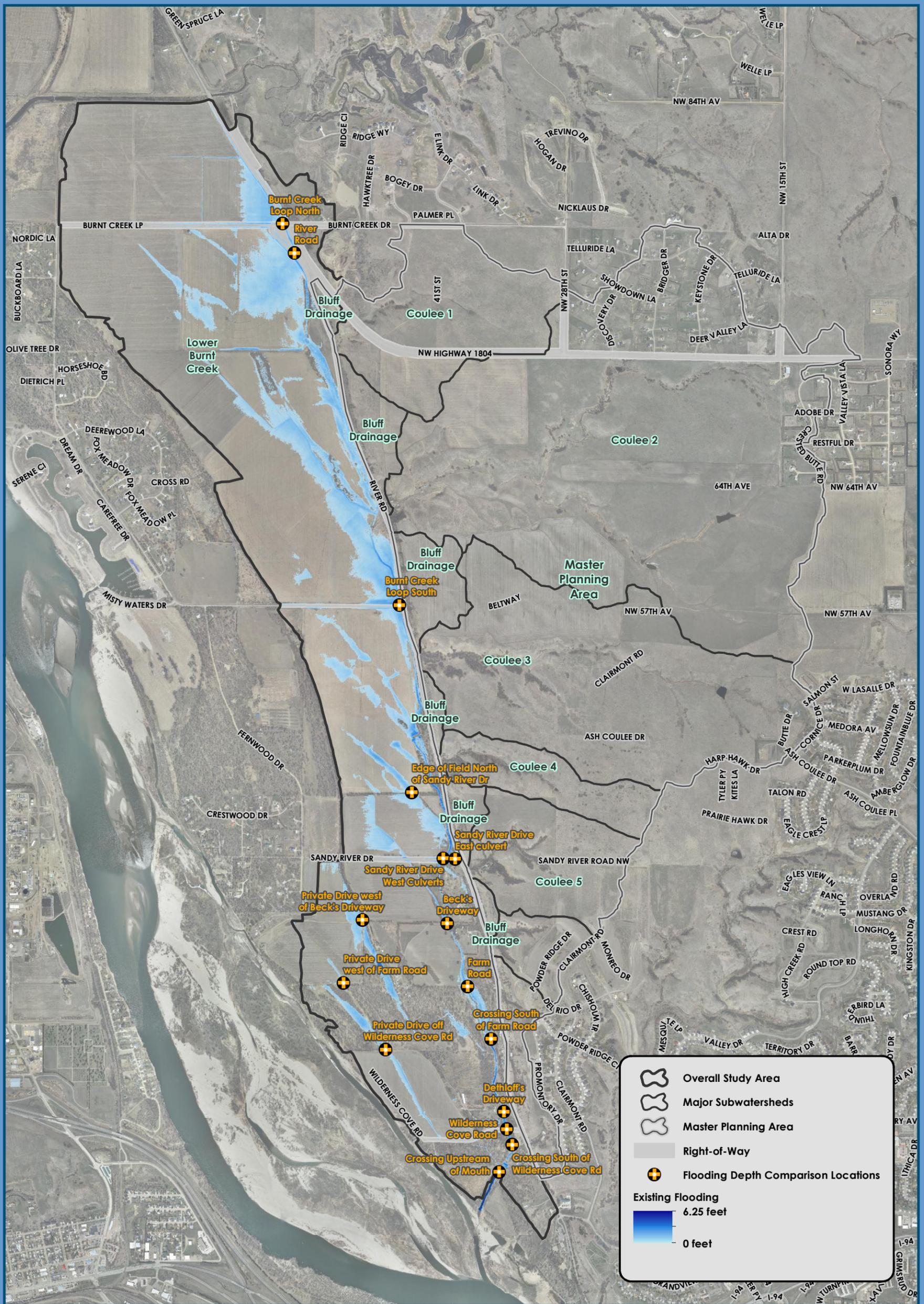
The locations where flood elevations along the Lower Burnt Creek channel and west overbank were compared between existing and future conditions are shown on *Figures 5-9 through 5-12*. *Table 5-3* summarizes the existing 2-, 10-, 25-, and 100-year event flood elevations immediately upstream of these locations.

Table 5-3: Lower Burnt Creek Existing Conditions Flood Elevations

Location	Existing Conditions Flood Elevations			
	2-Year	10-Year	25-Year	100-Year
Burnt Creek Loop North	1639.9'	1640.4'	1640.7'	1641.1'
River Road	1638.3'	1638.7'	1639'	1639.6'
Burnt Creek Loop South	1636.9'	1638.3'	1638.8'	1639.7'
Sandy River Drive West Culverts	1634.7'	1635.8'	1636.3'	1637.2'
Sandy River Drive East culvert	1634.6'	1635.8'	1636.3'	1637.1'
Beck's Driveway	1634.2'	1634.8'	1635.2'	1635.7'
Farm Road	1633.8'	1634.3'	1634.7'	1635.6'
Crossing South of Farm Road	1633.3'	1634'	1634.6'	1635.5'
Dethloff's Driveway	1631'	1633.2'	1634.4'	1635.3'
Wilderness Cove Road	1630.9'	1632.7'	1633.6'	1635.2'
Crossing South of Wilderness Cove Rd	1630.6'	1631.3'	1631.7'	1632'
Crossing Upstream of Mouth	1630.3'	1630.4'	1630.6'	1631.1'
Edge of Field North of Sandy River Dr	1636.8'	1637.1'	1637.3'	1637.5'
Private Drive west of Beck's Driveway	1633.5'	1634'	1634.3'	1635.2'
Private Drive west of Farm Road	1636.3'	1636.4'	1636.5'	1636.6'
Private Drive off Wilderness Cove Rd	1633.7'	1634.1'	1634.3'	1635.2'

*Locations shaded in green are located away from the main channel.

By comparison, Missouri River 100-year flood elevations range from approximately 1639 on the south end to 1641 on the north end, indicating that except for the area between the Burnt Creek flood bypass channel and Burnt Creek Loop, the Missouri River flood elevations are well above the 100-year flood elevations on Lower Burnt Creek that are driven by local watershed runoff.



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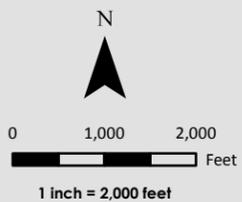
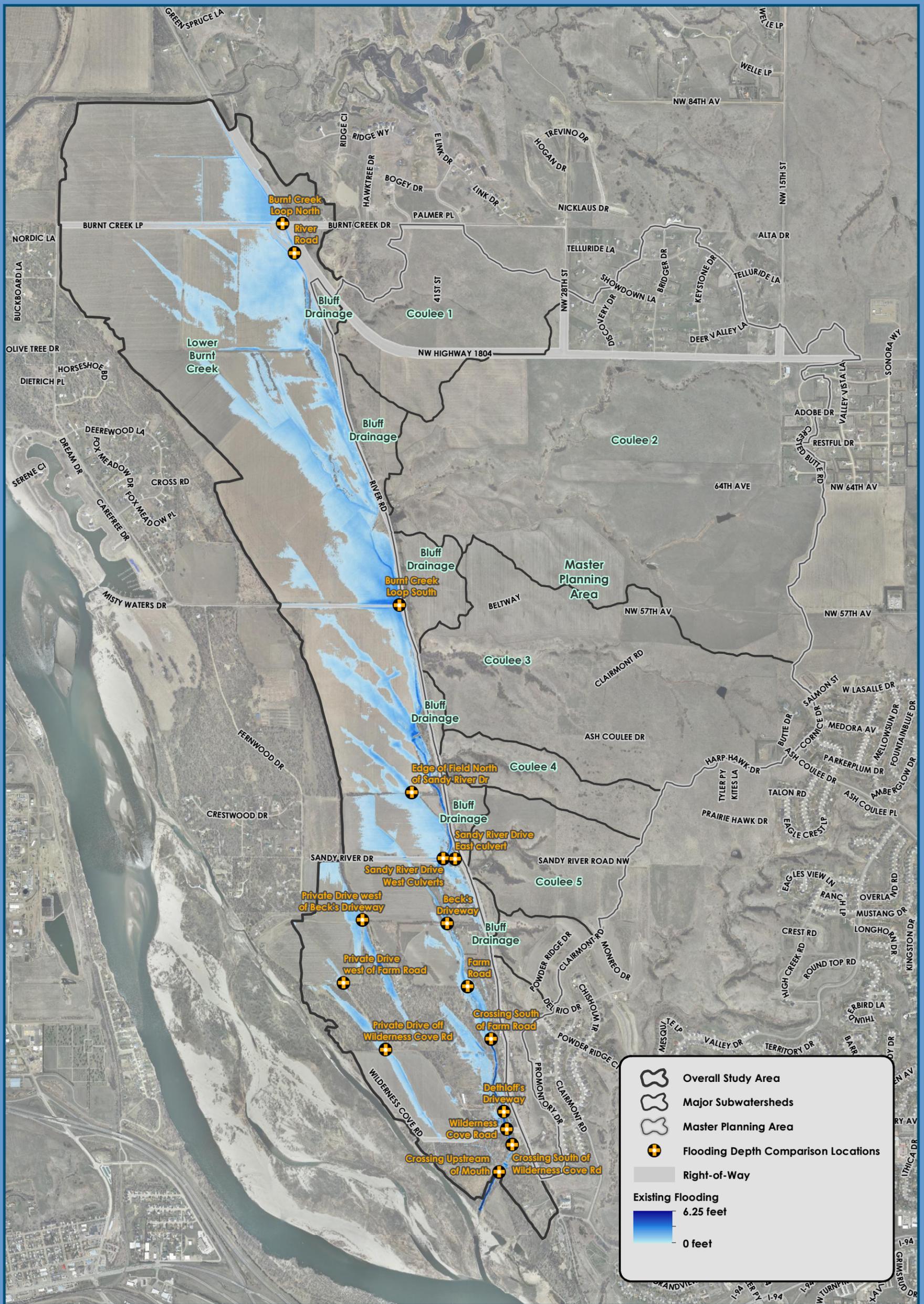


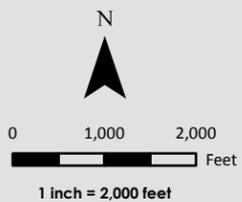
Figure 5-9:
Lower Burnt Creek Flood Inundation (2-Year Event)

City of Bismarck
Ash and Ward Coulee Stormwater Master Plan





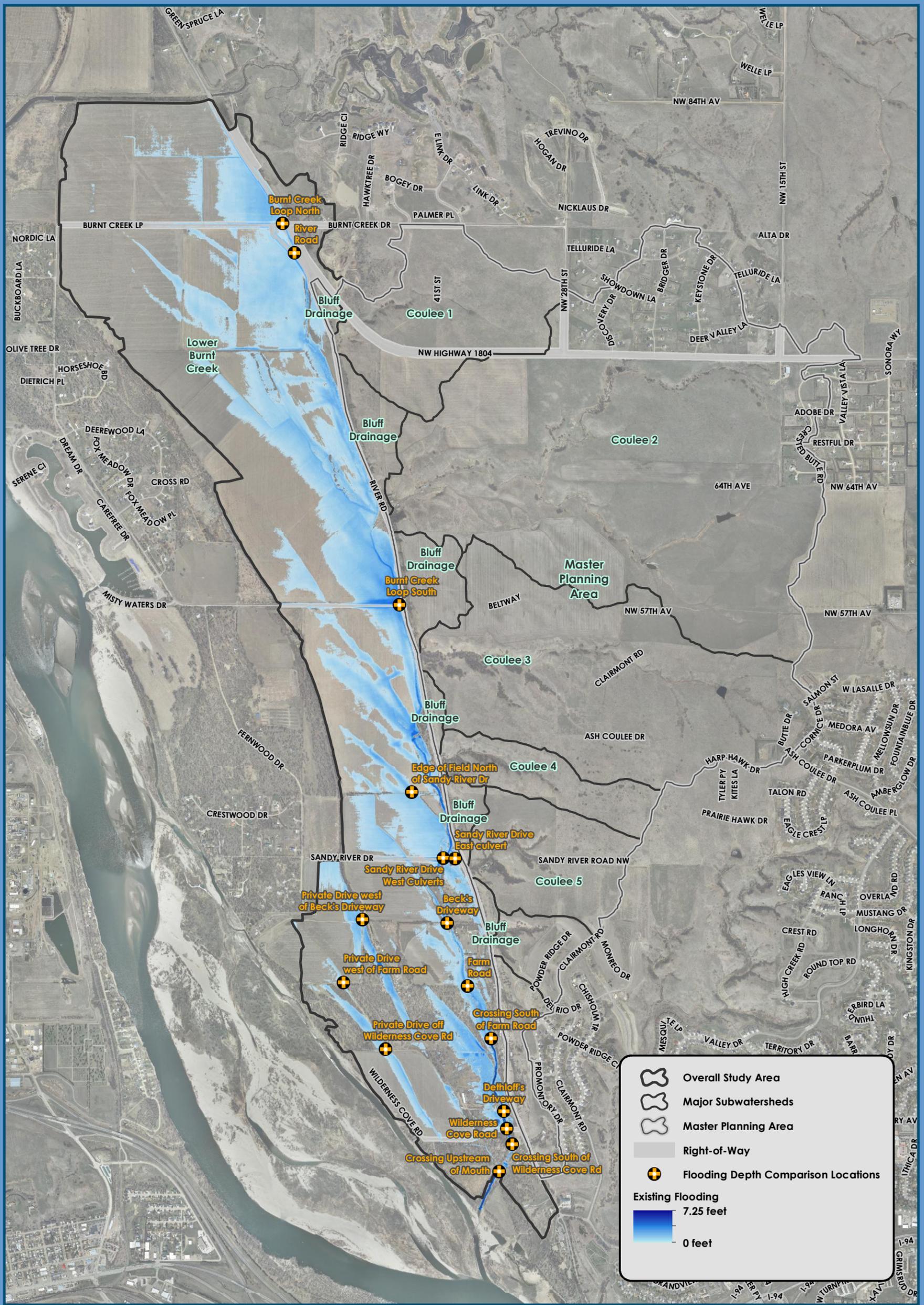
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**Figure 5-10:
Lower Burnt Creek Flood Inundation (10-Year Event)**

**City of Bismarck
Ash and Ward Coulee Stormwater Master Plan**





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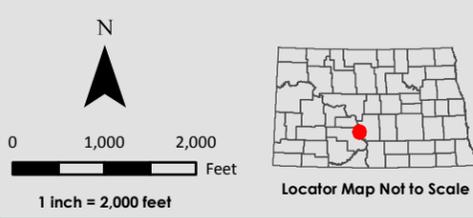
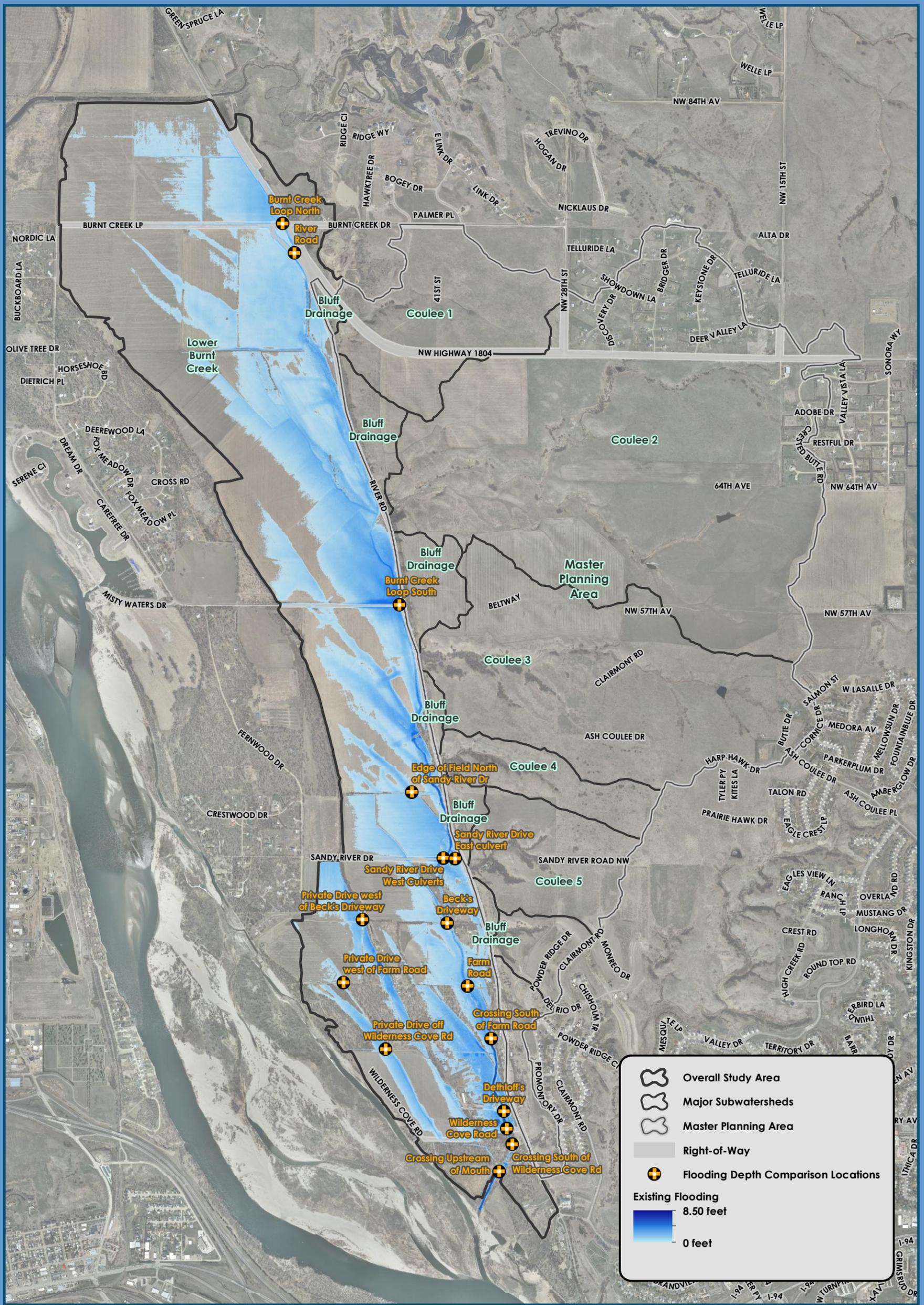


Figure 5-11:
Lower Burnt Creek Flood Inundation (25-Year Event)
City of Bismarck
Ash and Ward Coulee Stormwater Master Plan





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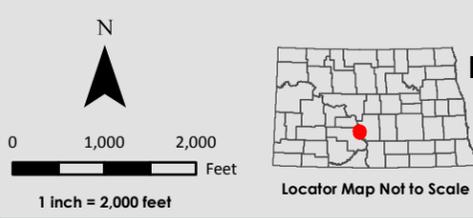


Figure 5-12:
Lower Burnt Creek Flood Inundation (100-Year Event)
City of Bismarck
Ash and Ward Coulee Stormwater Master Plan



6.0 FULL BUILD-OUT, NO CONTROLS

Evaluation of the full build-out conditions with no stormwater controls provides a baseline for measuring the relative performance of the various stormwater master plan alternatives and illustrates the need for stormwater management.

6.1 Peak Flows

As expected, full build-out of the watershed significantly increases peak flows (*Table 6-1*). Several observations are notable:

- The full build-out with no controls peak 2-year flow would increase to between the existing 10- and 25-year event, and the 6-hour, 100-year peak flow could more than double in Coulee 2 (largest watershed).
- The relative increase in flows is most noticeable for smaller events, which is typical for urban development as the relative effect of losing the infiltration capacity of the soil when it is converted to impervious area is most pronounced.

Table 6-1: Summary of Existing and Proposed No BMPs Peak Flows at Main Compliance Point

Coulee	6-Hour			
	2-yr	10-yr	25-yr	100-yr
Coulee 1				
Existing	17	63	110	242
Future No Controls	50	96	147	275
Percent Change	195%	53%	33%	13%
Coulee 2				
Existing	92	513	1,022	2,135
Future No Controls	549	1,245	1,856	4,632
Percent Change	498%	143%	82%	117%
Coulee 3				
Existing	27	217	508	1,280
Future No Controls	397	841	1,367	2,479
Percent Change	1379%	288%	169%	94%
Coulee 4				
Existing	11	57	119	259
Future No Controls	80	174	264	461
Percent Change	607%	207%	122%	78%
Coulee 5				
Existing	16	72	179	382
Future No Controls	106	247	371	642
Percent Change	584%	240%	107%	68%
Coulee 6				
Existing	11	49	105	215
Future No Controls	41	88	154	267
Percent Change	277%	80%	46%	24%

6.2 Road Level of Service

While the flow rates are increased dramatically and the frequency of overtopping would increase, the change in the Level of Service classifications is only modest (*Figure 6-1*) because most of the River Road crossings already do not meet Level of Service under existing conditions and the Lower Burnt Creek corridor has storage / flow attenuation capacity to route the significant increase in flow rates without increasing overtopping

6.3 Coulee Stability

Figures 6-2 and 6-3 illustrate that for full build-out with no controls, there are several areas that will not be stable with unreinforced vegetation only. In these areas, as well as other areas of concentrated flow that may be created by new storm sewer discharges from developments, additional armoring including riprap for long stretches of the coulee valleys would be required.

6.4 Lower Burnt Creek

While the roadway level of service does not change appreciably along Lower Burnt Creek, *Table 6-2* summarizes the flood elevation changes at various locations if full build-out with no stormwater management occurs in the Ash-Ward Coulee watersheds. While the magnitude of the water level increase is not dramatic, because of the flat topography, the increases could create issues particularly along the main channel.

Table 6-2: Lower Burnt Creek Flood Elevation Changes - Future No Controls

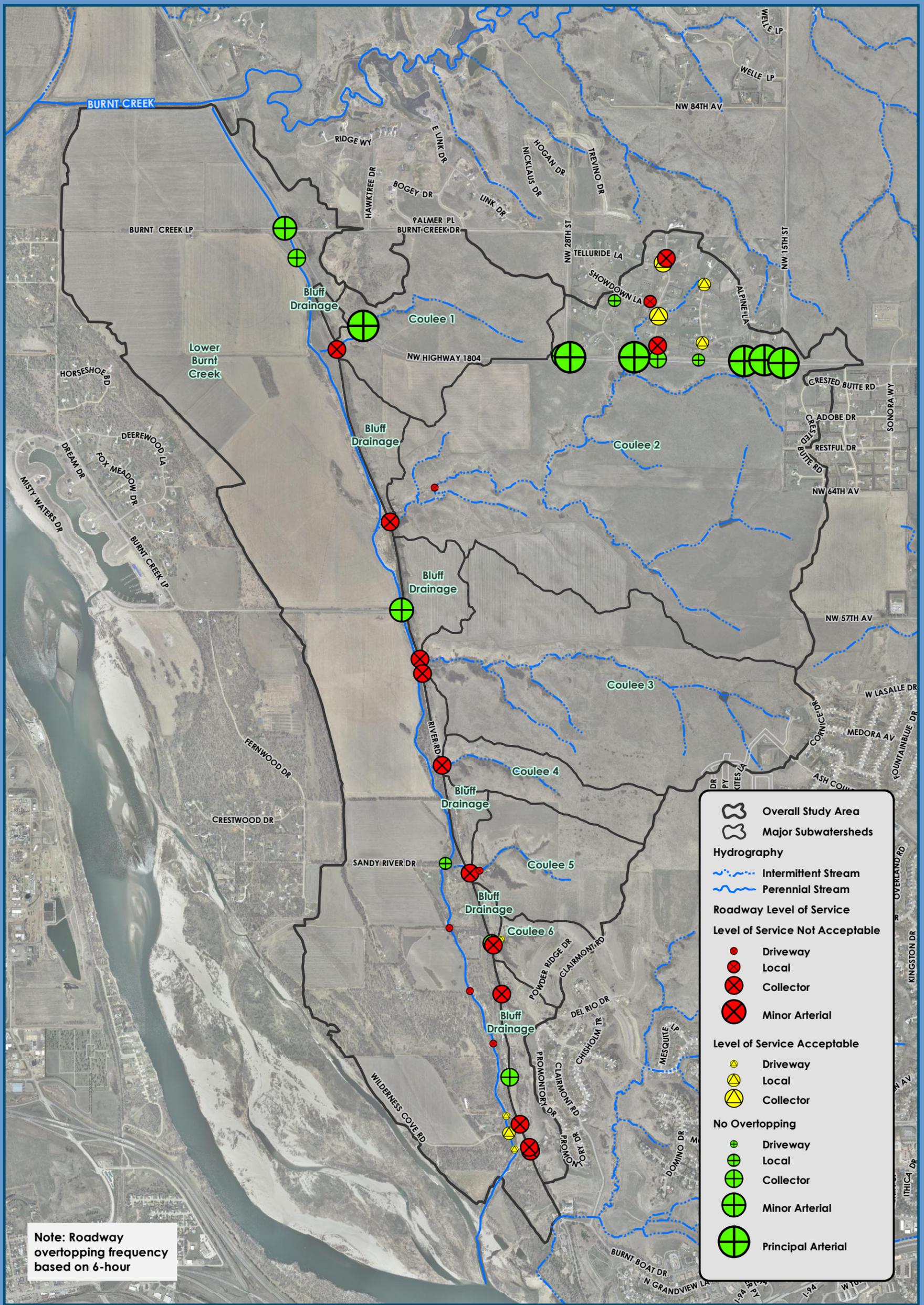
Location	Changes from Existing Conditions			
	2-Year	10-Year	25-Year	100-Year
Burnt Creek Loop North	0'	0'	0'	0'
River Road	0.1'	0.2'	0.2'	0.2'
Burnt Creek Loop South	1.2'	0.5'	0.6'	0.6'
Sandy River Drive West Culverts	0.9'	0.5'	0.5'	0.4'
Sandy River Drive East culvert	1'	0.5'	0.5'	0.4'
Beck's Driveway	0.5'	0.3'	0.2'	0.2'
Farm Road	0.3'	0.2'	0.5'	0.3'
Crossing South of Farm Road	0.6'	0.4'	0.5'	0.3'
Dethloff's Driveway	1.4'	1'	0.5'	0.3'
Wilderness Cove Road	1.1'	0.8'	0.8'	0.3'
Crossing South of Wilderness Cove Rd	0.5'	0.3'	0.2'	0.1'
Crossing Upstream of Mouth	0'	0'	0'	0'
Edge of Field North of Sandy River Dr	0'	0'	0'	0'
Private Drive west of Beck's Driveway	0.1'	0'	0.2'	0.3'
Private Drive west of Farm Road	0'	0'	0'	0'
Private Drive off Wilderness Cove Rd	0'	0'	0.1'	0.3'

*Positive value means elevation is higher than existing conditions.

Green highlighted cells are located away from the Lower Burnt Creek main channel.

6.5 Conclusions

The results from the full build-out, no controls scenario demonstrate the need for providing stormwater management to reduce peak flows, not create coulee stability issues, and not increase flood elevations within Lower Burnt Creek that would be caused by local watershed runoff.



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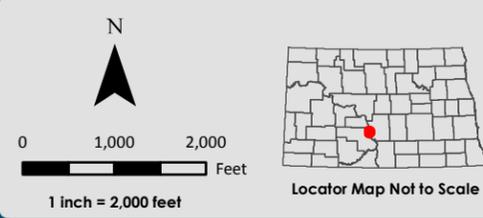
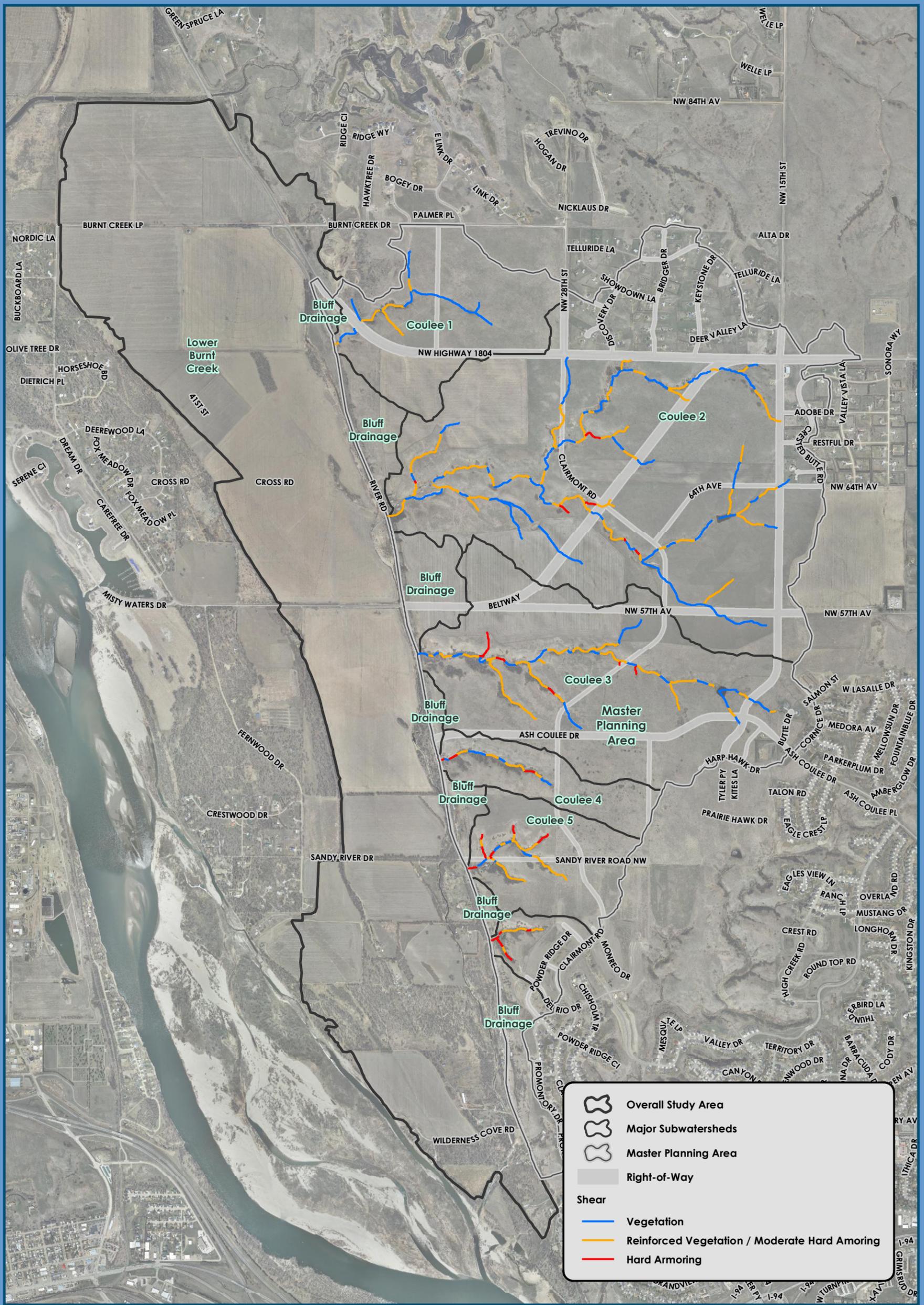


Figure 6-1:
Full Build-Out No Controls Roadway Level of Service
City of Bismarck
Ash and Ward Coulee Stormwater Master Plan





	Overall Study Area
	Major Subwatersheds
	Master Planning Area
	Right-of-Way
Shear	
	Vegetation
	Reinforced Vegetation / Moderate Hard Armoring
	Hard Armoring

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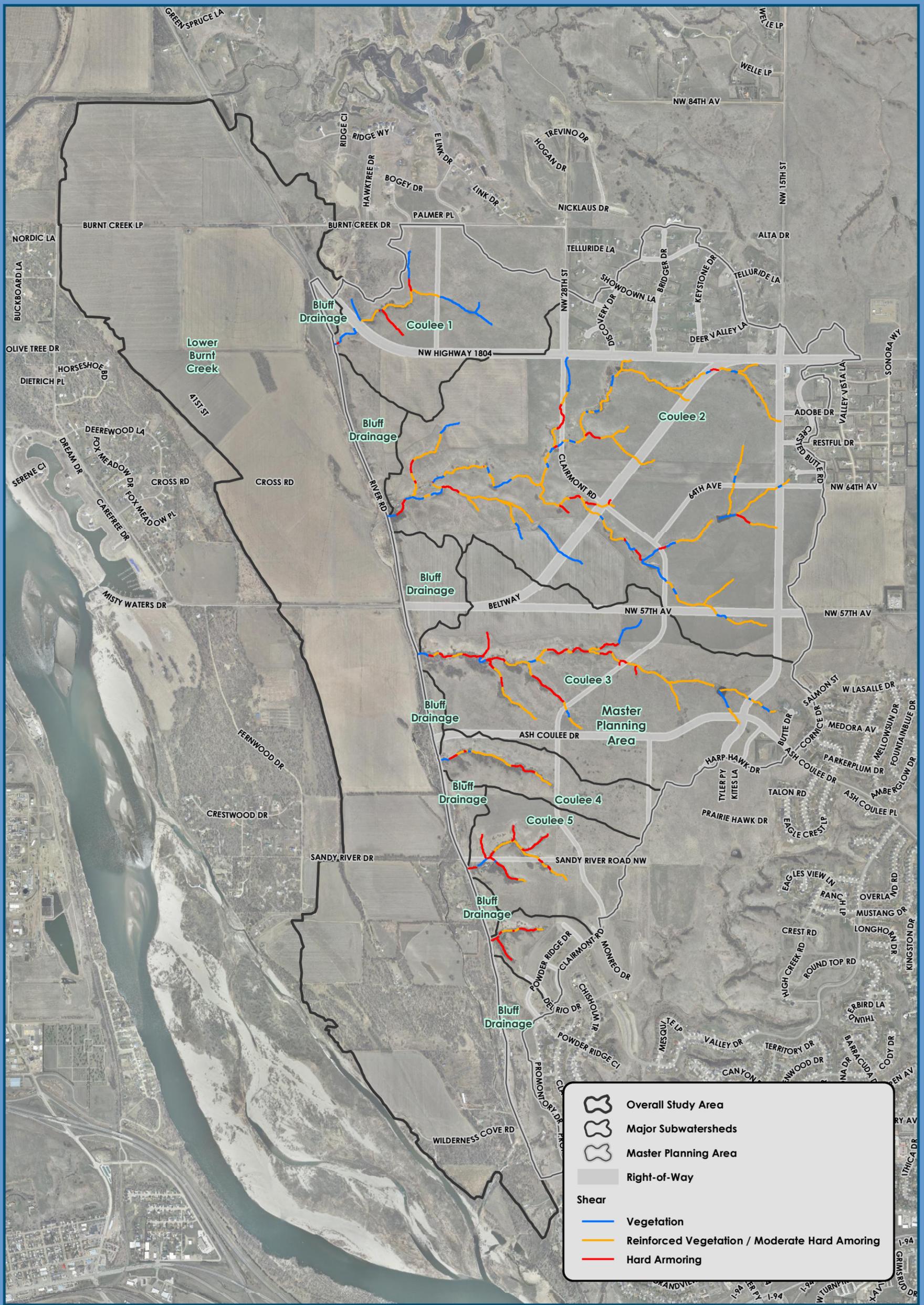
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Locator Map Not to Scale

Figure 6-2:
Full Build-Out No Controls –
Coulee Shear Stress (2-Year)

City of Bismarck
Ash and Ward Coulee Stormwater Master Plan





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Figure 6-3:
Full Build-Out No Controls –
Coulee Shear Stress (25-Year)

City of Bismarck
Ash and Ward Coulee Stormwater Master Plan



7.0 STORMWATER MASTER PLAN

The proposed stormwater Master Plan utilizes traditional regional detention practices. Traditional detention refers to instituting practices that the City has typically employed in adjoining master planned areas. One deviation from the City’s past Master Plan approaches, however, is that all detention facilities are located at separate embankments rather than combined with road crossing embankments. The reason for this approach is that because of the deep coulee valleys and City standards for road slopes, the storage upstream of most road crossings would far exceed the State’s threshold for triggering a State Dam Permit if the culvert under the roadway did not meet stream crossing standards.

Key elements of this Master Plan include:

- Provide approximately 151 acre-feet total of new detention storage through the use of fifteen “valley storage” detention facilities scattered throughout Coulees 1 through 5 to:
 - Reduce future runoff rates equal to or less than existing runoff rates (i.e. pre-post detention) for the 6-hour, 2-, 10-, and 100-year events;
 - Provide water quality treatment meeting the intent of the City’s MS4 permit requirements; and
 - Limit the increases in inundation along the Lower Burnt Creek corridor compared to existing conditions;
- Incorporate an existing regional detention basin within the Ashwood Subdivision (immediately north of ND1804 between Discovery Drive and Bridger Drive);
- Maintain coulee valley storage upstream of proposed road crossings that meet State Stream Crossing criteria;
- In areas that cannot be feasibly drained to a regional detention facility, such as Coulee 6 and the areas along the Missouri River bluff, require on-site detention located outside of the geotechnical setback that meets the City ordinances for both peak discharge control and water quality treatment; and
- Provide minor culvert improvements at select locations along Lower Burnt Creek such that the Master Plan conditions create similar peak flood levels along Lower Burnt Creek compared to existing conditions.

The Master Plan improvements are illustrated in *Figure 7-1*. The following sections provide additional detail on each of the improvements and the performance of this Master Plan with respect to the design criteria outlined in *Section 1*.

7.1 Detention Facilities

7.1.1 Regional Detention Basin Geometries

As outlined in the previous section, a total of fifteen new regional detention facilities are proposed as part of this alternative, which are summarized in *Table 7-1* and shown on *Figure 7-2*. Basin geometry and preliminary grading plans are shown in the *Exhibits* section of this

report. Note that detention facilities are concept in design and can be modified to meet the overall development plans of the specific area as long as the stage-area relationship and key outlet and overflow elevations are maintained.

Outlet structures were designed such that frequent rainstorms up to approximately the 2-year event would be conveyed through a low-capacity orifice (4 to 6 inches in diameter), which would drain to a large manhole. The small orifice is needed in order to provide the necessary water quality treatment to meet the City’s MS4 criteria as well as slowly release the runoff volume so as not to exacerbate flooding issues along Lower Burnt Creek. During final design of these facilities, measures to limit the potential for frequent clogging of the low-flow outlet will need to be incorporated; one example of an approach for reducing clogging potential is shown on *Sheet C16* in the *Exhibits*. Further, access paths for maintenance will need to be incorporated into the final design / easement for each facility.

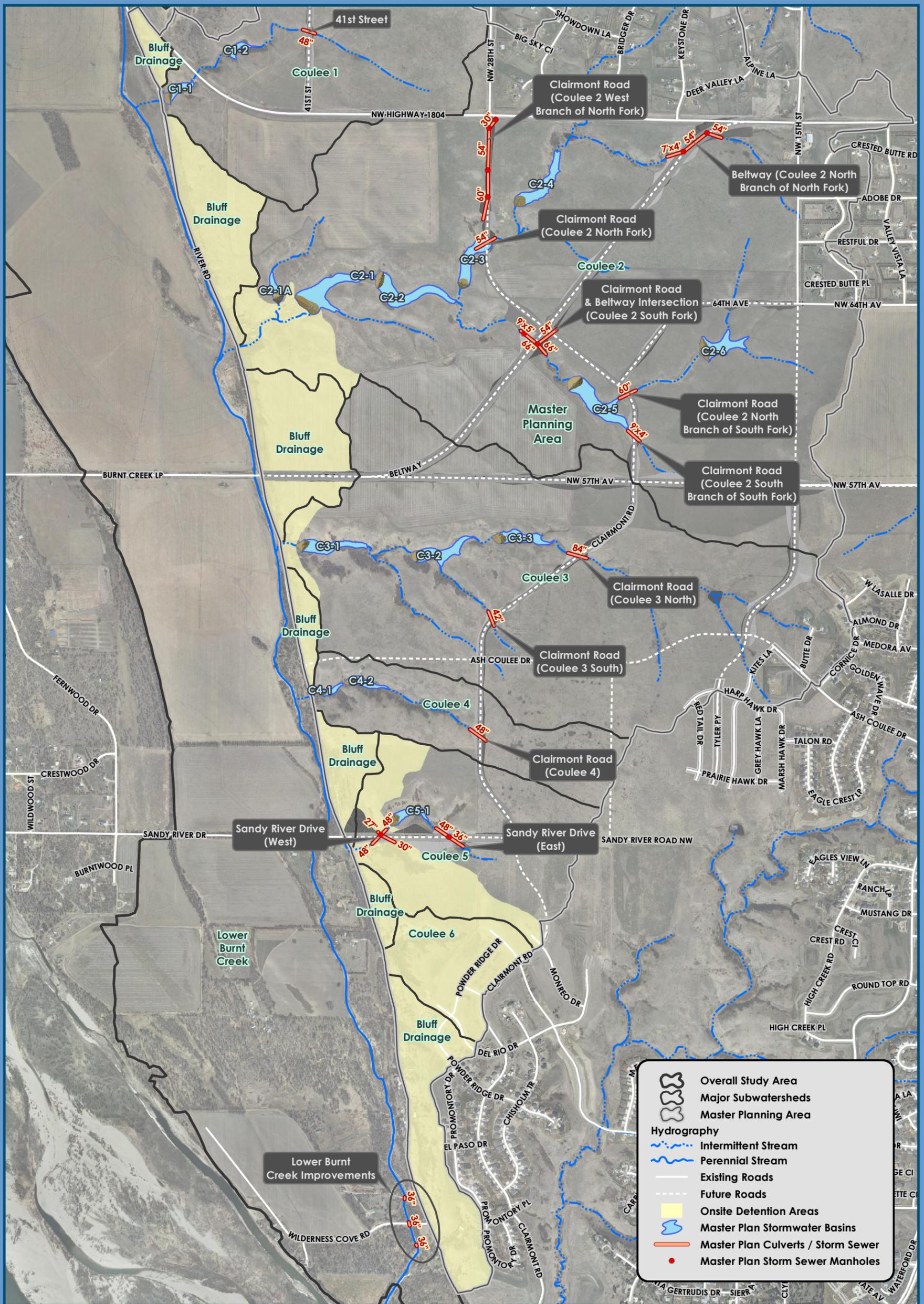
During larger flood events, water would begin to pour over the rim of the large manhole and through an open grate covering the entire manhole top. A larger culvert would then carry the combined low and high flows under the embankment. During extreme flood events such as the 100-year event, runoff would be allowed to spill over the armored emergency spillway.

Table 7-1: Summary of Master Plan Detention Basin

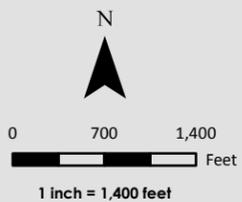
Basin Name	Basin Type	Maximum Storage ¹ (acre-feet)	Maximum Area ¹ / Easement Area ² (acres)	Bottom Elevation (NAVD 88)	Overflow Elevation (NAVD 88)
C1-1	Valley	4.6	0.93 / 1.07	1647	1659
C1-2	Valley	2.9	0.62 / 0.7	1684	1694.5
C2-1	Valley	17.7	4.24 / 4.67	1664	1673
C2-1A	Valley	3.3	0.68 / 0.75	1668	1681
C2-2	Valley	13.5	3.71 / 4.13	1678	1688
C2-3	Valley	10.7	1.78 / 1.92	1697	1710.5
C2-4	Valley	17.4	2.54 / 2.78	1732	1750
C2-5	Valley	17.2	3.91 / 4.29	1752	1767
C2-6	Valley	12.2	2.12 / 2.33	1803	1817
C3-1	Valley	11.1	2.26 / 2.5	1644	1662.5
C3-2	Valley	10.8	2.44 / 2.7	1684	1698.5
C3-3	Valley	12.9	1.88 / 2.07	1714	1732.5
C4-1	Valley	3.2	0.5 / 0.54	1646	1663
C4-2	Valley	6.7	0.89 / 0.93	1671	1688.5
C5-1	Valley	6.7	1.07 / 1.17	1682	1699
Total	N/A	150.9	29.57 / 32.55	N/A	N/A

1 – Maximum Storage and Maximum Area are based on the overflow elevation.

2 – Easement Area is based on the higher of the 6-hr, 100-yr event elevation plus one foot or the emergency overflow elevation.



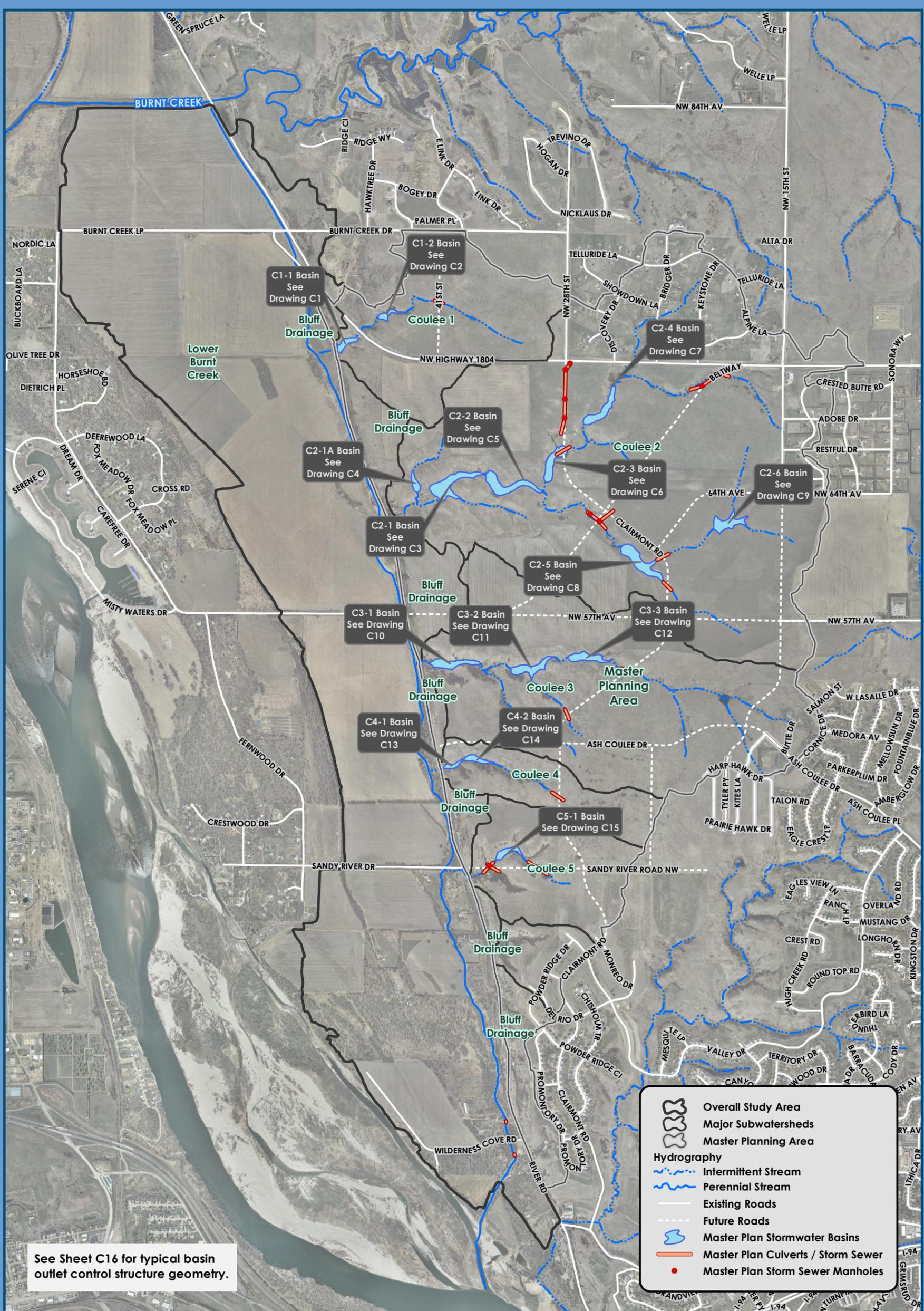
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**Figure 7-1:
Master Plan**

**City of Bismarck
Ash and Ward Coulee Stormwater Master Plan**

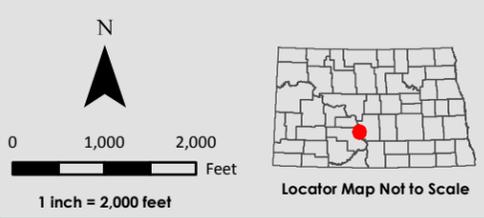




See Sheet C16 for typical basin outlet control structure geometry.

- Overall Study Area
- Major Subwatersheds
- Master Planning Area
- Hydrography**
- Intermittent Stream
- Perennial Stream
- Existing Roads
- Future Roads
- Master Plan Stormwater Basins
- Master Plan Culverts / Storm Sewer
- Master Plan Storm Sewer Manholes

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**Figure 7-2:
Master Plan Basin Locations**

**City of Bismarck
Ash and Ward Coulee Stormwater Master Plan**



7.1.2 On-Site Detention Requirements

As noted previously, there are several areas along the Missouri River bluffs that are not feasible to drain to a regional detention facility. These areas are shown on **Figure 7-1**, and developers will need to provide on-site detention meeting the City's standard stormwater management criteria:

- Detain Post-Development peaks such that they do not exceed pre-development peak runoff rates for the 6-hour, 2-, 10-, and 100-year events.
- Provide water quality treatment meeting the sizing requirements outlined in Appendix 1 of the State's NPDES Permit (current version) or an equivalent quantitative approach similar to the one outlined in **Appendix G**.

Areas that are currently shown as "Bluff Drainage" on **Figure 7-1** will need to be re-directed to a coulee either to the north or south or safely down the Missouri River bluff using properly designed measures. Additionally, all on-site detention facilities should be located outside of the geotechnical setback line.

7.2 Road Crossing Improvements

7.2.1 City Master Plan Improvements

In addition to the construction of the detention facilities, several new culvert crossings will be required to meet the level of service for each road classification (**Figure 7-3 and Exhibits**). Because individual development areas could alter drainage patterns and fill in shallow drainage corridors outside the coulee valleys as part of the development, culvert crossings were only sized and included in this Master Plan where contributing watersheds exceed 40 acres.

Culvert crossings were designed such that they would meet the State Stream Crossing criteria under full build-out condition, and in the case of DOT crossings (existing ND1804 and future Beltway), the 24-hour, 25-year outlet velocity was set to a maximum of 10 feet per second.

Most road crossings over coulees were oriented such that traditional single culverts would be appropriate. However, there are three locations that would require storm sewer if the roads are ultimately designed and constructed along the Master Plan alignments:

- North end of Beltway (referred to as Coulee 2, North Branch of North Fork) – At this location, the alignment of the Beltway and the coulee valley are nearly identical, requiring converting the coulee to a storm sewer (**Sheet C18**). Because of the steep grades and higher topography along the existing ND1804, limiting uncontrolled overflow to the south on the upstream side of the storm sewer will be a key design consideration.
- Intersection of Clairmont Road and Beltway – The main coulee valley and a smaller coulee tributary intersect at the same location as the proposed road intersection. Because of the likely required height of the Beltway embankment, combining the coulee confluence into a branched storm sewer appears to be the most practical approach (**Sheet C21**). Another future design consideration for this intersection is the Clairmont Road profile, alignment, and cross section immediately west of the intersection that will likely need to be adjusted to avoid filling in a large section of the coulee valley.

- Sandy River Drive – While the existing grade drop between Sandy River Drive at River Road and the top of the Missouri River bluffs will likely result in modifications to the proposed Sandy River Drive alignment, if the road goes in as shown, several coulee valleys combine east of River Road, as shown on *Sheet C28*. In order to efficiently accommodate the drainage from each of these valleys, a branched storm sewer is included in this Master Plan.

7.2.2 County Recommended Improvements

Figure 5-4 shown previously illustrates that several of the River Road crossings do not meet level of service requirements for roadway overtopping frequency under existing land use conditions. Since this road will remain in the County and one of the Master Plan objectives is to not increase peak discharges at River Road for the 2-, 10-, 25-, and 100-year events, improving River Road culvert crossings is not included in the Master Plan. However, this Master Plan includes the improvements that would be needed in order for River Road to not overtop in the 25-year event, which are also shown in *Figure 7-3* and summarized in *Table 7-2* below.

Table 7-2: River Road Recommended County Improvements

Location	Add / Replace	Pipe Type	Pipe Size	Upstream Invert	Downstream Invert
River Rd Coulee 1	Add	Horiz Ellipse	38"x24"	1641.4	1640.44
River Rd Coulee 2	Add	Box	8'x4'	1637.21	1637
River Rd Coulee 3	Replace	Box	14'x5'	1636.14	1635.79
River Rd Coulee 5	Add	Circular	42"	1637.72	1637.47
River Rd Coulee 6 South	Replace	Arch	65"x40"	1636.5	1635.92
River Rd near Dethloff Driveway	Replace	Circular	24"	1650.5	1650
River Rd south of Coulee 6 North	Replace	Circular	24"	1672	1671.15
River Road at Becher Property	Replace	Circular	24"	1648.16	1647.05
River Road at Becher Property	Replace	Circular	24"	1649.56	1647.05

7.3 Maximum Impervious Criteria

The performance of this stormwater Master Plan is based on assumptions of impervious area percentages for the future land uses noted in *Section 2*. Therefore, any proposed development that includes increased impervious area over what was assumed should at a minimum:

1. Provide on-site stormwater management devices such that the 2-, 10-, and 100-yr 6-hr peak flows leaving the site are equal to or less than the peak flows that would occur under the conditions assumed in the Master Plan. Note that runoff from pervious and impervious areas should be calculated separately, consistent with this study.
2. Confirm to the satisfaction of the City that the proposed impervious percentage increases and associated runoff volume increases do not have an adverse impact on Lower Burnt Creek.

7.4 Performance

7.4.1 Peak Flows

The Master Plan reduces peak flow rates entering Lower Burnt Creek to at or below existing peak flow rates for the 2-, 10-, and 100-year events for Coulees 1 through 5, as required by the City of Bismarck ordinances (*Table 7-3*). As the table illustrates, peak discharges for the smaller events such as the 2- and 10-year event are “over detained” such that the reductions in peak discharge compared to existing conditions are significant. The reason for the over detention for these smaller events, which will be described later in this section, is that other performance criteria (water quality and Lower Burnt Creek flooding), are the most restrictive criteria for this Master Plan approach. Peak discharge control is also provided for the 25-year event to meet County Highway requirements for Coulees 1 through 5.

Due to the configuration of Coulee 6 and the existing home that is in the coulee valley, it is not feasible to locate a regional detention facility within this coulee; therefore, on-site peak discharge control meeting the City’s requirements are required throughout the Coulee 6 watershed. By providing on-site peak discharge control (i.e. not a regional approach), modest increases in peak discharge at River Road are expected up to the 25-year event; however, the increase in the 25-year event is only 4 cfs (less than 4 percent).

Table 7-3: Summary of Existing and Master Plan Peak Flows at Coulee Compliance Points

Coulee	6-Hour			
	2-yr	10-yr	25-yr	100-yr
Coulee 1				
Existing	17	63	110	242
Master Plan	5	55	110	217
Percent Change	-68%	-12%	0%	-11%
Coulee 2				
Existing	92	513	1,022	2,135
Master Plan	18	236	556	934
Percent Change	-80%	-54%	-46%	-56%
Coulee 3				
Existing	27	217	508	1,280
Master Plan	17	201	508	1,085
Percent Change	-38%	-7%	0%	-15%
Coulee 4				
Existing	11	57	119	259
Master Plan	4	13	53	247
Percent Change	-64%	-76%	-56%	-5%
Coulee 5				
Existing	16	72	179	382
Master Plan	13	71	175	266
Percent Change	-17%	-2%	-2%	-30%
Coulee 6				
Existing	11	49	105	215
Master Plan	14	54	109	209
Percent Change	27%	10%	4%	-3%

Figure 7-4 illustrates the peak flows (6-hour duration) for the 2-, 10-, 25-, and 100-year events at all the collector and arterial crossings where land use changes upstream are expected. Peak 25- and 100-year flows for the 24-hour storm duration are shown in **Figure 7-5** at all the NDDOT crossings.

7.4.2 Road Level of Service

Figure 7-6 displays the overtopping frequency of roadway and driveways on main conveyance routes relative to the required level of service outlined in **Section 1**. Peak 6-hour, 25- and 100-year stages along with the freeboard of the 100-year peak stage in relation to the overflow elevation are displayed in **Figure 7-7** for all collector street crossings and 79th Avenue NE. Since the NDDOT requires evaluation of crossings based on the 24-hour duration, **Figure 7-8** illustrates the peak stages for the 24-hour, 25- and 100-year events, 100-year freeboard, and 25-year outlet velocity. 25-year velocity is less than 10 ft/sec for all DOT crossings.

While there are existing roadways and driveways that do not meet the Level of Service criteria, these crossings are either outside the focus of the Master Planning area (i.e. on Lower Burnt Creek) or are within the Ashwood rural residential subdivision. Other than these crossings, these figures illustrate that all new crossings and River Road crossings meet the level of service requirements outlined in this report.

7.4.3 Peak Basin Stages

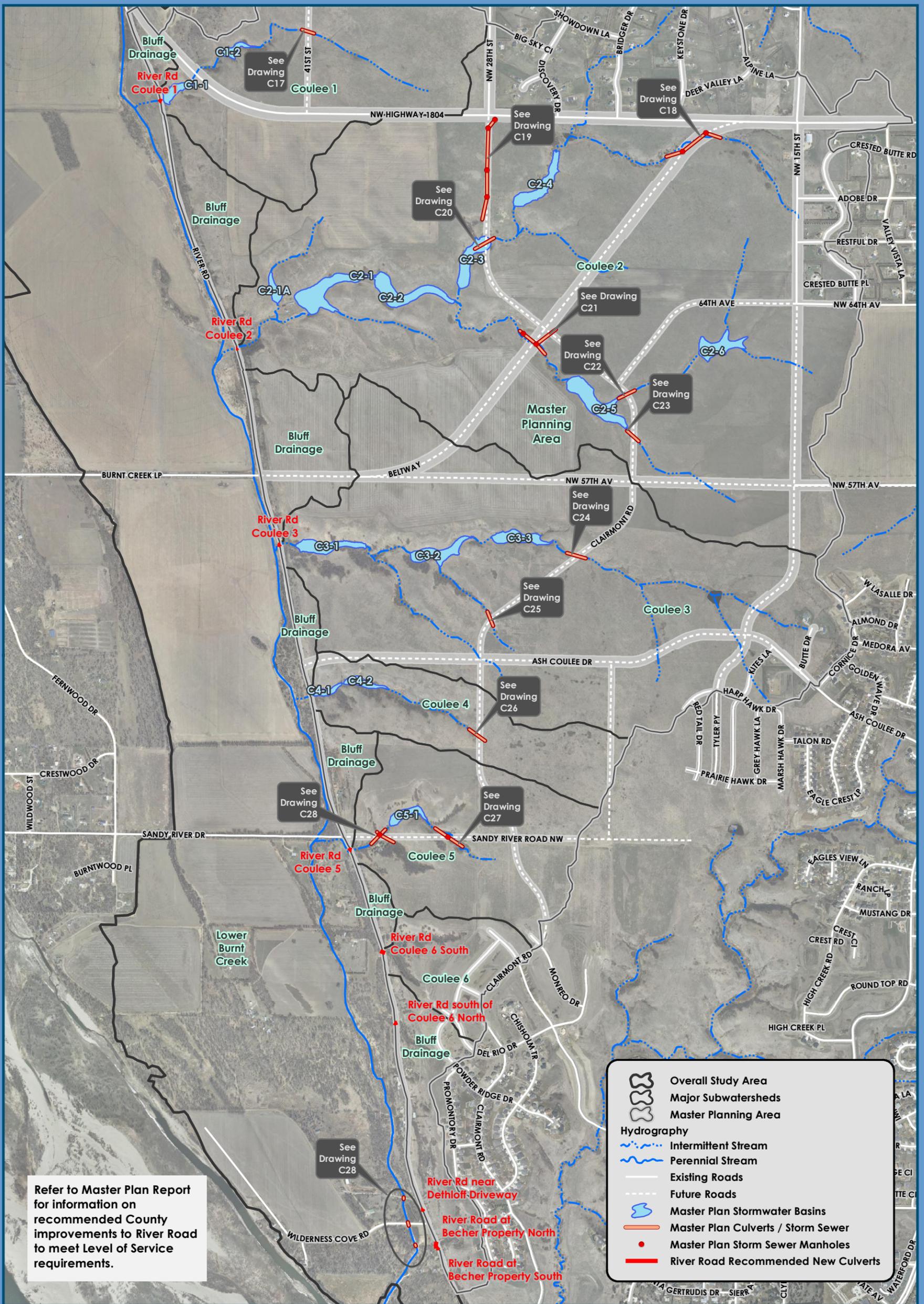
Peak basin stages for the Master Plan are displayed in **Figure 7-9** for the 6-hour event. The 24-hour, 100-year elevation and emergency overflow elevation are shown as well for comparison. Many of the proposed facilities have flow over the emergency spillways in the 100-year event, so appropriate armoring techniques will be needed for the spillway, such as the measures described in **Appendix C**.

7.4.4 Water Quality Performance

Table 7-4 summarizes the water quality performance of the Master Plan, which indicates that the detention facilities will trap slightly more than 80 percent of the sediment (Total Suspended Solids or TSS) generated from the fully built-out coulees. As described in **Section 1.3** and **Appendix G**, providing 80 percent TSS meets the intent of the City’s MS4 permit. It should be noted that these results do not account for any water quality treatment that could be provided via on-site detention facilities within Development Subareas A or B. Specifics of the water quality analysis are included in **Appendix G**.

Table 7-4: Master Plan Water Quality Performance

Scenario	TSS Trapped Compared to No Controls (Percent)
Master Plan	80.4%



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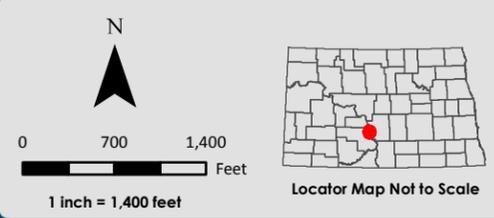
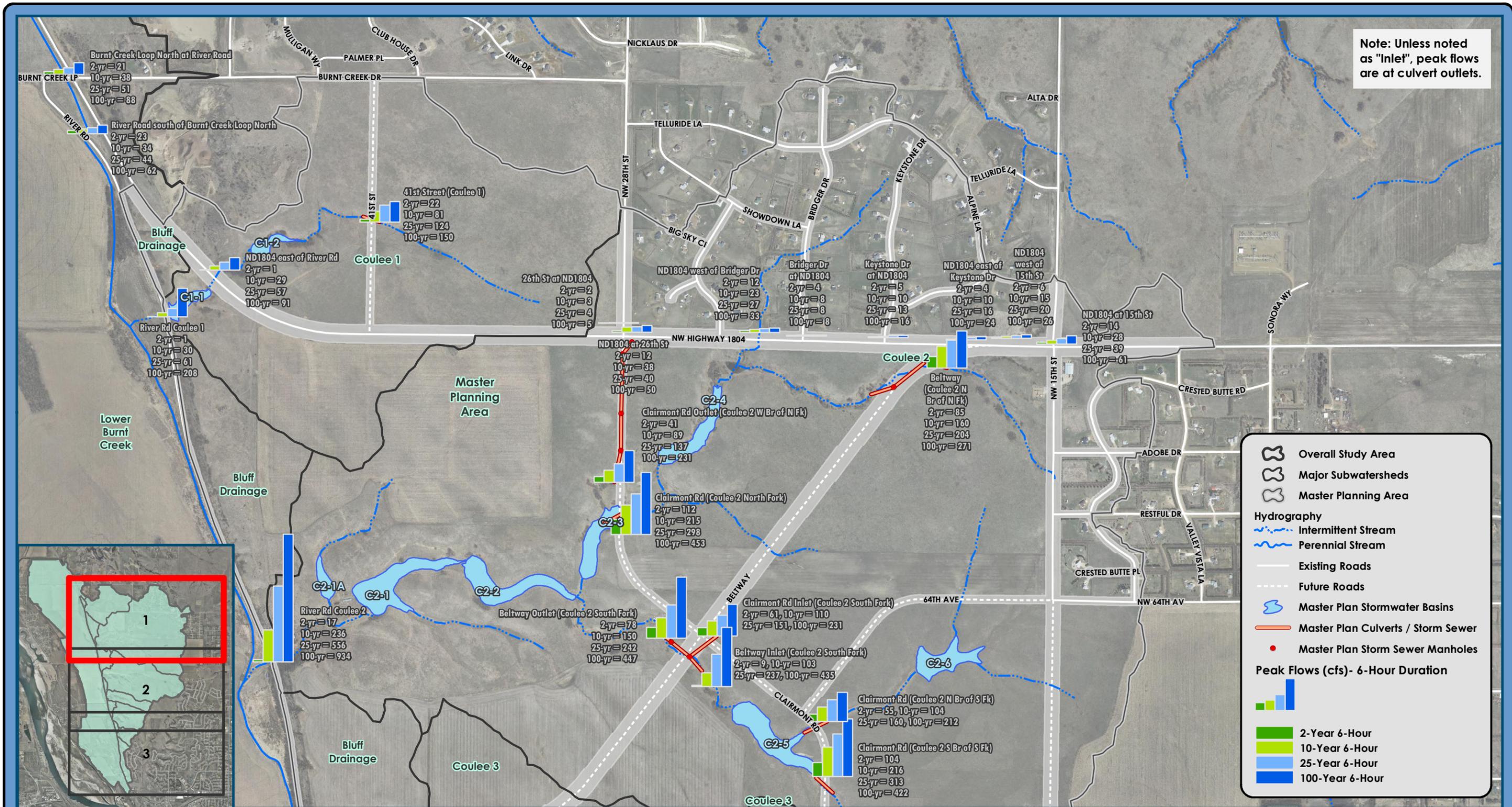


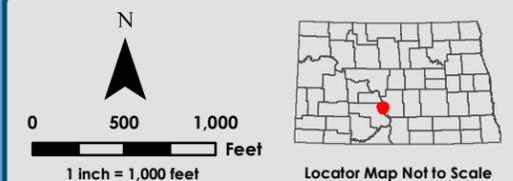
Figure 7-3:
Master Plan Conveyance Improvements
 City of Bismarck
Ash and Ward Coulee Stormwater Master Plan

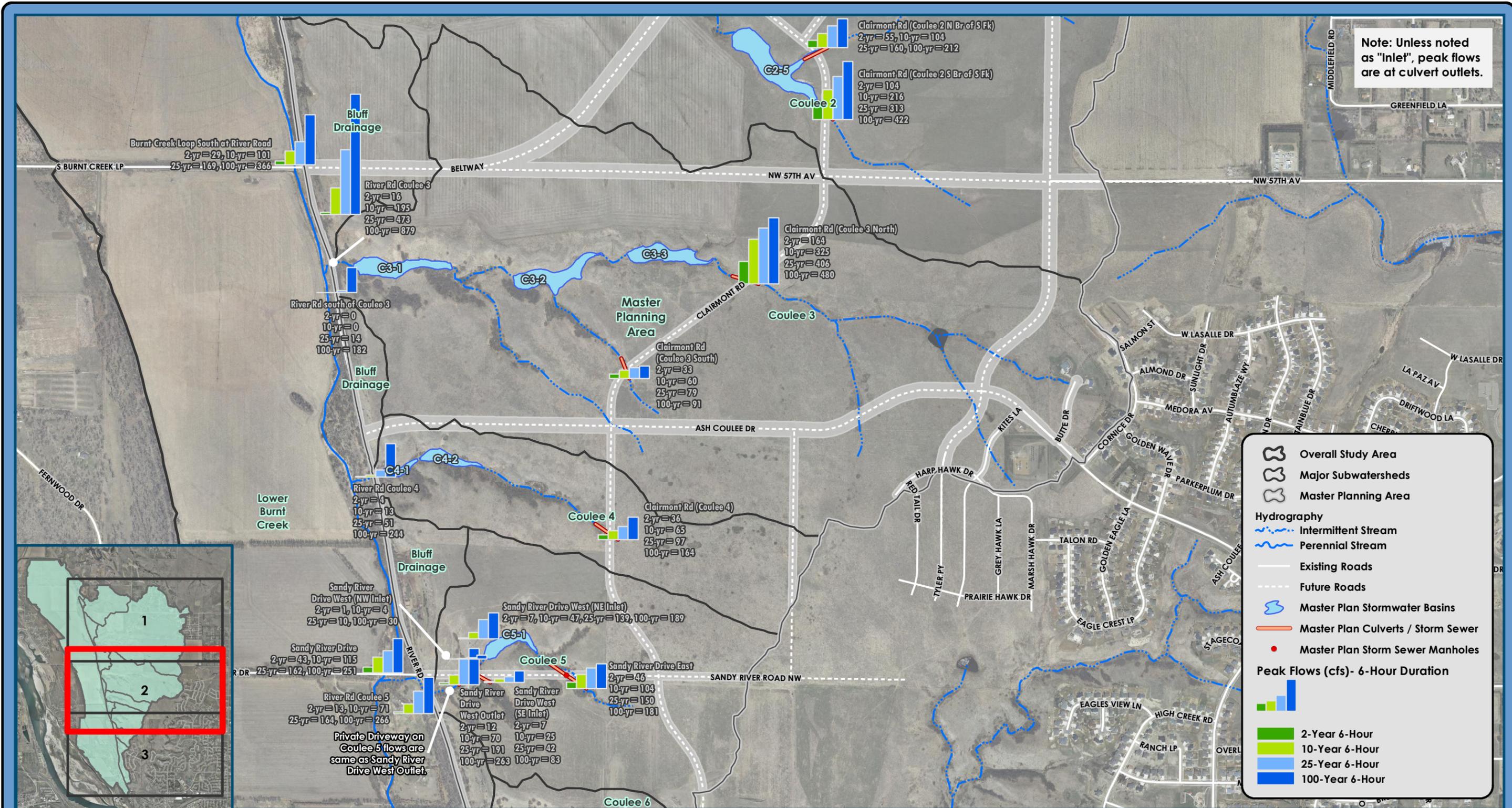




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Figure 7-4: Page 1 of 3
 Master Plan Peak Flows at Key Crossings
 City of Bismarck
 Ash and Ward Coulee Stormwater Master Plan





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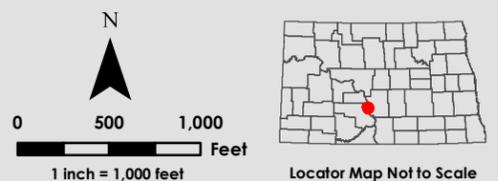
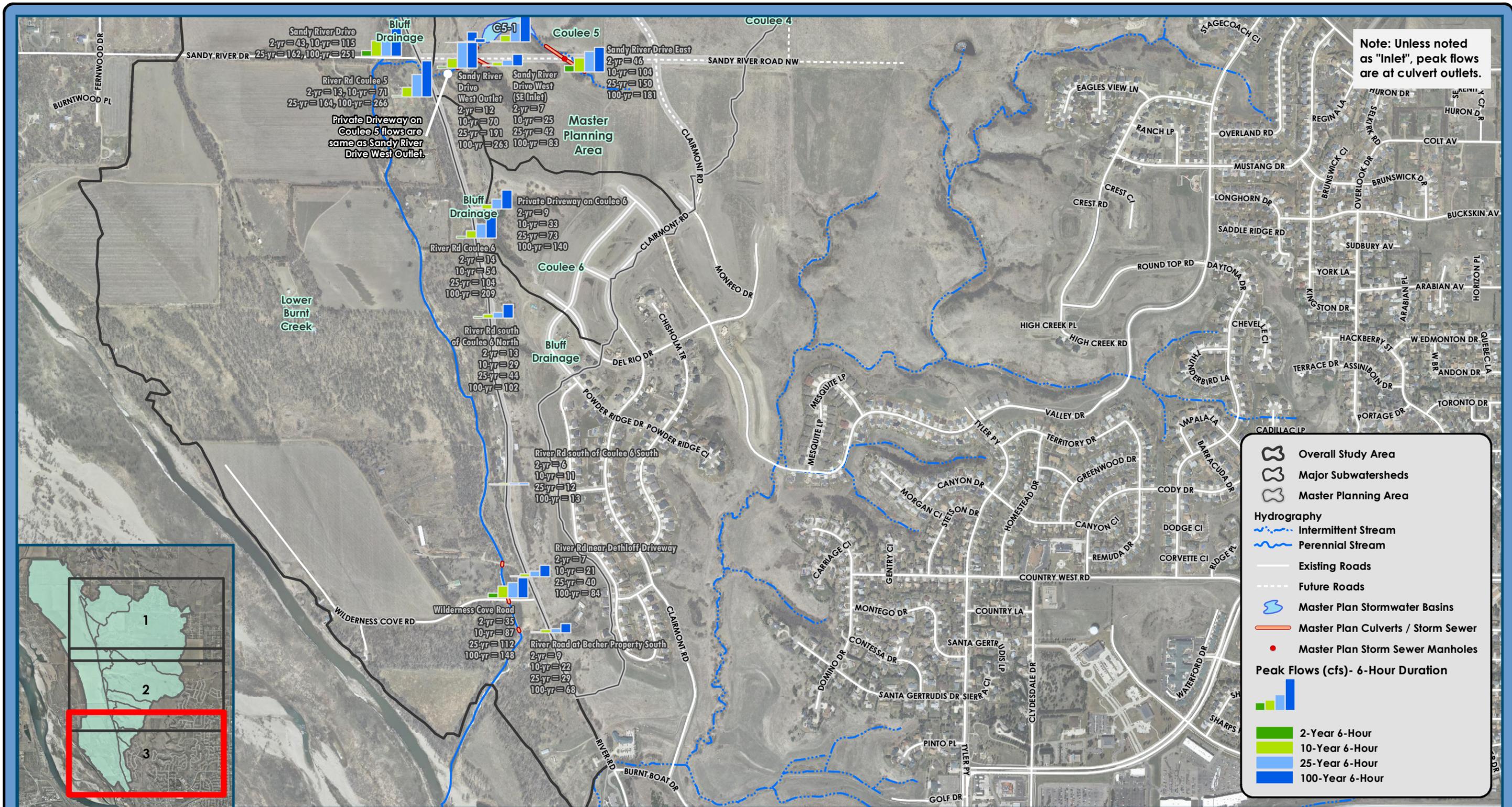


Figure 7-4: Page 2 of 3
Master Plan Peak Flows at Key Crossings
 City of Bismarck
 Ash and Ward Coulee Stormwater Master Plan

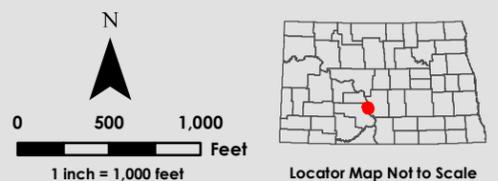


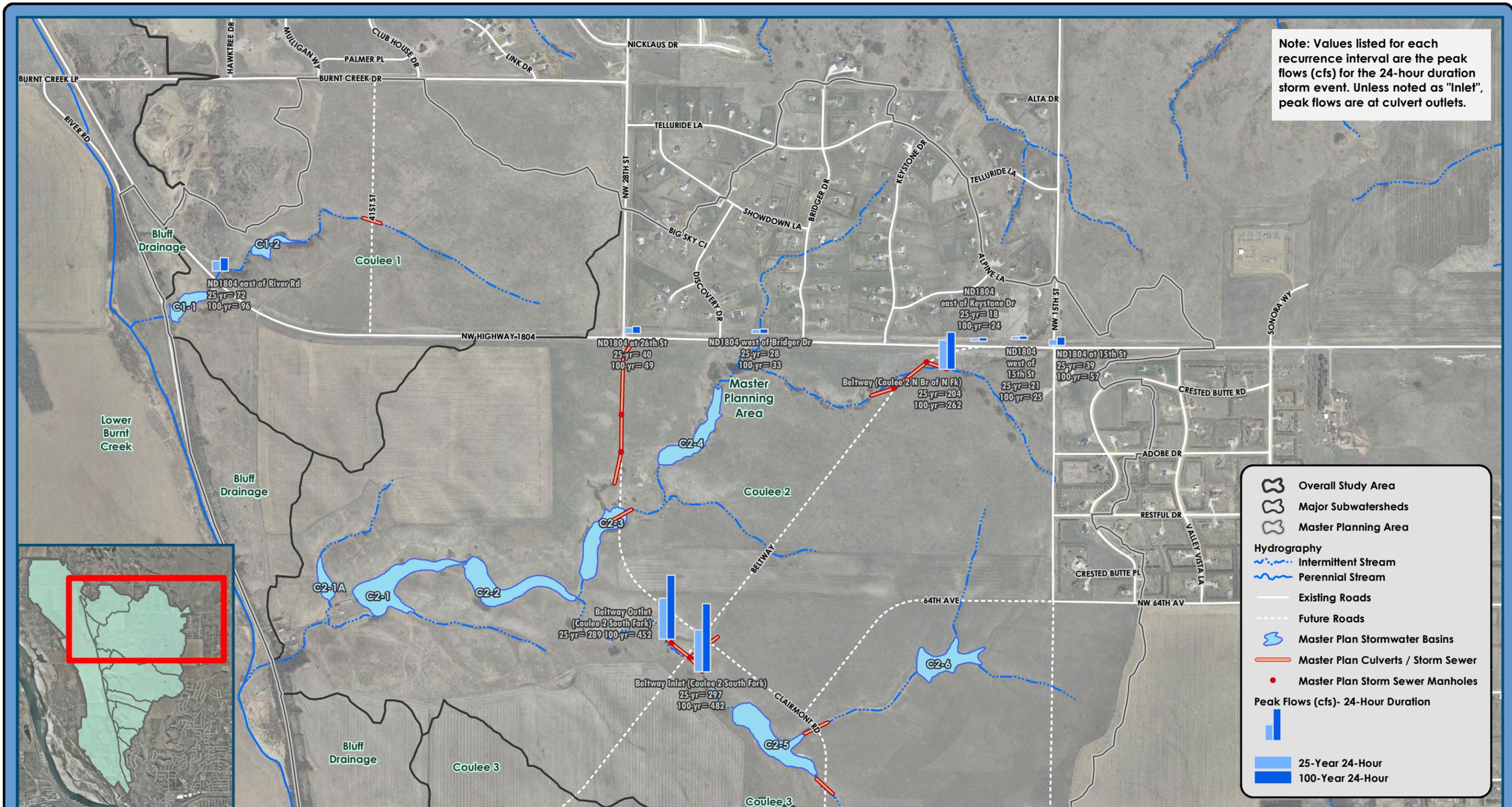


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Figure 7-4: Page 3 of 3
Master Plan Peak Flows at Key Crossings

City of Bismarck
Ash and Ward Coulee Stormwater Master Plan





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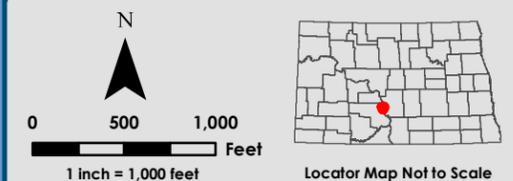
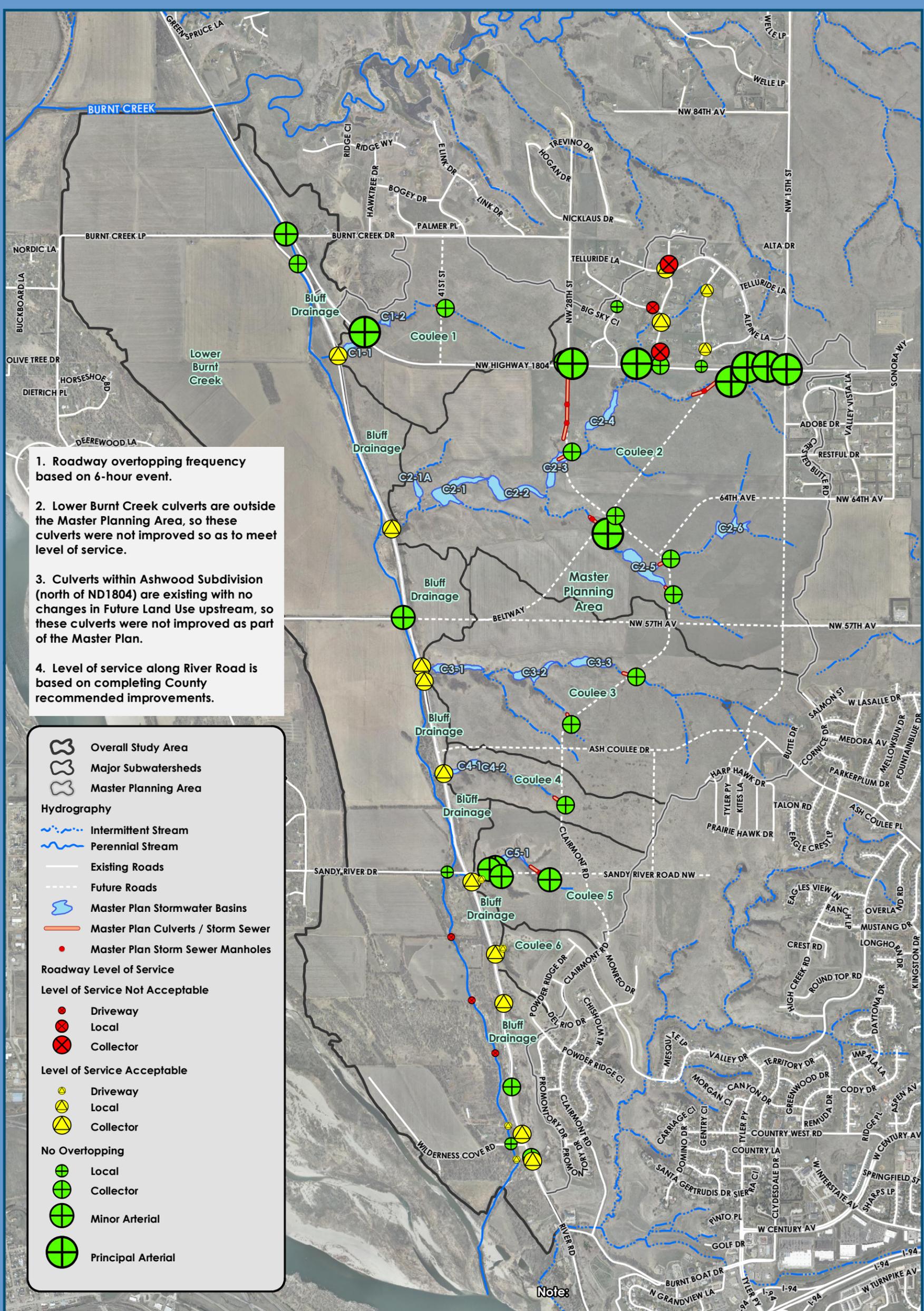


Figure 7-5:
Master Plan Peak Flows at NDDOT Crossings
City of Bismarck
Ash and Ward Coulee Stormwater Master Plan





1. Roadway overtopping frequency based on 6-hour event.
2. Lower Burnt Creek culverts are outside the Master Planning Area, so these culverts were not improved so as to meet level of service.
3. Culverts within Ashwood Subdivision (north of ND1804) are existing with no changes in Future Land Use upstream, so these culverts were not improved as part of the Master Plan.
4. Level of service along River Road is based on completing County recommended improvements.

	Overall Study Area
	Major Subwatersheds
	Master Planning Area
Hydrography	
	Intermittent Stream
	Perennial Stream
	Existing Roads
	Future Roads
	Master Plan Stormwater Basins
	Master Plan Culverts / Storm Sewer
	Master Plan Storm Sewer Manholes
Roadway Level of Service	
Level of Service Not Acceptable	
	Driveway
	Local
	Collector
Level of Service Acceptable	
	Driveway
	Local
	Collector
No Overtopping	
	Local
	Collector
	Minor Arterial
	Principal Arterial

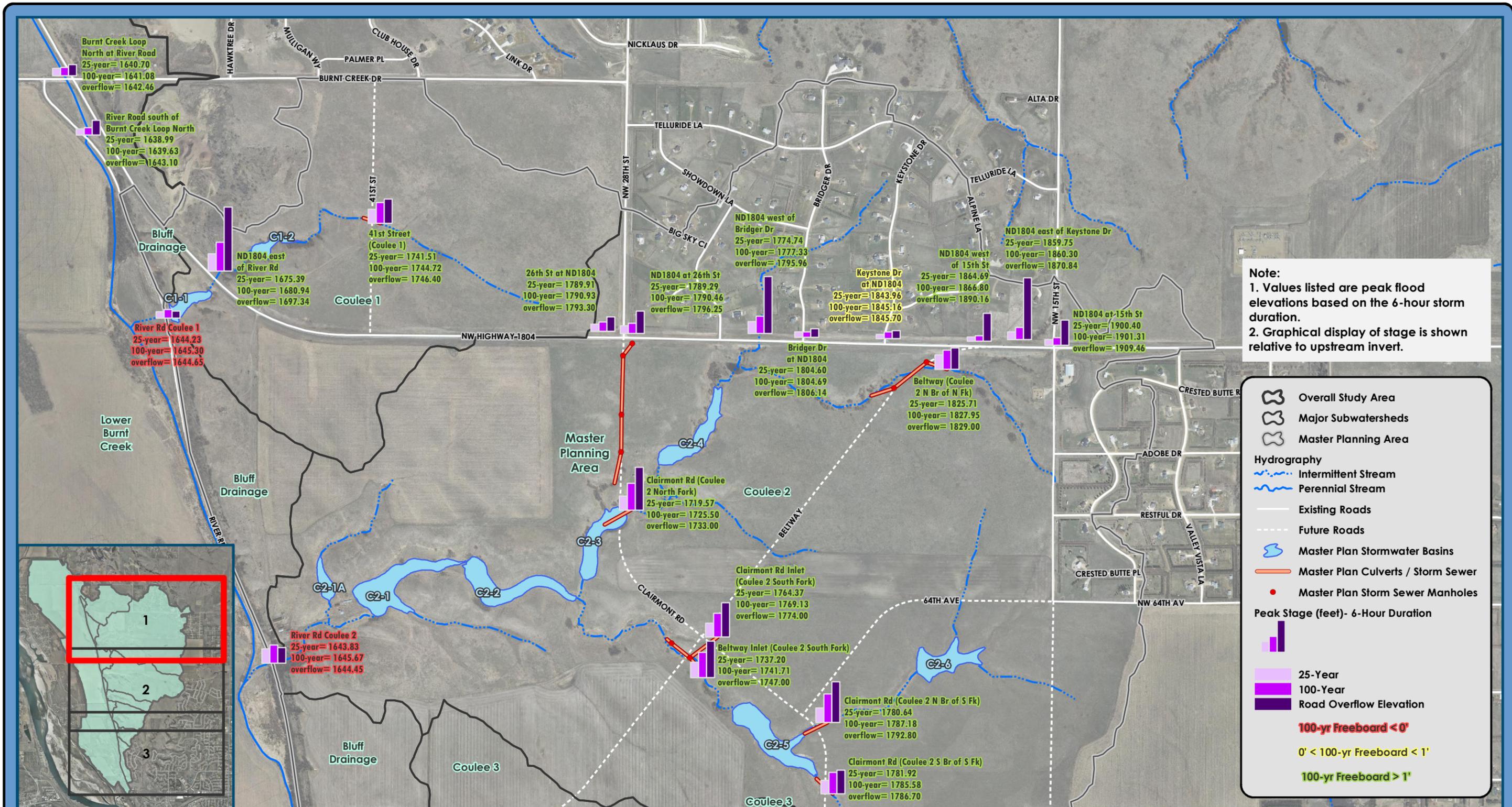
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0 1,000 2,000
Feet
1 inch = 2,000 feet

Locator Map Not to Scale

Figure 7-6:
Master Plan Roadway Level of Service
City of Bismarck
Ash and Ward Coulee Stormwater Master Plan





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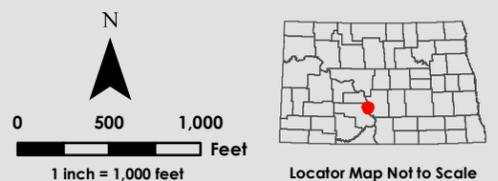
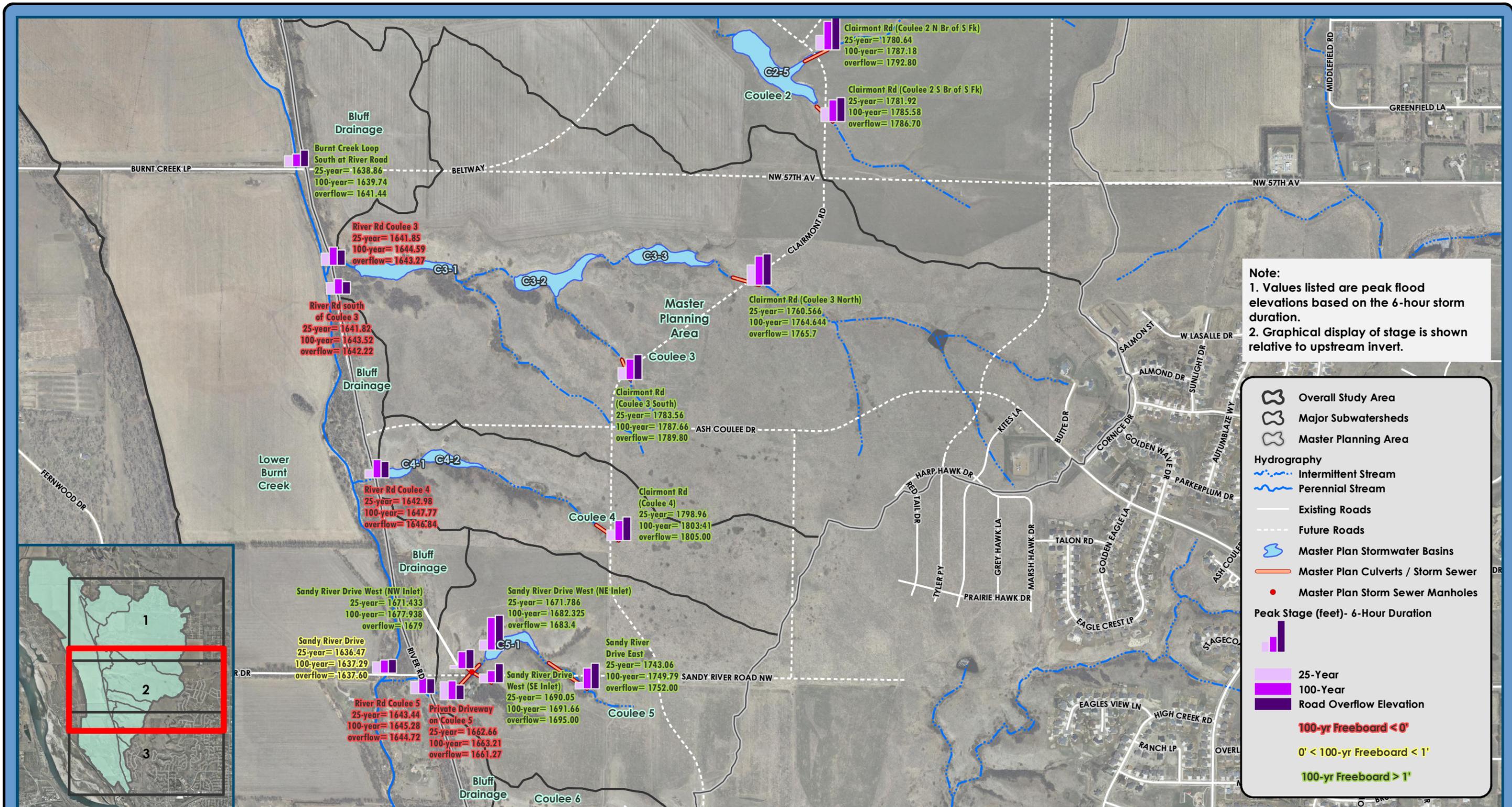


Figure 7-7: Page 1 of 3
 Master Plan Peak Stages at Key Crossings
 City of Bismarck
 Ash and Ward Coulee Stormwater Master Plan





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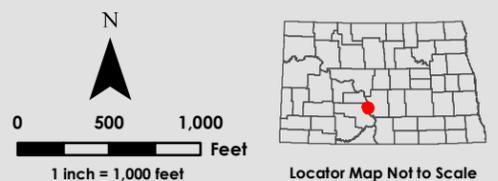
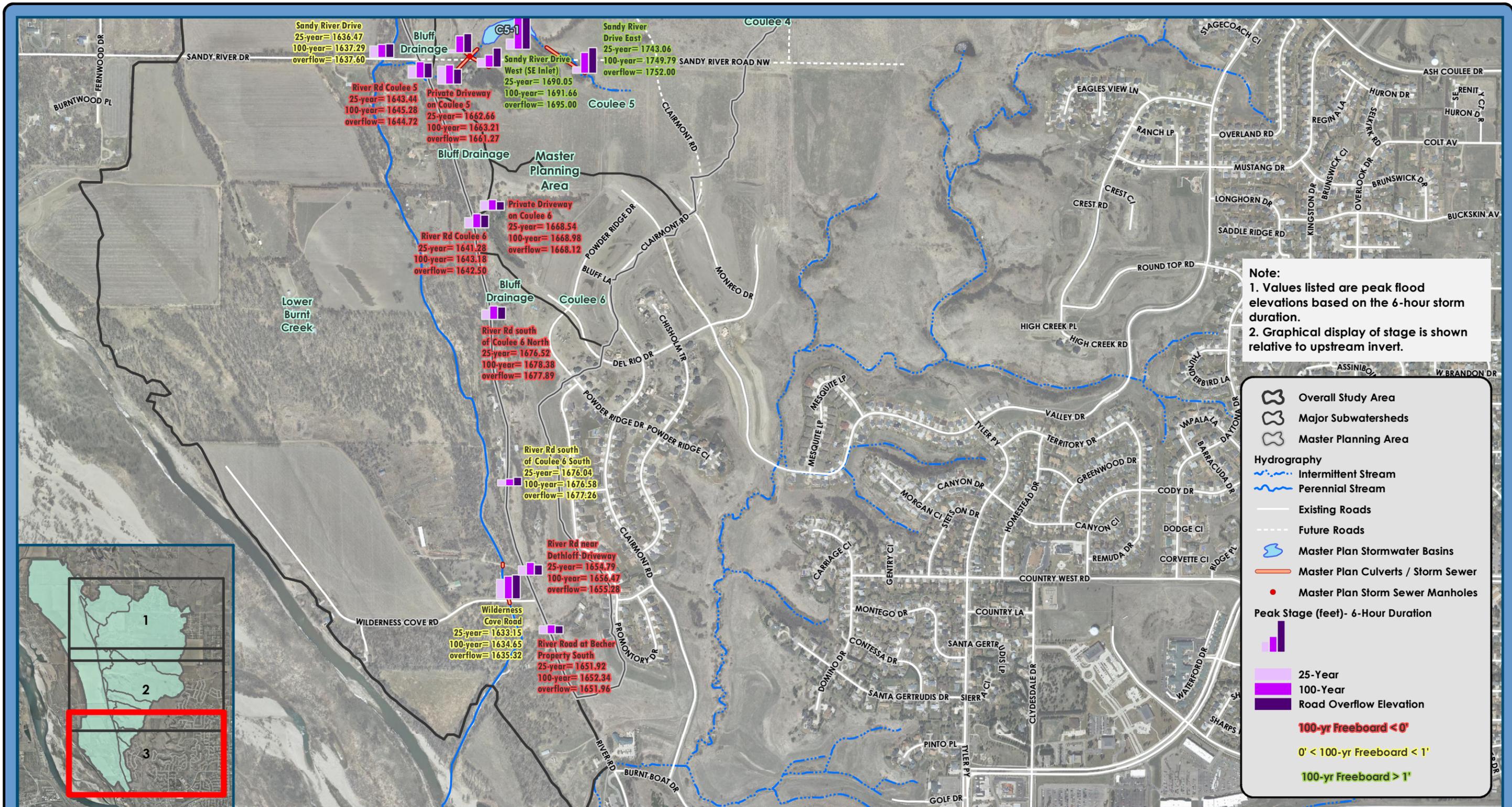


Figure 7-7: Page 2 of 3
 Master Plan Peak Stages at Key Crossings
 City of Bismarck
 Ash and Ward Coulee Stormwater Master Plan





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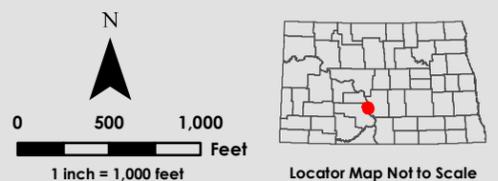
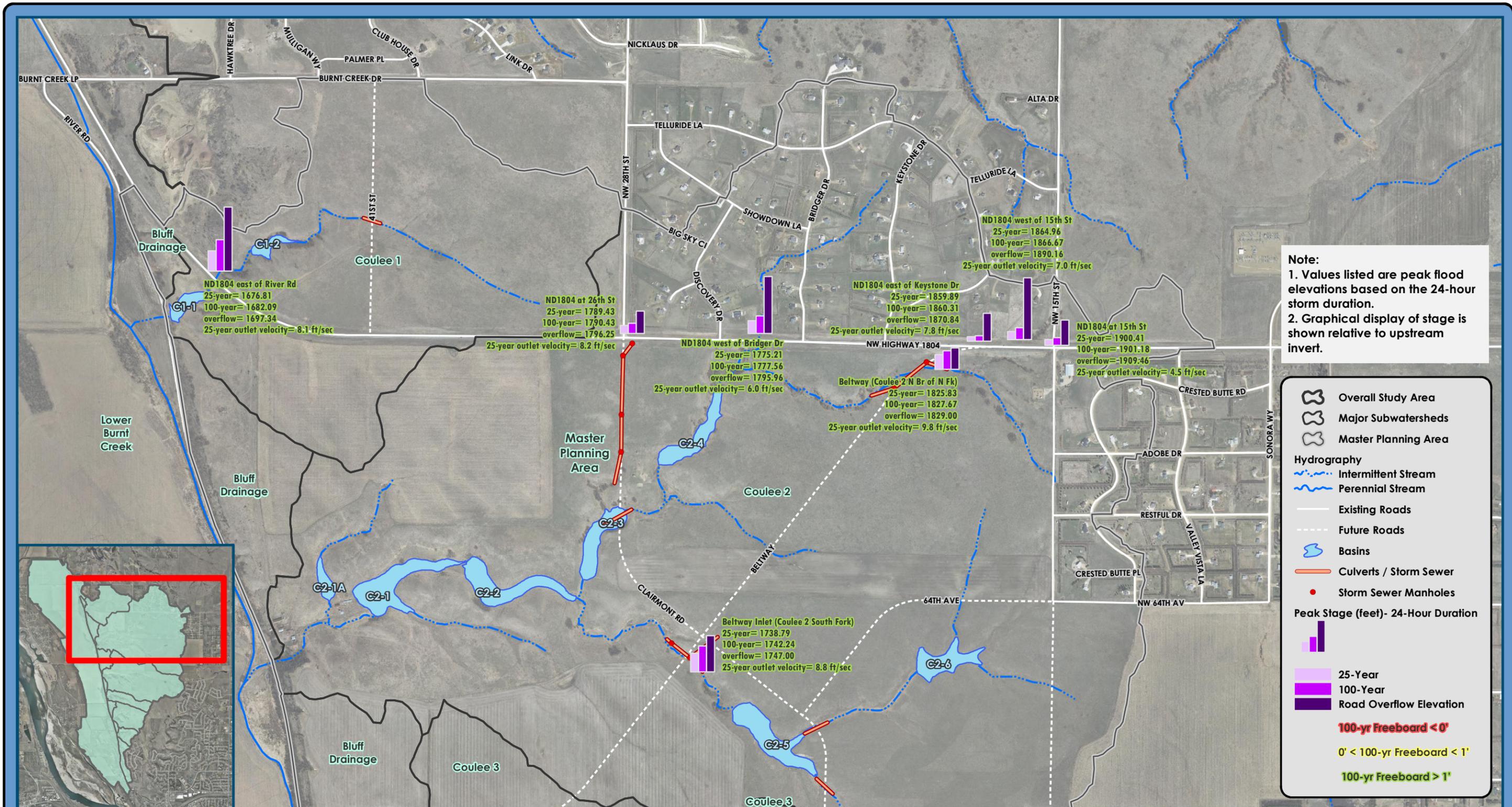


Figure 7-7: Page 3 of 3
 Master Plan Peak Stages at Key Crossings
 City of Bismarck
 Ash and Ward Coulee Stormwater Master Plan





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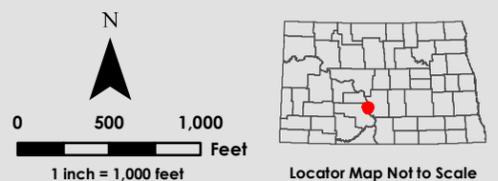
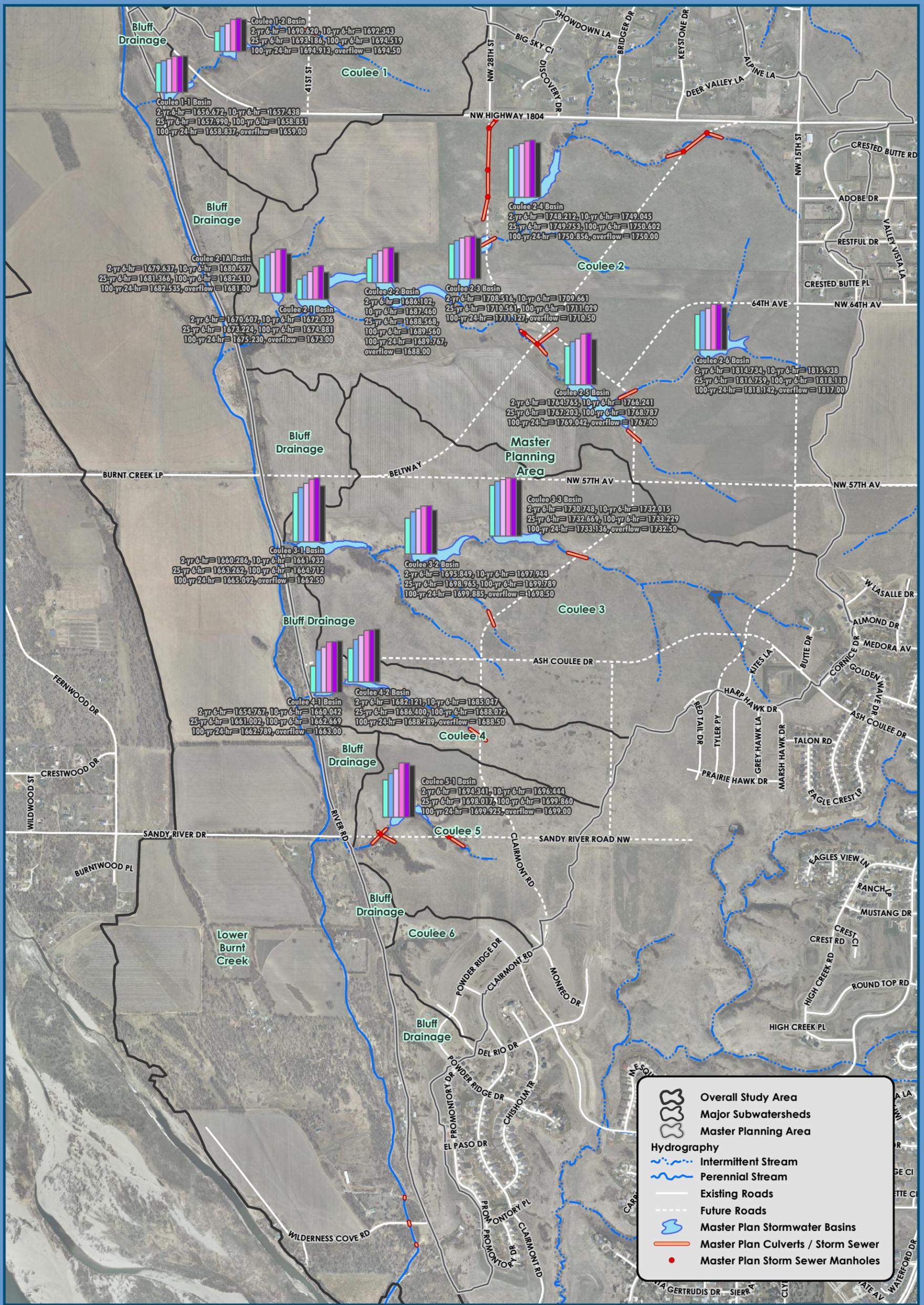


Figure 7-8:
Master Plan Peak Stages at NDDOT Crossings
City of Bismarck
Ash and Ward Coulee Stormwater Master Plan





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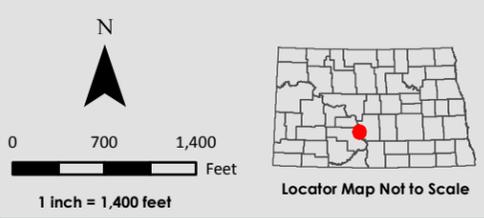


Figure 7-9:
Master Plan Peak Basin Stages

City of Bismarck
Ash and Ward Coulee Stormwater Master Plan



7.4.5 Coulee Stability

Since the Master Plan focuses on controlling peak discharges at the coulee outlets rather than at every point within the coulee valleys, there are a number of locations where the shear stress will increase compared to existing conditions (*Figures 7-10 and 7-11*). Hard armoring measures will likely be needed in several locations in Coulees 5 and 6 because of the steep topography. Many of the side branches and main stems of the coulees and sections will also require vegetation reinforcement (such as turf reinforcement mat).

As described in *Section 3.2.2*, this Master Plan includes a Coulee Stability BMP toolbox that provides several potential surface armoring techniques that will be required throughout the coulees as the watershed develops (*Appendix C*).

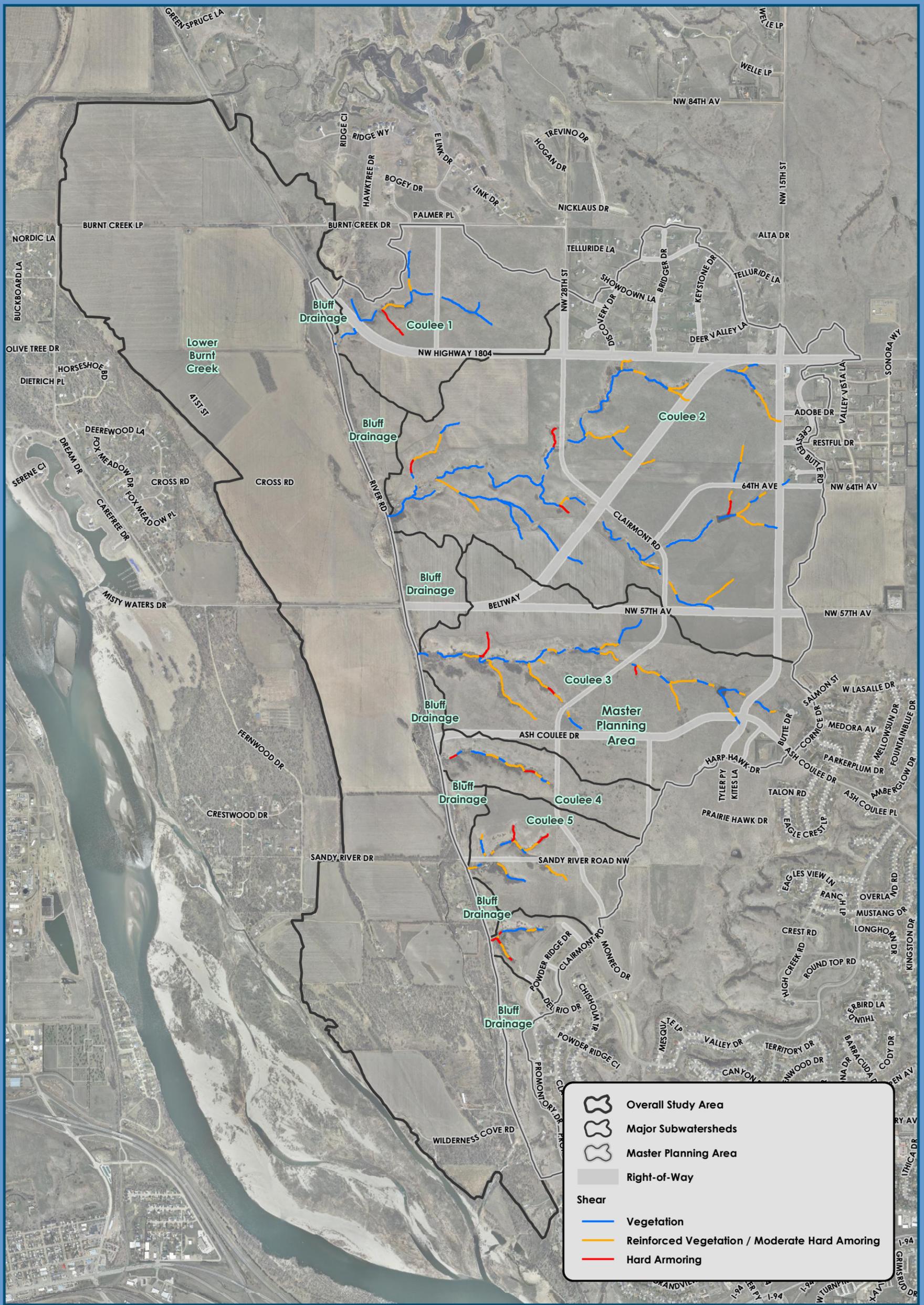
7.4.6 Lower Burnt Creek

For the comparison locations along Lower Burnt Creek, the Master Plan will maintain existing 2-through 100-year flood elevations, with many locations being reduced, as displayed in *Table 7-5*. The over-detention and relatively minor downstream conveyance improvements mitigate for the development within the Ash-Ward Coulee watersheds.

Table 7-5: Lower Burnt Creek Flood Elevation Changes – Master Plan

Location	Changes from Existing Conditions			
	2-Year	10-Year	25-Year	100-Year
Burnt Creek Loop North	0'	0'	0'	0'
River Road	0'	0'	0'	0'
Burnt Creek Loop South	-0.6'	0'	0'	0.1'
Sandy River Drive West Culverts	-0.2'	0.1'	0.1'	0.1'
Sandy River Drive East culvert	-0.2'	0.1'	0.1'	0.1'
Beck's Driveway	0'	0.1'	0.1'	0'
Farm Road	0'	0'	-0.3'	-0.1'
Crossing South of Farm Road	0'	0'	-0.2'	-0.1'
Dethloff's Driveway	-0.4'	-1'	-0.6'	-0.2'
Wilderness Cove Road	-0.3'	-0.6'	-0.5'	-0.7'
Crossing South of Wilderness Cove Rd	-0.1'	-0.1'	0.1'	0'
Crossing Upstream of Mouth	0'	0'	0'	0'
Edge of Field North of Sandy River Dr	0'	0'	0'	0'
Private Drive west of Beck's Driveway	0.1'	0'	0'	-0.4'
Private Drive west of Farm Road	0'	0'	0'	0'
Private Drive off Wilderness Cove Rd	0'	0'	0'	-0.5'

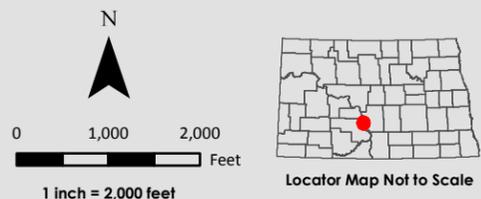
*Positive value means elevation is higher than existing conditions.
Green highlighted cells are located away from the Lower Burnt Creek main channel.

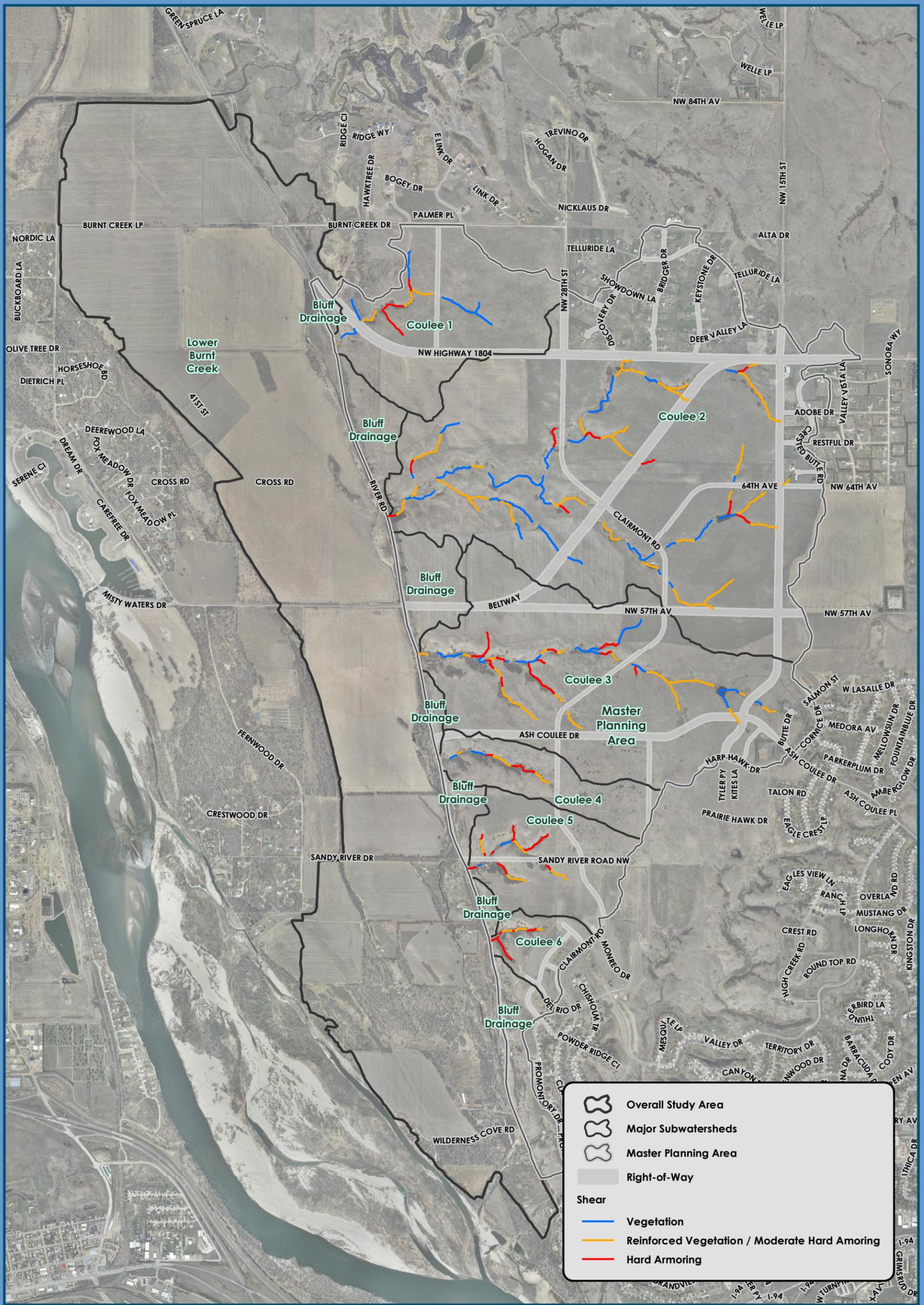


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**Figure 7-10:
Master Plan - Coulee Shear Stress (2-Year Event)**

**City of Bismarck
Ash and Ward Coulee Stormwater Master Plan**





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**Figure 7-11:
Master Plan - Coulee Shear Stress (25-Year Event)**

**City of Bismarck
Ash and Ward Coulee Stormwater Master Plan**



N

0 1,000 2,000 Feet

1 inch = 2,000 feet

Locator Map Not to Scale

7.5 Minimum Easement Requirements

Easements that extend above 100-year flood limits will be needed for the proposed detention facilities; however, all detention facilities are located within the geotechnical setback area and discussions with City staff indicate that the City will require the coulee valleys to be dedicated open space regardless of whether or not detention facilities are located within the coulee valley. Therefore, it is likely that a blanket Open Space / Stormwater easement will ultimately be dedicated for the coulees similar to the approach taken for recently platted Edgewood Village 7th Addition and Bismarck Edgewood Storm and Sanitary Improvements.

Nevertheless, preliminary easements for the detention basin embankments maximum inundation area have been created and are shown on **Figure 7-1** and in the **Exhibits**. Easement boundaries for detention basins were based on the 6-hour, 100-year event plus one foot or the emergency overflow elevation, whichever is higher.

7.6 Permitting Considerations

7.6.1 U.S. Army Corps of Engineers

While there are no wetlands within the Master Planning area that are registered on the National Wetland Inventory, there are likely wetlands located along the coulee valley in various locations, particularly at the lower ends of the coulees, which could include areas associated with Master Plan facilities. Additionally, the coulees (particularly Coulee 2) may meet jurisdictional requirements to be covered under Section 404 of the Clean Water Act.

Based on past interactions with U.S. Army Corps of Engineers (USACE) staff on other projects in Central and Western North Dakota, it is likely that any wetlands present within the main coulee valleys, and potentially the coulee drainage-ways themselves will be considered jurisdictional and potential impacts may be subject to review under Section 404 of the Clean Water Act. Note that a jurisdictional determination cannot be made until a formal request has been made. Therefore, as elements of this Master Plan are implemented, a wetland delineation and request for jurisdictional determination should be made early in the design process to determine permitting implications.

7.6.2 NDDOT

While only minor new development north of ND 1804 is proposed, the main interaction with NDDOT will likely come as part of the future Beltway construction that runs between 57th Avenue and the existing ND1804. The level of coordination and approvals from NDDOT that may be needed will entirely depend on when (and if) this roadway is constructed relative to development within the Master Planning area.

Further, the Master Plan assumes that the basin designed as part of the Ashwood subdivision remains in place, which utilizes the ND1804 embankment and culvert as the control structure to attenuate flows. Coordination with NDDOT will be needed if at some point the NDDOT expands ND 1804 and/or decides to replace this culvert.

7.6.3 ND State Water Commission

This Master Plan has been specifically prepared such that detention basins have less than 25 acre-feet of storage and that all road crossings meet Stream Crossing Standards and therefore, do

not trigger regulation of stormwater detention facilities or road crossings as dams. Therefore, any modifications to this plan, particularly if detention facilities should at any point be incorporated into road crossings, should be carefully reviewed to verify that either Stream Crossing Standards are met or that the facility can store less than 25 acre-feet, as determined by the storage from the natural channel invert to the lowest surface overflow point.

8.0 OPINION OF PROBABLE COSTS, IMPLEMENTATION PLAN, AND FUNDING SUMMARY

8.1 Opinion of Probable Costs

Opinions of probable costs were developed for each of the regional facilities incorporated into the Master Plan (*Exhibits*). Unit rates were developed based on review of local bids, NDDOT bid data, and material costs obtained directly from suppliers. The opinion of probable costs shown in *Table 8-1* does not include land acquisition costs. Additionally, there will be regional costs associated with stabilizing the main coulee that are not included in the opinions of probable cost. The exact costs are difficult to estimate since stabilization within specific areas is dependent on a detailed investigation of the local vegetation type and cover, soils, and hydraulic properties. A detailed analysis was not within the scope of this study so specific costs for coulee stabilization have not been developed.

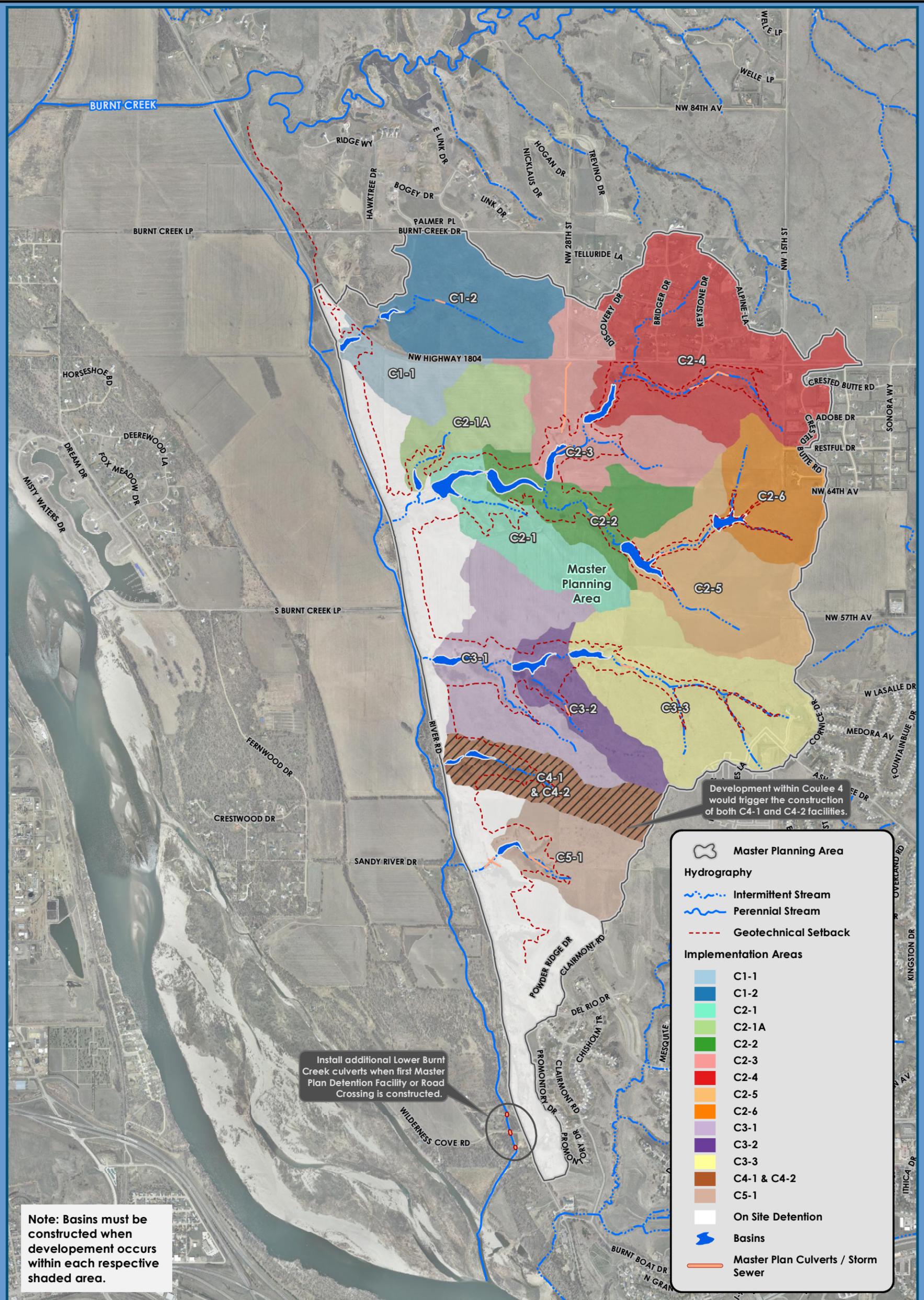
Table 8-1: Summary of Opinion of Probable Costs

Coulee and Facility Name	Facility Type	Opinion of Probable Cost ¹
<i>Coulee 1</i>		<i>\$1,126,545</i>
C1-1	Regional Detention	\$598,650
C1-2	Regional Detention	\$403,050
41st Street	Road Crossing	\$124,845
<i>Coulee 2</i>		<i>\$8,584,250</i>
C2-1	Regional Detention	\$1,386,600
C2-1A	Regional Detention	\$427,200
C2-2	Regional Detention	\$567,750
C2-3	Regional Detention	\$479,850
C2-4	Regional Detention	\$550,050
C2-5	Regional Detention	\$608,100
C2-6	Regional Detention	\$986,100
Beltway - North Branch of North Fork	Road Crossing	\$858,545
Clairmont Road - West Branch of North Fork	Road Crossing	\$1,073,870
Clairmont Road - North Fork	Road Crossing	\$220,110
Clairmont Road & Beltway Intersection - South Fork	Road Crossing	\$796,775
Clairmont Road - North Branch of South Fork	Road Crossing	\$203,145
Clairmont Road - South Branch of South Fork	Road Crossing	\$426,155
<i>Coulee 3</i>		<i>\$2,766,310</i>
C3-1	Regional Detention	\$853,950
C3-2	Regional Detention	\$610,650
C3-3	Regional Detention	\$810,450
Clairmont Road - North	Road Crossing	\$372,940
Clairmont Road - South	Road Crossing	\$118,320
<i>Coulee 4</i>		<i>\$1,108,895</i>
C4-1	Regional Detention	\$508,950
C4-2	Regional Detention	\$433,050
Clairmont Road	Road Crossing	\$166,895
<i>Coulee 5</i>		<i>\$1,250,585</i>
C5-1	Regional Detention	\$642,600
Sandy River Drive - East	Road Crossing	\$302,470
Sandy River Drive - West	Road Crossing	\$305,515
<i>Lower Burnt Creek</i>		<i>\$47,705</i>
Lower Burnt Creek Culvert Improvements	Culvert Improvements	\$47,705
Grand Total		\$14,884,290

¹Includes a 15% estimating contingency and 30% for Engineering and Administration. Costs do not include any land or easement acquisition.

8.2 Implementation Plan

An implementation plan has been developed for this Master Plan to balance capital outlays with proposed development patterns. The key trigger for construction of a particular regional facility is when development within the direct contributing area for a regional facility occurs. The proposed implementation plan for the Master Plan is shown on *Figure 8-1*.

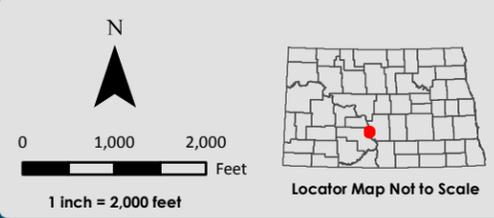


Note: Basins must be constructed when development occurs within each respective shaded area.

Install additional Lower Burnt Creek culverts when first Master Plan Detention Facility or Road Crossing is constructed.

Development within Coulee 4 would trigger the construction of both C4-1 and C4-2 facilities.

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**Figure 8-1:
Implementation Plan**
City of Bismarck
Ash and Ward Coulee Stormwater Master Plan



8.3 Funding Summary

The City of Bismarck utilizes revenue generated through Special Assessments to pay for improvements associated with regional stormwater facilities that benefit properties contributing drainage to those facilities. Currently the City allocates the costs of its stormwater Special Assessment Districts based on parcel/lot square footage of each land-use type within the Assessment District. Stormwater Assessment District boundaries are determined by watershed areas with the assessments applied based on land-use type. Right-of-way, coulees, detention ponds, and other non-developable lots and open spaces are considered non-assessable acreage. The City carries the portions of the cost of the improvement for any un-annexed property within the Assessment District by holding the allocated assessment amount in abeyance until a time in which the benefitted land is annexed to the City.

In order to determine equitability in the spreading of assessments associated with varying amounts of contributing runoff per unit area from various land use types, the City currently applies “factors” to each land-use type for the purpose of determining equivalent residential acres within the Assessment District, as follows:

- Residential: 1.0
- Commercial: 2.0
- Park property with revenue producing facility (i.e. pool): 2.0 (Non-Residential)
- Park property without revenue producing facility: 1.0 (Residential)
- Schools and Churches: 2.0 (Non-Residential)

Ultimately, each assessable land-use type within the Assessment District is assigned either a Residential Factor of “1” or a Non-Residential (Commercial) factor of “2.” These factors are then applied to the acreage for each land-use type in order to allocate the improvement costs based on equivalent residential acres. For example, if the total assessable watershed acreage is 500 acres, with 200 acres of Residential and 300 acres of Commercial, the equivalent Residential acreage for the Residential land-use is 200 ($200 * 1$) and the equivalent Residential acres for the Commercial land-use is 600 ($300 * 2$), for a total of 800 equivalent residential acres. Therefore, in this example, the Residential land-use would be allocated 25% ($200 / 800$) of the total costs for regional facilities within the watershed and the Commercial land-use category would be allocated 75% ($600 / 800$) of the total costs.

As previously identified, the total watershed acreage of the Ash and Ward Coulee Watershed is approximately 2,531 acres. Of the total watershed area, approximately 379 acres will require on-site detention (See *Figure 7-1*, shown previously) meeting all of the City ordinances because these areas do not drain to a regional facility. The net watershed area that could be subject to regional assessments would be 2,152 acres. Based on City standard practice, 25% of the 2,152 acres is assumed to be non-assessable (non-developable lots), leaving 1,614 acres as assessable acreage. Based on the future land use (*Figure 2-2*, shown previously), it was determined that approximately 1,495 acres of the estimated assessable watershed acreage is Residential and 119 is Non-Residential. *Table 8-3* presents the calculation of the cost per assessable acre and the total Master Plan total project cost of \$14,836,585, which does not include the minor costs associated

with the Lower Burnt Creek culvert improvements (\$47,705). Based on input from City Work Group, the Lower Burnt Creek improvements will be completed as a non-assessable City project.

Table 8-2: Determination of Assessable Acres

Coulee 1	
Total Watershed ¹	250.64
Non-Assessable (25%)	62.66
Assessable Acreage	187.98
Residential Ratio ²	100.0%
Residential Acres	187.98
Non-Residential Acreage	0.0
Coulee 2	
Total Watershed ¹	1143.53
Non-Assessable (25%)	285.88
Assessable Acreage	857.65
Residential Ratio ²	86.16%
Residential Acres	738.95
Non-Residential Acreage	118.70
Coulee 3	
Total Watershed ¹	554.45
Non-Assessable (25%)	138.61
Assessable Acreage	415.84
Residential Ratio ²	100.0%
Residential Acres	415.84
Non-Residential Acreage	0.0
Coulee 4	
Total Watershed ¹	102.36
Non-Assessable (25%)	25.59
Assessable Acreage	76.77
Residential Ratio ²	100.0%
Residential Acres	76.77
Non-Residential Acreage	0.0
Coulee 5	
Total Watershed ¹	100.91
Non-Assessable (25%)	25.23
Assessable Acreage	75.68
Residential Ratio ²	100.0%
Residential Acres	75.68
Non-Residential Acreage	0.0

¹Total Watershed Area does not include portions of watershed which require on-site detention.

²Calculated as the ratio of: (LD Res. + LD Res Urban Reserve + MD Res. + Rural Res) / (LD Res. + LD Res Urban Reserve + MD Res. + Rural Res + Commercial) within each coulee as noted in Table 2-3.

Table 8-3: Assessment for Master Plan Improvements

Land Use	Assseable Acres ¹	Factor	Equivalent Residential Acres	% Total Equivalent Residential Acres	Master Plan Total Cost	Cost Per Assessable Acre
Coulee 1						
Residential	188	1	188	100%	\$1,126,545	\$5,992
Non-Residential	0	2	0	0%	\$0	\$0
Total	188		188	100%	\$1,126,545	
Coulee 2						
Residential	739	1	739	76%	\$6,497,817	\$8,793
Non-Residential	119	2	237	24%	\$2,086,433	\$17,585
Total	858		976	100%	\$8,584,250	
Coulee 3						
Residential	416	1	416	100%	\$2,766,310	\$6,653
Non-Residential	0	2	0	0%	\$0	\$0
Total	416		416	100%	\$2,766,310	
Coulee 4						
Residential	77	1	77	100%	\$1,108,895	\$14,439
Non-Residential	0	2	0	0%	\$0	\$0
Total	77		77	100%	\$1,108,895	
Coulee 5²						
Residential	76	1	76	100%	\$1,250,585	\$16,520
Non-Residential	0	2	0	0%	\$0	\$0
Total	76		76	100%	\$1,250,585	

¹Rounded to nearest acre.

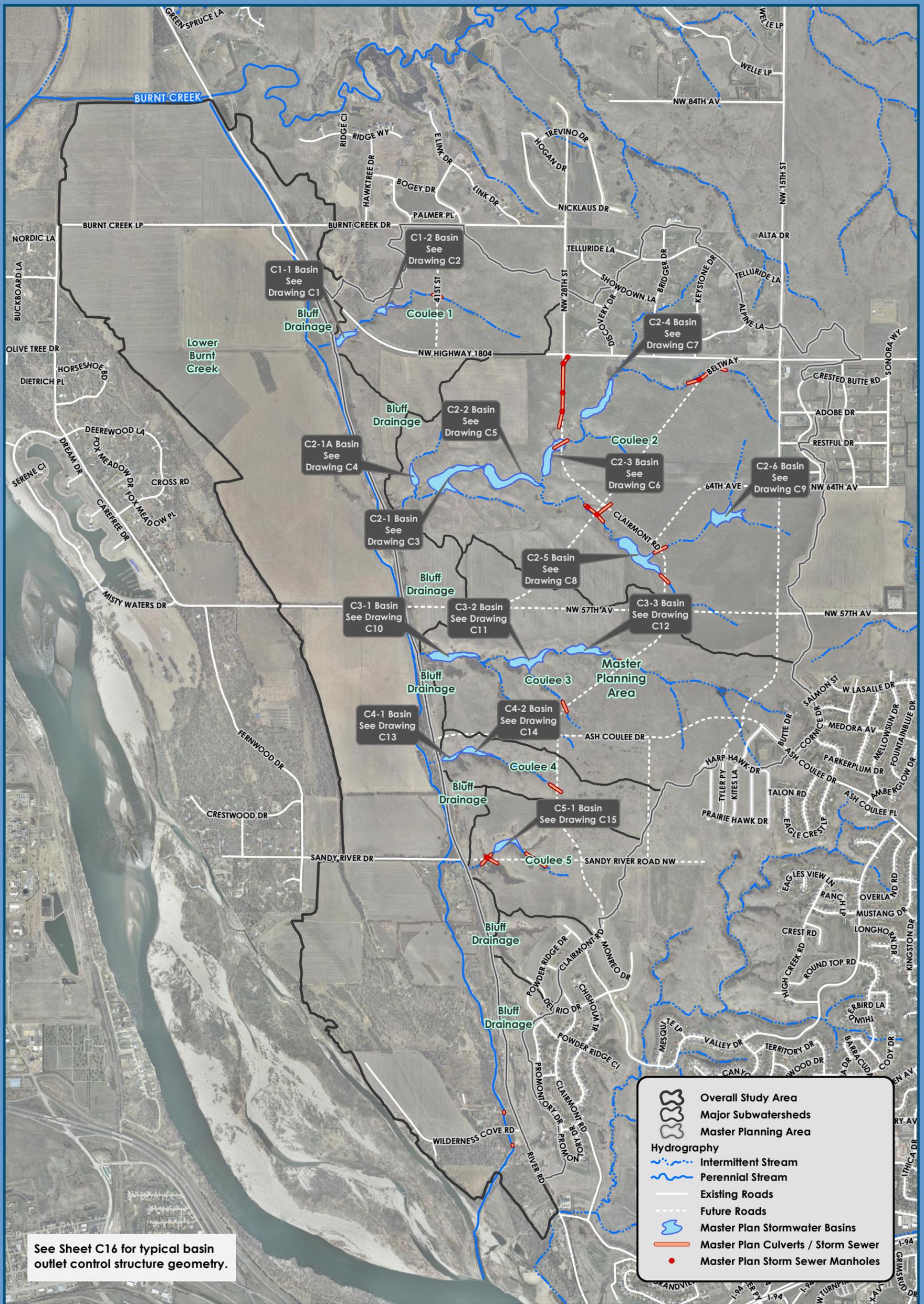
²Master Plan Total Cost includes costs associated with the Sandy River Drive (West) Crossing. Areas requiring on-site detention contribute to this crossing but are excluded from estimated Assessable Acres. If the Sandy River Drive (West) crossing is constructed generally as shown in this Master Plan, watershed areas that require on-site detention but contribute to this crossing would likely be assessed the portion of the Master Plan cost associated with the crossing.

9.0 CONCLUSIONS AND RECOMMENDATIONS

This Master Plan meets all City, County, and State requirements outlined in *Section 1.3* of this report for stormwater management given the proposed land use plan currently adopted by the City. In addition, this plan provides information that establishes a Geotechnical Setback line to provide the City guidance for areas that require more detailed geotechnical investigation if these areas are proposed to be developed.

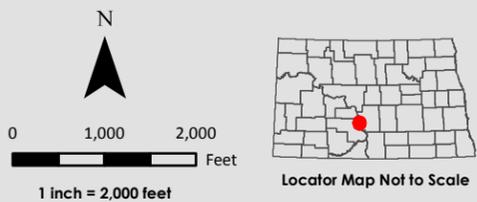
The performance of this Master Plan with respect to the objectives and goals is contingent on the future land use plan prepared by the City and regional planning organizations and the associated impervious area assumed for each land use. Modifications of the proposed land use plan or higher impervious percentages within specific land uses will necessitate review of this Master Plan.

EXHIBITS



See Sheet C16 for typical basin outlet control structure geometry.

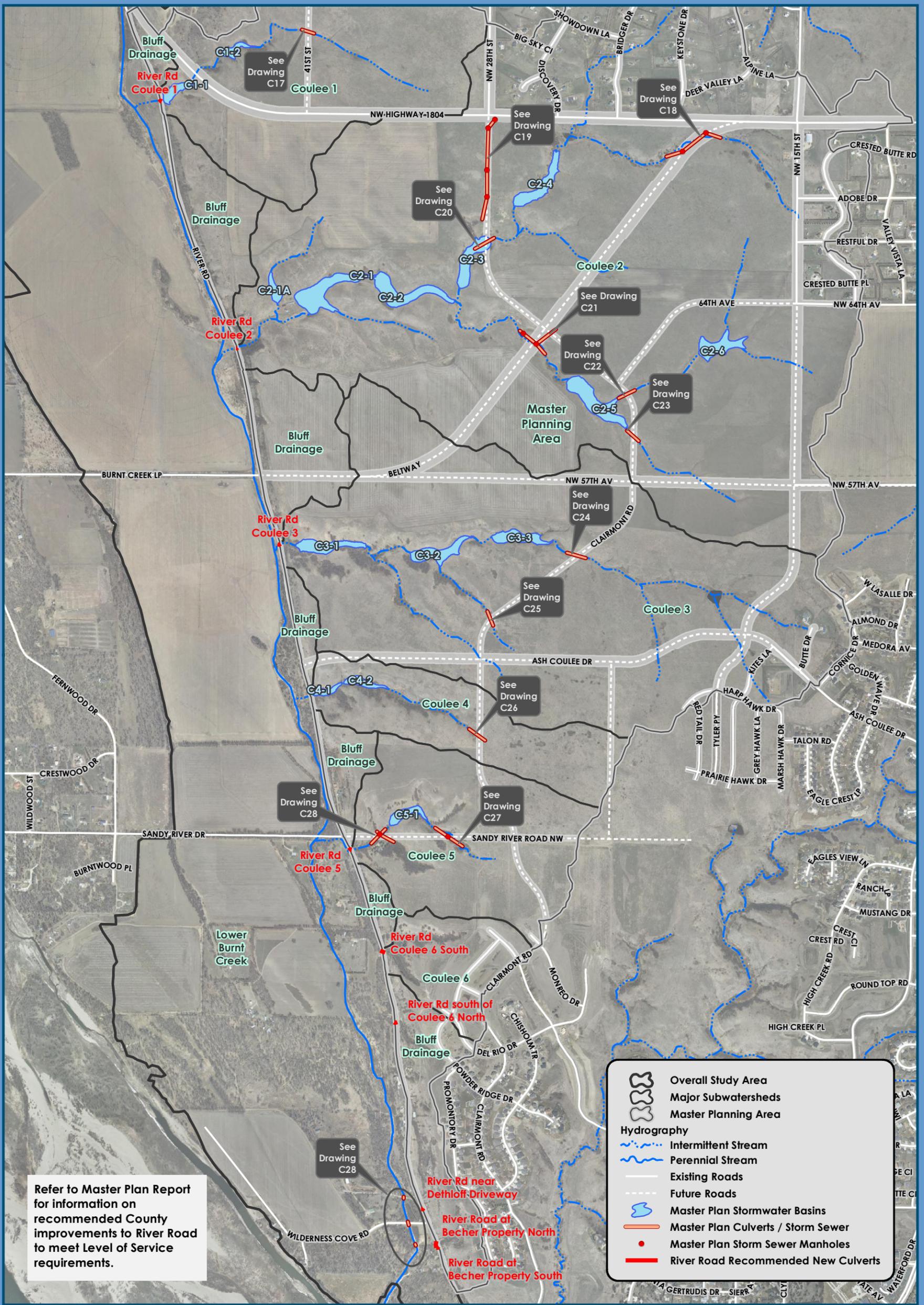
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**Regional Detention
Facility Exhibit Locator Map**

City of Bismarck
Ash and Ward Coulee Stormwater Master Plan





Refer to Master Plan Report for information on recommended County improvements to River Road to meet Level of Service requirements.

	Overall Study Area
	Major Subwatersheds
	Master Planning Area
Hydrography	
	Intermittent Stream
	Perennial Stream
	Existing Roads
	Future Roads
	Master Plan Stormwater Basins
	Master Plan Culverts / Storm Sewer
	Master Plan Storm Sewer Manholes
	River Road Recommended New Culverts

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0 700 1,400
Feet

1 inch = 1,400 feet

Locator Map Not to Scale

Road Crossing Exhibit Locator Map

City of Bismarck

Ash and Ward Coulee Stormwater Master Plan



Plotted By: Jason Gerving Date: Tuesday, July 14, 2015 1:27:54 PM
 Last Saved By: Jason Gerving Date: Tuesday, July 14, 2015 1:27:54 PM
 File: L:\City of Bismarck\F00501-2013-06 Bismarck Ash and Ward Coulee Watershed Master Plan\030 Preliminary Engineering Drawings\01-Civil\C1-1_Alt1_Figures.dwg

STAGE STORAGE	
ELEVATION	AREA (AC)
1647.00	0.01
1648.00	0.07
1650.00	0.15
1652.00	0.26
1654.00	0.41
1656.00	0.61
1658.00	0.82
1659.00	0.93

C1-1 BASIN:
 BOTTOM ELEV: 1648.00
 OVERFLOW: 1659.00
 STORAGE: 4.60 AC-FT
 SEE TABLE FOR
 STAGE-AREA
 RELATIONSHIP

CONCEPT DRAINAGE
 EASEMENT BOUNDARY
 (1.27 AC)

48" DIAMETER MANHOLE (SOLID
 LID) WITH 4" ORIFICE HOLE
 DRILLED. INVERT ELEV: 1648.00

80 LF 18" RCP OUTLET PIPE

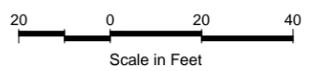
18' WIDE SPILLWAY
 ELEVATION: 1659.00
 CONCRETE SILL OVERFLOW AND
 TURF REINFORCEMENT APPLIED TO
 EMBANKMENT SLOPE

8'x4' BOX MANHOLE WITH HAALA
 BCTM 8'x4' GRATE
 RIM ELEV: 1656.50
 PIPE INVERT ELEV: 1646.50

78" RCP FES INVERT ELEV: 1644.10
 RIPRAP PROTECTION ON OUTFALL

90 LF 78" RCP OUTLET PIPE

- LEGEND**
- CONTOURS - INTERMEDIATE
 - CONTOURS - INDEX
 - PROPOSED CONTOURS - INTERMEDIATE
 - PROPOSED CONTOURS - INDEX
 - CURB & GUTTER
 - BITUMINOUS PAVEMENT
 - CONCRETE
 - STORM DRAIN
 - FLARED END SECTION



DATE	REVISION	APPROVED



ASH AND WARD COULEE STORMWATER MASTER PLAN
 CITY OF BISMARCK
 CITY OF BISMARCK, BURLEIGH COUNTY NORTH DAKOTA

DRAWING TYPE
FIGURE
PREPARED BY
JG
CHECKED / APPROVED
JL / JH
DATE
JULY 2015
PROJECT NUMBER
P00501-2013-06
SHEET
1 of 29

C1



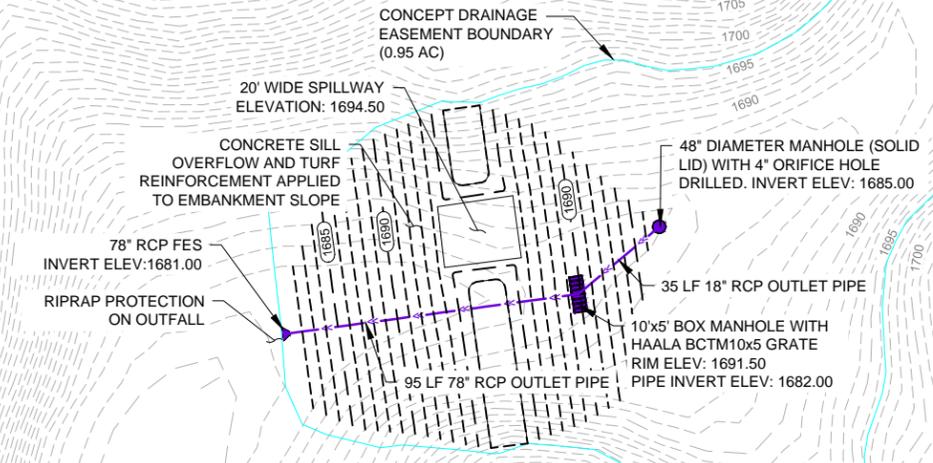
Engineers Opinion of Probable Costs

ITEM	ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
1	Bonding	1	LS	\$11,700	\$11,700
2	Mobilization	1	LS	\$77,500	\$77,500
3	Erosion Control	1	LS	\$14,800	\$14,800
4	Unclassified Excavation	3,700	CY	\$9	\$32,600
5	Dispose of Unclassified Excavation	3,700	CY	\$7	\$24,500
6	Embankment Fill	6,500	CY	\$9	\$57,200
7	18-inch RCP Low-Flow Outlet Pipe	80	LF	\$65	\$5,200
8	48-inch Concrete Round Manhole with 4-inch Orifice Hole Drilled and Clogging Protection	1	EA	\$4,000	\$4,000
9	78-inch RCP Outlet Pipe	90	LF	\$435	\$39,200
10	78-inch Flared End Section	1	EA	\$4,700	\$4,700
11	8'x4' Box Manhole (10.5' height), Pre-Cast Base	1	LS	\$13,800	\$13,800
12	HAALA BCTM8x4 Bar Grate	1	EA	\$5,000	\$5,000
13	Type VH Riprap	120	TON	\$100	\$12,000
14	Strip, Stockpile, and Replace Topsoil	750	CY	\$9	\$6,600
15	Seeding - Class VI	1,880	SY	\$1.5	\$2,800
16	Concrete Sill	1	LS	\$35,700	\$35,700
17	Erosion Control Mat	1,880	SY	\$3	\$5,700
18	Turf Reinforcement Mat	170	SY	\$6	\$1,100
19	Access Road	1	LS	\$20,000	\$20,000
20	Mitigation	1	LS	\$25,000	\$25,000
				Subtotal Construction Costs	\$399,100
				15% Contingencies	\$59,865
				Section 404 Permitting (5%)	\$19,955
				Legal, Administration & Engineering (30%)	\$119,730
				TOTAL PROJECT COSTS	\$598,650
21	Property Acquisition	1.1	Acre	\$0	\$0
				TOTAL FACILITY COSTS	\$598,650

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Plotted By: Jason Gervig Date: Tuesday, July 14, 2015 8:10:07 AM
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STAGE STORAGE	
ELEVATION	AREA (AC)
1684.00	0.01
1685.00	0.05
1687.00	0.14
1689.00	0.26
1691.00	0.37
1693.00	0.49
1694.50	0.60



C1-2 BASIN:
 BOTTOM ELEV: 1685.00 OVERFLOW: 1694.50
 STORAGE: 2.90 AC-FT
 SEE TABLE FOR STAGE-AREA RELATIONSHIP

- LEGEND**
- CONTOURS - INTERMEDIATE
 - CONTOURS - INDEX
 - PROPOSED CONTOURS - INTERMEDIATE
 - PROPOSED CONTOURS - INDEX
 - CURB & GUTTER
 - BITUMINOUS PAVEMENT
 - CONCRETE
 - STORM DRAIN
 - FLARED END SECTION



DATE	REVISION	APPROVED



ASH AND WARD COULEE STORMWATER MASTER PLAN
 CITY OF BISMARCK
 CITY OF BISMARCK, BURLEIGH COUNTY NORTH DAKOTA

DRAWING TYPE	FIGURE
PREPARED BY	JG
CHECKED / APPROVED	JL / JH
DATE	JULY 2015
PROJECT NUMBER	P00501-2013-06
SHEET	2 of 29

C2



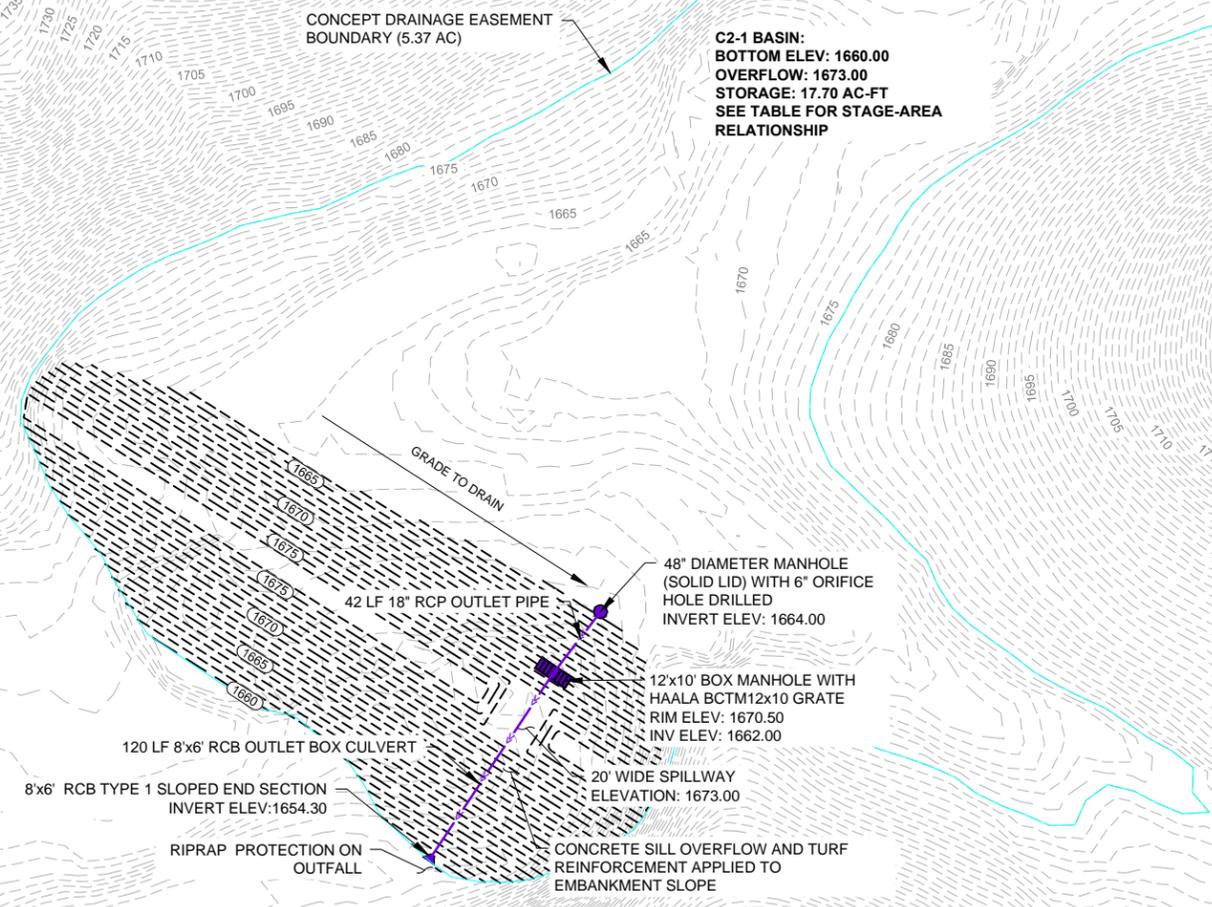
Engineers Opinion of Probable Costs

ITEM	ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
1	Bonding	1	LS	\$7,900	\$7,900
2	Mobilization	1	LS	\$52,200	\$52,200
3	Erosion Control	1	LS	\$10,000	\$10,000
4	Unclassified Excavation	0	CY	\$9	\$0
5	Dispose of Unclassified Excavation	0	CY	\$7	\$0
6	Embankment Fill	2,400	CY	\$9	\$21,200
7	18-inch RCP Low-Flow Outlet Pipe	35	LF	\$65	\$2,300
8	48-inch Concrete Round Manhole with 4-inch Orifice Hole Drilled and Clogging Protection	1	EA	\$4,000	\$4,000
9	78-inch RCP Outlet Pipe	95	LF	\$435	\$41,400
10	78-inch Flared End Section	1	EA	\$4,700	\$4,700
11	10'x5' Box Manhole (7.5' height), Pre-Cast Base and Custom Bar Grate	1	LS	\$14,400	\$14,400
12	HAALA BCTM10x5 Bar Grate	1	EA	\$6,500	\$6,500
13	Type VH Riprap	120	TON	\$100	\$12,000
14	Strip, Stockpile, and Replace Topsoil	520	CY	\$9	\$4,600
15	Seeding - Class VI	1,300	SY	\$1.5	\$2,000
16	Concrete Sill	1	LS	\$35,700	\$35,700
17	Erosion Control Mat	1,300	SY	\$3	\$3,900
18	Turf Reinforcement Mat	140	SY	\$6	\$900
19	Access Road	1	LS	\$20,000	\$20,000
20	Mitigation	1	LS	\$25,000	\$25,000

				Subtotal Construction Costs	\$268,700
				15% Contingencies	\$40,305
				Section 404 Permitting (5%)	\$13,435
				Legal, Administration & Engineering (30%)	\$80,610
				TOTAL PROJECT COSTS	\$403,050
21	Property Acquisition	0.7	Acre	\$0	\$0
				TOTAL FACILITY COSTS	\$403,050

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STAGE STORAGE	
ELEVATION	AREA (AC)
1660	0.30
1662	0.65
1664	0.90
1666	1.23
1668	1.71
1670	2.76
1673	3.50



C2-1 BASIN:
 BOTTOM ELEV: 1660.00
 OVERFLOW: 1673.00
 STORAGE: 17.70 AC-FT
 SEE TABLE FOR STAGE-AREA
 RELATIONSHIP

CONCEPT DRAINAGE EASEMENT
 BOUNDARY (5.37 AC)

- LEGEND**
- CONTOURS - INTERMEDIATE
 - CONTOURS - INDEX
 - PROPOSED CONTOURS - INTERMEDIATE
 - PROPOSED CONTOURS - INDEX
 - CURB & GUTTER
 - BITUMINOUS PAVEMENT
 - CONCRETE
 - STORM DRAIN
 - FLARED END SECTION



DATE	REVISION	APPROVED



ASH AND WARD COULEE STORMWATER MASTER PLAN
 CITY OF BISMARCK
 CITY OF BISMARCK, BURLEIGH COUNTY NORTH DAKOTA

DRAWING TYPE	FIGURE
PREPARED BY	JG
CHECKED / APPROVED	JL / JH
DATE	JULY 2015
PROJECT NUMBER	P00501-2013-06
SHEET	3 of 29

C3



Engineers Opinion of Probable Costs

ITEM	ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
1	Bonding	1	LS	\$27,000	\$27,000
2	Mobilization	1	LS	\$179,500	\$179,500
3	Erosion Control	1	LS	\$34,200	\$34,200
4	Unclassified Excavation	11,000	CY	\$9	\$96,800
5	Dispose of Unclassified Excavation	11,000	CY	\$7	\$72,600
6	Embankment Fill	26,800	CY	\$9	\$235,900
7	18-inch RCP Low-Flow Outlet Pipe	42	LF	\$65	\$2,800
8	48-inch Concrete Round Manhole with 4-inch Orifice Hole Drilled and Clogging Protection	1	EA	\$4,000	\$4,000
9	8'x6' RCB Outlet Pipe	120	LF	\$750	\$90,000
10	8'x6' RCB Type 1 Sloped End Section (6')	1	EA	\$7,000	\$7,000
11	12'x10' Box Manhole (8.5' height), Pre-Cast Base and Custom Bar Grate	1	LS	\$25,000	\$25,000
12	HAALA BCTM12x10 Bar Grate	1	EA	\$12,000	\$12,000
13	Type VH Riprap	120	TON	\$100	\$12,000
14	Strip, Stockpile, and Replace Topsoil	2,200	CY	\$9	\$19,400
15	Seeding - Class VI	5,490	SY	\$1.5	\$8,100
16	Concrete Sill	1	LS	\$35,700	\$35,700
17	Erosion Control Mat	5,490	SY	\$3	\$16,500
18	Turf Reinforcement Mat	150	SY	\$6	\$900
19	Access Road	1	LS	\$20,000	\$20,000
20	Mitigation	1	LS	\$25,000	\$25,000

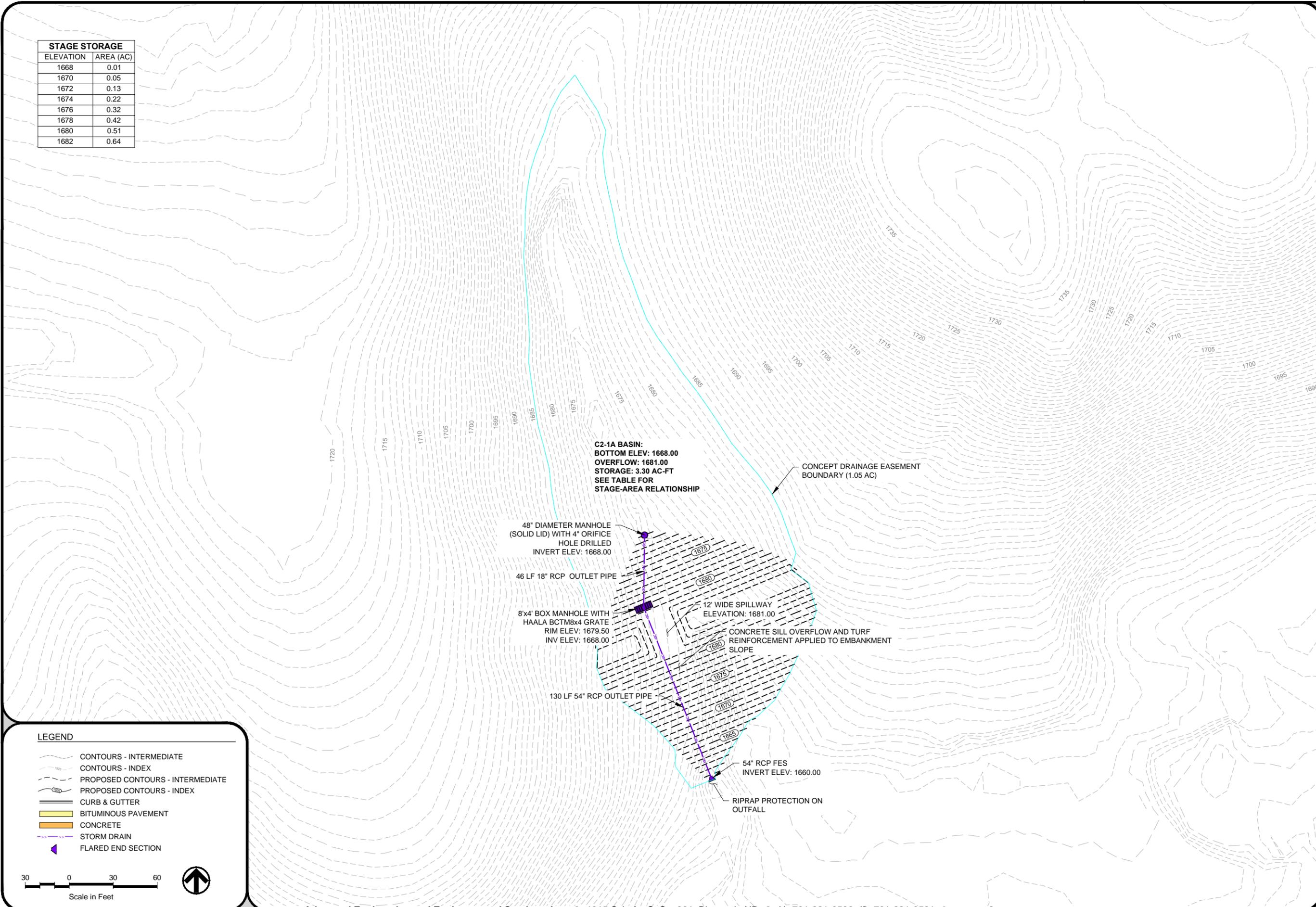
Subtotal Construction Costs				\$924,400	
15% Contingencies				\$138,660	
Section 404 Permitting (5%)				\$46,220	
Legal, Administration & Engineering (30%)				\$277,320	
TOTAL PROJECT COSTS				\$1,386,600	
21	Property Acquisition	4.7	Acre	\$0	\$0
TOTAL FACILITY COSTS				\$1,386,600	



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 Last Saved By: Jason Gervig Date: Tuesday, July 14, 2015 1:30:13 PM

STAGE STORAGE	
ELEVATION	AREA (AC)
1668	0.01
1670	0.05
1672	0.13
1674	0.22
1676	0.32
1678	0.42
1680	0.51
1682	0.64



- LEGEND**
- CONTOURS - INTERMEDIATE
 - CONTOURS - INDEX
 - - - PROPOSED CONTOURS - INTERMEDIATE
 - - - PROPOSED CONTOURS - INDEX
 - CURB & GUTTER
 - BITUMINOUS PAVEMENT
 - CONCRETE
 - STORM DRAIN
 - ◀ FLARED END SECTION



APPROVED		REVISION		DATE	
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ASH AND WARD COULEE STORMWATER MASTER PLAN CITY OF BISMARCK CITY OF BISMARCK, BURLEIGH COUNTY NORTH DAKOTA					
Bismarck					
DRAWING TYPE					
FIGURE					
PREPARED BY					
JG					
CHECKED / APPROVED					
JL / JH					
DATE					
JULY 2015					
PROJECT NUMBER					
P00501-2013-06					
SHEET					
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C4					



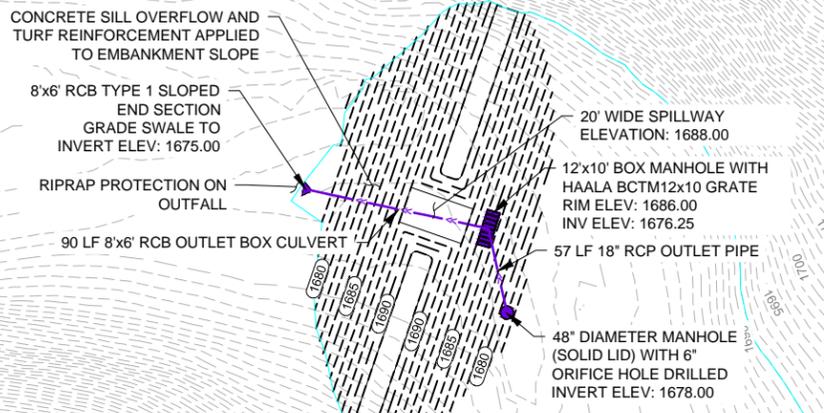
Engineers Opinion of Probable Costs

ITEM	ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
1	Bonding	1	LS	\$8,300	\$8,300
2	Mobilization	1	LS	\$55,300	\$55,300
3	Erosion Control	1	LS	\$10,600	\$10,600
4	Unclassified Excavation	0	CY	\$9	\$0
5	Dispose of Unclassified Excavation	0	CY	\$7	\$0
6	Embankment Fill	4,300	CY	\$9	\$37,900
7	18-inch RCP Low-Flow Outlet Pipe	46	LF	\$65	\$3,000
8	48-inch Concrete Round Manhole with 4-inch Orifice Hole Drilled and Clogging Protection	1	EA	\$4,000	\$4,000
9	54" RCP Outlet Pipe	130	LF	\$260	\$33,800
10	54" FES	1	EA	\$2,700	\$2,700
11	8'x4' Box Manhole (12.5' height), Pre-Cast Base and Custom Bar Grate	1	LS	\$15,600	\$15,600
12	HAALA BCTM8x4 Bar Grate	1	EA	\$5,000	\$5,000
13	Type VH Riprap	120	TON	\$100	\$12,000
14	Strip, Stockpile, and Replace Topsoil	740	CY	\$9	\$6,600
15	Seeding - Class VI	1,850	SY	\$1.5	\$2,800
16	Concrete Sill	1	LS	\$35,700	\$35,700
17	Erosion Control Mat	1,850	SY	\$3	\$5,600
18	Turf Reinforcement Mat	140	SY	\$6	\$900
19	Access Road	1	LS	\$20,000	\$20,000
20	Mitigation	1	LS	\$25,000	\$25,000
				Subtotal Construction Costs	\$284,800
				15% Contingencies	\$42,720
				Section 404 Permitting (5%)	\$14,240
				Legal, Administration & Engineering (30%)	\$85,440
				TOTAL PROJECT COSTS	\$427,200
21	Property Acquisition	0.8	Acre	\$0	\$0
				TOTAL FACILITY COSTS	\$427,200

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STAGE STORAGE	
ELEVATION	AREA (AC)
1678	0.03
1680	0.29
1682	1.00
1684	1.62
1686	2.36
1688	3.05



C2-2 BASIN:
 BOTTOM ELEV: 1678.00
 OVERFLOW: 1688.00
 STORAGE: 13.50 AC-FT
 SEE TABLE FOR STAGE-AREA RELATIONSHIP

CONCEPT DRAINAGE EASEMENT BOUNDARY (4.63 AC)

- LEGEND**
- CONTOURS - INTERMEDIATE
 - CONTOURS - INDEX
 - PROPOSED CONTOURS - INTERMEDIATE
 - PROPOSED CONTOURS - INDEX
 - CURB & GUTTER
 - BITUMINOUS PAVEMENT
 - CONCRETE
 - STORM DRAIN
 - FLARED END SECTION



DATE	REVISION	APPROVED



ASH AND WARD COULEE STORMWATER MASTER PLAN
 CITY OF BISMARCK
 CITY OF BISMARCK, BURLEIGH COUNTY NORTH DAKOTA

DRAWING TYPE	FIGURE
PREPARED BY	JG
CHECKED / APPROVED	JL / JH
DATE	JULY 2015
PROJECT NUMBER	P00501-2013-06
SHEET	5 of 29

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Engineers Opinion of Probable Costs

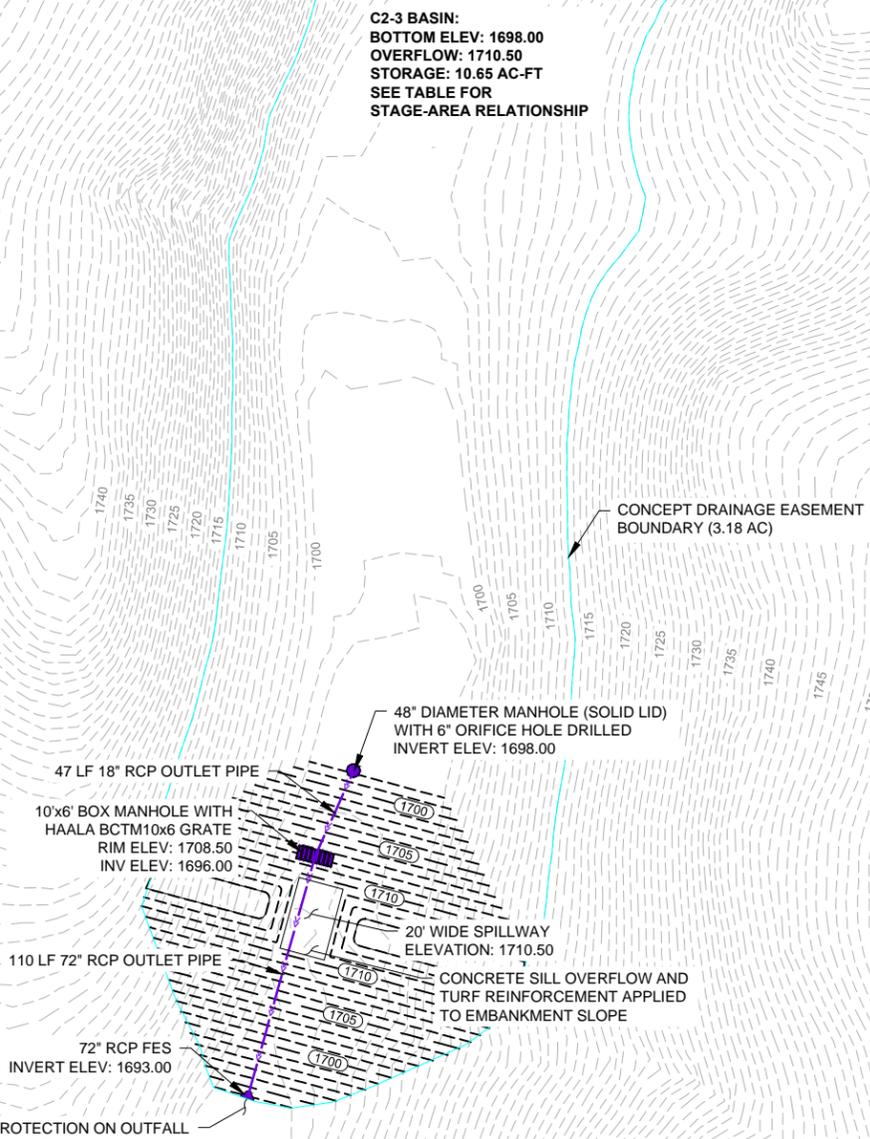
ITEM	ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
1	Bonding	1	LS	\$11,100	\$11,100
2	Mobilization	1	LS	\$73,500	\$73,500
3	Erosion Control	1	LS	\$14,000	\$14,000
4	Unclassified Excavation	0	CY	\$9	\$0
5	Dispose of Unclassified Excavation	0	CY	\$7	\$0
6	Embankment Fill	5,200	CY	\$9	\$45,800
7	18-inch RCP Low-Flow Outlet Pipe	57	LF	\$65	\$3,800
8	48-inch Concrete Round Manhole with 4-inch Orifice Hole Drilled and Clogging Protection	1	EA	\$4,000	\$4,000
9	8'x6' RCB Outlet Pipe	90	LF	\$750	\$67,500
10	8'x6' RCB Type 1 Sloped End Section (6')	1	EA	\$7,000	\$7,000
11	12'x10' Box Manhole (9' height), Pre-Cast Base and Custom Bar Grate	1	LS	\$25,700	\$25,700
12	HAALA BCTM12x10 Bar Grate	1	EA	\$12,000	\$12,000
13	Type VH Riprap	120	TON	\$100	\$12,000
14	Strip, Stockpile, and Replace Topsoil	1,020	CY	\$9	\$9,000
15	Seeding - Class VI	2,550	SY	\$1.5	\$3,800
16	Concrete Sill	1	LS	\$35,700	\$35,700
17	Erosion Control Mat	2,550	SY	\$3	\$7,700
18	Turf Reinforcement Mat	150	SY	\$6	\$900
19	Access Road	1	LS	\$20,000	\$20,000
20	Mitigation	1	LS	\$25,000	\$25,000
				Subtotal Construction Costs	\$378,500
				15% Contingencies	\$56,775
				Section 404 Permitting (5%)	\$18,925
				Legal, Administration & Engineering (30%)	\$113,550
				TOTAL PROJECT COSTS	\$567,750
21	Property Acquisition	4.1	Acre	\$0	\$0
				TOTAL FACILITY COSTS	\$567,750

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STAGE STORAGE	
ELEVATION	AREA (AC)
1697.00	0.01
1698.00	0.08
1700.00	0.29
1702.00	0.47
1704.00	0.80
1706.00	1.12
1708.00	1.53
1710.50	1.70

- LEGEND**
- CONTOURS - INTERMEDIATE
 - CONTOURS - INDEX
 - PROPOSED CONTOURS - INTERMEDIATE
 - PROPOSED CONTOURS - INDEX
 - CURB & GUTTER
 - BITUMINOUS PAVEMENT
 - CONCRETE
 - STORM DRAIN
 - FLARED END SECTION



DATE	REVISION	APPROVED



ASH AND WARDCOULEE STORMWATER MASTER PLAN
 CITY OF BISMARCK
 CITY OF BISMARCK, BURLEIGH COUNTY NORTH DAKOTA

DRAWING TYPE FIGURE
PREPARED BY JG
CHECKED / APPROVED JL / JH
DATE JULY 2015
PROJECT NUMBER P00501-2013-06
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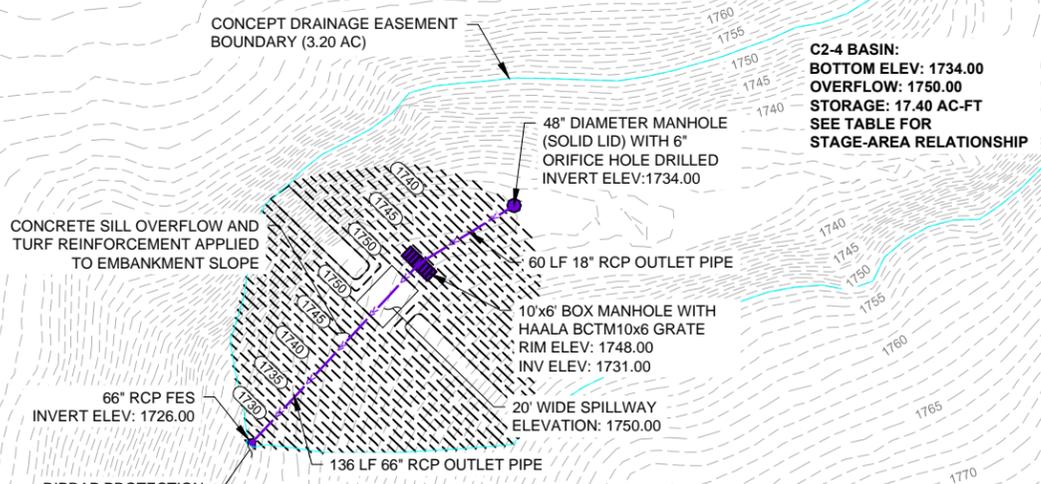
Engineers Opinion of Probable Costs

ITEM	ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
1	Bonding	1	LS	\$9,400	\$9,400
2	Mobilization	1	LS	\$62,100	\$62,100
3	Erosion Control	1	LS	\$11,900	\$11,900
4	Unclassified Excavation	0	CY	\$9	\$0
5	Dispose of Unclassified Excavation	0	CY	\$7	\$0
6	Embankment Fill	5,100	CY	\$9	\$44,900
7	18-inch RCP Low-Flow Outlet Pipe	47	LF	\$65	\$3,100
8	48-inch Concrete Round Manhole with 4-inch Orifice Hole Drilled and Clogging Protection	1	EA	\$4,000	\$4,000
9	72" RCP Outlet Pipe	110	LF	\$380	\$41,800
10	72" FES	1	EA	\$4,000	\$4,000
11	10'x6' Box Manhole (12.5' height), Pre-Cast Base and Custom Bar Grate	1	LS	\$21,500	\$21,500
12	HAALA BCTM10x6 Bar Grate	1	EA	\$7,000	\$7,000
13	Type VH Riprap	120	TON	\$100	\$12,000
14	Strip, Stockpile, and Replace Topsoil	810	CY	\$9	\$7,200
15	Seeding - Class VI	2,030	SY	\$1.5	\$3,000
16	Concrete Sill	1	LS	\$35,700	\$35,700
17	Erosion Control Mat	2,030	SY	\$3	\$6,100
18	Turf Reinforcement Mat	190	SY	\$6	\$1,200
19	Access Road	1	LS	\$20,000	\$20,000
20	Mitigation	1	LS	\$25,000	\$25,000
				Subtotal Construction Costs	\$319,900
				15% Contingencies	\$47,985
				Section 404 Permitting (5%)	\$15,995
				Legal, Administration & Engineering (30%)	\$95,970
				TOTAL PROJECT COSTS	\$479,850
21	Property Acquisition	1.9	Acre	\$0	\$0
				TOTAL FACILITY COSTS	\$479,850

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STAGE STORAGE	
ELEVATION	AREA (AC)
1732	0.01
1734	0.11
1736	0.26
1738	0.42
1740	0.73
1742	1.01
1744	1.37
1746	1.68
1748	2.04
1750	2.42

- LEGEND**
- CONTOURS - INTERMEDIATE
 - CONTOURS - INDEX
 - PROPOSED CONTOURS - INTERMEDIATE
 - PROPOSED CONTOURS - INDEX
 - CURB & GUTTER
 - BITUMINOUS PAVEMENT
 - CONCRETE
 - STORM DRAIN
 - FLARED END SECTION



DATE	REVISION	APPROVED



ASH AND WARD COULEE STORMWATER MASTER PLAN
 CITY OF BISMARCK
 CITY OF BISMARCK, BURLEIGH COUNTY NORTH DAKOTA

DRAWING TYPE	FIGURE
PREPARED BY	JG
CHECKED / APPROVED	JL / JH
DATE	JULY 2015
PROJECT NUMBER	P00501-2013-06
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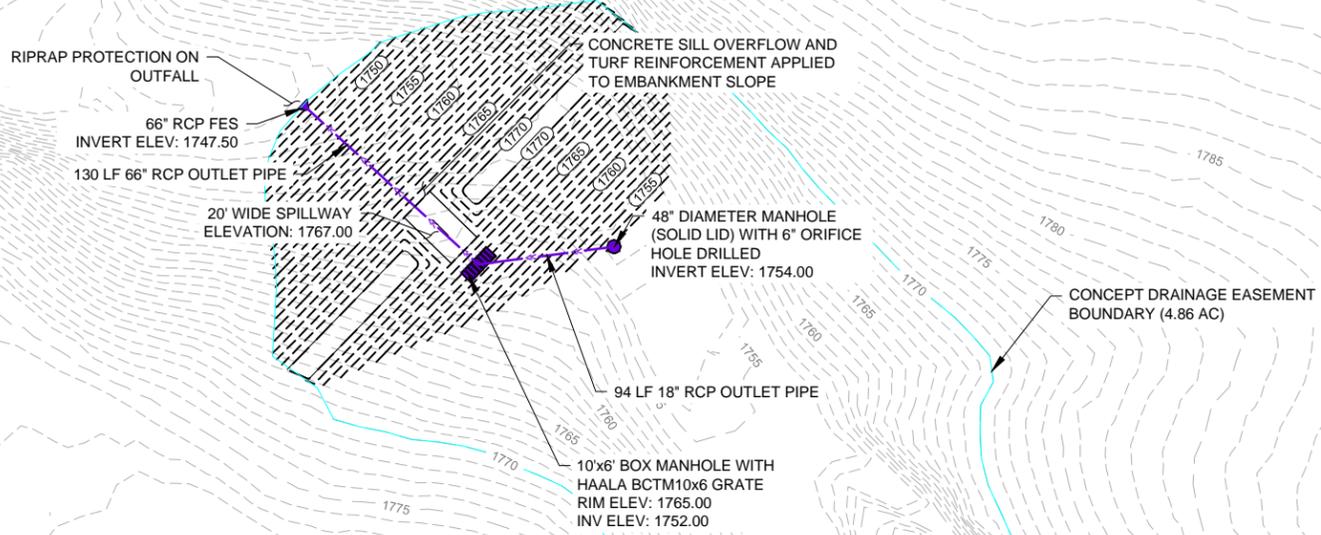
Engineers Opinion of Probable Costs

ITEM	ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
1	Bonding	1	LS	\$10,700	\$10,700
2	Mobilization	1	LS	\$71,200	\$71,200
3	Erosion Control	1	LS	\$13,600	\$13,600
4	Unclassified Excavation	0	CY	\$9	\$0
5	Dispose of Unclassified Excavation	0	CY	\$7	\$0
6	Embankment Fill	7,500	CY	\$9	\$66,000
7	18-inch RCP Low-Flow Outlet Pipe	60	LF	\$65	\$3,900
8	48-inch Concrete Round Manhole with 4-inch Orifice Hole Drilled and Clogging Protection	1	EA	\$4,000	\$4,000
9	66-inch RCP Outlet Pipe	136	LF	\$330	\$44,900
10	66-inch FES	1	EA	\$3,500	\$3,500
11	10'x6' Box Manhole (17' height), Pre-Cast Base and Custom Bar Grate	1	LS	\$26,800	\$26,800
12	HAALA BCTM10x6 Bar Grate	1	EA	\$7,000	\$7,000
13	Type VH Riprap	120	TON	\$100	\$12,000
14	Strip, Stockpile, and Replace Topsoil	1,040	CY	\$9	\$9,200
15	Seeding - Class VI	2,590	SY	\$1.5	\$3,900
16	Concrete Sill	1	LS	\$35,700	\$35,700
17	Erosion Control Mat	2,590	SY	\$3	\$7,800
18	Turf Reinforcement Mat	250	SY	\$6	\$1,500
19	Access Road	1	LS	\$20,000	\$20,000
20	Mitigation	1	LS	\$25,000	\$25,000
				Subtotal Construction Costs	\$366,700
				15% Contingencies	\$55,005
				Section 404 Permitting (5%)	\$18,335
				Legal, Administration & Engineering (30%)	\$110,010
				TOTAL PROJECT COSTS	\$550,050
21	Property Acquisition	2.8	Acre	\$0	\$0
				TOTAL FACILITY COSTS	\$550,050

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Plotted By: Jason Gervig Date: Tuesday, July 14, 2015 1:45:56 PM
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STAGE STORAGE	
ELEVATION	AREA (AC)
1752	0.01
1754	0.12
1756	0.42
1758	0.76
1760	1.24
1762	1.49
1764	2.03
1767	3.01



C2-5 BASIN:
 BOTTOM ELEV: 1754.00
 OVERFLOW: 1767.00
 STORAGE: 17.20 AC-FT
 SEE TABLE FOR
 STAGE-AREA RELATIONSHIP

- LEGEND**
- CONTOURS - INTERMEDIATE
 - CONTOURS - INDEX
 - PROPOSED CONTOURS - INTERMEDIATE
 - PROPOSED CONTOURS - INDEX
 - CURB & GUTTER
 - BITUMINOUS PAVEMENT
 - CONCRETE
 - STORM DRAIN
 - FLARED END SECTION



DATE	REVISION	APPROVED



ASH AND WARDE COULEE STORMWATER MASTER PLAN
 CITY OF BISMARCK
 CITY OF BISMARCK, BURLEIGH COUNTY NORTH DAKOTA

DRAWING TYPE FIGURE
PREPARED BY JG
CHECKED / APPROVED JL / JH
DATE JULY 2015
PROJECT NUMBER P00501-2013-06
SHEET 8 of #29

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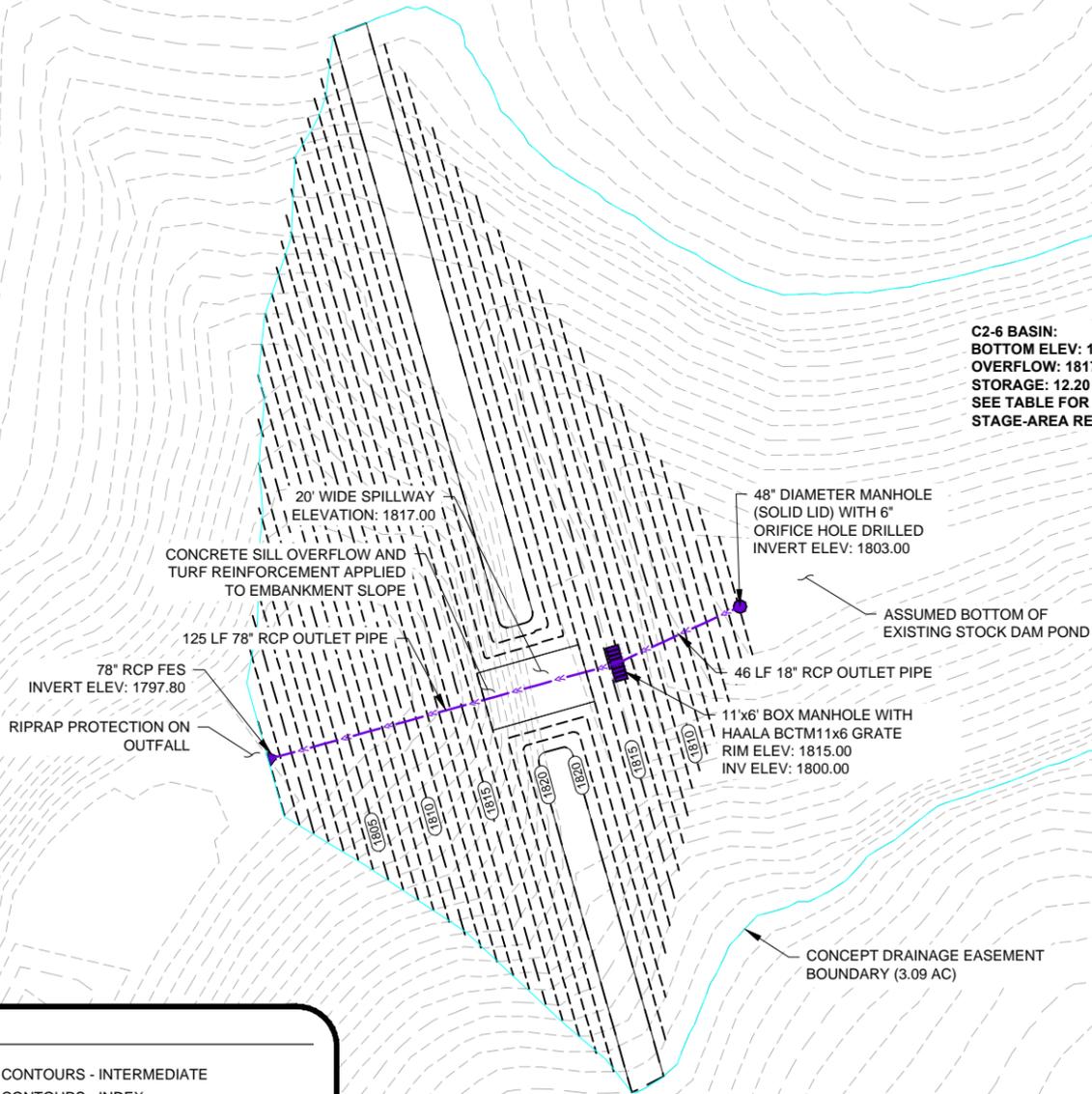


Engineers Opinion of Probable Costs

ITEM	ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
1	Bonding	1	LS	\$11,900	\$11,900
2	Mobilization	1	LS	\$78,700	\$78,700
3	Erosion Control	1	LS	\$15,000	\$15,000
4	Unclassified Excavation	0	CY	\$9	\$0
5	Dispose of Unclassified Excavation	0	CY	\$7	\$0
6	Embankment Fill	10,200	CY	\$9	\$89,800
7	18-inch RCP Low-Flow Outlet Pipe	94	LF	\$65	\$6,200
8	48-inch Concrete Round Manhole with 4-inch Orifice Hole Drilled and Clogging Protection	1	EA	\$4,000	\$4,000
9	66-inch RCP Outlet Pipe	130	LF	\$330	\$42,900
10	66-inch FES	1	EA	\$3,500	\$3,500
11	10'x6' Box Manhole (14' height), Pre-Cast Base and Custom Bar Grate	1	LS	\$23,300	\$23,300
12	HAALA BCTM10x6 Bar Grate	1	EA	\$7,000	\$7,000
13	Type VH Riprap	120	TON	\$100	\$12,000
14	Strip, Stockpile, and Replace Topsoil	1,450	CY	\$9	\$12,800
15	Seeding - Class VI	3,630	SY	\$1.5	\$5,400
16	Concrete Sill	1	LS	\$35,700	\$35,700
17	Erosion Control Mat	3,630	SY	\$3	\$10,900
18	Turf Reinforcement Mat	210	SY	\$6	\$1,300
19	Access Road	1	LS	\$20,000	\$20,000
20	Mitigation	1	LS	\$25,000	\$25,000
				Subtotal Construction Costs	\$405,400
				15% Contingencies	\$60,810
				Section 404 Permitting (5%)	\$20,270
				Legal, Administration & Engineering (30%)	\$121,620
				TOTAL PROJECT COSTS	\$608,100
21	Property Acquisition	4.3	Acre	\$0	\$0
				TOTAL FACILITY COSTS	\$608,100

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STAGE STORAGE	
ELEVATION	AREA (AC)
1803	0.18
1805	0.33
1807	0.49
1809	0.67
1811	0.86
1813	1.21
1815	1.55
1817	1.89



C2-6 BASIN:
 BOTTOM ELEV: 1803.00
 OVERFLOW: 1817.00
 STORAGE: 12.20 AC-FT
 SEE TABLE FOR
 STAGE-AREA RELATIONSHIP

20' WIDE SPILLWAY
 ELEVATION: 1817.00

CONCRETE SILL OVERFLOW AND
 TURF REINFORCEMENT APPLIED
 TO EMBANKMENT SLOPE

48" DIAMETER MANHOLE
 (SOLID LID) WITH 6"
 ORIFICE HOLE DRILLED
 INVERT ELEV: 1803.00

ASSUMED BOTTOM OF
 EXISTING STOCK DAM POND

125 LF 78" RCP OUTLET PIPE

78" RCP FES
 INVERT ELEV: 1797.80

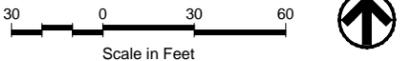
RIPRAP PROTECTION ON
 OUTFALL

46 LF 18" RCP OUTLET PIPE

11'x6' BOX MANHOLE WITH
 HAALA BCTM11x6 GRATE
 RIM ELEV: 1815.00
 INV ELEV: 1800.00

CONCEPT DRAINAGE EASEMENT
 BOUNDARY (3.09 AC)

- LEGEND**
- CONTOURS - INTERMEDIATE
 - CONTOURS - INDEX
 - PROPOSED CONTOURS - INTERMEDIATE
 - PROPOSED CONTOURS - INDEX
 - CURB & GUTTER
 - BITUMINOUS PAVEMENT
 - CONCRETE
 - STORM DRAIN
 - FLARED END SECTION



DATE	REVISION	APPROVED



ASH AND WARD COULEE STORMWATER MASTER PLAN
 CITY OF BISMARCK
 CITY OF BISMARCK, BURLEIGH COUNTY NORTH DAKOTA

DRAWING TYPE	FIGURE
PREPARED BY	JG
CHECKED / APPROVED	JL / JH
DATE	JULY 2015
PROJECT NUMBER	P00501-2013-06
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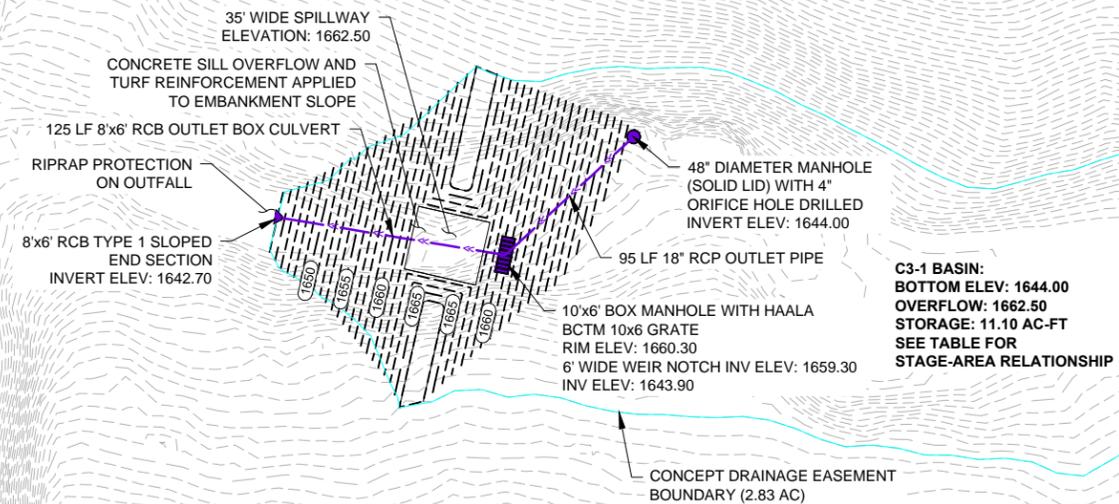
Engineers Opinion of Probable Costs

ITEM	ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
1	Bonding	1	LS	\$19,200	\$19,200
2	Mobilization	1	LS	\$127,700	\$127,700
3	Erosion Control	1	LS	\$24,400	\$24,400
4	Unclassified Excavation	8,000	CY	\$9	\$70,400
5	Dispose of Unclassified Excavation	8,000	CY	\$7	\$52,800
6	Embankment Fill	15,800	CY	\$9	\$139,100
7	18-inch RCP Low-Flow Outlet Pipe	46	LF	\$65	\$3,000
8	48-inch Concrete Round Manhole with 4-inch Orifice Hole Drilled and Clogging Protection	1	EA	\$4,000	\$4,000
9	78" RCP Outlet Pipe	125	LF	\$435	\$54,400
10	78" FES	1	EA	\$4,700	\$4,700
11	11'x6' Box Manhole (13' height), Pre-Cast Base and Custom Bar Grate	1	LS	\$23,500	\$23,500
12	HAALA BCTM11x6 Bar Grate	1	EA	\$8,000	\$8,000
13	Type VH Riprap	120	TON	\$100	\$12,000
14	Strip, Stockpile, and Replace Topsoil	1,610	CY	\$9	\$14,200
15	Seeding - Class VI	4,020	SY	\$1.5	\$6,000
16	Concrete Sill	1	LS	\$35,700	\$35,700
17	Erosion Control Mat	4,020	SY	\$3	\$12,100
18	Turf Reinforcement Mat	200	SY	\$6	\$1,200
19	Access Road	1	LS	\$20,000	\$20,000
20	Mitigation	1	LS	\$25,000	\$25,000
				Subtotal Construction Costs	\$657,400
				15% Contingencies	\$98,610
				Section 404 Permitting (5%)	\$32,870
				Legal, Administration & Engineering (30%)	\$197,220
				TOTAL PROJECT COSTS	\$986,100
21	Property Acquisition	2.3	Acre	\$0	\$0
				TOTAL FACILITY COSTS	\$986,100

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STAGE STORAGE	
ELEVATION	AREA (AC)
1644	0.01
1646	0.05
1648	0.13
1650	0.19
1652	0.31
1654	0.49
1656	0.75
1658	1.06
1660	1.37
1661.5	1.60



- LEGEND**
- CONTOURS - INTERMEDIATE
 - CONTOURS - INDEX
 - PROPOSED CONTOURS - INTERMEDIATE
 - PROPOSED CONTOURS - INDEX
 - CURB & GUTTER
 - BITUMINOUS PAVEMENT
 - CONCRETE
 - STORM DRAIN
 - FLARED END SECTION



DATE	REVISION	APPROVED



ASH AND WARDCOULEE STORMWATER MASTER PLAN
CITY OF BISMARCK
 CITY OF BISMARCK, BURLEIGH COUNTY NORTH DAKOTA

DRAWING TYPE
FIGURE
PREPARED BY
JG
CHECKED / APPROVED
JL / JH
DATE
JULY 2015
PROJECT NUMBER
P00501-2013-06
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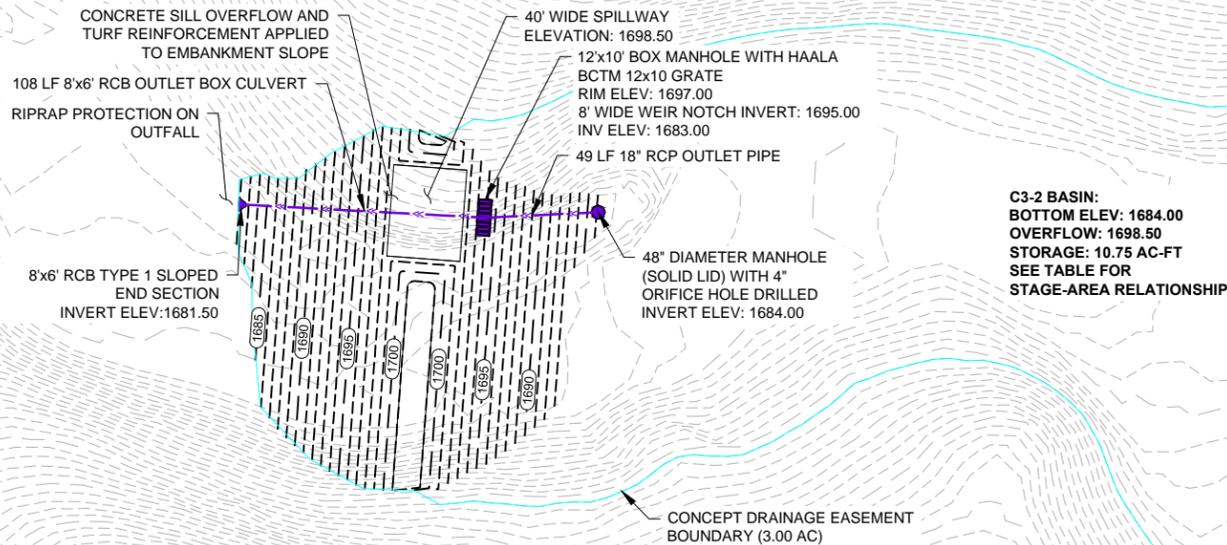
Engineers Opinion of Probable Costs

ITEM	ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
1	Bonding	1	LS	\$16,600	\$16,600
2	Mobilization	1	LS	\$110,600	\$110,600
3	Erosion Control	1	LS	\$21,100	\$21,100
4	Unclassified Excavation	4,500	CY	\$9	\$39,600
5	Dispose of Unclassified Excavation	4,500	CY	\$7	\$29,700
6	Embankment Fill	10,200	CY	\$9	\$89,800
7	18-inch RCP Low-Flow Outlet Pipe	95	LF	\$65	\$6,200
8	48-inch Concrete Round Manhole with 4-inch Orifice Hole Drilled and Clogging Protection	1	EA	\$4,000	\$4,000
9	8'x6' RCB Outlet Pipe	125	LF	\$750	\$93,800
10	8'x6' RCB Type 1 Sloped End Section (6')	1	EA	\$7,000	\$7,000
11	12'x4' Box Manhole (17.3' height), Pre-Cast Base and Custom Bar Grate	1	LS	\$26,500	\$26,500
12	Saw cut 6' Weir Notch in Box MH	1	LS	\$3,000	\$3,000
13	HAALA BCTM12x4 Bar Grate	1	EA	\$8,000	\$8,000
14	Type VH Riprap	120	TON	\$100	\$12,000
15	Strip, Stockpile, and Replace Topsoil	910	CY	\$9	\$8,100
16	Seeding - Class VI	2,270	SY	\$1.5	\$3,400
17	Concrete Sill	1	LS	\$35,700	\$35,700
18	Erosion Control Mat	2,270	SY	\$3	\$6,900
19	Turf Reinforcement Mat	380	SY	\$6	\$2,300
20	Access Road	1	LS	\$20,000	\$20,000
21	Mitigation	1	LS	\$25,000	\$25,000

				Subtotal Construction Costs	\$569,300
				15% Contingencies	\$85,395
				Section 404 Permitting (5%)	\$28,465
				Legal, Administration & Engineering (30%)	\$170,790
				TOTAL PROJECT COSTS	\$853,950
22	Property Acquisition	2.5	Acre	\$0	\$0
				TOTAL FACILITY COSTS	\$853,950

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STAGE STORAGE	
ELEVATION	AREA (AC)
1684	0.03
1686	0.1
1688	0.19
1690	0.40
1692	0.66
1694	1.09
1696	1.49
1697.50	1.80



- LEGEND**
- CONTOURS - INTERMEDIATE
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 - PROPOSED CONTOURS - INTERMEDIATE
 - PROPOSED CONTOURS - INDEX
 - CURB & GUTTER
 - BITUMINOUS PAVEMENT
 - CONCRETE
 - STORM DRAIN
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DATE	REVISION	APPROVED



ASH AND WARDE COULEE STORMWATER MASTER PLAN
CITY OF BISMARCK
 CITY OF BISMARCK, BURLEIGH COUNTY NORTH DAKOTA
 C3-2 BASIN

DRAWING TYPE FIGURE
PREPARED BY JG
CHECKED / APPROVED JL / JH
DATE JULY 2015
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Engineers Opinion of Probable Costs

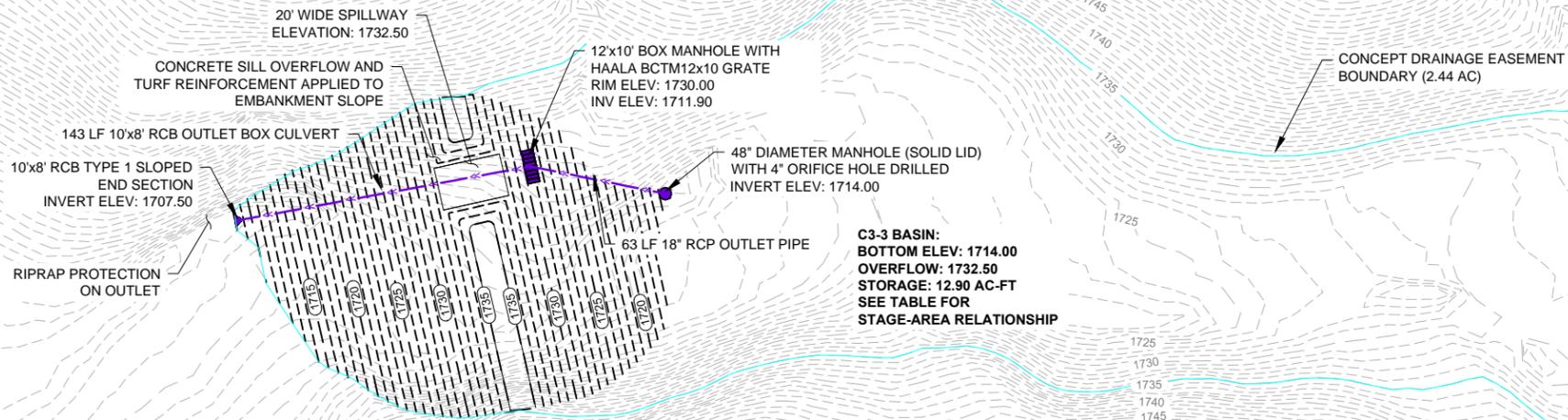
ITEM	ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
1	Bonding	1	LS	\$11,900	\$11,900
2	Mobilization	1	LS	\$79,100	\$79,100
3	Erosion Control	1	LS	\$15,100	\$15,100
4	Unclassified Excavation	0	CY	\$9	\$0
5	Dispose of Unclassified Excavation	0	CY	\$7	\$0
6	Embankment Fill	5,100	CY	\$9	\$44,900
7	18-inch RCP Low-Flow Outlet Pipe	49	LF	\$65	\$3,200
8	48-inch Concrete Round Manhole with 4-inch Orifice Hole Drilled and Clogging Protection	1	EA	\$4,000	\$4,000
9	8'x6' RCB Outlet Pipe	108	LF	\$750	\$81,000
10	8'x6' RCB Type 1 Sloped End Section (6')	1	EA	\$7,000	\$7,000
11	12'x10' Box Manhole (14' height), Pre-Cast Base and Custom Bar Grate	1	LS	\$33,800	\$33,800
12	Saw cut 6' Weir Notch in Box MH	1	LS	\$3,000	\$3,000
13	HAALA BCTM12x10 Bar Grate	1	EA	\$12,000	\$12,000
14	Type VH Riprap	120	TON	\$100	\$12,000
15	Strip, Stockpile, and Replace Topsoil	860	CY	\$9	\$7,600
16	Seeding - Class VI	2,140	SY	\$1.5	\$3,200
17	Concrete Sill	1	LS	\$35,700	\$35,700
18	Erosion Control Mat	2,140	SY	\$3	\$6,500
19	Turf Reinforcement Mat	340	SY	\$6	\$2,100
20	Access Road	1	LS	\$20,000	\$20,000
21	Mitigation	1	LS	\$25,000	\$25,000

				Subtotal Construction Costs	\$407,100
				15% Contingencies	\$61,065
				Section 404 Permitting (5%)	\$20,355
				Legal, Administration & Engineering (30%)	\$122,130
				TOTAL PROJECT COSTS	\$610,650
22	Property Acquisition	2.7	Acre	\$0	\$0
				TOTAL FACILITY COSTS	\$610,650

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STAGE STORAGE	
ELEVATION	AREA (AC)
1714	0.01
1716	0.08
1718	0.17
1720	0.32
1722	0.57
1724	0.75
1726	0.90
1728	1.09
1730	1.27
1732.50	1.75



LEGEND

- CONTOURS - INTERMEDIATE
- CONTOURS - INDEX
- PROPOSED CONTOURS - INTERMEDIATE
- PROPOSED CONTOURS - INDEX
- CURB & GUTTER
- BITUMINOUS PAVEMENT
- CONCRETE
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- FLARED END SECTION



DATE	REVISION	APPROVED



ASH AND WARD COULEE STORMWATER MASTER PLAN
 CITY OF BISMARCK
 CITY OF BISMARCK, BURLEIGH COUNTY NORTH DAKOTA

DRAWING TYPE	FIGURE
PREPARED BY	JG
CHECKED / APPROVED	JL / JH
DATE	JULY 2015
PROJECT NUMBER	P00501-2013-06
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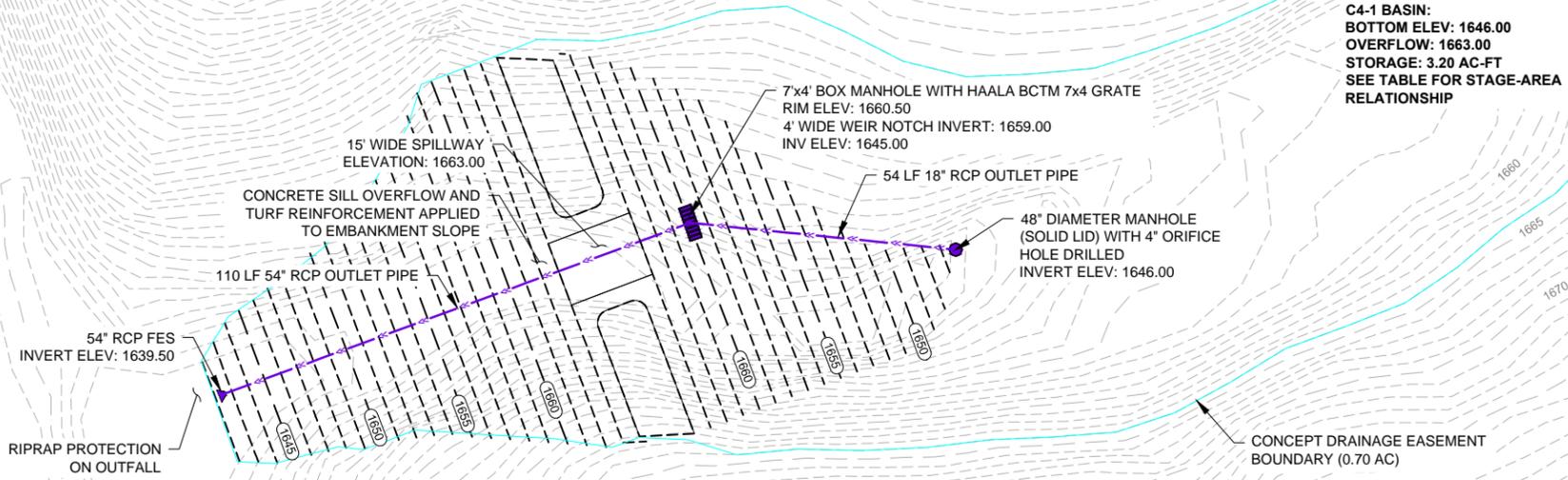


Engineers Opinion of Probable Costs

ITEM	ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
1	Bonding	1	LS	\$15,800	\$15,800
2	Mobilization	1	LS	\$104,900	\$104,900
3	Erosion Control	1	LS	\$20,000	\$20,000
4	Unclassified Excavation	0	CY	\$9	\$0
5	Dispose of Unclassified Excavation	0	CY	\$7	\$0
6	Embankment Fill	8,100	CY	\$9	\$71,300
7	18-inch RCP Low-Flow Outlet Pipe	63	LF	\$65	\$4,100
8	48-inch Concrete Round Manhole with 4-inch Orifice Hole Drilled and Clogging Protection	1	EA	\$4,000	\$4,000
9	10'x8' RCB Outlet Pipe	143	LF	\$1,000	\$143,000
10	10'x8' RCB Type 1 Sloped End Section (6')	1	EA	\$10,000	\$10,000
11	12'x10' Box Manhole (17' height), Pre-Cast Base and Custom Bar Grate	1	LS	\$38,700	\$38,700
12	HAALA BCTM12x10 Bar Grate	1	EA	\$12,000	\$12,000
13	Type VH Riprap	120	TON	\$100	\$12,000
14	Strip, Stockpile, and Replace Topsoil	1,030	CY	\$9	\$9,100
15	Seeding - Class VI	2,580	SY	\$1.5	\$3,800
16	Concrete Sill	1	LS	\$35,700	\$35,700
17	Erosion Control Mat	2,580	SY	\$3	\$7,800
18	Turf Reinforcement Mat	510	SY	\$6	\$3,100
19	Access Road	1	LS	\$20,000	\$20,000
20	Mitigation	1	LS	\$25,000	\$25,000
				Subtotal Construction Costs	\$540,300
				15% Contingencies	\$81,045
				Section 404 Permitting (5%)	\$27,015
				Legal, Administration & Engineering (30%)	\$162,090
				TOTAL PROJECT COSTS	\$810,450
21	Property Acquisition	2.1	Acre	\$0	\$0
				TOTAL FACILITY COSTS	\$810,450

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STAGE STORAGE	
ELEVATION	AREA (AC)
1646	0.01
1648	0.04
1650	0.06
1652	0.08
1654	0.13
1656	0.19
1658	0.29
1660	0.38



C4-1 BASIN:
 BOTTOM ELEV: 1646.00
 OVERFLOW: 1663.00
 STORAGE: 3.20 AC-FT
 SEE TABLE FOR STAGE-AREA RELATIONSHIP

- LEGEND**
- CONTOURS - INTERMEDIATE
 - CONTOURS - INDEX
 - PROPOSED CONTOURS - INTERMEDIATE
 - PROPOSED CONTOURS - INDEX
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ASH AND WARD COULEE STORMWATER MASTER PLAN
 CITY OF BISMARCK
 CITY OF BISMARCK, BURLEIGH COUNTY NORTH DAKOTA
 C4-1 BASIN

DRAWING TYPE FIGURE
PREPARED BY JG
CHECKED / APPROVED JL / JH
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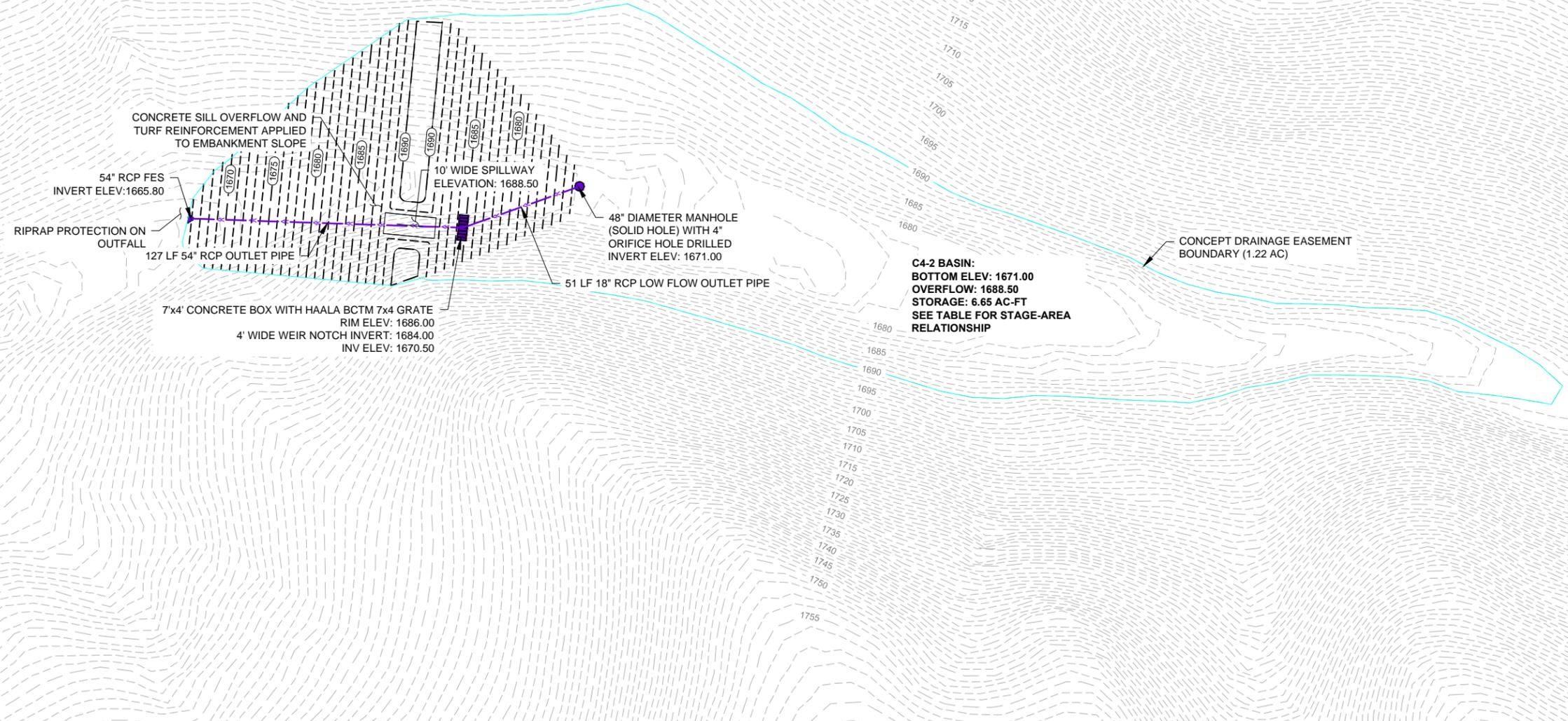
Engineers Opinion of Probable Costs

ITEM	ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
1	Bonding	1	LS	\$9,900	\$9,900
2	Mobilization	1	LS	\$65,900	\$65,900
3	Erosion Control	1	LS	\$12,600	\$12,600
4	Unclassified Excavation	2,400	CY	\$9	\$21,200
5	Dispose of Unclassified Excavation	2,400	CY	\$7	\$15,900
6	Embankment Fill	5,400	CY	\$9	\$47,600
7	18-inch RCP Low-Flow Outlet Pipe	54	LF	\$65	\$3,600
8	48-inch Concrete Round Manhole with 4-inch Orifice Hole Drilled and Clogging Protection	1	EA	\$4,000	\$4,000
9	54-inch RCP Outlet Pipe	110	LF	\$260	\$28,600
10	54-inch FES	1	EA	\$2,700	\$2,700
11	7'x4' Box Manhole (15.5' height), Pre-Cast Base and Custom Bar Grate	1	LS	\$16,700	\$16,700
12	Saw cut 4' Weir Notch in Box MH	1	LS	\$3,000	\$3,000
13	HAALA BCTM7x4 Bar Grate	1	EA	\$4,000	\$4,000
14	Type VH Riprap	120	TON	\$100	\$12,000
15	Strip, Stockpile, and Replace Topsoil	480	CY	\$9	\$4,300
16	Seeding - Class VI	1,190	SY	\$1.5	\$1,800
17	Concrete Sill	1	LS	\$35,700	\$35,700
18	Erosion Control Mat	1,190	SY	\$3	\$3,600
19	Turf Reinforcement Mat	200	SY	\$6	\$1,200
20	Access Road	1	LS	\$20,000	\$20,000
21	Mitigation	1	LS	\$25,000	\$25,000

				Subtotal Construction Costs	\$339,300
				15% Contingencies	\$50,895
				Section 404 Permitting (5%)	\$16,965
				Legal, Administration & Engineering (30%)	\$101,790
				TOTAL PROJECT COSTS	\$508,950
22	Property Acquisition	0.5	Acre	\$0	\$0
				TOTAL FACILITY COSTS	\$508,950

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STAGE STORAGE	
ELEVATION	AREA (AC)
1671	0.01
1673	0.06
1675	0.11
1677	0.19
1679	0.29
1681	0.42
1683	0.53
1685	0.66
1686	0.79



- LEGEND**
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ASH AND WARD COULEE STORMWATER MASTER PLAN
 CITY OF BISMARCK
 CITY OF BISMARCK, BURLEIGH COUNTY NORTH DAKOTA
 C4-2 BASIN

DRAWING TYPE
FIGURE
PREPARED BY
JG
CHECKED / APPROVED
JL / JH
DATE
JULY 2015
PROJECT NUMBER
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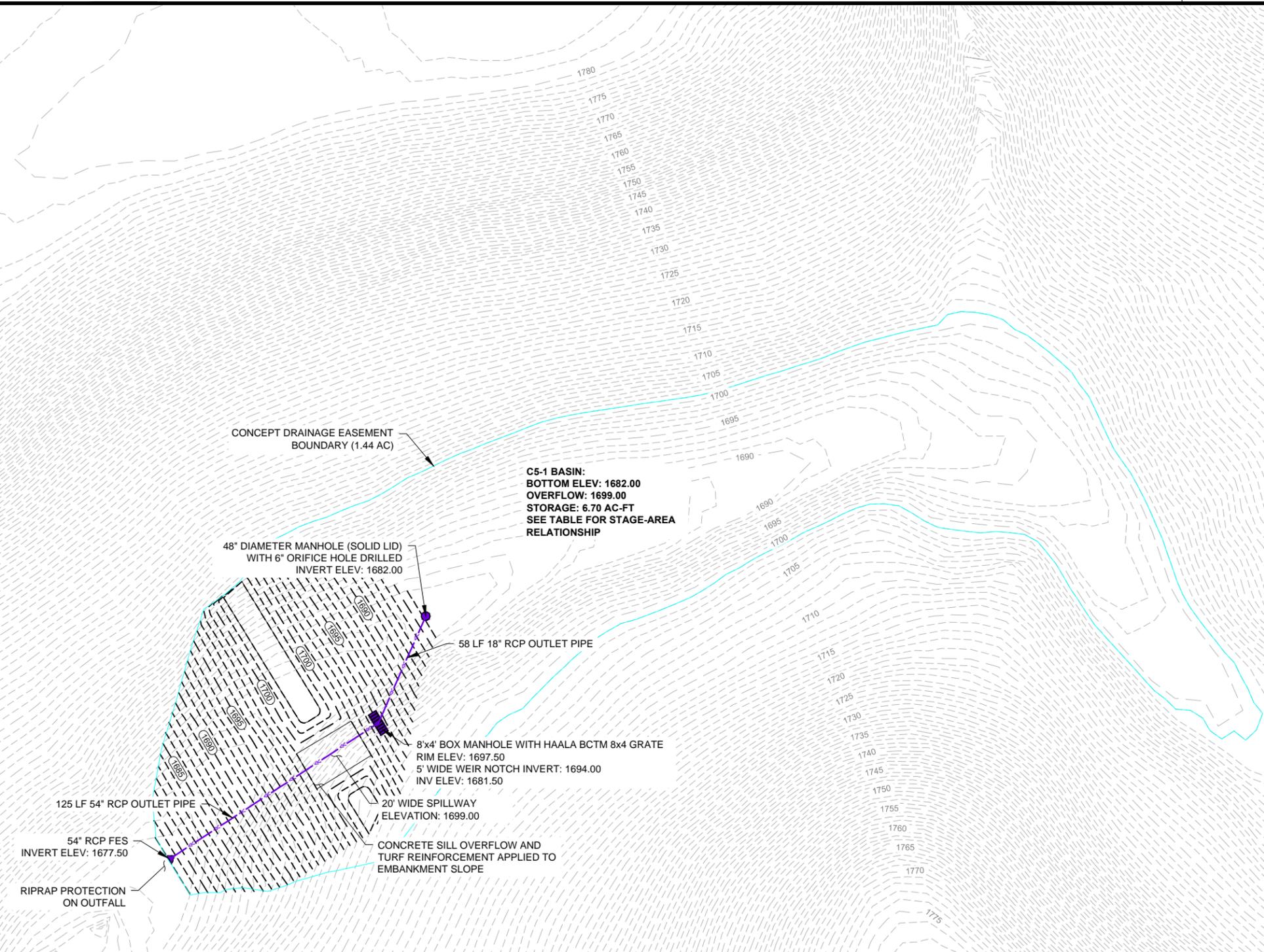
Engineers Opinion of Probable Costs

ITEM	ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
1	Bonding	1	LS	\$8,500	\$8,500
2	Mobilization	1	LS	\$56,100	\$56,100
3	Erosion Control	1	LS	\$10,700	\$10,700
4	Unclassified Excavation	0	CY	\$9	\$0
5	Dispose of Unclassified Excavation	0	CY	\$7	\$0
6	Embankment Fill	4,400	CY	\$9	\$38,800
7	18-inch RCP Low-Flow Outlet Pipe	51	LF	\$65	\$3,400
8	48-inch Concrete Round Manhole with 4-inch Orifice Hole Drilled and Clogging Protection	1	EA	\$4,000	\$4,000
9	54-inch RCP Outlet Pipe	127	LF	\$260	\$33,100
10	54-inch FES	1	EA	\$2,700	\$2,700
11	7'x4' Box Manhole (16' height), Pre-Cast Base and Custom Bar Grate	1	LS	\$17,100	\$17,100
12	Saw cut 4' Weir Notch in Box MH	1	LS	\$3,000	\$3,000
13	HAALA BCTM7x4 Bar Grate	1	EA	\$4,000	\$4,000
14	Type VH Riprap	120	TON	\$100	\$12,000
15	Strip, Stockpile, and Replace Topsoil	670	CY	\$9	\$5,900
16	Seeding - Class VI	1,670	SY	\$1.5	\$2,500
17	Concrete Sill	1	LS	\$35,700	\$35,700
18	Erosion Control Mat	1,670	SY	\$3	\$5,100
19	Turf Reinforcement Mat	170	SY	\$6	\$1,100
20	Access Road	1	LS	\$20,000	\$20,000
21	Mitigation	1	LS	\$25,000	\$25,000

				Subtotal Construction Costs	\$288,700
				15% Contingencies	\$43,305
				Section 404 Permitting (5%)	\$14,435
				Legal, Administration & Engineering (30%)	\$86,610
				TOTAL PROJECT COSTS	\$433,050
22	Property Acquisition	0.9	Acre	\$0	\$0
				TOTAL FACILITY COSTS	\$433,050

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STAGE STORAGE	
ELEVATION	AREA (AC)
1682	0.01
1684	0.08
1686	0.14
1688	0.23
1690	0.33
1692	0.44
1694	0.56
1696	0.71



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 - STORM DRAIN
 - FLARED END SECTION



APPROVED	REVISION	DATE



ASH AND WARDCOULEE STORMWATER MASTER PLAN
 CITY OF BISMARCK
 CITY OF BISMARCK, BURLEIGH COUNTY NORTH DAKOTA

DRAWING TYPE
FIGURE
PREPARED BY
JG
CHECKED / APPROVED
JL / JH
DATE
JULY 2015
PROJECT NUMBER
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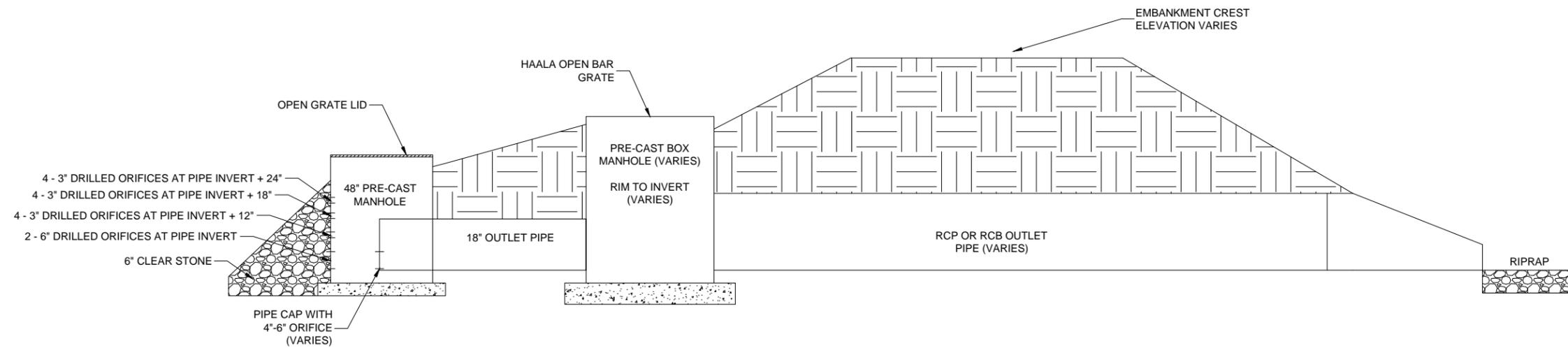
C15



Engineers Opinion of Probable Costs

ITEM	ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
1	Bonding	1	LS	\$12,500	\$12,500
2	Mobilization	1	LS	\$83,200	\$83,200
3	Erosion Control	1	LS	\$15,900	\$15,900
4	Unclassified Excavation	3,800	CY	\$9	\$33,500
5	Dispose of Unclassified Excavation	3,800	CY	\$7	\$25,100
6	Embankment Fill	8,900	CY	\$9	\$78,400
7	18-inch RCP Low-Flow Outlet Pipe	58	LF	\$65	\$3,800
8	48-inch Concrete Round Manhole with 4-inch Orifice Hole Drilled and Clogging Protection	1	EA	\$4,000	\$4,000
9	54-inch RCP Outlet Pipe	125	LF	\$260	\$32,500
10	54-inch FES	1	EA	\$2,700	\$2,700
11	8'x4' Box Manhole (16.5' height), Pre-Cast Base and Custom Bar Grate	1	LS	\$19,100	\$19,100
12	Saw cut 5' Weir Notch in Box MH	1	LS	\$3,000	\$3,000
13	HAALA BCTM8x4 Bar Grate	1	EA	\$5,000	\$5,000
14	Type VH Riprap	120	TON	\$100	\$12,000
15	Strip, Stockpile, and Replace Topsoil	770	CY	\$9	\$6,800
16	Seeding - Class VI	1,930	SY	\$1.5	\$2,900
17	Concrete Sill	1	LS	\$35,700	\$35,700
18	Erosion Control Mat	1,930	SY	\$3	\$5,800
19	Turf Reinforcement Mat	240	SY	\$6	\$1,500
20	Access Road	1	LS	\$20,000	\$20,000
21	Mitigation	1	LS	\$25,000	\$25,000

				Subtotal Construction Costs	\$428,400
				15% Contingencies	\$64,260
				Section 404 Permitting (5%)	\$21,420
				Legal, Administration & Engineering (30%)	\$128,520
				TOTAL PROJECT COSTS	\$642,600
22	Property Acquisition	1.2	Acre	\$0	\$0
				TOTAL FACILITY COSTS	\$642,600



1 TYPICAL OUTLET STRUCTURE
C16 SCALE: NONE

DATE	REVISION	APPROVED



ASH AND WARD COULEE STORMWATER MASTER PLAN
 CITY OF BISMARCK
 CITY OF BISMARCK, BURLEIGH COUNTY NORTH DAKOTA
 TYPICAL OUTLET STRUCTURE

DRAWING TYPE	FIGURE
PREPARED BY	JG
CHECKED / APPROVED	JL / JH
DATE	JULY 2015
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Engineers Opinion of Probable Costs

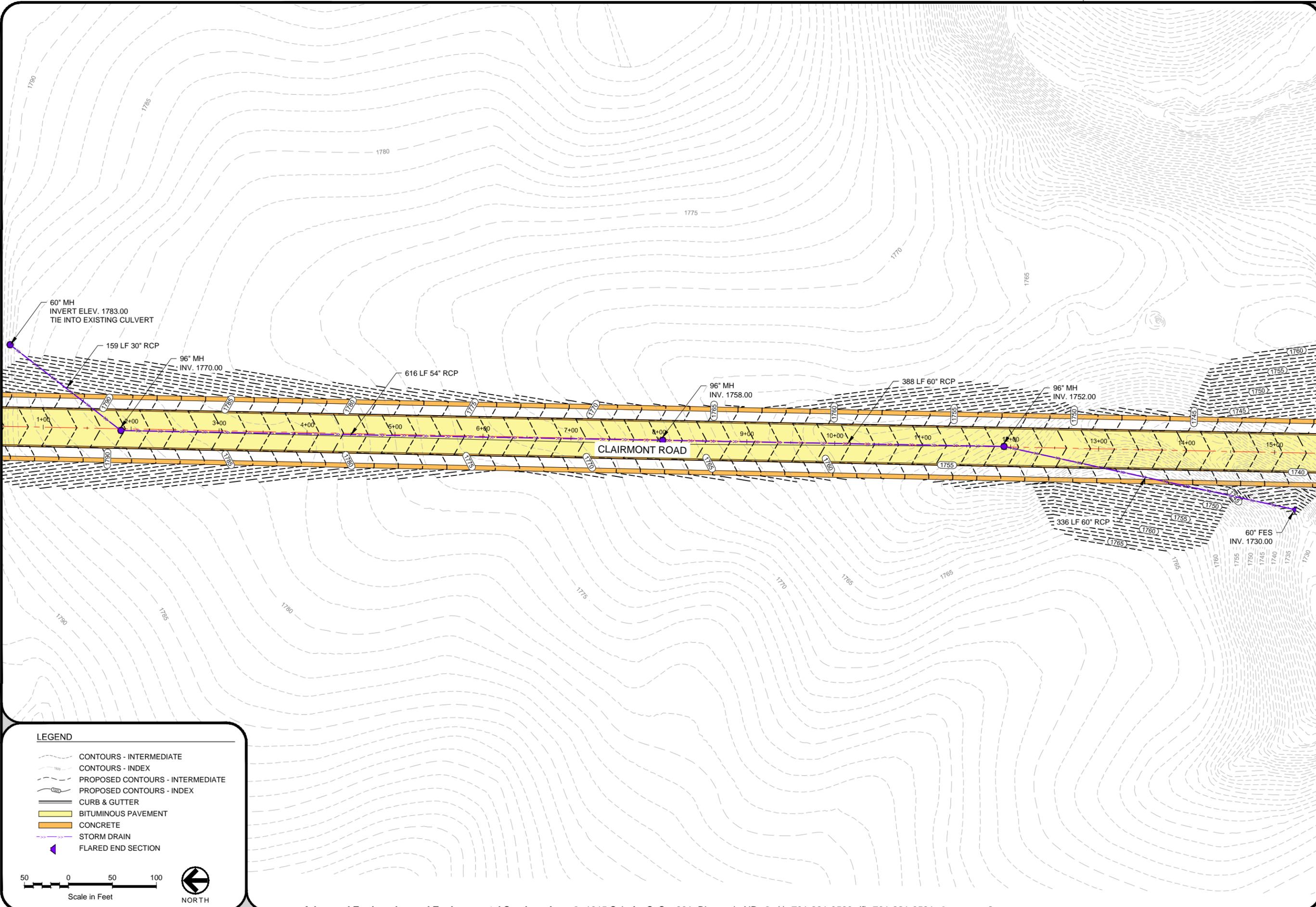
ITEM	ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
1	Bonding	1	LS	\$2,600	\$2,600
2	Mobilization	1	LS	\$16,700	\$16,700
3	Erosion Control	1	LS	\$3,200	\$3,200
4	Pipe Compacted Backfill	920	CY	\$10	\$8,800
5	Strip, Stockpile, and Replace Topsoil	290	CY	\$9	\$2,700
6	Seed and Mulch	1,700	SY	\$2	\$3,400
7	48-inch RCP	184	LF	\$220	\$40,500
8	48-inch FES	2	EA	\$2,400	\$4,800
9	Type VH Riprap	40	TON	\$84	\$3,400
Subtotal Construction Costs					\$86,100
15% Contingencies					\$12,915
Legal, Administration & Engineering (30%)					\$25,830
TOTAL PROJECT COSTS					\$124,845
10	Property Acquisition		Acre	\$0	\$0
TOTAL FACILITY COSTS					\$124,845



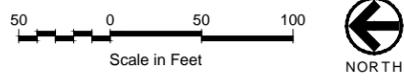
Engineers Opinion of Probable Costs

ITEM	ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
1	Bonding	1	LS	\$17,300	\$17,300
2	Mobilization	1	LS	\$115,000	\$115,000
3	Erosion Control	1	LS	\$21,900	\$21,900
4	Pipe Compacted Backfill	2,700	CY	\$10	\$25,700
5	Strip, Stockpile, and Replace Topsoil	800	CY	\$9	\$7,200
6	Seed and Mulch	4,800	SY	\$2	\$9,600
7	54-inch RCP	653	EA	\$260	\$169,800
8	7'x4' RCB	250	LF	\$675	\$168,800
9	7'x4' Type 1 Sloped End Section	1	EA	\$5,000	\$5,000
10	10'x5' RCB MH	1	EA	\$25,000	\$25,000
11	96-inch MH	1	EA	\$20,000	\$20,000
12	Type VH Riprap	80	TON	\$84	\$6,800
				Subtotal Construction Costs	\$592,100
				15% Contingencies	\$88,815
				Legal, Administration & Engineering (30%)	\$177,630
				TOTAL PROJECT COSTS	\$858,545
13	Property Acquisition		Acre	\$0	\$0
				TOTAL FACILITY COSTS	\$858,545

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DATE	REVISION



ASH AND WARD COULEE STORMWATER MASTER PLAN
CITY OF BISMARCK
 CITY OF BISMARCK, BURLEIGH COUNTY NORTH DAKOTA
 CLAIRMONT ROAD - WEST BRANCH OF NORTH FORK

DRAWING TYPE FIGURE
PREPARED BY JG
CHECKED / APPROVED JL / JH
DATE JULY 2015
PROJECT NUMBER P00501-2013-06
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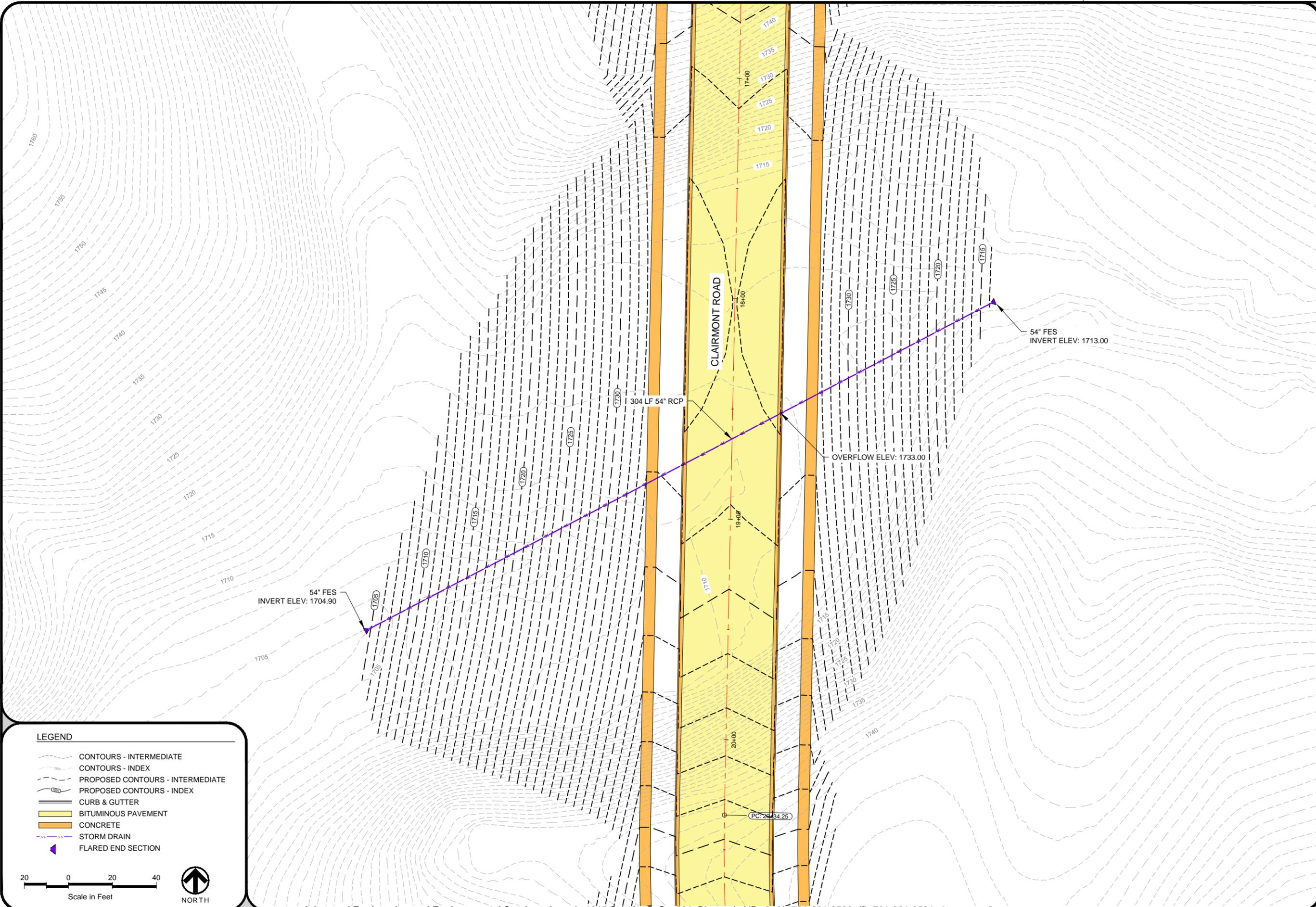
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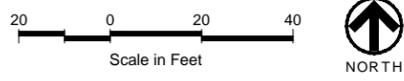
Engineers Opinion of Probable Costs

ITEM	ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
1	Bonding	1	LS	\$21,600	\$21,600
2	Mobilization	1	LS	\$143,800	\$143,800
3	Erosion Control	1	LS	\$27,400	\$27,400
4	Pipe Compacted Backfill	6,750	CY	\$10	\$64,200
5	Strip, Stockpile, and Replace Topsoil	1,200	CY	\$9	\$10,800
6	Seed and Mulch	3,950	SY	\$2	\$7,900
7	30-inch RCP	159	LF	\$110	\$17,500
8	54-inch RCP	616	EA	\$260	\$160,200
9	60-inch RCP	724	LF	\$290	\$210,000
10	60-inch FES	1	EA	\$3,000	\$3,000
11	96-inch MH	3	EA	\$20,000	\$60,000
12	60-inch MH	1	EA	\$10,000	\$10,000
13	Type VH Riprap	50	TON	\$84	\$4,200
				Subtotal Construction Costs	\$740,600
				15% Contingencies	\$111,090
				Legal, Administration & Engineering (30%)	\$222,180
				TOTAL PROJECT COSTS	\$1,073,870
14	Property Acquisition		Acre	\$0	\$0
				TOTAL FACILITY COSTS	\$1,073,870

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ASH AND WARD COULEE STORMWATER MASTER PLAN
CITY OF BISMARCK
CITY OF BISMARCK, BURLEIGH COUNTY NORTH DAKOTA
CLAIMONT ROAD - COULEE 2 (NORTH FORK)

DATE	REVISION	APPROVED

DRAWING TYPE	FIGURE
PREPARED BY	JG
CHECKED / APPROVED	JL / JH
DATE	JULY 2015
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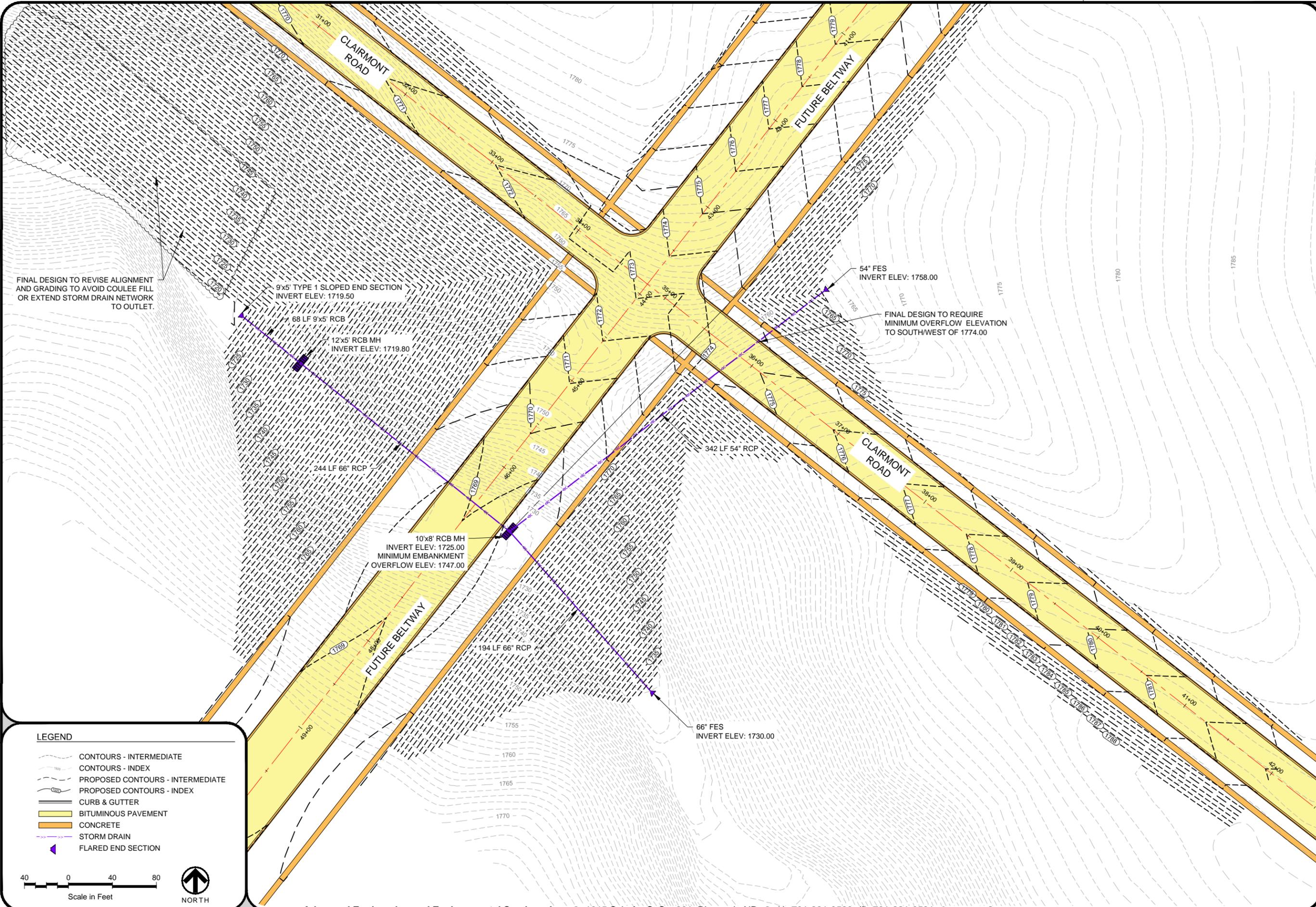
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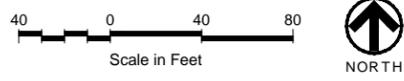
Engineers Opinion of Probable Costs

ITEM	ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
1	Bonding	1	LS	\$4,500	\$4,500
2	Mobilization	1	LS	\$29,500	\$29,500
3	Erosion Control	1	LS	\$5,700	\$5,700
4	Pipe Compacted Backfill	1,900	CY	\$10	\$18,100
5	Strip, Stockpile, and Replace Topsoil	290	CY	\$9	\$2,700
6	Seed and Mulch	1,700	SY	\$2	\$3,400
7	54-inch RCP	304	LF	\$260	\$79,100
8	54-inch FES	2	EA	\$2,700	\$5,400
9	Type VH Riprap	40	TON	\$84	\$3,400
				Subtotal Construction Costs	\$151,800
				15% Contingencies	\$22,770
				Legal, Administration & Engineering (30%)	\$45,540
				TOTAL PROJECT COSTS	\$220,110
10	Property Acquisition		Acre	\$0	\$0
				TOTAL FACILITY COSTS	\$220,110

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ASH AND WARDCOULEE STORMWATER MASTER PLAN CITY OF BISMARCK CITY OF BISMARCK, BURLEIGH COUNTY NORTH DAKOTA CLAIRMONT ROAD & BELTWAY INTERSECTION (COULEE & SOUTH FORK)
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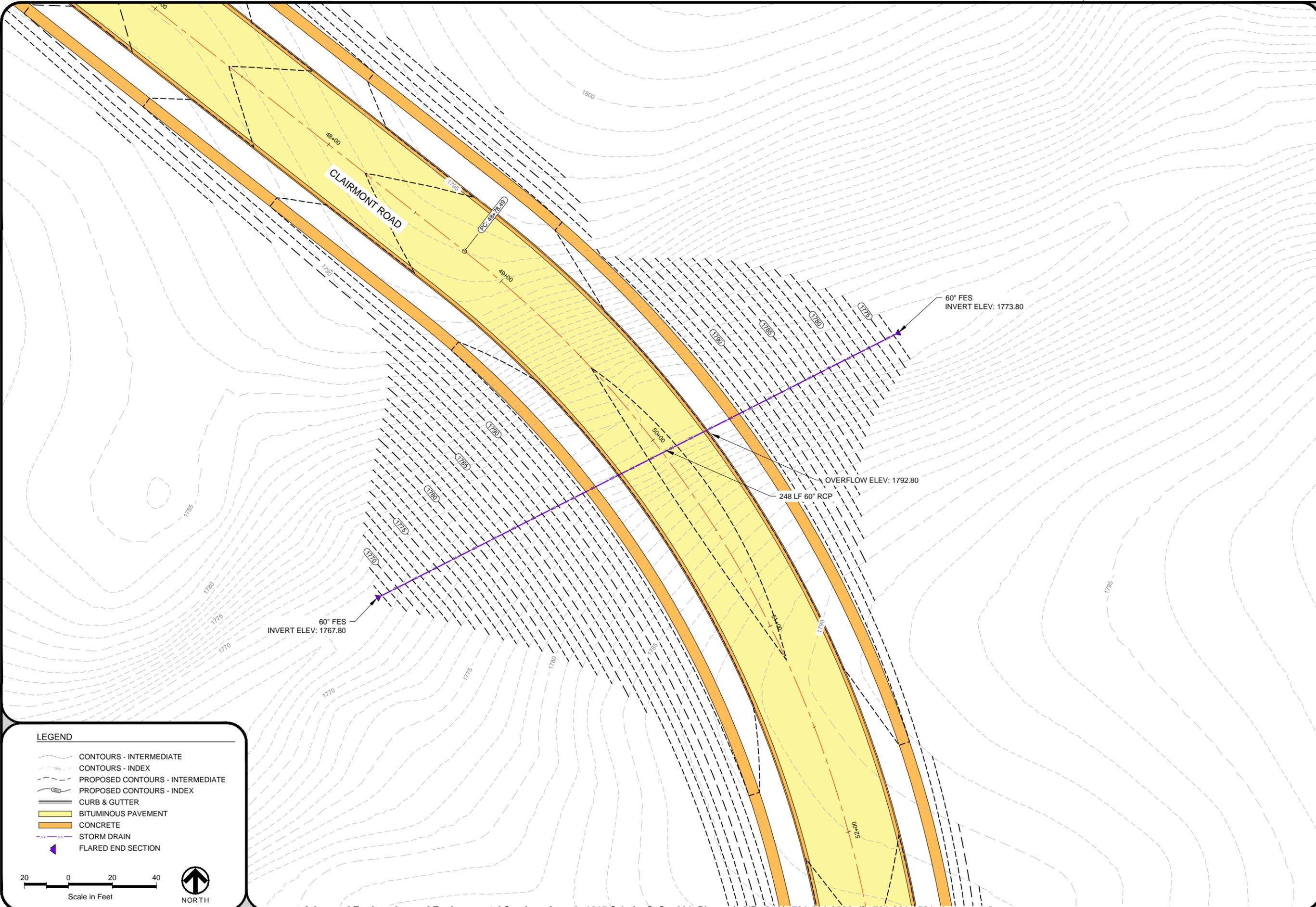


Engineers Opinion of Probable Costs

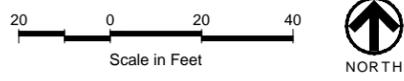
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1	Bonding	1	LS	\$16,100	\$16,100
2	Mobilization	1	LS	\$106,700	\$106,700
3	Erosion Control	1	LS	\$20,400	\$20,400
4	Pipe Compacted Backfill	3,500	CY	\$10	\$33,300
5	Strip, Stockpile, and Replace Topsoil	510	CY	\$9	\$4,600
6	Seed and Mulch	3,000	SY	\$2	\$6,000
7	54-inch RCP	342	LF	\$260	\$89,000
8	54-inch FES	1	EA	\$2,700	\$2,700
9	66-inch RCP	438	LF	\$330	\$144,600
10	66-inch FES	1	EA	\$3,500	\$3,500
11	9'x5' RCB	68	LF	\$800	\$54,400
12	9'x5' Type 1 Sloped End Section	1	EA	\$7,750	\$7,800
13	12'x5' RCB MH	1	EA	\$23,600	\$23,600
14	10'x8' RCB MH	1	EA	\$30,000	\$30,000
15	Type VH Riprap	80	TON	\$84	\$6,800
				Subtotal Construction Costs	\$549,500
				15% Contingencies	\$82,425
				Legal, Administration & Engineering (30%)	\$164,850
				TOTAL PROJECT COSTS	\$796,775
16	Property Acquisition		Acre	\$0	\$0
				TOTAL FACILITY COSTS	\$796,775

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DATE	REVISION	APPROVED



ASH AND WARD COULEE STORMWATER MASTER PLAN
 CITY OF BISMARCK
 CITY OF BISMARCK, BURLEIGH COUNTY NORTH DAKOTA
 CLAIRMONT ROAD - COULEE 2 (NORTH BRANCH OF SOUTH FORK)

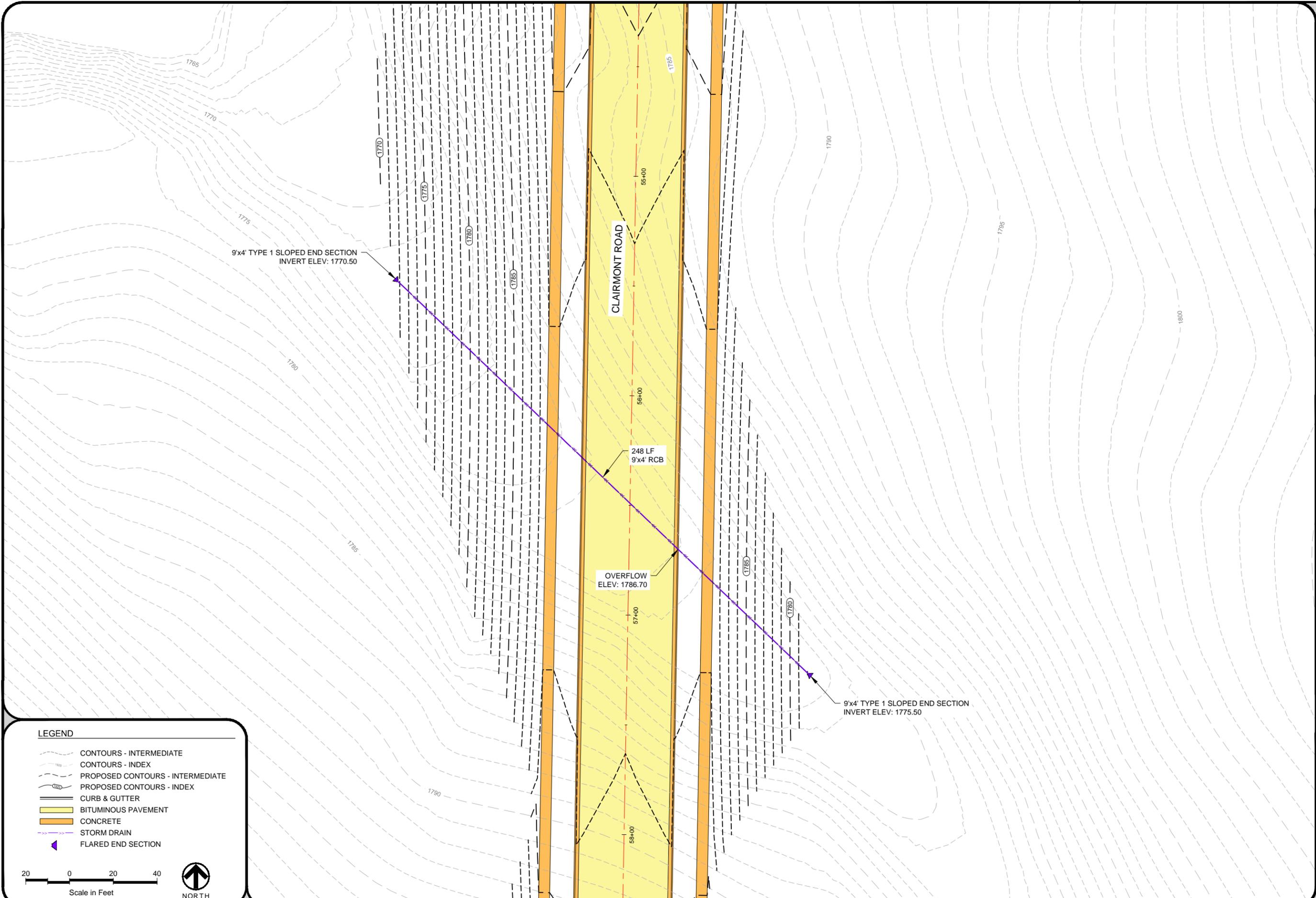
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CHECKED / APPROVED JL / JH
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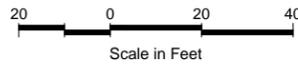
Engineers Opinion of Probable Costs

ITEM	ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
1	Bonding	1	LS	\$4,100	\$4,100
2	Mobilization	1	LS	\$27,200	\$27,200
3	Erosion Control	1	LS	\$5,200	\$5,200
4	Pipe Compacted Backfill	1,770	CY	\$10	\$16,900
5	Strip, Stockpile, and Replace Topsoil	250	CY	\$9	\$2,300
6	Seed and Mulch	1,500	SY	\$2	\$3,000
7	60-inch RCP	248	LF	\$290	\$72,000
8	60-inch FES	2	EA	\$3,000	\$6,000
9	Type VH Riprap	40	TON	\$84	\$3,400
				Subtotal Construction Costs	\$140,100
				15% Contingencies	\$21,015
				Legal, Administration & Engineering (30%)	\$42,030
				TOTAL PROJECT COSTS	\$203,145
10	Property Acquisition		Acre	\$0	\$0
				TOTAL FACILITY COSTS	\$203,145



LEGEND

- CONTOURS - INTERMEDIATE
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DATE	REVISION	APPROVED



ASH AND WARD COULEE STORMWATER MASTER PLAN
 CITY OF BISMARCK
 CITY OF BISMARCK, BURLEIGH COUNTY NORTH DAKOTA
 CLAIMONT ROAD - COULEE 2 (SOUTH BRANCH OF SOUTH FORK)



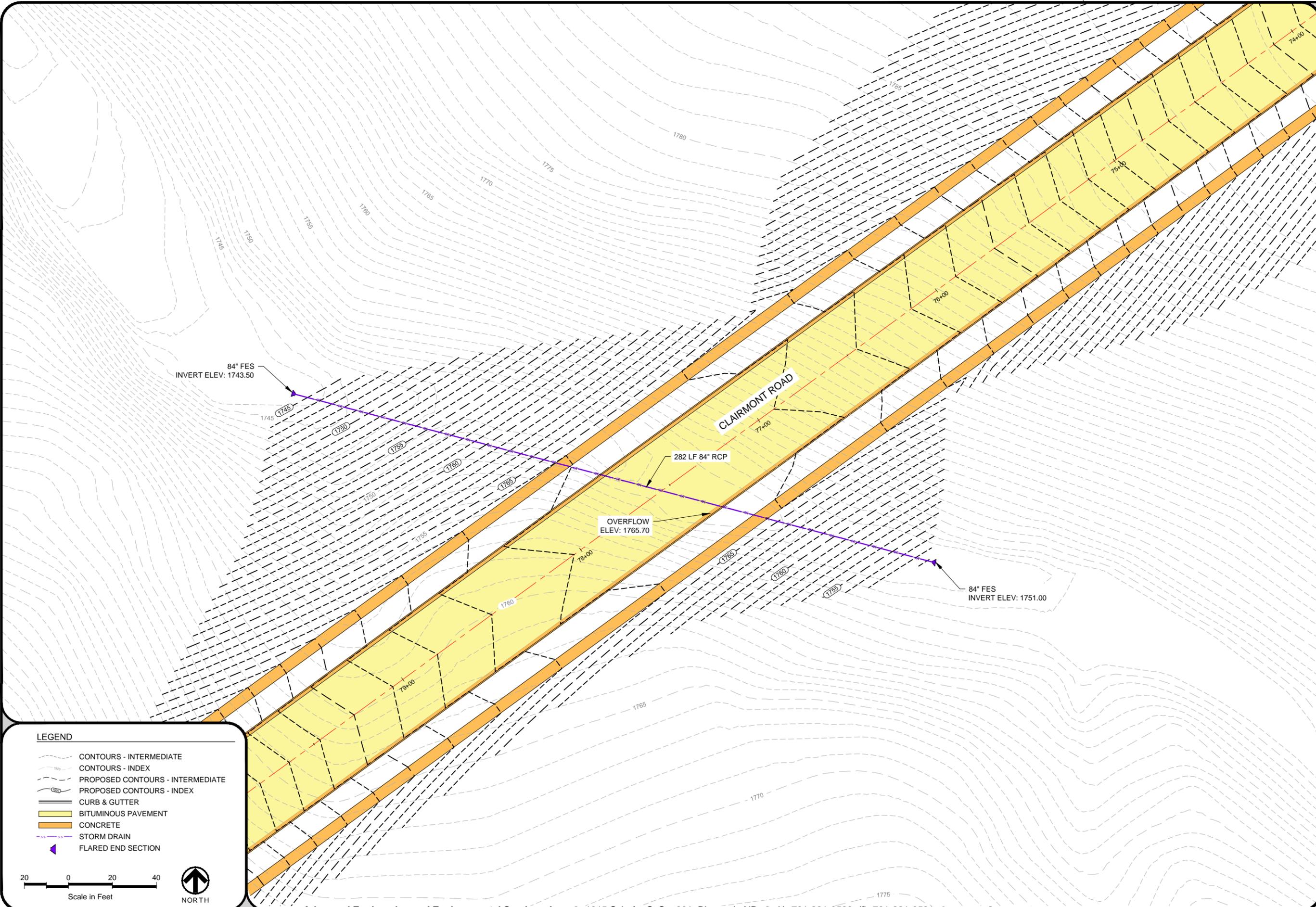
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CHECKED / APPROVED	JL / JH
DATE	JULY 2015
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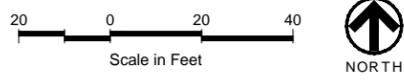

Engineers Opinion of Probable Costs

ITEM	ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
1	Bonding	1	LS	\$8,600	\$8,600
2	Mobilization	1	LS	\$57,100	\$57,100
3	Erosion Control	1	LS	\$10,900	\$10,900
4	Pipe Compacted Backfill	1,300	CY	\$10	\$12,400
5	Strip, Stockpile, and Replace Topsoil	250	CY	\$9	\$2,300
6	Seed and Mulch	1,480	SY	\$2	\$3,000
7	9'x4' RCB	248	LF	\$725	\$179,800
8	9'x4' Type 1 Sloped End Section	2	EA	\$6,500	\$13,000
9	Type VH Riprap	80	TON	\$84	\$6,800
				Subtotal Construction Costs	\$293,900
				15% Contingencies	\$44,085
				Legal, Administration & Engineering (30%)	\$88,170
				TOTAL PROJECT COSTS	\$426,155
10	Property Acquisition		Acre	\$0	\$0
				TOTAL FACILITY COSTS	\$426,155

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- LEGEND**
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ASH AND WARD COULEE STORMWATER MASTER PLAN
CITY OF BISMARCK
 CITY OF BISMARCK, BURLEIGH COUNTY NORTH DAKOTA
 CLAIRMONT ROAD - COULEE 3 (NORTH)

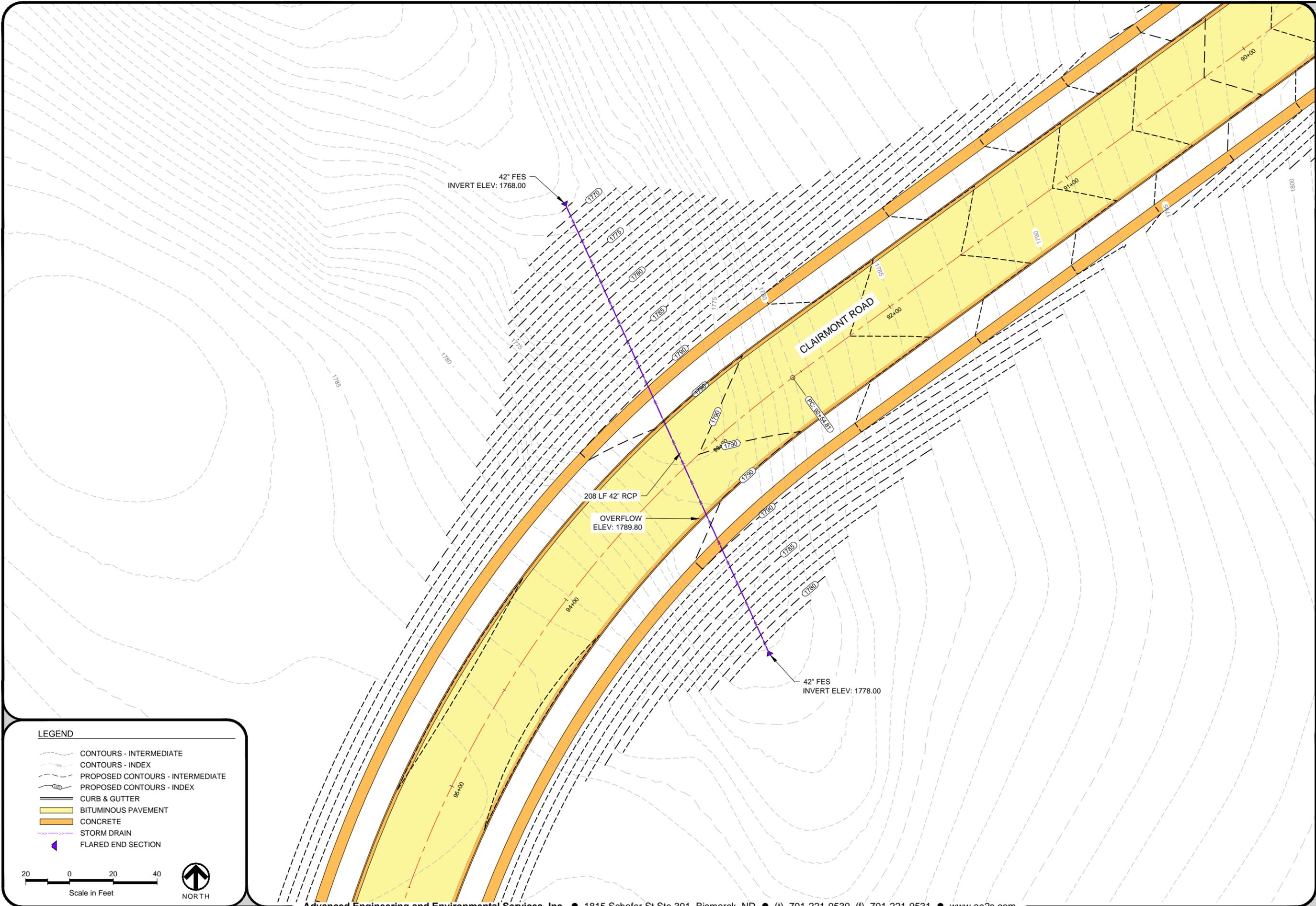
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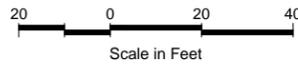
Engineers Opinion of Probable Costs

ITEM	ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
1	Bonding	1	LS	\$7,500	\$7,500
2	Mobilization	1	LS	\$50,000	\$50,000
3	Erosion Control	1	LS	\$9,600	\$9,600
4	Pipe Compacted Backfill	3,250	CY	\$10	\$30,900
5	Strip, Stockpile, and Replace Topsoil	360	CY	\$9	\$3,300
6	Seed and Mulch	2,170	SY	\$2	\$4,400
7	84-inch RCP	282	LF	\$480	\$135,400
8	84-inch FES	2	EA	\$5,500	\$11,000
9	Type VH Riprap	60	TON	\$84	\$5,100
Subtotal Construction Costs					\$257,200
15% Contingencies					\$38,580
Legal, Administration & Engineering (30%)					\$77,160
TOTAL PROJECT COSTS					\$372,940
10	Property Acquisition		Acre	\$0	\$0
TOTAL FACILITY COSTS					\$372,940



LEGEND

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DATE	REVISION	APPROVED



ASH AND WARD COULEE STORMWATER MASTER PLAN
 CITY OF BISMARCK
 CITY OF BISMARCK, BURLEIGH COUNTY NORTH DAKOTA
 CLAIRMONT ROAD - COULEE 3 (SOUTH)



DRAWING TYPE	FIGURE
PREPARED BY	JG
CHECKED / APPROVED	JL / JH
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PROJECT NUMBER	P00501-2013-06
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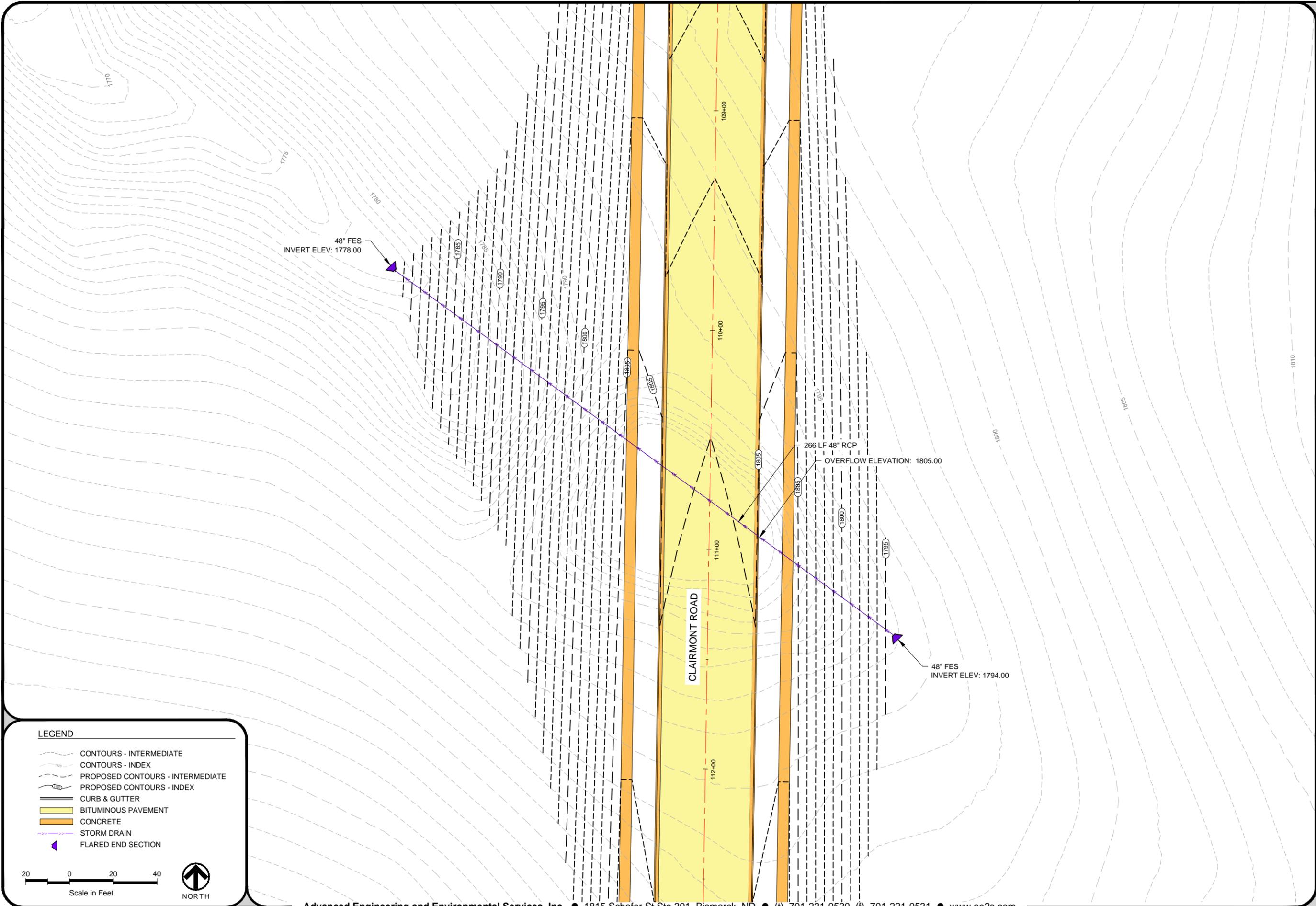
Engineers Opinion of Probable Costs

ITEM	ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
1	Bonding	1	LS	\$2,400	\$2,400
2	Mobilization	1	LS	\$15,900	\$15,900
3	Erosion Control	1	LS	\$3,100	\$3,100
4	Pipe Compacted Backfill	970	CY	\$10	\$9,300
5	Strip, Stockpile, and Replace Topsoil	175	CY	\$9	\$1,600
6	Seed and Mulch	1,035	SY	\$2	\$2,100
7	42-inch RCP	208	LF	\$190	\$39,600
8	42-inch FES	2	EA	\$2,100	\$4,200
9	Type VH Riprap	40	TON	\$84	\$3,400

				Subtotal Construction Costs	\$81,600
				15% Contingencies	\$12,240
				Legal, Administration & Engineering (30%)	\$24,480
				TOTAL PROJECT COSTS	\$118,320
10	Property Acquisition		Acre	\$0	\$0
				TOTAL FACILITY COSTS	\$118,320

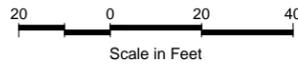
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LEGEND

- CONTOURS - INTERMEDIATE
- CONTOURS - INDEX
- PROPOSED CONTOURS - INTERMEDIATE
- PROPOSED CONTOURS - INDEX
- CURB & GUTTER
- BITUMINOUS PAVEMENT
- CONCRETE
- STORM DRAIN
- FLARED END SECTION



ASH AND WARD COULEE STORMWATER MASTER PLAN
 CITY OF BISMARCK
 CITY OF BISMARCK, BURLEIGH COUNTY NORTH DAKOTA
 CLAIRMONT ROAD - COULEE 4



DRAWING TYPE	FIGURE
PREPARED BY	JG
CHECKED / APPROVED	JL / JH
DATE	JULY 2015
PROJECT NUMBER	P00501-2013-06
SHEET	26 of 29

C26

DATE	REVISION	APPROVED



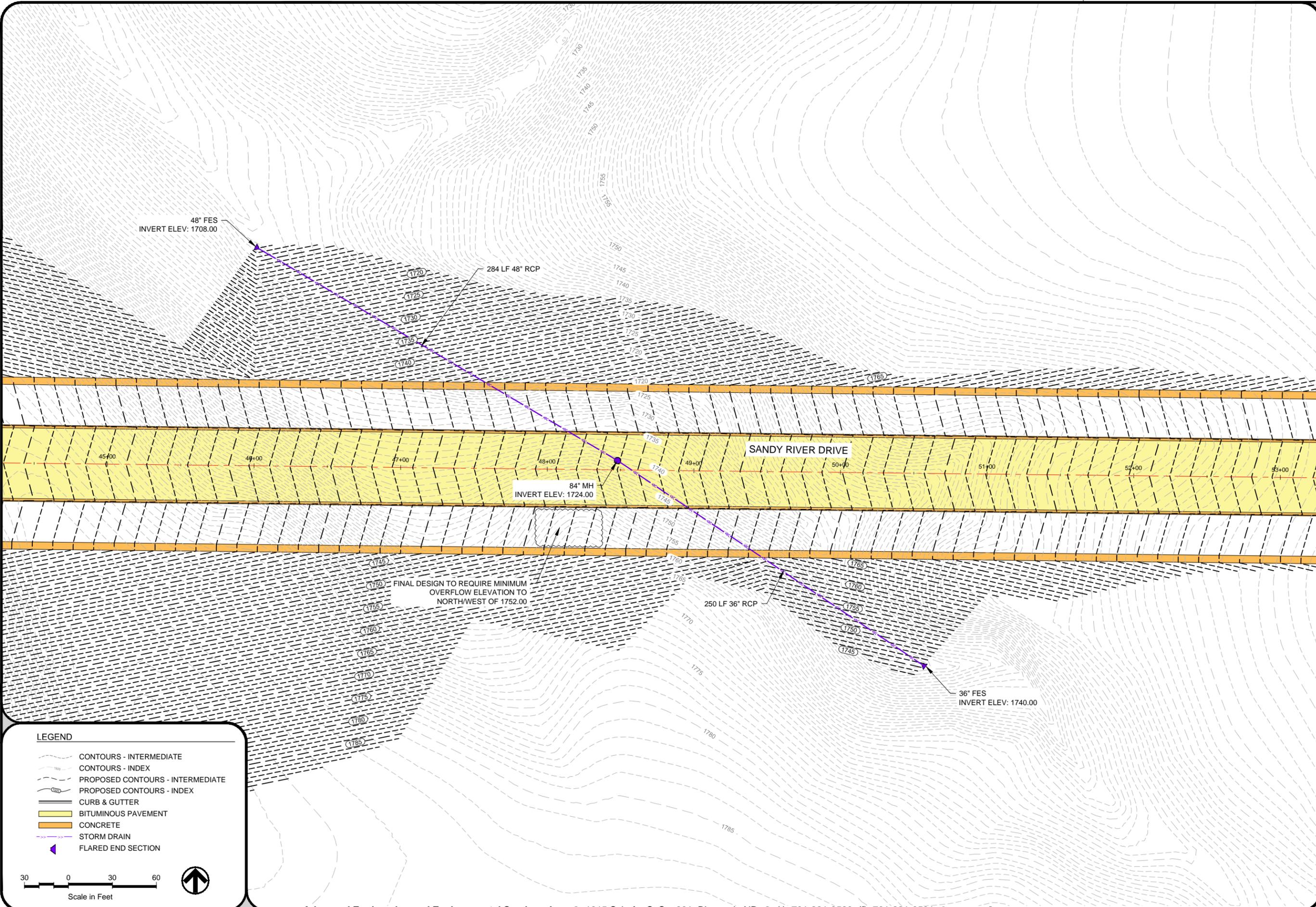


Engineers Opinion of Probable Costs

ITEM	ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
1	Bonding	1	LS	\$3,400	\$3,400
2	Mobilization	1	LS	\$22,400	\$22,400
3	Erosion Control	1	LS	\$4,300	\$4,300
4	Pipe Compacted Backfill	1,390	CY	\$10	\$13,300
5	Strip, Stockpile, and Replace Topsoil	230	CY	\$9	\$2,100
6	Seed and Mulch	1,380	SY	\$2	\$2,800
7	48-inch RCP	266	LF	\$220	\$58,600
8	48-inch FES	2	EA	\$2,400	\$4,800
9	Type VH Riprap	40	TON	\$84	\$3,400
				Subtotal Construction Costs	\$115,100
				15% Contingencies	\$17,265
				Legal, Administration & Engineering (30%)	\$34,530
				TOTAL PROJECT COSTS	\$166,895
10	Property Acquisition		Acre	\$0	\$0
				TOTAL FACILITY COSTS	\$166,895

File: L:\City of Bismarck\00501-2013-06 Bismarck Ash and Ward Coulee Watershed Master Plan\030 Preliminary Engineering Drawings\01-Civil\C-Sandy River Dividing

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 Last Saved By: Jason Gerving Date: Tuesday, July 14, 2015 11:07:10 AM



- LEGEND**
- CONTOURS - INTERMEDIATE
 - CONTOURS - INDEX
 - PROPOSED CONTOURS - INTERMEDIATE
 - PROPOSED CONTOURS - INDEX
 - CURB & GUTTER
 - BITUMINOUS PAVEMENT
 - CONCRETE
 - STORM DRAIN
 - FLARED END SECTION



DATE	REVISION



ASH AND WARDCOULEE STORMWATER MASTER PLAN
 CITY OF BISMARCK
 CITY OF BISMARCK, BURLEIGH COUNTY NORTH DAKOTA
 SANDY RIVER DRIVE - COULEE 5 (EAST CROSSING)

DRAWING TYPE FIGURE
PREPARED BY JG
CHECKED / APPROVED JL / JH
DATE JULY 2015
PROJECT NUMBER P00501-2013-06
SHEET 27 of 29

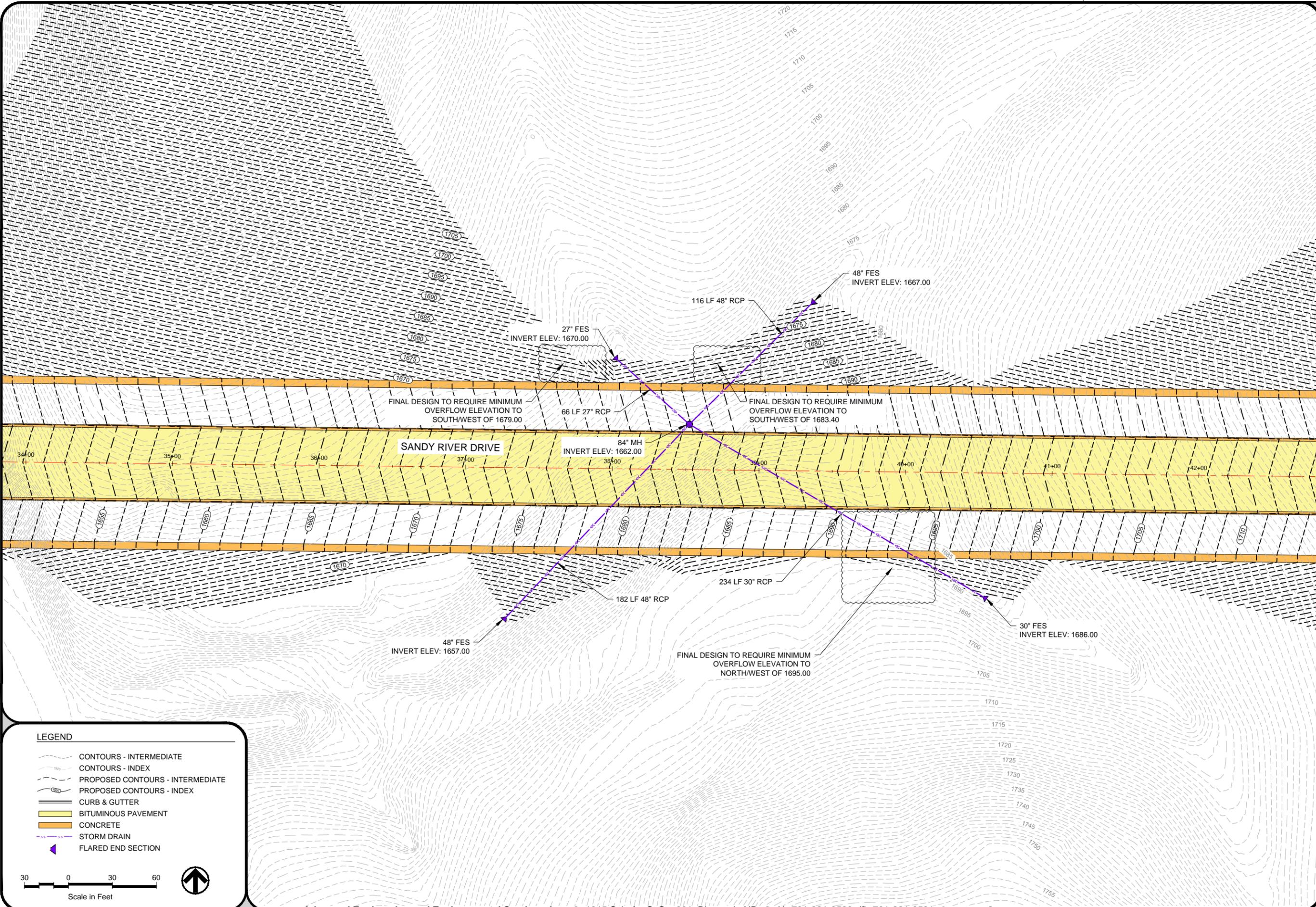
C27



Engineers Opinion of Probable Costs

ITEM	ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
1	Bonding	1	LS	\$6,100	\$6,100
2	Mobilization	1	LS	\$40,500	\$40,500
3	Erosion Control	1	LS	\$7,800	\$7,800
4	Pipe Compacted Backfill	2,350	CY	\$10	\$22,400
5	Strip, Stockpile, and Replace Topsoil	415	CY	\$9	\$3,800
6	Seed and Mulch	2,475	SY	\$2	\$5,000
7	36-inch RCP	250	LF	\$140	\$35,000
8	36-inch FES	1	EA	\$1,700	\$1,700
9	48-inch RCP	284	LF	\$220	\$62,500
10	48-inch FES	2	EA	\$2,400	\$4,800
11	84-inch MH	1	EA	\$15,000	\$15,000
12	Type VH Riprap at Outfall	40	TON	\$100	\$4,000
				Subtotal Construction Costs	\$208,600
				15% Contingencies	\$31,290
				Legal, Administration & Engineering (30%)	\$62,580
				TOTAL PROJECT COSTS	\$302,470
13	Property Acquisition		Acre	\$0	\$0
				TOTAL FACILITY COSTS	\$302,470

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- LEGEND**
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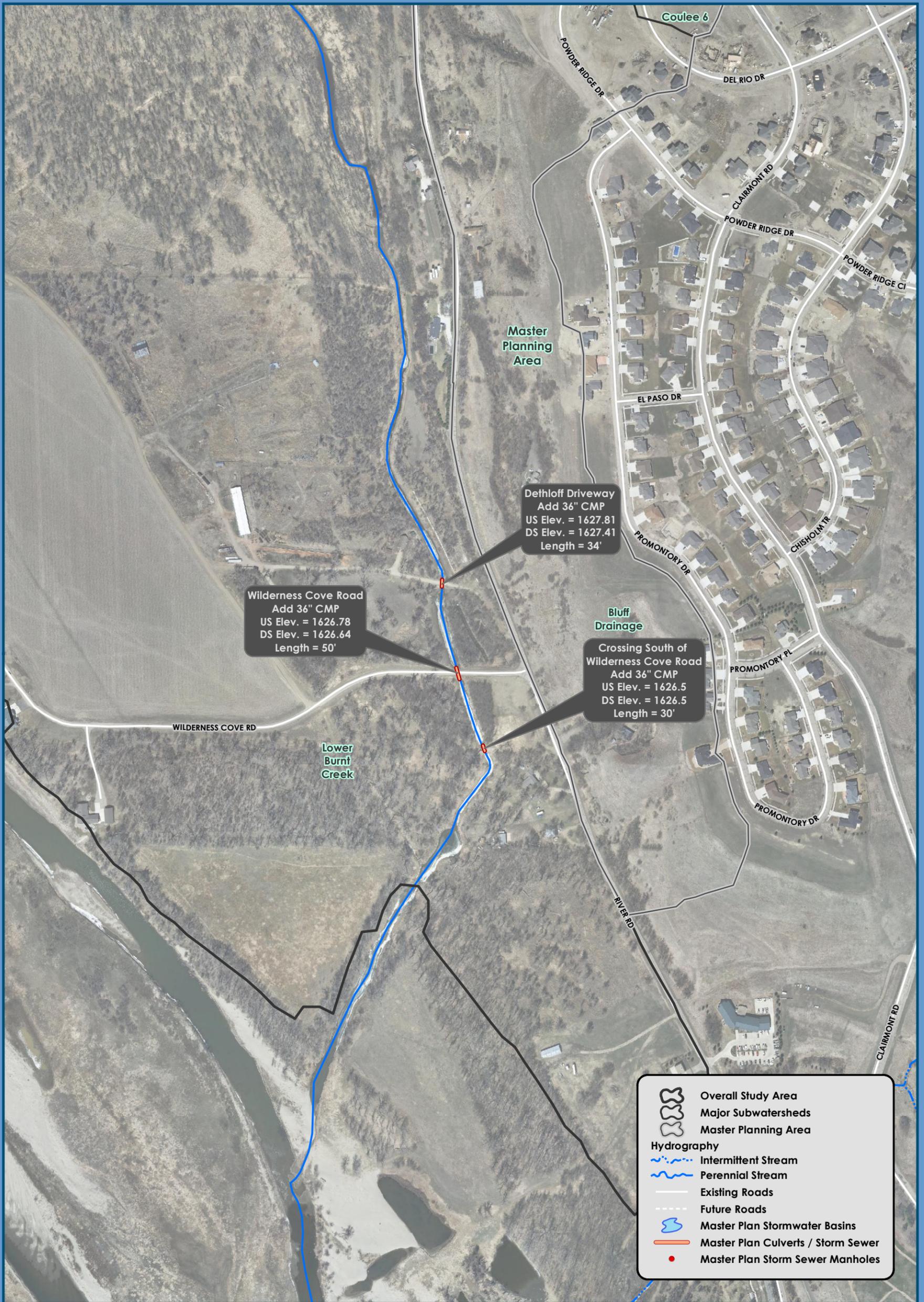


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<p>ASH AND COULEE STORMWATER MASTER PLAN CITY OF BISMARCK, BURLEIGH COUNTY NORTH DAKOTA SANDY RIVER DRIVE - COULEE S (WEST CROSSING)</p>																					
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">DRAWING TYPE</td> <td style="width: 50%;">FIGURE</td> </tr> <tr> <td>PREPARED BY</td> <td>JG</td> </tr> <tr> <td>CHECKED / APPROVED</td> <td>JL / JH</td> </tr> <tr> <td>DATE</td> <td>JULY 2015</td> </tr> <tr> <td>PROJECT NUMBER</td> <td>P00501-2013-06</td> </tr> <tr> <td>SHEET</td> <td>28 of 29</td> </tr> </table>		DRAWING TYPE	FIGURE	PREPARED BY	JG	CHECKED / APPROVED	JL / JH	DATE	JULY 2015	PROJECT NUMBER	P00501-2013-06	SHEET	28 of 29								
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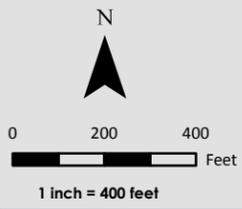
Engineers Opinion of Probable Costs

ITEM	ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
1	Bonding	1	LS	\$6,200	\$6,200
2	Mobilization	1	LS	\$40,900	\$40,900
3	Erosion Control	1	LS	\$7,800	\$7,800
4	Pipe Compacted Backfill	2,390	CY	\$10	\$22,800
5	Strip, Stockpile, and Replace Topsoil	440	CY	\$9	\$4,000
6	Seed and Mulch	2,630	SY	\$2	\$5,300
7	27-inch RCP	66	LF	\$90	\$6,000
8	27-inch FES	1	EA	\$1,200	\$1,200
9	48-inch RCP	298	LF	\$220	\$65,600
10	48-inch FES	2	EA	\$2,400	\$4,800
11	30-inch RCP	234	LF	\$110	\$25,800
12	30-inch FES	1	EA	\$1,300	\$1,300
13	84-inch MH	1	EA	\$15,000	\$15,000
14	Type VH Riprap at Outfall	40	TON	\$100	\$4,000
				Subtotal Construction Costs	\$210,700
				15% Contingencies	\$31,605
				Legal, Administration & Engineering (30%)	\$63,210
				TOTAL PROJECT COSTS	\$305,515
15	Property Acquisition		Acre	\$0	\$0
				TOTAL FACILITY COSTS	\$305,515



	Overall Study Area
	Major Subwatersheds
	Master Planning Area
Hydrography	
	Intermittent Stream
	Perennial Stream
	Existing Roads
	Future Roads
	Master Plan Stormwater Basins
	Master Plan Culverts / Storm Sewer
	Master Plan Storm Sewer Manholes

Any reliance upon this map is at user's own risk. AE2S does not warrant the map or its features are either spatially or temporally accurate or fit for a particular use.



Drawing C29:
Lower Burnt Creek Improvements

City of Bismarck
Ash and Ward Coulee Stormwater Master Plan





Engineers Opinion of Probable Costs

ITEM	ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
1	Bonding	1	LS	\$1,000	\$1,000
2	Mobilization	1	LS	\$6,400	\$6,400
3	Erosion Control	1	LS	\$1,300	\$1,300
4	Miscellaneous Additional Earthwork / Backfill / Restoration	1	LS	\$15,000	\$15,000
5	36-inch CMP - Dethloff Driveway	34	LF	\$80	\$2,800
6	36-inch CMP - Wilderness Cove Road	50	LF	\$80	\$4,000
7	36-inch CMP - McCormick Property	30	LF	\$80	\$2,400
				Subtotal Construction Costs	\$32,900
				15% Contingencies	\$4,935
				Legal, Administration & Engineering (30%)	\$9,870
				TOTAL PROJECT COSTS	\$47,705
#REF!	Property Acquisition		Acre	\$0	\$0
				TOTAL FACILITY COSTS	\$47,705