Apex Engineering Group
Water | Transportation| Municipal | Facilities

Technical Memorandum

SE 563 Regional Stormwater Improvements in Section 17
City of Bismarck, ND

To: Michael Mart, PE
City of Bismarck Engineering Department

From: Apex Engineering Group, Inc.
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Re: SE 563 Regional Stormwater Improvements in Section 17
Bismarck, ND
Project No. 16.105.0100

Date: March 22, 2019

This document was originally issued and sealed by Chelsea M. Nible, Registration Number PE-10610 on 03/22/2019 and the original document is stored at the City of Bismarck.

This technical memorandum constitutes our understanding of items discussed and decisions reached. In the event there are questions, additions, or corrections, please contact the author.

1.0 Introduction

This technical memorandum addresses Apex Engineering Group's update of the North Washington Street Watershed InfoSWMM model and design results for five ponds west of Washington Street and south of 57th Avenue. The ponds include the Amberglow Pond located upstream of proposed Amberglow Drive embankment, and four other ponds in the northeast quarter of Section 17, named North, South, East, and West Ponds. Updates to the Mica Drive Pond were also included in the model. See Figure 1 for the location of the ponds. The results were used to prepare the Sewer Improvement District 563 Construction Plan set. The locations and layout of these ponds represent a collaborative effort between the City, Landowners, and Apex Engineering Group.

Apex Engineering Group was tasked to maintain the flow rate at Washington Street to the previously modeled parameters, including the TP 40 rainfall. Refer to the Technical Memorandum dated November 24, 2015 for the preliminary study analysis.

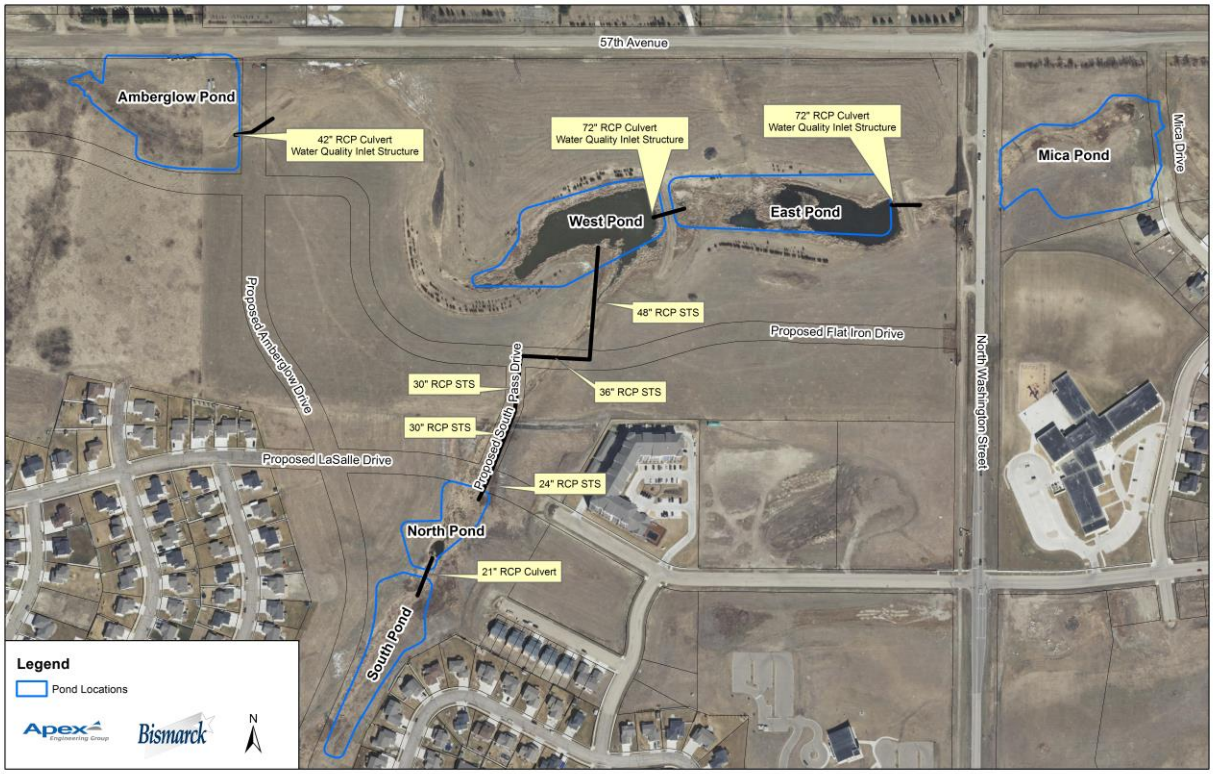


Figure 1. Pond Locations

2.0 Hydrologic Model Input

The North Washington Street Watershed InfoSWMM model was updated to reflect changes in the watershed, which included land use and rainfall data. Additional watersheds were delineated to correspond with proposed development layouts and the Heritage Ridge Stormwater Management Plan (SWMP) provided by the City of Bismarck. Land use was only updated for watersheds that are upstream of the 7'x5' box culvert at North Washington Street. The watershed is made up of predominantly "B" soils. These three factors (hydrologic soil group, subcatchment areas, and land use) were used to calculate new curve numbers for the watershed. The hydrologic soil group data that was used is shown in Figure 3 and the land use data is shown in Figure 4.

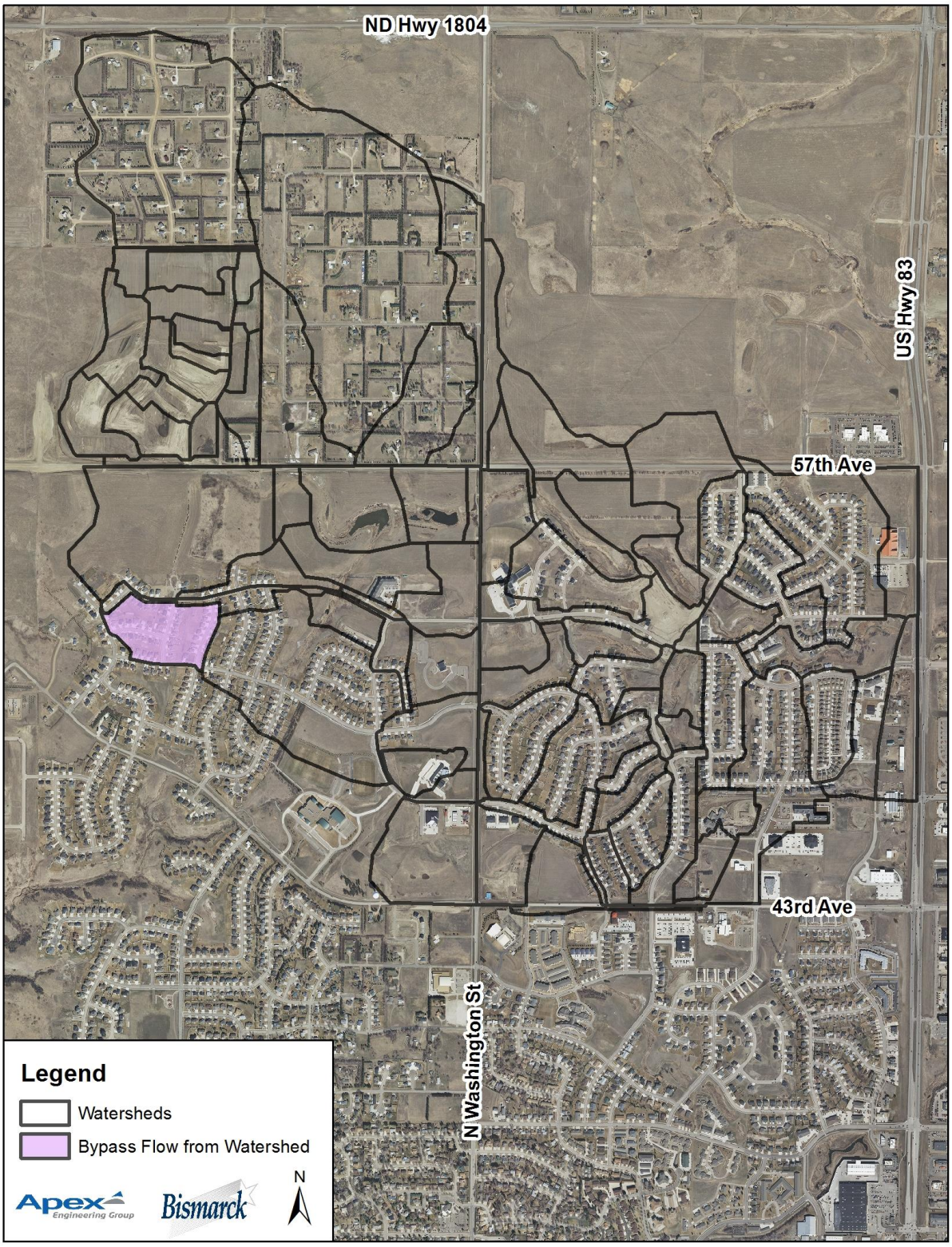


Figure 2. Watersheds

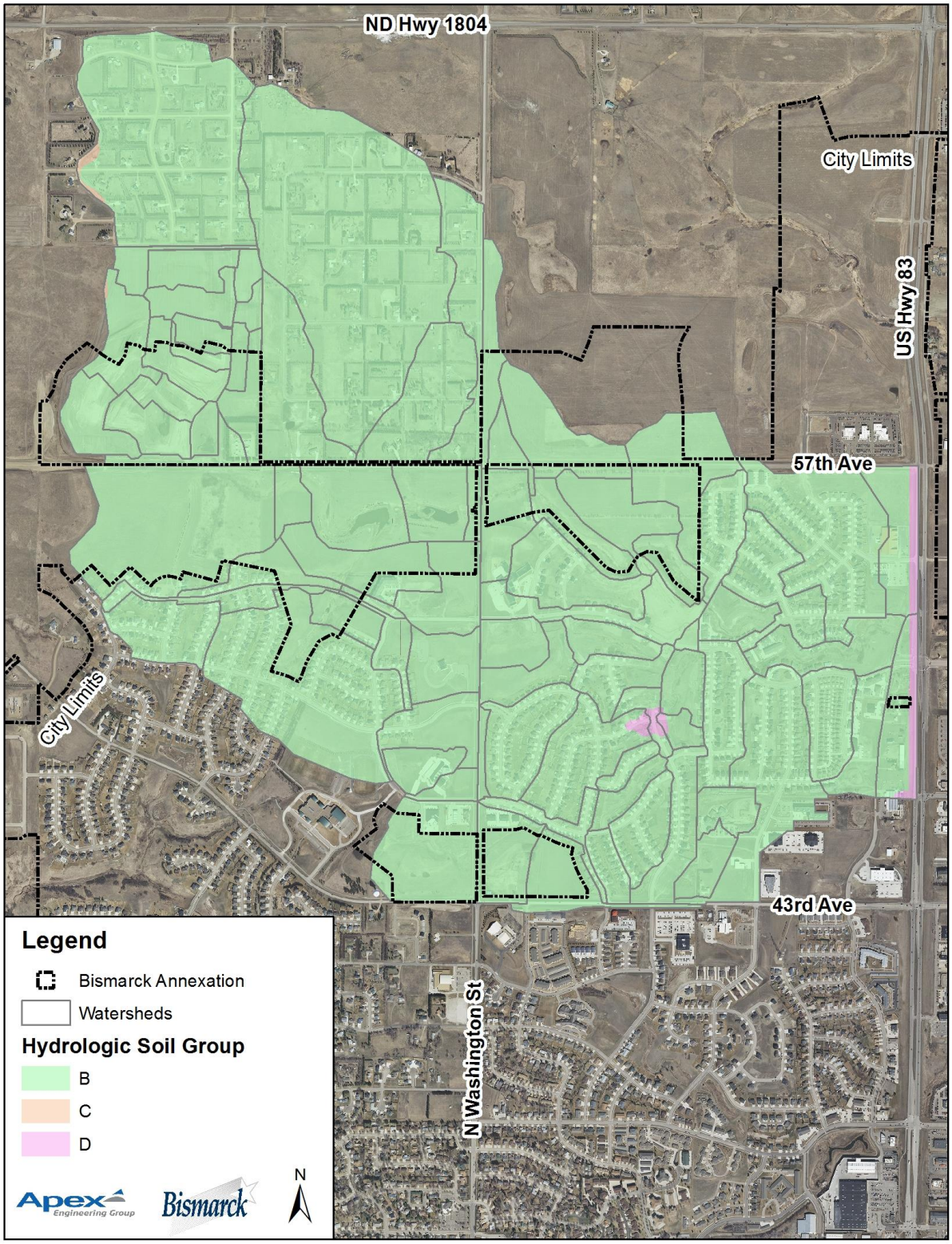
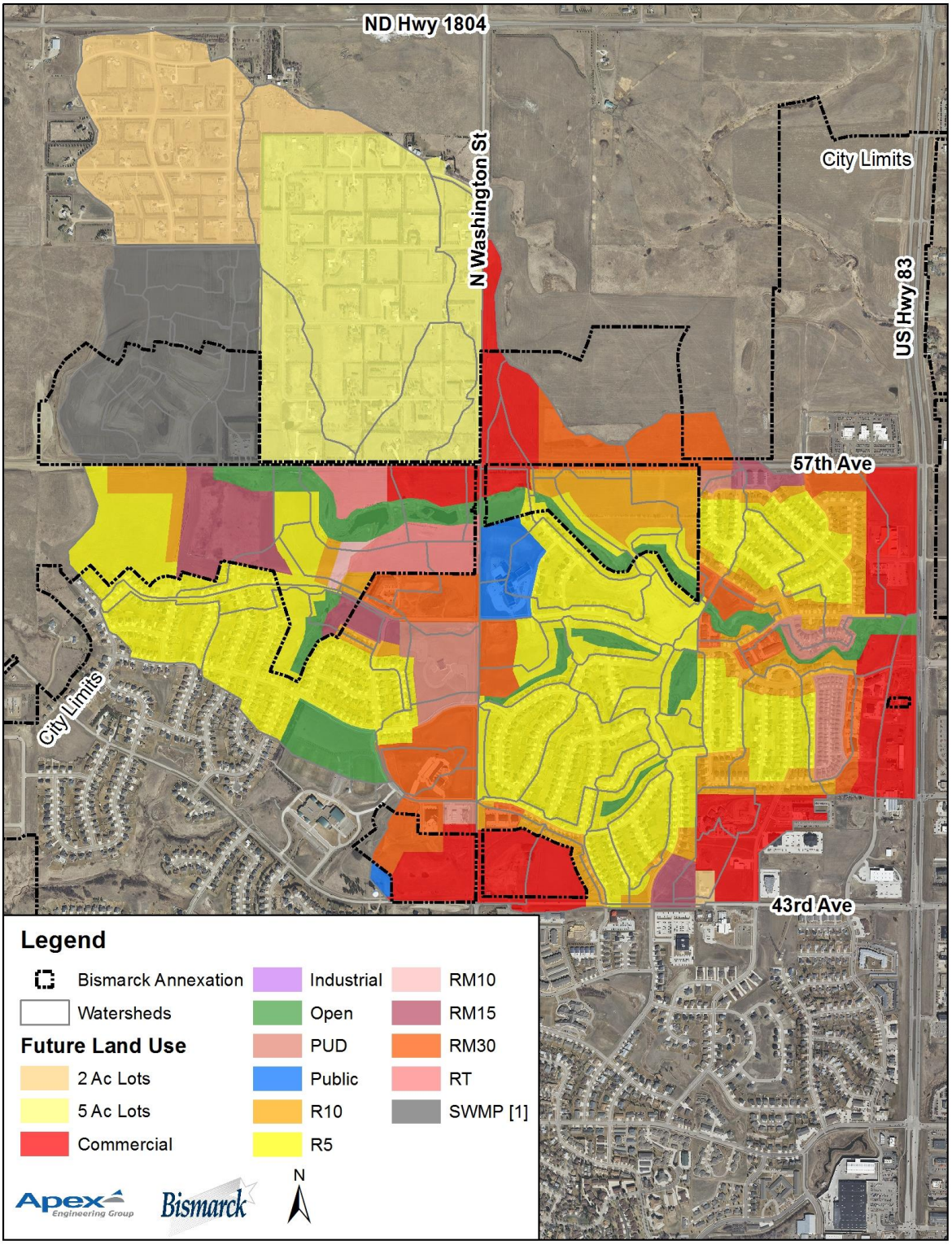


Figure 3. Hydrologic Soil Group



[1] The land use designation SWMP indicates that the CN values were taken directly from the Stormwater Management Plan.

Figure 4. Land Use Data

The model was updated using the curve numbers provided from the Heritage Ridge and Heritage Park Second Additions SWMP dated October 13, 2017. The SWMP included Heritage Ridge Addition, Heritage Park Addition, Heritage Park Addition First Replat, and Heritage Park Second Addition.

Values for time of concentration were updated for watersheds upstream of the 7'x5' box culvert at North Washington Street. The times of concentration in the InfoSWMM model were updated with the values from the Heritage Ridge SWMP, with the exception that a minimum value of 10 minutes was applied to align it with the rest of the model. For watersheds not included in Heritage Ridge, the time of concentration was calculated using the longest flow path and taking sheet flow into account where appropriate.

The NOAA's Atlas 14 Rainfall data was used as shown in Table 1. This data is an increase over the TP-40 values that were used to design the regional ponds east of Washington Street. The Atlas 14 values were modeled across the entire watershed to indicate the effect the new data would have on existing infrastructure.

Table 1. Atlas 14 Rainfall Data

Storm Event	Atlas 14 Data
2-Year, 6-Hour	1.63"
10-Year, 6-Hour	2.49"
25-Year, 6-Hour	3.18"
100-Year, 6-Hour	4.45"

The City requested that bypass flow from an existing storm sewer upstream of the South Pond be included in the model. The watershed is approximately 20 acres and is shown in Figure 2. This watershed contributes approximately 25 cfs of bypass flow on a 100-year event to the North Washington Street Watershed.

3.0 Hydraulic Model Input

Hydraulic components of the model were updated in watersheds upstream of the 7'x5' box culvert at North Washington Street. The Heritage Ridge SWMP was reviewed by Apex Engineering and the watersheds, detention ponds and pipe sizes and grades were included in the InfoSWMM model.

Five regional ponds were modeled and designed. Two of the regional ponds are located at the site of the two existing stock dams just west of the 7'x5' box culvert through North Washington Street. Two more proposed regional ponds are located to the south and discharge to a storm sewer which conveys flow to the West Pond. The fifth pond is located upstream of the Amberglow Drive embankment.

The storm sewer from the North Pond to the West Pond was designed to meet the criteria laid out in Section 6.1.2 of the Stormwater Design Standards Manual. Future inlet and storm sewer capacities were taken into account to size the ponds and the storm sewer. The storm sewer was sized to not allow bypass flow on a 5-year event at the low point near the intersection of LaSalle Drive and South Pass Drive. On a 5-year event, there is approximately 14 cfs entering the storm sewer in the south gutter, and 14 cfs entering the storm sewer in the north gutter. Above a 5-year event, it was assumed that the water in the south gutter would overflow into the North Pond, and water in the north gutter would flow in the street down South Pass Drive.

The low point on Flat Iron Drive is the outfall for the storm sewer system. The storm sewer outfall pipe was designed to a 25-year event, 72 cfs. Above a 25-year event, the water will overflow into a channel to the West Pond. This overflow channel will be designed by the developer. The hydraulic grade line in the storm sewer does not exceed 0.5 feet above the crown of the pipe on the 5-year event per Table 6-5 of the City of Bismarck 2018 Stormwater Design Standards Manual. The 100-year event does not cause the storm sewer to surcharge above the street elevation on this system. Velocities for the 5-year event were within the minimum and maximum requirements. Minimum entrance and exit loss coefficients for culverts and storm sewer manholes were obtained from Section 6.3.2 of the City of Bismarck Stormwater Design Standards Manual.

4.0 Model Results

After several iterations of different modeling scenarios, it was determined that the increased runoff caused by the updated rainfall and land use has created a need for more storage in this area of the watershed. The allowable flow rate through Washington Street produced by the old model is 306 cfs on a 100-year, 6-hour event. Existing downstream infrastructure was designed with that flow rate. The resulting flow through the 7' x 5' box culvert at Washington Street is 236 cfs which is less than the allowable 306 cfs. Smaller structures were used to utilize the storage available in the ponds and to restrict flows downstream to prevent overtopping of the existing embankments east of Washington Street.

The East and West Ponds were developed approximately at the existing stock dam locations. The hydraulics of these ponds are sensitive to the downstream water surface elevations. The South Pond and North Pond are located upstream of the future LaSalle Drive. The storage results for the model can be found in Table 2.

Table 2. Pond Data

Location	Invert (NGVD 29)	100-Year Depth (ft)	100-Year WSE Elevation (NGVD 29)	Volume Used (ac-ft)	Top of Embankment (NGVD 29)
Amberglow Drive Embankment	1890.0	6.3	1896.3	13.2	1897.5
East Pond	1859.0	7.0	1866.0	14.9 [1]	1867.5
West Pond	1865.5	7.1	1872.6	15.8 [1]	1874.0
South Pond	1886.8	7.3	1894.1	8.3	1896.0
North Pond – Lasalle Dr Embankment	1884.7	4.5	1889.2	2.8	1890.5
Mica Drive Embankment	1852.0	9.8	1861.8	22.2	1862.0

[1] Excludes wetland features which are assumed to be full

The volumes and stages described in Table 2 are the result of using multi-stage weir structures and outlet pipes through each embankment. At least one foot of freeboard is available in each pond based on the volumes used to develop the model.

5.0 Design Data & Assumptions

The riprap designed at each pond outfall was completed using the 100-year event. The velocities at all of the outfalls were less than 11 fps, except for the South Pond outfall which had a velocity of 11.3 fps.

A water quality weir has been incorporated in the Amberglow, East, and West ponds. The water quality weirs were sized to treat 1800 cubic feet per impervious acre draining to the pond per the methodology detailed in Appendix 5 of the Stormwater Design Standards Manual. The water quality volume for the Amberglow Pond excludes Heritage Ridge, because it has its own system of on-site ponds. The water quality volumes required and the volumes provided by the ponds are shown in Table 3 below.

Table 3. Water Quality Volumes

Pond	Volume Needed (ac-ft)	Volume Provided (ac-ft)
Amberglow Drive Pond	1.65	2.65
West & East Ponds (Combined)	4.85	6.27[1]

[1] Excludes wetland features which are assumed to be full

6.0 Conclusion

The updated rainfall and land use have caused an increase in the amount of runoff that needs to be managed. Five regional detention ponds and related stormwater improvements west of North Washington Street have been designed to limit the flows at Washington Street to the previously modeled parameters.