Apex Engineering Group
Water | Transportation | Municipal | Facilities

Technical Memorandum

North Washington Street Watershed Model
City of Bismarck | 12.105.0022

To: Brad Wright, PE

From: Apex Engineering Group, Inc.
Scott M. Schneider, PE, CFM
Chelsea Wattier, EIT

Re: N Washington Street Watershed Model
Bismarck, ND
Project No. 12.105.0022

Date: July 2, 2014

REGISTERED PROFESSIONAL ENGINEER
SCOTT M SCHNEIDER
PE-5347
DATE 7-2-14
NORTH DAKOTA

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.

Introduction

This technical memorandum addresses Apex Engineering Group's review of the existing models and the development of the North Washington Street Watershed InfoSWMM model. Apex Engineering Group was tasked with verifying the pipe sizes that would be installed at four road crossings between North Washington Street and Normandy Street in the NW ¼ of Section 16 of T139N R80W. The watershed location can be found in Figure 1. These road crossings are Mica Drive, Flint Drive, Normandy Street and Lasalle Drive. The road crossing locations can be found in Figure 2. The InfoSWMM model was developed to help evaluate storage and conveyance structures proposed by the previous Stormwater Management Plans.

Evaluation of Existing Models

The existing models consist of the 2004 North Washington Street Watershed Stormwater Management Plan and the 2007 update. Both of these models were built using the HEC-1 Flood Hydrograph Package developed by the U.S. Army Corps of Engineers. Apex Engineering received a digital and hard copy of the 2004 HEC-1 model from Houston Engineering. For the 2007 update to the HEC-1 model, only a hard copy was received from Swenson & Hagen.

The 2004 Masterplan was developed by updating and refining portions of the HEC-1 Hay Creek model. This masterplan addressed the major control points at that time, including 57th Avenue NW, North Washington Street, Halifax Drive (now known as Normandy Street), Canada Drive, and US Highway 83.

The 2007 Masterplan Update was developed to further refine the model by adding more control points and storage to reflect future conditions. Two of these additional control points were master planned to cross the main coulee in subbasin HC3-9, and were referred to as Unnamed Street #1 and Unnamed Street #2. These streets have since been named Mica Drive and Flint Drive, respectively. However, only Mica is reflected in the hard copy of the model that was received.

Development of InfoSWMM Model

The InfoSWMM model was built according to the following criteria and assumptions:

1. The hydrologic analysis was based on a 6-hour rainfall event with a Type 2 Distribution. Rainfall depths from TP-40 were used as the basis of analysis.
2. The 2, 10, 25 and 100 year events were evaluated.
3. Land use was further refined using the Stormwater Management Plans. Curve numbers were assigned for each land use as per the City of Bismarck Stormwater Design Standards Manual. Composite curve numbers were then calculated for each subbasin. The land use is shown in Figure 3.
4. Time of concentration was calculated for each subbasin by finding the longest flow path, and taking sheet flow into account where appropriate.
5. Existing conditions in developed areas were modeled from Stormwater Management Plans and field data.
6. The 2004 Masterplan was used to model proposed conditions west of Washington Street.
7. The 2007 Masterplan Update was used to model proposed conditions from Washington St to Canada Dr.

Two alternatives of the InfoSWMM model were run to analyze which was more effective for the control of runoff from the watershed. One alternative has the stormwater runoff from the southern area of the Boulder Ridge subdivision entering the main coulee upstream of Normandy Street, and the other alternative models flows entering below Normandy Street. When the runoff is routed above Normandy Street, it backs up high enough to overtop Normandy Street on the 100-year event. For this reason, it is our recommendation to route the runoff from the southern portions of Boulder Ridge to the downstream side of Normandy Street.

The developer's engineer provided storage curves for the Mica, Flint & Normandy crossings. The storage at Lasalle was modeled using the existing contours and lot lines and reducing the pond volume

to account for fill used to build up the lots. The storage volume west of Washington Street was assumed to be equal to what was modeled in the 2004 and 2007 Masterplans.

Various pipe sizes and configurations were modeled to minimize impacts on existing downstream structures and development. The configuration that had the least impact on downstream structures and property is a single 73" x 45" RCP arch at the Mica and Flint crossings, and a single 54" RCP at the Normandy & Lasalle crossings. These pipe sizes maximize the use of available storage in order to reduce impacts downstream. A cast-in-place structure with wingwalls, a 3-foot high water quality weir and 3 square feet of orifices was modeled in front of each pipe. The storage upstream of the weirs provides the volume required to contain the first half inch of runoff from the local watershed impervious areas. This is in compliance with the State Health Department's requirements for post construction best management practices.

Model Comparison

The total area and composite curve number for the Apex Engineering InfoSWMM model are very similar to those of the 2007 Masterplan Update. This accounts for the similarity between the two models in the total volume of stormwater runoff. These similarities are seen in the table below.

Table 1 Volume Comparison between Models

	Swenson & Hagen 2007 Masterplan Update	Apex Engineering InfoSWMM Model
Total Watershed Area (Ac)	1445	1474
Composite Curve Number	78	77
2 Year Event Total Volume (Ac-ft)	34	37
10 Year Event Total Volume (Ac-ft)	96	97
25 Year Event Total Volume (Ac-ft)	138	136
100 Year Event Total Volume (Ac-ft)	212	207

Some differences exist in the time of concentration values. These differences control the timing and magnitude of peak flows. These differences can be attributed to the inclusion of sheet flow where it was appropriate in the InfoSWMM model, making the time of concentration longer for many subbasins. The time of concentration values and the dynamic modeling capability of the InfoSWMM model results in peak flows that are less than in previous HEC-1 models.

Results

The City of Bismarck Stormwater Design Standards Manual states the depth of water that is allowable as cross street flow for each street classification. For the design event, or 25-year event, local streets can have 6" of water above the crown, and collector streets can have 3". For the 100-year event local streets can have 9" of water at the crown, and collector streets can have 6". All of the new structures and the two downstream structures meet the cross flow design standard, which is the controlling design requirement for this project. The model results show that the road is overtopped at Canada Drive by 1" and Ottawa Drive by 5" on the 100-year event. The road

crossings were not overtopped on the 25-year event. Tables 2 through 6 summarize the peak flows and water surface elevations for each event at the four new road crossings and the first downstream structure, Canada Drive.

Table 2 InfoSWMM Model Results for Mica Drive

Mica Drive Top of Road: 1862.00 73"x45" RCP Arch			
Frequency	Peak Inflow (cfs)	Peak Outflow (cfs)	Water Surface Elevation (NGVD 29)
2-Year	62	51	1855.6
10-Year	163	145	1857.2
25-Year	226	196	1858.6
100-Year	307	259	1861.0

Table 3 InfoSWMM Model Results for Flint Drive

Flint Drive Top of Road: 1843.55 73"x45" RCP Arch			
Frequency	Peak Inflow (cfs)	Peak Outflow (cfs)	Water Surface Elevation (NGVD 29)
2-Year	67	60	1838.7
10-Year	159	149	1840.3
25-Year	231	195	1841.5
100-Year	346	245	1843.4

Table 4 InfoSWMM Model Results for Normandy Street

Normandy Street Top of Road: 1833.10 54" RCP			
Frequency	Peak Inflow (cfs)	Peak Outflow (cfs)	Water Surface Elevation (NGVD 29)
2-Year	85	62	1826.9
10-Year	212	147	1829.1
25-Year	277	191	1830.7
100-Year	371	234	1832.7

Table 5 InfoSWMM Model Results for Lasalle Drive

Lasalle Drive Top of Road: 1839.00 54" RCP			
Frequency	**Peak Inflow (cfs)**	**Peak Outflow (cfs)**	**Water Surface Elevation (NGVD 29)**
2-Year	70	65	1833.0
10-Year	138	123	1834.4
25-Year	200	164	1835.6
100-Year	329	224	1838.2

Table 6 InfoSWMM Model Results for Canada Drive

Canada Drive Top of Road: 1823.20 2-60" RCP			
Frequency	**Peak Inflow (cfs)**	**Peak Outflow (cfs)**	**Water Surface Elevation (NGVD 29)**
2-Year	114	108	1818.6
10-Year	282	260	1820.8
25-Year	365	327	1821.8
100-Year	467	413	1823.3

Atlas 14 Rainfall Analysis

The InfoSWMM model was also run with rainfall depths taken from Atlas 14. Table 6 below shows the increase in rainfall values compared to the TP-40 which had been used to size infrastructure for the watershed thus far. When the larger Atlas 14 rainfall values are modeled, all of the roadway crossings are overtopped on the 100-year event; however the cross flow depth on Mica Drive, Flint Drive and Normandy Street meets the allowable depth in the Stormwater Design Standards Manual. Lasalle Drive, Canada Drive and Ottawa Street would all be overtopped by depths greater than the allowable depths. All of the crossings are in compliance for the 25-year event. The infrastructure planning for this project was based on the TP-40 values for two reasons: first, the previous storm water master plans were based on the TP-40 values and the second, the development master planning was approved by the City prior to the Atlas 14 values being published. The development master planning was based on the main coulees being used for conveyance and storage with development backing up to the coulee on both sides. The Atlas 14 values would require additional storage within this development and possibly downstream in order to not overtop the roadways.

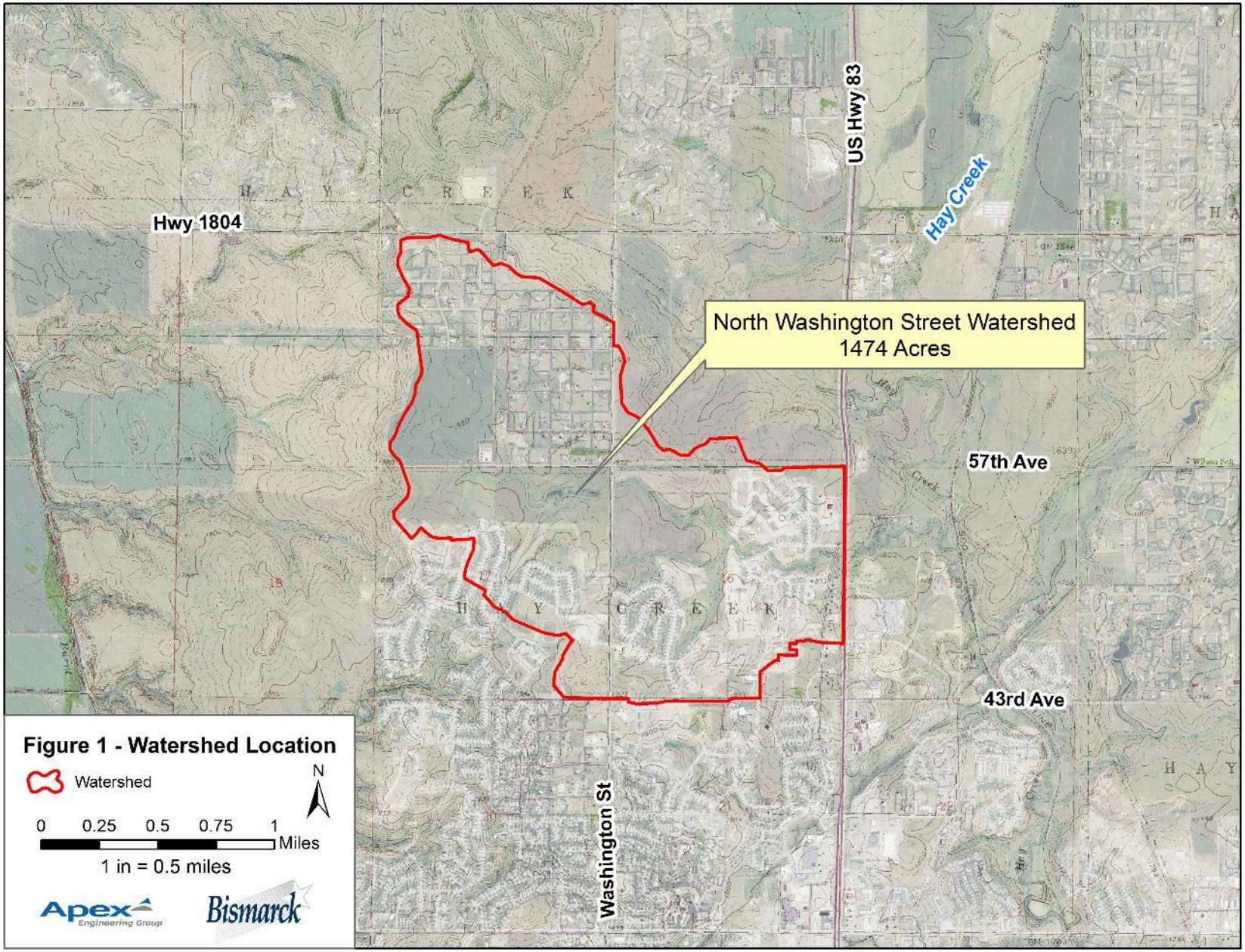
Because the roadways only overtop on the 100-year event and the depths are not excessive, it was concluded to utilize the TP-40 values for this infrastructure improvements project.

Table 6 Rainfall Depth Summary

Frequency	TP-40 Rainfall (in)	Atlas 14 Rainfall (in)
2-Year	1.60	1.63
10-Year	2.50	2.49
25-Year	3.00	3.18
100-Year	3.80	4.45

Conclusions and Recommendations

The North Washington Street Watershed InfoSWMM Model was built to gain a better understanding of the storage and conveyance conditions of the watershed and to properly size the structures at the Mica Drive, Flint Drive, Normandy Street, and Lasalle Drive road crossings to meet the Storm Water Design Standards Manual. The model allowed the crossings to be sized while minimizing impacts on downstream development and structures. All of the new and downstream structures meet the City's stormwater design manual requirements for cross-flow for the 25 and 100-year events. Each new structure also has a water quality weir incorporated into the structure to meet the ND Department of Health's MS4 requirements of storing the first half inch of runoff from impervious areas. It is important to note that these results are only valid if the storage west of Washington Street that is described in the 2004 Masterplan is constructed.


Hwy 1804
US Hwy 83
Hay Creek
North Washington Street Watershed
1474 Acres
57th Ave
43rd Ave
Washington St
H A Y C R E E K
Figure 1 - Watershed Location
Watershed
N
0 0.25 0.5 0.75 1 Miles
1 in = 0.5 miles
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57th Ave
N Washington St
Flint Dr
Mica Dr
Normandy St
Lasalle Dr
Figure 2 - Crossing Locations
Embankment Area
Pipes
0 175 350 525 700
Feet
1 in = 350 feet
N
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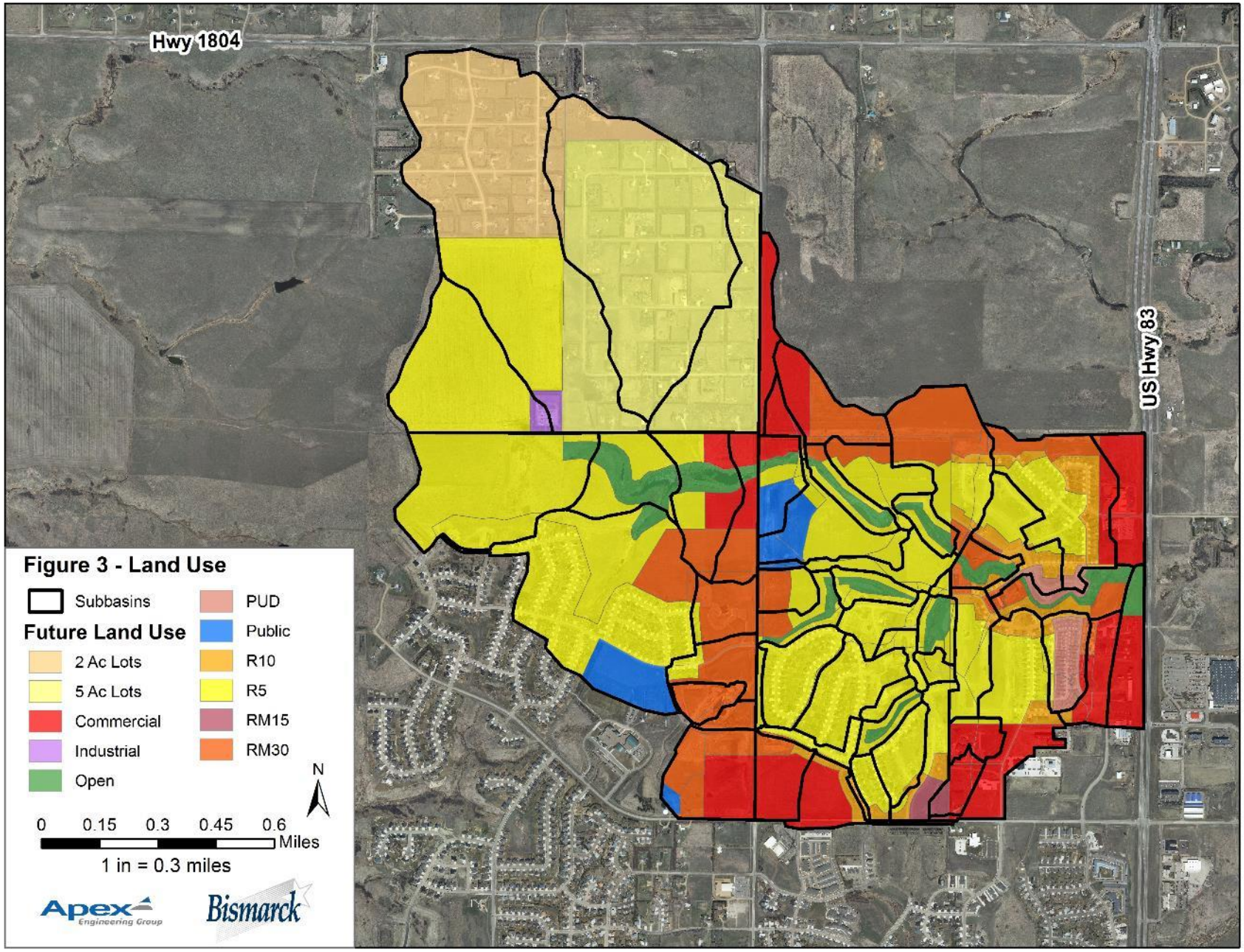
Hwy 1804
US Hwy 83
Figure 3 - Land Use
Subbasins
Future Land Use
2 Ac Lots
5 Ac Lots
Commercial
Industrial
Open
PUD
Public
R10
R5
RM15
RM30
N
0 0.15 0.3 0.45 0.6
Miles
1 in = 0.3 miles
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