

SECTION 9
ALTERNATIVE ANALYSIS: STORM SEWER

9.01 GENERAL

A. Alternatives Analysis Overview

This section discusses alternatives analyzed to address existing flooding in the Forest Park area, based on discussions between City and Strand Associates staff. Each alternative includes a description, the effects on flooding in the Forest Park area, the effects on flooding watershedwide and the planning-level OPCC. Each alternative is modeled using a 2-hour duration storm event that was established as the critical duration storm as described in Section 7. The inlet capacity analysis methodology used in Section 9 is described in Section 7.02. Costs presented were estimated using historical bid costs, where available, and supplemented by other reference sources. All estimated project costs include allowances for engineering (15 percent) and construction contingency (15 percent), soils investigation where necessary, and land acquisition costs. The goal of this report is to provide City personnel with the information required to initiate the budgeting and planning phase for facilities improvements. All costs are presented in second quarter 2010 dollars. Future construction costs should be adjusted for inflation when final project schedules are determined. OPCC estimates should be updated during the design phase. Detailed OPCCs are included in Appendix H.

B. Existing Detention in Watershed

Our modeling has included incorporation of nine existing detention basins in the modeled watersheds. The available storage volume at each existing detention facility for a 100-year storm event and a summary is included in Table 9.01-1.

C. Alternatives Analysis Design Criteria Goals

At the onset of this project, the City established the following design goals for the alternatives analysis in the Forest Park Area.

1. 10-Year Goal: Conveyance of the 10-year storm event in storm sewers under surcharged pipe flow conditions (i.e., hydraulic grade line no greater than the ground elevation). Undersized downstream storm sewer systems present a challenge to meeting this goal.

2. 25-Year Goal: No surface flooding of home foundations during the 25-year storm event. No surface flooding of home foundations during the 25-year storm event, for purposes of this plan, consist of surface flooding depths greater than 2 inches above the Triangulated Irregular Network (TIN) provided by the City at the outline of the home as shown on aerial photography provided by the City. This is considered the best available information because survey of home foundation/first floor elevations/low entry point is not available. We recommend that during design of the recommended alternative, all flood-prone homes be surveyed to obtain their foundation/first floor elevations/low entry point. Model results adjacent to the flood-prone homes should then be compared to the

Existing Detention Facilities	Maximum WSEL	Storage Volume (acre-feet)
Gangler	683.79	97.84
Graystone	648.26	13.41
Hillside	675.20	44.98
Kenosha Bible Church	698.80	1.57
Kenosha Commons	703.90	2.11
Lincoln Park	615.84	46.48
Nash Park	710.51	13.21
Old Elm	721.78	1.15
Pike Creek Grease Interceptor	605.01	0.43
Total Existing Detention		221.18

Table 9.01-1 Existing Storage Volume in 100-Year Storm Event

surveyed elevations. Modifications should be made to the recommended improvements if necessary to keep the 25-year water surface elevation below the surveyed foundation/first floor elevation (lowest entry point). In general, allowing street flooding will increase the likelihood of infiltration/inflow (I/I) in the sanitary sewer system.

3. 100-Year Overflow: Run the 100-year storm event in the model and report the results including the location of 100-year storm event overflow, if any. Providing an acceptable 100-year overflow route may not be achievable because of topographic constraints in the study area without significant expenditures. In urban environments, this is typically done by either upsizing the downstream storm sewer system or embarking on an urban stream daylighting project. An urban stream daylighting project for the Forest Park Area would likely consist of purchasing road right-of-way and homes to create an open channel, likely from 60th Street northeast to the Pike Creek outfall. An urban stream daylighting project has not been analyzed as part of this plan.

D. Overview of Alternatives Analyzed

The components of each alternative analyzed for the Forest Park North Area and Forest Park South Area are shown in Table 9.01-2. The Agreement calls for four alternatives to be developed for the limits of the detailed study area. These alternatives were considered as potential measures to meet the goals identified above. As you will find in the description of each alternative below, Alternatives 1 and 5 do not meet these goals and are removed from further consideration. Alternatives 2, 3, and 4 are considered for the Forest Park North Area. Alternative 6 is considered for the Forest Park South Area. Alternative 7 is considered for both the Forest Park North and South Areas.

Amendment No. 2 to this project included evaluating Alternatives 8, 9, 10, and 11. These Alternatives were analyzed with a model that varies slightly from the model used to analyze Alternatives 1 through 7. Therefore, there are new existing conditions flood extents maps (Figures 7.02-18, 7.02-19, 7.02-20, 7.02-21, 7.02-22, and 7.02-23) that results of the Alternatives 8, 9, 10, and 11 analysis can be compared.

Amendment No. 3 to this project included evaluating Alternative 12.

**TABLE 9.01-2
 SUMMARY OF ALTERNATIVES ANALYZED**

Alternative	Strand Alternative Designation	Figure No.	Alternative Description	
			Forest Park North	Forest Park South
1	1N	9.02-1 and -2	Nash Park Detention Basin Modifications	N/A
2	2NG1	9.03-2 and -3	Underground Detention in Forest Park	N/A
3	5N	9.04-2	Underground Detention in Church Parking Lot Northwest of Pershing/61st Street	N/A
4	6N	9.05-3	Pumping station in Forest Park Area Pumping to Detention Basin in Vacant Land Southwest of 60th Avenue/60th Street Intersection	N/A
5	1S	9.06-1	N/A	Disconnect Interconnection with Storm Sewer on 65th Street
6	2S	9.07-1	N/A	Conveyance Upgrade to Underground Detention at Forest Park School
7	2NS	9.08-4	Home Purchase and Conversion to Dry Detention Basins and Underground Detention	Home Purchase and Conversion to Dry Detention Basins
8	8		Existing Inlets and Leads combined with Upsizing of Existing Bottleneck Storm Sewers along Pershing Boulevard, 42nd Avenue, 59th Street, and 60th Street (stopping at 39th Avenue)	N/A
9	9		Upsized Inlets and Inlet Leads (see Figure 7.02-10), Upsized Forest Park North Mainline (as necessary), and Upsized Existing Bottleneck Storm Sewers as defined in Alternative 8 seeking to pass the 10-year storm event	N/A
10	10		N/A	Existing Inlets and Leads combined with Upsizing of Existing Bottleneck Storm Sewers along 49th Avenue, 67th Street, 67th Place, 47th Avenue (stopping at 70th Street) and Taft Road (upstream of Pershing Blvd)
11	11		N/A	Upsized Inlets and Inlet Leads (see Figure 7.02-10), Upsized Forest Park South Mainline (as necessary), and Upsized Existing Bottleneck Storm Sewers as defined in Alternative 10 seeking to pass the 10-year storm event
12	12	9.15-1	Storm sewer and inlet improvements between 46th Avenue and Pershing Boulevard.	N/A

9.02 ALTERNATIVE 1 (1N)–NASH PARK DETENTION BASIN MODIFICATIONS

Modifications to the outfall structure that controls discharge from the existing Nash Park Detention Basin are considered in this alternative. The existing outfall structure shown in Figures 9.02-1 and 9.02-2 is a multistage structure that is ultimately controlled by a 10-inch-diameter orifice.

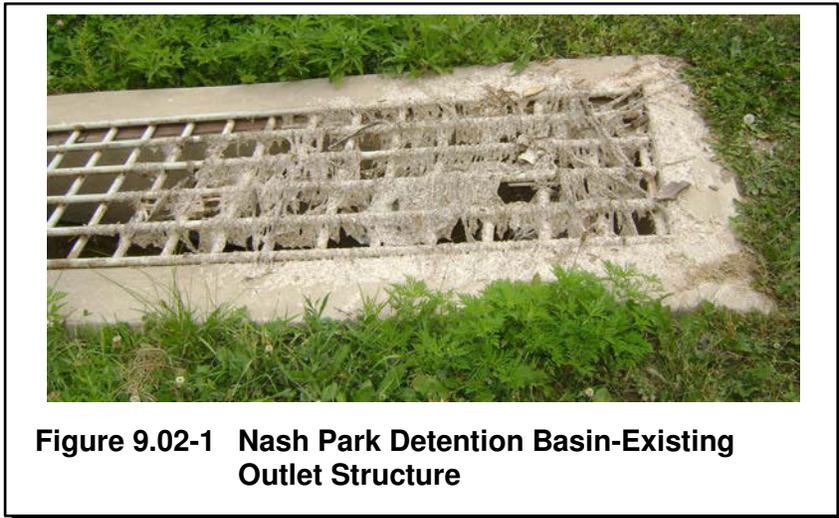


Figure 9.02-1 Nash Park Detention Basin-Existing Outlet Structure

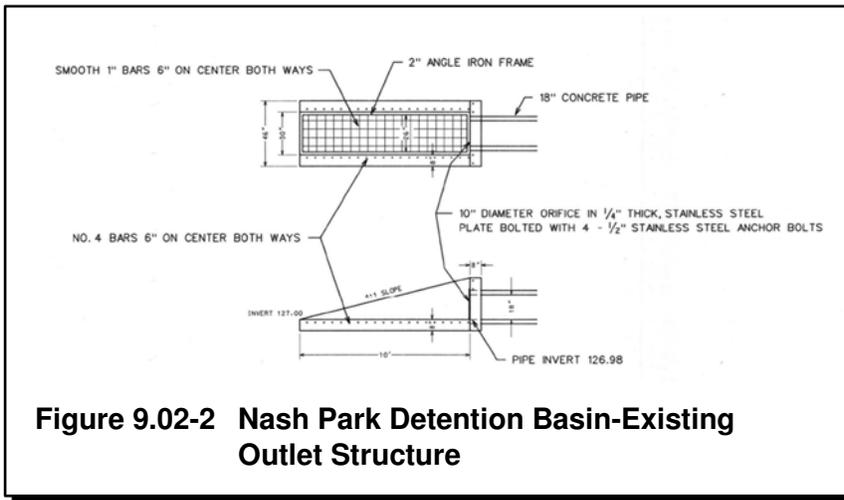


Figure 9.02-2 Nash Park Detention Basin-Existing Outlet Structure

This alternative considers modifying the existing outlet structure from a 10-inch orifice to a 4-inch orifice.

The overall effect of Alternative 1 at the Watershed and Forest Park North indicator points is included in Table 9.02-1. This alternative has virtually no effect on the Forest Park area or on a watershedwide basis during the 10-year storm event. Alternative 1 was not pursued further because the improvement was ineffective. Initial runs for the 25-year and 100-year storm event show this change would actually exacerbate downstream flooding as flows in the 60th Street storm sewer main would have less opportunity to back up into the Nash Park Pond.

**TABLE 9.02-1
 ALTERNATIVE 1—PEAK DISCHARGE RATES AND HGL BY INDICATOR POINT (10-YEAR STORM EVENT)**

Node	Pipe	Indicator Node Type	Node Location	Maximum Flow (cfs)			Maximum HGL (ft)			
				Existing Conditions 10-Year	Alternative 1 10-Year	Change	Ground Elevation	Existing Conditions 10-Year	Alternative 1 10-Year	Change
Watershed Indicator Points										
8	P-7	Outfall	Pike Creek Outfall	492.0	491.9	-0.1	619.72	598.94	598.94	0.00
5	P-800	Center Mainline Outfall	(N) Lake Michigan Outfall	579.1	579.0	-0.1	587.70	585.75	585.75	0.00
6	P-4655	South Mainline Outfall	(S) Lake Michigan Outfall	386.3	386.4	0.0	585.09	582.08	582.08	0.00
11482	P-11482	System Convergence: North	37th Avenue/52nd Street	162.2	162.4	0.2	642.00	642.81	642.81	0.00
6128	P-6128	System Convergence: Central	60th St.	115.4	119.6	4.2	644.11	636.85	636.83	-0.01
Forest Park North Indicator Points										
11553	P-11553	Enter North Study Area	(W) 51st Avenue/60th Street	86.9	87.3	0.4	691.95	691.50	691.52	0.02
5634	P-5634	Low Point: North System	51st Avenue/61st Street	111.8	111.3	-0.5	681.21	679.40	679.33	-0.07
5770	P-5770	Low Point: North System	49th Avenue/61st Street	102.1	102.5	0.4	676.89	675.07	675.05	-0.02
5794	P-5794	Low Point: North System	46th Avenue North of 61 st Street	12.9	13.0	0.0	664.71	665.75	665.73	-0.02
10232	P-10232.1	Exit North Study Area	60th Street/Pershing Boulevard	101.1	101.2	0.1	660.29	660.81	660.82	0.01

9.03 ALTERNATIVE 2 (2NG1)–UNDERGROUND DETENTION IN FOREST PARK

Providing underground detention in Forest Park is considered in this alternative. A picture of Forest Park is shown in Figure 9.03-1. Figure 9.03-2 shows the layout of this project. Figure 9.03-3 shows the locations of necessary storm sewer and inlet upgrades to achieve a 10-year storm event capacity in the Forest Park North watershed in conjunction with two underground detention basins. Figure 9.03-4 shows the WDNR RR Sites Map showing locations of closed and active remediation sites in the vicinity of this project, none of which appear to impact this Alternative.



Figure 9.03-1 Alternative 2-Forest Park Facing West from 46th Avenue

The overall effect of Alternative 2 at the Watershed and Forest Park North indicator points is included in Table 9.03-1. During the 25-year storm event, no homes are flooding up to the foundation/first floor elevation (low entry point) using the criteria described in Section 9.01. Figure 9.03-5 shows the flooding depths during the 25-year storm event with Alternative 2 in place. Figure 9.03-6 shows the flooding depths during the 100-year storm event with Alternative 2 in place.

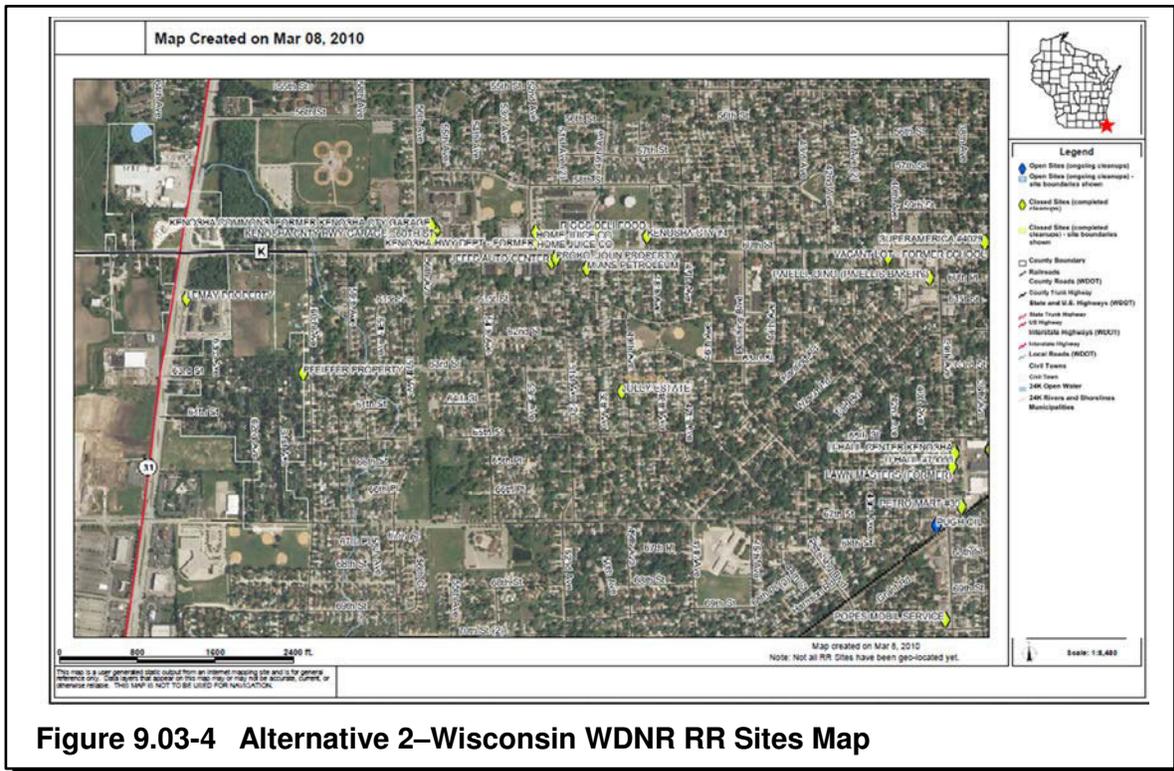
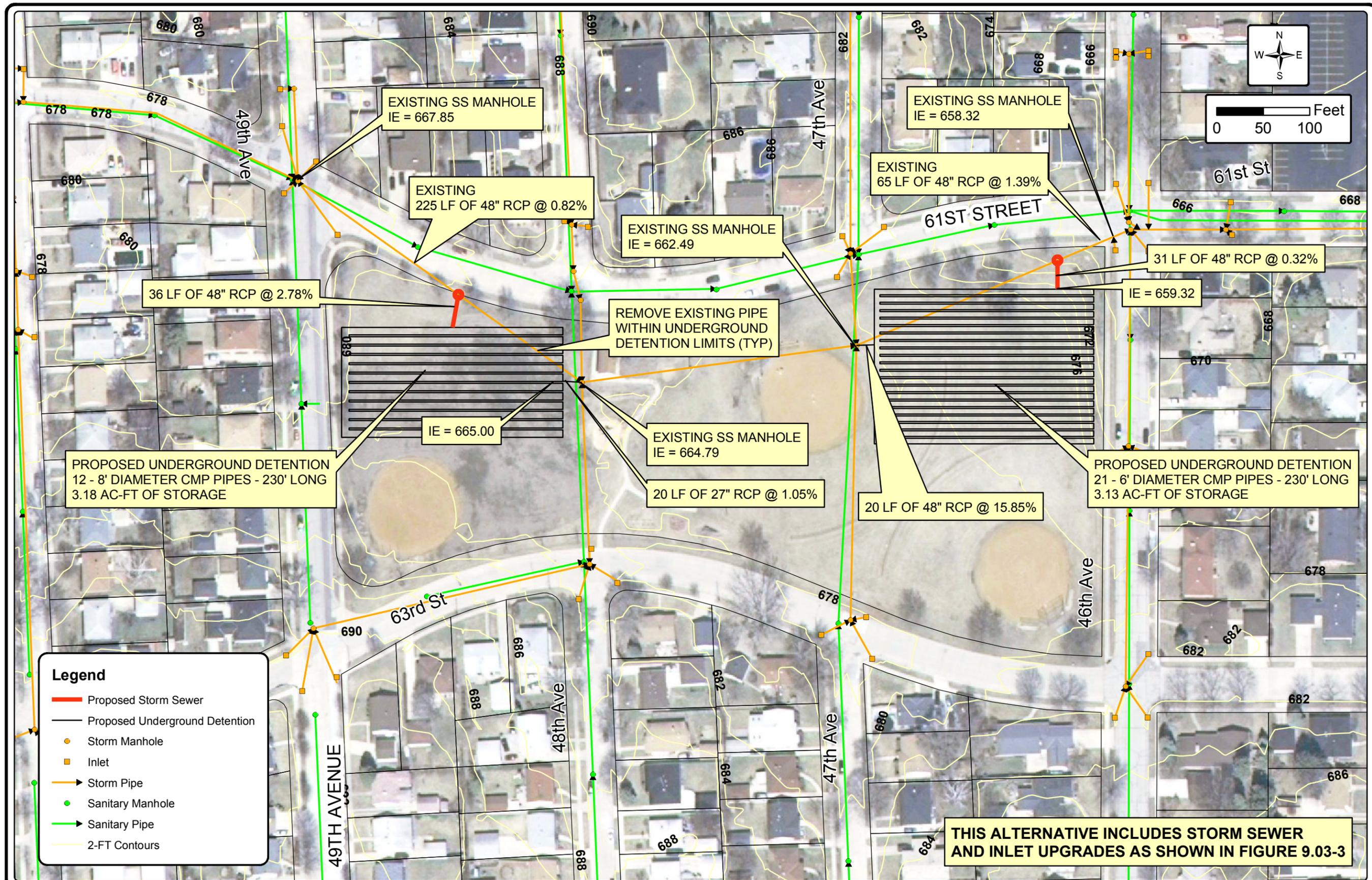


Figure 9.03-4 Alternative 2–Wisconsin WDNR RR Sites Map



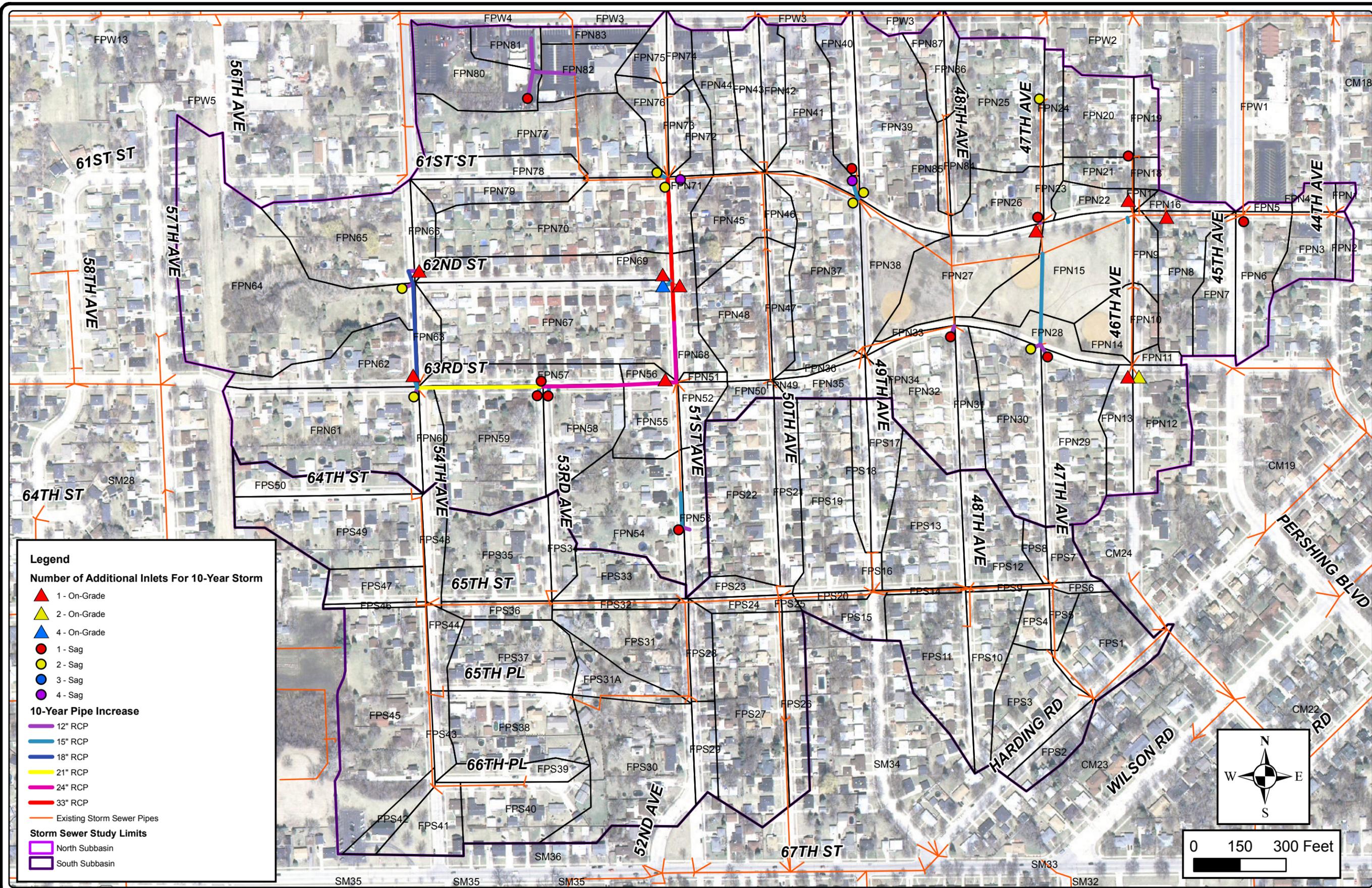
THIS ALTERNATIVE INCLUDES STORM SEWER AND INLET UPGRADES AS SHOWN IN FIGURE 9.03-3

**ALTERNATIVE 2 (2NG1)
 FOREST PARK UNDERGROUND DETENTION
 (2005 AERIAL)
 FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
 CITY OF KENOSHA
 KENOSHA COUNTY, WISCONSIN**



FIGURE 9.03-2
 1540.001

S:\MAD\1500-1599\1540\001\Data\GIS Data\Figures\Report Figures\Storm Analysis\Figure 9.06-1 - Remove Interconnection at 50th and 65th.mxd



Legend

Number of Additional Inlets For 10-Year Storm

- ▲ 1 - On-Grade
- ▲ 2 - On-Grade
- ▲ 4 - On-Grade
- 1 - Sag
- 2 - Sag
- 3 - Sag
- 4 - Sag

10-Year Pipe Increase

- 12" RCP
- 15" RCP
- 18" RCP
- 21" RCP
- 24" RCP
- 33" RCP
- Existing Storm Sewer Pipes

Storm Sewer Study Limits

- North Subbasin
- South Subbasin

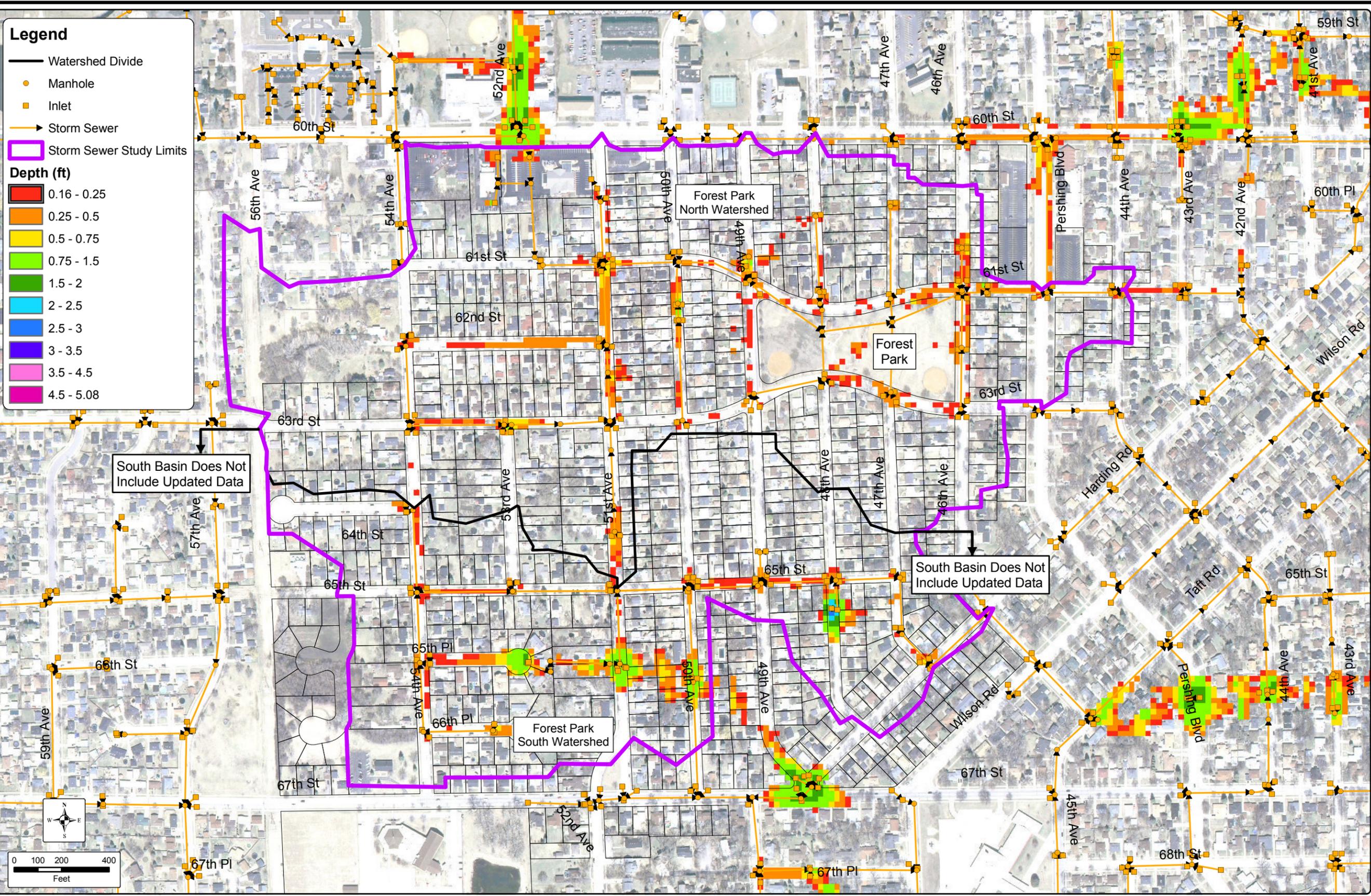
10-YEAR ADDITIONAL INLETS (REQUIRED IN ALTERNATIVE 2, 3, 4 & 7)
(2005 AERIAL)

FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN



FIGURE 9.03-3
1540.001

s:\MAD\1500-1599\1540\001\Data\GIS Data\Figures\Report Figures\Storm Analysis\Final Figures\Figure 9.03-3 - Forest Park Inlet Locations.mxd



ALTERNATIVE 2 - 25-YEAR
FLOOD EXTENTS

FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN



FIGURE 9.03-5
1540.001



The OPCC is shown in Table 9.03-2. The underground detention cost is based on use of a corrugated metal pipe (CMP) underground detention system as manufactured by Contech. The CMP product is coated with an aluminized finish (rather than the typical zinc coating), and Contech reports that this product has a 75-year lifespan because lesser abrasion is expected in an underground detention application. However, other options as shown in Table 9.03-7 could be high density polyethylene (HDPE) pipe detention system (ADS) with maximum 60-inch pipe size, polypropylene vaults (Stormtech), concrete stormwater vaults (such as the StormTrap product), or polypropylene cellular blocks (Stormbloc). Each of these options has a varying cost and footprint. For example, a StormTrap system, while maximizing storage for a given footprint, would bring the cost of this alternative from \$3.68 million to \$4.19 million. Cost research done as part of this project shows that the CMP product appears to be the most cost-effective of the underground detention option types researched.

Underground detention was chosen as the most feasible detention type in Forest Park as opposed to a surface dry detention basin because of the following reasons.

1. The functionality of Forest Park as a home to three baseball fields would be compromised. A dry detention basin providing storage at equivalent elevation would result in the loss of all three baseball fields without enough space to rebuild them in the bottom of the basin.
2. There are safety concerns in a residential area with a dry detention basin of this depth (6 to 10 feet of ponding depth) during the 100-year storm event.

Table 9.03-3 provides advantages and disadvantages of this alternative.

**TABLE 9.03-1
 ALTERNATIVE 2-PEAK DISCHARGE RATES BY INDICATOR NODE (10-YEAR, 2 HOUR DURATION)**

Node	Pipe	Indicator Node Type	Node Location	Maximum Flow (cfs)			Maximum HGL (ft)			
				Existing Conditions 10-Year	Alternative 2 10-Year	Change	Ground Elevation	Existing Conditions 10-Year	Alternative 2 10-Year	Change
Watershed Indicator Points										
8	P-7	Outfall	Pike Creek Outfall	496.0	479.8	-16.2	619.72	598.94	598.92	-0.02
5	P-800	Center Mainline Outfall	(N) Lake Michigan Outfall	580.1	582.6	2.5	587.70	585.75	585.77	0.02
6	P-4655	South Mainline Outfall	(S) Lake Michigan Outfall	386.3	386.4	0.0	585.09	582.08	582.08	0.00
11482	P-11482	System Convergence: North	37th Avenue/52nd Street	163.1	162.2	-0.8	642.00	642.81	642.80	-0.01
6128	P-6128	System Convergence: Central	60th St.	115.9	117.5	1.7	644.11	636.85	634.99	-1.86
368	P-368	System Convergence: South	40th Avenue/76th Street	271.7	271.3	-0.4	645.00	640.44	640.41	-0.03
Forest Park North Indicator Points										
11553	P-11553	Enter North Study Area	(W) 51st Avenue/60th Street	87.1	87.0	-0.1	691.95	691.50	691.58	0.08
5634	P-5634	Low Point: North System	51st Avenue/61st Street	111.3	126.3	15.1	681.21	679.40	680.41	1.01
5770	P-5770	Low Point: North System	49th Avenue/61st Street	120.0	124.3	4.3	676.89	675.07	674.59	-0.48
5794	P-5794	Low Point: North System	46th Avenue North of 61 st Street	12.9	5.6	-7.4	664.71	665.75	662.31	-3.44
10232	P-10232.1	Exit North Study Area	60th Street/Pershing Boulevard	101.2	94.8	-6.4	660.29	660.81	658.92	-1.89

**TABLE 9.03-2
 ALTERNATIVE 2—OPINION OF PROBABLE COST**

Item	Capital Cost
Forest Park Underground Detention	\$3,680,000

**TABLE 9.03-3
 ALTERNATIVE 2—ADVANTAGES/DISADVANTAGES**

Advantages	Disadvantages
<ul style="list-style-type: none"> ▪ Makes use of existing City-owned open space. ▪ Provides storage directly adjacent to a flooding problem area. ▪ Contamination Potential-As shown in Figure 9.03-4, WDNR’s Remediation and Redevelopment (RR) Sites Web site does not show this parcel as contaminated nor are there any immediately adjacent contaminated sites. 	<ul style="list-style-type: none"> ▪ Expense of underground detention.

9.04 ALTERNATIVE 3 (5N)–UNDERGROUND DETENTION IN IMMANUEL BAPTIST CHURCH PARKING LOT

In an effort to leverage the use of downstream open land, we have analyzed Alternative 3 as underground detention in the Immanuel Baptist Church parking lot. A picture of the location is shown in Figure 9.04-1. Figure 9.04-2 shows the layout of this project. Figure 9.03-3 shows the locations of necessary storm sewer and inlet upgrades to achieve a 10-year storm event capacity in the Forest Park North watershed in conjunction with the underground detention basin. Figure 9.03-4 shows the WDNR RR Sites Map showing locations of closed and active remediation sites in the vicinity of this project, none of which appear to impact this Alternative.

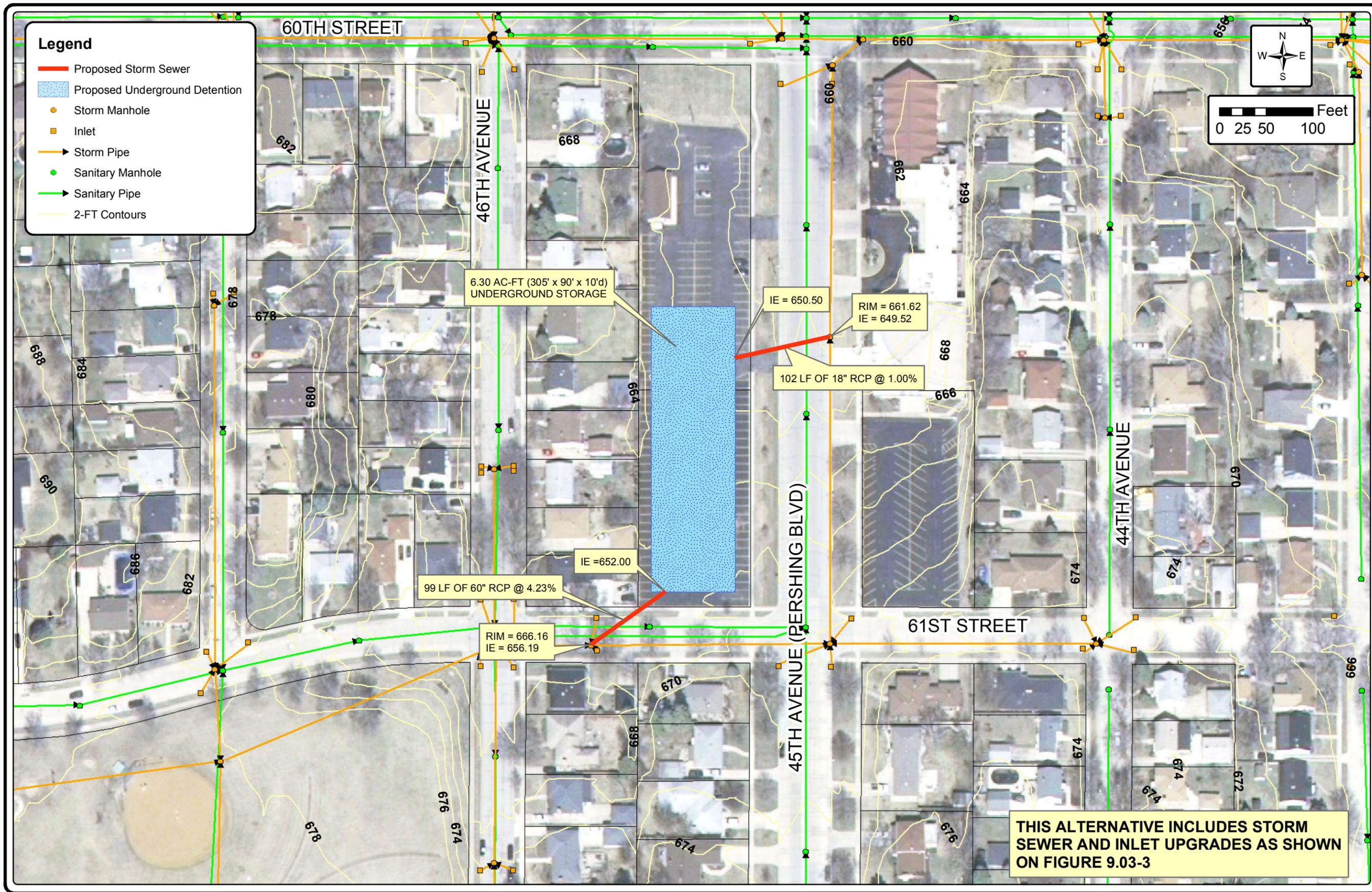


Figure 9.04-1 Alternative 3–Immanuel Baptist Church Parking Lot Northwest from Pershing Boulevard/61st Street Intersection

The overall effect of Alternative 3 at the Watershed and Forest Park North indicator points is included in Table 9.04-1. During the 25-year storm event, no homes are flooding up to the foundation/first floor elevation (low entry point) using the criteria described in Section 9.01. Figure 9.04-3 shows the flooding depths during the 25-year storm event with Alternative 3 in place. Figure 9.04-4 shows the flooding depths during the 100-year storm event with Alternative 3 in place.

The opinion of probable cost is shown in Table 9.04-2. The cost is based on use of a concrete vault underground detention system as manufactured by Stormtrap. However, other options as shown in Figure 9.03-7 could be HDPE pipe detention system with maximum 60-inch pipe size (ADS), polypropylene vaults (Stormtech), corrugated metal pipe system (Contech), or polypropylene cellular blocks (Stormbloc). Each of these options has a varying cost and footprint. Given site constraints, the concrete vault was used for purposes of this plan.

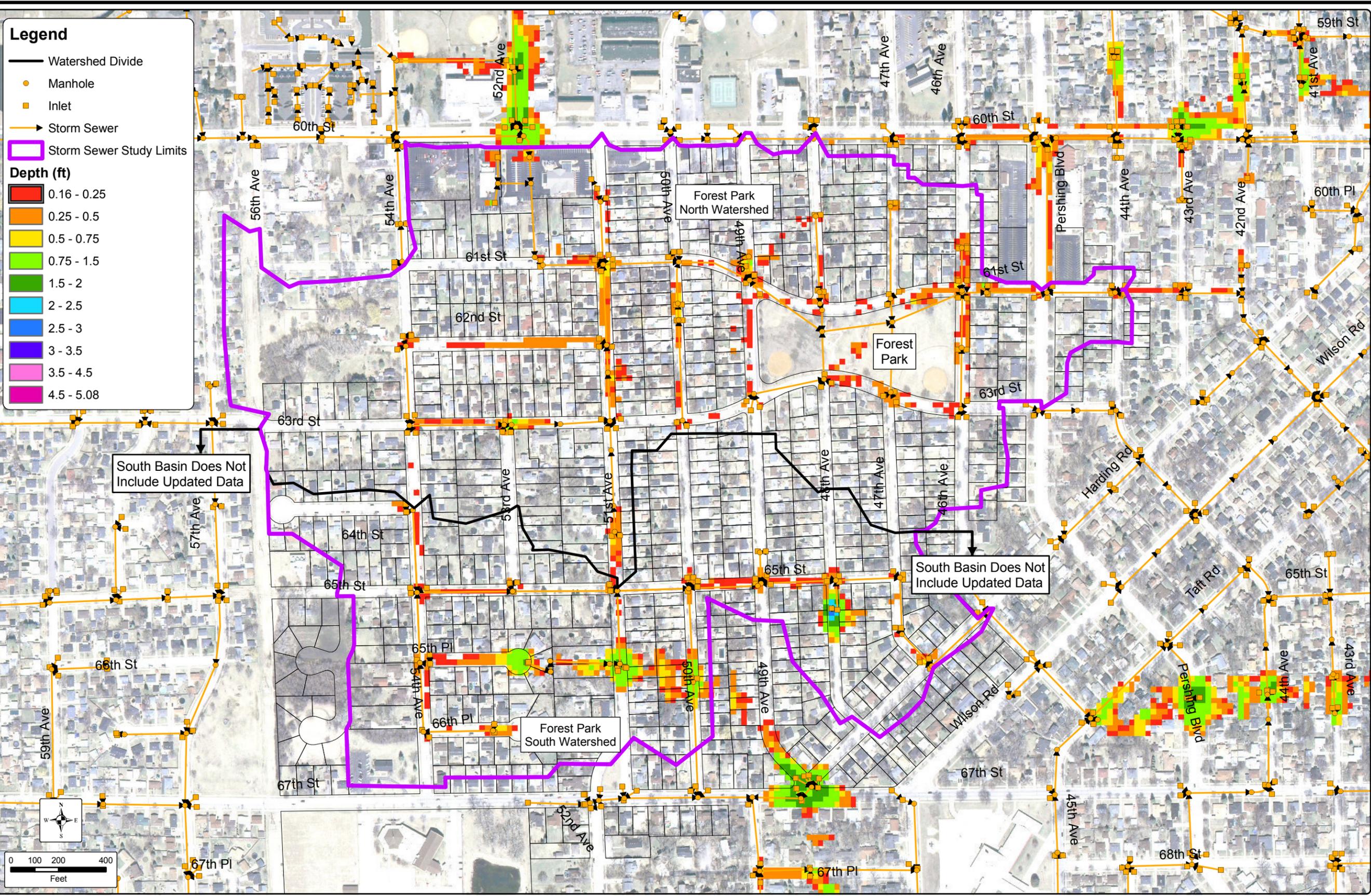
Table 9.04-3 provides advantages and disadvantages of this alternative.



ALTERNATIVE 3 (5N)
UNDERGROUND DETENTION IN CHURCH PARKING LOT
(2005 AERIAL)
FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN

STRAND
 ASSOCIATES, INC.
 ENGINEERS

FIGURE 9.04-2
 1540.001

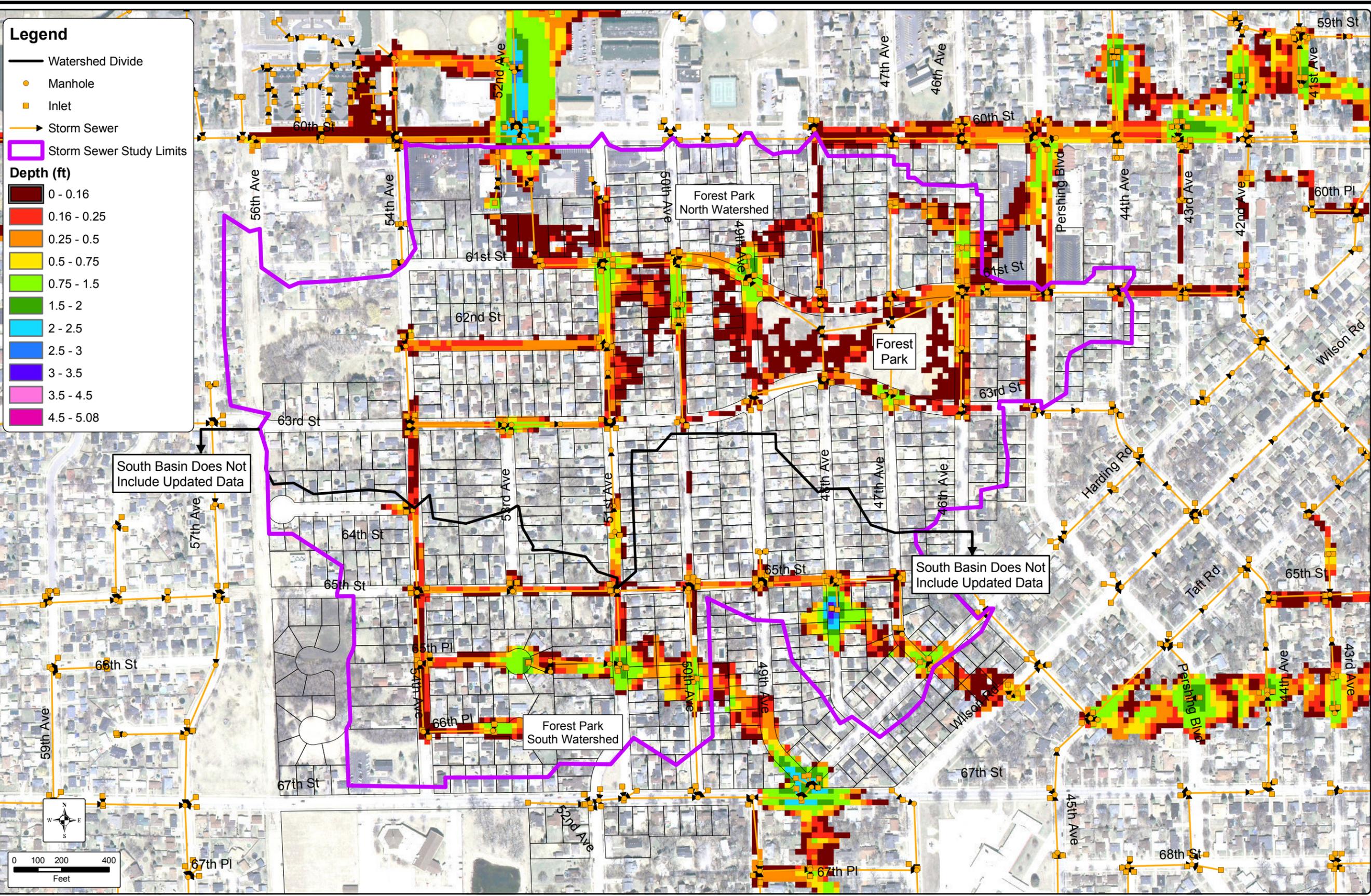


ALTERNATIVE 3 - 25-YEAR
FLOOD EXTENTS

FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN



FIGURE 9.04-3
1540.001



Legend

- Watershed Divide
- Manhole
- Inlet
- Storm Sewer
- Storm Sewer Study Limits

Depth (ft)

- 0 - 0.16
- 0.16 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1.5
- 1.5 - 2
- 2 - 2.5
- 2.5 - 3
- 3 - 3.5
- 3.5 - 4.5
- 4.5 - 5.08

**ALTERNATIVE 3 - 100-YEAR
 FLOOD EXTENTS**
FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN

STRAND
 ASSOCIATES, INC.
 ENGINEERS

FIGURE 9.04-4
 1540.001

**TABLE 9.04-1
 ALTERNATIVE 3—PEAK DISCHARGE RATES BY INDICATOR POINT (10-YEAR STORM EVENT)**

Node	Pipe	Indicator Node Type	Node Location	Maximum Flow (cfs)			Maximum HGL (ft)			
				Existing Conditions 10-Year	Alternative 3 10-Year	Change	Ground Elevation	Existing Conditions 10-Year	Alternative 3 10-Year	Change
Watershed Indicator Points										
8	P-7	Outfall	Pike Creek Outfall	492.0	479.1	-12.9	619.72	598.94	598.92	-0.02
5	P-800	Center Mainline Outfall	(N) Lake Michigan Outfall	579.1	584.5	5.4	587.70	585.75	585.78	0.02
6	P-4655	South Mainline Outfall	(S) Lake Michigan Outfall	386.3	386.3	0.0	585.09	582.08	582.08	0.00
11482	P-11482	System Convergence: North	37th Avenue/52nd Street	162.2	162.0	-0.1	642.00	642.81	642.80	-0.01
6128	P-6128	System Convergence: Central	60th St.	115.4	118.5	3.1	644.11	636.85	634.10	-2.75
368	P-368	System Convergence: South	40th Avenue/76th Street	270.7	271.1	0.4	645.00	640.44	640.47	0.03
Forest Park North Indicator Points										
11553	P-11553	Enter North Study Area	(W) 51st Avenue/60th Street	86.9	87.3	0.4	691.95	691.50	691.57	0.07
5634	P-5634	Low Point: North System	51st Avenue/61st Street	111.8	125.4	13.6	681.21	679.40	680.28	0.88
5770	P-5770	Low Point: North System	49th Avenue/61st Street	102.1	114.5	12.4	676.89	675.07	674.25	-0.82
5794	P-5794	Low Point: North System	46th Avenue North of 61 st Street	12.9	5.6	-7.3	664.71	665.75	661.84	-3.91
10232	P-10232.1	Exit North Study Area	60th Street/Pershing Boulevard	101.1	91.6	-9.6	660.29	660.81	656.76	-4.05

**TABLE 9.04-2
 ALTERNATIVE 3—OPINION OF PROBABLE COST**

Item	Capital Cost
Underground Detention Basin	\$3,585,000

**TABLE 9.04-3
 ALTERNATIVE 3—ADVANTAGES/DISADVANTAGES**

Advantages	Disadvantages
<ul style="list-style-type: none"> ▪ Provides storage directly adjacent to a flooding problem area. ▪ Overflow route from underground detention bypasses Forest Park home areas. ▪ Open land in an urban environment. ▪ Contamination Potential-As shown in Figure 9.03-4, WDNR's Remediation and Redevelopment (RR) Sites Web site does not show this parcel as contaminated nor are there any immediately adjacent contaminated sites. 	<ul style="list-style-type: none"> ▪ Expenses of purchasing a privately-owned parcel. ▪ Expense of underground detention.

9.05 ALTERNATIVE 4 (6N)–PUMPING STATION IN FOREST PARK PUMPING TO DETENTION BASIN IN UPSTREAM VACANT LAND

In an effort to leverage the use of upstream open land, we have analyzed Alternative 4 as a pumping station in Forest Park that pumps up to a detention basin in vacant land southwest of the 60th Avenue/60th Street intersection. A picture of the pump station location is shown in Figure 9.05-1. Figure 9.05-2 shows the layout of this project.

Figure 9.03-3 shows the locations of necessary storm sewer and inlet upgrades to achieve a 10-year storm event capacity in the Forest Park North watershed in conjunction with the pump station system. Figure 9.03-4 shows the WDNR RR Sites Map showing locations of closed and active remediation sites in the vicinity of this project, none of which appear to impact this Alternative.

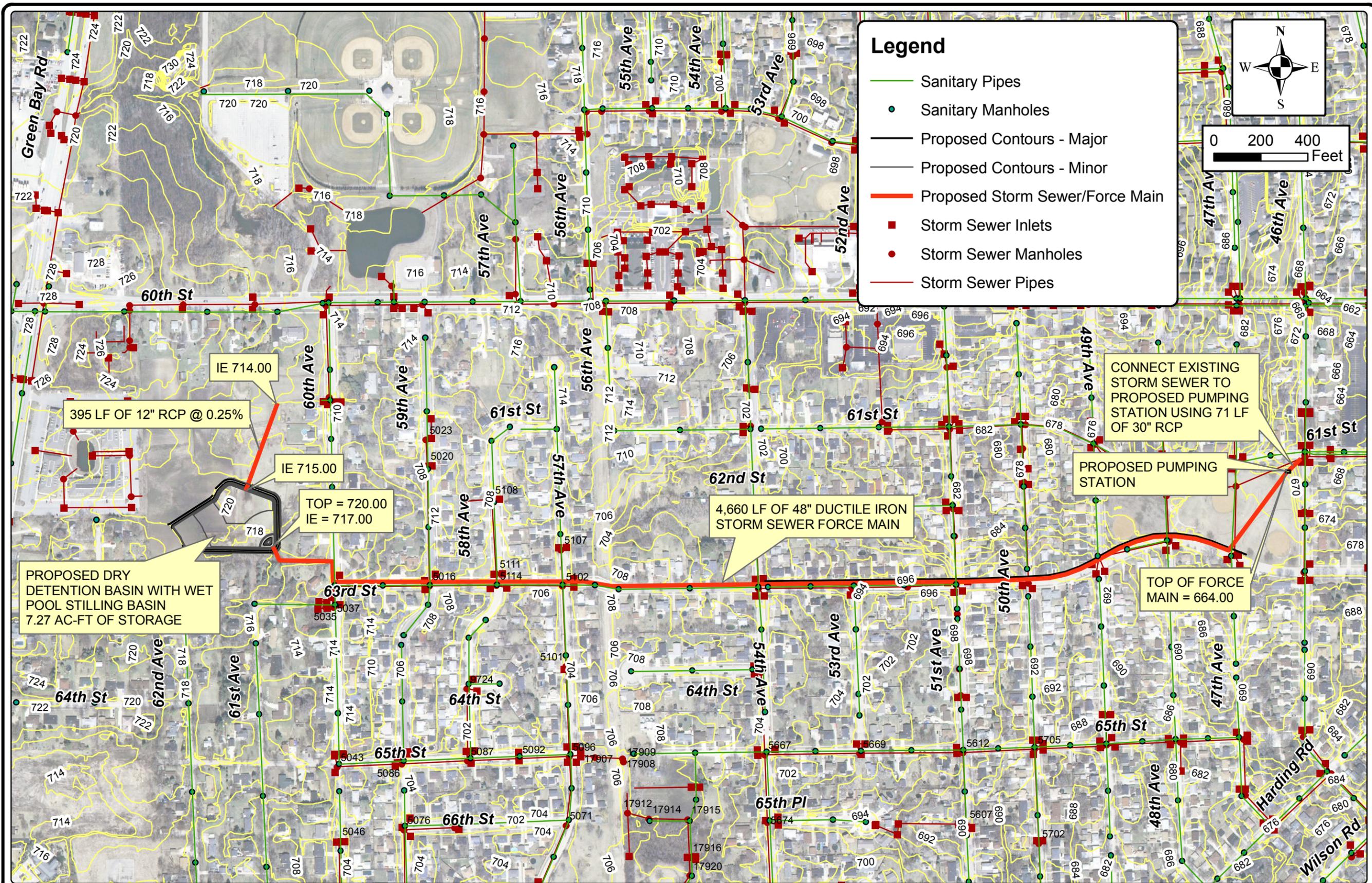


Figure 9.05-1 Alternative 4–Forest Park Facing from 46th Avenue/61st Street Intersection at Potential Location of Pumping Station

The inlet capacity analysis methodology is described in Section 7.02. The pump station would need to be designed for a peak flow rate of about 85 cubic feet per second and would require a 48-inch ductile iron force main discharging to a detention basin in upstream vacant land.

The overall effect of Alternative 4 at the Watershed and Forest Park North indicator points is included in Table 9.05-1. During the 25-year storm event, no homes are flooding up to the foundation/first floor elevation (low entry point) using the criteria described in Section 9.01. Figure 9.05-3 shows the flooding depths during the 25-year storm event with Alternative 4 in place. Figure 9.05-4 shows the flooding depths during the 100-year storm event with Alternative 4 in place.

The opinion of probable cost is shown in Table 9.05-2. Table 9.05-3 provides advantages and disadvantages of this alternative.



Legend

- Sanitary Pipes
- Sanitary Manholes
- Proposed Contours - Major
- Proposed Contours - Minor
- Proposed Storm Sewer/Force Main
- Storm Sewer Inlets
- Storm Sewer Manholes
- Storm Sewer Pipes

0 200 400 Feet

PROPOSED DRY DETENTION BASIN WITH WET POOL STILLING BASIN
7.27 AC-FT OF STORAGE

395 LF OF 12" RCP @ 0.25%

IE 714.00

IE 715.00

TOP = 720.00
IE = 717.00

4,660 LF OF 48" DUCTILE IRON STORM SEWER FORCE MAIN

CONNECT EXISTING STORM SEWER TO PROPOSED PUMPING STATION USING 71 LF OF 30" RCP

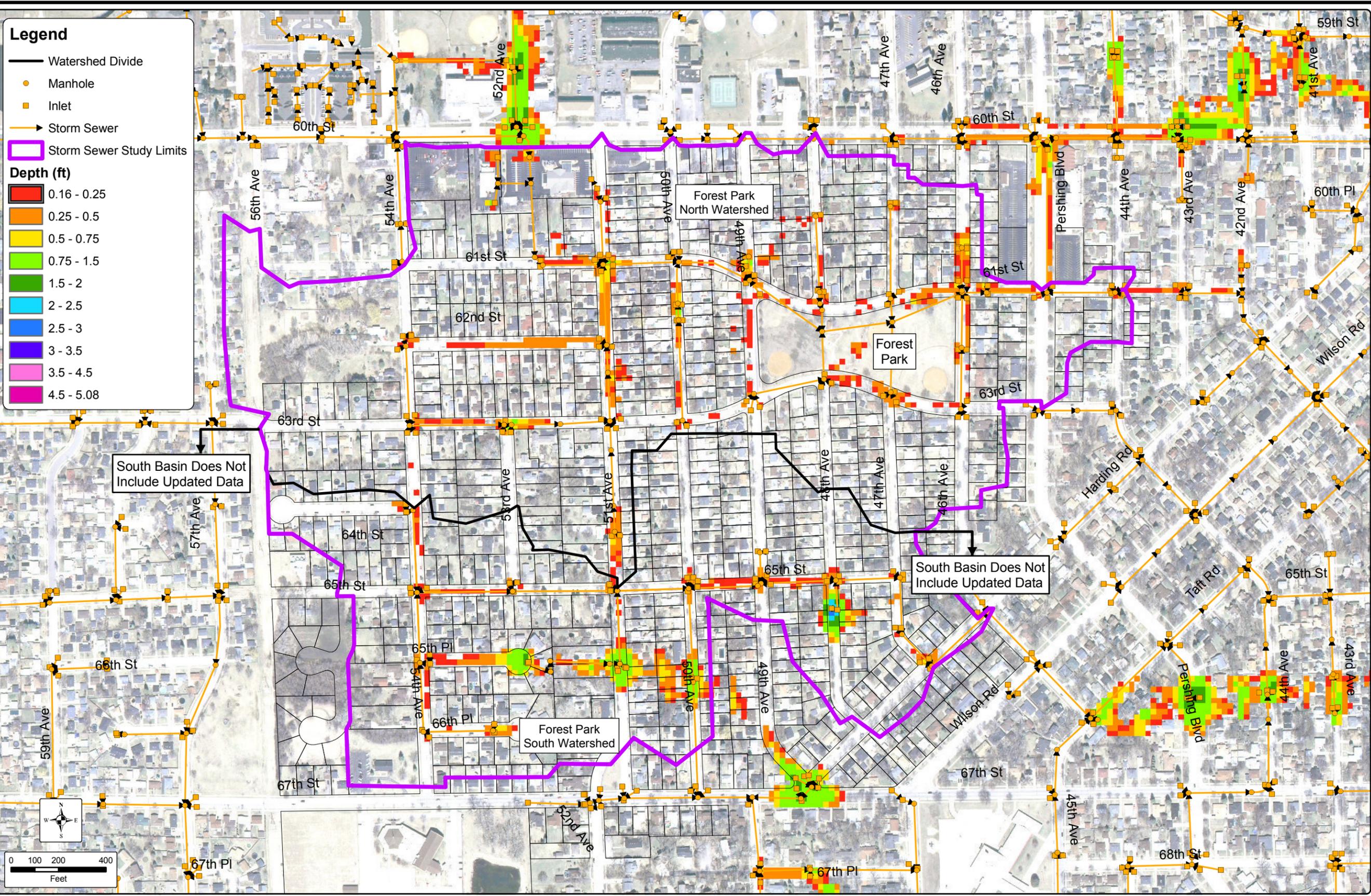
PROPOSED PUMPING STATION

TOP OF FORCE MAIN = 664.00

ALTERNATIVE 4 (6N)
PUMP STATION IN FOREST PARK AREA PUMPING TO DETENTION BASIN
IN VACANT LAND SOUTH WEST OF 60TH AVE/60TH ST.
FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN



FIGURE 9.05-2
1540.001

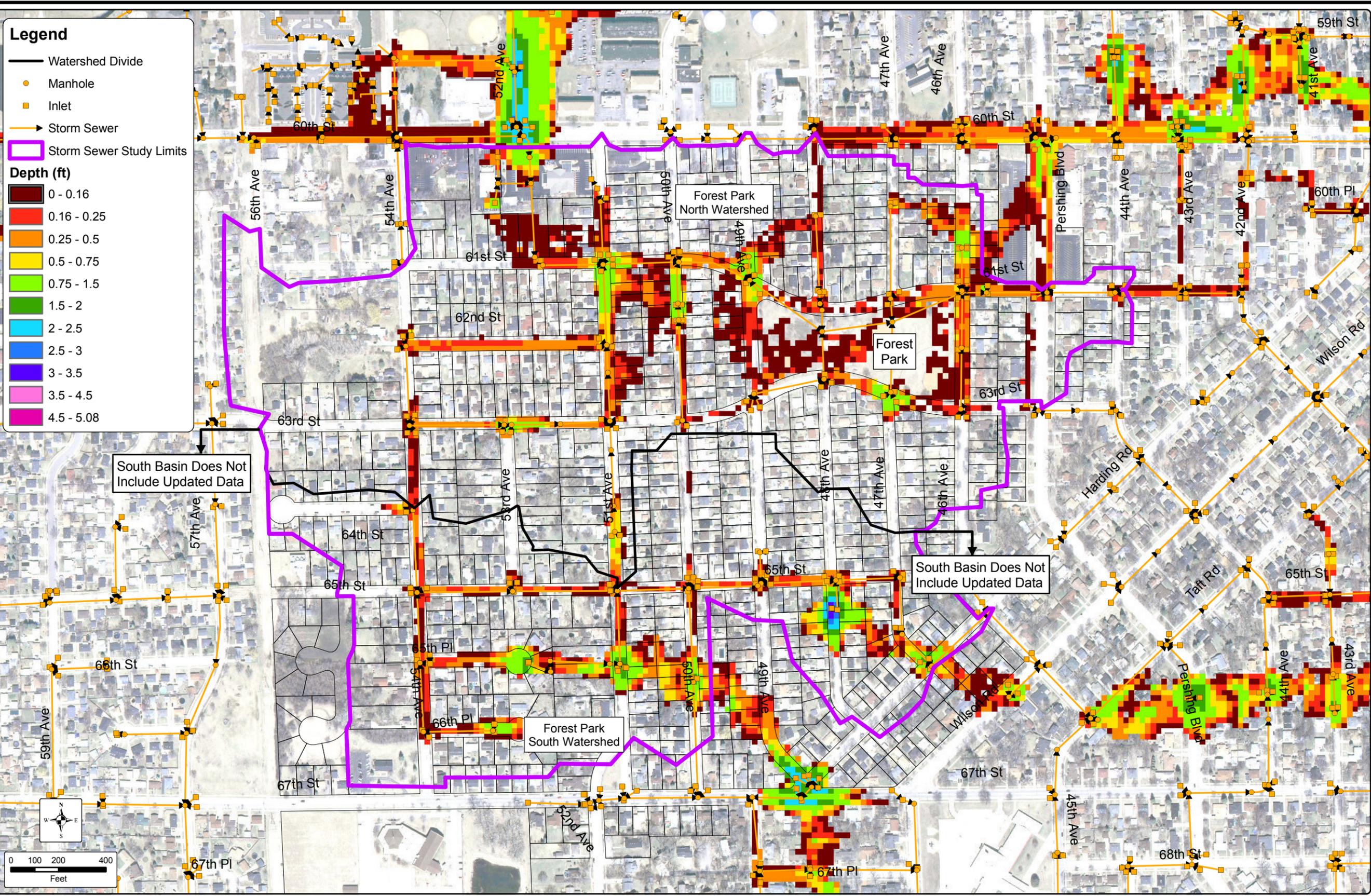


ALTERNATIVE 4 - 25-YEAR
FLOOD EXTENTS

FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN



FIGURE 9.05-3
1540.001



ALTERNATIVE 4 - 100-YEAR
FLOOD EXTENTS

FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN



FIGURE 9.05-4
1540.001

**TABLE 9.05-1
 ALTERNATIVE 4—PEAK DISCHARGE RATES BY INDICATOR NODE (10-YEAR STORM EVENT)**

Node	Pipe	Indicator Node Type	Node Location	Maximum Flow (cfs)			Maximum HGL (ft)			
				Existing Conditions 10-Year	Alternative 4 10-Year	Change	Ground Elevation	Existing Conditions 10-Year	Alternative 4 10-Year	Change
Watershed Indicator Points										
8	P-7	Outfall	Pike Creek Outfall	492.0	478.5	-13.5	619.72	598.94	598.92	-0.02
5	P-800	Center Mainline Outfall	(N) Lake Michigan Outfall	579.1	583.5	4.4	587.70	585.75	585.77	0.02
6	P-4655	South Mainline Outfall	(S) Lake Michigan Outfall	386.3	386.3	0.0	585.09	582.08	582.08	0.00
11482	P-11482	System Convergence: North	37th Avenue/52nd Street	162.2	158.9	-3.3	642.00	642.81	642.81	0.00
6128	P-6128	System Convergence: Central	60th St.	115.4	117.4	2.0	644.11	636.85	634.17	-2.68
368	P-368	System Convergence: South	40th Avenue/76th Street	270.7	271.7	1.0	645.00	640.44	640.43	-0.01
Forest Park North Indicator Points										
11553	P-11553	Enter North Study Area	(W) 51st Avenue/60th Street	86.9	87.2	0.3	691.95	691.50	691.56	0.06
5634	P-5634	Low Point: North System	51st Avenue/61st Street	111.8	125.1	13.3	681.21	679.40	679.84	0.44
5770	P-5770	Low Point: North System	49th Avenue/61st Street	122.9	114.5	-8.4	676.89	675.07	673.81	-1.26
5794	P-5794	Low Point: North System	46th Avenue North of 61 st Street	12.9	5.2	-7.7	664.71	665.75	663.09	-2.66
10232	P-10232.1	Exit North Study Area	60th Street/Pershing Boulevard	101.1	80.7	-20.5	660.29	660.81	659.46	-1.35

**TABLE 9.05-2
 ALTERNATIVE 4—OPINION OF PROBABLE COST**

Item	Capital Cost
Pumping Station, Force Main, and Detention Basin	\$13,581,000

**TABLE 9.05-3
 ALTERNATIVE 4—ADVANTAGES/DISADVANTAGES**

Advantages	Disadvantages
<ul style="list-style-type: none"> ▪ Open land in an urban environment. ▪ Contamination Potential-As shown in Figure 9.03-4, WDNR's Remediation and Redevelopment (RR) Sites Web site does not show this parcel as contaminated nor are there any immediately adjacent contaminated sites. 	<ul style="list-style-type: none"> ▪ Expenses of purchasing a privately-owned parcel. ▪ Expense of construction and ongoing operational and maintenance costs of a pumping station. ▪ Expense of a force main to convey stormwater to the detention basin.

9.06 ALTERNATIVE 5 (1S)–DISCONNECT INTERCONNECTION WITH STORM SEWER ON 65TH STREET

The City has indicated it would like to assess the impact of disconnecting the interconnection that occurs between the Pike Creek/Center Mainline storm sewer system and the South Mainline storm sewer system at the intersection of 50th Avenue and 65th Street. This interconnection consists of a field-poured concrete obstruction that in effect creates a vertical half of an 18-inch pipe orifice. Alternative 5 analyzes this disconnection and Figure 9.06-1 shows the concept.

The overall effect of Alternative 5 at the Watershed and Forest Park South indicator points for the 2-hour 10-year duration storm event is included in Table 9.06-1. As this table shows, implementation of this alternative would direct more flow east from the 50th Avenue/65th Street intersection. While this relieves flooding at Node 5702 at the 50th Avenue low point to the south, it will have the effect of creating additional flooding at 48th Avenue and near the intersection of 46th Avenue/Taft Road. Figure 2.01-1 shows less than a 5-year storm sewer capacity at these two locations as well as at conduits farther downstream. Also, the storm sewer system south of the orifice also has bottlenecks of less than a 5-year storm capacity. It appears that by splitting the flow as the orifice currently does, both downstream systems are taking more of an equivalent flow considering that there are bottlenecks in both directions. In fact, modeling of the 10-year storm event shows that the orifice passes 8.23 cfs and the pipe to the south passes 7.12 cfs, virtually equivalent flows.

It would appear leaving the orifice in place is the most beneficial to the current storm sewer system arrangement. However, because of the flooding in the area, it would be beneficial to create additional storage in the 50th Avenue area between 65th Street and 67th Street or to provide additional conveyance capacity to underground storage in the Forest Park School open area. These two alternatives are analyzed as Alternatives 6 (2S) and 7 (2NS), respectively.

Alternative 5 was not pursued further because the improvement was not effective.

The OPCC is shown in Table 9.06-2. Table 9.06-3 provides advantages and disadvantages of this alternative.



ALTERNATIVE 5 (1S)
 DISCONNECT INTERCONNECTION WITH STORM SEWER ON 65TH ST.
 (2005 AERIAL)
 FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
 CITY OF KENOSHA
 KENOSHA COUNTY, WISCONSIN



FIGURE 9.06-1
 1540.001

**TABLE 9.06-1
 ALTERNATIVE 5—PEAK DISCHARGE RATES BY INDICATOR POINTS (10-YEAR STORM EVENT)**

Node	Pipe	Indicator Node Type	Node Location	Maximum Flow (cfs)			Maximum HGL (ft)			
				Existing Conditions 10-Year	Alternative 5 10-Year	Change	Ground Elevation	Existing Conditions 10-Year	Alternative 5 10-Year	Change
Watershed Indicator Points										
8	P-7	Outfall	Pike Creek Outfall	492.0	495.9	3.8	619.72	598.94	598.95	0.01
5	P-800	Center Mainline Outfall	(N) Lake Michigan Outfall	579.1	578.0	-1.1	587.70	585.75	585.75	0.00
6	P-4655	South Mainline Outfall	(S) Lake Michigan Outfall	386.3	386.4	0.0	585.09	582.08	582.08	0.00
11482	P-11482	System Convergence: North	37th Avenue/52nd Street	162.2	161.4	-0.7	642.00	642.81	642.81	0.00
6128	P-6128	System Convergence: Central	60th St.	115.4	115.4	0.0	644.11	636.85	637.10	0.25
368	P-368	System Convergence: South	40th Avenue/76th Street	270.7	271.7	1.0	645.00	640.44	640.45	0.01
Forest Park South Indicator Points										
5677	P-5677	65th Place: Cul du Sac Low Point	65th Place	9.8	7.7	-2.1	693.83	694.33	692.77	-1.56
5607	P-5607	Low Point: South System	51st Ave: Mid-Block	8.7	9.1	0.3	689.73	691.15	691.16	0.01
5702	P-5702	Low Point: South System	50th Ave: Mid-Block	11.8	8.4	-3.5	686.32	685.42	681.69	-3.73
5721	P-5721	Low Point: South System	48th Avenue/65th Street	5.9	5.2	-0.7	680.24	681.64	681.63	-0.01
5698	P-5698	Exit South Study Area: South	50th Avenue/67th Street	17.8	14.1	-3.7	687.75	680.22	679.06	-1.15
6028	P-6028	Exit South Study Area: East	46th Avenue/Harding Road	28.1	29.4	1.3	684.81	670.89	671.12	0.23

**TABLE 9.06-2
 ALTERNATIVE 5—OPINION OF PROBABLE COST**

Item	Capital Cost
Orifice Removal and South Pipe Disconnection	\$10,100

**TABLE 9.06-3
 ALTERNATIVE 5—ADVANTAGES/DISADVANTAGES**

Advantages	Disadvantages
<ul style="list-style-type: none"> ▪ Inexpensive project. ▪ Less stormwater will be forced south toward a known flooding problem area. 	<ul style="list-style-type: none"> ▪ More stormwater will be forced to the Center Mainline storm sewer system.

9.07 ALTERNATIVE 6 (2S)–CONVEYANCE UPGRADE AND UNDERGROUND DETENTION AT FOREST PARK SCHOOL

This alternative is aimed at providing flooding relief for portions of the Forest Park South study area. It includes an upsized storm sewer leading to underground detention at Forest Park School as shown in Figure 9.07-1. Figure 9.07-2 shows a picture of the Forest Park School site.

Figure 9.07-1 shows the locations of necessary storm sewer and inlet upgrades to achieve a 10-year storm event capacity in the Forest Park South watershed in conjunction with the underground detention basin and conveyance upgrades.



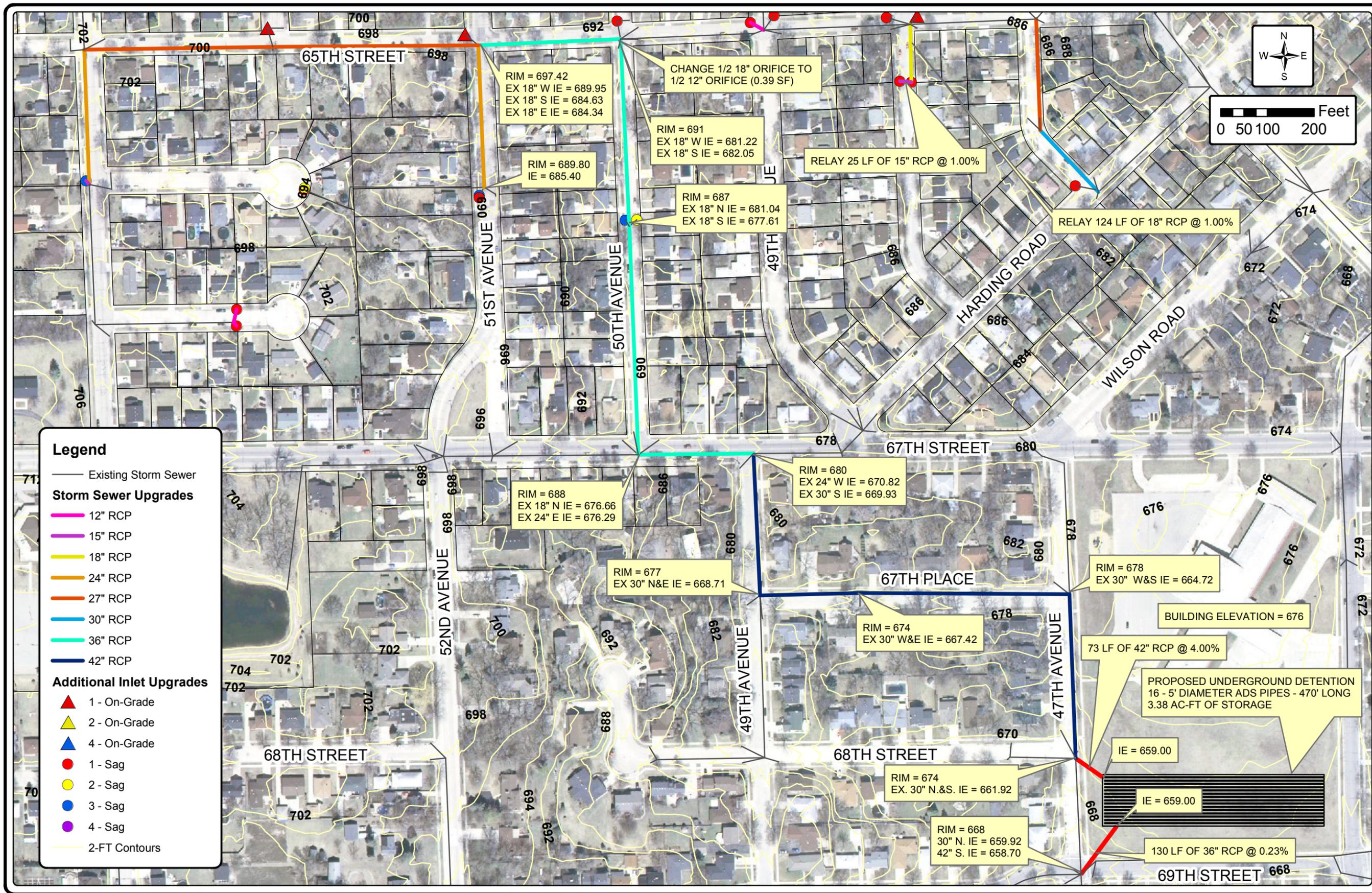
The overall effect of Alternative 6 at the Watershed and Forest Park South indicator points is included in Table 9.07-1. During the 25-year storm event, no homes are flooding up to the foundation/first floor elevation (low entry point) using the criteria described in Section 9.01. Figure 9.07-3 shows the flooding depths during the 25-year storm event with Alternative 6 in-place. Figure 9.07-4 shows the flooding depths during the 100-year storm event with Alternative 6 in place.

The OPCC is shown in Table 9.07-2. The underground detention cost is based on use of an HDPE underground pipe detention system as manufactured by ADS. However, other options as shown in Figure 9.03-7 could be concrete vaults system (Stormtrap), polypropylene vaults (Stormtech), corrugated metal pipe system (Contech), or polypropylene cellular blocks (Stormbloc). Each of these options has a varying cost and footprint. Given the low height (5 feet) of the system to fit the site, the HDPE pipe underground detention system was used for purposes of this plan.

Underground detention was chosen as the most feasible detention type in the Forest Park School recreational field site as opposed to a surface dry detention basin because of the following reasons.

1. The functionality of the open area as a recreational field would be compromised with less space being available for recreation.
2. There are safety concerns with placement of a dry detention basin in a school recreational site. Fencing of the facility could somewhat mitigate this concern but also may attract youth to climb and jump over the fence.

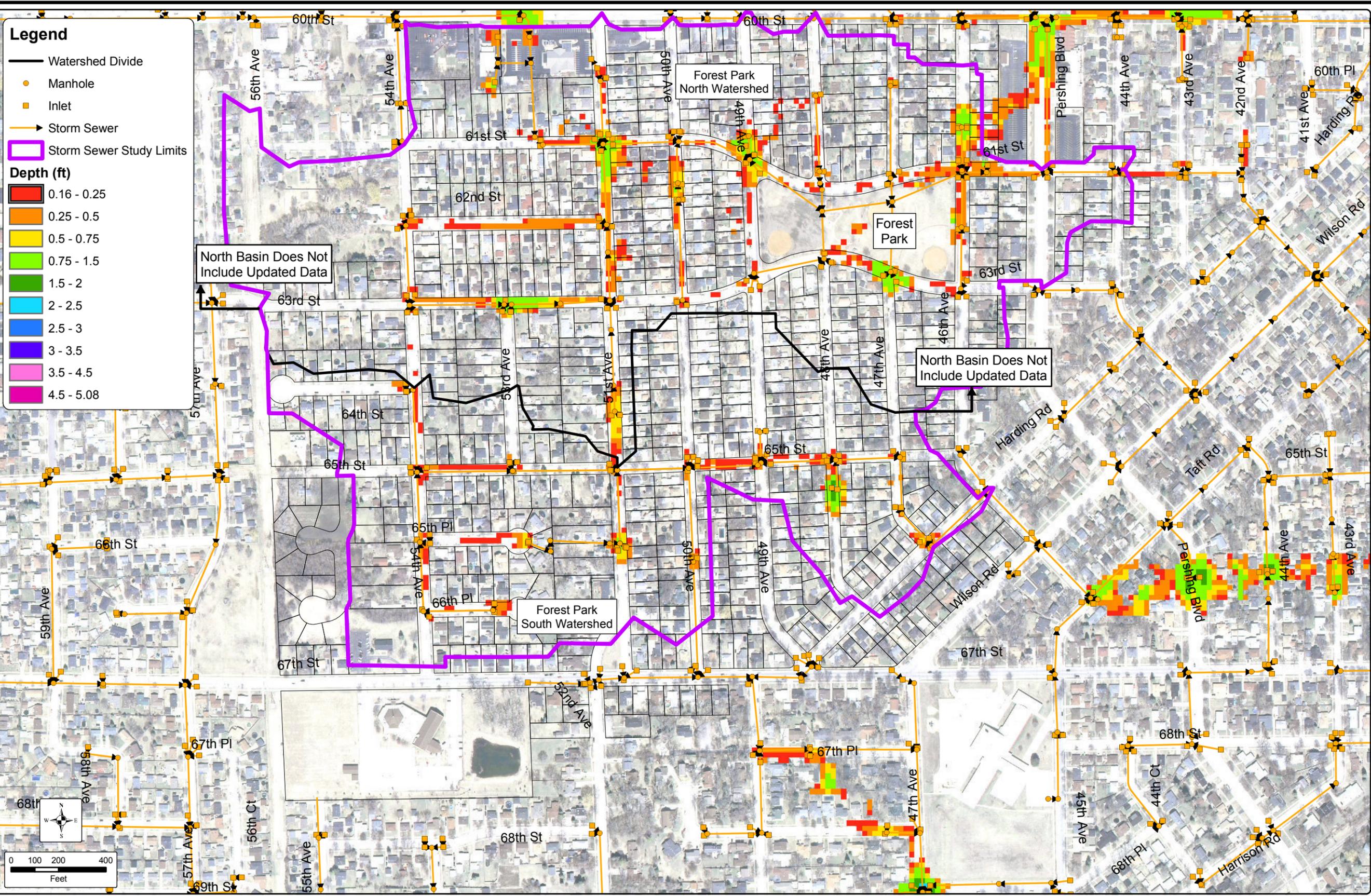
Table 9.07-3 provides advantages and disadvantages of this alternative.



ALTERNATIVE 6 (2S)
PROPOSED PIPE UPGRADE TO UNDERGROUND DETENTION
 (2005 AERIAL)
 FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
 CITY OF KENOSHA
 KENOSHA COUNTY, WISCONSIN



FIGURE 9.07-1
 1540.001



Legend

- Watershed Divide
- Manhole
- Inlet
- Storm Sewer
- Storm Sewer Study Limits

Depth (ft)

- 0.16 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1.5
- 1.5 - 2
- 2 - 2.5
- 2.5 - 3
- 3 - 3.5
- 3.5 - 4.5
- 4.5 - 5.08

**ALTERNATIVE 6 - 25-YEAR
FLOOD EXTENTS**

**FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN**



**FIGURE 9.07-3
1540.001**

**TABLE 9.07-1
 ALTERNATIVE 6—PEAK DISCHARGE RATES BY INDICATOR NODE (10-YEAR STORM EVENT)**

Node	Pipe	Indicator Node Type	Node Location	Maximum Flow (cfs)			Maximum HGL (ft)			
				Existing Conditions 10-Year	Alternative 6 10-Year	Change	Ground Elevation	Existing Conditions 10-Year	Alternative 6 10-Year	Change
Watershed Indicator Points										
8	P-7	Outfall	Pike Creek Outfall	492.0	479.4	-12.6	619.72	598.94	598.92	-0.02
5	P-800	Center Mainline Outfall	(N) Lake Michigan Outfall	579.1	579.4	0.3	587.70	585.75	585.75	0.00
6	P-4655	South Mainline Outfall	(S) Lake Michigan Outfall	386.3	386.3	0.0	585.09	582.08	582.08	0.00
11482	P-11482	System Convergence: North	37th Avenue/52nd Street	162.2	162.6	0.5	642.00	642.81	642.81	0.00
6128	P-6128	System Convergence: Central	60th St.	115.4	117.8	2.4	644.11	636.85	637.85	1.00
368	P-368	System Convergence: South	40th Avenue/76th Street	270.7	270.6	-0.1	645.00	640.44	640.73	0.29
Forest Park South Indicator Points										
5677	P-5677	65th Place: Cul du Sac Low Point	65th Place	9.8	4.5	-5.3	693.83	694.33	694.01	-0.32
5607	P-5607	Low Point: South System	51st Ave: Mid-Block	8.7	12.4	3.7	689.73	691.15	687.46	-3.69
5702	P-5702	Low Point: South System	50th Ave: Mid-Block	11.8	34.6	22.8	686.32	685.42	680.75	-4.67
5721	P-5721	Low Point: South System	48th Avenue/65th Street	5.9	10.5	4.6	680.24	681.64	680.76	-0.88
5698	P-5698	Exit South Study Area: South	50th Avenue/67th Street	17.8	41.3	23.6	687.75	680.22	677.88	-2.34
6028	P-6028	Exit South Study Area: East	46th Avenue/Harding Road	28.1	29.4	1.3	684.81	670.89	671.12	0.23
5491	P-5491.1	Exit from Forest Park School	47th Ave./69th St.	52.2	47.1	-5.1	664.98	666.82	662.93	-3.89

**TABLE 9.07-2
 ALTERNATIVE 6—OPINION OF PROBABLE COST**

Item	Capital Cost
Underground Detention and Conveyance Upgrades	\$3,009,000

**TABLE 9.07-3
 ALTERNATIVE 6—ADVANTAGES/DISADVANTAGES**

Advantages	Disadvantages
<ul style="list-style-type: none"> ▪ Makes use of existing open space. ▪ Provides storage directly adjacent to a flooding problem area. ▪ Contamination Potential-As shown in Figure 9.03-4, WDNR's Remediation and Redevelopment (RR) Sites Web site does not show this parcel as contaminated nor are there any immediately adjacent contaminated sites. 	<ul style="list-style-type: none"> ▪ Expense of underground detention. ▪ Is in a school athletic field.

9.08 ALTERNATIVE 7 (2NS)–HOME PURCHASE AND CONVERSION TO DRY DETENTION BASINS

For some flood mitigation projects, a cost-effective means of providing flood relief is to purchase homes that currently flood and convert the land to dry detention basin(s). In Alternative 7, we have analyzed the purchase and demolition of 13 homes and conversion of the land to three dry detention basins. Dry detention basins are preferable to wet detention basins in residential areas mainly for safety reasons but also to not have a standing pool of water adjacent to basements of remaining homes. In addition, a dry detention basin in the northwest corner of Forest Park is included in the alternative as well as underground detention in the northeast corner of Forest Park. Pictures of the three locations are shown in Figures 9.08-1, 9.08-2 and 9.08-3. Figure 9.08-4 shows the layout of this project.

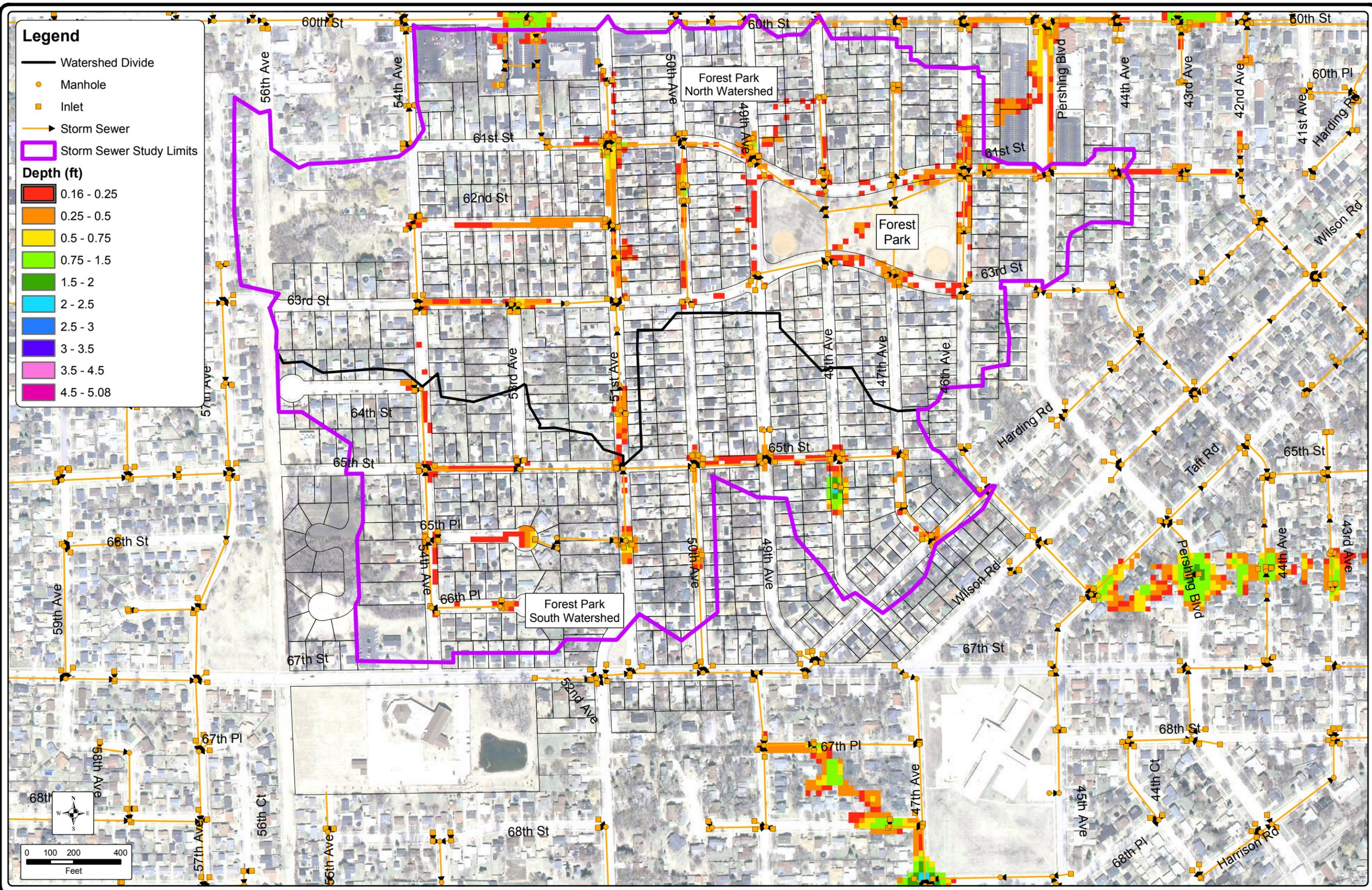


Figure 9.08-4 shows the locations of necessary storm sewer and inlet upgrades to achieve a 10-year storm event capacity in the Forest Park South watershed in conjunction with the dry detention basins construction and home purchase. Figure 9.03-3 shows the locations of necessary storm sewer and inlet upgrades to achieve a 10-year storm event capacity in the Forest Park North watershed in conjunction with the dry detention basins construction, underground detention, and home purchase.

The overall effect of Alternative 7 at the Watershed, Forest Park North, and Forest Park South indicator points is included in Table 9.08-1. During the 25-year storm event, no homes are flooding up to the foundation/first floor elevation (low entry point) using the criteria described in Section 9.01. Figure 9.08-5 shows the flooding depths during the 25-year storm event with Alternative 7 in place. Figure 9.08-6 shows the flooding depths during the 100-year storm event with Alternative 7 in place.

The OPCC is shown in Table 9.08-2. The underground detention cost is based on use of a CMP underground detention system as manufactured by Contech. The CMP product is coated with an aluminized finish (rather than the typical zinc coating), and Contech reports that this product has a 75-year lifespan because lesser abrasion is expected in an underground detention application. However, other options as shown in Figure 9.03-7 could be HDPE pipe detention system (ADS), polypropylene vaults (Stormtech), concrete stormwater vaults (such as the StormTrap product), or polypropylene cellular blocks (Stormbloc). Each of these options has a varying cost and footprint. Cost research done as part of this project shows that the CMP product appears to be the most cost-effective of the detention option types researched.

Table 9.08-3 provides advantages and disadvantages of this alternative.



ALTERNATIVE 7 - 25-YEAR
FLOOD EXTENTS

FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN



FIGURE 9.08-5
1540.001

S:\MAD\1500-1599\1540\001\Data\GIS Data\Figures\Report Figures\Storm Analysis\Figure 9.08-5 Alt7 25yr Event 11x17.mxd

**TABLE 9.08-1
 ALTERNATIVE 7—PEAK DISCHARGE RATES BY INDICATOR NODE (10-YEAR STORM EVENT)**

Node	Pipe	Indicator Node Type	Node Location	Maximum Flow (cfs)			Maximum HGL (ft)			
				Existing Conditions 10-Year	Alternative 7 10-Year	Change	Ground Elevation	Existing Conditions 10-Year	Alternative 7 10-Year	Change
Watershed Indicator Points										
8	P-7	Outfall	Pike Creek Outfall	496.0	480.6	-15.4	619.72	598.94	598.92	-0.02
5	P-800	Center Mainline Outfall	(N) Lake Michigan Outfall	580.1	585.7	5.6	587.70	585.75	585.78	0.03
6	P-4655	South Mainline Outfall	(S) Lake Michigan Outfall	386.3	386.3	0.0	585.09	582.08	582.08	0.00
11482	P-11482	System Convergence: North	37th Avenue/52nd Street	163.1	163.5	0.4	642.00	642.81	642.81	0.00
6128	P-6128	System Convergence: Central	60th St.	115.9	119.6	3.7	644.11	636.85	634.32	-2.53
368	P-368	System Convergence: South	40th Avenue/76th Street	271.7	270.7	-1.0	645.00	640.44	640.43	-0.01
Forest Park North Indicator Points										
11553	P-11553	Enter North Study Area	(W) 51st Avenue/60th Street	87.1	87.1	0.0	691.95	691.50	691.57	0.07
5634	P-5634	Low Point: North System	51st Avenue/61st Street	111.3	126.6	15.4	681.21	679.40	680.02	0.62
5770	P-5770	Low Point: North System	49th Avenue/61st Street	120.0	112.5	-7.5	676.89	675.07	673.40	-1.67
5794	P-5794	Low Point: North System	Hilda Reyes House	12.9	9.7	-3.2	664.71	665.75	664.04	-1.71
10232	P-10232.1	Exit North Study Area	60th Street/Pershing Boulevard	101.2	97.4	-3.8	660.29	660.81	659.08	-1.73
Forest Park South Indicator Points										
5677	P-5677	65th Place: Cul du Sac Low Point	65th Place	4.7	4.5	-0.2	693.83	694.33	694.01	-0.32
5607	P-5607	Low Point: South System	51st Ave: Mid-Block	12.0	13.4	1.4	689.73	691.15	687.27	-3.87
5702	P-5702	Low Point: South System	50th Ave: Mid-Block	40.3	11.1	-29.2	686.32	685.42	684.54	-0.88
5721	P-5721	Low Point: South System	48th Avenue/65th Street	5.1	10.7	5.6	680.24	681.64	680.79	-0.84
5698	P-5698	Exit South Study Area: South	50th Avenue/67th Street	47.8	17.3	-30.5	687.75	680.22	680.02	-0.19
6028	P-6028	Exit South Study Area: East	46th Avenue/Harding Road	29.3	26.6	-2.7	684.81	670.89	670.77	-0.13
5491	P-5491.1	Exit from Forest Park School	47th Ave./69th St.	52.2	52.1	-0.1	664.98	666.82	666.83	0.01

**TABLE 9.08-2
 ALTERNATIVE 7—OPINION OF PROBABLE COST**

Item	Capital Cost
Home Purchase and Dry Detention Basins: North	\$4,377,000
Home Purchase and Dry Detention Basins: South	\$3,700,000
Total	\$8,077,000

**TABLE 9.08-3
 ALTERNATIVE 7—ADVANTAGES/DISADVANTAGES**

Advantages	Disadvantages
<ul style="list-style-type: none"> ▪ Removes 13 homes from the modeled 100-year flood extents. ▪ Creates green space in locations where homes were purchased. ▪ Forest Park North-Overflow route from 46th Ave. detention basin bypasses Forest Park home areas. ▪ Contamination Potential-As shown in Figure 9.03-4, WDNR's Remediation and Redevelopment (RR) Sites Web site does not show this parcel as contaminated nor are there any immediately adjacent contaminated sites. 	<ul style="list-style-type: none"> ▪ Expenses of purchasing privately-owned parcels. ▪ Displacement of City residents.

9.09 ALTERNATIVES ANALYSIS (ALTERNATIVES 1 THROUGH 7)

Table 9.09-1 summarizes the alternatives discussed in Sections 9.02 through 9.08. Alternatives 2, 3, 4, and 7 for the Forest Park North area and Alternatives 6 and 7 for the Forest Park South area meet the Alternative Analysis Design Criteria Goals (10- and 25-Year) listed in Section 9.01 C. Alternatives 1 and 5 do not meet these goals.

To assist the City in selecting a preferred alternative, Table 9.09-1 also has selection criteria that will help in arriving at a preferred alternative. Selection criteria include the following.

1. Local Criteria
 - a. Amount of storage volume (ac-ft) provided by the Alternative.
 - b. Meeting of Forest Park Area 10-Year Goal described in Section 9.01.
 - c. Meeting of Forest Park Area 25-Year Goal described in Section 9.01.

2. Watershed-Based Criteria for 10-Year Storm Event
 - a. Forest Park North-Hydraulic grade line (HGL) decrease at Pershing Boulevard/60th Street intersection.
 - b. Forest Park South-HGL decrease at 50th Avenue/67th Street.
 - c. Forest Park South-HGL decrease at 47th Avenue/69th Street intersection.
 - d. Forest Park South-HGL decrease at 46th Avenue/Harding Road.

After discussion with the City regarding these alternatives, we will recommend a cost-effective alternative that best meets the City's goals for the project after considering the selection criteria, and other City goals and objectives.

TABLE 9.09-1

ALTERNATIVES ANALYZED (ALTERNATIVES 1 THROUGH 7)

Alternative	Strand Alt. Designation	Alternative Description	Alternative Selection Criteria							
			Additional Storage Provided (ac-ft)	Forest Park North: 10-Year HGL Decrease at Pershing Blvd./60th St. (ft)	Forest Park South: 10-Year HGL Decrease at 50th Ave./67th St. (ft)	Forest Park South: 10-Year HGL Decrease at 47th Ave./69th St. (ft)	Forest Park South: 10 Year HGL Decrease at 46th Ave./Harding Road	10-Year Goal Met	25-Year Goal Met	Opinion of Probable Construction Cost
Forest Park North Alternatives										
1	1N	Nash Park Detention Basin Modifications	N/A	+0.01	N/A	N/A	N/A	No	No	\$5,000
2	2NG1	Underground Detention in Forest Park and Storm Sewer/Inlet Upgrades	6.31	-1.89	N/A	N/A	N/A	Yes	Yes	\$3,680,000
3	5N	Underground Detention in Church Parking Lot Northwest of Pershing/61st Street and Storm Sewer/Inlet Upgrades	6.30	-4.05	N/A	N/A	N/A	Yes	Yes	\$3,585,000
4	6N	Pumping station in Forest Park Area Pumping to Detention Basin in Vacant Land Southwest of 60th Avenue/60th Street Intersection and Storm Sewer/Inlet Upgrades	7.27 (25-Year)	-1.35	N/A	N/A	N/A	Yes	Yes	\$13,581,000
7	2NS	Home Purchase, Two Dry Detention Basins, One Underground Detention Basin and Storm Sewer/Inlet Upgrades	4.90	-1.73	N/A	N/A	N/A	Yes	Yes	\$4,377,000
Forest Park South Alternatives										
5	1S	Disconnect Interconnection with Storm Sewer on 65th Street	N/A	N/A	-1.15	-0.05	+0.23	No	No	\$10,100
6	2S	Conveyance Upgrade to Underground Detention at Forest Park School and Storm Sewer/Inlet Upgrades	3.38	N/A	-2.34	-3.89	+0.23	Yes	Yes	\$3,009,000
7	2NS	Home Purchase, Two Dry Detention Basins and Storm Sewer/Inlet Upgrades	3.36	N/A	-0.19	+0.01	-0.13	Yes	Yes	\$3,700,000

9.10 ALTERNATIVE 8–EXISTING INLETS AND LEADS COMBINED WITH UPSIZING OF EXISTING BOTTLENECK STORM SEWERS (FOREST PARK NORTH)

As described in Section 7.02 C. Design Storm Evaluation, there are significant storm sewer conveyance bottlenecks downstream of the Forest Park North area. In Alternative 8, we have analyzed upsizing of storm sewer bottlenecks along Pershing Boulevard, 42nd Avenue, 59th Street and 60th Street (stopping at 39th Avenue). In the Forest Park North Area, the alternative includes analysis of existing storm sewers, inlets, and inlet leads as they exist today. Figure 9.10-1 shows the layout of this alternative including storm sewer upsizing necessary to pass the 10-year design storm in the vicinity of the bottleneck area. Figures 9.10-2, 9.10-3, and 9.10-4 (attached in pocket folders in Volume 2 of this document) show the flooding depths during the 10-year, 25-year, and 100-year storm events with Alternative 8 in place. These figures also show the freeboard or lack thereof from the computed water surface elevation to the low entry point at 37 analysis points.

The increase in flow at the downstream end of the bottleneck upsizing is shown in Table 9.10-1. Table 9.10-2 shows the effects of Alternative 8 at the 37 Analysis points. The overall effect of Alternative 8 at the Watershed, Forest Park North, and Forest Park South indicator points is included in Table 9.10-3. Appendix N includes the storm sewer mainline 10-year storm event profiles with Alternative 8 in-place in the Forest Park North area.

	Existing 10-Year Flow (cfs)	Alt 8 10-Year Flow (cfs)	Existing 25-Year Flow (cfs)	Alt 8 25-Year Flow (cfs)	Existing 100-Year Flow (cfs)	Alt 8 100-Year Flow (cfs)
Pike Creek Mainline (P-9745) at 39th Ave/59th Street Intersection	111	104	118	118	125	132
Lake Michigan North Mainline (P-10221)	116	201	119	208	123	209

Table 9.10-1 Alternative 8-Increase in Flow at Downstream End of Bottlenecks

	No. of Analysis Points With 0 to 0.25 Feet of Freeboard	No. of Analysis Points With 0.25 to 0.5 Feet of Freeboard	No. of Analysis Points With 0.5 to 1.0 Feet of Freeboard	No. of Analysis Points With Greater than 1.0 Feet of Freeboard	No. of Analysis Points Showing Lowest Entry Point Flooding	Total
Existing 10-Year	1	6	15	12	3	37
10-Year w/Alt	0	7	15	12	3	37
Existing 25-Year	2	9	17	6	3	37
25-Year w/Alt	0	10	16	8	3	37
Existing 100-Year	8	13	10	0	6	37
100-Year w/Alt	8	13	10	0	6	37

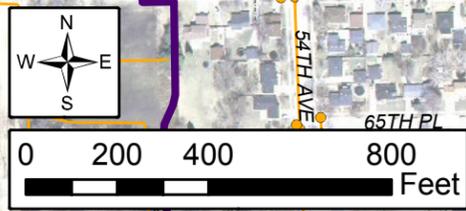
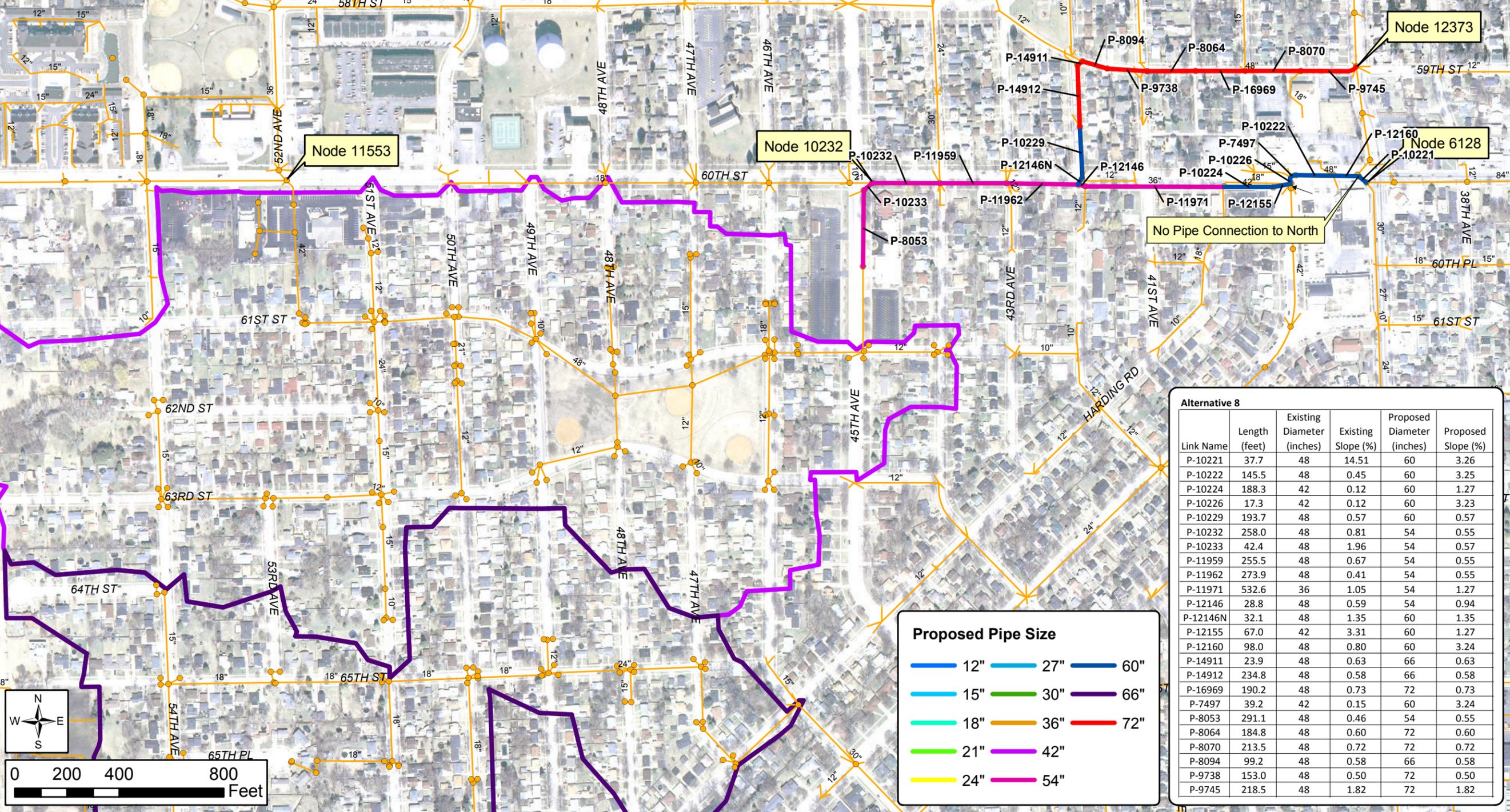
Table 9.10-2 Alternative 8-Effects at 37 Analysis Points

The OPCC is shown in Table 9.10-4. Table 9.10-5 provides advantages and disadvantages of this alternative.

Legend

Storm Sewer Study Limits

- North Subbasin
- South Subbasin
- Storm Sewer Manhole
- Storm Sewer Main



Proposed Pipe Size

- 12" (Blue)
- 15" (Cyan)
- 18" (Teal)
- 21" (Light Green)
- 24" (Yellow)
- 27" (Light Blue)
- 30" (Green)
- 36" (Orange)
- 42" (Purple)
- 48" (Dark Purple)
- 54" (Red)
- 60" (Dark Blue)
- 66" (Dark Purple)
- 72" (Red)

Alternative 8

Link Name	Length (feet)	Existing Diameter (inches)	Existing Slope (%)	Proposed Diameter (inches)	Proposed Slope (%)
P-10221	37.7	48	14.51	60	3.26
P-10222	145.5	48	0.45	60	3.25
P-10224	188.3	42	0.12	60	1.27
P-10226	17.3	42	0.12	60	3.23
P-10229	193.7	48	0.57	60	0.57
P-10232	258.0	48	0.81	54	0.55
P-10233	42.4	48	1.96	54	0.57
P-11959	255.5	48	0.67	54	0.55
P-11962	273.9	48	0.41	54	0.55
P-11971	532.6	36	1.05	54	1.27
P-12146	28.8	48	0.59	54	0.94
P-12146N	32.1	48	1.35	60	1.35
P-12155	67.0	42	3.31	60	1.27
P-12160	98.0	48	0.80	60	3.24
P-14911	23.9	48	0.63	66	0.63
P-14912	234.8	48	0.58	66	0.58
P-16969	190.2	48	0.73	72	0.73
P-7497	39.2	42	0.15	60	3.24
P-8053	291.1	48	0.46	54	0.55
P-8064	184.8	48	0.60	72	0.60
P-8070	213.5	48	0.72	72	0.72
P-8094	99.2	48	0.58	66	0.58
P-9738	153.0	48	0.50	72	0.50
P-9745	218.5	48	1.82	72	1.82

**ALTERNATIVE 8 - 10 YEAR STORM SEWER TO BE UPSIZED
(FOREST PARK NORTH)**

**FOREST PARK AREA STORM AND SANITARY SEWER MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN**



**FIGURE 9.10-1
1540.001**

**TABLE 9.10-3
 ALTERNATIVE 8—PEAK DISCHARGE RATES BY INDICATOR NODE (10-YEAR STORM EVENT)**

Node	Pipe	Indicator Node Type	Node Location	Maximum Flow (cfs)			Maximum HGL (ft)			
				Existing Conditions 10-Year	Alternative 8 10-Year	Change	Ground Elevation	Existing Conditions 10-Year	Alternative 8 10-Year	Change
Watershed Indicator Points										
8	P-7	Outfall	Pike Creek Outfall	496.7	480.5	-16.2	619.72	598.95	598.92	-0.03
5	P-800	Center Mainline Outfall	(N) Lake Michigan Outfall	597.6	602.6	5.0	587.70	585.84	585.86	0.02
11482	P-11482	System Convergence: North	37th Avenue/52nd Street	163.3	161.2	-2.1	642.00	642.81	642.81	0.00
12373	P-12373	System Convergence: North	39th Ave/59th Street	109.6	98.3	-11.3	653.87	646.73	646.63	-0.10
6128	P-6128	System Convergence: Central	39th Ave/60th Street	152.0	230.3	78.3	644.11	633.82	636.05	2.23
Forest Park North Indicator Points										
11553	P-11553	Enter North Study Area	(W) 51st Avenue/60th Street	84.4	84.4	0.0	691.95	690.77	690.78	0.01
5634	P-5634	Low Point: North System	51st Avenue/61st Street	109.4	109.7	0.3	681.21	679.29	679.27	-0.02
5770	P-5770	Low Point: North System	49th Avenue/61st Street	93.7	100.7	7.0	676.89	675.04	675.01	-0.03
5794	P-5794	Low Point: North System	Hilda Reyes House	12.6	7.5	-5.1	664.71	665.75	665.59	-0.16
10232	P-10232.1	Exit North Study Area	60th Street/Pershing Boulevard	100.7	125.9	25.2	660.29	660.10	657.54	-2.56

**TABLE 9.10-4
 ALTERNATIVE 8—OPINION OF PROBABLE COST**

Item	Capital Cost
Downstream Bottleneck Upsizing	\$759,800
Subtotal	\$759,800
15% Construction Contingency	\$114,000
15% Engineering Contingency	\$114,000
Soil Borings	\$5,000
Grand Total	\$992,800

**TABLE 9.10-5
 ALTERNATIVE 8—ADVANTAGES/DISADVANTAGES**

Advantages	Disadvantages
<ul style="list-style-type: none"> Improves flooding conditions during the 10-year storm event with lesser improvement in the 25-year and 100-year storm events 	<ul style="list-style-type: none"> Increased flows and HGLs at downstream end of bottleneck upsizing.

9.11 ALTERNATIVE 9–10-YEAR STORM SEWERS, INLETS, AND LEADS IN FOREST PARK NORTH COMBINED WITH UPSIZING OF EXISTING BOTTLENECK STORM SEWERS (FOREST PARK NORTH)

As described in Section 7.02 C. Design Storm Evaluation, there are significant storm sewer conveyance bottlenecks downstream of the Forest Park North area. In Alternative 9, we have analyzed upsizing of storm sewer bottlenecks along Pershing Boulevard, 42nd Avenue, 59th Street, and 60th Street (stopping at 39th Avenue). In the Forest Park North Area, the alternative includes inlet and inlet lead upsizing as described in Section 7.02 C. Design Storm Evaluation. It also includes mainline storm sewer upsizing in the Forest Park North Area as described herein. Figure 9.11-1 shows the layout of this alternative including storm sewer upsizing necessary to pass the 10-year design storm in the vicinity of the bottleneck area and in the Forest Park North watershed. Figures 9.11-2, 9.11-3, and 9.11-4 (attached in pocket folders in Volume 2 of this document) show the flooding depths during the 10-year, 25-year, and 100-year storm events with Alternative 9 in place. These figures also show the freeboard or lack thereof from the computed water surface elevation to the low entry point at 37 analysis points.

The increase in flow at the downstream end of the bottleneck upsizing is shown in Table 9.11-1. Table 9.11-2 shows the effects of Alternative 9 at the 37 Analysis points. The overall effect of Alternative 9 at the Watershed and Forest Park North, indicator points is included in Table 9.11-3. Appendix O includes the storm sewer mainline 10-year storm event profiles with Alternative 9 in-place in the Forest Park North area.

	Existing 10-Year Flow (cfs)	Alt 9 10-Year Flow (cfs)	Existing 25-Year Flow (cfs)	Alt 9 25-Year Flow (cfs)	Existing 100-Year Flow (cfs)	Alt 9 100-Year Flow (cfs)
Pike Creek Mainline (P-9745) at 39th Ave/59th Street Intersection	111	112	118	127	125	140
Lake Michigan North Mainline (P-10221)	116	216	119	220	123	233

Table 9.11-1 Alternative 9-Increase in Flow at Downstream End of Bottlenecks

	No. of Analysis Points With 0 to 0.25 Feet of Freeboard	No. of Analysis Points With 0.25 to 0.5 Feet of Freeboard	No. of Analysis Points With 0.5 to 1.0 Feet of Freeboard	No. of Analysis Points With Greater than 1.0 Feet of Freeboard	No. of Analysis Points Showing Lowest Entry Point Flooding	Total
Existing 10-Year	1	6	15	12	3	37
10-Year w/Alt	1	2	5	28	1*	37
Existing 25-Year	2	9	17	6	3	37
25-Year w/Alt	0	3	13	19	2	37
Existing 100-Year	8	13	10	0	6	37
100-Year w/Alt	3	8	16	6	4	37

*Further investigation is needed at 6116 49th Avenue that shows a window elevation of 678.49 and an adjacent ground elevation of 679.20. If the ground elevation is used as the low entry point, then the low entry point would not flood during the 10-year storm event and this table entry would go to 0.

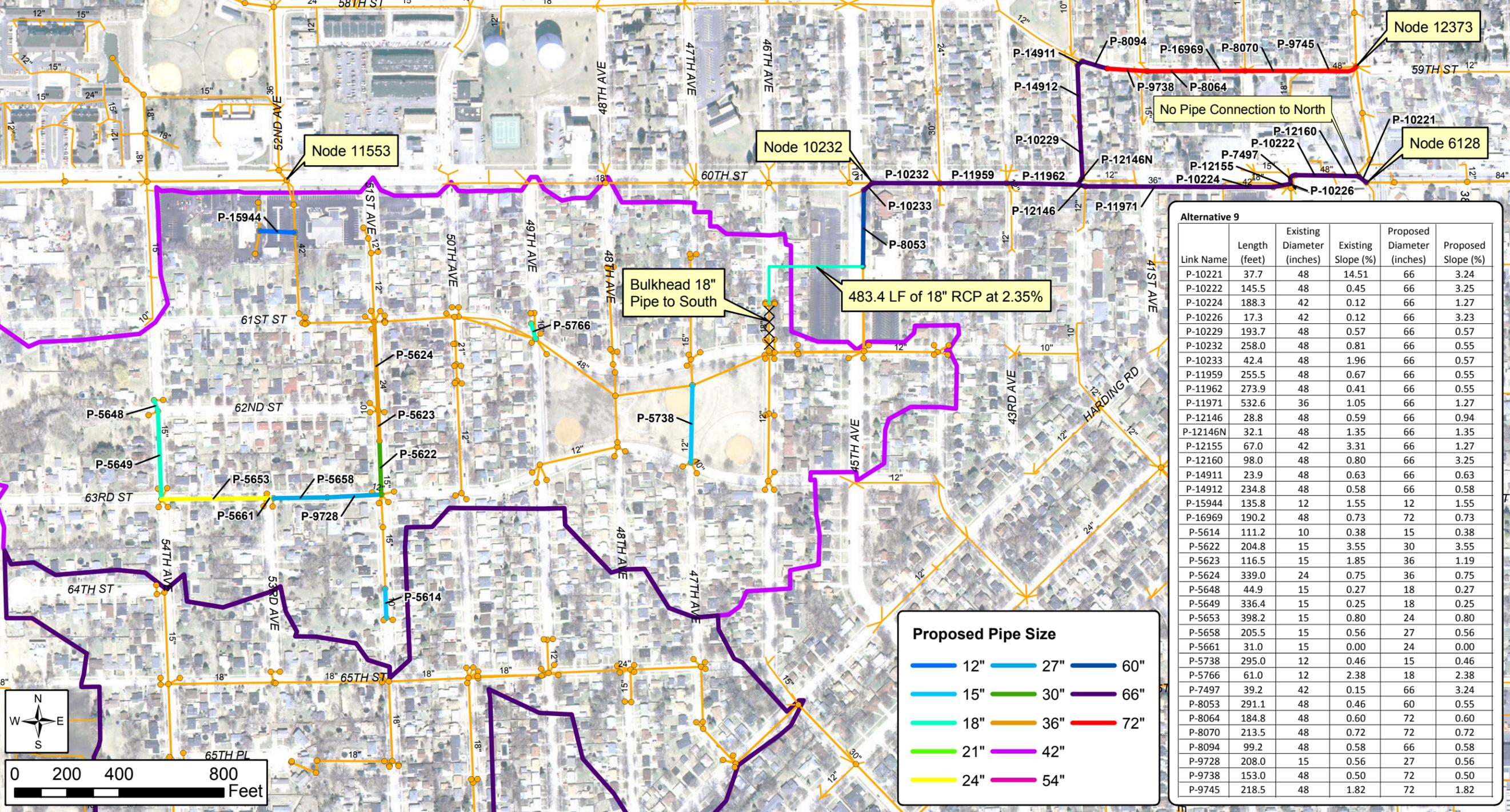
Table 9.11-2 Alternative 9-Effects at 37 Analysis Points

The OPCC is shown in Table 9.11-4. Table 9.11-5 provides advantages and disadvantages of this alternative.

Legend

Storm Sewer Study Limits

- North Subbasin
- South Subbasin
- Storm Sewer Manhole
- Storm Sewer Main



Proposed Pipe Size

- 12" (Blue)
- 15" (Light Blue)
- 18" (Cyan)
- 21" (Green)
- 24" (Yellow)
- 27" (Light Green)
- 30" (Green)
- 36" (Orange)
- 42" (Purple)
- 48" (Dark Purple)
- 54" (Red)
- 60" (Dark Blue)
- 66" (Purple)
- 72" (Red)

Alternative 9

Link Name	Length (feet)	Existing Diameter (inches)	Existing Slope (%)	Proposed Diameter (inches)	Proposed Slope (%)
P-10221	37.7	48	14.51	66	3.24
P-10222	145.5	48	0.45	66	3.25
P-10224	188.3	42	0.12	66	1.27
P-10226	17.3	42	0.12	66	3.23
P-10229	193.7	48	0.57	66	0.57
P-10232	258.0	48	0.81	66	0.55
P-10233	42.4	48	1.96	66	0.57
P-11959	255.5	48	0.67	66	0.55
P-11962	273.9	48	0.41	66	0.55
P-11971	532.6	36	1.05	66	1.27
P-12146	28.8	48	0.59	66	0.94
P-12146N	32.1	48	1.35	66	1.35
P-12155	67.0	42	3.31	66	1.27
P-12160	98.0	48	0.80	66	3.25
P-14911	23.9	48	0.63	66	0.63
P-14912	234.8	48	0.58	66	0.58
P-15944	135.8	12	1.55	12	1.55
P-16969	190.2	48	0.73	72	0.73
P-5614	111.2	10	0.38	15	0.38
P-5622	204.8	15	3.55	30	3.55
P-5623	116.5	15	1.85	36	1.19
P-5624	339.0	24	0.75	36	0.75
P-5648	44.9	15	0.27	18	0.27
P-5649	336.4	15	0.25	18	0.25
P-5653	398.2	15	0.80	24	0.80
P-5658	205.5	15	0.56	27	0.56
P-5661	31.0	15	0.00	24	0.00
P-5738	295.0	12	0.46	15	0.46
P-5766	61.0	12	2.38	18	2.38
P-7497	39.2	42	0.15	66	3.24
P-8053	291.1	48	0.46	60	0.55
P-8064	184.8	48	0.60	72	0.60
P-8070	213.5	48	0.72	72	0.72
P-8094	99.2	48	0.58	66	0.58
P-9728	208.0	15	0.56	27	0.56
P-9738	153.0	48	0.50	72	0.50
P-9745	218.5	48	1.82	72	1.82

**ALTERNATIVE 9 - 10 YEAR STORM SEWER TO BE UPSIZED
(FOREST PARK NORTH)**

**FOREST PARK AREA STORM AND SANITARY SEWER MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN**



**FIGURE 9.11-1
1540.001**

**TABLE 9.11-3
 ALTERNATIVE 9—PEAK DISCHARGE RATES BY INDICATOR NODE (10-YEAR STORM EVENT)**

Node	Pipe	Indicator Node Type	Node Location	Maximum Flow (cfs)			Maximum HGL (ft)			
				Existing Conditions 10-Year	Alternative 9 10-Year	Change	Ground Elevation	Existing Conditions 10-Year	Alternative 9 10-Year	Change
Watershed Indicator Points										
8	P-7	Outfall	Pike Creek Outfall	496.7	521.3	24.6	619.72	598.95	598.99	0.04
5	P-800	Center Mainline Outfall	(N) Lake Michigan Outfall	597.6	603.8	6.2	587.70	585.84	585.86	0.04
11482	P-11482	System Convergence: North	37th Avenue/52nd Street	163.29	161.1	-2.2	642.00	642.81	642.81	0.00
12373	P-12373	System Convergence: North	39th Ave/59th Street	109.6	98.3	-11.3	653.87	646.73	646.50	-0.23
6128	P-6128	System Convergence: Central	60th St.	151.96	244.6	92.6	644.11	633.82	637.51	3.69
Forest Park North Indicator Points										
11553	P-11553	Enter North Study Area	(W) 51st Avenue/60th Street	84.4	84.8	0.4	691.95	690.77	690.98	0.21
5634	P-5634	Low Point: North System	51st Avenue/61st Street	109.4	125.3	15.9	681.21	679.29	679.82	0.53
5770	P-5770	Low Point: North System	49th Avenue/61st Street	93.7	104.3	10.6	676.89	675.04	675.14	0.10
5794	P-5794	Low Point: North System <i>Note: Pipe Connection To Mainline Moved to Tie In On Pershing Blvd.</i>	Hilda Reyes House	12.6	N/A	N/A	664.71	665.75	661.59	-4.16
10232	P-10232.1	Exit North Study Area	60th Street/Pershing Boulevard	100.7	147.8	47.1	660.29	660.10	653.00	-7.1

**TABLE 9.11-4
 ALTERNATIVE 9—OPINION OF PROBABLE COST**

Item	Capital Cost
10-Year Inlet and Inlet Lead Upgrades (FPN)	\$432,000
10-Year Mainline Storm Sewer Upgrades (FPN)	\$451,000
Downstream Bottleneck Upsizing	\$1,255,000
Subtotal	\$2,138,000
15% Construction Contingency	\$321,000
15% Engineering Contingency	\$321,000
Soil Borings	\$5,000
Grand Total	\$2,785,000

**TABLE 9.11-5
 ALTERNATIVE 9—ADVANTAGES/DISADVANTAGES**

Advantages	Disadvantages
<ul style="list-style-type: none"> Provides a 10-year storm event level of protection in the Forest Park North area. 	<ul style="list-style-type: none"> Increased flows and HGLs at downstream end of bottleneck upsizing.

9.12 ALTERNATIVE 10–EXISTING INLETS AND LEADS COMBINED WITH UPSIZING OF EXISTING BOTTLENECK STORM SEWERS (FOREST PARK SOUTH)

As described in Section 7.02 C. Design Storm Evaluation, there are significant storm sewer conveyance bottlenecks downstream of the Forest Park South area. In Alternative 10, we have analyzed upsizing of storm sewer bottlenecks along 49th Avenue, 67th Street, 47th Avenue (stopping at 70th Street), and Taft Road (upstream of Pershing Boulevard). In the Forest Park South Area, the alternative includes analysis of the existing storm sewers, inlets, and inlet leads as they exist today. Figure 9.12-1 shows the layout of this alternative including storm sewer upsizing necessary to pass the 10-year design storm in the vicinity of the bottleneck area. Figures 9.12-2, 9.12-3, and 9.12-4 (attached in pocket folders in Volume 2 of this document) show the flooding depths during the 10-year, 25-year, and 100-year storm events with Alternative 10 in-place. These figures also show the freeboard or lack thereof from the computed water surface elevation to the low entry point at 34 analysis points

The increase in flow at the downstream end of the bottleneck upsizing is shown in Table 9.12-1. Table 9.12-2 shows the effects of Alternative 10 at the 34 Analysis points. The overall effect of Alternative 8 at the Watershed, Forest Park North, and Forest Park South indicator points is included in Table 9.12-3. Appendix P includes the storm sewer mainline 10-year storm event profiles with Alternative 10 in-place in the Forest Park North area.

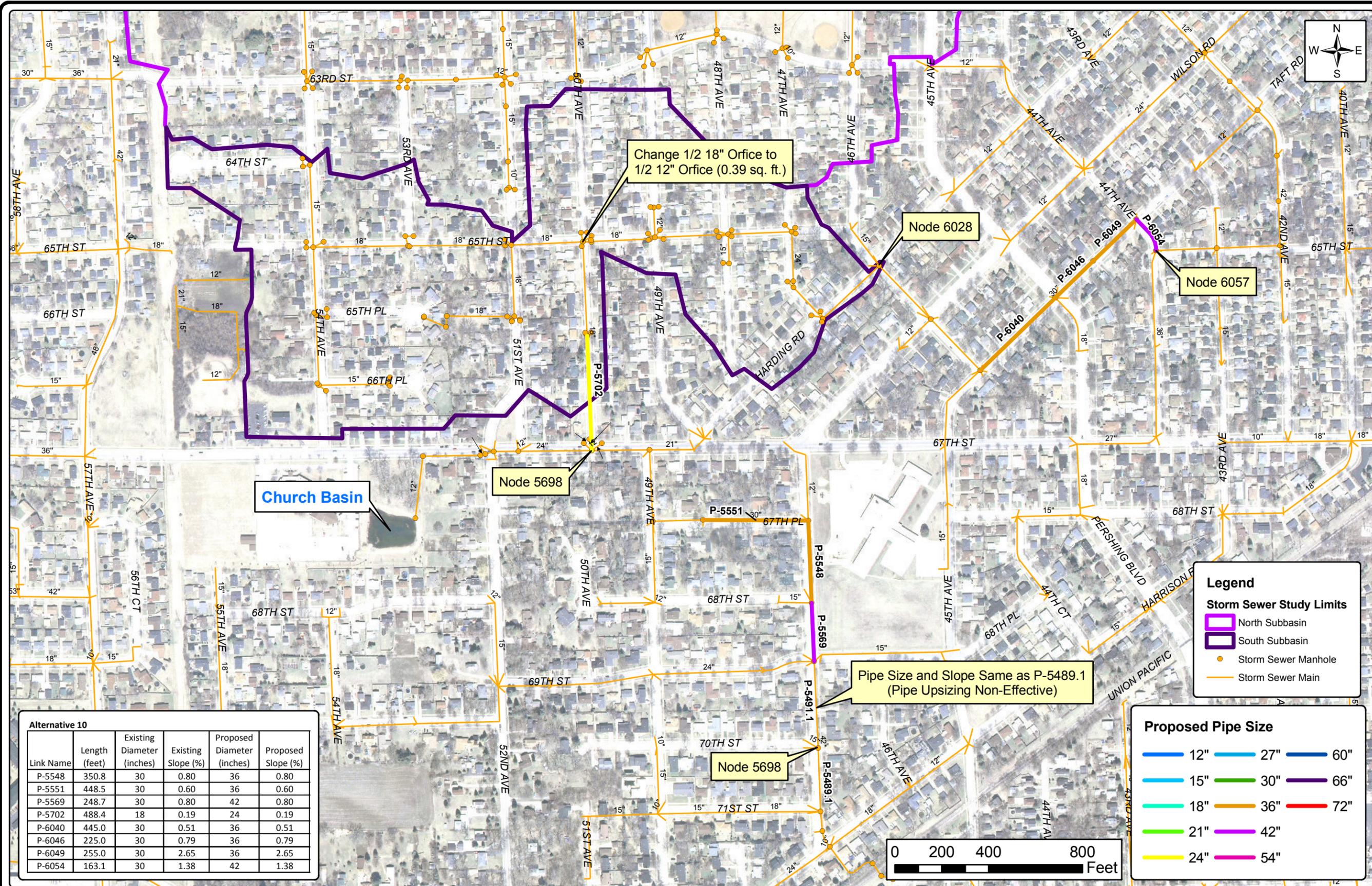
	Existing 10-Year Flow (cfs)	Alt 10 10-Year Flow (cfs)	Existing 25-Year Flow (cfs)	Alt 10 25-Year Flow (cfs)	Existing 100-Year Flow (cfs)	Alt 10 100-Year Flow (cfs)
Lake Michigan North Mainline (P-6054) at 44th Ave/65th Street Intersection	41	58	41	58	41	61
Lake Michigan South Mainline (P-5491.1)	54	52	58	58	42	37

Table 9.12-1 Alternative 10-Increase in Flow at Downstream End of Bottlenecks

	No. of Analysis Points With 0 to 0.25 Feet of Freeboard	No. of Analysis Points With 0.25 to 0.5 Feet of Freeboard	No. of Analysis Points With 0.5 to 1.0 Feet of Freeboard	No. of Analysis Points With Greater than 1.0 Feet of Freeboard	No. of Analysis Points Showing Lowest Entry Point Flooding	Total
Existing 10-Year	2	2	15	14	1	34
10-Year w/Alt	0	2	9	22	1	34
Existing 25-Year	2	8	10	10	4	34
25-Year w/Alt	1	6	13	10	4	34
Existing 100-Year	5	10	11	1	7	34
100-Year w/Alt	5	11	10	1	7	34

Table 9.12-2 Alternative 10-Effects at 34 Analysis Points

The OPCC is shown in Table 9.12-4. Table 9.12-5 provides advantages and disadvantages of this alternative.



Change 1/2 18" Orifice to 1/2 12" Orifice (0.39 sq. ft.)

Node 6028

Node 6057

Church Basin

Node 5698

Pipe Size and Slope Same as P-5489.1 (Pipe Upsizing Non-Effective)

Node 5698

Legend

Storm Sewer Study Limits

- North Subbasin
- South Subbasin
- Storm Sewer Manhole
- Storm Sewer Main

Proposed Pipe Size

- 12"
- 15"
- 18"
- 21"
- 24"
- 27"
- 30"
- 36"
- 42"
- 54"
- 60"
- 66"
- 72"

Alternative 10

Link Name	Length (feet)	Existing Diameter (inches)	Existing Slope (%)	Proposed Diameter (inches)	Proposed Slope (%)
P-5548	350.8	30	0.80	36	0.80
P-5551	448.5	30	0.60	36	0.60
P-5569	248.7	30	0.80	42	0.80
P-5702	488.4	18	0.19	24	0.19
P-6040	445.0	30	0.51	36	0.51
P-6046	225.0	30	0.79	36	0.79
P-6049	255.0	30	2.65	36	2.65
P-6054	163.1	30	1.38	42	1.38



ALTERNATIVE 10 - 10 YEAR STORM SEWER TO BE UPSIZED (FOREST PARK SOUTH)

FOREST PARK AREA STORM AND SANITARY SEWER MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN



FIGURE 9.12-1
1540.001

**TABLE 9.12-3
 ALTERNATIVE 10—PEAK DISCHARGE RATES BY INDICATOR NODE (10-YEAR STORM EVENT)**

Node	Pipe	Indicator Node Type	Node Location	Maximum Flow (cfs)			Maximum HGL (ft)			
				Existing Conditions 10-Year	Alternative 10 10-Year	Change	Ground Elevation	Existing Conditions 10-Year	Alternative 10 10-Year	Change
Watershed Indicator Points										
6	P-4655	South Mainline Outfall	(S) Lake Michigan Outfall	386.3	386.3	0.0	585.09	582.08	582.08	0.00
368	P-368	System Convergence: South	40th Avenue/76th Street	270.7	271.7	1.0	645.00	640.56	640.43	-0.13
Forest Park South Indicator Points										
5677	P-5677	65th Place: Cul du Sac Low Point	65th Place	9.6	9.8	0.2	693.83	694.33	694.33	0.00
5607	P-5607	Low Point: South System	51st Ave: Mid-Block	8.6	8.5	-0.1	689.73	691.17	691.13	-0.04
5702	P-5702	Low Point: South System	50th Ave: Mid-Block	13.2	18.8	5.6	686.32	687.39	684.82	-2.57
5721	P-5721	Low Point: South System	48th Avenue/65th Street	5.7	6.0	0.3	680.24	681.59	681.56	-0.03
5698	P-5698	Exit South Study Area: South	50th Avenue/67th Street	18.9	22.9	4.0	687.75	680.27	680.58	0.31
6028	P-6028	Exit South Study Area: East	46th Avenue/Harding Road	28.1	27.5	-0.6	684.81	670.90	670.84	-0.06
6057	P-6057	Downstream end of upsizing	44th Avenue/65th St.	63.5	80.5	17.0	655.10	651.58	653.86	2.28
5491	P-5491.1	Exit from Forest Park School	47th Avenue/69th Street	53.5	51.7	-1.8	664.98	666.72	666.86	0.14
5489	P-5489.1	Downstream end of upsizing	47th Avenue/70th Street	53.6	51.7	-1.9	665.84	665.39	665.60	0.21

**TABLE 9.12-4
 ALTERNATIVE 10—OPINION OF PROBABLE COST**

Item	Capital Cost
Downstream Bottleneck Upsizing	\$281,000
Subtotal	\$281,000
15% Construction Contingency	\$42,000
15% Engineering Contingency	\$42,000
Soil Borings	\$5,000
Grand Total	\$370,000

**TABLE 9.12-5
 ALTERNATIVE 10—ADVANTAGES/DISADVANTAGES**

Advantages	Disadvantages
<ul style="list-style-type: none"> Improves flooding conditions during the 10-year storm event with lesser improvement in the 25-year and 100-year storm events 	<ul style="list-style-type: none"> Increased flows and HGLs at downstream end of bottleneck upsizing.

9.13 ALTERNATIVE 11–10-YEAR STORM SEWERS, INLETS, AND LEADS IN FOREST PARK SOUTH COMBINED WITH UPSIZING OF EXISTING BOTTLENECK STORM SEWERS (FOREST PARK SOUTH)

As described in Section 7.02 C. Design Storm Evaluation, there are significant storm sewer conveyance bottlenecks downstream of the Forest Park South area. In Alternative 11, we have analyzed upsizing of storm sewer bottlenecks along 49th Avenue, 67th Street, 47th Avenue (stopping at 70th Street), and Taft Road (upstream of Pershing Boulevard). In the Forest Park South Area, the alternative includes inlet and inlet lead upsizing as described in Section 7.02 C. Design Storm Evaluation. It also includes mainline storm sewer upsizing in the Forest Park South Area as described herein. Figure 9.13-1 shows the layout of this alternative including storm sewer upsizing necessary to pass the 10-year design storm in the vicinity of the bottleneck area and in the Forest Park South watershed. Figures 9.13-2, 9.13-3, and 9.13-4 (attached in pocket folders in Volume 2 of this document) show the flooding depths during the 10-year, 25-year, and 100-year storm events with Alternative 11 in place. These figures also show the freeboard or lack thereof from the computed water surface elevation to the low entry point at 34 analysis points.

The increase in flow at the downstream end of the bottleneck upsizing is shown in Table 9.13-1. Table 9.13-2 shows the effects of Alternative 11 at the 34 Analysis points. The overall effect of Alternative 11 at the Watershed and Forest Park South indicator points is included in Table 9.13-3. Appendix Q includes the storm sewer mainline 10-year storm event profiles with Alternative 11 in-place in the Forest Park South area.

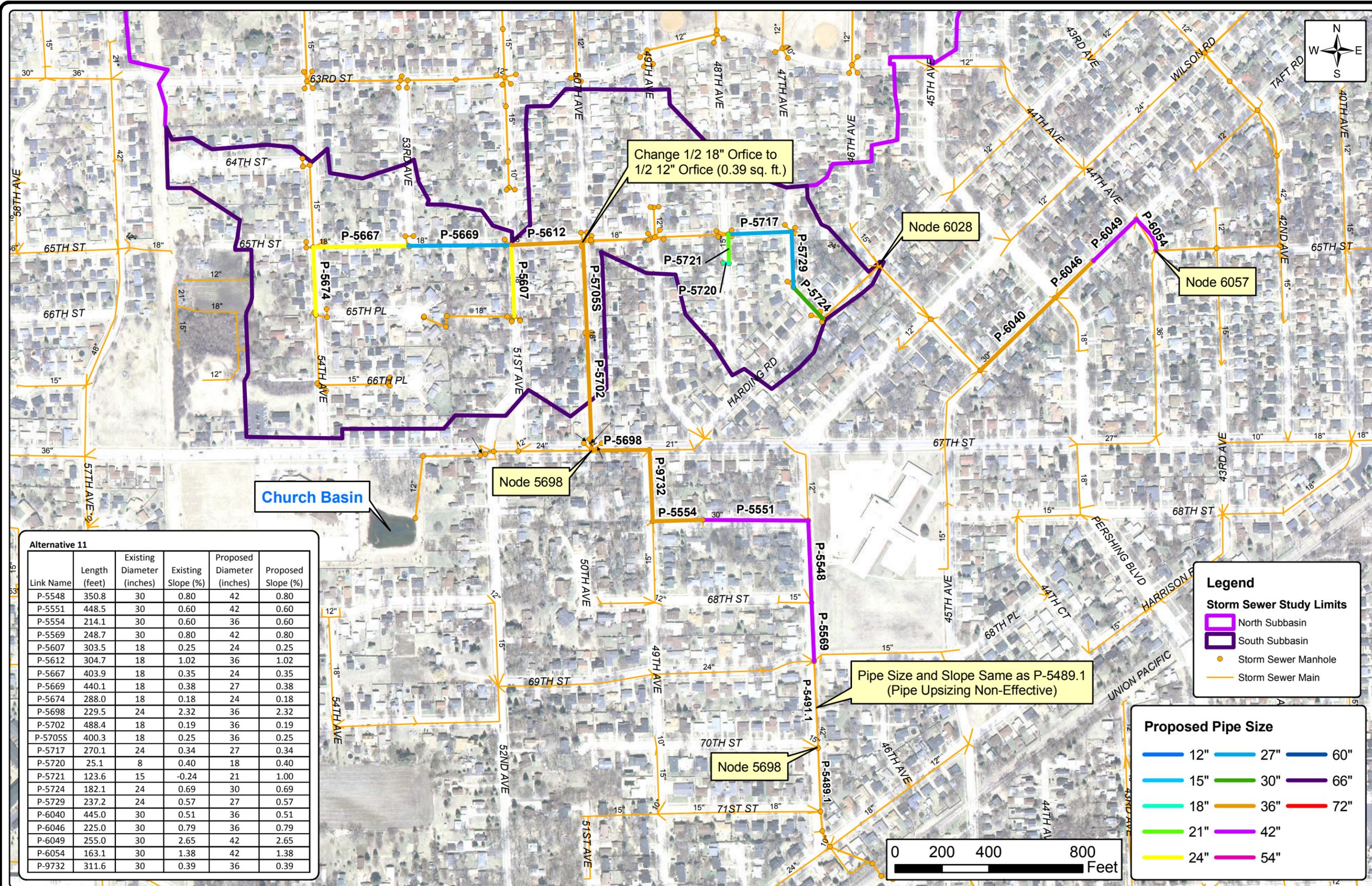
	Existing 10-Year Flow (cfs)	Alt 11 10-Year Flow (cfs)	Existing 25-Year Flow (cfs)	Alt 11 25-Year Flow (cfs)	Existing 100-Year Flow (cfs)	Alt 11 100-Year Flow (cfs)
Lake Michigan North Mainline (P-6054) at 44th Ave/65th Street Intersection	41	60	41	62	41	66
Lake Michigan South Mainline P-5491.1)	54	58	58	42	42	38

Table 9.13-1 Alternative 11-Increase in Flow at Downstream End of Bottlenecks

	No. of Analysis Points With 0 to 0.25 Feet of Freeboard	No. of Analysis Points With 0.25 to 0.5 Feet of Freeboard	No. of Analysis Points With 0.5 to 1.0 Feet of Freeboard	No. of Analysis Points With Greater than 1.0 Feet of Freeboard	No. of Analysis Points Showing Lowest Entry Point Flooding	Total
Existing 10-Year	2	2	15	14	1	34
10-Year w/Alt	0	0	4	30	0	34
Existing 25-Year	2	8	10	10	4	34
25-Year w/Alt	1	0	8	25	0	34
Existing 100-Year	5	10	11	1	7	34
100-Year w/Alt	4	7	15	3	5	34

Table 9.13-2 Alternative 11-Effects at 34 Analysis Points

The OPCC is shown in Table 9.13-4. Table 9.13-5 provides advantages and disadvantages of this alternative.



Change 1/2 18" Orifice to 1/2 12" Orifice (0.39 sq. ft.)

Node 6028

Node 6057

Node 5698

Church Basin

Pipe Size and Slope Same as P-5489.1 (Pipe Upsizing Non-Effective)

Node 5698

Alternative 11

Link Name	Length (feet)	Existing Diameter (inches)	Existing Slope (%)	Proposed Diameter (inches)	Proposed Slope (%)
P-5548	350.8	30	0.80	42	0.80
P-5551	448.5	30	0.60	42	0.60
P-5554	214.1	30	0.60	36	0.60
P-5569	248.7	30	0.80	42	0.80
P-5607	303.5	18	0.25	24	0.25
P-5612	304.7	18	1.02	36	1.02
P-5667	403.9	18	0.35	24	0.35
P-5669	440.1	18	0.38	27	0.38
P-5674	288.0	18	0.18	24	0.18
P-5698	229.5	24	2.32	36	2.32
P-5702	488.4	18	0.19	36	0.19
P-5705S	400.3	18	0.25	36	0.25
P-5717	270.1	24	0.34	27	0.34
P-5720	25.1	8	0.40	18	0.40
P-5721	123.6	15	-0.24	21	1.00
P-5724	182.1	24	0.69	30	0.69
P-5729	237.2	24	0.57	27	0.57
P-6040	445.0	30	0.51	36	0.51
P-6046	225.0	30	0.79	36	0.79
P-6049	255.0	30	2.65	42	2.65
P-6054	163.1	30	1.38	42	1.38
P-9732	311.6	30	0.39	36	0.39

Legend

Storm Sewer Study Limits

- North Subbasin
- South Subbasin
- Storm Sewer Manhole
- Storm Sewer Main

Proposed Pipe Size

- 12"
- 15"
- 18"
- 21"
- 24"
- 27"
- 30"
- 36"
- 42"
- 54"
- 60"
- 66"
- 72"



ALTERNATIVE 11 - 10 YEAR STORM SEWER TO BE UPSIZED (FOREST PARK SOUTH)

FOREST PARK AREA STORM AND SANITARY SEWER MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN



FIGURE 9.13-1
1540.001

**TABLE 9.13-3
 ALTERNATIVE 11—PEAK DISCHARGE RATES BY INDICATOR NODE (10-YEAR STORM EVENT)**

Node	Pipe	Indicator Node Type	Node Location	Maximum Flow (cfs)			Maximum HGL (ft)			
				Existing Conditions 10-Year	Alternative 11 10-Year	Change	Ground Elevations	Existing Conditions 10-Year	Alternative 11 10-Year	Change
Watershed Indicator Points										
6	P-4655	South Mainline Outfall	(S) Lake Michigan Outfall	386.3	386.3	0.0	585.09	582.08	582.08	0.00
368	P-368	System Convergence: South	40th Avenue/76th Street	270.7	271.7	1.0	645.00	640.56	640.44	-0.12
Forest Park South Indicator Points										
5677	P-5677	65th Place: Cul du Sac Low Point	65th Place	9.6	7.0	-2.6	693.83	694.33	694.09	-0.24
5607	P-5607	Low Point: South System	51st Ave: Mid-Block	8.6	13.8	5.2	689.73	691.17	687.96	-3.21
5702	P-5702	Low Point: South System	50th Ave: Mid-Block	13.2	38.1	24.9	686.32	687.39	682.26	-5.13
5721	P-5721	Low Point: South System	48th Avenue/65th Street	5.7	10.4	4.7	680.24	681.59	680.35	-1.24
5698	P-5698	Exit South Study Area: South	50th Avenue/67th Street	18.9	45.2	26.3	687.75	680.27	680.06	-0.21
6028	P-6028	Exit South Study Area: East	46th Avenue/Harding Road	28.1	30.0	1.9	684.81	670.90	671.2	0.30
6057	P-6057	Downstream end of upsizing	44th Avenue/65th St.	63.5	82.8	19.3	655.10	651.58	654.27	2.69
5491	P-5491.1	Exit from Forest Park School	47th Ave./69th St.	53.5	57.9	4.4	664.98	666.72	667.11	0.39
5489	P-5489.1	Downstream end of upsizing	47th Avenue/70th Street	53.6	59.2	5.6	665.84	665.39	666.69	1.30

**TABLE 9.13-4
 ALTERNATIVE 11—OPINION OF PROBABLE COST**

Item	Capital Cost
10-Year Inlet and Inlet Lead Upgrades (FPN)	\$260,500
10-Year Mainline Storm Sewer Upgrades (FPN)	\$647,000
Downstream Bottleneck Upsizing	\$583,500
Subtotal	\$1,491,000
15% Construction Contingency	\$223,500
15% Engineering Contingency	\$223,500
Soil Borings	\$5,000
Grand Total	\$1,943,000

**TABLE 9.13-5
 ALTERNATIVE 11—ADVANTAGES/DISADVANTAGES**

Advantages	Disadvantages
<ul style="list-style-type: none"> Provides a 10-year storm event level of protection in the Forest Park South area. 	<ul style="list-style-type: none"> Increased flows and HGLs at downstream end of bottleneck upsizing.

9.14 ALTERNATIVE ANALYSIS (ALTERNATIVES 8 THROUGH 11)

Tables 9.14-1 and 9.14-2 summarize the alternatives discussed in Sections 9.10 through 9.13. Alternative 9 for the Forest Park North area and Alternative 11 for the Forest Park South area meet the Alternative Analysis Design Criteria Goals (10- and 25-Year) listed in Section 9.01 C. Alternatives 8 and 10 do not meet these goals.

To assist the City in selecting a preferred alternative, Tables 9.14-1 and 9.14-2 also have selection criteria that will help in arriving at a preferred alternative. Selection criteria include the following.

1. Local Criteria
 - a. Amount of storage volume (ac-ft) provided by the Alternative.
 - b. Meeting of Forest Park Area 10-Year Goal described in Section 9.01.
 - c. Meeting of Forest Park Area 25-Year Goal described in Section 9.01.
 - d. Number of Low Entry Points Flooding During 10-, 25-, and 100-year storm events.
 - e. Number of Low Entry Points with 1.0 foot or greater freeboard during the 10-, 25-, and 100-year storm events.
2. Watershed-Based Criteria
 - a. Forest Park North-Hydraulic grade line (HGL) decrease at various points shown in Table 9.14-1.
 - b. Forest Park South-HGL decrease at various points shown in Table 9.14-2.
 - c. Flow increase at downstream end of bottleneck upsizing as shown in Tables 9.14-1 and 9.14-2.

After discussion with the City regarding these alternatives, we will recommend a cost-effective alternative that best meets the City's goals for the project after considering the selection criteria, and other City goals and objectives.

Table 9.14-1 shows that Alternative 8 will increase flows and HGLs at the downstream terminus of the bottleneck upsizing. It also shows that there will be improvement in the flooding conditions in the Forest Park North Area. However, the increase in flows and HGLs at the downstream terminus of the bottleneck upsizing may have the effect of shifting flooding issues from the Forest Park North Area to downstream areas.

Table 9.14-1 shows that Alternative 9 will increase flows and HGLs at the downstream terminus of the bottleneck upsizing. It also shows that there will be significant improvement in the flooding conditions in the Forest Park North Area. In effect, Alternative 9 provides a 10-year storm event level of protection for the Forest Park North Area. However, the increase in flows and HGLs at the downstream terminus of the bottleneck upsizing may have the effect of shifting flooding issues from the Forest Park North Area to downstream areas.

Table 9.14-2 shows that Alternative 10 will increase flows and HGLs at the downstream terminus of the bottleneck upsizing. At and downstream of the 47th Ave/70th St intersection, Table 9.14-2 shows

decreases in flows at this location (Pipe P-5491.1). This is deceiving in that the bottlenecks downstream of this location are creating flooding that in effect stagnate the ability for storm sewers in this area to pass more flow. Alternative 10 contributes to the severity of flooding in this area because of the higher HGL created in the vicinity of Node 5489 (47th Ave/70th Street Intersection). It also shows that there will be improvement in the flooding conditions in the Forest Park South Area. However, the increase in flows and HGLs at the downstream terminus of the bottleneck upsizing may have the effect of shifting flooding issues from the Forest Park South Area to downstream areas.

Table 9.14-2 shows that Alternative 11 will increase flows and HGLs at the downstream terminus of the bottleneck upsizing. At and downstream of the 47th Ave/70th St intersection, Table 9.14-2 shows decreases in flows at this location (Pipe P-5491.1). This is deceiving in that the bottlenecks downstream of this location are creating flooding that in effect stagnate the ability for storm sewers in this area to pass more flow. Alternative 11 contributes to the severity of flooding in this area because of the higher HGL created in the vicinity of Node 5489 (47th Ave/70th St Intersection). It also shows that there will be improvement in the flooding conditions in the Forest Park South Area. In effect, Alternative 11 provides a 10-year storm event level of protection for the Forest Park South Area. However, the increase in flows and HGLs at the downstream terminus of the bottleneck upsizing may have the effect of shifting flooding issues from the Forest Park South Area to downstream areas.

In the case of Alternatives 8 through 11, modeling shows that bottleneck upsizing will have the effect of increasing downstream peak flows and HGLs. While these alternatives improve flooding conditions in the Forest Park Area, they may have the effect of shifting flooding issues from the Forest Park Area to downstream areas. Typical stormwater management planning protocol would dictate that downstream pipe upsizing be coupled with upstream detention to minimize downstream flow increases. Therefore, we recommend that the increased flow be offset by addition of detention upstream of the bottlenecks (similar to Alternatives 3 and 6) or by further study of potential downstream impacts.

Consideration should be given to the impact of the 100-year storm in the Forest Park North and South Areas. While each of the alternatives meet the 10-year and 25-year design criteria goals, the 100-year storm still causes flooding that appears to be at a level that will enter homes with the alternative in place. If a home has the potential to be flooded, we would recommend expanding improvements provided within a particular alternative to bring the 100-year flood elevation to an acceptable level. Alternatively, the City could consider buying flood impacted properties and removing them from the urban floodplain.

Being a planning-level study that has both data and model limitations, modeled elevations should not be taken as exact but rather as a representation of anticipated flooding depths and extents. This underlies the importance of maintenance of freeboard to home low entry points. We therefore suggest that the City consider maintaining a minimum of 1-foot of freeboard between the modeled high water elevation during the 100-year storm event and the home low entry points.

As can be seen in the flood extent maps for the various alternatives, each of the alternatives will still have flooding outside of City right-of-way that will cause nuisance flooding on resident's properties. The City should make a determination on the community-acceptability of this flooding.

**TABLE 9.14-1
 ALTERNATIVES ANALYZED (ALTERNATIVES 8 AND 9)**

Alt.	Strand Alt. Designation	Alternative Description	Alternative Selection Criteria											Opinion of Probable Construction Cost
			Additional Storage Provided (ac-ft)	Number of Low Entry Points With Greater Than 1.0 feet of Freeboard for 10, 25, and 100-year storm events out of 34 Analysis Points	Number of Low Entry Points With Flooding During 10, 25, and 100-year storm events out of 34 Analysis Points	Forest Park North (Node 11553): 10-Year HGL Decrease at 52nd Ave./ 60th St. (ft)	Forest Park North (Node 10232): 10-Year HGL Decrease at Pershing Blvd./ 60th St. (ft)	Forest Park North (Node 6128): 10-Year HGL Decrease at 39th Ave./ 60th St. (ft)	Forest Park North (Node 12373): 10-Year HGL Decrease at 39th Ave./ 59th St. (ft)	Flow Increase at 39th Ave./59th St (P-9745) for 10, 25, and 100 year storm events	Flow Increase at 39th Ave./60th St (P-10221) for 10, 25, and 100 year storm events	10-Year Goal Met	25-Year Goal Met	
Forest Park North Alternatives														
8	8	Existing Inlets and Leads combined with Upsizing of Existing Bottleneck Storm Sewers along Pershing Boulevard, 42nd Avenue, 59th Street, and 60th Street (stopping at 39th Avenue)	N/A	12/8/0	3/3/6	0.01	-2.56	2.23	-0.10	-7/0/7	85/89/86	No	No	\$992,800
9	9	Upsized Inlets and Inlet Leads (see Figure 7.02-10), Upsized Forest Park North Mainline (as necessary), and Upsized Existing Bottleneck Storm Sewers as defined in Alternative 8 seeking to pass the 10-year storm event	N/A	28/19/6	1*/2/4	0.21	-7.10	3.69	-0.23	1/9/15	100/101/110	Yes	Yes	\$2,785,000

*Further investigation is needed at 6116 49th Avenue that shows a window elevation of 678.49 and an adjacent ground elevation of 679.20. If the ground elevation is used as the low entry point, then the low entry point would not flood during the 10-year storm event and this table entry would go to 0.

**TABLE 9.14-2
 ALTERNATIVES ANALYZED (ALTERNATIVES 10 AND 11)**

Alt.	Strand Alt. Designation	Alternative Description	Alternative Selection Criteria											Opinion of Probable Construction Cost
			Additional Storage Provided (ac-ft)	Number of Low Entry Points With Greater Than 1.0 feet of Freeboard for 10, 25, and 100-year storm events out of 37 Analysis Points	Number of Low Entry Points With Flooding During 10, 25, and 100-year storm events out of 37 Analysis Points	Forest Park South (Node 5698): 10-Year HGL Decrease at 47th Ave./ 70th St. (ft)	Forest Park South (Node 5489): 10-Year HGL Decrease at 50th Ave./ 67th St. (ft)	Forest Park South (Node 6028): 46th Ave./ Harding Road	Forest Park South (Node 6057): 44th Ave./ 65th St.	Flow Increase at 44th Ave./65th St (P-6054) for 10, 25, and 100 year storm events	Flow Increase at 47th Ave./70th St (P-5491.1) for 10, 25, and 100 year storm events	10-Year Goal Met	25-Year Goal Met	
Forest Park South Alternatives														
10	10	Existing Inlets and Leads combined with Upsizing of Existing Bottleneck Storm Sewers along 49th Avenue, 67th Street, 67th Place, 47th Avenue (stopping at 70th Street) and Taft Road (upstream of Pershing Blvd)	N/A	22/10/1	1/4/7	0.31	0.21	-0.06	2.28	17/17/20	-2/0/5	No	No	\$370,000
11	11	Upsized Inlets and Inlet Leads (see Figure 7.02-10), Upsized Forest Park South Mainline (as necessary), and Upsized Existing Bottleneck Storm Sewers as defined in Alternative 10 seeking to pass the 10-year storm event	N/A	30/25/3	0/0/5	-0.21	1.30	0.30	2.69	19/21/25	4/-16/-4	Yes	Yes	\$1,943,000

9.15 ALTERNATIVE 12–RELIEF SEWER: 46TH AVENUE TO PERSHING WITH 61ST STREET DISCONNECTION

Toward the end of this project, the City requested an assessment of the impact of disconnecting the storm sewer along 61st Street from the low point on 46th Avenue between 60th Street and 61st Street and replacing it with a storm sewer connecting along Pershing Boulevard. Under existing conditions, the hydraulic grade line at the low point on 46th Avenue is higher than the ground elevation causing the storm sewer system to surcharge. Much of this surcharging appears to be caused by the 61st Street storm sewer mainline “backcharging” the low point on 46th Avenue. This causes more stormwater to get to the low point creating the potential for more surface flooding. Connecting the storm sewer into the mainline at Pershing Boulevard, where the hydraulic grade line is lower than the low point elevation on 46th Avenue, allows the stormwater to drain more efficiently than if connected at 61st Street. Alternative 12 analyzes this connection location and Figure 9.15-1 shows the concept.

The overall local effect of Alternative 12 for the 10-, 25-, and 100-year storm events are included in Tables 9.15-1 and 9.15-2. As this table shows, implementation of this alternative would direct more flow east to Pershing Boulevard from the 46th Avenue low point. While this relieves flooding at the 46th Avenue low point, the hydraulic grade line and flow rate are increased at the new connection to the storm sewer system at Pershing Boulevard (Node 8053 increases by 0.24 feet in the 100-year storm and Pipe P-8053 flow is increased by 3.84 cfs in the 100-year storm). However, model results show that the effect of this increase appears to be negligible at the Pershing Boulevard/60th Street intersection. The City should confirm that the HGL increase in the vicinity of Node 8053 will not affect nearby buildings. Figure 9.15-2 shows the flood extent map with this alternative in place for the 10-, 25-, and 100-year storm events. This figure has flow vectors turned on to show how surface flows navigate from the 61st Street/46th Avenue intersection to the 46th Avenue lowpoint. It also shows how surface flows navigate northeasterly from 46th Avenue and 61st Street to Pershing Boulevard. Table 9.15-3 includes the opinion of probable construction cost for this alternative.

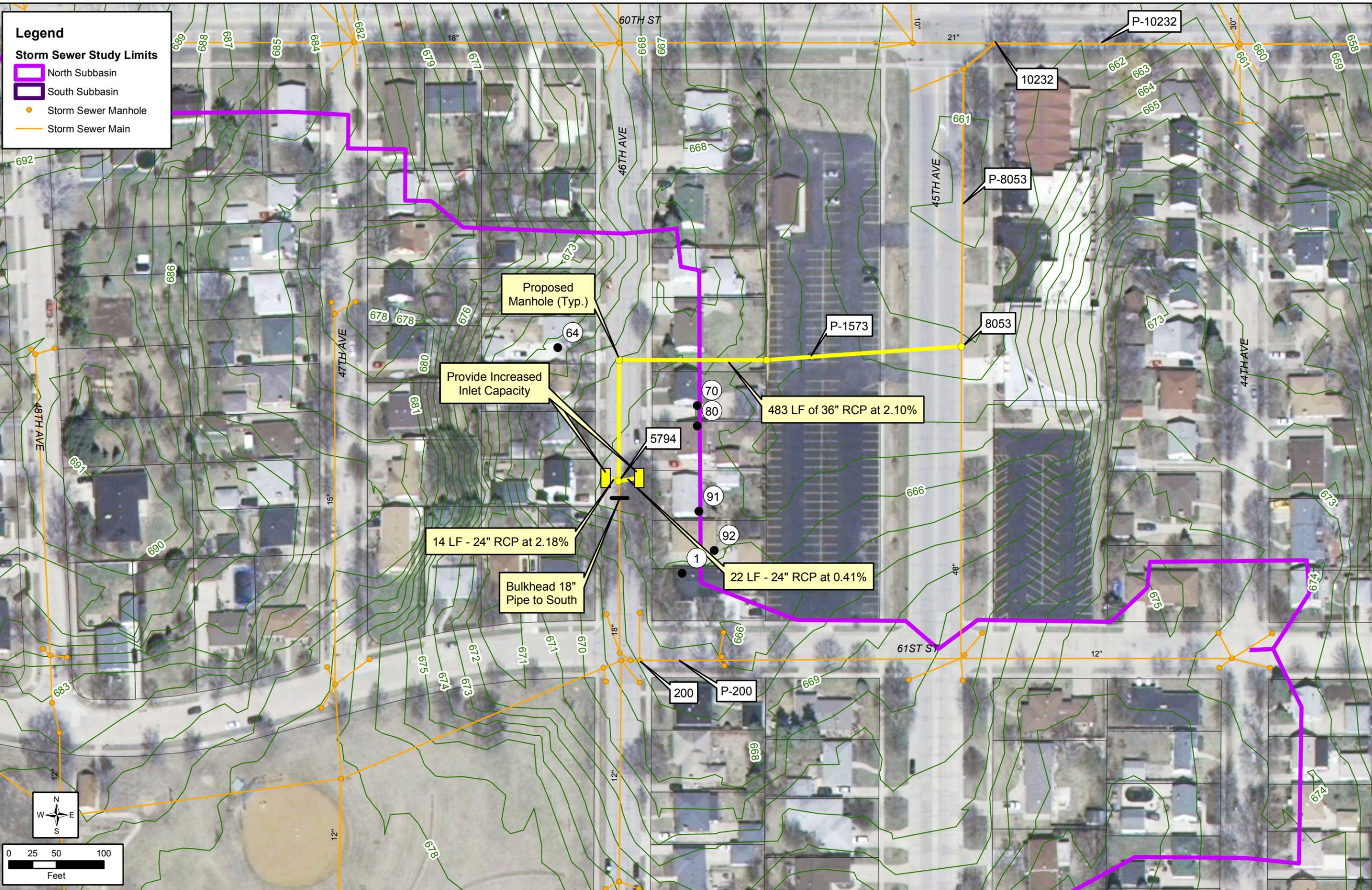
The proposed storm sewer from 46th Avenue to Pershing Boulevard was designed to reduce flooding at the low point of 46th Avenue during a 10-year design storm. Along with this storm sewer, additional inlets would be needed at the 46th Avenue low point as well as upsized storm sewers connecting the additional inlets to the proposed 46th Avenue mainline to Pershing Boulevard.

It appears that although the flooding along Pershing Boulevard would slightly increase, the benefit of decreased surface flooding at the low point on 46th Avenue would outweigh the downstream increases. It thus appears that this alternative is feasible in reducing flooding depths during the 10-year design storm at the 46th Avenue low point.

Legend

Storm Sewer Study Limits

- North Subbasin
- South Subbasin
- Storm Sewer Manhole
- Storm Sewer Main

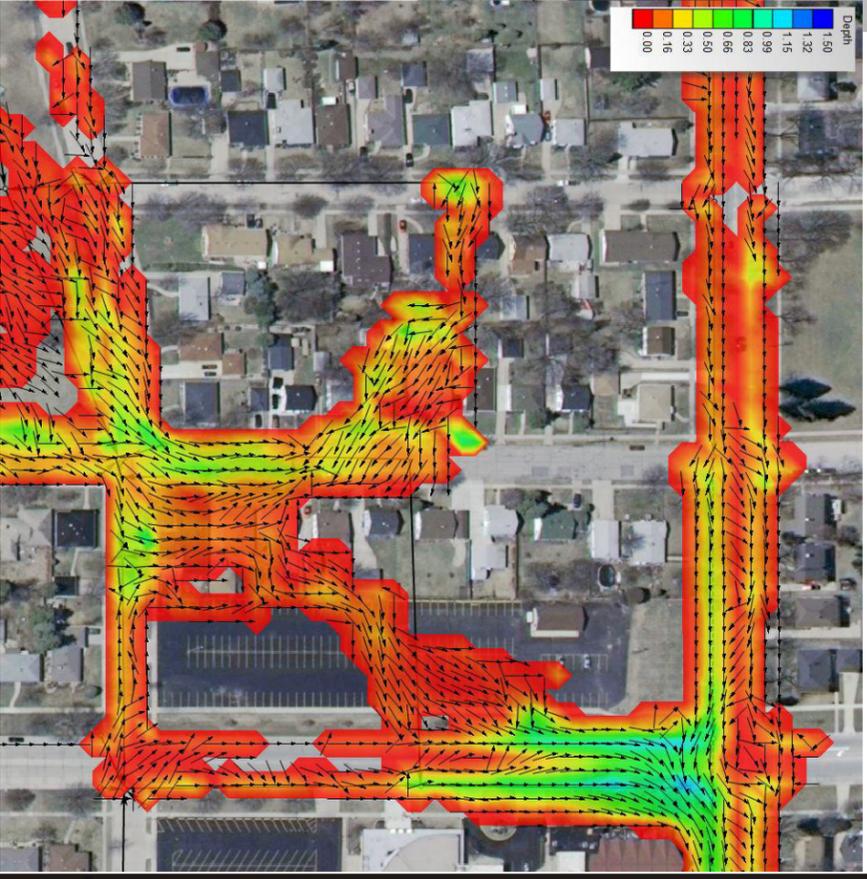
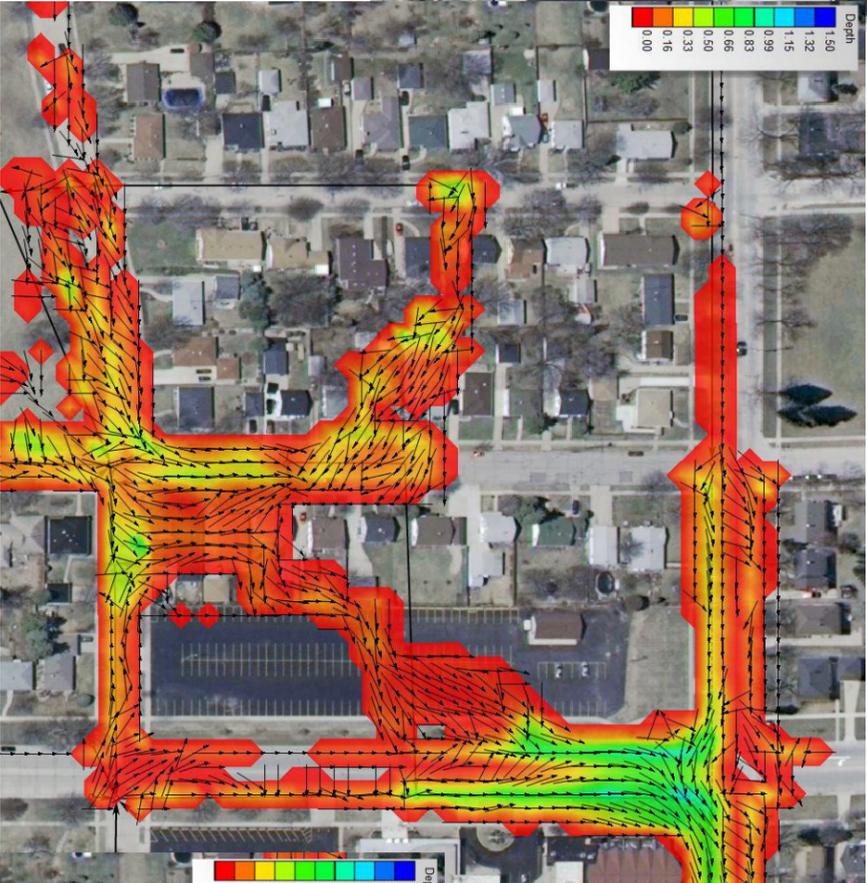
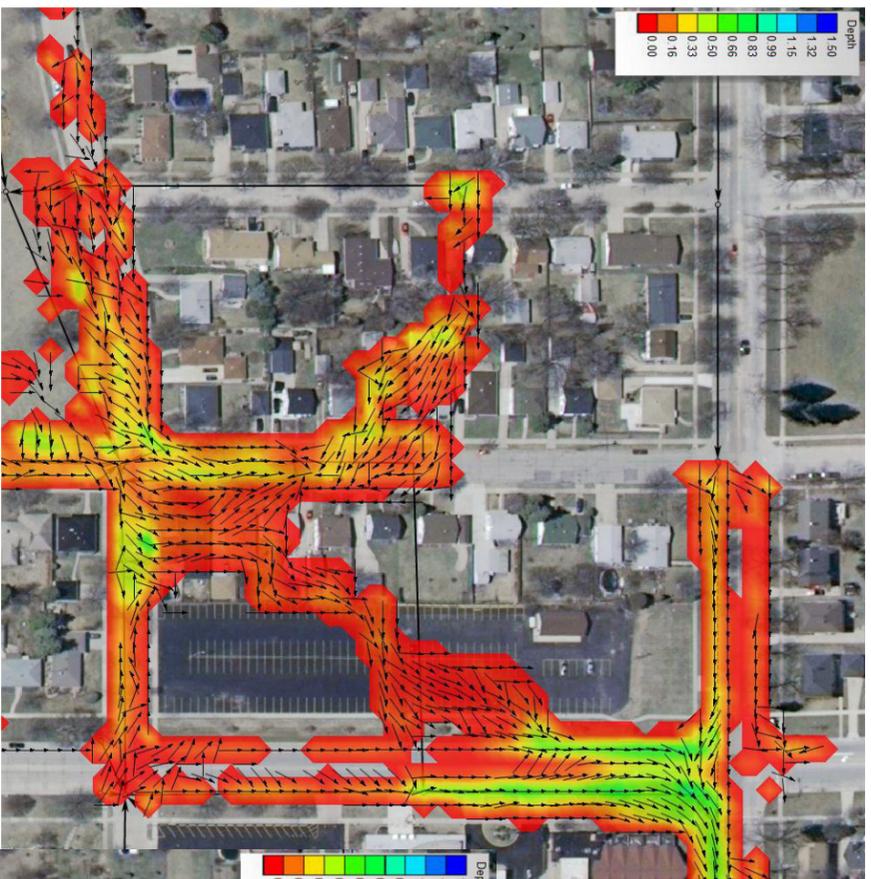


ALTERNATIVE 12
(FOREST PARK NORTH)

FOREST PARK AREA STORM AND SANITARY SEWER MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN



FIGURE 9.15-1
1540.001



**ALTERNATIVE 12 – FLOOD EXTENT MAPS
(FOREST PARK NORTH)**

**FOREST PARK AREA STORM AND SANITARY SEWER MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN**

**TABLE 9.15-1
 ALTERNATIVE 12–LINK AND NODE RESULTS**

XPSWMM Node/Link	Rim Elevation	Ex 10-Yr HWEL/Flow	Alt 12 10-Yr HWEL/Flow	Ex 25-Yr HWEL/Flow	Alt 12 25-Yr HWEL/Flow	Ex 100-Yr HWEL/Flow	Alt 12 100-Yr HWEL/Flow
5794	664.7	665.76	664.79	665.84	664.79	665.93	664.95
1573	----	----	34.29	----	36.38	----	37.38
200	666.73	666.95	666.97	666.98	667.01	667.04	667.05
P-200	----	84.95	86.39	88.50	85.87	101.10	97.38
8053	661.57	661.93	662.18	661.99	662.23	662.02	662.26
P-8053	----	86.58	90.17	90.28	91.46	101.03	104.87
10232	660.29	660.83	660.88	661.00	661.00	661.16	661.08
P-10232	----	100.72	101.31	103.15	103.77	108.47	108.04

**TABLE 9.15-2
 ALTERNATIVE 12–FLOODING ANALYSIS POINTS RESULTS**

Point	City Surveyed Elevation	City Comment	Street Name	House Number	Ex. 10-Yr HWEL	Alt 12 10-yr HWEL	Ex. 25-Yr HWEL	Alt 12 25-Yr HWEL	Ex. 100-Yr HWEL	Alt 12 100-Yr HWEL
1	666.77	wind	61st Street	4520	666.13	666.13	666.15	666.15	666.17	666.15
64	669.6	door	46th Avenue	6028	670.26	669.83	670.18	669.84	670.22	669.86
70	666.01	wind	46th Avenue	6035	665.78	----	665.82	----	665.94	----
80	666.01	wind	46th Avenue	6039	665.44	----	665.48	----	665.56	----
91	665.99	well	46th Avenue	6049	665.68	665.46	665.74	665.46	665.83	665.49
92	665.49	wind	46th Avenue	6051	665.94	665.94	665.95	665.95	665.98	665.97

**TABLE 9.15-3
 ALTERNATIVE 12–OPINION OF PROBABLE COST**

Item	Capital Cost
10-Year Inlet and Inlet Lead Upgrades (FPN)	\$32,100
10-Year Mainline Storm Sewer Upgrades (FPN)	\$114,400
Subtotal	\$146,500
15% Construction Contingency	\$22,000
15% Engineering Contingency	\$22,000
Soil Borings	\$2,500
Drainage Easements (3)	<u>\$6,000</u>
Grand Total	\$199,000