City of Omaha Master Plan

Papillion Creek Watershed

Public Works Department

Planning Department

Sanitary Interceptor Sewer Element

Omaha Nebraska
2015

Adopted By
City Council
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CITY OF OMAHA MASTER PLAN

PAPILLION CREEK WATERSHED

SANITARY INTERCEPTOR SEWER ELEMENT

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ES.1 PURPOSE

The purpose of this document, developed by Carollo Engineers for the City of Omaha, is to update the Sanitary Interceptor Sewer Element (SISE) of the City of Omaha Master Plan. The SISE is now referred to as the Papillion Creek Sanitary Interceptor Master Plan, or the PCSIMP. The PCSIMP is required to:

1. Analyze the capacity of the sanitary sewer trunk system tributary to the Papillion Creek Wastewater Treatment Plant (PCWWTP) in both Douglas and Sarpy Counties;
2. Determine the impacts of projected growth of the service area on the capacity of the interceptor system;
3. Develop a near term and long range capital improvement program (CIP) that provides for adequate expansion of the system within Omaha's current and future zoning jurisdication, to serve both existing and future customers;
4. Establish new user fees for connecting to the sanitary system. These fees will be used to fund the projects identified in the CIP. The fees are paid into a dedicated fund referred to as the Interceptor Sewer Fund.

The process to determine the CIP schedule includes an evaluation of the City's Present Development Zone (PDZ). As a result, the agreed upon modifications to the PDZ are communicated as a part of this PCSIMP. In addition, this PCSIMP provides design parameters for sanitary sewers that are used by the City of Omaha Public Works Department and outside consultants to adequately size the proposed sewer extensions listed in the CIP.

ES.2 INTRODUCTION

The City of Omaha Public Works Department (PWD) owns and operates a wastewater collection and treatment system that serves Omaha and surrounding communities in the metro area. The system of over 12 million[1] linear feet collects wastewater through both separate as well as combined sewers that convey both sanitary flow as well as storm water to two major waste water treatment plants: the Missouri River Wastewater Treatment Plant (MRWWTP), and the PCWWTP A third smaller wastewater treatment plant, the Elkhorn Wastewater Treatment Plant serves a small area of Western Douglas County.

[1] Counts Sanitary Improvement Districts owned interceptors in Douglas and Sarpy Counties, no satellites.

The PCSIMP focuses on the service area of the PCWWTP. This area totals almost 300 square miles and corresponds primarily to the Papillion Creek watershed within Douglas and Sarpy County. This area includes the majority of sanitary sewers within Omaha's wastewater service area. A small area consisting of approximately 9 square miles, is combined sewers in the eastern portion of the area. Figure ES.1 illustrates the existing service area of the PCWWTP and the study area for this Master Plan. Existing system capacity evaluations were based on a hydraulic model of about 1 million linear feet of the City's interceptor sewers and primary trunk lines as shown in Figure ES.1. Pipe diameters ranging from as small as 10-inches along the Elkhorn Plant Interceptor to the 114-inch by 108-inch rectangular interceptor at the headworks of the PCWWTP are included in the model.

For the purpose of this planning document, and ultimately to define the use of the Interceptor Sewer Fund, the City of Omaha defines an interceptor sewer as follows:

"An interceptor sewer serves an area greater than 1,000 acres or more than 10,000 people; or has two or more upstream S&ID outfall connections".

The projects and costs presented in the CIP, the associated fees, and the financial plan presented in this PCSIMP are based on the expansion of the interceptor system utilizing this definition. The costs presented in the CIP do not represent the full cost of service for wastewater collection and treatment. Costs such as life cycle replacement costs associated with the interceptor system, which is nearing 50 years in age in many locations, are not included with the capacity improvement projects included in the CIP.

ES.3 PREVIOUS MASTER PLAN STUDY

This study builds on the previous SISE study completed for the City by HDR, which was adopted by the City on May 19, 2009. In the SISE 2009 study, the costs associated with the interceptor capacity improvements to accommodate growth were highly conservative, and that report noted that additional data was necessary to provide more accurate costs. The CIP costs developed in the SISE evaluation totaled $449 million through 2050; of which, $329 million were needed for capacity improvements, while $120 million were needed for sewer extensions to service growth.

The SISE recommended the installation of a permanent flow metering system to better quantify both the dry and wet weather flows in the system, and the development of a more comprehensive collection system model. The City acted on these recommendations. In 2010, the City of Omaha completed the installation of a permanent flow and rain monitoring system, and significant additional details were added to the collection system computer model. This new data and model were used and enhanced in this study to provide results that more accurately represent the current hydraulics of the system. This provides for a much higher level of confidence in the projections of future needs.

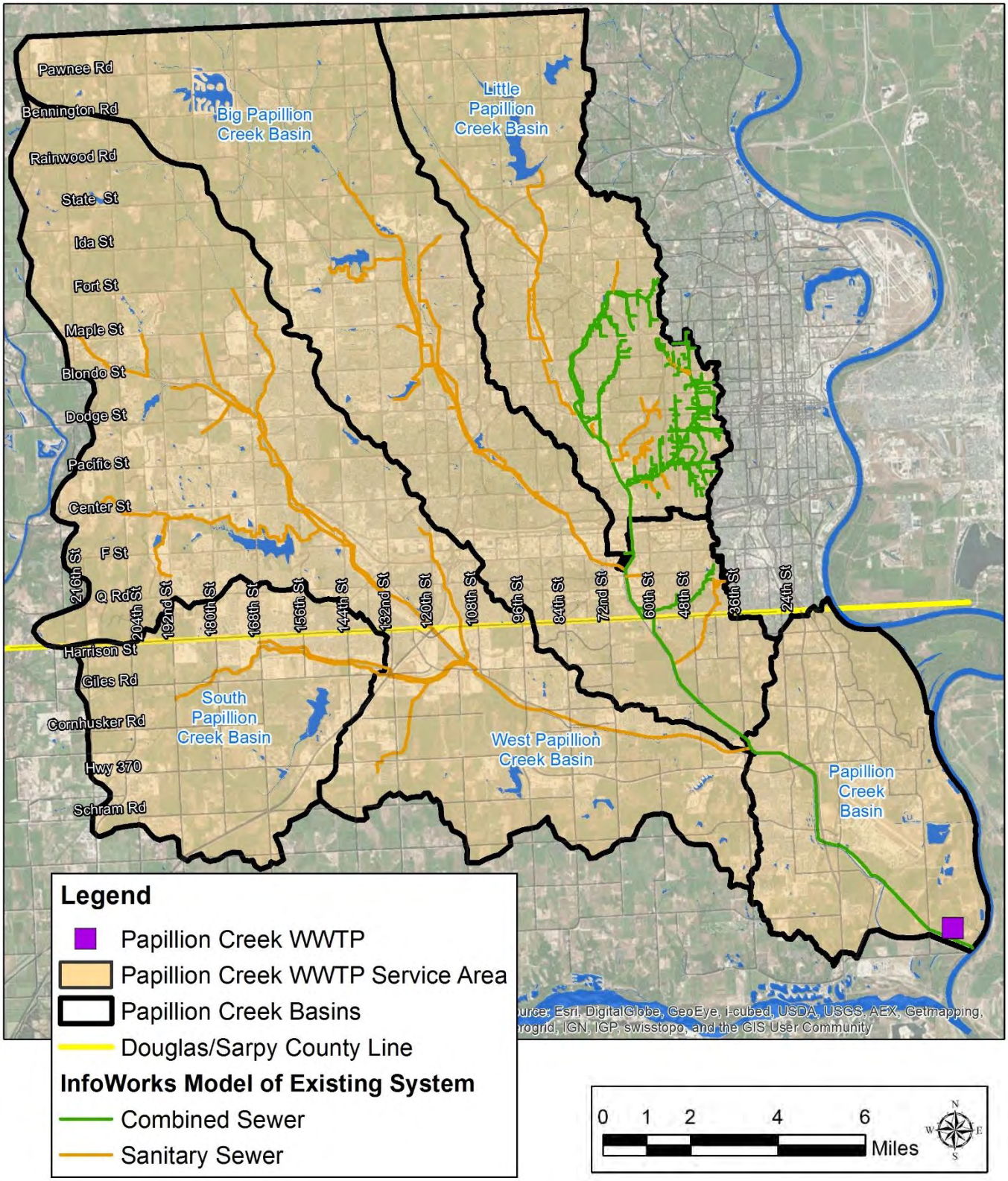

Figure ES.1 – Existing PCWWTP Service Area
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

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ES.4 POPULATION AND LAND USE

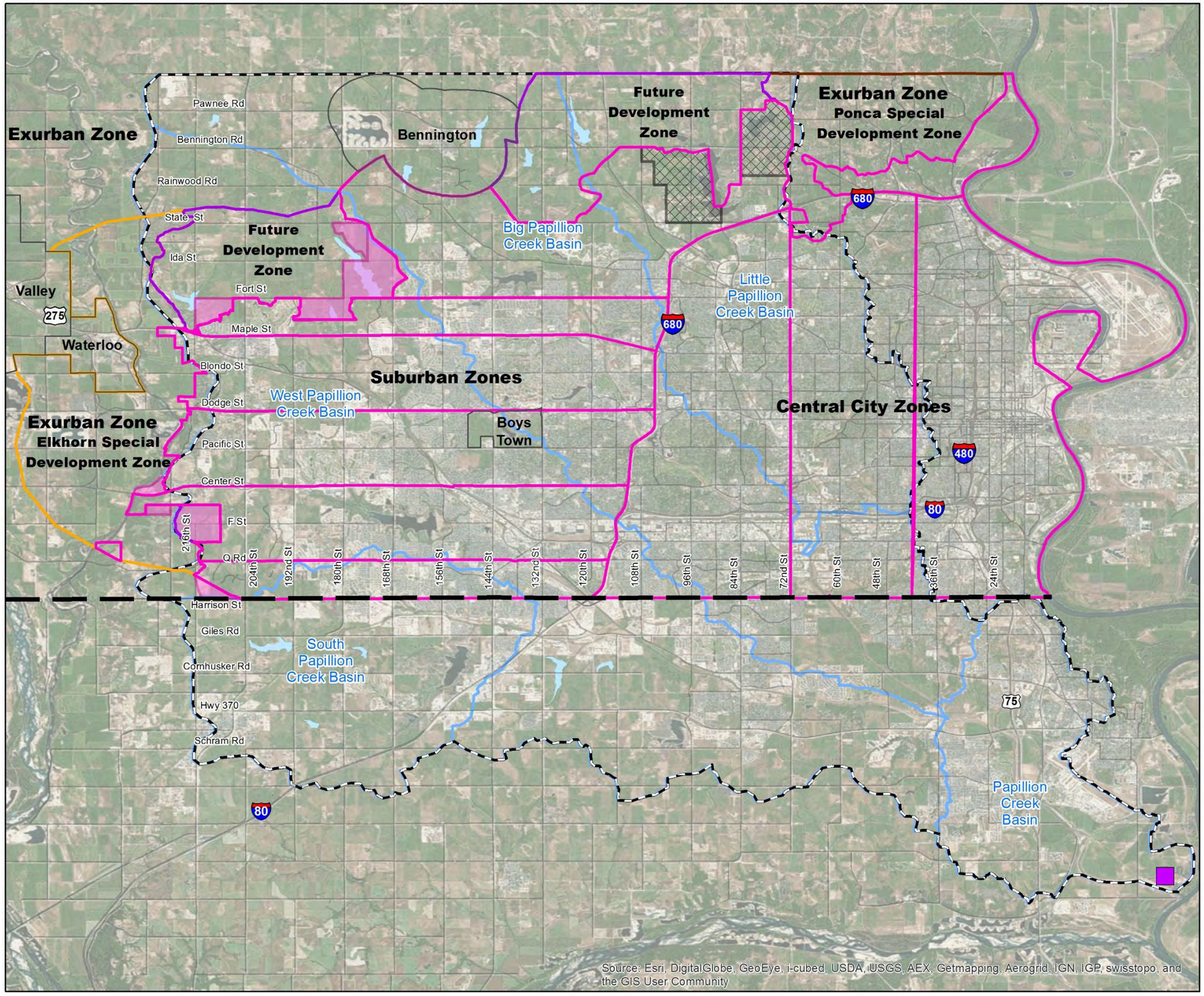
The SISE (2009) included population and land use data from the Bureau of Business Research (BBR) at the University of Nebraska, Lincoln. This PCSIMP includes the use of population and land use projections provided by the Metropolitan Area Planning Agency (MAPA). The MAPA population and land use information was also used for the City of Omaha Transportation Master Plan Study.

The City and Carollo worked closely throughout this study with MAPA to verify that the information provided accurately represented the future projected population and land use. Input from the City Planning Department was provided early in the process to validate the data. The population and land use data was then used to develop an estimate of both the existing and future sanitary sewer flows.

Stakeholder meetings with representatives from the development community were conducted during the planning process. The stakeholders provided input into the development of the PDZ. In addition, engineering consultants representing the interests of the development community were allowed to review, comment, and provide validation of the estimated sewer extension costs used in the CIP. The requested PDZ expansion in the northwest part of the Papillion Creek watershed required additional study by the City due to existing and projected capacity constraints on the roadway network. The City worked with MAPA and an outside consultant on roadway modeling to evaluate various development scenarios and the anticipated impacts on the roadway network. The outcome of this modeling effort showed the need to adjust the Arterial Street Improvement Program (ASIP) fee in order to fund roadway improvements necessary to serve the new areas of development within the time frame requested by the development community. Figure ES.2 is a map of the final approved PDZ.

The PDZ boundary amendment adds approximately 4.33 square miles to, and removes approximately 3.97 square miles from the current Present Development Zone for a net gain of about 0.36 square miles. There are approximately 3.74 square miles of new land available for development, after excluding the area in and around Dam Site 15A. About 2.2 square miles of this land is in the northwest along Fort Street near 168th, 180th, and 208th Streets, while the remaining 1.5 square miles are in southwest Douglas County.

The baseline and future population projections are summarized in Table ES.1 and the baseline and 2050 land use is summarized in Table ES.2. The population projections are also illustrated in Figure ES.3 along with the total estimates from the SISE (2009) for comparison, while the baseline and build out land use are illustrated in Figure ES.4. These statistics show that the population is estimated to increase by 237,746 people (45 percent) from the baseline year to 2050. These changes will significantly increase the base sanitary flow within the service area. The additional sanitary flow will require capacity improvements to the existing infrastructure, along with sewer extensions to provide for the desired growth in the outer boundaries of the service area.



Legend

Existing PDZ Sectors

- Ponca Exurban
- Elkhorn Exurban
- Future Development Zones
- Present Development Zone

Proposed Changes in PDZ

- Add to PDZ
- Remove from PDZ
- Papillion Creek WWTP
- Papillion Creek WWTP Service Area
- Papillion Creek Basins
- Douglas/Sarpy County Line
- ETJ Boundaries
- Proposed NRD Reservoirs

0 1.75 3.5 7 Miles

N W E S

Figure ES.2 – Proposed Changes in Present Development Zone
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

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Table ES.1 Baseline and Future Population Estimates by County in Service Area
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

County in Service Area	Baseline Population(1)	2020 Population(2)	2030 Population(2)	2040 Population(2)	2050 Population(2)
Douglas (3)	373,887	412,079	449,462	480,773	510,991
Sarpy (3)	139,864	168,817	196,624	218,964	234,505
Total in Service Area	**513,751**	**580,897**	**646,086**	**699,737**	**745,497**
Percentage Increase from Baseline Year	**---**	**13%**	**26%**	**36%**	**45%**

Notes:
(1) As calculated using 2010 census data.
(2) As calculated using the MAPA population projections.
(3) Minor amount of population in County may be outside of service area.

Table ES.2 Land Use Area by County in Service Area
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

County	Gross(1) Area (ac)	SF Area (ac)	MF Area (ac)	COM Area (ac)	IND Area (ac)	Other(1,2) Area (ac)
Baseline						
Douglas	108,538	31,087	3,145	6,011	1,692	66,602
Sarpy	53,334	10,622	1,512	1,867	837	38,497
Totals	**161,872**	**41,709**	**4,657**	**7,878**	**2,529**	**105,099**
Percent Land use Category of Total	**---**	**25%**	**3%**	**5%**	**2%**	**65%**
Year 2050						
Douglas	108,538	41,456	3,930	10,075	3,651	49,425
Sarpy	53,334	17,910	2,009	6,207	3,654	23,553
Totals	**161,872**	**59,367**	**5,939**	**16,282**	**7,305**	**72,978**
Percent Land use Category of Total	**---**	**36%**	**4%**	**10%**	**5%**	**45%**

Notes:
(1) Does not include highway/road corridors. Total sewershed area = 187,133 acres.
(2) Other includes areas not contributing sanitary flow (e.g. agriculture, open space, etc.).

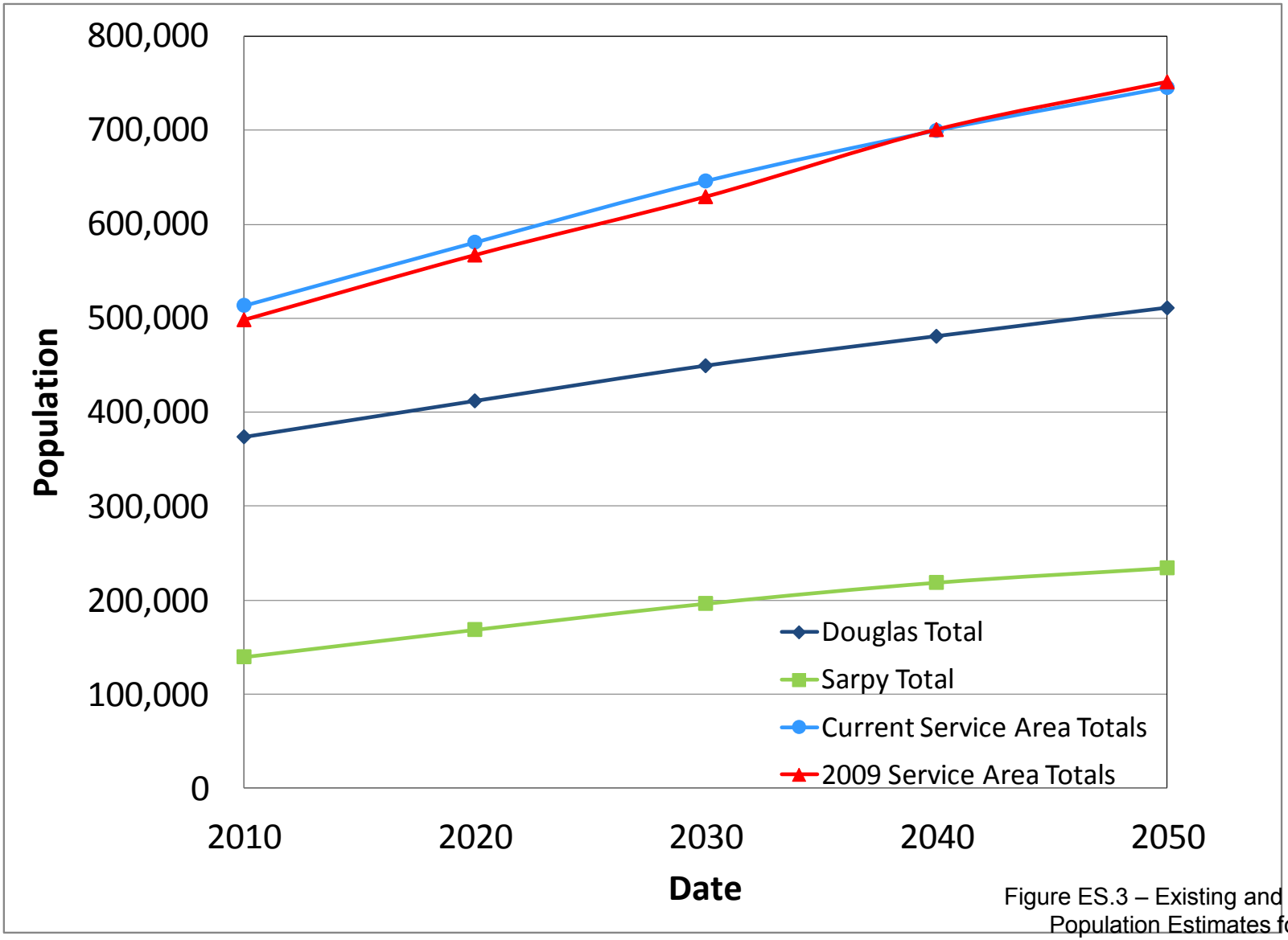

Figure ES.3 – Existing and Projected Population Estimates for the PCWWTP Service Area

Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

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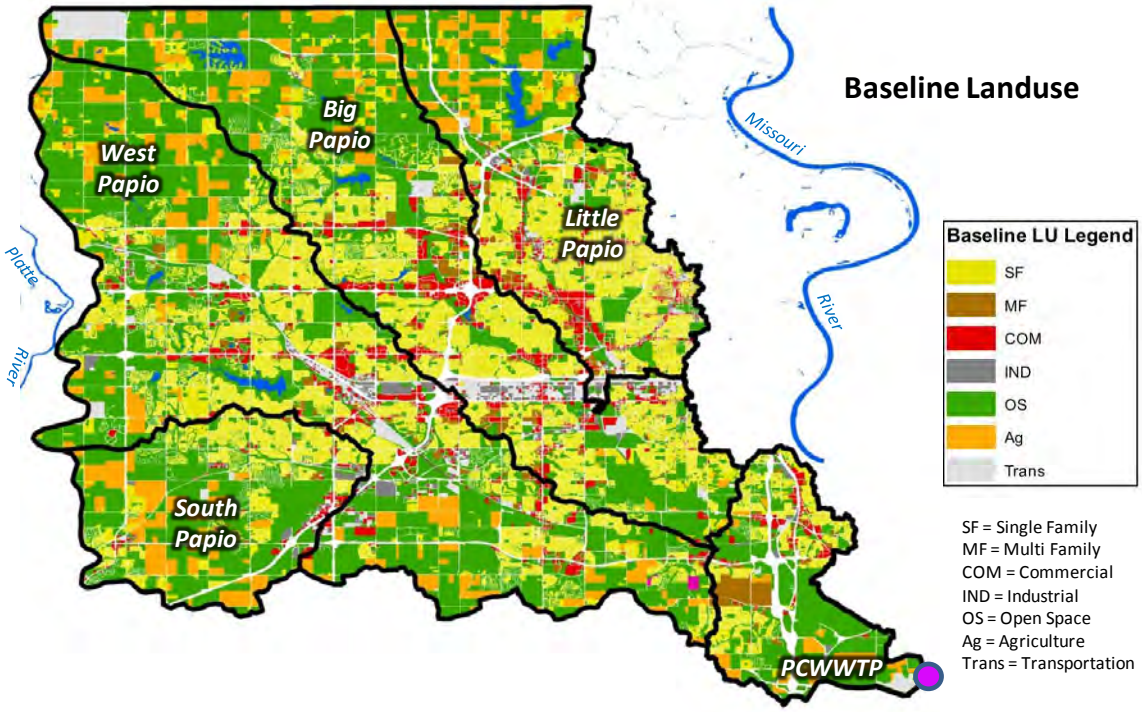

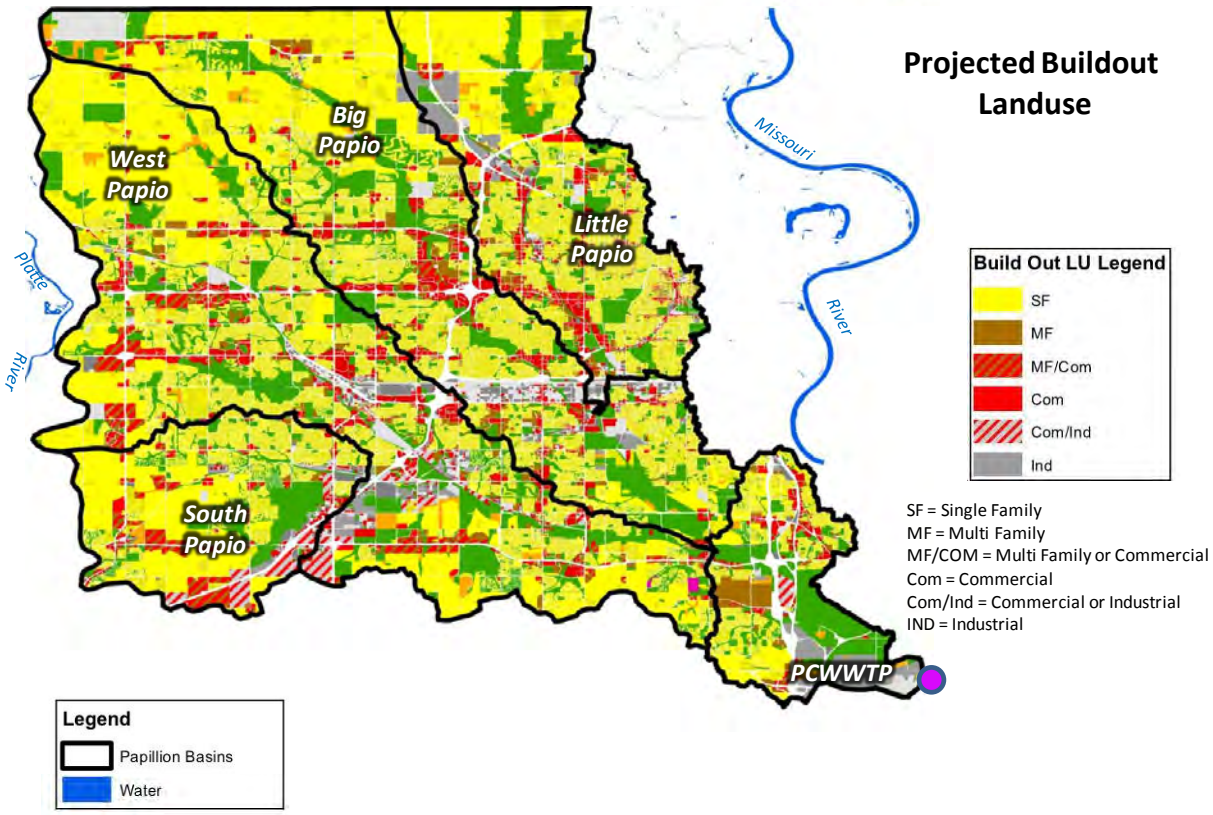

Figure ES.4 – Baseline and Buildout Landuse Estimates

Papillion Creek Sanitary Interceptor Master Plan

City of Omaha, NE

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ES.5 INTERCEPTOR MODEL UPDATE AND CALIBRATION

Base sanitary flows were estimated throughout the system using the population and land use projections. Flow metering data from the permanent meters along the interceptor was also utilized. The estimated sanitary flows were compared to measured flows at each permanent metering site. The model was calibrated to accurately represent the sanitary flows generated by the population and land use. The detailed data and analysis techniques provided very reliable estimates on a per unit basis. These per unit estimates were then used to project sanitary flow in the future based on increases in population and land use.

Table ES.3 summarizes the results from the analysis for unit flow factors in gallons per capita per day (gpcd) for multi-family and single family residential and in gallons per acre per day (gpad) for industrial and commercial. These factors along with inflow and Infiltration rates calculated for each sewer basin sub-catchment were used in the hydraulic model to develop the CIP plan. The values presented in this table are for high level planning and modeling purposes, and are not intended for specific sanitary sewer design.

Table ES.3 Calibrated Base Sanitary Flow (BSF) Factors
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

Land Use Category	Unit	Value
Single Family Residential (SF)	gpcd	59
Multi Family Residential (MF)	gpcd	59
Commercial (COM)	gpad	855
Industrial (IND)	gpad	91

Table ES.4 summarizes the existing and projected base sanitary flows by basin. These base sanitary flows do not include infiltration that can be present during dry weather conditions due to groundwater. The total existing base sanitary flow for the PCWWTP service area is estimated at 37.7 mgd. The metro area experienced a prolonged dry period, resulting in low average flows at the PCWWTP. It is assumed that this extended dry spell reduced the amount of dry weather infiltration into the sanitary collection system. The 2014 1st Quarter average dry weather flow at the PCWWTP was approximately 39 mgd. The measured flow at the WWTP correlated very favorably with the estimated base sanitary flow, and provided a high level of confidence in the data and analysis techniques.

The City maintains an InfoWorks CS collection system computer model. The model was first created for the Omaha CSO Program, and has been upgraded over time to include detailed information on the sanitary and combined sewer collection system, including significant upgrades to the sanitary system as recommended by the SISE (2009). Carollo coordinated with the City and consulting engineers who have worked with the model and its development as a part of the City of Omaha CSO Program Management Team to update the hydraulics of the model with the best available field and as-built information.

The base sanitary flows shown in Table ES.4 were used along with the measured DWF data to estimate dry weather infiltration, or DWI. DWI is typical throughout collection systems and result from cracks in pipes and manholes that leak groundwater into the system. This infiltration varies throughout the system based on localized shallow groundwater tables. It is important to identify this component of the sanitary flow to produce an accurate dry weather flow estimate. An analysis of the available data determined that the existing average DWI equated to approximately 11 mgd across the service area.

Table ES.4 Baseline and Future Base Sanitary Flow Estimates by Basin Papillion Creek Sanitary Interceptor Master Plan City of Omaha, NE

Basin	Baseline BSF (mgd)(1)	2020 BSF (mgd)(2)	2030 BSF (mgd) (2)	2040 BSF (mgd)(2)	2050 BSF (mgd)(2)	Percent Increase from Baseline Year
Big Papillion Creek Basin	11.80	12.99	14.13	15.13	16.30	**38%**
Little Papillion Creek Basin	8.08	8.79	9.41	9.81	10.16	**26%**
Papillion Creek Basin	3.06	3.53	3.90	4.10	4.26	**39%**
South Papillion Creek Basin	2.95	3.54	4.44	5.59	7.00	**137%**
West Papillion Creek Basin	11.84	13.98	16.46	18.92	21.30	**80%**
Totals	**37.73**	**42.83**	**48.34**	**53.56**	**59.02**	**56%**
Percentage Increase from Baseline Year	**---**	**14%**	**28%**	**42%**	**56%**	**---**

Notes:
(1) As calculated using 2010 census data and City 2013 land use.
(2) As calculated using the MAPA population projections and land use projections.

Adding this to the average base sanitary flow (37.7 mgd), the average DWF for the existing system is estimated to be 48.7 mgd. This correlates very well to recent historic measurements at the PCWWTP. It was decided by the City and Carollo that this DWI value should remain constant for future planning purposes. This results in the Average Dry Weather Flow, or ADWF, estimated at the PCWWTP for 2020, 2030, 2040, and 2050 at 53.8 mgd, 59.3 mgd, 64.6 mgd, and 70.0 mgd respectively.

The interceptor sewers convey not only DWF, but also extraneous wet weather flows (WWF) that enter the system through a variety of sources (e.g. cracked pipes, deteriorated manholes, illicit stormwater connections, etc.). This WWF caused by rainfall events, includes increased Infiltration (beyond dry weather conditions) and Inflow, or commonly referred to as inflow and infiltration (I/I). I/I must be accommodated so that rainfall events do not result in overloading of the system capacity which can cause sewage a sanitary sewer overflow, or SSO. An SSO is the term used by the EPA for instances when sanitary sewage escapes public sewer system and enters private homes and businesses, and/or flow into nearby waterways. SSOs are not permitted under the Clean Water Act and can result in impacts to public health, and could lead to penalties and fines being levied by regulatory agencies. As pipes age, they tend to experience increased I/I due to an increase in cracks and deterioration.

Wet Weather flows that include the influence of I/I were developed using data from the permanent metering system, a system of rain gauges maintained by the City and the Papio–NRD, and radar rainfall estimates. This provided a reliable database of information to complete the model calibration and an accurate estimation of flows throughout the 300 square mile service area. The model was recalibrated to accurately predict a variety of flow conditions based on measured flows, depths, and velocities.

ES.6 LEVEL OF SERVICE ASSUMPTIONS

The calibrated interceptor model was used to predict the flows and hydraulic response in the system for both current and future planning periods. Level of service (LOS) assumptions were developed by the City and Carollo to apply to the modeling effort to determine what conditions would need to be planned for in the future. LOS assumptions and criteria used to develop the capacity improvements and sewer extensions include:

- **Design Storm** - The 10-year, 24 hour design storm (SCS Type II distribution) was used to determine WWF and test the hydraulic capacity of the sewers. This storm has a 1-hour peak intensity of 1.82 inches per hour and a total of 4.28 inches of rain over the 24 hour period. The 10-year storm is commonly used to plan sanitary sewer collection system improvements.

- **Infiltration and Inflow (I/I)** – I/I was determined from the model calibration effort. The model was used to estimate saturated soil conditions and back-to-back storm events that produce design level infiltration conditions. The infiltration hydrograph developed for the 2010 calibration period was examined by the City and Carollo and it was decided that use of this hydrograph for the design storm conditions was reasonable to represent infiltration throughout the system, The peak inflow was aligned with the peak infiltration and peak dry weather flow to produce the peak wet weather flow for the design event. The peak baseline wet weather flow upstream of the PCWWTP was estimated at 189 mgd for the 10-year design storm. This correlates well to major historic events measured at the PCWWTP. The projected 2050 estimate for peak flow equaled 209 mgd, which is an increase of 20 mgd over baseline conditions, mainly due to growth in the system. Figure ES.5 illustrates the baseline and 2050 hydrographs and associated 10-year design event hyetograph upstream of the PCWWTP.
- **Surcharge** – The surcharge condition for analysis of deficiencies in the existing and future system was chosen to be a peak hydraulic grade line (HGL) no closer than three foot below the rim elevation of any manhole along a reach of pipeline. This criterion allows some surcharge during 10-year design event conditions. This allowable surcharge provides for greater pipe capacities and in turn lowers the costs of capacity improvements. Maintaining an HGL of three feet below the rim or ground surface also provides for a margin of safety against potential SSOs.
- **Capacity Improvements** - Parallel pipes will be used where possible to relieve existing restrictive pipelines. If multiple parallel pipelines already exist within the reach of pipeline in question, then additional relief pipelines (instead of upsizing existing pipes) would be considered on a project by project basis by the City and Carollo.
- **Sewer Extensions** - Sewer extensions to accommodate growth in upstream areas of the service area were laid out very simply, using existing stream alignments and general topography. Carollo applied minimum and maximum pipe slopes as per City standards (NDEQ Title 123) in laying out these future sewers. Additional detailed design will need to be developed for these sewer extensions in the future.

The LOS criteria for sewer extension pipelines overlap into the design criteria for new sewers. The City has specific criteria to guide the design of sewers in new developments. As part of this PCSIMP, the City has updated their recommended design criteria.

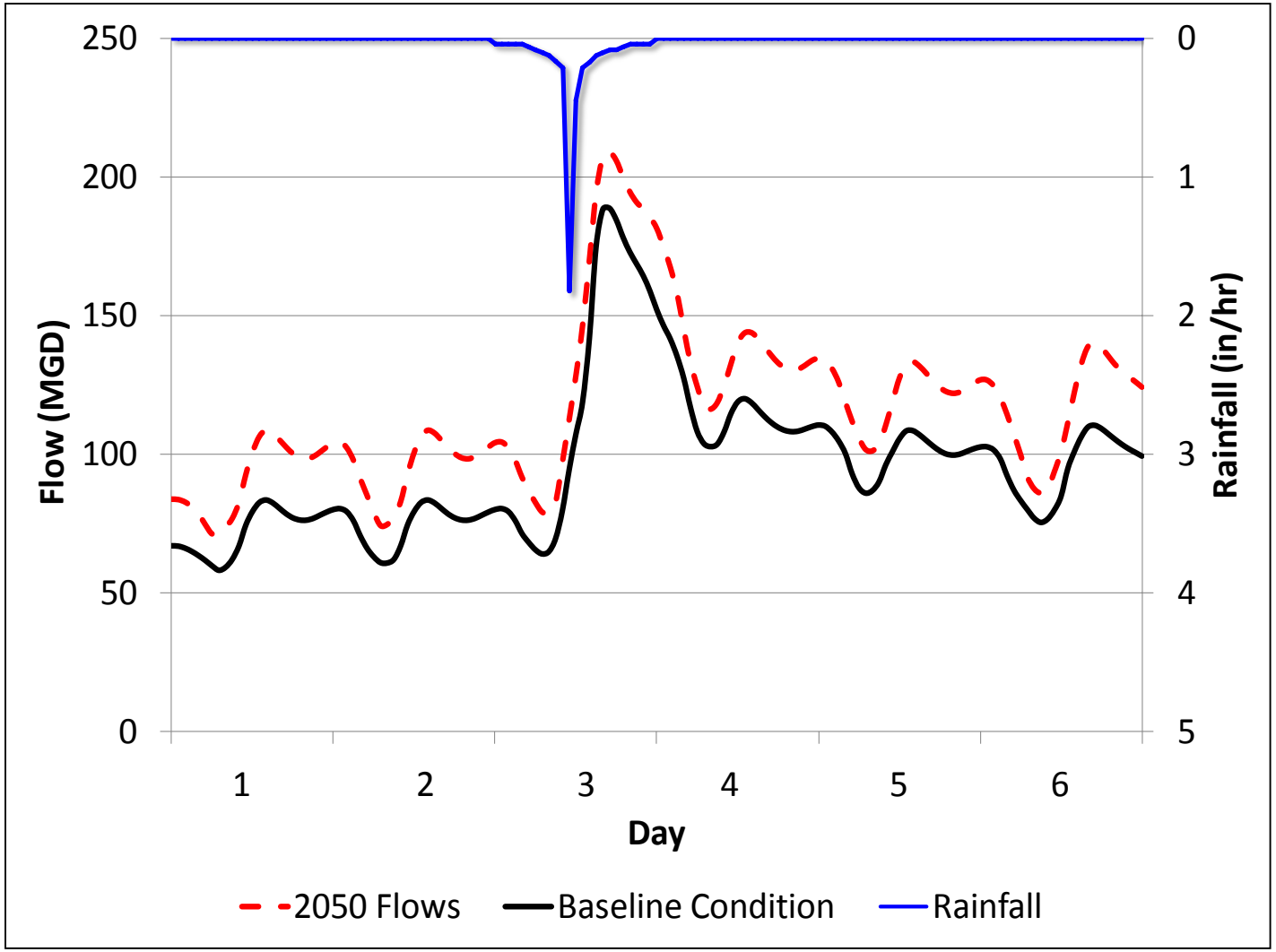

Figure ES.5 – Baseline and 2050 Design Storm Flows Upstream of PCWWTP

Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

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ES.7 RECOMMENDED DESIGN CRITERIA

A review of criteria presented in previous reports along with a review of the data used in this report was conducted to develop recommended design criteria. The flow criteria are consistent with information presented in previous reports, as well as with regulatory and other published design criteria (NDEQ Title 123, Ten States Standards). Table ES.5 summarizes the recommended design flows on a unit gallon per capita per day (gpcd) basis to be used for new sanitary interceptor extensions and for sewers that may meet the definition of an interceptor. Designs that do not utilize the recommended criteria must provide a study that justifies the use of different criteria, and must be approved by the Public Works Department.

This criterion applies to the design of sanitary sewers that are extended for new development. The designs of interceptors that serve existing developed areas will require an evaluation of the potential I/I contribution and may result in an adjustment to the I/I allowance used in the design.

Table ES.5 Sanitary Sewer Interceptor Extension Unit Flow Rates
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

Source	Unit	Value
Single Family Residential (SF)	gpcd	83
Multi Family Residential (MF)	gpcd	83
Commercial (COM)	gpad	1500
Industrial (IND)	gpad	1500
Infiltration/Inflow (new growth areas)	gpcd	17

Table ES.6 summarizes the population density statistics that should be used when estimating population per dwelling unit (DU) or per acre. These numbers have been carried over from past studies, or based on the MAPA data used for this study if new information was provided. A ratio of peak hourly flow to average flow should be calculated by the Standard City of Omaha Equation: *PF = 4.5 – 0.5 x Log10(Population)*. This peaking factor is applied after unit flow rates for I/I are added to the contributing area average flow rate.

Table ES.6 Estimated Density Variables Papillion Creek Sanitary Interceptor Master Plan City of Omaha, NE		
Variable	**Unit**	**Value**
Single Family Residential (SF)	people/DU	2.58(1)
Multi Family Residential (MF)	people/DU	1.76(1)
Residential Aggregate SF/MF	people/DU	2.47(1)
SF Dwelling Units (DU) per Gross Developable Acres	DU/ acre	4.26
MF Dwelling per Gross Developable Acres	DU/acre	15.37
Commercial/Industrial (COM/IND)	Acres allotted/100 people	3.6(2)
Gross Developable Acres to Total Gross Acres	percent	68.5%(1)
Population per Total Gross Residential Acres	People/acre	8.3(1,2)

Notes:
(1) Updated since 2009 study based on MAPA input.
(2) Use only for planning and design if specific land use is unknown.

The following information is provided to clarify the use of information provided in Table ES.6:

- If commercial/industrial acres are not known or specifically designated otherwise under direction of the City's Planning Department, the estimation of 3.6 gross developable acres per population of 100 people can be assumed. This aligns with previous studies.
- The term "gross developable acres" for SIDs and commercial/industrial parcels means the total land area encompassed by a parcel's outer property boundaries, which includes interior streets and green space.
- The term "Total Gross Acres" which may also be referred to as Total Gross Residential acres, excludes certain green space areas within a development, such as major stream riparian areas and forested and/or steep terrain areas. Other external set-aside areas that are not considered part of "gross acres" include highways; schools; parks and native prairies; regional reservoirs; the Douglas County Landfill and its assumed eastward expansion area; and other reserved government property. Therefore, actual total land consumption ("total gross acres") will be considerably higher and will vary among sub-basins.

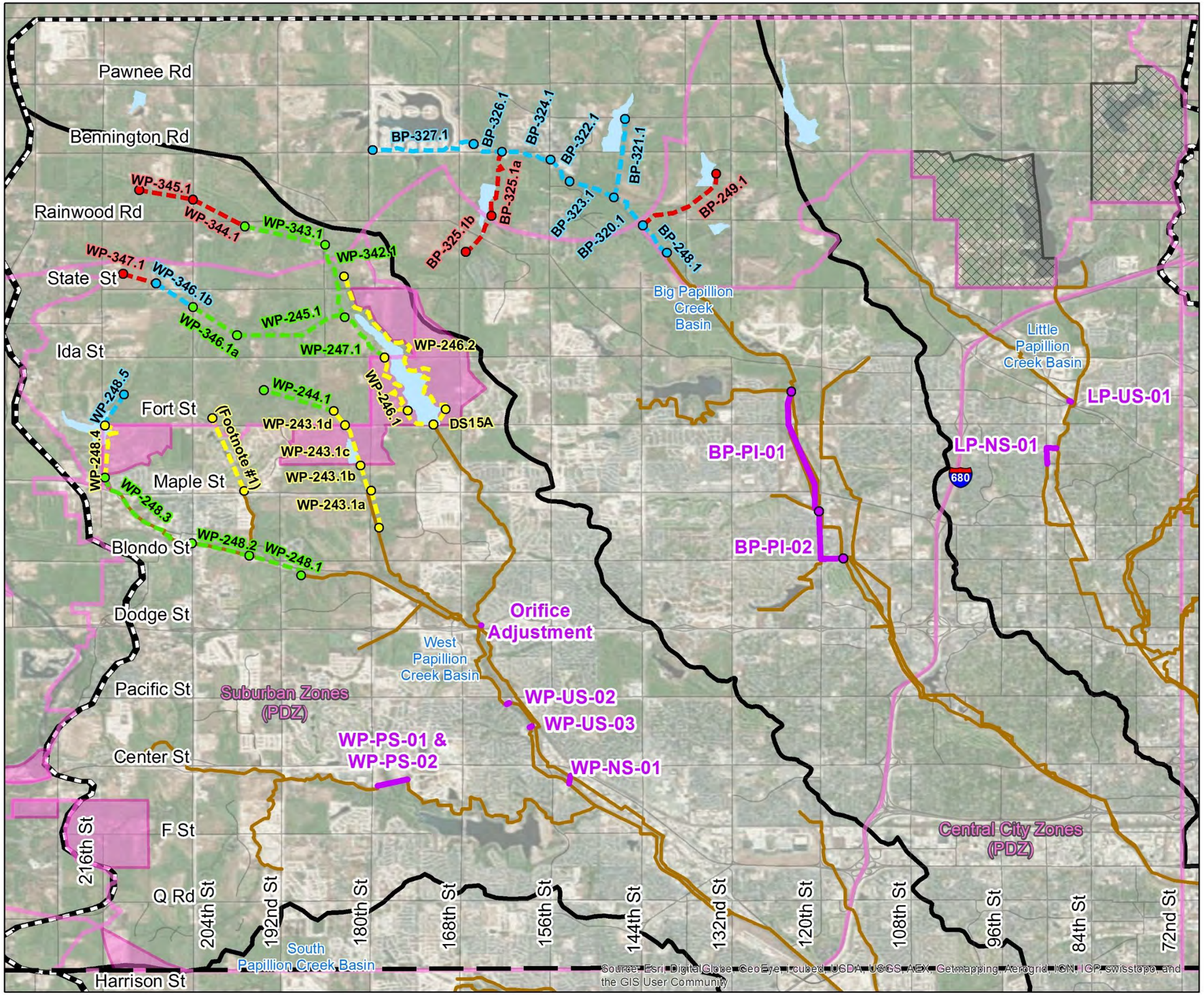
ES.8 CAPITAL IMPROVEMENT PROGRAM

The InfoWorks CS model of the interceptor system was used to analyze the projected future flows along with the 10-year design storm and the resulting design level I/I. The flows for the baseline condition, 2020, 2030, 2040, and 2050 were entered into the model and the LOS criteria were applied to examine current and future hydraulic conditions as growth occurred in the system. Initially, timing of the projects in the Capital Improvement Program (CIP) was based strictly on flows generated by the population and land use information. However, the timing of projects was adjusted given stakeholder input on where and when growth would occur. The CIP includes sewer extensions to serve new areas and downstream capacity improvements necessary to accommodate the growth of the system. Figure ES.6 shows the proposed projects included in the CIP.

The cost estimates for each project are based on the planning level assumptions that were developed by Carollo and the City. Independent checks were conducted by local consulting engineers to validate the projected costs. The costs for future construction are escalated using an inflation rate of 3.1%. This escalation rate was chosen based on a review of the Engineering News Record Construction Cost Index. In addition, the City's sewer rate model utilizes this inflation rate.

Table ES.7 summarizes the total project cost estimates by planning period through 2050. Details of these estimates are shown in Table ES.8 and Table ES.9. The estimated total cost of capacity improvements are approximately $72.6 million, while the total cost of sewer extensions is $112.5 million, resulting in an estimated $185 million in improvements needed through 2050. The majority of the capacity improvements ($57 million) are anticipated to be required in the 2026 – 2030 period. $40 million and $43 million will need to be completed in sewer extensions during the 2015 - 2030 period and 2031 - 2040 period, respectively. Note that the first three planning periods are at five-year intervals while the second two periods are in 10-year increments.

During the final development of this report and further discussion with stakeholders, it was discovered that the report did not provide or discuss the need for additional sewer interceptor extension project(s) to serve an undeveloped area that lies within the City's Future Development Zone (FDZ), upstream of the existing Elkhorn WWTP. Such area is the drainage basin north of Maple and west of 192nd Street north to approximately Ida Street, and is likely within the next area to be added to the PDZ. A line is shown on Figure ES.6 to indicate the need for a near term (2015-2020) sewer extension project to serve this area. City staff will work with stakeholders in the area to develop the additional interceptor sewer extension(s) and associated costs to serve such area. This project and associated costs will be included as part of the next interceptor study update. Additionally, the City shall develop a Capital Improvement Plan to support the desired growth and development of the area upstream of the existing Elkhorn WWTP.



Footnote #1: Refer to section ES.8 for project details.

Legend

- CIP Relief Sewers

Timing of CIP Extension Projects

- 2015-2020
- 2021-2030
- 2031-2040
- 2041-2050
- Development Zones
- Add to PDZ
- Remove from PDZ
- Papillion Creek WWTP Service Area
- InfoWorks Model of Existing System
- Papillion Creek Basins
- Douglas/Sarpy County Line
- Proposed NRD Reservoirs

0 0.75 1.5 3 Miles

N W E S

Figure ES.6 – Capacity Improvements and Sewer Extensions (2015 – 2050)

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City of Omaha, NE

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Table ES.7 Capital Improvement Program Cost Estimates Papillion Creek Sanitary Interceptor Master Plan City of Omaha, NE			
Planning Period	**Capacity Improvements**	**Sewer Extensions**	**TOTALS**
2015-2020	$0	$14,003,390	$14,003,390
2021-2025	$5,094,000	$17,967,000	$23,061,000
2026-2030	$56,986,000	$8,478,000	$65,464,000
2031-2040	$10,562,000	$43,016,000	$53,578,000
2041-2050	$0	$29,013,000	$29,013,000
TOTALS	**$72,642,000**	**$112,477,390**	**$185,119,390**

For comparison purposes, the capacity improvements developed for this study are $263 million less than those developed for the SISE (2009). Major reasons for this difference include the improved flow monitoring, improvements to the calibrated InfoWorks model, and the application of flow balancing techniques between existing interceptors to maximize the capacities of the current system. The difference in the cost estimates for the sewer extensions is $8 million. This comparison, along with the vetting of costs by local consultants provides confidence in these costs estimates.

Table ES.8 details the cost estimates for the capacity improvements and sewer extensions needed to convey design level flows and meet expected growth within the near term planning period, which is 2015 through 2020. Table ES.9 summarizes the cost estimates for capacity improvements and sewer extensions needed according to mid-term projections for 2021 through 2030. The long term CIP including proposed projects from 2031 out to 2050 are included in the main body of this report.

ES.9 FINANCIAL ANALYSIS

The CIP defined when, where, and how much the improvements will cost to provide for an efficiently operating interceptor system. The financial analysis, as part of this study, is necessary to develop how these projects are paid for in order to keep the Interceptor Sewer Fund, or ISF, efficiently operating so that money is available to provide for construction of projects. Funds to pay for these projects are paid through the connection fees established in this PCSIMP. The City is authorized to recover connection fees from new users who connect to the collection system in order to fund the expansion of the interceptors for future users. The Omaha Municipal Code Sections 31-255, 31-256, 31-257, and 31-259 detail these authorizations. Section 21-259 defines the fees that may be imposed on new connections to the collection system. The current connection fees are summarized in Table ES.10. Historic connections are illustrated in Figure ES.7.

Table ES.8 Near Term Capital Improvement Projects (2015-2020)
Papillion Creek Sewer Interceptor Master Plan
City of Omaha, NE

Projects Name	Description	Pipe Diameter (inches)	Pipe Length (Feet)	Cost Basis	Planning Level Project Construction Cost Estimate (2015 Dollars)						Construction Subtotals (2015 dollars)	Total Cost Subtotals (midpoint of Construction)
					2015	2016	2017	2018	2019	2020		
SEWER EXTENSIONS												
WP-243.1A	Between 180th and 192nd, to Maple	18	2,923	City Unit Price	$1,320,000						$1,320,000	$1,320,000
WP-243.1B	Between 180th and 192nd, Maple to PDZ	18	2,165	City Unit Price		$814,000					$814,000	$814,000
WP-243.1C	Between 180th and 192nd, PDZ to Fort	18	3,289	City Unit Price			$867,000				$867,000	$922,000
WP-243.1D	Cuts through Fort Street alignment	18	1,279	Carollo Spreadsheet						$460,000	$460,000	$536,000
WP 248.4	Near 216th Street Between Maple and Fort	18	4,750	City Unit Price		$1,700,000					$1,700,000	$1,700,000
WP 246.1	West Side Dam Site 15A interceptor to Ida	27	5,843	City Unit Price				$2,330,000			$2,330,000	$2,553,000
WP 246.2	East Side Dam Site 15A interceptor to State St	18	15,610	City Unit Price		$3,130,000					$3,130,000	$3,130,000
DS15A	Dam Site 15A Sanitary Sewer through the dam	27/18	2241/1450	HDR Design	$2,100,000						$2,100,000	$2,100,000
Next Planning Study				**City PM Estimate**			**$350,000**				**$350,000**	**$350,000**
Additional Monitoring				**City PM Estimate**			**$350,000**				**$350,000**	**$350,000**
Current Obligations(1)					**$228,390**						**$228,390**	**$228,390**
SUBTOTALS			**35,859**		**$3,648,390**	**$5,644,000**	**$1,567,000**	**$2,330,000**	**-**	**$460,000**	**$13,649,390**	**$14,003,390**

Notes:
(1) SID. 513 Interceptor Sewer Reimbursement.

Table ES.9 Mid-Term Capital Improvement Projects (2021-2030)
Papillion Creek Sewer Interceptor Master Plan
City of Omaha, NE

Projects Name	Description	Pipe Diameter (inches)	Pipe Length (feet)	Est. Construction (Cost $2015 $)	Est. Total Project Cost (2015 $)	Est. Construction Cost (2015 $)	Est. Total Project Cost (2015 $)	Construction Subtotals (2015 Dollars)	Total Cost Subtotals (mid-point of Construction)
				2021-2025		2026-2030			
CAPACITY IMPROVEMENTS				**$4,374,000**	**$5,094,000**	**$39,507,000**	**$56,986,000**	**$43,881,000**	**$62,080,000**
BP-PI-01	Parallel Interceptor	42	9,700			$16,296,000	$23,506,000	$16,296,000	$23,506,000
BP-NS-01	New Siphon (stream x-ing)	15	800			$4,950,000	$7,140,000	$4,950,000	$7,140,000
BP-PI-02	Parallel Interceptor	42	4,900			$8,232,000	$11,874,000	$8,232,000	$11,874,000
WP-PS-01	Pump Station Upgrade (4 to 8 mgd)	---	---			$9,000,000	$12,982,000	$9,000,000	$12,982,000
WP-PS-02	Parallel Force Main	14	1,838			$1,029,000	$1,484,000	$1,029,000	$1,484,000
WP-NS-01	New Siphon (stream x-ing)	12	630	$3,119,000	$3,633,000			$3,119,000	$3,633,000
Orifice Adjustment	Optimize orifice setting for flow split	18	---	$100,000	$116,000			$100,000	$116,000
WP-US-02	Upgrade Siphon	24	190	$627,000	$730,000			$627,000	$730,000
WP-US-03	Upgrade Siphon	24	160	$528,000	$615,000			$528,000	$615,000
SEWER EXTENSIONS				**$14,234,000**	**$17,967,000**	**$6,085,000**	**$8,478,000**	**$20,319,000**	**$26,445,000**
WP-244.1	Sewer Extension for Growth	18	4,403	$1,585,000	$1,904,000			$1,585,000	$1,904,000
WP-245.1	Sewer Extension for Growth	24	6,724	$3,228,000	$3,997,000			$3,228,000	$3,997,000
WP-245.1	Sewer Extension for Growth (stream x-ing)	24	150	$297,000	$368,000			$297,000	$368,000
WP-247.1	Sewer Extension for Growth	27	3,925	$2,120,000	$2,625,000			$2,120,000	$2,625,000
WP-247.1	Sewer Extension for Growth (stream x-ing)	27	150	$334,000	$414,000			$334,000	$414,000
WP-248.1	Sewer Extension for Growth	27	3,022			$1,632,000	$2,215,000	$1,632,000	$2,215,000
WP-248.1	Sewer Extension for Growth	27	600			$1,337,000	$1,814,000	$1,337,000	$1,814,000
WP-248.2	Sewer Extension for Growth	15	3,503			$1,051,000	$1,470,000	$1,051,000	$1,470,000
WP-248.3	Sewer Extension for Growth	15	6,882			$2,065,000	$2,979,000	$2,065,000	$2,979,000
WP-342.1	Sewer Extension for Growth	24	5,665	$2,719,000	$3,471,000			$2,719,000	$3,471,000
WP-342.1	Sewer Extension for Growth (stream x-ing)	24	150	$297,000	$379,000			$297,000	$379,000
WP-343.1	Sewer Extension for Growth	18	4,610	$1,660,000	$2,185,000			$1,660,000	$2,185,000
WP-343.1	Sewer Extension for Growth (stream x-ing)	18	300	$446,000	$587,000			$446,000	$587,000
WP-346.1A	Sewer Extension for Growth	18	3,061	$1,102,000	$1,450,000			$1,102,000	$1,450,000
WP-346.1A	Sewer Extension for Growth (stream x-ing)	18	300	$446,000	$587,000			$446,000	$587,000
SUBTOTALS			**35,174**	**$18,608,000**	**$23,061,000**	**$45,592,000**	**$65,464,000**	**$64,200,000**	**$88,525,000**

Table ES.10 Current Development Fees by Land Use Type Papillion Creek Sanitary Interceptor Master Plan City of Omaha, NE	
Land Use Type	**Connection Fee**
Single Family - SFR(1)	$1,100
Mobile Home - MH(2)	$847
Multi-Family - MFR(1)	$858
Commercial/Industrial – C/I(3)	$5,973
Notes: (1) Per family unit. (2) Per mobile home pad. (3) Per acre.	

The City has maintained a consistent methodology for calculating connection fees to recover the costs of constructing interceptor sewers to serve new development in the service area. Based on updated assessments of new development, system demands, and capital improvement costs, the City adopts connection fees for four basic classes of new development. Three of these classes apply to residential developments for (1) single family and duplex residences, (2) mobile homes, and (3) multi-family residences. The fourth class applies to all non-residential (commercial, industrial, and institutional) developments. Residential fees are expressed as a rate per housing unit. Non-residential fees are expressed as a rate per acre of development. The Municipal Code also contains special authority to calculate a connection surcharge when a non-residential development is likely to produce sewage discharges in excess of 3,000 gallons per day.

At the request of the City, Carollo has limited its financial analysis to the City's existing fee structure, and the adequacy of planned fee increases to pay for the costs of interceptor sewer system improvements from 2015 through 2020. The following City directives guided the financial analysis and projection of interceptor revenues to finance future CIP requirements:

- Maintain the existing Interceptor fee structure as set forth in Section 31-259 of the Municipal Code.
- Maintain the existing dollar value of Interceptor fees for 2015. Increases per year from 2016 through 2019 are summarized in Table ES.11.
- Exempt new development from paying the Interceptor fees in an area referred to as the Interstate 680/80 Loop.
- Estimate increases in Interceptor fees beyond 2019 to provide sufficient income to achieve a positive balance in the ISF.

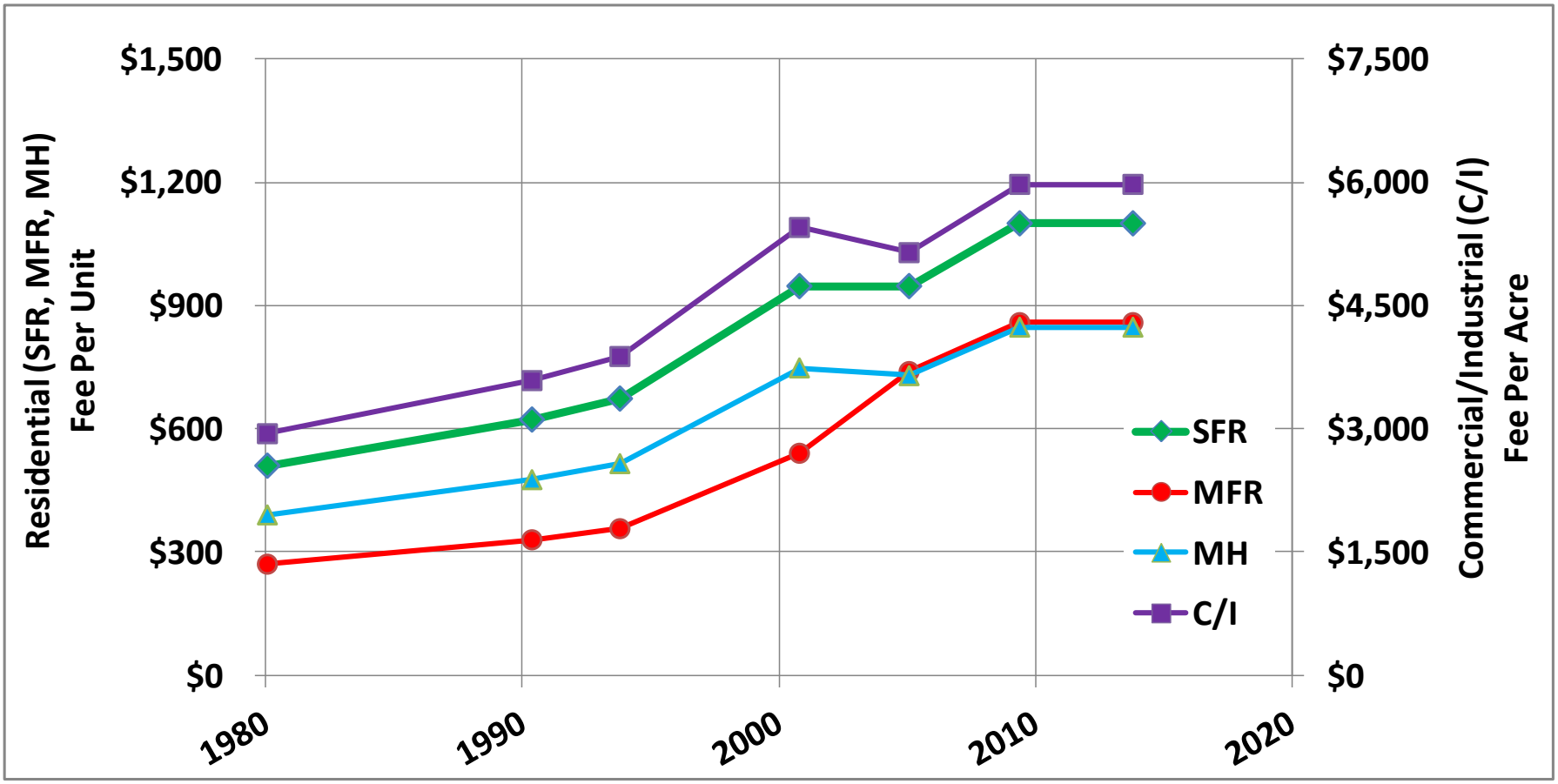

Figure ES.7 – Historical Connection Fees in Omaha
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

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Table ES.11 summarizes projections of ISF fees based on a continuation of existing fee structure through 2015, a 6 percent increase in 2016, with increases from 2017 through 2019 as the same dollar amount as the difference between 2015 and 2016. New developments are projected to generate an estimated $12.0 million in connection fees from FY 2015 through FY 2020. Capital improvements to the interceptor sewer system are estimated to cost $14.0 million during this six-year period. The ending balance in the fund is projected to decrease by $2 million between FY 2015 and FY 2020. The starting fund balance utilized for this report period $6.2 million. The projected balance at the end of the short term CIP approximately $4.6 million.

Table ES.11 Projected ISF Fees by Land Use Type
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

Land Use Type	2015	2016	2017	2018	2019
Single Family	$1,100	$1,166	$1,232	$1,298	$1,364
Mobile Home	$847	$898	$949	$999	$1,050
Multi-Family	$858	$909	$961	$1,012	$1,064
Commercial/Industrial	$5,973	$6,331	$6,690	$7,048	$7,407

Based on projections of new development and very moderate increases in connection fees, the City will need to rely on cash balances in the ISF to help pay for planned interceptor sewer system improvements through FY 2023. The available cash balance in the ISF at the start of FY 2015 should provide sufficient financial resources to cover differences between the receipt of anticipated connection fee income and capital expenditures for sewer system improvements. This draw-down in cash reserves will require the City to carefully monitor development patterns and the receipt of connection fee income over the next few years. A proactive plan should be developed to better understand and monitor anticipated expenditures and receipts.

Looking beyond 2020, the CIP expenditures, and cash flow projections suggest that the City will have to significantly increase connection fees on an annual basis beyond 2020. Without the necessary increase in fees, the fund may not be able to pay for the infrastructure necessary to provide for growth and expansion of the system. Growth and expansion to serve the desired new customers are vital to continue the economic growth in Omaha and the metro area. Given the potentially significant financial risks and impacts that are looming beyond 2020, the City needs to identify a set of acceptable strategies to finance future CIP improvements to support and serve the anticipated new development that is projected by the MAPA population and land use information.

This financial analysis does not incorporate potential income from interceptor fee surcharges paid by commercial and industrial development that discharge more than 3,000 gallons per acre per day of wastewater into the City's sanitary sewer system. Additional research and modeling are required to estimate the likelihood and extent of such developments during the planning period from 2015 through 2050. Based on the current charge of $5,973 and an assumed 1,500 gallons per acre per day of dry weather flow, the surcharge would equate to $3.98 per gallon per day of dry weather flow. The surcharge will only apply to anticipated discharges over the per acre baseline set forth in the Municipal Code.

ES.10 RECOMMENDATIONS, CONCLUSIONS, AND POLICIES

This study has a provided an updated basis for developing a CIP for the Papillion Creek Interceptor Sewers and recommended how capacity improvements and sewer extensions can be financed through 2020. The City has applied the recommendations from the previous study (SISE, 2009) to improve flow monitoring throughout the system and significantly improve the collection system model that now provides an excellent tool for examining system hydraulics and testing capital improvements. By completing this study update, the City and Carollo have helped reduce the capital improvements necessary for efficient operation of the interceptor system by over $250 million, while maximizing the capacity of the current infrastructure.

This Interceptor Master Plan update has provided the necessary information for planning interceptor improvements and updating the Interceptor Sewer Fund. However, several recommendations are being made to further refine the needs for comprehensive planning, management, and operations of the collection system tributary to the PCWWTP. Following is a summary of technical and financial based recommendations.

- **Development of a Detailed I/I Management Program** – The detailed spatial identification of I/I throughout the PCWWTP service area is not currently possible based on the number of permanent flow meters. Therefore, a more detailed flow monitoring program should be initiated to further identify where I/I is occurring within catchments much smaller than the current catchments defined by the permanent monitoring network. This program will also require additional detailed modeling and analysis with the intent to identify cost-effective subcatchments that can be rehabilitated to cost effectively control I/I and additional downstream capacity improvements. In particular, the area upstream of the Elkhorn WWTP requires further monitoring and modeling to understand the existing system capacity and to better plan for growth impacts.

- **Initiate Full Cost of Service Study in PCWWTP Service Area** – This interceptor master plan does not define several other costs of providing sewer service within the PCWWTP service area. Costs for providing annual operation and maintenance (O&M), improvements needed to sewers other than the interceptor sewers (based on useful life and condition), improvements needed for the PCWWTP, and other ancillary costs should be summarized so that the City managers understand that these Interceptor CIP projects are only part of the overall costs needed to manage the efficient operation of this extensive sanitary sewer system and its service area.
- **Initiate a Comprehensive Financial Analysis** - As the City proceeds with the Interceptor planning process, the City might wish to consider and/or evaluate the following based on the limits of the financial analysis conducted for this interceptor study:
  - Update the City's Wastewater Enterprise Fund financial model in order to better understand, anticipate, and plan for potential short falls in the Interceptor Sewer Fund, as well as model potential internal transfers to the Interceptor Sewer Fund to underwrite planned CIP costs that exceed projected impact fee revenues.
  - Refine the cash flow projections for the Interceptor Sewer Fund based on more specific timing of developments, additional revenues from industrial Interceptor fee surcharges, and additional expenditures related to internal and/or external construction financing.
  - Update the Municipal Code and business practices to provide clear and comprehensive authority and guidance regarding the timing, calculation, and collection of Interceptor fees and surcharges.
  - Consider a future restructuring of the Interceptor Sewer Connection Fee to an equivalent dwelling unit or EDU basis of computing the charges imposed on new development. Such a restructuring will more closely align the sewer system demands of new developments with the connection fees that ultimately pay for the system improvements.

The City should closely monitor the fund balance, along with the cash flow into and out of the fund. The projected cash flow of receipts into the fund and the anticipated cost of construction for the projects defined in the CIP are estimates that are highly variable based on future economic conditions. The availability of funds to pay for the projects defined in the CIP should be monitored and reported to the Directors of the Planning Department, Public Works Department, and Finance Department, along with the Mayor's office, on a regular basis.

The City may consider completing a separate technical study and evaluation of the sanitary system that would be completed in advance of and independent of the update to the sanitary Master Plan. By separating the two evaluations, the data to support the Master Plan would be developed up front, and would shorten the duration of the time required to complete the Master Plan.

In addition to the technical and financial recommendations listed above, it is recommended that continued coordination occur with other items that may influence the rate of development, including limitations within the transportation system. As stated in previous studies, this study should be updated every 3 to 5 years. The next study should be implemented beginning in late 2017 or early 2018 to ensure that the study is completed in time to update a fee structure that will support the continued desired growth of the system. Any additional information acquired by the City with regard to the existing system capacity and growth patterns will be incorporated at that time.

The following are recommended policies contained in previous reports that should remain essentially unchanged:

- The current practice of encouraging in-fill development in the I-680 loop by waiving the fee should be continued.
- The area affected by the special connection fee per Sec. 31-257 in the Omaha Municipal Code remains the same “The sewer connection fee provided for in this division shall be paid only for those new sewer connections outside zones A, B and C of the city's urban development policy which will flow through the city sanitary sewer system, also sometimes called the waste water collection system, in the Papillion Creek Watershed.” Figure ES.2 shows Zones A, B, C referred to as Central City Zones.
- The current policy of transferring ownership of newly constructed SID outfall sewers to the City should be maintained.
- It is recommended that interceptor sewer plans follow the guidelines and policies as set forth in the City’s Master Plan.
- The cost of any deviations from the plan or a restudy to justify the deviation will be paid by the developer prior to the planned future study updates.
- Acquisition payments will be made to SID's entering into agreements as funds are available. Condemnation will be considered for interceptors planned for acquisition but without agreements.
- The balance in the Fund should be kept at a minimum, thus reducing the accumulation of interest, which is not returned to the Fund, but rather added to the City’s general fund.

- The Interceptor Sewer Fee should continue to be collected with building permit applications.

The updated recommendations as a result of this study are as follows:

- Allow for planning and design ofnear term Program Projects in Table ES.8 for continued expansion of the interceptor system to serve potential development areas to the northwest. An additional near term project was identified at the finalization of this report and is noted on Figure ES.6. This project and associated costs will be included as part of the next interceptor study update.
- Sizing of future sewers should be generally based on 2050 development potential of Douglas County and adhere to the Recommended Design Criteria, summarized in Sections ES.7 and 4.3.
- This study should be updated every 3 to 5 years. The next study should be implemented beginning in late 2017 or early 2018 to ensure that the study is completed in time to update a fee structure that will support the continued desired growth of the system.
- Additional flow monitoring at key locations to further validate existing interceptors capacity deficiencies and for prioritization of sewersheds with high inflow and infiltration. A recommend flow monitoring budget is included in the Capital Improvement Program costs in Table ES.8.
- Funding the estimated costs of the projects will require an increase in the connection fee. Connection fees are recommended to be re-balanced in 2016 and each subsequent year as per Table ES.11.

INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of this document, developed by Carollo Engineers for the City of Omaha, is to update the Sanitary Interceptor Sewer Element (SISE) of the City of Omaha Master Plan. The SISE is now referred to as the Papillion Creek Sanitary Interceptor Master Plan, or the PCSIMP. The PCSIMP is required to:

1. Analyze the capacity of the sanitary sewer system tributary to the Papillion Creek Wastewater Treatment Plant (PCWWTP);
2. Determine the impacts of projected growth of the service area on the capacity of the interceptor system;
3. Develop a near term and long range capital improvement program (CIP) that provides for adequate expansion of the system to serve both existing and future customers;
4. Establish new user fees for connecting to the sanitary system. These fees will be used to fund the projects identified in the CIP. The fees are paid into a dedicated fund referred to as the Interceptor Sewer Fund.

The process to determine the CIP schedule includes an evaluation of the City's Present Development Zone (PDZ). As a result, the agreed upon modifications to the PDZ are communicated as a part of this PCSIMP. In addition, this PCSIMP provides design parameters for sanitary sewers that are used by the City of Omaha Public Works Department and outside consultants to adequately size the proposed sewer extensions listed in the CIP.

The scope of services for this update was developed by the City and Carollo to meet the objectives and criteria required by the City. The following is a list of the key elements of the study;

- Project and Stakeholder Coordination
- Review Available Data
- Update Population and Flow Projections
- Update the Hydraulic Model
- Interceptor Analysis and CIP Development
- Determine Interceptor Funding Options
- Preparing the Master Plan Document

1.2 GOALS AND OBJECTIVES

The overall goals and objectives of this PCSIMP efforts are to:

- Develop a fully dynamic hydraulic model of the interceptor system using flow monitoring and rainfall data recently collected by the City.
- Determine and verify the capacity of the existing Papillion Creek Sanitary Trunk Sewers classified as part of the interceptor system in Douglas and Sarpy Counties.
- Determine the impacts of projected growth of the service area on the capacity of the interceptor system in Douglas and Sarpy Counties.
- Identify needed improvements to the existing Papillion Creek Sanitary Sewer system, both for its current state and as future growth comes online.
- Identify needed interceptor extensions within the City's present and future zoning jurisdiction to serve future growth.
- Develop a near term and long range capital improvement program (CIP) that provides for adequate expansion of the system to serve both existing and future customers within the City's present and future zoning jurisdiction.
- Recommend an adequate fee structure, as paid by new users that connect to the sanitary system, to fund the projects identified in the CIP and to maintain a responsible Interceptor Sewer Fund (ISF) balance.
- Make recommendations for other future projects or programs to continue to support the Interceptor Master Planning effort.

The processes to determine the CIP schedule includes an evaluation of the City's Present Development Zone (PDZ). As a result, the agreed upon modifications to the PDZ are communicated as a part of this PCSIMP. In addition, this PCSIMP provides design parameters for sanitary sewers that are used by the City of Omaha Public Works Department and outside consultants to adequately size the proposed sewer extensions listed in the CIP.

1.3 SYSTEM DESCRIPTION

The City of Omaha is located on the eastern border of Nebraska along the Missouri River within Douglas County. Washington County boarders the northern extent of the City and Council Bluffs, Iowa is located directly across the Missouri River. The City of Omaha was incorporated in 1857 and the Omaha metropolitan area currently supports over 430,000 citizens within the municipal boundary. Other towns and cities in the Omaha metropolitan area include Bellevue, Papillion, La Vista, Ralston, Gretna, Bennington, Boys Town, and Carter Lake. Part or all of these locations are served by the sewer facilities owned and operated by the City and comprise a total population of nearly 650,000. Figure 1.1 illustrates the Omaha metropolitan area and service areas of the total Omaha service area and Combined Sewer System (CSS) service area.

The metro area wastewater collection system is over 12 million[1] linear feet and conveys flows to two major wastewater treatment plants and one smaller wastewater treatment plant in west Omaha. The Missouri River Wastewater Treatment Plant (MRWWTP) is located just south of the Veteran's Memorial Bridge at the Missouri River and accommodates the majority of the combined sewer flows in the City. The Papillion Creek Wastewater Treatment Plant PCWWTP is located along the Missouri River at the mouth of Papillion Creek. A third smaller wastewater treatment plant, the Elkhorn Wastewater Treatment Plant (EWWTP) is located in western Douglas County along West Papillion Creek. The City has completed an extensive CSO Long Term Control Plan (LTCP) which focuses on the MRWWTP service area and the combined sewer portion of the PCWWTP service area.

The service area of the PCWWTP totals approximately 300 square miles (187,000 acres), which includes sewers within Douglas and Sarpy Counties. The majority of the system is comprised of sanitary sewers but also includes some combined sewers in the eastern portion of the service area. The combined portion of the service area only accounts for approximately 9 square miles of the total PCWWTP service area. Of this, approximately 2 square miles will be separated and converted to sanitary sewers by 2027. This was estimated by the City according to planned projections in the updated LTCP (October 2014) and other future separation as part of the Renovation of Combined sewer (RNC) Program. The PCWWTP includes one combined sewer overflow (CSO) directly upstream of the plant to accommodate excess wet weather flows during extreme events. This plant has an average daily flow between 58 and 64 MGD on an average annual basis. The average minimum monthly average for 2014 was 39.8 MGD. Peak wet weather capacity is approximately 138 MGD for a duration of 24 hours or shorter. Figure 1.2 illustrates the existing service area of the PCWWTP.

[1] Counts Sanitary Improvement Districts owned interceptors in Douglas and Sarpy Counties, no satellites.

Figure 1.1 – Omaha, Nebraska Metropolitan Area
(source: City of Omaha GIS)
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

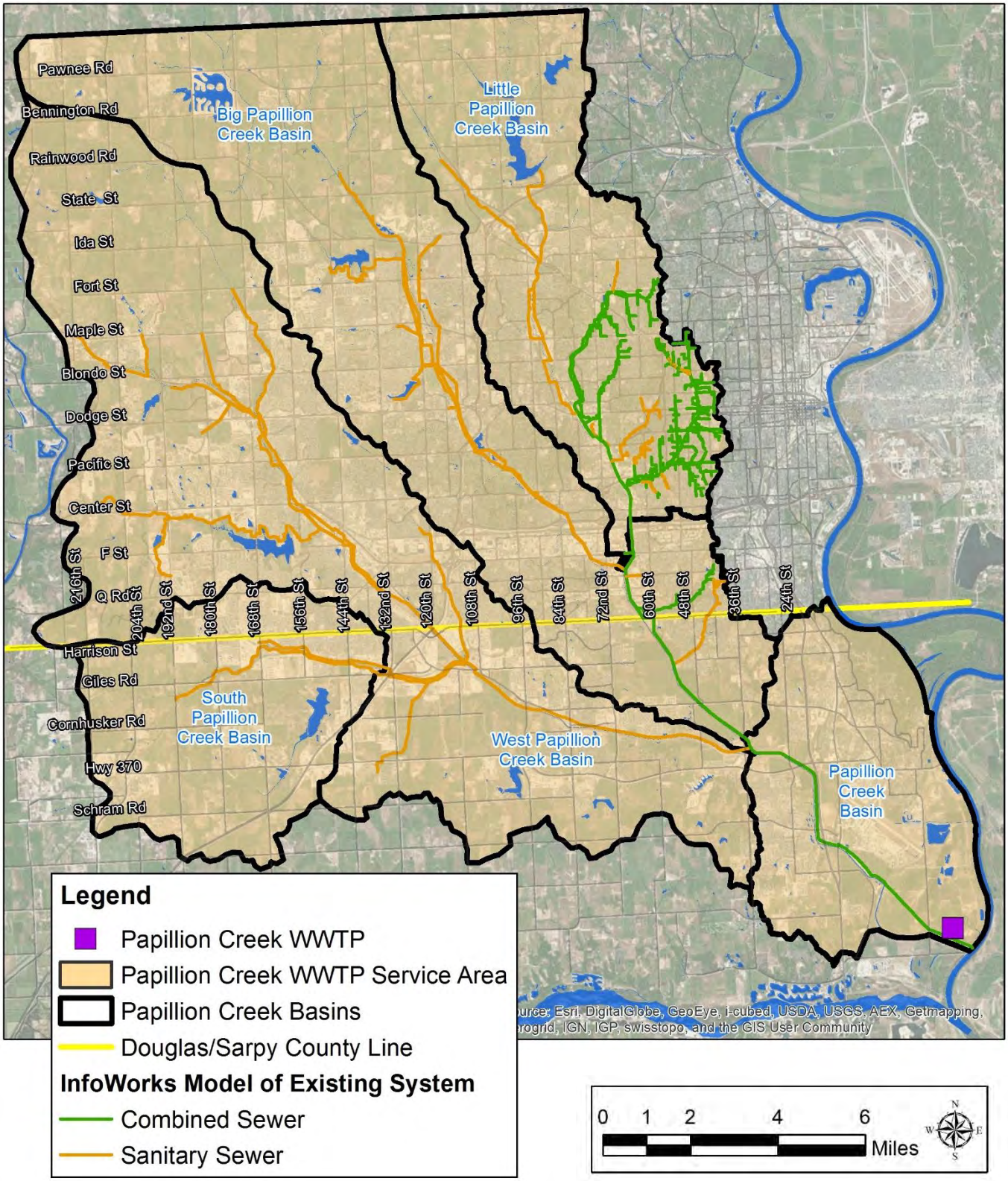

Figure 1.2 – Existing PCWWTP Service Area
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

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Of the approximately 8 million[2] linear feet of sanitary pipe in the PCWWTP Service Area, only about 1 million linear feet is hydraulically modeled which primarily consists of the Interceptor system and areas of combined sewers. The model of the system has improved over time and underwent improvements in 2010, adding detail to the modeled interceptor system to support the CSO Program. The modeled system contains pipe diameters ranging from as small as 10” along the Elkhorn Plant Interceptor to the 114” x 108” rectangle interceptor at the head works of the PCWWTP.

1.4 PREVIOUS INTERCEPTOR MASTER PLAN STUDY

This study builds on the previous study completed for the City by HDR titled “Sanitary Interceptor System Element” (SISE) and adopted by the City Council on May 19, 2009. Again, this element is part of a comprehensive City Of Omaha Master Plan which stated these objectives in 1999 Concept Element:

1. *“The City will install sanitary sewers to promote contiguous growth and adherence to the Master Plan. Omaha will achieve a significantly higher development potential when sewers are utilized throughout the Papillion Creek watershed."*
2. *"Omaha will continue to maintain a sewer system that has enough excess capacity to accommodate growth expectations. The Papio Watershed Sewage Treatment Plant serves many surrounding communities besides Omaha. Currently (1999), there is adequate capacity in the trunk lines and treatment plant. However, there is a finite capacity to the system. As the system approaches capacity, the allocation of use between communities must be studied to prevent limitations to Omaha's growth.”*

In the 2009 study key scope elements included:

- Evaluation of the impact of population projections using UNL Bureau of Business Research.
- Updating of the hydraulics computer model to include new development and new flow monitoring efforts in the Watershed. (8 area rain gauges, and 4 temporary flow meters).
- Review of the interceptor fund.
- Evaluation of interceptor requirements, funding needs, and anticipated revenues.

[2] Counts Sanitary Improvement Districts owned interceptors in Douglas and Sarpy Counties, no satellites.

The total CIP developed in the 2009 SISE evaluation totaled $449 million through 2050; of which, $329 million were estimated for capacity improvements, while $120 million were estimated for sewer extensions to service growth. These costs associated with the interceptor capacity improvements to accommodate growth were highly conservative, and the report noted that additional data was necessary to provide more accurate planning and costs.

This 2009 Study concluded with recommendations for the installation of a permanent flow metering system to better quantify both the dry and wet weather flows in the system, and the development of a more comprehensive collection system model. In addition, this study acknowledged the uncertainty of the cash flow projections and recommended a future study to be completed when the 2010 Census data was made available.

1.5 ADDITIONAL DOCUMENTATION

Various reports, documents, and data were provided by the City to Carollo and reviewed as part of this work. Below is a brief list of supporting data provided:

- CSO Hydraulic Model for the Papillion Creek Watershed (InfoWorks CS).
- GIS Data from City of Omaha and other entities, including layers: existing sewers, Sanitary Improvement Districts (SID), Present, and Future Development Zones, proposed Dam Sites, proposed sewer extensions with designs approved.
- Existing population from 2010 census data (employment populations unavailable).
- Future Population, Land Use, and Employment data from Metropolitan Area Planning Agency (MAPA) in the format of GIS polygons based on a growth model.
- Financial Data relating to the Interceptor Sewer Fund.

Additionally these Reports and Technical Memorandums were provided for review:

1.5.1 2010 Flow and Rainfall Monitoring Report

The City acted on the recommendations of the 2009 Study and completed the installation of a permanent flow and rain monitoring system in 2010. This increased the flow monitoring to 13 permanent sites and 9 temporary sites. Available rainfall data was also increased to approximately 20 sites, 6 as permanent City of Omaha rain gauges, and the remaining available through Papio Natural Resource District flood warning network. In addition, radar rainfall distribution and analysis was performed for the 2010 precipitation and used to calibrate the CSO hydraulic model.

1.5.2 Omaha CSO InfoWorks CS Model: 2010 Calibration and Model Update TM

This technical memorandum summarize the calibration utilizing the 2010 Flow and Rainfall monitoring, as well as updates from additional City records drawings and field confirmations. These significant upgrades to the CSO hydraulic model resulted in refinements and additional details to support the Papillion Creek collection system computer model. This new data and model were used and enhanced in this study to provide results that much more accurately represent the current hydraulics of the system and provide a much higher level of confidence in the projections of future needs.

1.5.3 Papillion Creek Watershed Management Plan- March 2014 Update

The Watershed Management Plan Update deals primarily with the continuation of how to implement the remaining water quality and structural flood control projects. Information of particular interest to the effort of the PCSIMP pertains to the proposed dam sites and the sub-watershed delineations which aided delineation of future sewershed boundaries.

Chapter 2

POPULATION AND LAND USE

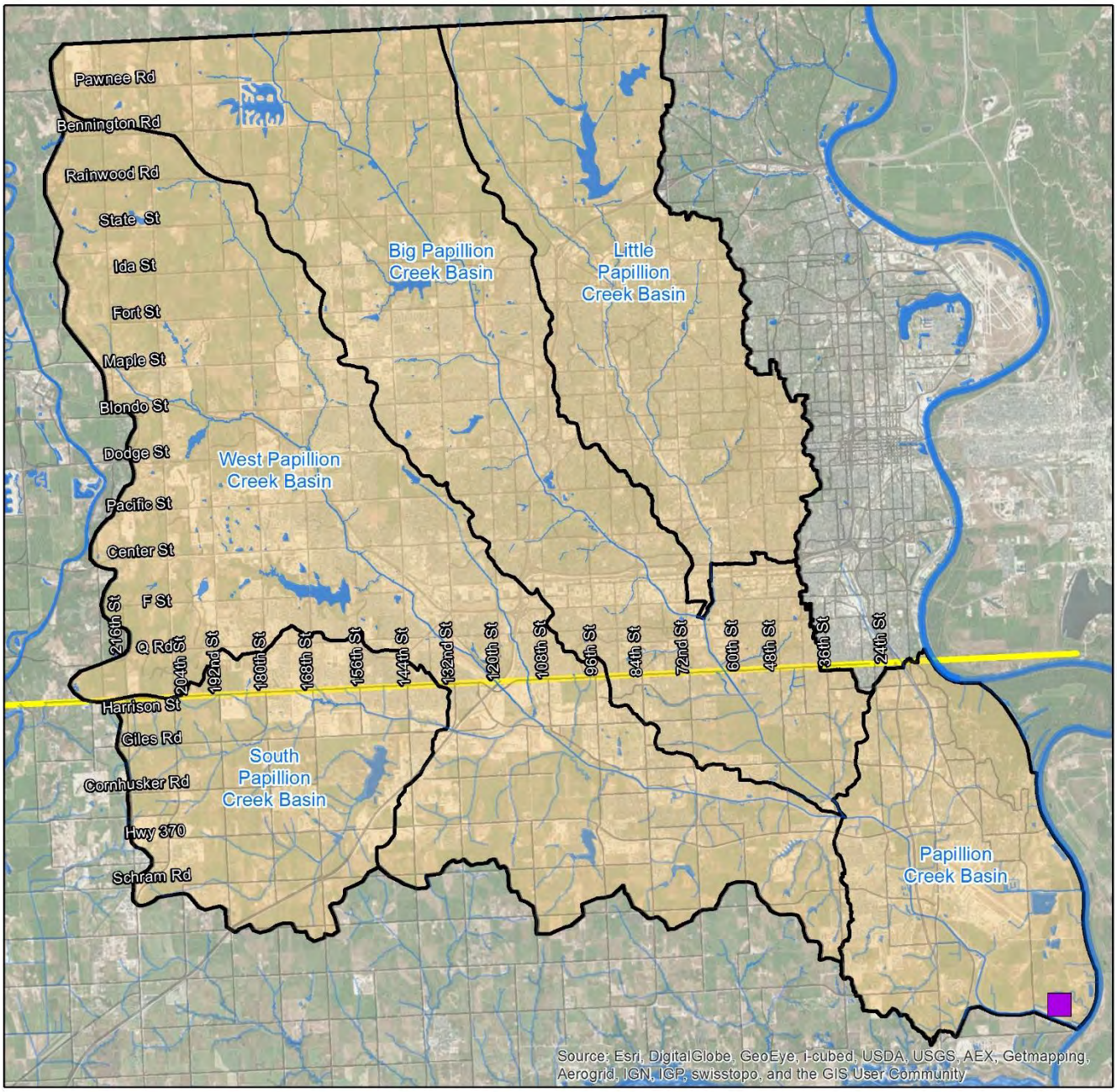
2.1 SUMMARY

This chapter summarizes the assumptions, methodologies, and results for estimating the baseline and future land use and population necessary to understand the base sanitary flows contributed to the sewers by human, commercial, and industrial water usage. The goal of this process is to use available population and land use data and correlate it to the planning years 2010 (baseline), 2020, 2030, 2040, and 2050 and to the hydraulic model sub-catchments contributing to the Papillion Creek WWTP service area. The population and land use development in the Papillion Creek sewershed to the year 2050, represents the end of the planning period, and has been used to establish interceptor sewer design capacity requirements.

In addition, Stakeholder meetings with representatives from the development community were conducted during the planning process. The stakeholders provided input into the development of the PDZ. In addition, engineering consultants representing the interests of the development community were allowed to review, comment, and provide validation of the estimated sewer extension costs used in the CIP. The requested PDZ expansion in the northwest part of the Papillion Creek watershed required additional study by the City due to existing and projected capacity constraints on the roadway network. The City worked with MAPA and an outside consultant on roadway modeling to evaluate various development scenarios and the anticipated impacts on the roadway network. The outcome of this modeling effort showed the need to adjust the Arterial Street Improvement Program (ASIP) fee in order to fund roadway improvements necessary to serve the new areas of development within the time frame requested by the development community. Chapter 5 will reflect the resulting CIP program based on the recommended PDZ changes.

2.2 STUDY AREA

The Papillion Creek Watershed, as defined by the Papillion Creek Watershed Partnership (PCWP) covers approximately 402 square miles of drainage area extending from northern Washington Country southward through Douglas and Sarpy Counties and is illustrated in Figure 2.1. The Papillion Creek discharges to the Missouri River just south of Bellevue. At this time the portion of the watershed in Washington County is primarily agricultural and sparsely populated. Moreover, there are no current plans to extend sewer service into Washington County; therefore, it is not included in this study. This study focuses only on the service area of the PCWWTP which totals approximately 300 square miles (187,000 acres) in area. There are a few developments outside the watershed and through wastewater sewer agreements, contribute to the Papillion Creek watershed service area.



Legend

- Papillion Creek WWTP
- Papillion Creek WWTP Service Area
- Papillion Creek Basins
- Douglas/Sarpy County Line
- Lakes, Creeks, and Rivers

0 1 2 4 6 Miles

N W E S

Figure 2.1 – Existing PCWWTP Service Area

Papillion Creek Sanitary Interceptor Master Plan

City of Omaha, NE

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The primary tributaries include the Big Papillion, Little Papillion, West Papillion, and South Papillion Creeks. The basins defined by these streams form the four major hydraulic sub-units of the watershed, with the fifth major sub-unit being that of the lower portion of Papillion Creek. For the purpose of this master plan study, the major stream basins have been divided further into sub-catchments to represent approximate sewersheds to be used in modeling and analysis.

Accommodation of the population growth through the planning year of 2050 for the PCWWTP service area was based on the development of available, developable land in Douglas County. A significant amount of growth has occurred in Sarpy County. This growth is projected to continue, thus this area and the contributing population has been included to determine the impact of wastewater flows on the lower reaches of the main interceptor sewers. However, the identification of required interceptor projects in Sarpy County is not included in this study.

2.3 POPULATION AND EMPLOYMENT

As stated in the 2009 Master Plan study, population analysis would be much improved when the 2010 Census tract is completed throughout the watershed. This current study effort was able to use this available data along with future population and employment estimates by Metropolitan Area Planning Agency (MAPA) to determine the base sanitary flow used within the InfoWorks model. Multiple data sources and methods were used to calculate the baseline and future estimates. The processes to determine these are summarized separately below.

2.3.1 Existing Population Estimates

The existing population estimates were based on the 2010 census data. The data was obtained from the census website and was parcel based data. A simple “area weighting method” was used to calculate the existing populations for each sub-catchment. This involved intersecting the census polygons and sub-catchments. Then the population in the overlapping regions was parsed to the overlapping sub-catchments based on the area overlapped by the census polygon. This process resulted in a total population estimate for each sub-catchment. It should be noted that no existing employment estimates were available from the census data, the City, or MAPA.

2.3.2 Future Population Projections

Future population estimates were based on information provided by MAPA. The data provided by MAPA was a set of GIS polygons, which included estimates for increases in population, employment, and land use (discussed below) for 2020, 2030, 2040, and 2050. The polygons did not change in area or shape over the different planning periods meaning the polygons represented the extent of the build out growth. The increases in population and employment within each sub-catchment were also processed using a simple area weighting method in a similar manner as the existing population estimates discussed previously. However, these estimates were also used as part of a two-step process to calculate the future land use. The two-step process is illustrated in Figure 2.2 and step 1 is discussed below.

Step 1 distributes the increase in population and employment from the future MAPA polygon to Sub-catchment 1. Employment numbers are distributed separately for Commercial (COM) and Industrial (IND) employment. This step is repeated to obtain the increase in population and employment by sub-catchment for 2020, 2030, 2040, and 2050. The increase in population estimates was then added to the baseline estimate to calculate the total populations by sub-catchment for the future periods. These estimates are summarized by basin in Table 2.1. Table 2.2 summarizes these statistics by county. These estimates by sub-catchment are detailed in Attachment 1 of Appendix A. Step 2 in Figure 2.2 is discussed below in the section on future land use processing.

Table 2.1 Baseline and Future Population Estimates by Basin
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

Basin	Baseline Population(1)	2020 Population(2)	2030 Population(2)	2040 Population(2)	2050 Population(2)
Big Papillion Creek Basin	151,403	168,186	182,885	195,154	209,275
Little Papillion Creek Basin	117,899	126,813	134,213	138,280	141,338
Papillion Creek Basin	37,491	43,514	47,505	48,715	49,553
South Papillion Creek Basin	49,156	55,968	65,115	75,419	84,983
West Papillion Creek Basin	157,803	186,416	216,368	242,168	260,348
Totals	**513,751**	**580,897**	**646,086**	**699,737**	**745,497**
Percentage Increase from Baseline Year	**---**	**13%**	**26%**	**36%**	**45%**

Notes:
(1) As calculated using 2010 census data.
(2) As calculated using the MAPA population projections.

Table 2.2	**Baseline and Future Population Estimates by County in Service Area Papillion Creek Sanitary Interceptor Master Plan City of Omaha, NE**				
County in Service Area	**Baseline Population(1)**	**2020 Population(2)**	**2030 Population(2)**	**2040 Population(2)**	**2050 Population(2)**
Douglas (3)	373,887	412,079	449,462	480,773	510,991
Sarpy (3)	139,864	168,817	196,624	218,964	234,505
Total in Service Area	**513,751**	**580,897**	**646,086**	**699,737**	**745,497**
Percentage Increase from Baseline Year	**---**	**13%**	**26%**	**36%**	**45%**

Notes:

(1) As calculated using 2010 census data.
(2) As calculated using the MAPA population projections.
(3) Minor amount of population in County may be outside of service area.

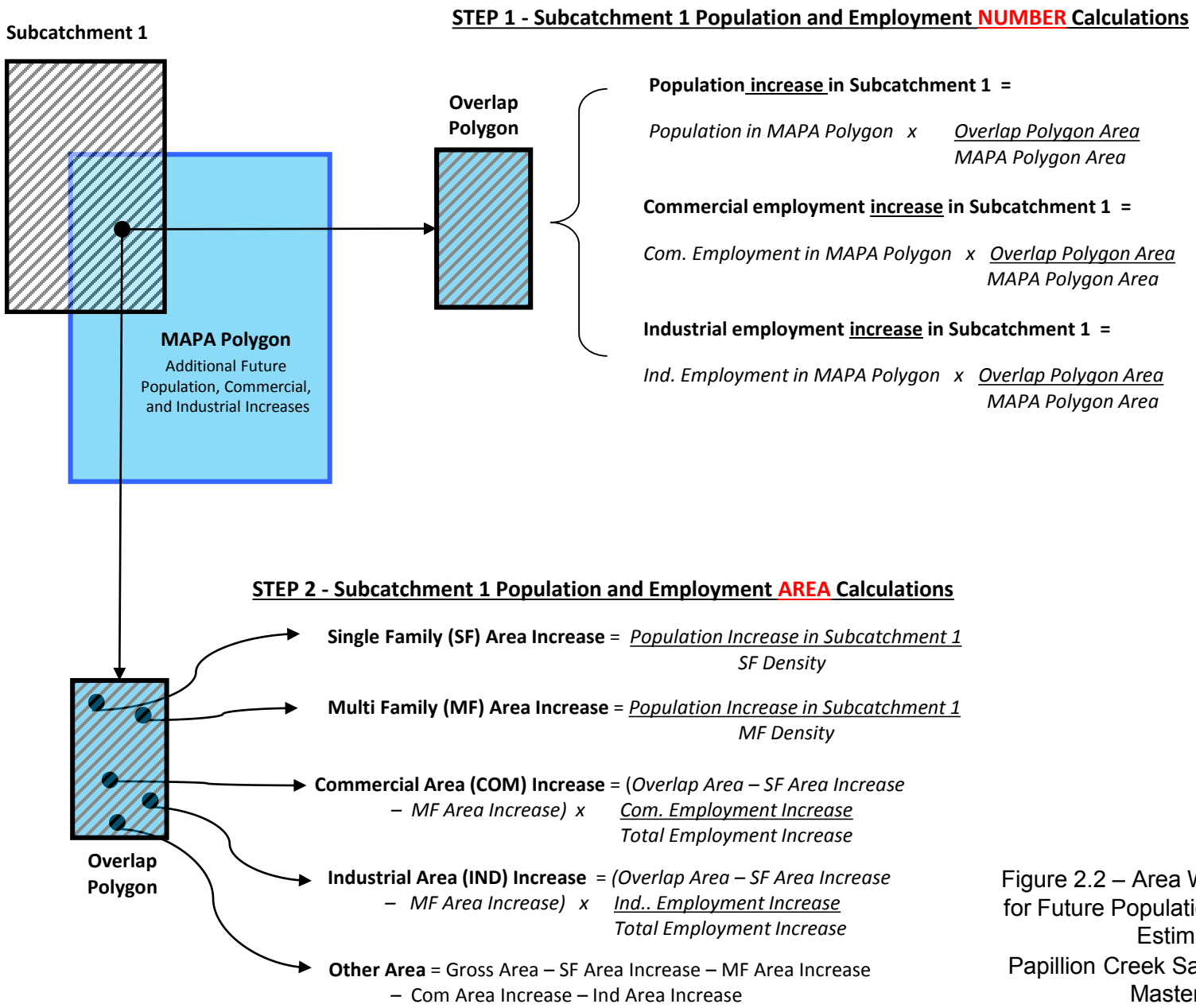

Figure 2.2 – Area Weighting Method for Future Population and Land Use Estimates

Papillion Creek Sanitary Interceptor Master Plan

City of Omaha, NE

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2.4 LAND USE

The current and future land use information was also used to calculate the base sanitary flow (BSF) for use within the InfoWorks model. Details on BSF are included later in this report. Multiple data sources and methods were used to calculate current and future land use estimates. The process to determine these is summarized below.

2.4.1 Existing Land Use Estimates

Although the baseline population is for 2010, the baseline land use estimates were based on information from 2013. Thus it was assumed that the land use in 2013 was representative of the land use in 2010 for the purposes of this study. The City provided the land use information to Carollo. The information was in the form of GIS data for Douglas and Sarpy Counties. In both counties, the existing land use was parcel-based data and included many different land use classifications. The land use designation assigned by the City were consolidated into the following land use categories for this analysis:

- Single Family Residential (SF)
- Multi-Family Residential (MF)
- Commercial (COM)
- Industrial (IND)
- OTHER (Agriculture, Transportation, Open Space, Water, Etc.)

These consolidated land use categories for the baseline land use condition within the service area are illustrated in Figure 2.3. This baseline parcel-level land use layer was intersected with the sub-catchments layer to calculate the area of each land use category by sub-catchment. These areas are summarized in Table 2.3 by basin and the detailed sub-catchment areas are included in in Attachment 2 of Appendix A. It was assumed that the land use totals in Table 2.3 and Attachment 2 of Appendix A are in terms of developable acres. This can be assumed given that the totals were based upon parcel based GIS data provide by the City. Thus, the majority of the undevelopable land (road corridors, ROW, etc.) were excluded from these totals. Table 2.4 is included it illustrate these land use totals by county.

Table 2.3 Baseline (2013) Land Use Area by Basin
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

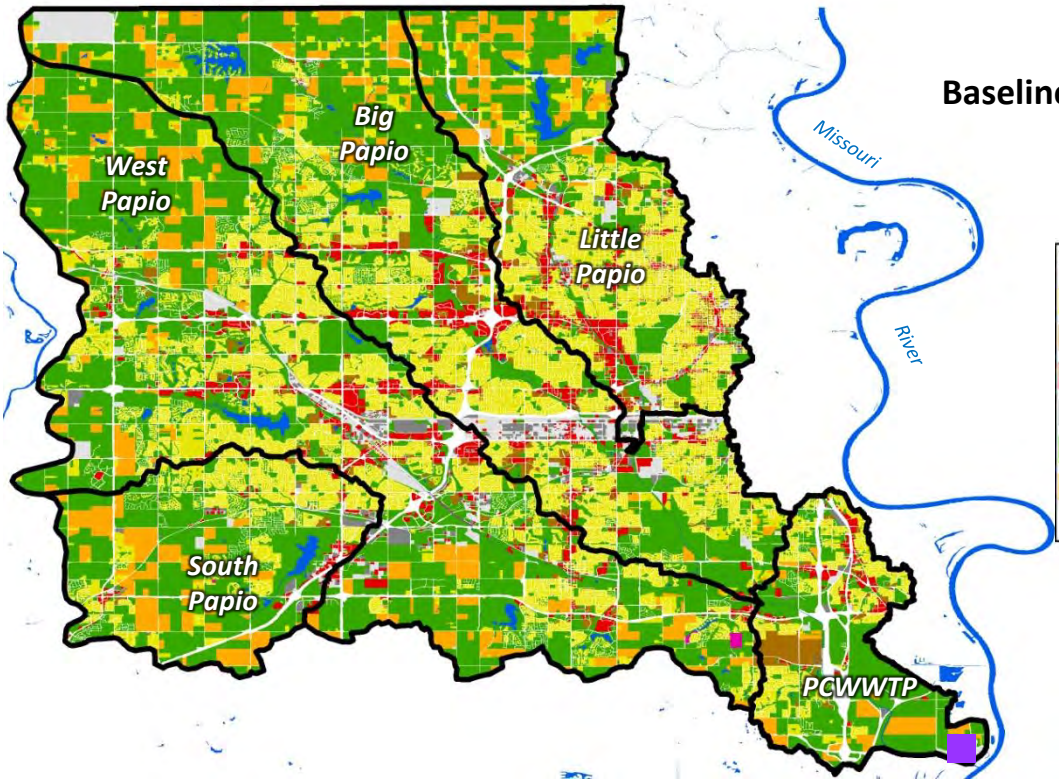
Basin	Gross[1] Area (ac)	SF Area (ac)	MF Area (ac)	COM Area (ac)	IND Area (ac)	Other[1,2] Area (ac)
Big Papillion Creek Basin	46,117	12,965	1,404	2,528	601	28,619
Little Papillion Creek Basin	26,128	8,825	1,067	1,725	442	14,068
Papillion Creek Basin	12,217	2,538	966	508	141	8,065
South Papillion Creek Basin	18,052	3,922	152	419	348	13,212
West Papillion Creek Basin	59,358	13,458	1,068	2,699	998	41,135
Totals	**161,872**	**41,709**	**4,657**	**7,878**	**2,529**	**105,099**

Notes:
(1) Does not include highway/road corridors. Total sewershed area = 187,133 acres.
(2) Other includes areas not contributing sanitary flow (e.g. agriculture, open space, etc.).

Table 2.4 Land Use Area by County in Service Area
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

County	Gross[1] Area (ac)	SF Area (ac)	MF Area (ac)	COM Area (ac)	IND Area (ac)	Other[1,2] Area (ac)
Baseline						
Douglas	108,538	31,087	3,145	6,011	1,692	66,602
Sarpy	53,334	10,622	1,512	1,867	837	38,497
Totals	**161,872**	**41,709**	**4,657**	**7,878**	**2,529**	**105,099**
Percent Land use Category of Total	**---**	**25%**	**3%**	**5%**	**2%**	**65%**
Year 2050						
Douglas	108,538	41,456	3,930	10,075	3,651	49,425
Sarpy	53,334	17,910	2,009	6,207	3,654	23,553
Totals	**161,872**	**59,367**	**5,939**	**16,282**	**7,305**	**72,978**
Percent Land use Category of Total	**---**	**36%**	**4%**	**10%**	**5%**	**45%**

Notes:
(1) Does not include highway/road corridors. Total sewershed area = 187,133 acres.
(2) Other includes areas not contributing sanitary flow (e.g. agriculture, open space, etc.).



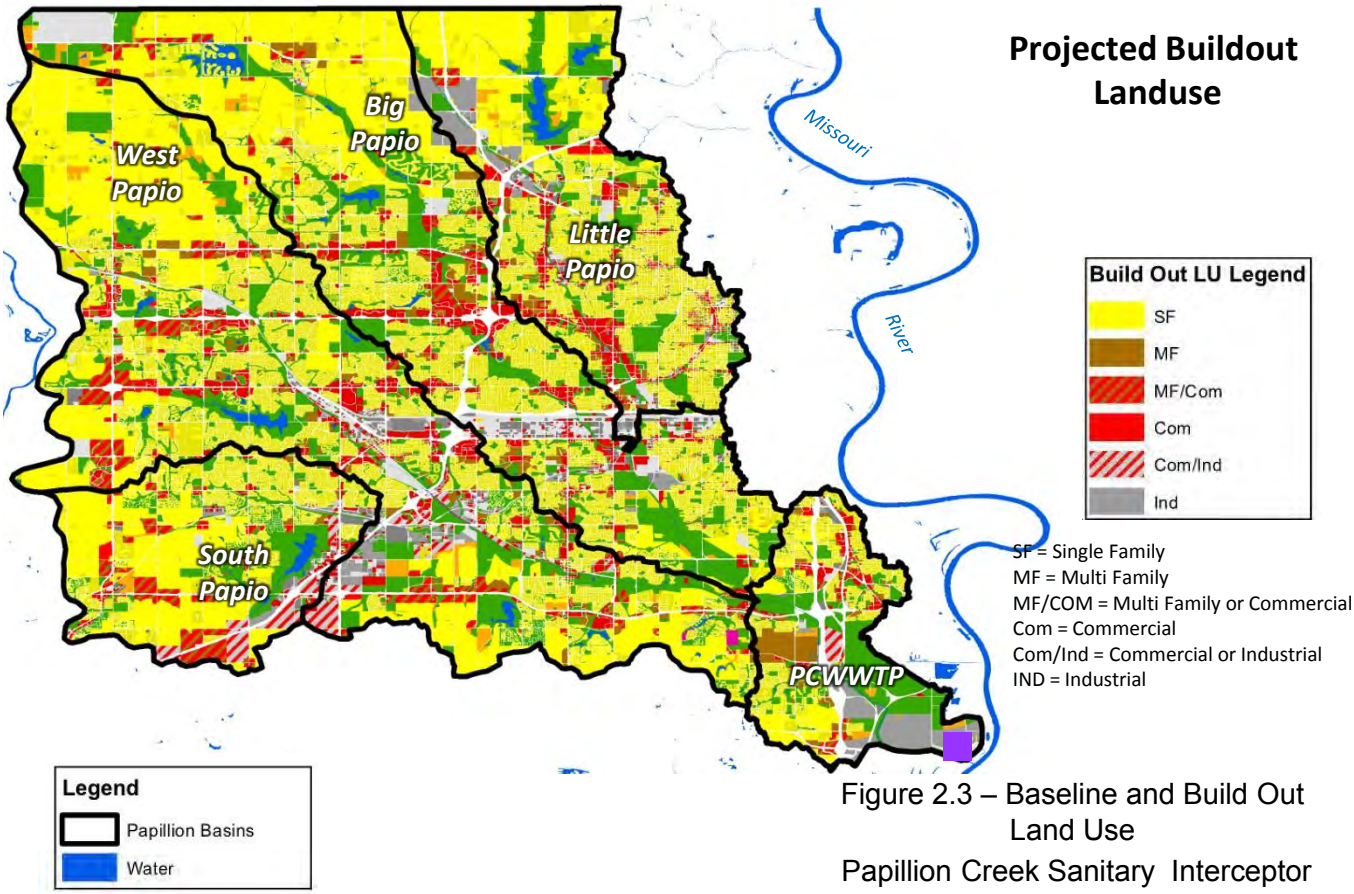


Figure 2.3 – Baseline and Build Out Land Use

Papillion Creek Sanitary Interceptor Master Plan

City of Omaha, NE

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2.4.2 Future Land Use Projections

The future land use information was provided to Carollo by MAPA in the form of GIS data consisting of a single file, which covered both Sarpy and Douglas counties. However, the future land use was not provided as parcel based data. The polygons were rather grouped by land use type and separated by roads and development boundaries. The land use area estimates within each polygon were already classified like the existing land use (SF, MF, COM, IND) but also included two additional categories for blends of MF with COM (MF/COM) and COM with IND (COM/IND). These additional two categories are predicted by MAPA when there could be a blend in the future land use estimates.

Within each of these future land use polygons, MAPA also provided population and employment estimates for each future planning period (2020, 2030, 2040, and 2050) based on the growth potential within each polygon from their model as discussed previously. The employment estimates were subdivided into COM and IND employment estimates.

Because no interim land use estimates were provided, area estimates for the interim periods (2020, 2030, 2040, and 2050) needed to be calculated. This is the second step of the two step process illustrated in Figure 2.2 which was discussed previously.

Step 2 uses the population and employment increases calculated for each sub-catchment in Step 1 to estimate the area of SF, MF, COM and IND land uses. It was assumed that population densities are distributed evenly across each MAPA polygon. The population densities were determined by averaging the calculated SF and MF population densities based on the existing land use and population from each of the major basins within the sewershed. This yielded 10.25 people per acre for SF and 29.13 for MF. A general overall sewershed population density SF and MF respectively calculated to 9.85 and 22.06. These Density estimates were based on an assumption that 80 percent of the increase in population will be SF and 20 percent of the increase in population will be MF, consistent with the MAPA assumptions for the Papillion Watershed Management Plan population and land use projections.

Due to these variances, this analysis determined that 10.8 people/acre for SF and 31.9 people/acre for MF would be conservative population densities to apply for future land use area projections based on select basins within the sewershed. These values correspond well with prior studies.

Once the SF and MF areas were calculated, the remaining area in the overlap polygon was assumed to be either COM or IND. The division of the remaining land in the overlap polygon as COM or IND was based on the COM and IND employment estimates provided by MAPA. These assumptions used to calculate future areas of land use in each sub-catchment follow that SF, MF, COM, and IND will replace OTHER land uses (e.g. agriculture, open space, etc.) as expansion or infill in each sub-catchment occurs. The 2050 land use acreages are summarized by basin in Table 2.3. Attachment 2 of Appendix A includes land use acreages by sub-catchment for all planning periods used in this study. Given that the SF and MF land use acreages were calculated based upon developable acres for SF/MF, it was assumed the project land use totals in Table 2.3, Table 2.4 and Attachment 2 of Appendix A can be classified as developable acres as well. This means that the baseline and projected totals can be directly compared in this report.

The second graphic in Figure 2.3 illustrates the land use coverage for build out. The build out graphic is included with the baseline land use graphic to show the extent of development within the service area. Much of the existing agricultural and open space lands are estimated to be replaced with residential, commercial, and industrial land uses within the service area. These future population estimates and land use areas were then used to calculate the future additional BSF contributions to the Papillion Creek Interceptors.

Table 2.5 2050 Land Use Area by Basin
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

Basin	Gross[1] Area (ac)	SF Area (ac)	MF Area (ac)	COM Area (ac)	IND Area (ac)	Other[1,2] Area (ac)
Big Papillion Creek Basin	46,117	17,445	1,700	3,745	1,115	22,112
Little Papillion Creek Basin	26,128	10,800	1,133	2,403	1,697	10,094
Papillion Creek Basin	12,217	3,434	1,040	915	1,716	5,113
South Papillion Creek Basin	18,052	6,695	336	2,634	826	7,560
West Papillion Creek Basin	59,358	20,993	1,730	6,585	1,952	28,099
Totals	**161,872**	**59,367**	**5,939**	**16,282**	**7,305**	**72,978**

Notes:
(1) Does not include highway/road corridors. Total sewershed area = 187,133 acres.
(2) Other includes areas not contributing sanitary flow (e.g. agriculture, open space, etc.).

Based on the estimates in Table 2.4, developed acreage in the service area that contributes to the base sanitary flow (SF+MF+COM+IND) is expected to increase from 35 percent (56,773 acres) to 55 percent (88,893 acres) of the gross area between baseline conditions and 2050. Therefore, the OTHER area (Agriculture, Open Space, etc.) is expected to decrease from 65 percent to 45 percent of the gross area, accordingly.

It must be stressed that this analysis is to estimate BSF for each sub-catchment which contributes to the interceptor sewer system. Therefore, land use or population changes within each sub-catchment polygon that don't significantly change the BSF in that sub-catchment are not critical to this analysis (although the accuracy of these future changes will matter when planning neighborhood sewers).

BASE SANITARY FLOWS AND MONITORED DATA

The main purpose of the population and land use projections discussed in Chapter 2 was to estimate the expected increase in base sanitary flows (BSF) for each sub-catchment. The interceptor improvements and expansions will be developed to accommodate these future flows. The process to calculate the existing and future BSF using the population and land use data is described below.

This section also includes documentation of the measured rainfall and flow data that was provided to Carollo by the City. The City owns and operates permanent flow meters and a rain gage network to quantify dry and wet weather flows within the PCWWTP service area. The City has been collecting both rainfall and flow data since 2010 based on the recommendations of the previous master plan study (SISE, 2009). This long-term data is instrumental in providing a quality database of flows, depths, velocities, and rainfall to facilitate the new calibration effort for the InfoWorks model (which will be discussed in detail later in this report).

3.1 EXISTING BASE SANITARY FLOWS

Estimating existing BSF requires metered dry weather flows (DWF). The existing flows assumed for each sub-catchment are necessary to predict unit factors that will be used to estimate future BSF. However, DWF also includes dry weather infiltration (DWI), so existing population and land use needs to be used to estimate BSF, which can then be added to an estimated DWI and calibrated to measure DWF.

The total existing BSF for the service area corresponds to the sanitary flow contributed by human, commercial and industrial activities to the system and is estimated at 37.7 MGD. It is expected to be close to the minimum flow that would be seen at the PCWWTP if there were no DWI (and no wet weather flows). The total DWI is estimated at 11 MGD, which produces an Average DWF (ADWF) of 48.7 MGD for the existing service area. These values were derived by analyzing meter data between 2010 and 2013. In particular, flows measured in January 2013 were used to help estimate DWF and BSF because DWI was very low during this period.

The metro area experienced a prolonged dry period, resulting in low average flows at the PCWWTP. It is assumed that this extended dry spell reduced the amount of dry weather infiltration into the sanitary collection system. The 2014 1st quarter average dry weather flow at the PCWWTP was approximately 39 mgd. The measured flow at the PCWWTP correlated very favorably with the estimated base sanitary flow, and provided a high level of confidence in the data and analysis techniques. The BSF from this data was used to estimate unit flow factors based on both population and land use.

Three typical methods are available for making BSF estimates at a sub-catchment level when population and land use estimates are available. Method 1 utilizes an iterative process to estimate the average unit population flow plus the average unit employment flow by comparing population, employment and measured BSF in each sub-catchment until a calculated average value in gallons per capita per day (gpcd) and gallons per employee per day (gped) provide a reasonable calibration to measured BSF for each sub-catchment as well as the system in total. This method could not be applied since there were no estimates of existing employment available for each sub-catchment.

Method 2 utilizes existing land use to calculate an average unit flow factor in gallons per acre per day (gpad) for each land use category. This method uses the Single Family (SF), Multi Family (MF), Commercial (Com), and Industrial (IND) acreages for each sub-catchment and iteratively estimates a unit flow for each based on the existing flows for each sub-catchment. Like Method 1, the differences in calculated and existing flows are minimized during calibration for each sub-catchment as well as for the system in total. However, this method has its limitations since different unit densities are averaged across the SF and MF categories. In reality, there can be significant differences in SF and MF densities on an acre basis. Also, parcel level data for future land use are rarely available from planning agencies, but are typically lumped together in larger polygons as is the case with the MAPA data described above.

Method 3 utilizes a hybrid approach where unit population flows are used to estimate human sanitary flows in each sub-catchment and unit acreage flows are used to estimate commercial and industrial flows. This method tends to be the most accurate of the three methods since it accounts for SF and MF densities as well as using acreage estimates for commercial and industrial flows since using only employee unit flow estimates for both COM and IND (Method 1) may not provide the most representative flows. Therefore, a unit flow per capita of 59 gpcd was calculated along with the gpad estimates for COM and IND land uses. This method provided both a smaller deviation between existing and estimated flows at a sub-catchment level as well as for the total service area. Figure 3.1 illustrates the process to develop the base sanitary flows for existing as well as future conditions.

Table 3.1 summarizes the results from the analysis for unit flow factors in gallons per capita per day (gpcd) for single family and multi-family residential and in gallons per acre per day (gpad) for industrial and commercial. These factors along with inflow and Infiltration rates calculated for each sewer basin sub-catchment were used in the hydraulic model to develop the CIP plan. The values presented in this table are for high level planning and modeling purposes, and are not intended for specific sanitary sewer design.

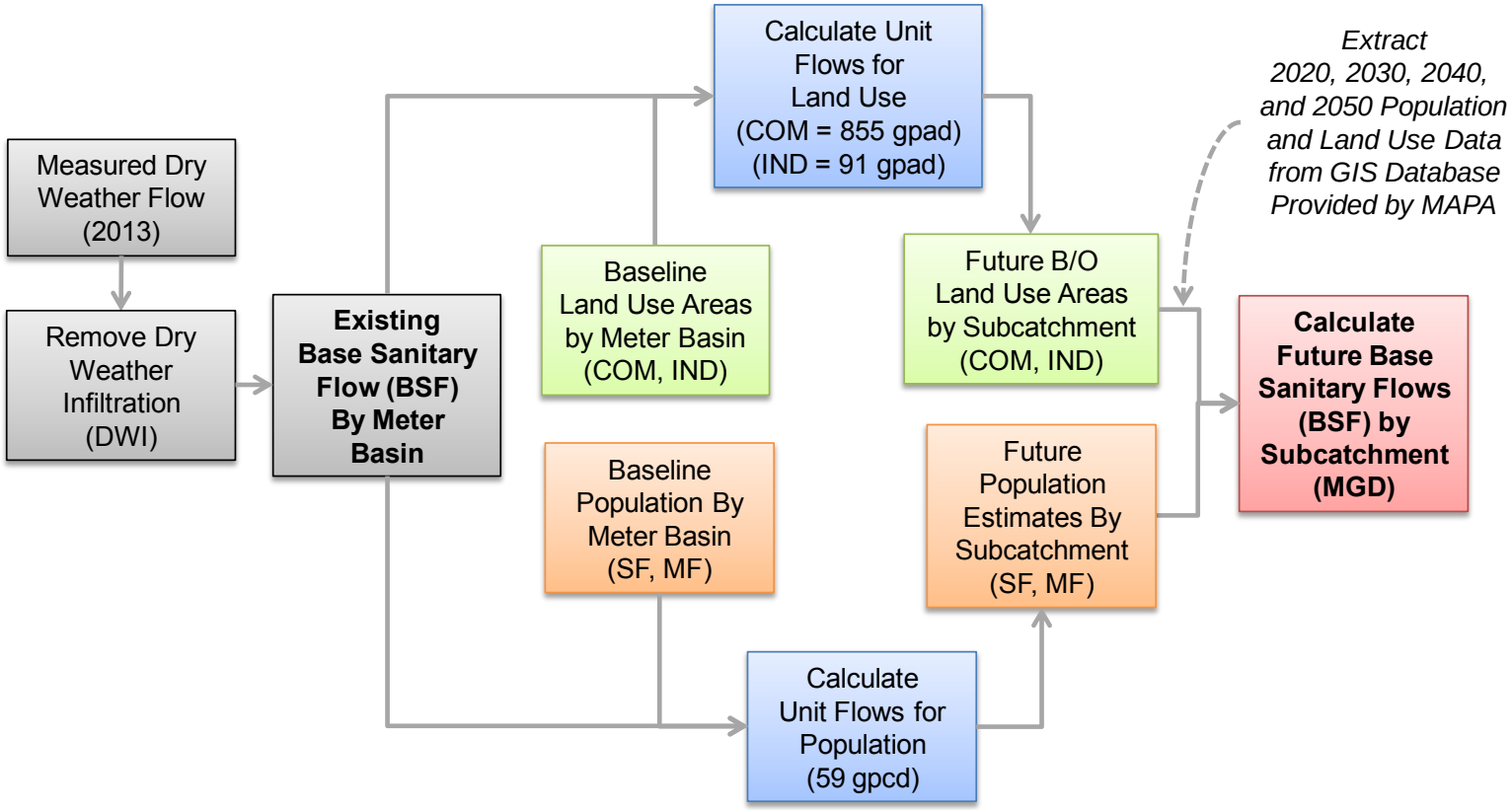

Figure 3.1 – Process Flow Chart for Estimating Base Sanitary Flows

Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

Table 3.1 Calibrated Base Sanitary Flow (BSF) Factors Papillion Creek Sanitary Interceptor Master Plan City of Omaha, NE		
Land Use Category	**Unit**	**Value**
Single Family Residential (SF)	gpcd	59
Multi-Family Residential (MF)	gpcd	59
Commercial (COM)	gpad	855
Industrial (IND)	gpad	91

3.2 FUTURE BASE SANITARY FLOWS

Method 3, a combination of utilizing the projected population numbers and projected COM and IND acreages, was employed to make future BSF estimates for this study. A population unit flow factor of 59 gpcd was applied to the future population (SF, MF) numbers, and land use flow factor were applied to the future land use projections (COM = 855 gpad, IND = 91 gpad) to calculate future BSF. The total base sanitary flow for each basin for each planning year period is summarized in Table 3.2. Attachment 3 of Appendix A lists the BSF by sub-catchment for each planning year period. These base sanitary flows do not include infiltration that can be present during dry weather conditions due to groundwater.

Table 3.2 Baseline and Future Base Sanitary Flow Estimates by Basin Papillion Creek Sanitary Interceptor Master Plan City of Omaha, NE						
Basin	**Baseline BSF (MGD)(1)**	**2020 BSF (MGD)(2)**	**2030 BSF (MGD)(2)**	**2040 BSF (MGD)(2)**	**2050 BSF (MGD)(2)**	**Percent Increase from Baseline Year**
Big Papillion Creek Basin	11.80	12.99	14.13	15.13	16.30	**38%**
Little Papillion Creek Basin	8.08	8.79	9.41	9.81	10.16	**26%**
Papillion Creek Basin	3.06	3.53	3.90	4.10	4.26	**39%**
South Papillion Creek Basin	2.95	3.54	4.44	5.59	7.00	**137%**
West Papillion Creek Basin	11.84	13.98	16.46	18.92	21.30	**80%**
Totals	**37.73**	**42.83**	**48.34**	**53.56**	**59.02**	**56%**
Percentage Increase from Baseline Year	**-**	**14%**	**28%**	**42%**	**56%**	**-**

Notes:
(1) As calculated using 2010 census data and City 2013 land use.
(2) As calculated using the MAPA population projections and land use projections.

As shown in Table 3.2, BSF will increase by 56 percent between 2010 and 2050. The majority of the growth is forecasted to occur in the Big Papillion, Little Papillion, South Papillion, and West Papillion Creek Basins.

3.3 MONITORED RAINFALL AND FLOW

The City has collected rainfall and flow data since 2010. At the beginning of this study, data was available through 2013. A summary of the data can be seen in Table 3.3. Carollo evaluated the datasets described in Table 3.3 to determine which would be best to perform model calibrations. Based on an extensive analysis of the data, Carollo and the City decided to further evaluate the 2010 (April through August) and 2013 (April through August) data to determine which should be used for model calibration.

Table 3.3	**Summary of Monitored Rainfall and Flow Data Papillion Creek Sanitary Interceptor Master Plan City of Omaha, NE**	
Parameter	**2010 Season (April – August)**	**2011-2013**
General	• CSO Calibration Effort • Data Interval: 5 minutes • Data used for 2010 calibration • Most data is good quality	• Continuous monitoring program • Data Interval: 15 minutes • 2013 data is good quality • 2011 and 2012 data is fair to poor quality
Rainfall	• 8 ground level gauges (City) • 13 NRD gauges • Radar rainfall extrapolation for each sub-catchment	• 8 ground level gauges (City) • 13 NRD gauges • Radar rainfall not used
Flow	• 13 permanent flow meters • 9 temporary flow meters	• 13 permanent flow meters

Advantages and disadvantages associated with the 2010 and 2013 data sets are summarized in Table 3.4. Based on this information and discussions with the City, the 2010 data set was selected for use in the new calibration effort. The major reasons why the 2010 data was used is because a calibration had already been performed using the data for the CSO model and this period also had detailed radar rainfall data that provided much more defined hyetographs across the 300 square mile service area. The available monitored flow, depth, and velocity data during 2010, including extensive rainfall data for virtual rain gages that were developed during the radar analysis program, provided the data necessary for a comprehensive calibration effort.

Table 3.4	Comparison of 2010 and 2013 Monitoring Data Papillion Creek Sanitary Interceptor Master Plan City of Omaha, NE	
Data Set	**Advantages**	**Disadvantages**
2010 (Apr – Aug)	• Consistent with CSO modeling (latest calibration effort) • Good rainfall response during period • Radar rainfall hyetographs in model for each sub-catchment • Flow & Level data in model • Temporary meters provide additional coverage	• High Dry Weather Infiltration • High Rainfall Induced Groundwater Infiltration
2013 (Apr – Aug)	• Newest data available • Fair rainfall response during period	• Rainfall averaging (Theissan polygons) from ground gages would be necessary for sub-catchments • Rain, flow and level data would need to be entered into model • Significant new calibration effort • 2011 and 2012 data is fair to poor quality

3.4 FLOW METER DATA ANALYSIS

There were 13 permanent flow meters and nine (9) temporary flow meters that were operational during 2010. Table 3.5 summarizes the information for these meters. Most of the data available for these meters, including depths, velocities, and flows, were of good quality. However, temporary meter 31 had data problems with measured accuracies during the calibration period and was therefore not used for calibration of 2010 dry or wet weather flows. The extensive metered data provided excellent information on the flows in interceptor system. However, due to the relatively few meter locations for the size of the service area, detailed information on the location of inflow and infiltration (I/I) at a small sub-catchment level was not possible. More information on the I/I analysis can be found in Chapter 4.

Table 3.5 Summary of Flow Meters
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

Meter Number	Manhole Number	Meter Type	Location	Pipe Diameter (in)
PERMANENT FLOW METERS				
32	0390004	ADS Flowshark	109th St & West Dodge Rd	30
33	0839020	ADS Flowshark	10800 Leavenworth St	54
36	0699028	ADS Triton	6303 L St	66
37	0719008	ISCO ADFM	4949 S 66th Plaza	72
42	0942004	ADS Flowshark	S 140th St & Old L St	30
43	0941005	ADS Flowshark	S 143rd St & Dayton St	48
44	4051002	ADS Triton	S 118th St & Harry Anderson Blvd	60
45	4052060	ADS Flowshark	110th St & Olive St	30
46	4052015	ISCO ADFM	S 109th St & Harry Anderson Blvd	72
47	4052051	ISCO ADFM	36th St & Brook Dr	78
48	4062002	ADS Triton	S 48th St & Cornhusker Ave	90
PCWWTP	401001	ADS Flowshark	Upstream of PCWWTP and downstream of CSO 201	108 x 108
59(1)	4052005	ADS Flowshark	110th St & Olive St	18
TEMPORARY FLOW METERS(2)				
5(3)	0692016	2150	66th and Center Street	30
6(3)	0692082	2150	63rd and Castelar Diversion	36
30	0421003	2150	115th and Papillion Parkway	24
31	0420005	2150	120th and Blondo Street	36
34	0265048	2150	78th and Davenport	42
35	0711065	2150	66th and Center Street	60
39	1142005	2150	163rd and Douglas Street	16
40	1142100	2150	166th and Farnam Street	30
41	0977005	2150	152nd and Grover Circle	30

Notes:
(1) Located along pipe that isn't included within the InfoWorks model so not included in this analysis.
(2) As denoted in City GIS database.
(3) Installed as part of CSO program and wasn't used in this analysis.

Figure 3.2 illustrates the locations of the flow meters within the interceptor system and the upstream flow meter basins that are defined by the meter locations. Figure 3.3 illustrates layout of the flow meters as a schematic representation of the meter sites.

Note: All modeled subcatchments were included in this figure for illustrative purposes as the flow metering basins were delineated using the subcatchment and sewer network connectivity within the InfoWorks model.

Figure 3.2 – Flow Metering Schematic
Papillion Creek Sanitary Interceptor
Master Plan
City of Omaha, NE

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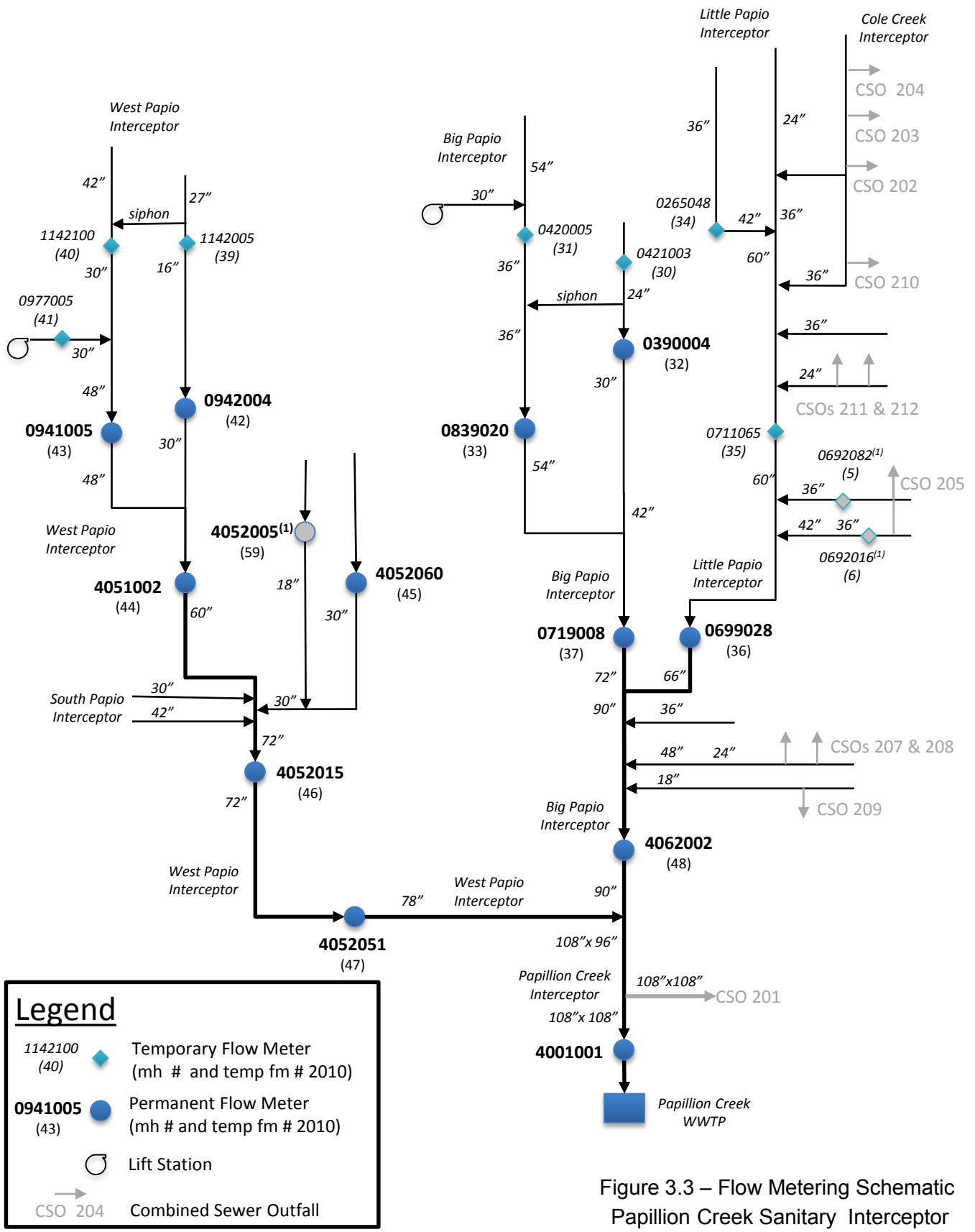

Notes:

(1) Flow meter not used during model calibration effort.

Figure 3.3 – Flow Metering Schematic
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

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3.5 RAINFALL ANALYSIS

The City owns and operates eight (8) ground level rain gages, which have a tipping bucket configuration and measures accumulated rainfall volume at 5-minute intervals. The City also has access to 13 Natural Resources District (NRD) gages throughout the service area, which are operated and maintained by NRD. Although 21 gages may seem like a good distribution of gages to quantify the rainfall across the service area, this network can easily miss intense rainfall patterns. If these types of rainfall patterns are missed, then it would be very difficult to calibrate the interceptor model to accurately represent inflow and infiltration across a multitude of events. This is especially true for the CSO area, which is why the City decided to supplement this data with radar rainfall during the 2010 Flow and Rain Monitoring Project. Figure 3.4 illustrates an example of the ground level rainfall captured at RG1, which was located at 102nd and U Street, from June 20th through June 23rd, 2010.

These ground level gages are also used to adjust (or “ground truth”) the radar data that was developed during the 2010 calibration period. The radar rainfall images, along with the ground level rainfall data, were used to create virtual rain gages. A primary reason the 2010 period was chosen for calibration of the PCWWTP service area was because of the excellent coverage and resolution the radar rainfall virtual gages provided. Without the virtual gages, it would have been difficult to accurately calibrate the model throughout the interceptor system. This fact doesn’t preclude the City from running other rainfall periods through the model by developing virtual rain gages using other techniques (like the Theissen Polygon Method of Rainfall Distribution) based on the 21 ground level gages. However to be truly accurate over the 300 square mile service area, it is recommended that radar rainfall images be used to develop the extensive virtual gage network.

Carollo assumed that the 2010 virtual rain gage data was as accurate as possible since it was used for the CSO LTCP modeling. Therefore, no adjustments were made to this data set, which was already available and input to the InfoWorks model. However, to provide a little more background on the statistics of the rainfall in the area for 2010, several graphs were developed using the hourly rainfall recorded by the National Oceanic and Atmospheric Administration (NOAA) gage at Eppley Airport. NOAA maintains high quality data at their gages and this gage provides a generalized example for precipitation patterns within the service area. Figure 3.5 illustrates hourly rainfall at the Eppley Airport gage over 2010. Figure 3.6 illustrates this same rainfall period with accumulated total volumes. At this gage, Omaha experienced slightly more than 35 inches of precipitation in 2010. Figure 3.7 illustrates daily, weekly, and monthly precipitation totals for 2010. These graphs are provided to show general trends in precipitation, but were not directly used in the calibration effort. These trends were used to illustrate the general rainfall patterns in the area for this calibration period. This was done to provide a general sense of the rainfall since the virtual rain gage data includes hundreds of individual virtual gages that are too extensive to summarize in any meaningful way. Therefore, the Eppley data was considered an adequate surrogate for illustrative purposes.

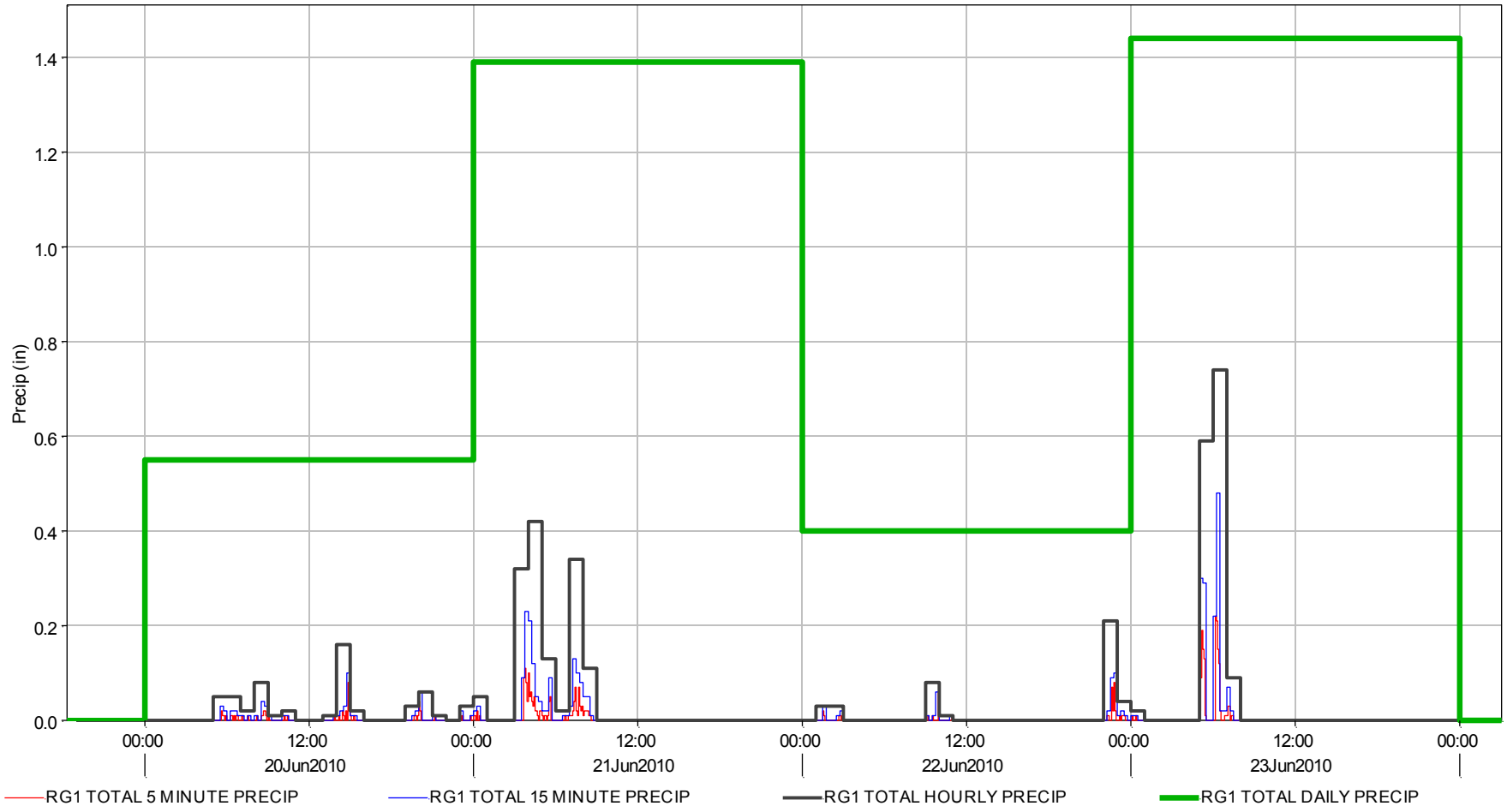

Figure 3.4 – Example Rainfall at gage RG1
(June 20-23, 2010)
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

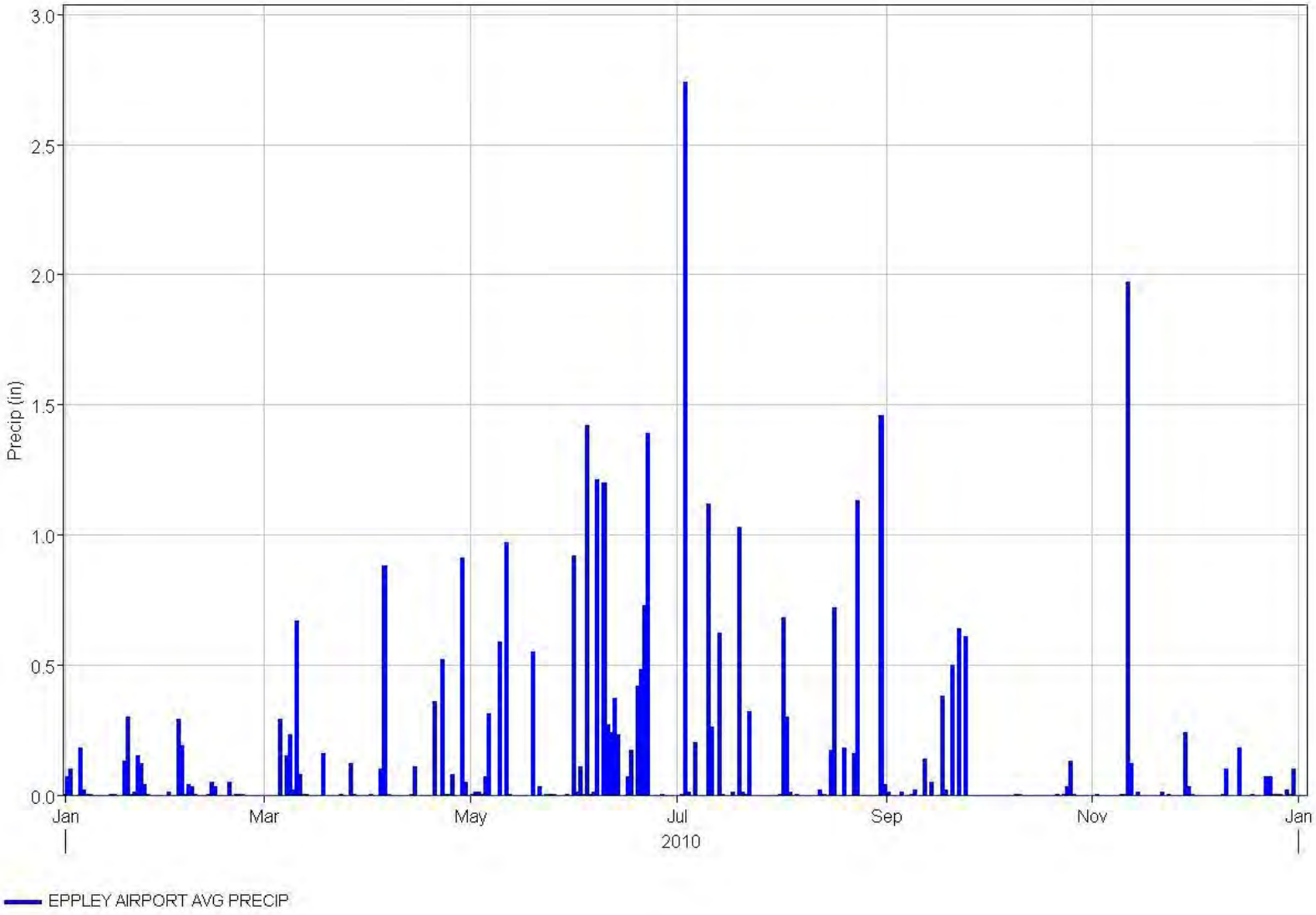

Figure 3.5 – Daily Rainfall at Eppley Airport (2010)
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

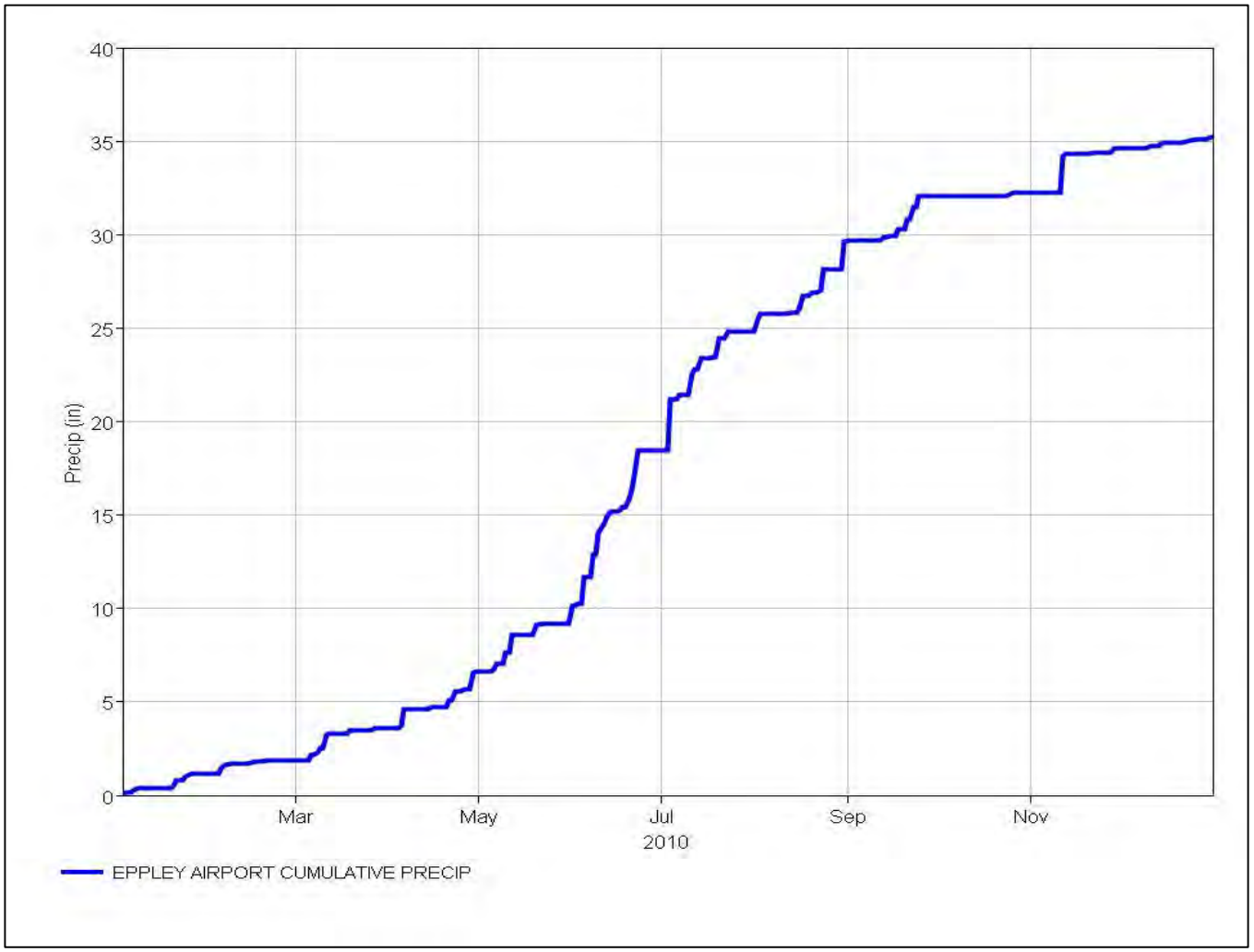

Figure 3.6 – Cumulative Daily Rainfall at Eppley Airport (2010)

Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

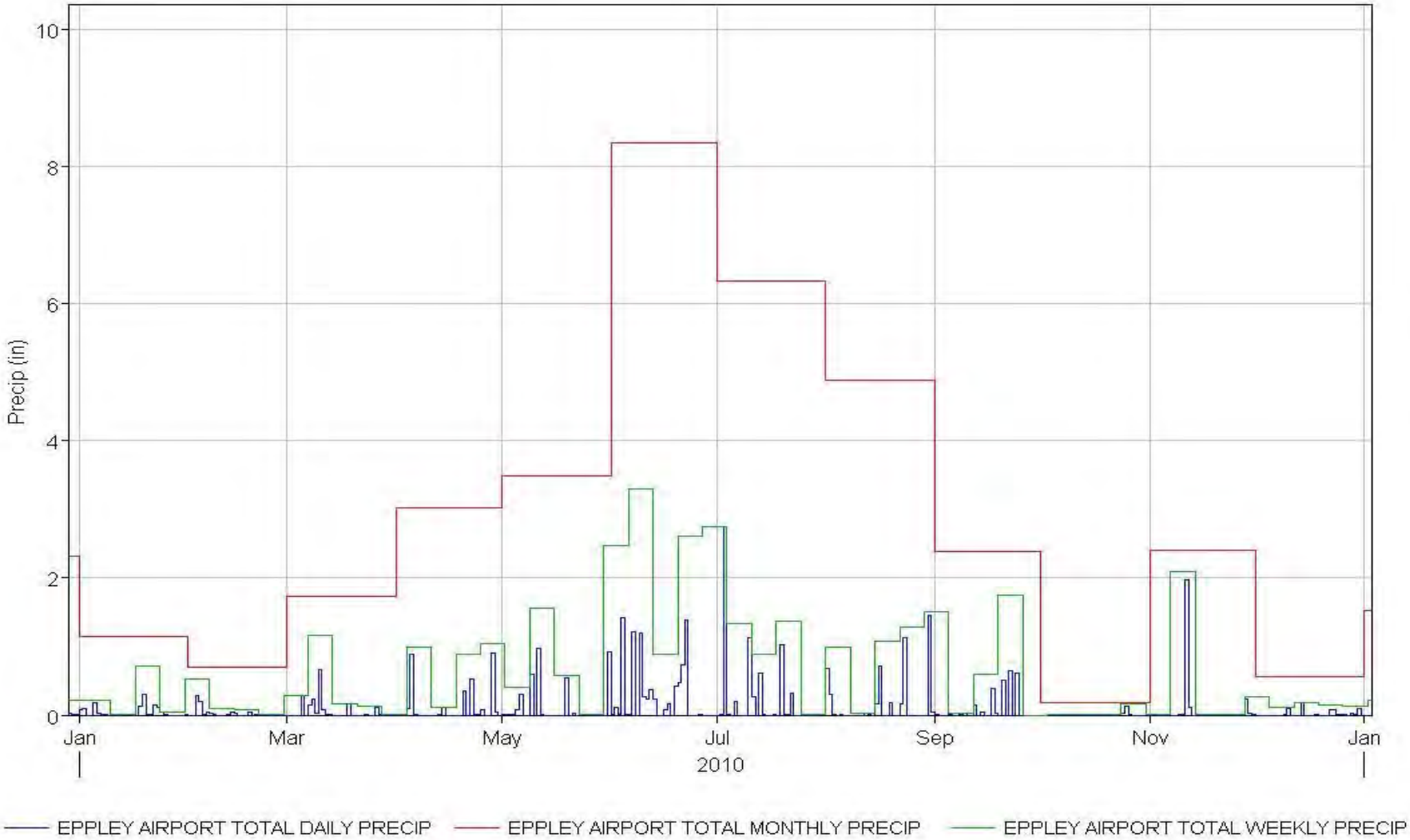

Figure 3.7 – Daily, Weekly, and Monthly Rainfall at Eppley Airport (2010)
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

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Chapter 4

EXISTING SYSTEM ANALYSIS

4.1 INTRODUCTION

This chapter begins with a summary of the updates to the interceptor system model and describes the results of a broad-level inflow and infiltration (I/I) analysis. Levels of service (LOS) assumptions are then described in detail as they apply to analyzing the existing system, while a summary of recommended design assumptions is included for application to sewer extensions to serve growth. Based on the LOS criteria, the updated and calibrated model was used to examine existing system deficiencies. These existing deficiencies are described in this chapter, while future needs, based on increases in flows due to growth, are described in the next chapter.

4.1.1 Update of Interceptor System Model

The City owns and operates an InfoWorks CS collection system model that has been built and updated by the CSO Program Management Team (PMT) who completed the CSO LTCP. This model was given to Carollo to update the interceptor hydraulics and flow inputs based on the most current data. Carollo worked with the City and PMT to bring the hydraulics of the model up to date with the best available field and as-built information. The majority of the modeled network for the Papillion Creek service area only includes pipes that are classified as interceptor pipes. The modeled pipes total about 1 million of the 8 million linear feet of sanitary sewers that are included in the service area.

For planning purposes and Interceptor Sewer Fund Allocation the definition for an interceptor is as follows:

"An interceptor sewer serves an area greater than 1,000 acres or more than 10,000 people; or has two or more upstream S&ID outfall connections"

This definition was important to determine areas that were not modeled in detail such as the collector lines to the Elkhorn Plant. This definition was also applied to understand the limits of the future extended sewers.

It is important to note that toward the end of the modeling analysis to the existing system and development of the draft CIP, the area upstream of the Elkhorn Treatment plant was found to require more detail in the model. The City staff evaluated GIS and as-built information and provided some data to be added to the model to support the extension or upsizing of collectors serving as interceptors to the Elkhorn WWTP. The study has determined that further refinement of the model in this region is necessary to plan for the future growth beyond the near term projects.

Detailed estimates of DWF and WWF throughout the system on a sub-catchment basis (very similar to the CSO system model) were completed. The model was extensively recalibrated to accurately predict a variety of flow conditions based on measured flows, depths, and velocities. The permanent metering system located throughout the interceptor system provided an excellent database of information to complete this model calibration. A database of ground-level rain gages as well as radar rainfall estimates supplied by the PMT provided critical information for accurately estimating flows throughout the 300 square mile service area. The model provides an excellent predictor of flows and hydraulics throughout the interceptor system. Appendix B provides the details on the model updates, calibration and validation procedures, and results.

4.1.2 Inflow and Infiltration Analysis

Inflow is rain water other than sanitary flow that enters a sewer system from sources which include roof leaders, cellar drains, yard drains, manhole covers, cross connections between storm drains and sanitary sewers, and storm water catch basins. Infiltration is water other than wastewater and inflow that enters a sewer system from the ground through means, which include defective pipes, pipe joints, or manholes (including service connections and foundation drains). Excessive Inflow and Infiltration (I/I) caused by significant storm events can contribute to the occurrence of overflows during and immediately after storm events as the capacity of the sewer system reaches its limits. Excessive I/I can also incur unnecessary treatment costs when conveyed to downstream wastewater treatment plants.

The City has limited information in the GIS for smaller diameter pipes that do not meet the definition of an interceptor. Therefore, the I/I analysis had to be completed at the flow meter basin level, which averages the I/I over all sub-catchments in each meter basin. I/I ratio estimations were performed separately for inflow and infiltration based on the updated wet weather calibration. The severity of I/I was calculated by dividing the estimated contributing area for inflow or infiltration by the total area in each sub-catchment. This simple ratio gives an indication of the severity of I/I at the basin level. Typical I/I ratios range from zero to about five percent.

The sanitary basins (and contributing sub-catchments) exhibited low levels of inflow (typically below three percent). The basins with inflow above three percent are generally basins collecting combined flow during wet weather, with the exception of the Hell Creek area that was built in the 1960's and 1970's. There were three basins that exhibited greater than six percent ratios for infiltration. These include one basin along the Big Papio Creek, just upstream of the confluence with the West Papio Creek which has 90 year old sewer; another near 120th and Blondo known for past I/I issues; and a basin along the West Papio Creek with SID's from the 1960's and 1970's. The City is aware of these areas and will continue to study and plan for the necessary rehabilitation.

Appendix C further describes I/I and details the analysis to quantify I/I. Based on this analysis, and the averaging of I/I ratios across the large meter basins, it is recommended that a study be initiated to include a process to further identify I/I within the PCWWTP service area, define the most cost-effective basins to rehabilitate to reduce I/I in the system, to provide the most benefit in reducing peak flows to the PCWWTP.

4.2 LEVEL OF SERVICE ASSUMPTIONS

LOS assumptions were developed by the City and Carollo to apply to the modeling effort to determine potential deficiencies in the current system and what conditions would need to be planned for in the future. The LOS criteria included assumptions on the level of design storm that would be applied to predict peak wet weather flows, the acceptable surcharge criteria in the pipelines to determine hydraulic deficiencies, the improvement configurations for existing pipelines (e.g. parallel versus upsizing), and minimum slopes for sewer extension pipelines.

4.2.1 Design Storm

It was decided by the City and Carollo that a 10-year, 24-hour design storm would be used to determine inflow conditions that would test the hydraulic capacity of the sewers during wet weather conditions. The 10-year, 24-hour design storm for Omaha has a peak 1-hour intensity of 1.82 inches per hour and a total volume of 4.28 inches of rain in 24 hours. This design event was developed using an SCS Type II distribution.

This level event is commonly used to plan sanitary sewer collection system improvements because it provides a reasonable level of wet weather I/I. For analysis purposes, this storm is applied equally throughout the 300 square mile service area. While this type of storm would usually not occur evenly across such a large area, it still provides a good planning level event to assess the capacity of the sewers on an equal basis.

The chosen design event will produce the majority of the inflow within the interceptor model, but assumptions need to be made to estimate a design condition for infiltration since this short duration, high intensity rainfall event will not produce appreciable wet weather infiltration, which occurs due to long wet periods that saturate the soil conditions.

4.2.2 Design Level Infiltration

Both dry and wet weather infiltration was accounted for during the design storm event. During the model update and recalibration both were determined and evaluated separately. The dry weather infiltration was calculated to be 11 MGD. During model runs this value is considered to be constant over the week period used to project design flows. This value was determined during dry weather flow calibrations and seems to represent a reasonable base infiltration estimate. This value was verified during drought conditions where very little dry weather infiltration was measured and the measured dry weather sanitary flows corresponded directly to measured sanitary flows at the plant meaning the assumption for dry weather infiltration is valid. This analysis is documented further in the discussion on the existing base sanitary flows in Chapter 3.

Wet weather infiltration is also necessary to account for independently because the design storm won't produce saturated soil conditions that contribute significant wet weather (including groundwater) infiltration. Therefore, wet weather infiltration is accounted for in the model through the updated wet weather calibration effort. The model was used to very accurately estimate saturated soil conditions and back-to-back storm events that produce design level infiltration conditions. It was decided by the City and Carollo that the wet weather infiltration will be calculated inside InfoWorks through the infiltration subcatchments. This means that the wet weather infiltration will vary based on the calibration and the design storm run through the model.

Therefore, the design flows projected for the existing design level event included dry weather infiltration (constant 11 MGD), dry weather flows (hourly diurnal flows averaging 37.7 MGD), wet weather infiltration (based on flow from infiltration sub-catchments), and wet weather inflow (based on 10-year event rainfall and calibrated I/I response). As mentioned above, the service area does have significant infiltration, which should be further quantified and managed.

4.2.3 Total Peak Design Flow

The peak inflow was aligned with the peak infiltration and peak dry weather flow to produce the peak total flow for the design event. The peak baseline wet weather flow upstream of the PCWWTP was estimated at 189 MGD. This correlates well to major historic events measured at the PCWWTP. For example, in the summer of 2014, the PCWWTP measured approximately 182 MGD based on a very large storm event. Because of the extent of the system, it is hard to define a specific design event based on a historical storm, but some rain gages registered rain close to 100-year rain event. Therefore, this historical event could have easily registered as a 10-year event, on average, across the entire system.

The projected 2050 estimate for peak flow equaled 209 MGD, which is an increase of 20 MGD over baseline conditions. This increase in peak flow is mainly due to the increase in peak dry weather flows due to growth. This peak flow is what could be expected at the PCWWTP in the future if no upstream restrictions were present in the interceptor system. Figure 4.1 illustrates the 10-year design event hyetograph and the associated baseline and 2050 hydrographs upstream of the PCWWTP.

4.2.4 Hydraulic Conditions

Two hydraulic conditions are used to examine the hydraulic results in the model; depth to diameter ratio (d/D), and surcharge. A d/D ratio is used to examine the “capacity” of the pipeline under certain flow conditions. The “d” is the depth of peak flow in any give interceptor segment and the “D” is the diameter of the pipes within that segment. Although a d/D of 100 percent typically is referred to as full pipe “capacity,” more flow can be conveyed through a sewer pipe under surcharge conditions (when the slope of the hydraulic grade line exceeds the slope of the pipe and the complete sewer segment is surcharged).

Therefore d/D is typically used to assess dry weather flow conditions. DWF (which includes base sanitary flow and dry weather infiltration) is applied in the model and the d/D ratios are examined to judge how efficient the system is in conveying DWFs. This ratio should always be lower than 90 percent and is typically judged acceptable if it is in the 75 to 85 percent range during peak dry weather flows. If this ratio is found to be too low during peak DWF (e.g. 20 percent) then deposition can be a problem since the flushing velocities will be low (e.g. less than 3 feet/sec).

The wet weather LOS surcharge condition for analysis of deficiencies in the existing network and future system configurations were chosen to be a peak hydraulic grade line (HGL) no closer than 3 foot below the rim elevation of any manhole along a reach of pipeline during the 10-year, 24-hour design event. This criterion would allow some surcharge during design event conditions, but allowed a margin of safety in the HGL predictions so as to limit the potential for an SSO. If a manhole has a rim elevation less than 3 feet from the crown of the pipe, this criteria does not apply since these shallow manholes are usually sealed and allow for surcharge conditions (or will need to be sealed in the near future).

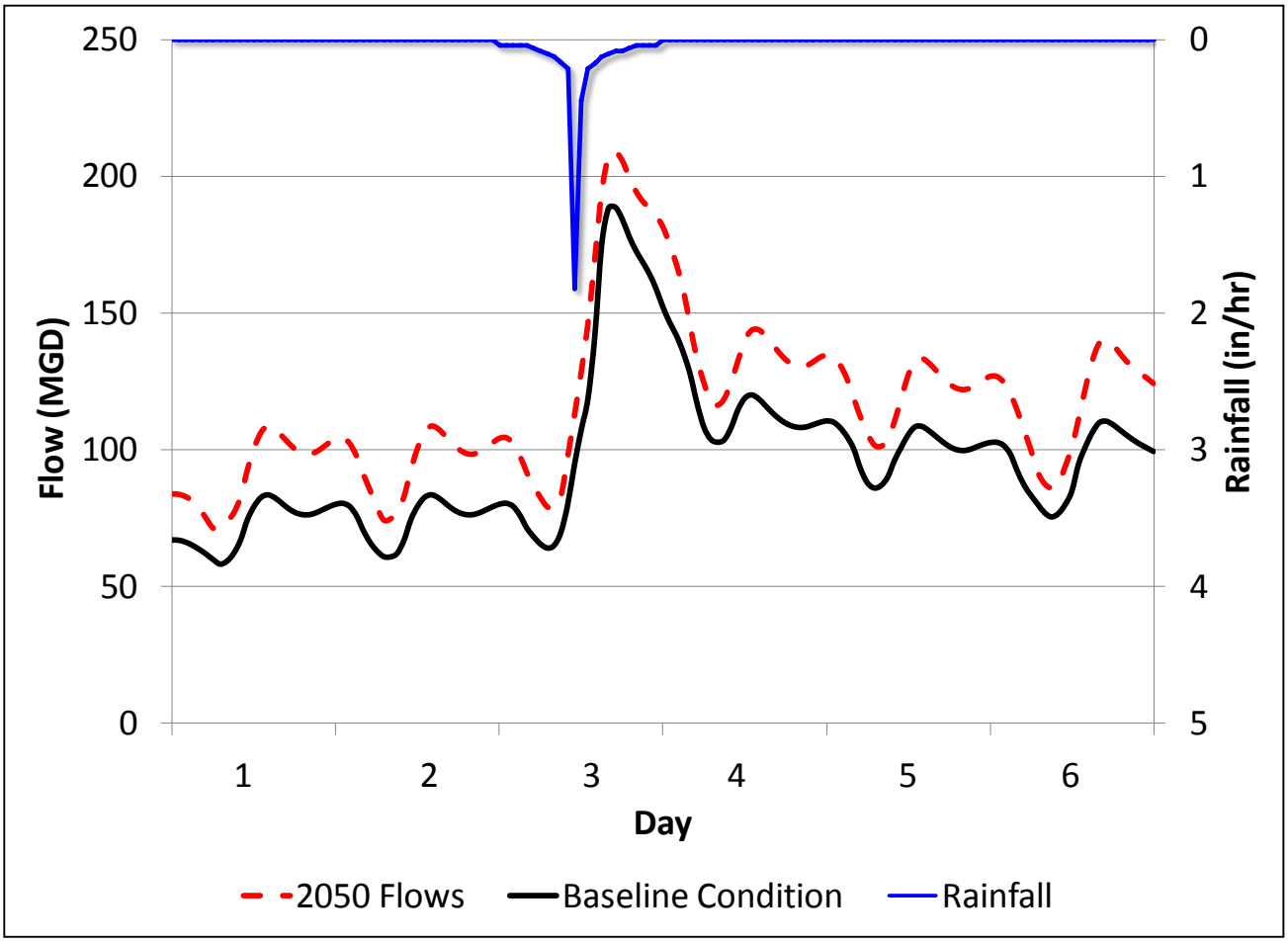

Figure 4.1 - Baseline and 2050 Design Flows Upstream of PCWWTP
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

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However, this surcharge condition does include some associated risk. This risk depends on the invert elevations of the lateral sewers that connect into the interceptor system. These lateral sewers are not included in the model but are the smaller diameter pipelines that directly service residential, commercial, and some industrial facilities. The City indicated that there were very few complaints related to wet weather backups and flooding due to wet weather events within the PCWWTP service area. As growth continues, and rainfall events larger than a 10-year, 24-hour event occur (which will happen, and may be more frequent due to climate change), surcharge and flooding should be closely tracked to make sure lateral sewers aren't being affected due to peak HGLs in the interceptor system.

4.2.5 Sewer Extension Criteria

Two additional LOS criteria were applied to new sewer extensions within the system. The first criterion includes that parallel pipes will be used where possible to relieve existing restrictive pipelines, instead of full pipeline replacement and upsizing which is usually more expensive than a smaller diameter parallel pipe to convey wet weather flows. This is the case unless multiple parallel pipelines already exist within the reach of the restrictive section.

However, this multiple pipeline criteria may be adjusted depending on the given situation with approval of the City. This criterion will need to be further investigated during detailed design, since an existing sewer may need to be replaced due to structural deterioration or is at the end of its useful life, and therefore a parallel sewer may not make sense if a larger sewer can just replace the existing restrictive sewer that will need to be replaced anyway.

The second criterion includes that any new pipelines that were configured as sewer extensions to accommodate growth in upstream areas of the service area would have a minimum slope of 0.09 percent. Planning level sewer extensions were laid out very simply, using existing stream alignments and general topography, in order to service upstream areas. Additional detailed design will need to be developed for these sewer extensions in the future. Therefore, these alignments may change and the size and slopes may change due to localized conditions. However, major changes are not expected in the diameter or length of sewers.

4.3 RECOMMENDED DESIGN CRITERIA

A review of criteria presented in previous reports along with a review of the data used in this report was conducted to develop recommended design criteria for new sewer extensions. These flow criteria are consistent with information presented in previous reports, as well as with regulatory and other published design criteria (NDEQ Title 123, Ten States Standards).

Table 4.1 summarizes the recommended design flows on a unit gallon per capita per day (gpcd) basis to be used for new sanitary interceptor extensions and for sewers that may meet the definition of an interceptor. Designs that do not utilize the recommended criteria must provide a study that justifies the use of different criteria, and must be approved by the Public Works Department.

Table 4.1 Sanitary Sewer Interceptor Extension Unit Flow Rates
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

Source	Unit	Value
Single Family Residential (SF)	gpcd	83
Multi-Family Residential (MF)	gpcd	83
Commercial (COM)	gpad	1,500
Industrial (IND)	gpad	1,500
Infiltration/Inflow (new growth areas)	gpcd	17

These criteria apply to the design of sanitary sewers that are extended for new development. The designs of interceptors that serve existing developed areas will require an evaluation of the potential I/I contribution and may result in an adjustment to the I/I allowance used in the design.

Table 4.2 summarizes the population density statistics that should be used when estimating population per dwelling unit (DU) or per acre. These numbers have been carried over from past studies, or based on the MAPA data used for this study if new information was provided. A ratio of peak hourly flow to average flow should be calculated by the Standard City of Omaha Equation: PF = 4.5 – 0.5 x Log10 (Population). This peaking factor is applied after unit flow rates for I/I are added to the contributing area average flow rate for sewers in areas of new construction.

Table 4.2 Estimated Density Variables
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

Variable	Unit	Value
Single Family Residential (SF)	people/DU	2.58(1)
Multi-Family Residential (MF)	people/DU	1.76(1)
Residential Aggregate SF/MF	people/DU	2.47(1)
SF Dwelling Units (DU) per Gross Developable Acres	DU/ acre	4.26
MF Dwelling per Gross Developable Acres	DU/acre	15.37

Table 4.2 Estimated Density Variables Papillion Creek Sanitary Interceptor Master Plan City of Omaha, NE		
Variable	**Unit**	**Value**
Commercial/Industrial (COM/IND)	Acres allotted/100 people	3.6(2)
Gross Developable Acres to Total Gross Acres	percent	68.5%(1)
Population per Total Gross Residential Acres	People/acre	8.3(1,2)
Notes: (1) Updated since 2009 study based on MAPA input. (2) Use only for planning and design if specific land use is unknown.		

The following information is provided to clarify the use of information provided in Table 4.2:

- If commercial/industrial acres are not known or specifically designated otherwise under direction of the City's Planning Department, the estimation of 3.6 gross developable acres per population of 100 people can be assumed. This value aligns with previous studies.
- The term "gross developable acres" for SIDs and commercial/industrial parcels means the total land area encompassed by a parcel's outer property boundaries, which includes interior streets and green space.
- The term "Total Gross Acres" which may also be referred to as Total Gross Residential acres, excludes certain green space areas within a development, such as major stream riparian areas and forested and/or steep terrain areas. Other external set-aside areas that are not considered part of "gross acres" include highways; schools; parks and native prairies; regional reservoirs; the Douglas County Landfill and its assumed eastward expansion area; and other reserved government property. Therefore, actual total land consumption ("total gross acres") will be considerably higher and will vary among sub-basins.

4.4 EXISTING SYSTEM CAPACITY AND RESTRICTIONS

The LOS criteria (described in section 4.2) were applied to the baseline conditions in the existing InfoWorks model to examine what capacity deficiencies are currently present within the interceptor system. The flows generated by the model include the 10-year, 24-hour inflow, the wet weather infiltration, the existing sanitary flow, and the dry weather infiltration. The model was run over a five-day period and results were reported at an hourly timestep. The hydraulic conditions the model produced were then examined based on the LOS criteria for d/D for dry weather and surcharge criteria for wet weather flows.

4.4.1 Dry Weather Hydraulics

The model was initially run using calibrated DWFs to examine the hydraulic conditions within the interceptor system during typical dry periods. It was found that dry weather peak flow conditions did not contribute to any surcharging in the current interceptor system.

However, peak DWFs caused some pipelines to exhibit high d/D ratios near 0.8 (or 80 percent capacity). Therefore, the current interceptor is properly sized for existing DWF's, but some interceptor reaches are approaching their peak DWF capacity.

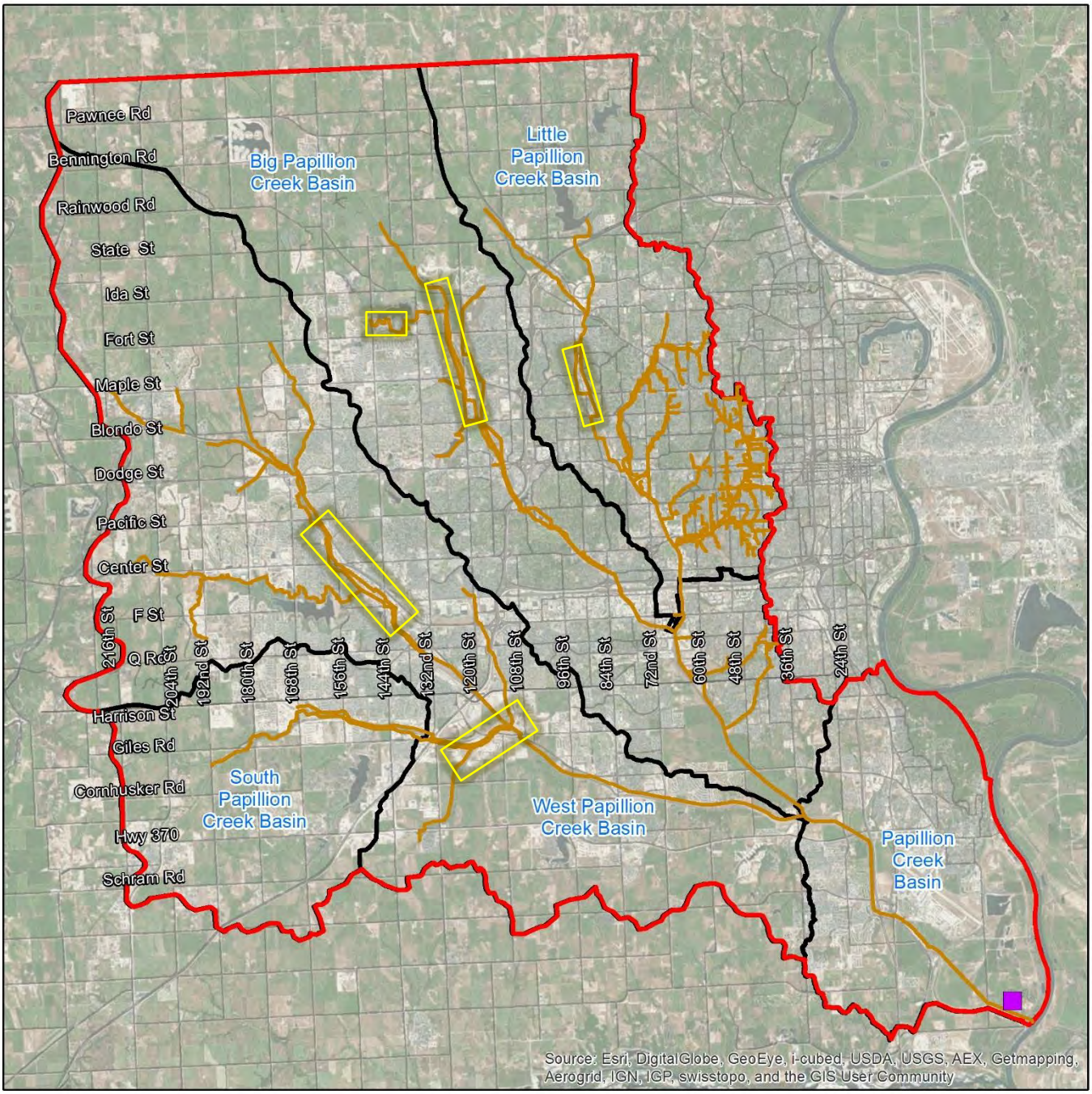
These DWFs do include some dry weather infiltration. Therefore, the interceptors should be reexamined if any improvements within the sub-catchments are completed since the improvements will reduce the dry weather infiltration and thus provide additional base sanitary flow capacity (e.g. I/I reduction will provide additional base sanitary flow capacity for upstream development).

4.4.2 Wet Weather Hydraulics

The model was also run using the calibrated WWFs to examine if any surcharge was present in the system and if the surcharge criteria were violated during the 10-year, 24-hour event. Since the 10-year event is an intense rainfall event with significant volume over a short period of time, it is not surprising that surcharge will occur in parts of the system.

However, since SSOs are not allowed per the Clean Water Act (CWA), any discharges out of manholes are not allowed and improvements will need to be initiated to remediate this type of hydraulic situation. Based on the design level flows and hydraulics within the model, one node in the model showed flooding (manhole 0975052 near 156th and Center) for the current baseline interceptor system. The City Public Works Department has been made aware of this and has scheduled field inspections during wet weather events to verify any flooding problems.

Surcharge was observed at several locations for existing conditions. Figure 4.2 illustrates the locations within the interceptor that exhibit surcharge during the 10-year, 24-hour event. These locations do not necessarily illustrate significant surcharge (beyond the above LOS criteria) but do show the general locations of restrictive areas. Only portions of these areas illustrated in the figure include the specific restrictive pipes that will need to be corrected. Again, because this study focuses on the separate sanitary system within the PCWWTP service area, any surcharge within the combined sewer pipeline within the service area were identified but are not part of the improvement projects since these are addressed in the CSO LTCP.



Legend

- InfoWorks Model
- Existing Interceptor Restriction
- Papillion Creek WWTP
- Papillion Creek WWTP Service Area
- Papillion Creek Basins

0 1.5 3 6 Miles

N W E S

Figure 4.2 - Existing Interceptor Restrictions
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

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The locations are generally described in Table 4.3 and illustrated in Figure 4.2. The improvements needed to meet LOS goals in these areas for existing as well as future conditions will be discussed in detail in the next chapter. Therefore, the table below is more for general location information of existing surcharged sewers during the design event. The City has already started to use this information to specifically check the assumptions in the model (pipe diameter, inverts, and configuration) in these areas so that improvements could be developed based on true field conditions.

It is important to note that toward the end of the modeling analysis to the existing system and development of the draft CIP, the area upstream of the Elkhorn Treatment plant was found to require more detail in the model. The City staff evaluated GIS and as-built information and provided some data to be added to the model to support the extension or upsizing of collectors serving as interceptors to the Elkhorn WWTP. The study has determined that further refinement of the model in this region is necessary to plan for the future growth beyond the near term projects.

The City of Elkhorn was annexed by Omaha in 2007 at that time the City put forth effort to get the newly owned sewer assets into its GIS system. During this current Interceptor Master Plan study it was realized that the sewer hydraulic model lacked the detail necessary to understand existing capacity restrictions. Some limited information was updated in the model with a goal to recommend further refinement for the next interceptor Master Plan study.

Table 4.3 Existing System Restrictions Papillion Creek Sanitary Interceptor Master Plan City of Omaha, NE		
Location Description	**Interceptor and Sub-catchment(s)**	**Hydraulic Issues**
Near Giles Road from 120th to 114 Street	West Papillion Creek, WP-3_1 and WP-3_1S	Northerly interceptor is surcharging which reduces freeboard to approximately 10 feet. No project was identified for this area as the interceptor is located in Sarpy county.
Along 120th Street from Military Avenue to Blondo Street	Big Papillion Creek, BP-29, BP-27, BP- 25	Interceptor is surcharging which reduces freeboard to a little less than 6 feet. There is a 54″ pipe upstream of the 36″ pipe. The portion of the 36″ is causing the surcharging in this area from manhole 0454002 to 0420006. The diameters of the pipes within the model are based on as-built data. The surcharging will be relieved by constructing a parallel interceptor in this area.
From 156th and Pacific to 132nd and Q Street	West Papillion Creek, WP-13, WP-12, WP-11, WP-10_1S, WP-9,	Easterly interceptor is surcharging which causes flooding by manhole 0975052 (near 156th and Center). Flooding will be relieved by diverting flow to the westerly interceptor, which has available capacity or adding a parallel interceptor.
Along 90th Street from Military Avenue to Maple Street	Little Papillion Creek, LP-19, LP- 20, LP-21, LP-22, LP-23, LP-24	Existing interceptor is surcharging which reduces freeboard to approximately 3 feet. This surcharging can be relieved by diverting flow to the parallel interceptor to the east.

CAPITOL IMPROVEMENT PROGRAM

5.1 METHODOLOGY

This Capital Improvement Program (CIP) was developed with extensive assistance from the City, to optimize the capacity of the existing system, identify improvements within the existing system due to hydraulic restrictions, and provide service to future customers. Each CIP project is either classified as a capacity improvement or a sewer extension project. The capacity improvements are identified for existing sewers while the extension projects are identified to provide service to future customers. All projects were sized utilizing the estimated 2050 sanitary flows, the I/I flows generated by the 10-yr., 24-hr. design storm, and the LOS criteria described previously. Some of the tasks performed to identify CIP projects included a flow balancing exercise and the potential for I/I reduction. The methodology to develop the CIP projects is discussed below.

5.1.1 Flow Balancing

Flow balancing was performed to optimize the capacity of the existing system. Flow balancing is a technique that can be used to divert excess flow from one pipeline to another that has additional capacity. If two interceptors are in relative close proximity to each other (either paralleling a creek, or where several pipes enter and exit a junction), flow from the overburdened sewer can be routed to the other sewer that has excess capacity and thus relieve the overburden sewer and maximize the capacity of the other sewer. This technique is especially applicable to the City's interceptor system since much of the system includes interceptors that parallel both sides of the creeks in the service area. Without a detailed model, this technique could not be applied - as was the case with the previous 2009 model.

This technique typically requires modifications to existing inverted siphons (siphons) that cross the creeks, or installation of new siphons at critical hydraulically restrictive points. The goal was to shift flows away from sewers with capacity deficiencies to sewers with available capacity if the two sets of sewers had similar inverts that would allow for flow to be directed from one to another. The projects identified during the flow balancing exercise were classified as capacity improvement projects.

5.1.2 I/I Reduction Potential

Inflow and Infiltration (I/I) reduction projects are typically used in CIPs to reduce flows in critical sub-catchments to reduce hydraulic restrictions in downstream pipelines. Reducing I/I also reduces the amount of flow that must be treated at the downstream treatment plant.

Investigation of potential I/I reduction projects to reduce conveyance and treatment improvements were limited due to detailed data absent in the model for the lateral pipelines throughout the sub-catchments. Another issue is that the number of permanent flow metering locations, although adequate for this interceptor analysis, is too sparse for effective analysis of localized I/I. To identify cost effective I/I reduction projects, smaller basins will need to be investigated in the future. It is suggested that additional flow monitoring be performed in areas where the City suspects high I/I in occurring and an I/I management program be implemented. Details on this approach are further discussed in Appendix ___<I/I Analysis> of this report.

5.1.3 Capacity Improvements and Sewer Extensions

The CIP projects identified in this master plan were either classified as sewer extensions or capacity improvements. It should be noted that all CIP projects were sized to convey the 2050 flows. Sewer extensions were identified as projects needed to extend service to future users through 2050. The City also worked with other stakeholders, such as the development community, to understand when sewer extensions would be needed in the near term within the interceptor system. These discussions resulted in recommending modification to the present development zone boundaries. Capacity improvements were defined as projects along existing pipes, which are under capacity based upon the 2050 flows during the 10-yr., 24-hr. storm event. The timing of capacity improvement projects were based upon the planning horizon flows which caused a deficiency within the existing system.

The capacity improvements were further defined by the type of project, which included the following classifications:

- US = Upgrade Siphon
- NS = New Siphon
- PI = Parallel Interceptor
- PS = Pump Station
- Orifice Adjustment = optimize orifice setting for flow split

Additionally, the first two letters of each CIP project correspond to the basin in which the project is located. The basins and abbreviations are included below.

- BP = Big Papillion Creek Basin
- LP = Little Papillion Creek Basin
- WP = West Papillion Creek Basin

The Level of Service (LOS) assumptions and criteria that were used to size the CIP projects are detailed in Chapter 4 of this report. The LOS information along with the cost assumptions detailed below was used to develop each project. An illustration of the CIP projects is included in Figure 5.1.

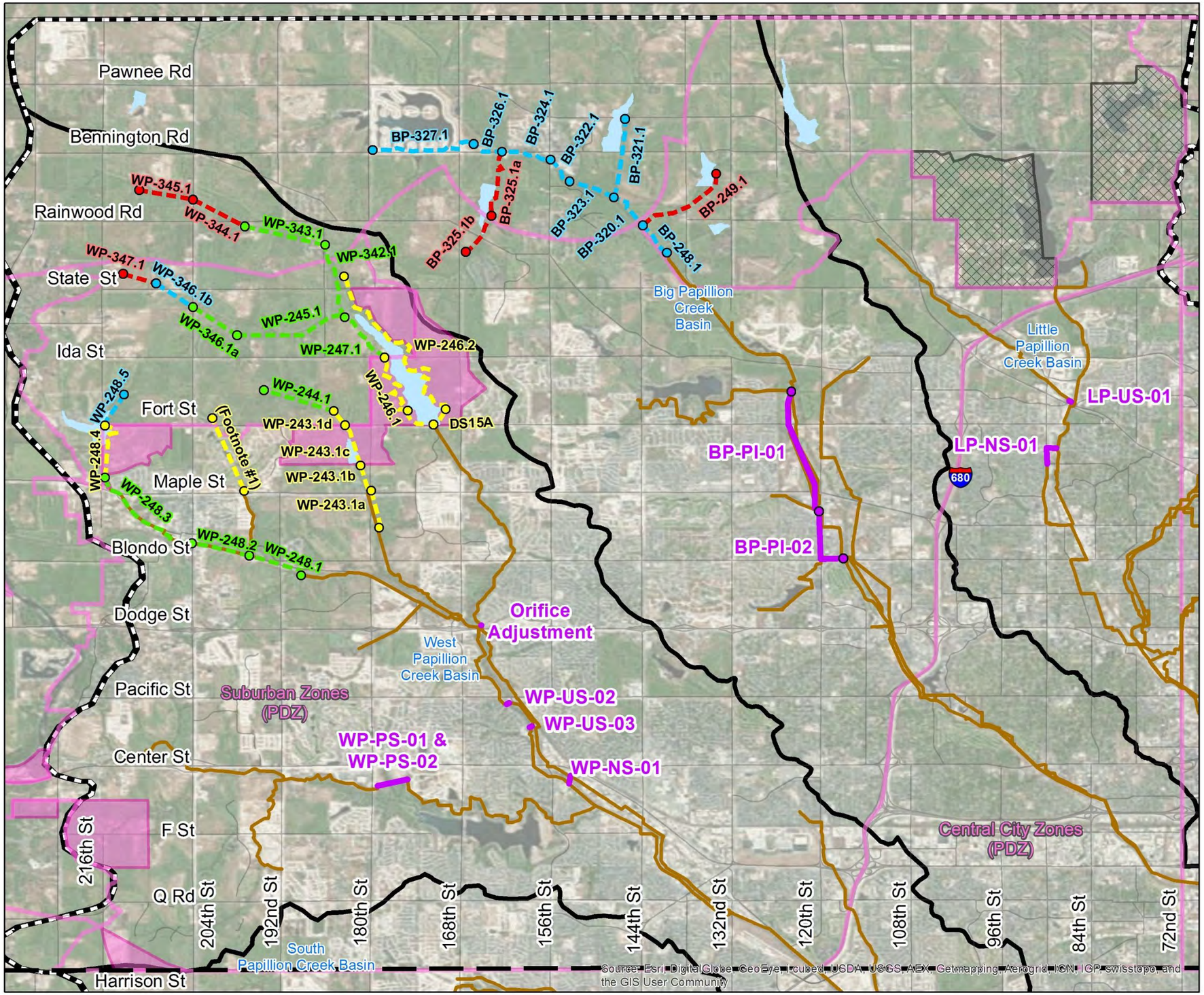
5.2 COST ASSUMPTIONS

The cost of each CIP project was determined based on unit costs, constructability factors, and an estimated inflation rate. To determine the CIP costs, unit costs for sanitary sewer pipelines were developed (for both gravity and pressure/force main pipes) as well as sanitary sewer pump stations. Assumptions for these planning-level costs are based upon Carollo's experience with other master planning projects in the Midwest as well as specific costs tracked by the City for similar projects. A summary of the unit costs and other assumptions are discussed separately below.

The costs presented for the identified improvements are based on assumptions below, adopted from the current City CIP, or developed based on recent bid tabulations. The costs shown are for planning purposes only and should be evaluated further during design as projects are developed. For reference, the cost estimates are generally considered to be a class 4 or 5 based on the Association for the Advancement of Cost Engineering International (AACE International, formerly known as the American Association of Cost Engineers) standards. Some of the costs for the near term projects may be more accurate than the long term projects but again, the costs are considered to be for planning purposes only and should be evaluated further during design.

5.2.1 Unit Costs

Unit costs were developed for both standard, and jacking and boring pipelines. The standard pipeline unit cost was used for all pipes except when stream crossings were identified using GIS information. It was assumed that for all stream crossings jacking and boring was needed and thus, the jacking and boring unit cost was used. Both unit costs were based on dollars per inch diameter per linear foot of pipe. The unit costs for both were vetted and confirmed by the City during the project. Additionally, some project costs were developed by the City through their standard engineering procedures to check against the unit cost assumptions. These specific projects are noted where used. A summary of the unit costs is included in Table 5.1.



Legend

- CIP Relief Sewers

Timing of CIP Extension Projects

- 2015-2020
- 2021-2030
- 2031-2040
- 2041-2050
- Development Zones
- Add to PDZ
- Remove from PDZ
- Papillion Creek WWTP Service Area
- InfoWorks Model of Existing System
- Papillion Creek Basins
- Douglas/Sarpy County Line
- Proposed NRD Reservoirs

0 0.75 1.5 3 Miles

N W E S

Footnote #1: Refer to section 5.3.3 for project details.

Figure 5.1 – CIP Projects
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

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Table 5.1 CIP Cost Assumptions Papillion Creek Sanitary Interceptor Master Plan City of Omaha, NE				
Assumption	**Unit**	**Value**	**Constructability Factor for Sewer Extension**	**Constructability Factor for Capacity Improvement**
Unit Cost for Standard Pipeline	$/inch diameter/LF	20.00	1.00	2.00
Unit Cost for Jack and Bore Pipeline	$/inch diameter/LF	55.00	1.50	2.50
Inflation Rate	%	3.1	-	-

5.2.2 Other Cost Assumptions (inflation, constructability, etc.)

The inflation rate used to determine the future value of the projects was set at 3.1 percent. The City proposed this figure based on past cost estimates the City uses for the interceptor system. To account for the potential constructability issues of each project, various constructability factors were applied. The constructability factors were varied depending on the type of sewer (standard vs. jack and bore) and the type of project (sewer extension vs. capacity improvement). Different factors were used for sewer extensions and capacity improvements due to the assumed location of the two types of projects. It was assumed that the majority of the sewer extensions would be located in undeveloped land and capacity improvements would be located in developed areas, resulting in higher factors. A summary of the constructability factors can be seen in Table 5.1.

5.3 SEWER EXTENSIONS

The sewer extensions were aligned to provide service to potential new customers within the Douglas County portion of the service area through 2050. Some of the extension projects were developed through discussions with the City and other stakeholders to address the needs of some of the near term developments. Many of these projects extend into previously undeveloped areas in Omaha and require new interceptor pipelines. However, it was assumed that all the extension pipelines would be new interceptor pipelines even when small diameter sewers currently serve some outlying areas. Therefore, the sewer extensions are sized to accommodate all land use in the outer areas regardless of what sewers are already there. This assumption was necessary because the amount of new flow in these areas will require significantly larger diameter pipes, and there is little known about the condition of the existing pipes (so it wouldn't be prudent to assume these existing pipes could even be cost effectively rehabilitated). As these extensions are designed in the future, more detailed investigations will be required to verify these assumptions.

The sewer extensions were grouped into three geographical areas, which include the Elkhorn, Bennington, and Dam Site 15A (156th and Fort Street) areas. The extensions for each area are discussed below. A summary of the design criteria for all of the sewer extensions by planning horizon is included in Table 5.2. The extensions were sized to convey the 2050 sanitary flows during the 10-yr., 24-hr. storm event. This requires that the majority of the extensions had a d/D at or below 1.0 during the design event. The slope of the pipes generally followed the slope of the existing ground based on the 2-foot GIS contours to maintain at least 10 feet of ground cover.

Table 5.2 Sewer Extension Design Criteria
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

Project ID	Pipe Diam. (inch)	Pipe Capacity (mgd)[1]	Pipe Slope (%)	Pipe Length (feet)
PERIOD: 2015-2020				
WP-243.1A	18	3.97	0.34	2,923
WP-243.1B	18	4.13	0.37	2,165
WP-243.1C	18	5.68	0.70	3,289
WP-248.4	18	5.76	0.72	4,800
WP-243.1D	18	8.07	1.41	1,279
WP-246.1	27	11.72	0.34	6,997
WP-246.2	18	3.97	0.34	15,610
PERIOD: 2021-2030				
WP-244.1	18	8.56	1.59	4,403
WP-245.1	24	8.75	0.36	6,921
WP-247.1	27	17	0.41	4,863
WP-248.1[2]	27	5.88	0.09	3,622
WP-248.2[2]	21	4.45	0.19	3,503
WP-248.3[2]	21	3.8	0.14	7,800
WP-342.1A	18	4.2	0.38	600
WP-342.1B	18	4.2	0.38	466
WP-342.1C	18	4.2	0.38	1,634
WP-342.1D	18	4.2	0.38	3,579
WP-343.1	18	3.72	0.30	5,318
WP-346.1A	18	4.22	0.39	3,361

PERIOD: 2031-2040				
BP-248.1	42	26.99	0.17	2,571
BP-320.1	42	26.91	0.17	2,902
BP-321.1	30	20.01	0.57	6,139
BP-322.1	42	19.99	0.09	2,117
BP-323.1	42	20.95	0.10	2,890
BP-324.1	36	23.01	0.29	3,082
BP-326.1	36	20.52	0.23	1,986
BP-327.1	36	46.3	1.15	6,565
WP-248.5	18	4.73	0.49	2,700
WP-346.1B	18	4.22	0.39	2,847
PERIOD: 2041-2050				
BP-249.1	24	11.58	0.63	6,371
BP-325.1A	30	21.13	0.64	5,387
BP-325.1B	30	13.19	0.25	3,235
WP-344.1	18	4.48	0.44	3,676
WP-345.1	15	1.64	0.15	3,250
WP-347.1	18	4.23	0.39	2,063

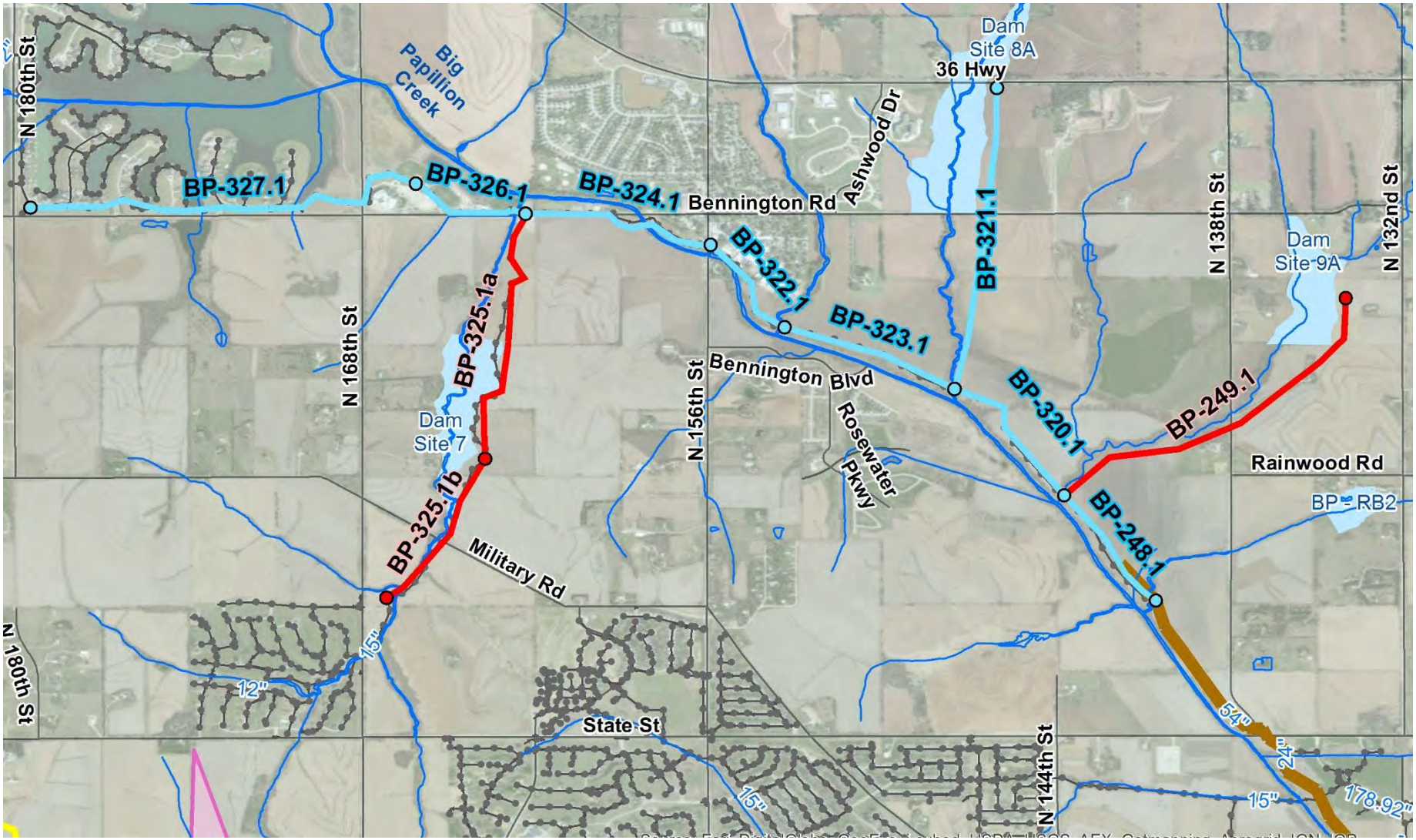
Notes:

(1) As calculated within InfoWorks for full pipe flow and no surcharge.

(2) Sewer extensions involve replacing existing sewers, and a new sewer that connects the Elkhorn WWTP service area to the existing interceptor sewer. Pipe slopes and capacities listed are the minimum given elevations of existing sewers.

5.3.1 Bennington Area

The extensions for the Bennington area are illustrated in Figure 5.2. The sewers were laid out based on the 2009 master plan to provide service for growth expected to occur in the Bennington area. The majority of the improvements in this area involve upsizing existing pipes rather than brand new sewers into undeveloped areas. The pipes west of 156th Street are existing outfall sewers not currently classified as interceptors, and not sized for the future service area. Just northwest of 138th Street and State Street an 18-inch City of Omaha Interceptor connects to a 54-inch. The upsizing of this portion of the interceptor will be classified as an extension and the costs are included in the CIP. Additional flow monitoring should be performed in the future to confirm the timing and capacity of the extensions given the timing of the projects.



Legend

CIP Extension Timing
- 2016 - 2020
- 2021 - 2030
- 2031 - 2040
- 2041 - 2050

- InfoWorks Model
- SewerLines and SewerNodes (not modeled)
- Proposed Dam Sites
- Proposed Additions to PDZ

0 0.25 0.5 1 Miles

N W E S

Figure 5.2 – Bennington Sewer Extensions
Papillion Creek Sanitary Interceptor Master Plan
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5.3.2 Dam Site 15A (156th and Fort)

The extensions near the proposed Dam Site 15A (156th and Fort) are illustrated in Figure 5.3. The sewers were laid out based on input from the City and stakeholders representing the developers in the area. This area is expected to develop rapidly after the construction of the new dam site. The sewers shown in orange in the figure at the downstream end of the dam have been designed and are being constructed as part of the construction contract with the dam. The extensions will be connected to the upstream end of these sewers. Projects WP-246.1 and 246.2 are to be constructed before 2020 to open up the area to development after the local traffic improvements had been made in the area. The improvements identified in the later planning horizons will facilitate the expected growth through 2050.

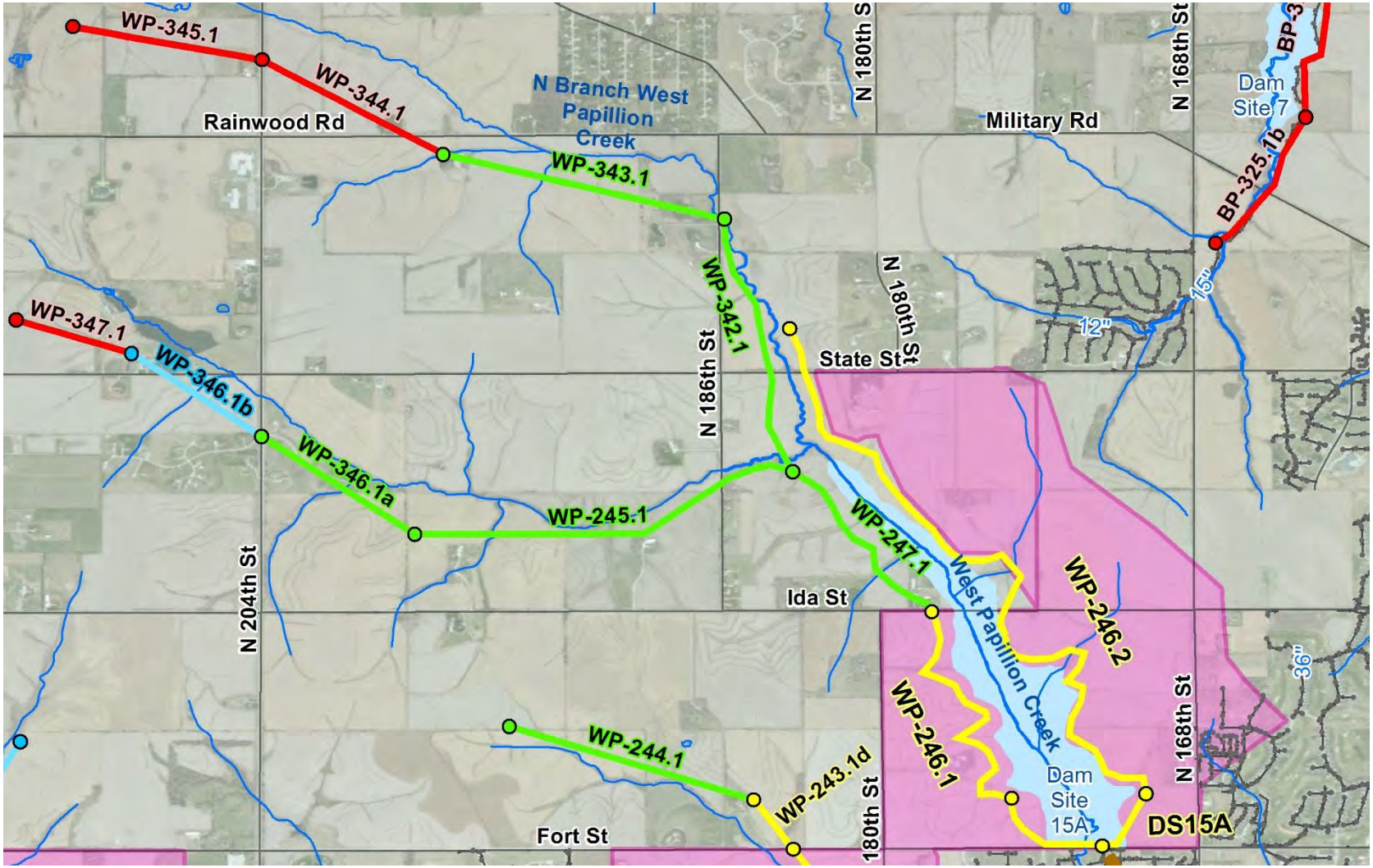
The projects in this area were segmented during this master plan based on feedback from the City. It should be noted that the two parallel interceptors upstream of the dam site, one stemming from Rainwood Street and 204th Street and the other from State Street and 216th Street, were aligned within the same model sub-catchment, WP-18-5. Upon review by the City and the sub watersheds completed for the Papillion Creek Watershed Management Plan-March 2014 Update, it was agreed that this model sub-catchment should contain both extensions. This also matches the extension alignments from 2009, however, the area should be refined with appropriate model sub-catchment delineation to support the future study. Also, the majority of the ground elevation and pipe inverts weren't modified as part of this master plan. This was because the GIS contour elevations didn't match what was shown in the plans provided for the dam by HDR. Due to the volatile nature of the population projections which were used to determine flow projections, and this upstream area being timed after 2020, if a pipe size was predicted to be a diameter smaller than the 2009 plan, the 2009 pipe size remained in the CIP. The diameters of the pipeline extensions upstream of the Dam site 15A reservoir ranged between 15-inches and 24-inches in diameter.

Lastly, the majority of the pipe diameters proposed in 2009 for the extensions upstream of the new dam site weren't updated. This was decided given that all of the pipes would need to be downsized based on the updated flows. The diameter of the pipeline extensions range between 15-inches and 24-inches in diameter.

5.3.3 Elkhorn Area

The extensions in the Elkhorn area are illustrated in Figure 5.4. The extensions along 180th street were consistent with the 2009 master plan but were segmented as part of this master plan. The City and developers identified the extensions along Old Lincoln Highway. It is envisioned that WP-248.1 be designed and constructed to facilitate the abandonment of the Elkhorn WWTP. The extensions upstream of the plant are to facilitate the growth expected to occur north of Maple Street. WP-248.4 will need to be constructed to open up this area to development. However, the existing system is undersized based on the estimated flows within the model. This is most likely the result of typical planning level limitations due to the size of the sub-catchment and existing sewers (10-18-inch diameter). Thus, as the development occurs, monitoring of the system should be performed so that capacity improvements are sized correctly and constructed at the appropriate time.

During the final development of this report and further discussion with stakeholders, it was discovered that the report did not provide or discuss the need for an additional sewer interceptor extension project(s) to serve an undeveloped area that lies within the City's FDZ, upstream of the existing Elkhorn WWTP. Such area is the drainage basin north of Maple and west of 192nd Street north to approximately Ida Street, and is likely within the next area to be added to the PDZ. A dashed line is shown on Figure 5.4 to indicate the need for a near term (2015-2020) sewer extension project to serve this area. City staff will work with stakeholders in the area to develop the additional interceptor sewer extension(s) and associated costs to serve such area. This project and associated costs will be included as part of the next interceptor study update. Additionally, the City shall develop a Capital Improvement Plan to support the desired growth and development of the area upstream of the existing Elkhorn WWTP.



Legend

CIP Extension Timing

- 2016 - 2020
- 2021 - 2030
- 2031 - 2040
- 2041 - 2050

- InfoWorks Model
- SewerLines and SewerNodes (not modeled)
- Proposed Dam Sites
- Proposed Additions to PDZ

0 0.3 0.6 1.2 Miles

N W E S

Figure 5.3 – Dam Site 15A Sewer Extensions

Papillion Creek Sanitary Interceptor Master Plan

City of Omaha, NE

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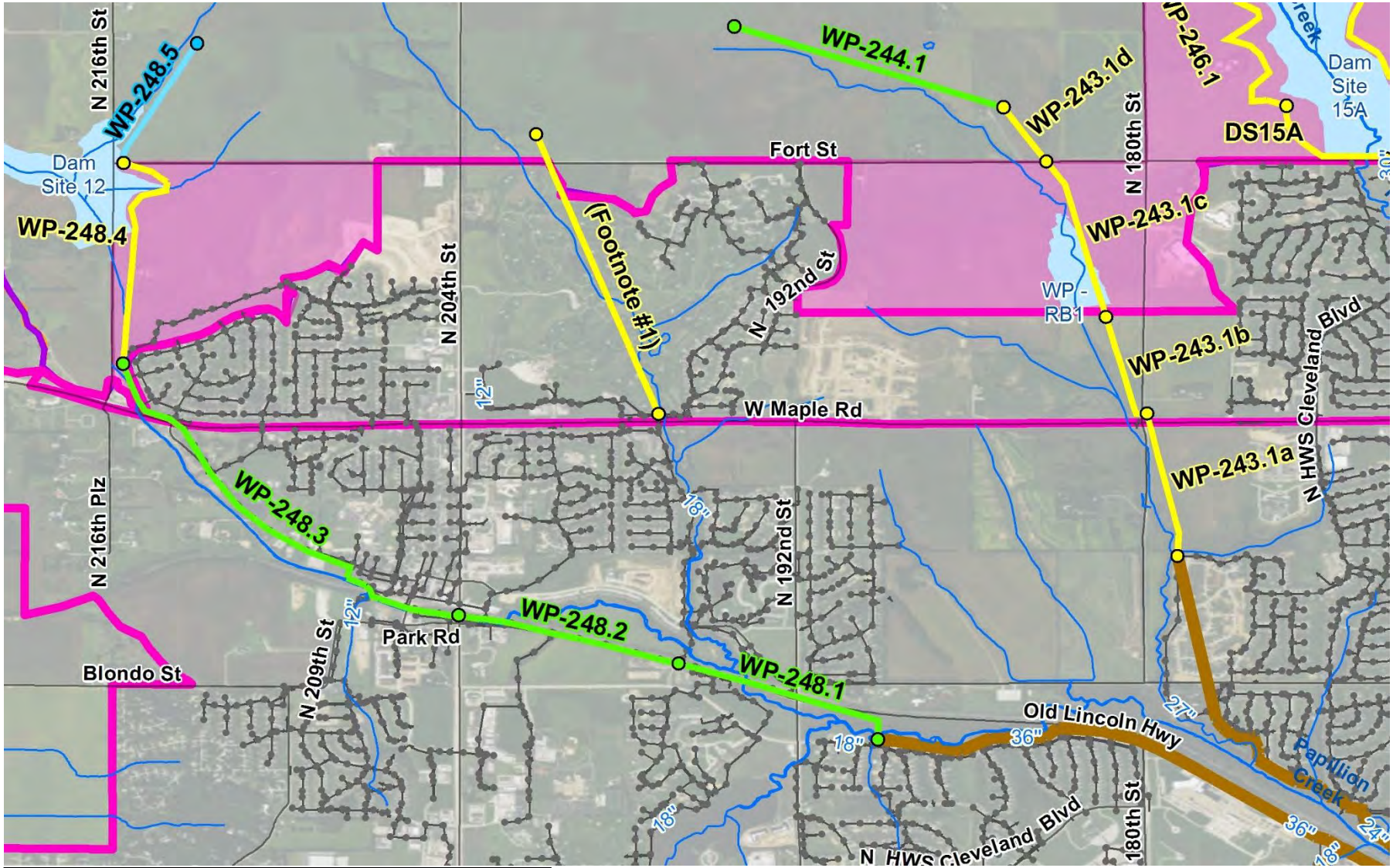

Legend

CIP Extension Timing

- 2016 - 2020
- 2021 - 2030
- 2031 - 2040
- 2041 - 2050

- InfoWorks Model
- SewerLines and SewerNodes (not modeled)
- Proposed Dam Sites
- PDZ Boundary
- Proposed Additions to PDZ

Footnote #1: Refer to section 5.3.3 for project details.

0 0.25 0.5 1 Miles

N W E S

Figure 5.4 – Elkhorn Area Sewer Extensions

Papillion Creek Sanitary Interceptor Master Plan
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5.4 CAPACITY IMPROVEMENTS

The capacity improvement projects were developed to address capacity deficiencies within the existing interceptor system based on future flow projections. These improvements are necessary for the system to support the continued growth that will occur within the Omaha metropolitan area. Each project will be discussed below and are separated given the planning horizons identified for project.

5.4.1 Baseline to 2020 Planning Horizon

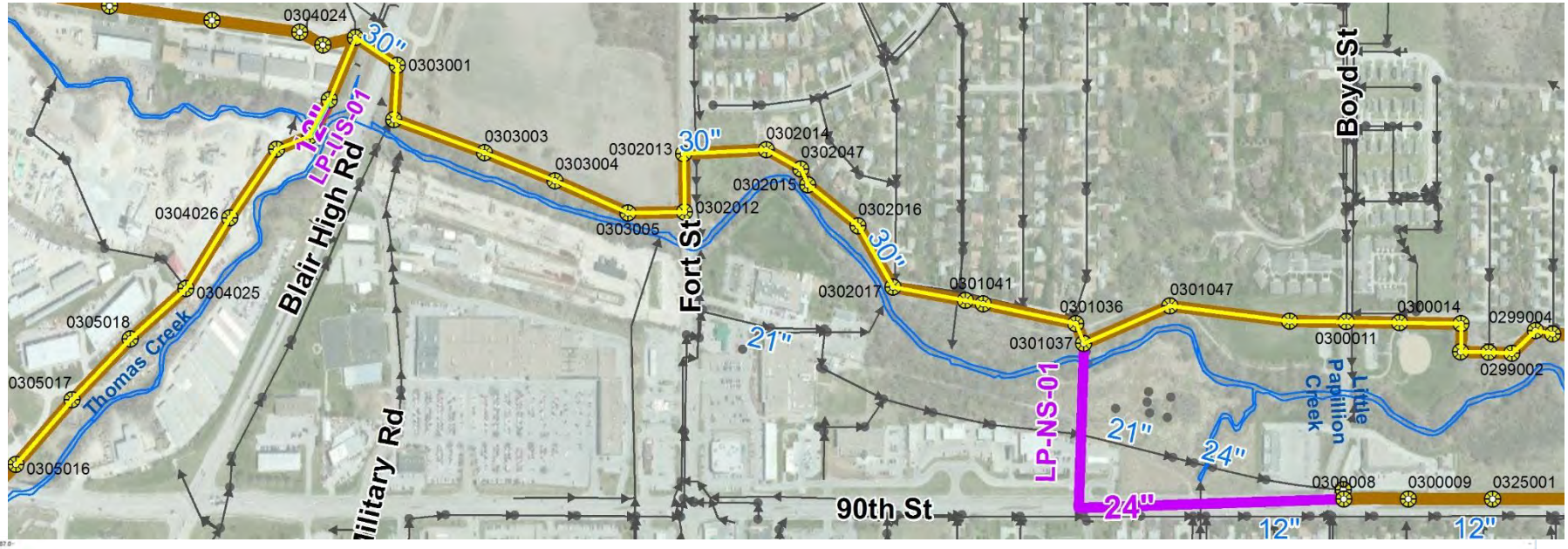
Construction of new siphons along the Little Papillion and West Papillion Interceptors, denoted as LP-NS-01 and WP-NS-01, respectively, are proposed during the 2031-2040 planning horizon. However, given modeling results and the predicted amount of flooding/surcharging in these areas based on the existing flows, an improvement may need to be implemented before 2020. A manhole near the proposed project WP-NS-01, is being monitored by the City Public Works Department and may be evaluated for a locking cover if it is shown to experience overflow conditions during wet weather. The hydraulic profile of the existing east interceptor near proposed project LP-NS-01 can be seen in Figure 5.5. In lieu of constructing the new siphon, pressurized manholes could be installed in the areas where flooding is predicted to occur. This option was preliminarily investigated because the cost of this full project improvement is upwards of $10 million.

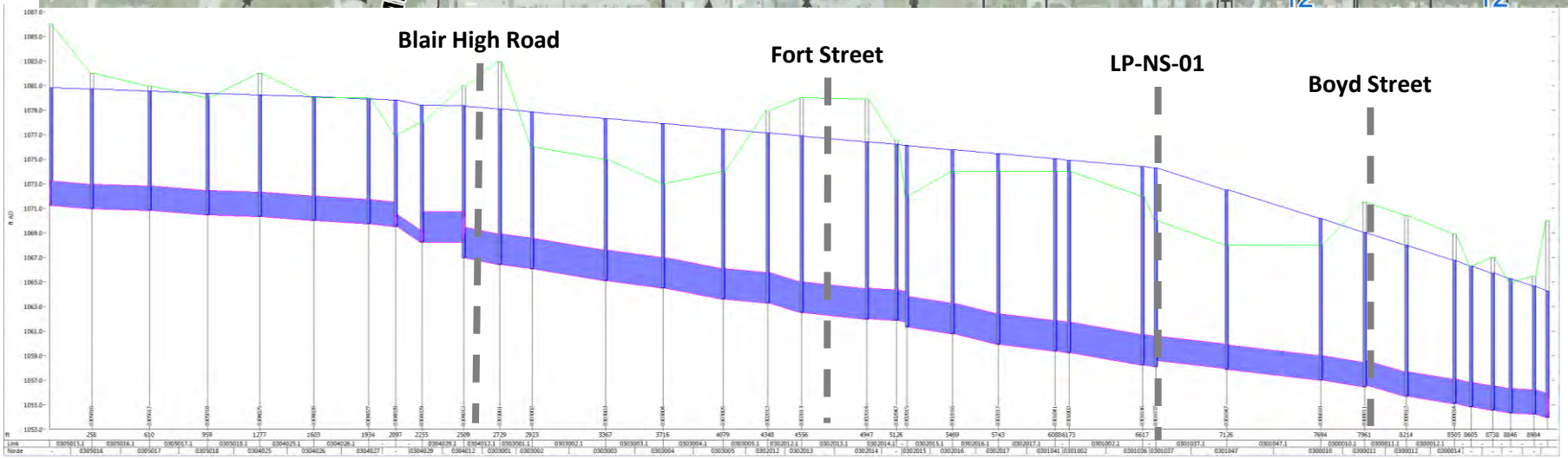
The option to seal the manholes in this area does carry some risk to the existing users in the area in terms of basement backups given the elevated grade line along parts of the existing sewer. Regardless if the new siphons are constructed or not, additional model refinement and monitoring should be performed to better understand the capacity of the existing system and to quantify future flows during wet weather events. This will allow the City to better understand the required timing and capacity of the proposed improvement. It is recommended that the City, at the very least, install a depth sensor(s) in reaches that the model shows can significantly surcharge during large wet weather events.

5.4.2 2021-2030 Planning Horizon

5.4.2.1 <u>Big Papio Interceptor</u>

Three projects are recommended along the Big Papio Creek which includes two new interceptor segments that will parallel existing interceptors along 120th Street from north of Fort Street to Blondo Road, and a new siphon. The two new 42-inch diameter segments that parallel the existing interceptor are designed to reduce the surcharging in this reach. There is a stream crossing associated with this project near the downstream end of BP-PI-01 where the proposed alignment crosses the West Maple Creek. This project is denoted in the CIP table as BP-NS-01 and includes three siphon barrels each 15-inches in diameter. A plan and profile view of BP-PI-01 and BP-PI-02 are illustrated in Figure 5.6 and Figure 5.7 respectively. The design criteria for these projects are listed in Table 5.3.





Legend

- Ground Surface (Profile)
- EGL (Profile)
- Selected Pipe (Profile)
- Selected Pipe (Plan)

Figure 5.5 – LP-NS-01 Profile – Pressurized Manholes
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

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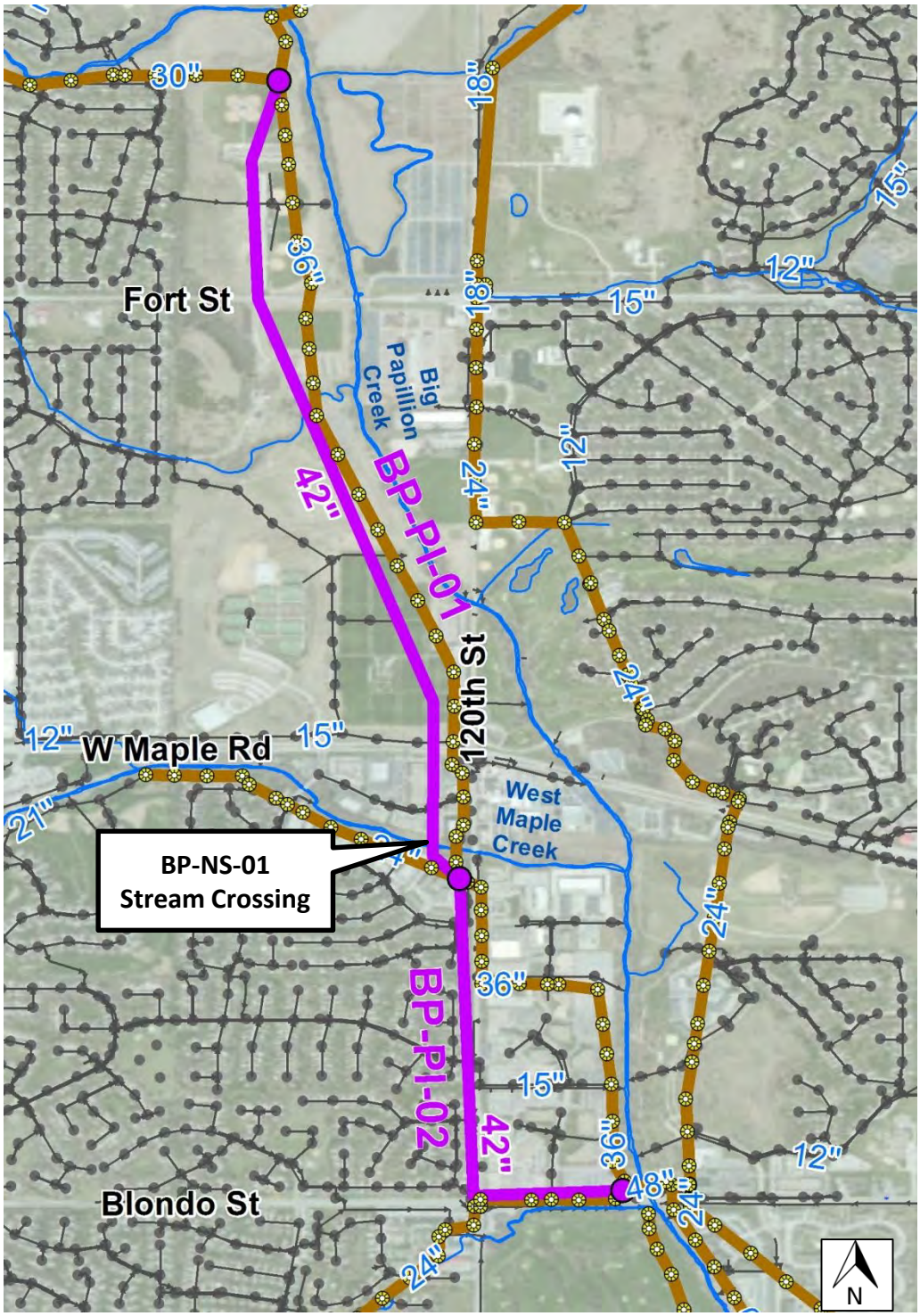

1" = 2000'

Legend

- Capacity Improvement Project
- InfoWorks Model
- SewerLines and SewerNodes (not modeled)

Figure 5.6 – BP-PI-01 and BP-PI-02 Plan
Papillion Creek Sanitary Interceptor
Master Plan
City of Omaha, NE

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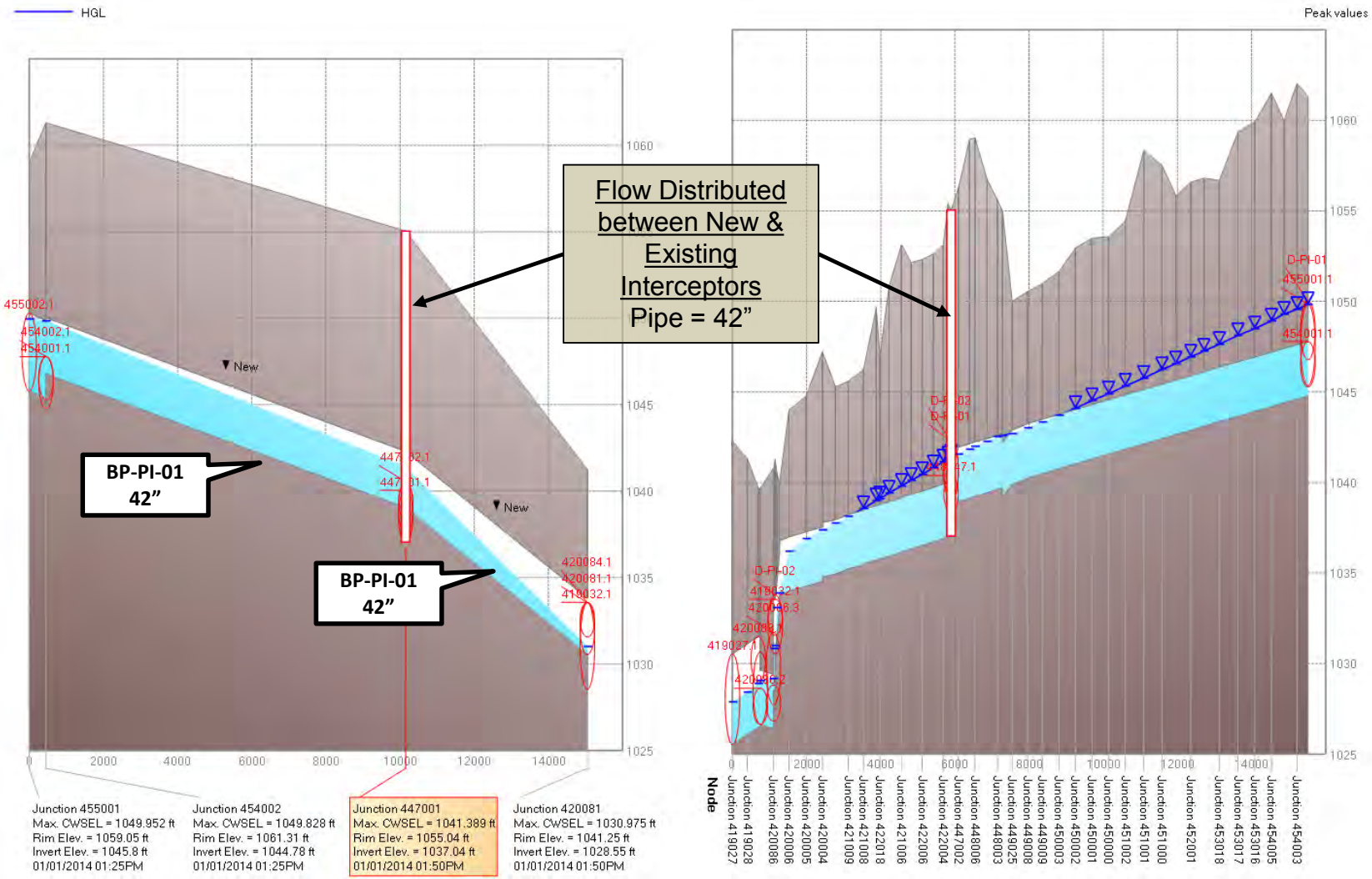

Figure 5.7 - BP-PI-01 and 02 Profile
Papillion Creek Sanitary Interceptor
Master Plan
City of Omaha, NE

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Table 5.3	Big Papio Interceptor Capacity Improvements Papillion Creek Sanitary Interceptor Master Plan City of Omaha, NE			
Project ID	**Pipe Diam. (inch)**	**Pipe Capacity (mgd)(1)**	**Pipe Slope (%)**	**Pipe Length (feet)**
BP-PI-01	42	21.73	0.11	10,500
BP-PI-02	42	24.56	0.14	4,900

Notes:
(1) As calculated within InfoWorks for full pipe flow and no surcharge.

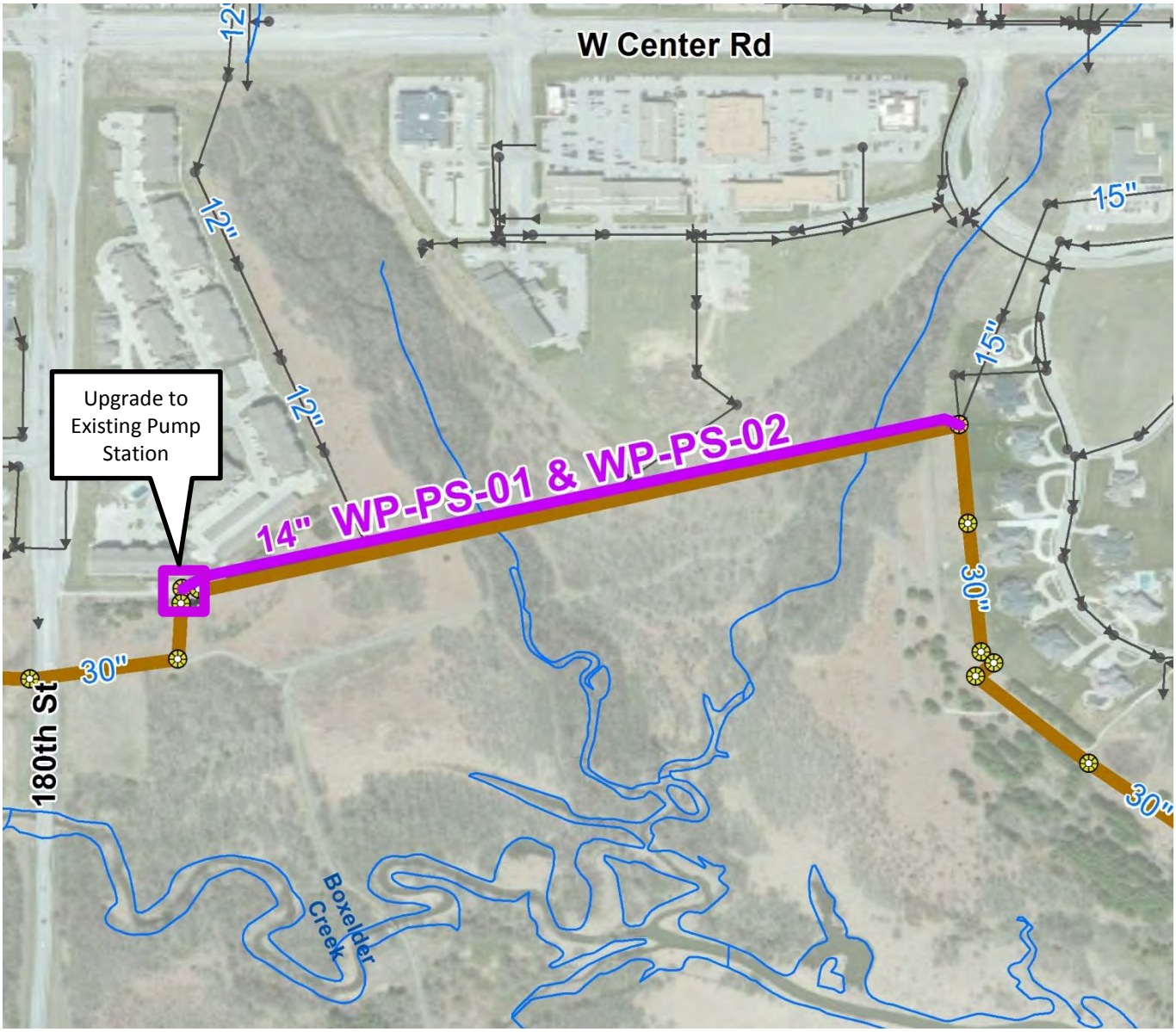
5.4.2.2 West Papio Interceptors

Two projects are needed to upgrade the existing pump station near 180th and Center (Zorinsky Lake), and construct a parallel 14-inch diameter force main to convey the increased flows. The plan and profile for WP-PS-01 and WP-PS-02 are illustrated in Figure 5.8 and Figure 5.9 respectively. The capacity of the pump station will be increased from 4 to 8 mgd through the addition of two pumps at the existing pump station.

A new siphon proposed near 156th and Industrial/Center was identified during the flow balancing exercise. It is designed to convey excess flows through the siphon to the existing interceptor on the west side of West Papillion Creek, which has available capacity. The plan and profile for WP-NS-01 are illustrated in Figure 5.10 and Figure 5.11, respectively. Table 5.4 summarizes the West Papio capacity improvements.

Adjustment to an existing orifice is proposed in order to balance flows upstream of an existing siphon just north of Dodge Street near 168th Street. This project is required to help balance the flow in the west Papillion basin and force more flow along the east interceptor, away from the siphon. In the model, the orifice discharge coefficient was reduced from 1.0 to 0.5 to accurately replicate the existing measured hydraulics in this area. The orifice structure should be carefully examined and adjusted to optimize the flow balancing of both dry and wet weather flows. Further analysis may require automated controls (or active means) to optimize the balance, but only passive means were assumed for this study. The plan and profile of the orifice adjustment is illustrated in Figure 5.12 and Figure 5.13, respectively.

Two additional projects identified involve upgrading two existing siphons which are both located south of Pacific street along Bob Boozer Drive (156th street). The plan and profile for WP-US-02 and WP-US -03 are illustrated in Figure 5.14 and Figure 5.11, respectively. The existing siphons are both three-barrel siphons with 14-inch diameter pipes. The new projects will replace one of the existing 14-inch diameter siphons with a single 24-inch diameter pipe. Table 5.4 summarizes the West Papio capacity improvements.



N

1" = 500'

Legend

- Capacity Improvement Project
- InfoWorks Model
- SewerLines and SewerNodes (not modeled)

Figure 5.8 – WP-PS-01 and WP-PS-02 Plan
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

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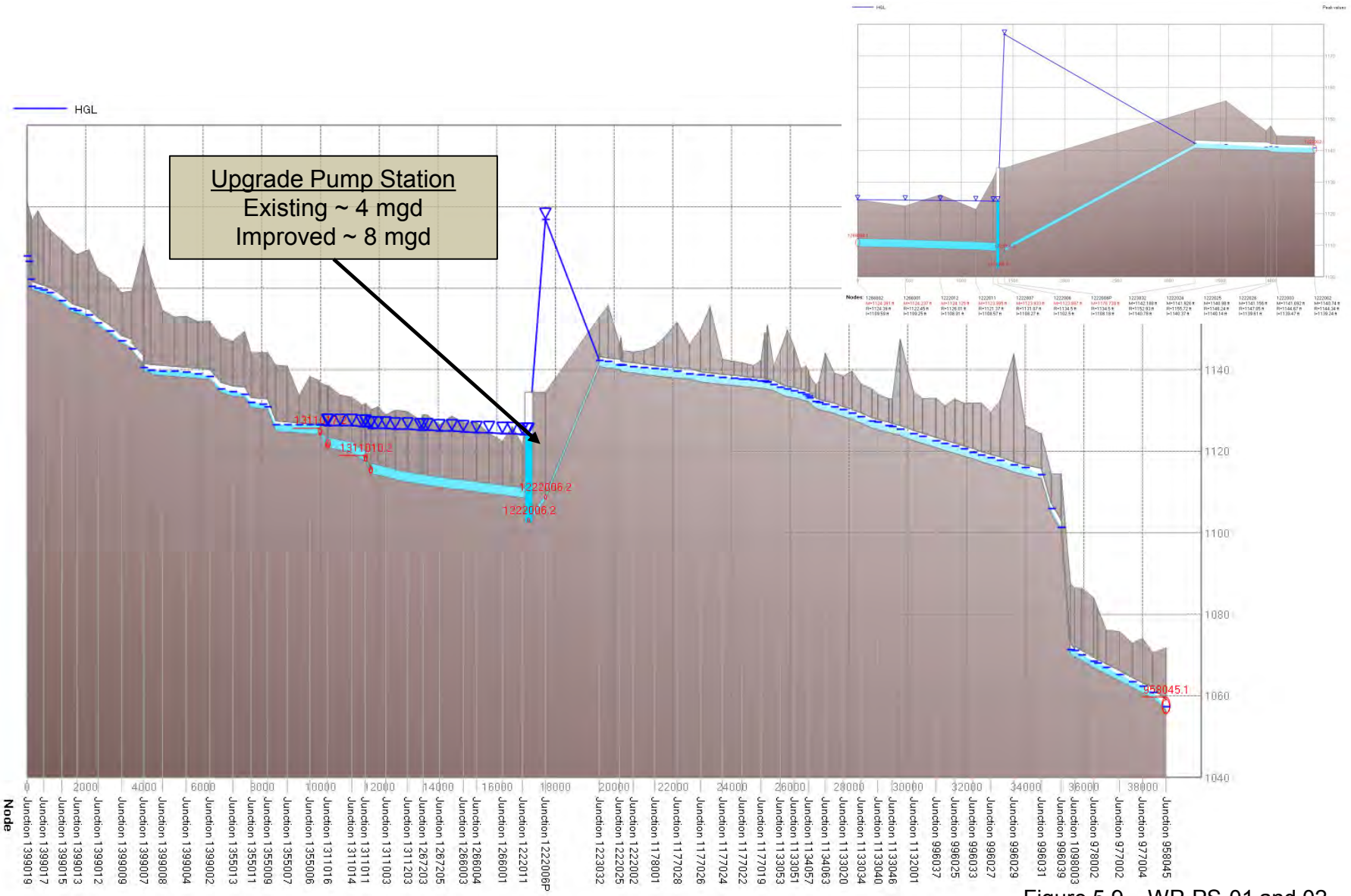
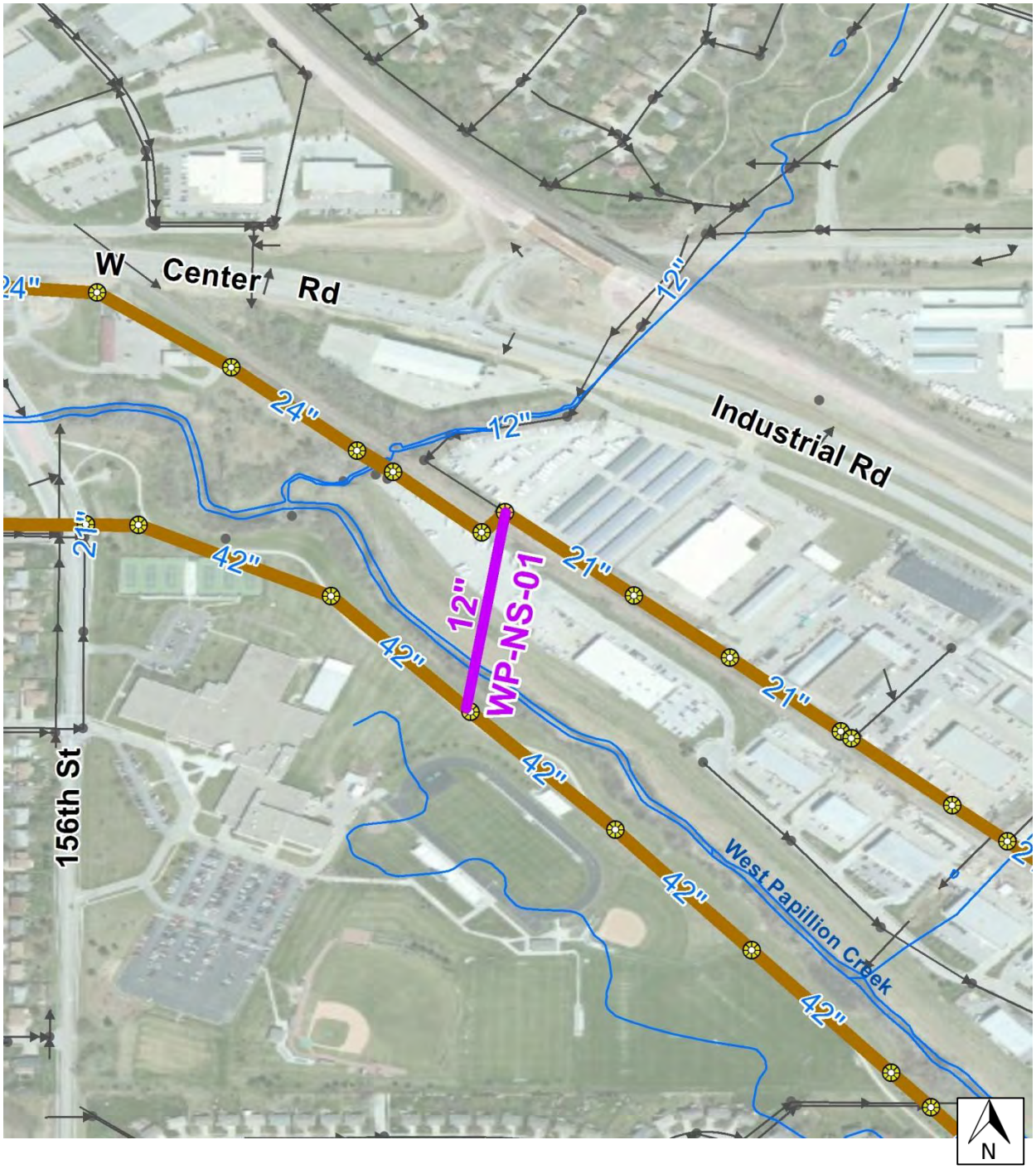


Figure 5.9 – WP-PS-01 and 02 - Profile

Papillion Creek Sanitary Interceptor Master Plan

City of Omaha, NE



1" = 500'

Legend

- Capacity Improvement Project
- InfoWorks Model
- SewerLines and SewerNodes (not modeled)

Figure 5.10 – WP-NS-01 Plan
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

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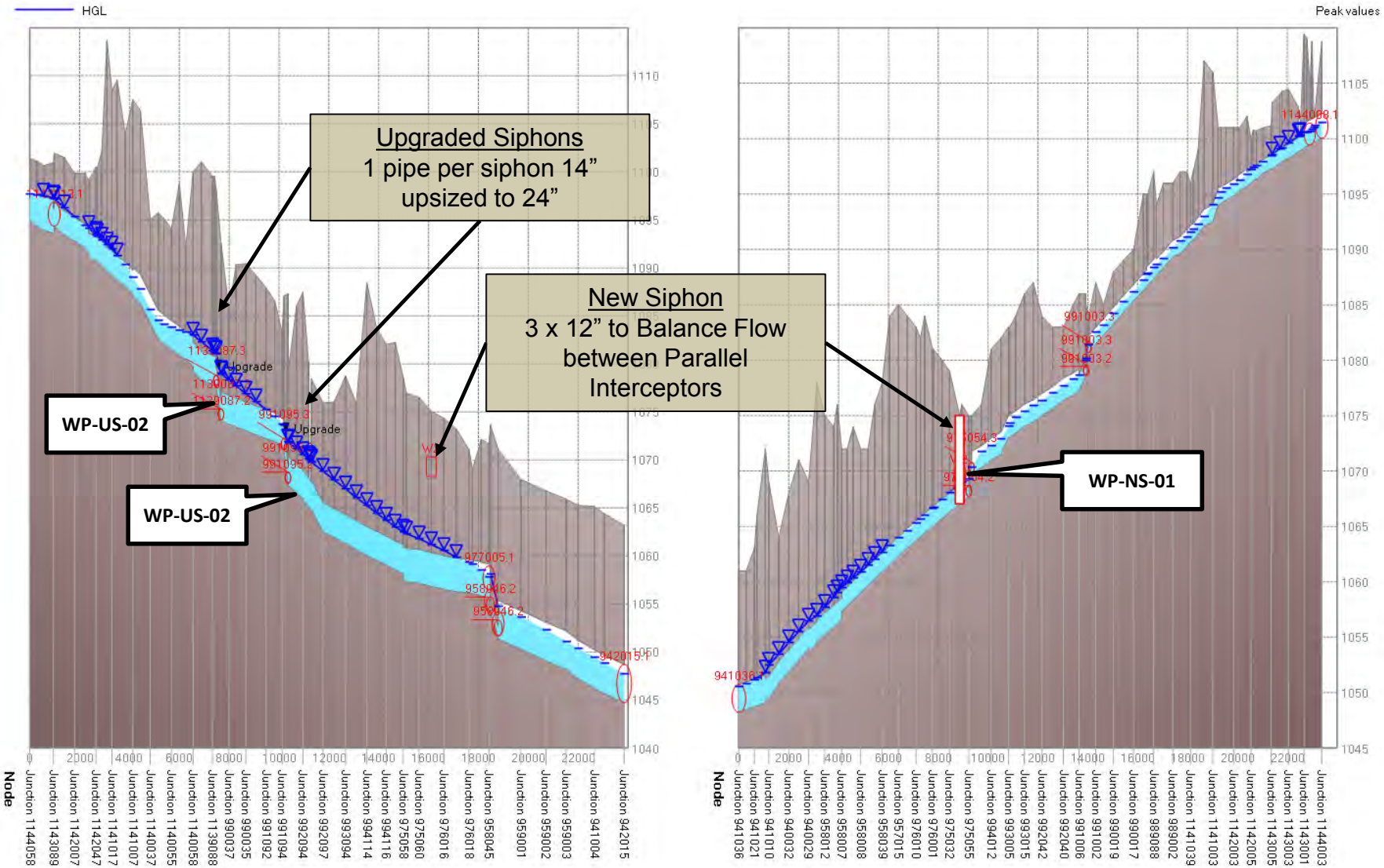
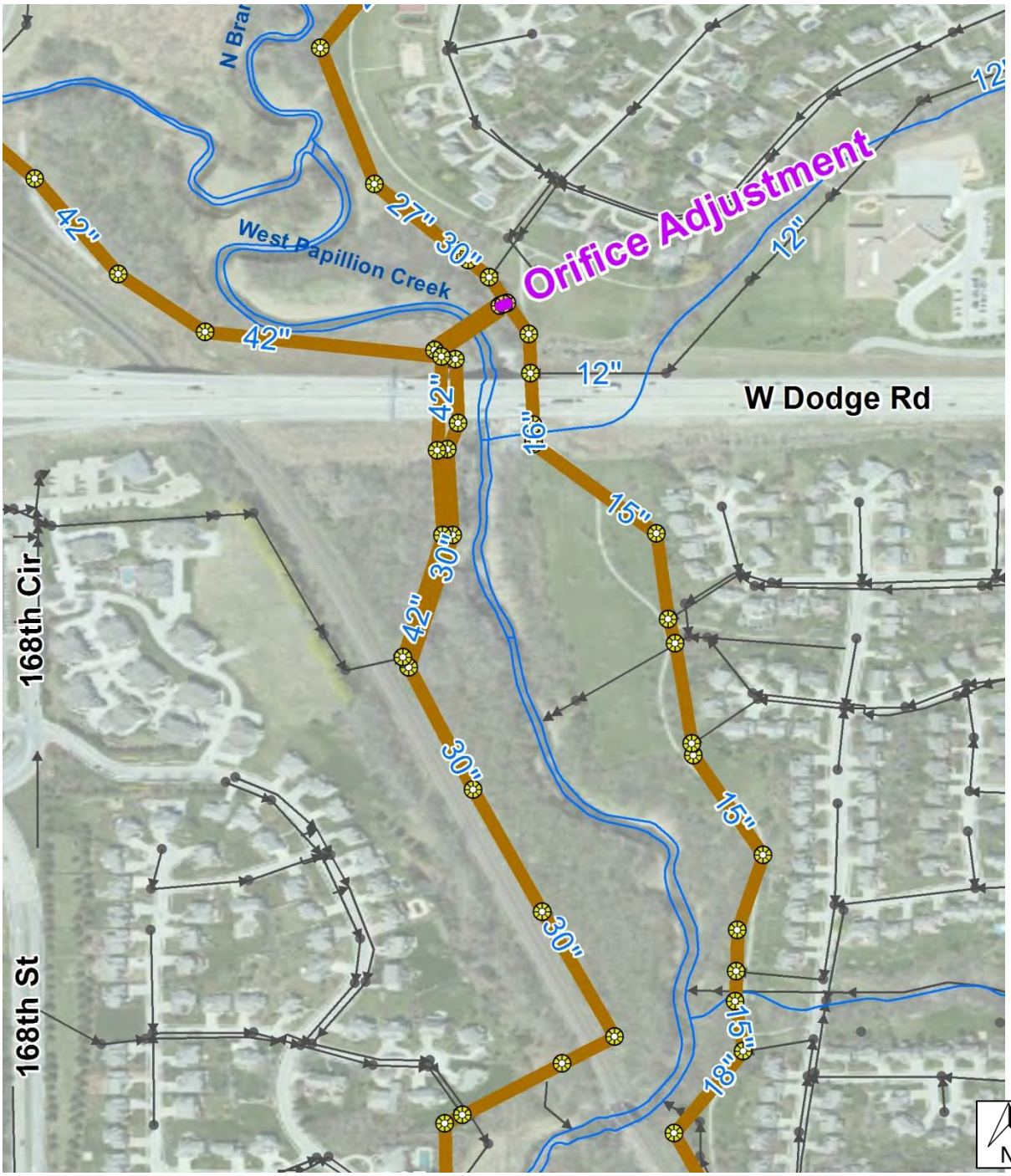


Figure 5.11 – WP-NS-01, WP-US-02, and WP-US-03 Profiles
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE



1" = 500'

Legend

- Capacity Improvement Project
- InfoWorks Model
- SewerLines and SewerNodes (not modeled)

Figure 5.12 – Orifice Adjustment Plan
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

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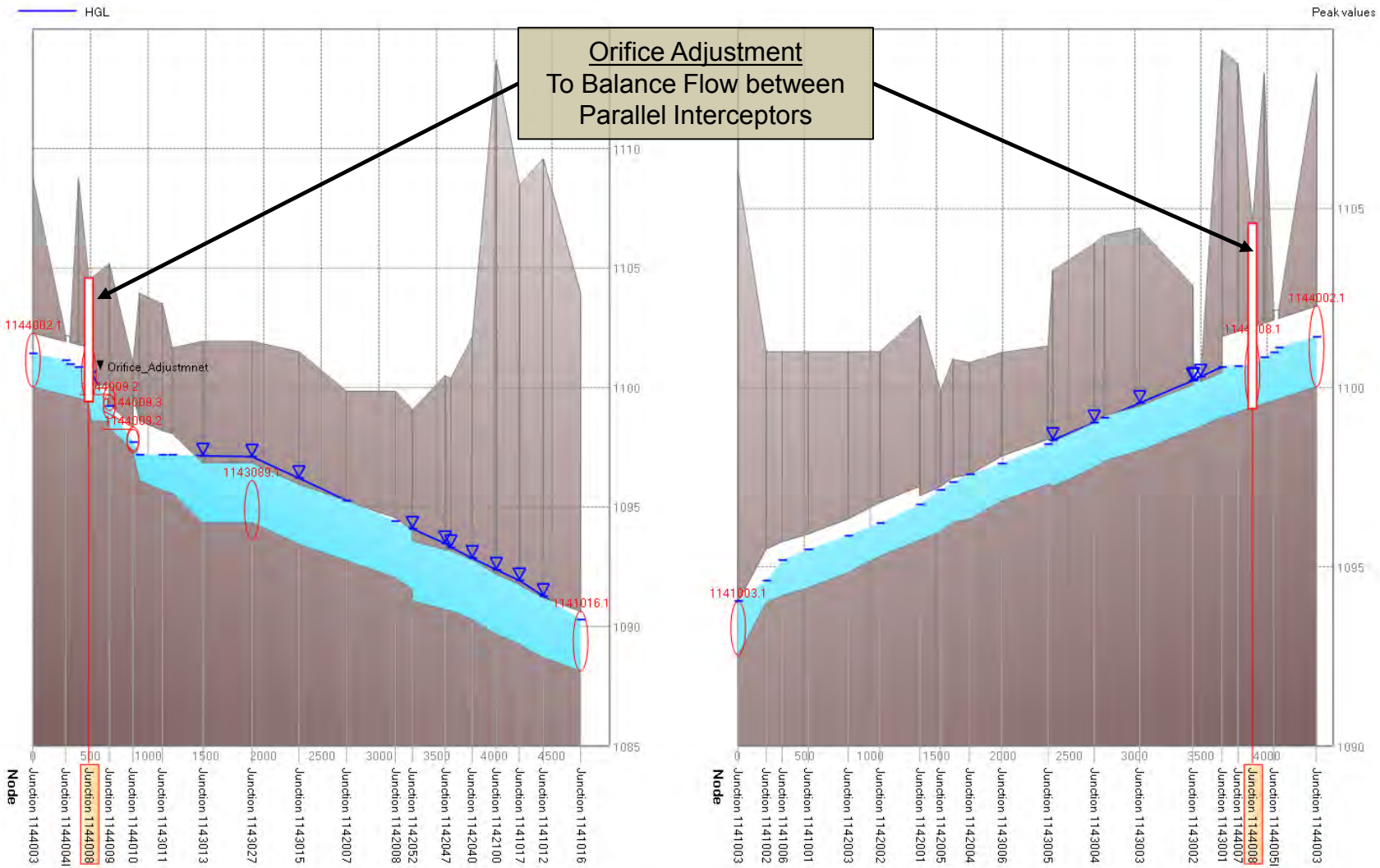
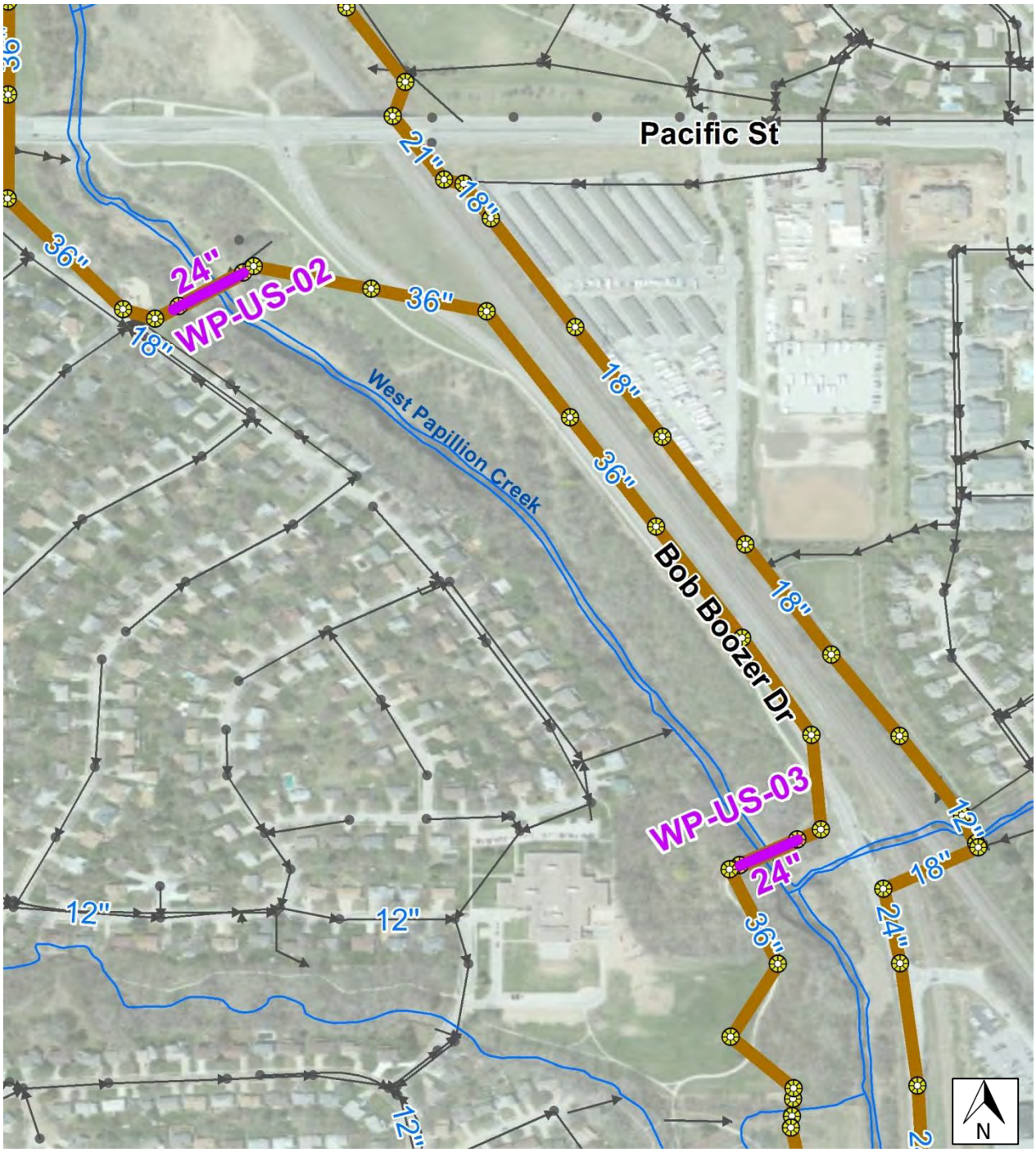


Figure 5.13 – Orifice Adjustment Profile
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE



1" = 500'

Legend

- Capacity Improvement Project
- InfoWorks Model
- SewerLines and SewerNodes (not modeled)

Figure 5.14 – WP-US-02 and WP-US-03 Plan
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

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Table 5.4 West Papio Interceptor Capacity Improvements Papillion Creek Sanitary Interceptor Master Plan City of Omaha, NE				
Project ID	**Pipe Diam. (inch)**	**Pipe Capacity (mgd)(1)**	**Pipe Slope (%)**	**Pipe Length (feet)**
WP-NS-01(2)	12	2.69	1.36	630
WP-US-02	24	17.27	1.86	190
WP-US-03	24	18.74	2.19	160

Notes:
(1) As calculated within InfoWorks for full pipe flow and no surcharge.
(2) Three barrel siphon. Capacity and pipe diameter are listed for each individual siphon.

5.4.3 2031-2040 Planning Horizon

Upgrades to an existing siphon are proposed just east of 90th and Military. The plan and profile for LP-US-01 is illustrated in Figure 5.15 and Figure 5.16, respectively. The existing siphon is a three-barrel siphon with pipe diameters of 8-inches, 10-inches, and 12-inches. The improvement increases the diameters of the two smaller barrels to 12-inches in diameter. This will decrease the surcharging along the existing interceptor for the 2050 flows.

The plan and profile for LP-NS-01 is illustrated in Figure 5.17 and Figure 5.18, respectively. The project is located between Fort and Maple streets along 90th street. It is designed to relieve the surcharging along the existing interceptor by conveying flows to an existing 21-inch diameter sewer located along 90th street. However, the relief sewer had to be designed as a siphon given the inverts of the existing sewers in the area. The east interceptor (24/30-inch diameter) is approximately 2-3 feet higher in elevation than the west interceptor (21-inch diameter). The new siphon is designed as a two-barrel siphon with 24-inch diameter pipes. The alignment of the siphon was selected to minimize the surcharging needed to convey flows to the east interceptor, which is the reason why a manhole farther upstream along the east interceptor was selected. Additionally as part of this project the model in this area should be updated to include a 21/24-inch sewer which parallels the existing interceptor. This would allow the siphon to be correctly sized given that the majority of the flows in the model are loaded to the easterly interceptor.

N

1" = 500'

Legend

- Capacity Improvement Project
- InfoWorks Model
- SewerLines and SewerNodes (not modeled)

Figure 5.15 – LP-US-01 Plan
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

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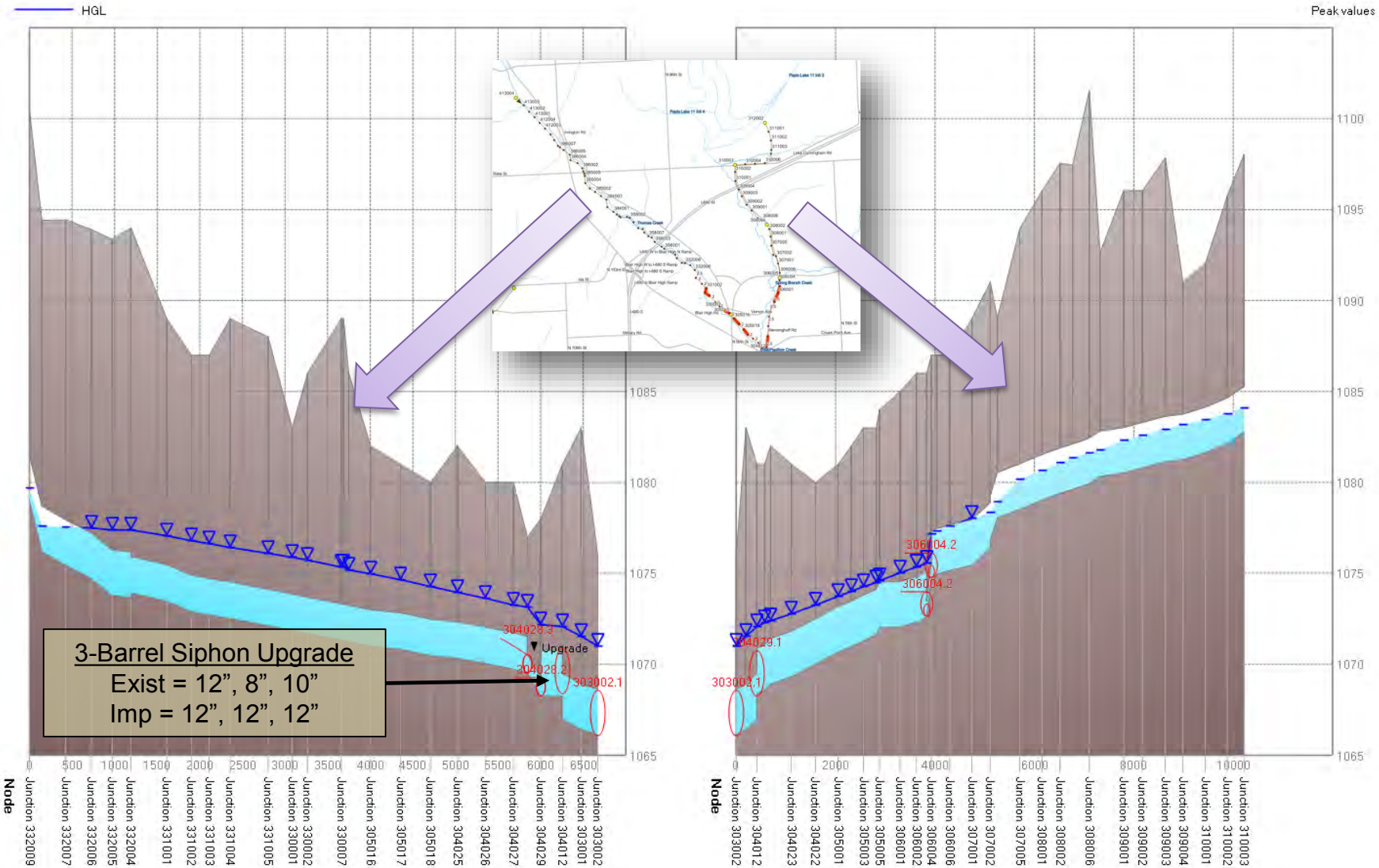

Figure 5.16 – LP-US-01 Profile
Papillion Creek Sanitary Interceptor
Master Plan
City of Omaha, NE

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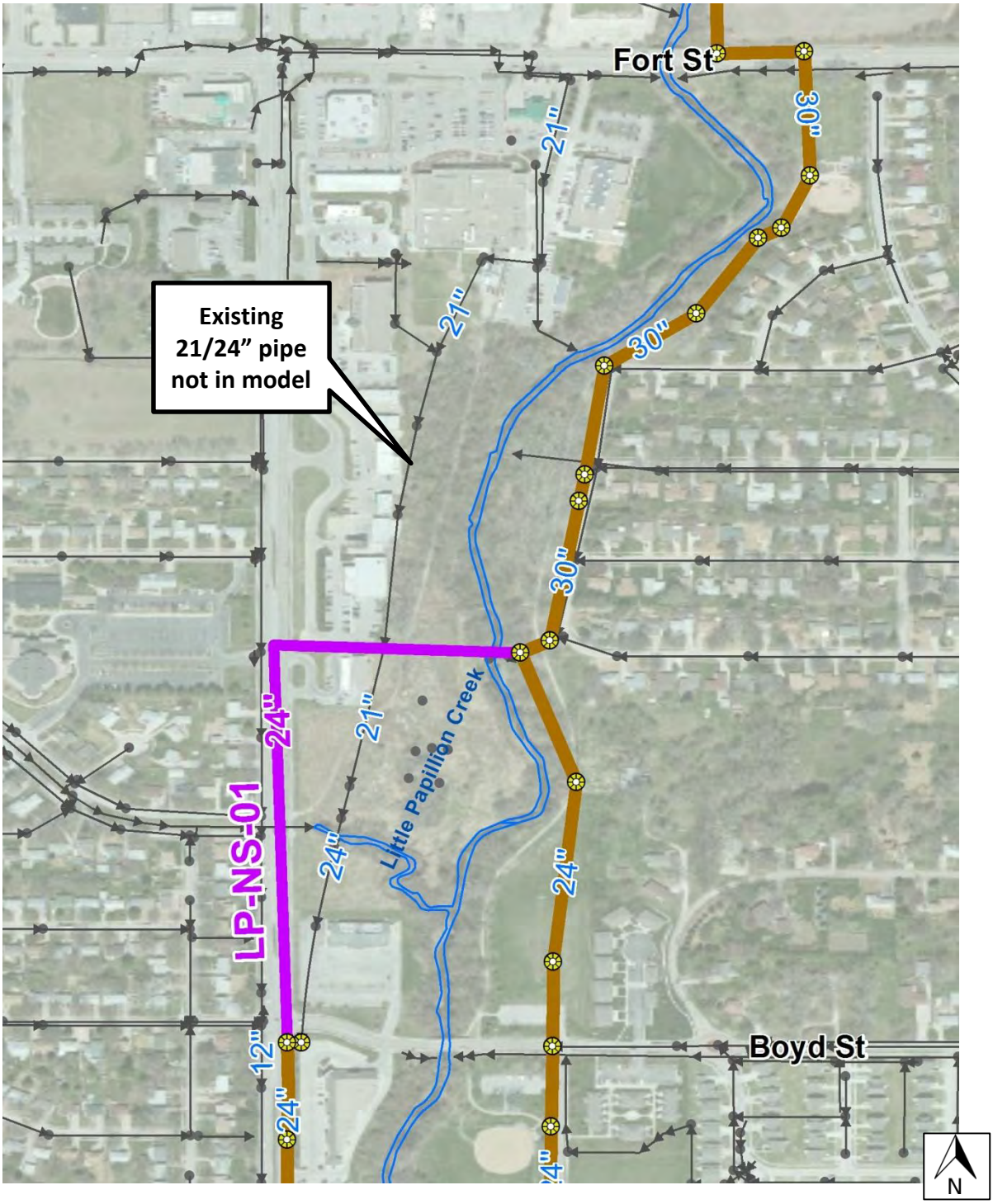

1" = 500'

Legend

- Capacity Improvement Project
- InfoWorks Model
- SewerLines and SewerNodes (not modeled)

Figure 5.17 – LP-NS-01 Plan
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

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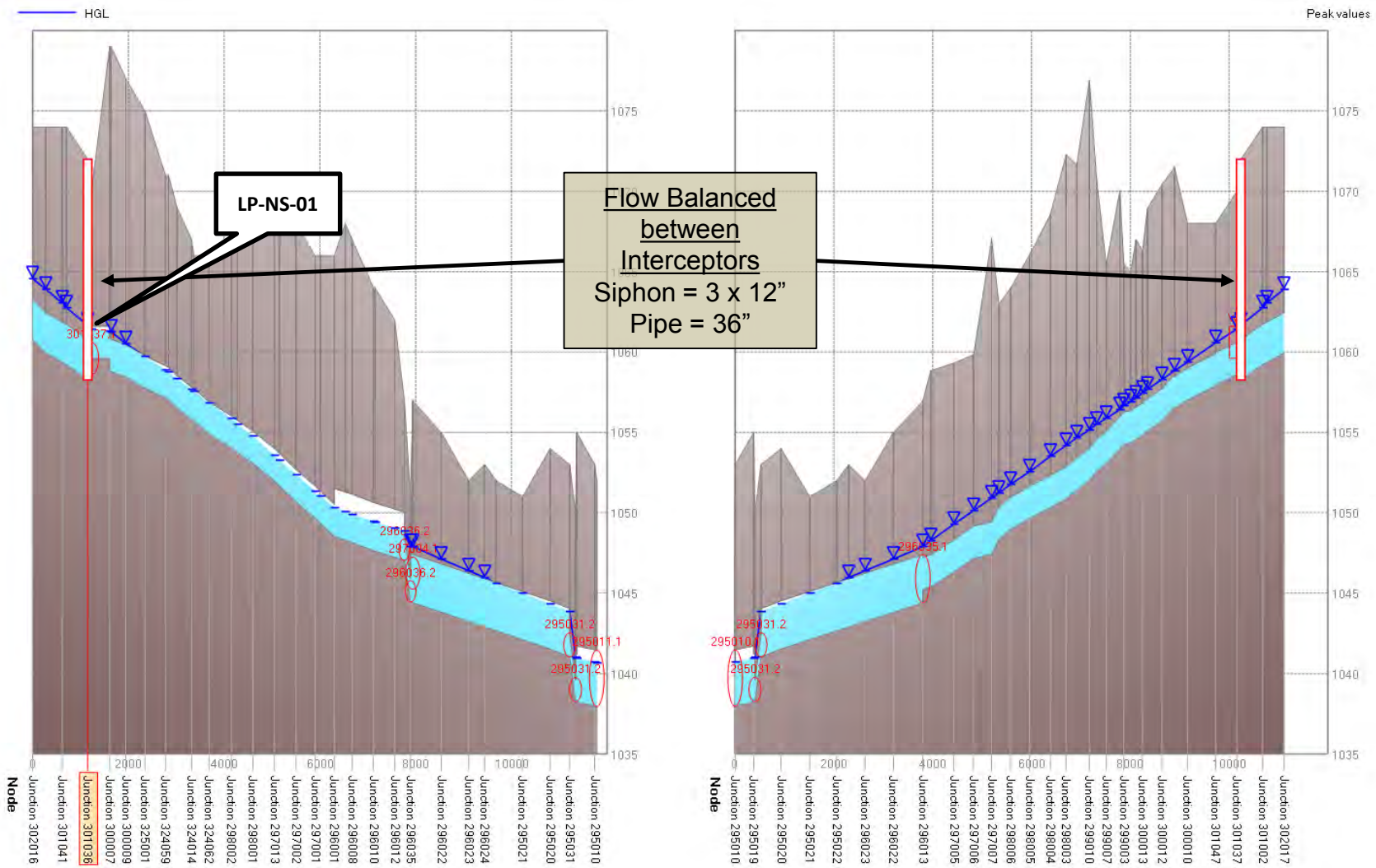

Figure 5.18 – LP-NS-01 Profile
Papillion Creek Sanitary Interceptor
Master Plan
City of Omaha, NE

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5.4.4 2041 – 2050 Planning Horizon

No capital improvements are identified for this planning horizon since capital improvements generally need to be completed before sewer extensions can be installed so that downstream interceptor pipelines are not overburdened from the upstream flows. This period is also far enough out in the future that development patterns are likely to change from the current assumptions. Therefore, capital improvements in this planning horizon should be further investigated during the next master plan update.

5.5 PLANNING-LEVEL PROJECT COST ESTIMATES

The assumptions and analyses discussed above were used to develop detailed costs for the improvement projects by planning horizon. The construction costs include planning-level cost estimates in 2015 dollars, which were then escalated to the estimated midpoint of construction to represent the total project cost. Furthermore the projects identified in the 2021-2030 planning horizon were broken out into two five-year periods, 2021-2025 and 2026-2030. The projects were denoted as such based on feedback from the City to illustrate the substantial CIP requirements during this time period for the identified capacity improvements. Table 5.5 summarizes total costs for the various planning periods.

Table 5.6 through Table 5.8 details the various capacity improvements and sewer extensions projects needed across all of the planning horizons. The estimated total cost of the capacity improvements are approximately $72.6 million, while the total cost of sewer extensions is $112.5 million, totaling approximately $185 million in improvements needed through 2050. The majority of the capacity improvements ($57 million), which support future sewer expansions, are needed in the 2026 – 2030 period. The most significant investment in sewer extensions ($43 million) will need to be completed in the 2031 – 2040 period.

For comparison purposes, the capacity improvements developed for this study are $257 million less than those developed for the previous 2009 master plan. Some of the reasons for this difference include the improved flow monitoring, the more detailed and calibrated InfoWorks model, and the application of flow balancing techniques between existing interceptors to maximize the capacities of the current system. The difference in the cost estimates for the sewer extensions is only $7.8 million (previous estimate was $120.2 million). This smaller difference was expected since the growth estimates contributing to sanitary sewer flow were not exceptionally different between this study and the 2009 study.

Table 5.5	**Capital Improvement Program Cost Estimates Papillion Creek Sanitary Interceptor Master Plan City of Omaha, NE**		
Planning Period	**Capacity Improvements**	**Sewer Extensions**	**TOTALS**
2015-2020	$0	$14,003,390	$14,003,390
2021-2025	$5,094,000	$17,967,000	$23,061,000
2026-2030	$56,986,000	$8,478,000	$65,464,000
2031-2040	$10,562,000	$43,016,000	$53,578,000
2041-2050	$0	$29,013,000	$29,013,000
TOTALS	**$72,642,000**	**$112,477,390**	**$185,119,390**

Table 5.6 Capital Improvement Program (CIP) Project Cost Estimates (2015 – 2020)
Papillion Creek Sewer Interceptor Master Plan
City of Omaha, NE

Projects Name	Description	Pipe Diameter (inches)	Pipe Length (Feet)	Cost Basis	Planning Level Project Construction Cost Estimate (2015 Dollars)						Construction Subtotals (2015 dollars)	Total Cost Subtotals (midpoint of Construction)
					2015	2016	2017	2018	2019	2020		
SEWER EXTENSIONS												
WP-243.1A	Between 180th and 192nd, to Maple	18	2,923	City Unit Price	$1,320,000						$1,320,000	$1,320,000
WP-243.1B	Between 180th and 192nd, Maple to PDZ	18	2,165	City Unit Price		$814,000					$814,000	$814,000
WP-243.1C	Between 180th and 192nd, PDZ to Fort	18	3,289	City Unit Price			$867,000				$867,000	$922,000
WP-243.1D	Cuts through Fort Street alignment	18	1,279	Carollo Spreadsheet						$460,000	$460,000	$536,000
WP 248.4	Near 216th Street Between Maple and Fort	18	4,750	City Unit Price		$1,700,000					$1,700,000	$1,700,000
WP 246.1	West Side Dam Site 15A interceptor to Ida	27	5,843	City Unit Price				$2,330,000			$2,330,000	$2,553,000
WP 246.2	East Side Dam Site 15A interceptor to State St	18	15,610	City Unit Price		$3,130,000					$3,130,000	$3,130,000
DS15A	Dam Site 15A Sanitary Sewer through the dam	27/18	2241/1450	HDR Design	$2,100,000						$2,100,000	$2,100,000
Next Planning Study				**City PM Estimate**			**$350,000**				**$350,000**	**$350,000**
Additional Monitoring				**City PM Estimate**			**$350,000**				**$350,000**	**$350,000**
Current Obligations(1)					**$228,390**						**$228,390**	**$228,390**
SUBTOTALS			**35,859**		**$3,648,390**	**$5,644,000**	**$1,567,000**	**$2,330,000**	**-**	**$460,000**	**$13,649,390**	**$14,003,390**

Notes:

(1) S.I.D. 513 Interceptor Sewer Reimbursement.

Table 5.7 Capital Improvement Program (CIP) Project Cost Estimates (2021 – 2030)
Papillion Creek Sewer Interceptor Master Plan
City of Omaha, NE

Projects Name	Description	Pipe Diameter (inches)	Pipe Length (feet)	Est. Construction (Cost $2015 $)	Est. Total Project Cost (2015 $)	Est. Construction Cost (2015 $)	Est. Total Project Cost (2015 $)	Construction Subtotals (2015 Dollars)	Total Cost Subtotals (mid-point of Construction)
				2021-2025		2026-2030			
CAPACITY IMPROVEMENTS				**$4,374,000**	**$5,094,000**	**$39,507,000**	**$56,986,000**	**$43,881,000**	**$62,080,000**
BP-PI-01	Parallel Interceptor	42	9,700			$16,296,000	$23,506,000	$16,296,000	$23,506,000
BP-NS-01	New Siphon (stream x-ing)	15	800			$4,950,000	$7,140,000	$4,950,000	$7,140,000
BP-PI-02	Parallel Interceptor	42	4,900			$8,232,000	$11,874,000	$8,232,000	$11,874,000
WP-PS-01	Pump Station Upgrade (4 to 8 mgd)	---	---			$9,000,000	$12,982,000	$9,000,000	$12,982,000
WP-PS-02	Parallel Force Main	14	1,838			$1,029,000	$1,484,000	$1,029,000	$1,484,000
WP-NS-01	New Siphon (stream x-ing)	12	630	$3,119,000	$3,633,000			$3,119,000	$3,633,000
Orifice Adjustment	Optimize orifice setting for flow split	18	---	$100,000	$116,000			$100,000	$116,000
WP-US-02	Upgrade Siphon	24	190	$627,000	$730,000			$627,000	$730,000
WP-US-03	Upgrade Siphon	24	160	$528,000	$615,000			$528,000	$615,000
SEWER EXTENSIONS				**$14,234,000**	**$17,967,000**	**$6,085,000**	**$8,478,000**	**$20,319,000**	**$26,445,000**
WP-244.1	Sewer Extension for Growth	18	4,403	$1,585,000	$1,904,000			$1,585,000	$1,904,000
WP-245.1	Sewer Extension for Growth	24	6,724	$3,228,000	$3,997,000			$3,228,000	$3,997,000

Table 5.7 Capital Improvement Program (CIP) Project Cost Estimates (2021 – 2030)
Papillion Creek Sewer Interceptor Master Plan
City of Omaha, NE

WP-245.1	Sewer Extension for Growth (stream x-ing)	24	150	$297,000	$368,000			$297,000	$368,000
WP-247.1	Sewer Extension for Growth	27	3,925	$2,120,000	$2,625,000			$2,120,000	$2,625,000
WP-247.1	Sewer Extension for Growth (stream x-ing)	27	150	$334,000	$414,000			$334,000	$414,000
WP-248.1	Sewer Extension for Growth	27	3,022			$1,632,000	$2,215,000	$1,632,000	$2,215,000
WP-248.1	Sewer Extension for Growth (stream x-ing)	27	600			$1,337,000	$1,814,000	$1,337,000	$1,814,000
WP-248.2	Sewer Extension for Growth	15	3,503			$1,051,000	$1,470,000	$1,051,000	$1,470,000
WP-248.3	Sewer Extension for Growth	15	6,882			$2,065,000	$2,979,000	$2,065,000	$2,979,000
WP-342.1	Sewer Extension for Growth	24	5,665	$2,719,000	$3,471,000			$2,719,000	$3,471,000
WP-342.1	Sewer Extension for Growth (stream x-ing)	24	150	$297,000	$379,000			$297,000	$379,000
WP-343.1	Sewer Extension for Growth	18	4,610	$1,660,000	$2,185,000			$1,660,000	$2,185,000

Table 5.7 Capital Improvement Program (CIP) Project Cost Estimates (2021 – 2030)
Papillion Creek Sewer Interceptor Master Plan
City of Omaha, NE

WP-343.1	Sewer Extension for Growth (stream x-ing)	18	300	$446,000	$587,000			$446,000	$587,000
WP-346.1A	Sewer Extension for Growth	18	3,061	$1,102,000	$1,450,000			$1,102,000	$1,450,000
WP-346.1A	Sewer Extension for Growth (stream x-ing)	18	300	$446,000	$587,000			$446,000	$587,000
SUBTOTALS			**35,174**	**$18,608,000**	**$23,061,000**	**$45,592,000**	**$65,464,000**	**$64,200,000**	**$88,525,000**

Table 5.8	Capital Improvement Program (CIP) Project Cost Estimates (2031 – 2040) Papillion Creek Sewer Interceptor Master Plan City of Omaha, NE				
Projects Name	**Description**	**Pipe Diameter (inches)**	**Pipe Length (feet)**	**Est. Construction (Cost $2015 $)**	**Total Cost Subtotals (mid-point of Construction)**
CAPACITY IMPROVEMENTS				**$5,736,000**	**$10,562,000**
LP-US-01	Upgrade Siphon	12	160	$528,000	$972,000
LP-NS-01	New Siphon (stream x-ing)	24	600	$3,960,000	$7,292,000
LP-NS-01	New Parallel Siphon	24	1,300	$1,248,000	$2,298,000
SEWER EXTENSIONS				**$23,359,000**	**$43,016,000**
BP-248.1	Sewer Extension for Growth	42	2,571	$2,160,000	$3,978,000
BP-320.1	Sewer Extension for Growth	42	2,902	$2,438,000	$4,490,000
BP-321.1	Sewer Extension for Growth	30	6,139	$3,683,000	$6,782,000
BP-322.1	Sewer Extension for Growth	42	2,117	$1,778,000	$3,274,000
BP-323.1	Sewer Extension for Growth	42	2,890	$2,428,000	$4,471,000
BP-324.1	Sewer Extension for Growth	36	3,082	$2,219,000	$4,086,000
BP-326.1	Sewer Extension for Growth	36	1,986	$1,430,000	$2,633,000
BP-327.1	Sewer Extension for Growth	36	6,565	$4,727,000	$8,705,000

Table 5.8	Capital Improvement Program (CIP) Project Cost Estimates (2031 – 2040) Papillion Creek Sewer Interceptor Master Plan City of Omaha, NE				
Projects Name	**Description**	**Pipe Diameter (inches)**	**Pipe Length (feet)**	**Est. Construction (Cost $2015 $)**	**Total Cost Subtotals (mid-point of Construction)**
WP-248.5	Sewer Extension for Growth	18	4,086	$1,471,000	$2,709,000
WP-346.1B	Sewer Extension for Growth	18	2,847	$1,025,000	$1,888,000
SUBTOTALS			**37,245**	**$29,095,000**	**$53,578,000**

Table 5.9	Capital Improvement Program (CIP) Project Cost Estimates (2031 – 2040) Papillion Creek Sewer Interceptor Master Plan City of Omaha, NE				
Projects Name	**Description**	**Pipe Diameter (inches)**	**Pipe Length (feet)**	**Est. Construction (Cost $2015 $)**	**Total Cost Subtotals (mid-point of Construction**
SEWER EXTENSIONS			**23,982**	**$11,610,000**	**$29,013,000**
BP-249.1	Sewer Extension for Growth	24	6,371	$3,058,000	$7,642,000
BP-325.1A	Sewer Extension for Growth	30	5,387	$3,232,000	$8,077,000
BP-325.1B	Sewer Extension for Growth	30	3,235	$1,941,000	$4,850,000
WP-344.1	Sewer Extension for Growth	18	3,376	$1,215,000	$3,036,000
WP-344.1	Sewer Extension for Growth (stream x-ing)	18	300	$446,000	$1,115,000

Table 5.9	Capital Improvement Program (CIP) Project Cost Estimates (2031 – 2040) Papillion Creek Sewer Interceptor Master Plan City of Omaha, NE				
Projects Name	**Description**	**Pipe Diameter (inches)**	**Pipe Length (feet)**	**Est. Construction (Cost $2015 $)**	**Total Cost Subtotals (mid-point of Construction**
WP-345.1	Sewer Extension for Growth	15	3,250	$975,000	$2,436,000
WP-347.1	Sewer Extension for Growth	18	2,063	$743,000	$1,857,000

FINANCIAL ANALYSIS

6.1 INTRODUCTION

The CIP defined when, where, and how much the improvements will cost to provide for an efficiently operating interceptor system. The financial analysis, as part of this study, is necessary to develop how these projects are paid for in order to keep the Interceptor Sewer Fund, or ISF, efficiently operating so that money is available to provide for construction of projects.

This chapter presents a review of the financial history and condition of the ISF, and projections of Capital Improvement Plan (CIP) expenditures, sewer connection fees, and fund balances through 2050. Particular attention is given to the six-year period from 2015 through 2020. The chapter concludes with findings, observations, and recommendations regarding the long-term management of the fund to support the CIP.

6.2 BACKGROUND

The City relies on sewer connection fees to pay for the costs of constructing sanitary interceptor sewer infrastructure to serve new development in the Papillion Creek service area. The authority and purpose of the connection fee are set forth in the following sections of the Omaha Municipal Code:

- Section 31-255 authorizes the “collection of fees for sanitary sewer connection to certain properties, to help defray the costs of enlarging and extending the interceptor sewer system serving such property.”
- Section 31-256 defines the interceptor sewer system as “those sewers shown and discussed in the Henningson, Durham, and Richardson (HDR) study, dated 2009, entitled ‘Sanitary Interceptor Sewer Master Plan Papillion Creek Watershed 2009’.”
- Section 31-257 states that the Interceptor fee “shall be paid only for those new sewer connections outside of zones A, B, and C of the city’s urban development policy which will flow through the city sanitary sewer system, also sometimes called the waste water collection system, in the Papillion Creek Watershed.”
- Section 31-259 defines the fees that may be imposed on new development. These fees are summarized in Table 6.1.

Table 6.1 New Development Fees Papillion Creek Sanitary Interceptor Master Plan City of Omaha, NE	
Land Use Type	**Fee**
Single Family (SF)(1)	$1,100
Mobile Home (MH)(2)	$847
Multi-Family (MF)(1)	$858
Commercial/Industrial(C/I)(3)	$5,973
Notes: (1) Per family unit (2) Per mobile home pad (3) Per acre	

The City has maintained a fee structure based on land use type since 1980. The City employs a comprehensive planning process to ensure that connection fees keep pace with regular updates to the sewer master plan and CIP. These updates are informed by projections of population and employment growth and the future designation of land uses for new development. In addition, updates are driven by an assessment of the current performance and future capacity requirements of the interceptor sewer system to support new development, as well as the timing and estimated costs of system improvements.

The City adopts connection fees for four basic classes of new development. Three of these classes apply to residential developments: (1) single family and duplex residences, (2) mobile homes, and (3) multi-family residences. The fourth class applies to all non-residential (commercial, industrial and institutional) developments. Fees for single family and multi-family developments are expressed as a rate per dwelling unit. Fees for mobile home developments are per development pad. Non-residential fees are per acre of development.

The City Code specifically defines development acres for purposes of calculating connection fees as follows:

“As used herein, the expression "institutional" refers primarily to religious assembly facilities and public and private schools. The connection fees for such institutional uses will be computed on acreage including the developed land, parking areas, and the land immediately adjacent to the facility which forms the usable part of the property, excluding unsewered playgrounds or sports activity areas. Commercial and industrial acreage shall be based upon the entire commercial or industrial zoned area, including any parking and outside storage areas.”

Omaha Municipal Code Section 31-259(b)

The Municipal Code also contains special authority to calculate a connection surcharge when a non-residential development is likely to produce sewage discharges in excess of 3,000 gallons per day.

6.2.1 Connection Fee History

The City's authority to collect connection fees in the Papillion Creek service area dates back to April 1980, following the completion of the Sanitary Interceptor Sewer Master Plan for the Papillion Creek Watershed in August 1979. Since its inception, the City has updated connection fees on five occasions, an average of once every four and a half years. Fee increases have averaged 17 percent for single family and mobile home developments, 27 percent for multi-family developments, and 16 percent for commercial and industrial developments. Table 6.2 provides details regarding the timing and changes in connection fees since 1980. This history is also illustrated in Figure 6.1.

Table 6.2 Interceptor Sewer Connection Fees, 1980-2015
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

	Interceptor Sewer Connection Fees			
Effective Date	**SF**	**MF**	**MH**	**C/I**
April 9, 1980	$510.00	$270.00	$390.00	$2,938.00
August 1, 1990	$622.20	$329.40	$475.80	$3,584.36
January 5, 1994	$673.20	$356.40	$514.80	$3,878.16
January 3, 2001	$947.00	$540.00	$748.00	$5,448.00
April 13, 2005	$947.00	$739.00	$729.00	$5,142.00
August 3, 2009	$1,100.00	$858.00	$847.00	$5,973.00

6.2.2 Interceptor Sewer Fund

The ISF accounts for connection fee income and the costs of interceptor sewer improvements. The ebb and flow of revenues and expenditures in the fund reflect an unavoidable mis-match between the timing of capital improvements and the receipt of associated connection fees. This timing challenge places particular importance on the financial management of the fund, effective planning to maintain a close concurrency of infrastructure improvements and private development, and the accumulation and management of healthy cash balances. Figure 6.2 illustrates the dynamic nature of the ISF between 2003 and 2014.

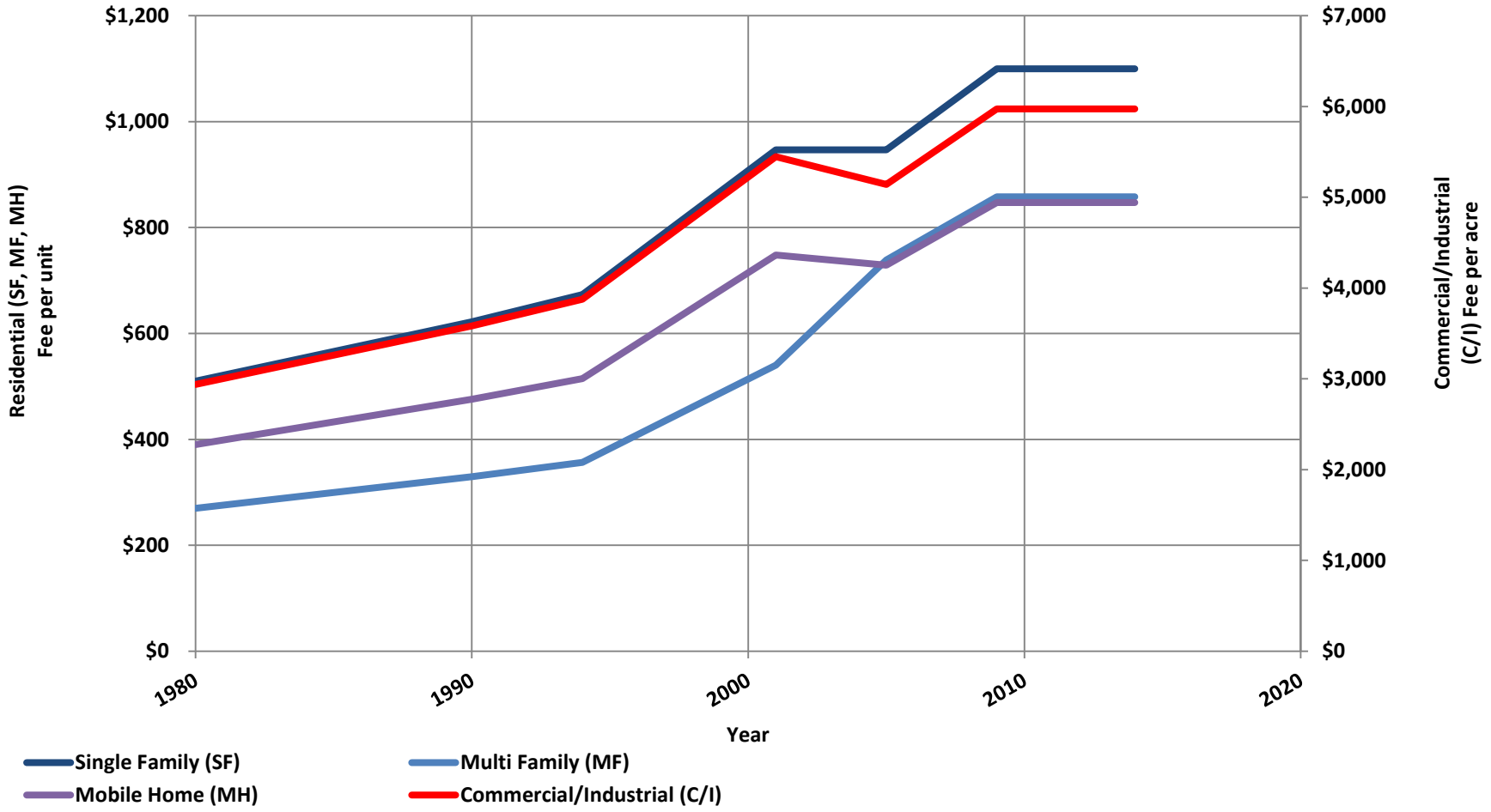

Figure 6.1 – Changes in Interceptor Sewer Connection Fees since 1980
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

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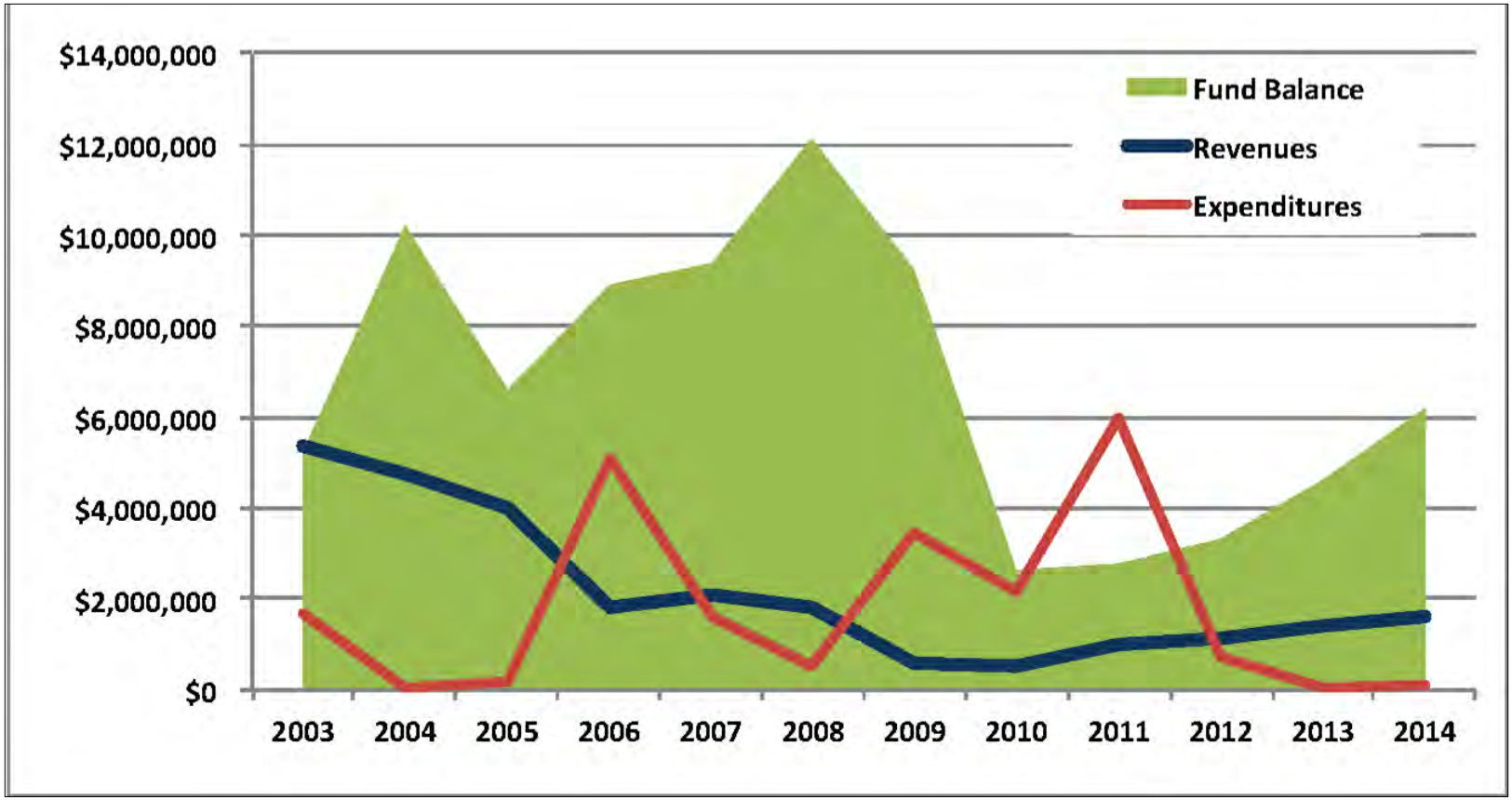

Figure 6.2 – Interceptor Sewer Construction Fund Revenues, Expenditures, and Fund Balances, 2003-2014
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

6.3 METHODOLOGY

6.3.1 City Directives and Guidance

At the request of the City, Carollo focused its financial analysis, findings, and recommendations to the City's existing fee structure, and the adequacy of planned fee increases to pay for the costs of interceptor sewer system improvements from 2015 through 2020. However, the fees were also examined from 2025 to 2050, but on a lesser-detailed basis as directed by the City. The following City directives guided the financial analysis and projection of interceptor revenues to finance future CIP requirements:

- Maintain the existing interceptor fee structure as set forth in Section 31-259 of the Municipal Code.
- Extend current fees through 2015, and then increase fees by 6 percent for 2016. For every year, thereafter, increase fees by the dollar amount of the increase from 2015 to 2016.
- Exempt new development in the area referred to as the 680/80 Loop. Development in this area will not be required to pay interceptor connection fees.
- Estimate connection fee increases beyond 2025 to provide sufficient income to achieve a positive balance in the ISF.

6.3.2 Projecting Future Sewer Demand and Interceptor Sewer Connections

Carollo worked with the City and Metropolitan Area Planning Agency (MAPA) to develop projections of sewer system demand, acres of new land development, and sewer connections through 2050. The resulting sewer demand projections were used to identify and schedule needed interceptor system improvements, while projected sewer connections were used, along with recommended fee increases, to estimate future connection fee income.

Detailed information about the use of population and land use data to inform modeling of the interceptor sewer system can be found in previous chapters of this report and appendices. Figure 6.3 provides a flow chart of the calculations used to produce sewer demand and connection fee income estimates resulting from new single family and multi-family residential developments. The flow chart excludes mobile home developments due to a lack of specific forecasting information.

The process for projecting sewer demand and sewer connections differed when it came to non-residential commercial and industrial developments. For these classes of land uses sewer system demand projections were based on estimates of future acres of land available for non-residential development, and the rates at which these acres would be developed between 2015 and 2050. Projections of new sewer connections relied on population estimates and a planning standard of 8/10ths of an acre of commercial and industrial land use for every 100 persons. Figure 6.4 illustrates the calculations used to produce sewer demand and connection fee income estimates resulting from new commercial and industrial developments.

Carollo developed an alternative approach to projecting system demand and sewer connections for commercial and industrial developments that rely on MAPA land use projections and systems modeling information regarding the amount of sewage flow per day per acre of development acre. The same base of information and calculations were applied to both projections of the sewer system demand and sewer connections, producing higher levels of sewer connections and connection fee income than produced by the method based on population estimates.

While this land use-based alternative approach produces sewer connection projections that are internally more consistent with the systems demand model, Carollo used the population-based approach to obtain more conservative sewer connection projections and connection fee income for purposes of this financial analysis. Figure 6.5 illustrates an alternative method of estimating sewer system demand, sewer connections, and connection fee income for commercial and industrial developments.

6.4 FINANCIAL ANALYSIS

The following analysis focuses on the cash flow and financial condition of the ISF during the period from 2015 through 2020. The analysis relies on two crucial sets of financial projections: (1) engineering estimates of the costs of interceptor sewer improvements required to meet future sewer system demand from new development (which are included in the previous chapter), and (2) connection fee income that is the product of recommended connection fees and projected sewer connections from new development. Interceptor connections, fees, and income are discussed below.

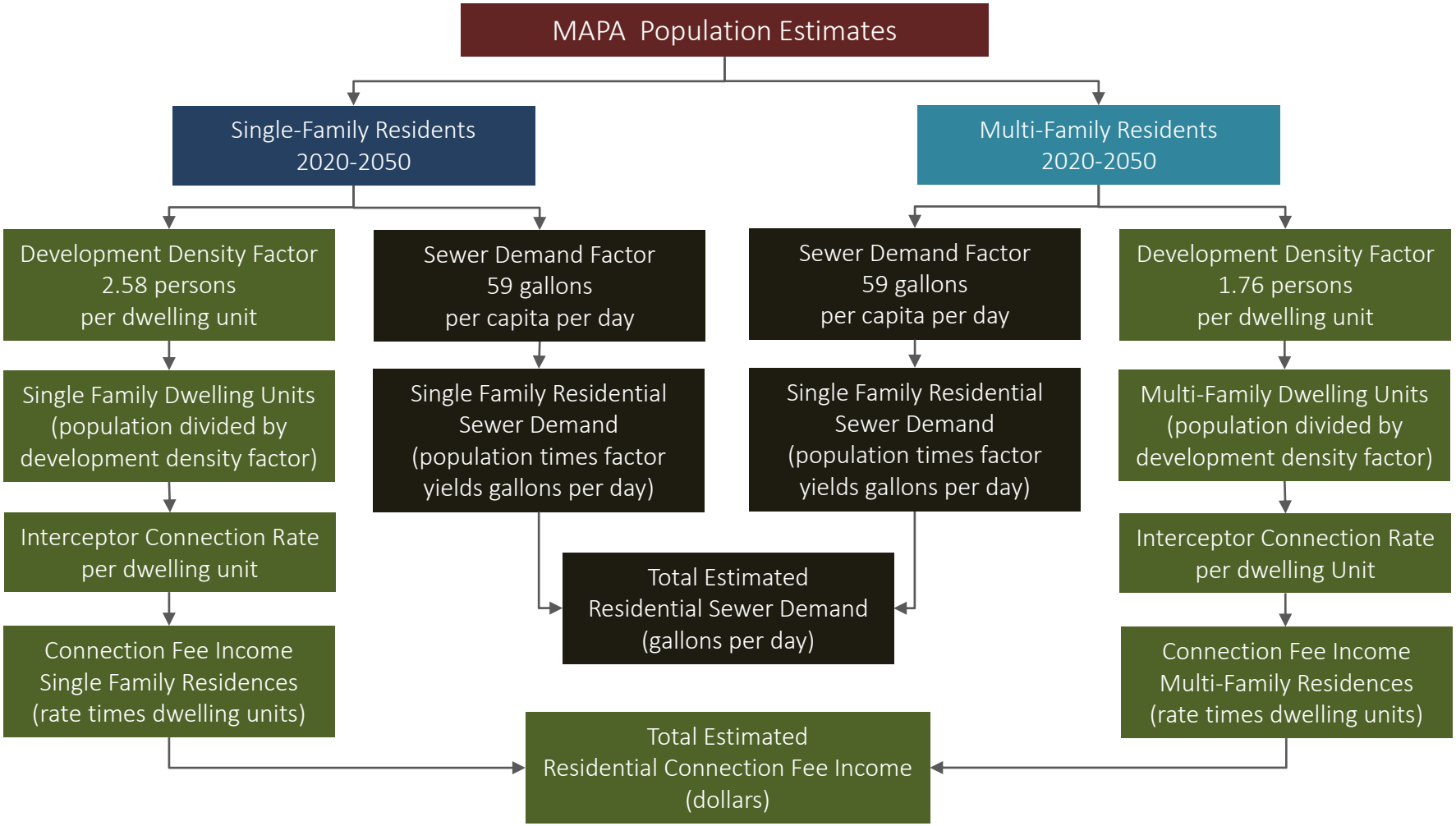

Figure 6.3 – Flow Chart of Planning Calculations for Single Family and Multi-Family Residential Developments
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

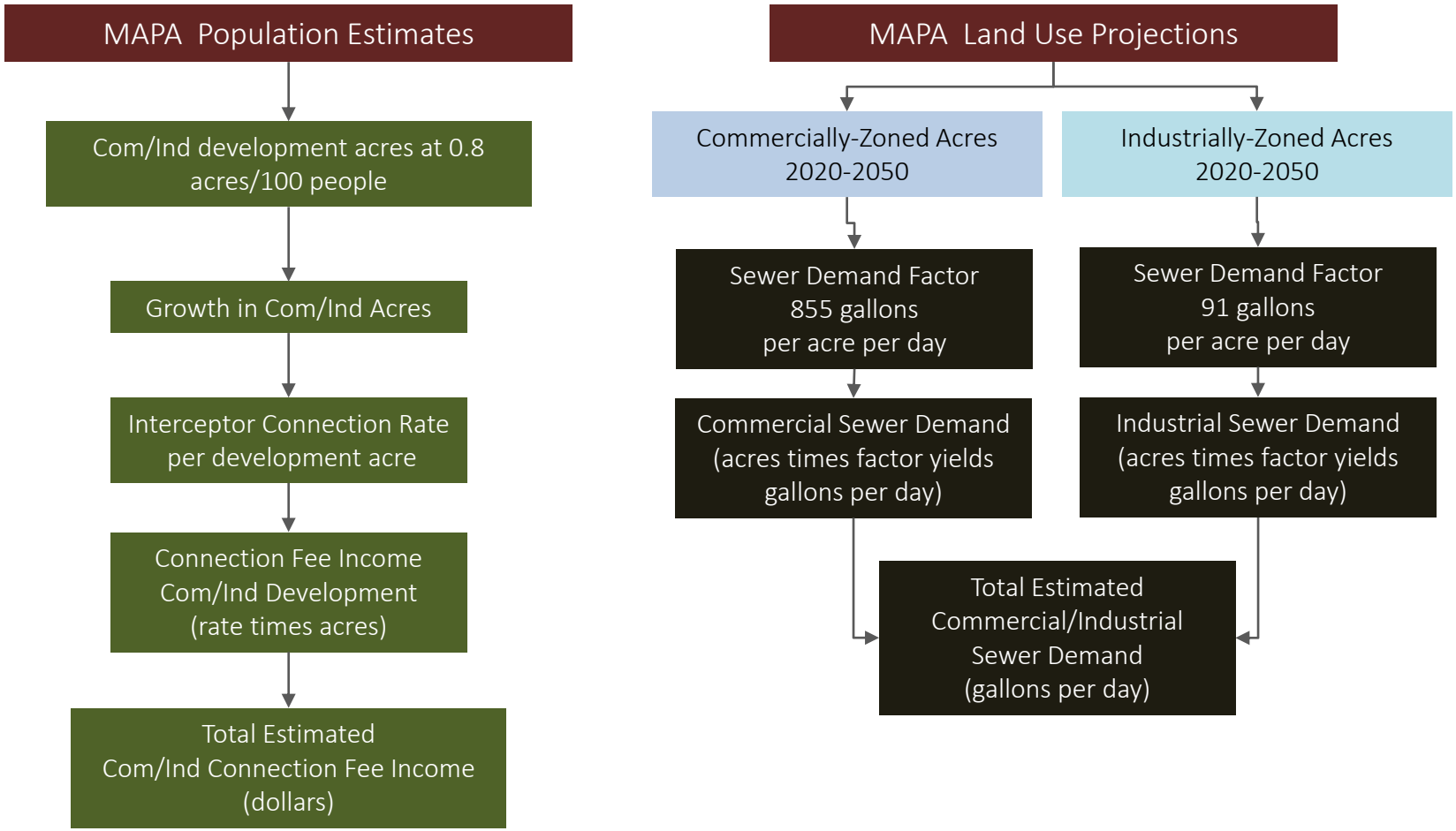

Figure 6.4 – Flow Chart of Planning Calculations to Estimate Sewer Demand, Sewer Connections and Connection Fee Income for Commercial and Industrial Developments
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

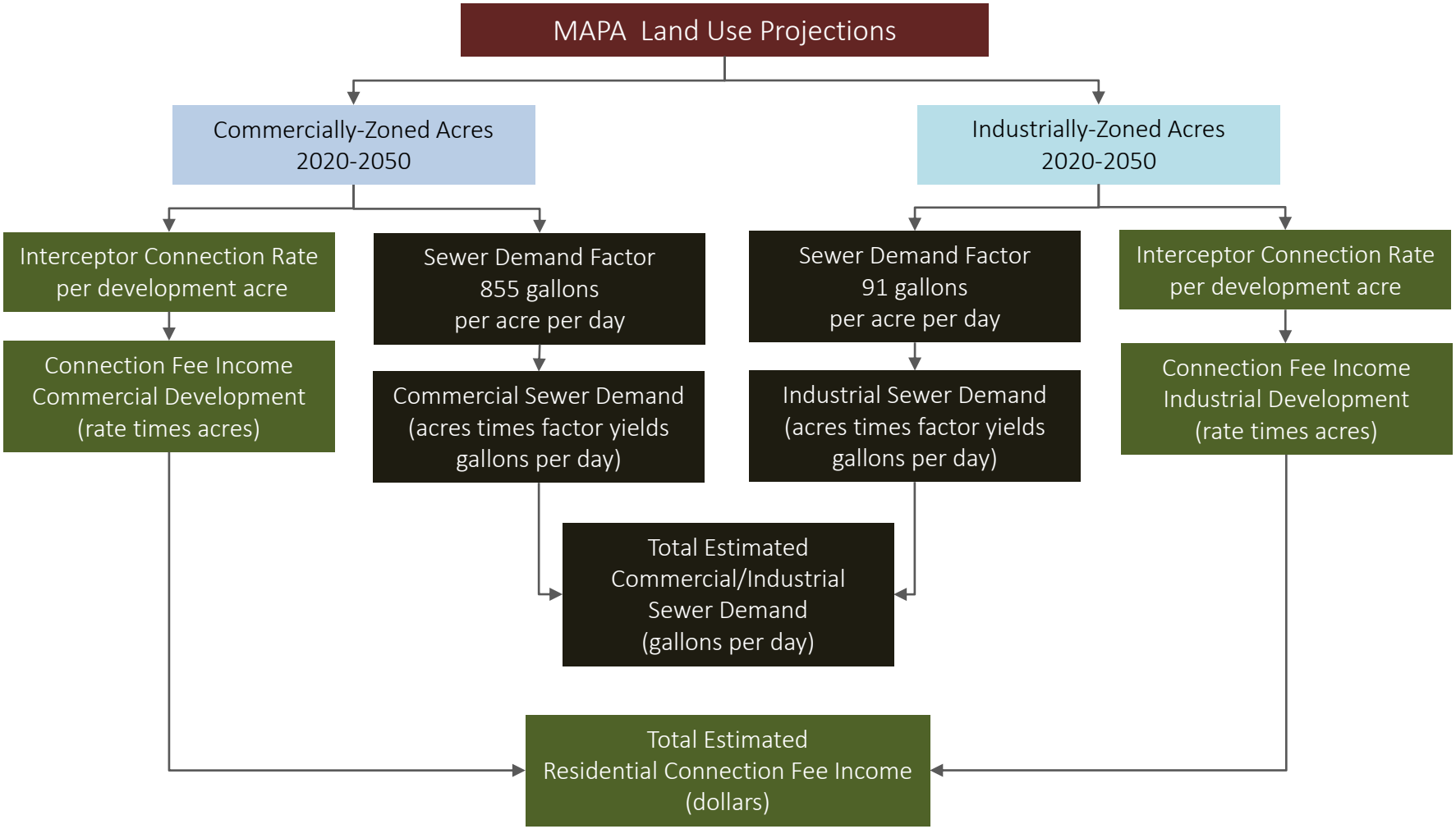

Figure 6.5 – Alternative Flow Chart of Planning Calculations for Commercial and Industrial Developments
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

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6.4.1 Interceptor Sewer Connections

Table 6.3 reports Carollo's projections of new residential dwelling units and commercial/industrial development acres for 2015 through 2050. These estimates were calculated based on population and land development data provided by the City and MAPA.

Table 6.3 Projections of Residential Dwelling Units and Acres of Commercial/Industrial Development, 2015-2050 Papillion Creek Sanitary Interceptor Master Plan City of Omaha, NE

Period	Single Family Residential (dwelling units)	Multi-Family Residential (dwelling units)	Commercial and Industrial (acres)	
			Population-Based	Land Use-Based
2015-2020	11,285	3,820	278	859
2021-2030	12,174	4,344	302	1,283
2031-2040	9,558	5,019	257	1,517
2041-2050	10,028	3,088	244	2,061
Totals	**43,045**	**16,272**	**1,080**	**5,720**

As previously stated, Carollo used a population-based approach to estimate acres of new commercial and industrial development for the purpose of projecting connection fee income.

6.4.2 Interceptor Sewer Connection Fees and Connection Fee Income

The City provided the following schedule of connection fees in Table 6.4 for purposes of estimating connection fee income. The fees for FY 2015 were originally adopted by the City in 2009. The fees increase by 6 percent for 2016, and then, for each subsequent year, the fees are increased by the dollar value of the increase in fees from 2015 to 2016.

Table 6.4	Projected Interceptor Sewer Connection Fees, FY 2015-2019 Papillion Creek Sanitary Interceptor Master Plan City of Omaha, NE				
Land Use Type	**2015**	**2016**	**2017**	**2018**	**2019**
Single Family(1)	$1,100	$1,166	$1,232	$1,298	$1,364
Mobile Home(2)	$847	$898	$949	$999	$1,050
Multi-Family(1)	$858	$909	$961	$1,012	$1,064
Commercial/Industrial(3)	$5,973	$6,331	$6,690	$7,048	$7,407

Notes:
(1) Per family unit
(2) Per mobile home pad
(3) Per acre

Table 6.5 combines the City's recommended connection fees with estimates of new development that will be subject to the connection fees during the next five fiscal years. For purposes of calculating annual connection fee income, Carollo distributed estimates of new development (residential dwelling units, mobile home pads, and commercial/industrial development acres) equally across the five fiscal years.

Table 6.5 Units/Acres of New Development and Connection Fees, 2015- 2020
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

	Single Family Residences		Mobile Home Residences		Multi Family Residences		Commercial/ Industrial	
Year	**Units**	**Fee**	**Pads**	**Fee**	**Units**	**Fee**	**Acres**	**Fee**
2015	1,881	$1,100	17	$847	637	$858	46	$5,973
2016	1,881	$1,166	17	$898	637	$909	46	$6,331
2017	1,881	$1,232	17	$949	637	$961	46	$6,690
2018	1,881	$1,298	17	$999	637	$1,012	46	$7,048
2019	1,881	$1,364	17	$1,050	637	$1,064	46	$7,407

Based on these projections of new development, the proposed fees will generate an estimated $12 million in connection fees income from FY 2015 through FY 2020. Capital improvements to the interceptor sewer system are estimated to cost $14 million during this five-year period. As a result, the ending balance in the ISF is projected to decrease by nearly $2 million between the close of FY 2014 and the close of FY 2020. A healthy fund balance in 2020 will be critical to City financing of the next phase of infrastructure improvements planned for the period from 2021 to 2030. Table 6.6 summarizes the projected financial transactions in the ISF between the close of FY 2014 and the close of FY 2020.

Table 6.6	**Projected Impacts to the Interceptor Sewer Construction Fund, FY 2015 - FY 2020 Papillion Creek Sanitary Interceptor Master Plan City of Omaha, NE**
Single Family Residential	$8,569,110
Mobile Home Residential	$58,440
Multi-Family Residential	$2,261,440
Commercial/Industrial	$1,154,020
Total Connection Fee Income	**$12,043,010**
CIP Requirements	**($14,003,390)**
Net Gain (Loss)	**($1,960,380)**
Estimated Fund Balance on 12/31/2014	**$6,200,000**
Estimated Fund Balance on 12/31/2020	**$4,239,620**

Figure 6.6 illustrates projected annual fee income and CIP requirements from 2015 through 2020. Both projections are based on equal annual levels of new development activity and CIP expenditures throughout the period. The increasing income trend reflects the impact of projected annual fee increases equal to the dollar value of a six percent increase in fees from 2015 to 2016.

6.4.3 Findings and Observations

Based on projections of new development and increases in connection fees, the City will be able to raise sufficient income to pay for planned interceptor sewer system improvements during the six-year planning period through FY 2020. The City should build and maintain the necessary balance in the ISF in anticipation of significant CIP requirements forecasted from 2021 through 2050.

Figure 6.7 compares forecasted CIP requirements and connection fee income during the 36-year planning period. The forecast assumes that fees will increase annually in amounts equal to the dollar value of a six percent increase in fees from 2015 to 2020. These projections clearly illustrate the challenges facing the Interceptor Sewer Construction Fund beyond 2020. The City can expect CIP requirements to outpace projected connection fee income by more than $2 million between 2015 and 2020, and $28.2 million between 2021 and 2050. These values are presented in 2015 dollars and correspond to the difference between the CIP requirements and the interceptor fee income.

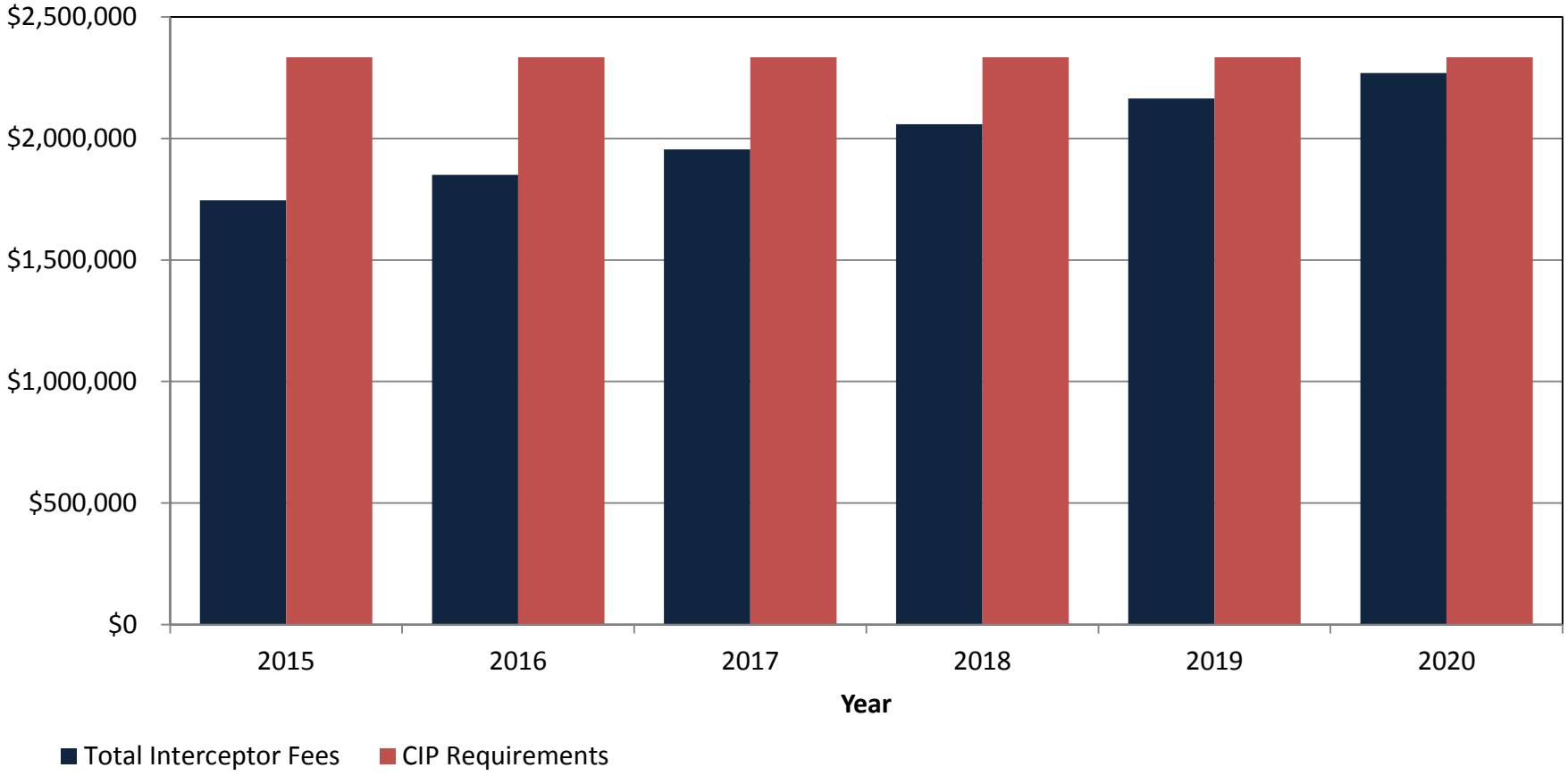

Figure 6.6 – Projected Interceptor Fee Income and CIP Requirements, FY 2015 – FY 2020

Papillion Creek Sanitary Interceptor Master Plan

City of Omaha, NE

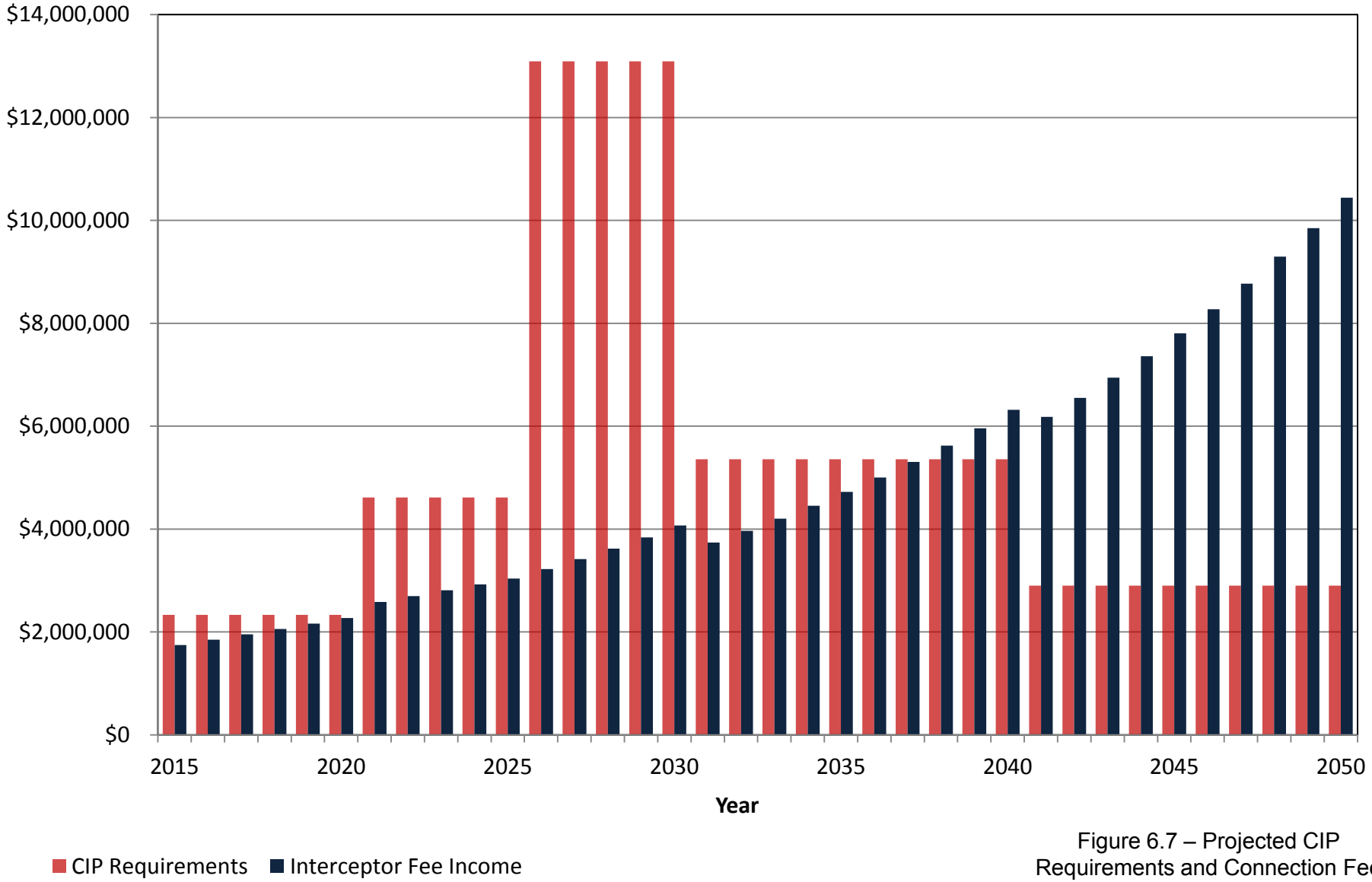

Figure 6.7 – Projected CIP Requirements and Connection Fee Income, 2015-2050
Papillion Creek Sanitary Interceptor Master Plan
City of Omaha, NE

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These projections suggest that the City carefully monitor new development patterns and the receipt of connection fee income during each stage of implementing the CIP. Furthermore, the City may want to develop contingency plans to provide internal inter-fund loans or obtain construction financing if the need arises to bridge any gap between the timing of capital expenditures and the receipt of connection fee income from new developments. CIP investment decisions will need to be tightly managed to maintain close concurrency between system improvements and private development, minimize construction financing requirements, and protect the financial integrity of the construction fund.

This financial analysis does not incorporate potential income from interceptor fee surcharges paid by commercial and industrial development that discharge more than 3,000 gallons per acre per day of wastewater into the City's sanitary sewer system. Additional research and modeling are required to estimate the likelihood and extent of such developments during the 36-year planning period from 2015 through 2050. Section 31-259 of the Municipal code states that, "If, in the opinion of the superintendent of the permits and inspections division, with the advice of the city engineer, a commercial or industrial connection is likely to significantly exceed the rate of flow of the peaking factor of two times 1,500 gallons per acre per day, a surcharge shall be computed…" Based on the current charge of $5,973 and an assumed 1,500 gallons per acre per day of dry weather flow, the surcharge would equate to $3.98 per gallon per day of dry weather flow. The surcharge will only apply to anticipated discharges over the per acre baseline set forth in the Municipal Code.

As the City advances its sanitary sewer master planning process, officials may wish to consider and/or evaluate the following program refinements:

- Update the City's Wastewater Enterprise Fund financial model in order to better understand, anticipate, and plan for potential short falls in the ISF, as well as model potential internal transfers to the ISF to underwrite planned CIP costs that exceed projected impact fee revenues.
- Refine the cash flow projections for the ISF based on more specific timing of developments, additional revenues from industrial Interceptor fee surcharges, and additional expenditures related to internal and/or external construction financing.
- Update the Municipal Code and business practices to provide clear and comprehensive authority and guidance regarding the timing, calculation, and collection of interceptor sewer connection fees and surcharges.
- Consider a future restructuring of the ISF to an equivalent dwelling unit or EDU basis of computing the charges imposed on new development. Such a restructuring will more closely align the sewer system demands of new developments with the connection fees that ultimately pay for the system improvements.

CONCLUSIONS, RECOMMENDATIONS & POLICIES

7.1 CONCLUSIONS

This study has a provided an updated basis for developing a CIP for the Papillion Creek Interceptor Sewers and recommended how capacity improvements and sewer extensions can be financed through 2020. The City has applied the recommendations from the previous study (SISE, 2009) to improve flow monitoring throughout the system and significantly improve the collection system model that now provides an excellent tool for examining system hydraulics and testing capital improvements. By completing this study update, the City and Carollo have helped reduce the capital improvements necessary for efficient operation of the interceptor system by over $250 million, while maximizing the capacity of the current infrastructure.

7.2 TECHNICAL AND FINANCIAL BASED RECOMMENDATIONS

This Interceptor Master Plan update has provided the necessary information for planning interceptor improvements and updating the Interceptor Sewer Fund (ISF). However, several recommendations are being made to further refine the needs for comprehensive planning, management, and operations of the collection system tributary to the PCWWTP. Because this study focuses on the Interceptor system tributary to the PCWWTP, minimal information was included on those sewers that are not part of the PCWWTP interceptor system (e.g. small diameter sewers tributary to the interceptor system). The existing small diameter sewers in the service area are extremely important to the proper operation and treatment of sewerage and should be further studied since many are reaching the end of their useful life and have not been comprehensively analyzed since they were installed. Many of these small diameter sewers are nearing 50 years in age.

Following is a summary of the technical and financial based recommendations.

7.2.1 Development of a Detailed I/I Management Program

The detailed spatial identification of I/I throughout the PCWWTP service area is not currently possible based on the number of permanent flow meters. Therefore, a more detailed flow monitoring program should be initiated to further identify where I/I is occurring within sub-catchments much smaller than most current sub-catchments defined by the permanent monitoring network. This program will also require additional detailed modeling and analysis with the intent to identify cost-effective sub-catchments that can be rehabilitated to cost effectively control I/I and additional downstream capacity improvements. It is recommended also that radar rainfall processing be used to develop an extensive virtual gage network across the broad study area for any future analysis.

A particular area where further monitoring and analysis is needed is in the Elkhorn area. The City of Elkhorn was annexed by Omaha in 2007 and at that time the City put forth effort to get the newly owned sewer assets into its GIS system. During this current Interceptor Master Plan study it was realized that the sewer hydraulic model lacked the detail necessary to understand existing capacity restrictions. Some limited information was updated in the model to address near term CIP projects. However, it is recommended to update the detail in the hydraulic model for use in the next Interceptor Master Plan study. The City has currently identified potential capacity concerns during wet-weather and is addressing inflow and infiltration sources. The information gathered by the City will be used to support the modeling updates in the next Interceptor Master Plan Study.

7.2.2 Initiate Full Cost of Service Study in PCWWTP Service Area

This interceptor master plan does not define several other costs of providing sewer service within the PCWWTP service area. Costs for providing annual operation and maintenance (O&M), improvements needed to sewers other than the interceptor sewers (based on useful life and condition), improvements needed for the PCWWTP, and other ancillary costs should be summarized so that the City managers understand that these Interceptor CIP projects are only part of the overall costs needed to manage the efficient operation of this extensive sanitary sewer system and its service area. During the course of this study, it was revealed that the PCWWTP had a study completed in 2009, and has shown actual 2015 flows are not meeting the study's flow predictions made in 2009, and would therefore greatly benefit from a comprehensive analysis and development of a CIP. These points are to re-emphasize that full cost of service for wastewater collection and treatment for the service area was not included in this current study.

7.2.3 Initiate Comprehensive Financial Analysis

As the City proceeds with the Interceptor planning process, the City might wish to consider and/or evaluate the following based on the limits of the financial analysis conducted for this interceptor study:

- Update the City's Wastewater Enterprise Fund financial model in order to better understand, anticipate, and plan for potential short falls in the Sanitary Interceptor Sewer Construction Fund, as well as model potential internal transfers to the Sanitary Interceptor Sewer Construction Fund to underwrite planned CIP costs that exceed projected impact fee revenues.
- Refine the cash flow projections for the Sanitary Interceptor Sewer Construction Fund based on more specific timing of developments, additional revenues from industrial Interceptor fee surcharges, and additional expenditures related to internal and/or external construction financing.

- Update the Municipal Code and business practices to provide clear and comprehensive authority and guidance regarding the timing, calculation, and collection of Interceptor fees and surcharges.
- Consider a future restructuring of the Interceptor Sewer Connection Fee to an equivalent dwelling unit or EDU basis of computing the charges imposed on new development. Such a restructuring will more closely align the sewer system demands of new developments with the connection fees that ultimately pay for the system improvements.

The City should closely monitor the fund balance, along with the cash flow into and out of the fund. The projected cash flow of receipts into the fund and the anticipated cost of construction for the projects defined in the CIP are estimates that are highly variable based on future economic conditions. The availability of funds to pay for the projects defined in the CIP should be monitored and reported to the Directors of the Planning Department, Public Works Department, and Finance Department, along with the Mayor's office, on a regular basis.

The City may consider completing a separate technical study and evaluation of the sanitary system that would be completed in advance of and independent of the update of the Sanitary Interceptor Master Plan. By separating the two evaluations, the data to support the Master Plan would be developed up front, and would shorten the duration of the time required to complete the Master Plan.

7.3 CURRENT POLICY RECOMMENDATIONS

In addition to the technical and financial recommendations listed, it is recommended that continued coordination occur with other items that may influence the rate of development, including limitations within the transportation system. Many meetings took place during the development of this study which includes decisions that could potentially influence policies related to the interceptor sewer system. Therefore, Appendix D is included with relevant meeting minutes and additional ancillary information that contributed to this effort. The purpose of this appendix is to provide historical information that can be encompassed within this report to provide additional background for future planning processes. Additionally a planning TM was compiled by the City and Carollo to outline some of the planning assumptions made/utilized during the master plan update. This TM is included in Appendix E.

The following are recommended policies contained in previous reports that should remain essentially unchanged.

- The current practice of encouraging in-fill development in the I-680 loop by waiving the fee should be continued. The area affected by the special connection fee per Sec. 31-257 in the Omaha Municipal code remains the same “The sewer connection fee provided for in this division shall be paid only for those new sewer connections outside zones A, B and C of the city's urban development policy which will flow through the city sanitary sewer system, also sometimes called the waste water collection system, in the Papillion Creek Watershed.
- The current policy of transferring ownership of newly constructed S&ID outfall sewers to the City should be maintained.
- It is recommended that interceptor sewer plans follow the guidelines and policies as set forth in the City’s Master Plan.
- The cost of any deviations from the plan or a restudy to justify the deviation will be paid by the developer prior to the planned future study updates.
- Acquisition payments will be made to S&ID’s entering into agreements as funds are available. Condemnation will be considered for interceptors planned for acquisition but without agreements.
- The balance in the Fund should be kept at a minimum, thus reducing the accumulation of interest, which is not returned to the Fund, but rather added to the City’s general fund.
- The Interceptor Sewer Fee should continue to be collected with building permit applications.

The policy recommendations as a result of this study are as follows:

- Allow for the planning and design of near term Program Projects in Table 5-6 for continued expansion of the interceptor system to serve potential development areas to the northwest. An additional near term project was identified at the finalization of this report and is illustrated in Figure 5.1. This project and the associated costs will be included as part of the next interceptor study update.
- Sizing of future sewers should be generally based on 2050 development potential of Douglas County and adhere to Section 4.3, Recommended Design Criteria.
- This study should be updated every 3 to 5 years. The next study should be implemented beginning in late 2017 or early 2018 to ensure that the study is completed in time to update a fee structure that will support the continued desired growth of the system.
- Additional flow monitoring at key locations to further validate existing interceptors capacity deficiencies and for prioritization of sewersheds with high inflow and

infiltration. Recommend flow monitoring budget is included in the Capital Improvement Program costs in Table 5-6

- Funding the estimated costs of the projects will require an increase in the connection fee. Connection fees are recommended to be re-balanced in 2016 and each subsequent year as per Table 6-4.

In addition, the PDZ boundary was recommended to be modified as shown in Figure 5.1, which adds approximately 4.33 square miles to and removes approximately 3.97 square miles from the current Present Development Zone for a net gain of about 0.36 square miles. There are approximately 3.74 square miles of new land available for development, after excluding the area in and around Dam Site 15A. About 2.2 square miles of this land is in the northwest along Fort Street near 168th, 180th, and 208th Streets, while the remaining 1.5 square miles are in southwest Douglas County.