City of Colusa

Wastewater Collection System Master Plan

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Executive Summary

The City of Colusa (City) Wastewater Collection System Master Plan (Master Plan) is intended to provide guidance to the City on the ability of the existing wastewater collection system to accommodate current and future flow as well as to provide options for future development. Specific objectives of the Master Plan include:

- Evaluation of the capacity of the existing wastewater collection system during design storm conditions.
- Identification of capital improvement projects recommended to correct any identified existing deficiencies.
- Evaluation of the ability of the existing system to accommodate future flows at design storm conditions.
- Identification of capital improvement projects recommended to accommodate future development within the City limits and Sphere of Influence (SOI), as identified in the *City of Colusa General Plan Update* 2005 – 2025 (Pacific Municipal Consultants and North Fork Associates, October 2007), which was adopted by the Colusa City Council in October 2007.

In addition, in May 2006, the California State Water Resources Control Board (SWRCB) issued statewide general Waste Discharge Requirements (WDRs) (Order No. 2006-0003-DWQ) for all publicly owned sanitary sewer systems greater than one mile in length. With the adoption of new WDRs, municipalities are now required to document system capacities and maintenance procedures to minimize overflows and failures. A key element of the WDRs is the completion of a Sewer System Management Plan (SSMP). Within the SSMP, municipalities are required to complete a System Evaluation and Capacity Assurance Plan (SECAP). The SECAP determines where hydraulic deficiencies exist and outlines a capital improvement program to ensure adequate capacity for dry and wet weather flow conditions. This Wastewater Collection System Master Plan provides the City with a plan that is consistent with the General Plan as well as fulfills the SECAP requirements of the SSMP.

ES.1 PROJECT OVERVIEW

The City of Colusa is located approximately 60 miles northwest of Sacramento in the center of the Sacramento Valley. The City's existing wastewater collection system covers an area of approximately 900 acres and provides service to almost 5,700 residents as well as commercial and industrial users. The City owns, operates, and maintains a network of over 26 miles of sewer pipelines (ranging in size from 4- to 18- inches in diameter), force mains, and six existing pump stations, which convey an average dry weather flow of 0.58 million gallons per day (MGD) from throughout the City's service area to the City of Colusa Wastewater Treatment Plant (WWTP) (Figure ES-1).

Wastewater collection system capacity was assessed using a dynamic flow routing model, Wallingford Software's *InfoWorks*. The dynamic model simulates backwater, looped connections, surcharging, and pressure flow that may occur within the City's collection system and is considered one of the most sophisticated means to assess sewer system capacity. The *InfoWorks* model simulates collection system hydraulic response during peak flow events resulting from a combination of peak diurnal sanitary flows (the peak wastewater flow from residences and businesses throughout the day), groundwater infiltration, and rainfall dependent infiltration and inflow (extraneous flow entering the system during or directly after a rain event).

Components of the existing wastewater collection system were consolidated into Geographic Information System (GIS) format for use in the hydraulic model. Manhole rim and invert elevations for the major trunk lines were professionally surveyed during August 2008. Other data, including pipe length, size, and slope, was obtained from AutoCAD and as-built drawings.

Existing sanitary wastewater flow as well as rainfall dependent infiltration and inflow within the City's system were determined by monitoring wastewater flow for a six-week period from February 14 to March 26, 2008. This flow monitoring data was used to construct and calibrate the hydraulic model.

Design storms are developed from statistical analysis of local precipitation records and represent the distribution of rainfall depths over a time increment for a given storm duration and frequency. Design storms are selected based on the level of protection desired for the wastewater collection system while considering the likelihood of the event. Based on experience with other similarly sized communities in the area, wastewater flows resulting from a 10-year frequency storm occurring over a 6-hour period (10-year, 6-hour design storm) were identified as the City's design service objective. Capacity improvements are recommended to provide adequate system capacity to convey peak flows during a 10-year 6-hour storm.

Wastewater collection systems can generally accommodate some degree of surcharging during peak hourly wet weather flow conditions. However, once a manhole surcharges, it takes very little additional flow for an overflow to occur. The criterion for acceptable levels of maximum surcharging, as established by the City of Colusa, is defined in Table ES-1. This standard was used when evaluating capacity in flow limited segments of sewer pipelines in all modeled scenarios.

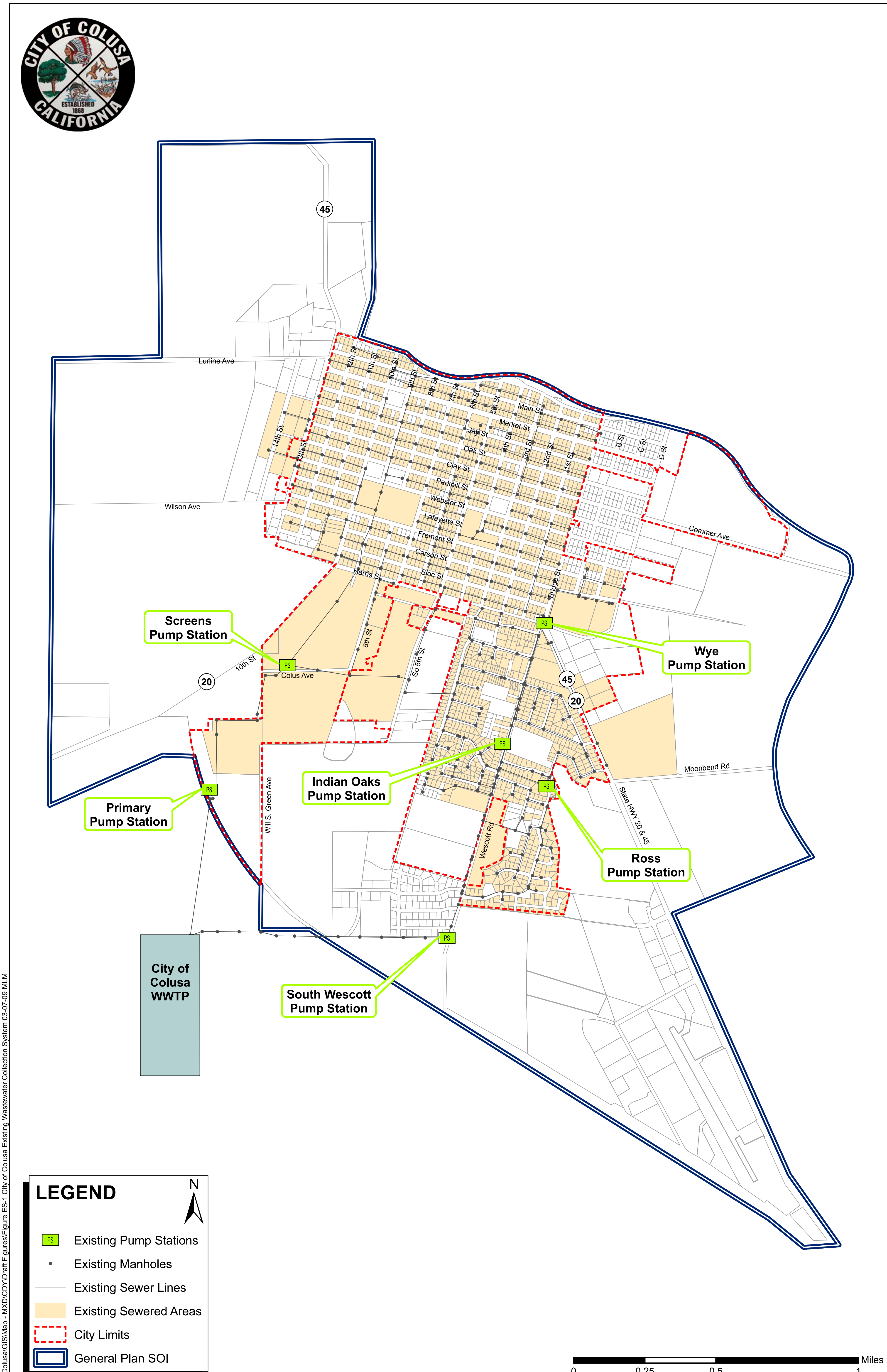


Figure ES-1
City of Colusa Significant Attributes of Existing Wastewater Collection System

Table ES-1
City of Colusa
Acceptable Manhole Surcharging
During Design Storm (10-year, 6-hour) Conditions

Manhole Depth [(a)]	Acceptable Level of Manhole Surcharging
Less than 4 feet	None
4 feet and greater	Not to exceed 3 feet below ground surface and maximum HGL of 8 feet above pipe

(a) Manhole depth as measured from the crown of the pipe to the rim of the manhole

ES.2 STUDY CONCLUSIONS

The City of Colusa's collection system was modeled and analyzed at a 10-year, 6-hour design storm for the following scenarios:

- Existing system with existing level of development at (summer) dry weather flow and during a design storm (10-year, 6-hour) event.
- Existing system with Future Developments – Phase I during design storm (10-year, 6-hour) event.

In addition, an analysis was performed to determine the infrastructure needed for Future Developments – Phase II (build-out of the General Plan SOI) during peak flow conditions.

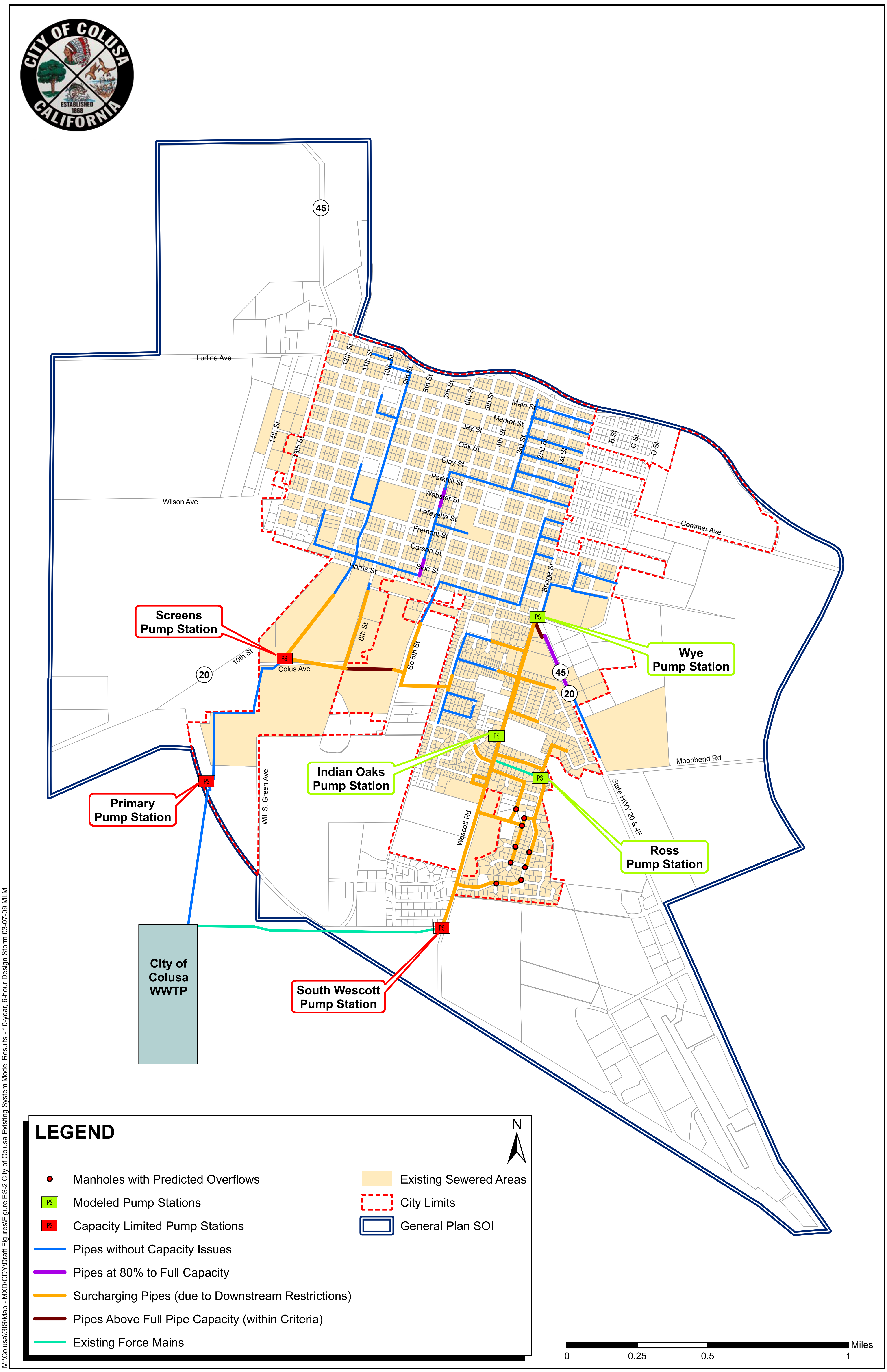
ES.2.1 EXISTING SYSTEM

At the existing level of development, during average daily dry weather flows, model simulations predict all pipes to be flowing at less than 80% capacity with no manholes surcharging. Average daily dry weather flow is 0.58 MGD at the City of Colusa's WWTP.

Under existing conditions, a 10-year, 6-hour design storm is estimated to generate a peak hourly wet weather flow of 2.3 MGD at the City's WWTP. This peak hourly wet weather flow is predicted to cause overflows and manhole surcharging in several different trunks within the system (Figure ES-2). The majority of these overflows and surcharging are caused by restrictions downstream at various pump stations that have insufficient pumping capacity.

ES.2.2 FUTURE DEVELOPMENTS – PHASE I

Future Developments – Phase I included infill of the existing City limits, redevelopment of parcels as defined in the General Plan, and "Special Consideration" areas. Special Consideration areas are existing areas outside the City limits that are currently on septic systems and future developments, which were identified by the City as likely to be accommodated within the existing collection system in the near-future.



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City of Colusa Wastewater Collection System Master Plan

Figure ES-2
City of Colusa Existing System Model Results - 10-year, 6-hour Design Storm

With the addition of flow from Future Developments – Phase I, the modeled peak hourly wet weather flow during the 10-year, 6-hour design storm event was estimated to be 4.2 MGD at the City's WWTP. These peak hourly wet weather flows resulted in an increase in overflows, capacity-limited pipelines, and manhole surcharging (Figure ES-3). The majority of pipelines within the City are impacted by downstream conditions. These downstream restrictions are directly related to pump station capacity, specifically at the Screens, Primary, South Wescott, and Wye pump stations. Of the surcharged pipelines, the only pipelines that exceed the established surcharging criteria are the 8-inch line from the intersection of 3rd Street and Parkhill Street to the intersection of 9th Street and Harris Street. This portion of the collection system, referred to as the 6th Street Trunk, is a shallow trunk with manhole depths less than 4 feet, which does not allow for any surcharging.

ES.2.3 FUTURE DEVELOPMENTS – PHASE II

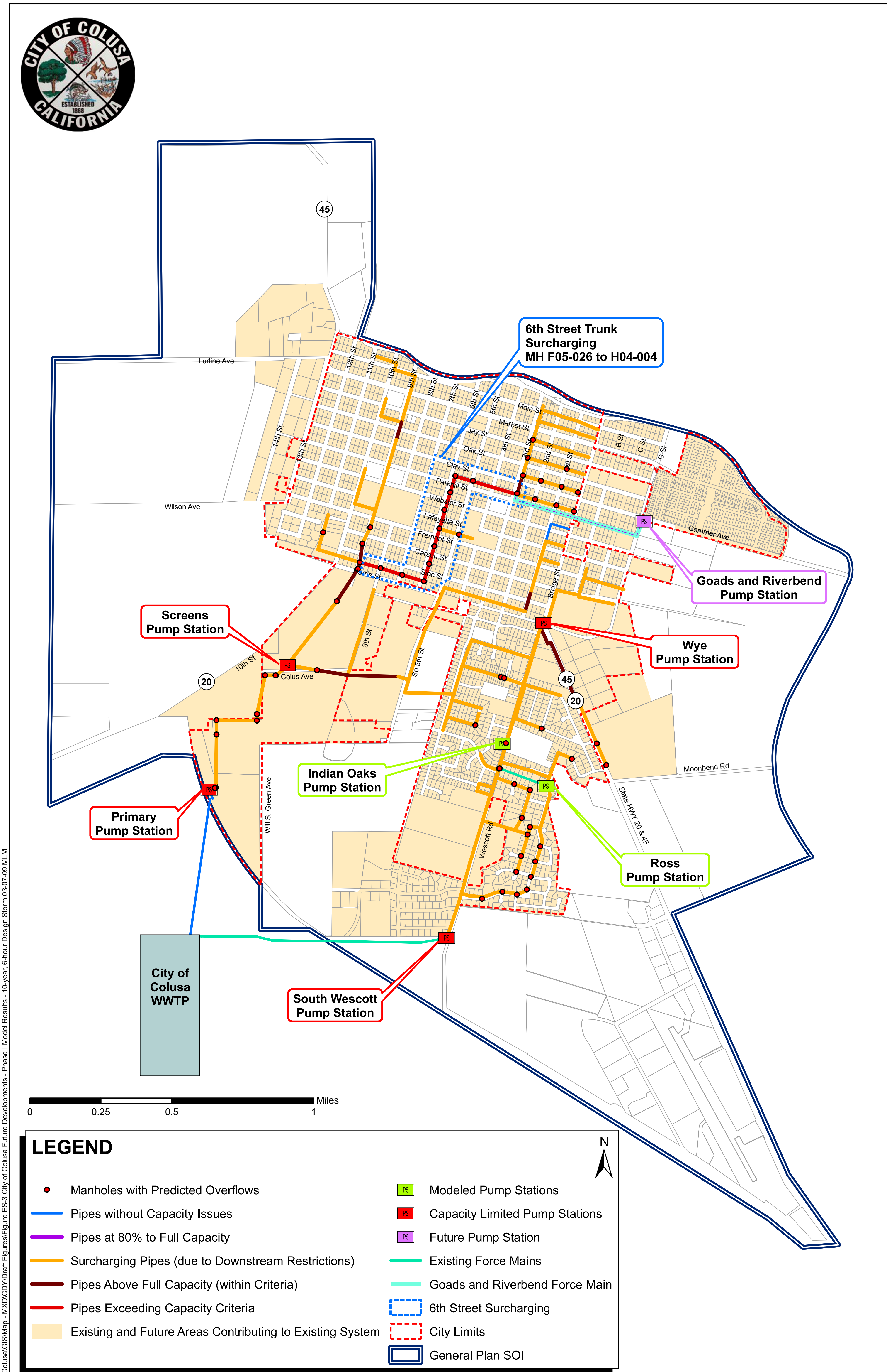
Future Developments – Phase II include build-out of the remainder of the General Plan SOI. These development areas are estimated to double the wastewater flow to 7.6 MGD and sufficient capacity does not exist in the existing collection system to accommodate this flow. New trunk sewers and upsizing of the Primary and South Wescott pump stations will be necessary to convey all future flow to the WWTP.

ES.3 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

This section summarizes recommendations for mitigating identified capacity issues and includes capital improvement projects (CIPs) for future development.

A large portion of the City's existing system is shallow, flat sewers. These pipelines are prone to debris deposition and a reduction in available capacity. Modeled scenarios in this Master Plan assume that pipes and manholes are in good condition and free from debris (i.e., clean-pipe conditions). Thus, the results of the modeling analysis indicate available capacity (or lack thereof) and do not take into consideration deteriorated conditions. Prior to initiating any capital improvement projects, it is recommended that the City assess the condition of the existing collection system. Condition assessment would include performing closed-circuit television (CCTV) inspections and structurally rating the existing sewer infrastructure as well as cleaning of each major sewer pipeline. The City could perform this assessment during one summer or split the work over a several year period. In addition, the City should also evaluate whether to perform the condition assessment on all 26 miles of pipeline or the approximately 15 miles of major pipelines.

In addition to condition assessment in known or suspected deteriorated areas, it is also recommended that additional dry and wet weather flow monitoring data be collected prior to initiating capital improvement projects to address these capacity issues. Additional data will refine the leakage rates and improve the accuracy of modeling simulations, which may decrease the degree of capital improvements required.



M:\Colusa\GIS\Map - MXD\CDY\Draft Figures\Figure ES-3 City of Colusa Future Developments - Phase I Model Results - 10-year, 6-hour Design Storm 03-07-09 MLM

Figure ES-3
City of Colusa Future Developments - Phase I Model Results - 10-year, 6-hour Design Storm

ES.3.1 MITIGATION STRATEGIES FOR EXISTING SYSTEM DEFICIENCIES

To alleviate predicted overflows in the existing system during a 10-year, 6-hour design storm, upsizing the South Wescott, Screens, and Primary pump stations is recommended. These improvements will reduce surcharging in upstream gravity lines. In addition, none of the existing pump stations have alarms or permanent emergency generators. If pumps fail, the wastewater will back up in the manholes and upstream sewer pipelines until City crews can bring the station back online. The Statewide WDRs require the City to take all reasonable steps to reduce or eliminate overflows within the system. For the City of Colusa, increasing the reliability of the pump stations includes the addition of alarms and emergency generators. Through discussions with City staff, it was determined that certain additional improvements, beyond the capacity needs, are also desired to increases reliability and safety. These improvements include the addition of Supervisory Control and Data Acquisition (SCADA) systems into the pump stations (to monitor pump operation and alert staff of station failure) and the addition of emergency generators. The recommended pump station improvements to mitigate existing system deficiencies are summarized in Table ES-2.

Table ES-2
City of Colusa
Summary of Recommended Pump Station Improvements – Existing Conditions at 10-year, 6-hour Design Storm

Pump Station	Current Capacity (gpm) [(a)]	Recommended Capacity (gpm) [(a)]	Additional Improvements
Indian Oaks	310	310	SCADA improvements & emergency generator
Primary [(b)]	600	**700**	Upsize pumps; SCADA improvements & emergency generator
Ross	300	300	Convert to submersible; SCADA improvements & emergency generator
South Wescott	450	**900**	Upsize pumps; SCADA improvements & emergency generator
Supply Yard/Screens [(b),(c)]	600	**700**	Upsize pumps; SCADA improvements & emergency generator
Wye	393	393	SCADA improvements & emergency generator
At Wastewater Treatment Plant			SCADA antenna

(a) Capacity is expressed in gallons per minute (gpm).
(b) Current rated capacities for Primary and Supply Yard/Screens lift stations were estimated by City staff.
(c) Supply Yard/Screens is also referred to as Screens.

ES.3.2 EXISTING SYSTEM MITIGATION STRATEGY FOR FUTURE DEVELOPMENTS – PHASE I

During model simulations, under 10-year, 6-hour design storm conditions with the addition of flows from Future Developments – Phase I, several overflows are predicted in the existing system. To alleviate these potential overflows, upsizing of the 6th Street Trunk and upsizing of the Screens, Primary, South Wescott, and Wye pump station are recommended to reduce surcharging in upstream gravity lines.

To reduce surcharging and overflows caused by hydraulic bottlenecks in the 6th Street Trunk, the pipe segments between manholes F05-026 and H04-004 need to be upsized from the existing 8-inches to 12-inches in diameter (Table ES-3). The 6th Street Trunk is the only area of the existing system that has significant surcharging and requires improvements.

Table ES-3
City of Colusa
Recommended Pipeline Improvements for Existing System Deficiencies – Future Developments – Phase I at 10-year, 6-hour Design Storm Conditions

Improvement Location	Recommended Improvement
6th Street Trunk (Manhole F05-026 to H04-004)	Upgrade 4,500 ft of pipe from 8- to 12-inch

In addition to the 6th Street Trunk improvement, pump station improvements are needed to the Primary, South Wescott, Screens, and Wye pump stations. Upgrades necessary to accommodate Future Developments – Phase I will require significant upgrades to the structures as well as the pumps. In addition, the force main from the South Wescott pump station to the WWTP is not large enough to accommodate future flow and a parallel force main will be necessary.

Analysis of the Primary and Screens pump stations indicated that sufficient grade exists between these two pump stations to abandon the Screens pump station and allow flow by gravity to the Primary pump station. It is recommended to replace the Primary pump station with a deeper, submersible-type pump station serving both the downtown area and the western portion of the General Plan SOI. The new Primary pump station would be constructed deeper so that the Screens pump station can be abandoned. In addition, construction of 3,500 feet of a new deeper, steeper gravity trunk sewer from the Screens location to the Primary pump station will be necessary. The recommended improvements to the Screens, Primary, South Wescott, and Wye pump stations to accommodate peak hourly wet weather flows from Future Developments – Phase I during the 10-year, 6-hour design storm are shown in Table ES-4.

Table ES-4
City of Colusa
Recommended Pump Station Improvements for Existing System Deficiencies – Future Developments – Phase I at 10-year, 6-hour Design Storm Conditions

Pump Station	Current Capacity (gpm) [(a)]	Recommended Capacity for Existing Conditions (gpm) [(a), (b)]	Recommended Capacity for Future Phase I (gpm) [(a)]	Improvement
Primary	600	700	**1,400**	New pump station
South Wescott	450	900	**1,500**	New pump station & parallel forcemain to treatment plant
Supply Yard/ Screens	600	700	Abandon and install 3,500 feet of new gravity sewer from old Screens pump station to Primary pump station	
Wye	393	393	**600**	New pumps

(a) Capacity is expressed in gallons per minute (gpm).
(b) Capacity Recommended for Existing Conditions discussed in Chapter 6.

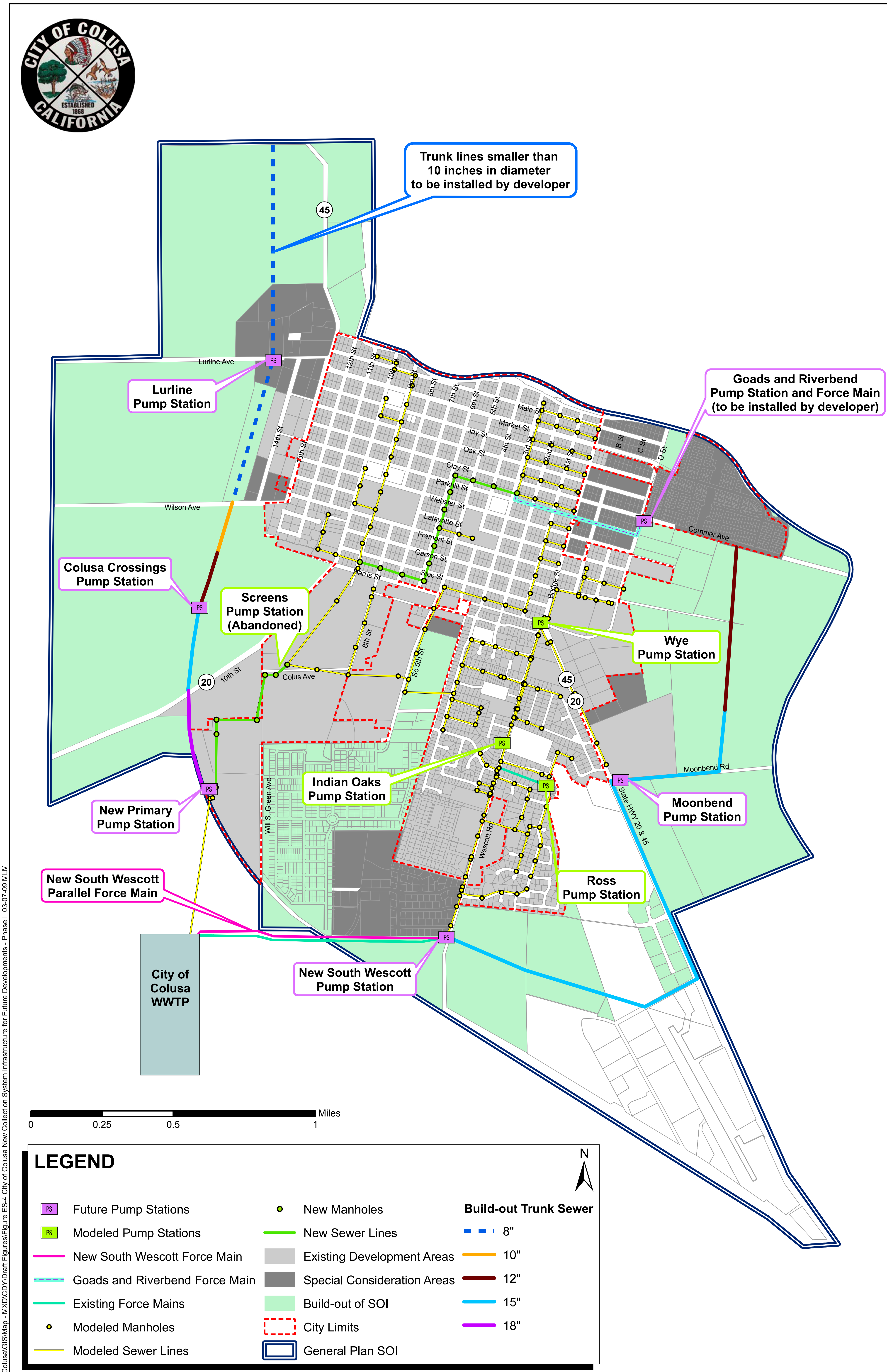
ES.3.3 STRATEGIES TO ACCOMMODATE FUTURE DEVELOPMENTS – PHASE II

Even with the improvements recommended above to the 6th Street Trunk and the Screens, Primary, South Wescott, and Wye pump stations, the City's existing collection system cannot handle flows from Future Developments – Phase II. Future Developments – Phase II will need to be accommodated with new sewer pipelines and pump stations. Recommended new pump stations and improvements to accommodate Future Developments – Phase II flows are summarized in Table ES-5. The alignments of new future gravity trunk sewers are shown in Figure ES-4. A summary of the proposed diameter and length of the recommended new trunk sewers are summarized in Table ES-6.

Table ES-5
City of Colusa
Recommended Pump Station Improvements for Future Developments – Phase II at 10-year, 6-hour Design Storm Conditions

Pump Station	Current Capacity (gpm) [(a)]	Recommended Capacity for Existing Conditions (gpm) [(a), (b)]	Recommended Capacity for Future – Phase II (gpm) [(a)]	Improvement
Primary	600	700	**2,800**	New pump station
South Wescott	450	900	**2,500**	New pump station & forcemain
Lurline (New – West SOI)	N/A	N/A	**100**	New pump station
Colusa Crossings (New – West SOI)	N/A	N/A	**600**	New pump station
Moonbend (New – East SOI)	N/A	N/A	**700**	New pump station

(a) Capacity is expressed in gallons per minute (gpm).
(b) Capacity Recommended for Existing Conditions discussed in Chapter 6.



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City of Colusa Proposed Future Developments - Phase II Trunk Sewer and Future Improvements

Table ES-6
City of Colusa
Recommended New Trunk Sewers for Future Developments – Phase II

New Trunk	Diameter (inches)	Length (feet)
Colusa Crossings Trunk	10	1,000
	12	1,100
	15	1,500
	18	2,000
Moonbend Trunk	12	3,100
	15	12,200

ES.4 SUMMARY OF CAPITAL COST ESTIMATES

Preliminary capital cost estimates for recommended improvements for existing conditions, Future Developments – Phase I, and Future Developments – Phase II (build-out of the General Plan SOI) are summarized in Table ES-7. These cost estimates are in current 2009 dollars. The cost estimates provided in Table ES-7 are planning level estimates and a more comprehensive cost breakdown for each recommended improvement should be evaluated during a pre-design analysis. In addition, prior to initiating any capital improvement projects, it is recommended that the City assess the condition of the existing collection system by performing CCTV inspections. Pipeline condition assessment would cost approximately $160,000 to $260,000 for about 15 miles of major pipelines to all City pipelines, respectively. This amount is equivalent to $33,000 to $52,000 per year for five years.

Costs estimates provided in Table ES-7 are divided between existing and future users. The Future Developments – Phase I users include infill and redevelopment within the City limits and Special Consideration Areas. The Future Developments – Phase II users include the remaining build-out of the General Plan SOI. In assigning costs, the costs estimated for improvements identified in Table ES-2 were assigned to existing users and the additional costs for any future developments were assigned to future users.

Table ES-7
City of Colusa
Distribution of Preliminary Cost Estimate – Existing Users and Future Users

Infrastructure	Current Capacity (gpm) [a]	Ultimate Capacity (gpm) [a]	Improvements	Existing Users Cost ($)	Future - Phase I/II Users Cost ($)
Pump Stations					
Indian Oaks	310	310	SCADA improvements & emergency generator	$125,000	
Primary [b]	600	2,800	New pump station	$515,000	$1,805,000
Ross	300	300	Convert to submersible; SCADA improvements & emergency generator	$365,000	
South Wescott [b]	450	2,500	New pump station	$640,000	$1,560,000
Supply Yard/Screens [c],[d]	600	Abandon and install 3,500 feet of new 18-inch gravity sewer from old Screens pump station to Primary pump station		$515,000	$685,000
Wye	393	600	Upsize pumps, SCADA improvements, & emergency generator	$125,000	$345,000
At Wastewater Treatment Plant			SCADA antenna	$40,000	
Lurline [b]	--	100	New Pump Station		$385,000
Colusa Crossings [b]	--	600	New Pump Station		$870,000
Moonbend [b]	--	700	New Pump Station		$940,000
Force main					
South Wescott [e]	900	2,500	4,600 feet of 12-inch parallel force main		$910,000
New Gravity Sewer [f]					
6th Street Trunk	8-inch	12-inch	4,500 feet of 12-inch sewer		$1,030,000
Colusa Crossings Trunk	--	10 to 18-inch	5,600 feet of new sewer		$1,550,000
Moonbend Trunk	--	12 to 15-inch	15,300 feet of new sewer		$4,180,000
SUBTOTAL – CONSTRUCTION COSTS (rounded)				$2,330,000	$14,260,000
Estimating Contingency (30%)				$700,000	$4,280,000
Design Administration (15%)				$350,000	$2,140,000
TOTAL CAPITAL COSTS (rounded)				**$3,380,000**	**$20,680,000**

(a) Capacity is expressed in gallons per minute (gpm).
(b) New pump station cost include emergency generator and SCADA improvements.
(c) Costs are for 3,500 feet of new 18-inch gravity sewer trunk at $19/inch-diameter foot and do not include pump station demolition.
(d) The decision to abandon the Screens pump station is dependent on building a new Primary pump station. However, an increase in capacity at the Screens station is needed for existing users prior to abandoning, as shown in Table 8-2.
(e) Costs are for 4,600 feet of new 12-inch parallel force main at $16.50/inch-diameter foot.
(f) Costs are for new trunk sewer at $19/inch-diameter foot.

Chapter 1

Introduction

1.1 PURPOSE

The City of Colusa (City) Wastewater Collection System Master Plan (Master Plan) is intended to provide guidance to the City on the ability of the existing wastewater collection system to accommodate current and future flow as well as to provide options for future development. Specific objectives of the Master Plan include:

- Evaluation of the capacity of the existing wastewater collection system during design storm conditions.
- Identification of capital improvement projects recommended to correct any identified existing deficiencies.
- Evaluation of the ability of the existing system to accommodate future flows at design storm conditions.
- Identification of capital improvement projects recommended to accommodate future development within the City limits and Sphere of Influence (SOI), as identified in the *City of Colusa General Plan Update* 2005 – 2025 (Pacific Municipal Consultants and North Fork Associates, October 2007), adopted by the Colusa City Council in October 2007.

In addition, in May 2006, the California State Water Resources Control Board (SWRCB) issued statewide general waste discharge requirements (WDRs) (Order No. 2006-0003-DWQ) for all publicly owned sanitary sewer systems greater than one mile in length. With the adoption of new WDRs, municipalities are now required to document system capacities and maintenance procedures to minimize overflows and failures. A key element of the WDRs is the completion of a Sewer System Management Plan (SSMP). Within the SSMP, municipalities are required to complete a System Evaluation and Capacity Assurance Plan (SECAP). The SECAP determines where hydraulic deficiencies exist and outlines a capital improvement program to ensure adequate capacity for dry and wet weather flow conditions. This Master Plan provides the City with a plan that is consistent with the General Plan as well as fulfills the SECAP requirements of the SSMP.

This report is divided into the following chapters:

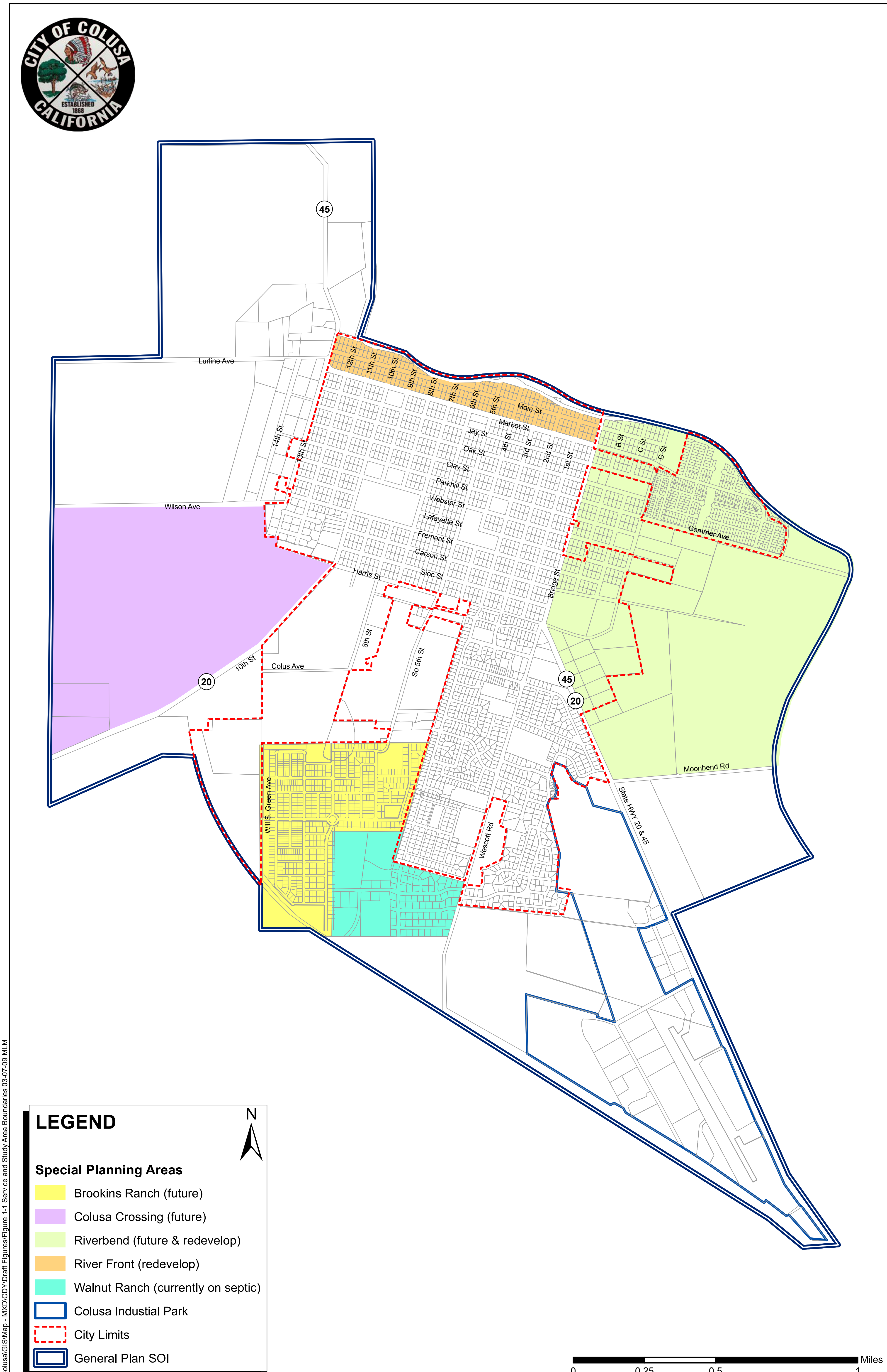
- Chapter 1 – Introduction
- Chapter 2 – Existing Collection System
- Chapter 3 – Land Use
- Chapter 4 – Future Flow Estimation

- Chapter 5 – Collection System Hydraulic Model
- Chapter 6 – Capacity Evaluation Results – Existing System
- Chapter 7 – Capacity Evaluation Results – Future
- Chapter 8 – Summary and Conclusions

1.2 STUDY AREA

The City of Colusa is located approximately 60 miles northwest of Sacramento in the center of the Sacramento Valley. Colusa is bordered on the north and east by the Sacramento River, which also defines the eastern boundary of Colusa County. Currently, approximately 5,700 people reside in Colusa, with a majority of residents living and working in the City.

The City has completed an update to their General Plan (*City of Colusa General Plan Update* 2005 – 2025), which was adopted by the Colusa City Council in October 2007, to direct future development. The General Plan identifies growth within the City limits and the Sphere of Influence (SOI). This Master Plan evaluates the ability of the City's existing wastewater collection system to provide capacity for the projected growth within the City limits and General Plan SOI. The City limits, General Plan SOI, and specific future development areas in the SOI are shown in Figure 1-1.



M:\Colusa\GIS\Map - MXD\CDY\Draft Figures\Figure 1-1 Service and Study Area Boundaries 03-07-09 MLM

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City of Colusa Wastewater Collection System Master Plan

Figure 1-1
City of Colusa Service and Study Area Boundaries

Chapter 2

Existing Wastewater Collection System

2.1 PURPOSE

The purpose of this chapter is to describe the City of Colusa's existing wastewater collection system.

This chapter is divided into the following sections:

- Description of Existing Wastewater Collection System
- GIS Database
- Existing Wastewater Flows

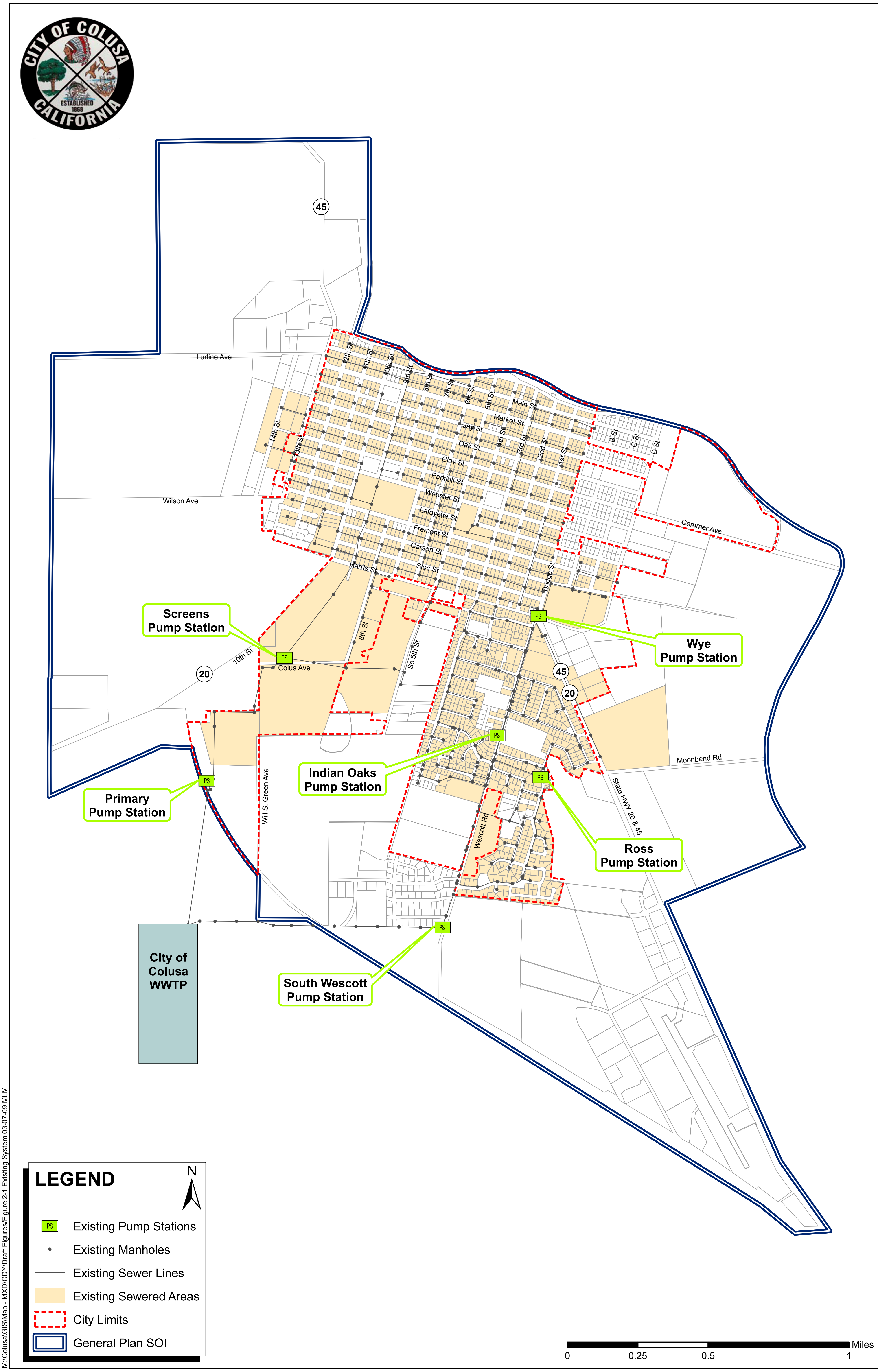
2.2 DESCRIPTION OF EXISTING WASTEWATER COLLECTION SYSTEM

The City of Colusa is located in the geographic center of the Sacramento Valley, with the Sacramento River bordering the City to the north and east. The terrain is flat, sloping slightly from north to south. The City's existing collection system generally follows this natural slope, flowing from north to the southwest.

The City of Colusa's existing wastewater collection system covers an area of approximately 900 acres and provides service to almost 5,700 residents as well as commercial and industrial users. The City owns, operates, and maintains a network of over 26 miles of sewer pipelines (ranging in size from 4- to 18- inches in diameter), force mains, and six existing pump stations, which convey flow from throughout the City's service area to the City of Colusa Wastewater Treatment Plant (WWTP). The City's existing wastewater collection system and significant attributes are shown in Figure 2-1.

2.2.1 PUMP STATIONS

A summary of the six existing pump stations in the City's system are summarized in Table 2-1. (The City has one additional pump station at the wastewater treatment plant (WWTP), the Headworks pump station. Since the Headworks station is located within the WWTP, it is considered part of the wastewater treatment process, not the collection system, and analysis is not included in this Master Plan.) The number of pumps and the average rated capacity of each pump, expressed in gallons per minute (gpm), are listed for all six stations. Except for the South Wescott and Ross pump stations, the stations lift the wastewater into adjacent gravity sewers. South Wescott pump station pumps wastewater into an 8-inch force main, which discharges to the City's WWTP.



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City of Colusa Wastewater Collection System Master Plan

Figure 2-1
City of Colusa Significant Attributes of Existing Wastewater Collection System

Table 2-1
City of Colusa
Summary of Existing Pump Stations

Pump Station	Type	Number of Pumps			Rated Capacity, each (gpm) (a)
		Total	Duty	Standby	
Indian Oaks	Submersible	2	1	1	310
Primary (b)	Vertical Centrifugal	2	1	1	600
Ross	Vacuum	2	1	1	300
South Wescott	Submersible	2	1	1	450
Supply Yard/Screens (b), (c)	Vertical Centrifugal	2	1	1	600
Wye	Submersible	2	1	1	393

(a) Rated capacity is for each pump expressed in gallons per minute (gpm).
(b) Rated capacities for Primary and Supply Yard/Screens lift stations were estimated by City staff.
(c) Supply Yard/Screens is also referred to as Screens.

The Primary and Screens pump stations receive flows from much of downtown Colusa. These stations are older stations and are believed to be constructed in the 1950s. Both stations show signs of deterioration and, due to their dry pit configurations, will tend to generate odors. None of the six existing stations have alarms or permanent emergency generators. If pumps fail, the wastewater will back up in the manholes and upstream sewer pipelines until City crews can bring the station back online.

2.3 GIS DATABASE

Limited pipe and manhole data was available for the majority of the wastewater collection system. A small amount of information was provided by the City in AutoCAD format and as-built drawings. Both of these data sources lacked most of the required information; notably manhole rim and pipeline invert elevations. Therefore, a significant surveying effort was required. Rim and invert elevations for the major trunk lines were professionally surveyed during August 2008 by Frayji Design Group. The survey included approximately 205 (of 395 total) manholes and pipe inverts and was collected on California Stateplane, Zone II, NAVD88 vertical datum. AutoCAD, as-built, and survey data were consolidated into Geographic Information System (GIS) format for use in the hydraulic model and for future use by the City for manhole and pipe inventory. For the purpose of hydraulically modeling the collection system, any remaining data gaps were interpolated using the nearest surrounding values.

Pipe information in the GIS database includes:

- Location
- Pipe size (diameter)
- Pipe slope
- Pipe material (where available)

Manhole information in the GIS database includes:

- Location
- Rim elevations
- Invert elevations

2.4 EXISTING WASTEWATER FLOWS

The following sections describe typical wastewater flow characteristics and the flow monitoring program used to determine existing flow in the system.

2.4.1 WASTEWATER FLOW CHARACTERIZATION

Wastewater collection systems are designed to convey peak hourly wet weather flows. Peak hourly wet weather flows are generally comprised of three elements: base sanitary flow, groundwater infiltration (GWI), and rainfall-dependent infiltration and inflow (RDI/I). Each component is described in more detail below.

Sanitary Flow

Sanitary flow is the component of wastewater generated directly by residential, commercial, and industrial users throughout a community. It is also referred to as base flow. Current total base flow is approximately 0.58 million gallons per day (MGD).

The majority of base flow is generated by residential and commercial users (i.e. restaurants, grocery stores, shops, etc.). Additional base flow is also generated by industrial users through process wastewater. The City of Colusa currently has no significant high flow industrial users. Prior to 2003, Pirelli Cable contributed an average daily flow of approximately 0.16 MGD.

Groundwater Infiltration

Groundwater infiltration (GWI) is groundwater that enters the collection system through cracks in sewer pipes, leaky joints, damaged sewer lateral connections, and poorly sealed manhole walls. Groundwater infiltration tends to vary seasonally depending on groundwater depth in relation to the depth of the sewer pipes. Typically, GWI is more significant during the wet season when groundwater elevations can rise due to rainfall and high river levels. For the City of Colusa’s wastewater collection system, groundwater infiltration is influenced by the Sacramento River. When the river levels are high for more than a few weeks, additional groundwater infiltration, on the order of 150,000 gallons per day (gpd), is observed in the collection system, mostly in the downtown area. The amount of groundwater infiltration was determined by comparing the City of Colusa’s WWTP flow (from January 2003 to January 2008) to the Sacramento River level during the same time period. In May 2006, the WWTP flow peaked at approximately 0.66 MGD, after an extended period of high river level from December 2005 through April 2006. This peak represents approximately 150,000 gpd of additional groundwater infiltration compared to typical peak flow when river levels are not high. This additional groundwater infiltration was applied to the downtown portion of the City as directed by City staff. Two-thirds (100,000 gpd) of this additional flow was applied to areas bound to the east and west by 13th Street and Bridge Street, respectively, and bound to the north and south by the Sacramento River and Clay Street, respectively. The remaining third (50,000 gpd) was applied to areas with the same east/west boundary, but extending from Clay Street four blocks south to Fremont Street.

Rainfall Dependent Infiltration and Inflow

Rainfall-dependent infiltration and inflow (RDI/I) is rainfall that enters the collection system. Infiltration is an indirect introduction of rainfall into the collection system through cracked sewer pipes, leaky joints, and manhole walls. Inflow quickly and directly enters the sewer system through leaky manholes covers, clean-outs, and illegal connections. RDI/I was determined through flow monitoring.

2.4.2 FLOW MONITORING

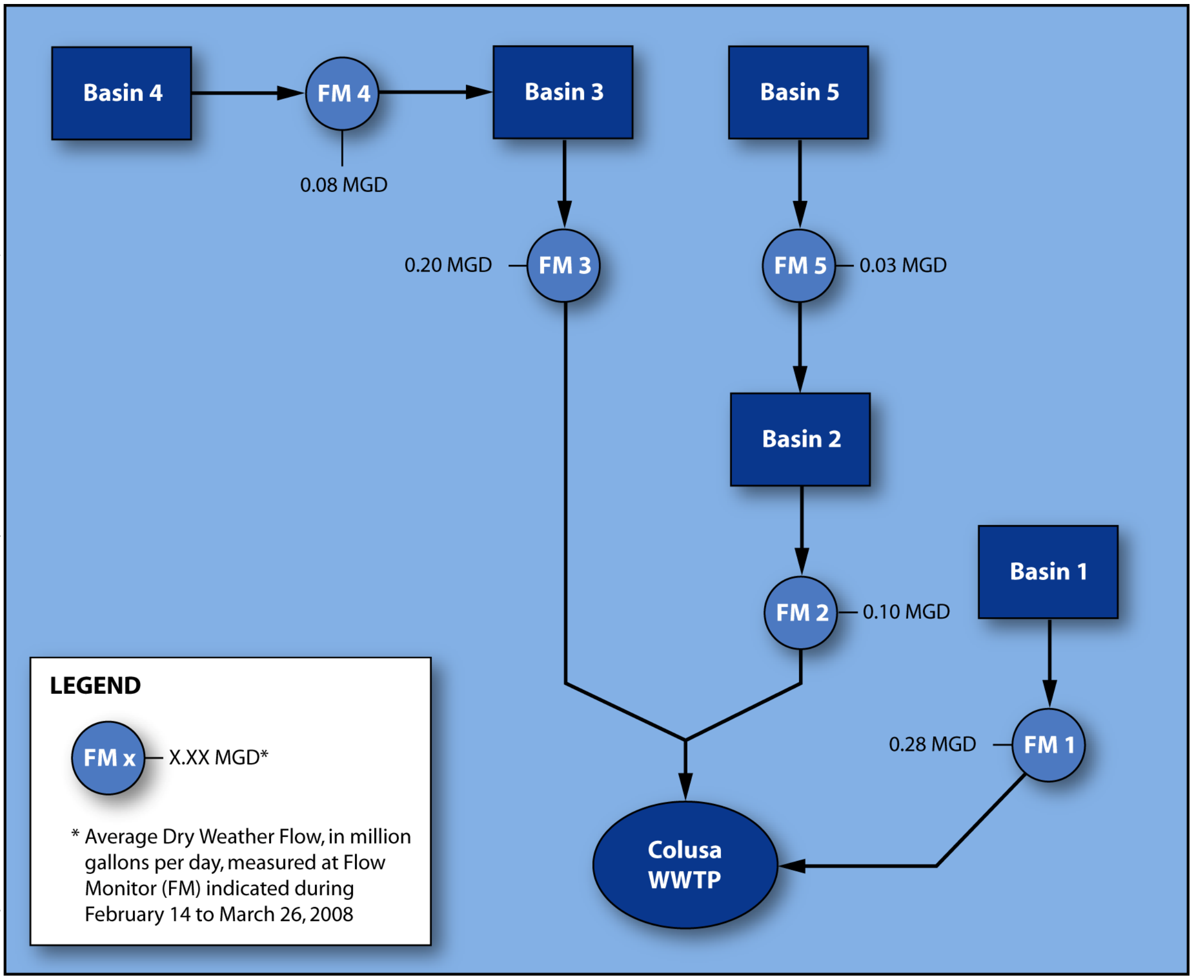
Existing wastewater flow during dry and wet weather conditions within the City's system was determined by monitoring flow for a six-week period from February 14 to March 26, 2008. The detailed flow monitoring report is included in Appendix A.

Five monitoring sites were chosen to divide the City's system into five basins: Basin 1, Basin 2, Basin 3, Basin 4, and Basin 5. Flow monitoring basins are either defined by a combination of flow monitors, which measure the wastewater flow into and out of a basin, or by a single flow monitor (terminal basin). In this case, Basins 1, 4, and 5 are terminal basins. A flow schematic showing the connectivity of the basins is shown in Figure 2-2 and the flow monitor locations and basins are shown in Figures 2-3. The flow monitor combinations used to isolate flows from each basin in this study are shown in Table 2-2.

Table 2-2
City of Colusa
Summary of Flow Monitoring Locations and Flow Monitoring Basins

Flow Monitoring Basin	Flow Monitoring Location (manhole)	Monitoring Site Equations [(a)]
Basin 1	K05-006	FM 1
Basin 2	I04-005	FM 2 – FM 5
Basin 3	H04-011	FM 3 – FM 4
Basin 4	H04-007	FM 4
Basin 5	H04-010	FM 5

(a) Equation used to determine flow from indicated basin as defined by flow monitors (FM).



X:\Active Projects\Colusa - COLU\COLU08 - Water & Sewer Master Plans\COLU08-002 Collection System Master Plan\Sewer Basins\COLU08-002_Flow Schematic.pdf 12-23-08 mlm

Figure 2-2
City of Colusa
Wastewater Collection System Flow Schematic

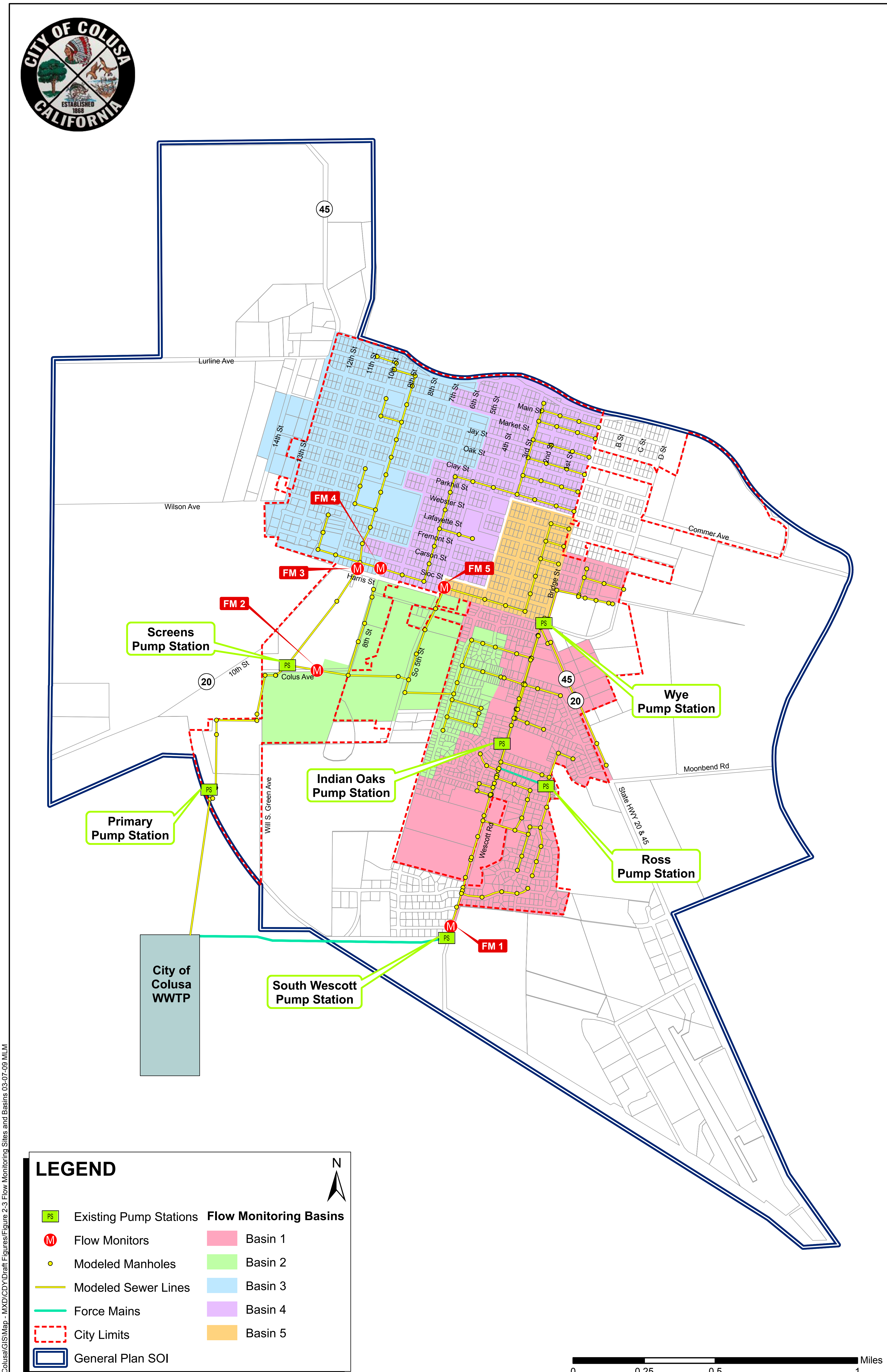


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Figure 2-3
City of Colusa Flow Monitoring Sites and Basins

Diurnal Patterns

A diurnal flow pattern is the variation in flow occurring over the course of a full day. In a 24-hour period, wastewater flow varies significantly with maximum flows typically occurring in the morning and early evening, and minimum flow occurring in the late evening/early morning. Each area of the City has its own unique pattern, which varies between weekdays and weekends. Typical weekday diurnal patterns for three representative basins (Basins 1, 3 and 4) are shown in Figure 2-4.

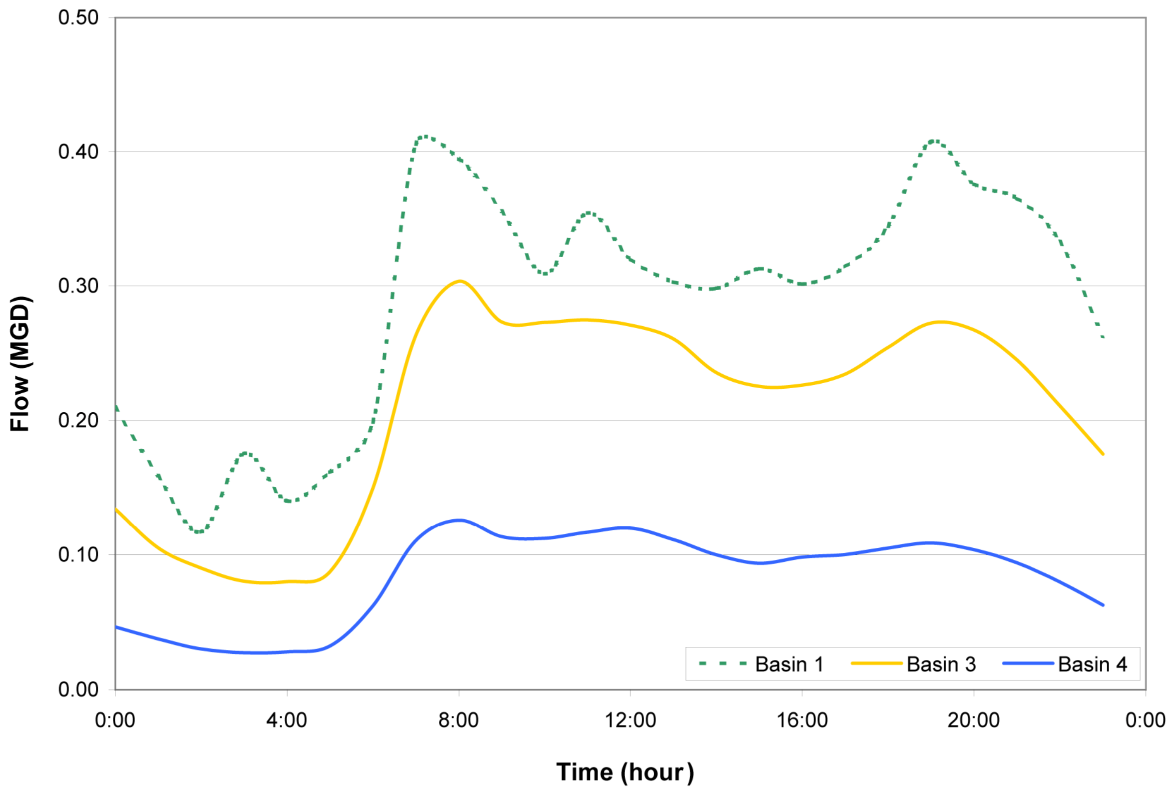

Figure 2-4
City of Colusa
Diurnal Flow Patterns – Weekday

Monitored Average and Peak Flows

Dry and wet weather flow monitoring data was collected from each flow monitor from February 14 to March 26, 2008 to develop diurnal patterns for each sewer basin, recognize areas with inflow and infiltration issues, and determine each sewer basin's response to peak hourly wet weather flows. Ultimately, this data was used to calibrate the model, as discussed in Chapter 5.

Dry weather flow monitoring used for this analysis was measured during the first two weeks of March (March 1 – 14, 2008). This period was selected because no rainfall was measured from February 25 to March 19.

The storm event producing the most significant response in the system during the flow monitoring study occurred from February 19 through February 24, 2008. Unfortunately, the winter of 2007-2008 was a relatively dry year and the storm event recorded during this time was not a large event. Storms can be classified based on duration and frequency. The storm frequency is typically expressed in terms of the storm return period. Storm duration is expressed in hours or days of precipitation. Storms with large return periods and short durations result in high peak hourly wet weather flows. In classifying the storm event occurring from February 19 through February 24, several storm durations (6 hour, 12 hour, 1 day, 2 day and 3 day) with their corresponding cumulative rainfall depths were plotted against statistical data for each storm duration (i.e., depth/duration/frequency, DDF, curves). For each of the plotted storm durations, the storm event from February 19 to February 24, as shown in Figure 2-5, was classified as having a frequency (or return period) of less than 2 years.

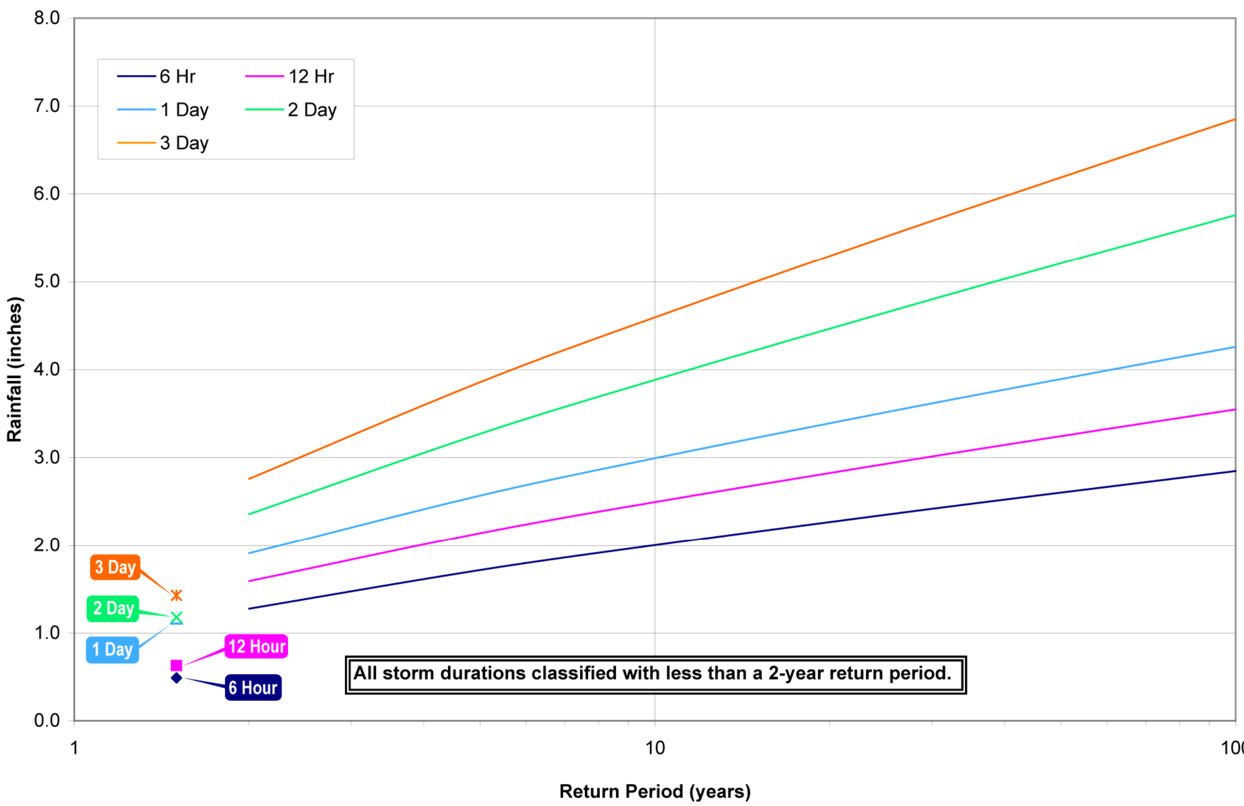

Figure 2-5
City of Colusa
Storm Size Classification

Average daily dry weather wastewater flows from the first two weeks of March and peak hourly wet weather flows observed during the February rainfall event are summarized by flow monitor in Table 2-3.

Table 2-3
City of Colusa
Summary of Existing Average and Peak Flows
February 14 to March 26, 2008

Flow Monitoring Site	Average Flow (MGD) [a], [b]	Peak Flow (MGD) [a], [c], [d]
FM 1	0.28	0.77
FM 2	0.10	0.21
FM 3	0.20	0.38
FM 4	0.08	0.16
FM 5	0.03	0.10
Total Flow to City of Colusa WWTP [e]	0.58	1.36

(a) MGD = million gallons per day.
(b) Average Flow = Average daily dry weather flow (ADWF).
(c) Peak Flow = Peak hourly wet weather flow (as measured during storm event).
(d) Total peak hourly wet weather flow determined from February 19 – 24, 2008 storm event.
(e) Total flow determined from the addition of flow from FM 1, FM 2 and FM 3.

Chapter 3

Land Use

3.1 PURPOSE

The purpose of this chapter is to provide an overview of the existing and future land use designations that were used to estimate modeled flows. Existing and future land uses were developed from the following sources:

- City Council adopted *City of Colusa 2005-2025 General Plan Update (General Plan, October 2007)*
- *Colusa Final Master Environmental Impact Report (MEIR, October 2007)*
- *County of Colusa General Plan (March 1989)*

The General Plan assumes build-out will occur in 2025. Actual growth will depend on a number of factors out of the City's control, including the economy, interest by the development community to build projects, and public support/opposition of new projects. The ultimate wastewater generation projected within the City limits and the General Plan Sphere of Influence (SOI) at build-out are the same regardless of the rate of growth. The projected wastewater generation estimated at build-out of the City limits and General Plan SOI was developed from land use designations as defined in the General Plan.

3.2 LAND USE DATA

Existing and proposed land use types were established from the City's General Plan update and MEIR. Future development on vacant lands was based on the land uses described in the General Plan for the various parcels within the General Plan SOI. The General Plan also provided a range of development densities for each residential land use. Specific densities from these ranges (as provided in the MEIR) were applied to the General Plan acreages to estimate equivalent dwelling units (EDUs) for build-out of future residential areas.

An EDU is a unit of measure that normalizes all land use types (housing, retail, office, etc) to the level of demand created by one single-family housing unit. For example, one EDU is equivalent to the wastewater generation (gallons per day) of an average City of Colusa single-family detached household. A small business designed to discharge three times as much wastewater as an average single-detached dwelling would have a generation rate of three EDUs in terms of a wastewater facility or wastewater infrastructure.

More detailed information regarding existing and future land uses is included in the following sections.

3.2.1 EXISTING AND FUTURE LAND USES

Existing development within the City was characterized by the land use types defined in the General Plan. In most cases, the density of currently developed areas was lower than the average density anticipated for future development. A summary of assumed residential densities used to classify existing development and for calculating EDUs for future development are shown below.

- **Estate Residential (ER)**. Represents a range of 1-3 dwelling units per acre with 1.5 single-family dwelling units per acre assumed for purposes of projecting future growth.
- **Low Density Residential (LDR)**. Represents a range of 3-8 dwelling units per acre with 6 single-family dwelling units per acre assumed for purposes of projecting future growth. Three units per acre was used for lands designated LDR and currently developed within the City limit based on field observations and aerial photography.
- **Medium Density Residential (MDR)**. Represents a range of 8-12 dwelling units per acre with 10 dwelling units per acre assumed for purposes of projecting future growth. The existing density for developed areas with the MDR designation is eight units per acre, based on field observations and verification using aerial photography.
- **High Density Residential (HDR)**. Represents a range of 12-20 dwelling units per acre with 16.5 dwelling units per acre assumed for purposes of projecting future growth. The existing density for developed areas with the HDR designation is twelve units per acre, based on field observations and verification using aerial photography.
- **Mixed Use (MU)**. There is currently little or no existing mixed use development within the City; existing development was defined as commercial or residential based on aerial photographs. Build-out mixed use areas were defined by assuming a two level development: commercial on the first floor and medium density residential on the second floor. Therefore, wastewater generation factors for both commercial and medium density residential applications were applied to estimate future flows from mixed use areas. It was assumed that areas designated as mixed use in the General Plan were redeveloped to mixed use regardless of their current land use.
- **Commercial**. Represents both commercial and professional land uses including office buildings, hotels, restaurants, convenience stores, veterinary hospitals, medical offices, dental offices, day care centers, banks, laundromats, carwashes, churches, etc. Wastewater generation within this land use category was based on acreage.
- **Public Facilities.** Represents public facility uses such as schools, the cemetery, the County health and welfare office, the fairgrounds, and City Hall. Wastewater generation within this land use category is based on acreage, with the exception of schools. Wastewater generation for schools vary based on the type of school and are estimated by school population (gallons per day per student).
- **Industrial**. This land use represents heavy industrial and office professional/light industrial uses including a trailer manufacturer, City corporation yards, agriculture-support businesses, farm equipment rental and sales businesses, a petroleum supplier, a rice mill, a fruit drying plant, grain and food processing facilities, and building material facilities. The industrial portion of the Colusa Industrial Park is specifically excluded

from this plan as discussed below in Section 3.2.3. Wastewater generation within this land use category is based on acreage.

- **Parks and Open Spaces (OS)**. Wastewater generation was assumed to be minimal/ insignificant for parks and open spaces.
- **Urban Reserve (UR)**. Portions of the sphere of influence are designated urban reserve. The land uses within the urban reserves are based on the County of Colusa General Plan (March 1989). Three land uses are identified within the sphere of influence including agricultural transition area, rural residential, and urban residential. Wastewater service will be provided to all these areas assuming one dwelling unit per acre as described in the MEIR. At one dwelling unit per acre, the wastewater generation factor would be equivalent to the Estate Residential generation factor.

As described in the MEIR, prior to calculating future EDUs and wastewater generation, 20-percent of the acreage was subtracted to account for future infrastructure (i.e. roads and sidewalks).

Summaries of existing and future acreages and EDUs, broken out by land use, are shown in Tables 3-1 and 3-2. The values shown in these tables do not reflect the same values shown in the MEIR Table 4.0-4 for the following reasons:

- The land uses and acreages in this analysis reflect only development that is/will be served by the City's wastewater collection system.
- The existing dwelling unit values and acreages in this analysis were determined from aerial photos and field verification/observations. The MEIR land uses appear to be based on the land uses shown as "existing" in Figure 2.2 of the updated General Plan. Figure 2.2 appears to be outdated and the aerial photos and street level observations showed that it did not accurately reflect current development.
- The land use for the Colusa Crossings planning area changed after completion of the MEIR and is reflected in the text of the General Plan. The housing density for low density residential and high density residential was 5 and 20 units per acre, respectively, for the Colusa Crossing area.
- The MEIR included a distinction between residential mixed use and non-residential mixed use. The General Plan did not separate these. As noted above, build-out mixed use areas were defined as assuming two levels of development: commercial on the first floor, and medium density residential on the second floor.

3.2.2 EXISTING DEVELOPMENT

Current records available for existing development and land uses within the City were limited to tax role data and minimal database information. Therefore, areas of existing development were determined through field observations and verification using aerial photography.

A summary of existing areas served by the City's wastewater system, broken down by land use (as defined in the General Plan and the MEIR), is presented in Table 3-1 and shown on Figure 3-1.

There are three significant areas with existing development (shown in Figure 3-1) that are not connected to the City's wastewater collection system. These include (1) the Goads area (located in the northeastern portion of the City), (2) the Walnut Ranch development (in the southern part of the City, east of the WWTP), and (3) the Colusa airport and industrial park (in the very southeastern portion of the City). All of these areas, with the exception of the Colusa Industrial Park, are currently served with septic tank and leachfield systems. The Colusa Industrial Park is served mostly by a private wastewater treatment plant with septic tank and leachfield systems in some areas.

Table 3-1
City of Colusa
Summary of Existing Land Use Acreage and EDUs [(a)]

Land Use Designation	EDUs	Total Acreage (Acres)
Estate Residential	20	44
Low Density Residential	1,514	423
Medium Density Residential	240	22
High Density Residential	102	3.5
Commercial	-	74
Industrial	-	65
Public Facility (includes schools, fairground, and cemetery)	-	142
Total	**1,876**	**774**

(a) Based on May 2006 aerial photograph, field observations, and new construction since aerial photo.

3.2.3 FUTURE DEVELOPMENT

The General Plan land uses within the sphere of influence are listed in Table 3-2 and are shown in Figure 3-2. Several special planning areas that are described in more detail in the General Plan are also shown in Figure 3-2.

Future wastewater generation was projected from these land uses, based on the number of anticipated EDUs for residential land uses, and based on acreage for commercial, industrial, and public facility type land uses. If existing land uses were not consistent with the General Plan land use, redevelopment consistent with the General Plan was assumed.

All areas within the City's SOI (with the exception of the Colusa Industrial Park, described in more detail below), including the Goads area and the Walnut Ranch development, were assumed to be connected to the City's wastewater collection system in the future.

The Colusa Industrial Park (CIP) consists of approximately 337 acres of land within the City's SOI. Based on direction from City staff, industrial land uses in the CIP were excluded from this study. It is assumed that the CIP will collect and treat any industrial wastewater produced.

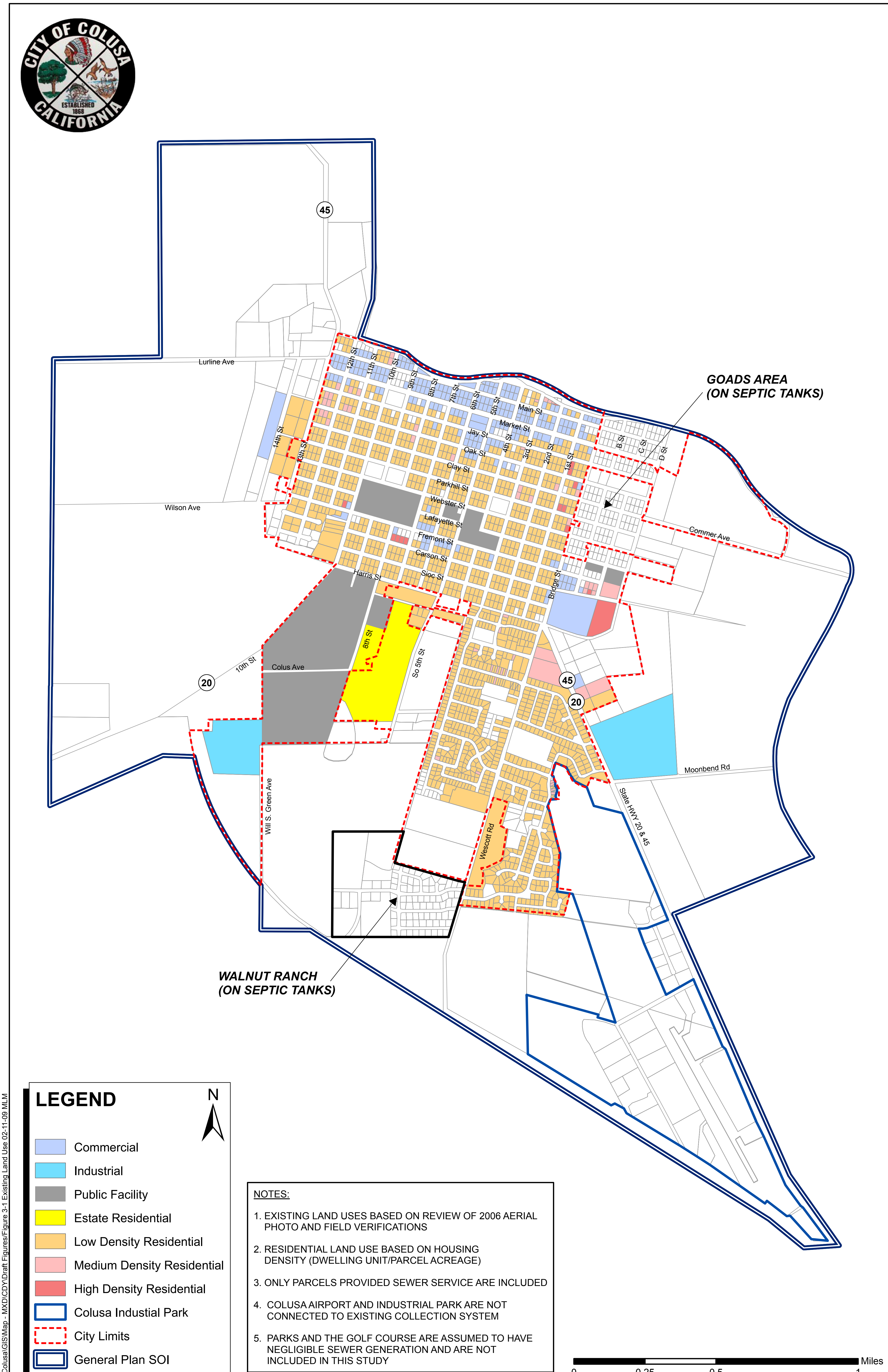

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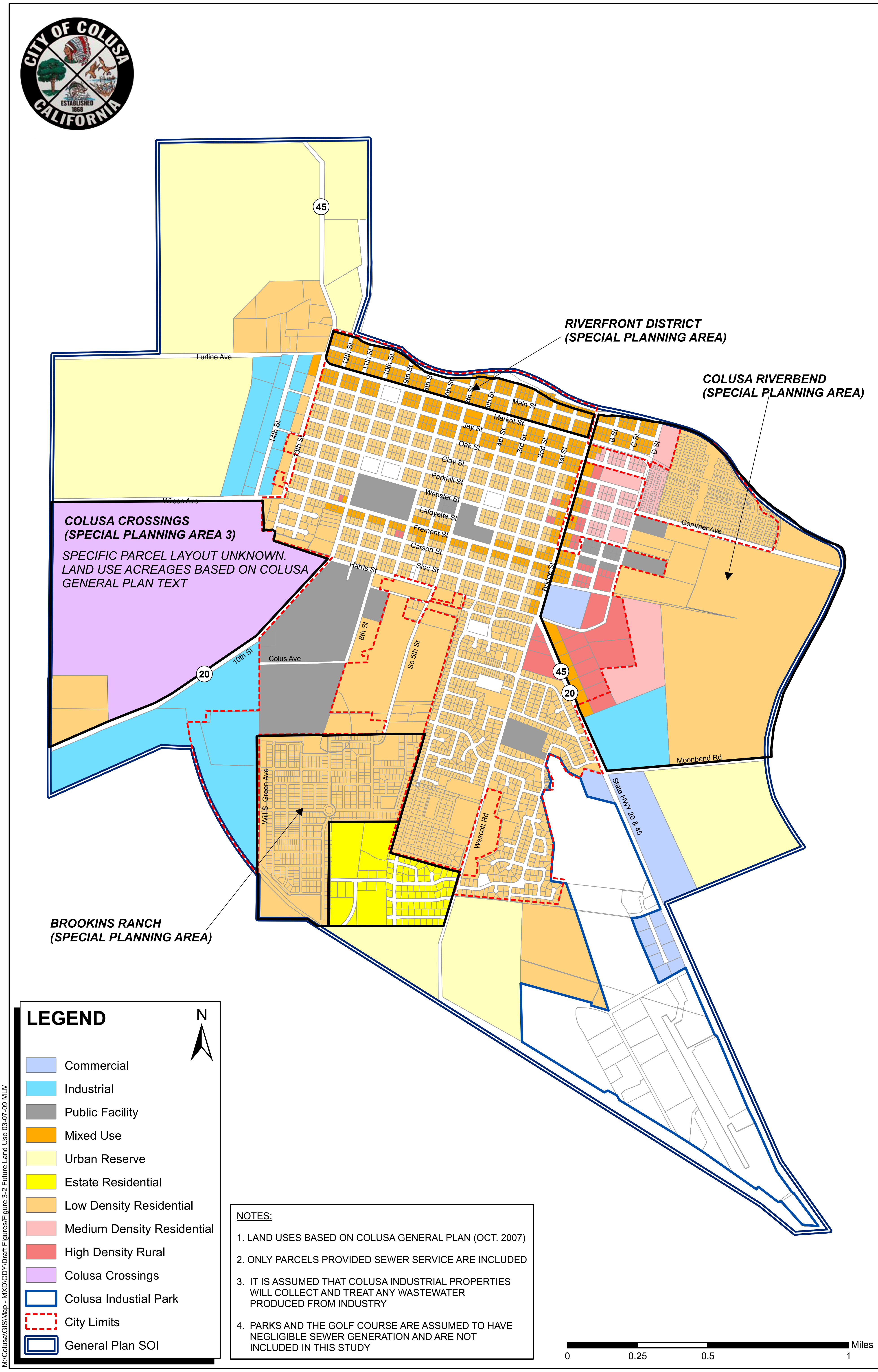
Figure 3-1
City of Colusa Existing Land Use

Table 3-2
City of Colusa
Summary of Future Land Use Acreage and EDUs [(a)]

Land Use Designation	EDUs	Total Acreage (Acres)
Urban Reserve	571	714
Estate Residential	89	74
Low Density Residential	6,574	1,362
Medium Density Residential	657	79
High Density Residential	989	70
Mixed Use	1,092	137
Commercial	-	97
Industrial	-	22
Office Professional/ Light Industrial	-	209
Public Facility	-	155
Total	**9,972**	**2,919**

(a) Based on City of Colusa General Plan Update (October 2007). Only parcels that have sewer service are included.



NOTES:

1. LAND USES BASED ON COLUSA GENERAL PLAN (OCT. 2007)
2. ONLY PARCELS PROVIDED SEWER SERVICE ARE INCLUDED
3. IT IS ASSUMED THAT COLUSA INDUSTRIAL PROPERTIES WILL COLLECT AND TREAT ANY WASTEWATER PRODUCED FROM INDUSTRY
4. PARKS AND THE GOLF COURSE ARE ASSUMED TO HAVE NEGLIGIBLE SEWER GENERATION AND ARE NOT INCLUDED IN THIS STUDY

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Figure 3-2
City of Colusa Future Land Use

Chapter 4

Future Flow Estimation

4.1 PURPOSE

The purpose of this chapter is to present an overview of the methods used to estimate wastewater flows for build-out of the General Plan Sphere of Influence. Characteristics of existing wastewater flows are described in Chapter 2. Estimated future peak hourly wet weather flows were used in the hydraulic model to determine potential future capital improvement projects and to size new trunk sewers.

4.2 BUILD-OUT DEVELOPMENT WASTEWATER FLOWS

Future land use designations within the City's General Plan Sphere of Influence (SOI) are described in Chapter 3. This section describes average unit wastewater rates and peaking factors that were applied to estimate average daily dry weather and peak hourly wet weather flows, respectively, from build-out of the General Plan SOI.

Average unit wastewater generation rates for future development areas were compiled based on a review of flow monitoring data and typical wastewater generation rates used by other communities in the Central Valley similar to Colusa.

4.2.1 AVERAGE DAILY DRY WEATHER FLOWS

As described in Chapter 3, a dwelling unit count was assigned to each future residential development area based on land use. From the flow monitoring data, an average unit flow of 210 gallons per day per dwelling unit (gpd/DU) was determined. This unit flow was applied to each future residential area to determine the average daily dry weather flow for each future residential parcel. A similar process was used for future commercial, industrial, and public/quasi-public areas using the unit wastewater generation values provided in Table 4-1. Open spaces such as parks, agricultural areas, and storm canals were assumed to contribute little to no wastewater to the system.

Average unit wastewater generation rates used in this study and recommended for future planning purposes are summarized in Table 4-1.

Table 4-1
City of Colusa
Average Wastewater Unit Generation Rates

Land Use Designations	Future Land Use Unit Flow [a]
Commercial	
Commercial	850 gpd/acre
Industrial	
Industrial	850 gpd/acre
Public Use	
Public Facility	1,350 gpd/acre
Schools – Elementary and Junior High	25 gpd/student
Schools – High School and Other	50 gpd/student
Open Space	
Open Space	0 gpd/acre
Parks	0 gpd/acre
Residential	
All Residential Designations	210 gpd/DU

(a) gpd/acre = gallons per day per net acre; gpd/DU = gallons per day per dwelling unit; gpd/student = gallons per day per student.

4.2.2 PEAK HOURLY WET WEATHER FLOWS

The unit flows listed in Table 4-1 represent average daily dry weather wastewater flow generated by users and do not include additional flow from storm events that cause peak hourly wet weather flows.

Two methods were used to determine peak hourly wet weather flows: 1) peaking average daily dry weather flows with a design storm event in the model and 2) applying a peaking factor.

For all infill and new developments using the existing collection system, a 10-year, 6-hour design storm was used in the model to peak average daily dry weather flows. Hourly design storm rainfall data was input into the model such that the peak rainfall (in the middle of the storm) coincided with a peak of the diurnal flow pattern (see Figure 2-4). Based on the leakage rates of each flow monitoring basin (as determined during wet weather model calibration), the model introduces the corresponding amount of inflow and infiltration that will enter the collection system from the design storm. This method of peaking dry weather flows varies for each flow monitoring basin and is based on the "leakiness" of each basin as determined from wet weather calibration.

For new developments that need new sewer infrastructure, a peaking factor was applied to daily dry weather flows. For the City of Colusa, a peaking factor of 3.1 was applied to dry weather flows. This peaking factor was developed using the Ten States Standards (*Recommended*

Standards for Wastewater Facilities: Policies for the Design, Review, and Approval of Plans and Specifications for Wastewater Collection and Treatment: 2004 Edition) Peak Factor Curve and the City's average dry weather flow of 0.58 MGD, and is consistent with City Design Standards. This peaking factor was applied to all new developments needing new sewer infrastructure regardless of location.

Chapter 5

Hydraulic Model

5.1 PURPOSE

The purpose of this chapter is to present an overview of the construction and calibration of the hydraulic model for the City of Colusa's wastewater collection system.

This chapter is divided into the following major sections:

- Modeling Software
- Model Inputs and Construction
- Model Calibration

5.2 MODELING SOFTWARE

Wastewater collection system capacity was evaluated using a dynamic flow routing model, Wallingford Software's *InfoWorks*. Dynamic flow routing models are considered one of the most sophisticated means to assess sewer system capacity. The model simulates sewer system hydraulic response during peak hourly wet weather flow events resulting from a combination of peak diurnal sanitary flows, groundwater infiltration, and rainfall dependent infiltration and inflow.

5.3 MODEL INPUTS AND CONSTRUCTION

The following inputs were used in construction of the hydraulic model and are described in more detail below:

- Pipes and Manholes
- Pump Stations
- Subcatchments
- Design Storm

5.3.1 PIPES AND MANHOLES

All sewer lines with a diameter of 8-inches and greater were modeled. In addition, smaller critical lines were modeled when necessary. The modeled portions of the sewer are shown in Figure 5-1.

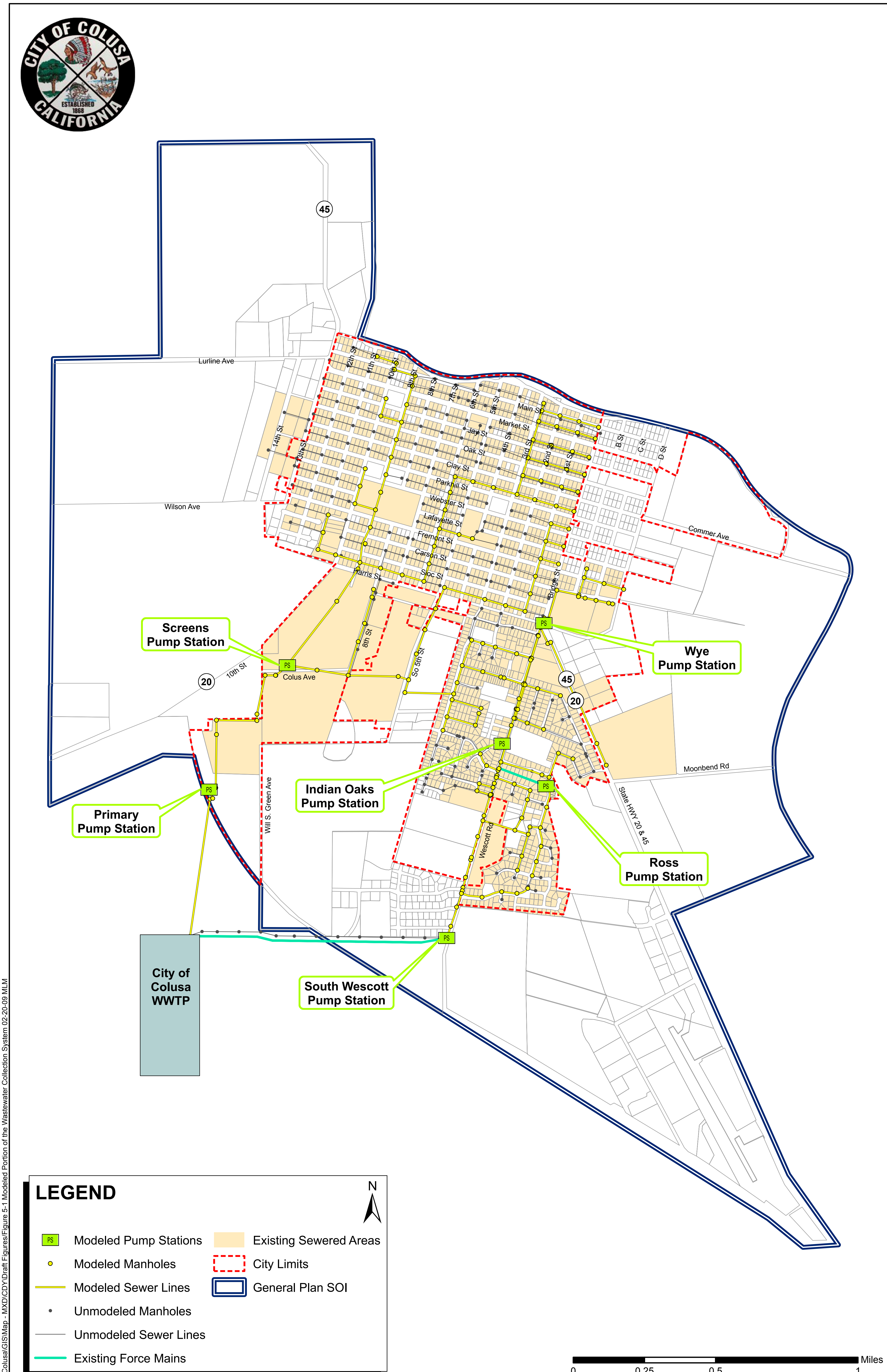

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Figure 5-1
City of Colusa Modeled Portion of the Wastewater Collection System

5.3.2 Pump Stations

All six pump stations were considered to have a significant impact on the system and were modeled. The characteristics of each pump station, including pumping capacities, are summarized in Table 2-1 of Chapter 2.

5.3.3 Subcatchments

Subcatchments are geographic areas within a sewer basin that represent a composite of land uses (such as residential, commercial, and industrial) and discharge to a common manhole. An Equivalent Dwelling Unit (EDU) count was assigned to each subcatchment to account for residential, commercial, and industrial flows. The EDU count for each subcatchment is multiplied by a per EDU wastewater generation rate to determine total average daily dry weather flow from the area. The per EDU generation rate for existing development is determined during the dry weather calibration. Flows for future subcatchments were determined using the process outlined in Chapter 4. Each subcatchment also includes coefficients, which represent the "leakiness" of the area included in that subcatchment. The coefficients determine how much rain-dependent inflow and infiltration enter the system and are determined based on the flow monitoring data.

5.3.4 Design Storm

Design storms are developed from statistical analysis of local precipitation records and represent the distribution of rainfall depths over a time increment for a given storm duration and frequency. The design storm concept assumes that a precipitation event of a particular frequency will produce rainfall-dependent infiltration and inflow (peak hourly wet weather flows) of the same magnitude as a naturally occurring storm of the same duration and frequency.

The storm frequency is typically expressed in terms of the storm return period. Storm duration is expressed in hours or days of precipitation. Storms with large return periods and short durations result in high peak hourly wet weather flows. Design storms are selected based on the level of protection desired for the wastewater collection system while considering the likelihood of the event. Based on experience with other similarly sized communities in the area, it is recommended that the City work toward providing adequate system capacity to convey peak hourly wet weather flows during a 10-year return period storm occurring over a 6-hour period (a 10-year, 6-hour storm).

Because design storms are developed based on local precipitation records, data from rainfall gauges in City of Colusa area were analyzed. According to the California Department of Water Resources (http://cdec.water.ca.gov/), a 10-year, 6-hour design storm in the City of Colusa's service area produces a total of 2.00 inches of rain.

A rainfall pattern (or hyetograph) was developed to distribute total rainfall over the storm's 6-hour duration. The hyetograph selected for this design storm is based on the Sacramento Method (Sacramento City and County Drainage Manual, December 1996), which assumes the highest intensity of rainfall occurs in the middle of the storm. The hyetograph used for the City's 10-year, 6-hour design storm is provided in Figure 5-2.

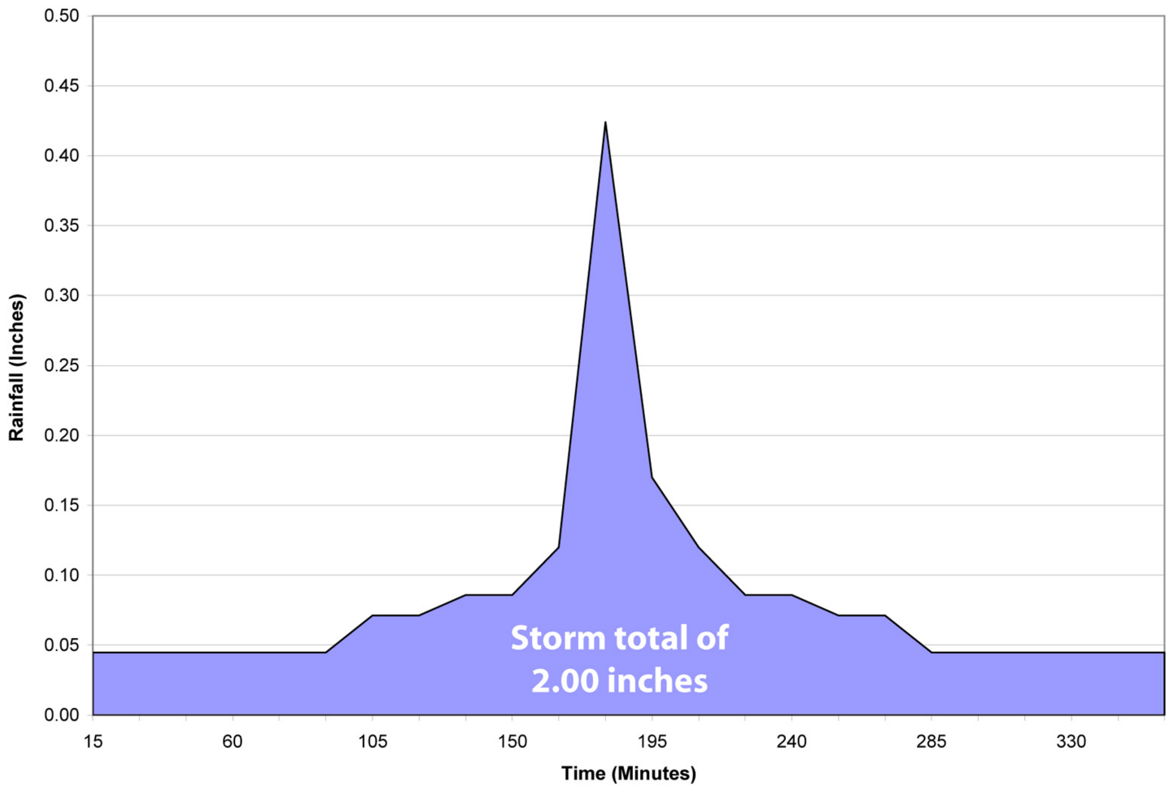


Figure 5-2
City of Colusa
10-Year, 6-Hour Design Storm Hyetograph

5.4 MODEL CALIBRATION

Calibration is the process of matching hydraulically modeled results with observed results to assure that a model accurately reflects actual conditions. Hydraulic models are calibrated for both dry weather and wet weather conditions.

5.4.1 DRY WEATHER CALIBRATION

The estimated wastewater flow generated from each flow monitoring basin was calculated by multiplying the EDU count of each land use type by an initial unit flow factor (Table 4-1). To calibrate the model, simulated flows were graphically compared to observed flows in *InfoWorks* at each flow monitoring location and unit flow factors adjusted until simulated flows sufficiently matched observed flows. An example of well calibrated dry weather flow for the Basin 3 flow monitor is shown in Figure 5-3. Dry weather flow calibration figures for all flow monitoring basins are provided in Appendix B.

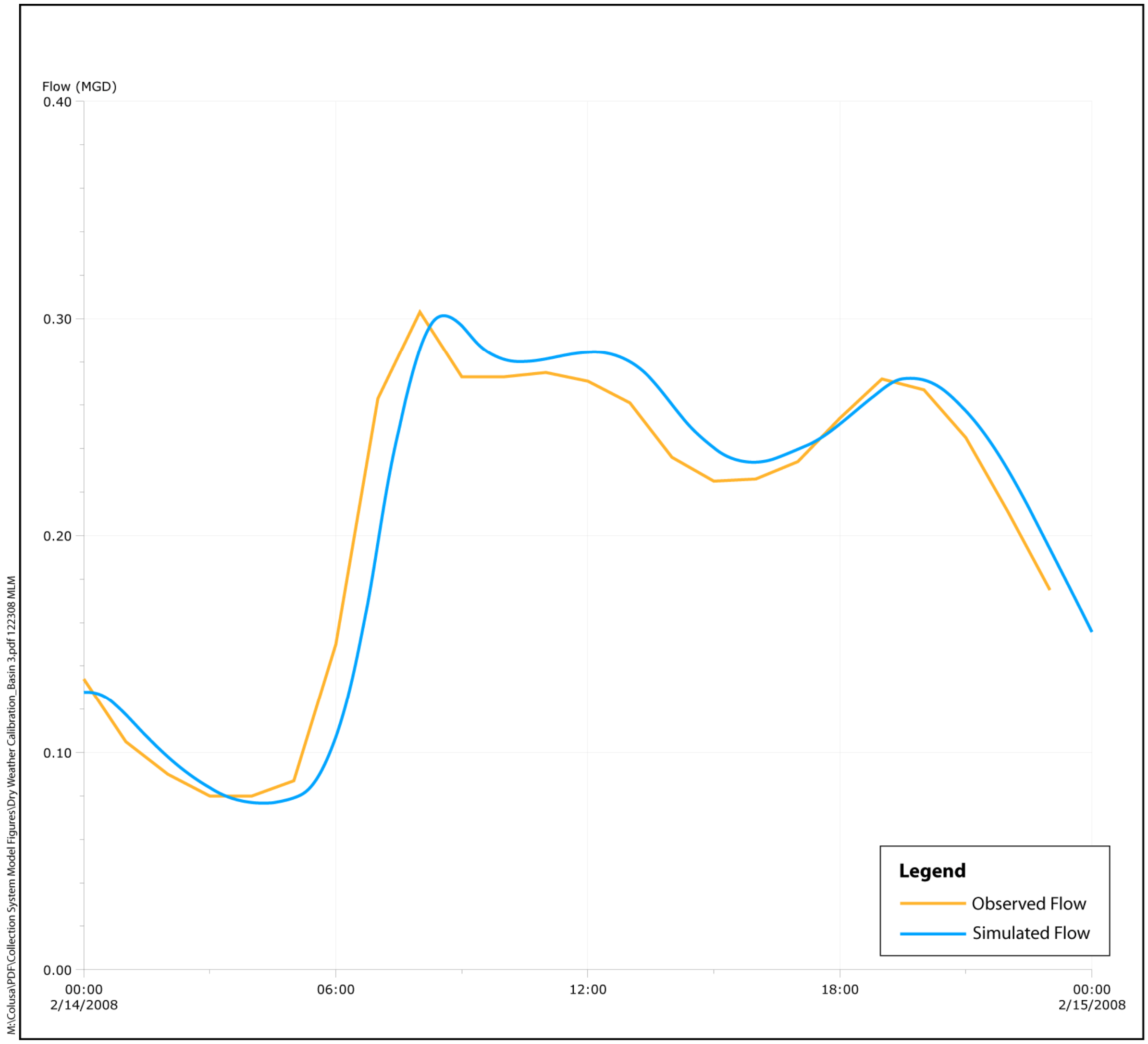


Figure 5-3
City of Colusa
Dry Weather Flow Calibration for Basin 3 Flow Monitor

5.4.2 WET WEATHER CALIBRATION

Once the dry weather flow calibration was completed for each flow monitoring site, wet weather calibration was performed. The most significant storm event during the flow monitoring study occurred from February 19 through February 24, 2008. Rainfall data collected during this duration showed that the peak 6-hour rainfall period produced approximately 0.48 inches of rain, categorizing this event as a 6-hour storm with less than a 2 year return period (2-year, 6-hour storm produces 1.28 inches of rain). Larger storms are ideal for model calibration, since these will more closely reflect the affects of the design storm. However, this storm did produce a response throughout the system (flows increased beyond dry weather flow) and a wet weather calibrated was performed based on this response. If this storm did not produce a measurable response, either the “leakiness” of each flow monitoring basin would have to be estimated or additional wet weather flow monitoring data would have to be collected. Additional wet weather flow monitoring during a larger storm event in the future would refine the model calibration.

To calibrate each of the City’s five sewer basins, the flow monitoring and rainfall data collected during the storm event from February 19 through February 24 was input into the model. The measured peak hourly wet weather flow at each flow monitor was compared to the simulated flow produced by the model. Coefficients, representing the “leakiness” of each flow monitoring basin (how much rain-dependent inflow and infiltration enter the system), were adjusted until the measured and simulated peak hourly wet weather flows matched. An example of the Basin 4 flow monitor’s wet weather calibration is shown in Figure 5-4. Wet weather flow calibration figures for all flow monitoring basins are provided in Appendix C.

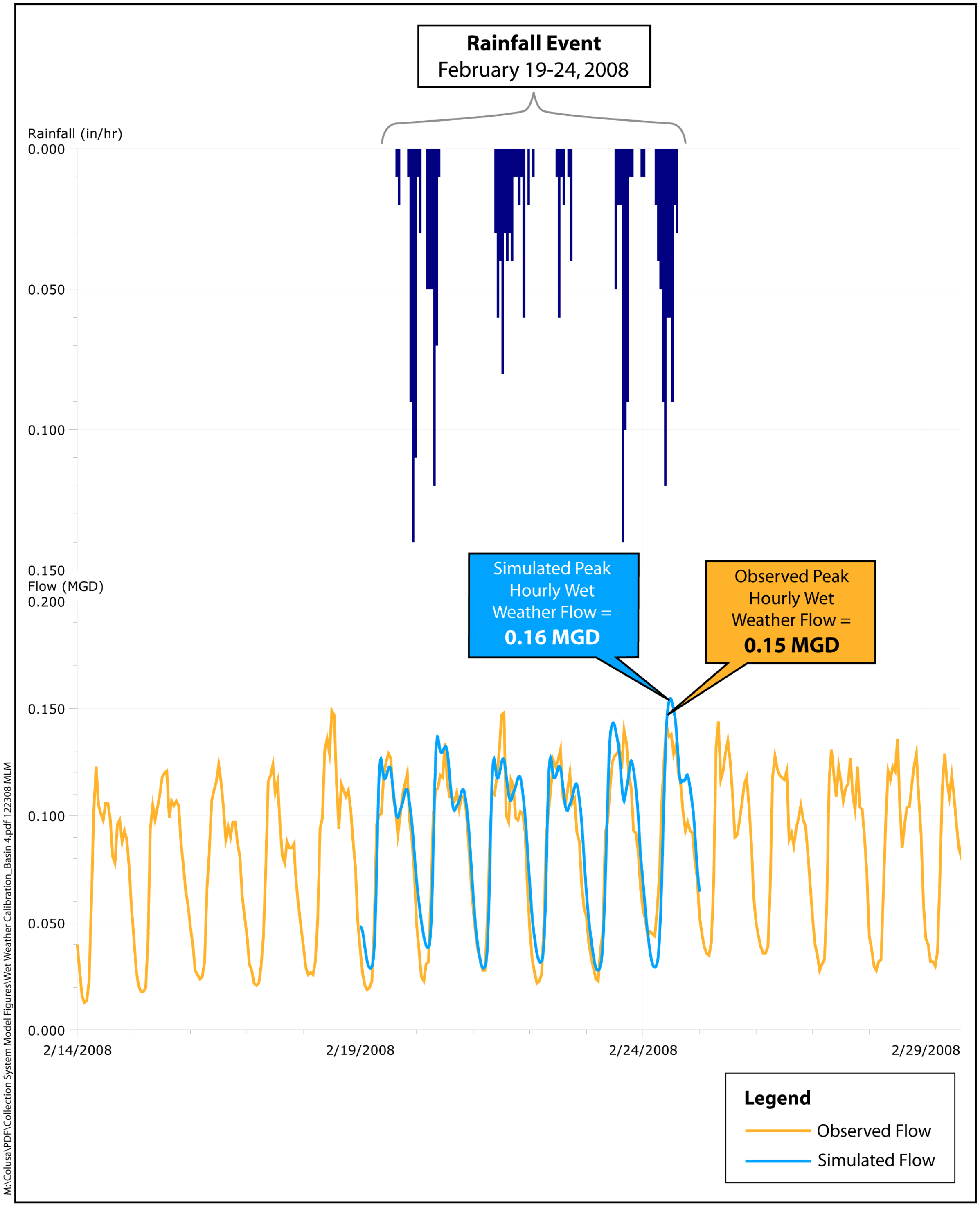


Figure 5-4
City of Colusa
Wet Weather Flow Calibration for Basin 4 Flow Monitor

Chapter 6

Capacity Evaluation Results – Existing System

6.1 PURPOSE

The purpose of this chapter is to provide a summary of the results of the model simulations for the existing system at the existing level of development and to provide a strategy for mitigating capacity issues identified in the model results. Modeling was conducted for a 10-year, 6-hour storm event for the existing level of development (modeling of future development impacts are discussed in Chapter 7). This chapter is divided into the following sections:

- Capacity Criteria
- Modeled Scenarios
- Model Results – Existing Level of Development
- Mitigation Strategies for Existing System Deficiencies

6.2 CAPACITY CRITERIA

Wastewater collection systems can generally accommodate some degree of surcharging during peak hourly wet weather flow conditions. However, once a manhole surcharges, it takes very little additional flow for an overflow to occur. Criteria for acceptable levels of maximum surcharging were developed with input from City of Colusa (City) staff. These criteria are presented in Table 6-1. These acceptable levels were used as criteria in evaluating capacity in flow limited segments of sewer pipelines in all modeled scenarios.

Table 6-1
City of Colusa
Acceptable Manhole Surcharging
During Design Storm (10-year, 6-hour) Conditions

Manhole Depth [(a)]	Acceptable Level of Manhole Surcharging
Less than 4 feet	None
4 feet and greater	Not to exceed 3 feet below ground surface and maximum HGL of 8 feet above pipe

(a) Manhole depth as measured from the crown of the pipe to the rim of the manhole.

6.3 MODELED SCENARIOS

Several scenarios were modeled to evaluate capacity at existing level of development in the existing system. The following simulations are described in more detail in the remainder of this chapter:

- Existing system with existing level of development at dry weather flow
- Existing system with existing level of development during design storm (10-year, 6-hour) event

Modeled scenarios assume clean-pipe conditions. The results of these modeling analyses indicate available capacities (or lack thereof) of the pipelines assuming pipes are in good condition and free from debris.

6.4 MODEL RESULTS – EXISTING LEVEL OF DEVELOPMENT

The following sections outline the modeling results for the existing system at the existing level of development as of March 2008 (existing level of development).

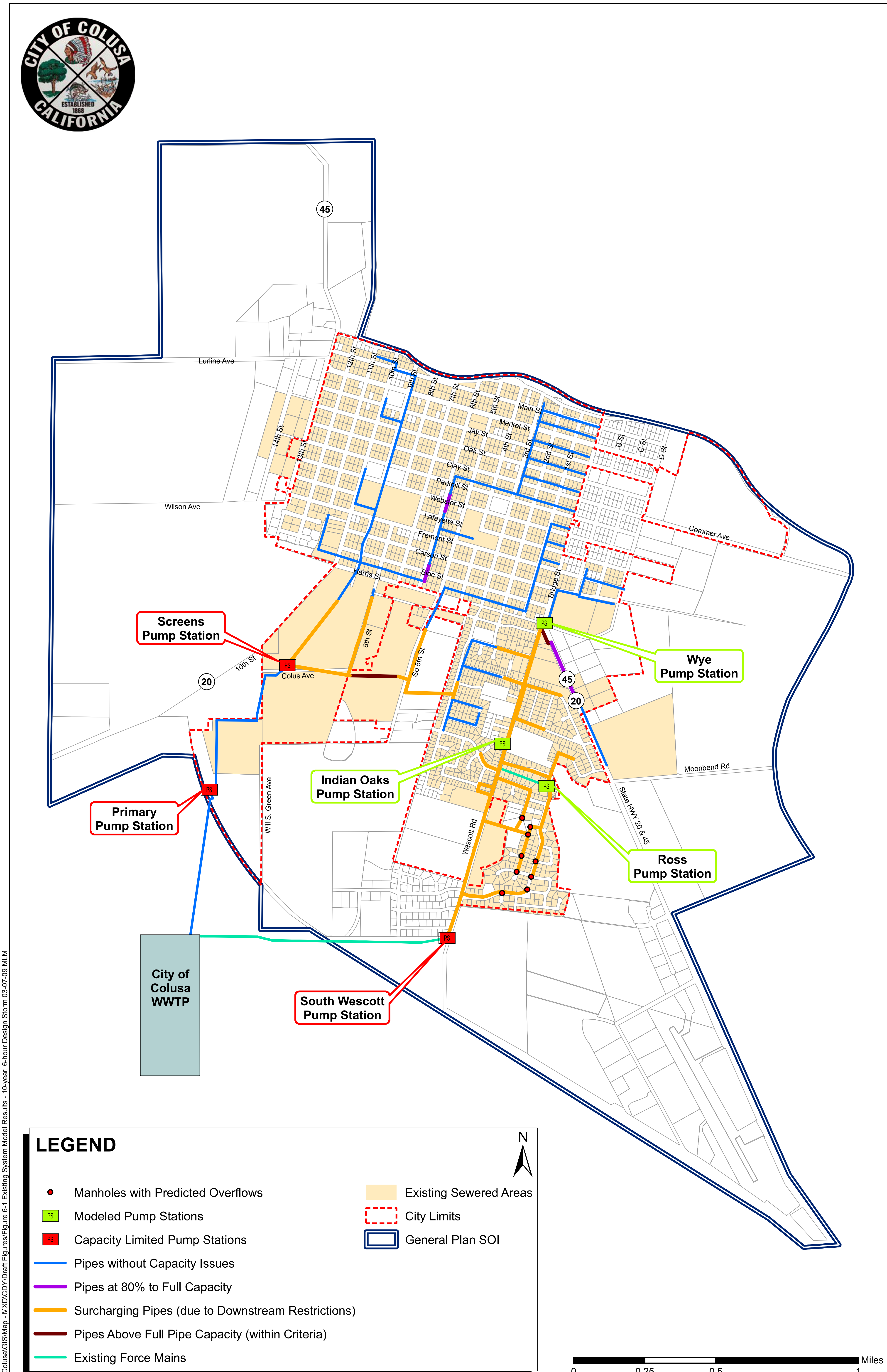
6.4.1 EXISTING SYSTEM - DRY WEATHER FLOW

At the existing level of development, during average daily dry weather flows, the model simulated all pipes to be flowing at less than 80% capacity and no manholes experienced surcharging.

6.4.2 EXISTING SYSTEM - DESIGN STORM (10-YEAR, 6-HOUR)

Under modeled conditions, a 10-year, 6-hour design storm is estimated to generate a peak hourly wet weather flow of 2.31 million gallons per day (MGD) at the City of Colusa's Wastewater Treatment Plant (WWTP). For comparison, existing peak diurnal flow (dry weather flow) at the treatment plant is 0.94 MGD and average daily dry weather flow is 0.58 MGD. Detailed model results of the existing system at the 10-year, 6-hour design storm by manhole and pipeline attributes are provided in Appendix D.

These modeled peak hourly wet weather flows are predicted to cause overflows and manhole surcharging in several different trunks within the system (Figure 6-1). In Figure 6-1, pipelines shown in purple are near full pipe conditions (between 80 and 100% full) and pipes shown in orange are impacted by downstream conditions. Surcharged pipes within the City's criteria and beyond the criteria are shown in dark red and red, respectively. Manhole locations where overflows are predicted are labeled and shown in red. Specific overflow locations are also listed below in Table 6-2. Manhole numbering for the entire modeled system is provided in Appendix E.



M:\Colusa\GIS\Map - MXD\CDY\Draft Figures\Figure 6-1 Existing System Model Results - 10-year, 6-hour Design Storm 03-07-09 MLM

Figure 6-1
City of Colusa Existing System Model Results - 10-year, 6-hour Design Storm

Table 6-2
City of Colusa
Summary of Modeled Overflows – Existing Conditions
at 10-year, 6-hour Design Storm

Overflowing Manholes		
J05-012	J05-041	J05-058
J05-028	J05-045	J05-063
J05-040	J05-049	J05-064

6.5 MITIGATION STRATEGIES FOR EXISTING SYSTEM DEFICIENCIES

During model simulations, under design storm conditions, several overflows are predicted in the existing system (Figure 6-1). These overflows and associated surcharging are primarily due to capacity restrictions at pump stations. To alleviate these potential overflows, upsizing the South Wescott, Screens, and Primary pump stations is recommended. These improvements will reduce surcharging in upstream gravity lines and prevent overflows in the manholes listed in Table 6-2.

Modeled scenarios assume that pipes and manholes are in good condition and free from debris (i.e., clean-pipe conditions). Thus, the results of the modeling analysis indicate available capacity (or lack thereof) and do not take into consideration deteriorated conditions. Prior to initiating any capital improvement projects, it is recommended that the City assess the condition of the existing collection system. Much of the existing collection system is shallow with slopes that are flatter than recommended. (Areas of the collection system with these conditions are shown in Appendix F.) These conditions often contribute to the accumulation of debris and surcharging conditions, irrespective of clean-pipe capacities. City staff has noted several areas where modeling simulations predict less than full-pipe conditions, but where staff has observed near surcharge conditions. When limited funds exist, the condition of these areas should be assessed prior to initiating any pump station improvements in order to determine the priority of improvements and best use of available funds. Condition assessments would include performing closed-circuit television (CCTV) inspections and structurally rating the existing sewer infrastructure as well as cleaning of each major sewer pipeline. The City could perform this assessment during one summer or split the work over a several year period. The City should also evaluate whether to perform the condition assessment on all 26 miles of pipeline or the approximately 15 miles of major pipelines.

In addition to condition assessment in known or suspected deteriorated areas, it is also recommended that additional dry and wet weather flow monitoring data be collected prior to initiating capital improvement projects to address these capacity issues. Additional data will refine the leakage rates and improve the accuracy of modeling simulations, which may decrease the degree of capital improvements required.

6.5.1 EXISTING SYSTEM MITIGATION STRATEGY – PUMP STATION IMPROVEMENTS

The recommended improvements to the existing system to accommodate peak hourly wet weather flows from existing development during the 10-year, 6-hour design storm only include upsizing the South Wescott, Screens and Primary pump stations. No upsizing of pipelines is needed.

As discussed in Chapter 2, none of the existing stations have alarms or permanent emergency generators. If pumps fail, the wastewater will back up in the manholes and upstream sewer pipelines until City crews can bring the station back online. The Primary and Screens pump stations are also old, show signs of deterioration, and tend to generate odors. In addition, the State of California now regulates sewer systems under separate Waste Discharge Requirements (Order No. 2006-0003-DWQ). Through these requirements, the City must take all reasonable steps to reduce or eliminate overflows within the system. For the City of Colusa, increasing the reliability of the pump stations includes two aspects:

1. Many utilities now incorporate Supervisory Control and Data Acquisition (SCADA) systems into their stations to monitor pump operation and alert staff of station failure. Adding SCADA to pump stations can be completed cheaply for both existing and future stations. Additionally, the City's newly upgraded wastewater treatment plant is equipped with a computer and alarm system that can receive these signals with minor improvements.
2. Most or all pump stations should be equipped with an emergency generator to operate the station during power failure.

Through discussions with City staff, it was determined that these additional improvements, beyond capacity needs, are also desired to increase reliability and safety. Additional pump station considerations include:

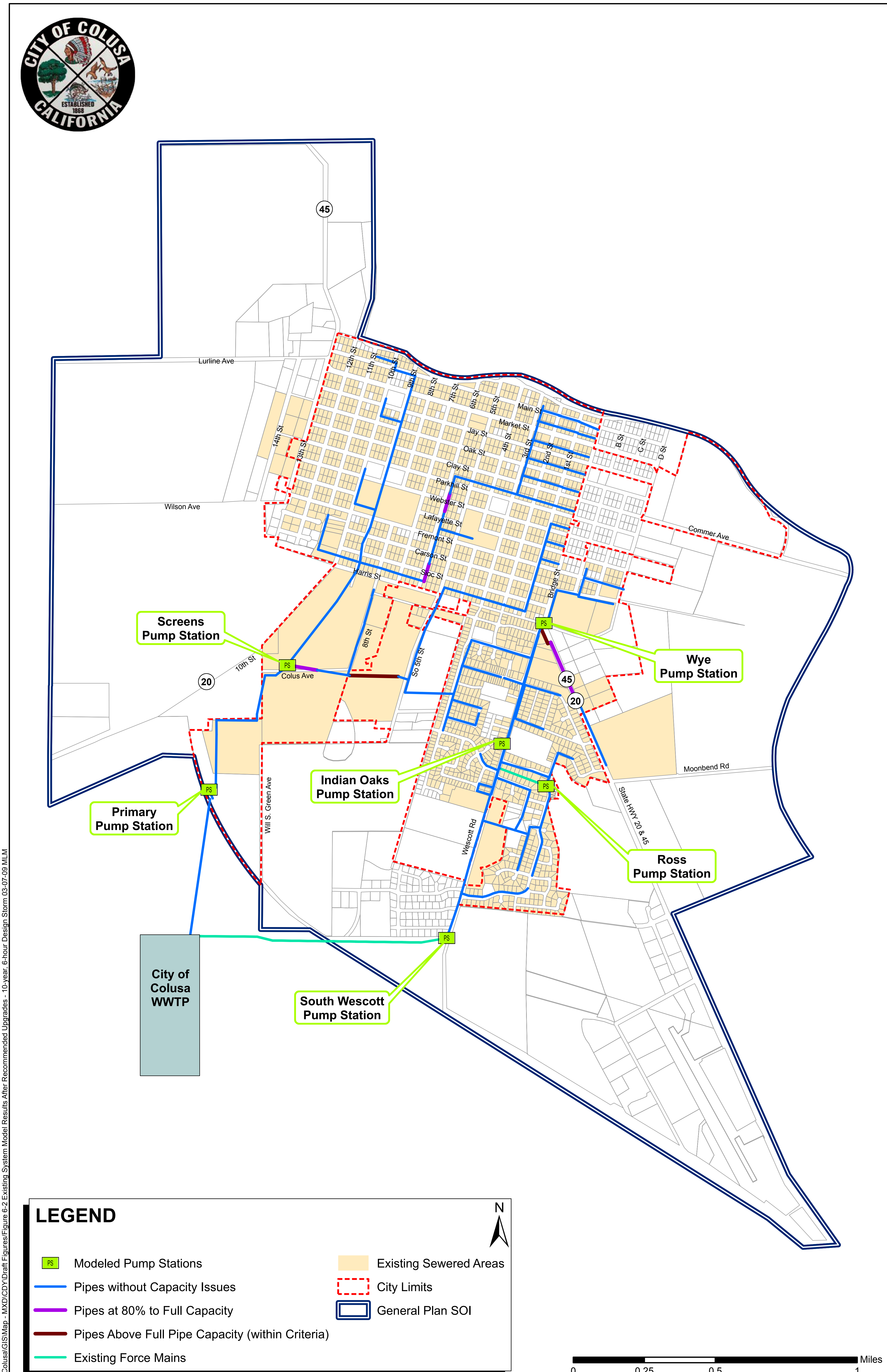
- The Ross pump station is a "vacuum" type station. These types of stations are generally not used for raw sewage. The City should consider converting this station to a submersible type station.
- Some pump stations will also receive additional flow from infill development and, in some cases, growth within the General Plan SOI. As a result, any pump station expansions should consider logical upsizing for growth at the same time.

The recommended pump station improvements to mitigate existing system deficiencies are summarized in Table 6-3. These improvements increase the existing pump station capacities to relieve downstream flow restrictions. Model simulation results after the recommended pump station improvements are shown in Figure 6-2.

Table 6-3
City of Colusa
Summary of Pump Station Improvements – Existing Conditions at 10-year, 6-hour Design Storm

Pump Station	Current Capacity (gpm) [a]	Recommended Capacity (gpm) [a]	Improvements
Indian Oaks	310	310	SCADA improvements & emergency generator
Primary [b]	600	**700**	Upsize pumps; SCADA improvements & emergency generator
Ross	300	300	Convert to submersible; SCADA improvements & emergency generator
South Wescott	450	**900**	Upsize pumps; SCADA improvements & emergency generator
Supply Yard/Screens [b],[c]	600	**700**	Upsize pumps; SCADA improvements & emergency generator
Wye	393	393	SCADA improvements & emergency generator
At Wastewater Treatment Plant			SCADA antenna

(a) Capacity is expressed in gallons per minute (gpm).
(b) Current rated capacities for Primary and Supply Yard/Screens lift stations were estimated by City staff.
(c) Supply Yard/Screens is also referred to as Screens.



M:\Colusa\GIS\Map - MXD\CDY\Draft Figures\Figure 6-2 Existing System Model Results After Recommended Upgrades - 10-year, 6-hour Design Storm 03-07-09 MLM

Figure 6-2
City of Colusa Existing System Model Results After Recommended Upgrades - 10-year, 6-hour Design Storm

Chapter 7

Capacity Evaluation Results – Future

7.1 PURPOSE

The purpose of this chapter is to provide a summary of the modeling results of the existing system's ability to accommodate future infill developments and Special Consideration Areas at a 10-year, 6 hour design storm event as well as to provide a strategy for mitigating capacity issues identified from the addition of these future developments. This chapter also provides recommendations of new infrastructure to accommodate build-out of the General Plan Sphere of Influence (SOI). Chapter 7 is divided into the following sections:

- Capacity Criteria
- Modeled Scenario
- Model Results – Future Developments – Phase I
- Mitigation Strategies for Existing System to Accommodate Future Developments – Phase I
- Strategies for Accommodating Future Developments – Phase II

7.2 CAPACITY CRITERIA

The capacity criteria established in Chapter 6 was also applied to model results for future developments utilizing the existing collection system. These capacity criteria are shown in Table 6-1.

7.3 MODELED SCENARIO

One scenario was modeled to evaluate capacity in the existing system with the addition of Future Developments – Phase I. The following simulation is described in more detail in the remainder of this chapter:

- Existing system with Future Developments – Phase I during design storm (10-year, 6-hour) event

Modeled scenarios assume that pipes and manholes are in good condition and free from debris (i.e., clean-pipe conditions). Thus, the results of the modeling analysis indicate available capacity (or lack thereof) and do not take into consideration deteriorated conditions.

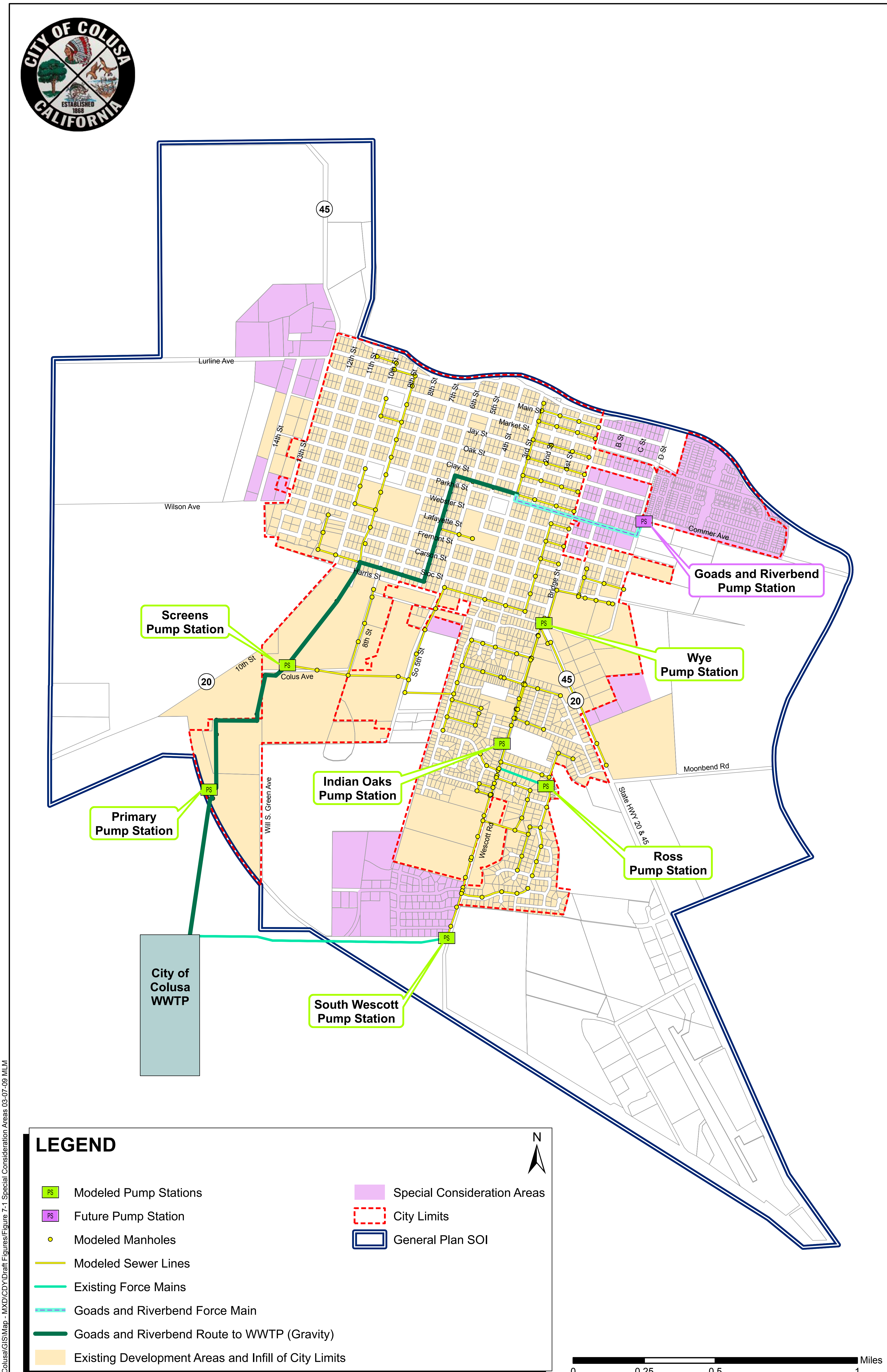
The existing system with Future Developments – Phase I was modeled to evaluate available capacity to accommodate these future developments. It was assumed that the improvements recommended in Chapter 6 (upsizing South Wescott, Primary, and Screens pump stations) were completed. Future Developments – Phase I included: (1) infill of the existing City limits, (2) redevelopment of parcels to match the land use defined in the General Plan and (3) "Special Consideration" areas. Special Consideration areas are existing development outside the City limits that are currently on septic systems and future developments, which were identified by the City as likely to be accommodated within the existing collection system in the near-future. Special Consideration areas and the pipelines in which they are assumed to flow into are shown in Figure 7-1. For Special Consideration areas on the east side of the existing system (e.g., Goads, Riverbend), an analysis of possible future connections to the existing system was performed (Appendix G). The recommended route shown in Figure 7-1 was determined to cause the least amount of impact on the existing system.

7.4 MODEL RESULTS ─ FUTURE DEVELOPMENTS – PHASE I

With the addition of peak hourly wet weather flows from Future Developments – Phase I, the modeled peak hourly wet weather flow during the 10-year, 6-hour design storm event was estimated to be 4.2 million gallons per day (MGD) at the City's wastewater treatment plant (WWTP). These peak hourly wet weather flows resulted in an increase in overflows, capacity-limited pipelines, and manhole surcharging (Figure 7-2). In Figure 7-2, pipelines shown in purple are near full pipe conditions (between 80 and 100% full) and pipes shown in orange are impacted by downstream conditions. Surcharged pipes within the City's criteria and beyond the criteria are shown in dark red and red, respectively. Manhole locations where overflows are predicted are labeled and shown in red. Manholes predicted to overflow are also provided in Table 7-1. In Table 7-1, manholes in bold are in addition to manholes highlighted as overflowing for existing conditions (as shown in Table 6-2). Manhole numbering for the entire modeled system is provided in Appendix E.

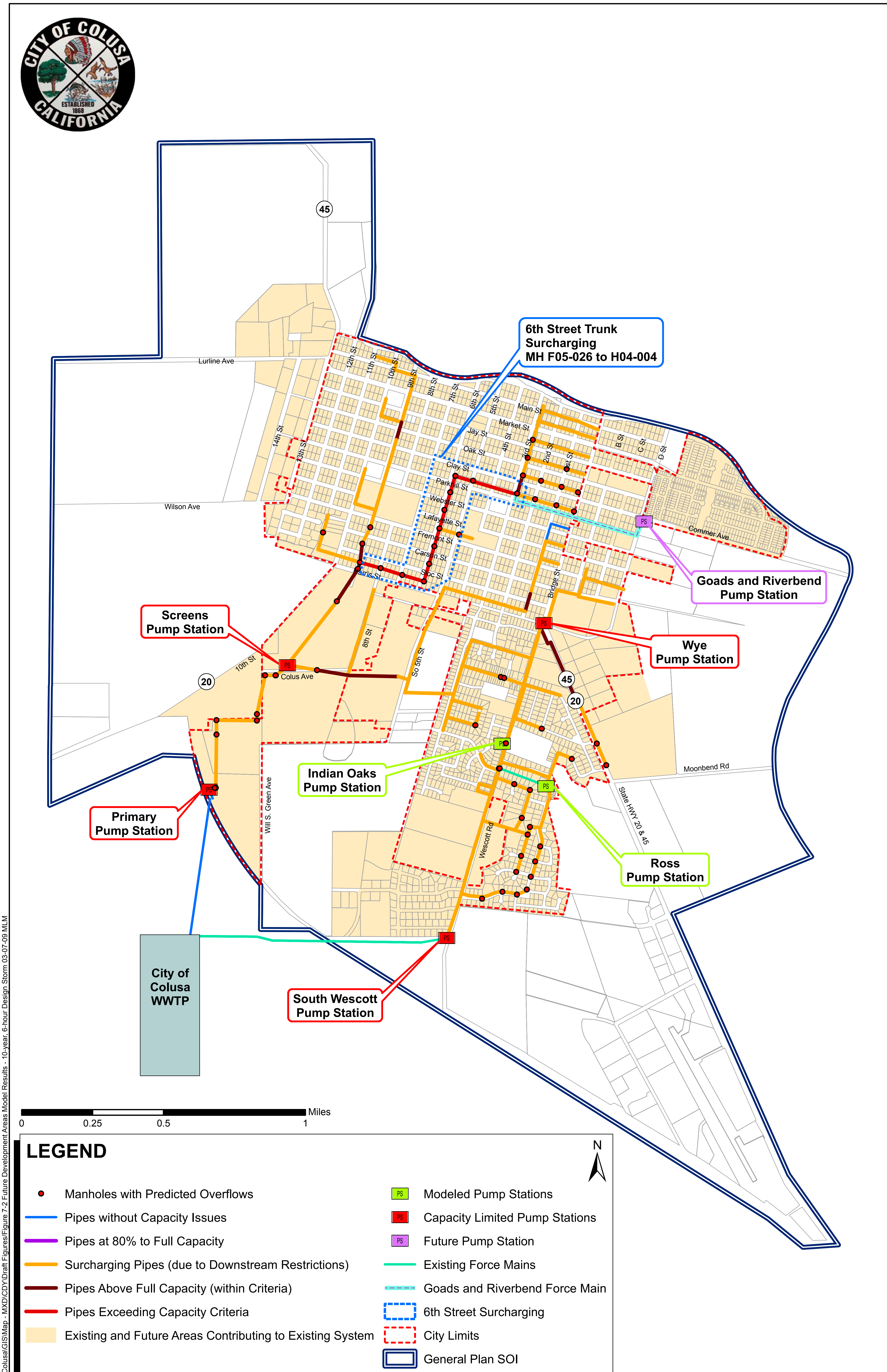
Table 7-1
City of Colusa
Summary of Modeled Overflows by Sewer Trunk –
Existing and Future Developments – Phase I at 10-year, 6-hour Design Storm

Overflowing Manholes				
F04-049	**F05-029**	**H04-008**	**I05-015**	**J03-004**
F04-050	**G04-006**	**H04-009**	**I05-019**	J05-012
F05-011	**G04-011**	**H04-016**	**I05-021**	J05-028
F05-016	**G04-017**	**H05-015**	**I05-022**	J05-040
F05-018	**G04-020**	**H05-032**	**I05-036**	J05-041
F05-021	**G04-027**	**H05-033**	**I05-054**	J05-045
F05-022	**G04-028**	**I04-005**	**I05-055**	J05-049
F05-023	**G04-030**	**I04-008**	**I06-001**	J05-058
F05-024	**G04-031**	**I04-009**	**I06-005**	J05-063
F05-026	**G04-037**	**I04-010**	**J03-001**	J05-064
F05-027	**H04-004**	**I04-011**	**J03-002**	
F05-028	**H04-005**	**I04-013**	**J03-003**	



M:\Colusa\GIS\Map - MXD\CDY\Draft Figures\Figure 7-1 Special Consideration Areas 03-07-09 MLM

Figure 7-1
City of Colusa Special Consideration Areas



M:\Colusa\GIS\Map - MXD\CDY\Draft Figures\Figure 7-2 Future Development Areas Model Results - 10-year, 6-hour Design Storm 03-07-09 MLM

Figure 7-2
City of Colusa Future Developments - Phase I Model Results - 10-year, 6-hour Design Storm

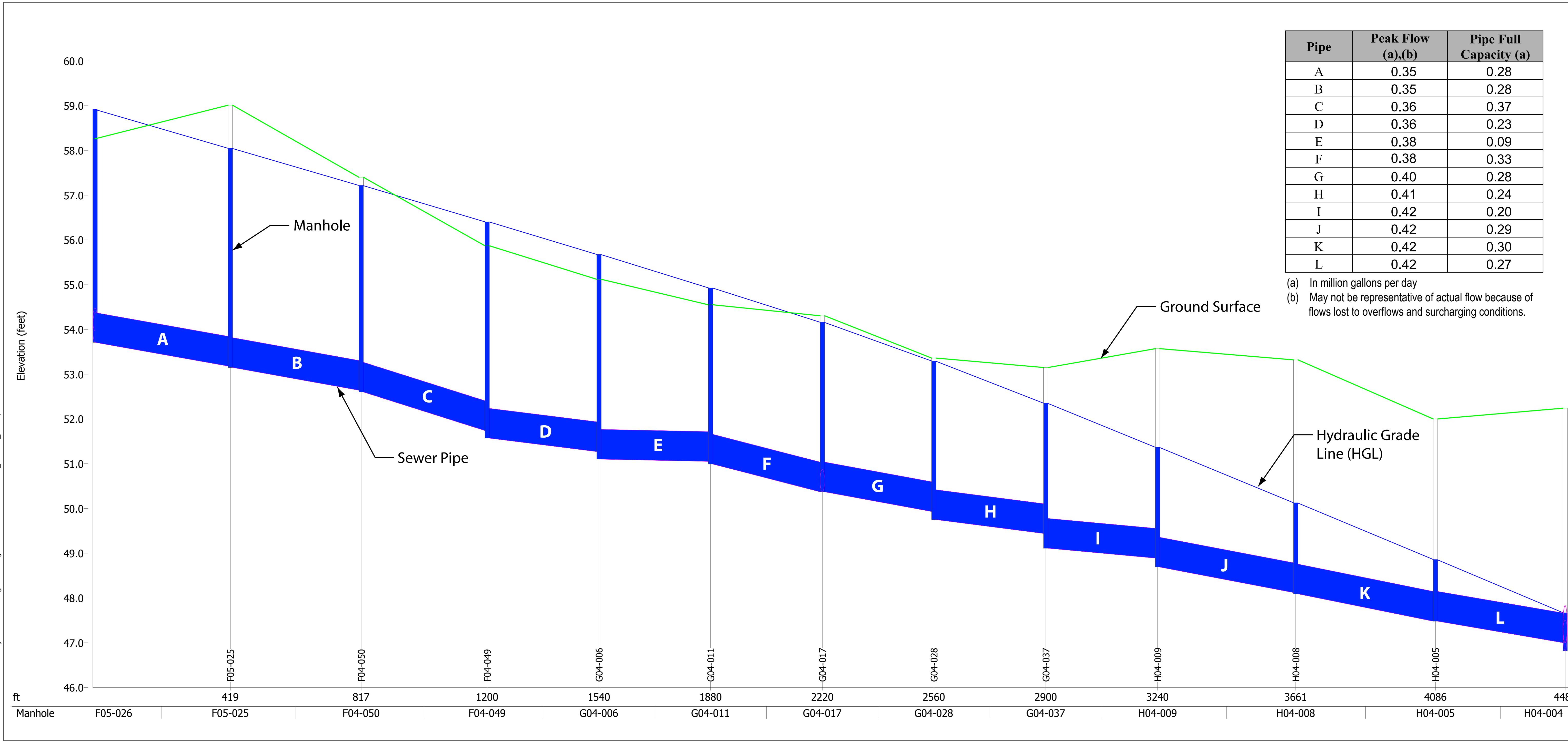
As seen in Figure 7-2, the majority of pipelines within the City are orange, which represent downstream restrictions. With the exception of the dark red and red colored lines (which represent under capacity pipelines), the downstream restrictions are directly related to pump station capacity, specifically at the Screens, Primary, South Wescott, and Wye pump stations. Pump station improvements to accommodate future development area flows under design storm conditions are discussed in Section 7.5.

Surcharging in pipelines shown in red in Figure 7-2 exceeded the City's surcharging criteria (Table 6-1). These pipe segments include from the intersection of 3rd Street and Parkhill Street to the intersection of 9th Street and Harris Street. This portion of the collection system is referred to as the "6th Street Trunk" throughout this report. The 6th Street Trunk is a shallow trunk in the downtown portion of the City and, based on the surcharging criteria, this trunk's depth does not allow for any surcharging (the manholes are less than 4 feet deep from the crown of the pipe to the ground surface). Other surcharged pipelines occur in deeper sewers, which allow some storage within the manhole during design storm condition. A profile view of the 6th Street Trunk is shown in Figure 7-3. These pipe segments are under capacity to convey the peak hourly flow from future development under the design storm condition and model simulation predicts this line to surcharge and overflow at several locations. The full pipe capacity and peak hourly flows are shown for each segment in a table in Figure 7-3. As shown in the table in Figure 7-3, the 6th Street Trunk's capacity cannot accommodate the peak hourly flows from Future Developments – Phase I under 10-year, 6-hour design storm conditions. Improvements to relieve capacity constraints to accommodate these future flows are discussed in Section 7.5.

7.5 MITIGATION STRATEGIES FOR EXISTING SYSTEM TO ACCOMMODATE FUTURE DEVELOPMENTS – PHASE I

During model simulations, under 10-year, 6-hour design storm conditions with the addition of flows from Future Developments – Phase I, several overflows are predicted in the existing system (Figure 7-2). To reduce surcharging in upstream gravity lines and alleviate potential overflows, upsizing of the Screens, Primary, South Wescott, and Wye pump station are recommended. In addition, the 6th Street Trunk segments shown in Figure 7-3 need to be upsized. Recommended improvements to the existing system to accommodate peak hourly wet weather flows from these future developments are shown in Table 7-2 and 7-3.

Modeled scenarios assume that pipes and manholes are in good condition and free from debris (i.e., clean-pipe conditions). Thus, the results of the modeling analysis indicate available capacity (or lack thereof) and do not take into consideration deteriorated conditions. Prior to initiating any capital improvement projects, it is recommended that the City assess the condition of the existing collection system. Much of the existing collection system, including the 6th Street Trunk, is shallow with slopes that are flatter than the City's current design standards. (Areas of the collection system with flat slopes and shallow manholes are shown in Appendix F.) These conditions often contribute to the accumulation of debris and surcharging conditions, irrespective of clean-pipe capacities. Condition assessments would include performing closed-circuit television (CCTV) inspections and structurally rating the existing sewer infrastructure as well as cleaning of each major sewer pipeline.



Pipe	Peak Flow (a),(b)	Pipe Full Capacity (a)
A	0.35	0.28
B	0.35	0.28
C	0.36	0.37
D	0.36	0.23
E	0.38	0.09
F	0.38	0.33
G	0.40	0.28
H	0.41	0.24
I	0.42	0.20
J	0.42	0.29
K	0.42	0.30
L	0.42	0.27

(a) In million gallons per day
(b) May not be representative of actual flow because of flows lost to overflows and surcharging conditions.

Figure 7-3
Future Developments - Phase I – 10-Year, 6-Hour Design Storm Profile of Surcharged Sewer Segments Along the 6th Street Trunk (Manhole F05-026 to H04-004)

The City could perform this assessment during one summer or split the work over a several year period. The City should also evaluate whether to perform the condition assessment on all 26 miles of pipeline or the approximately 15 miles of major pipelines.

In addition to condition assessment in known or suspected deteriorated areas, it is also recommended that additional dry and wet weather flow monitoring data be collected prior to initiating capital improvement projects to address these capacity issues. Additional data will refine the leakage rates and improve the accuracy of modeling simulations, which may decrease the degree of capital improvements required.

7.5.1 EXISTING SYSTEM MITIGATION STRATEGY FOR FUTURE DEVELOPMENTS – PHASE I – GRAVITY PIPELINE IMPROVEMENTS

To reduce surcharging and overflows caused by hydraulic bottlenecks in the 6th Street Trunk, the pipe segments between manholes F05-026 and H04-004 need to be upsized from the existing 8-inches to 12-inches in diameter (Table 7-2). The 6th Street Trunk is the only area of the existing system that has significant surcharging and will require improvements.

Table 7-2
City of Colusa
Recommended Improvements for Existing System Deficiencies –
Future Developments – Phase I at 10-year, 6-hour Design Storm Conditions

Improvement Location	Suggested Improvement
6th Street Trunk (MH F05-026 to MH H04-004)	Upgrade 4,500 ft of pipe from 8- to 12-inch

7.5.2 EXISTING SYSTEM MITIGATION STRATEGY FOR FUTURE DEVELOPMENTS – PHASE I – PUMP STATION IMPROVEMENTS

To accommodate peak hourly wet weather flows from Future Developments – Phase I during the 10-year, 6-hour design storm, improvements are needed to the Primary, South Wescott, Screens, and Wye pump stations. Recommended capacity upgrades for existing conditions described in Chapter 6 can likely be accommodated by equipment upsizing. However, upgrades necessary to accommodate Future Developments – Phase I will require significant upgrades to the structures as well as the pumps. In addition, the force main from the South Wescott pump station to the WWTP is not large enough to accommodate the Future Developments – Phase I flow and an 8-inch parallel force main will be necessary.

Analysis of the Primary and Screens pump stations indicated that sufficient grade exists between these two pump stations to abandon the Screens pump station and allow flow by gravity to the Primary pump station. In addition, the Primary and Screens pump stations are older, show signs of deterioration, generate odors, and are inconsistent with the submersible-type pump stations that the City has recently used with good success. It is recommended to replace the Primary pump station with a deeper, submersible-type pump station serving both the downtown area and the western portion of the General Plan SOI (discussed below). The new Primary pump station would be constructed deeper so that the Screens pump station can be abandoned. In addition, construction of 3,500 feet of a new deeper, steeper gravity trunk sewer from the Screens location to the Primary pump station will be necessary. Given that significant upgrades will be required at both pump stations to accommodate Future Developments – Phase I, logical use of funds suggests accommodating these improvements while upsizing the capacity of the Primary pump station.

The recommended improvements to the Screens, Primary, South Wescott and Wye pump stations to accommodate peak hourly wet weather flows from Future Developments – Phase I during the 10-year, 6-hour design storm are shown in Table 7-3. These improvements increase the existing pump station capacities to relieve downstream flow restrictions and the corresponding impacts on pipeline surcharging. Model simulation results after the recommended pump station and pipeline improvements are shown in Figure 7-4.

Table 7-3
City of Colusa
Recommended Pump Station Improvements for Existing System Deficiencies – Future Developments – Phase I at 10-year, 6-hour Design Storm Conditions

Pump Station	Current Capacity (gpm) [(a)]	Recommended Capacity for Existing Conditions (gpm) [(a), (b)]	Recommended Capacity for Future – Phase I (gpm) [(a)]	Improvement
Primary	600	700	**1,400**	New pump station
South Wescott	450	900	**1,500**	New pump station & parallel force main to treatment plant
Supply Yard/ Screens	600	700	Abandon and install 3,500 feet of new gravity sewer from old Screens pump station to Primary pump station	
Wye	393	393	**600**	New pumps

(a) Capacity is expressed in gallons per minute (gpm).
(b) Capacity Recommended for Existing Conditions discussed in Chapter 6.

7.6 STRATEGIES FOR ACCOMMODATING FUTURE DEVELOPMENTS – PHASE II CONDITIONS

Even with the improvements recommended to the 6th Street Trunk and the Screens, Primary, South Wescott, and Wye pump stations, the City's existing collection system cannot handle flows from Future Developments – Phase II (build-out of the General Plan SOI). Future Developments – Phase II will need to be accommodated with new sewer pipelines and pump stations. This section discusses the infrastructure needed to accommodate these developments. (Sewer system collection areas for these future developments are provided in Appendix H.)

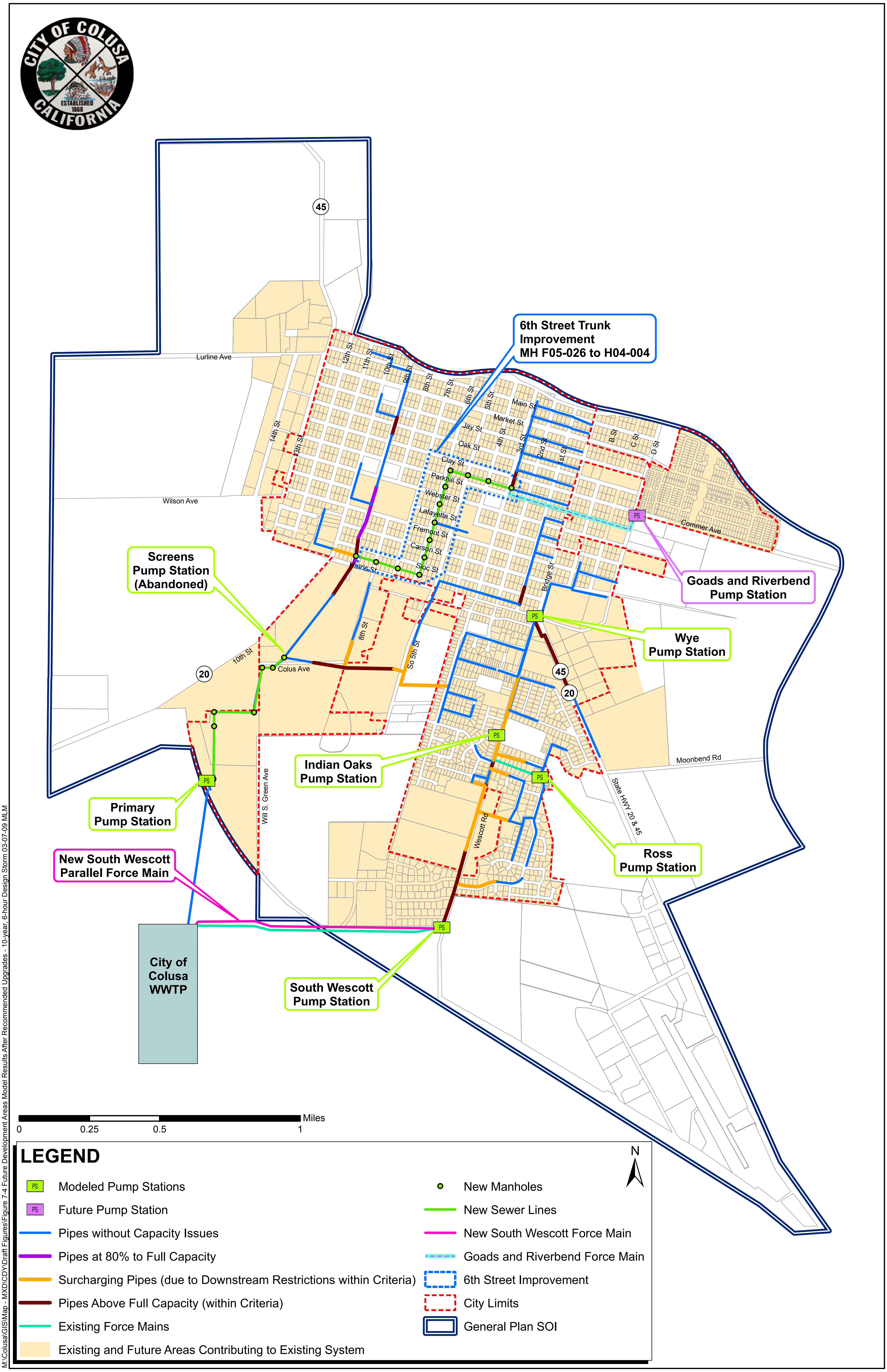


Figure 7-4
City of Colusa Future Developments - Phase I Model Results After Recommended Upgrades - 10-year, 6-hour Design Storm

7.6.1 Future Pump Station Design Features

For cost estimating and planning purposes, certain assumptions have been made with respect to new sewer pump station design. Some of these assumptions are consistent with the current design standards and some are enhancements or proposed changes to the current design standards. Future pump stations were sized and costs estimated based on the following assumptions:

- The City's flat topography will require several additional pump stations to serve growth and the existing shallow, flat sewers in the downtown area are not consistent with the City's current design standards. Future pump stations will be deeper and more frequent than existing pump stations to comply with the current standards.
- Pump stations shall sit on a plot at least 40 feet by 40 feet square. This plot should be at least 150 feet away from any area designated for public use or recreation and 100 feet away from the nearest home or business.
- Pump stations shall consist of a minimum of two submersible centrifugal sewage pumps (one duty, one standby unit).
- Pump stations shall have telemetry installed to monitor power failure, generator status, wet well levels, alarm conditions, pump failure, seal failure, hour meter readings, and other sensing points as required by the City. The control panel will communicate to the WWTP.
- All pump stations are required to be equipped with a standby diesel-powered engine generator sized to run both pumps at the same time. The generator shall be housed in a soundproof and waterproof enclosure.
- The City will need two major stations to serve the west side of the General Plan SOI and one new station for the east side of the General Plan SOI.
- Wastewater from the western portion of the General Plan SOI will ultimately flow to the new Primary pump station. This pump station will need to be expanded to eventually pump about 4 MGD to the WWTP.
- The South Wescott pump station will need to be expanded to serve all growth on the eastern side of the City. The station has an ultimate capacity of 3.6 MGD. A parallel, 12-inch force main will also be required to convey flows to the WWTP (an increase in size from the recommended 8-inch force main to convey Future Developments – Phase I flows).

Suggested pump station improvements to accommodate Future Developments – Phase II flows are summarized in Table 7-4.

Table 7-4
City of Colusa
Recommended Pump Station Improvements for Future Developments – Phase II
at 10-year, 6-hour Design Storm Conditions

Pump Station	Current Capacity (gpm) [(a)]	Recommended Capacity for Existing Conditions (gpm) [(a), (b)]	Recommended Capacity for Future – Phase II (gpm) [(a)]	Improvement
Primary	600	700	**2,800**	New pump station
South Wescott	450	900	**2,500**	New pump station & force main
Lurline (New – West SOI)	N/A	N/A	**100**	New pump station
Colusa Crossings (New – West SOI)	N/A	N/A	**600**	New pump station
Moonbend (New – East SOI)	N/A	N/A	**700**	New pump station

(a) Capacity is expressed in gallons per minute (gpm).
(b) Capacity Recommended for Existing Conditions discussed in Chapter 6.

7.6.2 New Gravity Sewer Infrastructure

To convey wastewater flows from Future Developments – Phase II, new gravity sewers are necessary. The approximate alignment of these future gravity trunk sewers are shown in Figure 7-5. These proposed new pipelines were sized and routed based on the following assumptions:

- The alignment of these new sewer lines follow future collector roads as identified in the General Plan's Circulation Diagram.
- The minimum slope for each proposed diameter of new sewer is based on the City Design Standards.
- The minimum pipe cover for trunk lines and minimum manhole depth is based on values established in the City Design Standards.
- For the purposes of this Master Plan, the minimum proposed diameter is 10-inches. Some smaller diameter trunk pipelines are shown for clarity. However, it is assumed that the cost of these sewer pipes will be the responsibility of the developer.
- Proposed new sewer pipelines were sized assuming 70% full as described in the City Design Standards. A peaking factor of 3.1 (as described in Section 4.2.2) was applied to dry weather flows from Future Developments – Phase II.

A summary of the proposed diameter and length of the recommended new trunk sewers to serve Future Developments – Phase II are summarized in Table 7-5. (More detail on pipeline sizing and new pump station locations is provided in Appendix I.)

Table 7-5
City of Colusa
Recommended New Trunk Sewer for
Future Developments – Phase II

New Trunk	Diameter (inches)	Length (feet)
Colusa Crossings Trunk	10	1,000
	12	1,100
	15	1,500
	18	2,000
Moonbend Trunk	12	3,100
	15	12,200

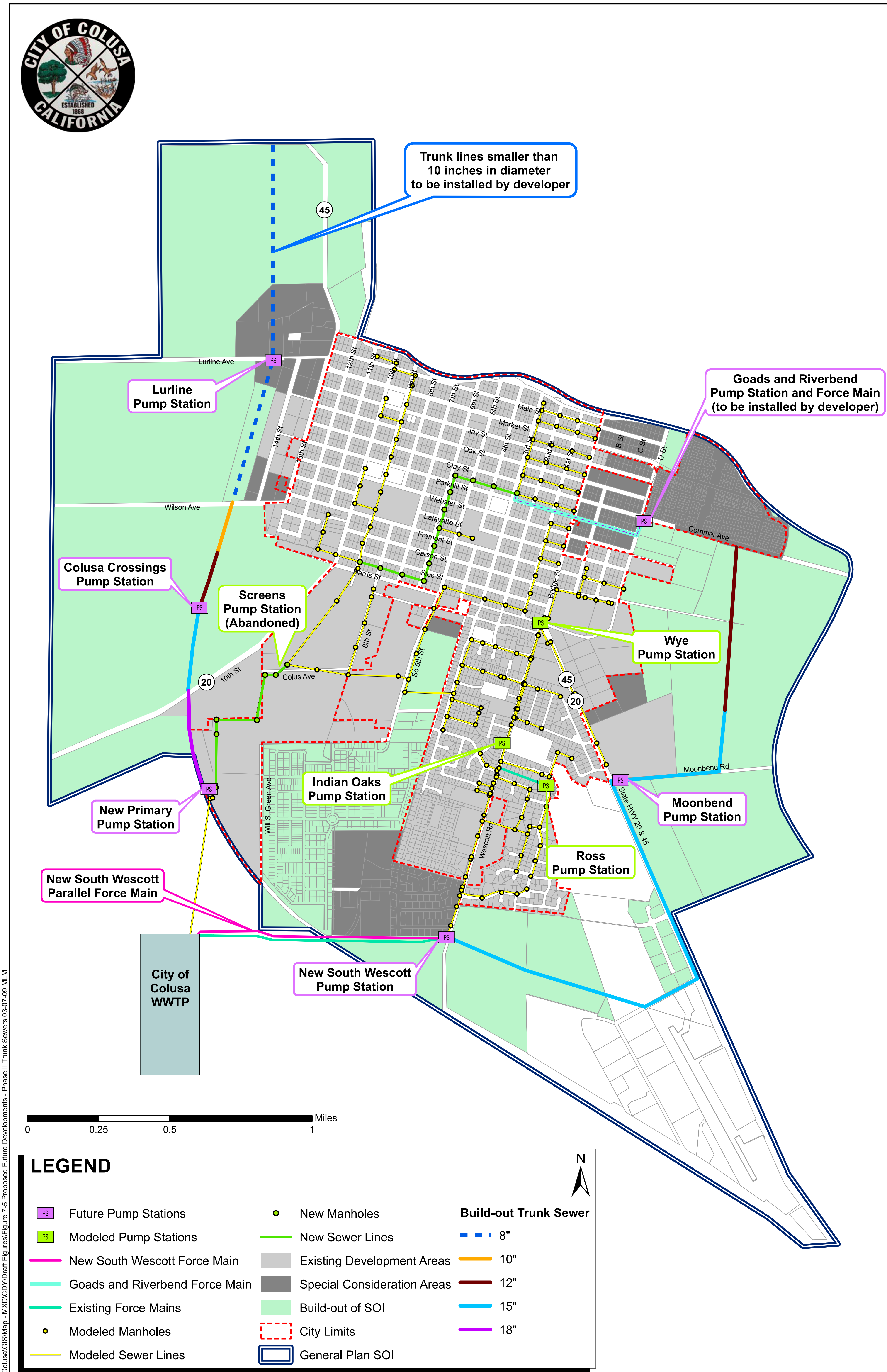


Figure 7-5

City of Colusa Proposed Future Developments - Phase II Trunk Sewers and Future Improvements

Chapter 8

Recommended Capital Improvement Projects

8.1 PURPOSE

The purpose of this chapter is to provide a summary of recommended Capital Improvement Projects (CIPs) for capacity mitigation strategies (for existing and future development areas) and for build-out development as well as associated planning level cost estimates for these recommended CIPs.

This chapter is divided into the following major sections:

- Summary of Recommended Improvements
- Capital Cost Estimates

8.2 SUMMARY OF RECOMMENDED IMPROVEMENTS

A summary of the CIPs recommended to mitigate capacity issues for existing and future development areas and the recommended infrastructure for build-out of the General Plan Sphere of Influence (SOI) is provided in Table 8-1. The need for and details of these improvements are discussed in detail in Chapters 6 and 7.

Prior to initiating any capital improvement projects, it is recommended that the City assess the condition of the existing collection system. Condition assessment would include performing closed-circuit television (CCTV) inspections and structurally rating the existing sewer infrastructure as well as cleaning of each major sewer pipeline. The City could perform this assessment during one summer or split the work over a several year period. In addition, the City should also evaluate whether to perform the condition assessment on all 26 miles of pipeline or the approximately 15 miles of major pipelines. Depending on the length of pipeline assessed, a condition assessment of the system would cost approximately $160,000 to $260,000, or $33,000 to $52,000 per year for five years.

In addition to condition assessment in known or suspected deteriorated areas, it is also recommended that additional dry and wet weather flow monitoring data be collected prior to initiating capital improvement projects to address these capacity issues. Additional data will refine the leakage rates and improve the accuracy of modeling simulations, which may decrease the degree of capital improvements required.

Table 8-1
City of Colusa
Summary of Recommended Improvements

Infrastructure	**Current Capacity (gpm) [(a)]**	**Improvements**					
		Existing Required Capacity (gpm) [(a)]		**Future – Phase I Required Capacity (gpm) [(a)]**		**Future – Phase II Required Capacity (gpm) [(a)]**	
Pump Stations							
Indian Oaks	310	310	SCADA/ emergency generator	--	--	--	--
Primary	600	700	Upsize pumps, SCADA/ emergency generator	1,400	New pump station	**2,800**	Upsize pumps
Ross	300	300	Submersible pump station, SCADA/ emergency generator	--	--	--	--
South Wescott	450	900	Upsize pumps, SCADA/ emergency generator	1,500	New pump station and parallel force main	**2,500**	Upsize pumps and parallel force main
Supply Yard/Screens	600	**700**	Upsize pumps, SCADA/ emergency generator	--	Abandon	--	--
Wye	393	393	SCADA/ emergency generator	**600**	New pumps	--	--
At Wastewater Treatment Plant	--	--	SCADA Antenna	--	--	--	--
Lurline (New)	--	--	--	--	--	100	New pump station
Colusa Crossings (New)	--	--	--	--	--	600	New pump station
Moonbend (New)	--	--	--	--	--	700	New pump station
Force main							
South Wescott	900	--	--	1,500	Parallel force main	**2,500**	Parallel force main
Gravity Sewer Lines							
6th Street Trunk	8-inch			12-inch	4,500 feet of new sewer		
Screens to Primary	--	--	--	18-inch	3,500 feet of new sewer	--	--
Colusa Crossing Trunk	--	--	--	--	--	10 to 18-inch	5,600 feet of new sewer
Moonbend Trunk	--	--	--	--	--	12 to 15-inch	15,300 feet of new sewer

(a) gpm - gallons per minute

The recommended improvements shown in Table 8-1 are the projects needed to accommodate existing development, Future Developments – Phase I (including infill, redevelopment within the City limits, and Special Consideration Areas), and Future Developments – Phase II (build-out of the General Plan SOI) at the 10-year, 6-hour design storm condition. The existing development improvements include upgrades to each of the City's existing pump stations to include Supervisory Control and Data Acquisition (SCADA), emergency generators, and a building for the generator and additional controls. For the Ross pump station, it is recommended to replace the existing pumps with submersible type pumps. Additional improvements such as upsizing the existing pumps in the Primary, South Wescott and Screens stations are recommended based on needed capacity to accommodate the existing development under design storm conditions.

As described in Chapter 7, Future Developments – Phase I is a combination of infill, redevelopment, and Special Consideration areas identified by the City. Future capacity projects are a combination of incremental expansion of existing pump stations and upsizing of some existing sewers. The facilities identified at Future Developments – Phase II are a combination of new trunk sewers, new pump stations, and expansions of existing pump stations.

Since many of the same facilities are modified or expanded as part of each of the development horizons (existing conditions, Future Developments – Phase I, or Future Developments – Phase II), the City will likely have to decide on a case-by-case basis to what degree it modifies each facility. As a result, the improvements in Table 8-1 are likely not to be implemented as shown in the table. Before implementing any of these improvements, the City should consider funding and the likelihood of near-term growth to determine logical modifications at each site. For some improvements, it may be reasonable to accommodate build-out needs during initial upsizing, rather than making step-wise improvements at each of the various stages of development.

8.3 CAPITAL COST ESTIMATES

The following section contains preliminary capital cost estimates for recommended improvements for existing conditions, Future Developments – Phase I, and Future Developments – Phase II. Construction cost estimates were based on $19 per inch-diameter-foot for new gravity sewers and $16.50 per inch-diameter-foot for new force mains, which includes materials of construction, installation, and disposal. Pump station costs are based on similar pump station construction projects as shown in Appendix J. These cost estimates are in current 2009 dollars. The preliminary capital cost estimates for each improvement assumes the each improvement is independent of the previous or subsequent improvement. For example, the improvements recommended for Future Developments – Phase I assumes that the improvements recommended for existing development were *not* made. Cost estimates are planning level estimates and a more comprehensive cost breakdown for each recommended improvement should be evaluated during a pre-design analysis.

8.3.1 EXISTING SYSTEM IMPROVEMENTS – EXISTING DEVELOPMENT CIPS

There are a number of pump station modifications that would improve reliability and provide capacity for peak flows at design storm conditions. These projects include replacement of pumping equipment with new larger pumps, addition of alarms and telemetry to each pump station, and addition of emergency generators, if space is available on site. Upsizing the existing pumps in the Primary, South Wescott, and Screens pump stations is recommended to meet the capacity needs of the existing development under design storm flows. Improvements to the Ross pump station are not based on capacity, but the City's desire to improve reliability and reduce maintenance. The Ross pump station is a "vacuum" type station, which is generally not used for raw sewage and requires excessive maintenance. The Ross pump station is recommended to be converted to a more conventional submersible station. Capital cost estimates for existing improvements are provided in Table 8-2.

Table 8-2
City of Colusa
Preliminary Cost Estimate for Existing System Improvements

Infrastructure	Current Capacity (gpm) [(a)]	Upsized Capacity (gpm) [(a)]	Improvements	Cost
Indian Oaks	310	310	SCADA improvements & emergency generator	$125,000
Primary	600	700	Upsize pumps, SCADA improvements & emergency generator	$515,000
Ross	300	300	Convert to submersible; SCADA improvements & emergency generator	$365,000
South Wescott	450	900	Upsize pumps, SCADA improvements & emergency generator	$640,000
Supply Yard/Screens	600	700	Upsize pumps; SCADA improvements & emergency generator	$515,000
Wye	393	393	SCADA improvements & emergency generator	$125,000
At Wastewater Treatment Plant			SCADA antenna	$40,000
SUBTOTAL – CONSTRUCTION COSTS (rounded)				$2,330,000
Estimating Contingency (30%)				$700,000
Design, Administration (15%)				$350,000
TOTAL CAPITAL COSTS (rounded)				**$3,380,000**

(a) gpm - gallons per minute

8.3.2 EXISTING SYSTEM IMPROVEMENTS – FUTURE DEVELOPMENTS – PHASE I CIPS

The addition of development within the City Limits and Special Consideration areas to the existing collection system will trigger incremental expansion of several pump stations and upsizing of some of the sewers. Much of the additional flows will be routed to the Primary and Screens pump stations. These pump stations will receive flows more than double their current capacity. In addition to the capacity restrictions, these pump stations are over 60 years old, show signs of deterioration, and are relatively shallow and, therefore, have limited ability to receive flows from growth. For these reasons, it is recommended to construct a new, deeper pump station at the Primary site, abandon the existing Screens pump station, and replace the Screens pump station with a new, deeper sewer connecting to the new Primary pump station. The technical feasibility of inexpensively upsizing the existing equipment at the Primary pump station from 600 gpm to 1,400 gpm is not known, so it is recommended to complete these major pump station projects as part of the near-term growth projects with sizing considerations for the ultimate build-out of the General Plan SOI. Capital costs estimates for Future Developments – Phase I improvements are shown in Table 8-3. As previously mentioned, the improvements and costs in Table 8-3 assume that no previous improvements were made.

Table 8-3
City of Colusa
Preliminary Cost Estimate for Future Developments – Phase I Improvements

Infrastructure	Current Capacity (gpm) [(a)]	Upsized Capacity (gpm) [(a)]	Improvements	Cost
Indian Oaks	310	310	SCADA improvements & emergency generator	$125,000
Primary [(b)]	600	1,400	New pump station	$1,460,000
Ross	300	300	Convert to submersible; SCADA improvements & emergency generator	$365,000
South Wescott [(b)]	450	1,500	New pump station	$1,560,000
Supply Yard/Screens [(c),(d)]	600	Abandon and install 3,500 feet of new 18-inch gravity sewer from old Screens pump station to Primary pump station		$1,200,000
Wye	393	600	Upsize pumps, SCADA improvements and emergency generator	$470,000
At Wastewater Treatment Plant			SCADA antenna	$40,000
Force main				
South Wescott [(e)]	900	1,500	4,600 feet of 8-inch parallel force main	$610,000
New Gravity Sewer				
6th Street Trunk [(f)]	8-inch	12-inch	4,500 feet of 12-inch sewer	$1,030,000
SUBTOTAL – CONSTRUCTION COSTS (rounded)				$6,860,000
Estimating Contingency (30%)				$2,060,000
Design Administration (15%)				$1,030,000
TOTAL CAPITAL COSTS (rounded)				**$9,950,000**

(a) gpm – gallons per minute
(b) New pump station cost include emergency generator and SCADA improvements
(c) Costs are for 3,500 feet of new 18-inch gravity sewer trunk at $19/inch-diameter foot and do not include pump station demolition.
(d) The decision to abandon the Screens pump station is dependent on building a new Primary pump station. However, an increase in capacity at the Screens station is needed as shown in Table 8-2.
(e) Costs are for 4,600 feet of new 8-inch parallel force main at $16.50/inch-diameter foot
(f) Costs are for 4,500 feet of new 12-inch gravity sewer trunk at $19/inch-diameter foot

8.3.3 FUTURE DEVELOPMENTS – PHASE II CIPS

Accommodating the flow from the General Plan SOI in the existing system is difficult because the existing system is very shallow in many areas and the City's Design Standards require deeper sewers and steeper sloped pipes. As a result, the flow from Future Developments – Phase II will generally be routed to new trunk sewers and pump stations on the east and west sides of the City and connect into an expanded, deeper Primary Pump Station and an expanded South Wescott Pump Station. The new infrastructure needed to serve unsewered areas of the General Plan SOI includes two new pump stations (Lurline and Colusa Crossings) and gravity sewer on the west side and one new pump station (Moonbend) and gravity sewer on the east side. An additional, parallel force main from South Wescott to the wastewater treatment plant is also required to accommodate future flows (8-inch for Future Developments – Phase I and 12-inch for Future Developments – Phase II). Capital cost estimates for improvements to accommodate Future Developments – Phase II (build-out of the General Plan SOI) are presented in Table 8-4. As previously mentioned, the improvements and costs in Table 8-4 assume that no previous improvements were made.

8.3.4 DISTRIBUTION OF IMPROVEMENT COSTS

The costs presented in Table 8-4 represent the total cost to make all the recommended improvements outlined in Chapters 6 and 7 assuming all improvements are made at once. To this point in this report, these costs have not been assigned to existing or future users. In Table 8-5, the costs of these improvements are divided between existing and future users. The future users include both Future Developments – Phase I (infill, redevelopment within the City limits, and Special Consideration Areas) and Future Developments – Phase II (build-out of the General Plan SOI). In assigning costs, the costs estimated for existing users in Table 8-2 were assigned to existing users and the additional costs for any future developments were assigned to Future Developments – Phase I/Phase II users.

In addition to assigning improvement costs to existing and Future Developments – Phase I/Phase II users, the costs for Future Developments – Phase I users (infill, redevelopment within the City limits, and Special Consideration Areas) and Future Developments – Phase II users is provided in Table 8-6.

Table 8-4
City of Colusa
Preliminary Cost Estimate for Future Developments – Phase II Improvements

Infrastructure	Current Capacity (gpm) [(a)]	Ultimate Capacity (gpm) [(a)]	Improvements	Cost ($)
Pump Stations				
Indian Oaks	310	310	SCADA improvements & emergency generator	$125,000
Primary [(b)]	600	2,800	New pump station	$2,320,000
Ross	300	300	Convert to submersible; SCADA improvements & emergency generator	$365,000
South Wescott [(b)]	450	2,500	New pump station	$2,200,000
Supply Yard/Screens [(c),(d)]	600	Abandon and install 3,500 feet of new 18-inch gravity sewer from old Screens pump station to Primary pump station		$1,200,000
Wye	393	600	Upsize pumps, SCADA improvements and emergency generator	$470,000
At Wastewater Treatment Plant			SCADA antenna	$40,000
Lurline [(b)]	--	100	New Pump Station	$385,000
Colusa Crossings [(b)]	--	600	New Pump Station	$870,000
Moonbend [(b)]	--	700	New Pump Station	$940,000
Force main				
South Wescott [(e)]	900	2,500	4,600 feet of 12-inch parallel force main	$910,000
New Gravity Sewer [(f)]				
6th Street Trunk	8-inch	12-inch	4,500 feet of 12-inch sewer	$1,030,000
Colusa Crossings Trunk	--	10 to 18-inch	5,600 feet of new sewer	$1,550,000
Moonbend Trunk	--	12 to 15-inch	15,300 feet of new sewer	$4,180,000
SUBTOTAL – CONSTRUCTION COSTS (rounded)				$16,590,000
Estimating Contingency (30%)				$4,980,000
Design Administration (15%)				$2,490,000
TOTAL CAPITAL COSTS (rounded)				**$24,060,000**

(a) gpm – gallons per minute
(b) New pump station cost include emergency generator and SCADA improvements
(c) Costs are for 3,500 feet of new 18-inch gravity sewer trunk at $19/inch-diameter foot, and do not include pump station demolition.
(d) The decision to abandon the Screens pump station is dependent on building a new Primary pump station. However an increase in capacity at the Screens station is needed as shown in Table 8-2.
(e) Costs are for 4,600 feet of new 12-inch parallel force main at $16.50/inch-diameter foot
(f) Costs are for new trunk sewer at $19/inch-diameter foot

Table 8-5
City of Colusa
Distribution of Preliminary Cost Estimate – Existing Users and Future Users

Infrastructure	Current Capacity (gpm) [(a)]	Ultimate Capacity (gpm) [(a)]	Improvements	Existing Users Cost	Future - Phase I/II Users Cost
Pump Stations					
Indian Oaks	310	310	SCADA improvements & emergency generator	$125,000	--
Primary [(b)]	600	2,800	New pump station	$515,000	$1,805,000
Ross	300	300	Convert to submersible; SCADA improvements & emergency generator	$365,000	--
South Wescott [(b)]	450	2,500	New pump station	$640,000	$1,560,000
Supply Yard/Screens [(c),(d)]	600	Abandon and install 3,500 feet of new 18-inch gravity sewer from old Screens pump station to Primary pump station		$515,000	$685,000
Wye	393	600	Upsize pumps, SCADA improvements and emergency generator	$125,000	$345,000
At Wastewater Treatment Plant			SCADA antenna	$40,000	--
Lurline [(b)]	--	100	New Pump Station	--	$385,000
Colusa Crossings [(b)]	--	600	New Pump Station	--	$870,000
Moonbend [(b)]	--	700	New Pump Station	--	$940,000
Force main					
South Wescott [(e)]	900	2,500	4,600 feet of 12-inch parallel force main	--	$910,000
New Gravity Sewer [(f)]					
6th Street Trunk	8-inch	12-inch	4,500 feet of 12-inch sewer	--	$1,030,000
Colusa Crossings Trunk	--	10 to 18-inch	5,600 feet of new sewer	--	$1,550,000
Moonbend Trunk	--	12 to 15-inch	15,300 feet of new sewer	--	$4,180,000
SUBTOTAL – CONSTRUCTION COSTS (rounded)				$2,330,000	$14,260,000
Estimating Contingency (30%)				$700,000	$4,280,000
Design Administration (15%)				$350,000	$2,140,000
TOTAL CAPITAL COSTS (rounded)				**$3,380,000**	**$20,680,000**

(a) gpm – gallons per minute
(b) New pump station cost include emergency generator and SCADA improvements
(c) Costs are for 3,500 feet of new 18-inch gravity sewer trunk at $19/inch-diameter foot, and do not include pump station demolition.
(d) The decision to abandon the Screens pump station is dependent on building a new Primary pump station. However an increase in capacity at the Screens station is needed as shown in Table 8-2.
(e) Costs are for 4,600 feet of new 12-inch parallel force main at $16.50/inch-diameter foot
(f) Costs are for new trunk sewer at $19/inch-diameter foot

Table 8-6
City of Colusa
Distribution of Preliminary Cost Estimate – Future Developments – Phase I and Phase II

Infrastructure	Current Capacity (gpm) (a)	Ultimate Capacity (gpm) (a)	Improvements	Future Users Phase I Cost	Future Users Phase II Cost
Pump Stations					
Indian Oaks	310	310	-- (g)	--	--
Primary (b)	600	2,800	New pump station	$600,000	$1,205,000
Ross	300	300	-- (g)	--	--
South Wescott (b)	450	2,500	New pump station	$625,000	$935,000
Supply Yard/Screens (c),(d)	600		Abandon and install 3,500 feet of new 18-inch gravity sewer from old Screens pump station to Primary pump station	$685,000	--
Wye	393	600	Upsize pumps, SCADA improvements and emergency generator	$345,000	--
At Wastewater Treatment Plant			-- (g)	--	--
Lurline (b)	--	100	New Pump Station	--	$385,000
Colusa Crossings (b)	--	600	New Pump Station	--	$870,000
Moonbend (b)	--	700	New Pump Station	--	$940,000
Force main					
South Wescott (e)	900	2,500	4,600 feet of 12-inch parallel force main	$610,000	$300,000
New Gravity Sewer (f)					
6th Street Trunk	8-inch	12-inch	4,500 feet of 12-inch sewer	$1,030,000	
Colusa Crossings Trunk	--	10 to 18-inch	5,600 feet of new sewer	--	$1,550,000
Moonbend Trunk	--	12 to 15-inch	15,300 feet of new sewer	--	$4,180,000
SUBTOTAL – CONSTRUCTION COSTS (rounded)				$3,895,000	$10,365,000
Estimating Contingency (30%)				$1,170,000	$3,110,000
Design Administration (15%)				$580,000	$1,550,000
TOTAL CAPITAL COSTS (rounded)				**$5,650,000**	**$15,030,000**

(a) gpm – gallons per minute
(b) New pump station cost include emergency generator and SCADA improvements
(c) Costs are for 3,500 feet of new 18-inch gravity sewer trunk at $19/inch-diameter foot, and do not include pump station demolition.
(d) The decision to abandon the Screens pump station is dependent on building a new Primary pump station. However an increase in capacity at the Screens station is needed as shown in Table 8-2.
(e) Costs are for 4,600 feet of new 12-inch parallel force main at $16.50/inch-diameter foot
(f) Costs are for new trunk sewer at $19/inch-diameter foot
(g) Improvements are assigned to existing users