ES-1. Executive Summary

This report summarizes the results and recommendations of the Collection System Master Plan project for the Napa Sanitation District. The Collection System Master Plan (CSMP) was prepared by GHD in close coordination with Napa Sanitation District (NapaSan) staff. The CSMP report will be used to guide improvements to the NapaSan collection system to accommodate current and future development and to ensure that NapaSan continues to provide a high level of service to its customers. NapaSan will use the results of this project, in conjunction with other planning and investigative efforts, to prioritize areas of the collection system for repair and rehabilitation work.

ES-1.1 Background and Purpose of the CSMP

The 2007 CSMP recommended that NapaSan implement an Infiltration and Inflow (I&I) reduction program that would reduce wet weather-induced I&I in the sanitary sewer collection system in prioritized locations through rehabilitation and replacement of sewer mains, manholes, and laterals. This strategy was implemented as an alternative to a capital improvement program focused on capacity improvements, with the goal to cost-effectively reduce I&I and the associated risks from excessive I&I in the collection system and minimize the burden on ratepayers. Since 2007, NapaSan has measured the outcome of its annual I&I reduction projects, modifying the ongoing I&I Reduction Program to include various rehabilitation methods for collection system assets, ranging from small to large-scale projects and measured the success of each project.

The existing collection system is comprised of approximately 274 miles of sewer mains and 30,000 public laterals, which represents approximately $500 million in asset value. Through the implementation of the I&I Reduction Program since 2007 and recent completion of capacity projects, NapaSan has used a data-driven process to identify and reduce risk within the collection system. NapaSan's sewer system and service area, including major drainage basins that comprise the system, are shown in Figure ES-1.

To understand collection system needs and prioritize investments for the next 10 years, NapaSan contracted with GHD to prepare this CSMP. This effort includes capturing the learnings from the I&I Reduction Program to date, building an all-pipes hydraulic model of the collection system, incorporating the latest available flow monitoring data, and allowing for detailed depiction of wet weather-induced I&I sources and impacts in the collection system. Using the new, robust hydraulic model, a mitigation strategy was applied to prioritize I&I reduction that addresses deficiencies occurring in more frequent storm events to reduce risk associated with limited collection system capacity. The analysis also evaluated I&I reduction and/or capacity improvements options for larger, less frequent storm events to create a cost-effective balance that leverages available funding and minimizes risk.

The most hydraulically beneficial projects will be prioritized to be completed over the next 10 years, and at that time it will be appropriate for another CSMP to incorporate further learnings and data and to re-set the priorities for the subsequent 10-year period in the I&I Reduction Program.

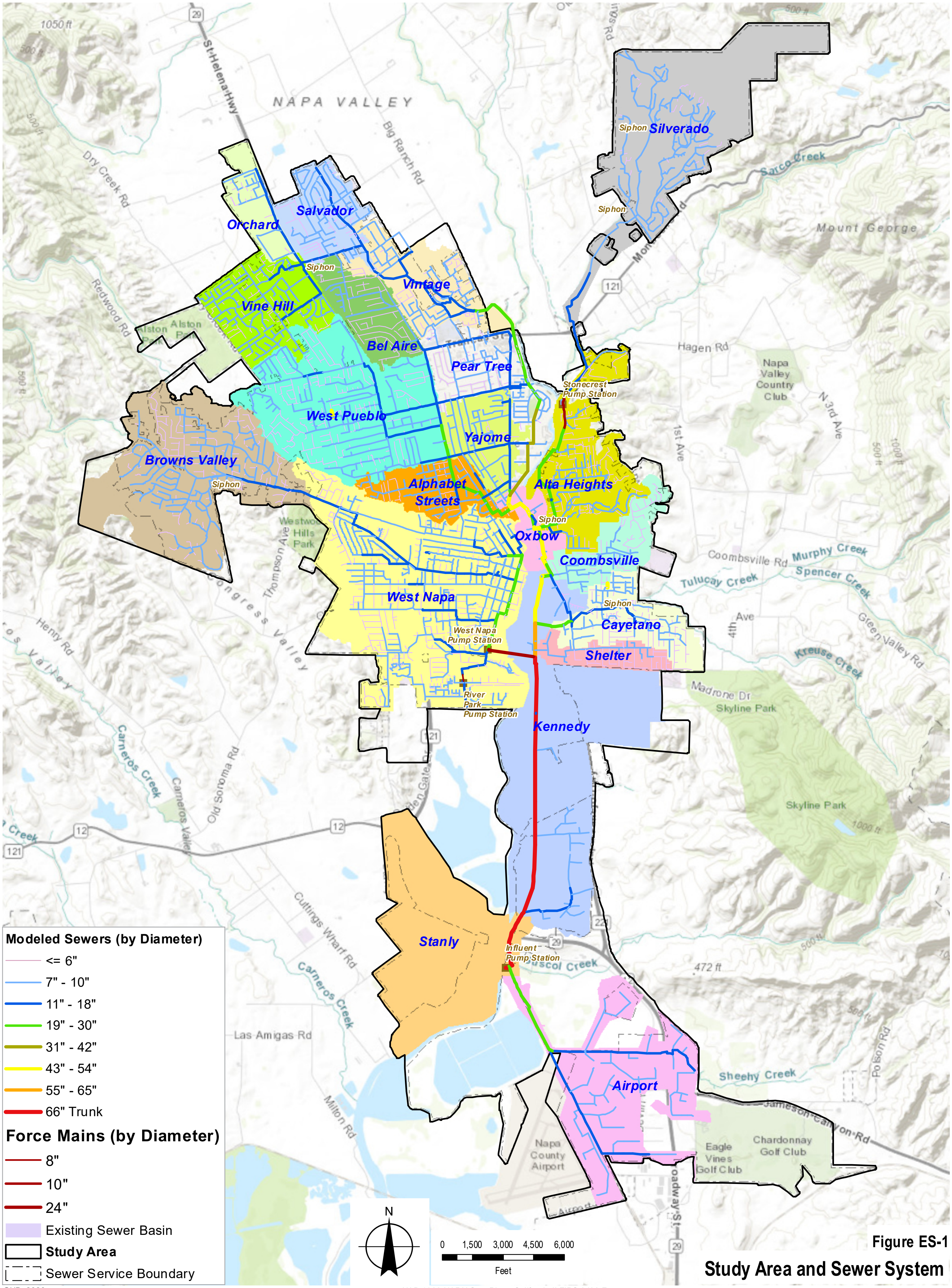

Figure ES-1

Study Area and Sewer System

This Executive Summary is presented in three parts:

- ***CSMP Preparation -*** describes the scope and methodologies of the hydraulic modeling effort, including key planning and technical assumptions incorporated into the collection system capacity analysis.
- ***Capital Improvement Program Recommendations -*** describes potential I&I rehabilitation projects, capacity improvement projects, sediment removal program, priorities, and estimated costs associated with all recommendations as part of a 10-year capital improvement program (CIP).
- ***CSMP Conclusions –*** summarizes the approach NapaSan has taken since 2007 to address I&I and overflows in the collection system due to the proactive I&I reduction program and dynamic modeling and CIP recommendations as a part of this CSMP, noting reductions in recordable overflows in key areas addressed by sewer and manhole rehabilitation projects since then.

ES-2. CSMP Preparation

NapaSan's collection system consists of approximately 274 miles of pipeline, ranging in size from 4-inch to 66-inch diameter pipe. A dynamic hydraulic model of all pipelines in the collection system was built using Innovyze's InfoWorks ICM v. 9.5.3. The model was developed through a systematic process to ensure that the model accurately portrays and predicts existing and future system capacities.

ES-2.1 Hydraulic Evaluation Considers Existing and Future Planning Scenarios

An existing conditions scenario reflects current capacity of the collection system based on existing development and flow monitoring data. Existing base wastewater flow was based on average winter water use records for both residential and commercial sources from 2018. The future scenario assumed buildout development conditions and involved updating existing base wastewater flow (BWF) to account for planned development projects, buildout of vacant or underdeveloped parcels, and parcels not previously served in accordance with the Existing Conditions Report land use guidelines. The Existing Conditions Report (ECR) is a document published by the City of Napa as part of their General Plan process.

ES-2.2 Calibrated Dynamic Model Informs Capacity and Planning

A dynamic hydraulic model of the entire NapaSan collection system was built to estimate flow inputs, route flows, and assess the collection system capacity. The model was based on data from NapaSan's Geographic Information System (GIS) and additional information provided by NapaSan staff. Flow monitoring data were collected at over 40 locations in the system by V&A Consulting Engineers from January through March of 2019, and used to calibrate the model during dry and wet weather conditions.

The model integrates various dry and wet weather flow parameters to determine system capacity under different flow and planning scenarios. Key flow components in the model include BWF, groundwater infiltration, and rainfall-derived inflow and infiltration.

Of these, RDI&I has the biggest impact on peak wet weather flows, and the basis for CIP development is a future wet weather scenario. This is substantiated by the fact that the model shows no overflows occur under existing or future dry weather scenarios, whereas the model shows overflows occurring during wet weather scenarios.

ES-2.3 CIP Development: Design Basis Criteria

Calibrated dry weather flow (DWF) and wet weather flow (WWF) parameters were checked to determine their applicability for use in identifying capacity deficiencies under future conditions and for sizing future sewers. The following were used to establish capacity analysis criteria:

Future Water Use from Parcels Experiencing No Growth: it is assumed that there will be no significant increases (i.e. from higher water use) or decreases (i.e. from water conservation) in existing usage rates for parcels that show no appreciable changes in zoning, landuse, dwelling type, or development status between existing and future scenarios.

Future RDI&I Contributions from Parcels Experiencing No Growth: it is assumed that there will be no significant reductions (i.e., from rehabilitation [rehab] or replacement of older sewers), or increases (i.e., from sewer deterioration) in I&I from currently developed parcels that show no appreciable changes in zoning, dwelling type, or development status between existing and future scenarios.

Wet Weather Flow: A series of design rainfall events were applied to the calibrated future wet weather model to determine peak design state. A 10-year 24-hour design storm was created with shape and timing based on actual historical storms from 2019. The storm produces 4.63 inches of rain in 24 hours and has a peak intensity of 0.951 in/hour. This storm was normalized for smaller return periods of 3- and 5-years to help in the project prioritization process.

The design basis condition used for all CIP analyses consists of a future buildout development, WWF condition, and the following assumptions:

- **Peak-on-Peak Design Storm Timing:** to elicit a worst-case scenario, the design storm was timed to cause its peak RDI&I to coincide with peak BWF, to produce a roughly peak-on-peak response in most areas of the service area.
- **The Browns Valley Trunk project** has been constructed and is assumed to be active and in service with all metering gates and weirs set at their model-optimized setting. Completion of this project is planned for October 2021.
- **A new West Napa Pump Station** has been constructed with a modeled firm pumping rate of 15.4 MGD, and a modeled peak pumping rate of 22.6 MGD with all pumps actively running. A detailed modeling analysis of the Browns Valley Trunk project and West Napa sewer basin confirms that the combination of the West Napa Pump Station pumping at 18.7 MGD, and the completion of all 3 and 5 year design storm triggered I&I reduction projects, minimizes system wide overflows during the 3- and 5-year design storms. Completion of this project is planned for 2021.
- **The 66-inch trunk main** from Imola Avenue to the Soscol Water Recycling Facility's Influent Pump Station headworks has been rehabilitated with a cured-in-place (CIPP) liner, resulting in a reduction in effective internal diameter from 66-inches to 63-inches, with corresponding

reduction in manning's N along the rehabilitated stretch between Imola Ave and the Influent Pump Station (IPS).

- **Sediment Removal:** The newly rehabilitated 66-inch trunk main experiences a cleaning process to remove sediment on an as-needed basis; for the design flow scenario, it will be assumed to have been just cleaned.

ES-3. Capital Improvement Program Recommendations

A complete comprehensive list of projects was created to eliminate all modeled overflows due to the 10-year design storm and future flows. GHD and NapaSan collaborated to develop a strategy to identify projects and solutions that includes not only I&I reduction techniques in NapaSan sewer mains, but also for sewer laterals and manholes, traditional pipe replacements (upsized pipes), and optimization strategies involving flow routing, pumping, and attenuation. Results and methods associated with the ***comprehensive*** CIP process are presented in Appendix H.

NapaSan desired a plan to complete the most hydraulically beneficial projects over the next 10 years. Starting in the year 2022, the ***executable*** 10-year CIP is based on the most realistic return on investment to reduce risks associated with a sanitary sewer overflow that could be achieved over the first 10 years of the CIP. The executable 10-year CIP is expected to cost approximately $76M and when complete, will remove overflow volumes from the system, per the 3-, 5-, and 10-year design storms listed in Table ES-1.

Table ES-1: Executable 10-year CIP Overflow Volumes

Design Storm	Total Overflow (gallons)		Difference (gallons)	% Difference
	Before 10 Yr CIP	After 10 Yr CIP		
3 Yr 24 Hr	87,900	0	87,900	100%
5 Yr 24 Hr	774,000	77,000	697,000	90%
10 Yr 24 Hr	3,893,000	821,000	3,072,000	79%

ES-3.1 10-Year CIP Implementation

All projects included in the executable 10-year CIP are I&I reduction-only projects, meaning no scenario was deemed to necessitate a capacity upsize project. Table ES-2 lists the recommended projects, phased by year and hydraulic benefit. Project costs were used to combine projects of similar priority (if multiple per year), up to an approximate annual capital program allotment of $7.8M. NapaSan has budgeted $78M for CIP projects over the 10-year life of the program.

In general, the hydraulic priority shown in Table ES-2 starts with projects in those basins that during the 3- and 5-year design storm events experience the highest modeled quantities of I&I and hydraulic deficiencies in the form of SSOs. These basins require higher levels of I&I reduction and are located at the upstream reaches of the collection system. Projects at the bottom of the table show lower I&I reduction efficacy and are generally solving smaller deficiencies that may only occur during the 10-year design storm.

Table ES-2: 10-Year CIP Project Phasing

Implementation Year	I&I Rehabilitation Project (Design Storm Trigger)			Flow Monitoring/I&I Reconn/Other Rehabilitation	Total Yearly I&I Rehabilitation Cost ($Millions)
	3 Year	5 Year	10 year		
1*	Vine Hill_1 ***($5.1M)***				**$5.1**
				Lassen Street Relief Weir	
2		Vine Hill_1 ***($5.8M)***			**$5.8**
3		Salvador_1 ***($5.2M)***			**$6.2**
				66-inch Trunk Cleaning ***($1M)***	
4		Bel Aire_1 ***($2.9M)***			**$6.1**
		Vintage_1 ***($3.2M)***			
5		West Pueblo_5 ***($1.1M)***			**$5.2**
		Browns Valley_3 ***($2.4M)***			
		West Napa_2 ***($1.7M)***			
				Coombsville_1	
				Browns Valley_1	
6		West Napa_4 ***($3.6M)***			**$7.5**
		West Napa_5 ***($3.9M)***			
				Post Flow Monitoring of all 3 & 5 Yr I&I projects	
				Phase 2 of 66-Inch Trunk Sewer Rehabilitation (1/3)	***$2.0***
7			Vine Hill_1 ***($3.6M)***		**$8.5**
			Pear Tree_1 ***($4.9M)***		
				Phase 2 of 66-Inch Trunk Sewer Rehabilitation (2/3)	***$8.0***
8			Salvador_1 ***($7.5M)***		**$7.5**
				Phase 2 of 66-Inch Trunk Sewer Rehabilitation (3/3)	***$8.0***
9			Salvador_2 ***($5.5M)***		**$7.7**
			West Napa_2 ***($2.2M)***		
10			Bel Aire_1 ***($8.1M)***		**$8.1**
11+			West Pueblo_2 ***($5.4M)***		**$9.0**
			West Pueblo_4 ***($3.6M)***		
				Silverado_1	
				Remaining West Pueblo Projects	
				Post Flow Monitoring of all 10 Yr I&I projects	

*Assumes 2022 is the first year of the 10-year CIP

Figure ES-2 displays each CIP project's relative priority and recommended phasing by key map project ID and each project's underlying basin color. The basin colors are laid out in a typical heat map fashion, and correspond to the year of implementation, with purple and red having the highest priority and green and blue representing the lowest priority, as shown in Table ES-2. Further, basins with a thin black hatching on top indicate they are recommended for additional investigation and determination of project scope and benefit (i.e., additional flow monitoring and I&I reconnaissance) as a first course of action before any I&I rehabilitation takes place. These are Coombsville_1 and Browns Valley_1.

The recommended project implementation strategy follows the hydraulic modeling strategy in that upstream projects with high modeled overflow volumes triggered during smaller storm events should be implemented first. The system-wide CIP project interdependence is mimicked by the dynamic hydraulic model in the sense that changes in one upstream area typically have some effect on downstream parts of the system. The organization and prioritization of all projects considered this interdependence, and it is recommended that NapaSan construct high priority projects as listed in Table ES-2 from top to bottom, to maximize benefits and minimize negative impacts.

Post-project flow monitoring should occur as reasonably practical after an I&I reduction project has been completed, or at the very least in grouped fashion, after the 5- and 10-year portions of all projects are completed. All of these projects are being recommended based on flow monitoring and calibrated dynamic hydraulic modeling results. GHD recognizes that real world execution of the rehabilitation work depends on many other factors such as street paving programs, physical access, I&I reconnaissance results in the form of pre- and post-flow monitoring, smoke and or dye testing, condition assessment and risk-based evaluations that are currently being developed by NapaSan's asset management program, as well as projects planned by other agencies. For these reasons, this CSMP recommends that the 10-year CIP project list be reviewed and potentially re-prioritized on an annual or as-needed basis.

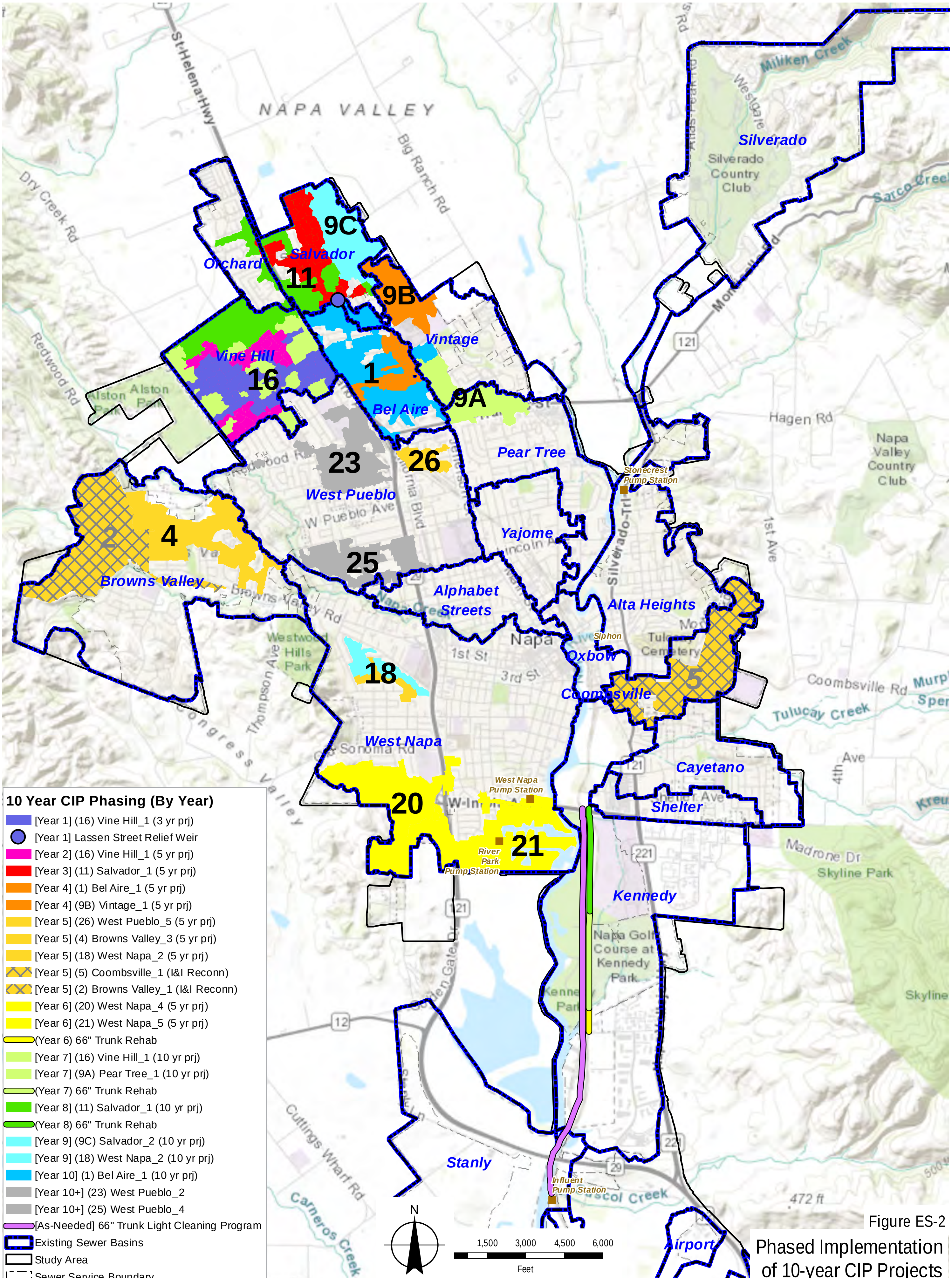

Figure ES-2

Phased Implementation of 10-year CIP Projects

Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

GHD, 2020

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ES-3.3 Sediment Removal Program

Sediment will be removed from Kaiser Road to the Soscol Water Recycling Facility (SWRF) during the 2021 rehabilitation project planned for the 66-inch trunk sewer. Following completion of that project, NapaSan should monitor sediment deposition through inspection of the 66-inch trunk sewer in 3-5 years and remove sediment in areas where depths are greater than three inches. It may modify the inspection frequency based on inspection results, particularly if the rate of sediment buildup decreases after the 66-inch rehabilitation project.

An as-needed sediment removal program is a cost-effective way of reducing overflow potential in the system whether it occurs before or after the completion of the 10-year CIP. Table ES-3 shows the cleaning reduction volumes and costs for the post 10-year CIP scenario, before and after cleaning an average of 7 inches of sediment (the amount identified during the 2018 66-inch Trunk Sewer Condition Assessment effort, and input into the design basis model scenarios) along the entire 3.1 miles of 66-inch trunk sewer.

Table ES-3: 66-inch Sediment Removal Program Results

Design Storm	Total Overflow (gallons)		Difference (gallons)	% Difference	Total Cleaning Cost ($M) ~ light cleaning	Removal Cost ($/gal) ~ light cleaning	Total Cleaning Cost ($M) ~ heavy cleaning	Removal Cost ($/gal) ~ heavy cleaning
	After 10 Yr CIP ~ No Cleaning	After 10 Yr CIP ~ Clean Pipe						
5 Yr 24 Hr	101,000	77,000	24,000	24%	$0.97 M	41	$2.90 M	121
10 Yr 24 Hr	1,388,000	821,000	567,000	41%	$0.97 M	2	$2.90 M	5

ES-3.4 Other Recommendations

In addition to the executable 10-year CIP and Sediment Removal programs, NapaSan should continue with the following recommendations:

- NapaSan's I&I Reduction program should continue, with emphasis on the collection and evaluation of data that achieves goals for improving level of service, reducing risk, and achieving a positive return on investment.
- NapaSan's current I&I Reduction Program is based on rehabilitating two percent of the sewer collection system per year. The hydraulic model, together with the ongoing measurement and analysis of WWFs through the I&I Reduction Program, should be used to study the effects of rehabilitating more than two percent per year.
- Where existing collection system pipelines exceed NapaSan standards for hydraulic performance, NapaSan should continue to apply its I&I Mitigation for New Development policy to proposed developments not analyzed by this master plan that would exacerbate current hydraulic performance. NapaSan may evaluate the current policy in the future depending on collection system hydraulic performance and measured flow conditions where the policy and related I&I reduction is implemented in the collection system.

ES-4. Conclusions

NapaSan's collection system has adequate dry weather capacity for existing and projected future conditions but has capacity deficiencies in specific areas during peak wet weather events. Older collection system assets such as sewer main and lateral pipes and manholes have more defects compared to newer assets, which tend to allow more rain-derived I&I to enter the collection system. There are two common approaches to alleviate capacity deficiencies:

1) upsize sewers, including downstream pipelines, pump station and treatment plant assets; and/or
2) decrease the I&I.

NapaSan's I&I reduction efforts since the inception of its I&I Reduction Program in 2007 have shown that I&I rehabilitation is a proven way to cost-effectively manage risk and renew aging infrastructure through targeted rehabilitation of known deficiency issues, as evidenced by the performance in the 2018 Collection System Rehabilitation Project and the 2018 Basin H Manhole Rehabilitation Project. These project basins experienced significant SSOs during large storm events in 2017. After construction of these rehabilitation projects in 2018, no overflows were observed at these locations during large wet-weather events in 2019. The results in terms of relative overflow reduction from the I&I reduction program efforts from 2017 and 2018 are shown in table ES-4.

Due to the success of NapaSan's I&I reduction program and the recommendation to proceed with the program, this master plan did not study the capacity improvements that would be required in lieu of continuing the I&I reduction program. An additional study would need to be conducted to determine the costs of such capacity improvements. Potential capacity improvement costs are expected to far exceed the cost of the I&I program during the 20-year planning period.

NapaSan's sewer assets typically have a 50-year life span, so renewing or replacing at least 2 percent of the collection system per year allows NapaSan to replace collection system assets near the end of their useful lives. The results from the detailed hydraulic modeling effort and 10-year CIP program prepared for this master plan will allow NapaSan to continue to mitigate collection system risk and maximize its capital program budget return on investment while providing the most hydraulic benefit in terms of I&I and overflow reduction potential.

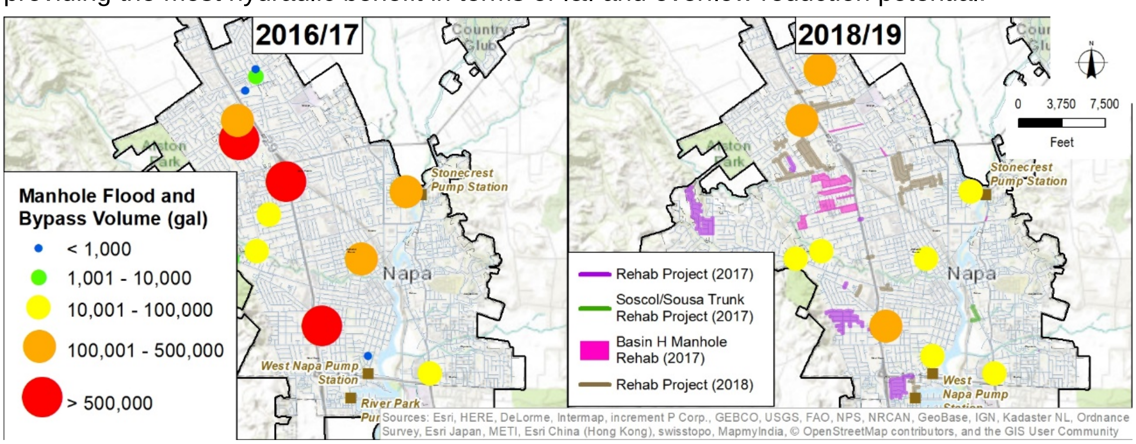

Figure ES-3: Overflow Reductions from 2017-2018 I&I Rehabiliation Projects