# COUNTY OF SAN MATEO

## Crystal Springs County Sanitation District

## SEWER MASTER PLAN

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# EXECUTIVE SUMMARY

In December 1996, the County of San Mateo engaged Brown and Caldwell to prepare a sewer system master plan for the Crystal Springs County Sanitation District (CSCSD). This executive summary presents the findings, conclusion, and recommendations regarding this system. It also proposes a capital improvement plan (CIP) and summarizes recommended rates and a revenue plan to finance proposed improvements.

## Background

The overall master planning process used for the sewer system master plan consisted of identifying capacity limitations along with structural deficiencies of the sewer system and developing an ongoing improvement program to correct the limitations. Part of the overall improvement program is the consideration for changing current maintenance activities to more appropriately match the needs of the sewer system. The improvement plan's goal is to develop a balance between capital projects and system maintenance to achieve a highly reliable collection system for the lowest overall cost.

A series of field inspections were performed to collect information on the collection system. Limited source detection methods (including smoke testing, manhole inspections, maintenance calls, television inspection and topographic surveying) were used to identify collection system structural deficiencies. Wet weather flow monitoring and hydraulic modeling were performed to develop a listing of hydraulic deficiencies. Projects were developed and prioritized based on the deficiencies and capital costs that were prepared. Methods for financing the recommended improvements are also included in the study.

## Findings

Review of known problem areas and interviews with County maintenance crews was used to prioritize field inspections in the CSCSD. Flow monitoring was also performed to evaluate the amount of remaining capacity in the wastewater collection system. This section presents the results of the field inspection and capacity analysis.

A manhole inspection program was performed in the winter and spring of 1997. Field crews documented the condition of 257 manholes. No serious defects were noted during the inspection. Results of the inspections were used to prioritize the television inspection program.

The smoke testing program was conducted during the summer of 1998. Areas with suspected high Inflow/Infiltration (I/I) were scheduled for testing. Field crews tested approximately 50,800 linear feet of sewer lines. A total of 59 collection system defects were documented during the program. No serious defects were noted.

The television inspection program was conducted during the winter of 1999. A total of 9,271 feet of the collection system was inspected. Over 210 structural defects were documented during the inspection. Results of the television inspection program were used to develop the CIP.

Flow monitoring was performed during the winters of 1997 and 1998. The purpose of the flow monitoring was to develop peak wastewater flow rates for use in the hydraulic model of the collection system. The capacity of the major trunk sewer along Polhemus Road was evaluated for this study. Results of the analysis indicate that approximately 5,000 linear feet of the trunk sewer has inadequate capacity.

## Recommendations

A CIP was developed based on the results of the field work and capacity analysis. A total of nine capital improvement projects were developed for the CSCSD. Eight of the projects are recommended to repair structural deficiencies. The remaining project is recommended to provide additional hydraulic capacity to the Polhemus Road trunk sewer. Estimated total construction costs for the projects range between $1,570,000 and 1,850,000 depending on the selected alternative improvement. The location of the improvement projects is listed below:

1. Timberlane Way
2. South Ascension Drive
3. Polhemus Road (north)
4. Polhemus Road (south)
5. Rainbow Drive
6. Enchanted Way
7. Parrot Drive
8. Lexington Avenue
9. Randall Road

# SECTION 1

# INTRODUCTION

This chapter introduces the sewer master planning process for the Crystal Springs County Sanitation District (CSCSD) of San Mateo County (County), including background, authorization, scope of work and report organization.

## Background and Purpose of Work

The overall master planning process used for the sewer system master plan consisted of identifying capacity limitations along with structural deficiencies of the sewer system and developing an ongoing improvement program to correct the limitations. Part of the overall improvement program is the consideration for changing current maintenance activities to more appropriately match the needs of the sewer system. The improvement plan's goal is to develop a balance between capital projects and system maintenance to achieve a highly reliable collection system for the lowest overall cost.

A series of field inspections were performed to collect information on the collection system. Limited source detection methods (including smoke testing, manhole inspections, maintenance calls, television inspection and topographic surveying) were used to identify collection system structural deficiencies. Wet weather flow monitoring and hydraulic modeling were performed to develop a listing of hydraulic deficiencies. Projects were developed and prioritized based on the deficiencies and capital costs that were prepared. Methods for financing the recommended improvements are also included in the study.

The County maintains and operates nine noncontiguous sewer districts containing approximately 130 miles of sewer mains. The sewer districts are:

1. Burlingame Hills Sewer Maintenance District
2. Crystal Springs County Sanitation District
3. Devonshire County Sanitation District
4. Emerald Lake Heights Sewer Maintenance District
5. Fair Oaks Sewer Maintenance District
6. Harbor Industrial Sewer Maintenance District
7. Kensington Square Sewer Maintenance District
8. Oak Knoll Sewer Maintenance District
9. Scenic Heights County Sanitation District

The CSCSD is located on the San Francisco Peninsula in the area roughly bounded by the Arthur Younger Freeway (Highway 92) in the south, the Junipero Serra Freeway (I-280) in the west, Crystal Springs Road in the north and Parrot Drive in the east.

Though the County has maintained and upgraded the collection system in the past, this work has been done without the benefit of master planning. This report provides a prioritized capital

improvement program along with recommended follow-up field investigations and potential funding mechanisms.

## Authorization

The County authorized this work through an agreement with Brown and Caldwell dated December 17, 1996.

## Scope of Work

The scope of work includes the following activities:

**Assessment of Existing Sewer Systems.** To develop a meaningful capital improvement program, it was necessary to determine the structural and hydraulic condition of the CSCSD collection system. Methods used to complete the evaluation included reviewing existing maps and records drawings, interviewing County maintenance workers and checking maintenance records, manhole inspections, wet weather flow monitoring, smoke testing and television inspection. Results from the flow monitoring program were used to develop wet weather hydrographs for use in the hydraulic model and determine which areas in the system had the highest infiltration/inflow rates.

**Development of Sewer System Capital Improvement Plans.** A listing of sewer system deficiencies were developed based on the sewer system assessment task. Capital projects were developed to correct each identified system deficiency. Capital projects were prioritized and estimated capital costs for each project were determined. Project priorities were reviewed with County staff and an annual schedule of required capital improvements were developed. A financial plan was developed to support the recommend projects. The financial plan includes financial alternatives and recommended sewer charges and revised connection fees, if any.

**Data Management.** Data generated during the study was entered into a series of Access databases for future use by the County. The databases will be submitted under separate cover to the County with the Master Plans.

**Master Plan Report.** Prepare a sewer system master plan report for the Crystal Springs District. The master plan report is supported by a series of technical memoranda prepared as part of the previous tasks. The master plan provides completed documentation of the recommended capital improvement projects as well as financing alternatives.

## Report Format

This Master Plan report has been organized as a reference report, to the extent possible. Each section in the report consists of one to two pages of descriptive text followed by a data table, graphical figure, or both. This report has 15 sections roughly divided as follows:

- Sections 1 through 3 describe the current County system and operating procedures.
- Sections 4 through 9 describe the field work programs.
- Sections 10 and 11 summarize the hydraulic modeling work.
- Sections 12 through 15 describe the capital improvement program and funding mechanisms.

Technical memoranda and backup material are also provided in the appendices following the main body of the report as identified in the Table of Contents.

# SECTION 2

# EXISTING SEWERS

The general physical characteristics of the Crystal Springs County Sanitation District (CSCSD) sewer collection system are described in this section. These characteristics provide the basis for physical evaluation of the collection system and determine the system's ability to convey current and projected wastewater flows.

## Description of Existing Facilities

The CSCSD's sewer collection system is characterized as a gravity system. Sewage pumping stations are not required due to the topography in the service area. The collection system consists of approximately 13 miles of 6-inch to 15-inch-diameter vitrified clay pipe. Most of the collection system has been constructed between the post World War II period and the present.

The main trunk sewer in the CSCSD is a 10-inch to 15-inch-diameter sewer located in the valley along Polhemus Road. This sewer roughly divides the CSCSD into two major drainage areas. The trunk sewer begins by collecting wastewater flows from County and State facilities located on Tower Road and Polhemus Road and then flows to the north and ultimately discharges wastewater flow to the Town of Hillsborough. The point of connection to the Town of Hillsborough is at the intersection of Polhemus Road and Crystal Springs Road. The CSCSD purchased capacity in the Town of Hillsborough and City of San Mateo sewer systems. Figure 2-1 depicts the CSCSD boundaries and collection system.

## Manhole Number System

A manhole numbering scheme was developed to aid in data management. The manhole numbering system consists of an eight-digit alphanumeric code. The first letter identifies the District within the County (C for CSCSD). The next four numbers identify the manhole within the CSCSD. A single letter code follows and is used for manholes with duplicate numbers (typically infill manholes constructed by the County). The last two numbers in the code describe the County map number.

# SECTION 3

# SEWER OPERATION AND MAINTENANCE

Prior to beginning the physical inspection of the Crystal Springs County Sanitation District (CSCSD), the current operation and maintenance procedures were reviewed. This section documents the results of that review.

## Known Problem Areas

Areas of known problems within the sewer collection system were identified through discussions with County personnel and review of the CSCSD maintenance records. Problem areas were identified by line blockages from roots and grease accumulations or sewer sags. The collection systems are on a cleaning frequency of once per year minimum and can range up to four times per year based on collection system call outs. Problems associated with flat sewers are not found in the CSCSD due to the relatively steep topography in the service area. There are no known manholes or pipelines with hydrogen sulfide corrosion problems.

Several approaches are available for addressing sewer maintenance problems. Grease problems are addressed by controlling grease discharges from commercial establishments by requiring grease traps and having an enforcement program to ensure that they function properly. Grease can accumulate at sags, areas with flat slopes, roots, and offset joints in sewers. Grease problems in residential areas are addressed by increased maintenance (hydroflushing of the sewer to flush the grease accumulation downstream).

Root problems are typically addressed by using an undersized root cutter, typically a 4-inch-diameter cutter for a 6-inch sewer. The County maintenance crews prefer to use an undersized cutter to prevent damage to the pipeline. Roots can also be addressed by chemical foam application to kill the roots. Application and reapplication is typically required on a 1- to 3-year cycle. The County has recently started using chemical root treatment in the Burlingame Hills Sewer Maintenance District.

Accumulations of rocks and gravel in the sewer line can be an indicator of broken pipe in the system. Television inspection should be performed in these areas to look for pipes in bad condition. A listing of the maintenance "hot-spots" for sewer laterals in the system requiring callouts more than twice a year is provided in Table 3-1. Sewer mains requiring two or more callouts per year are summarized in Table 3-2. A description of the problem is also provided. This listing was used to develop the collection system physical inspection programs described in the following sections.

**Table 3-1. Callout Summary for Sewer Laterals**

| Street number | Street name | Year | Reason for callout | | | | |
|---|---|---|---|---|---|---|---|
| | | | Roots | Grease | Paper | Inspection | Comment |
| 2267 | Allegheny Wy | 1992 | x | | | | Lateral OK |
| 2275 | Allegheny Wy | 1995 | | | | | No cleanout, Permit 2539 |
| 1506 | Ascension Dr | 1996 | x | | | | |
| 1542 | Ascension Dr | 1990 | x | | | | |
| 1548 | Ascension Dr | 1987 | x | | | | |
| 1624 | Ascension Dr | 1993 | | | | | Bad spot; lateral needs repair |
| 1630 | Ascension Dr | 1987 | | x | | | No cleanout |
| 1312 | Bel Aire Rd | 1994 | | | | | Permit 2477Lateral OK |
| 1327 | Bel Aire Rd | 1978 | x | | | | "T"-Cleanout |
| 1330 | Bel Aire Rd | 1995 | x | | | | |
| 1366 | Bel Aire Rd | 1979 | | | | x | |
| 1456 | Bel Aire Rd | 1978 | | | | | No cleanout |
| 1480 | Bel Aire Rd | 1985 | | | | | No cleanout |
| 20 | Bennington Dr | 1976 | | | | | Lateral OK |
| 1520 | Brandywine Rd | 1980 | x | | | | Lateral OK |
| 1547 | Brandywine Rd | 1993 | | | | | VOID Permit 2386. Owner taking responsibility of uninspected work. |
| 2193 | Bunker Hill Dr | 1990 | x | | | | |
| 2220 | Bunker Hill Dr | 1992 | | | x | | Permit 2219 & Lateral OK |
| 5 | Crown Ct | 1986 | | | | x | Permit 0945 |
| 20 | Crown Ct | 1986 | | | | | Permit 0946 |
| 45 | Crown Ct | 1987 | | | | x | Permit 1475 |
| 1341 | Enchanted Wy | 1986 | x | | | | Off-set |
| 1354 | Enchanted Wy | 1993 | | | | | No cleanout |
| 1515 | Forge Rd | 1996 | x | | x | | |
| 2011 | Kings Ln | 1996 | x | | | | Off-set, Lateral OK |
| 2034 | Kings Ln | 1979 | | | | x | Permit 0164 |
| 2041 | Kings Ln | 1984 | x | | | | Lateral OK |
| 1261 | Laurel Hill Dr | 1993 | | | | | No cleanout |
| 1263 | Laurel Hill Dr | 1992 | x | | | | Permit 1549 (1987), Hair |
| 1263 | Laurel Hill Dr | 1993 | x | | x | | |
| 1479 | Laurel Hill Dr | 1996 | | | | | Permit 2706 Voided - Owner decided not to reconstruct cleanout. "T"-cleanout |
| 1415 | Lexington Ave | 1992 | | | | | No cleanout |
| 1607 | Lexington Ave | 1980 | | | | | No cleanout |
| 1628 | Lexington Ave | 1992 | | | | | No cleanout |
| 1659 | Lexington Ave | 1987 | x | | | | |
| 1660 | Lexington Ave | 1985 | | | | | Cleanout OK |

| Street number | Street name | Year | Reason for callout | | | | |
|---|---|---|---|---|---|---|---|
| | | | Roots | Grease | Paper | Inspection | Comment |
| 1690 | Lexington Ave | 1979 | x | | | | No cleanout |
| 1719 | Lexington Ave | 1977 | | | | | Rocks in Cleanout |
| 1723 | Lexington Ave | 1995 | | | x | | Dirt, Permit 2597 |
| 1784 | Lexington Ave | 1994 | | | | | Lateral OK |
| 1880 | Lexington Ave | 1978 | x | | | | Lateral OK |
| 1912 | Lexington Ave | 1995 | | | | | Permit 2552, Non-standard cleanout |
| 2036 | Lexington Ave | 1995 | | | | | No cleanout, Lateral OK |
| 2136 | Lexington Ave | 1980 | | | | | Lateral OK |
| 1786 | Los Altos Dr | 1993 | | | | | No cleanout |
| 1805 | Los Altos Dr | 1979 | x | | x | | No cleanout |
| 1812 | Los Altos Dr | 1988 | x | | | | Off-set |
| 1936 | Los Altos Dr | 1996 | | | | | Lateral OK |
| 1983 | Los Altos Dr | 1979 | x | | | | |
| 15 | Lundys Ln | 1987 | x | | | | Improper cleanout |
| 1707 | Monticello Rd | 1994 | x | | | | |
| 1708 | Monticello Rd | 1987 | x | | | | |
| 1759 | Monticello Rd | 1986 | | | | | Repair lateral (Off-Set) |
| 30 | Mountain View Pl | 1995 | | | | | No cleanout |
| 1136 | Parrott Dr | 1985 | | | | x | Repair Main |
| 1151 | Parrott Dr | 1985 | x | | | | |
| 1163 | Parrott Dr | 1991 | x | | x | | |
| 1203 | Parrott Dr | 1993 | | | | | Lateral OK |
| 1230 | Parrott Dr | 1979 | x | | | | Lateral OK |
| 1311 | Parrott Dr | 1992 | | | | | Mud & Needs Repair |
| 1399 | Parrott Dr | 1991 | | | | | Permit 2170 & Broken Pipe |
| 1426 | Parrott Dr | 1980 | | | | | Broken Lateral |
| 1475 | Parrott Dr | 1993 | | | | | Lateral OK |
| 1499 | Parrott Dr | 1985 | | x | | | Combo & mud |
| 1563 | Parrott Dr | 1977 | | | | | Broken lateral |
| 1615 | Parrott Dr | 1979 | x | | | | Lateral OK |
| 1615 | Parrott Dr | 1980 | x | | | | Lateral OK |
| 1616 | Parrott Dr | 1992 | x | | | | Grass |
| 1636 | Parrott Dr | 1975 | | | | x | Lateral OK |
| 1684 | Parrott Dr | 1975 | | | | | No cleanout |
| 1691 | Parrott Dr | 1996 | x | | x | | |
| 1699 | Parrott Dr | 1985 | x | | | | |
| 1798 | Parrott Dr | 1975 | x | | | | No cleanout |
| 1819 | Parrott Dr | 1978 | x | | | | Lateral OK |
| 1835 | Parrott Dr | 1991 | x | | | | Lateral OK |
| 1883 | Parrott Dr | 1993 | | | | | No cleanout |
| 15 | Powhatan Pl | 1993 | x | | | | Lateral OK |
| 2024 | Queens Ln | 1990 | x | | | | |
| 2029 | Queens Ln | 1996 | | | x | | |

| Street number | Street name | Year | Reason for callout | | | | |
|---|---|---|---|---|---|---|---|
| | | | Roots | Grease | Paper | Inspection | Comment |
| 2030 | Queens Ln | 1992 | x | | | | |
| 2072 | Queens Ln | 1994 | x | | x | | |
| 2083 | Queens Ln | 1984 | x | | | | |
| 2154 | Queens Ln | 1996 | x | | | | |
| 2177 | Queens Ln | 1994 | x | | | | |
| 2184 | Queens Ln | 1991 | | | | | No cleanout; too far back of property line |
| 1427 | Rainbow Dr | 1991 | | | | | Permit 2143, No cleanout |
| 1844 | Randall Rd | 1994 | x | | | | Lateral OK |
| 1876 | Randall Rd | 1991 | x | | | | |
| 1884 | Randall Rd | 1995 | | | | | Permit 2207 |
| 30 | Roxbury Ln | 1994 | x | | | | |
| 35 | Roxbury Ln | 1982 | | | | | Permit 0407 |
| 1510 | Seneca Ln | 1995 | x | | | | "T"-cleanout connects to manhole. Letter sent. |
| 25 | Shelburne Pl | 1993 | x | | x | | |
| 2224 | Sheraton Pl | 1985 | x | | x | | |
| 2230 | Sheraton Pl | 1992 | x | | | | Lateral OK |
| 139 | Starlite Dr | 1985 | x | | | | Lateral OK |
| 148 | Starlite Dr | 1993 | | | | | No cleanout |
| 163 | Starlite Dr | 1976 | | | x | | No cleanout |
| 1456 | Tarrytown Rd | 1995 | | | | | Rocks, Permit 2637 |
| 1911 | Ticonderoga Dr | 1978 | | | | | No cleanout |
| 1992 | Ticonderoga Dr | 1991 | | | x | | Lateral OK |
| 2012 | Ticonderoga Dr | 1980 | | | | | No cleanout |
| 2043 | Ticonderoga Dr | 1980 | | | | | No cleanout |
| 2059 | Ticonderoga Dr | 1994 | | | | | No cleanout |
| 2096 | Ticonderoga Dr | 1990 | x | | | | |
| 2124 | Ticonderoga Dr | 1987 | | | | x | Permit 1460 |
| 2062 | Timberlane Wy | 1980 | | | | | Permit 0253 |
| 2083 | Timberlane Wy | 1986 | | | | x | Permit 1073 |
| 2087 | Timberlane Wy | 1986 | | | | x | Permit 1075 |
| 2095 | Timberlane Wy | 1986 | | | | x | Permit 1074 |
| 5 | White Plains Ct | 1980 | x | | | | Lateral OK |
| 35 | White Plains Ct | 1977 | | | | | Cleanout repair |
| 1615 | Yorktown Rd | 1985 | x | | | | Off-set |
| 1644 | Yorktown Rd | 1992 | | x | | | No cleanout |
| 1712 | Yorktown Rd | 1978 | x | | | | Lateral OK |

**Table 3-2. Callout Summary for Sewer Mains**

| Street number | Street name | Year | Reason for callout | | | | |
|---|---|---|---|---|---|---|---|
| | | | Roots | Grease | Paper | Inspection | Comment |
| 10 | Burgoyne Ct | 1977 | x | | | | Main OK |
| 1359 | Enchanted Wy | 1978 | x | | | | |
| 1405 | Enchanted Wy | 1978 | | | | | Main OK (3) |
| 1835 | Parrott Dr | 1980 | x | | | | |
| 1835 | Randall Rd | 1980 | | x | x | | |
| 1624 | Ascension Dr | 1985 | x | x | | | |
| 1136 | Parrott Dr | 1985 | | | | xx | |
| 1835 | Parrott Dr | 1985 | xxx | | | | |
| 1306 | Bel Aire Rd | 1986 | | | | xxxx | Main OK, Off-Set (Bel Aire Rd & Parrot Dr) |
| 1405 | Enchanted Wy | 1986 | x | | | | Main OK (2) |
| 1250 | Parrott Dr | 1986 | | | | | Broken Main, Main Ok |
| 2029 | Queens Ln | 1987 | xxx | | | | |

# SECTION 4

# MANHOLE INSPECTION

The manhole inspection program was conducted during the winter and spring of 1997. Field crews documented the condition of 257 manholes in the Crystal Springs County Sanitation District (CSCSD). This section presents the results of the manhole inspection program.

## Purpose and Objective

Manhole inspection was performed to evaluate manholes as potential infiltration/inflow (I/I) sources and document their physical condition. Additionally, the manhole inspection results were used to prioritize the smoke testing and television inspection programs. The manhole inspection program did not include all the manholes in the CSCSD. Manholes were selected for inspection to provide a representative sample of the manholes in the CSCSD.

During the inspection, the general condition of the manhole and incoming/outgoing pipelines was determined. Photographs of the incoming/outgoing pipelines were taken to determine their condition. The following conditions were documented during the inspection:

- Manhole bench/channel condition
- Roots in the manhole or pipeline
- Grease in the manhole or pipeline
- Manhole frame/cover condition
- Presence of I/I in the manhole or pipeline
- Major debris in the manhole or pipeline
- General physical condition of the pipeline.

## Findings

The major manhole defects noted during the manhole inspection program are listed in Table 4-1. The major pipeline defects observed from the photographs are listed in Table 4-2. A technical memorandum, dated October 12, 1998, describing the manhole inspection in more detail is provided in Appendix A. Attachments A, B and C for the technical memorandum were provided in the original submittal. Manhole inspection forms and photographs are provided under separate cover in a series of three-ring binders.

**Table 4-1. Manhole Defects**

| Defect type | Number |
|---|---|
| Bench/Channel Defects | 10 |
| Roots | 5 |
| Grease | 23 |
| Frame and Cover Problems | 12 |
| Active or signs of Infiltration/Inflow | 7 |
| Major Debris in Channel | 12 |
| Manholes Inspected | 257 |

**Table 4-2. Pipeline Defects Noted from Manhole Inspection Program**

| | |
|---|---|
| Pipes with separated joints greater than moderate and deflections greater than 1 inch | 12 |
| Pipes with greater than minor corrosion | 0 |
| Pipes with infiltration/inflow | 0 |
| Pipes with greater than light grease | 25 |
| Pipes with greater than light roots | 38 |
| Pipes with roots and grease | 3 |
| Pipes with cracks and fractures | 22 |
| Pipes with plugs and obstructions | 0 |

# SECTION 5

# FLOW MONITORING PROGRAM

A flow monitoring program was implemented to measure flow rates during dry weather and discrete rainfall events. This section describes the flow monitoring program. Flows and flow rates developed from the flow monitoring efforts are described in Sections 8 and 9.

Wastewater flows were divided into base sanitary flow (BSF) and wet weather infiltration/inflow (I/I) components for this study. Base sanitary flow factors are based on dry weather flow monitoring performed during the winter of 1997. Due to limited rainfall during the winter of 1997, additional wet weather flow monitoring was performed during the following season. El Niño effects resulted in extensive rainfall during the months of January and February of 1998. Wet weather flow projections are based on flow monitoring results from the second flow monitoring program in 1998. Results of the 1997 flow monitoring program are provided in Appendix B. Results of the 1997-1998 flow monitoring program are provided in the County of San Mateo 1997 – 1998 flow monitoring program dated January 14, 1998, and March 4, 1998.

## Purpose and Objective

The purpose of the flow monitoring program was to measure the existing collection system flows at various locations in the Crystal Springs County Sanitation District (CSCSD). Wet weather and dry weather flow rates were measured to develop design flows for use in a hydraulic model of the collection system. Additionally, a rain gauge was installed at 2295 Cobblehill Place to determine how collection system flows reacted to various rainfall events. The rain gauge was moved to a County facility located at the 1551 Tartan Trail Road Pump House.

Table 5-1 summarizes the measured flow rates for each monitoring station in the CSCSD for the 1997/1998 flow monitoring period. The location of the flow monitors and rain gauges is shown on Figure 5-1. The technical memorandum describing the 1997 flow monitoring program is provided in Appendix B. Attachments A and B for the technical memorandum were provided in the original submittal. This memorandum describes the location of the flow monitors and rain gauges, and the complete results of the flow monitoring program.

**Table 5-1. Flow Monitoring Results, million gallons per day 1997/1998**

| Flow monitoring site | Minimum dry weather flow | Average dry weather flow | Peak wet weather flow |
|---|---|---|---|
| 21 Line 1* | 0.07 | 0.11 | 0.89 |
| 21 Line 2* | 0.01 | 0.61 | 4.60 |
| 22 Line 2 | 0.03 | 0.12 | 0.95 |
| 23 | 0.12 | 0.44 | 2.31 |

*Flow monitors located in same manhole measuring two lines.

# SECTION 6

# SMOKE TESTING PROGRAM

The smoke testing program was conducted during the summer of 1998. Field crews tested approximately 50,800 linear feet of sewer lines in the Crystal Springs County Sanitation District (CSCSD). This section presents the results of the smoke testing program.

## Purpose and Objective

Smoke testing is a quick and effective method for identifying many types of wastewater collection system deficiencies. Typical defects encountered during a smoke testing program include the following:

1. Broken or deteriorated building laterals.
2. Improperly capped cleanouts.
3. Broken or deteriorated sewer mains in unpaved areas.
4. Unsealed or damaged manholes.
5. Sags and/or obstructions in the mains.
6. Direct and indirect connections between storm and sanitary sewer systems.
7. Untrapped or improper building plumbing.
8. Illegal sewer connections from/to storm drain systems

Although smoke testing is an efficient method of identifying collection system inadequacies, certain conditions affect the interpretation and effectiveness of the test. One factor that affects smoke testing results is the extent and porosity of the cover over the sewer main or service lateral. For instance, pilot studies have indicated that only one-third or less of lateral defects are detected by smoke testing.

## Smoke Testing Results

Smoke testing was performed during the dry months of August and September 1998 to ensure that smoke was not trapped in high groundwater. The areas tested in the CSCSD area are shown on Figure 6-1. Smoke testing areas were selected based on the results of the flow monitoring program. Areas with suspected high I/I rates were selected for smoke testing.

No major defects were noted during the smoke testing program. A total of 59 defects were located and documented during the program. The most prevalent defect was missing or damaged cleanout covers. The majority of these defects are located on the private side of the property line. A summary of the smoke testing defects is provided in Table 6-1. A technical memorandum, dated October 13, 1998, describing the smoke testing program in more detail is provided in Appendix C. Smoke testing reports and photographs are also provided in Appendix C.

Insert Figure 6-1

**Table 6-1. Smoke Testing Defect Summary**

| Defect type | Number of defects |
|---|---|
| Cleanout | 52 |
| Lateral | 2 |
| Illegal drain | 2 |
| Storm drain cross connection | 1 |
| Manhole leaks | 1 |
| Pavement cracks | 1 |
| Other | 0 |
| Total footage tested: | 50,794 |

# SECTION 7

# TELEVISION INSPECTION PROGRAM

The television inspection program was conducted during the winter of 1999. Field crews inspected approximately 9,271 linear feet of sewer lines in the Crystal Springs County Sanitation District (CSCSD). This section presents the results of the television inspection program.

## Purpose and Objective

The purpose of the television inspection program of mainline sewers was to observe and document the internal condition of the pipeline in reference to infiltration/inflow (I/I) and structural deterioration. Results of the television inspection were then used to develop capital improvement programs described in Sections 13 and 14. The following conditions were observed and documented:

1. Structural Integrity—the number, type and extent of cracks and/or broken, crushed, shattered or collapsed pipe.

2. Root Intrusion—the amount and severity of the roots were documented.

3. I/I—the location of I/I sources were documented.

4. Protruding Laterals—a lateral's protrusion into the pipeline was estimated to judge if it will interfere with rehabilitation or routine maintenance.

5. Defective lateral connections—defective lateral connections such as broken pipe at the connections, broken saddles, cracks and the connections, pieces missing from the connection, and structural defects in the lateral were documented.

6. Offset or Open Joints—offset or open joints were visually estimated from the inspection to determine if they would require spot repairs prior to rehabilitation.

7. Pipe Sags—the extent of sags or misalignment was judged to help determine the structural integrity of the pipeline and their suitability for rehabilitation.

8. Corrosion—hydrogen sulfide corrosion of concrete sewers was identified and documented.

## Television Inspection Results

The areas scheduled for television inspection in the CSCSD area are shown on Figure 7-1. Sewers were selected for television inspection if they met one of the following four criteria:

- Excessive maintenance callouts
- Manhole inspection program noted a pipeline defect
- Special request from the County maintenance personnel
- A mainline defect was noted during the smoke testing program.

Sewers scheduled for television inspection were cleaned or flushed prior to inspection to allow for a better structural inspection. Approximately 2,000 linear feet of mainline sewer could not be inspected due to severe defects in the line, which blocked the path of the camera, or lack of access to the sewer. When a severe defect was encountered, the camera setup was reversed to attempt an inspection of the sewer whenever possible. Results of the television inspection program are summarized in Table 7-1. Complete results of the program are provided in Appendix D.

**Table 7-1. Television Inspection Summary**

| Description | Total |
|---|---|
| Footage attempted | 9,947 |
| Footage completed | 9,355 |
| | |
| Cracks | |
| Radial | 21 |
| Longitudinal | 2 |
| | |
| Joints | |
| Minor offset joint | 0 |
| Major offset joint | 5 |
| | |
| Laterals | |
| Protruding lateral | 4 |
| Defect at connection | 2 |
| Dead connection | 6 |
| | |
| Roots | |
| Roots at joint | 148 |
| Roots at lateral | 14 |
| | |
| Infiltration/Inflow | |
| At joint | 0 |
| At crack | 0 |
| At roots | 0 |
| At inside lateral | 0 |
| At lateral connection | 0 |
| At inside lateral and at connection | 0 |
| | |
| Alignment | |
| Sag in line | 5 |
| Pipe out of round | 0 |
| | |
| Structural | |
| Piece missing | 6 |
| Shattered/broken | 2 |
| Crushed or collapsed | 2 |
| | |
| Mineral Stains | |
| At joint | 0 |
| At cracks | 0 |
| | |
| Sulfide Corrosion | |
| Minor | 0 |

# SECTION 8

# BASE SANITARY FLOWS

The results of the flow monitoring program described in Section 5 were used to establish base sanitary flow (BSF) rates. Base sanitary flow rates are used with wet weather flow rates and the hydraulic model to determine the amount of available capacity in the collection system. Wet weather flow rates and the hydraulic modeling are discussed in subsequent sections of the report. This section describes the methodology used to develop base sanitary flow rates for the Crystal Springs County Sanitation District (CSCSD).

## Dry Weather Flow

BSF is wastewater contributed by residential, commercial, industrial and public users. Base flow is directly related to land use and varies throughout the day and between weekdays and weekends. BSF from residential areas has a typical diurnal pattern with peak flows occurring in the morning after 7:00 a.m. and a second smaller peak occurring in the evening. A typical dry weather hydrograph is shown on Figure 8-1.

BSF flow contributions to the hydraulic model are based on the flow monitoring data collected during dry weather periods. Actual dry weather flow hydrographs were extracted from the flow monitoring data and used in the model. Peaking factors normally estimated for subsequent use in the hydraulic analysis were not needed since the actual diurnal flow pattern from the flow monitoring could be used directly in the hydraulic model.

Dry weather periods were used to minimize the amount of groundwater infiltration (GWI) included in the calculation. GWI occurs when groundwater levels are above the sewer pipes and the pipes have defects that allow infiltration. Some groundwater infiltration is undoubtedly included in the BSF rates. However, extensive review of accurate water use data in each District would be needed to determine the amount of groundwater infiltration in each area. Based on our review of the flow monitoring, GWI is not a significant factor in the total wastewater flow in the CSCSD area. BSF projections were not prepared for future land use conditions. Land use planners for the County and affected City agencies indicated that growth or significant infilling were not expected in the future.

BSF rates used for the service area for each of the flow monitoring sites are presented in Table 8-1. A complete description of the flow monitoring program is given in Appendix B. Additionally, the technical memorandum describing the flow projections and hydraulic modeling in more detail is provided in Appendix E.

Insert Figure 8-1

**Table 8-1. Base Sanitary Flow Rates**

| Flow monitor | Base sanitary flow, mgd |
|---|---|
| 21 Line 1* | 0.195 |
| 21 Line 2* | 0.286 |
| 22 Line 2 | 0.150 |
| 23 | 0.320 |

*Flow monitor located in same manhole measuring two lines.

# SECTION 9

# INFLOW/INFILTRATION RATES

The flow monitoring program described in Section 5 was performed to establish inflow/infiltration (I/I) rates. I/I rates are used in conjunction with base sanitary flow (BSF) rates (established in Section 8) and the hydraulic model to determine the amount of available capacity in the collection system. This section describes the methodology used to develop I/I rates for the Crystal Springs County Sanitation District (CSCSD).

## Wet Weather Flow

I/I consists of direct inflow of stormwater runoff and rainfall-induced infiltration of stormwater percolating through the soil into the collection system. Inflow occurs when storm water enters the collection system through illegally connected catch basins, area drains or home roof gutter downspouts, or through manhole covers of cleanout lids. Inflow can become severe if surface flooding occurs and manholes and cleanouts are submerged or used to drain low-lying areas.

I/I accounts for the large increase in peak flows that occur during rainfall events. In areas with older sewers, I/I is typically the largest component of the total wastewater flow. I/I was evaluated by calculating the "R" factor for each of the monitored basins for each storm. An "R" factor is the percentage of rainfall volume falling on an area that enters the collection system as I/I. The composite minimum and maximum "R" factor, based on the flow monitoring data, for each flow monitoring location is listed in Table 9-1. The flow monitors service areas and R factor used for the wet weather flow projections are shown on Figure 9-1.

A wet weather design storm was developed to determine the effects of I/I on the capacity of the wastewater conveyance system. The January 18, 1998, rainfall event was very similar to a 5-year design storm in terms of intensity, duration, and volume. Therefore, this storm was selected as the design event. Minor adjustments were made to the rainfall hydrograph to account for differences in the volume between the actual storm and the 5-year design rainfall.

Unit hydrographs were developed for each basin to develop wet weather hydrographs for use in the model. Unit hydrographs are based on the "R" factor and the individual runoff characteristics for each basin. Synthetic hydrographs were added to the base flow hydrographs and the total flow hydrograph was then input to the hydraulic model. A typical wet weather synthetic hydrograph is shown on Figure 9-2. A complete description of the I/I flow projections is provided in the Technical Memorandum provided in Appendix E.

**Table 9-1. R Factor**

| Flow Monitoring Site | Minimum | Maximum |
|---|---|---|
| 21 Line 1 | 0.031 | 0.044 |
| 21 Line 2 | 0.054 | 0.091 |
| 22 Line 2 | 0.047 | 0.102 |
| 23 | 0.037 | 0.097 |

Insert Figure 9-1

Insert Figure 9-2

# SECTION 10

# HYDRAULIC MODEL DESCRIPTION

A hydraulic model was prepared of the Crystal Springs County Sanitation District's (CSCSD) wastewater collection system trunk sewer. The model was used to evaluate the capacity of the pipelines to carry existing peak wet weather flows. This section presents a description of the model and the model development.

## Computer Model

Major trunk sewers in each of the sewer Districts were modeled to determine where capacity deficiencies exist. The HYDRA model developed by PIZER, Inc., was used to simulate wastewater flows in the each of the Districts collection systems. HYDRA routes flow hydrographs (developed in Section 9) through the collection system and accounts for the time delays of peak flow from various tributary areas as the flows move downstream.

For the CSCSD, the Polhemus Road trunk sewer was modeled. This sewer includes nearly all the pipelines 8 inches in diameter or larger in the CSCSD. This trunk sewer is composed of 8-inch- and 15-inch-diameter gravity sewers in the upstream portion. Near the downstream end of the trunk sewer, the diameter decreases to 10 inches.

Most of the pipeline data used in the model was taken from the existing County collection system maps. Pipeline data required by the model includes upstream and downstream inverts and pipeline length and diameter. Surveying was completed to fill in gaps in the data or questionable data.

Modeled flow is compared to the theoretical capacity of each pipe segment. The capacity of each pipeline is a function of the pipeline slope and diameter. If capacity deficiencies were detected, then the program was used to size the appropriate relief and/or replacement sewer size. A typical example hydrograph comparing the model hydrograph to actual flow monitoring is shown on Figure 10-1. The technical memorandum describing the flow development and modeling is provided in Appendix E.

# SECTION 11

# MODEL RESULTS

An evaluation of the pipeline capacities was performed using the flows developed in Sections 8 and 9 and the hydraulic model described in Section 10. This section describes the results of the capacity evaluation developed for the Crystal Springs County Sanitation District (CSCSD).

## Capacity Analysis

The capacity of the existing system was evaluated using peak wet weather flows. This flow condition is generated by existing development in the service area (Section 8) under design storm conditions (Section 9).

The model routes the flow through the pipe network, calculates the capacities of the pipes, and compares the routed flows to the pipe capacities to identify inadequate pipes. The pipe capacity calculations are based on a Manning's roughness coefficient of 0.013. Pipes were defined to be hydraulically inadequate if the depth of flow is 100 percent or greater of the pipe diameter. The model sized relief and replacement sewer sizes for all inadequate sewers.

The results of the model indicate a severe bottleneck where the Polhemus Road trunk sewer changes to 10 inches in diameter. Nearly all the 10-inch-diameter sewer is unable to convey peak wet weather flow without surcharging. Model results are shown on Figure 11-1. The technical memorandum describing the flow development and modeling is provided in Appendix E. Additionally, the complete HYDRA modeling results are provided in Appendix E.

# SECTION 12

# UNIT COSTS

This section presents the basis for the estimated unit costs that were developed for estimating the construction costs and the capital costs of recommended capital improvements. The cost index and the development of the capital costs of gravity sewer pipeline construction and rehabilitation are presented.

## Capital Costs

The total capital investment necessary to complete a project consists of expenditures for construction, engineering services, contingencies, and such overhead items as legal and administrative services and financing. The various components of capital costs are described below. Unit construction costs were developed for the following construction and rehabilitation methods:

- Remove and Replace—recommended for pipelines with serious structural or hydraulic capacity deficiencies where trenchless construction is typically more expensive or not practical.
- Sliplining—recommended for pipelines with minor structural deficiencies or root intrusion and minimal sags.
- Pipe Bursting—recommended method for increasing capacity of structurally deficient 6-inch-diameter lines to 8-inch-diameter lines and provides minimal disruption to the community.
- Chemical Root Treatment—recommended for lines with root intrusion.
- Do Nothing—no capital project is recommended for lines with minor structural deficiencies and light root intrusion. For this option, television re-inspection in a maximum of 10 years is recommended.
- Increase O& M—recommended for lines with minor root intrusion and grease buildup.
- Spot Repair—recommended for lines with severe defects that create maintenance problems or where required prior to implementing other rehabilitation methods.

**Cost Index.** A good indicator of changes over time in construction costs is the Engineering News Record (ENR) 20-city Construction Cost Index (CCI), which is computed from prices of construction materials and labor, and based on a value of 100 in 1913. Cost data in this report are based on an ENR CCI of 6000, representing costs in March 1999.

**Construction Costs.** Construction costs presented in the master plan represent preliminary cost estimates of the materials, labor and services necessary to build the proposed projects. The cost estimates are prepared to be indicative of the cost of construction in the study area. In considering cost estimates, it is important to realize that changes during final design, as well as future changes in

the cost of material, labor and equipment, will cause comparable changes in the estimated costs. Unit costs used in this study were obtained from a review of pertinent sources of reliable construction cost information. Construction cost data given in this report are not intended to represent the lowest prices that can be achieved for each type of work, but rather are intended to represent planning-level estimates for budgeting purposes. The following assumptions were made in the development of the unit costs:

- Remove and Replace—Costs include excavation, backfill, compaction, haul off and asphalt repair. Material costs for 8-inch- to 21-inch-diameter sewers are for PVC or VCP. Material costs for 24-inch-diameter or larger sewers are for RCP. Replacement costs for 6-inch-diameter lines include cost for 8-inch-diameter replacement materials. The costs have been developed based on average trench depth not exceeding 15 feet.
- Sliplining—Costs include the use of HDPE as the liner material, construction of access pits and an average service lateral reconnection fee. Sewage bypass pumping is only needed on a localized basis and, therefore, is not included in the costs.
- Pipe Bursting—Costs include the use of HDPE as the liner material, construction of access pits and an average service lateral reconnection fee. Costs include the bypassing of sewage.
- Chemical Root Treatment—Costs include application and removal with hydroflush equipment. Costs also include reapplication every 2 years.
- Do nothing—Costs for this option are for television re-inspection in 10 years at a rate of $1.50/foot for the data collection and data review.
- Spot Repair—A cost of $800 has been included in the estimates for each spot repair occurrence.

Table 12-1 presents the unit construction costs for construction and rehabilitation of gravity sewer pipelines.

## Contingencies, Engineering, and Overhead

Construction contingencies, engineering and overhead are assumed to be 40 percent of the construction cost. It is appropriate to allow for the uncertainties unavoidably associated with planning-level layout of projects. Such factors as unexpected geotechnical conditions, extraordinary utility relocation and alignment changes are a few of the items that can increase project cost for which it is wise to make allowance in preliminary estimates.

Engineering services associated with projects include preliminary investigations and reports, site and route surveys, geotechnical explorations, preparation of drawings and specifications, construction services, surveying and staking, and sampling and testing of materials. Overhead charges cover such items as legal fees, financing expenses, administrative costs, and interest during construction.

**Table 12-1. Gravity Sewer Pipe Unit Construction Costs**

| Pipe diameter, inches | Relief and replacement sewer cost, $/foot | Sliplining, $/foot | Root treatment, $/foot | Pipe bursting, l.f. |
|---|---|---|---|---|
| 6 | 85 | n/a | 3 | 90 |
| 8 | 85 | 55 | 3 | 90 |
| 10 | 100 | 70 | 4 | 115 |
| 12 | 110 | 90 | 5 | 145 |
| 15 | 120 | 110 | 6 | 175 |
| 18 | 140 | n/a | n/a | n/a |
| 21 | 180 | n/a | n/a | n/a |
| 24 | 195 | n/a | n/a | n/a |
| 27 | 220 | n/a | n/a | n/a |
| 30 | 230 | n/a | n/a | n/a |
| 33 | 255 | n/a | n/a | n/a |
| 36 | 285 | n/a | n/a | n/a |
| 42 | 305 | n/a | n/a | n/a |
| 48 | 355 | n/a | n/a | n/a |

Other Costs:

$800/spot repair

Reinspect in 10 years = $1.50/foot

# SECTION 13

# RECOMMENDED COLLECTION SYSTEM IMPROVEMENTS

Improvements will be necessary to the Crystal Springs County Sanitation District (CSCSD) collection system to adequately convey peak wet weather flows (PWWF). This section presents the recommended improvements for accommodating the hydraulic capacity problems identified in Section 11. Capital improvement projects for correcting structural deficiencies as well as the hydraulic deficiencies are provided in Section 14.

## Collection System Sewer Sizing

The improvements recommended for correcting the hydraulic capacity problems are based on the model results for peak wet weather flow. The model selects pipe sizes for parallel relief pipes and replacement pipes. The main drawback to relief sewers is the increased amount of sewer pipe in the ground for the maintenance crews. For this report, alternatives and costs have been developed assuming a larger sewer will replace the existing sewer. However, the County will have to decide on a case-by-case basis during the design of each project as to whether to construct replacement or parallel relief sewers.

Sewer sizes developed by the computer model were verified and modified where necessary to reduce potential maintenance problems. Maintenance problems can arise when a larger sewer discharges into a smaller sewer. The diameters of the smaller sewers are modified to be no smaller than the upstream pipe. In some cases, a sewer is extended for several reaches to connect two portions of the collection system with hydraulic problems.

Short lengths and isolated reaches of over-capacity pipe have, in some cases, not been included with the recommended relief/replacement sewer program. These reaches are not considered significant hydraulic problems because resulting backwater would be minor.

Nearly 5,000 linear feet of the Polhemus Road trunk sewer was identified as hydraulically deficient. A 10-inch and 12-inch relief sewer is recommended to relieve the existing trunk sewer. The location of the recommended relief sewer is shown on Figure 13-1. Table 13-1 summarizes the modeling results.

**Table 13-1. Recommended Replacement Sewers**

| Upstream manhole | Downstream manhole | Existing diameter, inches | Length, ft | Recommended replacement sewer sizes, inches |
|---|---|---|---|---|
| C019105 | C014405 | 10 | 1,714 | 8 |
| C014405 | C000301 | 10 | 3,280 | 12 |
| Total | | | 4,994 | |

## Infiltration / Inflow Reduction

The use of collection system rehabilitation to reduce the overall PWWF within the basin was considered as an option prior to developing the recommendations listed in Table 13-1 for pipe replacement. Collection system rehabilitation is used to accomplish two main objectives:

1. Provide a continuing level of service with regard to the structural integrity of the collection system.

2. Reduce the overall level of I/I entering the collection system for either peak flow rates or for total I/I flow into the system.

I/I studies nationwide have demonstrated that effective removal of I/I from the collection system requires a comprehensive implementation of collection system rehabilitation of both the sanitary sewer and the private building lateral. Agencies, such as, East Bay Municipal utilities District, Vallejo Sanitation and Flood Control District, and the City and County of Honolulu have performed pilot rehabilitation programs documenting the need for comprehensive rehabilitation for effective I/I removal. The effective amount of I/I reduction possible, even with comprehensive rehabilitation, is a subject of some debate within the sewer industry. Claims range from over 90 percent removal to less than 40 percent removal of the I/I from the collection system. Many things impact the ability of the rehabilitation effectiveness in removing I/I for a long period of time (50 years is considered a reasonable time measure for effectiveness of rehabilitation program). An average long-term effectiveness of 75 percent was assumed for I/I removal from the collection system for this study, based on the results of similar work in the Bay Area.

This type of area-wide rehabilitation approach is critical for collection systems where field data from condition assessment programs show no one area of the collection system as having a significantly higher level of sewer defects that contribute to I/I in the collection system. The Crystal Springs County Sanitation District condition assessment data indicates that the entire district will require comprehensive rehabilitation to provide the required reduction in I/I related flows to avoid the capacity limitations within the existing collection system configuration.

The capacity limitation of 1.74 mgd in the 10-inch sewer in Polhemus requires a 1.86 mgd reduction in the projected PWWF of 3.60 mgd as shown in Appendix E. Effectively, 52 percent of the PWWF will need to be eliminated from the system through a comprehensive rehabilitation program of the district. Using the 75 percent effectiveness criteria, which could be considered optimistic, then the entire collection system in the district will require comprehensive rehabilitation.

The cost associated with complete collection system rehabilitation, using the unit costs provided in Table 12-1, equals $5.15 million for the 13 miles of collection system approximated as 8-inch rehabilitated sewer at $75/lf (assumes approximately a 50/50 split between slip lining and pipe bursting of equivalent 8-inch-diameter pipe). The rehabilitation of the sewer laterals will cost approximately $50/ft when considering landscaping replacement or the use of trenchless construction methods. The estimated total length of sewer laterals in the district is about 10 miles. Therefore, the estimated construction cost for lateral rehabilitation is $2.64 million. The total estimated construction cost for a rehabilitation program that is effective enough to eliminate the requirement for a new larger capacity sewer is approximately $7.79 million. The estimated replacement construction cost for the increased capacity of sewer in Polhemus Road is $655,300 as shown for the two Polhemus Road projects listed in Table 14-1.

## Wastewater Cost of Treatment

The cost of treating the increased PWWF will have to be borne by the rate payers of the district. The current cost of treatment charged by the City of San Mateo is approximately $0.00125/gallon treated. Using this rate the cost of treating the PWWF storm event total flow of approximately 10.5 million gallons, as shown in Figure 9-2 as the area under the projected wet weather flow line, equals $13,125 per peak flow event. Given that this is a once in five-year condition, the overall cost impact to eliminate the wet weather flows is not practical based on the cost analysis shown above. Planning and negotiation should begin with the Town of Hillsborough and the City of San Mateo regarding the need for collection system capacity down stream of the district.

The County needs to carefully review the terms of the operating agreements for accommodating wastewater flow with each of these agencies to determine who is responsible for the cost of any potential downstream improvements required as the result of construction of a new larger-capacity sewer for the district. The operating agreements should provide a basis of negotiation and planning for developing the recommended projects so that no agency is overly burdened with the cost of the new facilities and that the potential for overflows is prevented.