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September 1, 2010

OC.CO

Ken Greenberg, Chief, Clean Water Act Compliance Office (WTR-7)
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Attention: Ms. Fatima Ty

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Los Angeles Regional Water Quality Control Board
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Los Angeles, CA 90013

Greetings:

**RE: Settlement Agreement and Final Order – Civil Action No. 01-191-RSWL and Civil Action No. 98-9039-RSWL Consolidated – Odor Master Plan Update**

Pursuant to Paragraph 45 in the amended Settlement Agreement and Final Order, the City has updated the Odor Control Master Plan to include results of new investigations, new odor hot spot areas, changes in odor control activities, progress towards completion of odor control activities, and completed odor control activities projects and results. Enclosed is a copy of the updated Odor Control Master Plan for 2010.

Odor control remains a high priority as the City continues to aggressively and proactively respond, investigate, and address all sewer odors. The construction of two state-of-the-art Air Treatment Facilities are near completion. As a result of the City's efforts, sewer-related odors for FY 2009/10 have been reduced by 37 percent as compared to the reference year of 2003/04.

If you have any questions, please contact Scott Hare at (323) 342-1583.

Sincerely,

Ali Poosti, Acting Division Manager
Wastewater Engineering Services Division
Bureau of Sanitation

AP/SH

**Distribution:**

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## CERTIFICATION

**Re: Settlement Agreement and Final Order – Civil Action No. 01-191-RSWL and Civil Action No. 98-9039-RSWL Consolidated – Sewer Odor Master Plan Update**

I certify under penalty of law that this document and its attachments were prepared either by me personally or under my direction or supervision in a manner designed to ensure that qualified and knowledgeable personnel properly gathered and presented the information contained therein. I further certify, based on my personal knowledge or on my inquiry of those individuals immediately responsible for obtaining the information that to the best of my knowledge and belief the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing and willful submission of a materially false statement.

[signature] 8/31/2010

Ali Poosti, Acting Division Manager
Wastewater Engineering Services Division
Bureau of Sanitation

Date

# City of Los Angeles
# SEWER ODOR CONTROL MASTER PLAN

Wastewater Engineering Services Division
Bureau of Sanitation
August 2010

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# ACRONYMS and ABBREVIATIONS

| | |
|---|---|
| ATF | Air Treatment Facility |
| AVORS | Additional Valley Outfall Relief Sewer |
| BOD | Biochemical Oxygen Demand |
| BOS | Bureau of Sanitation |
| CBD | Central Business District (Sewer) |
| CFM | Cubic Feet per Minute |
| CIP | Capital Improvement Program |
| CIS | Coastal Interceptor Sewer |
| CSSA | Collection System Settlement Agreement |
| ECIS | East Central Interceptor Sewer |
| EVIS | East Valley Interceptor Sewer |
| EVRS | East Valley Relief Sewer |
| GBIS | Glendale-Burbank Interceptor Sewer |
| $H_2S$ | Hydrogen Sulfide |
| HAS | Hyperion Service Area |
| HTP | Hyperion Treatment Plant |
| LAGWRP | L.A.-Glendale Water Reclamation Plant |
| LARWQCB | L.A. Regional Water Quality Control Board |
| LCIS | La Cienega Interceptor Sewer |
| LCSFVRS | La Cienega-San Fernando Valley Relief Sewer |
| MH | Maintenance Hole |
| NCOS | North Central Outfall Sewer |
| NEIS | North-East Interceptor Sewer |
| NHIS | North Hollywood Interceptor Sewer |
| NORS | North Outfall Replacement Sewer |
| NOS | North Outfall Sewer |
| NOTF | North Outfall Treatment Facility |
| NPDES | National Pollutants Discharge Elimination System |
| OAB | Odor Advisory Board |
| PPM | Parts per Million |
| SLA | South Los Angeles |
| SSO | Sanitary Sewer Overflow |
| TISA | Terminal Island Service Area |
| TIWRP | Terminal Island Water Reclamation Plant |
| TWRP | Tillman Water Reclamation Plant |
| USEPA | U.S. Environmental Protection Agency |
| VOC | Volatile Organic Compounds |
| VORS | Valley Outfall Relief Sewer |
| VSF | Valley Spring (Lane) – Forman (Ave) Intersection |
| WCED | Wastewater Collection Engineering Division |
| WCSD | Wastewater Collection Services Division |
| WHIS | West Hollywood Interceptor Sewer |

| | |
|---|---|
| WLAIS | West L.A. Interceptor Sewer |
| WRS | Westwood Relief Sewer |

# EXECUTIVE SUMMARY

## INTRODUCTION

The City of Los Angeles operates a wastewater collection system that consists of approximately 6,700 miles of sewers, 47 pumping plants, diversion structures, and various support facilities. This system collects sewage from 550 square miles and transports it to one of four sewage treatment plants operated by the City.

A natural phenomenon within any wastewater collection system is the production of odorous gases especially hydrogen sulfide. The City has been working diligently to address these odor issues and has made significant progress in controlling odors within its sewer system. Many odor control measures are being implemented. Two state-of-the art Air Treatment Facilities (ATFs) are under construction with more planned. The two that are being built will go into service soon. A $2 million study of the ATF Program is about to conclude and is expected to provide valuable information regarding the future use of ATF at various locations throughout the city. The use of air scrubbers at various problem locations in the collection system has reduced air pressure in the sewer system and the application of odor control chemicals to sewage has reduced hydrogen sulfide concentration in treated sewers by up to 90 percent.

The City's on-going operation and maintenance efforts have also provided significant benefits to the odor control program. The on-going repair of trap maintenance holes and construction of local sewers has alleviated the migration of odors from large diameter sewers to local residences while perpetual sewer cleaning has decreased the potential for septic conditions to occur. The multi-year rehabilitation of the Lower NOS has concluded and flow has been routed back into the NOS away from the North Outfall Replacement Sewer (NORS). This has greatly reduced the flow in the NORS, resulting in a noticeable reduction in gas pressure in the NORS and at the NORS siphon.

These odor control measures have produced a successful odor control program in the City of Los Angeles and sewer odors and odor complaints continue to decline steadily. The City operates an odor complaint hotline, which allows for more timely responses and quick resolutions to sewer-related odor complaints.

This Master Plan evaluates the current odor control program, conducts studies in strategic areas throughout the city, identifies causes of odors, and provides recommendations for improvements. It will be updated on an annual basis to assure that odor control strategies/measures are periodically challenged, solutions remain proactive, and technologies are current and effective.

## EVALUATION OF THE COLLECTION SYSTEM

Through analysis of odor complaints and spot testing of sewer pressure, the City identified several key areas to study. Specific sewers in these areas were targeted for detailed testing and analysis based on the location of odor complaints as well as the physical characteristics of the sewers such as insufficient pipe slope, severe slope reductions, and the proximity of problematic structures such as inverted siphons, drop structures, and junction structures.

Four areas with pockets of unusually high levels of complaints have been identified as "Areas of Concern" and the sewers in these areas received the most investigation. They are:

- East NOS Corridor – NOS
- La Cienega/San Fernando Corridor – LCSFVRS/WHIS/LCIS
- Baldwin Hills/Culver City Area – NORS/ECIS/NOS/WLAIS/WRS/NCOS
- East Valley Area – AVORS/EVRS/VORS/NHIS/NOS

In order to gain a more complete and accurate overview of the collection system, five additional areas have been identified as "Areas of Study" and were analyzed as well. They are:

- South Los Angeles Area – NOS
- Coastal Interceptor Sewer – CIS
- Harbor Area
- West Valley Area – VORS/AVORS/EVIS
- Miscellaneous Locations – NOS/COS

Air pressure and hydrogen sulfide ($H_2S$) levels in the sewers in each area are monitored in order to qualify and quantify the odors, help identify the causes of odor complaints, and help determine the optimum solutions.

## RECOMMENDATIONS/CONSIDERATIONS

For the Areas of Concern, the following options are being considered:

### East NOS Corridor

- Consider the introduction of odor control chemicals to the NOS
- Build an airline for the Gilroy Street siphon if feasible or place a small scrubber at the siphon inlet
- Coordinate with the LAG Treatment Plant in order to modify their biosolids discharge schedule so that biosolids are discharged in multiple, small increments throughout a 24-hour period rather than all at once
- Regarding pressure at Mission and 6$^{th,}$ wait and see how the new ATF at Jefferson and La Cienega changes condition of the ECIS sewer
- Determine if the planned NEIS 2 project will improve ventilation conditions
- Extend a local sewer that isolates homes from the high gas pressure within the NOS

- Continue pressure and $H_2S$ testing to better understand the effects of the LAG Treatment Plant

  As part of the ATF Review Study, the consulting team of HDR Engineering/Malcom Pirnie has conducted detailed pressure studies of several drop structures to understand air dynamics at these structures and also help determine if flow management can improve conditions in the associated sewers including the NOS, NEIS, and the ECIS. Their recommendations will be available by November of this year.

**La Cienega/San Fernando Corridor**

- Consider increasing the capacity of the scrubber at the Genesee Siphon from 5,000 cfm to 7,500 cfm to further depressurize the lower portion of the LCSFVRS
- Test downstream of Venice & San Vicente to determine if the high pressure at that location is an isolated phenomenon or part of a bigger problem.

**Baldwin Hills/Culver City Area**

- Continue monitoring the NOS and NCOS, especially in the vicinity of the airline connection between these two sewers
- Continue monitoring WLAIS and WRS for any increase in pressure spikes during morning hours
- Continue monitoring NORS and ECIS
- Monitor the effectiveness of the Jefferson and La Cienega ATF and the NCOS ATF once the units are online
- Re-evaluate after ATF Study is complete

**East Valley Area**

- Conduct periodic, thorough pressure testing in the East Valley area
- Continue monitoring pressure on the EVRS and NHIS and seal MHs where necessary

For the Areas of Study, the following options are being considered:

**South Los Angeles Area**

- Continue monitoring for pressure and $H_2S$ concentrations
- Divert additional flow from the south branch of the Maze to the COS after it is on line
- Continue shock dosing Florence Ave and 74$^{th}$ Street Sewers to reduce H2S concentration in the South Maze

**Coastal Interceptor Sewer**

- Re-test for pressure and/or $H_2S$ periodically to allow adequate time to address any odor issues that may occur in the future

**Harbor Area**

- Re-test for pressure and/or $H_2S$ periodically to allow adequate time to address any odor issues that may occur in the future

**West Valley Area**

- Re-test for pressure and/or $H_2S$ periodically to allow adequate time to address any odor issues that may occur in the future

**Miscellaneous Locations – NOS/COS upstream of Hyperion**

- Pressure is not a problem in the NOS and COS sewers in this area
- Re-test for pressure and/or $H_2S$ periodically to allow adequate time to address any odor issues that may occur in the future

To meet the immediate needs of the collection system, the City will continue all odor control activities including odor complaint response and investigation, routine sewer maintenance, chemical addition, air withdraw and treatment using scrubbers, sewer construction and repair, and on-going monitoring of sewer air pressure and odor concentration.

The ATF Review Study is evaluating the ATF implementation program in light of experiences and concerns with the interim scrubbers, drop structure design, and changes to the collection system flows. This study is evaluating the use of proposed ATFs at the 23rd & San Pedro, Mission & Jesse, Humboldt, Richmond, and the NORS/ECIS sites. As part of this evaluation, the study includes an analysis of multiple drop structures and siphons and their effects on the sewer system, the creation of a predictive computer model for gas pressure, and a study of non-methane hydrocarbons. The goal is to ensure that the solutions proposed, and ultimately constructed, are the optimal solution and the best use of funds for mitigating sewer odors.

**Note: For more detail on each area please refer to the Tech Memos.**

# 1.0 INTRODUCTION

## 1.1 History of the Sewer System

The City of Los Angeles operates and maintains a complex wastewater collection system that serves a 550 square mile area with a network of pipes that range in size from 6-inches to 150-inches in diameter. The pipes running beneath the City total approximately 6,700 linear feet. This does not include the hundreds of miles of privately owned sewer laterals which connect private residences and industrial clients to the City's sewers. Although the City of Los Angeles has had some type of sewer conveyance system since the late 1800's, it consisted of transporting the sewage in pipes to the edge of town or low population areas and discharging it into a field or ditch. The system expanded and by 1908 could accommodate a population of 750,000 and discharged into the ocean at the present location of the Hyperion Treatment Plant. However, the sewage was not being treated at all. It was not until 1920 that the residents voted to begin sewage treatment, beginning our modern sewage conveyance and treatment system. Odors have always been an issue with residents from the very beginnings of the sewer system and as the City has enlarged its sewer system, odor control has become a larger area of concern.

The City of Los Angeles is expanding and will continue to expand in the future. Upgrading the sewer system and the treatment plants has been and will continue to be an on-going process in order to handle the anticipated increase in sewage that accompanies an increasing population and to address the aging infrastructure. This will need to be accompanied by a continuous and increasingly sophisticated effort to control sewer odors.

A key part of the City's odor control efforts is the formulation of this Odor Control Master Plan which evaluates the current odor control program and provides recommendations for future efforts. As part of the evaluation process, the City reviewed its existing odor complaint procedures, investigation and cleaning practices, preventive maintenance schedules, operation and maintenance policies and practices, and mitigation measures including manhole sealing, trap maintenance hole repair, and chemical treatment. This Master Plan presents the results of this evaluation along with the recommendations.

## 1.2 Odor Generation

Prior to 1923, very little was known about the generation and release of sewer odors in Los Angeles or elsewhere. It was generally known that air ventilating from sewers could be offensive at times, but little was known about the specific odor compounds or how they were formed. Sewer gases can include nitrogen, oxygen, carbon dioxide, hydrogen sulfide, ammonia, and methane. Organic gases such as volatile organic compounds (VOCs) contribute to the nuisance odors but the major cause of odors in wastewater is hydrogen sulfide (H2S), an inorganic gas that is detectable even in very low concentrations. Hydrogen sulfide has a rotten egg smell and is heavier than air, so it does not disperse into the atmosphere.

A natural phenomenon within any wastewater collection system is the production of odorous gases. Over the last decade the potential for odorous air release from the sewer system has increased due to the effectiveness of the City's industrial pretreatment program, which includes the removal of heavy metals that would otherwise precipitate dissolved sulfide from solution. The City has been working diligently to address these odor issues and has made significant progress in controlling odors within its sewer system.

Hydrogen sulfide is generated within sewage when sulfates, naturally present in wastewater, are converted to hydrogen sulfide by bacteria residing in the slime layer on the pipe walls, or on debris in the wastewater. This activity increases when certain conditions exist in the collection system such as low dissolved oxygen content, high-strength wastewater, long detention times, and elevated wastewater temperatures. For example, low sloping sewers cause the flow to slow down, resulting in the increased settling of organic solids and grit in the sewer. This debris deposition further slows down the flow. Consequently, this condition increases sewage detention times in the sewer, allowing the sewage to become oxygen deficient or septic.

Hydrogen sulfide and other dissolved gases are released in areas of turbulent flow. For that reason, higher hydrogen sulfide concentrations are generally found near line bends, pipe size changes, areas of dynamic slope changes, junction structures, diversion structure, siphons, etc. This gas will typically escape the sewer system through maintenance holes as part of the natural movement of air in and out of the sewer system caused by the daily rise and fall of flow levels in the sewers. However, constrictions in the sewer or reduced sewer headspace due to continuous high flows can result in venting of gases from the sewers.

## 1.3 History of Odor Control

During the design and construction of the North Outfall Sewer (NOS) in the mid 1920s, it was recognized that settled debris in the bottom of sewers can increase odor production. Therefore, the NOS was designed with a slope which would provide the highest possible water velocity to prevent debris deposition. Furthermore, the NOS was constructed with a semi-elliptical cross section and lined with corrosion-resistant clay tiles above the spring line. However, an inspection in 1936 found that large portions of the sewer were missing tiles, mortar joints between the tiles were reduced to mushy gypsum, and the concrete behind the tiles was found to be soft and porous. Engineers realized that the solution to prevent damage and deterioration of the sewer pipes was to prevent the formation of hydrogen sulfide gas and its oxidation to sulfuric acid, thus reducing the accumulation of acid on the pipe walls.

On February 24, 1937, the Board of Public Works adopted the Board report recommending that the City conduct an experiment to ventilate a portion of the NOS to reduce the formation of acid producing gas. The experiment used a fan to evacuate air at one location and admitted fresh air at various intervals along the sewer. Ventilation started on January 3, 1938. Daily records were kept of the following items: fan speed, quantity of exhausted air, temperatures of the exhaust air and atmosphere, H2S content of the exhaust air, amount of vacuum in suction line, and quantity of air admitted at the various openings in the sewer. At the end of the experiment in November 1938, the condition of the entire outfall was so greatly improved that the City Engineer recommended that a permanent ventilation station be built at the test site. More ventilation stations were constructed to ventilate other sections of the NOS and the Central Outfall sewer as well. In the 1940s, it was discovered that inverted siphons were a significant cause of gas ventilating from the NOS due to the blockage of the sewer's headspace caused by the siphon. Ventilation and deodorization systems were installed on the upstream side of the siphons to prevent odors releasing into the atmosphere.

In the 1950s and 60s the City of Los Angeles grew considerably and the volume of wastewater had subsequently increased. As existing collection systems began to reach capacity, additional sewers were constructed to carry the increased flow. This increased flow and its gas ended up in the NOS and other outfall sewers, increasing the ventilation of gas from these outfalls. Since the principles of natural sewer ventilation were not understood at this time, it was decided to seal the offending maintenance holes with tar and sand, and occasionally, insert trays filled with activated charcoal to adsorb the odor compounds.

Unknown at the time, sealing maintenance holes to prevent the release of gas resulted in increased pressure in the sewer. With no pathway for release, the pressure increased at those locations, causing sewer odors to vent through other maintenance holes nearby and in many cases, be forced up house connections and released through the roof vents of homes. The City began installing "gas traps" on tributary sewers to prevent the upstream migration of sewer pressure. In some cases, new sewers were built to intercept tributary sewers and route the flow to a location where air pressure could be controlled.

The increase in sewage and subsequent increase in pressure led to more odor complaints and the City began an aggressive program of chemical addition in the early 1990s. Chemicals are commonly used today to react with or remove dissolved sulfide and hydrogen sulfide from wastewater. Since hydrogen sulfide gas is the main compound responsible for odor complaints, chemical addition strategies for eliminating it were developed as far back as the early 1940s when the City was adding chemicals to control odors from sewers on an as-needed basis. Chlorine or hypochlorite solutions were used due to availability and effectiveness. In the 1950s, iron-containing solutions such as ferrous chloride and ferric chloride dominated as supplies increased and costs became more reasonable. Iron solutions are still a very common chemical used for sulfide control in sewers and have a high degree of effectiveness; however, due to their rising cost, the City of Los Angeles has shifted to magnesium hydroxide, which is less costly and more effective. The City targeted its chemical addition program at those locations most susceptible to generating sewer odors and therefore, where it would have the greatest benefit for the entire system.

It was not until the mid-1990s that the dynamics of natural sewer pressurization were identified and understood by scientists and engineers. Many large-diameter sewer depressurization projects were designed and installed in various parts of the country based on the new natural pressurization dynamics research. These successful projects demonstrated that the pressure effect in sewers could be calculated to a high degree of certainty and that control measures could be successfully designed, installed and operated.

The odor control program consists of systematic monitoring of the wastewater system, an effective operation and maintenance program, effective response procedures, adequate design standards, construction of relief sewers, construction of new odor control facilities, and implementation of new technologies. Additionally, in an on-going effort to better understand the nature of sewer odors and provide for continued improvements, the odor control program includes field investigations and analysis to identify the character of odors throughout the collection system.

The odor-control measures employed/planned by the City all work in concert with each other. It is these elements, when put together, that make the City's wastewater collection odor control program effective. The City has developed an odor complaint hotline, which allows for a more timely response, and quicker resolution of sewer-related odor complaints. The application of odor control chemicals has reduced hydrogen sulfide concentration in treated sewers by up to 90%. The use of air scrubbers at various hotspot locations in the collection system has contributed to a reduction in the release of odors in known venting areas. The construction of relief sewers such as East Central Interceptor Sewer and North East Interceptor Sewer Phase I have provided relief and reduced the high air pressures occurring in the sewer due to hydraulically overloaded pipes. The on-going repair of trap maintenance holes and construction of local sewers has alleviated the migration of odors from large-diameter sewers into neighborhoods and properties. The on-going maintenance program has decreased the potential for septic conditions. These odor control measures have led to a successful odor control program. While it is impossible to completely eliminate odor complaints, the City has and will continue to mitigate sewer odors through monitoring, complaint response, and effective implementation of odor control technologies.

The City's overall goal is to implement a cost effective and community-supported odor control program that will mitigate and control sewer odors, effectively inform the neighborhood councils, community groups and the Odor Advisory Board of the odor issues, and inform and advise the Board of Public Works and the City Council on the odor control program.

## 1.4 Collection System Settlement Agreement and Origin of the Master Plan

The City was required to develop an Odor Master Plan as part of the Collection System Settlement Agreement (CSSA). The CSSA is a settlement between the USEPA, the LARWQCB, a number of community groups representing residents in

South Los Angeles and the Santa Monica Baykeeper. In January 2001, the parties filed a lawsuit against the City of Los Angeles which alleged that the City's Sanitary Sewer Overflows (SSOs) and odor problems violated the Clean Water Act and the terms and conditions of the National Pollutants Discharge Elimination System (NPDES) Permits for the Hyperion Treatment Plant and the Terminal Island Water Reclamation Plant for the operation and maintenance of the City's sewer system. In October 29, 2004, the Court officially approved and implemented the Collection System Settlement Agreement (CSSA) between the City of Los Angeles and the EPA.

Sewer odor was a major and pervasive issue in some South Los Angeles areas. The CSSA addressed the odor problems by requiring the City to complete and institute numerous studies, projects, programs and capital improvement projects. One of the major requirements was the preparation of a City-wide odor control master plan. The master plan was to include an assessment of known problem areas, additional testing and monitoring, and recommended actions. The City was to develop the plan in consultation with the Odor Advisory Board. The first Odor Control Master Plan was issued in 2006 and was the first comprehensive odor control master plan produced by the City. Prior to this, there were standard operating procedures and measures in place to control odors, but no detailed plan on how to systematically reduce odors throughout the collection system.

In November 2009, a Modification to the Settlement Agreement was entered by the Court. The modification contained additional odor measures that the City needed to address including updating the Odor Master Plan annually.

## 1.5 Purpose and Objectives

The purpose of the Odor Control Measures Master Plan is to be both educational and functional. This document will provide a history of the odor issues in the City's wastewater collection system, establish an understanding of the science of sewer odor production and the technologies available, and present a proactive plan to manage and address the sewer odors.

The general objectives of the Odor Control Master Plan are:

- Provide an overview of odor issues associated with the wastewater collection system.
- Document and evaluate the current odor control program.
- Document the effort to characterize odors and identify their causes within the collection system.
- Provide recommendations to effectively manage odors in the collection system.
- Provide a proactive systematic approach to odor prevention and control.

The objective of the City's wastewater collection system odor control program is to proactively address sewer odor issues in the wastewater collection system by performing the following activities:

- Monitoring the wastewater collection system;
- Documenting and respond to odor complaints;
- Improving the design of the sewer system;
- Installing/building odor-control units/facilities;
- Dosing selected pipelines with chemicals to eliminate components that lead to odors and;
- Investigating new technologies to identify better materials or processes to control odors.

Additionally, in an on-going effort to better understand the nature of sewer odors, the odor control program includes an effort to investigate the character of odors throughout the collection system and evaluate the current operation and maintenance policies and practices.

The effort to monitor the sewer system will involve developing and implementing a city-wide odor and ventilation monitoring system including installing hydrogen sulfide gas monitors (data loggers) in sewer maintenance holes, installing sewer air pressure monitors to measure pressure differences in key locations to detect the potential for off-gassing to the atmosphere, and collecting data to determine the odor-causing characteristics of sewage. After sufficient amounts of this data have been collected, it will be analyzed along with the sewer system's physical characteristics including the location of system restrictions and sewer gas constrictions such as siphons, in order to identify and prioritize potential causes and sources of odors. The City will also conduct various innovative tests such as concurrent air withdrawal and air pressure measurement tests (fan tests) to verify the cause of venting gasses from the sewer system and to help identify and validate appropriate solutions.

The City already has a system in place for documenting and responding to odor complaints. The City will continue this effort and will work with the residents to promptly and effectively address their concerns.

The City has developed and implemented an extensive system of capital improvement projects to reduce odors and improve the overall operation of the collection system. These projects include the reconstruction of major sewers which reduce the system's off-gassing by increasing sewer headspace, the construction of permanent gas/odor removal and filtering facilities, and chemical injection systems that will inhibit the generation of hydrogen sulfide gas within the sewage.

The City has also embarked on an effort to identify and evaluate new technologies to mitigate and resolve odor issues. The City will implement the new technologies, where appropriate, through either the operation and maintenance program or the capital improvement program. The City will also optimize the operation of this technology, monitoring and adjusting the systems to ensure maximum effectiveness.

The overall strategy and goal is to implement a community-supported odor control program that will keep the public informed at various levels and to inform and advise the Board of Public Works and the City Council at every stage of the program.

## 1.6 Task Descriptions

The following general tasks are the basis of the odor control program:

- Monitor and respond to odor complaints.
- Measure hydrogen sulfide levels and air pressure in sewers to determine the quantity and quality of sewer venting gas.
- Collect and test samples to determine the characteristics of the sewage if the sewers are venting gas.
- Research physical characteristics of the sewer system including the location of restriction and sewer gas constrictions such as siphons and slope reductions.
- Analyze all data and information collected and determine the causes of the odors.
- Identify available, appropriate solutions and any technology available to help manage, mitigate, or eliminate odors.
- Evaluate the various alternatives and technologies.
- Recommend cost effective alternatives that are supported by the community.
- Keep the community informed through meetings with the Odor Advisory Board and public outreach efforts such as attending community meetings and distributing informative literature.
- Implement the recommendations through the operation and maintenance program or the capital improvement program.
- Monitor the performance of new applied technologies and make improvements as necessary.
- Summarize all of the findings, requirements, recommendations, and results in this master plan so that it becomes the blue print for mitigating sewer odors in our neighborhoods.
- Manage the odor control program and monitor its effectiveness. Make adjustments and improvements to the system as necessary to maximize performance.

# 2.0 EXISTING COLLECTION SYSTEM

The City's wastewater collection system is comprised of a network of underground pipes that extend throughout the city, conveying wastewater to one of four treatment plants for processing. The City-owned and operated system consists of approximately 6,500 miles of major interceptor and mainline sewers. Approximately 650 miles of these sewers are primary sewers, which range in size from 16 inches to over 12 feet in diameter. Approximately 170 miles of the primary sewers are major interceptor and outfall sewers. The rest of the sewers (approx. 5,850 miles) are smaller secondary sewers that range in diameter from 6 inches to 15 inches. The system also includes 47 pumping plants, diversion structures, and various other support facilities such as maintenance yards.

The City owns and operates four major wastewater treatment facilities: Hyperion Treatment Plant (HTP) in Playa del Rey, the Donald C. Tillman Water Reclamation Plant (TWRP) in the Sepulveda Basin, Los Angeles-Glendale Water Reclamation Plant (LAGWRP) across the freeway from Griffith Park, and the Terminal Island Water Reclamation Plant (TIWRP) near the Los Angeles Harbor.

The system provides service to approximately 600,000 private residences, commercial establishments and industries within the City. The private sewer laterals, which connect buildings to the City's mainline sewers, are privately owned and maintained, and their total length is approximately 11,000 miles. The City also has contracts to provide waste water services to 29 satellite agencies. The agencies contracting with the City operate their own collection systems, which discharge into the City's system. Payment is based on the amount and volume of flow measured at their connection to the City's system.

The City's wastewater service area consists of two distinct drainage basin areas: the Hyperion Service Area (HSA) and the Terminal Island Service Area (TISA). The HSA covers over 500 square miles ($mi^2$) and serves the majority of the Los Angeles population. In addition, this service area includes several non-City agencies that contract with the City for wastewater service. The TISA is approximately 18 $mi^2$ and serves the Los Angeles Harbor area.

## 2.1 Hyperion Service Area Interceptor and Outfall Sewers

The following sixteen sewers comprise the major interceptor and outfall system for the HSA:

### 2.1.1 Coastal Interceptor Sewer (CIS)

The CIS serves the coastal area of the Santa Monica Bay north of the Hyperion Treatment Plant (HTP) to Topanga State Beach near Malibu. This sewer conveys wastewater directly to the HTP from Pacific Palisades, Venice, Mar Vista, the City of Santa Monica, and adjacent areas served by the Los Angeles County Sanitation District (such as Marina Del Rey).

The CIS is a circular pipe that ranges in diameter from 24 to 72 inches and is approximately 9.4 miles in length. Some parts are constructed of vitrified clay and other parts are reinforced concrete pipe. The concrete pipe is lined with polyvinyl chloride (PVC) to prevent corrosion of the concrete by sewer gasses.

### 2.1.2 Central Outfall Sewer (COS)

The COS was constructed in 1907 and originally conveyed wastewater directly to the Pacific Ocean. Now it conveys wastewater to the HTP. The COS is about 10 miles long and is, for the most part, elliptical in shape measuring 60 inches wide by 73 inches high, although some portions are 57-inch and 69-inch-diameter circular sections. Its original construction was brick and mortar. It was rehabilitated in the 1940s by replacing some of the brick and mortar, and subsequently lining the sewer with steel mesh and gunite.

### 2.1.3 North Outfall Sewer (NOS)

The NOS is one of the primary outfall sewers used to convey wastewater to the HTP. The NOS extends upstream from the HTP through Culver City, into downtown Los Angeles, continuing east of the Elysian Hills, turning north to travel around the Santa Monica Mountains, and then west through the southern portion of the San Fernando Valley (approximately 58 miles in length).

The NOS was constructed from the mid 1920s to the early 1930s. It is a combination circular and semi-elliptical sewer constructed of concrete, reinforced concrete, and vitrified clay. The portions of the NOS constructed of concrete are lined with clay tiles to resist corrosion. The downstream portion of the NOS (from the HTP to the intersection of La Cienega Boulevard and Rodeo Road) is currently being rehabilitated and therefore, flow is being diverted away from this section. Flow is being diverted into the North Central Outfall Sewer (NCOS) at the intersection of La Cienega Boulevard and Rodeo Road and into the North Outfall Replacement Sewer (NORS) in the Baldwin Hills area.

### 2.1.4 North Central Outfall Sewer (NCOS)

The North Central Outfall Sewer (NCOS) was constructed in 1957 to provide additional capacity to the system between the Baldwin Hills area and the HTP. This sewer relieves the lower portion of the NOS. The NCOS is a circular sewer with a maximum diameter of 114 inches and is close to 8 miles long. It is constructed of reinforced concrete pipe lined with PVC.

### 2.1.5 North Outfall Replacement Sewer (NORS)

The North Outfall Replacement Sewer (NORS), completed in 1993, relieves the NOS from the HTP to the point where the NCOS connects to the NOS in Baldwin Hills (approx. 8 miles). The NORS can also accept flow from several other interceptor sewers. The NORS is a circular pipe, which ranges in diameter from 96 to 150 inches. The NORS is constructed from reinforced concrete pipe lined with PVC.

### 2.1.6 West Los Angeles Interceptor Sewer (WLAIS)

The WLAIS primarily serves the West Los Angeles area by conveying wastewater to the NOS or to the NORS. The upstream portion of the WLAIS varies in size from 33 to 60 inches and is comprised of circular and semi-elliptical segments constructed in the 1920s. The lower section was constructed in 1950 with circular, reinforced concrete pipe lined with PVC, and includes an elevated box section (4’ H x 6’ W) crossing over Ballona Creek in Culver City. The entire WLAIS is approximately 4 miles long. It currently flows into the NORS through a diversion structure.

### 2.1.7 Westwood Relief Sewer (WRS)

The WRS was constructed in 1962 to provide additional capacity for overloaded sewers in the Westwood area. It also accepts some wastewater from Beverly Hills. The WRS is about 4.5 miles long, is circular in shape, varies in size from 33 inches to 60 inches, and is constructed of vitrified clay pipe and reinforced concrete pipe. The sewer crosses the creek using a concrete box similar to that used by the WLAIS. This sewer, which previously discharged into the NOS in Culver City, now discharges into the NORS via the same diversion structure that routes flow from the WLAIS.

#### 2.1.8 Wilshire-Hollywood Interceptor Sewer (WHIS)

The WHIS was constructed in the early to mid 1970s in order to intercept wastewater from trunk sewers in the Hollywood area and convey this flow to the La Cienega-San Fernando Valley Relief Sewer. This sewer ranges in diameter from 24 to 69 inches and is constructed of vitrified clay pipe and reinforced concrete pipe lined with PVC.

#### 2.1.9 La Cienega Interceptor Sewer (LCIS)

The LCIS serves West Hollywood and the area that lies roughly between West Hollywood and Baldwin Hills. It was constructed in the 1920s with circular and semi-elliptical reinforced concrete pipe ranging in size from 27 inch diameter circular pipe to 63 inch-tall elliptical pipe. The LCIS is slightly over 6 miles long and outlets into the NOS, which is then diverted into the NORS.

#### 2.1.10 La Cienega-San Fernando Valley Relief Sewer (LCSFVRS)

The LCSFVRS was constructed in 1955 to relieve the NOS at the downstream (east) end of the San Fernando Valley near Toluca Lake. The LCSFVRS routes sewage directly through the Santa Monica Mountains and to the West Hollywood area. At Sierra Bonita Avenue, it splits into twin 42-inch pipes that join back into one 60-inch pipe downstream. The sewer travels through the Genesee Siphon near Venice Boulevard and along Genesee Avenue before reconnecting with the NOS near the intersection of Rodeo Road and Jefferson Boulevard. The LCSFVRS is approximately 11 miles long and is primarily constructed of reinforced concrete pipe lined with PVC, and ranges in diameter from 48 to 84 inches. The downstream portion of the LCSFVRS is a combination of 99-inch semi-elliptical and 99-inch by 115-inch rectangular sections.

#### 2.1.11 Valley Outfall Relief Sewer (VORS)

The VORS was constructed between 1953 and 1962 to relieve the NOS in the San Fernando Valley and essentially parallels the NOS for much of the Valley (approximately 16 miles). The VORS is constructed of PVC-lined, reinforced concrete pipe and ranges in diameter from 24 to 66 inches.

#### 2.1.12 Additional Valley Outfall Relief Sewer (AVORS)

The AVORS was installed in the late 1960s to provide additional hydraulic relief to the NOS and the VORS in the western portion of the San Fernando Valley. This sewer is one of the major pipelines conveying flow to the Tillman Water Reclamation Plant. The AVORS also parallels the NOS. It is constructed of vitrified clay pipe and PVC-lined reinforced concrete pipe ranging in diameter from 48 to 96 inches, and is over 10 miles long.

#### 2.1.13 East Valley Relief Sewer (EVRS)

The EVRS was constructed in the early 1980s to relieve the AVORS and the NOS near Kester Avenue and Magnolia Boulevard. Wastewater within this relief sewer can be routed through the NOS towards either the LA/Glendale Water Reclamation Plant or through the Santa Monica Mountains via the LCSFVRS to the HTP. The EVRS is almost 7 miles long. It varies in diameter from 39 inches to 51 inches, and is constructed of vitrified clay pipe and reinforced concrete pipe lined with PVC.

#### 2.1.14 East Valley Interceptor Sewer (EVIS)

The EVIS was constructed in 1987 and routes wastewater from the northeastern areas of the San Fernando Valley (City of San Fernando, Sylmar, Pacoima, Mission Hills, Panorama City, etc.) to the Tillman Plant. This sewer is constructed of vitrified clay pipe and PVC lined-reinforced concrete pipe. It varies in diameter from 36 inches to 84 inches, and is close to 9 miles long.

#### 2.1.15 East Central Interceptor Sewer (ECIS)

The ECIS was constructed in 2004. It will relieve the east-west segment of the NOS, from its outlet connection to the NCOS to the vicinity of Mission Road and Jesse Street near the Los Angeles River. The ECIS is approximately 11.5 miles long and 11 feet in diameter.

#### 2.1.16 Northeast Interceptor Sewer (NEIS)

The NEIS is approximately 10 miles in length extending from Mission Road and Jesse Street to Pecan Grove where the future Glendale Burbank Interceptor will be connected. The NEIS is being constructed in two phases. Construction of Phase I was completed in 2005. The NEIS Phase II has been combined with the GBIS and both are now in the pre-design phase. Construction is currently scheduled to be completed by 2020.

## 2.2 Terminal Island Service Area Interceptor Sewers and Force Mains

The TISA collection system consists of a network of major interceptor sewers and force mains that ultimately discharge into TITP for treatment and disposal. TISA collection system is comprised of four interceptor sewer systems. The four interceptor sewer systems are named after the respective force main through which their flow is pumped to the TITP. The following sections discuss the four interceptor sewer systems further.

### 2.2.1 Fries Avenue Interceptor Sewer System (FISS)

Wastewater collected from the Wilmington Basin is discharged into the Fries Avenue Interceptor Sewer System (FISS). The FISS also serves various industrial dischargers, some of which are on Harbor Department property. The FISS consists of four major pumping plants serving their respective interceptor (primary) sewers. The first three major pumping plants are Hawaiian and B Pumping Plant (No. 677), East Wilmington Pumping Plant (No. 676), and Fries Avenue Pumping Plant (No. 666). These three major pumping plants discharge directly to TITP via a common 30-inch force main known as the Fries Avenue Force Main. The Fries Avenue Force Main receives additional flow from a connecting pumping plant located in the northern portion of Terminal Island. This fourth pumping plant is the Harris Avenue Pumping Plant (No. 669) and is tributary to only the TITP via the Fries Avenue Force Main. The 30-inch Fries Avenue Force Main is the single major means of wastewater conveyance from the Wilmington Basin to Terminal Island, and crosses under the East Basin Channel of the Los Angeles Harbor.

### 2.2.2 San Pedro Interceptor Sewer System (SPISS)

The San Pedro Interceptor Sewer System (SPISS) serves most of the residential areas of San Pedro, the industrial area consisting primarily of the Phillips Conoco Refinery, and some industrial facilities located on Harbor Department property. The SPISS contains one major pumping plant serving its respective primary sewers. The major pumping plant is San Pedro Pumping Plant (No. 691). This pumping plant discharges directly to TITP via a 30-inch force main, the principle means of wastewater conveyance from San Pedro Basin. The 30-inch San Pedro force main traverses the Los Angeles Harbor Main Channel near the Vincent Thomas

Memorial Bridge. A supplement to the SPISS system allows all flows from the Wilmington Basin into FISS to be diverted to the San Pedro Pumping Plant.

#### 2.2.3 Terminal Way Interceptor Sewer System (TISS)

Terminal Way Interceptor Sewer System (TISS) collects wastewater from the residential areas of the Coastal Zone of San Pedro Basin, the land use areas along Harbor Boulevard, the heavy industrial area south of 22nd Street, and Terminal Island not tributary to Harris Avenue Pumping Plant. Wastewater collected by the TISS from the Coastal Zone and industrial area south of 22nd Street is conveyed by means of a double-barrel siphon traversing the Main Channel of Los Angeles Harbor toward the sole major pumping plant of the TISS: the Terminal Way Pumping Plant (No. 671). This pumping plant is connected to TITP via a dual force main system (24-inch and 20-inch) that provides system redundancy.

#### 2.2.4 Former U.S. Navy Sewer System and Facility

The former "U.S. Navy Sewer System and Facility" consists of four separate force mains (two 6-inch, one 12-inch, and one 20-inch), a pumping plant, and collector sewers that previously served the U.S. Naval Reservation on Terminal Island. After the decommissioning of the U.S. Navy facilities, the City of Long Beach took over the assets of the U.S. Navy Sewer System and Facility that continues to deliver wastewater to the TITP.

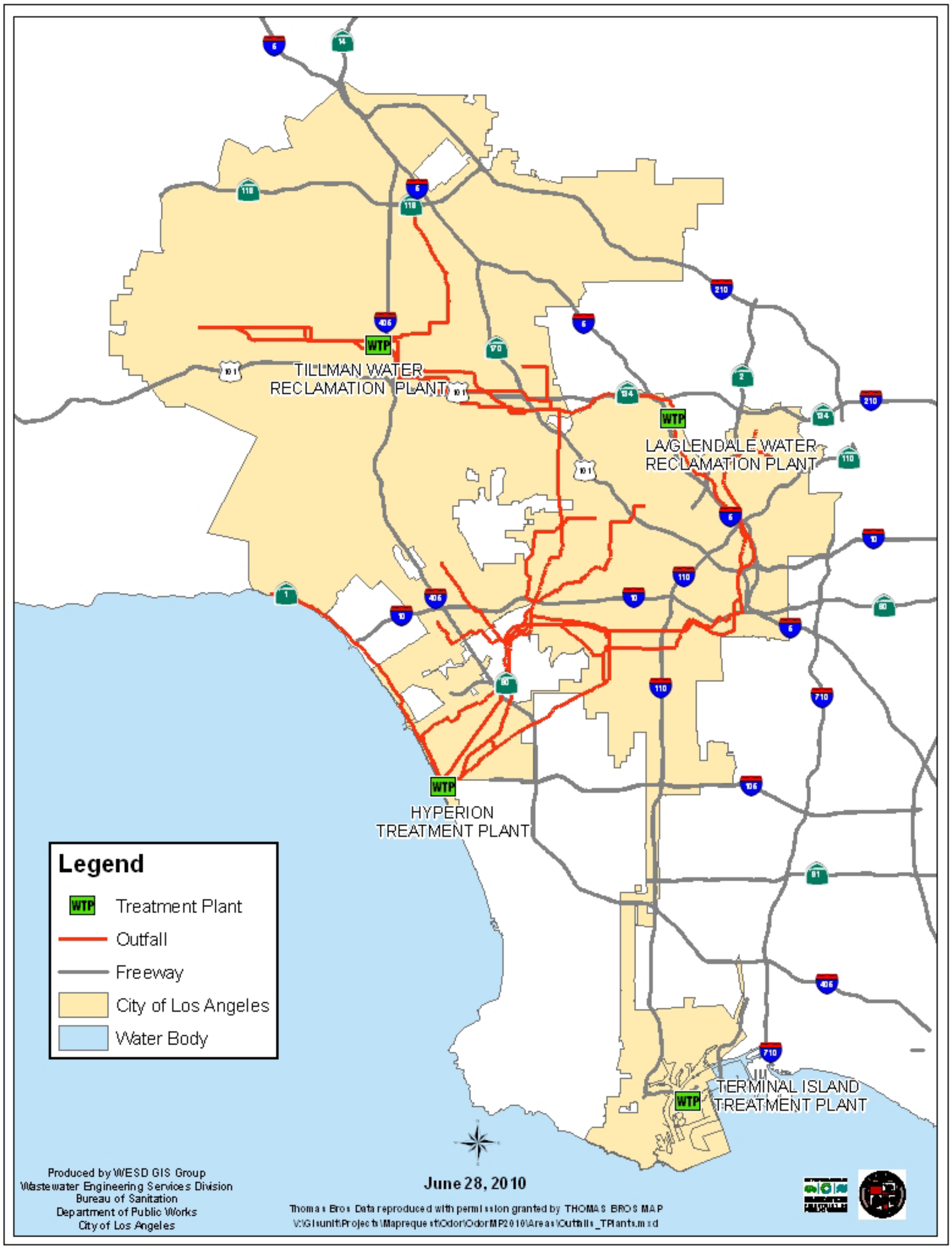
TILLMAN WATER
RECLAMATION PLANT
LA/GLENDALE WATER
RECLAMATION PLANT
HYPERION
TREATMENT PLANT
TERMINAL ISLAND
TREATMENT PLANT
Legend
Treatment Plant
Outfall
Freeway
City of Los Angeles
Water Body
Produced by WESD GIS Group
Wastewater Engineering Services Division
Bureau of Sanitation
Department of Public Works
City of Los Angeles
June 28, 2010
Thomas Bros Data reproduced with permission granted by THOMAS BROS MAP
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FIG. 2.1

# 3.0 OUTREACH

The City has been actively engaged in outreach activities for the residents of Los Angeles regarding the Bureau's Sewer Odor Control Program. The outreach has multiple purposes. The first is to educate the public about the City's efforts to control odors and about tools the City has made available to the public to facilitate their communication with the City. The other goal is to gather feedback from the public about the City's odor control efforts in order to measure the effectiveness of our programs and re-evaluate and modify them if necessary.

**The odor control outreach program can be divided into three principal components:**

1. Communication and coordination with the community-based Odor Control Advisory Board,
2. Distribution of flyers and refrigerator magnets containing odor control information and means of contacting the City for sewer odor issues,
3. Conducting an annual survey of the public in those areas where odors are the worst in order to gather feedback.

## 3.1 Odor Advisory Board

As part of the CSSA, the City was also required to create an Odor Advisory Board with members representing South Los Angeles communities to help assess the odor issues and review the City's mitigation efforts CSSA authorized the Odor Advisory Board to work closely with the City in its effort to resolve and mitigate sewer odors to the maximum extent practicable. The CSSA states that the Odor Advisory Board's role will last for the term of the Settlement Agreement (10 yr-term), unless it is terminated by mutual consent of all the parties. The Board serves as the City's primary point-of-contact with residents of south Los Angeles regarding sewer odor control issues.

The Odor Advisory Board interest focuses mostly in the south Los Angeles communities (mainly around MLK/Rodeo between La Cienega and Arlington) which fall within the 8th, 9th and 10th Council Districts. The Odor Advisory Board was formed in September 2002 and began meeting on a monthly basis. Odor complaints, odor investigation procedure, the mitigation measures and the long-term odor control efforts underway by the City were provided to the Odor Advisory Board for review and input and the City continues to provide the Odor Board with quarterly reports on odor control efforts.

The Air Treatment Facilities (ATFs) were to be placed at strategic points throughout the City, concentrated in those areas with the most odor complaints, many of which were in South Los Angeles. The original locations of the ATFs were presented to the OAB and subsequently, when the construction of five of the ATFs were placed on hold until the outcome of the ATF Review Study, the City presented again to the Board for input and comments. The City reports at least quarterly to the OAB on the progress of the Study. The Board members have attended several field trips including a Fan Test, the Hyperion Treatment Plant, the East Central Interceptor Sewer (ECIS) construction site at the southeast corner of La Cienega Avenue and Jefferson Boulevard and the ATF at ECIS. The Odor Advisory Board also met with the independent odor consultant to provide input for the Independent Review of the Odor Control report called for in the original CSSA and the Independent Odor Expert hired by the City as required in the CSSA Modification regarding the ATF Review Study.

The Board members made several recommendations for improving both the City's odor hotline and the outreach effort to inform residents about the hotline, and assisted in the Odor Hotline public outreach by distributing the flyers as included in the newsletters. The City, along with the Community Liaison, has attempted to recruit new members and keep the board functioning at a time when attendance has been decreasing. As part of the Modification to the Settlement Agreement, the OAB was expanded. The OAB is meeting again on a quarterly basis and will have close communication with the Odor Expert and the Community Liaison.

The Odor Advisory Board continues to provide valuable input in the City's odor control effort including outreach efforts and providing feedback regarding the effectiveness of the interim odor control facilities and concerns of the community.

## 3.2 Odor Expert and Community Liaison

As part of the Modification to the CSSA that was entered into the Court in November 2009, the City hired an Independent Odor Expert (Expert) and a Community Liaison. The role of the Independent Odor Expert is to review all ATF Review Study related documents and provide comments and recommendations. The Expert also attends OAB meetings where he discusses any material he has received from the City and answers questions from the OAB. The Odor Expert will work closely with the City and shall serve until June 30, 2011 or until the study is complete. The Community Liaison facilitates information exchange and discussion between the community and the City regarding odor conditions, sewer odor control activities, and the ATF Evaluation Study. The Community Liaison will serve until June 30, 2014, which is the completion date for the CSSA.

## 3.3 Odor Outreach Program

### 3.3.1 Annual Survey

Since June 2006, the City has conducted annual feedback interviews to measure the effectiveness of the Sewer Odor Hotline. The interview process includes conducting street interviews at problematic locations throughtout the City, mailing questionnaires to residents that complained through the Odor Hotline, and conducting presentations and distributing surveys at community meetings. All of the results are compiled and the survey results are reported in the CSSA Annual Report.

Overall, the community feedback has been very positive and encouraging. About half of the survey respondents noticed sewer odors in their community and approximately 70% felt that odors had decreased in the last few years. Regarding the hotline, the majority of the respondents were still unaware of the hotline. For those that were aware of it, comments for improving the hotline stressed the importance of maintaining a quick response time to odor complaints.

### 3.3.2 Newspaper Advertising

Due to the overall lack of public awareness regarding the odor hotline as discovered from last year's survey, the City began advertising the hotline in community-based newspapers in the South Los Angeles area. Newspapers were considered best since residents were reluctant to post signs along the street that advertised the hotline due to the negative image signs would convey about the community to passing motorists. The City is examining other methods of advertising that take these concerns into consideration. The ads were placed in local papers only and informed residents of the existence of the hotline and how to use it. The Bureau did see an increase in complaints after running the ads. The Bureau may continue to use this method as a tool to inform residents about the Odor Hotline.

### 3.3.3 Flyer Distribution

Odor control hotline flyers and magnets are distributed at community fairs, BOS Open Houses, neighborhood council presentations, and any other community meeting. The City distributes educational flyers that explain the City's odor control program and advertise the odor control hotline and a web site which the City operates as well. A sample of the odor control outreach flyer is attached at the end of this section.

# 4.0 SEWER ODOR GENERATION AND EMMISION

## 4.1 Odor ($H_2S$) Generation

Hydrogen sulfide is generated within sewage when sulfates, naturally present in wastewater, are converted to hydrogen sulfide by bacteria residing in the slime layer on the pipe walls, or on debris in the wastewater. This activity increases when certain conditions exist in the collection system such as low dissolved oxygen content, high-strength wastewater, long detention times, and elevated wastewater temperatures. For example, low sloping sewers cause the flow to slow down, resulting in the increased settling of organic solids and grit in the sewer. This debris deposition further slows down the flow. Consequently, this condition increases sewage detention times in the sewer, allowing the sewage to become oxygen deficient or septic.

## 4.2 The Phenomenon of Sewer Pressurization

Studies of air flow in the City's sewer system, especially in those areas that are experiencing strong and frequent sewer odors, show that the primary cause of odor release is pressurization of the sewer headspace.

**Pressurization of the headspace is directly related to the following:**

- Friction drag, influenced by wastewater velocity
- Change in wastewater velocity, influenced by change in slopes
- Physical characteristics of the system which influence airflow, such as:

  a- Depth of flow (d/D) and headspace constriction
  b- Diameter changes in downstream direction
  c- Inverted siphons
  d- Confluence of major tributary sewers
  e- Negative slope change

### Friction Drag and Air Movement in Conduits

The driving force which moves air within sewer pipes is friction between the sewer headspace air and the moving wastewater. For most of the sewer system, the only resistance to air movement in a sewer pipe is friction between the air and the walls of the pipe. Given these two principals, it is possible to generate a velocity gradient profile for air movement in sewers (Fig. 4.2.1). As might be anticipated, the velocity of the air is at a maximum near the surface of the water and decreases rapidly with increasing distance from the sewage. It is important to note that there are no stagnant air zones and that virtually *all* air in a sewer is moving with the wastewater.

There are many minor factors which act to enhance or diminish this friction and therefore the velocity and pressure of air in sewers. The friction factor between the water and air increases when the surface of the water is "roughened" by the generation of waves and "whitecaps" through turbulence or water velocities in excess of 5-feet-per-second (fps). This type of turbulence can be generated by steep slopes or drops.

Strong turbulence, such as that generated by large hydraulic jumps, long gravity drops, or a spraying force main, increases friction dramatically since the water is churned into individual droplets. The droplets have many times the surface area of smooth water flow and therefore generate increased friction with the air. This high friction added to the effects of increased sewage velocity can move high volumes of air down sewers. To make matters worse, turbulence in wastewater also increases the release of odors and corrosion-causing compounds from wastewater, such as hydrogen sulfide gas.

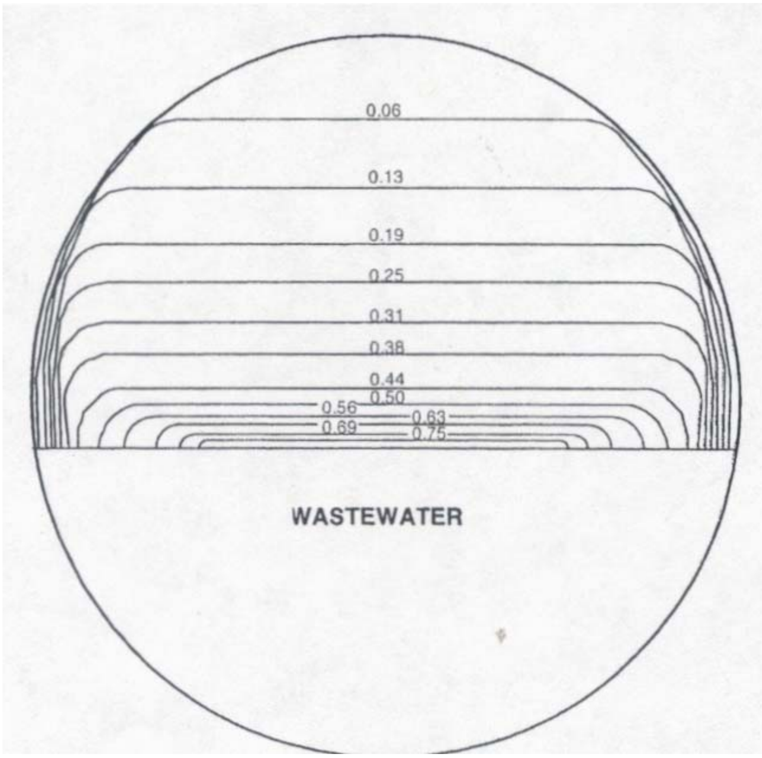



**FIGURE 4.2.1**
**IDEALIZED AIR VELOCITY CONTOURS**
**IN PERCENT OF WASTEWATER VELOCITY**

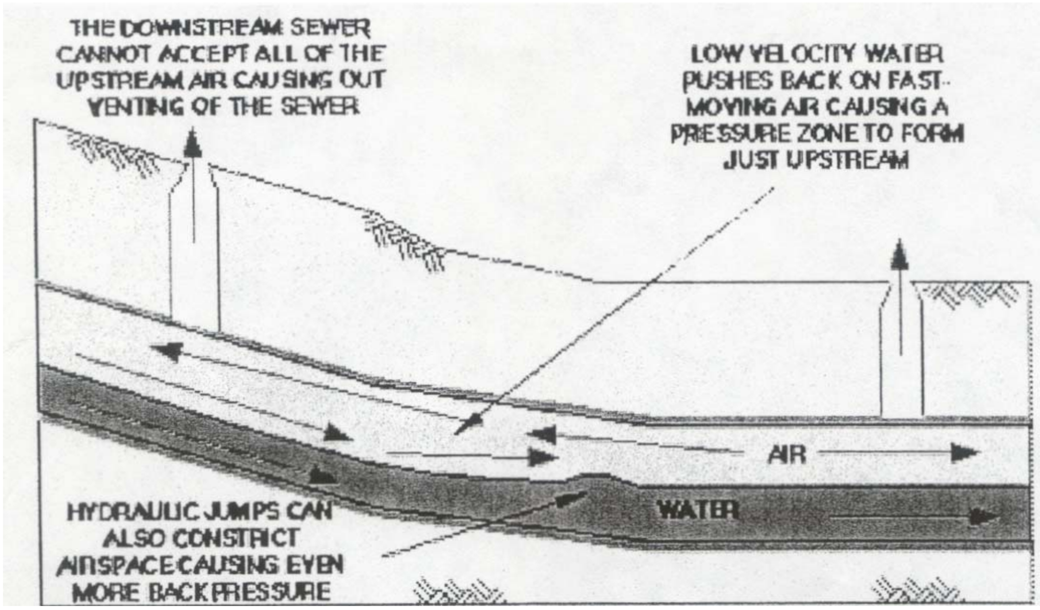



**FIGURE 4.2.2**
**PRESSURIZATION DUE TO SLOPE CHANGE**

### 4.2.1 Pressurization Due to Slope Reduction

Just as fast-moving wastewater can accelerate air movement; conversely, a slow-moving, calm water surface will exert minimal drag on the air and move relatively small volumes of air. Additionally, if the wastewater flow decelerates, then the friction between the fast-moving air and the slow-moving sewage will slow the air movement. Therefore, when the velocity of wastewater decreases due to a flattening of sewer slopes, the fast-moving air from upstream collides into the slower air in the flatter segment, generating high gas pressure. This high pressure pushes sewer gasses through the nearest openings and into the atmosphere, causing complaints (Fig. 4.2.2).

### 4.2.2 Pressurization Due to Air Headspace Constriction

The ratio of wastewater flow depth to the pipe diameter is expressed as d/D. When the pipe is half full, this ratio equals 0.5 and it equals 1 when the pipe is running full. Since the headspace above the wastewater conveys moving air, a constriction in this space will "squeeze" this air and it will become pressurized. Headspace constriction is one of the main causes of pressurization in the collection system. As the wastewater flow increases, it takes up more space in the pipe (the d/D increases) and the gasses are forced out and escape through any available routes such as house connections or vent holes.

### 4.2.3 Reducing Pipe Diameter in the Downstream Direction

A pipe's diameter is sometimes reduced in the downstream direction in order to "squeeze" past an existing underground structure. This creates a choke point in the pipe. The surface of the flow approaching this bottleneck tends to rise, forcing the air above into wave fronts that are pushed backwards. When these air waves collide with the air traveling downstream, pressurization occurs, forcing the gasses out of the sewer system.

### 4.2.4 Inverted Siphons

Any extensive sewage collection system in a metropolitan area is usually designed with inverted siphons due to the abundance of interfering structures. Inverted siphons are pipes or other conduits that dips down in order to pass under a structure blocking the path of the pipe. Because they have to dip down, they are always full of water and have no headspace in the pipe available for the movement of air. They therefore block the flow of any air that is traveling down the pipe towards them. Alternate air pipes called "air jumpers" are built for the air movement past the siphon and they join with the sewer once the siphon ends. Some jumpers are undersized and have become a source of gas pressurization.

### 4.2.5 Confluence of Major Tributary Sewers

Turbulence in wastewater flow not only leads to higher gas pressures in the sewers but also facilitates the release of hydrogen sulfide gas from the sewage into the headspace. When gas vents from a sewer into the atmosphere, it is the hydrogen sulfide gas that people smell and find so offensive. When one flow stream enters into another at a strong angle (i.e. perpendicular), it generates significant turbulence and leads to pressure and strong odor releases.

# 5.0 ODOR CONTROL TECHNOLOGIES

There are many technologies and strategies available to address odors in the collection system including liquid phase treatment, vapor phase treatment, and hydraulic improvements.

## 5.1 Liquid Phase Treatment

Liquid Phase Treatment is the addition of chemicals into the sewage in order to limit the generation of hydrogen sulfide ($H_2S$). Various chemicals can be employed for this purpose. The most common chemicals used are discussed below.

### 5.1.1 Calcium Nitrate (BIOXIDE)

Adding nitrates reduces sulfide generation in the sewage by replacing sulfates as the source of oxygen for the bacteria. This reduces the conversion of sulfates to sulfides. Calcium nitrate can affect sewage plant operations if overdosed. The increased nitrate levels in the sewage may result in the formation of nitrogen gas bubbles that inhibit settling in the treatment plant's primary clarifiers. But, when properly dosed, calcium nitrate will not have any negative impact on either pump station or treatment plant operations. As a benefit, the addition of calcium nitrate may result in a small reduction of $BOD_5$ in the plant influent, and furthermore, calcium is a required micro-nutrient for biomass growth.

### 5.1.2 Iron Salt

Ferrous chloride is an iron salt that reacts with sulfides and precipitates them out of the liquid. When this salt is added to wastewater, it immediately separates into ferrous iron and chloride. The ferrous iron then reacts with the sulfides to form ferrous sulfide, an iron-bound sulfide molecule that cannot dissolve in the wastewater. The subsequent decrease in dissolved sulfides reduces vapor phase H2S concentrations, reducing odor emissions. Its disadvantages include its proclivity, depending on the relative solubility of the potential resultant compounds, to react with negatively charged ions in the wastewater other than sulfide.

### 5.1.3 Metal Salts

Metal salts, such as ferrous sulfate, react with hydrogen sulfide and precipitate it out of solution by forming an insoluble metallic sulfide. The dose is 4.5 grams of ferrous sulfate for each gram of sulfide to be oxidized. This is less expensive than peroxide or chlorine.

The primary disadvantage of the above products is that they may contain a high free acid content which will increase the pH of the sewage. This can interfere with biodegradation of the waste.

### 5.1.4 Potassium Permanganate

This is a strong oxidizing agent that reacts with hydrogen sulfide in a variety of ways, depending on whether the stream is acidic or alkaline. In waste streams in which the pH is neutral, a variety of reactions occur, yielding elemental sulfur, sulfate, thionates, dithionates, and manganese sulfide end products. Potassium permanganate has been fairly effective when added to sludge dewatering operations, where it is added to the suction side of the sludge pumps feeding the dewatering unit. It has a few disadvantages. Dosages are difficult to predict and control in most liquid applications. The high cost and high dose, 6 or 7 parts of potassium permanganate are needed for each part of hydrogen sulfide, are discouraging. Safety precautions are required for handling and storage.

### 5.1.5 Chlorine and Sodium Hypochlorite

Chlorine combines with water to form hypochlorous and hydrochloric acid which kills the bacteria that produce hydrogen sulfide. It also oxidizes the sewage, which helps prevent the production of hydrogen sulfide. There are several disadvantages associated with chlorine. Chlorine also kills the beneficial, waste-degrading bacteria used to treat sewage. It also combines with urine in the waste stream to form chloramines, which are difficult to remove. Toxic or carcinogenic chlorinated hydrocarbons may form during treatment of chlorinated sewage. Additionally, chlorine is a hazardous material, requiring special safety precautions.

### 5.1.6 Hydrogen Peroxide

Hydrogen peroxide reacts with hydrogen sulfide, forming sulfur and water (see the chemical equation below). The reaction occurs quickly. Generally, 90% of the reaction occurs within 10 to 15 minutes and is completed within 20 to 30 minutes. For this reason, it is used to treat local problems only, since it doesn't have long-lasting or far-reaching effects. Any excess hydrogen peroxide decomposes, releasing oxygen and water, thereby increasing the dissolved oxygen in the stream. There are some disadvantages. It is relatively expensive and dangerous. It requires special safety procedures when handling, including the use of protective clothing. Face shields must be worn during bulk storage loading, repair, and maintenance of the facility. Spontaneous combustion is possible.

hydrogen peroxide + hydrogen sulfide ⟶ elemental sulfur + water

pH < 8.5 $$H_2O + H_2S \longrightarrow S + 2H_2O$$

hydrogen peroxide + sulfide ion ⟶ sulfite ion + water

pH > 8.5 $$2H_2O_2 + S^{2-} \longrightarrow SO_2^{2-} + 2H_2O$$

### 5.1.7 Oxygen/Air Injection

Oxygenation helps beneficial aerobic and facultative anaerobic bacteria reproduce faster than undesirable anaerobes. This allows the beneficial bacteria to consume more of the available nutrients. Its beneficial use is typically limited to force main applications due to its low saturation characteristics under atmospheric conditions.

oxygen + ionized hydrogen sulfide $\xrightarrow{bacteria^*}$ thiosulfate ion + water

$$2O_2 + 2HS^+ \xrightarrow{bacteria^*} S_2O_3^{2-} + H_2O$$

* anaerobic or facultative anaerobic bacteria

#### 5.1.8 Caustic Shock Dosing

Sodium hydroxide is added directly to the sewage through a maintenance hole upstream of the sulfide producing zone. It is added at a volume and rate to elevate and pH above 12.5 for at least 30 minutes to inactivate or kill the sulfate reducing bacteria. Periodic caustic shock dosing can effectively remove all sulfide forms.

#### 5.1.9 Magnesium Hydroxide

Continuous Addition – As the pH of wastewater rises, the natural state of sulfides in the wastewater shifts away from offensive H2S gas and towards dissolved sulfides in solution. Magnesium hydroxide raises the pH of wastewater and has a residual buffering capacity that maintains an elevated pH for a significant distance downstream of the application point. For this reason, magnesium hydroxide is continuously added to wastewater to raise and buffer it pH to within a range of 7.5 to 8.6. At a pH of 8.6, only 3% of sulfides exists as H2S gas while the vast majority of sulfides are held in solution in the form of disulfide and dissolved sulfide. Consequently, maintaining a high pH provides effective odor control.

## 5.2 Vapor Phase Treatment

Another strategy is Vapor Phase Treatment, which involves containing or treating the gasses and odors directly. Treatment methods involve either containing the gasses or filtering odors from gasses escaping from the collection system. Applications include sealing maintenance holes, inserting devices into maintenance holes, or constructing large facilities such as carbon scrubbers, biofilters, or biotrickling filters, the technology that the ATFs employ.

#### 5.2.1 Sealing Maintenance holes

The most straightforward method to treat odors in the vapor phase is to contain the vapors. The simplest solution is to simply prevent the gas from venting from the sewer system through the maintenance holes by sealing the maintenance hole lid with a mixture of roofing tar and sand. Sealing of maintenance holes is performed mostly on maintenance holes located on the large diameter sewers that experience headspace pressurization.

#### 5.2.2 Gas Trap Maintenance Hole

Another solution to trapping the gas is to construct a gas trap maintenance hole. A gas trap maintenance hole forms a water seal similar to a p-trap, which blocks sewer gasses from traveling upstream past the structure. They are constructed at locations where small diameter sewers discharge into large outfall sewers and they prevent pressurized sewer gases from being forced from the large sewer into the smaller sewers.

#### 5.2.3 Maintenance Hole Inserts

Inserts (e.g. Bioteg MH Biofilter) filter odors from sewer gases traveling up maintenance holes and are used at several locations throughout the city. Microorganisms in the filter media oxidize and remove odors from the gas before it exits the maintenance hole lid.

### 5.2.4 Large Air Treatment Facilities

Large air treatment facilities can be constructed to reduce the air pressure in sewers and remove the odors from large volumes of sewer gases before releasing it into the atmosphere. These facilities include carbon scrubbers, biofilters, and biotrickling filters.

#### *5.2.4.1 Carbon scrubbers*

Carbon scrubbers use activated carbon to adsorb $H_2S$ as it passes through the media. Advantages of carbon scrubbers include having a small footprint and a $H_2S$ removal rate of up to 99.5%. Scrubbers have several disadvantages including:

- Can only handle small flow rates (typically less than 20,000-CFM)
- Carbon media can require frequent replacement, depending on loadings
- Significant O&M cost
- Upgrading is difficult if flows increase due to process expansion
- Can let other odorous compounds pass through when media becomes "spent"
- Requires frequent operator attention to check state of media

#### *5.2.4.2 Biofilters*

Biofilters have proven to be an effective technology for removing VOC-type odors, hydrogen sulfide, and ammonia from air exhausted from livestock facilities. Biofilters are used quite frequently in waste water treatment systems. Proper biofilter design is critical for providing effective and economical treatment. To ensure proper performance, information regarding the relationship between unit flow rate through the biofilter media and the unit pressure drop across the media is needed. A biofilter uses microorganisms supported on organic media (bark, wood chips, compost) to convert odorous gases into non-odorous compounds. An organic media biofilter can destroy up to 90% of the VOCs in a foul air stream. Contaminated air passes through the filter where the microorganisms consume the organic carbon and produce CO2, water, and biomass. The bacteria residing in the water film on the media oxidize hydrogen sulfide to sulfuric acid, much of which is washed out of the bed as a result of the irrigation process or during wet weather events.

Organic media biofilters uses non-hazardous compounds, employ a relatively simple concept and require little maintenance, however they do have several disadvantages which include the following:

- Large footprint required (up to 2,500 sq ft. for 30,000 CFM @ 20 PPM H2S)
- Large capital cost
- Difficult to upgrade for increased air flows
- Settling of biofilter media can cause air channels to form in the media bed, reducing performance over time
- Organic media needs to be replaced after 3-5 years

#### *5.2.4.3 Biotrickling Filter*

Biotricking filters use the most current technology available. Water trickles over the filters, which are columns filled with inert packing media and a biofilm develops on the surface of the media. The biofilm is nourished by nutrients fed into the trickling stream to support biofilm growth. Most of the pollutant degradation occurs in the biofilm by a mass transfer and biological process. Natural media used in the filters can include soil, peat, compost, or bark, however, most biotrickling filters use engineered media which provide the advantages of natural media with a lower rate of fouling and longer life. The water is recycled over the media and the system is also supplied with essential nutrients for the biological organisms, which are the primary method in which contaminants are removed from the air. The organisms responsible for odor removal are usually aeriobic since the system is well aerated. Contaminated gas is supplied either co-current or countercurrent to the water's direction. Biotrickling filters are more operate similar to biofilters with a more complex removal system that is suited to treat compounds that when degraded, produce an acidic by-product such as H2S.

## 5.3 Hydraulic Design Improvements

In some cases odors vent from the sewer due to poor or inadequate hydraulic design. Another strategy for reducing odors venting from the collection system is implementing the adequate sewer design criteria to avoid hydraulic and geometric characteristics that either increase the production of odors or constrict the flow of gas in the sewer headspace, forcing it out of the sewer.

### 5.3.1 Low Flow Velocity

If sewage flows too slowly, sediment within the sewage settles out and deposits within the pipe. These deposits provide an ideal environment for an anaerobic slime layer where hydrogen sulfide is produced. Sewers should be designed to provide an adequate flow velocity to reduce the deposition of solids within the sewage and help eliminate the development of H2S.

### 5.3.2 Inverted Siphons

Significant odor issues have been associated with air pressure build-up on the upstream side of inverted siphons. It lies with the fact that the sewer pipe in a siphon flows completely full with no headspace within the pipe to convey the gas. Therefore, air ducts or "air jumpers" are needed to transport the gases across the siphon. These air jumpers have historically been undersized. Air jumper should be designed to provide sufficient headspace to convey the air across.

# 6.0 ODOR CONTROL MEASURES

Municipalities face daily challenges in their effort to control and mitigate sewer-related odors. The City has implemented a successful program to control and reduce odors within its collection system which has made significant improvements. Various measures are employed to reduce the generation and release of odors from the sewer system. They include:

- odor complaint response and investigation;
- routine sewer maintenance;
- chemical addition;
- air withdrawal and treatment from the collection system;
- sewer construction and repair; and
- on-going monitoring of sewer air pressure and odor concentration.

This section discusses these various odor control measures and procedures the City uses as part of the Odor Control Program.

## 6.1 Odor Complaint Response and Investigation

The Bureau of Sanitation, Wastewater Collection Systems Division (WCSD) responds to various odor complaints from the public. However, complaint investigation is geared toward identifying and mitigating sewer-related odors. Non-sewer issues are referred to other city departments or outside agencies for follow-up investigation and mitigation efforts.

The public can file an odor complaint through a 24-hour, operator-assisted odor complaint hotline (1-866-44SEWER) or use the City's website at www.lasewers.org. The City is trying to emphasize the 3-1-1 phone number for government services and information as the best way to file an odor complaint. Additional complaints are received through direct contact from the public and referrals from council offices other city departments.

The odor complaint response and investigation involves the following process:

1. The complaint is directed to the appropriate maintenance yard
2. A field crew investigates the complaint, identifies the source and determines/implements necessary actions to mitigate the odor such as cleaning the sewer, sealing maintenance holes, inspecting trap maintenance holes for structural integrity and function, or referring the matter to other city departments or outside agencies if it is not related to sewers.
3. The crew documents its findings and actions on an Odor Complaint Response Form and submits document for review and data entry.

4. For hotline complaints, WCSD informs the complainant within 7 days of the complaint about the findings, actions, and/or status of investigation and also gathers feedback. A 30-day callback is conducted if the complainant so requests.
5. Follow-up inspections are conducted if necessary
6. Problems not correctable by maintenance staff are referred to WCSD's Engineering Section for further investigation and possible solution. Typical engineering activities include:
   - reviewing sewer plans
   - conducting on-site field visits
   - reviewing odor complaints in the surrounding area
   - reviewing available flow monitoring data
   - monitoring pressure and $H_2S$ levels and evaluating the data
   - requesting repair of trap maintenance holes or other sewer structures by an on-call contractor
   - proposing a capital improvement project (CIP) such as hydraulic relief pipes, air treatment facilities, chemical addition systems, etc.

Fiscal year 2009/2010 there were 134 sewer related odor complaints. Compared to last fiscal year 2008/09, sewer related complaints were reduced by 48% (see FIG. 6.1.2). The first half of the fiscal year was challenging for the Bureau of Sanitation since a major portion of the sewer related odor complaints occurred during the 1st quarter of the fiscal year due to increased ventilation type complaints caused by defective trap maintenance holes, sewer ventilation through maintenance holes, odors from various major sewer rehabilitation projects and odors affecting those properties with house connections directly connected to large diameter sewers (see FIG. 6.1.1). Comparatively, the second half of the fiscal year was significantly improved due to repairs of trap maintenance holes, increased inspection of sewer maintenance hole and the completion of those sewer rehabilitation projects. All sewer related odor complaints were properly investigated and addressed.

| | Trap MH Defect | Sewer Ventilation | HC to >18-inch Sewer | Septic | Total |
|---|---|---|---|---|---|
| 1st Qtr | 2 | 41 | 7 | 5 | 55 |
| 2nd Qtr | 0 | 10 | 2 | 13 | 25 |
| 3rd Qtr | 0 | 18 | 4 | 5 | 27 |
| 4th Qtr | 1 | 16 | 3 | 7 | 27 |
| Total | 3 | 85 | 16 | 30 | 134 |

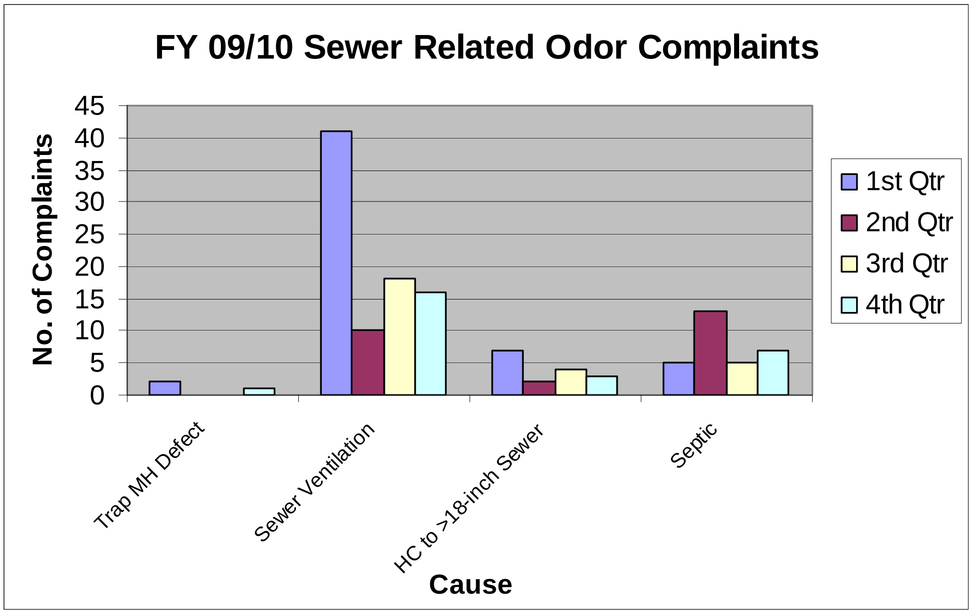



FIG. 6.1.1

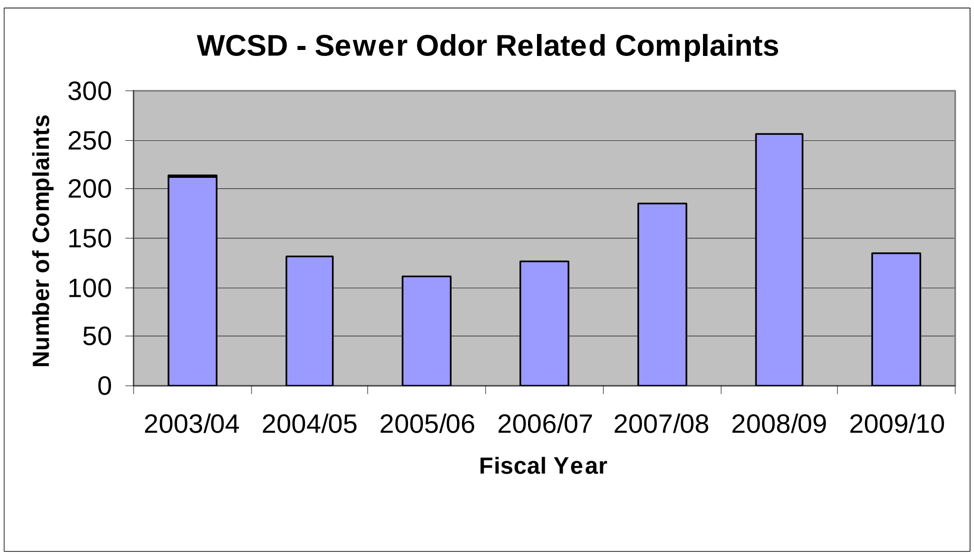



FIG. 6.1.2

## 6.2 Routine Sewer Maintenance

Routine sewer maintenance is necessary to allow the wastewater to flow freely and unimpeded in the sewer pipe. Obstructions in the sewer slow the sewage and cause debris to settle. As discussed earlier, this promotes the generation of hydrogen sulfide. Preventive maintenance includes sewer cleaning, root control, and trap inspection and/or maintenance. Other maintenance includes sealing sewer maintenance holes or other access points, where needed, to prevent the release of foul odors.

- **Sewer Cleaning and Root Control**
  Sewer pipes are inspected and cleaned periodically to prevent conditions that exacerbate hydrogen sulfide generation. There are several traditional cleaning techniques used to clear blockages. They include hydroflushing, rodding, and bucketing.

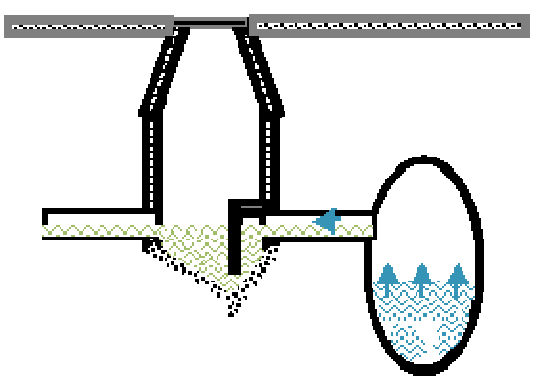
  *Hydroflushing* – Directs a high-velocity stream of water against the pipe wall. This process removes debris and grease build-up and clears blockages within small-diameter pipes.

  *Rodding* – A continuous or sectional rod with a blade at the end is inserted into the pipe and rotated. This action breaks-up grease deposits, cuts roots, and loosens debris.

  *Bucketing* – A cylindrical "bucket" with one closed end is pulled through the line, removing sediment and other material. This process partially removes large deposits of silt, sand, gravel, and some types of solid waste.

  All sewers are cleaned at least once every five years and more frequently in known "hot spots". Approximately 65,000 pipe segments (2800 miles) are cleaned annually. In addition to hydraulic and mechanical cleaning, chemicals are applied into root infested sewers to clear the roots from the pipe. Approximately 400 miles of sewers are treated annually.

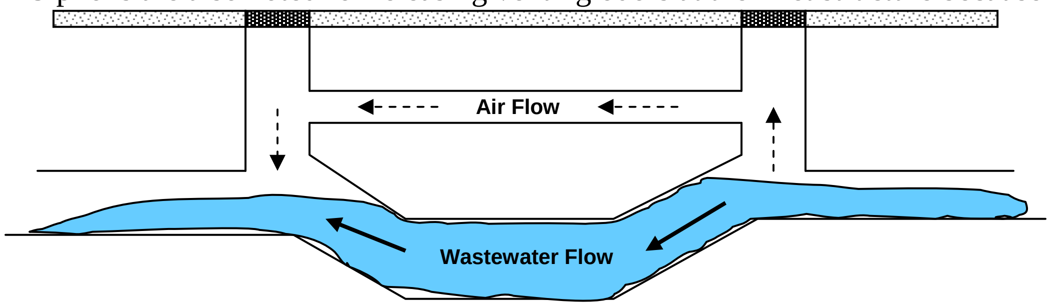
- **Trap Maintenance Hole Inspection and Cleaning**



Trap maintenance holes are inspected and cleaned on a quarterly basis. These structures are used to prevent the migration of sewer gases throughout the collection system. They are typically located where small sewers, 6-inches to 15-inches, connect to large interceptor and outfall sewers since high gas pressures are more prevalent in large sewers. Trap maintenance holes act similarly to p-traps used in residential plumbing by creating a water seal that blocks the sewer gases.

- **Siphon Inspection and Cleaning**
Sewer siphons descend to carry sewage under obstructions such as rivers, storm drains, or other utilities, and then regain elevation after passing the obstruction. The siphon always remains full of water, causing the sewage to move very slowly through a siphon during periods of low flow. For this reason, siphons and other submerged lines are prone to debris deposition and are likely sources of high $H_2S$ generation. To prevent this, siphons are cleaned quarterly.

Siphons are also noted for releasing venting odors at the inlet structure because the




full pipe blocks the air flowing downstream with the sewage. High turbulence at the siphon inlet aggravates this problem by stripping $H_2S$ out of solution and sending it airborne, adding to the odor. An air duct called an "air jumper" conveys the airflow past the siphon from the inlet to the outlet structure. Air jumpers often follow the sunken (inverted) path of the siphon line, allowing condensate to collect and impede the air movement unless it is drained. To prevent this, inverted airlines either drain automatically with pump systems or are dewatered manually using a vacuum truck. The pump systems are inspected periodically and manual vacuuming is performed on an as-needed basis.

- **Sealing Maintenance Holes**

Sewer maintenance holes provide access for maintenance crews. However, they also provide a route for sewer gases to escape when pressures build up. Sewer gasses can become pressurized for multiple reasons. At times of high sewage flow, the sewage

occupies a greater proportion of sewer volume than at times of low flow. As a consequence, some air in the sewer is displaced and finds its way out through maintenance holes or other access structures. Conversely, as flows decrease, fresh air is drawn into the sewers. This is a natural ventilation process that occurs in the collection system. As sewage flows, air in the pipe's headspace is dragged with it. Higher velocity flows will tend to pull in and drag more air down the pipes. When this air is blocked by an obstruction, it will vent through any relief available such as nearby maintenance holes. In areas where odors continuously vent, maintenance holes are sealed. Typically, this is done as part of regular maintenance activities or in response to odor complaints.

### 6.3 Chemical Control Technologies

Chemical or "liquid phase" control technologies limit the production of hydrogen sulfide by preventing sulfides from forming in sewage. There are numerous chemicals and methods employed for controlling sulfides, depending on the conditions under which they are being employed. For example, chemicals can halt new sulfide production or neutralize existing sulfides. The Bureau of Sanitation has researched and tested many types of liquid phase treatment since the early 1990s. Pilot studies were conducted to measure the performance of various chemical applications such as sodium hydroxide (caustic soda), ferric chloride addition, ferrous chloride, hydrogen peroxide, calcium nitrate (Bioxide), and magnesium hydroxide (Thioguard). The City began routine application of odor control chemicals in 1997.

Developing a chemical control program requires an extensive survey of the collection system in order to accurately choose a chemical and locate an injection point that will be effective. This process is described below.

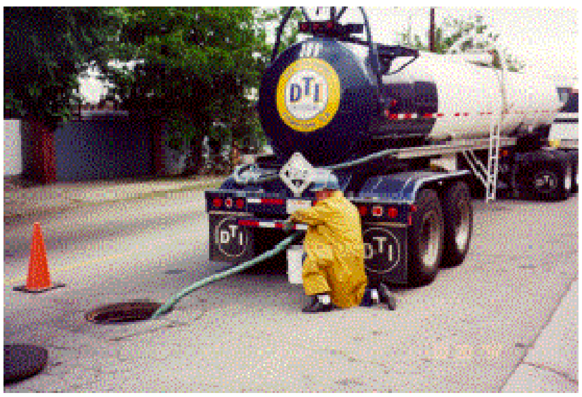
1. Review odor complaint history – Look for repeat odor complaints in a community.
2. Review collection system maps - Check size and type of nearby sewers (local sewer, interceptor sewer, or outfall sewer), pipe slope, flow rates and levels, locations of maintenance holes, junctions or tributary structures, and any pump plants or siphons.
3. Preliminary sampling – Sample the wastewater for total and dissolved sulfides, pH, and temperature. Hydrogen sulfide is measured using hand held meters and/or continuous data logging monitors. Sample all major tributary points to the problem area and proceed toward the upstream reaches. This is a quick and effective method to isolate problem areas requiring further investigation.
4. Determine baseline $H_2S$ profile and sulfide mass loading – Once a problem area is isolated, additional samples are taken to develop the baseline data profile which includes maximum, minimum, and average $H_2S$ levels over a period of 24-hours or more. This will be compared with data taken during the trial-and-error applications to measure effectiveness. Analysis of dissolved sulfide concentrations in samples along with known flow information helps determine the amount of sulfide present and where it is coming from.
5. Determine location for chemical injection – The monitoring data will identify the area generating sulfide. The injection point will be located at the most upstream reach of the generation zone to ensure adequate treatment.

Although there are theoretical formulas and rules regarding the dosing requirements for each liquid phase treatment process, it is not an exact science. Field analysis of the results and subsequent adjustments are required. Therefore, trial and error applications are common until an adequate dose level is achieved. Continuous monitoring is necessary to determine a cause-and-effect relationship of each treatment. Monitoring for

$H_2S$ is typically performed inside the maintenance holes because hydrogen sulfide dilutes immediately after exhausting into ambient air making concentrations much lower in the air outside the maintenance hole. Along with monitoring, each application should be correlated with the corresponding number of odor complaints in the affected area. A reduction in the number of odor complaints is an indication that the dosing levels are working.

Currently the Bureau of Sanitation is using a 50% sodium hydroxide solution called caustic soda and continuous Thioguard (magnesium hydroxide) addition to control odors in the collection system.

- **Caustic Shock Dosing Application**




The Bureau of Sanitation has been using caustic soda in a process called "caustic shock dosing" routinely since 1997 to control sulfide generation. The selection of this treatment was based on positive past experiences and its success in neighboring municipalities such as Los Angeles County and Orange County. Additionally, this treatment is ideal for the sewers targeted due to their long detention times which allow adequate contact time for treatment. Furthermore, caustic shock dosing is a very flexible process and can be mobilized quickly to treat any area of the collection system.

Periodic caustic shock dosing can effectively remove all sulfide forms. It inactivates, or kills, the biological slime layer where sulfates are transformed to sulfides. Monitoring has shown that the slime layer requires 3 to 5 days to re-form and reach full sulfide production again, depending upon pH, temperature, and contact time of the caustic soda. It rebounds more quickly in warmer weather. Therefore, the frequency of the shock dosing schedule varies with the seasons so as to prevent a complete rebound of hydrogen sulfide production.

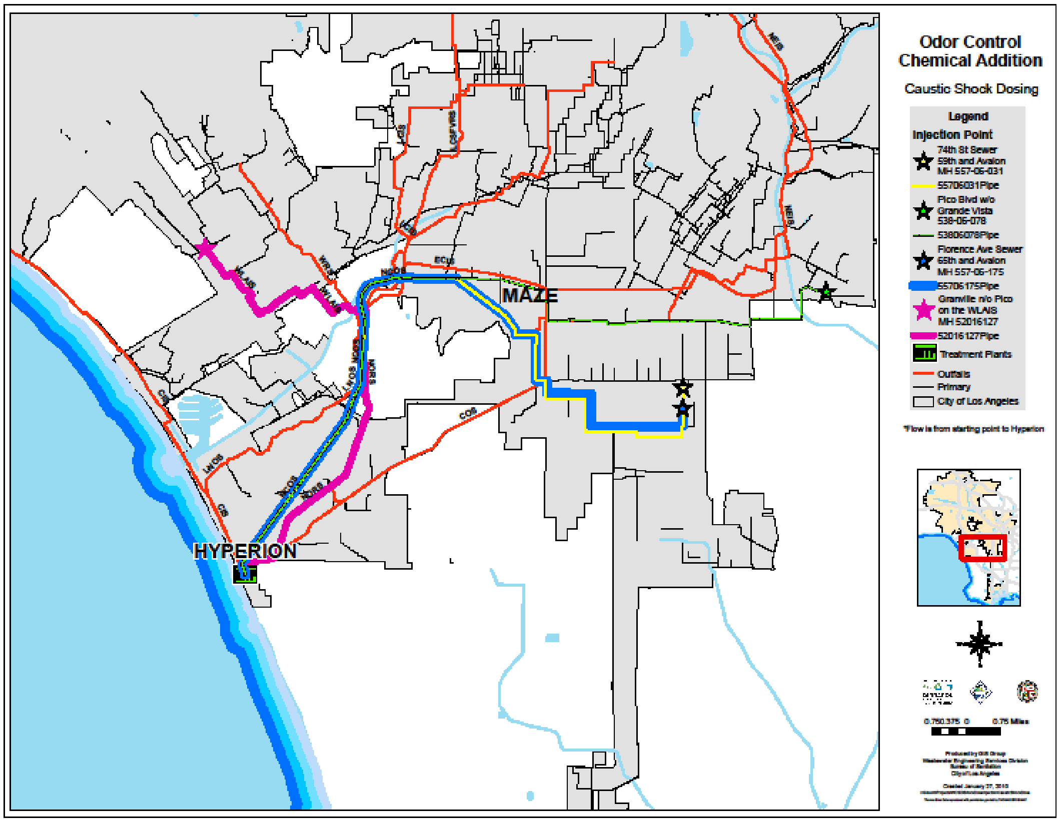
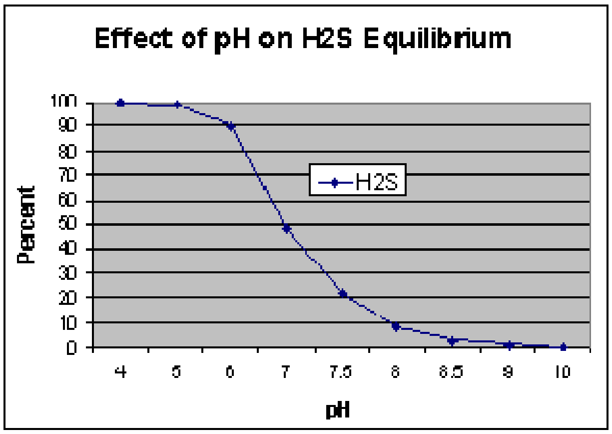



**FIG. 6.3.1**

Caustic soda is added directly to the wastewater stream through a maintenance hole upstream of the area to be treated and at the sulfide-producing zone. It is added at a volume and rate sufficient to elevate the pH above 12.5 for at least 30 minutes to inactivate or kill the sulfate-reducing bacteria. Continuous pH monitors are placed downstream of the application point to confirm that adequate treatment levels are attained. Caustic soda is applied upstream of the sulfide-generating area 1 to 3 times per week, depending on the generation rate and time of year. It is currently being applied to sewer reaches upstream of the Maze area which accounts for approximately 46% of the sulfide loading to the Maze Area Sewer System. The caustic injection in the South Los Angeles area is conducted on the Florence Ave Sewer and 74$^{th}$ Street Sewer. Both sewers are tributary to the South Branch of the Maze. In October 2009, caustic shock dose was re-started in the Boyle Heights Area Sewer System tributary to the NOS and North Branch of the Maze. This addition replaced the continuous magnesium hydroxide addition after re-evaluation of the effectiveness of this application. In August of 2008, caustic shock dose application began in the WLAIS due to higher H2S concentrations as a result of high dissolved sulfide generation caused by solids deposition in the large diameter sewer. See figure 6.3.1 for the chemical flow path.

As a safety precaution, all chemical applications are scheduled in advance and announced to all collection system personnel to avoid accidental contact with the chemical as it passes down the sewer system. Additionally, the treatment plant is notified prior to application. A shock dose schedule bulletin is distributed to wastewater collection system personnel, including those at treatment plants and the Bureaus of Engineering and Contract Administration. The bulletin includes location, date, time and volume of caustic to be added to the collection system.

- **Magnesium Hydroxide Continuous Addition**




As the pH of wastewater rises, the natural state of sulfides in the wastewater shifts away from offensive $H_2S$ gas and towards dissolved sulfides in solution. Magnesium hydroxide raises the pH of wastewater and has a residual buffering capacity that maintains an elevated pH for a significant distance downstream of the application point. For this reason, magnesium hydroxide is continuously added to wastewater to raise and buffer its pH to within a range of 7.5 and 8.6. As the graph shows, at a pH of 7, approximately 50% of all sulfides exist as $H_2S$ gas. At pH 8, that number falls to 10% and at pH 8.6, only 3% of sulfides exist as $H_2S$ gas while the vast majority of sulfides are held in solution in the form of disulfide and dissolved sulfide. A slight drop in pH results in a significant increase in $H_2S$ produced and thus emitted into the atmosphere. Consequently, maintaining a high pH provides effective odor control.

The City has been using a 65% magnesium hydroxide slurry as a non-hazardous means to regulate the pH of its wastewater since September 2003 as the result of a successful pilot testing. This application requires 20 to 25 gallons of magnesium hydroxide per million gallons of wastewater to control odors. Currently, magnesium hydroxide is injected from the Tillman Water Reclamation Plant and is introduced to AVORS to raise the pH of the downstream sewers in the NOS, EVRS, and the LCSFVRS. See figure 6.3.2 for the chemical flow path. This benefits both the Studio City area, Hollywood and Mid-City areas. The magnesium hydroxide addition in the Boyle Heights area was replaced by caustic shock dose treatment as described earlier.

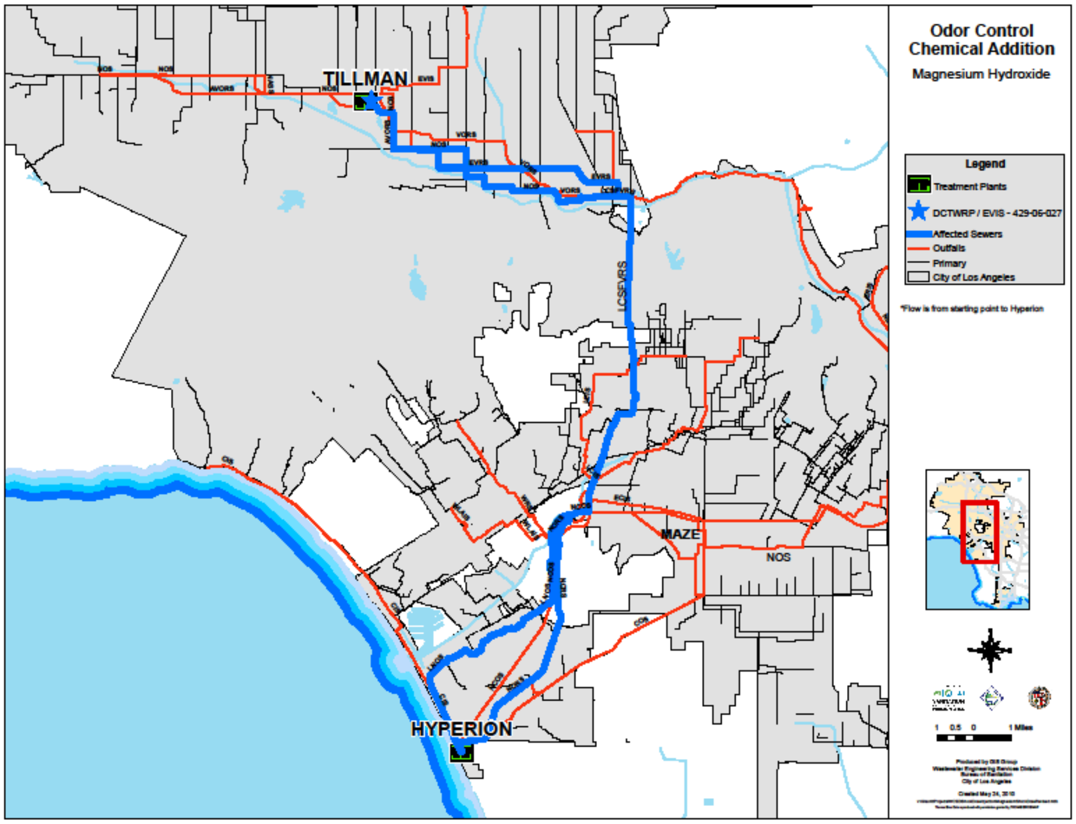


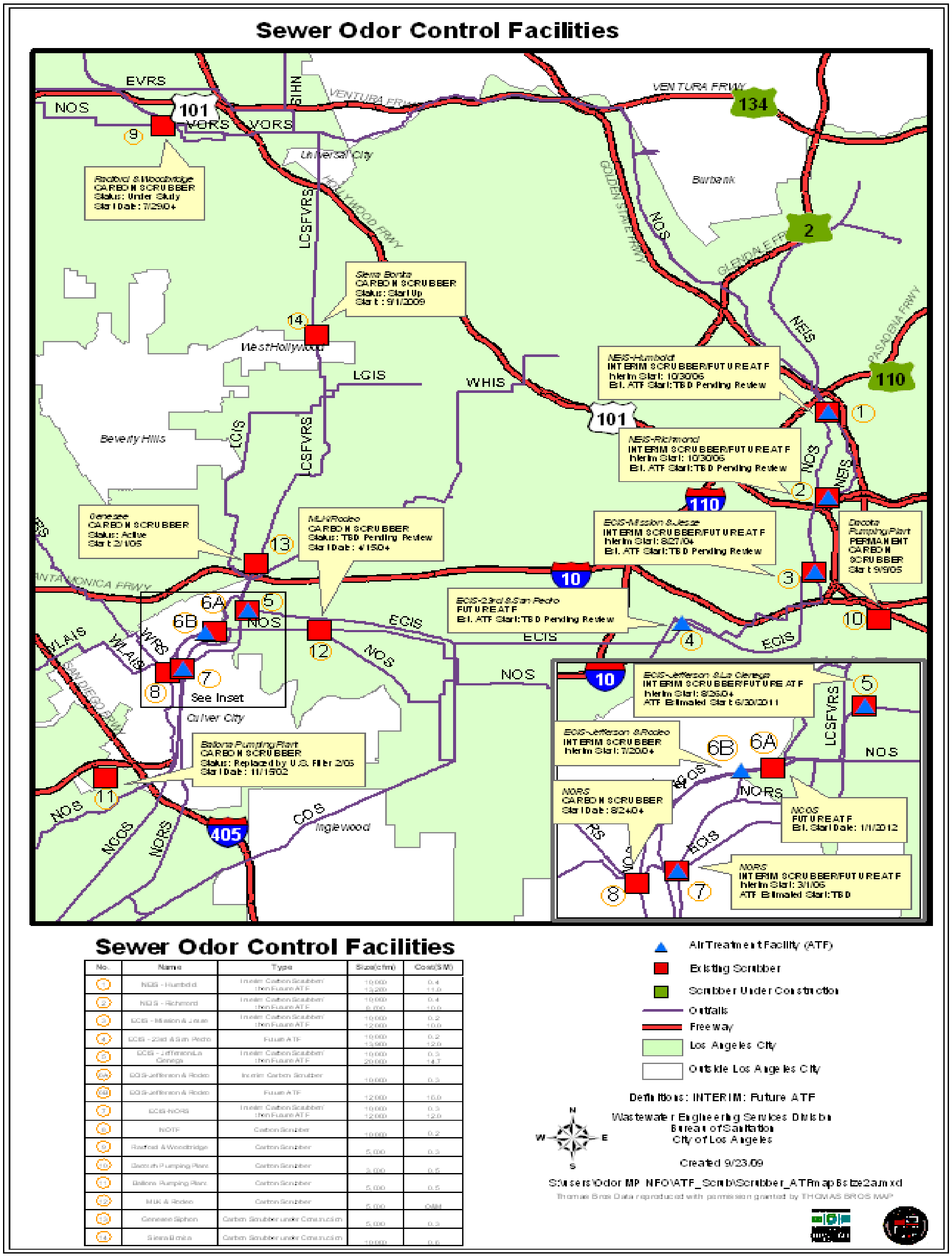

**FIG. 6.3.2**

## 6.4 Air Treatment

The City has conducted multiple studies of sewer gas pressure and odors. In the spring of 2001, the City embarked on a comprehensive air pressure monitoring study of several large-diameter sewers in central Los Angeles in order to identify the cause of persistent odor complaints along these sewers. The study identified distinct high pressure zones in sewers around the South LA area including:

- North Outfall Sewer (NOS)
- Maze Area Sewer System (Maze)
- La Cienega San Fernando Valley Relief Sewer (LCSFVRS)
- North Outfall Replacement Sewer (NORS)
- West Los Angeles Interceptor Sewer (WLAIS)
- Westwood Relief Sewer (WRS)

To address the high pressure zones and localize odor hot spots in the collection system, carbon scrubbers were constructed and permanent air treatment facilities are planned to alleviate and mitigate the odor emissions from the collection system (see figure 6.1)




| No. | Name | Type | Size(cfm) | Cost($M) |
|---|---|---|---|---|
| 1 | NEIS - Humboldt | Interim Carbon Scrubber/ then Future ATF | 10,000<br>15,200 | 0.4<br>11.0 |
| 2 | NEIS - Richmond | Interim Carbon Scrubber/ then Future ATF | 10,000<br>8,000 | 0.4<br>10.0 |
| 3 | ECIS - Mission & Jesse | Interim Carbon Scrubber/ then Future ATF | 10,000<br>12,000 | 0.2<br>10.0 |
| 4 | ECIS - 23rd & San Pedro | Future ATF | 10,000<br>13,900 | 0.2<br>12.0 |
| 5 | ECIS - Jefferson/La Cienega | Interim Carbon Scrubber/ then Future ATF | 10,000<br>20,000 | 0.3<br>14.7 |
| 6A | ECIS-Jefferson & Rodeo | Interim Carbon Scrubber | 10,000 | 0.3 |
| 6B | ECIS-Jefferson & Rodeo | Future ATF | 12,000 | 16.0 |
| 7 | ECIS-NORS | Interim Carbon Scrubber/ then Future ATF | 10,000<br>12,000 | 0.3<br>12.0 |
| 8 | NOTF | Carbon Scrubber | 10,000 | 0.2 |
| 9 | Radford & Woodbridge | Carbon Scrubber | 5,000 | 0.3 |
| 10 | Dacotah Pumping Plant | Carbon Scrubber | 3,000 | 0.5 |
| 11 | Ballona Pumping Plant | Carbon Scrubber | 5,000 | 0.5 |
| 12 | MLK & Rodeo | Carbon Scrubber | 5,000 | O&M |
| 13 | Genesee Siphon | Carbon Scrubber under Construction | 5,000 | 0.3 |
| 14 | Sierra Bonita | Carbon Scrubber under Construction | 10,000 | 0.6 |

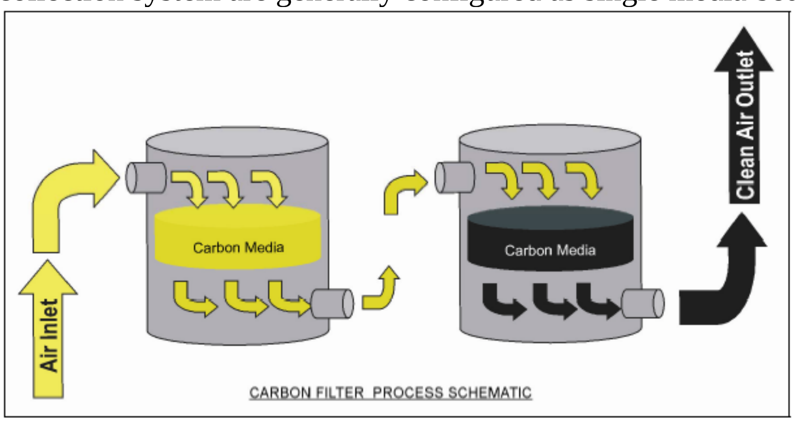
**Figure 6.4**

Figure **6.4** shows locations and information regarding the carbon scrubbers, the interim units, and the planned ATFs.

### 6.4.1 Carbon Adsorption

In July of 2001, the City conducted the ECIS Odor Control Study. These studies and other odor complaint investigations led to the recommendation that odor removal equipment be installed at various locations along ECIS in the South Los Angeles and central L.A. and at various pressure zones in the collection system. The solutions to remove odors in the area were the installation of 7 Air Treatment Facilities (ATF) which operate using biotrickling filters and activated carbon. Each ATF was going to take approximately 2-3 years to design and build; therefore, the City chose to install interim activated carbon scrubbers while the permanent ATFs were being planned. The seven interim units have a treatment capacity of 10,000 cubic feet per minute (cfm). Furthermore, seven additional carbon scrubbers were constructed to address other local odor issues in the collection system. These units range in treatment capacity from 3000 to 10,000 cfm. In total, 14 carbon scrubbers were constructed, but eventually one was removed leaving 13 carbon adsorption scrubbers in operation.

Conventional adsorption systems offer an effective approach to controlling odors in many situations. In municipal installations, odorous air is typically directed through a vessel containing adsorption media such as activated carbon. Odorous compounds in sewer gases are adsorbed onto the media. Adsorption systems in the City's wastewater collection system are generally configured as single media bed system. Activated carbons




are highly porous materials. Due to large surface areas, activated carbon is able to adsorb hydrogen sulfide, other reduced sulfur compounds and volatile organic compounds (VOC). These odor-causing compounds are attracted to and adhere to the carbon's pore structure. This process relieves the air pressure in the system while preventing the release of odors. There are currently thirteen carbon scrubbers operating in the wastewater collection system.

Scrubbers are operated under a permit issued by the South Coast Air Quality Management District (SCAQMD). As required by the permit, an operations staff monitors the hydrogen sulfide concentration of the influent air and the treated emissions in order to gage the performance of the scrubber. The typical hydrogen sulfide removal rate is 99%. These readings are posted on a quarterly basis on the City's odor website at www.lasewers.org. Carbon media in each unit is replaced periodically before expected odor contaminant breakthrough. The frequency of change-out, range from monthly to quarterly to bi-annually depending on the contaminant loadings to the carbon scrubber. Seven interim carbon scrubbers have been installed with plans to replace these units, if necessary, with permanent air treatment facilities (ATFs). They include:

1. ECIS Drop Structure - Mission and Jesse
2. ECIS Drop Structure - 23rd and San Pedro
3. ECIS Siphon – Rodeo and La Cienega
4. NORS/ECIS Junction
5. NCOS Siphon – Rodeo and Jefferson
6. NEIS Drop Structure - Humboldt and San Fernando Rd
7. NEIS - Richmond

Seven additional carbon scrubbers are installed at other sites to address localized odor hotspots within the collection system. They include:

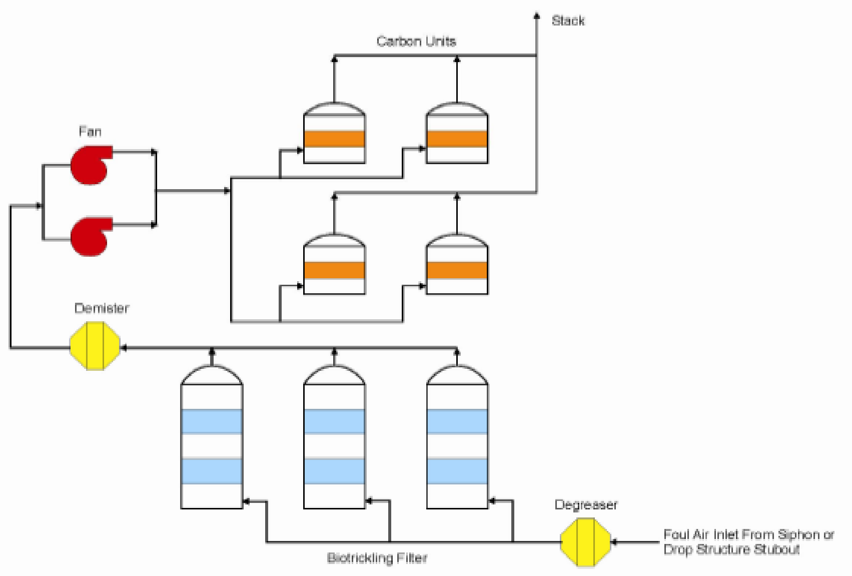
1. LCSFVRS – Sierra Bonita
2. LCSFVRS Siphon – Genesee
3. NOS Siphon – Radford
4. Maze/NOS Junction – Rodeo and Martin Luther King
5. WLAIS/NOS Junction – North Outfall Treatment Facility (NOTF)
6. Ballona Pump Plant
7. Dakotah Pump Plant

The installation of the carbon adsorption units alleviated and improved sewer ventilation conditions and odor emissions. However, there were operational challenges and adjustments. The 23rd and San Pedro carbon unit was removed in August 2008 as it was discovered that turning off and isolating the unit from the sewer system eliminated fugitive emissions from that location. This unit was eventually relocated to the NOTF. Some units were changed to operate in the passive mode. The passive operation allowed the use of the natural sewer pressures instead of mechanical means to move air through the carbon bed. This mode of operation eliminated pre-mature odor breakthrough from the carbon adsorption unit.

#### 6.4.2 Air Treatment Facilities (ATF)

Since the study in 2001 has been completed, additional sewers have been constructed, and other sewer repair and replacement projects have been completed. Due to these changes in the collection system, the City has come to question some of the assumptions that led to the recommendation for scrubbers and ultimately the ATFs at several of the proposed locations. In 2008, the City began conducting a study of drop structures, siphons, and the sewer system as a whole to re-evaluate the use of ATFs at the proposed locations. This study was called the ATF Review Study (Study). As part of the Modification to the Collection System Settlement Agreement which was entered by the Court in November 2009, the City was required to hire an Independent Odor Expert to review the City's interim and final findings from the ATF Review Study (Study). Until the Study is completed, the City decided to delay the design and construction of five of the seven ATFs.

To treat odors associated with two of the City's largest and newest wastewater conveyance tunnels, ECIS and NEIS, and the existing North Central Outfall Sewer (NCOS), the City of Los Angeles has been testing various odor control strategies for many years in order to develop the most cost-effective approach. After careful evaluation of the alternatives Air Treatment Facilities (ATF) using a 2-stage odor control system employing biotrickling filtration technology followed by a carbon adsorption polishing step.



ODOR CONTROL PROCESS SCHEMATIC

Biotrickling filter technology utilizes microbial cells that are attached to a medium inside the reactor, which then oxidize the odorous constituents to odorless compounds. The odor contaminants transfer from the gas to the liquid phase and subsequently to the microbial biofilm, or it is transferred directly from the gas to the biofilm, where it is oxidized biologically to odorless compounds. The oxidative by-products, namely sulfuric acid, are the removed through the trickling effluent. The treated effluent is then polished by carbon adsorption.

Currently, two (2) of the seven (7) planned permanent ATFs are under construction, they are the ATF at East Central Interceptor Sewer Siphon and LCSFVRS (Jefferson & La Cienega) and the ATF at North Central Outfall Sewer Siphon (NCOS). The ATFs were strategically placed to reduce the long standing odor issues in the South Los Angeles/Baldwin Hills area. The ATF at ECIS is in the start-up phase and construction is scheduled for completion in summer 2010. The facility is designed to ventilate and treat ECIS at the siphon and the LCSFVRS to mitigate sewer gas emissions. The facility will be treating 20,000 cfm of foul air. EPA approved the City's request for extension of ATF's construction end date from May 23, 2008 to September 30, 2010. The ATF located at 6000 Jefferson Blvd is designed to ventilate the pressurized North Central Outfall Sewer (NCOS) in order to mitigate emission of sewer gas. The facility will treat 12,000 cfm of foul air. The modified settlement date for construction of this facility is May

### 6.5 Sewer Construction and Repair

Sewer construction and repair play an important role in the City's odor control effort. Some odor problems are inherent in a given sewer's design and require auxiliary sewers to be built. Some problems are the result of failing components which need repair or replacement. Additionally, the City has been engaged in a large capital improvement program constructing new, major sewers which have multiple benefits for the collection system as a whole, one of which is odor control.

The City is continuously identifying locations where house connection laterals from private properties tie directly into a large outfall sewer instead of a small, local sewer. This is a direct source of odors since large sewers are much more likely to have high odor levels and high gas pressures. A direct connection allows odors from the large line to escape up the house connection and into the house or property. To address this issue, the City constructs local sewers adjacent to the large sewer to which the house connections will be reconnected in order to isolate the properties from the odor source. A trap maintenance hole is constructed at the end of the local line before connecting back to the large diameter sewer.

Trap maintenance holes are inspected quarterly and as part of an odor complaint investigation. As previously stated, there are instances when the integrity of these structures is compromised, in which case, the defective trap is repaired. The Bureau has identified all known problematic trap maintenance holes and has begun a program of repairing them on a systematic basis. This fiscal year, the City approved a new standard design of a trap maintenance hole. The new design will ensure a continuous seal and allow crews better accessibility to maintain the trap maintenance hole without compromising the seal. As a result of the modified Collection System Settlement Agreement, a project to upgrade 300 trap maintenance holes using the new trap design standard will be implemented in the upcoming fiscal years (see FIG. 6.5). Phase 1 of the construction, replacement, and upgrade of trap maintenance holes began during the 4th quarter of this fiscal year. This project is scheduled to upgrade 29 trap maintenance holes by 3rd quarter FY 2010/11. The major focus of trap repairs will be performed in the South Los Angeles area. It is expected that these upgrades will significantly improve sewer odor releases where trap maintenance holes are located.

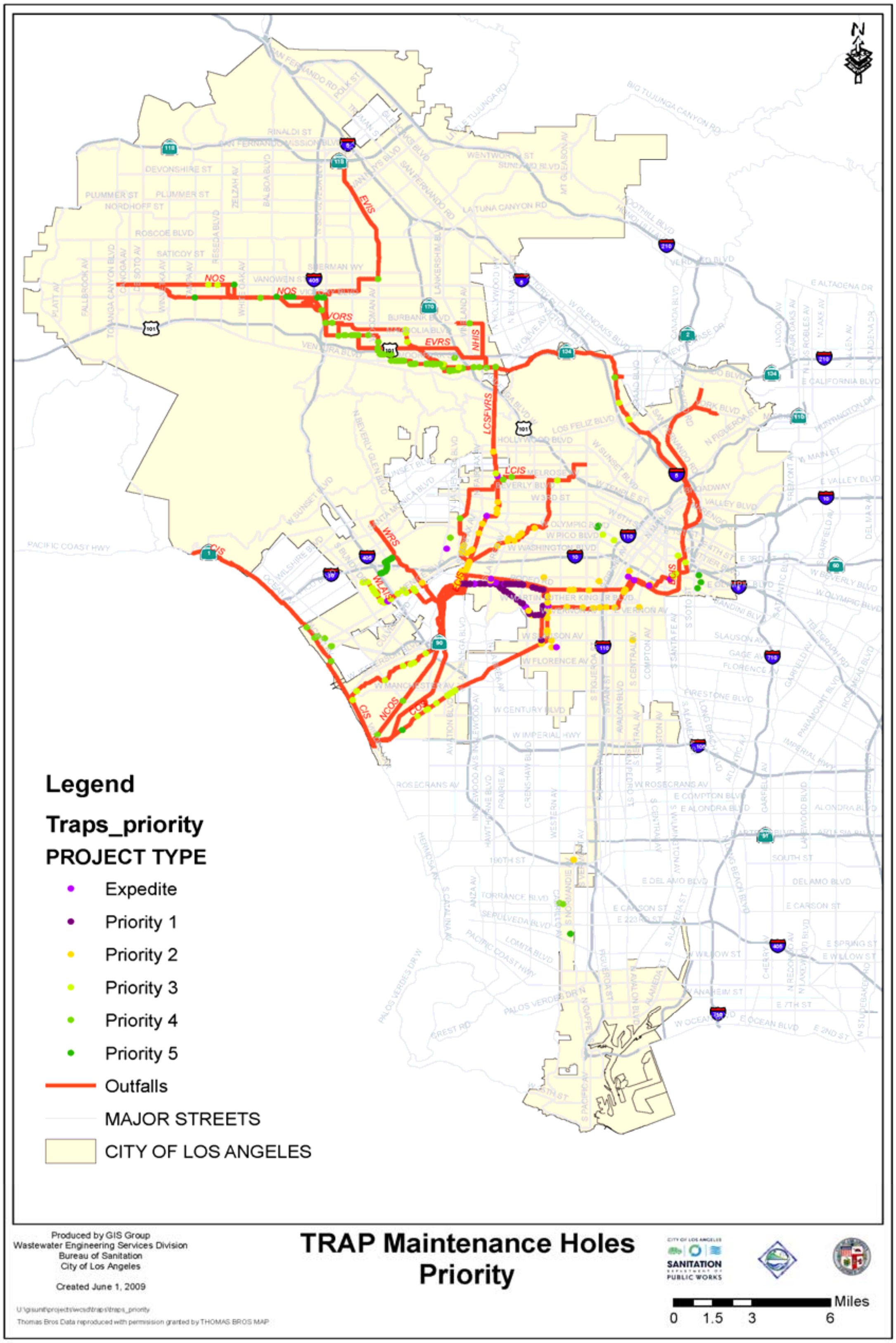

Legend
Traps_priority
PROJECT TYPE
Expedite
Priority 1
Priority 2
Priority 3
Priority 4
Priority 5
Outfalls
MAJOR STREETS
CITY OF LOS ANGELES
Produced by GIS Group
Wastewater Engineering Services Division
Bureau of Sanitation
City of Los Angeles
Created June 1, 2009
TRAP Maintenance Holes
Priority
SANITATION
Miles
0 1.5 3 6

FIG. 6.5

The City's program of constructing new, major sewers has many benefits, including odor control. The new sewers provide much-needed additional capacity to the collection system and relieve the existing sewers, which are carrying flows over their intended capacity. This not only improves the hydraulic capacity of the system, but also decreases the air pressures in the pipe's headspace above the flow. As flow is diverted from the existing sewers, the air space in these pipes increases and the air pressure therefore decreases. This reduces the likelihood of sewer gases venting out of the sewer system. The City continues to assess the hydraulic needs of the wastewater collection system and provide hydraulic relief where needed, reducing air pressure in the system. Flow diversion from NORS to Lower NOS in March 2010 has caused pressure reduction in the NORS siphon at the 405 Freeway. See Table 9.3 for more information.

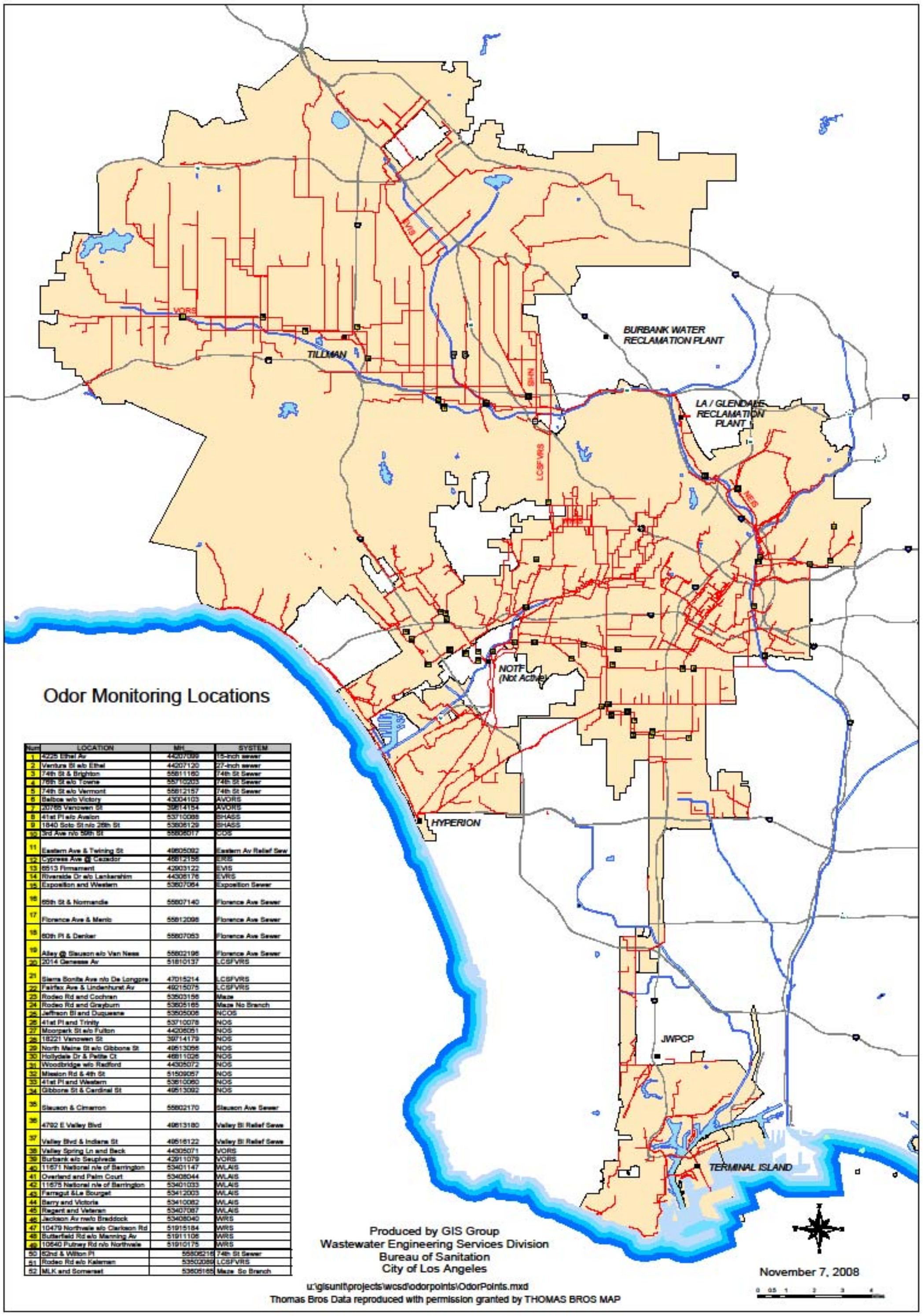
## 6.6 Monitoring

The collection system is regularly monitored in order to identify the source and cause of sewer related odors. A number of monitoring stations have been established at strategic locations in order to measure the parameter associated with odors (See Fig 6.6).

These locations include known odor hot spots, outfall and interceptor sewers, pressure zones, areas of turbulence, sharp slope change in sewer pipes (grade breaks), and sewer pipes with long detention times such as flat, low-velocity sewers. Parameters evaluated are:

a. Wastewater Characteristics – includes total and dissolved sulfides, pH, and temperature. These characteristics determine the potential for $H_2S$ formation.
b. $H_2S$ Gas Concentration – determines potential for odor complaints if released.
c. Air Pressure – determines potential sites of odor release
d. Sewer Odor Complaints – helps evaluate effectiveness of odor control measures and helps identify potential hot spots in the collection system

Monitoring is conducted at least semi-annually at designated points to gage the seasonal variation in odor generation and to monitor the adequacy and effectiveness of any chemical treatment. It is also used to confirm the location and potential of odor hotspots locations. This information is used as part of the odor master planning efforts.




| Num | LOCATION | MH | SYSTEM |
|---|---|---|---|
| 1 | 4225 Ethel Av | 44207099 | 15-inch sewer |
| 2 | Ventura Bl e/o Ethel | 44207120 | 27-inch sewer |
| 3 | 74th St & Brighton | 55811160 | 74th St Sewer |
| 4 | 76th St e/o Towne | 55710203 | 74th St Sewer |
| 5 | 74th St e/o Vermont | 55812157 | 74th St Sewer |
| 6 | Balboa w/o Victory | 43004103 | AVORS |
| 7 | 20755 Vanowen St | 39814154 | AVORS |
| 8 | 41st Pl e/o Avalon | 53710088 | BHASS |
| 9 | 1840 Soto St n/o 28th St | 53806129 | BHASS |
| 10 | 3rd Ave n/o 59th St | 55806017 | COS |
| 11 | Eastern Ave & Twining St | 49605092 | Eastern Av Relief Sew |
| 12 | Cypress Ave @ Cazador | 46812158 | ERIS |
| 13 | 6513 Firmament | 42903122 | EVIS |
| 14 | Riverside Dr e/o Lankershim | 44306176 | EVRS |
| 15 | Exposition and Western | 53607064 | Exposition Sewer |
| 16 | 65th St & Normandie | 55807140 | Florence Ave Sewer |
| 17 | Florence Ave & Menlo | 55812098 | Florence Ave Sewer |
| 18 | 60th Pl & Denker | 55807053 | Florence Ave Sewer |
| 19 | Alley @ Slauson e/o Van Ness | 55802196 | Florence Ave Sewer |
| 20 | 2014 Genesee Av | 51810137 | LCSFVRS |
| 21 | Sierra Bonita Ave n/o De Longpre | 47015214 | LCSFVRS |
| 22 | Fairfax Ave & Lindenhurst Av | 49215075 | LCSFVRS |
| 23 | Rodeo Rd and Cochran | 53503156 | Maze |
| 24 | Rodeo Rd and Grayburn | 53505165 | Maze No Branch |
| 25 | Jeffreon Bl and Duquesne | 53505006 | NCOS |
| 26 | 41st Pl and Trinity | 53710078 | NOS |
| 27 | Moorpark St e/o Fulton | 44206051 | NOS |
| 28 | 18221 Vanowen St | 39714179 | NOS |
| 29 | North Maine St e/o Gibbons St | 49513056 | NOS |
| 30 | Hollydale Dr & Petite Ct | 46811026 | NOS |
| 31 | Woodbridge w/o Radford | 44305072 | NOS |
| 32 | Mission Rd & 4th St | 51509057 | NOS |
| 33 | 41st Pl and Western | 53610060 | NOS |
| 34 | Gibbons St & Cardinal St | 49513092 | NOS |
| 35 | Slauson & Cimarron | 55802170 | Slauson Ave Sewer |
| 36 | 4792 E Valley Blvd | 49613180 | Valley Bl Relief Sewe |
| 37 | Valley Blvd & Indiana St | 49516122 | Valley Bl Relief Sewe |
| 38 | Valley Spring Ln and Beck | 44305071 | VORS |
| 39 | Burbank e/o Seuplveda | 42911079 | VORS |
| 40 | 11671 National n/e of Barrington | 53401147 | WLAIS |
| 41 | Overland and Palm Court | 53408044 | WLAIS |
| 42 | 11675 National n/e of Barrington | 53401033 | WLAIS |
| 43 | Farragut &Le Bourget | 53412003 | WLAIS |
| 44 | Barry and Victoria | 53410062 | WLAIS |
| 45 | Regent and Veteran | 53407087 | WLAIS |
| 46 | Jackson Av nw/o Braddock | 53408040 | WRS |
| 47 | 10479 Northvale e/o Clarkson Rd | 51915184 | WRS |
| 48 | Butterfield Rd e/o Manning Av | 51911106 | WRS |
| 49 | 10640 Putney Rd n/o Northvale | 51910175 | WRS |
| 50 | 82nd & Wilton Pl | 55806216 | 74th St Sewer |
| 51 | Rodeo Rd e/o Kalsman | 53502089 | LCSFVRS |
| 52 | MLK and Somerset | 53605165 | Maze So Branch |

**FIG. 6.6**

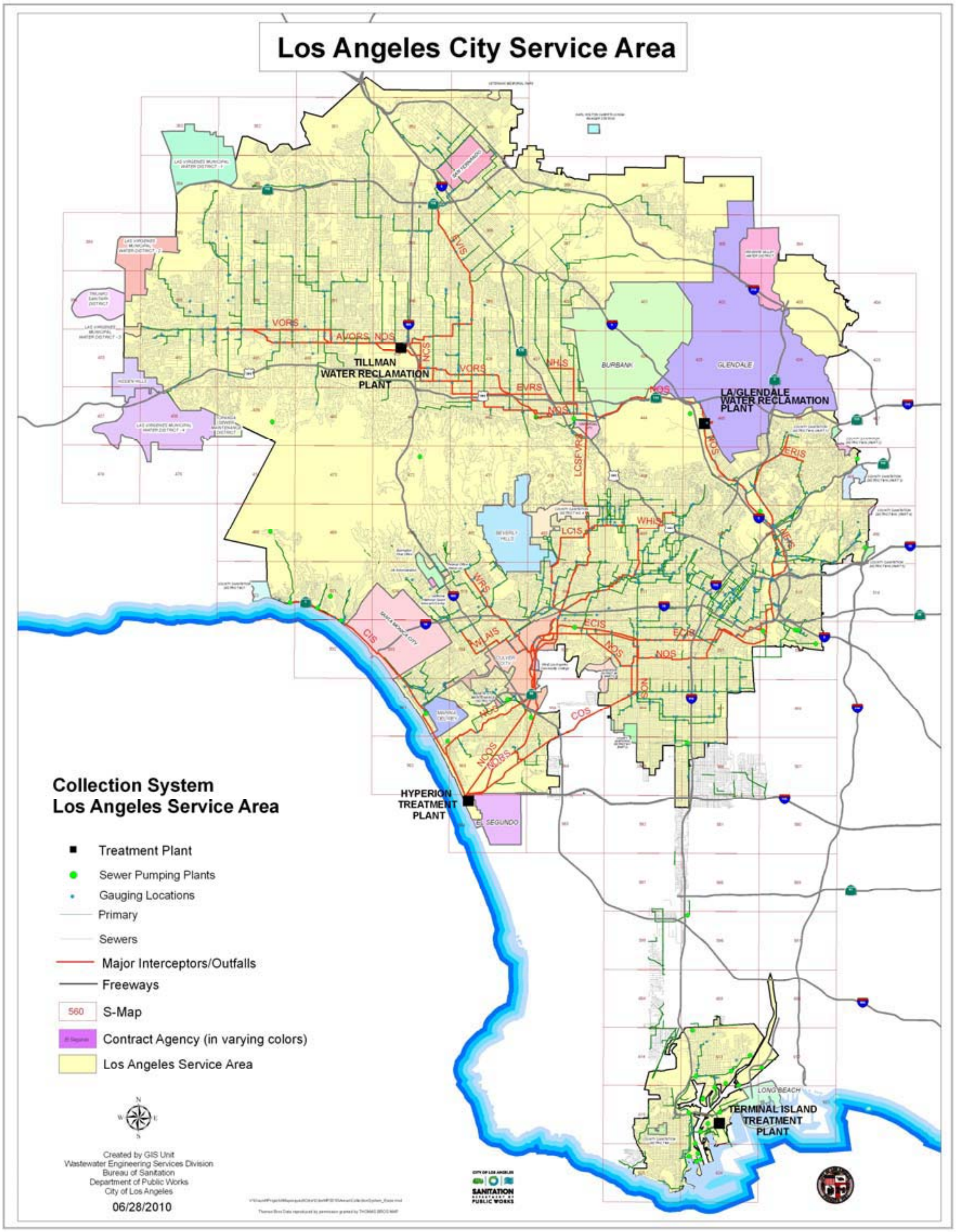

Los Angeles City Service Area
TILLMAN WATER RECLAMATION PLANT
LA/GLENDALE WATER RECLAMATION PLANT
HYPERION TREATMENT PLANT
TERMINAL ISLAND TREATMENT PLANT
BURBANK
GLENDALE
SEGUNDO
LONG BEACH
VORS
AVORS
NOS
NCS
EVRS
LCSFVRS
ERIS
WHIS
LCIS
WRS
CIS
AIS
ECIS
COS
NOOS
Collection System
Los Angeles Service Area
Treatment Plant
Sewer Pumping Plants
Gauging Locations
Primary
Sewers
Major Interceptors/Outfalls
Freeways
560
S-Map
Contract Agency (in varying colors)
Los Angeles Service Area
Created by GIS Unit
Wastewater Engineering Services Division
Bureau of Sanitation
Department of Public Works
City of Los Angeles
06/28/2010
SANITATION

**FIG. 6.7**

# 7.0 Previous Odor Master Plan

In the previous Master Plan, four areas in the city with an unusually high number of complaints were identified as "hot spot" areas (see FIG. 7.1). They are:

- Studio City/North Hollywood Area – NOS & NHIS
- The Maze Area - South Los Angeles – NOS
- Sierra Bonita/West Hollywood Area VSF – LCSFVRS
- West Los Angeles/Culver City Area – WLAIS & WRS

Five additional areas were identified as potential areas of concern and were analyzed in order to gain an accurate overview of the collection system. They are:

- Venice - Westchester Area (CIS)
- Baldwin Hills - Wilshire (WHIS/LCIS)
- Harbor Area
- West Valley
- East Los Angeles – Boyle Heights

It was recommended that all areas be monitored on a continuous basis, so the City can stay abreast of changes in the sewer system as they occur. Below is a summary of location specific recommendations from the 2009 Odor Master Plan.

**Studio City/N. Hollywood Area**

- Continue chemical addition at the Tillman plant. *Since implementation, the $H_2S$ level has gone down significantly in the EVRS.*

- Recommend the construction of the Glendale Burbank Interceptor Sewer (GBIS) as a long-term solution by reducing the pressure in the area.

- Flow in Forman Ave should be diverted to the NOS to lower the pressure in the Forman sewer line. *This has been implemented.*

**The Maze Area**

- Florence Avenue Sewer and the 74$^{th}$ Street Sewer should be routinely cleaned to reduce hydrogen sulfide generated by these sewers. *The last cleaning in 2008 removed approximately 120 tons of debris.*

- Continue chemical treatment in the Maze area to keep the hydrogen sulfide levels low. *Implemented and Ongoing*

**Sierra Bonita/West Hollywood Area/Toluca Lake**

- Recommend the construction of the Glendale Burbank Interceptor Sewer (GBIS) as the long-term solution by reducing flow down the LCSFVRS

- Recommend the construction of an 8" parallel sewer in Forman Avenue so that the homes along Forman Ave between Valley Spring Lane and Riverside Drive can disconnect from the Forman Avenue Sewer which has high gas pressure. *This recommendation has been cancelled since the removal of a gas trap that was blocking airflow in the Forman Ave line.*

***LCSFVRS Upper Reach:***

- Recommend the use of the Sierra Bonita Scrubber to reduce gas pressure in the Hollywood area which should improve odor issues. *Implemented*

***LCSFVRS Lower Reach***

- With the 10,000 cfm carbon scrubber in operation at the Genesee Siphon site, the LCSFVRS Lower Reach is depressurized. It is recommended to keep the scrubber in operation and monitor the reach to evaluate the scrubber's effectiveness. *Implemented*

- Recommend continuation of chemical addition at the Tillman plant to reduce the level of hydrogen sulfide in the downstream sewers, including the LCSFVRS. *Implemented and Ongoing*

**West L.A./Culver City Area**

- Recommend the operation of the new NOTF Scrubber to reduce pressure in the WLAIS/WRS. *Implemented*

- Debris accumulation in the WLAIS causes increased hydrogen sulfide levels. Additional maintenance holes will be constructed in order to facilitate the cleaning of this debris. *Implemented*

For the areas identified as potential areas of concern, the recommendations are as follows:

**Venice/Westchester Area**

Pressure is not a problem. Continue monitoring to address any odor issues that may occur in the future.

**Harbor Area**

Pressure is not a problem. Continue monitoring to address any odor issues that may occur in the future.

**Baldwin Hills /Wilshire Area**

Pressure is not a problem. Continue monitoring to address any odor issues that may occur in the future.

**West Valley Area**

Pressure is not a problem. Continue monitoring to address any odor issues that may occur in the future.

**East Los Angeles – Boyle Heights Area**

Recommend the construction of the Odor Control Hollydale Sewer Project that will build an 8-inch diameter sewer in Hollydale Drive parallel to the NOS. *Implemented*

Continue monitoring to address any odor issues that may occur in the future.

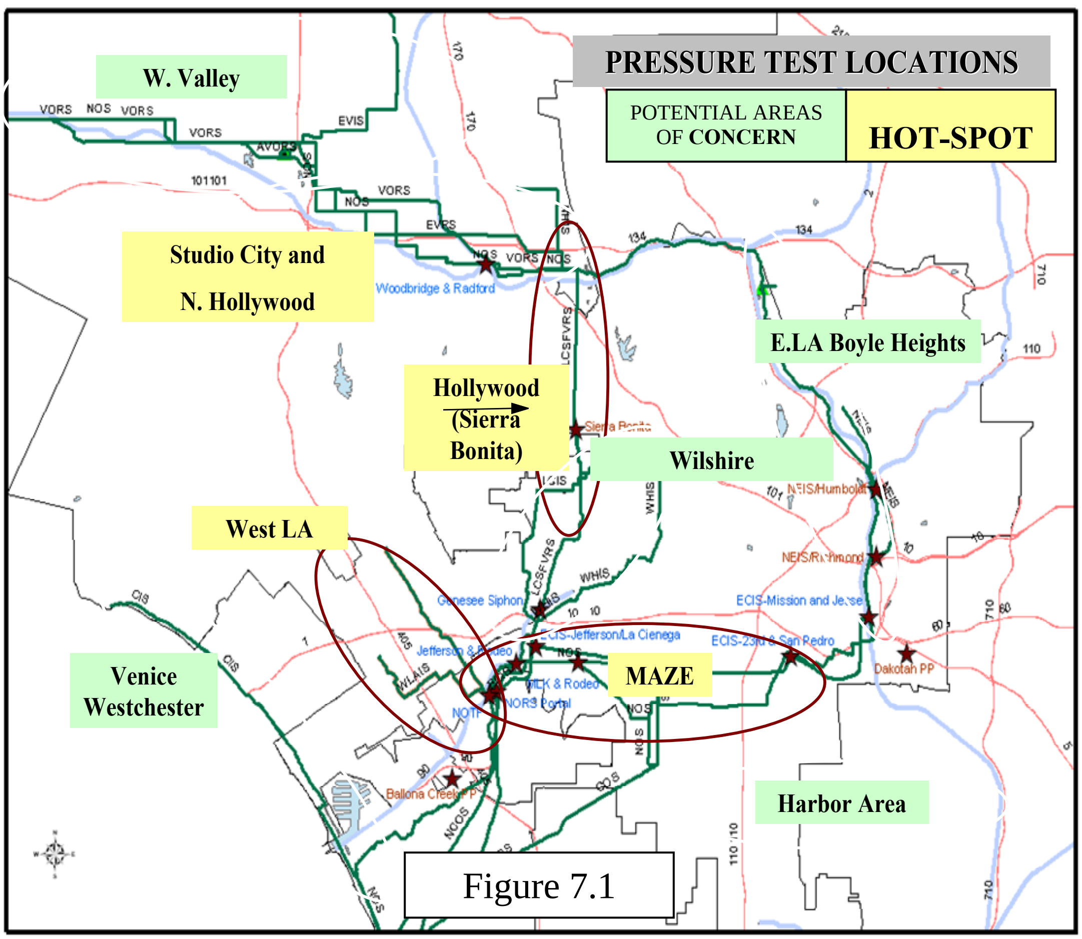



Figure 7.1

# 8.0 Studied Areas

This section will provide a technical document for each of the four locations identified as Areas of Concern and another five locations identified as Areas of Study (see Fig. 8.2). Testing locations within these areas were selected based on a detailed study of the physical characteristics of the collection system in the area as well as history of odor complaints (see Fig. 8.1). Each document contains an introduction, test results, data analysis, conclusion and recommendation.

**Areas of Concern**

- East NOS Corridor
- La Cienega/San Fernando Corridor
- Baldwin Hills/Culver City Area
- East Valley Area

**Areas of Study**

- South Los Angeles Area
- Coastal Interceptor Sewer
- Harbor
- West Valley Area
- Miscellaneous Locations

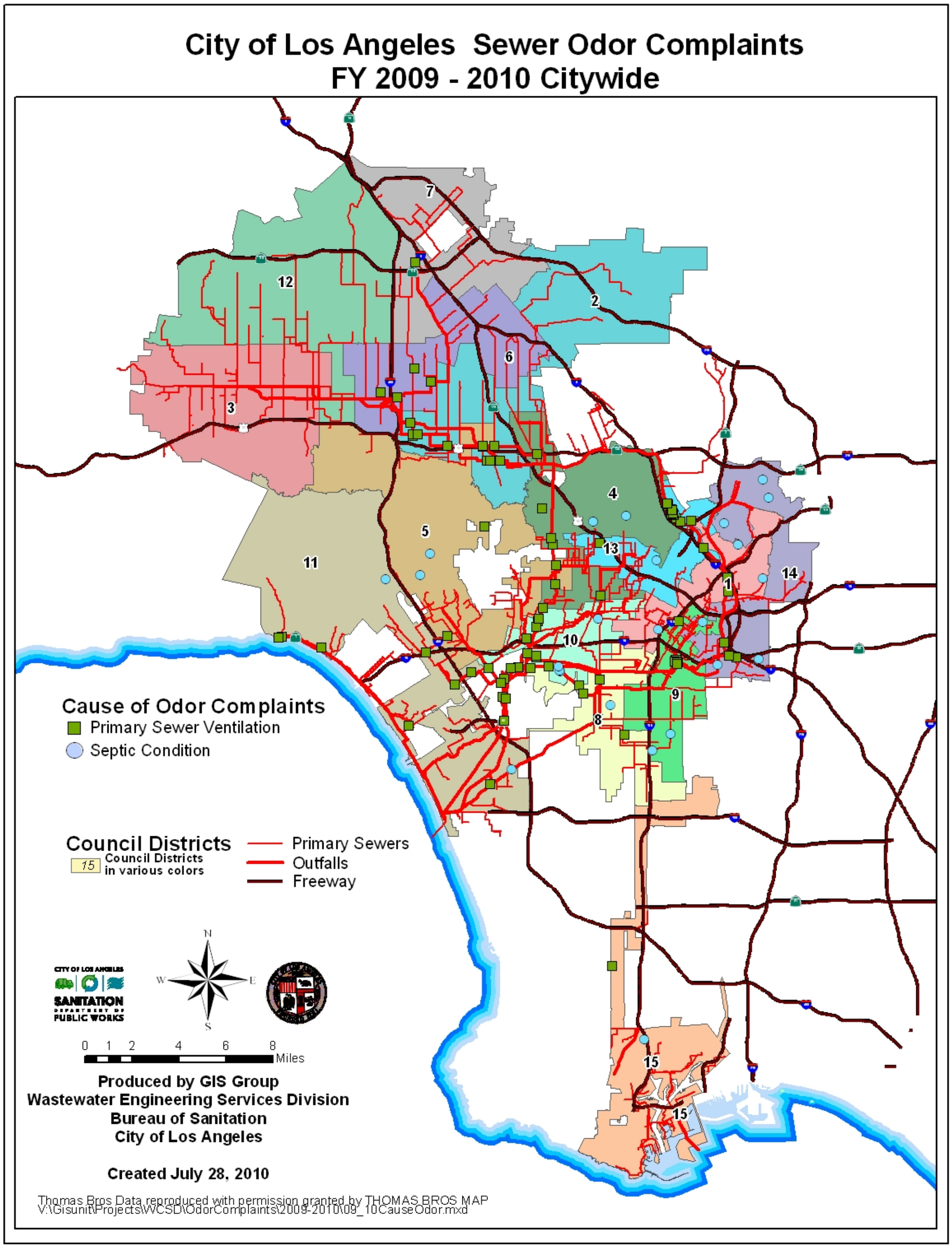

City of Los Angeles Sewer Odor Complaints
FY 2009 - 2010 Citywide
Cause of Odor Complaints
Primary Sewer Ventilation
Septic Condition
Council Districts
Council Districts in various colors
Primary Sewers
Outfalls
Freeway
0 1 2 4 6 8 Miles
Produced by GIS Group
Wastewater Engineering Services Division
Bureau of Sanitation
City of Los Angeles
Created July 28, 2010
Thomas Bros Data reproduced with permission granted by THOMAS BROS MAP
V:\Gisunit\Projects\WCSD\OdorComplaints\2009-2010\09_10CauseOdor.mxd

FIG. 8.1

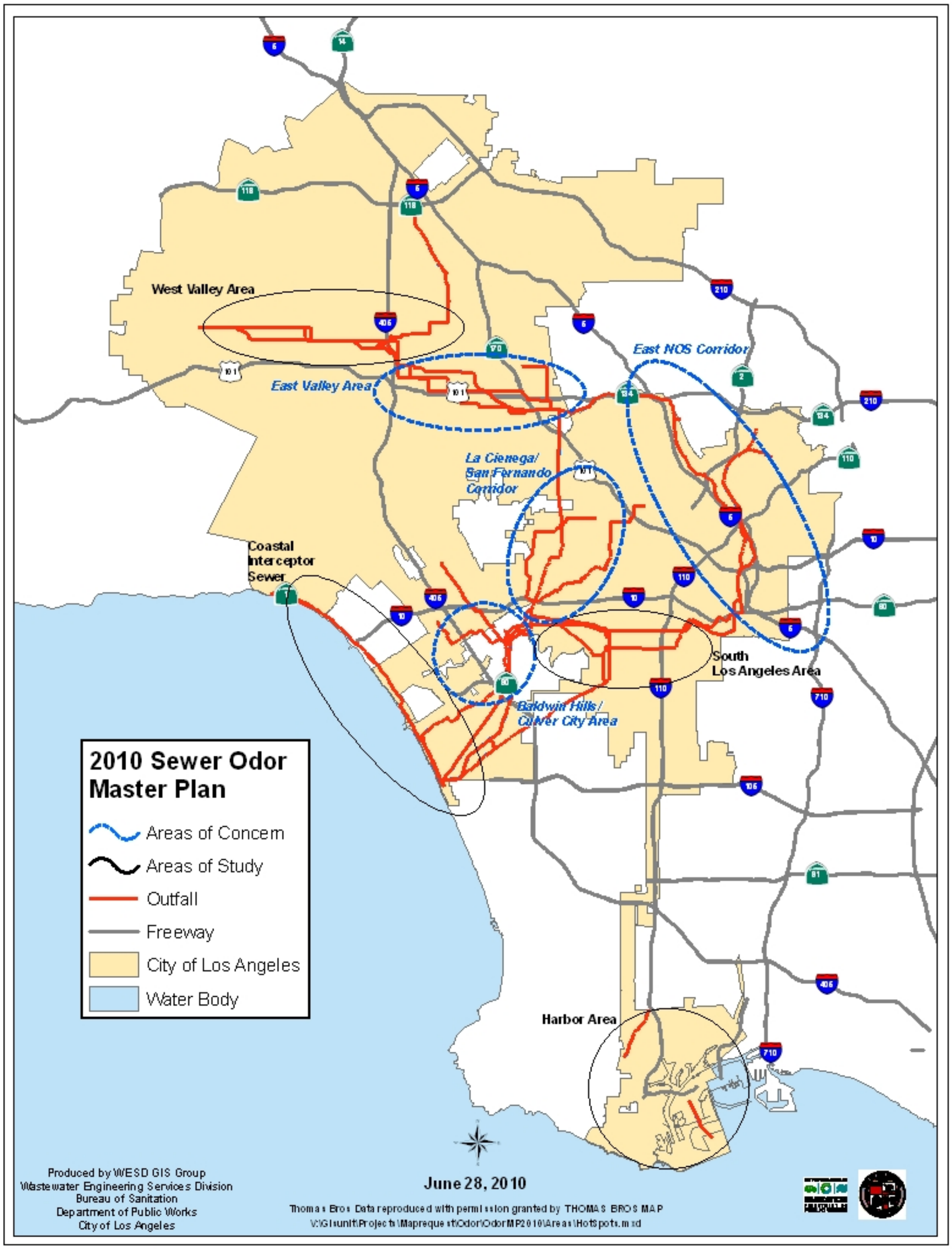

2010 Sewer Odor Master Plan
Areas of Concern
Areas of Study
Outfall
Freeway
City of Los Angeles
Water Body
West Valley Area
East Valley Area
East NOS Corridor
La Cienega/ San Fernando Corridor
Coastal Interceptor Sewer
South Los Angeles Area
Baldwin Hills/ Culver City Area
Harbor Area
Produced by WESD GIS Group
Wastewater Engineering Services Division
Bureau of Sanitation
Department of Public Works
City of Los Angeles
June 28, 2010
Thomas Bros Data reproduced with permission granted by THOMAS BROS MAP

**FIG. 8.2**

# 9.0 TECH MEMOS FOR AREAS OF CONCERN

## 9.1 East NOS Corridor

**INTRODUCTION**

This report provides a discussion and analysis of the sewer air pressure test conducted for the East North Outfall Sewer Corridor Sewer System on April 2010. The area of concern covers the NOS sewer starting upstream at Forman and Valley Spring in Toluca Lake continuing east to the Los Angeles Glendale Water Reclamation Plant (LAGWRP), then moving southerly from LAGWRP to the Enterprise siphon located at Mission and Enterprise in the Boyle Heights area. The entire area was monitored by conducting instantaneous air pressure readings with handheld digital manometer while sections considered an odor hotspot were monitored and analyzed using data logging pressure manometers and hydrogen sulfide monitors.

MONITORING LOCATIONS

Table 9.1 shows the list of maintenance holes monitored in the East NOS Corridor between Valley Spring Lane and Foreman to Enterprise Siphon at the Los Angeles River. Figure 9.1 displays a map of the monitoring locations along the East NOS Corridor. Along this segment there are several sewer structures and pipeline conditions that may increase sewer gas pressure and cause odor complaints. Along the alignment are four siphon structures including Mariposa, Doran, Gilroy and Enterprise. Also included are junction structures, diversion structure and drop structures. The justification of the monitoring points selected is identified in Table 9.1.

## TEST RESULTS

**Table 9.1**
**Monitoring Locations and Results**

| ID | LOCATION | MH NO. | SEWER | JUSTIFICATION | 2010 PRESSURE (in/w.c.) | 2006 PRESSURE (in/w.c.) | H2S (ppm) | FLOW (CFS) |
|---|---|---|---|---|---|---|---|---|
| 1 | VALLEYHEART & MORNINGSIDE | 44402003 | NOS | Pipe Size Reduction | 0.03 | - | - | 53 |
| 2 | VALLEYHEART DR R/W | 44403001 | NOS | Siphon Pressure Effect | 0 | - | - | 53 |
| 3 | GLENFELIZ | 46802048 | NOS | Slope Reduction | 0 | 0.01 | - | 65 |
| 4 | HOLLYDALE & PETITE CT | 46811026 | NOS | Siphon Pressure Effect | 0.19 | 0.01 | 23.4<br>13.7 | 69 |
| 5 | BLAKE AV @ BARCLAY | 49505035 | NOS | Slope Reduction | 0 | 0.04 | - | 74 |
| 6 | GIBBONS & CARDINAL | 49513092 | NOS | Junction/Primary Sewer Interconnection | 0 | - | 5.3 | 24 |
| 7 | MISSION RD N/O 6TH ST | 51509154 | NOS | Drop Structure Effect | 0.24 | 0.02 | 22 | 29 |
| 8 | MISSION RD U/S SIPHON | 51513003 | NOS | Siphon Pressure Effect | 0.05 | 0.12 | - | 40 |

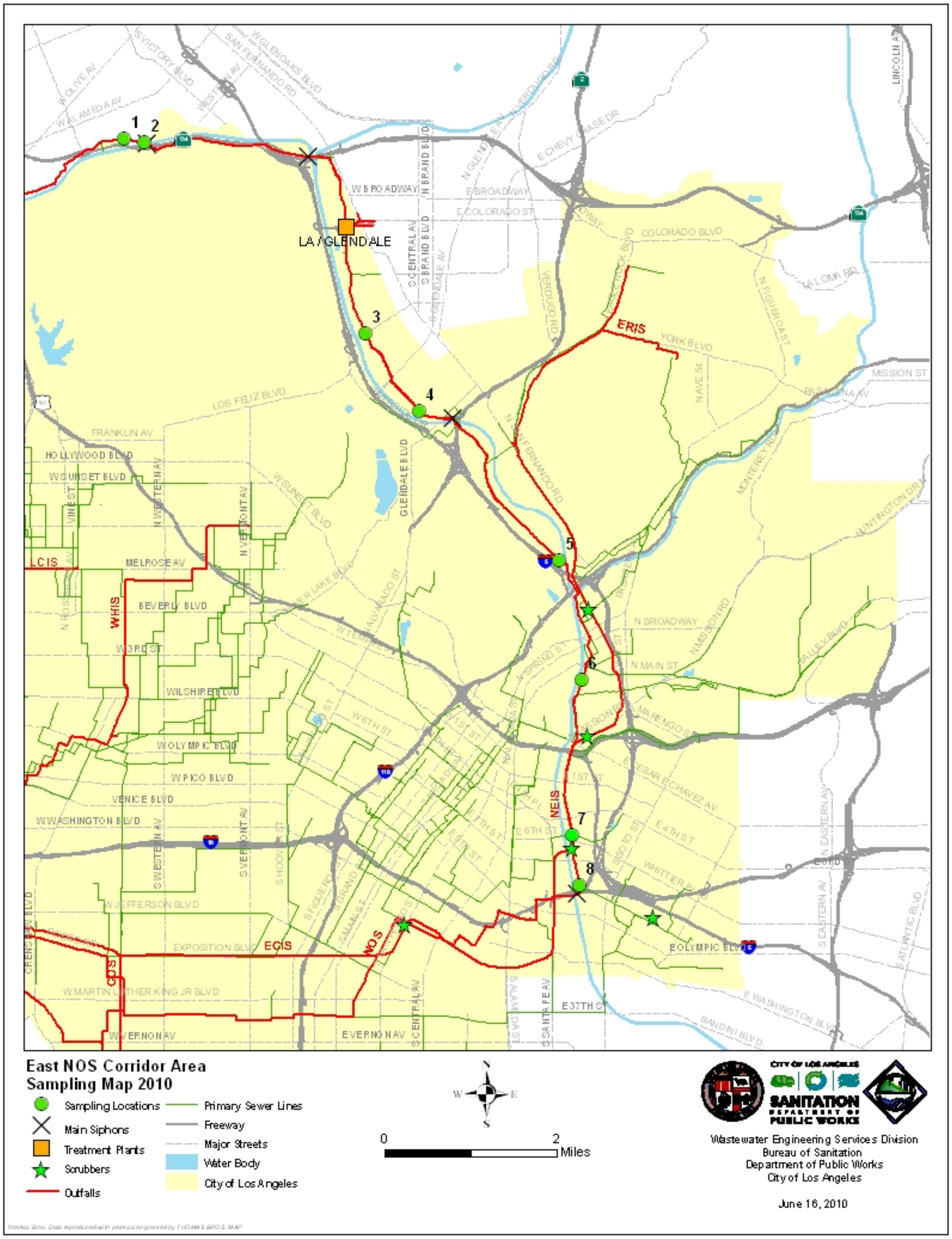

East NOS Corridor Area
Sampling Map 2010
Sampling Locations
Main Siphons
Treatment Plants
Scrubbers
Outfalls
Primary Sewer Lines
Freeway
Major Streets
Water Body
City of Los Angeles
0
2
Miles
N
S
E
W
LA / GLENDALE
ERIS
NEIS
ECIS
NOS
WHIS
LCIS
CDS
1
2
3
4
5
6
7
8
Wastewater Engineering Services Division
Bureau of Sanitation
Department of Public Works
City of Los Angeles
June 16, 2010

FIG. 9.1

## DATA ANALYSIS

In general the pressure in the NOS along the eastern corridor is between zero and 0.05 inches of water column. However, two hot-spot pressure areas were identified at location 4 at Hollydale and Petit and location 7 at Mission and 6$^{th}$. Hollydale and Petite had an average pressure in 2010 of 0.19 inches water column. Pressures significantly increased at this location compared to 2006 which measured at 0.01 inches water column. In addition, the hydrogen sulfide (H2S) concentrations in 2010 averaged 13.7 ppm. At Mission and 6$^{th}$, the average pressure increased to 0.24 inches water column in 2010 from 0.02 inches water column measured in 2006. The increase in pressure and hydrogen sulfide is due to back pressure from the ECIS into the NOS through the drop structure. In 2007, NOS flows entering the Mission & Jesse drop structure was significantly reduced by diverting more flow from the NOS to NEIS at the upstream Humboldt drop structure. The reduced flow at the Mission and Jesse drop structure allowed more air escape up the drop structure air return line and hence into the NOS.

## CONCLUSIONS

The increase in sewer ventilation pressure at Hollydale and Petite is a result of the Gilroy siphon back pressure. In addition, continued discharge of biosolids from the upstream LA-Glendale Water Reclamation Plant is contributing to the hydrogen sulfide concentration spikes along this alignment.

The increase in sewer gas ventilation along the NOS near Mission and Jesse is a result of back pressure from the Mission and Jesse NOS/ECIS drop structure.

## POTENTIAL SOLUTIONS

The culmination of high pressure and high H2S has been the cause of odor complaints in the area. A solution would be to build an airline for the Gilroy Street siphon if feasible in order to relieve pressure behind the siphon. An alternative to this would be to coordinate with LAG Treatment Plant to discharge their solids in several equal increments through out a 24 hour period instead of one main discharge that creates a pressure spike. Another alternative would be to place a small scrubber at the siphon inlet to alleviate the upstream pressure buildup. Additionally chemical addition to reduce H2S levels in the NOS is being considered. These are all considerations that need to be discussed further to see which is most effective for this particular section of the NOS.

Regarding pressure at Mission and 6$^{th}$ we will wait and see how the new ATF at Jefferson and La Cienega changes the condition of the ECIS sewer. If ECIS is fully depressurized, then this location will no longer be an issue.

We need to determine if the planned NEIS 2 project will improve hydraulics and ventilation conditions. NEIS 2 would relieve the section of the North Outfall Sewer (NOS) south of LAG and convey flow from the GBIS to provide additional capacity.

To reduce odor complaints, extending the construction of local sewer to isolate homes away from direct connection to the NOS needs to be considered. More studies are needed to better understand the ventilation conditions and hydrogen sulfide levels contributed by LAGWRP.

Currently under the ATF Review Study; conducted by HDR Consultants, a more detailed work is taking place to understand ventilation around drop structures and how flow management can improve conditions in the NOS. We will have their recommendations in the coming months.

**RECOMMENDATIONS/CONSIDERATIONS**

- Continue to monitor this area for pressure and hydrogen sulfide
- Control air flow dynamics through sewer flow management by manipulating sewage flow through various sewers

## 9.2 La Cienega/San Fernando Corridor
### LCSFVRS-WHIS-LCIS

**INTRODUCTION**

The LCSFVRS (11 miles) was constructed in the mid 1950's to relieve the NOS in the Toluca Lake area in the southeast San Fernando Valley. The upper reach of the LCSFVRS starts at the intersection of Valley Spring Lane and Forman Avenue and travels south through the Santa Monica Mountains to Sierra Bonita Avenue where it splits into twin 42-inch diameter pipes at Sierra Bonita Avenue and Hollywood Boulevard. It becomes a single 60-inch diameter pipe at the intersection of Martel Avenue and Clinton Street. The sewer continues south and travels through the Genesee Siphon situated just south of Venice Boulevard and Genesee Avenue and eventually reconnects with the NOS near the intersection of Rodeo Road and Jefferson Boulevard in south Los Angeles.

Odor complaints along the La Cienega San Fernando Valley Relief Sewer (LCSFVRS) prompted the City to investigate the causes and determine appropriate measures to alleviate the odor emissions. The 2006 Odor Master Plan discussed this investigation and evaluation and provided recommendations to address the odor issues. Subsequently two carbon scrubbers were constructed along the LCSFVRS. A 5,000 cfm carbon scrubber was constructed at the lower reach of the LCSFVRS at the Genesee Siphon and a 10,000 cfm carbon scrubber was constructed at the upper reach of the LCSFVRS at De Longpre Street and Gardner Avenue. Furthermore, a chemical addition program, utilzing a continuous addition of magnesium hydroxide, was implemented for this area in September 2005.

For the 2010 Odor Master Plan, the corridor along the LCSFVRS was expanded to cover tributary sewers including the West Hollywood Interceptor Sewer (WHIS), and La Cienega Interceptor Sewer (LCIS).

## TEST RESULTS

**Table 9.2**
**Monitoring Locations and Results**

| ID | LOCATION | STRUCT. NO. | SEWER | 2010 PRESSURE | 2006 PRESSURE | H2S (ppm) | FLOW (CFS) |
|---|---|---|---|---|---|---|---|
| 1 | SIERRA BONITA S/O HOLLYWOOD | 47015212 | LOWER LCSFVRS | -0.38 | 0.45 | 4.4 | 104 |
| 2 | GARDNER & HAMPTON | 49204108 | UPPER LCSFVRS | -0.72 | 0.46 | - | 104 |
| 3 | GARDNER N/O SANTA MONICA BL | 49204109 | LOWER LCSFVRS | -0.12 | -0.24 | - | 104 |
| 4 | MELROSE & DETROIT | 49208066 | LCIS | -0.02 | 0.07 | - | 8 |
| 5 | ROSEWOOD E/O POINSETTIA PL | 49208189 | PRIMARY Sewer Confluence to LCSFVRS | 0.01 | 0.12 | - | 13 |
| 6 | 300 HAUSER ST | 49216010 | LOWER LCSFVRS | 0.05 | 0.13 | - | 124 |
| 7 | 700 8TH ST | 51803209 | LOWER LCSFVRS | 0.1 | 0.08 | - | 140 |
| 8 | 1500 GENESEE | 51807165 | LOWER LCSFVRS | 0.18 | 0.18 | - | 140 |
| 9 | 840 NORTON AVE | 51702134 | WHIS | 0.04 | - | - | 8 |
| 10 | VENICE & SAN VICENTE | 51705210 | WHIS | 0.1 | 0.01 | - | 25 |
| 11 | 5900 GENESEE N/O SIPHON | 51810137 | LOWER LCSFVRS | 0.32 | 0.3 | 3.1 | 156 |
| 12 | BURCHARD & VENICE | 51810199 | LCIS | 0.07 | 0.01 | 3.8 | 21 |
| 13 | BY SEE'S CANDY | 53502116 | LCIS | 0.04 | - | 4 | 24 |
| 14 | RODEO RD & KALSMAN | 53502089 | LCSFVRS & NOS | -0.01 | 0 | 3.5 | 184 |
| 15 | RODEO & JEFFERSON BL | 53502081 | LCIS | -0.14 | 0.01 | 12.6 | 23 |

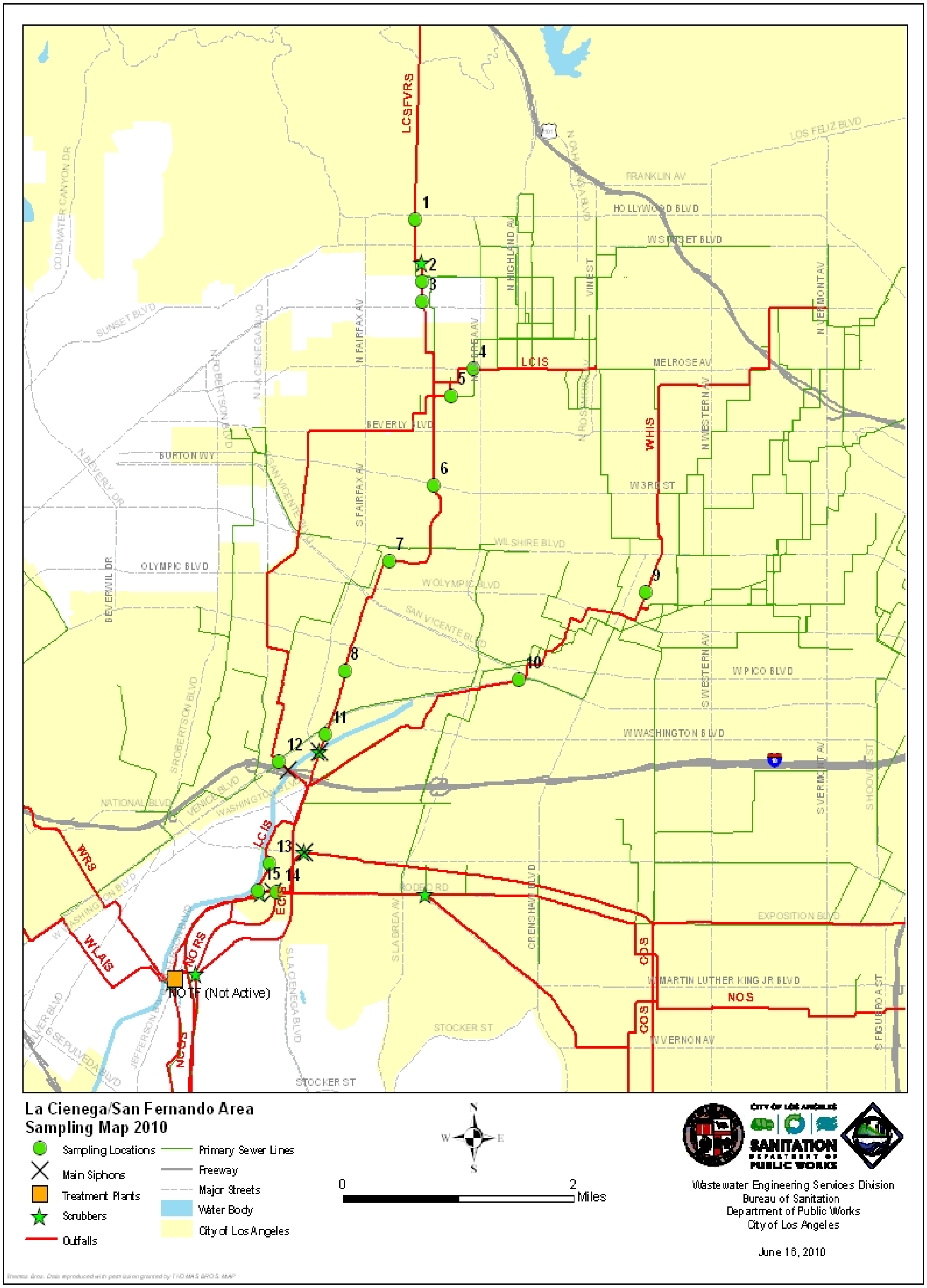

La Cienega/San Fernando Area
Sampling Map 2010
Sampling Locations
Main Siphons
Treatment Plants
Scrubbers
Outfalls
Primary Sewer Lines
Freeway
Major Streets
Water Body
City of Los Angeles
0
2
Miles
Wastewater Engineering Services Division
Bureau of Sanitation
Department of Public Works
City of Los Angeles
June 16, 2010
LCSFVRS
LCIS
WHIS
NOS
COS
WRS
WLAIS
NORS
NCOS
ECIS
NOTF (Not Active)
HOLLYWOOD BLVD
MELROSE AV
BEVERLY BLVD
W 3RD ST
WILSHIRE BLVD
OLYMPIC BLVD
W PICO BLVD
W WASHINGTON BLVD
EXPOSITION BLVD
MARTIN LUTHER KING JR BLVD
W VERNON AV
STOCKER ST
RODEO RD
SUNSET BLVD
FRANKLIN AV
LOS FELIZ BLVD

FIG. 9.2

## DATA ANALYSIS

The upper reach of the LCSFVRS, which travels between the Hollywood Hills and the Fairfax District, has a history of strong air ventilation due to the combined effect of a high approach velocity and geometric slope reduction downstream of Sierra Bonita and Hollywood Boulevard. Since the completion of the Sierra Bonita Scrubber, located at the intersection of Gardner Street and De Longpre Street, the sewer gas pressure has improved to below atmospheric levels, in most cases. The table below shows the gas pressure during the latest round of testing compared to the 2006 pressure data.

**Table 9.2.1**

| LCSFVRS | Air Pressure (in. w.c) | | Air Pressure 2006 | |
|---|---|---|---|---|
| MH No. | Max | Avg. | Max | Avg. |
| 470-15-212 | -0.08 | -0.38 | 1.09 | 0.45 |
| 492-04-109 | -0.07 | -0.12 | 0.69 | -0.24 |
| 492-16-010 | 0.23 | 0.05 | 0.45 | 0.13 |
| 518-03-209 | 0.35 | 0.1 | 0.36 | 0.08 |
| 518-07-165 | 0.52 | 0.18 | 0.42 | 0.18 |
| 518-10-137 | 0.71 | 0.32 | 0.48 | 0.3 |

The highest recorded air ventilation at Sierra Bonita and Hollywood Boulevard was a **negative** -0.08 compared to **positive** 1.09 previously. The data shows that Sierra Bonita Scrubber creates a vacuum in the upper reach of that corridor that extends approximately 3 miles downstream (MH 492-16-010). Consequently, odor complaints have been substantially reduced.

The lower reach of the corridor, which extends from Martel Avenue to Genesee Street, is still pressurized due to the Genesee siphon that is located at Genesee Street and Cologne south east of Venice Boulevard. This siphon has a 36” above ground airline. The diurnal pressure recorded during the latest round of testing showed no significant change in the pressure compared to the earlier 2006 data. The pressure has remained high due to the siphon’s effect on upstream pressure. The Genesee siphon scrubber is relatively old and probably in need of an upgrade to a higher rate of air withdrawal (7500 CFM).

The other two major sewers in this study; the WHIS and the LCIS, for the most part are not a source of problems and have remained unchanged since 2006. There is one location on the WHIS at Venice and San Vicente with an average pressure of 0.1 inches water column that needs to be investigated further to find cause of this positive pressure.

## CONCLUSION

The upper section of LCSFVRS has improved and been depressurized due to the recent activation of the Sierra Bonita scrubber. The lower section continues to experience positive pressure because of the back pressure from the Genesee siphon. The 36” airline may be undersized and the Genesee scrubber may also be undersized.

The LCIS and the WHIS showed no real pressure problems except for the sampling location on the WHIS at Venice and San Vicente. This should be investigated further.

## RECOMMENDATIONS/CONSIDERATIONS

- Continue to monitor this area for pressure and hydrogen sulfide
- Control air flow dynamics through sewer flow management by manipulating sewage flow through various sewers
- Continue chemical injection at the Tillman Treatment Plant
- Conduct pressure tests around the Genesee siphon to either
  - Consider increasing capacity of the Genesee scrubber at the Genesee siphon to further depressurize the lower portion of the LCSFVRS
  - Or consider increasing airline capacity by adding another conduit to transfer more air across siphon
- Test downstream of Venice and San Vicente on the WHIS to determine if high pressure at that location is an isolated phenomenon possibly due to the hydraulic jump (slope reduction from 0.0021 to 0.0007) or part of a bigger problem such as back pressure from a downstream sewer.

## 9.3 Baldwin Hills/Culver City Area
**NORS-ECIS-NOS-WLAIS-WRS-NCOS**

### INTRODUCTION

The Baldwin Hills/Culver City Area includes outfall and interceptor sewers servicing the West Los Angeles/Culver City and Baldwin Hills areas bounded by Jefferson Boulevard to the north, San Diego Freeway to the south, La Cienega Boulevard to the east, and Palms to the west. The sewers include the North Outfall Replacement Sewer (NORS), East Central Interceptor Sewer (ECIS), North Outfall Sewer (NOS), West Los Angeles Interceptor Sewer (WLAIS), Westwood Relief Sewer (WRS), and North Central Outfall Sewer (NCOS). The area covered is presented in Figure 9.3.

The West Los Angeles/Culver City/Baldwin Hills areas are currently experiencing moderate to high odor emissions. The City is considering several options to better manage air movement in these sewers, thereby decreasing pressure and ultimately, odor complaints. These options are:

- Continuously improving Flow Management
- Isolating NORS Sewer Headspace through Air Curtain installation at the NORS Diversion Structures
- Constructing an Air Conduit between the NORS and the NCOS
- Utilizing Existing and Future ATFs

The NORS has been highly pressurized for many years and is the source of significant sewer gas ventilation, due in part to the undersized air jumpers at the NORS siphon and the large volume of gas traveling into the NORS headspace from upstream sewers, and its limited headspace resulting from the excess flow being diverted from the NOS. The gas that pressurizes the NORS headspace is from the confluence of flow routed to NORS from the outfalls connected to it including the WLAIS and WRS.

The lower reach of the North Outfall Sewer (NOS) had been closed and under rehabilitation for several years. During the rehabilitation, sewage from the West LA Interceptor Sewer (WLAIS) and Westwood Relief Sewer (WRS) traditionally carried by the NOS was being diverted into the NORS via Diversion 3. With the rehabilitation of the lower portion complete, that flow was returned to the NOS on December 18, 2009. It is estimated that 76 cfs of West Los Angeles sewage is being diverted to the lower NOS instead of the NORS.

Additionally, in January 2010 another section of the NOS rehabilitation, from Diversion 3 to the upper reach at Jefferson and Rodeo, was completed, allowing more flow to return to the NOS at NORS Diversion 2. The combined result of both diversions has reduced flow in NORS, therefore increasing headspace and reducing pressure. The pressure data presented below shows the improvement in the Culver City/West Los Angeles and Baldwin Hills areas.

By the next fiscal year (FY2010/11), two permanent Air Treatment Facilities (ATFs) will be operational. These two strategically placed ATFs will be able to remove and scrub foul air from the ECIS, NORS and NCOS in tandem, which should reduce sewer gas pressure in this area. The city will be monitoring this area very closely once the ATFs become operational.

## TEST RESULTS

**Table 9.3**
**Monitoring Locations and Results**

| ID | LOCATION | DESCRIPTION | STRUCT. NO. | SEWER | POST NOS DIV | PRE NOS DIV | H2S (ppm) | FLOW (CFS) |
|---|---|---|---|---|---|---|---|---|
| 1 | JEFFERSON & HOLDREGE U/S DIV2 | U/S Diversion Structure | 53506091 | NOS | -0.38 | - | - | 202 |
| 2 | 6000 BLK JEFFERSON (DIV. 2) | Diversion Structure | 53505018 | NORS | - | 0.16 | - | 125 |
| 3 | 6050 JEFFERSON | Siphon Outlet | 53505007 | NCOS | | -0.33 | - | 134 |
| 4 | LACIENEGA & ALADDIN | U/S Junction Structure | 53506116 | ECIS | 0.02 | 0.28 | 28.6 | 178 |
| 5 | IVY & PERHAM | U/S Junction Structure | 53506132 | NORS | -0.02 | 0.04 | 1.70 | 0.05 |
| 6 | 9310 JEFFERSON | Between Diversion Structures | 53505028 | NOS | 0.07 | - | - | 77 |
| 7 | CULVER CITY PARK | U/S Junction Structure | 53505021 | NORS | 0.02 | 0.05 | - | 125 |
| 8 | LEAHY & JEFFERSON | U/S Diversion Structure | 53505029 | NOS | 0.05 | 0.33 | - | - |
| 9 | 9940 JEFFERSON/JXN | Junction Structure | 53509022 | ECIS/NORS | -0.01 | 0.26 | - | 299 |
| 10 | 3726 JASMINE | U/S Diversion Structure | 53404122 | WRS | 0.18 | - | - | 21 |
| 11 | VENICE & OVERLAND | | 53407074 | WLAIS | 0.10 | - | - | 34 |
| 12 | FARRAGUT & LE BOURGET | U/S Diversion Structure | 53412003 | WLAIS | -0.04 | -0.03 | 2 | 41 |
| 13 | WLA COLLEGE | | 53513013 | NOS | -0.06 | - | - | - |
| 14 | WLA COLLEGE BY WALL | D/S Junction Structure | 53513007 | NORS | 0.05 | 0.27 | - | 299 |
| 15 | BERNARDO & EVEWARD | | 55901009 | NOS | 0.03 | - | - | - |

| ID | LOCATION | DESCRIPTION | STRUCT. NO. | SEWER | POST NOS DIV | PRE NOS DIV | H2S (ppm) | FLOW (CFS) |
|---|---|---|---|---|---|---|---|---|
| 16 | HANNUM & BRISTOL PKWY | U/S Siphon | 55905006 | NORS | 0.19 | 0.29 | 34.20 | 299 |
| 17a | FOX HILLS MALL U/S SIPHON | U/S Siphon | 55905008 | NOS | -0.04 | - | - | - |
| 17b | FOX HILLS MALL U/S SIPHON | Siphon | 55905008 | NOS | 0.05 | - | - | - |
| 18 | AIRLINE BTWN NOS & NCOS | Airline | 56008055 | NOS/NCOS | -0.01 | - | - | - |
| 19 | GREENVALLEY CIR & BRISTOL PKWY | Siphon Inlet | 55905005 | NCOS | -0.17 | - | - | 135 |

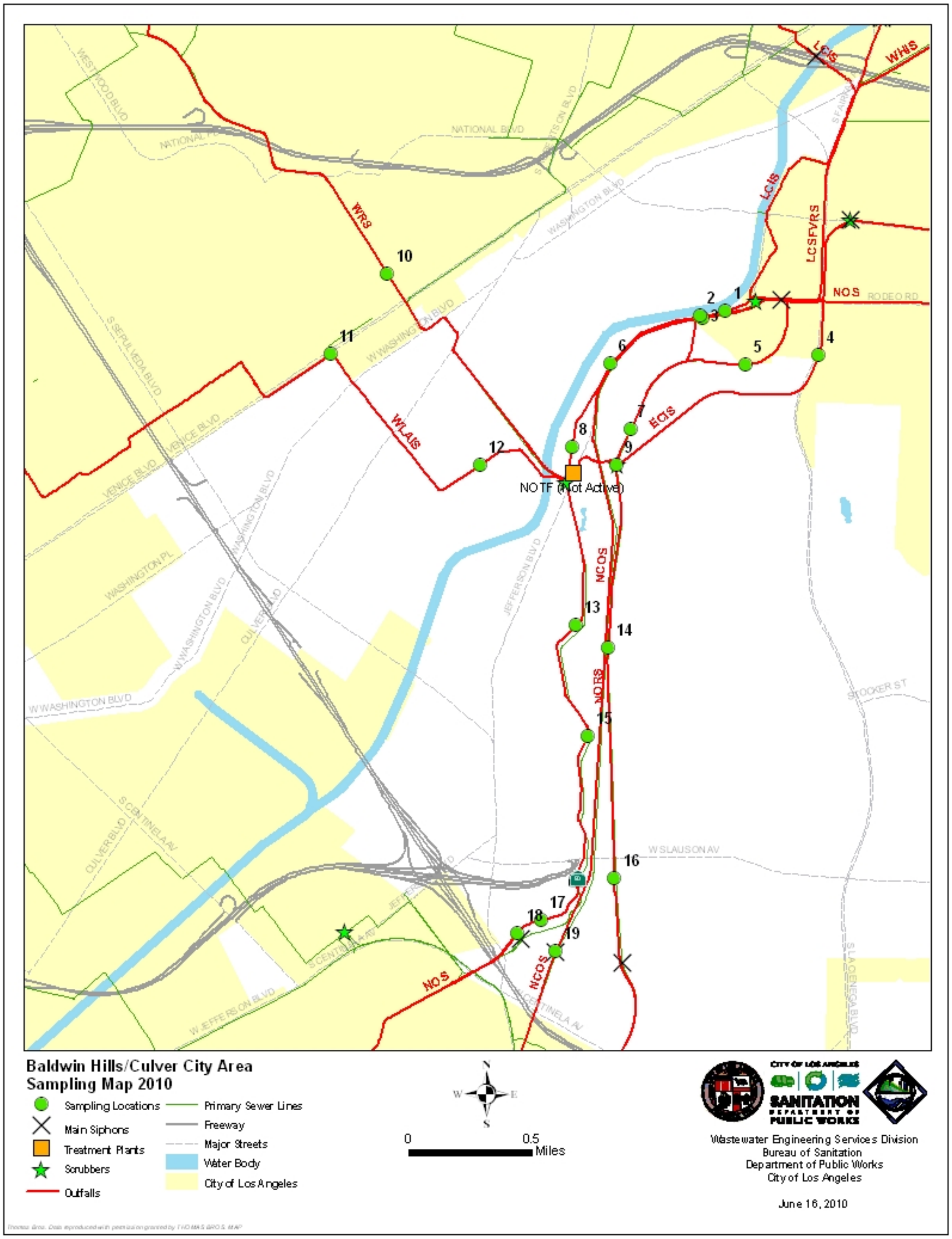

WR3
10
11
WLAIS
12
NOTF (Not Active)
LCIS
WHIS
LCSFVRS
NOS
RODEO RD
1
2
3
4
5
6
7
8
9
ECIS
NCOS
13
14
NORS
15
16
17
18
19
NOS
NCOS
NATIONAL BLVD
WASHINGTON BLVD
W WASHINGTON BLVD
VENICE BLVD
S SEPULVEDA BLVD
WASHINGTON PL
CULVER BLVD
JEFFERSON BLVD
W JEFFERSON BLVD
S CENTINELA AV
W SLAUSON AV
STOCKER ST
S LA CIENEGA BLVD
Baldwin Hills/Culver City Area
Sampling Map 2010
Sampling Locations
Main Siphons
Treatment Plants
Scrubbers
Outfalls
Primary Sewer Lines
Freeway
Major Streets
Water Body
City of Los Angeles
N
W
E
S
0
0.5
Miles
SANITATION
DEPARTMENT OF PUBLIC WORKS
Wastewater Engineering Services Division
Bureau of Sanitation
Department of Public Works
City of Los Angeles
June 16, 2010
Thomas Bros. Data reproduced with permission granted by THOMAS BROS. MAP

**FIG. 9.3**

## DATA ANALYSIS

The NCOS average pressures were between -0.35 inches water column (in. w.c.) upstream at the 6000 block of Jefferson Blvd and -0.17 in. w.c. downstream at the NCOS siphon under the 405 freeway.

The WLAIS and WRS were monitored instantaneously at 0.1 in. w.c. and 0.18 in. w.c. respectively. Further downstream on the WLAIS, continuous monitoring showed an average pressure of -0.02 in. w.c.

The NOS was monitored after flow had been diverted into this sewer and pressures were between -0.38 and 0.07 in. w.c. The airline connecting the NOS headspace to NCOS headspace had an average pressure of -0.01.

Average pressures on the ECIS downstream of the Jefferson/La Cienega siphon was 0.28 in. w.c. prior to the NOS diversion and 0.02 in w.c. after the NOS diversion. The average pressure at ECIS/NORS connection was 0.26 in. w.c. pre NOS diversion and -0.01 in. w.c. post NOS diversion.

Two locations were monitored on the NORS upstream of the ECIS/NORS connection. The average pressures were -0.02 in w.c. at Ivy and Perham and 0.02 in.w.c. further downstream at Culver City Park. Continuing downstream on NORS from the ECIS/NORS junction, the average pressure at the WLA College was 0.27 before the diversion and 0.05 after the diversion. Upstream of the NORS siphon at the intersection of Hannum and Bristol Pkwy, the pressures were 0.29 before and 0.19 after the diversion.

**Table 9.3.1**

| ECIS/NORS | Avg Pressure (in H2O) | | Description |
|---|---|---|---|
| MH No. | Pre NOS Diversion | Post NOS Diversion | |
| 535-06-116 | 0.28 | 0.02 | ECIS U/S of ECIS/NORS Junction |
| 535-09-022 | 0.26 | -0.01 | ECIS/NORS Junction |
| 535-13-007 | 0.27 | 0.05 | NORS D/S of ECIS/NORS Junction |
| 559-05-006 | 0.29 | 0.19 | NORS U/S of NORS Siphon |

## CONCLUSION

Currently, the NCOS is experiencing negative gas pressure upstream of the siphon at the 405 Freeway including at the siphon inlet.

The pressure in the West LA sewers is generally negative with a few spots that are slightly positive. There are some pressure spikes from 9 to 10 am that need to be monitored in case they become more frequent.
With the NOS in service, it is receiving wastewater flow and pressure that otherwise would have been sent to the NORS. Odor issues have not arisen since the diversion to the NOS.

There are some definitive changes in the NORS and the ECIS due to the NOS diversion. Average pressures in the NORS have declined by approximately 34% and by 90% in the ECIS. Flow management will be an integral part of balancing sewer headspace and therefore air pressure throughout the sewer system.

**RECOMMENDATIONS/CONSIDERATIONS**

- Continue to monitor this area for pressure and hydrogen sulfide
- Control air flow dynamics through sewer flow management by manipulating sewage flow through various sewers
- Continue monitoring the NOS and NCOS in the vicinity of the airline connection between these two sewers
- Continue monitoring the WLAIS and WRS for any increase in pressure spikes during morning hours.
- Monitor the effectiveness of the Jefferson and La Cienega ATF and the NCOS ATF once the units are online
- Analyze any change in airflow dynamics that results from the proposed construction of sewer air curtains at NORS Diversions 1, 2, and 3

## 9.4 East Valley Area
### AVORS-EVRS-VORS-NHIS-NOS

### INTRODUCTION

The significant sewers in the East Valley Area are the East Valley Relief Sewer (EVRS) and portions of the North Outfall Sewer (NOS) and the Valley Outfall Relief Sewer (VORS). The North Hollywood Interceptor Sewer (NHIS), and the Forman Avenue sewer from Camarillo Street to Valley Spring Lane is also included in this study area. These outfall sewers were evaluated to locate high gas pressure and determine the cause for each.

Effluent from the Tillman Water Reclamation Plant (TWRP) flows through this area. The TRWP does not treat biosolids and therefore returns them to the sewer system to be conveyed to Hyperion for treatment. These concentrated biosolids travel via the EVRS and NOS to the Toluca Lake area. At the intersection of Valley Spring Lane and Forman Avenue, this flow is split between the La Cienega/San Fernando Valley Relief Sewer (LCSFVRS) and the NOS-East Branch on its way to Hyperion. This high concentration of biosolids causes the sewage to produce excessive $H_2S$, leading to odor problems.

Several previous recommendations have been implemented that have reduced gas pressure and hydrogen sulfide concentrations in this area's sewers. The construction of a carbon scrubber at the Radford Siphon in Studio City and the addition of magnesium hydroxide to the sewer system at the TWRP are two measures that have had significant benefit. The diversion of flow from the Forman Avenue Sewer to the NOS has lowered gas pressure in the Forman Avenue Sewer and reduced odor complaints in this area. Furthermore, a trap maintenance hole on the Forman Ave Sewer was removed, allowing backed-up gas pressure to flow downstream, greatly reducing gas pressure.

## TEST RESULTS

**Table 9.4**
**Monitoring Locations and Results**

| ID | LOCATION | STRUCT. NO. | SEWER | 2010 PRESSURE | 2006 PRESSURE | H2S (ppm) | FLOW (cfs) |
|---|---|---|---|---|---|---|---|
| 1 | BURBANK BL E/O SEPULVEDA | 42911079 | VORS | 0.08 | 0.15 | 6.8 | 4 |
| 2 | BURBANK @ KESTER | 42912154 | VORS | 0.07 | 0.05 | - | 9 |
| 3 | RIVERSIDE & WHITSETT (SIPHON) | 44204168 | EVRS | 0.00 | - | - | 66 |
| 4 | WOODBRIDGE & WHITSETT | 44208092 | NOS | 0.00 | - | - | - |
| 5 | WOODBRIDGE & RADFORD | 44305072 | NOS | 0.03 | - | 2.3 | 26 |
| 6 | BECK N/O CHIQUITA | 44305253 | NOS | 0.00 | - | - | 26 |
| 7 | RIVERSIDE & LANKERSHIM | 44306176 | EVRS | 0.22 | 0.02 | 10.3 | 66 |
| 8 | CAHUENGA & HUSTON | 44303148 | NHIS | 0.18 | 0.05 | - | 5 |
| 9 | CAHUENGA & CAMARILLO | 44303147 | NHIS | 0.25 | - | - | 5 |
| 10 | FORMAN & CAMARILLO | 44303071 | PRIMARY | 0.04 | - | - | 11 |
| 11 | FORMAN S/O RIVERSIDE | 44307055 | PRIMARY | 0.04 | - | 3.2 | 11 |
| 12 | VALLEY SPRING & FORMAN | 44307158 | VSF | 0.02 | 0.05 | - | 12 |

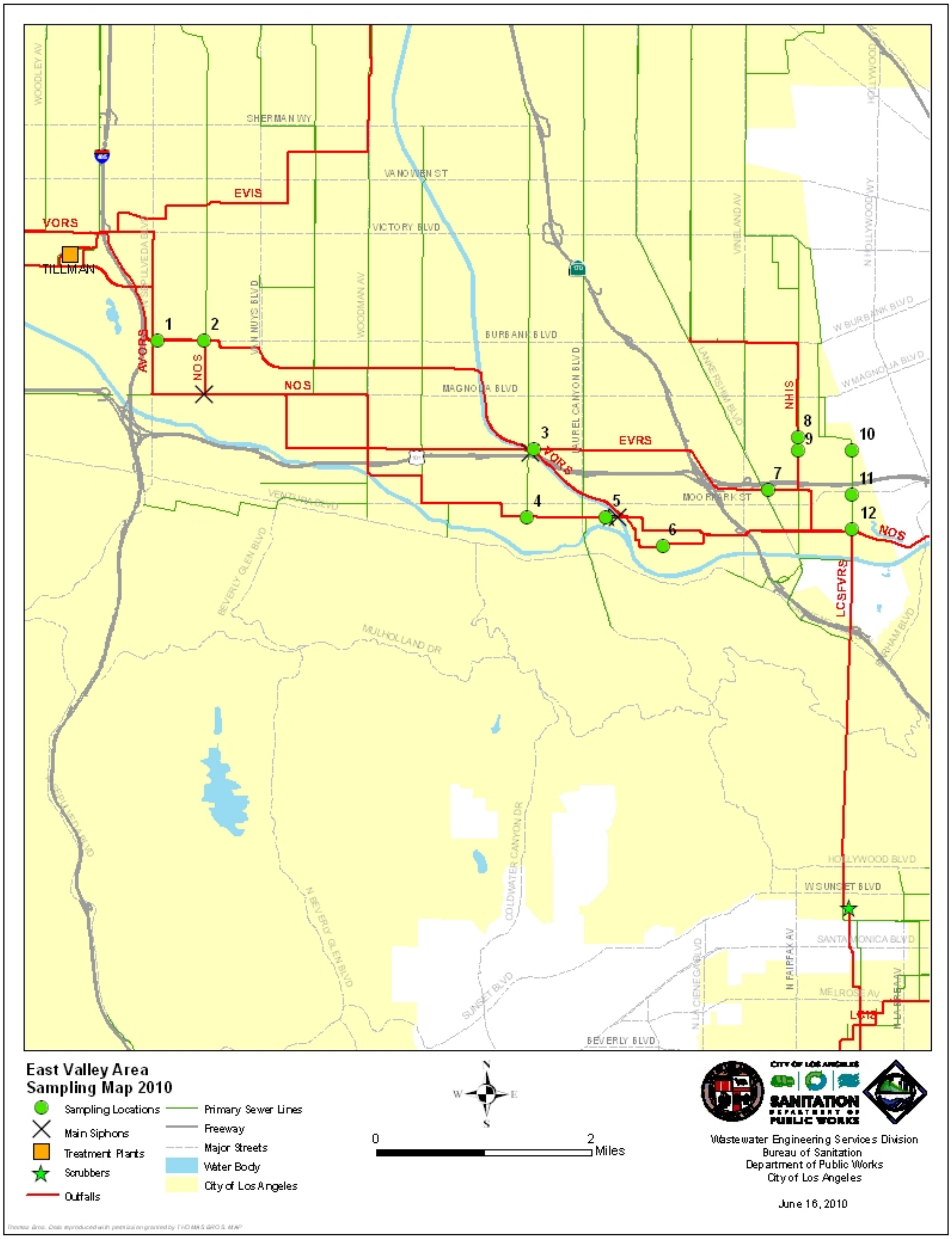

SHERMAN WY
VANOWEN ST
VICTORY BLVD
BURBANK BLVD
MAGNOLIA BLVD
MOORPARK ST
MULHOLLAND DR
HOLLYWOOD BLVD
W SUNSET BLVD
SANTA MONICA BLVD
MELROSE AV
BEVERLY BLVD
EVIS
VORS
TILLMAN
AVORS
NOS
EVRS
NHIS
LCSFVRS
1
2
3
4
5
6
7
8
9
10
11
12
East Valley Area
Sampling Map 2010
Sampling Locations
Main Siphons
Treatment Plants
Scrubbers
Outfalls
Primary Sewer Lines
Freeway
Major Streets
Water Body
City of Los Angeles
0
2
Miles
N
S
W
E
SANITATION
Wastewater Engineering Services Division
Bureau of Sanitation
Department of Public Works
City of Los Angeles
June 16, 2010

**FIG. 9.4**

## DATA ANALYSIS

The VORS sewer has not historically been a problem except for one area near the intersection of Burbank Boulevard and Sepulveda Boulevard. This area was sampled in April, 2010 at two locations. Location 1 at Burbank Boulevard east of Sepulveda had an average pressure of 0.08 inches of water, compared to 0.15 in 2006. Downstream on the VORS at location 2, the average pressure was 0.07.

The NOS was also sampled at several locations with a history of high gas pressure. The average pressures at these locations were between 0 and 0.03, displaying an improvement.

The upstream (westerly) reach of the EVRS had an average pressure of 0.00 and further east on the downstream side the average pressure was 0.22. In 2006, the pressure at this location was 0.02.

The NHIS flows into EVRS at the intersection of Cahuenga and Riverside. Gas pressure was measured in maintenance holes at Cahuenga and Huston (No. 8) and Cahuenga and Camarillo (No. 9). The average pressure at MH 8 was 0.18 compared to 0.05 in 2006. The average pressure at MH 9 was 0.25.

Other measurements were taken on the Forman Avenue Sewer, a 30" primary sewer along Forman Avenue that empties into the LCSFVRS. The average pressure on the upstream reach was 0.04 and on the downstream reach, the average pressure was 0.02.

## CONCLUSION

**VORS:** The average pressures in the VORS were slightly positive.

**NOS:** On average, the pressure in the NOS was generally negative with a few locations slightly positive. The 5,000 cfm scrubber at Woodbridge and Radford is effectively maintaining negative pressure in the NOS upstream of the Radford siphon.

**EVRS**: Gas pressure in the EVRS was positive at tested locations with pressure increasing in the downstream direction. The high gas pressure (0.22 in-wc) at Riverside and Lankershim may possibly be due to turbulence created at the junction with the NHIS. The EVRS also carries the concentrated biosolids from the TWRP. The combination of concentrated biosolids and turbulence would create more gas in the headspace, pressurizing the EVRS and connecting lines.

**NHIS:** Positive pressures were recorded on the NHIS and are mainly attributed to physical characteristics of the sewer line and back pressure from the junction with the EVRS.

**RECOMMENDATIONS/CONSIDERATIONS**

- Continue to monitor this area for pressure and hydrogen sulfide
- Control air flow dynamics through sewer flow management by manipulating sewage flow through various sewers
- Continue monitoring pressure on the EVRS/NHIS and seal maintenance holes where necessary

# 10.0 TECH MEMOS FOR AREAS OF STUDY

## 10.1 South Los Angeles

### INTRODUCTION

In South Los Angeles, the alignment of the NOS, known as the "Maze" area, has historically been an area of high odor emissions and frequent odor complaints. Currently the majority of the wastewater that flows into the Maze sewer system is from various tributaries that service the South Los Angeles areas. All other flows have been diverted to NEIS and ECIS. Since these major diversions, pressures in the Maze system have been reduced.

The South Branch of the NOS picks up flow from the Florence Avenue sewer, 74th Street sewer and Slauson Avenue sewer. The South Branch runs along Martin Luther King Boulevard to Rodeo Road where it intersects the North Branch of the NOS. The North Branch mainly receives flow from the NOS along 41st Place in which most of the flow is from the Boyle Heights area and local flow entering from the 23rd and Trinity area. Most sewers that feed into the Maze South Branch of NOS have very flat slopes and the minimum 3 ft/s scour velocity is rarely met. In this condition, sewers build up with debris and the system becomes anaerobic where H2S production increases. Several construction projects are planned to address this in the near future. Meanwhile, the City monitors the sewers continuously for H2S, pressure, and wastewater pH. There is a 5000 CFM scrubber that operates at the intersection of MLK and Rodeo to clean sewer gases before it is vented into the atmosphere. Caustic shock dosing is conducted to control the generation of hydrogen sulfide along the tributary sewers to the Maze.

This area was sampled around key locations to look for any major changes in pressure since last time it was tested.

## TEST RESULTS

**Table 10.1**
**Monitoring Locations and Results**

| ID | LOCATION | STRUCT. NO. | SEWER | 2010 PRESSURE | 2006 PRESSURE | H2S (ppm) | FLOW (cfs) |
|---|---|---|---|---|---|---|---|
| 1 | San Pedro St Alley w/o San Pedro | 53703199 | NOS | 0.04 | - | - | 72 |
| 2 | TRINITY S/O 23RD ST | 53702211 | NOS | 0.05 | - | - | - |
| 3 | 33RD & TRINITY | 53706186 | NOS | 0.05 | - | - | 0.4 |
| 4 | 41ST PL & TRINITY | 53710078 | NOS | -0.05 | -0.04 | 33.5 | 10 |
| 5 | HYDE PARK E/O HAAS | 55806092 | FLORENCE AV | 0.00 | - | 9.4 | 1 |
| 6 | 62ND E/O WILTON | 55806216 | 74TH ST | 0.00 | - | 2.2 | 22 |
| 7 | 4th Ave N/O Slauson | 55802143 | South Branch Primary | -0.02 | - | - | - |
| 8 | 4th Ave S/O Vernon | 53614020 | South Branch Primary | 0.00 | - | 3.9 | 51 |
| 9 | MLK & Somerset | 53605165 | NOS/Maze South Branch | 0.02 | 0.00 | 37.8 | 62 |
| 10 | Rodeo & Grayburn | 53605166 | NOS/Maze North Branch | 0.00 | - | 33.2 | - |
| 11 | COCHRAN & RODEO | 53503156 | NOS D/S MAZE | 0.01 | -0.09 | 23.8 | 134 |

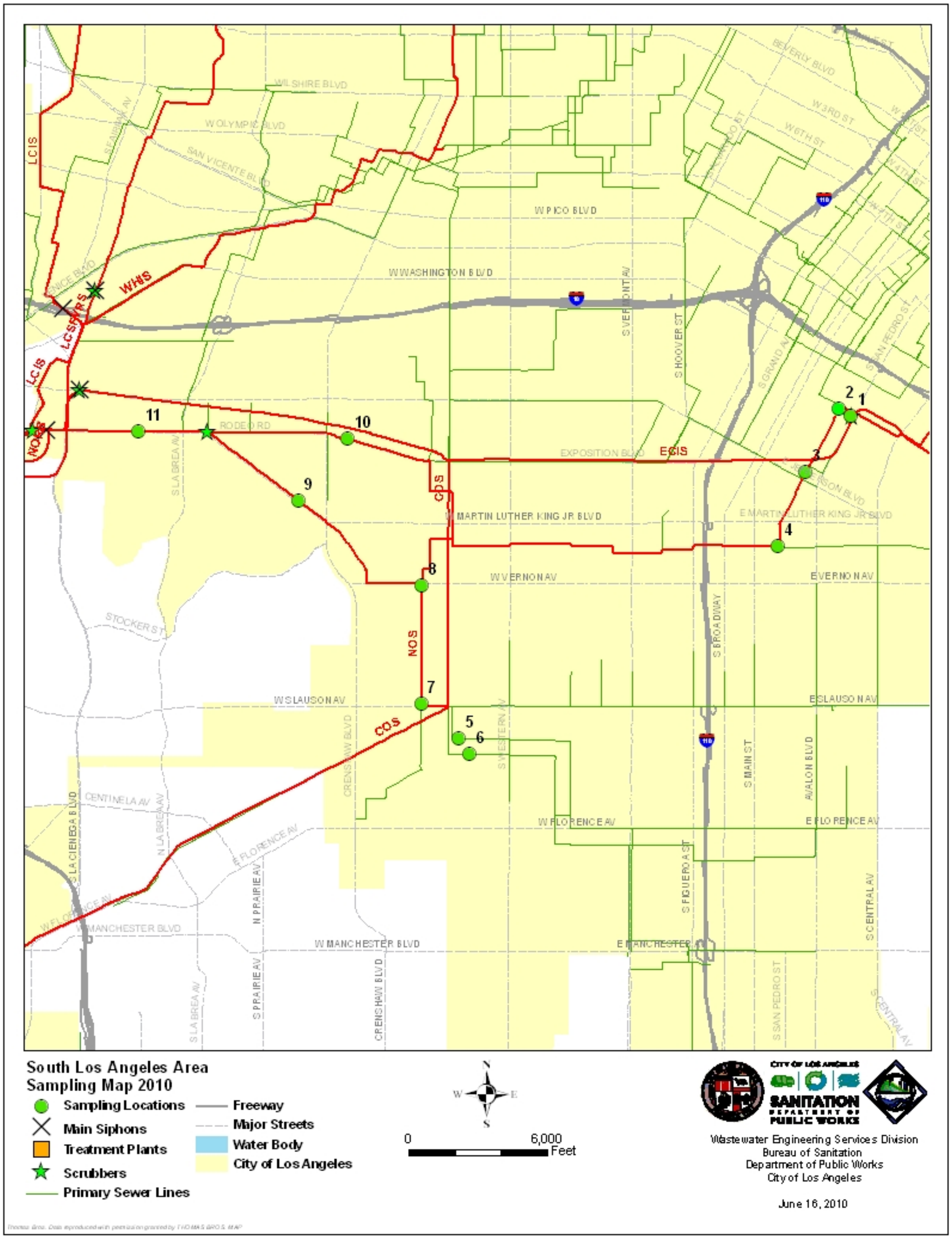

South Los Angeles Area
Sampling Map 2010
Sampling Locations
Main Siphons
Treatment Plants
Scrubbers
Primary Sewer Lines
Freeway
Major Streets
Water Body
City of Los Angeles
0
6,000
Feet
N
S
E
W
Wastewater Engineering Services Division
Bureau of Sanitation
Department of Public Works
City of Los Angeles
June 16, 2010
SANITATION
WILSHIRE BLVD
W OLYMPIC BLVD
SAN VICENTE BLVD
W PICO BLVD
W WASHINGTON BLVD
RODEO RD
EXPOSITION BLVD
MARTIN LUTHER KING JR BLVD
W VERNON AV
E VERNON AV
STOCKER ST
W SLAUSON AV
E SLAUSON AV
CENTINELA AV
W FLORENCE AV
E FLORENCE AV
W MANCHESTER BLVD
E MANCHESTER
S LA BREA AV
S HOOVER ST
S BROADWAY
S MAIN ST
AVALON BLVD
S CENTRAL AV
S FIGUEROA ST
CRENSHAW BLVD
S WESTERN AV
S LA CIENEGA BLVD
LCIS
WHIS
NOS
COS
ECIS
1
2
3
4
5
6
7
8
9
10
11

FIG. 10.1

## DATA ANALYSIS

Average pressure at the most upstream section located at 23rd and San Pedro; just upstream of the drop structure, is 0.04 in/wc. At Trinity south of 23rd Street, average pressure is 0.05 in/wc. Continuing downstream, at 33rd and Trinity, pressure remains at 0.05 in/wc. At location 4 at 41st Place and Trinity, pressure continues to be negative at -0.05 which is almost unchanged from 2006 data, at -0.04 in-wc. Next, the Florence Ave Sewer and 74th Street Sewer were monitored upstream of their diversion into south branch of NOS. Pressures were close to atmospheric at both locations. MHs 7, 8, 9, and 10, pressures varied between -0.02 to 0.02 in-wc. The average pressure at Cochran and Rodeo on NOS was 0.01 compared to 2006 at -0.09.

## CONCLUSION

Short-term, pressures and $H_2S$ levels have been kept under control through continuous monitoring and proactive chemical addition and the on-going operation of a carbon scrubber at the Maze South Branch. Long-term solutions are needed to reduce septic conditions in these sewers.

## RECOMMENDATIONS/CONSIDERATIONS

- Continue to monitor this area for pressure and hydrogen sulfide
- Control air flow dynamics through sewer flow management by manipulating sewage flow through various sewers
- Continue shock dosing Florence Avenue and 74th Street Sewers to reduce $H_2S$ concentration in the South Maze
- Upgrade Trap MHs to stop gas migrating up into local sewers from large, pressurized sewers

## 10.2 Coastal Interceptor Sewer (CIS)

### INTRODUCTION

The Coastal Interceptor Sewer (CIS) is the major outfall serving Venice Westchester area. This area is relatively mountainous in the north, around Pacific Palisades, and relatively flat through Santa Monica and Venice to the south.

The CIS originates at Los Angeles County Sanitation District No. 27. It then follows the coastline along the Pacific Coast Highway, south easterly through Pacific Palisades, to a siphon just upstream of the City of Santa Monica. The CIS serves the coastal area of the Santa Monica Bay north of the HTP to Topanga State Beach near Malibu. This sewer conveys wastewater directly to the HTP from Pacific Palisades, Venice, Mar Vista, the City of Santa Monica, and adjacent areas (such as Marina Del Rey) served by the Los Angeles County Sanitation District no. 27. The CIS is a circular pipeline that ranges in diameter from 24 to 72 inches and is approximately 9.4 miles in length. It is constructed of vitrified clay pipe and reinforced concrete lined with polyvinyl chloride (PVC).

The Venice Pumping Plant is the largest pumping plant in the wastewater collection system, and the only pumping plant located on one of the wastewater collection system outfalls. The Venice Pumping Plant is located at the south end of Venice on the CIS, at Hurricane Street and the Grand Canal. The pumping plant was constructed in 1958, and modified in 1987 and again in 1997 to increase its capacity and reliability. The pumping plant currently has a theoretical capacity of 99 cfs with four pumps operating and one pump on standby. The pumping plant discharges into the CIS through a 48-inch-diameter force main extending south across the Marina Del Rey harbor entrance channel.

## TEST RESULTS

**Table 10.2**
**Monitoring Locations and Results**

| ID | LOCATION | STRUCT. NO. | SEWER | 2010 PRESSURE | 2006 PRESSURE | FLOW (cfs) |
|---|---|---|---|---|---|---|
| 1 | PCH | 52115303 | CIS | -0.09 | - | 6 |
| 2 | PCH | 53203005 | CIS | -0.02 | 0.01 | 5 |
| 3 | PCH & ENTRADA | 53203016 | CIS | - | 0.01 | 5 |
| 4 | PCH | 53203029 | CIS | -0.03 | 0 | 10 |
| 5 | MAIN ST (SANTA MONICA) | 53314073 | CIS | 0.00 | 0 | - |
| 6 | MAIN ST (SANTA MONICA) | 53314072 | CIS | 0.00 | - | - |
| 7 | VIA DOLCE R/W | 56111066 | CIS | 0.00 | 0 | 76 |
| 8 | VISTA DEL MAR | 56208041 | CIS | -0.82 | 0.03 | 78 |
| 9 | VISTA DEL MAR | 56313039 | CIS | -0.73 | 0.03 | 77 |

## DATA ANALYSIS

Instantaneous pressure readings were taken along CIS in April, 2010. Pressures were generally negative on the upstream to very negative in the downstream part of CIS.

## CONCLUSION

The test indicated that sewer gas pressure in this area is generally near or below atmospheric level and pressure is not currently a problem in this sewer

## RECOMMENDATIONS/CONSIDERATIONS

- Continue to monitor this area for pressure and hydrogen sulfide
- Control air flow dynamics through sewer flow management by manipulating sewage flow through various sewers


Coastal Interceptor Sewer (CIS)
Sampling Map 2010
Sampling Locations
Main Siphons
Treatment Plants
Scrubbers
Outfalls
Primary Sewer Lines
Freeway
Major Streets
Water Body
City of Los Angeles
0
10,000
Feet
HYPERION
WLAIS
NCOS
NORS
COS
CIS
Wastewater Engineering Services Division
Bureau of Sanitation
Department of Public Works
City of Los Angeles
June 16, 2010

**FIG. 10.2**

# 10.3 Harbor Area

## INTRODUCTION

This section discusses the pressure test conducted in the Harbor Area Primary Sewer System in April of 2010. There are four interceptor sewer systems in the Harbor area that convey the wastewater generated in this area to the Terminal Island Treatment Plant. The interceptor sewer systems are named after their respective force mains through which their flow is pumped to the TITP.

Fries Avenue Interceptor Sewer System (FISS), consists of three major pumping plants and their respective interceptor sewers, all of which serve the community of Wilmington. The FISS also serves various industrial dischargers, some of which are on Harbor Department property.

Terminal Way Interceptor Sewer System (TISS) collects and transports wastewater from the San Pedro area to the TITP. The TISS also serves the industrial area south of 22nd Street and Terminal Island. The main pumping plant on this system is the Terminal Way Pumping Plant.

San Pedro Interceptor Sewer System (SPISS) serves the residential areas of San Pedro and Wilmington and the industrial area consisting primarily of the Phillips Conoco Refinery. It also serves some industrial discharges located on Harbor Department property.

A supplement to this system allows all flows from the FISS to be diverted to the San Pedro Pumping Plant. The only exception to this is that the flow from the Harris Avenue Pumping Plant remains tributary to TITP via the Fries Avenue Force Main.
The "U.S. Navy Sewer System and Facility" consists of four separate force mains (two 6", one 12", and one 20"), a pumping plant, and collector sewers that used to serve the U.S. Naval Reservation on Terminal Island. After the decommissioning of the U.S. Navy, the City of Long Beach took over the assets of the US Navy Sewer System and Facility that deliver the wastewater to the TITP.

## TEST RESULTS

**Table 10.3**
**Monitoring Locations and Results**

| ID | LOCATION | STRUCT. NO. | SEWER | 2010 PRESSURE | 2006 PRESSURE | FLOW (cfs) |
|---|---|---|---|---|---|---|
| 1 | ALAMEDA N/O F ST | 61311139 | HARBOR | -0.01 | 0 | 1 |
| 2 | MCFARLAND AV R/W | 61311112 | HARBOR | 0.00 | 0.002 | 4 |
| 3 | B ST | 61313048 | HARBOR | 0.00 | 0 | 3 |
| 4 | WILMINGTON & SAN PEDRO | 61908038 | HARBOR | -0.09 | 0.001 | 0.2 |
| 5 | CHANNEL ST | 61908083 | HARBOR | 0.00 | -0.004 | 5 |
| 6 | PACIFIC AV | 62005014 | HARBOR | 0.02 | - | 7 |
| 7 | HARBOR BL | 62009041 | HARBOR | 0.02 | 0 | 0 |
| 8 | PACIFIC AV | 62516010 | HARBOR | -0.02 | 0 | 0.4 |
| 9 | CRESCENT AV R/W | 62401114 | HARBOR | 0.01 | -0.001 | 0.5 |
| 10 | HARBOR BL R/W | 62013030 | HARBOR | 0.01 | 0 | 3 |

## DATA ANALYSIS

Instantaneous pressures were taken on May 2010 in the Harbor area. Pressures varied between -0.09 and 0.02. This data is fairly similar to conditions in 2006.

## CONCLUSION

The test indicated that sewer air pressure in this area is generally near atmospheric level.

## RECOMMENDATIONS/CONSIDERATIONS

- Continue to monitor this area for pressure and hydrogen sulfide
- Control air flow dynamics through sewer flow management by manipulating sewage flow through various sewers

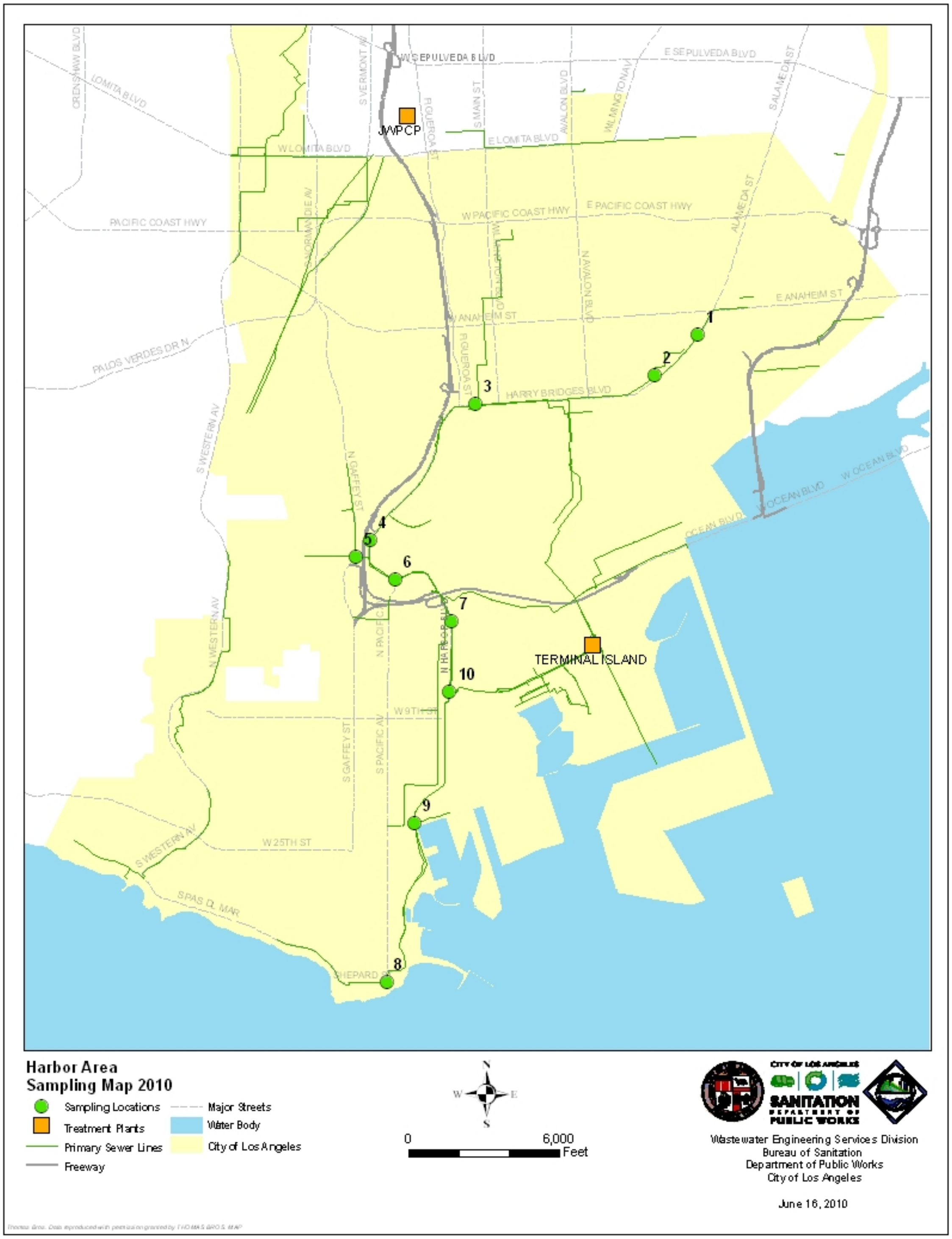

Harbor Area
Sampling Map 2010
Sampling Locations
Treatment Plants
Primary Sewer Lines
Freeway
Major Streets
Water Body
City of Los Angeles
JWPCP
TERMINAL ISLAND
0
6,000
Feet
Wastewater Engineering Services Division
Bureau of Sanitation
Department of Public Works
City of Los Angeles
June 16, 2010

**FIG. 10.3**

## 10.4 West Valley Area

### INTRODUCTION

This section discusses the pressure test conducted in the West San Fernando Valley Area sewers in April, 2010. Wastewater generated in the west valley is conveyed to four interceptor sewers: the North Outfall Sewer (NOS), the Valley Outfall Relief Sewer (VORS), the Additional Valley Outfall Relief Sewer (AVORS), and the East Valley Interceptor Sewer (EVIS). Most of the wastewater flow is routed to the Tillman Water Reclamation Plant (TWRP).

### TEST RESULTS

**Table 10.4**
**Monitoring Locations and Results**

| ID | LOCATION | STRUCT. NO. | SEWER | 2010 PRESSURE | 2006 PRESSURE | FLOW (cfs) |
|---|---|---|---|---|---|---|
| 1 | VANOWEN & MASON | 39614176 | VORS | 0.00 | -0.001 | 2 |
| 2 | VANOWEN & ETIWANDA | 39714176 | VORS | 0.00 | - | 13 |
| 3 | VICTORY E/O ETIWANDA | 43002139 | AVORS | 0.07 | 0.04 | 36 |
| 4 | WOODMAN & HART | 39914195 | EVIS | 0.02 | - | 33 |
| 5 | VICTORY & HASKELL | 42902209 | EVIS | 0.03 | 0.02 | 63 |

### DATA ANALYSIS

Instantaneous gas pressures readings were taken in April, 2010 in the western part of San Fernando Valley. Pressures were generally around atmospheric level in the VORS, and EVIS sewers. Location 3 on the AVORS at Victory Bl. east of Etiwanda had an average pressure of 0.07. This MH is upstream of a siphon.

### CONCLUSION

The test indicated that sewer air pressure in this area is generally near atmospheric level. Because of the nearby siphon, Location 3 has the highest pressure in this area and should be monitored for any changes in pressure.

### RECOMMENDATIONS/CONSIDERATIONS

- Continue to monitor this area for pressure and hydrogen sulfide, especially near Victory and Etiwanda
- Control air flow dynamics through sewer flow management by manipulating sewage flow through various sewers

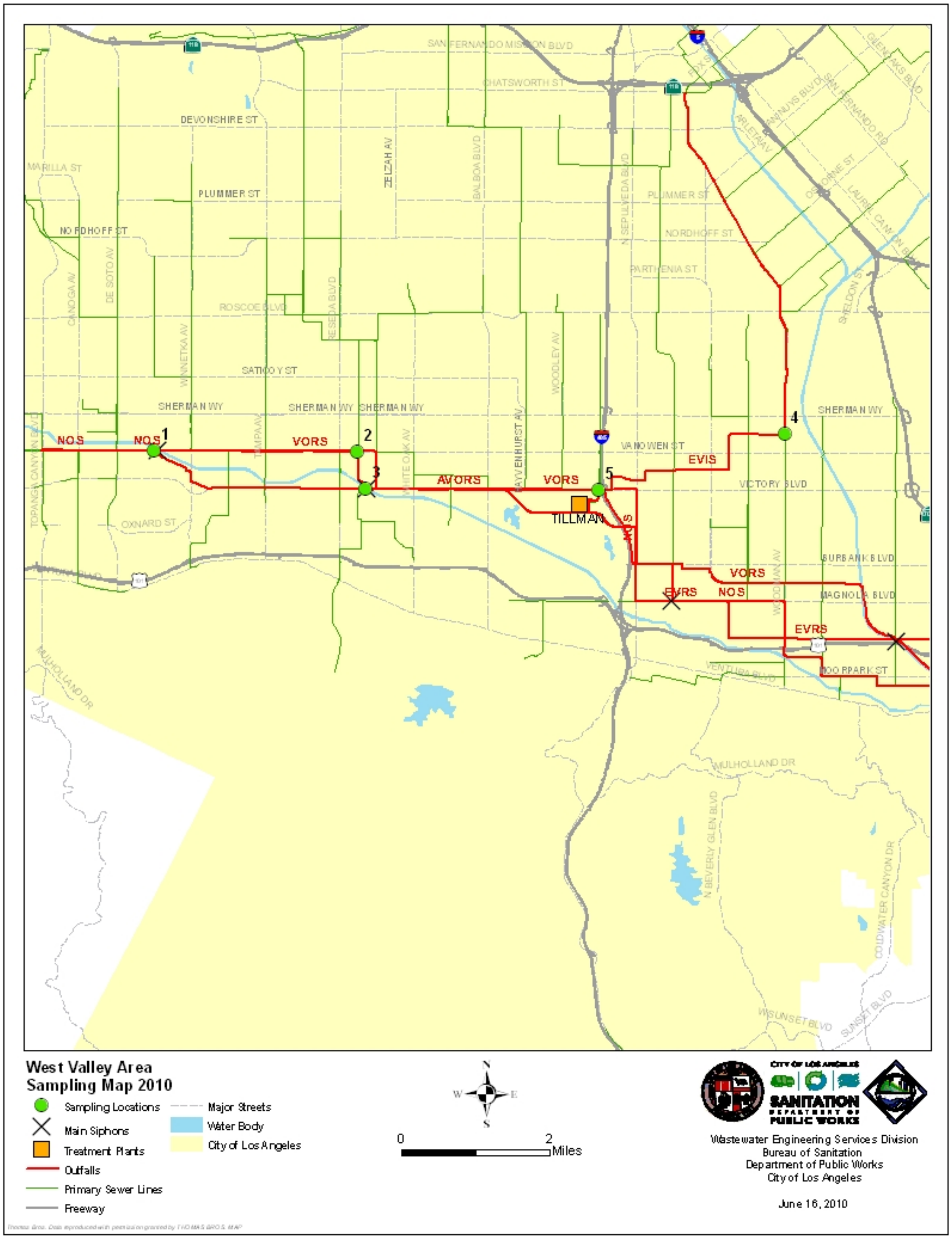

West Valley Area
Sampling Map 2010
Sampling Locations
Main Siphons
Treatment Plants
Outfalls
Primary Sewer Lines
Freeway
Major Streets
Water Body
City of Los Angeles
0
2
Miles
Wastewater Engineering Services Division
Bureau of Sanitation
Department of Public Works
City of Los Angeles
June 16, 2010
NOS
VORS
AVORS
EVIS
EVRS
TILLMAN
SHERMAN WY
VICTORY BLVD
VANOWEN ST
BURBANK BLVD
MAGNOLIA BLVD
MULHOLLAND DR
DEVONSHIRE ST
PLUMMER ST
NORDHOFF ST
ROSCOE BLVD
SATICOY ST
OXNARD ST

FIG. 10.4

## 10.5 Miscellaneous Locations

### INTRODUCTION

In order to have a more complete study, some random locations were monitored along the NOS and COS upstream of the Hyperion Treatment Plant although no odor problems have been reported in the area.

### TEST RESULTS

**Table 10.5**
**Monitoring Locations and Results**

| ID | LOCATION | STRUCT. NO. | SEWER | 2010 PRESSURE | FLOW (cfs) |
|---|---|---|---|---|---|
| 1 | LA BREA & JUNIPER DMV PARKING | 55915008 | COS | -0.06 | 0.002 |
| 2 | LMU D/S SIPHON | 56014059 | NOS | -1.05 | 128 |
| 3 | CABORA DR & SINALOA RD | 56301221 | NOS | 0.00 | 128 |
| 4 | PERSHING N/O REES | 56301209 | NOS | -0.02 | 128 |

### DATA ANALYSIS

Instantaneous pressure readings taken on the NOS between the 405 siphon and Hyperion were negative.  An instantaneous pressure reading on the COS was -0.06.  Currently, the COS is being rehabilitated and there is no flow in this sewer.

### CONCLUSION

The test indicated that sewer air pressure in this area is generally negative to near atmospheric level.

### RECOMMENDATIONS/CONSIDERATIONS

- Continue to monitor this area for pressure and hydrogen sulfide
- Control air flow dynamics through sewer flow management by manipulating sewage flow through various sewers


Outfalls Upstream of Hyperion
Sampling Map 2010
Sampling Locations
Main Siphons
Treatment Plants
Scrubbers
Outfalls
Primary Sewer Lines
Freeway
Major Streets
Water Body
City of Los Angeles
0
6,000
Feet
HYPERION
NCOS
NOS
COS
NORS
CIS
1
2
3
4
Wastewater Engineering Services Division
Bureau of Sanitation
Department of Public Works
City of Los Angeles
June 16, 2010

**FIG. 10.5**

# 11.0 FURTHER STUDIES AND INVESTIGATIONS

## 11.1 ATF Study

This study is analyzing the air flow dynamics in the wastewater collection system in order to evaluate the need for five planned Air Treatment Facilities and consider alternatives to insure the best possible solution. Work entails creating an air-flow modeling study of the collection system, a study of drop structures' effects on sewer odors, a study of non-methane hydrocarbons associated with sewage, and a study of siphons' effects on sewer air pressure.

The constructions of the five ATFs have been put on hold pending the outcome of this study. This study will impact the schedule and probably the scope of the ATF program.

## 11.2 NORS Siphon Feasibility Study

This is a scoping study that resulted in a feasibility report on various alternatives for improving sewer air movement at the NORS siphon under the 405 Freeway. Five alternatives were investigated.

1. New single air jumper line
2. Place fan in existing air jumper line
3. Place ATF at siphon inlet
4. Install interceptor airline connecting NORS to NCOS
5. Flow management and upsize existing ATFs

The study concluded that only Options 3, 4, and 5 were feasible, considering cost and technical factors. How the city develops these alternatives in the most efficient and cost effective ways will be discussed more in upcoming reports.

## 11.3 CIS – Chautauqua Pump Plant

As a result of odor complaints made by residents of Pacific Palisades during a community meeting, WCSD and WESD staff investigated the sewers in the vicinity of PCH and Temescal Canyon Road. The investigation focused on the pump plant at PCH and Chautauqua Boulevard. The lid for MH 532-03-007 at the pump plant force main rattles and jumps within its frame when the pumps are running allowing a significant ventilation of odors. We recommended that a sealable lid be constructed for this location as well as the two MH lids upstream of the Temescal Pumping Plant.

# 12.0 RECOMMENDATIONS/CONSIDERATIONS

To meet immediate odor control needs, the City will continue all current odor control activities including odor complaint response and investigation, routine sewer maintenance, chemical addition, air withdraw and treatment using scrubbers, sewer construction and repair, trap MH replacement program, and on-going monitoring of sewer air pressure and $H_2S$ concentration.

Continuous pressure testing equipment will be used to perform long-term pressure and $H_2S$ tests through the system in order to gather more accurate and more comprehensive pressure data of the sewer system. Additionally, pressure testing will be performed wherever pressure problems arise or where there are special circumstances where valuable information can be gained. Spot testing will continue as well throughout the system to allow thorough monitoring of the collection system.

The use of air scrubbers at various locations in the collection system has helped reduce the release of odors in known problem areas. The diversion of flow from the NORS back to the NOS in the Culver City area has helped decrease the pressure in the NORS and ECIS. Since these diversions, the City has been testing sewers we suspect will be affected by these flow changes to determine what else will help relieve pressure in NORS.

The most significant effort currently underway is the ATF Study that is evaluating the ATF implementation program in light of experiences encountered with the scrubbers. This is a multi-faceted study that is being carried out by a team led by HDR Engineering. It includes analysis of siphons, drop structures, non-methane hydrocarbons, and the proposed ATFs. It will also help the City produce our first computer model of the air dynamics within the sewer system.

The use of ATFs at the 23rd & San Pedro, Mission & Jesse, Humboldt, and Richmond sites will be assessed in the ATF study. The ultimate purpose of the study is to ensure that the solutions proposed, and ultimately constructed, are the optimal solution and the best use of funds for mitigating sewer odors.

The implementation plan is developed with the intention to provide immediate needs while satisfying long-term requirements. Table 12.1 presents the implementation plan for the various odor control projects and programs either already underway or recommended by this master plan.

Table 12.2 presents project cost data obtained from the WCIP Project Description and 10-Year Expenditure Plan 2006/07 – 2015/16.

The Sewer Odor Control Master Plan will be updated annually to assure that odor control strategies/measures are periodically challenged, solutions remain proactive, and technologies are current and effective.

**TABLE 12.1**
**ODOR CONTROL IMPLEMENTATION PLAN**

| | Short-term Plan | Intermediate Plan | Long-term Plan |
|---|---|---|---|
| East NOS Corridor | - Continue to Monitor<br>- Flow Mngment<br>- Review LAG TP solids discharge schedule | - Continue to Monitor<br>- Flow Mngment<br>Study Possible Considerations<br>- Scrubber @ Gilroy Siphon<br>- Add Airline to Gilroy Siphon<br>- Extend Local Sewer | - Continue to Monitor<br>- Flow Mngment<br><br>Relief Sewer<br>- NEIS 2 |
| La Cienega / San Fernando Corridor | - Continue to Monitor<br>- Flow Mngment<br>- Continue Chemical Injection at Tillman<br>- Conduct pressure test around Genesee Siphon<br>- Monitor WHIS near confluence of major lines | - Continue to Monitor<br>- Flow Mngment<br>- Monitor for any pressure change post ATF start up<br>- Upgrade Trap MHs<br><br>Study Possible Considerations<br>- Up-size Genesee Siphon Scrubber<br>- Additional Airline @ Genesee Siphon | - Continue to Monitor<br>- Flow Mngment |
| Baldwin Hills / Culver City Area | - Continue to Monitor<br>- Flow Mngment<br>- Monitor for pressure change post ATF start up<br>- Analyze airflow dynamics as a result of NORS Divs. 1, 2 and 3 air curtain | - Continue to Monitor<br>- Flow Mngment<br>- Upgrade Trap MHs<br>- Identify long term plan for NORS siphon | - Continue to Monitor<br>- Flow Mngment<br>- Upgrade Trap MHs |
| East Valley Area | - Continue to Monitor<br>- Flow Mngment<br>- Continue pressure and H2S monitoring on EVRS/NHIS<br>- Seal maintenance holes where necessary | - Continue to Monitor<br>- Flow Mngment<br>- Upgrade Trap MHs | - Continue to Monitor<br>- Flow Mngment<br>- Upgrade Trap MHs<br><br>Relief Sewer<br>- GBIS |

| | Short-term Plan | Intermediate Plan | Long-term Plan |
|---|---|---|---|
| South Los Angeles | - Continue to Monitor<br>- Flow Mngment<br>- Continue shock dosing Florence Ave Sewer & 74th St Sewer to reduce H2S conc. in S Maze<br>- Upgrade Trap MHs<br>- Continue monitoring for pressure and H2S | - Continue to Monitor<br>- Flow Mngment<br>- Upgrade Trap MHs<br>- Divert S. Los Angeles tributaries from South branch back to COS after re-hab completion | - Continue to Monitor<br>- Flow Mngment |
| Coastal Interc. Sewer (CIS) | - Continue to Monitor<br>- Flow Mngment | - Continue to Monitor<br>- Flow Mngment | - Continue to Monitor<br>- Flow Mngment<br>- Upgrade Trap MHs |
| Harbor Area | - Continue to Monitor<br>- Flow Mngment | - Continue to Monitor<br>- Flow Mngment | - Continue to Monitor<br>- Flow Mngment |
| West Valley Area | - Continue to Monitor<br>- Flow Mngment | - Continue to Monitor<br>- Flow Mngment<br>- Re-visit AVORS siphon for any change | - Continue to Monitor<br>- Flow Mngment<br>- Upgrade Trap MHs |
| Review of ATF program | ATF Review Study to assess the ATFs effectiveness | Possible Construction of ATFs | Operate ATFs |
| Odor Hotline Outreach | On-going | On-going | On-going |

**TABLE 12.2**
**ODOR CONTROL PROJECT/PROGRAM COST**

| Title | Estimated Cost ($) | Estimated Completion Date |
|---|---|---|
| ATF ECIS - 23rd & San Pedro | 17,896,420 | On-Hold |
| | | |
| ATF ECIS – La Cienega & Jefferson | 10,402,880 | 2011 |
| | | |
| ATF ECIS – Mission & Jesse | 6,060,260 | On-Hold |
| | | |
| ATF NCOS Siphon | 17,325,840 | 2012 |
| | | |
| ATF NEIS – Humboldt & SF | 9,335,120 | On-Hold |
| | | |
| ATF NEIS – Richmond St | 7,919,610 | On-Hold |
| | | |
| ATF NORS | 9,382,700 | On-Hold |
| | | |
| Odor Control - Hollydale Sewer | 4,191,300 | 2010 |
| | | |
| Sierra Bonita Scrubber | 365,000 | 2009 |
| | | |
| Woodbridge Scrubber Relocation | 355,200 | 2009 |
| | | |
| Chemical Treatment Application | 3,515,000/yr | On-going |
| | | |
| 14 Scrubbers (Operations & Maintenance) | 1,615,000/yr | On-going |
| | | |
| Trap Maintenance Hole Program | 3,100,000 | 2013 |
| | | |
| Outreach | 50,000/yr | On-going |
| | | |
| Odor Control – Future | 1,000,000/yr | On-going |

Source: WCIP Project Description and 10-Year Expenditure Plan 2006/07 – 2015/16

# 13.0 Short History of Previous Tests

**2003 ECIS/NORS/NCOS Fan Test Report**

A Fan Test was conducted during the week of April 28, 2003. Three temporary air withdrawal facilities were installed at future ATF sites. Each air withdrawal facility was equipped with a variable-speed fan capable of withdrawing 10,000, 7,500, and 5,000 cubic feet of air per minute. The air withdrawn by the fans was filtered through carbon scrubbers in order to reduce odor complaints. The twelve air pressure data loggers were again installed in the same maintenance holes for one week. Air was withdrawn simultaneously from the three sites using all possible combinations of 5000, 7500, and 10000 cfm for each reach. The test results showed significant pressure reductions at 10 of the 12 locations when compared to the initial test data taken in the spring of 2001. The locations where significant air pressure reductions were not achieved were the areas near the Hyperion Treatment Plant and upstream of the Maze system. These locations were several miles downstream and upstream; respectively, of the air withdrawal locations. The most effective air withdrawal condition was when all three fans were withdrawing 10,000 cfm simultaneously. The ECIS/NORS/NCOS Fan Test Report dated July 2003 discussed in detail the Fan Test.

**2006 NORS Siphon Fan Test**

This test was conducted for 3 weeks in November 2006, to better understand the effect of back pressure caused by this siphon. A 20,000 CFM fan with variable speed was placed upstream of the siphon. The fan was to vacuum sewer gas; through a scrubber, starting at 10,000 CFM and incrementally increase capacity to the maximum of 20,000 CFM. Monitors were placed in other systems upstream to this siphon to show if these systems were impacted by NORS siphon back pressure. The results showed that pressure was immediately reduced closest to the scrubber and this effect was extremely small further away from the source, with no change at all in the other systems. In conclusion we were left with more questions as to whether running the fan for a longer period of time would have given a different set of results.

**2006 Mission and Jesse Drop Structure Test and Effect of the Carbon Scrubber**

The East Central Interceptor Sewer (ECIS) drop shaft structure receives flow diverted from the North Outfall Sewer (NOS) where flow plunges approximately 60 feet to the ECIS. The turbulence will cause sewer gases to escape from MHs or migrate to connecting sewers causing odor complaints. A 10,000-cfm interim scrubber was placed to alleviate air pressures. A year prior to ECIS, there were no odor complaints filed; however, eighteen complaints were filed in the 21 months following the commissioning of ECIS in August 2004. This test was to quantify the pressure impact the drop structure contributes without the 10,000 cfm interim carbon scrubber. The resulting pressure data indicated that the ECIS drop shaft structure generates significant air pressure to cause changes in the air dynamics within the sewer. If no changes are seen in the foreseeable future then a permanent air treatment facility will be needed to alleviate air pressures within the sewer system and control odor complaints.

**2007 Humboldt Diversion Test**

This test was to assess the pressure in the NOS, NEIS and ECIS from Humboldt to 23rd and San Pedro and to establish a "Base Line" data pressure prior to diversion as well as post diversion. A through study analysis of pressure data before and after the diversion concluded that the decreased flow in NOS due to diversion reduced the pressure in the NOS in the Humboldt area ( Expected), however, a significant increase in pressure was recorded at NOS near Mission and Jesse area ( unexpected). That pressure is directly related to increased flow in NEIS with added turbulence at the ECIS/NEIS junction and the ECIS Drop structure. All five sites at Mission and Jesse followed the same trend of pressure diurnals for the same testing periods which indicate that the drop structure is causing a back pressure as well as pushing pressure into ECIS at 7$^{th}$ and Santa Fe hundredth of feet on the downstream leg of ECIS, the same can be said about NOS d/s of the Drop Structure. Analyzing the pressure at 23$^{rd}$ and San Pedro area concluded the same pressure dynamics as Mission and Jesse as far as added flow to ECIS which added pressure to all confluent MHs in that area; namely the NOS. This test and the pressure dynamics at 23$^{rd}$ and san Pedro created a need to look at ECIS under the new conditions from 23$^{rd}$ and San Pedro to NORS Siphon.

**2008 23$^{rd}$ and San Pedro Ventilation Study**

This study assessed the impact of the carbon scrubber located at the southwest corner of 23$^{rd}$ Street and San Pedro Street. This drop structure directs sewage from NOS into ECIS. The scrubber has been turned off since October 31$^{st}$, 2006 and the City is considering removing it. The ventilation dynamics within the East Central Interceptor Sewer (ECIS) and the North Outfall Sewer (NOS) in the vicinity of this drop structure was studied. Sealing off the carbon scrubber was found to have drastically lowered the air pressure in the NOS which had been greatly affected by back pressure from the ECIS ventilating up through the drop structure. We cannot explain why sealing the scrubber would so significantly impact the movement of gas through the drop structure. Sewer odors were not present in the general vicinity of the scrubber since it was sealed. This along with the results of the pressure tests would indicate that removing the carbon scrubber from 23$^{rd}$ and San Pedro will not cause an increase in sewer pressure or odor complaints.

**2008 Baldwin Hills Pressure Test**

The City has several on-going odor control measures in this area. Sewer pressure and odor complaints have begun to rise after a period of decline. This pressure study is part of a larger effort to determine why. This test monitored gas pressure and hydrogen sulfide ($H_2S$) levels within the sewers in the Baldwin Hills and South L.A. areas. By evaluating the pressures, we hoped to determine some specific causes of sewer gas pressure in this region. This test monitored pressure within the NORS, NOS, NCOS, LCSFVRS, and ECIS. One particular goal was to try to determine the effect the restricted airline at the NORS siphon has on gas pressure in the NORS and nearby sewers. The results of the pressure monitoring showed that the choke point at the NORS siphon influences pressure in the NORS and ECIS. NORS backpressure also influences, to different degrees, the other interconnecting sewers as was shown by a later pressure testing after the Blackwelder diversion of LCIS and LCSFVRS to ECIS (July 2009). The negative pressure in the NCOS is not understood as yet.